A REPORT ON POLLUTION

OF THE OHIO RIVER

IN THE

WHEELING, WEST VIRGINIA AREA

U. S. ENVIRONMENTAL PROTECTION AGENCY

REGION III

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INTRODUCTION

On the basis of reports, surveys or studies, the Administrator of the U. S. Environmental Protection Agency, having reason to believe that pollution from sources in Ohio and West Virginia was endangering the health or welfare of persons in Ohio and West Virginia, called a conference of the States of Ohio and West Virginia, the Ohio River Valley Water Sanitation Commission (ORSANCO) and the U. S. Environmental Protection Agency (EPA) on the interstate pollution of the Ohio River. The conference was called in accordance with Section 10(d) of the Federal Water Pollution Control Act, as amended (33 U.S.C. 1160).

The purpose of this report is to delineate the characteristics of this pollution of the Ohio River; the municipal and industrial sources of this pollution; the effects of this pollution upon water quality and water uses; the adequacy of present wastewater treatment facilities; and future abatement requirements.

This report on pollution of the interstate waters of the Ohio River is based upon: previous reports; data and other material obtained from ORSANCO and the U. S. Geological Survey (USGS); information furnished by other Federal, State, and local agencies and individuals; official records of the Department of the Interior; and data obtained by EPA, formerly Federal Water Quality Administration, during field studies in July and August 1970.

The U. S. Department of Justice has already filed civil injunctions against five industries within the conference area. These are the Wheeling-Pittsburgh Steel Corporation plants at Steubenville, Ohio and Follansbee, West Virginia, the Koppers Company at Follansbee, West Virginia, Valley Camp Coal Company at Triadelphia, West Virginia, and Weirton Steel Division of the National Steel Corporation at Weirton, West Virginia.

SUMMARY

The portion of the Ohio River from Toronto, Ohio to McMechen, West Virginia, is the subject of this report. The river is used commercially for transportation of goods and industrial water supply. People in the area use the river for water supplies, pleasure boating and a small amount of fishing.

The river water quality is degraded throughout the area from Toronto, Ohio, to McMechen, West Virginia. Sludge banks, oil slicks, medicinal tasting phenols and harmful substances were found polluting the river. Bacteria were found in numbers exceeding the Federally approved standards set by the States. The presence of disease-producing bacteria was also verified. Other harmful substances found in excessive concentrations in the river include cyanide and lead.

Fish population studies of this area are characterized by an abundance of predominately pollution tolerant species. Good tasting fish were brought in and placed in wire baskets at selected points in this study area. Over a three day period, they acquired various levels of off-flavors depending on the site. Fish from a site 0.6 miles downstream from the Koppers Company outfalls acquired the most extreme off-flavor found. Some of the fish at this site died from the pollution in the river. Studies of the bottom dwelling organisms, suspended algae and attached growths were made in this area by EPA biologists at the same time as the water quality studies. Samples collected downstream from several of the major

industrial complexes indicated areas of serious degradation, followed in nearly every case by zones of partial natural recovery. All samples taken, however, indicated a degraded water quality.

The quality of the effluents from industrial outfalls was found to be very poor. Pollution from the industries which were surveyed contributes to violations of Federal-State water quality requirements for the Ohio River. In addition, violations of existing Federal laws concerning discharge of oil and refuse were noted at industrial outfalls.

CONCLUSIONS

1. The Ohio River from Toronto, Ohio (river mile 60.0) to McMechen, West Virginia (river mile 96.1) is degraded by waste discharges from Ohio and West Virginia, causing interstate pollution which endangers health and welfare of persons in both States.
2. The Ohio River from Toronto, Ohio to McMechen, West Virginia often contains excessive amounts of oil, phenols, cyanide and other chemicals discharged by industries in the area. Oils and solids settle to the river bottom near the outfalls and form putrescent, objectionable sludge deposits. Phenols, cyanide and other chemicals harm or kill fish and other aquatic life and taint the flavor of fish flesh; they also are a cause of much concern to municipal water supply operators.
3. Several industries along the Ohio River from Toronto, Ohio to McMechen, West Virginia discharge wastes which cause visible pollution in the area of the outfalls.
4. The Ohio River from Toronto, Ohio to McMechen, West Virginia often contains excessive densities of bacteria including pathogenic varieties which originate from untreated or inadequately treated domestic sewage; as a result, the use of the Ohio River for any type of recreation is hazardous to human health.

5. The major sources of municipal and industrial wastes being discharged to the Ohio River from Toronto, Ohio to McMechen, West Virginia are:

Municipalities

Toronto, Ohio

Steubenville, Ohio

Mingo Junction, Ohio

Brilliant, Ohio

Tiltonsville, Ohio

Belmont County S. D. #1

Weirton, West Virginia

Wellsburg, West Virginia

Beech Bottom,West Virginia

Wheeling, West Virginia

McMechen, West Virginia

Industries

Weirton Steel - Division of National Steel Corporation

Wheeling-Pittsburgh Steel Corporation

Koppers Company

6. Many tributaries to the Ohio River from Toronto, Ohio, to McMechen, West Virginia, are polluted by mine drainage which impairs use of the streams for water supplies, water-based recreation and fish propagation, and it aesthetically damages and degrades property values.

RECOMMENDATIONS

It is recommended that:

1. All waste waters discharged to the Ohio River or its tributaries in the conference area from municipal and industrial sources, including active mining operations, meet the following criteria:

   a. the total oil concentration shall be less than or equal to 10 mg/l and no irridescence shall be visible.

   b. the concentration of settleable solids plus the concentration of suspended solids shall not exceed 30 mg/l.

   c. pH shall be between six and nine standard units.

   d. there shall be no net acidity concentration.

   e. the total iron concentration shall be 7 mg/l or less.

   f. the discharge shall not contain amounts of the following substances which would cause the concentration in the receiving stream to exceed the acceptable level as specified in the most recent edition of the <u>USPHS Drinking Water Standards</u>:

Arsenic	Copper	Phenols
Barium	Cyanide	Selenium
Cadmium	Lead	Silver
Chromium, hexavalent	Nickel	Zinc

   g. the discharge shall not contain harmful or toxic material which kill over half the test organisms in a 96-hour bioassay.

2. All municipal waste treatment plants in the conference area shall provide a minimum of secondary treatment and adequate disinfection of their waste effluents. Secondary treatment is defined as that which provides a minimum of 85 percent reduction of both suspended solids and oxygen demanding material as measured by the 5-day biochemical oxygen demand (BOD_5) test. Adequate disinfection is defined as that which provides an effluent which will contain a concentration not greater than 200 per 100 ml of fecal coliform organisms as a geometric average value, nor greater than 400 per 100 ml of these organisms in more than 10 percent of the samples tested.

3. All industrial waste sources are to provide, as a minimum, the equivalent of secondary treatment.

4. All municipal and industrial waste sources including active mining operations in the conference area have treatment facilities installed and operating to meet the recommended criteria by December 31, 1974, except when completion is required earlier by the Federally approved water quality standards or by court decision. Interim dates for all waste sources in the conference area be submitted to the Conference Chairman within three months.

5. All concentrations of materials be determined according to the procedures outlined in the latest edition of Standard Methods.

AREA

The Ohio River defines the boundary between West Virginia and Ohio. Figure 1 represents 36 miles of the river which are the subject of this report. Most of the towns in the study area are situated along the river as shown in Figure 1. About 165,000 people lived in all these towns in 1970, a decrease of approximately seven percent since 1960.[1,2]

Every second of the day an average of 36,000 cubic feet of water comes down the river into the area under consideration here. A drop of water in the river may take from 10 hours to 10 days to pass through this area. The average time of travel through this area is 30 hours. Tributary streams along this reach of the river add an average of 1500 cubic feet of water per second to the river. The flow in the river at any given time is controlled by the locks and dams. Flows during this study ranged from 12,800 cfs to 53,600 cfs as calculated from data on the Pike Island Dam releases.

The Corps of Engineers maintains three locks and dams on this reach of the Ohio River providing a nine foot pool depth for year-round navigation. The Pike Island Lock and Dam (Figure 1) is the newest of the three. The Pike Island locks provide a vertical lift of 17.8 feet while the older locks at Warwood and McMechen provide lifts of only 8.4 feet and 7.3 feet, respectively. The upper 24 miles of the river in this area are on the pool maintained by Pike Island Dam.

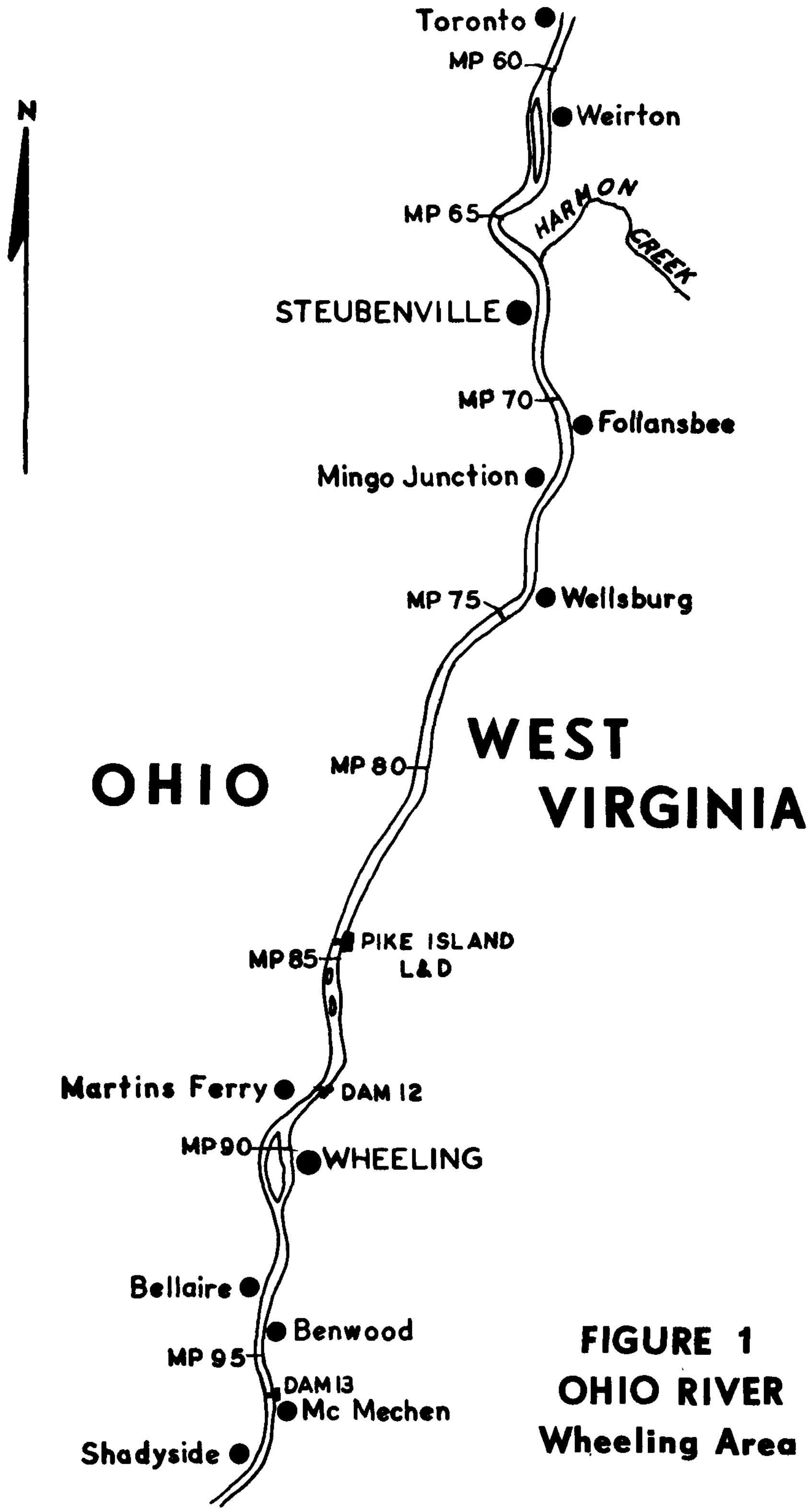


FIGURE 1
OHIO RIVER
Wheeling Area

In this area, the river flows in a narrow valley about 600 feet deep. Occasional islands and small flood plains exist at wide parts of the valley. At the upstream portion of the reach of the river under consideration, the valley walls contain thick clays, which are used in that area's ceramics industry. Coal and limestone appear on hilltops further downstream. These deposits are found closer down to the river as it flows south past Wheeling. The combination of limestone and coal produces highly buffered water draining from the many old surface mines in the area. The sulfate and iron from mine drainage have colored many tributary stream beds red and orange. Historically, it was the rich coal veins in this area which brought the steel industry to Weirton, Steubenville, and Wheeling. Large electric generating plants were built more recently. These electric plants use some of the worlds tallest smokestacks to carry smoke from their coal fired boilers above the hilltops and spread it over ridges and valleys. The older steel industry and the newer power generating plants both depend on the river to carry fuel for their furnaces and to supply water necessary for their operation.

WATER USES

PRESENT USES

The Ohio River from Toronto, Ohio, river mile 60.0, to McMechen, West Virginia, river mile 96.1, is used primarily for navigation and as a source for industrial water supplies. Other uses include municipal water supplies, recreation and fishing. At the present time, there are no hydro-electric power plants on the Ohio River in this area.

Municipal Water Supply

Three communities in this reach use the Ohio River as a raw source for water supply. Toronto and Steubenville, Ohio and Wheeling, West Virginia use the Ohio to supply approximately 113,900 people with 13.94 million gallons per day. All other communities along the river in this reach rely on ground water from infiltration galleries, Ranney wells, and drilled wells for raw water sources.

Fishing

Commercial fishing is non-existent on the Ohio River within this study area. However, the river is used for sport fishing although the use is limited by the type of fish population (predominately carp, gizzard shad and channel catfish) and the edibility of the fish. Fishermen are also reluctant to fish in the river because of the oil, scum, and debris that persist throughout the area.

Recreation

Boating is the main recreational use of the Ohio River in this area. The Corps of Engineers reports that the 14 marinas, ramps, or docks along the 36 miles of river between Toronto and McMechen have a mooring capacity of 488 berths. For comparison, the 40 miles of river in Pennsylvania from Pittsburgh to the Pennsylvania-West Virginia line has a mooring capacity of 185 berths at nine facilities.[3]

Water contact recreation, such as water skiing and swimming, is limited because of the oil and floating debris that persists in most sections of the river. More important, but not visible, is the high concentration of bacteria, including pathogenic organisms, indicating the presence of a health hazard to persons coming in contact with the water.

Industrial Water Supply

The Ohio River from Toronto, Ohio to McMechen, West Virginia, is used extensively by industries as a source of process and cooling water. Total water use is in excess of 2.8 billion gallons per day, of which approximately 90 percent is used as once-through cooling water for thermal electric power generation. Two major steel producers account for the majority of the remaining ten percent, the bulk of which is used for cooling purposes.

Navigation

Navigation is an integral part of the economic growth of this area. Commercial barges carry an ever increasing quantity of material over this reach as shown in the table below:

Year	Millions of Tons through Pike Island Locks	
	Upstream	Downstream
1965	12.0	4.5
1967	14.1	4.3
1968	15.2	4.6

The U. S. Army Corps of Engineers indicate that the following tonnages of materials passed through the Pike Island Lock in 1968:

Material	Total Tonnage in Millions of Tons	
	Upstream	Downstream
Coal & Coke	8.1	1.1
Oil & Gasoline	3.6	0.4
Iron & Steel	0.7	1.8
Stone, Sand & Gravel	0.2	0.2
All Others	2.6	1.1

The predominance of transportation of fuels is also reflected in the types of terminal facilities in this area. The following table lists the number of terminals capable of handling the specific material:

Material	Number of Terminals
Coal & Coke	16
Oil & Gasoline	10
Iron & Steel	6
Sand & Gravel	6

Some facilities can handle more than one type of material making the above list non-additive. A total of 37 separate terminals exist, but the above list does not include all the types of terminals in the area. Other terminals handle miscellaneous materials or provide mooring services.[4]

WATER USES AS DEFINED BY WATER QUALITY STANDARDS

In the establishment of Water Quality Standards, the States listed the uses for each interstate stream in order to determine the applicable water quality criteria. The following delineates the uses of the Ohio River as given by West Virginia and Ohio in their respective Water Quality Standards, as approved by the Federal Government:

West Virginia

1. Water Contact Recreation
2. Water Supply, Public
3. Water Supply, Industrial
4. Water Supply, Agricultural
5. Propagation of Fish and Other Aquatic Life
6. Water Transport, Cooling and Power
7. Treated Wastes Transport and Assimilation

Ohio

1. Public Water Supply
2. Industrial Water Supply
3. Aquatic Life - Warm Water Fish
4. Recreation
5. Agricultural Use and Stock Watering

GENERAL WATER QUALITY CRITERIA

Each State's Water Quality Standards included criteria designed to protect the water uses of the stream. Specific approved criteria by States are listed in Table 1. The following is the

TABLE 1

Current Approved Specific Criteria-Ohio River

Ranges	West Virginia	Ohio
pH (Standard Units)	6.0-8.5	6.0-8.5
Maximums		
Temperature (°F)		
(May-November)	87°	1/
(December-April)	73°	1/
Temperature change (over natural)	5°	5°
Threshold Odor No. @ 60°C	8*	24*
Total Coliforms /100 ml	1000**	-
Fecal Coliform /100 ml	-	200**
Radioactivity (ci/l)		
Gross Beta	1000	1000
Dissolved Strontium-90	10	10
Dissolved Alpha	3	3
Maximum Concentrations (mg/l)		
Toxic Substances	1/10 TL_{m96}	1/10TL_{m48}
Arsenic	0.01	0.05
Barium	0.50	1.0
Cadmium	0.01	0.01
Chromium (hexavalent)	0.05	0.05
Lead	0.05	0.05
Silver	0.05	0.05
Nitrates	45.0	-
Phenol	0.001	-
Cyanide	0.025	0.025
Floride	1.0	1.0
Selenium	0.01	0.01
Iron (Total)	-	-
Manganese (Total)	-	-
Dissolved Solids	-	750.0
Dissolved Solids	-	500.0**
Minimum Concentrations (mg/l)		
Dissolved Oxygen	5.0	4.0
For 16 of any 24 hours	-	-
Daily Average	-	5.0

* - Daily average.
** - Monthly average.

1/ See TABLE 2.

TABLE 2

Ohio's Temperature Criteria for the Ohio River

Maximum Temperature (°F) During Month

January	50	July	89
February	50	August	89
March	60	September	87
April	70	October	78
May	80	November	70
June	87	December	57

general criteria adopted by the respective States and approved by the Federal Government:

West Virginia

"Certain characteristics of sewage, industrial wastes or other wastes or factors which render waters directly or indirectly detrimental to the public health or unreasonably and adversely affect such waters for present or future reasonable uses, are objectionable in all the waters of the State. Therefore, the State Water Resources Board does hereby proclaim that the following general conditions are not allowed in any of the waters of the State."

"No sewage, industrial wastes or other wastes entering any of the waters of the State shall cause therein or materially contribute to any of the following conditions thereof, which shall be the minimum conditions allowable:

1. Distinctly visible floating or settleable solids, suspended solids, scum, foam or oily sleeks of unreasonable kind or quality;
2. Objectionable bottom deposits or sludge banks;
3. Objectionable odors in the vicinity of the waters;
4. Objectionable taste and/or odor in municipal water supplies;
5. Concentration of materials poisonous to man, animal or fish life;
6. Dissolved oxygen concentration to be less than 3.0 milligrams per liter at the point of maximum oxygen depletion;

7. Objectionable color;

8. Objectionable bacterial concentrations;

9. Requiring an unreasonable degree of treatment for the production of potable water by modern water treatment processes as commonly employed."

Ohio

"Minimum conditions applicable to all waters at all places at all times:

1. Free from substances attributable to municipal, industrial or other discharges that will settle to form putrescent or otherwise objectionable sludge deposits;

2. Free from floating debris, oil, scum, and other floating materials attributable to municipal, industrial or other discharges in amounts sufficient to be unsightly or deleterious;

3. Free from materials attributable to municipal, industrial, or other discharges producing color, odor or other conditions in such degree as to create a nuisance;

4. Free from substances attributable to municipal, industrial or other discharges in concentrations or combinations which are toxic or harmful to human, animal or aquatic life."

SOURCES OF WASTES

The conference area contains numerous sources of untreated or inadequately treated wastes which are harmful and hazardous. These sources are given here in their order of significance as they affect water uses.

The most important source of wastewater in the area causing pollution is the steel industry and its related industries. Iron and steel are produced at Steubenville and Mingo Junction, Ohio by the Wheeling-Pittsburgh Steel Corporation, and at Weirton, West Virginia by the Weirton Steel Division of the National Steel Corporation. The flue gas wash water from these blast furnaces at these plants passes through clarifiers to remove solids. These clarifiers are frequently overloaded, however, and solids are discharged to the river where they form deposits on the stream bottom.

The steel is shaped and sometimes coated at other steel plants in the area. Weirton Steel Division of National Steel has shaping and coating operations at Weirton, West Virginia and Steubenville, Ohio. Wheeling-Pittsburgh Steel Corporation has shaping and coating plants at Steubenville, Mingo Junction, Yorkville and Martins Ferry, Ohio; and at Follansbee, Beech Bottom, and Benwood, West Virginia. Most of these steel plants have at least some elementary form of wastewater treatment. Oil is another significant waste found in steel mill discharges, especially from the shaping and coating plants. Rolling mills use lubricating oils in the large machinery as well as coating oils on the steels being formed. A portion of these oils find their way into the river. Other wastes from steel mills are: acid and alkaline materials from rinses, hexavalent chromium, cyanide and iron.

The steel companies also produce coke for their furnaces. Coke is made by heating coal in the absence of air. The wastewaters from coke plants contain phenols, cyanides, ammonia and organic chemicals. The coke plants at Weirton and Follansbee, West Virginia, owned by Weirton and Wheeling-Pittsburgh Steel, treat their effluents to remove much of the pollutants.

The Koppers Company operates a coal tar plant at Follansbee, West Virginia. Coal tar is supplied from the nearby coke plants. Various solvents, tars, and chemicals are produced. Wastewaters from the plant contain phenols, oils, solids, and alkaline materials.

Raw and inadequately treated sewage discharged to the river and streams is also a major pollution problem in this reach of the Ohio. These wastes carry great numbers of intestinal bacteria from human excretions, and pathogenic organisms are present. The municipal waste sources discharging to the Ohio River in the conference area are listed in Table 3. Several municipalities do not provide complete sewage collection systems for all the homes in their area. Harmon Creek, at Weirton, West Virginia, for example, reflects the lack of a complete collection system in that area. The high bacteria concentrations found in Harmon Creek are an indication that

TABLE 3

Sources of Municipal Wastes
Ohio River - Wheeling Area

River Mile	Name	Population Served	Type of Treatment
59.0	Toronto, Ohio	8,000	Primary + Chlorination
68.0	Steubenville, Ohio	34.700	Primary + Chlorination
71.0	Mingo Junction, Ohio	5,300	Primary + Chlorination
74.5	Brilliant, Ohio	2,400	Primary + Chlorination
82.0	Rayland, Ohio	600	Primary + Chlorination
83.0	Tiltonsville, Ohio	2,570	Primary + Chlorination
84.0	Yorkville, Ohio	1,800	Primary + Chlorination
92.0	Belmont County S. D. #1		Primary + Chlorination
	(Martins Ferry, Ohio)	11,600	
	(Bridgeport, Ohio)	3,700	
	(Brookside, Ohio)	800	
	(Bellaire, Ohio)	10,900	
61.8	Weirton, West Virginia	30,000	Primary + Chlorination
70.5	Follansbee, West Virginia	5,000	Secondary + Chlorination
74.2	Wellsburg, West Virginia	5,500	None
78.0	Beech Bottom, West Virginia	500	None
91.0	Wheeling, West Virginia	70,000	Primary + Chlorination
94.2	Benwood, West Virginia	3,500	Secondary + Chlorination
96.0	McMechen, West Virginia	3,000	Primary + Chlorination

many homes discharge raw sewage directly into the creek.

Coal mining activities are the third most important source of waste. Coal mining and related activities are carried out on tributaries to the Ohio River. Acid water drains from old, inactive mines carrying high concentrations of iron and sulfate. Active mines also discharge similarly polluted water. Frequently, water from the coal preparation plants pollute the receiving streams with black coal dust. Mine refuse piles are also a known source of highly polluted water. The water pollution from coal mining activity is a unique source of industrial waste in that it continues long after the mining has ceased. Acid waters carrying iron, sulfates and other dissolved materials comes from many sites of mining activity; the receiving streams become red and yellow, and the stream beds are caked with "yellowboy," a yellow precipitate of iron hydroxide usually containing calcium sulfate and aluminum hydroxide. Mine refuse is washed to the streams where it accumulates in stream beds. Many of the tributaries to the Ohio River in this area are grossly polluted by waste from coal mining activities.

Other industries discharge polluted waters. Thermal electric generating plants discharge large volumes of heated water. American Electric Power operates the Cardinal Plant and the Tidd Plant at Brilliant, Ohio and the Beech Bottom Plant at Power, West Virginia. The Cardinal and Tidd Plants, in combination, are a significant source of heated water. The Federal Paper Company at Steubenville, Ohio and the Saint George Paper Company at Wellsburg, West Virginia are among the paper processing plants known to discharge high amounts of solids. The river below these plants has been visibly discolored by these discharges. Sand and gravel companies frequently discharge excess concrete to the banks of the river. Large fan-like deposits of concrete extend into the river at these locations. Oil terminals along the river have had few incidents of oil spills, but oil slicks have been observed in the area. Other industries in the area have discharges which have not been investigated.

Table 4 is a listing of industrial dischargers to the Ohio River in the Wheeling area. Effluents from some of these industries were sampled during the field survey for this report. Coal mining operations are not included in the table. Only coal loading facilities are listed.

TABLE 4

Industrial Sources of Waste

to the Ohio River

Mile Point	Industry	Comment
59.3R	Toronto Paperboard Company	
60.5R	Titanium Metals Corporation of America	
61.8L	Standard Slag Company	Solids
62.0L	Weirton Steel-Division of National Steel Corporation	Oil, Solids Metalic Iron, Phenols, Cyanide Hexavalent Chromium, Lead, Acidic Material
64.6R	Sinclair Oil Company	Tank farm
65.7L	Advance Metal Lithographing, Inc. Signode Corporation	Solids
66.3L	Starvaggi Industries, Inc.	Solids
66.8R	Eastern Ohio River Sand and Gravel Co.	Solids
67.3R	Federal Paperboard Company, Inc.	Solids, Heat
67.4R	Hartje Brothers	No outfall visible
68.3R	Weirton Steel-Division of National Steel Corporation	Oil, Acidic Materials
68.6L	Allied Oil Company	Tank farm
68.7R	Wheeling-Pittsburgh Steel Corporation North Steubenville Plant Steubenville, Ohio	Oil, Iron, Lead Cyanide, Solids Manganese, Acidic Materials, Heat
68.8L	Wheeling-Pittsburgh Steel Corporation East Steubenville Plant Follansbee, West Virginia	Phenols, Heat Cyanide
69.1L	Allied Oil Company	Terminal

TABLE 4 (Continued)

Mile Point	Industry	Comment
69.2L	Koppers Company, Incorporated Follansbee, West Virginia	Phenols, Oil Solids, Heat Cyanide
70.3L	Wheeling-Pittsburgh Steel Corporation Follansbee Plant Follansbee, West Virginia	
70.6L	Follansbee Steel Company Follansbee, West Virginia	
70.8R	Wheeling-Pittsburgh Steel Corporation South Steubenville Plant Mingo Junction, Ohio	Oil, Iron, Solids, Lead, Hexavalent Chromium, Heat Alkaline Materials
71.1R	Penn Central Railroad	
71.8R	Nickle Plate Railroad	
73.3L to 73.7L	Banner Fibreboard Company West Virginia Pulp and Paper Company Pillsbury Company Mammoth Plastics, Incorporated	
74.1L	S. George Company	Solids
76.1R	Ohio Ferro Alloys Corporation	
76.5R	Ohio Power Company Cardinal and Tidd Plants	Heat
79.2L	Wheeling-Pittsburgh Steel Corporation Beech Bottom Plant Beech Bottom, West Virginia	Oil
79.8L	Ohio Power Company Beech Bottom Plant	Heat
81.1R	Tri-State Asphalt Corporation	
81.1R	Ohio Coal and Construction Company	
82.2L	Valley Camp Coal Company, No. 1-Short Creek	
82.6R	Standard Oil	

TABLE 4 (Continued)

Mile Point	Industry	Comment
83.5R	Wheeling-Pittsburgh Steel Corporation Yorkville Plant, Yorkville, Ohio	Oil, Solids, Iron Heat, Phenols Acidic Materials
85.5L	Esso Standard Oil Company	Terminal
85.6L	Sun Oil Company	Terminal
85.8L	American Oil Company	Terminal
86.6L	Warwood Tool Company	
86.7L	Wheeling Stamping Company	
87.9R	Wheeling-Pittsburgh Steel Corporation Martins Ferry Plant Martins Ferry, Ohio	
88.0L	Centre Foundry and Machine Company	
88.2L	Pure Oil Company	Terminal
88.9R	Quaker State Oil Company	Terminal
91.1L	Contractors Supply Corporation of West Virginia	
91.8L	Standard Sand and Gravel Company	
91.9L	Delta Concrete Company	
93.6L	Hanna Coal Company - Division of Consolidation Coal Company Shoemaker Mine	
93.8R	Delta Concrete Company	
94.4L	Wheeling-Pittsburgh Steel Corporation Benwood Plant Benwood, West Virginia	

EFFECTS OF POLLUTION ON WATER QUALITY AND USES

Various studies have been made in the study area to define the effects of pollution on water quality and water uses. In addition, the U. S. Environmental Protection Agency maintains one sampling station in the area as part of its Pollution Surveillance Program.

Figure 2 and Table 5 are descriptions of the 13 stations that were sampled by the EPA during a special study conducted from July 27 through August 7, 1970. These data illustrate the condition of the river during warm summer months. The EPA study shows that the river is in a degraded condition throughout the area. The pollution from the Weirton-Steubenville area degrades the river water quality in that area. Water quality improves downstream to a maximum just above the Pike Island Lock and Dam. At that point, the river water quality is at its best in this reach of the river. Industrial and municipal wastes cause degradation of the river from that point to the downstream end of the study area.

Both Ohio and West Virginia have agreed on the desirability of the "four freedoms" of water quality. These freedoms outline the rights to clean water which every citizen has. Each of the "four freedoms" listed below was violated during the study period.

"1. Free from substances attributable to municipal, industrial or other discharges that will settle to form putrescent or otherwise objectionable sludge deposits;"

Figure 2

Sample Locations

Legend

▲ Stream Sample Locations

Industry Outfall Sample Locations

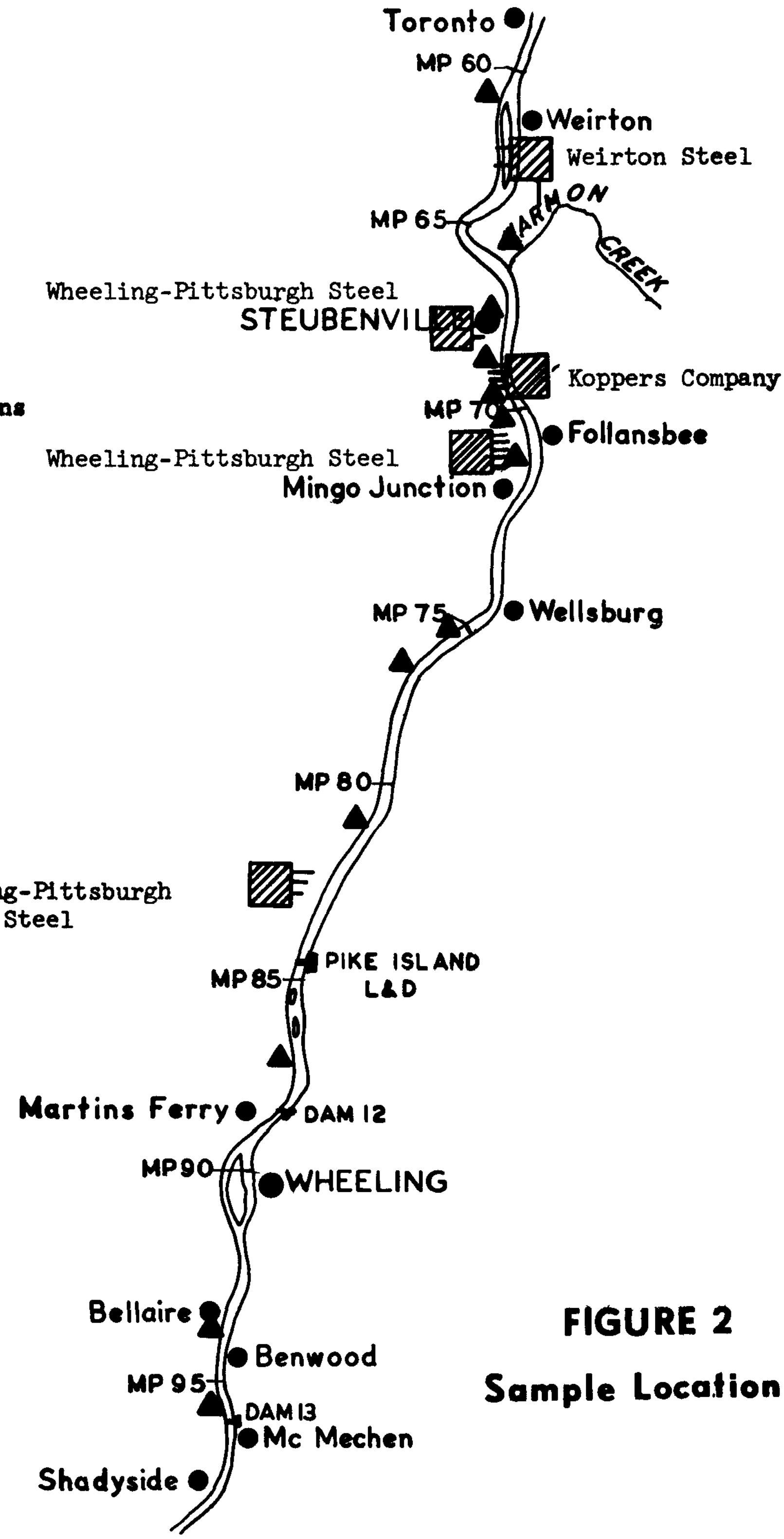


FIGURE 2

Sample Locations

TABLE 5

Sampling Stations
Special Study-EPA-Ohio River
July-August, 1970

Description	Mile Point
Ohio River downstream of Toronto, Ohio	60.8
Ohio River opposite Steubenville, Ohio, water intake	65.3
Harmon Creek at W. Va. Route 2 bridge	-
Ohio River upstream of Steubenville, Ohio, sewage treatment plant	67.1
Ohio River downstream of Steubenville, Ohio, sewage treatment plant	67.9
Ohio River downstream of Wheeling-Pittsburgh Steel and Koppers Company	70.0
Ohio River downstream of Follansbee, West Virginia	72.0
Ohio River downstream of Wellsburg, West Virginia	75.0
Ohio River downstream of Brilliant, Ohio, sewage treatment plant	75.6
Ohio River upstream of Wheeling-Pittsburgh Steel, Yorkville, Ohio	82.7
Ohio River at Wheeling, West Virginia, raw water intake 1/	86.7
Ohio River opposite Bellaire, Ohio, water intake	94.0
Ohio River upstream of Lock and Dam No. 13	95.5

1/ EPA Pollution Surveillance Station.

Oils and solids from industries form sludge banks in the Ohio River and its tributaries.

"2. Free from floating debris, oil, scum, and other floating materials attributable to municipal, industrial or other discharges in amounts sufficient to be unsightly or deleterious;"

Oils from industries form slicks and scum on the Ohio River.

"3. Free from materials attributable to municipal, industrial or other discharges producing color, odor, or other conditions in such degree as to create a nuisance;"

Phenols, mine drainage and sewage from industries and municipalities create nuisances in the Ohio River and its tributaries.

"4. Free from substances attributable to municipal, industrial or other discharges in concentrations or combinations which are toxic or harmful to human, animal or aquatic life."

Pathogenic bacteria, chemicals and heavy metals from industries and municipalities are toxic and harmful to human, animal and aquatic life.

Much of the pollution along the river has interstate effects between Ohio and West Virginia.

BACTERIAL POLLUTION

Municipal sewage contains high numbers of bacteria, frequently including pathogenic bacteria, derived from human excreta. These pathogenic bacteria can cause gastro-intestinal diseases such as typhoid fever, dysentery and diarrhea. Infectious hepatitis, a virus disease, can also be caused by ingesting sewage-polluted water. Eye, ear, nose, throat or skin infections may result from bodily contact with such water. As the densities of pathogenic bacteria are reduced by sewage treatment or forces of natural purification, the hazards of contacting disease are proportionately reduced.

Sewage also contains readily detectable coliform bacteria which typically occur in excreta or feces and are always present in sewage-polluted water. Though generally harmless in themselves, coliform bacteria have been considered indicators of the presence of pathogenic bacteria. The coliform group includes several types of bacteria which may come from sources other than excreta.

Testing for fecal coliform bacteria is becoming more popular as an indicator of bacterial pollution because fecal coliform bacteria specifically inhabit the intestinal tract of man and warm-blooded animals. The presence of these organisms in water is positive proof of fecal contamination which may contain associated, disease producing organisms.

Coliform Bacteria

Presently, the States of Ohio and West Virginia use the total coliform group as an indicator of bacterial pollution. The State of Ohio is in the process of changing its recreational criterion for bacteria to the fecal coliform group. Specific bacterial criteria by State are listed in Table 1, on page 17.

Pollution surveillance by the U. S. Environmental Protection Agency includes samples at one station in the area sampled twice a month since January 1967. Through October 1970, the Ohio River at the Wheeling, West Virginia, water treatment plant intake has exceeded West Virginia's water quality standard of 1,000 total coliforms per 100 ml in 32 of the 33 months.

In the study of the Ohio River in July and August 1970, total coliform densities in this conference area exceeded West Virginia's standard of 1,000 per 100 ml 100 percent of the time (120 samples). Total coliform densities exceeded 5,000 per 100 ml 77.5 percent of the time and exceeded 10,000 per 100 ml 46.7 percent of the time. Figure 3 shows the average total and fecal coliform densities as plotted against Ohio River mile points.

Salmonella Bacteria

In addition, a pathogen study was made at two sampling points during this study. While coliform densities indicate the magnitude of fecal pollution which may contain disease-producing organisms, detection of pathogenic Salmonella bacteria in water is positive proof that these disease-producing bacteria are actually present.

Modified Moore swab samples were taken at the following locations:

Description	River Mile
Ohio River below Steubenville, Ohio sewage treatment plant	67.9
Ohio River at Bellaire, Ohio	94.0

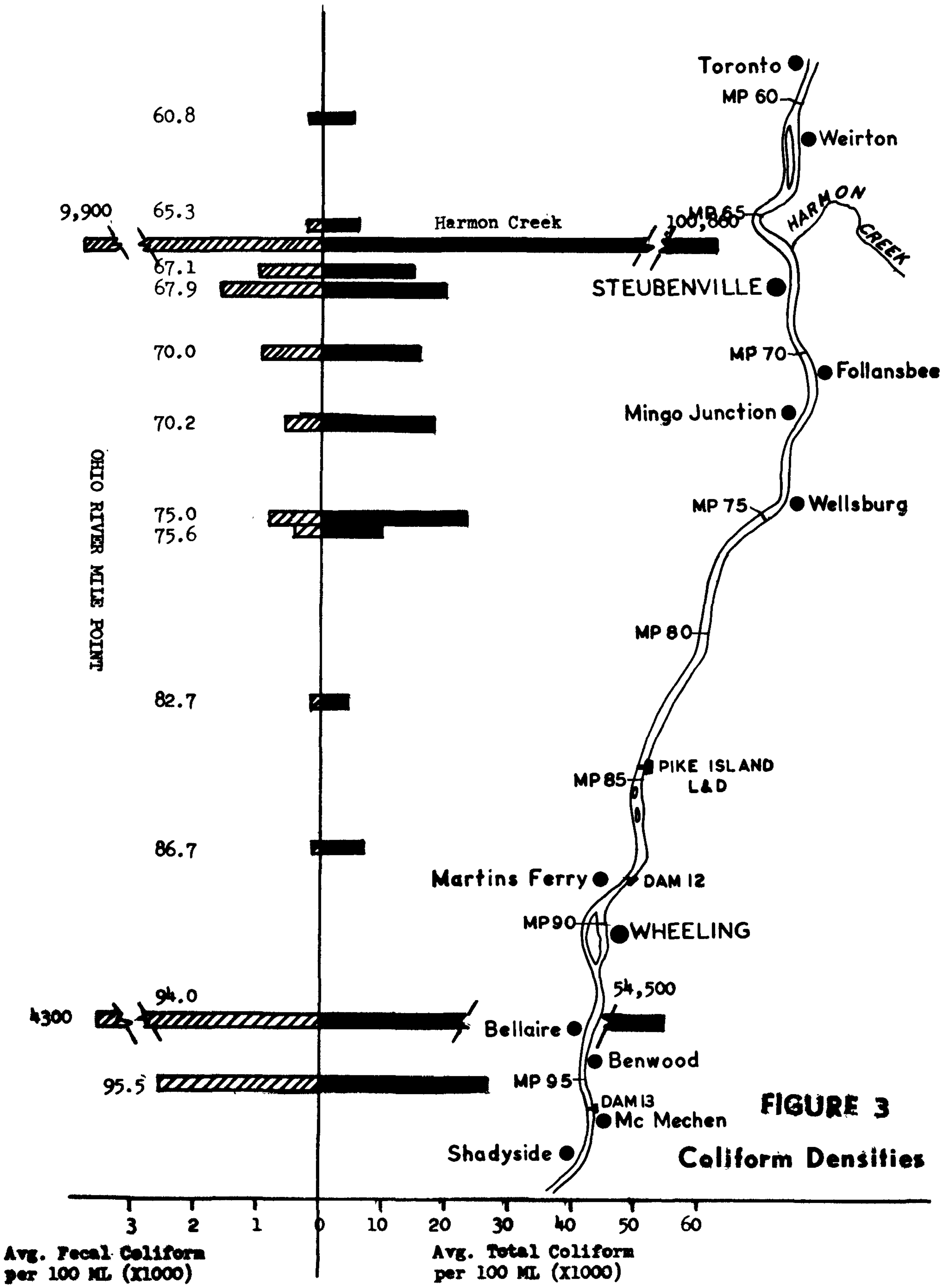


FIGURE 3

Coliform Densities

Salmonella, an enteric pathogen, was isolated at both stations, showing the existence of a health hazard in the river water.

Sewage treatment plants can drastically reduce the amount of bacteria in sewage depending upon the capacity and type of plant disinfection practices and the skill of the plant operators.

PHENOLS

Phenolic materials have plagued municipal water users of the Ohio River for years. Chlorination of finished water containing excessive phenols gives a medicinal taste and odor to the water. Experience has shown that phenolic concentrations in the Ohio River are at a maximum in the winter months when the biological degradation of the phenols is retarded by cold water temperatures. For example, EPA pollution surveillance data obtained during the period 1966-1970 from the Ohio River at Wheeling had an average phenolic concentration of 0.002 mg/1 for the period May through November and increased to 0.024 mg/1 for the period December through April. Maximum concentration recorded during this period was 0.078 mg/1, which occurred in January, 1970.

ORSANCO records of the Wheeling water treatment plant intake for the year 1969 show an average phenolic concentration of 0.005 mg/1 for the period May through November and an increase to 0.011 mg/1 for the period December through April.

West Virginia's criteria for phenols in the Ohio River is 0.001 mg/l The State of Ohio has not set a phenolic standard for the Ohio River. The special study in the warm months of July and August, 1970, showed the average phenolic concentration at the Wheeling station to be 0.002 mg/l, however, a high of 0.053 mg/l was detected at the stream station located 16.7 miles upstream of Wheeling, West Virginia.

OIL POLLUTION

Oil pollution is one of the most visible forms of pollution in the Ohio River in this area. Surface oil destroys the aesthetic value of the river and restricts its use for recreation. A large number of complaints lodged by citizens in this area to the U. S. Environmental Protection Agency concern floating surface oils. Oils also coalesce with natural sediment and other suspended material to form bottom deposits that are toxic to bottom animals, thus restricting the use of the river for aquatic life.

Oil samples were not collected as part of the special two week stream study conducted in this area. However, floating surface oils were observed on numerous occasions by the field crews. Oil analyses were part of the special 3-day industrial outfall sampling program which followed the stream sampling program. Oil concentrations in excess of 1,000 mg/l were recorded at outfalls of the Wheeling-Pittsburgh Steel Corporation's North Steubenville and Yorkville, Ohio plants. Oil concentrations exceeded 20 mg/l in

34 of 57 outfall samples taken during the 3-day period.

SLUDGE DEPOSITS

Sludges or settleable solids are a highly objectionable form of pollution since they are so readily controlled. During the EPA field survey, sludge banks were found in the river below industrial outfalls despite the churning of the powerful tow boats on the river. Notable sludge banks are found at Weirton Steel outfalls near Browns Island and at the mouth of Harmon Creek. Wheeling-Pittsburgh Steel outfalls at Yorkville have sludge banks along the shore near the outfalls. These sludges vary in consistency, but all inhibit aquatic life, hinder navigation, and cause nuisance conditions.

CYANIDES

The discharge of cyanide to water bodies is critical to the aquatic environment because of the toxic nature of the material. The States of Ohio and West Virginia have established a maximum limit of 0.025 mg/1 of cyanide for the Ohio River. During the two week study in this area, this value was exceeded in nine of 86 samples (10.5 percent). The maximum concentration found was 0.040 mg/1. EPA's pollution surveillance data at the Wheeling water intake during the period 1968-1970 shows an average of 0.02 mg/1 with a maximum of 0.08 mg/1

During the 3-day industrial outfall sampling program, ORSANCO's effluent standard of 0.2 mg/1 for cyanide was exceeded at three outfalls, that is, Weirton Steel at Weirton, and Koppers Company and Wheeling-Pittsburgh Steel at Steubenville.[5]

COAL MINE DRAINAGE

Many of the tributary streams to the Ohio River are intensely polluted by coal mine drainage.

Stream pollution problems within these tributary areas attributable to mine drainage are: high concentrations of acidity, iron, manganese, sulfate, and hardness; low pH, and turbidity and bottom deposits from chemical precipitates. Siltation caused by runoff from mining activities often causes severe local stream pollution problems.

The pollutants from mine drainage impair the principal water uses for municipal, industrial and agricultural water supplies; certain water-based recreation; and support and propagation of fish and other aquatic life. In addition, these pollutants cause corrosion of instream facilities and aesthetically damage and degrade the waterfront property values.

EFFECTS OF POLLUTION ON AQUATIC LIFE

In conjunction with the physical, chemical and bacteriological studies conducted during July and August 1970, certain biological studies were carried out to determine the extent of the effects of pollutants on the aquatic life of the Ohio River from Stratton, Ohio (M.P. 54.4) to New Martinsville, West Virginia (M.P. 129.1). These studies, which included fish flavor evaluations and sampling for bottom organisms, suspended algae and attached growths, were conducted at 15 stations throughout the study area (see Table 6). The fish population data was taken from previous studies.

FISH POPULATIONS

Fish population studies of the upper Ohio River were conducted during the period 1957-1959 by the ORSANCO-University of Louisville aquatic life study.[6] The analyses of the data collected during that study consisted of dividing the Ohio River into 100 mile sections for comparative purposes. The sections 0-100 miles and 100-200 miles downstream from Pittsburgh, Pennsylvania, cover the stretch of the river under consideration in this report. A total of 20 samples were collected from 14 different lock chambers in the first 200 miles of the Ohio River.

In general, the fish population of the upper Ohio River during the 1957-1959 period consisted primarily of bullhead, carp, and shiners. The standing crop for section 0-100 miles was 38 pounds per surface acre and for section 100-200 miles was 124 pounds per acre.

TABLE 6

List of Biological Sampling Stations*

Mile Point	Description
54.4	New Cumberland Locks and Dam
56.0	Below New Cumberland Locks and Dam
62.0	In the back-channel of the Ohio River around Brown Island
63.0	In the main channel around Brown Island, approximately 0.7 miles below National Steel
66.2	Old Lock and Dam #10, above Steubenville, Ohio
68.0	Left - 1.3 miles below Harmon Creek Right - 0.1 miles below Steubenville Sewage Treatment Plant
69.9	Left - 0.6 miles below Koppers Company Right - 1 mile below Wheeling-Pittsburgh Steel
71.9	Right - 0.4 miles below Wheeling-Pittsburgh Steel, Mingo Junction
78.0	Right - 1 mile below Ohio Power Company
83.0	0.2 miles above Wheeling-Pittsburgh Steel, Yorkville, Ohio
84.0	Right - 0.6 miles below Wheeling-Pittsburgh Steel, Yorkville, Ohio
87.4	Lock and Dam #12
93.4	Left - 2 miles below Wheeling Sewage Treatment Plant
96.1	Lock and Dam #13, 1.4 miles below Wheeling-Pittsburgh Steel, Benwood, W.Va.
129.1	Lock and Dam #15

*Phytoplankton samples were collected at the chemical sampling stations and are listed in this section by station number and mile point.

A 1967-1969 study was conducted by the Federal Water Quality Administration similar to the 1957-1959 study. However, most of the lock chambers used during the earlier study have been replaced by newer and larger structures. A total of seven samples were collected within the section of the Ohio River under study in this report. The following table summarizes the composition of the fish population sampled during this study:

Range of Percentage (by weight) Composition
of Fish Population 1967-69

Species	M.P. 54.4	M.P. 84.2	M.P. 129.1
Carp	73.7 - 78.4	43.2 - 69.2	4.6 - 9.6
Bullheads	8.0 - 14.7	8.6 - 14.7	1.4 - 1.9
Gizzard Shad	2.4 - 2.6	5.0 - 32.1	1.6 - 7.8
Channel Catfish	2.4 - 5.6	4.5 - 4.7	45.9 -47.7
Sunfishes	1.5 - 4.4	2.1 - 3.3	10.5 -20.9
Minnows	1 - 2.2	3.9 - 8.6	17.6 -19.6
No. of species	20 - 26	18 - 26	20 - 25
Pounds/acre	180 - 238	153 - 263	78 -108

The data obtained for the 1957-59 study for individual sampling locations is not available. The only comparison that can be made must be based on the accumulated data for a 100 mile section of the river. The section of the river under study here overlaps these 100 mile sections as presented in the publication reporting on the 1957-59 study.[6]

There are, however, some observations that can be drawn from the comparative data presented in this report. The 1967-69 study indicates little change in composition from the 1957-59 study in the first 100 miles of the Ohio River downstream of Pittsburgh. The 1967-69 data shows a predominance of carp, bullhead and gizzard shad. The primary difference between the two studies in this section (0-100 miles) appears to be (1) fewer minnows (2) more gizzard shad and (3) increase in the standing crop of fishes.

The fish composition observed at mile point 129.1 indicates improvement of water quality downstream of the first 100 miles of the Ohio River. The predominance of channel catfish and sunfishes (including the basses), along with a decrease in the carp and bullheads is indicative of more favorable conditions for pollution sensitive fishes.

In summary, fish population of the section of the Ohio River from New Cumberland, West Virginia to New Martinsville, West Virginia (74.7 miles) is characterized by an abundance of fish, predominately pollution tolerant species in the upper part of this section, and some increase in pollution sensitive fishes in the lower part of this section of the river.

FISH TAINTING

Several studies have been made in the past three years concerning the palatability of fish caught in the Ohio River. Results of these studies have shown that fish taken from nearly all points in the Ohio River have an unacceptable flavor and are generally considered undesirable for eating. Certain locations produce off-flavors in fish flesh which are characterized as being "very extreme" while others are nearly acceptable.

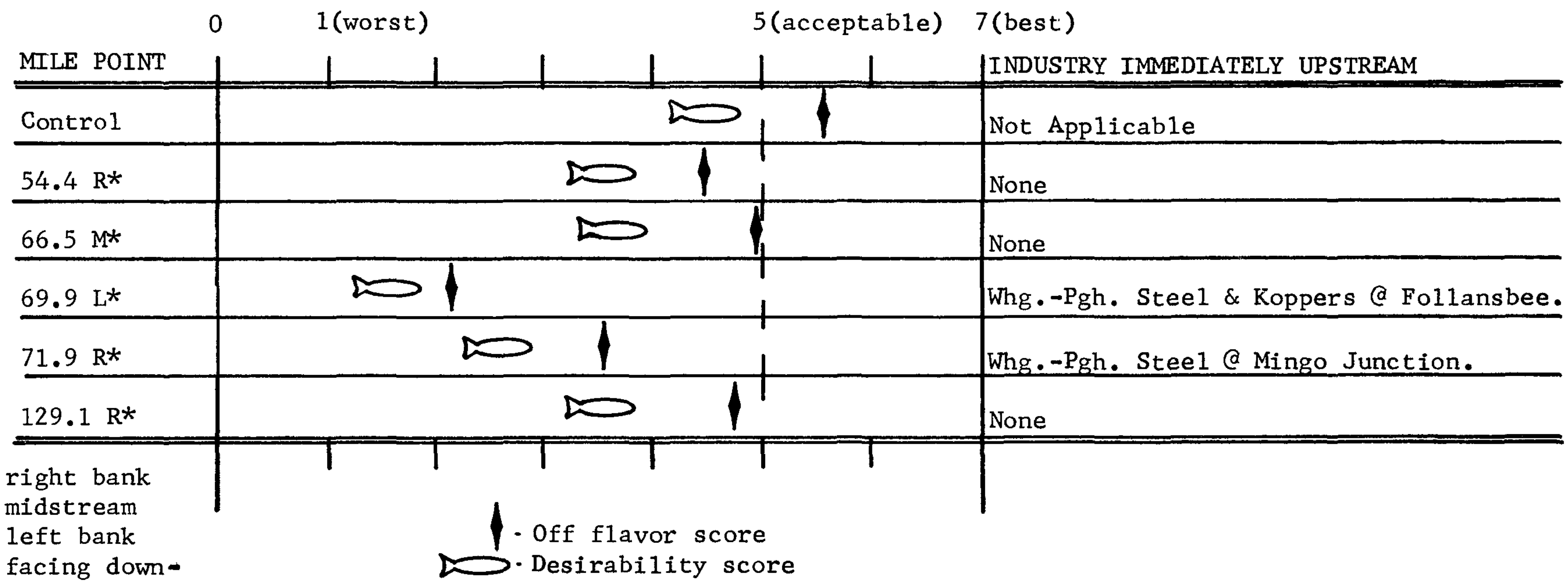
To identify sources of wastes producing off-flavors, channel catfish known to have an acceptable flavor were placed in wire baskets downstream from industrial outfalls. After an exposure period of 72 hours, the surviving fish were retrieved and subjected to a panel test. The judges scored on seven point scales the degree of off-flavor and of over-all desirability. The results of the evaluation are shown in Table 7. Fish flesh having scores from five to seven are considered to be acceptable. Using this criterion, only the control fish would be considered acceptable. The river water at all locations tested gave an undesirable flavor to the good fish placed there in this study.

Two of the catfish held at M.P. 54.4 did not survive the exposure period. The remaining four acquired a moderate off-flavor. During the four previous studies of this nature, no sample from the Ohio River ever acquired such an extreme off-flavor as was found at M.P. 69.9. This station was located 0.6 miles downstream from the Koppers Company outfalls at Follansbee, West Virginia. Of the six fish held at this location, only two survived the three day exposure period, indicating a presence of toxic substances in the water.

TABLE 7

FISH FLAVOR EVALUATION, OHIO RIVER, AUGUST 1970

DESIRABILITY & OFF-FLAVOR SCORES



* R right bank
M midstream
L left bank
facing downstream

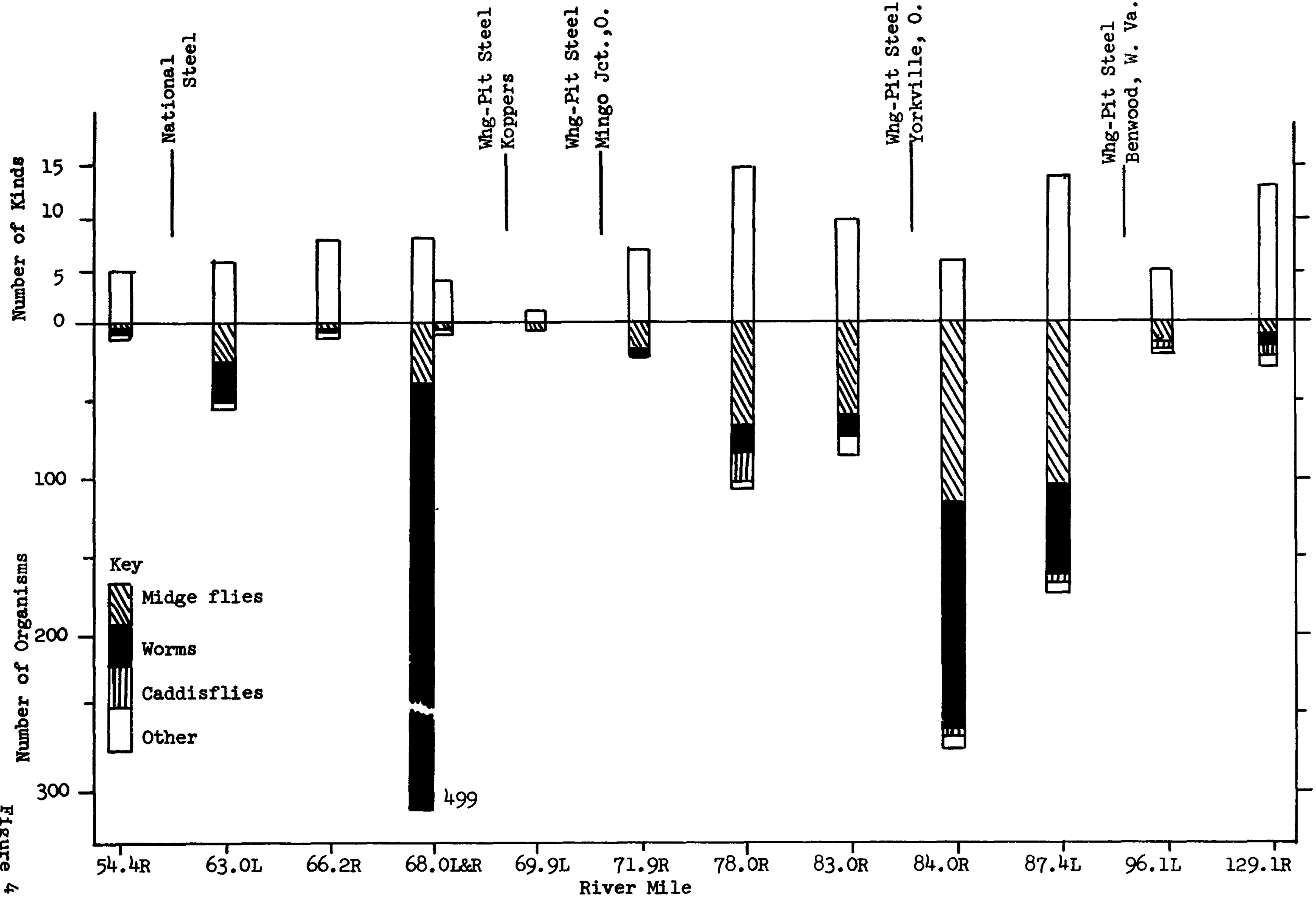
Fish held at M.P. 71.9, downstream of the Mingo Junction, Ohio industrial complex, were rated by the judges as having a strong off-flavor. At M.P. 129.1, the degree of off-flavor was rated as moderate, similar to the two uppermost stations.

BOTTOM ORGANISMS

Bottom dwelling organisms (macroinvertebrates), such as insect larvae, snails, clams, worms, etc. are useful in determining the effects of pollutants. These organisms lack a means of rapid locomotion and are thus prevented from making extended migrations. Because of their limited migration and their relatively long life cycles, bottom organisms reflect conditions at the sampling point for an extended period of time, and thus serve as indicators of prevailing water quality conditions.

Bottom organisms were collected during this study using a Peterson dredge and rock filled basket samplers. The baskets were exposed at a depth of one to two feet for a period of four weeks. These artificial substrates provided a habitat for colonization unaffected by variations in sediment or bottom materials. The results of the basket sampling are summarized in Figure 4.

In general, aquatic worms comprised a large percentage of each sample. Pollution-sensitive forms, such as mayflies and stoneflies, were absent; however, caddisflies, which are tolerant of a wide range of environmental condition, were collected at several stations. All samples collected from M.P. 54.4 to M.P. 71.9 contained relatively low numbers of organisms and limited diversity,



Composition of Bottom Samples Collected with Basket Samplers
Ohio River, July - August, 1970

Figure 4

indicating degraded water quality. The basket sample on the left (West Virginia) bank at M.P. 69.9 contained only two midge fly larvae, indicating toxic conditions at that station. As noted earlier, this station is a short distance downstream from the Koppers Company plant at Follansbee, West Virginia. This was the poorest sample collected throughout the study area. At M.P. 78.0, diversity increased, indicating a recovery zone. This increase in diversity was also apparent, although to a lesser degree, at M.P. 83.0. Diversity decreased again at M.P. 84.0, probably as a result of discharges from the Yorkville, Ohio plant of Wheeling-Pittsburgh Steel Company.

Another increase in diversity occurred at M.P. 87.4, again indicating a partial recovery. At M.P. 96.1, downstream from the Benwood plant of Wheeling-Pittsburgh Steel, numbers and diversity were limited. However, at M.P. 129.1, diversity had again increased.

As initially stated, all samples indicated a degraded water quality. However, samples collected downstream from several of the major industrial complexes indicated areas of more serious degradation, followed in nearly every case by zones of partial recovery.

SUSPENDED ALGAE

Suspended algae (phytoplankton) occupy a position at the bottom of the food chain and are, therefore, important members of the aquatic community. An over-abundance of suspended algae indicates the presence of excessive amounts of nutrients in the water while low numbers of suspended algae generally indicate either a lack of nutrients or the presence of toxic substances.

During this study, samples were collected on July 27 and August 3 at the 12 stations designated as sampling points for chemical analyses. These samples were used for suspended algal counts and chlorophyll concentrations. The results are summarized in Figures 5 and 6.

All of the algal counts from this portion of the Ohio River fall within the range of those indicative of unproductive waters. There was a general increase in numbers as the water flowed downstream, indicating a possible increase in nutrient levels. Chlorophyll concentrations remained fairly stable throughout the study area with a slight increase in the downstream samples. These studies do not distinguish between toxic effects or lack of nutrients.

ATTACHED GROWTH

The attached growths (periphyton) are similar to the suspended algae in their environmental role. However, since they are attached instead of free floating, they reflect the prevailing water quality at a given point in the stream in much the same way as do the bottom organisms.

For this study, attached growths were collected on glass slides exposed at the surface for a four-week period in floating samplers. Four slides from each sampler were prepared for Sedgwick-Rafter counts, and each of the remaining four slides were prepared for chlorophyll analysis. The composition of the attached growths and the chlorophyll values are shown in Figures 7 and 8, respectively.

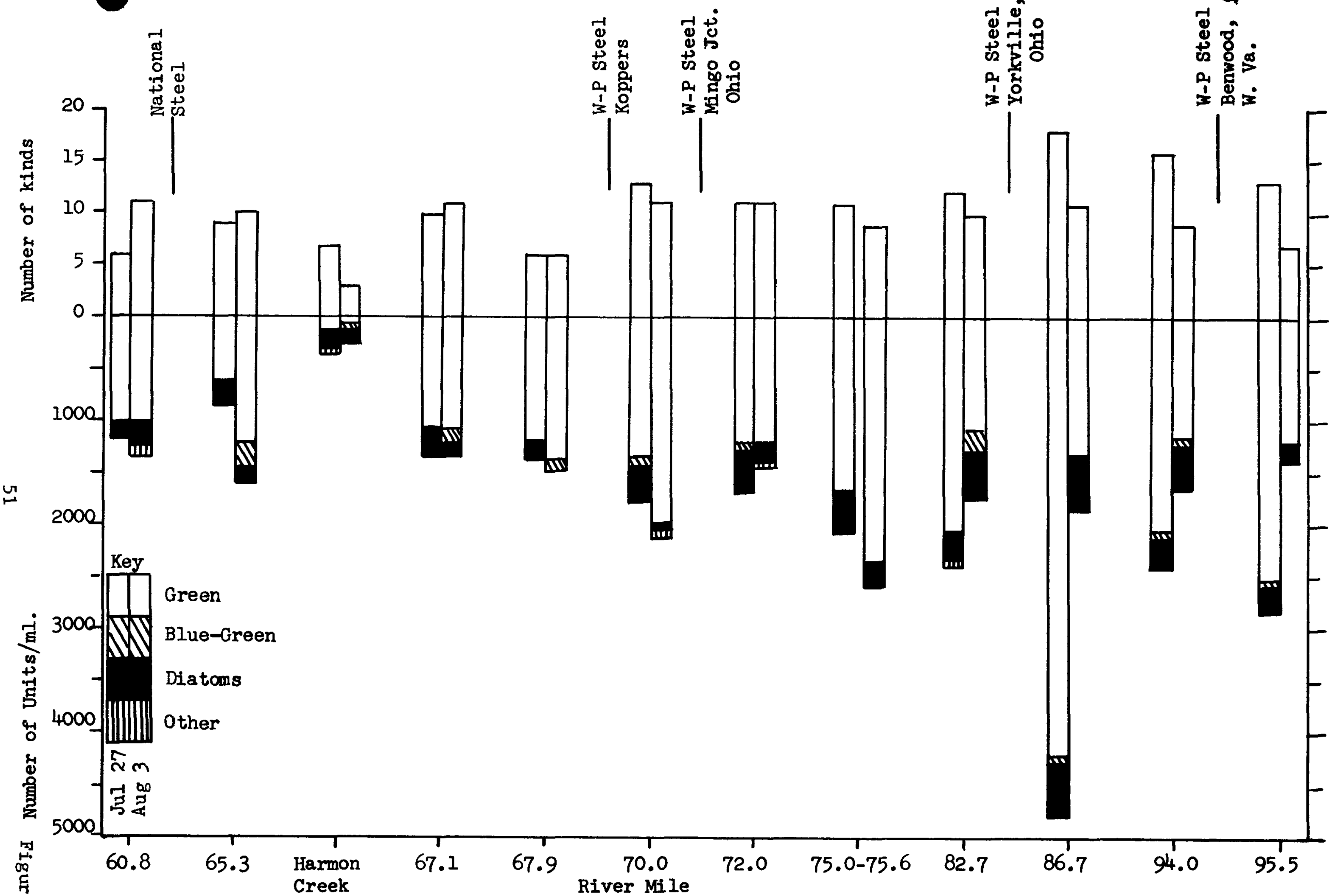
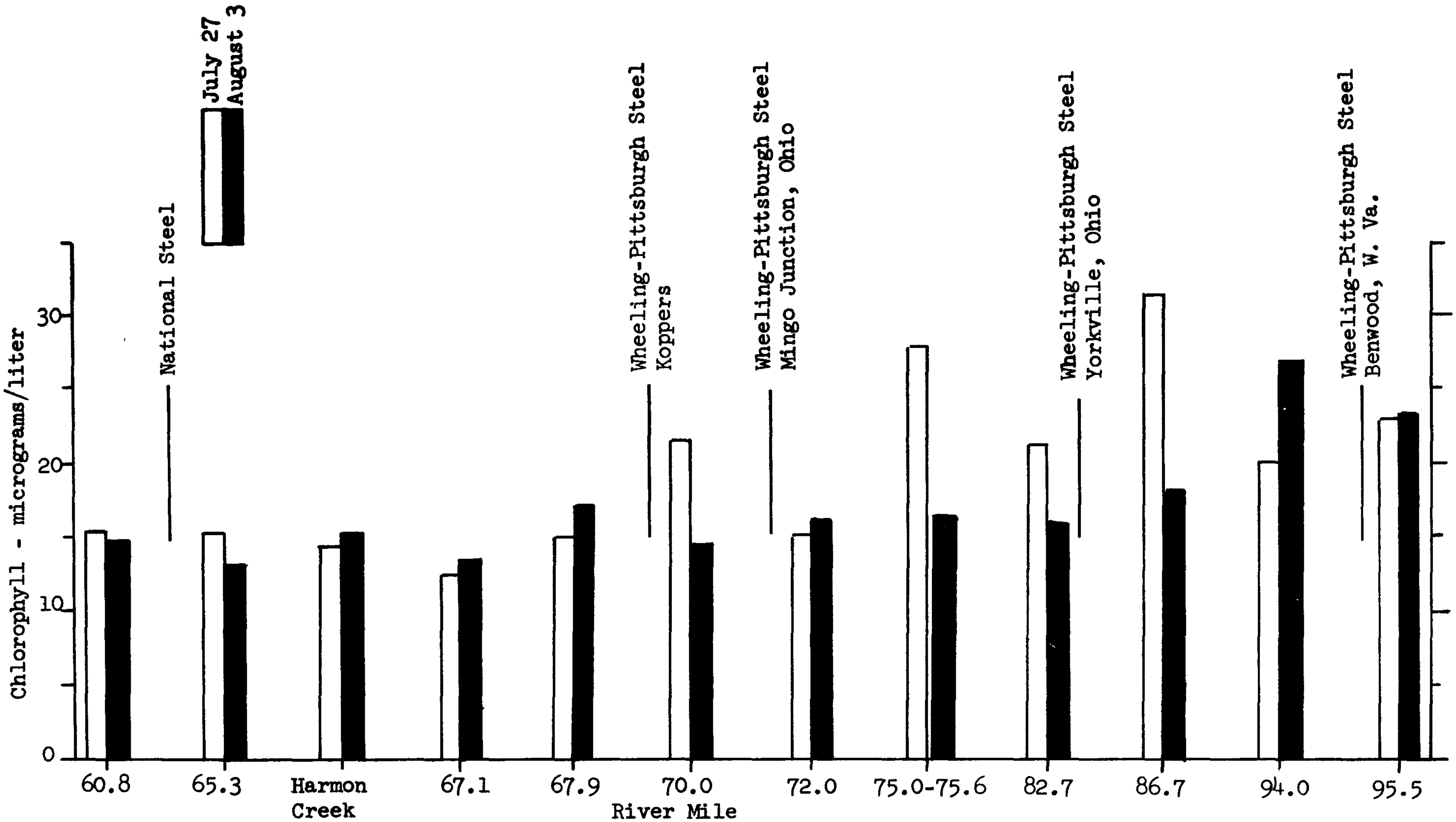


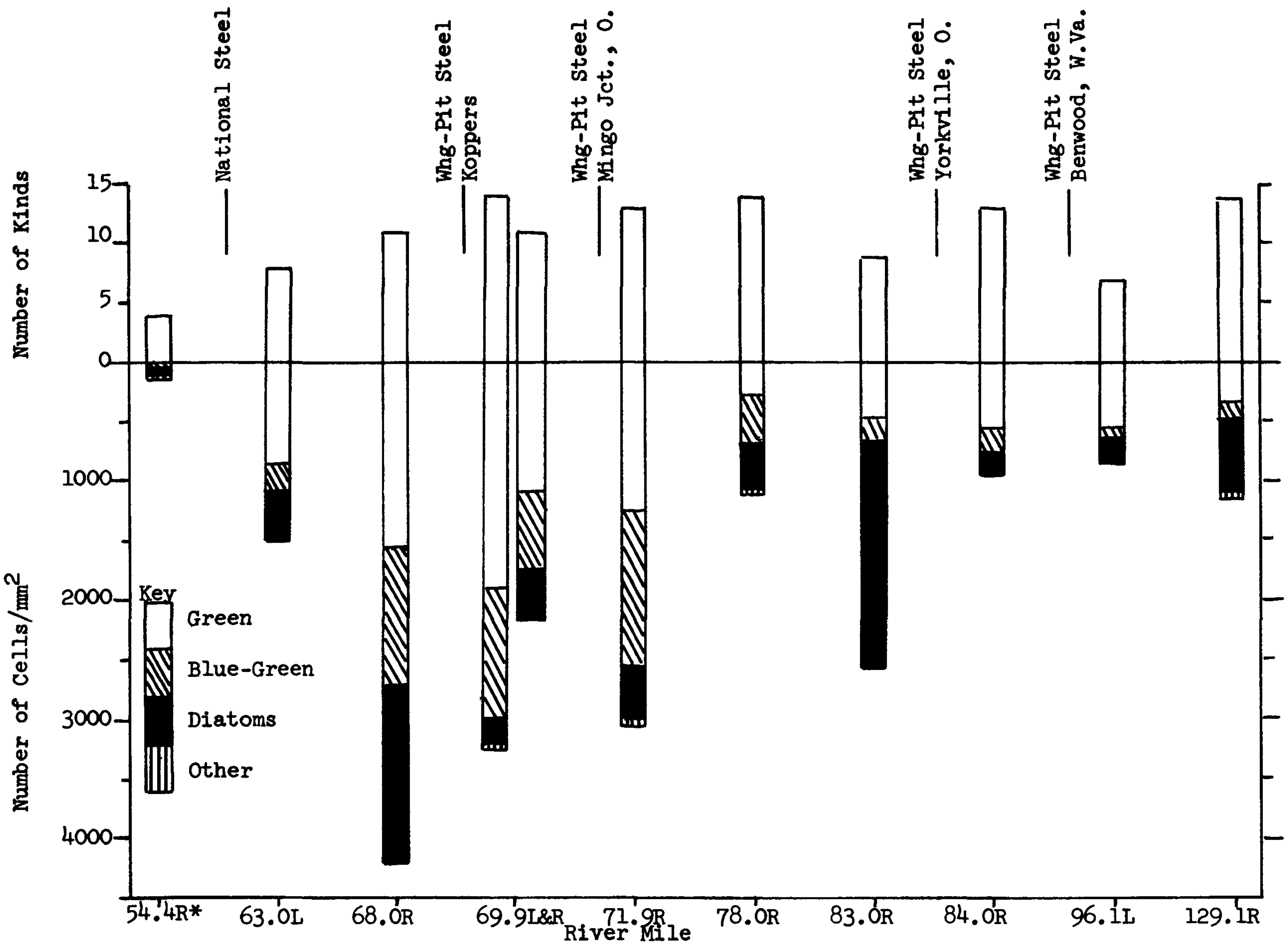
Figure 5

Composition of Suspended Algae. Ohio River, July 27 and August 3, 1970.



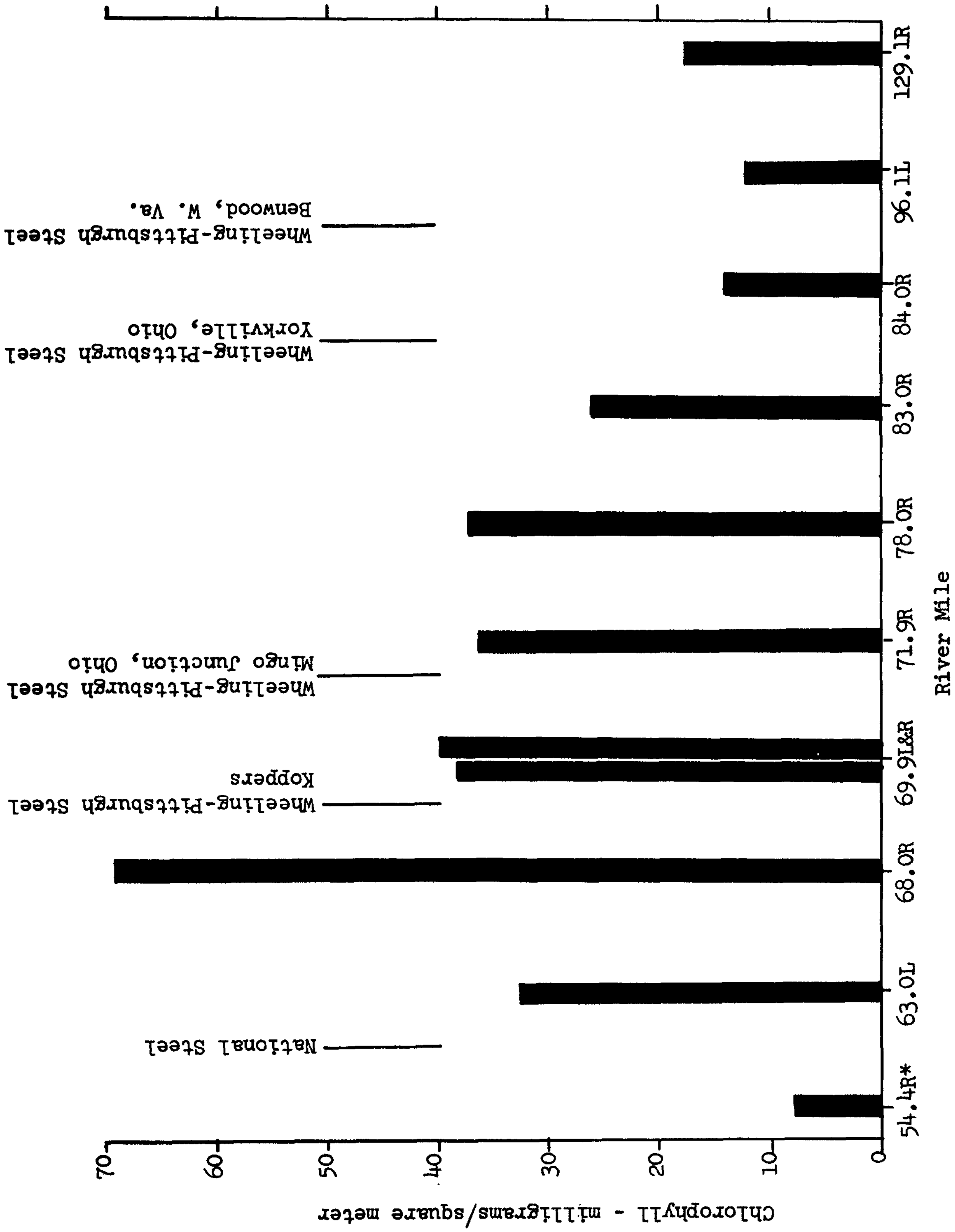
Concentrations of Chlorophyll in the Ohio River. July 27 and August 3, 1970

Figure 6



Composition of Attached Growths, Ohio River, August, 1970

Figure 7



1 Quantity of Chlorophyll in Attached Growths
Ohio River, July - August, 1970

*Material scraped from lock wall.

Figure 8

An examination of the data shows an increase in both numbers of cells and quantity of chlorophyll from M.P. 54.4 to M.P. 68.0, indicating a probable increase in available nutrients at the latter station. Downstream from M.P. 68.0, both total counts and quantity of chlorophyll show a gradual decline. This is indicative of either a decreasing availability of nutrients or an increasing concentration of toxic substances in the water or both. Numbers and quantity of chlorophyll decreased downstream from Koppers Company at M.P. 69.9, suggesting toxic influences.. Decreases also occurred downstream from the Yorkville plant of Wheeling-Pittsburgh Steel at M.P. 84.0 and downstream from the Benwood plant of Wheeling-Pittsburgh Steel at M.P. 96.1. These decreases were small but do suggest a prevailing presence of toxic substances in the plant effluents. At M.P. 129.1, a slight increase was evident, indicating a partial zone of recovery.

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