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ASSABET RIVER BASIN

1984-1985

WATER QUALITY SURVEY DATA

WASTEWATER DISCHARGE DATA AND ANALYSIS

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FOREWORD

The Massachusetts Division of Water Pollution Control was established by the Massachusetts Clean Water Act, Chapter 21 of the General Laws as amended by Chapter 685 of the Acts of 1966. Included in the duties and responsibilities of the Division is the periodic examination of the water quality of various coastal waters, rivers, streams and ponds of the Commonwealth, as stated in section 27, paragraph 5 of the Acts. This section further directs the Division to publish the results of such examination together with the standards of water quality established for the various waters. The Technical Services Branch of the Division of Water Pollution Control has, among its responsibilities, the execution of this directive. This report is published under the Authority of the Acts and is among a continuing series of reports issued by the Division presenting water quality data and analyses, water quality management plans, baseline and intensive limnological studies and various special studies.

ABSTRACT

Massachusetts Division of Water Pollution Control. 1984-1985. Assabet River Basin Water Quality Survey Data, Wastewater Discharge Data and Analysis. 77 p., 36 tables, 6 figs.

Water quality data were collected and analyzed both from 30 stations spanning the entire Assabet River during July 17 and 19, 1985, and from 12 stations in the upper river approximately monthly from December 1984 through October 1985. In addition, data were gathered from wastewater treatment plants discharging to the Assabet corresponding with river survey dates.

River water quality parameters listed in the report are temperature, dissolved oxygen, five-day BOD, COD, pH, total alkalinity, suspended solids, total solids, total Kjeldahl-nitrogen, ammonia-nitrogen, nitrate-nitrogen, total phosphorus, chloride, sulfate, total and fecal coliform bacteria, total metals, phenols, oil and grease, and purgeable organic compounds. Wastewater samples were analyzed for all the previously mentioned parameters with the exception of dissolved oxygen, sulfate, and purgeable organics, and the addition of settleable solids.

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INTRODUCTION

This report is a compilation and analysis of the results of field and laboratory examinations of the Assabet River and its wastewater discharges during the years 1984 and 1985 by the Technical Services Branch of the Division of Water Pollution Control (DWPC).

The study had, as its goals, the determination of the causes of odor and other problem conditions in the upper portions of the river through Westborough and Northborough, and the updating of the water quality data base for the Assabet River as a whole. To this end, the data in this report are divided into a section on the upper river surveys, a section on the full river survey, and a section on wastewater discharge information.

The sampling program consisted of several phases. The upper portion of the river was sampled for chemical and bacteriological parameters approximately monthly from December 1984 through October 1985. The entire river was sampled July 17 and 19, 1985, when on the first day a complete set of chemical and bacteriological data were taken, as well as some metal and volatile organic compound data. On the second day an early morning sampling of only dissolved oxygen and temperature were taken. Corresponding wastewater data were gathered during the times of all river surveys by the Compliance Monitoring Section of the DWPC.

River water quality was evaluated by taking grab samples of river water at the stations listed in Table 2. Water temperature was measured at the time of sample collection. Dissolved oxygen determinations were made by Technical Services Branch personnel using the Winkler method.

All other chemical and bacteriologial samples were transported to the Lawrence Experiment Station of the Department of Environmental Quality Engineering (DEQE), where they were analyzed according to procedures set forth in the most current edition of the American Public Health Association's Standard Methods for the Examination of Water and Wastewater. The data were compiled and tablulated by personnel of the DWPC.

River flow measurements during the surveys were collected by the United States Geological Survey (USGS) at the USGS gaging station on the Assabet River in the town of Maynard. It must be noted that these measurements were intended to give an indication of the flow regime of the river during the sampling, although most of the surveys did not extend into Maynard.

ISCO automatic samplers were used to obtain 24-hour composite samples, where possible, from the six municipal dischargers on the river: the Westborough Wastewater Treatment Plant (WWTP), the Shrewsbury WWTP, the Marlborough West WWTP, the Hudson WWTP, the Maynard WWTP, and the Concord MCI WWTP. Since the Shrewsbury WWTP discharges through a long (1.5 mile) partially open pipe, samples were frequently taken both at the final effluent at the plant, and from the end of the pipe. (A composite sample is indicated in this report by bracketing the days over which the sample was taken, i.e., 7/16-17/85, whereas, a grab sample is indicated by a single date, i.e., 8/7/85 or August 7, 1985). However, coliform, oil and grease, purgeable organic compounds, and phenols were always grab sampled.

Figure 1

ASSABET RIVER BASIN CLASSIFICATION

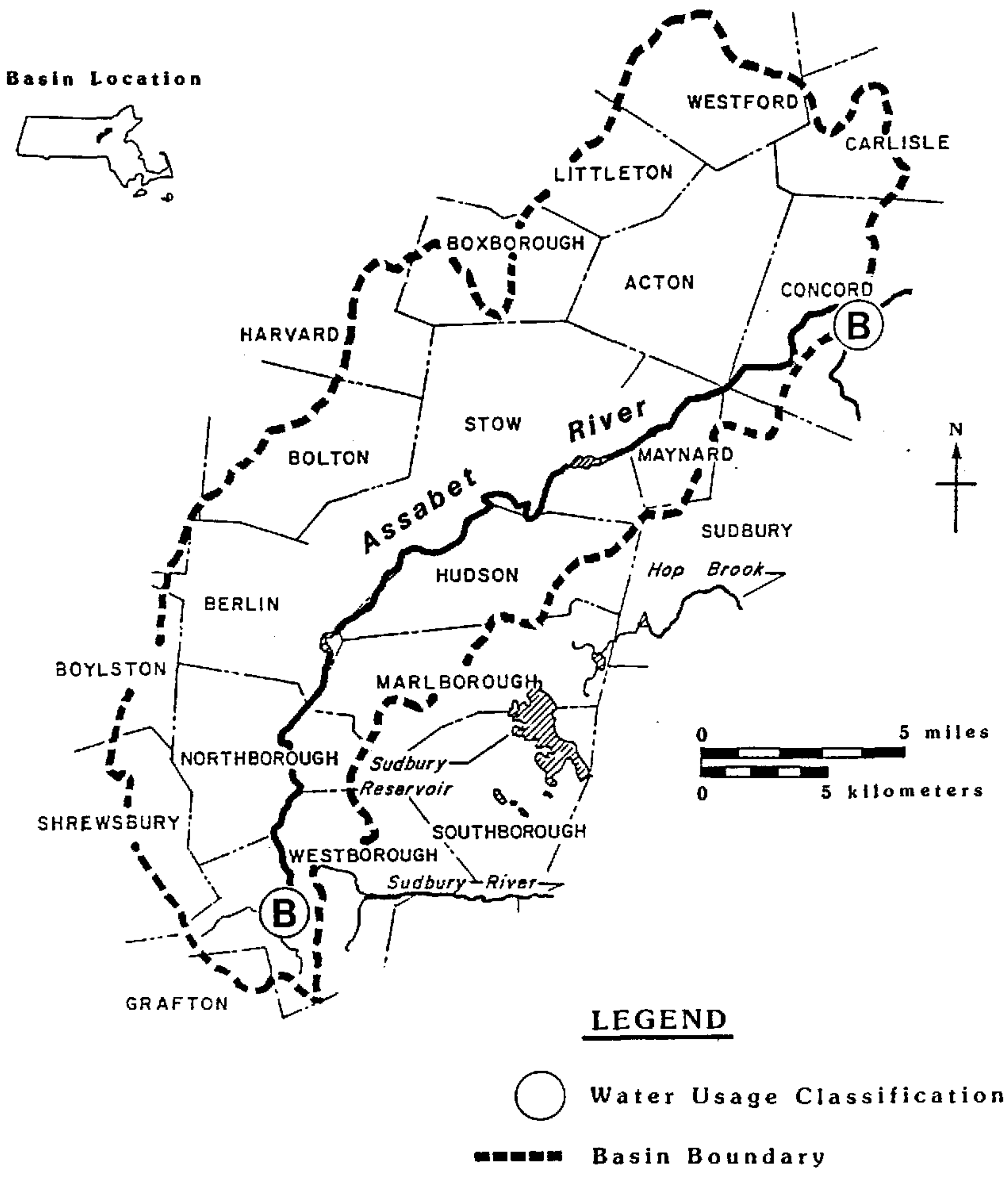


TABLE 1

1985 ASSABET RIVER BASIN WATER QUALITY CLASSIFICATION*

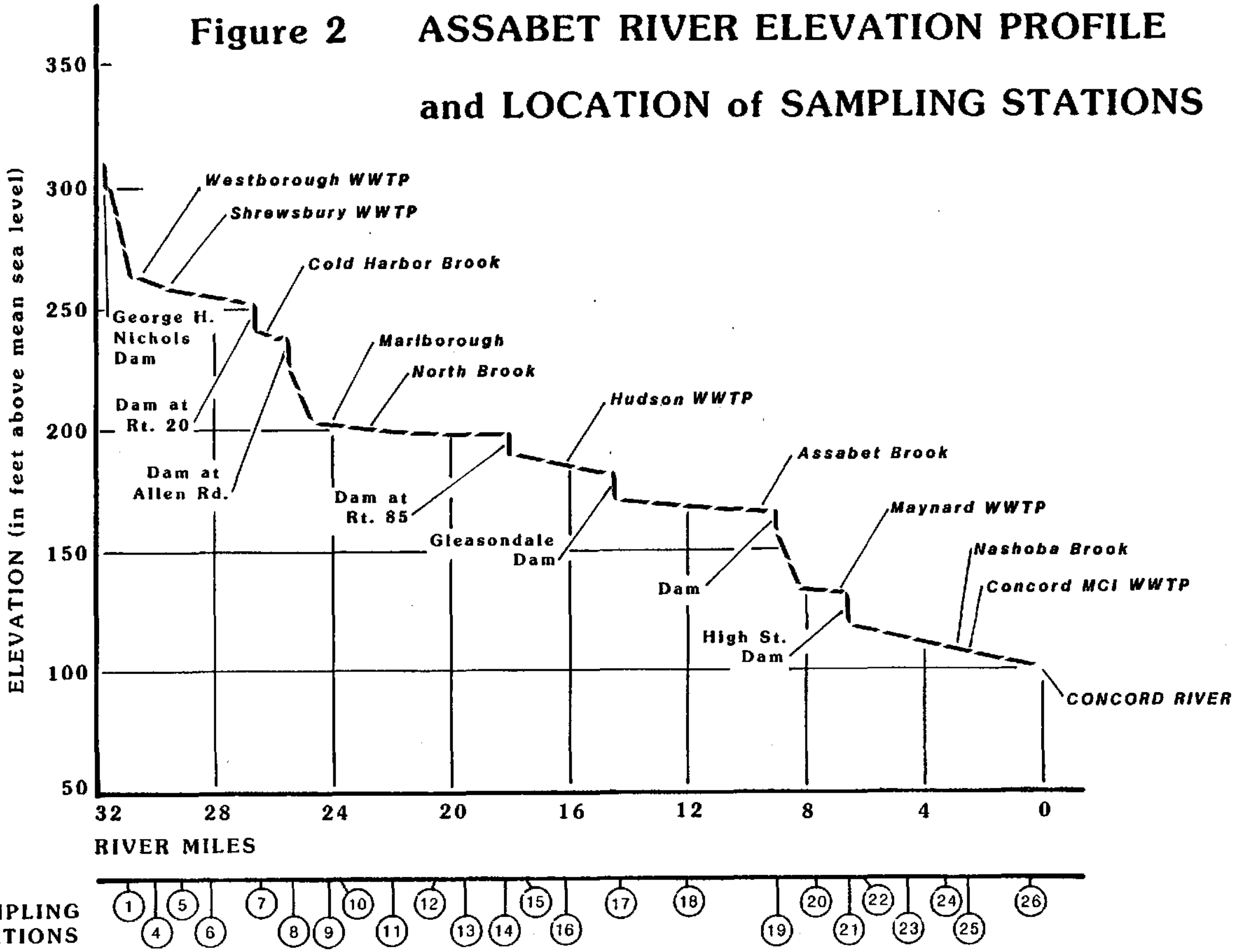
BOUNDARY	MILE POINT	CLASSIFICATION	DESIGNATED USES	OTHER RESTRICTIONS
Source to Westborough WWTP	31.8 - 30.4	B	Aquatic Life Recreation (P&S)	314 CMR 4.04(3)
Westborough STP to outlet of Boons Pond	30.4 - 12.4	B	Aquatic Life Recreation (P&S)	--
Outlet of Boones Pond to confluence with Sudbury River	12.4 - 0.0	B	Warm Water Fishery Recreation (P&S)	--
White Pond to its outlet in Stow and those tributaries thereto	--	A	Public Water Supply	MGL., Ch. 111
Gates Pond to the intake in Berlin and those tributaries thereto	--	A	Public Water Supply	MGL., Ch. 111
Unnamed Brook from its source to Gates Pond, Berlin	--	A	Public Water Supply	MGL., Ch. 111
Millham Brook Reservoir to its outlet in Marlborough and those tributaries thereto	--	A	Public Water Supply	MGL., Ch. 111
Lake Williams to its outlet in Marlborough and those tributaries thereto	--	A	Public Water Supply	MGL., Ch. 111
Cold Harbor Brook Reservoir in Shrewsbury and those tributaries thereto	--	A	Public Water Supply	MGL., Ch. 111
Sandra Pond to its outlet in Westborough and those tributaries thereto	--	A	Public Water Supply	MGL., Ch. 111

TABLE 1 (CONTINUED)

BOUNDARY	MILE POINT	CLASSIFICATION	DESIGNATED USES	OTHER RESTRICTIONS
Sudbury Reservoir in Westborough, Marlborough, Southborough, Framingham and those tributaries thereto	--	A	Public Water Supply	MGL., Ch. 111
Nagog Pond to its outlet in Acton and tributaries thereto	--	A	Public Water Supply	MGL., Ch. 111
Other surface waters of the Assabet River Drainage Area *unless otherwise* denoted above	--	B	--	314 CMR 4.04(3)

*Massachusetts Water Quality Standards, 1985

Figure 2 ASSABET RIVER ELEVATION PROFILE and LOCATION of SAMPLING STATIONS



PHYSICAL CHARACTERISTICS OF THE ASSABET RIVER

The Assabet River, originating in impounded swamplike land in southwestern Westborough, flows through several highly populated areas including Westborough, Northborough, Hudson, Maynard, and Concord, until it joins with the Sudbury River in Concord to form the Concord River. It currently receives major discharges from five municipal wastewater treatment plants and a state prison treatment plant.

The varying physical characteristics of the Assabet River play a critical role in the chemical and biological activities which occur in the river. The re-occurring presence of dams and the slow moving, swampy impoundments they create are vital factors in the water quality of the Assabet River. Figure 1 shows the drainage basin, major tributaries and the assigned water use classification (see Table 1) of the Assabet River and its tributaries. Figure 2 shows the Assabet profile, with changes in elevation, location of dams and wastewater treatment plant discharges. In the following description, the mile point from the confluence with the Sudbury River is shown in parentheses.

The Assabet River begins at the outlet of the George H. Nichols Multiple-Purpose Dam in the southwest section of Westborough. The dam creates a small impoundment of about 0.6 sq. mi. which collects water drainage from an area of about 7 sq. mi., much of which is swampland. The dam was intended to provide fish and wildlife habitat and low flow augmentation for pollution abatement. Decaying organic matter formed by the insufficient removal of trees and roots when the area was flooded produces inferior water quality within the impoundment. In addition, proper flow regulation is absent. Water which does flow through the dam, however, is aerated, and the resulting water quality in the newly emerging Assabet is good as far as dissolved oxygen and bacteriological parameters are concerned.

After a short, fast flowing stretch, the river begins its characteristic sluggish flow. Hocomonco Stream joins the river just above where the first of six wastewater treatment plant discharges into the Assabet - the town of Westborough Wastewater Treatment Plant (WWTP) (30.2). Shortly downstream the Shrewsbury WWTP discharges to the river. The Assabet meanders its way through swamplike lands and flows by a golf course before reaching the next impounded area and dam on Route 20 in Northborough (26.5). Soon, another relatively steep gradient causes the river to accelerate through a small industrial complex. Then, taking a 90° turn, the Assabet enters the "headwater" pool of the Allan Road dam impoundment (25.4). After flowing through pasture lands, the basic pattern of the river is repeated - the Marlborough West WWTP (24.1) coincides with the slowing of the river flow. The river flows through swamplands until the dam at Route 85 in Hudson (18.2). Through Hudson center the flow is constricted by industrial developments on both banks. Passing out of Hudson center the pattern is again repeated - the Hudson WWTP discharges into the Assabet just above the swampland impoundment created by the Gleasondale dam (14.4). Following a short rapid section, the river flows in its characteristic slow meandering style for 4.5 miles through the town of Stow.

Flowing over the American Woolen Dam (9.0) and into the town of Maynard, the river's gradient sharply increases and the flow is channeled through the center of Maynard. The Assabet, for the fourth time, repeats its pattern - flowing into the Powder Mill impoundment and receiving the discharge from the Maynard WWTP (6.3). From the Powder Mill dam, to the confluence with the Sudbury River, the river's gradient is relatively uniform. The Assabet flows through West Concord receiving its final discharge from the Massachusetts Correctional Institution (MCI) at West Concord (2.4). The river slowly reaches the Sudbury River just north of the center of Concord. The confluence of the Assabet and Sudbury rivers produces one main stream - the Concord River.

Figure 3

LOCATION of SAMPLING STATIONS

ASSABET RIVER BASIN

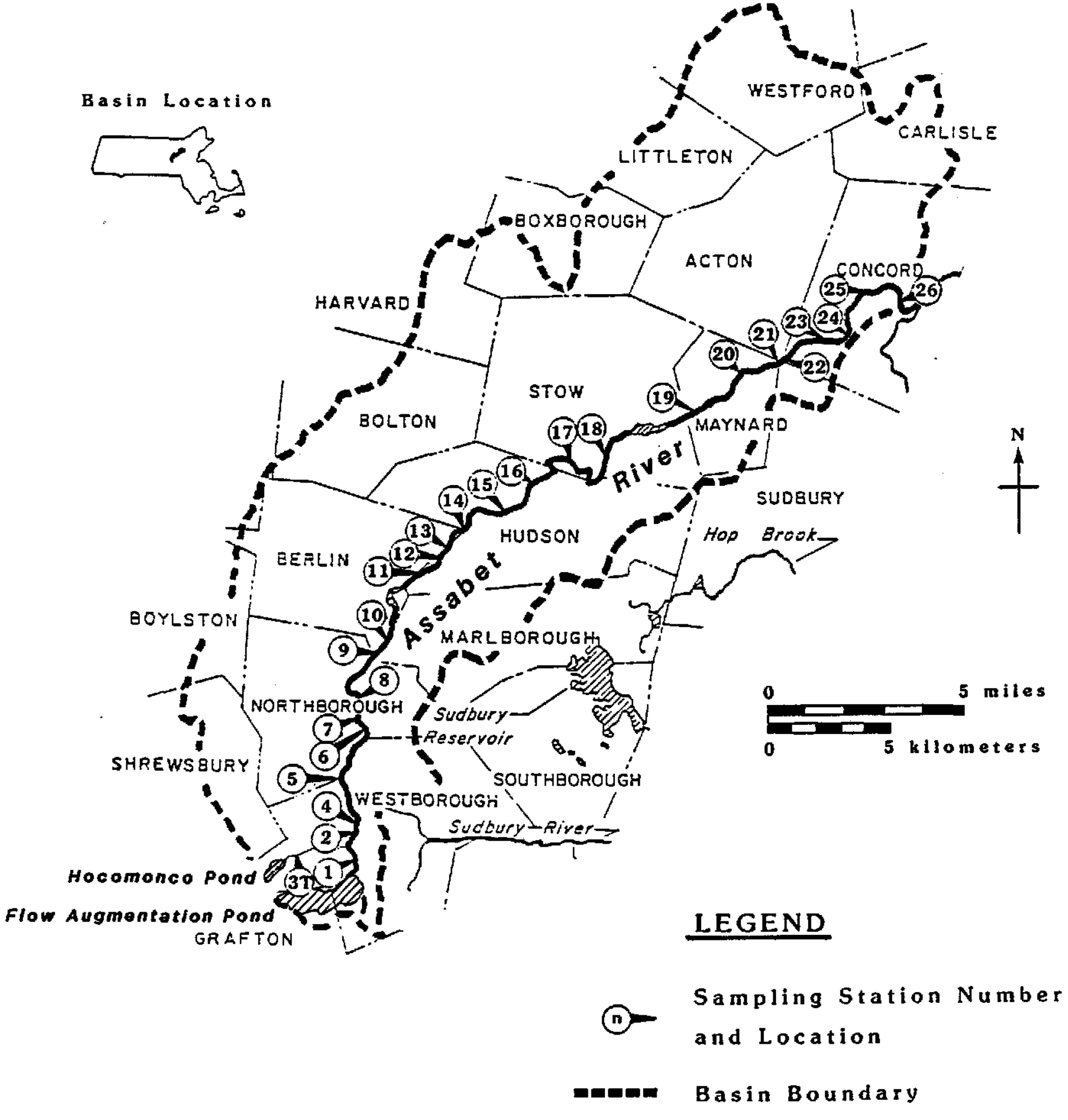


TABLE 2

1984-1985 ASSABET RIVER BASIN SURVEYS

LOCATION OF SAMPLING STATIONS

STATION NUMBER	LOCATION	RIVER MILE
AS01	Water Outlet, George H. Nichols Multi-Purpose Dam, Westborough	31.8
AS02	Maynard Street, Westborough	31.0
AS03 (T)	Outlet of Hocomonco Pond, Otis Street, Westborough	30.5, 0.5
AS04	Route 9, Westborough	30.1
AS04 (T)	Hop Brook, Westborough/Northborough Line	29.6
AS05	Route 135, Westborough/Northborough Line	29.2
AS06	School Street, Northborough	28.3
AS06 (S)	Winn Street, off the shore, Northborough	26.7
AS06 (T)	Small tributary, School Street, Northborough	26.9, 0.05
AS07	Above Dam, Route 20, Northborough	26.5
AS07 (T)	Cold Harbor Brook, Hudson Street, Northborough	26.2, 0.1
AS08	Above Dam, Allen Road, Northborough	25.4
AS09	Boundary Street, Northborough/Marlborough Line	24.2
AS10	Robin Hill Road, Marlborough	23.8
AS11	Bigelow Road, Berlin	22.0
AS12	Four Bridges Road, off the shore, Hudson	20.6
AS13	Chapin Road, Hudson	19.6
AS14A, B	Above or below dam, Route 85, Hudson	18.2
AS15	Forest Avenue, Hudson	17.6
AS16	Cox Street, Hudson	16.2
AS17A, B	Above or below dam, Route 62, Stow	14.4

TABLE 2 (CONTINUED)

STATION NUMBER	LOCATION	RIVER MILE
AS18	Boon Road, Stow	12.1
AS19	Route 62/117, above dam, Maynard	9.0
AS20	Routes 27/62 at USGS gage, Maynard	7.7
AS21A, B	Above or below dam, Acton	6.5
AS22	Route 62, first bridge, Concord	6.1
AS23	Route 62, second bridge, Concord	4.6
AS24	Route 62, third bridge, Concord	3.3
AS25	Routes 2/2A, Concord	2.6
AS26	Nashawtuc Hill, off the shore, Concord	0.4
SU15	Sudbury River, Nashawtuc Hill Road, Concord	0.0, -0.5
CO01	Concord River, Lowell Road, Concord	0.0, +0.1

(T) - Tributary
(S) - Supplemental Station
A - Above dam
B - Below dam

DATA ANALYSIS

Introductory Summary

Municipal wastewater treatment plant discharges and impoundments continue to plague the Assabet River as they have done for two decades. The only portion of the river meeting class B water quality conditions throughout the year is the first mile starting at the headwaters prior to any wastewater discharges. Sampling programs in 1965, 1969, 1974, 1979 and 1985 all document significant dissolved oxygen deficits and excessive fecal coliform counts. Significant stretches of the river support dense populations of algae and macrophytes during the summer months. Decaying vegetation, sediments in impoundments and slow-moving sections, and anaerobic in-stream conditions have been responsible for odor complaints.

The majority of the water quality problems in the Assabet River can be attributed to the discharges associated with the five major municipal wastewater treatment plants and a treatment plant that serves the Massachusetts Correctional Institute at Concord. Accordingly, the interaction of these discharges with river hydrology and chemistry will be explored in this report.

For analytical purposes, the river will be divided into two segments, upper and lower. The upper segment, where fairly extensive water quality data were taken in 1984-85, extends from the headwaters in Westborough to Boundary Street, Marlborough. The lower segment, where data were gathered for two days in 1985, begins at Boundary Street, and extends until the confluence with the Sudbury River. The upper segment can be discussed in greater detail because of the quantity of the data available.

The chemical and biological parameters of principle interest which will be examined as to source and effect are dissolved oxygen (D.O.), five-day biochemical oxygen demand (BOD_5), ammonia-nitrogen, phosphorus, and fecal coliform bacteria. D.O. and BOD_5 are plotted in Figures 4 and 5 for the entire river. We will see that, as illustrated in Figure 6, which plots D.O. with time for the upper river, the water quality problems which occur, and which have occurred for over ten years, are exacerbated in the summer, when river flows are at a minimum (yielding minimum dilutions), and decay and vegetative growth processes are at a maximum.

Other water quality problems exist in the Assabet river, such as non-point and toxic pollutants, but they are difficult to quantify at this time. Toxics are discussed under a separate heading in this analysis.

Segment Analysis

The first segment of the river begins in the headwaters at the outlet of the George H. Nichols Dam, AS01, and ends at the Marlborough line, AS09. A fairly thorough once monthly survey was undertaken in this segment in 1984-1985, whose results appear in Tables 3 to 21. Water quality problems in this segment are due primarily to the Westborough and Shrewsbury WWTP discharges, and are the most severe in the Assabet River.

The reason for the severity of the water quality problems here is threefold. First, the two wastewater treatment plants, Westborough and Shrewsbury, are in need of upgrading due to frequent overloading and less than optimal equipment performance. Thus, each of them, at times, produces an inferior quality effluent. Second, these treatment plants discharge to a small and often slow-moving river close to its headwaters, where the quantity of dilution water is limited, especially during summer low flow periods. (Dissolved oxygen standard violations during the summer are illustrated in Figure 6). Finally, organic sediments, originating in the treatment plant effluents, have accumulated on the bottom and banks of the Assabet in this segment which, in the natural process of decay, utilize oxygen from the water as well as produce unpleasant odors.

The first river station in this study, AS01, was located below the spillway of the George H. Nichols dam, i.e., at the very beginning of the river proper. The construction of the dam created immediate problems. Tree stumps and roots, left after clearing an area for the impoundment, decay and create a D.O. demand and a probable source of ammonia. Past study of the impoundment, "Baseline Water Quality of Selected Lakes and Ponds in the Assabet River Basin, 1974," indicate a variation of D.O. with depth, but no such recent data were taken. Dissolved oxygen readings at AS01, however, were usually good, with only the mid-July level of 4.4 mg/l slightly below the 5.0 standard for a Class B river. BOD_5 levels, though, were generally high during the summer for a "clean water" station, reflecting the decay processes occurring. Ammonia-nitrogen and phosphorus were also elevated here during the summer.

The next station of interest, AS04 on Route 9, is located below the Westborough WWTP. Hocomonco stream enters the river upstream of this, but the flow rate is low enough to cause minimal impact in conventional water quality parameters. The dissolved oxygen at AS04 is below the 5.0 mg/l standard from May through August, partly due to decreased stream velocity and aeration, but basically due to an increased BOD_5 loading from the Westborough WWTP. At this point also, ammonia-nitrogen and phosphorus nutrient values are elevated over upstream values, again due primarily to the WWTP. Nutrient values will remain high, due to the influence of this and other WWTP's, along most of the rest of the Assabet River.

Station AS05 is located after the Shrewsbury WWTP discharges to the Assabet. Once again we see a low D.O., and even higher BOD_5, ammonia-nitrogen, and phosphorus values, indicative of impacts of the upstream WWTP's. In addition, very high levels of fecal coliform bacteria are observed here frequently, and for several stations downstream, due to the Shrewsbury discharge.

From AS05 it is interesting to note the pronounced increase in ammonia values through AS07. This is the probable result of organic degradation from both water and sediment sources.

Station AS07, located on Route 20, above the dam in Northborough, is the point at which the D.O. "sag" occurs, the lowest dissolved oxygen values in the upper segment of the river occurred here, as can be seen in Figures 4 and 6. In fact, in the summer, the concentration of dissolved oxygen here falls nearly to zero. This explains the frequent complaints by river neighbors of foul odors emanating from the river- anaerobic decomposition is probably occurring in the river and on the exposed river banks, producing the unpleasant odors. In addition, the river from AS06 flows slowly, and the dam on the river reduces the velocity of flow still more and creates a small impoundment where sedimentation is likely to occur. Thus, there is a large oxygen demand due to both benthic and kinetic considerations. These accumulated sediments will continue to be a problem for some time after the new Westborough/Shrewsbury WWTP is on line.

From AS07, the Assabet flows over a dam, reaerating. In addition, the intermittent but highly aerated tributary, Cold Harbor Brook, joins the Assabet about a half mile downstream. The increase in dissolved oxygen allows both a continuing decrease in BOD (see Figure 5) and a conversion of ammonia-nitrogen to nitrate-nitrogen. Organic sedimentation though, continues to occur as the Assabet flows slowly through wetland areas. By AS09, BOD_5, ammonia-nitrogen, and fecal coliform bacteria levels have all decreased, although standards violations do occur in the fecal coliform values. However, dissolved oxygen at AS08 and AS09 falls below the 5 mg/l standard during the summer. High nutrient levels, attributable to the upstream WWTP's, cause profuse growth of aquatic vegetation from AS08 through AS09 and beyond.

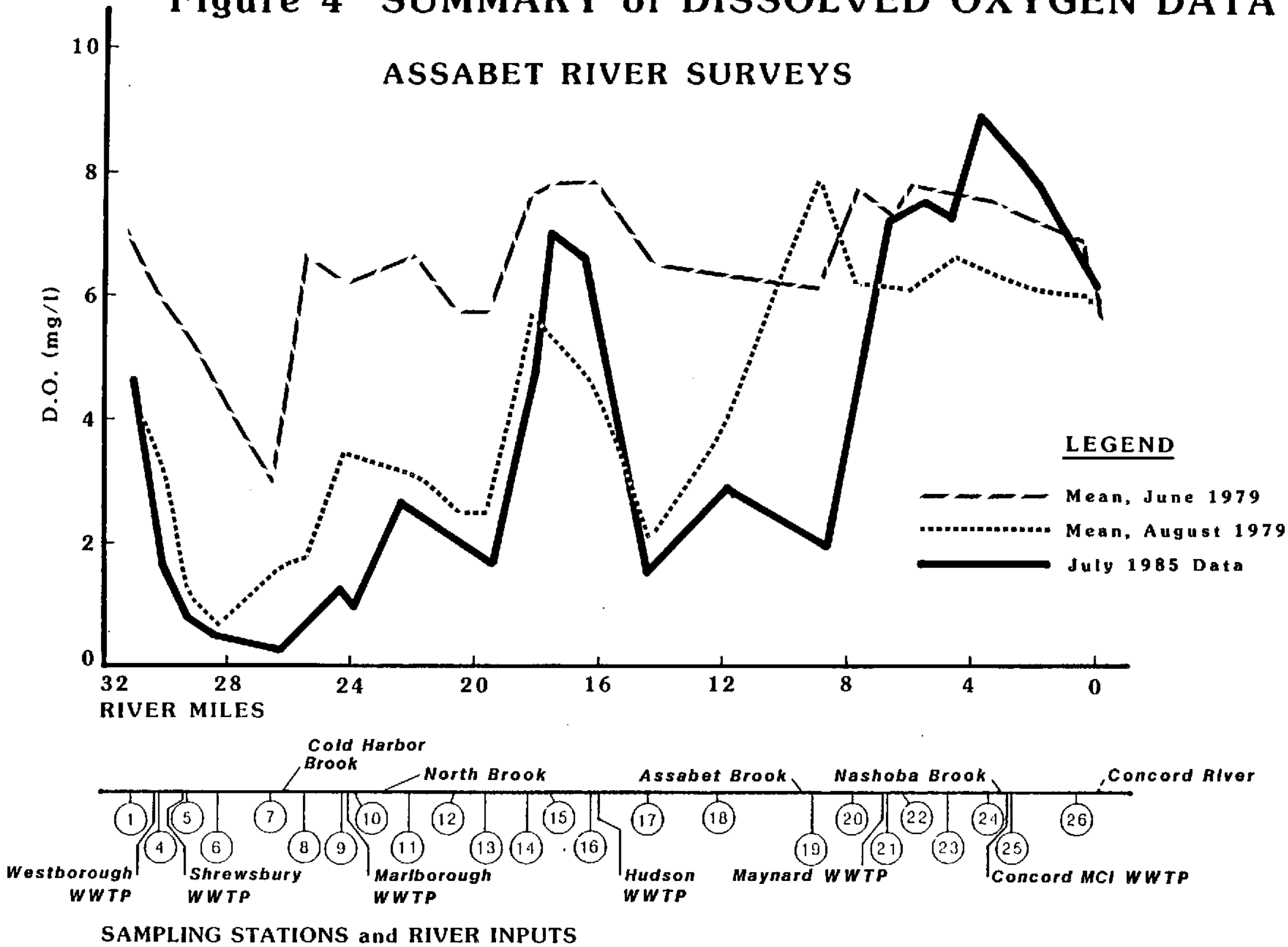
The lower Assabet River from AS10 through its confluence with the Sudbury River is beset with similar problems to those described on the upper Assabet, such as D.O. and fecal coliform standard violations, and high nutrient levels but in much less severe form. The lower river was synoptically surveyed during the week of July 17, 1985.

Dissolved oxygen during this time period was frequently below the 5 mg/l standard for a Class B river, as can be seen in Figure 4. Generally, the reasons for this, as before, are due to the effluent of the wastewater treatment plants creating an oxygen demand, as well as the nature of the Assabet, a river which flows slowly through swampy areas with little aeration. BOD_5 values instream, as can be seen in Figure 5, drop to a much lower level than in the upper Assabet.

Nutrients, including nitrogen compounds such as ammonia and nitrates, and especially phosphorus, primarily of treatment plant origin, continue to be very high in this segment, as well as in the upper segment. This leads to prolific aquatic weed growth in slow moving parts of the river.

Finally, there is an indication from this one-day survey, that fecal coliform levels in the lower stretch of the river are in some areas, at some times, above the 200 organisms per 100 ml standard. The areas of violation, in this survey, do not coincide well with wastewater treatment plant effluent discharges, and so are probably of wildlife or non-point source origin.

Figure 4 SUMMARY of DISSOLVED OXYGEN DATA



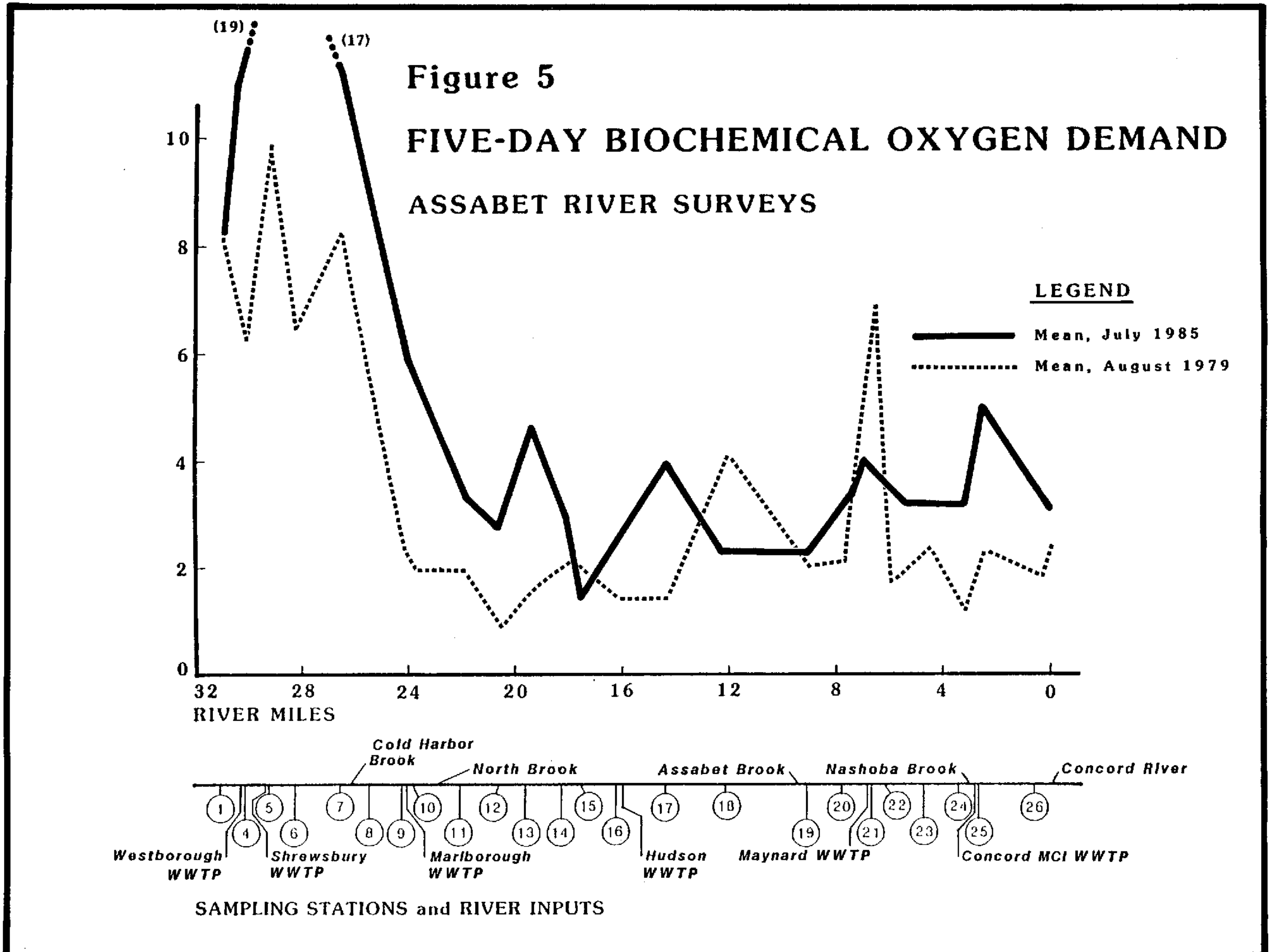


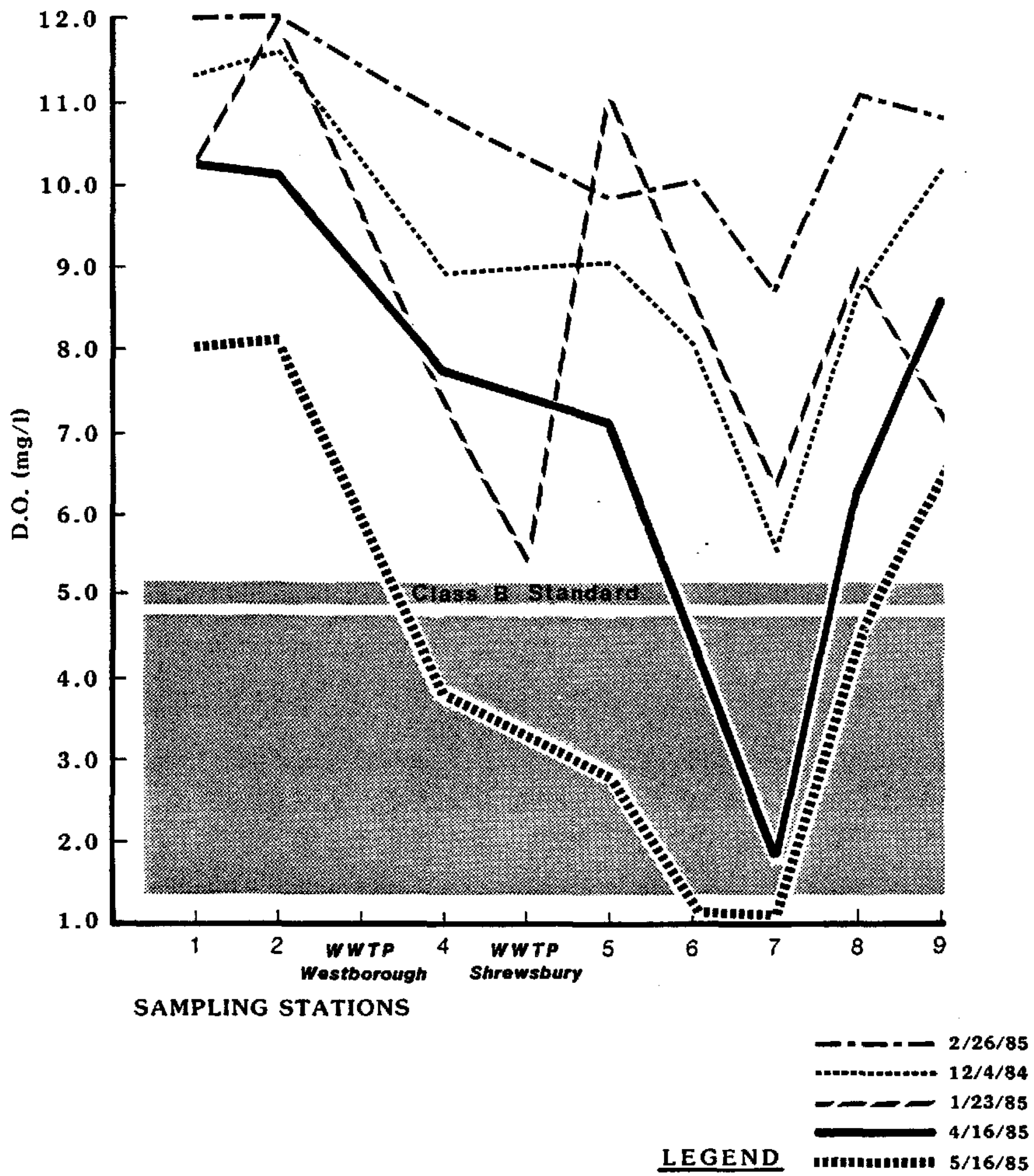
Figure 5

FIVE-DAY BIOCHEMICAL OXYGEN DEMAND

ASSABET RIVER SURVEYS

Figure 6 DISSOLVED OXYGEN TRENDS

UPPER ASSABET RIVER, 1984-85



Waste Discharges

The major discharges on the Assabet River are five municipal sewage treatment plants and a treatment plant that serves the Massachusetts Correctional Institute at Concord. The location of the treatment plants are found on Figure 2. The compliance monitoring section of the Division of Water Pollution Control (DWPC) has surveyed these WWTP's concurrent with the recent water quality, as well as at other times, with extensive studies on the Westborough and Shrewsbury plants. Laboratory analyses of these discharges appear in Tables 30 to 35. The following section is a description of treatment plants as they exist now, of the problems they create in the Assabet River, and of their future upgrades.

Westborough

The Westborough WWTP is the most upstream discharge on the Assabet river, very near the headwaters. The facility uses the extended aeration process with disinfection by chlorination. The sand filter beds were not used during 1985 due to the disruption caused by the construction of the new facilities. The present plant went into use in 1971. Average flow to the plant is about 1.2 to 1.5 MGD, but due to inflow and infiltration during wet weather, the flow can reach higher values. The design flow is 1.1 MGD.

During the 1984-1985 wastewater surveys as listed in Table 30, the Westborough plant generally performed well. Its NPDES permit allows an April through October daily maximum BOD_5 and total suspended solids of 30 mg/l each, which the WWTP met in all days tested except July 16-17. The WWTP also generally met its fecal coliform limits, with two exceptions. Flows through the plant were generally high. Unfortunately after this study was completed, the Westborough WWTP had major operational problems for several months.

The Westborough plant is in the process of upgrading its operation to become the Westborough/Shrewsbury regional WWTP. Part of the town of Hopkinton will also be tied in, but its flow contribution will be proportionally low. The new advanced secondary facility, which should be on-line early in 1987, has a design capacity of 7.68 MGD. It will use primary clarification, multi-channel oxidation, secondary clarification, sand filtration and seasonal post-aeration. It is expected to produce a high quality effluent, i.e., summer daily maximum BOD_5 of 15 mg/l, dissolved oxygen of 6 mg/l, and ammonia of 1.5 mg/l.

Shrewsbury

Shortly downstream from the Westborough effluent, the Shrewsbury WWTP discharge, averaging 1.6 MGD, enters the Assabet River. The close proximity of the two discharges multiplies the water quality problem. The plant, in use since 1963, is a secondary trickling filter facility with disinfection via chlorination. The effluent travels in a long pipe to the Assabet. Inflow and infiltration cause major operational problems during wet weather.

The Shrewsbury plant performed poorly throughout the one-year sampling program. It frequently violated its NPDES permit limits in BOD_5, suspended solids, and fecal coliform bacteria. Samples of effluent were taken both at the clarifier outlet, and at the outfall to the Assabet. In addition, the effluent is extremely high in nutrients, as would be expected for this type of secondary plant.

Shrewsbury is joining the new Westborough Regional WWTP which should be on line early in 1987. This merger into the advanced WWTP should greatly improve the upper Assabet River water quality.

Marlborough West

About 5.4 miles downstream from the two previously mentioned plants, the Marlborough West WWTP discharges about 1.9 MGD into the Assabet River. Much of the influent to the plant is industrial in origin, which explains some high heavy metals concentrations in the effluent during the monitoring of the plant in 1985. Planning has begun for upgrading this plant for increased flows and ammonia oxidation. Expected completion is in 1989.

Hudson

At river mile point 16.0, the Hudson Wastewater Treatment Plant enters the Assabet River with a design flow of 2.0 MGD. Hudson is served presently by a secondary WWTP, but the MDWPC has determined that advanced secondary treatment is needed in order for the Assabet River to meet its Class B standard. The upgraded plant presently under construction has a design flow of 2.63 MGD, and will include post aeration and ammonia removal. It should be completed by the latter part of 1986.

Maynard

Effluent from the Maynard WWTP with an average flow rate of 0.9 MGD enters the Assabet River at mile point 6.8. It is currently a secondary activated sludge plant but although it will remain secondary, it is in the process of upgrading treatment to include an innovative technology - rotating biological contactors. The new facilities should be completed by the end of 1986.

Concord MCI WWTP

The Concord Correctional Institution WWTP (mile point 2.4) is a small discharge to the Assabet River averaging 0.188 MGD, with a design capacity of 0.162 MGD. Its treatment process consists of extended aeration, activated sludge with sand-anthracite filters and final chlorination. The wastewater treatment system at this point is over-capacity and plans exist to expand the prison by 250 beds. Thus, upgrading the WWTP should be a priority.

Toxic Pollutants

Included in the 1984-1985 sampling program on the Assabet River were a limited number of toxic pollutant samples such as heavy metals, purgeable organic compounds, and phenolic compounds. Testing was limited due to difficulties encountered because of the multiplicity of substances to be tested for, the development only recently of techniques to detect these substances in trace quantities, and the past lack of emphasis in controlling these toxics.

Heavy metals were tested at selected times in the river water column (see Tables 18 and 27), in the wastewater treatment plant effluents (see Tables 30-35), and in the sediment (see Table 21). Copper and zinc levels in the water column often exceeded the EPA national "white book" guidelines, listed in Table 36 for in-stream concentrations. Interestingly, copper and zinc were also present in the sediment in higher levels than found in many other Massachusetts sediments.* Copper and zinc were found in the effluents of all the WWTP's in this study at various concentrations. The probable source of the copper at the WWTP's is the drinking water supplied to the municipalities where copper piping is typically used. The laboratory levels of detection in this study of cadmium, lead, and mercury are higher than the "white book" in-stream criteria; thus, we can not predict from these data whether these three metals pose a problem instream.

Finally, nickel was found in high concentrations in the Marlborough West WWTP effluent, and the nickel concentration found downstream in the Assabet at AS10 was in excess of the "white book" chronic criterion.

Purgeable or volatile organic compounds were tested for in the water column in a limited number of samples listed in Tables 19 and 28. These compounds were either present in very small quantities, or non-existent at the sites tested. However, it must be remembered that both the number of samples taken and the number of sites they were taken at were extremely limited.

Phenols (phenol, ortho- and meta- substituted phenols, and possibly certain para- substituted phenols) were tested for in the water column at AS03T and AS04 several times during 1985 as shown in Table 19. These stations were chosen because of their proximity to the EPA Superfund site at Hocomonco Pond in Westborough, which is contaminated with creosote. Phenols were found in the stream leading from Hocomonco to the Assabet, and downstream in the Assabet River. Further testing, including sediments in the Assabet, is probably warranted.

Overall, the potential for toxic effects exists at some places in the Assabet, but actual effects are unknown, and possibly masked by more conventially recognized pollution problems such as low dissolved oxygen or chlorine compounds from WWTP effluents. Thus, when the new WWTP's are on line, evaluation of toxicity effects will be facilitated.

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*McGinn, Joseph. "A Sediment Control Plan for the Blackstone River." DEQE, Office of Planning and Program Management. 1981. pp 95-96.

WATER QUALITY SAMPLING DATA

UPPER ASSABET RIVER BASIN

TABLE 3

1984-1985 UPPER ASSABET RIVER BASIN SURVEYS

TIME (hr/min) - TEMPERATURE (°F) - DISSOLVED OXYGEN (mg/l)

STATION NUMBER		12/4/84	1/23/85	2/26/85	4/16/85	5/16/85	6/27/85	7/17/85	8/22/85	9/10/85	10/17/85
AS01	*	0915	1023	0930	0910	0935	1034	0836	0930	0910	0906
	**	41	36	36	50	62	68	75	72	65	55
	***	11.3	10.3	12.2	10.2	8.0	8.0	4.4	5.8	6.8	8.2
AS02		0925	1039	0945	0920	0950	1042	--	--	--	0914
		41	36	34	51	58	61	--	--	--	54
		11.6	12.2	12.3	10.1	8.1	7.2	--	--	--	8.6
AS03T		--	--	--	--	--	1112	850	940	930	--
		--	--	--	--	62	60	73	68	67	--
		--	--	--	--	5.1	2.7	1.3	3.0	5.9	--
AS04		1040	1040	1001	0952	1006	1050	0905	0947	0940	0929
		45	41	43	53	57	60	70	69	63	54
		8.9	7.4	10.8	7.7	3.8	2.4	1.5	2.9	5.0	5.6
AS05		1050	1100	1011	1005	1016	1126	0915	0957	1013	0945
		45	39	46	54	56	57	70	66	62	53
		9.0	11.0	9.8	7.1	2.8	3.2	0.8	1.1	4.9	4.4
AS06		1105	1125	1031	1015	1036	1140	0922	1012	1028	0953
		45	36	41	54	56	60	--	--	--	--
		8.0	8.6	10.0	4.6	1.2	1.3	0.5	0.9	4.1	1.6
AS06T		--	1130	--	--	--	- -	--	--	--	--
		--	36	--	--	--	--	--	--	--	--
		--	11.0	--	--	--	--	--	--	--	--

* Time
** Temperature
*** Dissolved Oxygen

TABLE 3 (CONTINUED)

STATION NUMBER	12/4/84	1/23/85	2/26/85	4/16/85	5/16/85	6/27/85	7/17/85	8/22/85	9/10/85	10/17/85
AS06S	--	--	1035	1032	1041	1150	--	--	--	--
	--	--	39	54	56	60	--	--	--	--
	--	--	9.3	2.2	1.1	0.9	--	--	--	--
AS07	1125	1136	1100	1040	1106	1200	0932	1023	1038	1009
	45	34	41	53	56	57	72	68	61	54
	5.6	6.3	8.7	1.8	1.1	0.7	0.2	0.6	3.1	1.0
AS07T	1215	---	1200	1114	1206	1212	0942	--	1108	--
	43	--	36	54	56	55	72	--	60	--
	12.8	--	13.3	9.7	9.1	9.2	7.5	--	8.6	--
AS08	1225	1147	1210	1056	1215	1219	--	1045	1115	1027
	45	36	39	54	60	58	--	68	62	54
	8.7	8.9	11.0	6.3	4.5	4.6	--	2.7	5.3	5.0
AS09	1235	1225	1225	1120	1245	1225	0950	1053	1128	1040
	44	32	40	56	58	58	71	66	61	52
	10.2	7.3	10.8	8.6	6.4	3.2	1.1	2.3	3.9	5.3

TABLE 4

1984-1985, UPPER ASSABET RIVER BASIN SURVEYS

CHEMICAL OXYGEN DEMAND DATA (mg/l)

STATION NUMBER	12/4/84	1/23/85	2/26/85	4/16/85	6/27/85	7/17/85	8/22/85	9/10/85	10/17/85
AS01	39	42	39	30	44	52	98	53	47
AS02	48	37	44	--	29	--	--	--	--
AS03T	--	--	--	--	15	29	--	27	--
AS04	48	88	61	45	44	57	109	53	71
AS05	100	167	92	90	93	71	103	74	99
AS06	68	93	53	50	54	71	--	53	66
AS07	68	88	61	55	49	62	109	59	66
AS07T	39	--	31	--	20	29	--	37	--
AS08	58	70	75	35	76	--	--	53	71
AS09	58	60	44	--	96	29	--	48	--

TABLE 5

1984-1985 UPPER ASSABET RIVER BASIN SURVEYS

FIVE-DAY BIOCHEMICAL OXYGEN DEMAND DATA (mg/l)

STATION NUMBER	12/4/84	1/23/85	2/26/85	4/16/85	5/16/85	6/27/85	7/17/85	8/22/85	9/10/85	10/17/85
AS01	2.4	4.8	4.8	2.7	--	6.6	8.1	5.7	4.5	2.1
AS02	3.0	2.7	8.1	--	1.5	6.6	--	--	--	--
AS03T	--	--	--	--	1.2	3.3	3.3	--	1.2	--
AS04	11	18	13	5.1	5.4	7.2	11	7.8	4.5	7.5
AS05	37	78	44	23	23	29	19	8.4	7.8	25.0
AS06	14	32	17	9.0	9.3	9.0	17	--	6.0	8.1
AS06T	--	2.1	--	--	--	--	--	--	--	--
AS06S	--	--	--	--	9.6	--	--	--	--	--
AS07	17	18	16	11	9.3	9.9	11	5.7	5.4	6.9
AS07T	--	--	4.5	--	--	1.8	2.4	--	1.5	--
AS08	5.4	13	13	5.4	5.4	6.6	--	--	4.8	8.1
AS09	2.4	11	13	--	--	6.3	5.4	--	8.4	6.9

TABLE 6

1984-1985 UPPER ASSABET RIVER BASIN SURVEYS

pH DATA (Standard Units)

STATION NUMBER	12/4/84	1/23/85	2/26/85	4/16/85	5/16/85	6/27/85	7/17/85	8/22/85	9/10/85	10/17/85
AS01	6.9	7.2	7.0	7.4	--	7.2	6.6	6.7	6.7	6.9
AS02	6.4	6.5	6.8	--	6.5	7.2	--	--	--	--
AS03T	--	--	--	--	7.1	7.3	7.1	--	6.8	--
AS04	6.0	6.9	6.8	7.1	7.1	6.9	7.1	6.8	6.6	6.8
AS05	6.3	6.9	6.6	7.0	7.0	7.0	7.3	7.0	6.8	7.1
AS06	6.2	6.8	6.5	7.0	6.8	7.3	7.3	--	6.6	7.2
AS06T	--	6.7	--	--	--	--	--	--	--	--
AS06S	--	--	--	--	6.8	--	--	--	--	--
AS07	6.7	7.0	6.2	7.1	6.9	7.2	7.3	7.1	6.5	7.1
AS07T	--	--	6.5	--	--	7.2	7.2	--	6.6	--
AS08	6.8	6.9	6.8	7.0	7.1	7.4	--	--	6.7	7.3
AS09	6.3	6.6	7.1	--	--	7.3	7.0	--	6.6	7.2

TABLE 7

1984-1985 UPPER ASSABET RIVER BASIN SURVEYS

TOTAL ALKALINITY DATA (mg/l)

STATION NUMBER	12/4/84	1/23/85	2/26/85	4/16/85	5/16/85	6/27/85	7/17/85	8/22/85	9/10/85	10/17/85
AS01	12	20	28	18	--	22	16	21	21	16
AS02	10	14	27	--	18	17	--	--	--	--
AS03T	--	--	--	--	43	32	38	--	34	--
AS04	9.0	47	41	36	55	25	34	24	21	20
AS05	29	75	30	48	72	65	58	47	35	59
AS06	16	55	27	39	55	47	66	--	27	50
AS06T	--	30	--	--	--	--	--	--	--	--
AS06S	--	--	--	--	71	--	--	--	--	--
AS07	35	65	10	49	72	67	70	63	26	59
AS07T	--	--	29	--	--	16	20	--	12	--
AS08	36	53	28	160	52	51	--	--	25	58
AS09	26	50	106	--	--	38	55	--	20	38

TABLE 8

1984-1985 UPPER ASSABET RIVER BASIN SURVEYS

TOTAL HARDNESS DATA (mg/l)

STATION NUMBER	12/4/84	1/23/85	2/26/85	4/16/85	5/16/85	6/27/85	7/17/85	9/10/85	10/17/85
AS01	26	31	29	28	--	26	30	26	27
AS02	26	31	30	--	25	26	--	--	--
AS03T	--	--	--	--	48	42	51	42	--
AS04	39	41	36	40	36	40	45	35	42
AS05	54	63	44	57	49	52	58	41	58
AS06	50	52	43	53	43	46	58	38	49
AS06T	--	54	--	--	--	--	--	--	--
AS06S	--	--	--	--	47	--	--	--	--
AS07	48	61	41	56	43	58	59	38	55
AS07T	--	--	26	--	--	30	40	23	--
AS08	48	57	39	49	42	53	--	34	41
AS09	47	49	37	--	--	43	55	34	43

TABLE 9

1984-1985 UPPER ASSABET RIVER BASIN SURVEYS

SUSPENDED SOLIDS DATA (mg/l)

STATION NUMBER	12/4/84	1/23/85	2/26/85	4/16/85	5/16/85	6/27/85	7/17/85	8/22/85	9/10/85	10/17/85
AS01	5.5	8.5	8.5	3.5	--	12	9.0	11	15	12
AS02	13	6.0	7.0	--	8.5	8.5	--	--	--	--
AS03T	--	--	--	--	9.5	1.0	16	--	4.5	--
AS04	14	33	13	5.0	14	4.5	13.5	7.5	11	18
AS05	31	76	19	13	20	14	9.5	12	47	22
AS06	23	41	23	8.0	13	2.5	7.5	--	15	6.0
AS06T	--	6.0	--	--	--	--	--	--	--	--
AS06S	--	--	--	--	9.0	--	--	--	--	--
AS07	20	12	18	5.0	8.0	2.5	8.0	63	13	6.5
AS07T	--	--	4.0	--	--	0.0	4.0	--	5.5	--
AS08	11	8.5	12	2.0	8.0	2.5	--	--	7.5	4.0
AS09	5.0	5.5	9.5	--	--	2.0	3.0	--	16	7.5

TABLE 10

1984-1985 UPPER ASSABET RIVER BASIN SURVEYS

TOTAL SOLIDS DATA (mg/l)

STATION NUMBER	12/4/84	1/23/85	2/26/85	4/16/85	5/16/85	6/27/85	7/17/85	8/22/85	9/10/85	10/17/85
AS01	74	120	120	68	--	78	98	110	90	130
AS02	110	100	96	--	120	82	--	--	--	--
AS03T	--	--	--	--	140	110	90	--	88	--
AS04	200	200	140	140	190	180	160	162	150	220
AS05	220	300	200	180	250	250	190	164	180	270
AS06	190	240	160	160	210	180	190	--	160	240
AS06T	--	160	--	--	--	--	--	--	--	--
AS06S	--	--	--	--	250	--	--	--	--	--
AS07	200	250	170	170	230	210	210	186	130	270
AS07T	--	--	120	--	--	120	110	--	100	--
AS08	200	220	170	140	180	200	--	--	150	200
AS09	190	190	150	--	--	180	170	--	170	200

TABLE 11

1984-1985 UPPER ASSABET RIVER BASIN SURVEYS

TOTAL KJELDAHL-NITROGEN DATA (mg/l)

STATION NUMBER	12/4/84	1/23/85	2/26/85	4/16/85	6/27/85	7/17/85	8/22/85	9/10/85	10/17/85
AS01	2.0	1.1	1.5	0.49	1.3	1.8	3.4	0.85	1.2
AS02	1.9	0.61	1.3	--	1.6	--	--	--	--
AS03T	--	--	--	--	0.74	1.9	--	0.32	--
AS04	2.3	7.8	2.3	6.4	1.9	2.7	5.2	1.0	1.4
AS05	3.4	7.0	4.4	3.4	8.8	6.6	5.3	4.5	6.3
AS06	3.0	5.0	2.4	4.4	7.0	4.7	--	1.9	4.3
AS06T	--	0.76	--	--	--	--	--	--	--
AS06S	--	--	2.0	--	--	--	--	--	--
AS07	3.2	5.2	3.6	3.7	9.0	7.2	6.9	2.0	6.4
AS07T	2.0	--	1.2	--	0.86	1.4	--	0.62	--
AS08	3.6	5.0	2.5	3.1	5.2	--	--	2.4	4.5
AS09	3.1	4.5	2.2	--	2.3	4.9	--	1.7	2.0

TABLE 12

1984-1985 UPPER ASSABET RIVER BASIN SURVEYS

AMMONIA-NITROGEN DATA (mg/l)

STATION NUMBER	12/4/84	1/23/85	2/26/85	4/16/85	6/27/85	7/17/85	8/22/85	9/10/85	10/17/85
AS01	0.06	0.02	0.01	0.00	0.05	0.16	0.22	0.03	0.13
AS02	0.03	0.06	0.00	--	0.09	--	--	--	--
AS03T	--	--	--	--	0.16	0.02	--	0.04	--
AS04	0.11	5.5	1.2	4.0	0.71	0.57	0.27	0.19	0.23
AS05	2.7	7.0	2.5	3.0	5.3	3.8	2.6	1.5	4.0
AS06	1.0	5.0	1.1	2.2	2.8	4.1	--	0.91	2.9
AS06T	--	0.10	--	--	--	--	--	--	--
AS06S	--	--	0.97	--	--	--	--	--	--
AS07	1.9	4.0	1.1	2.6	4.7	6.3	4.4	1.2	4.2
AS07T	0.05	--	0.01	--	0.12	0.00	--	0.04	--
AS08	3.0	5.0	0.87	2.1	4.7	--	--	1.3	2.8
AS09	1.6	4.5	0.79	--	1.7	3.8	--	0.78	1.2

TABLE 13

1984-1985 UPPER ASSABET RIVER BASIN SURVEYS

NITRATE-NITROGEN DATA (mg/l)

STATION NUMBER	12/4/84	1/23/85	2/26/85	4/16/85	6/27/85	7/17/85	8/22/85	9/10/85	10/17/85
AS01	0.2	0.4	0.1	0.0	0.2	0.0	0.3	0.1	0.1
AS02	0.2	0.4	0.2	--	0.3	--	--	--	--
AS03T	--	--	--	--	0.2	0.1	--	0.0	--
AS04	4.5	0.4	0.2	0.1	3.0	1.7	2.6	2.6	4.7
AS05	0.9	0.5	0.3	0.2	0.7	0.1	0.7	0.5	0.6
AS06	1.0	0.6	0.4	0.3	0.5	0.1	--	0.7	0.4
AS06T	--	1.3	--	--	--	--	--	--	--
AS06S	--	--	0.4	--	--	--	--	--	--
AS07	1.3	0.5	0.4	0.1	0.3	0.0	0.6	0.7	0.3
AS07T	0.06	--	0.4	--	0.5	0.2	--	0.2	--
AS08	1.4	0.5	0.4	0.2	0.9	--	--	0.8	0.3
AS09	1.5	0.5	0.5	--	1.6	0.9	--	1.3	0.9

TABLE 14

1984-1985 UPPER ASSABET RIVER BASIN SURVEYS

TOTAL PHOSPHORUS DATA (mg/l)

STATION NUMBER	12/4/84	1/23/85	2/26/85	4/16/85	6/27/85	7/17/85	8/22/85	9/10/85	10/17/85
AS01	0.14	0.06	0.12	0.12	0.10	0.19	0.14	0.09	0.1
AS02	0.11	0.06	0.16	--	0.09	--	--	--	--
AS03T	--	--	--	--	0.06	0.10	--	0.06	--
AS04	1.4	0.94	0.34	2.2	1.4	2.4	1.2	1.1	1.7
AS05	1.6	1.8	0.86	1.5	1.9	3.1	1.4	1.1	2.2
AS06	1.0	1.0	0.72	1.9	1.4	2.6	--	0.7	1.7
AS06T	--	0.09	--	--	--	--	--	--	--
AS06S	--	--	0.68	--	--	--	--	--	--
AS07	1.4	1.1	0.76	1.4	1.9	3.0	1.4	0.69	2.5
AS07T	0.23	--	0.11	--	0.10	0.25	--	0.08	--
AS08	1.2	0.82	0.58	1.0	1.1	--	--	0.72	1.6
AS09	1.0	0.64	0.54	--	0.99	3.0	--	0.72	1.1

TABLE 15

1984-1985 UPPER ASSABET RIVER BASIN SURVEYS

SULFATE DATA (mg/l)

STATION NUMBER	12/4/84	1/23/85	2/26/85	4/16/85	5/16/85	6/27/85	7/17/85	9/10/85	10/17/85
AS01	8.5	14	39	6.0	--	11	16	8.1	8.0
AS02	9.5	15	11	--	10	14	--	--	--
AS03T	--	--	--	--	9.0	12	18	11	--
AS04	18	22	15	16	20	22	27	20	23
AS05	28	39	21	20	20	28	25	22	28
AS06	22	28	20	19	18	25	39	21	24
AS06T	--	25	--	--	--	--	--	--	
AS06S	--	--	--	--	21	--	--	--	--
AS07	30	34	18	23	21	29	33	20	30
AS07T	--	--	16	--	--	16	17	14	--
AS08	28	31	18	21	5.0	28	--	20	27
AS09	26	30	18	--	--	26	21	20	22

TABLE 16

1984-1985 UPPER ASSABET RIVER BASIN SURVEYS

TOTAL COLIFORM BACTERIA DATA (organisms/100 ml)

STATION NUMBER	12/4/84	1/23/85	2/26/85	4/16/85	5/16/85	6/27/85	7/17/85	8/22/85	9/10/85	10/17/85
AS01	100	5	20	140	200	100	700	100	200	100
AS02	150	20	20	--	1,000	300	--	--	--	700
AS03T	--	--	--	--	200	1,300	1,000	500	500	--
AS04	6,000	100	50	750	22,000	9,100	7,000	10,000	1,200	33,000
AS05	150,000	930,000	65,000	7,000	130,000	20,000	80,000	20,000	20,000	24,000
AS06	12,000	43,000	5,200	5,000	17,000	8,000	98,000	21,000	6,000	12,000
AS06T	--	20	--	--	--	--	--	--	--	--
AS06S	--	--	15,000	40,000	90,000	9,000	--	--	--	--
AS07	40,000	93,000	9,000	98,000	85,000	10,000	90,000	12,600	12,000	6,900
AS07T	--	--	400	100	1,200	1,200	300	--	8,000	--
AS08	--	40,000	18,000	16,000	20,000	3,300	--	24,000	24,000	3,200
AS09	--	8,000	14,000	5,000	8,500	2,400	800	2,500	13,000	600

TABLE 17

1984-1985 UPPER ASSABET RIVER BASIN SURVEYS

FECAL COLIFORM BACTERIA DATA (organisms/100 ml)

STATION NUMBER	12/4/84	1/23/85	2/26/85	4/16/85	5/16/85	6/27/85	7/17/85	8/22/85	9/10/845	10/17/85
AS01	5	<5	<5	25	<20	<5	10	<20	40	<20
AS02	10	<5	<5	--	40	20	--	--	--	40
AS03T	--	--	--	--	<20	60	200	240	140	--
AS04	100	<5	<5	10	480	280	300	260	380	2,100
AS05	10,000	430,000	6,000	20	700	1,200	4,500	1,500	1,200	1,300
AS06	400	750	60	100	480	160	32,000	1,200	1,300	980
AS06T	--	10	--	--	--	--	--	--	--	--
AS06S	--	--	300	2,600	800	500	--	--	--	--
AS07	3,900	24,000	220	3,500	560	700	35,000	560	3,000	400
AS07T	--	--	200	30	200	200	5	--	2,000	--
AS08	--	1,000	600	900	240	600	--	1,600	4,400	360
AS09	--	400	650	20	40	160	20	140	1,800	<20

TABLE 18

1984-1985 UPPER ASSABET RIVER BASIN SURVEYS

TOTAL METALS DATA (mg/l)

STATION NUMBER	METALS									
	Al	Cd	Cr	Cu	Fe	Pb	Hg	Mn	Ni	Zn
					6/27/85					
AS04	<0.10	<0.01	<0.02	0.02	0.63	<0.04	<0.0002	0.08	<0.05	0.07
AS05	0.12	<0.01	<0.02	0.03	0.54	<0.04	<0.0002	0.08	<0.05	0.04
					7/17/85					
AS01	<0.10	<0.02	<0.02	<0.02	1.7	0.05	<0.0002	0.15	<0.05	0.04
AS03T	<0.10	<0.02	<0.02	<0.02	0.98	<0.04	<0.0002	1.6	<0.05	<0.03
AS04	<0.10	<0.02	<0.02	0.03	0.79	<0.04	<0.0002	0.10	<0.05	0.10
AS05	<0.10	<0.02	<0.02	0.05	0.80	<0.04	<0.0002	0.12	<0.05	0.07
					9/10/85					
AS01	0.14	<0.02	<0.02	<0.02	0.52	<0.04	<0.0002	0.06	<0.05	0.03
AS04	0.15	<0.02	<0.02	0.02	0.47	<0.04	<0.0002	0.12	<0.05	0.03
AS05	1.0	<0.02	<0.02	0.05	0.70	<0.04	<0.0002	0.10	<0.05	0.03
					10/17/85					
AS01	<0.1	<0.02	<0.02	<0.02	0.42	<0.04	--	0.05	<0.05	<0.03
AS04	0.25	<0.02	<0.02	0.05	0.40	<0.04	--	0.07	<0.05	0.03
AS05	0.30	<0.02	<0.02	0.04	0.45	<0.04	--	0.09	<0.05	0.03

TABLE 19

1985 UPPER ASSABET RIVER BASIN SURVEYS

PURGEABLE ORGANIC, PHENOLIC, AND OIL AND GREASE COMPOUNDS

STATION NUMBER	PURGEABLE ORGANICS (µg/l)	PHENOLS (mg/l)	OIL & GREASE (mg/l)
	6/27/85		
AS03T	none detected	0.04	--
AS04	none detected	0.09	--
	7/17/85		
AS03T	none detected	--	0.9
AS04	methylene chloride - 1.0 chloroform - 1.3 bromodichloromethane - <1.0	--	0.9
	8/22/85		
AS03T	--	0.03	--
	9/10/85		
AS03T	--	0.03	--

TABLE 20

1985 UPPER ASSABET RIVER BASIN SURVEY

EMBANKMENT DATA

12/4/85

STATION NUMBER	TOTAL VOLATILE SOLIDS (%)	TOTAL KJELDAHL-NITROGEN (mg/kg dry wt.)	TOTAL PHOSPHORUS (mg/kg dry wt.)
AS04	26.2	10,380	2,770
AS05	18.7	10,050	3,150
AS07	16.5	10,814	3,081

TABLE 21

1984-1985 UPPER ASSABET RIVER BASIN SURVEY

SEDIMENT METALS DATA
(All data in mg/kg dry weight)

10/17/85

STATION NUMBER	Al	Cd	Cr	Fe	Cu	Mn	Ni	Pb	Zn
AS04	9,300	3.0	26	12,000	900	315	16	125	405
AS05	3,350	1.5	22	6,500	190	105	10	44	150
AS07	15,200	3.5	110	13,500	750	195	22	105	480

WATER QUALITY SAMPLING DATA

ASSABET RIVER BASIN

July 1985

TABLE 22

1985 ASSABET RIVER BASIN SURVEY

TIME (hr. min.) - TEMPERATURE (°F) - DISSOLVED OXYGEN (mg/l)

Run 1: 7/17/85 Run 2: 7/19/85

STATION NUMBER		RUN 1	RUN 2	STATION NUMBER	RUN 1	RUN 2
AS01	*	0836	0545	AS11	1008	0635
	**	75	74		72	71
	***	4.4	5.7		2.6	0.9
AS03T		0850	0555	AS12	1019	0640
		73	74		73	72
		1.3	1.6		2.0	0.8
AS04		0905	0557	AS13	1031	0645
		70	69		74	72
		1.5	1.2		1.7	0.7
AS05		0915	0600	AS14A	1041	0650
		70	67		74	73
		0.8	0.6		4.8	1.4
AS06		0922	0607	AS14B	1045	0650
		69	67		77	73
		0.5	0.3		7.2	3.9
AS07		0932	0613	AS15	1105	0700
		72	71		75	74
		0.2	0.3		6.8	3.3
AS07B		0935	0613	AS16	1119	0705
		71	71		77	74
		4.4	2.6		5.6	3.2
AS07T		0942	0620	AS17B	1130	0710
		72	72		77	74
		7.5	7.3		6.6	7.0
AS09		0950	0625	AS17A	1144	--
		71	70		77	--
		1.1	0.5		1.6	--
AS10		0958	0630	AS18	1155	0715
		72	70		77	75
		0.7	0.8		2.7	3.4

TABLE 22 (CONTINUED)

STATION NUMBER	RUN 1	RUN 2
AS19	1209	0730
	79	75
	1.9	2.4
AS20	1222	0740
	79	73
	7.3	6.2
AS21A	1245	0750
	80	72
	7.6	5.4
AS21B	1255	0750
	80	73
	6.9	6.7
AS22	1305	0755
	80	72
	7.3	6.6
AS23	1319	0800
	80	72
	9.0	5.1
AS24	1343	0805
	79	73
	8.0	4.3
AS25	1354	0815
	80	75
	7.8	5.2
AS26	1419	0830
	80	76
	6.2	5.6
SU15	1407	0830
	84	76
	6.4	6.9
CO01	1430	0835
	83	76
	5.8	6.3

* Time

** Temperature (°F)

*** Dissolved Oxygen (mg/l)

TABLE 23

1985 ASSABET RIVER BASIN SURVEY

RESULTS OF LABORATORY ANALYSES
(All units in mg/l)

7/17/85

STATION NUMBER	BOD_5	COD	TOTAL ALKALINITY	HARDNESS
AS01	8.1	52	16	30
AS03T	3.3	29	38	51
AS04	11	57	34	45
AS04A	2.4	29	24	--
AS05	19	71	58	58
AS06	17	71	66	58
AS07	11	62	70	59
AS07T	2.4	29	20	40
AS09	5.4	29	55	55
AS10	6.3	48	54	59
AS11	3.0	48	40	56
AS12	2.1	43	35	53
AS13	4.5	48	25	64
AS14B	3.0	48	44	53
AS15	1.5	48	38	53
AS16	2.7	43	38	48
AS17B	3.9	48	34	56
AS18	2.1	43	36	53
AS19	2.1	43	34	50
AS20	3.3	43	30	44
AS21A	3.6	48	26	44
AS22	3.0	48	28	46
AS23	3.0	43	28	47
AS24	3.0	43	28	47
AS25	5.1	38	27	46
AS26	2.4	48	28	45
SU15	4.2	48	28	45
CO01	4.2	58	28	45

TABLE 24

1985 ASSABET RIVER BASIN SURVEY

RESULTS OF LABORATORY ANALYSES
(All units in mg/l unless otherwise noted)

7/17/85

STATION NUMBER	SUSPENDED SOLIDS	TOTAL SOLIDS	SULFATE	pH (Standard log. units)
AS01	9.0	98	16	6.6
AS03T	16	90	18	7.1
AS04	13.5	160	27	7.1
AS05	9.5	190	25	7.3
AS06	7.5	190	39	7.3
AS07	8.0	210	33	7.3
AS07T	4.0	110	17	7.2
AS09	3.0	170	21	7.0
AS10	7.0	190	30	7.0
AS11	3.0	180	84	7.2
AS12	2.0	170	28	7.1
AS13	2.0	220	35	6.8
AS14B	2.0	170	23	7.8
AS15	4.5	180	27	7.7
AS16	2.0	190	30	7.7
AS17B	2.0	220	58	7.6
AS18	2.0	200	33	7.6
AS19	4.0	180	26	7.6
AS20	5.0	160	19	7.6
AS21A	6.0	180	23	7.7
AS22	4.0	170	30	7.8
AS23	3.5	160	21	7.8
AS24	4.0	160	26	7.4
AS25	5.0	150	23	7.5
AS26	5.0	160	18	7.4
SU15	10	170	22	7.2
CO01	13	160	25	7.4

TABLE 25

1985 ASSABET RIVER BASIN SURVEY

RESULTS OF LABORATORY ANALYSES
(All units in mg/l)

7/17/85

STATION NUMBER	TOTAL KJELDAHL-NITROGEN	AMMONIA-NITROGEN	NITRATE-NITROGEN	PHOSPHORUS
AS01	1.8	0.16	0.0	0.19
AS03T	1.9	0.02	0.1	0.10
AS04	2.7	0.57	1.7	2.4
AS05	6.6	3.8	0.1	3.1
AS06	4.7	4.1	0.1	2.6
AS07	7.2	6.3	0.0	3.0
AS07T	1.4	0.0	0.2	0.25
AS09	4.9	3.8	0.9	3.0
AS10	5.6	3.3	0.7	2.7
AS11	4.0	1.2	0.8	0.98
AS12	2.5	0.63	1.3	1.1
AS13	2.4	0.59	1.2	1.0
AS14B	2.5	0.70	0.8	0.94
AS15	2.4	0.39	0.9	0.99
AS16	1.9	0.06	0.9	0.83
AS17B	1.5	0.14	1.5	0.98
AS18	1.5	0.06	1.2	1.0
AS19	1.5	0.16	0.4	1.0
AS20	1.4	0.05	0.3	0.78
AS21A	1.3	0.10	1.0	0.98
AS22	1.1	0.14	0.8	0.90
AS23	1.3	0.14	1.5	0.92
AS24	1.5	0.04	0.9	0.90
AS25	1.2	0.08	1.4	0.69
AS26	1.4	0.31	0.8	0.60
SU15	1.2	0.11	0.1	0.14
CO01	1.1	0.10	0.6	0.16

TABLE 26

1985 ASSABET RIVER BASIN SURVEY

TOTAL AND FECAL COLIFORM BACTERIA
(Organisms/100 ml)

7/17/85

STATION NUMBER	TOTAL COLIFORM BACTERIA	FECAL COLIFORM BACTERIA
AS01	700	10
AS03T	1,000	200
AS04	7,000	300
AS04A	2,400	91
AS05	80,000	4,500
AS06	98,000	32,000
AS07	90,000	35,000
AS07T	300	5
AS09	800	20
AS10	900	20
AS11	100	<5
AS12	1,800	640
AS13	600	200
AS14B	700	140
AS15	5,200	880
AS16	1,900	600
AS17B	1,100	300
AS18	200	80
AS19	50	<5
AS20	30,000	2,200
AS21A	3,000	460
AS22	2,900	480
AS23	800	100
AS24	700	200
AS25	11,000	500
AS26	1,100	160
SU15	3,000	70
CO01	40	<5

TABLE 27

1985 ASSABET RIVER BASIN SURVEY

TOTAL METALS DATA (mg/l)

7/17/85

STATION NUMBER	Al	Cd	Cr	Cu	Fe	Pb	Hg	Mn	Ni	Zn
AS01	<0.10	<0.02	<0.02	<0.02	1.7	0.05	0.0000	0.15	<0.05	0.04
AS03T	<0.10	<0.02	<0.02	<0.02	0.98	<0.04	0.0000	1.6	<0.05	<0.03
AS04	<0.10	<0.02	<0.02	0.03	0.79	<0.04	0.0000	0.10	<0.05	0.10
AS05	<0.10	<0.02	<0.02	0.05	0.80	<0.04	0.0000	0.12	<0.05	0.07
AS10	<0.10	<0.02	<0.02	0.03	1.5	<0.04	0.0000	0.68	0.08	0.03
AS17	<0.10	<0.02	<0.02	0.02	0.31	<0.04	0.0000	0.06	<0.05	0.03
AS21	<0.10	<0.02	<0.02	<0.02	0.60	<0.04	0.0000	0.13	<0.05	0.03
AS22	<0.10	<0.02	<0.02	<0.02	0.57	0.04	0.0000	0.11	<0.05	<0.03
AS23	<0.10	<0.02	<0.02	<0.02	0.43	0.05	0.0000	0.05	<0.05	<0.03

TABLE 28

1985 ASSABET RIVER BASIN SURVEY

PURGEABLE ORGANIC, AND OIL AND GREASE COMPOUNDS

7/17/85

STATION NUMBER	PURGEABLE ORGANICS (μg/l)	OIL & GREASE (mg/l)
AS03T	none detected	0.9
AS04	methylene chloride - 1.0	0.9
	chloroform - 1.3	
	bromodichloromethane - <1.0	
AS20	none detected	--
AS21	none detected	0.7
AS22	none detected	0.9
AS23	none detected	--

STREAMFLOW DATA

TABLE 29

1985 ASSABET RIVER BASIN

U.S.G.S. GAGE AT MAYNARD

FLOW DATA*

DATE	DISCHARGE (ft^3/sec)
December 4, 1984	82
January 23, 1985	67
February 26, 1985	218
April 16, 1985	139
May 16, 1985	80
June 27, 1985	68
July 17, 1985	41
August 22, 1985	45
September 10, 1985	98
October 17, 1985	98

*Data from U.S.G.S. with drainage area of 116 sq. mi.

WASTEWATER DISCHARGE DATA

ASSABET RIVER BASIN

TABLE 30

WESTBOROUGH WASTEWATER TREATMENT PLANT

RESULTS OF LABORATORY ANALYSES
(All units in mg/l unless otherwise noted)

	12/4/84[1]	1/23/85[1]	2/26/85[1]	4/16/85[1]	5/16/85[1]
PARAMETER	EFFLUENT	EFFLUENT	EFFLUENT	EFFLUENT	EFFLUENT
COD	92	102	75	80	--
BOD_5	8.0	34	21	4.8	10
pH (Standard Log. Units)	6.2	7.1	7.2	7.4	7.7
Total Alkalinity	17	101	98	107	136
Suspended Solids	17	14	6.5	11	13
Total Solids	350	320	280	290	300
Hardness	61	49	75	63	42
Sulfate	40	36	35	32	2.0
Total Kjeldahl-Nitrogen	2.8	15	14	33	--
Ammonia-Nitrogen	0.17	9.5	10	12	--
Nitrate-Nitrogen	12	0.4	0.0	0.0	--
Total Phosphorus	6.8	2.4	1.8	21	--
Chlorine Residual[1]	0.5	2.0	1.8	1.2	--
Total Coliform (organisms/100 ml)[1]	24,000	160	50	30	--
Fecal Coliform (organisms/100 ml)[1]	4,300	10	5	5	--
Flow (MGD)	--	--	1.67	1.61	--
Aluminum	--	--	--	0.26	--
Cadmium	--	--	--	<0.02	--
Chromium	--	--	--	<0.02	--
Copper	--	--	--	0.07	--
Iron	--	--	--	0.21	--
Mercury	--	--	--	<0.0002	--
Manganese	--	--	--	<0.02	--
Nickel	--	--	--	<0.05	--
Lead	--	--	--	0.01	--
Tin	--	--	--	<0.10	--
Zinc	--	--	--	0.33	--

[1] Grab sample

TABLE 30 (CONTINUED)

PARAMETER	6/26-27/85 EFFLUENT	7/16-17/85 EFFLUENT	8/21-22/85 EFFLUENT	9/9-10/85 EFFLUENT	10/16-17/85 INFLUENT	10/16-17/85 EFFLUENT
COD	120	166	59	53	--	--
BOD_5	16	45	7.8	5.6	160	13
pH (Standard Log. Units)	7.1	7.0	7.0	6.8	7.1	6.7
Total Alkalinity	31	30	27	32	143	19
Suspended Solids	23	119	3.0	18	76	14
Total Solids	330	310	294	330	650	360
Settleable Solids (ml/l)	1.0	14	0.0	--	--	--
Hardness	--	--	--	--	--	--
Sulfate	--	--	--	--	--	--
Chloride	62	39	69	--	--	60
Total Kjeldahl-Nitrogen	4.0	14	14	1.5	36	5.4
Ammonia-Nitrogen	0.14	0.24	0.16	0.15	24	0.26
Nitrate-Nitrogen	10	4.1	11	11	0.0	14
Total Phosphorus	3.6	6.5	4.2	5.2	7.5	5.2
Chlorine Residual[1]	1.5	1.4	0.95	1.4	--	--
Total Coliform (organisms/100 ml)[1]	230	2,400	230	200	--	24,000
Fecal Coliform (organisms/100 ml)[1]	40	<36	36	<20	--	7,900
Flow (MGD)	1.25	3.85	1.24	1.43	--	--
Aluminum	0.11	0.57	0.18	<0.10	--	--
Cadmium	<0.02	<0.02	<0.02	<0.02	--	--
Chromium	<0.02	<0.02	<0.02	<0.02	--	--
Copper	0.09	0.34	0.04	0.05	--	--
Iron	0.31	0.82	0.08	0.10	--	--
Mercury	--	--	<0.0002	<0.0002	--	--
Manganese	0.04	0.08	<0.02	<0.02	--	--
Nickel	<0.05	<0.05	<0.05	<0.05	--	--
Lead	<0.04	0.07	0.04	<0.04	--	--
Tin	<0.5	<0.5	<0.5	--	--	--
Zinc	0.22	0.14	0.04	0.05	--	--
Silver	--	--	--	<0.02	--	--

[1] Grab sample

TABLE 31

SHREWSBURY WASTEWATER TREATMENT PLANT

RESULTS OF LABORATORY ANALYSES
(All units mg/l unless otherwise noted)

PARAMETER	12/4/84[1] EFFLUENT[2]	1/23/85[1] EFFLUENT[2]	2/26/85[1] EFFLUENT[2]	4/16/85[1] EFFLUENT[3]	5/16/85[1] EFFLUENT[3]
COD	340	307	285	302	--
BOD_5	200	200	200	81	105
pH (Standard Log. Units)	7.3	7.1	7.2	7.1	7.1
Total Alkalinity	195	197	173	163	203
Suspended Solids	94	81	72	83	67
Total Solids	550	530	470	440	540
Hardness	127	96	160	127	78
Sulfate	63	56	65	42	5.0
Total Kjeldahl-Nitrogen	62	34	39	39	--
Ammonia-Nitrogen	27	25	19	22	--
Nitrate-Nitrogen	--	0.0	0.0	0.0	--
Total Phosphorus	20	4.2	6.9	6.7	--
Chlorine Residual[1]	0.2	0.4	0.15	--	--
Total Coliform (organisms/100 ml)[1]	240,000	240,000	1,300,000	--	--
Fecal Coliform (organisms/100 ml)[1]	9,300	43,000	14,000	--	--
Flow (MGD)	--	--	--	2.2	1.6 (est.)
Aluminum	--	--	--	0.30	--
Cadmium	--	--	--	<0.02	--
Chromium	--	--	--	<0.02	--
Copper	--	--	--	0.25	--
Iron	--	--	--	0.66	--
Mercury	--	--	--	0.001	--
Manganese	--	--	--	<0.02	--
Nickel	--	--	--	<0.05	--
Lead	--	--	--	<0.04	--
Tin	--	--	--	0.13	--
Zinc	--	--	--	0.49	--

[1] Grab sample
[2] Outfall to river
[3] Clarifier outfall

TABLE 31 (CONTINUED)

PARAMETER	6/27/85[1] EFFLUENT[3]	EFFLUENT[2]	7/16-17/85 EFFLUENT[3]	EFFLUENT[2]
COD	296	301	330	280
BOD_5	93	22	132	114
pH (Standard Log. Units)	7.3	7.4	7.1	7.3
Total Alkalinity	183	187	213	192
Suspended Solids	43	28	57	87
Total Solids	470	430	540	530
Settleable Solids (ml/l)	0.5	0.16	3.8	1.4
Chloride	74	77	72	79
Total Kjeldahl-Nitrogen	51	44	30	39
Ammonia-Nitrogen	21	21	23	21
Nitrate-Nitrogen	0.1	0.1	0.0	0.0
Total Phosphorus	6.6	7.1	7.9	9.0
Chlorine Residual[1]	--	0.10	--	0.4
Total Coliform (organisms/100 ml)[1]	--	240,000	--	43,000
Fecal Coliform (organisms/100 ml)[1]	--	93,000	--	2,400
Flow (MGD)	1.61	--	1.55	--
Aluminum	0.38	0.18	0.27	0.22
Cadmium	<0.02	<0.02	<0.02	<0.02
Chromium	<0.02	<0.02	<0.02	<0.02
Copper	0.24	0.22	0.28	0.23
Iron	0.55	0.51	0.82	0.67
Manganese	0.10	0.11	0.10	0.10
Nickel	<0.05	<0.05	<0.05	<0.05
Lead	<0.04	<0.04	0.05	<0.04
Tin	<0.5	<0.5	<0.50	<0.50
Zinc	0.10	0.13	0.14	0.14

[1] Grab sample
[2] Outfall to river
[3] Clarifier outfall

TABLE 31 (CONTINUED)

PARAMETER	8/21-22/85 EFFLUENT[3]	8/21-22/85 EFFLUENT[2]	9/9-10/85 EFFLUENT[2]	10/16-17/85 INFLUENT	10/16-17/85 EFFLUENT[3]
COD	277	288	207	--	--
BOD_5	102	120	69	350	140
pH (Standard Log. Units)	7.3	7.5	7.6	7.3	6.8
Total Alkalinity	198	196	151	175	146
Suspended Solids	41	44	52	210	130
Total Solids	474	480	460	710	580
Settleable Solids (ml/l)	1.6	1.5	--	--	--
Chloride	77	81	--	--	--
Total Kjeldahl-Nitrogen	51	41	22	24	22
Ammonia-Nitrogen	19	20	18	21	22
Nitrate-Nitrogen	0.1	0.2	0.1	0.2	0.1
Total Phosphorus	8.1	7.5	6.5	5.3	5.0
Chlorine Residual[1]	--	0.60	0.10	--	--
Total Coliform (organisms/100 ml)[1]	--	430	46,000	--	46,000
Fecal Coliform (organisms/100 ml)[1]	--	36	9,300	--	360
Flow (MGD)	1.546	--	1.920	--	--
Aluminum	0.15	0.19	1.6	--	--
Cadmium	<0.02	<0.02	<0.02	--	--
Chromium	<0.02	<0.02	<0.02	--	--
Copper	0.23	0.24	0.26	--	--
Iron	0.62	0.62	2.0	--	--
Mercury	0.0001	0.0009	<0.0002	--	--
Manganese	0.11	0.11	0.10	--	--
Nickel	<0.05	<0.05	<0.05	--	--
Lead	0.07	0.06	<0.04	--	--
Tin	<0.5	<0.5	--	--	--
Zinc	0.12	0.12	0.15	--	--
Silver	--	--	<0.02	--	--

1 Grab sample
2 Outfall to river
3 Clarifier outfall

TABLE 32

MARLBOROUGH WEST WASTEWATER TREATMENT PLANT

RESULTS OF LABORATORY ANALYSES
(All units mg/l unless otherwise noted)

	1/7-8/85	1/9/85[1]		1/9-10/85	1/16/85	7/16-17/85
PARAMETER	EFFLUENT	INFLUENT	EFFLUENT	EFFLUENT	EFFLUENT	EFFLUENT
COD	87	306	142	157	128	113
BOD_5	11	140	18	20	14	17
pH (Standard Log. Units)	7.0	7.0	7.0	7.2	6.9	7.3
Total Alkalinity	150	110	130	120	190	74
Suspended Solids	13	120	31	38	22	65
Total Solids	390	390	400	590	450	550
Settleable Solids (ml/l)	--	--	0.0	0.1	0.0	0.0
Chloride	215	48	76	90	--	106
Total Kjeldahl-Nitrogen	26	17	18	36	20	3.2
Ammonia-Nitrogen	18	17	18	31	19	1.1
Nitrate-Nitrogen	1.1	0.2	0.9	0.6	0.5	8.7
Total Phosphorus	2.4	3.3	2.9	2.4	3.8	1.3
Chlorine Residual[1]	--	--	--	--	--	1.0
Total Coliform (organisms/100 ml)[1]	--	--	--	--	--	9,300
Fecal Coliform (organisms/100 ml)[1]	--	--	--	--	--	2,300
Flow (MGD)	1.18	--	1.19	1.19	1.16	1.42
Aluminum	<0.1	<0.1	<0.1	0.1	<0.1	<0.10
Cadmium	0.01	0.00	0.01	0.01	0.00	<0.02
Chromium	0.02	0.04	0.04	0.08	0.04	0.03
Copper	0.08	0.34	0.11	0.12	0.14	0.08
Iron	0.31	1.7	0.72	0.72	0.63	0.27
Mercury	0.0000	0.0000	0.0000	0.0000	0.0006	--
Manganese	0.10	0.10	0.15	0.15	0.14	0.07
Nickel	0.54	1.1	0.52	6.5	1.4	1.0
Lead	0.04	0.04	0.00	0.07	0.00	<0.04
Tin	<0.50	<0.50	<0.50	<0.50	<0.5	<0.50
Zinc	0.08	0.20	0.17	0.18	0.19	0.11
Silver	--	--	--	--	0.00	--

[1] Grab sample

TABLE 33

HUDSON WASTEWATER TREATMENT PLANT

RESULTS OF LABORATORY ANALYSES
(All units in mg/l unless otherwise noted)

PARAMETER	7/16-17/85 EFFLUENT
COD	147
BOD_5	25
pH (Standard log. units)	7.3
Total Alkalinity	87
Suspended Solids	16
Total Solids	700
Settleable Solids (ml/l)	0.0
Chloride	165
Total Kjeldahl-Nitrogen	21
Ammonia-Nitrogen	11
Nitrate-Nitrogen	3.3
Total Phosphorus	7.0
Chlorine Residual[1]	0.8
Total Coliform (organisms/100 ml)[1]	150,000
Fecal Coliform (organisms/100 ml)[1]	2,400
Flow (MGD)	2.5
Aluminum	0.30
Cadmium	<0.02
Chromium	<0.02
Copper	0.13
Iron	0.85
Manganese	0.12
Nickel	<0.05
Lead	0.06
Tin	<0.50
Zinc	0.11

[1] Grab sample

TABLE 34

MAYNARD WASTEWATER TREATMENT PLANT

RESULTS OF LABORATORY ANALYSES
(All units in mg/l unless otherwise noted)

PARAMETER	7/16-17/85 EFFLUENT
COD	90
BOD_5	16
pH (Standard log. units)	6.0
Total Alkalinity	4.0
Suspended Solids	8.5
Total Solids	330
Settleable Solids (ml/l)	0.0
Chloride	47
Total Kjeldahl-Nitrogen	7.3
Ammonia-Nitrogen	0.51
Nitrate-Nitrogen	13
Total Phosphorus	6.2
Chlorine Residual[1]	1.3
Total Coliform (organisms/100 ml)[1]	930
Fecal Coliform (organisms/100 ml)[1]	36
Flow (MGD)	0.85
Aluminum	0.24
Cadmium	<0.02
Chromium	<0.02
Copper	0.03
Iron	0.75
Manganese	0.28
Nickel	<0.05
Lead	<0.04
Tin	<0.50
Zinc	0.19

[1] Grab sample

TABLE 35

CONCORD MCI WASTEWATER TREATMENT PLANT

RESULTS OF LABORATORY ANALYSES
(All units in mg/l unless otherwise noted)

PARAMETER	7/16-17/85 EFFLUENT
COD	137
BOD_5	42
pH (Standard log. units)	7.0
Total Alkalinity	40
Suspended Solids	57
Total Solids	290
Settleable Solids (ml/l)	0.0
Chloride	40
Total Kjeldahl-Nitrogen	19
Ammonia-Nitrogen	0.97
Nitrate-Nitrogen	3.6
Total Phosphorus	3.1
Chlorine Residual[1]	0.3
Total Coliform (organisms/100 ml)[1]	240,000
Fecal Coliform (organisms/100 ml)[1]	93,000
Flow (MGD)	0.275
Aluminum	0.24
Cadmium	<0.02
Chromium	<0.02
Copper	0.02
Iron	0.20
Manganese	0.02
Nickel	<0.05
Lead	<0.04
Tin	<0.50
Zinc	0.08

1 Grab sample

TABLE 36

NATIONAL WATER QUALITY CRITERIA METALS AND OTHER COMMON CONTAMINANTS

Freshwater (µg/l)

POLLUTANT	HARDNESS (mg/l)	4 DAY AVG/3 YR.	1 HOUR AVG/3 YR.
1) Arsenic (III)	--	190	360
2) Cadmium**	20	0.32	0.64
	50	0.66	1.8
3) Chlorine	--	11	19
4) Chromium (III)**	20	55	465
	50	120	980
Chromium (VI)	--	11	16
5) Copper**	20	3.0	3.9
	50	6.5	9.2
6) Cyanide	--	5.2	22
7) Lead**	20	0.41	11
	50	1.3	34
8) Mercury	--	0.012	2.4
		24-HOUR AVERAGE	MAXIMUM
9) Nickel**	20	28	319
	50	56	641
10) Silver**	20	[0.12]	0.09
	50	[0.12]	0.44
11) Zinc**	20	47	74
	50	47	159

** Numbers for the freshwater criteria for these compounds are derived from the equation .

[] Data indicate that toxicity may occur as low as 0.12 µg/l; this value is not a criterion.

THE ASSESSMENT OF WATER POLLUTION

A workable definition of the term "water pollution" is difficult to formulate simply because pollution problems are extremely variable and site-specific. The word "pollute" literally means to "render impure"; however, a more acceptable definition of pollution must take factors into account such as the chemical, physical, and biological characteristics of natural water, the intended use of a receiving water, and an understanding of the nature and fate of a given pollutant after its introduction into a body of water. Regardless of how we choose to define it, water pollution involves the addition of certain characteristics to a water body which may render that water unfit for its intended utilization. Some of the more common forms of water pollution include: oxygen demanding organic wastes and sewage derivatives; man-made organic compounds such as pesticides, some industrial wastes, and inorganic toxic compounds; infectious disease producing agents; nutrients and sediments from land runoff; radioactive substances; oil and grease; and thermal discharges. In some instances, the combined effects of two or more contaminants are further enhanced by their interaction. In short, whether discharged from residences, institutions, or industries, each form of pollution has a characteristic effect on the water into which it is introduced. The receiving water may become unsightly, malodorous, and/or a hazard to public health, and consequently its uses may be severely limited.

Methods used for the assessment of water quality generally fall into three main categories: chemical, physical, and biological. Chemical analyses may include the determination of pH and alkalinity in addition to the concentrations of various ions, metals, and dissolved gases such as oxygen, carbon dioxide and hydrogen sulfide. Physical parameters often measured are temperature, color, turbidity, and flow characteristics. Biological methods may be categorized as either field surveys which are an attempt to ascertain the numbers and kinds of aquatic organisms associated with various water qualities, or laboratory studies in which bioassays are conducted to determine the levels of toxicity of different chemical parameters for a given test organism.

The parameters listed above are measured in most water quality surveys conducted by the Massachusetts Division of Water Pollution Control. Although no bioassay studies are done by the Division, the Biological Section conducts macroinvertebrate surveys on selected rivers and streams throughout the Commonwealth. In addition, microscopic examinations are conducted during most surveys to determine the abundance and kinds of algae and other microorganisms present in the water. Finally, bacterial samples are obtained and analyzed during each water quality survey.

Two types of samples are collected for chemical analysis. A grab sample is an instantaneous sample collected to indicate water quality conditions at a particular time. Composite samples are collected over a period of time at specific intervals. This method gives a better indication of the overall water quality situation during the sampling period.

Oxygen Relationships

The dissolved oxygen (D.O.) in water refers to the uncombined oxygen held in solution and thereby made available to aquatic organisms for respiration. Sources of dissolved oxygen include atmospheric aeration and the direct addition of oxygen as the byproduct of chemical reduction reactions and algal photosynthesis. Whereas respiratory processes of aquatic organisms consume oxygen throughout the day and night, photosynthetic release of oxygen is restricted to the daylight hours. As a result, productive waters exhibit a characteristic diurnal variation in dissolved oxygen concentration. The solubility of oxygen (O_2) in water is primarily a function of water temperature and the atmospheric partial pressure of oxygen. Saturation levels at standard pressure (760 mm Hg) range from 14.6 mg/l O_2 at 0°C to 6.6 mg/l O_2 at 40°C.

Organic matter is introduced to a river or stream either as the result of natural phenomena, such as the deposition of leaves and other plant materials in autumn, or by the discharge of pollutants resulting from human related activities. Regardless of its origin, organic matter is gradually decomposed by bacteria which utilize the available dissolved oxygen in the water. Therefore, the ability of a stream segment to assimilate these organic materials, that is, its waste assimilative capacity, is dependent upon the amount of dissolved oxygen present in the water. In many instances, the assimilation of large amounts of organic wastes severely depletes the oxygen concentration in the water body rendering it unsuitable for the existence of aquatic organisms such as invertebrates and fish.

The biochemical oxygen demand (BOD) is a measure of the amount of oxygen required by bacteria to decompose a given amount of organic matter. This decomposition process occurs in two distinct steps each governed by a specific kind of bacteria. During the first step, or carbonaceous stage, carbon compounds are stabilized with a concurrent release of carbon dioxide. The second stage, nitrification, begins approximately seven days later and is the process by which nitrogenous substances are broken down to ammonia and ultimately to nitrate. The total combined oxygen demands of both stages is the ultimate BOD which may be exerted over a period of thirty days or more. Through recurrent use, the five day BOD (BOD_5) has been accepted as the standard test used in water quality analysis. While the BOD_5 of untreated sewage normally ranges from 150 to 300 mg/l, the BOD_5 of an unpolluted water rarely exceeds 2 mg/l.

Some types of organic wastes are not readily broken down by bacteria but can be decomposed by chemical processes. The chemical oxygen demand (COD) refers to the amount of oxygen required for the dichromate oxidation of a given amount of organic matter. Since some organic matter in any waste is not biodegradable, the COD is usually greater than the BOD.

Nutrients

Nutrients are substances that are essential to the growth or reproduction of organisms. In aquatic habitats algae and macrophytes rely on dissolved nitrogen and phosphorus compounds as nutrients and, as such, these substances are not harmful at low concentrations. Wastewater discharges often contain large amounts of carbon, nitrogen, and phosphorus containing compounds. Excessive nutrient loading of a water body increases plant production. As a result of this increased productivity, rapidly multiplying algal populations or "blooms" occur which may severely limit the potential use of the water. In many instances a high oxygen demand is exerted by the decomposing algae resulting from a sudden dieback.

Nitrogen compounds exist in water in a variety of forms. They may occur as cellular components, particulate matter, soluble organic substances or inorganic ions. These different forms and their interrelated chemical reactions are collectively known as the nitrogen cycle. Organic nitrogen in the form of protein, amino acid, or urea occurs in water containing organic wastes. Oxidation and reduction of these nitrogenous compounds are closely linked to the metabolic activity of many kinds of microorganisms. As described above, nitrification is tied to bacterial action, and is carried out by a fixed sequence of reactions through which ammonia, nitrite, and ultimately nitrate are produced. Therefore, the progress of decomposition of organic nitrogen can be determined by assessing the relative amounts of these compounds. Ammonia (NH_3) results from the initial decomposition of organic nitrogen and is always present in untreated sewage. It can also be formed by the reduction of nitrite. Ammonia exerts a high oxygen demand and is toxic to many aquatic organisms. Oxidation of ammonia yields nitrite (NO_2^-) which is quickly converted to nitrate (NO_3^-), the end product of the decomposition of nitrogenous matter. Nitrate is the form of nitrogen that is directly available to algae and other aquatic plants as a nutrient.

Phosphorus is present in water bodies in dissolved, colloidal, or particulate states and originates primarily from agricultural runoff and wastewaters containing detergents. It may exist as orthophosphate, polyphosphate, or in organic compounds. Although phosphorus occurs in natural waters in smaller amounts than nitrogen, it is an essential plant nutrient.

Coliform Bacteria

Fecal coliform bacteria are found in the intestinal tract of warm-blooded animals. Although not a serious health hazard by themselves, their presence in water is a good indication that sewage and associated pathogenic microorganisms may be present. Since coliforms can be detected by relatively simple test procedures they are used to indicate the extent of bacterial pollution from sewage and combined sewer overflows. Tests are usually conducted to determine the number of fecal and total coliforms present in water or wastewater. The number of total coliforms includes those of fecal origin and from non-fecal sources such as soil, grain, or decaying vegetation. In areas where urban runoff is a problem, total coliform levels can be very high, whereas fecal coliform levels may remain minimal as long as sewage is not present in the water. Often municipal wastes are disinfected at a treatment plant to kill bacteria before they are discharged to a receiving water.

pH and Alkalinity

The pH of water is a measure of its hydrogen ion (H^+) concentration on an inverse logarithmic scale which ranges from 0 to 14. pH values of less than 7 indicate higher H^+ content and therefore acidic solutions whereas pH values above 7 denote alkaline solutions. The pH of pure water at 25°C is 7.00; however, natural waters exhibit a wide range of pH values depending upon their chemical and biological characteristics. Unpolluted river water usually has a pH between 6.5 and 8.5. In productive segments, a diurnal fluctuation in pH may occur as photosynthetic organisms take up dissolved carbon dioxide during the daylight hours. Drastic changes in pH occur when industrial effluents containing strong acids or alkali are discharged to a water body. These pH shifts are sometimes toxic to aquatic organisms. Alkalinity is defined as the capacity of water to neutralize acid. This property is attributed to the presence of several different solute species. These are primarily carbonates and bicarbonates but also hydroxides, borates, silicates, and phosphates. Alkalinity is expressed in milligrams per liter of equivalent calcium carbonate.

Solids

Suspended solids refers to the particulate matter that either floats on the surface of, or is in suspension in, water or wastewater, and is removable by laboratory filtering techniques. That matter remaining in the water after filtering is referred to as dissolved solids. Suspended solids in a stream may settle out in sluggishly flowing segments causing sediments to build up on the substrate. This siltation can be particularly harmful to fish eggs and larvae by hindering their mechanisms for obtaining oxygen from the water. Suspended solids analysis provides a reliable measure of the efficiency of wastewater treatment facilities. Primary treatment should remove about 50 percent of the suspended solids from an influent while 90 percent removal should result from secondary treatment. The test for total solids measures all suspended and dissolved solids in water. They are measured by evaporating the water from a sample of known volume and weighing the residue. This residue can then be ignited in a furnace to determine the organic portion. Turbidity is a measure of the clarity of a water sample and is related to solids content. The laboratory test is based on the scattering and absorption of light by the sample and the results are expressed in Nephelometric Turbidity Units (NTU).

Color

The color of natural water is primarily due to the leaching of organic debris and is empirically determined by comparing the sample with known concentrations of colored solution. It is then expressed in standard units of color. Severe color problems resulting from a pollution discharge are described qualitatively rather than numerically. Although color may not be harmful to aquatic life, it may render the water unacceptable for drinking purposes and for some types of industrial use.

Other Parameters

Depending upon specific river conditions, a water quality survey may include additional analyses such as those for oil and grease, heavy metal, or toxic organic compound content. Grease in a wastewater consists of a mixture of fats, waxes, free fatty acids, calcium and magnesium soaps, mineral oils, and certain other nonfatty substances.

Heavy metals and certain organic compounds are toxic to aquatic organisms when present in sufficient quantities. They may also have an adverse effect on sewage and industrial wastewater treatment systems. Metals that are often monitored are cadmium, chromium, copper, iron, lead, manganese, nickel, and zinc.

APPENDIX A

ANALYTICAL METHODS USED AT LAWRENCE EXPERIMENT STATION

PARAMETER	METHOD	REPORTED AS
BOD	5-day oxygen depletion at 20°C	mg/l BOD
Dissolved Oxygen	Azide modification of Winkler method. 0.0375 N sodium thiosulfate titrant, 300 ml sample	mg/l D.O.
pH	Electrometric, glass indicator, silver chloride reference	pH Standard Logarithmic Units
Turbidity	Nephelometric. Hach Turbidimeter. Model 2100A	Nephelometric Turbidity Units
Total Alkalinity	0.02 N sulfuric acid potentiometric titration to pH 4.5, Orion Model 701, digital pH meter	mg/l $CaCO_3$
Suspended Solids	Filtration through standard glass fiber filter paper. Residue dried at 103-105°C. Gravimetric	mg/l S.S.
Total Solids	Evaporation to dryness at 103-105°C. Gravimetric	mg/l T.S.
Settleable Solids	Gravimetric settling using an Imhoff cone	ml/l sett. solids
Total Kjeldahl-Nitrogen	Acid digestion using Technical BD-40 Block Digester. Colorimetric analysis (reaction of ammonia, sodium salicylate, sodium nitroprusside, and sodium hypochlorite in buffered alkaline medium) using Technicon Auto Analyzer II	mg/l TKN
Ammonia-Nitrogen	Phenate method, automated. Colorimetric analysis using Technicon Auto Analyzer II	mg/l NH_3-N
Nitrate-Nitrogen	Hydrazine reduction method, automated. Colorimetric analysis using Technicon Auto Analyzer II	mg/l NO_3-N

ANALYTICAL METHODS (CONTINUED)

PARAMETER	METHOD	REPORTED AS
Total Phosphate	Acid digestion using Technicon BD-40 Block Digester. Ascorbic acid reduction colorimetric method using Technicon Auto Analyzer II	mg/l P
Total Coliform	Membrane filter technique	Total coliforms/100 ml
Fecal Coliform	Membrane filter technique	Fecal coliforms/100 ml
COD	Dichromate reflux	mg/l COD
Conductivity	Wheatstone Bridge type meter. Yellow Springs Instrument conductivity bridge, Model 31	µmhos/cm
Color	Visual comparison of sample with known concentrations of colored solutions	Color Units
Chloride	Argentometric (titration with silver nitrate)	mg/l Cl
Silica	Colorimetric analysis (silico-molybdate reduction in acidic solution to "heteropoly blue" by aminonaphtholsulfonic acid) Technicon Auto Analyzer I	mg/l SiO_2
Cadmium, copper, chromium, iron, lead, magnesium, manganese, nickel, zinc, hardness (Ca+Mg)	Atomic Absorption Spectrophotometry. Air-acetylene flame. Perkin-Elmer Model 403	mg/l
Aluminum, Tin	Atomic Absorption Spectrophotometry. Nitrous oxide-acetylene flame. Perkin-Elmer Model 403	mg/l
Hexavalent Chromium	Colorimetric using diphenylcarbazide. Klett-Summerson photoelectric colorimeter	mg/l Cr^{+6}
Phenols	4-amino anti-pyrine colorimetric method	mg/l