UPPER ASSABET RIVER

1988

DISSOLVED OXYGEN DATA

EXECUTIVE OFFICE OF ENVIRONMENTAL AFFAIRS
JOHN P. DEVILLARS, SECRETARY

DEPARTMENT OF ENVIRONMENTAL QUALITY ENGINEERING
DANIEL S. GREENBAUM, COMMISSIONER

DIVISION OF WATER POLLUTION CONTROL
CORNELIUS J. O'LEARY, ACTING DIRECTOR

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By

Nora E. Hanley
Environmental Engineer

TECHNICAL SERVICES BRANCH
MASSACHUSETTS DEPARTMENT OF WATER POLLUTION CONTROL
WESTBOROUGH, MASSACHUSETTS

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MAY 1989

Publication #15964-36-25-5-89-C.R.
Approved By: Ric Murphy State Purchasing Agent

TITLE: Assabet River 1988 Dissolved Oxygen Data

DATE: May 1, 1989

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Approved by:

Alan N Cooperman

Alan N. Cooperman, M.S. P.E.

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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 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.

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INTRODUCTION

In the past several years the Assabet River has been the focus of much public controversy. Inadequately treated municipal effluents caused severe dissolved oxygen depletion and odor problems in the river, particularly in the Upper Assabet River near Northborough. Consequently, the Division of Water Pollution Control (DWPC) has expended considerable effort to document and remedy the problem. Water quality sampling programs were conducted in 1965, 1969, 1974, 1979, 1985 and 1987. Additionally, the four major municipal wastewater treatment plants (WWTPs) on the Upper Assabet River, the Westborough, Marlborough West, Hudson, and Maynard WWTPs, have either upgraded, or are in the process of upgrading their facilities.

During the summer of 1988, dissolved oxygen (D.O.) was sampled and analyzed for (using the modified Winkler Method, described in Appendix B) in the Upper Assabet River on approximately two days per month. The purpose of the sampling program was to document dissolved oxygen levels instream, particularly in view of the fact that the Westborough WWTP, which discharges into the area in question, was recently upgraded to have advanced wastewater treatment. The Marlborough West WWTP has not yet completed its upgrade to advanced wastewater treatment, and so data from the river in the vicinity of this discharge will provide good information for future comparative studies.

As indicated in Table 1, twelve river locations from Westborough to Hudson were sampled during this study. On most sampling days, both early morning and afternoon surveys were conducted to check for photosynthetic activity.

ANALYSIS

For dissolved oxygen data analysis it is important to note physical river conditions. The Westborough WWTP discharges between stations AS02 and AS04, and the Marlborough West WWTP discharges between stations AS09 and AS10. In addition, the Assabet River, in much of the study area, is slow moving and wetlands oriented, particularly near AS07A, AS11, and AS14A. Finally, organic sediment deposits, of wastewater treatment plant origin, exist in parts of the slow moving stretches of the Upper Assabet.

Another factor likely to effect dissolved oxygen concentrations is river flow. River flow during most of the summer of 1988 was very low. Table 11 gives USGS flow data for the Assabet River at Maynard. Appendix A describes survey weather conditions. Although this study did not extend into Maynard, the figures in Table 11 can be used as a relative measure of river flow upstream. The 7-day, 10-year (7Q10) low flow at the Maynard gage is 16 cfs; so, river flows in 1988 approached a fairly low historical flow level. Thus, the capacity of the river to dilute wastewater was limited.

Diurnal variations in D.O. levels occurred on the Assabet during sunny days, indicative of photosynthesis, as shown in Figures 1,4,5, and 6. Figures 2 and 3 show D.O. levels on rainy days. Obviously, photosynthesis plays a major role in Upper Assabet River D.O. levels.

D.O. values in the early morning at stations AS07A, AS11 and AS14 did not meet the Class B water quality standard of 5 mg/l. These stations are located at particularly marshy or impounded areas of the river, with organic sediment accumulation, and downstream of WWTPs. As described above, low flows and diurnal D.O. variations due to photosynthesis contribute to the low D.O. problem. Overall, D.O. levels at certain locations in the Assabet River during low river flows will probably continue to violate water quality standards to some degree, due to the nature of the river, the abundant algae, the wastewater discharges, and the organic sediments.

TABLE 1

UPPER ASSABET RIVER

LOCATION OF SAMPLING STATIONS

STATION	LOCATION	RIVER MILE
AS02	Maynard Street, Westborough	31.0
AS04	Route 9, Westborough	30.1
AS05	Route 135, Westborough/Northborough	29.2
AS06	School street, Northborough	28.3
AS07A	Above dam, Route 20, Northborough	26.5
AS07B	Below dam, Route 20, Northborough	26.4
AS09	Boundary Street, Northborough/Marlborough	24.2
AS10	Robin Hill Road, Marlborough	23.8
AS11	Bigelow Road, Berlin	22.0
AS13	Chapin Road, Hudson	19.6
AS14A	Footbridge off Brigham Park Street, Hudson	18.5
AS14B	Below dam, Route 85, Hudson	18.2

Wastewater Treatment Locations:

- Westborough WWTP at river mile 30.2
- Marlborough West WWTP at river mile 24.1

TABLE 2

UPPER ASSABET RIVER

DISSOLVED OXYGEN DATA - 07/08/88

STATION	TIME (hr)	TEMPERATURE (°C)	D.O. (mg/l)
AS02	0452	21	7.9
AS05	0457	21	3.9
AS06	0503	22	5.1
AS07A	0511	23	4.9
AS09	0518	21	4.4
AS10	0524	22	4.2
AS11	0533	21	0.9
AS13	0540	23	2.8
AS14A	0549	23	3.8
AS14B	0553	23	7.1

TABLE 3

UPPER ASSABET RIVER

DISSOLVED OXYGEN DATA - 07/14/88

STATION	TIME (hr)	TEMPERATURE (°C)	D.O. (mg/l)
AS02	1459	26	8.0
AS05	1518	27	6.8
AS06	1520	27	7.2
AS07A	1530	26	6.9
AS07B	1530	26	7.3
AS09	1533	29	10.8
AS10	1540	27	6.9
AS11	1545	27	10.6
AS13	1551	27	6.9
AS14A	1559	29	8.6
AS14B	1600	29	7.1

TABLE 4

UPPER ASSABET RIVER

DISSOLVED OXYGEN DATA - 07/15/88

STATION	TIME (hr)	TEMPERATURE (°C)	D.O. (mg/l)
AS02	0520	21	6.0
AS04	0530	23	4.1
AS05	0535	23	3.8
AS06	0541	24	4.3
AS07A	0549	24	3.3
AS07B	0550	24	5.8
AS09	0600	24	4.2
AS10	0605	24	3.3
AS11	0615	24	2.0
AS13	0629	25	4.3
AS14A	0636	26	1.5
AS14B	0642	26	6.8

TABLE 5

UPPER ASSABET RIVER

DISSOLVED OXYGEN DATA - 07/21/88

STATION	TIME (hr)	TEMPERATURE (°C)	D.O. (mg/l)	TIME (hr)	TEMPERATURE (°C)	D.O. (mg/l)
AS02	0600	21	6.0	1339	18	7.2
AS04	0615	22	4.7	1331	20	5.4
AS05	0620	22	3.9	1324	20	5.9
AS06	0625	22	4.8	1320	20	5.6
AS07A	0635	23	2.8	1312	21	3.6
AS07B	0634	23	5.7	1312	21	6.9
AS09	0645	23	4.7	1305	21	6.0
AS10	0651	22	4.0	1302	20	4.3
AS11	0700	22	2.4	1254	21	2.8
AS13	0706	24	4.2	1247	21	1.5
AS14B	0724	24	5.8	1237	23	6.5
AS14A	0715	24	2.4	1243	22	1.5

TABLE 6

UPPER ASSABET RIVER

DISSOLVED OXYGEN DATA - 07/28/88

STATION	TIME (hr)	TEMPERATURE (°C)	D.O. (mg/l)	TIME (hr)	TEMPERATURE (°C)	D.O. (mg/l)
AS02	0552	24	5.4	1327	26	6.4
AS04	0600	24	5.4	1334	25	5.9
AS05	0608	23	4.3	1404	24	5.4
AS06	0615	22	4.9	1410	24	5.2
AS07A	0625	23	3.2	1418	23	4.1
AS07B	0624	23	5.8	1418	23	5.8
AS09	0630	22	5.3	1425	23	5.3
AS10	0635	22	4.1	1430	23	4.7
AS11	0645	22	3.3	1435	23	3.9
AS13	0650	22	2.7	1445	22	3.7
AS14A	0700	23	2.1	1450	23	3.3
AS14B	0705	23	4.6	1455	23	5.0

TABLE 7

UPPER ASSABET RIVER

DISSOLVED OXYGEN DATA - 08/04/88

STATION	TIME (hr)	TEMPERATURE (°C)	D.O. (mg/l)	TIME (hr)	TEMPERATURE (°C)	D.O. (mg/l)
AS02	0620	26	4.9	1319	30	5.2
AS04	0630	26	3.8	1325	28	5.0
AS05	0640	23	2.0	1332	29	5.4
AS06	0645	23	2.7	1337	28	5.1
AS07A	0650	23	1.8	1344	29	4.6
AS07B	0651	23	4.0	1344	29	6.3
AS09	0700	24	3.2	1350	29	2.7
AS10	0702	23	3.1	1354	28	4.9
AS11	0710	23	2.6	1401	28	5.7
AS13	0720	24	2.3	1407	29	4.0
AS14A	0725	25	1.7	1413	29	5.0
AS14B	0730	25	4.8	1416	29	6.0

TABLE 8

UPPER ASSABET RIVER

DISSOLVED OXYGEN DATA - 08/11/88

STATION	TIME (hr)	TEMPERATURE (°C)	D.O. (mg/l)	TIME (hr)	TEMPERATURE (°C)	D.O. (mg/l)
AS02	0600	24	6.0	1340	29	7.1
AS04	0606	22	3.7	1348	27	6.1
AS05	0615	22	3.9	1357	29	6.5
AS06	0620	23	3.9	1404	28	7.6
AS07A	0635	24	3.3	1410	29	6.3
AS07B	0635	24	6.7	1410	28	7.0
AS09	0640	22	4.6	1418	30	10.1
AS10	0645	24	2.5	1427	26	4.4
AS11	0655	24	1.3	1436	26	9.8
AS13	0710	25	5.2	1444	29	7.8
AS14A	0715	25	2.4	1455	26	6.5
AS14B	0720	26	7.2	1505	28	6.8

TABLE 9

UPPER ASSABET RIVER

DISSOLVED OXYGEN DATA - 08/15/88

STATION	TIME (hr)	TEMPERATURE (°C)	D.O. (mg/l)	TIME (hr)	TEMPERATURE (°C)	D.O. (mg/l)
AS02	0615	28	3.7	1303	26	5.9
AS04	0620	25	2.7	1306	25	6.4
AS05	0630	27	3.1	1314	26	6.2
AS06	0631	27	3.6	1318	25	7.0
AS07A	0640	24	2.7	1322	26	5.6
AS07B	0640	24	3.3	1322	27	5.6
AS09	0650	24	3.7	1330	28	9.5
AS10	0655	25	2.1	1333	27	3.0
AS11	0655	25	1.6	1340	27	11.0
AS13	0700	26	3.4	1345	27	8.3
AS14A	0710	26	3.0	1348	27	5.4
AS14B	0715	26	5.2	1352	27	7.2

TABLE 10

UPPER ASSABET RIVER

DISSOLVED OXYGEN DATA - 09/08/88

STATION	TIME (hr)	TEMPERATURE (°C)	D.O. (mg/l)	TIME (hr)	TEMPERATURE (°C)	D.O. (mg/l)
AS02	0735	13	8.7	1246	16	8.4
AS04	0745	18	5.6	1252	22	6.6
AS05	0755	17	5.6	1259	19	6.0
AS06	0802	17	5.9	1303	18	6.0
AS07A	0809	17	5.3	1312	18	5.3
AS07B	0809	17	8.2	1312	18	7.4
AS09	0820	15	7.6	1319	19	8.9
AS10	0826	15	6.2	1323	19	6.2
AS11	0835	16	4.3	1330	18	6.4
AS13	0845	16	3.6	1336	18	5.9
AS14A	0856	17	4.9	1340	20	5.6
AS14B	0905	18	8.1	1345	19	7.3

TABLE 11

ASSABET RIVER FLOW DATA*

U.S.G.S. GAGE AT MAYNARD

DATE	DISCHARGE** ($ft.^3/sec$)
7-8-88	23
7-14-88	39
7-15-88	36
7-21-88	57
7-28-88	243
8-4-88	78
8-11-88	34
8-15-88	35
9-8-88	115

* Data from U.S.G.S. measured on the Assabet River in Maynard.

** (ft^3/sec): cubic feet per second

NOTE: 7-day, 10-year low flow is 16 cfs

FIGURE 1

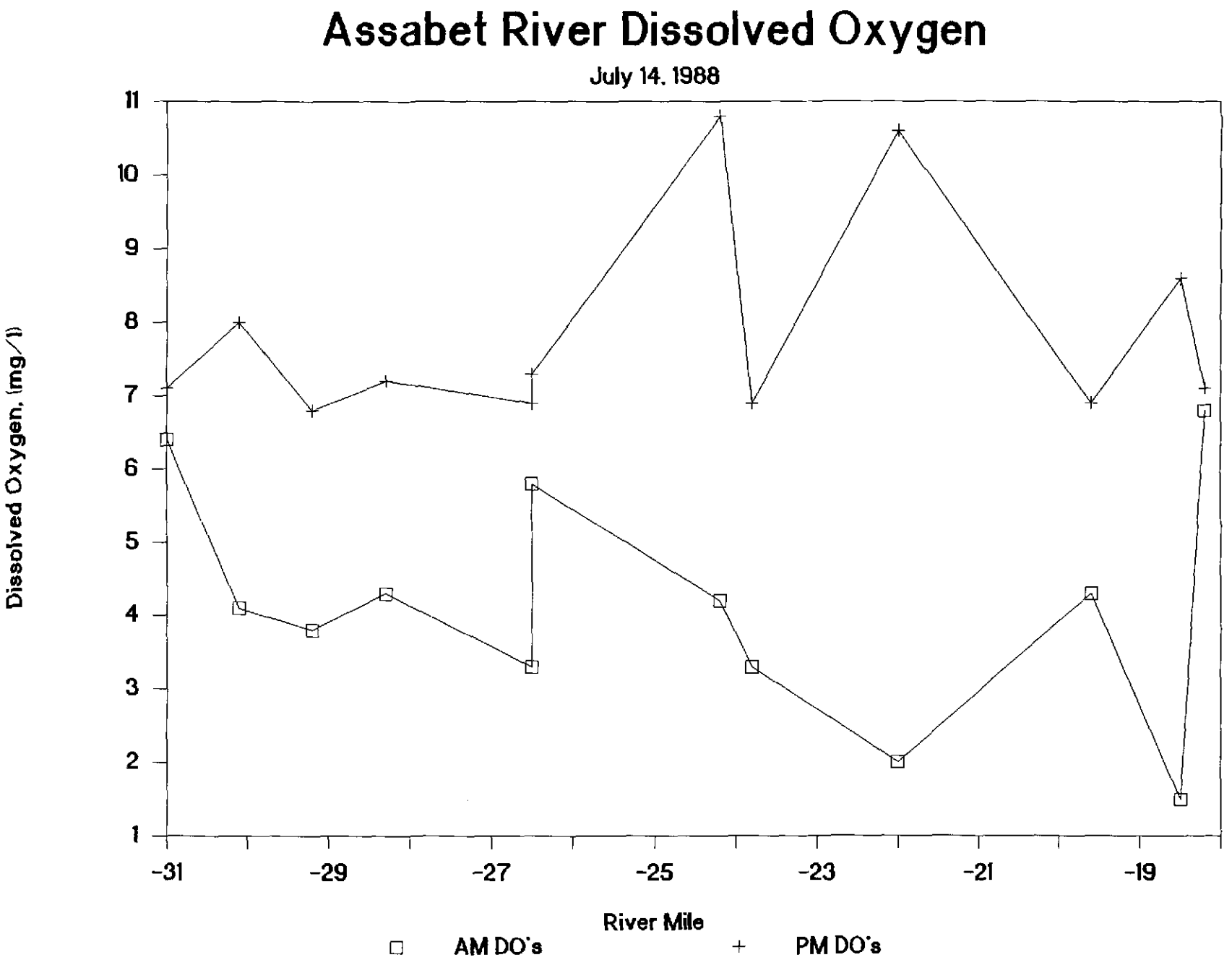

Assabet River Dissolved Oxygen
July 14, 1988
Dissolved Oxygen, (mg/l)
11
10
9
8
7
6
5
4
3
2
1
-31
-29
-27
-25
-23
-21
-19
River Mile
AM DO's
PM DO's

FIGURE 2

ASSABET RIVER DISSOLVED OXYGEN

July 21, 1988

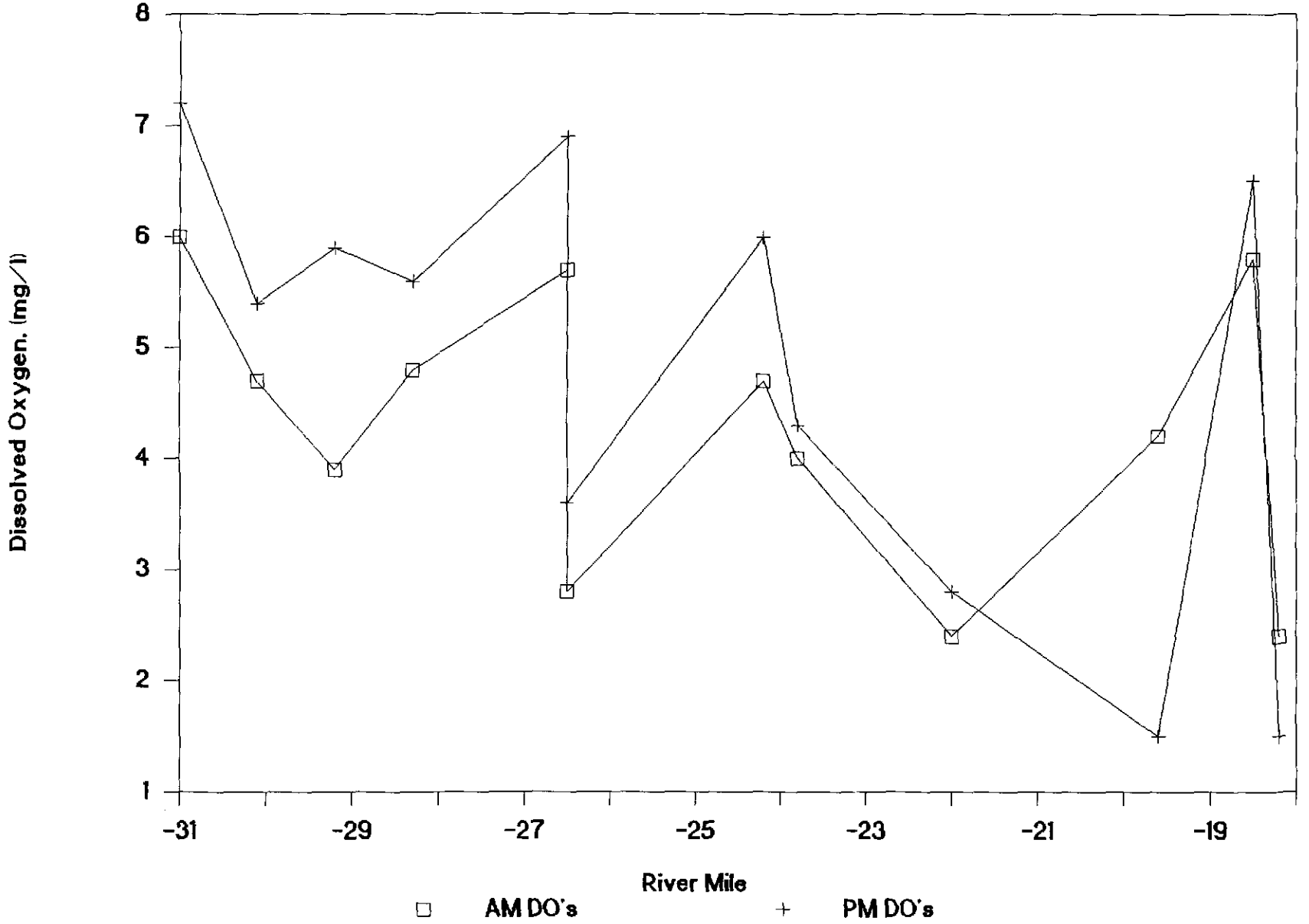


FIGURE 3

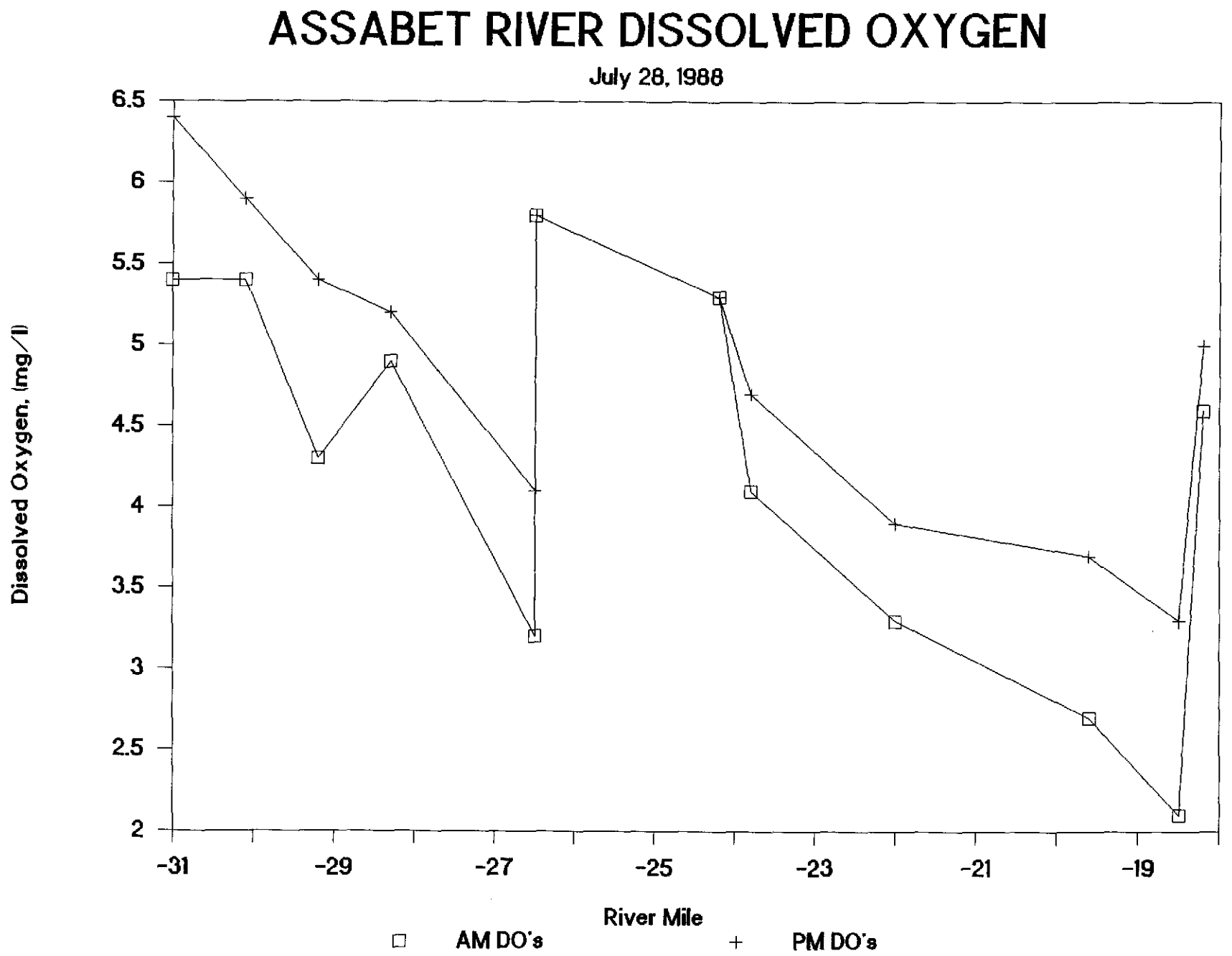

ASSABET RIVER DISSOLVED OXYGEN
July 28, 1988
Dissolved Oxygen, (mg/l)
6.5
6
5.5
5
4.5
4
3.5
3
2.5
2
-31
-29
-27
-25
-23
-21
-19
River Mile
AM DO's
PM DO's

FIGURE 4

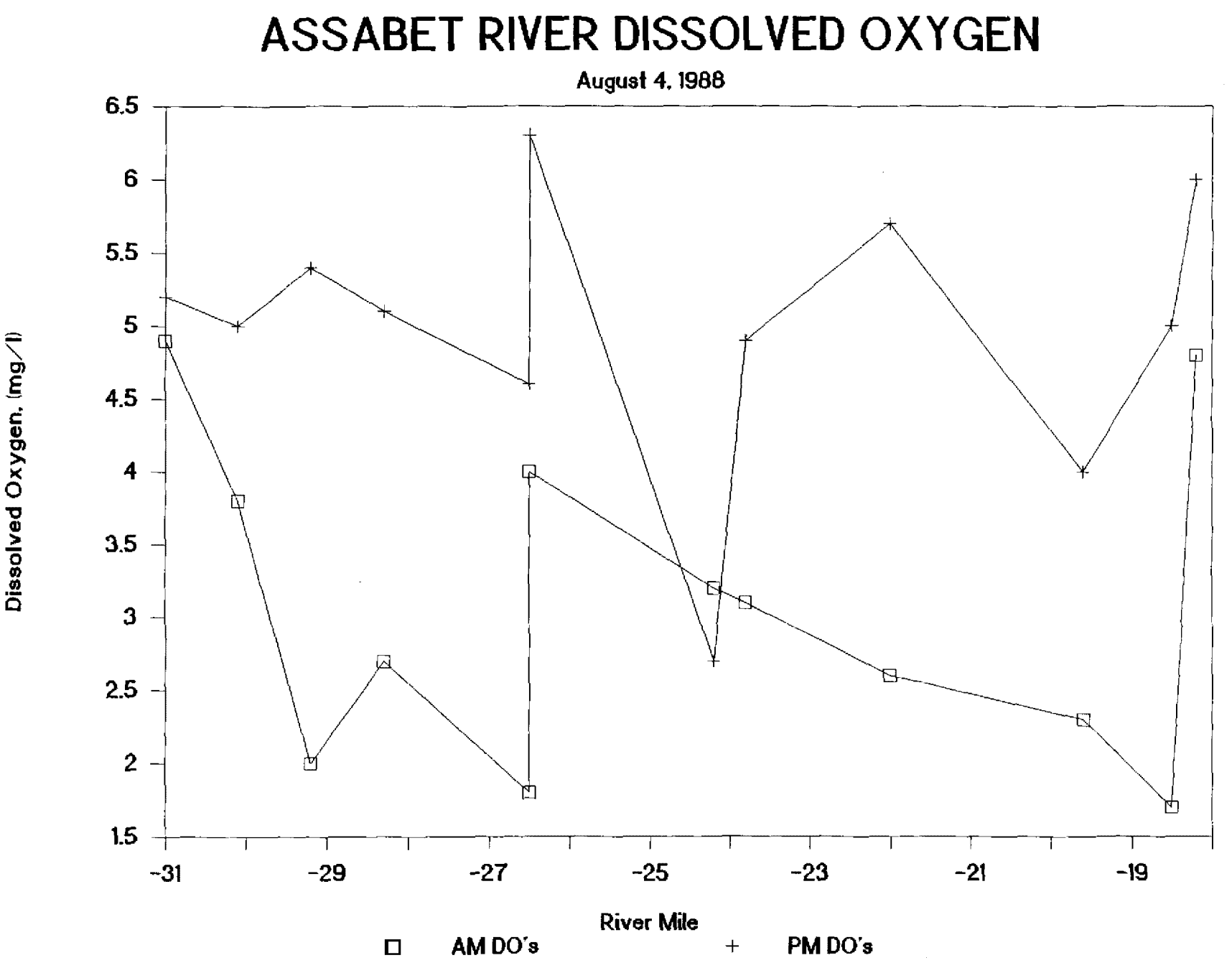

ASSABET RIVER DISSOLVED OXYGEN
August 4, 1988
Dissolved Oxygen, (mg/l)
6.5
6
5.5
5
4.5
4
3.5
3
2.5
2
1.5
-31
-29
-27
-25
-23
-21
-19
River Mile
AM DO's
PM DO's

FIGURE 5

ASSABET RIVER DISSOLVED OXYGEN

August 11, 1988

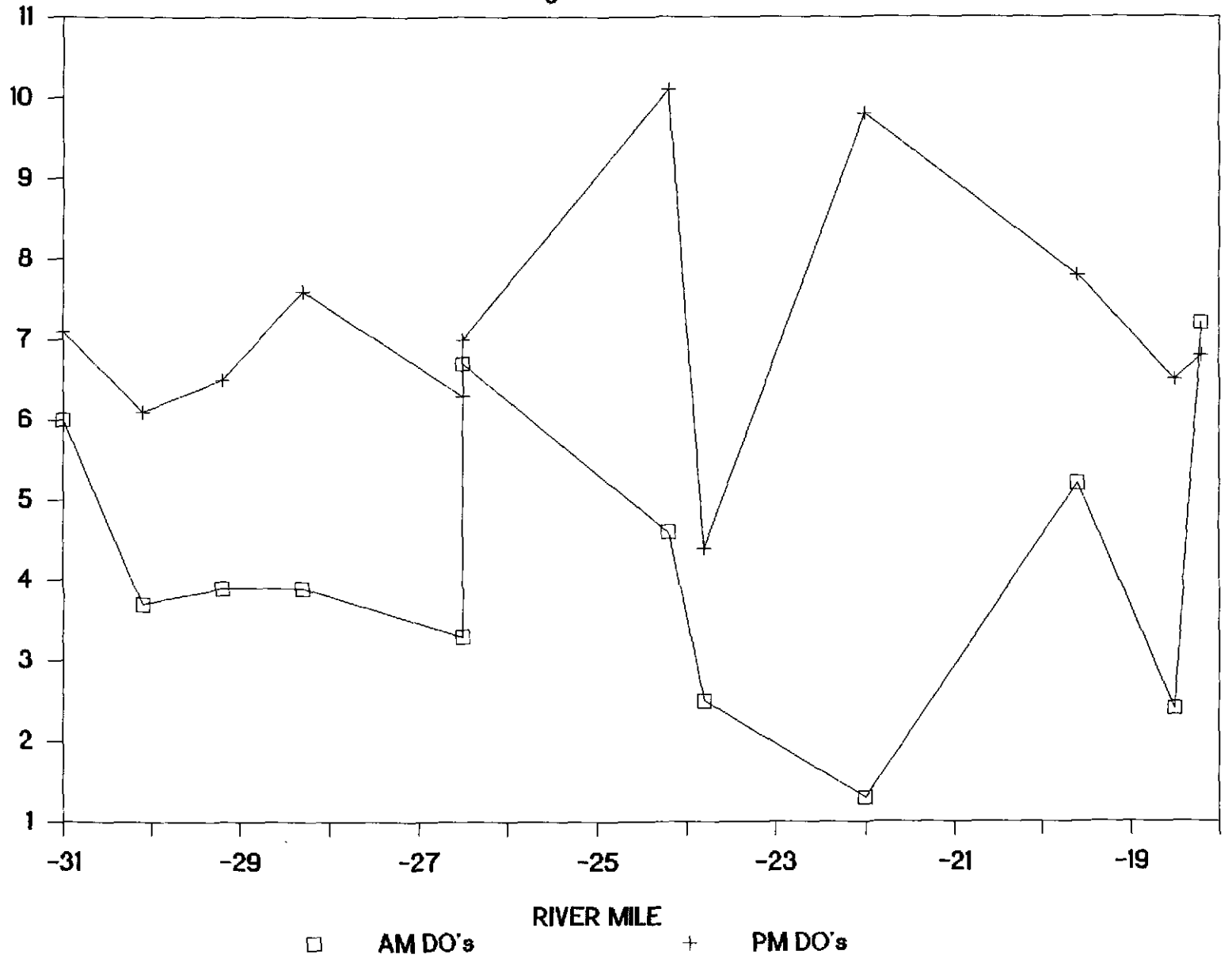
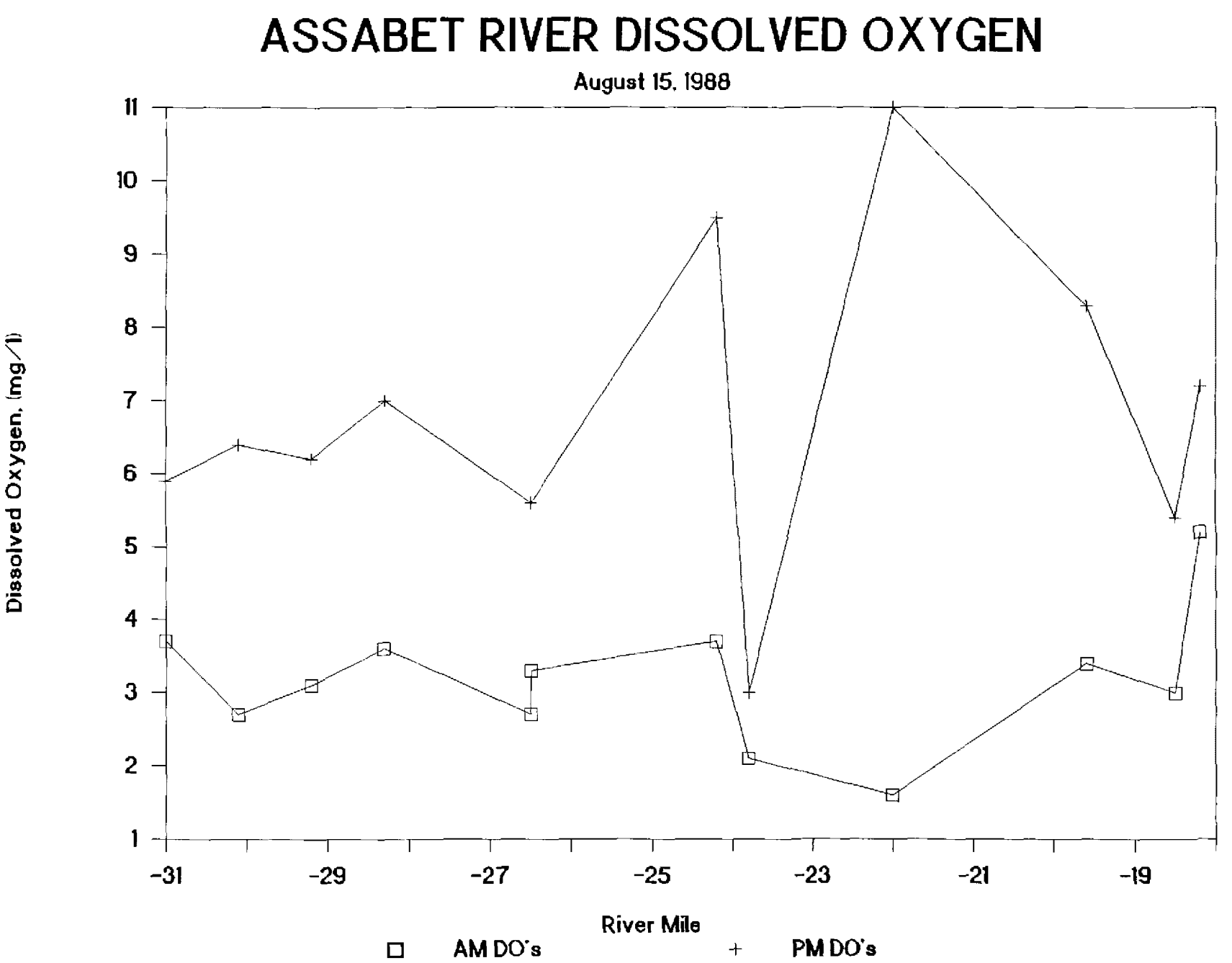


FIGURE 6


ASSABET RIVER DISSOLVED OXYGEN
August 15, 1988
Dissolved Oxygen, (mg/l)
11
10
9
8
7
6
5
4
3
2
1
-31
-29
-27
-25
-23
-21
-19
River Mile
AM DO's
PM DO's

APPENDIX A

MEMORANDUM

TO: Nora Hanley, Environmental Engineer III

FROM: Margo Webber, Environmental Engineer III MTW

DATE: August 30, 1988

RE: 1988 Assabet River D.O.'s

During the months of July and August 1988 six weekly early morning and early afternoon dissolved oxygen surveys were run on the Assabet River. Early morning runs began around 0600 hours and early afternoon runs began around 1330 hours. Each survey had twelve stations, beginning at Maynard Street (AS02) in Westborough and ending at Route 85 (AS14B) in Hudson. The stations are listed in Table 1.

The first survey was a morning only survey conducted on July 8th. On July 14 an afternoon run was done with an early morning run the following day. The remaining five surveys had the morning and afternoon runs conducted on the same day.

The weather during the surveys varied as follows:

July 14-15, 1988 - sunny
July 21 - Hard rain, grey day
July 28 - Drizzle in morning, downpour in afternoon
August 4 - Hazy, hot (90°+) and humid
August 11 - Hazy, hot (90°+) and humid
August 15 - Hazy, hot (95°) and humid

The data shows definite diurnal swings during the sunny hot weather. The wet weather surveys did not show as much of a variation, indicating photosynthesis plays a major role in the instream D.O. concentrations. Algae and duckweed was evident in the river during the surveys. Furthermore, during the last three surveys in August there was hot, dry weather with little rain. Each week the flows were lower in the river and each week the early morning dissolved oxygen was lower. Potentially the instream sediment demands were having a greater affect as the flow decreased.

Instream field pH analyses was taken only during the August 4th and August 11th surveys. On August 4th different pH meters were used, which could give slightly different readings. Both surveys had higher pH's observed below the Marlborough West WWTP in the afternoon. During the August 11th survey (same meter), every station was observed to have a higher pH in the afternoon. This further confirms the affects of photosynthesis on the D.O.

The data has been entered into the computer (dBase) and graphed (Lotus).

MW/v
Attachments
cc: P. Hogan
A. Cooperman
R. Isaac

APPENDIX B

Winkler Method for Dissolved Oxygen Determination (Azide Modification)

The Winkler or iodometric method and its modifications are among the standard procedures for determining dissolved oxygen. The test depends upon the fact that oxygen oxidizes Mn^{2+} to a higher state-of-valence under alkaline conditions and that manganese in higher states-of-valence is capable of oxidizing I^- to free I_2 under acidic conditions. Thus the amount of free iodine released is equivalent to the dissolved oxygen originally present. The iodine is measured with standard sodium thiosulfate solution and interpreted in terms of dissolved oxygen.*

1. Oxidation of manganous sulfate by 0_2 in water

   $$MnO_4 + 2\ KOH = Mn(OH)_2 + K_2SO_4$$

   $$2\ Mn(OH)_2 + O_2 = 2\ MNO(OH)_2$$

2. Manganous hydroxide is white precipitate which changes to brown when oxidized. Reaction with 0_2 occurs on surface of flox, so mixing is important.

3. When manganic hydroxide is acidified, manganic sulfate is formed.

   $$MN\ O(OH)_2 + 2H_2SO_4 = Mn(SO_4)_2 + K_2\ SO_4 + 3H_2O$$

4. In the presence of iodide the manganic salt acts as an oxidizing agent, releasing free iodide.

   $$Mn(SO_4) + 2KI = MnSO_4 + I_2 + K_2SO_4$$

5. The iodine which is stoichiometrically equivalent to the D.O. of the sample is titrated with sodium thiosulfate.

   $$I_2 + 2Na_2S_2O_3 = Na_2S_4O_6 + 2NaI$$

   $$2Na_2S_2O_3 = I_2 = Mn(SO_4)_2 = 2MnO(OH)_2 = O_2$$

6. Nitrite interference is overcome by the use of sodium azide (NaN_3) in the alkali reagent.

*Sawyer, Clair N. and Perry L. McCarty, Chemistry for Environmental Engineers, McGraw-Hill, 1978, pages 411-413.

APPENDIX C

Saturation Values for Dissolved Oxygen in Fresh Water

TEMPERATURE °C	D.O. SATURATION
10	11.3
11	11.0
12	10.8
13	10.5
14	10.3
15	10.0
16	9.8
17	9.6
18	9.4
19	9.2
20	9.0
21	8.8
22	8.7
23	8.5
24	8.3
25	8.2
26	8.0
27	7.9
28	7.7
29	7.6
30	7.4

APPENDIX D

Commonwealth of Massachusetts

Water Resources Commission

Division of Water Pollution Control

MASSACHUSETTS SURFACE WATER QUALITY STANDARDS

4.01: GENERAL PROVISION

(1) Title. These regulations shall be known as the "Massachusetts Surface Water Quality Standards."

(2) Organization of Standards. These standards comprise five units: General Provisions (314 CMR 4.01), Application of Standards (314 CMR 4.02), Water Quality Criteria (314 CMR 4.03), Antidegradation Provisions (314 CMR 4.04), and Basin Classification and Maps (314 CMR 4.05).

(3) Authority. The Massachusetts Surface Water Quality Standards are adopted by the Division pursuant to the provisions of M.G.L. c.21, S27.

(4) Purpose. The Massachusetts Act charges the Division with the duty and responsibility to enhance the quality and value of the water resources of the Commonwealth and directs the Division to take all action necessary or appropriate to secure to the Commonwealth the benefits of the Federal Act. The objective of the Federal Act is the restoration and maintenance of the chemical, physical and biological integrity of the Nation's waters. To achieve the foregoing requirements the Division has adopted these standards which designate the uses for which the various waters of the Commonwealth shall be enhanced, maintained and protected; which prescribe the water quality criteria required to sustain the designated uses; and which contain regulations necessary to achieve the designated uses and maintain existing water quality including, where appropriate, the prohibition of discharges.

(5) Definitions. As used in these standards, the following words have the following meanings:

Artificial conditions - Those conditions resulting from human alteration of the chemical, physical or biological integrity of waters.

Beneficial use - Any use not impairing the most sensitive use designated in the classification tables contained in 314 CMR 4.05; except that in no case shall the assimilation or transport of pollutants be deemed a beneficial use.

Cold water fishery - Waters whose quality is capable of sustaining a year-round population of cold water trout (salmonidae).

PUBLICATION: #15,303-12-100-3-88-CR-100-4-88-CR Second Printing Approved by Ric Murphy, State Purchasing Agent

Division - The Massachusetts Division of Water Pollution Control, as established by General Laws c.21, S26.

Discharge - Any addition of any pollutant to the waters of the Commonwealth.

EPA - The United States Environmental Protection Agency.

Federal Act - The Federal Water Pollution Control Act, as amended, 33 U.S.C. SS1251, et seq.

Massachusetts Act - The Massachusetts Clean Waters Act, as amended, General Laws, c.21, SS26-53, inclusive.

Pollutant - Any element or property of sewage, agricultural, industrial or commercial waste, runoff, leachate, heated effluent, or other matter, in whatever form and whether originating at a point or major nonpoint source, which is or may be discharge, drained or otherwise introduced into any sewerage system, treatment works or waters of the Commonwealth.

Primary contact recreation - Any recreation or other water use, such as swimming and water skiing, in which there is prolonged and intimate contact with the water sufficient to constitute a health hazard.

Seasonal cold water fishery - Waters whose quality is capable of sustaining only an extremely limited cold water population on a year-round basis, with cold water fish in these streams provided largely by stocking.

Secondary contact recreation - Any recreation or other water use in which contact with the water is either incidental or accidental, such as fishing, boating and limited contact incident to shoreline activities.

Segment - A finite portion of a water body established by the Division for the purpose of classification.

Surface Waters - All waters other than ground waters within the jurisdiction of the Commonwealth, including without limitation, rivers, streams, lakes, ponds, springs, impoundments, estuaries, wetlands and coastal waters.

Warm water fishery - Waters whose quality is not capable of sustaining a year-round cold water or seasonal cold water fishery.

Waters of the Commonwealth - All waters within the jurisdiction of the Commonwealth, including, without limitation, rivers, streams, lakes, ponds, springs, impoundments, estuaries, wetlands, coastal waters, and ground waters.

(6) Severability. If any provision of these standards is held invalid, the remainder of these standards shall not be affected thereby.

4.02: APPLICATION OF STANDARDS

(1) Establishment of Effluent Limitations. In regulating discharges of pollutants to surface waters, the Division will limit or prohibit such discharges to insure that the water quality standards of the receiving waters will be maintained or attained. The determination by the Division of the applicable level of treatment for an individual discharger will be made in the

establishment of effluent limitations in the individual discharge permits in accordance with 314 CMR 3.10(3), (4), (5) and (6). In establishing water quality based effluent limitations, the Division must consider natural background conditions, existing discharges, must protect existing downstream uses, and must not interfere with the maintenance and attainment of beneficial uses in downstream waters. Toward this end, the Division may provide a reasonable margin of safety to account for any lack of knowledge concerning the relationship between the pollutants being discharged and their impact on the quality of the receiving waters.

(2) Mixing Zones. In applying these standards, the Division may recognize, where appropriate, a limited mixing zone or zone of initial dilution on a case-by-case basis. The location, size and shape of these zones shall provide for the maximum protection of aquatic resources. At a minimum, mixing zones must:

a) Meet the criteria for aesthetics;

b) Be limited to an area or volume that will minimize interference with the designated uses or established community of aquatic life in the segment;

c) Allow an appropriate zone of passage for migrating fish and other organisms; and

d) Not result in substances accumulating in sediments, aquatic life or food chains to exceed known or predicted safe exposure levels for the health of humans or aquatic life.

(3) Hydrologic Conditions. The Division will determine the most severe hydrologic condition at which water quality standards must be met. In classifying the inland surface waters and in applying these standards to such waters, the critical low flow condition at and above which these standards must be met is the average minimum consecutive seven-day flow to be expected once in ten years, unless otherwise stated by the Division in these standards. In artificially regulated waters, the critical low flow will be established by the Division through agreement with the Federal, state or private interest controlling the flow. The minimum flow established in such agreement will become the critical low flow under this section for those waters covered by the agreement.

(4) Procedures for Sampling and Analysis. For the purpose of collecting, preserving and analyzing samples in connection with these water quality standards, the fifteenth edition of Standard Methods of the Examination of Water and Wastewater published by the American Public Health Association, or Methods for Chemical Analysis of Water and Wastes published by the U.S. Environmental Protection Agency should be used. Where a method is not given in these publication, the latest procedures of the American society for Testing Materials (ASTM) shall be used, or any other equivalent method approved by the Director.

4.03: MINIMUM WATER QUALITY CRITERIA AND ASSOCIATED USES

(1) Description of Contents. 314 CMR 4.03 sets forth the Classes to be used by the Division in classifying the surface waters according to the uses

for which the waters shall be enhanced, maintained and protected. For each class, the most sensitive beneficial uses are identified and minimum criteria for water quality in the water column are established. In interpreting and applying the minimum criteria in 314 CMR 4.03(4), the Division shall consider local conditions including, but not limited to:

a) the characteristics of the biological community;

b) temperature, weather, flow, and physical and chemical characteristics; and

c) synergistic and antagonistic effects of combinations of pollutants.

(2) Coordination with Federal Criteria. The Division will use EPA criteria established pursuant to Section 304(a)(1) of the Federal Act as guidance in establishing case-by-case discharge limits for pollutants not specifically listed in these standards but including under the heading "Other Constituents" in 314 CMR 4.03(4), for identifying bioassay application factors and for interpretations of narrative criteria. Where the minimum criteria specifically listed by the Division in this part differ from these contained in the federal criteria, the provisions of the specifically listed criteria in these standards shall apply.

(3) Classes and Designated Uses. The surface waters will be assigned to one of the classes listed below. Each class is defined by the most sensitive, and therefore governing, uses which it is intended to protect. The classes are:

Classes for Inland Waters

Class A - Waters assigned to this class are designated for use as a source of public water supply.

Class B - Waters assigned to this class are designated for the uses of protection and propagation of fish, other aquatic life and wildlife; and for primary and secondary contact recreation.

Class C - Waters assigned to this class are designated for the uses of protection and propagation of fish, other aquatic life and wildlife; and for secondary contact recreation.

Classes for Coastal and Marine Waters

Class SA - Waters assigned to this class are designated for the uses of protection and propagation of fish, other aquatic life and wildlife; for primary and secondary contact recreation; and for shellfish harvesting without depuration in approved areas.

Class SB - Waters assigned to this class are designated for the uses of protection and propagation of fish, other aquatic life and wildlife; for primary and secondary contact recreation; and for shellfish harvesting with depuration (Restricted Shellfish areas).

Class SC - Waters assigned to this class are designated for the protection and propagation of fish, other aquatic life and wildlife; and for secondary contact recreation.

(4) Minimum Criteria. The following minimum criteria are adopted and shall be applicable to all surface waters.

A. These minimum criteria are applicable to all waters of the Commonwealth, unless criteria specified for individual classes are more stringent.

	Parameter	Criteria
1.	Aesthetics	All waters shall be free from pollutants in concentrations or combinations that: a) Settle to form objectionable deposits; b) Float as debris, scum or other matter to form nuisances; c) Produce objectionable odor, color, taste or turbidity; or, d) Result in the dominance of nuisance species.
2.	Radioactive Substances	Shall not exceed the recommended limits of the United States Environmental Protection Agency's National Drinking Water Regulations.
3.	Tainting Substances	Shall not be in concentrations or combinations that produce undesirable flavors in the edible portions of aquatic organisms.
4.	Color, Turbidity, Total Suspended Solids	Shall not be in concentrations or combinations that would exceed the recommended limits on the most sensitive receiving water use.
5.	Oil and Grease	The water surface shall be free from floating oils, grease and petrochemicals and any concentrations or combinations in the water column or sediments that are aesthetically objectionable or deleterious to the biota are prohibited. For oil and grease of petroleum origin the maximum allowable discharge concentration is 15 mg/l.
6.	Nutrients	Shall not exceed the site-specific limits necessary to control accelerated or cultural eutrophication
7.	Other Constituents	Waters shall be free from pollutants in concentrations or combinations that: a) Exceed the recommended limits on the most sensitive receiving water uses; b) Injure, are toxic to, or produce adverse physiological or behavioral responses in

humans or aquatic life; or,

c) Exceed site-specific safe exposure levels determined by bioassay using sensitive species.

B. Inland Waters - the following additional minimum criteria are applicable to inland water classifications.

For Class A waters:

	Parameter	Criteria
1.	Dissolved Oxygen	Shall be a minimum of 5.0 mg/l in warm water fisheries and a minimum of 6.0 mg/l in cold water fisheries.
2.	Temperature	Shall not exceed 83°F (28.3°C) in warm water fisheries or 68°F (20°C) in cold water fisheries nor shall the rise resulting from artificial origin exceed 4.0°F (2.2°C).
3.	pH	As naturally occurs.
4.	Total Coliform Bacteria	Shall not exceed a log mean for a set of samples of 50 per 100 ml during any monthly sampling period.
5.	Turbidity	None other than of natural origin.
6.	Total Dissolved Solids	Shall not exceed 500 mg/l.
7.	Chlorides	Shall not exceed 250 mg/l.
8.	Sulfates	Shall not exceed 250 mg/l.
9.	Nitrate	Shall not exceed 10 mg/l as nitrogen.

For Class B waters:

Parameter		Criteria
1.	Dissolved Oxygen	Shall be a minimum of 5.0 mg/l in warm water fisheries and a minimum of 6.0 mg/l in cold water fisheries.
2.	Temperature	Shall not exceed 83°F (28.3°C) in warm water fisheries or 68°F (20°C) in cold water fisheries, nor shall the rise resulting from artificial origin exceed 4.0°F (2.2°C).
3.	pH	Shall be in the range of 6.5-8.0 standard units and not more than 0.2 units outside of the naturally occurring range.

4.	Fecal Coliform Bacteria	Shall not exceed a log mean for a set of samples of 200 per 100 ml, nor shall more than 10% of the total samples exceed 400 per 100 ml during any monthly sampling period, except as provided in 310 CMR 4.02(1).

For Class C waters:

Parameter		Criteria
1.	Dissolved Oxygen	Shall be a minimum of 5.0 mg/l in warm water fisheries and a minimum of 6.0 mg/l in cold water fisheries.
2.	Temperature	Shall not exceed 83°F (28.3°C) in warm water fisheries or 68°F (20°C) in cold water fisheries, nor shall the rise resulting from artificial origin exceed 4.0°F (2.2°C).
3.	pH	Shall be in the range of 6.5-9.0 standard units and not more than 0.2 units outside of the naturally occurring range.
4.	Fecal Coliform Bacteria	Shall not exceed a log mean for a set of samples of 1000 per 100 ml, nor shall more than 10% of the total samples exceed 2500 per 100 ml during any monthly sampling period, except as provided in 310 CMR 4.02(1).