Report on Water Pollution

in the

LAKE ERIE BASIN

SOUTHEASTERN MICHIGAN AREA

RAISIN RIVER

UNITED STATES DEPARTMENT OF THE INTERIOR

FEDERAL WATER POLLUTION CONTROL ADMINISTRATION

GREAT LAKES REGION

MAY 1967

REPORT ON

WATER POLLUTION IN THE LAKE ERIE BASIN
SOUTHEASTERN MICHIGAN AREA
RAISIN RIVER

MAY 1967

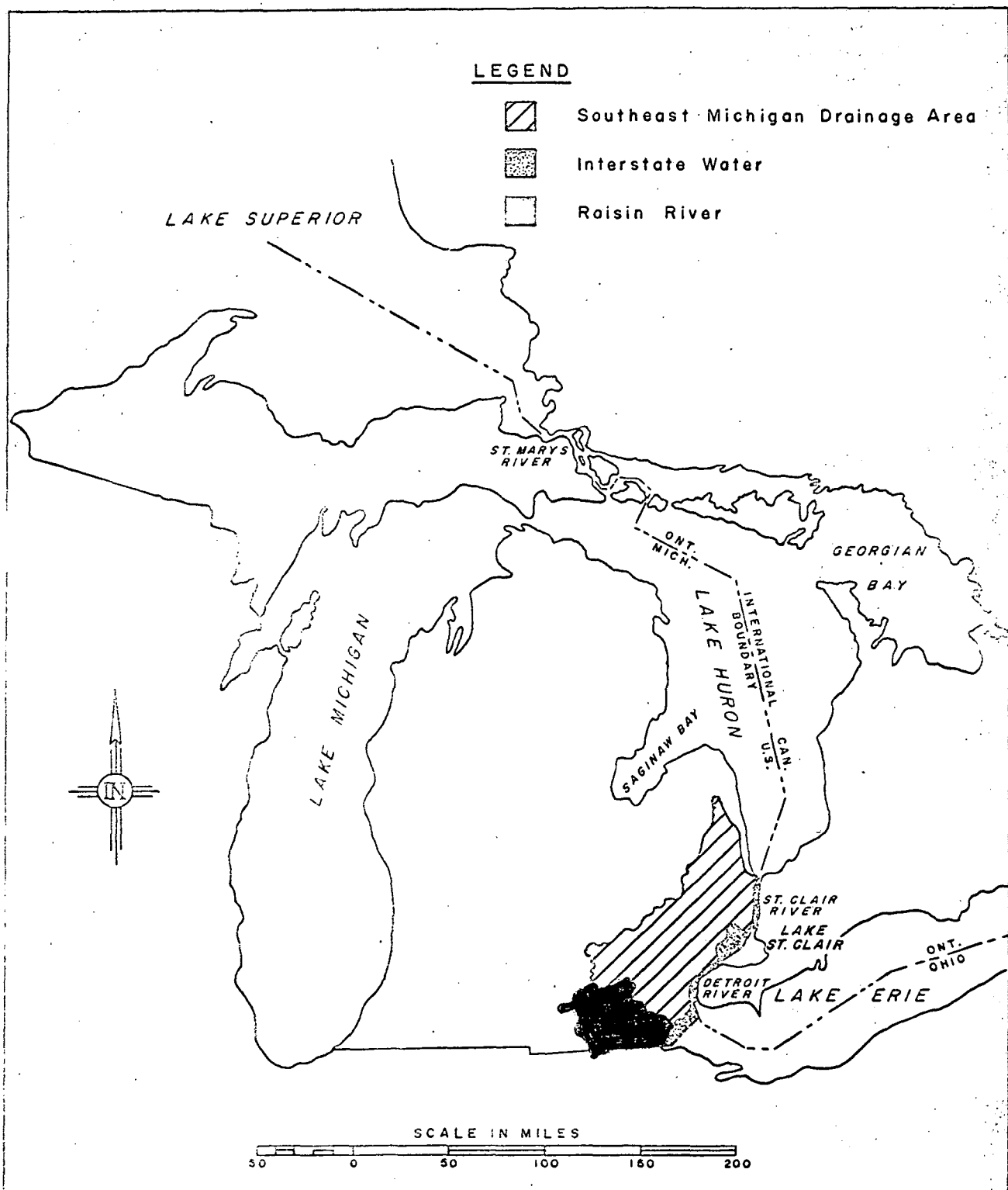
U.S. DEPARTMENT OF THE INTERIOR
Federal Water Pollution Control Administration
Great Lakes Region
Detroit Program Office
U.S. Naval Air Station
Grosse Ile, Michigan

PREFACE

The southeastern Michigan area draining into Lake Erie has been recognized as one of the major water pollution areas of the Lake Erie system. Extending across the natural watershed boundaries of southeastern Michigan's major tributaries is the metropolitan area of Detroit and its suburbs. The water quality problems of Lake Erie, Detroit River, Lake St. Clair, St. Clair River, and the individual tributaries are interrelated and compounded by the urbanization and industrialization of the area.

The complexity of the problem requires a comprehensive plan for "CLEAN WATER" that takes into account the cause and effect relationships of water resource utilization from the headwaters of the smallest tributary to the large water reservoirs that constitute the Great Lakes.

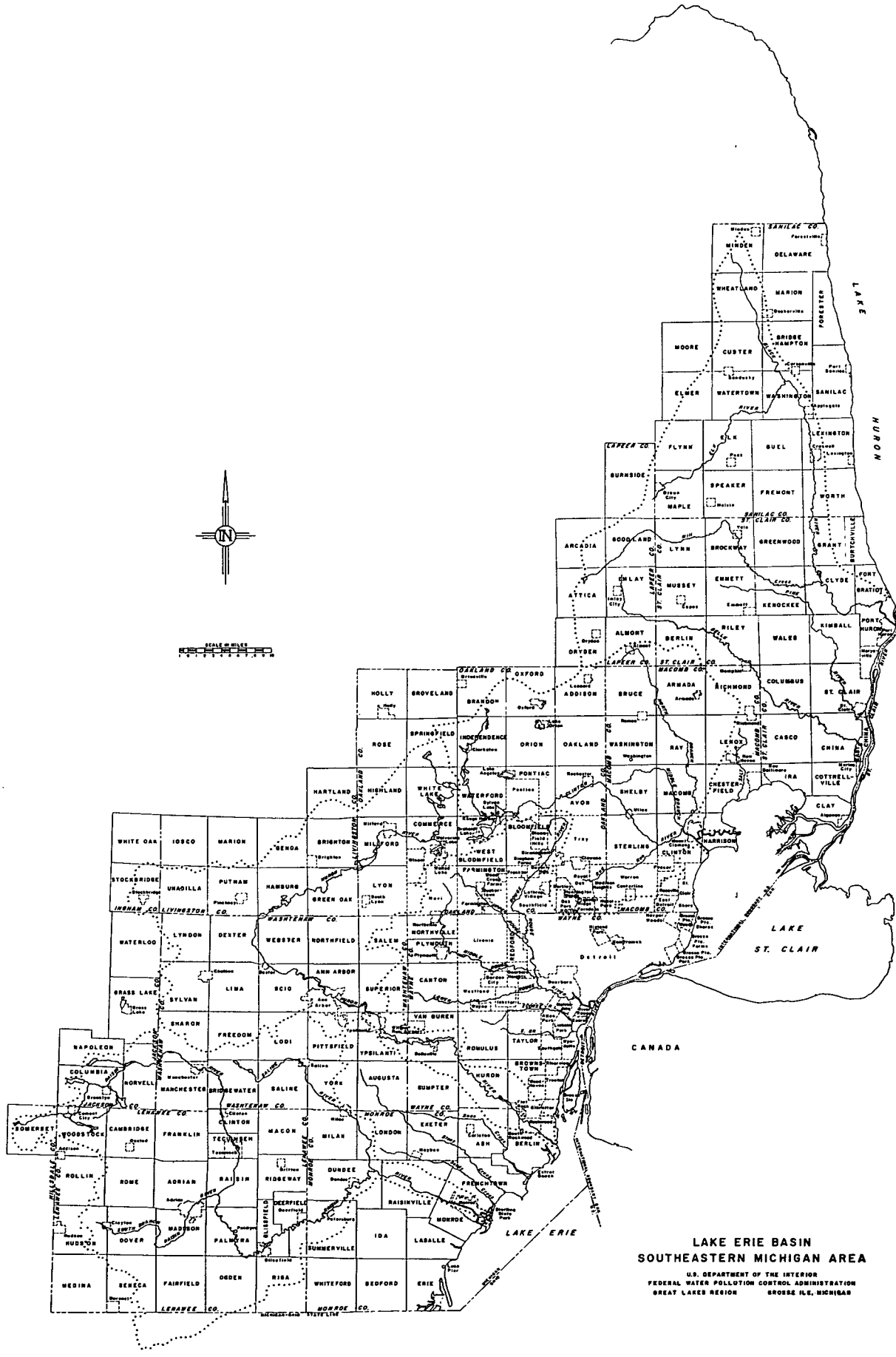
This document was assembled by the Detroit Program Office, Federal Water Pollution Control Administration, with the intention that it be used together with information from other sources to develop a comprehensive plan for water pollution control in the southeast Michigan tributaries of the Lake Erie Basin. The intended purpose of the plan would be to restore the usefulness of these waters for recreational purposes, provide a more suitable environment for fish and aquatic life, and enhance the value of this resource. It would improve the quality of the area's waters for municipal and industrial purposes, aesthetic enjoyment, and other beneficial uses.



DETROIT PROGRAM OFFICE
GREAT LAKES-ILLINOIS RIVER BASIN PROJECT

LOCATION MAP
LAKE ERIE BASIN
RAISIN RIVER

U.S. DEPARTMENT OF THE INTERIOR
FEDERAL WATER POLLUTION CONTROL ADMINISTRATION
GREAT LAKES REGION GROSSE ILE, MICHIGAN



LAKE ERIE BASIN
SOUTHEASTERN MICHIGAN AREA

U.S. DEPARTMENT OF THE INTERIOR
FEDERAL WATER POLLUTION CONTROL ADMINISTRATION
GREAT LAKES REGION — GROSSE ILE, MICHIGAN

TABLE OF CONTENTS

	Page
INTRODUCTION	1
GENERAL DESCRIPTION	5
Climate	7
Hydrology	8
Drought Flow	8
WATER USE	9
Municipal	9
Industrial	9
Recreation	9
SOURCES AND CHARACTERISTICS OF WASTES	13
Municipal	13
Industrial	15
POPULATION AND WASTE LOAD PROJECTIONS	29
WATER QUALITY	37
Chemical	37
Microbiology	40
Tributaries	
Saline River	40
Little River Raisin	41
South Branch River Raisin	41
Summary of Water Quality	43
SUMMARY AND WATER QUALITY PROBLEMS	79

LIST OF TABLES

		Page
1.	Municipal Water Supplies	10
2.	Projected Water Use	12
3.	Municipal Waste Characteristics	16
4.	Industrial Waste Inventory	24
5.	Population and Waste Flow Projections	31
6.	BOD_5 Projections	32
7.	Sampling Stations	
	Mainstream	34
	Tributaries	35
8.	Water Quality - Annual Bacteriological Densities	44
9.	Water Quality - Annual Chemical Concentrations	47
10.	Water Quality - Tributaries - Annual Bacteriological Densities	52
11.	Water Quality - Tributaries - Annual Chemical Concentrations	53
12.	Summary of Findings of Salmonella Survey	76

LIST OF FIGURES

		Page
1.	River Raisin Basin	6
2.	Municipal and Industrial Outfalls	23
3.	Population and Municipal Waste Flow Projection	33
4.	Location of Sampling Stations	36
5.	Total Coliform - Seasonal Median Values	55
6.	Dissolved Oxygen - 1966 Annual Values	56
7.	BOD_5 - 1966 Annual Values	57
8.	COD - 1966 Annual Values	58
9.	Nitrate - 1966 Annual Values	59
10.	Ammonia Nitrogen - 1966 Annual Values	60
11.	Nitrite - 1966 Annual Values	61
12.	Organic Nitrogen - 1966 Annual Values	62
13.	Total Phosphate - 1966 Annual Values	63
14.	Total Soluble Phosphate - 1966 Annual Values	64
15.	Total and Dissolved Solids - 1966 Annual Values	65
16.	Suspended Solids - 1966 Annual Values	66
17.	Chlorides - 1966 Annual Values	67
18.	Phenol - 1966 Annual Values	68
19.	Iron - 1966 Annual Values	69
20.	Total Coliform Seasonal Values	70
21.	Distribution of Salmonella	78

INTRODUCTION

AUTHORITY

Comprehensive water pollution control studies were authorized by the Federal Water Pollution Control Act of 1956, as amended (33 USC 466 et seq.).

> Sec. 3.(a) "The Secretary shall, after careful investigation, and in cooperation with other Federal agencies, with State water pollution control agencies and interstate agencies, and with the municipalities and industries involved, prepare or develop comprehensive programs for eliminating or reducing the pollution of interstate waters and tributaries thereof and improving the sanitary condition of surface and underground waters. In the development of such comprehensive programs due regard shall be given to the improvements which are necessary to conserve such waters for public water supplies, propagation of fish and aquatic life and wildlife, recreational purposes, and agricultural, industrial, and other legitimate uses. For the purpose of this section, the Secretary is authorized to make joint investigations with any such agencies of the condition of any waters in any State or States, and of the discharges of any sewage, industrial wastes, or substance which may adversely affect such waters."

> Sec. 5(f) "The Secretary shall conduct research and technical development work, and make studies, with respect to the quality of the waters of the Great Lakes, including an analysis of the present and projected future water quality of the Great Lakes under varying conditions of waste treatment and disposal, an evaluation of the water quality needs of those to be served by such waters, an evaluation of municipal, industrial, and vessel waste treatment and disposal practices with respect to such waters, and a study of alternate means of solving water pollution problems (including additional waste treatment measures) with respect to such waters."

Initiation of the Great Lakes-Illinois River Comprehensive Program Activity followed an appropriation of funds by the 86th Congress late in 1960. In accordance with the provisions of the Act, the Secretary of Health, Education, and Welfare delegated the responsibility for the study

to the Division of Water Supply and Pollution Control of the Public Health Service. Passage of the "Water Quality Act of 1965" gave the responsibility for these studies to the Federal Water Pollution Control Administration (FWPCA). As a result of Reorganization Plan No. 2 of 1966, the FWPCA was transferred from the Department of Health, Education, and Welfare to the Department of the Interior effective May 10, 1966.

PURPOSE

This report presents the water quality of the River Raisin, Michigan as it exists today, and includes predictions of population, water use, and waste load trends for future years. Its purpose is to present information that can be used as a basis for developing a basin-wide water pollution control program. The objectives of the Federal Water Pollution Control Administration are to enhance the quality and value of the Nation's water resources, and to prevent, control, and abate water pollution through cooperative municipal, State, and Federal pollution control programs.

SCOPE

The area covered by this report is the River Raisin drainage basin which is part of the Southeastern Michigan Area tributary to Lake Erie.

While some of the data from the entire River Raisin Basin are presented herein, most of the water quality data collected by Federal Water Pollution Control Administration are in the main river between the Village of Clinton and the mouth of the river at Monroe, Michigan.

ORGANIZATION

The Detroit Program Office, located at the Naval Air Station, Grosse Ile, Michigan, began collecting water quality data on the River Raisin in 1966. Its staff include specialists in several professional skills, including sanitary engineers, hydrologists, biologists, chemists and bacteriologists. The resources of the Robert A. Taft Sanitary Engineering Center at Cincinnati, Ohio have been utilized, and assistance and guidance have been obtained from the Great Lakes-Illinois River Basins Project, Chicago.

ACKNOWLEDGEMENTS

The Detroit Program Office has received the cooperation and assistance of local, State, and Federal agencies, as well as interested individuals. The principal agencies taking an active part in providing assistance in the preparation of the report are as follows:

State Agencies -

Michigan Water Resources Commission
Michigan Department of Public Health

Federal Agencies -

U.S. Department of Commerce
Weather Bureau
Office of Business Economics
Bureau of Census

U.S. Department of the Interior
Bureau of Commercial Fisheries
Bureau of Sports, Fisheries, and Wildlife
Bureau of Outdoor Recreation
Geological Survey

GENERAL DESCRIPTION

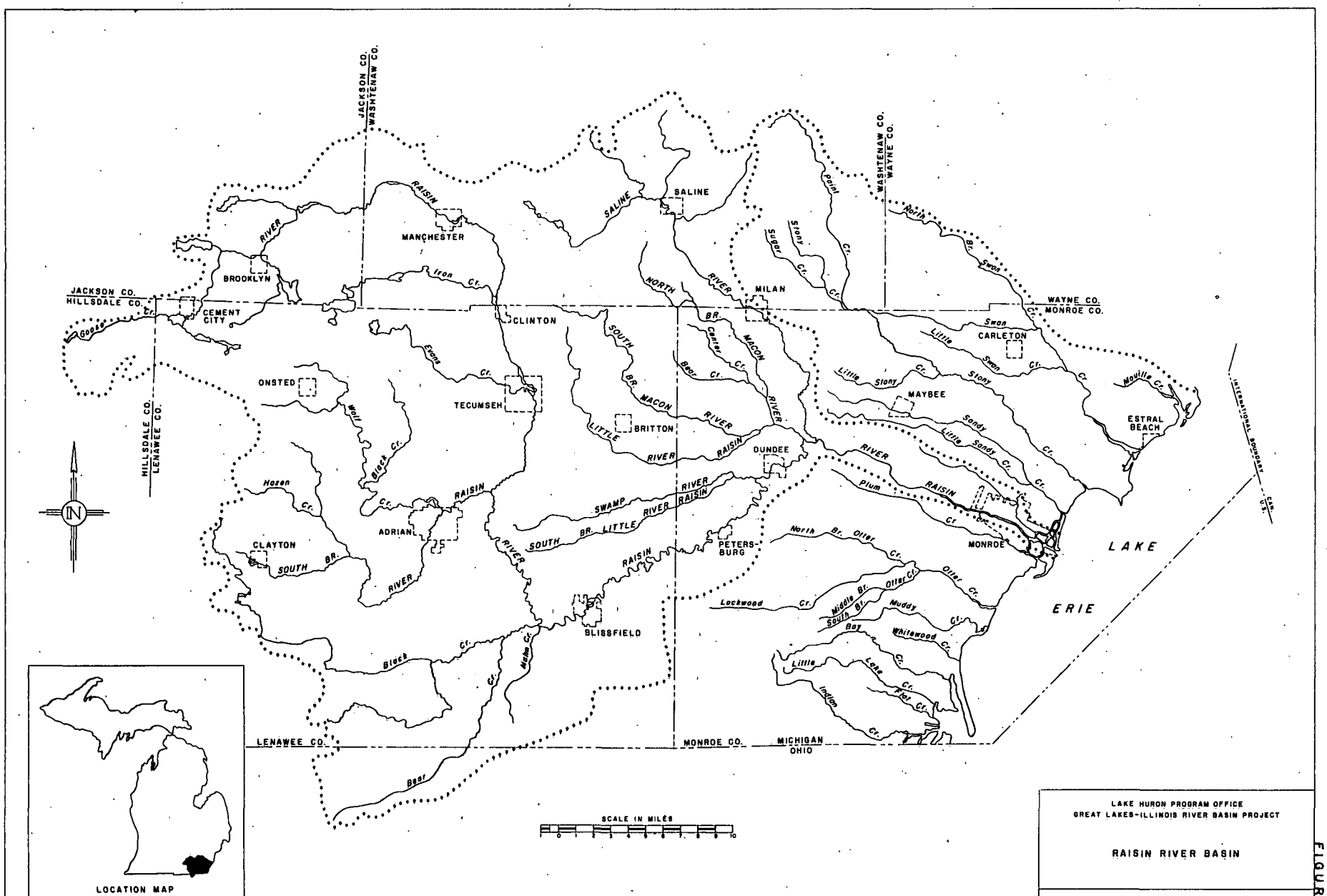
Area Description

The River Raisin is the thirteenth largest primary drainage system in Michigan. The River Raisin drains an area of 1070 square miles and discharges to Lake Erie at Monroe, Michigan. The River Raisin Basin includes most of Lenawee County and portions of Washtenaw, Monroe, Jackson, and Hillsdale in Michigan, and a portion of Fulton County in Northern Ohio. The river has its headwaters in northwestern Lenawee County approximately 50 miles west of Monroe, Michigan. The river first flows southeasterly, then northeasterly to Dundee, and finally easterly to its mouth at Lake Erie. The total fall of the river is about 500 feet.

The basin has a shape similar to that of a frying pan with the last fifteen miles of the river draining a narrow strip of land approximately 2.5 miles wide. A series of low-head dams are spaced at one-mile intervals near the mouth of the river. Lake-affected backwater extends approximately 3 miles upstream to the first low-head dam. A dredged channel is maintained by the Corps of Engineers in the lower 1.5 miles of the River Raisin to serve the Port of Monroe.

The River Raisin Basin is sparsely settled. The major population centers are Monroe in Monroe County and Adrian in Lenawee County. Industrial activity includes paper and manufacturing plants located in Monroe and electroplating plants in Adrian.

The River Raisin Basin is bounded on the northwest by the Grand River Basin, on the north by the Huron River Basin, on the east by Lake Erie, and State of Ohio to the south, Figure 1.


JACKSON CO.
WASHTENAW CO.
HILLSDALE CO.
LENAWEE CO.
WASHTENAW CO.
WAYNE CO.
WAYNE CO.
MONROE CO.
LENAWEE CO.
MONROE CO.
MICHIGAN
OHIO
SALINE
MANCHESTER
BROOKLYN
CEMENT CITY
CLINTON
MILAN
CARLETON
MAYBEE
ESTRAL BEACH
ONSTED
TECUMSEH
BRITTON
DUNDEE
ADRIAN
CLAYTON
PETERSBURG
MONROE
BLISSFIELD
LAKE ERIE
INTERNATIONAL BOUNDARY
RAISIN RIVER
SALINE
North Br. Saline
Stony Cr.
Sugar Cr.
Paint
Iron Cr.
NORTH BR. RAISIN RIVER
Goose Cr.
Evans Cr.
Wolf
Black Cr.
Hazen Cr.
SOUTH BR. RAISIN RIVER
SOUTH BR. MACON RIVER
Bear Cr.
Center Cr.
MACON RIVER
LITTLE RIVER RAISIN
SWAMP RIVER
SOUTH BR. LITTLE RIVER RAISIN
Swan
Little Swan Cr.
Little Stony Cr.
Stony Cr.
Mouille Cr.
Sandy
Little Sandy Cr.
Cr.
Plum
RAISIN RIVER
North Br. Otter Cr.
Otter Cr.
Middle Br. Otter Cr.
South Br.
Lockwood Cr.
Muddy Cr.
Bay
Whitewood Cr.
Little Lake Cr.
Indian Cr.
Flat Cr.
Black Cr.
Hicks Cr.
Bear
LOCATION MAP
SCALE IN MILES
0 1 2 3 4 5 6 7 8 9 10
LAKE HURON PROGRAM OFFICE
GREAT LAKES-ILLINOIS RIVER BASIN PROJECT
RAISIN RIVER BASIN
U.S. DEPARTMENT OF THE INTERIOR
FEDERAL WATER POLLUTION CONTROL ADMINISTRATION
GREAT LAKES REGION GROSSE ILE, MICHIGAN
FIGURE 1

Tributaries to the River Raisin include the South Branch River Raisin which flows through Adrian, Saline River, Black Creek, Swamp Raisin Creek, and Macon Creek.

The topography of the River Raisin Basin is relatively flat. Exceptions are the Irish Hills and the lake district in the northwestern part of the basin. There is a marked difference between the north and west portions and the east and south portions of the watershed in soils and natural drainage. The lighter textured well-drained soils occur in the uplands, while the heavier textured and more poorly-drained soils occur in the lower lands. The western section of the basin is characterized by moraines and the eastern section is primarily glacial lake deposits.

Climate

The River Raisin Basin is influenced greatly by its location in the center of the Great Lakes area which tends to modify the air masses that pass through the area. The resulting climate can be described as having many storms, wide seasonal temperature variation, and a relatively constant yearly precipitation distribution. The precipitation in the winter months is usually in the form of snow.

At Adrian, located roughly in the center of the Basin, the average temperature is 50°F , with average summer and winter temperatures of 72°F and 28°F, respectively. The normal yearly precipitation at Adrian is 32 inches with 49 percent falling during the 5-month period, May through September. The growing season averages 158 days.

Hydrology

Location of U.S. Geological Survey Gages

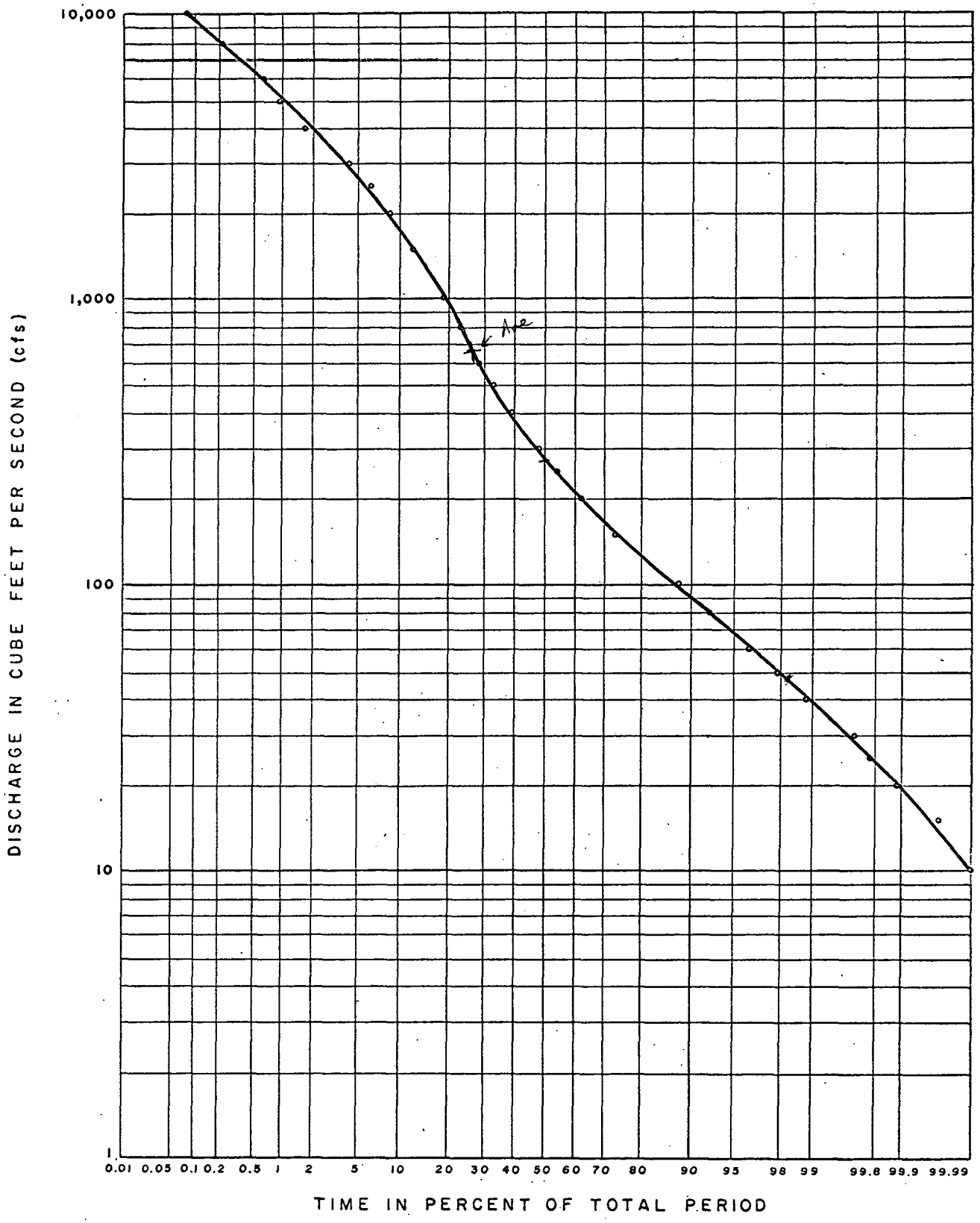
There are three U.S. Geological Survey stream gaging stations in the River Raisin Basin. Of these three stations, one was utilized by the Federal Water Pollution Control Administration (FWPCA) in this report. This station is River Raisin near Monroe, Michigan located 0.8 miles downstream from the Ida Maybee Road on the northeast bank. It has a drainage area of 1034 square miles and has been in continuous operation since September 1937. The maximum and minimum discharges at this station are 12,900 and 2 cubic feet per second (cfs), respectively. For the period of record, the average discharge is 661 cfs.

Drought Flow

The one, seven, and thirty-day low flows (once-in-ten-years) have been calculated for the U.S. Geological Survey station near Monroe. They are as follows:

One-day (once-in-ten-years)	21 cfs
Seven-day (once-in-ten-years)	35 "
Thirty-day (once-in-ten-years)	47 "

FLOW DURATION CURVE
RAISIN RIVER AT MONROE
1938-1964



WATER USE

Municipal Water Use

The River Raisin Basin has a population served by public water supplies of about 74,000 people. Except for Monroe, all the towns in the Basin get their water from either wells or the River Raisin. Monroe takes its water from Lake Erie.

Total municipal water use in the Basin is approximately 12 million gallons per day (MGD). The 2020 projected use is expected to be around 197 MGD.

Table 1 lists the present water supplies and the sources. In Table 2 the projected municipal water use for 1990 and 2020 are shown.

Industrial Water Use

This section will consider only the major industrial water users in the River Raisin Basin that obtain their water from other than public supplies. The volume of this water is about 35 MGD. Projected water use for 2020 is estimated to be 182 MGD. The projected industrial use is shown in Table 2.

Ford Motor Company plant at Monroe uses about 7 MGD of water for process and cooling. They also use approximately 120 MGD of water for waste dilution which will not be included in the present or projected use figures.

Water-Related Recreation

Lakes and streams in the River Raisin Basin are under increasing pressure for various recreational uses. There are approximately 300 lakes and ponds in the Basin with the majority located in the morainic headwaters area adjacent to Irish Hills. These natural lakes and artificial impoundments vary in size up to 800 acres. The shores of larger lakes are intensively used for summer homes, with an increasing trend toward year-round residences.

TABLE 1. MUNICIPAL WATER SUPPLIES*
River Raisin Basin

Town	1960 Pop.	Owner**	Source	Treatment**
Brooklyn	1,000	M	Wells in rock 40' to 131' deep	5
Bedford Twp.	650	T	Wells in rock 59' to 90' deep	5
Carleton	1,379	M	Wells in rock 98' to 100' deep	3 & 5
Dundee	2,377	M	River Raisin 50' of 12" intake 10' deep	2
Erie Twp.	320	P	Wells in rock 125' to 200' deep	-
La Salle Twp.	200	P	Well in rock 101' deep	-
Monroe	23,000	M	Lake Erie 5500' of 30" intake, 21' deep	1 & 6
Petersburg	1,000	M	Wells in rock 78' to 80' deep, hydrogen sulfide removal	5
Addison	575	M	Wells in drift 108' deep	4
Adrian	20,347	M	Lake Adrian 30" intake	2 & 6
Blissfield	2,700	M	River Raisin	1
Cambridge Twp.	600	P	Wells in drift 85' to 90' deep	-
Britton	600	M	Wells in drift 60' deep	5
Clinton	1,500	M	Wells in drift 34' to 42' deep	-
Deerfield	900	M	River Raisin	1
Onsted	500	M	Wells in drift 154' & 178' deep	5
Palmyra Twp.	200	P	Wells in drift 135' deep	-
Tecumseh	7,000	M	Wells in drift 76' to 146' deep	5 & 6
Manchester	1,600	M	Wells in drift 117' deep	4
Milan	3,600	M	Wells in drift 82' to 102' deep	-
Saline	2,300	M	Wells in drift 116' deep	5 & 6

* Taken from "Data on Public Water Supplies in Michigan," Engineering Bulletin No. 4 by the Michigan Department of Public Health.
**See Owner and Treatment Code, page 11.

OWNER AND TREATMENT CODES

Owner Code:

M = City or Village

T = Township

P = Private

D = District

C = County

S = State

U.S. = Federal

Treatment Code:

1. Std. Filtration*
2. Lime softening**
3. Zeolite softening
4. Iron removal
5. Chlorination
6. Fluoridation

* Implies at least chlorination, chemical coagulation, and rapid sand filtration.

**Lime softening includes filtration.

Recreation facilities include Onsted, Petersburg, and Sharonville State Game Areas, Walter Hayes and Sterling State Parks, Allens and Sand Lakes Public Fishing Sites, roadside parks, county and municipal parks and golf courses. The River Raisin Basin in 1965 had approximately 9,000 boats registered by residents. These boats are used on the numerous lakes and streams of the basin as well as on Lake Erie.

Boating, swimming, water skiing, and fishing are popular water-oriented uses in the basin. The main stem of the River Raisin from Clinton to Deerfield, a total length of 42 miles, is a recognized canoe trail publized by the Michigan Tourist Council and the Michigan Department of Conservation.

Recreation, inventory, and analyses are contained in the Bureau of Outdoor Recreation report "Water-Oriented Outdoor Recreation Lake Erie Basin" August 1966.

Table 2. PROJECTED WATER USE
(MGD)

	1965	1990	2020
Municipal*	12	34	97
Industrial	35	77	182
Total	47	111	279

*Includes water for small industries

SOURCES AND CHARACTERISTICS OF WASTES

Municipal

The River Raisin has a population served by sewerage systems of approximately 68,000 people. The total wastewater flow from the nine plants is about 10.5 million gallons per day (MGD). Table 3 gives a summary of the treated discharges of these plants and Figure 2 shows their location.

The Michigan Department of Public Health requires that all sewage treatment plants chlorinate their effluents year-round as of January 1967. During 1965 and 1966 chlorination was required for all plants for a minimum period from May 15 to September 15; however, some plants were required to chlorinate continuously year-round.

All of the data in this section are based on monthly average figures for 1965 as reported by the plants to the Michigan Department of Public Health.

Adrian Sewage Treatment Plant
1965

This activated sludge plant is the second largest plant in the basin. The population served of about 19,800 contributed in 1965 an average flow of 2.83 MGD. The 5-day biochemical oxygen demand (BOD_5) varied during this period from 7 to 34 milligrams per liter (mg/l) with an average of 14 mg/l. The BOD_5 removal efficiency of this plant was about 93 percent. The effluent was chlorinated continuously throughout the year.

Blissfield Sewage Treatment Plant
1965

The Blissfield STP is a primary unit which served about 2600 people. Average flow for 1965 was 0.49 MGD. Effluent BOD_5 during the year varied from 23 to 150 mg/l with an average of 53 mg/l. Plant BOD_5 removal was 43%. The effluent was chlorinated continuously year-round.

Clinton Sewage Treatment Plant
1965

This primary plant served about 1500 people which contributed an average flow of 0.08 MGD in 1965. Effluent BOD_5 values averaged 134 mg/l with variations between 116 and 152 mg/l. Plant BOD_5 removal was 46%. The effluent was chlorinated from May 15 to September 14*.

Dundee Sewage Treatment Plant
1965

The Dundee primary plant had an average flow of 0.2 MGD contributed by a population served of 2300. There was limited information concerning the effluent BOD_5 of this plant. BOD_5 removal was about 36% which left an effluent BOD_5 value of 68 mg/l in June 1965. The effluent was chlorinated from May 15 to September 15*.

Manchester Sewage Treatment Plant
1965

This trickling filter plant served about 1600 people which contributed an average flow in 1965 of 0.53 MGD. Effluent BOD_5 values during the year varied from 20 to 36 mg/l with an average of 28 mg/l. Plant BOD_5 removal was 56%. The effluent was chlorinated from May 15 to September 15*.

Milan Sewage Treatment Plant
1965

In 1965 an average wastewater flow of 0.8 MGD was treated by this trickling filter plant. The plant served about 3600 people. The 86% BOD_5

*1965-1966 chlorination period was May 15 to September 15.

removal held the average effluent BOD_5 to 34 mg/l with only variations between 25 and 45 mg/l. The effluent was chlorinated from May 15 to September 15*.

Monroe Sewage Treatment Plant
1965

This primary plant was the largest in the basin with an average flow in 1965 of 4.54 MGD. This plant served about 27,000 people in the Monroe area. Effluent BOD_5 values varied during the year from 49 to 98 mg/l with an average value of 75 mg/l. Plant BOD_5 removal was 59%.** The effluent was chlorinated from May 15 to September 15*.

Saline Sewage Treatment Plant
1965

The 2300 people served by this trickling filter plant contributed an average flow of 0.32 MGD in 1965. The average effluent BOD_5 of 45 mg/l was due to the 82% removal of the plant. The effluent was chlorinated from May 15 to September 15*.

Tecumseh Sewage Treatment Plant
1965

This trickling filter plant removed about 80% of the BOD_5 contributed by its population served of 7300. The 1965 average flow was 0.71 MGD. Effluent BOD_5 values varied during the year from 33 to 62 mg/l with an average of 45 mg/l. The effluent was chlorinated continuously throughout the year.

Industrial

Seventeen industries discharged wastes directly to watercourses within the River Raisin Basin. A total discharge of approximately 156 MGD of

**1963 value from 1965 PHS Report Detroit River-Lake Erie Project.

TABLE 3. MUNICIPAL WASTE CHARACTERISTICS

Plant Name	Flow (MGD)	5-Day BOD*	Temp. °F	Susp. Solids*	Susp. Vol. Solids *	pH
Adrian	2.83	14	62	35	27	7.2
Blissfield	0.49	53	57	57	41	7.4
Clinton	0.08	134	-	124	99	-
Dundee	0.20	68	59	59	36	7.4
Manchester	0.53	28	54	23	15	7.7
Milan	0.80	34	66	34	24	7.5
Monroe	4.54	74	60	62	46	7.4
Saline	0.32	45	56	50	28	-
Tecumseh	0.71	45	59	75	47	7.7

* Reported as mg/l

industrial waste originated from electroplating operations, paper mills, cement production, chemical companies, fabricating and manufacturing companies, and automative plants. Table 4 shows the industrial waste inventory and Figure 2 their outfall locations.

Treatment or control provided by these industries has been rated by the Michigan Water Resources Commission as adequate for 9 industries, inadequate for 5 industries, adequacy or control not determined for 2 industries and control provided-protection unreliable for one industry as of April 1, 1966.

Avis Industries-Hurd Lock Division is located in the City of Adrian and discharges wastes from electroplating operations to the South Branch River Raisin. The average flow is 0.28 MGD and the significant waste constituents are chromium, copper, and cyanide. Treatment consists of chemical oxidation of cyanide, chemical reduction and precipitation of chromium, and neutralization by intermixing acid and alkaline wastes. Sanitary sewage is discharged to the City of Adrian. Treatment is rated as adequate by the Michigan Water Resources Commission.

Buckeye Products Corporation is located in the City of Adrian and discharges wastes originating from electroplating operations to the South Branch River Raisin. The average flow is 0.2 MGD and contains concentrations of chromium, copper, and cyanide. Treatment consists of chemical oxidation of cyanide, chemical reduction of chromium, and neutralization by intermixing of acid and alkaline wastes. Sanitary sewage is discharged to the City of Adrian for treatment. Adequacy of treatment has not been determined by the Michigan Water Resources Commission.

Consolidated Packaging Corporation-North Side Division is located within the City of Monroe and discharges to the River Raisin. The average flow from the manufacture of liner board from waste paper and corrugating medium from straw is 7.5 MGD with the main waste constituents being BOD_5, suspended solids, and coliforms. Treatment includes coagulation and settling. Sanitary sewage is treated by the City of Monroe. Treatment is rated as inadequate by the Michigan Water Resources Commission (MWRC). Plans are being prepared for construction of new facilities.

Consolidated Packaging Corporation-South Side Division is located in Monroe and discharges to the River Raisin. The average flow of 7.0 MGD originates from paper board manufacturing. The principal waste constituents are suspended solids, BOD_5, and coliforms. Treatment consists of sedimentation. Sanitary sewage is treated by the City of Monroe. Treatment is rated as inadequate by the MWRC. Plans are being made for new facilities.

Dundee Cement Company, located in Dundee Township, Monroe County, discharges wastes from the production of cement to Mason Creek, a tributary of the River Raisin. The average flow is 1.4 MGD with suspended solids and pH being the major waste constituents. Waste treatment consists of a clarifier and is rated as inadequate by the State. Action is underway to improve the degree of treatment.

Gray, Inc. is located in the City of Tecumseh and produces electric components. The average discharges to the River Raisin is 0.01 MGD and contains no significant pollutants. Treatment consists of a holding tank and chlorination. Sanitary wastes are treated by the City of Tecumseh. Treatment has been rated as adequate by the MWRC.

Ford Motor Company-Metal Stamping Division is located in Monroe and discharges wastes originating from electroplating operations to the River Raisin. The average flow is 130 MGD with the principal waste constituents being cyanide, copper, nickel, chromium, and zinc. Treatment consists of dilution, chemical coagulation, and alkaline chlorination. Waste treatment is inadequate and requires a higher degree of cyanide removal. Sanitary wastes are treated in a primary-type plant with chlorination.

Hoover Ball and Bearing Co.-Universal Die Casting Div. is located in Saline and discharges wastes from electroplating operations to the Saline River, a tributary of the River Raisin. The average flow is 0.57 MGD with discharges of cyanide, copper, and chromium. Treatment consists of oxidation of cyanide with chlorine, and the precipitation and settling of the metal components. Sanitary sewage is discharged to the Saline municipal treatment plant. Treatment is rated as adequate by the MWRC.

Monroe Auto Equipment Company is located in Monroe. This company discharges 0.02 MGD containing chromium, soluble and free oils, and cooling water. Soluble oils are hauled away. Sanitary sewage and chromium wastes are treated by the City of Monroe. Treatment is rated as adequate by the MWRC.

Monroe Paper Products Company, located in Monroe, discharges wastes from the manufacture of paperboard to the River Raisin. The average discharge of 2.2 MGD contains solids, BOD_5, and coliforms. Treatment consists of chemical coagulation and sedimentation. Treatment is rated as inadequate by the MWRC. Plans are being prepared for new facilities. Sanitary sewage is treated by the City of Monroe.

Revco, Inc. is located in Deerfield and discharges from the production of refrigeration equipment an average of 0.03 MGD to the River Raisin. Waste constituents consist of washer water and bonderite. The bonderite solution is treated with sodium bisulfite to reduce the chromate. Sanitary wastes are treated by a septic tank and tile field. Treatment is rated as adequate by the MWRC.

Simplex Paper Corporation, located in Palmyra Township, Lenawee County, discharges 0.25 MGD from the production of building paper to the River Raisin. The principal waste constituents are solids, clay, coloring materials, and BOD_5. Treatment consists of a save-all. The adequacy of the control provided has not been determined by the MWRC. Sanitary sewage is treated in a septic tank and tile field.

Stauffer Chemical Company-Anderson Chemical Div. located in Weston, produces metallic-organic chemicals. An average flow of 0.23 MGD is discharged to Black Creek, a tributary of the River Raisin. Waste constituents include acid, alkali, BOD_5, and chlorides. Treatment consists of a lagoon and HCI recovery. Sanitary sewage is treated by a company-extended aeration plant with chlorination. Treatment is rated as adequate by the MWRC.

Tecumseh Products Company, located in the City of Tecumseh, manufactures refrigeration equipment. Wastes consist of 1.44 MGD of cooling waters which are discharged to the River Raisin. Sanitary sewage is discharged to the City of Tecumseh for treatment. Control is rated as adequate by the MWRC.

Union Bag-Camp Paper Company-River Raisin Paper Company Div. is located in Monroe. Wastes, averaging 4.57 MGD, originate from the manufacture of boxboard and are discharged to the River Raisin. The main waste constituents are suspended solids and BOD_5. Treatment consists of chemical coagulation and settling. Treatment is rated as inadequate by the MWRC. Plans are being prepared for additional treatment facilities. Sanitary sewage is treated by the City of Monroe.

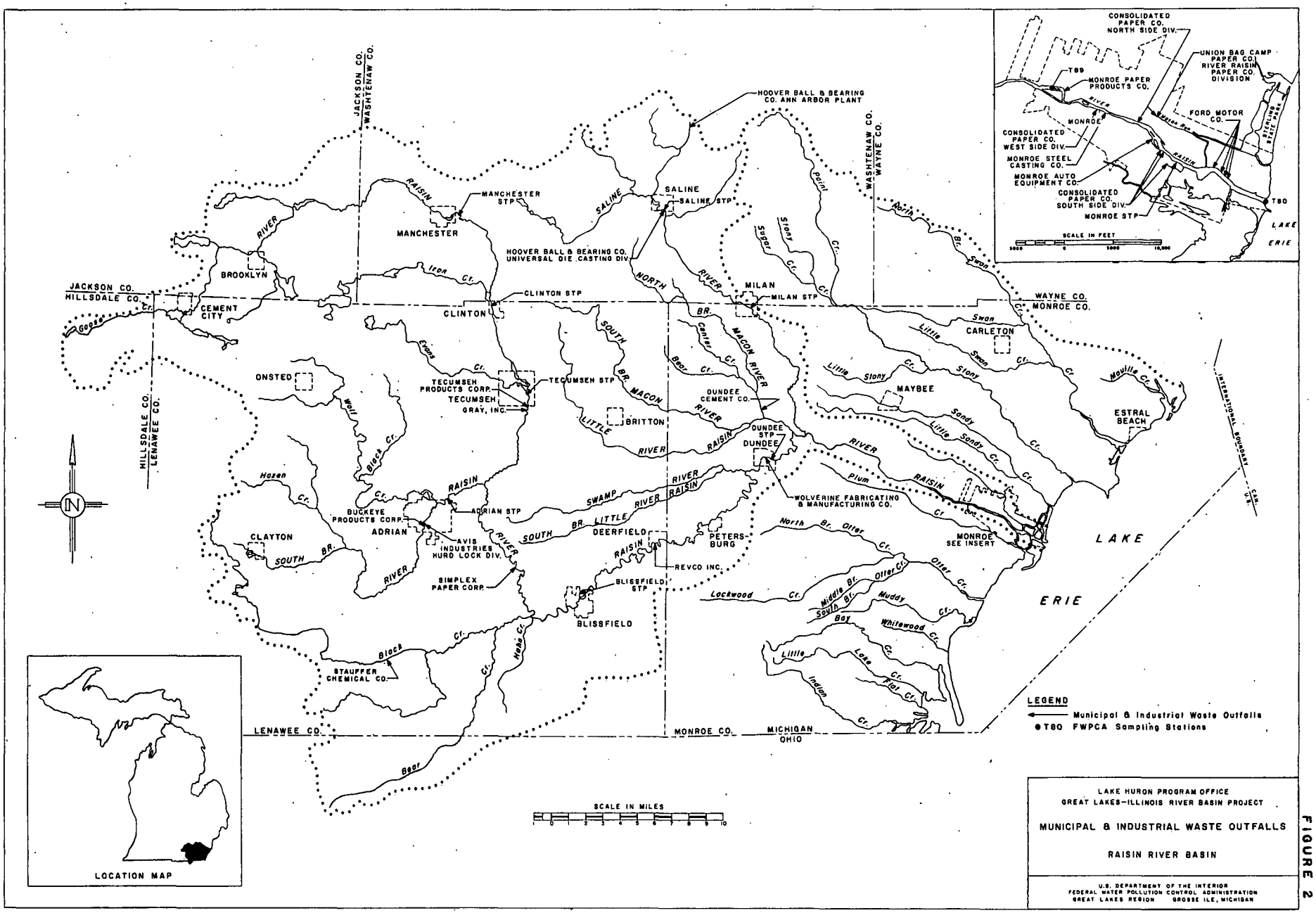
Wolverine Fabricating and Manufacturing Company is located in Dundee. Wastes averaging 0.03 MGD and containing solids are discharged to the River Raisin. No industrial waste treatment is provided. The plant control is rated as adequate by the MWRC. Sanitary sewage is discharged to the City of Dundee for treatment.

As a result of the enforcement conferences on Detroit River and Lake Erie pollution, an agreement was reached between the MWRC and various industries and municipalities to provide remedial action. These agreements were presented by MWRC at Third Conference, Lake Erie Pollution 3/22/67. The schedule for completion of treatment facilities is shown below.

River Raisin Time Schedule for Remedial Action

Industrial and Municipal Treatment

Industry	Construction Completion
Time Container Corp.	
Monroe Paper Products Div.	1/1/69
Consolidated Packaging Corp.	
North Plant	1/1/69
South Plant	1/1/69
Union Bag-Camp Corp.	
Monroe	1/1/69
Ford Motor Company	
Monroe	12/1/68
Municipal	
City of Monroe	1/1/69
Frenchtown Township	5/1/69
Monroe Township	5/1/69



LAKE HURON PROGRAM OFFICE
GREAT LAKES–ILLINOIS RIVER BASIN PROJECT

MUNICIPAL & INDUSTRIAL WASTE OUTFALLS

RAISIN RIVER BASIN

U.S. DEPARTMENT OF THE INTERIOR
FEDERAL WATER POLLUTION CONTROL ADMINISTRATION
GREAT LAKES REGION GROSSE ILE, MICHIGAN

FIGURE 2

TABLE 4. RAISIN RIVER INDUSTRIAL WASTE INVENTORY
1965

Industry	Location	Receiving Stream	Waste Constituents	Waste Flow (MGD)	Treatment Provided	MWRC Rating 1966*
Avis Industries - Hurd Lock Division	Adrian	Raisin River	Chrome	0.28	Reduction with bisulfite, ppt w/lime, sludge settled & hauled away	A
Buckeye Products Corp.	Adrian	Raisin River	Acid, alkali, toxic metals	0.20	CN-oxid.w/chlor. Cr^6 red w/bisulfite	B
Consolidated Packaging Corp. - No. Side Plant	Monroe	Raisin River	Coliform,BOD, susp.solids	7.50	Sedimentation	E
Consolidated Packaging Corp. - So. Side Plant	Monroe	Raisin River	Coliform,BOD, susp.Solids	7.00	Sedimentation	E
Dundee Cement Co.	Dundee	Macon Creek	Solids, H_2S, caustic	1.40	Lagoon-aeration	Dc
Gray, Inc.	Tecumseh	Raisin River	Toxic metals	0.01	Holding tank batch chlorin.	A

Note: *A - Adequate control.
B - Control provided - adequacy not established.
E - Inadequate control.
Dc - Control provided - protection unreliable - construction underway.

TABLE 4. RAISIN RIVER INDUSTRIAL WASTE INVENTORY (cont.)
1965

Industry	Location	Receiving Stream	Waste Constituents	Waste Flow (MGD)	Treatment Provided	MWRC Rating 1966*
Ford Motor Company	Monroe	Raisin River	Toxic metals, oil, CN	130.00	Dilution, chem. coagulation, alkaline chlor.	Ep
Hoover Ball & Bearing Co. - Universal Die Casting Co.	Saline	Saline River	Acids, alkali, toxic metals, CN	0.57	CN_6 w/chlor., Cr^6 red w/bisulfite, ppt of Cr^3 w/lime, 3 waste lagoons	A
Hoover Ball & Bearing Co.	Pittsfield Township	Wood Outlet Drain	Cooling water	0.03	None	A
Monroe Auto Equip. Co.	Monroe	Raisin River	None	0.02	None	A
Monroe Paper Products Co.	Monroe	Raisin River	Coliform, susp. solids, BOD	2.20	Sedimentation, chem. coagulation	E

Note: * A - Adequate control.
E - Inadequate or treatment.
Ep - Control inadequate - plans being prepared.

TABLE 4. RAISIN RIVER INDUSTRIAL WASTE INVENTORY (Cont.)
1965

Industry	Location	Receiving Stream	Waste Constituents	Waste Flow (MGD)	Treatment Provided	MWRC Rating 1966*
Revco, Incorporated	Deerfield	Raisin River	Washer water, bonderite	0.03	Treat bonderite sol. w/sod. bisulfite to reduce Cr^6	A
Simplex Paper Corp.	Palmyra	Raisin River	Fiber, BOD	0.25	Save-all	B
Stauffer Chem. Co. - Anderson Chem. Div.	Weston	Black Creek	Acid, alkali, organics	0.23	Lagoon	A
Tecumseh Products Co.	Tecumseh	Raisin River	Cooling water only	1.44	None	A
Union Bag-Camp Paper Corp.-River Raisin Paper Co. Div.	Monroe	Raisin River	Susp. Solids, BOD	4.57	Sedimentation	E
Wolverine Fabricating & Mfg. Co.	Dundee	Raisin River	Paper, Fiber	0.03	None - wet lap machine	A

Note: *A - Control adequate.
B - Control provided - adequacy not established.
E - Control inadequate.

TABLE 4. RAISIN RIVER INDUSTRIAL WASTE INVENTORY (cont.)
(Waste Components - pounds per day)

Industry	Flow (MGD)	BOD_5	Susp. Solids	Sett. Solids	Oil (gals)	Fe	Cu	Zn	Cr
Avis Industries - Hurd Lock Div.	0.28	-	-	-	-	-	-	-	0.35
Buckeye Products Corp.- Adrian	0.2	-	-	-	-	-	8.3	-	2
Consolidated Paper Co.									
North Plant	7.5	17,200	7,800	780	123	-	-	-	-
South Plant	7.0	7,000	10,600	5,300	36	-	-	15	-
Dundee Cement Co. (5/18/66)	1.4	480	1,750	-	-	-	-	-	-
Gray, Inc.	0.01	No significant pollutants							
Ford Motor Co. - Monroe	130	9,600	-	-	1,700	-	700	125	136
Hoover Ball & Bearing Co. - Univ. Die Casting	0.57	-	-	-	-	-	3.3		18.5
Hoover Ball & Bearing Co. - Ann Arbor Plant	0.03	Cooling water							

TABLE 4. RAISIN RIVER INDUSTRIAL WASTE INVENTORY (Cont.)
(Waste components - pounds per day)

Industry	Flow (MGD)	BOD_5	Susp. Solids	Sett. Solids	Oil (gals)	Fe	Cu	Zn	Cr
Monroe Paper Prod. Co.	2.2	1,900	1,480	1,400	5	15	3	93	-
Revco, Inc. Deerfield	0.03	No significant pollutants							
Simplex Paper Corp. - Palmyra	0.25	500	-	-	-	-	-	-	-
Monroe Auto Equip. Co.	0.02	Cooling water							
Stauffer Chem. Co. Anderson Chem. Div. Weston	0.23	430	15	-	-	-	-	-	-
Tecumseh Prod. Co.	1.44	Cooling water							
Union Bag-Camp Corp.-Monroe	4.57	11,770	3,600	320	92	20	-	-	-
Wolverine Fabricating & Mfg. Co. Dundee	0.03	60	50	-	-	-	-	-	-

POPULATION AND WASTE LOAD PROJECTIONS

Demographic studies were conducted by the Great Lakes-Illinois River Basins Project, Chicago for the southeastern Michigan portion of the Lake Erie drainage basin of which the River Raisin is a part. Population trends on a national, regional, and county basis were analyzed and population projections were developed for the River Raisin Basin. Included in the River Raisin population projections are the two drainage areas tributary to Lake Erie as shown in Figure 1.

The population centers in the River Raisin Basin are Monroe (22,968), Adrian (20,347), and Tecumseh (7,045) according to 1960 census figures.

The total 1960 population in the River Raisin Basin, including the population of incorporated and unincorporated areas, was estimated to be 208,000. By the year 1990, the total population was estimated to increase to 400,000, of which 210,000 would be municipal and served by sewerage systems. In 2020, the total population was estimated to be 760,000, of which 590,000 would be municipal population. In the River Raisin Basin, each municipal area was analyzed and it was determined that these areas would be urbanized and served by sewerage systems in 1990 and 2020.

Table 5 shows the estimated populations and waste flow projections for the River Raisin Basin in 1990 and 2020.

For the River Raisin Basin, 1965 population served by municipal sewage systems was 68,000. This population served was used to determine the 1965 BOD_5 loading to the River Raisin. BOD_5 projections were based on present day inventory information obtained from the Michigan Water Resources Commission, Michigan Department of Public Health, and U.S. Public Health Service.

The results of the BOD_5 projections are shown in Table 6. Total BOD_5 to the River Raisin, with removal of 68 percent for municipal wastes, and an assumed removal of 43 percent for industrial wastes, was determined to be 53,190 pounds per day. In 1990 and 2020, these wastes will amount to 121,500 and 297,000 pounds per day, respectively.

TABLE 5. POPULATION AND WASTE FLOW PROJECTIONS

	1965	1990	2020
Population Served	68,000	210,000	590,000
Waste Flows (MGD)			
Municipal			
Residential	8.5	23	70
Industrial	2.0	4	10
Subtotal	10.5	27	80
Industrial* (direct to river)	40	88	208
Total to Raisin River (MGD)	50.5	115	288

*Does not include approximate 120 MGD used by Ford Motor Co. for dilution water.

TABLE 6. BOD_5 PROJECTIONS (#/day)

	1965	1990	2020
Untreated BOD			
Municipal			
Residential	11,500	37,800	118,000
Industrial	2,060	4,500	10,800
Subtotal	13,560	42,300	128,800
Industrial (direct to river)	86,200	190,000	450,000
Total Untreated BOD	99,760	232,300	578,800

Treated BOD to Raisin River	1965	1990	2020
Municipal			
With present 68% removal	4,290	13,500	41,200
With 90% removal	1,356	4,230	1,290
With 95% removal	678	2,100	640
With 99% removal	136	420	130
Industrial (direct to river)			
With present 43% removal	48,900	108,000	256,000
With 90% removal	8,620	19,000	45,000
With 95% removal	4,300	9,500	22,500
With 99% removal	860	1,900	4,500
Total BOD to River Raisin			
With present 47% removal	53,190	121,500	297,000
With 90% removal	9,680	23,230	57,900
With 95% removal	4,840	11,600	29,000
With 99% removal	970	2,300	5,800

FIGURE 3

POPULATION AND MUNICIPAL WASTE FLOW PROJECTIONS FOR THE RAISIN RIVER BASIN

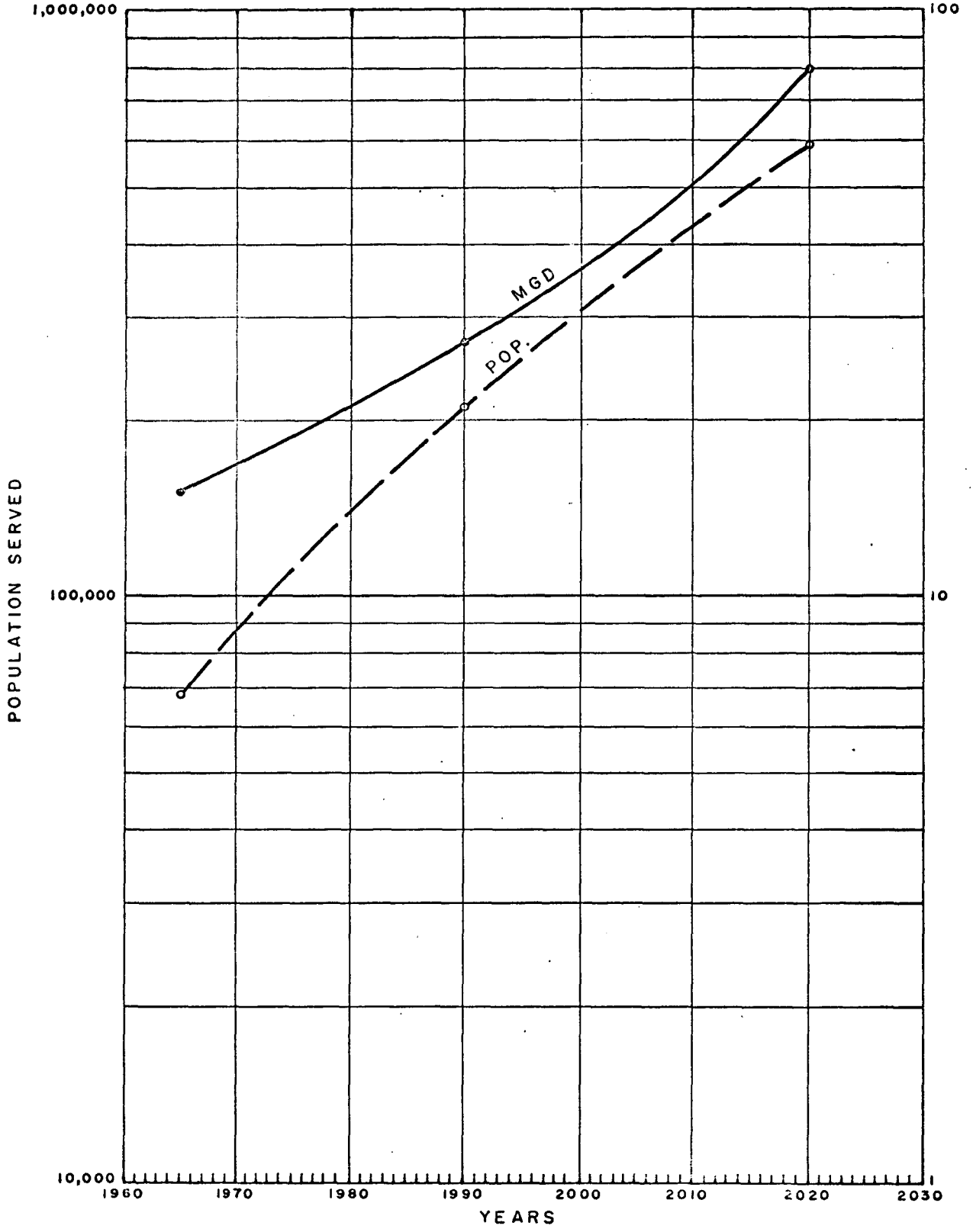


TABLE 7. RIVER RAISIN SAMPLING STATIONS

MAINSTREAM STATIONS

Station	Mile Point	Location
T80	0.00	Mouth of River Raisin between buoys 11 and 12
T81	0.50	600' below confluence of channel connecting below Plum Creek Bay and River Raisin
T82	1.13	500' below Turning Basin between buoys 15 and 17
T83	1.56	Below Monroe sewage treatment plant
T84	1.95	Under I-75 bridge in Monroe
T85	3.00	Winchester St. bridge in Monroe
T86	3.40	Macomb St. bridge in Monroe
T87	3.55	N. Monroe St. bridge in Monroe
T88	4.25	Roessler St. bridge in Monroe
T89	4.95	US-24 bridge in Monroe
T90	13.40	Ida-Maybee Rd. bridge upstream of USGS gage
T310	22.00	Railroad bridge in Dundee
T315	23.75	US-23 Bridge in Dundee
T320	30.30	Petersburg Rd. bridge
T325	39.20	So. County Highway bridge in Deerfield
T330	50.00	Intersection of Blissfield and Iffland Rd. below Blissfield sewage treatment plant
T331	57.30	Crockett Rd. bridge
T335	61.20	U.S. 223 bridge in Palmyra
T340	66.95	Academy Rd. bridge at USGS gage
T350	71.20	Sutton Rd. bridge at USGS gage
T365	79.70	Stair Rd. bridge downstream from Clinton

TABLE 7. RIVER RAISIN SAMPLING STATIONS (cont.)

TRIBUTARY STATIONS

Station	Mile Point	On Tributary	Confluence Mile Point	Location
T301	0.40	Saline River	17.40	Bigelow Rd. bridge
T303	17.30	Saline River	17.40	Maple Rd. bridge
T304	0.50	Little River Raisin	18.40	Stowell Rd. bridge
T316	0.60	Swamp Raisin Cr.	24.50	Davis Rd. bridge
T332	0.10	Black Creek	55.90	Crockett Rd. bridge
T346	1.85	South Branch	68.95	Howell Hwy. bridge near Adrian
T347	4.70	South Branch	68.95	College St. bridge in Adrian

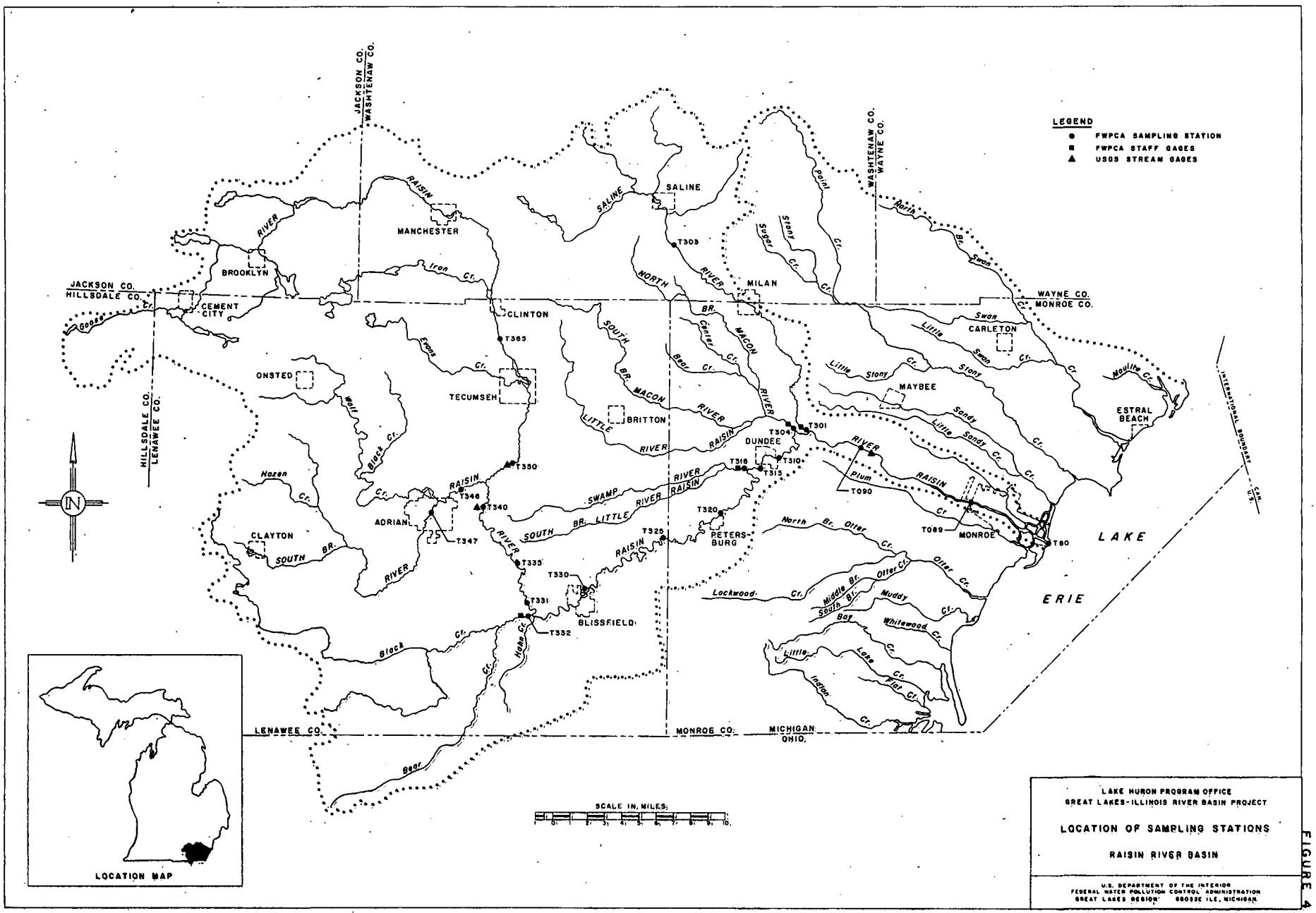

LEGEND
FWPCA SAMPLING STATION
FWPCA STAFF GAGES
USGS STREAM GAGES
JACKSON CO.
WASHTENAW CO.
HILLSDALE CO.
LENAWEE CO.
WAYNE CO.
MONROE CO.
MANCHESTER
BROOKLYN
CEMENT CITY
CLINTON
SALINE
MILAN
CARLETON
MAYBEE
ESTRAL BEACH
ONSTED
TECUMSEH
BRITTON
DUNDEE
ADRIAN
CLAYTON
PETERSBURG
MONROE
BLISSFIELD
LAKE ERIE
T305
T365
T350
T346
T340
T347
T335
T330
T331
T332
T304
T301
T315
T310
T320
T325
T090
T089
T80
RAISIN RIVER
SOUTH BR. RAISIN RIVER
NORTH BR. RAISIN RIVER
LITTLE RAISIN RIVER
SWAMP CR.
MACON RIVER
SOUTH BR. MACON RIVER
NORTH BR. MACON RIVER
BEAR CR.
CENTER CR.
IRON CR.
EVANS CR.
WOLF CR.
BLACK CR.
HORN CR.
HOZEN CR.
GOOSE CR.
SUGAR CR.
STONY CR.
POINT CR.
NORTH BR. SWAN CR.
LITTLE SWAN CR.
SWAN CR.
LITTLE STONY CR.
STONY CR.
MOULTON CR.
SANDY CR.
LITTLE SANDY CR.
PLUM CR.
NORTH BR. OTTER CR.
OTTER CR.
MIDDLE BR. OTTER CR.
SOUTH BR. OTTER CR.
LOCKWOOD CR.
MUDDY CR.
BAY
WHITEWOOD CR.
LITTLE LAKE CR.
FLAT CR.
INDIAN CR.
INTERNATIONAL BOUNDARY (CAN. - U.S.)
LENAWEE CO.
MONROE CO.
MICHIGAN
OHIO
SCALE IN MILES
0 1 2 3 4 5 6 7 8 9 10
LOCATION MAP
LAKE HURON PROGRAM OFFICE
GREAT LAKES-ILLINOIS RIVER BASIN PROJECT
LOCATION OF SAMPLING STATIONS
RAISIN RIVER BASIN
U.S. DEPARTMENT OF THE INTERIOR
FEDERAL WATER POLLUTION CONTROL ADMINISTRATION
GREAT LAKES REGION GROSSE ILE, MICHIGAN

FIGURE 4

WATER QUALITY

Mainstream River Raisin

Water quality measurements made in 1966 presented in this report are: total coliform, dissolved oxygen (DO), 5-day biochemical oxygen demand (BOD_5), chemical oxygen demand (COD), notrogens (ammonia, organic, nitrate, and nitrite), phosphates (total and total soluble), solids (total, suspended, and dissolved), total hardness (as $CaCO_3$), calcium, conductivity, chlorides, iron, phenol, and pH. Values from these measurements are found in Tables 8-11 and Figures 5-20.

Samples were collected on a biweekly basis at twelve locations on the main stem and seven locations on the tributaries. The survey extended from February 9 , 1966 to January 11 , 1967. A total of 20 sampling runs were completed for most stations. Temperature determinations were made in the field and the dissolved oxygen samples acidified with titrations being made at the laboratory. All other analyses were initiated and completed at the laboratory.

In 1966 the River Raisin survey consisted of stations from T089, milepoint 4.95 (MP 4.95) upstream to T365, milepoint 79.7 (MP79.7). Station T089 is located above the polluted Monroe area as stated in the 1965 Detroit River-Lake Erie Report. A limited number of water quality measurements were made at station T080, located at the mouth of the River Raisin, to indicate whether the level of pollution had changed since the 1965 Enforcement Conference on the Detroit-Lake Erie Project.

Chemical

Dissolved oxygen averages ranged from 8.0 to 11.0 mgl from T365, MP 79.7 below Clinton, to T089, MP 4.95 within the City of Monroe and decreased

to 3.3 mgl at T080, MP 0.0 below the City of Monroe. At T080 the minimum value was 0.2 mgl which was found during the summer months and indicated that there was no change since 1962-1964 when zero DO values were found. The maximum value at T080 was 10.3 mgl found during the fall and was the lowest of the maximum values found on all the sampling points as shown on Figure 6.

BOD_5 averaged from 3 to 5 mgl between T365 and T089. At T365, MP 79.7 below Clinton, T335, MP 61.2 below Tecumseh and the South Branch of the River Raisin which carries wastes for Adrian, and T330, MP 50.0 below Blissfield, maximum values of 11 to 13 mgl were found during the summer months as shown on Figure 7.

COD averaged 22 to 41 mgl from T365 to T089 with the greatest averages found at T335 and T331. The highest value, 98 mgl, was found at T335 as shown on Figure 8.

High levels of nitrate and ammonia nitrogen were found as shown on Figures 9 and 10. The nitrate average at T365 was .5 mgl and continued to increase in a downstream direction until 3.5 mgl was found at T089. From T089 to T080, the nitrate concentration reduced to 1.2 mgl. The nitrate concentration averages between T340, MP 66.9 below Tecumseh and the South Branch River Raisin, and T089 were above 1.6 mgl, and the maximum values ranged from 7.4 to 14.4 mgl. Ammonia nitrogen concentrations averages were .26 to .68 mgl from T365 to T089, with the averages over .50 mgl at T340, T335, and T331. Maximum values over 1.00 mgl were found between T350 (MP 71.2 below Tecumseh but above the South Branch River Raisin) and T331, MP 57.3 above Black Creek.

From T365 to T089, nitrite averages ranged from .02 to .05 mgl the highest values at T340, and organic nitrogen averages ranged from .12 to .22 mgl (Figures 11 and 12).

Total and total soluble phosphates at all sampling points had values (as PO_4) over .045 mgl. From T350 to T080, average total phosphate values were over .60 mgl, and average total soluble values were over .40 mgl. The highest values were recorded between T340 and T330 with values over 1.00 mgl (as PO_4) as shown on Figures 13 and 14.

Solids (total, dissolved and suspended) generally showed an increase from station T365 to station T089. Total solids averages increased from 373 to 553 mgl. Suspended solids averages were from 19 to 65 mgl with the averages at T331 and T330 being 41 and 65 mgl, respectively, as shown on Figures 15 and 16.

Conductivity, calcium, chlorides, and hardness generally showed a gradual increase from T365 to T089 (T365 to T080 in case of chlorides - see Figure 17). The only exception was for total hardness when at T330 the highest average of 348 mgl was found.

Phenols for all sampling points, T365 to T080, had values of 5 to 12 ug/l, all above the U.S. Public Health Service drinking water standard of 1 ug/l. The phenolic concentration average in 1966 at T080 was 8 ug/l compared with the average of 7 ug/l that was reported in the 1965 Detroit River-Lake Erie Report as shown on Figure 18.

Iron averages were from .9 to 1.9 mgl while maximum values of 1.8 to 5.7 mgl were found at all of the sampling points (T365 to T089) as shown in Figure 19.

pH values were constant with a range of values found from 8.0 to 8.2 mgl.

Microbiology

Coliform densities which were divided into three seasons: prechlorination, January 1 - May 14, 1966; chlorination, May 15 - September 15, 1966; post-chlorination, September 16 -January 11, 1967; are found in Figure 20 and Table 8. Medians did not fall as expected during the chlorinating season. Some sampling points such as T340, MP 66.9, and T335, MP 61.2 (influenced by Adrian and Tecumseh areas), T330, MP 50.0, and T325, MP 39.2 (influenced by Flissfield STP), and T320, MP 30.3 (influenced by Petersburg - no treatment), had density medians greater than the non-chlorinating seasons January 1 - May 14 and September 16 - January 11, 1967. Adrian, Tecumseh, and Blissfield STP chlorinated year-round in 1966. During the chlorination season, nine of the twelve sampling points had medians over 2400 organisms/ 100 ml. Overall coliform densities were high and at T080, MP 0.0 mouth of the River Raisin and below the Monroe STP, the medians were 106,000 and 200,000 organisms/100 ml during the non-chlorinating seasons and a median of 6400 organisms/100 ml during chlorination.

Tributaries

Saline River

Sampling points, T303 and T301, are located in the Saline River. Station T303, MP 17.3 from River Raisin, is located above the Milan STP and T301, MP 0.4 from the River Raisin, is located below the STP. Coliform densities for both points were approximately the same with the medians over 2400 organisms/100 ml. DO, BOD_5, COD, pH, and chlorides were not at serious levels. Phenols and phosphates decreased as water flowed from T303 to T301 while nitrogen, conductivity, and solids increased.

From T303 to T301, there was a continuous reduction in concentration averages except for nitrates - 1.0 to 2.2 mg/l, and total solids - 562 to 602 mg/l, and dissolved solids - 541 to 580 mg/l. Even with reduction from T303 to T301, nutrient averages were high; total phosphate - 1.45 to 0.82 mg/l, total soluble phosphate - 1.15 to 0.68 mg/l, ammonia nitrogen - .87 to .70 mg/l, and organic nitrogen - .17 to .16 mg/l.

Conductivity, phosphates, nitrates, ammonia nitrogen, and all solids from T301 would affect the water quality in the River Raisin.

Little River Raisin

Station T304, MP 0.4 from confluence with River Raisin, is located in the Little River Raisin and receives the effluent discharge from the Dundee Cement Company located on the Macon River a short distance upstream. There were extremely high average levels of conductivity - 1096 umhos, nitrate - 5.7 mg/l, and total solids - 1480 mg/l, dissolved solids - 1423 mg/l, and suspended solids - 56 mg/l. Phosphates, phenols, and ammonia and organic nitrogen were at levels which could affect the water quality.

Conductivity, nitrates, and solids would be detrimental to the water use of the River Raisin because of their extremely high concentrations.

South Branch River Raisin

Station T347, MP 4.7 from confluence with River Raisin, is located above the Adrian STP and station T346, MP 1.8 from confluence with River Raisin, is located below the STP. Water quality was affected by industries and the Adrian STP.

At station T347, average total phosphates were .63 mg/l, total soluble phosphates - .29 mg/l, nitrates - 2.6 mg/l, total solids - 566 mg/l,

dissolved solids - 496 mg/l, suspended solids - 71 mg/l, ammonia nitrogen - .34 mg/l, organic nitrogen - .17 mg/l, and phenols - 8 ug/l. Coliform medians for all seasons were over 2400 organisms/100 ml.

At station T346, below the Adrian STP, all water quality measurements except solids were approximately the same as T347, but coliforms increased dramatically. The average found at T346 were: phenols - 10 ug/l, total phosphates - 3.40 mg/l, total soluble phosphates - 2.38 mg/l, nitrates - 4.4 mg/l, ammonia nitrogen -.97 mg/l, and organic nitrogen - .74 mg/l.

Summary of Water Quality

The various water quality measurements made in 1966 indicate that the upper River Raisin, between stations T365 and T089, is in various stages of pollution. Coliform densities, before, during, and after the chlorination period at most sampling points, were above 2400 organisms/100 ml. Nutrient measurements (phosphates and nitrogen compounds) were at a very high level. Dissolved oxygen, BOD_5, and COD concentrations appeared to be at low pollution levels. Phenols, for all sampling ranges, were above the U.S. Public Health Service drinking water standards of 1 ug/l and may cause taste and odor problems. Iron and solid measurements show high levels of these pollutants which can cause problems for water users.

In 1966, the water quality measurements such as coliforms, DO, nitrates, phosphates, chlorides, and phenols, made at station T080, mouth of the River Raisin, showed that the degree of pollution in the River Raisin has not changed since 1962-1964, the years covered by the 1965 Detroit River-Lake Erie Report. The significantly low DO values, high coliform densities, high nutrient values (nitrates and phosphates), and high phenolic concentrations show that there is significant pollution in the River Raisin.

The Little River Raisin adversely affects the River Raisin with its high conductivity, nitrates, and solids load.

The South Branch River Raisin carries into the River Raisin high coliform densities, and nutrient concentrations (phosphates and nitrogen).

TABLE 8. RIVER RAISIN RIVER - WATER QUALITY
ANNUAL BACTERIOLOGICAL DENSITIES*

STATION		Pre-chlorination (Jan 1-May 14)			Chlorination (May 15-Sept 14)			Post-chlorination (Sept 15-Jan 11)		
		Total Coliform	Fecal Coliform	Fecal Strep	Total Coliform	Fecal Coliform	Fecal Strep	Total Coliform	Fecal Coliform	Fecal Strep
T080	Med	106,000	-	-	6,400	-	-	200,000	-	-
	Max	150,000	-	-	7,900	-	-	980,000	-	-
	Min	61,000	-	-	5,700	-	-	10,000	-	-
	NS	2			3			3		
T089	Med	2,300	230	32	960	170	220	1,900	380	170
	Max	9,300	720	330	44,000	610	950	11,000	970	530
	Min	750	60	16	290	60	32	660	160	40
	NS	7	7	5	8	6	6	5	5	4
T090	Med	5,000	630	96	2,500	170	130	5,600	400	160
	Max	32,000	1,000	320	27,000	1,600	650	25,000	1,800	480
	Min	3,500	400	90	300	40	54	1,300	50	52
	NS	5	5	3	8	6	6	5	5	4
T310	Med	5,500	590	100	31,000	4,400	250	62,000	1,100	400
	Max	15,000	2,900	560	820,000	31,000	2,500	630,000	14,000	1,400
	Min	2,900	460	40	3,700	240	30	5,000	>370	90
	NS	7	7	6	8	8	7	5	5	4
T320	Med	5,500	980	80	23,000	3,600	520	-	-	-
	Max	40,000	3,700	88	47,000	8,900	3,500	-	-	-
	Min	4,800	460	72	4,600	340	60	-	-	-
	NS	4	4	2	8	7	6			

*1966 values - Membrane Filter Technique (MF/100ml)

TABLE 8. RIVER RAISIN - WATER QUALITY
ANNUAL BACTERIOLOGICAL DENSITIES*

STATION		Pre-chlorination (Jan 1-May 14)			Chlorination (May 15-Sept 14)			Post-chlorination (Sept 15-Jan 11)		
		Total Coliform	Fecal Coliform	Fecal Strep	Total Coliform	Fecal Coliform	Fecal Strep	Total Coliform	Fecal Coliform	Fecal Strep
T325	Med	750	80	≥10	14,000	280	400	3,700	260	180
	Max	1,300	100	-	73,000	4,800	2,100	16,000	590	420
	Min	190	60	-	650	≥100	180	1,800	70	58
	NS	2	2	1	6	6	5	5	5	4
T330	Med	2,700	60	20	20,000	510	140	-	-	-
	Max	80,000	1,200	540	47,000	3,000	1,700	-	-	-
	Min	350	50	10	1,100	80	50	-	-	-
	NS	7	7	5	7	7	7			
T331	Med	2,400	200	470	1,500	-	-	-	-	-
	Max	78,000	5,200	890	-	-	-	-	-	-
	Min	2,300	20	50	-	-	-	-	-	-
	NS	3	3	2	1					
T335	Med	27,000	400	160	42,000	1,900	130	26,000	1,100	200
	Max	66,000	6,000	1,200	73,000	2,800	710	79,000	6,600	480
	Min	4,400	140	50	5,500	100	70	3,200	>110	86
	NS	7	7	6	8	7	7	5	5	4
T340	Med	1,600	69	13	57,000	470	120	2,500	78	73
	Max	6,700	<100	22	1,900,000	25,000	1,400	15,000	400	390
	Min	400	10	8	2,300	> 27	64	1,000	50	60
	NS	6	6	4	8	8	7	5	5	4

*1966 values - Membrane Filter Technique (MF/100ml)

TABLE 8. RIVER RAISIN - WATER QUALITY
ANNUAL BACTERIOLOGICAL DENSITIES*

STATION		Pre-chlorination (Jan 1-May 14)			Chlorination (May 15-Sept 14)			Post-chlorination (Sept 15-Jan 11)		
		Total Coliform	Fecal Coliform	Fecal Strep	Total Coliform	Fecal Coliform	Fecal Strep	Total Coliform	Fecal Coliform	Fecal Strep
T350	Med	4,100	100	60	1,800	230	210	4,900	240	170
	Max	7,200	690	280	6,500	490	1,700	48,000	3,200	1,300
	Min	1,100	40	5	690	50	10	1,100	70	88
	NS	7	7	5	8	6	6	5	5	4
T365	Med	21,000	2,800	720	3,700	410	290	32,000	3,700	770
	Max	160,000	6,500	2,700	13,000	810	610	190,000	11,000	8,800
	Min	6,000	900	300	600	70	28	8,400	2,100	370
	NS	6	6	5	7	7	6	5	5	4
	Med									
	Max									
	Min									
	NS									
	Med									
	Max									
	Min									
	NS									
	Med									
	Max									
	Min									
	NS									

*1966 values - Membrane Filter Technique (MF/100ml)

TABLE 9. RIVER RAISIN - WATER QUALITY
ANNUAL VALUES 1966

Station		pH	Cond.	Cl	Phenol	DO	BOD_5	COD	Tot. PO_4	Sol. PO_4	NO_3-N	NO_2-N	NH_3-N	Org-N
T080														
	Avg	-	-	33	-	3.3	-	-	.61	.40	1.2	-	-	-
	Max	-	-	39	-	10.3	-	-	1.00	.70	3.5	-	-	-
	Min	-	-	27	-	0.2	-	-	.40	.20	.1	-	-	-
	NS			8		5			8	8	8			
T089														
	Avg	8.1	680	34	5	11.0	4	26	.61	.46	3.5	.03	.34	.19
	Max	8.6	860	49	11	15.2	9	41	1.10	1.00	9.5	.09	.85	.71
	Min	7.4	510	21	1	5.5	1	7	.20	<.025	.1	.00	.02	.01
	NS	20	18	20	19	20	20	19	20	20	20	20	19	19
T090														
	Avg	8.2	670	33	7	10.6	4	27	.70	.49	3.4	.03	.40	.17
	Max	8.7	840	51	14	13.9	8	48	1.40	1.10	14.4	.11	.99	.32
	Min	7.6	520	20	3	5.4	1	9	.30	.08	.1	.0	.03	.01
	NS	18	18	18	18	18	18	17	17	17	18	18	18	18
T310														
	Avg	8.1	630	32	9	10.1	4	27	.70	.55	3.6	.03	.35	.17
	Max	8.5 q	800	48	20	13.7	9	41	2.00	1.60	12.1	.12	.80	.42
	Min	7.6	490	19	4	5.7	1	15	.10	.10	.1	.01	.03	.01
	NS	20	20	20	20	20	20	19	20	20	20	20	20	20
T320														
	Avg	8.1	620	31	9	8.5	3	27	.90	.70	2.8	.04	.40	.14
	Max	8.4	700	42	13	13.0	6	35	1.70	1.60	9.5	.14	.68	.22
	Min	7.7	510	19	5	5.3	1	17	.40	.20	.1	.00	.22	.05
	NS	12	12	12	12	11	12	11	12	12	12	12	12	12

Note: Phosphates reported as PO_4.
All results in mg/l, except phenol - ug/l.

TABLE 9. RIVER RAISIN - WATER QUALITY
Annual Values 1966

Station		pH	Cond.	Cl	Phenol	DO	BOD_5	COD	Tot. PO_4	Sol. PO_4	NO_3-N	NO_2-N	NH_3-N	Org-N
T325														
	Avg	8.1	640	33	12	8.0	3	24	.99	.80	3.1	.04	.41	.22
	Max	8.6	760	39	25	12.7	5	31	2.70	2.00	8.6	.12	1.01	.97
	Min	7.7	500	26	4	5.3	1	14	.20	.03	.0	.00	.22	.02
	NS	12	12	12	13	13	12	12	13	13	13	13	12	12
T330														
	Avg	8.0	630	30	8	9.0	4	29	1.15	.65	2.4	.04	.45	.17
	Max	8.4	700	47	17	13.2	13	40	3.80	1.60	8.0	.06	.74	.28
	Min	7.7	510	18	3	5.8	2	20	.20	$<.025$	.4	.01	.20	.09
	NS	14	14	14	14	14	14	12	14	14	14	14	14	14
T331														
	Avg	8.0	600	22	10	9.4	5	33	1.15	.80	1.6	.03	.68	.16
	Max	8.1	640	24	18	11.4	6	41	1.30	1.00	2.9	.04	1.33	.23
	Min	7.8	570	19	6	8.2	3	28	.90	.60	.9	.02	.22	.11
	NS	4	4	4	4	4	4	4	4	4	4	4	4	4
T335														
	Avg	8.1	600	26	10	9.3	5	41	1.56	1.08	2.4	.04	.51	.13
	Max	8.4	760	48	18	13.1	12	98	3.10	2.60	7.4	.10	1.18	.26
	Min	7.9	490	16	4	5.8	2	16	.50	.30	.1	.01	.14	.02
	NS	20	20	20	20	20	20	18	20	20	20	20	20	20
T340														
	Avg	8.1	600	26	9	9.0	3	25	2.14	1.65	2.3	.05	.61	.17
	Max	8.4	740	36	23	13.0	6	38	5.70	4.70	8.5	.13	1.40	.33
	Min	7.8	490	15	3	4.8	1	17	.40	.30	.1	.01	.11	.02
	NS	19	19	19	19	19	19	18	18	19	19	19	19	19

Note: Phosphates reported as PO_4.
All results in mg/l, except phenol - ug/l.

TABLE 9. RIVER RAISIN - WATER QUALITY
Annual Values 1966

Station		pH	Cond.	Cl	Phenol	DO	BOD_5	COD	Tot. PO_4	Sol. PO_4	NO_3-N	NO_2-N	NH_3-N	Org-N
T350	Avg	8.2	540	16	10	9.7	4	24	.67	.51	.9	.03	.46	.13
	Max	8.5	680	33	22	16.3	11	48	2.40	1.90	2.6	.05	1.70	.22
	Min	7.9	480	12	3	5.6	1	16	.10	.04	.0	.01	.14	.03
	NS	20	20	2	20	20	19	20	20	20	20	20	19	19
T365	Avg	8.2	480	13	10	10.1	3	22	.19	.14	.5	.02	.26	.12
	Max	8.4	600	25	31	15.6	4	35	.40	.40	1.4	.05	.41	.22
	Min	7.9	370	9	4	5.4	1	16	.08	<.025	.1	.01	.12	.02
	NS	18	18	18	18	18	17	18	18	18	18	18	17	17
	Avg													
	Max													
	Min													
	NS													
	Avg													
	Max													
	Min													
	NS													
	Avg													
	Max													
	Min													
	NS													

Note: Phosphates reported as PO_4.
All results in mg/l, except phenol - ug/l.

TABLE 9. RAISIN RIVER - WATER QUALITY
Annual Values 1966

Station		Total Solids	Dissolved Solids	Suspended Solids	Sodium	Potassium	Iron	Calcium	Hardness	CN	SO4	Mg
T080	Avg	-	-	-	-	-	-	-	-	-	-	-
	Max	-	-	-	-	-	-	-	-	-	-	-
	Min	-	-	-	-	-	-	-	-	-	-	-
	NS											
T089	Avg	553	525	28	19	14	1.35	96	331	.00	133	26
	Max	677	670	135	29	27	5.70	115	432	.00	220	33
	Min	465	400	4	13	5	.34	75	258	.00	90	21
	NS	20	20	20	9	9	10	9	9	4	9	9
T090	Avg	540	503	28	21	12	.88	91	325	.00	114	26
	Max	740	710	65	28	23	2.10	115	426	-	180	32
	Min	450	400	2	15	5	.40	73	246	-	80	18
	NS	18	18	18	7	7	8	7	7	1	7	7
T310	Avg	499	470	28	18	7	.88	91	307	.01	107	26
	Max	604	590	61	28	10	2.20	107	358	-	150	31
	Min	425	380	3	10	6	.20	70	260	-	70	21
	NS	20	20	20	9	9	10	9	9	1	9	9
T320	Avg	499	461	38	20	7	1.10	91	310	.00	92	25
	Max	562	500	85	30	9	1.80	107	352	-	110	30
	Min	432	400	8	15	5	.30	73	264	-	70	21
	NS	12	12	12	5	5	6	5	5	1	5	5
T325	Avg	498	472	26	23	8	1.23	85	303	-	98	26
	Max	630	620	64	28	9	1.80	105	370	-	130	33
	Min	420	401	4	16	6	.45	67	252	-	70	21
	NS	13	13	13	5	5	5	5	5		5	5

TABLE 9. RAISIN RIVER - WATER QUALITY
Annual Values 1966

Station		Total Solids	Dissolved Solids	Suspended Solids	Sodium	Potassium	Iron	Calcium	Hardness	CN	SO4	Mg
T330	Avg	518	455	65	19	7	1.15	90	348	.01	103	27
	Max	739	540	280	27	9	2.70	101	390	-	130	33
	Min	462	380	4	15	5	.20	66	242	-	70	19
	NS	14	14	14	8	8	9	8	8	1	8	8
T331	Avg	469	428	41	17	7	1.91	86	306	.00	97	27
	Max	499	470	107	19	7	4.30	90	332	-	110	30
	Min	427	392	7	14	6	.90	78	278	-	70	25
	NS	4	4	4	4	4	4	4	4	1	4	4
T335	Avg	466	430	35	19	7	1.27	83	295	.00	91	26
	Max	579	530	88	24	9	4.50	94	334	-	110	32
	Min	393	360	2	13	5	.30	68	258	-	60	22
	NS	20	20	20	9	9	10	9	9	1	9	9
T340	Avg	472	449	25	22	7	1.18	84	298	.00	98	25
	Max	692	690	98	30	9	4.60	98	340	-	130	29
	Min	390	374	5	16	5	.10	61	232	-	70	20
	NS	19	19	19	8	8	9	8	8	1	8	8
T350	Avg	395	374	22	13	5	.85	78	284	.02	75	26
	Max	544	510	62	18	6	2.00	109	376	-	90	31
	Min	340	320	6	9	3	.10	61	244	-	50	23
	NS	20	20	20	9	9	10	9	9	1	8	9
T365	Avg	373	354	19	10	4	.92	72	263	.01	60	25
	Max	559	547	81	13	5	2.60	81	288	.01	80	27
	Min	330	300	2	8	2	.06	64	240	.01	40	23
	NS	18	18	18	7	7	8	7	7	3	7	7

TABLE 10. TRIBUTARIES TO RAISIN RIVER - WATER QUALITY
ANNUAL BACTERIOLOGICAL DENSITIES *

Station		Pre-chlorination (Jan 1-May 14)			Chlorination (May 15-Sept 14)			Post-chlorination (Sept 15-Jan 11)		
		Total Coliform	Fecal Coliform	Fecal Strep	Total Coliform	Fecal Coliform	Fecal Strep	Total Coliform	Fecal Coliform	Fecal Strep
T301	Med	8,100	3,200	770	400	-	-	-	-	-
Saline R.	Max	18,000	5,400	2,300	-	-	-	-	-	-
	Min	1,900	1,100	170	-	-	-	-	-	-
	NS	4	4	3	1					
T303	Med	13,000	11,000	5,000	5,200	460	530	-	-	-
Saline R.	Max	-	-	-	-	-	-	-	-	-
	Min	-	-	-	-	-	-	-	-	-
	NS	1	1	1	1	1	1			
T304	Med	1,700	190	80	170	-	-	-	-	-
Little	Max	26,000	530	650	-	-	-	-	-	-
Raisin	Min	100	40	20	-	-	-	-	-	-
	NS	4	4	3	1					
T346	Med	41,000	400	190	4,300	95	850	5,500	550	140
South	Max	360,000	21,000	6,700	180,000	3,700	2,100	70,000	2,400	470
Branch	Min	4,500	100	90	800	10	110	3,600	20	20
	NS	5	5	4	6	4	4	5	5	4
T347	Med	6,000	1,700	90	15,000	4,500	1,400	-	-	-
South	Max	180,000	13,000	6,600	25,000	8,100	2,300	-	-	-
Branch	Min	1,400	320	36	5,400	870	480	-	-	-
	NS	5	5	4	2	2	2			

*1966 values - Membrane Filter Technique (MF/100ml)

TABLE 11. TRIBUTARIES TO RAISIN RIVER - WATER QUALITY
Annual Values 1966

Station		pH	Cond.	Cl	Phenol	DO	BOD_5	COD	Tot. PO_4	Sol. PO_4	NO_3-N	NO_2-N	NH_3-N	Org-N
T301	Avg	8.1	770	35	6	10.3	4	23	.82	.68	2.2	.03	.70	.16
Saline	Max	8.4	870	44	11	12.0	9	32	1.30	1.30	5.2	.05	1.42	.24
River	Min	7.7	710	30	3	8.7	2	12	.10	.08	.5	.02	.21	.11
	NS	5	5	5	5	5	5	5	5	5	5	5	5	5
T303	Avg	7.8	750	27	10	8.0	5	22	1.45	1.15	1.0	.14	.87	.17
Saline	Max	7.8	770	27	13	12.0	5	24	2.30	2.00	1.3	.26	1.06	.24
River	Min	7.7	720	27	6	4.0	5	19	.60	.30	.7	.02	.67	.10
	NS	2	2	2	2	2	2	2	2	2	2	2	2	2
T304	Avg	7.8	1100	74	7	9.1	4	21	.34	.24	5.7	.04	.45	.17
Little	Max	8.2	1560	136	9	11.2	7	35	1.00	.90	14.0	.08	.82	.22
Raisin	Min	7.1	670	32	3	5.1	2	13	<.025	<.025	1.9	.02	.21	.08
	NS	5	5	5	5	5	5	5	5	5	5	5	5	5
T346	Avg	8.1	730	54	10	9.6	4	36	3.40	2.38	4.4	.06	.97	.26
South	Max	8.7	1020	180	25	13.3	7	57	8.20	5.20	11.8	.10	2.72	.74
Branch	Min	7.7	540	27	5	4.4	1	22	.70	.50	.3	.02	.20	.08
	NS	16	16	16	16	16	15	16	16	16	16	16	16	16
T347	Avg	8.1	630	24	8	10.4	6	36	.63	.29	2.6	.03	.34	.17
South	Max	8.4	760	43	16	13.3	18	50	.90	.80	7.4	.05	.50	.23
Branch	Min	7.8	500	13	4	5.5	2	22	.20	<.025	.3	.01	.22	.04
	NS	7	6	7	7	7	7	7	7	7	7	7	7	7

Note: Phosphates reported as PO_4.
All results in mg/l, except phenol - ug/l.

TABLE 11. TRIBUTARIES TO RAISIN RIVER - WATER QUALITY
Annual Values 1966

Station		Total Solids	Dissolved Solids	Suspended Solids	Sodium	Potassium	Iron	Calcium	Hardness	CN	SO_4	Mg
T301	Avg	602	580	23	25	9	1.10	115	398	.01	152	30
Saline	Max	669	660	38	34	11	1.50	128	438	.01	180	32
River	Min	551	530	6	17	8	.70	106	356	.00	110	24
	NS	5	5	5	5	5	5	5	5	2	5	5
T303	Avg	562	541	22	30	10	1.6	118	410	-	170	29
Saline	Max	614	610	38	-	-	-	-	-	-	-	-
River	Min	509	471	5	-	-	-	-	-	-	-	-
	NS	2	2	2	1	1	1	1	1	1	1	1
T304	Avg	1480	1423	56	38	88	12.3	173	673	-	576	32
Little	Max	2631	2580	186	70	274	28.4	273	1095	-	1470	37
Raisin	Min	619	474	10	11	10	.6	96	328	-	100	22
	NS	5	5	5	5	5	5	5	5		5	5
T346	Avg	566	527	39	33	10	2.07	97	337	.00	134	27
South	Max	800	790	142	51	14	6.00	115	400	-	170	33
Branch	Min	338	330	8	16	7	.30	65	238	-	80	20
	NS	16	16	16	6	6	8	7	7	1	7	7
T347	Avg	566	496	71	18	7	2.96	99	353	.00	145	29
South	Max	759	590	360	32	10	11.80	120	430	.00	170	34
Branch	Min	464	399	3	11	5	.20	75	278	.00	130	23
	NS	7	7	7	5	5	5	5	5	4	4	4

RAISIN RIVER
TOTAL COLIFORM SEASONAL MEDIAN VALUES
1966

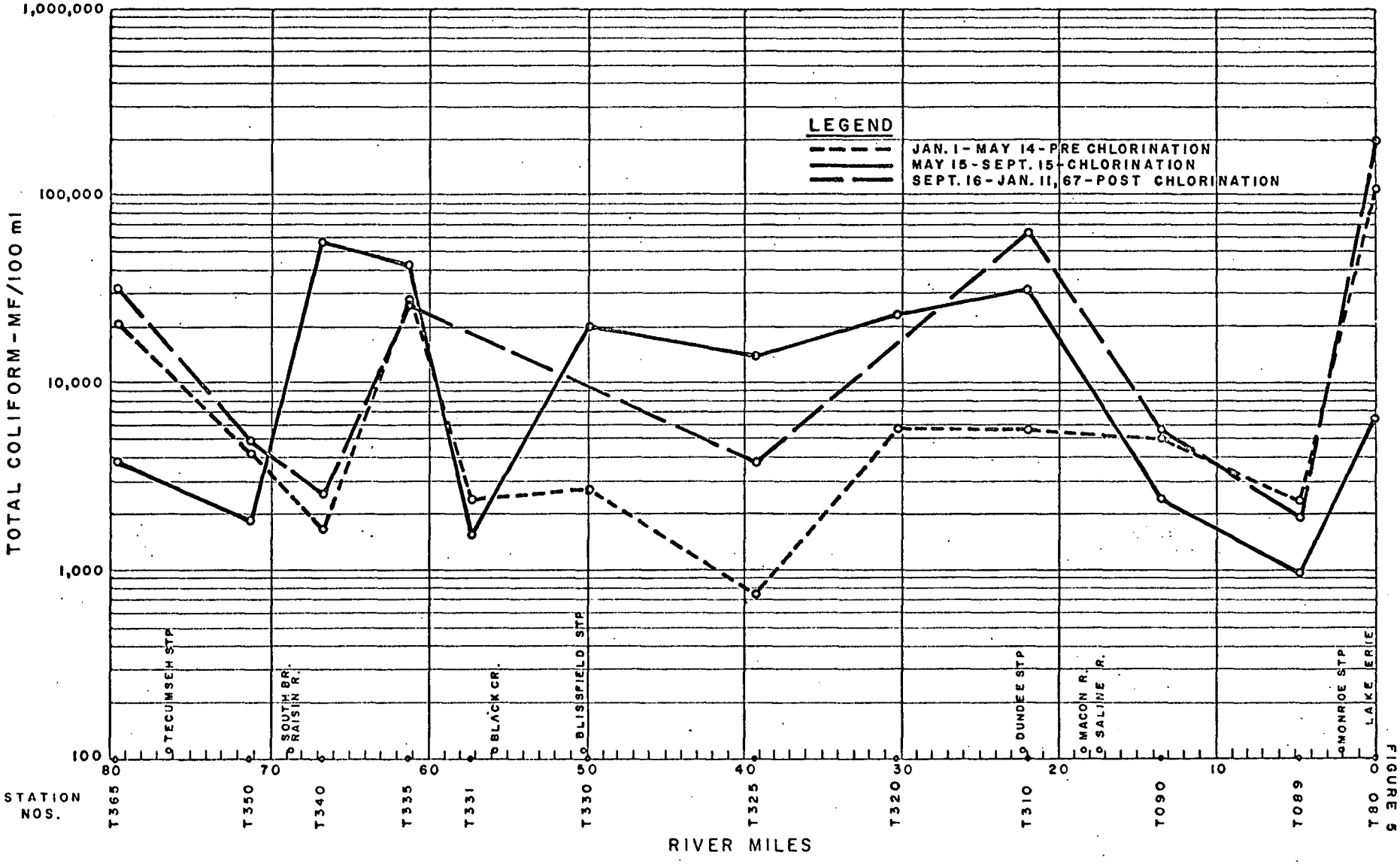


FIGURE 5

RAISIN RIVER
DISSOLVED OXYGEN ANNUAL VALUES
1966

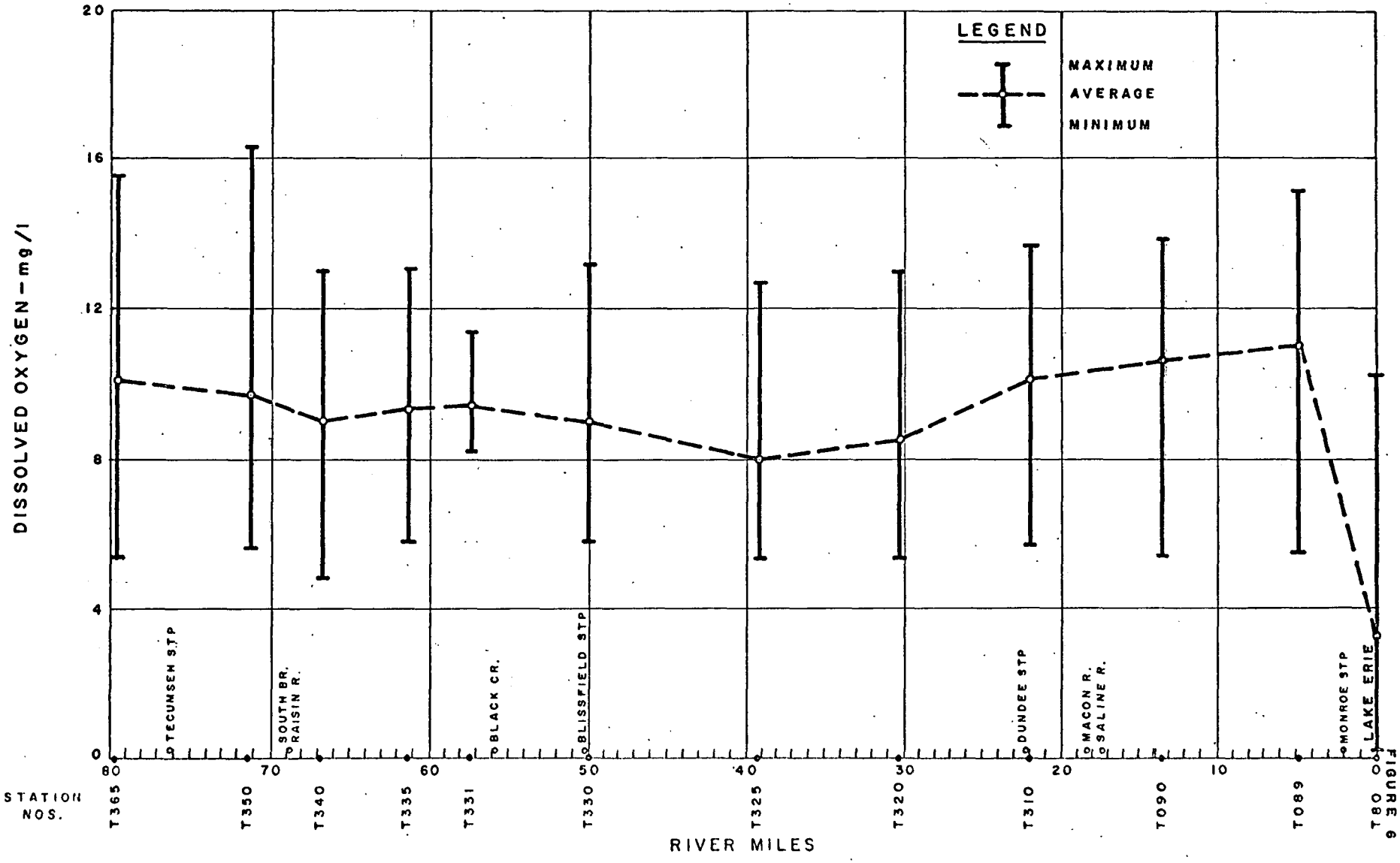


FIGURE 6

RAISIN RIVER
BOD_5 ANNUAL VALUES
1966

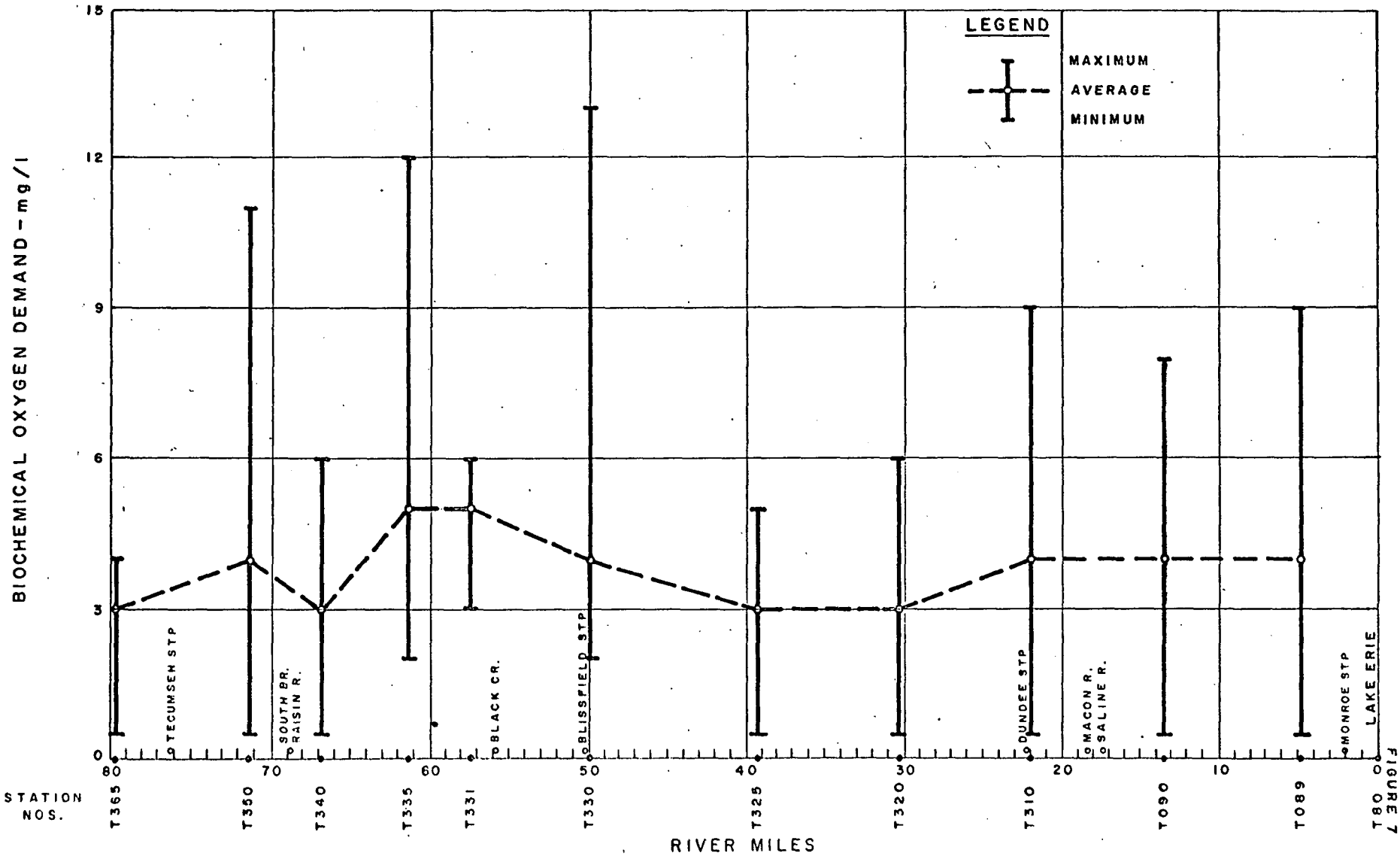


FIGURE 7

RAISIN RIVER
COD ANNUAL VALUES
1966

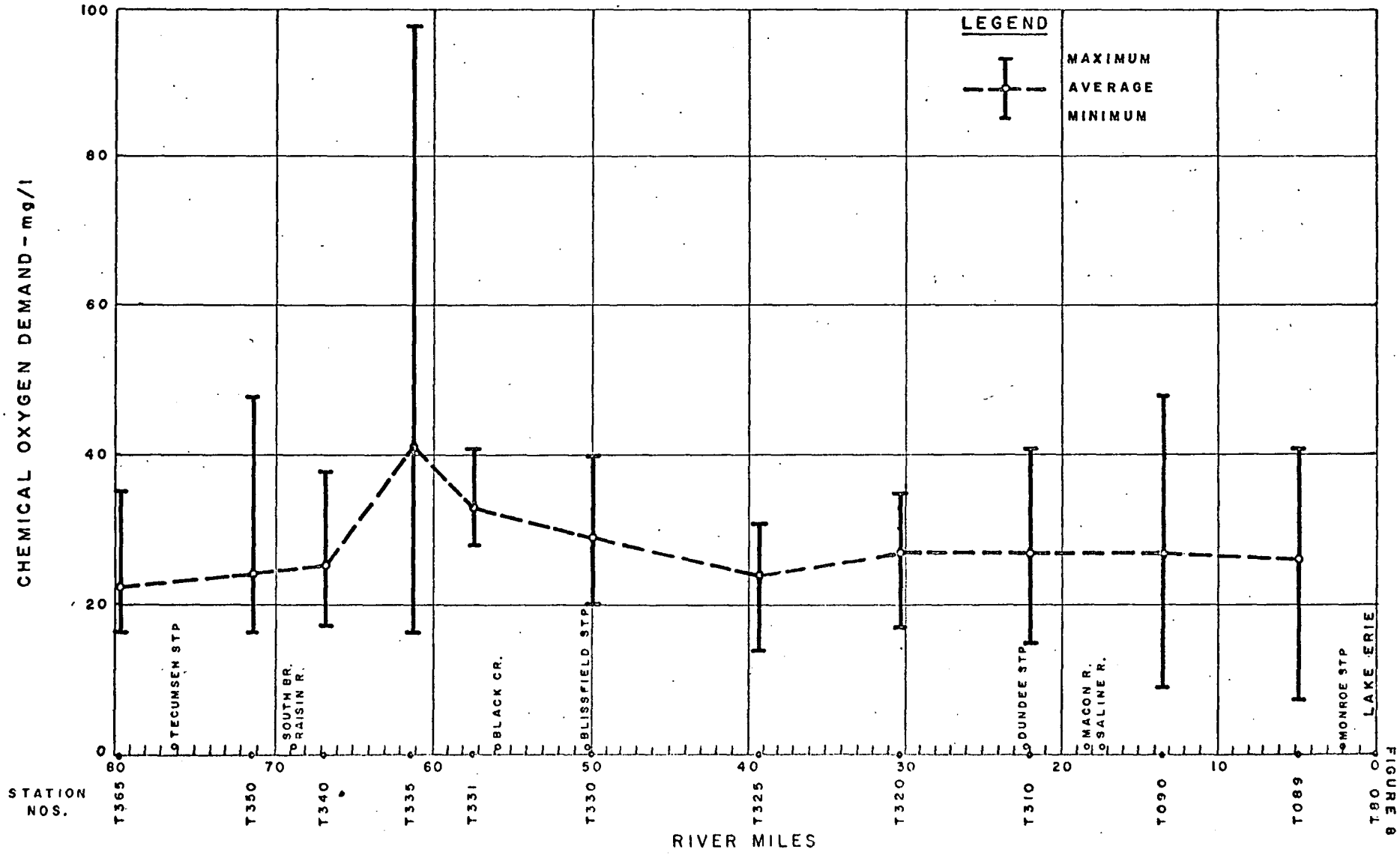


FIGURE 8

RAISIN RIVER
NITRATE ANNUAL VALUES
1966

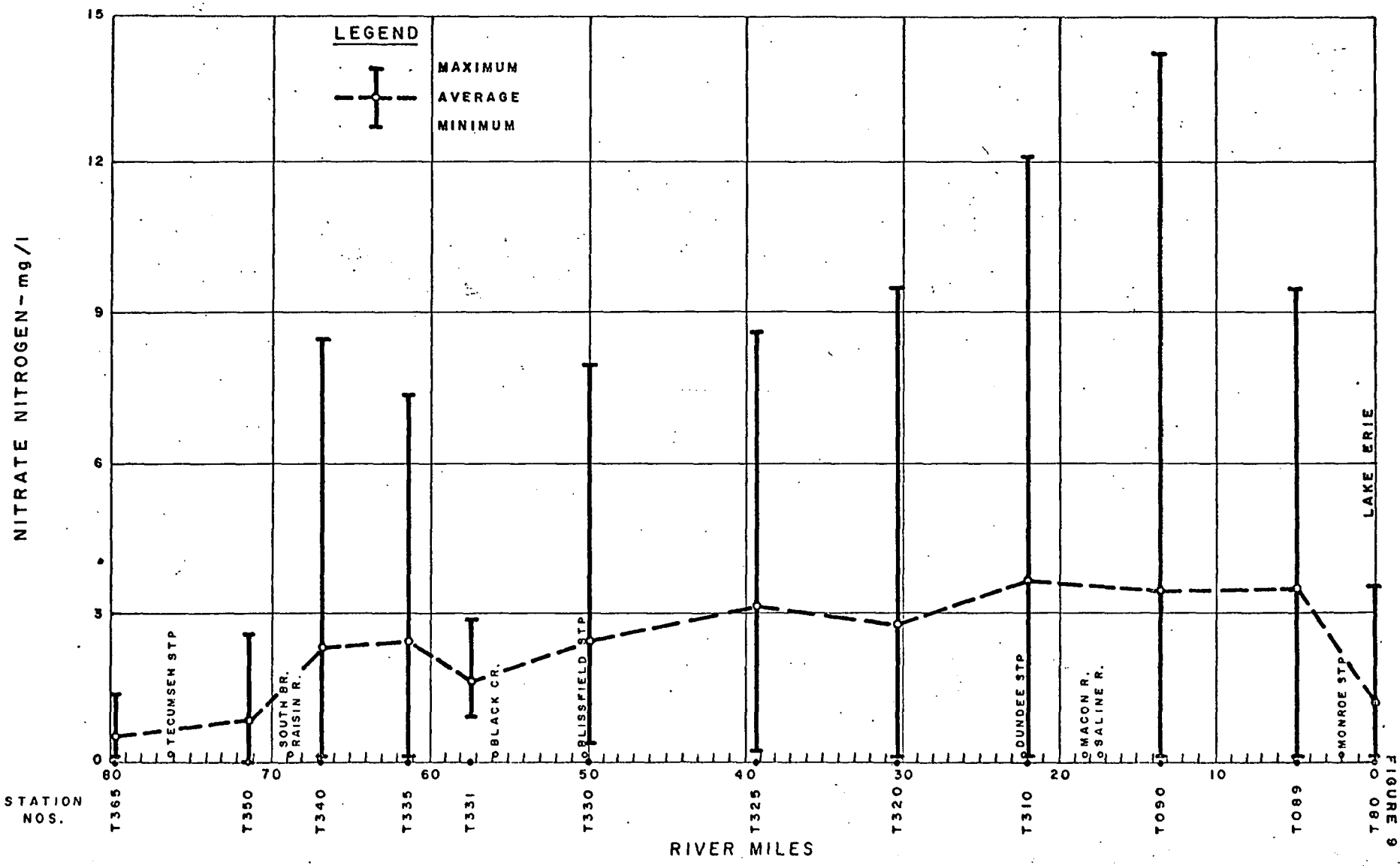


FIGURE 9

RAISIN RIVER
AMMONIA NITROGEN ANNUAL VALUES
1966

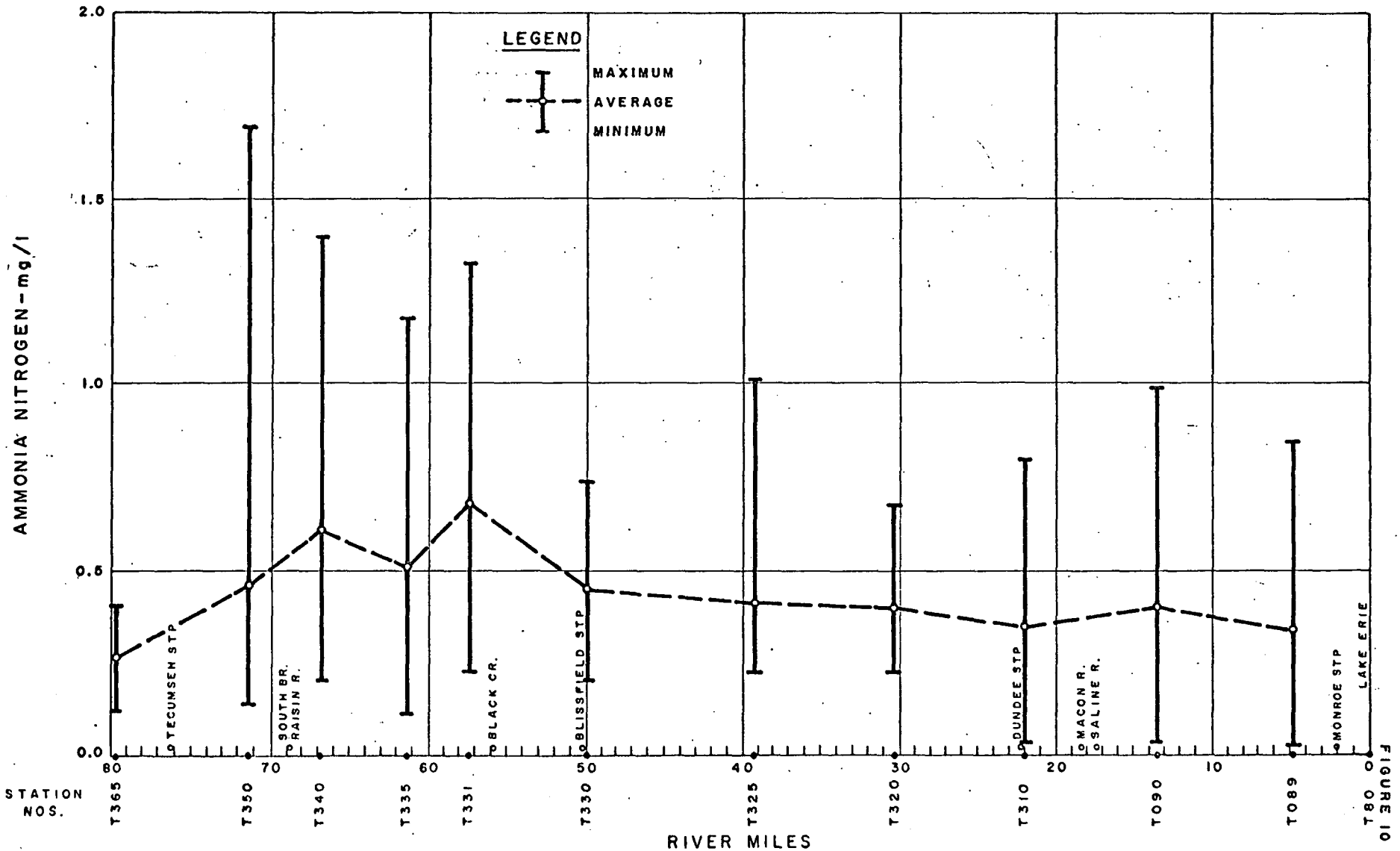


FIGURE 10

RAISIN RIVER
NITRITE ANNUAL VALUES
1966

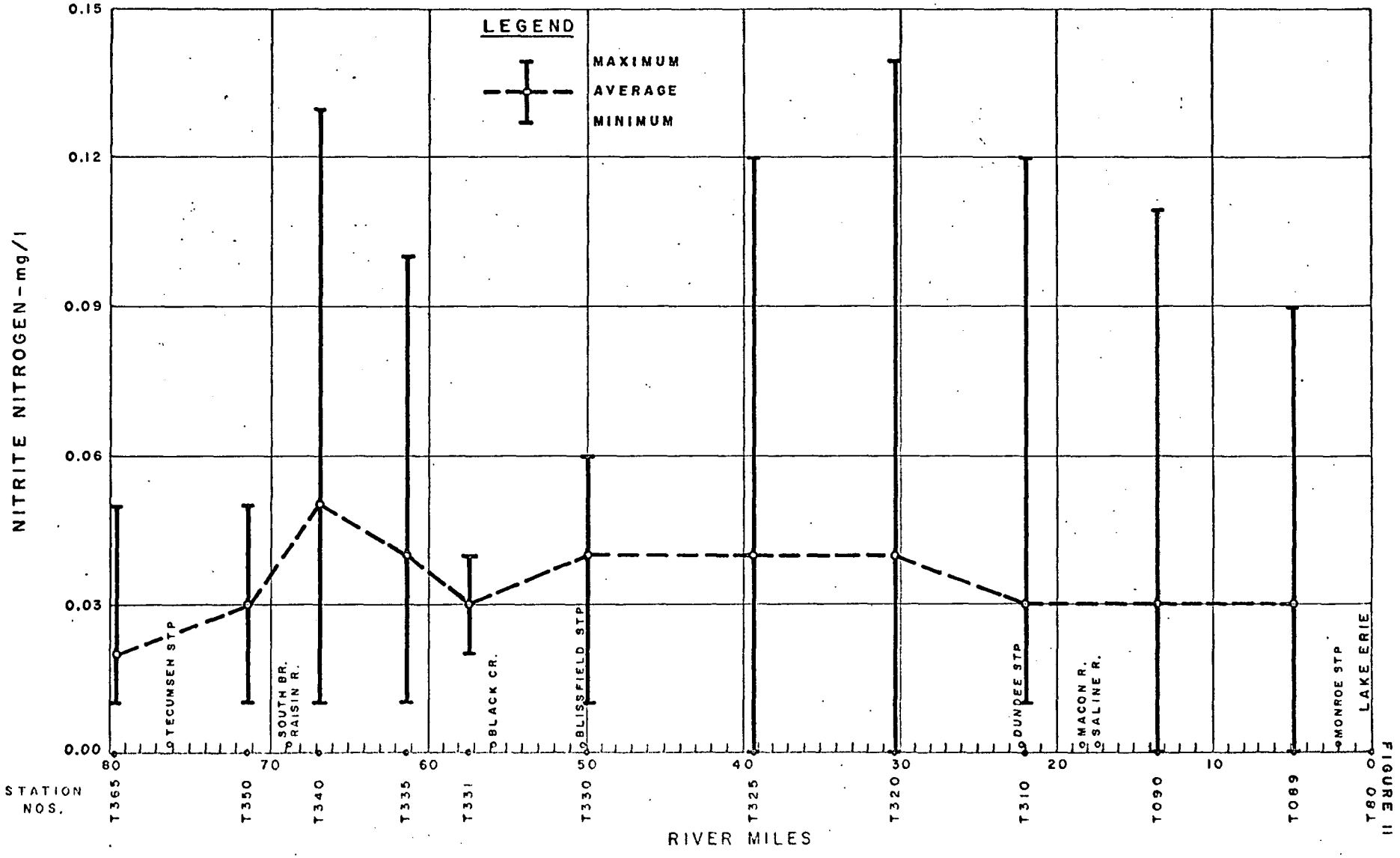


FIGURE 11

RAISIN RIVER
ORGANIC NITROGEN ANNUAL VALUES
1966

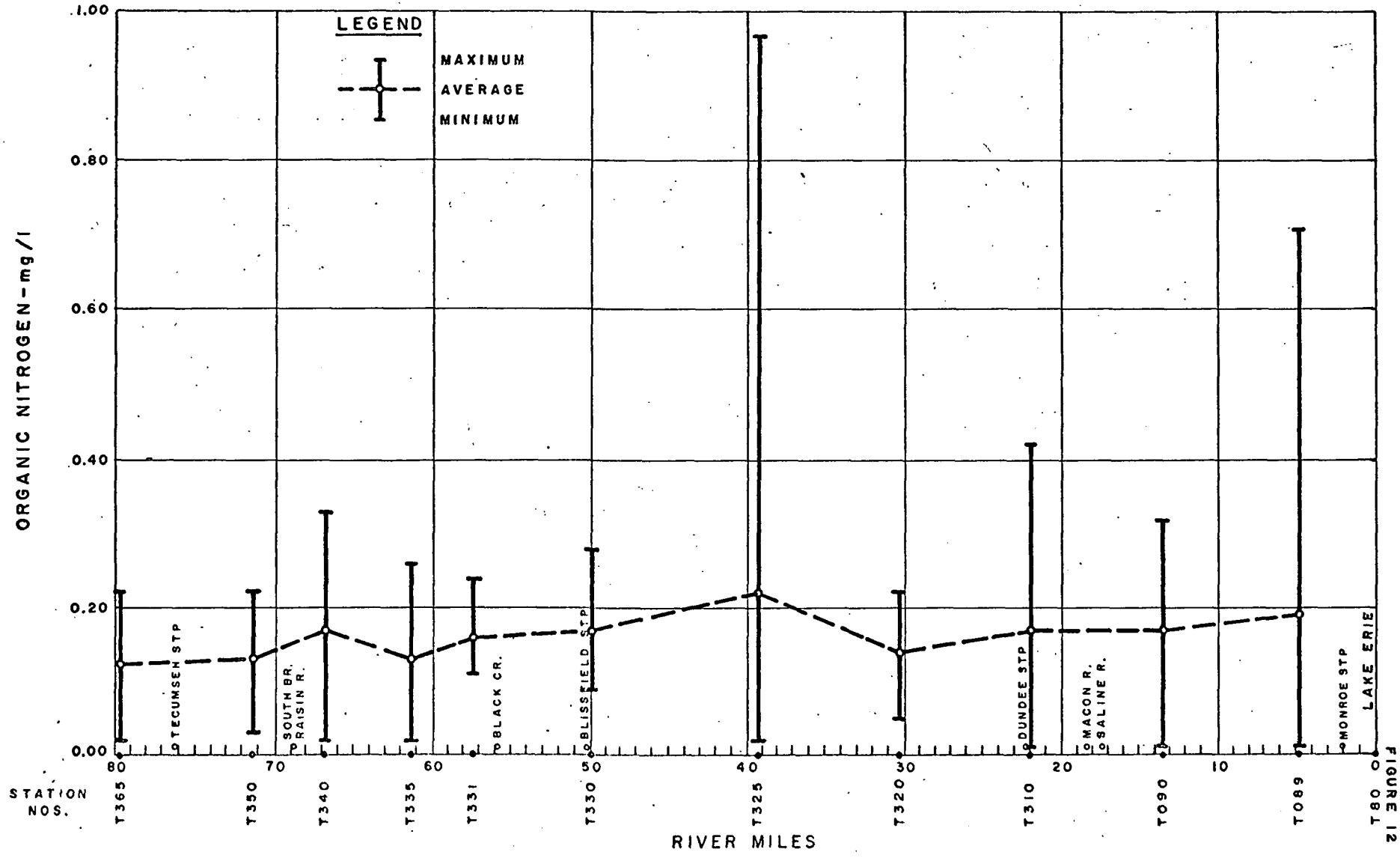


FIGURE 12

RAISIN RIVER
TOTAL PHOSPHATE ANNUAL VALUES
1966

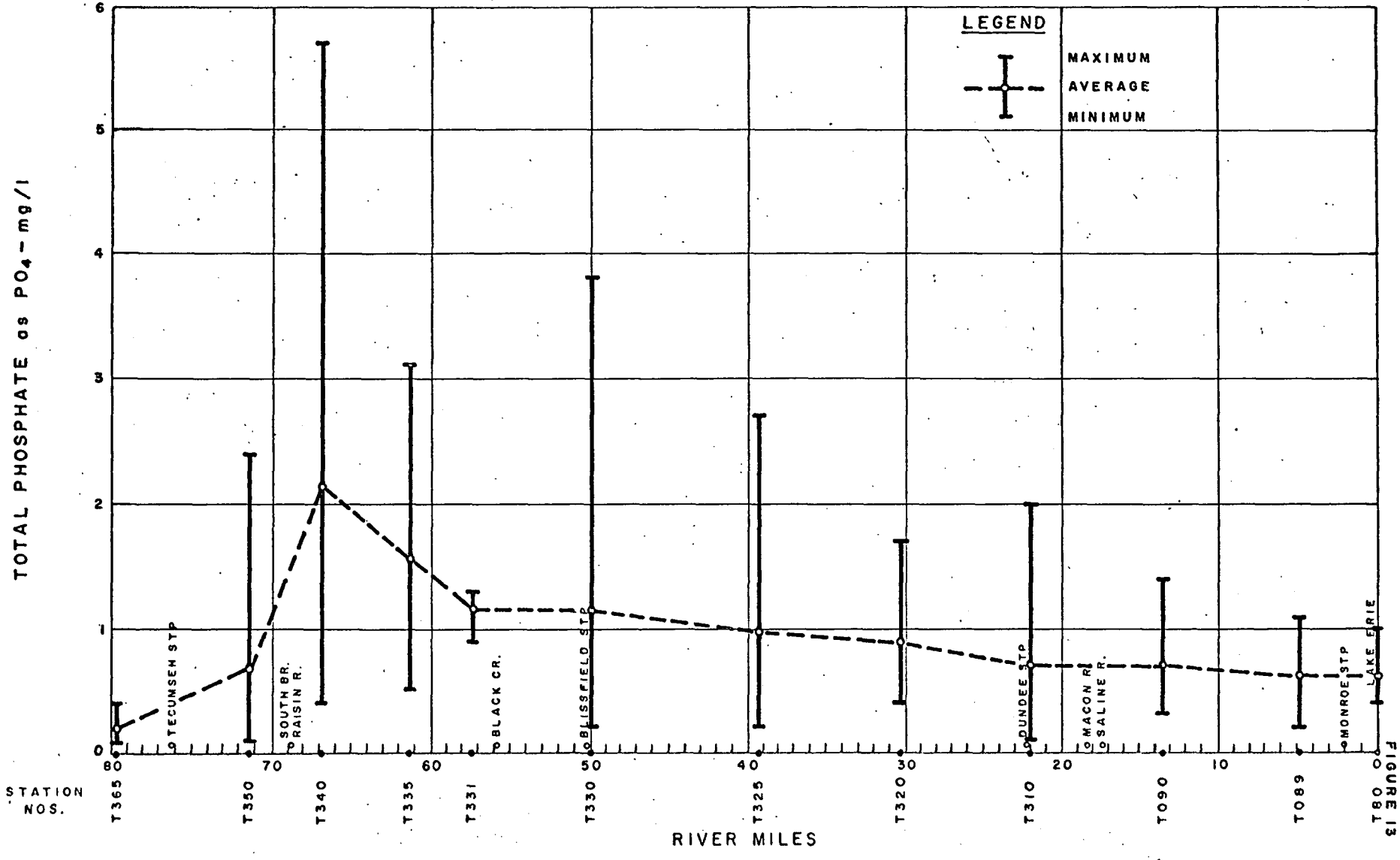


FIGURE 13

RAISIN RIVER
TOTAL SOLUBLE PHOSPHATE ANNUAL VALUES
1966

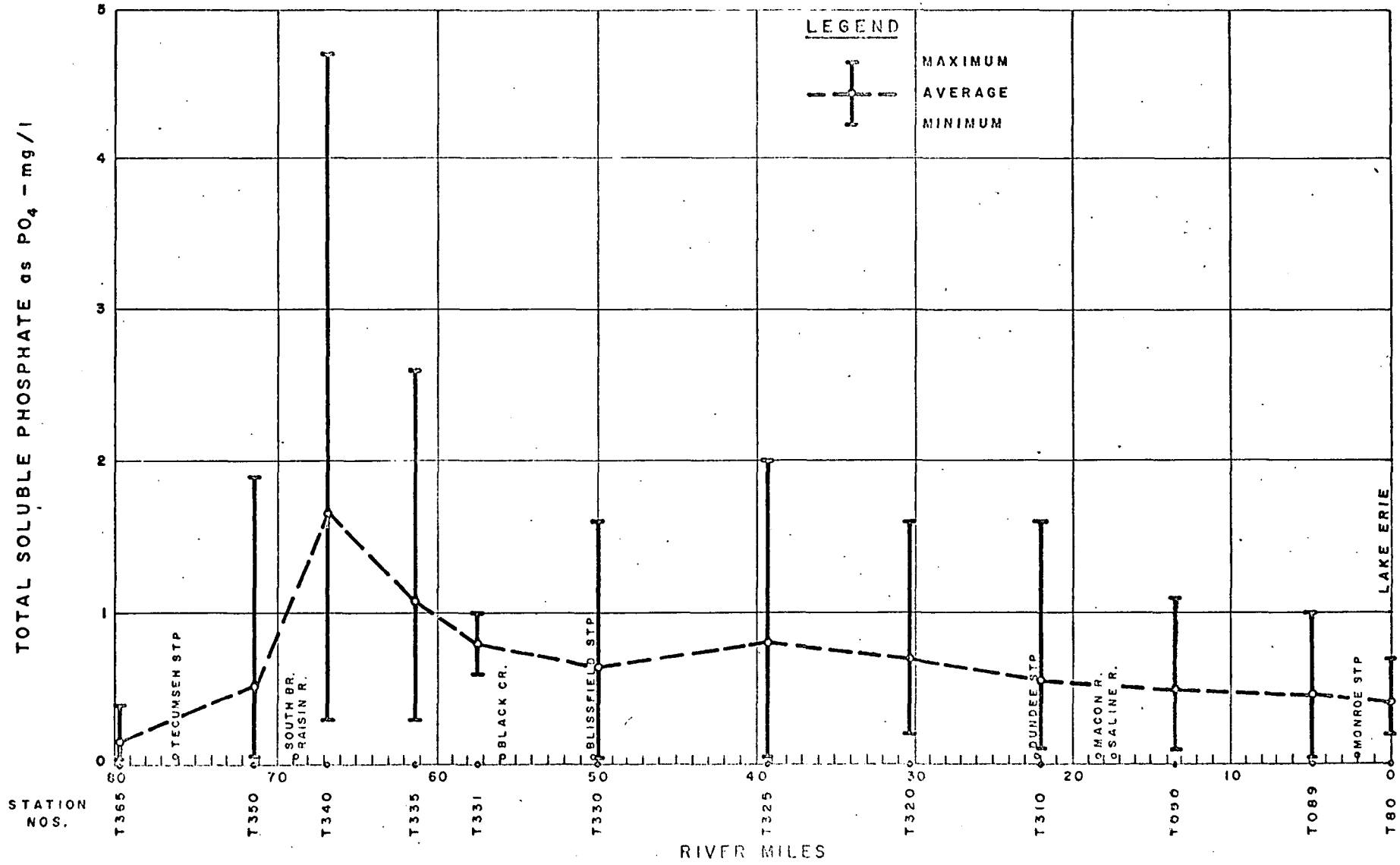


FIGURE 14

RAISIN RIVER
TOTAL & DISSOLVED SOLIDS ANNUAL AVERAGES
1966

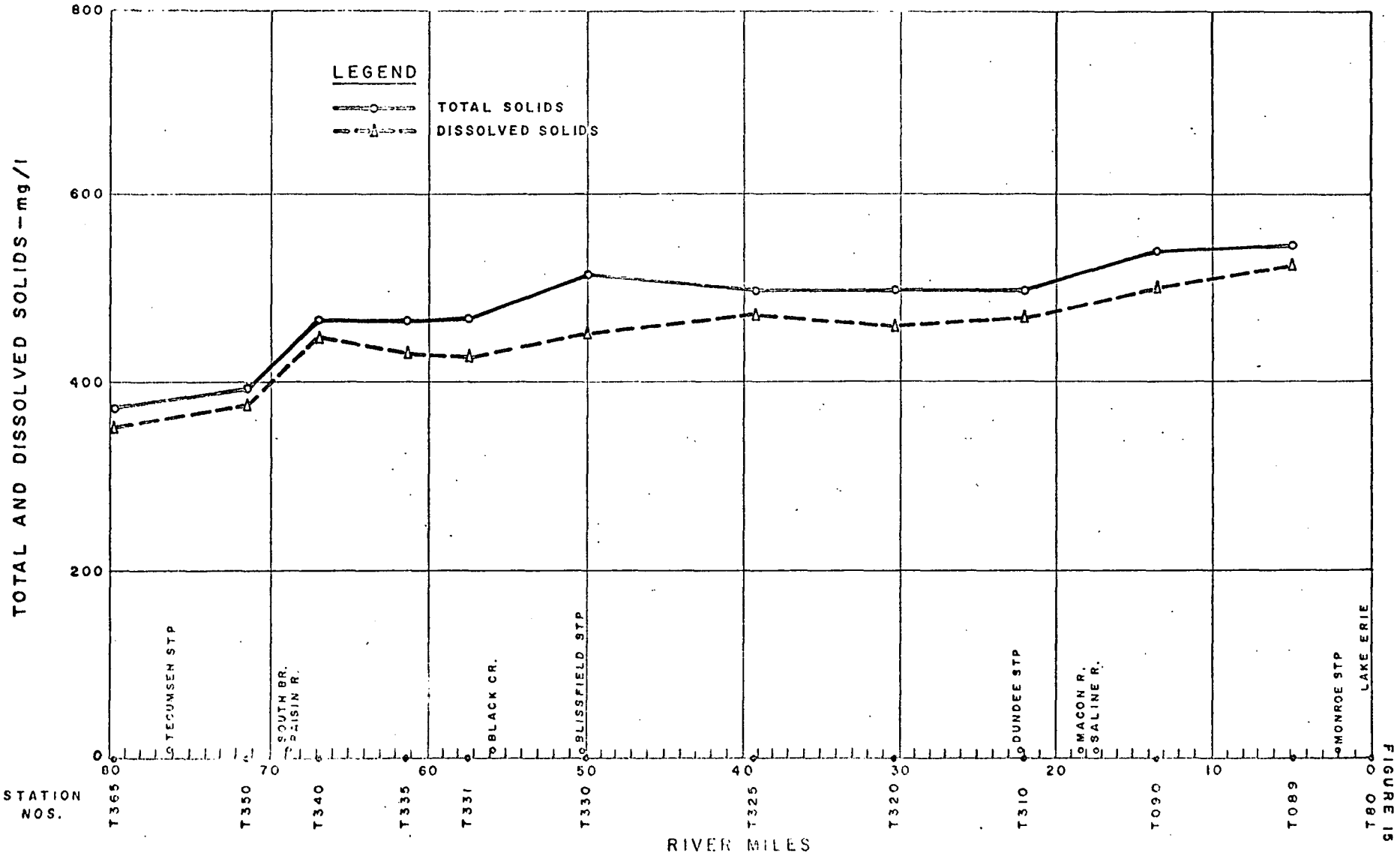


FIGURE 15

RAISIN RIVER
SUSPENDED SOLIDS ANNUAL VALUES
1966

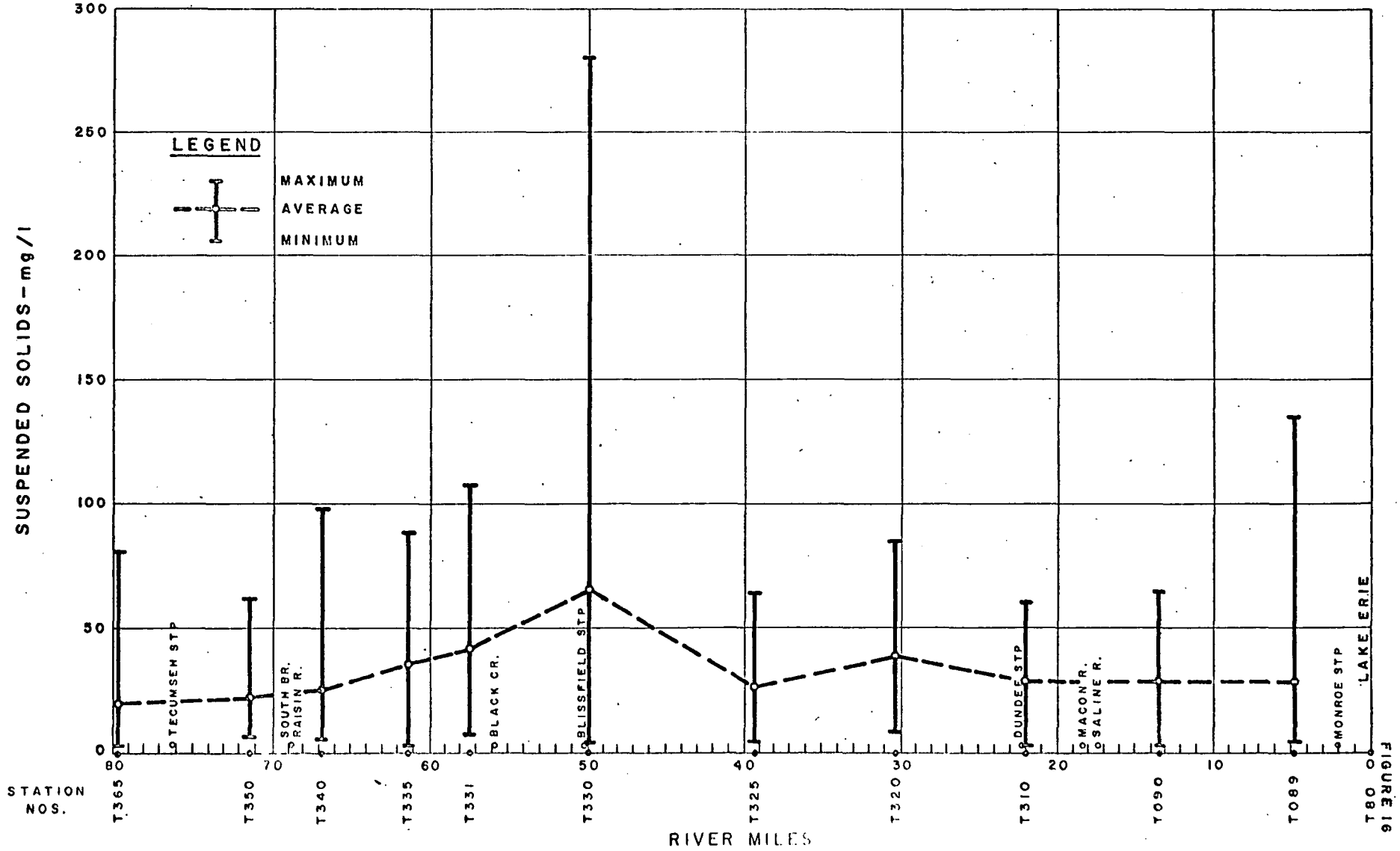


FIGURE 16

RAISIN RIVER
CHLORIDE ANNUAL VALUES
1966

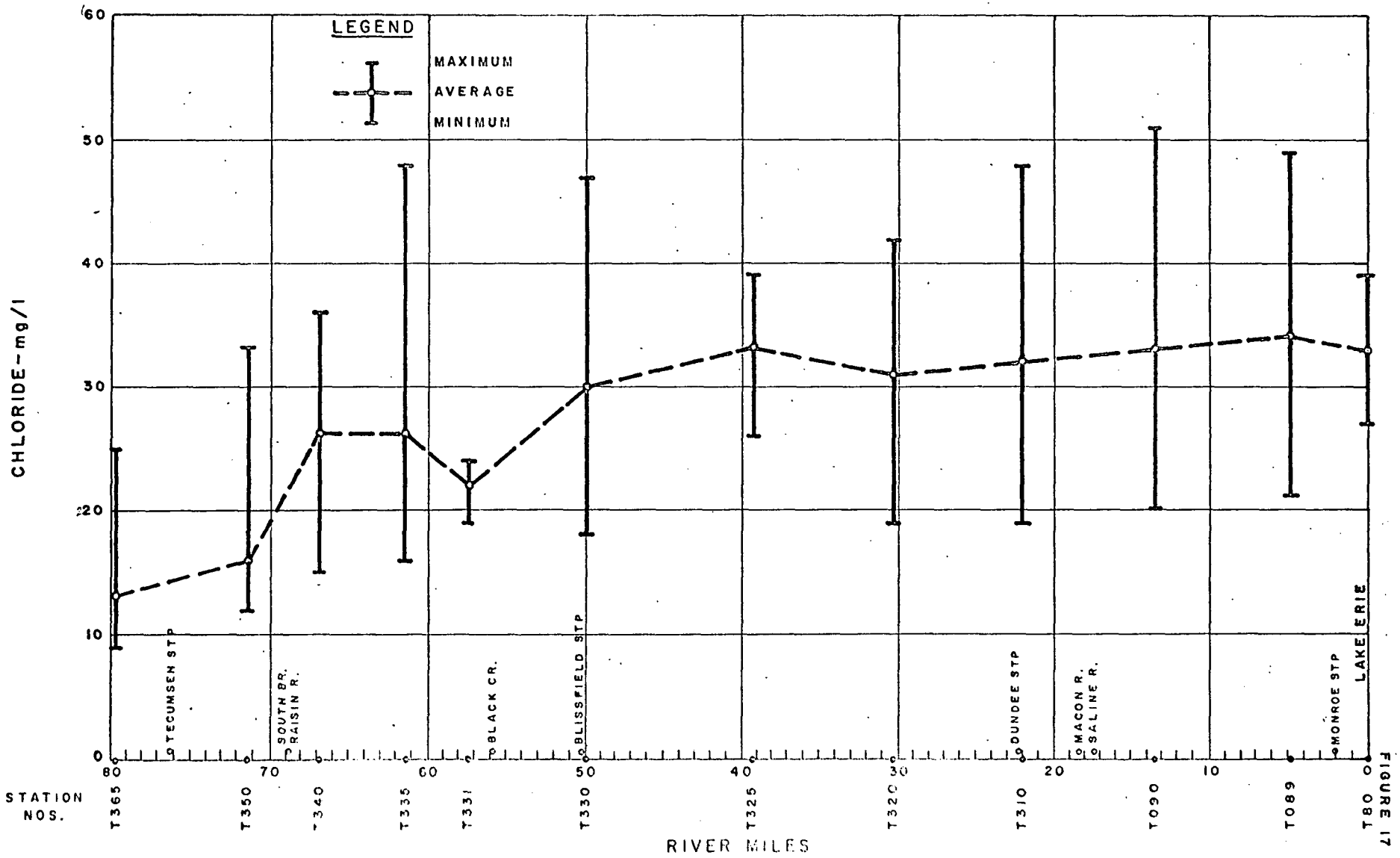


FIGURE 17

RAISIN RIVER
PHENOL ANNUAL VALUES
1966

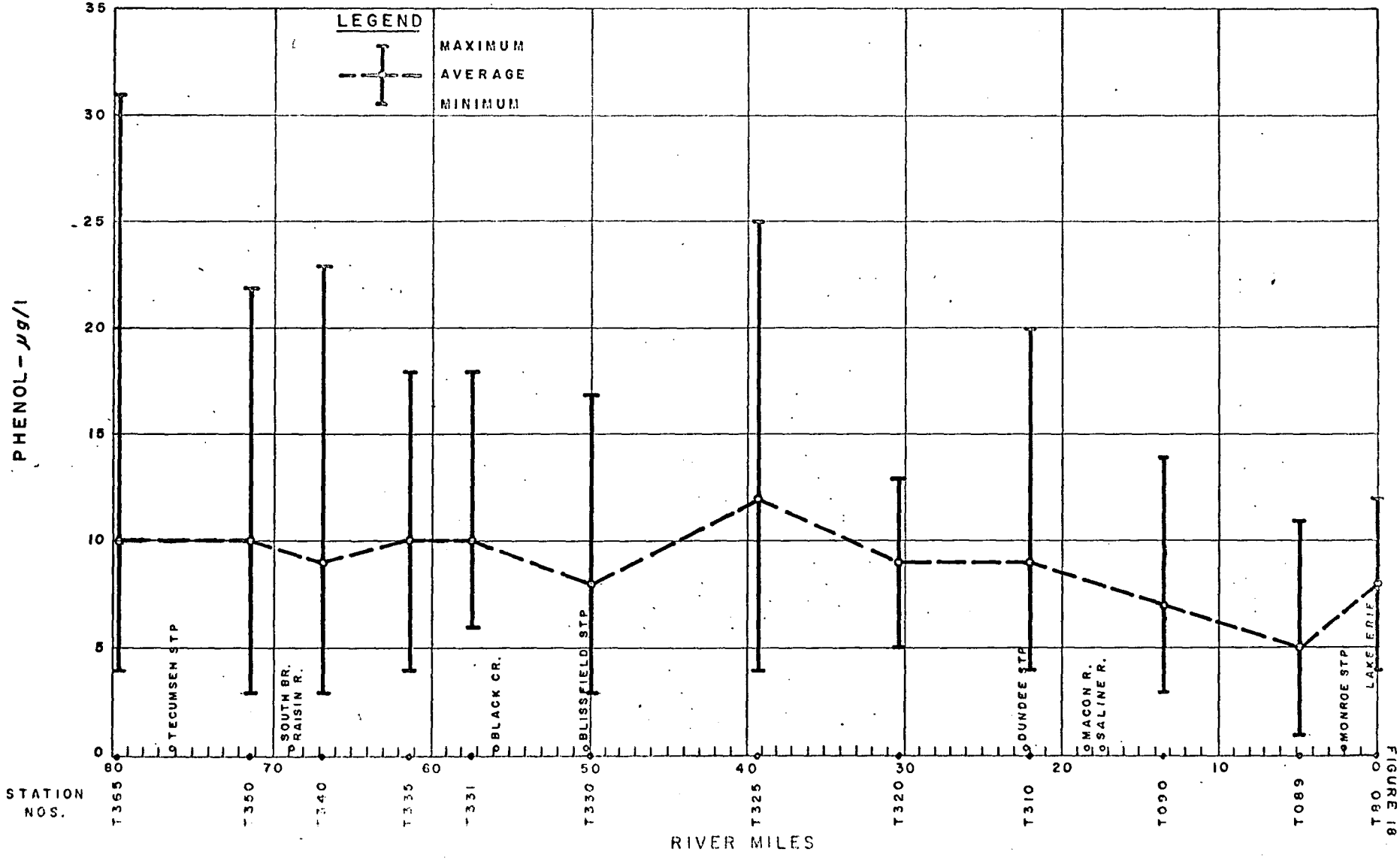


FIGURE 18

RAISIN RIVER
IRON ANNUAL VALUES
1966

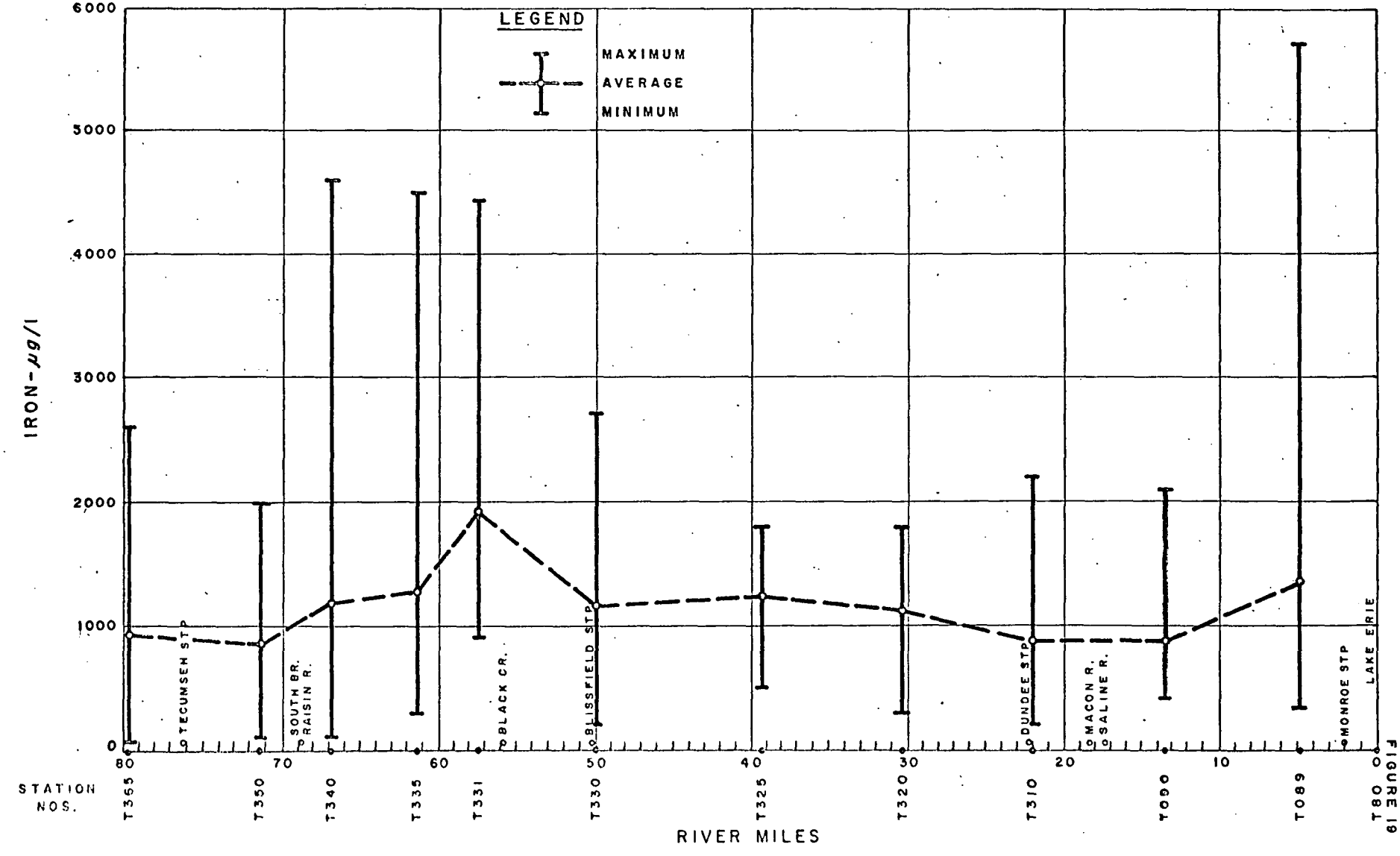


FIGURE 19

RAISIN RIVER
TOTAL COLIFORM SEASONAL VALUES
1966

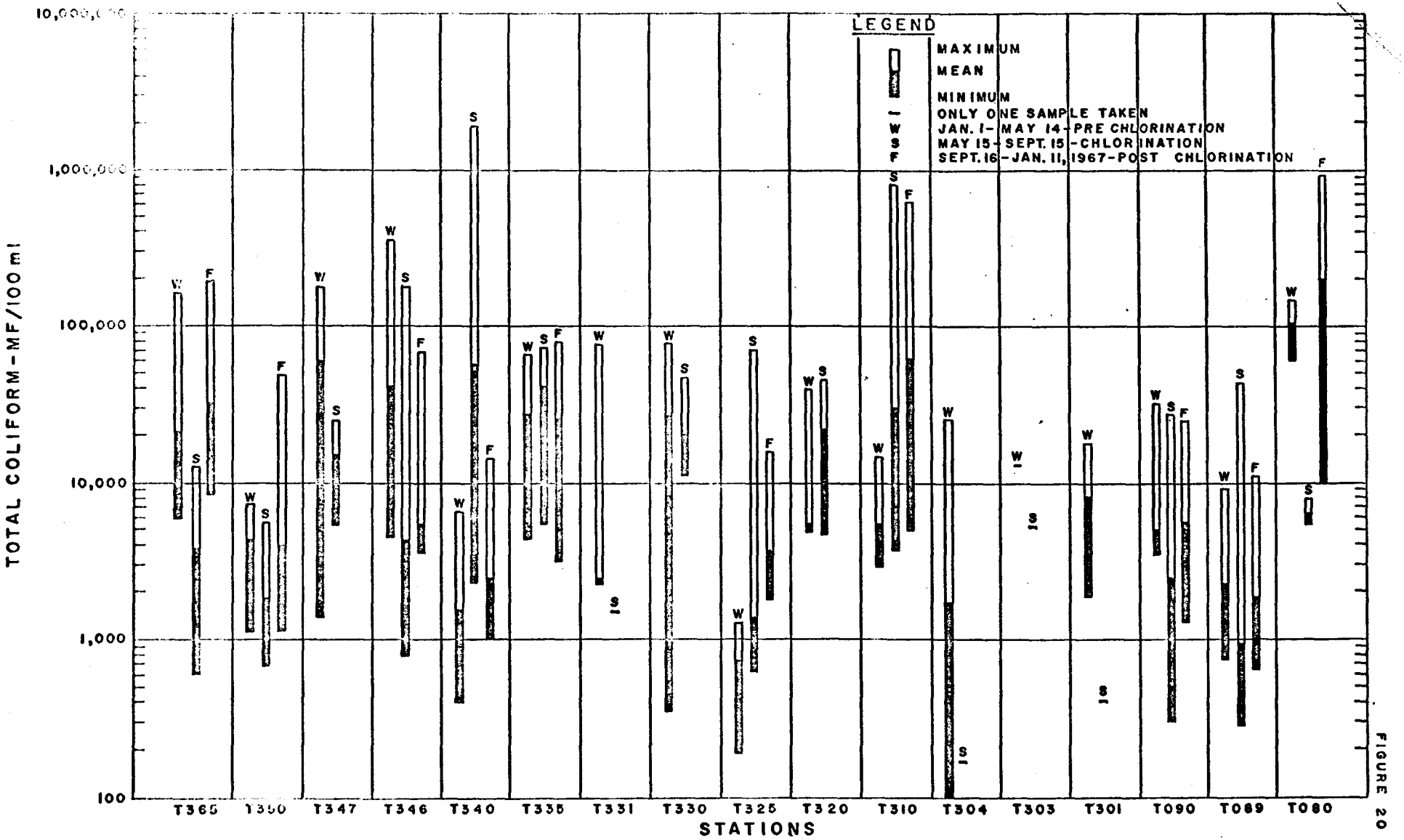


FIGURE 20

DISTRIBUTION OF SALMONELLA IN THE LOWER RAISIN RIVER

In January 1966, a salmonella survey of the lower portion of the Raisin River was initiated which lasted until September of the same year. At the time the survey was undertaken, very little information existed regarding the distribution of this group of pathogens in this stream.

Samples were collected from sampling sites via a modified Moor gauze pad technique. The following tabulation shows the coding of these sites, together with an explanation of the kind of sample collected and location (Figure 21).

Code	Sample Site	Kind of Water Sampled
1	Ida-Maybee Bridge	Raw river water
2	Time Container Corp.	River intake water
3	Time Container Corp.	Clarifier effluents
4	Time Container Corp.	Effluent discharging at riverbank
5	Dam located above NYCRR bridge	Raw river water
6	River 10-15 feet NE of Ben Hellenberg Field	Raw river water
7	Consolidated Paper Co. - North Side Division in front of plant	Combined discharge of East and West clarifiers
8	Union-Bag Camp Paper Company	East clarifier effluent
9	Union-Bag Camp Paper Company	West clarifier effluent
10	Mason Run at Detroit Avenue crossing	Combined effluents from Consolidated Paper North Side Div. and Union-Bag Camp Paper Co.
11	Mason Run pumphouse road bridge	" " "
12	Water intake pumphouse serving Consolidated & Union-Bag Camp Co.	Raw Lake Erie water
13	Mason Run bridge near Ford Motor Co.	Combined discharges of Consolidate Paper Co.-North Side Div. & Union-Bag Camp Co.

Code	Sample Site	Kind of Water Sampled
14	Consolidated Paper Co.-South Side Div. west outfall behind tanks	Effluent
15	Consolidated Paper Co.-South Side Div. east outfall behind tanks	Effluent
16	Consolidated Paper Co.-South Side Div. Infilco clarifier	Clarifier effluent
17	Consolidated Paper Co.-South Side Div. cut receiving clarifier effluents	Combined effluents
18	Consolidated Paper Co.-South Side Div. 36" pipe E. of Monroe STP	Effluent
19	Monroe sewage treatment plant	Treated, but unchlorinated effluent
20	Consolidated Paper Co.-North Side Div. outfall below dam	Effluent

When time permitted, samples for determination of fecal streptococci, total and fecal coliform densities by the membrane technique were taken at the time the gauze pads were retrieved. Final identification of suspected salmonellae was carried out at the U.S. Public Health Service Communicable Disease Center, Atlanta, Georgia.

Findings

A total of 34 modified Moor pads were placed in the water at the various sampling sites for periods of time ranging from 2-4 days. During the survey period, a total of 25 samples were collected and examined by the membrane technique.

A total of 13 salmonella serotypes were isolated from 6 of the 20 sampling sites. These 6 sites yielded samples with total coliform densities ranging from 3700 - 460,000 organisms/100 ml; fecal coliform counts ranging from 700 - 1100 organisms/100 ml; and fecal streptococcal densities ranging from 180 - greater than 7000 organisms/100 ml of sample.

The following salmonella serotypes were isolated from the 6 sites previously mentioned (see Figure 21).

Site	Salmonella Serotype Isolated
2	new brunswick
4	infantis
6	san diego
11	derby; typhi murium var. copenhagen; typhi murium
13	typhi murium; anatum; bredeney; derby
19	derby; cubana; infantis; eimsbuettel; heidelberg; thompson; montevideo

Through the cooperation of the Michigan Water Resources Commission and the management of Consolidated Paper Company, Union-Bag Camp Paper Company, and Time Container Corporation some sampling was carried out at waste clarifiers. Clarifier sampling was undertaken only after salmonellae had been isolated from plant effluents discharging into the River Raisin.

In the instance of Time Container Corporation, S.new brunswick had been isolated at the point of the raw water intake overflow (site 2), and S.infantis was isolated from the plant outfall to the river (site 4). When a subsequent sampling of the plant clarifier effluents was carried out, no salmonellae were isolated.

Sampling was conducted at the clarifiers of the Consolidated Paper Company's North Side Division and the Union-Bag Camp Paper Company clarifiers after S.typhi murium, S. anatum, and S. bredeney had been isolated from the waters of Mason Run. The Run originates on the properties of the two companies and carries their waste water via the Run which is on their jointly shared

properties and eventually discharges into the mouth of the River Raisin. During the period starting September 8, 1966 and ending September 12, 1966, gauze pad sampling was carried out at sites 8, 9, 10, 11, 12, and 13. The following results were obtained:

Sampling Site	Salmonella Serotypes Isolated	Membrane Filter Technique (organisms/100 ml) Total Coli	Fecal Coli	Fecal Strep
12	none	200	30	60
8	none	390,000	-	740
9	none	22,000	-	700
10	none	570,000	-	< 14,600
11	derby; typhi murium var. copenhagen; typhi murium	210,000	< 700	7,000
13	derby	460,000	< 800	7,000

No salmonellae were isolated from samples taken at sites 18, 17, 16, and 20.

Table 12 summarizes the data pertinent to the survey.

TABLE 12. SUMMARY OF FINDINGS OF RAISIN RIVER SALMONELLA SURVEY
January 1966-September 1966

Code	Duration of Sampling Period From	To	Membrane Filter Technique Organisms/100ml Total Coli	Fecal Coli	Fecal Strep	Salmonella Serotypes Isolated
1	9/23	9/26	400	80	10	None
2	5/13	5/16	7,300	1,100	360	new brunswick
	5/20	5/23	550	120	120	*
3	8/5	8/8	240	--	1,800	None
	8/5	8/8	800	--	3,000	None
4	5/20	5/23	3,700	--	180	infantis
5	5/6	5/9	--	--	--	*
6	4/22	4/25	--	--	--	san diego
7	6/13	6/16	330,000	--	22,000	None
	7/15	7/19	290,000	25,000	72,000	None
8	6/16	6/20	8,000	200	600	None
	6/24	6/27	7,000	--	40	None
	6/27	6/30	52,000	--	390	None
	9/8	9/12	390,000	--	740	None
9	6/16	6/20	12,000	< 1,000	500	None
	6/24	6/27	3,100	--	150	None
	6/27	6/30	24,000	--	710	None
	9/8	9/12	22,000	--	700	None
10	9/8	9/12	570,000	--	>14,600	None

*Pad removed by unknown party or parties.

TABLE 12. SUMMARY OF FINDINGS OF RAISIN RIVER SALMONELLA SURVEY (cont.)
January 1966-September 1966

Code	Duration of Sampling Period From	To	Membrane Filter Technique Organisms/100ml Total Coli	Fecal Coli	Fecal Strep	Salmonella Serotypes Isolated
11	9/8	9/12	210,000	> 700	> 7,000	derby; typhi murium var. copenhagen; typhi murium
12	6/27	6/30	200	--	410	None
	7/15	7/19	2,000	< 10	3,300	None
	9/8	9/12	200	30	60	None
	9/13	9/16	170	30	110	None
13	2/25	2/28	--	--	--	typhi murium; anatum
	4/29	5/2	76,000	700	5,900	bredeny
	9/8	9/12	460,000	> 800	7,000	derby
14	4/22	4/25	--	--	--	None
15	4/22	4/25	--	--	--	None
16	9/13	9/16	4,000	--	80	None
17	9/13	9/16	24,000	--	50	None
18	2/25	2/28	--	--	--	None
19	1/24	1/26	--	--	--	infantis; eimsbuettel; cubana
	1/28	1/31	--	--	--	derby; eimsbuettel; heidelberg; thompson; montevideo
20	5/6	5/9	--	--	--	*

*Pad removed by unknown party or parties.

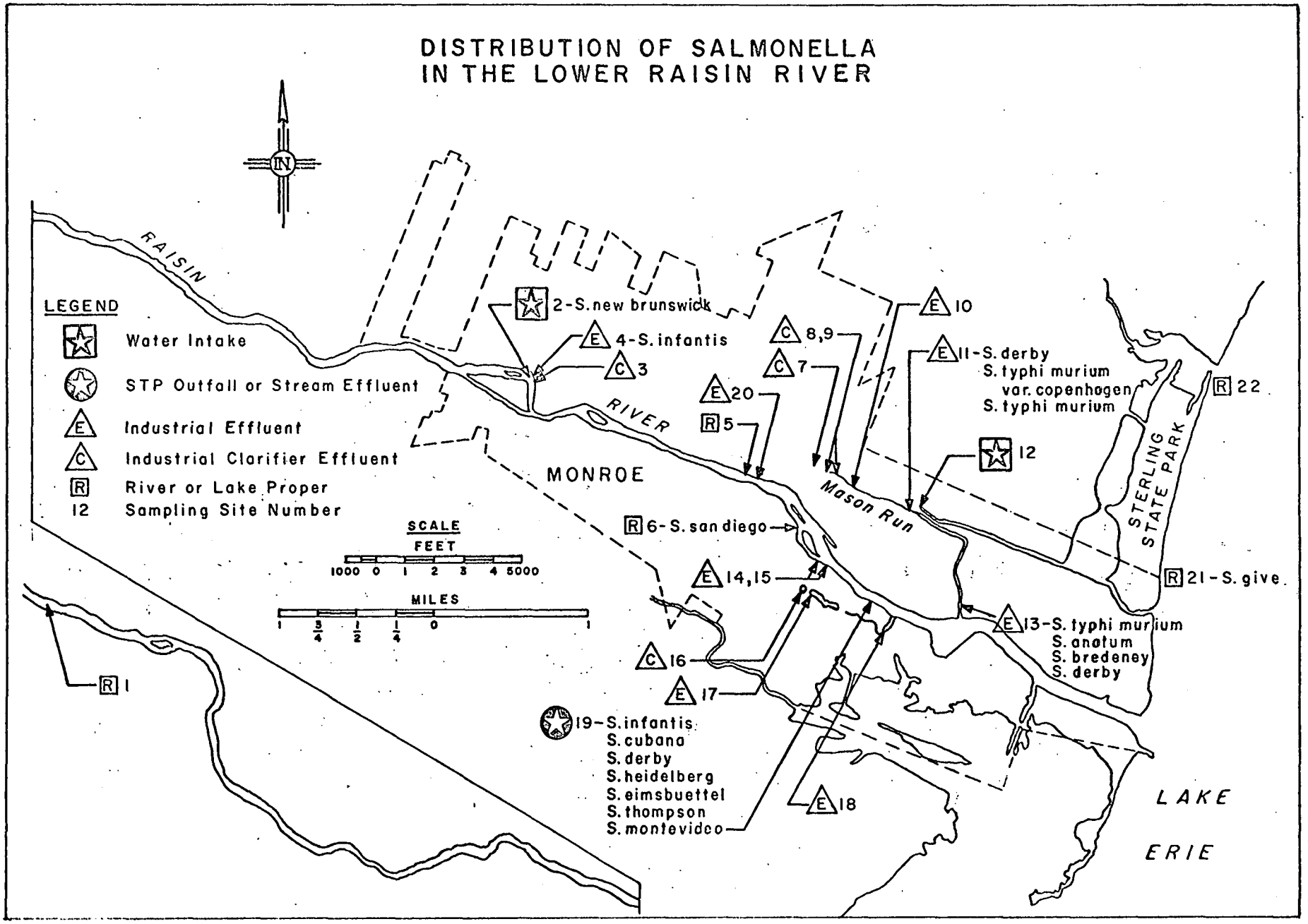

DISTRIBUTION OF SALMONELLA
IN THE LOWER RAISIN RIVER
IN
RAISIN
RIVER
MONROE
Mason Run
STERLING
STATE PARK
LAKE
ERIE
LEGEND
Water Intake
STP Outfall or Stream Effluent
E Industrial Effluent
C Industrial Clarifier Effluent
R River or Lake Proper
12 Sampling Site Number
SCALE
FEET
1000 0 1 2 3 4 5000
MILES
1 3/4 1/2 1/4 0 1
2-S.new brunswick
E 4-S.infantis
C 3
C 8,9
C 7
E 10
E 11-S.derby
S.typhi murium
var.copenhagen
S.typhi murium
R 22
E 20
R 5
12
R 6-S.san diego
E 14,15
R 21-S.give
E 13-S.typhi murium
S.anatum
S.bredeney
S.derby
C 16
E 17
19-S.infantis
S.cubana
S.derby
S.heidelberg
S.eimsbuettel
S.thompson
S.montevideo
E 18
R 1

FIGURE 21

SUMMARY AND WATER QUALITY PROBLEMS

The population centers in the River Raisin Basin are Monroe (22,968), Adrian (20,347), and Tecumseh (7,045), according to 1960 census figures. The total 1960 population in the River Raisin Basin, including the population of incorporated and unincorporated areas, was estimated to be 208,000 persons. The population served by sewer systems was approximately 68,000. There were four primary plants: Blissfield, Clinton, Dundee, and Monroe; five secondary plants - Adrian, Manchester, Milan, Saline, and Tecumseh; and one village, Onstead,which provided no treatment for collected sewage. The total waste water flow from the nine plants is about 10.5 million gallons per day.

Seventeen industries discharged wastes directly to watercourses within the River Raisin Basin. A total discharge of approximately 156 million gallons per day of industrial waste originated from electroplating operations, paper mills, cement production, chemical companies, facricating and manufacturing companies, and automotive plants. Approximately 120 million gallons per day of this total discharge is dilution water used by the Ford Motor Company at Monroe. The principal industries are located at Monroe, Adrian, Dundee, and Tecumseh.

In 1966 the River Raisin was routinely sampled at several stations from Clinton, Michigan - milepoint (MP) 79.7 - downstream to MP 4.95 located above the Monroe area that was studied in detail in the 1965 Detroit River-Lake Erie Report. A number of water quality measurements were also made at a station at the mouth of the river, MP 0.0, to determine any change in the level of pollution from that reported during the 1965 Enforcement Conference on the Detroit River and Lake Erie. No significant changes in water quality were indicated.

Dissolved oxygen averages ranged from 8.0 to 11.0 mg/l from MP 79.7 below Clinton to MP 4.95 within the City of Monroe, and decreased dramatically to 3.3 mg/l at MP 0.0 below the City of Monroe. At MP 0.0, the minimum value was 0.2 mg/l, which was found during the summer months and indicated that there was no change since 1962-1964 when zero DO values were found.

BOD_5 averaged from 3 to 5 mg/l between MP 79.7 and MP 4.95. Maximum values of 11 to 15 mg/l were found during the summer months below Clinton (MP 79.7), below Tecumseh (MP 71.2), below the confluence of the South Branch River Raisin which carries wastes for Adrian (MP 61.2), and below Blissfield (MP 50).

High levels of nitrate and ammonia nitrogen were found in the River Raisin. The nitrate average at MP 79.7 was .5 mg/l and continued to increase in a downstream direction until 3.5 mg/l was found at MP 4.95. From MP 4.95 to MP 9.9, the nitrate concentration reduced to 1.2 mg/l. Some dilution effect by lake water may be expected at this station. The nitrate concentration averages between MP 66.9, below Tecumseh and the South Branch River Raisin, and MP 4.95 were above 1.6 mg/l, and the maximum values ranged from 7.4 to 14.4 mg/l. Ammonia nitrogen concentration averages were .26 to .68 mg/l, from MP 79.7 to MP 4.95, with the averages over .50 mg/l at MP's 66.9, 62.3, and 57.3. Maximum values over 1.00 mg/l were found between MP 71.2 below Tecumseh (but above South Branch River Raisin) to MP 57.3 above Black Creek.

From MP 79.7 to 4.95, nitrite averages ranged from .02 to .05 mg/l with the highest values at MP 66.9, and organic nitrogen averages ranged from .12 to .22 mg/l.

Total and total soluble phosphates at all sampling points had values (as PO4) over .045 mg/l. From MP 71.2 to 0.0, average total phosphate values were over .6 mg/l, and average total soluble values were .4 mg/l. The highest values were recorded between MP 66.9 and MP 50.0, with values over 1 mg/l (as PO4).

Solids (total, dissolved, and total suspended) generally showed an increase from MP 79.7 to 4.95. Total solids avererages increased from 373 to 553 mg/l. Suspended solids averages were 19 to 65 mg/l with the averages at MP 57.3 and 50.0 being 41 to 65 mg/l, respectively.

Chloride concentrations increased steadily from MP 79.7 to MP 0.0. The average ranged from 13 mg/l at MP 79.7 to 33 mg/l at MP 0.0

Phenols for all sampling points, MP 79.7 to MP 0.0, had values of 5 to 12 ug/l - all above the U.S. Public Health Service drinking water standard of 1 ug/l. The phenolic concentration average in 1966 at MP 0.0 was 8 ug/l compared with the average of 7 ug/l that was reported in the 1965 Detroit River-Lake Erie Report.

Coliform density data were grouped into three seasons: pre-disinfection January 1 - May 14, 1966; disinfection - May 15 - September 15, 1966; and post-disinfection - September 16 - January 11, 1967. The data indicated no significant differences in the seasonal medians except in the lower reaches of the River Raisin. The disinfection season medians exceeded the nondisinfection season medians at a number of sampling locations. These included MP 66.9 and MP 61.2 below Adrian and Tecumseh, MP 50.0 and MP 39.2 below Blissfield, and MP 30.3 below Petersburg. During the disinfection season, median coliform densities exceeded 1,000 organisms per 100 ml at all 12 sampling locations, and exceeded 2,400 organisms per 100 ml at 9 of these

stations. Overall median coliform densities for the entire 1966 survey period exceeded 1,000 at all stations and exceeded 2,400 at all but two stations. Median coliform densities at the mouth of the River Raisin (MP 0.0) below the City of Monroe were 106,000, 6400, and 200,000 org/100 ml for pre-disinfection, during, and post disinfection seasons, respectively. These values are based on limited sampling, not conducted on the same daily basis as the river sampling program.

A short survey on the recovery of salmonella-type organisms was conducted in 1966 on the lower River Raisin. Salmonella organisms were isolated at the raw water intake at Time Container Corporation and at the plant outfall. Three serotypes - S. Typhimurium, S. Anatum, and S. Bredeney - were isolated from the waters of Mason Run in the Monroe area. Several serotypes were isolated from six of twenty sampling sites. A health hazard was thereby shown to exist in the River Raisin between MP 4.95 and MP 9.9.

The confluence of the Saline River (SAL) with the River Raisin is at River Raisin MP 17.4. Two sampling points are located in the Saline River. Station MP 17.3 SAL is located below the Saline STP (MP 19.7), and MP 0.4 SAL is located below the Milan STP (MP 9.9). Coliform densities for both points were approximately the same with the medians over 2,400 organisms/100 ml. DO, BOD, COD, pH, and chlorides were not at serious levels. Phenols and phosphates decreased as water flowed from MP 17.3 to MP 0.4 while nitrogen, conductivity, and solids increased. Conductivity, phosphates, nitrates, ammonia nitrogen, and all solids from MP 0.4 would affect the water quality in the River Raisin.

The confluence of the River of the Little River Raisin (LRR) with the River Raisin is at River Raisin MP 18.4. Station MP 0.4 LRR is below the effluent discharge from the Dundee Cement Company located on the Macon River a short distance upstream. There were extremely high average levels of: conductivity - 1096 umhos; nitrates - 5.7 mg/l; and total solids - 1,480 mg/l; dissolved solids - 1,423 mg/l; and suspended solids - 56 mg/l. Phosphates, phenols, and ammonia and organic nitrogen were at levels which could adversely affect the water quality in the River Raisin. Conductivity, nitrates, and solids would be detrimental to the water use of the River Raisin because of their extremely high concentrations.

The confluence of the South Branch River Raisin (SBR) with the River Raisin is at Raisin MP 68.95. Station MP 4.7 SBR is located above the Adrian STP and station MP 1.8(SBR)is located below the STP. Water quality at MP 1.8 was affected by industries and the Adrian STP.

At MP 4.7, average total phosphates were .63 mg/l; total soluble phosphates - .29 mg/l; nitrates as N - 2.6 mg/l; ammonia nitrogen - .34 mg/l; organic nitrogen - 17 mg/l; total solids - 566 mg/l; dissolved solids 496 mg/l; suspended solids - 71 mg/l; and phenols - 8 ug/l. Coliform median was over 2,400 organisms per 100 ml.

At MP 1.8 below the Adrian STP, the averages were: phenols - 10 ug/l; total phosphates - 3.40 mg/l; total soluble phosphates - 2.38 mg/l; nitrates - 4.4 mg/l; ammonia nitrogen - 97 mg/l; and organic nitrogen - .74 mgl.

The various water quality measurements made in 1966 indicate that the River Raisin between stations MP 79.7 and MP 4.95 are in various stages of pollution. Coliform densities, before, during, and after the disinfection period at most sampling points were above 2,400 organisms/100 ml. Nutrient

measurements (phosphates and nitrogen compounds) were at a very high level which can produce algal blooms. Average DO and BOD_5 concentrations appeared to be at low pollution levels. DO levels at most stations declined during the summer months to average values of 5-6 mg/l. Supersaturation levels occurred in the lower river from MP 22.0 to MP 4.95. BOD_5 values at a number of locations below waste sources increased significantly following periods of rainfall. Phenols, for all sampling ranges, were above the U.S. Public Health Service drinking water standards. Iron and solid measurements show high levels of these pollutants which can cause problems for water users.

In 1966 the water quality measurements such as coliforms, DO, nitrates, phosphates, chlorides, and phenols made at MP 0.0 mouth of the River Raisin, showed that the degree of pollution in the River Raisin has not changed since 1962-1964 - the years covered by the 1965 Detroit River-Lake Erie Report. The significantly low DO values, high coliform densities, high nutrient values (nitrates and phosphates), and high phenolic concentrations show that there is significant pollution in the River Raisin.

The Little River Raisin affects the River Raisin with its high conductivity, nitrates, and solids load.

The South Branch River Raisin carries into the River Raisin high coliform densities, and nutrient concentrations (phosphates and nitrogen).

The communities of Blissfield, Clinton, Dundee, and Monroe discharge primary effluent to the river. Consolidated Packaging Corporation, Ford Motor Company, Monroe Paper Products Company, and Union-Bag Camp Paper Corporation have treatment rated as inadequate by the MWRC. As a result of the Enforcement Project, action has already been taken against the City of Monroe and the industries aforementioned by the MWRC.

Surface waters of the River Raisin Basin are used for both municipal and industrial water supplies. The City of Adrian (20,347) obtains water from an impoundment on Wolf Creek, a tributary of the River Raisin. Blissfield (2,653), Deerfield (866), and Dundee (2,377), obtain water from the River Raisin. Monroe (22,968) obtains water from an intake on Lake Erie. Approximately 72 percent of the basin population of 72,000 served by public water supplies obtains water from surface waters with 38 percent obtaining waters from the River Raisin. Wells in both drift and rock at depths from 40 to 200 feet are used as a water source for the remainder of the public water supplies. Total municipal water use, residential, commercial, and industrial, is approximately 12 million gallons per day. Projected requirements for the year 2020 is 97 million gallons per day.

A number of industries also obtain part or all of their water supply from private sources. With the exception of two industries in Palmyra using surface waters, groundwater is the industrial water source in the upper River Raisin and tributaries. These include industries in Adrian, Brooklyn, Milan, Saline, and Weston. Surface waters are used by industries at Dundee, principally the Dundee Cement Company (1.5 million gallons per day). In the Monroe area, surface waters are used with the exception of the Ford Motor Company which obtains about 7 million gallons per day from wells. Other principal users in this area are the Consolidated Paper Company (18.7 million gallons per day), Monroe Paper Products Company (2.2 million gallons per day), and Union Bag-Camp Corporation-River Raisin Paper Div. - (4.5 million gallons per day). Total volume used is approximately 35 million gallons per day. Projected requirements for the year 2020 is 182 million gallons per day.

Not included in these figures is the present use of approximately 120 million gallons per day of water from Sterling State Park canal for waste dilution by the Ford Motor Company.

A critical factor at present is the dissolved oxygen concentration especially in the lower reach below Monroe. Dissolved oxygen concentrations of less than 1 mg/l have been observed during the summer months. Although yearly average DO levels were sufficient in most stream reaches, summer levels were in general from 50-80 percent saturation. Supersaturation occurred at sampling locations from below Dundee to Monroe. Oxygen demand in the River Raisin is a function both to the unsatisfied carbonaceous and nitrogenous wastes for the many sources and the secondary effect of biological growth caused by the nutrient loadings to the river.

Organic material in the stream exists in a number of forms. Direct addition of material from effluents is presently critical in a number of areas, especially below Monroe. The resuspension of settled material which accumulated as a sludge creates high oxygen demands during periods of high stream velocity which occur frequently but of short duration during summer rainstorms. The dieoff of organisms, especially algae, imposes a demand when the necessary elements of sunlight and nutrients are no longer sufficient. Another source of organic material to the system is overland runoff from both urban and rural areas. This source is an intermittent one occurring during periods of rainfall. The effect is generally not apparent during the high flow period but occurs when the flow again returns to normal and the material settles to form sludge.

Increased temperature causes an increase in the rate of biological conversion of organic material. This is more pronounced on the nitrogenous wastes. The major sources of heat to the upper river system are the sewage

treatment plants and solar radiation absorption caused by destruction of shade tree cover along the banks. The industrial complex in the Monroe area adds a considerable thermal load to the lower River Raisin and Lake Erie. Temperatures in excess of 25°C have been observed in the lower reaches below Monroe and at the mouth of the River Raisin.

Suspended materials of an inorganic nature also affect the water quality but in secondary effects. The silt and sand when settled destroy the bottom habitat. This change in the environment destroys the plants and animals which are not tolerant of a silted bottom. The food chain of the higher fishes is thus broken, and the valuable fishes no longer are present, even though the water is otherwise of acceptable quality. Mud and silt also destroy spawning beds necessary for maintenance of fish population. Suspended materials, especially mud and silt, also destroy the esthetic values of the waters.

The effluent flow of those industries in the basin with toxic metals as a waste product is limited. These industries are associated with the automotive parts industry and are located in the Adrian and Monroe areas. Spills from plating operations have been assoicated with fish kills. Another significant source of toxicants is the use of various pesticides for individual, agricultural, and other uses.