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BLACK RIVER
WASTE LOAD ALLOCATION REPORT

U.S. Environmental Protection Agency
Region V
Surveillance and Analysis Division
Eastern District Office

Volume I

BLACK RIVER

WASTE LOAD ALLOCATION REPORT

Prepared for the
OHIO ENVIRONMENTAL PROTECTION AGENCY

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BLACK RIVER
WASTE LOAD ALLOCATION REPORT

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PREFACE

Section 303(e) of the Federal Water Pollution Control Act Amendments of 1977 provides for the establishment of a Continuous Planning Process by the State on a river basin scale consistent with other sections of the 1977 Amendments. The river basin plan, or Section 303(e) plan, is a water quality management plan for the streams, rivers, and tributaries and the total land and surface area within a planning area defined by the State. The purpose of the plan is to coordinate and direct the State's water quality decisions on a river basin scale. The plan is neither a broad water and related land resources plan nor a basinwide facilities plan; it is a document that identifies the basin's water quality problems - including a determination of existing water quality, applicable standards, and significant point and nonpoint sources of pollution - and sets forth a cost-effective remedial program for those problems including effluent limitations and other control strategies; it identifies Section 201 facility decision planning and Section 208 areawide planning needs; it sets forth priorities for municipal facilities planning and construction grants and for industrial permit processing; and it establishes the timing of plan implementation.

The Waste Load Allocation Report (WLAR) is a comprehensive water quality report that provides the technical basis for the Section 303(e) plan. It focuses upon the relationships of existing water uses with duly adopted water quality standards. The WLAR identifies and ranks point source dischargers in terms of adverse impact on water quality; provides recommended schedules of compliance and target compliance dates; assesses municipal treatment needs; recommends appropriate revisions to water quality standards; and recommends an appropriate monitoring and surveillance program. Where necessary, because of severe water quality problems, the WLAR establishes maximum daily pollution loadings that can be discharged to a stream segment; makes individual point source load allocations; and, where possible, assess nonpoint source pollution.

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SECTION I
OBJECTIVES

The objectives of the Waste Load Allocation Report are to provide the basis for a water quality management plan for the Black River Planning Area pursuant to Section 303(e) of the Federal Water Pollution Control Act Amendments of 1977, and to support the National Pollutant Discharge Elimination System (NPDES) permitting process pursuant to Section 402 of the 1977 Amendments. NPDES permit conditions for point source dischargers include effluent limitations, compliance schedules, and effluent monitoring requirements.

SECTION II
SCOPE

The Black River Planning Area encompasses in excess of 515 square miles of drainage in the Lake Erie Basin including the total drainage of the Black River (467 square miles), Beaver Creek (44 square miles), Martin Run (4 square miles), and a few square miles draining directly to the lake. Figure II-1 illustrates the area of study and its location within the State. Figure II-2 is a more detailed illustration of the Planning Area denoting significant political boundaries. Based upon the 1970 census, the population residing in the area is estimated to be 250,000 people or roughly 2.3 percent of the State's 1970 population of 10,650,000 people; the Planning Area accounts for about 1.2 percent of the surface area of Ohio. There are 159 known point source dischargers within the Planning Area, including 114 municipal and semi-public sewage treatment plants and 45 industrial facilities including municipal water treatment plants.

Because of the extremely low water quality design flows of Beaver Creek and the Black River above Elyria, sophisticated water quality modeling was generally not required to establish effluent limitations for dischargers to these streams in conformance with applicable water quality standards. However, such techniques were employed to study the complex water quality problems of the eleven mile segment of the Black River from the northern portions of Elyria to Lorain. Effluent limitations in conformance with water quality standards were developed for the major dischargers in this segment.

Approximately 40 stream sampling stations throughout the Planning Area were employed as part of this study to assess compliance with water quality standards during spring runoff conditions (April-May, 1974). In addition, 14 stations in the lower Black River were intensively sampled during summer low flow conditions for water quality simulation purposes (July 1974, July 1979). Aside from water quality data obtained by the USGS and the Ohio Environmental Protection Agency at and below the USGS stream flow gaging station in Elyria, there are not much long term data available for the Planning Area. Available water quality data from previous Ohio EPA and U.S. EPA studies and miscellaneous sources were assembled and included herein.

Of the 45 industrial facilities, 16 of the more significant dischargers were inspected, and effluent sampling programs were completed at Harshaw Chemical Company and the U.S. Steel - Lorain Works. The Elyria, Lorain, and Oberlin sewage treatment plants were inspected, with sampling programs completed at the Elyria and Lorain facilities. In addition, a field reconnaissance program was conducted to identify dischargers to the Elyria storm sewer system. Since NPDES permits are now effective for many dischargers in the Planning Area, the effluent limitations and other requirements of these permits are reviewed herein in terms of consistency with applicable water quality standards and effluent limitation guidelines. Recommendations for modification of these permits are made as appropriate.

FIGURE II-1

BLACK RIVER PLANNING AREA
LOCATION MAP

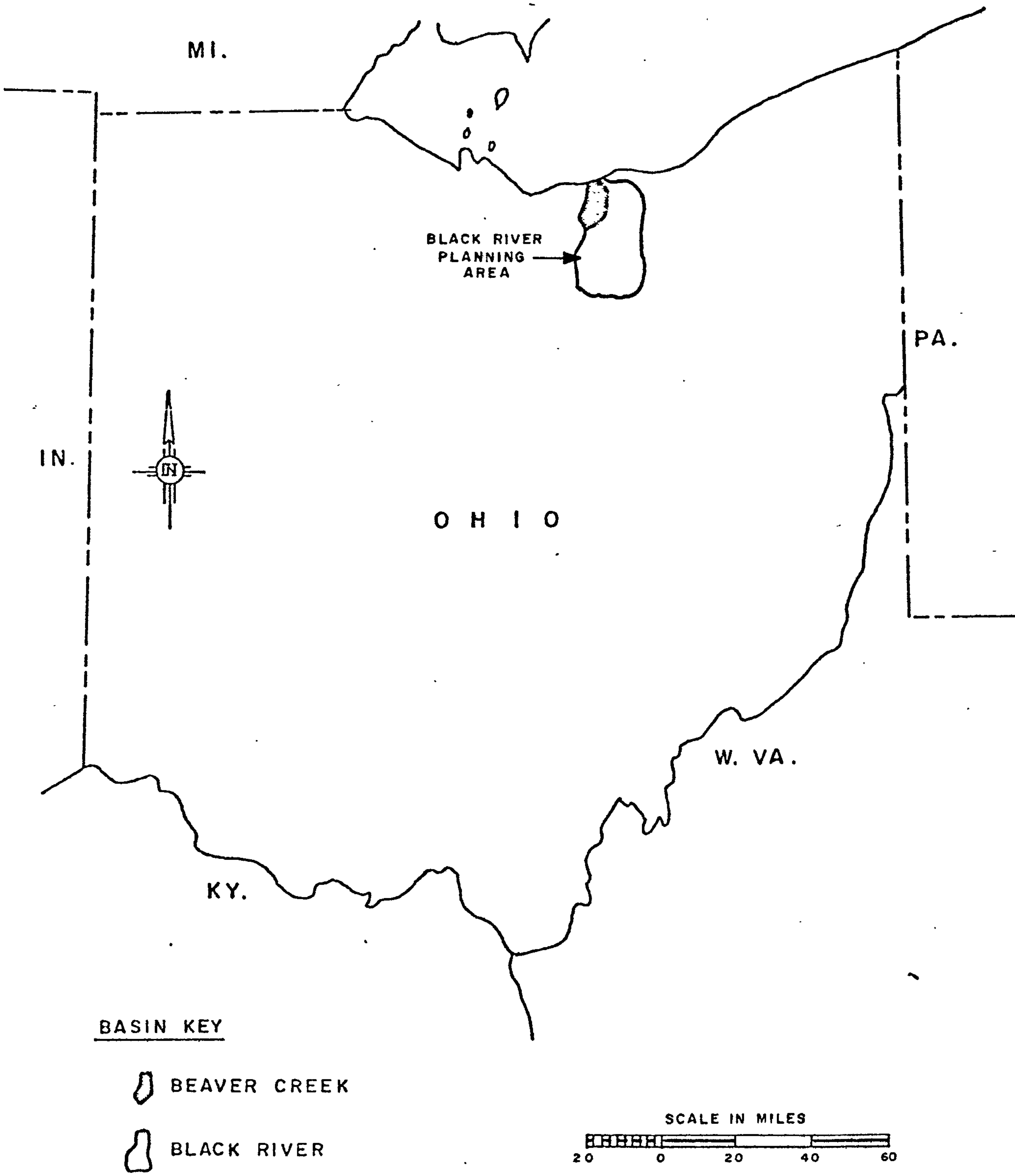
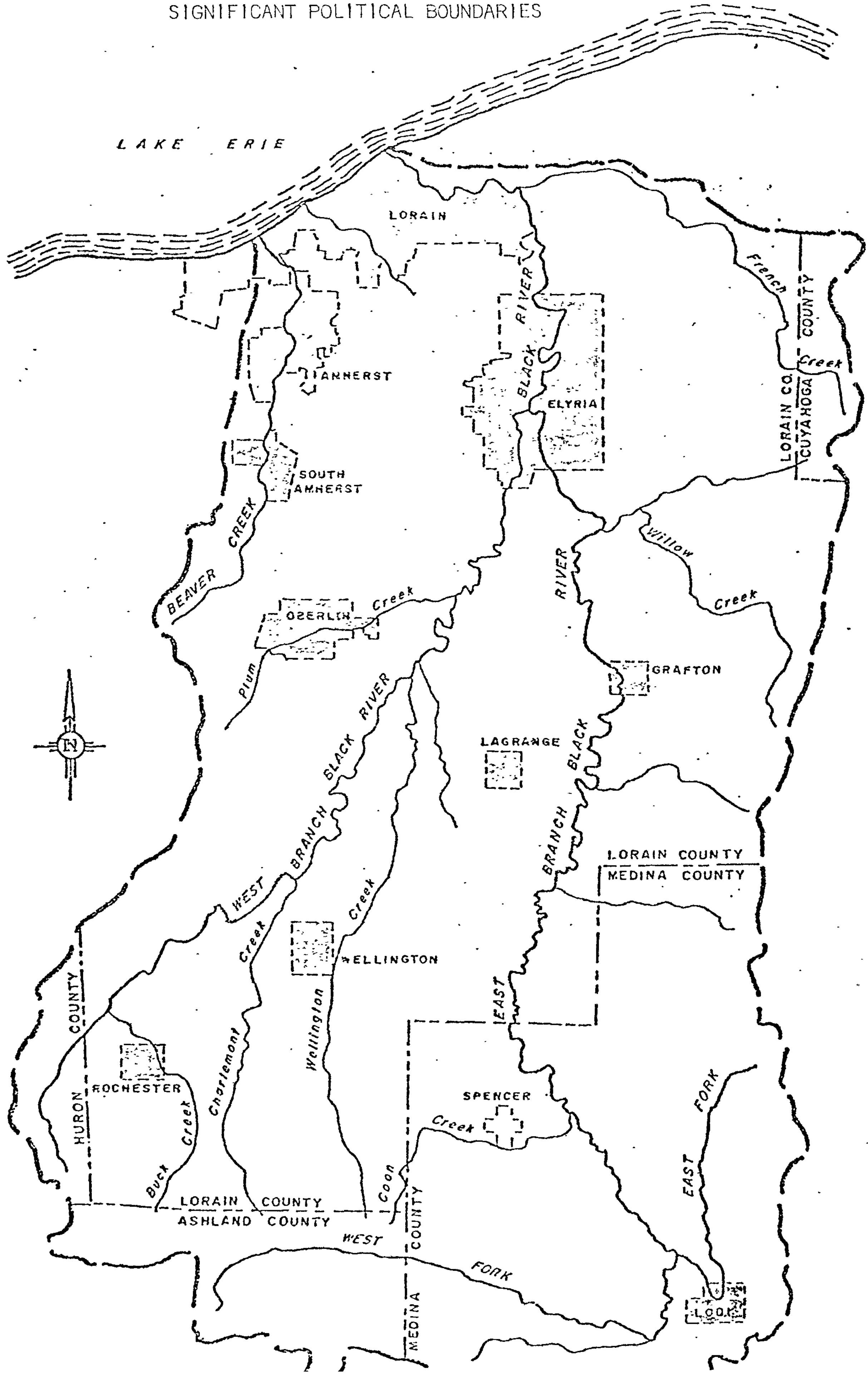


FIGURE II-2

BLACK RIVER PLANNING AREA

SIGNIFICANT POLITICAL BOUNDARIES



SECTION III
FINDINGS AND CONCLUSIONS

(1) There are 159 known point source dischargers within the Black River planning area, including 114 public and semi-public sewage treatment plants, 38 industrial facilities, and 7 water treatment plants. Four facilities discharge directly to Lake Erie, 127 discharge to streams with water quality design flows of zero cfs, and 28 discharge to lake-affected areas of the Black River or to streams having a significant water quality design flow.

(2) Upstream of Elyria, most streams have good quality water and are in substantial compliance with Ohio water quality standards. Violations of the cadmium and lead standards were found at several locations, apparently the result of agricultural non-point source pollution. Bacterial standards were exceeded throughout the basin due to the discharge of inadequately disinfected sanitary wastes.

(3) Large discharges of ammonia and other oxygen-demanding materials from the Elyria sewage treatment plant cause continuing and substantial violations of Ohio Water Quality Standards for ammonia and dissolved oxygen in the main stem of the Black River. Thermal discharges from the U.S. Steel-Lorain Works cause violations of the temperature standards in the Black River, and, the discharge of oxygen demanding wastes from this facility contribute to the violation of dissolved oxygen standards. In addition, the oil discharge from U.S. Steel Outfall 001 is causing violations of Section 3745-1-04(B) of the Ohio Water Quality Standards, despite being in compliance with current NPDES permit conditions. Upon

reaching design flow, the discharge from the French Creek Sewage Treatment Plant will become a significant factor in the dissolved oxygen balance in French Creek and in the Black River.

(4) The classification of the main stem of the Black River as "water quality limiting" is warranted since conventional municipal secondary treatment for the Elyria and French Creek sewage treatment plants, and BPCTCA for the U.S. Steel-Lorain Works are not adequate to achieve water quality standards. Most remaining streams in the planning area should be similarly classified due to their low water quality design flows.

(5) With minor exceptions, Ohio's warmwater habitat use designation and associated water quality criteria are achievable throughout the planning area with well demonstrated, conventional industrial and municipal treatment technologies. The seasonal warmwater habitat use designation is appropriate for limited reaches below the Brentwood Estates, Eaton Estates, Grafton, Lagrange, Lodi, and Oberlin Sewage Treatment Plants.

(6) Maximum and average temperature standards for the lower Black River for the period April 15 to June 15 should be increased $3^{\circ}F$ to reflect the response of the river to weather conditions and the recommended reduced thermal loadings at the U.S. Steel-Lorain Works.

SECTION IV
RECOMMENDATIONS

1. The water quality management strategy and point source effluent limitations presented in Section IX and Appendix IV should be implemented through the NPDES permit program pursuant to Section 402 of the 1977 Amendments.

2. Trunk and collector sewers should be constructed as soon as possible in Avon, North Ridgeville, and Sheffield to eliminate the semi-public treatment plants in those communities and to avoid constructing many AWT facilities.

3. The Amherst STP should be abandoned and combined with the Lorain sewerage system to avoid advanced treatment requirements at Amherst. Likewise, treatment plants planned for the Quarry Creek area should be designed to discharge directly to Lake Erie or to discharge to the Lorain sewerage system.

4. Consideration should be given to regionalizing sewage treatment plants south of Elyria to eliminate many smaller facilities and minimize the number and extent of seasonal warmwater habitat classifications.

5. The City of Elyria must develop and implement a strong industrial pretreatment program to prevent upsets of the existing treatment plant and future advanced waste treatment processes.

6. The primary water quality monitoring network presented in Section X should be implemented by the Ohio Environmental Protection Agency in accordance with Section 106 of the 1977 Amendments.

7. The Ohio Environmental Protection Agency should include an intensive survey of the lower Black River in the mid 1980's as part of its monitoring strategy. The intensive survey is recommended to demonstrate the effects of municipal and industrial treatment and to update the waste load allocation. Non-point source pollution surveys in the agricultural areas should be considered as follow up to document sources of water quality procedures upstream of Elyria.

SECTION V
PLANNING AREA DESCRIPTION

The Black River Planning Area is described below in terms of geography, geology, meteorology, land and water uses, demography, the economy of the area, and the hydrology of the major streams. By design, the information and data presented are of a general nature for the purpose of providing background information only. Of necessity, the hydrology section is more detailed. Most of the material is presented for the planning area as a whole, whereas hydrologic information is presented for specific streams and stream segments. More detailed information concerning the description of the Planning Area can be found in appropriate listed references.

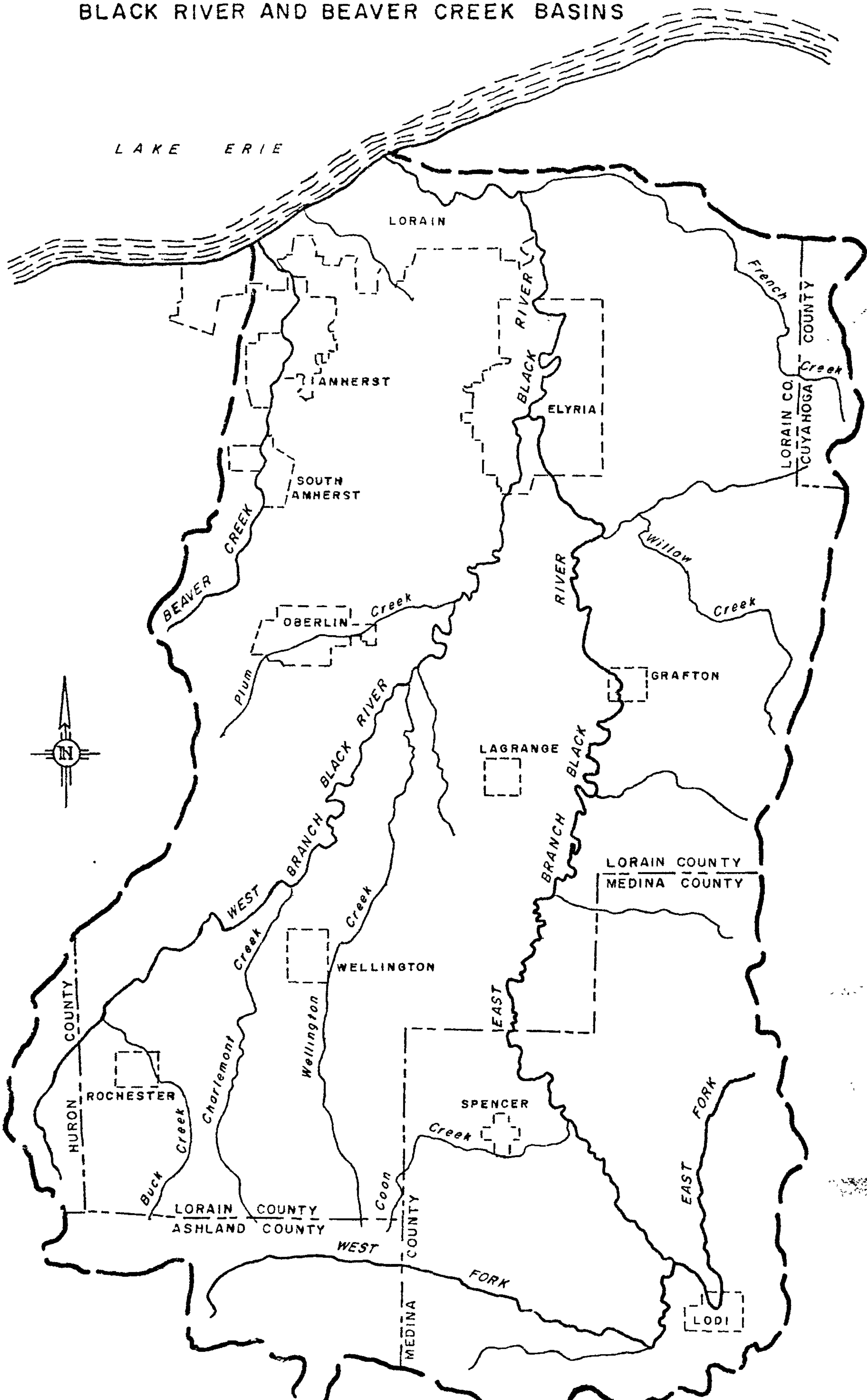
A. Geography[1,2,3]

The Black River and Beaver Creek basins are located in the north central part of Ohio and drain slightly in excess of 515 square miles or about 1.2 percent of the surface area of the State (Figure II-1). The Black River portion is primarily located within Lorain County with some parts of the basin also extending into Cuyahoga, Medina, Huron, and Ashland Counties. The Beaver Creek basin lies entirely within Lorain County (Figure V-1).

The general topography and character of the land surface is a result of glacial action during the Wisconsin and Illinoian periods. The surface is low and relatively flat with a gentle slope from the southern townships to the lake shore. However, a narrow valley has been cut by the Black River and the lake front in Avon Lake and Sheffield Lake is bordered by a cliff.

FIGURE V-I

BLACK RIVER PLANNING AREA
BLACK RIVER AND BEAVER CREEK BASINS



Black River

The origin of the Black River lies near the boundary between Sullivan and Troy townships in Ashland County. From that point the main stem, which includes the East Branch and West Fork, flows 78 miles to Lake Erie at Lorain. Two major tributaries are the West Branch and French Creek, forming confluences at river miles 15.4 and 5.1, respectively. The total drainage area of the basin is 467 square miles and the elevation of the stream ranges from 1138 feet above sea level at its source to 573 feet above sea level at its mouth, giving an average fall of 7.6 feet per mile. However, the river actually falls to the level of Lake Erie, 573 feet above sea level, at about river mile 6.5. Figure V-2 presents a more detailed view of the slope of the stream.

Beaver Creek

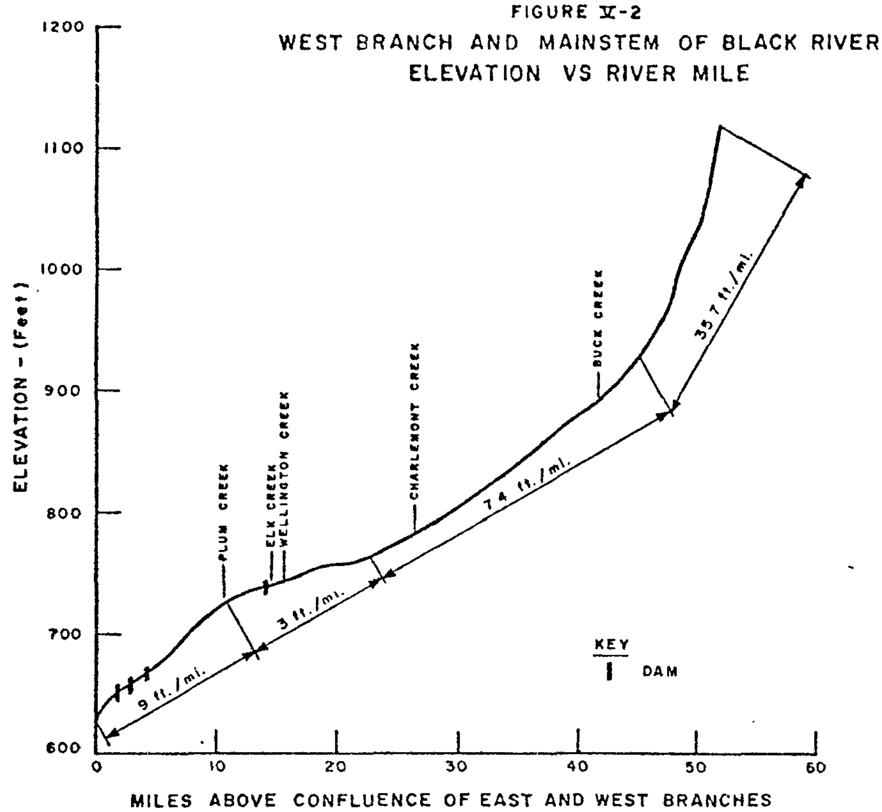
From its source in the extreme southwest corner of Russia township, Beaver Creek flows 12.2 miles to Lake Erie and drains a total area of 44 square miles. Its range in elevation is from 806 feet above sea level at the source to 573 feet at Lake Erie, giving an average fall of 19.1 feet per mile.

Martin Run, a small tributary to Lake Erie between Beaver Creek and the Black River drains 4 square miles. In addition, a few square miles of land along the lake shore drains directly to Lake Erie.

B. Geology[1,2,3]

The northern and western parts of Ohio are in the Glacial Plains division of the Central Lowlands province, and the southeastern part is in the Allegheny Plateau province. The boundary between these provinces is the northern edge of the Glaciated Plateau shown in Figure V-3. Figure V-3 also shows the principal physiographic subdivisions in the State. The Black River Planning Area includes three of these subdivisions; the Lake Plains,

FIGURE V-2
WEST BRANCH AND MAINSTEM OF BLACK RIVER
ELEVATION VS RIVER MILE



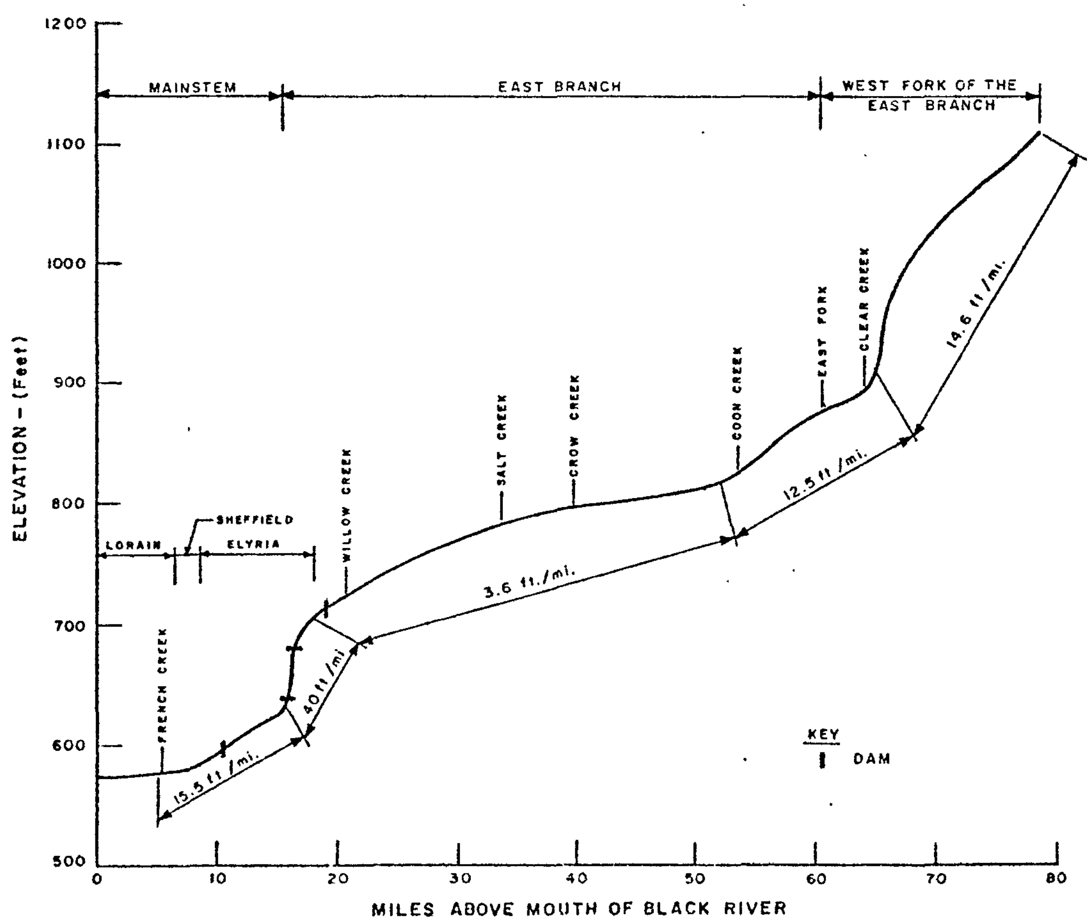
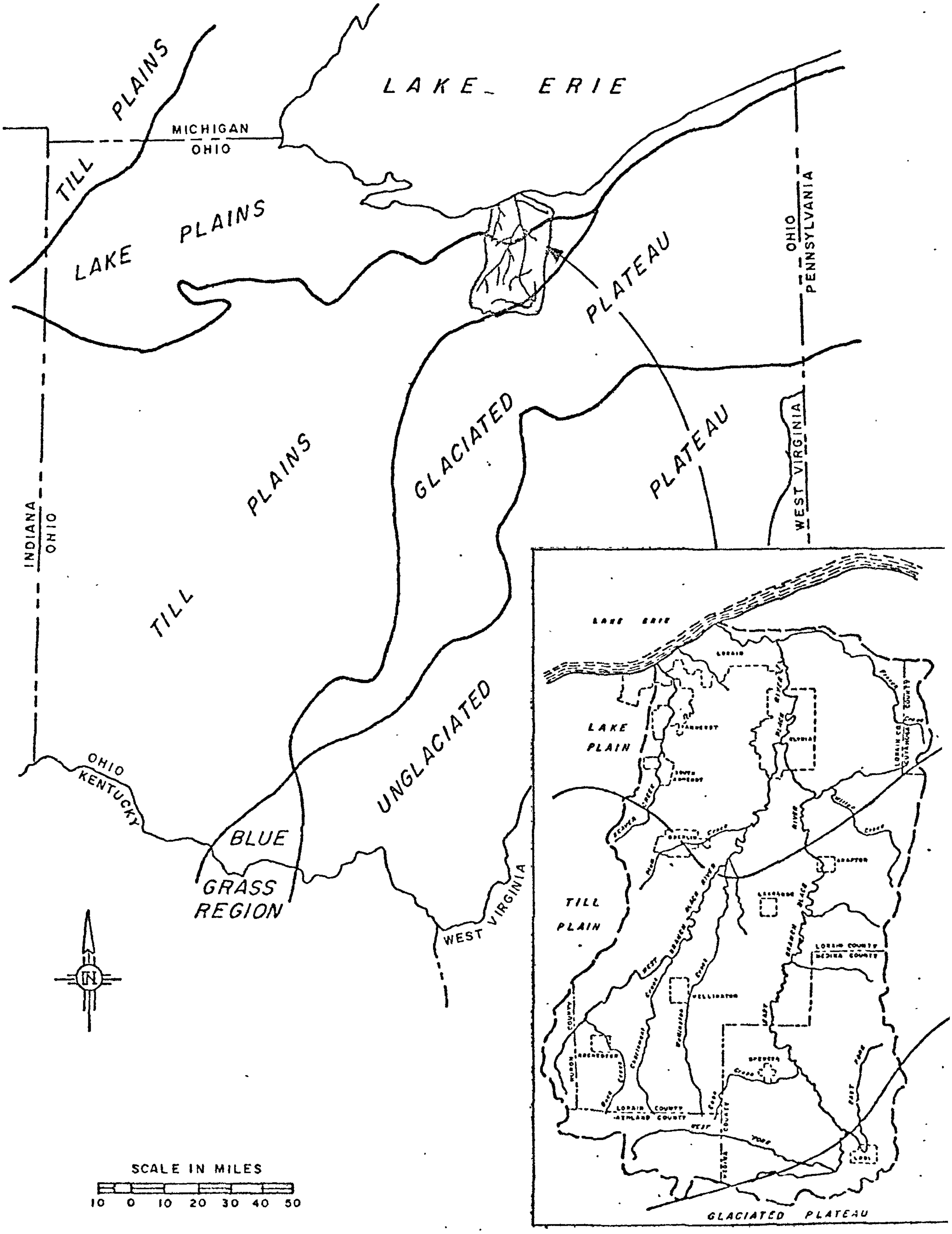


FIGURE V - 3
PHYSIOGRAPHY OF OHIO



PHYSIOGRAPHY OF BLACK RIVER
PLANNING AREA

the Till Plains, and the Glaciated Plateau. All of the regions have been glaciated, and the area is low and generally flat, with the exception of the Glaciated Plateau. The Lake Plains encompasses a fifteen mile narrow strip along the Lake Erie shoreline. The remainder of the Planning Area lies within the Till Plains, except for a few square miles along the southeastern edge which extend into the Glaciated Plateau.

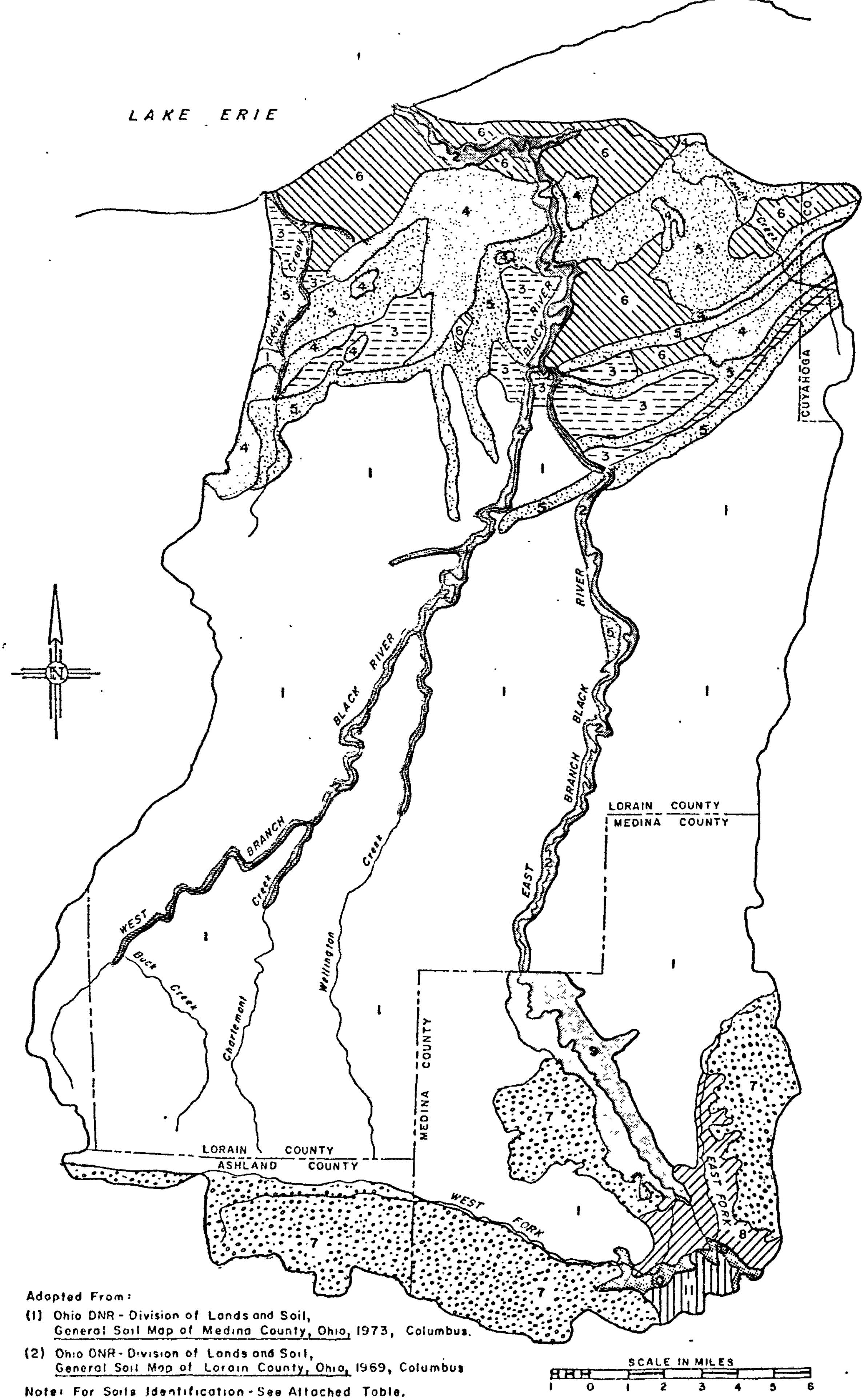
Bedrock formations consist of shale, sandstone, and limestone of the Devonian and Mississippian systems. Devonian rocks are prevalent in a narrow band along Lake Erie, while younger Mississippian formations are found under the Till Plains to the south. The soils overlying the bedrock are glacial deposits of the Wisconsin Age. These soils are thin and quite diversified as a result of glaciation, but generally, heavy clays predominate. Such clayish soils exhibit a small water storage capacity which, along with the low permeability of the bedrock, result in relatively low dry weather streamflows due to low groundwater storage. Figure V-4 is a soils association map and Figure V-5 is a groundwater availability map, both of which serve to illustrate the above. A more detailed description of the soils in the Planning Area can be found in References 1, 2, and 3.

C. Meteorology[4]

The Black River Planning Area has a climate which is marked by large annual, daily, and day-to-day variations in temperature. Summers are moderately warm and humid with a few days when temperatures exceed 90°F, whereas winters are moderately cold and cloudy with only a few days of subzero temperatures. As shown in Table V-1, the annual mean temperature for the area is about 51°F with monthly averages ranging from 28°F in January to 73°F in July.

Precipitation varies widely from year to year, but is normally abundant and well distributed with fall being the driest season. As shown in Table V-2, the mean annual precipitation is about 34.5 inches with the mean monthly precipitation varying from about 2.2 inches in December to 3.5 inches in April. Figure V-6 is an isohyetal map depicting the variation in mean annual precipitation from about 33 inches near Lake Erie to 36 inches in the southeastern section of the area. Table V-3 and Figures V-7 and V-8 present

FIGURE V-4
BLACK RIVER PLANNING AREA
SOILS ASSOCIATION MAP



Adopted From:

(1) Ohio DNR - Division of Lands and Soil, General Soil Map of Medina County, Ohio, 1973, Columbus.

(2) Ohio DNR - Division of Lands and Soil, General Soil Map of Lorain County, Ohio, 1969, Columbus

Note: For Soils Identification - See Attached Table.

FIGURE V-4

SOILS ASSOCIATION MAP KEY

1	MAHONING-ELLSWORTH, mostly nearly level to gently sloping, somewhat poorly, poorly, and moderately well drained soils of glacial till plains.
2	CHAGRIN-ORRVILLE-WAYLAND, nearly level, well, somewhat poorly, and poorly drained soils of stream first bottoms.
3	FITCHVILLE-LURAY-SEBRING, mostly nearly level to depressional, somewhat poorly, very poorly, and poorly drained soils on broad, glacial lake plain flats.
4	ALLIS-FRIES-MITIWANGA, mostly nearly level to depressional, somewhat poorly and poorly drained, shallow to shale or sandstone bedrock soils of the glacial lake plain.
5	HASKINS-JIMTOWN-(OSHTEMO), nearly level to sloping, somewhat poorly and well drained sandy and gravelly soils of beach ridges, glacial outwash plains, and stream terraces.
6	MAHONING-MINER, nearly level to depressional, somewhat poorly and poorly drained soils of the glacial lake and till plains.
7	BENNINGTON-CARDINGTON, nearly level to gently sloping, somewhat poorly drained and moderately well drained upland soils formed in silty clay loam or clay glacial till.
8	CARDINGTON-BENNINGTON, mostly gently sloping to moderately steep, moderately well and somewhat poorly drained upland soils formed in silty clay loam or clay loam glacial till.
9	HASKINS-CANEADEA-LOBDELL, nearly level to gently sloping, somewhat poorly drained and moderately well drained terrace and flood plain soils formed either in loamy material overlying clayey glacial lake-deposited sediments or clayey sediments and stream-deposited sediments.
10	FITCHVILLE-CHILI-BOGART, nearly level to sloping, somewhat poorly drained and well drained, mainly terrace soils formed either in silty, glacial lake-deposited sediments or loamy material overlying sand and gravel.
11	CARLISLE-LURAY-LORAIN, nearly level, very poorly drained organic and glacial lake bed soils formed either in thick layers of partly decomposed plants or silty and clayey glacial lake-deposited sediments.

FIGURE V-5

BLACK RIVER PLANNING AREA

UNDERGROUND WATER AVAILABILITY MAP

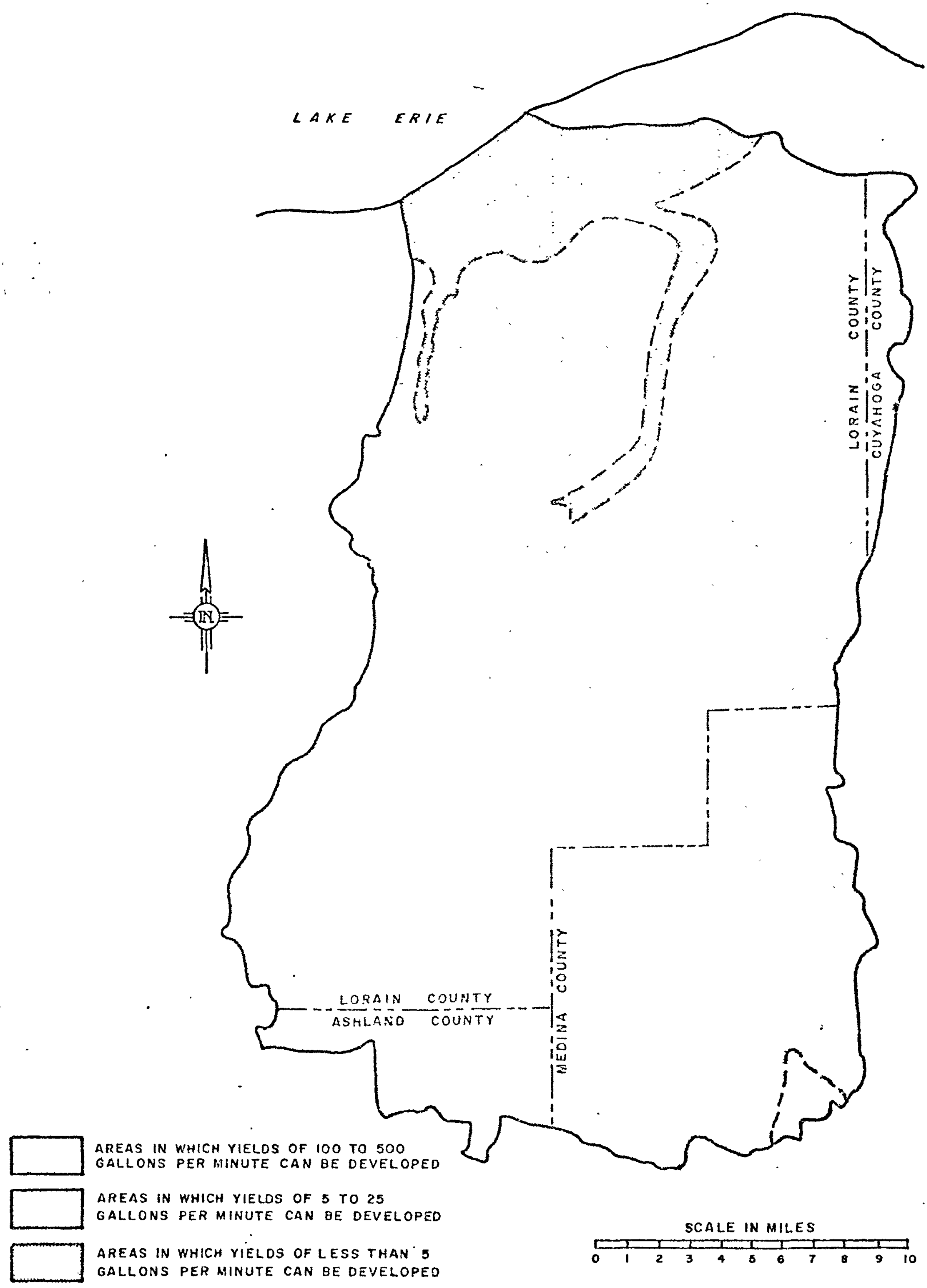


TABLE V-1

BLACK RIVER PLANNING AREA

Average temperature (^oF)

Location	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Cleveland (Airport)	28.4	28.5	35.1	47.0	58.0	67.8	71.9	70.4	64.2	53.4	41.3	30.5	49.5
Elyria*	27.3	29.2	35.9	48.5	59.4	68.6	72.3	70.6	64.8	54.2	41.8	30.3	50.2
Oberlin*	29.0	29.5	37.0	48.7	59.5	69.3	73.0	71.5	65.1	54.2	41.6	31.2	50.8
Upper Sandusky	29.1	30.2	38.3	49.9	60.9	70.7	74.2	72.6	65.8	54.5	41.3	31.1	51.6

TABLE V-2

BLACK RIVER PLANNING AREA

Average Precipitation (inches)

Location	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Cleveland (Airport)	2.67	2.33	3.13	3.39	3.52	3.43	3.31	3.38	2.90	2.42	2.61	2.34	35.35
Elyria*	2.68	2.29	2.94	3.71	3.06	3.15	2.69	3.57	2.84	2.54	2.84	2.25	34.56
Oberlin*	2.47	2.08	2.84	3.33	3.48	3.75	3.30	3.24	2.89	2.33	2.35	2.14	34.20
Upper Sandusky	2.73	2.23	3.18	3.26	3.52	4.33	3.39	3.05	2.79	2.26	2.49	2.18	35.41

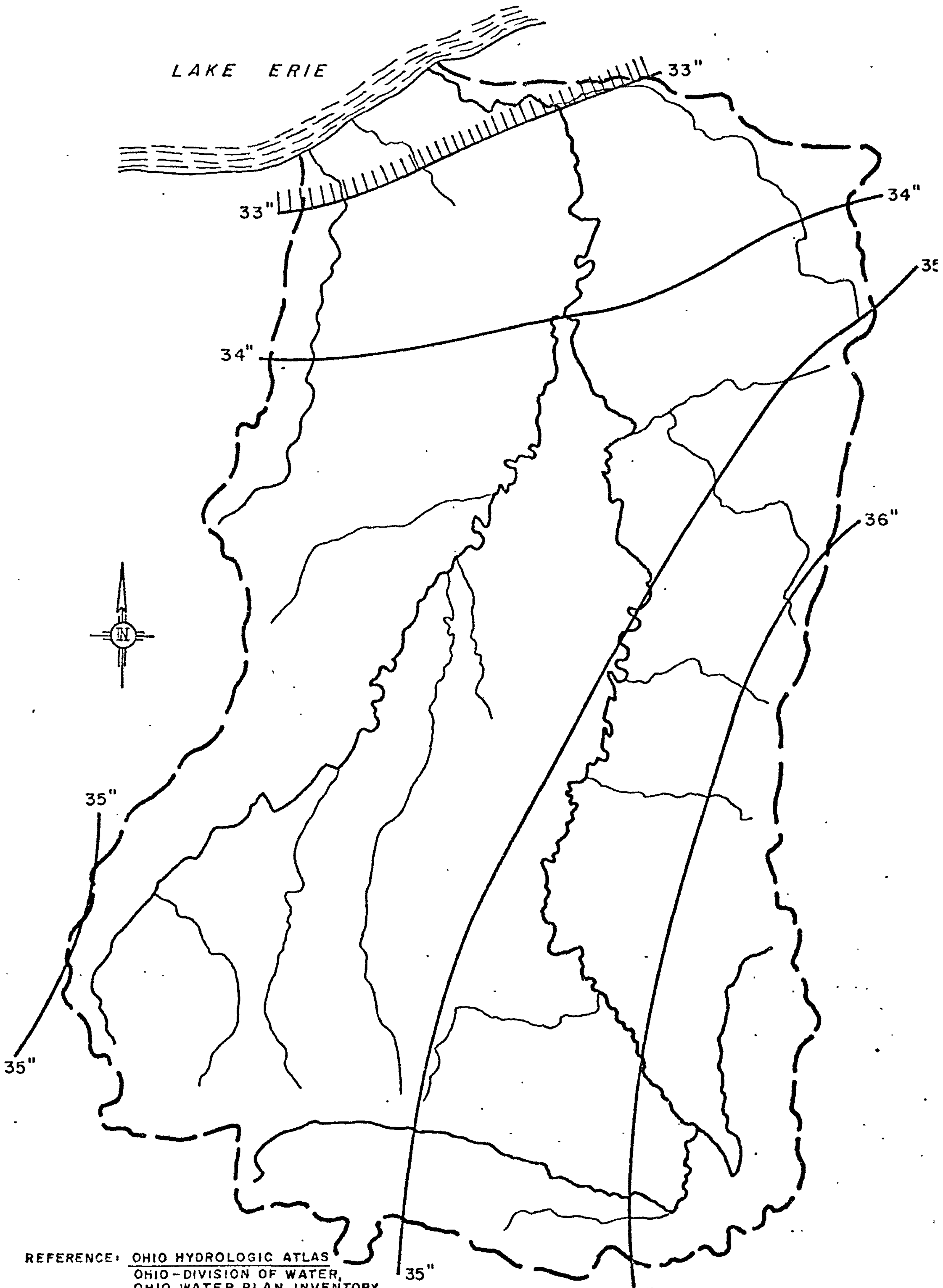
* These stations are in the planning area.

Reference: U. S. Department of Commerce, NOAA, "Climatological Data, Ohio", Annual Summary, Volume 78, No. 13, 1973.

FIGURE V-6

BLACK RIVER PLANNING AREA

ISOHYETAL MAP



REFERENCE: OHIO HYDROLOGIC ATLAS
OHIO - DIVISION OF WATER,
OHIO WATER PLAN INVENTORY
REPORT NO. 13, COLUMBUS, 1962

TABLE V-3

BLACK RIVER BASIN

MONTHLY MEAN PRECIPITATION PROBABILITY

Month	Probability greater than or equal to										
	0.05	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	0.95
January	0.62	0.87	1.24	1.58	1.92	2.27	2.67	3.15	3.77	4.76	5.69
February	0.83	1.05	1.36	1.63	1.88	2.14	2.42	2.74	3.16	3.80	4.40
March	1.17	1.45	1.85	2.19	2.51	2.83	3.18	3.59	4.10	4.89	5.60
April	1.61	1.93	2.38	2.74	3.09	3.43	3.80	4.23	4.76	5.57	6.31
May	1.45	1.77	2.23	2.60	2.94	3.29	3.68	4.12	4.67	5.51	6.27
June	1.43	1.78	2.27	2.67	3.06	3.45	3.88	4.38	5.00	5.97	6.84
July	1.21	1.52	1.97	2.34	2.70	3.06	3.46	3.92	4.50	5.40	6.22
August	1.35	1.65	2.07	2.42	2.74	3.08	3.43	3.85	4.37	5.16	5.88
September	0.95	1.21	1.59	1.91	2.21	2.52	2.86	3.27	3.77	4.56	5.29
October	0.48	0.71	1.06	1.38	1.70	2.05	2.45	2.93	3.56	4.56	5.51
November	0.90	1.14	1.47	1.76	2.04	2.32	2.63	2.98	3.43	4.14	4.78
December	0.74	0.96	1.26	1.52	1.77	2.02	2.30	2.62	3.04	3.69	4.28
Annual	25.77	27.64	30.03	31.84	33.44	34.98	36.58	38.33	40.46	43.52	46.15

Reference: Ohio Department of Natural Resources - Division of Water, Unpublished Data.

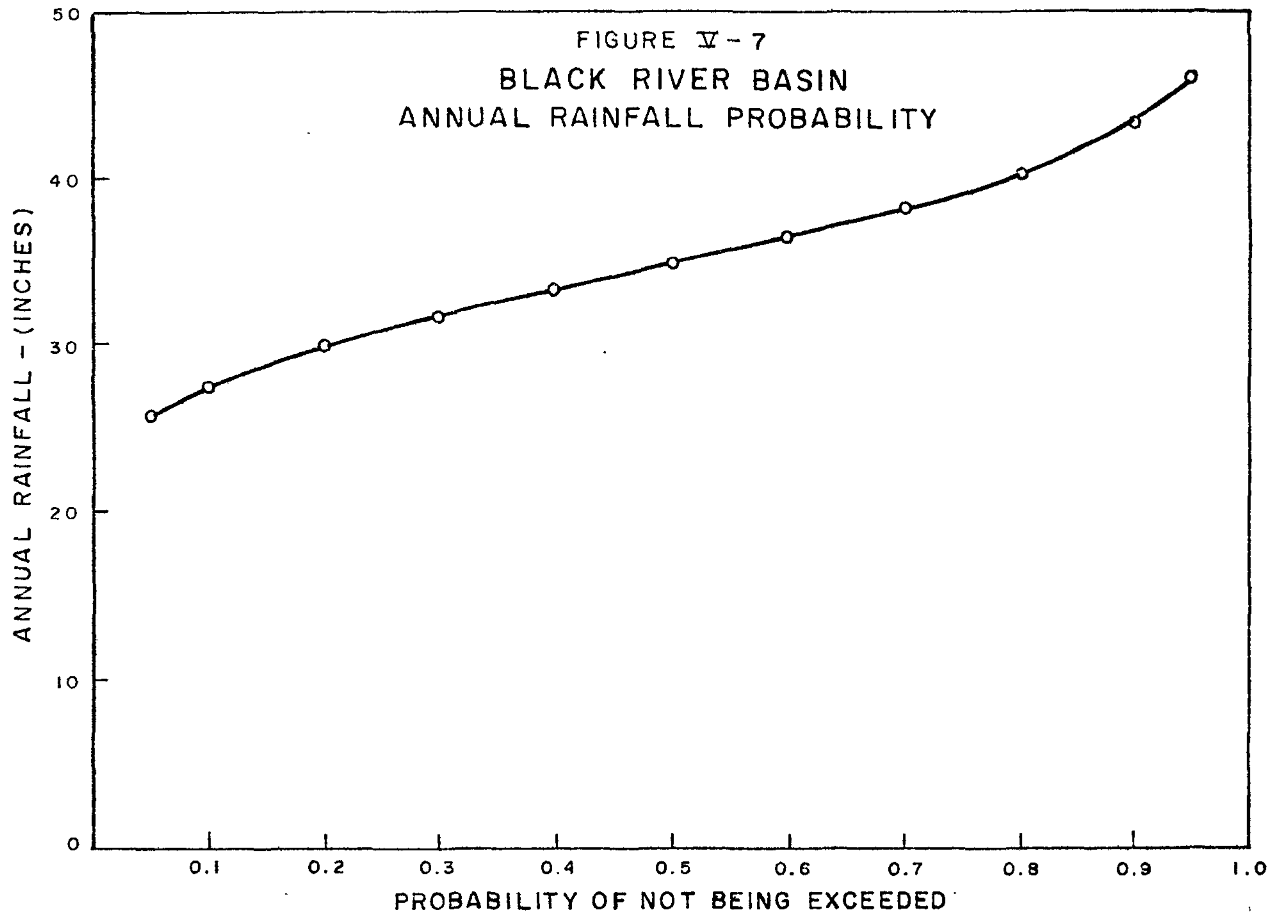


FIGURE V-7
BLACK RIVER BASIN
ANNUAL RAINFALL PROBABILITY
ANNUAL RAINFALL - (INCHES)
50
40
30
20
10
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
PROBABILITY OF NOT BEING EXCEEDED

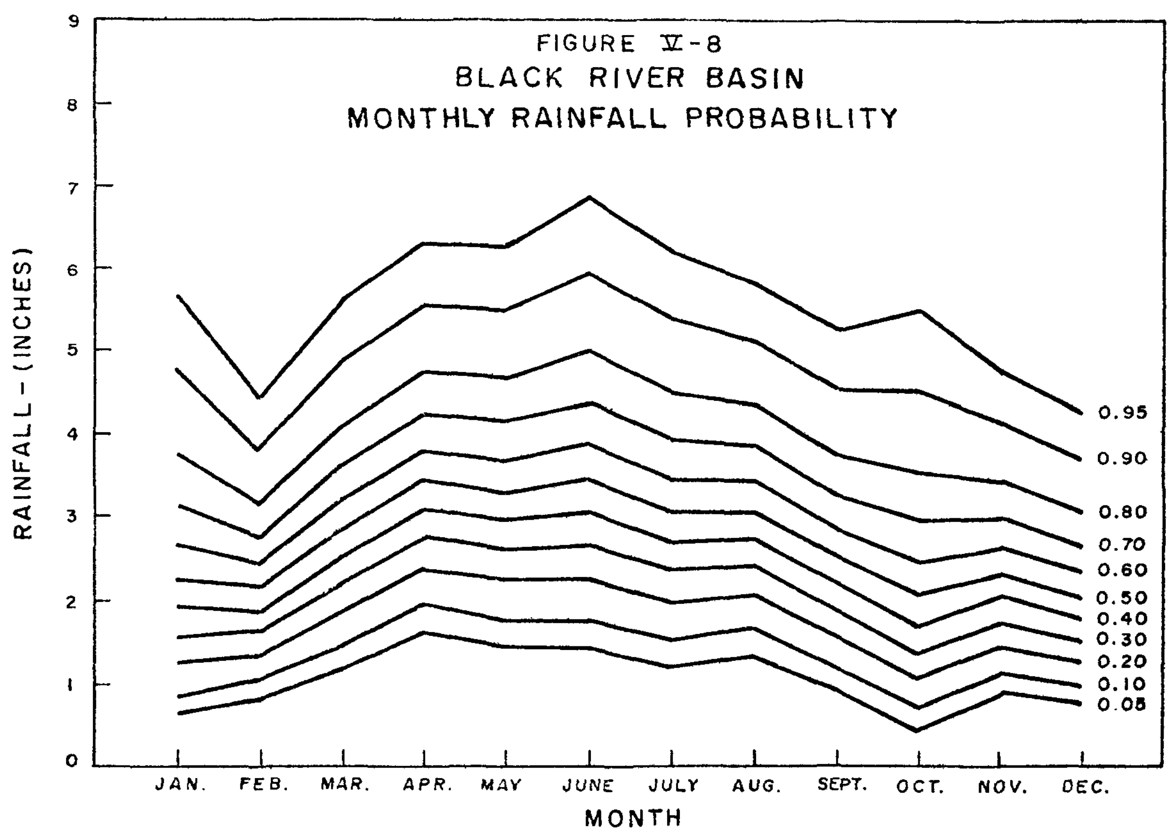


FIGURE V-8
BLACK RIVER BASIN
MONTHLY RAINFALL PROBABILITY
RAINFALL - (INCHES)
9
8
7
6
5
4
3
2
1
0
0.95
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.05
JAN.
FEB.
MAR.
APR.
MAY
JUNE
JULY
AUG.
SEPT.
OCT.
NOV.
DEC.
MONTH

the monthly and annual distribution of precipitation, respectively, demonstrating the seasonal variation in precipitation. The annual snowfall increases eastward across the Planning Area from 35 inches near the border with Erie and Huron counties to about 50 inches on the eastern edge near Cuyahoga County.

Table V-4 presents the average dates of killing frost, average annual snowfall, and average length of growing season for 5 stations in and around the Planning Area.

D. Land and Water Uses[5,6,7]

Table V-5 summarizes the land use within the four counties in the Black River and Beaver Creek basins. It is important to note that the basins include only small portions of Ashland, Huron, and Medina Counties. Land uses in these counties are primarily forest and farmland. Approximately 10 percent of the Planning Area is urban and developed area, 55 percent cropland, 10 percent pasture and rangeland, 15 percent forest, and 10 percent farmland and other nonfarmland.

Major recreational areas include the Lake Erie shoreline, Spencer Lake State Wildlife Area in Spencer, and Findlay State Park in Wellington, which provide for swimming, camping, boating, and fishing.

Existing public water supplies are listed in Table V-6 with projected public water withdrawals through 2006. To meet future water demands, the Northwest Ohio Water Development Plan recommended that Grafton, LaGrange, and Spencer obtain water by direct withdrawal from the East Branch of the Black River, Lodi obtain water from a storage reservoir constructed on the East Branch of the Black River, South Amherst and Eaton Estates obtain their water from Elyria, Oberlin obtain water by direct withdrawal from the West Branch of the Black River, Wellington construct another water supply reservoir, and Elyria and Lorain construct new Lake Erie pipelines. Several other plans were considered but were found unfeasible. Additional information can be found in Reference 5.

Table V-7 lists agricultural water withdrawal for all or part of the 4 counties included in the Planning Area. Current industrial water

TABLE V-4

CLIMATIC DATA FOR BLACK RIVER PLANNING AREA

Location	Dates of Killing Frost		Average Length Of Growing Season (days)	Avg. Annual Snowfall (inches)	Location	
	First	Last			Latitude	Longitude
Ashland	October 11	April 29	164	35.8	40°52'	82°18'
Cleveland	November 2	April 21	195	50.5	41°24'	81°51'
Elyria	October 16	May 3	166	42.5	41°23'	82°04'
Oberlin	October 11	May 7	157	37.4	41°18'	82°13'
Upper Sandusky	October 5	April 30	158	27.9	40°51'	83°17'

Reference: Climatic Guide for Selected Locations in Ohio, Ohio DNR - Division of Water, Columbus.

TABLE V-5

BLACK RIVER PLANNING AREA
LAND USE, 1967 (acres)

Land Use	Ashland County	%	Huron County	%	Lorain County	%	Medina County	%
Urban & Developed	16,208	6.0	18,225	5.7	47,300	15.0	19,598	7.3
Cropland	151,479	56.6	208,666	65.7	151,339	48.0	148,558	55.1
Pasture & Range	30,959	11.5	19,571	6.2	21,154	6.7	24,739	9.2
Forest	51,388	19.2	43,000	13.5	49,656	15.7	41,814	15.5
Other land in Farm	14,033	5.2	10,019	3.2	23,239	7.4	19,571	7.2
Other land not in Farm	3,097	1.1	18,131	5.2	22,712	7.2	15,326	5.7
Total	267,164		317,612		315,400		269,606	

Reference: Ohio-Soil and Water Conservation Needs Inventory, Ohio Soil and Water Conservation Needs Committee, Columbus, 1971.

TABLE V-6

BLACK RIVER PLANNING AREA
PUBLIC WATER SUPPLIES

Community	Present Water Source	1973 Consumption (mgd)	PROJECTED WITHDRAWAL (mgd)* 1976	1986	1996	2006
Elyria[(1)]	Lake Erie	13.83	17.63	24.21	32.05	40.70
Grafton	Reservoir & Willow Creek	0.25 (est.)	0.35	0.50	0.67	0.86
LaGrange	Quarry	0.08	0.12	0.18	0.26	0.35
Lodi	Wells	0.28	0.36	0.46	0.60	0.75
Lorain[(2)]	Lake Erie	14.0	15.69	20.36	25.53	31.29
Oberlin	Reservoir and W.Br. of Black R.	0.90	1.14	1.59	2.11	2.69
South Amherst	Quarry	0.095	0.16	0.26	0.39	0.55
Spencer	Coon Creek & Reservoir	0.07	0.06	0.08	0.11	0.15
Wellington	3 Reservoirs	0.43	0.55	0.78	1.04	1.34

[(1)] Also supplies Sheffield, North Ridgeville, Amherst, and parts of Carlisle and Elyria Townships.
[(2)] Also supplies part of Sheffield Lake.

References: 1973 Ohio EPA Water Treatment Plant Inventory.
Northwest Ohio Water Development Plan, Ohio Department of Natural Resources, Columbus, 1967.

TABLE V-7

BLACK RIVER PLANNING AREA
AGRICULTURAL WATER WITHDRAWAL (mgd)

County*	Farm & Suburban Homes	Farm Irrigation	Golf Course Irrigation	Greenhouse & Nursery Irrigation	Livestock
Ashland	0.166	-	-	-	0.131
Huron	0.666	0.135	0.044	0.021	0.517
Lorain	2.314	0.808	0.509	0.948	0.592
Medina	0.399	0.002	0.022	0.132	0.182

* Basins included

Ashland County - Black & Vermilion River Basins
Huron County - Black, Huron, Sandusky & Vermilion R. Basins
Lorain County - Black & Vermilion River & Beaver Cr. Basins
Medina County - Black River Basin

Reference: Northwest Ohio Water Development Plan, Ohio Department of Natural Resources, Columbus, 1967.

withdrawal is presented in Table V-8. Projected industrial water demand from municipal water systems in Lorain County are presented in Table V-9. Total water usage from all sources in the Planning Area is shown in Table V-10.

Lake Erie is the largest public raw water supply providing 27.8 mgd to Elyria and Lorain or about 93 percent of all water used by municipalities. Only one city, Lodi, uses groundwater as a supply, whereas the remaining municipalities use other surface waters. The Black River is the largest source of industrial water, supplying 173 mgd to the U.S. Steel - Lorain Works, American Shipbuilding, and Republic Steel with U.S. Steel using about 171 mgd. The Ohio Edison-Edgewater Generating Plant uses about 110 mgd of lake water primarily for cooling purposes. Groundwater supplies only a small portion of the needs of the Planning Area.

E. Demography[8]

According to the 1970 census, the population of the Black River Planning Area is approximately 250,000 people, or about 2.3 percent of the State's 1970 population. The population is geographically skewed toward the northern section of the basin with about 60 percent of the people residing in Lorain and Elyria. Table V-11 lists the major population centers and the percent change in population between 1960 and 1970. The population of communities in the basin increased between 3.2 and 77.1 percent, with Amherst, South Amherst, and North Ridgeville experiencing the largest gains. Table V-12 presents population projections to the year 2000 for the sewage service areas. The population of all service areas are projected to increase until 2000, except for Brentwood Lakes and Eaton Estates, where constant populations are expected.

Employment projections for Lorain County presented in Table V-13 show that the total employment and the unemployment rate in the county are expected to increase. Table V-14 lists the ten largest employers in the Planning Area and their current full production employment.

TABLE V-8

BLACK RIVER PLANNING AREA
INDUSTRIAL WATER USAGE

Discharger	Type of Industry	Location	Water Source	Receiving Stream	Water Usage (mgd)
Abex Corporation	Foundry	Elyria	Elyria	E. Br. of Black River	0.069
American Crucible Products Co.	Foundry	Lorain	Lorain	Lake Erie	0.015
American Ship Building Co.	Ship Building	Lorain	Black River	Black River	0.55
Ashland Oil Company	Oil Terminal	Lorain	Runoff, Lorain	Black River	0.001
Bendix Westinghouse Co.	Automotive Air Brake System Mfg.	Elyria	Elyria	Black River	0.021
Buckeye Molding	Plastics Fabrication	Elyria	Elyria	E. Br. of Black River	0.14
Cleveland Steel Products	Steel Fabrication	Wellington	Wellington	Charlemont Creek	0.1
Diamond Products	Machine Shop	Elyria	Elyria	E. Br. of Black River	0.002
Dreco Inc.	Plastics Fabrication	North Ridgeville	Elyria	French Creek	0.03
Elyria Water Treatment Plant	Water Treatment	Lorain	Lake Erie	Lake Erie	13.8
Emtec Manufacturing	Spring Manufacture	Elyria	Elyria	E. Br. of Black River	0.04
General Industries	Plastics and Electric Motors	Elyria	Elyria	E. Br. of Black River	0.1
GMC-Fisher Body	Automobile Manufacture	Elyria	Elyria	W. Br. of Black River	2.0

TABLE V-8 (Cont'd)

BLACK RIVER PLANNING AREA
INDUSTRIAL WATER USAGE

Discharger	Type of Industry	Location	Water Source	Receiving Stream	Water Usage (mgd)
Grafton Water Treatment Plant	Water Treatment	Grafton	Reservoir, Willow Creek	W. Br. of Black River	0.22
Harris Tire Service	Tire Manufacture	Lodi	Lodi	E. Br. of Black River	0.025
Harshaw Chemical Co.	Chemical Manufacture	Elyria	Elyria	E. Br. of Black River	0.7
Invacare Corporation	Wheelchair Manufacture	Carlisle Township	Elyria	W. Br. of Black River	0.06
Koehring Plant #1	Machinery Production	Lorain	Lorain	Black River	0.05
Koehring Plants #3 and 5	Parts Warehouse	Elyria	Elyria	E. Br. of Black River	0.02
Lake Erie Plastics Co.	Plastics Fabrication	Elyria	Elyria	E. Br. of Black River	0.0013
Lear Siegler Co.	Pump Manufacture	Elyria	Elyria	E. Br. of Black River	0.023
Lodi Water Treatment Plant	Water Treatment	Lodi	Wells	E. Br. of Black River	0.28
Lorain Elyria Sand Co.	Sand and Gravel Processing	Lorain	Black River, Lorain	Black River	0.25

TABLE V-8 (Cont'd)

BLACK RIVER PLANNING AREA
INDUSTRIAL WATER USAGE

Discharger	Type of Industry	Location	Water Source	Receiving Stream	Water Usage (mgd)
Lorain Water Treatment Plant	Water Treatment	Lorain	Lake Erie	Lake Erie	14.0
Nelson Stud Welding	Metal Fastener Manufacture	Elyria	Elyria	Beaver Creek	0.03
Oberlin Water Treatment Plant	Water Treatment	Oberlin	Reservoir	W. Br. of Black River	0.09
Obitts Chemical Company	Solvent Recovery	Elyria	Elyria	E. Br. of Black River	0.03
Ohio Edison - Edgewater Plant	Power Production	Lorain	Lorain, Lake Erie	Lake Erie	110.0
Ohio Metallurgical Service Inc.	Steel Heat Treating	Elyria	Elyria	E. Br. of Black River	0.0002
Ohio Screw Product Company	Screw Production	Elyria	Elyria	E. Br. of Black River	0.004
Pfaudler Company	Chemical Equipment Manufacture	Elyria	Elyria	E. Br. of Black River	0.03
Republic Steel	Steel Pipe & Tube Manufacture	Elyria	West Branch - Black R., Elyria	W. Br. of Black River	1.3
Servisteel Corporation	Machine Shop	Sheffield	Lorain	French Creek	0.001
Sohio-Lorain County Terminal	Oil Terminal	Eaton Township	Runoff, wells	Bannister Ditch	0.002
Spencer Water Treatment Plant	Water Treatment	Spencer	Coon Creek, Reservoir	Coon Creek	0.05

TABLE V-8 (Concl'd)

BLACK RIVER PLANNING AREA
INDUSTRIAL WATER USAGE

Discharger	Type of Industry	Location	Water Source	Receiving Stream	Water Usage (mgd)
Stanadyne - Western Division	Steel Fabrication	Elyria	Elyria	Black River	0.68
Standard Pipe Protection	Steel Fabrication	Lorain	Lorain	Black River	0.016
Sterling Foundry	Foundry	Wellington	Wellington	Charlemont Creek	0.014
Tappan, Inc.	Heating & Air Conditioning Units Manufacture	Elyria	Elyria	W. Br. of Black River	0.062
U. S. Steel	Steel Production	Lorain	Black River, Lorain	Black River	171.
Wellington Water Treatment Plant	Water Treatment	Wellington	3 Reservoirs	Charlemont Creek	0.43

TABLE V-9

LORAIN COUNTY
PROJECTED INDUSTRIAL WATER DEMAND (1)
(mgd)

City	1978	1990
Elyria (2)	5.9	8.8
Grafton	0.4	0.72
LaGrange	0.19	0.39
Lorain	6.9	8.6
Oberlin	1.31	1.97
South Amherst	0.63	1.01
Wellington	0.7	1.17

Notes: (1) Includes only water obtained from municipal systems.
(2) Including Elyria, Amherst, North Ridgeville, Sheffield, and parts of Carlisle & Elyria Township.

Reference: Water and Sewer Study for Lorain County, Kleinoeder-Schmidt and Associates, Woodruff Inc., Cleveland, 1974.

TABLE V-10

BLACK RIVER PLANNING AREA
1973 WATER USAGE ESTIMATES

Use	Lake Erie	Other Surface Waters	Municipal	Wells
Municipal	27.8	1.8	-	0.4
Industrial	110.2	173	10.8	-
Agriculture	-	-	-	3.1
Other	-	0.1	19.2	2.7
Total	138.0	174.9	30	6.2

References:
1. Water and Sewer Study for Lorain County, Kleinoeder-Schmidt and Associates, Woodruff Inc., Cleveland, 1974.
2. 1973 Ohio EPA Water Treatment Plant Inventory
3. Northwest Ohio Water Development Plans, Ohio Department of Natural Resources, Columbus, 1967.

TABLE V-11

BLACK RIVER PLANNING AREA
MAJOR POPULATION CENTERS

	1960	1970	% Change (1960-1970)
Lorain County			
Amherst	6750	9818	+45.5
Avon	6002	7137	+18.9
Eaton	5886	6430	+9.2
Elyria	43782	53359	+21.9
Grafton	1683	1766	+4.9
Lagrange	1007	1066	+5.9
Lorain	68932	76733	+11.3
North Ridgeville	8057	13142	+63.1
Oberlin	8198	8686	+6.0
Sheffield	1664	1806	+8.5
South Amherst	1657	2934	+77.1
Wellington	3599	4101	+14.0
Medina County			
Lodi	2313	2387	+3.2

Source: Ohio Department of Natural Resources, Northeast Ohio Water Development Plan, Columbus, November 1972

Table V-12

Population Projections by
Sewage Service Area

Service Area	Population (Estimated) 1980	1985	1990	1995	2000
Lorain County					
Avon STP	(Shown into French Creek 1980)				
Brentwood Lakes Estates	750	750	750	750	750
Eaton Homes Estates	1,920	1,920	1,920	1,920	1,920
Elyria STP	60,700	67,400	75,800	81,600	88,400
French Creek STP	32,600	38,900	43,300	46,600	49,300
Grafton STP	1,970	2,100	2,230	2,390	2,550
LaGrange STP	1,200	1,300	1,390	1,490	1,600
Lorain STP	104,000	113,000	122,000	130,000	118,000
North Ridgeville	(Shown into French Creek 1980)				
Oberlin STP	11,000	12,000	13,000	14,000	15,000
Wellington STP	4,660	5,130	5,620	6,060	6,520
Medina County					
Lodi STP	3,150	4,000	4,000	5,250	5,850
Spencer STP	1,200	1,550	1,800	2,000	2,250

Reference:

Northeast Ohio Areawide Coordinating Agency, Water Quality Program, Sewage Treatment Plant Load and Flow Projections, Technical Appendix A34, August 1978, revised November 1979.

TABLE V-13

LORAIN COUNTY - EMPLOYMENT PROJECTIONS
(1975-2000)

Industry	1975	1980	1985	1990	1995	2000
Metals Industry	15,718	16,115	16,031	16,094	16,114	16,328
Transportation Equipment	12,721	13,632	13,894	14,025	14,418	14,418
Machinery	5,844	6,830	7,463	8,156	8,598	9,037
Chemicals	2,275	2,630	2,887	3,112	3,112	3,112
Other Manufacturing	7,337	7,401	7,728	8,027	8,320	8,519
Transportation, Communication & Utilities	5,874	6,411	6,860	7,276	7,641	7,910
Trade	17,706	19,379	21,021	22,569	23,887	24,857
Financial, Insurance & Real Estate	2,911	3,185	3,455	3,711	3,927	4,086
Business, Repair & Personal Services	5,547	6,065	6,557	7,020	7,415	7,705
Entertainment	722	790	857	921	974	1,014
Professional & Related Services	16,131	17,650	19,132	20,528	21,716	22,591
Public Administration	3,349	3,665	3,975	4,268	4,517	4,701
Agriculture, Farming and Fishing	1,532	1,321	969	740	528	352
Mining	169	179	179	180	173	166
Construction	4,802	5,597	5,597	5,928	6,219	6,434
Total Employment	102,637	110,492	116,606	122,592	127,591	131,231
Unemployment Rate (%)	5.85	6.08	6.70	6.86	7.26	7.74

Reference: Unpublished Data, Ohio Department of Economic and Community Development.

TABLE V-14

BLACK RIVER PLANNING AREA
TEN LARGEST EMPLOYERS

Industry	Activity	Location	Employment Full Production
U. S. Steel - Lorain Works	Steel Production	Lorain	8500
Ford Motor Co.	Auto Manufacture	Lorain	7869
GMC - Fisher Body	Auto Manufacture	Elyria	2700
Bendix Westing-house	Automotive Air Brakes Manufacture	Elyria	1600
Ridge Tool	Tool Manufacture	Elyria	1425
Lorain Products	Electrical Equipment Manufacture	Lorain	1250
Stanadyne - Western	Steel Fabrication	Elyria	1100
American Shipbuilding	Ship Production and Repair	Lorain	960
Tappan Inc.	Heating and Air Conditioning Unit Production	Elyria	856
Luxaire	Rubber Product Fabrication	Elyria	726

Reference: Elyria and Lorain Chambers of Commerce

F. Economy

The economy of the Black River Planning Area is quite diverse with industrial activity predominating in Elyria and Lorain and agricultural activity predominating throughout the remainder of the basin. Major industries include the manufacture of steel and steel products, various inorganic chemicals, and automobile assembly, shipbuilding, and power production. Important natural resources include sandstone and natural gas. The numbers of various types of industries for Lorain County in 1973 are listed in Table V-15.

There is one port facility located in Lorain serving mainly as a shipping and receiving facility for U.S. Steel-Lorain Works, American Shipbuilding, and as a coal shipping terminal.

G. Location of Point Source Dischargers

Figure V-9 illustrates the distribution of known point source dischargers in the Black River Planning Area. Tables V-16 through V-20 provide discharger NPDES permit numbers, receiving stream and flow rates. Altogether there are 114 public and semi-public sewage treatment plant dischargers, 38 industrial facilities, and 7 water treatment plants in the planning area. Of the industrial dischargers, about two-thirds (24) are located in the city limits of Elyria or Lorain and most discharge to the mainstem of the Black River. The remaining industrial facilities are uniformly distributed throughout the area. As noted earlier, the United States Steel Corporation - Lorain Works is the most significant industrial discharger in the area with a total effluent flow of 171 MGD.

Public and semi-public sewage treatment plants comprise most of the dischargers in the basin. Out of the 114 treatment plants, most facilities are small with an effluent flow of less than 1 MGD. Only the Elyria (6.2 MGD), Lorain (14.2 MGD) and French Creek Council of Governments (7.5 MGD) sewage treatment plants have a flow exceeding 1 MGD with the effluent flow at Wellington and Amherst STP approximately equal to 1 MGD. The smaller sewage treatment plants typically serve individual facilities

TABLE V-15

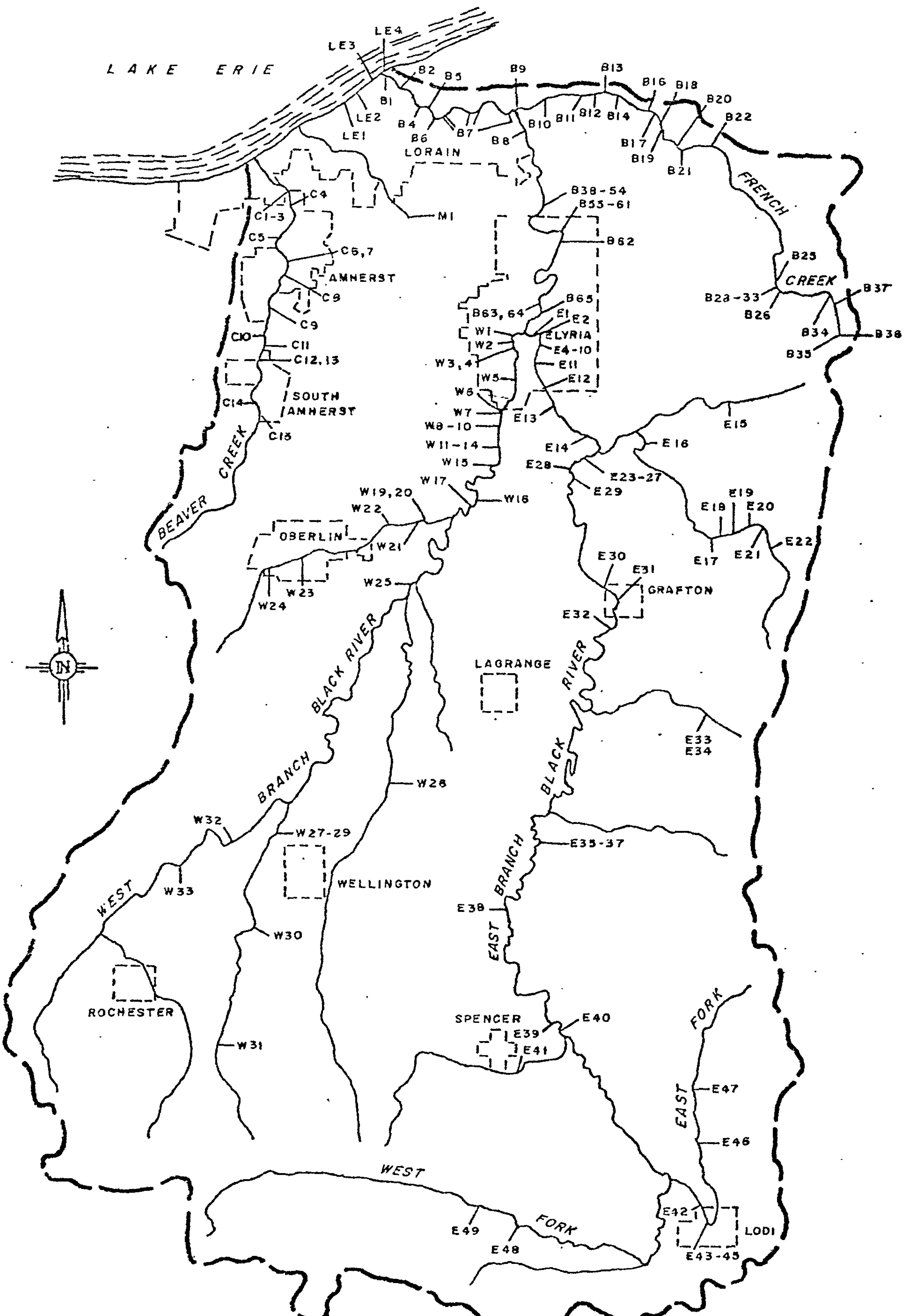
MANUFACTURING FIRMS IN LORAIN COUNTY

Rank	Industrial Classification	No. of Firms (1973)
1	Fabricated Metals	78
2	Nonelectrical Machinery	56
3	Printing and Publishing	26
4	Primary Metal Industries	21
5	Rubber and Plastics	20
6	Stone, Clay, and Glass	20
7	Electrical Machinery	17
8	Transportation Equipment	16
9	Food and Kindred Products	15
10	Miscellaneous Manufacturing	15
11	Chemicals and Allied Products	14
12	Instruments & Related	6
13	Furniture and Fixtures	5
14	Petroleum and Coal	4
15	Lumber and Wood	4
16	Apparel and Related	3
17	Paper and Allied Products	1
Total		321

Reference: Manufacturing and Employment Characteristics, Lorain County Economic Series No. 2, Lorain County Regional Planning Commission, Elyria, 1974.

FIGURE V-9

BLACK RIVER PLANNING AREA DISCHARGER LOCATION MAP



NOTE: REFER TO TABLES V-15 TO V-19 FOR DISCHARGER IDENTIFICATION AND APPENDIX I FOR MORE DETAILED LOCATION MAPS

TABLE V-16
BLACK RIVER PLANNING AREA
DISCHARGERS TO LAKE ERIE
AND MINOR TRIBUTARIES

DISCHARGER	NPDES PERMIT NO.	OEPA PERMIT NO.	RECEIVING STREAM	WATER SOURCE	MILES FROM MAIN STEM	MILE POINT MAIN STEM	FLOW (MGD)
1 Elyria Water Treatment Plant Lorain	OH 0042030	V309*0AD	Lake Erie	Lake Erie	-	-	0.08
2 American Crucible Products Lorain			Lake Erie	Lorain	-	-	0.01
3 Lorain Water Treatment Plant Lorain	OH 002259	V311*0AD	Lake Erie	Lake Erie	-	-	0.14
4 Ohio Edison - Edgewater Plant Lorain	OH 0051306	B305*AD	Lake Erie	Lake Erie	-	-	117
Cresthaven Subdivision STP	OH 002613	G851*AD	Martin Run	Elyria	-	6.2	0.03
Avon STP Avon	OH 0023965	A800*AD	Powdermaker ditch	Lorain		3.3	0.09

TABLE V-17
BLACK RIVER PLANNING AREA
BLACK RIVER DISCHARGERS

	DISCHARGER	NPDES PERMIT NO.	OEPA PERMIT NO.	RECEIVING STREAM	WATER SOURCE	MILES FROM MAIN STEM	MILE POINT MAIN STEM	FLOW (MGD)
B1	Lorain STP Lorain	OH 0026093	E805*AD	Black River	Lake Erie	-	0.2	14.3
B2	American Ship Building Co. Lorain	OH 0002356	N369*AD	Black River	Black River	-	0.7	0.5
B4	Lorain-Elyria Sand Co. Lorain			Black River	Black River	-	1.3	0.5
B5	Ashland Oil Terminal Lorain	OH 0051497	G305*AD	Black River	Runoff, Lorain	-	1.7	*
B6	Koehring Co., Plant #1 Lorain	OH 0001929	S318*AD	Black River	Lorain	-	1.9	0.003
B7a	U.S. Steel - Lorain Wks. Outfall 004, Lorain		D328*AD	Black River	Black River	-	2.56	22
B7b	U.S. Steel - Lorain Wks. Outfall 003, Lorain		D328*AD	Black River	Black River	-	2.63	68
B7c	U.S. Steel - Lorain Wks. Outfall 002, Lorain		D328*AD	Black River	Black River	-	3.5	27
B7d	U.S. Steel - Lorain Wks Outfall 005, Lorain		D328*AD	Black River	Black River	-	3.92	3
B7e	U.S. Steel - Lorain Wks. Outfall 001, Lorain		D328*AD	Black River	Black River	-	5.0	51
B8	Standard Pipe Protection Lorain	OH 0051675	Q320*AD	Black River	Lorain	-	6.0	0.016
B9	Barr School Sheffield			French Creek	Lorain	0.1	5.1	0.0045
B10	Servisteel Corp. Sheffield	OH 0051845	C313*AD	Unnamed tributary to French Creek	Lorain	2.0	5.1	0.0015

* Flow is variable.

TABLE V-17
(continued)
BLACK RIVER PLANNING AREA
BLACK RIVER DISCHARGERS

DISCHARGER	NPDES PERMIT NO.	OEPA PERMIT NO.	RECEIVING STREAM	WATER SOURCE	MILES FROM MAIN STEM	MILE POINT MAIN STEM	FLOW (MGD)
311 Brookside High School Sheffield			French Creek	Lorain	2.0	5.1	0.025
312 Schmidt's Other Hayseed Sheffield			French Creek	Lorain	3.3	5.1	0.007
313 Camp Wahoo Sheffield			French Creek	Lorain	3.4	5.1	0.0049
314 French Creek Council of Govts. STP Sheffield			French Creek	Lorain	3.5	5.1	7.5 (design)
316 Our Lady of Wayside Inn Avon			French Creek	Lorain	5.7	5.1	0.005
317 Avon Oaks Nursing Home Avon			French Creek	Lorain	5.8	5.1	0.0235
318 Meyerhaufer Apts. Avon			French Creek	Lorain	6.0	5.1	0.0015
319 French Creek Tavern Avon			French Creek	Lorain	6.1	5.1	0.004
320 Avon Professional Bldg Avon			French Creek	Lorain	6.2	5.1	0.0015
321 Tom's County Club Avon			French Creek	Lorain	6.9	5.1	0.006
322 Avon High School Avon			French Creek	Lorain	7.1	5.1	0.011
325 St. Peter's Church and School North Ridgeville			French Creek	Elyria	12.7	5.1	0.006

* Flow is variable.

TABLE V-17
(continued)
BLACK RIVER PLANNING AREA
BLACK RIVER DISCHARGERS

DISCHARGER	NPDES PERMIT NO.	OEPA PERMIT NO.	RECEIVING STREAM	WATER SOURCE	MILES FROM MAIN STEM	MILE POINT MAIN STEM	FLOW (MGD)
26 Ridgewood Motor Court North Ridgeville			French Creek	Elyria	13.1	5.1	0.0125
28 Dreco Plastics North Ridgeville	OH 0051616	Q318*AD	Unnamed tributary to French Creek	Elyria	14.1	5.1	0.02
29 First Congregational United Church North Ridgeville			Unnamed tributary to French Creek	Elyria	14.4	5.1	0.0007
30 Fields Elementary School Fields			Unnamed tributary to French Creek	Elyria	14.9	5.1	0.007
31 Autorama Drive-in North Ridgeville			Unnamed tributary to French Creek	Elyria	15.0	5.1	0.007
32 Fields United Methodist Church North Ridgeville			Unnamed tributary to French Creek	Elyria	15.1	5.1	0.0025
33 Good Samaritan Nursing Home North Ridgeville		R800*AD	Unnamed tributary to French Creek	Elyria	15.1	5.1	0.0235
34 Chestnut Ridge Estates STP North Ridgeville	OH 0043435	A814*AD	Unnamed tributary to French Creek	Elyria	15.1	5.1	0.022
35 Howard Johnson's Restaurant North Ridgeville			Unnamed tributary to French Creek	Elyria	15.6	5.1	0.015
36 Ohio Manor Motel North Ridgeville			Unnamed tributary to French Creek	Elyria	15.6	5.1	0.0011
37 Gibson Mobile Home Park North Ridgeville			Unnamed tributary to French Creek	Elyria	16.2	5.1	0.003
38 Owen's Oil Service Station Sheffield			Storm sewer	Lorain	0.8	8.3	0.0015
39 Mary's House of Many Flavors Ice Cream Shop, Sheffield			Storm sewer	Lorain	0.2	8.3	0.0005

Flow is variable.

TABLE V-17
(continued)
BLACK RIVER PLANNING AREA
BLACK RIVER DISCHARGERS

	DISCHARGER	NPDES PERMIT NO.	OEPA PERMIT NO.	RECEIVING STREAM	WATER SOURCE	MILES FROM MAIN STEM	MILE POINT MAIN STEM	FLOW (MGD)
340	Heisler's Truck Co. Sheffield			Storm sewer	Lorain	1.2	8.3	0.0015
341	Perkins Restaurant Sheffield			Storm sewer	Lorain	1.3	8.3	0.009
342	Manners Big Boy Restaurant Sheffield			Storm sewer	Lorain	1.3	8.3	0.01
343	St. Vincent de Paul Church Sheffield			Storm sewer	Lorain	1.3	8.3	0.0043
B44	Tudy's Restaurant Sheffield			Storm sewer	Lorain	1.9	8.3	0.006
B45	Clark Oil Service Station Sheffield			Storm sewer	Lorain	2.0	8.3	0.0015
B46	Pick-N-Pau Supermarket Sheffield			Storm sewer	Lorain	2.2	8.3	0.005
B47	McDonald's Restaurant Sheffield			Storm sewer	Lorain	2.4	8.3	0.0056
B48	Iski's Sunoco Service Station Sheffield			Storm sewer	Lorain	2.8	8.3	0.0015
B49	Sheffield Shopping Center STP Sheffield			Storm sewer	Lorain	2.8	8.3	0.05
B50	Central Security National Bank of Lorain County, Sheffield			Storm sewer	Lorain	2.8	8.3	0.0028
B51	Horizon Apartments Sheffield		S800*AD	Storm sewer	Lorain	2.8	8.3	0.085
B52	St. Peter and Paul Church Sheffield			Storm sewer	Lorain	2.8	8.3	0.002

* Flow is variable.

TABLE V-17
(continued)
BLACK RIVER PLANNING AREA
BLACK RIVER DISCHARGERS

	DISCHARGER	NPDES PERMIT NO.	OEPA PERMIT NO.	RECEIVING STREAM	WATER SOURCE	MILES FROM MAIN STEM	MILE POINT MAIN STEM	FLOW (MGD)
B53	Broadway Assembly Sheffield			Storm sewer	Lorain	3.3	8.3	0.0075
B54	Clearview and Durling Schools Sheffield	OH 0043648	T812*AD	Storm sewer	Lorain	3.9	8.3	0.0273
B55	Center Ridge Medical Building North Ridgeville			Ridgeway Ditch	Elyria	4.4	10.1	0.0025
B56	Rae Apartments North Ridgeville			Ridgeway Ditch	Elyria	4.4	10.1	0.006
B57	Kalt Manufacturing North Ridgeville	OH 0051802	S379*AD	Ridgeway Ditch	Elyria	4.5	10.1	0.001
B58	Ridgeview Shopping Center STP North Ridgeville		R862*AD	Ridgeway Ditch	Elyria	4.5	10.1	0.035
B59	Beckett Corp. North Ridgeville			Ridgeway Ditch	Elyria	4.8	10.1	0.004
B60	Lake Ridge Academy North Ridgeville			Ridgeway Ditch	Elyria	5.3	10.1	0.004
B61	Crestview Knolls STP North Ridgeville	OH 0043451	A815*AD	Ridgeway Ditch	Elyria	6.1	10.1	0.025
B62	Elyria STP Elyria	OH 0025003	D834*AD	Black River	Lake Erie	-	10.4	6.2
B63	Lake Erie Plastics Elyria			Storm sewer	Elyria	1.4	13.0	0.002
B64	Stanadyne - Western Division Elyria	OH 0000426		Strom sewer	Elyria	1.9	13.0	0.49
B65	Bendix Westinghouse Elyria	OH 0001261	C365*AD	Storm sewer	Elyria	2.3	13.1	0.006

* Flow is variable.

TABLE V-18
BLACK RIVER PLANNING AREA
WEST BRANCH DISCHARGERS

DISCHARGER	NPDES PERMIT NO.	OEPA PERMIT NO.	RECEIVING STREAM	WATER SOURCE	MILES FROM MAIN STEM	MILE POINT MAIN STEM	FLOW (MGD)
W1 Ohio Screw Products Elyria			Storm Sewer	Elyria	0.5	0.6	0.0006
W2 GMC - Fisher Body Division Elyria	OH 0000272	S301*AD	Storm Sewer	Elyria	1.2	0.7	1.22
W3 Koehring Plants 3 & 5 Elyria			Storm Sewer	Elyria	0.2	0.9	0.0003
W4 Tappan Inc. Elyria			Storm Sewer	Elyria	0.6	0.9	0.025
W5 Republic Steel Corp. Elyria	OH 0001295	D311*AD	West Branch of Black River	West Branch of Black River	-	001-2.2 002-1.8	1.92
W6 Lorain County Animal Protective League, Elyria	OH 0044342		West Branch of Black River	Elyria	-	3.1	0.002
W7 Invacare Corp. Elyria	OH 0000833	S362*AD	West Branch of Black River	Elyria	-	3.4	0.0006
W8 Herman Apartments Elyria			West Branch of Black River	Elyria	-	4.1	0.0025
W9 Oberlin Savings Bank Elyria	OH 0043664		West Branch of Black River	Elyria	-	4.1	0.002
W10 Country Garden Apts. Elyria	OH 0043591		West Branch of Black River	Elyria	-	4.1	0.002
W11 Elyria County Club Elyria	OH 0043702		Unnamed tributary to West Branch of Black River	Elyria	0.7	4.3	0.02
W12 Bethel Baptist Church Russia Twp			Unnamed tributary to West Branch of Black River	Groundwater	2.6	4.3	0.001
W13 Church of the Open Door Elyria	OH 0044407		Unnamed tributary to West Branch of Black River	Elyria	3.9	4.3	0.007

TABLE V-18
(Continued)
BLACK RIVER PLANNING AREA
WEST BRANCH DISCHARGERS

DISCHARGER	NPDES PERMIT NO.	OEPA PERMIT NO.	RECEIVING STREAM	WATER SOURCE	MILES FROM MAIN STEM	MILE POINT MAIN STEM	FLOW (MGD)
W14 Lorain County Airport Russia Twp.			Unnamed tributary to West Branch of Black River	Groundwater	4.6	4.3	0.0015
W15 Forest Hills Country Club Carlisle Twp.			West Branch of Black River	Groundwater	-	4.3	0.0015
W16 West Carlisle School Carlisle Twp.			West Branch of Black River	Groundwater	-	8.3	0.004
W17 Pheasant Run Village Lagrange		W801*AD	West Branch of Black River	Sunset Lake	-	8.6	0.07
W19 Twining Motor Sales Oberlin			Unnamed tributary to Plum Creek	Oberlin	1.3	10.3	0.0012
W20 East Oberlin Community Church Oberlin			Unnamed tributary to Plum Creek	Oberlin	1.5	10.3	0.002
W21 Oberlin Assembly of God Oberlin			Unnamed tributary to Plum Creek	Oberlin	1.5	10.3	0.0015
W22 Oberlin STP Oberlin	OH 0020427	D825*AD	Plum Creek	Reservoir	2.6	10.3	0.9
W23 Glorious Faith Church Oberlin			Unnamed tributary to Plum Creek	Oberlin	5.3	10.3	0.0005
W24 Almighty Church Oberlin			Unnamed tributary to Plum Creek	Oberlin	5.6	10.3	0.002
W25 Oberlin Water Treatment Plant Oberlin			West Branch of Black River	Reservoir	-	15.2	0.004
W26 Findley State Forest Wellington Twp.			Findley Lake	Groundwater	7.7	15.7	0.0022
W27 Wellington STP Wellington		C814*AD	Unnamed tributary to Charlemont Creek	Reservoir	0.9	26.6	1.0

TABLE V-18
(Continued)
BLACK RIVER PLANNING AREA
WEST BRANCH DISCHARGERS

DISCHARGER	NPDES PERMIT NO.	OEPA PERMIT NO.	RECEIVING STREAM	WATER SOURCE	MILES FROM MAIN STEM	MILE POINT MAIN STEM	FLOW (MGD)
W28 Cleveland Steel Products Wellington	OH 0051586	S373*AD	Unnamed tributary to Charlemont Creek	Wellington	1.9	26.6	0.1
W29 Sterling Foundry Wellington	OH 0051934	D352*AD	Unnamed tributary to Charlemont Creek	Wellington	1.9	26.6	0.0095
W30 Wellington Water Treatment Plant Wellington	OH 0030325	V320*OAD	Charlemont Creek	Reservoir	4.2	26.6	0.012
W31 Ukranian-American Asso. Camp Huntington Twp.			Charlemont Creek	Groundwater	8.3	26.6	0.002
W32 Panther Trails Camp Ground Wellington Twp.			West Branch of Black River	Groundwater	-	27.9	0.0125
W33 Echo Valley Golf Course Brighton Twp.			West Branch of Black River	Groundwater	-	33.0	0.0013

TABLE V-19

BLACK RIVER PLANNING AREA
EAST BRANCH DISCHARGERS

DISCHARGER	NPDES PERMIT NO.	OEPA PERMIT NO.	RECEIVING STREAM	WATER SOURCE	MILES FROM MAIN STEM	MILE POINT MAIN STEM	FLOW (MGD)
E1 Obitts Chemical Elyria	OH 0022365	F303*AD	East Branch of Black River	Elyria	-	0.6	0.011
E2 Harshaw Chemical Elyria	OH 0000558		East Branch of Black River	Elyria	-	0.7	0.58
E4 Tiffany's Steak House Elyria			Storm Sewer	Elyria	1.6	1.0	0.02
E5 Emtec Manufacturing Elyria			Storm Sewer	Elyria	0.7	1.0	0.033
E6 Ohio Metallurgical Services Elyria	OH 0051420	S336*AD	Storm Sewer	Elyria	1.5	1.0	0.0005
E7 Pfaudler Co. Elyria	OH 0000728	S304*AD	Storm Sewer	Elyria	0.8	1.0	0.003
E10 Lear Siegler Co. Elyria	OH 0002089	S342*AD	Storm Sewer	Elyria	1.2	1.0	0.0144
E11 Diamond Products Co. Elyria			Storm Sewer	Elyria	0.6	1.2	0.002
E12 Grace Lutheran Church Elyria			East Branch of Black River	Elyria	-	3.0	0.0013
E13 Calvary Baptist Church Elyria			East Branch of Black River	Elyria	-	3.6	0.0013
E14 East Carlisle School Carlisle Twp.			East Branch of Black River	Elyria	-	4.1	0.01
E15 Sohio Service Station North Ridgeville			Fortune Ditch to Willow Creek	Elyria	1.6	5.5	0.0013
E16 Ohio Edison - Eaton Line Shop Eaton			Unnamed tributary to Willow Creek	Wells	2.2	5.5	0.00125

TABLE V-19
(Continued)
BLACK RIVER PLANNING AREA
EAST BRANCH DISCHARGERS

	DISCHARGER	NPDES PERMIT NO.	OEPA PERMIT NO.	RECEIVING STREAM	WATER SOURCE	MILES FROM MAIN STEM	MILE POINT MAIN STEM	FLOW (MGD)
E17	Sohlo - Lorain County Terminal North Eaton	OH 0000795	N359*AD	Bannister Ditch to Willow Creek	Runoff, Groundwater	5.3	5.5	*
E18	Eaton Town Hall Eaton			Willow Creek	Groundwater	5.4	5.5	0.002
E19	Trinity Lutheran Church Eaton			Willow Creek	Groundwater	5.5	5.5	0.0025
E20	Eaton School Eaton			Willow Creek	Groundwater	5.7	5.5	0.008
E21	Eaton Estates STP Eaton	OH 0026140	H823*AD	Willow Creek	Groundwater	5.8	5.5	0.2
E22	North Eaton Baptist Church North Eaton			Willow Creek	Groundwater	7.1	5.5	0.003
E23	Brush School Carlisle Twp.			Unnamed tributary to East Branch of Black River	Groundwater	2.0	5.9	0.005
E24	Brentwood Lake Estates STP (Lorain County SD #59) Carlisle Twp.	OH 0026158	H824*AD	Unnamed tributary to East Branch of Black River	Groundwater	0.9	5.9	0.12
E25	Brentwood Golf Course Carlisle Twp.			Unnamed tributary to East Branch of Black River	Groundwater	2.1	5.9	0.01
E26	Midview High School Carlisle Twp.			Unnamed tributary to East Branch of Black River	Groundwater	2.5	5.9	0.028
E27	Grafton State Farm STP Eaton			Unnamed tributary to East Branch of Black River	Groundwater	5.1	5.9	0.065
E28	LaPorte Apts. LaPorte			East Branch of Black River	Groundwater	-	6.9	0.0125
E29	Butternut Terrace Apts. Carlisle Twp.			East Branch of Black River	Groundwater	-	7.0	0.0025

* Flow is variable

TABLE V-19
(Continued)
BLACK RIVER PLANNING AREA
EAST BRANCH DISCHARGERS

DISCHARGER	NPDES PERMIT NO	OEPA PERMIT NO	RECEIVING STREAM	WATER SOURCE	MILES FROM MAIN STEM	MILE POINT MAIN STEM	FLOW (MGD)
E30 Grafton STP Grafton	OH 0025372	B824*AD	East Branch of Black River	Reservoir	-	11.2	0.2
E31 Grafton Water Treatment Plant Grafton	OH 0045730	W3023AD	Hill - Spaulding Ditch	Reservoir	0.6	12.1	0.006
E32 Indian Hollow Golf Club STP Lagrange			East Branch of Black River	Groundwater	-	16.2	0.008
E33 Belden School Belden			Salt Creek	Groundwater	3.2	18.3	0.005
E34 J&M Butchering Co. Grafton Twp.			Unnamed tributary to Salt Creek	Groundwater	3.2	18.3	Unknown
E35 Litchfield School Litchfield			Unnamed tributary to East Branch of Black River	Groundwater	5.9	28.7	0.004
E36 Litchfield Barber Shop Litchfield			Unnamed tributary to East Branch of Black River	Groundwater	5.9	28.7	0.0015
E37 D&H Truck Stop Litchfield			Unnamed tributary to East Branch of Black River	Groundwater	5.9	28.7	0.004
E38 Columbia Gas Transmission Co. Wellington Twp.	OH 0034762	N389*AD	Unnamed tributary to East Branch of Black River	Groundwater	3.2	31.8	0.0004
E39 Spencer STP Spencer	OH 0022071	A818*AD	Spencer Creek	Reservoir	1.2	34.9	0.1
E40 Spencer Lake Camp Ground Spencer Twp.			Spencer Lake	Groundwater	-	36.0	0.008
E41 Spencer Water Treatment Plant Spencer	OH 0030520	W310*0AD	Coon Creek	Reservoir	2.8	38.1	Unknown
E42 Lodi STP Lodi	OH 0041939	Z311*0AD	East Fork of East Branch of Black River	Groundwater	1.6	45.1	0.29

TABLE V-19
(Continued)
BLACK RIVER PLANNING AREA
EAST BRANCH DISCHARGERS

	DISCHARGER	NPDES PERMIT NO.	OEPA PERMIT NO.	RECEIVING STREAM	WATER SOURCE	MILES FROM MAIN STEM	MILE POINT MAIN STEM	FLOW (MGD)
E43	Lodi Water Treatment Plant Lodi	OH 0041939	Z311*0AD	Unnamed tributary to East Fork of East Branch of Black River	Groundwater	2.2	45.1	0.0056
E44	Lodi Motel Lodi			Unnamed tributary to East Fork of East Branch of Black River	Lodi	2.2	45.1	0.006
E45	Harris Tire Service Lodi	OH 0001180	R319*AD	Unnamed tributary to East Fork of East Branck of Black River	Lodi	2.2	45.1	0.026
E46	Sherwood Forest Camping Area Chatham Twp.			East Fork of East Branch of Black River	Groundwater	5.6	45.1	0.015
E47	Pierce Recreational Area Chatham Twp.			East Fork of East Branch of Black River	Groundwater	8.8	45.1	0.01
E48	Wordens Trailer Park Homer Twp.			West Fork of East Branch of Black River	Groundwater	-	52.3	0.01
E49	Homerville High School Homerville			West Fork of East Branch of Black River	Groundwater	-	53.6	0.0026

TABLE V-20
BLACK RIVER PLANNING AREA
BEAVER CREEK DISCHARGERS

	DISCHARGER	NPDES PERMIT NO.	OEPA PERMIT NO.	RECEIVING STREAM	WATER SOURCE	MILES FROM MAIN STEM	MILE POINT MAIN STEM	FLOW (MGD)
C1	Dewey Road Inn Amherst			Unnamed tributary to Beaver Creek	Lorain	2.0	2.0	0.002
C2	Lorain County Rehabilitation Center Amherst			Unnamed tributary to Beaver Creek	Lorain	2.8	2.0	0.005
C3	Nelson Stud Welding Elyria	OH 0021610	S340*AD	Unnamed tributary to Beaver Creek	Elyria	6.0	2.0	0.02
C4	Lorain Oak Hills Farms STP Amherst			Beaver Creek	Lorain	-	2.3	0.01
C5	Amherst STP Amherst	OH 0021628	D801*AD	Beaver Creek	Lorain	-	3.7	1.0 (design)
C6	Ohio Turnpike Service Plaza #5 STP Amherst TWP			Unnamed tributary to Beaver Creek	Groundwater	1.4	5.1	0.03
C7	Amherst Mobile Home Park Amherst			Unnamed tributary to Beaver Creek	Lorain	2.3	5.1	0.025
C8	Westwood Mobile Home Park Amherst TWP		V826*AD	Beaver Creek	Groundwater	-	5.6	0.08
C9	Pinecrest Apartments South Amherst	OH 0044890		Beaver Creek	South Amherst	-	6.7	0.025
C10	Cleveland Quarries South Amherst			Beaver Creek	Groundwater	-	8.3	0.00015
C11	South Amherst Schools South Amherst			Beaver Creek	South Amherst	-	8.6	0.011
C12	Oak Park Lake Oberlin			Squires Ditch	Groundwater	4.1	9.1	0.002
C13	Maranatha Temple Pentecostal Oberlin			Squires Ditch	Oberlin	5.3	9.1	0.002

TABLE V-20
(Continued)
BLACK RIVER PLANNING AREA
BEAVER CREEK DISCHARGERS

DISCHARGER	NPDES PERMIT NO.	OEPA PERMIT NO.	RECEIVING STREAM	WATER SOURCE	MILES FROM MAIN STEM	MILE POINT MAIN STEM	FLOW (MGD)
C14 Church of the Nativity South Amherst			Beaver Creek	South Amherst	-	9.7	0.02
C15 Oberlin Masonic Hall Oberlin			Herrick Ditch	Oberlin	3.0	10.7	0.002

such as churches, schools or restaurants or small residential developments including apartments and mobile home trailer parks. Figure V-9 shows the majority of the sanitary waste dischargers are clustered in the unsewered areas near the larger metropolitan centers in the northern portion of the planning area, i.e. in Sheffield and Sheffield Lake east of Lorain, in the communities south of Elyria, and, in Amherst and South Amherst along Beaver Creek. In the less populated southern half of the basin, there are not as many sewage treatment plants. Those present are more uniformly distributed than in the northern half of the basin.

Water treatment plants are generally located within the smaller cities in the southern half of the planning area. The Elyria and Lorain water treatment plants are located on the lake and serve the northern half of the planning area.

H. Hydrology[11,12,13]

The hydrology in the Black River planning area is directly related to geological formations and soil conditions which have minimal water storage capacity. Surface materials are generally rather dense and impermeable and the glacial deposits contain only limited amounts of permeable sand and gravel. Bedrock in the area is mainly shale and contributes virtually no groundwater to stream flow. Hence, groundwater storage is limited. In addition, there are no significant reservoirs or water developments to augment flows in the basin. The result of the above conditions is that stream flows fluctuate widely with changes in precipitation but are typically very low during sustained dry weather periods. A more detailed description of the streamflow characteristics of the Black River and Beaver Creek follows:

Black River

Figure V-10 is a cumulative drainage area graph for the Black River showing both the drainage area and the location on the main stem of major and minor tributaries. Approximately 80 percent of the total drainage area lies above the USGS stream gage at Elyria (River Mile 15.2). Significant

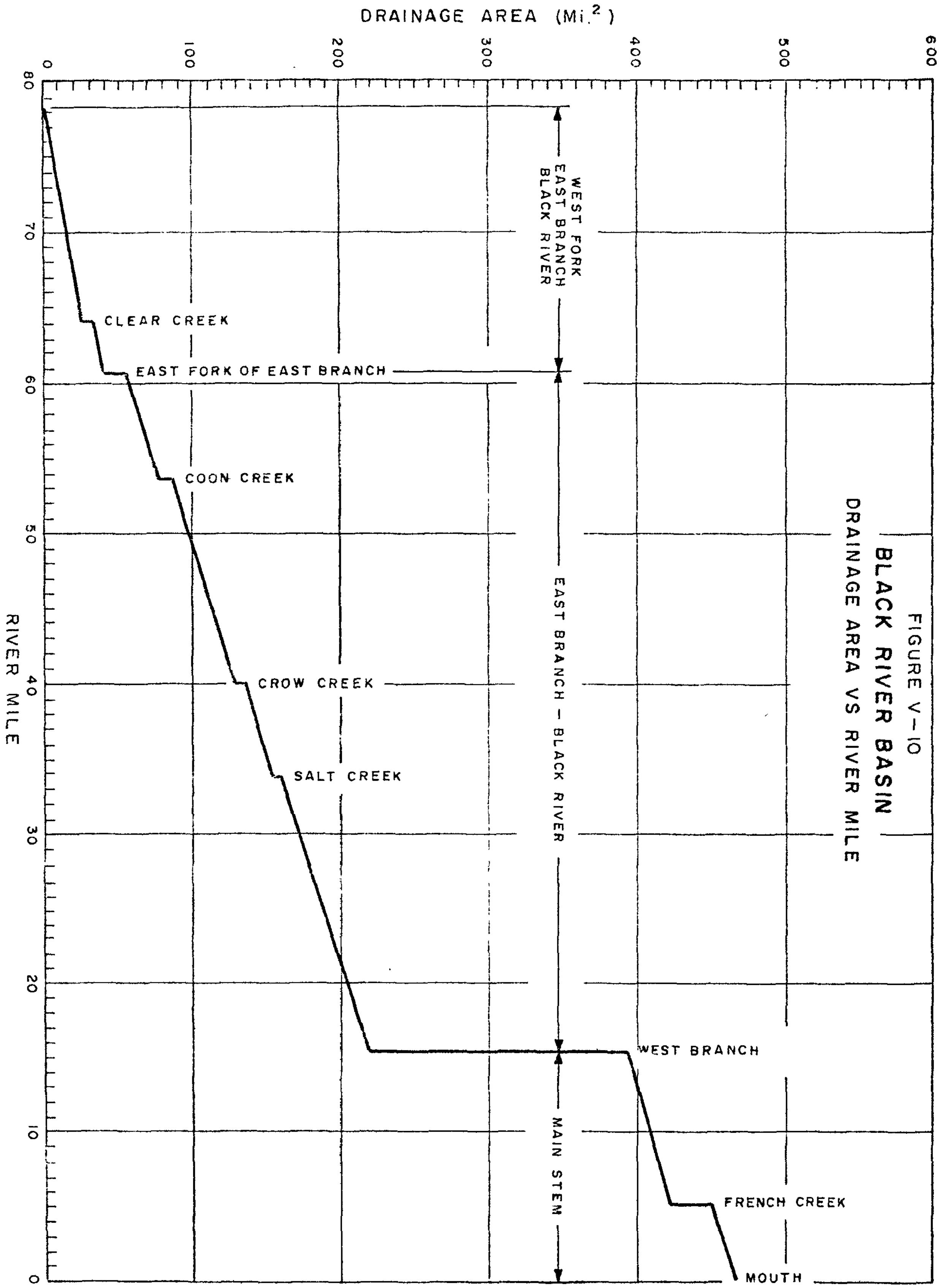


FIGURE V-10
BLACK RIVER BASIN
DRAINAGE AREA VS RIVER MILE

changes in the slope of the main stem are illustrated in Figure V-2 along with the location of manmade impoundments in the Elyria area. These low head dams were originally installed to maintain a supply of river water for withdrawal during periods of low flow. However, only the dam on the West Branch near East 15th Street is currently used to provide an industrial water supply for Republic Steel. Reservoirs supplied by the Black River near Grafton, Oberlin, Spencer, and Wellington are used as water supplies by these municipalities.

Figure V-11 is a flow duration curve for the Black River at the USGS gaging station in Elyria. As shown, the flow of the stream is expected to be greater than 50 cfs only 50 percent of the time and greater than 8 cfs about 90 percent of the time. Conversely, the flow is expected to be greater than 750 cfs about 10 percent of the time. These data are also illustrated in Figure V-12 which includes a monthly hydrograph of the stream at the same location. These data are significant in that while expected mean monthly flows may range between 31 cfs in September and October to over 800 cfs in March, the flow is expected to be greater than 50 cfs only half of the time. The expected mean annual flow is just below 300 cfs.

As illustrated by these figures, the water quality design flow throughout the basin above French Creek is extremely low, with the Elyria sewage treatment plant contributing much more than half of the water quality design flow above the lake-affected portion of the stream. It is significant to note that of the 140 dischargers in the Black River basin, 112 discharge to streams or segments with water quality design flows of zero or streams with no natural flow.

Depending upon the level of Lake Erie, the Black River reaches lake level between River Mile 6.5 and River Mile 5.1 where French Creek discharges into the main stem. From this point to the mouth of the stream at Lorain Harbor, the river is considered an estuary. The flow regime is altered further from River Mile 5.0 to 2.5 by the intake pumpage and discharges of the U.S. Steel-Lorain Works. Additional information concerning the water quality design flow of the stream in this area can be found in Appendices II and III.

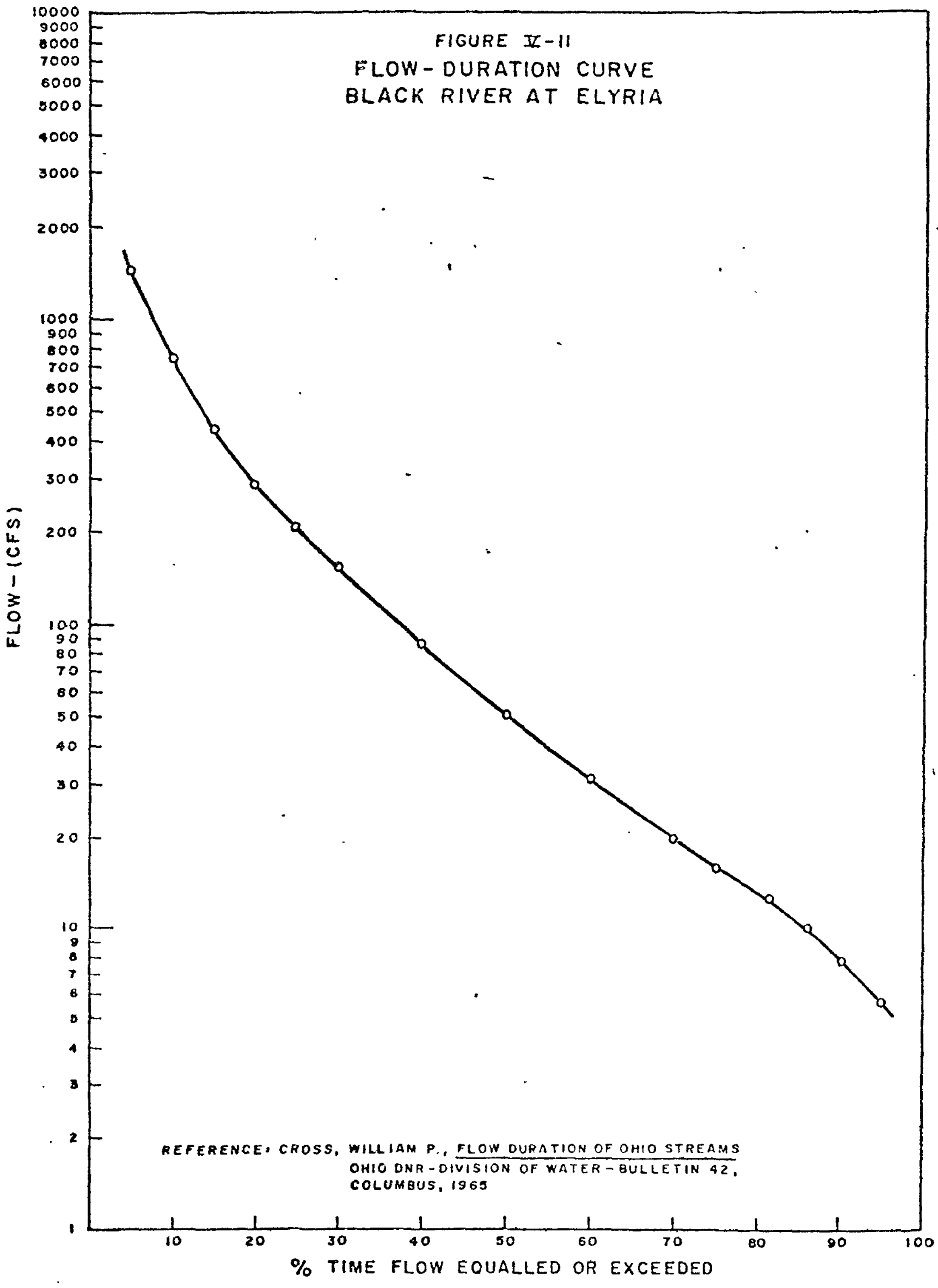


FIGURE V-11
FLOW-DURATION CURVE
BLACK RIVER AT ELYRIA
FLOW-(CFS)
% TIME FLOW EQUALLED OR EXCEEDED
REFERENCE: CROSS, WILLIAM P., FLOW DURATION OF OHIO STREAMS
OHIO DNR-DIVISION OF WATER-BULLETIN 42,
COLUMBUS, 1965

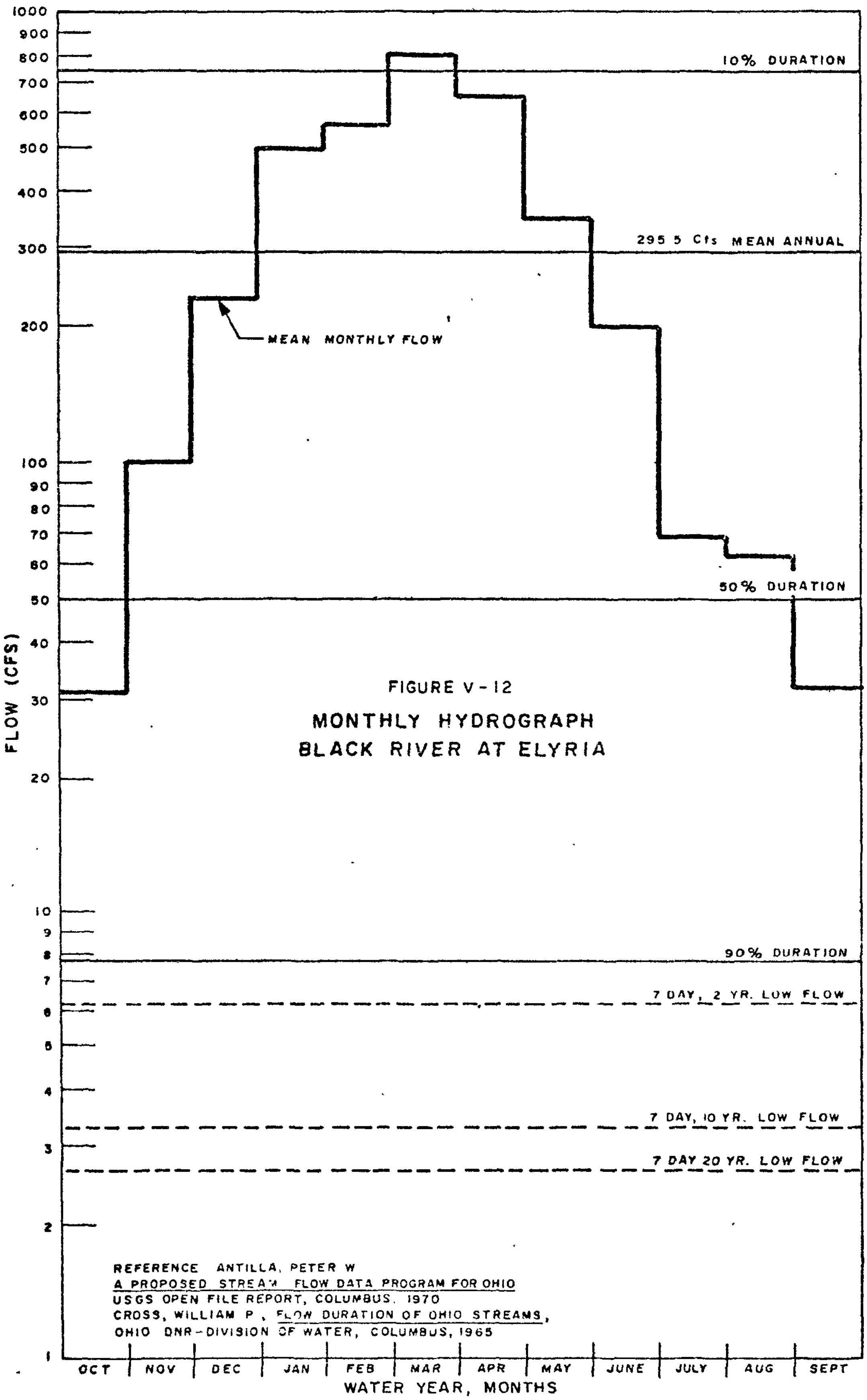


FIGURE V-12
MONTHLY HYDROGRAPH
BLACK RIVER AT ELYRIA

Beaver Creek

As noted above, there are no hydrologic data available for Beaver Creek. Since the Beaver Creek Basin is geographically similar to the upper sections of the Black River basin, hydrologic data for the Black River in conjunction with wastewater discharge data presented in Table V-20 were employed to develop the water quality design flow profile for Beaver Creek.

REFERENCES - SECTION V

1. United States Department of Agriculture Soil Conservation Service, Soil Survey of Lorain County, Ohio, 1973.

2. Ernest, J. E. and Musgrave, D. K., An Inventory of Ohio Soils - Lorain County, Ohio Department of Natural Resources - Division of Lands and Soil Progress Report No. 36, Columbus, Ohio, 1972.

3. Hayhurst, Ernest N. and Powell, Kenneth, An Inventory of Ohio Soils - Medina County, Ohio Department of Natural Resources - Division of Lands and Soil Progress Report No. 39, Columbus, 1973.

4. United States Department of Commerce - NOAA, "Climatological Data, Ohio", Annual Summary, Volume 78, Number 13, 1973.

5. Ohio Department of Natural Resources - Division of Water, Northwest Ohio Water Development Plans, Columbus, 1967.

6. Ohio Soil and Water Conservation Needs Committee, Ohio - Soil and Water Conservation Needs Inventory, Columbus, 1971.

7. Ohio Environmental Protection Agency, Water Treatment Plant Inventory, 1973.

8. Ohio Department of Economic and Community Development, unpublished data.

9. Kleinoeder - Schmidt and Associates, Woodruff Inc., Water and Sewer Study for Lorain County, Cleveland, Ohio 1974.

10. Ohio Department of Natural Resources, Northeast Ohio Water Development Plan, November 1972.

11. United States Department of the Interior Geological Survey Water Resources Division, A Proposed Streamflow Data Program for Ohio, Columbus, Ohio, June 1970.

12. State of Ohio Department of Natural Resources Division of Water, Flow Duration of Ohio Streams, Bulletin 31, Columbus, Ohio, January 1959.

13. State of Ohio Department of Natural Resources Division of Water, Gazetteer of Ohio Streams Report No. 12 Ohio Water Plan Inventory, Columbus, Ohio 1960.

14. Lorain County Regional Planning Commission, Manufacturing and Employment Characteristics, Lorain County Economic Series No. 2, Elyria, Ohio 1974.

SECTION VI
WATER QUALITY STANDARDS

Water quality standards in Ohio were adopted by the Ohio Environmental Protection Agency (Ohio EPA) on July 11, 1972, and Federally approved on September 29, 1972. These standards were re-adopted by Ohio without change on July 27, 1973, with other statewide standards and again Federally approved on December 18, 1973. Federal exception to a few of the statewide criteria were amended by Ohio on January 8, 1975, and Federally approved May 14, 1975. The water quality standards were further revised by Ohio EPA on February 14, 1978. However, all of these revisions were not Federally approved. Specifically, criteria for dissolved oxygen and cyanide as well as various use designations and downgradings and the definition of low flow streams were the major items excepted from Federal approval. All use designations and associated criteria not specifically excepted from Federal approval were approved by U.S. EPA and are in effect as State adopted-Federally approved water quality standards. At this writing U.S. EPA is in the process of promulgating certain standards for Ohio. Reference is made to the February 14, 1978 water quality standards and the following correspondence from U.S. EPA for additional information concerning those parts of the standards excepted from Federal approval:

1. Adamkus, Valdas V., Deputy Regional Administrator, Region V, U.S. EPA, Chicago, Illinois to (Honorable James A. Rhodes, Governor of Ohio, Columbus, Ohio) May 17, 1978, 2 pp w/attachment.

2. Adamkus, Valdas V., Deputy Regional Administrator, Region V, U.S. EPA, Chicago, Illinois to (Honorable James A. Rhodes, Governor of Ohio, Columbus, Ohio) August 9, 1978, 2 pp w/attachment.

With respect to this document and waste load allocations included herein, the Warmwater Aquatic Habitat designation was considered throughout the basin. The proposed U.S. EPA dissolved oxygen criterion of 5.0 mg/l (minimum at any time) was employed as a basis for establishing effluent limitations for oxygen demanding wastes. Criteria for other critical pollutants (temperature, ammonia-N, total cyanide, phenolics, and metals) were obtained from the State-adopted Federally approved standards applicable to the Black River. The achievability of the warmwater aquatic habitat throughout the basin is addressed in Section IX.

TABLE VI-1
Black River and Lake Erie
Water Quality Standards
Stream Segment Classification

Constituent	Warm Water Habitat	Seasonal Warm Water Habitat	Limited Warm Water Habitat	Lake Erie
Temperature	Table VI-2	Table VI-3	Table VI-2	Tables VI-4,5,6
pH	6.5 to 9	6.5 to 9	6.5 to 9	6.5 to 9
DO	Min 5.0 mg/l for at least 16 hrs in 24 hrs min 4.0 mg/l any time	3.0 mg/l at all times	1 mg/l July Avg 3.0 mg/l May, June September, October	6.0 mg/l
NH_3	.05 mg/l unionized	.05 unionized with most stringent 1.5 mg/l	10 mg/l	.025 mg/l unionized 6.5 mg/l max.
Dissolved Solids	May exceed one but not both a) 1500 mg/l b) 150 mg/l attributable to human activity	May exceed one but not both a) 1500 mg/l b) 150 mg/l attributable to human activity	May exceed one but not both a) 1500 mg/l b) 150 mg/l attributable to human activity	200 mg/l
Cyanide	0.025 mg/l	.025 mg/l	.025 mg/l	a) .025 mg/l b) .005 mg/l amenable to chlorination
Phenolic Compounds	.010 mg/l	.010 mg/l	.040 mg/l	.001 mg/l
Beryllium	1.10 mg/l	1.10 mg/l	1.10 mg/l	1.10 mg/l
Cadmium	.012 mg/l	.012 mg/l	.012 mg/l	.012 mg/l
Chromium	.100 mg/l	.100 mg/l	.100 mg/l	.050 mg/l
Copper	.1 X 96 hour LC_{50}	.1 X 96 hour LC_{50}	.1 X 96 hour LC_{50}	.005 mg/l
Iron	1.000 mg/l	1.000 mg/l	1.000 mg/l	1.000 mg/l
Lead	.030 mg/l	.030 mg/l	.030 mg/l	.030 mg/l
Mercury	.00005 mg/l monthly average .0002 any time	.00005 mg/l monthly average .0002 any time	.00005 mg/l monthly average .0002 any time	.00005 mg/l monthly average .0002 any time

TABLE VI-1
Black River and Lake Erie
Water Quality Standards
Stream Segment Classification
Continued

Constituent	Warm Water Habitat	Seasonal Warm Water Habitat	Limited Warm Water Habitat	Lake Erie
Nickel	.01 X 96 hour LC_{50}	.01 X 96 hour LC_{50}	.01 X 96 hour LC_{50}	.025 mg/l
Selenium	.01 X 96 hour LC_{50}	.01 X 96 hour LC_{50}	.01 X 96 hour LC_{50}	.010 mg/l
Silver	.01 X 96 hour LC_{50}	.01 X 96 hour LC_{50}	.01 X 96 hour LC_{50}	.050 mg/l
Zinc	.01 X 96 hour LC_{50} based on hardness	.01 X 96 hour LC_{50} based on hardness	.01 X 96 hour LC_{50} based on hardness	.030 mg/l
Oil & Grease	a) No floating oil b) 5 mg/l freon extractable material	a) No floating oil b) 5 mg/l freon extractable material	a) No floating oil b) 5 mg/l freon extractable material	a) No floating oil b) 5 mg/l freon extractable material
MBAS	.500 mg/l	.500 mg/l	.500 mg/l	.500 mg/l
Pesticides	Table VI-7	Table VI-7	Table VI-7	Table VI-7 or Safe Drinking Water Act, whichever is more stringent
Phosphorous	a) Limited to prevent nuisance growth b) 1 mg/l where algae problem	a) Limited to prevent nuisance growth b) 1 mg/l where algae problem	a) Limited to prevent nuisance growth b) 1 mg/l where algae problem	a) Limited to prevent nuisance growth b) 1 mg/l where algae problem
Phthalate esters	.003 mg/l	.003 mg/l	.003 mg/l	.003 mg/l
PCB	.000001 mg/l	.000001 mg/l	.000001 mg/l	Absent from public water supplies
Toxic Substances	a) .1 X 96 hour TLm or LC_{50} b) Persistent toxicant .01 X 96 hour TLm or LC_{50}	a) .1 X 96 hour TLm or LC_{50} b) Persistent toxicant .01 X 96 hour TLm or LC_{50}	a) .1 X 96 hour TLm or LC_{50} b) Persistent toxicant .01 X 96 hour TLm or LC_{50}	a) .1 X 96 hour TLm or LC_{50} b) Persistent toxicant .01 X 96 hour TLm or LC_{50}

TABLE VI - 2

General Lake Erie Basin - includes all surface waters of the state within th[e] boundaries of the Lake Erie drainage basin, excluding those water bodies as designated in Tables 5h through 5j, and Table 5a. Shown as degrees Fahrenheit and (Celsius).

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

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

TABLE VI-3

Seasonal Warm Water Habitat

Seasonal daily maximum temperature limitations for Seasonal Warmwater Habitat. Shown as Degrees Fahrenheit and (Celsius).

Month	Daily Maximum
January	70(21.1)
February	70(21.1)
March	75(23.9)
April	80(26.7)
May	84(28.9)
June	89(31.7)
July	89(31.7)
August	89(31.7)
September	89(31.7)
October	84(28.9)
November	76(24.4)
December	70(21.1)

LAKE ERIE STANDARDS

Temperature

(a) There shall be no water temperature changes as a result of human activity that cause mortality, long-term avoidance, exclusion from habitat, or adversely affect the reproductive success of representative aquatic species, unless caused by natural conditions.

(b) At no time shall water temperature exceed a monthly or bi-weekly average, or at any time exceed the daily maximum temperature as indicated in Table 7a and 7b. The average and daily maximum temperature standards shall apply and be measured outside of a thermal mixing zone at any point on a thermal mixing zone boundary at depths greater than three feet, as defined in Rule 3745-1-11(B)(2)(a) and (b) of the Ohio Administrative Code.

(c) The temperature of the hypolimnetic waters of Lake Erie shall not exceed at any time a daily maximum as indicated in Table 7c.

Table VI-4 Lake Erie Western Basin - includes the area of Lake Erie west of a line drawn from Pelee Point, Canada to Scott Point on Catawba Island. Shown as degrees Fahrenheit and (Celsius).

	Jan. 1-31	Feb. 1-29	Mar. 1-15	Mar. 16-31	Apr. 1-15	Apr. 16-30	May 1-15	May 16-31	June 1-15
Average:	-	-	-	-	-	53 (11.7)	59 (15.0)	65 (18.3)	75 (23.9)
Daily Maximum:	35 (1.7)	38 (3.3)	39 (3.9)	45 (7.2)	51 (10.6)	56 (13.3)	64 (17.8)	72 (22.2)	78 (25.6)

	June 16-30	July 1-31	Aug. 1-31	Sept. 1-15	Sept. 16-30	Oct. 1-15	Oct. 16-31	Nov. 1-30	Dec. 1-31
Average:	80 (26.7)	83 (28.3)	83 (28.3)	78 (25.6)	76 (24.4)	66 (18.9)	60 (15.6)	53 (11.7)	-
Daily Maximum:	83 (28.3)	85 (29.4)	85 (29.4)	83 (28.3)	81 (27.2)	71 (21.7)	65 (18.3)	58 (14.4)	46 (7.8)

Table VI-5 Lake Erie Central Basin - includes the area of Lake Erie east of a line drawn from Pelee Point, Canada to Scott Point on Catawba Island to the Pennsylvania-Ohio state line. Shown as degrees Fahrenheit and (Celsius).

	Jan. 1-31	Feb. 1-29	Mar. 1-15	Mar. 16-31	Apr. 1-15	Apr. 16-30	May 1-15	May 16-31	June 1-15
Average:	-	-	-	-	43 (6.1)	53 (11.7)	59 (15.0)	63 (17.2)	75 (23.9)
Daily Maximum:	35 (1.7)	38 (3.3)	39 (3.9)	45 (7.2)	48 (8.9)	56 (13.3)	63 (17.2)	72 (22.2)	78 (25.6)

	June 16-30	July 1-31	Aug. 1-31	Sept. 1-15	Sept. 16-30	Oct. 1-15	Oct. 16-31	Nov. 1-30	Dec. 1-31
Average:	80 (26.7)	83 (28.3)	83 (28.3)	76 (24.4)	71 (21.7)	66 (18.9)	58 (14.4)	48 (8.9)	-
Daily Maximum:	83 (28.3)	85 (29.4)	85 (29.4)	81 (27.2)	76 (24.4)	71 (21.7)	63 (17.2)	53 (11.7)	46 (7.8)

Table VI-6 Seasonal daily maximum temperature limitations for the hypolimnetic regions of Lake Erie. Shown as degrees fahrenheit and (celcius).

Month	Daily Maximum
January	44 (6.7)
February	44 (6.7)
March	44 (6.7)
April	47 (8.3)
May	51 (10.6)
June	54 (12.2)
July	59 (15.0)
August	59 (15.0)
September	55 (12.8)
October	46 (7.8)
November	41 (5.0)
December	38 (3.3)

Table VI-7
Permissible Concentrations
of
Pesticides (micrograms per liter)

Pesticide	Public Water Supply ug/l	Warmwater Habitat ug/l
*Aldrin	1.0	0.01
Benzene Hexachloride		0.1
Chlordane	3.0	0.01
Chlorophenoxy herbicides		
2,4-D	100.0	
2,4,5-TP (Silvex)	10.0	
Ciodrin		0.1
Coumaphos		0.001
Dalapon		110.0
*DDT	50.0	0.001
Demeton		0.1
Diazinon		0.009
Dicamba		200.0
Dichlorvos		0.001
*Dieldrin	1.0	0.005
Diquat		0.5
Dursban		0.001
Endosulfan		0.003
Endrin	0.2	0.002
Guthion		0.005
*Heptachlor	0.1	0.001
Heptachlor Epoxide	0.1	
Lindane	4.0	0.01
Malathion		0.1
Methoxychlor	100.0	0.005
Mirex		0.001
Naled		0.004
Parathion		0.008
Phosphamidon		0.03
Simazine		10.0
TEPP		0.4
Toxaphene	5.0	0.005

*Banned

SECTION VII
SUMMARY OF POINT SOURCE EFFLUENT LOADINGS

Effluent data for significant dischargers in the Black River Planning Area obtained from Ohio EPA monthly operating reports, U.S. EPA point source sampling programs, and U.S. Army Corps of Engineers Permit Applications are summarized in Tables VII-1 through VII-7. Effluent data for most semi-public sewage treatment plants with capacities less than 0.05 mgd are not available.

Black River Basin (Tables VII-1 - VII-5)

The most significant municipal discharger in terms of impact on water quality is the Elyria sewage treatment plant, which discharges over 3,000 lbs/day of BOD_5, 2000 lbs/day of suspended solids, and 2000 lbs/day of ammonia to the stream. In addition, significant quantities of cyanide and various metals were found in the plant effluent during a U.S. EPA sampling survey. Although the Lorain sewage treatment plant is larger than the Elyria facility in capacity, the impact of its effluent on the receiving stream is less, owing to the location of the plant and the more efficient treatment provided. Because of its location on Plum Creek, loadings from the Oberlin sewage treatment plant are significant in terms of effects on stream quality.

By far, the most significant industry in the Planning Area is the U.S. Steel - Lorain Works. Based upon a 1979 U.S. EPA survey, this plant discharged in excess of 20,000 lbs/day of suspended solids, 3700 lbs/day of oil and grease, 2100 lbs/day of ammonia, 70 lbs/day of cyanide, 50 lbs/day of phenol, and a thermal loading in excess of one billion BTU/hr. The plant also discharges over 3400 lbs/day of iron, in addition to about 30 lbs/day of chromium, 10 lbs/day of copper, 30 lbs/day of lead, and 170 lbs/day of zinc. However, recent improvements in wastewater treatment at this facility (blast furnace recycle and improved oil and grease removal) have reduced the discharges somewhat. The 1979 U.S. Steel data can be found in Volume II. Because of their location, smaller Elyria industries have significant impacts on stream quality.

Beaver Creek Basin (Table VII-6)

The Amherst sewage treatment plant is the most significant discharger in the basin discharging about 350 lbs/day of BOD_5 and 400 lbs/day of suspended solids. There are no significant industrial dischargers in the Beaver Creek basin.

Direct Dischargers to Lake Erie (Table VII-7)

Referring to Table VII-7, the Ohio Edison-Edgewater Plant discharges about 650 million BTU/hr of heat and 1,600 lbs/day of suspended solids to the lake. The Lorain and Elyria water treatment plants are the other significant Lake Erie dischargers.

A ranking of point source dischargers is presented in Section IX.

TABLE VII-1

BLACK RIVER PLANNING AREA - BLACK RIVER DISCHARGERS

EFFLUENT LOADINGS (LBS/DAY)
(Cross except where noted)

scharger	Lorain STP	Lorain STP	American Shipbuilding (Net)	Lorain-Elyria Sand (Net)	Koehring Plant No. 1	Elyria STP	Elyria STP	Stanadyne Co. Western Division
le Point - Main Stem	0.2	0.2	0.7	1.3	1.9	10.4	10.4	13.0
ta Source	Sept.'73-Aug.'74 Chio EPA Monthly Data	July 23-26, 1974 U.S. EPA Survey	COE Permit Application	COE Permit Application	COE Permit Application	Sept.'73-Aug.'74 Chio EPA Monthly Data	July 23-26, 1974 U.S. EPA Survey	1973 Ohio EPA Data + COE Permit Appl.
w (mgd)	14.64	13.06	0.55	0.48	0.0025	7.9	6.85	0.49
D5	1,060	660	70	104	13.2	3,100	4,800	-
D	6,830	2,100	-	1,050	120	11,300	11,050	107
C		4,600		64	30		3,300	
loride		8,800		-	1.4	8,900	8,200	6.8
oride		110			0.12		60	
lfate		12,600		-	1.5		7,160	150
tal Solids		58,700	680	35,000	760		40,200	1,680
spended Solids	2,450	2,140	1,580	31,700	210	2,000	2,310	93
ssolved Solids		51,000	-	3,300	550		36,400	1,580
tal Phosphorus	740	770	0.05	26	0.02	410	620	1.8
onia (N)	930	460	-	0.5	0.04	2,130	1,100	13
trate + Nitrite -N	130	540	0.05	6.4	0.02	25.1	12.7	35
N		700	2.8	-	0.05		1,250	14
l and Grease		-		-	14.5		170	
anide		0.73			-		17	0.09
nols		0.73		-	0.03		2.7	
tal Barium				-	-			
tal Cadmium		-			0.001		1.2	3.8
tal Chromium		0.3		-	4.2		4.0	0.5
avalent Chromium								0.4
tal Copper		4.5			1.3		1.5	1.5
tal Iron		57			21		47.5	0.1
tal Lead		-					-	
tal Manganese					4.2			-
tal Mercury		-			-		-	
tal Nickel		1.3			0.02		19.3	62.3
tal Zinc		8.3			2.9		5.8	0.2
ermal Load (10^6 BTU/hr.)								

BLACK RIVER PLANNING AREA - TRIBUTARIES TO BLACK RIVER

EFFLUENT LOADINGS (LBS/DAY)
(Gross except where noted)

ischarger	Avon STP Avins Ditch	Mills Rd. STP (2 plants) Trib. to French Cr	Albin Homes STP Trib. to French Cr	Westport Homes STP French Creek	Chest. Ridge Est. STP Trib. to French Cr.	Ridgeview S.C. STP Ridgeway Ditch	Crestview Knolls STP Ridgeway Ditch	Bendix Westinghouse Storm Sewer
ile Point - Main Stem	5.1	5.1	5.1	5.1	5.1	10.1	10.1	14.1
ta Source	1973 Ohio EPA Monthly Data	1973 Ohio EPA Monthly Data	1973 Ohio EPA Monthly Data	Oct.'73-Dec.'73 Monthly Data	1973 Ohio EPA Monthly Data	1973 Ohio EPA Monthly Data	1973 Ohio EPA Monthly Data	COE Permit Application
ow (mgd)	0.1	0.6	0.18	0.11	0.022	0.035 (Design)	0.025 (Design)	0.005
OD5	20.4	115	11	5.7	0.94	2.6	4	1.0
OD								3.9
OC								
loride								8.5
uoride								
lfate								
tal Solids								83
spended Solids	10.6	132	9	6.0	1.3	3.2	4.4	0.8
ssolved Solids								81
tal Phosphorus								0.001
monia (N)								0.03
trate + Nitrite -N								-
l								0.23
l and Grease								4.2
anide								
enols								
tal Barium								
tal Cadmium								
tal Chromium								
xavalent Chromium								
tal Copper								
tal Iron								
tal Lead								
tal Manganese								
tal Mercury								
tal Nickel								
tal Zinc								
ermal Load (10^6 BTU/hr.)								

TABLE VII-3

BLACK RIVER BASIN - U. S. STEEL - LORAIN WORKS

EFFLUENT LOADINGS (LBS/DAY)
(Gross except where noted)

arger	U. S. Steel Outfall 001	U. S. Steel Outfall 001	U. S. Steel Outfall 001	U. S. Steel Outfall 001	U. S. Steel Outfall 005	U. S. Steel Outfall 005	U. S. Steel Outfall 005	U. S. Steel Outfall 005
Point - Main Stem	5.0	5.0	5.0	5.0	3.92	3.92	3.92	3.92
Source	COE Permit Application	July 1973-June '74 Ohio EPA Monthly Data	Sept. 12-15, 1972 U. S. EPA Survey	July 23-26, 1974 U. S. EPA Survey	COE Permit Application	July '73-June '74 Ohio EPA Monthly Data	Sept. 12-15, '72 U. S. EPA Survey	July 23-26, '74 U. S. EPA Survey
(mgd)	16.1	51	44	48.5	8	3	2.5	3.18
	310			810	400			194
				1,605				53
	2,290		1,640	7,232	930		4.7	229
	310			2,158	-			106
ide	2,810	532	1,300	1,200	1,000	225	13	212
ide	9.5		17	7	7.7		0.2	1.2
te	4,170	-	1,780	2,410	1,470	-	-	354
Solids	12,600		-	12,830	7,000		90	843
nded Solids	-	1,100	630	2,006	-	168	70	62
lved Solids	14,500		6,400	10,094	8,300		120	1.023
Phosphorus	-				-			
ia (N)	52		83	-	51		-	0.7
te + Nitrite -N	102			75	75			25
	3.36			-	61			4
nd Grease	210	603	1,390	3,982	-	5	6	27
de	-		1.3		1		0.07	
ls	2.4	0.03	-		0.35	0.06	0.01	
Chromium	-		25	17.9	-		-	0.7
alent Chromium			4				-	
Copper			1.3	4.1	-		0.2	-
Iron	260	23.2	563	567	-		13	6
Lead	12		-		-		-	
Manganese			-				0.2	
Mercury	-		-				-	
Nickel					-			
Sodium	135			1,595	1,150			185
Zinc	11		21	65	0.7		0.7	2.9
al Load (10^6 BTU/hr)	18		119	180	11.3		6	13

TABLE VII-3
(Cont'd)

BLACK RIVER BASIN - U. S. STEEL - LORAIN WORKS

EFFLUENT LOADINGS (LBS/DAY)
(Gross except where noted)

charger	U. S. Steel Outfall 002	U. S. Steel Outfall 002	U. S. Steel Outfall 002	U. S. Steel Outfall 002	U. S. Steel Outfall 003	U. S. Steel Outfall 003	U. S. Steel Outfall 003	U. S. Steel Outfall 003
e Point - Main Stem	3.5	3.5	3.5	3.5	2.63	2.63	2.63	2.63
a Source	COE Permit Application	July '73-June '74 Ohio EPA Monthly Data	Sept. 12-15, '72 U. S. EPA Survey	July 23-26, 1974 U. S. EPA Survey	COE Permit Application	July '73-June '74 Ohio EPA Monthly Data	Sept. 12-15, '72 U. S. EPA Survey	July 23-26, '74 U. S. EPA Survey
v (mgd)	32.6	37	28.2	29.6	76	68	68	68
5	3,800			1,565	-			567
20				5,680				9,836
	34,000		4,130	4,130	1,900		-	1,700
	4,100			1,241	-			380
oride	25,000	3,840	160	2,804	-	6,416	-	5,864
oride	176		11	11	160		94	90
fate	12,500	5,270	13,240	5,030	-	2,775	-	6,053
l Solids	94,700		12,800	16,477	-		-	19,860
ended Solids	12,000	-	1,420	1,720	-	-	-	5,049
solved Solids	82,700		6,630	16,110	1,260		-	11,350
l Phosphorus	-				-			
onia (N)	9,500		3,140	260	200		-	853
ate + Nitrite -N	400			193	-			130
	10,700			346	210	163		794
and Grease	850	180	510	740	-		--	-
nide	260		143	6.6	-		1.7	76
ols	390	36.7	210	5.2	5	-	0.2	35
l Chromium	-		0.7	12.1	-		3.6	-
valent Chromium			-				3.3	
l Copper	-		2.3	5.0	47		13	-
l Iron	2,800	6.2	460	248	2,660	30.5	320	681
l Lead	44		-	18.6	45		-	-
l Manganese			10				-	
l Mercury	0.11		-		-		-	
l Nickel								
l Sodium				2,422	4,500			2,140
l Zinc	200		27	12.7	19		31	34
mal Load (10^6 BTU/hr)	150		177	302	308		276	500

TABLE VII-3
(Cont'd)

BLACK RIVER BASIN - U. S. STEEL - LORAIN WORKS

EFFLUENT LOADINGS (LBS/DAY)
(Gross except where noted)

ischarger	U. S. Steel	U. S. Steel	U. S. Steel	U. S. Steel				
ile Point - Main Stem	Outfall 004 2.56	Outfall 004 2.56	Outfall 004 2.56	Outfall 004 2.56				
ata Source	COE Permit Application	July '73-June '74 Ohio EPA Monthly Data	Sept. 12-15, 1972 U. S. EPA Survey	July 23-26, 1974 U. S. EPA Survey				
low (mgd)	28.7	22	22	22				
OD5	-			429				
OD20				7,466				
OD	490		-	370				
OC	-			184				
hloride	520	2,830	5,200	7,527				
luoride	160		190	80				
ulfate	-	288	-	796				
otal Solids	7,200		15,500	22,340				
uspended Solids	-	1,622	3,000	6,548				
issolved Solids	12,000		11,300	12,850				
otal Phosphorus	-							
mmonia (N)	840		800	1,026				
itrate + Nitrite -N	-			25				
KN	870							
il and Grease	-	521	-	-				
yanide	6.5		100	57				
henols	11.2		10	3.5				
otal Chromium	-		-	-				
exavalent Chromium			-					
otal Copper	-		-	-				
otal Iron	980	21.4	320	88				
otal Lead	17		-	10.7				
otal Manganese			80					
otal Mercury	0.012		-					
otal Nickel								
otal Sodium	2,400			1,842				
otal Zinc	95		20	55				
hermal Load (10^6 BTU/hr)	185		120	195				

TABLE VII-4

BLACK RIVER PLANNING AREA - WEST BRANCH

EFFLUENT LOADINGS (LBS/DAY)
(Gross except where noted)

ischarger	GMC-Fisher Body Storm Sewer	Republic Steel 002 (Net) W.Br. Black River	Republic Steel 001 (Net) W.Br. Black R.	Lagrange STP Kelner Ditch	Oberlin STP Plum Creek	Wellington STP Tributary to Charlemont Creek	Sterling Foundry Tributary to Charlemont Creek	Wellington WTP Charlemont Cre
ile Point - Main Stem	0.7	1.8	2.2	8.8	10.3	26.6	26.6	26.6
Source	COE Permit Appli.; OEPA data July'73-June'74	COE Permit Application	COE Permit Application	1973 Ohio EPA Monthly Data	1973 Ohio EPA Monthly Data	1973 Ohio EPA Monthly Data	COE Permit Application	July-Oct. 197 Ohio EPA Monthly Data
ow (mgd)	1.46	0.58	1.34	0.083	1.17	0.47	0.0055	0.012
BOD_5	-	-	-	3.8	160	31	0.32	
COD	8.25	44	110				110	
TOC	192							
hloride	2,470	-	70				1.9	
luoride	-	0.24	-				0.024	
ulfate	2,900	2,500	110				2.5	
tal Solids	18,000	3,200	1,800				34	
uspended Solids	160	-	1,800	3.4	105	33	9	32
issolved Solids	17,500	3,000	-				25	
tal Phosphorus	4.2						-	
monia (N)	51	0.04	0.11				0.008	
itrate + Nitrite -N	22	4.8	-				0.016	
KN	70	-	2.3				0.5	
il and Grease	200	34	45				0.06	
anide	0.5	-	-				-	
henols	0.13	0.17	0.22				-	
tal Barium	-						-	
tal Cadmium	-	-	-				-	
tal Chromium	3.7	-	0.5				-	
xavalent Chromium	2.4						-	
tal Copper	2	0.7	0.7				-	
tal Iron	3.5	720	1,400				-	
tal Lead	0.3	0.04	-				-	
tal Manganese	-						-	
tal Mercury	-						-	
tal Nickel	5.6	0.13	0.3				-	
tal Zinc	9.5	0.3	-				-	
ermal Load (10^6BTU/hr.)							-	

TABLE VII-5

BLACK RIVER PLANNING AREA - EAST BRANCH OF THE BLACK RIVER

EFFLUENT LOADINGS (LBS/DAY)
(Gross except where noted)

scharger	Harshaw Chemical E.Br.Black River	Harshaw Chemical E.Br.Black River	Pfaudler Co. Storm Sewer	General Industries Storm Sewer	Abex Corp. Storm Sewer	Lear Siegler Co. Storm Sewer	Eaton Estates STP Willow Creek	Brentwood Lake Estates STP Trib.to E.B.Black
le Point - Main Stem	0.7	0.7	1.0	1.0	1.0	1.0	5.5	5.9
a Source	Consent Decree Interim Limits	Aug.28-29, 1974 U.S. EPA Survey	COE Permit Application	Elyria City Permit	COE Permit Application	COE Permit Application	1973 Monthly Data Ohio EPA	Jan.-Feb. 1974 Ohio EPA Monthly Data
w (mgd)	0.479	0.59	0.003	0.017	0.044	0.0144	0.094	0.07
)r				0.76	2.4	0.16	8.3	2.7
)				27	15	14		
C		74		19				
loride		18,220	0.6	6	12	3.8		
uoride		9.4	0.025		0.16			
lfate		3,100	0.7	7.1	-	1.4		
tal Solids		24,500	4.9	37	113	26.5		
spended Solids	1,600	3,400		0.3	18	3.7	9.1	5.4
ssolved Solids		21,960		36	95	23		
tal Phosphorus		0.8	-	0.14	-	-		
onia (N)	1,000	144			-	-		
trate + Nitrite -N		39	0.025	0.11	-	-		
N		162			-	0.002		
l and Grease	40	8.9		19.3	33	1.6		
anide		-		0.03		-		
enols		-				-		
tal Barium		0.6		-		0.7		
tal Cadmium	4	4.1			0.055	-		
tal Chromium	8	2			0.02	-		
xavalent Chromium				0.025		-		
tal Copper	12	3.1				0.002		
tal Iron		37	0.003	0.13	0.1	0.004		
tal Lead	4	0.9		1.3		-		
tal Manganese		0.7		0.02	-	-		
tal Mercury	0.02	0.0039			-	-		
tal Nickel	8	0.5				0.004		
tal Zinc	8	6.9		0.1		-		
ermal Load (10^6BTU/hr.)								

TABLE VII-5
(Cont'd)

BLACK RIVEP FLANNING AREA - EAST BRANCH OF THE BLACK RIVER

EFFLUENT LOADINGS (LBS/DAY)
(Gross except where noted)

scharger	Grafton State Farm STP Trib. to E.B. Black	Grafton STP E.Br. Black River	Spencer STP Spencer Creek	Lodi STP E.Fk.E.Br.Black R	Harris Tire Serv. Trib. to E.Fk.E.Br. Black River			
le Point - Main Stem	5.9	11.2	34.9	45.1	45.1			
ta Source	Jan.'72-Jan.'73 OHIO EPA Monthly Data	1971-1972 OHIO EPA Monthly Data	1973 OHIO EPA Monthly Data	1973 OHIO EPA Monthly Data	COE Permit Application			
w (mgd)	0.06 (Est.)	0.18 (Est.)	0.074	0.28	0.018			
D5	9.4	28	12	9.64	0.45			
D					2.25			
C								
loride								
uoride								
lfate								
tal Solids								
spended Solids	15	18	15	7.8	0.45			
ssolved Solids								
tal Phosphorus								
monia (N)								
trate + Nitrite -N								
N								
l and Grease								
anide								
enols								
tal Barium								
tal Cadmium								
tal Chromium								
xavalent Chromium								
tal Copper								
tal Iron								
tal Lead								
tal Manganese								
tal Mercury								
tal Nickel								
tal Zinc								
ermal Load (10^6 BTU/hr.)								

TABLE VII-6

BLACK RIVER PLANNING AREA - BEAVER CREEK BASIN

EFFLUENT LOADINGS (LBS/DAY)
(Gross except where noted)

charger e Point - Main Stem	Amherst STP Beaver Creek 3.7	Ohio Turn.Plaza STP Trib.to Beaver Cr. 5.1	B-Bar-B Mobile Homes STP Beaver Creek 5.6	Pinecrest Apts. STP Beaver Creek 6.7				
a Source	1973 OHIO EPA Monthly Data	1973 OHIO EPA Monthly Data	1973 OHIO EPA Monthly Data	1973 OHIO EPA Monthly Data				
w (Mgd)	1.55	0.064	0.08 (Design)	0.025 (Design)				
5	343	1.5	5.5	0.3				
)								
loride								
loride								
lfate								
tal Solids								
spended Solids	400	1.6	6.8	0.6				
ssolved Solids								
tal Phosphorus	160							
monia (N)								
trate + Nitrite -N								
l								
l and Grease								
anide								
enols								
tal Barium								
tal Cadmium								
tal Chromium								
xavalent Chromium								
tal Copper								
tal Iron								
tal Lead								
tal Manganese								
tal Mercury								
tal Nickel								
tal Zinc								
ermal Load (10^6BTU/hr.)								

TABLE VII-7

LAKE ERIE DISCHARGERS

EFFLUENT LOADINGS (LBS/DAY)
(Gross except where noted)

...scharger ...le Point - Main Stem	Elyria Water Treatment Plant	Lorain Water Treatment Plant	Ohio Edison Edgewater Plant	Ohio Edison Edgewater Plant	Cresthaven Homes STP*			
...ta Source	COE Permit Application	COE Permit Application	1974 Ohio EPA Monthly Data	COE Permit Application	1973 Ohio EPA Monthly Data			
...w (mgd)	0.75	0.04	110.2	117.17	0.058			
...D5				4,880	2.6			
...D				39,020				
...C								
...loride	150							
...oride								
...lfate	11,000			9,170				
...al Solids			197,100					
...spended Solids			63,800		4			
...ssolved Solids								
...al Phosphorus				960				
...onia (N)				240				
...rate + Nitrite -N				1,370				
...				510				
... and Grease				-				
...nide				-				
...nols								
...al Barium								
...al Cadmium				-				
...al Chromium				26				
...avalent Chromium								
...al Copper				52				
...al Iron				1,940				
...al Lead				-				
...al Manganese				81				
...al Mercury				-				
...al Nickel				-				
...al Zinc				17				
...rmal Load (10^6 BTU/hr.)				655				

* Discharges to Martin Run

SECTION VIII
EXISTING WATER QUALITY, BIOLOGY, and SEGMENT CLASSIFICATION

A. EXISTING WATER QUALITY

Secondary objectives of the Waste Load Allocation Report are to characterize the existing water quality of Planning Area streams and to define streams and stream segments where State-adopted, Federally-approved water quality standards are not being achieved. Unfortunately, there is no long-term comprehensive water quality data base for the entire Black River Planning Area. Table VIII-1 is a listing of current water quality stations maintained by the USGS, Ohio EPA, Lorain County Metropolitan Park District, and municipal sewage treatment plants. Figure VIII-1 illustrates the station locations. Although the reasons for maintaining these sampling stations are diverse, there is some duplication of effort which could be partially minimized by the implementation of the recommended Primary Water Quality Network (Section X) and more importantly, through coordination of the monitoring programs by the Ohio EPA. Water quality data obtained by these sources are briefly reviewed below and are presented in Volume II. Also included are the results of several U.S. EPA surveys.

In general, water quality upstream of Elyria is fairly good with isolated problems caused by discharges from smaller municipal and industrial facilities. However, from Elyria downstream to Lake Erie, the water quality in the Black River is poor owing to discharges from the Elyria STP and the U.S. Steel-Lorain Works.

TABLE VIII-1

BLACK RIVER PLANNING AREA
STREAM MONITORING STATIONS

Operating Agency	Station No.	Stream	Station Description	Latitude	Longitude	River Mile	Analyses*	Frequency
ited States Geological Survey	4	Black River	Black River at Ford Road Elyria	41°24'42"	82°05'45"	9.8	2,3,5,16,17,18,20,21,23,24,26 27,28,29,38,42	Biweekly
	4	Black River	Black River at Ford Road Elyria	41°24'42"	82°05'45"	9.8	3,5,7	Continuous
	8	Black River	Black River in Cascade Park Elyria	41°22'49"	82°06'17"	14.8	1	Continuous
	16	East Branch of Black River	East Branch at Crook Street Grafton	41°15'51"	82°03'39"	13.1	2,3,5,10,16,17,18,20,21,23,24, 26,27,28,29,38,42,44	Biweekly**
	16	East Branch of Black River	Eest Branch at Crook Street Grafton	41°15'51"	82°03'39"	13.1	3,5	Continuous
	17	West Branch of Black River	West Branch, 200' upstream of U. S. 20 - Elyria	41°20'10"	82°07'15"	4.2	2,3,5,10,16,17,18,20,21,23,24, 26,27,28,29,38,42,44	Biweekly**
	17	West Branch of Black River	West Branch, 200' upstream of U. S. 20 - Elyria	41°20'10"	82°07'15"	4.2	3,5	Continuous
	20	West Branch of Black River	West Branch at Kipton - Nickel Road - Oberlin	41°15'54"	82°10'47"	16.9	2,3,5,16,17.18,20,23,24,26,27,28	Yearly
	20	West Branch of Black River	West Branch at Kipton - Nickel Road - Oberlin	41°15'54"	82°10'47"	16.9	1	***
io EPA	5	Black River	Black River at Ford Road Elyria	41°24'42"	82°05'45"	9.8	1,3,5,7,18,21,23,24,52	Biweekly
	5	Black River	Black River at Ford Road Elyria	41°24'42"	82°05'45"	9.8	8,9,13,14,15,16,26,30,33,34,36, 39,40,47	Every 3 weeks

* See attached key
* Hg. TOC-3 times per year
* During low flow periods

TABLE VIII-1 (Cont'd)

BLACK RIVER PLANNING AREA
STREAM MONITORING STATIONS

Operating Agency	Station No.	Stream	Station Description	Latitude	Longitude	River Mile	Analyses*	Frequency
ıio EPA (Cont'd)	5	Black River	Black River at Ford Road Elyria	41°24'42"	82°05'45"	9.8	2,10.12.20.32.37,49,53	Every 4 weeks
	5	Black River	Black River at Ford Road Elyria	41°24'42"	82°05'45"	9.8	11,22,25,29,30,35,37,41,42,43,44, 45,46,48,54	<Monthly
ɔraIn County Metro Park Commission	3	Black River	Black River at SR 2 Bridge Elyria	41°24'38"	82°06'00"	9.5	2,3,4,6,7,9,19,23,26,50,51,52	Weekly
	9	Black River	Black River in Cascade Park Elyria	41°22'45"	82°06'28"	14.9	2,3,4,6,7,9,19,23,26,50,51,52	Weekly
	10	French Creek	French Creek at East River Rd. Sheffield	41°27'28"	82°06'20"	0.6	3,50	Biweekly
	11	French Creek	French Creek at Root Road North Ridgeville	41°23'28"	82°00'42"	13.0	3,50	Biweekly
	12	French Creek	French Creek at Lear-Nagel Rd. North Ridgeville	41°23'59"	81°59'31"	16.3	3,50	Biweekly
	13	Jungbluth Ditch	Jungbluth Ditch at E. River Rd Sheffield	41°27'28"	82°06'19"	0.1	3,50	Biweekly
	14	Unnamed Tributary to French Creek	Unnamed Trib. at Jaycox Road North Ridgeville	41°25'07"	82°00'23"	0.5	3.50	Biweekly
	15	East Branch of Black River	East Branch at Robson Road Laporte	41°19'38"	82°04'14"	5.7	2,3,4,6,7,9,19,23,26,50,51,52	Weekly
	18	West Branch of Black River	West Branch at Carlisle Reservation, Carlisle Twp.	41°16'45"	82°08'47"	9.8	2,3,4,6,7,9,19,23,26,50,51,52	Weekly

* See Attached key

TABLE VIII-1 (Cont'd)

BLACK RIVER PLANNING AREA
STREAM MONITORING STATIONS

Operating Agency	Station No.	Stream	Station Description	Latitude	Longitude	River Mile	Analyses*	Frequency
ain County Metro ark Commission (Cont'd)	19	West Branch of Black River	West Branch at Parsons Road Russia Township	41°16'45"	82°09'46"	14.6	2,3,4,6,7,9,19,23,26,50,51,52	Weekly
	21	Plum Creek	Plum Creek at U.S. 20-SR10 Carlisle Township	41°18'03"	82°09'35"	0.8	2,3,4,6,7,9,19,23,26,50,51,52	Weekly
ain STP	1	Black River	Black River, 200' downstream of outfall - Lorain	41°28'17"	82°10'56"	0.16	7,8	Daily
	1	Black River	Black River, 200' downstream of outfall - Lorain	41°28'17"	82°10'56"	0.16	52	3/week
	1	Black River	Black River, 200' downstream of outfall - Lorain	41°28'17"	82°10'56"	0.16	15,16,17,18,19	Weekly
	2	Black River	Lorain STP, 200' upstream of outfall - Lorain	41°28'14"	82°10'47"	0.24	7,8	Daily
	2	Black River	Lorain STP, 200' upstream of outfall - Lorain	41°28'14"	82°10'47"	0.24	52	3/week
	2	Black River	Lorain STP, 200' upstream of outfall - Lorain	41°28'14"	82°10'47"	0.24	15,16,17,18,19	Weekly
·ia STP	6	Black River	Black River, 1000' downstream of outfall - Elyria	41°24'35"	82°05'26"	10.2	7,8	2/week
	6	Black River	Black River, 1000' downstream of outfall - Elyria	41°24'35"	82°05'26"	10.2	15,16,17,18,19,52	Weekly
	7	Black River	Black River, 1000' upstream of outfall - Elyria	41°24'29"	82°05'37"	10.6	7,8	2/week

See attached key

TABLE VIII-1 (Concl'd)

BLACK RIVER PLANNING AREA
STREAM MONITORING STATIONS

Operating Agency	Station No.	Stream	Station Description	Latitude	Longitude	River Mile	Analyses*	Frequency
Elyria STP (Cont'd)	7	Black River	Black River, 1000' upstream of outfall - Elyria	41°24'29"	82°05'27"	10.6	15,16,17,18,19,52	Weekly
Amherst STP	22	Beaver Creek	Beaver Creek, 500' downstream of outfall	41°24'36"	82°13'57"	3.6	7	Daily
	22	Beaver Creek	Beaver Creek, 500' downstream of outfall	41°24'36"	82°13'57"	3.6	8	Biweekly
	23	Beaver Creek	Beaver Creek, 500' upstream of outfall	41°24'27"	82°13'57"	3.8	7	Daily
	23	Beaver Creek	Beaver Creek, 500' upstream of outfall	41°24'27"	82°13'57"	3.8	8	Biweekly

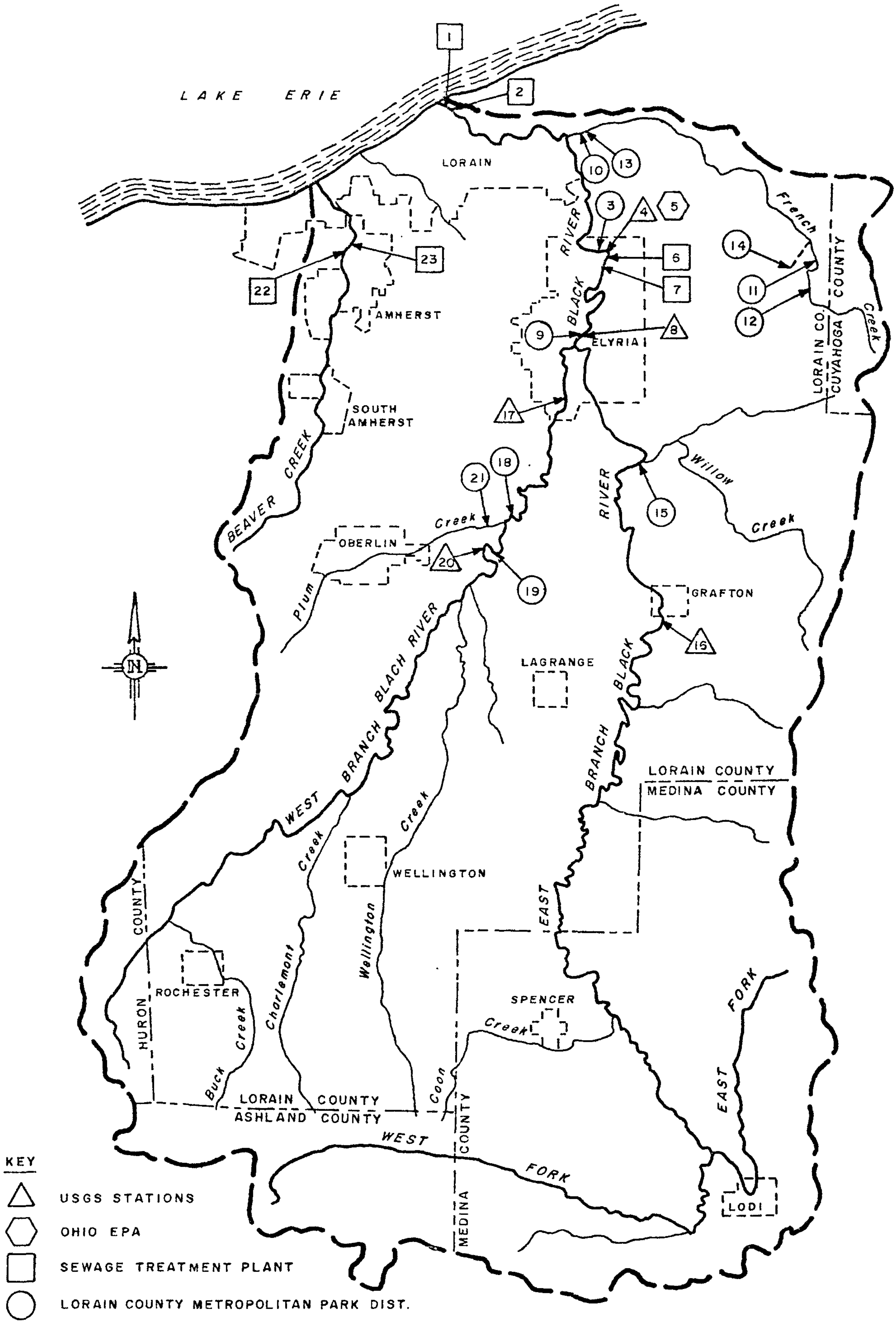
* See attached key

Key for Table VIII-1

Number	Constituent	Number	Constituent
1	Flow	28	Carbonate
2	pH	29	Total Hardness
3	Temperature	30	Alkalinity
4	Turbidity	31	Cyanide
5	Conductivity	32	Hexavalent Chromium
6	Color	33	MBAS
7	Dissolved Oxygen	34	Aluminum
8	BOD_5	35	Arsenic
9	COD	36	Barium
10	TOC	37	Cadmium
11	Phenols	38	Calcium
12	Oil and Grease	39	Copper
13	Pesticides	40	Iron
14	TKN	41	Lead
15	Ammonia-N	42	Magnesium
16	Nitrate-N	43	Manganese
17	Nitrite-N	44	Mercury
18	Total Phosphorus	45	Nickel
19	Orthophosphate	46	Potassium
20	Total Solids	47	Selenium
21	Dissolved Solids	48	Sodium
22	Volatile Solids	49	Zinc
23	Chloride	50	Total Bacteria
24	Fluoride	51	Total Coliform
25	Sulfite	52	Fecal Coliform
26	Sulfate	53	Fecal Streptococci
27	Bicarbonate	54	Chlorine Demand

FIGURE VIII-1

BLACK RIVER PLANNING AREA STREAM MONITORING STATIONS



1. USGS

The USGS monitors the East and West Branches of the Black River for calcium, magnesium, alkalinity, hardness, dissolved solids, chloride, sulfate, fluoride, nitrite, nitrate, pH, specific conductance, temperature, total organic carbon, and mercury. Temperature and specific conductance are monitored continuously. Grab samples are obtained two or three times per month, but all of the above constituents are not analyzed each sampling. Streamflows are not recorded at the time of sampling. Data obtained for the West Branch for the 1973 water year (Station 04200400) near U.S. Highway 20 indicate the stream is moderately hard to hard with total hardness concentrations ranging from 110 to 360 mg/l. Most values were above 200 mg/l. The stream is slightly alkaline with pH values ranging from 7.1 to 8.7 standard units. From these data it appears that water quality standards for chloride, dissolved solids, pH, temperature and mercury are being achieved. The stream quality of the East Branch (Station 04199900) is similar to that of the West Branch except for a slightly lower pH in the range of 6.9 to 8.5 standard units. Mercury was detected at 1.1 μg/l on one occasion, exceeding the 0.5 μg/l water quality standard. Water quality at these stations is generally good since they are above the most significant point source dischargers in the basin. However, because of the limited scope of the sampling program, and the lack of data at water quality design flows, a full assessment of compliance with water quality standards at these locations cannot be made solely with USGS data.

In addition to continuous monitoring for dissolved oxygen and grab sampling for total phosphorus, the Black River is monitored by the USGS at the Ford Road bridge below the Elyria Sewage Treatment Plant at the same frequency and for the same constituents described above. The effects of the dischargers in the Elyria area and most notably the effects of the Elyria STP are quite evident as shown by the dissolved oxygen data. The then effective daily minimum water quality standard of 4.0 mg/l was not achieved on 26 of 30 days in June 1973, 21 of 31 days in July, 31 of 31 days in August and every day the monitor was in service during September. This trend continued in the 1974, 1975, and 1976 water years. The daily average standard of 5.0 mg/l was also not achieved for most of the 1973 summer.

These trends for dissolved oxygen continued through 1976 except for periods of abnormally high river flows. The hardness and pH data are similar to data obtained for the tributaries, although dissolved solids concentrations are somewhat higher. As noted above the limited scope of the USGS sampling permits only a partial assessment of compliance with water quality standards.

2. OHIO EPA (Attachment A, Volume II)

The Ohio EPA also samples the Black River at the Ford Road bridge and at Cascade Park. The frequency of analysis is monthly and more of the water quality limited constituents are studied. Data from the State's 1976-77 Section 305(b) report to the U.S. EPA are presented in Attachment A, Volume II. Data are included for many of the constituents studied by the USGS and also include analyses for metals, pesticides, phenolics, MBAS, nutrients, cyanide, and chemical and biochemical oxygen demand. These data show continual bacterial contamination and relatively high concentrations of ammonia, cadmium, hexavalent chromium, copper, zinc, phenolics, total Kjeldahl nitrogen, total organic carbon, and oxygen demanding substances. Arsenic, mercury, lead, and selenium, as well as all of the common pesticides studied were not detected.

3. LORAIN COUNTY METROPOLITAN PARK DISTRICT (Attachment B, Volume II)

The Lorain County Metropolitan Park District (LCMPD) monitors the Black River in Cascade Park and in the Black River Reservation at Route 2, the East Branch at LaPorte, the West Branch at Parsons Road and at Carlisle Reservation, and Plum Creek at the intersection of Routes 10 and 20.[2] Samples are collected and analyzed for temperature, dissolved oxgyen, chemical oxygen demand, pH, color, turbidity, total bacteria, total and fecal coliform, chloride, sulfate, and total and orthophosphate. The LCMPD also monitored four stations for total bacteria during 1974. Data for 1973 and 1974 are presented in Attachment B, Volume II.

These data show the Black River at Cascade Park and in the Black River Reservation to be in compliance with the pH and chloride water quality standards and in substantial compliance with the dissolved oxygen standards. Concentrations of less than 5.0 mg/l were recorded on only one day in August 1973 at each station. The former fecal coliform standard of 200 organisms/100 ml (geometric mean) appears to be exceeded a large portion of the time at each station. The bacterial contamination in the Elyria area probably results from combined sewer overflows and from septic tank drainage in areas not serviced by sewers. Data for the East Branch at LaPorte show the stream to be in compliance with pH, dissolved oxygen, and chloride standards, but not in compliance with the bacteriological standards.

The water quality at the West Branch stations is similar to that on the East Branch and the main stem, although the bacterial densities are less at the Parsons Road Station. The Plum Creek station had the highest bacterial densities and the lowest dissolved oxygen concentrations during 1973, most likely the result of discharges from the Oberlin STP.

4. MUNICIPAL SEWAGE TREATMENT PLANTS (Attachment C, Volume II)

Most municipalities operating sewage treatment plants are required by the State of Ohio to monitor the receiving streams upstream and downstream of the plant discharges on a continuing basis consistent with plant performance monitoring. The larger facilities generally monitor the streams for BOD_5, dissolved oxygen, ammonia, total nonfilterable solids, and fecal coliform, while the smaller facilities generally monitor for BOD_5 and dissolved oxygen only. Data obtained during 1974 upstream and downstream of the Elyria, Lorain, and Amherst sewage treatment plants are presented in Attachment C, Volume II. Because these data are not always related to streamflow at the time of sampling, it is not possible to quantitatively assess the impact of these facilities on the receiving streams. In the case of the Lorain STP, which discharges to the Black River near its mouth in Lake Erie, surface samples are taken along the left bank of the river looking upstream. Because of the sampling locations and the complicated hydrology in that area, these data cannot be employed to fully assess the impact of the Lorain STP. The data obtained generally illustrate bacterial contamination above and below the municipal facilities, and high ammonia concentrations in the Black River.

5. OTHER MONITORING

The then Ohio Department of Health, Division of Engineering conducted a survey of the Black River in the Elyria area in October and November 1970.[3] The results of that survey are presented as Attachment D, Volume II.

6. U.S. EPA SURVEYS

From 1972 to 1979 the U.S. EPA has conducted numerous water quality surveys in the Black River basin to support enforcement actions with the U.S. Steel Corporation for its Lorain Works and to develop the data necessary to complete this waste load allocation. The results of these studies are presented in Volume II, Attachments E to M. A brief description of each is provided below.

a. March 1-3, 1972 (Attachment E, Volume II)

A fish flesh tainting study was completed in the vicinity of the U.S. Steel - Lorain Works under high stream flow conditions in March 1972.[4] The results indicate that fish flesh flavor was adversely affected from downstream of U.S. Steel Outfall 002 (coke plant) to the downstream end of the U.S. Steel turning basin. Phenolics and possibly oils were indicated to be possible causes of the tainting.

b. September 12-14, 1972 (Attachment F, Volume II)

Grab samples were obtained at eight locations from River Mile 6.6, above U.S. Steel, to the lake. The data demonstrate the intrusion of lake water at the U.S. Steel plant and the highest levels of ammonia and cyanide near the coke plant outfall (river mile 3.5).

c. April 30, 1974 (Attachment G, Volume II)

Grab samples were obtained at 22 stations in the upper Black River and Beaver Creek on April 30, 1974 (five on Beaver Creek, nine on the East Branch of the Black River, and, eight on the West Branch). Data from this survey clearly demonstrated the adverse impact of the Amherst STP on Beaver Creek and highlighted relatively minor water quality problems in the upper part of the Black River basin. Bacterial contamination was prevalent at all sampling stations and high oxygen demand and ammonia concentrations were detected below several smaller sewage treatment plants. However, these problems affect only limited areas downstream of the plants.

d. May 2, 1974 (Attachment H, Volume II)

Eighteen locations on the main stem of the Black River from the confluence of the East and West Branches in Elyria to the river mouth, one location in French Creek, and two locations in Lake Erie were sampled on May 2, 1974.[4] Grab samples were obtained at each site and temperature, dissolved oxygen and conductivity profiles were completed at one foot or three foot intervals at the deep water stations. The data from this survey demonstrated the significant increase in stream temperature caused by the U.S. Steel - Lorain Works and highlighted the impact of the Elyria STP and U.S. Steel discharges on dissolved oxygen levels in the lower river. Concentrations as low as two to three milligrams per liter were recorded despite a river flow of 168 cfs. Problems with ammonia, cyanide and phenolics were also noted in the lower river. A total cyanide concentration of 230 μg/l was recorded near U.S. Steel. The present water quality standard is 25 μg/l. Relatively high levels of metals were also detected. The intrusion of lake water into the Black River was again demonstrated.

e. July 23-26, 1974 (Attachment I, Volume II)

An intensive survey of the lower Black River was completed from July 23-26, 1974.[4] Three consecutive 24 hour composite samples were obtained at fourteen locations from Elyria to Lake Erie as well as at the Elyria and Lorain sewage treatment plants and at U.S. Steel outfalls and intakes. The data from this survey were used to develop temperature and dissolved oxygen water quality models of the lower Black River. The survey was conducted during a period of dry weather and low stream flow which represented near critical conditions. Temperature and dissolved oxygen problems noted in the May 1974 survey were accentuated and the lake intrusion flow was actually demonstrated with precise velocity measurements using special instrumentation. Reference is made to Attachment I, Volume II and Appendices II and III for additional detail.

f. July 9-11, 1974 (Attachment J, Volume II)

A benthic and sediment chemistry survey of the lower Black River including sixteen sampling sites was conducted from July 9-11, 1974. These data confirmed what was indicated by the poor water quality data below Elyria and demonstrated that benthic conditions in the stream had deteriorated from 1972 when a similar study was conducted. Sediment chemistry and benthic data obtained in the vicinity of U.S. Steel clearly demonstrated the adverse biological impact of plant discharges. Extremely high oil levels were found in the sediments downstream of U.S. Steel Outfall 001.

g. July 9-11, 1974 (Attachment K, Volume II)

In conjunction with the biological survey and the July 23-26, 1974 intensive survey, sediment samples and water samples from selected

U.S. Steel outfalls were analyzed for polynuclear aromatic hydrocarbons.[5] Some of these compounds are known carcinogens. The results of the study confirmed the presence of polynuclear aromatic compounds in the sediments near the U.S. Steel Plant, most notably near the coke plant Outfall 002.

h. September 16, 1975 (Attachment L, Volume II)

Grab samples were obtained at nine sampling points from U.S. Steel river intake WI-3 to Lake Erie on September 16, 1975. Surface, mid-depth, bottom samples were collected at the deep water stations. The data are presented in Attachment L, Volume II.

i. July 16-19, 1979 (Attachment M, Volume II)

A second intensive survey of the lower Black River was completed from July 16-19, 1979. Most of the sampling points employed in the July 23-26, 1974 survey were included, the only significant difference being that depth-integrated samples were obtained at the deep water stations in lieu of surface mid-depth and bottom samples. The data from this survey are presented in Attachment M, Appendix II, and reviewed in Appendices II and III. Since there were no significant differences in waste treatment at the Elyria STP and U.S. Steel, the stream quality data obtained are quite similar to those obtained in 1974. Stream flow conditions were also close to critical or design levels and lake intrusion was again demonstrated.

B. BIOLOGY OF THE BLACK RIVER

History

Changes in the aquatic biota of Lake Erie and its southern tributaries over the past 150 years have been attributed to a variety of factors. Ditching and draining of the marshes and swamps near rivers and along the lakeshore eliminated large areas of valuable aquatic habitat. These areas supported large stands of aquatic vegetation used for feeding, spawning, and nursery areas by native fish such as northern pike, muskellunge, mud-minnows, and sticklebacks. The rich benthic community usually associated with this aquatic vegetation was also adversely impacted. Once these drained areas were farmed, soil erosion increased and siltation of the previously silt-free gravel riffles and sand bottom pools reduced spawning habitats for fish including river chub, bigeye chub, hornyhead chub, mimic shiner and sand darter. The construction of mill dams on tributary streams also had deleterious effects on fish, blocking migratory routes of species such as lake sturgeon, smallmouth bass, walleye and a variety of suckers. In addition to these stream alterations, the population growth and industrial development in the area resulted in the introduction of a variety of organic and inorganic materials into the lake and streams of the region. These factors indicate that the biota currently inhabiting Lake Erie and tributary streams such as the Black River are the end product of decades of adverse influences stemming from development of the region.

2. Fish

Early studies of the fish of Lorain County indicated the presence of eighty-three species from the Black River, Vermilion River and adjacent areas of Lake Erie in 1889 to 1892. Those species which could be equated with current common and scientific names are presented in Table VIII-2. Fish reported as abundant in the area included lake sturgeon, white sucker, black redhorse, shorthead redhorse, bluntnose minnow, sand shiner, common shiner, emerald shiner, hornyhead chub, creek chub, golden shiner, lake herring, mudminnow, green sunfish, pumpkinseed and freshwater drum. Other common species in the area were walleye, sauger, yellow perch, largemouth bass, smallmouth bass, rock bass, muskellunge and channel catfish. Goldfish were not reported at this time and carp were uncommon.

In a seining study conducted from 1959 to 1960, forty-eight species and five hybrid combinations of fish were reported from collections made throughout the Black River Basin. These species are presented in Table VIII-2. Those fish which were only encountered in the mainstem of the Black River and French Creek excluding hybrids are depicted in Figure VIII-2. This study concluded that fish which required unsilted streams and an abundance of aquatic vegetation such as the brown bullhead, rosyface shiner, hornyhead chub, sand shiner and pumpkinseed, which were common or abundant in 1892, had decreased in abundance. Those species favoring muddy conditions or

TABLE VIII-2

FISH COLLECTED FROM THE BLACK RIVER AND ADJACENT WATERS

Scientific Name	Common Name	Year of Study 1889-1892*	1959-1960**	1971-1974†
ACIPENSERIDAE (sturgeon)				
Acipenser fulvescens	Lake sturgeon	X		
AMIIDAE (bowfin)				
Amia calva	Bowfin	X		X
ANGUILLIDAE (freshwater eel)				
Anguilla rostrata	American eel	X		
ATHERINIDAE (silversides)				
Labidesthes sicculus	Brook silverside	X		X
CATOSTOMIDAE (suckers)				
Carpiodes cyprinus	Quillback	X		X
Catostomus commersoni	White sucker	X	X	X
Erimyzon sucetta	Lake chubsucker	X		
Hypentelium nigricans	Northern hog sucker	X	X	X
Minytrema melanops	Spotted sucker	X		X
Moxostoma anisurum	Silver redhorse	X		
Moxostoma carinatum	River redhorse	X		
Moxostoma duquesnei	Black redhorse	X		X
Moxostoma erythrurum	Golden redhorse		X	X
Moxostoma macrolepidotum	Shorthead redhorse	X		X
CENTRARCHIDAE (sunfish)				
Ambloplites rupestris	Rock bass	X	X	X
Lepomis cyanellus	Green sunfish	X	X	X
Lepomis gibbosus	Pumpkinseed	X	X	X
Lepomis gulosus	Warmouth			X
Lepomis humilis	Orangespotted sunfish			X
Lepomis macrochirus	Bluegill	X	X	X
Lepomis megalotis	Longear sunfish	X		
Micropterus dolomieui	Smallmouth bass	X	X	X
Micropterus salmoides	Largemouth bass	X	X	X
Pomoxis annularis	White crappie	X	X	X
Pomoxis nigromaculatus	Black crappie	X		X
CLUPEIDAE (herring)				
Alosa pseudoharengus	Alewife			X
Dorosoma cepedianum	Gizzard shad	X	X	X
COTTIDAE (sculpin)				
Cottus bairdi	Mottled sculpin	X	X	X
CYPRINIDAE (minnows and carp)				
Campostoma anomalum	Stoneroller	X	X	X
Carassius auratus	Goldfish		X	X
Clinostomus elongatus	Redside dace	X	X	
Cyprinus carpio	Carp	X	X	
Ericymba buccata	Silverjaw minnow	X	X	X
Hybopsis amblops	Bigeye chub	X		X
Hybopsis storeriana	Silver chub	X		
Nocomis biguttatus	Hornyhead chub	X	X	
Nocomis micropogon	River chub			X
Notemigonus crysoleucas	Golden shiner	X	X	X
Notropis ardens	Rosefin shiner	X		
Notropis atherinoides	Emerald shiner	X	X	X
Notropis blennius	River shiner			
Notropis chrysocephalus	Striped shiner			X
Notropis cornutus	Common shiner	X	X	
Notropis dorsalis	Bigmouth shiner		X	
Notropis emiliae	Pugnose shiner			X
Notropis hudsonius	Spottail shiner	X	X	X
Notropis rubellus	Rosyface shiner	X	X	X
Notropis spilopterus	Spotfin shiner		X	X
Notropis stramineus	Sand shiner	X	X	X
Notropis umbratilis	Redfin shiner		X	X
Notropis volucellus	Mimic shiner			X
Notropis whipplei	Steelcolor shiner	X		
Notropis heterolepis	Blacknose shiner		X	
Phoxinus eos	Northern redbelly dace		X	
Phoxinus erythrogaster	Southern redbelly dace	X	X	
Pimephales notatus	Bluntnose minnow	X	X	X
Pimephales promelas	Fathead minnow	X	X	X

TABLE VIII-2 (Continued)

Scientific Name	Common Name	Year of Study 1889-1892*	1959-1960**	1971-1974†
CYPRINIDAE (Continued)				
Rhinichthys atratulus	Blacknose dace	X	X	X
Rhinichthys cataractae	Longnose dace	X		X
Semotilus atromaculatus	Creek chub	X	X	X
CYPRINODONTIDAE (killifish)				
Fundulus diaphanus	Banded killifish	X		
ESOCIDAE (pike)				
Esox americanus americanus	Redfin pickerel		X	
Esox americanus vermiculatus	Grass pickerel	X		X
Esox lucius	Northern pike	X		X
Esox masquinongy	Muskellunge	X		X
GADIDAE (codfish)				
Lota lota	Burbot	X		X
GASTEROSTEIDAE (stickleback)				
Culaea inconstans	Brook stickleback	X	X	X
HIODONTIDAE (mooneye)				
Hiodon tergisus	Mooneye	X		
ICTALURIDAE (freshwater catfish)				
Ictalurus melas	Black bullhead	X	X	X
Ictalurus natalis	Yellow bullhead	X	X	X
Ictalurus nebulosus	Brown bullhead	X	X	X
Ictalurus punctatus	Channel catfish	X		X
Noturus flavus	Stonecat	X		X
Noturus gyrinus	Tadpole madtom	X		
Noturus miurus	Brindled madtom	X		
LEPISOSTEIDAE (gar)				
Lepisosteus osseus	Longnose gar	X		X
Lepisosteus platostomus	Shortnose gar	X		
OSMERIDAE (smelt)				
Osmerus mordax	Rainbow smelt			X
PERCICHTHYIDAE (temperate bass)				
Morone chrysops	White bass	X	X	X
PERCIDAE (perch)				
Ammocrypta pellucida	Eastern sand darter	X		
Etheostoma blennioides	Greenside darter	X	X	X
Etheostoma caeruleum	Rainbow darter	X	X	X
Etheostoma flabellare	Fantail darter	X	X	X
Etheostoma nigrum	Johnny darter	X	X	X
Perca flavescens	Yellow perch	X	X	X
Percina caprodes	Logperch	X	X	X
Percina copelandi	Channel darter	X		
Percina maculata	Blackside darter	X	X	X
Percina peltata	Shield darter	X		
Percina phoxocephalum	Slenderhead darter	X		
Stizostedion canadense	Sauger	X		
Stizostedion vitreum vitreum	Walleye	X		X
Stizostedion vitreum glaucum	Blue pike	X		
PERCOPSIDAE (trout-perch)				
Percopsis omiscomaycus	Trout-perch	X	X	X
PETROMYZONTIDAE (lamprey)				
Petromyzon marinus	Sea lamprey			X
Ichthyomyzon unicuspis	Silver lamprey	X		X
SALMONIDAE (trout)				
Coregonus artedii	Lake herring	X		
Coregonus clupeaformis	Lake whitefish	X		
Oncorhynchus kisutch	Coho salmon			X
Oncorhynchus tshawytscha	Chinook salmon			X
Salmo gairdneri	Rainbow trout			X
Salvelinus namaycush	Lake trout	X		
SCIAEIDAE (drum)				
Aplodinotus grunniens	Freshwater drum	X		X
UMBRIDAE (mudminnow)				
Umbra pygmaea	Central mudminnow	X	X	
HYBRIDS				
Bluegill X pumpkinseed			X	
Brown bullhead X black bullhead				X

TABLE VIII-2 (Continued)

Scientific Name	Common Name	Year of Study 1889-1892*	1959-1960**	1971-1974†
HYBRIDS (Continued)				
Carp X goldfish			X	X
Common shiner X striped shiner				X
Green sunfish X pumpkinseed			X	
Green sunfish X longear sunfish			X	
Redside dace X redbelly dace			X	
White crappie X black crappie				X
TOTAL NUMBER OF SPECIES EXCLUDING HYBRIDS		83	48	70

* Collected in Black and Vermilion Rivers(8)

** Collected in Black River and its tributaries(9)

† Collected in Lake Erie and lower portions of Chagrin, Cuyahoga and Rocky Rivers(2)

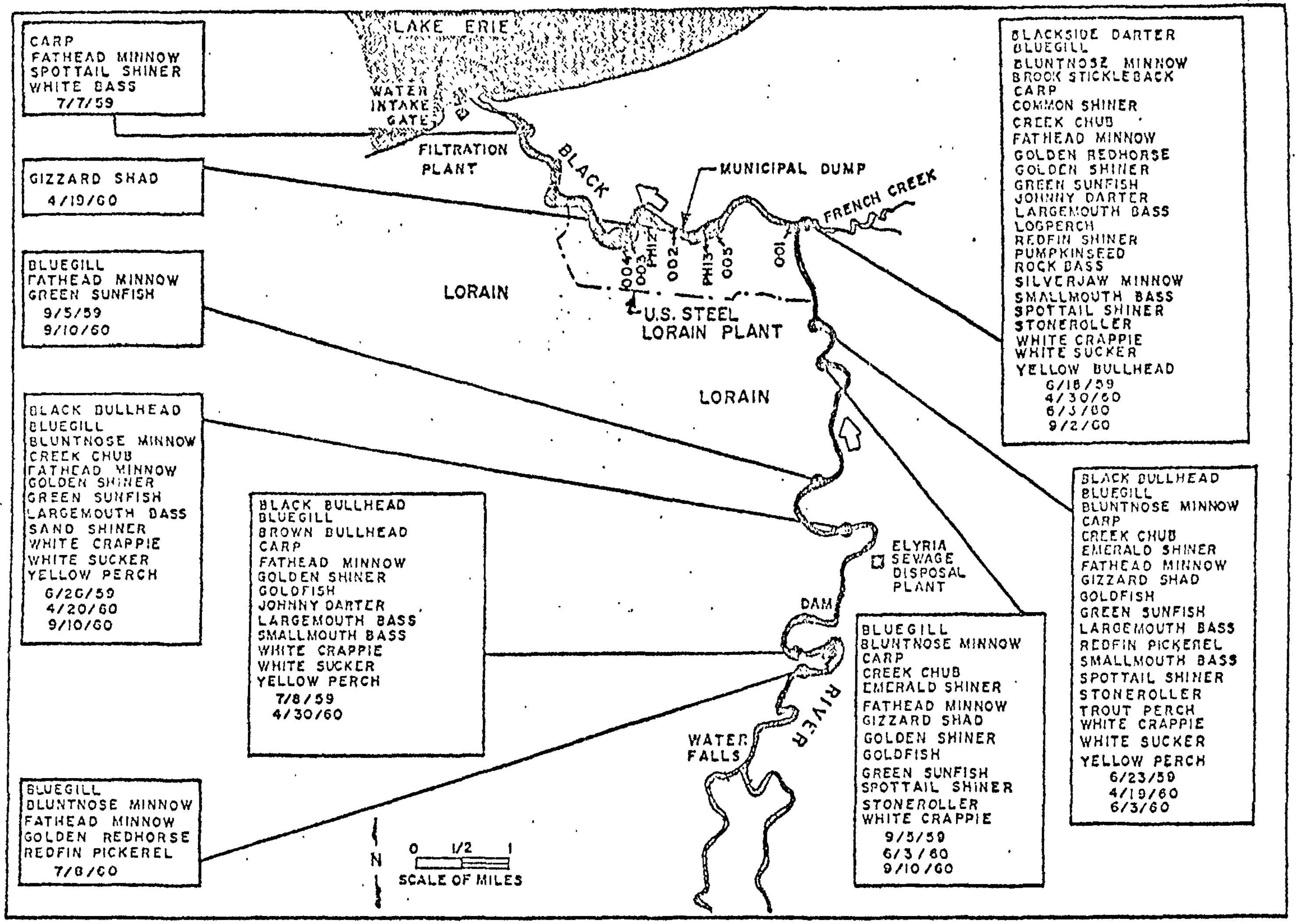


FIGURE VIII-2 Fish Collected During a Seining Study of the Black River and French Creek From 1959 to 1960 little aquatic vegetation such as green sunfish, fathead minnow, black bullhead, creek chub, common shiner and Johnny darter which were reported in 1892 had remained or had become common. Additionally, carp and goldfish had now become established in the area.

An intensive fishery survey of several streams and the lakeshore area near Cleveland, Ohio was conducted from 1971 to 1972. A total of seventy fish species and subspecies (plus six hybrids) were collected from the lakeshore area and the lower portions of the Chagrin, Cuyahoga and Rocky Rivers. These species are presented in Table VIII-2. Predominant species collected (accounting for 5 percent or more of the total number of fish collected) were alewife, gizzard shad, emerald shiner, rosyface shiner, spotfin shiner, bluntnose minnow, yellow perch and a hybrid of the common shiner and striped shiner. Despite the fact that the fish populations in the Cleveland area have been altered in the past 150 years, almost all of the former species are still present within the area. These isolated populations are potential repopulation sources.

In summary, fish studies of the Black River and adjacent waters indicate the fish community of the river has changed substantially since 1889 but that a variety of fish still exist in its mainstem and its tributaries. Other recent fish studies indicate small populations of many species found in the 1800's are present in the lake or other south shore tributaries. These populations represent potential repopulation sources for streams along the south shore of Lake Erie including the Black River.

3. Benthic Macroinvertebrates

Shifts in the major components of the benthic macroinvertebrate community of Lake Erie from one characterized largely by mayflies to one predominated by oligochaeta (aquatic earthworms) worms and midge larvae have been discussed by several authors. Although similar changes would be assumed to have occurred in the benthic macroinvertebrate communtiies of its tributary streams such as the Black River, these changes have not been recorded.

A series of thirty benthic samples collected in the lower reaches of the Black River in 1950 indicated that its benthic community was comprised mainly of tubificid worms (Tubifex and Limnodrilus) and leeches. Worm densities ranged from 598 to 1244 worms per square meter. Sphaeriid clams, midge larvae and amphipods were present but not common. Sediments were reported as being rich in decomposing organic matter similar to the highly enriched western basin tributaries like the Maumee River. The highest levels of organic enrichment in these ten south shore tributaries appeared to be related to high population levels in the stream basins.

The Environmental Protection Agency made collections (July 1972 and 1974) in the Black River from its mouth and adjacent lakeshore area to its East and West Branches above their confluence. In 1972, the sampling was limited to the lower 7 miles of the river. Oligochaeta worms dominated these samples ranging in density from 787 to 243,729 worms per square meter. Leeches were common and midge larvae were generally present in low numbers. Sphaeriid clams were common in the lower 3 miles of the river near the lake and both pulmonate and prosobranch snails appeared infrequently. Amphipods and isopods were collected mainly at the mouth of the river.

In the EPA's July 1974 collections (list of taxa collected shown in Table VIII-3) obligochaeta worms were predominant in samples from the lower 15 miles of the river and ranged from 400 to 502,000 worms per square meter. Leeches were common in the lower 3 miles of the river and sphaeriid clams, pulmonate snails and prosobranch snails in the lower mile. Midge larvae occurred sporadically and were absent from mile 1 to 5. A general improvement in the quality of the benthic community appeared above mile 10 in the Black River and in its East and West Branches. This was noted by the occurrence of mayflies, caddis flies and a variety of midges. EPA concluded that the Black River had a degraded benthic fauna below Elyria to its mouth.

These studies of benthic macroinvertebrates in the lower Black River indicate that at least since 1950 the community has been dominated by oligochaeta worms. Although the specific composition of the worm association in the river is not known it is probably similar to the association in the Cleveland Harbor area. This worm association included large amounts of tubificid worms such as Limnodrilus hoffmeisteri, L cervix and Pelascolex multisetosus and the sphaeriid clam Pisidium all indicative of high levels of

TABLE VIII-3

BENTHIC MACROINVERTEBRATE TAXA COLLECTED IN THE BLACK RIVER BASIN BY EPA IN JULY 1974

ANNELIDA

- Oligochaeta (aquatic "earthworms")
- Hirundinea (leeches)
  - Helobdella sp.
  - H. stagnalis
  - H. elongata
  - Erpobdella sp.

ARTHROPODA

- Crustacea
  - Hyalella arteca
  - Gammarus faciatus
- Insecta
  - Colepotera (aquatic beetles)
    - Dubiraphia sp.
    - Stenelmis sp.
  - Diptera (midges)
    - Abdabesmyia sp.
    - Chironomus sp.
    - Cryptochironomus sp.
    - Cricotopus sp.
    - Polypedilum sp.
    - Tribelos sp.
    - Stictochironomus sp.
    - Endochironomus sp.
    - Tanytarsus sp.
    - Psectrocladius sp.
    - Procladius sp.
    - Simulium sp.
    - Orthocladiinae papae
    - Chironominae pupae
  - Ephemeroptera (mayflies)
    - Hexagenia limbata
    - Caenis sp.
    - Baetis sp.
  - Megaloptera (fishflies)
    - Sialis sp.
  - Trichoptera (caddis flies)
    - Agraylea sp.
    - Chimarra obseura
    - Hydrospsyche sp.
    - Cheumatopsyche sp.
    - Trichoptera pupae

MOLLUSCA

- Gastropoda (snails)
  - Physa sp.
  - Pleurocera ap.
  - Valvata sincera
- Bivalvia (clams)
  - Sphearium sp.
  - S. transversum
  - S. musculum
  - Pisidium sp.

HYDRACARINA (water mites)

PLATYHELMINTHES (flatworms)

- Turbellaria

organic enrichment. Lesser amounts of leeches, pulmonate snails and midge larvae (Procladius, Chironomus and Cryptochironomus) were also common. It also appears that the numbers of worms have increased over the years. Other benthic taxa are limited in the lower river but a wide variety of species still exist in the upper mainstem of the river and its two branches.

C. Segment Classification

As part of the Section 303(e) Continuous Planning Process, the states are required to classify streams or segments of streams as either "water quality" or "effluent" limiting. Effluent limiting segments are those where applicable water quality standards are being met, or there is certainty that these standards will be achieved by application of effluent limitations required by Sections 301(b)(1)(A) and 301(b)(1)(B) of the 1972 Amendments. The corresponding level of treatment required for municipalities is conventional secondary treatment and that for industries is Best Practicable Control Technology Currently Available (BPCTCA). Water quality limiting segments are those where standards are not being achieved and where application of the above treatment levels is not sufficient to achieve water quality standards. Ohio EPA originally classified segments of the Black River in the February 15, 1973 Section 303(e) Continuous Planning Process submission (see Figure VIII-3). This report classified the following streams or segments as water quality limiting:

Black River - Main stem from mouth to confluence of East and West Branches

East Branch - From confluence with West Branch to Lodi

West Branch - From Northern boundary of Elyria to confluence with Wellington Creek

French Creek

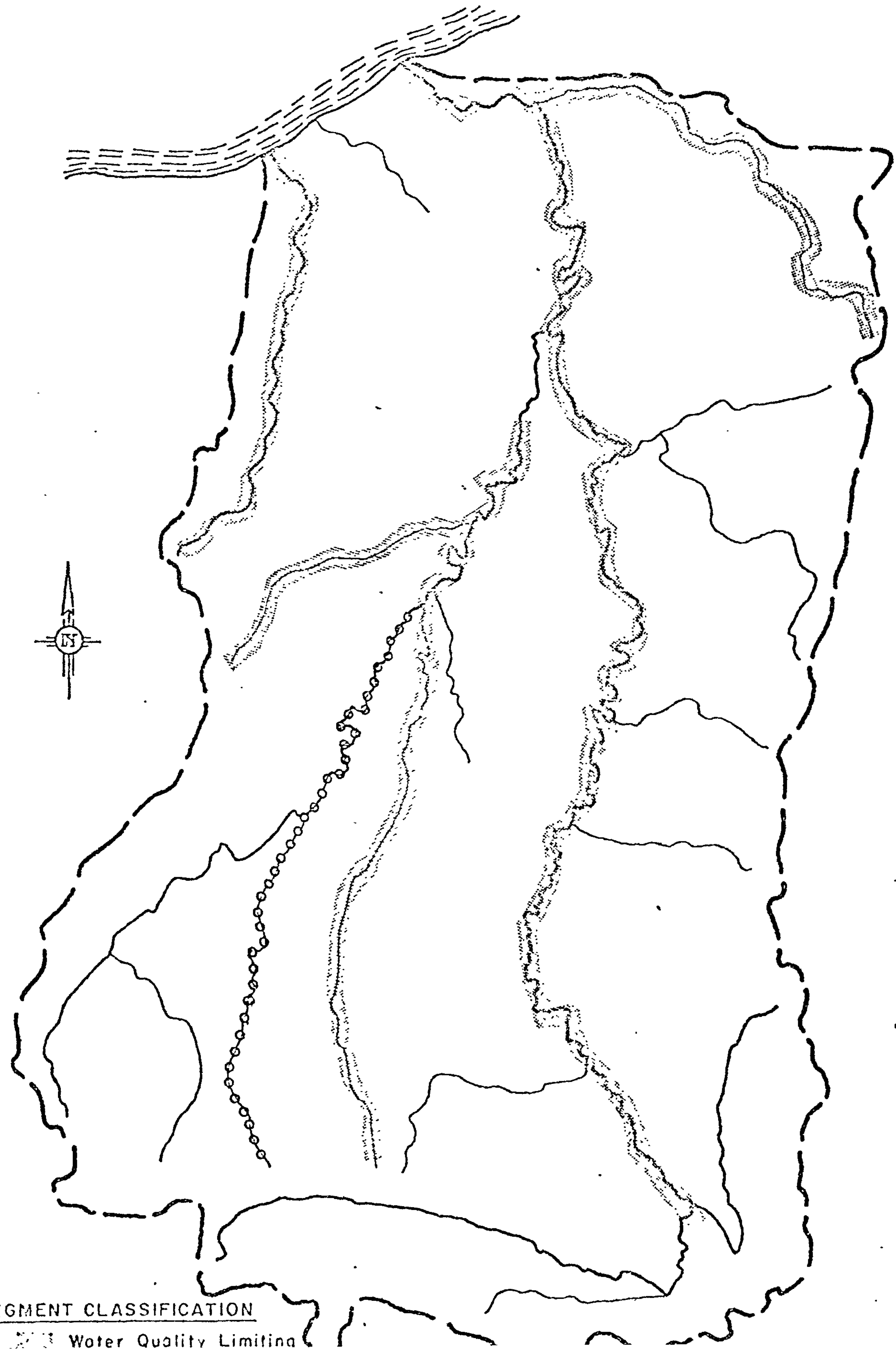
Plum Creek

Wellington Creek

Beaver Creek

Only Charlemont Creek and the West Branch from its confluence with Charlemont Creek to its confluence with Wellington Creek were classified as "effluent" limiting.

FIGURE VIII-3
BLACK RIVER PLANNING AREA
STREAM SEGMENT CLASSIFICATION



SEGMENT CLASSIFICATION

Water Quality Limiting

Based upon locations of dischargers, existing water quality, and hydrologic characteristics, the original classification was modified to include additional segments (see Figure VIII-4). Table VIII-4 presents segment descriptions and classifications. Table VIII-5 presents a listing of dischargers by segments, with the most significant dischargers ranked from most significant to least significant. For water quality segments, those dischargers which cause the segment to be so classified are noted. As shown, most water quality limited segment classifications are the result of municipal or semi-public sewage treatment plant dischargers, the most notable exception being Segment 1 where discharges from the U.S. Steel - Lorain Works have a significant impact on stream quality. Table VIII-6 presents a ranking of the ten most significant dischargers in the planning area. Discharger identification numbers in Tables V-16 to V-20 and Figure V-9 are also used in Figure VIII-4 and Tables VIII-4 and VIII-5.

Segment 1 Black River - Main Stem Harbor Mouth to East 31st Street Bridge

Six industries and one municipal sewage treatment plant discharge to this water quality limited segment of the Black River. U.S. Steel - Lorain Works is by far the most significant discharger in this segment as well as in the entire Planning Area. U.S. Steel discharges through five outfalls, a total flow of 178 mgd, 20,000 lbs/day suspended solids; 3700 lbs/day oil and grease; 2100 lbs/day ammonia-nitrogen; 70 lbs/day of cyanide; 54 lbs/day phenolics, and a thermal load of 660 million BTU/hr. Process water is taken from the river through two intakes. (The suspended solids discharge has been reduced with the installation of a blast furnace recycle system in late 1979).

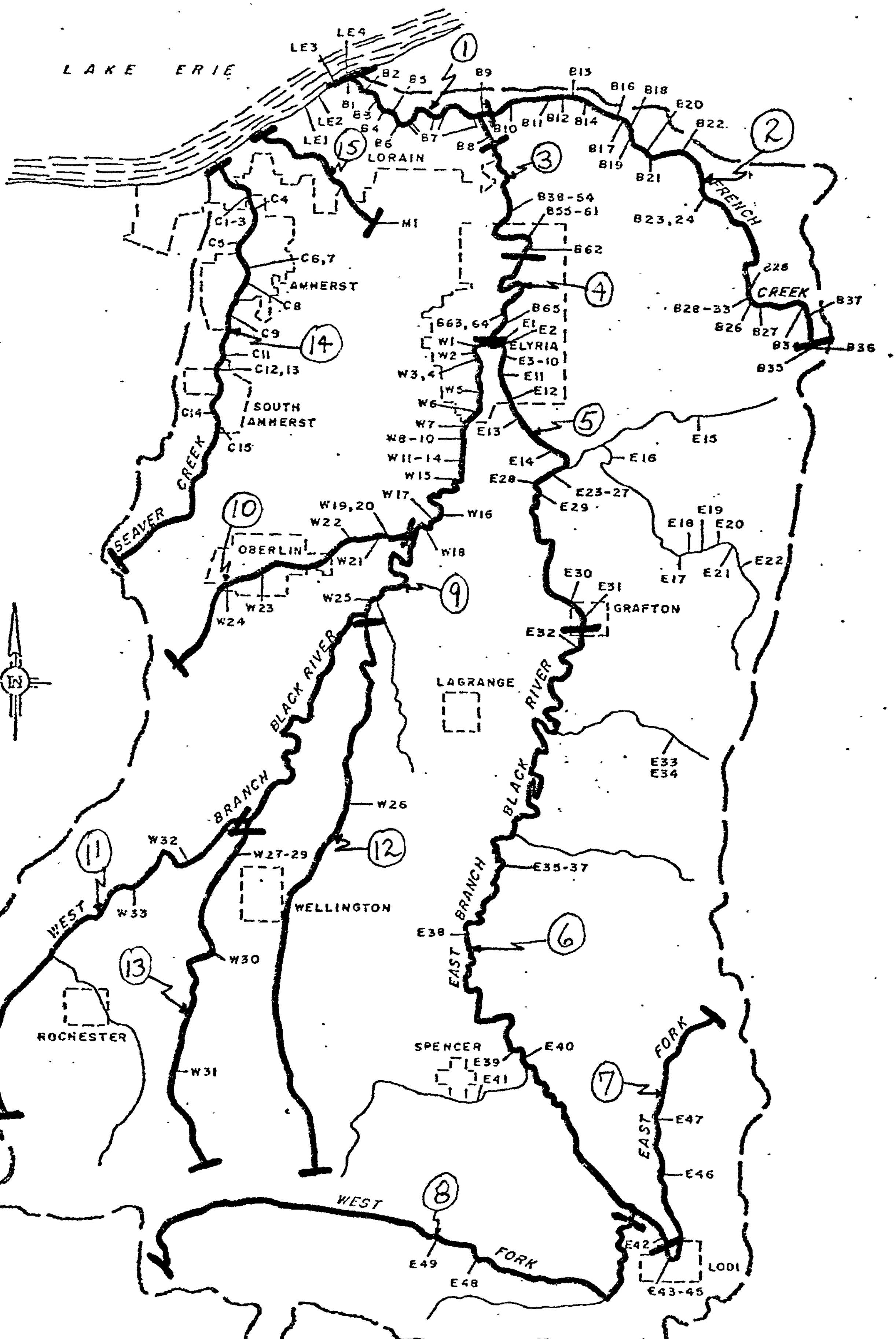
The Lorain Sewage Treatment Plant is a smaller but still significant discharger to the segment. The facility presently discharges about 17 mgd of treated sewage containing 300 lbs/day BOD_5, 400 lbs/day ammonia and small amounts of cyanide and phenolics.

The remaining industrial facilities in this segment have only small discharges which do not have a significant impact on stream quality.

During critical low flow periods stream flow entering this segment from upstream is composed almost entirely of the Elyria STP flow. Stream

FIGURE VIII-4

BLACK RIVER PLANNING AREA
SEGMENT CLASSIFICATIONS



NOTE: REFER TO APPENDIX I FOR
DISCHARGER IDENTIFICATION

TABLE VIII-4

BLACK RIVER PLANNING AREA
SEGMENT CLASSIFICATION

Segment Number	Segment Description (Downstream to Upstream)	Segment Classification
1	Black River - Main Stem - Harbor mouth to East 31st Street Bridge	Water Quality Limiting
2	French Creek - Confluence with Black River to Headwaters	Water Quality Limiting
3	Black River - Main Stem - East 31st Street Bridge to Elyria STP	Water Quality Limiting
4	Black River - Elyria STP to confluence of East and West Branches	Effluent Limiting
5	East Branch - Confluence of East and West Branches to Parsons Road (Grafton)	Water Quality Limiting
6	East Branch - Parsons Road (Grafton) to Lodi STP on East Fork	Water Quality Limiting
7	East Fork of East Branch - Lodi STP to Headwaters	Effluent Limiting
8	West Fork of East Branch confluence of East and West Forks to Headwaters	Effluent Limiting
9	West Branch - Confluence of East and West Branches to confluence with Charlemont Creek	Water Quality Limiting
10	Plum Creek - Confluence with West Branch to Headwaters	Water Quality Limiting
11	West Branch - Confluence with Charlemont Creek to Headwaters	Effluent Limiting
12	Wellington Creek - Confluence with West Branch to Headwaters	Effluent Limiting
13	Charlemont Creek - Above confluence with tributary (Wellington STP) to Headwaters	Effluent Limiting
14	Beaver Creek - Mouth to Headwaters	Water Quality Limiting
15	Martin Run - Mouth to Headwaters	Water Quality Limiting

TABLE VIII-5

BLACK RIVER PLANNING AREA
DISCHARGER RANKING BY SEGMENT

Segment 1 (Black River - Main Stem - Harbor Mouth to East 31st Street Bridge)

Discharger	Segment Classification
*B7 - U.S. Steel	Water Quality Limiting
*B1 - Lorain STP	
B2 - American Shipbuilding Co.	
B4 - Lorain-Elyria Sand Co.	
B8 - Standard Pipe Protection	
B6 - Koehring Co. - Plant No. 1	
B5 - Ashland Oil Terminal	

Segment 2 (French Creek - Confluence with Black River to Headwaters)

Discharger	Segment Classification
*B14 - French Creek Council of Govts. STP	Water Quality Limiting
*(B9, B11-B13, B16-B22, B25, B26) - 13 Semi-public dischargers to French Creek	
*(B29-B32, B34-B37) - 8 Semi-public dischargers to an unnamed tributary to French Creek	
*B33 - Good Samaritan Nursing Home	
B28 - Dreco Plastics	
B10 - Servisteel Corp.	

Segment 3 (Black River - Main Stem - East 31st Street Bridge to Elyria STP)

Discharger	Segment Classification
*B62 - Elyria STP	Water Quality Limiting
*(B38-B39, B41-B54) - 16 Semi-public dischargers to a storm sewer	
(B38-B39, B41-B54) - 16 Semi-public dischargers to Ridgeway Ditch	
B59 - Beckett Corp.	
B57 - Kalt Manufacturing	
B40 - Heisler's Truck Co.	

Segment 4 (Black River - Elyria STP to Confluence of East and West Branches)

Discharger	Segment Classification
B64 - Stanadyne-Western Division	Effluent Limiting
B65 - Bendix-Westinghouse	
B63 - Lake Erie Plastics	

* - Denotes a major contributor to "water quality limiting" classification.

TABLE VIII-5
(Continued)

BLACK RIVER PLANNING AREA
DISCHARGER RANKING BY SEGMENT

Segment 5 (East Branch - Confluence of East and West Branches to Parsons Road (Grafton))

Discharger	Segment Classification
*E30 - Grafton STP	Water Quality Limiting
*E21 - Eaton Estates STP - Discharger to Willow Creek	
*(E23-E27) - 5 Semi-public dischargers to an unnamed tributary to the East Branch of the Black River	
*(E15, E18-E20, E22) - 5 Semi-public dischargers to Willow Creek	
E5 - Emtec Manufacturing	
E10 - Lear Siegler Co.	
*(E12-E14, E28-E29) - 5 Semi-public dischargers to the East Branch of the Black River	
*E4 - Tiffany's Steak House	
E31 - Grafton WTP	
E11 - Diamond Products	
E6 - Ohio Metallurgical Services	
E16 - Ohio Edison - Eaton Line Shop	
E17 - Sohio - Lorain County Terminal	

Segment 6 (East Branch - Parsons Road (Grafton) to Lodi STP on East Fork)

Discharger	Segment Classification
*E42 - Lodi STP	Water Quality Limiting
*E39 - Spencer STP	
*(E35-E37) - 3 Semi-public dischargers to an unnamed tributary to the East Branch of the Black River	
*E32 - Indian Hollow Golf Club STP	
*E40 - Spencer Lake Campground	
*(E33-E34) - 2 Semi-public dischargers to Salt Creek	
E38 - Columbia Gas Transmission	
E41 - Spencer WTP	

Segment 7 (East Fork of East Branch - Lodi STP to Headwaters)

Discharger	Segment Classification
(E44, E46-E47) - 3 Semi-public dischargers to the East Fork of the East Branch of the Black River	Effluent Limiting
E45 - Harris Tire Service	
E43 - Lodi WTP	

* - Denotes a major contributor to "water quality limiting" classification.

TABLE VIII-5
(Continued)

BLACK RIVER PLANNING AREA
DISCHARGER RANKING BY SEGMENT

Segment 8 (West Fork of East Branch - Confluence of East and West Forks to Headwaters)

Discharger	Segment Classification
(E48-E49) - 2 Semi-public dischargers to the West Fork of the East Branch of the Black River	Effluent Limiting

Segment 9 (West Branch - Confluence of East and West Branches to Confluence with Charlemont Creek)

Discharger	Segment Classification
*W2 - GMC-Fisher Body Division	Water Quality Limiting
*W5 - Republic Steel Corp.	
W17 - Pheasant Run Village	
(W11-W14) - 4 Semi-public dischargers to an unnamed tributary to the West Branch of the Black River	
W4 - Tappan Inc.	
(W6, W8-W10, W15-W16) - 6 Semi-public dischargers to the West Branch of the Black River	
W1 - Ohio Screw Products	
W25 - Oberlin WTP	
W3 - Koehring Co. - Plants No. 3 & No. 5	
W7 - Invacare Corp.	

Segment 10 (Plum Creek - Confluence with West Branch to Headwaters)

Discharger	Segment Classification
*W22 - Oberlin STP	Water Quality Limiting
*(W19-W21, W23-W24) - 5 Semi-public dischargers to an unnamed tributary to Plum Creek	

Segment 11 (West Branch - Confluence with Charlemont Creek to Headwaters)

Discharger	Segment Classification
(W32-W33) - 2 Semi-public dischargers to the West Branch of the Black River	Effluent Limiting

Segment 12 (Wellington Creek - Confluence with West Branch to Headwaters)

Discharger	Segment Classification
W26 - Findley State Forest	Effluent Limiting

* - Denotes a major contributor to "water quality limiting" classification.

TABLE VIII-5
(Continued)

BLACK RIVER PLANNING AREA
DISCHARGER RANKING BY SEGMENTS

Segment 13 (Charlemont Creek - Above Confluence with Tributary (Wellington STP) to Headwaters)

Discharger	Segment Classification
W27 - Wellington STP	Effluent Limiting
W28 - Cleveland Steel Products	
W29 - Sterling Foundry	
W31 - Ukranian-American Association Camp	
W30 - Wellington WTP	

Segment 14 (Beaver Creek - Mouth to Headwaters)

Discharger	Segment Classification
*C5 - Amherst STP	Water Quality Limiting
*(C4, C8-C9, C11, C14) - 5 Semi-public dischargers to Beaver Creek	
*(C1-C2, C6-C7) - 4 Semi-public dischargers to an unnamed tributary to Beaver Creke	
C3 - Nelson Stud Welding	
*(C12-C13) - 2 Semi-public dischargers to Squire's Ditch	
*C15 - Oberlin Masonic Hall	
C10 - Cleveland Quarries	

Segment 15 (Martin Run - Mouth to Headwaters)

Discharger	Segment Classification
*M1 - Cresthaven Subdivision STP	Effluent Limiting

TABLE VIII-6

Ten Most Significant Dischargers
in the Black River Planning Area

(Based on Impact on Water Quality)

1. U.S. Steel - Lorain Works
2. Elyria STP
3. Lorain STP
4. French Creek STP
5. Oberlin STP
6. Amherst STP
7. Wellington STP
8. GMC - Fisher Body Division
9. Republic Steel Corporation
10. Lodi STP

quality during low flow periods is also significantly affected by lake quality. The stream segment is classified as water quality limiting because of the U.S. Steel and Lorain STP dicharges.

Segment 2 French Creek

There are currently twenty-five dischargers to French Creek, twenty-two of which are small semi-public sewage plants which contribute a total flow of about 0.19 MGD. By far, the most significant discharger is the French Creek Council of Governments (COG) Sewage Treatment Plant which has a design flow of 7.5 mgd. Presently the facility operates significantly below capacity discharging about 1.9 mgd and stream loadings of 24 lbs/day suspended solids (1.5 mg/l), 16 lbs/day BOD_5 (1.0 mg/l), and 10 lbs/day phosphorous (0.7 mg/l). The Avon STP was scheduled to be connected with the French Creek STP, however, due to the recent defeat of a sewer levy in Avon the connection has not been made. Many of the semi-public facilities do not presently have effective NPDES permits.

Two relatively small industries also discharge into French Creek. Neither Dreco Plastics (0.02 mgd) nor Servisteel Corporation (0.0015 mgd) however is considered a significant discharger because of the small effluent loadings.

The natural flow of French Creek during dry weather conditions is essentially zero because of the limited groundwater storage capacity and the relatively small drainage area (32 square miles). The low natural flow results in the stream being classified as a seasonal warm water habitat above the French Creek STP and a warm water habitat from the treatment plant to the confluence with the Black River. For planning purposes, the stream segment is classified as water quality limiting because conventional secondary treatment is not adequate to achieve water quality standards.

Segment 3 Black River East 31st Street Bridge to Elyria STP

There are twenty-five dischargers to this segment of the Black River. The Elyria Sewage Treatment Plant is the largest discharger and the primary cause of the "water quality limiting" classification. The facility discharges at a rate of 8 mgd and has a major impact on dissolved oxygen, ammonia, cyanide, phenol and phosphorus levels in the river. Based upon discharger records and a 1974 U.S. EPA survey, existing treatment at Elyria results in the following effluent quality:

BOD_5	41 mg/l
Suspended Solids	32 mg/l
Ammonia-N	18 mg/l
Total Phosphorus	12.2 mg/l
DO	2.5 mg/l

Most of the remaining dischargers in this segment are unpermitted small semi-public sewage treatment plants with a combined flow of 0.29 mgd discharging to the river through a storm sewer or Ridgeway Ditch.

Three small industries, Beckett Corporation, Kalt Manufacturing, and Heisler's Trucking Company, also discharge in this segment of the Black River, and have minimal impact on stream quality because of their small flow (less than .005 mgd).

The seven day, ten year low flow of the Black River at USGS gage just upstream of this segment is 3.3 cfs. Because of the low stream flow, secondary treatment at Elyria STP is not adequate to achieve water quality standards, thus necessitating the water quality limiting classification.

Segment 4 Black River - Elyria STP to Confluence of East and West Branches

This effluent limiting segment of the Black River has only three dischargers; Stanadyne - Western Division, Bendix - Westinghouse, and Lake Erie Plastics. Stanadyne is the largest of the three, with a flow rate of 0.49 MGD. The other two are considerably smaller (0.006 MGD and 0.002 MGD for Bendix - Westinghouse and Lake Erie Plastics, respectively), and are limited to discharging cooling water and boiler blowdown only. Stanadyne discharges significant loadings of chromium, hexavalent chromium, copper, nickel, and zinc.

Segment 5 East Branch - Elyria to Grafton

There are seventeen semi-public facilities discharging a total of .49 MGD to this segment of the Black River. In addition, six industries, one municipal sewage treatment plant, and one municipal water treatment plant are located in this segment.

The effluent loadings from the Grafton STP (0.2 mgd) and the many semi-public facilities cause the water quality limiting designation of this segment. Significant loadings of oxygen-demanding materials, ammonia and suspended solids are discharged by these sources. Harshaw Chemical Company was the worst discharger in segment 5 prior to connecting with the Elyria STP. Presently there is no process water discharge to the river from this facility. Of the six industrial facilities, none are considered major polluters. Emtec Manufacturing, and Lear Siegler have the largest discharges in this group.

Segment 6 East Branch - Grafton to Lodi

Segment 6 contains two municipal sewage treatment plants, seven semi-public facilities, one industrial source and one water treatment plant. The Lodi STP is the largest discharger in the segment at 0.29 MGD. The Spencer STP (0.096 MGD) is about one-third the size of the Lodi STP. The cumulative flow of the seven semi-public facilities is much smaller than the two STP's accounting for only 0.03 MGD. During low flow periods the sanitary wastes from these facilities make up most of the flow of the stream, thus necessitating the "water quality limiting" classification. Of the public and semi-public treatment plants, only the Spencer and Lodi STPs have effective NPDES permits.

Segment 7 East Fork of East Branch - Lodi STP to Headwaters

There are only five dischargers to this "effluent limiting" segment of the Black River. The three semi-public dischargers provide the greatest flow (0.031 MGD) into the river and are the most significant dischargers. Harris Tire Service, which discharges only non-contact cooling water, and the Lodi WTP are smaller and do not significantly impact water quality. In the absence of the point source dischargers, there would be no natural flow in this segment during dry weather periods.

Segment 8 West Fork of East Branch - Confluence of East and West Forks to Headwaters

Only two dischargers are located on this "effluent limiting" segment of the Black River. Worden's Trailer Park and Homerville High School discharge sanitary wastes and have a combined flow of 0.0126 MGD. Neither facility has an effective NPDES permit. Again, there is no natural flow to this segment during dry weather periods.

Segment 9 West Branch - Confluence of East and West Branches to Confluence with Charlemont Creek

This "water quality limiting" segment contains eleven semi-public dischargers (total flow of 0.865 MGD), six industrial dischargers, and one municipal water treatment plant. GMC-Fisher Body Division with a flow of 1.6 MGD, has the largest discharge in this segment. The existing NPDES permit for this plant contains effluent limitations for hexavalent chromium (0.05 mg/l), total chromium (0.5 mg/l), total copper (0.5 mg/l), free cyanide (0.05 mg/l), total nickel (0.5 mg/l), pH (6-9 standard units) and total suspended solids (20 mg/l). Republic Steel Corporation is the second largest discharger in the segment. Unlike GMC, Republic obtains its process water supply from the river so there is no increase in river flow at this facility despite significant loadings of suspended solids, iron, and oil and grease. GMC and Republic Steel are the dischargers primarily responsible for the water quality limiting classification. The remaining industries in this segment cause little detriment to water quality.

This segment originates at the confluence of Charlemont Creek and the west branch of the Black River. Estimated dry weather stream flow of .83 cfs is composed of upstream sanitary discharges. Little additional flow enters the west branch until the confluence with Plum Creek which contributes about 2.2 cfs mostly from Oberlin STP.

Segment 10 Plum Creek

Five semi-public facilities (total flow 0.0072 MGD) and the Oberlin STP (1.4 MGD) discharge to Plum Creek. Only the Oberlin STP has an effective NPDES permit. During low flow periods, Plum Creek has no natural flow. This fact, in conjunction with the significant discharges of sanitary waste, cause the stream to be classified as a water quality limited segment.

Segment 11 West Branch - Confluence with Charlemont Creek to Headwaters

Panther Trails Campground and Echo Valley Golf Course are the only two dischargers in this effluent limited segment. Both are semi-public sewage plants operating without NPDES permits. In general, water quality in this segment is good.

Segment 12 Wellington Creek

Findlay State Forest (0.0022 MGD) is the only discharger to this effluent limiting stream segment. During critically low flow periods natural stream flow is only about one half that of the State Forest.

Segment 13 Charlemont Creek - Wellington STP to Headwaters

Wellington STP (0.467 MGD) is the most significant of the five dischargers to Charlemont Creek. Two small industrial facilities, the Wellington Water Treatment Plant and a small semi-public facility also discharge to this segment. The drainage area of Charlemont Creek is relatively small such that the critical low flow of the creek at the confluence with the west branch (0.8 cfs) consists entirely of point source discharges. These low flow characteristics results in the water quality limiting classification.

Segment 14 Beaver Creek Basin

There are fifteen dischargers to Beaver Creek, including two minor industrial dischargers, twelve small semi-public dischargers (combined flow 0.2 mgd) and the Amherst sewage treatment plant (1.3 mgd). The Amherst STP is by far the largest discharger in this segment contributing 360 lbs/day (33 mg/l) suspended solids; 350 lbs/day (32 mg/l) BOD_5; and 22 lbs/day (2.0 mg/l) phosphorus. Stream quality is degraded downstream of the Amherst plant, however upstream quality is generally good. (See April 30, 1974 U.S. EPA survey.)

Critical stream flow usptream of Amherst STP (0.3 cfs) is made up entirely of upstream discharges. Since secondary treatment at the Amherst STP is not so sufficient to attain water quality standards, the creek is classified as a water quality limited segment.

Segment 15 Martin Run

Cresthaven Subdivision STP (0.03 mgd) is the only discharger to Martin Run. For planning purposes this intermittent stream is classified as "effluent limited".

REFERENCES - SECTION VIII

1. U.S. Geological Survey, Water Resources Data for Ohio, 1973, 1974, 1975, 1976.

2. Personal communication between Mr. Scott Machol, U.S. EPA and Mr. Henry L. Minert, Director-Secretary, Lorain County Metropolitan Park District, Board of Park Commissioners, Elyria, Ohio.

3. Ohio Department of Health, Division of Engineering, "Survey of the Black River in the Elyria, Ohio Area", January 25, 1971.

4. U.S. Environmental Protection Agency, Technical Support Document for Proposed NPDES Permit U.S. Steel Corporation Lorain Plant, July 1975.

5. U.S. Environmental Protection Agency, United States Steel, Lorain, Ohio, Works, Black River Survey: Analysis for Hexane Organic Extractables and Polynuclear Aromatic Hydrocarbons.

6. Westinghouse, Environmental Systems Department, Thermal Discharge Demonstration, United States Steel Corporation, Lorain Plant, February 1976.

SECTION IX
WATER QUALITY MANAGEMENT AND PLANNING

A. Recommended Point Source Controls

1. Legislative Requirements

As presented in Section I, the primary objectives of this study are to provide the basis for a water quality management plan pursuant to Section 303(e) of the 1977 Amendments and to support the National Pollutant Discharge Elimination System (NPDES) pursuant to Section 402 of the 1977 Amendments. Within the scope of these broad objectives, this section of the Waste Load Allocation Report presents the remedial steps necessary to attain water quality standards applicable to the Black River Planning Area. These water quality standards are discussed in Section VI.

Violations of water quality standards in the Black River Planning Area are primarily attributable to point source dischargers regulated through the NPDES permit system. The NPDES permit system is a basic mechanism established by Section 402 of the 1977 Amendments for enforcing the effluent limitations applicable to direct or point source dischargers into the navigable waters. The function of the permit is to define precisely the discharger's obligation under the Federal Clean Water Act, translating the general requirements of the applicable effluent standards or water quality requirements into effluent limitations tailored to the discharger's particular operation. The permit also defines the schedule by which a discharger must attain compliance with the effluent limitations. On March 11, 1974, the

the U.S. Environmental Protection Agency transferred the NPDES permit issuing authority to the Ohio Environmental Protection Agency. NPDES permits issued after that date have been and will be issued by the State subject to EPA concurrence. Both the U.S. EPA and the Ohio EPA may enforce the conditions in these permits.

Under Section 402, NPDES permits are required to conform to Sections 301, 302, 306, 307, 308 and 403 of the 1977 Amendments or, prior to the taking of necessary implementing actions relating to all such requirements, conditions as the Administrator determines are necessary to carry out the provisions of the Act. Of these sections, Section 301, 307, and 308 are the more significant in terms of the development of NPDES permits:

a. Section 301 "Effluent Limitations"

Section 301(b)(1)(A) of the 1977 Amendments requires, as a minimum, that effluent limitations for point sources shall conform to the best practical control technology currently available (BPCTCA) or, for publicly owned treatment works, at least secondary treatment by July 1, 1977. However, Section 301(b)(1)(C) requires that any more stringent limitations necessary to meet other State requirements including water quality standards shall also be achieved by July 1, 1977. Section 301 paragraph (b)(2)(A) requires the installation of Best Available Control Technology Economically Achievable (BACTEA) by July 1, 1984 for all pollutants determined to be toxic under Section 307(a)(1) of the Act. For conventional pollutants, as defined in 304(a)(4), Best Conventional Pollutant Control Technology must be installed by July 1, 1984 at sources other than publicly owned treatment works.

b. Section 307 "Toxic and Pretreatment Effluent Standards"

Section 307 requires the Administrator of the U.S. Environmental Protection Agency to establish effluent limitations for toxic pollutants which shall take into account the toxicity of the pollutant, its persistence, degradability, the usual or potential presence of the affected organisms in any waters, the importance of the affected organisms and the effect of the toxic pollutant on such organisms. Each toxic standard must be set at the level which the Administrator determines provides an ample margin of safety (Section 307(a)(4)). The Act specifically provides that the standard may be in the form of a prohibition and further states that national policy is that the discharge of toxic pollutants in toxic amounts be prohibited (Section 101(a)(3)). Furthermore, Section 307 requires the Administrator to establish pretreatment standards for the introduction of pollutants into publicly owned treatment works. These standards are directly enforceable by the Ohio Environmental Protection Agency and U.S. Environmental Protection Agency against users of treatment works. Users are also subject to the monitoring provisions of Section 308.

c. Section 308 "Inspections, Monitoring, and Entry"

Section 308(a) provides that the Administrator shall require the owner or operator of any point source to establish and maintain records, make reports, install monitoring equipment, develop monitoring programs and to provide entry to the Administrator, or his authorized representative, to inspect such records, monitoring equipment, and sample effluents. In addition, Section 308(b) provides that all such information pertaining to Section 308(a) be made available to the public, with the exception of information protected as trade secrets.

In summary, point source dischargers are required to comply with either Best Practical Control Technology Currently Available (BPCTCA), secondary treatment, or applicable water quality standards by July 1, 1977, whichever is limiting, and, Best Conventional Technology, or Best Available Technology Economically Achievable, whichever is limiting, by July 1, 1984. Compliance schedules and self-monitoring requirements are included in NPDES permits to insure that effluent limitations are being achieved.

2. Discharger Classification

Point source dischargers in the Black River Planning Area are classified into three general categories by receiving waters:

(1) Direct dischargers to Lake Erie

(2) Dischargers to "Low-Flow Streams" defined by Region V's simplified wasteload allocation technique, and to streams with water quality design flows of zero.

(3) Dischargers to larger streams and dischargers to lake-affected areas of streams that flow into Lake Erie.

A recommended water quality management strategy for each category is presented below.

Attachment A of Appendix IV is a summary of final effluent limitations in presently effective NPDES permits. Attachment B of Appendix IV presents recommended permit modifications for dischargers whose issued permits are not consistent with applicable effluent limitations and water quality standards. Attachment C of Appendix IV presents a brief fact sheet including recommended effluent limitations, monitoring requirements, and special permit conditions for those dischargers that currently do not have NPDES permits.

a. CATEGORY 1 DIRECT DISCHARGERS TO LAKE ERIE

Ohio has not classified the nearshore waters of Lake Erie as "Effluent Limiting" or "Water Quality Limiting". For the purpose of this study, these waters are considered to be effluent limiting, that is, direct dischargers to Lake Erie are limited by BPCTCA/BCT/BATEA effluent guidelines for industries or secondary treatment guidelines for municipalities. Table IX-1 lists the direct dischargers to Lake Erie within the Black River Planning Area. The discharger identification numbers correspond with those listed in Figure V-9.

Permits have been issued for the Lorain and Elyria water treatment plants and the Ohio Edison - Edgewater Generating Plant.

(1) Elyria and Lorain Water Treatment Plants

The NPDES permits for the Elyria and Lorain water treatment plants issued by the Ohio EPA were based upon the State's assessment of BPCTCA as there are no Federal effluent guidelines for water treatment plants. The respective permits as issued are consistent with water quality objectives.

TABLE IX-1

DIRECT DISCHARGERS TO LAKE ERIE

Discharger Identification No. (Figure V-9)	Discharger and Location
LE 1	Elyria Water Treatment Plant Lorain
LE 2	American Crucible Products Co. Lorain
LE 3	Lorain Water Treatment Plant Lorain
LE 4	Ohio Edison - Edgewater Plant Lorain

(2) Ohio Edison Company

The Ohio EPA permit effective April 1977, is based upon the effluent guidelines for the Steam Electric Power Generating Category issued on March 4, 1974.

Final effluent limitations for Ohio Edison should be modified to conform with the final Steam Electric Power Generating Point Source Category effluent limitations published by the U.S. EPA on October 8, 1974 and new BPCTCA/BCT/BATEA regulations when promulgated.

The existing permit has no limitations on oil and grease, chromium, total phosphorus, and total zinc and pH for Outfall 601. However, these chemicals will be included in the permit effective April 14, 1982. It is suggested that all wastewaters, except non-contact cooling water be routed to ashponds.

(3) American Crucible Products Company

The American Crucible Products Company manufactures submersible pumps, bronze gears, and other bronze parts and discharges about 6000 gpd of cooling water to Lake Erie. There is no effective permit for this facility. Recommended effluent limitations include oil and grease (10 mg/l daily average, and 20 mg/l daily maximum), suspended solids (30 mg/l daily average, 45 mg/l daily maximum), and a condition that the discharge be restricted to non-contact cooling water and boiler blowdown.

b. CATEGORY 2 DISCHARGERS TO "LOW-FLOW STREAMS" AND ZERO FLOW STREAMS

The hydrology of the Black River is such that there is little natural flow throughout most of the basin during dry weather periods. The water quality design low flow at the USGS gage on the East Branch of the Black River is zero and only 3.3 cfs at the USGS gage in Elyria. During prolonged dry weather periods streamflow throughout the basin is almost entirely made up of effluent flow. A significant stream flow is maintained downstream of the Elyria STP during low flow periods. Hence, except for the Black River mainstem downstream of Elyria, most streams in the Black River Basin are classified as low flow streams for the purpose of this report.

There are 111 dischargers to the low flow segments of the Black River. Of these discharges only three industries and ten municipal sewage treatment plants have an effluent design flow equal to or greater than one hundred thousand gallons per day (0.1 MGD). (see Table IX-2). The remaining facilities are small semi-public waste treatment plants, water treatment plants, or industries which have little direct discharge or that discharge to one of the municipal sewage treatment plants.

Effluent quality obtained from discharger monitoring reports for 1978 and 1979 for the ten municipal treatment plants are summarized in Volume II, Attachment N. These data show effluent quality from Amherst, Grafton, and Spencer are typical of secondary treatment with monthly average BOD_5 concentrations between 20 and 45 mg/l and suspended solids from 20 to 60 mg/l. Wellington, Spencer and LaGrange have slightly better effluent quality achieving discharge levels of 18 to 20 mg/l BOD_5 and 25 to 30 mg/l suspended solids. French Creek COG STP and the municipalities of Oberlin, Eaton Estates and Brentwood Lakes Estate have advanced treatment facilities capable of achieving effluent quality of 10 mg/l BOD_5 and 12 mg/l suspended solids. None of the facilities are designed to remove ammonia-N. However, some nitrification occurs at facilities where the present flow is less than the design flow (i.e., French Creek COG STP). All facilities practice effluent disinfection during summer months and six plants chlorinate all year.

Effluent limitations for the 10 larger municipal sewage treatment plants were determined using a simplified procedure adopted by U.S. EPA Region V for municipal sewage treatment plants discharging to low flow streams (see Appendix V). This methodology can be applied to single municipal dischargers located on streams where the upstream flow is equal to or less than the design discharge flow, the design discharge flow is 10 MGD or less; and there are no or only limited interactive effects from the most upstream discharger on a segment with more than one discharger. Water quality in these segments is highly dependent upon effluent quality. Hence, upstream quality is less significant than for systems where the

Table IX-2

Facilities Greater than 0.1 MGD
Discharging to Low Flow Streams

Municipal Sewage Treatment Plants

Amherst
Brentwood Estates
Eaton Estates
French Creek COG
Grafton
LaGrange
Lodi
Oberlin
Spencer
Wellington

Industrial Dischargers

Republic Steel Corporation Elyria
GMC - Fisher Body Division
Stanadyne - Western Division

upstream flows are much greater than design effluent flows.

The simplified method incorporates a mass balance technique to determine ammonia-nitrogen limitations; a simplified Streeter-Phelps analysis to determine carbonaceous oxygen demand limits; a sensitivity analysis; and, suspended solids limits determined from BOD limits. The method requires data for stream design flow, upstream quality, stream physical characteristics, travel time, and effluent design flow.

Tables IX-3 through IX-12 present the data used in the simplified methodology for the ten municipal sewage treatment plants. In general, upstream design flows were determined from upstream discharges or from drainage area yields based upon flow data obtained at the USGS gage in Elyria. Upstream temperature and pH data were determined from U.S. EPA water quality surveys and stream slope was taken from USGS 7.5 minute series topographical maps. Travel time, stream width, depth and flow were measured for all but the smallest facilities where estimates were based upon slope, flow, and measured values below similar facilities in the basin. Stream reaction rates were adjusted for temperature and depth as suggested in the Region V report. An upper limit on the depth adjusted CBOD reaction rates of 1.0 was used in the analysis as recommended by the Region V Ad Hoc Committee on Waste Load Allocations. The diurnal dissolved oxygen variation was assumed to be 2 mg/l as suggested by Region V since measurements downstream of the facilities often showed large DO fluctuations which are not expected to persist after installation of more advanced treatment. Population and STP flow projections for the planning period were obtained from the Northeast Ohio Areawide Coordinating Agency.

The only facility that did not strictly meet all the criteria for the simplified methodology is the Grafton STP. In this case, the sum of the upstream design discharge flows is 1.6 cfs whereas the projected flow of the Grafton plant is 0.59 cfs (0.38 MGD). Considering that the design flow of the East Branch of the Black River is 0.0 cfs three miles above the confluence with the West Branch, the critical flow upstream of Grafton cannot be as high as 1.6 cfs. Because good stream quality data are available upstream of the plant and upstream low flow is likely to be less than sum of upstream dischargers, some of which are located over 10 miles upstream, the simplified method was applied for this plant as well.

Table IX-3

Amherst STP
Documentation for Input Variable Selection

Applicable WQS

1. Dissolved Oxygen	5.0 mg/l daily minimum
2. Ammonia-N	0.05 mg/l unionized ammonia-N
3. Temperature	74°F monthly average 82°F daily maximum
4. pH	6-9 su

Input Variables	Value	Measured Value	Range for Sensitivity Analysis	Source
1. Stream				
a. Upstream Flow ($Q_{7,10}$)	0.36 cfs			A Proposed Streamflow Data Program for Ohio, Antilla, P. W., USGS, Columbus, Ohio 1970
b. Upstream Quality				Measured data from July 23-26, 1974 EPA survey.
1. Temperature	75°F		68 to 82°F	
2. Dissolved Oxygen	7.13 mg/l		6 to 8.0 mg/l	
3. pH	7.5 su		7.2 to 7.8 su	
4. Ammonia-N	0.05 mg/l		0 to 0.4 mg/l	
5. CBOD	2 mg/l		1 to 5 mg/l	
c. Stream Slope	15 ft/mile		12-18 ft/mile	U.S. Geological Survey 7.5 Minute Series Topographical Map 1969
d. Time-of-Travel Velocity	0.6 ft/sec	0.7 ft/sec $V_2 = V_1\left(\frac{Q_2}{Q_1}\right)^{0.4}$	.5-.9 ft/sec	June 30, 1978 EPA Survey Ohio EPA; Policy and Procedures Manual for Developing Wasteload Allocations, June 1979
e. Depth	0.3 ft	0.4 ft $D_2 = D_1\left(\frac{Q_2}{Q_1}\right)^{0.6}$	.2 to .6 ft	June 30, 1978 EPA survey Ohio EPA; Policy and Procedures Manual for Developing Wasteload Allocations, June 1979
f. Reaction Rates				
1. CBOD	1.2		0.9-1.5	Recommended rates
2. NBOD	.615		.46 to .77	
3. Reaeration	17.8			Tsivoglou rate adjusted for temp.
2. STP				
a. Design Flow	3.25 cfs			NOACA, 208 Agency, Load and Flow Projections, 1979
b. Dissolved Oxygen	6.5 mg/l		6 to 8.0 mg/l	Selected value

Table IX-4

Brentwood Estates - STP
Documentation for Input Variable Selection

Applicable WQS				
1. Dissolved Oxygen	5.0 mg/l daily minimum			
2. Ammonia-N	0.05 mg/l unionized ammonia-N			
3. Temperature	74°F monthly average 82°F daily maximum			
4. pH	6-9 su			

Input Variables	Value	Measured Value	Range for Sensitivity Analysis	Source
1. Stream				
a. Upstream Flow ($Q_{7,10}$)	0.0 cfs			Lorain County Planning Commission
b. Upstream Quality				U.S. EPA April 30, 1974 and July 23-26, 1974 Surveys
1. Temperature	75°F		68 to 82°F	
2. Dissolved Oxygen	7.25 mg/l		6 to 8.5 mg/l	
3. pH	7.7 su		7.4 to 8.0 su	
4. Ammonia-N	0.05 mg/l		0 to 0.44 mg/l	
5. CBOD	2.0 mg/l		1 to 5.0 mg/l	
c. Stream Slope	23.5 ft/mile			U.S. Geological Survey 7.5 Minute Series Topographical Map 1970
d. Time-of-Travel Velocity	0.2 ft/sec		0.15 to 0.25 ft/sec	December 19, 1979 Survey at Wellington STP
e. Depth	0.2 ft		0.15 to 0.25 ft.	Measured below Wellington STP Ohio EPA, Policy and Procedures Manual for Developing Wasteload Allocations, June 1979
f. Reaction Rates				Values are recommended rates adjusted for temperature and depth as suggested in simplified technique.
1. CBOD	1.2		0.9-1.5	
2. NBOD	0.615		0.46 to 0.77	
3. Reaeration	9.3		6.97 to 11.6	
2. STP				
a. Design Flow	0.186 cfs			NOACA, 208 Agency, load and flow projections, 1979
b. Dissolved Oxygen	6.5		6 to 8.0 s.u.	Selected value

Table IX-5

Eaton Estates - STP
Documentation for Input Variable Selection

Applicable WQS				
1. Dissolved Oxygen	5.0 mg/l daily minimum			
2. Ammonia-N	0.05 mg/l unionized ammonia-N			
3. Temperature	$74^{o}F$ monthly average $82^{o}F$ daily maximum			
4. pH	6-9 su			
Input Variables	**Value**	**Measured Value**	**Range for Sensitivity Analysis**	**Source**
1. Stream				
a. Upstream Flow ($Q_{7,10}$)	0.0 cfs			$Q_{7,10}$ drainage area yield on Black River at Elyria USGS Station No. 04200500
b. Upstream Quality				U.S. EPA April 30, 1974 and July 23-26, 1974 Surveys
1. Temperature	$75^{o}F$		68 to $82^{o}F$	
2. Dissolved Oxygen	7.25 mg/l		6 to 8.53 mg/l	
3. pH	7.7 s.u.		7.4 to 8.0 s.u.	
4. Ammonia-N	0.05 mg/l		0 to 0.44 mg/l	
5. CBOD	2.0 mg/l		1 to 5.0 mg/l	
c. Stream Slope	7.3 ft/mi			U.S. Geological Survey 7.5 Minute Series Topographical Map 1970
d. Time of Travel Velocity	0.2 ft/sec		0.15 to 0.25 ft/sec	December 19, 1979 Survey Wellington STP
e. Depth	0.2 ft		0.15 to 0.25 ft/sec	December 19, 1979 Survey Wellington STP
f. Reaction Rates				Values are recommended rates adjusted for temperature and depth as suggested in simplified technique
1. CBOD	1.2		0.9-1.5	
2. NBOD	0.615		0.46 to 0.77	
3. Reaeration	2.89		2.17 to 3.6	
2. STP				
a. Design Flow	0.31 cfs			NOACA, 208 Agency, load and flow projections, 1979
b. Dissolved Oxygen	6.5 mg/l		6 to 8.0 mg/l	Selected value

Table IX-6

French Creek - STP
Documentation for Input Variable Selection

Applicable WQS				
1. Dissolved Oxygen	5.0 mg/l daily minimum			
2. Ammonia-N	0.05 mg/l unionized ammonia-N			
3. Temperature	77°F monthly average 82°F daily maximum			
4. pH	6-9 su			

Input Variables	Value	Measured Value	Range for Sensitivity Analysis	Source
1. Stream				
a. Upstream Flow ($Q_{7,10}$)	0.27 cfs		None	Summation of upstream discharge flow (Section V)
b. Upstream Quality				Ohio EPA July 17 - August 22, 1975 Survey, U.S. EPA July 23-26, 1974, April 30, 1974 Surveys
1. Temperature	77°F		72 to 82	
2. Dissolved Oxygen	7.12 mg/l		6.0 to 8.38	
3. pH	7.6 s.u.		7.2 to 8.0	
4. Ammonia-N	0.05 mg/l		0.0 to 0.44	
5. CBOD	2.0 mg/l		1.0 to 5.0	
c. Stream Slope	4.04 ft/mi			U.S. Geological Survey 7.5 Minute Series Topographical Map 1970
d. Time-of-Travel Velocity	0.44 ft/sec	0.28 at 2.82 cfs $V_2 = V_1\left(\frac{Q_2}{Q_1}\right)^{0.4}$	0.33 to 0.55 ft/sec	August 14, 1978 EPA Survey, Ohio EPA: Policy and Procedures Manual for Developing Wasteload Allocations, June 1979
e. Depth	1.2 ft	0.6 ft. $D_2 = D_1\left(\frac{Q_2}{Q_1}\right)^{0.6}$	0.9 to 1.5 ft	August 14, 1978 EPA Survey Ohio EPA; Policy and Procedures Manual for Developing Wasteload Allocations, June 1979
f. Reaction Rates				Values are recommended rates adjusted for temperature and depth as suggested in simplified technique
1. CBOD	0.856		0.64 to 1.07	
2. NBOD	0.68		0.51 to 0.85	
3. Reaeration	3.6		2.7 to 4.5	
2. STP				
a. Design Flow	8.6 cfs			NOACA, 208 Agency, load and flow projections, 1979
b. Dissolved Oxygen	6.5 mg/l		6.0 to 8.0	Selected value

Table IX-7

Grafton STP
Documentation for Input Variable Selection

Applicable WQS				
1. Dissolved Oxygen	5.0 mg/l daily minimum			
2. Ammonia-N	0.05 mg/l unionized ammonia-N			
3. Temperature	$74^{\circ}F$ monthly average $82^{\circ}F$ daily maximum			
4. pH	6-9 su			

Input Variables	Value	Measured Value	Range for Sensitivity Analysis	Source
1. Stream				
a. Upstream Flow ($Q_{7,10}$)	1.64 cfs			Summation of upstream discharge flows
b. Upstream Quality				April 30, 1974, EPA Survey
1. Temperature	$75^{\circ}F$		$68\text{-}82^{\circ}F$	
2. Dissolved Oxygen	7.25 mg/l		6-8.53 mg/l	
3. pH	7.7 su		7.4 - 8.0 su	
4. Ammonia-N	0.05 mg/l		0-0.44 mg/l	
5. CBOD	2.0 mg/l		1-5 mg/l	
c. Stream Slope	3.33 ft/mile			U.S. Geological Survey 7.5 Minute Series Topographical Map 1970
d. Time-of-Travel Velocity	0.227 ft/sec	0.484 ft/sec $V_2 = V_1 \left(\frac{Q_2}{Q_1}\right)^{0.4}$	0.17-0.28 ft/sec	December 19, 1979 EPA Survey Ohio EPA; Policy and Procedures Manual for Developing Wasteload Allocations, June 1979.
e. Depth	0.16 ft	0.5 $D_2 = D_1 \left(\frac{Q_2}{Q_1}\right)^{0.6}$	0.12-0.2 ft	December 19, 1979 EPA Survey Ohio EPA; Policy and Procedures Manual for Developing Wasteload Allocations, June 1979.
f. Reaction Rates				Values are recommended rates adjusted for temperature and depth as suggested in simplified technique.
1. CBOD	1.2		0.9-1.5	
2. NBOD	0.615		0.46-0.77	
3. Reaeration	1.49		1.12-1.86	
2. STP				
a. Design Flow	0.594 cfs			NOACA, 208 Agency, Load and Flow Projections, 1979
b. Dissolved Oxygen	6.5 mg/l		6.0-8.0 mg/l	Selected value

Table IX-8

Lagrange STP
Documentation for Input Variable Selection

Applicable WQS

1. Dissolved Oxygen	5.0 mg/l daily minimum
2. Ammonia-N	0.05 mg/l unionized ammonia-N
3. Temperature	74°F monthly average 82°F daily maximum
4. pH	6-9 su

Input Variables	Value	Measured Value	Range for Sensitivity Analysis	Source
1. Stream				
a. Upstream Flow ($Q_{7,10}$)	0.0 cfs		0.0-0.15 cfs	Summation of upstream discharge flows (Section V)
b. Upstream Quality				April 30, 1974 and July 23-26, 1974 EPA Survey
1. Temperature	73°F		68-79°F	
2. Dissolved Oxygen	7.38 mg/l			
3. pH	7.6 su		7.4-8.0 su	
4. Ammonia-N	0.05 mg/l			
5. CBOD	2.0 mg/l			
c. Stream Slope	10.0 ft/mile			U.S. Geological Survey 7.5 Minute Series Topographical Map 1973
d. Time-of-Travel Velocity	0.2 ft/sec	0.2 ft/sec	0.1 - 0.3 ft/sec	December 19, 1979 EPA Survey
e. Depth	0.3 ft	0.3 ft	0.15-0.45 ft	December 19, 1979 EPA Survey
f. Reaction Rates				Values are recommended rates adjusted for temperature and depth as suggested in simplified technique
1. CBOD	1.15		0.9-1.4	
2. NBOD	0.56		0.42-0.7	
3. Reaeration	3.86		2.9-4.8	
2. STP				
a. Design Flow	0.243 cfs			NOACA, 208 Agency, Load and Flow Projections, 1979
b. Dissolved Oxygen	6.5 mg/l		6-8.0 mg/l	Selected value

Table IX-9

Lodi STP
Documentation for Input Variable Selection

	Value	Measured Value	Range for Sensitivity Analysis	Source
Applicable WQS				
1. Dissolved Oxygen	5.0 mg/l daily minimum			
2. Ammonia-N	0.05 mg/l unionized ammonia-N			
3. Temperature	74^oF monthly average 82^oF daily maximum			
4. pH	6-9 su			
Input Variables				
1. Stream				
a. Upstream Flow ($Q_{7,10}$)	0.097			Summation of upstream discharge flows (Section V)
b. Upstream Quality				April 30, 1974 EPA Survey
1. Temperature	73^oF		$68-79^oF$	
2. Dissolved Oxygen	7.38 mg/l		6-8.68 mg/l	
3. pH	7.6 su		7.4-8.0 su	
4. Ammonia-N	0.05 mg/l		0.0-0.44 mg/l	
5. CBOD	2.0 mg/l		1-5.0 mg/l	
c. Stream Slope	9.26 ft/mile			U.S. Geological Survey 7.5 Minute Series Topographical Map 1973
d. Time-of-Travel Velocity	0.215 ft/sec	0.32 ft/sec $V_2 = V_1 \left(\frac{Q_2}{Q_1}\right)^{0.4}$	0.16-0.27 ft/sec	December 19, 1979 EPA Survey Ohio EPA, Policy and Procedures Manual for Developing Wasteload Allocations, June 1979.
e. Depth	0.39 ft $D_2 = D_1 \left(\frac{Q_2}{Q_1}\right)^{0.6}$	0.73 ft	0.2-0.7 ft.	December 19, 1979 EPA Survey 7.5 Minute Ohio EPA, Policy and Procedures Manual for Developing Wasteload Allocations, June 1979
f. Reaction Rates				Values are recommended rates adjusted for temperature and depth as suggested in simplified technique.
1. CBOD	1.15		0.9-1.4	
2. NBOD	0.56		0.42-0.7	
3. Reaeration	3.84		2.9-4.8	
2. STP				
a. Design Flow	1.115 cfs			NOACA, 208 Agency, Load and Flow Projections, 1979
b. Dissolved Oxygen	6.5 mg/l		6-8.0 mg/l	Selected value

Table IX-10

Oberlin STP
Documentation for Input Variable Selection

Applicable WQS				
1. Dissolved Oxygen	5.0 mg/l daily minimum			
2. Ammonia-N	0.05 mg/l unionized ammonia-N			
3. Temperature	$74^{\circ}F$ monthly average $82^{\circ}F$ daily maximum			
4. pH	6-9 su			

Input Variables	Value	Measured Value	Range for Sensitivity Analysis	Source
1. Stream				
a. Upstream Flow ($Q_{7,10}$)	0.004 cfs			Summation of upstream discharge flows (Section V)
b. Upstream Quality				June 30, 1978 and April 30, 1974 EPA Surveys
1. Temperature	$73^{\circ}F$		$68\text{-}79^{\circ}F$	
2. Dissolved Oxygen	7.4 mg/l		6-8.68 mg/l	
3. pH	7.8 su		7.4-8.2 su	
4. Ammonia-N	0.05 mg/l		0.0-0.44 mg/l	
5. CBOD	2.0 mg/l		1-5 mg/l	
c. Stream Slope	8.33 ft/mile			U.S. Geological Survey 7.5 Minute Series Topographical Map 1969
d. Time-of-Travel Velocity	0.2 ft/sec	0.18 ft/sec $V_2 = V_1\left(\frac{Q_2}{Q_1}\right)^{0.4}$	0.15-0.25 ft/sec	December 19, 1979 EPA Survey Ohio EPA, Policy and Procedures Manual for Developing Wasteload Allocations, June 1979
e. Depth	0.87 ft	0.76 ft $D_2 = D_1\left(\frac{Q_2}{Q_1}\right)^{0.6}$	0.65-1.08 ft	December 19, 1979 EPA Survey Ohio EPA, Policy and Procedures Manual for Developing Wasteload Allocations, June 1979
f. Reaction Rates				
1. CBOD	0.9		0.67-1.12	Values are recommended rates adjusted for temperature and depth as suggested in simplified technique
2. NBOD	0.56		0.42-0.7	
3. Reaeration	3.2		2.4-4.0	
2. STP				
a. Design Flow	3.4 cfs			NOACA, 208 Agency, Load and Flow Projections, 1979
b. Dissolved Oxygen	6.5 mg/l		6-8.0 mg/l	Selected value

Table IX-11

Spencer STP
Documentation for Input Variable Selection

Applicable WQS				
1. Dissolved Oxygen	5.0 mg/l daily minimum			
2. Ammonia-N	0.05 mg/l unionized ammonia-N			
3. Temperature	74°F monthly average 82°F daily maximum			
4. pH	6-9 su			

Input Variables	Value	Measured Value	Range for Sensitivity Analysis	Source
1. Stream				
a. Upstream Flow ($Q_{7,10}$)	0.0 cfs			Summation of upstream discharge flows (Section V)
b. Upstream Quality				April 30, 1974 EPA Survey
1. Temperature	73°F		68-79°F	
2. Dissolved Oxygen	7.4 mg/l		6-8.68 mg/l	
3. pH	7.6 su		7.4-8.0 su	
4. Ammonia-N	0.05 mg/l		0-0.44 mg/l	
5. CBOD	2.0 mg/l		1-5 mg/l	
c. Stream Slope	26.25 ft/mile			U.S. Geological Survey 7.5 Minute Series Topographical Map 1973
d. Time-of-Travel Velocity	0.2 ft/sec		0.1-0.3 ft/sec	December 19, 1979 EPA Survey below Wellington STP
e. Depth	0.4 ft	0.2-0.6 ft		December 19, 1979 EPA Survey below Wellington STP
f. Reaction Rates				Values are recommended rates adjusted for temperature and depth as suggested by simplified technique.
1. CBOD	1.15		0.9-1.4	
2. NBOD	0.56		0.42-0.7	
3. Reaeration	10.15		7.6-12.7	
2. STP				
a. Design Flow	0.35 cfs			NOACA, 208 Agency, Load and Flow Projections, 1979
b. Dissolved Oxygen	6.5 mg/l		6-8.0 mg/l	Selected value

Table IX-12

Wellington STP
Documentation for Input Variable Selection

Applicable WQS

1. Dissolved Oxygen	5.0 mg/l daily minimum
2. Ammonia-N	0.05 mg/l unionized ammonia-N
3. Temperature	74°F monthly average 82°F daily maximum
4. pH	6-9 su

Input Variables	Value	Measured Value	Range for Sensitivity Analysis	Source
1. Stream				
a. Upstream Flow ($Q_{7,10}$)	0.19 cfs			Summation of upstream discharge flow (Section V)
b. Upstream Quality				April 30, 1974, July 23-26, 1974 EPA Surveys
1. Temperature	7.3°F		68-79°F	
2. Dissolved Oxygen	7.4 mg/l		6-8.68 mg/l	
3. pH	7.6 su		7.4-8.0 su	
4. Ammonia-N	0.05 mg/l		0-0.44 mg/l	
5. CBOD	2.0 mg/l		1-5.0 mg/l	
c. Stream Slope	25.25 ft/mile			U.S. Geological Survey 7.5 Minute Series Topographical Map 1973
d. Time-of-Travel Velocity	0.37 ft/sec	0.19 ft/sec $V_2 = V_1 \left(\frac{Q_2}{Q_1}\right)^{0.4}$	0.3-0.45 ft/sec	December 19, 1979 EPA Survey Ohio EPA Policy and Procedures Manual for Developing Wasteload Allocations, June 1979
e. Depth	0.69 ft	0.25 ft $D_2 = D_1 \left(\frac{Q_2}{Q_1}\right)^{0.6}$	0.5-0.9 ft	December 19, 1979 EPA Survey Ohio EPA Policy and Procedures Manual for Developing Wasteload Allocations, June 1979
f. Reaction Rates				Values are recommended rates adjusted for t temperature and depth as suggested in simplified technique.
1. CBOD	0.99		0.75-1.25	
2. NBOD	0.56		0.42-0.7	
3. Reaeration	18.2		13.6-22.7	
2. STP				
a. Design Flow	2.03 cfs			NOACA, 208 Agency, Load and Flow Projections, 1979
b. Dissolved Oxygen	6.5 mg/l		6-8.0 mg/l	Selected value

The results of the simplified modeling approach are summarized in Table IX-13. These results show that with the exception of Grafton, all treatment facilities must discharge less than 3 mg/l of ammonia in order that water quality standards not be exceeded. Extremely low levels of BOD_5 (less than 5 mg/l) are shown for all but three plants - Amherst, Spencer, and Wellington. A significantly higher BOD_5 loading is computed for Wellington (17 mg/l) since the steep slope downstream of the plant contributes to high reaeration in this segment.

The sensitivity of allowable effluent loadings to the characteristics of each system was evaluated for each STP. Ranges for input parameters, shown in Tables IX-3 to IX-12, represent the uncertainty in the value selected for a particular characteristic. Where measurements at or near critical flow were obtained, the ranges of inputs are small, while larger ranges were used where such data are not available. The results of the sensitivity analyses are summarized in Table IX-13 and illustrated in Appendix V. Ranges in effluent quality presented in Table IX-13 are the maximum ranges computed in each sensitivity analysis. Ammonia-nitrogen ranges for all plants reflect the sensitivity of ammonia water quality standards to pH and, to a lesser extent, temperature. The computed range of BOD_5 for most plants is quite small (less than 5 mg/l). Effluent requirements are generally not sensitive to upstream water quality, but are more sensitive to stream temperature, reaeration rate, BOD reaction rate and to a lesser extent stream velocity.

Recommended NPDES permit limits based upon this analysis are presented in Table IX-14. Concentrations are weekly averages not to be exceeded. For those treatment plants where BOD_5 concentrations less than 10 mg/l were computed, a 10 mg/l effluent limit is recommended to protect the stream from severe deoxygenation and to provide limits which can be attained with conventional treatment systems i.e., biological treatment with nitrification and post filtration. These limits may be revised depending upon U.S. EPA's final promulgation of Ohio WQS or should the U.S. EPA develop a maximum technology requirement for municipalities on low flow streams. Seasonal limits for BOD_5 were evaluated, however, because of higher allowable limits for ammonia nitrogen and corresponding higher NBOD

Table IX-13

Results of Simplified Wasteload Allocation Procedures

	D.O.	Computed Effluent Quality					
		Ammonia, mg/l			BOD_5, mg/l		
	STP	Expected	Max.	Min.	Expected	Max.	Min.
Amherst	6.5	3.3	6.6	1.7	12.9	19	9
Brentwood	6.5	1.9	3.8	0.9	6.2	8.6	4
Eaton	6.5	1.9	3.8	0.9	1.2	2.1	0
Grafton	6.5	7.0	9.0	5.5	2.8	6.6	0.9
LaGrange	6.5	2.6	4.1	1.1	1.5	3.2	0
Lodi	6.5	2.8	4.5	1.2	1.8	3.3	0.6
Oberlin	6.5	1.7	4.1	0.7	2.4	3.5	0
Spencer	6.5	2.6	4.1	1.1	6.6	11.0	3.0
Wellington	6.5	2.6	4.1	1.1	17.2	22.5	12.5

Table IX-14

Recommended Effluent Limits

	Ammonia, mg/l May-Oct	Ammonia, mg/l Nov-Apr	Suspended Solids mg/l	Phosphorus mg/l	BOD_5 mg/l	D.O. mg/l
Amherst*	3.0	6.0	12.0	1.0	12.0	6.0
Brentwood Lakes Estates	1.5	5.0	10.0	--	10.0	6.0
Eaton Estates	1.5	5.0	10.0	--	10.0	6.0
Grafton	1.5	5.0	10.0	--	10.0	6.0
LaGrange	1.5	5.0	10.0	--	10.0	6.0
Lodi	1.5	5.0	10.0	--	10.0	6.0
Oberlin	1.5	5.0	10.0	1.0	10.0	6.0
Spencer	2.0	5.0	10.0	--	10.0	6.0
Wellington	2.0	5.0	20.0	1.0	15.0	6.0

*For additional discussion see Section IX-D, Municipal Treatment Needs.

values, seasonal BOD_5 limitations are not warranted. Occasional violations of the minimum dissolved oxygen water quality standard may result with these limits, (10 mg/l BOD_5, 1.5 mg/l NH_3-N) however, the affected area will generally extend less than 3 miles downstream of the treatment plants and with the exception of the stream below Eaton Estates STP, dissolved oxygen levels should not drop below 2 mg/l. Hence, Ohio's seasonal warmwater habitat use designation may be warranted for limited reaches of these streams. Recommended ammonia-nitrogen limitations (1.5 mg/l) are slightly less than the maximum concentration required to meet the water quality standards to somewhat offset higher BOD_5 limits (10 mg/l vs 1 to 5 mg/l). While higher ammonia-nitrogen limits are allowed during winter conditions reflecting lesser ammonia toxicity with lower temperatures, nitrification is required throughout the year since low flows often occur during winter months. Effluent limitations in Table IX-14 are consistent with nitrification and post filtration for all municipalities except Wellington. Wellington does not require filtration to achieve the higher BOD_5 limits. Phosphorus limits for Amherst, French Creek COG, Oberlin, and Wellington are included based upon the Great Lakes Water Quality Agreement of 1978[1] which specified phosphorus limits for facilities greater than 1 mgd discharging in the Lake Erie drainage basin.

For the many semi-public dischargers it is recommended that wherever possible they tie in with municipal sewage treatment plants. Since stream quality downstream of these smaller facilities during low flow periods is composed almost entirely of effluent flow, existing and proposed semi-public sanitary discharges should have requirements consistent with municipal treatment plants on low flow streams (see Table IX-15). Appendix IV lists the facilities which should have effluent limits that conform with this guideline.

NPDES permits for industrial dischargers to low flow stream segments must conform with BPCTCA/BCT/BATEA effluent guidelines, or achieve water quality standards whichever is more stringent. Since many industrial dischargers do not fall into categories for which Section 304 effluent limitation guidelines are promulgated, proposed permit conditions were developed taking into account water quality standards, existing effluent quality, and "best engineering judgment" BPCTCA, BCT, BATEA. Recommended effluent limitations for unpermitted discharges are presented in Appendix IV Attachment C.

Table IX-15

Recommended Effluent Limitations
for Small Sanitary Discharges to Low Flow Streams

Constituent	Monthly Avg.	Weekly Avg.
BOD_5		10 mg/l
Total Suspended Solids		10 mg/l
Ammonia-N		
May-October		2.0 mg/l
November-April		5.0 mg/l
Dissolved Oxygen (minimum)		6 mg/l
Fecal Coliform	1000/100 ml	2000/100 ml
pH		6-9

c. CATEGORY 3 DISCHARGERS TO LOWER BLACK RIVER

Table VIII-5 is a list of dischargers to the mainstem of the Black River. Reference is made to Figure V-9 for discharger locations. Water quality and effluent data clearly demonstrate the most significant dischargers in this segment are the U.S. Steel-Lorain Works, Elyria STP, and Lorain STP. In the future, the French Creek COG STP may also contribute significant loadings to the Black River via French Creek at design discharge levels.

Mathematical water quality models were employed to assess the degree of treatment required to attain temperature and dissolved oxygen water quality standards. Appendix II describes the temperature simulation model that was developed for the Black River. This model was verified using data obtained during July 1974 and July 1979 U.S. EPA water quality surveys. The EPA computer model AUTOSS was selected to simulate dissolved oxygen. Appendix III describes the model, and model calibration and verification studies. The application of the temperature and dissolved oxygen models for water quality planning is described below. These models have the capability to simulate the interaction between the Black River and Lake Erie which has a significant bearing on the water quality in the Black River.

(1) Temperature

As discussed in Appendix II, the temperature simulation model provides an expected river temperature distribution (i.e. maximum, minimum and average daily temperatures over a given time period) at critical points in the lower Black River. Note that the Ohio WQS contain average and maximum criteria. The average criteria represent the arithmetic mean of multiple, equally spaced, daily average temperatures over a consecutive 15 or 30 day period; and, the maximum daily temperature is the highest arithmetic mean of temperatures for any two consecutive hours during a 24 hour day. The "average" model output is directly comparable to the "average" value in the WQS. However, the "maximum" model output (or, value exceeded a given percentage of time) is an average value over 24 hours as opposed to the

2 hour averaging period for maximum temperatures specified in the standards. Hence, the model "maximum" value is expected to be lower than the WQS "maximum" value by about half of the diurnal temperature variation in the stream.

The model requires as input meteorological data, stream hydrology including lake flow, effluent thermal loadings, and lake temperatures. For temperature simulation purposes the Black River near U.S. Steel was divided into three reaches; an upstream section (Elyria STP to U.S. Steel water intake WI-3, RM 10.8 to 3.88); a midsection dominated by the discharge from Outfall 002 (river intake WI-3 to the upstream end of the turning basin, RM 3.88 to 2.85); and, the turning basin dominated by Outfalls 003 and 004 (RM 2.85 to 2.40).

For water temperature projections, hourly weather data at Cleveland, Ohio were obtained from the National Weather Record Center for the period 1957 through 1976.[2] The hourly data were averaged by means of a separate computer model to provide daily average meteorological conditions, daily equilibrium temperatures (E), and heat exchange rates (K). This model summarizes daily E and K values to provide respective means and standard deviations for the twenty year period in time increments associated with the Ohio temperature standards.

Monthly flow duration data at the USGS gage at Elyria provided the upstream flow for the temperature model. French Creek flow was assumed to be a fraction of the upstream flow on the Black River at the Elyria gage plus the design discharge from the French Creek STP. The flow at the Elyria STP was established as the design flow of the plant. The standard deviation of the current flow of that facility was also considered. An expression for lake flow affecting each of the three stream segments included in the temperature model was developed from stream data and demonstrates the inversely proportional relationship of lake flow to upstream river flow (see Appendix II). Daily lake temperatures for the years 1976 through 1978 were obtained from the Lorain Water Treatment Plant.[3]

Self monitoring data from U.S. Steel collected from September 1976 through June 1978 provided thermal load data and expected variation (standard deviation) for each discharge. Recent completion of a blast furnace recycle system reportedly removes about 125×10^6 BTU/hr from Outfalls 003 and 004.[4] To evaluate the effect of this treatment, the temperature model was run with measured thermal loads at U.S. Steel less the expected reduction due to recycle at the blast furnaces. Standard deviations of the thermal loads at Outfalls 003 and 004 were reduced proportionately.

Results from this "existing case" simulation are illustrated in Figures IX-1 to IX-3. The figures present the daily average computed temperature and the daily average temperature exceeded 5% of the time for each time increment contained in the water quality standards. The 5% temperature is expected to be exceeded once every twenty days or about once during each time interval in the water quality standards. It is important to note the model predicts daily average water temperature at each location in the stream and that temperature at the water surface is expected to be warmer than the average and temperature at the bottom is expected to be cooler. Since U.S. EPA intensive survey data show minimal diurnal variations of temperature in the lower Black River, daily maximum temperatures as defined in the Ohio WQS would be expected to be only 1 or 2^{o}F above the daily average values exceeded 5% of the time as computed with the model.

Figure IX-1 and 2 show expected temperatures below Outfall 001 and at Intake WI-3. Note that computed daily average stream temperatures exceed the average WQS during May and June. However, the daily maximum WQS is expected to be exceeded (temperature exceeded 5% of the time) from April through August by 1^{o}F to 5^{o}F in this segment. Stream temperatures are hottest from Intake WI-3 to the upstream end of the turning basin (midsection). Here the average WQS is exceeded by the average computed temperature from April through July. Daily maximum WQS are projected to be exceeded from March through November by as much as 12^{o}F. Turning Basin temperatures are cooler than midsection temperatures but still are projected to exceed maximum temperature standards in April through July, September, and November. EPA survey data and the temperature model verification studies confirm these violations.

FIGURE IX-1

BLACK RIVER TEMPERATURES
AT RIVER MILE 5.0
EXISTING U.S STEEL THERMAL LOADINGS

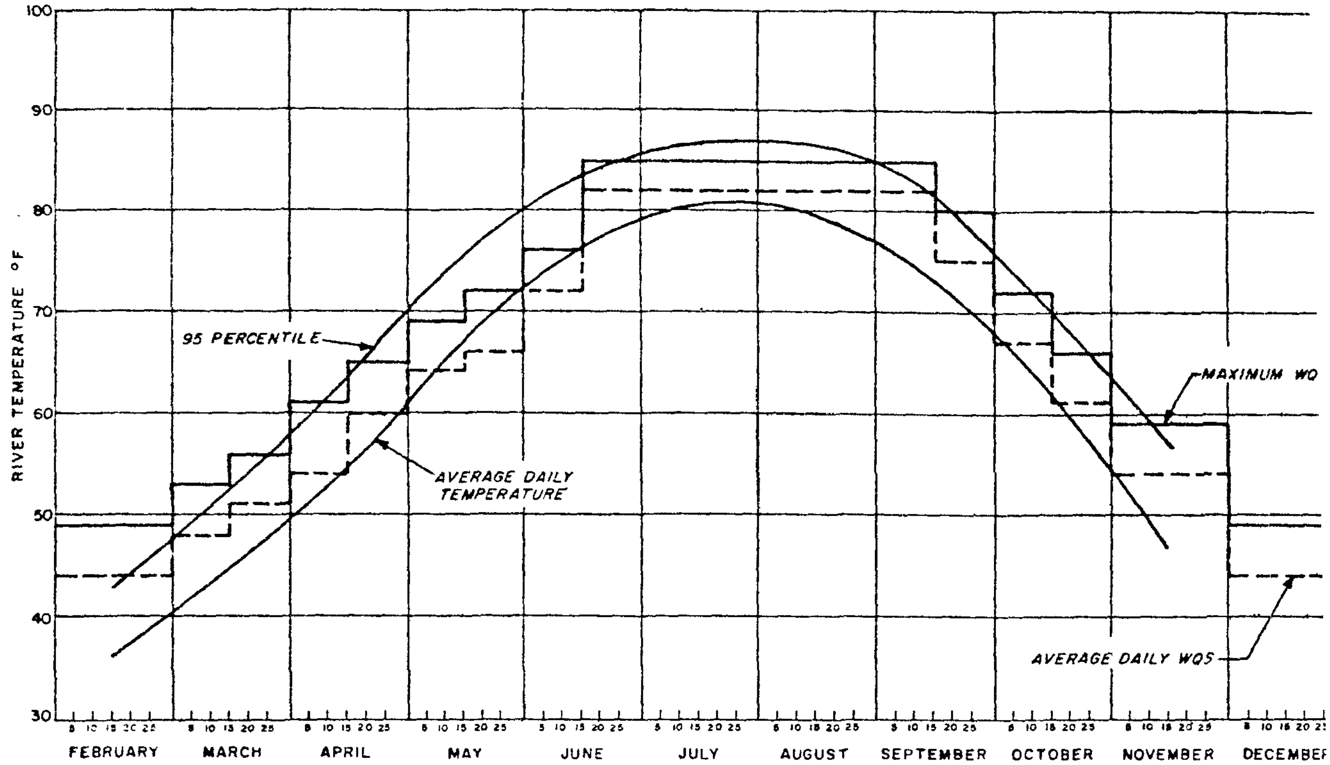


FIGURE IX-2

BLACK RIVER TEMPERATURES
AT RIVER MILE 3.88
EXISTING U.S. STEEL THERMAL LOADINGS

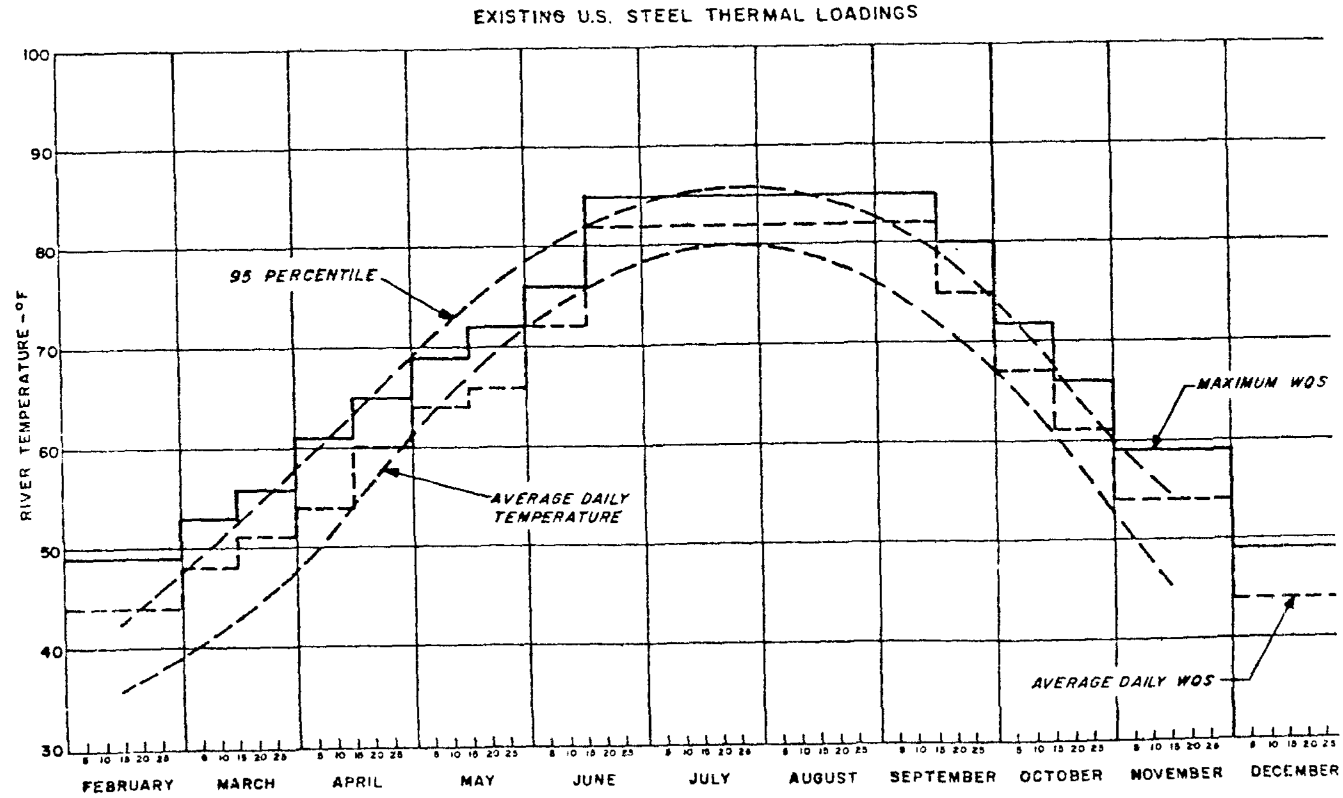
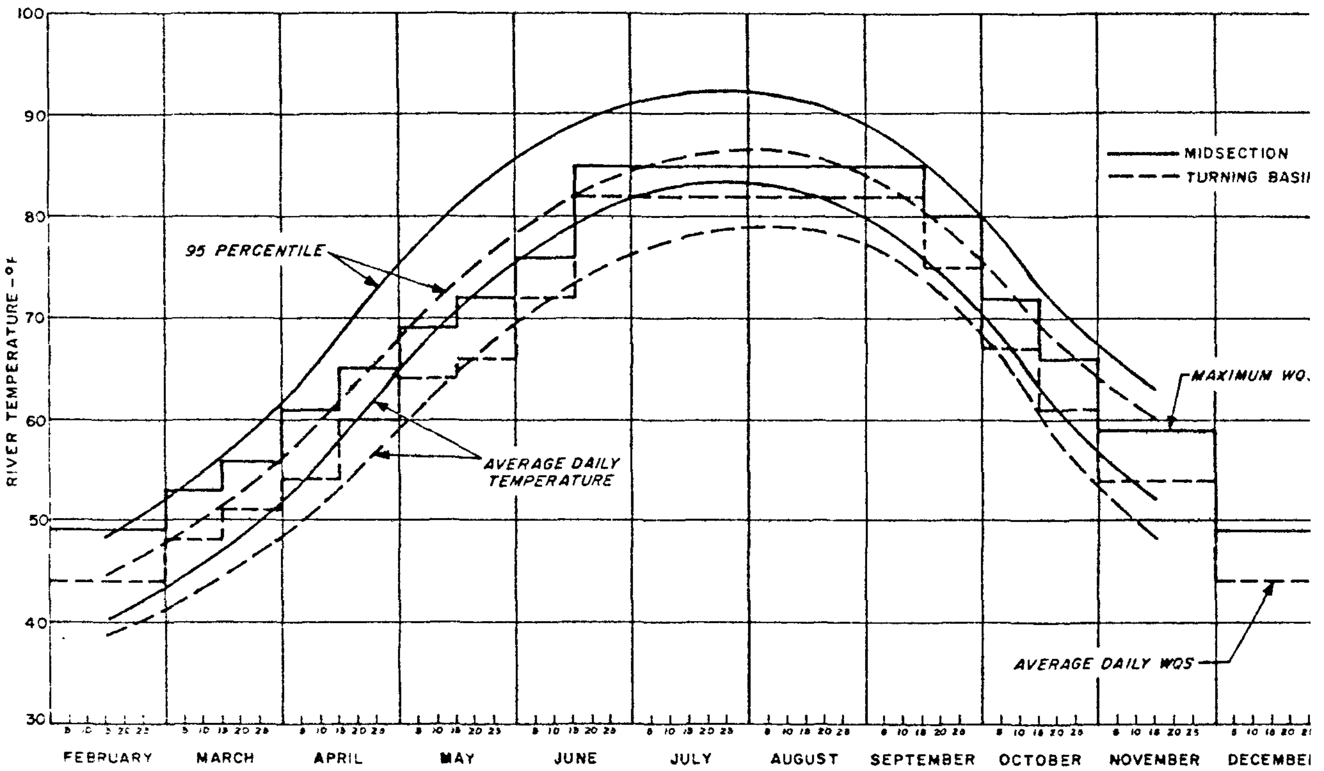


FIGURE IX-3

BLACK RIVER TEMPERATURES
IN MIDSECTION AND TURNING BASIN
EXISTING U.S. STEEL THERMAL LOADINGS



To determine effluent limits required to attain Ohio temperature standards throughout the year, two treatment alternatives were evaluated. The first involves recycle of the effluent from U.S. Steel Outfall 001 with only a 5% blowdown to the river. The second alternative includes recycle of Outfall 001 and recycle of cooling water for the primary coolers at the coke plant which discharge at Outfall 002. This is expected to reduce the thermal laod from Outfall 002 by 120 x 10^6 BTU/hr.[4] Thermal loads used in the analysis are presented in Table IX-16.

Computed temperatures for the two alternatives are illustrated in figures IX-4 to IX-7. Recycling the current discharge from Outfall 001 can reduce stream temperatures in the upstream segment by as much as 10^{o}F (Figure IX-4 and 5). Stream temperatures in this segment are projected to achieve water quality standards throughout the year with the exception of perhaps the latter part of May when average and maximum WQS would be exceeded by 1 to 2^{o}F. Midsection temperatures (Figure IX-6) are expected to exceed daily maximum standards a high percentage of the time for the months April through November, however, the margin of exceedance is expected to be reduced by about 3^{o}F by recycling the discharge from Outfall 001.

Recycle of cooling water for the coke plant primary coolers at Outfall 002 can result in a 6^{o}F reduction in average temperatures in the midsection (see Figure IX-7). Recycling Outfall 001 and the primary coolers at Outfall 002 should result in compliance with Ohio temperature standards in the lower Black River except during the period from April 16 to June 15. In this two month period maximum temperature standards are exceeded by 3^{o}F and the daily average criteria are exceeded in late May by 1.5^{o}F. Similar violations are also expected during this period in the turning basin.

Additional thermal load reductions at U.S. Steel were evaluated but the reductions produced only slightly cooler temperatures (1^{o} to 2^{o}F) while significantly increasing treatment costs. Because of the high temperatures and relatively low flow rate, recycle of the primary coolers at Outfall 002 appears to be a cost effective method to reduce thermal loads from that outfall.

Table IX-16

U.S. Steel - Lorain Works
Thermal Load Allocations

Measured Thermal Loadings (9/76 to 6/78)

Outfall	001	005	002	003	004
Loading (10^6 BTU/hr)	83.7	4.4	251.2	333.0	95.6
Std. Dev.	35.8	2.6	69.6	145.8	69.9
Flow (MGD)	51	3	26.5	68	22
No. of Measurements	95	91	231	95	94

Existing Case - Reduction of 125 x 10^6 BTU/hr for Blast Furnace Recycle in Outfalls 003 and 004

Outfall	001	005	002	003	004
Loading (10^6 BTU/hr)	84	4	251	258	44
Std. Dev.	36	3	70	113	32
Flow (MGD)	51	3	26.5	68	22

Alternative One - Existing Loadings with Recycle of Outfall 001 (5% Blowdown to 001)

Outfall	001	005	002	003	004
Loading (10^6 BTU/hr)	4	4	251	258	44
Std. Dev.	2	3	70	113	32
Flow (MGD)	2.5	3	26.5	68	22

Alternative Two - Alternative One with Recycle of Primary Coolers at Outfall 002

Outfall	001	005	002	003	004
Loading (10^6 BTU/hr)	4	4	131	258	44
Std. Dev.	2	3	37	113	32
Flow (MGD)	2.5	3	19.3	68	22

FIGURE IX-4

BLACK RIVER TEMPERATURES
AT RIVER MILE 5.0
ALTERNATIVE-1 (RECYCLE OF OUTFALL 001)

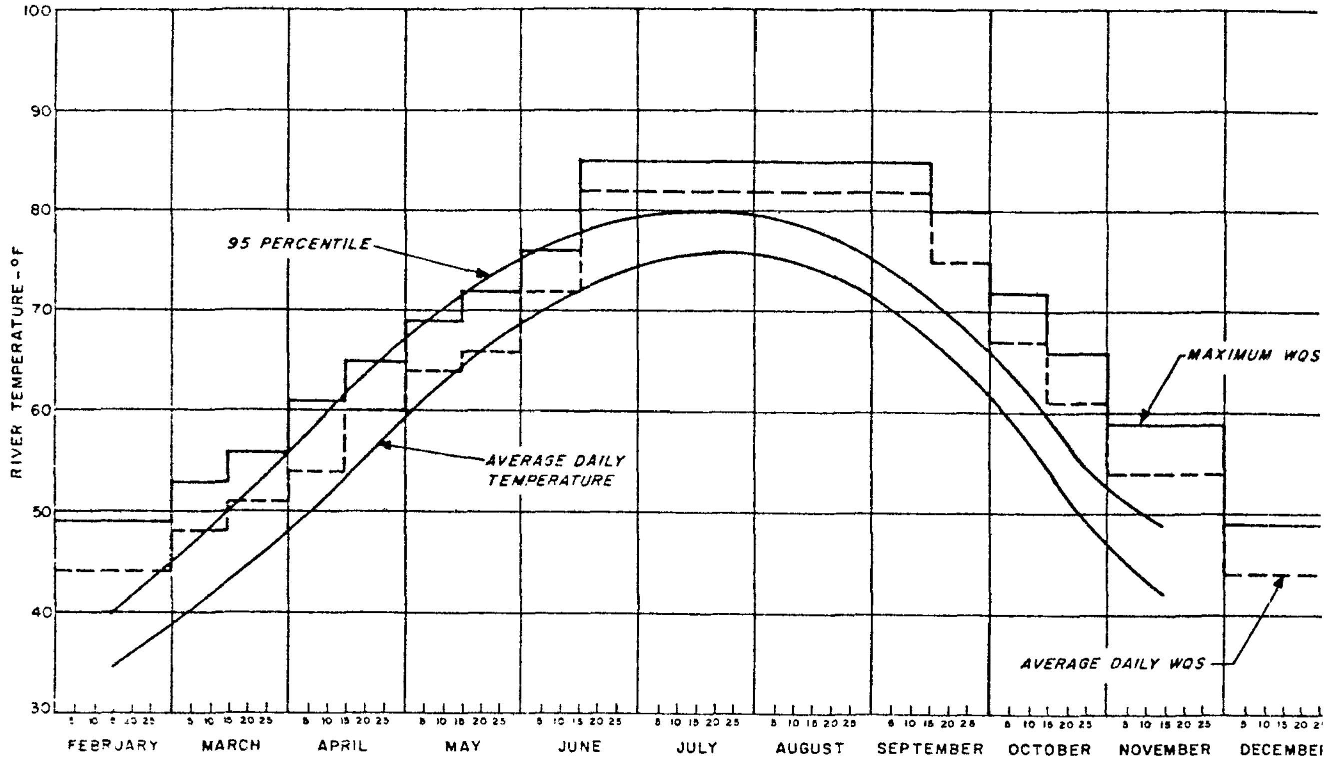


FIGURE IX-5

BLACK RIVER TEMPERATURES
AT RIVER MILE 3.88
ALTERNATIVE-1 (RECYCLE OF OUTFALL 001)

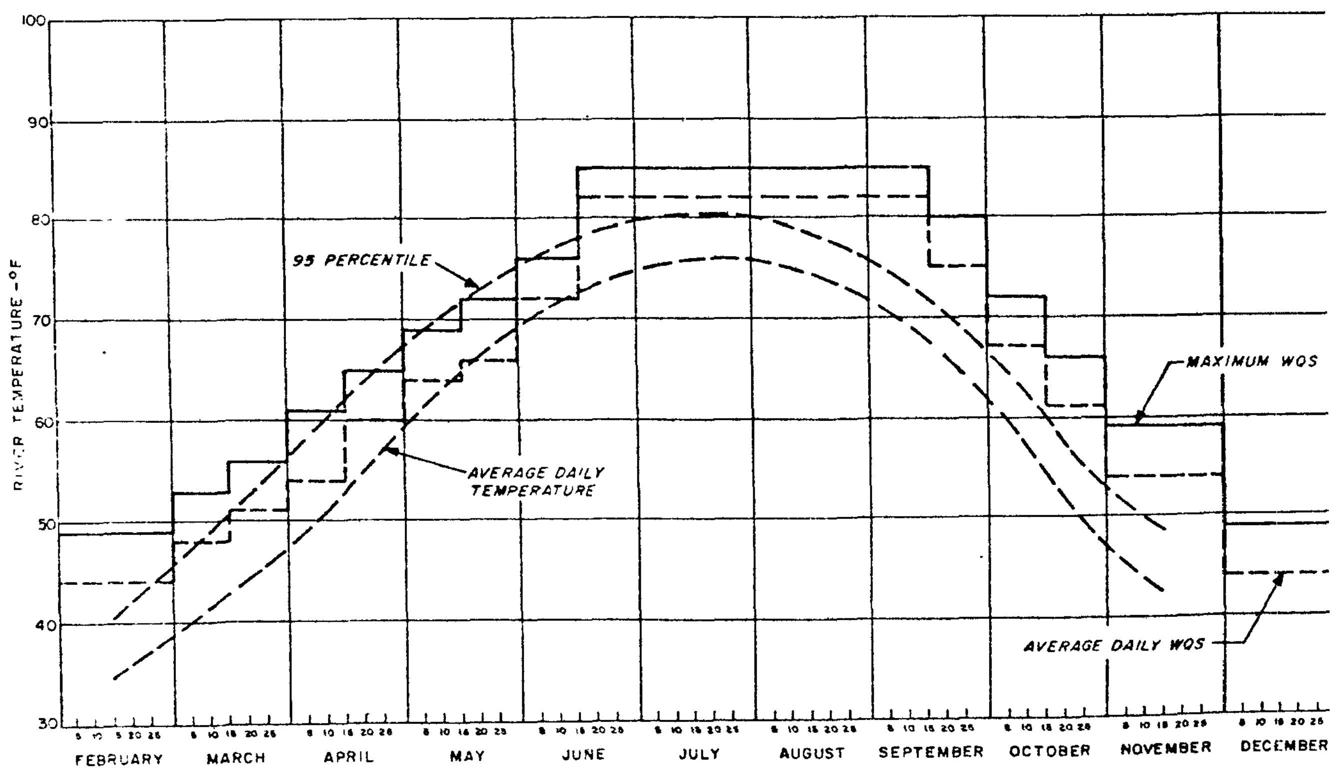


FIGURE IX-6

BLACK RIVER TEMPERATURES IN MIDSECTION AND TURNING BASIN

ALTERNATIVE-1 (RECYCLE OF OUTFALL 001)

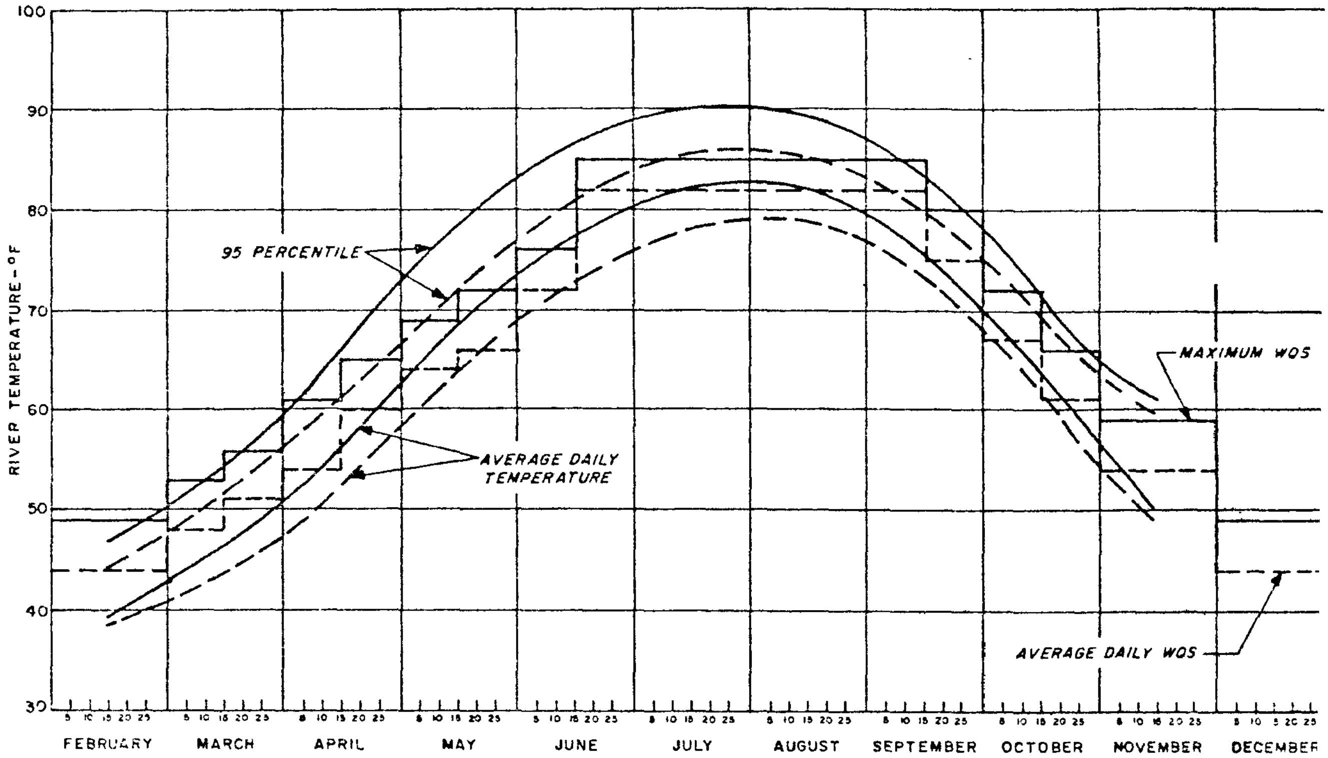
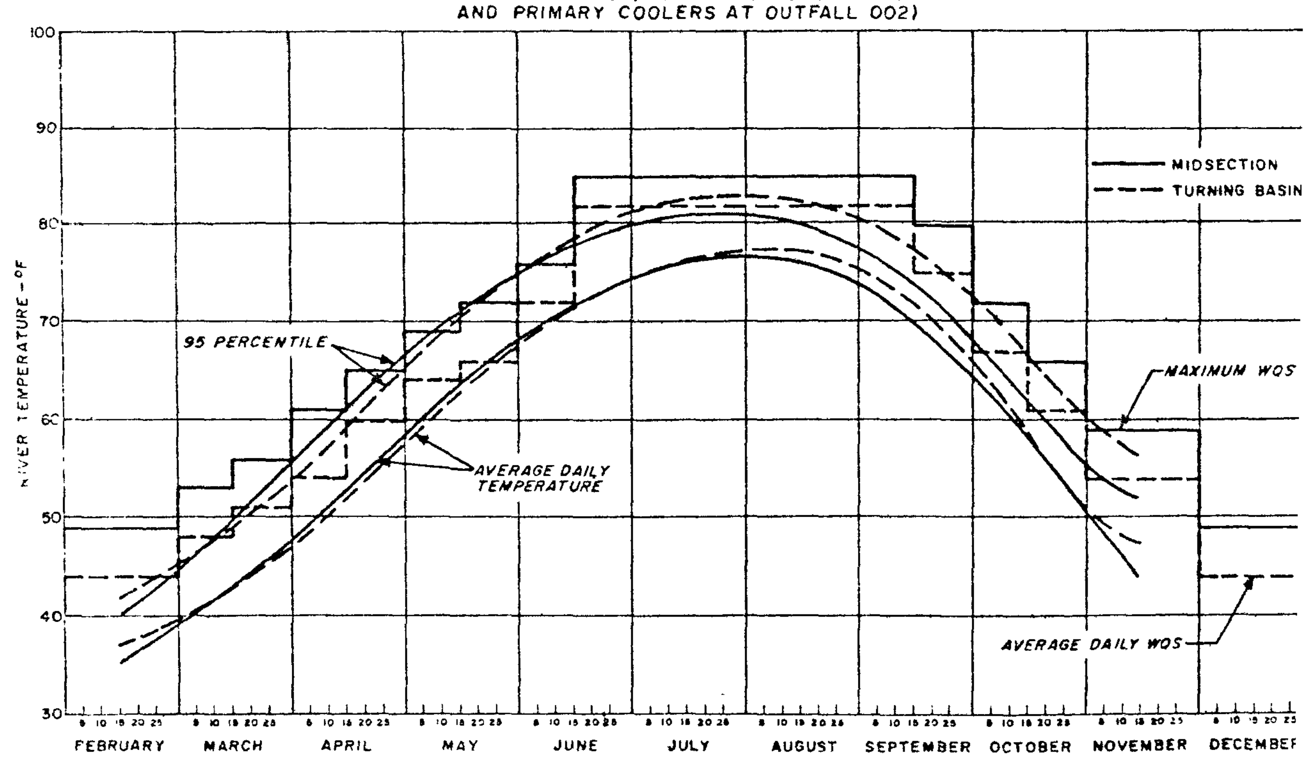


FIGURE IX-7

BLACK RIVER TEMPERATURES IN MIDSECTION AND TURNING BASIN

ALTERNATIVE-2 (RECYCLE OF OUTFALL 001 AND PRIMARY COOLERS AT OUTFALL 002)



The Lorain Plant Thermal Discharge Demonstration, United States Steel Corporation[5] suggests that even with elevated stream temperatures in the lower Black River there will be a cool zone of passage for fish to move upstream of U.S. Steel Corporation. While this is the case from the lake upstream to the turning basin, U.S. EPA intensive survey data and the temperature simulations indicate this is not the case from the turning basin (RM 2.9) to Outfall 001 (RM 5.0) without thermal controls at Outfalls 001 and 002. U.S. EPA intensive survey data (July 1974, July 1979) show significant temperature stratification (10°F) from the turning basin downstream to the lake where the stream channel is about 30 feet deep. However, upstream of the turning basin where the stream is less than 12 feet deep, top to bottom temperature measurements varied by at most 3 to 4 degrees Fahrenheit. Considering that under existing thermal loads maximum daily temperature standards will be exceeded 40% of the time from May through September (by as much as 12°F upstream of the turning basin), there is no zone of passage for fish to avoid high stream temperatures. Significant heat reduction is required at U.S. Steel to achieve water quality standards and protect movement of fish through the lower Black River. While much of the dredged section of the lower river is not a suitable habitat for fish spawning, the basin upstream of U.S. Steel has many suitable habitats.

(2) Dissolved Oxygen

In assessing treatment alternatives for dissolved oxygen in the lower Black River, primary emphasis was placed on modeling dissolved oxygen under critical low flow, high temperatures conditions. These are virtually the same conditions encountered during the July 1974 and July 1979 U.S. EPA intensive surveys. Data from these surveys were used to calibrate and verify the AUTOSS model (Appendix III).

(a) Physical Conditions

Table IX-17 presents the hydrologic and physical characteristics used for model projections. The design flow above the Elyria STP is the seven-

Table IX-17

Lower Black River Physical and Hydrologic Characteristics

River Mile	Flow cfs Entering	Flow cfs Total	Width Ft.	Depth Ft.	Dispersion sqft./sec
10.8	Elyria STP 19.1	22.4	60	0.88	2
6.5			60	0.88	
6.0			87	2.2	
5.5			105	4.1	
5.0	French Creek 8.9	31.3	138	6.1	
4.5			181	7.0	2
4.0			231	8.2	125
3.5			238	10.0	
3.0			315	14.5	
2.95				14.5	
2.85			235	15.0	
2.82			433	20.0	
2.8			500	27.0	125
2.68			767	30.0	
2.55			1200		725
2.4			500		
2.0			535	30.0	
1.5			523		
1.0			269		725
0.0			331	30.6	
-0.1			1700	21.2	140
-0.2			3200	21.0	
-0.4				26.6	
-0.6			800	30.2	140

day ten-year low flow determined at the USGS gage in Elyria (3.3 cfs).[6] In the sensitivity analysis the effects of higher flows were also evaluated. For low flow, dry weather projections, dry weather municipal flows were estimated as the product of the design flow and the ratio of 1979 average summer flow to 1979 average annual flow. The low flow of French Creek above the French Creek STP is estimated to be 0.3 cfs. Since the projected flow below the Elyria STP of 22.3 cfs is nearly identical to the flow measured during the July 1974 U.S. EPA survey (21 cfs), stream physical characteristics (widths, depths, and velocity) determined in the 1974 survey were used for model projections.

The amount of lake water mixing in the lower Black River was found to be a function of net downstream flow above U.S. Steel (see Appendices II and III), which is the sum of the flows at the Elyria USGS gage, the Elyria STP, and French Creek, or about 31.2 cfs at critical conditions. This falls between 23 cfs measured during the 1974 survey and 41 cfs measured during the July 1979 survey. Dispersion coefficients for the projections were estimated from the measured dispersion coefficients from the two surveys and the lake flow/river flow relationships determined for the temperature model. Figure IX-8 presents 1974 and 1979 measured dispersion coefficients as well as the values used in the projections.

(b) Reaction Rates

Table IX-18 presents a summary of reaction rates used for water quality projections. CBOD and NBOD stream reaction rates were obtained from the model calibration and verification studies, with the exception of the CBOD reaction rate for the Elyria STP to U.S. Steel segment, where a reaction rate of 0.3 day^{-1} was specified as being more representative of conditions below a well-treated effluent[7]. The stream reaeration rate was calculated using the relationships applied in the July 1979 simulation. Sediment oxygen demand in the lower Black River was measured in conjunction with both the 1974 and 1979 intensive surveys (see Appendix III and Volume II). For projections with more advanced treatment, the sediment oxygen demand (SOD) was estimated to be half of the 1979 measured values. Variations in stream reaction rates and SOD rates were

FIGURE IX - 8
DISPERSION COEFFICIENTS

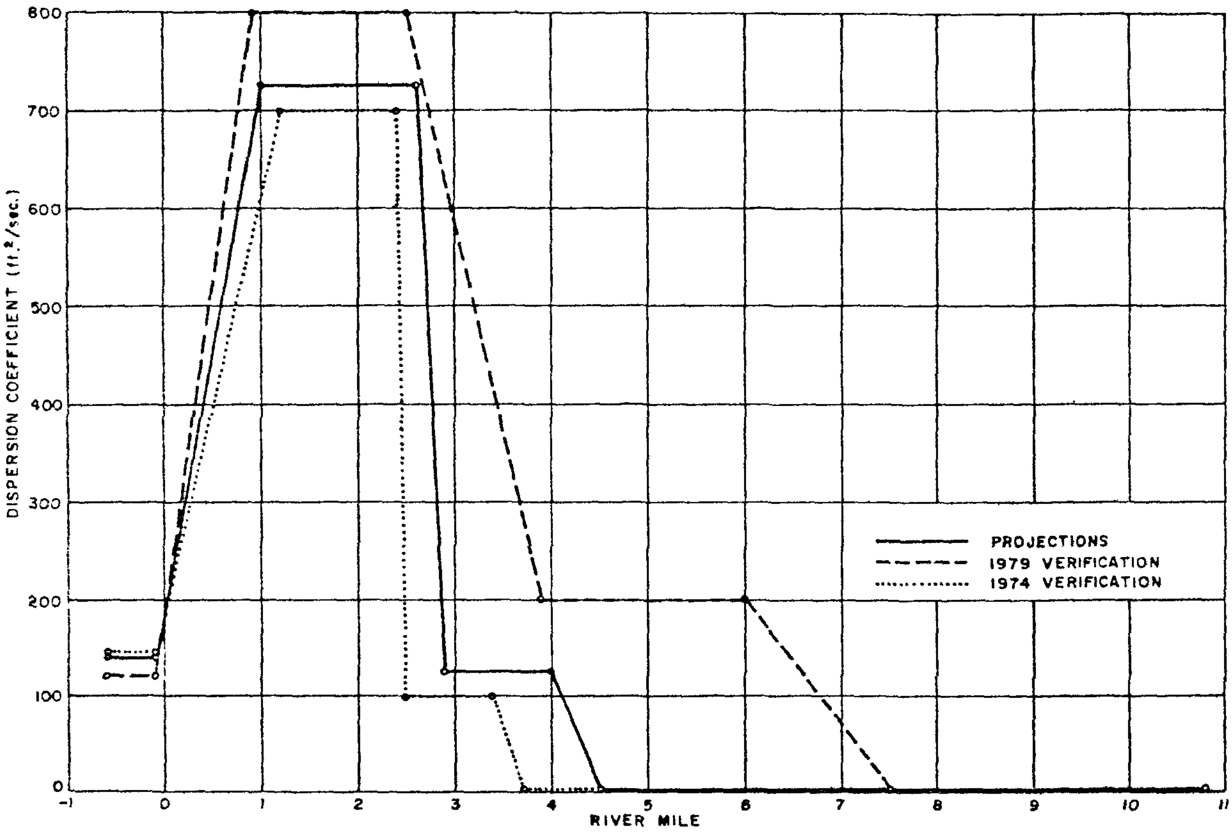


Table IX-18

Reaction Rates for the Lower Black River

Rates	River Miles 10.8 - 6.0	6.0 - 2.9	2.9 to Lake
CBOD	0.3	0.1	0.05
NBOD	0.3	0.1	0.05
Reaeration	7.6	0.35 - 0.14	0.024
SOD (1/2 1979 value)	0.0	0.0 - 0.28	0.28 - 0.56

evaluated in the sensitivity analysis.

(c) Dissolved Oxygen Projections

Various treatment alternatives were evaluated to determine effluent limitations for oxygen demanding substances for the major dischargers in the lower Black River. For the Elyria STP secondary treatment, secondary treatment with nitrification, and secondary treatment with nitrification and filtration were studied. The French Creek STP presently has secondary treatment with post filtration and is required by a July 6, 1979 Ohio EPA order to complete Step II design for nitrification by September 1, 1982.[8] Three alternatives were evaluated for the French Creek STP: (1) the proposed system; (2) effluent limits required to attain water quality standards in French Creek as determined in the previous section; and, (3) direct discharge to Lake Erie. The consulting engineer for the City of Lorain indicates that it is more cost effective to provide a direct discharge to Lake Erie from the Lorain STP rather than to provide additional treatment and maintain the current discharge to the Black River.[9] The options evaluated for the Lorain STP were the existing discharge to the River and a discharge to the Lake. For the U.S. Steel-Lorain Works the three cases evaluated in the thermal modeling were also evaluated with the dissolved oxygen model. These cases include (1) existing permit limitations, (2) recycle of Outfall 001 with a 5% blowdown to the river and an EPA estimate of BATEA at Outfall 002, and (3) recycle at Outfall 001 with BATEA and primary cooler recycle at 002. The 95 percentile temperatures computed in the thermal analysis were used for dissolved oxygen simulations. Effluent loadings for the treatment alternatives are presented in Table IX-19. The effect of the existing discharges can be seen in Appendix III.

Figures IX-9 to IX-12 show the impact of each facility on dissolved oxygen in the lower Black River. For this analysis a base condition was selected which included nitrification and filtration at Elyria STP, effluent limits at French Creek COG STP required to meet WQS in French Creek, Lorain STP discharging to the Lake, and U.S. Steel with recycle at Outfall 001 and BATEA at Outfall 002 (option 2). Effluent loadings for three of the facilities were held constant at the base condition while successively more stringent treatment levels for the remaining facility were evaluated.

Table IX-19

Effluent Loadings for Selected Treatment Alternatives

	Alternative	Flow cfs.	BOD_5	CBOD	NH_3-N	NBOD	D.O.	Thermal Load (10^6 BTU/hr)
			Concentration, mg/l					
Elyria	1. Secondary	19.1	21.7	65.0	20.0	91.4	3.3	
	2. Secondary, Nitrification	19.1	20.0	60.0	1.5	6.86	5.0	
	3. Secondary, Nitrification, Filters	19.1	10.0	30.0	1.5	6.86	5.0	
French Creek	1. Secondary, Nitrification Filters	8.9	7.5	22.4	1.6	7.25	2.9	
	2. Effluent Quality to meet WQS	8.9	1.7	5.2	1.6	7.25	6.0	
	3. Discharge to Lake	0.3	1.3	4.0	0.1	0.5	7.5	
Lorain	1. Discharge to River	27.4	20.0	60.0	20.0	91.4	3.7	
	2. Discharge to Lake	0	0	0	0	0	0	
U.S. Steel	1. Existing Permit							
	001	92.8	1.3	4.0	0	0		84
	005	3.6	0	0	0	0		4
	002	46.4	0.4	1.2	2.2	10.1		251
	003 & 004	139.2	0	0	1.2	5.4		302
	2. Same as Alt. 1 Except 001	4.6	1.3	4.0	0	0		4
	and 002	46.4	0.4	1.2	0.55	2.5		251
	3. Same as Alt. 1 Except 001	4.6	1.3	4.0	0	0		4
	and 002	29.9	0.6	1.9	.85	3.9		131

FIGURE IX-9
BLACK RIVER PROJECTIONS
ELYRIA

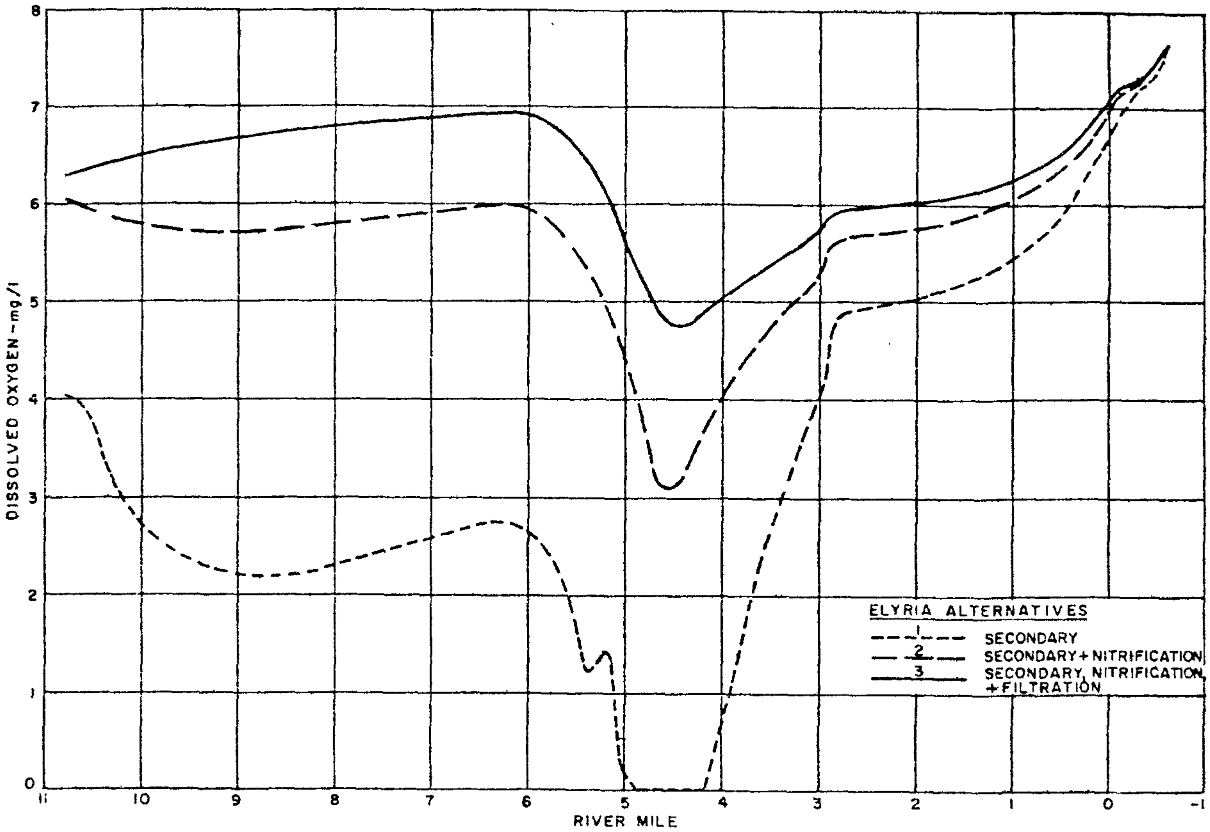


FIGURE IX-10
BLACK RIVER PROJECTIONS
FRENCH CREEK

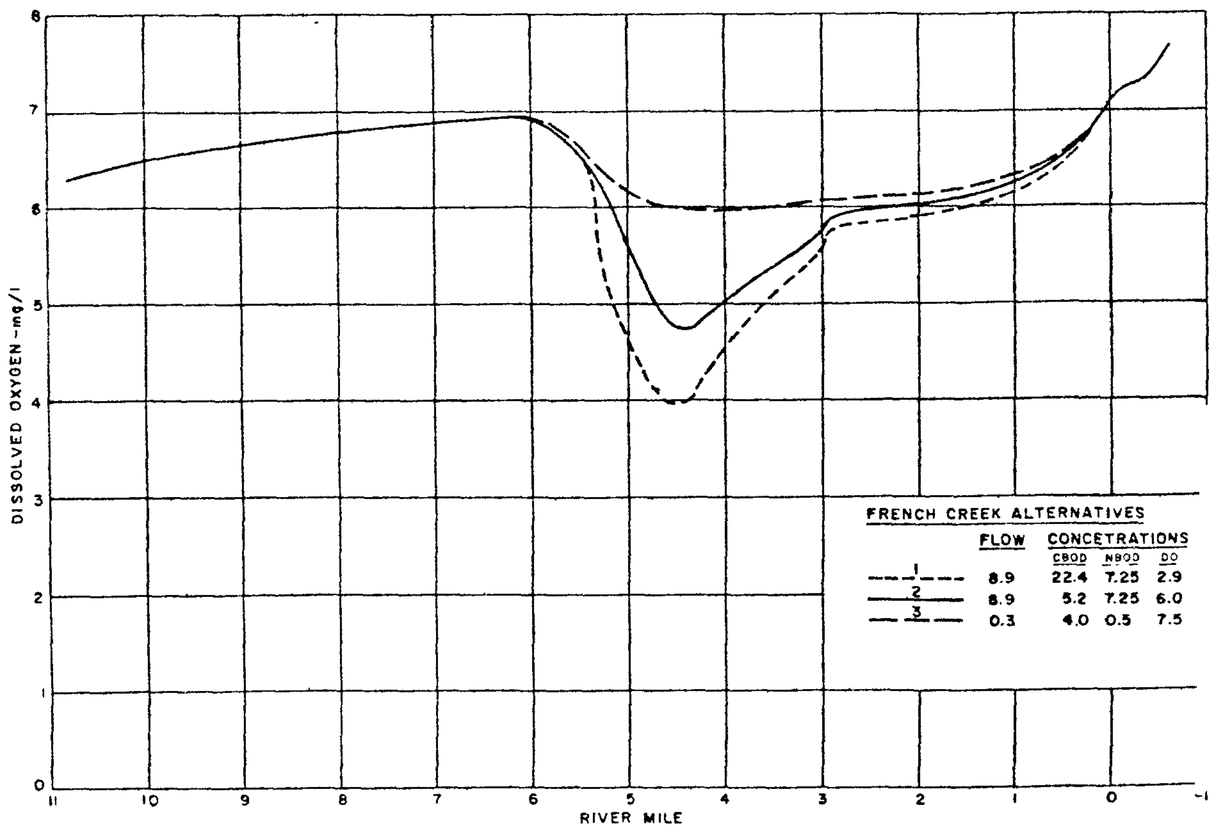


FIGURE IX-11

BLACK RIVER PROJECTIONS

LORAIN

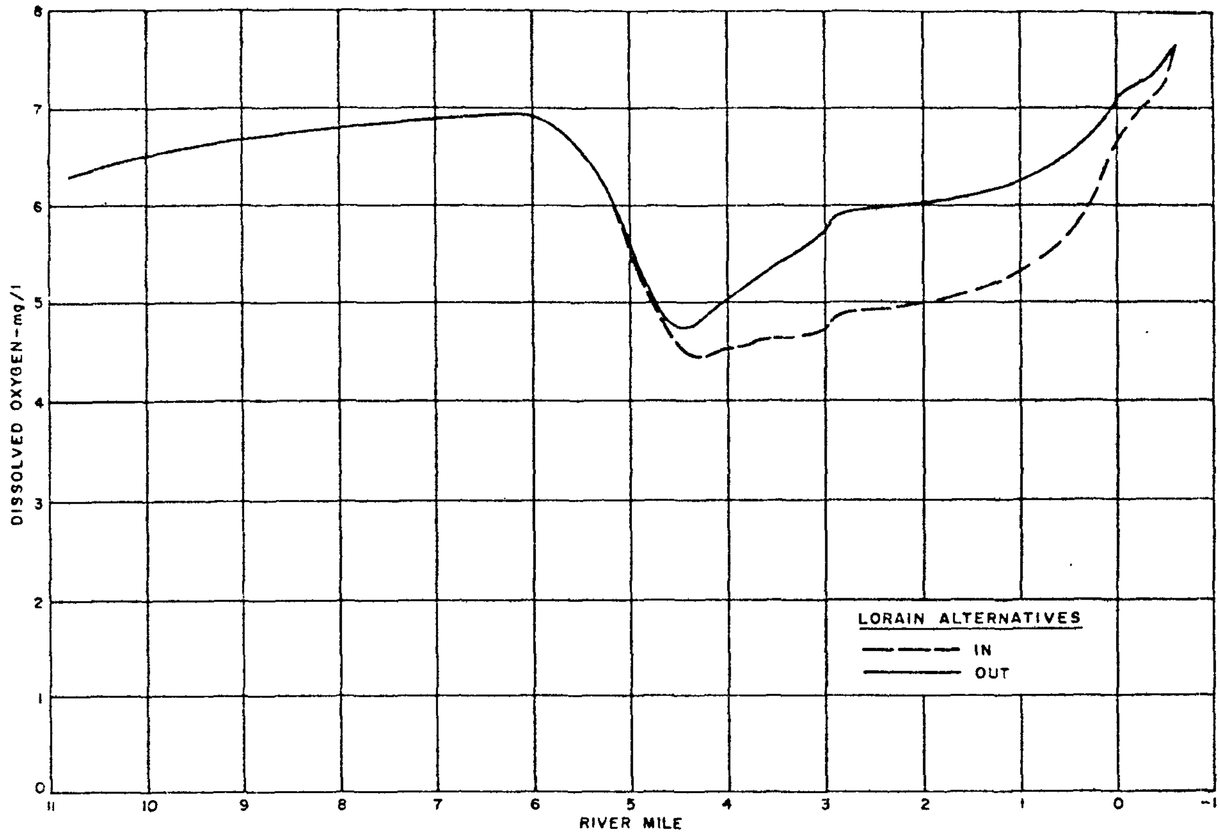
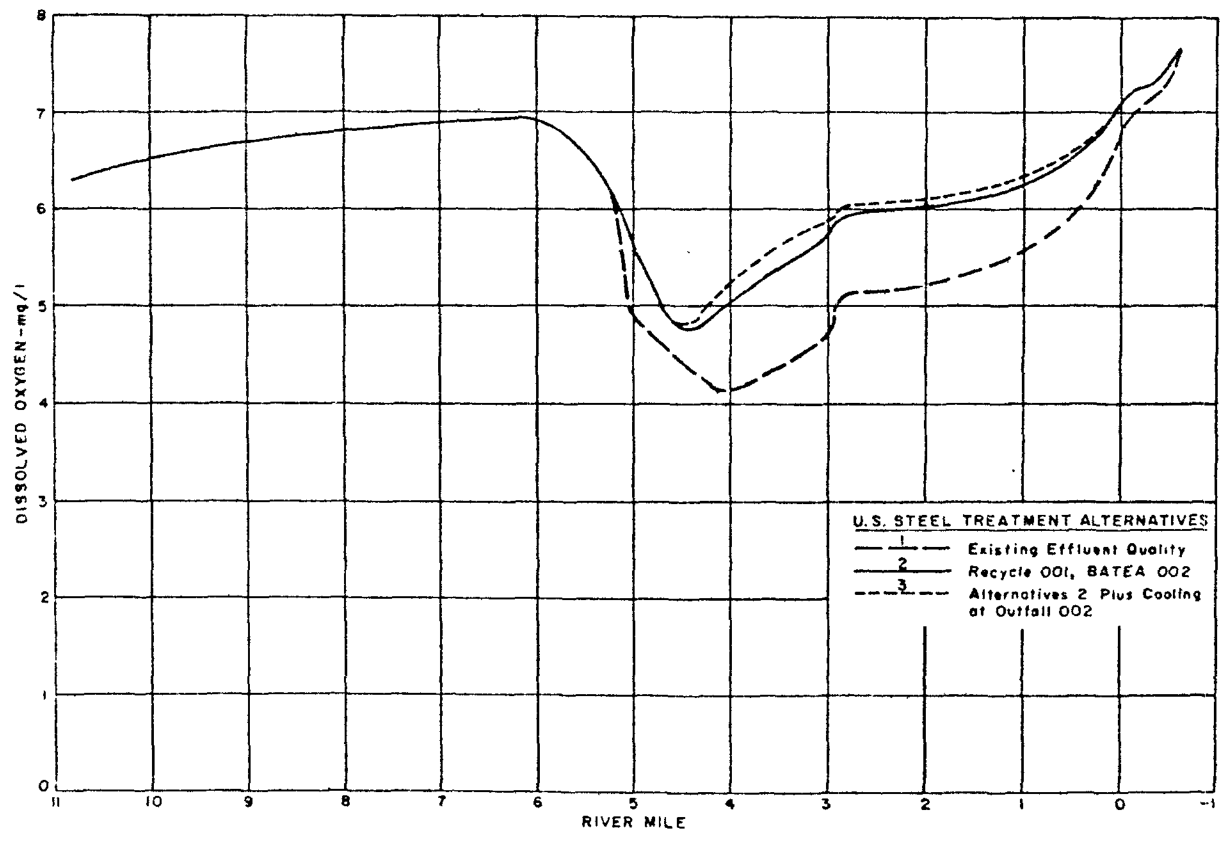


FIGURE IX-12

BLACK RIVER PROJECTIONS

U.S. STEEL



AUTOSS calculates daily average stream concentrations in contrast to the EPA proposed dissolved oxygen standard which is a minimum concentration to be achieved at all times. Since intensive survey data indicate that diurnal DO fluctuation and DO stratification near the DO sag point are less than 1 mg/l, it is expected the actual daily minimum stream DO resulting from the treatment alternatives will be within 0.5 mg/l of the average computed value from the model. Because this range is within the expected accuracy of the model, simulations were not directed at achieving instream concentrations higher than the minimum standard.

Figure IX-9 shows the impact of the Elyria STP effluent on water quality in the Black River. With secondary treatment, average dissolved oxygen concentrations below the minimum standard of 5 mg/l are projected throughout most of the river. Nitrification at Elyria, is projected to significantly improve stream quality but post filtration of the effluent is required to achieve 5 mg/l throughout the river. It is important to note that the minimum dissolved oxygen concentration occurs upstream of U.S. Steel Intake WI-3 (RM 4.0), and not immediately downstream of the Elyria STP. In the four mile river segment below the STP the stream is relatively shallow and fast moving. At river mile 6 the stream begins to widen and deepen causing stream velocity and reaeration rate to diminish dramatically. As a result, a large portion of the BOD is exerted between river mile 3 and 6. Downstream of river mile 3.5 the river starts to recover because of the influence of Lake Erie.

The impact of French Creek COG STP is shown in Figure IX-10. French Creek empties into the Black River just upstream of the critical dissolved oxygen point. Figures IX-9 shows that if the French Creek STP discharge were removed from French Creek and directed to the Lake, minimum DO in the lower Black River would improve by 1 mg/l over the quality expected with very low BOD limits at the plant (alternative 2). This is primarily the result of an increase in the dispersion coefficient at critical flow conditions due to a reduced net downstream flow. With French Creek discharging to Lake Erie, dispersion coefficients determined from the July 1974 survey were applied since the flow during the survey (23 cfs) is about the same as the expected stream flow of 22 cfs with French Creek out of the system. With regard to the impact on DO in French Creek and the lower

Black River a direct discharge to the Lake is clearly the preferred option.

The Lorain STP is located at the mouth of the Black River and as such has little impact (0.3 mg/l) on mimimum DO occurring at River Mile 4.0 (See Figure IX-11). A discharge to the river, however, reduces DO by 1.0 mg/l from river mile 1.0 to 3.0 when compared to a lake discharge.

The treatment options for U.S. Steel are presented in Figure IX-12. Assuming existing quality at Outfalls 001 and 002 (alternative 1) U.S. Steel discharges 2000 lbs/day of CBOD and 2500 lbs/day NBOD near the DO sag point with a resulting minimum stream DO of 4.2 mg/l. By recycling Outfall 001 and applying BATEA at Outfall 002 (alternative 2), 95% of the CBOD load and 75% of the ammonia loading in this segment are removed and the minimum DO increases to 4.8 mg/l. Recycle of the primary coolers at Outfall 002 (alternative 3) does not significantly change the minimum DO from alternative 2 since CBOD and NBOD effluent loadings were not changed. Hence, the thermal discharge from Outfall 002 has little effect on dissolved oxygen concentrations at the most critical point in the stream.

(d) Sensitivity Analysis

A sensitivity analysis was performed to evaluate the reliability of these projections. For this study, stream characteristics input to AUTOSS were varied over a range of expected values while effluent loadings were held constant. Since most characteristics had been measured during intensive surveys, the range of inputs selected was generally plus and minus 25% of the original values (See Table IX-20). In evaluating the sensitivity to temperature, the projected temperatures were increased and decreased by 3^{o}F. To evaluate the sensitivity to upstream flow, the sum of the 2000 year design flow of all upstream dischargers was applied. When the upstream flow was increased the dispersion coefficient was set equal to the July 1979 intensive survey values since the increased flow was nearly identical to the measured flow during the 1979 survey. In evaluating the effect of upstream quality and lake quality, CBOD, NBOD and DO values were simultaneously changed to reflect better and worse quality. A zero sediment oxygen demand was evaluated in the sensitivity analysis. Finally, to determine the impact of the dispersion coefficients, the dispersion coefficient curve

Table IX-20

Sensitivity Analysis Inputs

		Range of Coefficients	
		Increase	Decrease
Sediment Oxygen Demand			0 SOD
Reaeration		+25%	-25%
KCBOD		+25%	-25%
KNBOD		+25%	-25%
	Quality		
Upstream	CBOD	6.0	2.0
Quality	NBOD	1.0	0.0
	D.O.	5.8	8.33
	Quality		
Lake	CBOD	4.0	2.0
Quality	NBOD	0.5	0.0
	D.O.	5.9	8.54
Temperature		+3°F	-3°F
Upstream Flow		12.5 cfs	
Dispersions Magnitude		+25%	-25%
Dispersions River Mile		+0.2 mi.	-0.2 mi.
Depth (velocity) Upstream Turning Basin		+25%	-25%
Depth (velocity) Downstream Turning Basin		+3 ft.	-3 ft.

(Figure IX-8) was shifted upstream and downstream 0.2 miles and, in a second study, the dispersion coefficients were varied plus and minus 25%.

The results of the sensitivity analysis are illustrated in Figure IX-13. This analysis shows that minimum stream DO is not highly dependent on any of these values, i.e., the uncertainty associated with various inputs to the model does not affect the selection of point source treatment alternatives. The maximum change in DO occurred when varying the reaeration rate and temperature and even for these parameters minimum DO changed by only 0.4 mg/l. Clearly, effluent loadings from the dischargers are the most significant factors affecting DO in the lower Black River.

(3) Recommended Effluent Limitations

Tables IX-21 to 24 present the recommended NPDES permit limitations based upon this analysis. The City of Elyria must install treatment capable of meeting weekly effluent limits of 8 mg/l BOD_5 and 2.0 mg/l ammonia-N. This will require upgrading the existing system to include more effective biological treatment including nitrification and post filtration of the effluent. In view of the fact that existing industrial discharges to the Elyria sewerage system often cause treatment plant upsets, the City must improve monitoring of these dischargers and develop a strong, enforceable pretreatment regulation to prevent upsets of the more sensitive advance treatment system which is required. Effluent limitations for heavy metals, cyanide and phenolics consistent with water quality standards are also presented for the Elyria STP to insure a pretreatment program is implemented.

At the French Creek COG STP, the proposed nitrification system must be installed and BOD_5 effluent limits of less than 5 mg/l are required in order to attain water quality standards in French Creek and the Black River. Considering that the existing effluent quality at the plant is excellent due to the fact sewage flow is only about one-third of plant design, stringent effluent limitations can be met by construction of nitrification facilities (or modifying operating practice) and restricting the allowable flow to the plant. However if sewer tie-ins are allowed to the extent influent flow approaches the design capacity of plant and effluent quality is reduced, the

FIGURE IX-13

DISSOLVED OXYGEN SENSITIVITY ANALYSIS

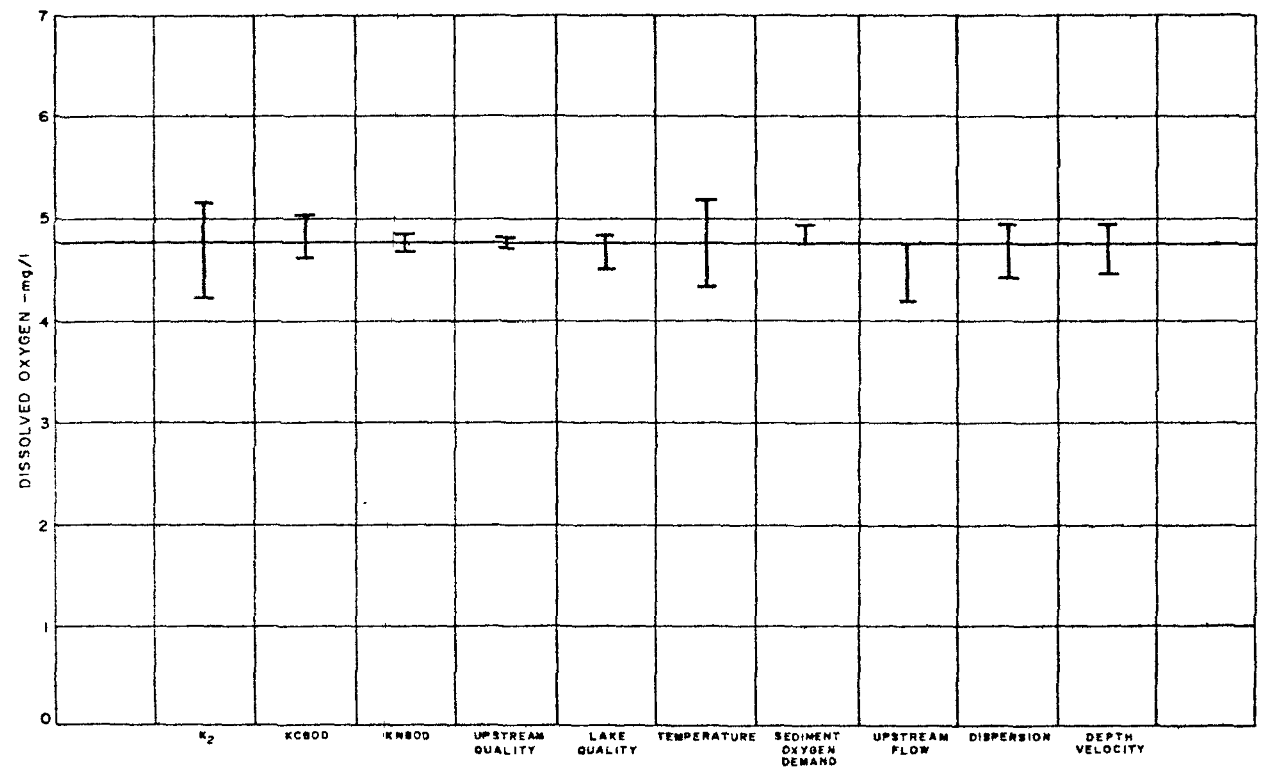


Table IX-21

Recommended Effluent Limitations

Elyria STP

Constituent	Monthly Avg.	Weekly Avg.
Total Suspended Solids		10 mg/l
BOD		8 mg/l
Ammonia-N		
May - October		2.0 mg/l
November - April		5.0 mg/l
Total Phosphorus		1.0 mg/l
Fecal Coliform	1000/100 ml	2000/100 ml
pH		6-9
Dissolved Oxygen (minimum)		6.0

	Daily Maximum
Cyanide, Total	25 µg/l
Cadmium	12 µg/l
Chromium	100 µg/l
Copper	20 µg/l
Lead	30 µg/l
Mercury	0.2 µg/l
Nickel	100 µg/l
Zinc	95 µg/l

Table IX-22

Recommended Effluent Limitations

French Creek Council of Governments
Sewage Treatment Plant

<u>Option 1 - Discharge to French Creek</u>

	Weekly Average
Total Suspended Solids	10 mg/l
BOD_5	2 mg/l
Ammonia-N	1.5 mg/l
Total Phosphorus	1.0 mg/l
Dissolved Oxygen	6.5 mg/l

<u>Option 2 - Discharge to Lake Erie</u>

	Monthly Average
Total Suspended Solids	10 mg/l
BOD_5	10 mg/l
Ammonia-N	No limitation
Total Phosphorus	1.0 mg/l
Dissolved Oxygen	6.5 mg/l

Table IX-23

Recommended Effluent Limitations

Lorain Sewage Treatment Plant
(Lake Erie Discharge)

Constituent	Monthly Avg.	Weekly Avg.
Total Suspended Solids	20	30
BOD_5	20	30
Ammonia-N	--	--
Total Phosphorus		1.0
Fecal Coliform	1000/100 ml	2000/100 ml

Table IX-24

Recommended Effluent Limitations
United States Steel Corporation
Lorain Works

(lbs/day unless otherwise noted)

	Outfall 001		Outfall 002		Outfalls 003, 004		Outfall 005	
	Monthly Average	Daily Maximum	Monthly Average	Daily Maximum	Monthly Average	Daily Maximum	Monthly Average	Daily Maximum
Thermal Discharge (10^6 BTU/hr)	--	10	--	210	--	634	--	12
Total Suspended Solids	BCT(1)	BCT(1)	BCT	BCT	BCT	BCT	--	--
Oil and Grease	BCT(1)	BCT(1)	BCT	BCT	BCT	BCT	--	--
Ammonia-N	--	--	--	136	BATEA	BATEA	--	--
Total Cyanide	--	--	--	13.9	--	35.1	--	--
Phenolics	--	--	--	5.6	--	14.0	--	--
Toxic Metals	BATEA(3)	BATEA	BATEA	BATEA	BATEA	BATEA	--	--
Toxic Organics	BATEA	BATEA	BATEA	BATEA	BATEA	BATEA	--	--
Carbonaceous Oxygen Demand	--	100	--	300	--	No Discharge	--	--

Notes:
(1) Best Conventional Technology Effluent Limitations or 95% Recycle of Existing Discharge from Outfall 001.
(2) pH 6 to 9 su for All Discharges.
(3) BATEA - Best Available Treatment Economically Achievable (to be proposed 12/80).

facility will have to consider further upgrading at the plant or constructing a direct discharge to Lake Erie. The most cost effective solution for the Lorain STP has been determined to be a direct discharge to Lake Erie.[9]

Recommended effluent limitations for the U.S. Steel-Lorain Works, include recycle of Outfall 001 with only a small blowdown to the river and BATEA at Outfall 002 (Table IX-24). Recycle at Outfall 001 is required to achieve temperature standards, and of equal importance, to achieve dissolved oxygen standards and compliance with Section 3745-1-04(B) of the Ohio Water Quality Standards. This section provides that to every extent practical and possible, state waters shall be free from floating debris, oil, scum and other floating materials entering the waters as a result of human activity in amounts sufficient to be unsightly or cause degradation. While U.S. Steel has been able to improve the discharge from Outfall 001 to the point of achieving current NPDES permit limitations for oil and grease (7 mg/l maximum), unfortunately, the company has not been able to prevent large amounts of floating oil from accumulating on the river which are clearly unsightly and sufficient to cause degradation (i.e., low dissolved oxygen levels and poor sediment quality). The only effective means of controlling this oil is to recycle the discharge and discharge only a small blowdown to the stream. This technology is common in the steel industry and has been demonstrated at other U.S. Steel plants.

Recycle of the primary coolers is required at Outfall 002 in order for the Black River to meet Ohio temperature standards throughout most of the year. Daily maximum cyanide and phenolic effluent limitations are required at Outfalls 002, 003, and 004 to achieve water quality standards in the river. Limits were calculated with a mass balance equation assuming no upstream load and the minimum total flow in the segment (i.e., upstream flow plus lake flow) as determined from the relationships presented in Appendix II, (103 cfs midsection and 260 cfs in turning basin). These recommendations should be incorporated into the next NPDES permit for the plant and include a compliance schedule consistent with installation of BCT/BATEA treatment by July 1, 1984.

Recommended permits for the remaining dischargers to the Black River are discussed in Appendix IV. Included are 17 semi-public sewage treatment plants in Sheffield which discharge a total of about 0.2 mgd of sanitary wastes to the North Ridge Road storm sewer. Due to the small discharge flow compared to the water quality design flow of the Black River, U.S. EPA secondary treatment guidelines are recommended for each discharger:

Constituent	Secondary Treatment Guidelines Monthly Avg.	Weekly Avg.
BOD_5 (mg/l)	30	45
Suspended Solids, (mg/l)	30	45
Fecal Coli. (No./100 ml)	200	400
pH (s.u.)	6-9	

It is also recommended that each tie-in to the Lorain sanitary sewer system when it is extended to the area.

B. Non Point Source Considerations

The Black River Basin consists of 10% urban and developed land, 55% cropland, 10% pasture and range, 15% forest, 10% farmland and other nonfarmland.

In the urban areas, non point source pollution is primarily from combined sewer overflows, urban runoff, and industrial runoff. The combined sewer overflows contain raw sewage which is high in suspended matter, CBOD and fecal coliform, and ammonia-N. Urban runoff is usually high in suspended matter and usually contains some oil, organic matter, and heavy metals. Industrial runoff is also high in suspended matter with some oil and organic matter. For areas around blast furnaces and coke plants, the runoff has the additional possibility of containing ammonia-N, cyanide, phenolics, and sulfides. In rural areas, non point source pollution is primarily from agricultural runoff. This runoff is characterized by suspended and dissolved solids, organic matter, nutrients and sometimes pesticides.

1. Dissolved Oxygen

In general, historical Black River water quality data are unsuitable for use in evaluating non point source loadings to the river because the data were not obtained to depict non-point source problems. The United States Geological Survey maintains the only continuous monitor on the Black River at the gage at Elyria, downstream from the confluence of the east and west river branches. Flow, dissolved oxygen, specific conductance, and temperature are recorded daily and reported in the annual USGS publication Water Resources Data for Ohio.[10] Daily maximum and minimum DO and temperature are reported.

USGS data for the water year 1973 was analyzed to determine the impact of storm water runoff on DO concentrations in the river. For this study, a storm event is defined as a 100% increase in stream flow at the USGS gage in Elyria over a 24 hour period. Dissolved oxygen is the only constituent reviewed because specific conductance and temperature were generally unchanged by storm water runoff.

Data from 37 storm events showed that on the average, the minimum daily DO increased 0.65 mg/l and the maximum DO increased 0.79 mg/l during storm events (Table IX-25). This indicates that massive amounts of organic material with a high BOD are not being added to the river upstream of Elyria during storm events. It should he noted that the USGS gage is at the confluence of the east and west branches of the Black River upstream of the major sewage treatment plants for the cities of Lorain and Elyria. The DO trend described above would probably differ if taken downstream of these facilities due to the possible bypass of organic material from the plants into the river during heavy storm events. Reference is made to a similar data review for the Mahoning River which showed only limited negative impacts downstream of the Youngstown area during storm events.[11]

2. Nutrients, Suspended Solids

In December 1975 the U.S. Army Corps of Engineers Buffalo District released the Lake Erie Wastewater Management Study Preliminary Feasibility Report[12] which assesses diffuse source contributions to Lake Erie and includes estimated loadings from major tributaries. The three parameters of primary concern in this study were NO_2-NO_3, phosphorus, and suspended solids. For these parameters, the Corps developed loading models which, when used with measured river flows, can accurately predict stream concentrations. The general equation is $Y = A + BX$, where

TABLE IX-25

DISSOLVED OXYGEN CHANGE WITH STORM EVENTS
(1973 U.S.G.S. WATER RESOURCES DATA FOR OHIO)

Minimum Concentration	Δ Before		Δ After		Δ Total	
No. of Events with Decreased Concentration	11/36	31%	18/37	49%	18/36	50%
Increased Concentration	22/36	61%	16/37	43%	16/36	44%
No Change	3/36	8%	3/37	8%	2/36	6%
Maximum Concentration	**Δ Before**		**Δ After**		**Δ Total**	
No. of Events with Decreased Concentration	10/36	28%	17/37	46%	8/36	22%
Increased Concentration	19/36	53%	14/37	38%	23/36	64%
No Change	7/36	19%	6/37	16%	5/36	14%

Δ Before = (Storm event D.O.) - (D.O. immediately preceding storm event)
Δ After = (D.O. immediately after storm event) - (Storm event D.O.)
Δ Total = (D.O. after storm) - (D.O. before storm)

Y is the parameter's concentration given in mg/l,

X is the river flow in cfs/sq. mile, and

A and B are coefficients which are dependent on the river and parameter.

For the Black River at the USGS gage A and B are as follows:

NO_2-NO_3	A = 1.09	B = .0020
Phosphorus	A = .20	B = .00072
Suspended Solids	A = 68.4	B = 2.30

According to this model, the concentrations of the above three parameters increase with increased flow in the Black River. This concentration rise with river flow is the result of nitrogen and phosphorous containing fertilizer and fertilizer laden soil being washed into the river during storm events. Soil erosion into the river causes the increase in suspended solids.

3. Metals

In Section VIII, violations of cadmium and lead standards were attributed to non-point source pollution. Similar findings were made in the Grand and Ashtabula Rivers and Conneaut Creek.[13] Cadmium is used in agriculture as a fungicide and cadmium succinate is used in insecticides and turf fungicides.[14] Lead acetate, lead arsenate, and lead arsenite are used in insecticides and lead arsenate is also used as a herbicide.[14] The use of these products in predominantly agricultural portion of Black River Basin may account for violations of the cadmium and lead standards. This situation can be improved, along with other runoff problems, through the use of improved farming practices. Additional assessment of non point source contributions, would require extensive non point source surveys. The International Joint Commission has outlined the procedures for conducting such surveys in their report of the proceedings of the Sandusky River Basin Symposium, May 2-3, 1975 in Tiffin, Ohio.[15] However, additional surveys were not conducted as part of this study since non-point source loadings do not include pollutants for which point source load allocations are necessary. Such studies are recommended as part of the Ohio EPA monitoring strategy.

Based upon this review, non-point source loadings to the basin do not have a significant impact on the constituents allocated in this report. The effect of non-point sources on the allocations is minimized by allocating loads at low flow conditions when surface water runoff in the basin is zero.

C. Total Maximum Daily Loads

Section 303(d) of the 1977 Amendments to the Clean Water Act requires that for streams where effluent limitations required by Section 301(b) are not stringent enough to maintain WQS, the State must determine the Total Maximum Daily Load (TMDL) of pollutants that can be discharged to the segment and still maintain water quality standards. TMDL's must be developed for each water quality constituent that contributed to the water quality limiting classification. The TMDL must take into account stream flow, upstream quality and stream assimilative capacity.

Section VIII of this report indicates that for planning purposes the Black River Basin is divided into fifteen segments, nine of which are classified as water quality limiting. The constituents of major concern in these segments are dissolved oxygen and ammonia nitrogen. Thus TMDL's must be determined for the oxygen demanding substances (BOD_5) and ammonia nitrogen. Since the assimilative capacity of stream segments for nonconservative substances is a function of stream and effluent flow as well as the location of the discharger within the segment, TMDL's were determined assuming the existing configuration of dischargers. Should new facilities propose to discharge to the segment or if existing facilities cease present operations the TMDL would be expected to change. Recommended effluent limitations for the major dischargers in the basin were presented in the first part of this section based upon water quality models. Effluent limitations for minor facilities were treated as a whole and required to have treatment consistent with the larger facilities. The TMDL for the water quality limited segments was computed as the sum of the recommended effluent limitations for the dischargers in a segment considering the design flow of the facilities. Table IX-26 presents the TMDL's for the nine water quality segments in the planning area. A thermal loading TMDL is included for Segment 1 since temperature standards are not achieved with existing or

Table IX-26

Total Maximum Daily Loads

Segment	BOD$_5$	Ammonia	Thermal*	Cyanide	Phenolics
	Loadings lbs/day				
Black River 1	135	136	700	49	19.6
French Creek 2	340	97			
Black River 3**	1140	270		3.0	
East Branch 5	50	10			
East Branch 6	330	70			
West Branch 9	8	2			
Plum Creek 10	130	30			
Beaver Creek 14	160	40			
Martin Run 15	2	0.4			

*10^6 BTU/hr

**Additional TMDL's for Segment 3

	lbs/day
Cadmium	1.4
Chromium	12.1
Copper	2.4
Lead	3.6
Mercury	.02
Nickel	12.1
Zinc	11.5

BPT thermal loads at U.S. Steel. However, it should be noted that the distribution of the thermal loads at the U.S. Steel facility is critical to attainment of Water Quality Standards. Total cyanide and phenolics TMDL's are also included for the U.S. Steel segment. TMDL's for cyanide and metals are included for Segment 3 since the Elyria STP discharge contributes to violations of those WQS'.

D. Municipal Treatment Needs

The preceding discussion evaluated the required effluent quality for existing facilities at year 2000 design flows. Other recent studies of the area reviewed the feasibility of regionalization of existing municipal facilities and/or the need for new sewage treatment plants in other parts of the basin. A report on the Lorain Regional Sewer System[16] recommended one of three plans for upgrading and expanding the existing Lorain and Amherst Sewage Treatment Plants, depending whether or not the Amherst facility is abandoned. One plan includes expanding the Lorain STP to 24 mgd, and Amherst STP to 3 mgd. The other plans suggest constructing a second major treatment plant next to Quarry Creek to serve the area west of Martin Run. The size of this plant would depend upon abandoning the Amherst STP. All three plans involve the extension of sanitary sewers to Sheffield Village, and Sheffield Lake and would allow the elimination of at least 20 semi-public treatment plans discharging to the Black River.

The selection of an alternative must take into account the respective cost as well as water quality impacts. While it is not within the scope of this report to conduct detailed cost analyses, it is important to recognize that two of these alternatives include a new 6 to 9 mgd plant on Quarry Creek. Since the stream has no natural flow, the facility would have to provide advanced waste treatment capable of achieving weekly BOD_5 effluent limits of 5 to 8 mg/l and 1.5 ammonia-N. On the other hand a direct discharge to Lake Erie or a discharge to the Lorain STP would require conventional secondary treatment and avoid the substantially higher capital and annual costs of an advanced treatment system. The facility planning process must carefully consider the advantages of discharging to the Lake. In either case, the Amherst plant should be abandoned and sewage from the area should be treated at the Lorain STP or a new facility discharging to the Lake.

The Lorain County Water and Sewer Study[17] recommended that Rochester build a sewage treatment plant. Since it would discharge to a zero flow stream, the effluent should be consistent with effluent limitations at other STP's (i.e. BOD_5-7 mg/l, ammonia 1.5 mg/l). The report also recommends the elimination of the Oberlin, Grafton, Eaton Estates, Brentwood Lake Estates, and Grafton State Farm sewage treatment plants by 1990 and construction of a sewage treatment plant south of Elyria to treat the wastewater from Eaton Township. The proposed plant south of Elyria would have to achieve effluent limitations of 7 mg/l BOD_5 and 1.5 mg/l ammonia, as it would discharge to a stream with a water quality design flow of zero cfs. An additional recommendation was the expansion of the Elyria sewer district to include Oberlin and eliminate the Oberlin STP. Since these options require similar treatment, the 201 facility plan should evaluate the relative costs of separate versus regional treatment plants.

E. Water Quality Standards Revisions

1. Low Flow Streams

The general warmwater habitat use designation and associated water quality criteria (5.0 mg/l minimum) cannot be achieved downstream of every municipality located on low flow streams in the planning area. However, the level of treatment recommended throughout the year at these facilities i.e., weekly BOD_5 limitations of 10 mg/l and nitrification, will prevent nuisance conditions in the summer months and provide for protection of most uses throughout the remainder of the year. The aquatic habitat immediately downstream of these facilities is generally good. Pools and riffle areas with sand and gravel bottoms are common. Minor sludge deposits were found below a few facilities, but deposits are not likely to persist with advanced treatment. Major problems were noted downstream of the Amherst STP. As noted in Section VIII, varied fish populations were found throughout the basin upstream of Elyria. Notwithstanding the above, the amount of habitat adversely affected below each facility with the degree of treatment recommended is not great, usually less than one or two miles. In summary, Ohio's seasonal warmwater habitat use designation is recommended for two mile reaches below the Brentwood Estates, Eaton Estates, Grafton, Lagrange, Lodi, and Oberlin Sewage Treatment Plants.

2. Black River Mainstem

The results presented herein clearly demonstrate that the warmwater habitat use designation and associated water quality criteria can be achieved throughout the lower Black River. However, minor problems with dissolved oxygen near U.S. Steel's upstream intake and with temperature near U.S. Steel Outfall 002 are expected. This analysis shows that a daily average dissolved oxygen standard in excess of five milligrams per liter can be achieved in this area. However, achieving five milligrams per liter on a daily minimum basis at the critical point is less certain, owing to the unknown effect of recycling U.S. Steel Outfall 001 upon the dispersion of lake water from U.S. Steel Intake WI-3 to Outfall 001. Since the analysis is not overly sensitive to factors other than waste loads and diurnal variation is likely to be small, deviations from the 5.0 mg/l minimum dissolved oxygen standard are also likely to be small. For some portion of lake affected area of the lower river dissolved oxygen levels less than 5.0 mg/l may occur at the stream bottom, but a large safe zone of passage above 5.0 mg/l should be available. Since this area is not particularly well suited for spawning, dissolved oxygen levels less than 5.0 mg/l near the bottom of a water column eight to thirty feet deep is not significant in terms of precluding movement or migration of fish.

With respect to stream temperatures, meteorological conditions make it difficult to achieve temperature standards throughout the year in the lower Black River even with significant thermal reductions at U.S. Steel. Recycle of U.S. Steel Outfall 001 and the primary coolers discharging through Outfall 002 will result in attainment of Ohio water quality standards except for a small exceedance (1 to 3°F) during the period April 16 through June 15. Chris Yoder, Chief, Water Quality Section, Ohio EPA indicates that minor exceedances of temperature standards during this period are not critical to the survival or movement of fish in the lower Black River.[18] The increased temperature, however, may change by a few weeks the migration of fish through this segment. It is therefore recommended that average and maximum temperature standards for the period April 16 to June 15 be increased $3^{o}F$ for the lower Black River. This modification in conjunction with the recommended thermal loading at U.S. Steel will result in attainment of water quality standards throughout the year.

Based upon the above, criteria associated with lesser uses than warmwater aquatic habitat are not warranted for the lower Black River.

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13. United States Environmental Protection Agency, Northeast Ohio Tributaries to Lake Erie Waste Load Allocation Report, Volumes I, II, March 1974.

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SECTION X
RECOMMENDED PRIMARY MONITORING NETWORK

Section 106(e)(1) of the Federal Water Pollution Control Act Amendments of 1977 provides that beginning with fiscal year 1975 (July 1974), the U.S. Environmental Protection Agency may not grant funds in support of State-administered programs for water quality improvement unless the State has established a suitable water quality monitoring strategy. The U.S. EPA has developed draft guidelines to assist the States in preparing the monitoring strategies required by Section 106. According to these guidelines, there are six basic types of monitoring that should be included in an overall water quality monitoring strategy:

(1) Monitoring in support of the State continuous planning process pursuant to Section 303(e) of the 1977 Amendments.

(2) Intensive monitoring surveys for setting priorities for establishing or improving pollution controls; determining quantitative cause and effect relationships of water quality; obtaining data for updating water quality management plans; determining the extent to which pollution control actions taken were successful; and, determining any additional water quality management actions required.

(3) A primary monitoring network to assess progress toward the July 1983 goal that, wherever attainable, all waters should be capable of supporting aquatic life and recreational uses; to establish baseline water quality; to maintain cognizance of water quality conditions throughout the State; and, to obtain the basic information needed for reports required by Section 305(b) of the 1977 Amendments.

(4) Compliance Monitoring of point source dischargers under permit through the National Pollution Discharge Elimination System (NPDES) pursuant to Section 402 of the 1977 Amendments.

(5) Monitoring of surface waters, groundwaters, sediments, and biological communities to determine whether toxic pollutants designated under Section 307(a) of the 1977 Amendments are entering the State's waters and for determining their origin and the priority for appropriate control in the event they are found.

(6) Groundwater monitoring to determine baseline groundwater quality and to provide early detection of pollution. In addition, potential sources of groundwater pollution should be monitored to complement actual groundwater monitoring.

One of the more important monitoring programs outlined above is the primary monitoring network as this program provides the basic information for both medium and long-range water quality management decisions as well as data necessary for Federal reporting purposes. The location of recommended primary water quality monitoring network stations for the Black River Planning Area are illustrated in Figure X-1. Appropriate station descriptions are provided in Table X-1. A sampling frequency of once per month is recommended at each station for each physical, chemical, and bacteriological constituent listed in the State-adopted Federally approved Water Quality Standards. A dissolved oxygen profile should be obtained at Station 1 since this is near the critical dissolved oxygen sag point in the lower Black River. Also, the sample for water chemistry should be obtained on the discharge side of U.S. Steel's intake pumps to obtain a well mixed sample of the river. Consideration should be given to establishing streamflow gaging stations downstream of the Elyria sewage treatment plant but above the East 31st Bridge in Lorain and on French Creek near its confluence with the Black River.

FIGURE X-1

BLACK RIVER PLANNING AREA

RECOMMENDED PRIMARY WATER QUALITY MONITORING NETWORK

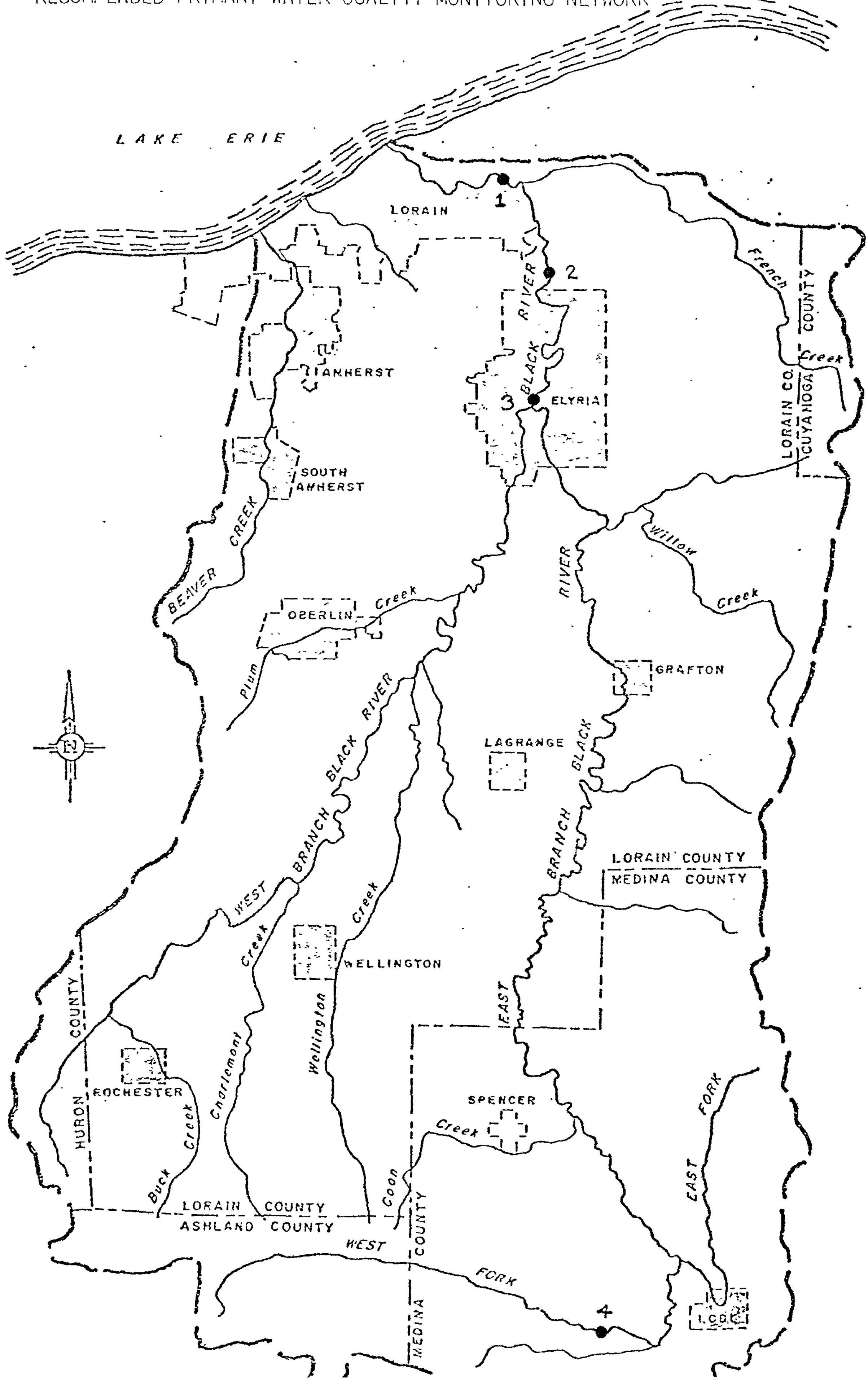


TABLE X-1

Recommended Primary Monitoring Network
Black River Planning Area

Station	Location	River Mile Black River	Latitude	Longitude	Station Description
1	Lorain	3.9	41°27'15"	82°07'53"	U.S. Steel - Lorain Works Water Intake WI-3
2	Elyria	10.1	41°24'42"	82°05'45"	Ford Road Bridge
3	Elyria	15.2	41°22'49"	82°06'17"	USGS Gage at Elyria
4	Esselburn	50.7	41°01'26"	82°04'31"	West Fork of East Branch Medina County Rd. T-28

ACKNOWLEDGMENTS

A study of this magnitude could not have been completed without assistance from many sources. The comprehensive water quality surveys were organized and carried out under the direction of the Eastern District Office Field Support Team. Over twenty people from U.S. EPA Region V Surveillance and Analysis Division participated in the field work, along with personnel from the Elyria, Lorain, and French Creek sewage treatment plants. The U.S. Steel Corporation Lorain Works provided excellent accommodations for U.S. EPA personnel during the field surveys. Laboratory analyses were completed in a timely fashion by the Eastern District Office Laboratory Team and the Region V Central Regional Laboratory. The Eastern District Office Field Support Team also conducted time-of-travel, reaction rate, and sediment studies. The U.S. Geological Survey was responsive in providing historical and current hydrologic data for the Black River. The U.S. EPA National Field Investigation Center conducted a biological study and the Ohio Environmental Protection Agency provided a considerable amount of detailed information unavailable from other sources. NASA Lewis Research Center generously provided computer facilities for the numerous water quality model runs necessary. GKY and Associates, Charles Delos, Scott Machol and Anthony Kizlauskas contributed technical assistance.

The authors gratefully acknowledge the assistance received from the many people and agencies who supported this effort. A special thanks goes to Deborah A. Neubeck and Carol Kopcak who typed the manuscript, and to Roland Hartranft who prepared many of the graphics.

Appendix I

Discharger Location Maps

FIGURE I-1

LOWER BLACK RIVER AND LAKE ERIE DISCHARGER LOCATION MAP

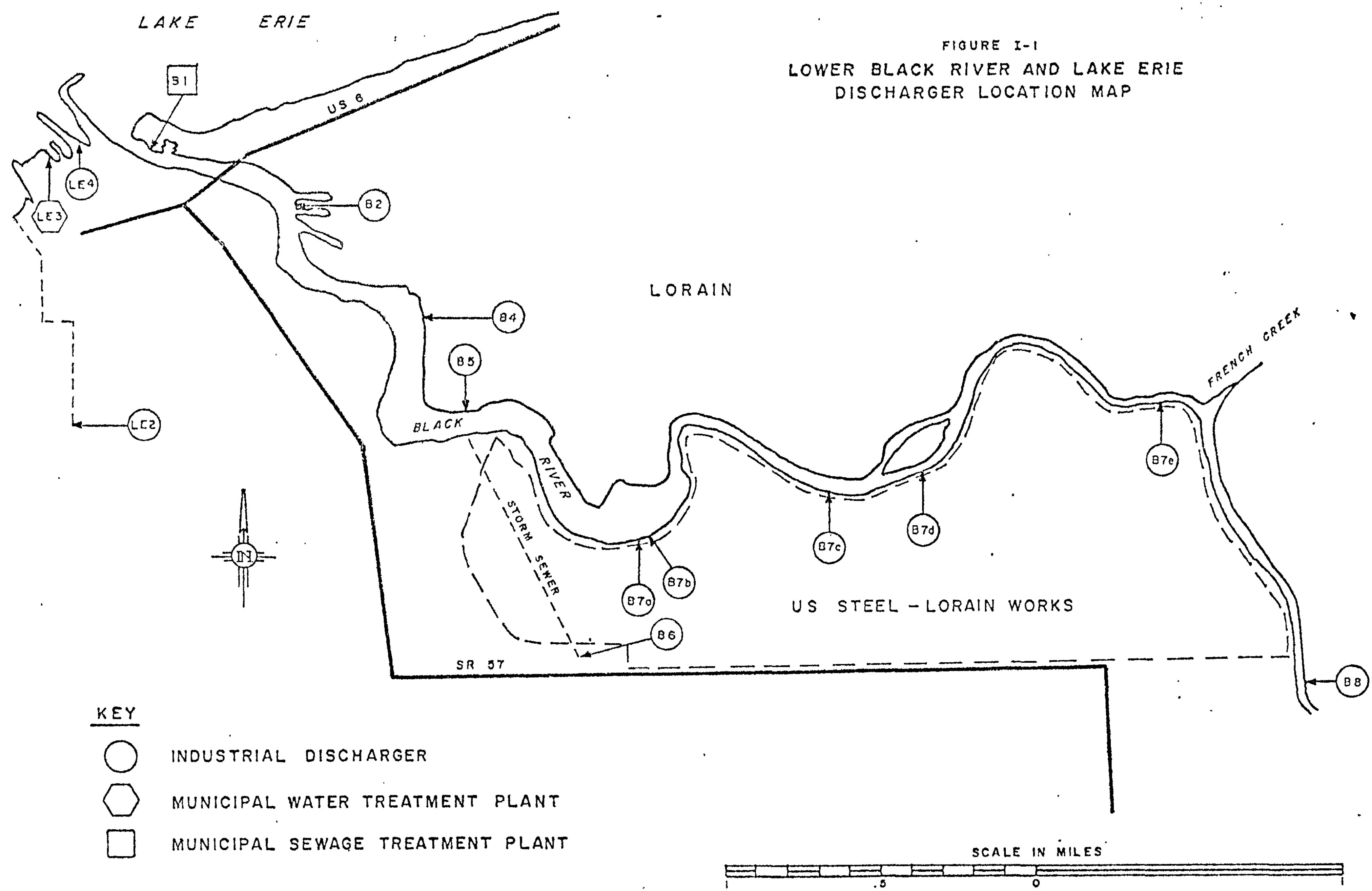


FIGURE I-2
FRENCH CREEK
DISCHARGER LOCATION MAP

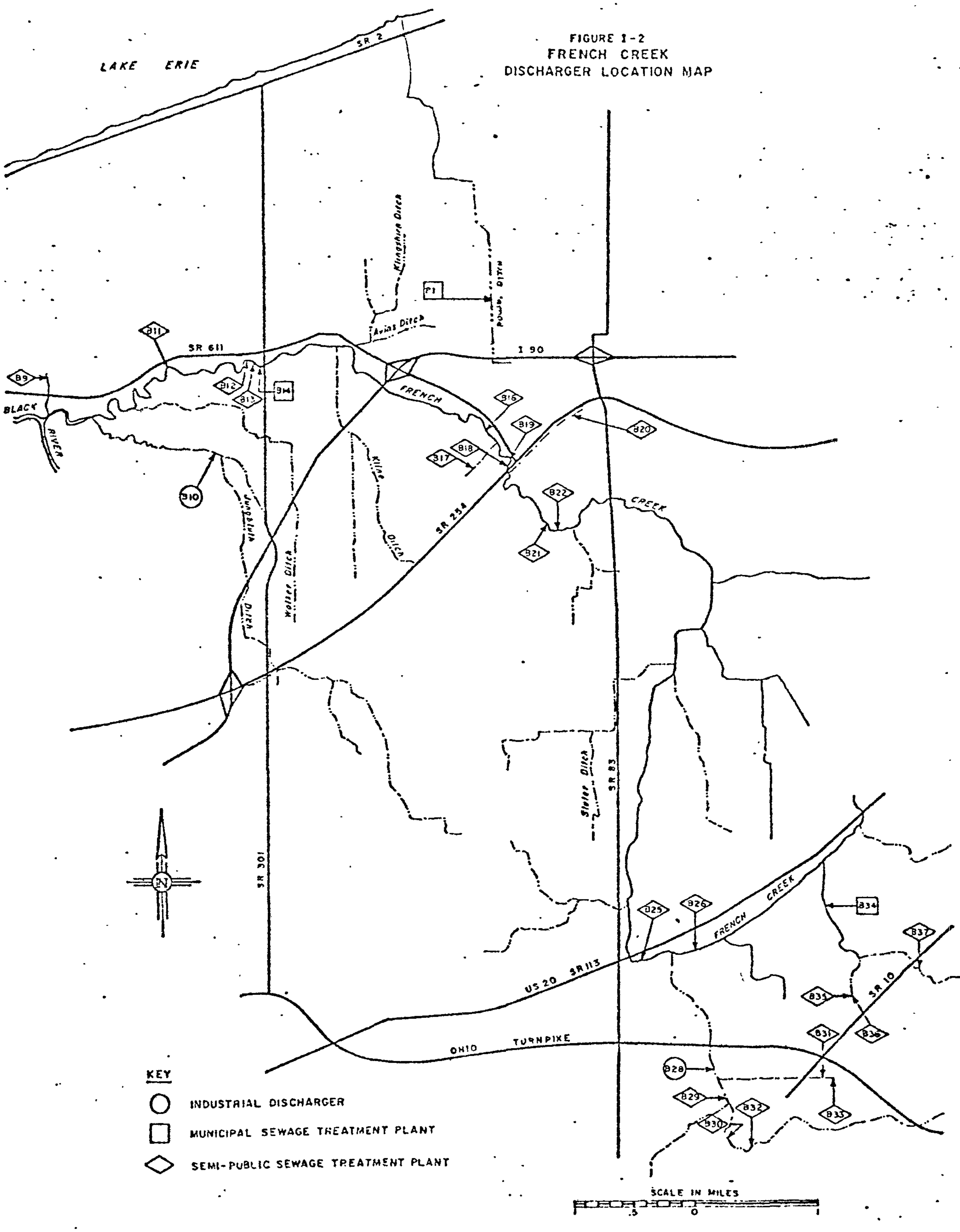


FIGURE I-3

RIDGEWAY DITCH
DISCHARGER LOCATION MAP

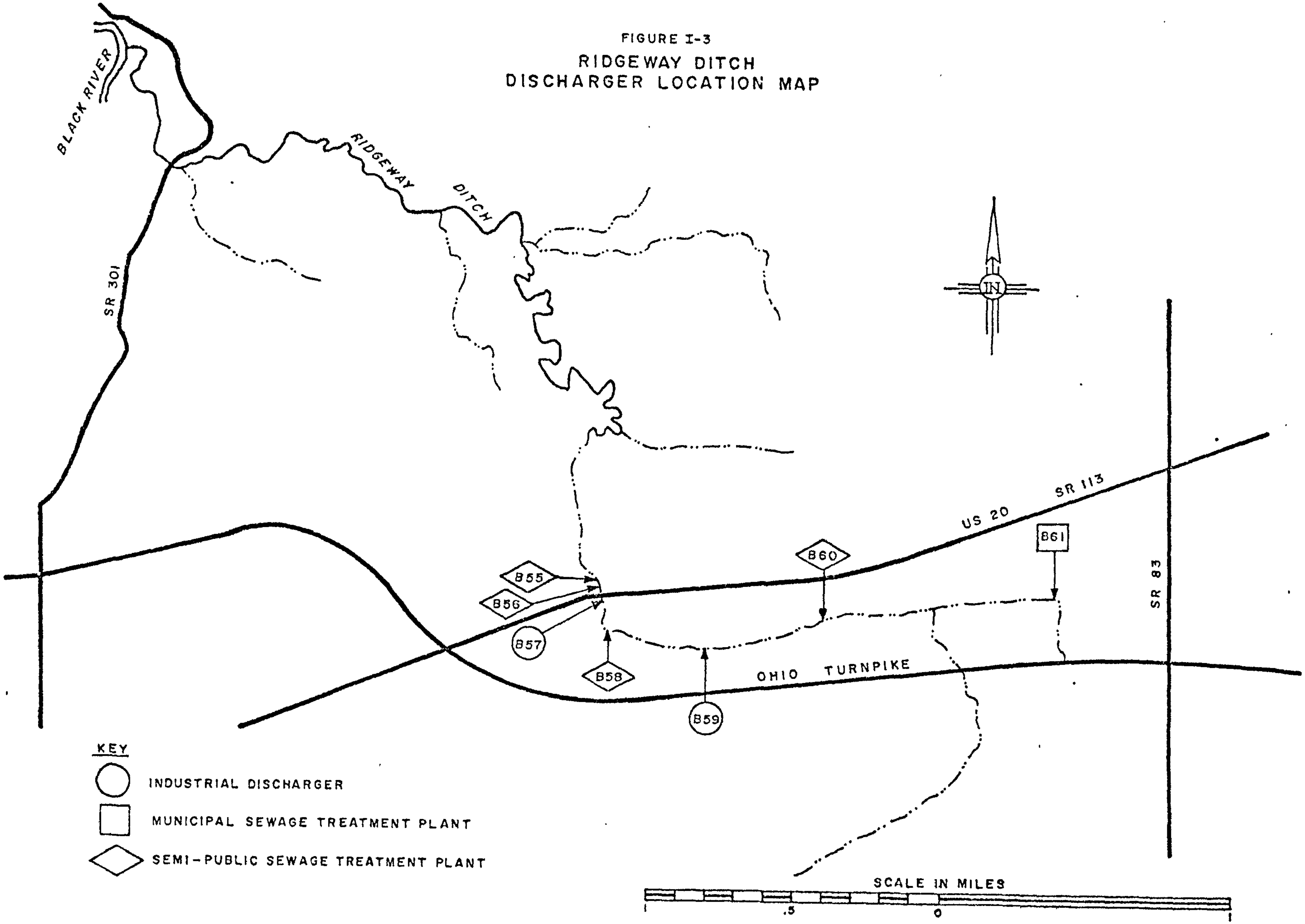


FIGURE I-4
BLACK RIVER
(ELYRIA STP TO EAST 31ST. ST. BRIDGE-LORAIN)
DISCHARGER LOCATION MAP

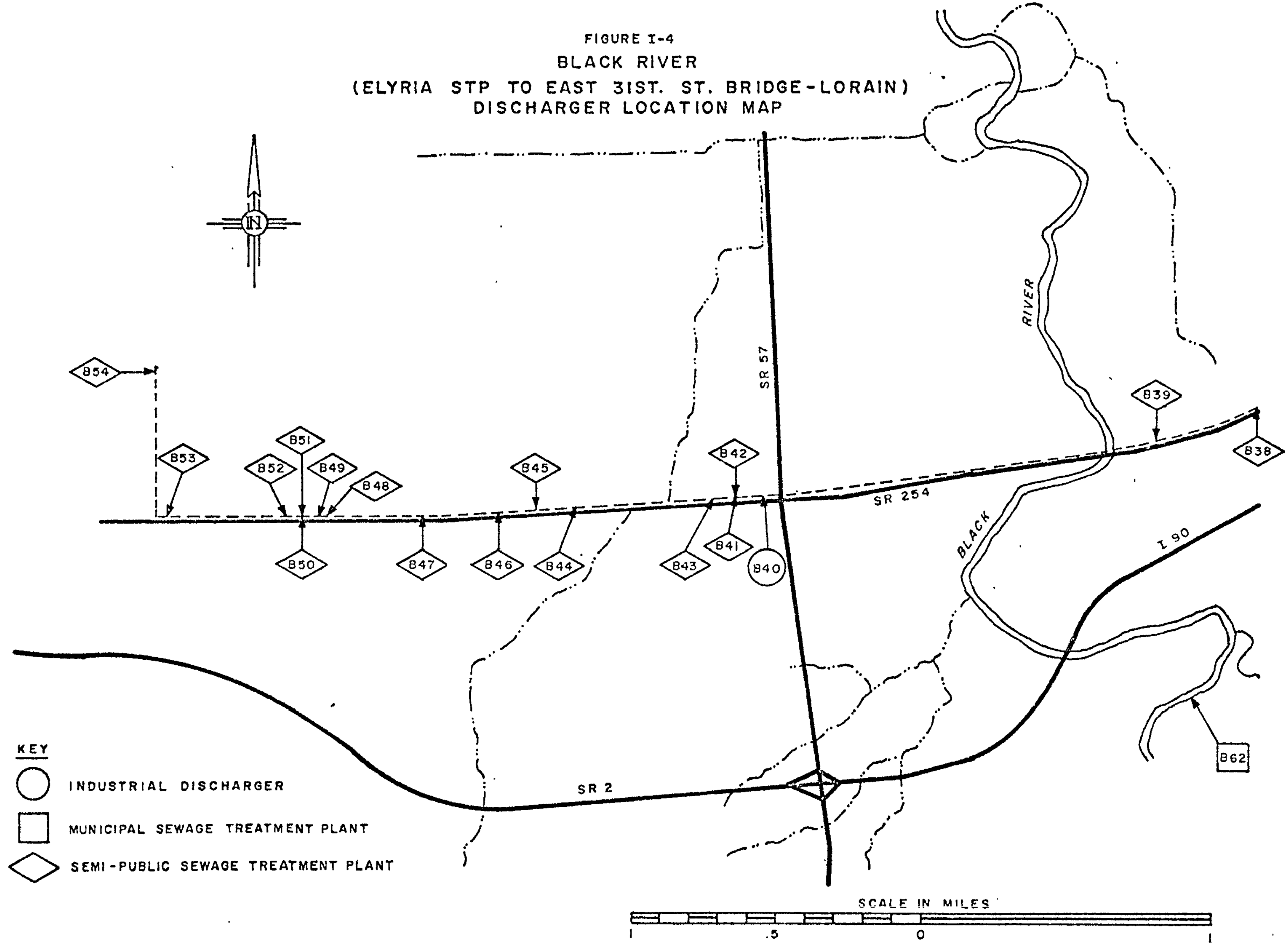


FIGURE I-5

BLACK RIVER

(CONFLUENCE OF EAST AND WEST BRANCHES TO ELYRIA STP)

DISCHARGER LOCATION MAP

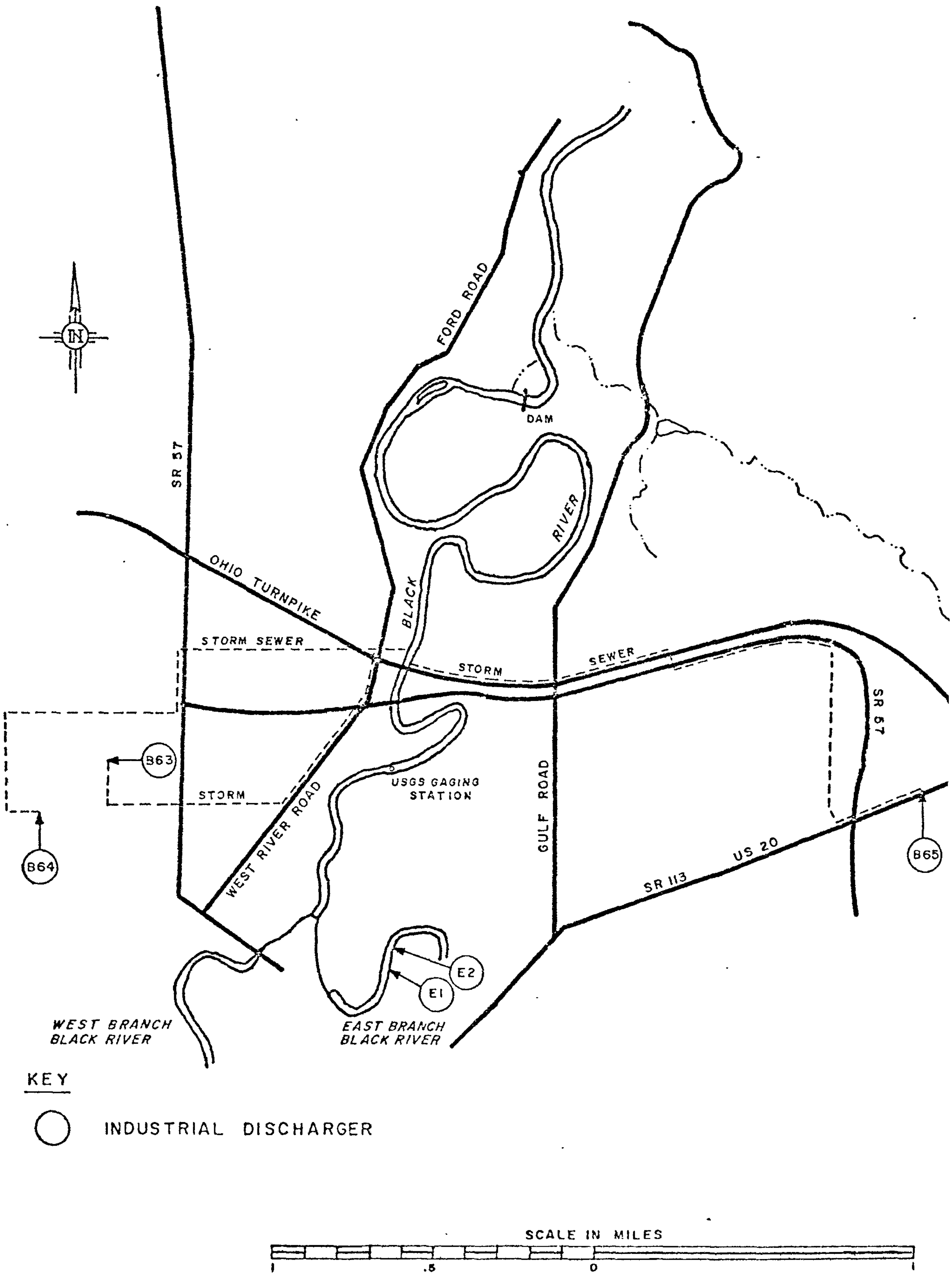
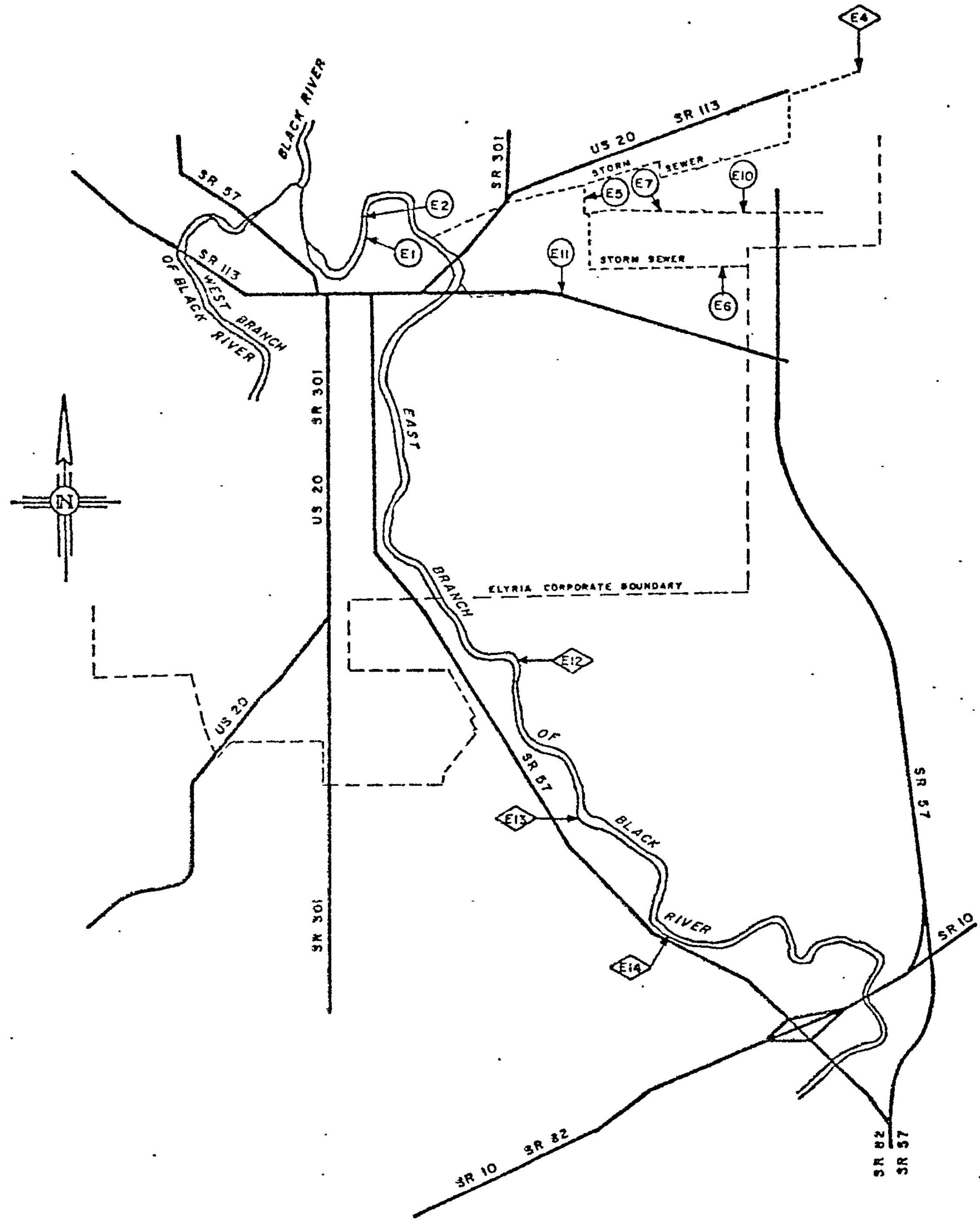


FIGURE I-6

EAST BRANCH OF BLACK RIVER
(CONFLUENCE OF EAST AND WEST BRANCHES TO SR 57)
DISCHARGER LOCATION MAP



KEY

○ INDUSTRIAL DISCHARGER

◇ SEMI-PUBLIC SEWAGE TREATMENT PLANT

SCALE IN MILES

1 .5 0 1

FIGURE I-7

EAST BRANCH OF BLACK RIVER (SR 57 TO GRAFTON)

DISCHARGER LOCATION MAP

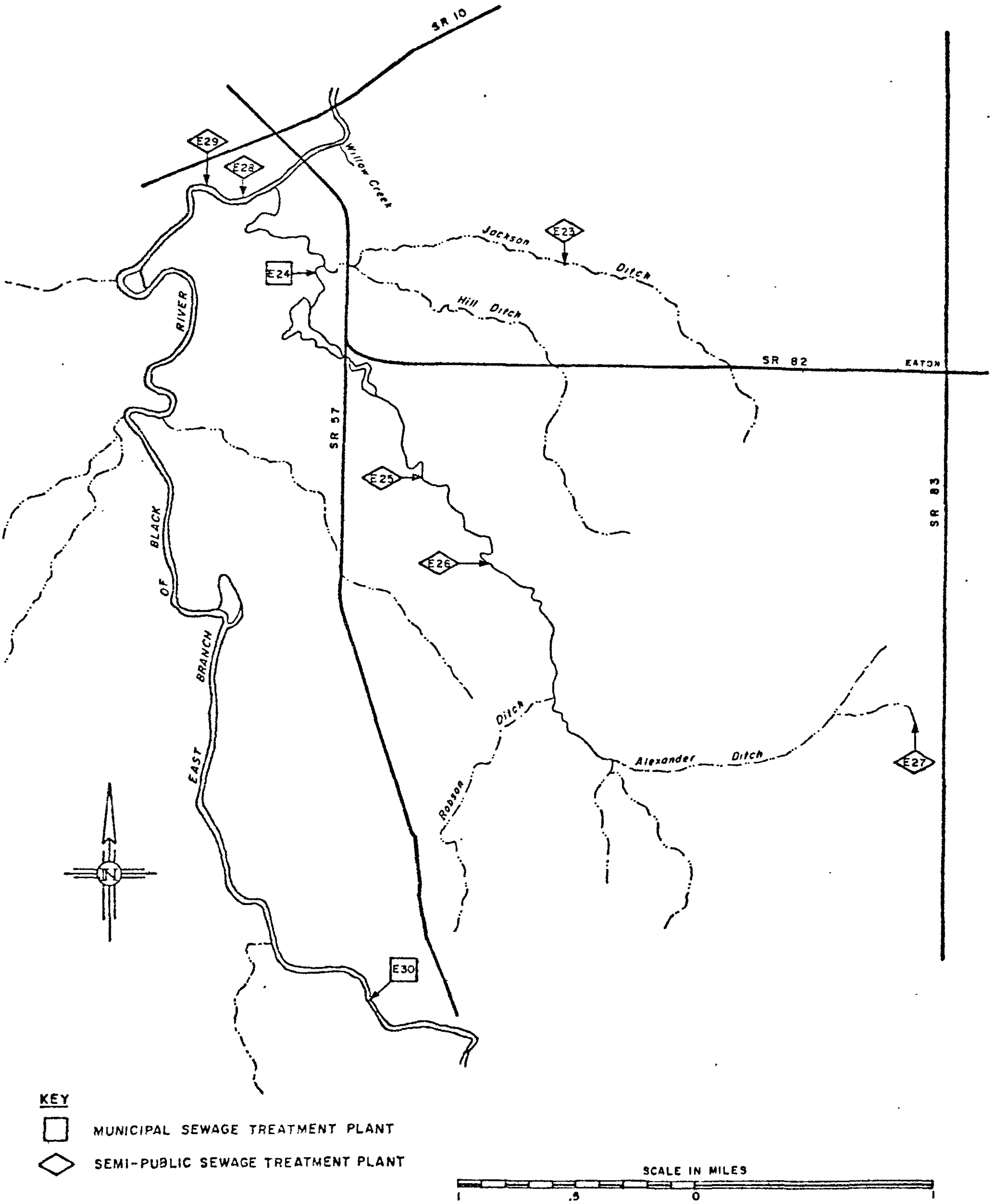


FIGURE I-8

WILLOW CREEK

DISCHARGER LOCATION MAP

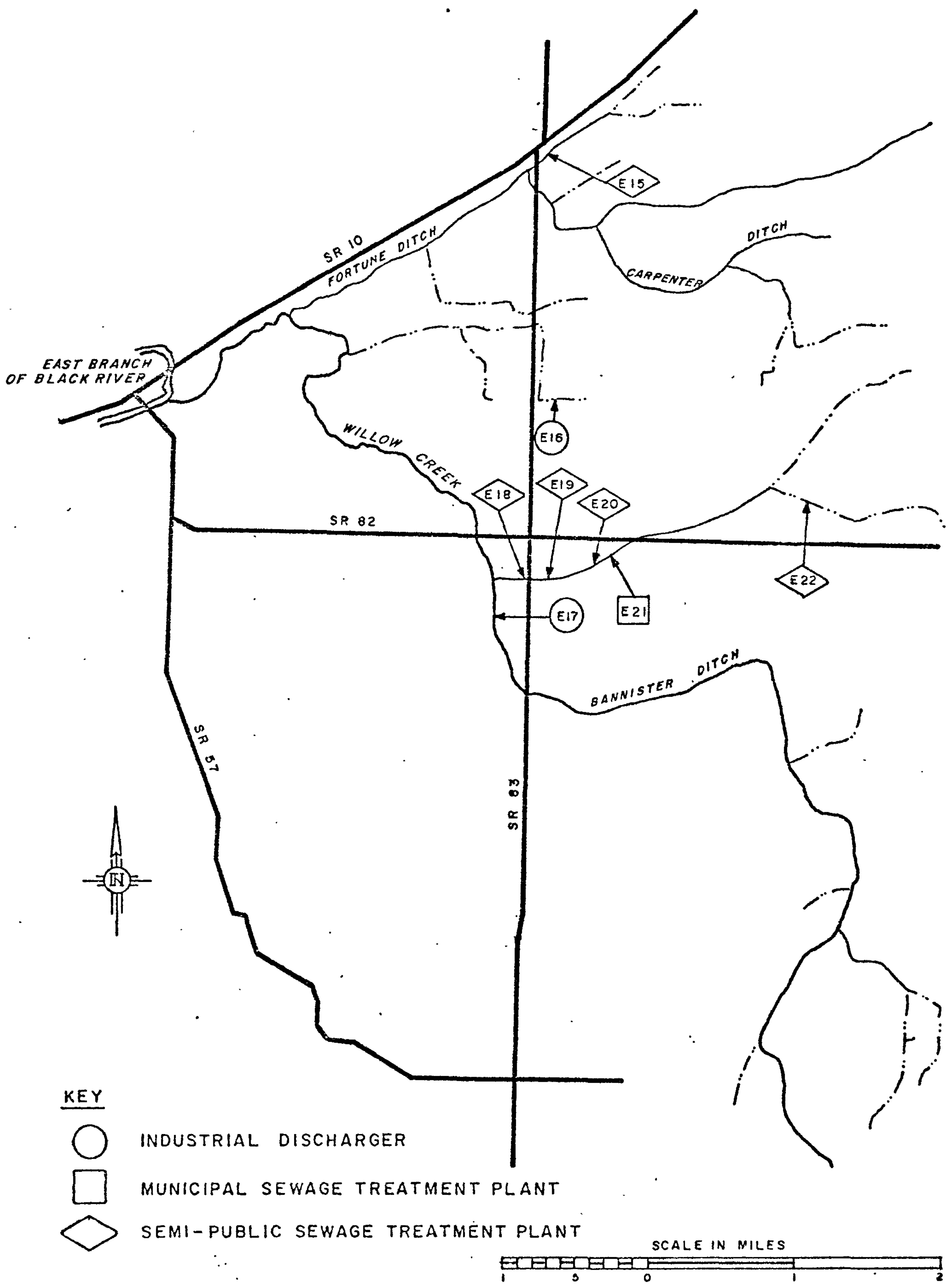


FIGURE I-9
EAST BRANCH OF BLACK RIVER (GRAFTON TO HEADWATERS)
DISCHARGER LOCATION MAP

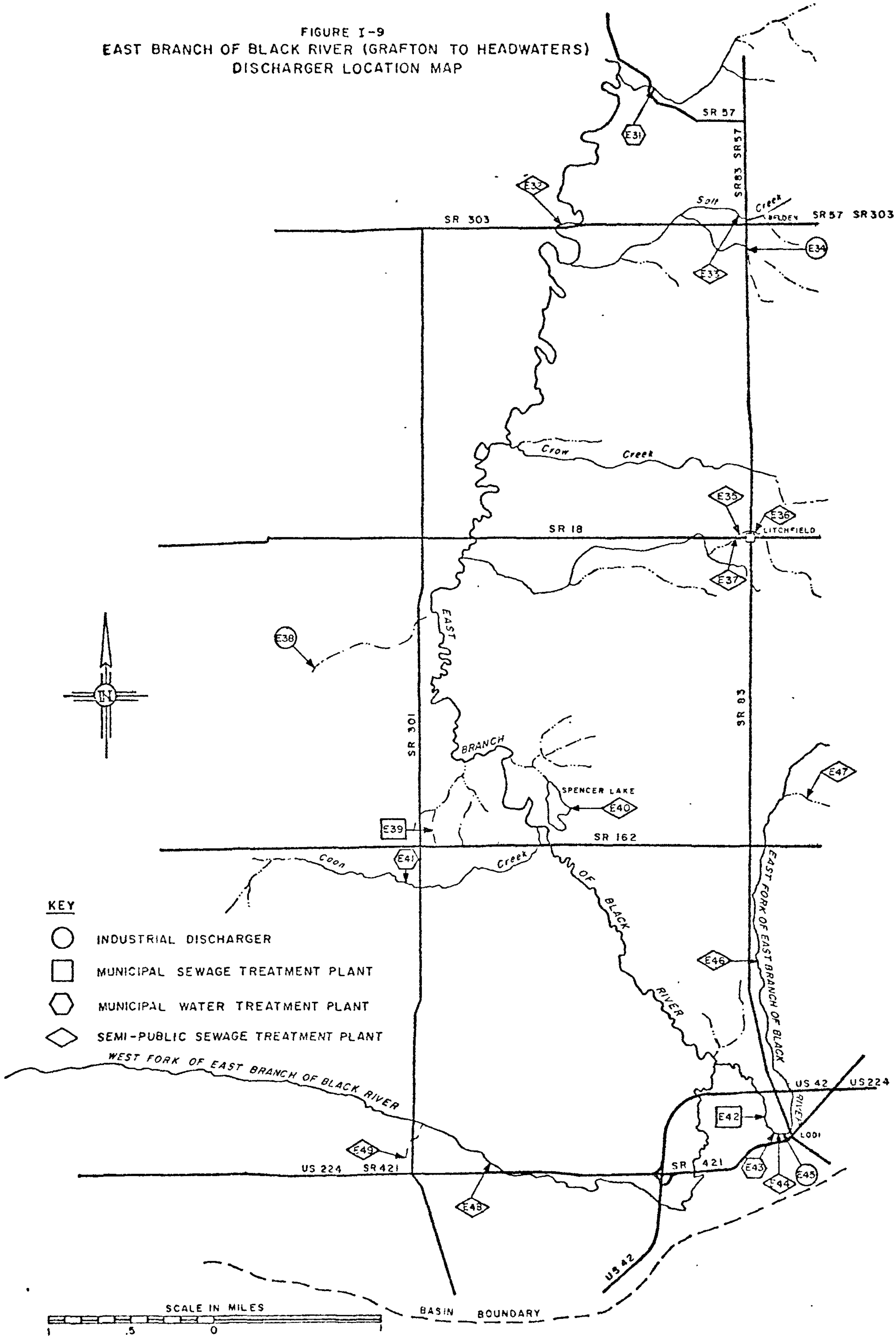


FIGURE I-10

WEST BRANCH BLACK RIVER
(CONFLUENCE OF EAST AND WEST BRANCHES TO SR 10)
DISCHARGER LOCATION MAP

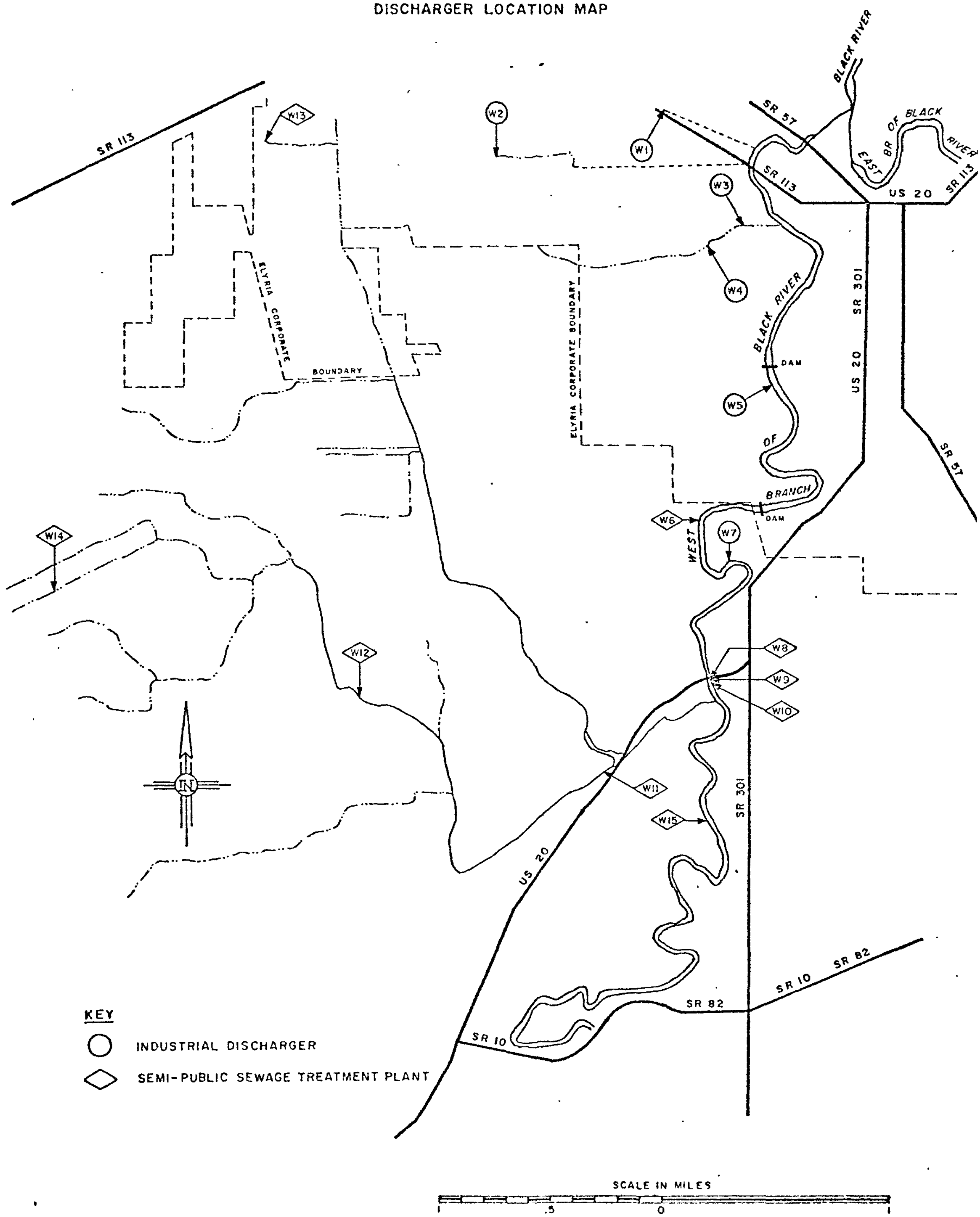
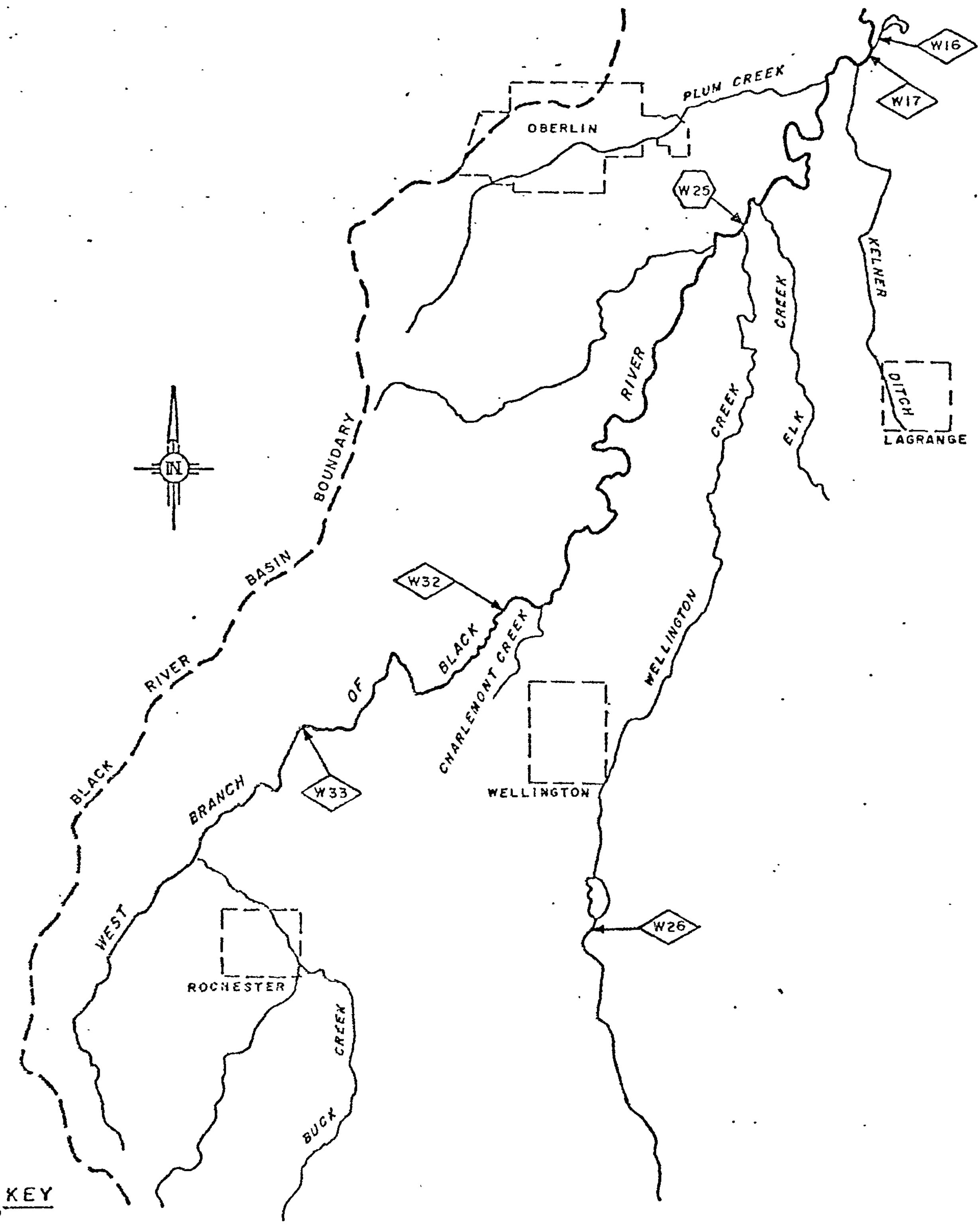


FIGURE I-11

WEST BRANCH OF BLACK RIVER (ABOVE SR 10)
DISCHARGER LOCATION MAP



KEY

MUNICIPAL WATER TREATMENT PLANT

MUNICIPAL SEWAGE TREATMENT PLANT

SEMI-PUBLIC SEWAGE TREATMENT PLANT

SCALE IN MILES

4 3 2 1 0 4 8

FIGURE I-12
PLUM CREEK DISCHARGER LOCATION MAP

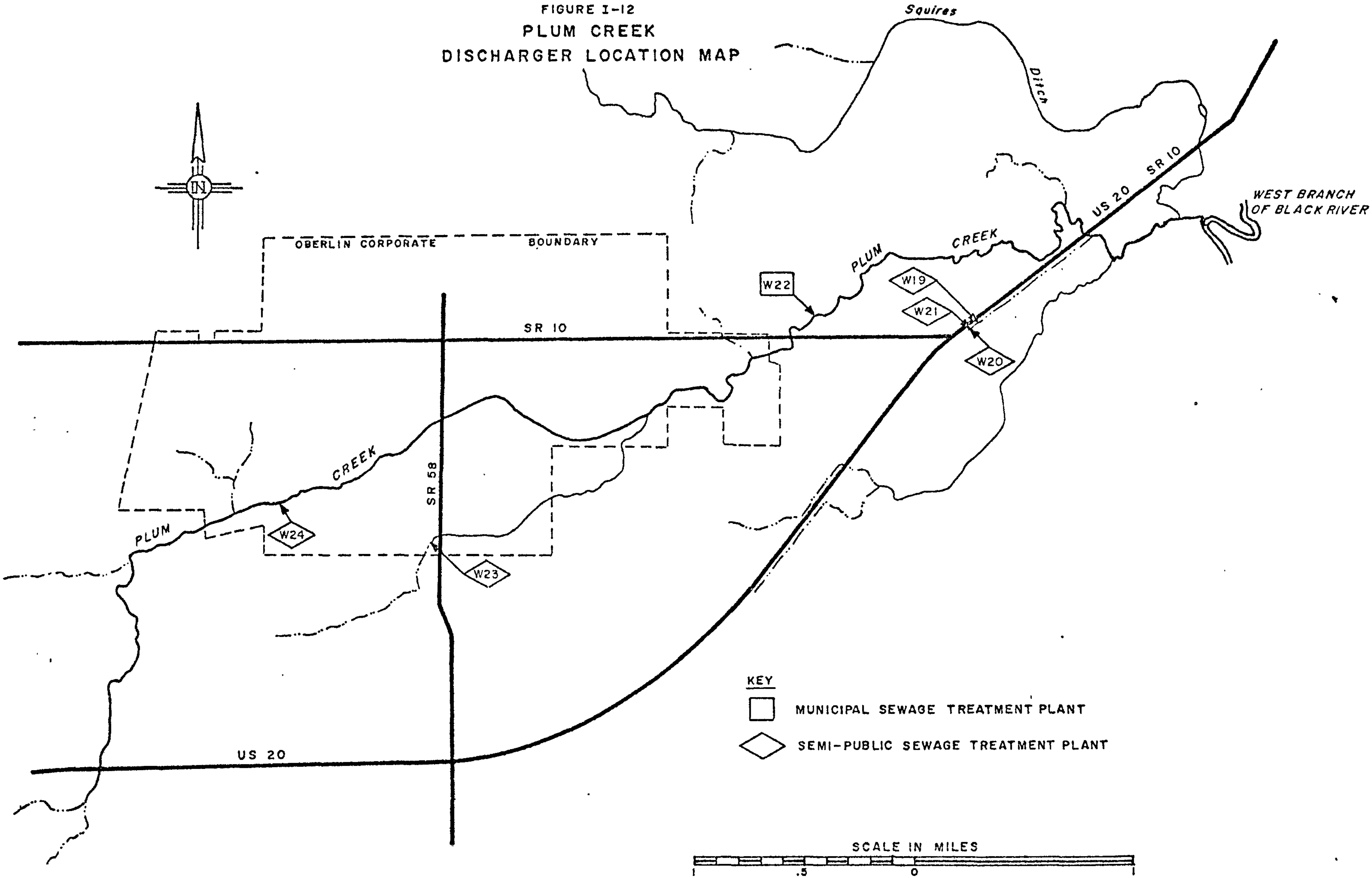


FIGURE I-13
CHARLEMONT CREEK
DISCHARGER LOCATION MAP

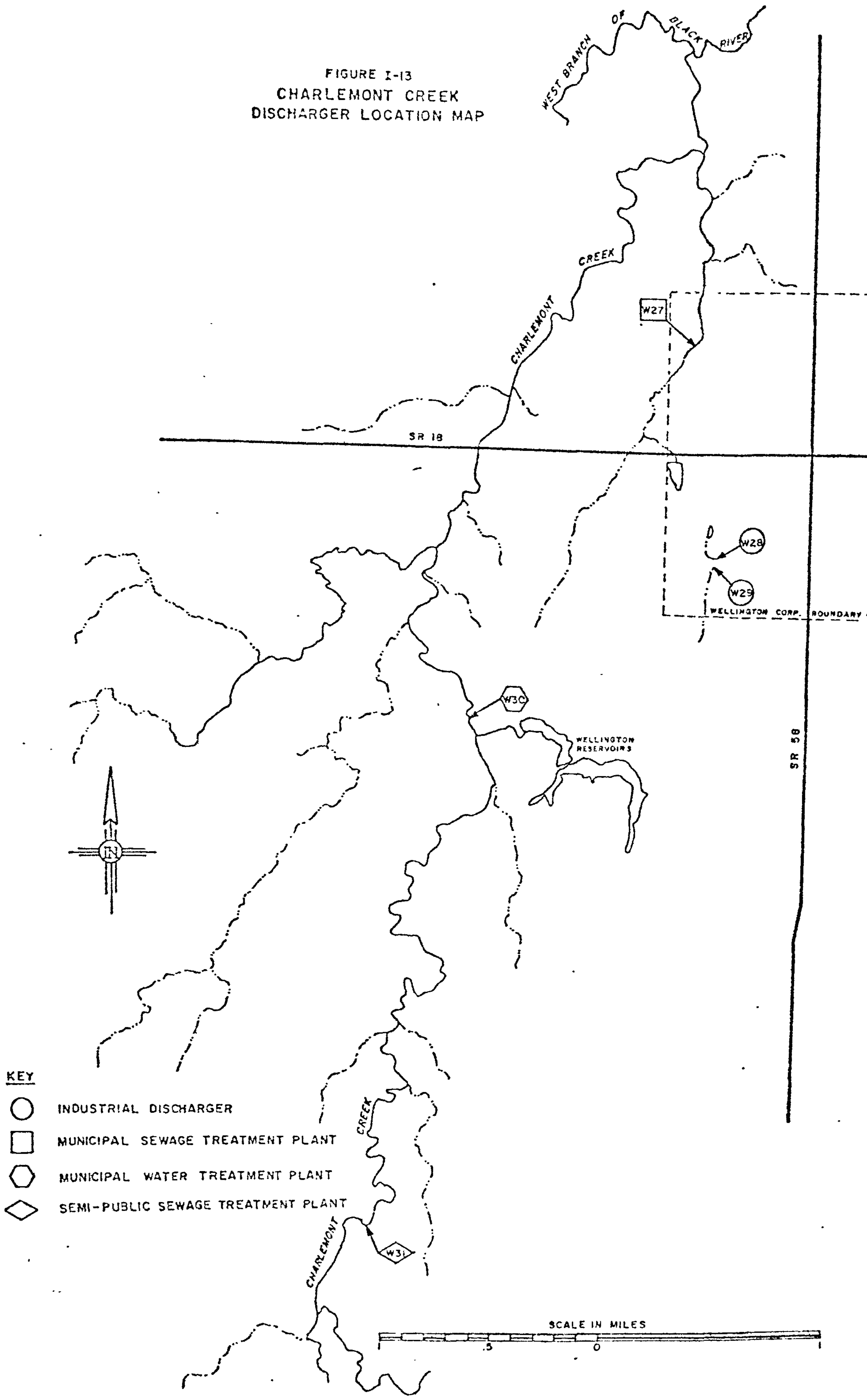
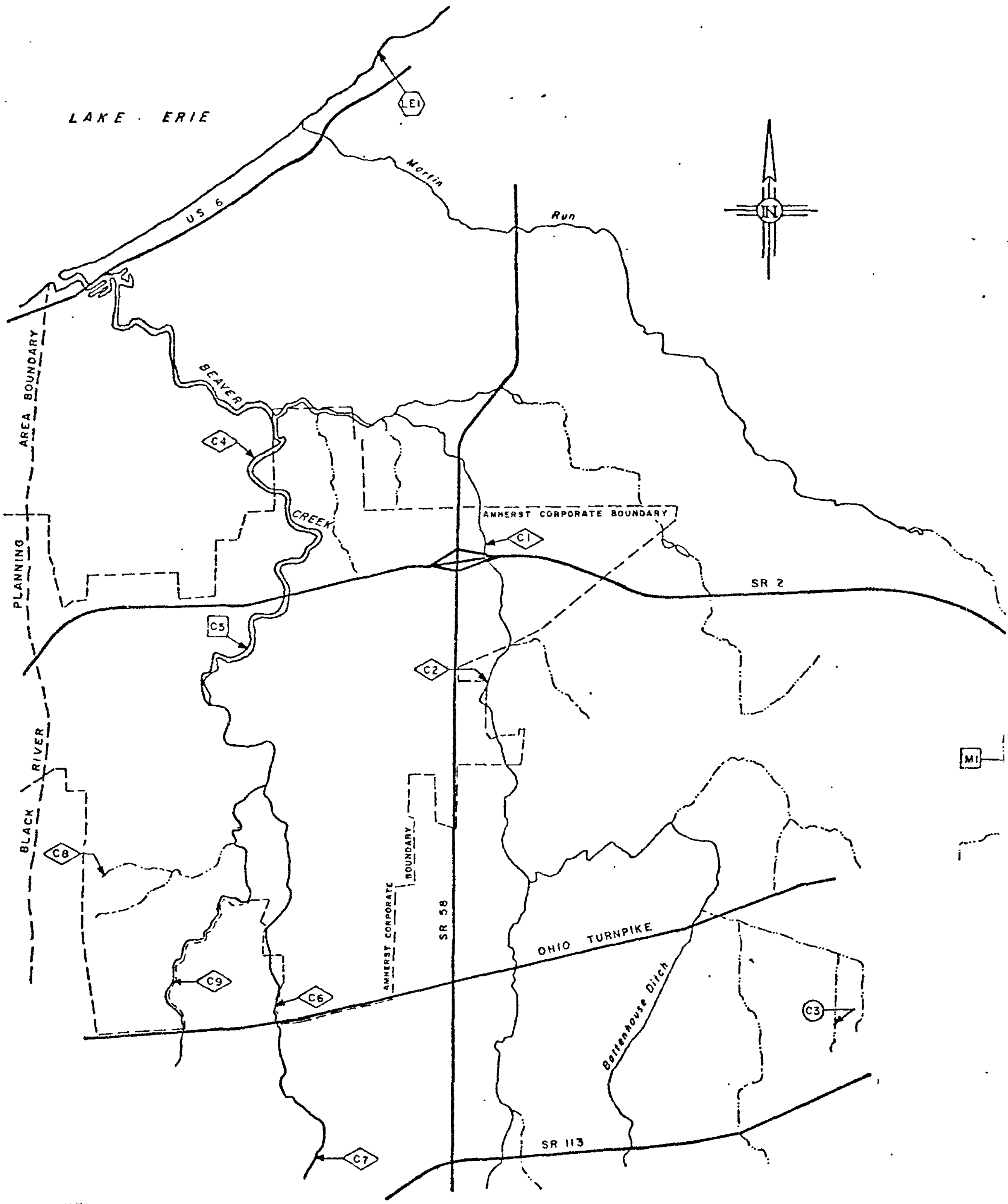


FIGURE I-14
BEAVER CREEK (MOUTH TO OHIO TURNPIKE)
DISCHARGER LOCATION MAP

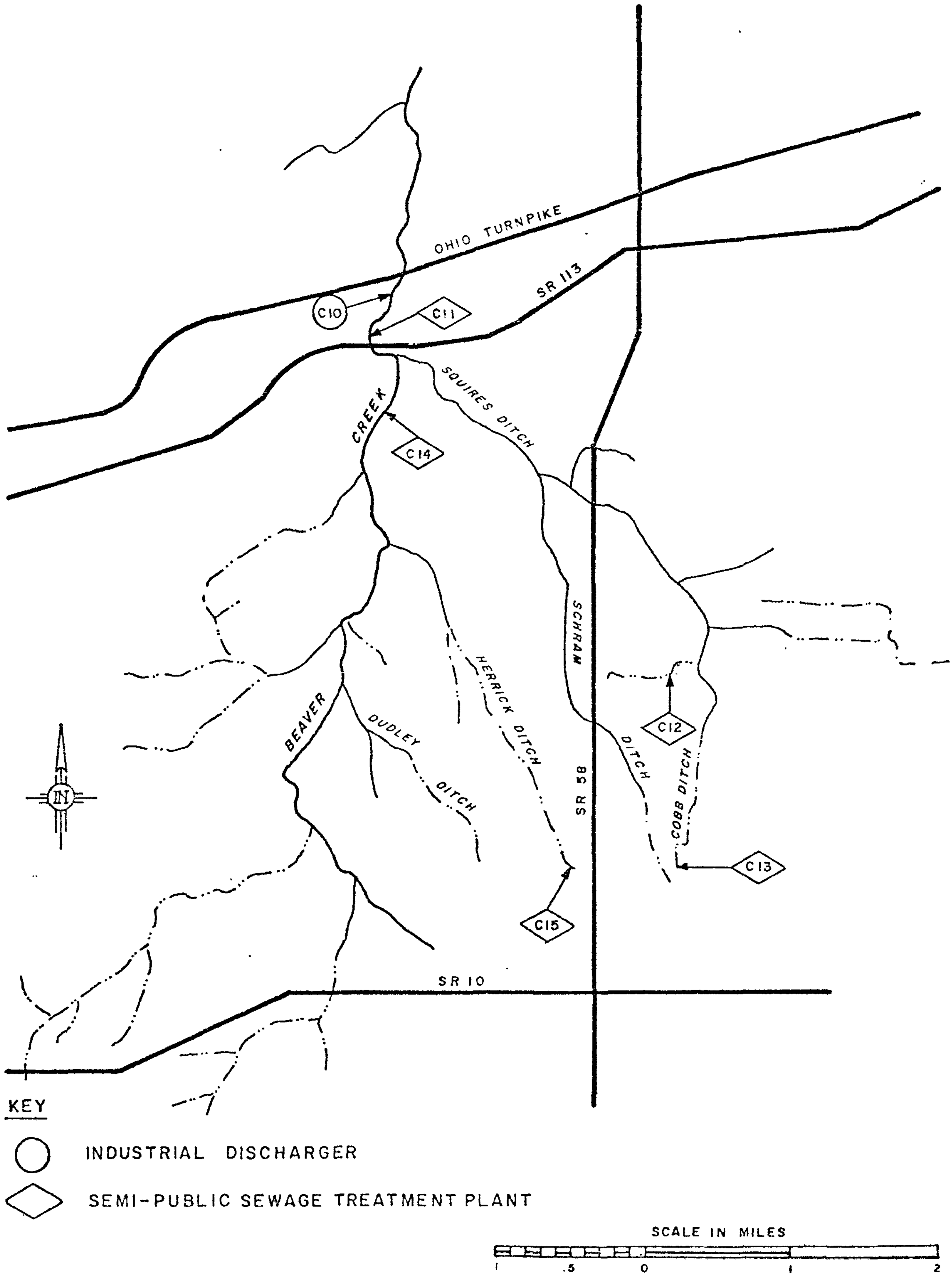


KEY

- INDUSTRIAL DISCHARGER
- MUNICIPAL SEWAGE TREATMENT PLANT
- SEMI-PUBLIC SEWAGE TREATMENT PLANT
- MUNICIPAL WATER TREATMENT PLANT

FIGURE I-15

BEAVER CREEK (OHIO TURNPIKE TO HEADWATERS)
DISCHARGER LOCATION MAP



Appendix II

Temperature Model

I. OHIO TEMPERATURE STANDARDS

Ohio Environmental Protection Agency adopted revised water quality standards on February 14, 1978. These standards were federally approved on May 17, 1978.[1] Temperature standards applicable to the Black River are presented in Table 1. Specified temperatures are monthly or bi-weekly averages and maximum values, not to be exceeded. Mixing zone criteria are provided for segments classified as limited warmwater habitat or as seasonal warmwater habitat.

Prior to these revisions Ohio temperature standards included a provision that stream temperatures not exceed more than 5°F the water temperature which would occur if there were no temperature change attributable to human activity. Maximum temperature standards and mixing zone criteria were also specified.

II. EXISTING CONDITIONS

Data from the Black River comprehensive water quality surveys conducted by the U.S. EPA on July 23-26, 1974, and July 16-19, 1979, accurately describe present temperature conditions in the lower Black River. Figure 1 is a map of the area showing the U.S. Steel-Lorain Works five river outfalls and the 13 stream stations where water quality was monitored. The temperature data obtained during these surveys indicate that thermal discharges from the U.S. Steel-Lorain Works cause Ohio temperature standards to be exceeded (Figure 2 and 3). Upstream of U.S. Steel, water temperatures are generally unaffected by human activities except for minor effects from sewage treatment plants. During the July 1974 survey temperatures upstream of U.S. Steel ranged from 68-72 degrees fahrenheit. The discharge at Outfall 001 (RM 5.0) however increased river temperature by about 15°F, well above the five degree ΔT standard then in effect. Just below Outfall 005, more than a mile downstream of Outfall 001, the river temperatures are approximately 12°F above the natural river temperature. This twelve degree temperature difference persisted at the surface downstream to the lower end of the turning basin (RM 2.4). Despite the large temperature increases, the maximum temperature standard then in effect (90°F) was not exceeded during the July 1974 survey.

Table 1

Ohio Temperature Standards Applicable to the Black River

Shown as degrees Fahrenheit and (Celsius)

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

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

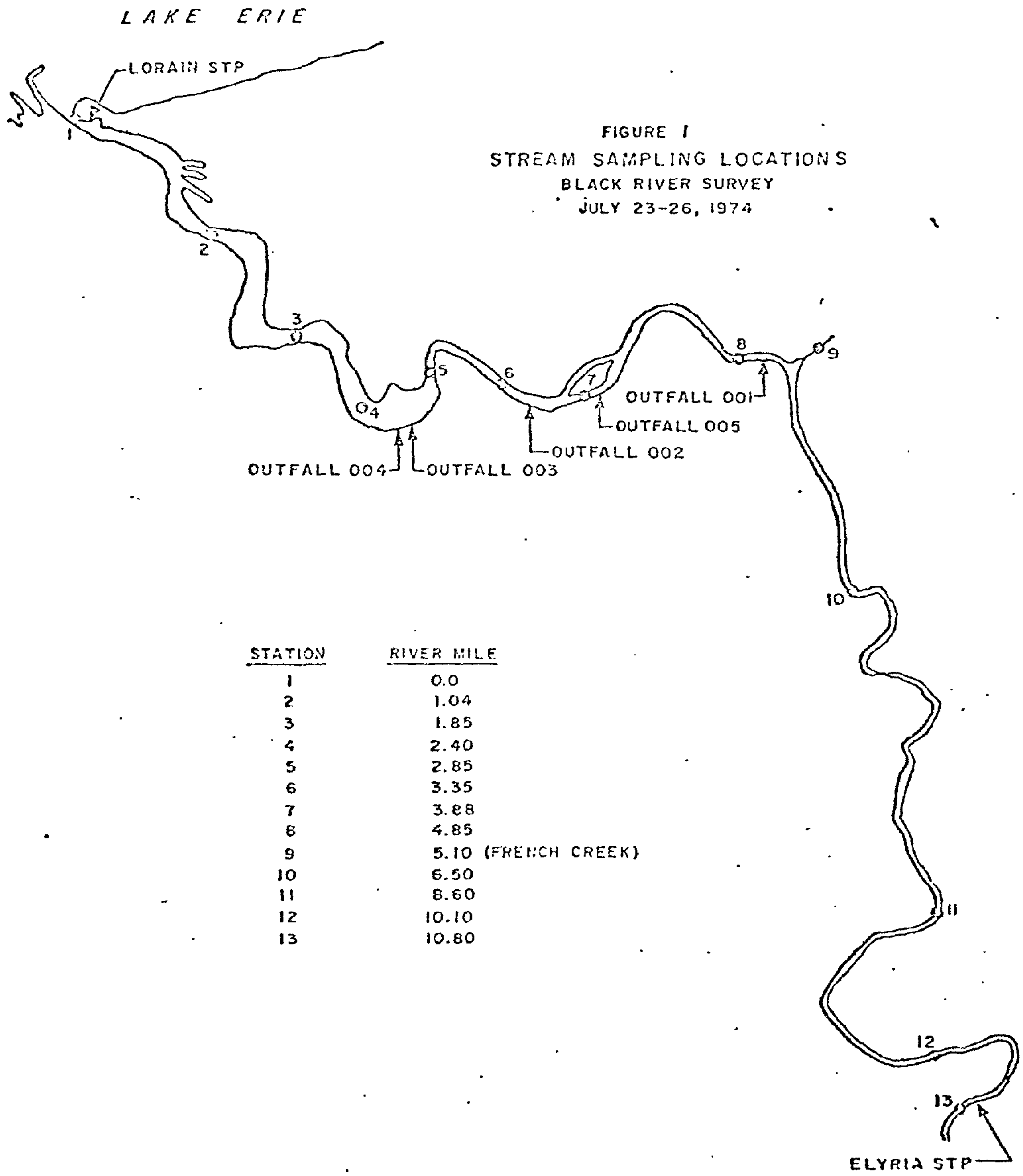


FIGURE I
STREAM SAMPLING LOCATIONS
BLACK RIVER SURVEY
JULY 23-26, 1974

STATION	RIVER MILE
1	0.0
2	1.04
3	1.85
4	2.40
5	2.85
6	3.35
7	3.88
8	4.85
9	5.10 (FRENCH CREEK)
10	6.50
11	8.60
12	10.10
13	10.80

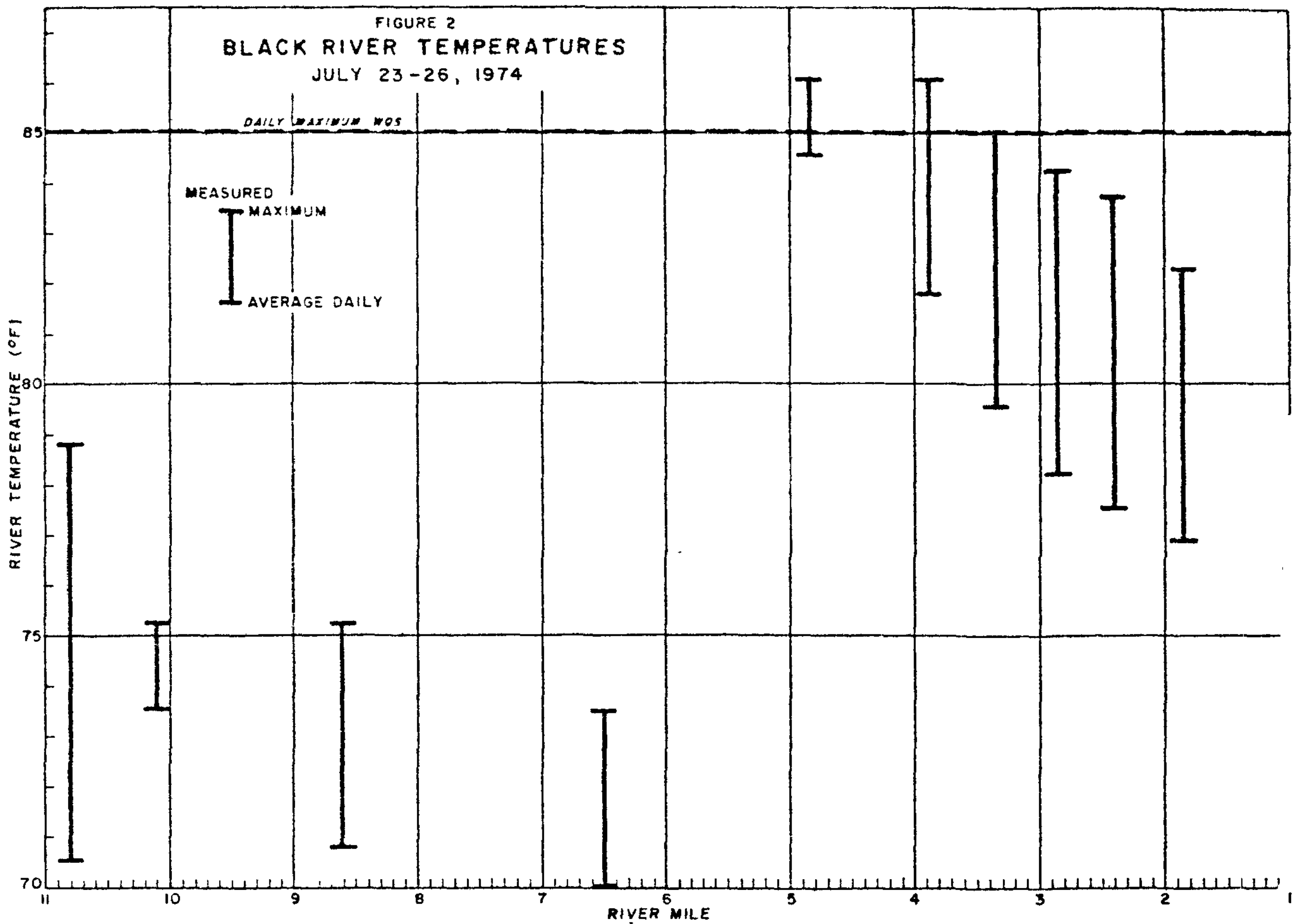


FIGURE 2
BLACK RIVER TEMPERATURES
JULY 23-26, 1974
DAILY MAXIMUM WQS
MEASURED
MAXIMUM
AVERAGE DAILY
RIVER TEMPERATURE (°F)
85
80
75
70
11
10
9
8
7
6
5
4
3
2
1
RIVER MILE

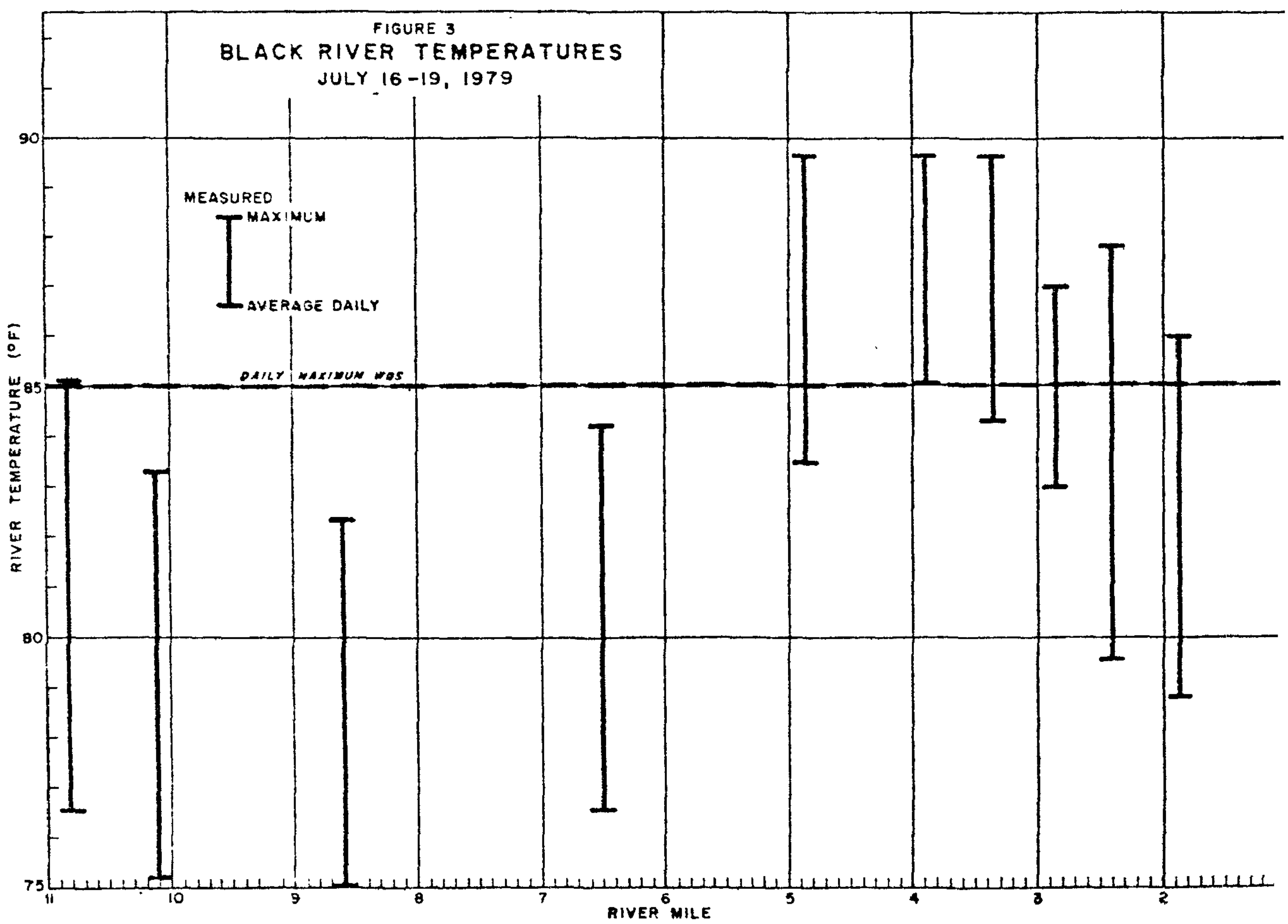


FIGURE 3
BLACK RIVER TEMPERATURES
JULY 16-19, 1979
DAILY MAXIMUM WQS
MEASURED
MAXIMUM
AVERAGE DAILY
RIVER TEMPERATURE (°F)
90
85
80
75
11
10
9
8
7
6
5
4
3
2
RIVER MILE

Similar conditions were observed in the July 1979 survey (Figure 3). Stream temperatures above U.S. Steel averaged about 75°F whereas downstream of Outfall 001 temperatures averaged about 84°F with maximum values approaching 90°F. Maximum temperature standards presently in effect (85°F) were exceeded at the river surface at all stations between river miles 2.0 and 5.0. At stations 6, 7, and 8 (river mile 3.35, 3.88, and 4.85) where the stream is not thermally stratified, the average daily temperatures on the first day of the survey exceeded the 85°F standard.

III. BLACK RIVER TEMPERATURE MODEL

Based upon the data reviewed above, it is evident U.S. Steel Corporation-Lorain Works must reduce its thermal loading to the Black River in order for the stream to achieve existing Ohio water quality standards. To assist in determining thermal effluent limitations a mathematical model was developed to simulate temperatures in the lower Black River.

The temperature model discussed herein is a modification of the original model developed by Schregardus and Amendola.[2,3] In this analysis the lower Black River is divided into three segments or stretches based upon physical and hydrologic characteristics. The upstream segment from Elyria STP to U.S. Steel intake WI-3 (RM 10.8-3.88) is treated as a free flowing stream in which heated waters cool as they flow downstream. The Edinger and Geyer one dimensional formulation is used to predict stream temperatures for this segment.[4]

The second segment is located between the Intake WI-3 and turning basin (RM 3.88-2.9). This segment averages about 15 feet deep and 250 feet wide. Temperatures are relatively constant along the length of this section but some horizontal stratification does exist. The temperatures are affected by lake intrusion but not to the same extent as in the turning basin. Outfall 002 discharges to this portion of the river and heated river water enters from upstream.

The Black River turning basin (RM 2.9-2.4) is the third segment. The turning basin is dredged periodically by the U.S. Army Corps of Engineers to a depth of about 30 feet and averages about 600 feet wide. Large quantities of water flow upstream from the lake and mix with the heated water discharged from Outfalls 003 and 004 and the heated water entering from upstream. Temperatures were relatively uniform across the surface; however, vertical temperature stratification existed throughout the basin during the two July surveys.

A cooling pond formulation was selected for the midsection and turning basin because of low stream velocities and the uniform surface temperature distribution. In this case a heat balance equation containing all the heat added to and removed from the segments was developed and solved for the average segment temperature.

The expressions developed to calculate temperature are presented below. Details on the development of these equations are presented in Reference 2.

Segment 1

$$T = E + (T_m - E)\, e^{-(KA/\rho C_p F_R)}$$

Segment 2

$$T_{ms} = \frac{\rho C_p\,(F_u T_u + F_{002} T_{002} + F_L\, T_L) + KAE}{KA + \rho C_p\,(F_L + F_{002} + F_u)}$$

Segment 3

$$T_B = \frac{\rho C_p\,\{(F_u + F_{002} + F_L)\, T_{ms} + F_{003} T_{003} + F_{004} T_{004} + (F_{LB} - F_L)\, T_L\} + KAE}{KA + \rho C_p\,(F_u + F_{002} + F_{003} + F_{004} + F_{LB})}$$

Where:

F_R = river flow

E = equilibrium temperature, ^oF

K = exchange coefficient, $BTU/ft^2\text{-}^oF$

A = surface area of the stream to the point where T is determined, ft^2

ρ = density of water, 62.4 lbs/ft^2

C_p = heat capacity of water, 1 BTU/lb-^oF

T_m = mixed temperature of the stream at the heat source discharge, ^oF

T_B = temperature of the turning basin, ^oF

T_{ms} = temperature of the mid-section, ^oF

$T_{002}, T_{003}, T_{004}$ = effluent temperature for U.S. Steel Outfalls 002, 003, and 004, ^oF

$F_{002}, F_{003}, F_{004}$ = effluent flow for U.S. Steel Outfalls 002, 003, and 004, cfs

F_{LB} = lake flow entering the basin at the downstream end, cfs

F_L = lake water flowing upstream along the bottom to the mid-section, cfs

Values for the equilibrium temperature and the heat exchange rate (K) are calculated using the procedures described by Parker[5] and the short wave radiation formulation developed by TVA.[6]

Based on these relationships a computer program (TEMPBR) was developed to simulate temperatures in the Black River. The program, patterned after a model developed and successfully applied on the Mahoning River,[7] calculates the statistical temperatures distribution at critical points in the river. Means and standard deviations of the equilibrium temperatures, heat exchange coefficients, thermal loadings, effluent flows and temperatures and lake temperature must be supplied to the model. A normal distribution random number generator (mean 0, standard deviation 1) is used with the following equation to calculate input values for each simulation:

$$V = \bar{x} + (S \times R)$$

Where:

V = input value

$\bar{x}$ = mean

S = standard deviation

R = computed supplied random number

By repeating the stream calculations many times the model simulates the variability of river temperatures resulting from expected independent changes in each of the input values. The resulting temperature distribution would not be available using only mean or extreme values for model inputs.

To insure that the model adequately duplicates the desired distribution of input data, a check is made of each set of numbers with a "t" statistic prior to use in the model. If the calculated statistic is not within the desired limits, a new set of random numbers is generated and tested.

As described in previous work[2,3] lake water intruding into the river has a significant impact on the temperature regime in the lower Black River. In this analysis lake intrusion flows corresponding to different upstream river flows were determined using the mass balance relationship discussed in Reference 2 and 3. Sodium and chloride data from four separate U.S. EPA surveys incorporating seven days of data were used to calculate lake flow at three critical points in the river, intake WI-3 (RM 3.88) midsection (RM 3.35) and turning basin (RM 2.6). At each site an expression was developed using a least squares fit procedure which relates lake flow to upstream river flow. Table 2 presents the flow data and the resulting equations for computing lake intrusion flow.

The model accepts either a constant upstream flow or a set of flows representing the expected flow distribution at the Elyria USGS gage. Flow at French Creek is the sum of the French Creek STP flow and a natural flow determined as a percentage of the flow at the Elyria USGS gage based on drainage areas.

Table 2

Computed Lake Intrusion Flow

Date	River Flow[1] (F_R)	Lake Intrusion Flow (F_L) Intake WI-3 (RM 3.88)	Midsection (RM 3.35)	Turning Basin (RM 2.4)
September 12, 1972	31.8	40.7	51.5	170
September 13, 1972	42.0	12.4	22.8	152
May 2, 1974	123.0	0.0	0.0	175*
July 23, 1974	19.8	45.4	95.4	387
July 24, 1974	21.0	50.0	99.0	332
July 25, 1974	22.1	39.2	89.9	277
September 3, 1975	223.9	--	--	27.6

[1] Sum of flow at USGS gage in Elyria and Elyria STP.

*Value not used in developing lake flow equation.

Computed Equations for Lake Intrusion Flow

Intake WI-3 $F_L = 326.e^{-.084\ F_R}$

Midsection $F_L = 731.e^{-.090\ F_R}$

Turning Basin $F_L = 342.e^{-.011\ F_R}$

Verification

To validate the predictive capabilities of TEMPBR, the model was applied using the July 23-26, 1974 and July 16-19, 1979 intensive survey data and the resulting computed temperatures were compared to measured values.

In general, values supplied to the model were daily average measurements from one of the intensive surveys. For U.S. Steel Outfalls 003 and 004, company flow estimates were used since reliable measurements could not be taken. Lake intrusion flows were calculated using the equations presented in Table 2. Daily stream flows supplied to the model are those recorded at the USGS gage at Elyria. Average meteorological conditions reported at Cleveland Hopkins Airport were used to compute the equilibrium temperatures (E) and heat exchange coefficients (K). Tables 3 and 4 present the input values used in verifying the model.

Surface areas used in model verification are presented in Table 5. Widths downstream of R.M. 6.5 were measured from a Corps of Engineers dredging map, a Lake Survey Harbor Map, and United States Geological Survey (USGS) quadrangle maps. Between R.M. 6.5-10.8 width measurements obtained during September, 1974, at a flow of 139 cfs were adjusted to survey flow conditions by the proportionality

$$\text{Width} \propto Q^n$$

where n was set at 0.15[1,2] (see Appendix III).

Measured and predicted temperatures for the July 23-26, 1974 survey are shown in Figure 4. The temperature model accurately predicted measured temperatures throughout the lower Black River. Upstream of U.S. Steel, computed values are within 1°F of the average measured temperatures. At Outfall 001 the model precisely duplicated the measured increase in stream temperatures and predicted within 0.4°F of the three day average measured value at station 7 (RM 3.88). Predicted temperatures differ by only 1°F and 0.5°F from the average measured values in the midsection and turning basin, respectively. Also the predicted range of temperatures (1 to 2°F) closely approximates the observed range of daily average temperatures.

Table 3

Black River Temperature Model (TEMPBR)
July 1974 Verification
Input Data

		Mean	Standard Deviation
Equilibrium Temperature (E)		70.6°F	0.0
Heat Exchange Coefficient (K)		145 BTU/ft^2-day-°F	0.0
Lake Temperature		71.1°F	0.0
Upstream Flows (3 values)		9.3 cfs, 9.8 cfs, 9.8 cfs	
French Creek Flow		1.6 cfs	
Elyria STP			
Flow		9.92 cfs	0.13
Temperature		75.5°F	0.0
U.S. Steel - Lorain			
Flow Outfall	001	75.1 cfs	2.4
	002	45.9 cfs	0.9
	003	105.0 cfs	0.0
	004	34.0 cfs	0.0
	005	4.9 cfs	0.1
Thermal Load	001	179 x 10^6 BTU/hr	14.7
	002	302 x 10^6 BTU/hr	6.1
	003	506 x 10^6 BTU/hr	31.0
	004	203 x 10^6 BTU/hr	20.7
	005	17.7 x 10^6 BTU/hr	1.5

Table 4

Black River Temperature Model (TEMPBR)
July 1979 Verification
Input Data

		Mean	Standard Deviation
Equilibrium Temperature (E)		76.6°F	0.0
Heat Exchange Coefficient (K)		93.3 BTU/ft^2-day-°F	0.0
Lake Temperature		74.7°F	1.75
Upstream Flows (3 values)		37.46 cfs, 29.74 cfs, 24.23 cfs	
French Creek Flow		2.6 cfs	
Elyria STP			
Flow		8.37 cfs	2.65
Temperature		71.73°F	0.0
U.S. Steel - Lorain			
Flow Outfall	001	62.0 cfs	0.0
	002	23.5 cfs	0.0
	003	68.0 cfs	0.0
	004	22.0 cfs	0.0
	005	2.3 cfs	0.0
Thermal Load	001	66.91 x 10^6 BTU/hr	16.43
	002	203.0 x 10^6 BTU/hr	4.01
	003	272.61 x 10^6 BTU/hr	44.74
	004	110.12 x 10^6 BTU/hr	13.07
	005	3.23 x 10^6 BTU/hr	1.17

Table 5

Black River Temperature Model (TEMPBR)
1974 and 1979 Verification
Surface Areas

Elyria STP to French Creek (RM 10.8-5.1)	2,332,915 sq.ft.
French Creek to U.S.S. 001 (RM 5.1-5.0)	89,760 sq.ft.
U.S.S. 001 to U.S.S. 005 (RM 5.0-3.92)	1,082,000 sq.ft.
U.S.S. 005 to U.S.S. WI-3 (RM 3.92-3.88)	42,000 sq.ft.
Midsection (RM 3.88-2.9)	1,190,000 sq.ft.
Turning Basin (RM 2.9-2.4)	1,630,000 sq.ft.

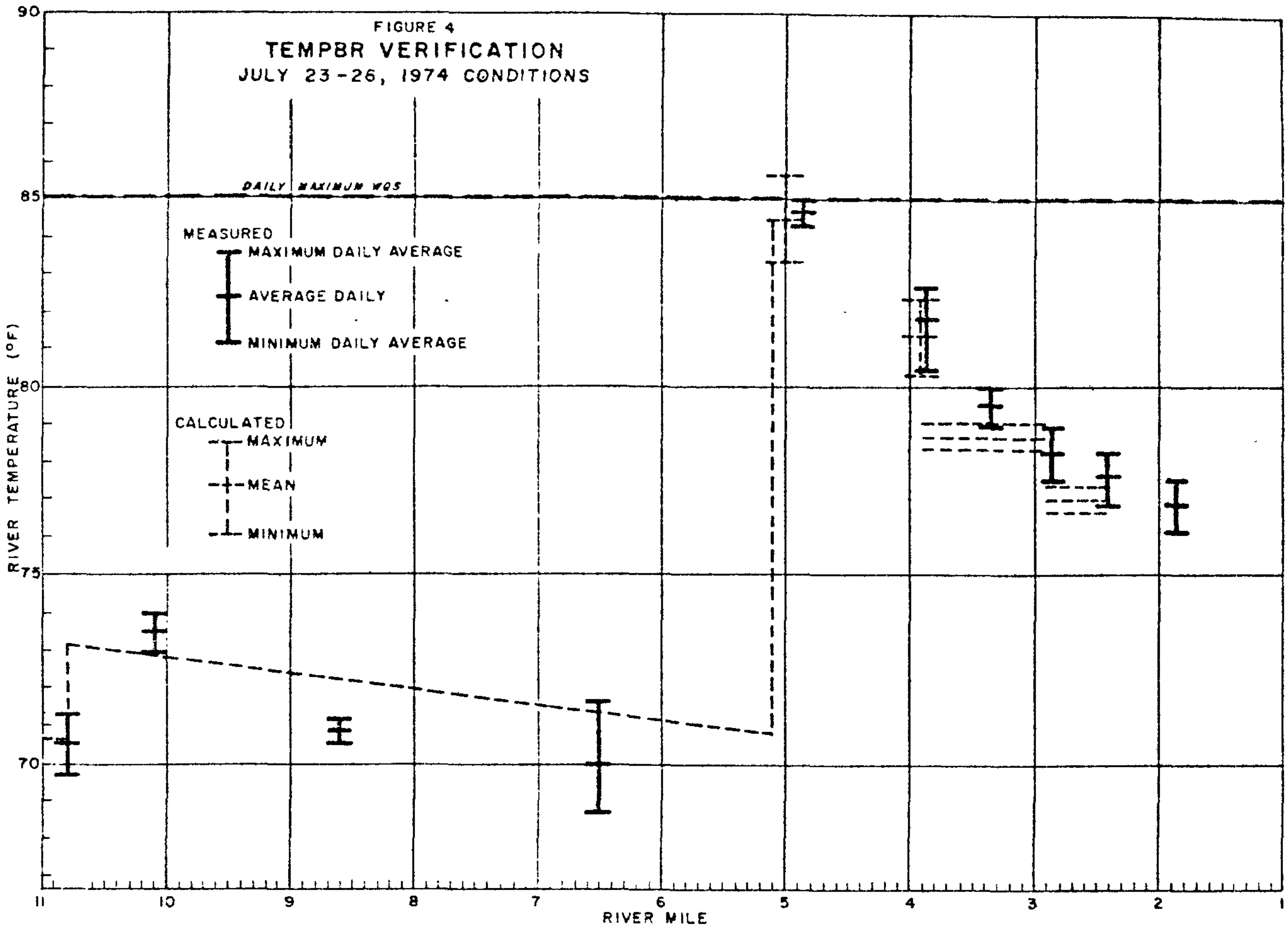


FIGURE 4
TEMPBR VERIFICATION
JULY 23-26, 1974 CONDITIONS
DAILY MAXIMUM WQS
MEASURED
MAXIMUM DAILY AVERAGE
AVERAGE DAILY
MINIMUM DAILY AVERAGE
CALCULATED
MAXIMUM
MEAN
MINIMUM
RIVER TEMPERATURE (°F)
RIVER MILE
90
85
80
75
70
11
10
9
8
7
6
5
4
3
2
1

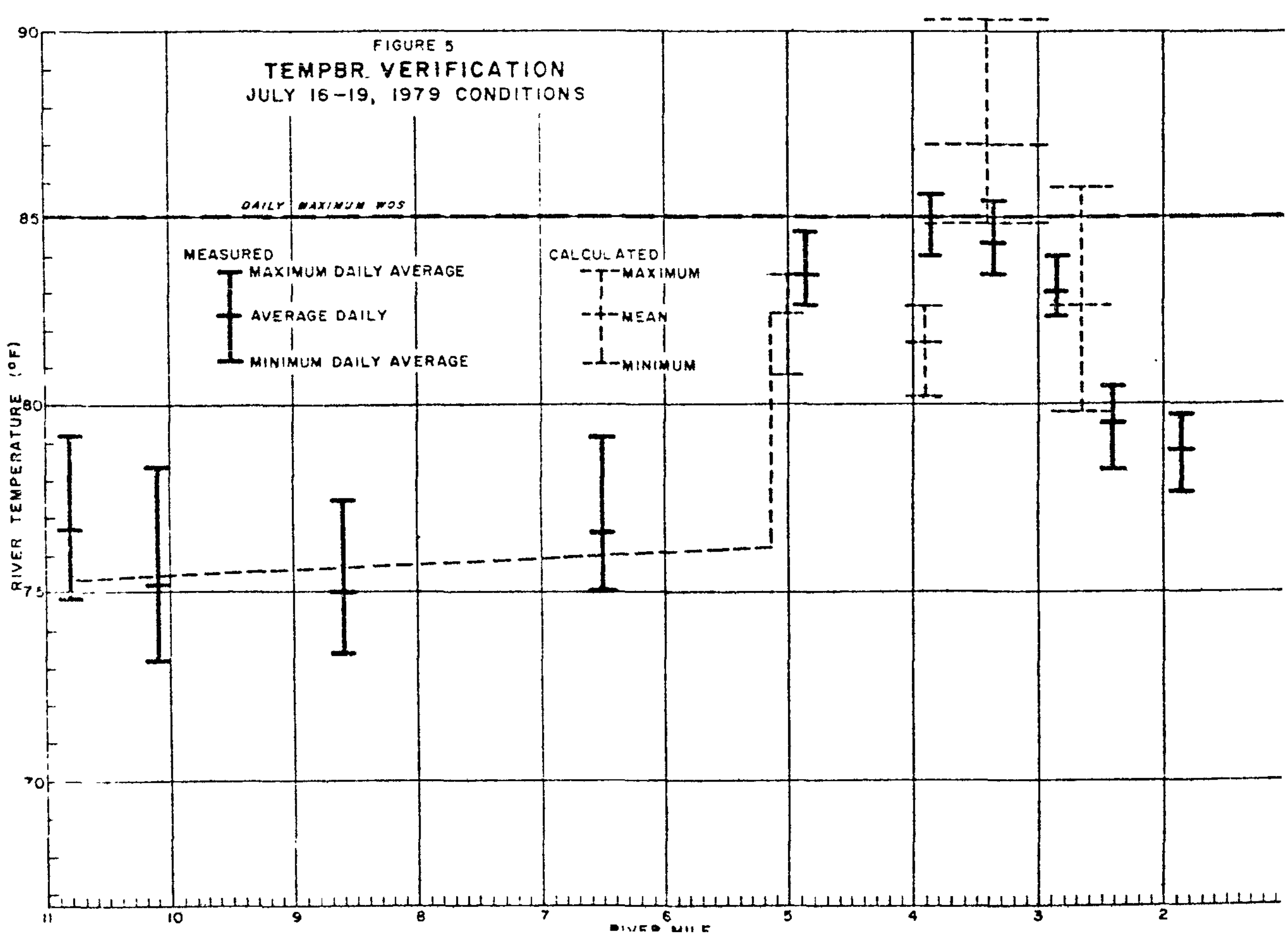


FIGURE 5
TEMPBR VERIFICATION
JULY 16-19, 1979 CONDITIONS
DAILY MAXIMUM WQS
MEASURED
MAXIMUM DAILY AVERAGE
AVERAGE DAILY
MINIMUM DAILY AVERAGE
CALCULATED
MAXIMUM
MEAN
MINIMUM
RIVER TEMPERATURE (°F)
90
85
80
75
70
11
10
9
8
7
6
5
4
3
2

Figure 5 shows the results of the July 16-19, 1979 simulation. Upstream of U.S. Steel the model accurately predicted the gradual increase in measured temperatures. At Outfall 001 the model predicted low by about 1.5^{o}F, and, at intake WI-3, predicted temperatures are about 3^{o}F below measured values. Through this stretch measured temperatures increased about 1.5^{o}F whereas predicted values decreased slightly. In the midsection, the model predicts about 2.5^{o}F above the average measured value. Apparently the heated water from Outfall 002 was affecting intake WI-3 and therefore being dispersed more than was predicted. In the turning basin the predicted temperature is within 0.5^{o}F of the measured value.

Based upon the ability of the model to replicate measured temperatures experienced during the two intensive surveys, the model is considered verified and was employed to compute allowable thermal loads for the U.S. Steel-Lorain Works. The results of the 1979 verification study indicates that allocations based upon the model under low flow conditions may result in slightly lenient (or high) thermal discharge limitations from U.S. Steel.

REFERENCES - APPENDIX II

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2. Schregardus, D.R., and Amendola, G.A., Black River Thermal Analysis, Conference on Environmental Modeling and Simulation, EPA 600/9-76-016, April 19-22, 1976.

3. U.S. EPA, Region V, Michigan-Ohio District Office, Technical Support Document for Proposed NPDES Permit, United States Steel Corporation Lorain Works, NPDES No. OH0001562, July 1975.

4. Edinger, J.E. and Geyer, J.C., "Heat Exchange in the Environment", Edison Electric Institute, New York, June 1965.

5. Thackston, E.L., and Parker, Frank L., "Effects of Geographical Location on Cooling Pond Requirements and Performance", EPA Publication No. 16130 FDQ 03/21, March 1971.

6. Tennessee Valley Authority, Heat and Mass Transfer Between a Water Surface and the Atmosphere, Water Resources Research Report No. 14, April 1972.

7. Amendola, G.A., Schregardus, D.R., Harris, W.H. and Moloney, M.E., Mahoning River Waste Load Allocation Study, U.S. EPA Eastern District Office, May 1978.

Appendix III

Dissolved Oxygen Model

INTRODUCTION

In order to assess the degree of treatment required to attain acceptable levels of dissolved oxygen in the Black River, a mathematical model of the system was constructed. EPA computer model AUTOSS[1] was calibrated using the July 1974 survey data and verified using July 1979 EPA survey data. Figure 1 illustrates the area of study.

BASIC APPROACH

The Black River upstream of river mile 6.5 is a shallow free flowing stream with moderate velocity and slope. Downstream of this point water level and quality are influenced by backwaters of Lake Erie; thus, although the system is not saline, it conforms to an accepted definition of an estuary.[2,3,4]

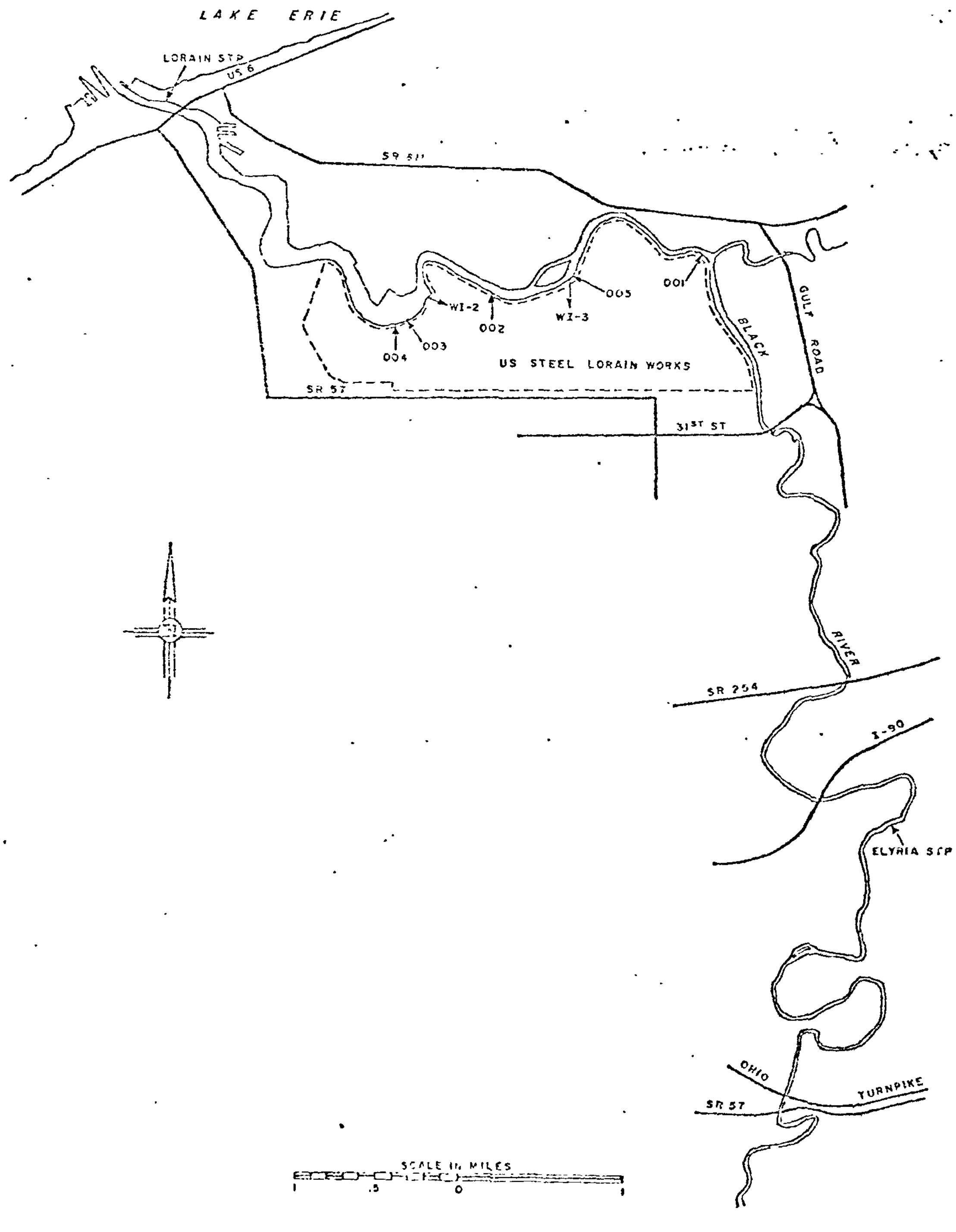
The estuary portion of the river downstream of river mile 2.9 is dredged to thirty feet and in summer somewhat stratified. Cool Lake Erie waters enter the river beneath the warmer river and effluent waters as a result of thermally induced density differences between the two.[5,6] Vertical concentration gradients, however, are not large. During the July 23-26, 1974 and July 16-19, 1979 EPA surveys, the variation of dissolved oxygen with depth averaged about 1 mg/l in the lower portion of the river. Consequently, it is appropriate to describe the system one dimensionally using the average concentration (from top to bottom) at each point as commonly applied to pollution analysis in stratified and unstratified estuaries.[5,7,8,9,10,11,12] In this case, the transport of material caused by the rather complex hydrodynamic behavior in the estuary portion of the river is described in terms of advective and dispersive transport along the longitudinal axis, as discussed by Harleman.[5]

In the Black River under constant flow and loading conditions the basic equation for the concentration, c, of any constituent is:[13]

$$O = -\frac{1}{A}(cQ) + \frac{1}{A}\left(\frac{d}{dx}\left(EA\frac{dc}{dx}\right)\right) - Kc \pm S$$

Figure 1

Lower Black River



where

A is area (L^2 units)
Q is flow (L^3/T)
E is the dispersion coefficient (L^2/T)
K is the first order decay coefficient ($1/T$)
S is the total distributed source term ($M/L^3/T$)
x is length (L)
L designates units of length
M units of mass
T units of time

The AUTOSS program employs a finite section or finite difference approach to solve the concentration equation. For this approach, the river between R.M. 0.0 - 10.8 is divided into a large number of equal length segments within which mixing is assumed to be complete. Concentrations are determined by advective and dispersive transport into and out of each section and by the sources and sinks of material within each section. Initially 0.1 mile segments were employed; however, it was found that 0.2 mile segments produced virtually identical results while reducing computer time. The latter segment size was therefore used throughout.

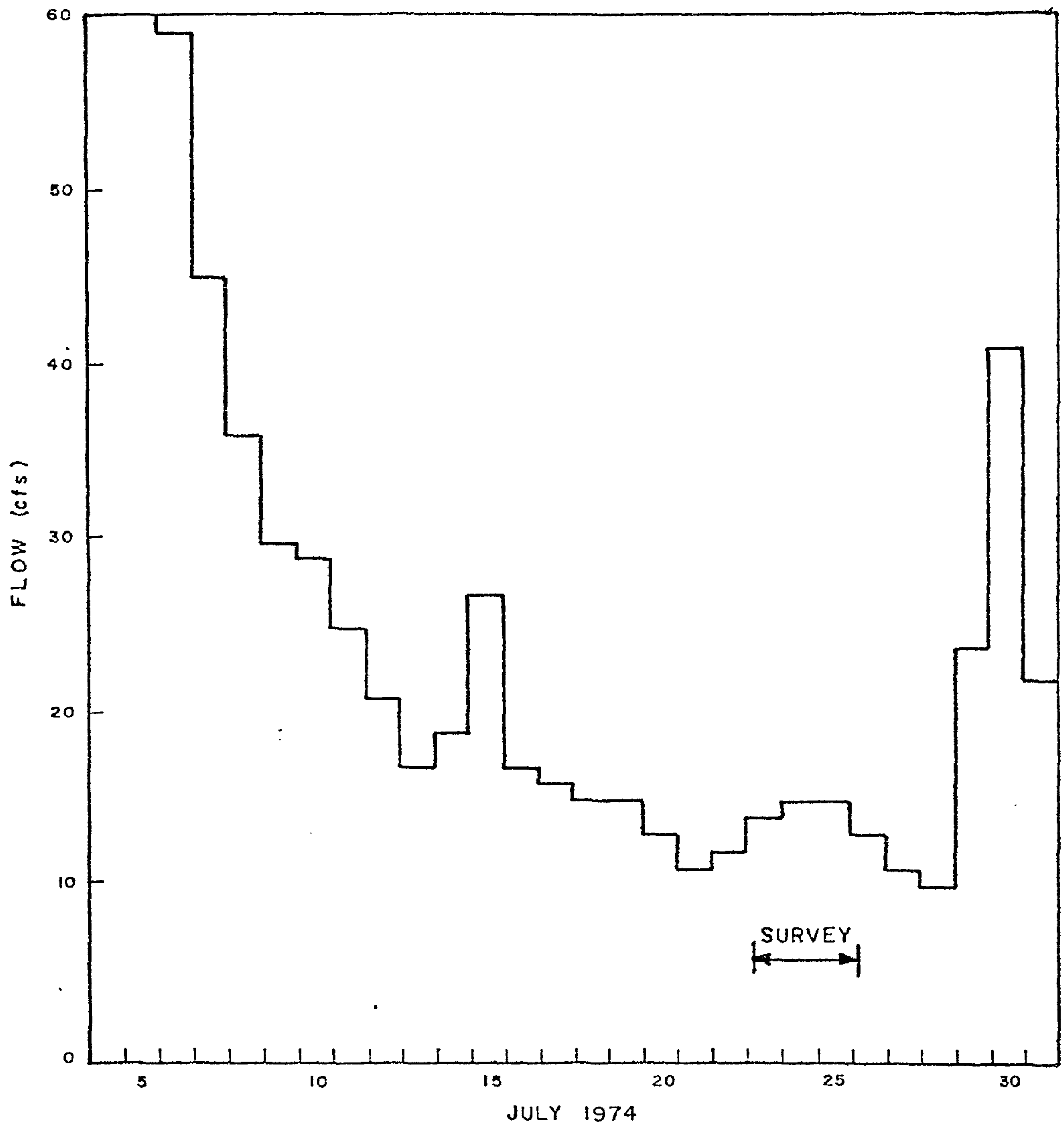
A more detailed description of AUTO-SS is presented in Attachment A.

MODEL CALIBRATION

AUTOSS was calibrated using the July 23-26, 1974 U.S. EPA survey data. The July 1974 hydrograph of the Black River at Elyria, Figure 2, indicates that a low and relatively steady flow regime had been maintained for about two weeks preceding the survey and continued throughout the survey period. The system was close to a steady state with respect to flow. Also, since the average stream flow during the 1974 survey was very close to the critical flow conditions used for water quality projections the data are especially useful for calibrating model coefficients.

Figure 2

DAILY HYDROGRAPH OF THE BLACK RIVER
U.S.G.S. STREAMFLOW GAGE AT ELYRIA (RM 15.2)



Stream geometry, dispersion, reaction rates, waste and tributary loadings, and upstream and downstream boundry conditions were determined from the data following procedures outlined by Thomann[13]. Since the flow regime during the July 1974 intensive survey was steady the three daily values were averaged together. Each day's data are comprised of 12 grab samples composited before laboratory analysis or 12 field measurements.

Hydraulic Characteristics

Lake Stage

The water level of Lake Erie (obtained from the Lake Survey Center of the National Oceanographic and Atmospheric Administration, Detroit) can be seen in Table 1 to have remained stable during the survey.

Flows

Flow of the Black River at Elyria (upstream of the reach under study) is shown in Figure 2. Flow was also measured at R.M. 10 and in French Creek. Flow inputs and diversions in the study reach are presented in Tables 4 and 5. Discharge flows for U.S. Steel Outfalls 001, 002 and 005 are EPA measurements whereas flows for Outfalls 003 and 004 are U.S. Steel estimates.

Width

Widths between R.M. 0.0 - 2.9 were obtained from a Corps of Engineers dredging map; widths between R.M. 2.9 - 6.5 were obtained from a Lake Survey Harbor Map and United States Geological Survey (USGS) quadrangle maps. These data are presented in Figure 3. Between R.M. 6.5 - 10.8 cross-sectional measurements were obtained during September, 1974, at a flow of 139 cfs for eight points on the river as shown in Table 2. These widths were adjusted to the July 1974 survey flow condition by the proportionality

$$\text{Width} \propto Q^n$$

Table 1

Stage of Lake Erie at Cleveland

Date	State (feet above sea level)
July 22, 1974	572.94
July 23, 1974	572.99
July 24, 1974	572.92
July 25, 1974	572.93

Table 2

Cross-sectional data for the free flowing portion of the river (September, 1974)
Flow = 139 cfs

Approximate River Mile	Width	Average Depth
10.8	34.8	1.71
10.4	62.5	2.07
10.1	105.5	3.09
9.7	67.5	1.3
9.5	76.5	2.11
8.3	63.5	0.86
7.8	107.2	1.76
6.5	114.	2.68
Average	78.9	1.95

Table 3

Time of travel between R.M. 10.7 - 6.5
as measured by dye tracers.
Flow = 20 cfs

River Mile	Miles	Travel Time (hours)	Velocity (ft/sec)
10.7 - 10.1	0.6	2.3	0.383
10.1 - 8.6	1.5	5.33	0.413
8.6 - 8.4	0.2	1.0	0.290
8.4 - 7.8	0.6	2.08	0.423
7.8 - 6.5	1.3	5.0	0.381
Total	4.2	15.7	-
Average	-	-	0.392

TABLE 4
July 23-26, 1974 EPA Survey
SODIUM AND CHLORIDE INPUTS TO THE BLACK RIVER

Identification	River Mile	Flow (cfs)	Na (mg/l)	Cl (mg/l)
Lorain STP	0.2	20.2	76	77.5
USS - 004	2.56	34.0	28.3	76.3
USS - 003	2.63	105.2	22.0	45.7
USS - W12	2.8	-186.6	18.2	35.3
USS - 002	3.5	45.8	28.0	46.7
USS - W13	3.88	-80.0	41.2	61.0
USS - 005	3.92	4.9	48.1	69.0
USS - 001	5.0	75.0	45.1	64.0
French Creek	5.1	1.6	117.0	102.7
Elyria STP	10.7	10.6	113.3	142
Black River (upstream)	10.8	13.25	96	120

TABLE 5
July 23-26, 1974 EPA Survey
INPUTS OF DISSOLVED OXYGEN,
CARBONACEOUS AND NITROGENOUS BOD

(mg/l unless otherwise noted)

	River Mile	Flow (cfs)	BOD_5	TKN	UBOD	CBOD	NBOD	DO
Lorain STP	0.2	20.2	6.0	6.4	50.0	24.4	25.6	3.6
USS - 004	2.56	34.0	6.7	7.23[3]	42.0	13.1	28.9	5.0
USS - 003	2.63	105.2	4.0	3.33	31.0	17.7	13.3	4.27
USS - W12	2.8	-186.6[1]	-	1.93	13.7	6.0	7.72	1.5
USS - 002	3.5	45.8	10.7	3.33	36.0	22.7	13.3	6.07
USS - W13	3.88	-80.0[2]	7.6	3.43	32.0	18.3	13.73	2.83
USS - 005	3.92	4.9	16	3.67	33.3	18.6	14.7	5.53
USS - 001	5.0	75.0	9.7	3.33	36.7	23.4	13.3	3.9
French Creek	5.1	1.6	3	1.17	10.7	6.0	4.7	7.35
Elyria STP	10.7	10.6	84	21.8	258	171	87	3.4
Black River (upstream	10.8	13.25	7.3	4.0	40.3	24.3	16.0	7.3

1 Set equal to sum of outfalls less 1 mgd evaporation.
2 Set equal to sum of outfalls.
3 NH_3 as N.

FIGURE 3

WIDTH OF BLACK RIVER

RIVER MILE 0.0 TO 6.5

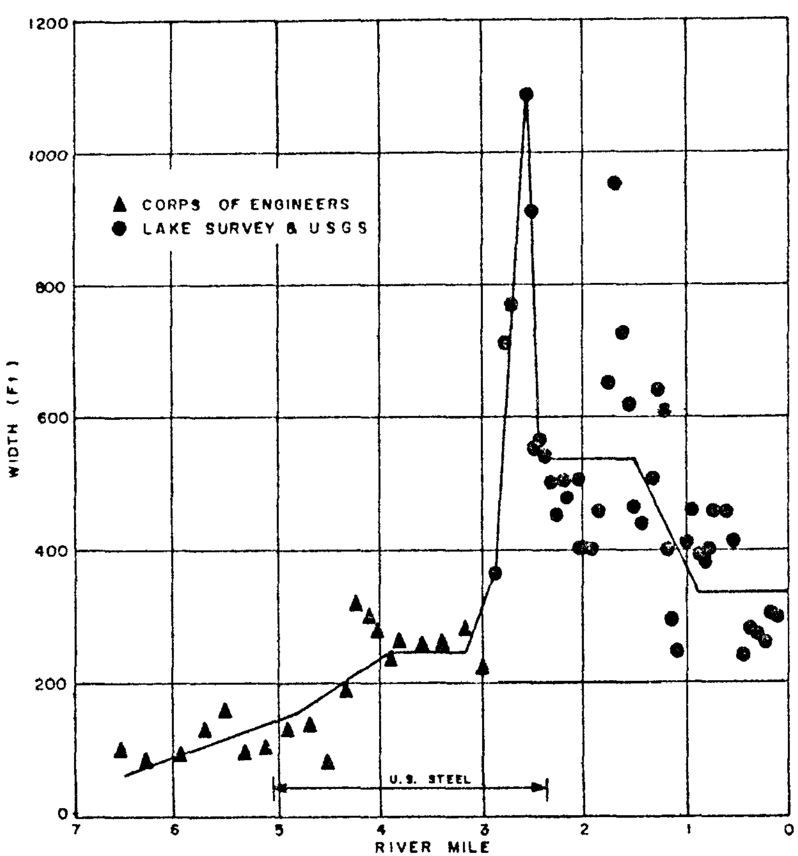
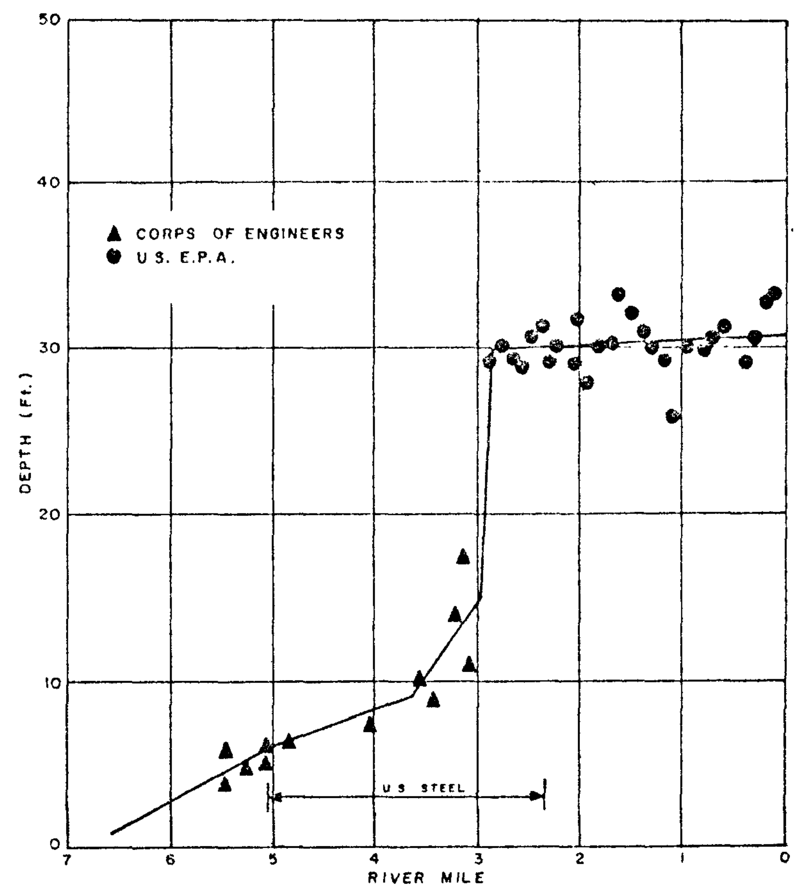


FIGURE 4

DEPTH OF BLACK RIVER

RIVER MILE 0.0 TO 6.5



where n was set at 0.15.[8,13] By this means the average width between R.M. 6.5 - 10.7 was found to be 60 feet.

Depth

Depth measurements across a large number of transects in the dredged portion of the river (R.M. 0.0 - 2.9) were available from the Corps of Engineers. Between R.M. 2.9 - 6.5 depth data were available from previous EPA surveys. Adjustment was made for the July 1974 lake level. Data for the estuary portion of the river are presented in Figure 4. Supporting data were available from the Corps of Engineers.[14] The effect of dredging is apparent in the sharp change in depth at R.M. 2.9.

Above R.M. 6.5 depth is a function of river flow rather than lake stage. Adequate numbers of depth measurements were available for a flow of 139 cfs, but the depth dependency on flow was not known. Since velocity in this segment was measured with dye traces during low flow, depth was calculated from continuity:

$$\text{Depth} = \text{Flow}/(\text{Width} \times \text{velocity})$$

By this means, an average depth of around 1 foot was calculated between Elyria STP and R.M. 6.5. This corresponds with actual measurements taken for gaging at R.M. 10 during the July 1974 survey.

Velocity

Velocity in the estuary portion of the river (below R.M. 6.5) was calculated from the flow and channel dimensions. Velocity in the free flowing portion (above R.M. 6.5) was measured by dye tracers as shown in Table 3. As the velocity was relatively constant between R.M. 10.7 - 6.5, the average velocity between these points was used.

Slope

The hydraulic slope of the stream was measured from USGS quadrangle maps and the Corps of Engineers river thalweg.[14] The slope was found to average 4.7 ft./mile between R.M. 10.7 - 6.5.

Below R.M. 6.5 the slope is very small as the river approaches lake level.

Dispersion

The longitudinal dispersion coefficient, E, was determined from the sodium and chloride profiles, using the finite difference, trial and error fit procedure described by Thomann.[13] The value of E is shown as a function of river mile in Figure 5. Inputs of sodium and chloride to the system are shown in Table 4; comparisons of the observed and predicted profiles are shown in Figures 6 and 7. Excellent agreement of observed and predicted values indicates that AUTOSS when applied using appropriate coefficients can effectively simulate the interaction between the river and the lake.

Nitrogenous BOD

Measurements of total Kjeldahl nitrogen (TKN), ammonia, and nitrite plus nitrate, taken during the July 1974 survey are shown in Figure 8. Downstream of R.M. 6.5 these curves represent concentrations near the water surface; mid and lower depths were not sampled for analyses of these parameters. Ammonia can be seen to comprise the bulk of the oxidizable nitrogen. Thus, as the rate limiting step can be expected to be ammonia oxidation,[15] a single first order kinetic reaction will closely approximate the three or four stage reaction (depending on whether starting with ammonia or organic nitrogen):[10,16]

$$\text{Org-N} - NH_3 - NO_2 - NO_3$$

Nitrogenous BOD (NBOD) was estimated to be 4.0 x TKN (total Kjeldahl nitrogen) concentration.[17]

In the stratified portion of the estuary it was necessary to estimate the average vertical concentration because vertical concentration profiles or composites were not obtained during the survey. Since the relative longitudinal distributions of NBOD (and CBOD), sodium, and chloride were similar, the relative vertical distributions were also assumed to be similar.

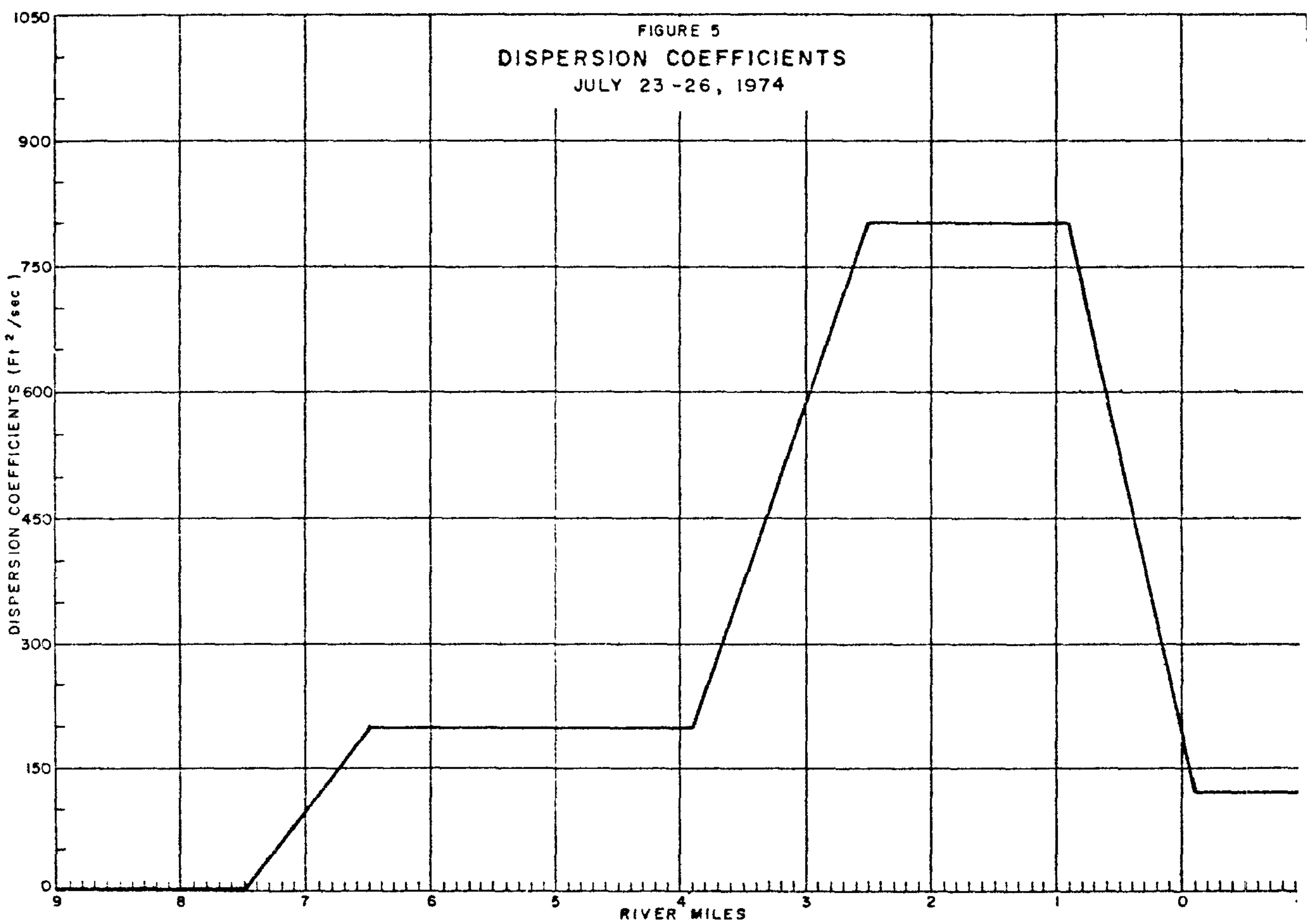


FIGURE 5
DISPERSION COEFFICIENTS
JULY 23-26, 1974
DISPERSION COEFFICIENTS (Ft² /sec)
1050
900
750
600
450
300
150
0
9
8
7
6
5
4
3
2
1
0
RIVER MILES

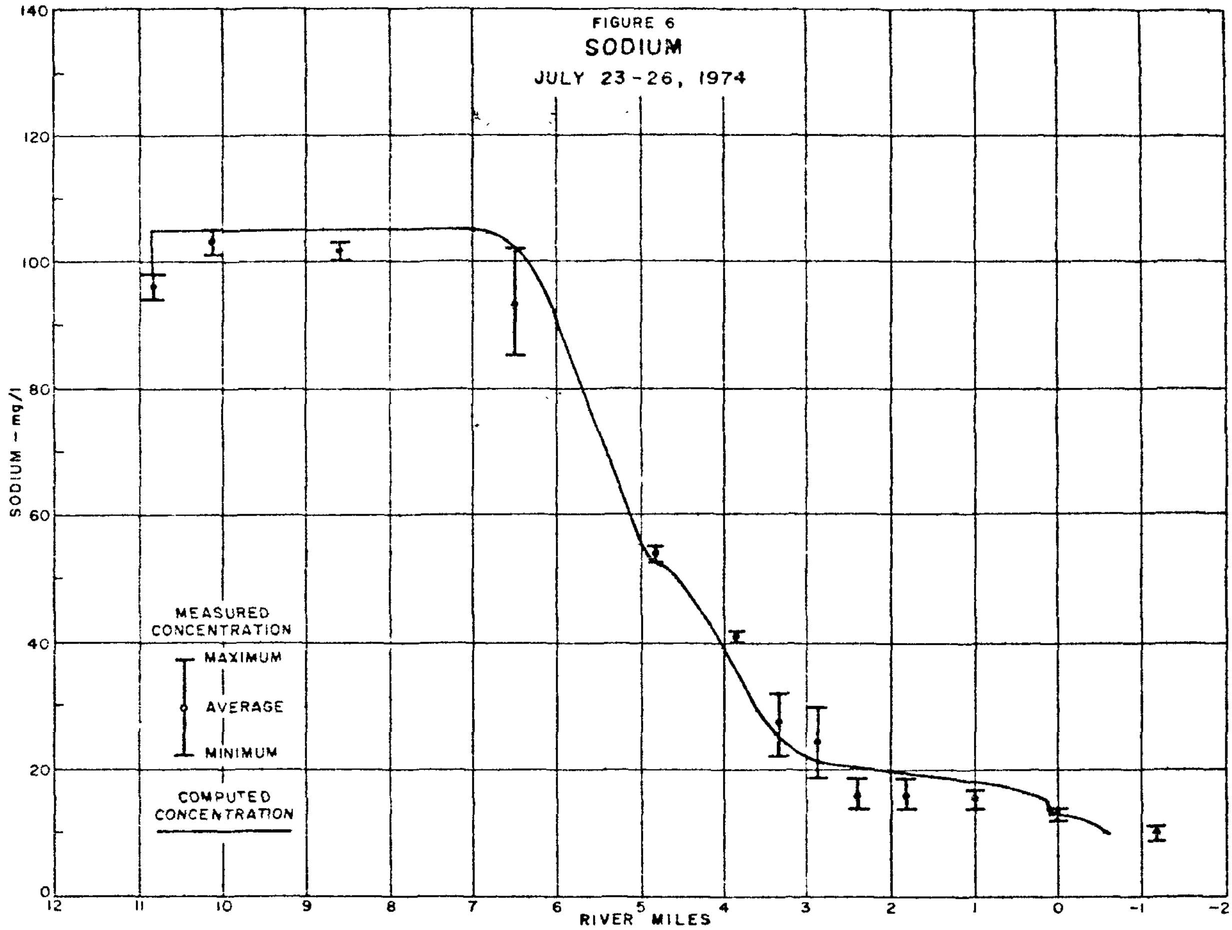


FIGURE 6
SODIUM
JULY 23-26, 1974
SODIUM - mg/l
RIVER MILES
MEASURED CONCENTRATION
MAXIMUM
AVERAGE
MINIMUM
COMPUTED CONCENTRATION
140
120
100
80
60
40
20
0
12
11
10
9
8
7
6
5
4
3
2
1
0
-1
-2

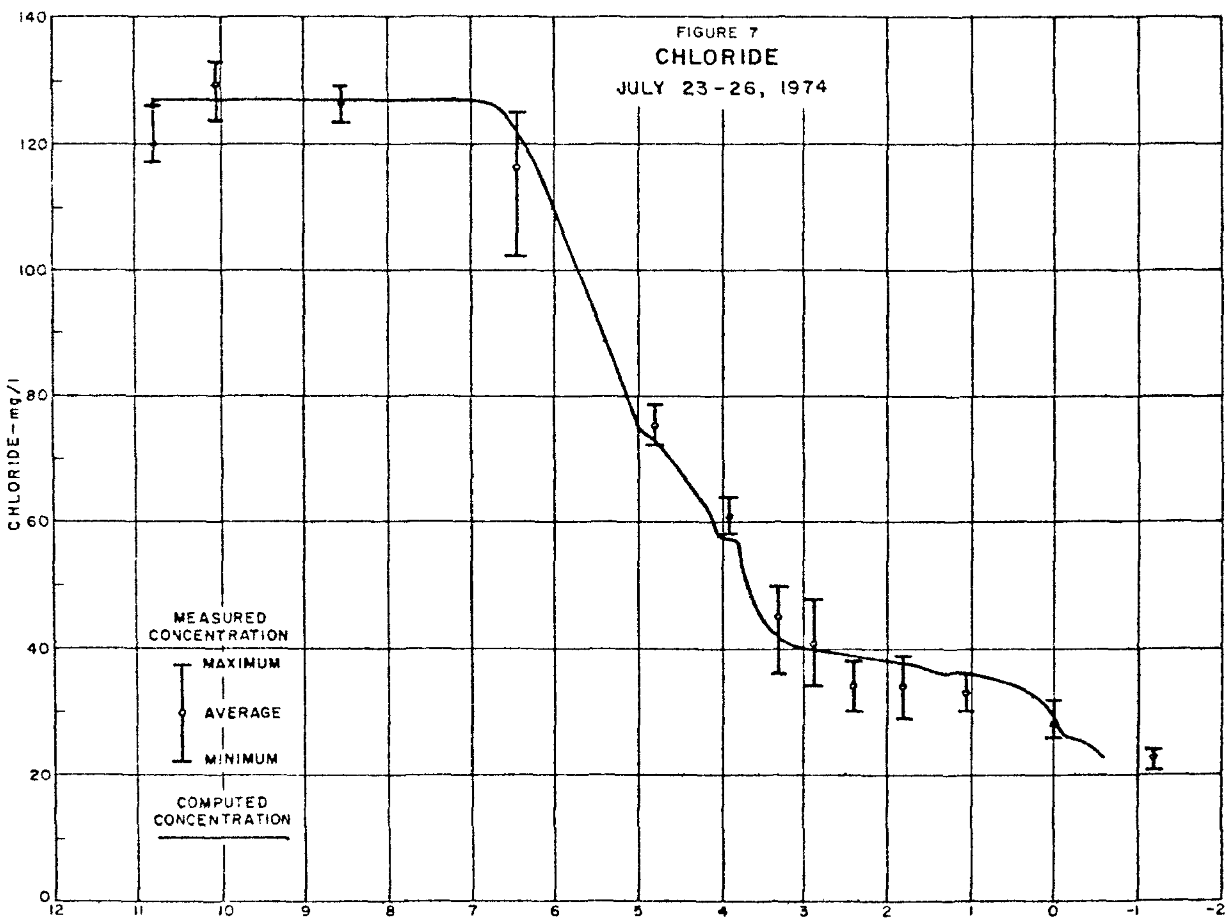
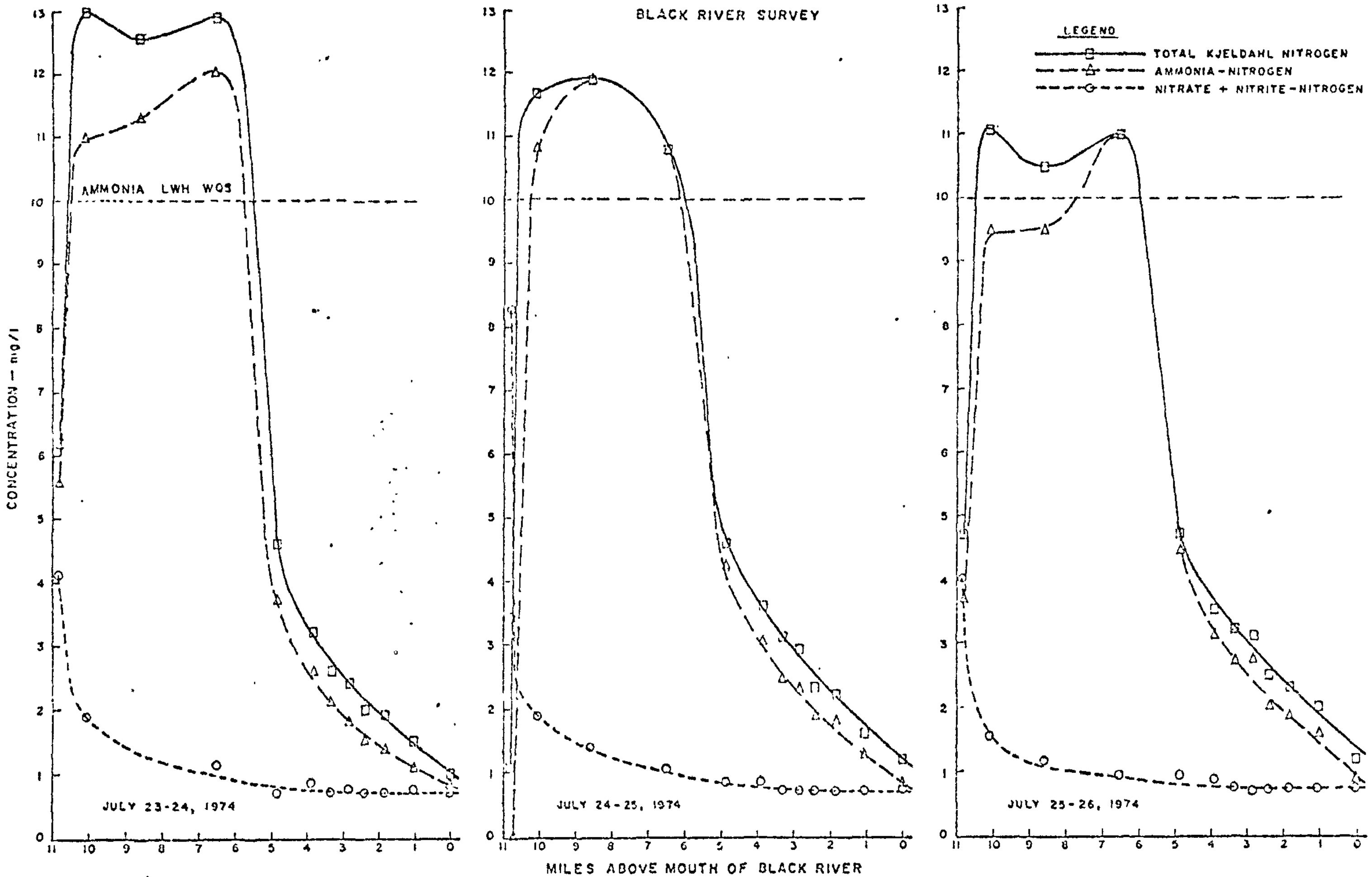


FIGURE 7
CHLORIDE
JULY 23-26, 1974
CHLORIDE - mg/l
MEASURED CONCENTRATION
MAXIMUM
AVERAGE
MINIMUM
COMPUTED CONCENTRATION
140
120
100
80
60
40
20
0
12
11
10
9
8
7
6
5
4
3
2
1
0
-1
-2

FIGURE 8

TOTAL KJELDAHL NITROGEN, AMMONIA-NITROGEN, NITRATE + NITRITE-NITROGEN VS RIVER MILE

BLACK RIVER SURVEY



The average level of NBOD at each point between R.M. 0.0-3.4 was calculated from the surface concentration multiplied by the ratio (0.9) of the average to surface concentration of sodium and chloride.

Differences in decay rates were expected to exist between the estuary and free flowing portions of the river, due to differences in benthal character, ratio of volume to benthal surface, and rate of replacement of fluid elements at the benthal interface.[10,12,18] In the free flowing portion (above R.M. 6.5) the decay coefficient was found to be 0.14 day^{-1} (base e) based upon the observed rate of disappearance. Such a low rate is characteristic of a system dominated by gross levels of carbonaceous BOD.[10] Not surprisingly, the hydrolytic conversion of organic nitrogen to ammonia proceeded faster than the oxidative step, causing ammonia levels to increase slightly moving downstream from Elyria STP to R.M. 6.5. Oxidation of TKN between the Elyria STP and R.M. 8.6 was negligible and as expected, there was no increase in the nitrite plus nitrate concentration in this reach. Indeed, a significant decrease was observed. This is attributed to the biochemical reduction of oxidized nitrogen occurring in anaerobic sediments known to exist in the pools of the free flowing portion of the river.[19,20] The slight oxidation between R.M. 8.6 and R.M. 6.5 was accompanied by a slight increase in nitrite plus nitrate concentration.

The decay coefficient in the estuary portion of the river was estimated to be 0.05 day^{-1}, based upon fit to the observed NBOD and DO levels. This unusually low rate is attributed to insufficient levels of dissolved oxygen existing through much of the estuary.[10,16] Assuming the nitrification inhibition function presented by Hydroscience[21] (and shown in Attachment B), the rate coefficient would be approximately 0.1 day^{-1} before reduction due to low dissolved oxygen.

Inputs of NBOD are presented in Table 5. Comparison of observed and predicted NBOD levels are shown in Figure 9.

Carbonaceous BOD

Carbonaceous BOD (CBOD) was determined from the long-term BOD (20 or 30 day BOD) less the NBOD. Average vertical concentrations between R.M. 0.0-3.4 were estimated in the same way as described for NBOD in the previous section.

FIGURE 9
NBOD
JULY 23-26, 1974

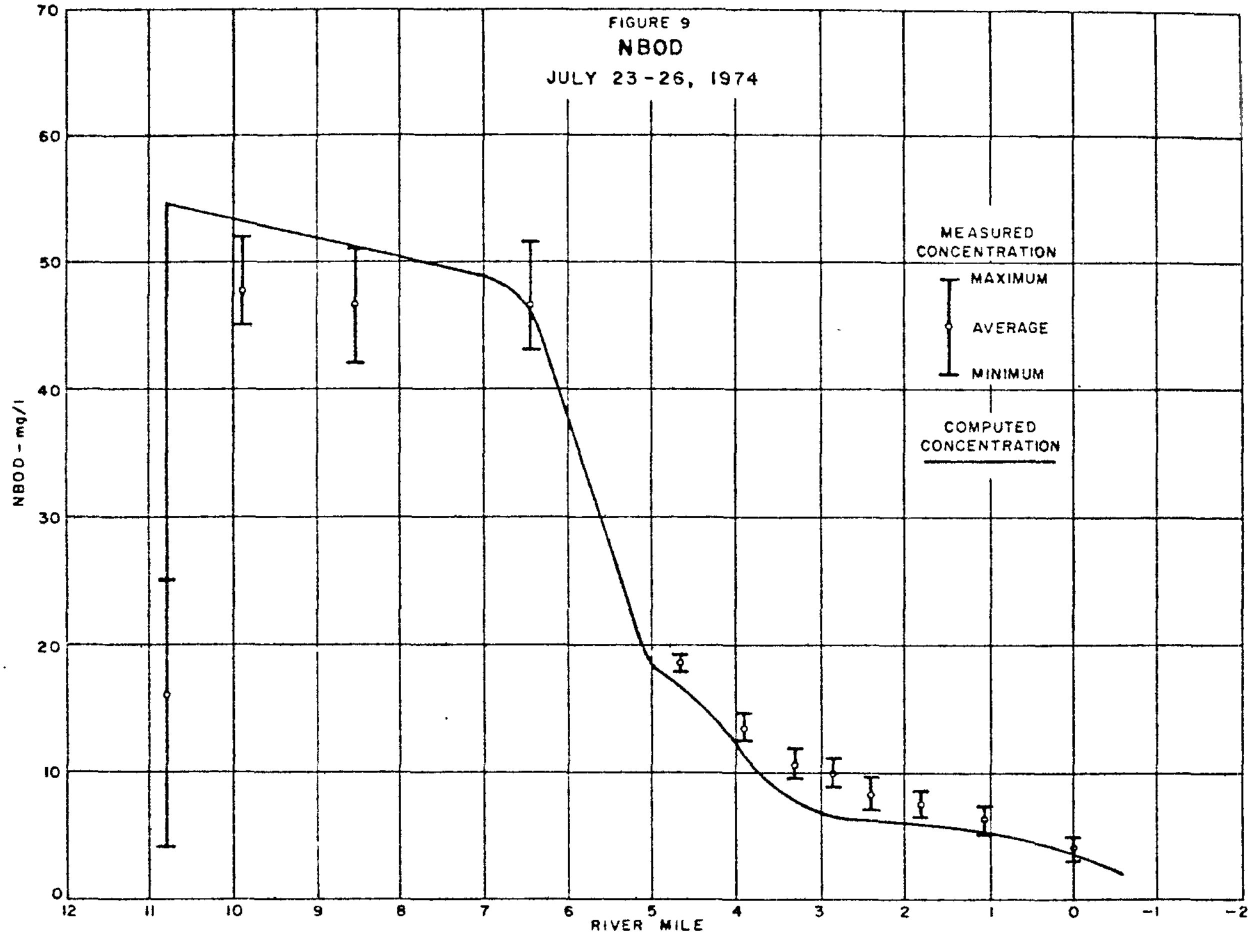
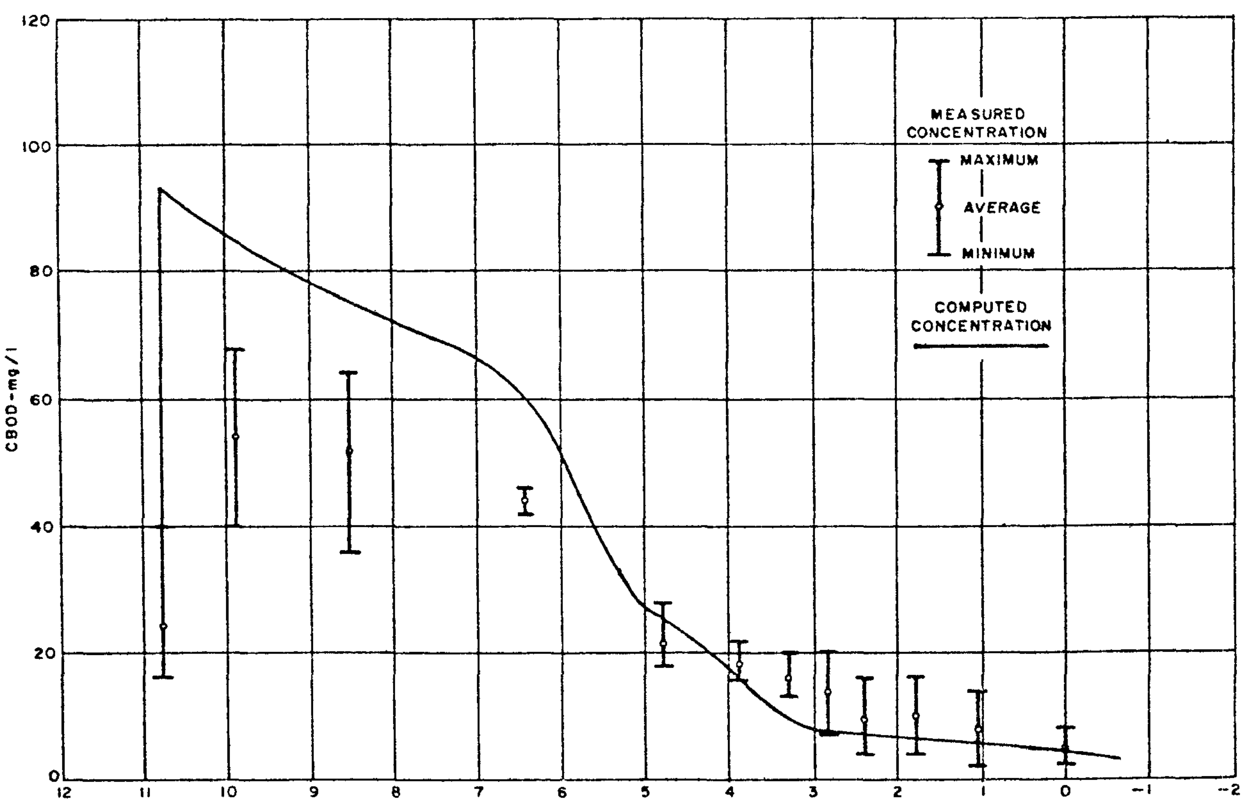


FIGURE 10
CBOD
JULY 23-26, 1974



The decay coefficient was estimated from the observed rates of disappearance and the observed levels of CBOD and DO. It was found to be 0.6 day^{-1} for one mile below Elyria STP, 0.5 day^{-1} in the remaining free flowing portion of the river and 0.1 day^{-1} in the estuary portion.

Inputs of CBOD are presented in Table 5. Comparison of the observed and predicted profiles is shown in Figure 10. It is believed that inadequate ice packing between time of collection and time of start of the BOD test for the samples collected at R.M. 8.6 and 10.1 contributes to the difference between observation and prediction at these points. Instream settling of CBOD may also account for some of the difference.

Algal Effects

The diurnal variation at some stations (11, 12, and 13) during the July 1974 survey appeared to be consistent with photosynthetic activity. At most stations including the critical area in the vicinity of U.S. Steel, however, the diurnal range was small. At Station 10 the large diurnal variation was opposite to any attributable to photosynthesis. Biological examination of the river, furthermore, did not reveal excessive growths of algae anywhere below Elyria STP. Thus there is little evidence that algal activity provides a significant amount of oxygen to the river on a daily average basis. Water quality was beneath the optimum for algal growth.

Sediment Oxygen Demand

In the 1974 survey sediment oxygen demand (SOD) was measured in the laboratory on samples taken from the riverbed in various locations. Results are presented in Table 6. For use in the model, this measurement is multiplied by the fraction of bottom covered by sludge material.

Due to the mixing procedure employed, (described in Attachment C), such laboratory measurements should exceed the true demand of undisturbed sediments. Nevertheless, the SOD (in mg/l/day) was found to be minor relative to the oxygen uptake of BOD in the water column (k_c x CBOD + k_n x NBOD, in mg/l/day).

TABLE 6
July 1974
SEDIMENT OXYGEN DEMAND

River Mile	Lab SOD Rate* $g\ O_2/m^2/day$ Max.	Min.	Mean	Estimated Fraction of Bottom Covered By Organic Material**
1.8	1.50	1.01	1.18	1.0
2.75	1.96	1.10	1.57	1.0
4.0	1.72	0.97	1.39	1.0
4.8	2.15	1.76	1.96	.25
5.3	6.35	3.85	5.03	.25

* At 23.5 - 25.0°C temperature
** Estimated from field description of benthal character

Effects of Temperature

Reaction rate coefficients were assumed to display an Arrhenius dependence on temperature:

$$K = k_{20}\ \theta^{T-20}$$

The temperature dependence coefficient, θ, was 1.024 for reaeration, 1.1 for nitrogenous decay, and 1.047 for carbonaceous decay.[1,13]

The temperature regime found during the July 1974 survey is shown in Figure 11.

Reaeration

Reaeration rate upstream of river mile 2.9 was calculated using the O'Connor formula modified as recommended by O'Connor:[10,21]

$$K_a = K_L/H$$

and

$$K_L = 12.9\ U^{1/2}H^{3/2}$$

constrained by

$$K_L \geq 2$$

where K_L is the surface renewal rate, H is depth,(ft) and U is velocity.(ft/sec)

The Tsivoglou formula[22] was considered for application to the free flowing portion but was found to significantly underestimate reaeration capacity. The Churchill formula, on the other hand, was not considered to be applicable for this situation as it was developed for streams with velocities considerably higher than found anywhere in the study reach, and depths greater than those found in the free flowing portion.[23] Its use would also underestimate reaeration capacity.

Formulations which relate reaeration to river velocity and depth are not applicable downstream of river mile 2.9 because of low stream velocities

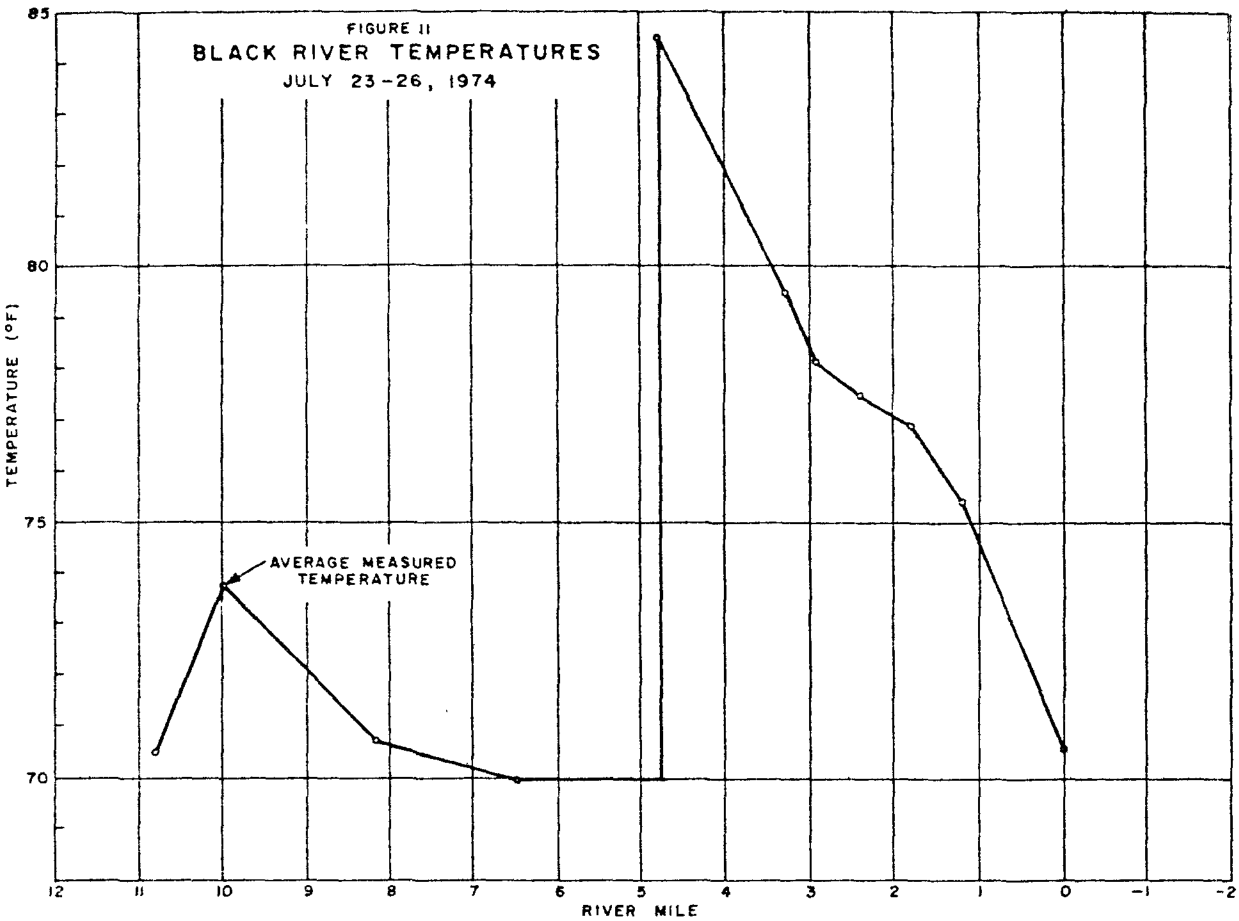


FIGURE 11
BLACK RIVER TEMPERATURES
JULY 23-26, 1974
AVERAGE MEASURED TEMPERATURE
TEMPERATURE (°F)
RIVER MILE
85
80
75
70
12
11
10
9
8
7
6
5
4
3
2
1
0
-1
-2

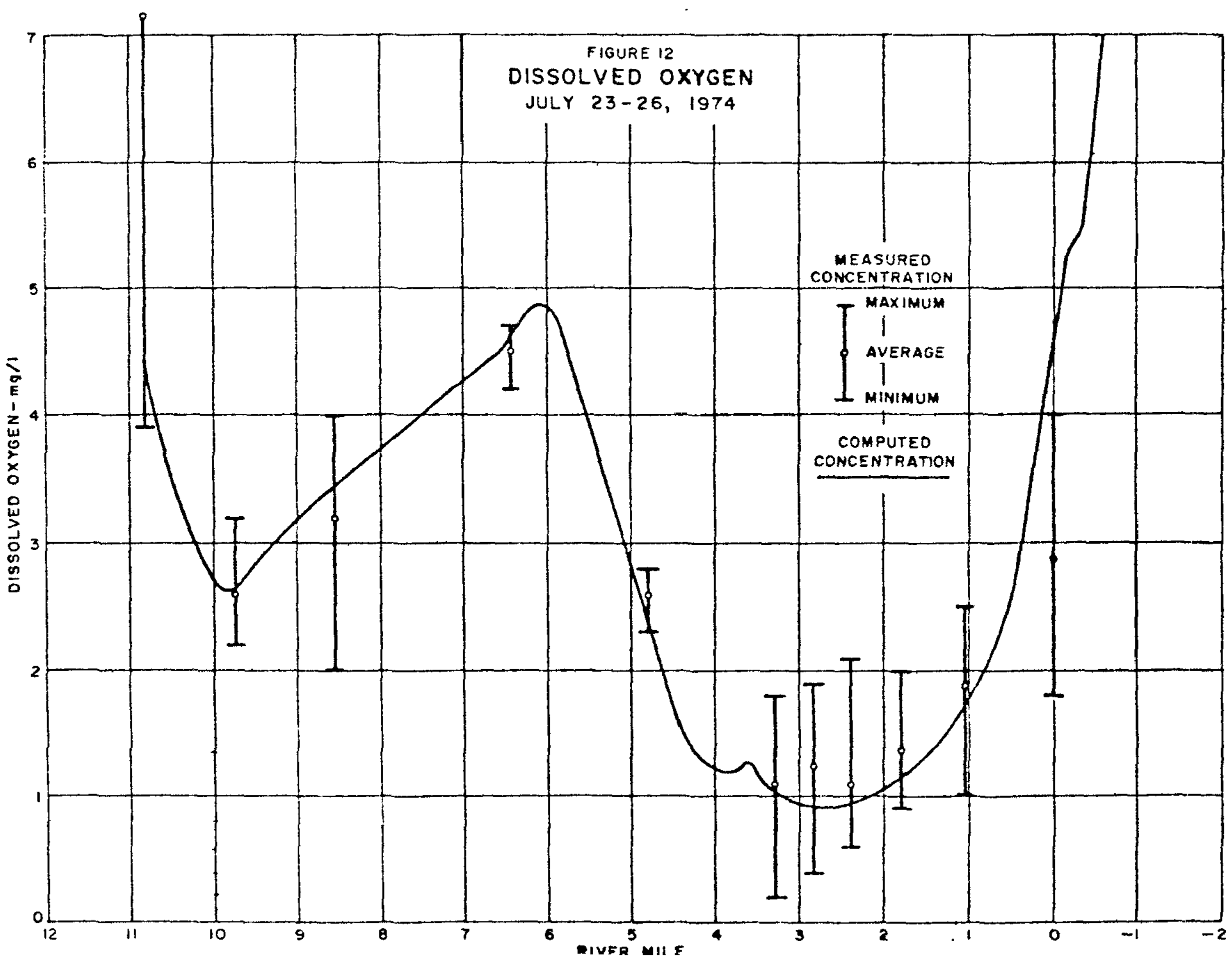


FIGURE 12
DISSOLVED OXYGEN
JULY 23-26, 1974
MEASURED CONCENTRATION
MAXIMUM
AVERAGE
MINIMUM
COMPUTED CONCENTRATION
DISSOLVED OXYGEN - mg/l
RIVER MILE
7
6
5
4
3
2
1
0
12
11
10
9
8
7
6
5
4
3
2
1
0
-1
-2

and the depth of the stream. Therefore, reaeration rate coefficients were based on a correlation developed by Banks and Herra[24] and successfully applied to the Saginaw River[25] which relates wind speed to oxygen surface transfer rate,

$$K_L = .384\ W^{0.5} - .088\ W + .0029W^2$$

$$Ka = K_L/H$$

where W is the wind speed in Km/hr. Average wind speed recorded at Cleveland Hopkins Airport during the July 1974 survey was used in the equation (10.3 km/hr).

Dissolved Oxygen

Inputs of dissolved oxygen (DO) are presented in Table 5. Comparison of the observed and predicted DO profiles are shown in Figure 12. It can be seen there is good correspondence between measured and computed values throughout the river. Using the previously described rates the model computed within 0.5 mg/l of average DO concentrations measured during the survey. The calibration, therefore, demonstrates that with the proper reaction rates the model can accurately simulate the complex hydrologic interaction between the river and the lake.

MODEL VERIFICATION

A second intensive survey of the lower Black River was conducted July 16-19, 1979 to obtain data for model verification. The survey was nearly identical to July 1974 survey, with the exception that depth integrated samples were collected in the estuary portion of the river in lieu of surface, mid-depth and bottom samples. Temperature, dissolved oxygen and conductivity depth profiles were also obtained at each sampling site. Stream characteristics input to AUTOSS were determined using the same procedures applied during model calibration.

Hydraulic Characteristics

Stream flow at the USGS gage in Elyria during the July 1979 survey averaged about 30 cfs and was slowly declining during the three-day survey from a small storm about 10 days before the study (see Figure 13). Inputs and withdrawals from the system, shown in table 7, are EPA measurements with the exception of discharge flow at U.S. Steel Outfalls 003 and 004 which are U.S. Steel estimates.

Stream widths and depths downstream of river mile 5 were the same as in the calibration run since lake level during this survey (572.3) was essentially the same as in July 1974 (572.9). However, values above that point were adjusted for flow based on relationships between values determined at 21 cfs and 139 cfs. As a result, widths and depths in the verification are slightly larger than the corresponding values used in model calibration in the upstream portion of the river.

Dispersion coefficients were calculated with sodium and chloride data using the same trial and error procedure applied during calibration (Figures 14 and 15). The resulting values, (Figure 16) are slightly less and shifted somewhat downstream from the July 1974 coefficients due to higher upstream flow.

Nitrogenous BOD

For model verification NBOD loadings and boundry conditons were assumed to be four times measured TKN values (see Table 7). Reaction rates from the July 1974 survey were initially applied in the verification, however, predicted stream concentrations did not agree well with averaged measured values. Rates from the 1974 survey appeared too low for the upper segment of the river and slightly high for the estuary portion. A NBOD reaction rate of 0.32 day^{-1}, gives good agreement between measured and computed concentration downstream of Elyria STP whereas a rate ranging from 0.0 at the mouth to 0.1 at river mile 5 worked best in the lower portion of the river. The NBOD rate in the free flowing portion of the river agrees well with values found in other Ohio streams.[26,27] The low rate in the estuary portion of the river may be partially caused by the low dissolved oxygen levels in this segment, however, rates did not increase as DO

FIGURE 13

DAILY HYDROGRAPH OF BLACK RIVER
AT ELYRIA (R.M. 15.2) FOR JULY, 1979

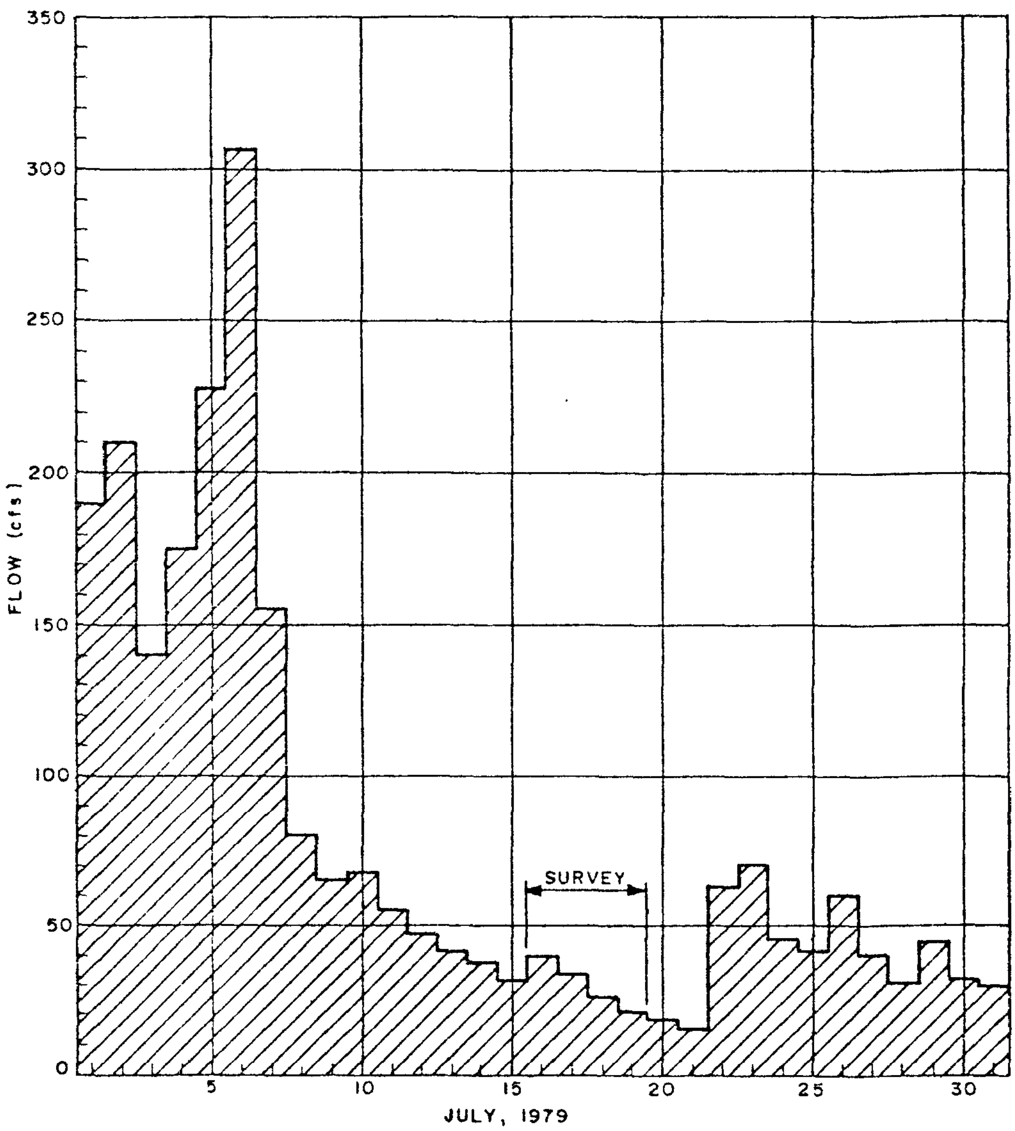


Table 7

Inputs of Dissolved Oxygen,
Carbonaceous and Nitrogenous BOD
July 16-19, 1979 EPA Survey

(mg/l unless otherwise noted)

	River Mile	Flow cfs	TKN	CBOD	NBOD	DO
Lake Erie	-0.6	—	0.5	3.6	2	8.0
Lorain STP	0.2	25.0	3.7	7.7	14.6	3.7
USS-004	2.56	34.0	6.6	5.1	26.5	4.8
USS-003	2.63	105.2	3.5	4.7	14.0	4.8
USS-WI2	2.8	175.6[1]				
USS-002	3.5	36.4	5.5	6.2	21.8	5.3
USS-WI3	3.88	99.4[1]				
USS-005	3.92	3.6	3.3	7.4	13.1	6.4
USS-001	5.0	95.8	2.2	13.2	8.8	3.8
French Creek	5.1	2.4	0.6	3.6	2.6	8.2
Elyria STP	10.7	9.8	19.2	64.5	76.8	3.3
Black River (Upstream)	10.8	30.4	1.5	9.4	6.0	9.4

[1]Set equal to sum of Outfalls.

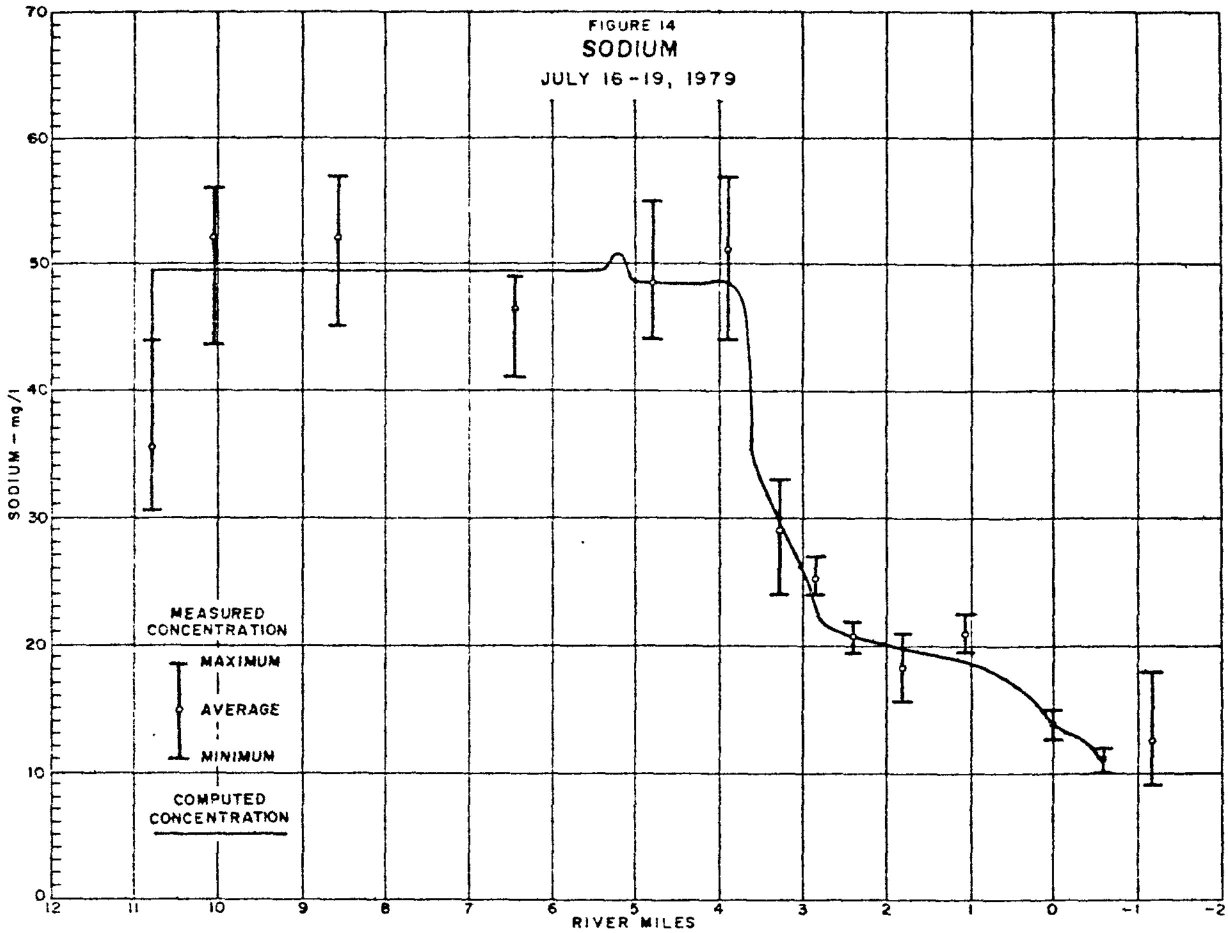


FIGURE 14
SODIUM
JULY 16-19, 1979
SODIUM - mg/l
RIVER MILES
MEASURED CONCENTRATION
MAXIMUM
AVERAGE
MINIMUM
COMPUTED CONCENTRATION
70
60
50
40
30
20
10
0
12
11
10
9
8
7
6
5
4
3
2
1
0
-1
-2

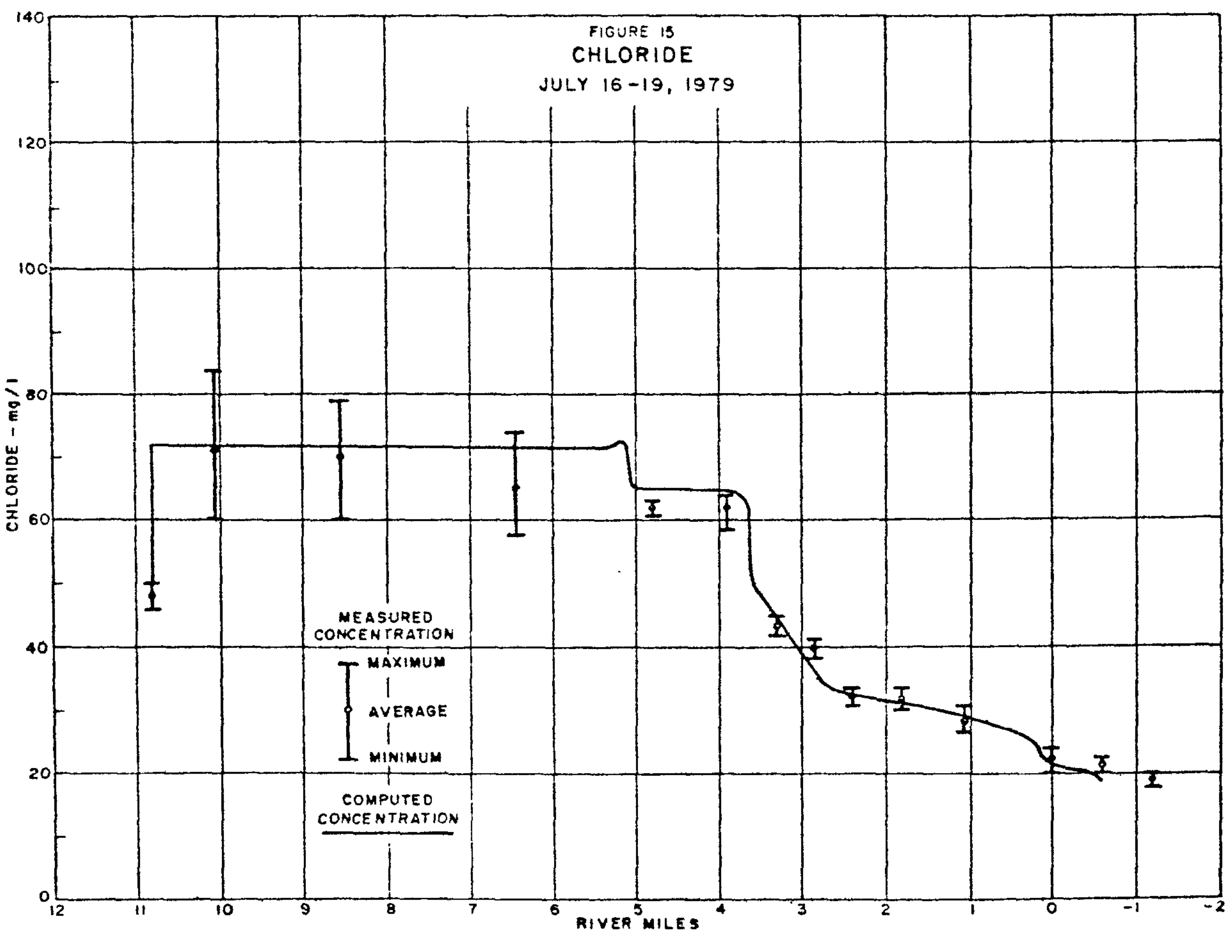


FIGURE 15
CHLORIDE
JULY 16-19, 1979
CHLORIDE - mg/l
RIVER MILES
MEASURED CONCENTRATION
MAXIMUM
AVERAGE
MINIMUM
COMPUTED CONCENTRATION
140
120
100
80
60
40
20
0
12
11
10
9
8
7
6
5
4
3
2
1
0
-1
-2

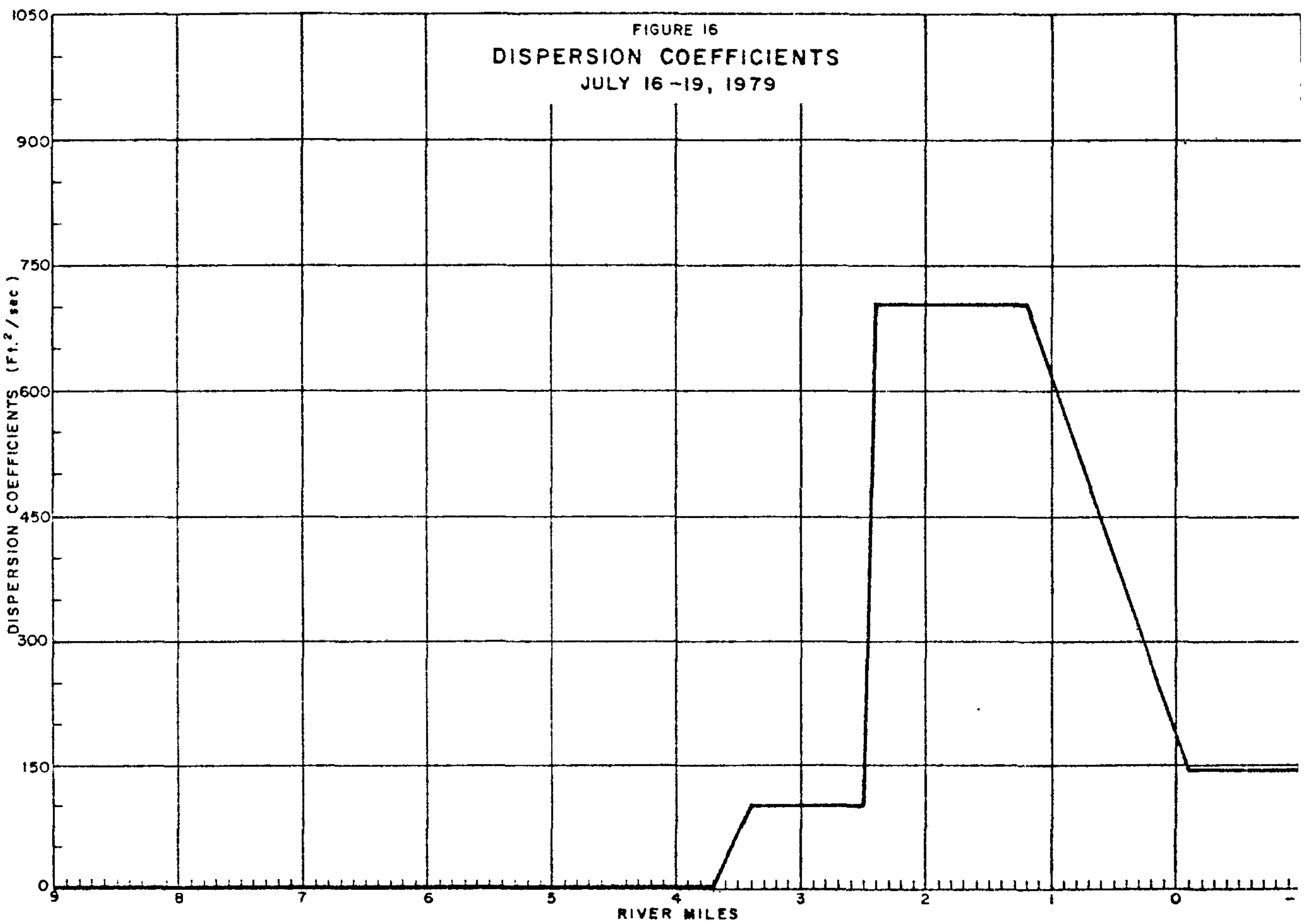


FIGURE 16
DISPERSION COEFFICIENTS
JULY 16-19, 1979
1050
900
750
600
450
300
150
0
DISPERSION COEFFICIENTS (Ft.² / sec)
9
8
7
6
5
4
3
2
1
0
RIVER MILES

concentrations increased near the mouth. With the high ratio of volume to benthal surface and the low NBOD concentration relative to upstream values, conditions are below optimum for rapid nitrification.

Figure 17 shows measured and computed concentrations with the selected reaction rates. Computed concentrations are within 2 mg/l of the average measured values at all stations.

Carbonaceous BOD

For the July 1974 intensive survey, BOD tests were conducted with and without a chemical nitrification inhibitor. Carbonaceous BOD concentrations determined in the 1979 survey are long term BOD's (30 day) inhibited for nitrification. Effluent loadings and boundry conditions are presented in Table 7.

Reaction rates determined in model calibration were supplied to the model but did not produce good agreement with measure concentrations. A reaction rate of 1.2 in the free flowing portion of the river was found to better replicate measured stream concentrations. The reaction rate of 0.14 worked well for both the 1974 and 1979 surveys between river miles 2.9 and 5.0 which is the critical area for dissolved oxygen. In the dredged portion of the river CBOD reaction rates decreased uniformly with river mile from a value of 0.05 at RM 2.9 to 0.0 at RM 1.5. A 0.0 rate was applied from RM 1.5 to the lake. Using these reaction rates, the model accurately replicated observed concentrations (see Figure 18).

Sediment Oxygen Demand

Sediment oxygen demand rates were measured using an in-situ benthic respirometer at four locations in the lower Black River on August 7 and 8, 1979. These values are very similar to rates determined in the July 1974 survey. Also, the portion of stream bottom covered with sediment was determined at 13 stations using an Eckman dredge. Sediment oxygen demand rates input to the model are the product of the measured rates and the percentage of bottom covered with sediment (see Table 8). Upstream of the turning basin (RM 2.9), SOD rates measured at R.M. 2.4 were applied since measured rates were not available. In the free flowing portions of the stream the sediment oxygen demand was assumed to be zero since the stream bed is generally hard and rocky.

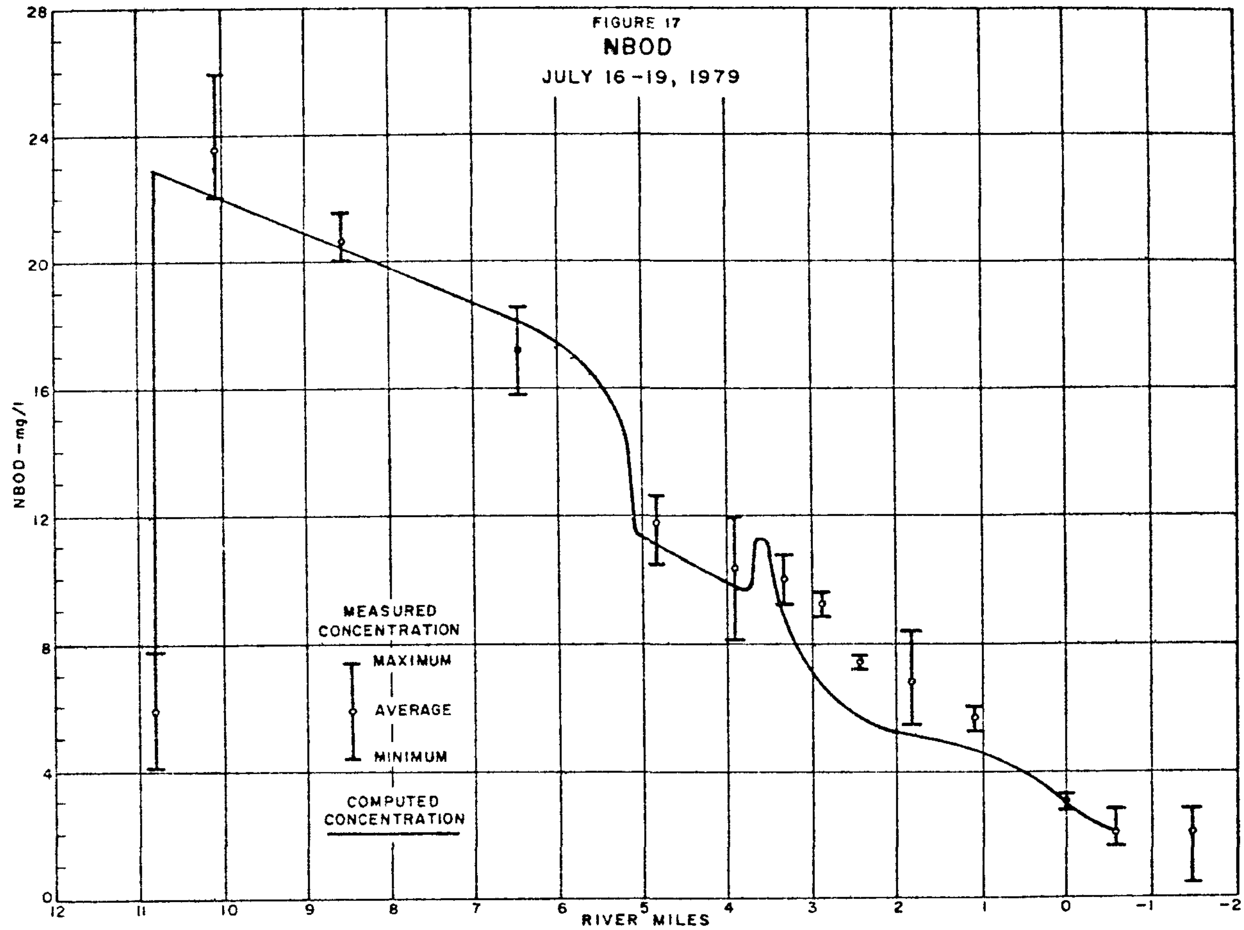


FIGURE 17
NBOD
JULY 16-19, 1979
NBOD - mg/l
RIVER MILES
MEASURED CONCENTRATION
MAXIMUM
AVERAGE
MINIMUM
COMPUTED CONCENTRATION

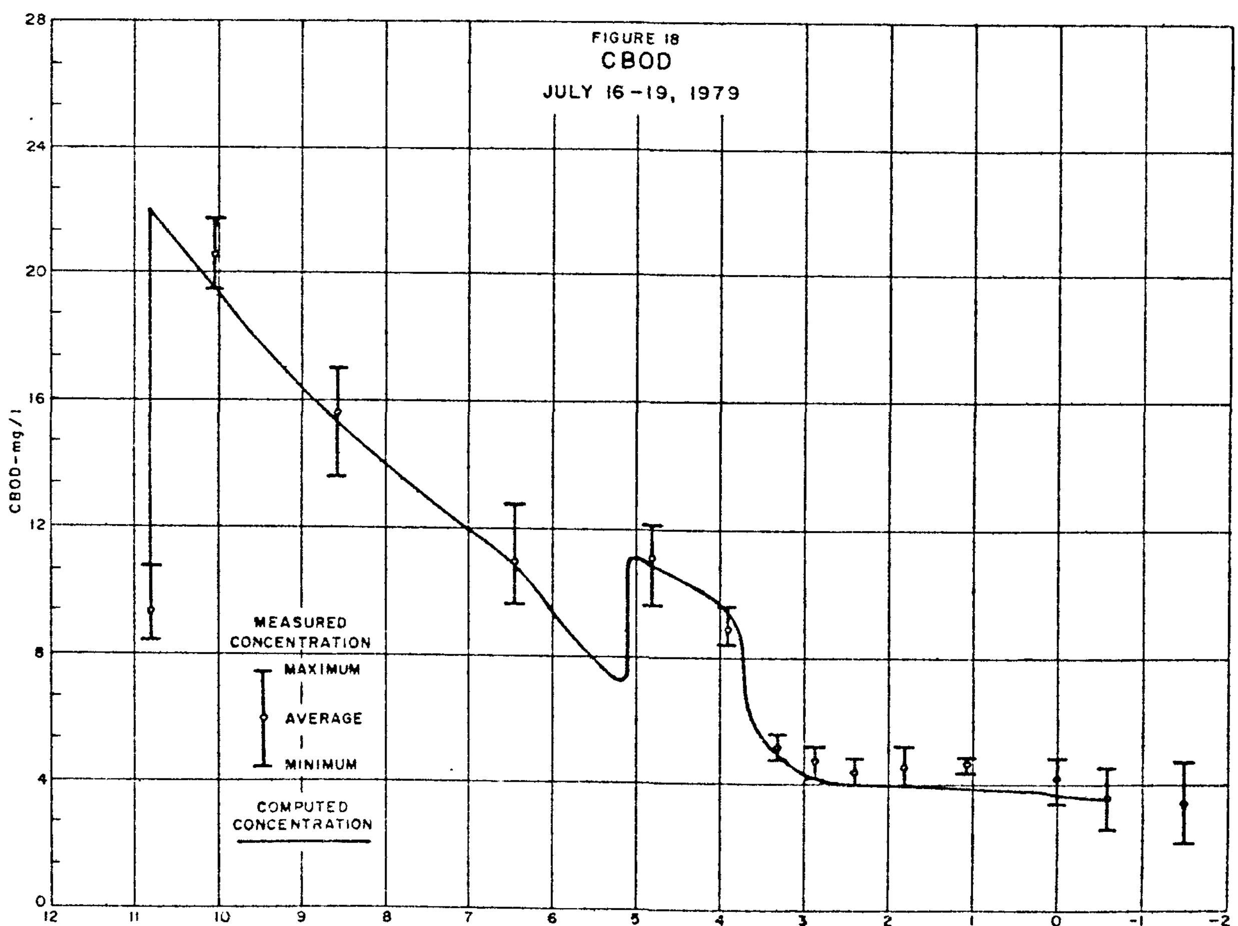


FIGURE 18
CBOD
JULY 16-19, 1979
CBOD-mg/l
MEASURED CONCENTRATION
MAXIMUM
AVERAGE
MINIMUM
COMPUTED CONCENTRATION

Table 8

Sediment Oxygen Demand
August 1979

River Mile	SOD Rate $gm/m^2/day$	Fraction of Bottom Covered by Organic Material	Rate Supplied to Model
-0.6	1.73[1]	.86[2]	1.49
0.0	.86[1]	.86	.74
.5	1.3	.43	.56
1.1	1.73[1]	.86	1.49
1.8	1.5	1.00	1.5
2.4	1.29[1]	1.00	1.29
2.85	1.29	1.00[2]	1.29
2.9	1.29	.43	.55
3.4	1.29	0	0
3.6	1.29	.43	.55
3.9	1.29	0	0
4.4	1.29	.29	.37
4.9	1.29	.29	.37
5.5	1.29	.43	.55
6.0	1.29	0	0

[1]Measured values

[2]Estimated fraction

Dissolved Oxygen

Dissolved oxygen inputs for model verification are presented in Table 7. Reaction rates for CBOD and NBOD are the values described above while reaeration rates were calculated using the formulas applied in model calibration. A comparison of measured and predicted DO concentrations, Figure 19, shows the model (dashed line) accurately reproduced the three day average measured values in the lower portions or the river downstream of river mile 5. The model predicts about 1.5 mg/l high at sampling stations 10 and 11 (river mile 6.5 and 8.6). Since CBOD and NBOD predicted concentrations agree well with measured values in this segment the model was rerun with the reaeration rate reduced to 6.0 from the value of 7.7 computed with the O'Connor formula. The results shown as the solid line agree with measured values throughout the river with the exception of river mile 10.1 where the measured value exceeds the predicted value by about 1.5 mg/l. This is likely the result of the large diurnal variation occurring at this station which does not occur at stations further downstream. At the other sampling stations computed values are generally within one-half mg/l of the average measured value.

In general, the rates calibrated with the July 1974 data did not adequately simulate observations from the July 1979 survey. Model reaction rates had to be adjusted or recalibrated in order to reproduce the July 1979 measured concentrations. The two data bases clearly demonstrated that with the proper reaction rates AUTOSS can accurately simulate the complex hydrological interaction between the river and the lake (Figures 17, 18 and 19). The stream hydrology computations were verified with the July 1979 survey data (Figures 14 and 15). Also identified by the calibration and verification is the critical segment between intake WI-3 and the turning basin where minimum DO concentrations occur. In this segment reaction rates from both July surveys were similar and the model replicated actual conditions.

Failure to verify reaction rates especially downstream of Elyria STP has little impact on modeling at critical flow conditions for load allocation purposes. Stream quality will be improved and CBOD reaction rates downstream from Elyria STP will be reduced by installation of advanced treatment. Also, in the estuary portion of the river, minimum DO concentrations will improve with installation of treatment eliminating any

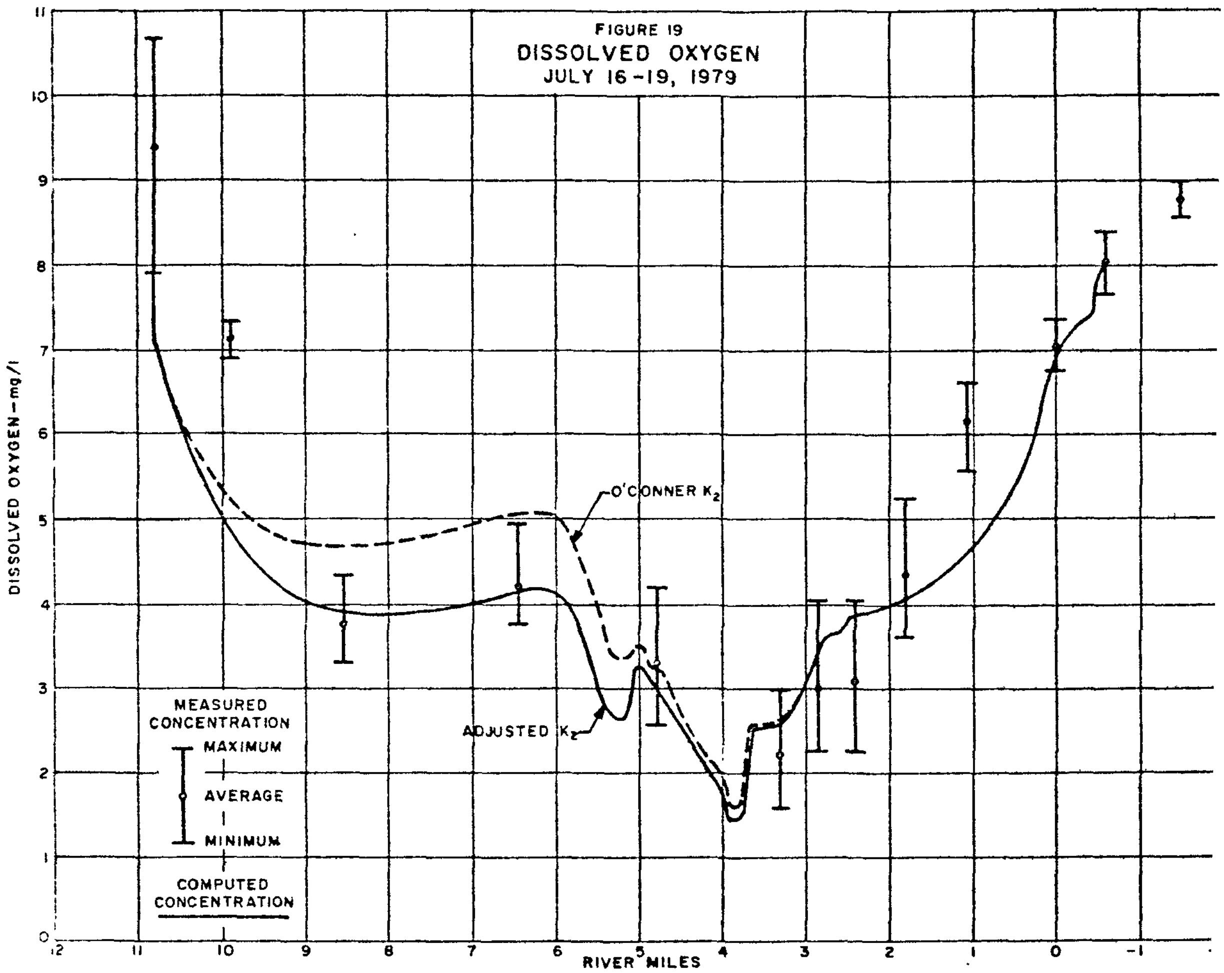


FIGURE 19
DISSOLVED OXYGEN
JULY 16-19, 1979
DISSOLVED OXYGEN-mg/l
RIVER MILES
O'CONNER K2
ADJUSTED K2
MEASURED CONCENTRATION
MAXIMUM
AVERAGE
MINIMUM
COMPUTED CONCENTRATION

DO related rate suppression which occurred during the two July surveys. It is important, however, to assess the impact of reaction rates on stream quality at critical conditions and the selection of treatment alternatives. Chapter IX describes the sensitivity analysis performed for this study and indicates effluent loadings, and not reaction rates, are the dominant factor in determining water quality in the lower Black River.

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ATTACHMENT A

AUTO-SS SOLUTION

EXCERPT FROM "AUTO-QUAL MODELLING SYSTEM"[1]

MODEL DEVELOPMENT

The development of AUTØSS and AUTØQD has been broken into sections. Because the two models have many of the same properties, a general development is given first. The last two sections will deal with each model separately and discuss the particular solution techniques used.

CHANNEL REPRESENTATION:

The first problem to be resolved in a model development is how to represent the stream or estuary being modelled in terms that can be mathematically described and represented on a digital computer. The method of representation used in these models is called the "channel-junction" method. Essentially this method consists of dividing the natural channel into a finite number of sections (See Figure 1). Each of these sections contains a finite volume of water. These sections (discrete volumes of water) are assumed to be uniform at a given instant in time in all their properties. This assumption is generally referred to as the "fully mixed assumption". Thus, any property of this volume of water, for instance, a constituent concentration, represents the average value for that volume. This average value has a point value at the center of the volume. These discrete volumes of water are referred to as junctions.

Generally the system being modelled is not static. There will be flow and movement of water in the system. Thus, the problem of representing flow and the consequential transfer of properties from one junction to another has to be dealt with. For this reason the concept of channels is introduced. Physically a channel may be thought of as the interface between two junctions. Computationally the channel is treated as a uniform, rectangular channel between junction midpoints. Water properties are not associated with channels. Channels are used (computationally) for the transfer of properties from junction to junction.

Various properties are associated with either a channel or a junction; the properties of a channel are:

1. Flow (ft^3/sec)
2. Velocity (ft/sec)
3. Dispersion coefficient (ft^2/sec)
4. Cross-sectional area (ft^2)
5. Depth (ft)
6. Width (ft)
7. Length (ft or miles)

The properties of a junction are:

1. Volume (ft^3)
2. Surface area (ft^2)
3. Constituent concentrations (ppm)
4. Temperature (°C)
5. Evaporation - rainfall (in/month)
6. Inflows (ft^3/sec)
7. Diversions (ft^3/sec)
8. Reaeration rate (1/day)
9. Photosynthesis - respiration rate (gr O_2/m^2/day)
10. Sediment uptake rate (gr O_2/m^2/day)
11. CBØD decay rate (1/day)
12. NBØD decay rate (1/day)
13. Constituent masses (ppm-ft^3)
14. Inflow concentrations (ppm).

Some of the junction properties are computed from channel values. For instance, junction volumes are computed by using the channel depths and widths on either side of the junction.

The system of channels and junctions used in a model is commonly called the "network". This network can be visualized as a system of pots (junctions) connected by hoses (channels). The network is established automatically in AUTØSS and AUTØQD. However, some basic information is required:

1. Starting river mile
2. Ending river mile
3. Number of sections.

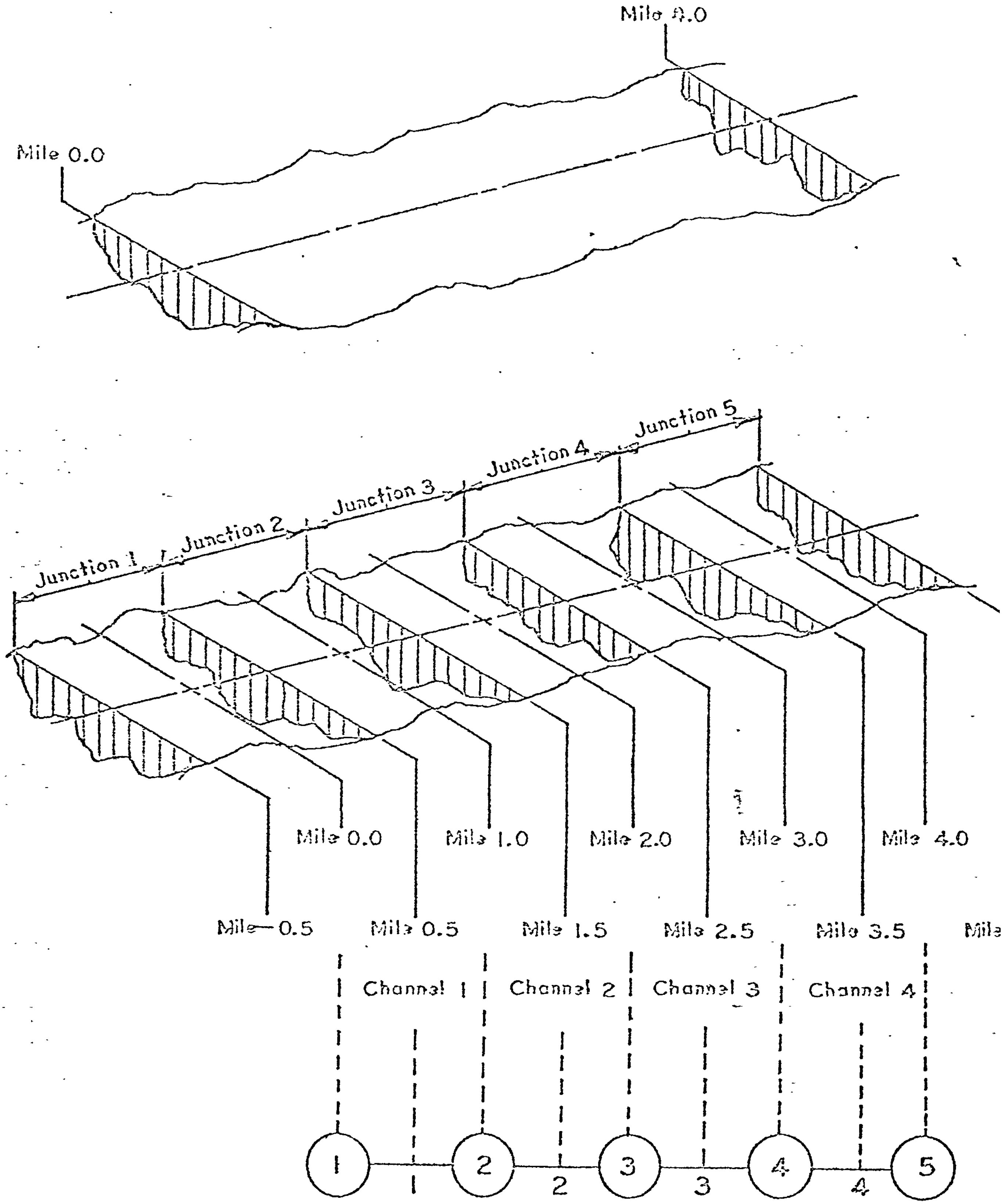
Thus far in the network representation the following assumptions have been made:

1. The natural channel can be accurately represented by a system of discrete volumes
2. Within each junction all water properties are uniform (fully mixed assumption)
3. Junction values have point values at the center of a junction.

These assumptions should be kept in mind when applying the models. Experience has shown that in most applications these assumptions are valid. However, some caution must be exercised in such cases as heavily stratified estuaries or impoundments.

The following example demonstrates how the network is established:

FIGURE 1


Mile 0.0
Mile 4.0
Junction 1
Junction 2
Junction 3
Junction 4
Junction 5
Mile 0.0
Mile 1.0
Mile 2.0
Mile 3.0
Mile 4.0
Mile -0.5
Mile 0.5
Mile 1.5
Mile 2.5
Mile 3.5
Channel 1
Channel 2
Channel 3
Channel 4
1
2
3
4
5
2
3
4

Given the basic data:

starting mile = 0.0

ending mile = 4.0

number of sections = 4

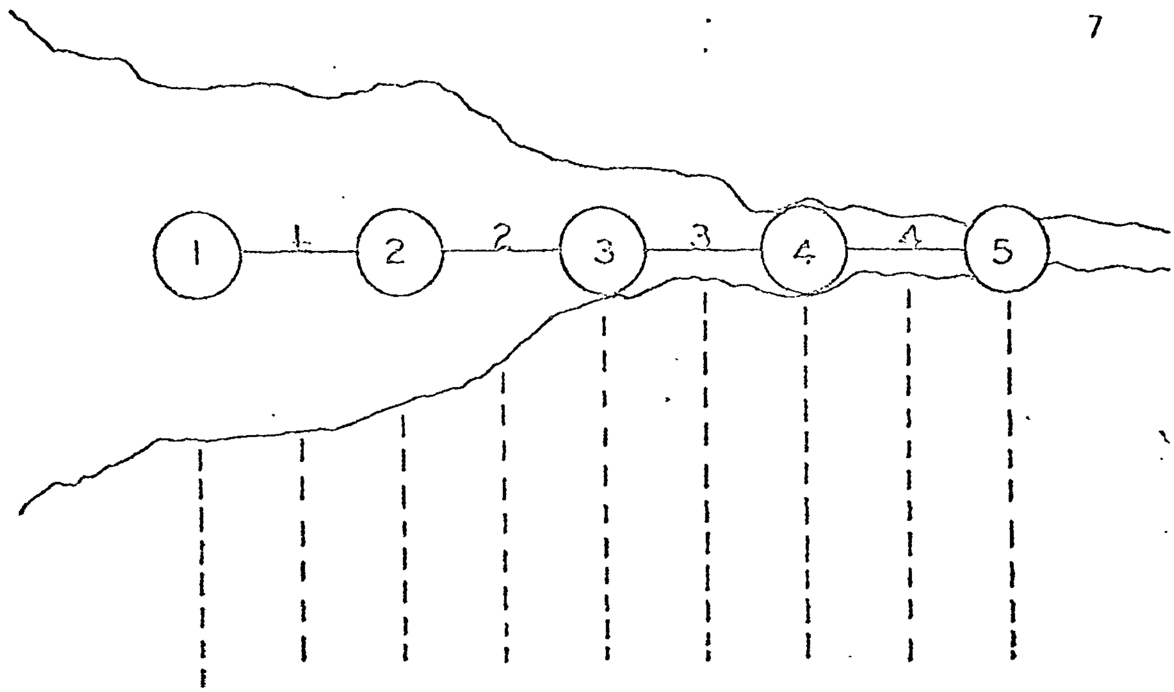
The network shown in Figure 1 would result from the above information.

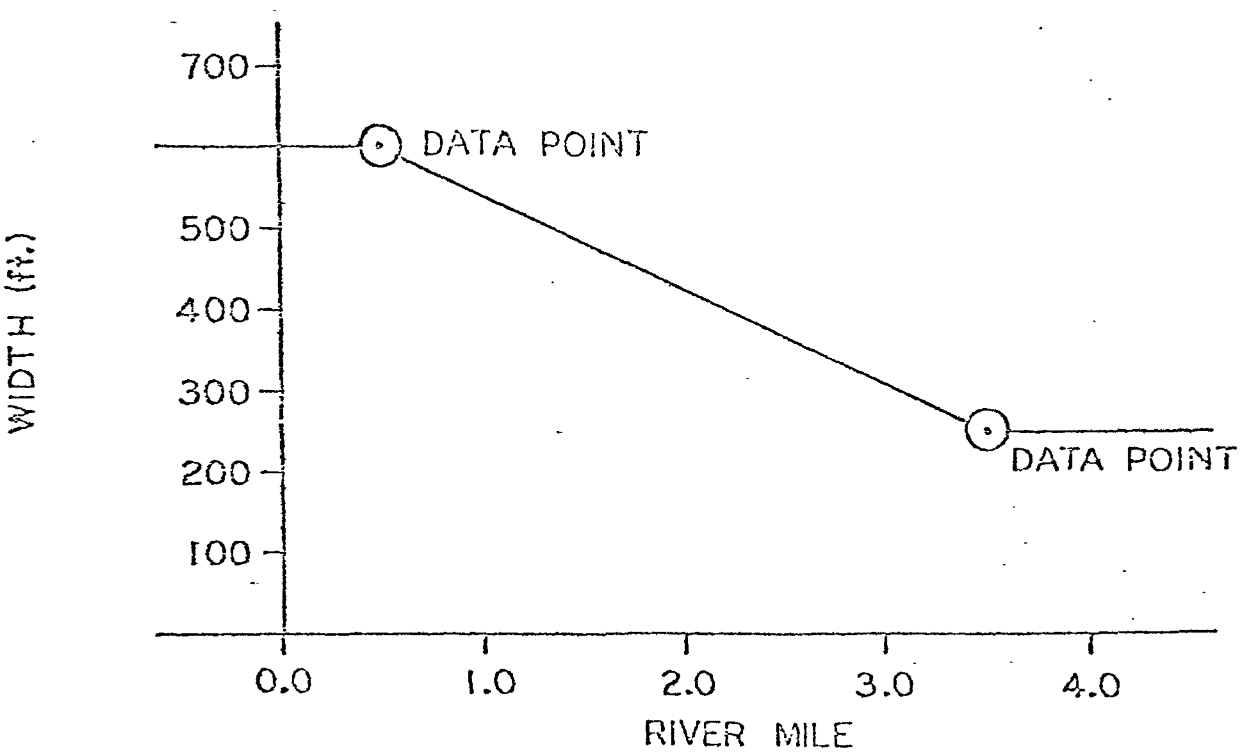
The starting and ending miles are the midpoints of the first and last junctions, respectively. The distance from junction interface to junction interface is equal to the length of the segment (ending mile minus starting mile) divided by the number of sections. This distance is referred to as the channel length. In AUTØSS and AUTØQD the channel lengths are constant throughout the network. The first and last junction will actually extend one-half of a channel length outside the defined segment. The stream and/or estuary being modelled is referred to as the segment, and the term "channel" is used as it pertains to the network.

At this point all that has been done is to define the network, the junction boundaries, and the channel lengths. The physical properties (width, depth, etc.) have not yet been determined. Most of these physical characteristics are read as input to the program. Those values that are not read are computed internally on the basis of data that has been read. The input data for these models is referenced to river miles. Once read the input data is either interpolated to define values over the entire segment, or in the case of point value data (such as inflows) it is assigned to the closest junction.

For example, if in the network shown in Figure 2, widths were read in as follows:

FIGURE 2





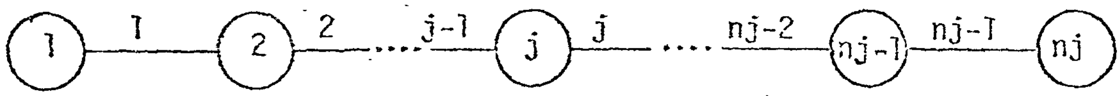
MILE 0.5 - CHANNEL 1; width = 600.0ft.
MILE 1.5 - CHANNEL 2; width = 483.3ft.
MILE 2.5 - CHANNEL 3; width = 366.7ft.
MILE 3.5 - CHANNEL 4; width = 250.0ft.

@ mile 0.5 width = 600.0 ft.

@ mile 3.5 width = 250.0 ft.

The program would assign the values of width as shown in Figure 2. The interpolating procedure, shown in Figure 2, is used for all physical data (see operating instructions for definition of physical data) whether it be a channel or junction parameter.

As a general example of how some of the internal computations on physical data are done, consider the following general network:



let d_j = mean depth of channel j (ft)

As_j = surface area of junction j (ft^2)

W_j = width of channel j (ft)

V_j = volume of junction j (ft^3)

L = channel length (constant)(ft)

W_j is an input to the program, d_j is computed on the basis of flow and L is defined in the network construction. The remaining are computed as follows:

$$As_j = \frac{(W_j + W_{j-1})}{2} L \ (ft^2)$$

$$V_j = \frac{(W_j d_j + W_{j-1} d_{j-1})}{2} L \ (ft^3).$$

The first and last junction's values are given by:

Last junction (nj):

$$As_{nj} = W_{nj-1}L \ (ft^2)$$

$$V_{nj} = W_{nj-1}\ d_{nj-1}L \ (ft^3),$$

First junction (1):

$$As_1 = W_1\ L \ (ft^2)$$

$$V_1 = W_1 d_1\ L \ (ft^3).$$

In general, when values are assigned to channels and they are needed to compute a junction parameter, the channel values on either side of the junction are averaged and that average value is used in the computations.

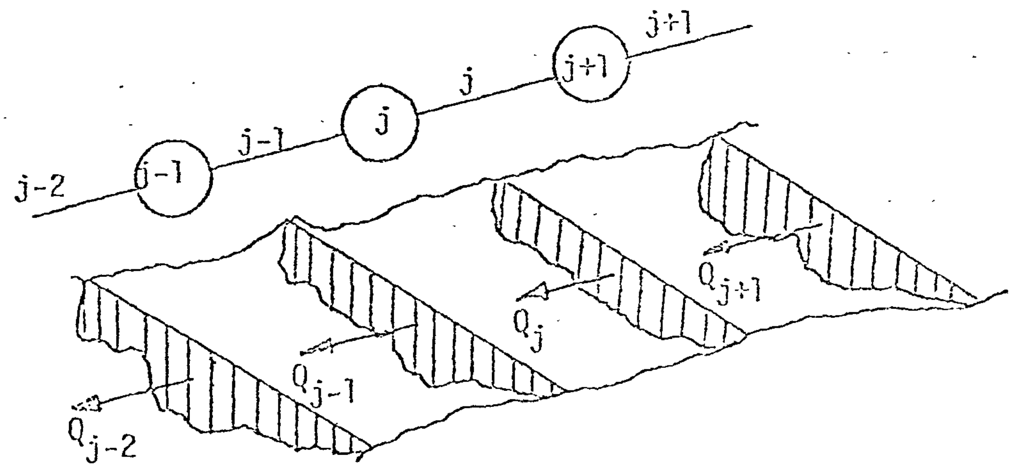
HYDRAULIC DEVELOPMENT:

The hydraulic solution used in AUTOSS and AUTOQD consists of two parts:

1. Determine the flows in each channel.
2. Determine the depths in each channel.

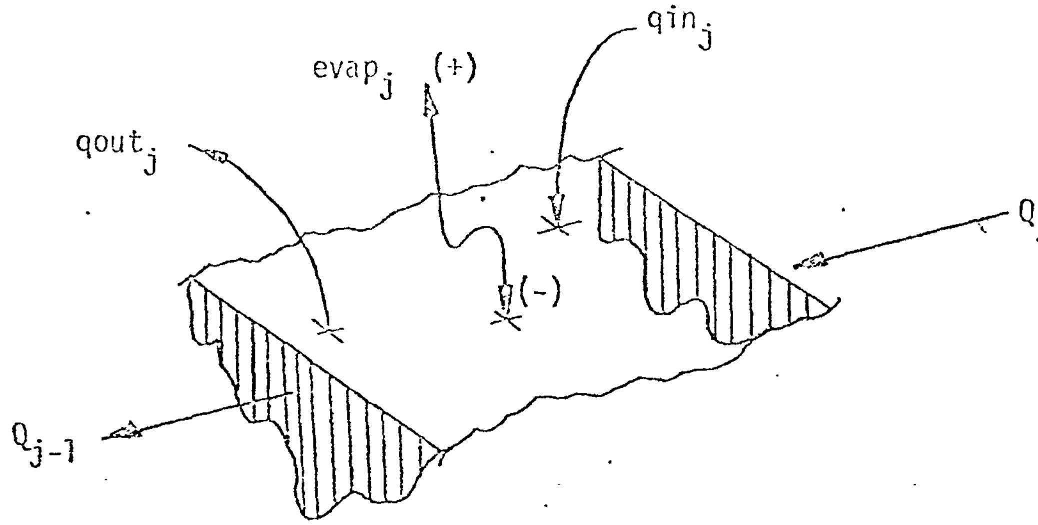
The solution represents a net, steady state situation. No attempt is made in these models to solve the equations governing tidal flow, storm surges, or any unsteady flow condition. That is why AUTOQD is called a quasi-dynamic model. The quality equations are integrated with time using net, steady state flows. The implicit assumption in this approach is that the hydraulic response to changes in flow is instantaneous, while the quality response lags in time. This assumption is acceptable in most instances.

The first part of the solution is a simple application of the principle of continuity. Consider the following situation:



where Q_j = flow rate in channel j (ft^3/sec)

Isolating junction j;



let;

qin_j = inflow to junction j (ft^3/sec)

$qout_j$ = diversion from junction j (ft^3/sec)

$evap_j$ = net evaporation minus rainfall at junction j (inches/month)

CF = conversion factor, to convert in/mo. to ft/sec

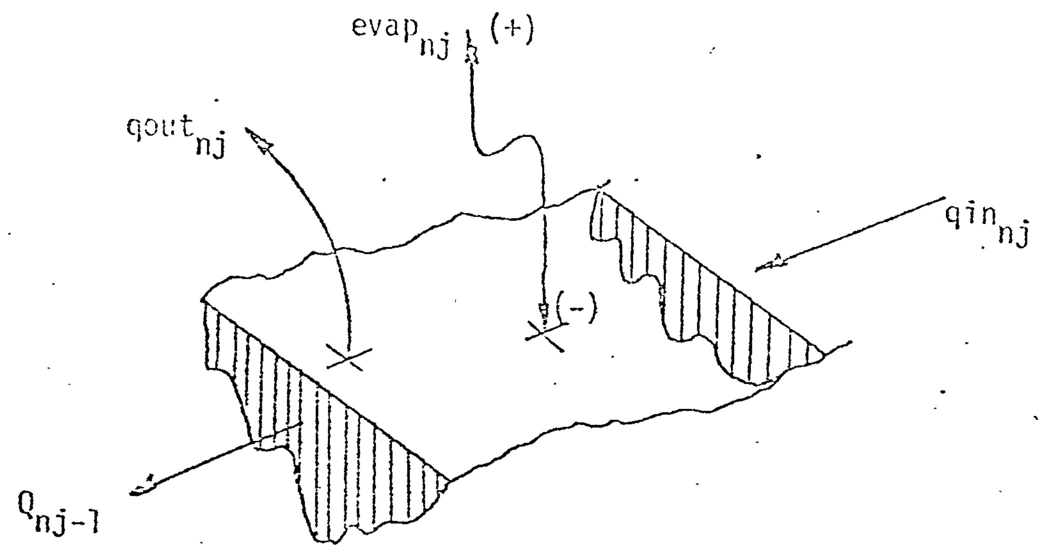
As_j = surface area of junction j (ft^2)

Q_{j-1} will be given by;

(1) $$Q_{j-1} = -Q_j - qin_j + qout_j + evap_j As_j CF \; (ft^3/sec)$$

The signs appear to be wrong in the above equation, this is because the sign convention used is: a flow from upstream to downstream is defined as negative. The above procedure is followed for all channels in the network, starting at the upstream end and working downstream.

However, the first and last junction are computed differently because each has only one channel connected to it. Taking the last junction (nj);

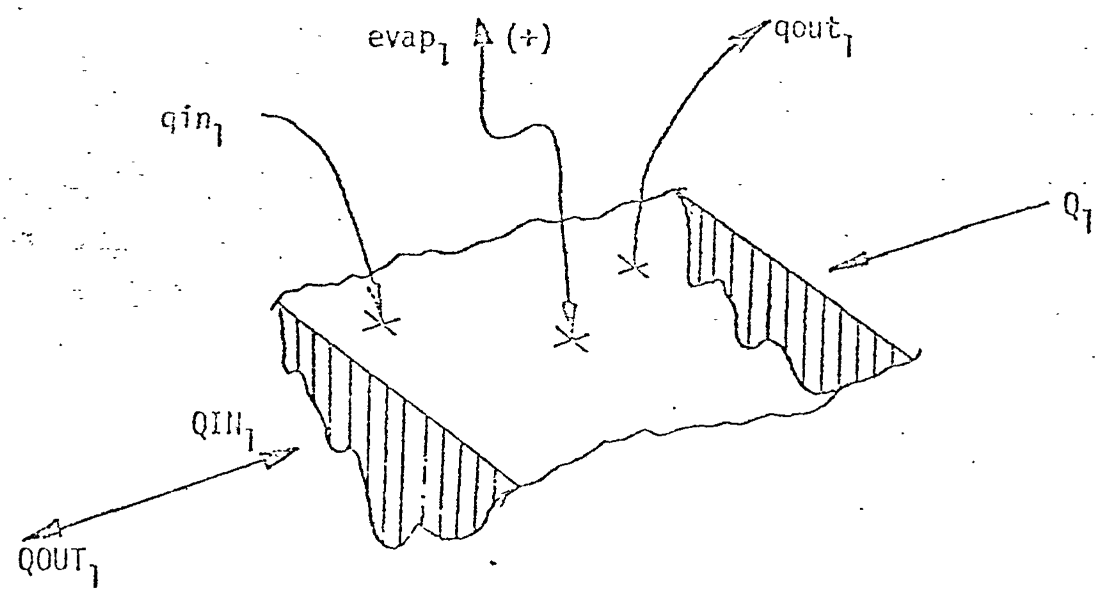


Q_{nj-1} will be given by;

(2) $$Q_{nj-1} = -qin_{nj} + evap_{nj} As_{nj} CF + qout_{nj} \quad (ft^3/sec)$$

(note sign convention)

Taking the first junction (1);



$QOUT_1$ $(-QIN_1)$ will be given by;

(3) $$\begin{matrix} QOUT_1 \\ (-QIN_1) \end{matrix} = -Q_1 + qin_1 - qout_1 - evap_1 As_1 CF \ (ft^3/sec)$$

A positive $QOUT_1$ indicates a flow out of the segment at the downstream end. A negative $QOUT_1$ represents an inflow and its absolute value is referred to as QIN_1.

After the above procedure has been completed, flows will have been established in all the channels. The second part of the solution, determining depths may proceed;

let d_i = mean depth of channel i (ft).

Depth can be given by an equation of the form;

(4) $$d_i = A_{1,i} Q_i^{A_{2,i}} + A_{3,i}$$

where $A_{1,i}$, $A_{2,i}$, and $A_{3,i}$ are emperical constants.

The coefficients of equation (4) ($A_{1,i}$, $A_{2,i}$, $A_{3,i}$) are entered as point inputs and interpolated over the segment. These coefficients may be determined from stage/discharge curves when availiable. In some special cases they may be computed. For example, assume the Manning Equation is applicable (a special case). The coefficients could then be determined as follows:

$$U = \frac{1.486}{n} R^{2/3} S^{1/2} \ (ft/sec)$$ Manning's Formula [6]

where;

U = velocity (ft/sec)

n = Manning's coefficient

R = hydraulic radius (ft)

S = water surface slope (ft/ft)

Assume the channel is wide compared to its depth, then $R \approx d$. For uniform steady flow $S \approx$ slope of channel bottom (S_0). Letting B = channel witdh (ft) and Q = flow rate (ft^3/sec), the Manning Formula may be written as;

$$\frac{Q}{Bd} = \frac{1.486}{n} d^2 S_0^{1/2}$$

solving for d,

$$d = \left[\frac{n}{1.486 B S_0^{1/2}}\right]^{0.6} Q^{0.6}$$

which corresponds to;

$$d = A_1 Q^{A_2} + A_3$$

with,

$$A_1 = \left[\frac{n}{1.486 B S_0^{1/2}}\right]^{0.6}$$

$$A_2 = 0.6$$

$$A_3 = 0.0$$

In an estuary the depth of flow may be essentially invariant with the flow magnitude. In that case A_1 equals 0.0 and A_3 represents the estuary depth at mean tide level.

There has been no distinction made between estuaries and free flowing streams in the hydraulic development. Since the models use daily average or net flows, the hydraulic differences between estuaries and streams may be represented in the coefficients of the depth equation. It is possible to link together the stream and estuary in these models.

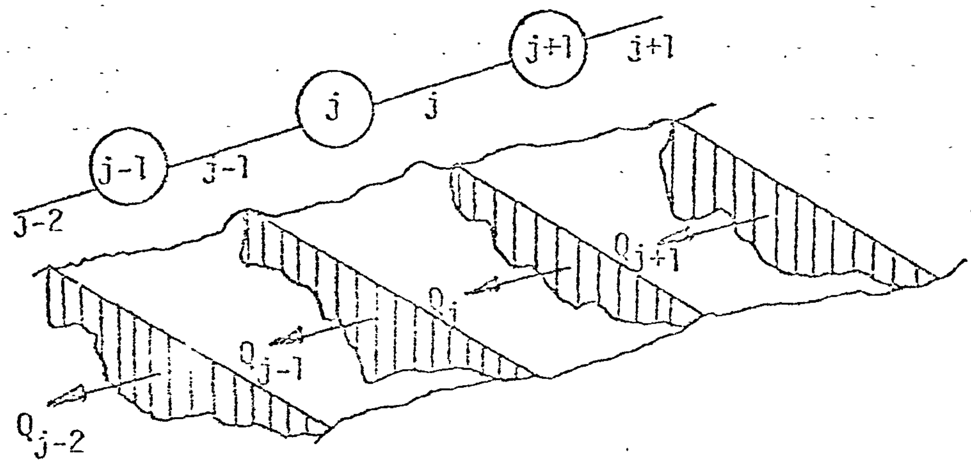
QUALITY DEVELOPMENT

The quality solutions used in AUTØSS and AUTØQD are based on the mass balance equations. A general development is given first and then the equations and solution techniques for AUTØSS and AUTØQD are given separately.

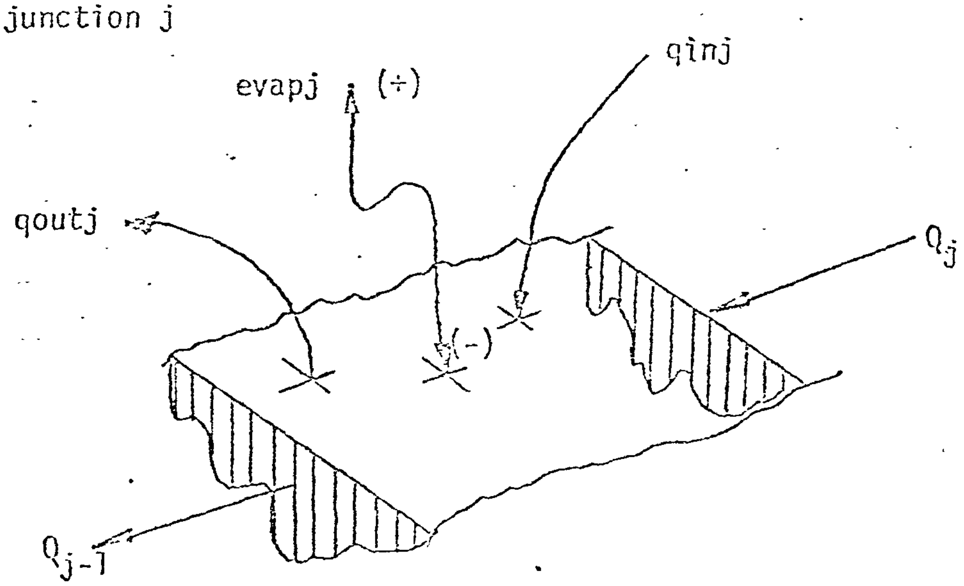
GENERAL QUALITY EQUATIONS:

CONSERVATIVE SUBSTANCES:

Isolating junctions j-1, j, j+1, and channels j+1, j, j-1, j-2



Taking junction j



Let C_j = constituent concentration (ppm) at junction j

C_{j-1} = " " " " j-1

C_{j+1} = " " " " j+1

Cin_j = inflow concentration (ppm) at junction j (associated with qin_j)

V_j = volume of junction j (ft^3)

Writing a mass balance for junction j

Mass in (during Δt) = $[Q_j C_{j+1} + qin_j Cin_j]\ \Delta t$(ppm ft^3/sec)

Mass out (during Δt) = $[Q_{j-1} C_j + qout_m C_m]\ \Delta t$(ppm ft^3/sec)

(Note sign convention on flows)

$$\frac{\Delta M_j}{\Delta t} = \text{Mass in} - \text{Mass out}$$

$$\frac{\Delta M_j}{\Delta t} = -Q_j C_{j+1} + qin_j Cin_j + Q_{j-1} C_j - qout_j C_j$$

$M_j = V_j C_j$ and

$$\frac{\Delta M_j}{\Delta t} = V_j \frac{\Delta C_j}{\Delta t}$$

(5) $$\frac{\Delta C_j}{\Delta t} = (-Q_j C_{j+1} + qin_j Cin_j + Q_{j-1} C_j - qout_j C_j) / V_j \text{(ppm/sec)}$$

If the flow were in the opposite direction the above equation would appear as:

(6) $$\frac{\Delta C_j}{\Delta t} = (Q_{j-1} C_{j-1} - Q_j C_j - qout_j C_j + qin_j Cin_j) / V_j \text{(ppm/sec)}$$

The flows used in equation 5 are used for further developments. Equations 5 and 6 are applicable to purely advective systems. However, in general there are exchanges due to tidal oscillations (in estuaries) and/or turbulent dispersion (in estuaries and free flowing streams). These exchanges are not included in equations 5 and 6. To express these changes, an analogy is made with Fourier's law of heat conduction [7]

$$\delta\dot{q} = -k\frac{\partial T}{\partial n}\,\delta A$$

where

$\delta\dot{q}$ = the heat flow across δA (BTU/hr)

δA = elemental cross sectional area (ft^2)

k = thermal conductivity (BTU/°K-ft)

T = absolute temperature (°K)

$\frac{\partial T}{\partial n}$ = derivative of temperature in the direction of the outward normal $\hat{n}$ (averaged over δA).

Integrating over A and considering the x direction

$$\dot{Q} = -kA\,\frac{\partial T}{\partial x}$$

The equation says that the heat transfer per unit time is proportional to the temperature gradient. The analogy is drawn that the mass transfer per unit time is proportional to the concentration gradient.

(7) $$\frac{\partial M}{\partial t} = -EA\,\frac{\partial C}{\partial x}$$

The constant of proportionality (E) is called the dispersion coefficient. It is considered a channel property and is an input parameter. The dispersion coefficient is important in both models, particularly in tidal bodies. This feature is now added to the mass balance equation (5):

(8) $$\frac{\Delta C_j}{\Delta t} = [-Q_j C_{j+1} + Q_{j-1} C_j - qout_j C_j + qin_j Cin_j] / V_j + [E_j A_j \frac{(C_j - C_{j+1})}{L} + E_{j-1} A_{j-1} \frac{(C_j - C_{j-1})}{L}] / V_j \text{ (ppm/sec)}$$

where

A_j = cross-sectional area of channel j (ft^2)

E_j = dispersion coefficient in channel j (ft^2/sec)

L = channel length (ft)

If qin and qout are zero and a uniform channel is assumed, the above equation reduces to the familiar form [8]:

(9) $$\frac{\partial C}{\partial t} = E \frac{\partial^2 C}{\partial x^2} - u \frac{\partial C}{\partial x} \quad (u = \text{velocity})$$

when the limit of $\underset{L \neq 0}{L \rightarrow 0}$ is taken.

Equation 8 is the basis for the solution of conservative constituents.

NON-CONSERVATIVE SUBSTANCES

The formulation for conservative substances also apply to non-conservative substances, however, the reactions of the substance with the environment and/or other substances must be added.

Three non-conservative substances are considered in these models:

1. CBØD - first stage (carbonaceous) Biochemical Oxygen Demand (BØD)
2. NBØD - second stage (nitrogenous) Biochemical Oxygen Demand (BØD)
3. DØ - Dissolved Oxygen

The oxidation of organic waste will be broken into three stages:

1. Oxidation of oxidizable carbon compounds
2. Oxidation of ammonia (to nitrite)
3. Oxidation of nitrite (to nitrate)

The oxidation of the carbon and nitrogen constituents will be considered separately.

FIRST STAGE OXYGEN DEMAND (CBØD)

Theoretically this term represents the ultimate oxygen demand of the organic carbon compounds, (carbonaceous BØD). It has been reported that this term has a theoretical value of 2.67C [9], where C is the organic carbon content. Realistically, this term represents the oxygen demand of inorganic compounds (chemical oxygen demand) as well as the oxidation of organic waste. To determine its value, various factors have been developed to be applied to 5-day BØD values to obtain the ultimate first stage oxygen demand. These factors may vary from 1.10 to 2.40, with 1.45 being the most common. CBØD may be obtained from BØD values as follows:

Determine the deoxygenation rate K_c (1/day) with no nitrification taking place. Then using BOD_5, again assuming no nitrification. CBØD will be given as:

(10)
$$CB\O D = \frac{B\O D_5}{(1.0 - e^{-5k_c})}$$

Note that if $K_c = 0.23$ (a common literature value) then $CB\O D = 1.45\ B\O D_5$.

If $BØD_n$ is known CBØD would be given as

(11) $$CBØD = \frac{BØD_n}{(1.0 - e^{-nkc})}$$

The behavior of CBØD in the natural waterway is described by the first order reaction [10]

(12) $$\frac{\partial CBØD}{\partial t} = -K_c CBØD$$

where Kc is the deoxygenation rate in the waterway. The complete equation for CBØD may now be written

let C_j = CBØD concentration in junction j (ppm)

Cin_j = CBØD inflow concentration at junction j (ppm)

(13) $$\frac{\Delta C_j}{\Delta t} = [-Q_j C_{j+1} + Q_{j-1} C_j - qout_j C_j + qin_j Cin_j] / V_j$$
$$-[E_j A_j \frac{(C_j - C_{j+1})}{L} + E_{j-1} A_{j-1} \frac{(C_j - C_{j-1})}{L}] / V_j$$
$$-Kc_j C_j$$

The deoxygenation rate Kc_j is the rate in the stream. K_c is entered as input to the program. The value entered is assumed to be the value at 20°C. Stream temperatures are also entered and K_c is then corrected according to the equation [11]

(14) $$K_c @T°C = (K_c @20°C)\,(1.047)^{(T-20)}$$

The oxidation of the organic carbon compounds (CBØD) is assumed to be independent of the dissolved oxygen concentration. This assumption, naturally, limits the application of these models to aerobic systems.

SECOND STAGE OXYGEN DEMAND (NBØD)

This constituent represents the ultimate oxygen demand of all the oxidizable nitrogen fractions. The oxidations of ammonia, nitrite and organic nitrogen are lumped together in this term. Organic nitrogen is included because it is generally assumed that organic nitrogen first hydrolyses to ammonia nitrogen and the oxidation occurs. The ultimate NBØD may be given by [12]

(15) $$NBØD = 4.57\ TKN + 1.14\ (NO_2^- - N)$$

where TKN Is the Total Kjeldahl Nitrogen (Organic N + Ammonia -N) and NO_2^- is nitrite nitrogen. The above relationship assumes that all the TKN and NO_2^- -N is oxidizable. If this is not the case an appropriate reduction factor, as determined by laboratory studies, will have to be applied.

It is assumed that the oxidation of the various nitrogen fractions (referred to as nitrification) can be characterized by one gross rate K_n (1/day). This rate is primarily a function of the nitrifying bacteria populations and temperature. Specifically, Nitrosomonas for the oxidation of ammonia to nitrate and Nitrobacter for the oxidation of nitrite to nitrate. Despite the laboratory BØD test results, it is reasonable, in most cases, to assume that the populations of Nitrosomonas and Nitrobacter are sufficient, in the stream, to bring about significant oxidation of the nitrogen fractions immediately upon their introduction to the natural stream. The nitrification rate K_n is entered as input to the model. A commonly used literature value is 0.103 (1/day). [13] NBØD is handled in the same way as CBØD.

(16) $$\frac{\partial NBØD}{\partial t} = -K_n NBØD$$

The complete equation for NBØD is identical to the one for CBØD except that K_n replaces K_c. As with K_c, K_n is temperature corrected according to the equation [14]

(17)
$$K_n @ T°C = (K_n @ 20°C)(1.017)^{T-20}$$

Nitrification is assumed to proceed independently of dissolved oxygen in AUTØSS. In AUTØQD, when DØ drops below 5% of the air saturation value the nitrification rate is set to zero.

DISSOLVED OXYGEN

Dissolved oxygen is the most complex constituent considered. Many factors enter into the DO budget, some of which are well understood, others of which very little is known. Below are the factors in the DØ budget considered here:

Oxygen Gain	Oxygen Loss
1. Atmospheric Reaeration	1. CBØD
2. Photosynthetic Production	2. NBØD
	3. Sediment uptake
	4. Biological respiration
	5. Evaporation

Some of the factors are considered as constant sources or sinks for a particular junction, while others are computed, such as CBØD and NBØD. The DO budget for junction j is written in equation form as:

(18)
$$\frac{\Delta DØ_j}{\Delta t} = [-Q_j DØ_{j+1} + Q_{j-1} DØ_j - qout_j DØ_j + qin_j DØin_j]/V_j$$
$$-[E_j A_j \frac{(DØ_j - DØ_{j+1})}{L} + E_{j-1} A_{j-1} \frac{(DØ_j - DØ_{j-1})}{L}]/V_j$$
$$-K_{C_j} CBØD_j - K_{N_j} NBØD_j + K_{2_j} (DØsat_j - DØ_j)$$
$$+(P_j - R_j - Sedmt_j) \frac{As_j}{V_j} \cdot CV - evap_j DØ_j CF/V_j$$

where

1. $DØj$ = dissolved oxygen concentration at junction j (ppm)
2. $DØin_j$ = dissolved oxygen input concentration at junction j (ppm)
3. $K_{C_j} CBØD_j$ = the rate of oxygen usage by CBØD
4. $K_{N_j} NBØD_j$ = the rate of oxygen usage by NBØD
5. $K_{2_j} (DØsat_j - DØ_j)$ = the rate of the addition of oxygen due to atmospheric reaeration. K_{2_j} (1/day) is the reaeration coefficient for junction j. $DØsat_j$ is the oxygen saturation concentration in junction j. Both K_{2_j} and/or $DØsat_j$ may be entered as input or they may be computed within the program. If the computing option is chosen, the following methods are used:

DØsat is computed by the equation [15]

(19)
$$DØsat_j = 14.62 - 0.367T_j + 0.0045T^2_j \text{ (ppm)}$$

where T_j is the water temperature (°C) at junction j.

Note: This equation assumes a salinity of 0.0 parts per thousand. Equation 19 is a simplication of the following equation:

$$DØsat = 14.6244 - 0.367134T + 0.044972T^2 - 0.0966S + 0.00205ST + 0.0002739S^2$$

where S is the salinity concentration in parts per thousand (°/₀₀). K_2 is computed by the Dobbin's O'Connor equation [16]

(20) $$K_{2_j} @20°C = \frac{12.9 u_j^{1/2}}{H_j^{3/2}}$$

where H_j = hydraulic radius (ft)

and u_j = velocity (ft/sec)

H_j is assumed to be equal to the depth.

K_2 is computed in the channels and then averaged to obtain junction values.

K_2 is also adjusted for temperature: [17]

(21) $$K_2@T°C = (K_2 @20°C)(1.024)^{T-20.0}(1/day)$$

With relatively minor program changes, other equations for computing the reaeration rate may be incorporated into the model to replace the above equation. The reader is referred to "Tracer Measurement of Stream Reaeration" [18] and "Characterization of Stream Reaeration Capacity" [19] for information on other methods for determining or computing the reaeration rate.

6. $P_j - R_j$ (Photosynthesis - Respiration Rate) = the net difference between the production of oxygen and the usage of oxygen by biological activity other than CBØD, NBØD and sediment uptake. It is a daily and volume averaged value

and has the units gr. O_2/m^2/day. In reality, these terms are difficult to evaluate. The reader is referred to available literature for further information.

7. $Sedmt_j$ = the net oxygen uptake of the sediments. It is entered as input and has the units gr. O_2/m^2/day. As with P-R this term is difficult to accurately evaluate. Various literature values have been presented. One method for obtaining field measurements is presented in "An In-Situ Benthic Respirometer." [20]

8. CV and CF are units conversion factors. The other terms in equation 18 have been previously defined.

The dissolved oxygen solution presented here should be viewed as an approximation. For most applications most of the important sources and sinks of oxygen have been accounted for in some form. In many applications the user may find many of the terms may be neglected.

AUTØSS SOLUTION:

For the steady state condition the time derivatives of equations (8), (13) and (18) are set to zero. The quality equations are written as:

1. Conservative Constituents.

$$0 = [-Q_j C_{j+1} + Q_{j-1} C_j - qout_j C_j + qin_j Cin_j] / V_j$$

(22)

$$-[E_j A_j (\frac{C_j - C_{j+1}}{L}) + E_{j-1} A_{j-1} (\frac{C_j - C_{j-1}}{L})] / V_j$$

2. Carbonaceous Oxygen Demand (CBOD)

$$0 = [-Q_j CBOD_{j+1} + Q_{j-1} CBOD_j - qout_j CBOD_j + qin_j CBODin_j] / V_j$$

(23)

$$-[E_j A_j (\frac{CBOD_j - CBOD_{j+1}}{L}) + E_{j-1} A_{j-1} (\frac{CBOD_j - CBOD_{j-1}}{L})] / V_j$$

$$-K_{C_j} CBOD_j$$

3. Nitrogenous Oxygen Demand (NBOD)

$$0 = [-Q_j NBOD_{j+1} + Q_{j-1} NBOD_j - qout_j NBOD_j + qin_j NBODin_j] / V_j$$

(24)

$$-[E_j A_j (\frac{NBOD_j - NBOD_{j+1}}{L}) + E_{j-1} A_{j-1} (\frac{NBOD_j - NBOD_{j-1}}{L})] / V_j$$

$$-K_{N_j} NBOD_j$$

4. Dissolved Oxygen (DO)

$$0 = [-Q_j DO_{j+1} + Q_{j-1} DO_j - qout_j DO_j + qin_j DOin_j] / V_j$$

$$-[E_j A_j (\frac{DO_j - DO_{j+1}}{L}) + E_{j-1} A_{j-1} (\frac{DO_j - DO_{j-1}}{L})] / V_j$$

(25)

$$-K_{C_j} CBOD_j - K_{N_j} NBOD_j + K_{2_j} (DOsat_j - DO_j) - evap_j CF \cdot DO_j / V_j$$

$$+(P_j - R_j - Sedmt_j) As_j CV / V_j$$

These equations are based on the same flow condition from which equations (8), (13) and (18) were derived. As before, all the remaining derivations are made on the basis of this flow condition. Derivations for the other flow possibilties are left to the reader. The models were designed to handle any flow possibility.

The set of equations for a constituent now appear as a set of linear equations with the junction concentrations as the only unknowns. Taking the conservative equation for junction j and solving for C_j gives;

(26) $$C_j = -\frac{\alpha_{j,3}}{\beta_j} - \frac{\alpha_{j,1}}{\beta_j} C_{j-1} - \frac{\alpha_{j,2}}{\beta_j} C_{j+1}$$

where;

$$\beta_j = [Q_{j-1} - qout_j - E_j A_j/L - E_{j-1} A_{j-1}/L]$$

$$\alpha_{j,1} = E_{j-1} A_{j-1}/L$$

$$\alpha_{j,2} = -Q_j + E_j A_j/L$$

$$\alpha_{j,3} = qin_j Cin_j$$

The coefficients for the first and last junction are:

Last junction (nj);

$$\beta_{nj} = -qout_{nj} - E_{nj-1} A_{nj-1}/L + Q_{nj-1}$$

$$\alpha_{nj,1} = E_{nj-1} A_{nj-1}/L$$

$$\alpha_{nj,2} = 0$$

$$\alpha_{nj,3} = qin_{nj} Cin_{nj}$$

First junction (1);

$$\beta_1 = -qout_1 - E_1 A_1/L$$

$$\alpha_{1,1} = 0$$

$$\alpha_{1,2} = E_1 A_1/L + Q_1$$

$$\alpha_{1,3} = qin_1 Cin_1$$

The equations for the first and last junction are written as;

(27) $$C_1 = -\frac{\alpha_{1,3}}{\beta_1} - \frac{\alpha_{1,2}}{\beta_1} C_2$$

(28) $$C_{nj} = -\frac{\alpha_{nj,3}}{\beta_{nj}} - \frac{\alpha_{nj,1}}{\beta_{nj}} C_{nj-1}$$

The coefficients for the other constituents are determined in the same manner as for the conservative constituents.

The basic solution technique used in AUTØSS is called the "Gauss-Seidel Iterative Method"[21]. A relaxation factor has been added to the method to increase or decrease the rate of change. The algorithm for this method is decribed as follows:

Given the system of equations;

$$C_1 = -\frac{\alpha_{1,3}}{\beta_1} - \frac{\alpha_{1,2}}{\beta_1} C_2$$

$$C_2 = -\frac{\alpha_{2,3}}{\beta_2} - \frac{\alpha_{2,1}}{\beta_2} C_1 - \frac{\alpha_{2,2}}{\beta_2} C_3$$

$$\vdots$$

$$C_j = -\frac{\alpha_{j,3}}{\beta_j} - \frac{\alpha_{j,1}}{\beta_j} C_{j-1} - \frac{\alpha_{j,2}}{\beta_j} C_{j+1}$$

$$\vdots$$

$$C_{nj} = -\frac{\alpha_{nj,3}}{\beta_{nj}} - \frac{\alpha_{nj,1}}{\beta_{nj}} C_{nj-1}$$

1. Assign initial values to the junction concentrations, these

values are approximations.

2. Starting at the first junction, compute a new concentration. Compute the difference between the old and new concentration;

$$\delta_C = C_{j,new} - C_{j,old}$$

Compute and store the new concentrations as;

$$C_j = C_{j,old} + \omega\delta_C$$

where ω is a relaxation factor.

Repeat this procedure for junctions 2, 3, 4, ..., nj.

3. If all the δ_C's computed in step 2 are within a specified limit (convergence criteria) then the solution is complete, if not, return to step 2 and repeat. Every time step 2 is repeated it is referred to as an iteration. The maximum number of iterations has been set at 1000 (see MAXCYC in Subroutine SØLVEX), this value may be changed by the user, if desired. The convergence criteria and ω have been set at 0.001 and 1.00 respectively (see DELMAX and RELAX in SØLVEX), these may also be changed.

Appendix IV

Effluent Limitations

Attachment A

Existing Permit Limitations

U.S. Environmental Protection Agency
Region V - Eastern District Office
Final NPDES Effluent Limitations (mg/l, except as noted)
Black River Planning Area - Black River Dischargers

Discharger	NPDES Permit Number	BOD_5 Monthly Avg.	BOD_5 Weekly Avg.	Suspended Solids Monthly Avg.	Suspended Solids Weekly Avg.	Total Phosphorus Monthly Avg.	Total Phosphorus Weekly Avg.	Ammonia-N July-Oct. Monthly Avg.	Ammonia-N July-Oct. Weekly Avg.	Ammonia-N Nov.-June Monthly Avg.	Ammonia-N Nov.-June Weekly Avg.	Dissolved O_2 Min.	Residual Cl_2 Daily Max.	pH (s.u.)	Fecal Coliform (No/100 ml) Monthly Avg.	Fecal Coliform (No/100 ml) Weekly Avg.	Comments
American Shipbuilding	OH0002356			30	45									6-9			Oil and grease 10 mg/l daily avg. 20 mg/l daily max.
Ashland Oil	OH0051497													6-9			Oil and grease: 15 mg/l weekly avg.
Bendix Westinghouse	OH0001261													6-9			
Clearview & Durling Schools	OH0043648	10	15	12	18								.2-.7	6-9	200	400	
Elyria STP	OH0025003	10	15	12	18	1.0	1.5	1.5	2.3	1.5	2.3	5.0	0.5	6-9	200	400	Oil and grease: 5 mg/l max.
Koehring Co. Plant #1	OH0001929			30	45									6-9			Oil and grease: 30 mg/l monthly avg. 45 mg/l weekly avg.
Lorain STP	OH0026093	10 20	15 30	10 20	15 30	1 1	1.5 1.5	1.5 --	2.3 --	 --	 --	5.0 --	.5 .5	6-9 6-9	200 200	400 400	Black River Discharge Lake Erie Option
Horizon Apts.	OEPA # S800*AD	10	15	12	18									6-9	200	400	
Standard Pipe Protection 001	OH0051675																Flow monitored
Standard Pipe Protection 002	OH0051675																Flow & temperature monitored

U.S. Environmental Protection Agency
Region V - Eastern District Office
Final NPDES Effluent Limitations (mg/l, except as noted)
Black River Planning Area - Sanitary Dischargers to Low Flow Streams

Discharger	NPDES Permit Number	BOD_5		Suspended Solids		Total Phosphorus		Ammonia-N July-Oct.		Ammonia-N Nov.-June		Dissolved O_2	Residual Cl_2	pH (s.u.)	Fecal Coliform (No/100 ml)		Comments
		Monthly Avg.	Weekly Avg.	Monthly Avg.	Weekly Avg.	Monthly Avg.	Weekly Avg.	Monthly Avg.	Weekly Avg.	Monthly Avg.	Weekly Avg.	Min.	Daily Max.		Monthly Avg.	Weekly Avg.	
Amherst STP	OH0021628																Final limits are no discharge connect to Lorain west side regional sewer system
Avon STP	OH0023965																To be abandoned and connected to the French Creek Interceptor
Brentwood Lake Estates STP	OH0026158	10	15	12	18										200	400	
Cresthaven STP	OH0026131	10	15	12	18							5.0					
Crestview Knolls STP	OH0043451	10	15	12	18							5.0					
Dreco Plastics	OH0051616		15		15								0.5			400	
Eaton Estates	OH0026140	10	15	12	18							5.0		6-9	200	400	
French Creek COG STP	OH0044512	10	15	12	18	1	1.5	1.5	2.25			5.0	.2-.7	6-9			
Good Samaritan Nursing Home	OH0043745	10	15	12	18										200	400	

U.S. Environmental Protection Agency
Region V - Eastern District Office
Final NPDES Effluent Limitations (mg/l, except as noted)
Black River Planning Area - Sanitary Dischargers to Low Flow Streams

(Continued)

Discharger	NPDES Permit Number	BOD_5 Monthly Avg.	BOD_5 Weekly Avg.	Suspended Solids Monthly Avg.	Suspended Solids Weekly Avg.	Total Phosphorus Monthly Avg.	Total Phosphorus Weekly Avg.	Ammonia-N July-Oct. Monthly Avg.	Ammonia-N July-Oct. Weekly Avg.	Ammonia-N Nov.-June Monthly Avg.	Ammonia-N Nov.-June Weekly Avg.	Dissolved O_2 Min.	Residual Cl_2 Daily Max.	pH (s.u.)	Fecal Coliform (No/100 ml) Monthly Avg.	Fecal Coliform (No/100 ml) Weekly Avg.	Comments
Grafton STP	OH0025372	10	12	10	12			1.5	2.3			5.0	.5	6-9	200	400	
Nelson Stud Welding	OH0021610	10	15	10	15								.5	6-9	200	400	
Oberlin STP	OH0020427	10	15	12	18	1.0	1.5	1.8	2.7			3.0	.5	6.5-9	1000	2000	
Pheasant Run Village	OEPA # W801*AD	10	15	12	18									6-9	200	400	
Pinecrest Apts.	OH0044890	10	15	12	18									6-9	200	400	
Ridgeview Shopping Center	OH0045098	10	15	12	18									6-9	200	400	
Spencer STP	OH0022071	24	36	30	45							5.0	.5	6.5-9	1000	2000	
Wellington STP	OH0028037	10	15	12	18								.2-.7	6-9			
Westwood Mobile Home Park	OH0045128	10	15	12	18									6-9	200	400	

U.S. Environmental Protection Agency
Region V - Eastern District Office
Final NPDES Effluent Limitations (mg/l, except as noted)
Black River Planning Area - Industrial Dischargers to Low Flow Streams

Discharger	NPDES Permit Number	BOD_5 Monthly Avg.	BOD_5 Weekly Avg.	BOD_5 (lb/day) Monthly Avg.	BOD_5 (lb/day) Weekly Avg.	Suspended Solids Monthly Avg.	Suspended Solids Weekly Avg.	Suspended Solids (lb/day) Monthly Avg.	Suspended Solids (lb/day) Weekly Avg.	Oil & Grease Monthly Avg.	Oil & Grease Weekly Avg.	Oil & Grease (lb/day) Monthly Avg.	Oil & Grease (lb/day) Weekly Avg.	pH (s.u.)	Total Iron Monthly Avg.	Total Iron Weekly Avg.	Other
Cleveland Steel Products	OH0051586					10	15			5	10			6-9			
Columbia Gas Transmission	OH0034762					30	45	.01	.015					6-9			
Grafton WTP	OH0045730					15	20							6-11.5			
Harris Tire Serice	OH0001980													6-9			
Invacare	OH0000833					30	45							6-9			
Lear-Siegler	OH0002089	30	45	.2	.4	30	45	5.5	11	10	20	1.7	3.4	6-9			
Ohio Metallurgical Services	OH0051420					10	15			5	10			6-9			
Pfaudler Co.	OH000728						45				20			6-9			
Republic Steel	OH0001295													6-9			*Temperature
Sohio-Lorain Co. Terminal	OH0000795													6.5-9			
Spencer WTP	OH0030520					15	20							6-11.5			
Sterling Foundry	OH0051934					10	15			5	10			6-9			
Lodi WTP	OH0041939													6-9.5	1.0	2.0	Cl-monitor

*The temperature of the effluent shall not exceed the temperature of the intake by more than 15°F (May-September) or 23° (October-April).

Attachment B

Recommended Modifications to Effluent Limitations

U. S. ENVIRONMENTAL PROTECTION AGENCY
REGION V
SURVEILLANCE AND ANALYSIS DIVISION
EASTERN DISTRICT OFFICE

RECOMMENDED PERMIT MODIFICATIONS

Discharger: Amherst

NPDES Permit No.: OH 0021628

Recommended Modifications:

Effluent limitations were determined using U.S. EPA, Region V, Simplified Waste Load Allocation Methodology for municipal sewage treatment plants on low flow streams (see Appendix V and Section IX.2)

Effluent Limitations:

Constituent	Present Performance	FINAL LIMITATIONS				MONITORING REQUIREMENTS	
		Present		Modified +		Sample Type	Frequency
		Avg.	Max.	Avg.	Max. Weekly		
		*					
BOD_5 (mg/l)					12		
Suspended Solids					12		
Ammonia							
May - October					3.0		
November - April					6.0		
Phosphorus					1.0		
Dissolved Oxygen (min. - mg/l)				6.0			

* Final limitations are "no discharge", based on connection to the Lorain West Side Regional Sewer District.

\+ Recommended modifications are present in the event that Amherst does not hook up to the regionalized system.

U. S. ENVIRONMENTAL PROTECTION AGENCY
REGION V
SURVEILLANCE AND ANALYSIS DIVISION
EASTERN DISTRICT OFFICE

RECOMMENDED PERMIT MODIFICATIONS

Discharger: Avon STP

NPDES Permit No.: OH 0023965

Recommended Modifications:

Present final limitations state that the STP is to be abandoned and connected into the French Creek Interceptor. Modified limits are presented in the event the STP is not connected to the French Creek Interceptor for some reason. Limits are based on Table IX-15.

Effluent Limitations:

Constituent	Present Performance	FINAL LIMITATIONS				MONITORING REQUIREMENTS	
		Present		Modified		Sample Type	Frequency
		Avg.	Max.	Avg.	Max. Weekly		
BOD_5 (mg/l)					10	Composite	1/week
Suspended Solids (mg/l)					10	"	"
Ammonia - N							
May - October					2.0	"	"
November - April					5.0	"	"
Dissolved Oxygen (mg/l - min)				6.0		Grab	"
Fecal Coliform (#/100 ml)				1000	2000	Grab	"

U. S. ENVIRONMENTAL PROTECTION AGENCY
REGION V
SURVEILLANCE AND ANALYSIS DIVISION
EASTERN DISTRICT OFFICE

RECOMMENDED PERMIT MODIFICATIONS

Discharger: Brentwood Lake Estates STP

NPDES Permit No.: OH 0026158

Recommended Modifications:

Effluent limitations were determined using U.S. EPA, Region V, Simplified Waste Load Allocation Methodology for municipal sewage treatment plants on low flow streams (see Appendix V and Section IX.2)

Effluent Limitations:

Constituent	Present Performance	FINAL LIMITATIONS Present Avg. Monthly	FINAL LIMITATIONS Present Max. Weekly	FINAL LIMITATIONS Modified Avg. Monthly	FINAL LIMITATIONS Modified Max. Weekly	MONITORING REQUIREMENTS Sample Type	MONITORING REQUIREMENTS Frequency
BOD_5 (mg/l)		10	15		10	Composite	Weekly
Suspended Solids (mg/l)		12	18		10	Composite	Weekly
Ammonia (mg/l)							
May - October		--	--		1.5	Composite	Weekly
November - April		--	--		5.0	Composite	Weekly
Dissolved Oxygen (mg/l - min)		--	--	6.0 min		Grab	Daily

U. S. ENVIRONMENTAL PROTECTION AGENCY
REGION V
SURVEILLANCE AND ANALYSIS DIVISION
EASTERN DISTRICT OFFICE

RECOMMENDED PERMIT MODIFICATIONS

Discharger: Eaton Estates STP

NPDES Permit No.: OH 0025140

Recommended Modifications:

Effluent limitations were determined using U.S. EPA, Region V, Simplified Waste Load Allocation Methodology for municipal sewage treatment plants on low flow streams (see Appendix V and Section IX.2)

Effluent Limitations:

Constituent	Present Performance	FINAL LIMITATIONS				MONITORING REQUIREMENTS	
		Present		Modified		Sample Type	Frequency
		Avg. Monthly	Max. Weekly	Avg.	Max. Weekly		
BOD_5 (mg/l)		10	15		10	Composite	1/week
Suspended Solids		12	18		10	Composite	1/week
Dissolved Oxygen (min - mg/l)			5.0 min		6.0 min	Grab	Daily
Ammonia (mg/l)							
May - October		--	--		1.5	Composite	1/week
November - April		--	--		5.0	Composite	1/week

U. S. ENVIRONMENTAL PROTECTION AGENCY
REGION V
SURVEILLANCE AND ANALYSIS DIVISION
EASTERN DISTRICT OFFICE

RECOMMENDED PERMIT MODIFICATIONS

Discharger: Elyria STP

NPDES Permit No.: OH0025003

Recommended Modifications:

Effluent limitations were determined using U.S. EPA water quality model - AUTO-SS.

Effluent Limitations:

Constituent	Present Performance	FINAL LIMITATIONS Present Avg. Month	FINAL LIMITATIONS Present Max. Week	FINAL LIMITATIONS Modified Avg. 30 day	FINAL LIMITATIONS Modified Avg. Week	MONITORING REQUIREMENTS Sample Type	MONITORING REQUIREMENTS Frequency
BOD_5 - mg/l		10	15		8	24 hr comp.	5/week
Total Suspended Solids (mg/l)		12	18		10	24 hr comp.	5/week
Ammonia-N - mg/l							
May-October		1.5	2.3		2.0	24 hr comp.	5/week
November-April		1.5	2.3		5.0	24 hr comp.	5/week
Total Phosphorus - mg/l		1.0	1.5		1.0	24 hr comp.	5/week
Fecal Coliform (#/100 ml)		200	400	1000	2000	Grab	Daily
pH (s.u.)		--	--		6-9	Grab	Daily
Dissolved Oxygen - mg/l		--	--		6.0	Grab	Daily

Constituent		FINAL LIMITATIONS Present Daily Max.	FINAL LIMITATIONS Modified Daily Max.	MONITORING REQUIREMENTS Sample Type	MONITORING REQUIREMENTS Frequency
Cyanide, total -	ug/l	5	25	24 hr comp.	Weekly
Cadmium	ug/l	5	12	24 hr comp.	Weekly
Chromium	ug/l	100	100	24 hr comp.	Weekly
Copper	ug/l	20	20	24 hr comp.	Weekly
Lead	ug/l	30	30	24 hr comp.	Weekly
Mercury	ug/l	0.2	0.2	24 hr comp.	Weekly
Nickel	ug/l	--	100	24 hr comp.	Weekly
Zinc	ug/l	5	95	24 hr comp.	Weekly

U. S. ENVIRONMENTAL PROTECTION AGENCY
REGION V
SURVEILLANCE AND ANALYSIS DIVISION
EASTERN DISTRICT OFFICE

RECOMMENDED PERMIT MODIFICATIONS

Discharger: French Creek COG STP

NPDES Permit No.: OH 0044512

Recommended Modifications:

Effluent limitations were determined using U.S. EPA, Water Quality Model - Auto-SS and Region V, Simplified Waste Load Allocation Methodology for municipal sewage treatment plants on low flow streams (see Appendix V and Section IX.A.2)

Effluent Limitations:

Constituent	Present Performance	FINAL LIMITATIONS				MONITORING REQUIREMENTS	
		Present**		Modified*		Sample Type	Frequency
		Avg. Monthly	Max. Weekly	Avg.	Max. Weekly		
BOD_5 (mg/l)		10	15		2	24 hour comp.	Daily
Suspended Solids		12	18		10	24 hour comp.	Daily
Total Phosphorus		1	1.5		1.0	24 hour comp.	Daily
Ammonia - N							
July - October		1.5	2.25		--	24 hour comp.	Daily
May - October		--	--		1.5	24 hour comp.	Daily
November - April		--	--		5.0	24 hour comp.	Daily
Residual Cl_2		.2-	.7		.5	Grab	Daily
Dissolved Oxygen (mg/l - min)		5.0			6.0	Grab	Daily
Fecal Coliform (#/100ml)		200	400	1000	2000	Grab	Daily

* Discharge to French Creek

** With discharge to Lake Erie present limitations without ammonia-N limits would be appropriate.

U. S. ENVIRONMENTAL PROTECTION AGENCY
REGION V
SURVEILLANCE AND ANALYSIS DIVISION
EASTERN DISTRICT OFFICE

RECOMMENDED PERMIT MODIFICATIONS

Discharger: Grafton STP

NPDES Permit No.: OH 0025372

Recommended Modifications:

Effluent limitations were determined using U.S. EPA, Region V, Simplified Waste Load Allocation Methodology for municipal sewage treatment plants on low flow streams (see Appendix V and Section IX.2)

Effluent Limitations:

Constituent	Present Performance	FINAL LIMITATIONS				MONITORING REQUIREMENTS	
		Present		Modified		Sample Type	Frequency
		Avg. Monthly	Max Weekly	Avg.	Max Weekly		
BOD_5 (mg/l)		10	12		10	Composite	1/week
Suspended Solids		10	12		10	Composite	1/week
Ammonia (mg/l)							
July - October		1.5	2.3		--	Composite	1/week
May - October		--	--		1.5	Composite	1/week
November - April		--	--		5.0	Composite	1/week
Residual Cl_2 (mg/l)			.5		.5	Grab	Daily
Dissolved Oxygen (mg/l - min.)				6.0		Grab	Daily

U. S. ENVIRONMENTAL PROTECTION AGENCY
REGION V
SURVEILLANCE AND ANALYSIS DIVISION
EASTERN DISTRICT OFFICE

RECOMMENDED PERMIT MODIFICATIONS

Discharger: LaGrange

NPDES Permit No.: OH 0046728

Recommended Modifications:

Effluent limitations were determined using U.S. EPA, Region V, Simplified Waste Load Allocation Methodology for municipal sewage treatment plants on low flow streams (see Appendix V and Section IX.2)

Effluent Limitations:

Constituent	Present Performance	FINAL LIMITATIONS				MONITORING REQUIREMENTS	
		Present		Modified		Sample Type	Frequency
		Avg. Monthly	Max. Weekly	Avg.	Max. Weekly		
BOD_5 (mg/l)		12	18		10	Composite	1/week
Suspended Solids (mg/l)		20	30		10	Composite	1/week
Dissolved Oxygen (mg/l)			5.0 min.		6.0 min.	Grab	Daily
Ammonia (mg/l)							
May - October		--	--		1.5	Composite	1/week
November - April		--	--		5.0	Composite	1/week

U. S. ENVIRONMENTAL PROTECTION AGENCY
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RECOMMENDED PERMIT MODIFICATIONS

Discharger: Oberlin STP

NPDES Permit No.: OH 0020427

Recommended Modifications:

Effluent limitations were determined using U.S. EPA, Region V, Simplified Waste Load Allocation Methodology for municipal sewage treatment plants on low flow streams (see Appendix V and Section IX.2)

Effluent Limitations:

Constituent	Present Performance	FINAL LIMITATIONS				MONITORING REQUIREMENTS	
		Present		Modified		Sample Type	Frequency
		Avg.	Max.	Avg.	Max.		
BOD_5 (mg/l)		10	15		10	Composite	3/week
Suspended Solids (mg/l)		12	18		10	Composite	3/week
Ammonia-N (mg/l)							
July - October		1.8	2.7		--	Composite	1/week
May - October		--	--		1.5	Composite	1/week
November - April		--	--		5.0	Composite	1/week
Total Phosphorus (mg/l)		1.0	1.5		1.0	Composite	3/week
Dissolved Oxygen (min. - mg/l)		3.0 min.			6.0 min.	Grab	Daily

U. S. ENVIRONMENTAL PROTECTION AGENCY
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RECOMMENDED PERMIT MODIFICATIONS

Discharger: Spencer

NPDES Permit No.: OH 0022071

Recommended Modifications:

Effluent limitations were determined using U.S. EPA, Region V, Simplified Waste Load Allocation Methodology for municipal sewage treatment plants on low flow streams (see Appendix V and Section IX.2)

Effluent Limitations:

Constituent	Present Performance	FINAL LIMITATIONS				MONITORING REQUIREMENTS	
		Present		Modified		Sample Type	Frequency
		Avg. Monthly	Max. Weekly	Avg.	Max. Weekly		
BOD_5 (mg/l)		24	36		10	8 hour comp.	1/week
Suspended Solids (mg/l)		30	45		10	8 hour comp.	1/week
Ammonia (mg/l)							
May - October		--	--		2.0	8 hour comp.	1/week
November - April		--	--		5.0	8 hour comp.	1/week
Dissolved Oxygen (mg/l)			5.0 min.		6.0 min.	Grab	Daily

U. S. ENVIRONMENTAL PROTECTION AGENCY
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RECOMMENDED PERMIT MODIFICATIONS

Discharger: Wellington

NPDES Permit No.: OH 0028037

Recommended Modifications:

Effluent limitations were determined using U.S. EPA, Region V, Simplified Waste Load Allocation Methodology for municipal sewage treatment plants on low flow streams (see Appendix V and Section IX.2)

Effluent Limitations:

Constituent	Present Performance	FINAL LIMITATIONS				MONITORING REQUIREMENTS	
		Present		Modified		Sample Type	Frequency
		Avg. Monthly	Max. Weekly	Avg.	Max. Weekly		
BOD_5 (mg/l)		10	15		15	Composite	2/week
Suspended Solids (mg/l)		12	18		20	Composite	2/week
Ammonia (mg/l)							
May - October		--	--		2.0	Composite	2/week
November - April		--	--		5.0	Composite	2/week
Dissolved Oxygen (mg/l)		--	--		6.0 min.	Grab	Daily
Phosphorus (mg/l)					1.0	Composite	2/week

U. S. ENVIRONMENTAL PROTECTION AGENCY
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EASTERN DISTRICT OFFICE

RECOMMENDED PERMIT MODIFICATIONS

Discharger: See Attached List

NPDES Permit No.: See Attached List

Recommended Modifications:

The present permits do not contain any limitations or monitoring requirements for ammonia or dissolved oxygen. The recommended limits are based on Table IX-15.

Effluent Limitations:

Constituent	Present Performance	FINAL LIMITATIONS				MONITORING REQUIREMENTS	
		Present		Modified		Sample Type	Frequency
		Avg.	Max.	Avg.	Max. Weekly		
BOD_5 (mg/l)		10	15		10	24 hour comp.	Monthly
Suspended Solids (mg/l)		12	18		10	24 hour comp.	Monthly
Ammonia - Nitrogen							
May - October (mg/l)					2.0	24 hour comp.	Monthly
November - April (mg/l)					5	24 hour comp.	Monthly
Dissolved Oxygen (mg/l)				6 min.		Grab	Daily
Fecal Coliform (#/100 ml)							
May - October				1000#	2000#		

DISCHARGER	NPDES PERMIT NO.
Chestnut Ridge STP City of North Ridgeville Sewer Department 36119 Center Ridge Road North Ridgeville, Ohio 44039	OH 0043435
Cresthaven STP Lorain County Sanitary Engineer 247 Hadaway Street Elyria, Ohio 44035	OH 0026131
Crestview STP City of North Ridgeville Sewer Department 36119 Center Ridge Road North Ridgeville, Ohio 44039	OH 0043451
Dreco Inc. 7887 Root Road Elyria, Ohio 44035	OH 0051616
Nelcon Stud Welding West Ridge Road and SR113 Elyria, Ohio 44035	OH 0021610

U.S. ENVIRONMENTAL PROTECTION AGENCY
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MICHIGAN-OHIO DISTRICT OFFICE

RECOMMENDED PERMIT MODIFICATIONS

DISCHARGER:

Bendix Westinghouse
901 Cleveland Street
Elyria, Ohio 44035

NPDES PERMIT NO: OH 0001261

RECOMMENDED MODIFICATIONS: (for Outfalls 002 and 004)

Oil and grease limitations should be added to the permit because the COE permit indicates that oil and grease may be a problem in those outfalls. The final limitations are based on Ohio EPA's estimate of BPCTCA.

EFFLUENT LIMITATIONS:

Constituent	FINAL LIMITATIONS				MONITORING REQUIREMENTS	
	Present		Modified		Sample Type	Frequency
	Avg.	Max.	Avg.	Max.		
Oil and Grease (mg/l)	--	--	10	20	Monthly	Grab

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RECOMMENDED PERMIT MODIFICATIONS

DISCHARGER:

GMC - Fisher Body Division
Telegraph Road
Elyria, Ohio 44035

NPDES PERMIT NO: OH 0000272

RECOMMENDED MODIFICATIONS:

Effluent limitations and monitoring requirements for Zinc and Oil and Grease in outfall 601 should be added to the permit because the company's COE permit application indicates that they are significant problems. The final limitations are based on Ohio EPA's estimate of BPCTCA.

EFFLUENT LIMITATIONS:

Constituent	FINAL LIMITATIONS				MONITORING REQUIREMENTS	
	Present		Modified		Sample Type	Frequency
	Avg.	Max.	Avg.	Max.		
Zinc, Total (mg/l)	--	--	0.5	1.0	24 hour comp.	2/week
Oil and Grease (mg/l)	--	--	10	20	2 grabs/24 hours	2/week

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RECOMMENDED PERMIT MODIFICATIONS

Discharger: Good Samaritan Nursing Home

NPDES Permit No.: OH 0043745

Recommended Modifications:

Effluent limitations are modified based on Table IX-15.

Effluent Limitations:

Constituent	Present Performance	FINAL LIMITATIONS				MONITORING REQUIREMENTS	
		Present		Modified		Sample Type	Frequency
		Avg. Monthly	Max. Weekly	Avg.	Max. Weekly		
BOD_5 (mg/l)		10	15		10	8 hour comp.	1/month
Suspended Solids		12	18		10	8 hour comp.	1/month
Ammonia - N							
May - October		--	--		2.0	8 hour comp.	1/month
November - April		--	--		5.0		
Dissolved Oxygen (mg/l - min.)		--	--		6.0	Grab	1/week
Fecal Coliform (#/100ml)		200	400	1000	2000	Grab	1/week

U. S. ENVIRONMENTAL PROTECTION AGENCY
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RECOMMENDED PERMIT MODIFICATIONS

Discharger: Invacare Corporation
443 Oberlin Road
Elyria, Ohio 44035

NPDES Permit No.: OH 0000833

Recommended Modifications:

Effluent limitations for Outfall 002 should be deleted because the sanitary wastes are discharged to Elyria sanitary sewers.

Effluent Limitations:

Constituent	Present Performance	Outfall 002 FINAL LIMITATIONS				MONITORING REQUIREMENTS	
		Present		Modified		Sample Type	Frequency
		Avg.	Max.	Avg.	Max.		
Flow (mgd)		--	--	--	--		
BOD_5 (mg/l)		30	45	--	--		
Suspended Solids (mg/l)		30	45	--	--		
Fecal Coli. (no/100ml)		200	400	--	--		
Cl_2 Residual (mg/l)		--	0.5				
pH (s.u.)		6 -	9	6 -	9		

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MICHIGAN-OHIO DISTRICT OFFICE

RECOMMENDED PERMIT MODIFICATIONS

DISCHARGER:

Koehring Plant #1
East 28th Street and Fulton Road
Lorain, Ohio 44052

NPDES PERMIT NO: OH 0001929

RECOMMENDED MODIFICATIONS:

The fecal coliform limitations and monitoring requirements for Outfalls 001, 003, and 004 should be eliminated because sanitary wastes are discharged to the Lorain Sewer System.

EFFLUENT LIMITATIONS:

Constituent	FINAL LIMITATIONS				MONITORING REQUIREMENTS	
	Present		Modified		Sample Type	Frequency
	Avg.	Max.	Avg.	Max.		
Fecal Coli (no/100 ml)	200	400	--	--	--	--

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EASTERN DISTRICT OFFICE

RECOMMENDED EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

Discharger: Lodi STP

NPDES Application No.: OH 0020991

NPDES Permit No.:

Justification:

Effluent limitations were determined using U.S. EPA, Region V, Simplified Waste Load Allocation Methodology for municipal sewage treatment plants on low flow streams (see Appendix V and Section IX.2)

Recommended Effluent Limitations and Monitoring Requirements

Constituent	Present Performance	LIMITATIONS				MONITORING REQUIREMENTS	
		Initial		Final		Sample Type	Frequency
		Avg.	Max.	Avg.	Max.		
Flow (mgd)	.281	--	--	.4	--	Continuous	Daily
BOD_5 (mg/l)	4	10	15		10	24 hour comp.	1/week
Suspended Solids (mg/l)	4	15	25		10	24 hour comp.	1/week
Ammonia - N (mg/l)							
May - October	--	--	--		1.5	24 hour comp.	1/week
November - April	--	--	--		5.0	24 hour comp.	1/week
Dissolved Oxygen (min. - mg/l)	5.4	--	--	6.0		Grab	Daily
Fecal Coli. (#/100ml)	--	200	400	1000	2000	Grab	1/month

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MICHIGAN-OHIO DISTRICT OFFICE

RECOMMENDED PERMIT MODIFICATIONS

DISCHARGER:

Ohio Edison Company - Edgewater Plant
200 Oberlin Avenue
Lorain, Ohio 44052

NPDES PERMIT NO: OH 0051306

RECOMMENDED MODIFICATIONS: (for Outfall 601)

The final effluent limitations should be modified to conform with the U.S. EPA steam Electric Power Generating Point Source Category Effluent Guidelines issued on October 8, 1974. The present final effluent limitations are based on the proposed effluent guidelines dated March 4, 1974.

EFFLUENT LIMITATIONS:

Constituent	FINAL LIMITATIONS Present Avg.	Present Max.	Modified Avg.	Modified Max.	MONITORING REQUIREMENTS Sample Type	Frequency
Flow (mgd)	--	--	--	--	Continuous	Daily
Residual Cl_2 (mg/l)	*	*	0.2	0.5	Grab	Daily
Temperature (°C)	--	--	--	--	Continuous**	Daily
Suspended Solids (mg/l)	15	45	--	--		
Oil and Grease (mg/l)	10	20	--	--		
Chromium, Total (mg/l)	--	0.2	--	--		
Phosphorus, Total (mg/l)	--	5.0	--	--		
Zinc, Total (mg/l)	--	1.0	--	--		
pH	6 to 9		6 to 9		Grab	Daily

* No discharge of residual chlorine

** Report Average and Maximum values

Special Conditions

Neither free available nor total residual chlorine may be discharged from any unit for more than 2 hours in any one day and not more than one unit may discharge free available or total residual chlorine at any one time.

U.S. ENVIRONMENTAL PROTECTION AGENCY
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SURVEILLANCE AND ANALYSIS DIVISION
MICHIGAN-OHIO DISTRICT OFFICE

RECOMMENDED PERMIT MODIFICATIONS

DISCHARGER:

Ohio Edison Company - Edgewater Plant
200 Oberlin Avenue
Lorain, Ohio 44052

NPDES PERMIT NO: OH 0051306

RECOMMENDED MODIFICATIONS: (Outfall 602)

The final effluent limitations should be modified to conform with the U.S. EPA Steam Electric Power Generating Point Source Category Effluent Guidelines issued on October 8, 1974.

EFFLUENT LIMITATIONS:

Constituent	FINAL LIMITATIONS				MONITORING REQUIREMENTS	
	Present*		Modified		Sample Type	Frequency
	Avg.	Max.	Avg.	Max.		
Flow (mgd)			--	--	24 hour total	Daily
Suspended Solids (mg/l)			30	100	Grab	Weekly
Oil and Grease (mg/l)			15	20	Grab	Weekly

* No discharge after July 1, 1980

U.S. ENVIRONMENTAL PROTECTION AGENCY
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MICHIGAN-OHIO DISTRICT OFFICE

RECOMMENDED PERMIT MODIFICATIONS

DISCHARGER:

Ohio Edison Company - Edgewater Plant
200 Oberlin Avenue
Lorain, Ohio 44052

NPDES PERMIT NO: OH 0051306

RECOMMENDED MODIFICATIONS: (Outfall 603)

The final effluent limitations should be modified to conform with the U.S. EPA Steam Electric Power Generating Point Source Category Effluent Guidelines issued on October 8, 1974.

EFFLUENT LIMITATIONS:

Constituent	FINAL LIMITATIONS				MONITORING REQUIREMENTS	
	Present		Modified		Sample Type	Frequency
	Avg.	Max.	Avg.	Max.		
Flow (mgd)	--	--	--	--	24 hour total	Weekly
Suspended Solids (mg/l)	15	45	--	50	24 hour comp.	Weekly
Oil and Grease (mg/l)	10	20	10	20	Grab	Weekly
pH (std. units)	6 to 9		6 to 9		Grab	Weekly

Special Conditions

Any untreated overflow from facilities designed, constructed, and operated to treat the volume of material storage runoff and construction runoff which is associated with a 10 year, 24 hour rainfall event shall not be subject to the above limitations.

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RECOMMENDED PERMIT MODIFICATIONS

DISCHARGER:

Ohio Edison Company - Edgweater Plant
200 Oberlin Avenue
Lorain, Ohio 44052

NPDES PERMIT NO: OH 0051306

RECOMMENDED MODIFICATIONS: (Outfall 604)

The final effluent limitations should be modified to conform with the U.S. EPA Steam Electric Power Generating Point Source Category Effluent Guidelines issued on October 8, 1974.

EFFLUENT LIMITATIONS:

Constituent	FINAL LIMITATIONS				MONITORING REQUIREMENTS	
	Present*		Modified		Sample Type	Frequency
	Avg.	Max.	Avg.	Max.		
Flow (mg/l)			--	--	24 hour total	Weekly
Suspended Solids (mg/l)			30	100	24 hour comp.	Weekly
Oil and Grease (mg/l)			15	20	24 hour comp.	Weekly
pH (std units)			6 to 9		Grab	Weekly

* No discharge by July 1, 1980

Special Conditions

Low volume waste sources: Wet Scrubber Air Pollution Control System
Ion Exchanger Water Treatment System
Laboratory and Sampling Stream
Floor Drainage
Water Treatment Evaporator blowdown
Cooling Tower Basin Cleaning Water
Blowdown from recirculating house service water systems.

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RECOMMENDED PERMIT MODIFICATIONS

DISCHARGER:

Ohio Edison Company - Edgewater Plant
200 Oberlin Avenue
Lorain, Ohio 44052

NPDES PERMIT NO: OH 0051306

RECOMMENDED MODIFICATIONS. (Outfall 605)

The final effluent limitations should be modified to conform with the U.S. EPA Steam Electric Power Generating Point Source Category Effluent Guidelines issued on October 8, 1974.

EFFLUENT LIMITATIONS:

Constituent	FINAL LIMITATIONS				MONITORING REQUIREMENTS	
	Present*		Modified		Sample Type	Frequency
	Avg.	Max.	Avg.	Max.		
Flow (mgd)			--	--	24 hour total	Weekly
Suspended Solids (mg/l)			30	100	24 hour comp.	Weekly
Oil and Grease (mg/l)			15	20	Grab	Weekly
Total Copper (mg/l)			1	1	24 hour comp.	Weekly
Total Iron (mg/l)			1	1	24 hour comp.	Weekly
pH (std units)			6 to	9	Grab	Weekly

*No discharge after July 1, 1980

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RECOMMENDED PERMIT MODIFICATIONS

DISCHARGER:

Pfaudler Company
820 Taylor Street
Elyria, Ohio 44035

NPDES PERMIT NO: OH 0000728

RECOMMENDED MODIFICATIONS:

The oil and grease and suspended solids limitations should be decreased because self-monitoring data shows that they are meeting the lower limits. The sample type for oil and grease should be a grab sample rather than a 24 hour composite sample.

EFFLUENT LIMITATIONS:

Constituent	FINAL LIMITATIONS				MONITORING REQUIREMENTS	
	Present		Modified		Sample Type	Frequency
	Avg.	Max.	Avg.	Max.		
Suspended Solids (mg/l)	--	45	--	10	24 hour comp.	Monthly
Oil and Grease (mg/l)	--	20	--	10	Grab	Monthly

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RECOMMENDED PERMIT MODIFICATIONS

Discharger: Pheasant Run Village

NPDES Permit No.: OEPA#W801*AD

Recommended Modifications:

Recommended effluent limitations are based on the analyses presented in Table IX-15.

Effluent Limitations:

Constituent	Present Performance	FINAL LIMITATIONS				MONITORING REQUIREMENTS	
		Present		Modified		Sample Type	Frequency
		Avg. Monthly	Max. Weekly	Avg.	Max. Weekly		
BOD_5		8	12		10	Composite	1/month
Suspended Solids		8	12		10	Composite	1/month
Ammonia - N							
July - October		1	1.9		--	Composite	1/month
November - June		2.5	5.0		--	Composite	1/month
May - October		--	--		2.0	Composite	1/month
November - April		--	--		5.0	Composite	1/month
Dissolved Oxygen (min.)		6.0		6.0		Grab	1/week
Fecal Coli. (#/100ml)		200	400	1000	2000	Grab	1/week

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RECOMMENDED PERMIT MODIFICATIONS

Discharger: Pinecrest Apartments

NPDES Permit No.: OH 0044890

Recommended Modifications:

Recommended limitations are based on the analyses presented in Table IX-15.

Effluent Limitations:

Constituent	Present Performance	FINAL LIMITATIONS				MONITORING REQUIREMENTS	
		Present		Modified		Sample Type	Frequency
		Avg. Monthly	Max. Weekly	Avg. Monthly	Max. Weekly		
BOD_5 (mg/l)		10	15		10	8 hour comp.	1/week
Suspended Solids (mg/l)		12	18		10	8 hour comp.	1/week
Ammonia - N							
May - October		--	--		2.0	8 hour comp.	1/week
November - April		--	--		5.0	8 hour comp.	1/week
Dissolved Oxygen (min. - mg/l)		--	--	6.0		Grab	1/week
Fecal Coli. (#100ml)		200	400	1000	2000	Grab	1/month

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RECOMMENDED PERMIT MODIFICATIONS

DISCHARGER:

Republic Steel Corporation
525 15th Street
Elyria, Ohio 44035

NPDES PERMIT NO: OH 0001295

RECOMMENDED MODIFICATIONS:

1) Discharge 001 be limited to noncontact cooling water and boiler blowdown as implied by the final effluent limitations
2) The permit should include a special condition that sanitary wastes be discharged to the Elyria sanitary sewer system as soon as sewers are extended into the area.

EFFLUENT LIMITATIONS:

Constituent	FINAL LIMITATIONS				MONITORING REQUIREMENTS	
	Present		Modified		Sample Type	Frequency
	Avg.	Max.	Avg.	Max.		

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RECOMMENDED PERMIT MODIFICATIONS

Discharger: Ridgeview Shopping Center

NPDES Permit No.: OH 0045098

Recommended Modifications:

Recommended effluent limitations are based on the analyses presented in Table IX-15.

Effluent Limitations:

Constituent	Present Performance	FINAL LIMITATIONS				MONITORING REQUIREMENTS	
		Present		Modified		Sample Type	Frequency
		Avg. Monthly	Max. Weekly	Avg. Monthly	Max. Weekly		
BOD_5 (mg/l)		10	15		10	Grab	1/week
Suspended Solids		12	18		10	Grab	1/week
Ammonia - N							
May - October		--	--		2.0	Grab	1/month
November - April		--	--		5.0	Grab	1/month
Dissolved Oxygen (min. - mg/l)		--	--	6.0		Grab	1/week
Fecal Coli. (#/100ml)		200	400	1000	2000	Grab	1/week

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RECOMMENDED PERMIT MODIFICATIONS

Discharger: Spencer WTP

NPDES Permit No.: OH 0030520

Recommended Modifications:

Effluent Limitations:

Constituent	Present Performance	FINAL LIMITATIONS Present Avg. Daily	Max. Daily	Modified Avg. Daily	Max. Daily	MONITORING REQUIREMENTS Sample Type	Frequency
Phosphate (lb/day)					1.0	Composite	Daily
Total Iron (mg/l)				1.0	2.0	Composite	Daily When Dschrg.
Susbended Soilds (mg/l		15	20	15	20	Comp site	Daily When Dschrg.
pH (s.u.)		6	11.5	6	9	Grab	Daily When Dschrg.

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RECOMMENDED PERMIT MODIFICATIONS

DISCHARGER:

Standard Pipe Protection
3100 East 31st Street
Lorain, Ohio 44052

NPDES PERMIT NO: OH 0051675

RECOMMENDED MODIFICATIONS:

The temperature limitations for Outfall 002 should be deleted because the discharge rate is small compared to the water quality design flow in the receiving stream.

EFFLUENT LIMITATIONS:

Constituent	FINAL LIMITATIONS				MONITORING REQUIREMENTS	
	Present		Modified		Sample Type	Frequency
	Avg.	Max.	Avg.	Max.		
Temperature	--	*				

* The effluent temperature should not exceed the intake temperature by more than 15°F during May thru October and by more than 23°F during November thru April.

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RECOMMENDED PERMIT MODIFICATIONS

Discharger: Westwood Mobile Home Park

NPDES Permit No.: OH 0045123

Recommended Modifications:

Recommended modifications are based on the analyses presented in Table IX-15.

Effluent Limitations:

Constituent	Present Performance	FINAL LIMITATIONS Present Avg. Monthly	Present Max. Weekly	Modified Avg.	Modified Max. Weekly	MONITORING REQUIREMENTS Sample Type	Frequency
BOD_5 (mg/l)		8	12		10	8 hour comp.	1/week
Suspended Solids		8	12		10	8 hour comp.	1/week
Ammonia - N							
July - October		1.0	1.5		--	8 hour comp.	
November - June		2.5	5.0		--	8 hour comp.	
May - October		--	--		2.0	8 hour comp.	1/month
November - pril		--	--		5.0	8 hour comp.	1/month
Dissolved Oxygen (min. - mg/l)		6.0		6.0		Grab	Daily
Fecal Coli. (#100ml)		200	400	1000	2000	Grab	1/month

Attachment C

Recommended Effluent Limitations
for Unpermitted Dischargers

U. S. ENVIRONMENTAL PROTECTION AGENCY
REGION V
SURVEILLANCE AND ANALYSIS DIVISION
EASTERN DISTRICT OFFICE

RECOMMENDED EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

Discharger: See Attached List #1

NPDES Application No.:

NPDES Permit No.:

Justification:

These are semi-public and industrial sewage treatment plants discharging to streams with a water quality design flow of zero cfs. The final limitations are based on the information contained in Table IX-15.

Recommended Effluent Limitations and Monitoring Requirements

Constituent	Present Performance	LIMITATIONS				MONITORING REQUIREMENTS	
		Initial		Final		Sample Type	Frequency +
		Avg.	Max.	Avg.	Max. Weekly		
BOD_5 mg/l					10	Grab	
Suspended Solids mg/l					10	Grab	
Ammonia-N							
May-October					2.0	Grab	
November-April					5.0	Grab	
D.O. (min mg/l)				6.0		Grab	
Fecal Coliform (#/100 ml)				1000	2000	Grab	

+ A reasonable monitoring frequency developed according to the volume of discharge.

Special Conditions

The entities in Sheffield, Avon, and North Ridgeville should tie-in to the French Creek Council of Governments STP as soon as sewers are extended into their area.

List # 1

DISCHARGER	LOCATION
Lorain County Animal Protective League	Elyria
Herman Apartments	Elyria
Oberlin Savings Bank	Elyria
Country Garden Apartments	Elyria
Elyria Country Club	Elyria
Tiffany's Steak House	Elyria
Bethel Baptist Church	Russia Township
Church of the Open Door	Elyria
Lorain County Airport	Elyria
Forest Hills Country Club	Carlisle Township
West Carlisle School	Carlisle Township
Twining Motor Sales	Oberlin
East Oberlin Community Church	Oberlin
Oberlin Assembly of God	Oberlin
Glorious Faith Church	Oberlin
Almighty Church	Oberlin
Findley State Forest	Oberlin
Ukranian-American Assoc. Camp	Huntington Township
Panther Trails Campground	Wellington Township
Echo Valley Golf Course	Brighton Township
Grace Lutheran Church	Elyria
Calvary Baptist Church	Elyria
East Carlisle School	Carlisle Township
SOHIO Service Station	North Ridgeville
Ohio Edison-Eaton Line Shop	Eaton
Eaton Town Hall	Eaton
Trinity Lutheran Church	Eaton
Eaton School	Eaton
North Eaton Baptist Church	North Eaton
Brush School	Carlisle Township
Brentwood Golf Course	Carlisle Township
Midview High School	Carlisle Township
La Porte Apartments	La Porte
Butternut Terrace Apartments	Carlisle Township
Indian Hollow Golf Club	Lagrange
Belden School	Belden
Litchfield School	Litchfield

DISCHARGER	LOCATION
Litchfield Barber Shop	Litchfield
D & H Truck Stop	Litchfield
Spencer Lake Campground	Spencer Township
Lodi Motel	Lodi
Sherwood Forest Camping Area	Chatham Township
Pierce Recreational Area	Chatham Township
Worden Trailer Park	Homer Township
Homerville High School	Homerville
Dewey Road Inn	Amherst
Lorain County Rehabilitation Center	Amherst
Lorain Oak Hills Farms STP	Amherst
Amherst Mobile Homes Park	Amherst
South Amherst Schools	South Amherst
Oak Park Lake	Oberlin
Maranatha Temple Pentecostal	Oberlin
Church of the Nativity	South Amherst
Oberlin Masonic Hall	Oberlin
Barr School	Sheffield
Brookside High School	Sheffield
Schmidt's Other Hayseed	Sheffield
Our Lady of Wayside Inn	Avon
Avon Oaks Nursing Home	Avon
Meyerhaufer Apartments	Avon
French Creek Tavern	Avon
Avon Professional Building	Avon
Tom's Country Club	Avon
Avon High School	Avon
St. Peter's Church and School	North Ridgeville
First Congregational United Church	North Ridgeville
Autorama Drive-In	North Ridgeville
Fields United Methodist Church	North Ridgeville
Howard Johnson Restaurant	North Ridgeville
Ohio Manor Motel	North Ridgeville
Gibson Mobile Home Park	North Ridgeville
Center Ridge Medical Building	North Ridgeville
Rae Apartments	North Ridgeville

DISCHARGER	LOCATION
Lake Ridge Academy	North Ridgeville
Beckett Corporation	North Ridgeville
Fields Elementary School	Field
Ohio Turnpike Service Plaza #5 STP	Amherst Township

U. S. ENVIRONMENTAL PROTECTION AGENCY
REGION V
SURVEILLANCE AND ANALYSIS DIVISION
EASTERN DISTRICT OFFICE

RECOMMENDED EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

Discharger: See Attached List #2

NPDES Application No.:

NPDES Permit No.:

Justification:

All of the entities discharge to storm sewers which discharge to the Black River. The final effluent limitations for BOD_5 and suspended solids are based on U.S. EPA secondary treatment guidelines.

Recommended Effluent Limitations and Monitoring Requirements

Constituent	Present Performance	LIMITATIONS				MONITORING REQUIREMENTS	
		Initial		Final		Sample Type	Frequency *
		Avg.	Max.	Avg.	Max.		
Flow (gpd)	--	--	--	--	--	Estimate	
BOD_5 (mg/l)	--	--	--	30	45	Grab	
Suspended Solids mg/	--	--	--	30	45	Grab	
Fecal Coliform (col/100 ml)	--	--	--	**		Grab	
pH (s.u.)	--	6	9	6	9	Grab	

* A reasonable monitoring frequency should be developed based on discharge volume.
** Fecal Coliform
7-day avg. = 2000
30-day avg. = 1000

Special Conditions

The listed entities should discharge to the Lorain Sanitary sewer system as soon as it is extended into the area.

List #2

DISCHARGER	LOCATION
MacDonald's Restaurant	1340 North Ridge Road Sheffield, Ohio 44054
St. Vincent De Paul Church	41295 North Ridge Road E Lorain, Ohio 44052
Mary's House of Many Flavors Ice Cream Shop	1390 North Ridge Road Sheffield, Ohio 44054
Owens Oil Service Station	2425 North Ridge Road E Sheffield, Ohio 44054
Sheffield Shopping Center	Sheffield, Ohio 44054
Manners Restaurant	2173 North Ridge Road E Sheffield, Ohio 44054
Perkins Cake and Steak House	2170 North Ridge Road E Sheffield, Ohio 44054
Central Security National Bank of Lorain County	105 Sheffield Center Sheffield, Ohio 44054
Clark Oil Service Station	1685 North Ridge Road E Sheffield, Ohio 44054
Pick-N-Pay Supermarket	Elyria Avenue and North Ridge Rd. Sheffield, Ohio 44054
Iski's Sunoco Station	1429 North Ridge Road E Sheffield, Ohio 44054
Tudy's Restaurant	1742 North Ridge Road E Avon, Ohio 44011
St. Peter and Paul Church	1500 Lincoln Blvd. Lorain, Ohio 44052
Broadway Assembly	Broadway at North Ridge Road Lorain, Ohio 44052
Heisler's Truck and Equipment Corp.	6438 Lorain Blvd. Elyria, Ohio 44035

U. S. ENVIRONMENTAL PROTECTION AGENCY
REGION V
SURVEILLANCE AND ANALYSIS DIVISION
MICHIGAN-OHIO DISTRICT OFFICE

RECOMMENDED EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

Discharger

American Crucible Products
1305 Oberlin Avenue
Lorain, Ohio 44052

NPDES Application Number: None

NPDES Permit Number: None

Justification

The company discharges about 6,000 gpd of non-contact cooling water to Lake Erie via the Lorain storm sewer system. Oil and Grease Limitations are based on Ohio EPA's estimate of BPCTCA.

Recommended Effluent Limitations and Monitoring Requirements

Constituent	Present Performance	LIMITATIONS				MONITORING REQUIREMENTS	
		Initial		Final		Sample Type	Frequency
		Avg.	Max.	Avg.	Max.		
Flow	--	--	--	--	--	24 hour total	Monthly
Oil and Grease	--	--	--	10	20	Grab	Monthly
pH	--	6 - 9		6 - 9		Grab	Weekly

Special Conditions

The discharge should be restricted to non-contact cooling water and boiler blowdown.

U. S. ENVIRONMENTAL PROTECTION AGENCY
REGION V
SURVEILLANCE AND ANALYSIS DIVISION
MICHIGAN-OHIO DISTRICT OFFICE

RECOMMENDED EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

Dischargers:

Camp Wahoo
5504 Colorado Avenue
North Ridgeville, Ohio 44039

Ridgewood Motor Court
35157 Center Ridge Road
North Ridgeville, Ohio 44039

NPDES Application Number: OH 0044369

NPDES Permit Number: None

Justification

Both entities are within 100 feet of one of the French Creek Council of Government STP trunk sewers.

Recommended Effluent Limitations and Monitoring Requirements

Constituent	Present Performance	LIMITATIONS				MONITORING REQUIREME[NTS]	
		Initial		Final		Sample Type	Freque[ncy]
		Avg.	Max.	Avg.	Max.		
--							

Special Conditions

The above dischargers should tie into the French Creek Council of Government sanitary sewer system.

U. S. ENVIRONMENTAL PROTECTION AGENCY
REGION V
SURVEILLANCE AND ANALYSIS DIVISION
MICHIGAN-OHIO DISTRICT OFFICE

RECOMMENDED EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

Discharger

Cleveland Quarries
South Amherst Road
Amherst, Ohio 44001

NPDES Application Number: OH 0051594

NPDES Permit Number: None

Justification

The company discharges about 100 gpd of process water to Beaver Creek. Suspended solids limitations are based on Ohio EPA's estimate of BPCTCA.

Recommended Effluent Limitations and Monitoring Requirements

Constituent	Present Performance	LIMITATIONS				MONITORING REQUIREMENTS	
		Initial		Final		Sample Type	Frequency
		Avg.	Max.	Avg.	Max.		
Flow (gpd)	100	--	--	--	--	Estimate	Monthly
Suspended Solids (mg/l)	--	--	--	30	45	Grab	Monthly
pH (s.u.)	--	--		6 - 9		Grab	Monthly

Special Conditions

None

U. S. ENVIRONMENTAL PROTECTION AGENCY
REGION V
SURVEILLANCE AND ANALYSIS DIVISION
MICHIGAN-OHIO DISTRICT OFFICE

RECOMMENDED EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

Discharger

Emtec Manufacturing
140 South Olive Street
Elyria, Ohio 44035

NPDES Application Number: None

NPDES Permit Number: None

Justification

The company discharges about 33,000 gpd of non-contact cooling water, Silver plating rinse waters, and wash waters to an Elyria storm sewer.

Recommended Effluent Limitations and Monitoring Requirements

Constituent	Present Performance	LIMITATIONS				MONITORING REQUIREMENTS	
		Initial		Final		Sample Type	Frequency
		Avg.	Max.	Avg.	Max.		
Flow (gpd)	33,000	--	--	--	--	24 Hour Total	Monthly
Silver (mg/l)	--	--	--	--	--	8 Hour Comp.	Monthly
pH	--	--		6 - 9		Grab	Biweekly

Special Conditions

1) The rinse water and wash water should be routed to the Elyria sanitary sewer system after pretreatment if necessary.
2) The discharge should contain non-contact cooling water and boiler blowdown.
3) If entity continues to discharge rinse water and wash water to the storm sewer, the Silver Monitoring requirements should be retained.

U. S. ENVIRONMENTAL PROTECTION AGENCY
REGION V
SURVEILLANCE AND ANALYSIS DIVISION
MICHIGAN-OHIO DISTRICT OFFICE

RECOMMENDED EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

Discharger

Diamond Products, Inc.
333 Prospect
Elyria, Ohio 44035

NPDES Application Number: None

NPDES Permit Number: None

Justification

The company discharges about 2000 gpd of cooling water to an Elyria Storm Sewer with oil contamination as a problem. The final effluent limitations are based on Ohio EPA's estimate of BPCTCA.

Recommended Effluent Limitations and Monitoring Requirements

Constituent	Present Performance	LIMITATIONS Initial Avg.	Initial Max.	Final Avg.	Final Max.	MONITORING REQUIREMENTS Sample Type	Frequency
Flow (gpd)	--	--	--	--	--	Estimate	Monthly
Oil and Grease (mg/l)	--	--	--	10	20	Grab	Monthly
pH (s.u.)	--	6 - 9		6 - 9		Grab	Monthly

Special Conditions

Method of flow estimation should be described in self-monitoring reports.

U. S. ENVIRONMENTAL PROTECTION AGENCY
REGION V
SURVEILLANCE AND ANALYSIS DIVISION
EASTERN DISTRICT OFFICE

RECOMMENDED EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

Discharger: Grafton State Farm Honor Prison
1800 South Avon - Belden Road
Eaton Twp, Ohio 44044

NPDES Application No.: OH 0043534

NPDES Permit No.: None

Justification:

The prison discharges about 65,000 gpd of sanitary wastes to Alexander Ditch, which has a 7-day 10-year low flow of 0 cfs. The initial effluent limitations are based on 1972 Ohio EPA monitoring reports, whereas the final limitations are based on the information contained in Table IX-15.

Recommended Effluent Limitations and Monitoring Requirements

Constituent	Present Performance	LIMITATIONS +				MONITORING REQUIREMENTS	
		Initial		Final		Sample Type	Frequency
		Avg.	Max.	Avg.	Max.		
Flow (mgd)	--	--	--	0.065	--	Continuous	
BOD_5 (mg/l)	18	25	50		10	8 hr comp.	Weekly
Suspended Solids mg/l	31	40	60		10	8 hr comp.	Weekly
NH_3-N (mg/l)	--	--	--		*	8 hr comp.	Monthly
DO (min) (mg/l)	5	--	--		6.0	Grab	Weekly
Fecal Coliform (no/100 ml)	--	200	400	1000	2000	Grab	Monthly
pH (s.u.)	--	6 - 9		6 - 9		Grab	Weekly

*NH_3-N

May-October = 2.0
November-April = 5.0

+ Average - Weekly Average
Maximum - Monthly Average

Special Conditions

None

U. S. ENVIRONMENTAL PROTECTION AGENCY
REGION V
SURVEILLANCE AND ANALYSIS DIVISION
EASTERN DISTRICT OFFICE

RECOMMENDED EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

Discharger: J & M Butchering Company
17333 Avon Belden Road
Grafton, Ohio 44044

NPDES Application No.: None

NPDES Permit No.: None

Justification:

The company discharges less than 10,000 gpd of process and sanitary wastes to an unnamed tributary of Salt Creek, which has a water quality design flow of zero cfs. The final limitations are based on the information contained in Table IX-15.

Recommended Effluent Limitations and Monitoring Requirements

Constituent	Present Performance	LIMITATIONS				MONITORING REQUIREMENTS	
		Initial		Final +		Sample Type	Frequency
		Avg.	Max.	Avg. 30 day	Avg. 7 day		
Flow (gpd)	--	--	--	--	--	Estimate	Monthly
BOD_5 (mg/l)	--	--	--		10	Grab	Monthly
Oil and Grease (mg/l)	--	--	--		7	Grab	Monthly
Ammonia (mg/l)						Grab	Monthly
May-October					2.0		
November-April					5.0		
Suspended Solids (mg/l)	--	--	--		10	Grab	Monthly
Fecal Coliform (#/100 ml)				1000	2000	Grab	Monthly
Dissolved Oxygen (min)mg/l	--	--	--	6		Grab	Monthly
pH (s.u.)	--	6 - 9		6 - 9		Grab	Monthly

+ Final limits are for 7 consecutive days.

Special Conditions

None

U. S. ENVIRONMENTAL PROTECTION AGENCY
REGION V
SURVEILLANCE AND ANALYSIS DIVISION
MICHIGAN-OHIO DISTRICT OFFICE

RECOMMENDED EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

Discharger

Koehring Plants No. 3 and 5
300 West River Road
Elyria, Ohio 44035

NPDES Application Number: OH 072 0X2 2 000549

NPDES Permit Number: None

Justification

The company discharges about 100 gpd of cooling water and boiler blowdown to an Elyria storm sewer.

Recommended Effluent Limitations and Monitoring Requirements

Constituent	Present Performance	LIMITATIONS				MONITORING REQUIREMENTS	
		Initial		Final		Sample Type	Frequency
		Avg.	Max.	Avg.	Max.		
Flow (gpd)	--	--	--	--	--	24 Hour Total	Monthly
pH (s.u.)	--	6 - 9		6 - 9		Grab	Monthly

Special Conditions

U. S. ENVIRONMENTAL PROTECTION AGENCY
REGION V
SURVEILLANCE AND ANALYSIS DIVISION
MICHIGAN-OHIO DISTRICT OFFICE

RECOMMENDED EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

Discharger

Lake Erie Plastics Company
Bond and Adams Street
Elyria, Ohio 44035

NPDES Application Number: None

NPDES Permit Number: None

Justification

The company discharges about 2,000 gpd of cooling water and boiler blowdown to an Elyria Storm Sewer.

Recommended Effluent Limitations and Monitoring Requirements

Constituent	Present Performance	LIMITATIONS Initial Avg.	LIMITATIONS Initial Max.	LIMITATIONS Final Avg.	LIMITATIONS Final Max.	MONITORING REQUIREMENTS Sample Type	MONITORING REQUIREMENTS Frequency
Flow (gpd)	2000	--	--	--	--	Estimate	Monthly
pH	--	6 - 9		6 - 9		Grab	Monthly

Special Conditions

1) The discharge should be limited to non-contact cooling water and boiler blowdown.
2) The method of flow estimation should be stated in the self-monitoring reports.

U. S. ENVIRONMENTAL PROTECTION AGENCY
REGION V
SURVEILLANCE AND ANALYSIS DIVISION
EASTERN DISTRICT OFFICE

RECOMMENDED EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

Discharger: Lodi STP

NPDES Application No.: OH0020991

NPDES Permit No.: --

Justification:

Effluent limitations were determined using U.S. EPA, Region V, Simplified Waste Load Allocation Methodology for municipal sewage treatment plants on low flow streams (see Appendix V and Section IX.2)

Recommended Effluent Limitations and Monitoring Requirements

Constituent	Present Performance	LIMITATIONS				MONITORING REQUIREMENTS	
		Initial		Final		Sample Type	Frequency
		Avg.	Max.	Avg.	Max.		
Flow mgd	.281	--	--	.4		Continuous	Daily
BOD_5 mg/l	4	10	15		10	Composite-24 hr	1/week
Suspended Solids mg/l	4	15	25		10	Composite-24 hr	1/week
Ammonia-N mg/l							
May-October	--	--	--		1.5	Composite-24 hr	1/week
November-April	--	--	--		5.0	Composite-24 hr	1/week
DO (min) (mg/l)	5.4	--	--	6.0		Grab	Daily
Fecal Coliform (#/100 ml)	--	200	400	1000	2000	Grab	1/month

U. S. ENVIRONMENTAL PROTECTION AGENCY
REGION V
SURVEILLANCE AND ANALYSIS DIVISION
MICHIGAN-OHIO DISTRICT OFFICE

RECOMMENDED EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

Discharger

Lorain - Elyria Sand Company
1840 Idaho Avenue
Lorain, Ohio 44052

NPDES Application Number: OH 070 0X2 3 000160

NPDES Permit Number: None

Justification

The company discharges about 0.48 mgd of gravel washwater to the Black River. The initial and final effluent limitations are based on the Ohio EPA estimate of BPCTCA. The present waste treatment system should be able to meet the suspended solids limitations.

Recommended Effluent Limitations and Monitoring Requirements

Constituent	Present Performance	LIMITATIONS Initial Avg.	LIMITATIONS Initial Max.	LIMITATIONS Final Avg.	LIMITATIONS Final Max.	MONITORING REQUIREMENTS Sample Type	MONITORING REQUIREMENTS Frequency
Flow (mgd)	0.48	--	--	--	--	Grab	Weekly
Suspended Solids (mg/l)	--	30	45	30	45	8 hour Comp.	Weekly
Oil and Grease (mg/l)	--	--	--	--	--	Grab	Monthly
pH	--	6 - 9		6 - 9		Grab	Weekly

Special Conditions

None

U. S. ENVIRONMENTAL PROTECTION AGENCY
REGION V
SURVEILLANCE AND ANALYSIS DIVISION
EASTERN DISTRICT OFFICE

RECOMMENDED EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

Discharger: Oberlin Water Treatment Plant
Parsons Road
Oberlin, Ohio 44074

NPDES Application No.: Oberlin - OH 0045195

NPDES Permit No.: None

Justification:

It is a lime softening plant discharging filter backwash and softening sludge. The final limitations are based on Ohio EPA's estimate of BPCTCA for Water Treatment Plants.

Recommended Effluent Limitations and Monitoring Requirements

Constituent	Present Performance	LIMITATIONS				MONITORING REQUIREMENTS	
		Initial		Final		Sample Type	Frequency
		Avg.	Max.	Avg.	Max.		
Flow (gpd)	--	--	--	--	--	Estimate	Biweekly, when discharging
Suspended Solids (mg/l)	--	--	--	15	20	Grab	"
pH	--	--		6-11.5		Grab	"

Special Conditions

None

U. S. ENVIRONMENTAL PROTECTION AGENCY
REGION V
SURVEILLANCE AND ANALYSIS DIVISION
MICHIGAN-OHIO DISTRICT OFFICE

RECOMMENDED EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

Discharger

Ohio Screw Products
818 Lowell Street
Elyria, Ohio 44035

NPDES Application Number: None

NPDES Permit Number: None

Justification

The company discharges about 600 gpd of cooling water to an Elyria storm sewer. The oil and grease limitations are based on Ohio EPA's estimate of BPCTCA.

Recommended Effluent Limitations and Monitoring Requirements

Constituent	Present Performance	LIMITATIONS				MONITORING REQUIREMENTS	
		Initial		Final		Sample Type	Frequency
		Avg.	Max.	Avg.	Max.		
Flow (gpd)	--	--	--	--	--	24 hour Total	Monthly
Oil and Grease (mg/l)	--	--	--	10	20	Grab	Monthly
pH	--	6 - 9		6 - 9		Grab	Monthly

Special Conditions

NONE

U. S. ENVIRONMENTAL PROTECTION AGENCY
REGION V
SURVEILLANCE AND ANALYSIS DIVISION
EASTERN DISTRICT OFFICE

RECOMMENDED EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

Discharger

Stanadyne - Western Division
377 Woodland Avenue
Elyria, Ohio 44035

NPDES Application Number: OH 070 0X2 2 000152

NPDES Permit Number: OH 0000426 (suspended)

Justification

The company discharges about 0.49 mgd of process and cooling water to an Elyria storm sewer. The initial effluent limitations are based on February-July, 1973 state operating reports. The final effluent limitations except for cadmium are based on existing effluent quality or the March 28, 1974 Electroplating BPCTCA guidelines, whichever is more stringent. The cadmium limitation is based on the Ohio EPA estimate of BPCTCA.

Recommended Effluent Limitations and Monitoring Requirements

Constituent	Present Performance	LIMITATIONS Initial Avg.	Initial Max.	Final Avg.	Final Max.	MONITORING REQUIREMENTS Sample Type	Frequency
Flow (mgd)	0.49	--	--	--	--	24 hour Total	Weekly
TSS (lb/day)	34	34	68	34	68	24 hour Comp.	Weekly
Hexa. Chromium (lb/day)	0.4	0.4	0.8	0.3	0.6	24 hour Comp.	Weekly
Cyanide-A* (lb/day)	--	--	--	0.09	0.18	24 hour Comp.	Weekly
Cyanide, Total (lb/day)	0.09	0.09	0.18	0.09	0.18	24 hour Comp.	Weekly
Cadmium, Total (lb/day)	--	--	--	0.05	0.10	24 hour Comp.	Weekly
Copper, Total (lb/day)	1.5	1.5	3.0	1.5	3.0	24 hour Comp.	Weekly
Nickel, Total (lb/day)	62.3	--	--	2.6	5.3	24 hour Comp.	Weekly
Zinc, Total (lb/day)	0.2	0.2	0.4	0.2	0.4	24 hour Comp.	Weekly
pH (s.u.) **	6 - 10	6 - 10		6 - 9.5		Continuous	--

*A - amenable to chlorination

** pH - maximum and minimum daily readings should be included in the self monitoring reports.

Special Conditions

NONE

U. S. ENVIRONMENTAL PROTECTION AGENCY
REGION V
SURVEILLANCE AND ANALYSIS DIVISION
EASTERN DISTRICT OFFICE

RECOMMENDED EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

Discharger

Tappan, Inc.
206 Woodford Street
Elyria, Ohio 44035

NPDES Application Number: None

NPDES Permit Number: None

Justification

The company discharges about 26,000 gpd of non-contact cooling water and boiler blowdown to an Elyria Storm Sewer.

Recommended Effluent Limitations and Monitoring Requirements

Constituent	Present Performance	LIMITATIONS				MONITORING REQUIREMENTS	
		Initial		Final		Sample Type	Frequency
		Avg.	Max.	Avg.	Max.		
Flow (gpd)	26,000	--	--	--	--	Daily Total	Biweekly
Temperature (^{o}F)	--	--	--	--	--	Grab	"
pH	--	6-9		6-9		Grab	"

Special Conditions

The discharge should be limited to non-contact cooling water and boiler blowdown.

U. S. ENVIRONMENTAL PROTECTION AGENCY
REGION V
SURVEILLANCE AND ANALYSIS DIVISION
EASTERN DISTRICT OFFICE

RECOMMENDED EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

Discharger: Wellington Water Treatment Plant

NPDES Application No.: None

NPDES Permit No.: None

Justification:

It is a lime softening plant discharging filter backwash and softening sludge. The final limitations are based on Ohio EPA's estimate of BPCTCA for Water Treatment Plants.

Recommended Effluent Limitations and Monitoring Requirements

Constituent	Present Performance	LIMITATIONS				MONITORING REQUIREMENTS	
		Initial		Final			
		Avg.	Max.	Avg.	Max.	Sample Type	Frequency
Flow (gpd)	--	--	--	--	--	Estimate	Biweekly, when discharging
Suspended Solids (mg/l)	--	--	--	15	20	Grab	"
pH	--				6-11.5	Grab	"

Appendix V

Technical Justification for NPDES Effluent Limitations for Municipalities on Low Flow Streams

Technical Justification for NPDES Effluent Limitations for Municipalities on Low Flow Streams

Prepared by

U.S. Environmental Protection Agency
Region V
Ad Hoc Committee on Waste Load Allocation and
Water Quality Standards

Technical Justification for NPDES Effluent Limitations for Municipalities on Low Flow Streams

Introduction

In order to better coordinate State, regional, and headquarters preparation and review of justification for AST/AWT projects, and to expedite the preparation and review process, a simplified methodology for determining effluent limitations for municipalities on low flow stream is proposed. The intent is to insure that public funds for water pollution abatement are spent in a cost effective fashion.

Effluent limits for municipalities located on low flow streams can be adequately established and justified by rather simplified methods which do not consume an inordinate amount of State resources to develop the limits, or Agency resources for project review. In Region V, these simplified methods are estimated to be applicable to more than fifty percent of the projects. While the potential savings in State and EPA resources are substantial, cost effective and technically sound effluent limitations to protect State-adopted and federally-approved water uses and water quality standards will result. Furthermore, if used on a regional or larger scale, consistent consideration of dischargers in similar circumstances would be insured.

Water quality models are available for the full range of hydrological characteristics (i.e. free flowing streams, estuaries, lakes), and their use is becoming increasingly widespread as river basin scale planning and 208/201 planning advances. However, one of the major precepts in working with water quality models is to select the least complicated model that adequately characterizes the system being studied. As models become more complex, data requirements to successfully operate the models increase significantly. In most cases, these data are not obtainable without the expenditure of substantial resources. It is clear that resources should be expended for model verification and calibration in those complex situations where simplified methods to characterize the combined effects of numerous dischargers are not adequate. However, for those isolated municipalities on low flow, free flowing streams, the expenditure of substantial resources to determine effluent limitations is not warranted; nor are such resources readily available in State agencies, U.S. EPA, or in the consulting engineering profession. For purposes of this paper, low flow streams are generally defined as those free-flowing streams where the water quality design flow upstream of a municipal discharger is equal to or less than the design municipal discharge flow. In Region V, all States use the $Q_{7,10}$ or hydraulically altered flow regimes as water quality design flows.

The simplified methods outlined below incorporate a mass balance technique to determine ammonia-nitrogen limitations; a simplified Streeter-Phelps analysis to determine carbonaceous oxygen demand limits; a sensitivity analysis; and, suspended solids limits related to the required BOD discharge. The analytical techniques proposed in the 1977 report Water Quality Assessment: A Screening Method for Nondesignated 208 Areas, prepared by Tetra Tech Inc. for U.S. EPA Environmental Research Laboratory are similar.(1)

Application and Constraints

The method should be applicable to single municipal dischargers located on free flowing streams where the upstream flow is equal to or less than design discharge flow; the design discharge flow is 10 MGD or less; and, there are no, or only limited, interactive effects from the most upstream discharger on a segment with more than one discharger. The method should only be used for the upstream discharger in such cases.

Water quality in these systems is highly dependent upon effluent quality. Hence, upstream quality is less significant than in systems where the upstream design flows are much greater than design effluent flows. The method can also be applied to simple systems where upstream flow is greater than STP flow provided upstream water quality and reaction kinetics are well documented.

Procedure

The following stepwise procedure is recommended for determining effluent limits for the simple single-source system:

1. Ammonia-N Effluent Limitations

Determine ammonia-N limitations by using applicable WQS, upstream flow and background concentration, and design effluent flow as shown below: (2)

Eq. 1 $$C_D = \{C_{WQS}(Q_D + Q_U) - C_U Q_U\}/Q_D$$

where

C_D = allowable design discharge concentration

C_{WQS} = water quality standard limit

C_U = upstream or background concentration

Q_D = design municipal discharge flow rate

Q_U = upstream design flow

When selecting the allowable instream ammonia-N WQS criterion (C_{WQS}) from tables or graphs relating the toxicity of unionized ammonia-N to pH and temperature, appropriate values for the expected pH and temperature conditions during the design season after mixing of the discharge and the receiving stream should be considered. In many cases use of the maximum pH and temperature values ever recorded is not realistic. If sufficient stream data are available, the use of temperature and pH data exceeded twenty-five percent of the time during the critical low flow season is appropriate. Where actual stream data are limited or not available, use of data from nearby streams or equilibrium water temperature data may be used as design conditions and to establish the range for a sensitivity analysis. For cases where the municipal effluent will comprise most of the stream flow, effluent pH data should be considered.

The mass balance technique can also be used for total residual chlorine or metals limits, if desired.

2. BOD_5 and Dissolved Oxygen Effluent Limitations

Determine effluent dissolved oxygen and BOD limitations with a simplified Streeter-Phelps[3] analysis employing both carbonaceous and nitrogenous oxygen demands. The equation used to calculate the DO deficit (D) below a point source is shown below: [2]

Eq. 2 $$D = Do \exp(-K_2 t) + (K_1 CBOD_o)/(K_2 - K_1)\{\exp(-K_1 t) - \exp(-K_2 t)\}$$

$$+ (K_3 NBOD_o)/(K_2 - K_3)\{\exp(-K_3 t) - \exp(-K_2 t)\}$$

$$DO_{avg.} = DO_s - D$$

where

Do = mixed DO deficit at effluent, mg/l
DO_s = DO at saturation, mg/l
$CBOD_o$ = mixed ultimate CBOD concentration below effluent, mg/l
$NBOD_o$ = mixed NBOD concentration below effluent, mg/l
K_1 = CBOD reaction rate (base e), day^{-1}
K_2 = Reaeration rate (base e) day^{-1}
K_3 = NBOD reaction rate (base e) day^{-1}
t = travel time below discharge, days

Incremental time periods are applied in equation 2 to determine the location of the minimum DO concentration (i.e. sag point). Successively lower CBOD values are applied until DO standards are met at the sag point.

DO standards are often presented as minimum values applicable at all times while the time average for outputs of steady state models are based upon the averaging period for input loadings, usually 24 hours. Hence, attainment of minimum DO standards is compensated for by modeling at a higher target dissolved oxygen, usually 1 mg/l higher than the minimum water quality standard. This level is to compensate for diurnal fluctuations in plant discharges and diurnal variation due to photosynthetic activity. Where both average and minimum dissolved oxygen standards are specified (i.e. 5.0 mg/l daily average and 4.0 mg/l minimum at any time) the average standard should be used as a target level. Use of a minimum dissolved oxygen standard as a target with a steady state model would result in violations of the standard.

The critical variables in a DO analysis on a small stream are the reaeration rate and to a lesser extent the CBOD and NBOD decay rates and effluent dissolved oxygen levels. Many formulations have been developed for predicting stream reaeration rates based upon physical characteristics such as width, depth, velocity, and slope.[4,5] Rathbun[6] suggests that the Tsivoglou formula[7] most accurately predicts stream reaeration. K_2 is calculated by equation 3. Also, a recent work by the United States Geological Survey and the Wisconsin Department of Natural Resources demonstrated the Tsivoglou relationships to be the most accurate of twenty predictive reaeration equations on small flow streams when compared with tracer methods.[8]

Eq. 3 $K_2 = 0.88\ VS$ at $20^{o}C$ $10 < Q < 300$ cfs

$K_2 = 1.8\ VS$ at $20^{o}C$ $1 < Q < 10$ cfs

where S is the slope in ft/mile and V is velocity in ft/sec. According to Dr. Tsiviglou, there is no evidence to support restricting the use of Equation 3 based upon minimum slope.(9) However, O'Connor's reaeration formulation may be used for larger, deeper streams with more uniform channel geometry:(4)

Eq. 4 $$K_2 = 12.9 \frac{V^{1/2}}{H^{3/2}} \text{ at } 20^{o}C$$

where

H is average stream depth in feet.

A review of reaction rates measured on low flow streams with similar depth, flow, and quality to those addressed is this analysis showed CBOD rates typically range from 0.3 to 1.3 (10,11,12,13) depending on depth and degree of treatment (Table 1). Adjusting CBOD day-1 rates by depth as suggested by Hydroscience(13) shows 0.3 day-1 to be a representative value for these low flow streams. CBOD rate, therefore, becomes:(14)

Eq. 5 $K = 0.3\ (D/8)^{-0.434}$ day-1 $0 < D < 8$

$K = 0.3$ day-1 $D \geq 8$

where

D = depth in feet

Based upon data presented in Table 1, the CBOD rate should be constrained to a maximum value of 1 day^{-1} after depth adjustment. Measured NBOD rates ranged from 0.27 to 0.50 day-1 and averaged 0.42 day-1 (Table 1). Since reaction rates are partially dependent on effluent treatment level it is appropriate to use the rates measured below similar facilities on small streams. Reaction rate studies on low flow streams where existing waste treatment is not adequate would provide little additional information since rates would be expected to change after installation of more advanced waste treatment. The use of the above-mentioned average rates are recommended unless other rates can be justified.

Reaction rates must be adjusted for stream temperature using the generalized expression: [15]

Eq. 6 $$K = K\ (\text{at } 20^{\circ}C)\ \theta^{(T-20)}$$

where

T = stream temperature $^{\circ}C$

θ = 1.024 for reaeration rate, 1.047 for CBOD rate, and 1.1 for NBOD rate.

In some cases, it may be advisable from design and operations standpoints to provide for less restrictive CBOD limitations and more restrictive NBOD (NH_3-N) limitations while maintaining the same ultimate oxygen demand of the effluent. (Ultimate oxygen demand is the sum of the carbonaceous demand and nitrogenous demands.) This may occur when resultant ammonia-N limits are 3 to 5 mg/l and CBOD limits are in the range of 5 to 10 mg/l. Stream reaction rate differences in CBOD and NBOD should be considered when adjusting effluent restrictions. Since each mg/l of ammonia-N is equivalent to about 4.5 mg/l of CBOD, lowering the allowable ammonia-N limit by 1 mg/l could have the effect of raising the CBOD limit by nearly 5 mg/l, if $K_C = K_N$.

As part of the dissolved oxygen analysis it is necessary to consider post aeration of municipal effluents and seasonal effluent limitations.

3. The sensitivity of computed effluent loads to input values should be determined by repeating the above analysis with changes in the input variables. For the mass balance calculations the sensitivity to the background conditions of flow and concentration should be addressed. For the Streeter-Phelps analysis it is necessary to evaluate sensitivity to background conditions, reaction rates

(CBOD, NBOD, and reaeration) and travel time. Each coefficient should be varied over a range of values that reflects the uncertainty in the particular variable. If direct measurements of certain input variables are made, the range about the variable would be small. If rates or rate formulations other than those suggested above are used, the sensitivity analysis should be used as part of the justification for the alternate rates. CBOD and NBOD rates should generally be varied plus or minus 33% to 50% about the selected value unless directly transferrable rate data are employed in which case a smaller range might be studied.

Results of the sensitivity analysis should be reviewed within the context of the effluent quality expected for various treatment levels. Thus, if effluent requirements computed using the range of inputs fall within the expected effluent quality from a single treatment level (i.e. AST or AWT) then additional analyses would not be required. However, if the required treatment level is heavily dependent upon selection of an input value where existing data are inadequate to characterize the variable, additional data should be obtained to more accurately define that model coefficient, thus clarifying the selection of the treatment alternative. For further confirmation of the selected effluent limitations, the sensitivity analysis can be rerun at a less stringent level of treatment (i.e. BOD_5 of 30 mg/l vs 15 mg/l).

4. After the sensitivity analysis is completed, suspended solids limitations should be related to the BOD requirements. Whenever BOD_5 limits of less than 15 mg/l are required, it is clear that post filtration will be necessary to insure consistent compliance with the BOD limits. Hence, suspended solids limits of 10 to 15 mg/l, based upon filter performance would be appropriate. Where BOD_5 limits in excess of 15 mg/l are required, post filtration is usually not necessary and suspended solids limits of 20 to 25 mg/l are appropriate. However, filters may be required where unusual wastewater characteristics are encountered (i.e. industrial wastes). For many plants, split flow filtering may be adequate to achieve applicable TSS and BOD_5 limits during the first five to ten years of a twenty year design life. Post filtration may also be necessary where stringent phosphorus limitations are prescribed, and will aid in toxics removal from STP effluents. The above limits were obtained from consultants and State agency

personnel and reflect consideration of consistency and reliably achieving the desired effluent quality.

Data Requirements

The data required for this type of analysis and suggested methods of obtaining these data are listed below:

1. Stream Design Flow - USGS low-flow publications; drainage area yields; measurements during low flow periods.

2. Upstream water quality - State or EPA water quality monitoring; sewage treatment plant monitoring; data for similar streams.

3. Stream Physical Characteristics (slope, depth, etc.) - field measurements; USGS topographic maps; special COE or county project maps; stream gazetteers.

4. Time of Travel - Dye studies; calculations based upon field measurements of widths, depths, etc.; estimates based upon slope/velocity relationships.

5. Effluent Design Flow - State or local agency population projections; Step I applications.

Direct measurements of time-of-travel, upstream quality, and stream physical characteristics should be employed for each segment studied, notably for those where post filtration of the STP effluent is considered. Since these data are readily obtainable with short duration, low resource surveys, efforts should be made to obtain the data through State agency monitoring programs or as part of the 201 grant process. When such data are not available, estimates can be made from some of the suggested sources listed above. The impact of less site specific data should be considered in the sensitivity analysis. Time of travel studies provide the most useful data when the upstream flow and existing STP flow are equivalent to the sum of the upstream $Q_{7,10}$ and the STP design flow. If flows in the immediate range of design flow are not encountered during the time-of-travel studies, a second study at a different flow will permit extrapolation of the data to the design flow.

NPDES Effluent Limitations

Typically, municipal effluent limitations are specified as 30 day and seven day average values for BOD_5, ammonia-N, and, suspended solids with daily maximum values for chlorine residual. Because of the high ratio of discharge flow to upstream flow for municipalities on low flow streams, the effects of the treated discharges on downstream water quality are particularly significant. Hence, the results of the simplified analysis should be employed as seven day average limits rather than thirty day averages. An alternate approach recently adopted by Michigan considers daily concentration limits based upon the water quality analysis and weekly mass loading limits based upon the design (20 year) flow of the facility and the daily effluent concentration limits. In any event, use of modeling results as 30 day averages is not consistent with the mathematical relationships used in the analysis.

The CBOD and NBOD outputs from the Streeter-Phelps analysis should be converted to BOD_5 and ammonia-N NPDES permit limitations with the following relationships:

$$BOD_5 = CBOD/3$$

$$NH_3\text{-}N = NOD/4.57$$

The factor for BOD_5 was derived from long term BOD data obtained at advanced and secondary sewage treatment plants[16,17,18] (Table 2). A statistical analysis of these data indicates there is no correlation between the $CBOD/BOD_5$ ratio and the percent industrial flow.

Margin of Safety

Section 303(d) of the Clean Water Act requires that a margin of safety reflecting the uncertainty in the relationships between effluent limitations and water quality be considered. Since this analysis relies heavily on site-specific data; incorporates a sensitivity analysis around effluent quality; addresses diurnal variation; and, addresses treatment system performance and reliability (i.e. post filtration where applicable), a margin of safety is implicity included. A separate margin of safety should be considered when the analysis is of questionable validity due to a lack of data about the system, or the applicable stream standards are only marginally protective of designated stream uses (i.e. minimum dissolved oxygen of 4.0 mg/l for warmwater fisheries).

Resource Requirements

Including the time required for minor field surveys (upstream water quality, time-of-travel, etc.) about two to three man-weeks of effort should be sufficient to develop an acceptable project justification report.

Example

Attachment A

Table 1

Reaction Rates Measured on Low Flow Streams

River	CBOD Rate Measured	CBOD Rate Depth Adjusted	NBOD* Rate	Treatment Level	Flow (cfs) River	Flow (cfs) STP	Depth (ft)
Upper Olentangy, Ohio (7)	1.24	0.43	--	AST - No nitrification	2.3	3.0	0.7
Patuxent River, Maryland (8)	0.30	0.3	.27-.50	AWT - Nitrification with microscreens	31	6.8	--
West Fork of Blue River, Indiana (9)	0.5-0.79	0.2-.32	0.5	AST - Secondary with rapid sand filters	4	1.4	0.9-1.2
Hydroscience (10)	.37-.96	.19-.42		Highly treated effluent with nitrification			1-3
Recommended Values		0.3	.42				

Depth Adjustment $K = K\ (\text{Measured})\ (D/8)^{.434}$ $D < 8$ ft

* Reaction rates are at 20°C

Table 2

CBOD/BOD_5 Data

State	Plant	Type	Flow (MGD)	Percent Industrial Flow	# of Samples	Ult. CBOD/BOD_5
Ohio	Lakewood	Activated Sludge	11.7	0%	1	3.27
Ohio	Mansfield	Activated Sludge	10.6	32%	1	3.43
Ohio	Shelby	Activated Sludge	1.2	0%	3	3.21
Ohio	Lorain	Activated Sludge	14.1	14%	4	3.13
Ohio	Coshocton	Activated Sludge	2.3	39%	1	4.34
Ohio	Conneaut	Activated Sludge	2.6	0%	1	2.61
Ohio	CRSD Easterly	Activated Sludge	136.0	12%	2	5.10
Minnesota	Minneapolis-St. Paul	Activated Sludge		27%	13	3.18
Wisconsin	Fall Creek	Trickling Filter			2	3.40
Wisconsin	Neenah-Menasha	Activated Sludge		40%	2	3.20
Wisconsin	Town Menasha East	Activated Sludge		22%	1	1.80
Wisconsin	Town Menasha West	Activated Sludge		42%	2	3.10
Wisconsin	Heart of the Valley	Act. and filters	5	<10%	2	2.75
Wisconsin	Depere	Activated Sludge		20%	1	3.00
Average						3.2

References

1) Tetra Tech Inc., Water Quality Assessment; A Screening Method for Nondesignated 208 Areas, U.S. EPA Publication No. EPA-600/9-77-023, August 1977.

2) Thomann, R.V., Systems Analysis and Water Quality Management, McGraw Hill Book Co., 1972, pp 65-122.

3) Streeter, H.W. and Phelps, E.B., "A Study of the Pollution and Natural Purification of the Ohio River, III, Factors Concerned in the Phenomena of Oxidation and Reaeration", U.S. Public Health Servant, Public Health Bulletin No. 146.

4) Covar, A.P., "Selecting the Proper Reaeration Coefficient for use in Water Quality Models", presented at the U.S. EPA Conference on Environmental Modeling and Simulation, April 1976.

5) Bennett, J.P., and Rathbun, R.E., "Reaeration in Open-Channel Flow, Geological Survey Professional Paper 737", 1972.

6) Rathbun, R.E., "Reaeration Coefficients of Streams, State-of-the-Art", Journal of the Hydraulics Division, ASCE, Vol. 103 No. HY4, April 1977.

7) Tsivoglou, E.C., and Wallace, J.R., "Characterization of Stream Reaeration Capacity", U.S. Environmental Protection Agency, Report No. EPA-R3-72-012, October 1972.

8) Grant, R.S. and Skavroneck, Comparison of Tracer Methods and Predictive Equations for Determination of Stream Reaeration Coefficients on Three Small Streams in Wisconsin, U.S. Geological Survey, Water Resources Investigation 80-19, March 1980.

9) Personal communication with Dr. Ernest Tsivoglou, March 26, 1980.

10) Personal Communication with Maan Osman, Upper Olentangy Water Quality Survey, Ohio EPA, September 1979.

11) Pheiffer, T.H., Clark, L,J., and Lovelace, N.L., "Patuxent River Basin Model, Rates Study", Presented at U.S. EPA Conference on Environmental Modeling and Simulations, April 1976.

12) Personal Communication with Dr. T.P. Chang, West Fork of Blue River Water Quality Survey, Indiana State Board of Health, September 1979.

13) Hydroscience Inc., Simplified Mathematical Modeling of Water Quality, U.S. EPA, March 1971.

14) Raytheon Co., Oceanographic and Environmental Services, Expanded Development of BEBAM-A Mathematical Model of Water Quality for the Beaver River Basin, U.S. EPA Contract No, 68-01-1836, May 1974.

15) Tetra Tech Inc., Rates, Constants, and Kinetic Formulations in Surface Water Quality Modeling, U.S. EPA Publication No. EPA-600/3-78-105, December 1978.

16) U.S. EPA, Region V, Eastern District Office, Dischargers Files.

17) Personal Communication with Mark Tusler, Water Quality Evaluation Section, Wisconsin Department of Natural Resources, October 17, 1979.

18) Upper Mississippi River 208 Grant Water Quality Modeling Study, Hydroscience Inc., January 1979.

Attachment A

Example Problem

1. Planning Area

Raccoon Creek is a small northern Ohio stream which flows 12 miles in a northerly direction discharging to Lake Erie west of Cleveland, Ohio. Similar to other northern Ohio streams, the creek's 44 square mile drainage area has little groundwater storage. As such, the stream has low natural flows during dry weather periods (Q_{7-10} of 0.36 cfs). Ohio Water quality standards designate Raccoon Creek as a warmwater fishery and for primary contact recreation.

The City of Lakeview, population about 10,000, operates a secondary sewage treatment plant which discharges to Raccoon Creek about 4 miles upstream of the mouth. The plant began operation in 1927 and provides treatment for a daily average flow of 1.2 MGD composed almost entirely of domestic wastes. The facility has a communitor, preaeration and grit removal tanks, primary settling tanks, trickling filters, secondary settling tanks and provisions for chlorination of the final effluent. Sludge disposal is accomplished by digestion and drying on sludge drying beds. Average effluent quality for 1978 was 33 mg/l suspended solids, 29 mg/l BOD_5, 7.7 mg/l dissolved oxygen and 6.1 mg/l phosphorus. The plant is the only significant discharge to the stream. Based upon 208 agency population projections plant design flow for the year 2000 is 2.1 MGD.

A U.S. EPA reconnaissance inspection on June 30, 1978, showed Raccoon Creek in the vicinity of the Lakeview STP contains areas of riffles and small pools. Upstream of the STP the substrate is primarily rocky with the stream having relatively high dissolved oxygen. Immediately downstream of the STP rocks are covered with slime, sludge worms are abundant, and the stream is malodorus. Dissolved oxygen concentrations below the minimum water quality standard occur regularly downstream of the STP. These observations clearly indicate the stream is not meeting the balanced warmwater fishery and primary contact recreation designations of the water quality standards despite average STP effluent quality in the immediate range of secondary treatment.

Effluent quality required to meet water quality standards was determined with simplified modeling techniques using available data for stream physical characteristics, reaction rates, and stream quality. The Raccoon Creek - Lakeview system meets the three criteria suggested for selecting the simplified method in that this is a single source system, critical stream flow (i.e. Q_{7-10}) upstream of the plant is less than effluent flow, and STP design flow is less than 10 MGD.

2. Wasteload Allocation

Stream data used in the allocation are presented in Table 1. Upstream flow and water quality data were not available for Raccoon Creek so Black River data were used. The Black River is adjacent to Raccoon Creek and has similar land use patterns. Representative stream velocities and depths were measured in a June 30, 1978, U.S. EPA survey and were adjusted for flow using relationships proposed by Ohio EPA. Sewage treatment plant design criteria for flow were taken from the Step 1 application or were assumed (dissolved oxygen effluent criteria). Assuming a diurnal DO fluctuation of 2.0 mg/l the allocation techniques were applied to meet a minimum DO standard of 5 mg/l.

Following methods outlined under Procedure 1, the ammonia-nitrogen effluent limitation was computed to be 2.60 mg/l. CBOD effluent limits of 21.3 mg/l were computed by the Streeter Phelps analysis. This corresponds to a BOD_5 limit of 7.1 mg/l using a CBOD to BOD_5 ratio of three. This level of ammonia and BOD_5 resulted in the average DO standard of 6 mg/l being met at the sag point which occurred 0.9 miles downstream of the outfall. A phosphorus limit of 1.0 mg/l is also required by Ohio EPA regulations (IJC) at this plant since Raccoon Creek is a tributary to Lake Erie and design flow is equal to or greater than one million gallons per day.

3. Sensitivity Analysis

The sensitivity of the allocated loads to the inputs are shown in Figures 1 and 2. Each input variable was changed separately with other input values remaining at the base conditions shown in Table 1. Also shown on figure 2 is the

Table 1

Documentation for Input Variable Selection

pplicable WQS				
1. Dissolved Oxygen	6.0 mg/l daily average 5.0 mg/l daily minimum			
2. Ammonia-N	0.05 mg/l unionized ammonia-N			
3. Temperature	$82^{o}F$ monthly average $85^{o}F$ daily maximum	July-September		
4. pH	6-9 su			
nput Variables	Value	Measured Value	Range for Sensitivity Analysis	Source
1. Stream				
a. Upstream Flow ($Q_{7,10}$)	0.36 cfs	--	None	$Q_{7,10}$ drainage area yield of 8.26×10^{-3} cfs/mi^2 on Black River at Elyria USGS Station No. 04200500, A Proposed Streamflow Data Program for Ohio, Antilla, P.W., USGS, Columbus, Ohio 1970
b. Upstream Quality				
1. Temperature 2. Dissolved Oxygen 3. pH 4. Ammonia-N 5. CBOD	$82^{o}F$ 7.9 mg/l 7.5 su 0.05 mg/l 2 mg/l		80 to $85^{o}F$ 6.0 to 8 mg/l 7.3 to 7.7 0 to 0.1 mg/l 1 to 3 mg/l	Measured data from July 23-26, 1974 EPA survey on Black River. See text for selection of input values and ranges for sensitivity analysis.
c. Stream Slope	15 ft/mile	--	12-18	U.S. Geological Survey 7.5 Minute Series Topographical Map 1969
d. Time-of-Travel, Velocity	0.6 ft/sec	0.7 ft/sec at 5.75 cfs $V_2 = V_1\left(\frac{Q_2}{Q_1}\right)^{0.4}$	0.4 to 0.8 ft/sec	June 30, 1978 EPA Survey Ohio EPA; Policy and Procedures Manual for Developing Wasteload Allocations, June 1979
e. Depth	0.3 ft	0.4 ft ave at 5.75 cfs $D_2 = D_1\left(\frac{Q_2}{Q_1}\right)^{0.6}$	0.15 to 0.45 ft	June 30, 1978 EPA survey Ohio EPA; Policy and Procedures Manual for Developing Wasteload Allocations, June 1979
f. Reaction Rates				
1. CBOD 2. NBOD	0.3 day^{-1} at 8 ft 0.42 day^{-1}	-- --	0.20 to 0.45 day^{-1} 0.25 to 0.75 day^{-1}	
2. STP				
a. Design Flow	2.1 MGD (year 2000)	--	None	NOACA, 208 Agency, Load and Flow Projections, 1979
b. Dissolved Oxygen	6.5 mg/l	--	6 to 8.0 mg/l	Selected value

FIGURE 1

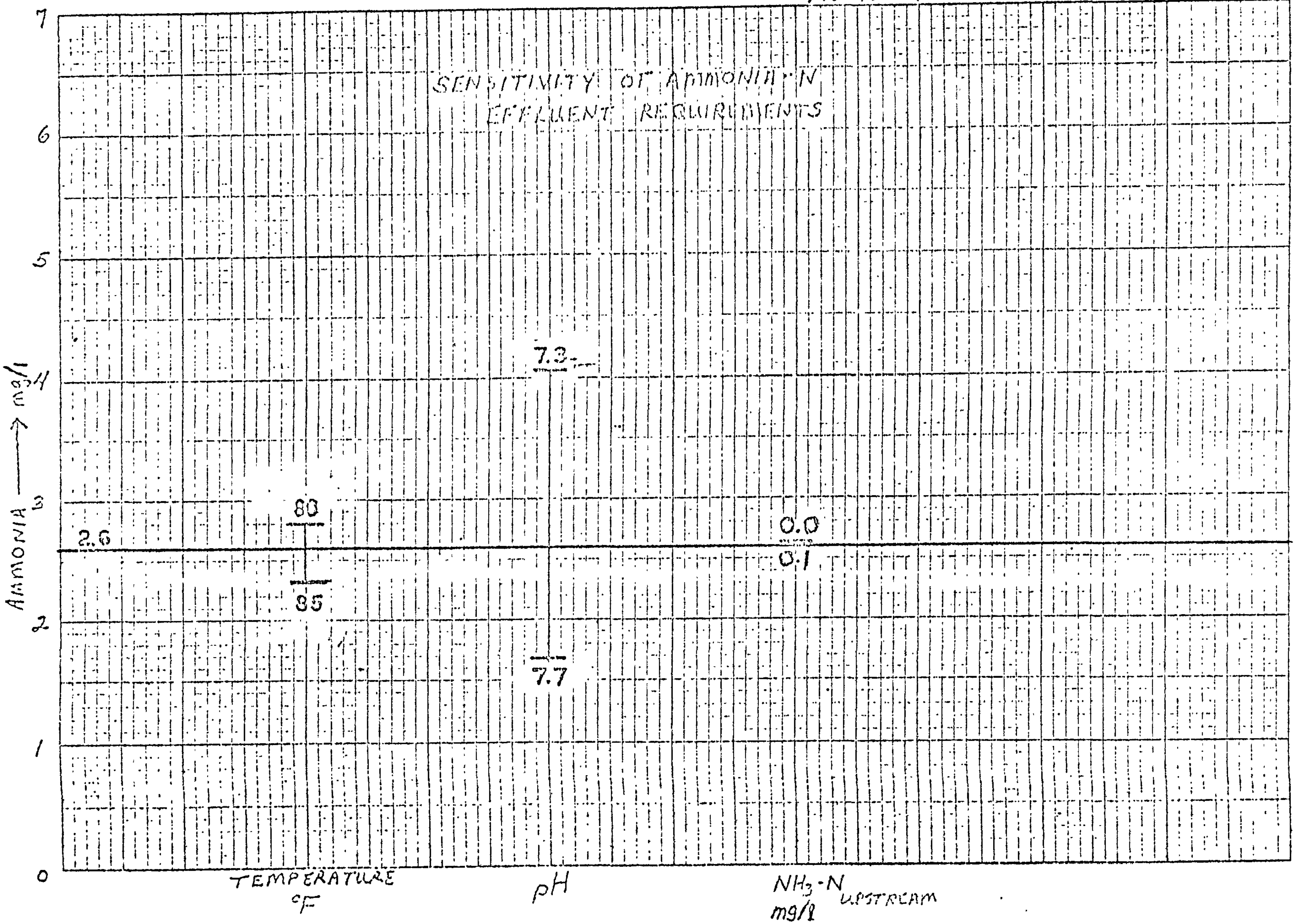
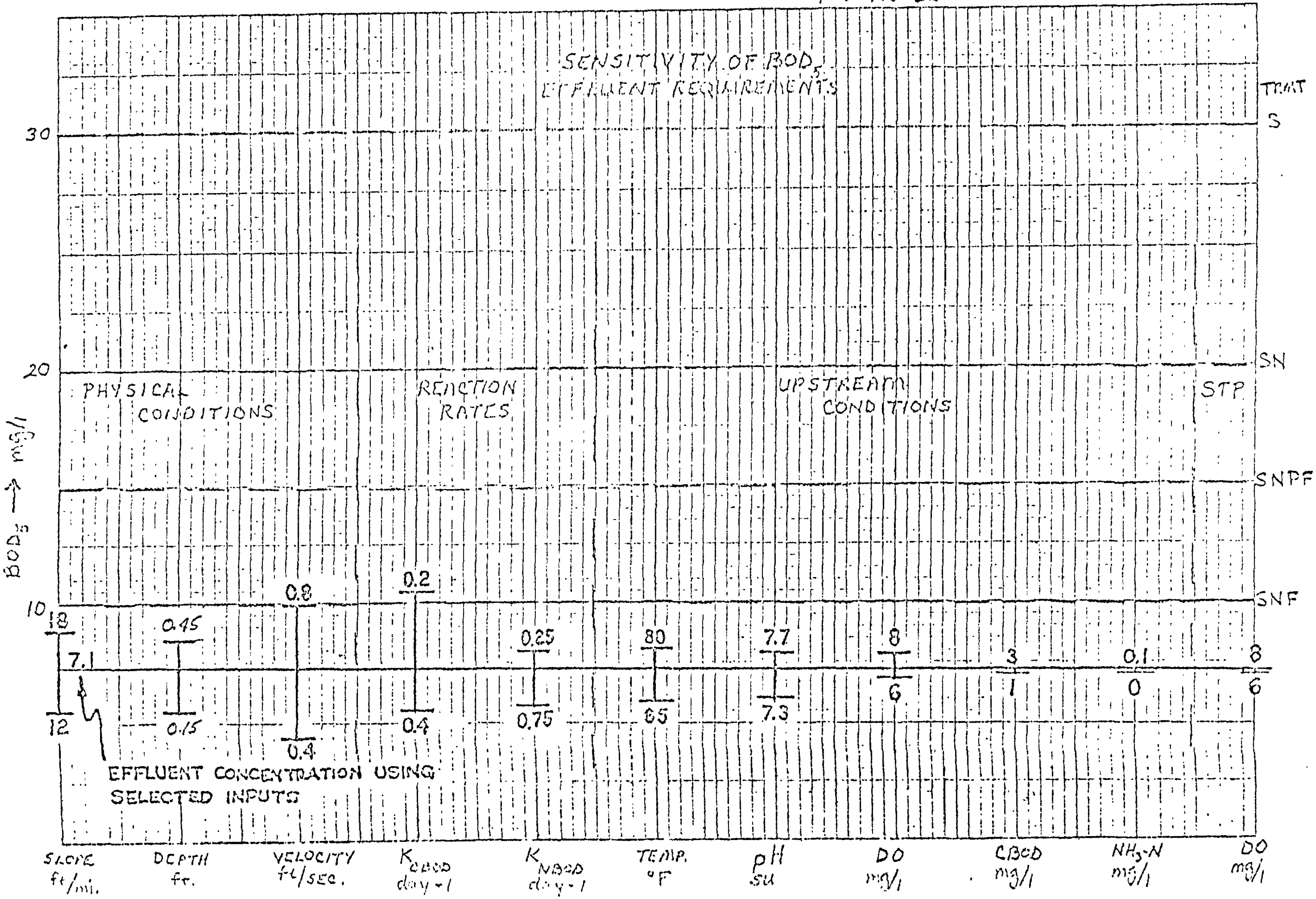

SENSITIVITY OF AMMONIA-N
EFFLUENT REQUIREMENTS
7
6
5
4
3
2
1
0
AMMONIA ⟶ mg/l
2.6
80
85
7.3
7.7
0.0
0.1
TEMPERATURE
°F
pH
NH_3-N UPSTREAM
mg/l

FIGURE 2


SENSITIVITY OF BOD5
EFFLUENT REQUIREMENTS
TRMT
S
SN
SNPF
SNF
STP
30
20
10
BOD5 → mg/l
PHYSICAL CONDITIONS
REACTION RATES
UPSTREAM CONDITIONS
18
7.1
12
0.45
0.15
0.8
0.4
0.2
0.4
0.25
0.75
80
65
7.7
7.3
8
6
3
1
0.1
0
8
6
EFFLUENT CONCENTRATION USING SELECTED INPUTS
SLOPE ft/mi.
DEPTH ft.
VELOCITY ft/sec.
K CBOD day-1
K NBOD day-1
TEMP. °F
pH su
DO mg/l
CBOD mg/l
NH3-N mg/l
DO mg/l

effluent quality associated with waste treatment levels (i.e. S-secondary treatment, N-nitrification, PF-partial filtration, F-complete filtration). For the Lakeview STP, ammonia-nitrogen effluent requirements are directly related to the water quality standards and are not sensitive to upstream concentrations. The range of ammonia-N concentrations is equivalent to the change in the water quality standards resulting from changes in temperature and pH. Effluent values are more sensitive to stream pH and less sensitive to temperature. However, the entire range of computed values require nitrification of the effluent.

The computed effluent limitation for BOD_5 changed by less than 2.0 mg/l from the base conditions when depth, slope, NBOD reaction rate, temperature, pH, upstream concentrations and effluent DO were changed over the range of values anticipated for this system. BOD_5 results were changed 3.3 and 2.8 mg/l, respectively, when CBOD reaction rate and velocity were varied over the expected range. Since only readily available data were used in this analysis the ranges selected for the sensitivity analysis were large (i.e. plus or minus 30 to 50%). Despite these large input ranges, computed BOD_5 ranges are relatively small. Also computed BOD_5 levels all correspond to the same treatment level (secondary treatment with nitrification and post filtration). Additional stream studies to more precisely define site specific inputs are not warranted because the anticipated range of inputs do not affect treatment system selection.

4. Recommended Effluent Limitations

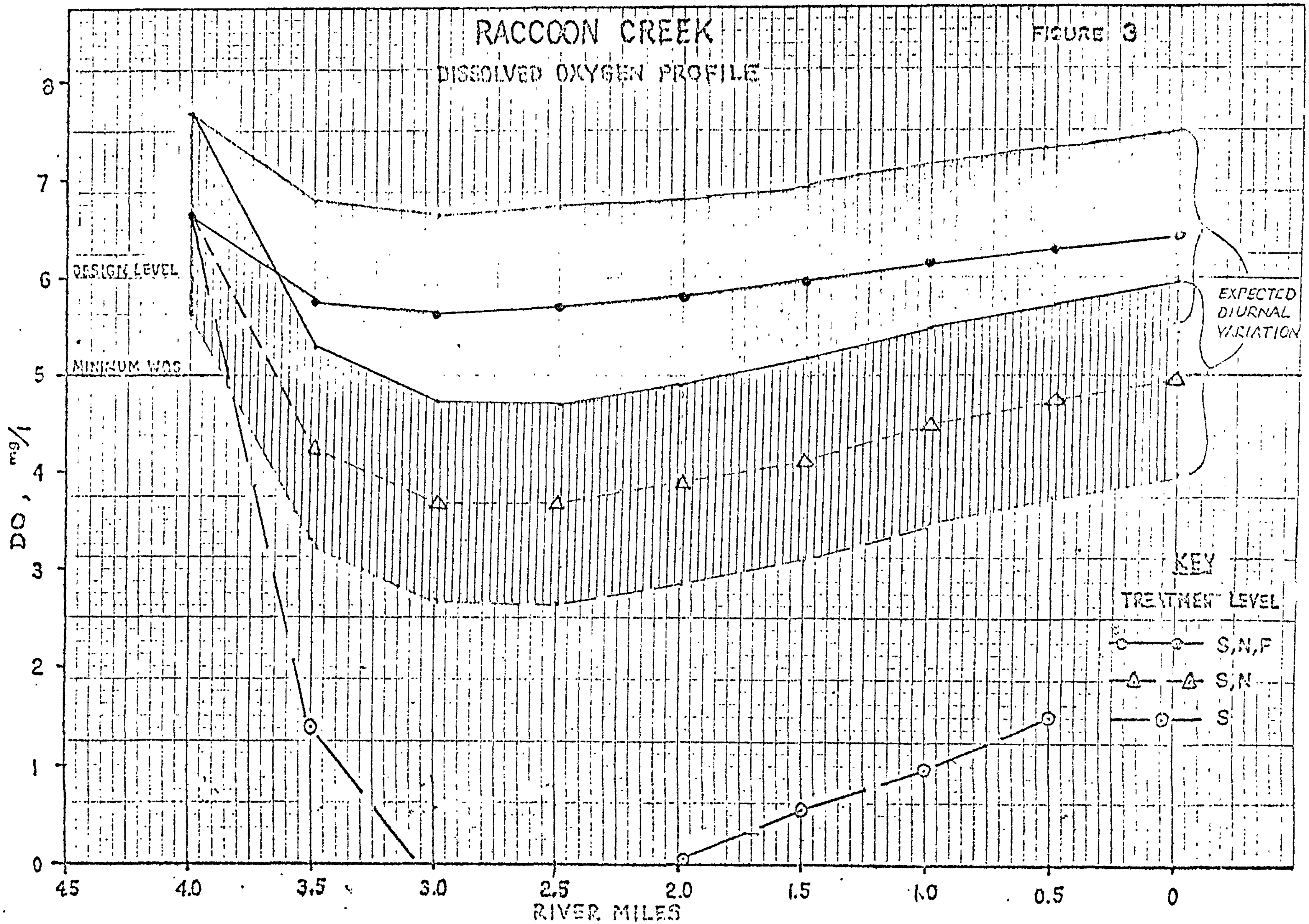
Recommended effluent limitations from this analysis are shown in Table 2 with the resulting DO concentration displayed in Figure 3. The recommended limits include a reduction of ammonia-nitrogen to 1.5 mg/l and an increase in BOD_5 to 10 mg/l. The BOD increase is offset by the lower ammonia limit which is not difficult to achieve. Seasonal effluent limits for the winter months are also included in Table 2. These values were computed using a stream temperature of $13^{o}C$, a value exceeded 25% of the time during November and March. Upstream flow was not changed for the seasonal analysis since streams in the area experience flows near the Q_{7-10} flow during the months of November through January. Recommended effluent levels require post filtration since low BOD limits cannot consistently be met without filters and higher effluent

Table 2

Recommended Effluent Limits
Seven Day Average

	May through October	November through April
Total Suspended Solids	10 mg/l	25 mg/l
BOD_5	10 mg/l	25 mg/l
Ammonia-N	1.5 mg/l	4.5 mg/l
Total Phosphorus	1.0 mg/l	1.0 mg/l
Total Residual Chlorine	0.1 mg/l*	0.1 mg/l*
Dissolved Oxygen	6.5 mg/l	7.5 mg/l

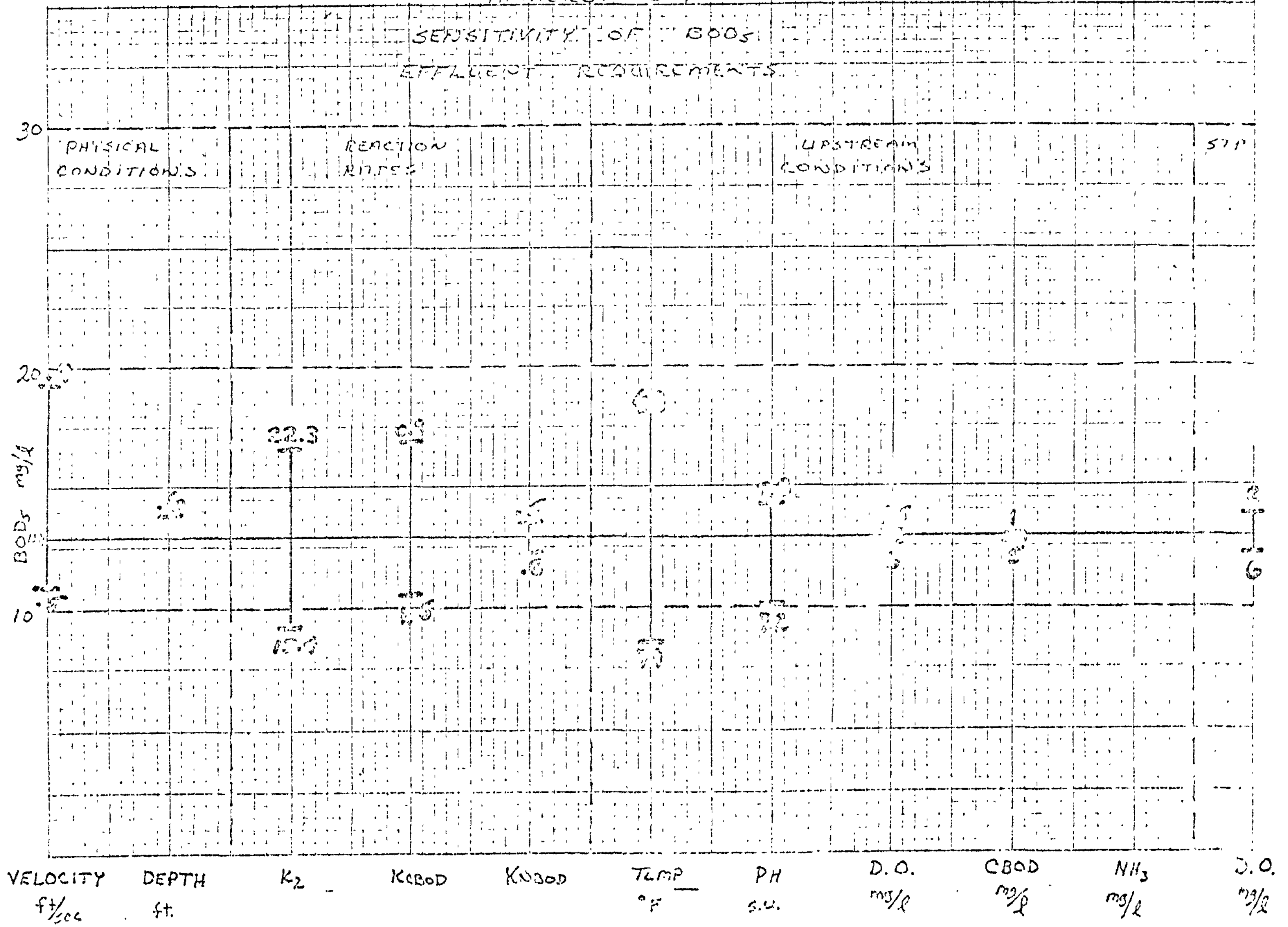
* Daily maximum



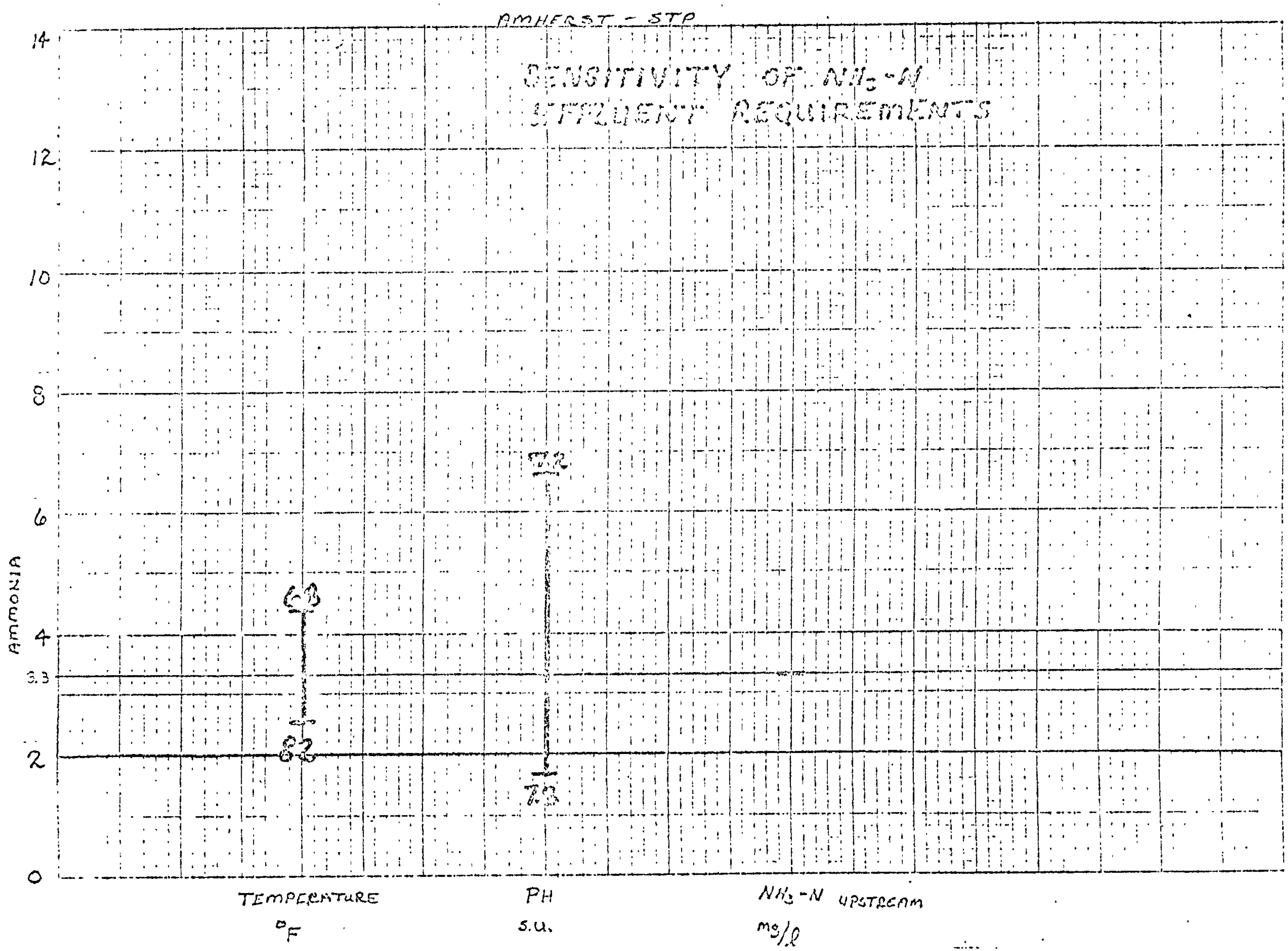
RACCOON CREEK
DISSOLVED OXYGEN PROFILE
FIGURE 3
DESIGN LEVEL
MINIMUM WQS
EXPECTED DIURNAL VARIATION
KEY
TREATMENT LEVEL
S,N,F
S,N
S
DO, mg/l
RIVER MILES
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0
8
7
6
5
4
3
2
1

loadings associated with secondary and nitrification treatment would cause DO concentrations to drop well below minimum water quality standards for the lower 3.5 miles of the stream (see Figure 3). Filtration will also insure more consistent compliance with the phosphorus limit of 1 mg/l required by OEPA regulations and the international agreements regarding phosphorus for Lake Erie.

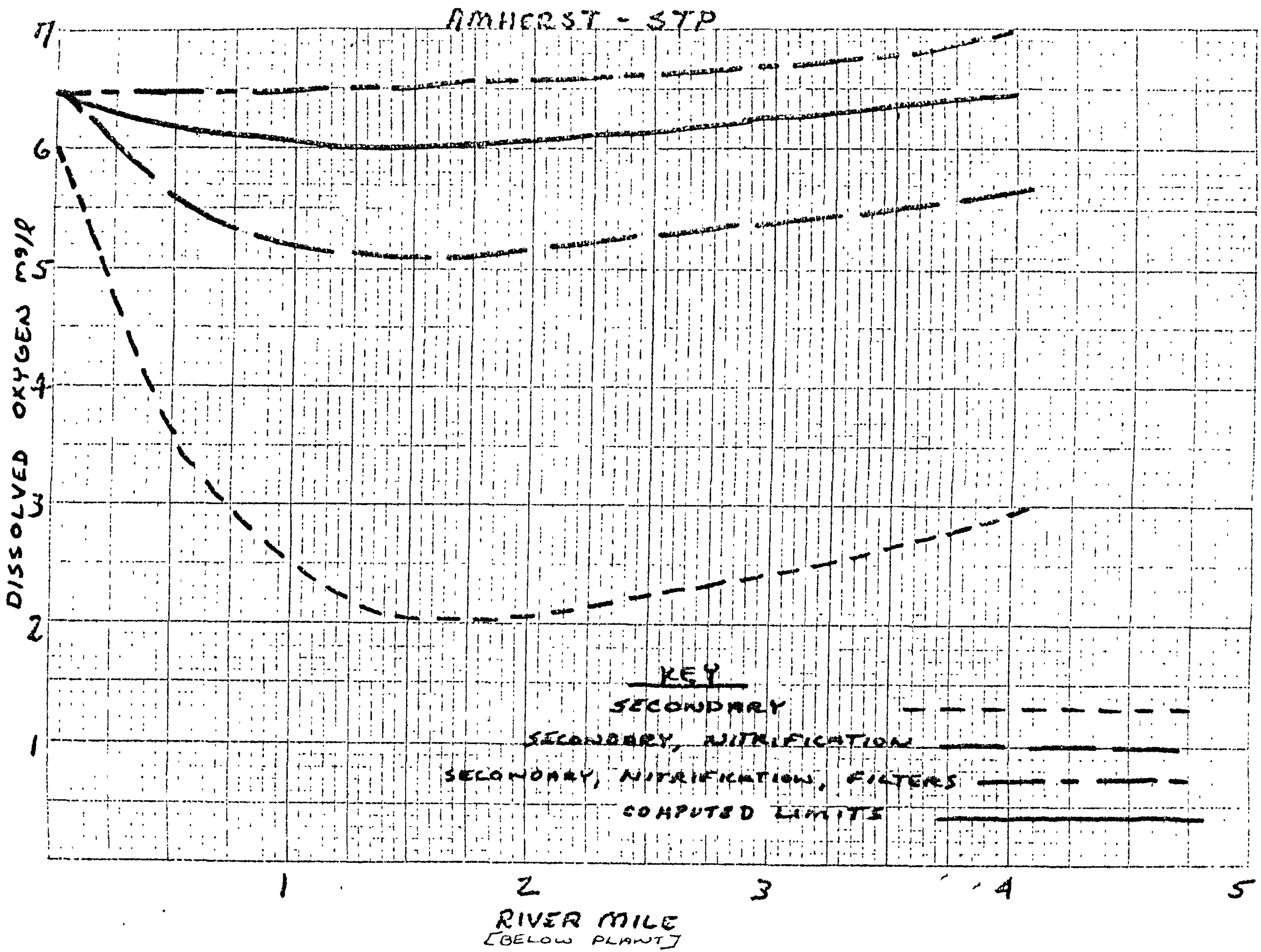
AMHERST - STP



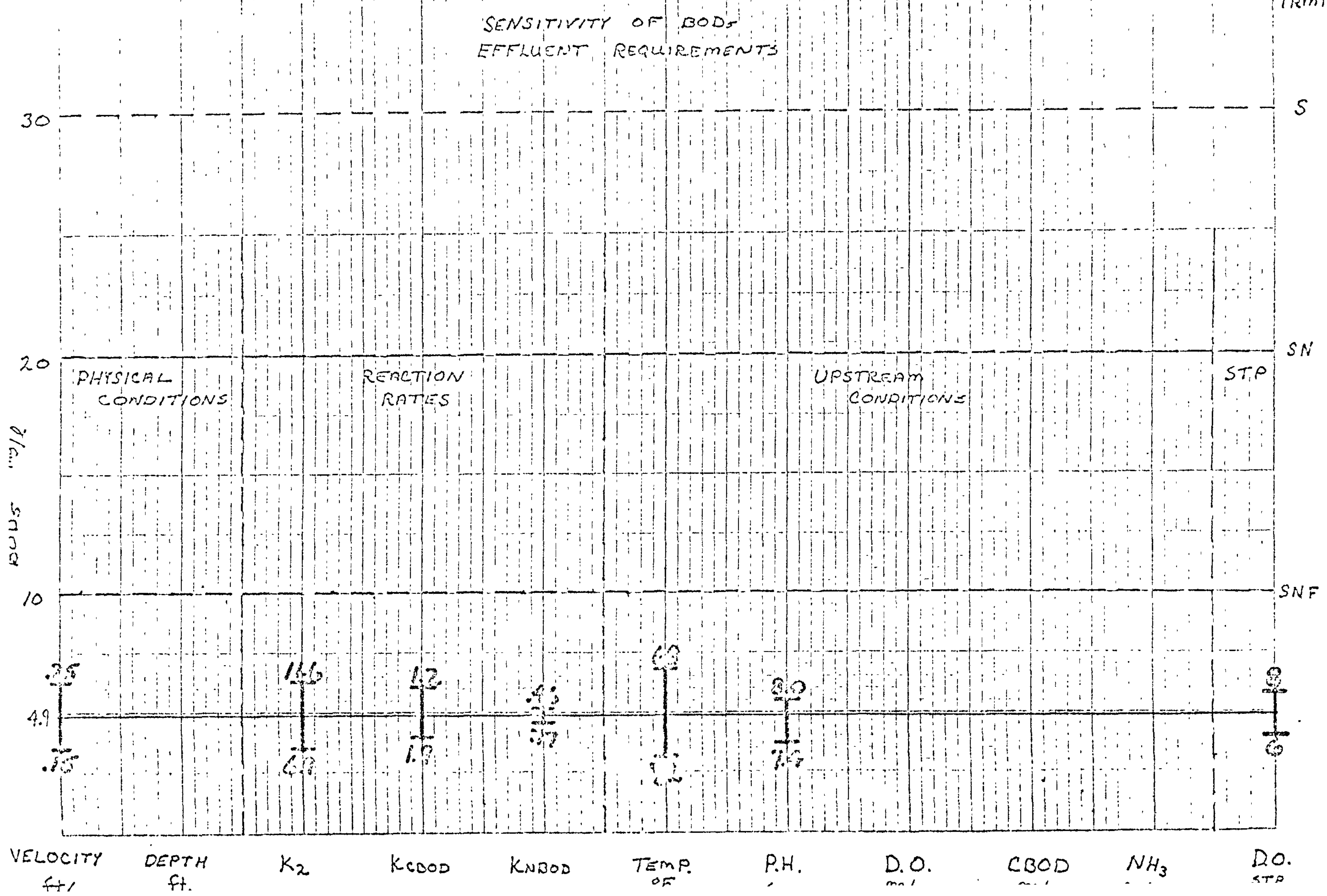
SENSITIVITY OF BOD5
EFFLUENT REQUIREMENTS
PHYSICAL CONDITIONS
REACTION RATES
UPSTREAM CONDITIONS
STP
30
20
10
BOD5 mg/l
22.3
6
VELOCITY ft/sec
DEPTH ft.
K2
KCBOD
KNBOD
TEMP °F
PH s.u.
D.O. mg/l
CBOD mg/l
NH3 mg/l
D.O. mg/l



AMHERST - STP
SENSITIVITY OF NH3-N
EFFLUENT REQUIREMENTS
AMMONIA
14
12
10
8
6
4
3.3
2
0
68
82
TEMPERATURE
°F
PH
S.U.
NH3-N UPSTREAM
mg/l

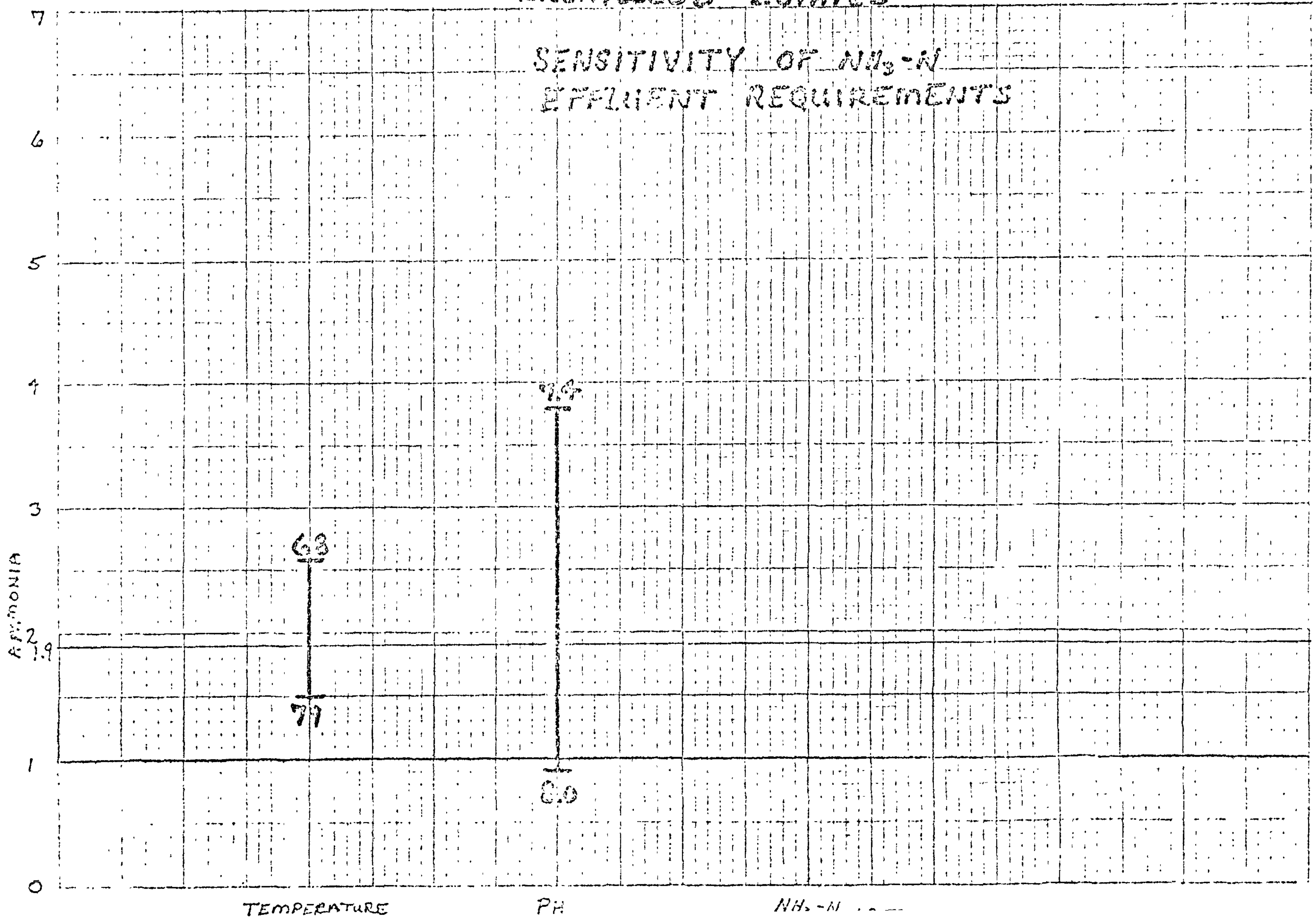

AMHERST - STP
DISSOLVED OXYGEN mg/l
7
6
5
4
3
2
1
RIVER MILE
[BELOW PLANT]
KEY
SECONDARY
SECONDARY, NITRIFICATION
SECONDARY, NITRIFICATION, FILTERS
COMPUTED LIMITS

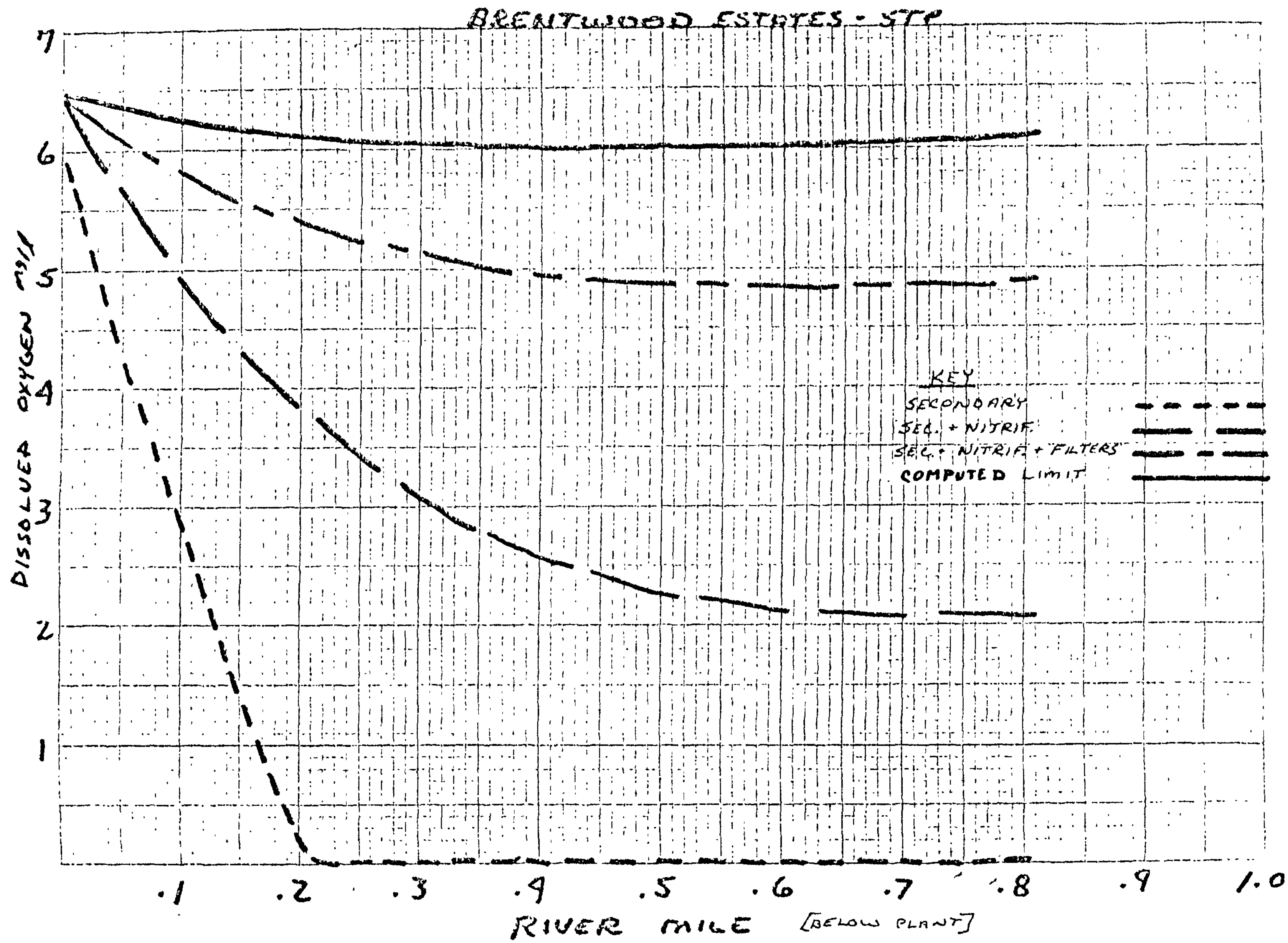
BRENTWOOD ESTATES



BRENTWOOD ESTATES

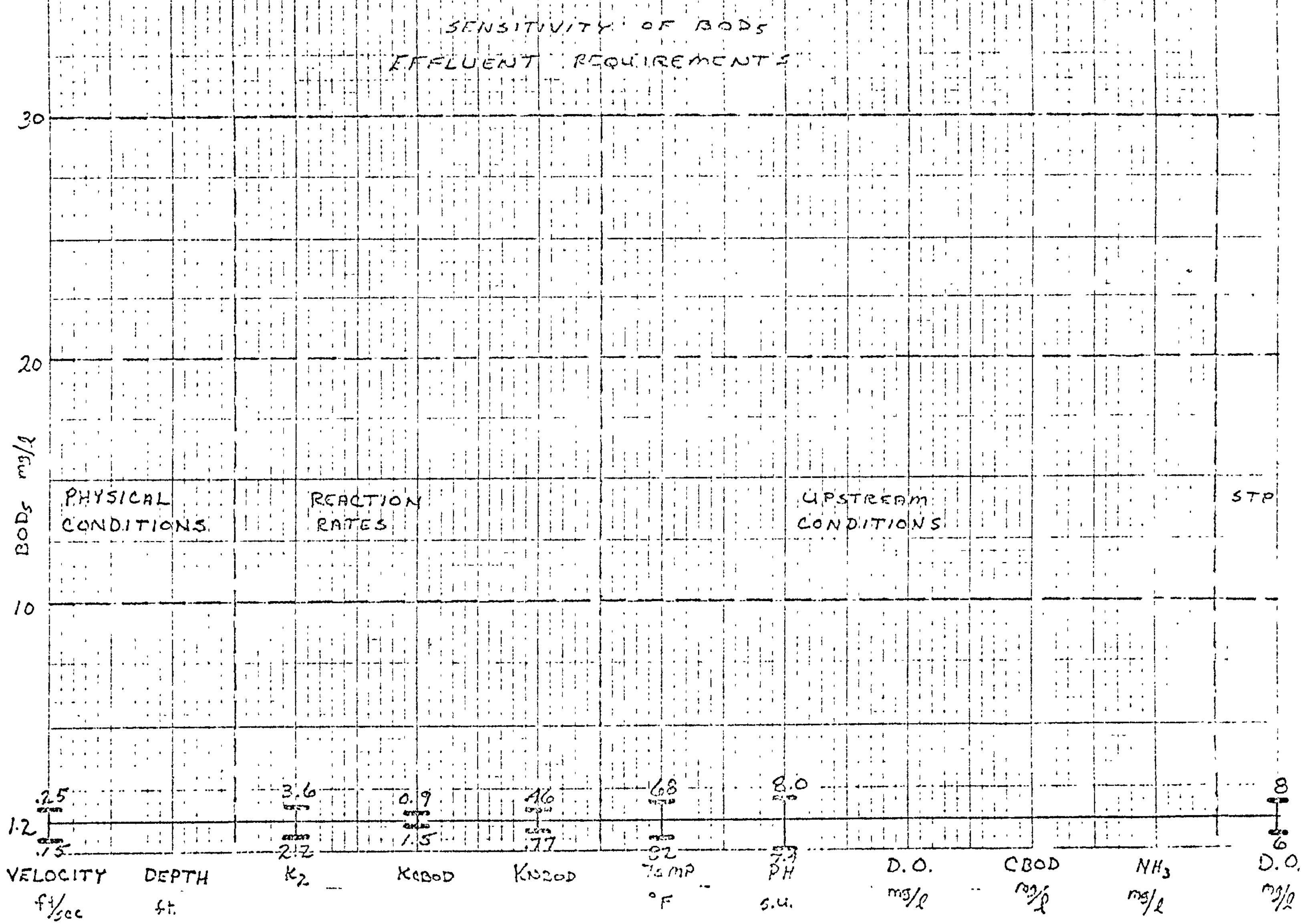
SENSITIVITY OF NH_3-N
EFFLUENT REQUIREMENTS

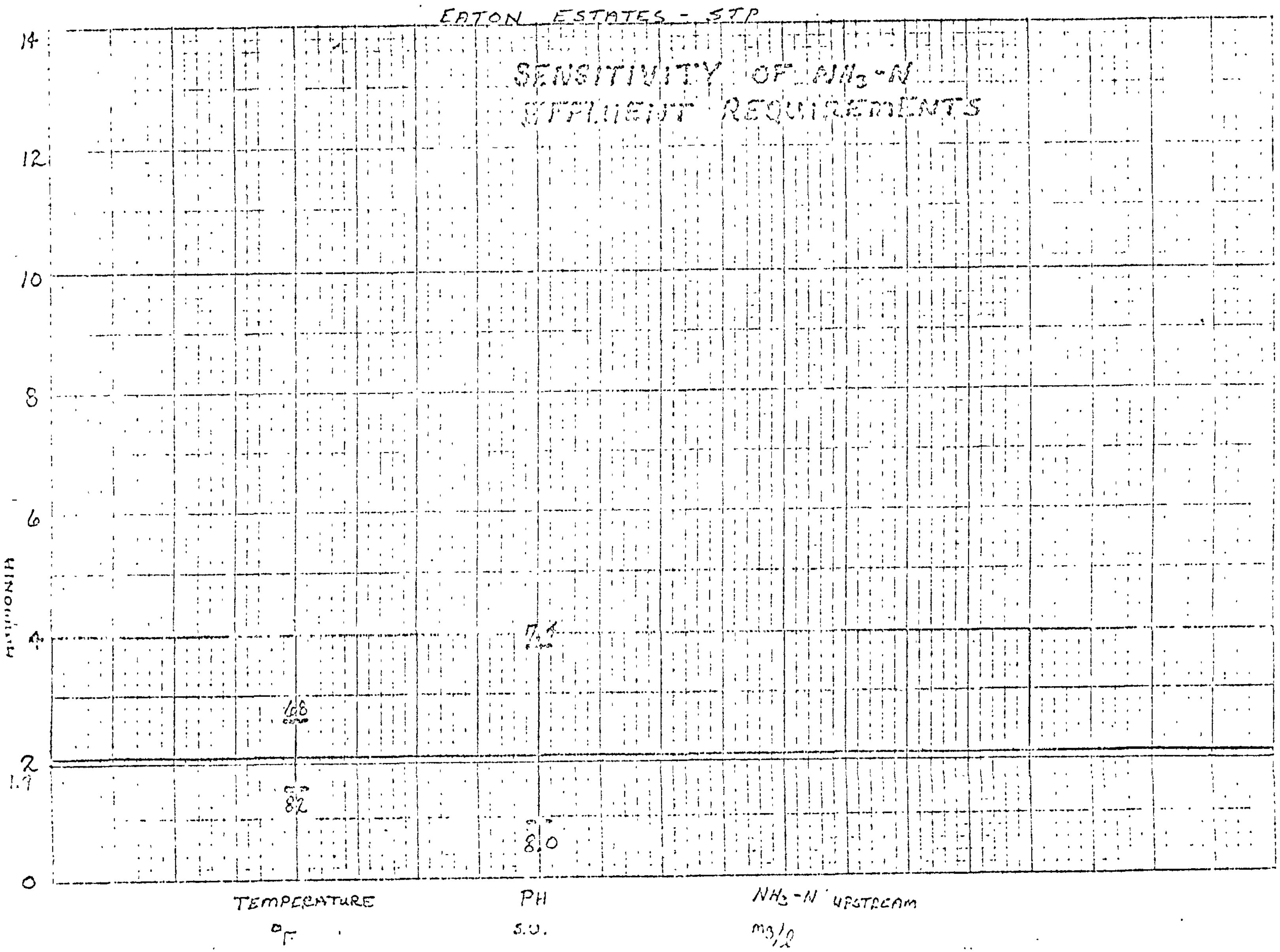


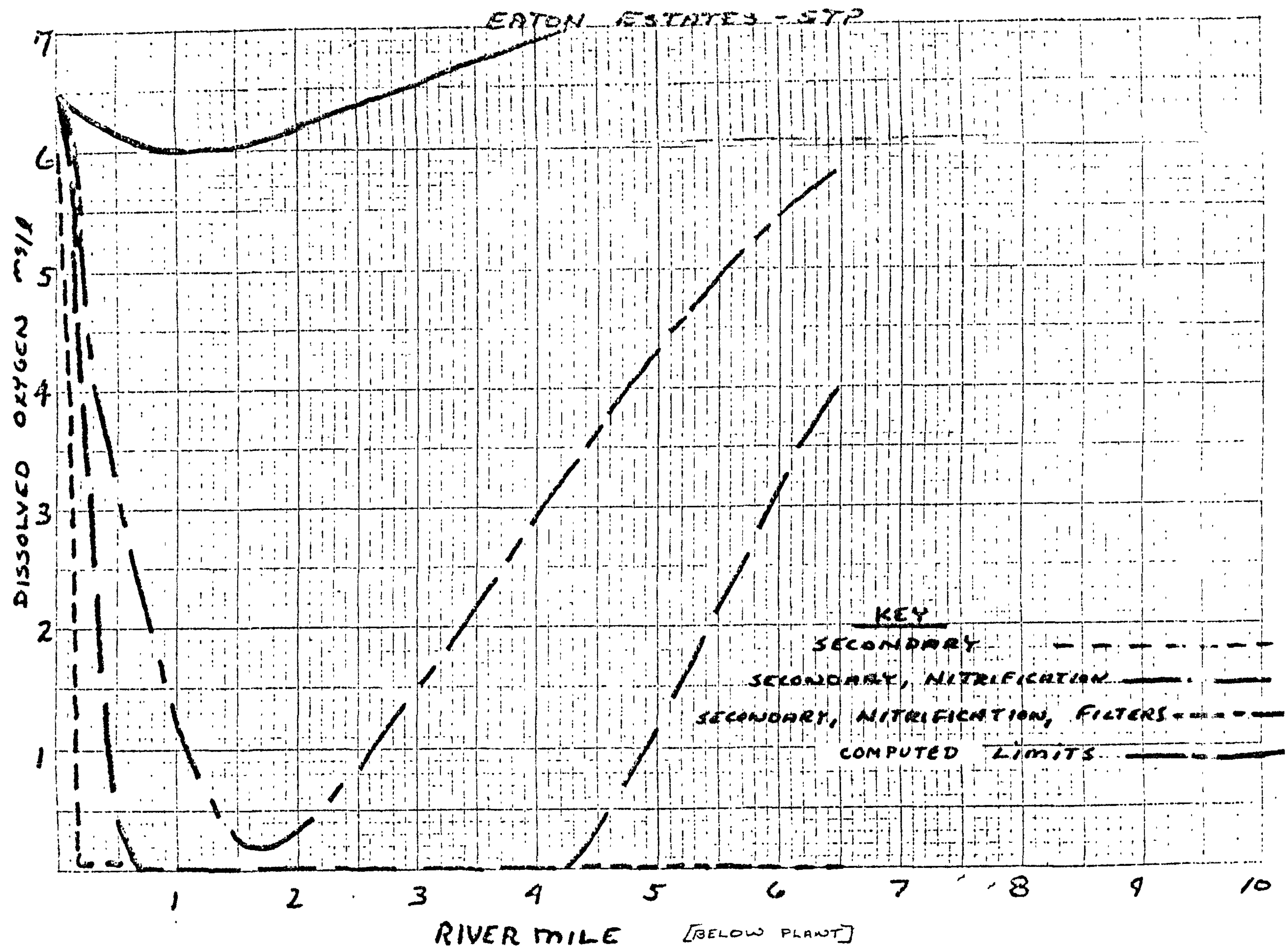

BRENTWOOD ESTATES - STP
DISSOLVED OXYGEN mg/l
7
6
5
4
3
2
1
.1
.2
.3
.4
.5
.6
.7
.8
.9
1.0
RIVER MILE [BELOW PLANT]
KEY
SECONDARY
SEC. + NITRIF.
SEC. + NITRIF. + FILTERS
COMPUTED LIMIT

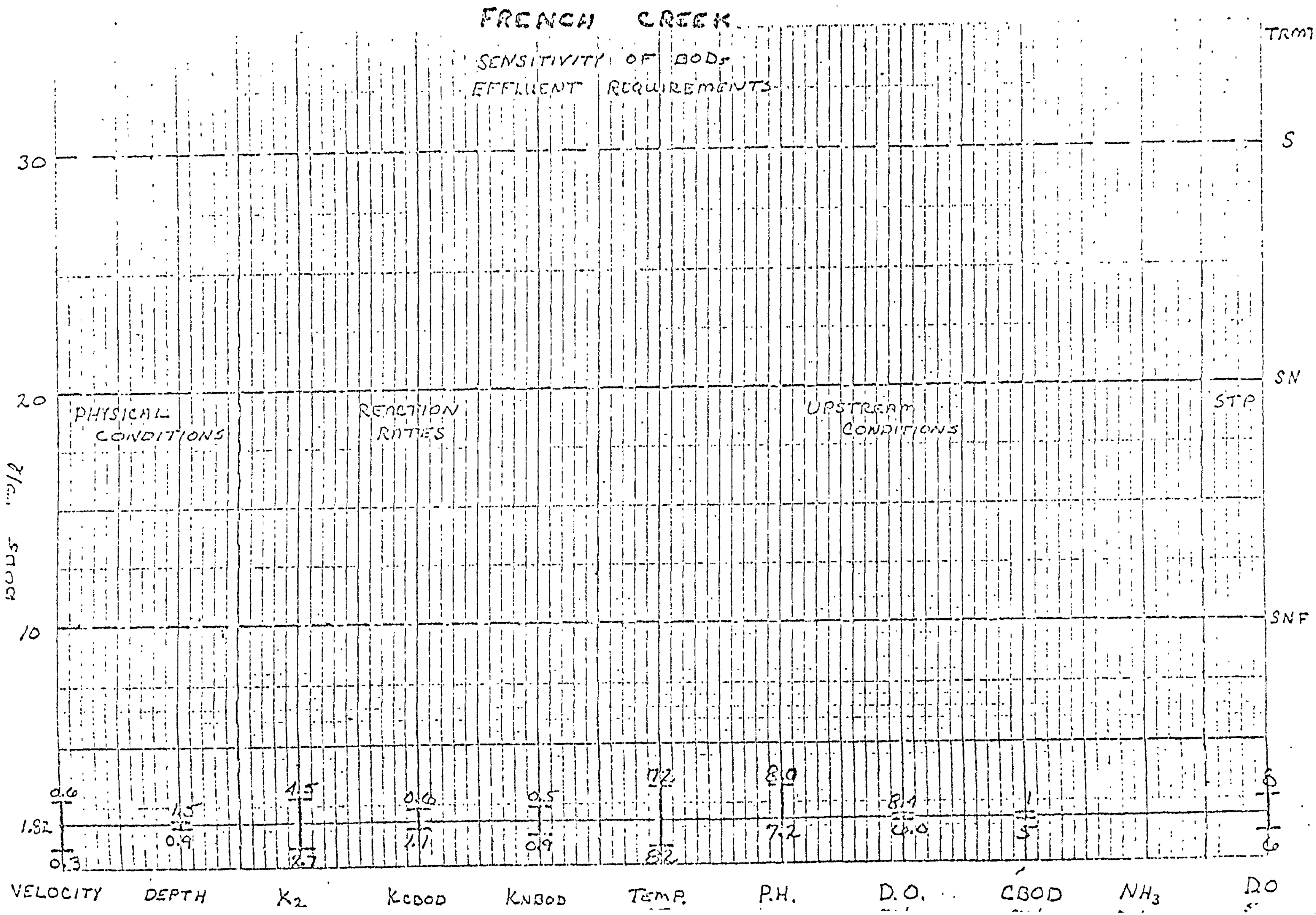
EATON ESTATES - STP

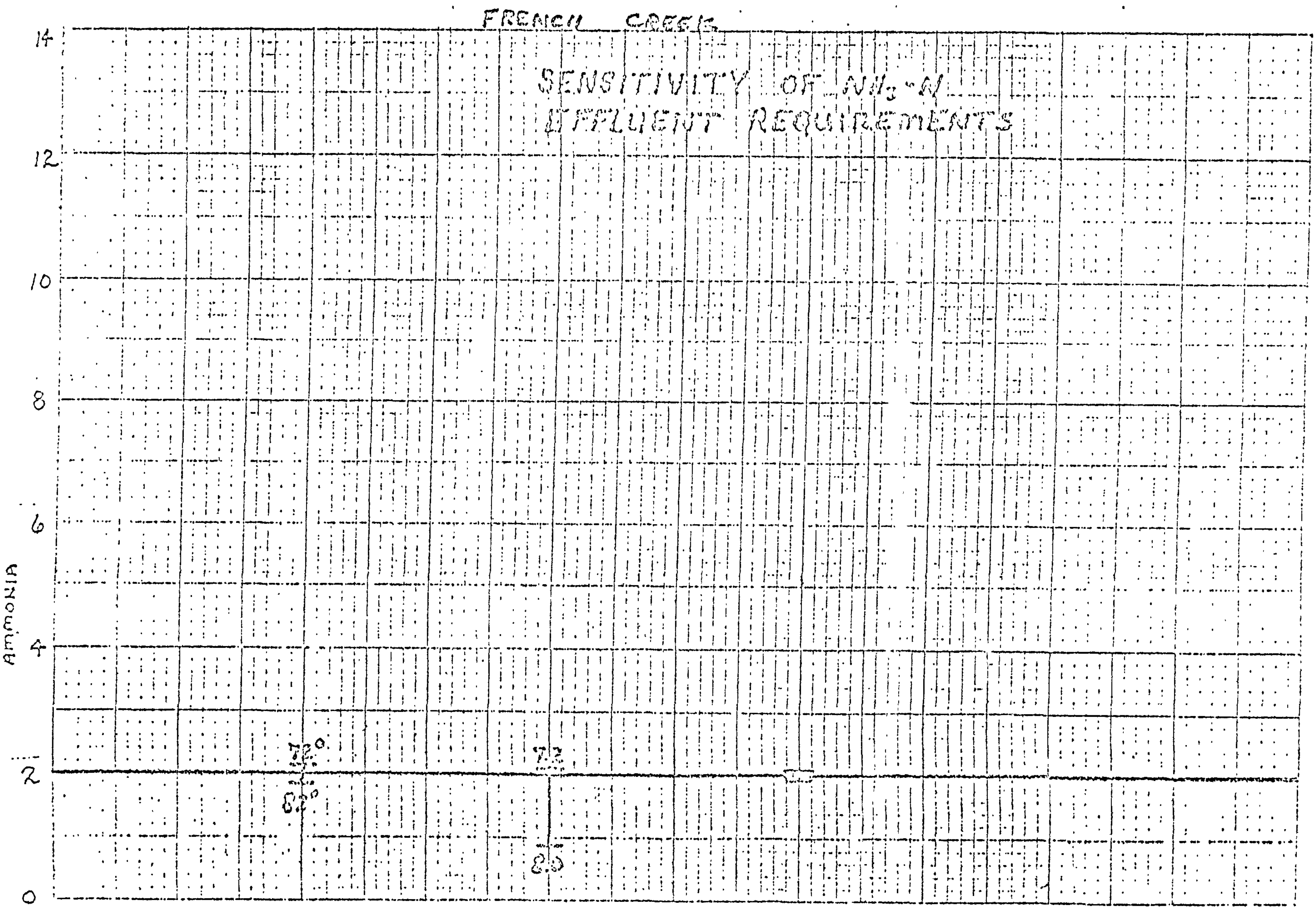
SENSITIVITY OF BOD_5 EFFLUENT REQUIREMENTS



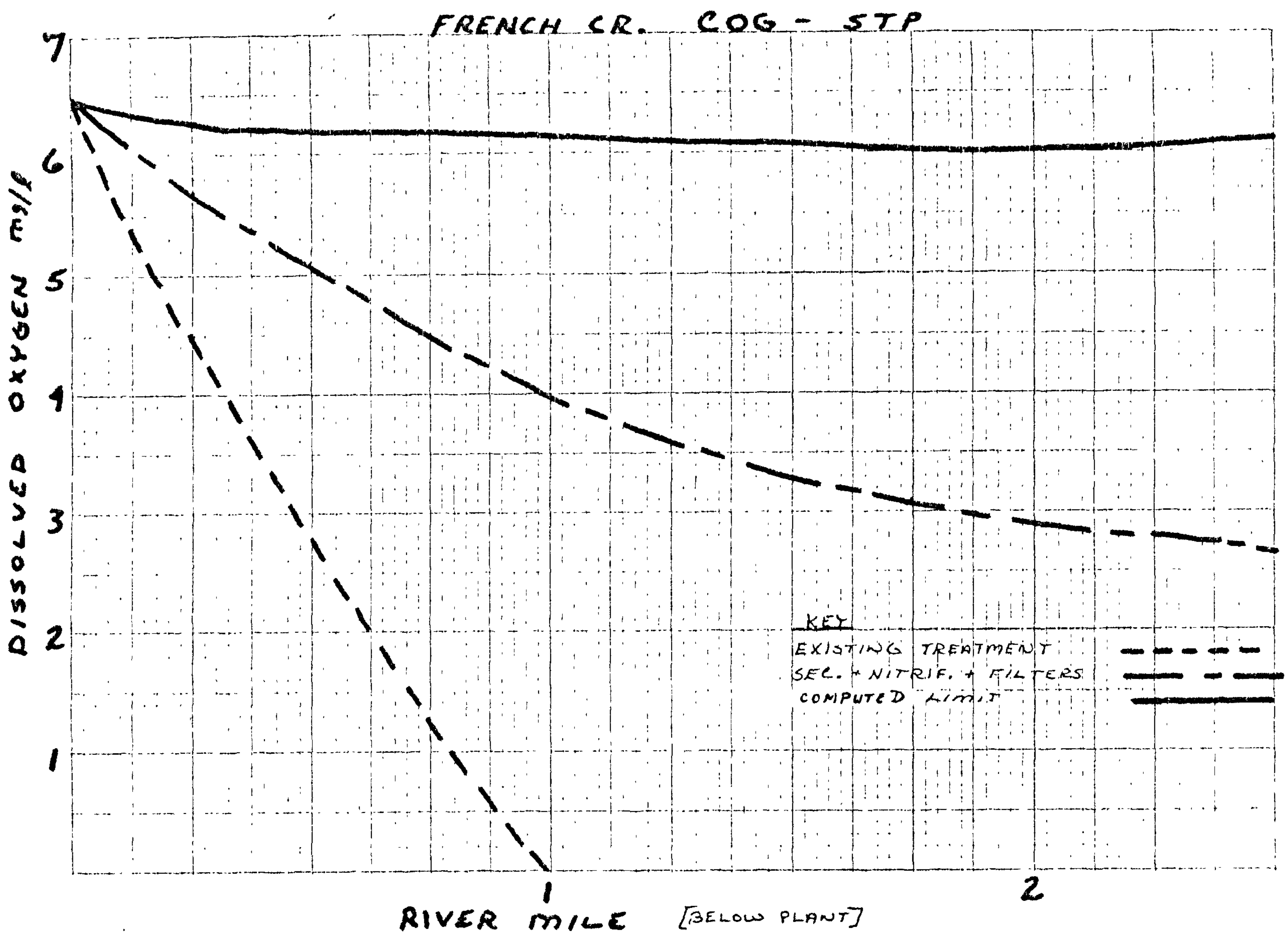

EATON ESTATES - STP
SENSITIVITY OF NH_3-N
EFFLUENT REQUIREMENTS
14
12
10
8
6
4
2
1.7
0
68
82
7.4
8.0
TEMPERATURE
°F
PH
S.U.
NH_3-N UPSTREAM
mg/l


EATON ESTATES - STP
DISSOLVED OXYGEN mg/l
7
6
5
4
3
2
1
1
2
3
4
5
6
7
8
9
10
RIVER MILE
[BELOW PLANT]
KEY
SECONDARY
SECONDARY, NITRIFICATION
SECONDARY, NITRIFICATION, FILTERS
COMPUTED LIMITS

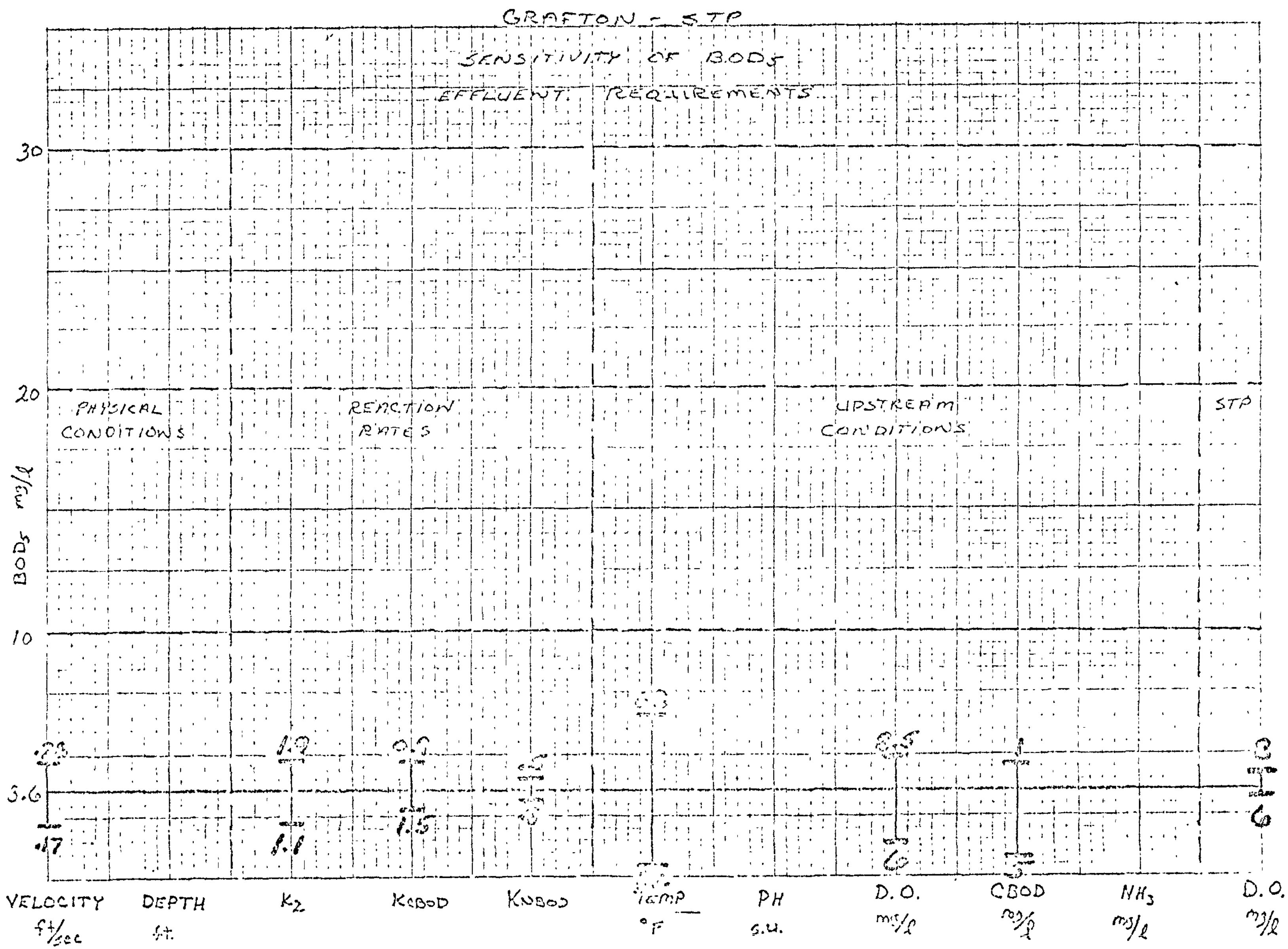

FRENCH CREEK
SENSITIVITY OF BOD5 EFFLUENT REQUIREMENTS
TRMT
S
SN
SNF
STP
30
20
10
1.82
BOD5 mg/l
PHYSICAL CONDITIONS
REACTION RATES
UPSTREAM CONDITIONS
0.6
0.3
1.5
0.9
4.5
2.7
0.6
1.1
0.5
0.9
7.2
8.2
8.0
7.2
8.4
6.0
1
5
6
6
VELOCITY
DEPTH
K2
KCBOD
KNBOD
TEMP.
P.H.
D.O.
CBOD
NH3
DO



FRENCH CREEK
SENSITIVITY OF NH3-N
EFFLUENT REQUIREMENTS
14
12
10
8
6
4
2
0
AMMONIA
7.2°
8.2°
7.2
8.5

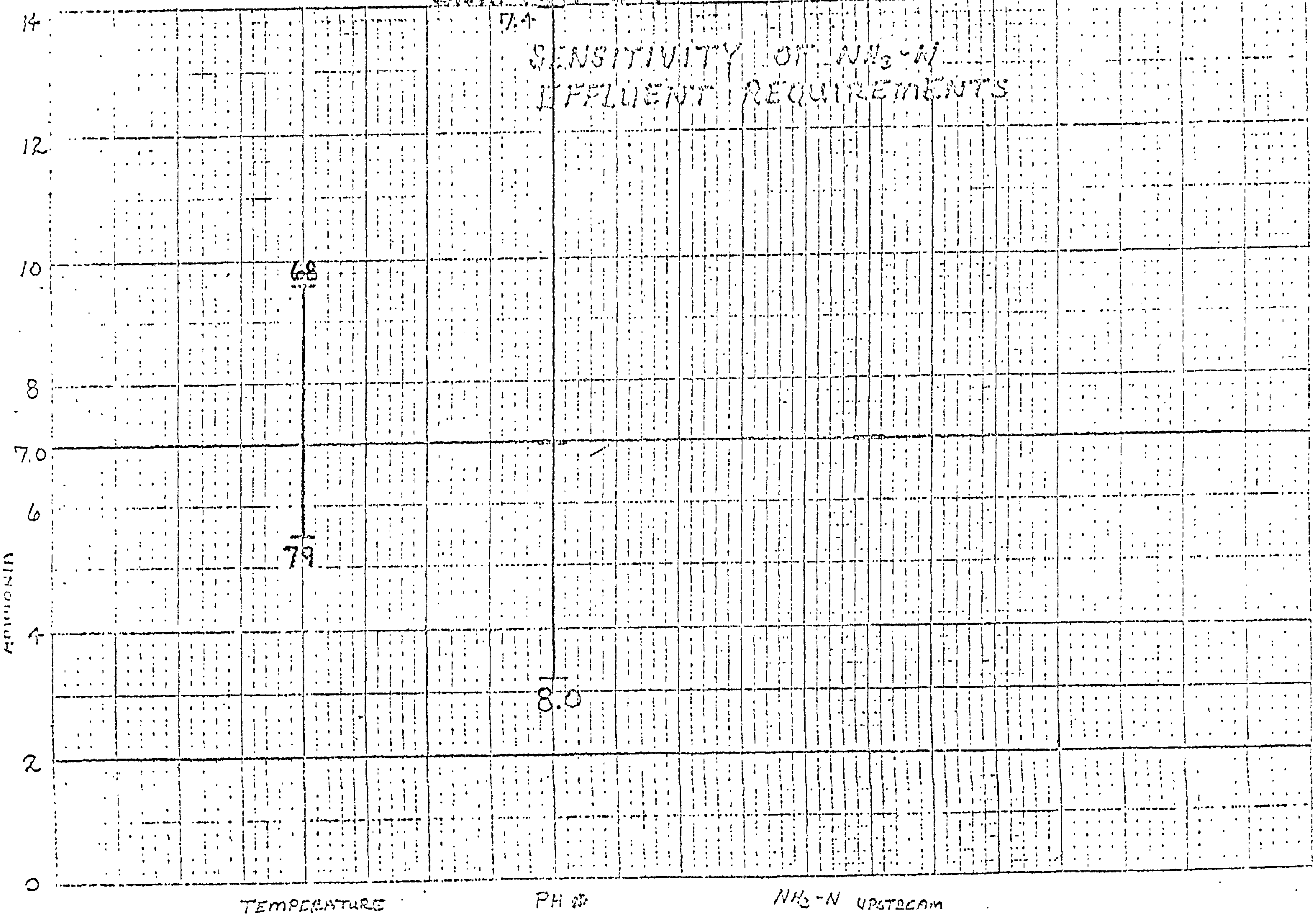


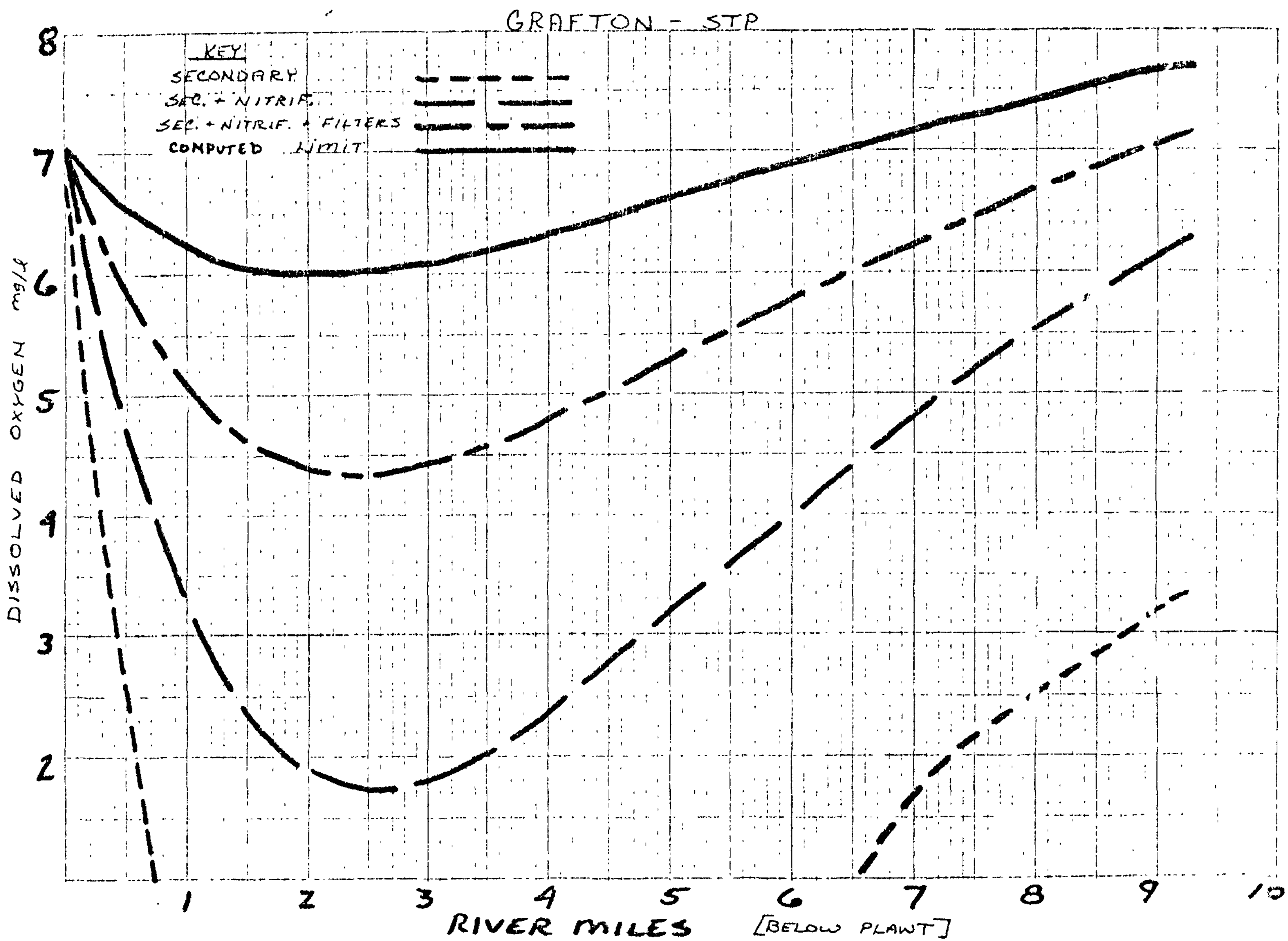
FRENCH CR. COG - STP
DISSOLVED OXYGEN mg/l
7
6
5
4
3
2
1
KEY
EXISTING TREATMENT
SEC. + NITRIF. + FILTERS
COMPUTED LIMIT
1
2
RIVER MILE [BELOW PLANT]

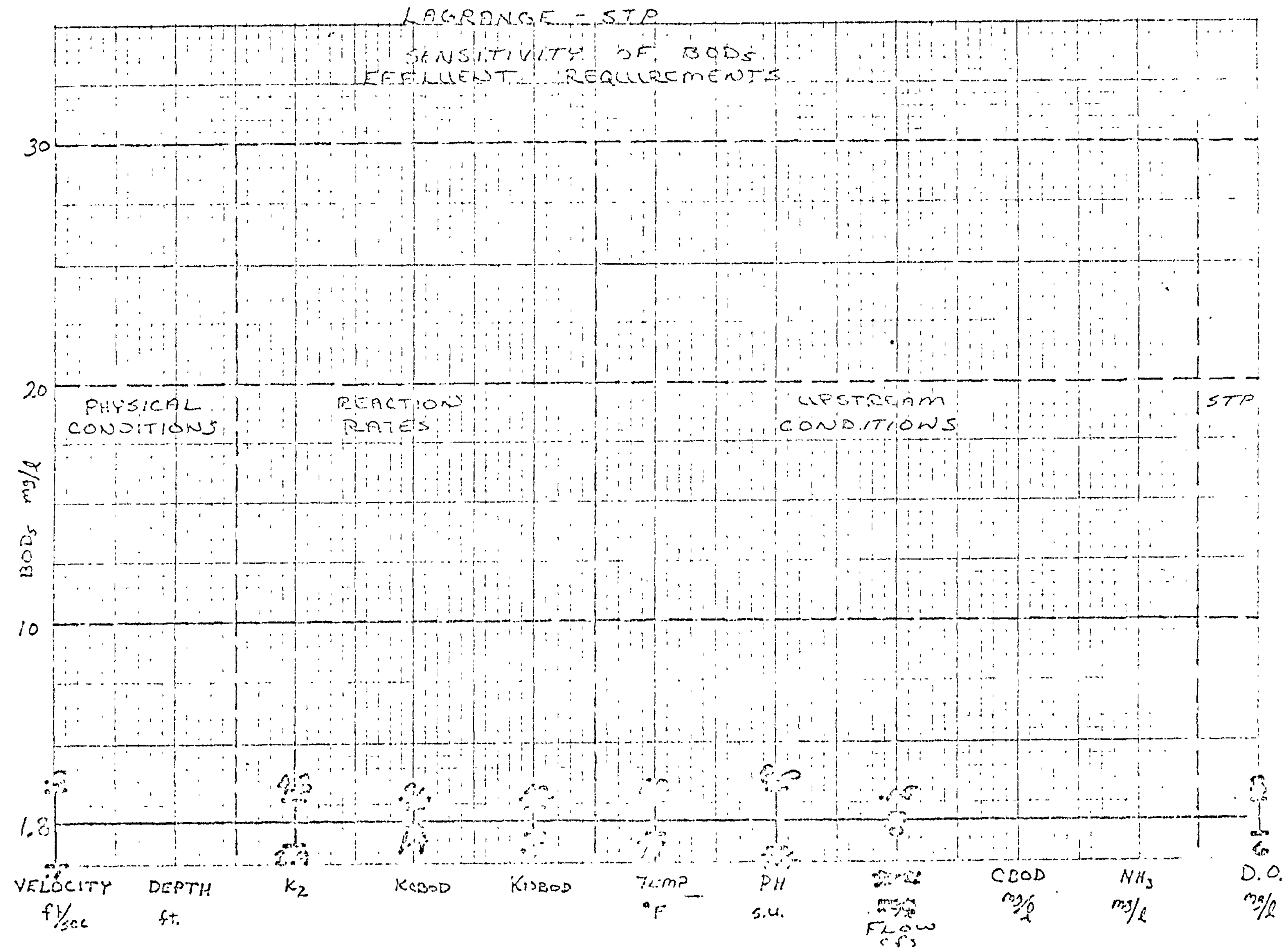

GRAFTON - STP
SENSITIVITY OF BOD5
EFFLUENT REQUIREMENTS
30
20
10
3.6
BOD5 mg/l
PHYSICAL CONDITIONS
REACTION RATES
UPSTREAM CONDITIONS
STP
.23
.17
1.9
1.1
0.9
1.5
8.5
6
1
5
8
6
VELOCITY ft/sec
DEPTH ft.
K2
KCBOD
KNBOD
TEMP °F
PH s.u.
D.O. mg/l
CBOD mg/l
NH3 mg/l
D.O. mg/l

GRAFTON - STP   TSIVOGLOU

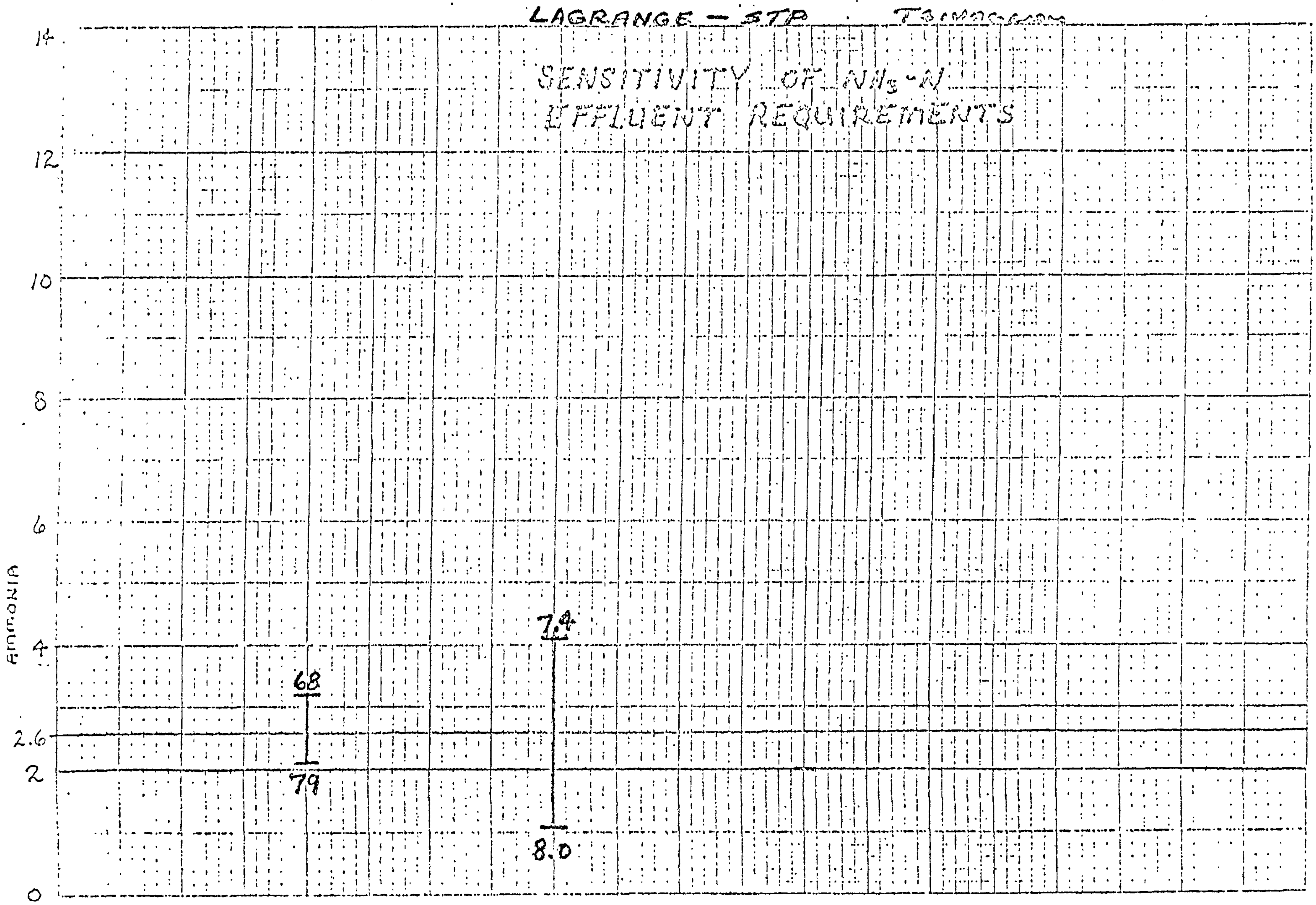
SENSITIVITY OF NH_3-N
EFFLUENT REQUIREMENTS



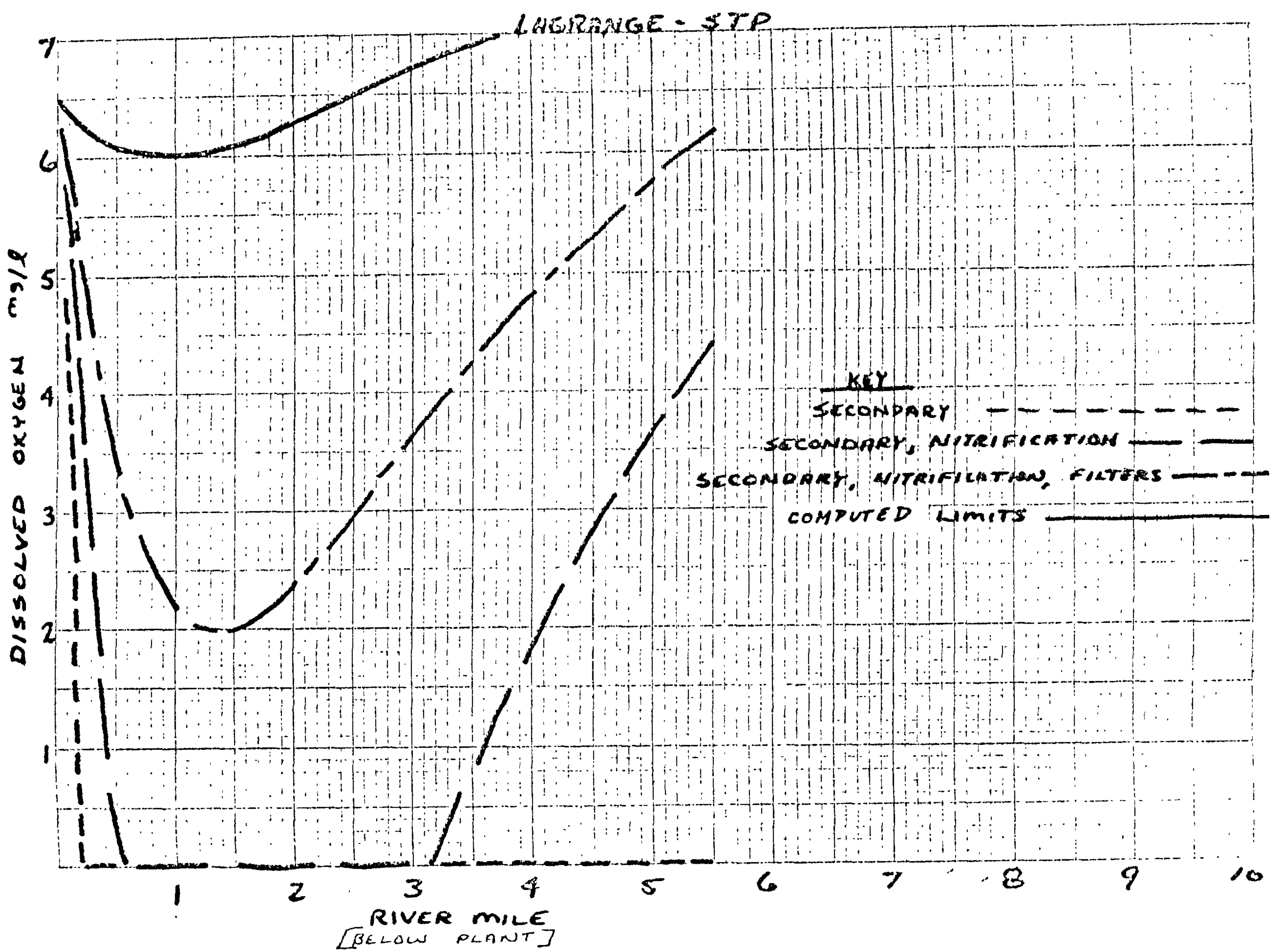

GRAFTON - STP
KEY
SECONDARY
SEC. + NITRIF.
SEC. + NITRIF. + FILTERS
COMPUTED LIMIT
DISSOLVED OXYGEN mg/l
8
7
6
5
4
3
2
1
2
3
4
5
6
7
8
9
10
RIVER MILES
[BELOW PLANT]

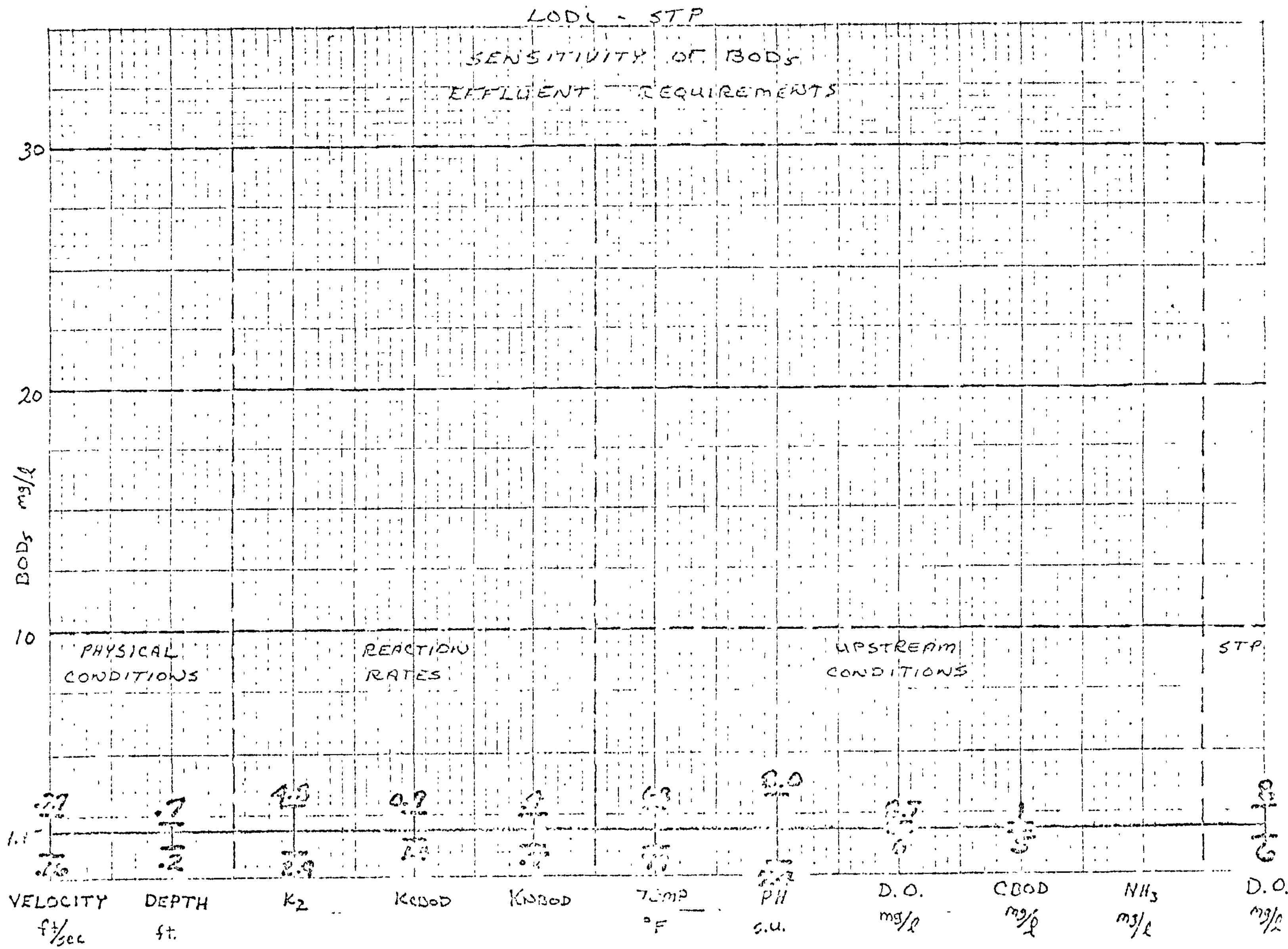


LAGRANGE - STP
SENSITIVITY OF BOD5
EFFLUENT REQUIREMENTS
PHYSICAL CONDITIONS
REACTION RATES
UPSTREAM CONDITIONS
STP
30
20
10
1.8
BOD5 mg/l
VELOCITY ft/sec
DEPTH ft.
K2
KCBOD
KNBOD
TEMP °F
PH s.u.
FLOW cfs
CBOD mg/l
NH3 mg/l
D.O. mg/l

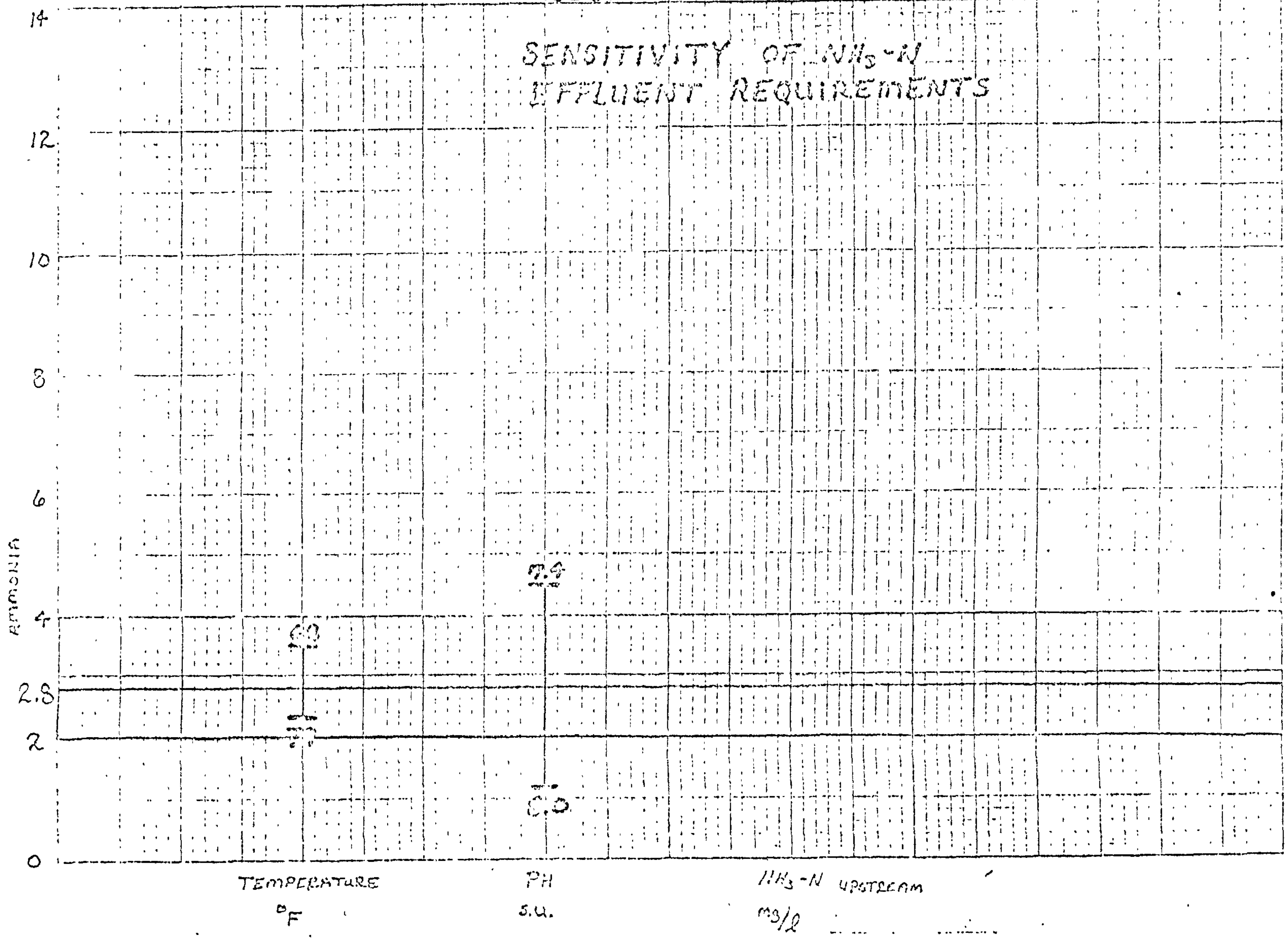


LAGRANGE — STP
SENSITIVITY OF NH3-N
EFFLUENT REQUIREMENTS
14
12
10
8
6
4
2.6
2
0
AMMONIA
68
79
7.4
8.0


LAGRANGE - STP
DISSOLVED OXYGEN mg/l
7
6
5
4
3
2
1
RIVER MILE
[BELOW PLANT]
1
2
3
4
5
6
7
8
9
10
KEY
SECONDARY
SECONDARY, NITRIFICATION
SECONDARY, NITRIFICATION, FILTERS
COMPUTED LIMITS

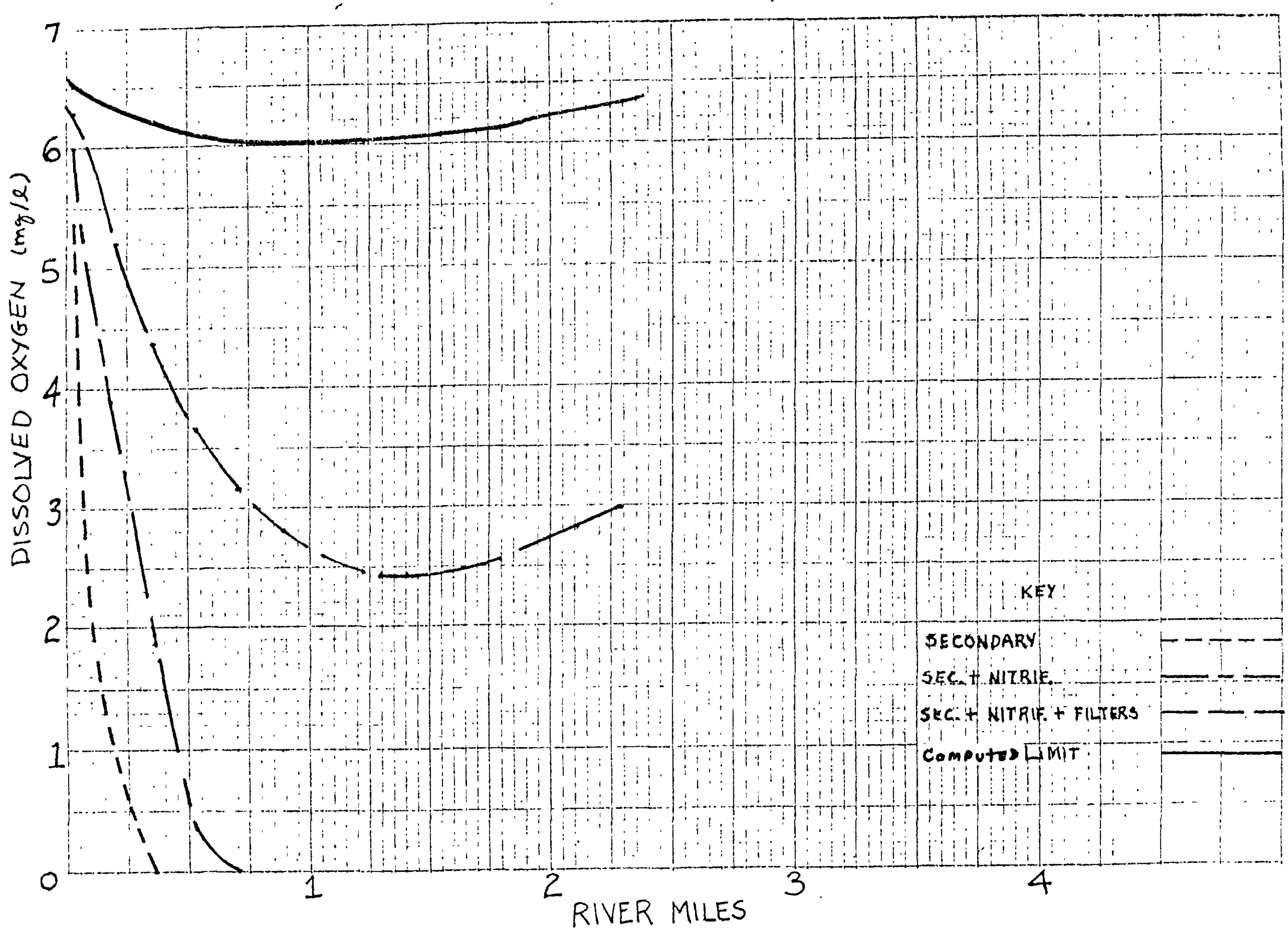

LODI - STP
SENSITIVITY OF BOD5
EFFLUENT REQUIREMENTS
30
20
10
BOD5 mg/l
PHYSICAL CONDITIONS
REACTION RATES
UPSTREAM CONDITIONS
STP
VELOCITY ft/sec
DEPTH ft.
K2
KcBOD
KNBOD
Temp °F
PH s.u.
D.O. mg/l
CBOD mg/l
NH3 mg/l
D.O. mg/l

LODI - STP



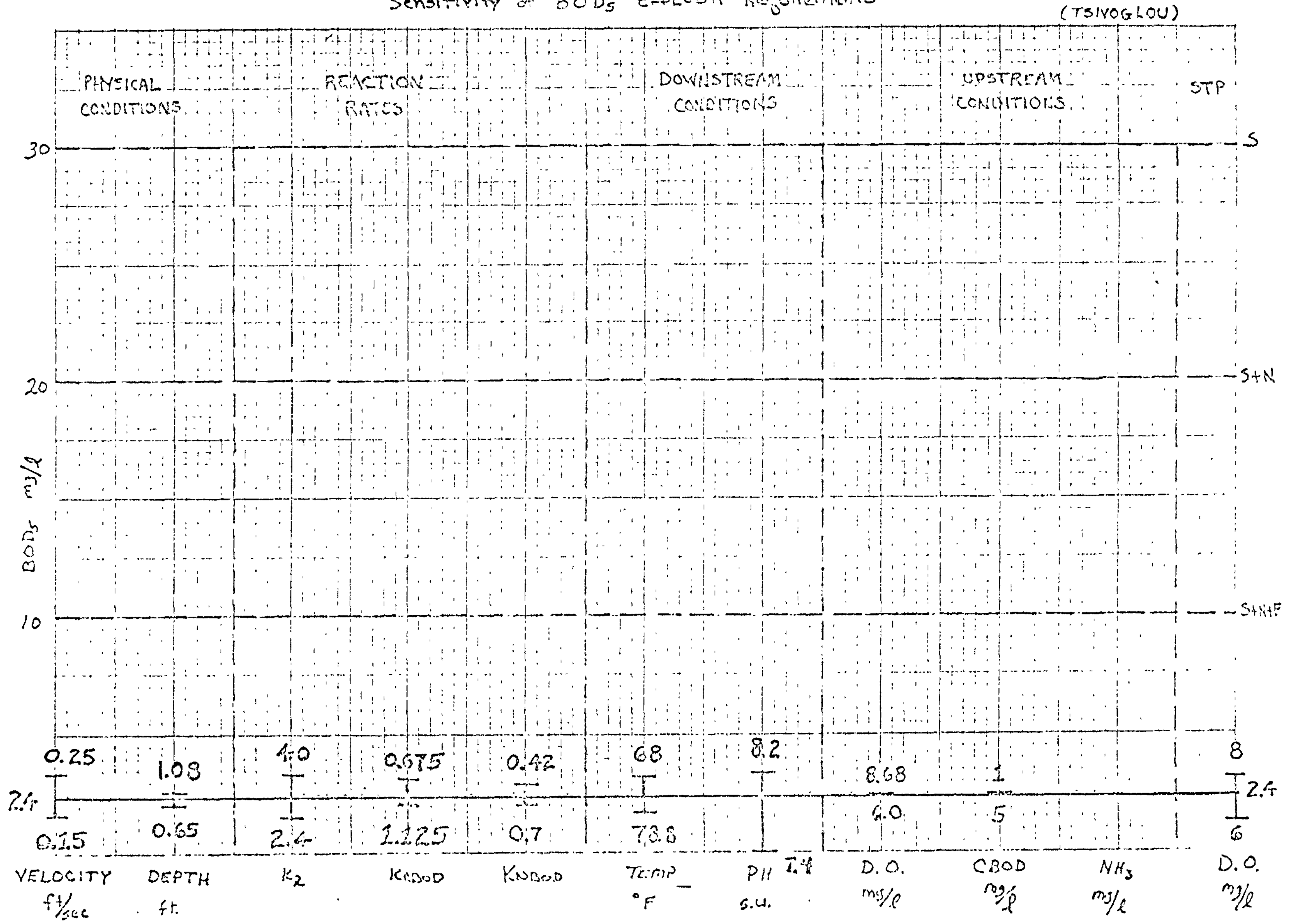
SENSITIVITY OF NH3-N
EFFLUENT REQUIREMENTS
AMMONIA
14
12
10
8
6
4
2.8
2
0
TEMPERATURE
°F
PH
S.U.
NH3-N UPSTREAM
mg/l

LODI

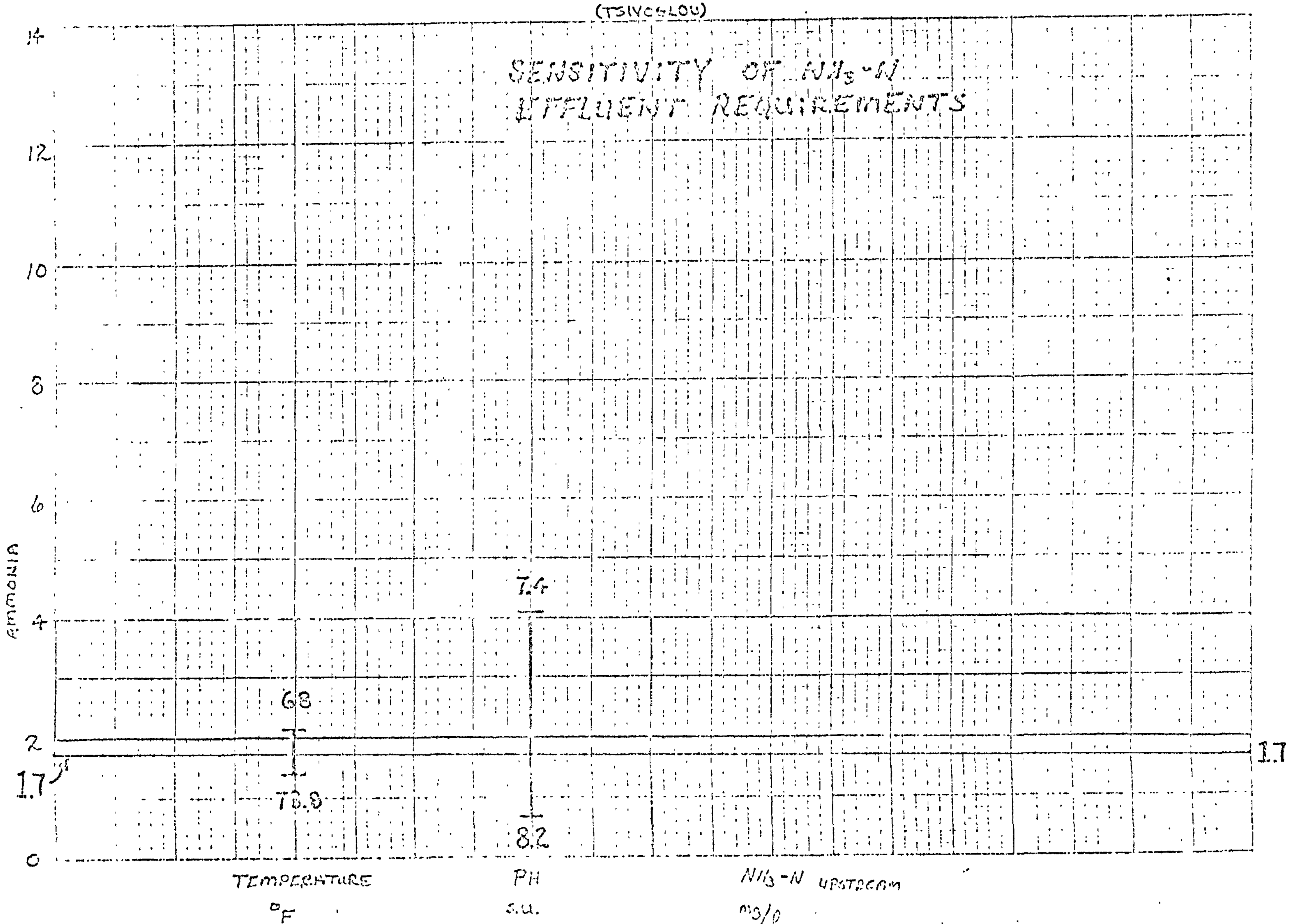

DISSOLVED OXYGEN (mg/l)
7
6
5
4
3
2
1
0
1
2
3
4
RIVER MILES
KEY
SECONDARY
SEC. + NITRIF.
SEC. + NITRIF. + FILTERS
COMPUTED LIMIT

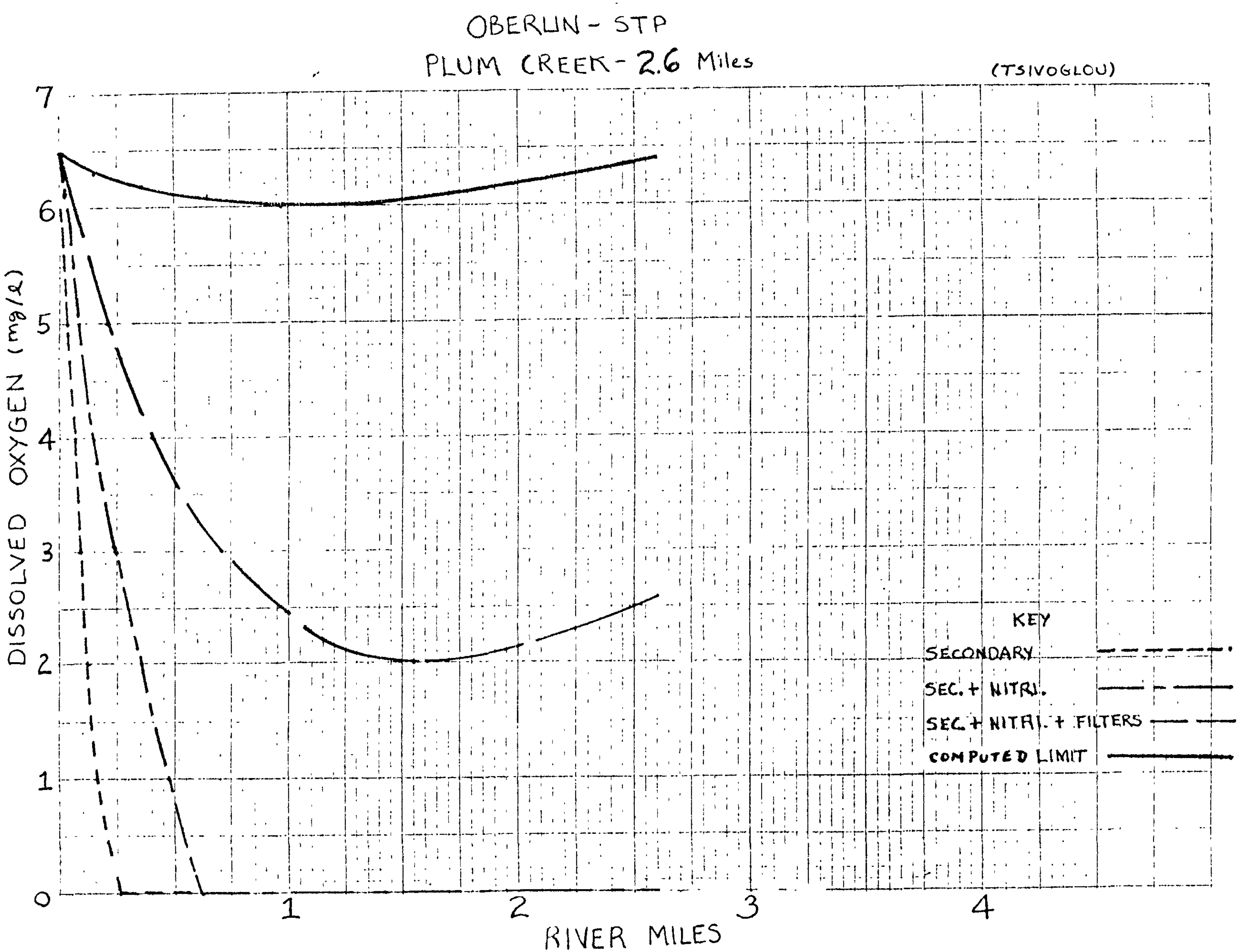
OBERLIN - STP

Sensitivity of BOD_5 Effluent Requirements

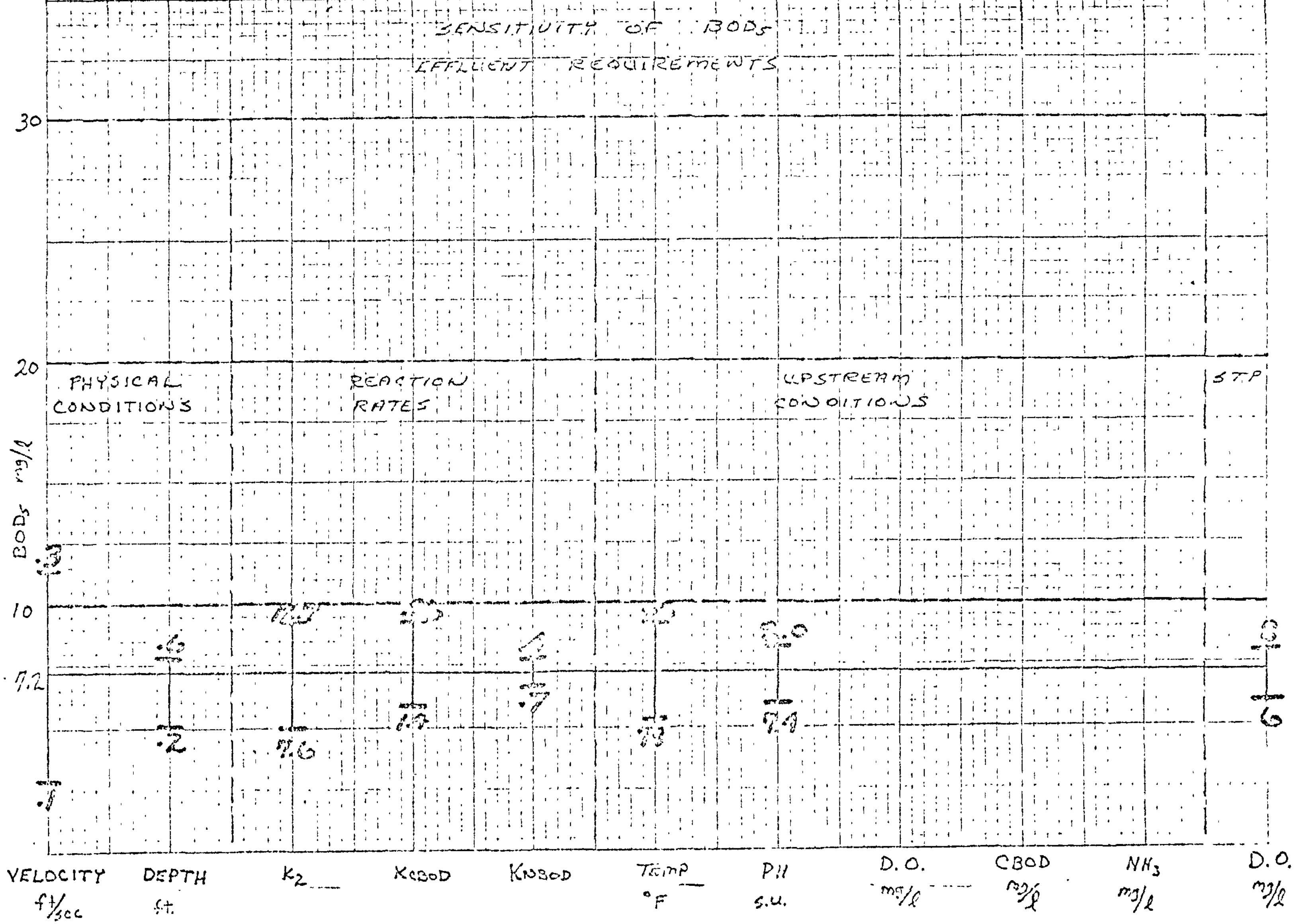


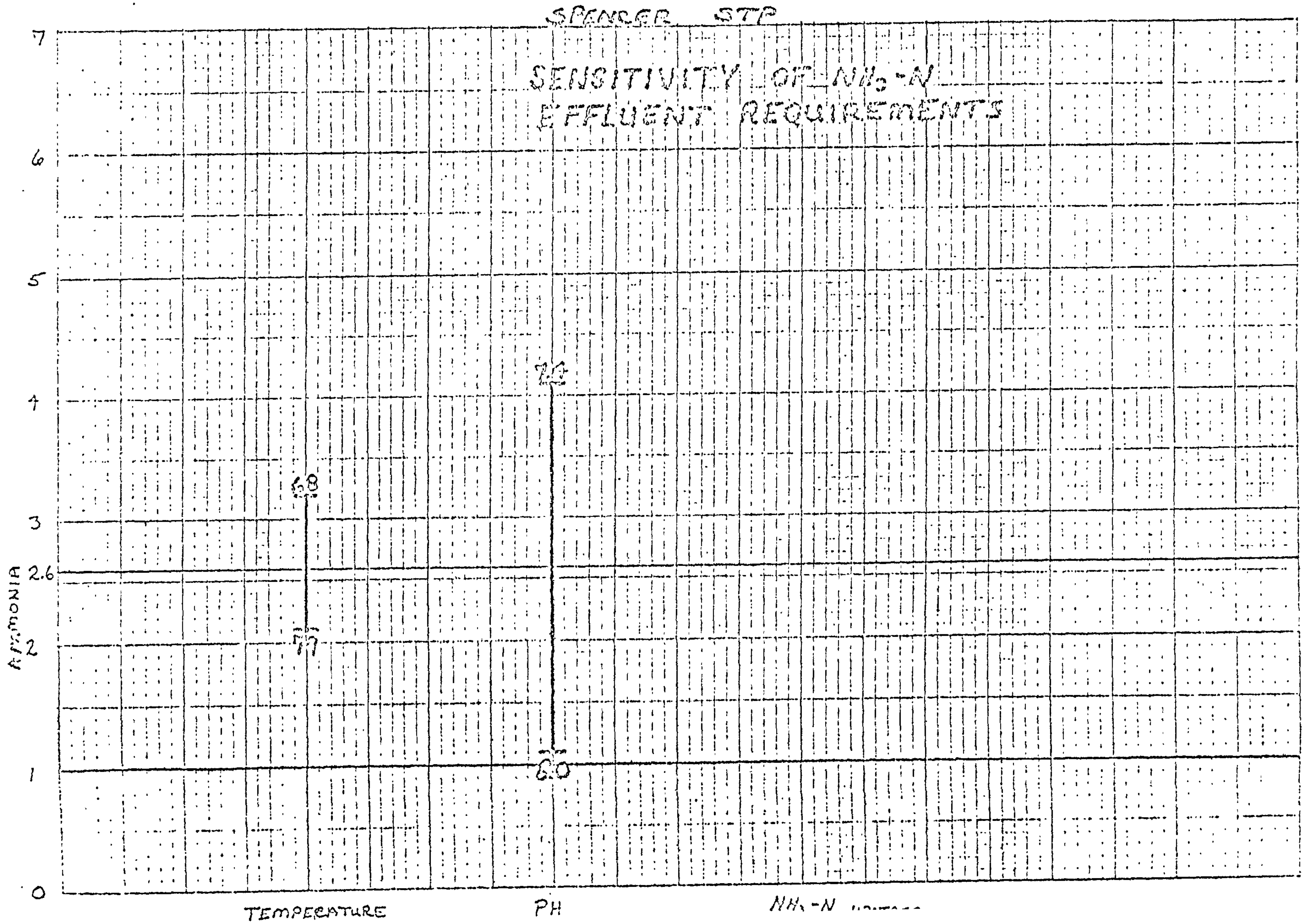
OBERLIN - STP
(TSIVOGLOU)

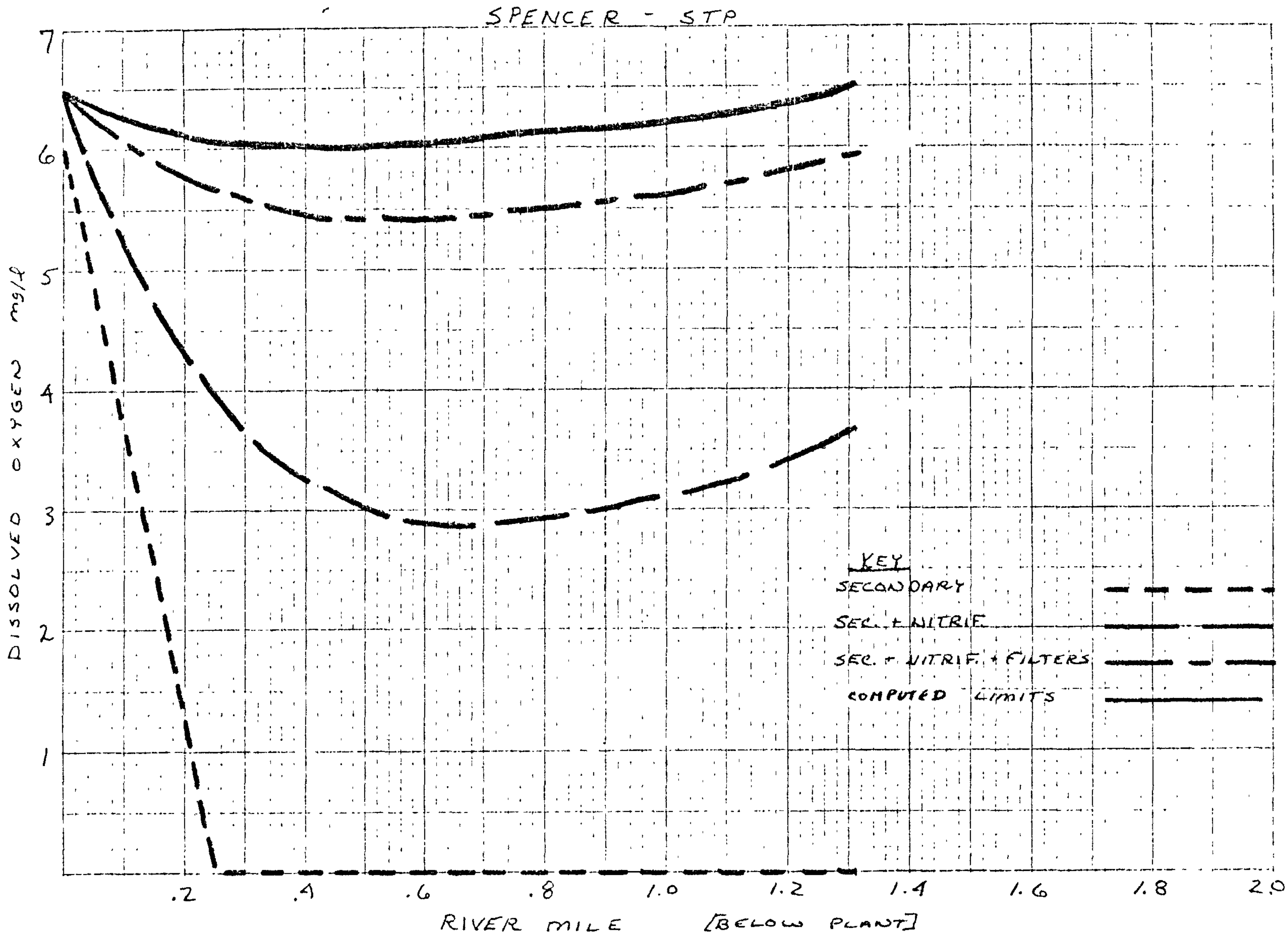



OBERLIN - STP
PLUM CREEK - 2.6 Miles
(TSIVOGLOU)
DISSOLVED OXYGEN (mg/l)
7
6
5
4
3
2
1
0
1
2
3
4
RIVER MILES
KEY
SECONDARY
SEC. + NITRI.
SEC. + NITRI. + FILTERS
COMPUTED LIMIT

SPENCER - STP


SENSITIVITY OF BOD5
EFFLUENT REQUIREMENTS
30
20
10
7.2
BOD5 mg/l
PHYSICAL CONDITIONS
REACTION RATES
UPSTREAM CONDITIONS
STP
VELOCITY ft/sec
DEPTH ft.
K2
KCBOD
KNBOD
TEMP °F
PH s.u.
D.O. mg/l
CBOD mg/l
NH3 mg/l
D.O. mg/l

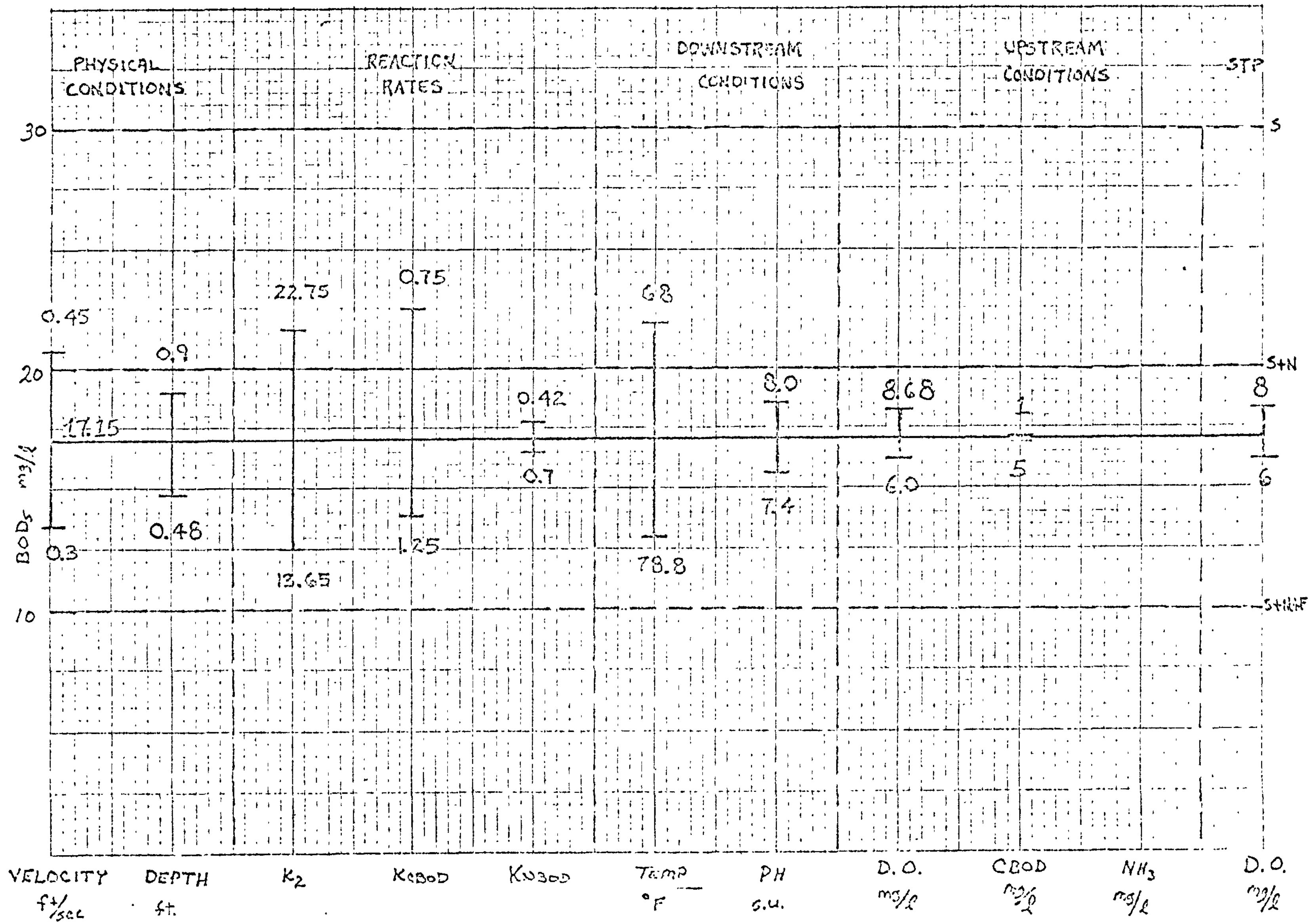

SPENCER STP
SENSITIVITY OF NH3-N
EFFLUENT REQUIREMENTS
7
6
5
4
3
2.6
2
1
0
AMMONIA
68
77
7.4
6.0
TEMPERATURE
PH
NH3-N

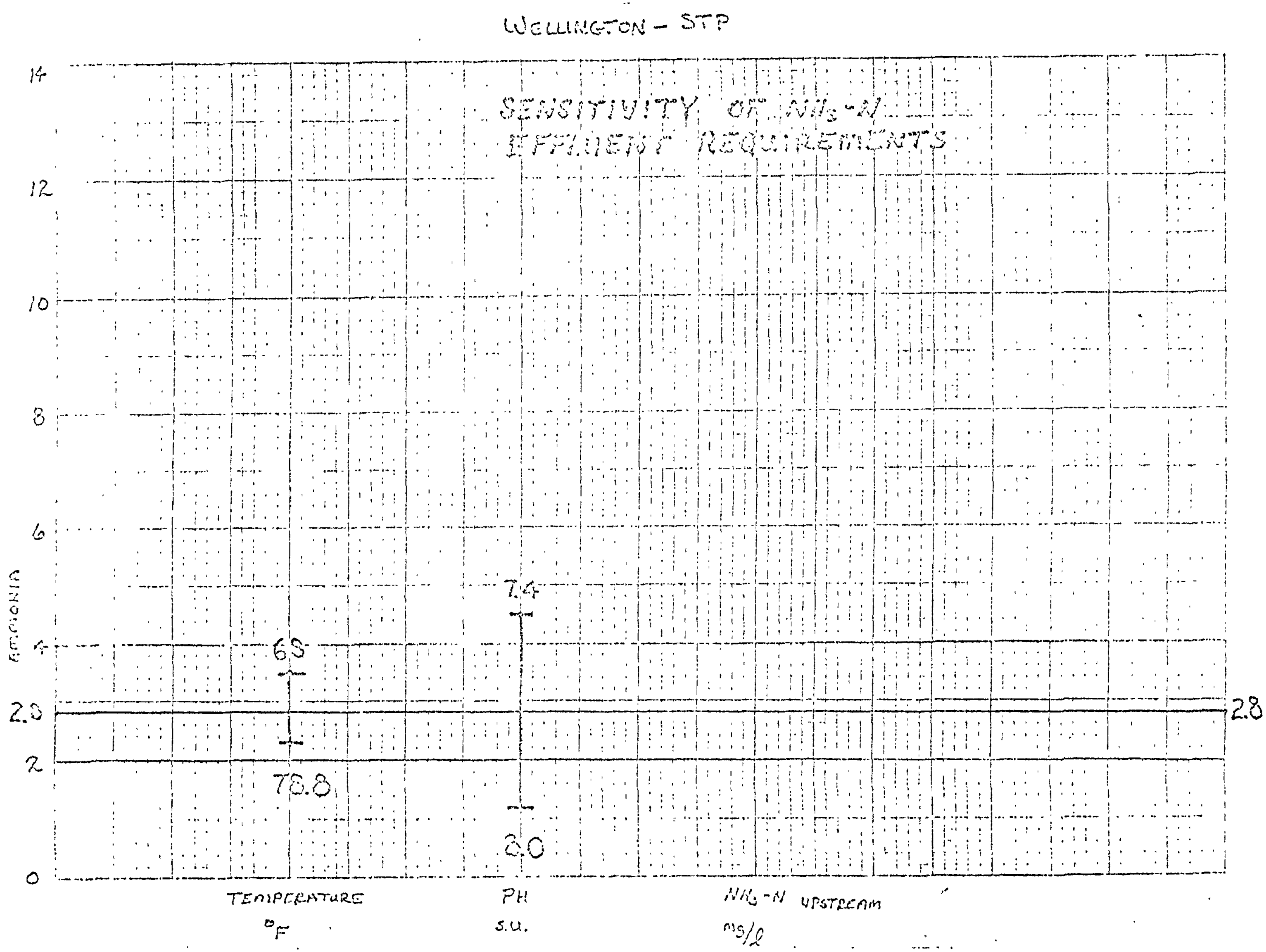


SPENCER - STP
DISSOLVED OXYGEN mg/l
7
6
5
4
3
2
1
.2
.4
.6
.8
1.0
1.2
1.4
1.6
1.8
2.0
RIVER MILE [BELOW PLANT]
KEY
SECONDARY
SEC. + NITRIF.
SEC. + NITRIF. + FILTERS
COMPUTED LIMITS

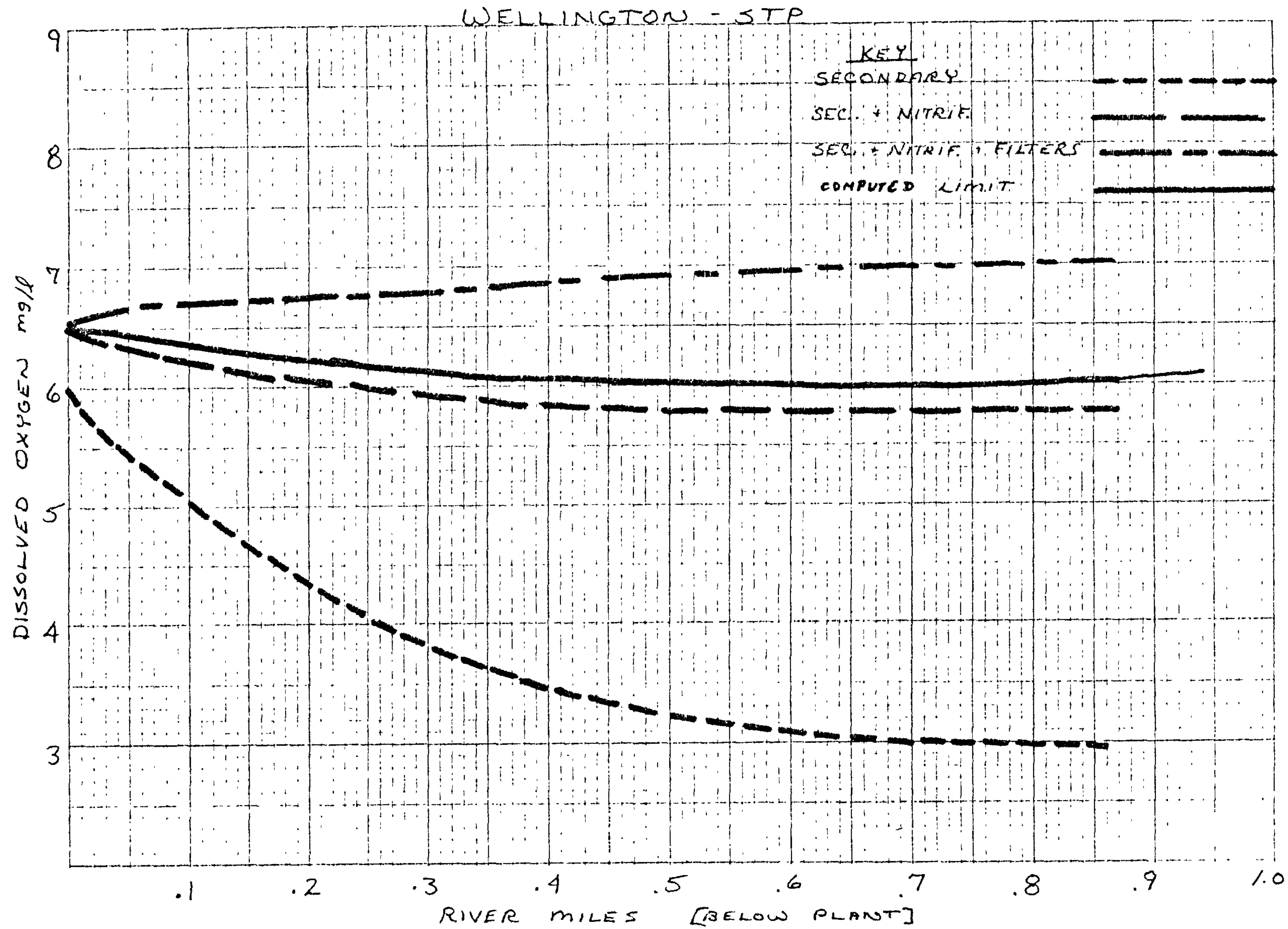
Wellington - STP

Sensitivity of BOD_5 Effluent Requirements





WELLINGTON - STP
SENSITIVITY OF NH3-N
EFFLUENT REQUIREMENTS
AMMONIA
14
12
10
8
6
4
2.9
2
0
2.8
65
78.8
7.4
8.0
TEMPERATURE
°F
PH
S.U.
NH3-N UPSTREAM
mg/l


WELLINGTON - STP
KEY
SECONDARY
SEC. + NITRIF.
SEC. + NITRIF. + FILTERS
COMPUTED LIMIT
DISSOLVED OXYGEN mg/l
9
8
7
6
5
4
3
.1
.2
.3
.4
.5
.6
.7
.8
.9
1.0
RIVER MILES [BELOW PLANT]