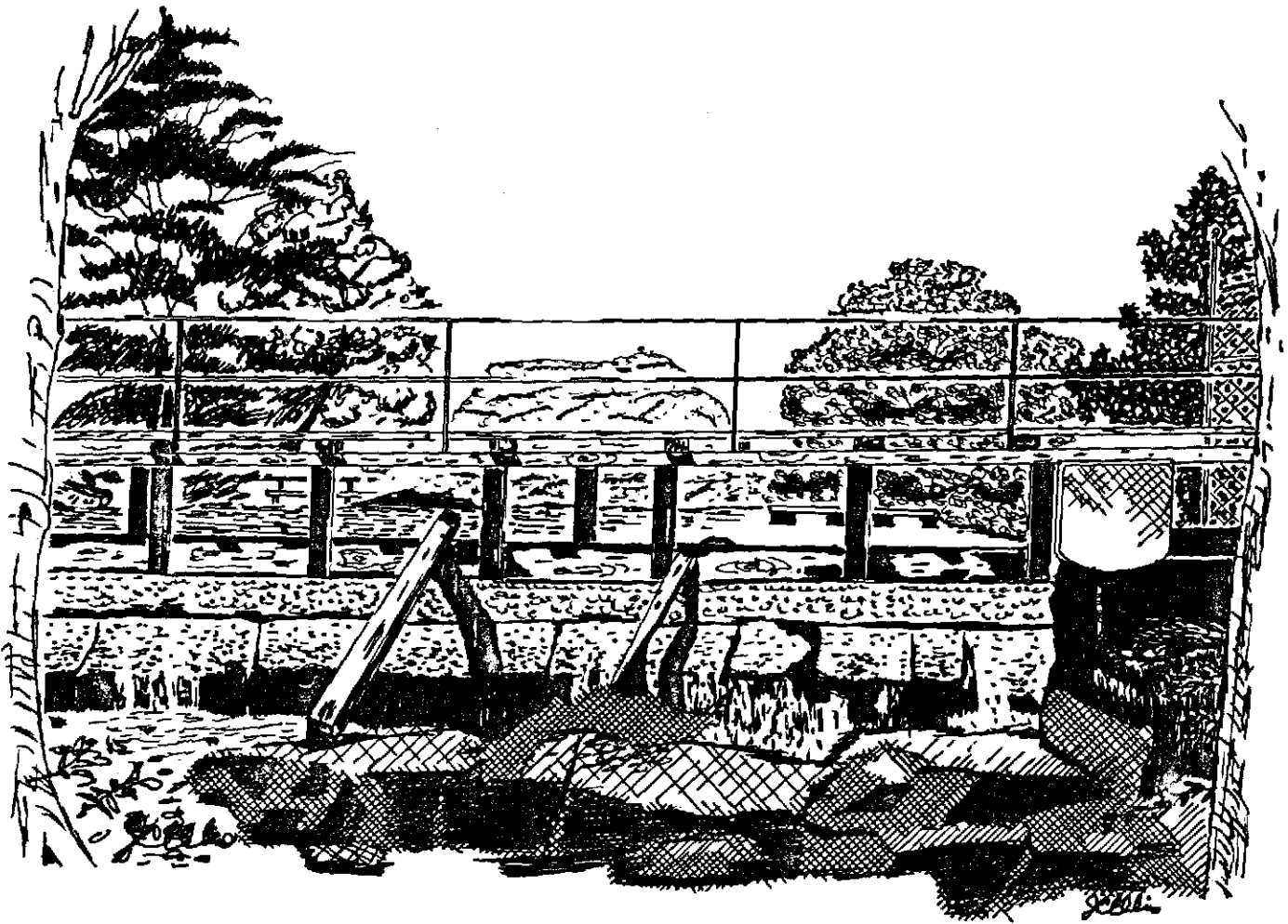


STONY BROOK



1974

part c

massachusetts water resources commission

DIVISION OF WATER POLLUTION CONTROL

thomas c. mcMahon, director

STONY BROOK
1974
WATER QUALITY ANALYSIS

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MASSACHUSETTS WATER RESOURCES COMMISSION

WESTBOROUGH

JUNE 1975

Cover

Stony Brook at the Outlet of Forge Pond
Forge Village
Westford, Massachusetts

Approved by:
Alfred C. Holland
Purchasing Agent

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TABLE OF CONTENTS

<u>ITEM</u>	<u>PAGE</u>
Acknowledgments	2
List of Tables	4
List of Figures	5
Background Information	7
Introduction	7
Socio-Economic Background	9
Historical	9
Present	9
Basin Description	13
Present Water Use	14
Present Water Quality	17
Waste Discharges	17
Non-Point Sources	17
Results of Water Quality Surveys	22
Survey Procedures	22
Stony Brook Basin Surveys	25
Future Conditions	43
Pollution Abatement Program	43
Conclusions	47
Recommendations for Future Study	48
References	49

LIST OF TABLES

<u>NUMBER</u>	<u>TITLE</u>	<u>PAGE</u>
1	Stony Brook Valley Cities and Towns; Land Area - Population	10
2	1971 Industrial Employment, Stony Brook Basin	11
3	Municipal Water Supplies, Stony Brook Basin	15
4	Stocked Trout Waters, Stony Brook Basin	16
5	Summary of Existing and Proposed Discharges, Stony Brook Basin	18
6	Meteorological Conditions, 1974 Stony Brook Surveys	26
7	Average Stream Flow, 1974 Stony Brook Surveys	27
8	Location of Sampling Stations, 1974 Stony Brook Surveys	29
9	Waste Load Allocation - Commodore Foods, Inc.	44
10	Waste Load Allocation - New England Apple Products Company, Inc.	45
11	Population Projections, Stony Brook Basin	46

LIST OF FIGURES

<u>NUMBER</u>	<u>TITLE</u>	<u>PAGE</u>
1	Stony Brook Basin	6
2	Classification Map	8
3	Location of Wastewater Discharges, Stony Brook Basin	19
4	Location of Municipal and Private Dumping Areas, Stony Brook Basin	21
5	Stony Brook Discharge Profile, June and August 1974 Surveys	28
6	Stony Brook Basin Location of Sampling Stations	30
7	Stony Brook, Minimum D.O., June and August 1974 Surveys	32
8	Stony Brook, Average Five-day B.O.D., June and August 1974 Surveys	34
9	Stony Brook, Average D.O. for June 1974	36
10	Stony Brook, Average D.O. for August 1974	37
11	Stony Brook, Average Total Phosphorus, June and August 1974 Surveys	38
12	Stony Brook, Average Pounds Five-day B.O.D., June and August 1974	39
13	Stony Brook, Average Pounds Ammonia-Nitrogen and Nitrate- Nitrogen for June 1974	40
14	Stony Brook, Average Pounds Ammonia-Nitrogen and Nitrate- Nitrogen for August 1974	41
15	Stony Brook, Total Coliform Densities, June and August 1974	42

STONY BROOK BASIN

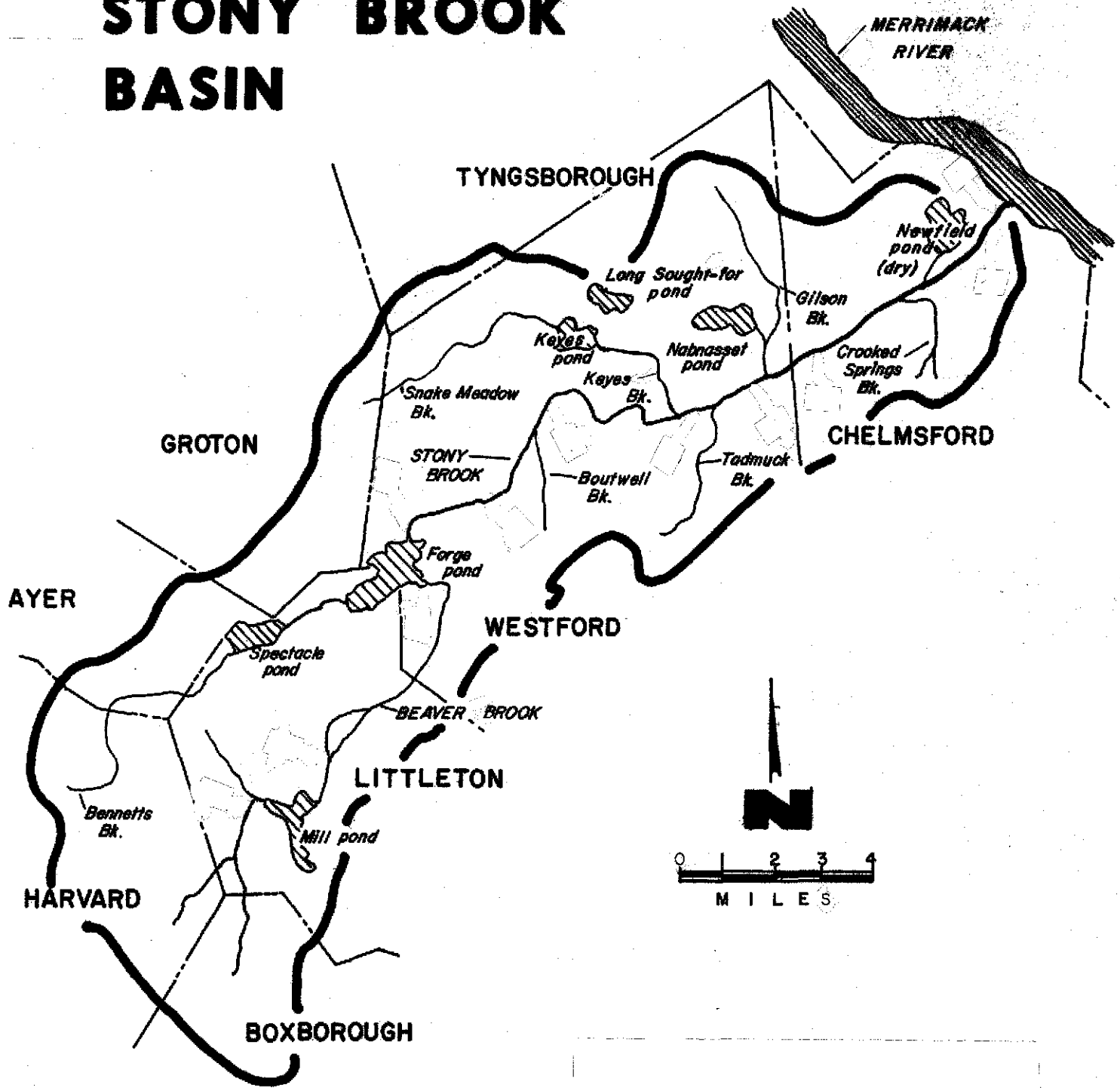


Figure 1

BACKGROUND INFORMATION

INTRODUCTION

Stony Brook is a tributary stream to the Merrimack River with a drainage area within Middlesex and Worcester counties of Massachusetts. Its headwaters originate between Ayer and Littleton as Beaver Brook. It flows generally north-easterly through Littleton, Westford, and North Chelmsford to join the Merrimack River. In its 22-mile length, Stony Brook drains an area of approximately 51 square miles and falls 200 feet. This drop of approximately ten feet per river mile is characteristic of most of the streams in eastern Massachusetts.

Dams create many impoundments along its entire length. The main stem is fed by numerous small brooks and streams along its path to the Merrimack River. The basin also includes a number of lakes and ponds suitable for recreational activities. Much of the upper reaches of Stony Brook are comprised of swampy, marsh-type areas encompassing the meandering brooks.

Population within the Stony Brook Basin has more than doubled during the past twenty years. In 1970, the seven towns in the basin had a combined population of 75,601. Most of the population within the Stony Brook Basin is employed in the manufacturing, wholesale, and retail trades.

Major sources of pollution within the Stony Brook Basin include New England Apple Products in Littleton, Commodore Foods, Inc. and Murray Printing Company in Westford, and Nye's Jap Enamelac and Gilet Wool Scouring in Chelmsford.

Water quality management for Stony Brook is presented within the Merrimack River Basin Water Quality Management Plan. This provides the technical, economic, social, and environmental basis for the identification and adoption of the means of achieving applicable water quality objectives within the Stony Brook Basin. That basin plan is in accordance with Section 303(e) of the Federal Water Pollution Control Act Amendments of 1972 and the Continuing Planning Process for Water Quality Management in Massachusetts of 1973.

STONY BROOK BASIN



CLASSIFICATION MAP

Figure 2

SOCIO-ECONOMIC BACKGROUND

Historical

The early settlements within the Stony Brook valley were agriculturally oriented, typical of Colonial New England. Gradually, manufacturing became established as the need for goods increased. Abundant water resources in the valley were used to supply power for industrial processes.

The waters from Stony Brook were first used for manufacturing in 1700 in Westford. After King Philip's War and the resettlement of the town, Captain Jonas Prescott built a mill at Stony Brook, near its source from Forge Pond. By 1710, Prescott had enlarged and improved the works by erecting forges for manufacturing iron. These iron works were among the first of their kind in New England and used a variety of ore known as "bog-iron." In 1865, the Forge Village Horse-Nail Company succeeded the Forge Company, utilizing its waterpower and building for making nails.

Probably the most significant event which occurred within the valley was the opening of the Stony Brook Railroad in 1848. This initiated the development of much business within the area. Four railroad stations, now villages, came about with the railroad's opening: Brookside, Westford, Graniteville, and Forge Village. Each developed to become a center of industry--particularly Graniteville and Forge Village. Graniteville became a center for the granite quarrying industry. The stone produced was used for paving, engine-beds, foundations for buildings, street curbing, window and door caps, bridges, and various other purposes. In 1848, Samuel Fletcher sold stone to the City of Lawrence who used it in the construction of a dam across the Merrimack River. Forge Village was known for its iron forges, ice-houses, corn mills, and sawmills. Of particular interest was the ice business, carried on with much success. Ice obtained from nearby Forge Pond was sold to the Boston and southern markets. Transportation, particularly the railroad, played a major role in the valley's economic enhancement.

The Abbot Worsted Mills began business in 1855 with John W. Abbot as managing partner and Charles G. Sargent, as a special partner. They manufactured fine worsted yarns for the making of braids and upholstery goods. Sargent later converted a sawmill and grist mill in Graniteville into shops for the manufacture of wool machinery. In 1879, the buildings and water power at Forge Village formerly occupied by the Forge Village Horse-Nail Company were purchased by Abbot and Company. Other mills in the valley included Moore's Woolen-Yarn Mill and Haywood and Burbeck's grist mill.

Fisheries resources within the valley were not neglected. In 1735, Benjamin Robens and Jonas Prescott were chosen by the townspeople of Westford to assess the dams across Stony Brook for "the cost of making conveniences for the passage of shad and alewives from the Merrimack River to Forge Pond." In those days when fish were abundant, it was important to have them pass the dams and reach the pond.

Present

The present economy of the Stony Brook Basin has not changed appreciably in its industrial base. Population within the basin has more than doubled during the past twenty years (see Table 1). In 1970, the seven towns in the basin had a combined population of 75,601. Most of the population within the basin is employed in the manufacturing, wholesale, and retail trades (Table 2).

TABLE 1

STONY BROOK VALLEY CITIES AND TOWNS

LAND AREA - POPULATION

<u>MUNICIPALITY</u>	<u>INCORPORATED (Year)</u>	<u>LAND AREA (Square Miles)</u>	<u>AREA IN BASIN (Square Miles)</u>	<u>POPULATION</u>		
				<u>1950</u>	<u>1960</u>	<u>1970</u>
Ayer	1871	8.82	1.56	5,740	**14,927	8,325
Boxborough	1783	10.39	4.14	439	744	1,451
Chelmsford	1655	22.54	4.75	9,407	15,130	31,432
Groton	1655	32.54	1.64	2,889	3,904	5,109
Harvard	1732	26.35	6.95	3,983	2,563	*12,536
Littleton	1715	16.46	10.45	2,349	5,109	6,380
Westford	<u>1729</u>	<u>30.25</u>	<u>20.30</u>	<u>4,262</u>	<u>6,261</u>	<u>10,368</u>
TOTALS	----	147.35	***51.10	29,069	48,638	75,601

* The large increase did not actually take place, the military and families living in the Harvard section of Fort Devens were not counted there in 1960.

** The large increase did not actually take place, the military and families living in the Ayer section of Fort Devens were not counted there in 1950.

*** Total includes a small portion of Tyngsborough which is relatively unpopulated

TABLE 2
 1971 INDUSTRIAL EMPLOYMENT
 STONY BROOK BASIN

<u>INDUSTRY</u>	<u>EMPLOYEES</u>	<u>PERCENT OF TOTAL</u>
1. Agriculture and Mining	119	1.33
2. Construction	790	8.80
3. Manufacturing	3,157	35.18
4. Transportation, Communication, and Utilities	343	3.82
5. Wholesale and Retail Trade	2,803	31.24
6. Finance, Insurance, and Real Estate	122	1.36
7. Service Industries	<u>1,639</u>	<u>18.27</u>
TOTALS	8,973	100.00

Figures include the following towns and cities: Ayer, Chelmsford, Groton, Harvard, Littleton, and Westford.

The following section is a description of the most economically important towns within the Stony Brook Basin:

The Town of Ayer was once primarily an agricultural community. Today, Ayer is mostly a residential community with many active agricultural interests. Wholesale and retail trades are the largest source of employment in the town, with service second in importance. Manufacturing firms produce cable wire, corrugated boxes, and packing machinery. Ayer is also a center for the apple industry. Fort Devens, a United States Army installation, is located in Ayer and provides considerable employment to local residents. Principal highways serving the town are State Routes 2A, 110, and 111.

Today, Boxborough is primarily engaged in agriculture, especially dairy farming and fruit growing. Some of the firms providing employment include a horticultural service, contractors, and a wholesale chemical firm. The principal highways serving the town are State Routes 2 and 111 and Interstate Route 495.

The Town of Chelmsford is principally suburban-residential in character, although it has had moderate industrial development. Nearly half of Chelmsford's population is employed in wholesale and retail trade. The service industry is second in importance. Some farming is carried on in the rural sections of the town, with poultry-raising, fruit-growing and dairying the principal activities. The manufacturing firms within the town produce cut stone, textiles, nylon resin pellets, and silicon power transistors. The principal highways serving Chelmsford are U.S. Route 3 and Interstate Route 495.

The Town of Groton is still a quaint and charming suburban community which has retained many of the old New England town characteristics. Manufacturing is the leading source of employment within the town today. Paper products and stereotype dry mats, electromechanical instrument drives, electronics components, and paper specialties are produced here. Principal highways serving the town are State Routes 225, 40, 111 and 119.

Since its founding in 1732, Harvard has remained an agricultural community. The principal crop is orchard fruit--apples and peaches. The combination of excellent farming soil and a natural water supply makes it a desirable farming locality. The principal highways serving the town are Interstate Route 495 and State Routes 2, 110, and 111.

Today, Littleton is an agricultural and residential community. The town has some of the finest apple orchards in the state. Manufacturing is the largest source of employment in the town. Second in importance are the wholesale and retail trades. Some of the manufactured products include ready-mix concrete, prune juice and fruit drinks, vinegar, and electronic equipment. Principal highways serving the town are State Routes 2, 2A, 110 and 119, and Interstate Route 495.

The Town of Westford is a small industrial-residential town. Manufacturing--especially printing--is the largest source of employment in the town. The principal firms in Westford are the Murray Printing Company (book lithographers) and C.G. Sargent's Sons Corporation, which produces textile machinery. The main highway serving the town is Interstate Route 495.

BASIN DESCRIPTION

Stony Brook originates between Ayer and Littleton as Beaver Brook and flows generally northeast through Littleton, Westford and Chelmsford where it enters the Merrimack River. In its 22-mile length it drains an area of approximately 51 square miles and falls 200 feet. Dams create many impoundments along its entire length. The main stem is fed by numerous small brooks and streams along its path to the Merrimack River. Numerous lakes and ponds are located within the basin. The terrain is characterized as being relatively woody and swampy with a generally urban-type surrounding area.

Originating in Wolf Swamp in Boxborough, Stony Brook begins as Beaver Brook. It then begins its relatively northeasterly course through Boxborough and into Littleton, crossing under Route 2 before entering Mill Pond. On its path to Mill Pond, Beaver Brook is joined by a number of small streams draining swampy regions.

From the outlet of Mill Pond, Beaver Brook crosses under Interstate Route 495 and flows through a relatively flat and open area. This stretch meanders considerably and is characterized as having a fairly wide flood plain. Beaver Brook terminates as it enters Forge Pond near Forge Village in Westford. The Spectacle Pond drainage area enters into Forge Pond at its southwest cove. A series of swamps and streams make up most of this system, dominated by Bennetts Brook, a major tributary to Spectacle Pond.

From the outlet of Forge Pond, Beaver Brook now becomes Stony Brook. It continues its northeasterly course, crossing under Route 225 in Forge Village and entering a swampy region approximately one-half mile from the outlet of Forge Pond. Stony Brook is joined by the small tributaries of Reed Brook and Boutwell Brook in Westford. Just downstream, it is impounded by a dam in the Village of Graniteville in Westford. Stony Brook then meanders through more swampland and turns sharply eastward before being impounded again at the Westford station. Keyes Brook, draining Keyes Pond, and Coldspring Brook join Stony Brook along this stretch.

Downstream, the river turns slowly northeasterly once again and follows the Boston and Maine railroad tracks closely. The terrain is mostly flat and swampy along this reach. Stony Brook is joined by Tadmuck Brook and a small unnamed stream before the impoundment at the Brookside Station in Westford. Stony Brook is impounded again just after crossing the Westford-West Chelmsford line. Backwater from this impoundment stretches into Westford. Gilson Brook and another unnamed tributary enter Stony Brook at this impoundment. Just downstream from the previous dam, the river is impounded once again. From here, Stony Brook continues northeasterly, meandering through some open and forested terrain into North Chelmsford. Stony Brook is fed by Crooked Springs Brook in this stretch.

It should be noted that the outlet of former Newfield Pond (also called Crystal Lake) in North Chelmsford once entered Stony Brook along this stretch. High flood waters a few years ago destroyed the dam at the outlet of the pond. Stony Brook finally crosses under Route 3 in North Chelmsford and flows a short distance before entering the Merrimack River.

PRESENT WATER USE

Natural water resources are abundant within the Stony Brook Basin. All of the municipalities in the basin rely on groundwater sources as their principal water supply (see Table 3).

Probably the most interesting aspects of a water resource deal with its recreational potential. Boating, canoeing, fishing, hunting, and swimming occur within the Stony Brook watershed. The Massachusetts Division of Fisheries and Game periodically stock trout in sections of Stony Brook in Westford and Chelmsford, Beaver Brook in Littleton and Boxborough, and in the tributary streams of Keyes Brook and Reed Brook in Westford, and Crooked Springs Brook in Chelmsford. Long Sought-For Pond in Westford also provides excellent trout fishing (Table 4).

Stony Brook meanders through marshland that is aesthetically appealing to many people interested in the enjoyment of the outdoors and its wildlife inhabitants. These freshwater wetlands found throughout the basin sustain much rich wildlife habitat. Some vegetative features found within these wetlands include buttonbush, alders, willows, maples, and various species of grasses and sedges essential for various wildlife inhabitants. The combination of soil and decaying vegetation adds to the richness of this environment. Various species of waterfowl and water-related mammals such as beaver, mink, and muskrat are found throughout these areas. The relationships among these numerous life chains provide the balance and stability that assure the survival of the terrestrial and aquatic communities.

It must also be mentioned, however, that Stony Brook is also used for the conveyance of wastes by various industries within its boundaries, as is so common in nearly all Massachusetts rivers and streams.

TABLE 3
MUNICIPAL WATER SUPPLY SOURCES
STONY BROOK BASIN

<u>MUNICIPALITY</u>	<u>SOURCE</u>
Ayer	Groundwater
Boxborough	Groundwater
Chelmsford	Groundwater
Groton	Groundwater
Harvard	Groundwater
Littleton	Groundwater
Westford	Groundwater

TABLE 4
STOCKED TROUT WATERS
STONY BROOK BASIN

<u>STREAM</u>	<u>TOWN</u>
Stony Brook	Westford
Stony Brook	Chelmsford
Beaver Brook	Littleton
Beaver Brook	Boxborough
Keyes Brook	Westford
Reed Brook	Westford
Crooked Springs Brook	Chelmsford
<u>PONDS</u>	
Long Sought-for Pond	Westford

PRESENT WATER QUALITY

STONY BROOK WASTEWATER DISCHARGES

There are numerous small wastewater discharges currently located within the Stony Brook Basin. A summary of existing and proposed discharges is listed in Table 5, and the location of these discharges is shown in Figure 3. Four discharges are located on the main stem of Stony Brook and one each on the Beaver Brook and Gilson Brook systems. These range from wool scouring wastes to industrial cooling waters. Stormwater runoff during periods of wet weather also contributes to the degradation of water quality within Stony Brook. Stony Brook receives various amounts and types of wastewater for its entire length. Partially treated nutrient-laden wastewater is discharged into Mill Pond from New England Apple Products. The effects of these wastes are reflected by the tremendous algal and duckweed "blooms" which occur during the warmer summer months when conditions are ideal, and the stored nutrients released. A water quality report on Mill Pond and other ponds within the basin will be published under separate cover.

Industrial cooling waters are discharged by Murray Printing Company, located at the outlet of Forge Pond in Westford. Farther downstream, Commodore Foods discharges partially treated food process wastes into Stony Brook. These enter the river just above an impoundment, which compounds the adverse effects. Nye's Jap Enamelac in Chelmsford discharges untreated rinse water containing metal-finishing and paint wastes directly into Stony Brook. The last wastewater discharge entering Stony Brook is from Gilet Wool Scouring in Chelmsford. The discharge, containing wool scouring and sanitary wastes, enters just above the confluence of Stony Brook with the Merrimack River.

NON-POINT SOURCES

The identification and evaluation of the effects of non-point sources of pollution upon the water quality of Stony Brook and its tributaries is an important consideration in overall water quality management. Non-point discharges to the environment can contribute greatly to the degradation of water quality. These types of discharges can result from both natural and man-made processes and may include agricultural activities, mining, urban and rural construction, urban storm runoff, and recreational activity. The following sections will discuss the significant types of non-point sources of pollution found within the Stony Brook Basin:

Urban and Rural Runoff

Urban and rural runoff periodically carries nutrients, bacteria, silt, chlorides (from road salting), and oil to Stony Brook, particularly during periods of high precipitation. These contaminants enter the river through street drains, sewers, and surface runoff. As will be discussed in the following section, these types of non-point sources of pollution play a significant role in the degradation of the water quality in Stony Brook, particularly influencing such parameters as coliform bacteria, BOD, and suspended solids.

Subsurface Sewage Disposal

Subsurface disposal of sanitary wastes can result in the reduction of water quality of groundwater and surface waters within the basin. Failing

TABLE 5
SUMMARY OF EXISTING AND PROPOSED DISCHARGES
STONY BROOK BASIN

<u>NUMBER</u>	<u>SOURCE AND LOCATION</u>	<u>RECEIVING WATER</u>	<u>EXISTING TREATMENT</u>	<u>PROPOSED TREATMENT</u>
1	Gilet Wool Scouring, Chelmsford	Stony Brook	None	Pre-treatment by 1976, Municipal tie- in by 1975
2	H.E. Fletcher Quarry, Westford	Gilson Brook	Settling Ponds	Settling Ponds
3	Nye's Jap Ename Lac, Chelmsford	Stony Brook	None	Best Practical Treat- ment by December, 1975
4	New England Apple Products Co., Inc., Littleton	Tributary to Mill Pond	Pre-treatment	Municipal tie-in
5	Commodore Foods, Inc. Westford	Stony Brook	Pre-treatment	Municipal tie-in
6	Murray Printing Co., Westford	Stony Brook	None	None*

* This discharges cooling water only.

STONY BROOK BASIN



LOCATION OF WASTEWATER DISCHARGES

Figure 3

subsurface disposal systems can be a major source of nutrients and coliform bacteria, particularly during periods of heavy rain when surface runoff is increased. This was shown in the analysis of the 1974 water quality survey data, when periods of substantial precipitation had an adverse effect upon various water quality parameters in Stony Brook.

Agriculture

Nutrients, particularly nitrogen and phosphorus from fertilizers and pesticides, are carried into Stony Brook and its tributaries by runoff from agricultural lands and rural areas. These may enter the river in a multitude of forms, ranging from storm drains to surface runoff. Excess nutrients degrade water quality by causing nuisance algal blooms and abnormally dense vascular aquatic plant growth. The application of fertilizers to agricultural lands by farmers and to lawns and gardens by individual homeowners are the main sources of these nutrients in the Stony Brook Basin.

Solid Waste Disposal

Dumps are potential sources of non-point pollution within the Stony Brook Basin. The types and locations of dumping areas within the basin can be seen in Figure 4. Heavy metals such as cadmium, cobalt, copper, lead, mercury, nickel, and zinc sometimes leach into the groundwater table and possibly contaminate municipal water supplies.

Land Stripping

The siltation of streams can occur from various land use practices, particularly sand and gravel operations. One such operation is located within the Stony Brook Basin. Improper management of these operations can cause erosion of the particular area in which the operation is based. Accelerated overland runoff carrying more silt than usual occurs.

STONY BROOK BASIN



LOCATION OF MUNICIPAL & PRIVATE DUMPING AREAS

Figure 4

RESULTS OF WATER QUALITY SURVEYS

Survey Procedures

The present program of water quality surveys on Massachusetts waters had its origin with the Department of Public Health, Division of Sanitary Engineering in the early 1960's. That Division, which at the time had the responsibility for water pollution control in the Commonwealth, began the practice of intensive sampling of a particular waterbody over a one or two week period. Under this method, samples were collected every six hours over two twenty-four hour periods during a week. Surveys were conducted during the summer and early fall in order to observe conditions of low flow when pollution effects are most pronounced. Usually, the survey was performed once early in the summer, then repeated a month or more later. This enabled data from the first survey to be analyzed in order to determine if additional sampling stations were required. In addition, it assured that all samples on a particular waterbody would not be collected when an industry which discharged wastes was on its summer shutdown.

Sampling locations were chosen in order to assess the effects of natural and man-made factors on water quality. In the case of a river, samples were usually taken above and below each major waste discharge. Additional samples were taken to assess the effects of tributary streams, dams and their impoundments, swamps, and rapids sections. Dissolved oxygen samples were collected and fixed in the field. Other samples were collected for chemical and bacterial analysis. The four chemical samples collected each day at each station were combined to produce one 24-hour composite sample for each station. Chemical and bacterial analyses were performed at the Department of Public Health's Lawrence Experiment Station. Analytical methods followed the procedures set forth in the current edition of Standard Methods for the Examination of Water and Wastewater by the American Public Health Association.

The original purpose of this sampling program was to examine and assess the quality of Massachusetts' waters. Chemical analyses included pH, alkalinity, five-day biochemical oxygen demand (BOD), and suspended solids. Bacterial samples were collected for coliform analysis, and microscopic examinations and sediment analysis were also performed. In some instances, samples were tested for certain metals. In later years, other tests were added, such as total phosphorus, the nitrogen series, and 2, 3, and 7-day BOD's.

In 1967, the Massachusetts Division of Water Pollution Control was established by an Act of the Legislature. One of the responsibilities of the new Division was "to examine periodically the water quality of the various coastal waters and rivers, streams, lakes, and ponds of the Commonwealth and publish the findings." This formalized the survey program which became a function of the Division's Water Quality Section. That section has continued the survey program each year since, and has published the results of all surveys on Massachusetts' rivers back to 1964.

Under a Division Research and Demonstration Project, work began on a computer model for river analysis in 1969. Prior to this, some stream analysis had been performed using survey results, but the complexity of the calculations involved had limited its use by an engineer with a slide rule. The use of the computer model allows that same engineer to evaluate all the factors influencing water quality, establish natural stream characteristics, and predict the effects of future waste loads and treatment schemes.

The model required additional data, however, and the scope of the survey program had to be expanded. Long-term BOD's were performed on the samples. Time of travel studies had to be performed under various flow conditions and a better understanding of basin hydrology and river geometry was required.

Basin planning requirements under the Federal Water Pollution Control Act Amendments of 1972 called for an accelerated modeling program by the Commonwealth. In order to collect all the necessary data and develop models for each of the major drainage basins, the Division was awarded a state grant to hire additional personnel. This has enabled the Water Quality Section to conduct eleven major river surveys in the summer of 1973 and nine during the summer of 1974, as well as most of the additional studies needed to complete all river basin plans by 1975.

In order to understand the data obtained from water quality surveys, some background knowledge of stream analysis is required. The primary emphasis in stream surveys and subsequent computer analysis is on studying the dissolved oxygen (DO). This parameter refers to the uncombined oxygen in the water which is available to aquatic life. DO is affected by numerous factors including physical characteristics of the stream (velocity, width, and depth), decomposition of wastes, temperature, and aquatic organisms. The study of the DO in a stream, therefore, involves a comprehensive analysis of several parameters. Samples from stream surveys are analyzed for the following:

Biochemical Oxygen Demand (BOD) - is a measure of the amount of oxygen required by bacteria to decompose organic matter. BOD is gradually exerted, usually in two stages. In the first stage, carbonaceous matter is stabilized; nitrogenous substances are broken down in the second. The exertion of both stages may require thirty days or more. Through repetition the five-day BOD has become the standard test in sanitary engineering. It is usually assumed that the five-day BOD includes only carbonaceous decomposition; in some cases, however, this may not be true. Long-term BOD's with readings at several intervals are necessary to fully define the two stages.

Suspended Solids - are the portion of the total solids which can be removed through filtration. The behavior of suspended solids in a stream is used to predict the settling of wastes. Where wastes settle out, bottom sludge deposits accumulate. Such deposits exert high oxygen demands.

Nutrients - are compounds which act as fertilizers for aquatic organisms. Small amounts are necessary to the ecological balance of a water body, but excessive amounts can upset the balance by causing nuisance growths of algae. Nutrients of carbon, nitrogen, and phosphorus are predominant in water bodies. Carbonaceous compounds are measured in the BOD test. Separate analyses are performed to measure the total phosphorus and forms of nitrogen. Nitrogen, besides acting as a nutrient, can exert a significant oxygen demand. Nitrogen appears in waterbodies as organic nitrogen, ammonia, nitrite, and nitrate. The conversion of one pound of ammonia to nitrite and ultimately into nitrate, requires 4.57 pounds of oxygen. The process of nitrification is usually predicted by observing the disappearance of ammonia and the appearance of nitrate.

Coliform Bacteria - are found in abundance in the intestinal tract of warm-blooded animals. They are not harmful in themselves, but their presence indicates that pathogenic bacteria may also be present. Since their presence can be detected by relatively simple test procedures, coliform are used to

indicate the extent of bacterial pollution. Fecal coliform make up about 90 percent of the total coliform in fecal pollution. Non-fecal coliform may originate in soil, grain, or decaying vegetation.

pH - measures the hydrogen ion concentration on an inverse logarithmic scale ranging from zero to fourteen. pH values under 7.0 indicate acidic solutions; values over 7.0 indicate alkaline solutions. Low pH values often indicate pollution from heavy metals, which can be toxic to aquatic life.

Stony Brook Basin Surveys

During 1974, the Water Quality Section of the Division of Water Pollution Control undertook an extensive water quality sampling in the Stony Brook Basin. There had been no previous study by this Division in the basin.

The 1974 water quality survey included eleven stations within the basin. Eight stations were located on Stony Brook and three on Beaver Brook, the headwater stretch of Stony Brook. Sampling was conducted on a 24-hour basis for three consecutive days, June 25-27 and August 27-29. Chemical composites were made over two 24-hour periods during each survey week. Dissolved oxygen samples were taken six times daily for three consecutive days each week. In addition, bacterial and microscopic samples were taken during both surveys.

Lake studies were conducted on selected bodies of water within the watershed. This was part of a lake restoration program now being initiated by the Division's Water Quality Section. Baseline surveys were conducted on Flushing Pond, Westford; Forge Pond, Littleton and Westford; Keyes Pond, Westford; Long Sought-For Pond, Westford; and Mill Pond in Littleton. These studies included bathymetric mapping of the ponds and a detailed mapping of the aquatic vegetation. Chemical samples were collected and analyzed for pH, alkalinity, total hardness, conductivity, silicate, ammonia-nitrogen, nitrate-nitrogen, and total phosphorus. Biological sampling included bottom sediment analysis for invertebrate organisms and the analyses of the lakes' algal and zooplankton populations. These studies will be published under a separate cover entitled Baseline Water Quality Surveys for Selected Lakes and Ponds in the Stony Brook Basin. This report should be completed by the early Fall of this year.

Flow data was gathered at selected reaches along Stony Brook and its tributaries during both surveys. This was done to estimate the flow regime during both survey weeks in order to assess the river's water quality in accordance with its discharge.

Meteorological conditions during the survey week greatly influenced water quality parameters such as dissolved oxygen, suspended solids, pH, alkalinity, nutrients, and coliform bacteria. Increased river flows diluted pollutants and gave a distorted picture of water quality conditions in Stony Brook. Table 6 depicts the weather conditions during the June and August 1974 water quality surveys on Stony Brook.

Water quality conditions in Stony Brook were generally below assigned Class B standards during the June and August 1974 surveys. Baseline water quality data does not exist on Stony Brook so there can be no comparison with other years or studies. The marshy, slow-moving areas coupled with the impoundments located throughout the length of Stony Brook had an adverse effect upon the dissolved oxygen in many stretches of the stream. The slow-moving, marshy areas generally tend to cause low dissolved oxygen concentrations, a condition similar to other Massachusetts streams with similar drainage patterns. The impoundments on Stony Brook also influenced various water quality parameters, particularly dissolved oxygen levels and nutrient concentrations. These impoundments cause a back-up of water which slows time of travel through these reaches, similar to conditions in a marshy stretch. The low dissolved

TABLE 6
 STONY BROOK 1974 SURVEY
 METEOROLOGICAL CONDITIONS

<u>JUNE 1974</u>			
<u>DATE</u>	<u>CLOUD COVER</u>	<u>PRECIPITATION</u>	<u>AIR TEMPERATURES</u>
Sunday, June 23	Mostly Overcast	Intermittent Showers	Near 80°F
Monday, June 24	Partly Cloudy	None	75 - 80°F
Tuesday, June 25	Mostly Overcast	Intermittent Heavy Showers	60 - 65°F
Wednesday, June 26	Mostly Overcast	Intermittent Heavy Showers	60 - 65°F
Thursday, June 27	Partly Cloudy	None	70 - 75°F
Friday, June 28	Clear	None	70 - 75°F
<u>AUGUST 1974</u>			
Sunday, August 25	Clear	None	Near 80°F
Monday, August 26	Partly Cloudy	None	80 - 85°F
Tuesday, August 27	Mostly Overcast	Showers	80 - 85°F
Wednesday, August 28	Mostly Overcast	Intermittent Heavy Showers	80 - 85°F
Thursday, August 29	Mostly Overcast	Intermittent Showers	80 - 85°F
Friday, August 30	Mostly Overcast	Intermittent Showers	Near 80°F

TABLE 7
 AVERAGE STREAM FLOW
 1974 STONY BROOK SURVEY

<u>LOCATION</u>	<u>RIVER MILE</u>	<u>JUNE (cfs)</u>	<u>AUGUST (cfs)</u>
Beaver Brook at Harwood Avenue, Littleton	16.8	5.14	0.00
Beaver Brook at Route 110-2a, Littleton	15.6	9.50	0.48
Beaver Brook at Beaver Brook Road, Westford	11.3	20.50	2.75
Concord Road, Route 225, Westford	10.3	24.50	3.75
Town Farm Road, Westford	9.6	27.35	3.53
Broadway Street, at Graniteville, Westford	8.1	40.50	4.16
Plain Road, at Westford Station, Westford	5.1	44.50	4.85
Chamberlain Road, at Brookside Station, Westford	3.3	46.33	5.20
School Street, West Chelmsford	2.5	57.35	8.63
Route 3a off R.R. Bridge, North Chelmsford	0.3	63.30	9.58
R.R. Bridge off Middlesex Street, North Chelmsford	0.1	63.80	9.63

DISCHARGE PROFILE

for JUNE and AUGUST 1974

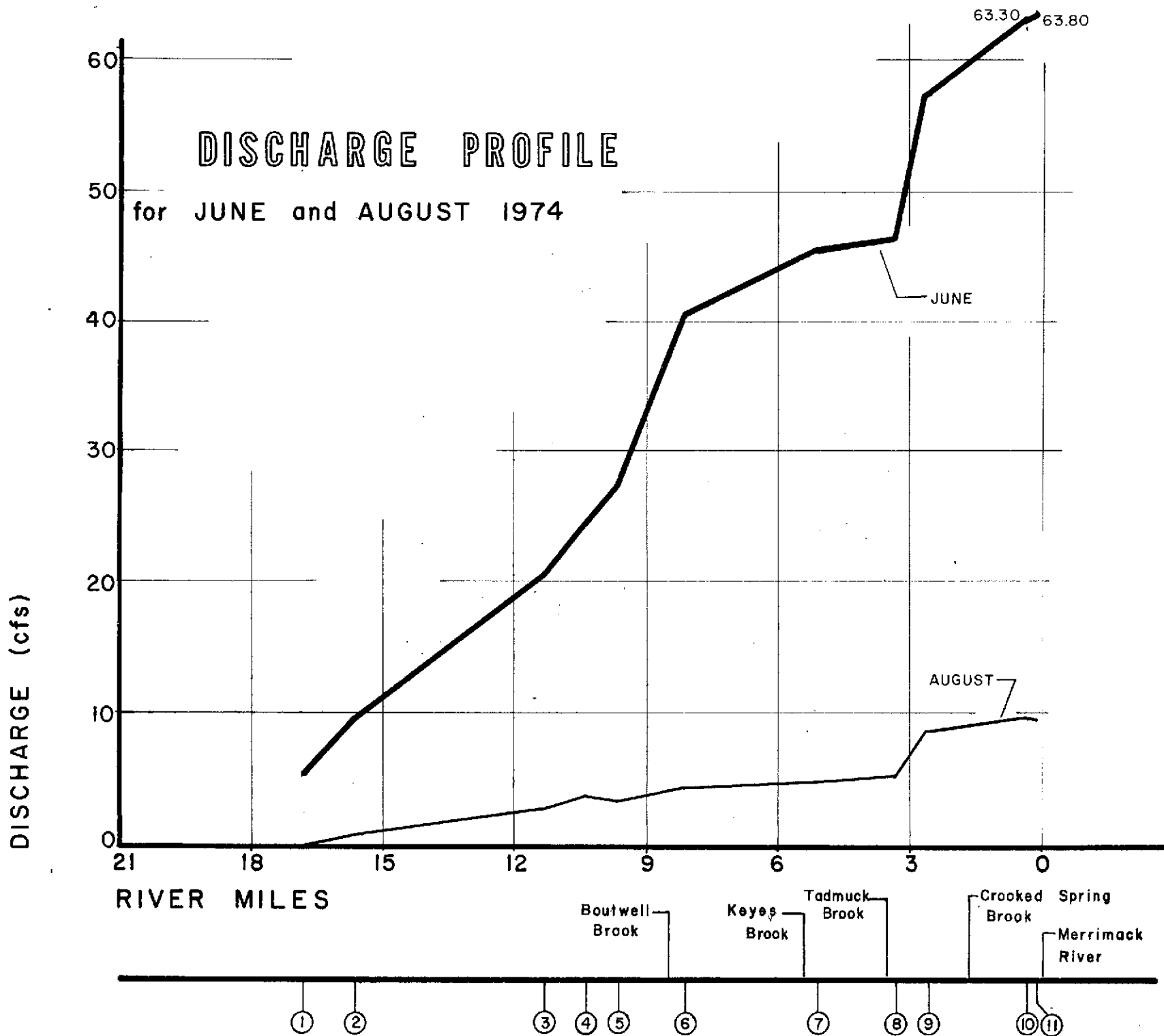


Figure 5

TABLE 8
 STONY BROOK 1974 SURVEYS
 LOCATION OF SAMPLING STATIONS

<u>STATION NUMBER</u>	<u>LOCATION</u>	<u>RIVER MILE</u>
ST01	Beaver Brook at Harwood Avenue, Littleton	16.8
ST02	Beaver Brook at Route 110-2a, Littleton	15.6
ST03	Beaver Brook at Beaver Brook Road, Westford	11.3
ST04	Concord Road, Route 225, Westford	10.3
ST05	Town Farm Road, Westford	9.6
ST06	Broadway Street at Graniteville, Westford	8.1
ST07	Plain Road at Westford Station, Westford	5.1
ST08	Chamberlain Road at Brookside Station, Westford	3.3
ST09	School Street, West Chelmsford	2.5
ST10	Route 3a off R.R. Bridge, North Chelmsford	0.3
ST11	R.R. Bridge off Middlesex Street, North Chelmsford	0.1

STONY BROOK BASIN



NOTE:

All waters in the Stony Brook Basin are classified as "B" waters.

LOCATION OF SAMPLING STATIONS

Figure 6

oxygen levels throughout most of Stony Brook can best be explained by the lack of aeration in the sluggish, marshy areas and the impoundments coupled with the decomposition of terrestrial and aquatic vegetation.

Minimum dissolved oxygen concentrations in Stony Brook were generally below Class B criteria (Figure 7). As shown in Table 7 and graphically represented in Figure 5, different flow regimes existed during each week of study. Unsettled weather conditions during both weeks also had an impact upon the water quality conditions in Stony Brook. This is important in that different hydrologic conditions coupled with the meteorological conditions during the survey weeks had an ultimate effect upon the pollutants in the water. Low flow conditions generally tend to cause the most severe problems in dissolved oxygen concentrations and other water quality parameters.

The first sampling station (ST01) was located on Beaver Brook at Harwood Avenue in Littleton. This is one of the major inlets to Mill Pond. The bottom consisted of a sandy-gravelly substrate with overhanging (terrestrial) vegetation. Water color was on the brownish side, typical of a swampy headwater stream. This station was nearly dried up during the August survey. Water quality conditions were generally poor, but there was no indication of organic pollution, as indicated by the low coliform bacteria densities during both weeks of survey (Figure 15). Dissolved oxygen levels were very low, but this is attributed to the low water levels and the swampy conditions.

The next station (ST02) was also located on Beaver Brook at Route 110-2A in Littleton. The substrate was a gravelly-rocky type with a relatively shallow water level ranging from one-half to one foot in depth. Aquatic vegetation was medium to heavy, with pondweed (Potamogeton sp.) and arrowhead (Sagittaria sp.) dominant. Water quality conditions were similar to those found at the first station. Dissolved oxygen concentrations were again very low. Nutrient levels increased slightly during the August survey when low flow conditions prevailed. Intermittent heavy showers during this week caused excessive runoff conditions which carried nutrient-laden waters from the marshes and farmlands in the area. From here, Beaver Brook meanders through a four-mile marshy stretch.

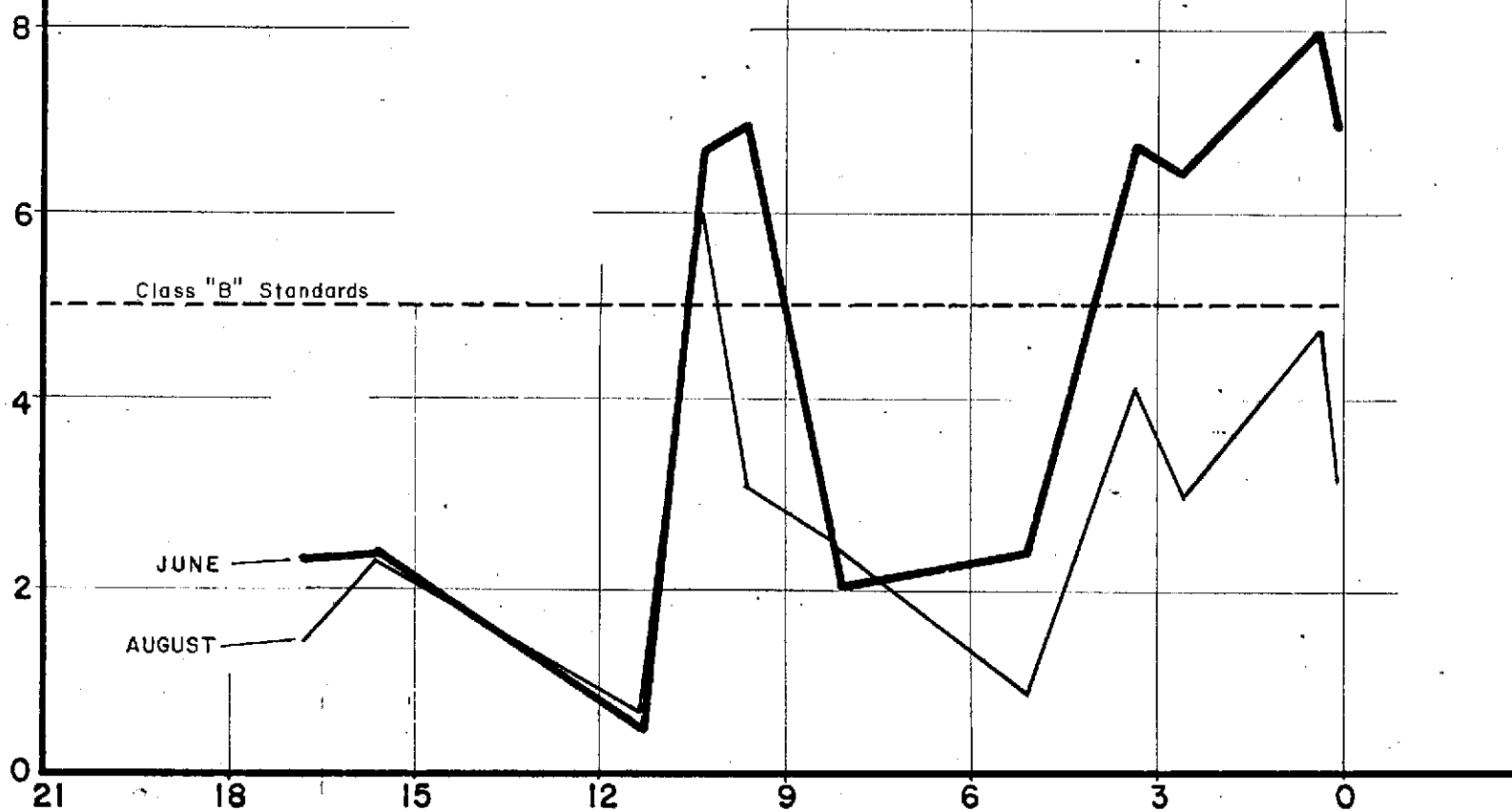
After leaving this slow-moving, sluggish reach, Beaver Brook was sampled again, this time at Beaver Brook Road (ST03) at the inlet of Forge Pond in Westford. Aquatic vegetation was dominated by duckweed (Lemna sp.). Shoreline vegetation was very heavy with buttonbush (Cephalanthus occidentalis), dogwoods (Cornus sp.), willows (Salix sp.), sedges (Carex sp.), and other marsh vegetation present. Water quality conditions had not changed appreciably from the previous two stations. Dissolved oxygen levels were extremely low during both weeks of survey. This can be explained by the lack of aeration in the sluggish marsh coupled with the decomposition of organic matter, a natural degradation. Five-day BOD concentrations increased in August, but this was due to the heavy precipitation which occurred towards the latter part of the week.

Station ST04 was located at the outlet of Forge Pond where Beaver Brook becomes Stony Brook. The sample was taken above the dam off Concord Road in Westford. Water quality was very good here, either meeting or exceeding Class B standards. Microscopic analysis revealed relatively moderate numbers of blue-green (Cyanophyceae) and green (Chlorophyceae) algae with numerous numbers of flagellated protozoa (Mastigophora) present in August. This could

minimum D.O.

for JUNE and AUGUST 1974

DISSOLVED OXYGEN (mg/l)



RIVER MILES

SAMPLING STATIONS

①

②

③

④

⑤

⑥

⑦

⑧

⑨

⑩

⑪

Boutwell Brook

Keyes Brook

Tadmuck Brook

Crooked Springs Brook

Merrimack River

Figure 7

be attributed to the relatively stagnant water here during the August survey. Although this was so, no reduction in water quality was evidenced.

Station ST05 was located on Stony Brook at Town Farm Road in Westford. Low flow conditions during August reduced the average dissolved oxygen concentrations to slightly below standards. Nutrient concentrations, average five-day BOD, and coliform bacteria were higher than the previous station, particularly during the later part of the August survey when it rained. These are graphically represented in Figures 8, 11, and 15.

Farther downstream, Stony Brook meets its first impoundment at Graniteville in Westford. Station ST06 at Broadway Street is located here, above the dam. A reduction in water quality occurred during both weeks of survey. Particularly evident was the depletion of dissolved oxygen concentrations. This was attributed to the back-up of water caused by the dam which reduced flow through this reach. Decomposition of organic matter and lack of aeration, typical of impounded waters, kept dissolved oxygen levels low. Microscopic analysis revealed relatively high concentrations of diatoms (Bacillariophyceae) and green algae (Chlorophyceae) present. Duckweed (*Lemna* sp.) was also present, although not in significant amounts. Coliform bacteria and five-day BOD concentrations increased after the showers during the week in August.

Station ST07 was located at the Westford Station impoundment off Plain Road in Westford, above the dam. Good aeration is provided by the rocky substrate below the dam. Water quality conditions were similar to the previous station. Average dissolved oxygen levels, again, were below standards. As at the previous station, average five-day BOD and coliform bacteria concentrations increased somewhat due to the runoff.

The next station (ST08) was located at the Brookside Station impoundment off Chamberlain Road in Westford. Water quality conditions varied somewhat here. Average dissolved oxygen concentrations were above criteria during both weeks of survey. Coliform bacteria densities were very high here, indicating organic pollutants in the water. This was particularly evident during the August survey when a combination of low flow conditions and heavy runoff were prevalent. Nutrient levels were also moderate, particularly ammonia-nitrogen and phosphorus concentrations. This is graphically represented in Figures 13 and 14. Average five-day BOD concentrations more than doubled from June to August (1.8 mg/l to 4.4 mg/l). This station was located just downstream from the discharge of food processing wastes by Commodore Foods, Inc. Most of the degradation in water quality could be attributed to that discharge. This impoundment, however, is typical of others on Stony Brook in that lack of aeration and stagnancy of the water may also be factors contributing to poor water quality.

Station ST09 was located off School Street in Chelmsford, at the last of a series of impoundments on Stony Brook. Water quality conditions were similar to the previous station. Average dissolved oxygen concentrations were above standards during both weeks of survey. Coliform bacteria densities were moderate but not as high as the previous station. Nutrient concentrations were similar to the last station--relatively high. Average five-day BOD levels decreased somewhat in relation to the previous station, but increased during the week in August when it rained. Microscopic analysis indicated moderate numbers of blue-green (Cyanophyceae) algae during August.

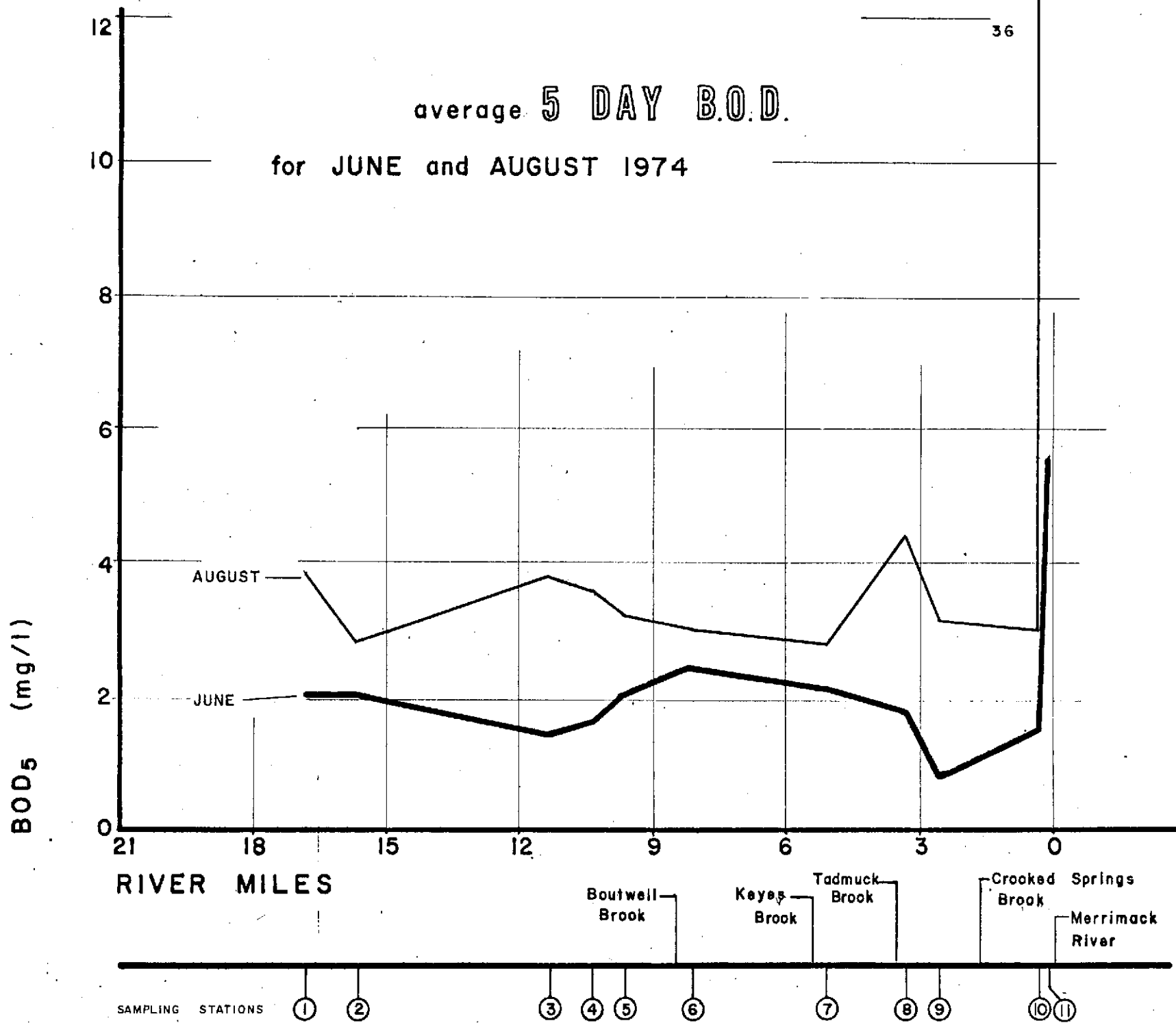


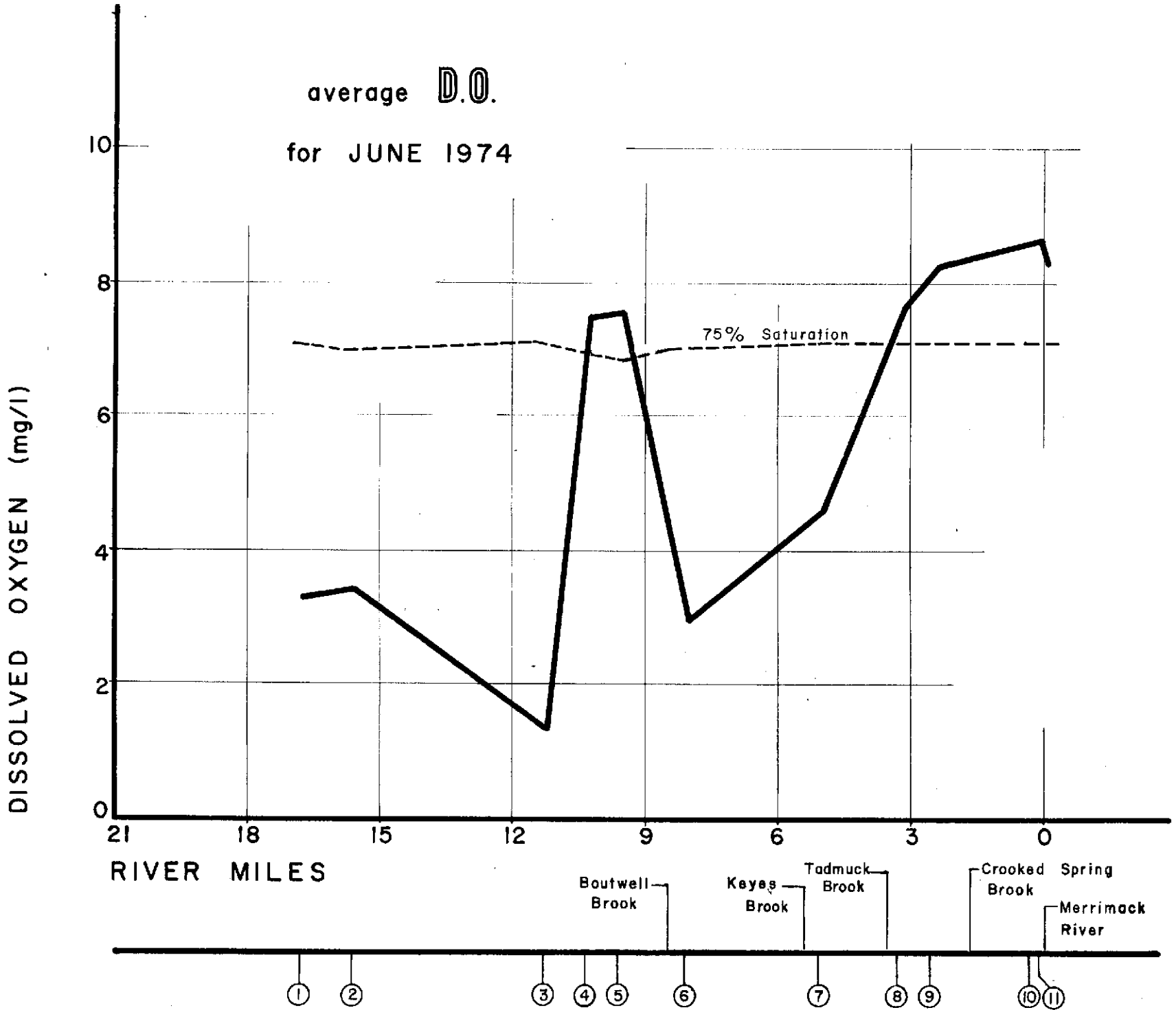
Figure 8

Station ST10 was located below the railroad bridge off Route 3 in Chelmsford. Water quality conditions were similar to the previous station. Average five-day BOD, nutrients and coliform bacteria increased somewhat, particularly during June when flow conditions were higher.

The final station (ST11) on Stony Brook was located below the railroad bridge off Middlesex Street in Chelmsford, just before it enters the Merrimack River. Water quality conditions degraded significantly here as the result of industrial wastes from Gilet Wool Scouring. Nearly all water quality parameters were violated during both surveys, particularly during the low flow conditions in August. Average five-day BOD, nutrients, and coliform densities were very high, especially the coliform bacteria which approached values for raw sewage.

The present water quality conditions observed in Stony Brook can be attributed to its sluggish, slow-moving reaches resulting from the back-water formed by the impoundments, together with the general topography of the basin. Small point and non-point sources of pollution add to the degradation of Stony Brook's present water quality.

Figure 9



average D.O.
for AUGUST 1974

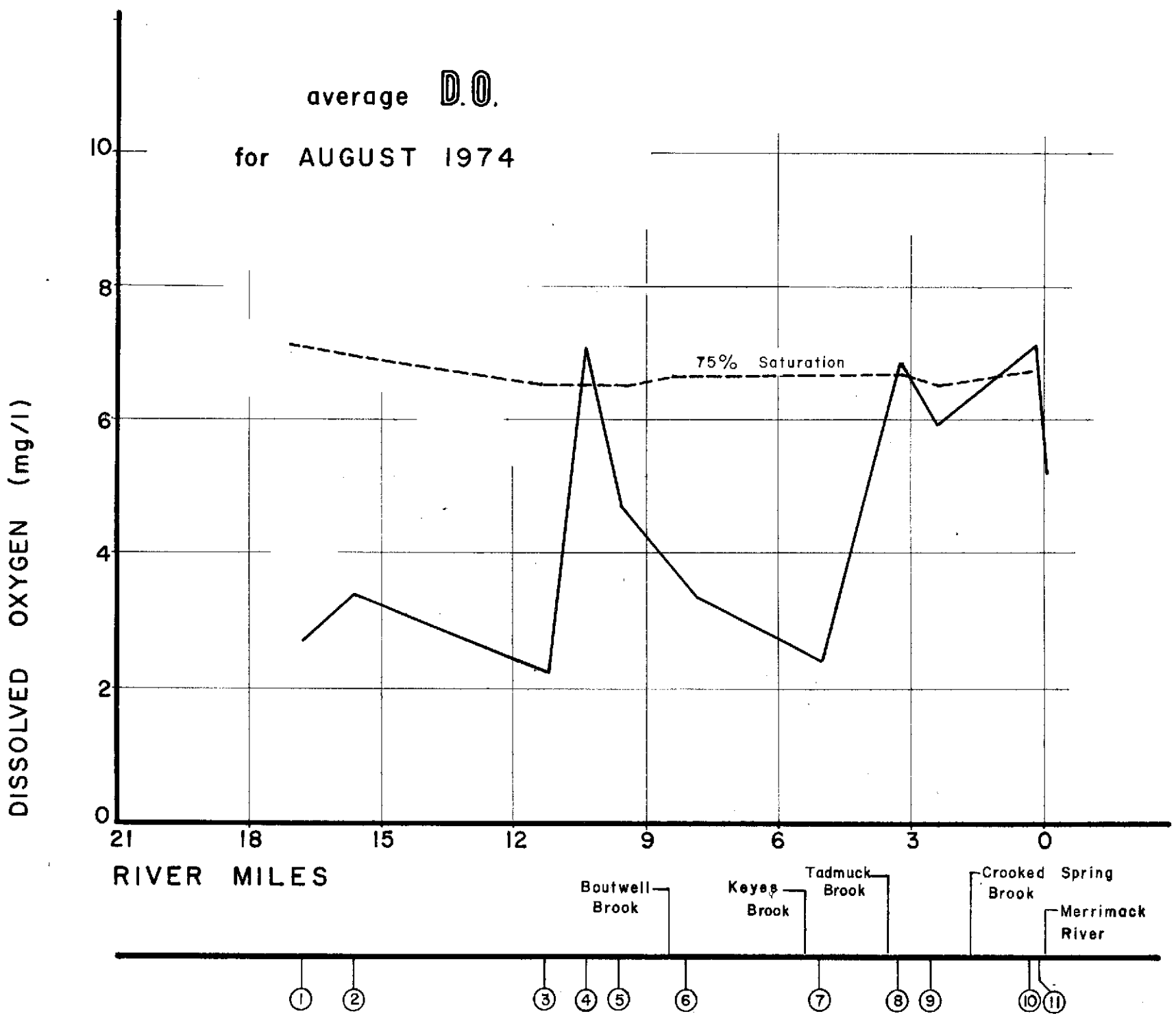
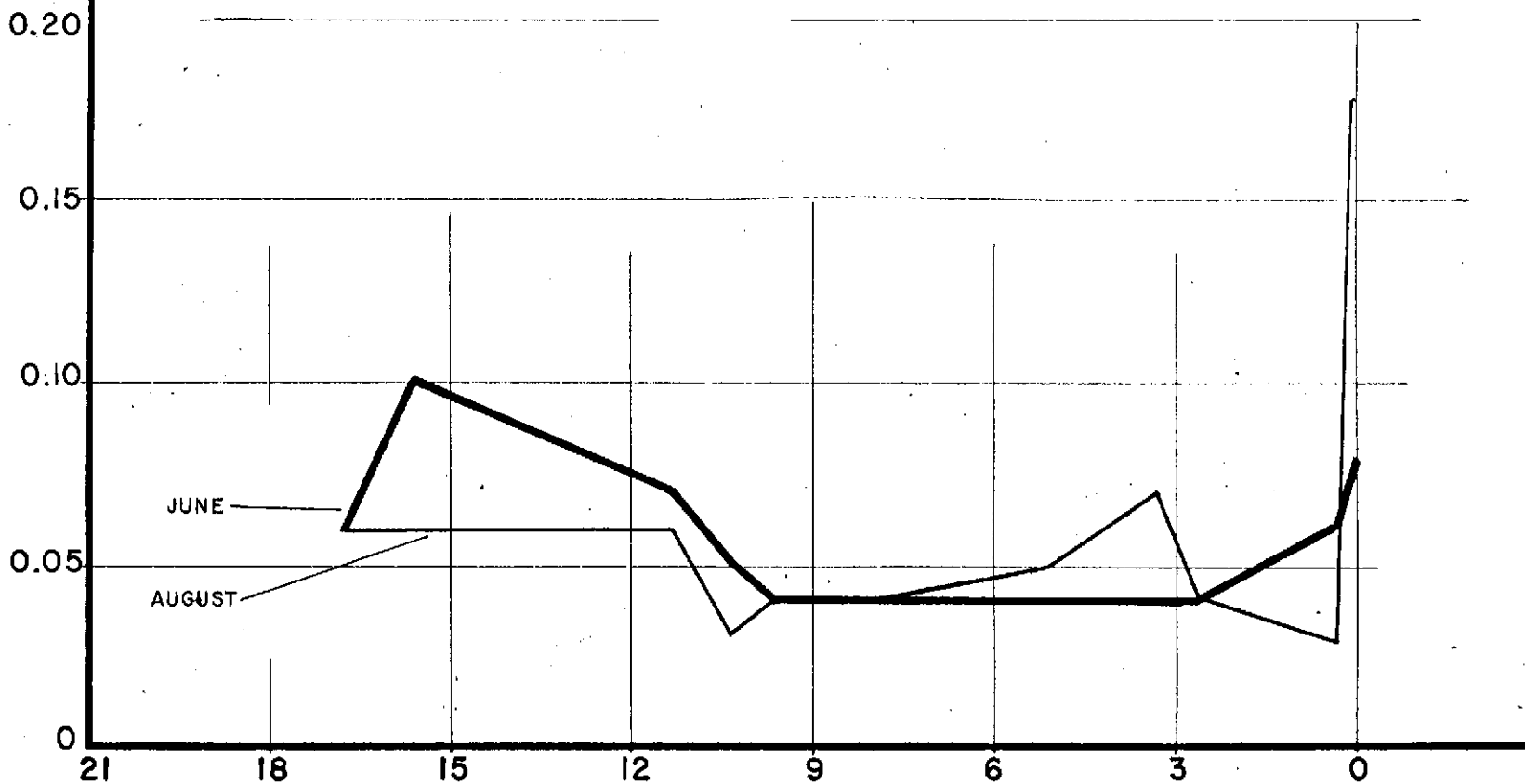


Figure 10

average **TOTAL PHOSPHORUS**
for JUNE and AUGUST 1974

TOTAL PHOSPHORUS (mg/l)



RIVER MILES

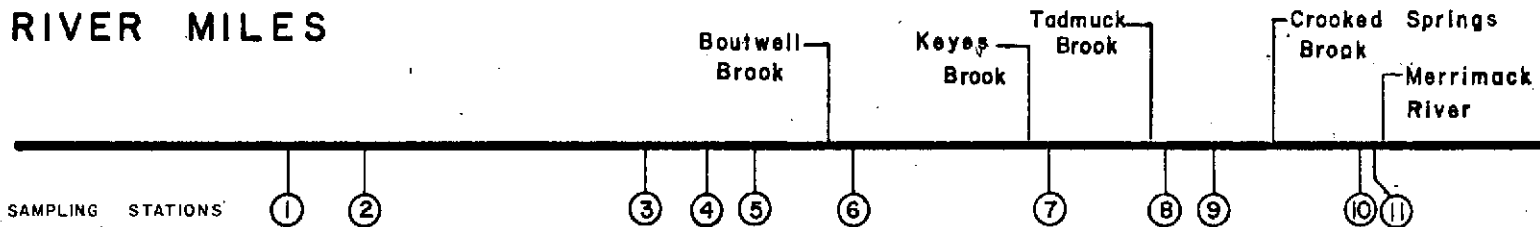


Figure II

Figure 12

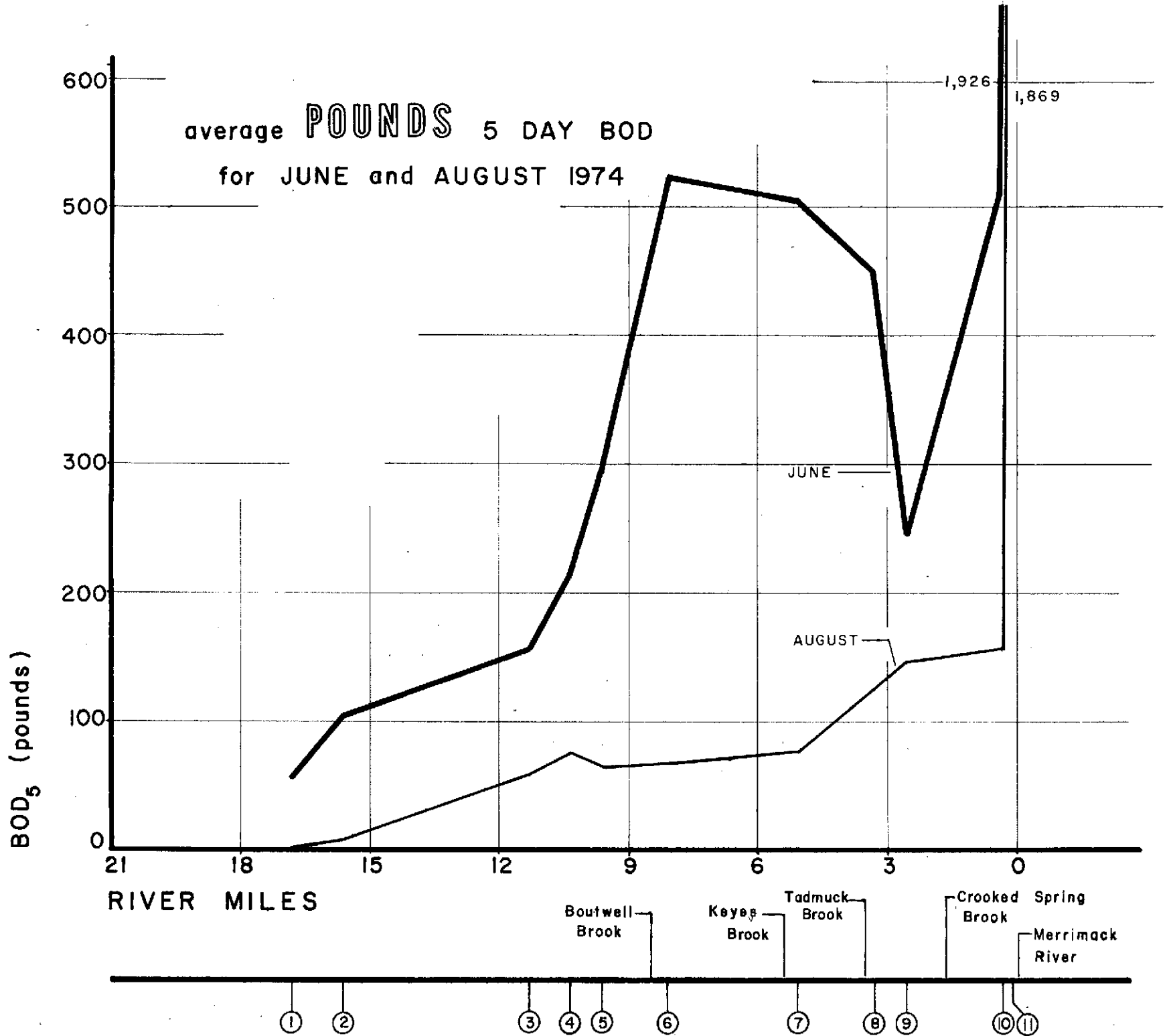
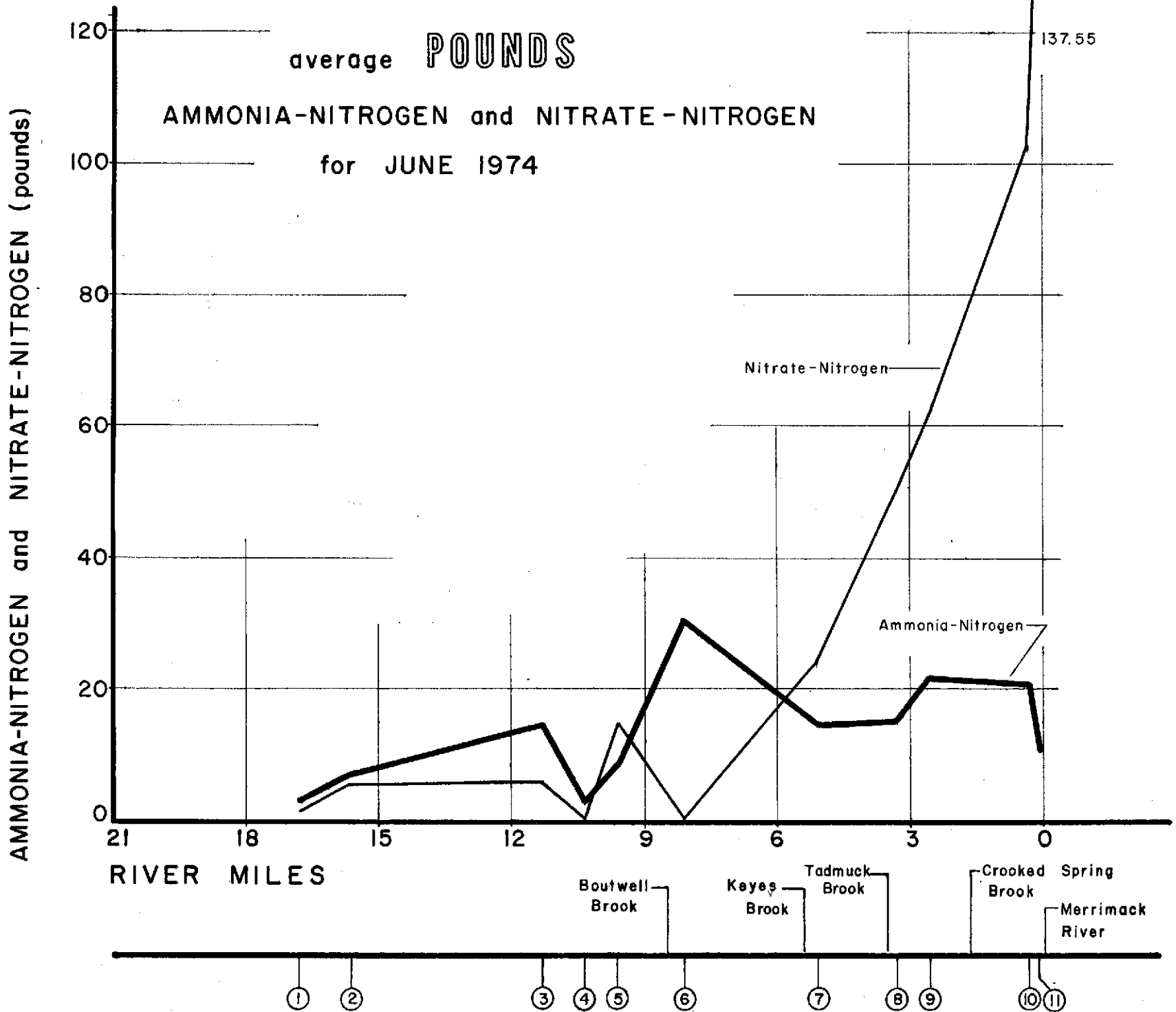


Figure 13

40



AMMONIA-NITROGEN and NITRATE-NITROGEN (pounds)

average POUNDS
AMMONIA-NITROGEN and NITRATE-NITROGEN
for AUGUST 1974

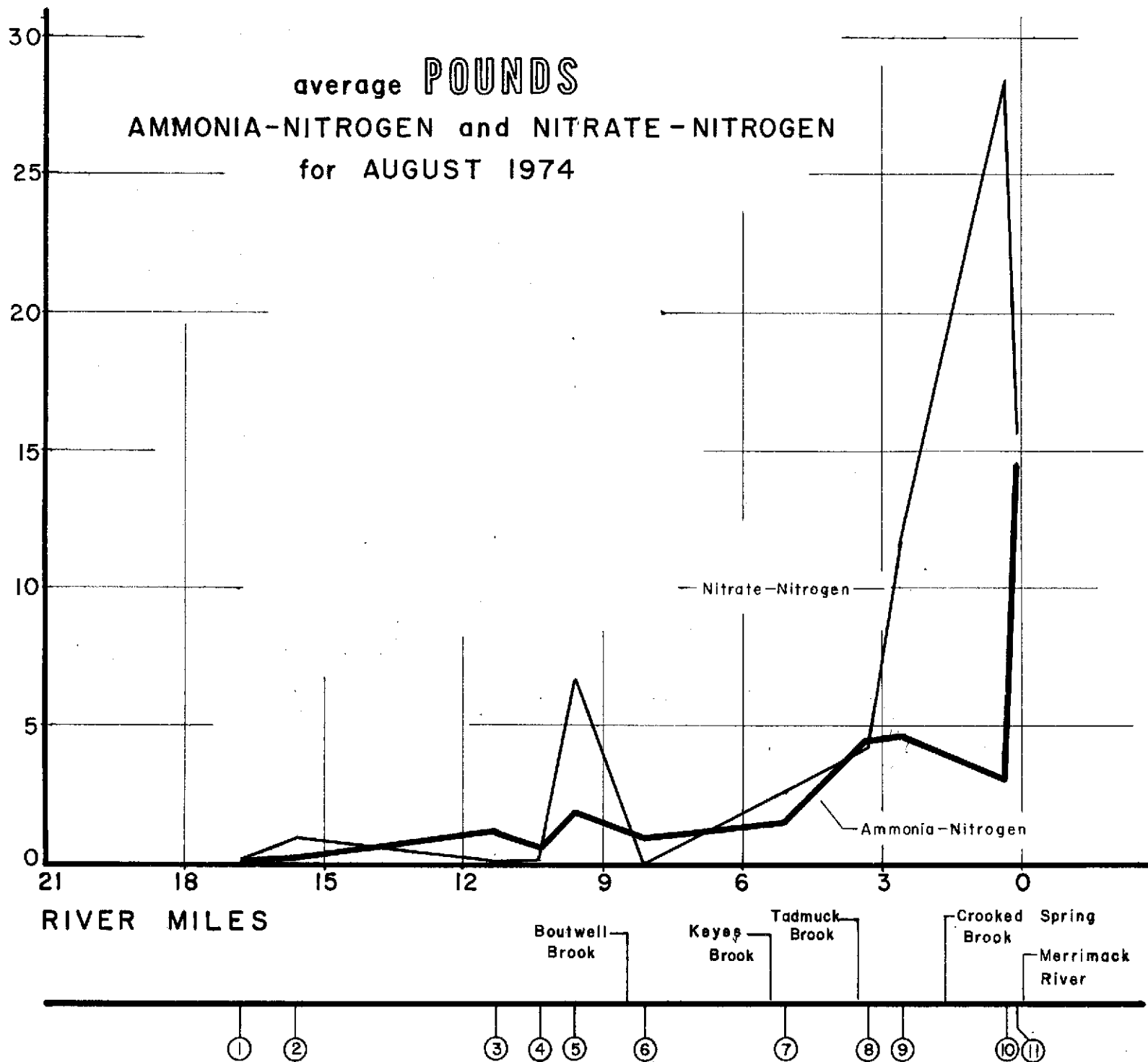


Figure 14

TOTAL COLIFORM GEOMETRIC MEAN

for JUNE and AUGUST 1974

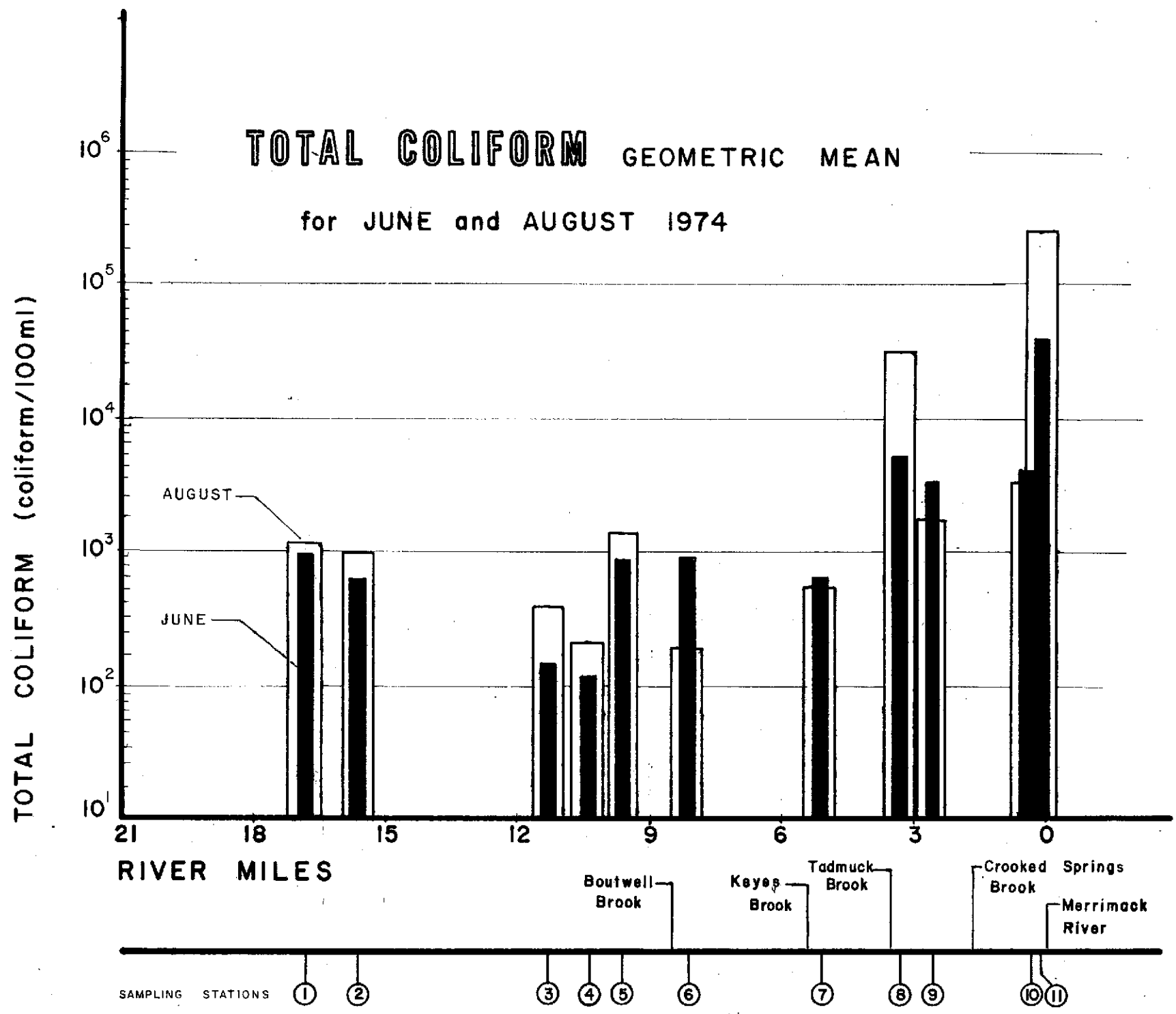


Figure 15

FUTURE CONDITIONS

POLLUTION ABATEMENT PROGRAM

A detailed pollution abatement program for the communities within the Stony Brook Basin is presented in the Merrimack River Basin Water Quality Management Plan prepared by this Division.

It is required under the National Pollutant Discharge Elimination System that each industrial and municipal discharger obtain a discharge permit which includes schedules of compliance or target dates of abatement for significant dischargers. Also, the industries themselves have their guidelines for the degree of treatment which they should employ.

There are presently six industrial wastewater dischargers within the basin. Table 5 is a summary of these discharges and their existing and proposed treatment schemes. Currently, of the six dischargers, H.E. Fletcher Quarry, New England Apple Products, and Commodore Foods, Inc. employ treatment of their wastewater. Waste load allocations, which establish effluent limitations set forth by the Permit Program, have been calculated for the latter two industries (Tables 9 and 10). These dischargers will have to meet stringent standards required by the permit system. Gilet Wool Scouring and Nye's Jap Enamelac are under Division orders for pretreatment of their wastewater. Murray Printing Company in Westford discharges industrial cooling waters to Stony Brook. The 1974 water quality survey showed no adverse effect of this discharge.

TABLE 9

WASTE LOAD ALLOCATION

STONY BROOK 1974 SURVEY

DISCHARGE: Commodore Foods, Inc., Westford

RECEIVING WATER DATA

Water Quality Class: B
River Mile: 3.3
Drainage Area: 43.24 mi.²
7-Day, 10-Year Low Flow: 4.30 cfs
D.O. Sat: 8.4 mg/l
D.O. Int: 8.0 mg/l
BOD₅: 2.8 mg/l
BOD_u: 4.0 mg/l

DISCHARGE DATA

Flow: 12,000 g.p.d. (0.018 cfs)
BOD₅: 39.4 mg/l (3.94 lbs/day)
BOD_u: 59.0 mg/l (5.89 lbs/day)

LOAD ALLOCATIONS

BOD₅: 39.4 mg/l (3.94 lbs/day)
BOD_u: 59.0 mg/l (3.94 lbs/day)

cfs: Cubic feet per second
Sat: Saturation values of dissolved oxygen
Int: Initial concentration of dissolved oxygen
BOD₅: Five-day biochemical oxygen demand
BOD_u: Ultimate biochemical oxygen demand

TABLE 10

WASTE LOAD ALLOCATION

STONY BROOK 1974 SURVEY

DISCHARGE: New England Apple Products Co., Inc., Littleton

RECEIVING WATER DATA

Water Quality Class: B
River Mile: Tributary just above Mill Pond
Drainage Area: 8.00 mi.²
7-Day, 10-Year Low Flow: 0.80 cfs
D.O. Sat: 8.4 mg/l
D.O. Int: 7.4 mg/l
BOD₅: 1.8 mg/l
BOD_u: 2.5 mg/l

DISCHARGE DATA

Flow: 50,000 g.p.d.
BOD₅: 26.00 lbs/day
BOD_u: 38.70 lbs/day

LOAD ALLOCATIONS

BOD₅: 28.0 mg/l
BOD_u: 41.9 mg/l

cfs: Cubic feet per second
Sat: Saturation values of dissolved oxygen
Int: Initial concentration of dissolved oxygen
BOD₅: Five-day biochemical oxygen demand
BOD_u: Ultimate biochemical oxygen demand

TABLE 11
 POPULATION GROWTH AND POPULATION PROJECTIONS
 STONY BROOK BASIN

MUNICIPALITY	1950 POPULATION	1970 POPULATION	1990 PROJECTION
Ayer	5,740	8,325	11,000
Boxborough	439	1,451	5,300
Chelmsford	9,407	31,432	43,600
Groton	2,889	5,109	6,694
Harvard	3,983	4,156	4,885
Littleton	2,349	6,380	11,100
Westford	<u>4,262</u>	<u>10,368</u>	<u>34,100</u>
TOTALS	29,069	75,601	116,679

SOURCE: Corps - Commonwealth Merrimack River Study

CONCLUSIONS

1. The many dams on Stony Brook create severe water quality problems by causing a back-up of water which slows travel time through these reaches. This causes a lack of aeration which inhibits decomposition of wastes and thus creates a settling basin.
2. The marshy, slow-moving reaches, coupled with the impoundments, have an adverse effect on the dissolved oxygen in many stretches of the stream.
3. Non-point sources of pollution in the basin are very evident, particularly during periods of high runoff.
4. Coliform bacteria showed increasing concentrations in downstream reaches of Stony Brook.
5. The degraded water quality conditions at Mill Pond in Littleton and Forge Pond in Westford impede their uses as recreational resources.
6. Stony Brook does not meet its assigned B classification, primarily due to low dissolved oxygen concentrations.

RECOMMENDATIONS FOR FUTURE STUDY

The 1974 Stony Brook survey provided good baseline data for a comparison with future water quality conditions within the basin. The next water quality survey for Stony Brook is planned for 1979. This survey should provide the following information with regards to the water quality conditions in the Stony Brook Basin:

1. Obtain a second set of water quality data for a comparison analysis with the 1974 survey.
2. Document water quality improvement, if any, within the basin.
3. Compare the degradation of water quality due to natural causes with the 1974 survey.
4. Assess the impact of non-point sources of pollution on water quality.

Special studies are needed within the Stony Brook Basin to further assess the stream's water quality conditions. Other studies to evaluate the effect of development within the basin should also be performed. The following special studies will provide needed information in these specific areas:

- a) Time of travel dye studies should be conducted during different flow regimes to help in establishing a working mathematical model for Stony Brook.
- b) Continued monitoring of the wastewater discharges by the Division's regional offices.
- c) Future lake studies on the ponds surveyed during 1974 to monitor any changes in water quality which would impair their recreational uses.
- d) Baseline lake studies on the ponds that were not included during the 1974 survey.
- e) Coliform bacteria studies on the tributaries of Stony Brook to determine if any organic pollution exists.
- f) Special studies to assess the effect of impoundments upon the stream's water quality conditions.

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