STATE OF OHIO

ANNUAL WATER QUALITY REPORT

Submitted Pursuant to the Requirements of

Section 305(b),

Federal Water Pollution Control Act Amendments of 1972

May, 1978

The Ohio Environmental Protection Agency
Columbus, Ohio 43215

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INTRODUCTION

This document is the third annual water quality report prepared by the Ohio Environmental Protection Agency (Ohio EPA).

1. Purpose of Report

Section 305 (b) of the 1972 Federal Water Pollution Control Act Amendments (Public Law 92-500) requires that each state submit an annual water quality report to the Administrator of the Federal Environmental Protection Agency. The report should include:

1) A description of the water quality during the preceding year of all navigable waters in the state (October through September);
2) An analysis of the extent to which all navigable waters of the state provide for the protection and propogation of a balanced population of shellfish, fish, and wildlife, and allow recreational activities in and on the water;
3) An analysis of the extent to which elimination of the discharge of pollutants will accomplish these objectives;
4) An estimate of the economic and social costs and benefits associated with the Act;
5) A description of the nature and extent of nonpoint sources of pollutants and recommendations for programs to control each category of sources, including an estimate of the costs of implementing such programs.

2. Organization

As requested by the U.S. EPA, this report concentrates on information and data obtained in water year 1976 (October through September). Earlier data was only included where significant trends have been noted. For

each water quality situation, a general sketch of the state of affairs in Ohio is presented.

In general, the comments given are developed from the data collected from each of the water quality monitoring stations. The sampling program from which the data is obtained is described in Section 3. A tabulation of the data collected in the Primary Water Quality Monitoring Network (PWQMN) is presented in Appendix 1. PWQMN data and the individual basin reports are the principal sources of information for the body of this report. Summary reports on field biological investigations and the Ohio Lakes Program are included. Funds required for the State of Ohio to meet Federal Water Quality Goals are presented.

3. Program of Water Quality Inventory

To sample Ohio waters, 91 primary water quality monitoring stations have been established throughout the state using several criteria, such as monitoring water quality upstream and downstream of major dischargers, or placement of monitoring stations where there may be any significant changes in water quality. Also, water quality in the upper reaches of a stream is measured as a reference for the natural stream conditions. High quality use areas are monitored. Measurements are also taken from streams entering from another state.

Particular placement of the 91 stations is left to the professional judgement of Ohio EPA district personnel. Specific criteria used are: availability of historical data at specific stream locations; ability to get a representative stream sample; and physical characteristics of the site.

In addition to the 91 primary stations, there are an additional 56 secondary water quality stations. These stations are located between

primary water quality stations where there is a specific data gap, and where additional data on relatively simple measured parameters can be collected. The purpose of each water quality station, whether it be primary or secondary, is to obtain indicator tests of water quality. By the original Ohio EPA guidelines, each primary station is sampled for 24 parameters on a monthly basis and for 23 additional parameters on a quarterly basis. Table 1 lists those parameters and their significance. Figure 1 shows the location of each of the primary stations, while Table 2 lists each primary station.

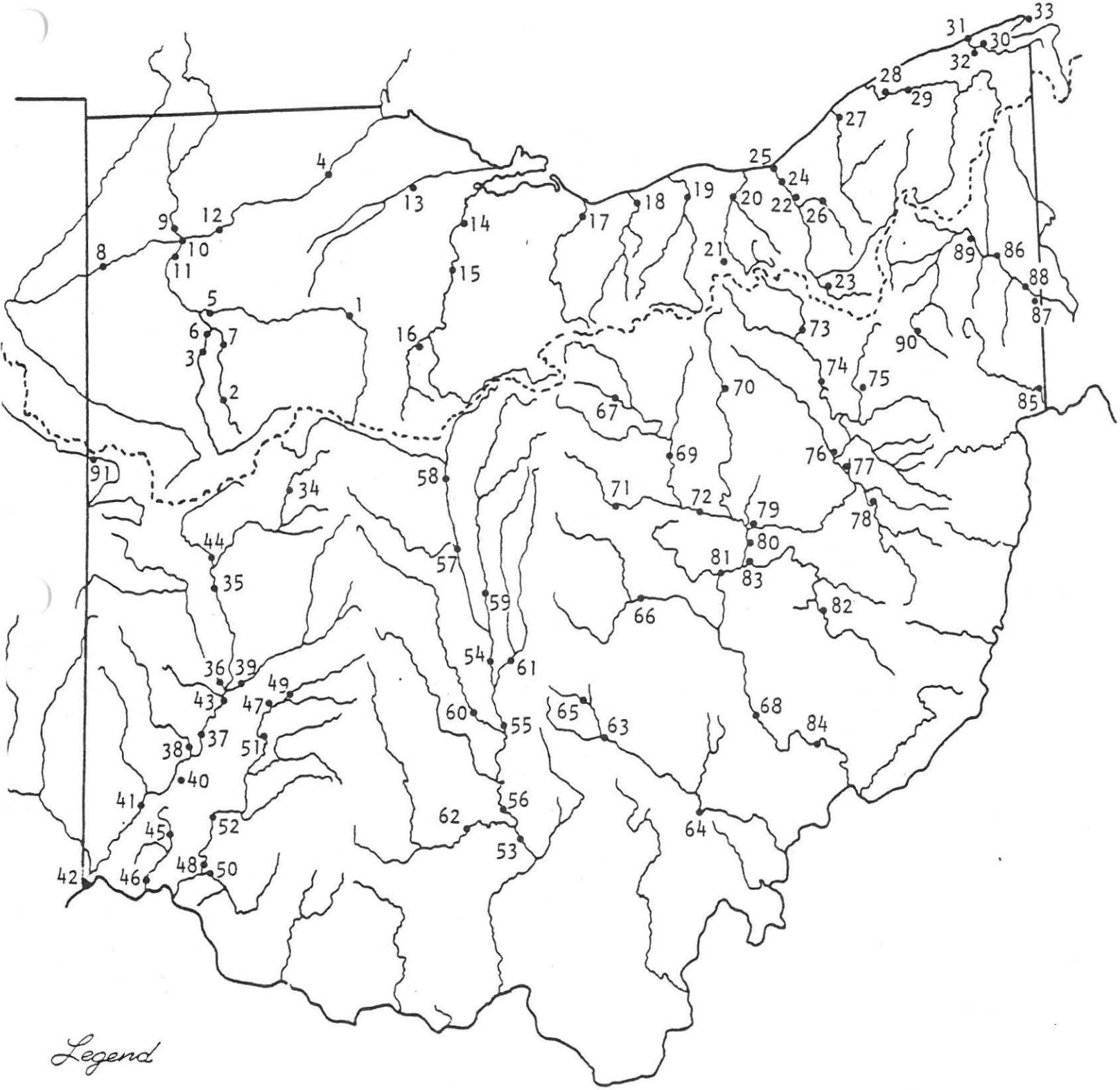
TABLE 1

Ohio EPA Primary Station Parameters

MONTLY	QUARTERLY
1. Flow (U.S.G.S.)	1. Alkalinity, Total, CaCO3
2. Water Temperature (field)	2. Acidity, Total, CaCO3
3. pH (field)	3. Hardness, Total, CaCO3
4. Dissolved Oxygen (field)	4. Sulfate, SO4
5. Conductivity (field)	5. Fluoride, Diss., F
6. Turbidity	6. Calcium, Total, Ca
7. Residue, Total Nflt. (Susp.)	7. Magnesium, Total, Mg
8. Residue, Total Flt. (Diss.)	8. Potassium, Total, K
9. Residue, Total	9. Sodium, Total, Na
10. Total Kjeldahl Nitrogen	10. Arsenic, Total As
11. Nitrogen, Ammonia, N	11. Barium, Total, Ba
12. Nitrite, N	12. Cadmium, Total, Cd
13. Nitrate, N	13. Chromium, Total, Cr
14. Phosphorus, Dissolved, P	14. Chromium, Hex, Cr
15. Phosphorus, Total, P	15. Copper, Total, Cu
16. Chloride, Cl	16. Iron, Total, Fe
17. BOD, 5 day	17. Lead, Total, Pb
18. COD	18. Manganese, Total, Mn
19. Carbon, Total Org., C	19. Mercury, Total, Hg
20. Cyanide	20. Selenium, Total, Se
21. MBAS	21. Silver, Total, Ag
22. Phenols	22. Zinc, Total, Zn
23. Fecal Coli, Total, MF	23. Oil-grease, Total
24. Fecal Strep, Total MF	

FIGURE 1

LOCATION OF PRIMARY WATER QUALITY MONITORING STATIONS
OHIO EPA WATER QUALITY INVENTORY PROGRAM



• Station Location 41 Station Designation
----- Divide Between Lake Erie and Ohio River Watersheds

NOTE:
Data for minor tributaries of the Ohio River are furnished by the Ohio River Regional Commission

TABLE 2

Primary Water Quality Monitoring Stations

Maumee River Basin

1. Blanchard R. near Findlay
2. Ottawa River at Allentown
3. Auglaize R. near Fort Jennings
4. Maumee R. at Waterville
5. Blanchard R. above Dupont
6. Auglaize R. near Cloverdale
7. Ottawa R. at Kalida
8. Maumee R. at Antwerp
9. Tiffin R. in Defiance
10. Maumee R. at Defiance
11. Auglaize R. near Defiance
12. Maumee R. at Florida

Portage River Basin

12. Portage R. Woodville

Sandusky River Basin

14. Sandusky R. near Fremont
15. Sandusky R. near Mexico
16. Tymochtee Crk. at Crawford

Huron River Basin

17. Huron R. at below Milan

Vermilion River Basin

18. Vermilion R. near Vermilion

Black River Basin

19. Black R. at Elyria

Rocky River Basin

20. Rocky R. near Berea
21. W. Br. Rocky R. below Medina

Cuyahoga River Basin

22. Cuyahoga R. at Independence
23. L. Cuyahoga R. at Akron
24. Cuyahoga R. at Cleveland-Lower Harvard Avenue
25. Cuyahoga R. at Cleveland-3rd Street
26. Tinkers Crk. at Bedford

Chagrin River Basin

27. Chagrin R. at Willoughby

Grand River Basin

28. Grand R. at Painesville
29. Grand R. near Painesville

Ashtabula River Basin

30. Ashtabula R. at Ashtabula
31. Ashtabula R. at 6th Street
32. Fields Brook at 15th Street

Conneaut Creek Basin

33. Conneaut Crk. at Conneaut

Great Miami River Basin

34. Miami R. at Lakeview
35. Miami R. below Piqua
36. Stillwater R. at Dayton
37. Miami R. at Miamisburg
38. Twin Crk. near Franklin
39. Mad R. near Dayton
40. Dick's Crk. near Excello
41. Miami R. at Hamilton
42. Miami R. near Lawrenceburg
43. Miami R. at Dayton
44. Loramine Crk. near Lockington

Mill Creek Basin

45. Mill Crk. at Sharonville
46. Mill Crk. at Cincinnati

L. Miami River Basin

47. Beaver Creek near Alpha
48. L. Miami R. at Milford
49. L. Miami R. near Oldtown
50. E. Fork L. Miami near Milford
51. L. Miami R. near Spring Valley
52. L. Miami R. near Foster

Scioto River Basin

53. Scioto R. at Higby
54. Scioto R. at Shadeville
55. Scioto R. near Circleville
56. Scioto R. at Chillicothe
57. Mill Crk. at Bellpoint
58. Scioto R. near Prospect

Scioto River Basin (con't)

59. Olentangy R. near Worthington
60. Big Darby Crk. at Darbyville
61. Big Walnut Crk. at Rees
62. Paint Crk. near Bourneville

Hocking River Basin

63. Hocking R. at Enterprise
64. Hocking R. at Athens
65. Hocking R. at Lancaster

Muskingum River Basin

66. Licking R. below Newark
67. Rocky Fork Below Mansfield
68. Muskingum R. at McConnellsville
69. Mohican R. at Greer
70. Killbuck Crk. below Wooster
71. Kokosing R. below Mt. Vernon
72. Walhonding R. at Nellie
73. Tuscarawas R. at Clinton
74. Tuscarawas R. Massillon
75. Nimishillen Crk. at North Industry
76. Sugar Crk. above New Philadelphia
77. Tuscarawas R. below New Philadelphia
78. Stillwater Crk. below Dennison
79. Tuscarawas R. at Coshocton
80. Muskingum R. below Coshocton
81. Muskingum R. at Dresdon
82. Wills Crk. below Cambridge
83. Wills. Crk. near Conesville
84. Muskingum R. below Beverly

L. Beaver Creek Basin

85. L. Beaver Crk. near E. Liverpool

Mahoning River Basin

86. Mahoning R. at Niles
87. Mahoning R. at Lowellville
88. Mahoning R. at Struthers
89. Mahoning R. at Warren
90. Mahoning R. at Alliance

Wabash River Basin

91. Wabash R. at State Line

NONPOINT SOURCES OF POLLUTION

Nonpoint sources of pollution are diffuse in nature, entering waterways over a wide spatial range by dispersed pathways. Examples of nonpoint sources of pollution include mine drainage, agricultural runoff, urban stormwater runoff, streambank erosion, runoff from animal feedlots, and combined sewer overflows. Water quality problems associated with nonpoint sources of pollution are most severe following periods of high runoff (i.e., spring rains or after moderate to intense rainfall following a period of extended dryness or moderate rains following a period of drought). This section will discuss several types of nonpoint sources of pollution and will evaluate their impact on the water quality in Ohio.

1. Mine Drainage

A. Introduction

Coal mining in Ohio dates back to the early 1800's when coal was locally extracted for home heating. Most of this early mining was by shallow underground drift mining methods, although in scattered areas where coal seams were very close to the surface, surface mining methods were employed. Coal mining gained industrial status by the 1850's when statewide distribution of the product was achieved.

Since then, the Ohio coal industry has undergone fantastic growth. Today, Ohio is a major coal producing state, with 46.6 million tons being mined in 1975. Of this, 67% was produced by surface mining operations. The picks and shovels of early days have been replaced by electrically operated shovels and draglines, with bucket capacities sometimes greater than 220 cubic yards. This type of equipment and production has placed Ohio fifth in the nation in surface mine production in recent years.

The growth of the industry was not without serious long term liability. This liability today represents more than 370,000 acres of land requiring reclamation and over 1300 miles of Ohio streams continuously or intermittently affected by the discharge of 1,000,000 pounds of acid in water per day from inactive mining operations.

The current situation is a result of these past factors: (1) poor mining practices, (2) limited technical development in the fields of mining engineering and reclamation science, (3) lack of general public concern, (4) lack of well enforced regulations relating to sources of coal mining pollution, and (5) natural phenomena associated with strip and deep mining.

Present mining operations can and generally are doing a respectable

job in the control of pollution. The Ohio strip mine law passed in 1972 is among the more stringent in the country. The technology to control most coal mining-related pollution is available and being used by some coal mining companies.

The spread of the mining pollution problem from active mines has greatly been reduced. However, pollution from the inactive areas is and will continue to be a major water quality problem in the mining regions of the state.

B. Affected Areas and Problems

Mine drainage significantly impacts water quality in the following drainage areas of the state:

1. Muskingum River Basin
2. Hocking River Basin
3. South Central Minor Tributaries of the Ohio River
4. Southeast Minor Tributaries of the Ohio River

The geographic area drained by these basins includes portions of 35 Ohio counties and covers over 12,000 square miles. The affected area is basically parallel to the Ohio River, which also serves as its eastern and southern boundaries. The Cleveland-Ashtabula, Youngstown area is the northern boundary while a line from Cleveland through Columbus to Portsmouth forms the western boundary.

Looking at the problem basin-by-basin, we find the following:

1) Within the Muskingum River Basin approximately 520 miles of stream are either continuously or intermittently polluted by mine drainage. Mine drainage contributes roughly 100 tons of sulfate per day to the Tuscarawas River between Massillon and Newcomerstown. In

addition to this, 8 tons of acidity per day enter the Muskingum River at the confluence of Moxahala Creek in Muskingum County just below Zanesville.

In the eastern portion of the basin, sulfates and dissolved solids are problem components especially in the Piedmont Lake area. Excessive concentrations of these components have rendered Piedmont Lake unsuitable as a source of potable water, although the recreational and fishery potentials of the lake have not been affected.

2) In the Hocking River Basin, most major tributaries are affected by mine drainage including Rush Creek, Sunday Creek, Monday Creek, and Federal Creek. The total length of affected stream is in excess of 220 miles in the above mentioned tributaries. Sunday and Monday Creeks are continuously acidic and contribute roughly 13 tons/day and 19 tons/day respectively of total acidity to the Hocking River. Rush Creek and Federal Creek are generally a neutral pH at the point of confluence. However, heavy rains in the upper portions of these watersheds can, and do result in 'slugs' of strongly acidic water entering the stream. This slugging has caused, and will continue to cause fish kills in these tributaries as well as in the Hocking River below their confluence. Water quality in the upper Rush Creek area is extremely poor. Iron, sulfates and manganese are currently causing water supply problems for the Perry County community of New Lexington.

3) The South Central minor tributaries of the Ohio River including Yellow Creek, Short Creek, Cross Creek, Wheeling Creek, McMahon Creek, Captina Creek, Sunfish Creek, and Duck Creek appear to be significantly degraded by mine drainage. The combined lengths and

drainage areas for these small watersheds are 270 miles and 1300 square miles respectively. In addition, the Little Muskingum River (length 67 miles, drainage area 314 square miles) is considered to be slightly to moderately degraded by mine drainage.

4) The portions of the Southeast Ohio River minor tributaries located between Marietta and Portsmouth are considered to be affected by mine drainage to various extents, ranging from insignificant to extremely severe. Total stream miles affected is approximately 700. Of this, significantly affected streams comprise 250 miles. Much of the affected area is owned by either the State of Ohio or the Federal Government and, apart from the pollution from inactive coal mines, is ideally suited for wildlife and recreational uses.

The most serious water quality problems are found in Raccoon Creek, which is not only the largest minor Ohio River tributary, but also the longest "creek" in the world. In this basin, acidity concentrations in excess of 1000 mg/l and pH readings of 2.2 have been recorded.

It is evident that mine drainage is a major water quality problem affecting the unglaciated portions of Eastern and Southeastern Ohio. It has caused the degradation of more than 1300 miles of some of the state's most beautiful streams. It has caused fish kills, and has made the water in some areas unsuitable for many uses.

Current legislation and regulations are an attempt to bring a reduction to the problem. The coal industry for the most part does comply with current reclamation and pollution control laws. The major problem remaining will be the control of the pollution emanating from the countless inactive mining operations throughout the area. The responsibility of this control necessarily rests to a large degree upon the Federal Government, since national energy demands are served by the coal producing states.

C. Formation of Mine Drainage

The removal of overburden often exposes pyritic materials (iron disulfide). As shown in equations 1 and 2, the exposure of this material to air and moisture results in the production of ferrous iron and sulfuric acid. The reaction then proceeds to form ferric hydroxide and more acid, as shown in equations 2 and 4.

$$2FeS_2 + 2H_20 + 7O_2 \rightarrow 2FeSO_4 + 2H_2SO_4 \quad (1)$$

(Pyrite) → (Ferrous Sulfate) + (Sulfuric Acid)

$$FeS_2 + 14Fe^{+3} + 8H_20 \rightarrow 15Fe^{+2} + 2SO_4{}^{-2} + 16H+ \quad (2)$$

(Pyrite) + (Ferric Iron) → (Ferrous Iron) + (Sulfate) + (Acid)

$$4FeSO_4 + O_2 + 2H_2SO_4 \rightarrow 2\ Fe_2\ (SO_4)_3 + 2H_20 \quad (3)$$

$$Fe_2\ (SO_4)_3 + 6H_20 \rightarrow 2Fe(OH)_3 + 3H_2SO_4 \quad (4)$$

As a result, the reaction of one molecule of pyrite ultimately leads to the release of four atoms of acid hydrogen.

Consequently, highly acidic water is often produced*. In such water, heavy metals such as iron, manganese, aluminum, and zinc are more soluble and enter into the solution to further pollute the water. Water of this type supports only limited water flora, such as acid-tolerant molds and algae; it will not support fish life; it destroys and corrodes metal piers, culverts, barges, etc; it increases the cost of water treatment for power plants and municipal water suppplies, and leaves the water unacceptable for recreation.

The amount and rate of acid formation, and the quality of water discharged depend on the amount and type of pyrite in the overburden and coal, time of exposure characteristics of the overburden,

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* pH is a common measure of acidity or alkalinity of water. A pH of 7.0 is neutral. A lower pH is acidic, higher is alkaline. For stream water a pH of 2.0 - 4.5 is very acid indeed.

and amount of available water. Crystalline forms of pyritic material are less subject to weathering and oxidation. Since oxidation is the primary reaction during early acid formation, less pyritic material exposed to air means less acid formation. Thus, an effective preventive method is to cover pyritic materials as soon as possible with earth, which serves as an oxygen barrier.

If the overburden also contains alkaline material such as limestone, acid water may not be discharged even though it is formed, because of inplace neutralization by the alkaline material. Discharges from this situation are usually high in sulfate. Enough water to satisfy equations 1, 2, and 4 is usually available in the overburden and coal material. Water also serves as the transport media that removes the oxidation products from the mining environment into streams.

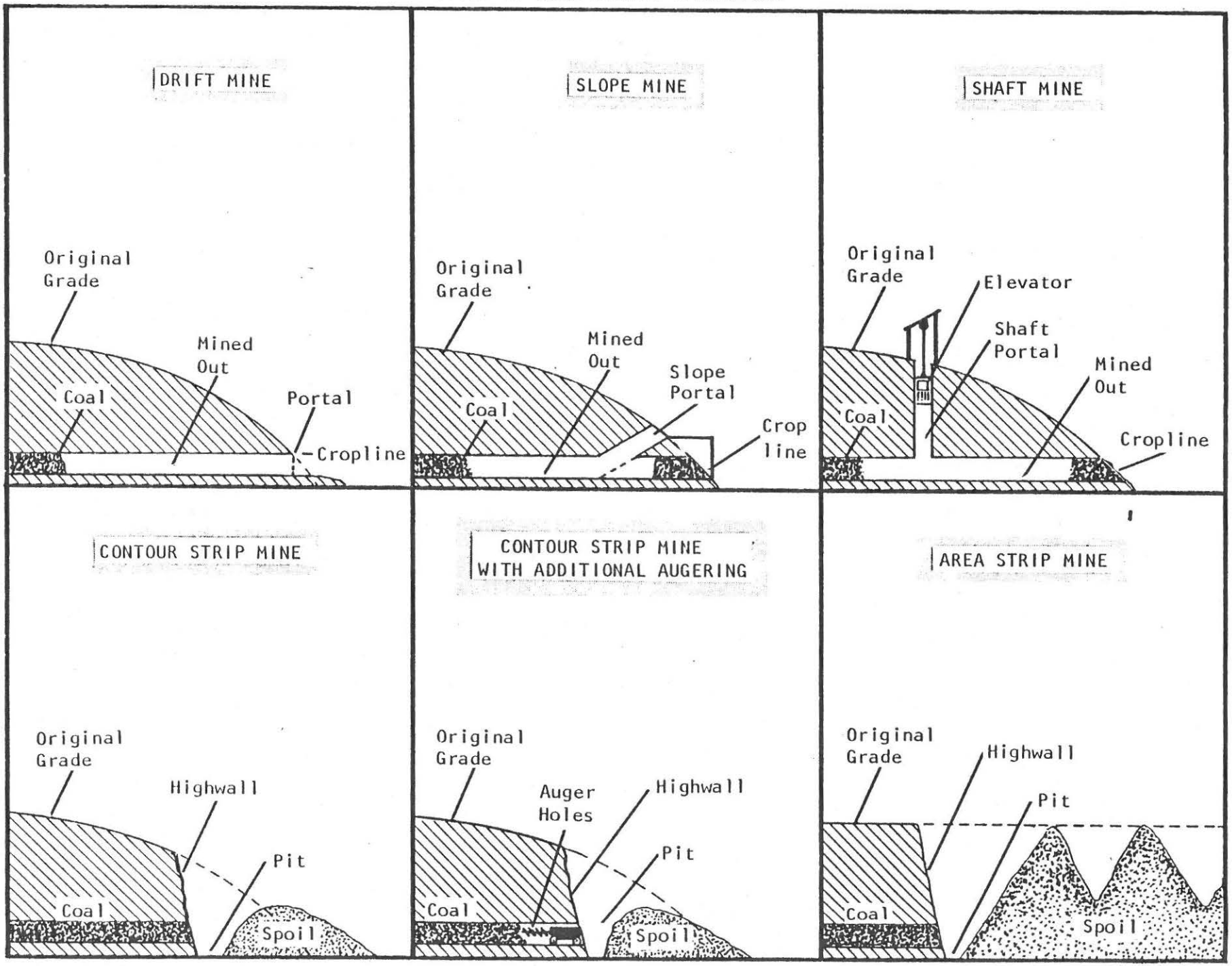
D. Discharge of Mine Drainage

The different types of mining operations is shown in Figure 2 . In underground mines, drift mines tend to produce a more highly acid water than do slope or shaft mines. This is because drift mine openings, being at the coal line, tend to allow any infiltration into the workings to drain out. Drift mines commonly yield mine water on a perpetual, yet unpredictable basis. Slope and shaft mines, because of the nature of the openings, tend to fill up more completely with water, thus sealing off oxygen and restricting acid production.

In surface mining operations, acid can be produced in the pit, on the face of the highwall, in any auger holes, and in the spoil. The requirements for acid production are the same as for underground operations, namely (1) pyrites, (2) oxygen, and (3) water.

FIGURE 2

TYPES OF COAL MINING OPERATIONS



Also, as in underground operations, control of the drainage is best affected by limiting one of these three primary constituents.

Acid water is also produced in coal refuse or gob piles. These piles are comprised of wastes from coal preparation and cleaning processes, the major objective of which is the removal of pyrites and other contaminants from the coal. The standard practice for many years has been to dispose of this refuse by dumping it along a stream bank or in a hollow which is close to the mining operation. Because of the loosely compacted nature of these piles, infiltration of both air and water is great and acid production extremely high.

Once produced, the acid may be either neutralized relatively rapidly, or may enter the stream virtually unaltered. The former case is the general rule where the spoil is predominantly of calcareous or limestone origin. In such cases, the acid is usually neutralized by the residual calcium carbonate according to the following reaction:

(Calcium Carbonate-Limestone) + (Sulfuric Acid) → (Gypsum) + (Water) + (Carbon Dioxide Gas)

The resultant discharge, while not acidic, generally contains high levels of hardness, total dissolved solids, and sulfate. These constituents, while they generally do not hurt aquatic life, do limit the consumptive (water supply, industrial, and agricultural) uses of the water.

Where limestone is not present, the residual soils are generally of a sandstone origin and are for the most part already acidic. In such cases, chemcial treatment of the acidic water is necessary to neutralize the acidity. The general principle is similar to the natural process discussed above with limestone or lime commonly used.

In limestone areas, the neutralization of the discharge causes

all or part of these dissolved metals to precipitate out as insoluble carbonates, sulfates, or hydroxides. This results in a sediment problem in the receivng stream, and can give the water a turbid appearance.

In sandstone areas, natural neutralization does not take place, so the dissolved components remain dissolved until the receiving stream's acidity is neutralized; usually at the confluence with a non-acid stream. In these cases, precipitation of the dissolved metals and associated sedimentation and turbidity problems are found below the confluence. This condition is present for example below the confluences of 1) Moxahala Creek and the Muskingum River, 2) Sunday and Monday Creeks and the Hocking River, 3) at the confluence of acidic minor Ohio tributaries and the Ohio River.

E. Control Alternatives, Needs, Costs

There are two distinct approaches to the control of mine drainage. One involves the collection and treatment of the mine drainage, while the other is oriented toward reclamation of the area to control the production and discharge of polluted water.

In the former case, conventional mine drainage treatment systems similar to those employed at active mining operations are used. Such systems are generally designed as follows:

1) Sandstone (acid) substrates

(collection) → (neutralization) → (aeration) → (clarification) → (discharge)

2) Limestone (non-acid) substrates

(collection) → (clarification) → (discharge)

Construction costs for these systems are moderate as earthen ponds

are commonly employed. Major construction costs are earthmoving, pumps, aerators, etc., while operational costs are predominately chemical (neutralization - usually slaked lime, crushed limestone, sodium hydroxide, or soda ash), power, and maintenance. The major drawback to the treatment oriented approach is the continual long-term cost of system operations and maintenance.

In the reclamation-oriented approach, initial costs are generally higher, although in many cases circumstances on site can affect cost. For example, a site with an inactive and unreclaimed contour strip operation may have sizable recoverable coal reserves and thus, the value of the coal may augment the otherwise high reclamation costs. The main advantages to this approach are twofold: 1) The elimination of the long-term operational costs required by the treatment approach and 2) The restoration of the area for improved esthetics.

In 1972, Ohio passed one of the toughest surface mining laws in the United States. More recent legislation has provided that the 4 cent per ton severance tax be used by the Divison of Reclamation for the reclamation of inactive mine sites. Although current laws provide for such reclamation only on state-owned land, legislation introduced in this legislative session provides for such reclamation on private land as well.

F. Costs

The costs presented below were reported by the Ohio Board on Unreclaimed Strip Mine Lands in their 1972 report entitled 'Land Reborn'. The costs are based on 1972 dollars, and should generally be increased by a factor of 1.5 to reflect current costs. Also, cost values are subjective and actual dollar costs can be developed only by the actual experience acquired during reclamation.

Basin	Cost (Thousands of Dollars)	
	Surface Mine Reclamation	Underground Mine Reclamation
Hocking River	19,740	98,500
Muskingum River	102,152	201,700
Ohio River Tributaries South Central	50,853	80,000
Ohio River Tributaries Southeast	70,080	61,550
Totals	260,825	441,750

Summing up, the estimated cost for complete mine reclamation in 1972 dollars is over $700,000,000 state-wide; after allowances for inflation, the cost will probably be over $1 billion in 1977 dollars.

Such costs are staggering and it is apparent that at the current severance tax credit of roughly 3 million per year, reclamation of all sites will be in the distant future.

A possible relief could come through previously proposed Federal legislation relating to surface mining and unreclaimed mine lands. Federal assistance could relieve the otherwise awesome financial obligation of mine land reclamation. Such a program should definitely put the majority of the money in the hands of State programs such as Ohio's so that it could be spent where it is needed most.

As an off-shoot, the Ohio coal industry stands to benefit from a reaffection type of approach, since the severance tax paid by the coal operations would be returned to them as payment for reclamation of inactive and unreclaimed areas.

G. Summary

As has been shown, a significant percentage of total stream miles in Ohio is currently degraded by mine drainage. Portions of this percentage

will have to be considered as degraded from irretrievable man-induced conditions, at least with respect to the 1983 goals of the Act.

In other areas, improvements may be affected or accomplished through the Land Reborn Program of the Department of Natural Resources. Funds and legislative authority are currently limited, however, and not sufficient for large scale, short term projects.

Protection of these streams from further degradation by existing and future dischargers is of primary importance. The technology to control pollution from such sources is currently available. The past practices of reduction in pollution control requirements for dischargers to these streams must cease if pollution control is to be effective. Accordingly, it is strongly recommended that these streams be classified as warm water fisheries and as suitable for such a use designation in all respects with the exception of the discharge of pollutants from inactive mining operations in the basin.

2. Agricultural Runoff of Sediment

The runoff from Ohio's croplands is a major contributor to water quality problems in many of Ohio's river basins. Notable among these are Maumee, Portage, Sandusky, Huron, Vermillion, Ashtabula, Scioto, Little Miami, and Great Miami Basin. A study by the Great Lakes Basin Commission concluded that in the Maumee River Basin, sediment was the greatest single non-point source pollutant, by weight from streams in the Lake Erie basin. This study as well as research being undertaken by the Corps of Engineers (Buffalo District Office), Toledo Metropolitan Council of Governments, investigations by scientists at Heidelberg College and Ohio State University, the Ohio Agricultural Research and Development Center, and others have illustrated the magnitude and impact of this problem on Ohio's waterways and lakes.

The net result of soil erosion from cropland is an increased level of suspended solids. This increased level of suspended solids creates high levels of turbidity in the water as well as a brown discoloration of the stream which is bad because it reduces light for photosynthesis and prevents the growth of some animal and plant life on stream beds. Rural runoff is also very detrimental from another aspect; transporting phosphorus and nitrogen compounds, pesticides and herbicides, and heavy metal ions attached to the sediment and dissolved in the water.

The adsorbing and transporting characteristics of suspended solids give rise to costly problems. For example, it is more costly for a water treatment plant to purify raw water having a high suspended solids content because more chemicals must be added during the treatment process to coagulate and precipate this material prior to filtering. Also, the cost of maintenance dredging to remove sediment from reservoirs, harbors on Lake Erie, and drainage ditches

and small streams continues to increase. Presently dredging costs to maintain Toledo Harbor totaled $1,500,000 in 1976 (1.7 million cubic yards) as compared to about $381,000 (1.1 million cubic yards) in 1965 (cost are dependent on size of dredge used, yardaged dredged, and proximity to disposal area). Ohio Department of Natural Resources spends approximately $500,000 annually for maintenance dredging of state owned lakes.

The indirect, adverse effects of suspended solids are more difficult to cost out and in many cases, cost figures cannot be determined. In recent years, much concern has been expressed regarding the movement of phosphorus and nitrogen compounds from croplands to Lake Erie. Scientists now believe that it is these two nutrients which appear to be most responsible for algae blooms in streams and Lake Erie, and for the accelerated rate of eutrophication (enrichment) of Lake Erie. Deposition of suspended solids causes destruction of aquatic habitat which in turn has an adverse impact on game and commercial fish by destroying food supplies and spawning grounds. A study of the benthic macroinvertebrate populations of Sandusky Bay by Herdendorf and Lindsay[1] revealed that the benthic species composition in Sandusky Bay has experienced a significant change in recent years. Apparently, eroded sediment carried by the Sandusky River and deposited in the Bay, has effected this change. Thirty-five years ago, fly larvae (dipterans) were the predominant benthic species in the Bay. They required a sand and gravel or hard clay bottom for survival. Today, sludge worms have replaced dipterans as the predominant benthic species. Sludge worms prefer a mud and silt bottom habitat which the Bay now provides. In thirty-five years, fly larvae, indicative of an oligotrophic state, have been replaced by sludge worms, indicative of a highly eutrophic state.

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1 Lindsay, W.K. & Herdendorf, C.E., Benthic Invertebrate Populations In Sandusky Bay, in Proceedings of Sandusky River Basin Symposium, May 2-3, 1975, Tiffin, Ohio.

The sediment loads carried by streams can amount, in many cases, to thousands of tons in any given year. It has been estimated that Lake Erie receives 8 million tons per year of sediment from Ohio rivers and streams. Of this total, the Maumee River contributes between 20-25% of the load. The Great Lakes Basin Commission study estimates that the current normal gross erosion rate for the Maumee River Basin drainage area to be about 11.5 million tons per year or an average of 2.61 tons per acre per year. This same study calculated the yearly sediment yield in the Maumee Basin to be 1.27 million tons or 0.29 tons per acre per year. This is about 11% of the total gross erosion discharged as suspended sediment to Maumee Bay annually. The 1.27 million figure agrees well with the U.S. Geological Survey figure of 1.24 million tons of suspended sediment passing the Waterville gage annually. Table 3 gives a breakdown by subbasins of the estimated normal gross erosion in the Maumee River Basin drainage area. The data indicates that the St. Joseph, St. Mary's, and Tiffin Basins are experiencing erosion rates greater than the remainder of the basin. Steeper slopes or different soil types may explain the accelerated erosion rates found in these basins.

The river basins surrounding the Maumee Basin have similar soil types and land use patterns. Their sediment yield (tons/acre/year) to Lake Erie is likewise similar. The Portage, Sandusky, and Huron Basins had annual sediment yield rates of 0.19, 0.37 and 0.33 tons/acre/year respectively as measured at the U.S. Geological Survey monitoring stations at Woodville on the Portage, near Fremont on the Sandusky, and at Milan on the Huron. However, in terms of total annual sediment discharged to Lake Erie, these three basins combined contribute only about 34% of the total that the Maumee River discharges annually to Lake Erie. The extent of nonpoint souces of pollution is best illustrated by a finding of Baker and Kramer, that 75% of the total phosphorus

TABLE 3

ESTIMATED CURRENT NORMAL GROSS EROSION** IN MAUMEE BASIN*

(Total Area, Including Urban & Streambank)

Sub-Basin Name	Total Acres	Total Tons	Tons Per Acre Per Year
Upper Maumee	222,989	401,000	1.6
Lower Maumee	585,110	901,000	1.3
North of Bay	115,432	162,000	0.9
South of Bay	22,364	22,000	0.8
St. Joseph	636,874	2,658,000	3.8
St. Mary	462,961	1,776,000	3.3
Tiffin	464,375	1,549,000	3.1
Auglaize	969,619	2,786,000	2.6
Blanchard	452,028	1,283,000	2.6
Total	3,931,752	11,538,000	

* Maumee River Basin Level B Study; Erosion and Sedimentation Technical Paper, Great Lakes Basin Commission, August 1975.

** Gross Erosion - total amount of soil movement within the catchment, including all forms of wash and rill erosion from agricultural land, gully and streambank erosion, and erosion from non-agricultural sources such as highway construction; or building development (from Soil Conservation by Norman Hudson, published by Cornell University Press).

delivered to Lake Erie from the Sandusky Basin originates from nonpoint sources.

On a statewide basis, the major rivers are estimated to have a sediment delivery rate of 0.07 to 0.88 tons/acre/year. This fact has added significance when one considers that in a survey conducted by the U.S. Soil Conservation Service (SCS) in 1971, it was found that 48% or 8.2 million acres of the agricultural land considered susceptible to erosion, yields a value of 3.9 million tons of sediment that potentially is being discharged yearly to the Ohio River and Lake Erie by Ohio rivers and streams. This figure could be high because not all the agricultural land in Ohio is susceptible to erosion. In fact, 43% of the total cropland (12.5 million acres) in Ohio is considered to be receiving adequate conservation treatment. In spite of these conservation efforts, the SCS estimates that 35% of Ohio's cropland (4.375 million acres) is subject to soil erosion.

Although the above figures are significant, studies have shown that when compared to other nonpoint sources of sediment (i.e., streambank erosion or construction activities), cropland erosion does not yield the greatest amount of sediment per acre. In fact, other activities, such as construction, may produce anywhere from 10 to 100 times more sediment per acre than does cropland erosion. However, due to the extensive area involved (in Ohio, 66% of the land is used for agricultural purposes), erosion of soil from agricultural land in Ohio produces more total sediment than any other nonpoint source.

Agricultural runoff resulting in erosion of soil has its greatest impact on water quality during periods of high runoff and intense rainfall. The erosion of soil and generation of sediment are triggered by the impact of raindrops striking bare soil at a high velocity (upwards of 20 mph). The raindrops shatter soil granules and detach particles from the soil mass. Water flowing across the soil surface transports these detached particles

downslope. Agricultural scientists have identified five factors that influence soil erosion: (1) rainfall intensity and duration (R), (2) soil erodibility (K), (3) length and steepness of slope (LS), (4) soil management practices (C), and (5) the erosion control practice factor (P). The Universal Soil Loss Equation incorporates these five factors to allow for the computation of the average annual soil loss in tons per acre (A). The equation is given below.

$$A = R \cdot K \cdot LS \cdot C \cdot P$$

From the above discussion, it should be apparent that surface runoff is the mechanism by which sediment is carried to streams. Therefore, land treatment practices should be geared to items 3, 4, and 5 above. The idea is to develop a good vegetative cover which will increase infiltration of water and thereby reduce runoff. Other control practices such as contour cropping and contour strip cropping plus no-tillage planting have proven very effective. These techniques can reduce by up to 90% the sediment load resulting from planting done without attention to this method. Water diversions utilizing stabilized waterways will also help reduce sediment loading.

In summary, sediment from agricultural land should not be thought of as a waste material which has been carelessly discarded, but rather as a valuable natural resource which has found its way to a stream because of soil erosion. The responsibility to correct this problem clearly lies with the farmers of Ohio. Only they can implement proper farming procedures which can minimize soil erosion and at the same time conserve a valuable natural resource.

3. Other Sources

A. Streambank Erosion

The erosion of streambanks produces sediment. The extent and magnitude of this problem in Ohio has not yet been clearly determined. Estimates as to the extent of this problem in the Maumee Basin were presented in a report by the Great Lakes Basin Commission (GLBC). The report cites a study by the Soil Conservation Service (SCS) which found the Auglaize River had more total eroding bank miles than any other river in the Maumee River Basin. The SCS study estimated that 577 bank miles of the Auglaize were eroding at a rate of 84.3 tons per eroding bank mile per year which compares to an average rate of 52.7 tons per eroding bank mile per year for the entire Maumee River Basin. The SCS study found that 77% of the streambanks had received stabilization treatment, which at 1974 prices, was estimated to have cost $121.3 million. An additional 10% of the streambanks were judged to be in need of treatment, which at 1974 prices was estimated to cost 25.6 million.

In the Ohio River Basin, 37,420 streambank miles or 12.7% of the total streambank miles (295,600) are experiencing erosion. Of this total 11,520 miles or 3.9% have severe erosion. The total damage attributable to this problem is estimated to be $3 million annually, while treatment costs to correct this problem are put at $21 million annually.

Streambank erosion can be reduced by: 1) removal of obstructions such as fallen trees or other debris which restrict stream flow and decrease a stream's capacity thereby increasing the flood potential; 2) reshaping stream-banks by decreasing the steepness and at the same time lengthening the banks thereby allowing water to flow onto the bank rather than cut into it; 3) using riprap or other lining to deflect the flow of water particularly at a turn where great pressure is exerted.

B. Feedlot Runoff

Animal production is an important commercial enterprise in Ohio. Like other commercial endeavors, waste materials are generated and if not properly controlled, can have serious adverse effects on water quality. Table 4 tabulates on a yearly basis, starting with 1969, the number of wildlife in streams killed by farm operations. Water quality problems associated with this activity arise primarily from feedlot runoff. Factors influencing feedlot runoff include precipitation, surface material, land slope, depth of waste accumulation, feedlot layout and exposure, and ration composition.

Runoff from feedlots contributes organic and nutrient material to streams and lakes as well as bacterial contamination. These constituents produce high rates of oxygen demand, algae blooms, taste and odor problems, and because of high fecal coliform counts, render the water unsafe for primary contact recreational activities. Runoff from feedlots is also responsible for killing wildlife, especially fish. During water year 1976, a silage liquor spill in a tributary of Massie Creek (Little Miami River Basin) caused an estimated kill of 6,000 fish.

Methods to control feedlot runoff include dikes, diversions, curbs, drainage way relocation, settling areas, and grass filters. Care and adherence to agronomy guidelines in the application of manure to land will help reduce runoff from this source.

C. Urban Runoff & Combined Storm Sewer Overflow

Runoff from urban land can have a significant adverse impact on the water quality of the receiving stream. This type of runoff has been characterized as having many of the same constituents that are found in raw municipal sewage. Urban land runoff may, however, prove to be even worse than raw

TABLE 4

ANIMAL KILLS ATTRIBUTABLE TO FARM OPERATIONS, OHIO, 1969-74*

DATE	COUNTY	WATER	NUMBER	POLLUTANT
1969				
4/28	Fayette	Sugar Cr	27,260	Liquid Fertilizer
5/17	Greene	Anderson Fk	350	Hog Lot
5/31	Paulding	Flat Rock Cr	14	Chemicals
6/11	Morrow	Kokosing R	2,331	Cattle
6/27	Highland	White Oak Cr	29	Lot
7/07	Preble	Elk Cr	500	Lot
8/03	VanWert	Dog Cr	17,402	Herbicide
9/07	Hardin	Taylor Cr	647	Dairy lot, silo
10/6	Ross	Buckskin Cr	98	Silo
1970				
7/08	Montgomery	N. Br. Wolf Cr	11,297	Pesticides
7/13	Highland	Dodson Fk	12,335	Cattle lot, silo, spoiled grain
7/15	Miami	Brush Cr	6,413	Cattle
8/07	Butler	Indian Cr	3,610	Hog lot
8/13	Pickaway	Congo Cr	65	Hog lot
9/25	Morrow	Flat Run	336	Cattle, milk
1971				
4/21	Preble	Four Mile Cr	466	Liquid fertilizer
6/14	Warren	Ritters Cr	118	Silo, manure
7/02	Warren	Newmans Run	7,592	Hog lot
7/11	Pickaway	Scippo Cr	42,354	Hog lot
7/23	Seneca	Rock Cr	12	Dairy Barn
9/04	Tuscarawas	Pleasant Valley Cr	2,600	Silo
9/04	Shelby	Turtle Cr	148	Dairy
9/07	Greene	N. Br. Caesars Cr	1,549	Lot
9/08	Preble	Four Mile Cr	4,233	Silo
9/08	Fairfield	Sycamore Cr	118	Silo
9/09	Preble	Elk Cr	1,723	Hog and cattle
9/10	Huron	Vermilion R	9	Silo
9/11	Tuscarawas	Pleasant Valley Cr	2,588	Silo
9/13	Hardin	Taylor Cr	3,324	Silo
1972				
5/24	Lawrence	Ice Cr	9,797	Chicken
6/01	Stark	Tr Nimishellen Cr	6,437	Chicken
6/07	Warren	E Turtle Cr	193	Cattle
7/18	Madison	Sugar Cr	6	Hog

TABLE 4 (con't)

DATE	COUNTY	WATER	NUMBER	POLLUTANT
1972 (con't)				
7/20	Miami	Brush Cr	445	Cattle
7/26	Adams	Flat Run	62	Manure
8/02	Preble	McKelligan Ditch	75	Silo
9/08	Clinton	Andersons Fk	6,281	Silo
9/14	Miami	Brush Cr	30	Cow
1973				
5/07	Warren	Newman Run	278	Hog manure
5/27	Scioto	Lick Run Cr	602	Chicken manure
6/03	Champ.*	L. Darby Cr	200	Cow manure
6/20	Trumbull	Trib. Mosquito Cr	555	Herbicides
6/26	Wyandot	L. Tymochtee Cr	3	Unknown
7/18	Clinton	Turkey Run	221	Hog manure
7/21	Sandusky	L. Muddy Cr	113	Toxaphene
9/04	Preble	Garrison Br	496	Hog manure
9/17	Auglaize	Owl Cr	275	Dairy wastes
9/19	Ashland	Trib. Grand R	709	Silo liquors
9/22	Crawford	L. Scioto R	147	Silo liquors
9/29	Hancock	Eagle Cr	11,761	Silo liquors
10/4	Union	Rock Fk Cr	500	Silo liquors
10/4	Delaware	Trib. Mill Cr	138	Silo liquors
10/8	Hancock	Lye Cr	42	Silo liquors
10/15	Crawford	Lost Cr	3,802	Hog manure
10/26	Mahoning	Island Cr	197	Silo liquors
1974				
5/03	Preble	Trib.Periwinkle Run	75	Hog lot sewage
5/24	Pickaway	Clarks Run	600	Herbicides
7/17	Champaign	Anderson Cr	280	Farm waste/pesticides
8/13	Madison	Thompson Fk	637	Hog lot sewage
8/27	Marion	Ulsh Ditch	135	Silo liquors
9/08	Crawford	Trib. Sand R	1,104	Silo liquors
9/17	Miami	L. Lost Cr	591	Silo liquors
9/23	Crawford	Mile Run	427	Silo liquors
10/1	Medina	Reeds Run	145	Silo liquors
10/14	Holmes	Mohican River	276	Cattle feedlot manure
11/19	Hancock	Binkley Ditch	4,471	Silo liquors

* From Publication 7, Division of Wildlife, Ohio Department of Natural Resources

sewage because of the load of heavy metals it contains such as mercury and lead. A Durham, North Carolina study which compared urban runoff from a 1.67 square mile watershed found that on an annual basis, the urban runoff yield of chemical oxygen demand was equal to 91% of the raw sewage yield, the biochemical oxygen demand yield was equal to 67%, and the urban runoff suspended solids yield was 20 times that contained in raw municipal waste for the same area.[2]

When considering the impact of urban runoff on water quality, the estimated daily loadings or annual discharge from this source may not be as important as the initial first flush. In fact, urban runoff studies seem to indicate that the critical water quality period may not necessarily be a 10 year, 7-day low flow, but rather the first flush period after a rainfall preceded by a period of low flow. It is during this first flush period that the accumulated oil and grease, heavy metals, nutrients, sediment, salt, etc. are washed from the streets and carried to streams. This source of pollution can be of such significance in urban areas that failure to consider it and make provisions for its control could mean that water quality problems might continue to persist in an area even though adequate control of point sources has been provided. Of significance is the discovery that urban runoff may be a major contributor of heavy metals to Ohio streams. Research on a moderate size city showed that between 100,000 and 250,000 pounds of lead and between 6,000 and 30,000 pounds of mercury annually were carried by urban runoff to a stream.

As noted earlier, the dust and dirt which collects on streets or is washed from urban properties (i.e., lawn fertilizer) contain appreciable quantities of nutrients. Nitrogen yield from urban runoff ranges from

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2 Colston, N.V., 1974, Characterization and Treatment of Urban Land Runoff, U.S. EPA Publication No. 670/2-74-096.

1.9 to 7.8 lbs/acre/year, while the phosphorus yield is from 0.98 to 2.8 lbs/acre/year. These values suggest the potential importance that urban runoff may play in the eutrophication process of Ohio lakes. Urban runoff may also be partly responsible for algae blooms which occur in several Ohio streams.

A study by Earthview, Inc.[3] attempted to estimate the pollutional load from street debris for 19 selected catchments in Toledo using extrapolations of street litter characteristics for Chicago. Earthview estimated the yearly pollutional load from these catchments to be 45.7 tons of BOD and 2,286 tons of suspended solids. The study also estimated the effect of the "peak-flush shock-loading" of a storm event which produced 2 hours of runoff with a two week interval between storms. Such a storm event could result in a BOD runoff load that is as much as 240% of the raw sanitary load, and have a suspended solids concentration of 2300 mg/l.

The effect on water quality in the Sandusky River at Bucyrus, Ohio, from combined sewer overflow was the subject of a year long study. The results showed that any 20 minute rainfall greater than 0.05 inches would produce an overflow.[4] The changes in various parameters between dry and wet weather flow in the Sandusky River at the 1st bridge downstream from the wastewater plant are summarized in Table 5. The effect on various water quality constituents in the Sandusky River due to combined sewer overflows in Bucyrus is clearly illustrated by this data. Table 6 presents estimated annual pollutant loadings to the Sandusky River resulting

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3 Earthview, Inc., 1973, Combined Sewer Pollution City of Toledo, prepared for Voices for Environment, Inc.

4 Burgess & Niple, Ltd., 1969, A Study of Stream Pollution From Combined Sewer Overflows and Feasibility of Alternate Plans for Pollution Abatement in Bucyrus, Ohio, Water Pollution Control Series, No. DAST-32.

TABLE 5

SUMMARY OF DRY AND WET WEATHER RIVER ANALYSIS IN THE SANDUSKY RIVER

AT 1st BRIDGE DOWNSTREAM OF BUCYRUS WASTEWATER TREATMENT PLANT*

Parameter	Dry (Avg)	Wet (Avg)	Wet (Max)	% Change Dry vs Wet
BOD (mg/l)	6	14	51	+ 133
Suspended Solids (mg/l)	49	192	960	+ 292
Total Solids (mg/l)	506	746	1335	+ 47
Total Phosphate as PO_4 (mg/l)	1.6	3.3	10.0	+ 106
Nitrate Nitrogen as NO_3 (mg/l)	6.7	7.5	24.8	+ 12
Ammonia Nitrogen as N (mg/l)	1.5	2.4	6.6	+ 60
Organic Nitrogen as N (mg/l)	2.4	3.8	14.7	+ 58
COD (mg/l)	244	114	220	- 53
Chlorides (mg/l)	38	53	158	+ 39

TABLE 6

ESTIMATED ANNUAL LOADINGS AND YIELDS TO THE SANDUSY RIVER RESULTING FROM COMBINED SEWER OVERFLOWS IN BUCYRUS, OHIO*

Parameter	Annual Loading (tons/year)	Yield** (Lbs/acre/year)
BOD	175	150
Suspended Solids	700	598
Nitrate Nitrogen	6.1	5.2
Total Phosphate as PO_4	15	13

* Data From: A Study of Stream Pollution From Combined Sewer Overflows and Feasibility of Alternative Plans for Pollution Abatement in Bucyrus, Ohio, Burgess & Niple, Ltd., 1969.

** Based on an area of 2340 acres.

from combined sewer discharges at Bucyrus. The study concluded that the most economical method of providing a high degree of protection to the Sandusky River would be collecting the combined sewer overflows with a large interceptor and using an aerated lagoon system to treat the waste load from the overflows. Table 7 gives current and future waste loads from combined sewer overflows and urban runoff from metropolitan areas in northeast Ohio.

By extrapolation of yield values developed by Colston, it is possible to project potential annual pollutant yields from urban runoff in the state. Table 8 presents these values. It is important for the reader to understand that the values listed are derived from extrapolations based on research done by Colston in Durham, North Carolina. For this reason, the values may underestimate or overestimate by an appreciable margin the extent of urban runoff in Ohio. Also, the impact which these total gross annual loadings may have on water quality in Ohio is unknown. The values are presented for the purpose of providing general information as to the possible extent of urban runoff because of lack of actual urban runoff pollutant loading data for most of the state.

More emphasis needs to be placed on the evaluation and assessment of the extent and impact of urban runoff and combined sewer overflows on the water quality of Ohio streams. Water quality management planning must assess the total urban pollution load - not just the point sources - when developing strategy to upgrade or maintain receiving water quality. Without adequate assessment of the urban stormwater contribution and providing controls for it, the upgrading of municipal treatment plants to provide secondary or advance treatment may, as studies in Roanoke, Virginia, and Durham, North Carolina show, fail to achieve the anticipated upgrading of water quality.

TABLE 7

CURRENT AND FUTURE WASTE LOADS FROM COMBINED SEWER

OVERFLOWS AND URBAN STORM RUNOFF IN TONS/YEAR*

Parameter	Akron-Cleveland Area Current	Akron-Cleveland Area Future	Warren-Youngstown Area Current	Warren-Youngstown Area Future	NE Ohio Urban Area Current	NE Ohio Urban Area Future
Total Solids	391,000	870,000	18,500	91,500	563,000	1,585,500
Suspended Solids	181,500	404,500	14,500	42,500	262,000	737,500
Volatile Suspended Solids	40,500	71,000	5,000	9,000	55,500	121,000
BOD_5	14,200	18,400	2,500	3,050	17,500	27,450
COD	64,000	102,000	9,500	14,000	86,500	167,000
Ammonia nitrogen as N	890	1,100	170	190	1,155	1,625
Organic Nitrogen as N	535	755	85	115	705	1,175
Nitrate as N	205	405	20	45	285	710
Total Phosphate	1,210	2,285	35	100	1,605	2,835
Soluble Phosphate	925	1,100	175	200	1,190	1,570
Phenols	35	39	7	7.4	45	52

* Northeast Ohio Water Development Plan, Main Report, Ohio Department of Natural Resources, 1972.

TABLE 8

ESTIMATED ANNUAL YIELD OF POLLUTANTS

ATTRIBUTABLE TO URBAN RUNOFF IN OHIO*

Parameter	Annual Yield (tons/year)**
COD	1,294,258
TOC	258,024
Total Solids	10,624,506
Volatile Solids	2,011,757
Suspended Solids	9,232,282
Volatile Suspended Solids	1,099,705
Kjeldahl Nitrogen as N	8,417
Total Phosphorus as P	6,485
Aluminum	88,308
Calcium	71,750
Cobalt	2,622
Chromium	2,208
Copper	2,208
Iron	140,740
Magnesium	97,966
Manganese	6,761
Nickel	1,656
Lead	4,001
Zinc	2,760

* Obtained from extrapolation of values in study by Colton (Characterization and Treatment of Urban Land Runoff, U.S. EPA Publication No. 670/2-74-096, 1974) for Durham, North Carolina (refer to text for further discussion concerning these figures).

** Assumes 2,759,612 acres of urban and built-up land based on 1971 CNIC report.

D. Pesticides

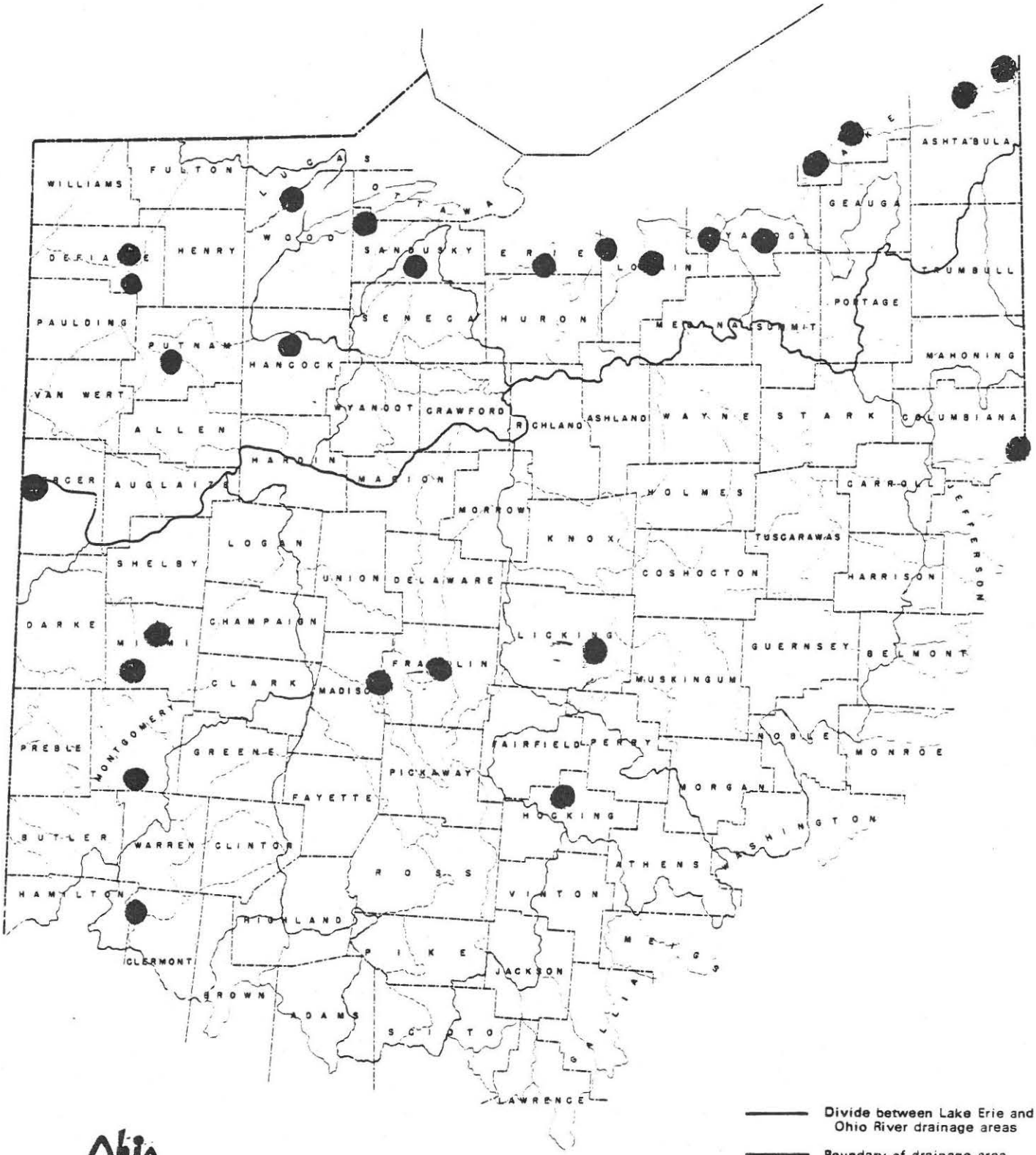
The Ohio Environmental Protection Agency manages a pesticide stream monitoring program including sample collection, laboratory analysis, and data handling of information derived from the residue analysis. The program includes a total of 26 sampling sites. Twelve of these sites are on Lake Erie tributaries, and the other fourteen are distributed statewide. Sites were chosen to monitor agricultural drainage and municipal industrial drainage into Ohio rivers and streams. The sampling sites are shown in Figure 3 and are listed in Table 9.

Pesticide contamination into these rivers can arise from home and garden use, industrial, commercial, and municipal sources, in the highly populated areas of southwest, central, and northeast Ohio. Agricultural sources are heaviest in the northwest. Due to social-economic conditions, pesticide usage in southeast Ohio is minimal.

The pesticide monitoring program includes monthly grab samples from twenty-six sites (See Figure 3) from April through November. Samples are analyzed by the Ohio Department of Health labs for the following pesticides: aldrin, lindane, chlordane, DDD, DDE, DDT, dieldrin, endrin, heptachlor, heptachlor-epoxide, methoxychlor, malathion, parathion, methylparathion, and BHC.

Data handling of the pesticide analysis sheet is done by the Division of Data and Systems, Ohio EPA, which enters information into the Federal STORET Water Quality Data System. Copies of the pesticide analysis sheet are maintained in the district office files and also in Columbus.

FIGURE 3



STATE OF OHIO
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF GEOLOGICAL SURVEY

FY-77
Pesticide Monitoring Stations

PRINCIPAL STREAMS AND THEIR DRAINAGE AREAS

TABLE 9

Stations Monitored During Fiscal Year 1977 For Pesticide Parameters

Maumee R. at Waterville

Portage R. at Woodville

Sandusky R. near Fremont

Huron R. below Milan

Vermilion R. near Vermilion

Black R. at Elyria

Rocky R. near Berea

Cuyahoga R. at Cleveland

Chagrin R. at Willoughby

Grand R. at Painesville

Ashtabula R. at Ashtabula

Conneaut Crk. at Conneaut

Ottawa R. at Kalida

Blanchard R. near Findlay

Auglaize R. at Defiance

Tiffin R. near Defiance

Great Miami R. below Piqua

Great Miami at Miamisburg

Stillwater R. above West Milton

Little Miami R. at Milford

Scioto R. at Dublin Rd.

Hocking R. at Enterprise

Licking R. near Newark

Little Beaver Crk. near E. Liverpool

Big Darby Crk. below W. Jefferson

Wabash R. at State line

Because these pesticide chemicals are relatively insoluble in water, detection of residues from grab samples indicates that in some areas of the state there may exist potential pesticide pollution problems. The data indicates that transport of these chemicals does occur through state surface waters. In recent years the most frequent pesticides detected in surface waters have been BHC and Lindane. The levels at which these residues occur do not pose any immediate health hazard; long range effects would be difficult to predict. More intensive sampling would have to be done to better define potential problems as well as to illustrate more statistically sound trends.

POINT SOURCES OF POLLUTION

Point sources of pollution are direct discharges of wastewater to a stream such as by a pipe, outfall, or ditch. Examples of point sources would be a municipal wastewater treatment plant or an industrial facility. Point sources differ from nonpoint sources in two ways: 1) point sources discharge, relatively speaking, a constant load to a receiving stream; this means that concentrations in the stream due to point sources decrease with increasing stream flow (become diluted as flow increases), 2) point sources have their greatest impact on streams during low flow periods (in some instances, point sources may be the sole source of flow in a stream during critical low flow periods). This section will examine the impact on water quality of industrial and municipal point sources. To facilitate the discussion, the state has been divided into 5 major river drainage regions: northwest, northeast, southeast, southwest and central. Figure 4 shows the location of these regions.

FIGURE 4

Major River Drainage Regions in Ohio

plant are believed responsible for high concentrations of phosphorus, lead, nickel, and zinc found in the two streams. The Village of Anna's wastewater treatment plant (WWTP) discharges to Clay Creek near its headquarters. Until January 31, 1977, Richardson Electroplating discharged heavy metals both to the WWTP and to Clay Creek via a storm sewer. Since Richardson has ceased operations, improvement in the water quality of Clay Creek with respect to heavy metals is anticipated. Ammonia and heavy metals problems have been documented downstream of Sidney's WWTP which discharges to the Great Miami River mainstem.

Several changes have been made which should improve water quality in this subbasin. In terms of municipal point sources, one discharge was eliminated, while one plant expanded its capacity and a new plant came on-line. Industrial dischargers spent a total $235,000 for improvements (K & S Circuits in Phillipsburg and Copeland Corp. in Sidney). Two industries formerly having discharges have either eliminated these discharges or improved on their quality (Farmview Meats in St. Paris and Logan Finishing in Lakeview), while another industry ceased operations (Richardson Electroplating in Anna).

(2) Stillwater River Subbasin

Good to high quality water is found in this subbasin, particularly in the upper segments near the headwaters. Although water quality

1. Southwest Region

This region is heavily populated, particularly the area between Cincinnati and Dayton. Continued population growth for the remainder of the century is expected here. Fecal coliform, low dissolved oxygen (DO) heavy metals, combined sewer overflows, and thermal pollution are the major water quality problems occurring in the region. The major drainage basins in the region are the Great Miami, Little Miami, Mill Creek, and the minor southwest tributaries to the Ohio River.

A. Great Miami River Basin

It is easier to discuss water quality in the Great Miami Basin by dividing it into four subbasins: 1) the upper Great Miami Subbasin which encompasses the area tributary to the Great Miami mainstem above Dayton, 2) the Mad River Subbasin, 3) the Stillwater River Subbasin, 4) and the lower Great Miami Subbasin which includes all the area within the Great Miami Basin from Dayton (mile 82.6) to the mouth and not covered by nos. 1, 2, and 3.

(1) Upper Great Miami River Subbasin

Water quality standards generally are being met in this subbasin. Nonetheless, some problem areas do exist. Even though water quality standards may not be violated, high concentrations of certain parameters are indicative of potential problems.

The problem of larger point source dischargers to small receiving streams creates localized problems in this subbasin. Two examples of this are Possum Run and Blue Jacket Creek downstream of the City of Bellefointaine, and Clay Run downstream of the Village of Anna. In the case of Bellefontaine, discharges from the wastewater treatment

standards are being met in this subbasin, elevated nutrient levels may signal potential problems in the future. For evaluation purposes, the federally recommended maximum level for phosphorus of 0.1 mg/l is used. With this value in mind, two potential problem areas are noted. One is Greenville Creek downstream of the Greenville WWTP where the phosphorus concentration averaged 0.31 mg/l, and the other is the mainstem near its mouth in Dayton where the phosphorus concentration averaged 0.32 mg/l. Sand and gravel operations and nonpoint source pollution have caused high turbidity readings in the lower segment of the mainstem. This problem should improve since Woodville Concrete has eliminated its discharge to the river. Rapid urban growth in the lower portions of this basin may impair future water quality. Objections by some basin residents caused Ohio Department of Natural Resources to remove scenic river status designation for this basin.

(3) Mad River Subbasin

Like the Stillwater River Subbasin, the Mad River Subbasin is characterized by having good to high quality water. This is particularly true of the headwaters and its tributaries which are spring fed, clear, cold and have good volume. Two areas of persistent degradation do exist in the upper segments. These include Dugan's Run which is affected by municipal and industrial discharges and the Mad River mainstem downstream of the Urbana WWTP.

The lower segment (from Springfield to the mouth) shows the effects of point source discharges. Figure 5 depicts seasonal concentrations of total phosphorus in the lower segment (Huffman Dam) compared to the nearly phosphorus free upper segment (S.R. 26). A few major point

FIG' 5

1977 SEASONAL TOTAL PHOSPHORUS CONCENTRATIONS
FOR THE MAD RIVER AT HUFFMAN DAM
(RIVER MILE 5.2) AND S.R. 36 (RIVER MILE 40.3)

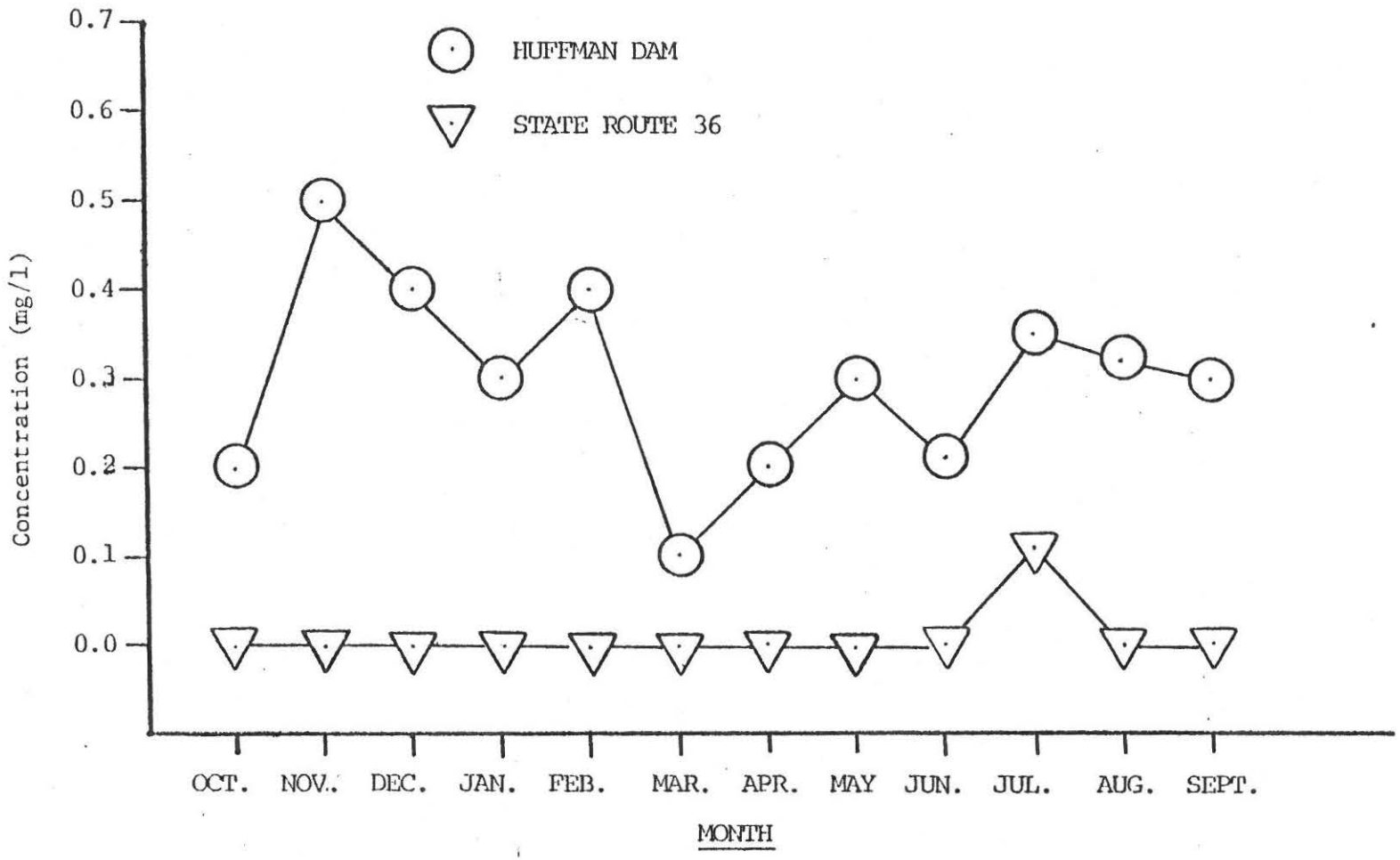


FIGURE 6
1977

SEASONAL AMMONIA AVERAGES ON THE
GREAT MIAMI RIVER AT MIAMISBURG (S.R. 725) AND
ELIZABETHTOWN (LAWRENCEBURG ROAD)

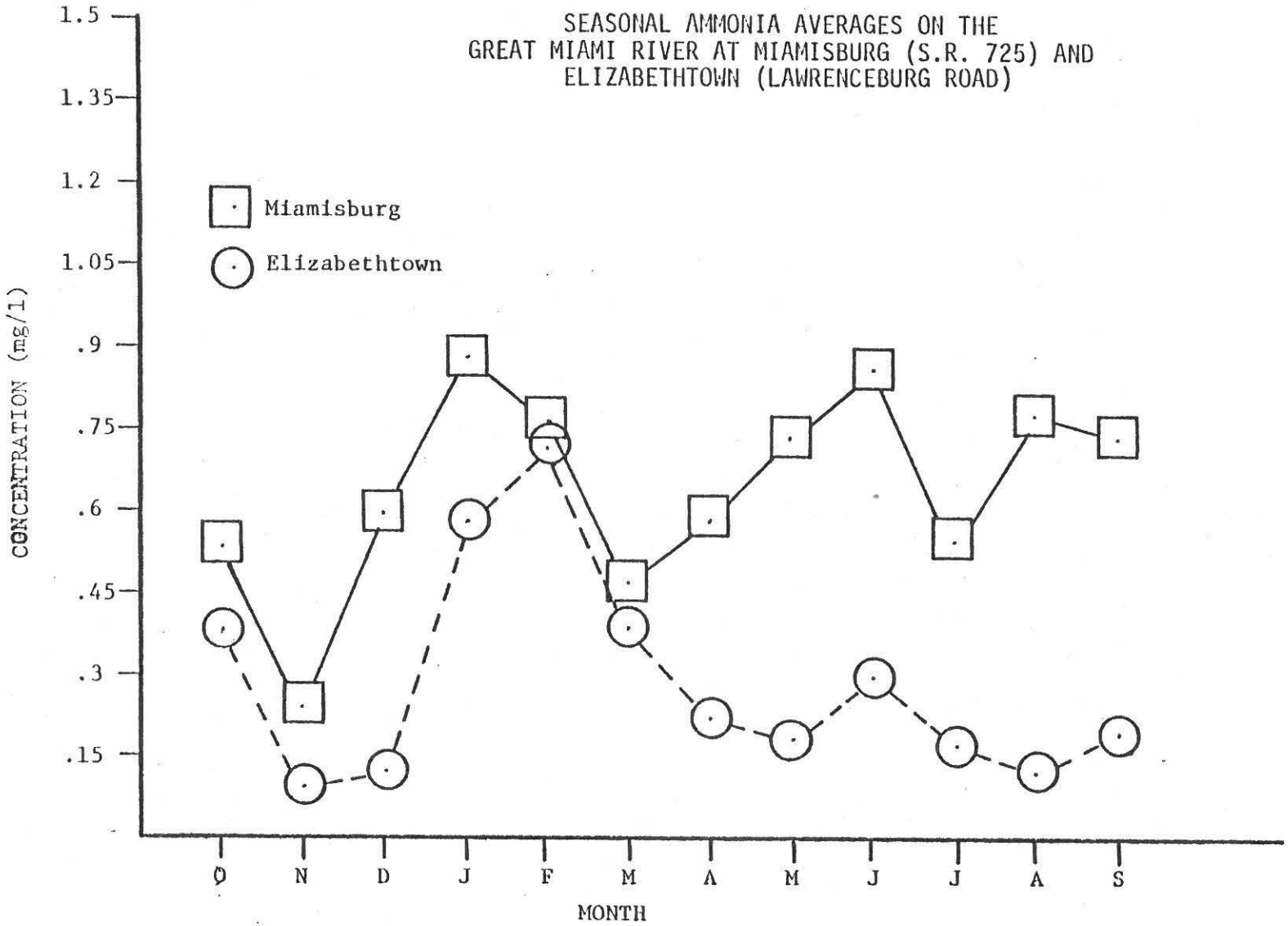
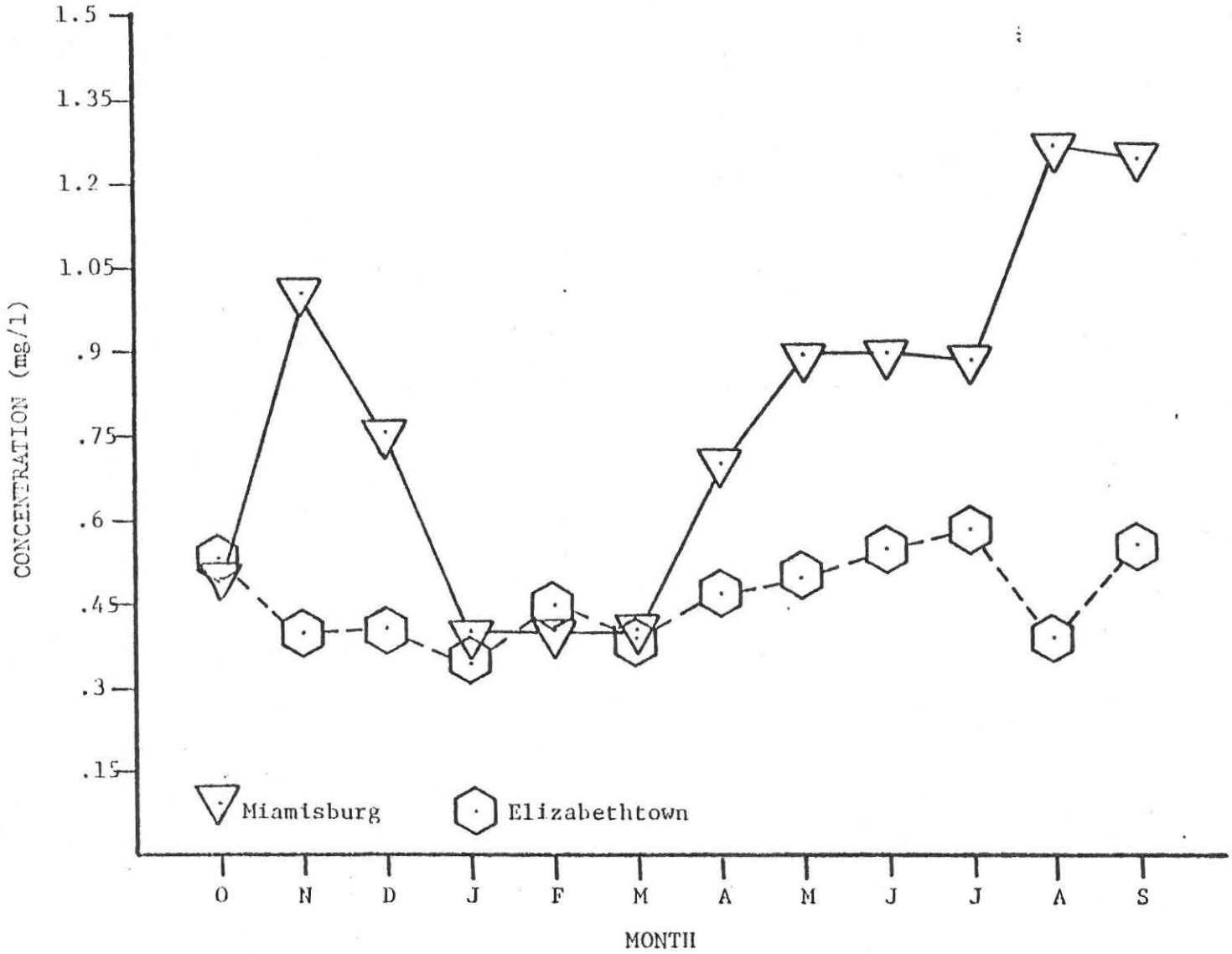


FIGURE 7
1977

SEASONAL TOTAL PHOSPHORUS AVERAGES ON THE GREAT MIAMI RIVER AT MIAMISBURG (S.R. 725) AND ELIZABETHTOWN (LAWRENCEBURG ROAD)



sources known to affect general water quality in the lower segment include: 1) intermittent point sources on Buck Creek, 2) the Ohio Edison Power Plant in Springfield (thermal load), 3) the Springfield WWTP, and 4) the Park Layne WWTP (high concentrations of ammonia and total phosphorus).

(4) Lower Great Miami River Subbasin

Extensive urbanization best characterizes the lower subbasin. The cumulative effect of industrial and municipal wastewater discharges has a pronounced negative influence on water quality throughout the entire lower mainstem. Paper mills discharge dyes and suspended solids which are aesthetically displeasing, steel mills discharge toxic materials such as cyanide loadings which depress dissolved oxygen levels.

Figures 6 and 7 illustrate examples of water quality problems that characterize much of this lower subbasin. Undesirable stream conditions in Sevenmile Creek 1 to 2 miles below the Eaton WWTP result from chemical and biological degradation. Stream recovery occurs about 5 miles below the WWTP, and at the mouth water quality is again good. A good portion of the flow of Dick's Creek is made up of the effluent from Armco Steel Corporation's four wastewater outfalls. The stream below these outfalls is usually orange or brown in color and frequently has a surface oil film. Sludge banks also occur downstream of the outfalls. Heavy metal contamination is quite evident at the Yankee Road sampling station. Other localized problem areas include Four Mile Creek below Oxford, Gregory Creek below the Butler County Hycrest Acres WWTP, and throughout much of the Taylor Creek (Hamilton County) drainage basin. In these areas, loading from numerous septic tanks plus discharge from semi-

public package plants create high concentrations of ammonia, total phosphorus, depressed dissolved oxygen levels, and aesthetic degradation in the form of sludge deposits and non-degradable sewage debris.

Thermal pollution in this subbasin is found below power plant discharges. A special thermal study entitled "Thermal Investigations of the Great Miami River near Dayton Power and Light Plant" released in September 1975 by the Southwest District Ohio EPA indicated the following: "Temperature Measurements in the Great Miami River during the Dayton Power and Light (DP&L) Tait Station Thermal Investigation" revealed violations of water quality standards for allowable mixing zone cross-sectional area and widths. Furthermore, it is most probable that violations of mixing zone length could have been found if temperatures were measured further downstream from this survey. Thermal discharge loads for DP&L Tait Station were found to be in excess of allowable loadings calculated for critical low flow periods and for the flow during the specific survey data. Given upstream ambient river temperatures above 25°C, it is likely that river temperatures greater then 32.2°C would occur outside the mixing zone below the DP&L Tait Station. Such warm water would be above general thermal requirements of OAC 3745-1 during June, July, August, and September and would not be conducive to a healthy aquatic environment.

A significant number of new plants or pollution reduction efforts are underway in the lower Great Miami Subbasin which should result in the upgrading of water quality in this region. Total industrial improvement costs are estimated at $2,940,000.

1977 Water Year Summary

The data from the Ohio EPA ambient water quality monitoring sites have been reviewed for the Great Miami River Basin. The analysis of this data indicates no significant changes in the water quality during the 1977 water year. The Mad River System is considered to have the best water quality in the basin, while the lower Great Miami has the worst water quality. Improvements in industrial and municipal wastewater treatment systems are being made throughout the basin. Although no changes in ambient quality can be determined, Table 10 lists changes in wastewater treatment plants located in the Great Miami River Basin. This list includes, new, upgraded, and abandoned treatment facilities for municipal, semi-public, and industrial discharges.

TABLE 10

GREAT MIAMI RIVER BASIN

MUNICIPAL AND SEMI PUBLIC DISCHARGERS

New or Upgraded Plants

Miami Whitewater Forest WWTP - New
Butler County Greencrest WWTP - New
LeSourdsville Regional WWTP - New
Pleasant Hill WWTP - Upgraded

Abandoned Plants

Germantown WWTP - B616*AD

INDUSTRIAL DISCHARGERS

New or Upgraded Plants

Armco Steel (D102) - Hamilton - Cooling Tower recycling system
Bergstrom Paper (A104*BD) - Upgrade
Crystal Tissue (A100) - In-plant recycling
Dayton Tire and Rubber (R101*AD)- Upgraded oil and grease removal
Detling Poultry (N101*AD) - Improved BOD removal

New or Upgraded Plants (continued)

Farmview Meats - Pretreatment
Frigidaire (C108*AD) - Upgraded metals treatment and recycling
Gulf Oil (G100*AD) - Upgraded aeration
Ohio Edison Company (B107*AD) - Upgrade treatment
West Carrollton Parchment Company (A110*BD) - Upgrade treatment
Worthington Steel Company - Upgrade treatment
Miles Laboratories (N116) - New Plant

Abandoned Plants

AMF, Incorporated (C104*CD) - Ceased Operations
Chrysler Corporation Plant #2 (N118*AD) - Cooling water recycled
Dayton Power and Light, Third Street (B113*AD) - Tie-in with STP
Dayton Power and Light, Longworth (B114*AD) - Tie-in with STP
R. L. Drake Company - Ceased Operations
Gould, Incorporated (C110*BD) - Tie-in with STP
Richardson Electroplating (C114*AD) - Ceased Operations

B. Little Miami River Basin

The upper segment of this basin (headwaters to confluence with Caesar Creek) is characterized by clean, spring fed tributaries which produce good to high quality waters. Water quality standards violations of ammonia and heavy metals did occur in this region at two stations. There was one hexavalent chromium violation noted on the Little Miami mainstem at Roxanna-New Burlington Road. Eight of ten ammonia samples taken on Beaver Creek at Factory Road violated standards, and on Little Beaver Creek at Factory Road, all 10 samples collected violated water quality standards. The latter stations also had an average total phosphorus concentration of 3.5 mg/l. Discharges from the Montgomery County Eastern Regional WWTP, Beaver Creek WWTP, and numerous semi-public dischargers are the probable causes of water quality degradation in these streams. Further water quality degradation occurs below Massie Creek due to urbanization patterns from nearby Xenia, Greene County and Southeastern Dayton. Nutrient values and biochemical oxygen demanding (BOD) wastes show a twofold increase in this area when compared to a headwater station.

The Little Beaver Creek and Beaver Creek Basins deserve special mention. The major point source in these two basins is the 10 million gallon a day Montgomery County Eastern Regional WWTP. Beginning at river mile 5.1 above the Eastern Regional WWTP, water quality is good. However, at Grange Hall Road (river mile 3.5), the water quality standards for ammonia are violated continuously at a yearly average of 5.82 mg/l. Although water quality shows improvement at the mouth (Factory Road),

high concentrations of total phosphorus and BOD_5 are still evident, and the ammonia concentration is still in violation of water quality standards at an average concentration of 3.55 mg/l.

Moving downstream, the middle segment (river mile 49.2 to 11.1) of the Little Miami has generally good water quality as the stream is beginning to recover from upstream loads. Localized water quality problems exist on Muddy Creek, Turtle Creek, and Sycamore Creek. However, the major problem occurs on Lytle Creek below the Wilmington WWTP and Randall Company (metal finishing) outfalls. Here, BOD_5, ammonia, phosphorus, lead, and zinc concentrations are high.

Water quality in this segment should improve with the expansion and upgrading of one WWTP and the construction of two new plants. Also, one industry ('TOTES', Inc.) reduced its chlorine discharge.

Water quality in the East Fork of the Little Miami River is generally good. The average phosphorus concentration near the mouth increased from 0.28 mg/l during water year 1975 to 0.68 mg/l in 1976. This increase is attributable to increased point source loads and lower stream flows. Bypassing of raw sewage from the Hall Run WWTP creates water quality problems in Hall Run. A similar situation occurs in the Shayler Run system. Both problems will be corrected by the East Fork Regional WWTP.

Water quality standards violations were noted at two stations in the lower segment (river mile 11.1 to mouth). The stations were Duck Creek at Wooster Pike where one dissolved oxygen, two ammonia, and one pH violations occurred, and Little Miami mainstem at Beechmont

Levy where one cadmium and one lead violation occurred. The Duck Creek station also had an average total phosphorus concentration of 1.08 mg/l. The water quality problems occurring in Duck Creek may be the result of industrial sources and combined sewer overflows. The heavy metals problem at the Beechmont Levy are probably due to urban runoff from parking lots and road drainage. Improvements in water quality of Dry Run are anticipated with the improvements in two municipal plants.

In assessing long term water quality improvements, several factors including flow patterns, rainfall and point and non-point sources must be evaluated and considered. Dissolved oxygen (D.O.) levels in the Little Miami mainstem at Spring Valley from 1970-1977 show that D.O. levels have improved significantly during the past 7 years. However, data covering the most recent three years, especially for ammonia and total phosphorus, shows a worsening of actual water quality. Figures 8 and 9 illustrate changes in water quality by river mile for average dissolved oxygen, BOD_5, ammonia, and total phosphorus values during the summer months of 1977. All 4 parameters show the degradation in water quality that occurs near Spring Valley due to municipal wastewater discharges from Xenia, Greene County and Eastern Montgomery County. Water Quality standard violations were found for ammonia, hexavalent chromium, copper, pH, dissolved oxygen, cadmium, and lead.

1977 Water Year Summary

The data from the Ohio EPA ambient water quality monitoring sites have been reviewed for the Little Miami River Basin. The analysis of this data indicates no significant changes in water quality during the 1977 water year. Although no changes in ambient quality can be determined, Table 11 lists changes in wastewater treatment plants located in the Little Miami River Basin. This list includes new, upgraded, and abandoned treatment facilities for municipal, semi-public, and industrial discharges.

Two reservoir projects on major tributaries of this basin have been under construction for several years. Both of these projects, Caesar Creek Reservoir and East Fork Reservoir, are nearing completion.

CAESAR CREEK RESERVOIR

The lake project conducted by the Army Corps of Engineers is proposed to be completed in the Spring of 1978, if the usual abundance of runoff is available from spring rains. The dam site is approximately three miles above the mouth of Caesar Creek, which is a tributary of the Little Miami River. The seasonal capacity of the lake will be 8,300 acre-feet and the additional area available for flood control purposes is 148,500 acre-feet. The dam will provide continuous flow to Caesar Creek allowing at least 15 $ft.^3/sec.$ during all times of the year. The dam has the capability of releasing water from several layers in the lake column to prevent drawing only from the epilimnion (which would be detrimental to the lake) or from the hypolimnion (which would be detrimental to the stream). The annual drawdown will be three feet. Construction of the camp ground sites,

picnic grounds, and public facilities will not be fully completed until 1980 when it will be turned over to the Department of Natural Resources.

EAST FORK RESERVOIR

The lake project conducted by the Army Corps of Engineers was proposed to be completed by the Spring of 1978. As of late March, the lake was approximately one half full, or 10-20 foot down below completed elevation, and being drawn down. Plans to build a county water intake to tap the lake as a water supply are in progress. The lake will be drawn down to almost zero in the winter to prepare for Spring construction. To prevent deliterious affects of drawing down during bird and fish nesting and spawning times, the lake level will not be brought to normal seasonal pool elevation. The dam site lies about twenty-one miles above the East Fork's confluence with the Little Miami River, with 342 square miles in its drainage basin. At a minimum, the dam will provide 4 $ft.^3$/sec. to the East Fork year around. The low-flow bypass system will have multi-level inlets to permit temperature control of the water released. The seasonal capacity will be approximately 9,207 acre-feet and another 211,755 acre-feet can be contained as a flood control measure. The annual drawdown is four feet. When completed, the Department of Natural Resources will be responsible for the project with the exception of the actual dam site.

Under the provisions of the new Ohio Water Quality Standards both of these reservoirs will be classified as exceptional warmwater habitats and State and National resource waters. In addition, Ohio EPA policy prohibits new discharges into State-owned lakes and reservoirs.

The effect that these two projects will have on water quality (both in the reservoirs and streams) is not known. Monitoring will take place during the 1978 water year to determine any changes in ambient water quality.

TABLE 11

LITTLE MIAMI RIVER BASIN

MUNICIPAL AND SEMI PUBLIC DISCHARGERS

New or Upgraded Plants

Green County (Sugarcreek) WWTP - New
Tanager Woods WWTP - New
Landen WWTP - New

Abandoned Plants

Bellbrook WWTP (A602*AD)
Academy Heights WWTP (G600*AD)
Winterhaven WWTP (G635*AD)
Montgomery County Sugarcreek WWTP (H606*CD)

INDUSTRIAL DISCHARGERS

New or Upgraded Plants

Cincinnati Milacron (C106*CD) - Upgraded treatment of plating wastes
Clermont Ready Mix - Settling and off site disposal
"totes", Inc. (R100*BD) - Industrial WWTP

Abandoned Plants

NONE

FIGURE 8

AVERAGE SUMMER VALUES (JASO-1977) FOR DISSOLVED OXYGEN (D.O.) AND BOD_5 ON THE LITTLE MIAMI MAIN STEM BY RIVER MILE (OEPA DATA)

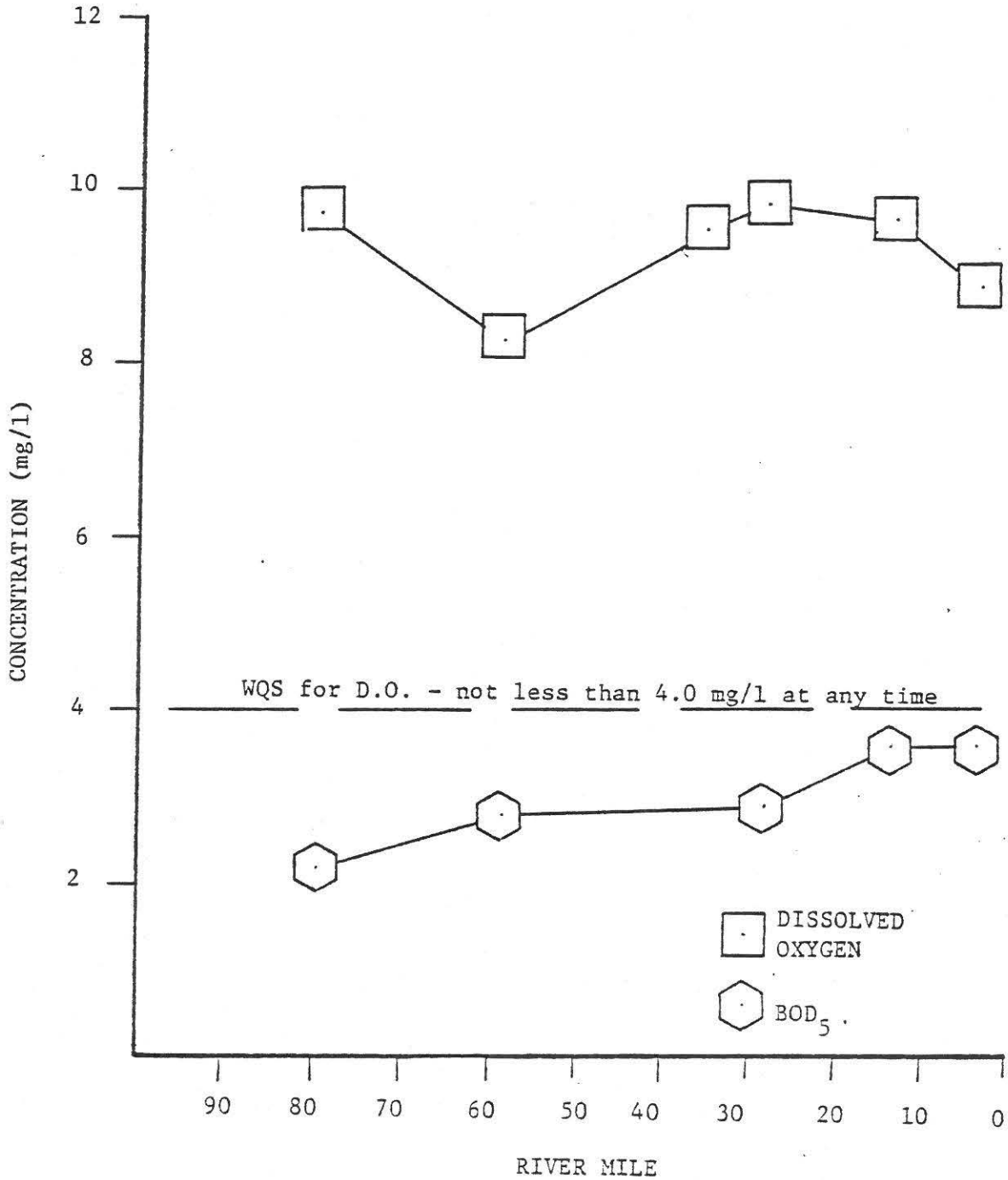
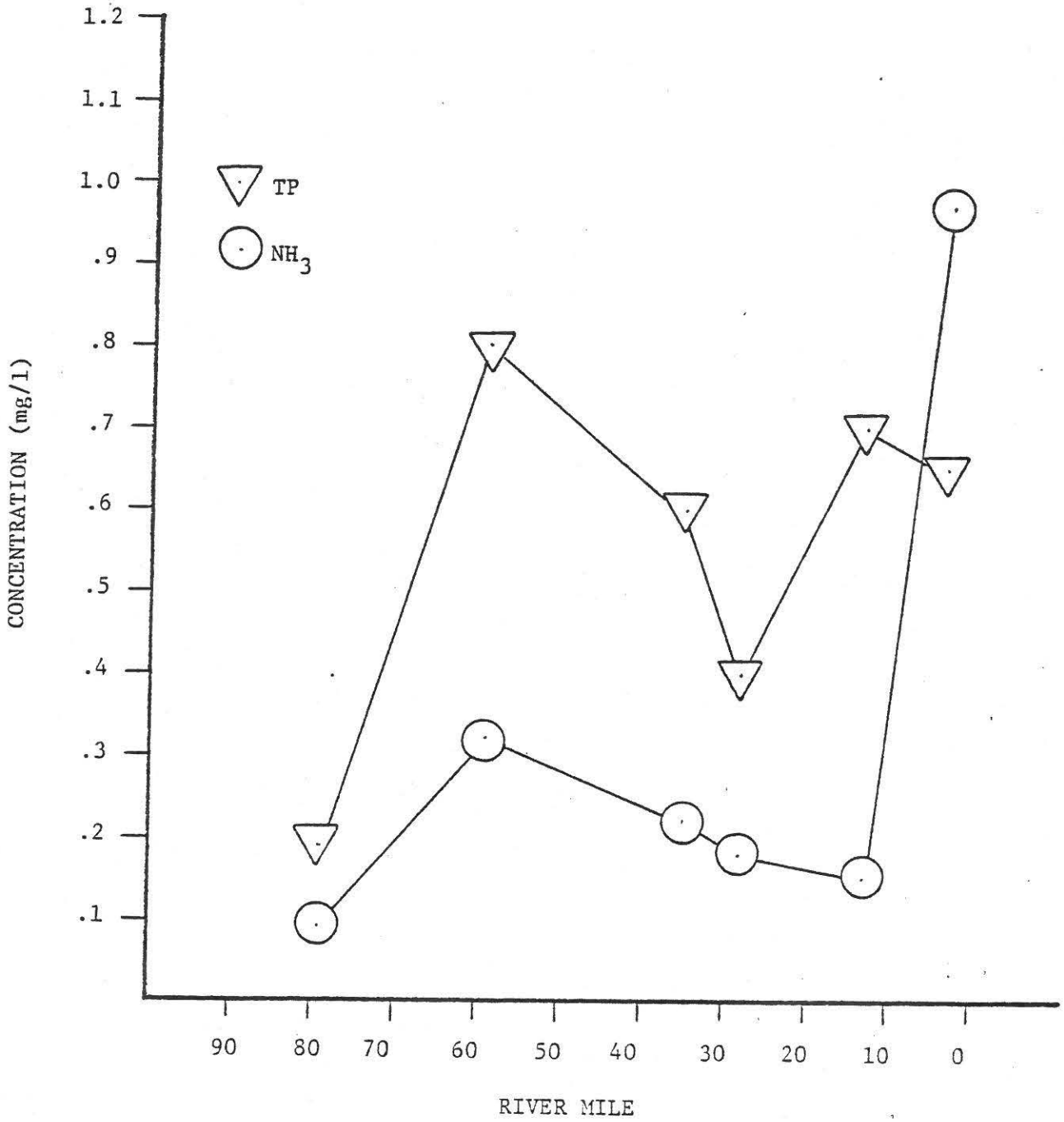


Figure 9
AVERAGE SUMMER VALUES (JASO-1977) FOR
TOTAL PHOSPHORUS (TP) AND AMMONIA (NH_3) ON
THE LITTLE MIAMI MAIN STEM BY RIVER MILE
(OEPA DATA)



C. Mill Creek Basin

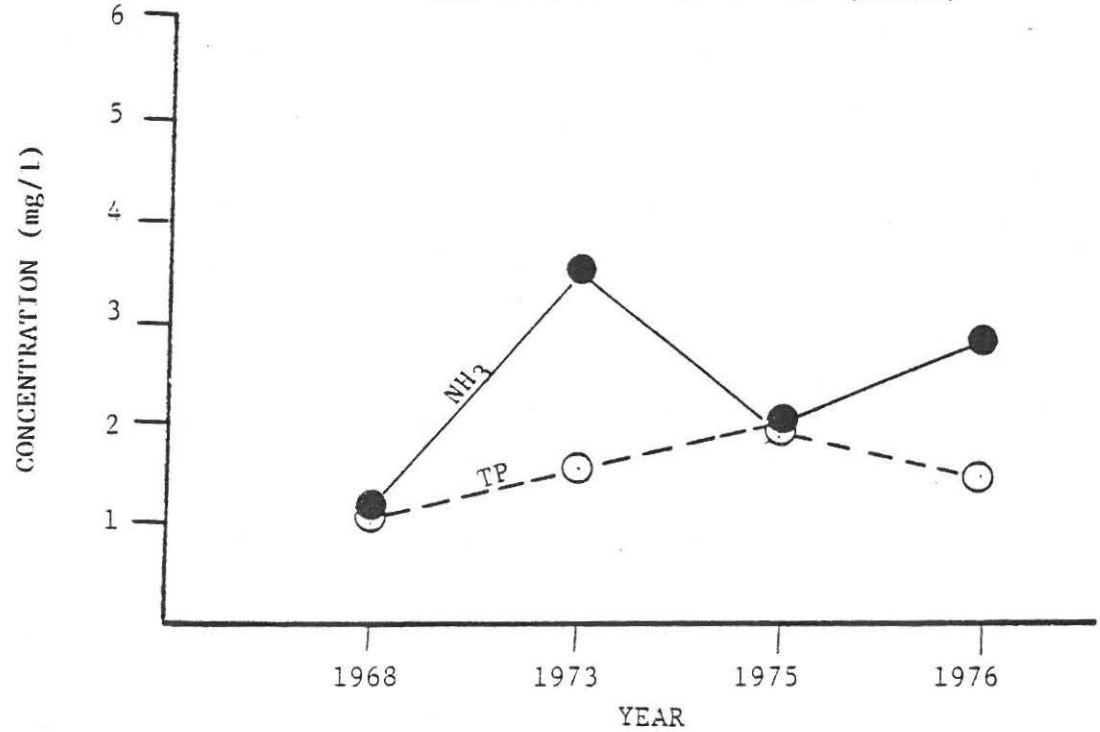
Water quality in the upper segment (headwaters to river mile 16.2) is degraded. One water quality standard violation was noted at the Sharon Road monitoring station for each of the following parameters: phenols, oil and grease, cadmium, and lead. Water quality problems at this station and two others (no violations) are due to semi-public package plants that discharge to streams that may have no flow at critical low flow periods. Intensive surveys in this area show that the average ammonia and total phosphorus concentration from the 16 semi-public and public WWTP are 4.3 mg/l and 6.6 mg/l respectively.

Water quality in the lower segment (river mile 16.2 to mouth) in this basin is extremely degraded. Numerous water quality standard violations for a variety of parameters were documented for this segment. For example, at Gest Street in Cincinnati, 8 of 13 samples for D.O. showed violations; 10 of 12 samples of ammonia were greater than 1.5 mg/l standard; 7 of 9 samples for phenols were in violation; 2 of 6 samples for lead were in violation; and 1 of 8 samples for zinc were in violation. Although no violations, elevated levels of total phosphorus and BOD_5 were noted at several sampling stations throughout the lower segment.

Urban runoff, combined storm sewer overflows, and numerous industrial discharges contribute heavily to the severe degradation of water quality in the lower segment. Figure 10 depicts water quality trends for 4 parameters at Gest Street (Cincinnati) which is near the mouth. By far the most degraded area of the mainstem is below Wayne Avenue (Cincinnati). Here, intermittent point source discharges contribute excessive loads of BOD_5, suspended solids, ammonia, and total phosphorus. Industrial dischargers add significant quantities of oil and grease, metals, and phenols.

FIGURE 10

AMMONIA (NH_3), TOTAL PHOSPHORUS (TP), BOD_5, AND DISSOLVED OXYGEN (D.O.) TRENDS FOR MILL CREEK AT GEST STREET (MOUTH)



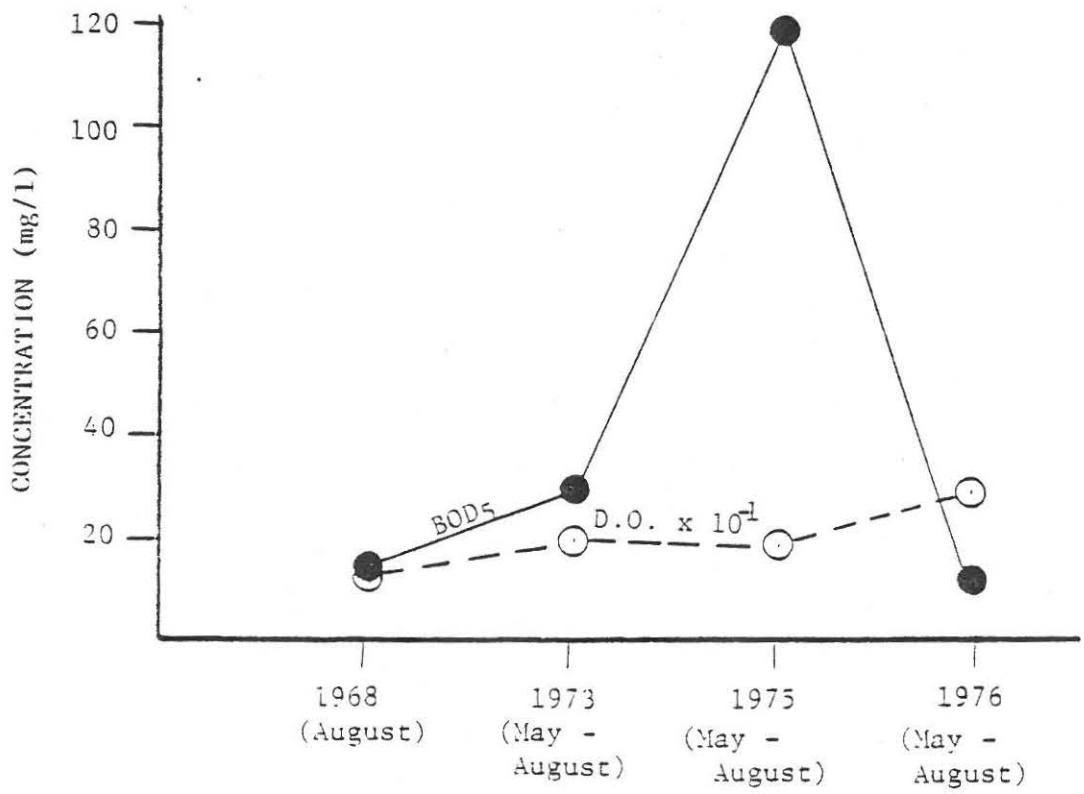
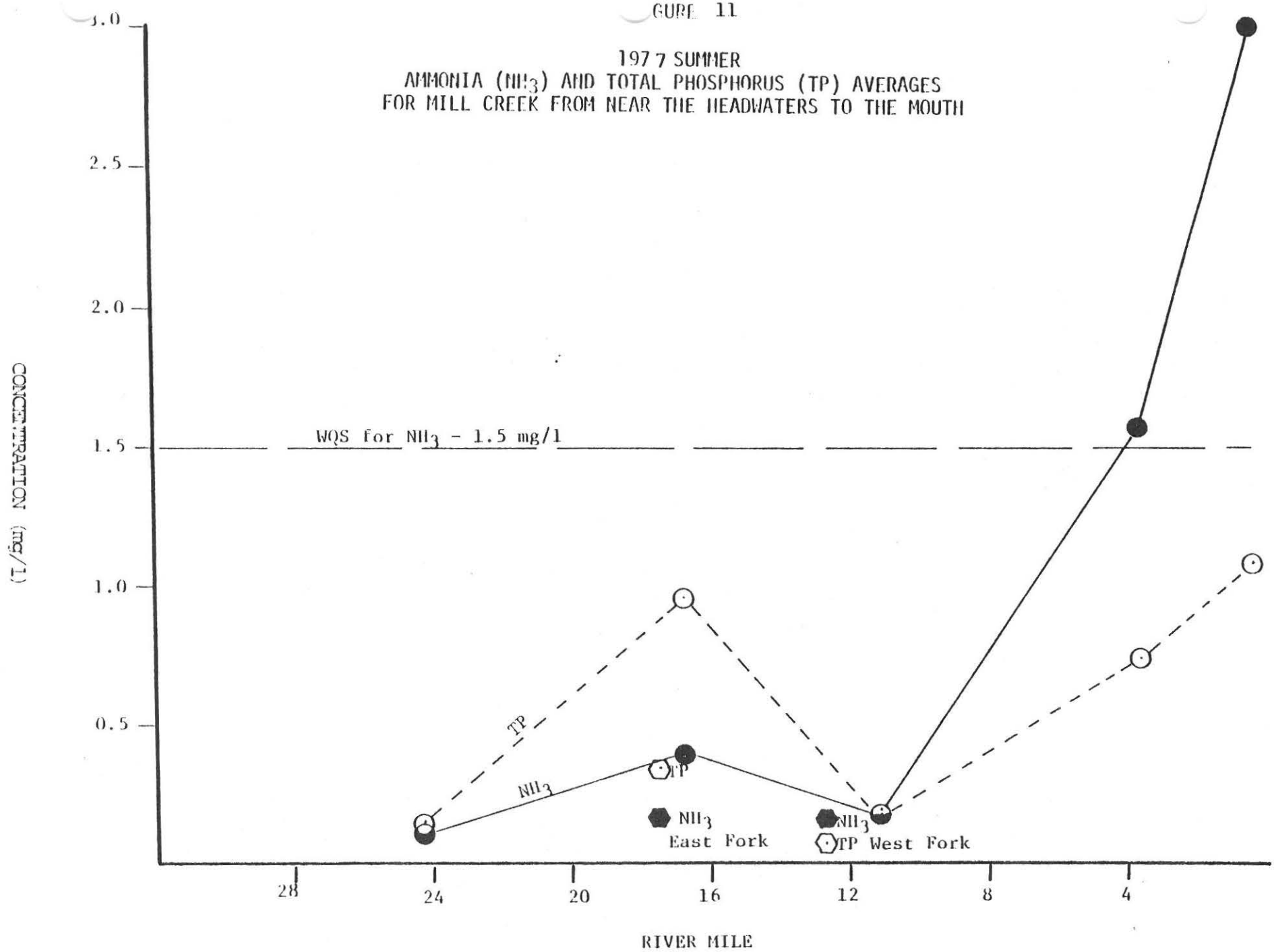


FIGURE 11


1977 SUMMER
AMMONIA (NH_3) AND TOTAL PHOSPHORUS (TP) AVERAGES
FOR MILL CREEK FROM NEAR THE HEADWATERS TO THE MOUTH
3.0
2.5
2.0
1.5
1.0
0.5
CONCENTRATION (mg/l)
WQS for NH_3 - 1.5 mg/l
TP
NH_3
TP
NH_3
East Fork
NH_3
TP West Fork
28
24
20
16
12
8
4
RIVER MILE

Industrial improvements totaling $91,000 should help improve water quality in the lower segment. Proctor and Gamble spent about $80,000 for acid control, while two other industries (Central Soya and McKesson Chemical) eliminated their discharges.

Water Quality in Mill Creek Basin is poor. It is degraded in the upper reaches because of numerous public and semi-public treatment plants discharging to small tributaries. It is extremely poor in the lower segments because of numerous combined storm sewer overflows in the Cincinnati area and many industrial discharges containing high levels of oil and grease, metals, and phenols. Figures 11 illustrates the degradation that takes place in Mill Creek from the headwaters to the mouth. Attainment of water quality standards in the lower segment of the basin will be difficult because of the enormous costs involved in correcting problems due to combined sewer overflows. Achievement of water quality standards in the upper segment should be possible with proper planning.

1977 Water Year Summary

The data from the Ohio EPA ambient water quality monitoring sites have been reviewed for the Mill Creek Basin. The analysis of this data indicates no significant change in water quality during the 1977 water year. Although no changes in ambient quality can be determined, Table 12 lists changes in wastewater treatment plants located in the Mill Creek Basin. This list includes new, upgraded, and abandoned treatment facilities for municipal, semi-public, and industrial discharges.

TABLE 12

MILL CREEK BASIN

MUNICIPAL AND SEMI-PUBLIC DISCHARGERS

New or Upgraded Plants

NONE

Abandoned Plants

NONE

INDUSTRIAL DISCHARGERS

New or Upgraded Plants

Emery Industries - Pretreatment, oil and grease removal
Ford Transmission - Pretreatment, oil and grease removal
General Electric (N106*AD) - Upgrade oil and grease treatment
General Motors Assembly - Pretreatment

Abandoned Plants

NONE

OHIO RIVER BASIN

The monitoring of the ambient water quality of the Ohio River is the responsibility of the Ohio River Valley Water Sanitation Commission (ORSANCO). However, dischargers into the Ohio River from Ohio are under the NPDES permit system as administered by the Ohio EPA. For this reason, Table 13 lists changes in wastewater treatment plants discharging into the Ohio River. This list includes new, upgraded, and abandoned treatment facilities for municipal, semi-public, and industrial discharges.

TABLE 13

OHIO RIVER BASIN

MUNICIPAL AND SEMI-PUBLIC DISCHARGERS

New or Upgraded Plants

NONE

Abandoned Plants

NONE

INDUSTRIAL DISCHARGERS

New or Upgraded Plants

C. F. Industries - Spill control
Chevron Asphalt (F100*AD) - Secondary Oil/Water separation
Cincinnati Gas and Electric Company, Miami Fort (B101*AD)
Coal runoff detention and neutralization
Cincinnati Gas and Electric Company, Beckjord (B100*AD)
Coal pile runoff treatment
Monsanto Chemical Company (F101) - Upgraded treatment facilities

Abandoned Plants

NONE

TABLE 14

SUMMARY OF INDUSTRIAL AND MUNICIPAL DISCHARGER IMPROVEMENTS IN MINOR SOUTHWEST OHIO RIVER TRIBUATRIES

County	Facility	Affected Stream	Status/Description
Clermont	Beechmont Woods WWTP	Trib. to Eight Mile Cr.	Under Construction
Clermont	Hopple Hill Farms WWTP	Trib. to Nine Mile Cr.	Under Construction
Hamilton	Foxtrail Farms WWTP	Five Mile Creek	New Plant

A. Municipals

County	Facility	Affected Stream	Status/Description
Hamilton	Cleves WWTP (new name-Indian Creek WWTP)	Ohio River	Turned over to MSD-expansion and improved treatment under construction
Hamilton	Little Miami WWTP	Ohio River	Secondary treatment under construction: to be totally completed by 7-1-78 (primary tanks to be renovated.
Hamilton	Mill Creek WWTP	Ohio River	Secondary treatment under construction; to be completed by 7-1-77

B. Industrials

Hamilton	Ashland Petroleum	Ohio River	Installation of oil/water separator
Hamilton	Chevron Asphalt	Ohio River	Treatment Plant approved (Cost - $94,000)
Hamilton	CG&E - Beckjord	Ohio River	Oil barrier (Cost-$10,000) Coal Pile Runoff (Cost-$150,000
Hamilton	CG&E - Miami Fort	Ohio River	Coal Pile Runoff (Cost-$220,000
Hamilton	CG&E - West End	Ohio River	All flows stopped
Hamilton	Hilltop Concrete	Ohio River	Settling/Neutralization construction started (Cost-$75,000)
Hamilton	Monsanto	Ohio River	Construction started (Cost-$2,400,000)
Hamilton	Tresler Oil	Ohio River	Neutralization (Cost-$20,000)

Total Industrial Improvement Cost $3,969,000

D. Minor Southwest Ohio River Tributaries

The minor southwest Ohio River streams include Four Mile Creek, Five Mile Creek, Eight Mile Creek, Nine Mile Creek, Ten Mile Creek, Twelve Mile Creek, Indian Creek, Bear Creek, Bullskin Creek and Muddy Creek. The only water quality violations noted in any of these streams during the 1976 water year occurred on Eight Mile Creek which had 3 dissolved oxygen violations. Elevated concentrations of total phosphorus were noted in a few streams.

There are a total of 15 known point sources. The major impact of these point sources appears to be the creation of isolated problem areas resulting from overloaded or poorly operated treatment facilities. There are also a number of intermittent point sources (storm sewer and combined storm sewer discharge points) in those streams flowing through Cincinnati. In many cases, severe degradation of stream water quality occurs below these types of discharges.

Table 14 lists those industrial and municipal facilities in the minor southwest Ohio River Tributary area that have made an effort to reduce pollution thereby upgrading water quality in this area.

2. Northwest Region

This region of the state consists of predominantly flat agricultural lands. The soils in this area are relatively impermeable resulting in runoff problems. As previously discussed, erosion of soil from agricultural lands and other sources with its subsequent transport of sediment to waterways is the primary water quality problem in this region. In addition, several industrial and municipal point source discharges give rise to localized water quality problems. Significant localized problem areas occur in the Ottawa River below Lima, the Blanchard River below Findlay, the Auglaize River below Wapakoneta, the Maumee River in the Toledo area, and the Sandusky River below Bucyrus and Fremont. The major drainage basins included in this region are the Maumee, Portage, Sandusky, Huron, and Vermilion.

A. Maumee River Basin

The primary water quality problems within the Maumee River Basin are violations of the water quality standard for fecal coliform bacteria, high nutrient concentrations and transport, a heavy suspended solids load, high turbidity, and occasional nuisance algal blooms with associated excessive diurnal oxygen and pH fluctuations. Concentrations of copper and zinc occasionally exceed standards; however the only consistent heavy metal violation is for hexavalent chromium in the Ottawa River downstream from Lima. Violation of the water quality standard for dissolved oxygen and ammonia occur at sampling stations in the Ottawa River downstream of Lima and in the Blanchard River below Findlay.

(1) Ottawa River Subbasin

The Ottawa River below Lima is seriously polluted due to discharges of major industrial and municipal loads. Dissolved oxygen, fecal coliforms,

MBAS, chromium, phenols, cyanide, and ammonia standards are consistently violated. The effects of discharges in the Lima area can be detected at the Kalida station near the mouth, a distance of 34 miles. At Kalida, dissolved oxygen and fecal coliform violations occurred during the 1977 sampling period. Of the heavy metals, only total iron and manganese appeared to have somewhat high maximum concentrations. Upstream at the Allentown station, the effects of point source discharges in the Lima area are more readily apparent. Here violations of the standard for dissolved oxygen, fecal coliform, MBAS, phenols, and hexavalent chromium occurred during the sampling year. The yearly average ammonia concentration was 9.2 mg/l, while nitrates averaged 5.7 mg/l. Again, total iron and manganese were the only other heavy metals, aside from hexavalent chromium, to have somewhat high levels.

Although the Ottawa remains seriously polluted downstream from Lima, improvement has taken place. An Ohio Department of Natural Resource fish survey in 1960 indicated that fish had been eliminated from the entire Ottawa River downstream of Lima and even for several miles in the Auglaize River downstream of its confluence with the Ottawa River. Ohio EPA did a fish survey in 1977 and found 23 species of fish inhabiting the Ottawa River near its mouth. Eleven species of fish relatively tolerant of pollution were found in the Ottawa River 15 miles downstream of Lima. Above Lima, a well-balanced warm water fishery was noted with 25 species collected, but for 5 to 10 miles below Lima, fish continue to be absent.

Improved treatment by the Lima WWTP coupled with the city's efforts to abate combined sewer overflows have helped significantly to improve water quality in the Ottawa River. A major refinery and chemical facility both have installed facilities to reduce the amount of ammonia

discharged to the river from their respective outfalls. Nonetheless, the ammonia concentrations still is far too high to meet water quality standards. Further treatment was installed by these two industries (Standard Oil and Vistron) in 1977 which should continue to improve water quality downstream of Lima. Hopefully by 1980, the lower Ottawa River may again become an important sport fishery.

Special Studies

Ottawa River - Since 1975 the Northwest District Office and the Aquatic Biology Laboratory have been collecting biological and chemical/physical data on the Ottawa River in order to evaluate the impact of industrial and municipal waste loads from the Lima area on stream water quality. Dissolved oxygen, fecal coliforms, MBAS, chromium, and ammonia standards are consistently violated downstream from Lima. However, the frequency and magnitude of water quality standards violations has decreased considerably since 1975.

Industrial pollution has been reduced because of improvements at Vistron, Standard Oil, and other industries. The Lima STP constructed new facilities in 1976 and has installed a new storm sewer control system.

During 1976 and 1977 the Northwest District Office conducted a fish survey of the Ottawa River in order to evaluate the impact of improved water quality downstream from Lima. By 1960 fish populations had been eliminated for at least 40 miles downstream of Lima in the Ottawa and Auglaize Rivers because of severe industrial and municipal pollution. The area of severe pollution presently extends to the Allentown Dam (approximately 8.5 miles downstream of the Lima STP). The Ottawa River

The Ottawa River shows continued recovery downstream of the Allentown Dam; however, complete recovery does not take place until near the mouth of the river. Only the station upstream from Lima (river mile 44.3) and the station near the mouth (river mile 0.8) had fish communities indicative of healthy stream conditions. The other stations showed some degree of stress and were lower in numbers of species collected. Figure 14 shows the number of species of fish collected and the dissolved oxygen and ammonia concentrations in the Ottawa River.

The dissolved oxygen and ammonia data were collected on August 31, 1977; note that the dissolved oxygen data downstream from Allentown are extrapolated from data collected during 1976 (this is indicated by a dashed line). The station above Lima is characterized by high dissolved oxygen concentrations, low ammonia concentrations, and a well rounded fish community composed of at least 26 different species.

Dissolved oxygen problems from combined sewer overflows in Lima reduce the number of species of fish above the Lima STP to 12, chlorine toxicity was probably a major factor in further reducing the number of fish species to six below the Lima STP. The discharges of Standard Oil Refinery and Vistron increase instream ammonia concentrations significantly. The high ammonia concentrations in combination with decreasing dissolved oxygen concentration all but eliminate fish from the Ottawa River down to the Allentown Dam. Downstream of the Allentown Dam the number of fish species increases as dissolved oxygen concentrations increase and ammonia levels decline; however, complete stream recovery does not appear to take place until near the mouth of the Ottawa River.

(2) Blanchard River Subbasin

In the Blanchard River downstream of Findlay, water quality standards are often violated for dissolved oxygen, ammonia, and fecal coliform. The water quality problem here results from inadequate sewage treatment facilities in the City of Findlay. The WWTP is severely overloaded by industrial wastes, particularly oxygen demanding wastes and ammonia. During the 1977 sampling year at the stations below Findlay there were 3 dissolved oxygen violations, 6 fecal coliform violations and 1 MBAS violation. The yearly average ammonia concentration was 1.95 mg/l, while nitrates and total phosphorus averaged 4.6 mg/l and 1.3 mg/l respectively. Of the heavy metals, only total iron and manganese had somewhat high maximum yearly concentrations.

Findlay is presently completing Step I of its construction grant process. In addition, the City adopted a new pretreatment ordinance in 1977. Such an ordinance will reduce industrial hoadings to the WWTP until new facilities can be completed and should help improve water quality below Findlay.

Special Studies

Blanchard River - During the summer and fall of 1975 the Northwest District Office conducted a water quality investigation in order to evaluate the effect of the cities of Findlay and Ottawa on the water quality of the Blanchard River. Additional work was done in the summer and fall of 1976 and 1977 upstream and downstream from Findlay. Both biological and chemical/physical samples were collected in the 57 mile segment of river that extended from near the mouth of the river to upstream from Findlay.

The most severe water quality problems observed in the Blanchard River during the study were low dissolved oxygen concentrations and high nutrient levels downstream of the Findlay STP. Violations of Ohio's fecal coliform bacteria standard were found at all sampled stations. Ammonia levels exceeded the existing standard (1.5 mg/l) for at least seven miles downstream from the Findlay STP during 1975; this distance was approximately five miles during 1977 (see figures 12 and 13). Dissolved oxygen levels violated standards for approximately 15 miles downstream from the Findlay STP during the summer of 1977 (Figure 13).

Although dissolved oxygen standards were violated downstream of the Ottawa STP during the summer and fall of 1975 (no sampling was done in 1976 and 1977), the macroinvertebrate data showed only minor changes indicating the effect was not severe.

The macroinvertebrate community in the Blanchard River was heavily stressed for more than seven miles downstream of the Findlay STP during 1975. The community at Station 7 (6.8 miles below STP) showed a major improvement from 1975 to 1977; however, complete recovery of the biological community may not take place until 15 miles downstream of the STP because of lowered dissolved oxygen concentrations. The major change in fish populations upstream and downstream of the Findlay STP was the elimination of darters below the STP due to lowered dissolved oxygen concentrations. However, good numbers of young largemouth bass were found as near to the STP as 1.6 miles. These bass were in and below a large riffle where dissolved oxygen levels increased.

The effects of combined sewer overflows could be observed in Findlay upstream of the STP, however, the impact of these overflows does not appear to be nearly as deleterious to the biological community as that of the STP.

The Findlay STP was heavily overloaded by the Ohio Northern Sugar Plant during November and December of 1976. This overload severely stressed the biological community of the Blanchard River downstream of the STP. This effect was not as severe during 1977, since the Findlay STP was not overloaded as greatly as in 1976.

The improvements in water quality downstream from Findlay between 1975 and 1977 reflect improved operation of the Findlay STP; however, complete recovery of the river will not take place until the Findlay STP is upgraded and a strong pretreatment ordinance is enforced by the City of Findlay.

(3) Swan Creek Subbasin

The water quality in Swan Creek is degraded due to waste effluents from Swanton WWTP, Whitehouse WWTP, and several industrial sources. The greatest degradation of water quality in Swan Creek occurs in the lower section where combined sewer overflows frequently enter the stream from sewer regulators in the City of Toledo. No water quality data was collected by Ohio EPA on Swan Creek during the 1977 water year.

(4) Auglaize River Subbasin

The main water quality problem in this basin occurs in and below Wapakoneta. Combined sewer overflows and discharges from the WWTP are responsible for degradation of water quality in this area. The discharge from the WWTP is estimated to contribute 25% or more of the flow in the river for about 20% of the year.

Problematic parameters below the WWTP outfall include dissolved oxygen, nutrients and fecal coliform. At the Fort Jennings sampling station, violations for dissolved oxygen and fecal coliform were noted

during the 1977 water year. The yearly average nitrate concentration was 3.1 mg/l with the maximum being 11.4 mg/l. Total phosphorus averaged 0.4 mg/l. Total iron averaged 13.2 mg/l with a maximum of 29.0 mg/l. The river was sampled just downstream of the Wapakoneta WWTP. Elevated concentrations of cadmium, chromium, and nickel were detected. Stream recovery appears to begin about 2 1/2 miles below the outfall. Here, based on the benthic aquatic community found, the stream is characterized as being moderately polluted. Fairly good stream recovery appears to occur about 6 miles below the WWTP.

(5) Lower Maumee River

The lower Maumee River in the Toledo area experiences frequent violations of the standards for fecal coliform and dissolved oxygen. The problems in this area can be attributed to the discharge of raw sewage into the river from combined sewer overflows during periods of low flow and during runoff events.

The report on the lower Maumee River and Toledo area by Enviro-Control, Inc.[5] addresses the pollution problems in the estuary region of the Maumee River (mile point 41.1 to the mouth). The investigators found that sewage stenches were present in some areas and violations of the State's dissolved oxygen and fecal coliform standards were common. The study indicated that there was little difference in water quality from the Maumee-Perrysburg Bridge to the mouth of the Maumee River. Thermal stratification of the waters in the estuary was found to be rare and slight when it occurs.

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5 Horowitz, J., Adams, J.R., and Bazel, L.A., 1975, Water Pollution Investigation: Maumee River and Toledo Area, U.S. EPA Publication No. 905/9-74-018.

The report showed dissolved oxygen to be the most significant water quality problem in the Maumee River estuary. The dissolved oxygen concentration never violated Ohio's standard of 5 mg/l as a daily average upstream of the DiSalle Bridge (mile point 6.9). However, violations for dissolved oxygen frequently occur from the Anthony Wayne Bridge (mile point 5.4) to the mouth. Violations were most severe near the Craig Bridge (mile point 3.6) which is just below the outfall discharging cooling water from a power plant.

Long retention times in the Maumee estuary, sludge beds below river mile point 6, the erratic performance of Toledo's sewage treatment plant, a large cooling water discharge from a power plant, and large rural sources of landwash were cited as the major factors contributing to the degradation of water quality in the lower Maumee River. The authors of the Enviro-Control report concluded that Toledo's water quality problems are largely local in their consequences. Most of the solids, nitrogen, phosphorus, and oxygen-demanding wastes which enter Maumee Bay originate in the large drainage area above Toledo.

An eleven week study was conducted by the Toledo Metropolitan Area Council of Governments on the lower Maumee River during the summer of 1975. Samples were collected on a weekly basis at 1.5 mile intervals for a number of water quality parameters from river mile point 8.5 to the mouth of the Maumee River. In addition, dissolved oxygen, temperature, and conductivity were measured at 0.5 mile intervals.

Analysis of the data collected indicated that mixing of the waters was rather complete in the study area. Although nutrients appeared to be uniformly mixed from the mouth of the Maumee River to mile point 8.5, dissolved oxygen concentrations showed a decline at and below river mile

5.5. Dissolved oxygen concentrations frequently violated Ohio's instantaneous standard of 4 mg/l below river mile 5.5 and average dissolved oxygen concentrations were less than 5 mg/l from river mile 5.5 to the mouth. Violations for fecal coliform bacteria were numerous. Forty-three percent or 86 out of 198 samples for fecal coliform analysis were in excess of 400 colonies/100 ml for the entire study area.

Although the lower portion of the Maumee River estuary is heavily polluted, the effects are largely localized in the Toledo area. Most of the solids, nutrients and oxygen-demanding wastes entering Maumee Bay are derived from upstream sources, primarily agricultural runoff.

(6) Improvements Within the Maumee River Basin

Numerous industries within the Maumee River Basin have upgraded and improved their treatment facilities during the last five years. Improvement in wastewater effluents from refineries, food processers, platers and metal finishers, and the chemical industry has greatly improved water quality in many streams within the basin. Improvements at foundries, steel plants, glass manufacturing plants, rubber processing plants, and power plants have also upgraded water quality within the basin.

Equally important to improved water quality within the Maumee River Basin are new and improved treatment facilities constructed by municipalities. Since 1971, six new wastewater treatment plants have been constructed in the basin; seven plants have added additional treatment facilities; and nine localities have constructed interceptor sewers. Funds have been released for the construction of additional treatment facilities at the Swanton WWTP and for the construction of sewer interceptors at three different localities. In addition, numerous municipalities are at different "steps" in the construction grant process. At least four

municipalities began construction of new treatment facilities and interceptor sewers, and one began constructing additional facilities along with interceptor sewers during 1977. The net effect of this construction will be to improve water quality in areas immediately downstream from these municipalities, as well as to upgrade water quality in the basin as a whole.

In addition to improving treatment facilities, controls have been tightened for new home, on-site, waste disposal systems and wastewater treatment systems are required for new subdevelopments. Better surveillance has resulted in the upgrading and improved operation of existing facilities within the basin.

New and Improved Municipal Facilities

Completed

Haskins (Wood Co.) - New activated sludge plant with rapid filters, new sewer system.

Oregon (Lucas Co.) - New plant, interceptor sewers.

Waterville (Lucas Co.) - Interceptor sewers.

Lucas County Metropolitan Sewer District - Interceptor sewers.

Under Construction

Grand Rapids (Wood Co.) - New facilities (oxidation ditch), new sanitary sewer system.

Arlington (Hancock Co.) - Aerated lagoons and polishing lagoon, new sanitary sewers.

Vanlue (Hancock Co.) - Waste stabilization lagoons, controlled discharge, new sanitary sewers.

Ada (Hardin Co.) - Expanded activated sludge plant, new sanitary sewers.

Beaverdam (Allen Co.) - Waste stabilization lagoons, controlled discharge, new sanitary sewers.

Liberty Center (Henry Co.) - Waste stabilization, continuous discharge, new sanitary sewers.

Swanton (Fulton Co.) - Additional treatment facilities.

Wood Co. - New sanitary sewer lines to Perrysburg and Toledo.

New Knoxville (Auglaize Co.) - Lagoon.

Sherwood (Defiance Co.) - New sanitary sewer system and waste stabilization ponds.

Holgate (Henry Co.) - New sanitary sewer system and waste stabilization ponds.

Ottoville (Putnam Co.) - New sanitary sewer system and oxidation ditch.

Sylvania (Lucas Co.) - Interceptor sewers - connection to County system - will eliminate their STP.

West Unity (Williams Co.) - Phase II - completing sewer separation project.

Whitehouse (Lucas Co.) - Additional 90,000 GPD plant capacity.

B. Portage River Basin

Water quality in the Portage Basin is generally good. Degradation of water quality does occur in the North Branch, the result of municipal wastewater dischargers from the Bowling Green WWTP. The water quality problem becomes particularly acute in the North Branch during low flow periods when nearly the entire flow in this segment stream is attributable to the Bowling Green WWTP discharge. Poe Ditch, the recipient of the Bowling Green WWTP discharge is the largest tributary to the North Branch. Problem parameters in Poe Ditch include dissolved oxygen, ammonia, MBAS, and fecal coliform. Similar problem parameters have been found in the North Branch below its confluence with Poe Ditch. At the Pemberville sampling station on the North Branch below Poe Ditch during the 1977 water year, the only violation of water quality standards noted was fecal coliform. Aside from a slightly high yearly average nitrate concentration (5.1 mg/l), all other parameter concentrations measured appeared to be within normal levels.

Downstream in the mainstem of the Portage at the Woodville station, the only water quality standard violation during 1977 was again fecal coliform. However, less than 50% of the samples collected were in violation of the fecal coliform standard at this station, while 83% of the samples collected at Pemberville violated standards. Maximum yearly concentrations of ammonia, BOD_5, MBAS, chloride and several of the heavy metals were higher at Woodville than at Pemberville. These increases are probably indicative of the additional industrial and municipal discharges throughout the basin. It is interesting to note that the percentage of fecal coliform violations at the Woodville station during the 1977 water year was 20% less than during the previous year.

High fecal coliform counts are the chief water quality problem in both the middle and South Branch of the Portage. Occasional violations of ammonia and MBAS have also been detected in both streams. Phenol violations have been detected in two tributaries to the Middle Branch, while mercury and phenols have been detected in the South Branch.

Other problem areas in the basin besides Poe Ditch and the North Branch include Rader Creek below McComb, Wolf Creek below Gibsonburg, Bull Creek below Jerry City, and the East Branch, a tributary to the South Branch, below Fostoria. The water quality problems in these areas result from significant point source discharges to low flow, small tributary streams. In the case of the East Branch, it receives the municipal discharge from the Fostoria WWTP plus raw sewage from combined sewer overflows in the city.

There appears to be a general improvement in water quality throughout the basin. This is probably reflective of improvements made in treatment facilities by industrial and municipal dischargers. No new serious degradations in water quality in the basin were detected during the 1977 water year. There appears to be an improvement in the water

quality of the North Branch in terms of a reduction in the total phosphorus concentration at the Pemberville stations. The installation of phosphorus removal equipment at the Bowling Green WWTP appears to have effected this change. Elsewhere, the installation of chlorine equipment at the North Baltimore WWTP should reduce fecal coliform levels in Rader Creek. In Fostoria, a new sewer project for the east side of town will eliminate septic tank discharges. The new secondary WWTP at Oak Harbor will help to maintain water quality in the mainstem and in the estuary area. Until controls can be found to contain the movement of sediments such as nutrients from the agricultural lands in the basin, the Portage River will continue to contribute significant quantities of materials which help accelerate the eutrophication process in Lake Erie.

Special Studies

East Branch of the Portage River - This project was initiated early in 1977 to study the effects of the Fostoria wastewater treatment plant discharge and combined sewer overflows on the East Branch of the Portage River. The study consisted of chemical and physical water sampling at 12 stations, collection of macroinvertebrates and fishes, and field observations of stream characteristics (e.g. sludge deposits, macrophyte stands).

The addition of organic wastes from Fostoria causes severe water quality degradation in the East Branch of the Portage River. The resulting D.O. sag reaches its minimum at the Brandeberry Road area (approx. 2.8 miles below the plant) and shows nearly complete recovery at the Cygnet Road area (approx. 7.1 miles below the plant). Copper, lead and aluminum are discharged from Fostoria in relatively large amounts, with copper and lead at times in violation of water quality standards. Metals violations

have been found at least as far downstream as Bays Road (last station prior confluence with South Branch). Ammonia levels in the East Branch below Fostoria have been found to be in violation of water quality standards, as far downstream as Cygnet Road.

The diversity of fish and aquatic macroinvertebrates is greatly decreased within the D.O. sag caused by Fostoria. The population of aquatic animals does not improve greatly until the Cygnet Road area, where dissolved oxygen levels recover and sludge deposits are lacking.

The Fostoria discharges probably have a minimal effect on the South Branch of the Portage River, due to adequate assimilation in the East Branch.

C. Sandusky River Basin

Overall, the water quality in the Sandusky River Basin ranges from fair to good. The water quality problems are: high nutrient concentrations and transport, a heavy suspended solids load, high turbidity, occasional nuisance algal blooms and associated excessive diurnal oxygen fluctuation, and high fecal coliform bacteria levels in many portions of the basin. The water quality problems within the basin are primarily the result of nonpoint source pollution and inadequate treatment of municipal wastes.

An intensive sampling program conducted by Ohio EPA during 1974 concentrated on moderate to low flow regions rather than peak discharges. The major water quality problems discovered during this study were primarily related to inadequate municipal sewage treatment facilities and combined sewer overflows. Problem areas include the Sandusky River below Bucyrus, Spring Run below Carey, Paramour Creek below Crestline

and the Sandusky River below Fremont.

Inadequate treatment of sewage at Crestline seriously degrades water quality in Paramour Creek. Frequent standards violations occur for dissolved oxygen, ammonia, foaming agents (MBAS) and fecal coliform bacteria. Fecal coliform bacteria densities were consistently above 15,000 per 100 ml. Less frequent violations occur for phenols and total copper.

As was discussed previously, a study by Burgess & Niple, Ltd. of the Bucyrus combined sewer system found that any rainfall event greater than 0.05 inch for a 20 minute duration would result in discharge of raw sewage to the Sandusky River. Rainfalls of this intensity can be expected to occur on an average of once every five days. The result is a serious water quality problem in the river below Bucyrus which has been blamed for several fish kills in this area. Frequent water quality standards violations occur in this reach for dissolved oxygen, ammonia and fecal coliform bacteria. Occasional standards violations occur for foaming agents (MBAS), phenols, copper and mercury.

In Spring Run, downstream from Carey, ammonia and fecal coliform bacteria violations have been measured. While dissolved oxygen violations have not been noted, it would seem likely that such violations would occur during the night and the early morning hours. Inadequate sewage treatment at Carey is the source of these materials.

Prior to 1976, Muskellunge Creek at Fremont received untreated sewage from a storm sewer serving the west side of Fremont. Violations of standards for dissolved oxygen, fecal coliform bacteria, ammonia, MBAS, and mercury were detected during the 1974 study. With the connection of this area to the Fremont sanitary sewer system in 1976, water quality in Muskellunge Creek has improved considerably.

The Sandusky River downstream from Fremont is essentially a lacustrine estuary of Lake Erie. This area receives heavy organic loadings from the Fremont WWTP which, in addition to domestic wastes, receives effluents from the Heinz Company and Northern Ohio Sugar Company. Frequent water quality standards violations occur in this area for dissolved oxygen and fecal coliform bacteria. An automatic water quality monitor located 0.7 miles downstream from the Fremont WWTP recorded numerous violations of the dissolved oxygen standard. Also, malfunction of in-plant equipment at the Fremont WWTP have caused fish kills downstream of the plant. A number of industries within the Sandusky River Basin have upgraded and improved their treatment facilities recently. These improvements have resulted in better water quality in some of the small receiving streams within the basin, but probably had little impact on water quality in the Sandusky River.

Improvements in the water quality of the Sandusky River have been primarily a result of upgrading municipal wastewater treatment plants. The cities of Attica, Bucyrus, and Upper Sandusky have added new treatment facilities within the last five years which should improve the quality of their respective effluents. In addition, Fremont proposes to improve and expand their present facilities by providing better sludge handling capabilities and greater capacity. The Bellevue WWTP now provides for phosphate removal.

Two major causes of water pollution within this basin have been unaffected by the State's pollution control program during the 1977 water year. These are nonpoint source pollution (primarily agricultural runoff) and combined sewer overflows from municipalities. It should be pointed out that Bucyrus is in the Step II phase of the construction

grant process and that detailed plans for the construction of improved treatment facilities, including the treatment of combined sewer overflows, should be completed in 1978.

D. Huron River Basin

Water quality in the Huron River Basin is generally very good with the exception of several tributaries to the mainstem and the West Branch both of which receive discharges from industrial and municipal sources. The most common water quality problem in the basin is fecal coliform bacteria with an occasional heavy metal violation in the mainstem and some of the smaller tributaries. Overall, the Huron River is one of the highest water quality streams in the northwest region.

Water quality is presently measured at two locations in the basin: the East Branch below Norwalk at Shaeffer Road and the mainstem below Milan off Mud Brook Road. During the 1977 water year, the only water quality standard violation noted at the East Branch station was fecal coliform bacteria. Of the four samples collected for these parameters, three were found to be in violation. All other parameters measured appeared to be well within acceptable limits. At the station on the mainstem below Milan, the most frequently occurring standards violation was fecal coliform bacteria. There was also one violation for mercury. Total iron concentrations, both the yearly average and maximum concentration, were somewhat high at 3.3 mg/l and 11.4 mg/l respectively.

Most of the point source related water quality problems in the basin are found in the West Branch. Specific problem areas include (1) Marsh Run, a tributary of the West Branch which receives primarily industrial discharges, (2) Jacob Creek, which drains into Holiday Lake, receives the

effluent from the Willard WWTP, and Rattlesnake Creek, a tributary to the East Branch, which receives the effluent from the Norwalk WWTP.

There have been a number of improvements in treatment facilities at industrial and municipal entities in the basin over the past five years. These improvements have had favorable effect on water quality in the basin. A continued improvement in water quality is anticipated as a number of municipalities begin facilities planning for the first phase of the Construction Grant Program.

E. Vermilion River Basin

The Vermilion River Basin is one of the most pollution free rivers in the State of Ohio due to the small number of discharges. The water quality of the basin has always been, and continues to be good. A few rather minor localized problems do exist below some communities, but these problems should be easily corrected as new or improved wastewater treatment facilities are constructed. Potential problem areas exist below Wakeman on the mainstem and below New London on Skellenger Creek (East Branch). While only fecal coliform bacteria violations were noted at these two areas, it is believed that other problems could exist at critical low flow conditions. Nonpoint source pollution is generally considered the greatest pollution problem in the basin, with sediment being the greatest single pollutant.

FIGURE 12: NUTRIENT AND DISSOLVED OXYGEN DATA FROM THE BLANCHARD RIVER, JULY-SEPTEMBER 1975

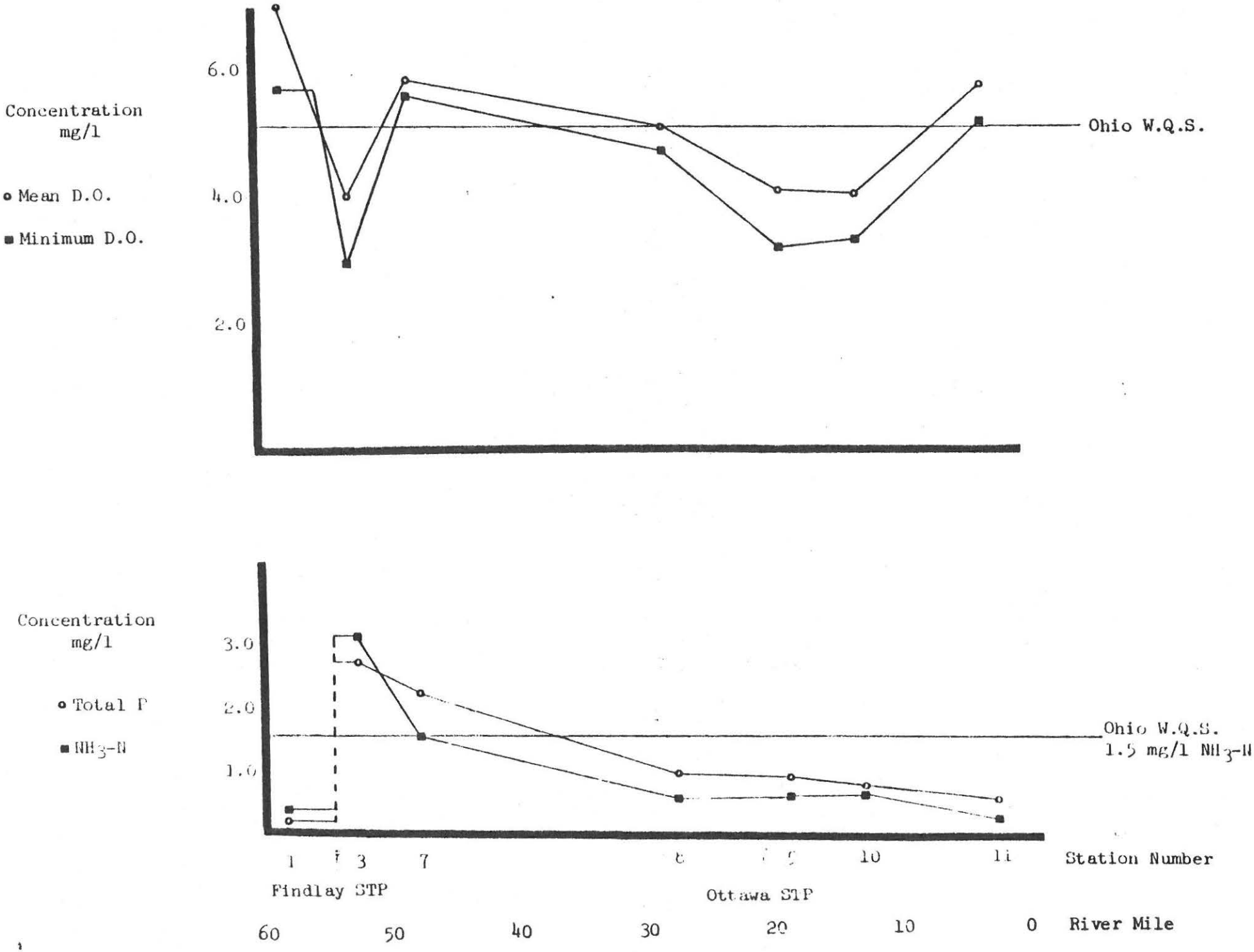


FIGURE 13: AMMONIA AND DISSOLVED OXYGEN DATA FROM THE BLANCHARD RIVER, JUNE AND AUGUST 1977

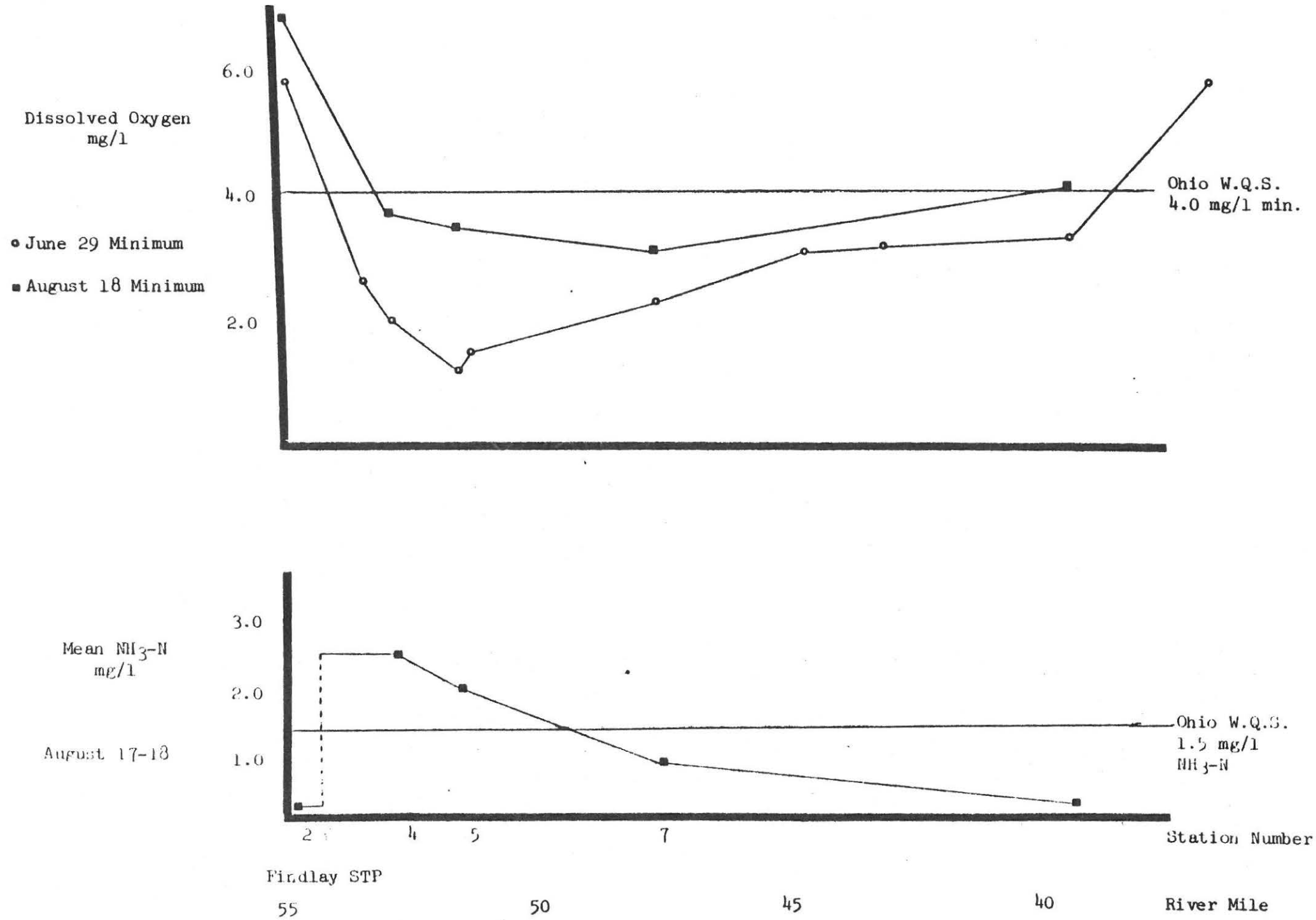
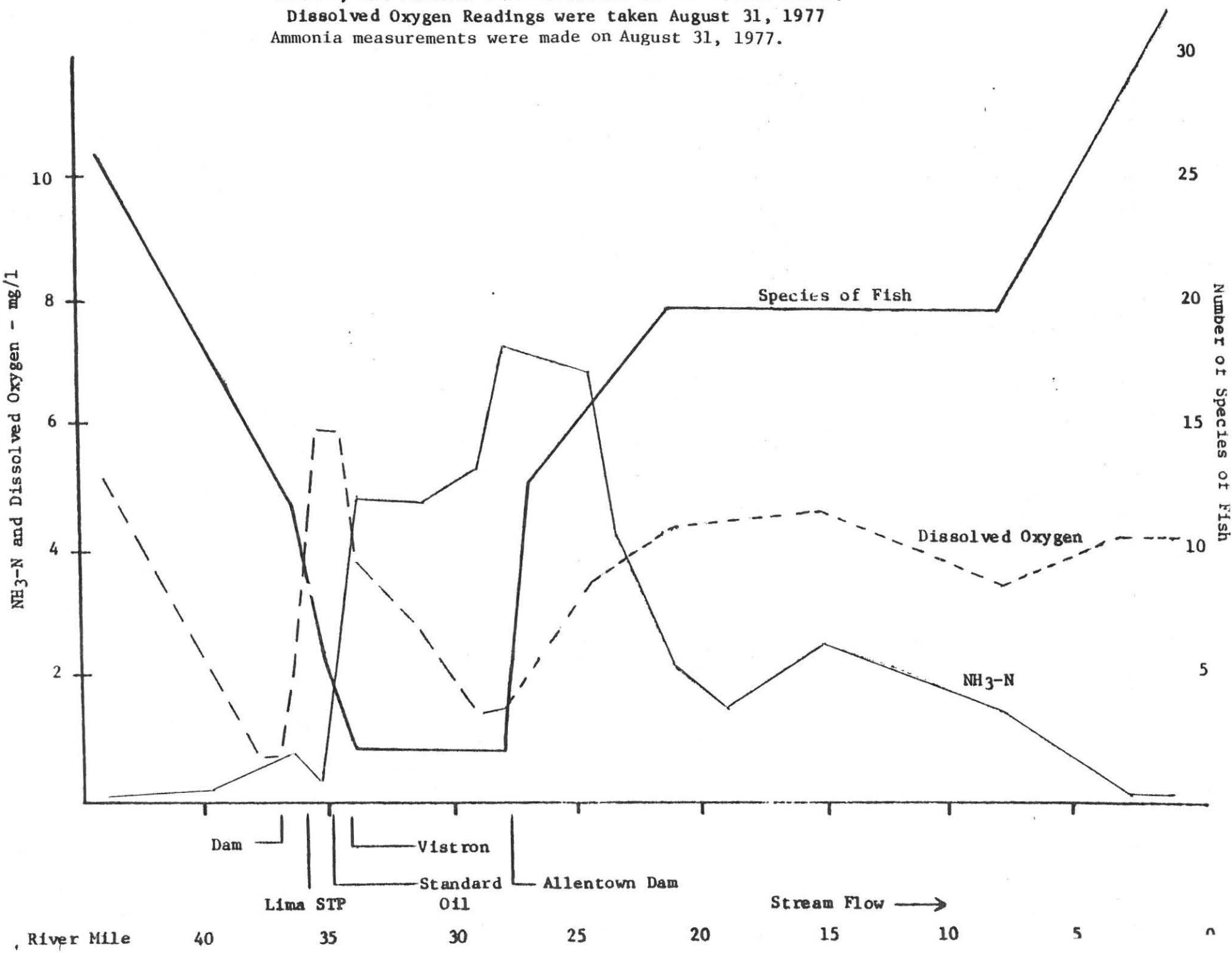


Figure 14 Number of Species of Fish Present, Dissolved Oxygen Minima, and Ammonia Concentrations in the Ottawa River. Dissolved Oxygen Readings were taken August 31, 1977 Ammonia measurements were made on August 31, 1977.



3. Northeast Region

This region encompasses the most heavily industralized areas of the state. Akron, Cleveland, Warren-Youngstown are major areas of population and industralization. Severe water quality problems, the result of both industrial and municipal point source discharges, occur in the lower Cuyahoga River (from the Cleveland Southerly WWTP to the mouth) and in the Mahoning River (from Warren to the Pennsylvania-Ohio stateline). Frequent violations of the water quality standards for dissolved oxygen, ammonia, heavy metals, fecal coliform bacteria, and phenols occur in these two segments. Other localized problem areas in this region include the Black River in and below Elyria and Fields Brook, a tributary to the Ashtabula River, in the City of Ashtabula. Other drainage basins in the region, in addition to the ones already mentioned, include the Rocky, Chagrin, Grand, Conneaut, and Little Beaver Creek Basins.

A. Black River Basin

The water quality in the middle and upper portions of the Black River basin is generally good. The upper reaches of the basin drain rural areas. Limited data in this area shows the water quality to be very good with the possible exception of fecal coliform bacteria violations. There are, however, several isolated problem areas experiencing degradation of water quality. Plum Creek downstream of Oberlin is a good example of such an area. Here, ammonia, dissolved oxygen, and fecal coliform bacteria frequently violate water quality standard limits.

The lower portion of the Black River, in the Lorain-Elyria area, flows through a heavily industrialized area. Industrial and municipal waste generated in this area cause degradation of water quality in the mainstem of the Black River. Ammonia, fecal coliform bacteria, and

dissolved oxygen were the parameters most frequently found to be in violations of water quality here. Other problem parameters include MBAS, copper, phenols, and hexavalent chromium. High concentrations of BOD, COD, and phosphorus were also measured here.

Ohio EPA maintained one primary water quality monitoring station on the Black River during the 1977 water year. This station was located at Cascade Park in Elyria just downstream of the confluence of the East and West Branches of the Black River. This site monitored the impact on water quality of upstream dischargers including a small part of Elyria. Ammonia and fecal coliform bacteria levels were the most frequent violations of water quality standards at the Cascade Park sampling location.

The water quality in the Black River becomes further degraded as it flows through the remainder of Elyria. Ohio EPA data collected during the 1975 water year at Ford Road in Elyria showed seven parameters violating water quality standards. Ammonia and fecal coliform bacteria were the parameters most frequently violating water quality standards here. Phenols, hexavalent chromium, copper, and mercury were also found to exceed water quality standards on several occasions. Data collected by the U.S. Geological Survey's continuous water quality monitor at this site during the 1976 and 1977 water year, showed numerous dissolved oxygen violations during the warmer summer months.

Further downstream, the tributary of French Creek empties into the Black River. Past sampling results showed violations of ammonia, dissolved oxygen and fecal coliforms and high concentrations of phosphorus near the town of Avon. However, the completion of a new tertiary wastewater treatment plant near North Ridgeville is expected to alleviate many of the wastewater related problems caused by Avon and North Ridgeville.

The following pollution abatement projects were accomplished in the Black River basin during the past five years:

(1) Ohio Water Development Authority - French Creek water treatment plant is a new 7.5 mgd tertiary treatment plant constructed in 1975.

(2) Oberlin Wastewater Treatment Plant - has been renovated during 1974 and 1975. The plant presently consists of a contact stabilization plant with a tertiary sand filter, phosphorus removal facilities and chlorination facilities. The capacity of the plant is 1.5 mgd.

(3) Wellington Sewage Treatment Plant - has added new primary tanks, aerobic digestors, a trickling filter and chlorination facilities in 1972. The plant capacity is 0.75 mgd.

(4) Lodi Wastewater Treatment Plant - was upgraded to a 0.350 mgd plant in 1972. The upgrading included the addition of micro-strainers and chlorination facilities.

(5) Spencer Wastewater Treatment Plant - is a new 0.086 mgd sewage system consisting of two waste stabilization ponds in series, and chlorination facilities. The facilities were constructed in 1971-72.

(6) Schneider Farms Plant - was expanded from a .045 mgd plant to a .100 mgd plant in 1973. Sewage treatment consists of an extended aeration plant, tertiary sand filter, chlorination facilities and sludge handling facilities.

(7) General Motors, Fisher Body Division, Elyria - has exceptional facilities for treating wastewaters from their large plating operation. These include the chemical reduction of chrome and oxidation of cyanide wastes. Further treatment includes precipitation of heavy metals and clarification. They also have sludge dewatering facilities, and pH adjustment controls.

(8) Republic Steel, Elyria - had a pickling operation for an architectural tubing and steel forming operation. The operations were changed, eliminating the pickling step with consequent improvement of their discharge.

(9) American Shipbuilding, Lorain - are planning improvement in oil and suspended solids removal from their discharge in the near future which will attain best practicable treatment levels.

(10) Stanadyne, Inc. Elyria - have recently installed modern facilities for treating wastewater from plating operations, which includes oxidation of cyanides, reduction of chromium wastes, and the precipitation of copper. They also have installed pH adjustment controls.

(11) Invacare, Inc., Elyria - are recycling treated wastewater from their plating operation using ion-exchange resins and reverse osmosis for part of their purifying procedures.

(12) Cleveland Steel Products - has installed waste oil storage tanks for off-site disposal of waste oils.

B. Rocky River Basin

Numerous municipal WWTP discharges throughout the basin give rise to frequent fecal coliform bacteria violations. There are only a few industrial dischargers in the basin. Other problematic parameters include ammonia, dissolved oxygen, MBAS, chloride, and phenols. Specific problem areas in the basin include the upper reaches of the West Branch, Abram Creek, and occasionally the lower reaches of the East Branch.

The upper reaches of the West Branch, below the City of Medina, are grossly polluted by the effluent from the overloaded Medina #200 WWTP. Stream recovery from this discharge does not fully occur before an additional pollutant load enters the West Branch from the Medina #100 WWTP. The combined effect of these two discharges causes violations of the water quality standards for dissolved oxygen, ammonia, MBAS, fecal coliform bacteria, and chlorides.

Abram Creek also has poor water quality due to the poorly treated Middleburg Heights WWTP effluent plus the added waste load from Brook Park WWTP. In addition to these two sources, other undetermined sources are contributing phenols, chlorides, and ammonia.

Degradation of water quality occurs in the lower reaches of the East Branch below the Berea WWTP. Here, violations of the water quality standard for ammonia are noted. The water in this segment is frequently turbid because of suspended solids and occasionally has a green color due to algal growth.

Water quality in this basin should improve significantly as two water pollution control projects are implemented. One of these projects is the Southwest Suburban Interceptor of the Cleveland Regional Sewer District, which will, within the next five years, divert discharges from Berea and other sewage treatment plants in this basin that are not providing advanced treatment to the Cleveland Southerly WWTP. The second project should correct the existing water quality problem in the upper West Branch when the effluents from the Medina 200 and 100 WWTP facilities are diverted to the Medina 500 WWTP which will have the capability of providing advanced wastewater treatment. This diversion should be accomplished within 4 years at which time water quality standards are expected to be met throughout the basin, although there may be isolated areas where bacteriological violations may occur due to nonpoint sources such as combined sewer overflows.

Several waste treatment facilities within the basin have improved their operations during the last few years. Lakewood WWTP has added phosphorus removal facilities, while two facilities, North Olmsted and Traxler Mast (a semi-public plant) have each increased their capacity (9 and 0.25 mgd respectively) and added tertiary treatment. In Medina County, Sewer District #300 completed construction of a 2 mgd plant in 1976. The plant provides pre-aeration and primary settling followed by a bio-surf wastewater treatment system and mechanical microscreens. Chlorination and phosphorus removal are also provided. Completion of this plant allowed for the elimination of two smaller plants. Medina Sewer District #500 Plant is presently being expanded from 1.5 mgd to 10 mgd.

C. Cuyahoga River Basin

The quality of water in the Cuyahoga River Basin ranges from very good to extremely poor. Generally, the upper reaches of the river and its tributaries are of high quality and support excellent populations of fish and other aquatic organisms. However, the middle and lower portions of the mainstem and the tributaries draining the industrialized and densely populated areas are of much poorer quality. In some areas there are continuous violations of water quality standards and little or no aquatic life can be found. The problem areas are divided into eight sections and will be discussed separately so that the varying degrees of water quality found in the Cuyahoga can be addressed in some detail. A basin map showing the locations of all the sampling sites referred to on the Cuyahoga is illustrated in Figure 15.

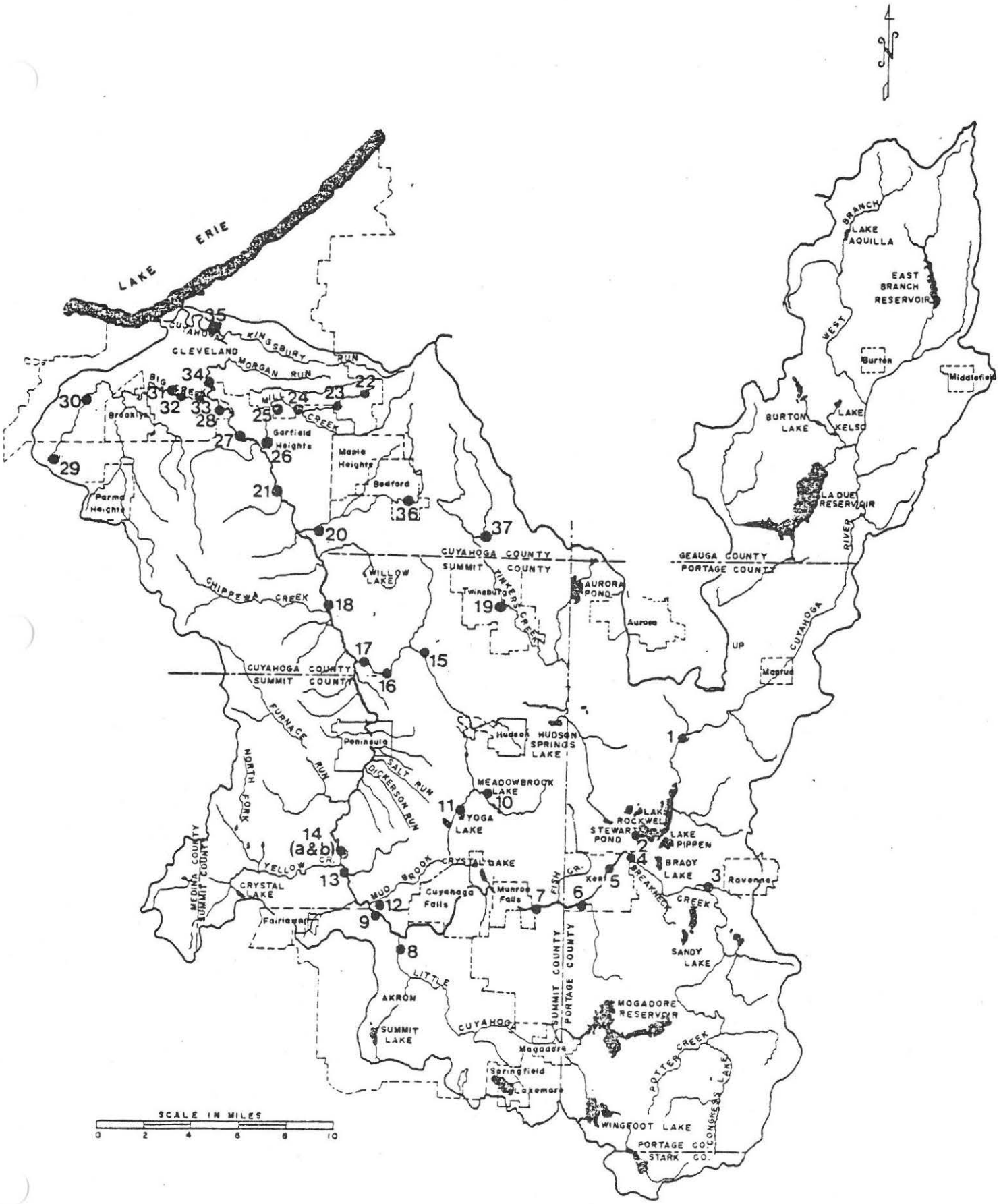


FIGURE 15 CUYAHOGA RIVER BASIN SHOWING 1977 SAMPLING SITES

(1) Headwaters to Lake Rockwell Spillway

The upper reaches of the Cuyahoga from the source downstream to Lake Rockwell Spillway has high water quality. A 25 mile portion of this area was designated as a "scenic river" by the Ohio Department of Natural Resources on June 26, 1974. The dischargers in the upper reaches consist of one municipal and several small industrial dischargers most of which are sand and gravel operations. Consequently, the impact of agricultural runoff and septic tanks may contribute the most significant pollutant loadings relative to the other sources in the area.

(2) Breakneck Creek

Entering the Cuyahoga just below Lake Rockwell is Breakneck Creek. The water quality in the lower reaches of Breakneck Creek are influenced by the discharges of two major municipal waste treatment plants, several industries, and numerous small semi-public waste treatment facilities. Sampling results indicate that Wahoo Ditch, an upstream tributary originating in Ravenna, is in violation of water quality standards for excessive ammonia and low dissolved oxygen concentrations. In addition, there were high concentrations of phosphorus, MBAS, BOD, TKN, and nitrates, all of which are associated with sanitary wastes. The source of these high concentrations of pollutants originates primarily from the Ravenna wastewater treatment plant. Although this facility recently upgraded and expanded their facility, their discharge makes up the majority of flow in Wahoo Ditch during low flow periods.

Additional monitoring is planned for this area to measure water quality improvements anticipated as a result of the improvements made at

the Ravenna plant. The immediate impact of Wahoo Ditch on Breakneck Creek is uncertain. The only recent data on Breakneck Creek is near the mouth of the stream. Samples collected at this point indicate no violations except for fecal coliform bacteria. This reflects the excellent assimilative capabilities of lower Breakneck Creek.

(3) Lake Rockwell Dam to the Confluence of the Little Cuyahoga River

The basic water quality problem associated with this segment is the low dissolved oxygen concentrations found in the many dam pool areas (see ~~Figure~~ 22). There are five dam pools in this stretch of the river. The Lake Rockwell Dam creates the major impoundment on the main stem of the Cuyahoga River. This reservoir serves as the primary water supply for the City of Akron which removes an average of 46 million gallons of water a day. During the dryer summer months very little or no water flows over the spillway. This considerably reduces the flow of the Cuyahoga River through the City of Kent since most of the remaining water originates from the area dischargers and Breakneck Creek. During these lower flow conditions, the river becomes semi-stagnate and the dissolved oxygen content is greatly reduced, especially during the early morning hours due to the effect of algae.

The primary sources of biochemical oxygen demanding substances in this segment come from Breakneck Creek and the Kent sewage treatment plant. However, there are also numerous semi-public discharges and some industrial discharges. Also, there is a significant new source scheduled for completion in 1978. This is the Fish Creek sewage treatment plant which will discharge 4 million gallons of wastewater per day. The badly needed treatment facility will be designed to provide the best treatment levels required by the State at this time. Even with the attainment of these high treatment levels, this source will still add an additional BOD load within the Munroe Falls Dam

Pool. This additional loading will not help ease the dissolved oxygen problem that occurs here during the summer months. For these reasons, it is extremely important that the best water quality reasonably attainable be achieved above the proposed Fish Creek discharge.

Calculations in a special stream study indicate that the dissolved oxygen concentrations in the Munroe Falls Dam Pool will not meet stream standards even with all major upstream sources of BOD reducing their effluents to provide the best treatment levels required by the State at this time. Accordingly, in-stream aeration or adoption of less stringent stream standards may be necessary for this segment.

Another area where stream standard violations are expected is in the Ohio Edison Dam Pool. To date, no stream samples have been collected here, but dissolved oxygen and temperature violations would seem probable. Investigations in this area are planned for the summer of 1978.

(4) Little Cuyahoga River

The Little Cuyahoga River drains a significant portion of the highly industrialized and urbanized area of Akron. It receives numerous industrial discharges, but no municipal or semi-public discharges. There are, however, numerous storm sewer overflows from the combined sewer system.

One sampling site located below the confluence of the old canal at the USGS gauge, was sampled on the Little Cuyahoga River during the 1977 water year. The data collected here indicated that six parameters were in violation of water quality standards. Fecal coliform bacteria values were in gross violation in all nine samples collected. The other parameters occasionally in violation included temperature, MBAS, copper, phenol, and cyanide. Also, elevated concentrations of ammonia, BOD, COD, and lead were measured which indicate potential problems.

(5) Confluence of the Little Cuyahoga to Canal Diversion Dam

The mainstem of the Cuyahoga in this reach is influenced primarily by one major discharger, the Akron sewage treatment plant, having a discharge of approximately 90 million gallons a day. The effluent from this plant can account for up to two-thirds of the flow in the Cuyahoga River during periods of critical low flow. Under these conditions, the Akron WWTP discharge has a major impact upon water quality in this segment. In addition, numerous discharges to the five major tributaries located in this segment also cause degradation of water quality in the mainstem. Only two of these tributaries, Mud Brook and Brandywine Creek, were investigated during the 1977 water year.

The general water quality in the Cuyahoga River begins to steadily deteriorate after it flows along the northern edge of Akron and receives the flow of the Little Cuyahoga River and then further deteriorates after it receives the effluent of the Akron sewage treatment plant. Violations of ammonia, MBAS, total phosphorus, and excessive phosphate values, lead, and fecal coliform bacteria violations occur downstream from Akron. A significant quantity of total pollutant loadings to this segment results from combined sewer overflows during periods of precipitation. High flows necessitate bypassing of untreated or partially treated sewage to the river. This practice is extremely detrimental to water quality because substantial quantities of pollutants are discharged to the Cuyahoga River during periods of bypassing. This procedure must be corrected if maintenance of high water quality conditions at all times downstream of Akron and through the National Recreation Area is to be achieved. The National Recreation Area will be discussed later in this section.

This portion of the mainstem is also affected by the flow from Mud Brook. Significant water quality problems exist in the upper reaches of Mud Brook where violations of the standard for ammonia, dissolved oxygen, and fecal coliform bacteria occur. High concentrations of BOD and phosphorus have also been measured in this area.

Below the Mud Brook confluence in the mainstem, the Cuyahoga River receives the effluents from numerous semi-public facilities. Considering the pollutant loads discharged to this segment, overall water quality is reasonably good. Near the end of this reach, the mainstem receives the flow from Brandywine Creek and the effluent from the Greenwood Village waste treatment facility. Violations of the standard for phenols and fecal coliform bacteria, in addition to excessive concentrations of BOD and phosphorus, have been detected at the mouth of Brandywine Creek. The sources of these pollutants in Brandywine Creek are from discharge from municipal waste treatment plants and a paper products company. On the mainstem downstream from Brandywine sampling site (see Figure 15), violations of the standard for dissolved oxygen, MBAS, copper, and fecal coliform bacteria were measured.

A considerable portion of this segment has been recently designated as a National Recreational Area. Public Law 93-555 was signed into law by President Ford on December 27, 1974. On June 26, 1975, the National Park Service established the area as the Cuyahoga Valley National Recreational Area and assigned William Birdsell as the Superintendent. Initial funds for purchasing the land were released on December 31, 1975. It is estimated that it will take three to five years to purchase the land and build the facilities to make it operable.

The area scheduled to become the National Recreational Area extends from Bath Road, just north of Akron, and follows the Cuyahoga River Valley, to Rockside Road just south of Cleveland. Several existing city parks are to be incorporated into the National Recreational Area. These include Virginia Kendall Park, Furnace Run Park, Hampton Hills Park, Brecksville Reservation and the Bedford Reservations.

(6) Tinkers Creek

Tinkers Creek is a major tributary to the Cuyahoga River. Water quality in this tributary is heavily influenced by the suburban/industrial land use patterns of the middle and lower portions of the basin. During low flow conditions, much of the flow in the stream is attributable to treated wastewater discharges. The watershed has numerous parks and natural scenic areas making it desirable to uphold water quality standards.

The Ohio EPA has maintained one primary water quality monitoring site on Tinkers Creek. The station is located in Bedford at the USGS gauging station. Data collected at this site during the 1977 water year indicated seven parameters to be in violation of water quality standards. Frequent violations of the standard for phenol and fecal coliform bacteria were measured, while occasional violations of the standard for zinc, total chromium, ammonia, hexavalent chromium, and lead were observed. Also, very high concentrations of total phosphorus have been measured.

Tinkers Creek receives the treated discharges of several significant municipal sewage treatment plants in addition to numerous smaller semi-public facilities and industrial discharges. Due to the excellent assimilation capabilities of lower Tinkers Creek, the organic impact of these sources is lessened thus avoiding total anoxic conditions. However, there are several localized areas of severe pollution in the watershed.

(7) Canal Diversion Dam to Cleveland Southerly STP

The water quality in this segment begins to deteriorate rapidly. As the Cuyahoga River flows toward the City of Cleveland, it begins to receive the wastes of numerous industrial operations. Also, many of the tributaries entering this portion of the mainstem add considerable amounts of pollutants. Two of the major tributaries are Tinkers Creek and Mill Creek. The problems associated with Tinkers Creek have already been discussed.

Mill Creek is a relatively small tributary to the Cuyahoga River, but it carries a high pollutant load. There are no municipal or semi-public facilities discharging to Mill Creek but there are numerous combined sewer overflows. Many of these carry wastes which are of industrial origin. Four industries located in the Mill Creek Basin are under NPDES permit, but apparently there are several others which should be. It is very difficult to determine the exact source of pollution coming from a storm sewer in a highly industrialized area. A thorough investigation will be necessary to locate the sources of these wastes in order to bring them under control. There are also two solid waste landfills along the banks of lower Mill Creek. Both of these are privately operated and are used primarily as industrial waste disposal sites. The specific impact of these landfills is uncertain but some leachate has been observed at both sites.

Sample site 26 (Figure 15) located on Canal Road near the mouth of Mill Creek measures the overall impact of the basin's problems. There were ten parameters found to be in violation of water quality standards during the 1977 water year. Some of the parameters such as ammonia, MBAS, zinc, copper, phenols and fecal coliform bacteria seem to be in constant violation of water quality standards; occasional violations were found for

mercury, lead, chloride, dissolved solids and dissolved oxygen. Below the confluence of Mill Creek, the water quality in the mainstem continues to deteriorate as it flows toward Cleveland.

(8) Cleveland Southerly Sewage Treatment Plant to Mouth

The water quality in the mainstem of the Cuyahoga River in this segment is polluted to the extent that general water quality standards cannot be met by feasible pollution abatement efforts. To deal with this situation, the Ohio EPA adopted less stringent standards for the lower Cuyahoga River on December 10, 1974. This segment begins at the discharge of the Cleveland Southerly Sewage Treatment Plant and flows north to Lake Erie through Cleveland. There are several tributaries which empty into the lower Cuyahoga, all of which have very poor water quality. These tributaries include Big Creek, Morgan Run, Burke Brook, and Kingsbury Run.

The major tributary, Big Creek, has land uses ranging from parks and recreational areas to heavily industrialized and commercialized areas. Big Creek is example of a stream having severe water quality problems resulting from uncontrolled urban runoff and industrial dischargers. Violations of standards for ammonia, phenols, copper, lead, zinc, oil and grease, and fecal coliform bacteria have been detected downstream from industrial dischargers and storm sewer overflows. Near the mouth of Big Creek, at Jennings Avenue, parameters in violation of water quality standards include ammonia, dissolved solids, oil and grease, fecal coliform bacteria, MBAS, phenols, chloride, copper, lead and zinc. Many of these parameters are nearly in constant violation.

The combined sewer overflow at Jennings Avenue is considered to be a significant pollutant source because it discharges waste during both wet and dry weather. The volume flow discharge from this sewer is significant while its quality is very poor. Raw sewage containing high amounts of suspended solids and oil and grease are continuously being discharged from it. This problem cannot be corrected until the southwest interceptor is completed sometime in 1981. This interceptor will also eliminate most of the industrial dischargers to Big Creek.

The principal source of municipal wastewater to the lower Cuyahoga River is from the Cleveland Southerly Wastewater Treatment Plant. The flow from this plant averages about 102 million gallons per day. During critical low flow periods, this discharge can account for up to 60% of the Cuyahoga River. The inadequately treated wastewater from this plant along with the need for frequent bypassing has a significant adverse impact on the water quality in the river. The Cleveland Southerly facility is currently being upgraded to meet the more stringent effluent limitations imposed upon it. The plant should be producing a much higher quality effluent by 1983.

This segment of the river also receives significant waste loads from numerous industrial sources from combined sewer overflows. The industrial sources consist primarily of two major chemical and four major steel plants.

The Ohio EPA samples at two locations in the lower Cuyahoga River - Lower Harvard Avenue (station 34, Figure 15) and West Third Street (station 35, Figure 15). Even with the less stringent water quality standards being applied, there were several water quality standard violations noted in the Lower Cuyahoga River. Toxic wastes such as ammonia, cyanide, phenols, and several heavy metals violate water quality standards or have been recorded at near violation levels. There are also low concentrations of dissolved oxygen

due to excessive amounts of biochemical and chemical oxygen demanding substances. Violations of dissolved oxygen standard of 5.0 mg/l occur during the hot summer months, but occur less frequently during April, May, and June.

The physical conditions of this portion of the river compound the water quality problems. The lower five miles of the river are continuously dredged for maintenance of the navigation channel. The intrusion of water from Lake Erie coupled with the physical characteristics of the navigation channel (deep and wide) reduces stream velocity throughout this lower section. The resulting slow time of travel along with elevated water temperature from steel making operations allows the oxygen demanding substances to exert themselves, thus lowering the dissolved oxygen levels to near zero in this section. Also, the water is reused several times by the large steel mills, which substantially increases the pollutants. These physical conditions will make the achievement of general water quality standards very difficult throughout the Lower Cuyahoga River.

Water Quality Trends

It is necessary for any pollution abatement program to monitor water quality trends in order to determine the worth of the program. Before several million dollars are spent in an area to improve wastewater treatment facilities it is very important to be able to determine the impact these efforts should have on the water quality of the receiving stream. Monitoring is very valuable for future pollution abatement projects.

To determine water quality trends, it is necessary to compile large volumes of data in order to account for a variety of influences. It is also necessary to collect data at a high frequency and over a long period of record. Many factors

must be taken into consideration such as varying weather conditons from year to year or other temporary influences such as major construction sites. Any of these factors may cause a brief improve-ment or deterioration of water quality which is not directly related to the pollution abatement efforts.

In the Cuyahoga River Basin most water quality data collected by Ohio EPA is limited both by the frequency of collection and by the period of record. There are however, sufficient quantities of data furnished to Ohio EPA by the Cities of Akron and Cleveland which give some indication of water quality trends in the Cuyahoga River near these cities. U.S. Geological Survey Water Quality Records from the continuous water quality monitoring stations are also available. This data meets the requirements for frequency of collection and period of record, which make it useful for trend analysis, but is limited to four parameters. This can also be used to determine extremes and "true" averages in a stream.

The water quality of the Cuyahoga River below the Akron WWTP appears to be improving steadily. Data furnished by the Akron Wastewater Quality Management Group shows that concentrations of most pollutants have been reduced significantly since 1969. The vast amount of data compiled by the Akron Wastewater Quality Management Group makes it possible to evaluate water quality trends in the Cuyahoga River below Akron.

Table 15 lists yearly averages for selected parameters at two monitoring locations. The "above" site refers to the upstream monitoring station which is located several hundred yards upstream of the Akron WWTP discharge. The downstream site, "below", is located at Ira Road which is approximately 2 miles downstream of the Akron WWTP discharge.

Table 15 Average Yearly Concentrations Of Selected Parameters In The Cuyahoga River Upstream And Downstream Of The Akron Wastewater Treatment Plant

water year	Dissolved Oxygen mg/l		Dissolved Oxygen % Saturation		Ammonia-N mg/l		Nitrates-N mg/l		B.O.D. mg/l		Total Phosphorus mg/l		C.O.D. mg/l	
	above	below	above	below	above	below	above	below	above	below	above	below	above	below
1969	8.1	7.4	72.3	67.4	1.00	5.66	0.79	0.57	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

* Converted from total phosphate values

DATA furnished by Akron Water Pollution Control Laboratory

A comparison of the "above" and "below" dissolved oxygen values shows only a slight reduction at the downstream site. The downstream site is located too close to the effluent to adequately measure the full impact the increased BOD load has on the dissolved oxygen concentration of the river. The assimilation of this BOD load brings about a reduction in the dissolved oxygen concentration further downstream, especially in the deep, slow moving portions of the river. The downstream concentrations of selected parameters shows a significant increase as a result of the Akron WWTP discharge. Improvements at the Akron Wastewater Treatment Plant have greatly reduced these pollutant concentrations over recent years. A comparison of the 1969 and 1976 water quality shows the impact of the Akron WWTP discharge on the Cuyahoga River to have been greatly reduced.

This significant improvement in water quality below the Akron WWTP discharge since 1969 is shown graphically in Figures 16 through 17. Figure 16 shows a steady yearly increase in the percent saturation of dissolved oxygen while Figure 17 shows a similar reduction of BOD concentrations, although increases in BOD were noted during 1972, 1973 and 1974. However, it does show that the immediate impact at the Akron WWTP discharge is lessening. Dissolved oxygen concentrations in the river above the plant have also increased since 1969, while upstream BOD concentrations have remained about the same.

Another indication of recovery in the river is shown in Figures 18 and 19. The drastic reduction of these pollutants since 1969 is remarkable. Average ammonia concentrations have decreased by almost 5 mg/l, as shown in Figure 18. The significant reduction in ammonia concentration is the result of improved nitrification at the Akron WWTP plant. Total phosphorus concentrations in 1975 and 1976 were reduced to one-fourth of the values recorded in 1969, as shown in Figure 19. This significant decrease can be attributed largely to the phosphate detergent ban enacted in the Akron area. These improvements in water quality show positive effects of the pollution abatement efforts made in this area.

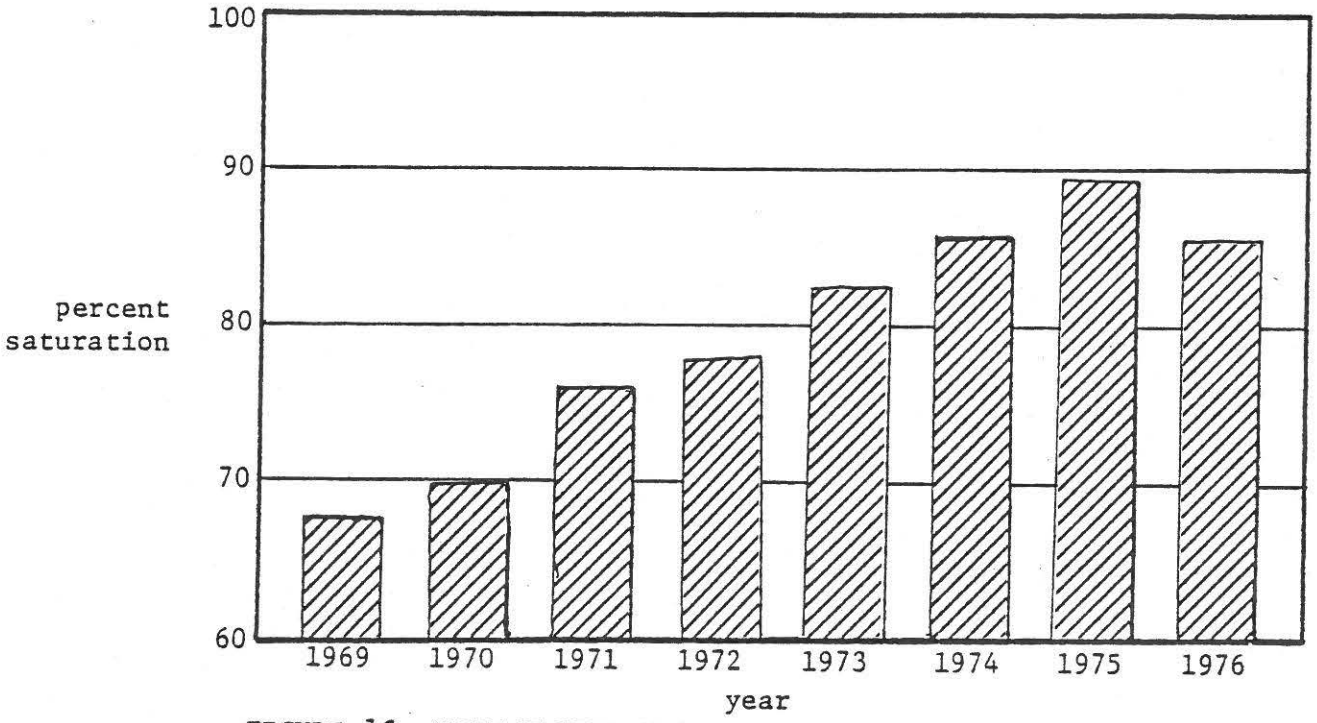


FIGURE 16 AVERAGE YEARLY PERCENT SATURATION OF DISSOLVED OXYGEN DOWNSTREAM OF AKRON STP

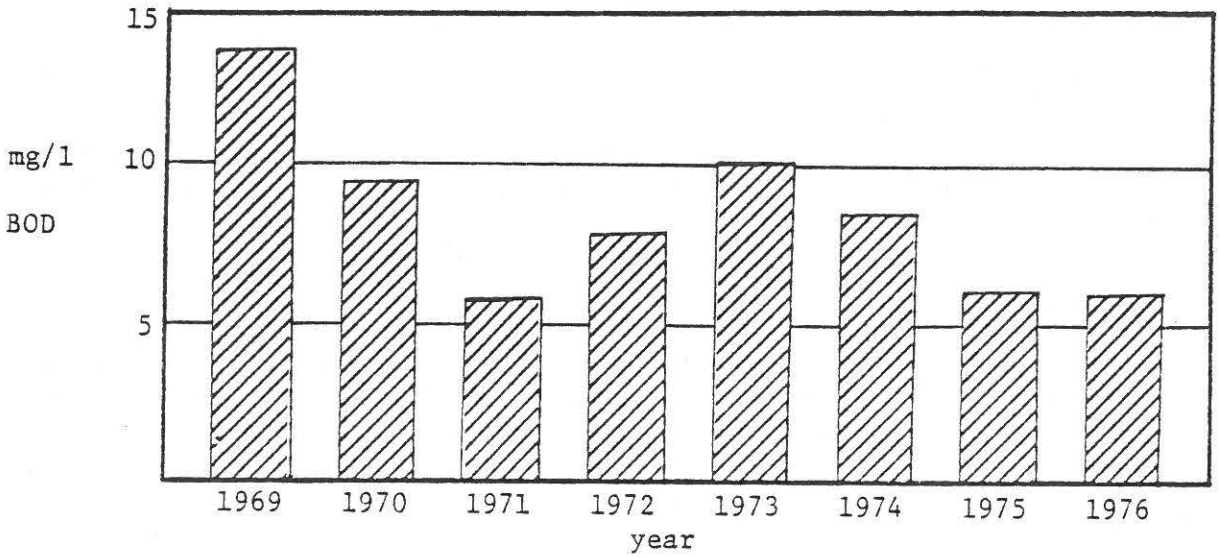


FIGURE 17 AVERAGE YEARLY CONCENTRATION OF BOD DOWNSTREAM OF AKRON STP

Data used to develop graphs furnished by Akron Water Pollution Control Laboratory

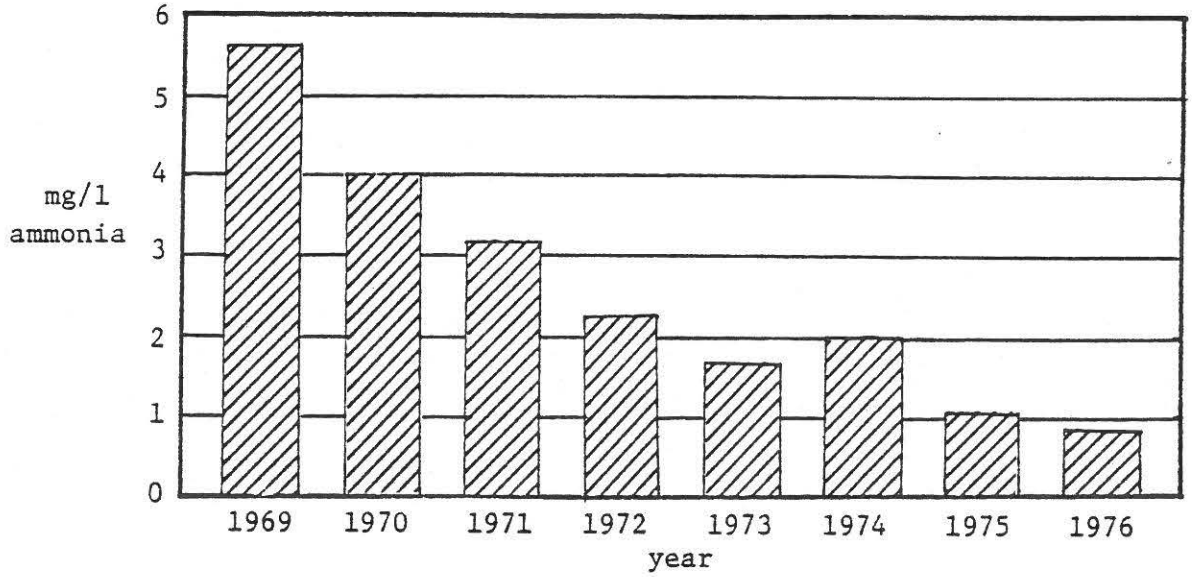


FIGURE 18 AVERAGE YEARLY CONCENTRATION OF AMMONIA DOWNSTREAM OF AKRON STP

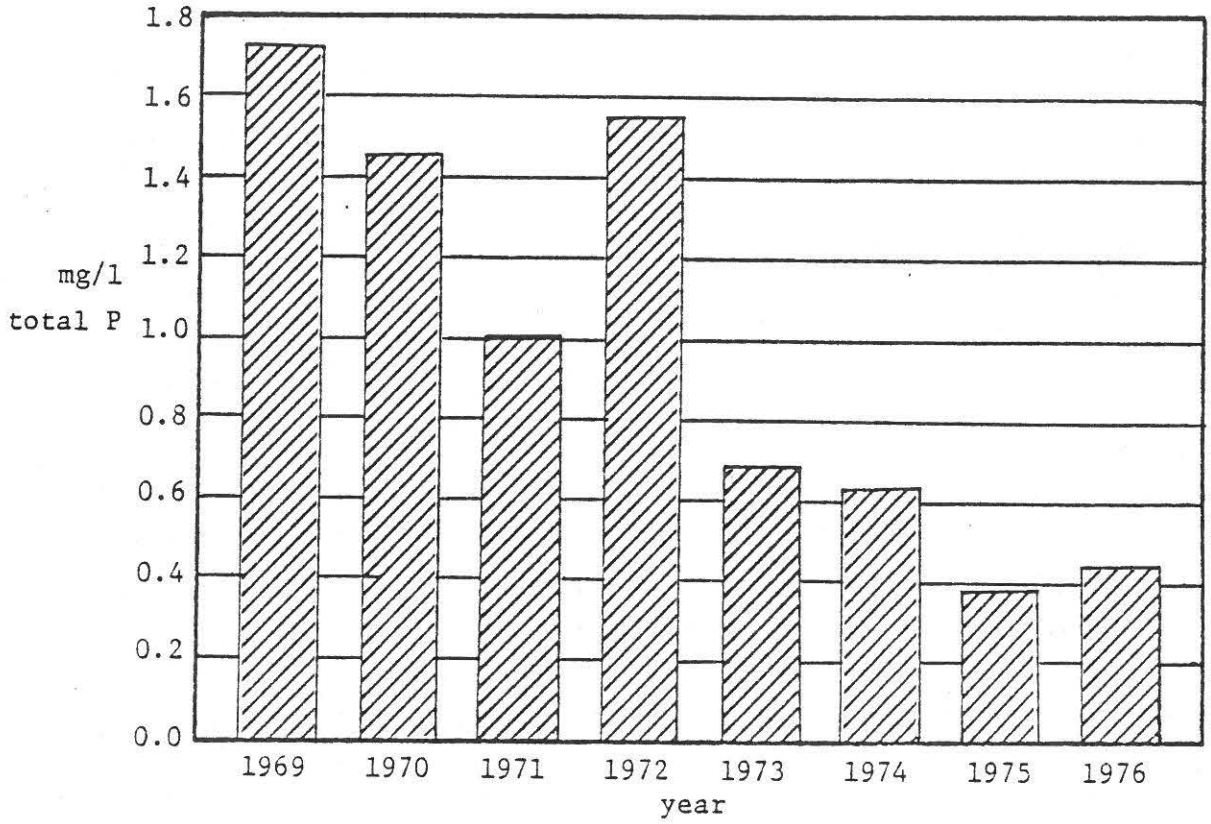


FIGURE 19 AVERAGE YEARLY CONCENTRATION OF TOTAL PHOSPHORUS DOWNSTREAM OF AKRON STP

Data used to develop graphs furnished by Akron Water Pollution Control Laboratory

At Independence, the Ohio EPA has collected water quality data since April 1973. The data base for this location was compiled from grab samples taken at a frequency of once or twice a month. Pollutant loadings (phosphorus and ammonia) were calculated for the 1974, 1975, and 1976 water years, since these were the only years with complete data. These parameters were selected because they showed the most noticeable improvements in the reach below the Akron WWTP. The average concentrations and loadings are presented in Table 16 below.

TABLE 16

AVERAGE CONCENTRATIONS AND LOADINGS FOR PHOSPHORUS AND AMMONIA AT INDEPENDENCE

water year	average flow cfs	average total phosphorus concentration mg/l	average total phosphorus loading lbs/day	average ammonia-N concentration mg/l	average ammonia-N loading lbs/day
1974	931	0.36	1534	0.76	4587
1975	2051	0.44	4880	0.56	4465
1976	1101	0.38	2030	0.55	3254

The average yearly total phosphorus loadings do not seem to show a conclusive Pattern, but rather seem to fluctuate randomly. Actually, phosphorus loadings at Independence have probably remained about the same or slightly decreased. The changing average daily loadings from year to year seem to reflect the flow conditions during the time samples were collected. It has been shown elsewhere that phosphorus loadings increase as flow increases, with maximum loadings occurring during maximum runoff conditions. This data seems to follow that pattern, but the number of samples collected is insufficient to reach a positive conclusion.

The average yearly ammonia values at Independence seem to show a definite improvement. This data indicate there was a slight reduction in the concentration and loading during the 1977 water year. A similar pattern was observed in the average concentrations recorded, and also the maximum ammonia values recorded during the three year period. Much of this improvement can be attributed to the increased nitrification at the Akron Wastewater Treatment Plant and improvements made by several municipalities in the Tinkers Creek Basin.

Substantial amounts of data and a report on the water quality of the lower Cuyahoga River have been furnished to Ohio EPA by the Cleveland Water Quality Program. Most of their data has been converted to loadings which more accurately reflect actual changes of water quality. Tables 17 and 18 list this information for two of their sampling sites. This data seems to indicate that substantial improvements in the water quality in the lower Cuyahoga River have taken place over the last several years. Pollutants which have been reduced significantly since 1970 include phosphorus, organic nitrogen and ammonia. Increases in the dissolved oxygen concentration are also evident. Biochemical oxygen demanding (BOD) substances have remained about the same below the Cleveland Southerly WWTP discharge, but have decreased at Center Street.

The Center Street sampling site is used to establish pollutant loadings entering Lake Erie from the Cuyahoga River. There has been much talk that Lake Erie may be recovering from its present state of advanced eutrophication as pollutant loads entering it are reduced. The data from the Center Street monitoring site would seem to indicate the pollutant loads entering Lake Erie from the Cuyahoga River have been reduced. This is illustrated by Figures 20, 21, and 22 which show three parameters which have shown significant improvements. There were some unexplainable increases of phosphorus in 1971 and organic nitrogen in 1972, but the general trend definitely shows a decreasing pollutant load to Lake Erie from the Cuyahoga River.

Table 17 Average Loadings For Cuyahoga River At Mile Point 11.0, Lower Harvard Avenue

	tons/day				
	1970	1971	1972	1973	1974
Average Flow, MGD	766	747	977	877	*842
Dissolved Oxygen	N/A	20.8	N/A	31.1	30.1
Biochemical Oxygen Demand	35.5	33.0	46.9	37.3	36.2
Chemical Oxygen Demand	208	196	208	165	169
Non-filterable Residue	249	246	583	311	312
Total Phosphorus	5.7	4.7	4.1	3.7	2.8
Organic Nitrogen	10.9	6.5	8.6	4.8	4.9
Ammonia Nitrogen	11.2	13.7	10.2	9.9	8.1
Nitrite Nitrogen	1.2	1.3	1.3	0.8	0.7
Nitrate Nitrogen	4.2	6.0	8.2	6.3	4.0

Table 18 Average Loadings For Cuyahoga River At Mile Point 1.0, Center Street

	tons/day				
	1970	1971	1972	1973	1974
Average Flow, MGD	805	784	1025	921	*884
Dissolved Oxygen	18.5	13.4	25.2	20.4	21.7
Biochemical Oxygen Demand	26.5	28.4	30.8	23.8	22.1
Chemical Oxygen Demand	154	170	154	134	114
Non-filterable Residue	225	167	141	158	162
Total Phosphorus	2.0	2.6	2.1	1.2	1.1
Organic Nitrogen	7.7	5.6	9.8	5.0	3.7
Ammonia Nitrogen	20.5	19.9	17.1	16.5	15.1
Nitrite Nitrogen	1.0	0.8	1.3	0.8	0.8
Nitrate Nitrogen	3.8	4.1	7.8	5.4	3.6

* Estimated Flow.

N/A - Not available due to equipment failure and limitation.

Tables from Cuyahoga River Monitoring Program For 1976, furnished by Cleveland Water Quality Program.

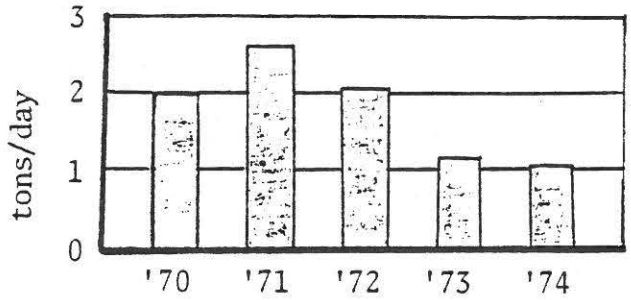


FIGURE 20 AVERAGE TONS PER DAY OF TOTAL PHOSPHORUS AT MOUTH OF CUYAHOGA RIVER

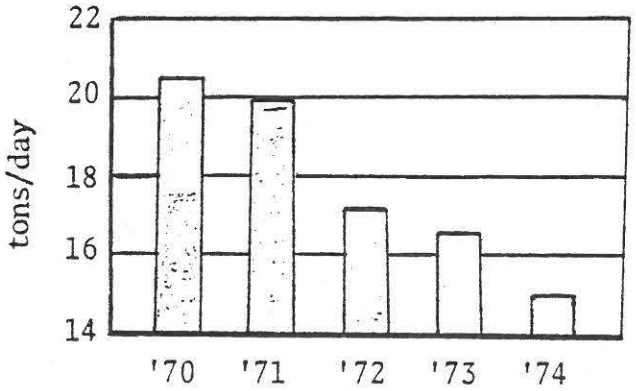


FIGURE 21 AVERAGE TONS PER DAY OF AMMONIA NITROGEN AT MOUTH OF CUYAHOGA RIVER

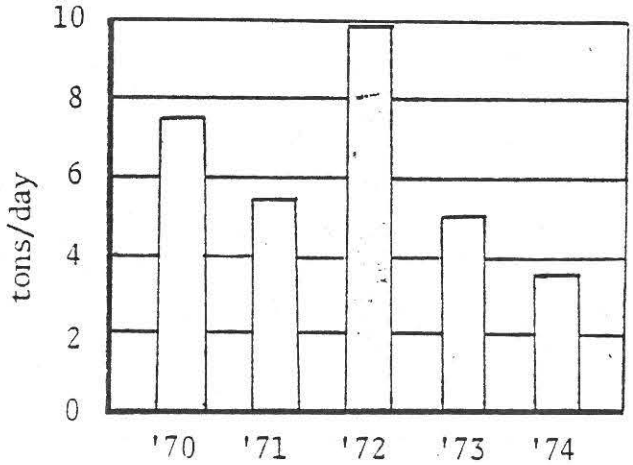


FIGURE 22 AVERAGE TONS PER DAY OF ORGANIC NITROGEN AT MOUTH OF CUYAHOGA RIVER

Data Furnished by Cleveland Water Quality Program

1977 Water Year Summary

The water quality of the Cuyahoga River, during the 1977 water year, experienced significant setbacks. Previous years data have been indicating steady signs of improving water quality downstream of Akron and Cleveland, the two largest metropolitan areas in the basin (1975 & 1976 305(b) Reports). However, during the past water year, two accidents are primarily responsible for the worsening conditions in the river.

On June 23, 1977, a twelve foot diameter sewer exploded in Akron. The accident was caused by the ignition of gases from an industrial spill of volatile latex material into the sewer.

This resulted in the loss of approximately 14 million gallons per day of raw sewage from the sanitary system and occured throughout the summer months of 1977. The sewage overflowed into the Ohio Canal which emptied into the Little Cuyahoga River and finally flowed into the Cuyahoga River.

The impact of this large volume of wastewater was severe. Elevated levels or violations of pH, ammonia, chloride, MBAS, fecal coliform bacteria, phosphours, BOD, lead, and phenols were detected in the Little Cuyahoga River as well as lower dissolved oxygen concentrations. Much of the wastes settled out forming large sludge deposits along the stream bottoms of the Ohio Canal and the Little Cuyahoga River.

The wastes were further diluted in the main stem of the Cuyahoga River but the water quality was still significantly impacted. Data collected by the U.S.G.S. continuous water quality monitor located at Old Portage revealed significant reductions of dissolved oxygen compared to previous years. In fact, dissolved oxygen concentrations dropped to zero several times during

the months of July and August. These anoxic conditions were caused by the decay of the large amounts of organic wastes entering the river from the ruptured sewer.

Further downstream (approx. 5 miles) at the Akron wastewater treatment plant, the water quality of the river was still greatly affected by the overflow of the raw sewage from the broken sewer. Data collected by the Akron Water Pollution Control Laboratory indicate that dissolved oxygen levels regressed to the lower levels which occurred in 1971. Until the 1977 water year, dissolved oxygen levels were showing a steady increasing trend since 1969. The average concentrations of other sewage related parameters were significantly higher than previous years data. Average ammonia concentrations for 1977 were double those that were recorded for the 1976 water year. The distance of the Cuyahoga River directly affected by the raw sewage overflow is uncertain. Data from the U.S.G.S. continuous water quality monitor located at Independence, (approx. 28 miles from the confluence of the Little Cuyahoga River), also indicate lower dissolved oxygen concentrations than previous years. There wer 17 days during the past water year where the concentration of dissolved oxygen dropped below the water quality standard of 4.0 mg/l. During the 1975 and 1976 water years, violations of the dissolved oxygen standard were measured on only three days out of each year by the continuous water quality monitor at Independence. It is probable that these violations were at least partially influenced by the spillage of raw sewage from upstream at Akron.

Further downstream at the Cleveland Southerly Sewage Treatment Plant, another accident occurred which caused water quality problems in the Cuyahoga River during the 1977 water year. On April 26, 1977, there was an explosion in the compressor building, which totally eliminated this

plant's aeration facilities. This limited treatment at this 90 million gallon per day plant to only primary settling and chlorination. This greatly increased the amounts of suspended solids, BOD, ammonia, and phosphorus entering the river. Repairs were not completed until June 22, 1977. The lower Cuyahoga River usually experiences low dissolved oxygen levels and high suspended solids and ammonia concentrations but conditions were significantly worse during these months.

The water quality conditions in other portions of the Cuyahoga River Basin generally remained the same. The expansion and upgrading of wastewater treatment systems is continuing throughout the basin and localized improvements in water quality are anticipated for the 1978 water year.

New and Improved Facilities

The following wastewater treatment facilities in the Cuyahoga River Basin have had improvements as listed within the last 5 years:

Municipal

1. City of Independence (Furmeyer Road Plant) has 250,000 gpd secondary treatment plant was constructed in 1972.

2. City of Solon's Central Plant, added centrifuge to sludge handling facilities in 1972.

3. City of Bedford - upgraded and expanded their existing plant to a 3.2 mgd tertiary treatment plant with oxidation towers, microscreens and phosphorus removal. Plant construction was completed in 1975.

4. City of Twinsburg - upgraded and expanded plant to a 2.2 mgd plant with activated sludge, phosphorus removal, and microscreens. Plant construction was completed in 1973.

5. Cuyahoga County Walton Hills Plant - expanded and upgraded their existing treatment plant to 0.75 mgd with hydroseives and aerated lagoons. This construction was completed in 1974.

6. Cuyahoga County Echo Hills Plant - a new 36,000 gpd treatment plant with activated sludge and microstrainers was constructed and completed in 1974.

7. Summit County Roseland Estates Plant - upgraded existing treatment plant with aerated lagoons. Construction was completed in 1975.

8. Summit County Robinwood Plant - a new .018 mgd tertiary treatment plant was constructed in 1975.

9. Summit County Ohio Sports Center Plant - a new .22 mgd tertiary treatment plant was constructed in 1974.

10. Summit County Aurora Shores Subdivision Plant - expanded and upgraded to a 0.25 mgd tertiary treatment plant. Construction was completed in 1974.

11. City of Akron - added Zimpro sludge treatment facilities in 1972 and have plans approved for sludge disposal facilities in 1977.

12. Mobile Manner - a new .04 mgd tertiary plant was constructed in 1975- Summit County semi-public plant.

13. Peninsula Night Club - Peninsula had a new .012 mgd tertiary treatment plant constructed in 1974.

14. Feil Lake Park, Summit County - a new .005 mgd tertiary treatment plant was constructed in 1974.

15. Village of Middlefield - upgraded existing treatment plant with an aerated lagoon.

16. City of Aurora (Waldon Plant) - expanded and upgraded plant to 160,000 gpd with activated sludge, sand filter, and metering. This was constructed in 1975.

17. City of Aurora (Geauga Lake Plant) - expanded plant to 400,000 gpd in 1975.

18. City of Aurora (Four Seasons Plant) - expanded plant with addition of a 40,000 gpd package plant.

19. City of Ravenna - expanded and upgraded plant to a 2.8 mgd activated sludge, phosphorus removal, microscreens, sludge digestion and gas recirculation. Construction was completed in 1975.

Industrial

1. Goodyear Aerospace: Oil water separation was installed.

2. Mohawk Rubber: Industrial process wastewater to City in 1970.

3. B.F. Goodrich, Main Plant: Installation of collection basin for oil and suspended solids removal.

4. B & O Railroad, Akron: Installed oil separator and holding tank.

5. Alside: Partial tie-in to sanitary (Mud Brook Interceptor) in 1971.

6. Hudson Plating: Shut down.

7. Tecumseh Cor. Box: Primary clarifier installed (1971).

8. Akron Packing: Sand filters and chlorination was provided and the system was upgraded with a flow equalization grease tank in 1976.

9. Procex: Eliminated process wastewater discharge.

10. North American Manufacturing: None (non-contact cooling water .012 mgd).

11. Cleveland Cap Screw: Tied process water into Cleveland system.

12. Bradley Metal: Installed recycle system; no discharge.

13. Lamson-Sessions, Brookpark; Tied into sanitary system.

14. Parr, Inc.: Eliminated process wastewater discharge.

15. GMC Chevrolet, Parma: Oil skimmers provided for storm water runoff.

16. Allied Chemical: Additional recycling capacity was provided. In 1976 a partial shut down was initiated and plans to eliminate the discharge were drawn up.

17. Elco: Tied into Cleveland system.

18. Harshaw Chemical: Hydrofluoric Acid process changed to yield dry by-products calcium sulfate which is trucked to landfills. Initiated construction for BPT facilities in 1976.

19. Ford Motor: Improved oil separation facilities provided. They will also combine all engine plant wastewater/soluble oil flows for treatment plant #2.

20. U.S. Steel Central Furnace: Added polymer feed to clarifier.

21. Republic Steel, Cleveland: Oil separation and solids removal were improved. Recycling systems were built for steel plant #1-4, blast furnace #5, and 6 blast furnaces in 1976.

22. Portage County Franklin Hills Plant - expanded to a 1.0 mgd secondary treatment plant in 1974, and added phosphorus removal in July 1976.

23. City of Broadview Heights (Vineyards) - a new .10 mgd plant with extended aeration and tertiary rapid sand filter was constructed in 1974.

24. Summit County - Fishcreek; (New Facility) is to discharge 4 mgd with tertiary bio-discs treatment and chlorination.

25. Macedonia #15 has submitted plans for expansion from 1 mgd to 3 mgd with extended aeration, phosphorus removal, and chlorination.

26. Summit County,Hudson #5 is planning an expansion of facilities to increase their flow from 0.2 mgd to 0.8 mgd.

27. Summit County, Westmont Woods; (New Facility) is to discharge 54,000 gpd with tertiary treatment and chlorination.

28. Cleveland Southerly - construction was initiated during 1976 to increase capacity from 90 mgd to 200 mgd. Treatment will be upgraded to tertiary with nitrification. Final completion of all phases of construction is scheduled for 1983 to 1985.

29. Middlefield Swiss Cheese: An additional surface aerator has been provided. Construction began on BAT facilities in 1976.

30. Johnson Plastics: Surface sand filters and chlorination was provided for sanitary waste.

31. A.C. Williams (Iron and Steel): Partially shut down.

32. A.C. Williams (Aluminum and Magnesium): Reduced production.

33. Hamilton Kent: Sanitary waste tied into Kent system.

34. Hydraulic Pressed Brick: Eliminated discharge.

35. Teledyne Monarch Plant#2: Improved oil removal.

36. Lamson-Sessions: Installed pretreatment and then tied all process and sanitary wastewater into Kent system.

37. Eclat Rubber: Shut down for urban renewal.

38. Norton Company, Tallmadge: Improved solids removal.

39. Hilltop Sand and Gravel: Improved settling basins and reduced storm water erosion.

40. Firestone: Oil collection basin installed.

41. J & L Steel: Blast furnace recycling was provided and also oil removal facilities for rolling mills.

42. E.I. DuPont: Clarifier provided and concrete bins built to contain zinc raw materials. Construction of an impounding basin was initiated in 1976 to handle contaminated water.

43. C.E.I.: Converted to dry fly ash handling.

44. Sherwin Williams: Process wastewater tied into Cleveland system.

45. Stroup Sand and Gravel: Improved settling basins and reduced storm water runoff.

46. Chrysler Corporation: Built pond with oil removal facilities.

47. Norandex: Improved solids removal. Discontinued anodizing operations in 1976.

48. Ferro Corporation, Cleveland Division: Pretreatment facilities.

49. Zircoa: Progressing towards complete recycle. Plans were approved for BAT facilities in 1976.

50. Great Lakes Etching: Eliminated chromium from operation.

51. Consolidated Natural Gas: Use of chromate paints stopped, also chrome treatment of cooling water discontinued. Chlorination of sanitary waste is to be completed in 1977.

52. Lester Industries: Preparing plans to tie into sanitary sewer.

Summary

The Cuyahoga River Basin exhibits water quality conditions ranging from clean water areas to grossly polluted zones. In the upper reaches, the river flows through farmland and sparsely populated areas. Isolated data collected in 1973 indicated that there were some dissolved oxygen and fecal coliform bacteria

violations in the upper reaches, but water quality is generally very good in this area.

The middle and lower sections of the Cuyahoga River receive considerable amounts of industrial and municipal wastes from Akron and Cleveland, and from numerous smaller cities and villages located on tributaries of the Cuyahoga River. The City of Kent, which is located in the upper middle section of the basin, marks the beginning of water quality degradation in the mainstem.

In the summer when stream flows are reduced, the City of Akron may use nearly the entire flow of the river at the Lake Rockwell Dam for water supply purposes. Under these circumstances, little water is available through the City of Kent to help dilute the high concentrations of coliform bacteria, BOD, ammonia, and phosphorus. Below the City of Kent, several small dams create pooling areas having slow moving water and reduced dissolved oxygen concentrations particularly during summer months.

The City of Akron, located in the middle portion of the Cuyahoga River Basin has a major impact upon the river. Numerous industrial discharges and the Akron Wastewater Treatment Plant contribute considerable amounts of pollutants to the river. During periods of low flow, these dischargers account for 80% of the flow in the Cuyahoga River below Akron.

Further downstream, at the confluence of Tinkers Creek, additional pollutant loads are added to the mainstem. Tinkers Creek receives the discharges from several sizable municipal waste treatment plants in addition to numerous smaller semi-public facilities and several industrial plants. Isolated areas in the upper slow moving portions of Tinkers Creek and its tributaries experience significant water quality problems. Although much of the upstream organic pollutant load may be reduced by natural stream purification processes before it reaches the Cuyahoga mainstem, nonetheless, the flow at the mouth of Tinkers Creek still contains significant concentrations of phosphorus and phenols.

The water quality in the lower section of the Cuyahoga River, which flows through the Cleveland area is poor. Major dischargers such as Cleveland Southerly Wastewater Treatment Plant and several sizable industries have a significant impact on the water quality in this reach. Also, the tributaries which empty into this segment of the river are severly polluted. The intrusion of Lake Erie waters at the mouth causes a stagnation in the river allowing time for the organic material to exert its load, thereby decreasing the dissolved oxygen concentration. During higher flows, urban runoff and combined sewer overflows contribute additional pollutant loadings to this already severly polluted segment of river.

Although numerous areas in the Cuyahoga River Basin are experiencing water quality violations, improvements in water quality are evident. The number of water quality violations and the maximum concentrations for many parameters are decreasing throughout the basin. Data collected in the Akron and Cleveland areas show there have been significant improvements in water quality in the Cuyahoga mainstem over the past 6 to 8 years. These trends indicate that pollution abatement efforts are beginning to accomplish their intended goals.

D. Chagrin River Basin

The Chagrin River is a fast flowing stream with good assimilative capabilities. Water quality throughout the basin is good even though it receives discharges from numerous wastewater treatment plants and leachates from areas having septic tanks. Because the vast majority of these plants are small and tend to be scattered throughout the basin, the only impact these facilities appear to have on stream water quality is to elevate bacterial levels above acceptable limits. All other water quality criteria appear to be in conformance with water quality standards with the exception of an occasional violation of the public water supply standard for phenols at the Willoughby water supply intake.

There is only one major industrial discharger in the basin. This facility is located in Chagrin Falls and discharges paper mill waste containing suspended solids and oxygen demanding materials. The major municipal dischargers include Chagrin Falls, Aurora, and Solon N.E. WWTP. There are over 50 small "package plants" serving commercial establishments and housing developments with flows of less than 0.025 mgd.

The lower reaches of the river have reaeration capabilities. In the Chagrin Falls area, the stream experiences a drop of more than 90 feet in gradient. Such a steep gradient provides excellent stream reaeration which assists in the natural assimilation of oxygen demanding materials such as those discharged by the paper mill and by the Chagrin Falls WWTP and other upstream sources.

One notable improvement in water quality in the basin is evident. The reach below the Chagrin Falls WWTP has lower levels of fecal coliform bacteria apparently due to the new advanced waste treatment facility completed by Chagrin Falls in 1973. Other improved facilities should help to upgrade quality in the basin. Chase Bag installed a new clarifier and additional tank storage which allows for more recycling and a reduced volume of discharge. Several municipal waste treatment facilities have increased their capacity and provided for advanced waste treatment. These include Aurora-Jackson Road, Russel Park, Pilgrim Village, and McFarland Creek.

1977 Water Year Summary

From the data collected during water year 1977, it appears that there was no significant change in the water quality of the Chagrin River from the 1976 water year. Except for phenolic compounds, all samples collected during the water year met the water quality standards.

Phenols were in violation of the public water supply intake criteria for 50 percent of the samples taken. The source of these violations is unknown.

E. Grand River Basin

Overall, water quality in the Grand River is very good. Most of the basin drains rural areas having few point source discharges. Those point sources have only a localized impact on water quality. The only problem area in the basin is located near the mouth of the Grand River. Here, several parameters have exceeded water quality standards. However, at the sampling station located at S.R. 84 just upstream from the mouth, data collected during the 1977 water year indicated very good quality water.

At sampling sites located at S.R. 535 in Painesville and near the mouth of the river, phenols and chlorides were nearly always in violation. Maximum recorded concentrations of phenols and chlorides were five and ten times the allowable concentrations respectively. In addition, dissolved solids and fecal coliform bacteria were well in excess of the allowable limits when samples were taken. Dissolved oxygen concentrations were often below 4 mg/l in the summer months. Occasional violations of the standard for ammonia and MBAS were recorded as were single violations for temperature, pH, and copper.

Using the long term data (1970-1976) collected at the U.S. Geological Survey continuous monitor station near Painesville, it is possible to evaluate water quality trends in the river at this location. It would appear that temperature, dissolved oxygen, and specific conductance values have remained fairly constant during the past six years. However, values for pH seem to have improved significantly. Although violations still occur, the frequency of these violations is less and the pH values lower. In 1970, maximum pH values recorded for each month ranged from 11.9 to 10.0, which were considerably over the upper pH limit of 9.0. By 1973, the maximum values ranged from 10.9 to 7.9. And 1976, during the water year, only one pH violation was recorded a 10.6 during the month of January.

have removed the dilution factor which was present during previous years.

The Painesville Sewage Treatment Plant, which is the primary source of organic pollutants on the lower Grand River, is scheduled to complete upgrading to a tertiary plant in 1978. Also many of the other sources of organic wastes have been eliminated or are scheduled to be eliminated. With these improvements, the dissolved oxygen and ammonia problems in the lower Grand River should be eliminated.

The dissolved solids and chlorides problem has improved but has not been eliminated by the closing of the Diamond Shamrock Company. These parameters are still in violation of water quality standards during lower flow periods. The source of these violations is from the abandoned Diamond Shamrock lagoon. This 200 acre waste lake continues to leach along the banks of the Grand River, causing dissolved solids and chloride violations when ever there is insufficient flow in the Grand River to dilute these materials.

pH violations which have occasionally occurred during past years should now be totally eliminated since the source of these violations was the Diamond Shamrock discharge.

The water quality of the lower Grand River should continue to show significant improvements during the next few years. Because of the pollution abatement efforts by the industries and the municipalities of this area the lower Grand River should return to a high quality stream.

In the upper reaches of the Grand River, it appears there were no significant changes in water quality during the 1977 water year. In these areas the water quality continues to remain very good.

This improvement in pH can be attributed in large part to pH control improvements made by an industrial facility. This same facility has recently ceased operations. Curtailment of this discharge to the river should bring about reductions in suspended solids, dissolved solids, chlorides. Further pollutant reductions are anticipated in this basin as improvements are made to the Painesville WWTP (upgrading to provide tertiary treatment). Several facilities including the Painesville Municipal Power Plant plan to eliminate their discharge while several industries propose to tie into municipal sanitary sewers. Elsewhere in the basin, two WWTP's (Chardon and Jefferson) expanded capacity and upgraded their respective treatment processes.

1977 Water Year Summary

The water quality in the lower segment of the Grand River appeared to experience several changes during the 1977 water year, according to data collected at State Route 535. Most of the changes were attributable to the elimination of the Diamond Shamrock discharge. Generally, historical problems with dissolved oxygen at this site seemed to worsen, while past problems with dissolved solids, chlorides, ammonia, and pH appeared to improve.

The number of days during the summer months which experienced dissolved oxygen violations were similar to previous years but the severity of the violations or the minimum concentrations seemed to worsen. This phenomenon was probably due to two circumstances.

First of all, weather conditions were less favorable during the 1977 water year. Generally lower flows and higher temperatures occurred during the water year, especially during the late spring months. This would cause lower dissolved oxygen concentrations even though organic pollutant loadings may have remained the same. Also, the elimination of the 90 million gallon per day Diamond Shamrock discharge, which was low in organic pollutants, may

F. Ashtabula River Basin

Water quality in this basin strongly parallels that of its neighboring basin to the west, the Grand River. This basin drains predominantly rural areas with only a few minor point sources causing localized problems. Water quality is very good throughout the entire basin with the exception of that portion located near the mouth in the City of Ashtabula. The major problem in this area is associated with industrial discharges to Fields Brook, a tributary to the Ashtabula River near its mouth.

Fields Brook receives the discharges from 9 industrial sources. Sampling of this stream reveals frequent standard violations for total dissolved solids, mercury, chlorides, phenols and MBAS. Less frequent standard violations for lead and copper have also been detected. The discharge from Fields Brook appears to degrade water quality in the mainstem of Ashtabula River, particularly during low flow periods. Discharges from Fields Brook are believed responsible for 2 dissolved oxygen violations, and single violations for chloride, copper, and lead noted at the 5th Street Bridge in Ashtabula. Fecal coliform bacteria violations were frequent occurrences at this location also.

Several industrial facilities in the basin have constructed or improved their waste treatment facilities. New Jersey Zinc installed a new lime slurry system to provide better pH control, while Diamond Shamrock has installed facilities to provide primary and secondary neutralization, filtration, and oil and grease removal. The total discharge volume from Diamond Shamrock was reduced during 1976 with the completion of a new cooling water recycle system. Olin Corp. is pursuing a program to improve pH control and also initiating steps to reduce the amounts of organic chemicals entering their waste treatment system. General Tire has significantly reduced its waste volume discharge and Reactive Metals plans to upgrade their wastewater treatment facility.

1977 Water Year Summary

The Ashtabula River basin has not changed significantly during the 1977 water year according to Ohio EPA's data; however, at the U.S.G.S. gauge at State Road (Ohio EPA's Primary Sampling Site) the first historical documented phenol violation of 18 ug/l was recorded on 11-17-76. On 4-7-77 the second phenol violation was documented as well as a 2.5 ug/l PCB concentration.

Continued monitoring of the Strong Brook tributary revealed the general location of the phenol source that has beenfound to be in violation in all samples taken at the mouth, with the highest concentration of 12,500 ug/l. Also, a .93 ug/l concentration of Dieldrin has been documented on 6-8-77 at the mouth of Strong Brook. Other compounds monitored at the mouth include Endosulfan I (.79 ug/l) and Endosulfan II (.72 ug/l).

The tributary to Fields Brook draining the Diamond Shamrock and Detrex property was monitored six times during the 1977 water year. Upstream of the Diamond Shamrock discharge at a point where State road corsses, a dense product was observed several times in the stream's sediment bottom. Apparently, a batch discharger releases this product periodically. Chemical analysis of this bottom sludge revealed 1.21 PPm of Trichlorethylene and .26 PPM of Tetrachlorethylene. Other typical violations associated with this tributary are chlorides, phenols, ammonia, MBAS, cadmium, Diss. Iron, oil and grease and lead.

G. Conneaut Creek Basin

Like the Grand and Ashtabula Rivers, Conneaut Creek drains rural areas with a few point source discharges resulting in minor localized water quality problems. Conneaut Creek is one of only a few streams in Ohio that can support a cold water fishery. It is not without its problems. Fecal coliform bacteria violations occur throughout the basin; the result of septic tank leaching or discharges from "package waste treatment plants" that serve commercial establishments or small housing developments.

A few heavy metal violations have been noted in the basin. A lead violation was noted at the Furnace Road station near the Ohio-Pennsylvania state line. One copper and one lead violation were observed at the U.S. Geological Survey gauging station just upstream of the City of Conneaut. Slightly elevated concentrations of nutrients have been noted at various sampling stations throughout the basin. The origin of these nutrients is probably the result of nonpoint sources and discharges from "package waste treatment plants."

1977 Water Year Summary

The Conneaut Creek basin in Ohio has not changed significantly during the 1977 water year according to Ohio EPA's data; however, at the U.S.G.S. gauge at Keefus Road (Ohio EPA's Primary Sampling Site) the first historical documented phenol violation of 29 ug/l was recorded on 11-17-76.

The single citizen complaint received during the late summer October 1977 was concerned with a major city of Conneaut Sanitary by-pass. On 9-1-77 The Conneaut Creek at Main Street (downstream by-pass) was found to be moderately high in fecal coliform bacteria (5800 #/100 ml). Also, the fecal coliform bacteria count average for the 1977 water year was sixteen times in magnitude higher at the mouth of the Conneaut Creek as compared to the 1976 water year average, indicating that the by-pass occurred for an extended period of time. The location of the by-pass was found to be between Center Street and Mill Street. To correct this situation the City of Conneaut increased their pumping capacity at their pumping stations by installing new compressors. All problems associated with the above by-pass are being addressed by current facility planning.

H. Mahoning River Basin

The water quality in the Mahoning River varies from extremely high to grossly polluted. The upper and middle reaches of the mainstem and most tributaries are of relatively high quality and include five major reservoirs for recreational and/or public water supply uses. As the river approaches and flows through the City of Warren, septic tank leachates and numerous combined sewer overflows cause elevations of bacterial levels and just downstream of Warren the water quality is drastically reduced by discharges from several industrial discharges. From here to the Ohio-Pennsylvania State line, a distance of more than fifteen river miles, the water quality is extremely poor. In fact, this reach is perhaps the most polluted body of water in the entire state of Ohio.

The existing water quality of the upper to middle reaches of the Mahoning River is generally very good and should continue to be of fairly high quality since much of the drainage basin lies in rural and low population density areas. Alliance is the only major city in the upper reaches of the basin and does have some impact on the water quality. According to data collected during 1977 at Alliance, the water quality is fairly good except that the stream standards for fecal coliform bacteria and phenols were violated occasionally.

Two high quality reservoirs, Lake Milton and Berlin Reservoir, are located in the middle reaches just downstream of Alliance. These reservoirs are used for primary and secondary contact recreation. The Pricetown sampling site on the mainstem just downstream of Lake Milton has high quality water with only occasional violations of the fecal coliform bacteria standard. The West Branch enters the mainstem just downstream of Newton Falls. This is a very high quality tributary as it generally flows through rural and undeveloped areas.

Water quality data collected at the Leavittsburg monitoring station, a

few miles upstream of Warren, indicates that water quality conditions here were relatively good. There are consistent violations of the general stream standard for fecal coliform bacteria presumably due to the discharge from the Newton Falls WWTP along with leaching from numerous septic tanks in the Newton Falls and Leavittsburg areas.

The Mahoning River flows from Leavittsburg into the northeast section of Warren past a steel mill and then south past two municipal parks. The water quality in this reach is relatively good despite discharges from combined sewer overflows and from the steel mill. All water quality criteria are well within stream standards except fecal coliform bacteria and occasionally, zinc and oil and grease.

The water quality in lower Mahoning River from Warren to Lowellville is extremely poor due to several factors. These include the need by industries to use and reuse the water, discharge of untreated or partially treated sanitary and industrial waste loads, and unnatural seasonal flow characteristics. This region is heavily industrialized with seven major steel plants which may reuse the total flow of the river from three to five times depending upon the time of year, and discharge large loads of suspended solids, oil and grease, ammonia, cyanide, phenolics, metals and heat. There is one power plant which also contributes to the thermal loadings in this reach. There are eight municipal primary and secondary wastewater treatment plants which discharge an average of 50 million gallons of wastes per day which cause elevations of BOD, ammonia, and bacteria.

The water quality of the Mahoning River changes drastically downstream of Warren due to pollutant loads discharged from the outfalls at the Republic Steel-Warren plant. The outfall from the blast furnace contributes significant loads of suspended solids to the river. Just downstream of the Republic

Steel plant, the Warren WWTP discharges to the river. The combination of these two discharges causes elevations in the river of fecal coliform bacteria, ammonia, and lead, as well as increased concentrations of phenols, zinc, and occasionally cyanide above water quality standards levels.

In Niles, problem parameters included fecal coliform bacteria, oil and grease, phenols, lead, ammonia, and zinc, all of which were above desirable water quality standard levels. Municipal wastewater discharges from WWTP's in Niles, McDonald, and Girard cause elevations of fecal coliform bacteria and ammonia. Industrial discharges in this area add ammonia, oil, grease, zinc, cyanide, chrome, phenol, heat, and metals to the river.

The water quality in the the Youngstown-Struthers area of the mainstem is further degraded by several industrial dischargers and municipal waste-water treatment plants. Oil and grease commonly covers much of the river's surface in this area. Ammonia, fecal coliform bacteria, temperature, phenols, and zinc are at elevated levels. In addition, there are occasional violations of cyanide and copper.

The water quality at Lowellville near the Ohio-Pennsylvania state line does not improve significantly. The Struthers WWTP is the only major point source discharger in this reach. However, fecal coliform bacteria, ammonia, temperature, phenols, and zinc concentrations are above desirable levels. Occasional high concentrations of oil and grease, cyanide and copper, and low dissolved oxygen readings have been noted.

Water Quality Standards are currently being met on most tributary streams and with the exception of bacteriological violations, are also met on the upper mainstem from Lake Milton downstream to Warren. Standards

are not met through the lower section of the Mahoning from downstream of Warren to the Ohio-Pennsylvania state line. The problematic parameters in this reach include fecal coliform bacteria, dissolved oxygen, temperature, ammonia, phenols, zinc and occasionally cyanide, copper and lead. Ohio Water Quality Standards (OAC 3745-1) include specific standards for the Mahoning River, which were adopted by the Water Pollution Control Board on July 11, 1972. The Mahoning standards were revised and promulgated in late 1977. Many permits and subsequent industrial waste control programs await the establishment of these new standards. By 1983 the Mahoning River at the state line will be suitable for fishing and public water supply.

Several industrial entities have recently constructed or are now building improved wastewater treatment facilities. Many other industries are in the planning stage towards providing improved wastewater facilities. Those industries which have completed improvements or plan improvements are listed below:

(1) Amsted Industries - improved pickle rinsewater pretreatment with tie-in with Alliance sanitary system completed.

(2) Babcock and Wilcox - improved pickle liquor treatment plus tie-in with Alliance.

(3) Transue Williams - pickle rinsewater pretreated and discharged to Alliance sanitary system. Steam operated forge hammers converted to compressed air operation.

(4) Rockwell International - discontinued operations.

(5) Copperweld - scheduled to build retention basin with planned 100% recycle of treated wastewater.

(6) Republic Steel, Warren - improved solids and oil treatment.

(7) Thomas Steel Strip - improved plating solution treatment.

(8) General Motors, Packard Electric - improved wastewater treatment with construction of tie-in with Warren now complete.

(9) RMI - improving their wastewater treatment facilities by use of improved retention basis.

(10) General Electric - has an on-going study and facility improved program for reduction of fluorides.

(11) Jones and Laughlin, Niles - installing improved facilities for reduction of chromium, zinc, suspended solids and oil loading in their discharge along with destruction of cyanide.

(12) Jones and Laughlin, Youngstown; Republic Steel, Youngstown; U.S. Steel, Youngstown, and McDonald; Youngstown Sheet and Tube, Youngstown, Campbell and Struthers - in the planning stage with Youngstown Sheet and Tube completing construction of cold rolling mill and pickle rinsewater treatment facilities at Campbell.

The following lists municipal wastewater treatment facilities that have been constructed or upgraded within the last five years:

(1) Mahoning County Meander Creek Wastewater Treatment Plant Facility (4 mgd) presently under construction and estimated to be in service by September 1976; unit process consists of two stage pure oxygen activated sludge treatment providing for phosphorus removal with lime addition, rapid sand filters and disinfection by ozonation; sludge to be incinerated.

(2) Village of Cortland Wastewater Treatment Plant - construction completed to upgrade and expand present treatment facilities; plant provides treatment with sludge to be spread on farm land.

(3) Trumbull County Brookfield No. 4 Wastewater Treatment Plant - plant upgraded and with additional capacity added to provide secondary treatment.

(4) Mahoning County Sherwood Forest Subdivision Wastewater Treatment Plant - plant upgraded to provide extended aeration with chlorination and additional capacity.

(5) Trumbull County Newton Manor Wastewater Treatment Plant - treatment consists of contact stabilization sand filter and chlorination.

(6) Village of Windham Wastewater Treatment Plant - treatment consists of oxidation ditch and chlorination.

I. Little Beaver Creek Basin

Water quality in the Little Beaver Creek Basin is good. Discharges from several municipal WWTP degrade water quality in localized areas and are probably responsible along with septic tank leachate for the violations of the fecal coliform bacteria standard that occur throughout the basin. Several industrial discharges cause additional violations of pH, phenols, chlorides, MBAS, heavy metals, and ammonia. About 36 stream miles have been designated as "Wild or Scenic" by the Ohio Department of Natural Resources. Because the basin has not experienced high intensity development, it has been able to retain much of its natural scenic beauty. Ten areas within the basin have been designated as natural areas. Several archaeological and historic sites have also been identified in the basin.

The headwaters of the Middle Fork of Little Beaver Creek receive the discharge from the Salem WWTP. Violations of the water quality standard for ammonia, phenol, and dissolved oxygen have been noted at the Beechwood Road sampling station downstream of the Salem WWTP discharge. Stone Mill, a tributary to the Middle Fork, drains the southern portions of Salem. The water quality in this stream is degraded by industrial discharges. Problematic parameters detected include MBAS, fecal coliform bacteria, lead, zinc and fluoride. Further downstream, an occasional dissolved oxygen and fecal coliform bacteria violations have been noted.

A water quality problem associated with an industrial waste discharge exists in the West Fork. The industrial facility discharges to a small tributary which flows into the West Fork. Sampling at the mouth of this tributary revealed significant water quality standard violations for pH, ammonia, phenols, chlorides, MBAS, and zinc. Occasional violations for fluoride and copper were also noted. The impact of this discharge on water quality in the West Fork appears to be localized amd confined primarily to the small tributary because sampling further downstream in the West Fork showed only a violation for fecal coliform bacteria. It should be pointed out that the industrial facility has made efforts to improve the quality of its discharge by upgrading its waste treatment system.

The most severe water quality problems in the basin are found in Stateline Creek. Stateline Creek, a small tributary to the North Fork, receives the discharge from several industrial facilities. Numerous water quality standard violations have been documented at the sampling site located near the mouth of the stream for ammonia, chloride, phenols, total iron and manganese. Other violations noted in this stream include selenium, lead, zinc, MBAS, and one PCB. These constituents emanate from two industrial facilities engaged in liquid waste disposal operations. Leakage and/or direct discharges from industrial lagoons is believed to be the means by which these constituents enter Stateline Creek. The flow from Stateline Creek has been shown to have an adverse impact on water quality in the North Fork of Little Beaver Creek. Violations of stream standards for lead and fecal coliform have been detected in the North Fork just downstream of its confluence with Stateline Creek. Sampling has also revealed high total iron concentrations at this location. A continuous water quality monitoring station has recently been installed by the U.S. Geological Survey near the mouth of Stateline Creek to monitor flow, pH, temperature, conductivity, and dissolved oxygen.

Several industrial facilities in the basin have improved or added new waste treatment capabilities. Eljer Plumbingware has eliminated their contact cooling water discharge thereby eliminating the discharge of lead to the receiving stream. Chemlime Corp. has completed construction of an industrial wastewater treatment system. Browning-Ferris Industries has discontinued use of 2 lagoons which were causing groundwater contamination as well as surface water problems.

1977 Water Year Summary

A total of 42 different locations were samples throughout the basin in addition to those sites covered in the 1977 water year. From the data collected during water year 1977, it appears that there was no significant change in the water quality of the Little Beaver Creek from the 1976 water year except for 2 out of 13 samples in violation of the phenol parameter at the U.S.G.S. gauge at mile point 4.4. The phenol violations are the first recorded at this U.S.G.S. gauge. Several problem areas that were monitored in the 1977 water year include sites in segments one and four.

In segment one violations of ammonia, MBAS, chlorides and phenols have been documented downstream of the old abandoned Neice Chemical lagoons. Samples were collected just before the lagoon tributary enters the Middle Fork of the Little Beaver Creek. The various violations are listed below:

Parameters	Number of samples collected	Max	Min	Aug.	Number of Violations
Ammonia mg/l	2	2.38	1.17		1
Phenols ug/l	4	44	12	24	4
Chlorides mg/l	3	333	196	250	1
MBAS mg/l	3	1.19	.74	.88	3

In segment 4 a citizen's complaint in East Palestine warranted sampling of a car wash discharging directly to the East Branch of Leslie Run. This discharge had violations of MBAS and Phenol (60 ug/l). Also, an industrial discharger to the headwaters of the East Branch of Leslie Run was thought to be contributing to water quality violations by discharging slug batches of process water. This headwater area will be routinely monitored to determine the various pollution parameters contributing to the above complaint.

Leachate from an Aluminum Dross spill near Bull Creek downstream of New Waterford increased stream concentrations of Arsenic into the violation zone (1700 ug/l) and had the potential of increasing other parameters (MBAS, Phenol, Diss. Fluoride, ammonia and chlorides) in Bull Creek above State Water Quality Standards if the area had not been cleaned up; however, thanks to Ohio EPA's Emergency Response Section the spill was properly disposed of.

In the headwaters to Bull Creek in Fairfield Township the first documented chloride violation (630 mg/l) from the previous salt pile at the inter-section of State Route 7 and State Route 14 was collected on 9-28-77. This area will be sampled once a month to monitor chloride leachate from this chili soil series industrial site.

Two significant industrial dischargers on the Little Beaver Watershed are Chemlime Corporation and Browning-Ferris Industries of Ohio, Inc. (BFI). Chemlime Corporation operates a liquid industrial waste disposal facility located on the Chemlime Run/West Fork Little Beaver Watershed (see attached map). The disposal facilities consist of a strip mine cut with lime neutralization equipment.

Industrial liquid wastes received for disposal by the company consist mainly of spent pickling acids (H_2-SO_4, HCl, HF, HNO_3). The acids are neutralized, and the resulting slurry is placed in the strip mine cut for settling. Pollution problems arose when leachate from the strip mine cut started entering Chemlime Run. The detrimental effects of the leachate were abated after Chemlime installed pollution control facilities to collect and treat the leachate. Construction of the facilities was completed in October, 1976.

The pollution control facilities consist of a neutralization-aeration-sedimentation plant preceded by a 2.1 acre or 4.45 MG surge pond. Water from the pond, along with lime slurry, is pumped to a flash mix tank for pH adjustment. It then flows to an 80,000 gallon basin for aeration. Solids settle out in two 150,000 gallon primary settling ponds and in two 620,000 gallon secondary settling ponds. The supernatant is discharged to Chemlime Run.

Discharge flows from the pollution control facilities averaged 0.56 MGD for 1977. The company's NPDES permit authorizes the following effluent quality:

EFFLUENT CHARACTERISTIC	DISCHARGE LIMITATIONS		
	Daily Avg	Daily Max	
Dissolved Solids		10,000	mg/l
Nitrate		500	mg/l
Phosphorus, Total		0.3	mg/l
Chloride		2,500	mg/l
Fluoride, Dissolved		10	mg/l
Chromium, Total		300	ug/l
Copper, Total		500	ug/l
Manganese, Total		1,500	ug/l
Nickel, Total		1,000	ug/l
Zinc, Total		1,000	ug/l
Iron, Dissolved		1,000	ug/l
Total Suspended Solids	35 mg/l	45	mg/l

The pH shall not be less than 6.0 S.U. nor greater than 9.0 S.U.

Although the pollution control facilities were designed to achieve an effluent quality within the above discharge limitations, effluent quality violations have commonly occurred with dissolved solids, nitrate, manganese and pH. Other permit violations have occurred because of ammonia, a pollutant that was not permitted for discharge. Ammonia concentrations in the effluent have varied between 200 and 300 mg/l.

Chemlime has taken steps to reduce the severity of the violations by terminating the disposal of certain wastes, which heavily contribute to such violations. Chemlime is also investigating several modifications to their disposal and leachate treatment methods, which may return the effluent quality back into compliance with their permit. Chemlime's non-compliance status has been referred to the Environmental Law Section for possible legal action.

In general, BFI parallels Chemlime. The entity operates a liquid industrial waste disposal facility and is located on the State Line Creek/North Fork Little Beaver Watershed (see attached map). Their disposal facilities presently consist of a 98 MG clay-lined lagoon with lime neutralization equipment. They have proposed to install an 80 MG lagoon and a deep well injection facility.

Industrial liquid wastes received for disposal by the company consist of spent pickling acids and inorganic and organic sludges. The acids are neutralized, and the resulting slurry is placed in the lagoon for settling. The sludges are placed directly into the lagoon. Pollution problems arose when leachate from two previous disposal lagoons started entering State Line Creek. The detrimental

effects of the leachate were abated after BFI recently (November, 1977) installed pollution control facilities to collect and treat the leachate. BFI is also in the process of covering and reclaiming the two now unused disposal lagoons.

BFI also employs a neutralization-aeration-sedimentation process for leachate treatment. Leachate from a 1 MG collection pond is pumped to a neutralization tank for pH adjustment. It is then aerated as it cascades down into a 3 MG primary settling lagoon, which overflows to a 1 MG secondary settling lagoon. The supernatant is discharged to the West Fork State Line Creek.

Discharge flows from the pollution control facilities have averaged 0.3 mGD. It is expected that the facilities will be able to meet the below listed effluent limitations in their proposed NPDES permit. The phenol limitation is still subject to change to a stricter limitation.

EFFLUENT CHARACTERISTIC	DISCHARGE LIMITATIONS
	Daily Max
Total Suspended Solids	45 mg/l
Iron, Total	1,000 ug/l
Lead, Total	100 ug/l
Manganese, Total	2,000 ug/l
Zinc, Total	1,000 ug/l
Phenol	2,000 ug/l

The pH shall not be less than 6.0 S.U. nor greater than 9.0 S.U.

Two parameters that are not limited in the permit, but occur in the effluent, are total dissolved solids and chlorides. Total dissolved solids are expected to range between 6,000 and 12,000 mg/l; whereas, chlorides are expected to range between 2,000 and 5,000 mg/l.

4. Southeast Region

The southeastern region of Ohio encompasses the Muskingum River Basin which is the largest drainage basin in the state (over 8,000 square miles), the Hocking River Basin, and the minor tributaries discharging directly to the Ohio River from East Liverpool to Portsmouth. This region lies entirely within the Allegheny Plateau Province. The far northern and western portions of the basin are glaciated, the remainder being unglaciated. Cropland is the primary land usage in the glaciated portion, while in the unglaciated areas land usage is devoted to pasture land and livestock. Significant amounts of coal still exist in the unglaciated portion. The mining of coal (particularly the pre-reclamation strip mining operations) and other related activities have given rise to the most common water quality problem in this region, acid-mine drainage. The extent and impact of mine drainage on water quality was discussed in a previous section. Aside from the mine drainage problem, many localized water quality problems associated with point source discharges occur in this region. This section of the report will highlight those problem areas in the Muskingum and Hocking River Basins. No new water quality data was obtained during the 1976 water year for the minor tributaries that discharge directly to the Ohio River. For this reason, no assessment of water quality in these streams will be made. For the vast majority of these streams, degradation of water quality due to mine drainage continues to be a major problem.

A. Muskingum River Basin

Perhaps the best way to describe water quality in the Muskingum Basin is to say that it is very diverse. The Tuscarawas River below Barberton and Massillon and Rocky Fork Creek below Mansfield have severe water quality problems. On the other hand, the Mohican River near Greer or the Muskingum

River near Beverly have excellent water quality. High fecal coliform counts are the most common water quality problem throughout the basin.

Occasional water quality standard violations of dissolved oxygen, cadmium and total iron were noted in Stillwater Creek below Urichsville. In Sugar Creek below the Strasburg WWTP, high levels of fecal coliform and total iron are often noted. Cadmium and copper violations have also been noted here. An industrial discharge is believed responsible for the heavy metals found in this location. Copper and cadmium violations have been recorded in Wills Creek below Cambridge. High concentrations of total iron and high fecal coliform counts occur regularly here also.

Apparent violations of the water quality standard for phenols were noted in the Muskingum River below Coshocton. The average phenol concentration (based on 10 samples) at this station was 14 ug/l. An industrial discharger is believed responsible for these high phenol concentrations. High phenol concentrations have also been noted in the Licking River below Newark. Heavy industrial loadings to the Newark WWTP coupled with inadequate treatment at the plant create serious water quality problems in this stream below the WWTP outfall. Ammonia, heavy metal, and dissolved oxygen violations frequently occur at the sampling station downstream from Newark.

The most severe point source problems occur in the upper third of the Muskingum Basin. Water quality standard violations for cadmium, copper, zinc, iron, total chromium, hexavalent chromium, phenol, ammonia, and to a lesser extent, MBAS are frequently noted in Rocky Fork Creek below Mansfield. Numerous industrial effluent discharges in this area create these problems. In the summer months when flows are low, heated discharges cause temperature violations. The elevated water temperatures coupled with biochemical

oxygen demanding substances result in dissolved oxygen violations. The water quality in Rocky Fork Creek is generally degraded from Mansfield downstream to its confluence with Black Fork. In Killbuck Creek below Wooster, violation of water quality standards for dissolved solids, ammonia, phenols, total iron, copper and lead have been noted. Industrial discharges are responsible for the water quality problems found in this stream segment.

Some of the most serious water quality problems in the entire Muskingum Basin occur in the Tuscarawas River in the Massillon-Barberton area. Low stream flows coupled with numerous industrial and municipal point sources combine to cause significant water quality degradation. Phenol, ammonia, dissolved oxygen, chloride, and total and dissolved solids parameters frequently are in violation of standards in this area. At Clinton, downstream of Barberton, phenol, ammonia, dissolved solids, total iron, chlorides, dissolved oxygen, and MBAS violations frequently are noted. Phenol violations are particularly serious at this station. A ten sample average showed the phenol concentration to be 66.6 ug/l with the maximum being 273 ug/l. Continuing downstream, the Tuscarawas River at New Philadelphia appears to recover somewhat and is not nearly as polluted as it was in the Massillon-Barberton area. Nonetheless, violations of the standards for chloride, ammonia, manganese, and total iron occurred below New Philadelphia. At Coshocton, prior to its confluence with the Walhonding River to form the Muskingum, the Tuscarawas River continues to have violation levels of total iron, manganese, and high levels of fecal coliforms. Apparent phenol concentrations in the river at Coshocton are well above the water quality

standard level. A ten sample average showed the phenol concentration here to be 29.2 ug/l with a maximum of 141 ug/l (the phenol standard is 10 ug/l). This is an alarmingly high concentration of phenols to be found on a continuous basis.

Nimishillen Creek below Canton is severely degraded. Fecal coliform, ammonia, and total iron violations occur often in this area. During periods of low flow, the dissolved oxygen in the stream drops below the standard of 5 mg/l. Although only one of four samples showed a phenol violation, the other three samples had values near the violation level.

Even though water quality in the upper Tuscarawas Basin is poor, it should begin improving as a result of improvements made by several industrial dischargers. Timken Roller Bearing in Canton recently spent $10 million for a central treatment facility to handle wastewater from its Gambrinus and Duber Avenue plants. When construction is complete, the water quality in Hurford Run should show significant improvement. Some improvement in water quality has already been noticed in Hurford Run because of a new biological treatment plant installed by Ashland Oil Company to reduce oil and grease and phenolic wastes. Water quality in the East Branch of Nimishillen Creek should improve dramatically following completion of a $19 million control pollution abatement facility by Republic Steel Corporation.

On the Tuscarawas River, Pittsburgh Plate Glass (PPG) in Barberton has discontinued production of soda ash but continues production of chlorine with caustic soda as a by-product. The release of high concentrations of dissolved solids discharged by PPG is expected to continue. Downstream at Dover, Empire Detroit Steel expects to have a complete treatment plant to handle its waste discharge. Greer Steel, which at this time has no facility to treat its wastes, expects to have such a facility within two years. Problematic parameters

associated with these two sources, which discharge to the Tuscarawas River, include total iron, pH, suspended solids and zinc. In New Philadelphia, Union Camp plans to upgrade their treatment facility which when completed should reduce the amount of suspended solids and BOD discharged to the Tuscarawas River.

Elsewhere, Barmet Corporation hopes to have a complete recycling system, which will wliminate discharge of aluminum, iron, and chlorides into Stillwater Creek. In the Wills Creek basin, both the Elwin G. Smith Co. and the Sandstone Corporation have added pollution control facilities. The former now pretreats some of its wastewater discharges only non-contact cooling water to Leatherwood Creek, having eliminated its discharge containing lead. Brockway Glass (Zanesville) has eliminated their oil and grease discharge to the Licking River. Essex International has added pre-treatment to reduce heavy metals concentration prior to discharge into the Zanesville sanitary sewer system. On the mainstem of the Muskingum River, the Philo Electric Generating Plant of Ohio Power Company has been closed, thereby, eliminating a tremendous volume of heated effluent. The water temperature in the Muskingum River is elevated as a result of the discharge of heated water from the Conesville Electric Generating Plant of Columbus & Southern Ohio Electric Company. The addition of cooling towers may help reduce the thermal load and its impact on water quality during periods of low stream flow. Improvements at the Beverly Plant of Ohio Power have also been made by the addition of another ash pond to contain waste.

Massillon has recently completed a secondary wastewater treatment plant, while Canton is nearing completion of its secondary treatment plant. These plant improvements should do much to improve the water quality in the Upper Tuscarawas River and Nimishillen Creek respectively.

In spite of the numerous water quality problems mentioned above, improvements can be noted in the basin. Chloride concentrations in the Tuscarawas River near Massillon-Barberton area have decreased somewhat since 1970. Copper concentrations in the Muskingum River below McConnelsville are much lower now than they were five years ago. When the other improvements noted above are completed, additional improvements in water quality are anticipated. Water quality in areas like Rocky Fork Creek below Mansfield, Licking River below Newark, Jerome Fork below Ashland, Killbuck Creek below Wooster, and others is expected to remain degraded due to municipal and industrial point sources. Until the acid-mine drainage problem can be corrected, water quality of many streams in this basin will continue to be poor.

1977 Water Year Summary

The 1977 water year produced little significant changes in water quality of the Muskingum River basin compared to the previous year. However, some major wastewater facility improvements and construction in the basin have just been completed which should provide improved water quality in these areas for the 1978 water year.

A slight improvement was noted in the upper Muskingum River below Coshocton for phenol concentrations. We still had violations of the water quality standards but limitations placed on the Coshocton wastewater facility for phenol seems to have produced lower detected concentrations in the Muskingum River. The sources and concentrations of phenols contributed by the lower segment of the Tuscarawas River to the upper Muskingum River have not been sufficiently studied to fully address the phenol violations encountered in the above area. Since, this office feels more data is needed on the lower Tuscarawas River segment above Coshocton, a monthly sampling site has been established

at the U.S.G.S. Gage in Newcomerstown, Ohio.

Analytical data for the 1977 water year did disclose water quality violations for heavy metals in the Mohican River at our monthly sampling site located at the U.S.G.S. Gage in Greer, Ohio. Until this year, our office was not aware of any significant water quality problems in this stream segment. During the 1977 water year violations for hexavalent chromium, copper, lead, and zinc were noted. The violations are believed to originate from the industrial waste generated in the Mansfield area contained excessive amounts of heavy metal through a special survey conducted in this area. However, we had no knowledge of the persistance of these metals in the Mohican River. The Southeast Office hopes to conduct a small survey in the present water year to better evaluate the travel of the heavy metals in the Mohican River from the confluence of Rocky Fork to the monitoring site located at Greer, Ohio.

Data compiled in Chippewa Creek shows no significant change in water quality since the dredging in late 1975. This information should answer inquiries in this area concerning the effects on water quality caused by the dredging operation.

Presently, the Ohio EPA is formulating intensive surveys for the Tuscarawas River from Massillon to Dover, Ohio and the entire Nimishillen Creek basin. These two studies should provide pertinent information necessary for the proper wastewater management practices to pursue to bring these stream segments in conformance with water quality standards.

In order to provide addtional water quality information on the Muskingum River basin, seven sampling sites have been added to our present sampling network.

Three of the sites to be sampled quarterly are:

1. Tuscarawas River at Massillon on Walnut Street.
2. Hurford Run at Canton near mouth.
3. Wolf Creek at Barberton near mouth.

Four of the sites to be sampled during low-flow conditions are:

1. Chippewa Creek at Easton at U.S.G.S. Gage.
2. Tuscarawas River at Canal Fulton on Market Street.
3. Sandy Creek at Waynesburg at U.S.G.S. Gage.
4. Wills Creek at Cambridge at U.S.G.S. Gage.

Any additional sampling sites will be sampled on an agency request basis.

Rocky Fork - study of the Rocky Fork was conducted during the summer and fall of 1977 by the Northwest District Office in order to evaluate the impact of industrial dischargers and the Mansfield STP upon stream quality.

The majority of the water quality standards violations were recorded downstream from the Mansfield STP. The Mansfield STP effluent causes violations of ammonia, copper, chromium, and nickel standards to the mouth of the Rocky Fork. These water quality standards continue to be violated in the Black Fork of the Mohican River downstream from its confluence with the Rocky Fork.

A survey of the fish and macroinvertebrate communities of the Rocky Fork indicated that the Rocky Fork is very polluted from Empire Detroit Steel to its confluence with the Black Fork (a distance of 14.5 miles). From a biological view, the most severely polluted

stretch of stream is immediately downstream from Empire Detroit Steel. The stream immediately downstream from Empire Detroit appears to be essentially devoid of fish and macro-invertebrates. Aquatic worms (oligochaetes) and "sewage fungus" constitute most of the biomass present at Longview Avenue. The Rocky Fork shows some minor recovery prior to the Manfield STP discharge; however, downstream from the STP fish populations are essentially eliminated.

A sediment bioassay conducted using the mayfly, Hexagenia, and sediments collected from five locations in the Rocky Fork indicated that stream sediments in Mansfield downstream from Empire Detroit Steel but upstream from the Mansfield STP were toxic, with 80% and 90% mortality recorded at two stations during a seven day test. Two stations downstream of the Mansfield STP had 20% and 25% mortality, while the upstream control had a mortality rate of only 5%. The Rocky Fork has a very high gradient downstream of the Mansfield STP and it is hypothesized that toxic sediments are transported out of the Rocky Fork into the Black Fork.

B. Hocking River Basin

Water quality in this basin, like the Muskingum Basin, is most adversely affected by mine drainage. Point source discharges cause a few localized problems, but overall, result in little degradation of stream water quality in this basin.

The Hocking mainstem in the Lancaster area is degraded due to industrial and municipal point source discharges to a greater extent than any other area in the basin. Problems in this area result from combined sewer overflows plus discharges of poorly treated municipal wastes from an overloaded WWTP. Slugs of heavy metals and oil and grease are frequently discharged by industrial sources to the sanitary system. These periodic slugs have an adverse effect on the WWTP operations resulting in poor removal of nutrients, heavy metals, and suspended solids. Sludge deposits in the river downstream of the WWTP attest to this problem. The problematic parameters in this area include periodic depressed dissolved oxygen levels, ammonia, heavy metals, and oil and grease. Occasional heavy metals are found in the mainstem upstream of the WWTP outfall. This is probably the result of combined sewer overflows. During water year 1976, nine samples were collected below the Lancaster WWTP for ammonia with two violations of the ammonia standard noted. Personnel from the WWTP collected ten ammonia samples downstream of their outfall; six of the ten samples violated the water quality standard. No violations of the dissolved oxygen standard were noted during the 1977 water year. Anchor Hocking Glass Company has two plants located in different sections of Lancaster. Each has a discharge to a small stream that is tributary to the Hocking mainstem. Both discharges contain suspended solids and organic matter.

Occasional slugs of oil and grease from an industrial source, which discharges to a sanitary sewer, create water quality problems in Rush Creek below Bremen. Action to correct this problem is underway. Four Mile Creek, a tributary to the Hocking mainstem near its mouth had periodic high levels of cyanide and heavy metal contamination resulting in fish kills. A photographic processing firm was responsible for these discharges but has recently relocated, thus eliminating the problem.

Presently there are 12 communities in this basin which have no facilities for treatment of municipal wastes. These communities are listed in Table 16. Of particular concern is the Village of Amanda. Septic tanks from residential properties are tiled into ditches and storm sewers that discharge to a tributary of Clear Creek. Water quality degradation in the tributary and in a small segment of Clear Creek has occurred because of this discharge. The Village of Amanda is eligible to receive Federal monies amounting to $12,713 to assist in the planning of a treatment facility.

During water year 1977, there were no new municipal or industrial dischargers in the basin. Both Bremen and Lancaster applied for federal grants to help finance the upgrading of present WWTP facilities. Both Anchor Hocking Plants are working on plans to recycle their waste flows. They hope to be able to eliminate their present discharge to Baldwin Run and Hunters Run by 1978.

There are several areas in the basin having high quality waters worthy of mention. One such area is the Clear Creek Basin (some slight problems in the Amanda area), which is the only major subbasin in the Hocking system whose waters are not degraded by mine drainage. The waters in this basin are generally very high quality and flow through a very picturesque area. In the Rush Creek subbasin, Center Branch Creek, Little Rush Creek and Raccoon Run have high quality water. Some other minor tributaries to the Hocking mainstem having high quality water include upper reaches of Hunters Run, Margaret Creek, and Four Mile Creek.

TABLE 19

COMMUNITIES WITHOUT SEWAGE TREATMENT PLANTS

ENTITY		COUNTY	POPULATION
Amanda	*	Fairfield	2,194
Buchtel		Athens	592
Coolville	*	Athens	672
Corning		Perry	838
Glouster	*	Athens	2,121
Jacksonville		Athens	545
Junction City	*	Perry	732
Murray City		Hocking	562
New Straitsville	*	Perry	947
Pleasantville		Fairfield	754
Shawnee		Perry	914
Trimble		Athens	542

*Have applied for Step 1 Federal Funding Grants

1977 Water Year Summary

Water quality in the Hocking River Basin has not changed significantly in the past few years. Acid mine drainage remains the most detrimental factor within the problem areas in the Hocking Basin and until this problem is adequately addressed, improvement in water quality in the basin will in most cases be negligible.

The Department of the Interior will be setting up a work unit during 1978 based on the Surface Mine Act to conduct an intensive survey on all aspects of mine reclamation and acid mine drainage. Hopefully, they will come up with some economically feasible solutions so that improvements can be initiated in the Hocking Basin.

Improvement in water quality due to the upgrading of point source discharges will be most noticeable in the Lancaster area. Presently, there are occasional dissolved oxygen, ammonia, fecal coliform, oil-grease, phenol, and lead violations of Water Quality Standards in the Hocking River around Lancaster. The Anchor Hocking Company Plant No. 2 in Lancaster will be eliminating its entire discharge by May, 1978. Anchor Hocking Plant No. 1, also in Lancaster, will eliminate all wastewater discharge except cooling water by July, 1978.

The City of Lancaster is presently awaiting approval for a Step 1 Construction Grant amounting to $428,000 for a Sewer System Evaluation Survey. Approval for initiating this survey will continue needed action for improving water quality in the Lancaster area.

5. Central Region

The Scioto River Drainage Basin encompasses approximately 6,510 square miles in the south central portion of Ohio. It is the third largest river basin in the state. Three distinct physiographic subdivisions are represented in the basin. About 65% of the basin is in the Glacial Till Plains of the Central Lowlands Province. The flat or gently rolling northern part of the basin is made up of thick glacial drift mantling the bedrock and filling the pre-glacial valleys. The eastern portion of the basin from Chillicothe north is in the Glaciated Plateau Province. Here the topography is more rolling, with rounded hills and valleys filled with glacial deposits. The southern and southeastern quarter of the basin lies within the Unglaciated Allegheny Plateau which is characterized by its steep slopes and rugged topography. Water quality within the basin ranges from fair to good. Violations of the fecal coliform standard (200 colonies/100 ml sample) is widespread throughout the basin. Areas where water quality problems exist include Marion, Columbus, Circleville, Chillicothe, Jackson, Marysville, Galion, and Reynoldsburg. Water quality in subbasins and in the mainstem will be discussed individually.

A. Olentangy River Basin

In previous years during low flow periods, the discharge from the Galion WWTP caused water quality standard violations for dissolved oxygen and ammonia. Some improvements to this plant were made in 1975, but overloading continues to cause degradation of water quality in the stream below the outfall. Nearby, Whetstone Creek experiences occasional dissolved oxygen and ammonia violations below Mt. Gilead and Cardington.

Downstream of the Delaware Dam and continuing to Worthington, water quality in the river is very good. This segment of river has been designated

a scenic river by the Department of Natural Resources. During the 1976 water year, sampling at the Stratford Road station downstream of the Delaware WWTP revealed an occasional ammonia violation. In the Columbus area, the water quality in the river becomes somewhat degraded due to urban stormwater runoff, a thermal discharge, and combined storm sewer overflows. Also, several industries discharge to the river near its mouth.

B. Little Scioto River Subbasin

For years, the combination of inadequate treatment of municipal wastes by the Marion WWTP coupled with low flows has severely degraded the water in the Little Scioto River below Marion. It is not uncommon to find the water in this segment totally devoid of oxygen during the summer months. Sludge deposits abound in this segment and the release of methane gas from these highly polluted sediments can be seen. Violations of the ammonia standard occur frequently. Marion has recently upgraded its WWTP to provide for advanced treatment. This should help improve water quality appreciably, but the polluted sediments may still cause occasional water quality problems.

C. Mill Creek Subbasin

Problem parameters in Mill Creek below Marysville include dissolved oxygen and ammonia. One phenol violation was noted in Mill Creek near its mouth. The water quality problems in this area result from industrial and municipal discharges. There are a number of industries in the Marysville area that utilize on site "package" treatment facilities to treat their waste flow. Such treatment facilities generally provide secondary treatment. The problem with several of these facilities is that their discharge goes to dry ditch tributaries of Mill Creek. The reduction levels in BOD and

ammonia that these facilities can provide is insufficient to prevent standards violations for ammonia and dissolved oxygen in the ditch and in Mill Creek. Advanced treatment may be required or pretreatment with discharge to the Marysville sanitary system should help alleviate this problem.

D. Big Walnut Creek Subbasin

Water quality in the upper reaches from the headwaters to Hoover Reservoir is good. A minor localized problem area exists in this segment near the Sunbury area where an industrial discharge and the discharge from the Sunbury WWTP result in a few minor water quality problems. Downstream of Hoover Reservoir, the water quality is good and is used as a water supply for the City of Columbus. In the lower segments, some degradation of the water quality occurs due to storm water runoff and combined sewer overflows. Occasional dissolved oxygen violations are noted in this lower segment.

Two tributaries discharge to the lower segment of Big Walnut Creek. These are Blacklick Creek and Alum Creek. Water quality in Blacklick Creek above the City of Reynoldsburg is good, but below the Reynoldsburg WWTP, serious degradation of water quality occurs. Poor treatment of municipal wastes, plus frequent bypassing, accounts for numerous dissolved oxygen, ammonia, and fecal coliform violations in this area. Sludge deposits downstream of the WWTP outfall further add to water quality degradation. It is hoped that the Reynoldsburg WWTP can be eliminated by diverting sewage flow into the Columbus system. The City of Westerville presently withdraws water from Alum Creek for water supply. Minor water quality problems exist in the lower segments of Alum Creek near its confluence with Big Walnut Creek, probably the result of storm water runoff and combined

storm sewer overflows. The only water quality standard violation detected in this segment during the 1976 water year was one low dissolved oxygen concentration.

E. Little Walnut Creek Subbasin

Little Walnut Creek enters the Scioto River just downstream from Big Walnut's confluence. The headwaters of the basin drain predominately agricultural lands. Other than during high runoff periods when sediments and nutrients are eroded from the agricultural lands, water quality in this area of the basin is good. Water quality is degraded below the City of Baltimore. Here an industrial source discharges paper mill wastes containing dyes and oxygen demanding materials to the stream. These materials in combination with the discharge from the Baltimore WWTP cause violations in the dissolved oxygen and ammonia standard. The dye discolors the water and the suspended solids material contained in the paper mill waste create sludge deposits thereby causing aesthetic degradation of the stream. Further downstream, local problems exist below the outfalls of the Canal Winchester and Rickenbacker Air Force Base WWTP facilities. Apparently in spite of these point source discharges upstream, the water quality in the stream near its mouth recovers because no water quality violations were noted during the 1976 sampling period at this location.

F. Big Darby Creek Subbasin

The entire basin is relatively free of point source pollution and has high quality water. About 54 miles of Big Darby Creek (From S.R. 38 to its confluence with the Scioto River) has been proposed for scenic river designation.

Water quality in Little Darby Creek is also good. A good portion of the basin drains predominately agricultural lands. Therefore, it is conceivable that occasional water quality problems may arise during high runoff periods.

G. Deer Creek Subbasin

Deer Creek, like Big Darby Creek, is a basin having few point source discharges and hence, has relatively high quality water. Localized water quality problems may occur below Mt. Sterling and Williamsport. A new WWTP at London has improved water quality conditions in Oak Run, a tributary to Deer Creek.

H. Paint Creek Subbasin

Paint Creek has the largest drainage area of all the tributary basins in the Scioto River drainage system. There are several problem areas in the upper reaches of the basin attributable to municipal point source discharges. The problem areas include Paint Creek below Washington Court House, Rattlesnake Creek below South Solon and Sabina, the North Fork of Paint Creek below New Holland, the East Fork of Paint Creek below Bloomingburg, and Rocky Fork Creek below Hillsboro. In these areas, infrequent to frequent violations of the standards for dissolved oxygen, ammonia, and fecal coliform are known to occur. Downstream of these areas, but upstream of Chillicothe, water quality in Paint Creek appears to recover from the upstream point source discharges. At the sampling station near Bourneville, the only

water quality violation noted during the water year was for fecal coliform. Although not a violation, the average nitrate concentration of 1.53 mg/l seems to illustrate the influence of the upstream municipal discharges. The average total iron and manganese concentrations of 4375 ug/l and 130 ug/l respectively are also somewhat high.

A particularly significant volume of paper mill waste is discharged to Paint Creek just prior to its confluence with the Scioto River in Chillicothe. This discharge has an adverse impact on water quality, particularly during lowflow periods. Although the paper mill company provides treatment in the form of aerated lagoons, significant amounts of oxygen demanding solids enter Paint Creek resulting in depressed dissolved oxygen levels. As these solids settle out in either the bottom of Paint Creek or the Scioto mainstem, they exert an additional oxygen demand. The discharge permit for the company requires that it reduce its present discharge load by one-half. The company is presently working towards attainment of its permit requirements.

I. Salt Creek Subbasin

Water quality in this basin is generally good. Lab error is believed responsible for the three oil and grease violations. The only other parameter observed to be in violation at the sampling site near Richmondale was fecal coliforms. Stream degradation in Little Salt Creek below the City of Jackson has been noted. Violation of the standards for ammonia, dissolved oxygen, and fecal coliform were recorded in this stream several miles below the Jackson WWTP outfall.

J. Scioto Mainstem

The upper Scioto Mainstem has generally good water quality. However, during summer months when flow is low, occasional dissolved oxygen and

ammonia problems in the Kenton and Green Camp areas occur. Fecal coliforms were sampled at the station below Kenton five times in 1977 and all five times the counts were above the standard for this parameter (the standard is 200 colonies per 100 ml of sample). This was the only standard violation noted at this station. Further downstream at the Prospect station, 7 samples collected for fecal coliform were in violation of the standard. Water quality in this area is expected to improve in the near future as a number of communities begin receiving grant monies for correcting their problems.

The segment of the mainstem from just above O'Shaugnessy Reservoir to Frank Road in Columbus has fair to good water quality. Water is withdrawn from the river just downstream of Griggs Reservoir to serve as a water supply for the City of Columbus. The lower segment has occasional water quality problems due to urban runoff and combined sewer overflows.

The most serious degradation of water quality in the mainstem occurs in the segment below Frank Road in Columbus and extends downstream to near Circleville, a distance of about 25 miles. The critical water quality problem in this area occurs during low flow periods. Under these conditions, the effluent from Columbus' two waste treatment plants may account for as much as 95% or more of the flow in the Scioto River below Columbus. Serious water quality problems occur in the river under these circumstances. Problem parameters include dissolved oxygen, ammonia, fecal coliform, and heavy metals. At the sampling station at Shadeville, which is downstream of the Columbus Jackson Pike WWTP but upstream of Columbus Southerly WWTP, of 48 samples collected during 1977 for fecal coliform, all 48 were in violation of the stream standard. During this same period, there were a total of 9 dissolved oxygen violations. The average ammonia concentration here was 2.6 mg/l with a maximum of 6.3 mg/l. Nitrate concentration averaged

3.5 mg/l (11.6 mg/l maximum), while total phosphorus concentrations averaged 1.3 mg/l (4.2 mg/l maximum). High levels of total iron, manganese, copper and zinc were noted. At the Circleville station which is downstream of Columbus Southerly WWTP, fecal coliform and dissolved oxygen violations continue to persist. Here too, total iron continued to increase in concentration from the previous station as did manganese, while copper and zinc concentrations remained about the same or decreased slightly. The ammonia concentration showed a significant decrease both in terms of the average concentration and the maximum concentration. Similar decreases occurred in the average nitrate and total phosphorus concentrations.

The river appears to recover somewhat by the time it reaches Chillicothe. The only parameter not meeting standards is fecal coliform, although the maximum and average number of colonies has decreased from the previous two upstream stations. No dissolved oxygen violations occurred and the average ammonia concentration has decreased by over 50%. Average nitrate concentration increased slightly, but was not in violation. Most heavy metals showed decreased in concentration when compared to the Circleville station.

At the last sampling station on the Scioto mainstem at Higby, water problems are again noted. Parameters not meeting water quality standards during the sampling period at this location include dissolved oxygen, fecal coliform, and phenols. The degradation in stream quality occurring at this location is most likely due to a combination of effects, one of which is the large volume of paper mill waste discharged to Paint Creek near its confluence with the Scioto and discharges from the Chillicothe WWTP. The average BOD_5 concentration at Higby shows nearly a 100% increase when compared to the station upstream of Paint Creek. Ammonia concentration at

Higby continue to show a decrease as do the average nitrate and total phosphorus concentrations. Also showing increases in terms of maximum values observed were several heavy metals including total iron, manganese, zinc, lead, and copper. The increases in heavy metals is probably indicative of industrial discharge in the City of Chillicothe plus urban-stormwater runoff.

Data collected during the 1977 water year by the Ohio River Valley Water Sanitation Commission (ORSANCO) at the mouth of Scioto seems to indicate a continued improvement in water quality. The average ammonia concentration has decreased to 0.28 mg/l at the mouth compared to an average concentration of 0.34 mg/l at Higby. The average nitrate concentration at the mouth decreased slightly when compared to the Higby station, but the average total phosphorus showed a slight increase. Maximum readings for heavy metals generally were higher at the mouth than at the Higby station. Both maximum total iron and lead showed increases, with the maximum lead concentration more than double the maximum value that occurred at Higby. Maximum manganese and zinc concentrations also were higher.

Water quality in the basin should improve because of the upgrading in quality or in some cases elimination of discharges by several industrial and municipal sources. In Circleville, Container Corporation of America installed a clarifier and dredged their lagoons which should reduce their BOD and suspended solids loading to the Scioto River. Also in Circleville, DuPont has added chlorination to its sewage plant and has installed continuous monitoring devices to detect accidental spills of paints as well as provide for onsite storage areas to contain spills. Owens Illinois in

Columbus will eliminate their discharge containing lead, arsenic, and chromium to the Scioto River. In Marysville, Abex Corporation now has their industrial wastes transported to a liquid waste treatment plant. This plant has also improved their domestic waste treatment system by installing a bio-disc and clarifier. Mead Paper Company in Chillicothe has added additional aerators to their lagoons and soon will be adding two secondary clarifiers. With the addition of these clarifiers, Mead plans to reroute their discharge about 3/4 of a mile downstream from its present location in Paint Creek. The new aerators should help reduce biochemical oxygen demand, while the clarifiers should help reduce the amount of solids discharged to the stream.

During the 1976 water year, the improved Marion WWTP began operation. Significant water quality improvement is expected in the Little Scioto below the WWTP as a result of these improvements. The new London WWTP was completed and put into operation resulting in a noticeable improvement in water quality in Oak Run below the discharge. Reduced loadings to the Scioto River at Circleville are anticipated as Circleville's new WWTP comes on-line. New facilities are presently under construction at Ashley (Alum Creek) and Bloomingburg (East Fork of Paint Creek). Construction of new sewage plants at New Holland (North Fork Paint Creek), Washington Court House (Paint Creek), and Chillicothe-Pleasant Valley Regional Sewer District started in 1977.

For the most part, water quality throughout much of the Scioto River Basin is good. The largest or most significant problem area occurs in the mainstem below Columbus during low flow periods when the discharge from the city's two WWTP may account for upwards of 95% of the flow in the Scioto River below Columbus. The effects on water quality in the Scioto which

these two plants can have was dramatically illustrated in 1976. A strike by municipal workers resulted in the by-passing of millions of gallons of raw sewage to the river. At several downstream locations, dissolved oxygen readings reached zero, and very low dissolved oxygen levels were noted as far downstream as Chillicothe. This unfortunate incident caused the estimated (Department of Natural Resources) death of 71,000 fish. Figures 31, 32, and 33, show the percentage of days each year starting with 1965 (except at Higby station) and continuing to 1976, that dissolved oxygen levels in the Scioto mainstem at Shadeville, Chillicothe, and Higby were less than 5.0 mg/l. The conclusions that can be drawn from such figures is limited without relating it to rainfall and streamflow data, although the trend seems to indicate a general improvement of this parameter.

1977 Water Year Summary

The previous 12 months ambient monitoring, special studies and cooperative water quality monitoring in the Central Ohio Area of the Scioto Basin has revealed neither significant improvements or declines in water quality.

Municipal sewage pollution continues to significantly degrade water quality of the Scioto River Mainstem below Columbus, Mill Creek below Marysville, Paint Creek below Washington Court House and Blacklick Creek below Reynoldsburg.

Within the past year new wastewater facilities at Circleville have been put on line. No evaluation of this facility has been completed. Construction of a new sewer system and treatment plant at Washington Court House has commenced. However, it will be several years until construction is completed and facilities on line.

Industrial pollution contributes to the degradation of water quality below Circleville and Walnut Creek below Baltimore. In addition industrial

wastes contribute significantly to inefficient wastewater plant operation at Marysville, Delaware and Columbus resulting in substantial water quality impact.

Anticipated within the next twleve months is an in depth survey of the Marysville reach of Mill Creek (Union County) and a reevaluation of the Scioto River Mainstem between Columbus and Chillicothe (Franklin-Pickaway Counties). Completion of the 208 Water Quality Management Plan for the Scioto River is also expected.

Little Scioto River - A major improvement in water quality in the Little Scioto River has occurred since the summer of 1976 due to the upgraded sewage treatment facilities at Marion. Decreased BOD_5, suspended solids, and ammonia concentrations in the Marion STP effluent have improved water quality considerably in the Little Scioto River. Biological recovery will probably lag behind water quality improvements until accumulated sludge deposits are flushed from the stream bed.

Scioto River - A qualitative biological survey of the Scioto River upstream and downstream from Kenton was conducted in August, 1977, in order to evaluate the impact of the Kenton STP upon the fish and macroinvertebrate community of the receiving stream. The diversity of the macroinvertebrates and the presence of several different species of mayfly larvae indicated that water quality was fair to good upstream and downstream from Kenton.

The species of fish collected upstream and downstream from the Kenton STP suggested good water quality at the time of sampling. The presence of 21 different species of fish immediately downstream from the STP reflects the good effluent quality of the discharge and the lack of toxic substances in the effluent. Water quality data collected during

May, 1977 showed no violations of water quality standards except for fecal coliform bacteria upstream from the Kenton STP.

The diversity of fish immediately below the STP outfall should emphasize the importance of maintaining low residual chlorine concentrations in sewage effluents if fish populations are to be maintained downstream from sewage outfalls. The most significant problem of the Kenton STP appears to be high effluent concentrations of phosphorus which may contribute to nuisance algal blooms further downstream.

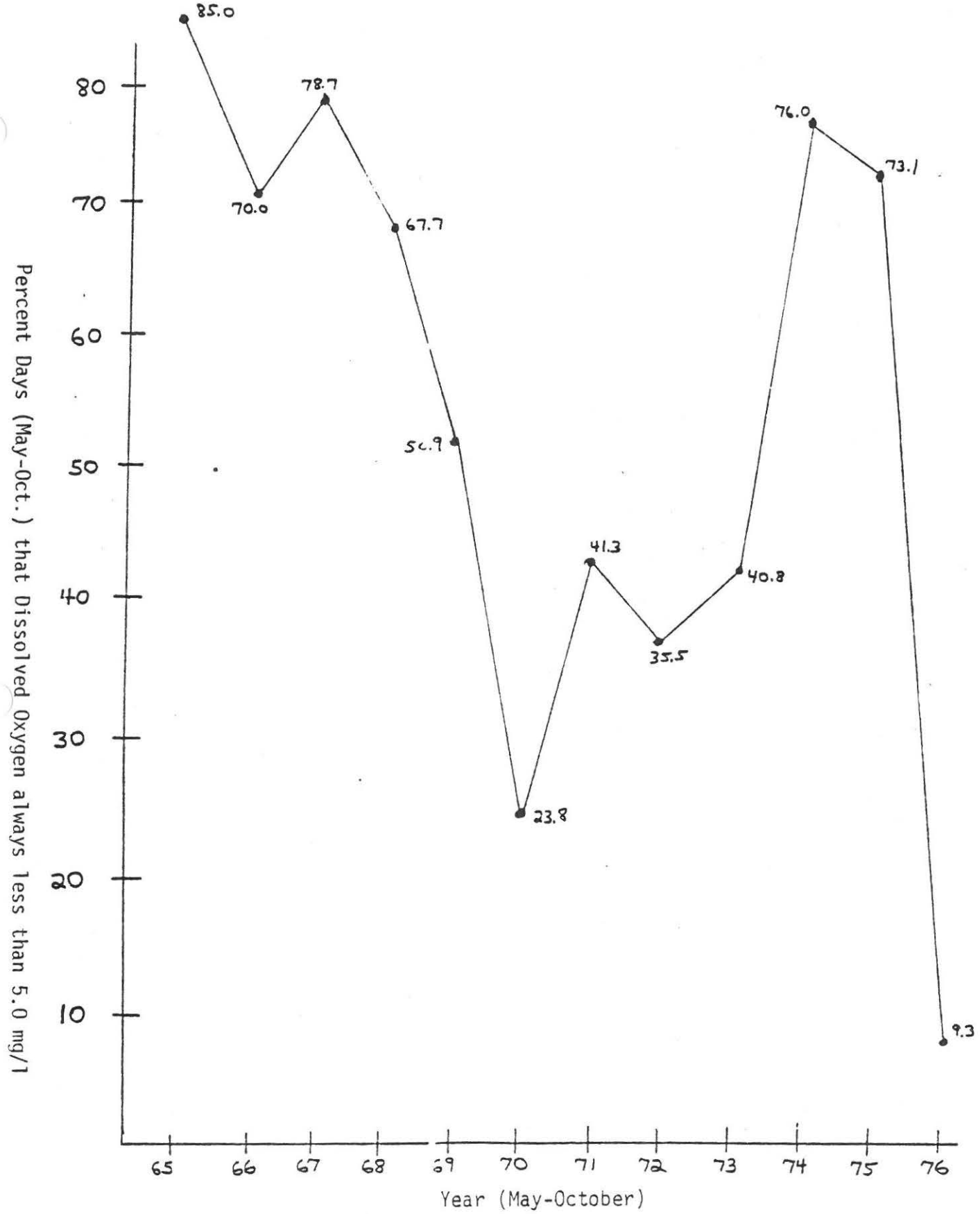


FIGURE 23 Dissolved Oxygen Trend - Scioto River below Shadeville

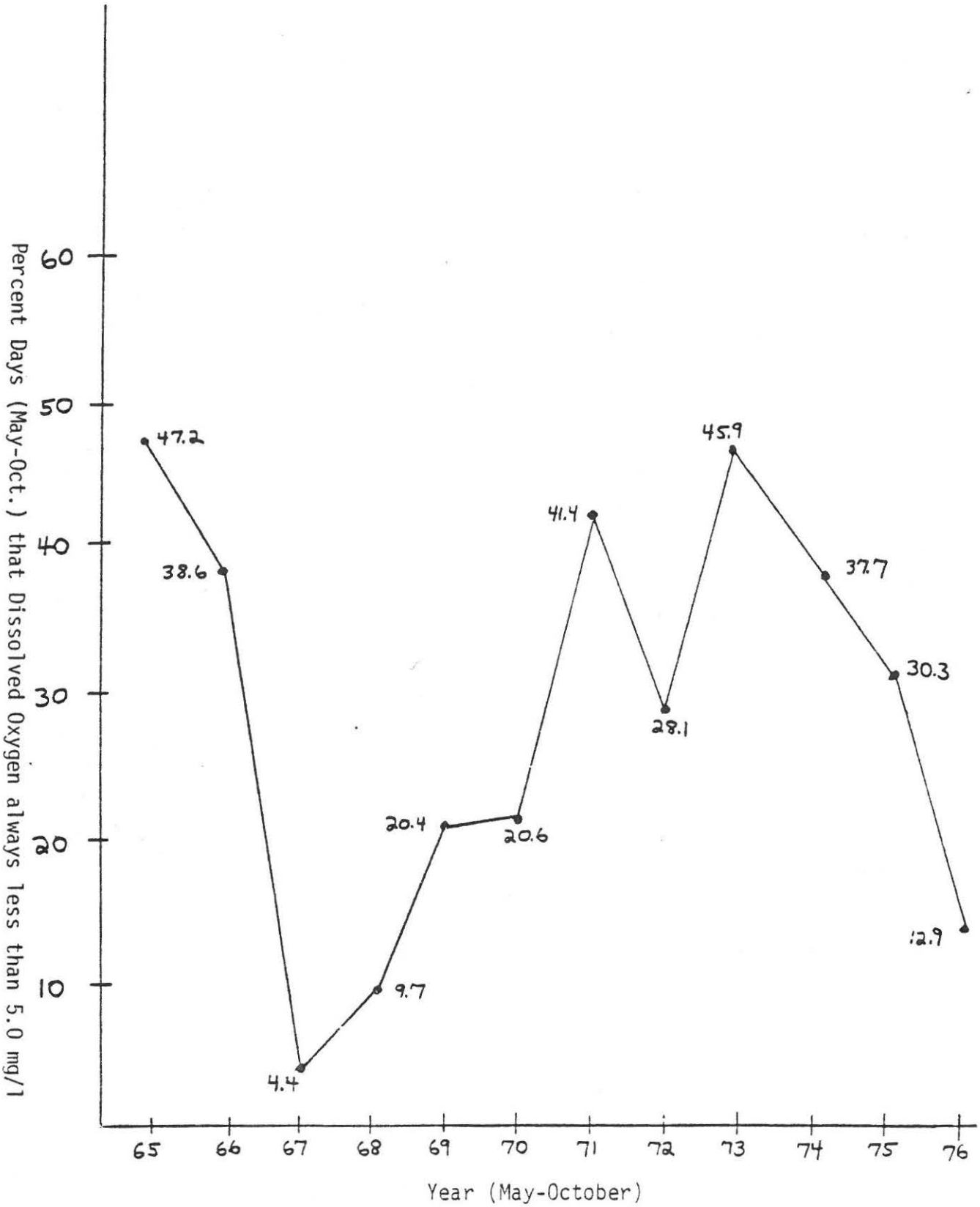


FIGURE 24 Dissolved Oxygen Trend - Scioto River at Chillicothe

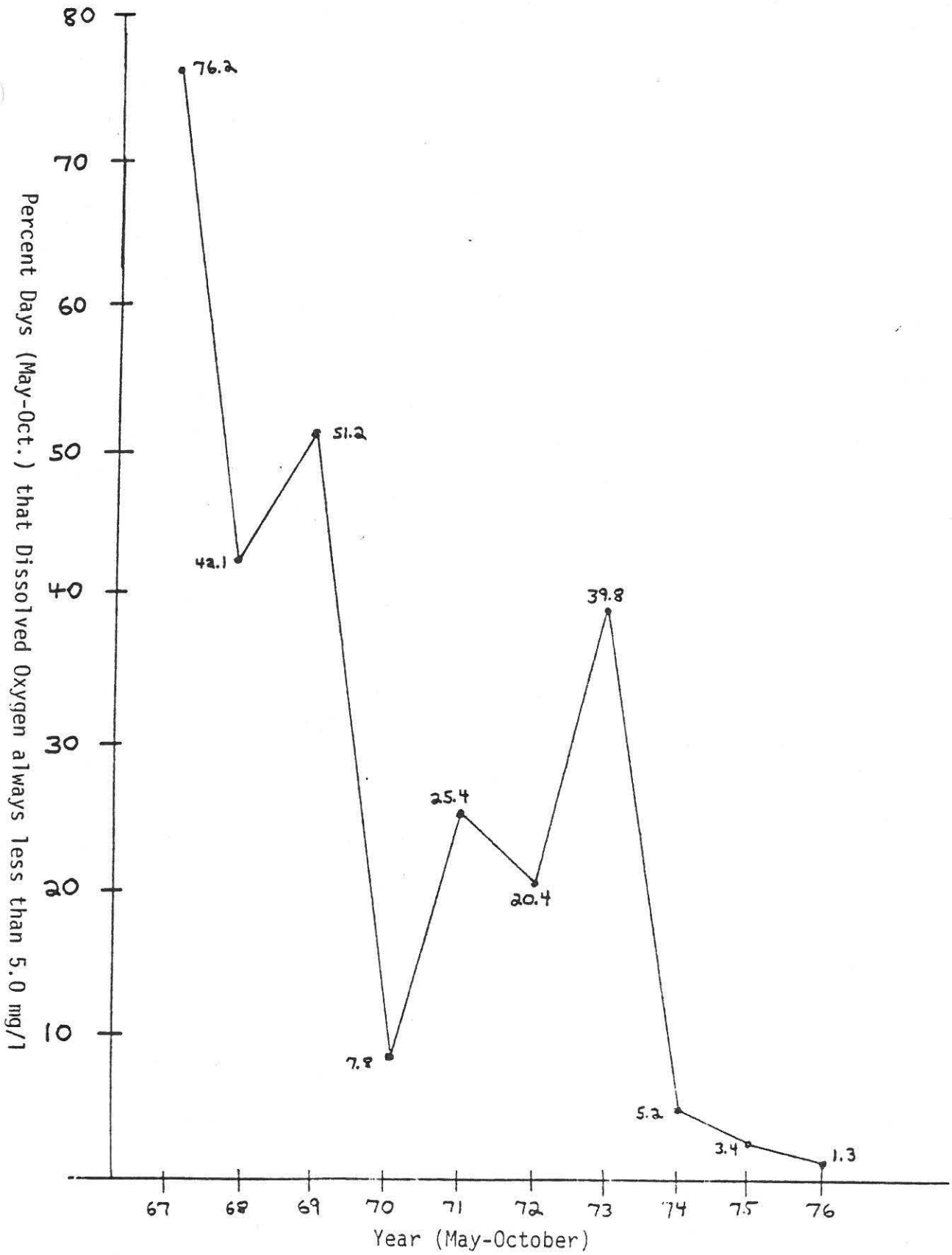


FIGURE 25 Dissolved Oxygen Trend - Scioto River at Higby

COSTS

The Federal Water Pollution Control Act requires that an estimate be made of the costs necessary to achieve the objectives of the Act. This section presents an estimate of the costs of construction of publicly-owned wastewater treatment plants needed to implement the provisions of the Act. Also provided is an estimate of the cost for industrial wastewater treatment facilities.

Cost estimates for the construction or upgrading of municipal wastewater treatment facilities were obtained from the 1976 Needs Survey. Table 20 presents a cost breakdown by category of the different types of municipal needs. The 1974 Needs Survey costs are also presented in Table 20 for comparison purposes. A few 1976 category estimates were lower when compared to 1974 estimates because the latest estimates reflect a better formulated and more consistent survey methodology and greater amounts of information became available from such sources as new facility plans, basin plans, and discharge permits. The significant cost differential between plants needed to provide secondary treatment vs. plants needed to provide more advanced waste treatment can be explained in two ways:

(1) more advanced waste treatments are needed to meet water quality standards because of the prevalence of low flow streams in Ohio, and

(2) the pollution abatement program conducted in Ohio prior to the enactment of the Act resulted in the installation of facilities designed for secondary treatment.

Table 21 presents estimates for the cost of constructing industrial wastewater facilities. The $386 million is on the low side because of the exclusions noted. The costs for very small industrial facilities were not estimated, although the total cost for these facilities could be substantial because of their large number.

TABLE 20

Municipal Wastewater Treatment Facilities
1974 Survey of Needs
and
1976 Survey of Needs

		June 1973 Millions of Dollars	January 1976 Millions of Dollars
Category I:	Facilities to meet "Secondary Treatment"	26	28
Category II:	Facilities to meet Advanced Treatment or Water Quality Standards	1,508	2,062
Category IIIA:	Sewer costs for correction of "infiltration/inflow" problems	635	629
Category IIIB:	Sewer costs for replacement/rehabilitation	115	432
Category IVA:	Construction of collection Sewers	626	975
Category IVB:	Construction of new inceptors	946	1,375
Category V:	Correction of bypassing problems due to combined sewers	3,790	1,765
Sub-total		7,646	7,270
Category VI:	Treatment and control of storm waters	6,570	3,936
Total		14,216	11,206

TABLE 21

COSTS ESTIMATES IN OHIO FOR INDUSTRIAL WASTEWATER

POLLUTION ABATEMENT FACILITIES

Hocking River	$ 480,000
Scioto River	3,060,000
Grand & Ashtabula Rivers	1,330,000
Maumee River	9,680,000
Sandusky River	1,430,000
Central Ohio River & Tributaries	39,850,000
Tuscarawas River	11,730,000
Little Beaver River	530,000
Southeast Ohio River & Tributaries	29,700,000
Southwest Ohio River & Tributaries	5,310,000
Little Miami River & Mill Creek	380,000
Huron, Vermilion & Black Rivers	17,960,000
Rocky, Chagrin & Cuyahoga Rivers	60,660,000
Great Miami & Wabash Rivers	18,910,000
Walhonding River	1,550,000
Portage River	600,000
Muskingum River	13,160,000
Mahoning River	127,700,000
Lake Erie	41,980,000
TOTAL	$386,000,000

Notes:

The cost figure was arrived at by estimating on a permit-by-permit basis the approximate cost per facility. All costs for entities located within a defined drainage area were tabulated and added to come up with the totals by basin. Then the costs for all drainage basins were added together for the total statewide cost figure.

All industrial permits (manufacturing and business service entities) and proposed permits on file with Central Office WM&C as of February 7, 1975 were used for cost estimating. Active surface mine abatement costs were included by basin for three hundred mines.

The power plants' costs for pollution sources other than thermal were estimated, but costs for cooling facilities at Hutchings, Gavin, and Davis-Besse were included.

This estimate did not include costs on abatement facilities at the municipal power plants, state-owned power plants, water treatment plants, gas stations, agricultural run-off and general non-stream run-off from most industrial manufacturing sites, pretreatment of industrial wastes going to municipal sewage plants and cooling facilities for most of the public utility steam electric power plants.

FIELD BIOLOGICAL INVESTIGATIONS

Biological monitoring programs are conducted by the Ohio Environmental Protection Agency (OEPA) in partial fulfillment of the requirements of the 1972 Federal Water Pollution Control Act Amendments. Sections 106(e), 303 and 305 of the Act specifically call for the establishment of biological "base-line" data for the major river basins and the use of those data in pollution abatement planning procedures. Additionally, these data will support the National Pollution Discharge Elimination System NPDES permit issuance process and the NPDES permit compliance monitoring.

Section 502(15) of Pl-92-500 defines biological monitoring as the "determination of the effects on aquatic life, including accumulation of pollutants in tissues, in receiving waters due to the discharge of pollutants". The biological monitoring programs of OEPA during 1972 were confined to benthic (bottom) community analyses due to limited staff resources. Current plans are underway, however, to restore the Agency's bioassay capability, increase the number of dischargers monitored, and to expand the biological parameters measured to include periphyton analyses. A laboratory capability is also being developed to determine levels of toxic materials in fish tissue.

The 1977 Field Biological Program consisted of two basic elements. Primary biological monitoring stations were established at selected Primary Water Quality Monitoring Network Stations. Forty of these stations were established and sampled for benthos (counts, identification, species diversity index) and periphyton (counts, identification, chlorophyll c, and ash-free biomass, autotrophic index). The analyses of data generated

from these sites will contribute to long-term analysis and will provide a long-term measure of the effectiveness of State Water Quality Standards to develop conditions satisfactory to support balanced indigenous aquatic communities.

A second program element assessed the impact of specific discharges on aquatic communities. Stations were located upstream and downstream from entities selected from the Ohio Major Dischargers List. The entities for biological monitoring 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 these stations measures the effectiveness of the Agency's water pollution control programs and the recovery of biological communities as degraded segments of streams are improved. Entities selected for biomonitoring in 1977 included seven sewage treatment plants (Van Wert, Lima, Eaton, Marion, Delaware, Mt. Vernon, Ashland) and two industries (K & S Circuits, PPG Industries).

Field and laboratory methods for the Primary Biological Network Stations and the Major Dischargers were essentially the same. Five multiple-plate artificial substrate samplers, of the modified Hester-Dendy type, were exposed for a six week period at each station. Major dischargers normally had one upstream station and at least two downstream from the outfall while one set of samplers was usually placed at each Primary Network Station.

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. At some stations, where the stream was greater than 40 feet wide, a set of five samplers was installed approximately 20 feet from each bank. Qualitative samples of 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 multiple-plates were placed. The qualitative collecting continued until, by gross examination, no additional species were being taken.

The multiple-plates were dismantled in the laboratory and the material washed through a US Standard Testing Sieve number 40 (0.425 mm openings). The 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 the 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 and currently acceptable taxonomic keys. After the benthic organisms had been identified and counted, species diversity indices (d) were calculated using the expression

$$d = \frac{ni}{n} \log 2 \frac{ni}{n}$$

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.

OHIO LAKES AND RESERVOIRS

A. General

Ohio has more than 200 publicly owned lakes and reservoirs over 14 acres in surface area. Combined surface area of all these lakes is more than 100,000 acres. In general, water quality is good. The common problems occurring are, for the most part, related to nutrient enrichment, which has resulted in large standing crops of algae and macrophyte aquatic plants. Some lakes in the east and southeastern parts of the state are being affected unfavorably by coal mining operations.

B. Current Survey Program

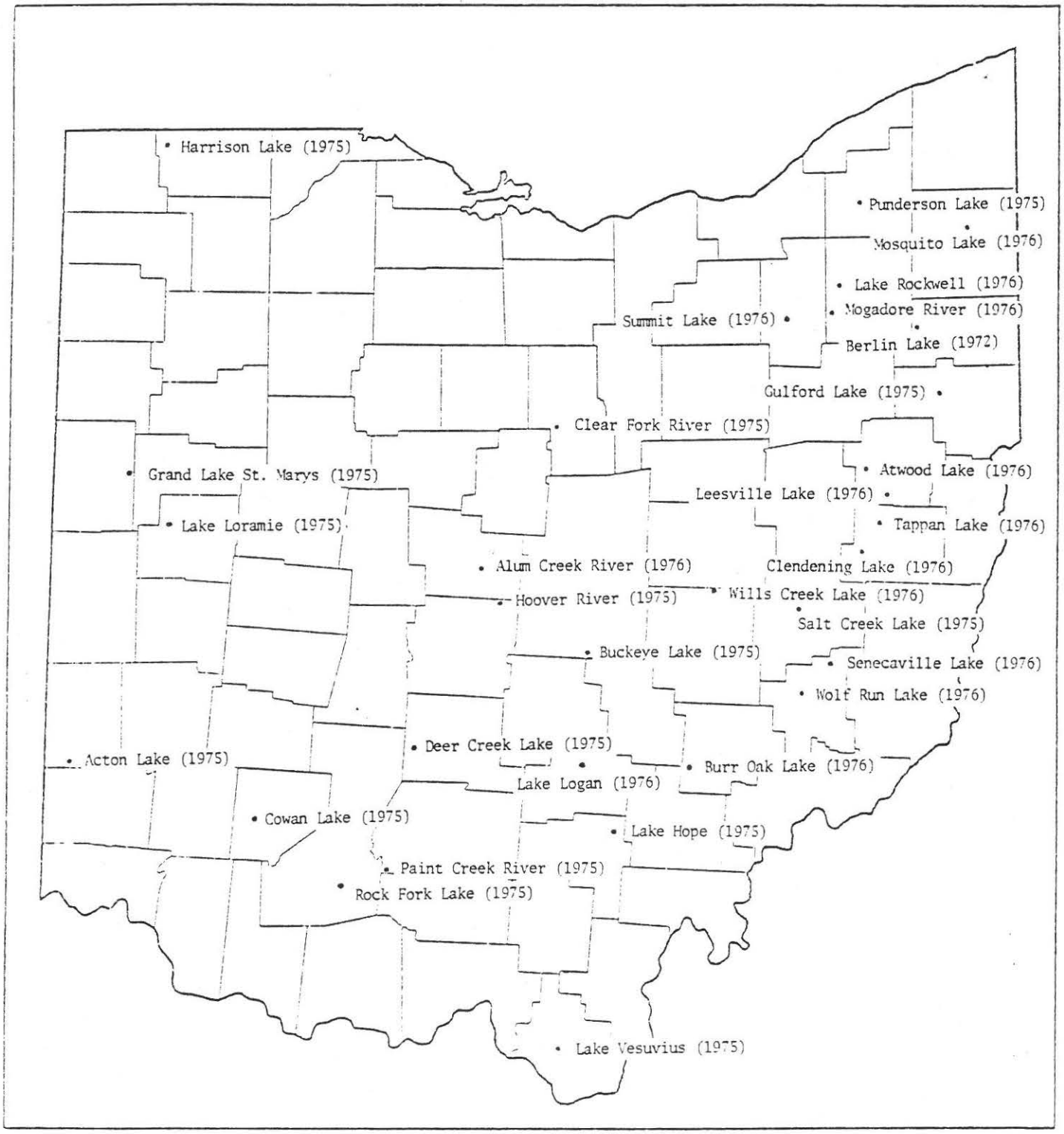
The joint Ohio EPA and USGS Lake Sampling Program began its 3rd season of sampling in 1977. Seventeen lakes were sampled in 1975, 14 in 1976, and 14 in 1977. Of the 45 lakes in Ohio classified as significant in the 1976(b)-314 lakes report to the Federal EPA, 34 have been surveyed. The Army Corp of Engineers collects data on Corp projects in the state. Local studies associated with colleges and universities are also being conducted. Figure 26 shows the lakes surveyed as well as showing each lake's location and the year it was surveyed.

C. Water Quality

The National Eutrophication Survey concluded after review of their data, that all 19 of the public lakes they sampled in Ohio were eutrophic on the basis of Vollenweider's system of trophic

FIGURE 26

Locations of Lakes Sampled to date in Ohio EPA Lakes Program - 1975 and 1976



level determination. The Ohio EPA Lake Survey also found problems associated with high nutrient loadings. Large standing crops of blue green algae were found during the summer months in most of the lakes sampled in 1975 and 1976. Scums of decomposing algal colonies were noted at the late summer sampling in Burr Oak Lake.

Nuisance growths of aquatic macrophytes, chiefly Myricophyllum sp., were noted in a number of lakes. These were being controlled by mechanical harvesting in some cases. It was found that stratification of lakes was occurring in the summer months in lakes over 17 feet in depth. Highly stratified lakes had little or, many times, no oxygen in the bottom waters.

Coal mining operations are affecting several lakes in the state. Piedmont Lake has a high sulphate concentration, as a result of current and previous strip-mine operations in the watershed. Lake Hope, an aesthetically beautiful lake, receives low pH waters coming from abandoned deep mines in its watershed. The pH at this lake was below 5.1 in the spring and below 6.3 in the summer when sampled by the Ohio EPA in 1975. A pH of 7.0 or greater would be natural to a lake in this region.

D. Control

Problems associated with nutrient loadings should be alleviated somewhat as new and improved sewage treatment plants come on line. A detergent phosphate ban similar to those instituted in Indiana and New York would have an immediate impact on lake nutrient loadings. The National Eutrophication Survey found that point sources contributed anywhere from 0 to 82% of the nutrient loadings to lakes they surveyed in Ohio, so the effect on each lake must be evaluated on an individual basis.

1977 Water Year Summary

Table 22 lists the lakes that were surveyed in 1977. Chlorophyll a was measured from phytoplankton collected at the zone of maximum D.O. and in a composite sample of water collected from the photic zone.

Table 22

List of Lakes in 1977 Field Season

Lake	Sampling Date	
Buck Creek	4-7-77	8-2-77
Deer Creek	4-23-77	8-16-77
Dillon	4-11-77	8-12-77
East Branch	4-28-77	8-15-77
Indian Lake	4-21-77	8-18-77
Killdeer Res.	5-5-77	8-4-77
Kiser	4-22-77	8-19-77
Knox	5-3-77	8-30-77
Long Lake	4-19-77	8-9-77
Nimisila	5-2-77	8-9-77
Piedmont	4-12-77	8-11-77
Stonelick	4-14-77	9-1-77
Turkey Foot	4-19-77	8-9-77
West Branch (M.J. Kirwin)	4-18-77	8-29-77

FISH TISSUE ANALYSIS

Introduction

Since its inception in 1972, the Ohio EPA has been responsible for the monitoring of pesticide levels in Ohio's surface waters. The monitoring programs for the last several years have indicated that while pesticide residues have been found in some of Ohio's surface waters, most monitoring stations in Ohio have reflected zero or near zero levels (Ohio EPA, 1976). Although this data has been useful, it provides no indication of the biological accumulation of these toxins in the aquatic system. Information concerning biological accumulation of pesticide residues is necessary to accurately assess the overall quality of the aquatic system.

In 1977 funds were made available which enabled the Ohio EPA to expand its pesticide surveillance program. This program was initiated to establish a surveillance program to monitor and assess PCB and pesticide residue levels in fish. The parameters selected for analysis include; hexachlorobenzene (HCB), toxaphene, methoxychlor, lindane, BHC, heptachlor, heptachlor epoxide, endrin, DDT, DDE, aldrin, dieldrin, mirex and PCB's (Aroclor 1254,1260).

Methods and Materials

Fish were collected from six sites in the Ohio River Drainage Basin and six sites in the Lake Erie Drainage Basin, beginning in March and continuing through October, 1977 (Table 23,

Figure 27). The Ohio EPA's resources for independent collection of fish samples being somewhat limited, a cooperative agreement was arranged with the Ohio Department of Natural Resources (ODNR). Fish were collected for the Ohio EPA by ODNR personnel through their regularly scheduled test-netting program. This arrangement limited Ohio EPA's selection of sampling sites, especially in considering stream sampling sites since ODNR's fish survey programs concentrate primarily on water impoundments.

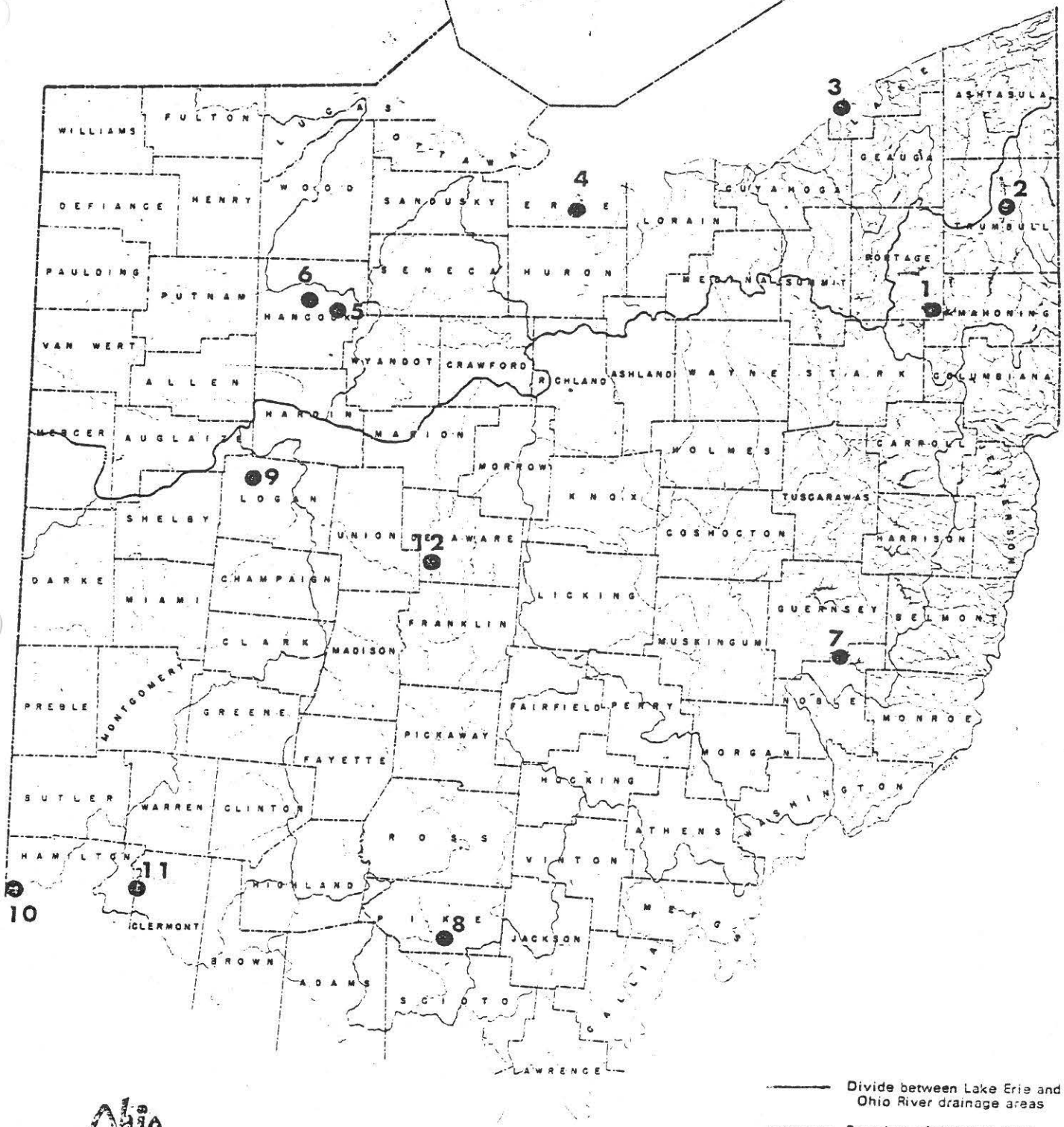
Coincidentally, the Ohio River Valley Water Sanitation Commission (ORSANCO) initiated a program to assess PCB levels in fish collected from the Ohio River Drainage Basin. At the request of ORSANCO, the Ohio EPA agreed to provide fish to ORSANCO for analysis by the Food and Drug Administration (FDA). Therefore, site selections, and the time of collection, were determined somewhat by ORSANCO's needs and by the ODNR test-netting schedule.

Fish selected for collection were: channel catfish (*Ictalurus punctatus*), bluegill sunfish (*Lepomis machrochirus*), crappie (*Pomoxis* spp.) and largemouth bass (*Micropterus salmoides*). These species were considered to be good biological indicators because: 1. The species selected represent several feeding levels (one bottom feeder, two intermediate predators and one primary predator) and 2. These species are game fish and give an indication of possible human exposure. Where possible, five individuals of each species, approximately one pound in size, were collected at each site. Sunfish were collected so as to

Table 23. Areas selected for fish collection for pesticide and PCB surveillance program, 1977. (See Figure 1).

Water Area	Drainage Basin	Date of Collection
1. Berlin Reservoir	Lake Erie	Last week in March
2. Mosquito Creek Reservoir	Lake Erie	Last week in March
3. Chagrin River	Lake Erie	10/25/77
4. Huron River	Lake Erie	11/01/77
5. Blanchard River @ above Findlay	Lake Erie	07/13/77
6. Blanchard River @ below Findlay	Lake Erie	07/14/77
7. Salt Fork Reservoir	Ohio River	05/03/77
8. Scioto River @ Piketon	Ohio River	06/07/77
9. Indian Lake	Ohio River	05/16/77
10. Great Miami River @ Elizabethtown	Ohio River	06/27/77
11. Little Miami River	Ohio River	Not Sampled
12. O'Shaughnessy Reservoir	Ohio River	10/20/77

Figure 27. Areas selected for fish collection for pesticide and PCB surveillance program.



STATE OF OHIO
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF GEOLOGICAL SURVEY

PRINCIPAL STREAMS AND THEIR DRAINAGE AREAS

provide three, one pound, composite samples. Due to the unavailability of the above mentioned species at the collection sites on the Chagrin and Huron Rivers, coho salmon (Onchorynchus kisutch) was the primary species collected at these two sites.

Upon capture, either by trap-nets or by electro-fishing, fish were scaled (catfish were skinned), filleted, double wrapped in aluminum foil, identified with a tag containing species, area of collection and date of collection, put on ice and frozen as soon as possible. If conditions prevented the filleting of fish in the field, they were later partially thawed, filleted and refrozen.

Fish samples were analyzed for PCB and pesticide residues, by the Ohio Department of Agriculture (ODA), using gas chromatography, at their facilities in Reynoldsburg, Ohio. The procedures used by ODA differed somewhat from the procedures outlined in the Pesticide Analytical Manual (HEW, 1975) in that liquid-liquid partitioning was not used for extraction. Extraction procedures followed those outlined by Erney (1974). Recovery tests and tests for efficiency indicated that the ODA procedures are as efficient as the PAM methodology.

The analytical limits for detection and quantitation are presented in Table 24. Samples that contained residue levels less than the level of detection are reported as non-detected. Those samples that contained residue levels between the level of detection and the level of quantitation are reported as trace. Residue levels are reported on a wet weight basis.

Table 24. Analytical limits of quantitation and detection.

Compound	Level of Detection (ppm)	Level of Quantitation (ppm)
1. Aldrin	0.002	0.01
2. Dieldrin	0.002	0.01
3. Endrin	0.002	0.01
4. Lindane	0.002	0.01
5. Heptachlor	0.002	0.01
6. Heptachlor Epoxide	0.002	0.01
7. Methoxychlor	0.01	0.05
8. Mirex	0.01	0.05
9. Toxaphene	0.05	0.10
10. DDT	0.004	0.02
11. DDE	0.002	0.01
12. TDE	0.004	0.02
13. HCB	0.002	0.01
14. BHC	0.002	0.01
15. PCB's (AR 1254/1260)	0.01	0.05

Of the 12 sites selected for fish collection, 11 were completed with 110 samples being collected. The Little Miami River was not sampled due to personnel and scheduling problems.

Twenty three catfish and 5 largemouth bass collected in the Ohio River Basin were sent to ORSANCO for analysis of PCB and pesticide residues. However, due to the large number of samples collected for the ORSANCO program, fish were analyzed only for PCB's. Samples collected in Ohio were returned to the Ohio EPA to be scanned for pesticide residues. Sixteen catfish and no largemouth bass were returned.

The Ohio Department of Agriculture was not able to complete the analysis of the 110 samples by January 31, 1978. As a result, the data reported represent fish samples collected from 9 of the 12 specified areas.

Due to the lack of normality and unequal variance in the sets of data, data were tested by non-parametric statistical methods. The Kruskal-Wallis test (Hollander and Wolf, 1973) was used to test for differences in contamination levels between areas and species, and is analagous to the parametric one way analysis of variance.

Results and Discussion

Pesticide residue and PCB concentrations in fish collected from the Ohio River Drainage Basin and the Lake Erie Drainage Basin are presented in Table 25 and Table 26 respectively. The analysis for pesticide residues was completed for 64 samples, while 90 samples were analyzed for PCB's.

ble 25 Pesticide residue and PCB concentrations (ppm) found in fish collected from the Ohio River Drainage Basin.

Area of collection	Species	Number analyzed	Residue	Range	Median
Salt Fork Res.	Crappie	4	HCB	[a]N.D. - 0.006	N.D.
			BHC	N.D.	N.D.
			DDE	[b]TR	TR
			Dieldrin	N.D.	N.D.
			PCB	TR	TR
	Sunfish	4	HCB	N.D.	N.D.
			BHC	N.D.	N.D.
			DDE	TR	TR
			Dieldrin	N.D.	N.D.
			PCB	TR	TR
	Catfish	2	HCB	N.D.	N.D.
			BHC	N.D.	N.D.
			DDE	TR	TR
			Dieldrin	TR	TR
		8	[c]PCB	TR - 0.010	TR
Scioto River @ Piketon	Crappie	1	HCB	N.D.	N.D.
			BHC	N.D.	N.D.
			DDE	TR	TR
			Dieldrin	N.D.	N.D.
			PCB	0.160	0.160
	Catfish	5	HCB	[d]N.D.A.	N.D.A.
			BHC	N.D.A.	N.D.A.
			DDE	N.D.A.	N.D.A.
			Dieldrin	N.D.A.	N.D.A.
			[c]PCB	0.600 - 9.900	1.300
Great Miami River @ Elizabethtown	Catfish	5	HCB	N.D.A.	N.D.A.
			BHC	N.D.A.	N.D.A.
			DDE	N.D.A.	N.D.A.
			Dieldrin	N.D.A.	N.D.A.
			[c]PCB	0.800 - 7.500	3.500

Table 25 Continued.

Area of collection	Species	Number analyzed	Residue	Range	Median
Indian Lake	Crappie	4	HCB	N.D.	N.D.
			BHC	N.D.	N.D.
			DDE	N.D. - TR	TR(2)[e]
			Dieldrin	N.D. - TR	N.D.
			PCB	N.D.	N.D.
	Sunfish	4	HCB	N.D.	N.D.
			BHC	N.D. - TR	TR(2)
			DDE	TR - 0.007	TR
			Dieldrin	TR	TR
			PCB	N.D. - TR	TR
	Largemouth Bass	5	HCB	N.D.A.	N.D.A.
			BHC	N.D.A.	N.D.A.
			DDE	N.D.A.	N.D.A.
			Dieldrin	N.D.A.	N.D.A.
			[c]PCB	N.D. - TR	N.D.
	Catfish	5	HCB	N.D.A.	N.D.A.
			BHC	N.D.A.	N.D.A.
			DDE	N.D.A.	N.D.A.
			Dieldrin	N.D.A.	N.D.A.
			[c]PCB	TR	TR
O'Shaughnessy Res.	Crappie	3	HCB	N.D.	N.D.
			BHC	N.D.	N.D.
			DDE	TR	TR
			Dieldrin	TR - 0.013	TR
			PCB	TR - 0.080	TR
	Sunfish	4	HCB	N.D.	N.D.
			BHC	N.D.	N.D.
			DDE	TR	TR
			Dieldrin	TR - 0.024	TR
			PCB	TR - 0.080	TR

le 25 Continued.

Area of collection	Species	Number Analyzed	Residue	Range	Median
O'Shaughnessy Res.	Largemouth Bass	5	HCB	N.D.	N.D.
			BHC	N.D.	N.D.
			DDE	TR	TR
			Dieldrin	TR	TR
			PCB	TR - 0.130;	TR
	Bullhead	1	HCB	N.D.	N.D.
			BHC	N.D.	N.D.
			DDE	0.007	0.007
			Dieldrin	0.011	0.011
			PCB	0.190	0.190

[a]N.D. = Non-detectable
[b]TR = Trace
[c]Samples were analyzed for PCB's by ORSANCO
[d]N.D.A. = No Data Abailable
[e]Number of samples which contained reported concentration

le 26. Pesticide residue and PCB concentrations (ppm) found in fish collected from the Lake Erie Drainage Basin.

Area of collection	Species	Number analyzed	Residue	Range	Median
Mosquito Creek Res.	Crappie	3	HCB	[a]N.D.	N.D.
			BHC	N.D.	N.D.
			DDE	N.D.	N.D.
			Dieldrin	N.D.	N.D.
			PCB	N.D.	N.D.
	Sunfish	2	HCB	N.D.	N.D.
			BHC	N.D.	N.D.
			DDE	N.D.	N.D.
			Dieldrin	N.D.	N.D.
			PCB	N.D.	N.D.
	Catfish	5	HCB	N.D.	N.D.
			BHC	N.D. - 0.040	0.008
			DDE	0.015 - 0.050	0.030
			Dieldrin	N.D. -[b]TR	TR
			PCB	0.330 - 0.690	0.060
Berlin Reservoir	Crappie	2	HCB	N.D.	N.D.
			BHC	N.D.	N.D.
			DDE	N.D.	N.D.
			Dieldrin	N.D.	N.D.
			PCB	N.D. - TR	-
	Sunfish	1	HCB	N.D.	N.D.
			BHC	N.D.	N.D.
			DDE	N.D.	N.D.
			Dieldrin	N.D.	N.D.
			PCB	N.D.	N.D.

ıle 26. Continued.

Area of collection	Species	Number analyzed	Residue	Range	Median
Berlin Reservoir	Catfish	2	HCB	TR	TR
			BHC	TR - 0.010	-
			DDE	0.060 - 0.360	-
			Dieldrin	0.028 - 0.030	-
			PCB	1.370 - 6.500	-
	Bullhead	2	HCB	N.D.	N.D.
			BHC	N.D.	N.D.
			DDE	0.006 - 0.008	-
			Dieldrin	TR	TR
			PCB	0.130 - 0.770	-
Blanchard River @ above Findlay	Crappie	3	HCB	N.D.	N.D.
			BHC	N.D.	N.D.
			DDE	TR	TR
			Dieldrin	TR	TR
			PCB	TR	TR
	Sunfish	4	HCB	N.D.	N.D.
			BHC	N.D.	N.D.
			DDE	TR	TR
			Dieldrin	TR	TR
			PCB	TR - 0.070	TR
	Largemouth Bass	4	HCB	N.D. - TR	TR(2)[c]
			BHC	N.D.	N.D.
			DDE	TR - 0.006	TR
			Dieldrin	TR	TR
			PCB	TR - 0.100	TR
	Catfish	1	HCB	0.006	-
			BHC	TR	-
			DDE	0.060	-
			Dieldrin	0.022	-
			PCB	0.860	-

T e 26. Continued.

Area of collection	Species	Number analyzed	Residue	Range	Median
Blanchard River @ below Findlay	Crappie	2	HCB	N.D.	N.D.
			BHC	N.D.	N.D.
			DDE	TR	TR
			Dieldrin	TR	TR
			PCB	TR	TR
	Sunfish	2	HCB	N.D. - TR	-
			BHC	N.D. - TR	-
			DDE	TR	TR
			Dieldrin	TR	TR
			PCB	TR	TR
	Largemouth Bass	2	HCB	N.D.	N.D.
			BHC	N.D.	N.D.
			DDE	TR - 0.006	-
			Dieldrin	TR	TR
			PCB	TR	TR
	Bullhead	1	HCB	N.D.	-
			BHC	N.D.	-
			DDE	0.010	-
			Dieldrin	TR	-
			PCB	TR	-
	Rockbass	1	HCB		
			BHC		
			DDE		
			Dieldrin		
			PCB		
Chagrin River	Coho Salmon	4	HCB		
			BHC		
			DDE		
			Dieldrin		
			PCB		

T le 26. Continued.

Area of collection	Species	Number Analyzed	Residue	Range	Median
Chagrin River	Golden Trout	1	HCB		
			BHC		
			DDE		
			Dieldrin		
			PCB		
	Sucker	4	HCB		
			BHC		
			DDE		
			Dieldrin		
			PCB		
Huron River	Coho Salmon	4	HCB		
			BHC		
			DDE		
			Dieldrin		
			PCB		
	Smallmouth Bass	2	HCB		
			BHC		
			DDE		
			Dieldrin		
			PCB		

[a]N.D. = Non-detectable
[b]TR - Trace
[c]Number of samples which contained the reported concentration

No samples contained detectable levels of aldrin, lindane, endrin, DDT, TDE, methoxychlor, mirex, toxaphene or heptachlor. Only one sample contained detectable levels of heptachlor epoxide (a sunfish from Indian Lake with 0.02 ppm).

Seven samples contained detectable levels of BHC (range: Tr - 0.040 ppm) and seven samples had detectable levels of HCB (range: Tr - 0.006 ppm). No samples exceeded the Water Quality Criteria (WQC) recommendations for accumulation of pesticides in aquatic organisims of 0.1 ppm. (Committee on Water Quality Criteria, 1972).

Dieldrin and DDE were the most prevalent chlorinated pesticide residues in the fish collected. Dieldrin was found in 42 fish samples and 54 samples contained detectable levels of DDE. Only one sample, a catfish from Berlin Reservoir with 0.36 ppm DDE, exceeded the WQC recommendations of 0.1 ppm. Catfish exhibited significantly greater ($P \leq 0.05$) accumulation levels of dieldrin and DDE than largemouth bass, sunfish or crappies.

The data indicates relatively low levels of organochlorines in Ohio fish, when compared to other studies. Fish collected from Lake Erie in 1970 and 1971 were analyzed for some chlorinated pesticides by Carr et al. (1972). Average residue levels ranged from 0.06 to 0.42 ppm for DDE, 0.07 to 0.52 ppm TDE, 0.03 to 0.025 ppm DDT, 0.18 to 0.90 ppm total DDT and 0.01 to 0.07 ppm dieldrin. Henderson et al. (1971) reported 93% of whole body fish samples, collected nationally in 1969, reflected levels of dieldrin up to 1.59 ppm. Total DDT levels were as

high as 57.8 ppm and were detected in 100% of the samples. Klaassen and Kadoum (1975) reported total DDT levels in 98% of the fish collected from a reservoir system in ansas ranging from trace to 0.57 ppm. Dieldrin was detected in 97% of the samples and ranged from trace to 0.17 ppm. Dieldrin levels as high as 1.6 ppm were found in catfish collected from a stream in Iowa (Morris and Johnson, 1971), while concentrations in other species collected ranged from 0.011 to 1.75 ppm.

The apparent low pesticide levels in Ohio fish may be a reflection of the decreased usage of many of the pesticides selected for analysis. Most have been suspended or classed for restricted use only, by the federal government or by the Ohio Department of Agriculture. The data reported, however, must be interpreted with some caution. The collection of fish of uniform size (approximately 1 pound or 12 inches) proved to be a greater problem than anticipated. In most cases, especially for sunfish and crappies, the samples represent a composite sample of relatively small fish with anywhere from 2 to 8 individuals per sample. In addition, the majority of the samples were collected in the spring. The combination of young fish collected in the spring, resulted in samples with a relatively low fat content, usually less than 1%. Considering the above factors, no reliable conclusions concerning pesticide residue levels in Ohio fish can be made.

Detectable levels of PCB's were found in 74 samples. No sunfish, largemouth bass or crappies had levels that exceeded the recommended Water Quality Criteria level of 0.5 ppm.

Sixteen of 31 catfish samples exceeded the WQC recommendation, and 4 exceeded the recommended FDA level for human consumption of 5 ppm (2 from the Great Miami River, 1 from the Scioto River and 1 from Berlin Reservoir). Catfish contained significantly higher PCB levels ($P \leq 0.05$) than other species collected.

The PCB levels reported for this study are similar to levels that have initially been reported by ORSANCO (unpublished). In their study of PCB levels in fish from the Ohio River Basin, concentrations ranged from non-detected to 17.5 ppm. Carr et al. (1972) reported average PCB levels in fish collected from Lake Erie to range from 0.08 to 4.4 ppm.

The sources of PCB contamination may be numerous. Until a few years ago. PCB's have been widely used as plasticizers, as sealers in waterproofing compounds and putty, in printing inks, in waxes, in synthetic adhesives, as dielectrics in capacitors, as hydraulic fluids, as high pressure lubricants and as a heat transfer medium (EPA, 1976). The Monsanto Company, the principal manufacturer, restricted the sale of PCB's for uses in which disposal could not be controlled, such as plasticizers, in 1970 and their main uses in the last several years have been as dielectric insulating fluids. In October, 1977, Monsanto ceased the manufacture of PCB's and withdrew from the market (personal communication). While the continued use of PCB's is on the decline, environmental contamination will probably continue for some time, due to the millions of pounds of PCB's already in landfills, soils, sediments and waters

(Pesticide Chemical News, 1976).

The significantly higher pesticide and PCB levels found in the catfish may be a reflection of their feeding habits and trophic level. The relatively low solubility of the organochlorines and PCB's favors their sorption on suspended and sedimented materials. A benthic feeder, such as the catfish, would most likely be more exposed to the residues monitored in this study. In addition, the relatively high trophic level of the catfish, coupled with their relatively high fat content, would favor this species' increased bioaccumulation of these lipid soluble contaminants.

Numerous investigators (Morris and Johnson 1971, Henderson et al. 1971, Bulkley et al. 1974, Reinert and Bergman 1974, Kelso and Frank 1974) have reported that pesticide and PCB levels in fish may vary with the time of colleciton, percent fat and the age of the fish. Considering the length of the collection period, March through October, and the wide range in size of the fish collected, the comparison of pesticide residue and PCB levels between collection areas would be tenuous. However, the present data indicates elevated levels of PCB's to be present in fish from the Scioto River at Piketon and the Great Miami River at Elizabethtown.

Summary and Conclusions

Fish were collected from 11 sampling sites in the Ohio River Drainage Basin and the Lake Erie Drainage Basin, and

analyzed for 14 pesticide residues and PCB's. Analysis was completed for 9 of the 11 areas. Heptachlor epoxide, HCB, BHC, DDE and dieldrin were the only pesticides detected. Dieldrin and DDE were the most prevalent pesticide residues, occuring in 64 - 84% of the samples respectively. Only 1 sample (catfish, 0.36 ppm DDE) exceeded the WQC recommendation for pesticides in aquatic organisms of 0.1 ppm.

PCB's (Aroclor 1254,1260) were detected in 82% of the samples analyzed. Sixteen of 31 catfish exceeded the WQC recommendation of 0.5 ppm and 4 catfish exceeded the FDA limit for human consumption of 5 ppm.

Catfish had relatively higher PCB and pesticide residue levels than the other species collected. This may be related to their benthic feeding habits and trophic level. The data also indicates elevated PCB levels to be present in fish collected from the Scioto River and the Great Miami River.

The data thus far provides some baseline information concerning the levels of PCB's and chlorinated pesticides in fish collected in Ohio. However, the length of the sampling season and the wide disparity in uniform size collection of individual fish samples precludes any definite conclusions concerning differences in species accumulation or in identifying areas with elevated contaminant levels.

As resources become available, a more intensive surveillance program should be initiated. Fish species that are readily collectable at all sampling sites should be selected for analysis to expedite the evaluation of contaminant levels

between areas. In addition, a concerted effort should be made at each sampling station to collect fish of the size specified for collection. Sampling should be initiated in late August and continued through October, as the accumulation of pesticide residues are likely to be the highest at this time. The list of contaminants monitored should be reviewed annually and ammended as current problem contaminant levels are reduced and new contaminants are discovered.