NBP-92-85

Blackstone River 1990

77pp + Appendices 133 pp

Wright, Runge, Lee, Chaudhury (URI)

Narragansett Bay Estuary Program

Current Report

The Narragansett Bay Project

BLACKSTONE RIVER 1990

PREPARED BY:

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#NBP-92-85

D-E-M
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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

NARRAGANSETT BAY
ESTUARY PROGRAM

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FOREWORD

The United States Congress created the National Estuary Program in 1984, citing its concern for the "health and ecological integrity" of the nation's estuaries and estuarine resources. Narragansett Bay was selected for inclusion in the National Estuary Program in 1984 , and the Narragansett Bay Project (NBP) was established in 1985. Narragansett Bay was designated an "estuary of national significance" in 1988. Under the joint sponsorship of the U.S. Environmental Protection Agency and the Rhode Island Department of Environmental Management, the NBP's mandate is to direct a program of research and planning focussed on managing Narragansett Bay and its resources for future generations.

The NBP will develop a draft Comprehensive Conservation and Management Plan (CCMP) by December, 1991, which will recommend actions to improve and protect the Bay and its natural resources.

The NBP has established the following seven priority issues for Narragansett Bay:

- management of fisheries
- nutrients and potential for eutrophication
- impacts of toxic contaminants
- health and abundance of living resources
- health risk to consumers of contaminated seafood
- land-based impacts on water quality
- recreational uses

The NBP is taking an ecosystem/watershed approach to address these problems and has funded research that will help to improve our understanding of various aspects of these priority problems. The Project is also working to expand and coordinate existing programs among federal, state and local agencies, as well as with academic researchers, in order to apply research findings to the practical needs of managing the Bay and improving the environmental quality of its watershed.

This report represents the technical results of an investigation performed for the Narragansett Bay Project. The information in this document has been funded by the State of Rhode Island under the R.I. Clean Water Act Environmental Trust Fund (R.I.G.L. 46-12-24.2 (c)) as part of a Cooperative Agreement between RIDEM and the University of Rhode Island. It has been subject to the Agency's and the Narragansett Bay Project's peer and administrative review and has been accepted for publication as a technical report by the Management Committee of the Narragansett Bay Project. The results and conclusions contained herein are those of the author(s), and do not necessarily represent the views or recommendations of the NBP.

EXECUTIVE SUMMARY

This report is a technical review of available information on water quality issues in the Blackstone River watershed. The final report has been written in the form of a technical "position paper" for the Narragansett Bay Project (NBP). The original purpose of the Blackstone River paper was to identity water pollution control and abatement measures that should be undertaken in order to protect or restore instream and downstream uses of the Blackstone River.

In all, 19 permitted dischargers were reviewed and 3 draft permits. Of these, 3 permits had expired and 6 were due to expire before January 1, 1991. Comparisons between the dischargers were made for all major permit limitations. Three municipal wastewater treatment facilities (WWTFs) currently provide seasonal advanced wastewater treatment (AWT) for biochemical oxygen demand (BOD) and total suspended solids (TSS) (Upper Blackstone Water Pollution Abatement District (UBWPAD), Hopedale and Northbridge) and 3 provide seasonal removal of nutrients (UBWPAD, Hopedale, and Burrillville).

Monthly discharge monitoring reports (DMR) for 1988-89 were reviewed and dischargers were ranked by loadings for BOD, TSS and fecal coliform (FC). In general, the rankings for BOD and TSS are a testament to the poor performance at the Blackstone Valley District Commission (BVDC) WWTF during those two years.

Mean discharges of BOD and TSS both exceed allowable limits by 142% and 173%. On the positive side, all other facilities appear to be performing exceptionally well with the percent of permit load being discharged ranging from 7% to 46%.

The permit design flows total approximately 65.4 million gallons per day (MGD) for Massachusetts (MA) and 44.9 MGD for Rhode Island (RI) (18.9 MGD without BVDC). The actual discharge flows according to the 1988-89 DMR data were for MA 40.9 MGD or 62.5% of the allowable (permit design) flow and for RI 32.0 MGD or 71.3%. Without BVDC, the RI discharge was 9.68 MGD or 51.2%.

A summary of the 1988 and 1989 Quarterly Noncompliance Reports (QNRs) were included. In general, violations occurred at most facilities infrequently. The most notable exception includes the chronic problems at the BVDC facility for TSS, BOD and FC.

A major weakness in the review of existing dry weather water quality conditions is the inability to evaluate a single survey which covers the entire Blackstone River. At best, the data were compared in an attempt to develop an understanding for the relative importance of the major point sources and, in general, trends within surveys and between the states. A major recommendation of this paper is the need for a comprehensive sampling effort to be conducted jointly by RI and MA.

There exists several problem areas associated with dissolved oxygen (DO). Violations were observed at two key locations, both downstream of major dischargers (UBWPAD and Woonsocket). This supports the idea that the problems, at least associated with DO, may be point source in origin not nonpoint source.

The evaluation of the system with DO water quality models has taken place. The MA modeling effort is old and should be updated, and the RI model calibration and validation is inadequate due to the lack of upstream water quality information in MA. It is recommended that a single model, QUAL2E, be applied to the entire river.

Based on the available data, there exist several problems with metals with respect to the acute and chronic criteria recommended by the United States Environmental Protection Agency (US EPA). Specifically, data indicates violations occur for cadmium (Cd), copper (Cu), lead (Pb) and zinc (Zn). No violations were observed for chromium (Cr) or nickel (Ni). The UBWPAD facility was shown to be significant relative to Cd, Cu, Ni and Zn. Again, at least for these metals and this discharge, this observation indicates that the solution to the problem may be with respect to point source control and not necessarily nonpoint source control. No significant increases in any metal could be associated with the Woonsocket facility. In general, the trends for Cd, Cu, Ni and Pb indicate that maximum concentrations in RI were typically at the state line and generally declined towards Slater's Mill.

Toxic modeling including trace metals and organics has never been performed in MA. Therefore, estimates for the loading of trace metals and organics to RI under various flows including the 7Q10 are not available. This really lies at the heart of a major problem that has yet to be adequately addressed in the Blackstone watershed. MA does not need the cooperation of RI to evaluate and manage the Blackstone in its borders. Whereas, RI needs cooperation from MA. With respect to modeling of trace metals and organics, RI can not conduct a wasteload allocation (WLA) on the Blackstone River, because the concentrations of specific toxics at the state line, that are boundary conditions of the model, are unknown.

Sediment resuspension has been indicated as a major issue on the Blackstone. However, the importance of resuspension in a WLA is probably minimal, because the assumption that critical periods are at low flows which will result in net settling in the river. The incoming concentrations of metals to RI during low flows are most likely point source in origin or a continuous baseline groundwater source, not resuspension.

The available metal data to adequately interpret the impact of wet weather on the Blackstone River is inadequate. At best, the information provides a ccnfirmation of the problems addressed under dry weather, steady state conditions. That is that there are violations to chronic and acute criteria for Cd, Cu and Pb and no violations for Ni and Cr. These violations occur in both RI and MA.

Problems, in most cases, already exist at prestorm concentrations. These concentrations rise during the storm to values which may be as much as an order of magnitude higher. In the case of Cd, concentrations exceed acute criteria during the event. For Pb, the peak concentrations are within 50% of the acute criteria. Larger and more intense storms will obviously result in higher concentrations and the potential for greater and more frequent violations exists.

The concentrations coming from MA for Cd, Cr, Cu and Ni are the highest observed in RI. On the other hand, TSS and Pb concentrations do increase significantly during wet weather events in RI.

Unlike the steady state condition given above, resuspension maybe the major component in the wet weather load. Unfortunately, the general interpretation of mass loading curves do not provide a separation of the various wet weather components (i.e. (a) bottom sediment resuspension and (b) runoff).

Nonpoint sources and river bottom sediments appear equally as important as point sources for the contribution of organics in the Blackstone River. For polychlorinated biphenyls (PCBs), concentrations exceed US EPA chronic criteria in RI under both wet and dry weather conditions. The concentrations of PCBs during wet weather conditions are a magnitude higher than during dry weather conditions. PCBs do not violate US EPA acute criteria for either wet or dry conditions.

Information was reviewed for dry weather conditions on the Providence River including the SINBADD, SPRAY and wet weather studies. Approximately 80-95% of the fresh water flows to the Providence River come from tributaries with the Blackstone River contributing by far the greatest flow. A total of 11 constituents were summarized and sources ranked. The Blackstone River at Slater's Mill consistently ranked first or second in regards to total mass discharged.

Wet weather data were also summarized for the major tributaries and WWTFs. The results strongly indicate the Blackstone River is a major contributor of all constituents measured.

This report also focused on a general discussion of the effects of "major" proposed projects that have a potential impact on water quality. The types of projects discussed included hydroelectric power projects, dams, dredging and out of basin water withdrawals.

Major recommendations from this report are given as follows:

1. The common list of water quality parameters evaluated under the effluent monitoring program should be expanded to include other parameters besides TSS, FC and BOD (i.e. trace metals) for all major dischargers.

2. Based on the 'Quarterly Noncompliance Reports' of 1988-89, several chronic problems need to be resolved, including TSS, BOD and FC concentrations at the BVDC WWTF, pH at four MA WWTFs, FC and BOD concentrations at the Woonsocket WWTF, and total residual chlorine (TRC) concentration at the Zambarano and Burrillville dischargers.

3. Among the present water quality problems in the Blackstone River, the acquisition of adequate water quality data that encompass both MA and RI is urgent. A comprehensive sampling effort for both dry and wet weather conditions should be conducted jointly by RI and MA. The sampling program should be designed and executed to overcome difficulties of interpreting the available data.

4. With regard to toxics modeling, the effort should be done jointly by MA and RI, using PAWTOXIC or TOXIWASP. The model can then be used to conduct an interstate wasteload allocation (WLA).

5. In MA, the DO model WLA is old and should be updated. A comprehensive interstate model and WLA for DO/BOD should be done jointly by MA and RI for the entire Blackstone River.

6. Postaudit of the 1983 DO model for MA should be conducted. This should also include the sediment oxygen demand (SOD) below the UBWPAD WWTF to assess the changes that have occurred as a result of AWT.

7. During wet weather events, pollutant contributions from

baseflow, runoff and bottom sediment resuspension need to be separated. This has been accomplished for the Pawtuxet River. Unfortunately, the effort on the Pawtuxet River is not directly transferable. Similar types of efforts can and should be made for the Blackstone River.

8. Discussions should take place with officials at each of the hydropower facilities to determine how each facility is operated. This will also require the evaluation of all available flow and stage records including those at each hydropower facility and the USGS gage at Woonsocket, RI.

9. A clear understanding of the state's authority with regard to hydropower operations should be ascertained.

10. A clear understanding of licensing requirements from the Federal Energy Regulatory Commission (FERC), as they relate to water quality issues, should be determined. It would also be appropriate, but probably difficult, to assess the attitude of the federal authority relative to the water quality problems in the Blackstone River, as they relate to existing and future hydropower operations.

11. All existing hydropower facilities should be investigated to determine if they are operated as run-of-the-river systems. If violations occur, then the frequency of violation should be determined. A detailed investigation into each facility's impact on downstream flow and water quality should be made.

12. Any proposed hydropower facility should undergo a rigorous evaluation to maintain the current water quality of the river.

13. Any proposed basin water withdrawals should be evaluated to protect the water quality of the river.

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1. Review of the Major Point Source Loadings to the Blackstone River

1.1 Water Quality Classification and Criteria

The Blackstone River and its tributaries include approximately 472 square miles (mi^2) of drainage area with a mean annual runoff of about 860 cubic feet per second (cfs). The Blackstone headwaters begin in Worcester, Massachusetts (MA) and flow south into Rhode Island (RI) discharging into the Seekonk River. The Seekonk River flows to the Providence River and ultimately Narragansett Bay. The water quality classification of the Blackstone River in MA is the responsibility of the MA Department of Environmental Protection (MA DEP), and in RI, it is the responsibility of the RI Department of Environmental Management (RI DEM). The water use classifications are given in Table A.1 of Appendix A. The only difference of note is the continuance of Class D and E definitions by RI to describe existing conditions only. MA has eliminated these classifications from their regulations. The general water quality criteria for each state are listed in Table A.2 for comparison and include the categories of aesthetics, radioactive substances, nutrients, tainting substances, and total suspended solids (TSS) among others. The class specific criteria are given in A.3 and include dissolved oxygen (DO), fecal coliform (FC), total coliform (TC), temperature (T), pH, color, turbidity, oil and grease. The information in Tables A.1 to A.3 was compiled from the regulations furnished by the state agencies (RI DEM 1988; MA DEQE 1985b).

1.2 Major Permitted Point Sources

There were 10 MA permits reviewed including 8 municipal facilities and 2 industries, and 9 for RI including 3 municipal, 1 hospital, 1 CSO and 4 industries. Permits in MA are issued jointly by the MA DEP and United States Environmental Protection Agency (US EPA) Region 1 while in RI permits are issued by RI DEM only. A listing of the permit identification numbers are given with expiration dates in Table 1.1.

If draft permits had reached the stage involving public hearings, they were available for review in this report. Three permits have currently expired which include the Uxbridge WWTF in MA and Central Falls CSOs and the Blackstone Valley District Commission (BVDC) WWTF in RI. The Uxbridge and BVDC draft permits have reached the stage of public hearings and are included in the summary tables of Appendix B. No draft permit for the Central Falls CSOs was available. Six additional permits are due to expire before January 1, 1991. Of these only the Upper Blackstone Water Pollution Abatement District (UBWPAD) permit is in a draft form currently under public review. No draft permits were available from the state agencies for the other five permits including Douglas WWTF in MA and Smithfield

Table 1.1 - Major Pollutant Discharge Elimination System Permits in the Blackstone River Watershed in Massachusetts and Rhode Island

Discharge	State ID (Federal)	Expiration Date	Receiving Water	Class
MASSACHUSETTS PERMITS				
Uxbridge WWTF	M-197 (MA0102440)	December 4, 1989	Blackstone River	B
UBWPAD WWTF	M-181 (MA0102369)	October 30, 1990	Blackstone River	B
Douglas WWTF	M-099 (MA0101095)	December 10, 1990	Mumford River	B
Guilford Industries	M-124 (MA0001538)	August 28, 1991	Gilbon Brook	B
Northbridge WWTF	M-051 (MA0100722)	June 30, 1992	Blackstone River	B
Hopedale WWTF	M-149 (MA0102202)	July 29, 1992	Mill River	B
N. E. Plating	M-383 (MA0005088)	September 29, 1992	Mill River	B
Grafton WWTF	M-065 (MA0101311)	September 21, 1994	Blackstone River	B
Upton WWTF	M-011 (MA0100196)	September 21, 1994	West River	B
Millbury WWTF	M-061 (MA0100650)	September 22, 1994	Blackstone River	B
RHODE ISLAND PERMITS				
Central Falls CSO	RI-0100145	October 17, 1988	Blackstone/Moshassuck	C/B
BVDC WWTF	RI-0100072	November 23, 1988	Seekonk River	SC
Smithfield Corporation	RI-0000485	December 9, 1990	Blackstone River	C
Tupperware Company	RI-0000566	December 9, 1990	Branch River	B
Burrillville WWTF	RI-0100455	December 11, 1990	Clear River	C
Woonsocket WWTF	RI-0100111	December 27, 1990	Blackstone River	C
GTE Products	RI-0001180	February 18, 1991	Blackstone River	C
Okonite Company	RI-0020141	July 31, 1991	Blackstone River	C
Zambarano Hospital	RI-0100129	September 21, 1992	Clear River	C

UBWPAD - Upper Blackstone Water Pollution Abatement District; WWTF - Wastewater Treatment Facility; BVDC - Blackstone Valley District Commission; Draft permits under review: UBWPAD WWTF, Uxbridge WWTF, BVDC WWTF, and City of Worcester CSO Facility

Corporation, Tupperware Company, Burrillville WWTF and Woonsocket WWTF in RI.

The receiving waters and their current classification are also given in Table 1.1. Although the definitions of each class for each state are essentially the same (Table A.1), the individual state's definition and/or interpretation of the general and class specific criteria (Table A.2 and A.3) have certainly led to different class designations for the Blackstone River. In MA, from Worcester to the RI state line, the Blackstone River is considered by MA DEP to be Class B, while RI DEM considers the Blackstone from the state line to the Seekonk River to be Class C. The states' interpretations are also similar for the major tributaries, since in MA, the Mumford, Mill and West Rivers and Gilbon Brook are Class B, while in RI the Clear River is Class C. The BVDC facility discharges into the marine waters of the Seekonk River which has the saltwater classification of SC.

1.3 Comparison of NPDES Discharge Limits

The permit limitations are summarized in Tables B.1 to B.10 in Appendix B. Although all permits have a common short list of constituents (i.e. BOD, FC and TSS), each permit may have other requirements that are unique. It appears that the development of these additional limitations are based on type of wastewater and the receiving water impact.

There are three MA municipal permits that require seasonal advanced wastewater treatment (AWT) for biochemical oxygen demand (BOD) and TSS including UBWPAD, Hopedale and Northbridge WWTFs (Table B.1). The strictest limit for BOD is a monthly average of 10 mg/L for both the UBWPAD and Northbridge discharges and for TSS is a monthly average of 10 mg/L for Northbridge only. All other municipal facilities have 30/30 BOD/TSS monthly average limits which are typical for secondary treatment. The industrial permits are summarized in Table B.2. The issuance of the three draft permits under review will not change existing BOD, TSS and flow limits (Table B.3).

The permit limitations for settleable solids (SS) and FC are essentially the same for the 12 sanitary dischargers, while the total residual chlorine (TRC) varies between facilities (Table B.4). The strictest limits for SS and FC are 0.1 ml/L SS for either monthly or weekly average conditions and 200 counts/100 ml FC for monthly average conditions. One major difference between the states is that MA has set seasonal limits on both the FC and TRC. Typically, no limits are in effect for these two constituents between either October or November and the end of March. RI's limits for FC and TRC are not seasonal. In general, the TRC limits for the MA permits are stricter, ranging from 1.5 to 0.04 mg/L. Several limits are listed as tentative pending instream toxicity testing. RI's TRC limit is 2.0 mg/L in all cases. The industrial permits are summarized in Table B.5. The limits for SS and FC on the three draft permits are the same as the existing permits, while the TRC limits are lower in all three cases (existing/draft - discharge): 1.5/0.012 - UBWPAD; 1.5/0.4 - Uxbridge; 2.0/0.013 - BVDC (Table B.6).

There are minor differences between the two states relative to pH limits (Table B.7). MA requires a tighter range for the municipal facilities (6.5 to 8.0) than for the industries (6.0 to 9.0). This is opposite to RI which requires a tighter range for industries (6.5 to 8.5) than for municipal facilities (6.0 to 9.0).

The specific nutrient limitations are summarized in Table B.8. The UBWPAD and Hopedale WWTFs have seasonal limits for ammonia (2.0 mg/L average monthly) and the Hopedale and Burrillville WWTFs have seasonal limits for total phosphorus (1.0 mg/L average monthly).

In regard to trace metals at the current time, only four industries have limits on their permits including New England Plating, Guilford Industries, GTE Products, and Okonite (Table B.9). The specific trace metals vary by permit. There is no single metal common to all four permits.

The nutrient and trace metal limits on the draft permits are summarized in Table B.10. Both the UBWPAD and BVDC facilities have expanded lists of metals and nutrients. There are no changes between the existing and draft permits for Uxbridge.

There are no current limits for organics on the existing permits. However, this may change in the future as more information becomes available on both the specific dischargers and the impact of trace levels of organics on the receiving waters.

1.4 Monthly Discharge Monitoring Report (DMR) Data 1988-89

For MA monthly effluent monitoring data (DMR), which is reported to the state and US EPA, have been summarized in this report for 9 dischargers including 7 WWTFs (Grafton, Hopedale, Millbury, Northbridge, Upper Blackstone Water Pollution Abatement District (UBWPAD), Upton, and Uxbridge) and 2 industries (Guilford and New England Plating). For RI, 8 dischargers have been evaluated including 4 WWTFs (Blackstone Valley District Commission (BVDC), Burrillville, Zambarano Hospital, and Woonsocket) and 4 industries (GTE, Okonite, Blackstone Smithfield and Tupperware).

The summaries of the 1988 and 1989 DMR reports are given in Tables C.1 and C.2 of Appendix C for MA and RI, respectively (MA DEP 1990a and RI DEM 1990a). The tables include arithmetic means, standard deviations, maximums and minimums. It is difficult to rank the dischargers by loading for most of the constituents, since each discharge does not necessarily have to report the same number of constituents. A summary of the monitoring lists of constituents by discharge is given in Table 1.2. The only parameters that are common between permits are

Table 1.2 - A Partial Listing of Constituents Reported in DMR Records for 1988-89

Discharge	BOD	TSS	FC	NH_3	TP	Cd	Cr	Cu	Pb	Ni	Zn
Massachusetts											
Grafton	*	*	*				*				
Guilford	*	*					*				
Hopedale	*	*	*	*	*						
Millbury	*	*	*								
NE Plating		*					*			*	*
Northbridge	*	*									
UBWPAD	*	*	*	*							
Upton	*	*	*								
Uxbridge	*	*	*								
Rhode Island											
BVDC	*	*	*	*	*		*	*		*	
Burrillville	*	*	*	*	*			*	*		
GTE		*					*		*		
Okonite								*			
Smithfield	*	*	*	*	*						
Tupperware	*	*	*	*	*						
Woonsocket	*	*	*			*	*	*	*	*	*
Zambarano	*	*	*								

* = DMR data reported for 1988 and/or 1989.

BOD, TSS and FC. This is a weakness that needs to be addressed by both states. It has merit to set the same monitoring requirements for all major dischargers, since it is very difficult to evaluate trends in instream water quality or to determine the relative impact of nonpoint sources of pollution without a comprehensive and longterm understanding of point source loadings. Therefore, it is recommended that the list of parameters evaluated under the current effluent monitoring program be expanded to include other parameters of interest (i.e. trace metals) and this list should be similar, if not the same, for all major dischargers. An argument is developed in support of this in detail in section 2 of this report.

Loadings and rankings for the most common constituents (BOD, TSS and FC) are presented in Tables 1.3 to 1.5. For comparison, the permit loads are given. The average load for the DMR data is then divided by the total allowable permit load to give a general estimate of a facility's performance and/or adequacy of the permit limit. Two significant statements may be drawn from Tables 1.3 and 1.4. On the negative side, in general, the tables are a testament to the poor performance at the BVDC over those two years. Mean discharges of BOD and TSS both exceed allowable by 142% and 173%, respectively. On the positive side, all other facilities appear to be performing exceptionally well with permit load ranging from 7% to 46%.

Fecal coliform data are not typically averaged as has been done in Table 1.5, since a single violation may be different by

Table 1.3 - Comparison of Actual BOD Discharged to Permit Limitations For Monthly Average Conditions

Discharge	Permit Limit mg/L	(lbs/day)	1988-89 DMR Average lbs/day	(Rank)	% of Allowable
Massachusetts					
Grafton	30	(400)	40	(9)	10
Guilford	30	(313)	61	(8)	20
Hopedale	30	(110)	30	(10)	27
Millbury	30	(300)	166	(4)	55
NE Plating	30	(---)	---		
Northbridge	20	(300)	95	(5)	32
UBWPAD	24	(10,119)	2,395	(2)	24
Upton	30	(75)	19	(11)	25
Uxbridge	30	(626)	80	(6)	13
Rhode Island					
BVDC	**30**	**(7,760)**	**11,024**	**(1)**	**142**
Burrillville	30	(375)	72	(7)	19
GTE	30	(---)	---		
Okonite	30	(---)	---		
Smithfield	30	(1.5)	<1	(14)	7
Tupperware	30	(1.5)	<1	(13)	27
Woonsocket	30	(4,000)	1,761	(3)	44
Zambarano	30	(30)	7	(12)	23

Permit limits for Hopedale, Northbridge and UBWPAD vary over the year. Actual values are provided elsewhere. The limits given here have been weighted to provide a yearly average. The calculation for Northbridge is given as an example:

[(6 months)(30 mg/L) + (6 months)(10 mg/L)]/12 months = 20 mg/L

Table 1.4 - Comparison of Actual TSS Discharged to Permit Limitations For Monthly Average Conditions

Discharge	Permit Limit mg/L	(lbs/day)	1988-89 DMR Average lbs/day	(Rank)	% of Allowable
Massachusetts					
Grafton	30	(400)	28	(11)	7
Guilford	30	(313)	90	(7)	29
Hopedale	30	(110)	45	(10)	41
Millbury	30	(300)	110	(4)	37
NE Plating	30	(33)	8	(14)	24
Northbridge	20	(300)	93	(6)	31
UBWPAD	24	(11,092)	2,981	(2)	27
Upton	30	(75)	12	(13)	16
Uxbridge	30	(626)	63	(8)	10
Rhode Island					
BVDC	**30**	**(7,760)**	**13,416**	**(1)**	**173**
Burrillville	30	(375)	105	(5)	28
GTE	30	(130)	47	(9)	36
Okonite	30	(---)	---		
Smithfield	30	(1.5)	<1	(16)	23
Tupperware	30	(1.5)	<1	(15)	46
Woonsocket	30	(4,000)	1,773	(3)	43
Zambarano	30	(60)	22	(12)	37

Permit limits for Hopedale, Northbridge and UBWPAD vary over the year. Actual values are provided elsewhere. The limits given here have been weighted to provide a yearly average. The calculation for Northbridge is given as an example:

[(6 months)(30 mg/L) + (6 months)(10 mg/L)]/12 months = 20 mg/L

Table 1.5 - Comparison of Actual Fecal Coliform Discharged to Permit Limitations For Monthly Average Conditions

Discharge	Permit Limit #/100ml	Permit Limit #/day	1988-89 DMR Average #/100ml	1988-89 DMR Average #/day	(Rank)	%	Comments
Massachusetts							
Grafton	200	1.2 E10	29.6	1.0 E09	(7)	8	
Guilford	200	9.4 E09	----				
Hopedale	200	4.4 E09	83.2	1.5 E09	(6)	34	
Millbury	200	9.0 E09	23.4	7.3 E08	(8)	8	
NE Plating	200	1.5 E09	----				
Northbridge	200	1.4 E10	----				
UBWPAD	200	4.2 E11	10.0	1.3 E10	(3)	3	
Upton	200	2.3 E09	528	3.0 E09	(4)	130	a
Uxbridge	200	1.9 E10	9.6	2.3 E08	(10)	1	
Rhode Island							
BVDC	200	2.3 E11	84.8	7.1 E10	(2)	31	
Burrillville	200	1.1 E10	17.9	5.2 E08	(9)	5	b
GTE	200	6.8 E09	----				
Okonite	200	2.9 E09	----				
Smithfield	200	4.5 E07	2.1	3.2 E05	(12)	1	
Tupperware	200	4.5 E07	121	1.8 E07	(11)	40	c
Woonsocket	200	1.2 E11	3164	1.0 E12	(1)	833	d
Zambarano	200	9.1 E08	700	2.5 E09	(5)	275	e

Several dischargers had significantly different means between 1988 and 1989. The numbers reported above were averages for the two years with the exception of Burrillville which had a 1989 mean of too numerous to count (TNTC). The individual year means are reported here for reference. More detail may be found in Appendix C and D.

a Upton: 868 #/100 ml - 1988 and 188 #/100 ml - 1989;
b Burrillville: 17.9 #/100 ml - 1988 and TNTC #/100 ml - 1989;
c Tupperware: 2.2 #/100 ml - 1988 and 204 #/100 ml - 1989;
d Woonsocket: 46 #/100 ml - 1988 and 6,282 #/100 ml - 1989;
e Zambarano: 2.8 #/100 ml - 1988 and 1,397 #/100 ml - 1989.

several orders of magnitude and, in turn, impact the yearly average by an order of magnitude. Therefore, this table should be used with a note of caution. This is evident by the rankings of Table 1.5, which shows the Woonsocket WWTF as the dominant discharge. This is a result of the high 1988-89 mean concentration of 3,264 #/100 ml based on the yearly averages for 1988 (46) and 1989 (6,282). In addition to Woonsocket, Upton and Zambarano facilities also exceed permit limits for the average conditions. For specific details concerning performance, refer to section 1.6 involving the quarterly noncompliance reports.

All three tables include the BVDC effluent. However, since BVDC actually discharges into the Seekonk River, to limit the discharge determinations to Blackstone River only, the results have been qualified both with and without BVDC in Table 1.6. With the BVDC discharge included, RI contributes approximately 80% of the TSS and BOD loading to the Blackstone/Seekonk Rivers. Without BVDC, MA contributes approximately 60%. This is also true for FC condition 2, as indicated, with the Woonsocket WWTF set at 1988 concentrations.

1.5 Comparison of Permit Design Flows to Actual Flows

The permit design flows total approximately 65.4 MGD for MA and 44.9 MGD for RI (18.9 MGD without BVDC). The actual discharge flows according to the 1988-89 DMR data were for MA

Table 1.6 - Comparison Between Massachusetts and Rhode Island Monthly Average Loadings 1988-89

State	TSS lbs/day	(%)	BOD lbs/day	(%)	Fecal Coliform Condition 1 #/day	%	Fecal Coliform Condition 2 #/day	%
				LOADINGS WITH BVDC				
MA	3,431	(18)	2,886	(18)	1.95 E10	(1)	1.95 E10	(18)
RI	15,363	(82)	12,864	(82)	1.07 E12	(99)	8.90 E10	(82)
				LOADINGS WITHOUT BVDC				
MA	3,431	(64)	2,886	(61)	1.95 E10	(1)	1.95 E10	(52)
RI	1,947	(36)	1,840	(39)	1.00 E12	(99)	1.80 E10	(48)

Condition 1 includes Woonsocket WWTF with a 1988-89 mean loading of 3,164 #/day; Condition 2 includes Woonsocket WWTF with 1988 mean loading of 46 #/day.

40.9 MGD or 62.5% of the allowable (permit design) flow and for RI 32.0 MGD or 71.3%. Without BVDC, the RI discharge was 9.68 MGD or 51.2%. These flows are listed by discharge in Table 1.7. Approximately 93% of the total point source flow into the Blackstone/Seekonk is contributed from three sources, UBWPAD (50.2%), BVDC (30.6%) and Woonsocket (11.9%).

Of these three major dischargers BVDC is closest to capacity at 72% followed by the UBWPAD (65%) and Woonsocket (54%). Of the other dischargers Hopedale is closest to capacity at 80% followed by Zambarano (79%) and NE Plating (70%).

Two requests were made by the NBP. The details are provided in sections 1.5.1 and 1.5.2 to follow. The first involved the assessment of whether any of four major facilities (UBWPAD, BVDC, Burrillville, and Woonsocket) would approach or exceed design capacity if presently unsewered areas within each facility's service area were sewered, or CSO or stormwater treatment were mandated. The estimates detailed below were made only for sewered flow and are summarized as follows.

Essentially both the UBWPAD and Woonsocket facilities have design flows which are sufficient to allow for expansion and still maintain a reserve. On the other hand, with the projected population increases, the BVDC facility would be near maximum capacity. Since a study is currently underway at BVDC which includes the evaluation of CSOs, one would expect that expansion of the facility capacity has been or will be addressed. Of the four facilities, only the Burrillville facility would exceed

Table 1.7 - Comparison of Actual Effluent Flows to Permit Limitations for Monthly Average Conditions

Discharge	Permit Limit MGD	(% of Total)	1988-89 DMR Average MGD	% of Allowable
Massachusetts				
Grafton	1.6	(1.4)	0.92	57
Guilford	1.25	(1.1)	0.29	23
Hopedale	0.588	(0.5)	0.47	80
Millbury	1.2	(1.0)	0.83	69
NE Plating	0.2	(0.2)	0.14	70
Northbridge	1.8	(1.6)	0.90	50
UBWPAD	56	(48.4)	36.56	65
Upton	0.3	(0.3)	0.15	50
Uxbridge	2.5	(2.2)	0.64	26
Rhode Island				
BVDC	31	(26.7)	22.32	72
Burrillville	1.5	(1.3)	0.77	51
GTE	0.9	(0.8)	0.06	6
Okonite	0.38	(0.3)	0.10	26
Smithfield	0.006	(<1)	0.004	67
Tupperware	0.006	(<1)	0.004	67
Woonsocket	16	(13.9)	8.65	54
Zambarano	0.12	(0.1)	0.095	79

design flow based on the population predictions.

CSO and stormwater flows are real concerns to existing facility capacities, if treatment is mandated. Although specifics relative to the facilities' drainage areas are not known, in general peak runoff rates in urban areas are typically high due to large impervious areas. The maximum reserve of any of the four facilities (UBWPAD (design - existing) 56 - 43.56 = 12.44 MGD) would probably not be sufficient without additional modifications to the system in the way of in line or off line storage. These modifications are becoming more typical in dealing specifically with CSOs in that they delay the arrival of the runoff, reduce the frequency and volume of overflows and more effectively use the WWTFs reserve over several poststorm days. However, connection of stormwater dischargers is not typical and usually avoided. The evaluation of these types of alternatives go far beyond the scope of effort in this report. They require a detailed monitoring and modeling effort of the system hydraulics. There are two projects in the watershed that may be useful in regards to this type of evaluation including the current engineering effort underway at the BVDC WWTF and the recently completed engineering analysis and design of the UBWPAD CSO facility.

The second request required an estimate of total flows based on projected population and manufacturing growth through the year 2000 in each service area. Results were similar to those given above in that the UBWPAD and Woonsocket WWTFs have adequate capacities to handle expansion and maintain a reserve. The BVDC facility would be at maximum capacity with no reserve and the Burrillville WWTF would exceed permit levels. The details are included in the following sections.

1.5.1 Potential Increase in Sewered Flow Based Upon Unsewered Area

As requested, an assessment has been made relative to four facilities (UBWPAD, BVDC, Burrillville, and Woonsocket WWTFs) and the potential for exceeding the design capacity, if presently unsewered areas within each facility's service area were sewered.

Burrillville - From information taken from both the State Guide Plan Element 121 (RI Division of Planning (DOP) 1989) and the State Guide Plan Element 711 (RI Office of State Planning (RI OSP) 1982) it was estimated that approximately 4,554 people were serviced by the WWTF in 1985. This is 31% of the overall population of 14,693. Based on the DMR average flow for 1989 of 0.53 MGD, flow per capita is approximately 115 gallons per capita per day (gpcd). For the assumption that 100% of the population is serviced, the approximate flow would be 1.69 MGD. This exceeds the current design capacity of 1.5 MGD and should be highlighted accordingly.

UBWPAD - From information in the 1986 Blackstone River Basin Plan (Dunn and Anderson 1986) the majority of the wastewater to the facility currently comes from the cities of

Worcester and Auburn. The majority of each city is tied in at present. This is approximately 195,000 people based on 1990 projections. The average per capita flow rate based on the average DMR reported flows for 1988-89 of 36.56 MGD is approximately 188 gpcd.

In the report, reference is made to several other communities that might either partially or totally tie-in to the UBWPAD in the future. These communities include Holden, West Boylston, Boylston, Leicester, and Paxton. Since no specific detail is supplied in the Dunn and Anderson report concerning the percentage of these communities that might tie-in, for the purposes of the NBP request, a conservative estimate of flow would be to include the entire 1990 population of the 5 communities or 37,400. Based on the flow of 188 gpcd this would result in an increase of 7.0 MGD or 43.56 MGD of total flow. This is still far below the design limit of 56 MGD and the current design flow is sufficient.

Woonsocket - According to published information (RI DOP 1989), 100% of the communities of Woonsocket and Blackstone and 15% of North Smithfield are tied into the Woonsocket facility. The 1985 projections for the three communities were 45,289, 8,500 and 10,202, respectively. After weighting the North Smithfield population accordingly, the total population sewered is approximately 55,000. For the 1988-89 average influent flow of 8.65 MGD, the per capita rate is approximately 162 gpcd. Assuming the system expands to include all of North Smithfield, the projected facility flow rate would be 10.37 MGD. This can be compared to the permit limit of 16 MGD. The conclusion is the current design flow is sufficient.

BVDC - The BVDC facility services 100% of Central Falls and Pawtucket, 29% of Cumberland, 8[illegible]% of the Rumford section of East Providence and 16% of Lincoln. Rumford was estimated to be approximately 25% of the overall East Providence area. Based on the 1985 population estimates (RI DOP 1989), the total sewered population is currently about 112,000. For the DMR average flow of 22.32 MGD, the per capita rate is approximately 200 gpcd. If all areas of Lincoln, Cumberland and Rumford are assumed to be tied in, the population increases to 147,000 and the BVDC flow rate would be 29.4 MGD. The current design flow is 31 MGD. These are essentially the same and should be highlighted.

1.5.2 Potential Increase in Sewered Flow Based Upon Population Forecasts Beyond the Year 2000

Burrillville - Population projections are available for the year 2010. Based on a 31% sewered area and the per capita flow rate as calculated above, the flow will be approximately 0.7 MGD. If the entire Burrillville area was sewered, the projected flow rate for 2010 would be about 2.19 MGD. The design flow is only 1.5 MGD at present.

UBWPAD - In the towns under consideration as either completely or partially tied in to the UBWPAD, the projected population increase is about 67,000 people by the year 2010.

With a per capita flow rate of 188 gpcd the increase of flow will be on the order of 12.6 MGD. This added to the existing flow rate of 36.56 MGD gives 49.16 MGD. The design flow of 56 MGD is sufficient.

Woonsocket - For the 2010 population projections and the North Smithfield figure of 15% sewered, the estimated flow for a per capita flow rate of 162 gpcd is about 9.5 MGD. This is compared with the current flow of 8.65 MGD and the design flow of 16 MGD. If the entire population of North Smithfield was included in the system, the flow rate would be about 11.1 MGD. The design flow is sufficient.

BVDC - Based on the population projections for 2010, the assumption the area covered by sewers does not change, and a per capita rate of 200 gpcd, the flow estimate is 22.4 MGD. If 100% of the communities are sewered this flow will increase to 30.4 MGD. This is essentially equal to the design flow of 31 MGD.

1.6 Comparison of Permit Limits to the 'Quarterly Noncompliance Reports' of 1988-89

A general evaluation of the performance of the UBWPAD, Burrillville, Woonsocket and BVDC WWTFs was requested to determine whether these facilities generally comply with their own NPDES permits. This was to be based only on the 1988 and 1989 Quarterly Noncompliance Reports (QNRs). The scope of work was expanded by the authors to include all major RI and MA dischargers. This provides a more complete performance evaluation of point sources to the Blackstone River. The QNRs were provided for MA by the US EPA Region 1 and for RI by RI DEM. A listing of each violation is included in Appendix D in Tables D.1 and D.2. A summary of the violations are provided in Table 1.8. If there was more than a single violation for a constituent in any given month (i.e. average monthly and maximum daily), it is simply indicated as a single violation month in Table 1.8.

In general, violations occurred at most facilities infrequently. The most notable exception includes the chronic problems at the BVDC facility relative to TSS, BOD and FC, which were indicated earlier in Tables 1.3 to 1.5 and are clearly evident in the summary. Almost all months were in violation. Other problems of significance would be relative to pH in MA for four of the WWTFs and in RI for FC and BOD at the Woonsocket WWTF and for TRC at the Zambarano and Burrillville dischargers.

2. Identification of Existing and Potential Water Quality Problems

As requested, a review relevant to existing water quality and pollutant loading data on the Blackstone River from its headwaters in MA to the Slater's Mill Dam/Seekonk River in RI has been made. Since changes have been occurring to some of the WWTFs through the 1980s, older water quality data may not depict current conditions. Only the most current studies are reported here. These are listed in Table 2.1 and water quality stations for each study are given in Appendix G. They include DO surveys

Table 1.8 - Summary of Violation Months for Massachusetts and Rhode Island Dischargers During 1988-89

Facility	TSS	BOD	SS	TRC	pH	FC	Flow	NH3	TP	Pb
Massachusetts										
Grafton WWTF			2	4	5	1				
Guilford	1	1			1					
Millbury WWTF	1	2		2			2			
N.E. Plating					10					
Northbridge WWTF					13					
UBWPAD WWTF	6		2		15	4		3		
Uxbridge WWTF		1		7	18					
Rhode Island										
BVDC	24	24	23			22				
Burrillville	3			13	6	3	2		2	
GTE	1									4
Okonite					2					
Smithfield							7			
Tupperware	2	1			1	1				
Woonsocket	7	10	3		7	16	3			
Zambarano	1			23	1	3				

Maximum violations = 24, which is equivalent to the 24 month period in 1988-89; TSS = total suspended solids; BOD = 5 day biochemical oxygen demand; SS = settleable solids; TRC = total residual chlorine; FC = fecal coliform; NH3 = ammonia; TP = phosphorus; Pb = lead.

Table 2.1 - Flows for Studies on the Blackstone River at the USGS Gaging Station at Woonsocket, RI

Study	Dates	Average Flow (cfs)
MA DEP[a]	6/18/85 - 6/20/85	412
URI[b]	7/ 8/85	185
URI	8/20/85	195
URI	10/ 8/85	681
EE[c]	8/21/87	120
EE	9/28/87 - 9/30/87	290
URI	10/22/88 - 10/26/88	443
URI	5/10/89 - 5/15/89	2,355
URI	6/12/89 - 6/15/89	1,248
MA DEP	7/11/89	399
MA DEP	8/14/89	3,440
MA DEP	9/18/89	615

[a] MA DEP = Massachesetts Department of Environmental Protection
[b] URI = University of Rhode Island
[c] EE = Ecology and the Environment, Inc.

in 1985 by MA Department of Environmental Quality Engineering (MA DEQE) (MA DEQE 1985a) and in 1987 by Ecology and Environment, Inc. (EE) (EE 1988) under the direction of the RI DEM, trace metal surveys in 1989 by MA DEP (unpublished data, 1990c), trace metal and organic surveys in 1985 by URI under the direction of the NBP (Quinn et al. 1987 and Wright 1988), and wet weather studies for both trace metals and organics in RI only in 1988-89 by URI again under the direction of the NBP (Wright et al. 1991a and 1991b). There were no wet weather data available in MA.

In interpreting the steady state figures, the concept of waste load allocations (WLA) should be kept in mind. A WLA is the equitable distribution of loading from all sources to allow for the receiving water to meet criteria at a critical low flow. This low flow is typically taken as the 7 consecutive day low flow with a return period of 10 years (7Q10). For reference in the discussion to follow, the Woonsocket United States Geological Survey (USGS) gage has a 7Q10 of 100 cubic feet per second (cfs). A survey conducted in flows significantly higher than the 7Q10 will not reflect the worst case situation in the river. Therefore, if a problem exists at a higher flow, it will probably be compounded at the 7Q10 depending on the relative importance of dilution to the specific constituent.

Also the time of year is important in evaluating water quality data, since the most critical time is typically in the late summer/early fall. This is in part due to the flow, but also include other complicating factors including high instream temperatures and high plant productivity. Therefore, if data represents the early summer, the resulting water quality profile may not be the worst case situation regardless of the flow.

Since the knowledge of the water quality at critical low flow is essential to making any regulatory decision relative to advanced wastewater treatment, there is the need to develop the ability to predict the water quality and evaluate alternatives. This is done through water quality modeling. Where available output from water quality models for the 7Q10 conditions have been presented below.

Specifically, NBP has requested current water quality problems be identified under both steady state and wet weather conditions for a range of flows. The steady state (dry weather) discussion is given in section 2.1 and summarized in section 2.1.1 and the wet weather in section 2.2 with a summary in section 2.2.1.

2.1 Steady State Conditions (Dry Weather)

The most current data has been graphed to provide snapshots of the Blackstone River's water quality from Worcester to Slater's Mill. These figures are given in Appendix E for DO (Figure E.1) and selected trace metals and organics (Figure E.2 to E.7A). For DO, the figure includes the 5.0 mg/L standard for Class B and C waters as described earlier in Appendix A and for trace metals and organics, the acute and chronic criteria as determined by US EPA Gold book formulas (Table 2.2) based on a hardness of 37.8 mg/L.

Dissolved Oxygen - In MA, the 1985 study included the sampling of 33 stations (Figure G.1) in the Blackstone watershed 9 times over 2+ days. A total of 297 DO measurements were taken. Of these, 36 were below the standard of 5.0 mg/L. The lowest single DO measurement, 3.2 mg/L, occurred in the Blackstone River above the dam off Chase Road in Grafton at river mile (RM) 21.2 (MA DEP WQS BS12). River miles in MA are referenced to zero at the MA/RI state line. The lowest daily mean, 5.2 mg/L, was in the Blackstone River off McCracken Road in Millbury RM 24 (MA DEP WQS BS10).

Figure E.1 is a plot of daily means. An oxygen sag appears between RM 30 and 25. The sag began above the UBWPAD discharge and ended just below it. The average flow at the Woonsocket USGS gage for the 1985 survey period was 412 cfs. This is approximately 4 times the 7Q10 flow of 100 cfs. Given the same set of discharge conditions, the instream oxygen profile would probably have been considerably lower, if the 7Q10 flow was observed and the timing was late summer. Violations would probably have occurred for daily means.

In RI, the September 1987 study was conducted by the consulting firm of Ecology and Environment, Inc. (EE). The study was prompted by the need to evaluate a potential withdrawal of 4 MGD from the Blackstone River for purposes of cooling by Ocean State Power . Although EE was under the

Table 2.2 - Fresh Water Aquatic Life Criteria (EPA 1986)

Parameter	Acute (μg/L)	Chronic (μg/L)
Arsenic	360	190
Cadmium	$e^{(1.128[\ln H]-3.828)}$	$e^{(0.7852[\ln H]-3.49)}$
Chromium III	$e^{(0.819[\ln H]+3.688)}$	$e^{(0.819[\ln H]+1.561)}$
Chromium VI	16	11
Copper	$e^{(0.9422[\ln H]-1.464)}$	$e^{(0.8545[\ln H]-1.465)}$
Lead	$e^{(1.273[\ln H]-1.46)}$	$e^{(1.273[\ln H]-4.705)}$
Mercury	2.4	0.012
Nickel	$e^{(0.846[\ln H]-3.3612)}$	$e^{(0.846[\ln H]+1.1645)}$
Selenium	260	35
Silver	$e^{(1.72[\ln H]-6.52)}$	acute/45 (a)
Zinc	$e^{(0.8473[\ln H]+0.8604)}$	$e^{(0.8473[\ln H]+0.7614)}$
Aldrin	4	--- (b)
Dieldrin	1	0.0019
Chlordane	2.4	0.0043
DDT	1.1	0.001
Endosulfan	0.22	0.056
Endrin	0.18	0.0023
Heptachlor	0.52	0.0038
Gamma-BHC	2.0	0.08
Toxaphene	0.73	0.0002
Cyanide	22	5.2
PCBs	2	0.014

H = hardness (mg/L as $CaCO_3$); (a) No EPA chronic criteria is available for silver. The chronic value should be determined by dividing the acute vlaue, given by the hardness equation, by an acute to chronic ratio of 45; (b) --- indicates that no data is available.

support of Ocean State Power, RI DEM played an active role in the development of the monitoring program. A total of 9 stations in RI were monitored every 4 hours for 2 days for a total of 108 DO measurements. There were no violations of the 5.0 mg/L standard reported. The lowest single DO measurement, 5.6 mg/L, occurred at the Route 122 bridge over the Blackstone River before the junction of the Branch River. This station is near the MA/RI state line. The flow at the Woonsocket USGS gage was about 290 cfs or approximately 3 times the 7Q10.

A second survey was actually collected in advance of EE's efforts by RI DEM in August 1987, for purposes of observing the Blackstone River at approximately 7Q10. Data collection was made once in the early morning hours at 4 locations. The lowest single oxygen concentration, 3.4 mg/L, occurred at the Manville Dam below the Woonsocket WWTF. The two data points above and below the Woonsocket facility give the impression of a significant DO sag. Since flows were near 7Q10 and the timing was late summer, one expects the observed DO to be near a worst case profile. However, it should be noted that the data is quite limited and any conclusions drawn from this survey should have that qualification.

Dissolved Oxygen 7Q10 - For MA, the most recent DO/BOD modeling effort occurred in the early 1980s. The effort included the Blackstone from Worcester to the MA/RI state line using a model (STREAM7) developed exclusively for the MA DEP in the early 1970s. The calibration and validation procedures were not reviewed in this report. Data used in this effort was from the 1970s. These results were published in 1983 (MA DEQE 1983) and it appears that they were used to help establish the advanced wastewater treatment (AWT) requirements at the UBWPAD facility shown in Appendix B. The model predictions for the 7Q10 flow are given in Figure E.8 for the permit limits that exist today at the UBWPAD. The model indicates a minimum DO at 3.85 mg/L with approximately 0.6 miles of violations.

In RI, EE used the DO/BOD model QUAL2E to simulate 7Q10 conditions. The model is based on the calibration with the September 1987 data and verification with data from August 1987. A detailed review of this effort was completed by the author and was submitted to RI DEM at their request. Without going into the weaknesses of their modeling effort highlighted in the review, their results are given in Figure E.8. The profiles essentially track the observed profile of August 1987. A DO sag occurs below the Woonsocket WWTF with the minimum concentrations occurring just above the Manville Dam. DO concentrations are violated in this area.

Trace Metals - In MA, metal samples were collected during a 1989 study that included 6 sampling locations sampled once in July, August and September for a total of 18 daily observations. The results are plotted in Figures E.2 to E.7 for Cd, Cr, Cu, Pb, Ni and Zn. Flows for the July and September surveys were steady state averaging 399 and 615 cfs at the Woonsocket USGS gage or 4 and 6 times the 7Q10. The August survey was taken during a wet weather period where a 2+ inch storm had resulted in flows in excess of 3,000 cfs.

In RI, three surveys were taken in 1985 that included the sampling of 8 stations 4 times each survey. The 24 daily averages are also reported in Figures E.2 to E.7. The flows at the Woonsocket gage were 185, 195 and 681 cfs or approximately 2 and 7 times higher than the 7Q10.

Cadmium - The UBWPAD discharge appears to cause a dramatic increase in instream concentrations. Of the 18 daily observations in MA, 11 are above acute criteria and 14 are above chronic criteria. Of the 24 daily averages in RI, 1 is above acute criteria and 17 are above chronic criteria. In general, concentrations decrease from the high below the UBWPAD through both MA and RI. There is no sharp increase of cadmium in RI. In general, Figure E.2 indicates a decline in cadmium concentrations from the state line to the mouth of the Blackstone.

Chromium - All chromium concentrations are well below acute or chronic criteria.

Copper - Similar to cadmium, the UBWPAD has a major impact on instream concentrations. In general, the concentrations continue to decline from this point through RI. With respect to the criteria in MA, 13 (of 18) observations exceed both acute and chronic criteria, while in RI all 24 observations exceed both criteria. There are no significant increases observed in RI. In general, the copper concentrations decline from the state line to the mouth of the Blackstone (Figure E.3).

Lead - In MA, 12 (of 18) observations were below the detection limit of 2.0 μg/L. Unfortunately, the chronic criteria (0.92 μg/L) is below the MA detection limit and little may be made of this data. In RI, all 24 points were above chronic criteria but below acute. There are some gradual increases of concentration at the lower reaches near Central Falls in RI. This is most pronounced in the October survey. However, if one recognizes the first station in RI over the state line as MA contribution to RI, fluctuations from these values are not really significant.

Nickel - For two of the three surveys in MA, the UBWPAD discharge appears to be significant. The other survey has very high incoming concentrations to this reach. From the UBWPAD discharge, all three surveys steadily decline to the state line. In RI, all three state line stations are twice as high as the MA surveys indicate. In general, concentrations in RI gradually decline from the state line levels. No data in either state were in violation of criteria.

Zinc - In MA, 6 (of 18) observations were above chronic criteria. There is no obvious trend consistent between surveys. All three state line samples are below chronic criteria as they enter RI. No data is available in RI.

Trace Metals 7Q10 - There has been no attempt at modeling metals in MA. For RI, the 1985 efforts by the URI/CVE group have led to a calibrated and validated model for trace metals

(PAWTOXIC). The application of the model to 7Q10 conditions was made by EE. The results of this effort are given in Figures E.9 to E.15 for Cd, Cr, Cu, Pb, Ni, Ag, and Zn. A major assumption in this application is the estimate of the MA/RI boundary concentrations. The background for the assumptions are given in the final report (EE 1988).

For cadmium, a continuous decline is indicated from the state line to Slater's Mill with all predictions being in violation of both acute and chronic criteria. For chromium, the trend is the same as cadmium but no violations occur. For copper, the profile is dominated by a sharp increase at the Woonsocket discharge. Although this was not evident in the actual observations in 1985 (Figure E.4), the 7Q10 application by EE assumes design flows and therefore, substantially higher loadings at the facility than actually occurred in 1985. All predictions for copper are in violation of the acute and chronic criteria. Lead is similar to cadmium with a general decrease from the state line boundary concentrations. Chronic criteria are violated for the entire river. The nickel profile is essentially flat and no violations occur. Silver rises above the chronic criteria due to inputs from the Woonsocket WWTF. Violations are indicated from the point of discharge to the end of the river. Zinc is similar to cadmium and lead. Violations occur from the state line to about 6 miles above the river's mouth.

Polychlorinated Biphenyls (PCBs) - In RI, samples for the evaluation of selected organics were also taken during the 1985 study indicated above. The results specific to PCBs are reported in Figure E.7A (Quinn et al. 1987). No data is available for MA. Of the 24 daily averages in RI, no data is above the acute criteria of 2,000 ng/L. However, 19 of the 24 means were above the chronic criteria of 14 ng/L. There appears to be a general decline from values at the state line until the lower reaches of the Blackstone near Central Falls/Pawtucket. In this area, instream concentrations increased for all three surveys.

2.1.1 Summary of Steady State Conditions

A major weakness in the above review is the inability to evaluate a single survey which covers the entire Blackstone River. By plotting the MA and RI data side by side, an attempt was made to develop an understanding for the relative importance of the major point sources and general trends within surveys and between the states. However, any of these interpretations are subject to argument because the amount of data is essentially inadequate and there are too many conditions that are variable between the MA and RI efforts, for instance: (a) stream flows, (b) season of sampling (i.e. early summer vs late summer), (c) the year of sampling, (d) frequency of sampling (i.e. composites vs individual grabs), and (e) laboratory procedure (i.e. trace metal detection limits). One of the major recommendations of this paper is the need for a comprehensive sampling effort to be conducted jointly by RI and MA. More detail will be supplied relative to this recommendation in later sections.

With the above qualifications in mind the following observations are made based on the available data and modeling efforts.

There exists several problem areas associated with oxygen. Violations were observed at two key locations, both downstream of major dischargers (UBWPAD and Woonsocket). This supports the idea that the problems, at least associated with DO, may be point source in origin not nonpoint source. Since the MA field efforts of 1985, the UBWPAD has been upgraded to AWT with the purpose of improving DO concentrations in the receiving water. However, even with this implementation, modeling forecasts made in 1983 still indicate violations will occur, although for only 0.6 miles. The modeling effort is old and should be updated.

Even more important than just the update is the opportunity which exists to postaudit the decision to go to AWT at the UBWPAD. In the late 1970s and early 1980s, many AWT alternatives were implemented based on the efforts of a modeler. A great deal of faith was placed on these efforts since millions of dollars went into construction. Since AWT has been in place for several years at UBWPAD, the river may be at an equilibrium with the current conditions. The 1983 decision can be postaudited now. The authors strongly recommend this take place, but with certain qualifications. Since the STREAM7 model is used exclusively by MA, its postaudit has meaning in only a general sense to the modeling and regulatory community but does not impact other AWT efforts in the planning stages elsewhere in the country. Whereas, a postaudit of a model like QUAL2E has more meaning, since it has been widely accepted by the modeling and regulatory community and has been endorsed by US EPA. Therefore, it is recommended that the postaudit involve not only STREAM7 but also QUAL2E, where QUAL2E is initially calibrated and verified with the same data sets that were originally used for STREAM7. A secondary result of this effort, which has significant meaning, will be the evaluation of the sediment oxygen demand and the changes that have occurred as a result of AWT.

In RI, the available data for calibration and verification of QUAL2E was inadequate and as a result the forecasts made by this effort are less than reliable. One of two sets of DO data indicate violations although the data set was very limited. A comprehensive effort both in monitoring and modeling are necessary.

Based on the available data, there exist several problems with metals relative to the US EPA recommended acute and chronic criteria. Specifically, data indicates violations occur for cadmium, copper, lead and zinc. No violations were observed for chromium or nickel. The UBWPAD facility was shown to be significant relative to cadmium, copper, nickel and zinc. Again, at least for these metals and this discharge, this observation indicates that the solution to the problem may be with respect to point source control and not necessarily nonpoint source control. No significant increases in any metal could be associated with the Woonsocket facility. In general, the trend for cadmium, copper, nickel, and lead indicates that maximum concentrations in RI were typically at the state line and generally declined towards Slater's Mill.

Based on the available data, there exists a problem with PCBs throughout most of the RI portion of the Blackstone. Chronic criteria are continually violated. The highest concentrations in each of the three surveys occurred at the state line. This raises some interesting questions as to the maximum levels of PCBs being experienced in MA and their sources.

Toxic modeling including trace metals and organics has never been performed in MA. Therefore, estimates of trace metal and organic loadings to RI under various flows including the 7Q10 are not available. This really lies at the heart of a major problem that has yet to be adequately addressed in the Blackstone watershed. MA does not need the cooperation of RI to evaluate and manage the Blackstone in its borders. Whereas, RI needs cooperation from MA. With respect to trace metal and organic modeling, RI can not conduct a WLA on the Blackstone River, because the concentrations of specific metals and PCBs at the model's boundary, which has been set at the state line, are unknown.

Sediment resuspension has been indicated as a major issue on the Blackstone. The authors believe it is important but this importance must be placed in the proper context. With regards to the steady state conditions, the PAWTOXIC model, for example, addresses resuspension and incorporates it into the modeling structure as a function of stream velocity. In some instances when velocities are high, the loading from resuspension may, in fact, be more significant than the point source or diffuse groundwater loading. The model allows you to evaluate different flow profiles and source loadings. However, the importance of resuspension in a WLA is probably minimal, because the assumption that critical periods are set around low flows results in net settling in the system. Resuspension is no longer an issue. When one looks at some of the baseline data reported here, for instance the URI studies of July and August 1985, the flows were within a factor of 2 of the 7Q10. The modeling effort clearly indicated that in all reaches net settling occurred. It would probably be reasonable to extend this conclusion into MA. Therefore, incoming concentrations of metals and PCBs to RI during these studies are most likely point source in origin or a continuous baseline groundwater source.

2.2 Unsteady State Conditions (Wet Weather)

There is no wet weather information available from MA. In RI, the NBP funded a major effort to characterize and describe the wet weather contributions from both point and nonpoint sources of pollution to the Providence River. This originally included one station along the Blackstone River at Slater's Mill located at the mouth of the Blackstone and the beginning of the Seekonk River (BRSM). Due to the controversy over the relative loadings from MA to RI in the Blackstone River, the project was expanded to include locations in the RI portion of the watershed, which included a river station at the MA/RI state line (BRSL). This provides the opportunity to compare the contributions from MA to RI (BRSL) and the final loadings of the Blackstone to the Seekonk River (BRSM).

In general, the two tributary locations (BRSL and BRSM) had their mass curves interpreted for wet weather (wet), dry weather baseflow (dry), and total event loadings (wet + dry). An example of mass loading interpretation is given in Figure 2.1 (Wright et al. 1991a). The wet component of the load is a combination of both resuspended material from bottom sediments due to higher velocities at higher flows and runoff related material which includes direct stormwater entry as well as CSOs. The dry load is an estimate of the pre and poststorm loadings associated with upstream point sources and dry weather nonpoint sources (i.e. groundwater inflow).

The wet weather sampling program on the upper Blackstone involved two storms on May 10-15, 1989 (1.94 inches total rainfall (TR)) and June 12-15, 1989 (0.37 inches TR). The larger storm is discussed here in detail. Information

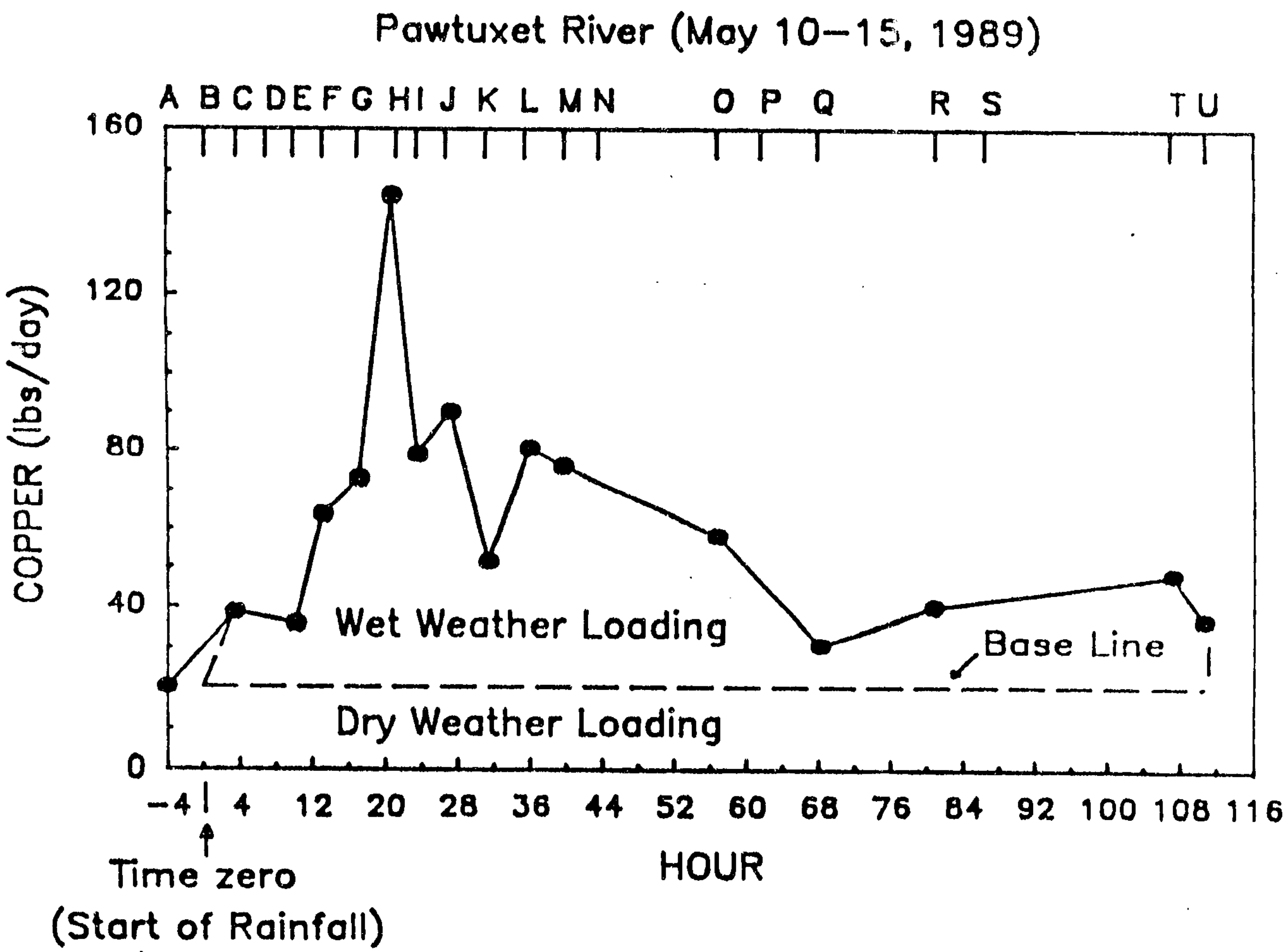

Figure 2.1 General Interpretation of Mass Loadings

pertaining to the sampling procedure and frequency are given in Wright et al. (1991a). The flow profiles for the two stations are provided in Figure 2.2. Flows at BRSM were approximately 30% higher than flows at the state line. The concentration and mass loading plots are given in Figures E.16 to E.21 for TSS, Cd, Cr, Cu, Ni and Pb. The results of the wet and total event loading components are summarized in Table 2.3.

A gross comparison may be made between the loads at the state line and those being discharged into the Seekonk River at Slater's Mill dam. Three general observations may be drawn. Either the MA loadings are higher, RI loadings are higher or the loadings are essentially equal. These results are summarized as the state line to Slater's Mill ratio (BRSL/BRSM) (SL/SM ratio in Table 2.3). The higher the ratio the greater the mass loading at the state line.

Table 2.3 is not an attempt to explain the complexities of the system that are associated with the fate and transport of the pollutants in RI. It is simply an attempt to indicate if the problem appears to be more related to MA or RI. A model would require significantly more field detail. It is important to note that all the constituents are nonconservative and, therefore, their concentrations may change with distance. Losses may be associated with, for instance, settling or time dependent transformations (i.e. nitrification).

For the total event loading, which combines the dry and wet components, the 4 metals Cd, Cr, Cu and Ni are similarly

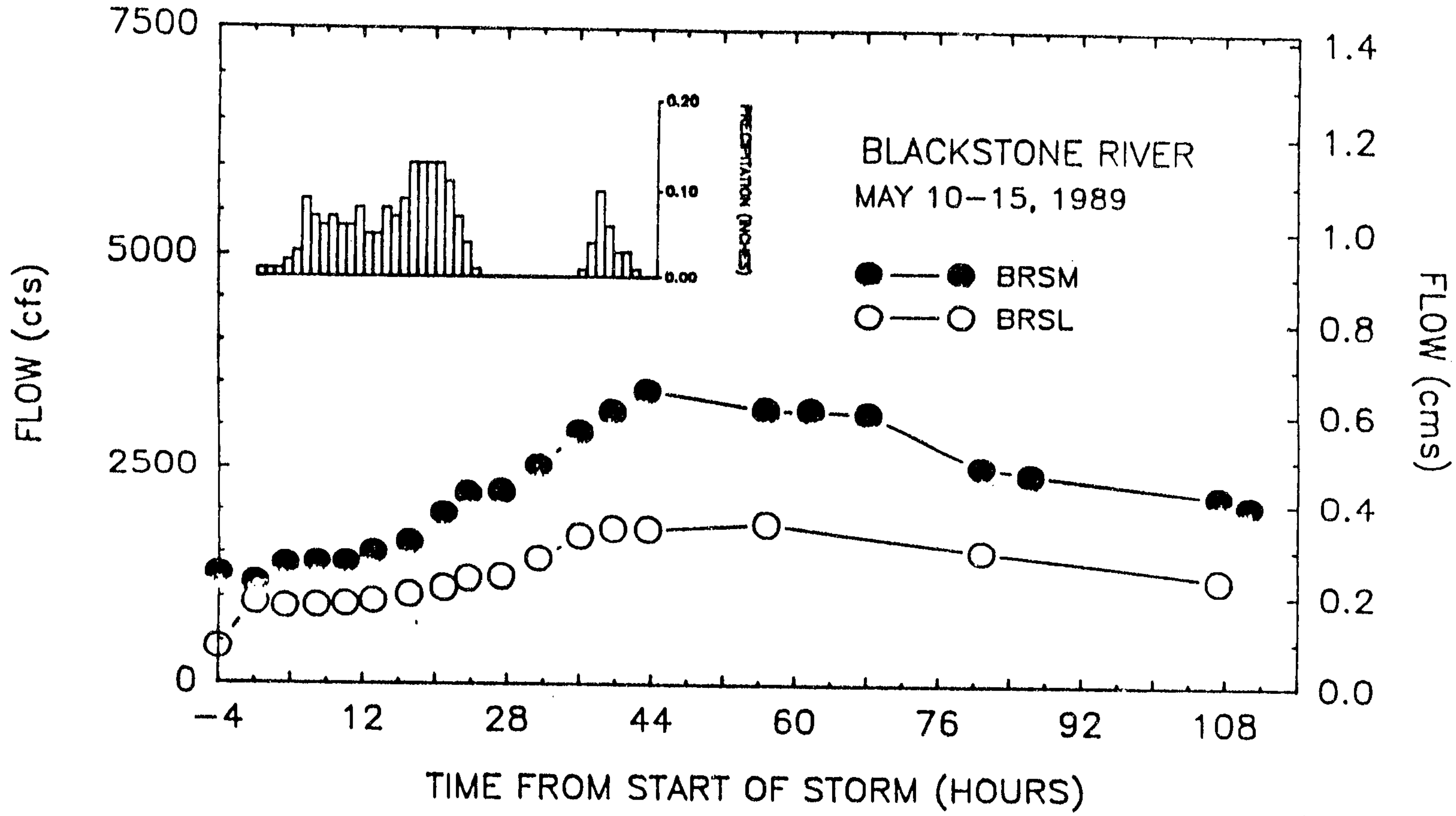

Figure 2.2 Flow Profiles for The Blackstone River at Slater's Mill (BRSM) and State Line (BRSL)

Table 2.3 - Comparison of Total and Wet Weather Mass Loadings Entering RI from MA and Discharging at the Mouth of the Blackstone River in Pawtucket, RI

	TOTAL MASS LOADING			WET WEATHER LOADING		
	BRSL (lb)	BRSM (lb)	SL/SM (%)	BRSL (lb)	BRSM (lb)	SL/SM (%)
TSS	380,754	901,854	42	248,635	590,144	42
Cd	49	58.6	83	18.6	26.6	70
Cr	255	336	76	148	220	67
Cu	570	750	76	360	344	105
Pb	215	599	36	121	353	34
Ni	328	417	79	187	153	122

BRSL - Blackstone River MA/RI State Line; BRSM - Blackstone River at Slater's Mill in Pawtucket, RI distributed in that the state line loads are approximately 75% to 85% of the loads at Slater's Mill. Whereas, for TSS and Pb, it is approximately 60%.

For the Cu and Ni wet weather loadings, the state line values are essentially equal to the values determined at Slater's Mill. The distribution for Cd and Cr again has the state line at approximately 70% of the Slater's Mill load. For TSS and Pb, it is approximately 35% to 40%.

Also on the wet weather concentration profiles of Appendix E, are the US EPA acute and chronic criteria for each of the metals and for PCBs. A brief summary of those results follows.

Cadmium - The wet weather event did cause the concentrations to exceed the acute criteria at BRSL on at least 6 occasions. The BRSM concentrations were all in excess of the chronic criteria but did not exceed the acute.

Chromium - All chromium concentrations including prestorm, storm related and poststorm samples were below the acute and chronic criteria.

Copper - All copper concentrations including prestorm, storm related and poststorm samples were in excess of both the acute and chronic criteria.

Lead - All lead concentrations including prestorm, storm related and poststorm samples were in excess of the chronic criteria only.

Nickel - All nickel concentrations including prestorm, storm related and poststorm samples were below the acute and chronic criteria.

PCBs - All PCB concentrations were above the chronic criteria but below the acute level.

2.2.1 Summary and Discussion of Wet Weather Conditions

Similar to the conclusions for the steady state condition, the available data to adequately interpret the impact of wet weather on the Blackstone River is inadequate. At best, the information provides a confirmation of the problems addressed in the steady state section, that is that there are violations occurring for Cd, Cu and Pb and no violations for Ni and Cr. These violations occur in both RI and MA.

Problems, in most cases, already exist at prestorm concentrations. These concentrations rise during the storm to values which may be as much as an order of magnitude higher. In the case of cadmium, concentrations exceed acute criteria during the event. For Pb, the peak concentrations are within 50% of the acute criteria. Larger and more intense storms will obviously result in higher concentrations and the potential for greater and more frequent violations exists.

The metal concentrations coming from MA are typically high for Cd, Cr, Cu and Ni. On the other hand, significant increases in concentrations of TSS and Pb occur in RI.

Unlike steady state conditions, resuspension may be the major component in the wet weather load. Unfortunately, the general interpretation of mass loading curves, like that included above for the curves of Appendix E, do not provide a separation of the various wet weather components (i.e. (a) bottom sediment resuspension and (b) runoff). Since resuspension is a key issue, information recently completed on the Pawtuxet River does provide a point of further discussion. The qualification is obvious, in that the discussion below centers on a different watershed. Similar estimates can be made for the Blackstone River.

The model, PAWTOXIC, was previously calibrated to the Pawtuxet River (Wright and McCarthy 1988). Since it is a steady state model, it may not be used to directly model a storm event. However, in the recent work by Roy Chaudhury (1991), the model was applied for the range of flows reported in the May 1989 storm given above. This provided an estimate of the resuspension of the TSS and selected metals, as if the increase in flows was simply baseline groundwater increases as opposed to runoff. This provides a prediction of the temporal profile at any given location. This has been plotted on Figures 2.3 and 2.4 for TSS and Cu. The difference between the baseflow estimates and the observations is the estimate of the runoff component. A summary is given in Table 2.4 for three metals and TSS. Approximately 75% of the observed wet load at the mouth of the Pawtuxet was associated with runoff for TSS, Cd, and Pb. The distribution between resuspension and runoff was essentially

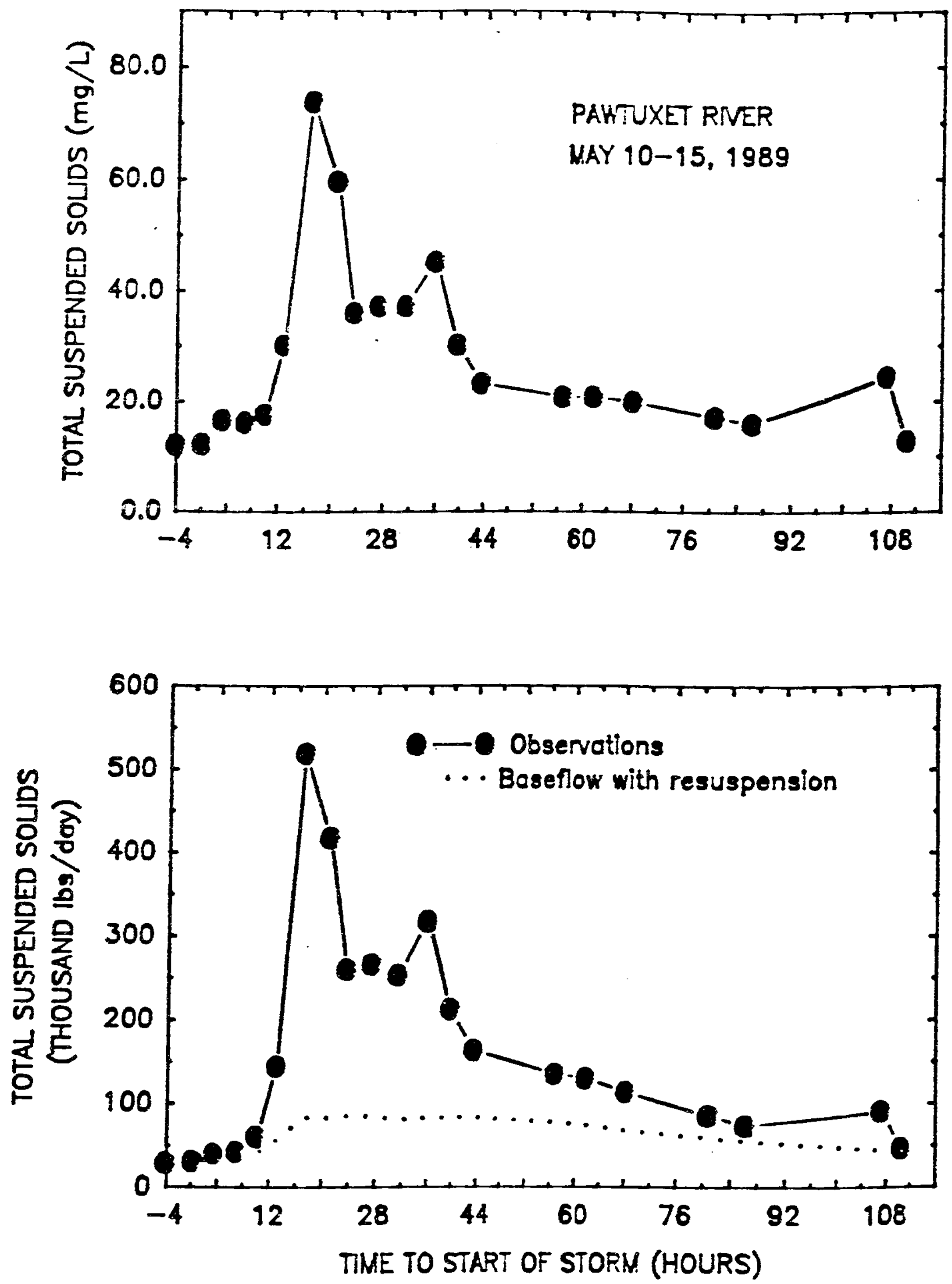

Figure 2.3 Temporal Variation of TSS at Pawtuxet River

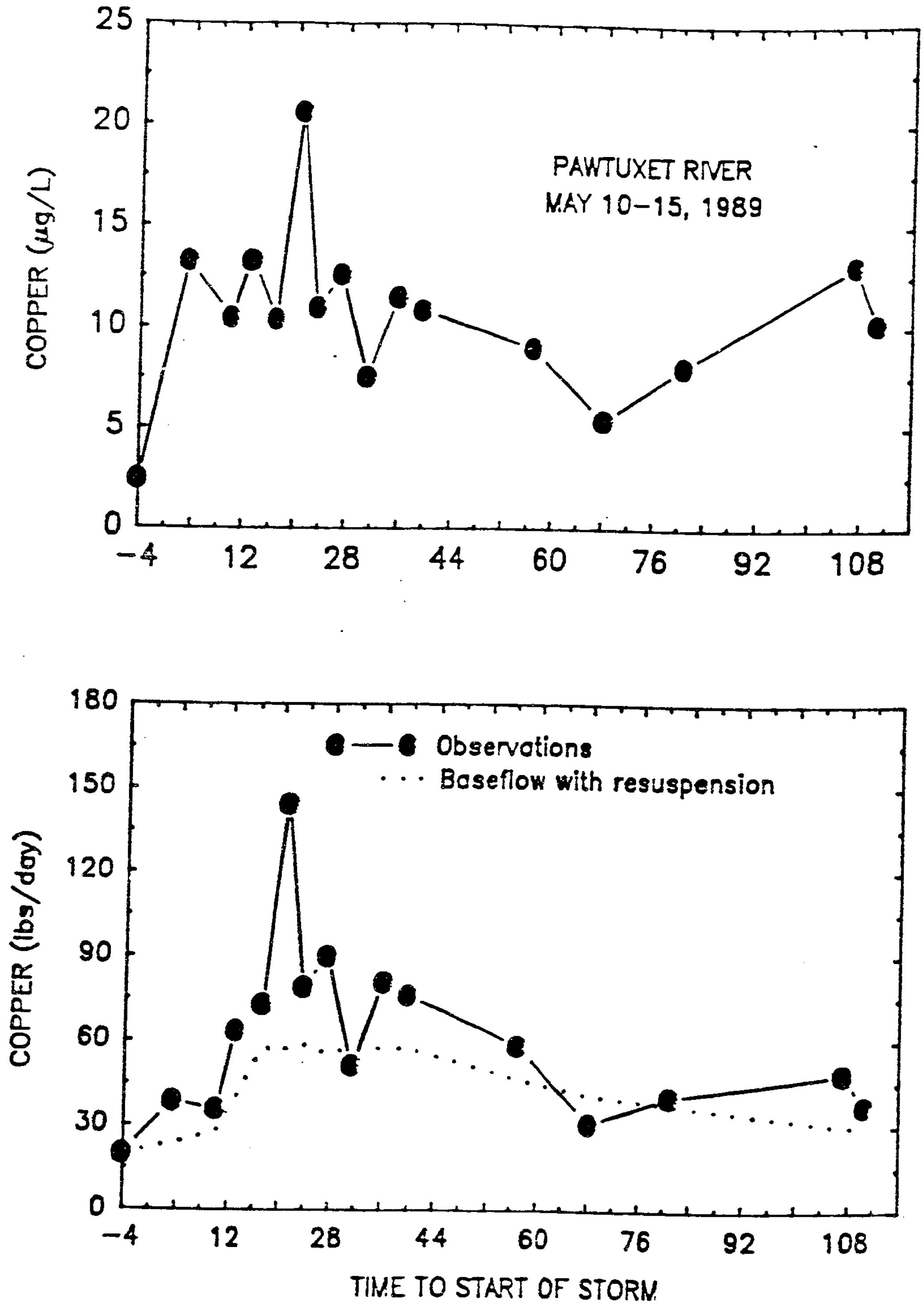

Figure 2.4 Temporal Variation of Cu at Pawtuxet River

Table 2.4 - Summary of Mass Loadings from the Wet Weather Loadings, Runoff and Resuspension During the Three Wet Weather Studies of 1988-89.

Constituent	Type	May 1989	
		(lbs/d)	%
TSS	Total WW	549,000	
	Runoff	400,000	72.9
	Resuspended	149,000	27.1
Copper	Total WW	108	
	Runoff	55	50.5
	Resuspended	53	49.5
Lead	Total WW	92	
	Runoff	72	78.3
	Resuspended	20	21.7
Cadmium	Total WW	8.7	
	Runoff	6.3	72.3
	Resuspended	2.4	27.7

Total WW - Total wet weather loading.

equal for Cu.

For Pb on the Pawtuxet, any effort to reduce the wet weather component must realize that if the public consensus make bottom sediments the target, they may only be 25% of the problem. Efforts may be better directed in defining the drainage areas that are contributing the highest runoff related loadings of lead and spend the effort dealing with stormwater.

Unfortunately, the effort on the Pawtuxet River is not directly transferable. Similar types of efforts can and should be developed for the Blackstone. Any effort to divide the wet weather loadings summarized in Table 2.3 at this point would simply be speculation.

3. Evaluate the Significance of the Blackstone River to Narragansett Bay Water Quality

The NBP requested the evaluation of the significance of the Blackstone River to Narragansett Bay water quality under both steady state and wet weather conditions. This included a comparison of the Blackstone River to other riverine, and point and nonpoint source inputs to Upper Narragansett Bay in terms of flow and pollutant loadings. Also a ranking of major pollutant sources to the Providence River is provided.

3.1 Comparison and Ranking of the Blackstone River to Other Riverine, and Point and Nonpoint Source Inputs to the Providence River and Upper Narragansett Bay

3.1.1 Steady State (Dry Weather) Conditions

The dry weather loading data for the Providence River and Upper Narragansett Bay were obtained from three surveys. All three were supported by the NBP and included the SINBADD cruises of 1985-86, the SPRAY cruises of 1986-87, and the wet weather study of 1988-89. Average flows for the three studies are reported in Table 3.1.

The eight sources of dry weather loadings included in Table 3.1 and located in Figure G.4 are the Blackstone River at Slater's Mill in Pawtucket, RI (BRSM), the Moshassuck River at the USGS gage in Providence, RI (MOSH), the Pawtuxet River above the Broad Street dam in Cranston, RI (PAWT), the Ten Mile River at the USGS gage in East Providence, RI (TENM), the Woonasquatucket River at Valley Street in Providence, RI (WOON), the Blackstone Valley District Commission WWTF in Pawtucket, RI (BVDC), the East Providence WWTF in East Providence, RI (EPRO), and the Narragansett Bay Commission WWTF in Providence, RI (NBCS).

The SINBADD study covered the entire Narragansett Bay at approximately 22 bay stations on high tides. Locations of these stations are given in Figure G.5. Samples were also collected at a number of smaller area rivers and several sewage treatment

Table 3.1 - Flows from Incoming Tributaries and Point Sources to the Providence River during Dry Weather Steady State Conditions (cfs)

STATION	SINBADD[a]				SPRAY[b] CRUISE	WET WEATHER[c]		
	1	2	3	4		1	2	3
BRSM	512	1669	1002	426	1048	142	1245	1403
MOSH	7	37	40	46	41	17	56	42
PAWT	115	607	297	167	473	245	450	542
TENM[d]	60	103	117	41	138	25	147	146
WOON	22	120	82	39	82	21	193	96
Total	716	2536	1538	719	1782	450	2091	2229
[%]	[85.7]	[95.2]	[91.3]	[78.8]	[90.6]	[81.4]	[92.2]	[94.0]
BVDC	31[e]	31	36	39	29	40	51	50
EPRO	7	12	13	12	12	7	12	11
NBCS	81	84	95	143	73	56	114	81
Total	119	127	147	194	184	103	177	142
[%]	[14.3]	[4.8]	[8.7]	[21.2]	[9.4]	[18.6]	[7.8]	[6.0]
Grand Total	835	2663	1685	913	1966	553	2268	2371

[a] SINBADD1 : Average daily flow of 10/22-24/85
SINBADD2 : Average daily flow of 11/18-21/85
SINBADD3 : Average daily flow of 4/ 7-10/86
SINBADD4 : Average daily flow of 5/19-22/86

[b] SPRAY CRUISE : Average daily flow of 10/11/86, 12/15/86
3/11/87, 4/12/87, 6/27/87, 8/12/87

[c] WET WEATHER 1 : Instantaneous pre-storm flow of 10/21/88
WET WEATHER 2 : Instantaneous pre-storm flow of 5/10/89
WET WEATHER 3 : Instantaneous pre-storm flow of 6/12/89

[d] No flow data available for four SINBADD studies, mean values from corresponding monthly averages in 1987 and 1988 used as estimates.

[e] No flow data available, values from SINBADD 2 used as estimates.

plants (STPs). Four cruises were performed (October and November 1985; April and May 1986), each lasting four days with analysis being performed on a number of constituents. For complete details, refer to Pilson and Hunt (1989) for trace metals and nutrients and Latimer et al. (1990) for organics.

The SPRAY cruises were primarily designed to monitor the Seekonk and Providence Rivers with a series of six sampling runs (October and December 1986; March, April, June, and August 1987). Sampling locations are supplied in Figure G.6. Coincident with each sampling run, five rivers and 3 STPs were sampled. Details are provided in Doering et al. (1989).

The wet weather study included the monitoring of the baseline conditions in the five major tributaries to the Providence River as well as the sampling of the three major dischargers. The locations are the same as indicated above and shown in Figure G.4. Three sampling periods occurred in October 1988; May and June 1989. Complete details are included in the five volume report by Wright et al. (1991a-e).

Table 3.2 is both a summary and ranking of the dry weather pollutant sources for these three surveys. Due to the implementation of a very effective pretreatment program at the NBCS, the table has been developed to highlight changes. The top of the table uses average data from all three studies covering the period 1985-90 and the bottom table uses average data from the last two studies for the period 1986-90.

For most constituents, the Blackstone River ranks either

Table 3.2 - Summary of dry weather rankings for pollutant sources to the Providence River

SOURCE	TSS	TN	TP	NH3	NO3	PO4	Cd	Cr	Cu	Ni	Pb	Ag	PCB
SINBADD, SPRAY, WET (1985-1989)													
BRSM	1	1	2	3	1	3	1	2	2	2	2	-	1
MOSH	8	7	5	7	7	8	8	8	7	8	8	5	6
WOON	7	6	7	6	5	7	7	6	6	7	5	4	4
TENM	5	-	-	8	3	6	4	5	5	3	6	-	-
PAWT	2	3	3	4	2	4	3	4	4	5	3	1	5
EPRO	6	5	6	5	4	5	6	7	8	6	7	3	3
BVDC	3	4	4	2	8	1	5	3	3	4	4	-	2
NBCS	4	2	1	1	6	2	2	1	1	1	1	2	7

SOURCE	TSS	TN	TP	NH3	NO3	PO4	Cd	Cr	Cu	Ni	Pb	Ag	PCB
SPRAY, WET (1986-1989)													
BRSM	1	-	-	3	1	3	1	1	2	2	1	-	-
MOSH	8	-	-	7	7	8	7	7	8	8	7	-	-
WOON	7	-	-	6	5	7	6	6	6	7	5	-	-
TENM	5	-	-	8	3	6	3	5	5	4	6	-	-
PAWT	2	-	-	4	2	4	2	3	4	5	3	-	-
EPRO	6	-	-	5	4	5	7	8	7	6	8	-	-
BVDC	3	-	-	2	8	1	5	2	3	3	4	-	-
NBCS	4	-	-	1	6	2	4	4	1	1	2	-	-

- : no data available; Rankings are the average of results from three studies including SPRAY, SINBADD, and NBP Wet Weather which spanned the years from 1985 to 1989 except for PCB from SINBADD (1985-86) only. Details relative to each study are provided in Appendix F Table F.1. Ranking of 1 equals the greatest contribution.

first or second. Specifics regarding the rankings and the actual loads can be seen in Appendix F.

3.1.2 Unsteady State (Wet Weather) Conditions

There are 12 constituents presented in this subsection including TSS, 5 trace metals, 3 nutrients and 3 organic compounds. The interpretation of the results included the determination of the three loadings described above (wet, dry and total) with the exception of the organic compounds, where only wet loads are reported (Wright et al. 1991a). Average flow volumes for the various sources are given in Table 3.3.

There are 8 sources for which wet weather loads can be determined. These include the 5 tributaries, the two bypasses and CSO9.

There are 11 sources for which total event loads can be determined. These include the 5 tributaries, 2 bypasses, 3 STPs and CSO9. For the tributaries, the total event loading is the sum of the dry and wet weather loads defined earlier. For the STPs, the total event loading and dry weather loading are the same. For the bypasses and CSO9, the total event loading and wet weather loading are the same.

The results have initially been summarized by constituent for each type of loading in a series of tables that are attached as Appendix F of this report. In general, the table format includes the mass loadings of each source for each storm event.

Table 3.3 - Flow Volumes from Incoming Tributaries and Point Sources to the Providence River during Wet Weather Conditions (MG)

Stations	TOTAL VOLUME (MG)		
	Storm 1	Storm 2	Storm 3
		TRIBUTARIES	
BRSM	1,144	7,553	1,481
MOSH	66.7	501	74.7
PAWT	795	3,067	741
TENM	96.3	1,122	174
WOON	110	995	142
Subtotal	2,212 [88.2%]	13,238 [95.2%]	2,613 [91.9%]
		STPS	
BVDC	82.4	162	67.3
EPRO	17.7	42.5	12.9
NBCS	152	353	137
BVDB	14.7	26.5	0.18
CSO9	19.60	55.95	8.75
NBCB	9.23	21.0	3.25
Subtotal	296 [11.8%]	661 [4.8%]	229 [8.1%]
Total	2,508	13,899	2,842

Storm 1 = 96 hours; Storm 2 = 112 hours; Storm 3 = 53 hours

[ ] : Percent age of tributary versus point source flows

Storm 1 : October 22-26, 1988
Storm 2 : May 10-15, 1989
Storm 3 : June 12-15, 1989

Rankings based on percent of total loading are given both by storm and as a total of all three storms. In the case of dry weather and total event loadings, sources have been grouped into two categories, (1) tributaries and (2) all other sources (including STPs, STP bypasses, and CSO 9). These totals by category have also been listed as a percent of total loading.

As an example of this information, the following discussion refers to TSS in Table F.3 in Appendix F. For the first storm, the highest loading (Rank #1) is the Pawtuxet River (PAWT) with 81,360 lbs followed by the Blackstone River (BRSM) (Rank #2) with 75,146 lbs. The lowest rank (Rank #11) is the East Providence STP with only 569 lbs. For all five tributaries, the total loading was 182,409 lbs, while all other dischargers totaled 176,286 lbs. Therefore, tributaries contributed 50.9% of the loading while the other sources contributed 49.1%.

Data is also available in the same table for the other two storms. In May, the order of the top two sources was reversed with BRSM first and PAWT second and in June the order returned to the PAWT first and BRSM second. The relative contribution from the tributaries was much higher than the October event. In May, the tributaries contributed 85.5% and in June 80.9%.

In addition, the three storms have been added together to give a total loading for the study. The overall rankings have BRSM first and PAWT second. The TSS loading from all sources for the three events was over 2.6 million lbs. The tributaries were responsible for 80.9% of this total.

The rankings and mass loadings for wet and total event conditions have been summarized in Tables 3.4 and 3.5 by source for the sum of all three storms. They offer the opportunity to compare the importance of each source for all constituents.

For the wet weather loadings of Table 3.4, the most obvious result is the dominance of the Blackstone River. It ranks first for 10 of 12 constituents and second for the other two. The percent of total wet weather loadings range from a high of 82.9% for PCBs to a low of 26.6% for PHC. If a general ranking were to be applied taking into account all parameters, then the top three sources would be in order the Blackstone, Pawtuxet and Ten Mile Rivers. Among bypasses, CS09 showed the highest contribution of wet weather loading except for TSS, Cr and Cu, and the contribution from NBC bypass (NBCB) was the second and the BVDC bypass (BVDB) contribution was the last.

For the total event loading of Table 3.5, some of the more important highlights are given below:

(1) The Blackstone River is ranked first for 7 of 14 constituents (TSS, 4 metals, and 2 nutrients). Its contribution for these 7 parameters range from a high of 54.4% (nitrate) to a low of (28.1%) for orthophosphate. The Blackstone ranks no lower than 7th out of 11 for any constituent; and,

(2) When the Pawtuxet, Blackstone and Ten Mile are summed together they contribute over half of the loadings for TSS, all metals and nitrate.

A comparison between tributaries and all other sources for

Table 3.4 - Summary of Rankings and Percent of Total Wet Weather Loading for All Three Storms for Suspended Solids, Trace Metals, Nutrients and Organics

	TSS	Cd	Cr	Cu	Pb	Ni	NH3	NO3	PO4	PHC	Ar 1654	ΣPCB
						RANKING						
BRSM	**1**	**1**	**1**	**1**	**1**	**1**	**2**	**1**	**1**	**2**	**1**	**1**
MOSH	4	6	5	8	5	7	8	5	8	4	3	4
PAWT	**2**	**2**	3	**2**	**2**	3	**1**	**2**	**2**	**1**	**2**	**2**
TENM	8	3	**2**	3	6	**2**	5	3	5	7	5	6
WOON	3	4	6	6	3	6	7	4	7	6	4	3
BVDB	7	8	7	7	8	8	6	7	6	*	*	*
CSO9	6	5	8	5	4	4	3	6	3	3	6	5
NBCB	5	7	4	4	7	5	4	8	4	5	7	7
					PERCENT OF TOTAL WET WEATHER LOADING							
BRSM	40.8	64.4	51.3	47.1	53.7	35.6	26.0	65.3	53.6	26.6	79.7	82.9
MOSH	4.1	1.5	4.6	4.6	5.7	3.5	1.5	3.1	0.9	9.7	2.3	2.4
PAWT	38.4	16.8	13.5	14.8	15.8	16.2	44.2	16.9	19.9	29.2	12.2	8.3
TENM	1.7	10.2	14.3	9.3	3.5	24.6	3.1	10.4	4.9	0.9	1.6	1.1
WOON	6.9	3.0	2.9	5.1	8.4	5.3	2.4	3.5	2.7	6.0	2.0	3.2
BVDB	2.4	1.0	2.8	4.9	2.6	3.4	2.6	0.2	3.3	*	*	*
CSO9	2.8	1.9	2.3	6.4	7.4	5.9	10.4	0.5	8.3	20.8	1.1	1.5
NBCB	2.9	1.1	8.4	7.7	2.8	5.6	9.9	0.2	6.4	6.8	1.1	0.6

Values for organics are from the first two storm events only.
* : BVDB flows were not available at the time of draft report.

Table 3.5 - Summary of Rankings and Percent of Total Event Loading for All Three Storms for Suspended Solids, Trace Metals, Nutrients and Microbiological Indicator Organisms

	TSS	Cd	Cr	Cu	Pb	Ni	NH3	NO3	PO4	I	II	III	IV	V
							RANKING							
BRSM	**1**	**1**	**1**	**1**	**1**	**2**	4	**1**	**1**	5	5	5	3	7
MOSH	6	7	7	9	7	9	11	6	11	4	4	4	9	8
PAWT	**2**	**2**	**2**	3	**2**	4	3	**2**	4	7	7	7	6	6
TENM	7	3	4	4	8	3	8	3	6	10	10	8	11	10
WOON	4	6	8	6	5	6	9	4	9	6	6	6	8	9
BVDC	3	5	3	**2**	3	5	**2**	11	**2**	9	9	9	**2**	**1**
EPRO	11	11	11	11	11	11	7	5	5	11	11	11	10	11
NBCS	5	4	5	5	4	**1**	**1**	7	3	8	8	10	**1**	**2**
BVDB	10	10	9	10	10	10	10	9	10	3	3	**2**	7	5
CSO9	9	8	10	8	6	7	5	8	7	**1**	**1**	**1**	4	3
NBCB	8	9	6	7	9	8	6	10	8	**2**	**2**	3	5	4
							PERCENT OF TOTAL EVENT LOADING							
BRSM	37.0	50.8	40.1	30.3	43.6	23.8	11.7	54.4	28.1	6.4	6.8	3.1	15.4	2.4
MOSH	3.1	1.2	3.1	2.0	3.8	1.3	0.3	2.0	0.3	8.7	7.7	4.0	1.4	1.8
PAWT	33.5	26.2	16.7	13.6	18.0	13.3	20.6	22.9	12.8	1.2	1.3	1.2	7.5	2.8
TENM	2.2	7.9	11.0	12.8	3.2	16.6	0.7	9.9	3.3	0.2	0.2	0.3	0.6	0.1
WOON	5.2	2.7	2.9	2.7	5.8	2.7	0.5	4.9	1.2	2.6	2.6	2.8	1.5	0.4
BVDC	9.2	4.1	11.3	19.1	12.5	11.2	21.0	0.1	23.5	0.3	0.3	0.1	21.8	73.4
EPRO	0.3	0.2	0.2	0.3	0.1	1.0	1.2	3.7	4.5	0.1	0	0	1.1	0.1
NBCS	4.5	5.2	7.0	12.7	6.1	25.0	40.0	1.6	21.7	0.8	0.7	0.1	23.2	5.7
BVDB	1.5	0.4	1.6	1.7	1.4	1.1	0.5	0.1	0.9	13.5	10.0	33.6	2.9	3.5
CSO9	1.7	0.8	1.3	2.2	3.9	2.0	1.8	0.2	2.1	49.2	51.9	34.5	12.8	5.3
NBCB	1.8	0.5	4.8	2.6	1.5	1.9	1.7	0.1	1.6	17.0	18.5	20.6	11.7	4.5

I - Fecal Coliform; II - E. coli; III - Enterococci; IV - C. perfringens;
V - Bacteriophage

total event loadings is given in Table 3.6. The constituents are ranked from the highest percent loading for each tributary to the lowest.

In evaluating these tables, one must keep in mind that tributaries are not just influenced by diffuse sources, but are a combination of all upstream point and nonpoint sources. Some tributaries may be clearly dominated by one or the other, but it is more likely the loading is a combination of both.

Tributaries contribute over 50% of the total event loading for nitrate, five trace metals (Cd, Pb, Cr, Cu and Ni) and TSS. The point sources contribute over 50% of the total event loading for ammonia and orthophosphate and all five microbial indicators.

4. Impact of Water Dependent Projects on Water Quality

4.1 Hydroelectric Power Projects

Hydropower projects may be designed to be compatible with water quality management, but poor operation and/or design may severely impair water quality. Most low head hydropower facilities are typically located on river systems with a size of the Blackstone or Pawtuxet Rivers. They are usually run-of-the-river facilities, which implies that the spillway elevation is the minimum point of turbine operation and flows are maintained at approximately natural river flows at all

Table 3.6 - Comparison of Tributary versus Point Source Total Event Loading by Percent of Total Loading

Parameter	Tributaries	Point Sources
Dissolved Nitrate	94.1	5.9
Total Cadmium	88.8	11.2
Suspended Solids	80.9	19.1
Total Lead	74.4	25.6
Total Chromium	73.8	26.2
Total Copper	61.4	38.6
Total Nickel	57.9	42.3
Dissolved Orthophosphate	45.7	54.3
Dissolved Ammonia	33.8	66.2
C. perfringens	26.4	73.6
Fecal coliform	19.1	80.9
E. coli	18.6	81.4
Enterococci	11.4	88.6
Bacteriophage	7.5	92.5

Tributaries include BRSM, MOSH, PAWT, TENM, and WOON; Point Sources include BVDC, EPRO, NBCS, BVDB, NBCB, and CSO9.

times. During turbine operation, flows are both passing through the turbines and over the spillway. When the turbines are shut down, all flow shifts to the spillway and an equilibrium is quickly reached.

The most obvious problem associated with a hydropower facility is the failure to run it as a run-of-the-river operation. If the water elevation drops below the spillway crest during turbine operation, after turbine shutdown there will be a delay in reaching the natural river flow until the water elevation builds to the spillway crest. This sudden lack of water may put a severe stress on the downstream ecosystem. On the other hand, a sudden release of flow through the turbine that far exceeds the natural stream flow can also cause water quality problems.

These problems do happen on the Blackstone River. A good example occurred in Woonsocket, RI, during one of the water quality surveys highlighted earlier (RI OSP 1982). Flows at the USGS gaging station in Woonsocket were reported by RI DEM personnel to vary from approximately 100 to 2000 cfs in the period of just a few hours. The average daily flows (natural stream flow) before, during and after the survey were typically 400-500 cfs. It is surmised that this was a direct result of the operation of one or both of the upstream hydropower facilities. The high flow probably occurred at peak power production and the low flow after turbine shutdown, while the impoundment(s) recovered from the drawdown. An evaluation of other daily records from the gage indicates that this was not an isolated incident.

The sudden increases of flow cause sediment resuspension. Along with the sediment comes other constituents of greater importance like trace metals, organics and BOD. Although the impact of the release is temporary, it is not simply localized to the area immediately downstream of the release. There is the potential for the flow surge caused by the release to be felt for miles. An excellent example of this was observed during the water quality studies on the Pawtuxet River in RI in 1983 (Wright and McCarthy 1988). At the time of the study, the Scituate Reservoir hydropower operation was routinely releasing flows ranging from a rate of 25 to over 100 million gallons per day in a 4 to 8 hour period. At a point along the river approximately 13 miles downstream of the release, the surge still doubled the flow even after passing through 7 run-of-the-river impoundments. It also caused suspended solids concentrations to increase in the surge by a factor of 2 to 3.

Another potential problem associated with any proposed hydropower facility is its impact on instream oxygen concentrations. The amount of aeration at a dam is a function of several variables including spillway or dam crest geometry, temperature, oxygen deficit and height of freefall. This aeration can be critical to maintaining minimum oxygen concentrations at low flows in areas downstream of the dam. Unfortunately, a turbine system is designed to effectively minimize aeration, since aeration in the unit or the discharge line lowers the efficiency of the turbine. The potential impact of a hydropower facility on oxygen concentrations could be predicted with a water quality model similar to those described earlier. The results of such a study could result in the recommendation to suspend turbine operation at low flows or provide some means of mitigation. For reference, the results of a recent study are available that provide such an analysis for a proposed hydropower facility on the Pawtuxet River (Wright, Liberti and Foster 1989).

It appears that the hydropower problems that exist today along the Blackstone are a RI issue, since there are no major hydropower facilities in MA according to MA DEP officials. However, given the uncertainty of the energy crisis and the fact there are several existing dams both in MA and RI that are potential sites for hydropower development, the future problems are not limited to RI.

It is not clear what authority state officials have a control of the regulation of flows by any major hydropower operation. At the present time, the RI officials are pursuing this issue with the federal authority (Federal Energy Regulatory Commission (FERC)), which licenses and controls the regulation of hydropower projects.

At a minimum, the following is recommended:

1. Discussions should take place with officials at each of the hydropower facilities to determine how each facility is

operated. This will also require the evaluation of all available flow and stage records including those at each hydropower facility and the USGS gage at Woonsocket.

2. A clear understanding of the state's authority in this matter should be determined.

3. A clear understanding of FERC's licensing requirements as they relate to water quality issues should be determined. It would also be appropriate, but probably difficult, to assess the attitude of the federal authority relative to the water quality problems in the Blackstone River as they relate to existing and future hydropower operations.

4. All existing hydropower facilities should be investigated to determine if they are operated as run-of-the-river systems. If violations occur, then the frequency of violation should be determined. A detailed investigation into each facility's impact on downstream flow and water quality should be made.

5. Any proposed facility should undergo a rigorous evaluation to protect and maintain the current water quality of the river.

4.2 Out of Basin Water Withdrawals

Water withdrawals that are taken out of the basin effectively reduce the river flow. This may or may not have an impact on the water quality. It depends on the magnitude of the withdrawal and its location. For either case, the analysis of the withdrawal is straightforward with any of the water quality models discussed earlier. An example of this type of model application is included in the work referenced earlier to Ocean State Power. The Ocean State Power study was required by the RI DEM to evaluate the proposed removal of 4 to 8 million gallons per day from the Blackstone River basin.

A reduction in flow results in lower velocities. A decrease in velocity effectively reduces reaeration in the system. Since reaeration is one of only two significant sources of oxygen in a river (the other being plant productivity), there is the potential of lowering the instream oxygen concentration. A water quality model will easily place this reduction in perspective and provide an analysis of its significance relative to the other source and other sinks of oxygen.

A reduction in flow also effectively reduces the available dilution in the river. If withdrawals are significant, one might expect increases of pollutant concentrations. This is of course dependent on the location of the withdrawal relative to the major pollutant sources. If the withdrawal occurs upstream of the dischargers, than the impact will be negative because available dilution will be less. If the withdrawal occurs downstream of the dischargers, than it may ironically reduce the mass of pollutants in the basin and actually improve the conditions of the river by reducing the mass of pollutants that must be assimilated. Again a water quality model will easily place the withdrawal issue in the proper perspective.

A reduction in flow also can result in exposure of contaminated sediments along the river's edge. These contaminated sediments are then exposed to wildlife and humans. This will also increase the possibility of erosion of these contaminated sediments during sudden periods of high flows.

4.3 Dredging

Dredging is the removal of sediments from the river bed to an environmentally safe disposal. It is typically done to deepen or widen navigation channels or to obtain fill material for land development. It is unusual to consider it as an alternative to reduce or eliminate bed sediments as a source of contaminants in rivers, although in some extreme cases, it might be considered as a last resort. In the case of the Blackstone River, it is not clear with the available data what the relative significance is of sediment resuspension compared to point and other nonpoint pollutant sources. This issue must be resolved before dredging becomes a serious alternative.

To properly evaluate the feasibility of dredging on the Blackstone, one must take into consideration the environmental impact during dredging, the toxicity of the dredged material, the location and costs associated with its ultimate disposal, and the toxicity of old sediment now exposed to surface waters. Although not all dredged material is contaminated, sediments in rivers downstream of urban and industrial centers will reflect the discharge history of the watershed and will most likely be high in trace metals, organics, etc. The extent of sediment resuspension due to dredging operations is related to characteristics of the dredged material, dredge type, size and configuration, water velocities, and other factors.

4.4 Dams

Typically, rivers in the northeastern United States have many old dams whose original purpose of industrial water supply or diversion may have long been ceased. The current benefits such as limited flood control, hydropower potential or stream aeration may not be sufficient to warrant costly maintenance or repairs. The water quality merits and liabilities of neglecting or removing these dams must be considered on a case by case basis.

Dams have essentially acted as sediment and pollutant traps over the years. If they are maintained in proper condition, they will only release these trapped sediments under extremely high flows. Therefore, the problem which exists behind the dams is essentially contained. The sediment issue becomes important if the dam is removed or breached. Sediment resuspension will occur and the sediment and any associated pollutants become a downstream problem.

5. Potential Water Quality Controls - Blackstone River

In order to adequately define structural and/or nonstructural controls in the Blackstone River, the existing problems need to be identified and quantified. The previous sections of this paper have been an attempt to define existing water quality and identify problem areas and constituents of concern for the Blackstone River. However, it has been pointed out several times that data is lacking in several areas including wet weather, and available water quality models are insufficient. As a result, the critical question of the relative importance of nonpoint loadings versus point loadings for certain pollutants can not be answered. Therefore, it is difficult to address the need for nonpoint pollutant control when the environmental benefit associated with each alternative is not clear. Instead, the option that is available at this point is to discuss, in general, the types of water pollution controls that have some merit in regards to the Blackstone River problems.

Water quality impacts to the Blackstone River (and the Providence River) can be divided into two broad categories: those having end of pipe or point source origins and those involving nonpoint sources (NPS) arising primarily from overland runoff. These can be further subdivided as follows: point sources may include municipal WWTFs, industrial dischargers, and combined sewer overflows (CSOs); and NPS may include diffuse or distributed sources or tributary inflows and is almost always associated with rainfall events. Three of the major types of nonpoint pollution are direct overland runoff, groundwater infiltration and stream bottom sediment resuspension.

Water quality loadings from nonpoint sources may be correlated with land use and intensity of land use activities. Land use activities may be divided into urban and rural types. Rural types include agricultural activities, woodland, idle land etc. Urban land types may include residential lands with septic systems, commercial land, transportation corridors, and land development sites. The Blackstone River watershed is comprised of a wide variety of land use types.

In agricultural areas such as farm lands, turf farms, and the like, nutrients and pesticides (both in dissolved and particulate forms) may be the primary pollutants. Evidence of nutrient contamination in a river may be reflected in accelerated instream productivity which results in large diel DO swings during the growing season. This is obviously unacceptable and should be avoided with appropriate nutrient controls. From the available DO data on the Blackstone River, large DO swings were not evident. However, data, especially in RI, are limited and it is difficult to conclude whether plant productivity and therefore, nutrient loadings are an issue. There is evidence of low oxygen concentrations at two locations in the river, but these appear to be point source related.

Microbiological contaminants such as fecal coliforms and enterococci can also be linked to NPS through poorly operating or designed septic systems and stormwater. Other major sources of these contaminants include municipal WWTFs and CSOs. Since stormwater runoff and CSOs are a wet weather issue, it is difficult to determine the extent of the problem since limited wet weather data exists in RI and does not exist in MA.

Trace metals and PCBs are probably one of the major areas of concern, since the available dry weather data indicate for some metals and PCBs elevated levels which exceed the chronic, and in some cases, the acute criteria. Since this may be a point source issue, it needs to be addressed with a waste load allocation. However, the limited wet weather data suggest that the problem is complicated by wet weather loadings. Whether the loadings are runoff related or from bottom resuspension is a very important issue if NPS controls are to result in lower instream concentrations. This is not clearly understood at this point.

In general, NPS controls are typically referred to as best management practices. These practices should be practicable and aid to achieve water quality compatible with quality goals. Since best management practices should be based on factors such as land use activities, physical conditions of the watershed, and are fairly site specific, only generalities can be provided at this point relative to the Blackstone River.

A number of best management practices to control NPS impacts are available. Most address activities within the land use itself. Source control measures may be as simple as enhancing rainfall infiltration into the ground, since the soil has an enormous absorption capacity for a variety of metals and other contaminants. This might mean simply changing or improving existing land covers, which includes the addition of vegetated buffer strips. Other means for control include retention of runoff via retention/detention basins. These basins may act as effective sediment and pollutant traps as well as providing a means to increase infiltration. Also, proper maintenance through frequent street sweeping and catch basin cleaning may be effective.

6. Potential Water Quality Controls - Providence River

Much of the material presented in Section 5 also holds true for the Providence River. The situation here is somewhat more complicated since the Providence River is tidally affected. Available data indicates that mixing and flushing rates are variable depending on fresh water inflow and rainfall intensity, duration, and amount. Impacts on the river during wet weather events are dependent on the extent of vertical and horizontal mixing.

Of the major tributaries flowing into the Providence River, the Blackstone River is the largest contributor of most pollutants. Instituting nonpoint source controls in the Blackstone watershed may have an impact on the Providence

River. However, the problem is identifying the fraction of the Blackstone River load that is NPS related.

Both the Moshassuck and Woonasquatucket Rivers drain most of the metropolitan Providence area. Nonpoint source controls to address street runoff would be beneficial in these watersheds. Due to the many CSO outfalls located along the Moshassuck and Woonasquatucket, fecal coliforms are a problem. This issue must be addressed. The Department of Civil and Environmental Engineering at URI is currently developing a systemwide computer simulation model to determine which of the CSO outfalls provide the greatest impact to the receiving waters. The results of that study should determine where to implement CSO mitigation techniques in a most cost effective means.

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APPENDIX A

A.1 Water Use Classification

	RHODE ISLAND	MASSACHUSETTS
Class A	(drinking) water supply	Waters assigned to this class are designated for use as a source of public water supply
Class B	Public water supply with appropriate treatment; agricultural uses; bathing or other primary contact recreational activities; fish and wildlife habitat.	Waters assigned to this class are designated for the uses of protection and propagation of fish, other aquatic life and and wildlife; and for primary and secondary contact recreation.
Class C	Boating, other secondary contact recreational activities; fish and wildlife habitat; industrial processes and cooling.	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.
Class D*	Migration of fish; good aesthetic value.	No classification exists.
Class E*	Nuisance conditions; uses limited to certain industrial processes and cooling, power, and navigation.	No classification exists.

* Classes D and E for Rhode Island shall be used to describe an existing condition only, and shall not be considered an acceptable goal for classification of any water.

A.2 General Water Quality Criteria

	RHODE ISLAND*	MASSACHUSETTS
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.	Same as Rhode Island.
Radioactive Substances	The level of radioactive materials in all waters shall not be in concentrations or combinations which would be harmful to human, animal or aquatic life, or result in concentrations in organisms producing undesirable conditions.	Shall not exceed the recommended limits of the U. S. EPA's National Drinking Water Regulations.
Nutrients	Nutrients shall not exceed the site-specific limits necessary to control accelerated or cultural eutrophication, and BMPs shall be used to control sedimentation and erosion.	Shall not exceed the site-specific limits necessary to control accelerated or cultural eutrophication.

* Rhode Island also considers Thermal Mixing Zones and Non-thermal Mixing Zones not listed in this table.

A.2 Continued

	RHODE ISLAND	MASSACHUSETTS
Tainting Substances	Not considered a specific criteria.	Shall not be in concentrations or combinations that produce undesirable flavors in the edible portions of aquatic organisms.
TSS	TSS not considered a specific criteria.	Shall not be in concentrations or combinations that would exceed the recommended limits on the most sensitive receiving water use.
Other General Criteria	At a minimum all waters shall be free of pollutants in concentrations or combinations that will: (a) Adversely affect the composition of bottom aquatic life; (b) Adversely affect the physical or chemical nature of the bottom; (c) Interfere with the propagation of fish and shellfish; or, (d) Undesirably alter the qualitative and quantitative character of the biota.	Waters shall be free from pollutants in concentrations or combinations that: (a) Exceed the recommended limits on the most sensitive receiving water use; (b) Injure, are toxic to, or produce adverse physiological or behavioral responses in humans or aquatic life; (c) Exceed site-specific safe exposure levels determined by bioassay using sensitive species.

Table A.3 Class Specific Criteria - Fresh Waters

	DISSOLVED OXYGEN	
	Rhode Island	Massachusetts
Class A	75% saturation, 16 hours/day, but not less than 5 mg/L at any place or time except as naturally occurs.	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.
Class B	75% saturation, 16 hours/day, but not less than 5 mg/L at any place or time except as naturally occurs.	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.
Class C	Minimum 5 mg/L any place or time, except as naturally occurs. Normal seasonal and diurnal variations above 5 mg/L will be maintained.	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.
Class D	A minimum of 2 mg/L at any place or time, except as naturally occurs.	No class D standards.

Table A.3 Continued

	FECAL COLIFORM	
	Rhode Island	Massachusetts
Class A	Not to exceed a median value of 20/100 ml and not more than 10% of the samples shall exceed a value of 200/100 ml.	No criteria given.
Class B	Not to exceed a median value of 200/100 ml and not more than 20% of the samples shall exceed a value of 500/100 ml.	Shall not exceed a log mean for a set of samples of 200 200/100 ml, nor shall more than 10% of the total samples exceed 400/100 ml during any monthly sampling period, except as provided in 314 CMR 4.02(1).
Class C	Not applicable.	Shall not exceed a log mean for a set of samples of 1,000/100 ml, nor shall more than 10% of the total samples exceed 2,500/100 ml during any monthly sampling period, except as provided in 314 CMR 4.02(1).
Class D	Not applicable.	No class D standards.

Table A.3 Continued

	TOTAL COLIFORM	
	Rhode Island	Massachusetts
Class A	Not to exceed a median value of 100/100 ml and not more than 10% of the samples shall exceed a value of 500/100 ml.	Shall not exceed a log mean for a set of samples of 50/100 ml during any monthly sampling period.
Class B	Not to exceed a median value of 1,000/100 ml and not more than 20% of the samples shall exceed a value of 2,400/100 ml.	No criteria given.
Class C	None in such concentrations that would impair any usages specifically assigned to this class.	No criteria given.
Class D	None in such concentrations that would impair any usages specifically assigned to this class.	No class D standards.

Table A.3 Continued

TEMPERATURE	Rhode Island	Massachusetts
Class A	No increase allowed other than of natural origin.	Shall not exceed 83°F in warm water fisheries or 68°F in cold water fisheries nor shall the rise resulting from artificial origin exceed 4°F.
Class B	Only such increases that will not impair any usages specifically assigned to this class*	Same as Class A
Class C	Only such increases that will not impair any usages specifically assigned to this class* or <u>cause the growth of unfavorable species of biota</u>.	Same as Class A
Class D	None except where the increase will not exceed the recommended limits on the most sensitive water use and in no case exceed 90°F.	Same as Class A.

* The temperature increase shall not raise the temperature of the receiving waters above the recommended limit on the most sensitive receiving water use and in no cases exceed 83°F. In no case shall the temperature of the receiving water be raised more than 4°F. Heated discharges into designated coldwater habitats shall not raise the temperature above 68°F outside an established thermal mixing zone.

Table A.3 Continued

	pH	
	Rhode Island	Massachusetts
Class A	As naturally occurs.	As naturally occurs.
Class B	6.5 - 8.0 or as naturally occurs.	Shall be in the range of 6.5 to 8.0 standard units and not more than 0.2 units outside of the naturally occurring range.
Class C	6.0 - 8.5*	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
Class D	6.0 -9.0	Shall be in the range of 6.5 - 8.5 standard units and not more than 0.2 units outside of the naturally occurring range

* In accordance with 40 CFR, Part 133.102 (c), those facilities achieving the level of effluent quality attainable through the application of secondary or equivalent treatment may discharge an effluent pH of 6.0 to 9.0 standard units.

Table A.3 Continued

COLOR AND TURBIDITY

	Rhode Island	Massachusetts
Class A	None other than of natural origin Not to exceed 5 NTU over background when the background is 50 NTU or less or have more than a 10% increase in turbidity when the background is more than 50 NTU.	Shall not be in concentrations or combinations that would exceed the recommended limits on the most sensitive receiving water use.
Class B	None in such concentrations that would impair any usages specifically assigned to this Class. Not to exceed 10 NTU over background when the background is 50 NTU or less, or have more than 20% increase in trubidity when the background is more than 50 NTU.	Same as Class A.
Class C	Same as Class B.	Same as Class A.
Class D	None in such concentrations that would impair any usages specifically assigned to this Class.	No Class D standards.

Table A.3 Continued

	OIL AND GREASE	
	Rhode Island	Massachusetts
Class A	None Allowable	The water surface shall be free from floating oils, grease and petrochemicals and any concentrations or combinations 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.
Class B	None Allowable	Same as Class A
Class C	Sludge deposits, floating solids oils, grease and scum shall not be allowed except for such small amounts that may result from the discharge of appropriately treated sewage or industrial waste effluents.	Same as Class A
Class D	Same as Class C	No Class D standards.

APPENDIX B

Table B.1 - Summary of Flow, Biochemical Oxygen Demand (BOD) and Total Suspended Solids (TSS) Effluent Limitations on Existing NPDES Permits for Municipal WWTFs

Facility	Flow (MGD)	BOD (mg/L) AVE M	BOD (mg/L) AVE W	BOD (mg/L) MAX D	TSS (mg/L) AVE M	TSS (mg/L) AVE W	TSS (mg/L) MAX D
MASSACHUSETTS PERMITS							
UBWPAD 11/1-5/31	56	30	45	50	30	45	50
UBWPAD 6/1-10/31	56	10	15	15	15	15	22.5
Millbury WWTF	1.2	30	45	50	30	45	50
Hopedale 10/1-3/31	0.588	30	45	50	30	45	50
Hopedale 4/1-9/30	0.588	15	15	25	15	15	25
Grafton WWTF	1.6	30	45	50	30	45	50
Douglas WWTF	0.18	30	45	50	30	45	50
Northbridge 10/1-3/31	1.8	30	45	50	30	45	50
Northbridge 4/1-9/30	1.8	10	10	15	10	10	15
Upton WWTF	0.3	30	45	50	30	45	50
Uxbridge WWTF	2.5	30	45	50	30	45	50
RHODE ISLAND PERMITS							
Woonsocket WWTF	16.0	30	45	50	30	45	50
BVDC WWTF	+++	30	45	50	30	45	50
Burrillville WWTF	1.5	30	45	50	30	45	50
Zambarano Hospital	0.12	30	45	50	60	+++	+++
	Additional Permit Limits in lbs/day (lbs)						
Douglas WWTF	0.18	45.1	67.6	75.1	45.1	67.6	75.1
Upton WWTF	0.3	75	113	125	75	113	125
Woonsocket WWTF	16.0	4,000			4,000		
BVDC WWTF	+++	7,760			7,760		
Burrillville WWTF	1.5	375			375		
Zambarano Hospital	0.12	(30)			(60)		

M - monthly; W - weekly; D - daily; UBWPAD - Upper Blackstone Water Pollution Abatement District; WWTF - Wastewater Treatment Facility; BVDC - Blackstone Valley District Commission; +++ No effluent limitation given - monitor only.

Table B.2 - Summary of Flow, Biochemical Oxygen Demand (BOD) and Total Suspended Solids (TSS) Effluent Limitations on Existing NPDES Permits for Industrial WWTFs

Facility	Flow (MGD)	BOD (mg/L) AVE M	BOD (mg/L) AVE W	BOD (mg/L) MAX D	TSS (mg/L) AVE M	TSS (mg/L) AVE W	TSS (mg/L) MAX D
MASSACHUSETTS PERMITS							
New England Plating	0.2(*)				20		30
Guilford Industries	1.25				30		60
RHODE ISLAND PERMITS							
Okonite Company	0.38						
GTE Products	0.9						
Smithfield Corp	0.006	30	45	50	30	45	50
Tupperware Company	0.006	30	45	50	30	45	50
Additional Permit Limits in lbs/day							
Guilford Industries	1.25	313		626	313		626
GTE Products	0.9				130		230
Smithfield Corp	0.006	1.5			1.5		
Tupperware Company	0.006	1.5			1.5		

M - monthly; W - weekly; D - daily; * - Additional flow includes maximum daily 0.30 MGD

Table B.3 - Summary of Flow, Biochemical Oxygen Demand (BOD) and Total Suspended Solids (TSS) Effluent Limitations on Draft NPDES Permits for Municipal WWTFs

Facility	Flow (MGD)	BOD (mg/L) AVE M	BOD (mg/L) AVE W	BOD (mg/L) MAX D	TSS (mg/L) AVE M	TSS (mg/L) AVE W	TSS (mg/L) MAX D
UBWPAD WWTF							
11/1 to 5/31	56	30	45	50	30	45	50
6/1 to 10/31	56	10	15	15	15	15	22.5
Uxbridge WWTF	2.5	30	45	50	30	45	50
BVDC WWTF	31	30	45	50	30	45	50
Additional Permit Limits in lbs/day (lbs)							
BVDC WWTF	---	7,756		19,182	7,756		19,182
Worcester CSO (a)	350 (b)						

--- Total flow to the plant's headworks shall be reported. All flows up to 84 MGD shall receive at least, primary treatment and disinfection. Flows up to 46 MGD must receive secondary treatment. Maximum daily flow not to exceed 46 MGD; (a) During the first and fifth years of the life of the permit, during the first four hours of each discharge, flow weighted composites of influent and effluent shall be collected and analyzed separately; (b) maximum daily flow.

Table B.4 - Summary of Settleable Solids (SS), Fecal Coliform (FC) and Total Residual Chlorine (TRC) Effluent Limitations on Existing NPDES Permits for Municipal WWTFs

Facility	SS (ml/L) AVE M	SS (ml/L) AVE W	SS (ml/L) MAX D	FC (/100 ml) AVE M	FC (/100 ml) AVE W	FC (/100 ml) MAX D	MAX TRC (mg/L)
MASSACHUSETTS PERMITS							
UBWPAD WWTF (a)		0.1	0.3	200	400	400	1.5 (c)
Millbury WWTF (b)		0.1	0.3	200	400	400	0.5
Hopedale WWTF	0.1	0.1	0.3	200	400	400	0.05 (d)
Grafton WWTF (b)		0.1	0.3	200	400	400	0.5
Douglas WWTF (b)		0.1	0.3	200	400	400	--- (e)
Northbridge							
10/1-3/31	0.1	0.1	0.3				
4/1-9/30	0.1	0.1	0.3	200	400	400	1.0
Upton WWTF (b)		0.1	0.3	200	400	400	0.04
Uxbridge WWTF (b)		0.1	0.3	200	400	400	1.5 (c)
RHODE ISLAND PERMITS							
Woonsocket WWTF		0.1	0.3	200	400	400	2.0
BVDC WWTF	0.1	0.1	0.3	200	400	400	+++
Burrillville WWTF		0.1	0.3	200	400	400	2.0
Zambarano Hospital		+++	+++	200	400	400	2.0

M - monthly; W - weekly; D - daily; UBWPAD - Upper Blackstone Water Pollution Abatement District; BVDC - Blackstone Valley District Commission; WWTF - Wastewater Treatment Facility; (a) FC and TRC are seasonal limits between 4/1 and 10/15; (b) FC and TRC are seasonal limits between 4/1 and 10/30; (c) TRC limit after 15 minutes contact at either peak daily (UBWPAD) or peak hourly (Uxbridge) flow; (d) TRC limit tentative; (e) The total chlorine residual (and/or other toxic components) of the effluent shall not result in any demonstrable harm to aquatic life or violate any water quality standard which has been or may be promulgated. Upon promulgation of any such standard, this permit may be revised or amended in accordance with such standards, the permittee being so notified; and +++ no limit given only monitoring required.

Table B.5 - Summary of Settleable Solids (SS), Fecal Coliform (FC) and Total Residual Chlorine (TRC) Effluent Limitations on Existing NPDES Permits for Industrial WWTFs

Facility	SS (ml/L) AVE M	SS (ml/L) AVE W	SS (ml/L) MAX D	FC (/100 ml) AVE M	FC (/100 ml) AVE W	FC (/100 ml) MAX D	MAX TRC (mg/L)
MASSACHUSETTS PERMITS							
New England Plating							
Guilford Industries							1.5
RHODE ISLAND PERMITS							
Okonite Company							
GTE Products							
Smithfield Corporation		0.1	0.3	200	400	400	2.0
Tupperware Company		0.1	0.3	200	400	400	2.0

M - monthly; W - weekly; D - daily

Table B.6 - Summary of Settleable Solids (SS), Fecal Coliform (FC) and Total Residual Chlorine (TRC) Effluent Limitations on Draft NPDES Permits for Municipal WWTFs

Facility	SS (ml/L)			FC (/100 ml)			MAX TRC (mg/L)
	AVE M	AVE W	MAX D	AVE M	AVE W	MAX D	
UBWPAD WWTF		0.1	0.3	200	400	400	0.012
Uxbridge WWTF		0.1	0.3	200	400	400	0.4
BVDC WWTF		0.1	0.3	200	400	400	0.013 (a)
Worcester CSO (b)				200	400	400	

(a) The limits for TRC are tentative pending further study. (Maximum daily TRC = 0.013 mg/L and average monthly = 0.0075 mg/L); (b) Grab samples for fecal coliform and total chlorine residual shall be collected once within the first two hours of each discharge and every eight hours thereafter for the duration of the discharge.

Table B.7 - Summary of pH Effluent Limitations for the Major Blackstone River NPDES Permits

Discharge	Minimum	Maximum
MASSACHUSETTS PERMITS		
UBWPAD WWTF	6.5	8.0
Millbury WWTF	6.5	8.0
Hopedale WWTF	6.5	8.0
Grafton WWTF	6.5	8.0
Douglas WWTF	6.5	8.0
Northbridge WWTF	6.5	8.0
Upton WWTF	6.5	8.0
Uxbridge WWTF	6.5	8.0
Guilford Industries	6.0	9.0
New England Plating	6.0	9.0
RHODE ISLAND		
Woonsocket WWTF	6.0	9.0
BVDC WWTF	6.0	9.0
Burrillville WWTF	6.0	9.0
Zambarano Hospital	6.0	9.0
Smithfield Corp	6.0	9.0
Tupperware Company	6.0	8.5
GTE Products	6.0	8.5
Okonite Company	6.0	8.5

UBWPAD - Upper Blackstone Water Pollution Abatement District; WWTF - Wastewater Treatment Facility; BVDC - Blackstone Valley District Commission

Table B.8 - Summary of Nutrient Effluent Limitations on Existing NPDES Permits for Municipal and Industrial WWTFs

Facility	Ammonia-Nitrogen (mg/L)			Total Phosphorus (mg/L)		
	AVE M	AVE W	MAX D	AVE M	AVE W	MAX D
MASSACHUSETTS PERMITS						
UBWPAD WWTF						
11/1 to 5/31	+++	+++	+++			
6/1 to 6/14	5.0	5.0	7.0			
6/15 to 10/31	2.0	2.0	2.5			
Hopedale WWTF						
4/1 to 4/30	10.0	10.0	15.0	1.0	1.0	1.5
5/1 to 5/31	5.0	5.0	8.0	1.0	1.0	1.5
6/1 to 9/30	2.0	2.0	3.0	1.0	1.0	1.5
RHODE ISLAND PERMITS						
Burrillville WWTF[a]			+++	1.0		
Tupperware Company[b]			+++			+++

M - monthly; W - weekly; D - daily; UBWPAD - Upper Blackstone Water Pollution Abatement District; WWTF - Wastewater Treatment Facility; +++ No effluent limitation given - monitor only; (a) Monitoring is also required for nitrate and nitrite. Phosphorus loading includes 12.5 lbs/day average monthly; (b) Monitoring is also required for nitrate and nitrite.

Table B.9 - Summary of Metal Effluent Limitations on Existing NPDES Permits

Facility and Metal	Metal (lbs/day) AVE M	Metal (lbs/day) AVE W	Metal (lbs/day) MAX D	Metal (mg/L) AVE M	Metal (mg/L) AVE W	Metal (mg/L) MAX D
MASSACHUSETTS PERMITS						
<u>New England Plating</u>						
Aluminum				1.5		2.0
Chromium +6				0.05		0.10
Chromium Total				1.5		2.0
Copper						0.88
Cyanide (amenable)				0.05		0.1
Cyanide Total						0.65
Iron				2.0		3.0
Nickel				1.8		3.0
Zinc				1.48		2.0
<u>Guilford Industries</u>						
Chromium Total	2.1		4.2			
RHODE ISLAND PERMITS						
<u>GTE Products</u>						
Chromium +6				0.05		0.10
Total Chromium				+++		+++
Silver				0.05		0.10
Lead				0.05		0.10
<u>Okonite Company</u>						
Copper						0.1

M - monthly; W - weekly; D - daily; +++ No effluent limitation given - monitor only.

Table B.10 - Summary of Flow, Trace Metal and Nutrient Effluent Limitations on Draft NPDES Permits for Municipal WWTFs

Constituent	UBWPAD WWTF		Uxbridge WWTF		BVDC WWTF	
	AVE M	MAX D	AVE M	MAX D	AVE M	MAX D
TRACE METALS						
Cadmium Total	1.0	2.0			9.3	43.0
Chromium +6					50.0	1100
Copper	7.0	11.0			0.06	2.9
Lead Total					5.6	140
Mercury Total					0.025	2.1
Nickel Total	95.0	861			8.3	75.0
Silver Total					0.05	2.3
Zinc Total	64.0	71.0			86.0	95.0
Cyanide Total					1.0	1.0
NUTRIENTS						
Phosphorus Total					---	---
Nitrate (as N)					---	---
Nitrite (as N)					---	---
Ammonia (as N)					---	---
11/1-5/31	---	---				
6/1-6/14	5.0	7.5				
6/15-10/31	2.0	2.5				

--- monitor only; No value or notation indicates no permit limitation.

APPENDIX C

Table C.1 - DMR Data Statistics for Major Massachusetts Dischargers in the Blackstone River Watershed for 1988 and 1989.

Facility	Year	Constituent	Discharge	Units	Mean	s	n	Max	Min
MASSACHUSETTS									
Guilford Industries	1988	FLOW	MAX D	MGD	0.44	0.10	12	0.70	0.36
	1988	TSS	AVE M	lbs/d	98.1	70.2	12	285	38.0
	1988	TSS	MAX M	lbs/d	161	163	12	651	45.8
	1988	BOD5	AVE M	lbs/d	74.0	101	12	392	21.1
	1988	BOD5	MAX M	lbs/d	116	177	12	670	30.2
	1988	Cr	AVE M	lbs/d	0.10	0.06	12	0.21	0.04
	1988	Cr	MAX M	lbs/d	0.13	0.08	12	0.33	0.05
	1989	FLOW	AVE M	MGD	0.29	0.03	12	0.34	0.24
	1989	FLOW	MAX D	MGD	0.47	0.13	12	0.81	0.33
	1989	TSS	AVE M	lbs/d	82.6	53.3	12	183	14.9
	1989	TSS	MAX M	lbs/d	116	65.6	12	216	19.5
	1989	BOD5	AVE M	lbs/d	48.0	18.6	12	78.0	16.5
	1989	BOD5	MAX M	lbs/d	59.5	22.8	12	100	19.1
	1989	Cr	AVE M	lbs/d	0.09	0.02	12	0.14	0.06
	1989	Cr	MAX M	lbs/d	0.16	0.18	12	0.73	0.07
Hopedale WWTF	1988	FLOW	AVE M	MGD	0.44	0.09	12	0.62	0.33
	1988	TSS	AVE M	mg/L	6.87	3.7	12	14.2	0.10
	1988	TSS	AVE W	mg/L	9.76	5.06	12	18.0	0.10
	1988	TSS	MAX D	mg/L	9.76	5.06	12	18.0	0.10
	1988	BOD5	AVE M	mg/L	8.81	3.56	12	16.0	4.94
	1988	BOD5	AVE W	mg/L	12.0	4.84	12	20.3	5.96
	1988	BOD5	MAX D	mg/L	12.0	4.84	12	20.3	5.96
	1988	FC	AVE M	#/100ml	79.5	26.1	12	140	41.0

M = monthly; W = weekly; D = daily; TSS = total suspended solids; BOD5 = 5 day biochemical oxygen demand; FC = fecal coliform; SS = settleable solids; NO3 = nitrate; NO2 = nitrite; NH3 = ammonia; TP = total phosphorus; CYAN = cyanide; TNTC = too numerous to count; s = standard deviation; n = number of samples.

Table C.1 - Continued.

Facility	Year	Constituent	Discharge	Units	Mean	s	n	Max	Min
MASSACHUSETTS									
Hopedale WWTF (Continued)	1988	FC	AVE W	#/100ml	119	40.2	12	175	41.0
	1988	FC	MAX D	#/100ml	119	39.3	12	175	46.0
	1988	SS	AVE M	ml/L	0.10	0	12	0.10	0.10
	1988	SS	AVE W	ml/L	0.10	0	12	0.10	0.10
	1988	SS	MAX D	ml/L	0.11	0.03	12	0.20	0.10
	1988	NH3	AVE M	mg/L	5.66	9.34	6	23.6	0.35
	1988	NH3	AVE W	mg/L	7.51	10.9	6	26.8	0.66
	1988	NH3	MAX D	mg/L	7.51	10.9	6	26.8	0.66
	1988	TP	AVE M	mg/L	0.87	0.07	6	0.95	0.75
	1988	TP	AVE W	mg/L	0.93	0.05	6	0.97	0.84
	1988	TP	MAX D	mg/L	0.94	0.05	6	0.98	0.84
	1989	FLOW	AVE M	MGD	0.50	0.10	12	0.67	0.39
	1989	TSS	AVE M	mg/L	4.73	2.12	12	9.0	2.70
	1989	TSS	AVE W	mg/L	6.23	2.53	12	10.8	3.40
	1989	TSS	MAX D	mg/L	6.23	2.53	12	10.8	3.40
	1989	BOD5	AVE M	mg/L	6.41	1.90	12	9.78	4.63
	1989	BOD5	AVE W	mg/L	8.37	2.53	12	13.1	5.31
	1989	BOD5	MAX D	mg/L	8.37	2.53	12	13.1	5.31
	1989	FC	AVE M	#/100ml	86.9	34.2	12	155	44.0
	1989	FC	AVE W	#/100ml	110	36.4	12	170	48.0
	1989	FC	MAX D	#/100ml	110	36.4	12	170	48.0
	1989	SS	AVE M	ml/L	0.10	0	12	0.10	0.10
	1989	SS	AVE W	ml/L	0.10	0	12	0.10	0.10
	1989	SS	MAX D	ml/L	0.10	0	12	0.10	0.10
	1989	NH3	AVE M	mg/L	1.02	0.79	6	2.43	0.13
	1989	NH3	AVE W	mg/L	1.70	1.19	6	3.86	0.22

M = monthly; W = weekly; D = daily; TSS = total suspended solids; BOD5 = 5 day biochemical oxygen demand; FC = fecal coliform; SS = settleable solids; NO3 = nitrate; NO2 = nitrite; NH3 = ammonia; TP = total phosphorus; CYAN = cyanide; TNTC = too numerous to count; s = standard deviation; n = number of samples.

Table C.1 - Continued.

Facility	Year	Constituent	Discharge	Units	Mean	s	n	Max	Min
MASSACHUSETTS									
Hopedale WWTF (Continued)	1989	NH3	MAX D	mg/L	1.70	1.19	6	3.86	0.22
	1989	TP	AVE M	mg/L	0.86	0.07	6	0.95	0.78
	1989	TP	AVE W	mg/L	0.95	0.04	6	1.0	0.89
	1988	TP	MAX D	mg/L	0.95	0.04	6	1.0	0.89
Millbury WWTF	1988	FLOW	AVE M	MGD	0.70	0.09	12	0.83	0.55
	1988	FLOW	MAX M	MGD	0.97	0.23	12	1.27	0.65
	1988	TSS	AVE M	mg/L	18.7	5.58	12	30.0	10.0
	1988	TSS	AVE W	mg/L	18.7	5.58	12	30.0	10.0
	1988	TSS	MAX D	mg/L	24.3	8.09	12	45.0	12.0
	1988	BOD5	AVE M	mg/L	19.1	6.07	12	30.0	9.0
	1988	BOD5	AVE W	mg/L	19.1	6.07	12	30.0	9.0
	1988	BOD5	MAX D	mg/L	23.3	6.49	12	34.0	15.0
	1988	FC	AVE M	#/100ml	23.9	3.93	7	29.0	19.0
	1988	FC	AVE W	#/100ml	24.3	4.08	6	29.0	19.0
	1988	FC	MAX D	#/100ml	32.9	4.88	7	40.0	30.0
	1989	FLOW	AVE M	MGD	0.95	0.19	12	1.26	0.67
	1989	FLOW	MAX M	MGD	1.28	0.37	12	2.13	0.76
	1989	TSS	AVE M	mg/L	20.5	7.75	12	34.0	11.0
	1989	TSS	AVE W	mg/L	20.6	7.87	12	34.0	11.0
	1989	TSS	MAX D	mg/L	26.3	9.26	12	43.0	13.0

M = monthly; W = weekly; D = daily; TSS = total suspended solids; BOD5 = 5 day biochemical oxygen demand; FC = fecal coliform; SS = settleable solids; NO3 = nitrate; NO2 = nitrite; NH3 = ammonia; TP = total phosphorus; CYAN = cyanide; TNTC = too numerous to count; s = standard deviation; n = number of samples.

Table C.1 - Continued.

Facility	Year	Constituent	Discharge	Units	Mean	s	n	Max	Min
MASSACHUSETTS									
Millbury	1989	BOD5	AVE M	mg/L	21.3	7.48	12	38.0	15.0
WWTF	1989	BOD5	AVE W	mg/L	21.3	7.48	12	38.0	15.0
(Continued)	1989	BOD5	MAX D	mg/L	26.7	9.75	12	50.0	16.0
	1989	FC	AVE M	#/100ml	23.0	10.1	6	42.0	13.0
	1989	FC	AVE W	#/100ml	23.0	10.1	6	42.0	13.0
	1989	FC	MAX D	#/100ml	28.3	11.7	6	50.0	20.0
Northbridge	1988	FLOW	AVE M	MGD	0.79	0.50	12	1.3	0
WWTF	1988	TSS	AVE M	mg/L	14.0	12.0	12	30.0	1.6
	1988	TSS	AVE W	mg/L	14.0	12.1	12	30.0	1.6
	1988	TSS	MAX D	mg/L	16.5	14.1	12	39.3	2.0
	1988	BOD5	AVE M	mg/L	13.7	12.7	12	27.0	1.0
	1988	BOD5	AVE W	mg/L	13.9	12.7	12	27.0	1.18
	1988	BOD5	MAX D	mg/L	15.0	13.5	12	29.0	2
	1989	FLOW	AVE M	MGD	1.01	0.54	12	1.6	0
	1989	TSS	AVE M	mg/L	11.2	11.6	12	26.5	0.8
	1989	TSS	AVE W	mg/L	11.2	11.6	12	26.5	0.8
	1989	TSS	MAX D	mg/L	12.1	12.3	12	28.0	1.2
	1989	BOD5	AVE M	mg/L	11.9	12.4	12	26.8	1.16
	1989	BOD5	AVE W	mg/L	11.9	12.4	12	26.8	1.16
	1989	BOD5	MAX D	mg/L	13.1	12.7	12	28.0	1.5

M = monthly; W = weekly; D = daily; TSS = total suspended solids; BOD5 = 5 day biochemical oxygen demand; FC = fecal coliform; SS = settleable solids; NO3 = nitrate; NO2 = nitrite; NH3 = ammonia; TP = total phosphorus; CYAN = cyanide; TNTC = too numerous to count; s = standard deviation; n = number of samples.

Table C.1 - Continued.

Facility	Year	Constituent	Discharge	Units	Mean	s	n	Max	Min
MASSACHUSETTS									
New England Plating	1988	FLOW	AVE M	MGD	0.14	0.02	12	0.17	0.11
	1988	FLOW	MAX D	MGD	0.20	0.02	12	0.23	0.16
	1988	TSS	AVE W	mg/L	6.04	2.30	12	10.3	3.6
	1988	TSS	MAX D	mg/L	7.63	3.34	12	13.0	3.7
	1988	Cr	AVE W	µg/L	193	75.2	12	360	60.0
	1988	Cr	MAX D	µg/L	259	108	12	440	60.0
	1988	Cu	MAX D	µg/L	260	159	12	590	130
	1988	Fe	AVE W	µg/L	615	293	12	1400	200
	1988	Fe	MAX D	µg/L	714	348	12	1640	240
	1988	Ni	AVE W	µg/L	370	105	12	540	220
	1988	Ni	MAX D	µg/L	451	151	12	660	230
	1988	Zn	AVE W	µg/L	1144	238	12	1460	780
	1988	Zn	MAX D	µg/L	1370	253	12	1770	1040
	1988	Al	AVE W	µg/L	1000	0	12	1000	1000
	1988	Al	MAX D	µg/L	1000	0	12	1000	1000
	1988	CYAN	MAX D	mg/L	0.22	0.14	12	0.44	0.03
	1989	FLOW	AVE M	MGD	0.14	0.02	12	0.17	0.11
	1989	FLOW	MAX M	MGD	0.20	0.02	12	0.25	0.15
	1989	TSS	AVE W	mg/L	8.47	3.69	12	18.2	5.2
	1989	TSS	MAX D	mg/L	10.7	4.60	12	19.2	5.5
	1989	Cr	AVE W	µg/L	135	86.9	12	270	5.0
	1989	Cr	MAX D	µg/L	190	150	12	490	1.0
	1989	Cu	MAX D	µg/L	164	70.0	12	350	100
	1989	Fe	AVE W	µg/L	322	82.3	12	460	190

M = monthly; W = weekly; D = daily; TSS = total suspended solids; BOD5 = 5 day biochemical oxygen demand; FC = fecal coliform; SS = settleable solids; NO3 = nitrate; NO2 = nitrite; NH3 = ammonia; TP = total phosphorus; CYAN = cyanide; TNTC = too numerous to count; s = standard deviation; n = number of samples.

Table C.1 - Continued.

Facility	Year	Constituent	Discharge	Units	Mean	s	n	Max	Min
MASSACHUSETTS									
New England Plating (Continued).	1989	Fe	MAX D	µg/L	395	132	12	670	220
	1989	Ni	AVE W	µg/L	276	334	12	1290	95.0
	1989	Ni	MAX D	µg/L	318	371	12	1460	120
	1989	Zn	AVE W	µg/L	1068	188	12	1300	740
	1989	Zn	MAX D	µg/L	1248	291	12	1780	800
	1989	Al	AVE W	µg/L	1000	0	12	1000	1000
	1989	Al	MAX D	µg/L	1000	0	12	1000	1000
	1989	CYAN	MAX D	mg/L	0.20	0.17	12	0.44	0.03
Upper Blackstone WPAD WWTF	1988	FLOW	AVE M	MGD	33.5	4.74	5	40.2	28.9
	1988	TSS	AVE M	mg/L	8.33	3.56	6	15.0	5.0
	1988	TSS	AVE W	mg/L	16.0	7.67	6	26.0	6.0
	1988	TSS	MAX D	mg/L	46.2	44.9	6	132.0	12.0
	1988	BOD5	AVE M	mg/L	7.00	2.61	6	11.0	4.0
	1988	BOD5	AVE W	mg/L	10.0	4.98	6	18.0	5.0
	1988	BOD5	MAX D	mg/L	14.2	8.35	6	29.0	6.0
	1988	FC	AVE M	#/100ml	14.6	12.9	5	35.0	5.0
	1988	FC	AVE W	#/100ml	65.4	47.1	5	127	13.0
	1988	FC	MAX D	#/100ml	421	539	5	1180	33.0
	1988	SS	AVE W	ml/L	<0.10	0.13	6	0.3	0
	1988	SS	MAX D	ml/L	0.42	0.61	6	1.5	0

M = monthly; W = weekly; D = daily; TSS = total suspended solids; BOD5 = 5 day biochemical oxygen demand; FC = fecal coliform; SS = settleable solids; NO3 = nitrate; NO2 = nitrite; NH3 = ammonia; TP = total phosphorus; CYAN = cyanide; TNTC = too numerous to count; s = standard deviation; n = number of samples.

Table C.1 - Continyed.

Facility	Year	Constituent	Discharge	Units	Mean	s	n	Max	Min
MASSACHUSETTS									
Upper	1989	FLOW	AVE M	MGD	39.6	7.41	12	51.9	31.3
Blackstone	1989	TSS	AVE M	mg/L	11.0	6.58	12	28.0	6.0
WPAD WWTF	1989	TSS	AVE W	mg/L	15.8	10.8	12	45.0	7.0
(Continued)	1989	TSS	MAX D	mg/L	38.8	47.7	12	181	9.0
	1989	BOD5	AVE M	mg/L	8.58	3.28	12	14.0	4.0
	1989	BOD5	AVE W	mg/L	10.4	3.75	12	18.0	4.0
	1989	BOD5	MAX D	mg/L	14.8	5.49	12	26.0	6.0
	1989	FC	AVE M	#/100ml	5.29	2.81	7	9.0	2.0
	1989	FC	AVE W	#/100ml	19.4	16.6	7	51.0	4.0
	1989	FC	MAX D	#/100ml	624	1203	7	3252	15.0
	1989	NH3	AVE M	mg/L	2.0	3.25	5	7.8	0.3
	1989	NH3	AVE W	mg/L	2.70	3.29	5	8.5	0.8
	1989	NH3	MAX D	mg/L	3.86	3.87	5	10.7	1.7
	1989	SS	AVE W	mg/L	0.03	0.04	12	0.1	0
	1989	SS	MAX D	mg/L	0.10	0.08	12	0.3	0
Uxbridge	1988	FLOW	AVE M	MGD	0.60	0.09	12	0.77	0.49
WWTF	1988	TSS	AVE M	mg/L	12.1	5.22	12	21.2	5.4
	1988	TSS	AVE W	mg/L	17.4	7.77	12	31.2	6.3
	1988	TSS	MAX D	mg/L	21.4	9.20	12	35.0	6.9
	1988	BOD5	AVE M	mg/L	13.6	7.05	12	24.3	6.1
	1988	BOD5	AVE W	mg/L	20.7	11.9	12	39.6	8.5
	1988	BOD5	MAX D	mg/L	27.7	20.5	12	81.0	8.6
	1988	FC	AVE M	#/100ml	5.7	1.94	4	7.6	3.7

M = monthly; W = weekly; D = daily; TSS = total suspended solids; BOD5 = 5 day biochemical oxygen demand; FC = fecal coliform; SS = settleable solids; NO3 = nitrate; NO2 = nitrite; NH3 = ammonia; TP = total phosphorus; CYAN = cyanide; TNTC = too numerous to count; s = standard deviation; n = number of samples.

Table C.1 - Continued.

Facility	Year	Constituent	Discharge	Units	Mean	s	n	Max	Min
MASSACHUSETTS									
Uxbridge WWTF (Continued).	1988	FC	AVE W	#/100ml	17.5	8.85	4	26.0	8.0
	1988	FC	MAX D	#/100ml	25.5	17.2	4	48.0	12.0
	1989	FLOW	AVE M	MGD	0.68	0.06	12	0.76	0.6
	1989	TSS	AVE M	mg/L	11.4	5.86	12	21.6	4.4
	1989	TSS	AVE W	mg/L	17.0	8.76	12	34.9	6.8
	1989	TSS	MAX D	mg/L	22.5	10.1	12	41.1	9.9
	1989	BOD5	AVE M	mg/L	16.3	8.46	12	29.6	6.2
	1989	BOD5	AVE W	mg/L	23.1	12.1	12	40.2	7.5
	1989	BOD5	MAX D	mg/L	28.0	14.5	12	48.0	8.7
	1989	FC	AVE M	#/100ml	13.6	11.1	7	31.4	4.1
	1989	FC	AVE W	#/100ml	56.5	30.9	7	104	23.0
	1989	FC	MAX D	#/100ml	85.5	57.3	7	184	25.0

M = monthly; W = weekly; D = daily; TSS = total suspended solids; BOD5 = 5 day biochemical oxygen demand; FC = fecal coliform; SS = settleable solids; NO3 = nitrate; NO2 = nitrite; NH3 = ammonia; TP = total phosphorus; CYAN = cyanide; TNTC = too numerous to count; s = standard deviation; n = number of samples.

Table C.1 - Continued.

Facility	Year	Constituent	Discharge	Units	Mean	s	n	Max	Min
MASSACHUSETTS									
Grafton WWTF.	1988	FLOW	AVE M	MGD	0.80	0.26	12	1.06	0.07
	1988	TSS	AVE M	mg/L	3.10	1.57	12	6.0	0.9
	1988	TSS	AVE W	mg/L	3.10	1.57	12	6.0	0.9
	1988	TSS	MAX D	mg/L	9.08	8.86	12	35.0	2.0
	1988	BOD5	AVE M	mg/L	5.42	2.72	12	12.0	3.0
	1988	BOD5	AVE W	mg/L	5.42	2.72	12	12.0	3.0
	1988	BOD5	MAX D	mg/L	10.8	4.99	12	20.0	5.0
	1988	FC	AVE M	#100/ml	37.2	71.0	5	164	1.25
	1988	FC	AVE W	#100/ml	37.2	71.0	5	164	1.25
	1988	FC	MAX D	#100/ml	137	269	5	620	5.0
	1989	FLOW	AVE M	MGD	1.04	0.22	11	1.31	0.73
	1989	TSS	AVE M	mg/L	4.18	1.66	11	6.0	2.0
	1989	TSS	AVE W	mg/L	4.18	1.66	11	6.0	2.0
	1989	TSS	MAX D	mg/L	14.5	10.4	11	32.0	5.0
	1989	BOD5	AVE M	mg/L	5.0	1.67	11	8.0	3.0
	1989	BOD5	AVE W	mg/L	5.0	1.67	11	8.0	3.0
	1989	BOD5	MAX D	mg/L	12.0	8.59	11	34.0	5.0
	1989	FC	AVE W	#100/ml	22.0	21.3	6	55.0	0.6
	1989	FC	AVE W	#100/ml	22.0	21.3	6	55.0	0.6
	1989	FC	MAX W	#100/ml	62.3	56.7	6	137	2.5

M = monthly; W = weekly; D = daily; TSS = total suspended solids; BOD5 = 5 day biochemical oxygen demand; FC = fecal coliform; SS = settleable solids; NO3 = nitrate; NO2 = nitrite; NH3 = ammonia; TP = total phosphorus; CYAN = cyanide; TNTC = too numerous to count; s = standard deviation; n = number of samples.

Table C.1 - Continued.

Facility	Year	Constituent	Discharge	Units	Mean	s	n	Max	Min
MASSACHUSETTS									
Upton WWTF	1988	FLOW	AVE M	MGD	0.15	0.04	11	0.2	0.09
	1988	TSS	AVE M	lbs/d	18.0	7.85	6	31.7	7.6
	1988	TSS	AVE M	mg/L	9.53	5.64	6	19.0	4.0
	1988	TSS	AVE W	mg/L	11.9	3.93	6	19.0	7.0
	1988	TSS	MAX D	mg/L	17.2	4.22	6	22.0	10.0
	1988	BOD5	AVE M	lbs/d	22.8	24.2	11	61.9	0.04
	1988	BOD5	AVE M	mg/L	21.2	13.3	7	37.1	3.2
	1988	BOD5	AVE W	mg/L	14.8	14.9	11	37.1	0.06
	1988	BOD5	MAX D	mg/L	18.2	15.9	11	38.5	0.25
	1988	SS	AVE W	ml/L	1.57	0.98	3	2.7	1.0
	1988	SS	MAX D	ml/L	5.33	4.16	3	10.0	2.0
	1988	FC	AVE M	#/100ml	<868	2357	8	6700	<2.0
	1988	FC	AVE W	#/100ml	<696	2110	10	6700	<2.0
	1988	FC	MAX D	#/100ml	<2580	7879	10	25000	<2.0
	1989	FLOW	AVE M	MGD	0.15	0.03	12	0.22	0.10
	1989	TSS	AVE M	lbs/d	15.7	9.44	7	26.1	0.67
	1989	TSS	AVE M	mg/L	9.47	5.81	6	16.0	0.5
	1989	TSS	AVE W	mg/L	12.1	7.31	7	20.8	1.25
	1989	TSS	MAX D	mg/L	21.4	13.0	7	38.0	2.0
	1989	BOD5	AVE M	lbs/d	12.0	13.8	12	37.9	0.8
	1989	BOD5	AVE M	mg/L	8.07	9.58	10	28.0	0.7
	1989	BOD5	AVE W	mg/L	9.52	11.0	12	30.5	0.8
	1989	BOD5	MAX D	mg/L	12.6	13.5	12	36.0	1.8
	1989	FC	AVE M	#/100ml	<188	568	11	1897	<2.0
	1989	FC	AVE W	#/100ml	<43.2	122	11	410	<2.0
	1989	FC	MAX D	#/100ml	<414	1276	12	4450	<2.0

M = monthly; W = weekly; D = daily; TSS = total suspended solids; BOD5 = 5 day biochemical oxygen demand; FC = fecal coliform; SS = settleable solids; NO3 = nitrate; NO2 = nitrite; NH3 = ammonia; TP = total phosphorus; CYAN = cyanide; TNTC = too numerous to count; s = standard deviation; n = number of samples.

Table C.2 - DMR Data Statistics for Major Rhode Island Dischargers in the Blackstone River Watershed for 1988 and 1989.

Facility	Year	Constituent	Discharge	Units	Mean	s	n	Max	Min
RHODE ISLAND									
Blackstone Smithfield Corp.	1988	FLOW	AVE M	GPD	3095	627	12	3920	1920
	1988	FLOW	MAX D	GPD	3794	730	12	4800	2786
	1988	TSS	AVE M	mg/L	10.6	6.33	12	25.7	<0.5
	1988	TSS	AVE W	mg/L	10.6	6.33	12	25.7	<0.5
	1988	TSS	MAX D	mg/L	10.6	6.33	12	25.7	<0.5
	1988	BOD5	AVE M	mg/L	3.42	1.24	12	6	<2
	1988	BOD5	AVE W	mg/L	3.42	1.24	12	6	<2
	1988	BOD5	MAX D	mg/L	3.42	1.24	12	6	<2
	1988	FC	AVE M	#/100ml	<2.25	0.62	12	4	<2
	1988	FC	AVE W	#/100ml	<2.25	0.62	12	4	<2
	1988	FC	MAX D	#/100ml	<2.25	0.62	12	4	<2
	1988	SS	AVE W	ml/L	0.1	0	12	0.1	0.1
	1988	SS	MAX D	ml/L	0.1	0	12	0.1	0.1
	1989	FLOW	AVE M	GPD	3971	383	12	4780	3383
	1989	FLOW	MAX D	GPD	6440	1201	12	8640	3840
	1989	TSS	AVE M	mg/L	9.93	5.27	12	17.3	1.8
	1989	TSS	AVE W	mg/L	9.93	5.27	12	17.3	1.8
	1989	TSS	MAX D	mg/L	9.93	5.27	12	17.3	1.8
	1989	BOD5	AVE M	mg/L	2.75	0.45	12	<3	<2
	1989	BOD5	AVE W	mg/L	2.75	0.45	12	<3	<2
	1989	BOD5	MAX D	mg/L	2.75	0.45	12	<3	<2
	1989	FC	AVE M	#/100ml	<2	0	12	<2	<2
	1989	FC	AVE W	#/100ml	<2	0	12	<2	<2
	1989	FC	MAX D	#/100ml	<2	0	12	<2	<2

M = monthly; W = weekly; D = daily; TSS = total suspended solids; BOD5 = 5 day biochemical oxygen demand; FC = fecal coliform; SS = settleable solids; NO3 = nitrate; NO2 = nitrite; NH3 = ammonia; TP = total phosphorus; CYAN = cyanide; TNTC = too numerous to count; s = standard deviation; n = number of samples.

Table C.2 - Continued.

Facility	Year	Constituent	Discharge	Units	Mean	s	n	Max	Min
RHODE ISLAND									
Blackstone Smithfield Corp. (Continued)	1989	SS	AVE W	ml/L	0.1	0	12	0.1	0.1
	1989	SS	MAX D	ml/L	0.1	0	12	0.1	0.1
	1989	NO3	MAX D	mg/L	3.27	1.43	8	5.5	2.1
	1989	NO2	MAX D	mg/L	<0.04	0.04	8	0.11	<0.01
	1989	NH3	MAX D	mg/L	1.71	1.41	8	3.9	0.17
	1989	TP	MAX D	mg/L	1.22	0.42	8	1.77	0.46
Burrillville WWTF	1988	FLOW	AVE M	MGD	1.01	0.09	11	1.24	0.92
	1988	FLOW	MAX D	MGD	1.34	0.12	11	1.59	1.25
	1988	TSS	AVE M	mg/L	19.4	8.87	12	37.3	10.4
	1988	TSS	AVE W	mg/L	28.0	18.2	12	69	13.0
	1988	TSS	MAX D	mg/L	38.3	26.3	12	84	16.0
	1988	BOD5	AVE M	mg/L	14.0	8.47	12	27.4	5.2
	1988	BOD5	AVE W	mg/L	18.3	9.58	12	38.2	8.0
	1988	BOD5	MAX D	mg/L	24.6	16.6	12	61.4	9.2
	1988	FC	AVE M	#/100ml	17.9	23.7	12	70.25	1.05
	1988	FC	AVE W	#/100ml	44.2	41.3	12	112.6	2.83
	1988	FC	MAX D	#/100ml	79.7	46.4	12	144	8.0
	1988	Pb	MAX D	mg/L	<0.05	0	2	<0.05	<0.05
	1988	Cu	MAX D	mg/L	0.07	0.06	2	0.11	0.03
	1988	TP	AVE M	lbs/d	7.55	4.01	11	15.2	2.40
	1988	TP	AVE M	mg/L	0.82	0.38	12	1.54	0.29
	1989	FLOW	AVE M	MGD	0.53	0.12	9	0.72	0.38
	1989	FLOW	MAX D	MGD	0.85	0.32	9	1.38	0.55

M = monthly; W = weekly; D = daily; TSS = total suspended solids; BOD5 = 5 day biochemical oxygen demand; FC = fecal coliform; SS = settleable solids; NO3 = nitrate; NO2 = nitrite; NH3 = ammonia; TP = total phosphorus; CYAN = cyanide; TNTC = too numerous to count; s = standard deviation; n = number of samples.

Table C.2 - Continued.

Facility	Year	Constituent	Discharge	Units	Mean	s	n	Max	Min
RHODE ISLAND									
Burrillville WWTF (Continued)	1989	TSS	AVE M	mg/L	10.2	3.03	12	15.2	6.0
	1989	TSS	AVE W	mg/L	13.4	4.09	12	20.0	8.5
	1989	TSS	MAX D	mg/L	16.1	5.79	12	26.0	9.0
	1989	BOD5	AVE M	mg/L	5.64	1.90	12	7.9	2.1
	1989	BOD5	AVE W	mg/L	8.70	4.07	12	18.9	2.8
	1989	BOD5	MAX D	mg/L	10.3	4.17	12	19.4	3.5
	1989	FC	AVE M	#/100ml	NA	NA	12	TNTC	2.5
	1989	FC	AVE W	#/100ml	NA	NA	12	TNTC	3.5
	1989	FC	MAX D	#/100ml	NA	NA	12	TNTC	6.0
	1989	SS	AVE M	ml/L	0.1	0	1	0.1	0.1
	1989	SS	AVE W	ml/L	0.1	0	3	0.1	0.1
	1989	SS	MAX D	ml/L	0.1	0	3	0.1	0.1
	1989	Pb	MAX D	mg/L	<0.03	0.02	4	0.04	<0.01
	1989	Cu	MAX D	mg/L	<0.10	0.06	4	0.16	<0.05
	1989	NO3	MAX D	mg/l	15.9	8.26	8	26.4	0.33
	1989	NO2	MAX D	mg/L	<0.62	0.25	8	3.65	<0.01
	1989	NH3	MAX D	mg/L	7.68	11.6	8	32.5	0.65
	1989	TP	AVE M	lbs/d	2.18	0.68	9	3.1	1.26
	1989	TP	AVE M	mg/L	0.52	0.10	12	0.76	0.34
GTE	1988	FLOW	AVE M	MGD	0.06	0.02	12	0.09	0.02
	1988	TSS	AVE M	lbs/d	28.4	13.1	12	52.9	14.0
	1988	TSS	MAX D	lbs/d	38.2	20.9	12	77.4	16.0
	1988	Cr	AVE M	mg/L	<0.02	0.01	12	0.05	<0.01
	1988	Cr	MAX D	mg/L	<0.03	0.01	12	0.06	<0.01
	1988	Pb	AVE M	mg/L	<0.03	0.02	12	0.06	0.01
	1988	Pb	MAX D	mg/L	<0.04	0.02	12	0.07	<0.02

M = monthly; W = weekly; D = daily; TSS = total suspended solids; BOD5 = 5 day biochemical oxygen demand; FC = fecal coliform; SS = settleable solids; NO3 = nitrate; NO2 = nitrite; NH3 = ammonia; TP = total phosphorus; CYAN = cyanide; TNTC = too numerous to count; s = standard deviation; n = number of samples; NA = not available due to many TNTC entries.

Table C.2 - Continued.

Facility	Year	Constituent	Discharge	Units	Mean	s	n	Max	Min
RHODE ISLAND									
GTE (Continued)	1988	Ag	AVE M	mg/L	<0.01	0.01	12	0.03	0.01
	1988	Ag	MAX D	mg/L	<0.01	0.01	12	0.02	0.01
	1989	FLOW	AVE M	MGD	0.05	0.02	12	0.06	0.02
	1989	TSS	AVE M	lbs/d	66.5	42.0	12	143	12.0
	1989	TSS	MAX D	lbs/d	99.7	58.0	12	209	17.0
	1989	Cr	AVE M	mg/L	0.09	0.08	12	0.30	0.02
	1989	Cr	MAX D	mg/L	0.12	0.13	12	0.50	0.03
	1989	Pb	AVE M	mg/L	<0.04	0.02	11	0.07	<0.01
	1989	Pb	MAX D	mg/L	0.06	0.05	11	0.17	0.01
	1989	Ag	AVE M	mg/L	0.02	0.02	11	0.04	0.01
	1989	Ag	MAX D	mg/L	0.02	0.02	11	0.04	0.01
Okonite	1988	FLOW	AVE M	MGD	0.07	0.06	4	0.13	0.02
	1988	FLOW	MAX D	MGD	0.24	0.05	4	0.28	0.17
	1988	Cu	MAX D	mg/L	0.03	0.02	4	0.05	0.01
	1989	FLOW	AVE M	MGD	0.13	0.02	4	0.15	0.11
	1989	FLOW	MAX D	MGD	0.26	0.02	4	0.28	0.24
	1989	Cu	MAX D	mg/L	0.04	0.01	4	0.05	0.02
Tupperware	1988	FLOW	AVE M	GPD	3444	244	12	3780	2892
	1988	FLOW	MAX D	GPD	3912	510	12	5040	3258
	1988	TSS	AVE M	mg/L	16.6	6.48	12	25.8	6.50
	1988	BOD5	AVE M	mg/L	6.92	7.38	12	26.0	<3.0
	1988	FC	AVE M	#/100ml	<2.20	0.58	12	4.0	<2.0

M = monthly; W = weekly; D = daily; TSS = total suspended solids; BOD5 = 5 day biochemical oxygen demand; FC = fecal coliform; SS = settleable solids; NO3 = nitrate; NO2 = nitrite; NH3 = ammonia; TP = total phosphorus; CYAN = cyanide; TNTC = too numerous to count; s = standard deviation; n = number of samples.

Table C.2 - Continued.

Facility	Year	Constituent	Discharge	Units	Mean	s	n	Max	Min
RHODE ISLAND									
Tupperware (Continued)	1989	FLOW	AVE M	GPD	3805	739	12	4834	2613
	1989	FLOW	MAX D	GPD	4946	815	12	6591	3762
	1989	TSS	AVE M	mg/L	28.5	30.18	12	120	6.0
	1989	BOD5	AVE M	mg/L	18.8	21.11	12	75.0	<3.0
	1989	FC	AVE M	#/100ml	204	692	12	2400	<2.0
	1989	NO3	MAX D	mg/L	0.60	0.42	8	1.40	0.05
	1989	NO2	MAX D	mg/L	0.10	0.04	8	0.15	0.04
	1989	NH3	MAX D	mg/L	16.7	3.50	8	22.0	12.3
	1989	TP	MAX D	mg/L	4.9	2.58	8	10.3	1.3
Woonsocket WWTF	1988	FLOW	AVE M	MGD	8.36	1.19	12	10.6	6.40
	1988	FLOW	MAX D	MGD	12.7	3.94	12	21.6	7.68
	1988	TSS	AVE M	mg/L	26.4	18.1	12	72.3	12.1
	1988	TSS	AVE W	mg/L	37.4	27.6	12	108	14.3
	1988	TSS	MAX D	mg/L	54.1	32.5	12	132	24.0
	1988	BOD5	AVE M	mg/L	33.2	11.6	12	54.0	16.7
	1988	BOD5	AVE W	mg/L	43.3	17.1	12	73.6	18.3
	1988	BOD5	MAX D	mg/L	69.9	23.5	12	111	37.0
	1988	FC	AVE M	#/100ml	46.0	50.9	12	187	3.5
	1988	FC	AVE W	#/100ml	140	170	12	601	6.4
	1988	FC	MAX D	#/100ml	438	258	12	602	36.0
	1988	Sb	MAX D	mg/L	<0.18	0.05	4	<0.02	<0.01
	1988	As	MAX D	mg/L	<0.01	0.01	4	<0.01	<0.01
	1988	Be	MAX D	mg/L	<0.01	0	4	<0.01	<0.01
	1988	Cd	MAX D	mg/L	<0.01	0	4	<0.01	<0.01

M = monthly; W = weekly; D = daily; TSS = total suspended solids; BOD5 = 5 day biochemical oxygen demand; FC = fecal coliform; SS = settleable solids; NO3 = nitrate; NO2 = nitrite; NH3 = ammonia; TP = total phosphorus; CYAN = cyanide; TNTC = too numerous to count; s = standard deviation; n = number of samples.

Table C.2 - Continued.

Facility	Year	Constituent	Discharge	Units	Mean	s	n	Max	Min
RHODE ISLAND									
Woonsocket WWTF (Continued)	1988	Cr	MAX D	mg/L	<0.05	0.01	4	0.06	<0.05
	1988	Cu	MAX D	mg/L	<0.07	0.02	4	0.09	<0.05
	1988	Pb	MAX D	mg/L	<0.05	0	4	<0.05	<0.05
	1988	Hg	MAX D	mg/L	<0.01	0	4	<0.01	<0.01
	1988	Ni	MAX D	mg/L	<0.04	0	4	0.04	<0.04
	1988	Se	MAX D	mg/L	<0.01	0	4	0.01	<0.01
	1988	Ag	MAX D	mg/L	<0.02	0.02	4	0.05	<0.01
	1988	Tl	MAX D	mg/L	<0.1	0	4	<0.10	<0.10
	1988	Zn	MAX D	mg/L	0.10	0.02	4	0.12	0.08
	1988	CYAN	MAX D	mg/L	0.10	0.07	4	0.18	0.04
	1989	FLOW	AVE M	MGD	8.93	1.24	12	10.7	7.22
	1989	FLOW	MAX D	MGD	12.5	1.89	12	15.0	9.31
	1989	TSS	AVE M	mg/L	22.9	4.6	12	32.8	17.0
	1989	TSS	AVE W	mg/L	29.2	7.0	12	45.8	22.6
	1989	TSS	MAX D	mg/L	48.4	15.9	12	83.0	32.0
	1989	BOD5	AVE M	mg/L	16.2	13.6	12	51.0	4.9
	1989	BOD5	AVE W	mg/L	22.7	22.2	12	84.6	6.0
	1989	BOD5	MAX D	mg/L	36.1	37.4	12	147	9.0
	1989	FC	AVE M	#/100ml	6282	21000	12	73000	10.6
	1989	FC	AVE W	#/100ml	NA	NA	12	TNTC	19.6
	1989	FC	MAX D	#/100ml	NA	NA	12	TNTC	56.0
	1989	Sb	MAX D	mg/L	<0.02	<0.02	4	<0.05	<0.01
	1989	As	MAX D	mg/L	<0.01	0	4	<0.01	<0.01
	1989	Be	MAX D	mg/l	<0.01	0	4	0.01	<0.01
	1989	Cd	MAX D	mg/L	<0.01	0	4	<0.01	<0.01
	1989	Cr	MAX D	mg/L	<0.03	0	4	<0.03	<0.03
	1989	Cu	MAX D	mg/L	<0.14	0.14	4	0.35	<0.05

M = monthly; W = weekly; D = daily; TSS = total suspended solids; BOD5 = 5 day biochemical oxygen demand; FC = fecal coliform; SS = settleable solids; NO3 = nitrate; NO2 = nitrite; NH3 = ammonia; TP = total phosphorus; CYAN = cyanide; TNTC = too numerous to count; s = standard deviation; n = number of samples; NA = not avaliable due to many TNTC entries.

Table C.2 - Continued.

Facility	Year	Constituent	Discharge	Units	Mean	s	n	Max	Min
RHODE ISLAND									
Woonsocket WWTF (Continued)	1989	Pb	MAX D	mg/L	<0.04	0.01	4	0.05	<0.04
	1989	Hg	MAX D	mg/L	<0.01	0	4	<0.01	<0.01
	1989	Ni	MAX D	mg/L	<0.04	0.02	4	0.07	<0.02
	1989	Se	MAX D	mg/L	<0.01	0.01	4	<0.02	<0.01
	1989	Ag	MAX D	mg/L	<0.02	0	4	<0.02	<0.02
	1989	Tl	MAX D	mg/L	<0.02	0.02	4	<0.01	<0.01
	1989	Zn	MAX D	mg/L	0.16	0.06	4	0.23	0.08
	1989	CYAN	MAX D	mg/L	0.13	0.06	4	0.18	0.04
Zambarano Hospital	1988	FLOW	AVE M	MGD	0.10	0	11	0.10	0.10
	1988	FLOW	MAX D	MGD	0.11	0	11	0.11	0.11
	1988	TSS	AVE M	mg/L	33.2	30.5	12	110	8.0
	1988	TSS	AVE W	mg/L	55.6	60.0	12	209	10.0
	1988	TSS	MAX D	mg/L	55.6	60.0	12	209	10.0
	1988	BOD5	AVE M	mg/L	<9.85	7.42	12	26.5	<1.0
	1988	BOD5	AVE W	mg/L	<15.4	13.1	12	45.0	1.0
	1988	BOD5	MAX D	mg/L	<15.4	13.1	12	45.0	1.0
	1988	FC	AVE M	#/100ml	<2.79	3.57	12	12.3	<1.0
	1988	FC	AVE W	#/100ml	<14.8	42.6	12	150	<1.0
	1988	FC	MAX D	#/100ml	<14.8	42.6	12	150	<1.0
	1988	SS	AVE W	ml/L	15.5	4.98	3	20.1	10.2
	1988	SS	MAX D	ml/L	25.1	18.9	4	40.0	0.5
	1989	FLOW	AVE M	MGD	0.10	0	12	0.10	0.10
	1989	FLOW	MAX D	MGD	0.11	0	12	0.11	0.11

M = monthly; W = weekly; D = daily; TSS = total suspended solids; BOD5 = 5 day biochemical oxygen demand; FC = fecal coliform; SS = settleable solids; NO3 = nitrate; NO2 = nitrite; NH3 = ammonia; TP = total phosphorus; CYAN = cyanide; TNTC = too numerous to count; s = standard deviation; n = number of samples.

Table C.2 - Continued.

Facility	Year	Constituent	Discharge	Units	Mean	s	n	Max	Min
RHODE ISLAND									
Zambarano	1989	TSS	AVE M	mg/L	21.4	10.9	12	51.0	6.0
Hospital	1989	TSS	AVE W	mg/L	30.8	18.3	12	81.9	7.0
(Continued)	1989	TSS	MAX D	mg/L	30.8	18.3	12	81.9	7.0
	1989	BOD5	AVE M	mg/L	<8.0	5.48	12	17.5	<1.0
	1989	BOD5	AVE W	mg/L	<12.7	8.26	12	30.0	<1.0
	1989	BOD5	MAX D	mg/L	<12.7	8.26	12	30.0	<1.0
	1989	FC	AVE M	#/100ml	1397	2568	12	6928	<1.0
	1989	FC	AVE W	#/100ml	NA	NA	12	TNTC	<1.0
	1989	FC	MAX D	#/100ml	NA	NA	12	TNTC	<1.0
	1989	SS	AVE W	ml/L	26.7	9.43	2	33.3	20.2
	1989	SS	MAX D	ml/L	32.6	31.8	8	100	0.05

M = monthly; W = weekly; D = daily; TSS = total suspended solids; BOD5 = 5 day biochemical oxygen demand; FC = fecal coliform; SS = settleable solids; NO3 = nitrate; NO2 = nitrite; NH3 = ammonia; TP = total phosphorus; CYAN = cyanide; TNTC = too numerous to count; s = standard deviation; n = number of samples; NA = not available due to many TNTC entries.

Table C.2 - Continued.

Facility	Year	Constituent	Discharge	Units	Mean	s	n	Max	Min
RHODE ISLAND									
BVDC WWTF	1988	FLOW	AVE M	MGD	22.1	2.0	12	23.9	19.9
	1988	TSS	AVE M	lbs/d	12164	4183	7	20108	7725
	1988	TSS	AVE M	mg/L	68.8	27.6	12	132	37.9
	1988	TSS	AVE W	mg/L	134	84.3	12	313	57.6
	1988	TSS	MAX D	mg/L	506	569	12	1994	96.0
	1988	BOD5	AVE M	lbs/d	11389	3087	7	17071	7926
	1988	BOD5	AVE M	mg/L	57.2	14.8	12	87.0	41.1
	1988	BOD5	AVE W	mg/L	79.9	28.1	12	127	40.8
	1988	BOD5	MAX D	mg/L	190	132	12	599	102
	1988	FC	AVE M	#/100ml	89.1	51.6	12	184	29.0
	1988	FC	AVE W	#/100ml	512	626	12	2300	44.0
	1988	FC	MAX D	#/100ml	NA	NA	12	TNTC	230
	1988	SS	AVE M	ml/L	1.39	2.50	12	9.0	0.01
	1988	SS	AVE W	ml/L	10.7	29.4	12	103	0.02
	1988	SS	MAX D	ml/L	32.6	46.7	12	147	0.1
	1988	Cr	MAX D	μg/L	<20.8	1.50	4	23.0	<20.0
	1988	Cu	MAX D	μg/L	72.8	36.0	4	124	40.0
	1988	Ni	MAX D	μg/L	125	80.5	4	220	41.0
	1989	FLOW	AVE M	MGD	22.6	19.3	12	25.5	19.3
	1989	TSS	AVE M	mg/L	75.3	37.2	12	132	23.4
	1989	TSS	AVE W	mg/L	147	86.2	12	280	27.6
	1989	TSS	MAX D	mg/L	598	486	12	1594	68.0
	1989	BOD5	AVE M	mg/L	61.2	16.2	12	84.7	37.3
	1989	BOD5	AVE W	mg/L	99.8	48.6	12	208	42.3
	1989	BOD5	MAX D	mg/L	330	239	12	852	63.0
	1989	NH3	MAX D	mg/L	9.34	3.61	8	16.5	5.3
	1989	FC	AVE M	#/100ml	80.5	68.1	12	230	27.0
	1989	FC	AVE W	#/100ml	334	377	12	1191	44.4

M = monthly; W = weekly; D = daily; TSS = total suspended solids; BOD5 = 5 day biochemical oxygen demand; FC = fecal coliform; SS = settleable solids; NO3 = nitrate; NO2 = nitrite; NH3 = ammonia; TP = total phosphorus; CYAN = cyanide; TNTC = too numerous to count; s = standard deviation; n = number of samples.

Table C.2 - Continued.

Facility	Year	Constituent	Discharge	Units	Mean	s	n	Max	Min
RHODE ISLAND									
BVCD WWTF	1989	FC	MAX D	#/100ml	TNTC	TNTC	12	TNTC	2300
(Continued)	1989	Cr	MAX D	µg/L	47.5	41.9	4	110	20.0
	1989	Cu	MAX D	µg/L	52.5	20.6	4	80.0	30.0
	1989	Ni	MAX D	µg/L	65.0	42.0	4	120	20.0
	1989	TP	MAX D	mg/L	3.51	1.36	8	5.5	1.5
	1989	SS	AVE M	ml/L	2.06	3.53	12	12.7	0.02
	1989	SS	AVE W	ml/L	7.91	11.1	12	38.6	0.07
	1989	SS	MAX D	ml/L	77.0	124	12	425	0.4

M = monthly; W = weekly; D = daily; TSS = total suspended solids; BOD5 = 5 day biochemical oxygen demand; FC = fecal coliform; SS = settleable solids; NO3 = nitrate; NO2 = nitrite; NH3 = ammonia; TP = total phosphorus; CYAN = cyanide; TNTC = too numerous to count; s = standard deviation; n = number of samples.

APPENDIX D

Table D.1 - Specific violation Data for Major Massachusetts Pollutant Dischargers in the Blackstone River Watershed as Indicated in the State DMR Data and Violations Reports for 1988 and 1989

Table D.2 - Specific violation Data for Major Rhode Island Pollutant Dischargers in the Blackstone River Watershed as Indicated in the State DMR Data and Violations Reports for 1988 and 1989

Table D.1 - Specific Violation Data for Major Pollutant Dischargers in the Blackstone River Watershed as Indicated in the State DMR Data and Violations Reports for 1988 and 1989.

Facility	Constituent	Date	Permit Discharge	Permit Limit	Measured
MASSACHUSETTS					
Grafton WWTF	SS	11/88	MAX D	0.3	1.0
	SS	03/89	AVE W	0.1	0.23
	SS	03/89	MAX D	0.3	5.2
	FC	08/88	MAX D	400	620
	TRC#	05/88	AVE M	0.5	0.6
	TRC#	10/88	AVE M	0.5	1.1
	TRC#	07/89	AVE M	0.5	0.7
	TRC#	08/89	AVE M	0.5	0.7
	pH	01/88	MIN D	6.5	6.4
	pH	02/88	MIN D	6.5	6.4
	pH	04/89	MIN D	6.5	6.4
	pH	07/89	MIN D	6.5	6.3
	pH	08/89	MIN D	6.5	6.4
Guilford Industries	BOD5	07/88	AVE M	*313	*392.1
	BOD5	07/88	MAX D	*626	*670.5
	TSS	07/88	MAX D	*626	*651.3
	pH	07/88	MAX D	9.0	9.4
Millbury WWTF	BOD5	01/89	AVE M	30	32
	BOD5	12/89	AVE M	30	38
	TSS	01/89	AVE M	30	34
	FLOW	04/89	AVE M	1.2	1.221
	FLOW	05/89	AVE M	1.2	1.261
	TRC#	04/88	AVE M	0.5	0.8
	TRC#	05/88	AVE M	0.5	0.9

M = monthly; W = weekly; D = daily; flow = (GPD); FLOW = (MGD); pH = (SU); TM = Trace Metals (mg/L); SS = settleable solids (ml/L); FC = fecal coliform (#/100 ml); TNTC = too numerous to count; TRC = total residual chlorine (mg/L); BOD5 = 5 day biochemical oxygen demand (mg/L; * = lbs/day); TSS = total suspended solids (mg/L; * = lbs/day).

Table D.1 - Continued.

Facility	Constituent	Date	Permit Discharge	Limit	Measured
MASSACHUSETTS					
N.E. Plating	pH	02/88	MAX D	9.0	12.0
	pH	03/88	MAX D	9.0	9.2
	pH	04/88	MIN D	6.0	3.0
	pH	04/88	MAX D	9.0	11.6
	pH	06/88	MAX D	9.0	10.1
	pH	08/88	MAX D	9.0	9.4
	pH	10/88	MAX D	9.0	10.4
	pH	01/89	MAX D	9.0	9.3
	pH	09/89	MAX D	9.0	10.0
	pH	10/89	MAX D	9.0	11.3
	pH	11/89	MAX D	9.0	11.0
Uxbridge WWTF	BOD5	07/88	MAX D	50	81.0
	TRC#	05/88	MAX D	1.5	1.8
	TRC#	09/88	MAX D	1.5	1.8
	TRC#	10/88	MAX D	1.5	1.6
	TRC#	04/89	MAX D	1.5	1.7
	TRC#	06/89	MAX D	1.5	2
	TRC#	07/89	MAX D	1.5	1.9
	TRC#	09/89	MAX D	1.5	1.9
	pH	01/88	MIN D	6.5	6.2
	pH	06/88	MIN D	6.5	6.1
	pH	07/88	MIN D	6.5	6.4
	pH	08/88	MIN D	6.5	6.2
	pH	09/88	MIN D	6.5	6.0
	pH	10/88	MIN D	6.5	6.0
	pH	11/88	MIN D	6.5	6.0
	pH	12/88	MIN D	6.5	6.0

M = monthly; W = weekly; D = daily; flow = (GPD); FLOW = (MGD); pH = (SU); TM = Trace Metals (mg/L); SS = settleable solids (ml/L); FC = fecal coliform (#/100 ml); TNTC = too numerous to count; TRC = total residual chlorine (mg/L); BOD5 = 5 day biochemical oxygen demand (mg/L; * = lbs/day); TSS = total suspended solids (mg/L; * = lbs/day).

Table D.1 - Continued.

Facility	Constituent	Date	Permit Discharge	Permit Limit	Measured
MASSACHUSETTS					
Uxbridge WWTF (Continued)	pH	01/89	MIN D	6.5	6.1
	pH	02/89	MIN D	6.5	6.1
	pH	05/89	MIN D	6.5	6.4
	pH	06/89	MIN D	6.5	6.3
	pH	07/89	MIN D	6.5	6
	pH	08/89	MIN D	6.5	6.0
	pH	09/89	MIN D	6.5	5.8
	pH	10/89	MIN D	6.5	5.8
	pH	11/89	MIN D	6.5	5.8
	pH	12/89	MIN D	6.5	5.9
Northbridge WWTF	pH	02/88	MIN D	6.5	6.3
	pH	04/88	MIN D	6.5	6.2
	pH	05/88	MIN D	6.5	6.1
	pH	07/88	MIN D	6.5	6.1
	pH	08/88	MIN D	6.5	6.1
	pH	09/88	MIN D	6.5	6.1
	pH	10/88	MIN D	6.5	6.1
	pH	05/89	MIN D	6.5	6.2
	pH	06/89	MIN D	6.5	6
	pH	07/89	MIN D	6.5	6
	pH	08/89	MIN D	6.5	6.2
	pH	09/89	MIN D	6.5	6.0
	pH	10/89	MIN D	6.5	6.2
UBWPAD WWTF	TSS	06/88	MAX D	22.5	53
	TSS	08/88	MAX D	22.5	26
	TSS	06/89	MAX D	22.5	42

M = monthly; W = weekly; D = daily; flow = (GPD); FLOW = (MGD); pH = (SU); TM = Trace Metals (mg/L); SS = settleable solids (ml/L); FC = fecal coliform (#/100 ml); TNTC = too numerous to count; TRC = total residual chlorine (mg/L); BOD5 = 5 day biochemical oxygen demand (mg/L; * = lbs/day); TSS = total suspended solids (mg/L; * = lbs/day).

Table D.1 - Continued.

Facility	Constituent	Date	Permit Discharge	Permit Limit	Measured
MASSACHUSETTS					
UBWPAD WWTF (Continued)	TSS	05/88	MAX D	50	132
	TSS	02/89	MAX D	50	181
	TSS	03/89	MAX D	50	68
	SS	05/88	AVE W	0.1	0.2
	SS	08/88	AVE W	0.1	0.3
	SS	05/88	MAX D	0.3	0.8
	SS	08/88	MAX D	0.3	1.5
	FC	05/88	MAX D	400	800
	FC	08/88	MAX D	400	1180
	FC	04/89	MAX D	400	907
	FC	06/89	MAX D	400	3252
	AMM	06/89	AVE M	5	7.8
	AMM	06/89	AVE W	5	8.5
	AMM	06/89	MAX D	7.5	10.7
	AMM	10/89	MAX D	2.5	3.2
	pH	06/88	MIN D	6.5	5.9
	pH	07/88	MIN D	6.5	5.7
	pH	08/88	MIN D	6.5	5.8
	pH	09/88	MIN D	6.5	5.9
	pH	01/89	MIN D	6.5	6.0
	pH	02/89	MIN D	6.5	6.4
	pH	03/89	MIN D	6.5	6.4
	pH	04/89	MIN D	6.5	6.2
	pH	05/89	MIN D	6.5	6.1
	pH	06/89	MIN D	6.5	6.1
	pH	07/89	MIN D	6.5	5.9
	pH	08/89	MIN D	6.5	5.7
	pH	09/89	MIN D	6.5	5.9

M = monthly; W = weekly; D = daily; flow = (GPD); FLOW = (MGD); pH = (SU); TM = Trace Metals (mg/L); SS = settleable solids (ml/L); FC = fecal coliform (#/100 ml); TNTC = too numerous to count; TRC = total residual chlorine (mg/L); BOD5 = 5 day biochemical oxygen demand (mg/L; * = lbs/day); TSS = total suspended solids (mg/L; * = lbs/day).

Table D.1 - Continued.

Facility	Constituent	Date	Permit Discharge	Permit Limit	Measured
MASSACHUSETTS					
UBWPAD WWTF (Continued)	pH	10/89	MIN D	6.5	6.1
	pH	11/89	MIN D	6.5	6.3

M = monthly; W = weekly; D = daily; flow = (GPD); FLOW = (MGD); pH = (SU); TM = Trace Metals (mg/L); SS = settleable solids (ml/L); FC = fecal coliform (#/100 ml); TNTC = too numerous to count; TRC = total residual chlorine (mg/L); BOD5 = 5 day biochemical oxygen demand (mg/L; * = lbs/day); TSS = total suspended solids (mg/L; * = lbs/day).

Table D.2 - Specific Violation Data for Major Rhode Island Pollutant Dischargers in the Blackstone River Watershed as Indicated in the State DMR Data and Violations Reports for 1988 and 1989.

Facility	Constituent	Date	Permit Discharge	Permit Limit	Measured Value
RHODE ISLAND					
Blackstone Smithfield Corp.	flow	01/89	MAX D	6,000	7,200
	flow	02/89	MAX D	6,000	6,240
	flow	03/89	MAX D	6,000	7,200
	flow	04/89	MAX D	6,000	7,200
	flow	05/89	MAX D	6,000	8,640
	flow	06/89	MAX D	6,000	6,720
	flow	08/89	MAX D	6,000	7,200
Burrillville WWTF	FLOW	04/88	MAX D	1.5	1.541
	FLOW	06/88	MAX D	1.5	1.590
	pH	02/89	AVE M	6 - 9	5.2
	pH	03/89	AVE M	6 - 9	5.4
	pH	04/89	AVE M	6 - 9	5.75
	pH	05/89	AVE M	6 - 9	5.75
	pH	06/89	AVE M	6 - 9	4.6
	pH	08/89	AVE M	6 - 9	5.8

M = monthly; W = weekly; D = daily; flow = (GPD); FLOW = (MGD); pH = (SU); TM = Trace Metals (mg/L); SS = settleable solids (ml/L); FC = fecal coliform (#/100 ml); TNTC = too numerous to count; TRC = total residual chlorine (mg/L); BOD5 = 5 day biochemical oxygen demand (mg/L; * = lbs/day); TSS = total suspended solids (mg/L; * = lbs/day).

Table D.2 - Continued

Facility	Constituent	Date	Permit Discharge	Permit Limit	Measured Value
RHODE ISLAND					
Burrillville WWTF (Continued)	PHOS	06/88	AVE M	1.0	1.48
	PHOS	07/88	AVE M	1.0	1.54
	PHOS*	06/88	AVE M	12.5	15.2
	PHOS*	07/88	AVE M	12.5	13.7
	FC	03/89	AVE M	200	17,682
	FC	03/89	AVE W	400	TNTC
	FC	03/89	MAX D	400	TNTC
	FC	04/89	AVE M	200	TNTC
	FC	04/89	AVE W	400	TNTC
	FC	04/89	MAX D	400	TNTC
	FC	10/89	AVE M	200	239.6
	FC	10/89	AVE W	400	571.0
	FC	10/89	MAX D	400	736.0
	TRC	01/88	MAX D	2.0	2.9
	TRC	03/88	MAX D	2.0	2.5
	TRC	04/88	MAX D	2.0	2.5
	TRC	10/88	MAX D	2.0	2.2
	TRC	11/88	MAX D	2.0	2.3
	TRC	12/88	MAX D	2.0	2.2
	TRC	01/89	MAX D	2.0	2.6
	TRC	02/89	MAX D	2.0	2.7
	TRC	03/89	MAX D	2.0	2.2
	TRC	04/89	MAX D	2.0	3.6
	TRC	06/89	MAX D	2.0	3.1
	TRC	10/89	MAX D	2.0	2.6
	TRC	11/89	MAX D	2.0	2.8

M = monthly; W = weekly; D = daily; flow = (GPD); FLOW = (MGD); pH = (SU); TM = Trace Metals (mg/L); SS = settleable solids (ml/L); FC = fecal coliform (#/100 ml); TNTC = too numerous to count; TRC = total residual chlorine (mg/L); BOD5 = 5 day biochemical oxygen demand (mg/L; * = lbs/day); TSS = total suspended solids (mg/L; * = lbs/day).

Table D.2 - Continued

Facility	Constituent	Date	Permit Discharge	Permit Limit	Measured Value
RHODE ISLAND					
Burrillville WWTF (Continued)	TSS	06/88	AVE M	30	33.9
	TSS	06/88	AVE W	45	62.0
	TSS	06/88	MAX D	50	84.0
	TSS	07/88	AVE M	30	37.3
	TSS	07/88	AVE W	45	69.0
	TSS	07/88	MAX D	50	78.0
	TSS	08/88	MAX D	50	82.0
GTE	LEAD	08/88	AVE M	0.055	0.050
	LEAD	10/88	AVE M	0.055	0.050
	LEAD	10/89	AVE M	0.065	0.050
	LEAD	11/89	MAX D	0.170	0.100
	TSS	10/89	AVE M	130	143.1
Okonite	pH	10/88	AVE M	6 - 9	5.9
	pH	09/89	AVE M	6 - 9	5.6
Tupperware	pH	12/89	AVE M	6 - 9	4.0
	FC	11/89	AVE M	200	2,400
	FC	11/89	AVE W	400	2,400
	FC	11/89	MAX D	400	2,400
	BOD5	12/89	AVE M	30	75
	BOD5	12/89	AVE W	45	75
	BOD5	12/89	MAX D	50	75
	BOD*	12/89	AVE M	1.5	1.63

M = monthly; W = weekly; D = daily; flow = (GPD); FLOW = (MGD); pH = (SU); TM = Trace Metals (mg/L); SS = settleable solids (ml/L); FC = fecal coliform (#/100 ml); TNTC = too numerous to count; TRC = total residual chlorine (mg/L); BOD5 = 5 day biochemical oxygen demand (mg/L; * = lbs/day); TSS = total suspended solids (mg/L; * = lbs/day); LEAD = (mg/L).

Table D.2 - Continued

Facility	Constituent	Date	Permit Discharge	Limit	Measured Value
RHODE ISLAND					
Tupperware (Continued)	TSS	11/89	AVE M	30	37.5
	TSS	12/89	AVE M	30	120
	TSS	12/89	AVE W	45	120
	TSS	12/89	MAX D	50	120
	TSS*	12/89	AVE M	1.5	2.61
Woonsocket WWTF	FLOW	07/88	MAX D	16	16.19
	FLOW	08/88	MAX D	16	16.31
	FLOW	11/88	MAX D	16	21.58
	pH	05/88	AVE M	6 - 9	3.97
	pH	06/89	AVE M	6 - 9	5.44
	pH	07/89	AVE M	6 - 9	5.29
	pH	08/89	AVE M	6 - 9	4.99
	pH	09/89	AVE M	6 - 9	5.44
	pH	10/89	AVE M	6 - 9	4.45
	pH	12/89	AVE M	6 - 9	4.27
	SS	08/89	AVE W	0.1	1.0
	SS	08/89	AVE M	0.3	10.0
	SS	09/89	AVE W	0.1	0.16
	SS	09/89	AVE M	0.3	1.3
	SS	12/89	AVE W	0.1	1.0
	SS	12/89	AVE M	0.3	4.0
	FC	05/88	MAX D	400	601
	FC	06/88	MAX D	400	601
	FC	07/88	MAX D	400	601

M = monthly; W = weekly; D = daily; flow = (GPD); FLOW = (MGD); pH = (SU); TM = Trace Metals (mg/L); SS = settleable solids (ml/L); FC = fecal coliform (#/100 ml); TNTC = too numerous to count; TRC = total residual chlorine (mg/L); BOD5 = 5 day biochemical oxygen demand (mg/L; * = lbs/day); TSS = total suspended solids (mg/L; * = lbs/day).

Table D.2 - Continued

Facility	Constituent	Date	Permit Discharge	Permit Limit	Measured Value
RHODE ISLAND					
Woonsocket WWTF (Continued)	FC	08/88	MAX D	400	601
	FC	09/88	MAX D	400	601
	FC	10/88	MAX D	400	601
	FC	11/88	AVE W	400	601
	FC	11/88	MAX D	400	602
	FC	02/89	MAX D	400	601
	FC	04/89	MAX D	400	1,201
	FC	05/89	AVE M	200	72,780
	FC	05/89	AVE W	400	TNTC
	FC	05/89	MAX D	400	TNTC
	FC	06/89	AVE W	400	1,483
	FC	06/89	MAX D	400	11,000
	FC	07/89	AVE M	200	765.3
	FC	07/89	AVE W	400	61,972.4
	FC	07/89	MAX D	400	TNTC
	FC	08/89	MAX D	400	1,000
	FC	09/89	AVE M	200	1,241.6
	FC	09/89	AVE W	400	22,245
	FC	09/89	MAX D	400	TNTC
	FC	10/89	AVE W	400	605.9
	FC	10/89	MAX D	400	1,280
	FC	12/89	MAX D	400	420
	BOD5	01/88	AVE W	45	48
	BOD5	01/88	MAX D	50	82
	BOD5	05/88	AVE M	30	31.6
	BOD5	05/88	MAX D	50	67

M = monthly; W = weekly; D = daily; flow = (GPD); FLOW = (MGD); pH = (SU); TM = Trace Metals (mg/L); SS = settleable solids (ml/L); FC = fecal coliform (#/100 ml); TNTC = too numerous to count; TRC = total residual chlorine (mg/L); BOD5 = 5 day biochemical oxygen demand (mg/L; * = lbs/day); TSS = total suspended solids (mg/L; * = lbs/day).

Table D.2 - Continued

Facility	Constituent	Date	Permit Discharge	Permit Limit	Measured Value
RHODE ISLAND					
Woonsocket WWTF (Continued)	BOD5	06/88	MAX D	50	61
	BOD5	08/88	AVE M	30	42.7
	BOD5	08/88	AVE W	45	48.7
	BOD5	08/88	MAX D	50	79
	BOD5	09/88	AVE M	30	45.2
	BOD5	09/88	AVE W	45	60.7
	BOD5	09/88	MAX D	50	89
	BOD5	10/88	AVE M	30	37.1
	BOD5	10/88	AVE W	45	46
	BOD5	10/88	MAX D	50	83
	BOD5	11/88	AVE M	30	54
	BOD5	11/88	AVE W	45	65.7
	BOD5	11/88	MAX D	50	111
	BOD5	12/88	AVE M	30	45.5
	BOD5	12/88	AVE W	45	73.6
	BOD5	12/88	MAX D	50	94
	BOD5	01/89	AVE M	30	51
	BOD5	01/89	AVE W	45	84.6
	BOD5	01/89	MAX D	50	147
	BOD*	11/88	AVE M	4,000	4,939.1
	TSS	08/88	AVE M	30	50.4
	TSS	08/88	AVE W	45	67
	TSS	08/88	MAX D	50	83
	TSS	09/88	AVE M	30	72.3
	TSS	09/88	AVE W	45	108.3
	TSS	09/88	MAX D	50	132

M = monthly; W = weekly; D = daily; flow = (GPD); FLOW = (MGD); pH = (SU); TM = Trace Metals (mg/L); SS = settleable solids (ml/L); FC = fecal coliform (#/100 ml); TNTC = too numerous to count; TRC = total residual chlorine (mg/L); BOD5 = 5 day biochemical oxygen demand (mg/L; * = lbs/day); TSS = total suspended solids (mg/L; * = lbs/day).

Table D.2 - Continued

Facility	Constituent	Date	Permit Discharge	Permit Limit	Measured Value
RHODE ISLAND					
Woonsocket WWTF (Continued)	TSS	10/88	AVE M	30	33.6
	TSS	10/88	AVE W	45	51.1
	TSS	10/88	MAX D	50	64
	TSS	11/88	MAX D	50	68
	TSS	01/89	MAX D	50	75
	TSS	04/89	MAX D	50	56
	TSS	12/89	AVE M	30	32.8
	TSS	12/89	AVE W	45	45.8
	TSS	12/89	MAX D	50	83
	TSS*	09/88	AVE M	4,000	4,658.3
Zambarano Hospital	pH	12/88	AVE M	6 - 9	5.91
	FC	03/89	AVE M	200	6,928.2
	FC	03/89	AVE W	400	TNTC
	FC	03/89	MAX D	400	TNTC
	FC	04/89	AVE M	200	4,898.98
	FC	04/89	AVE W	400	TNTC
	FC	04/89	MAX D	400	TNTC
	FC	09/89	AVE M	200	4,899
	FC	09/89	AVE W	400	TNTC
	FC	09/89	MAX D	400	TNTC
	TRC	02/88	AVE W	2	2.09
	TRC	02/88	MAX D	2	7.5
	TRC	03/88	MAX D	2	4
	TRC	04/88	MAX D	2	2.25

M = monthly; W = weekly; D = daily; flow = (GPD); FLOW = (MGD); pH = (SU); TM = Trace Metals (mg/L); SS = settleable solids (ml/L); FC = fecal coliform (#/100 ml); TNTC = too numerous to count; TRC = total residual chlorine (mg/L); BOD5 = 5 day biochemical oxygen demand (mg/L; * = lbs/day); TSS = total suspended solids (mg/L; * = lbs/day).

Table D.2 - Continued

Facility	Constituent	Date	Permit Discharge	Limit	Measured Value
RHODE ISLAND					
Zambarano Hospital (Continued)	TRC	05/88	AVE W	2	2.15
	TRC	05/88	MAX D	2	4
	TRC	06/88	AVE W	2	2.07
	TRC	06/88	MAX D	2	5
	TRC	07/88	AVE W	2	3
	TRC	07/88	MAX D	2	5
	TRC	08/88	MAX D	2	5
	TRC	09/88	AVE W	2	4.936
	TRC	09/88	MAX D	2	10
	TRC	10/88	AVE W	2	3.95
	TRC	10/88	MAX D	2	4
	TRC	11/88	AVE W	2	2.65
	TRC	11/88	MAX D	2	4
	TRC	12/88	AVE W	2	3.22
	TRC	12/88	MAX D	2	10
	TRC	01/89	AVE W	2	2.1
	TRC	01/89	MAX D	2	5
	TRC	02/89	AVE W	2	4.4
	TRC	02/89	MAX D	2	7.5
	TRC	03/89	AVE W	2	4
	TRC	03/89	MAX D	2	8
	TRC	04/89	AVE W	2	5.21
	TRC	04/89	MAX D	2	7.5
	TRC	05/89	AVE W	2	4.55
	TRC	05/89	MAX D	2	10
	TRC	06/89	AVE M	2	10

M = monthly; W = weekly; D = daily; flow = (GPD); FLOW = (MGD); pH = (SU); TM = Trace Metals (mg/L); SS = settleable solids (ml/L); FC = fecal coliform (#/100 ml); TNTC = too numerous to count; TRC = total residual chlorine (mg/L); BOD5 = 5 day biochemical oxygen demand (mg/L; * = lbs/day); TSS = total suspended solids (mg/L; * = lbs/day).

Table D.2 - Continued

Facility	Constituent	Date	Permit Discharge	Permit Limit	Measured Value
RHODE ISLAND					
Zambarano Hospital (Continued)	TRC	06/89	AVE W	2	3.5
	TRC	06/89	MAX D	2	6
	TRC	07/89	AVE W	2	3.9
	TRC	07/89	MAX D	2	7.5
	TRC	08/89	AVE W	2	3.6
	TRC	08/88	MAX D	2	10
	TRC	09/88	AVE W	2	3.07
	TRC	09/88	MAX D	2	8
	TRC	10/89	AVE W	2	5.2
	TRC	10/89	MAX D	2	10
	TRC	11/89	AVE W	2	6.3
	TRC	11/89	MAX D	2	10
	TRC	12/89	AVE W	2	3.4
	TRC	12/89	MAX D	2	7.5
	TSS	12/88	AVE M	60	110
	TSS*	12/88	AVE M	60	87.2

M = monthly; W = weekly; D = daily; flow = (GPD); FLOW = (MGD); pH = (SU); TM = Trace Metals (mg/L); SS = settleable solids (ml/L); FC = fecal coliform (#/100 ml); TNTC = too numerous to count; TRC = total residual chlorine (mg/L); BOD5 = 5 day biochemical oxygen demand (mg/L; * = lbs/day); TSS = total suspended solids (mg/L; * = lbs/day).

Table D.2 - Continued

Facility	Constituent	Date	Permit Discharge	Permit Limit	Measured Value
RHODE ISLAND					
Blackstone Valley District Commission WWTF	TSS	01/88	AVE M	30	103.3
	TSS	01/88	AVE W	45	147.0
	TSS	01/88	MAX D	50	320.0
	TSS	02/88	AVE M	30	53.3
	TSS	02/88	AVE W	45	63.0
	TSS	02/88	MAX D	50	176.0
	TSS	03/88	AVE M	30	52.1
	TSS	03/88	AVE W	45	57.6
	TSS	03/88	MAX D	50	256.0
	TSS	04/88	AVE M	30	78.2
	TSS	04/88	AVE W	45	235.4
	TSS	04/88	MAX D	50	607.0
	TSS	05/88	AVE M	30	39.4
	TSS	05/88	AVE W	45	70.3
	TSS	05/88	MAX D	50	170.0
	TSS	06/88	AVE M	30	51.3
	TSS	06/88	AVE W	45	78.0
	TSS	06/88	MAX D	50	156.0
	TSS	07/88	AVE M	30	63.0
	TSS	07/88	AVE W	45	172.0
	TSS	07/88	MAX D	50	587.0
	TSS	08/88	AVE M	30	37.9
	TSS	08/88	AVE W	45	65.0
	TSS	08/88	MAX D	50	96.0
	TSS	09/88	AVE M	30	79.5
	TSS	09/88	AVE W	45	222.1
	TSS	09/88	MAX D	50	1261.0

M = monthly; W = weekly; D = daily; flow = (GPD); FLOW = (MGD); pH = (SU); TM = Trace Metals (mg/L); SS = settleable solids (ml/L); FC = fecal coliform (#/100 ml); TNTC = too numerous to count; TRC = total residual chlorine (mg/L); BOD5 = 5 day biochemical oxygen demand (mg/L; * = lbs/day); TSS = total suspended solids (mg/L; * = lbs/day); LEAD = (mg/L).

Table D.2 - Continued

Facility	Constituent	Date	Permit Discharge	Permit Limit	Measured Value
RHODE ISLAND					
Blackstone Valley District Commission WWTF (Continued)	TSS	10/88	AVE M	30	56.2
	TSS	10/88	AVE W	45	79.7
	TSS	10/88	MAX D	50	212.0
	TSS	11/88	AVE M	30	132.5
	TSS	11/88	AVE W	45	313.6
	TSS	11/88	MAX D	50	1994.0
	TSS	12/88	AVE M	30	78.9
	TSS	12/88	AVE W	45	112.4
	TSS	12/88	MAX D	50	240.0
	TSS	01/89	MAX D	50	91.0
	TSS	02/89	AVE M	30	45.6
	TSS	02/89	AVE W	45	90.0
	TSS	02/89	MAX D	50	224.0
	TSS	03/89	AVE M	30	80.8
	TSS	03/89	AVE W	45	218.4
	TSS	03/89	MAX D	50	1020.0
	TSS	04/89	AVE M	30	92.4
	TSS	04/89	AVE W	45	175.9
	TSS	04/89	MAX D	50	534.0
	TSS	05/89	AVE M	30	131.3
	TSS	05/89	AVE W	45	280.4
	TSS	05/89	MAX D	50	1594.0
	TSS	06/89	AVE M	30	102.1
	TSS	06/89	AVE W	45	244.0
	TSS	06/89	MAX D	50	627.0
	TSS	07/89	AVE M	30	92.0
	TSS	07/89	AVE W	45	152.3

M = monthly; W = weekly; D = daily; flow = (GPD); FLOW = (MGD); pH = (SU); TM = Trace Metals (mg/L); SS = settleable solids (ml/L); FC = fecal coliform (#/100 ml); TNTC = too numerous to count; TRC = total residual chlorine (mg/L); BOD5 = 5 day biochemical oxygen demand (mg/L; * = lbs/day); TSS = total suspended solids (mg/L; * = lbs/day); LEAD = (mg/L).

Table D.2 - Continued

Facility	Constituent	Date	Permit Discharge	Permit Limit	Measured Value
RHODE ISLAND					
Blackstone Valley District Commission WWTF (Continued)	TSS	07/89	MAX D	50	647.0
	TSS	08/89	AVE M	30	132.6
	TSS	08/89	AVE W	45	240.0
	TSS	08/89	MAX D	50	1230.0
	TSS	09/89	AVE M	30	80.7
	TSS	09/89	AVE W	45	152.7
	TSS	09/89	MAX D	50	747.0
	TSS	10/89	AVE M	30	44.5
	TSS	10/89	AVE W	45	96.3
	TSS	10/89	MAX D	50	284.0
	TSS	11/89	AVE M	30	51.4
	TSS	11/89	AVE W	45	64.0
	TSS	11/89	MAX D	50	118.0
	TSS	12/89	MAX D	50	68.0
	TSS	01/88	AVE M	7760	20108
	TSS	02/89	AVE M	7760	11735
	TSS	03/89	AVE M	7760	10372
	TSS	04/89	AVE M	7760	14994
	TSS	06/89	AVE M	7760	9036
	TSS	07/89	AVE M	7760	11181
	BOD5	01/88	AVE M	30	87.7
	BOD5	01/88	AVE W	45	126.0
	BOD5	01/88	MAX D	50	191.0
	BOD5	02/88	AVE M	30	57.1
	BOD5	02/88	AVE W	45	69.0
	BOD5	02/88	MAX D	50	102.0
	BOD5	03/88	AVE M	30	61.7

M = monthly; W = weekly; D = daily; flow = (GPD); FLOW = (MGD); pH = (SU); TM = Trace Metals (mg/L); SS = settleable solids (ml/L); FC = fecal coliform (#/100 ml); TNTC = too numerous to count; TRC = total residual chlorine (mg/L); BOD5 = 5 day biochemical oxygen demand (mg/L; * = lbs/day); TSS = total suspended solids (mg/L; * = lbs/day); LEAD = (mg/L).

Table D.2 - Continued

Facility	Constituent	Date	Permit Discharge	Permit Limit	Measured Value
RHODE ISLAND					
Blackstone Valley District Commission WWTF (Continued)	BOD5	03/88	AVE W	45	80.0
	BOD5	03/88	MAX D	50	144.0
	BOD5	04/88	AVE M	30	60.8
	BOD5	04/88	AVE W	45	109.3
	BOD5	04/88	MAX D	50	169.0
	BOD5	05/88	AVE M	30	44.9
	BOD5	05/88	MAX D	50	144.0
	BOD5	06/88	AVE M	30	45.0
	BOD5	06/88	AVE W	45	69.0
	BOD5	06/88	MAX D	50	158.0
	BOD5	07/88	AVE M	30	53.0
	BOD5	07/88	AVE W	45	88.4
	BOD5	07/88	MAX D	50	196.0
	BOD5	08/88	AVE M	30	44.1
	BOD5	08/88	AVE W	45	59.1
	BOD5	08/88	MAX D	50	119.0
	BOD5	09/88	AVE M	30	45.1
	BOD5	09/88	AVE W	45	58.1
	BOD5	09/88	MAX D	50	178.0
	BOD5	10/88	AVE M	30	44.0
	BOD5	10/88	AVE W	45	52.9
	BOD5	10/88	MAX D	50	108.0
	BOD5	11/88	AVE M	30	78.0
	BOD5	11/88	AVE W	45	127.0
	BOD5	11/88	MAX D	50	599.0
	BOD5	12/88	AVE M	30	68.3
	BOD5	12/88	AVE W	45	79.7

M = monthly; W = weekly; D = daily; flow = (GPD); FLOW = (MGD); pH = (SU); TM = Trace Metals (mg/L); SS = settleable solids (ml/L); FC = fecal coliform (#/100 ml); TNTC = too numerous to count; TRC = total residual chlorine (mg/L); BOD5 = 5 day biochemical oxygen demand (mg/L; * = lbs/day); TSS = total suspended solids (mg/L; * = lbs/day); LEAD = (mg/L).

Table D.2 -- Continued

Facility	Constituent	Date	Permit Discharge	Permit Limit	Measured Value
RHODE ISLAND					
Blackstone Valley District Commission WWTF (Continued)	BOD5	12/88	MAX D	50	174.0
	BOD5	01/89	AVE M	30	48.0
	BOD5	01/89	AVE W	45	56.9
	BOD5	01/89	MAX D	50	102.0
	BOD5	02/89	AVE M	30	47.9
	BOD5	02/89	AVE W	45	62.9
	BOD5	02/89	MAX D	50	134.0
	BOD5	03/89	AVE M	30	73.0
	BOD5	03/89	AVE W	45	164.9
	BOD5	03/89	MAX D	50	472.0
	BOD5	04/89	AVE M	30	60.3
	BOD5	04/89	AVE W	45	86.4
	BOD5	04/89	MAX D	50	30.9
	BOD5	05/89	AVE M	30	60.5
	BOD5	05/89	AVE W	45	117.3
	BOD5	05/89	MAX D	50	605.0
	BOD5	06/89	AVE M	30	84.7
	BOD5	06/89	AVE W	45	208.0
	BOD5	06/89	MAX D	50	852.0
	BOD5	07/89	AVE M	30	47.6
	BOD5	07/89	AVE W	45	76.0
	BOD5	07/89	MAX D	50	293.0
	BOD5	08/89	AVE M	30	81.6
	BOD5	08/89	AVE W	45	136.7
	BOD5	08/89	MAX D	50	508.0
	BOD5	09/89	AVE M	30	61.0
	BOD5	09/89	AVE W	45	77.7

M = monthly; W = weekly; D = daily; flow = (GPD); FLOW = (MGD); pH = (SU); TM = Trace Metals (mg/L); SS = settleable solids (ml/L); FC = fecal coliform (#/100 ml); TNTC = too numerous to count; TRC = total residual chlorine (mg/L); BOD5 = 5 day biochemical oxygen demand (mg/L; * = lbs/day); TSS = total suspended solids (mg/L; * = lbs/day); LEAD = (mg/L).

Table D.2 - Continued

Facility	Constituent	Date	Permit Discharge	Permit Limit	Measured Value
RHODE ISLAND					
Blackstone Valley District Commission WWTF (Continued)	BOD5	09/89	MAX D	50	331.0
	BOD5	10/89	AVE M	30	48.6
	BOD5	10/89	AVE W	45	75.6
	BOD5	10/89	MAX D	50	139.0
	BOD5	11/89	AVE M	30	83.5
	BOD5	11/89	AVE W	45	93.0
	BOD5	11/89	MAX D	50	152.0
	BOD5	12/89	AVE M	30	37.3
	BOD5	12/89	MAX D	50	63.0
	BOD5	01/88	AVE M	7760	17071
	BOD5	02/89	AVE M	7760	12572
	BOD5	03/89	AVE M	7760	12283
	BOD5	04/89	AVE M	7760	11658
	BOD5	05/89	AVE M	7760	8804
	BOD5	06/89	AVE M	7760	7926
	BOD5	07/89	AVE M	7760	9406
	SS	01/88	AVE M	0.1	9.0
	SS	01/88	AVE W	0.1	103.3
	SS	01/88	MAX D	0.3	147.0
	SS	02/88	MAX D	0.3	1.6
	SS	03/88	AVE M	0.1	1.32
	SS	03/88	AVE W	0.1	5.59
	SS	03/88	MAX D	0.3	1.5
	SS	04/88	AVE W	0.1	0.26
	SS	04/88	MAX D	0.3	32.0
	SS	06/88	MAX D	0.3	2.0
	SS	07/88	AVE M	0.1	0.98

M = monthly; W = weekly; D = daily; flow = (GPD); FLOW = (MGD); pH = (SU); TM = Trace Metals (mg/L); SS = settleable solids (ml/L); FC = fecal coliform (#/100 ml); TNTC = too numerous to count; TRC = total residual chlorine (mg/L); BOD5 = 5 day biochemical oxygen demand (mg/L; * = lbs/day); TSS = total suspended solids (mg/L; * = lbs/day); LEAD = (mg/L).

Table D.2 - Continued

Facility	Constituent	Date	Permit Discharge	Limit	Measured Value
RHODE ISLAND					
Blackstone Valley District Commission WWTF (Continued)	SS	07/88	AVE W	0.1	4.09
	SS	07/88	MAX D	0.3	20.05
	SS	08/88	AVE M	0.1	0.45
	SS	08/88	AVE W	0.1	0.17
	SS	08/88	MAX D	0.3	1.2
	SS	09/88	AVE W	0.1	0.17
	SS	09/88	MAX D	0.3	1.7
	SS	10/88	AVE M	0.1	1.04
	SS	10/88	AVE W	0.1	2.46
	SS	10/88	MAX D	0.3	33.0
	SS	11/88	AVE M	0.1	1.51
	SS	11/88	AVE W	0.1	10.97
	SS	11/88	MAX D	0.3	51.0
	SS	12/88	AVE M	0.1	2.11
	SS	12/88	AVE W	0.1	1.18
	SS	12/88	MAX D	0.3	100.0
	SS	01/89	AVE M	0.1	1.63
	SS	01/89	AVE W	0.1	14.31
	SS	01/89	MAX D	0.3	100.0
	SS	02/89	AVE M	0.1	12.71
	SS	02/89	AVE W	0.1	38.6
	SS	02/89	MAX D	0.3	425.0
	SS	03/89	AVE M	0.1	3.4
	SS	03/89	AVE W	0.1	15.4
	SS	03/89	MAX D	0.3	200.0
	SS	04/89	AVE M	0.1	1.68
	SS	04/89	AVE W	0.1	2.84

M = monthly; W = weekly; D = daily; flow = (GPD); FLOW = (MGD); pH = (SU); TM = Trace Metals (mg/L); SS = settleable solids (ml/L); FC = fecal coliform (#/100 ml); TNTC = too numerous to count; TRC = total residual chlorine (mg/L); BOD5 = 5 day biochemical oxygen demand (mg/L; * = lbs/day); TSS = total suspended solids (mg/L; * = lbs/day); LEAD = (mg/L).

Table D.2 - Continued

Facility	Constituent	Date	Permit Discharge	Permit Limit	Measured Value
RHODE ISLAND					
Blackstone Valley District Commission WWTF (Continued)	SS	04/89	MAX D	0.3	40.0
	SS	05/89	AVE M	0.1	1.32
	SS	05/89	AVE W	0.1	10.06
	SS	05/89	MAX D	0.3	18.0
	SS	06/89	AVE M	0.1	0.11
	SS	06/89	AVE W	0.1	0.6
	SS	06/89	MAX D	0.3	2.5
	SS	07/89	AVE M	0.1	0.38
	SS	07/89	AVE W	0.1	2.45
	SS	07/89	MAX D	0.3	16.0
	SS	08/89	AVE M	0.1	0.68
	SS	08/89	AVE W	0.1	3.78
	SS	08/89	MAX D	0.3	29.0
	SS	09/89	AVE M	0.1	2.72
	SS	09/89	AVE W	0.1	6.48
	SS	09/89	MAX D	0.3	90.0
	SS	10/89	MAX D	0.3	0.5
	SS	11/89	MAX D	0.3	2.2
	SS	12/89	MAX D	0.3	0.4
	FC	01/88	MAX D	400	23000
	FC	02/88	MAX D	400	2300
	FC	03/88	MAX D	400	23000
	FC	04/88	AVE W	400	2300
	FC	04/88	MAX D	400	TNTC
	FC	05/88	AVE W	400	857
	FC	05/88	MAX D	400	230000
	FC	06/88	MAX D	400	23000

M = monthly; W = weekly; D = daily; flow = (GPD); FLOW = (MGD); pH = (SU); TM = Trace Metals (mg/L); SS = settleable solids (ml/L); FC = fecal coliform (#/100 ml); TNTC = too numerous to count; TRC = total residual chlorine (mg/L); BOD5 = 5 day biochemical oxygen demand (mg/L; * = lbs/day); TSS = total suspended solids (mg/L; * = lbs/day); LEAD = (mg/L).

Table D.2 - Continued

Facility	Constituent	Date	Permit Discharge	Permit Limit	Measured Value
RHODE ISLAND					
Blackstone Valley District Commission WWTF (Continued)	FC	07/88	MAX D	400	230000
	FC	08/88	AVE W	400	857
	FC	08/88	MAX D	400	23000
	FC	09/88	AVE W	400	444
	FC	09/88	MAX D	400	23000
	FC	10/88	AVE W	400	444
	FC	10/88	MAX D	400	2300
	FC	01/89	MAX D	400	2300
	FC	02/89	MAX D	400	230000
	FC	03/89	MAX D	400	2300
	FC	04/89	MAX D	400	230000
	FC	05/89	AVE W	400	617
	FC	05/89	MAX D	400	230000
	FC	06/89	MAX D	400	230000
	FC	07/89	AVE W	400	1191
	FC	07/89	MAX D	400	23000
	FC	08/89	AVE W	400	857
	FC	08/89	MAX D	400	TNTC
	FC	09/89	AVE M	200	230
	FC	09/89	MAX D	400	2300
	FC	10/89	MAX D	400	TNTC
	FC	11/89	AVE W	400	4444
	FC	11/89	MAX D	400	2300
	FC	12/89	MAX D	400	2300

M = monthly; W = weekly; D = daily; flow = (GPD); FLOW = (MGD); pH = (SU); TM = Trace Metals (mg/L); SS = settleable solids (ml/L); FC = fecal coliform (#/100 ml); TNTC = too numerous to count; TRC = total residual chlorine (mg/L); BOD5 = 5 day biochemical oxygen demand (mg/L; * = lbs/day); TSS = total suspended solids (mg/L; * = lbs/day); LEAD = (mg/L).

APPENDIX E

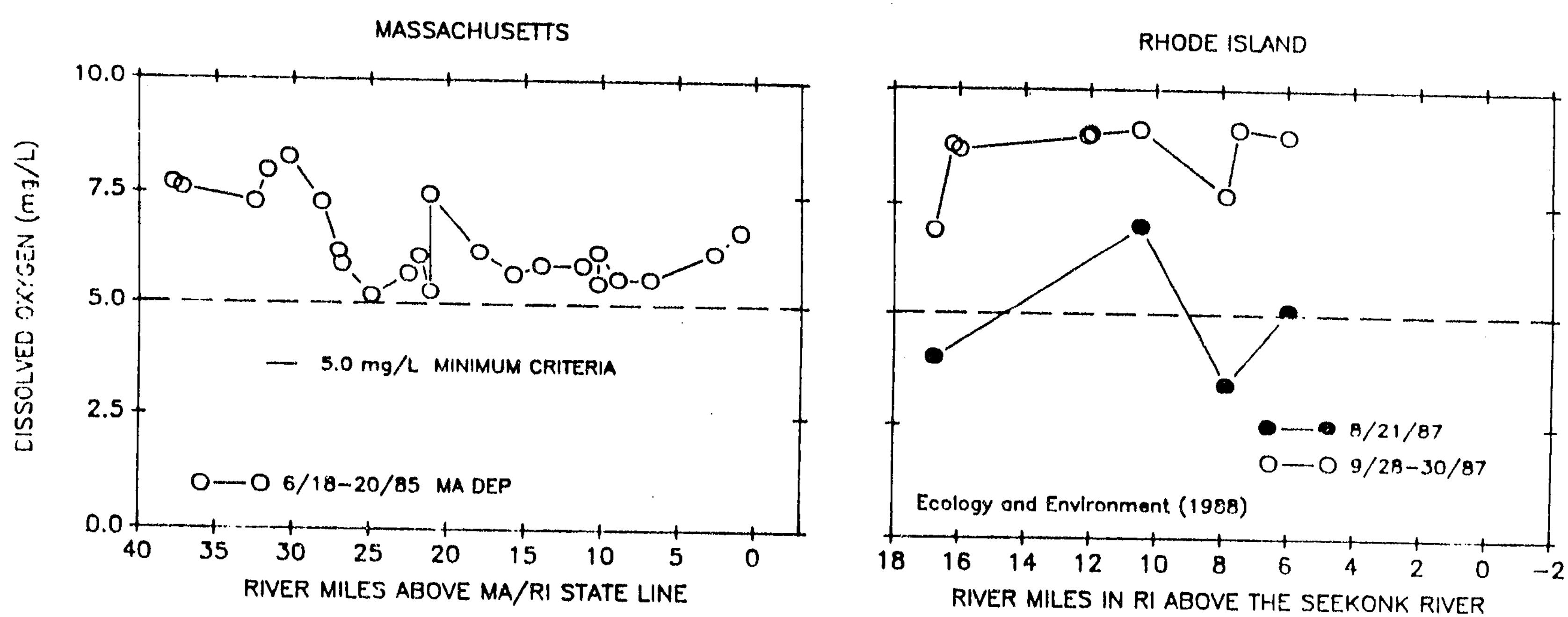


Figure E.1 Actual Steady State Dissolved Oxygen Profiles in the Blackstone River from Worcester MA, to above Central Falls, RI

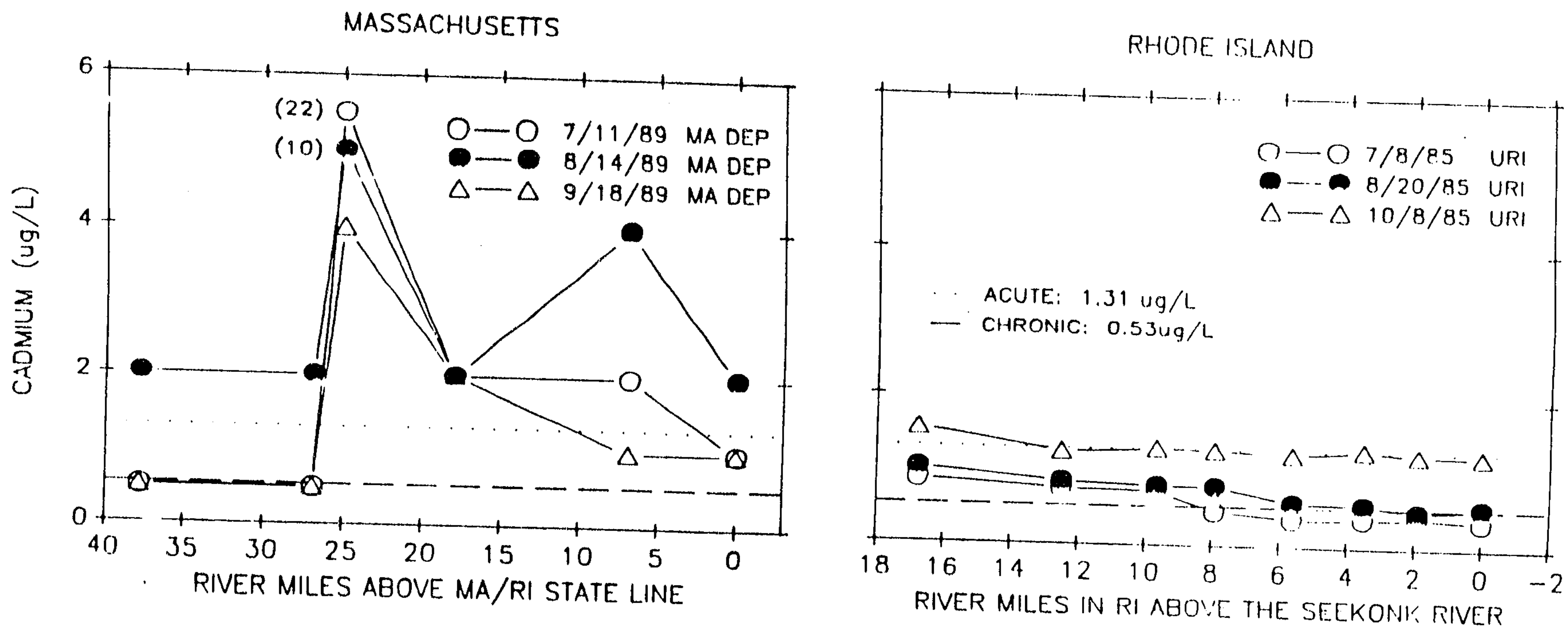


Figure E.2 Actual Steady State Cadmium Profiles in the Blackstone River from Worcester MA, to Pawtucket, RI

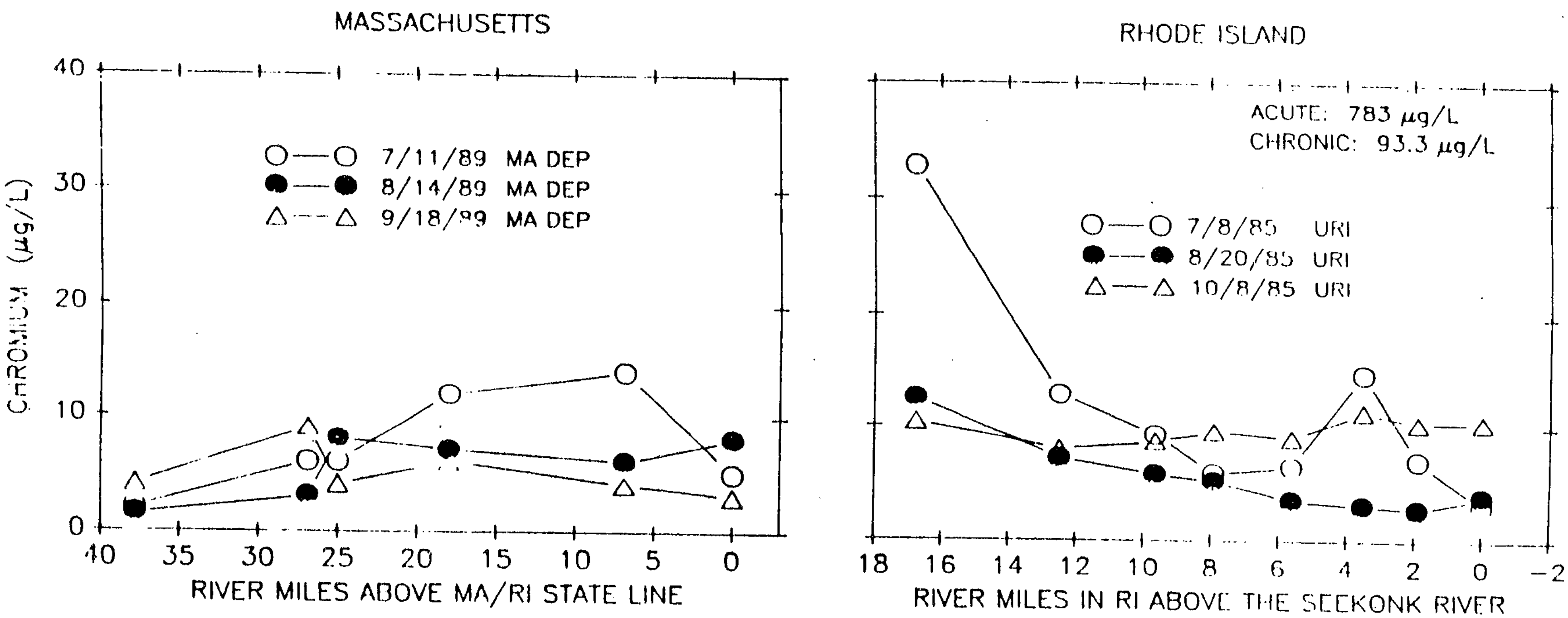


Figure E.3 Actual Steady State Chromium Profiles in the Blackstone River from Worcester MA, to Pawtucket, RI

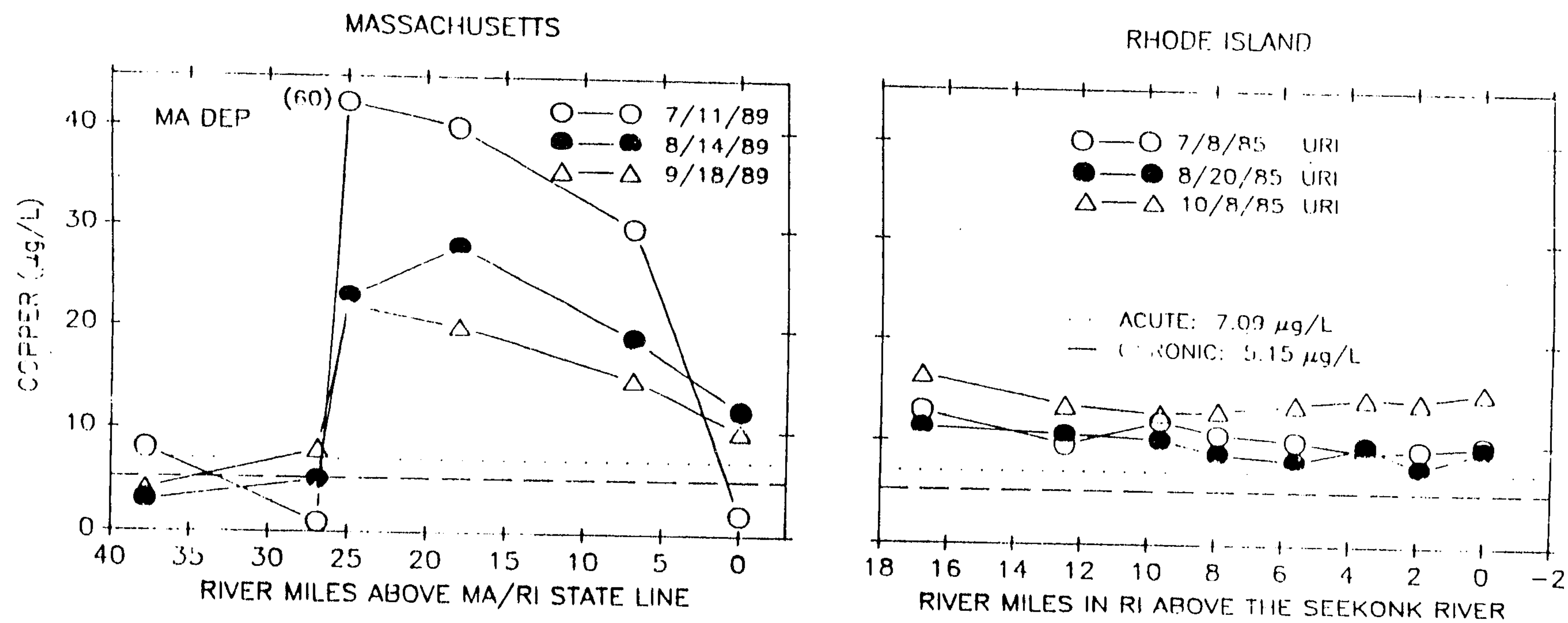


Figure E.4 Actual Steady State Copper Profiles in the Blackstone River from Worcester MA, to Pawtucket, RI

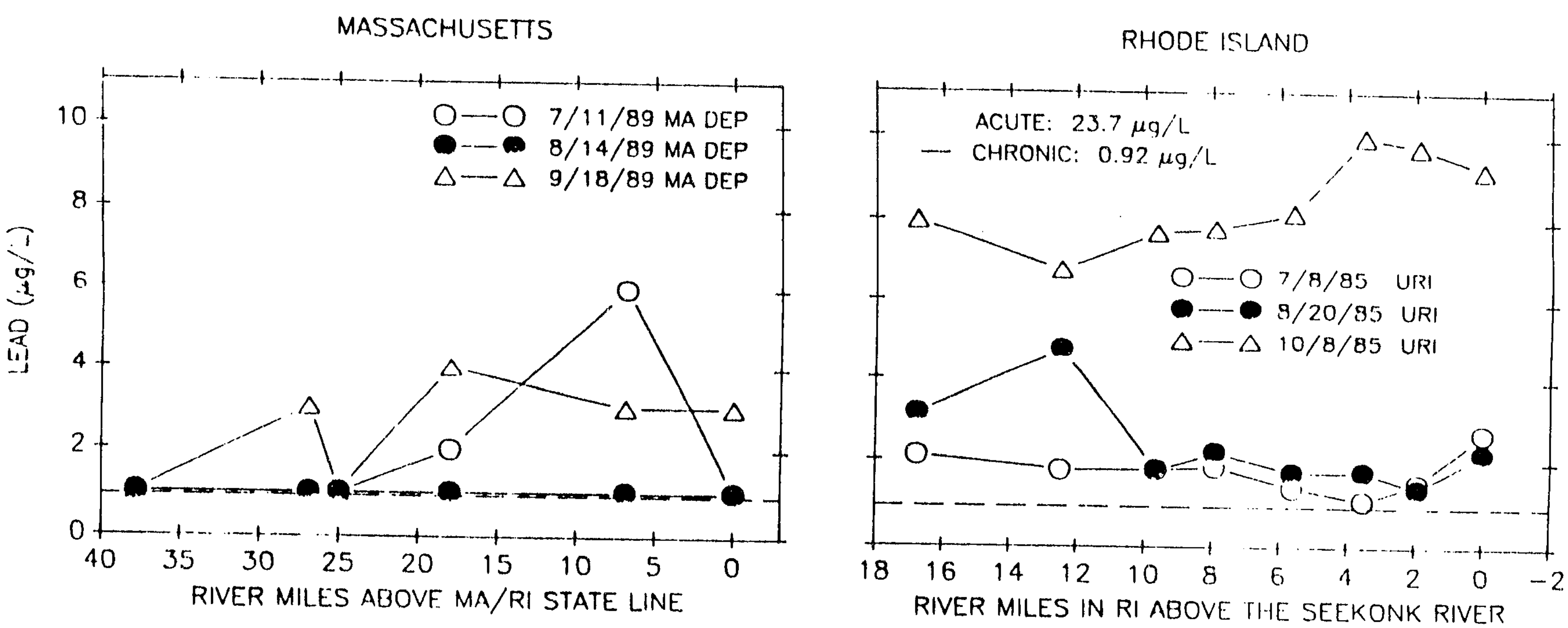


Figure E.5 Actual Steady State Lead Profiles in the Blackstone River from Worcester MA, to Pawtucket, RI

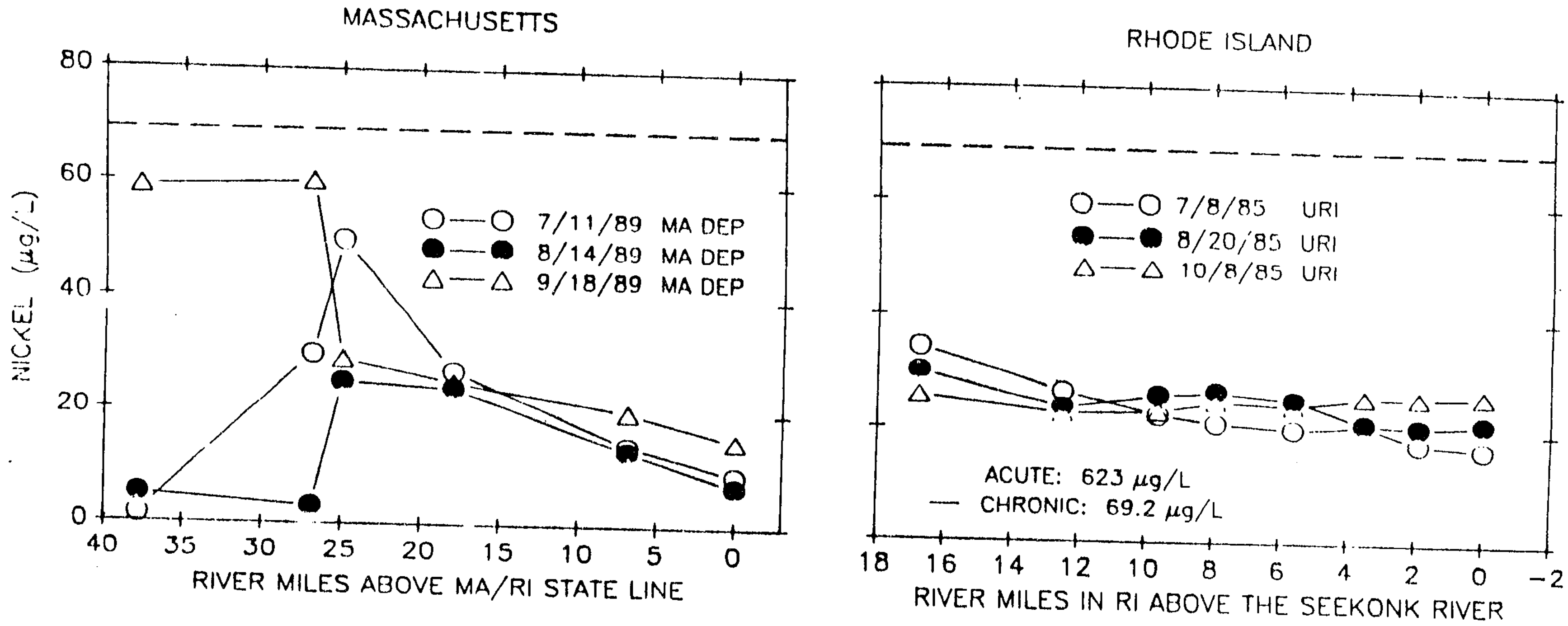


Figure E.6 Actual Steady State Nickel Profiles in the Blackstone River from Worcester MA, to Pawtucket, RI

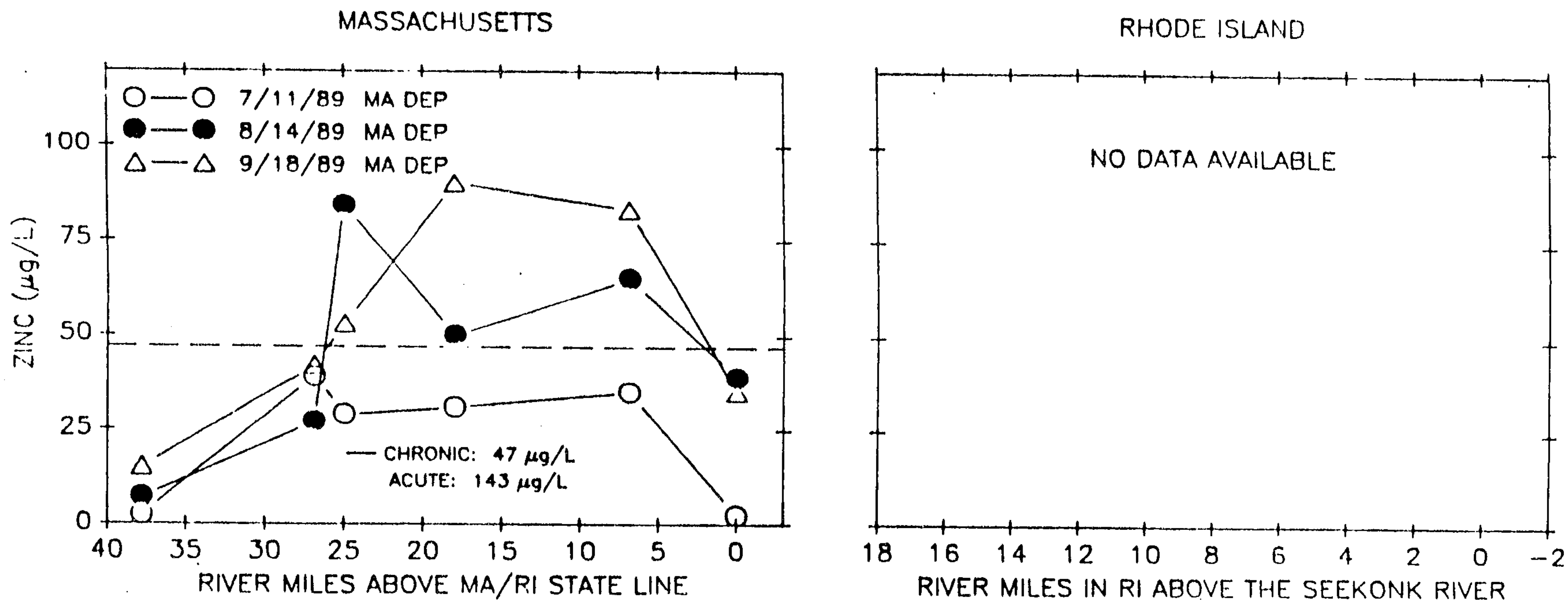


Figure E.7 Actual Steady State Zinc in the Blackstone River from Worcester MA, to RI/MA State Line (BRSL)

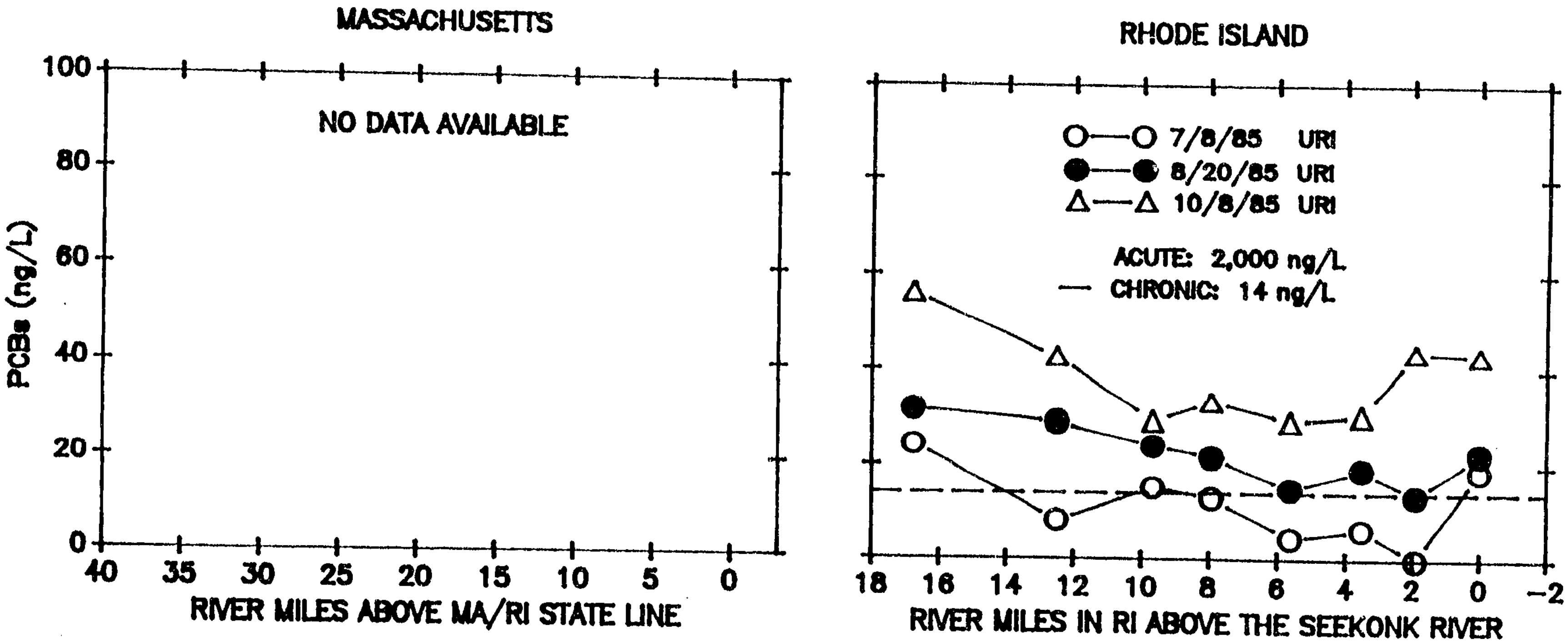


Figure E.7A Actual Steady State PCB Profiles in the Blackstone River from RI/MA State Line (BRSL) to Pawtucket, RI

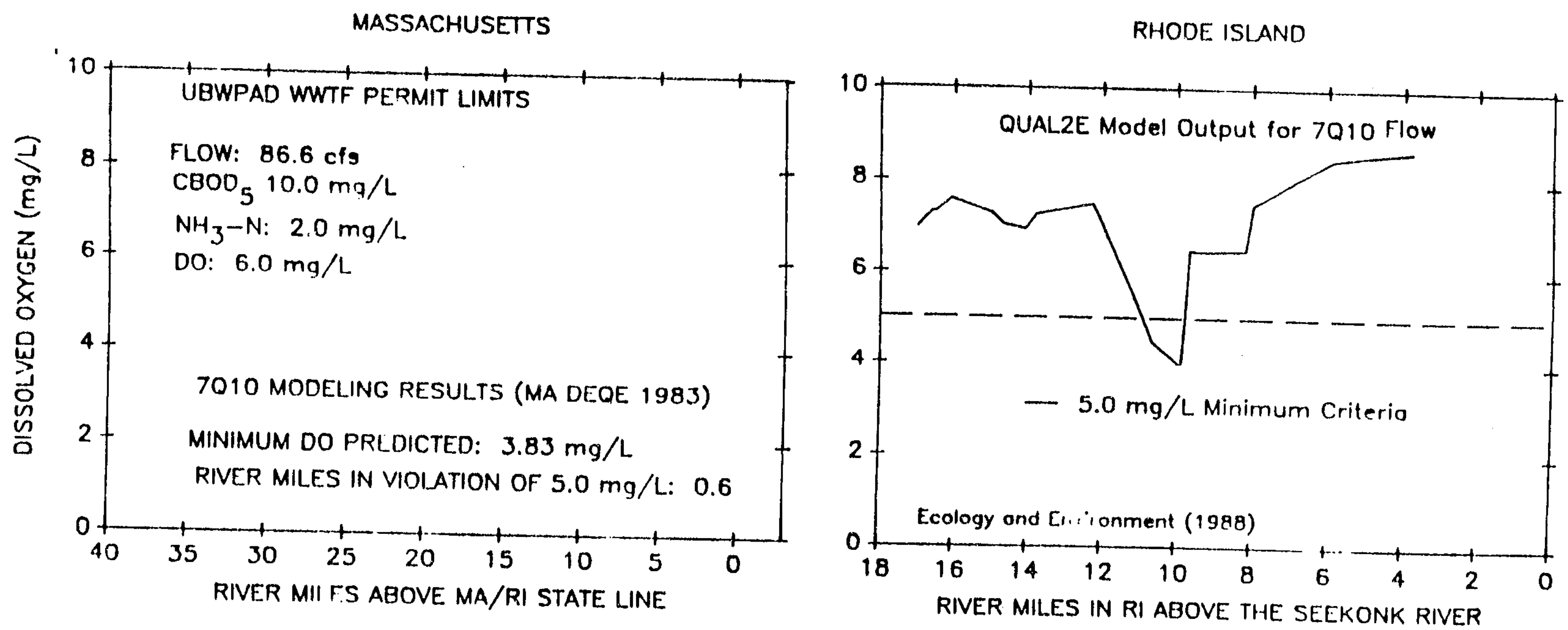


Figure E.8 Predicted Steady State Dissolved Oxygen Profiles in the Blackstone River for 7Q10 Flows

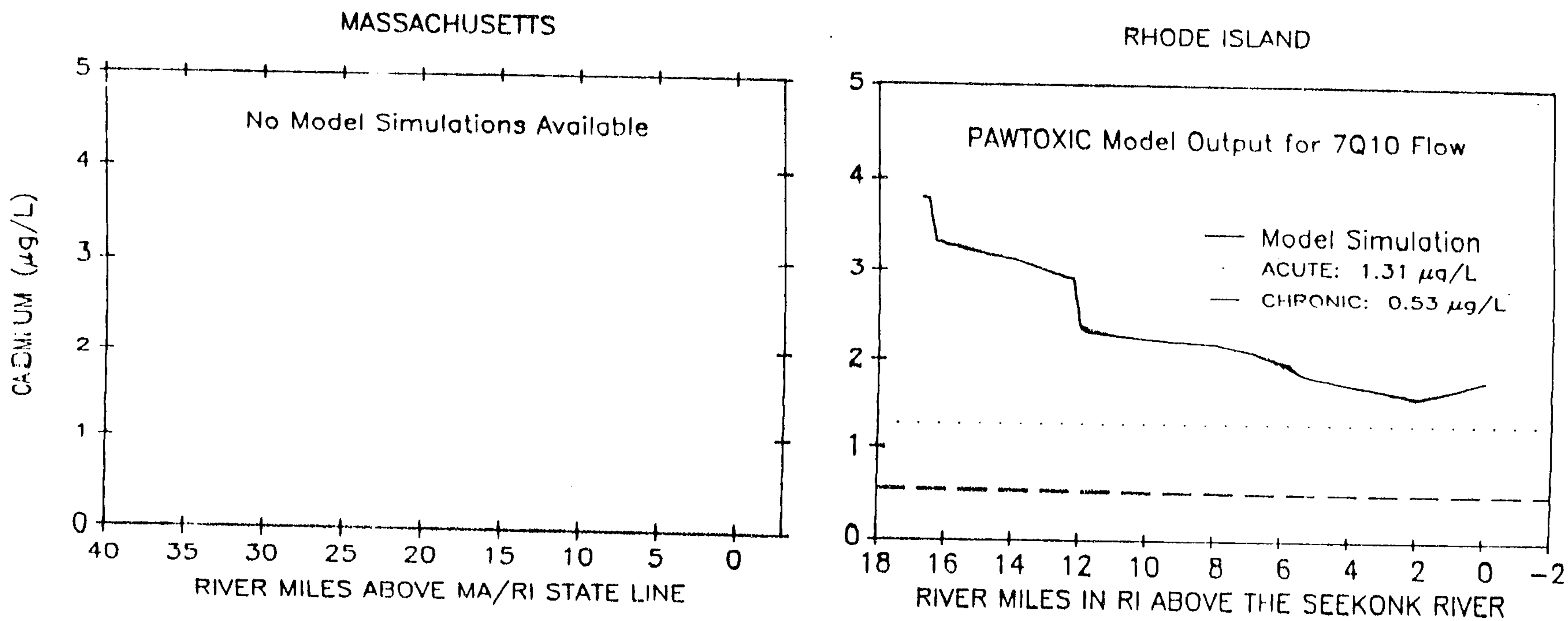


Figure E.9 Predicted Steady State Cadmium Profiles in the Blackstone River for 7Q10 Flows

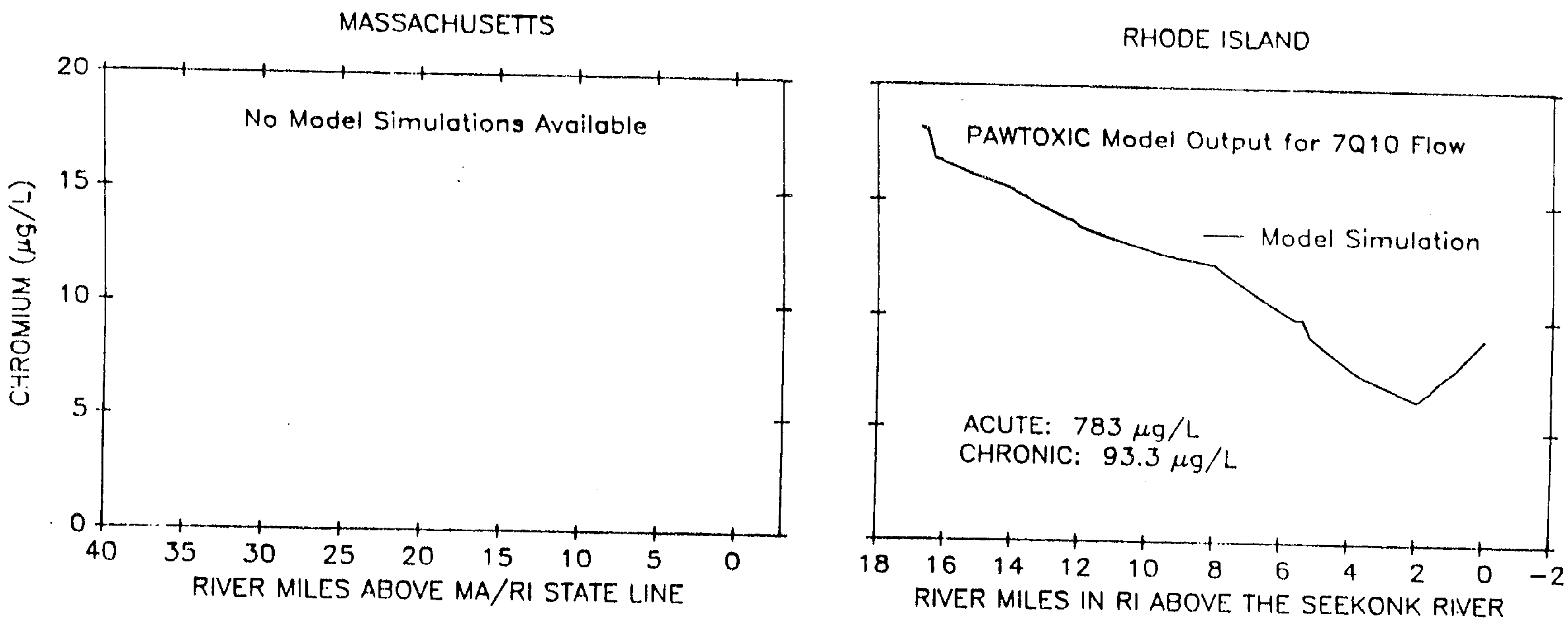


Figure E.10 Predicted Steady State Chromium Profiles in the Blackstone River for 7Q10 Flows

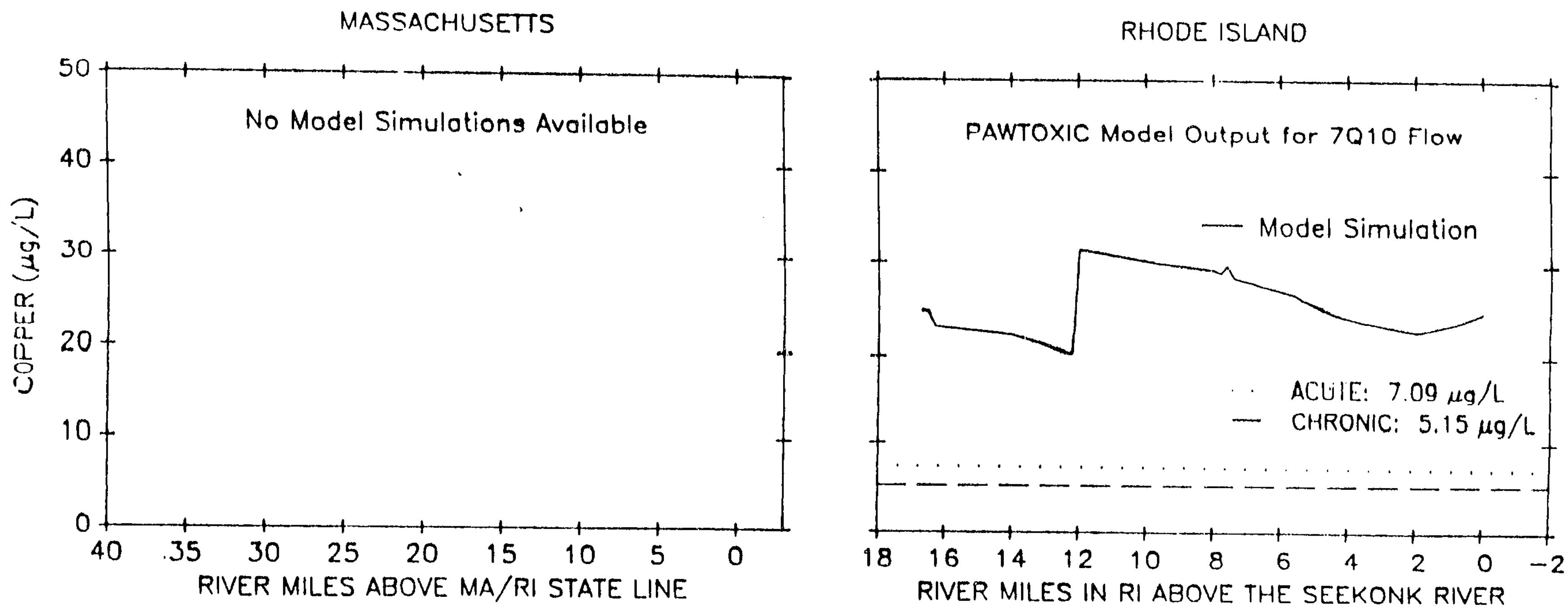


Figure E.11 Predicted Steady State Copper Profiles in the Blackstone River for 7Q10 Flows

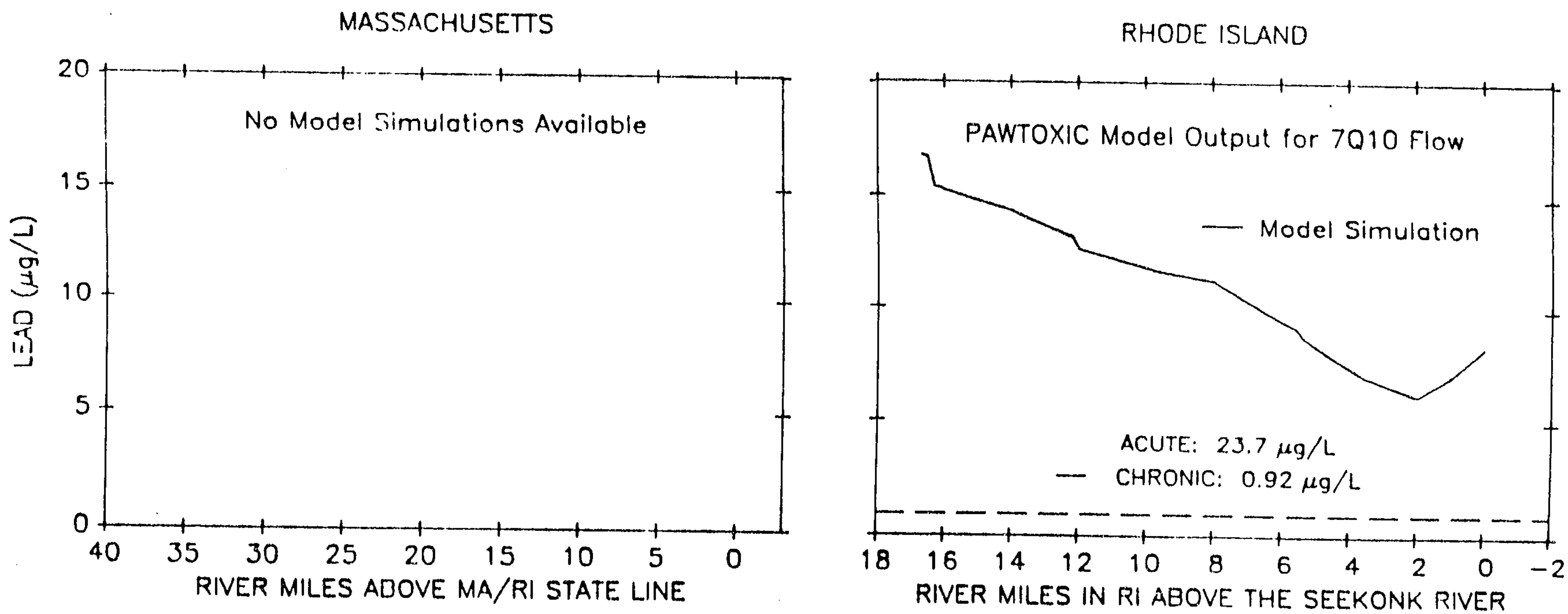


Figure E.12 Predicted Steady State Lead Profiles in the Blackstone River for 7Q10 Flows

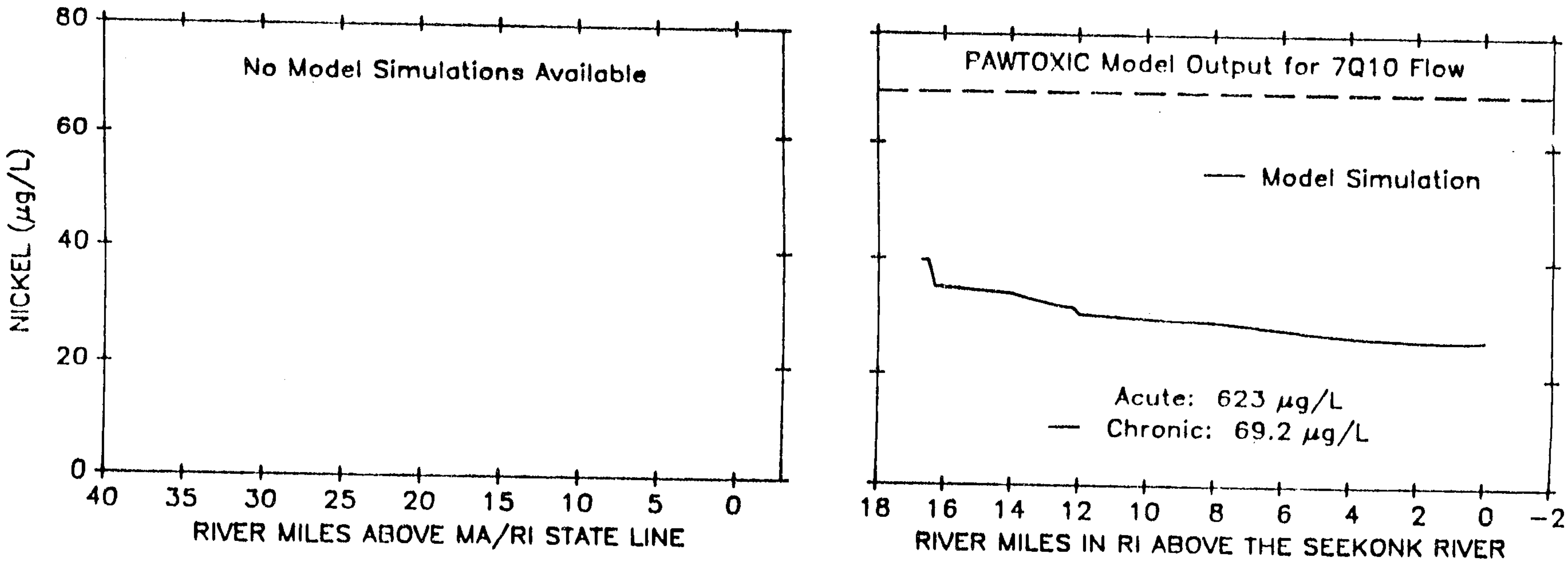


Figure E.13 Predicted Steady State Nickel Profiles in the Blackstone River for 7Q10 Flows

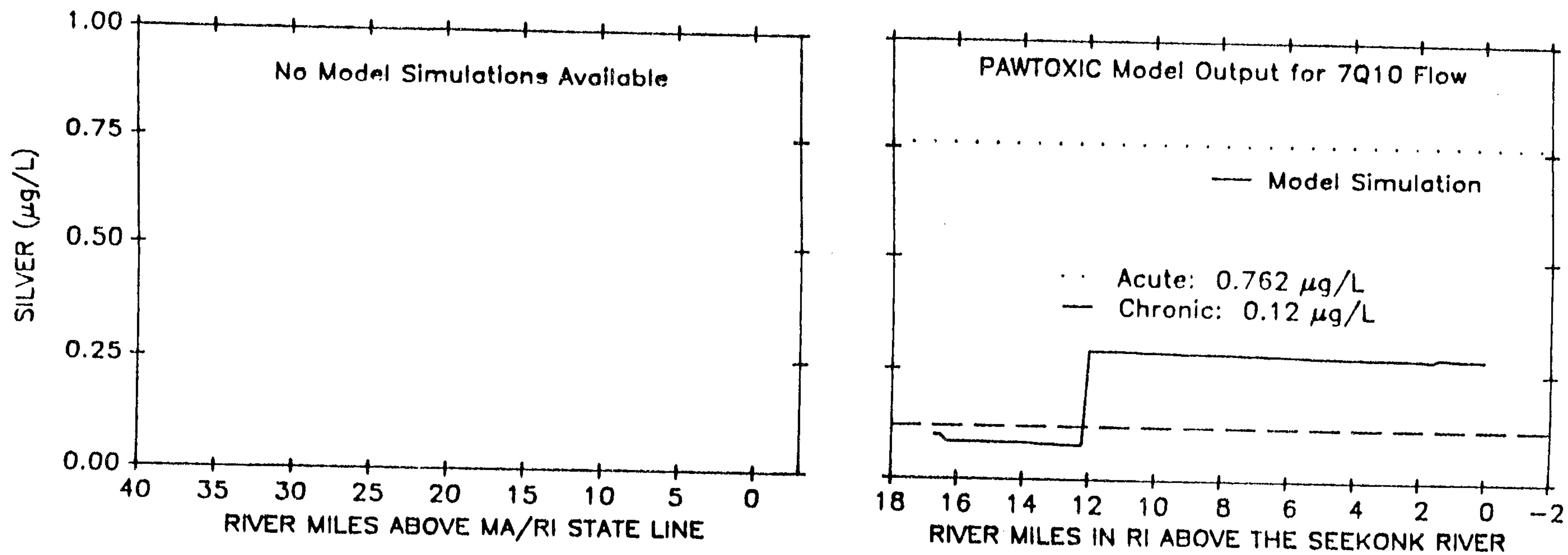


Figure E.14 Predicted Steady State Silver Profiles in the Blackstone River for 7Q10 Flows

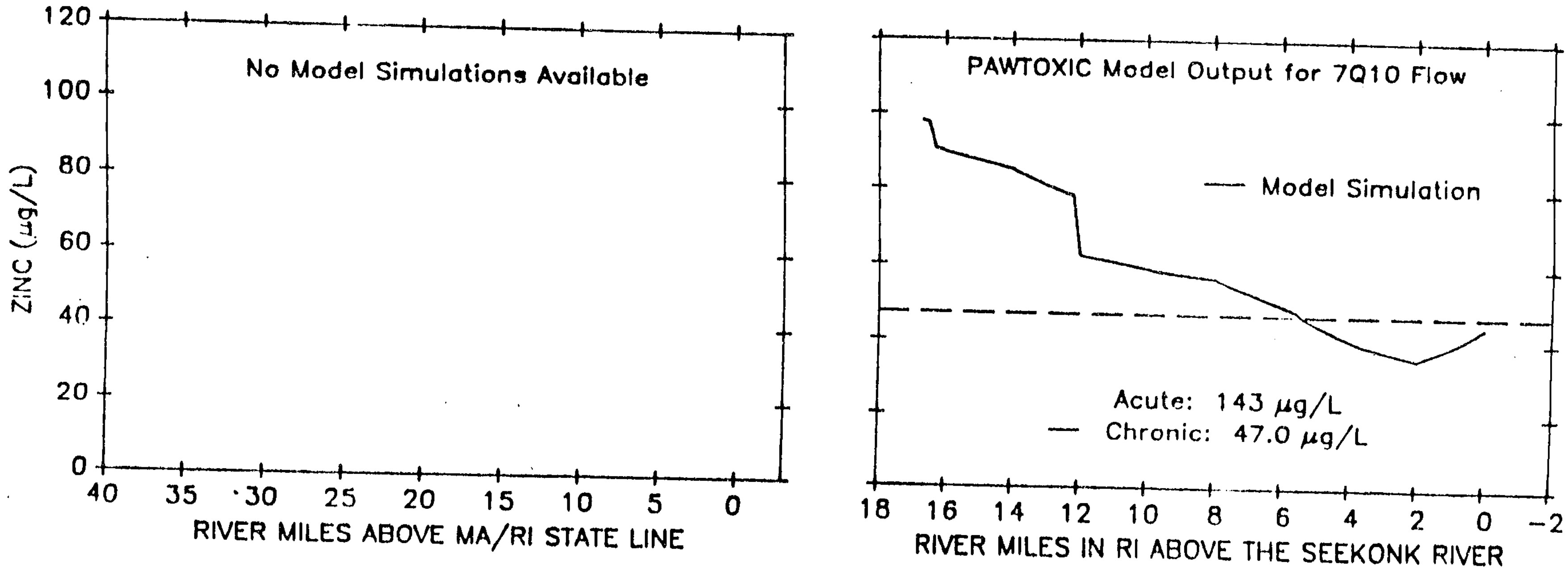


Figure E.15 Predicted Steady State Zinc Profiles in the Blackstone River for 7Q10 Flows

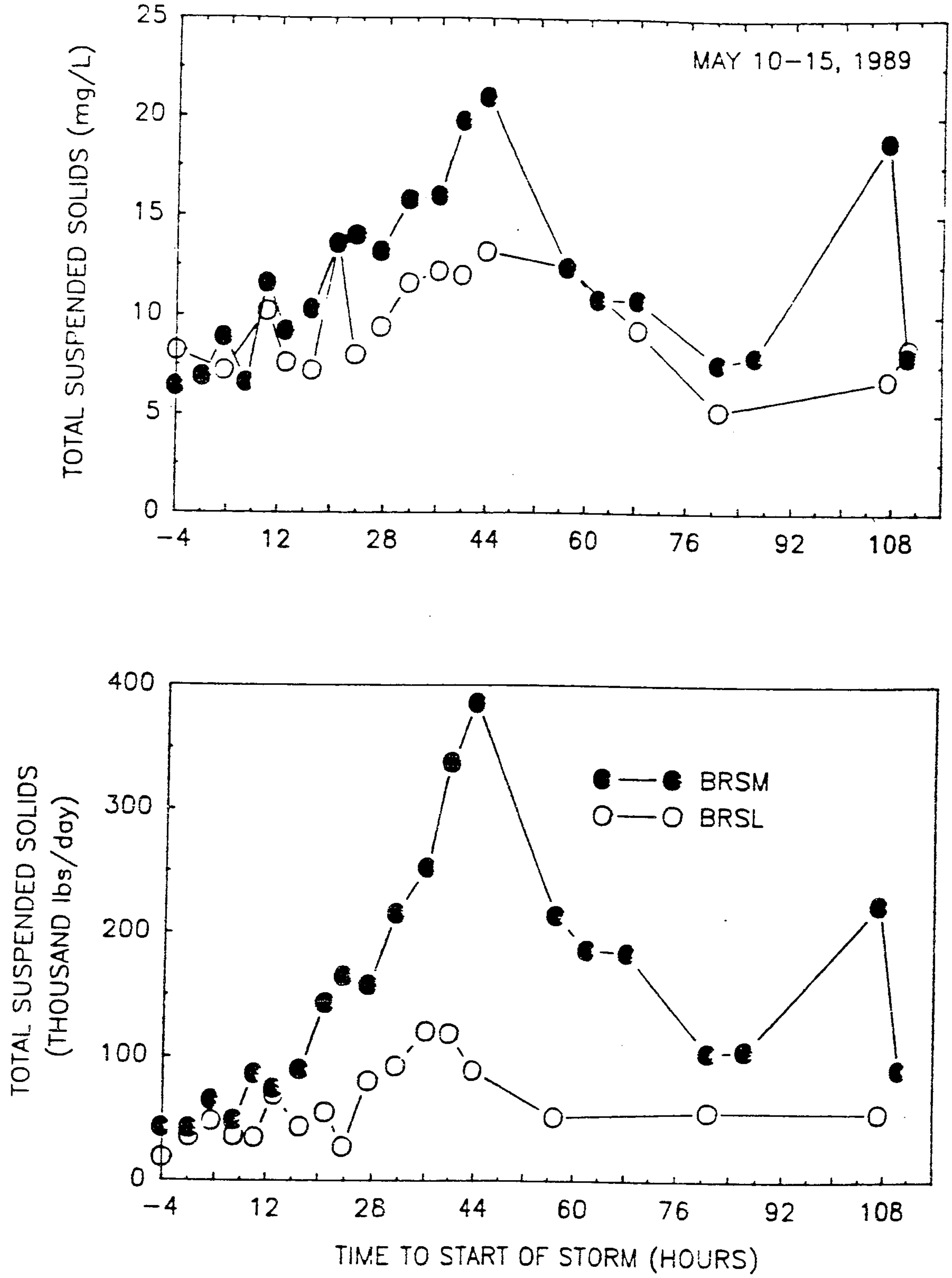


Figure E.16 Actual Wet Weather TSS Profiles for the Blackstone River for Water Quality Stations at the RI/MA State Line (BRSL) and at Pawtucket, RI (BRSM)

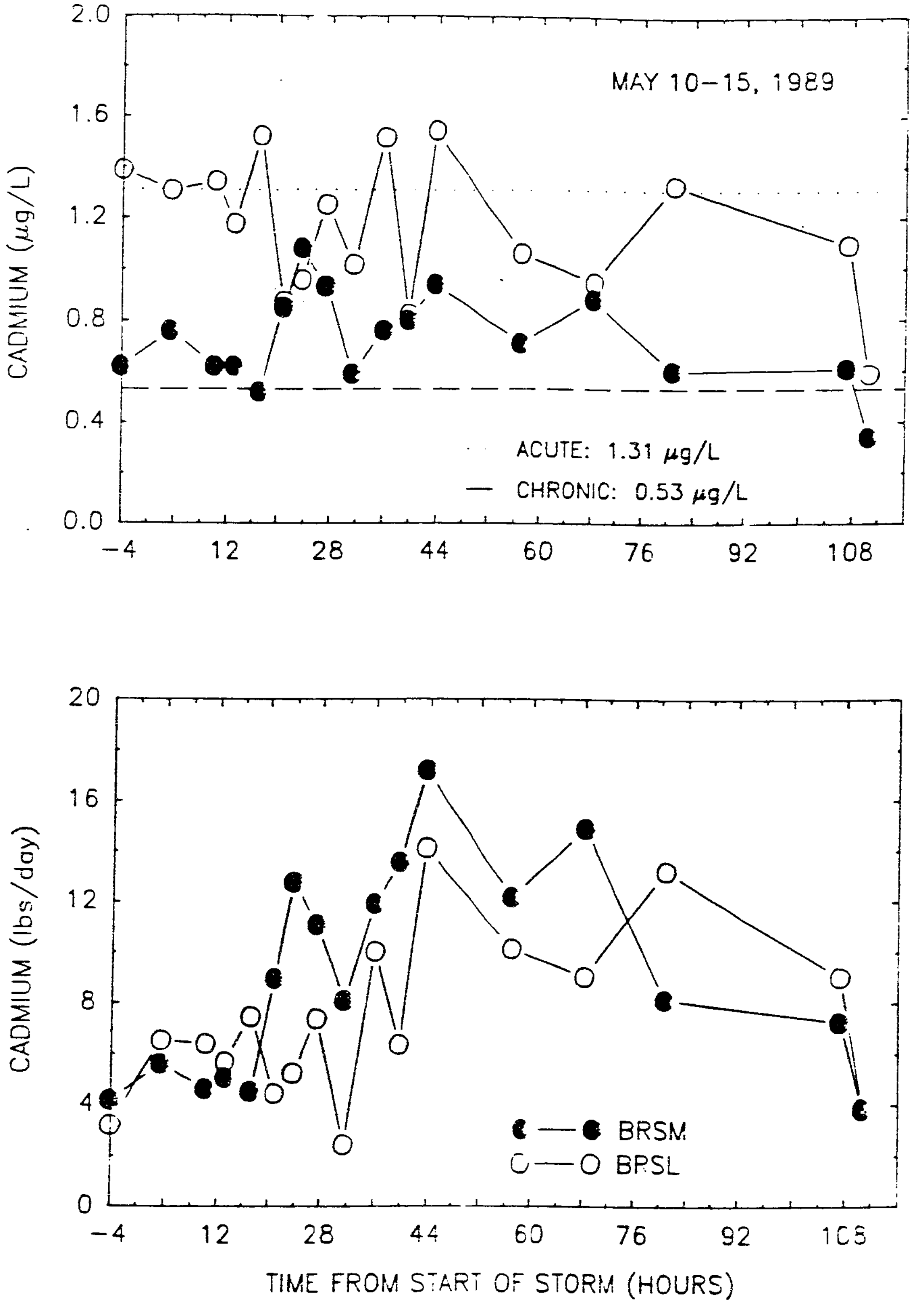


Figure E.17 Actual Wet Weather Cadmium Profiles for the Blackstone River for Water Quality Stations at the RI/MA State Line (BRSL) and at Pawtucket, RI (BRSM)

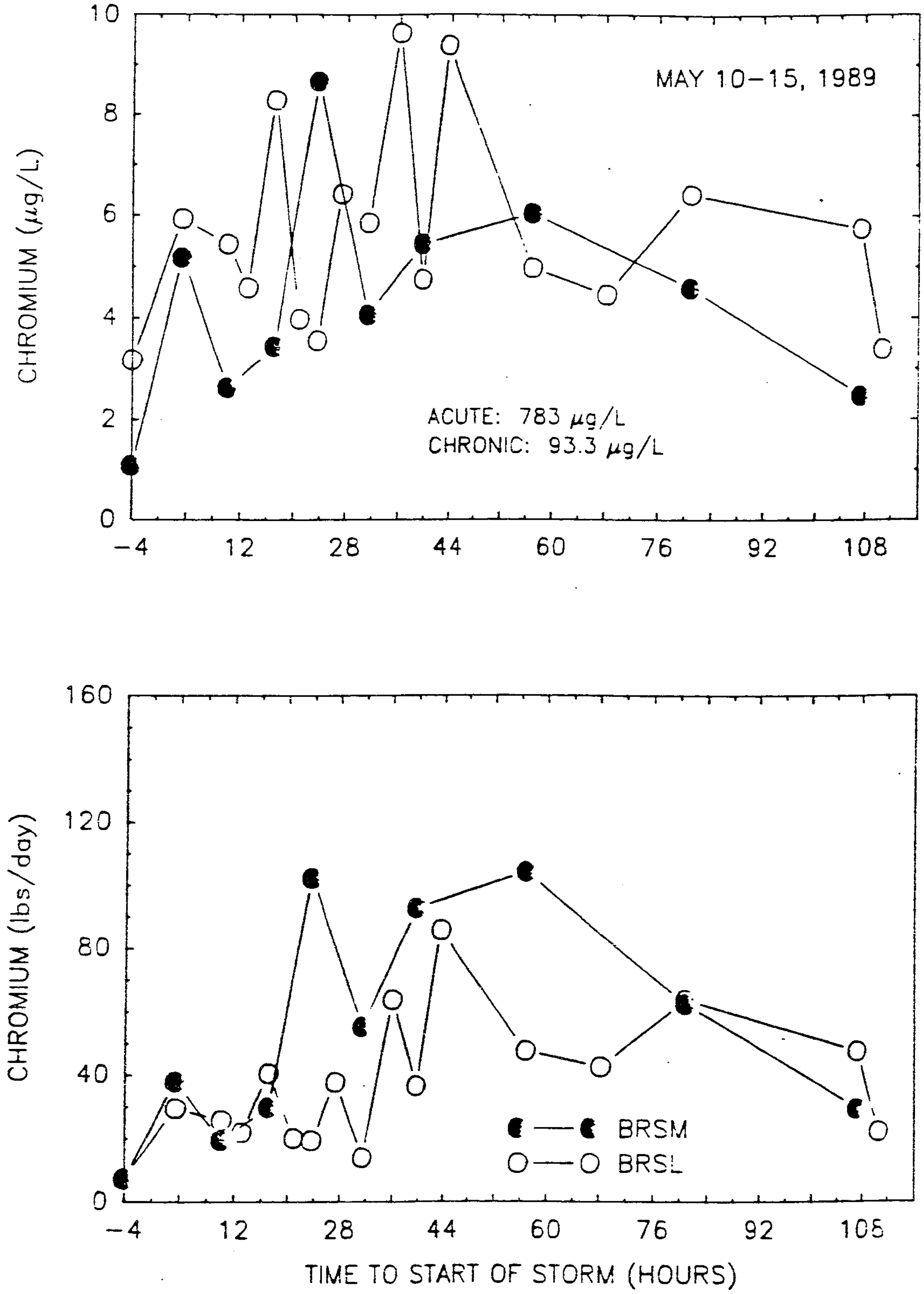


Figure E.18 Actual Wet Weather Chromium Profiles for the Blackstone River for Water Quality Stations at the RI/MA State Line (BRSL) and at Pawtucket, RI (BRSM)

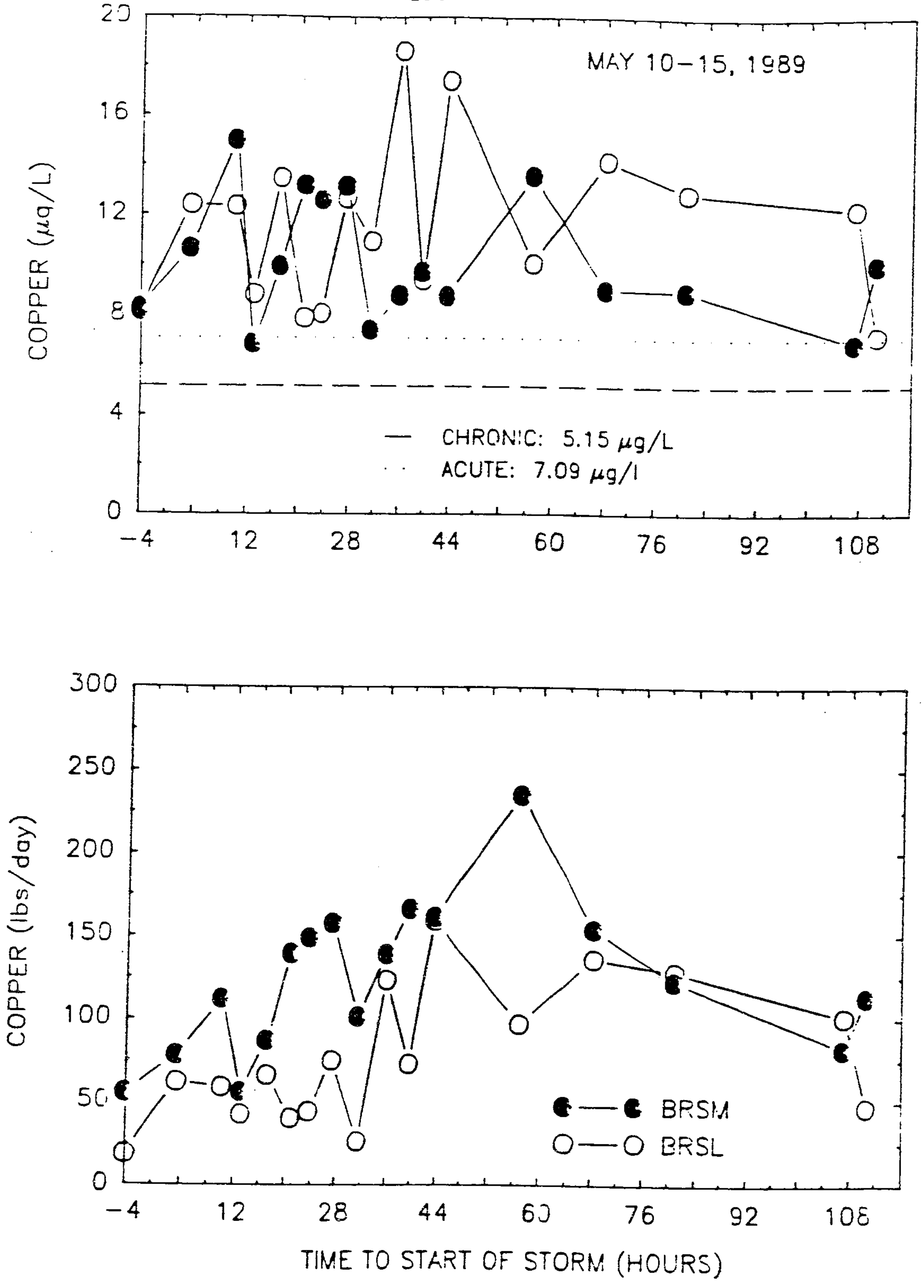
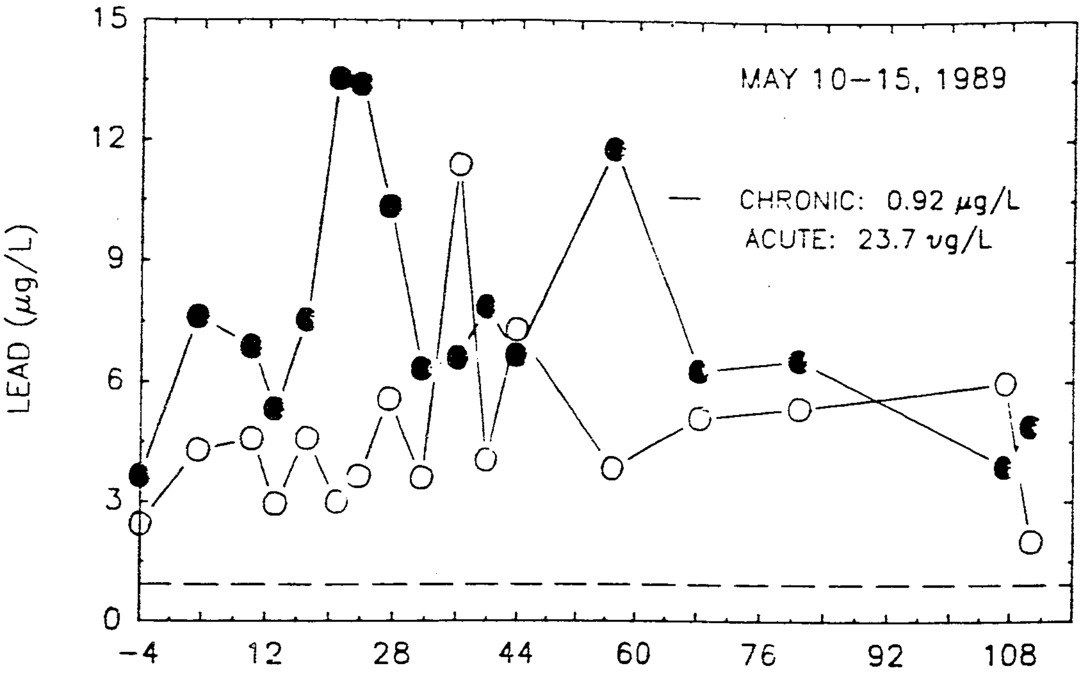


Figure E.19 Actual Wet Weather Copper Profiles for the Blackstone River for Water Quality Stations at the RI/MA State Line (BRSL) and at Pawtucket, RI (BRSM)



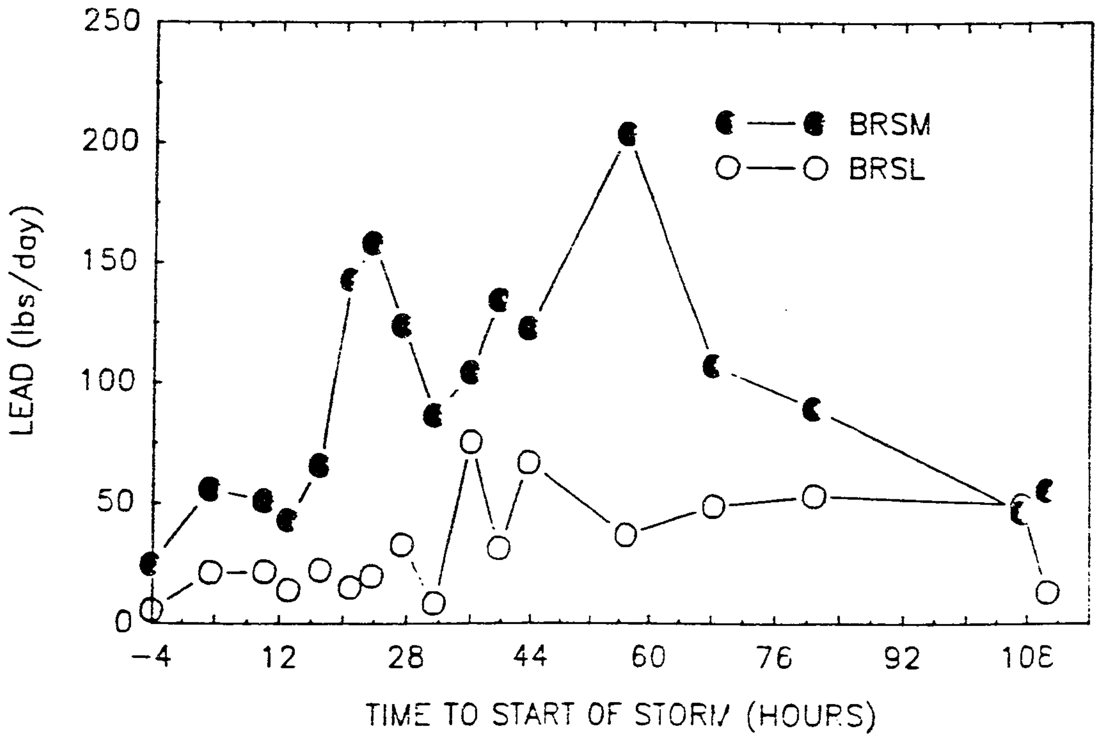


Figure E.20 Actual Wet Weather Lead Profiles for the Blackstone River for Water Quality Stations at the RI/MA State Line (BRSL) and at Pawtucket, RI (BRSM)

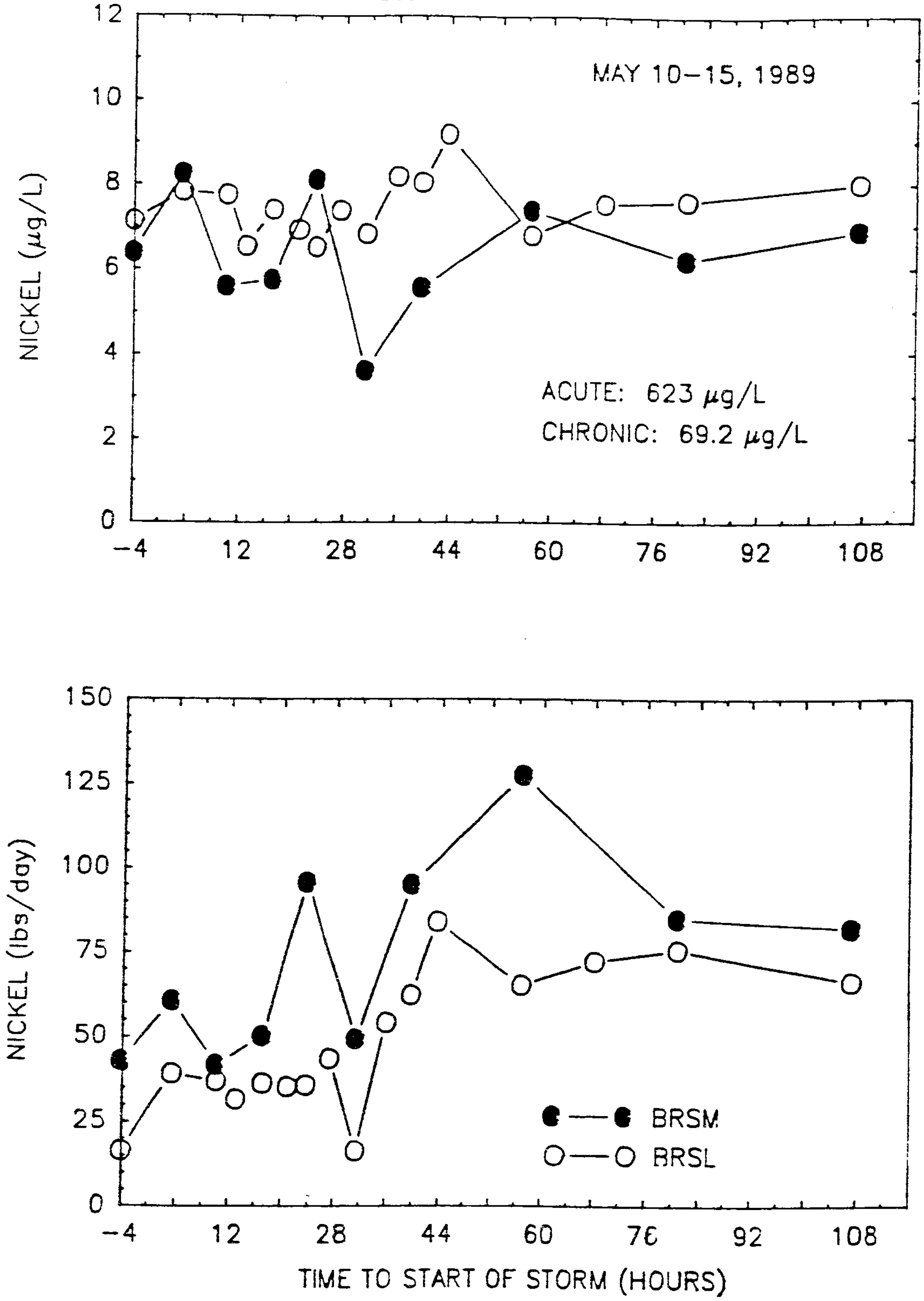


Figure E.21 Actual Wet Weather Nickel Profiles for the Blackstone River for Water Quality Stations at the RI/MA State Line (BRSL) and at Pawtucket, RI (BRSM)

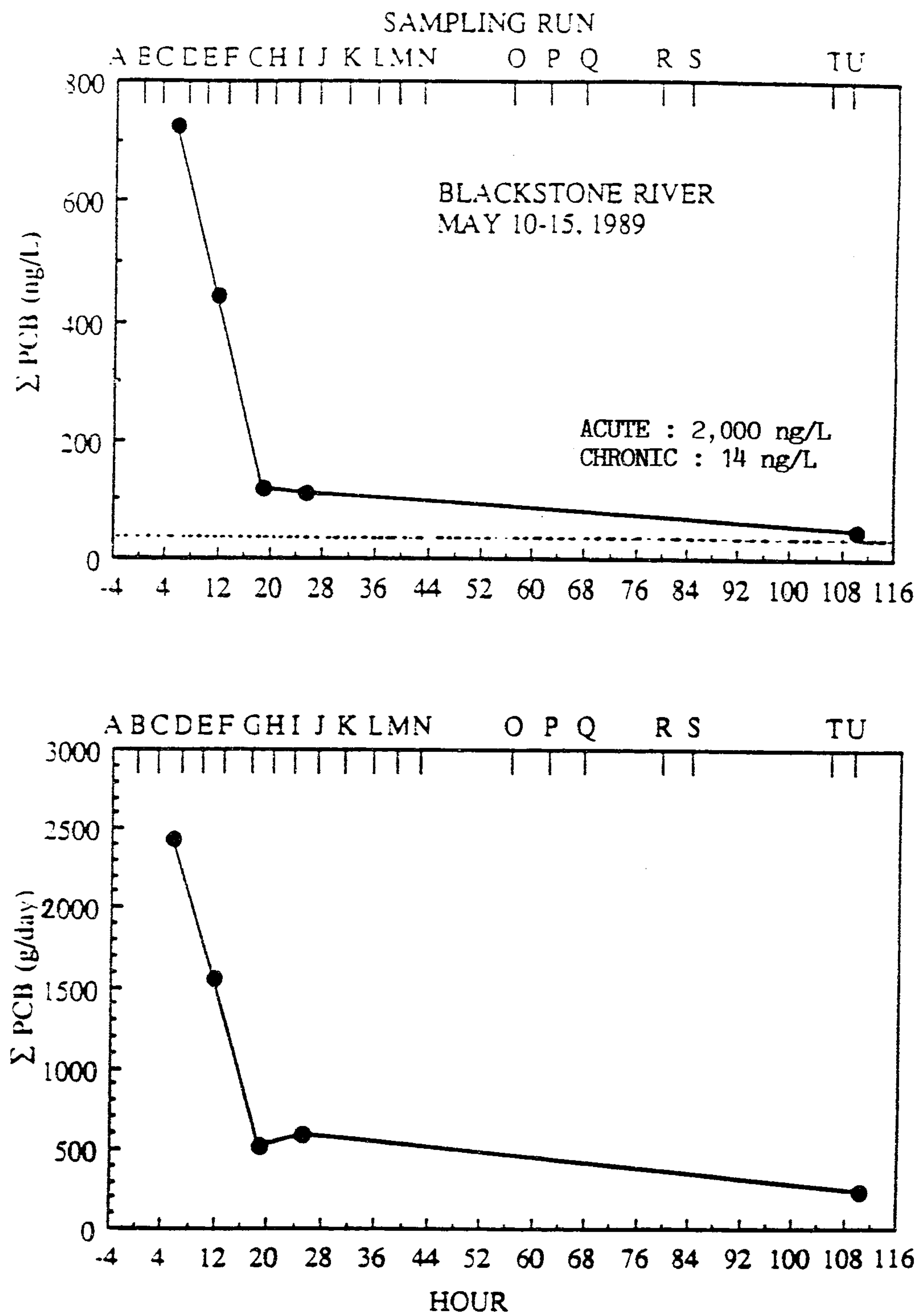


Figure E.22 Actual Wet Weather PCB Profiles for the Blackstone River for Water Quality Station at Pawtucket, RI (BRSM)

APPENDIX F

Table F.1 - Dry weather loads as determined by three different studies for the indicated constituents (lbs/day).

STATION	SINBADD (1984-86)	SPRAY (1987)	WET (1988-89)	TOTAL MEAN	PERCENT OF TOTAL
		CADMIUM (lbs/day)			
BRSM	7.74 (1)	6.49 (1)	3.00 (1)	5.74 (1)	51.6
MOSH	0.14 (6)	0.04 (8)	0.06 (7)	0.08 (8)	0.7
PAWT	1.24 (3)	1.41 (2)	2.17 (2)	1.61 (3)	14.5
TENM	----	1.25 (3)	0.40 (5)	0.83 (4)	7.5
WOON	0.07 (7)	0.14 (5)	0.15 (6)	0.12 (7)	1.1
BVDC	1.22 (4)	0.13 (6)	0.43 (4)	0.59 (5)	5.3
NBCS	4.42 (2)	0.90 (4)	0.65 (3)	1.99 (2)	17.9
EPRO	0.38 (5)	0.07 (7)	0.03 (8)	0.16 (6)	1.4
		CHROMIUM (lbs/day)			
BRSM	10.84 (2)	----	13.72 (1)	12.28 (2)	23.2
MOSH	0.26 (7)	----	0.48 (6)	0.37 (8)	0.7
PAWT	1.22 (5)	----	8.40 (3)	4.81 (4)	9.1
TENM	----	----	2.73 (5)	2.73 (5)	5.2
WOON	1.50 (4)	----	1.34 (6)	1.42 (6)	2.7
BVDC	7.94 (3)	----	9.80 (2)	8.87 (3)	16.7
NBCS	37.14 (1)	----	6.73 (4)	21.94 (1)	41.4
EPRO	0.95 (6)	----	0.15 (7)	0.55 (7)	1.0

---- no data available

Table F.1 - Continued

STATION	SINBADD (1984-86)	SPRAY (1987)	WET (1988-89)	TOTAL MEAN	PERCENT OF TOTAL
		AMMONIA (lbs/day)			
BRSM	----	2890 (2)	946 (4)	1918 (3)	14.9
MOSH	----	44.9 (7)	6.8 (8)	25.9 (7)	0.2
PAWT	----	2330 (3)	1472 (3)	1901 (4)	14.7
TENM	----	1.6 (8)	18.4 (6)	10.0 (8)	0.1
WOON	----	157 (6)	13.9 (7)	85.5 (6)	0.7
BVDC	----	1970 (4)	2997 (2)	2484 (2)	19.3
NBCS	----	6680 (1)	5770 (1)	6225 (1)	48.3
EPRO	----	359 (5)	135 (5)	247 (5)	1.9
		NITRATE (lbs/day)			
BRSM	----	17300 (1)	15167 (1)	16234 (1)	51.0
MOSH	----	785 (7)	432 (6)	609 (7)	1.9
PAWT	----	7640 (2)	6960 (2)	7300 (2)	23.0
TENM	----	3560 (3)	----	3560 (3)	11.2
WOON	----	1047 (5)	1748 (4)	1398 (5)	4.4
BVDC	----	628 (8)	19.8 (7)	324 (8)	1.0
NBCS	----	942 (6)	877 (5)	910 (6)	2.9
EPRO	----	1050 (4)	1893 (3)	1472 (4)	4.6

---- no data available

Table F.1 - Continued

STATION	SINBADD (1984-86)	SPRAY (1987)	WET (1988-89)	TOTAL MEAN	PERCENT OF TOTAL
		COPPER (lbs/day)			
BRSM	44.55 (2)	45.00 (2)	40.53 (2)	43.36 (2)	19.3
MOSH	1.72 (6)	1.90 (7)	1.15 (7)	1.59 (7)	0.7
PAWT	15.91 (4)	9.82 (3)	23.10 (4)	16.28 (4)	7.3
TENM	----	9.82 (3)	6.55 (5)	8.19 (5)	3.7
WOON	2.58 (5)	2.53 (5)	2.39 (6)	2.50 (6)	1.1
BVDC	16.15 (3)	8.87 (4)	43.70 (1)	22.91 (3)	10.2
NBCS	188.89 (1)	162.00 (1)	32.57 (3)	127.82 (1)	57.0
EPRO	1.15 (7)	2.22 (6)	0.94 (8)	1.44 (8)	0.6
		NICKEL (lbs/day)			
BRSM	60.63 (2)	45.20 (2)	27.17 (2)	44.33 (2)	20.9
MOSH	1.19 (7)	0.73 (8)	0.39 (8)	0.77 (8)	0.4
PAWT	14.30 (3)	17.60 (4)	18.27 (5)	16.72 (5)	7.9
TENM	----	20.80 (3)	18.82 (4)	19.81 (3)	9.3
WOON	4.75 (5)	2.04 (7)	1.86 (7)	2.88 (7)	1.4
BVDC	11.00 (4)	16.90 (5)	27.00 (3)	18.30 (4)	8.6
NBCS	123.10 (1)	130.00 (1)	63.27 (1)	105.46 (1)	49.7
EPRO	3.93 (6)	5.38 (6)	2.29 (6)	3.87 (6)	1.8

---- no data available

Table F.1 - Continued

STATION	SINBADD (1984-86)	SPRAY (1987)	WET (1988-89)	TOTAL MEAN	PERCENT OF TOTAL
		LEAD (lbs/day)			
BRSM	18.86 (2)	14.45 (1)	23.90 (1)	19.07 (2)	18.1
MOSH	0.98 (7)	0.84 (7)	1.09 (7)	0.97 (8)	0.9
PAWT	15.21 (3)	4.62 (3)	13.32 (3)	11.05 (3)	10.5
TENM	----	1.97 (6)	1.89 (6)	1.93 (6)	1.8
WOON	1.55 (6)	2.42 (5)	1.97 (5)	1.98 (5)	1.9
BVDC	11.43 (4)	3.17 (4)	14.46 (2)	9.69 (4)	9.2
NBCS	155.97 (1)	12.60 (2)	8.95 (4)	59.17 (1)	56.3
EPRO	3.65 (5)	0.19 (8)	0.14 (8)	1.33 (7)	1.3
		SILVER (lbs/day)			
BRSM	----	----	----	----	----
MOSH	1.19 (4)	----	----	1.19 (5)	1.1
PAWT	50.60 (1)	----	----	50.60 (1)	46.6
TENM	----	----	----	----	----
WOON	----	3.15	----	3.15 (4)	2.9
BVDC	----	----	----	----	----
NBCS	50.20 (2)	----	----	50.20 (2)	46.2
EPRO	3.44 (3)	----	----	3.44 (3)	3.2

---- no data available

Table F.1 - Continued

STATION	SINBADD (1984-86)	SPRAY (1987)	WET (1988-89)	TOTAL MEAN	PERCENT OF TOTAL
		TOTAL NITROGEN (lbs/day)			
BRSM	8.37 (1)	----	----	8.37 (1)	35.3
MOSH	0.24 (7)	----	----	0.24 (7)	1.0
PAWT	4.28 (3)	----	----	4.28 (3)	18.1
TENM	----	----	----	----	----
WOON	0.46 (6)	----	----	0.46 (6)	1.9
BVDC	1.85 (4)	----	----	1.85 (4)	7.8
NBCS	7.94 (2)	----	----	7.94 (2)	33.5
EPRO	0.56 (5)	----	----	0.56 (5)	2.4
		TOTAL PHOSPHORUS (lbs/day)			
BRSM	1.38 (2)	----	----	1.38 (2)	28.2
MOSH	0.38 (5)	----	----	0.38 (5)	7.8
PAWT	0.92 (3)	----	----	0.92 (3)	18.8
TENM	---------	----	----	----	----
WOON	0.08 (7)	----	----	0.08 (7)	1.6
BVDC	0.44 (4)	----	----	0.44 (4)	9.0
NBCS	1.57 (1)	----	----	1.57 (1)	32.0
EPRO	0.13 (6)	----	----	0.13 (6)	2.7

---- no data available

Table F.1 - Continued

STATION	SINBADD (1984-86)	SPRAY (1987)		WET (1988-89)		TOTAL MEAN		PERCENT OF TOTAL
		ORTHOPHOSPHATE (lbs/day)						
BRSM	----	1130	(3)	1267	(3)	1199	(3)	18.7
MOSH	----	8.0	(7)	7.7	(7)	7.9	(8)	0.1
PAWT	----	1130	(3)	737	(4)	933.5	(4)	14.6
TENM	----	209	(5)	----		209	(6)	3.3
WOON	----	64.4	(6)	46.2	(6)	55.3	(7)	0.9
BVDC	----	1320	(2)	2220	(1)	1770	(1)	27.7
NBCS	----	1420	(1)	1933	(2)	1677	(2)	26.2
EPRO	----	619	(4)	396	(5)	546	(5)	8.5
		TOTAL SUSPENDED SOLIDS (lbs/day)						
BRSM	----	----		25700	(1)	25700	(1)	30.3
MOSH	----	----		1130	(8)	1130	(8)	1.3
PAWT	----	----		22367	(2)	22367	(2)	26.4
TENM	----	----		2460	(5)	2460	(5)	2.9
WOON	----	----		2017	(7)	2017	(7)	2.4
BVDC	----	----		18877	(3)	18877	(3)	22.3
NBCS	----	----		10153	(4)	10153	(4)	12.0
EPRO	----	----		2044	(6)	2044	(6)	2.4

---- no data available

Table F.1 - Continued

STATION	SINBADD (1985-86)	SPRAY (1987)	WET (1988-89)	TOTAL MEAN	PERCENT OF TOTAL
			PCB (lb/day)		
BRSM	1.15 (1)	----	----	1.15 (1)	60.8
MOSH	0.02 (6)	----	----	0.02 (6)	1.1
PAWT	0.12 (4)	----	----	0.12 (4)	6.4
TENM	----	----	----	----	----
WOON	0.08 (5)	----	----	0.08 (5)	4.2
BVDC	0.21 (3)	----	----	0.21 (3)	11.1
NBCS	0.30 (2)	----	----	0.30 (2)	15.9
EPRO	0.01 (7)	----	----	0.01 (7)	0.5

---- no data available

Table F.2 Wet Weather Loads RUNOFF Related (wet only) for the Indicated Constituents (lbs)

Station	October Storm 1	May Storm 2	June Storm 3	Total Storms 1-3	Percent of Total
		TOTAL SUSPENDED SOLIDS			
BRSM	67,146 (1)	590,144 (1)	26,367 (2)	683,657 (1)	40.8
MOSH	10,427 (5)	53,875 (4)	4,619 (4)	68,921 (4)	4.1
PAWT	49,360 (2)	549,008 (2)	44,696 (1)	643,064 (2)	38.4
TENM	1,946 (8)	22,615 (7)	4,262 (5)	28,823 (8)	1.7
WOON	6,850 (7)	105,404 (3)	3,026 (6)	115,280 (3)	6.9
BVDB	10,302 (6)	29,836 (5)	249 (8)	40,387 (7)	2.4
CSO9	16,412 (4)	23,718 (6)	6,946 (3)	47,076 (6)	2.8
NBCB	36,283 (3)	9,785 (8)	1,462 (7)	47,530 (5)	2.9
Total	198,726	1,384,385	91,627	1,674,738	

( ) - Rank based on total wet weather loads

Table F.2 Continued

CADMIUM

Station	October Storm 1	May Storm 2	June Storm 3	Total Storms 1-3	Percent of Total
BRSM	6.80 (1)	26.60 (1)	3.00 (1)	36.40 (1)	64.4
MOSH	0.15 (7)	0.57 (6)	0.12 (6)	0.84 (6)	1.5
PAWT	3.18 (2)	5.02 (3)	1.32 (2)	9.52 (2)	16.8
TENM	0.30 (3)	5.23 (2)	0.26 (4)	5.79 (3)	10.2
WOON	0.06 (8)	1.13 (4)	0.53 (3)	1.72 (4)	3.0
BVDB	0.18 (6)	0.36 (7)	0.01 (8)	0.55 (8)	1.0
CSO9	0.30 (3)	0.59 (5)	0.18 (5)	1.07 (5)	1.9
NBCB	0.29 (5)	0.31 (8)	0.04 (7)	0.64 (7)	1.1
Total	11.26	39.81	5.49	56.56	

( ) - Rank based on total wet weather loads

Table F.2 Continued

CHROMIUM									
Station	October Storm 1		May Storm 2		June Storm 3		Total Storms 1-3		Percent of Total
BRSM	103.0	(1)	220.0	(1)	8.3	(2)	331.3	(1)	51.3
MOSH	4.6	(5)	23.9	(5)	1.0	(6)	29.5	(5)	4.6
PAWT	6.6	(4)	71.2	(3)	9.3	(1)	87.1	(3)	13.5
TENM	0.5	(8)	88.5	(2)	3.2	(3)	92.2	(2)	14.3
WOON	1.5	(7)	14.3	(6)	2.8	(4)	18.6	(6)	2.9
BVDB	11.6	(2)	6.1	(8)	0.1	(8)	17.8	(7)	2.8
CSO9	4.2	(6)	8.8	(7)	1.8	(5)	14.8	(8)	2.3
NBCB	7.7	(3)	46.0	(4)	0.3	(7)	54.0	(4)	8.4
Total	139.7		478.8		26.8		645.3		

( ) - Rank based on total wet weather loads

Table F.2 Continued

COPPER									
Station	October Storm 1		May Storm 2		June Storm 3		Total Storms 1-3		Percent of Total
BRSM	109.0	(1)	344.0	(1)	15.3	(1)	468.3	(1)	47.1
MOSH	9.0	(6)	30.7	(5)	6.0	(6)	45.7	(8)	4.6
PAWT	36.5	(3)	96.3	(2)	14.8	(2)	147.6	(2)	14.8
TENM	3.9	(7)	82.1	(3)	6.8	(5)	92.8	(3)	9.3
WOON	3.1	(8)	40.4	(4)	7.5	(4)	51.0	(6)	5.1
BVDB	19.7	(5)	29.2	(6)	0.2	(8)	49.1	(7)	4.9
CSO9	28.2	(4)	26.4	(7)	9.1	(3)	63.7	(5)	6.4
NBCB	52.0	(2)	21.6	(8)	2.9	(7)	76.5	(4)	7.7
Total	261.4		670.7		62.5		994.6		

( ) - Rank based on total wet weather loads

Table F.2 Continued

LEAD									
Station	October Storm 1		May Storm 2		June Storm 3		Total Storms 1-3		Percent of Total
BRSM	53.8	(1)	353	(1)	25.9	(1)	432.7	(1)	53.7
MOSH	7.4	(5)	36.4	(4)	2.4	(7)	46.2	(5)	5.7
PAWT	14.7	(3)	91.3	(2)	21.2	(2)	127.2	(2)	15.8
TENM	0.6	(7)	24.0	(6)	3.9	(4)	28.5	(6)	3.5
WOON	2.7	(6)	61.6	(3)	3.4	(6)	67.7	(3)	8.4
BVDB	0.1	(8)	6.6	(8)	14.4	(3)	21.1	(8)	2.6
CSO9	24.0	(2)	32.2	(5)	3.6	(5)	59.8	(4)	7.4
NBCB	13.3	(4)	8.0	(7)	1.5	(8)	22.8	(7)	2.8
Total	116.5		613.1		76.3		805.9		

( ) - Rank based on total wet weather loads

Table F.2 Continued

NICKEL									
Station	October Storm 1		May Storm 2		June Storm 3		Total Storms 1-3		Percent of Total
BRSM	153	(1)	153	(2)	8.7	(5)	314.7	(1)	35.6
MOSH	2.0	(6)	28.0	(5)	0.8	(8)	30.7	(7)	3.5
PAWT	53.5	(2)	56.2	(3)	33.7	(1)	143.4	(3)	16.2
TENM	16.4	(4)	182	(1)	18.8	(3)	217.2	(2)	24.6
WOON	2.0	(6)	42.9	(4)	2.1	(7)	47.0	(6)	5.3
BVDB	0.1	(8)	16.8	(6)	12.9	(4)	29.8	(8)	3.4
CSO9	12.0	(5)	16.1	(7)	23.7	(2)	51.8	(4)	5.9
NBCB	29.3	(3)	15.8	(8)	4.3	(6)	49.4	(5)	5.6
Total	268.3		510.8		105.0		884.1		

( ) - Rank based on total wet weather loads

Table F.2 Continued

AMMONIA						
Station	October Storm 1	May Storm 2	June Storm 3	Total Storms 1-3	Percent of Total
BRSM	3,140 (2)	3,488 (2)	528 (3)	7,156 (2)	26.0
MOSH	54 (7)	275 (8)	90 (7)	419 (8)	1.5
PAWT	3,943 (1)	6,155 (1)	2,046 (1)	12,144 (1)	44.2
TENM	14 (8)	652 (5)	190 (4)	856 (5)	3.1
WOON	106 (5)	408 (7)	136 (5)	650 (7)	2.4
BVDB	154 (4)	535 (6)	18 (8)	707 (6)	2.6
CSO9	60 (6)	1,817 (3)	984 (2)	2,361 (3)	10.4
NBCB	818 (3)	1,779 (4)	114 (6)	2,711 (4)	9.9
Total	8,289	15,109	4,106	27,504	

( ) - Rank based on total wet weather loads

Table F.2 Continued

NITRATE					
Station	October Storm 1	May Storm 2	June Storm 3	Total Storms 1-3	Percent of Total
BRSM	61,746 (1)	60,138 (1)	5,556 (1)	127,440 (1)	65.3
MOSH	379 (5)	5,071 (4)	531 (5)	5,981 (5)	3.1
PAWT	7,669 (2)	22,155 (2)	3,048 (2)	32,872 (2)	16.9
TENM	1,218 (4)	16,453 (3)	2,563 (3)	20,234 (3)	10.4
WOON	2,275 (3)	3,854 (5)	655 (4)	6,784 (4)	3.5
BVDB	77 (7)	356 (7)	4 (8)	437 (7)	0.2
CSO9	162 (6)	630 (6)	164 (6)	956 (6)	0.5
NBCB	4 (8)	263 (8)	56 (7)	323 (8)	0.2
Total	73,530	108,920	12,577	195,027	

( ) - Rank based on total wet weather loads

Table F.2 Continued

ORTHOPHOSPHATE									
Station	October Storm 1		May Storm 2		June Storm 3		Total Storms 1-3		Percent of Total
BRSM	8,419	(1)	2,625	(1)	2,609	(1)	13,653	(1)	53.6
MOSH	50	(7)	130	(8)	61	(7)	241	(8)	0.9
PAWT	1,918	(2)	1,631	(3)	1,522	(2)	5,071	(2)	19.9
TENM	24	(8)	1,023	(4)	210	(5)	1,257	(5)	4.9
WOON	234	(5)	275	(7)	182	(6)	691	(7)	2.7
BVDB	289	(4)	535	(6)	20	(8)	844	(6)	3.3
CSO9	72	(6)	1,670	(2)	365	(3)	2,107	(3)	8.3
NBCB	572	(3)	751	(5)	296	(4)	1,619	(4)	6.4
Total	11,577		8,640		5,265		25,482		

( ) - Rank based on total wet weather loads

Table F.2 Continued

PHC							
Station	October Storm 1		May Storm 2		Total Storms 1-2		Percent of Total
BRSM	416	(2)	724	(2)	1140	(2)	26.6
MOSH	168	(4)	246	(4)	414	(4)	9.7
PAWT	131	(5)	1120	(1)	1251	(1)	29.2
TENM	12	(7)	27	(7)	39	(7)	0.9
WOON	17	(6)	239	(5)	256	(6)	6.0
BVDB	*		*		*		*
CSO9	605	(1)	283	(3)	888	(3)	20.8
NBCB	206	(3)	84	(6)	290	(5)	6.8
Total	1555		2723		4278		

( ) - Rank based on total load; * - BVDB flows were not available at the time of the draft report.

Table F.2 Continued

Station	Ar 1254				
	October Storm 1		May Storm 2		Total Storms 1-2		Percent of Total

Station	October Storm 1		May Storm 2		Total Storms 1-2		Percent of Total
BRSM	248.0	(1)	884.0	(1)	1132.0	(1)	79.7
MOSH	7.6	(4)	25.5	(4)	33.1	(3)	2.3
PAWT	35.4	(2)	138	(2)	173.4	(2)	12.2
TENM	0.9	(6)	22.5	(5)	23.4	(5)	1.6
WOON	0.9	(6)	27.0	(3)	27.9	(4)	2.0
BVDB	*		*		*		*
CSO9	11.4	(3)	4.4	(7)	15.8	(6)	1.1
NBCB	5.0	(5)	10.7	(6)	15.7	(7)	1.1
Total	309.2		1,112.0		1,421.2		

Ar 1254

( ) - Rank based on total load; * - BVDB flows were not available at the time of the draft report.

Table F.2 Continued

Station	October Storm 1		May Storm 2		Total Storms 1-2		Percent of Total
	Σ PCB						
BRSM	288.0	(1)	2250.0	(1)	2538.0	(1)	82.9
MOSH	8.9	(4)	65.2	(4)	74.1	(4)	2.4
PAWT	27.5	(3)	227	(2)	254.5	(2)	8.3
TENM	0.9	(7)	31.5	(5)	32.4	(6)	1.1
WOON	1.1	(6)	97.3	(3)	98.4	(3)	3.2
BVDB	*		*		*		*
CSO9	31.7	(2)	13.2	(6)	44.9	(5)	1.5
NBCB	5.6	(5)	13.2	(6)	18.8	(7)	0.6
Total	363.7		2,697.4		3,061.1		

( ) - Rank based on total load; * - BVDB flows were not available at the time of the draft report.

Table F.3 Wet Weather TOTAL EVENT Loads (Wet + Dry) for the Indicated Constituents (lbs)

TOTAL SUSPENDED SOLIDS					
Station	October Storm 1	May Storm 2	June Storm 3	Total Storms 1-3	Percent of Total
River Input					
BRSM	75,146 (2)	810,144 (1)	91,710 (2)	977,000 (1)	37.0
MOSH	14,427 (7)	58,549 (5)	7,869 (7)	80,845 (6)	3.1
PAWT	81,360 (1)	689,008 (2)	112,696 (1)	883,064 (2)	33.5
TENM	3,626 (10)	45,948 (6)	8,845 (6)	58,419 (7)	2.2
WOON	7,850 (9)	119,154 (4)	9,670 (5)	136,674 (4)	5.2
Subtotal	182,409 [50.9%]	1,722,803 [85.5%]	230,790 [86.5%]	2,136,002 [80.9%]	
STPs, STP Bypasses, and CSO9					
BVDC	40,935 (4)	187,819 (3)	14,532 (3)	243,286 (3)	9.2
EPRO	569 (11)	4,839 (11)	1,356 (10)	6,764 (11)	0.3
NBCS	71,785 (3)	35,499 (7)	11,551 (4)	118,835 (5)	4.5
BVDB	10,302 (8)	29,836 (8)	249 (11)	40,387 (10)	1.5
CSO9	16,412 (6)	23,718 (9)	6,946 (8)	47,076 (9)	1.7
NBCB	36,283 (5)	9,785 (10)	1,462 (9)	47,530 (8)	1.8
Subtotal	176,286 [49.1%]	291,496 [14.5%]	36,096 [13.5%]	503,878 [19.1%]	
Overall Total	358,695	2,014,299	266,886	2,639,880	

( ) - Rank based on total load; [ ] - Percent of total load associated with rivers versus point sources with CSO9

Table F.3 Continued

CADMIUM					
Station	October Storm 1	May Storm 2	June Storm 3	Total Storms 1-3	Percent of Total
River Input					
BRSM	8.80 (2)	44.9 (1)	13.7 (1)	67.47 (1)	50.8
MOSH	0.23 (8)	1.07 (7)	0.23 (7)	1.53 (7)	1.2
PAWT	10.40 (1)	19.0 (2)	5.36 (2)	34.76 (2)	26.2
TENM	0.82 (5)	8.50 (3)	1.11 (4)	10.43 (3)	7.9
WOON	0.16 (11)	2.73 (6)	0.71 (5)	3.60 (6)	2.7
Subtotal	20.4 [83.6%]	76.2 [90.1%]	21.2 [89.1%]	117.8 [88.7%]	
STPs, STP Bypasses, and CSO9					
BVDC	1.03 (4)	3.96 (4)	0.41 (6)	5.40 (5)	4.1
EPRO	0.20 (9)	0.08 (11)	0.05 (9)	0.33 (11)	0.2
NBCS	1.95 (3)	3.09 (5)	1.88 (3)	6.92 (4)	5.2
BVDB	0.18 (10)	0.36 (9)	0.01 (11)	0.55 (10)	0.4
CSO9	0.30 (6)	0.59 (8)	0.18 (8)	1.07 (8)	0.8
NBCB	0.29 (7)	0.31 (10)	0.04 (10)	0.64 (9)	0.5
Subtotal	4.0 [16.4%]	8.4 [9.9%]	2.6 [10.9%]	15.0 [11.3%]	
Overall Total	24.4	84.6	23.8	132.8	

( ) - Rank based on total load; [ ] - Percent of total load associated with rivers versus STPs

Table F.3 Continued

CHROMIUM

Station	October Storm 1		May Storm 2		June Storm 3		Total Storms 1-3		Percent of Total
River Input									
BRSM	115.0	(1)	256.7	(1)	79.0	(1)	450.7	(1)	40.1
MOSH	6.2	(7)	26.1	(6)	2.3	(7)	34.6	(7)	3.1
PAWT	21.8	(3)	141.2	(2)	24.2	(2)	187.2	(2)	16.7
TENM	2.5	(9)	111.4	(3)	9.7	(3)	123.6	(4)	11.0
WOON	2.2	(10)	24.3	(8)	6.5	(6)	33.0	(8)	2.9
Subtotal	148 [61.9%]		560 [75.2%]		122 [87.1%]		830 [73.9%]		
STPs, STP Bypasses, and CSO9									
BVDC	20.3	(4)	99.0	(4)	7.3	(5)	126.6	(3)	11.3
EPRO	0.4	(11)	0.9	(11)	0.4	(9)	1.7	(11)	0.2
NBCS	46.8	(2)	24.4	(7)	7.6	(4)	78.8	(5)	7.0
BVDB	11.6	(5)	6.1	(19)	0.1	(11)	17.8	(9)	1.6
CSO9	4.2	(8)	8.8	(9)	1.8	(8)	14.8	(10)	1.3
NBCB	7.7	(6)	46.0	(5)	0.3	(10)	54.0	(6)	4.8
Subtotal	91 [38.1%]		185 [24.8%]		18 [12.9%]		293 [26.1%]		
Total	239		745		140		1,123		

( ) - Rank based on total load; [ ] - Percent of total load associated with rivers versus STPs

Table F.3 Continued

COPPER					
Station	October Storm 1	May Storm 2	June Storm 3	Total Storms 1-3	Percent of Total
River Input					
BRSM	141.0 (2)	596.0 (1)	154.0 (2)	891.0 (1)	30.3
MOSH	12.0 (8)	36.7 (7)	9.3 (7)	58.0 (9)	2.0
PAWT	84.5 (4)	236.0 (3)	78.6 (3)	399.1 (3)	13.6
TENM	9.5 (9)	133.4 (4)	233.7 (1)	376.6 (4)	12.8
WOON	5.7 (10)	59.4 (6)	13.2 (6)	78.3 (6)	2.7
Subtotal	253 [37.4%]	1,062 [63.2%]	489 [83.2%]	1,804 [61.3%]	
STPs, STP Bypasses, and CSO9					
BVDC	129.0 (3)	406.0 (2)	27.5 (5)	562.5 (2)	19.1
EPRO	1.7 (11)	5.7 (11)	2.7 (10)	10.1 (11)	0.3
NBCS	193.0 (1)	130.0 (5)	50.1 (4)	373.1 (5)	12.7
BVDB	19.7 (7)	29.2 (8)	0.2 (11)	49.1 (10)	1.7
CSO9	28.2 (6)	26.4 (9)	9.1 (8)	63.7 (8)	2.2
NBCB	52.0 (5)	21.6 (10)	2.9 (9)	76.5 (7)	2.6
Subtotal	424 [62.6%]	619 [36.8%]	99 [16.8%]	1,141 [38.7%]	
Total	677	1,681	588	2,945	

( ) - Rank based on total load; [ ] - Percent of total load associated with rivers versus STPs

Table F.3 Continued

Station	October Storm 1	May Storm 2	June Storm 3	Total Storms 1-3	Percent of Total
		LEAD			
		River Input			
BRSM	61.8 (1)	468.0 (1)	131.1 (1)	660.9 (1)	43.6
MOSH	11.4 (7)	41.0 (5)	5.4 (8)	57.8 (7)	3.8
PAWT	28.7 (4)	184.7 (2)	59.5 (2)	272.9 (2)	18.0
TENM	1.9 (9)	35.7 (6)	10.6 (4)	48.2 (8)	3.2
WOON	4.3 (8)	73.5 (4)	10.3 (5)	88.0 (5)	5.8
Subtotal	108 [47.8%]	803 [77.6%]	217 [85.1%]	1,128 [74.5%]	
		STPs, STP Bypasses, and CSO9			
BVDC	30.2 (3)	151.0 (3)	8.0 (7)	189.2 (3)	12.5
EPRO	0.1 (10)	1.2 (11)	0.3 (11)	1.6 (11)	0.1
NBCS	50.6 (2)	32.5 (7)	9.8 (6)	92.9 (4)	6.1
BVDB	0.1 (11)	6.6 (10)	14.4 (3)	21.1 (10)	1.4
CSO9	24.0 (5)	32.2 (8)	3.6 (9)	59.8 (6)	3.9
NBCB	13.3 (6)	8.0 (9)	1.5 (10)	22.8 (9)	1.5
Subtotal	118 [52.2%]	232 [22.4%]	38 [14.9%]	387 [25.5%]	
Total	226	1,035	255	1,515	

( ) - Rank based on total load; [ ] - Percent of total load associated with rivers versus STPs

Table F.3 Continued

NICKEL					
Station	October Storm 1	May Storm 2	June Storm 3	Total Storms 1-3	Percent of Total
River Input					
BRSM	206.0 (2)	344.0 (1)	72.7 (2)	622.7 (2)	23.8
MOSH	2.6 (10)	29.8 (7)	2.3 (11)	34.6 (9)	1.3
PAWT	142.0 (3)	133.0 (4)	72.0 (3)	347.0 (4)	13.3
TENM	40.2 (5)	331.0 (2)	62.2 (5)	433.4 (3)	16.6
WOON	6.0 (8)	60.8 (6)	3.8 (10)	70.6 (6)	2.7
Subtotal	397 [50.3%]	899 [68.9%]	213 [41.1%]	1,509.0 [57.7%]	
STPs, STP Bypasses, and CSO9					
BVDC	97.0 (4)	128.0 (5)	68.4 (4)	293.4 (5)	11.2
EPRO	4.7 (9)	16.9 (8)	4.8 (8)	26.4 (11)	1.0
NBCS	250.0 (1)	212.0 (3)	191.0 (1)	653.0 (1)	25.0
BVDB	0.1 (11)	16.8 (9)	12.9 (7)	29.8 (10)	1.1
CSO9	12.0 (7)	16.1 (10)	23.7 (6)	51.8 (7)	2.0
NBCB	29.3 (6)	15.8 (11)	4.3 (9)	49.4 (8)	1.9
Subtotal	393 [49.7%]	406 [31.1%]	305 [58.9%]	1,104 [42.3%]	
Total	790	1,305	518	2,613	

( ) - Rank based on total load; [ ] - Percent of total load associated with rivers versus STPs

Table F.3 Continued

AMMONIA					
Station	October Storm 1	May Storm 2	June Storm 3	Total Storms 1-3	Percent of Total
River Input					
BRSM	3,680 (4)	11,738 (4)	2,704 (4)	18,122 (4)	11.7
MOSH	60 (9)	296 (11)	123 (8)	479 (11)	0.3
PAWT	9,143 (2)	15,485 (3)	7,358 (3)	31,986 (3)	20.6
TENM	25 (11)	790 (8)	243 (6)	1,058 (8)	0.7
WOON	110 (8)	478 (10)	196 (7)	784 (9)	0.5
Subtotal	13,018 [33.5%]	28,787 [35.7%]	10,624 [29.8%]	52,429 [33.8%]	
STPs, STP Bypasses, and CSO9					
BVDC	8,186 (3)	16,327 (2)	8,027 (2)	32,540 (2)	21.0
EPRO	191 (6)	1,619 (7)	23 (10)	1,833 (7)	1.2
NBCS	16,440 (1)	29,851 (1)	15,850 (1)	62,141 (1)	40.0
BVDB	154 (7)	535 (9)	18 (11)	707 (10)	0.5
CSO9	60 (9)	1,817 (5)	984 (5)	2,861 (5)	1.8
NBCB	818 (5)	1,779 (6)	114 (9)	2,711 (6)	1.7
Subtotal	25,849 [66.5%]	51,928 [64.3%]	25,016 [70.2%]	102,793 [66.2%]	
Total	38,867	80,715	35,640	155,222	

( ) - Rank based on total load; [ ] - Percent of total load associated with rivers versus STPs

Table F.3 Continued

NITRATE					
Station	October Storm 1	May Storm 2	June Storm 3	Total Storms 1-3	Percent of Total
River Input					
BRSM	89,746 (1)	142,638 (1)	54,139 (1)	286,523 (1)	54.4
MOSH	859 (6)	7,706 (6)	1,956 (7)	10,521 (6)	2.0
PAWT	45,669 (2)	57,155 (2)	17,928 (3)	120,752 (2)	22.9
TENM	3,378 (5)	30,453 (3)	18,088 (2)	51,919 (3)	9.9
WOON	5,415 (3)	14,354 (4)	5,805 (5)	25,574 (4)	4.9
Subtotal	145,067 [96.4%]	252,306 [94.5%]	97,916 [90.7%]	495,289 [94.1%]	
STPs, STP Bypasses, and CSO9					
BVDC	140 (9)	48 (11)	33 (10)	221 (11)	0.1
EPRO	4,810 (4)	8,901 (5)	5,996 (4)	19,707 (5)	3.7
NBCS	240 (7)	4,480 (7)	3,750 (6)	8,470 (7)	1.6
BVDB	77 (10)	356 (9)	4 (11)	437 (9)	0.1
CSO9	162 (8)	630 (8)	164 (8)	956 (8)	0.2
NBCB	4 (11)	263 (10)	56 (9)	323 (10)	0.1
Subtotal	5,433 [3.6%]	14,678 [5.5%]	10,003 [9.3%]	30,991 [5.9%]	
Total	150,500	266,984	107,919	526,280	

( ) - Rank based on total load; [ ] - Percent of total load associated with rivers versus STPs

Table F.3 Continued

ORTHOPHOSPHATE					
Station	October Storm 1	May Storm 2	June Storm 3	Total Storms 1-3	Percent of Total
River Input					
BRSM	12,419 (1)	10,416 (2)	5,175 (2)	28,010 (1)	28.1
MOSH	54 (11)	167 (11)	93 (10)	314 (11)	0.3
PAWT	4,918 (4)	5,364 (4)	2,478 (4)	12,760 (4)	12.8
TENM	96 (9)	2,123 (6)	1,065 (5)	3,284 (6)	3.3
WOON	334 (7)	485 (10)	342 (8)	1,161 (9)	1.2
Subtotal	17,821 [54.2%]	18,555 [41.3%]	9,153 [42.0%]	45,529 [45.8%]	
STPs, STP Bypasses, and CSO9					
BVDC	5,560 (3)	11,000 (1)	6,799 (1)	23,359 (2)	23.5
EPRO	1,233 (5)	2,364 (5)	870 (6)	4,467 (5)	4.5
NBCS	7,311 (2)	10,000 (3)	4,271 (3)	21,582 (3)	21.7
BVDB	289 (8)	535 (9)	20 (11)	844 (10)	0.9
CSO9	72 (10)	1,670 (7)	365 (7)	2,107 (7)	2.1
NBCB	572 (6)	751 (8)	296 (9)	1,619 (8)	1.6
Subtotal	15,037 [45.8%]	26,320 [58.7%]	12,621 [58.0%]	53,978 [54.2%]	
Total	32,858	44,875	21,774	99,507	

( ) - Rank based on total load; [ ] - Percent of total load associated with rivers versus STPs

Table F.3 Continued

FECAL COLIFORM									
Station	October Storm 1		May Storm 2		June Storm 3		Total Storms 1-3		Percent of Total
River Input									
BRSM	5.00E13	(6)	3.47E14	(4)	1.96E13	(4)	4.17E14	(5)	6.4
MOSH	8.60E13	(4)	3.30E14	(5)	1.51E14	(3)	5.67E14	(4)	8.7
PAWT	2.39E13	(8)	4.65E13	(7)	7.66E12	(7)	7.80E13	(7)	1.2
TENM	2.35E12	(10)	9.22E12	(8)	1.34E12	(9)	1.29E13	(10)	0.2
WOON	4.94E13	(7)	1.13E14	(6)	1.07E13	(5)	1.72E14	(6)	2.6
Subtotal	2.12E14 [8.2%]		8.48E14 [26.0%]		1.90E14 [27.3%]		1.25E15 [19.1%]		
STPs, STP Bypasses, and CSO9									
BVDC	5.83E12	(9)	1.31E13	(9)	3.07E12	(8)	2.20E13	(9)	0.3
EPRO	2.32E10	(11)	1.07E11	(11)	2.14E10	(11)	1.52E11	(11)	0.1
NBCS	5.21E13	(5)	6.28E11	(10)	6.72E11	(10)	5.34E13	(8)	0.8
BVDB	2.62E14	(3)	6.12E14	(2)	9.54E12	(6)	8.84E14	(3)	13.5
CSO9	1.58E15	(1)	1.31E15	(1)	3.25E14	(1)	3.22E15	(1)	49.2
NBCB	4.67E14	(2)	4.81E14	(3)	1.64E14	(2)	1.11E15	(2)	17.0
Subtotal	2.37E15 [91.8%]		2.41E15 [74.0%]		5.07E14 [72.7%]		5.29E15 [80.9%]		
Total	2.58E15		3.26E15		6.97E14		6.54E15		

( ) - Rank based on total load; [ ] - Percent of total load associated with rivers versus STPs

Table F.3 Continued

Station	October Storm 1	May Storm 2	June Storm 3	Total Storms 1-3	Percent of Total
			E. COLI		
			River Input		
BRSM	3.81E13 (6)	2.70E14 (4)	1.96E13 (4)	3.28E14 (5)	6.8
MOSH	6.85E13 (4)	1.77E14 (5)	1.26E14 (3)	3.72E14 (4)	7.7
PAWT	2.23E13 (8)	3.54E13 (7)	4.42E12 (7)	6.21E13 (7)	1.3
TENM	2.31E12 (10)	6.91E12 (8)	8.36E11 (9)	1.01E13 (10)	0.2
WOON	4.40E13 (5)	7.25E13 (5)	6.79E12 (6)	1.23E14 (6)	2.6
Subtotal	1.75E14 [8.5%]	5.62E14 [24.9%]	1.58E14 [32.0%]	8.95E14 [18.6%]	
		STPs, STP Bypasses, and CSO9			
BVDC	5.79E12 (9)	5.75E12 (9)	2.17E12 (8)	1.37E13 (9)	0.5
EPRO	2.32E10 (11)	1.04E10 (11)	8.96E09 (11)	4.26E10 (11)	0
NBCS	3.38E13 (7)	2.24E11 (10)	3.09E11 (10)	3.43E13 (8)	0.7
BVDB	1.70E14 (3)	3.03E14 (3)	7.50E12 (5)	4.81E14 (3)	10.0
CSO9	1.29E15 (1)	1.05E15 (1)	1.55E14 (2)	2.50E15 (1)	51.9
NBCB	3.84E14 (2)	3.43E14 (2)	1.64E14 (1)	8.91E14 (2)	18.5
Subtotal	1.88E15 [91.5%]	1.70E15 [75.1%]	3.35E14 [68.0%]	3.92E15 [81.4%]	
Total	2.06E15	2.26E15	4.93E14	4.82E15	

( ) - Rank based on total load; [ ] - Percent of total load associated with rivers versus STPs

Table F.3 Continued

ENTEROCOCCI					
Station	October Storm 1	May Storm 2	June Storm 3	Total Storms 1-3	Percent of Total
River Input					
BRSM	1.03E13 (5)	2.88E13 (6)	7.20E12 (3)	4.63E13 (5)	3.1
MOSH	1.37E13 (4)	4.09E13 (4)	5.90E12 (4)	6.05E13 (4)	4.0
PAWT	6.55E12 (7)	7.51E12 (7)	3.43E12 (6)	1.75E13 (7)	1.2
TENM	2.95E11 (10)	2.66E12 (8)	9.50E11 (7)	3.91E12 (8)	0.3
WOON	7.29E12 (6)	3.09E13 (5)	4.46E12 (5)	4.27E13 (6)	2.8
Subtotal	3.81E13 [5.6%]	1.11E14 [17.1%]	2.19E13 [12.2%]	1.71E14 [11.3%]	
STPs, STP Bypasses, and CSO9					
BVDC	7.57E11 (9)	5.57E11 (9)	2.16E11 (8)	1.53E12 (9)	0.1
EPRO	1.16E09 (11)	7.47E09 (11)	1.78E10 (11)	2.64E10 (11)	0
NBCS	1.20E12 (8)	2.52E10 (10)	7.13E10 (9)	1.30E12 (10)	0.1
BVDB	4.10E14 (1)	9.80E13 (3)	5.45E10 (10)	5.08E14 (2)	33.6
CSO9	1.16E14 (3)	2.95E14 (1)	1.10E14 (1)	5.21E14 (1)	34.5
NBCB	1.18E14 (2)	1.46E14 (2)	4.67E13 (2)	3.11E14 (3)	20.6
Subtotal	6.46E14 [94.4%]	5.40E14 [82.9%]	1.57E14 [87.8%]	1.34E15 [88.7%]	
Total	6.84E14	6.51E14	1.79E14	1.51E15	

( ) - Rank based on total load; [ ] - Percent of total load associated with rivers versus STPs

Table F.3 Continued

C. PERFRINGENS

Station	October Storm 1		May Storm 2		June Storm 3		Total Storms 1-3		Percent of Total
River Input									
BRSM	2.04E13	(6)	1.79E14	(2)	3.33E13	(3)	2.33E14	(3)	15.4
MOSH	6.71E12	(8)	1.02E13	(10)	4.52E12	(7)	2.14E13	(9)	1.4
PAWT	2.42E13	(5)	7.76E13	(5)	1.20E13	(5)	1.14E14	(6)	7.5
TENM	7.66E10	(11)	8.11E12	(11)	3.78E11	(11)	8.50E12	(11)	0.6
WOON	3.84E12	(9)	1.63E13	(8)	2.70E12	(8)	2.28E13	(8)	1.5
Subtotal	5.52E13 [5.5%]		2.91E14 [37.1%]		5.29E13 [32.9%]		4.00E14 [26.5%]		
STPs, STP Bypasses, and CSO9									
BVDC	5.51E13	(4)	2.34E14	(1)	3.98E13	(1)	3.29E14	(2)	21.8
EPRO	1.28E12	(10)	1.29E13	(9)	2.51E12	(9)	1.67E13	(10)	1.1
NBCS	2.26E14	(1)	8.97E13	(4)	3.49E13	(2)	3.51E14	(1)	23.2
BVDB	1.53E13	(7)	2.76E13	(6)	5.25E11	(10)	4.34E13	(7)	2.9
CSO9	6.71E13	(3)	1.02E14	(3)	2.44E13	(4)	1.94E14	(4)	12.8
NBCB	1.45E14	(2)	2.71E13	(7)	5.26E12	(6)	1.77E14	(5)	11.7
Subtotal	9.53E14 [94.5%]		4.93E14 [62.9%]		1.08E14 [67.1%]		1.11E15 [73.5%]		
Total	1.01E15		7.84E14		1.61E14		1.51E15		

( ) - Rank based on total load; [ ] - Percent of total load associated with rivers versus STPs

Table F.3 Continued

BACTERIOPHAGE					
Station	October Storm 1	May Storm 2	June Storm 3	Total Storms 1-3	Percent of Total
			River Input		
BRSM	1.41E12 (8)	2.04E12 (8)	1.17E13 (2)	1.52E13 (7)	2.4
MOSH	3.03E12 (7)	5.52E12 (7)	2.93E12 (7)	1.15E13 (8)	1.8
PAWT	3.31E12 (6)	9.70E12 (5)	4.96E12 (5)	1.80E13 (6)	2.8
TENM	5.63E10 (10)	3.02E11 (10)	5.21E10 (10)	4.10E11 (10)	0.1
WOON	4.26E11 (9)	3.63E11 (9)	1.75E12 (8)	2.54E12 (9)	0.4
Subtotal	8.23E12 [11.0%]	1.79E13 [20.7%]	2.14E13 [4.5%]	4.77E13 [7.5%]	
			STPs, STP Bypasses, and CSO9		
BVDC	2.24E13 (1)	1.26E13 (4)	4.31E14 (1)	4.66E14 (1)	73.4
EPRO	5.29E10 (11)	2.59E11 (11)	3.97E10 (11)	3.52E11 (11)	0.1
NBCS	1.22E13 (3)	1.44E13 (3)	9.58E12 (3)	3.62E13 (2)	5.7
BVDB	7.73E12 (5)	1.42E13 (2)	9.87E10 (9)	2.20E13 (5)	3.5
CSO9	8.63E12 (4)	1.82E13 (1)	7.04E12 (4)	3.39E13 (3)	5.3
NBCB	1.53E13 (2)	8.80E12 (6)	4.39E12 (6)	2.85E13 (4)	4.5
Subtotal	6.64E13 [89.0%]	6.85E13 [79.3%]	4.53E14 [95.5%]	5.87E14 [92.5%]	
Total	7.46E13	8.64E13	4.74E14	6.35E14	

( ) - Rank based on total load; [ ] - Percent of total load associated with rivers versus STPs

APPENDIX G

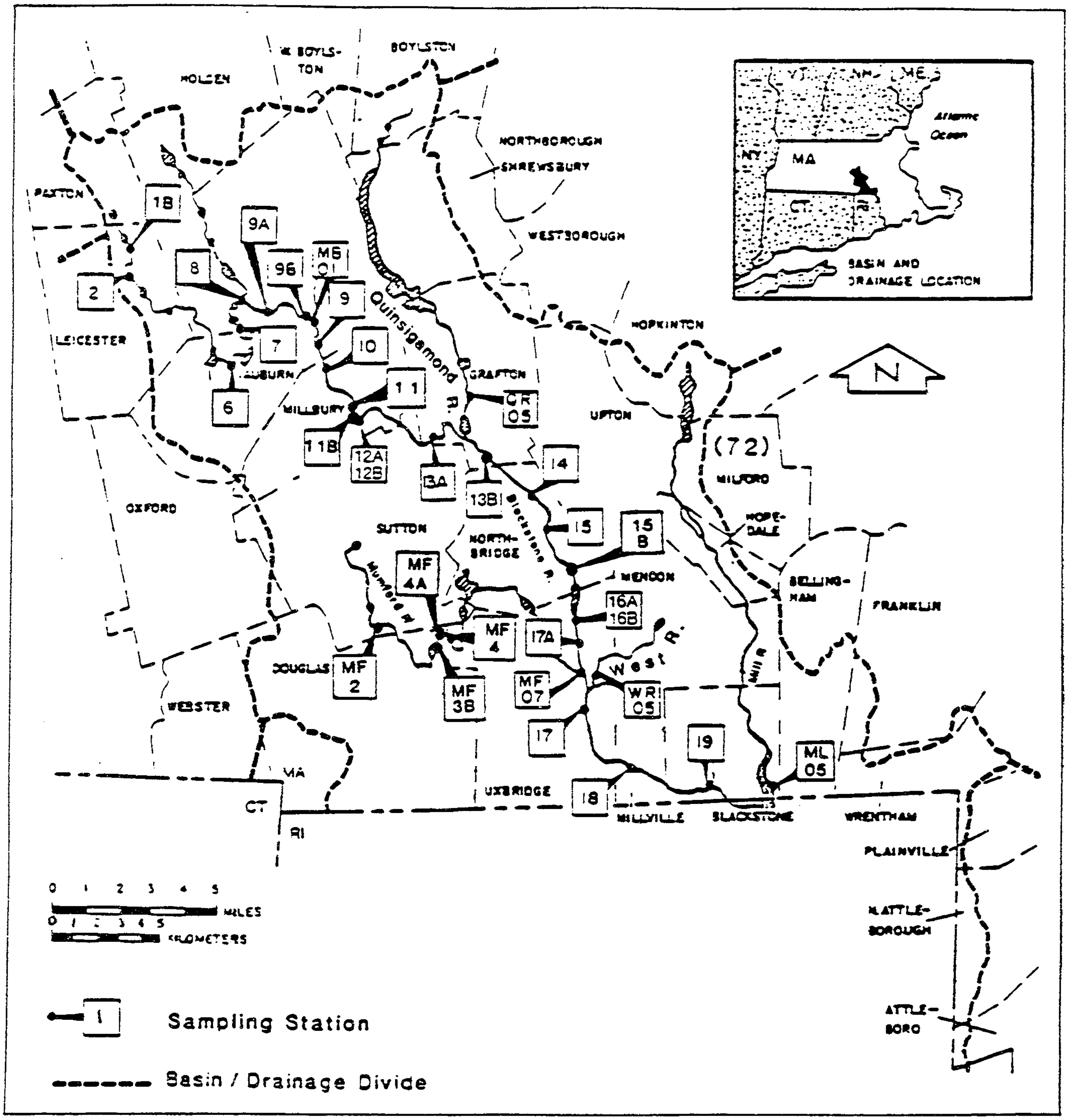


Figure G.1 Sampling Locations for the 1985 MA DEQE Study
(MA DEQE 1985)

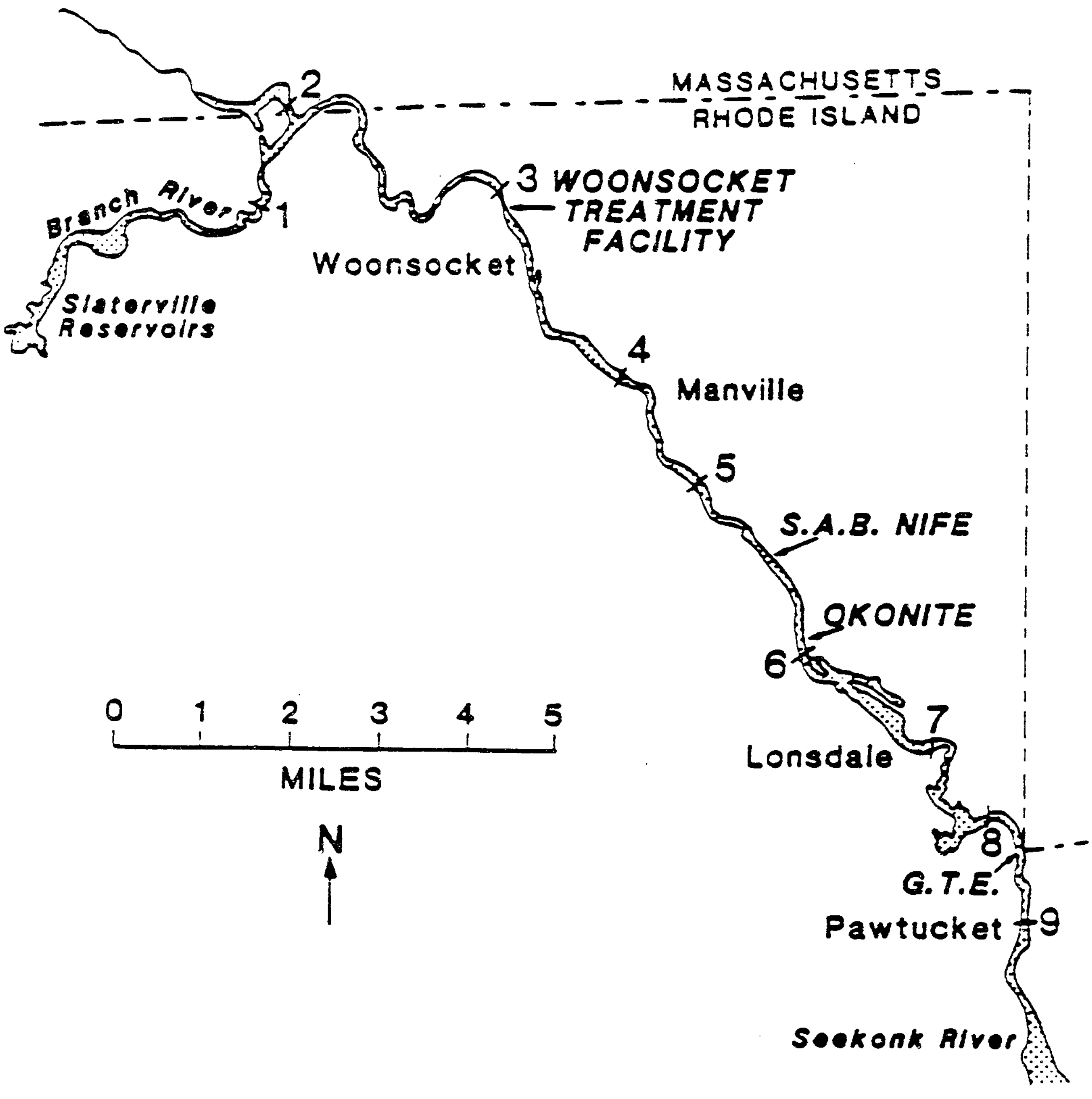


Figure G.2 Sampling Locations for the 1985 URI Study (Wright 1988)

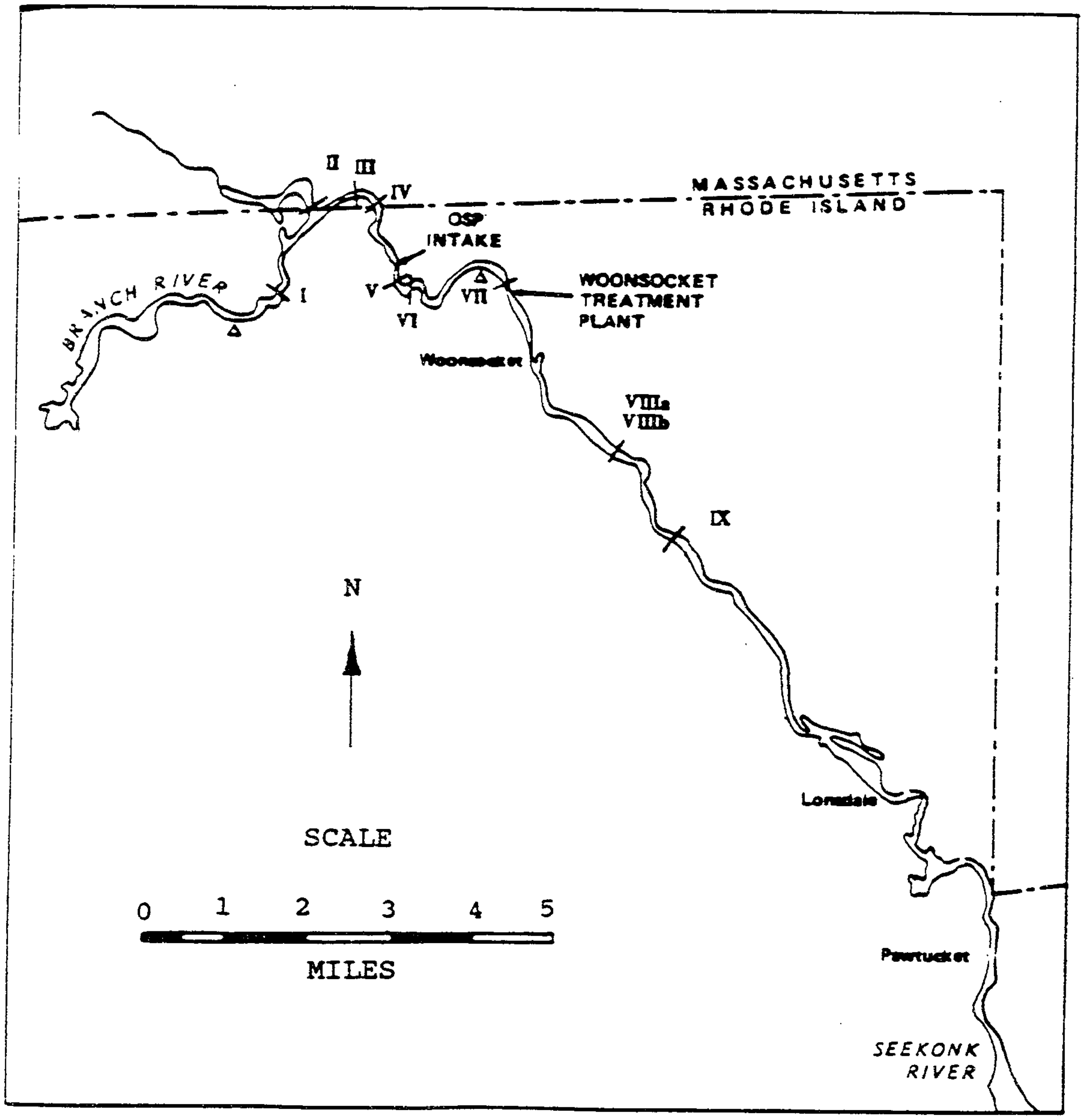


Figure G.3 Sampling Locations for the 1988 Ocean State Power Study (OSP 1988)

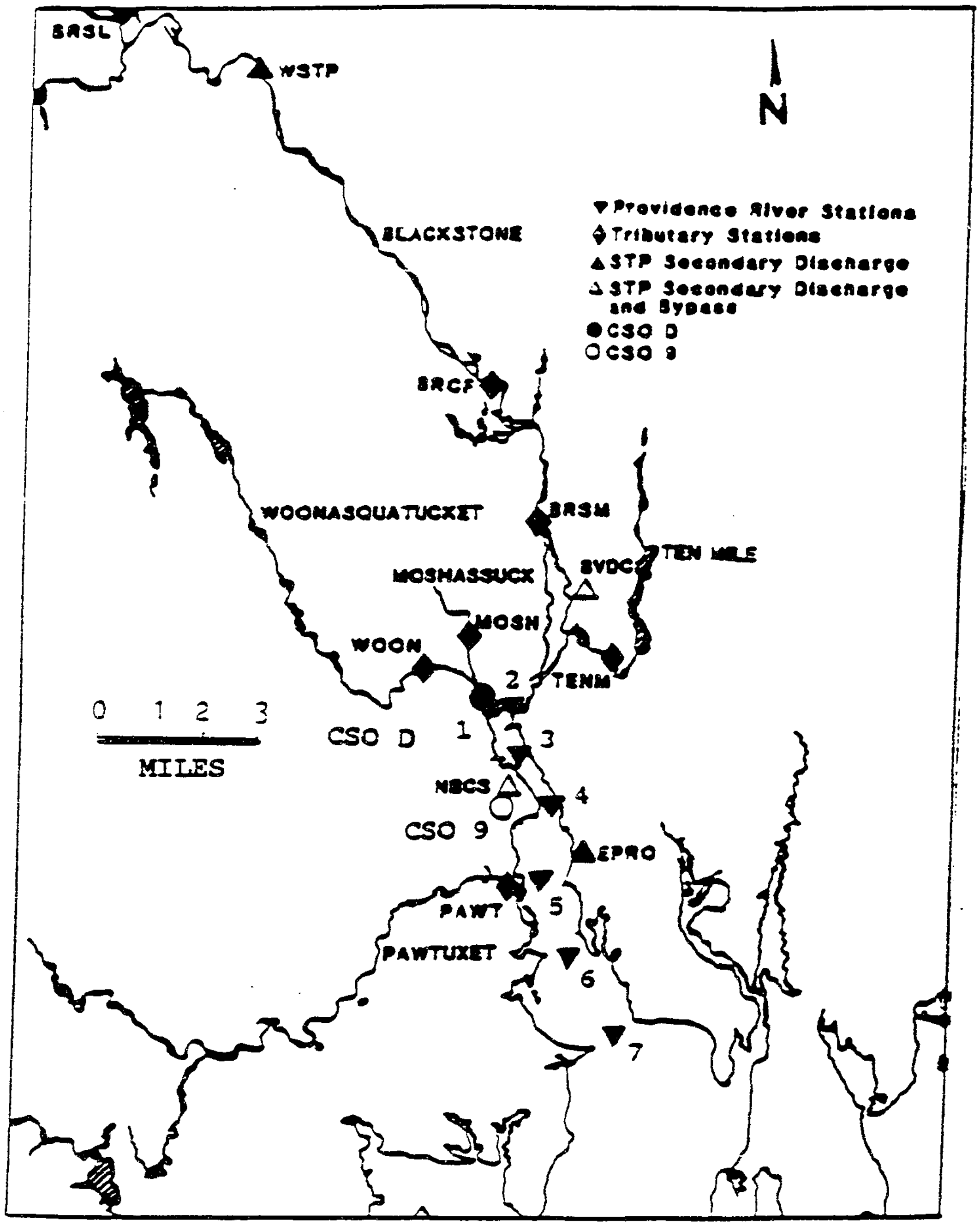


Figure G.4 Sampling Locations for the 1988/89 URI Wet Weather Study (Wright et al. 1991a)

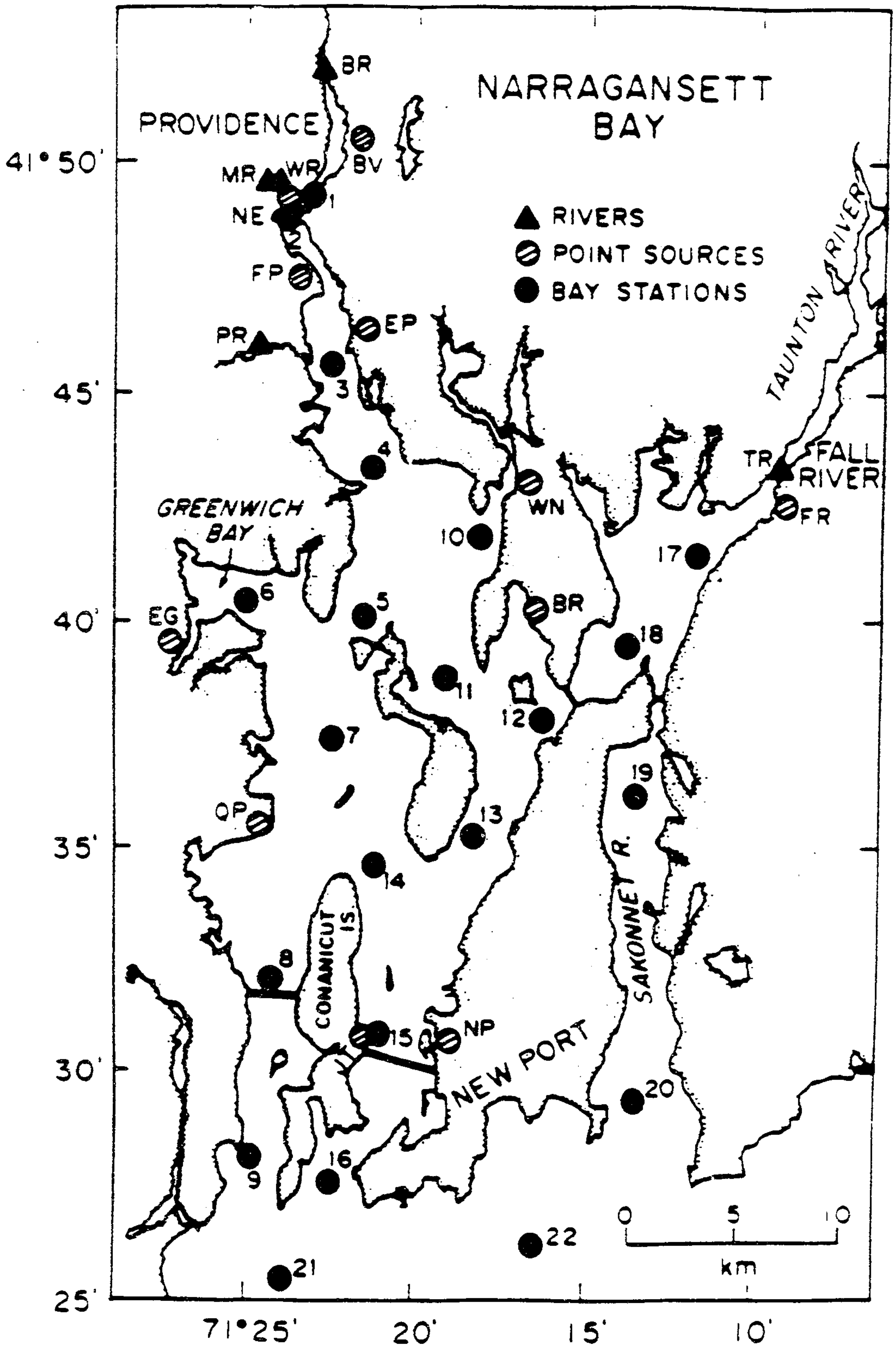


Figure G.5 Sampling Locations for the 1985/86 URI SINBADD Study (Pilson and Hunt 1989)

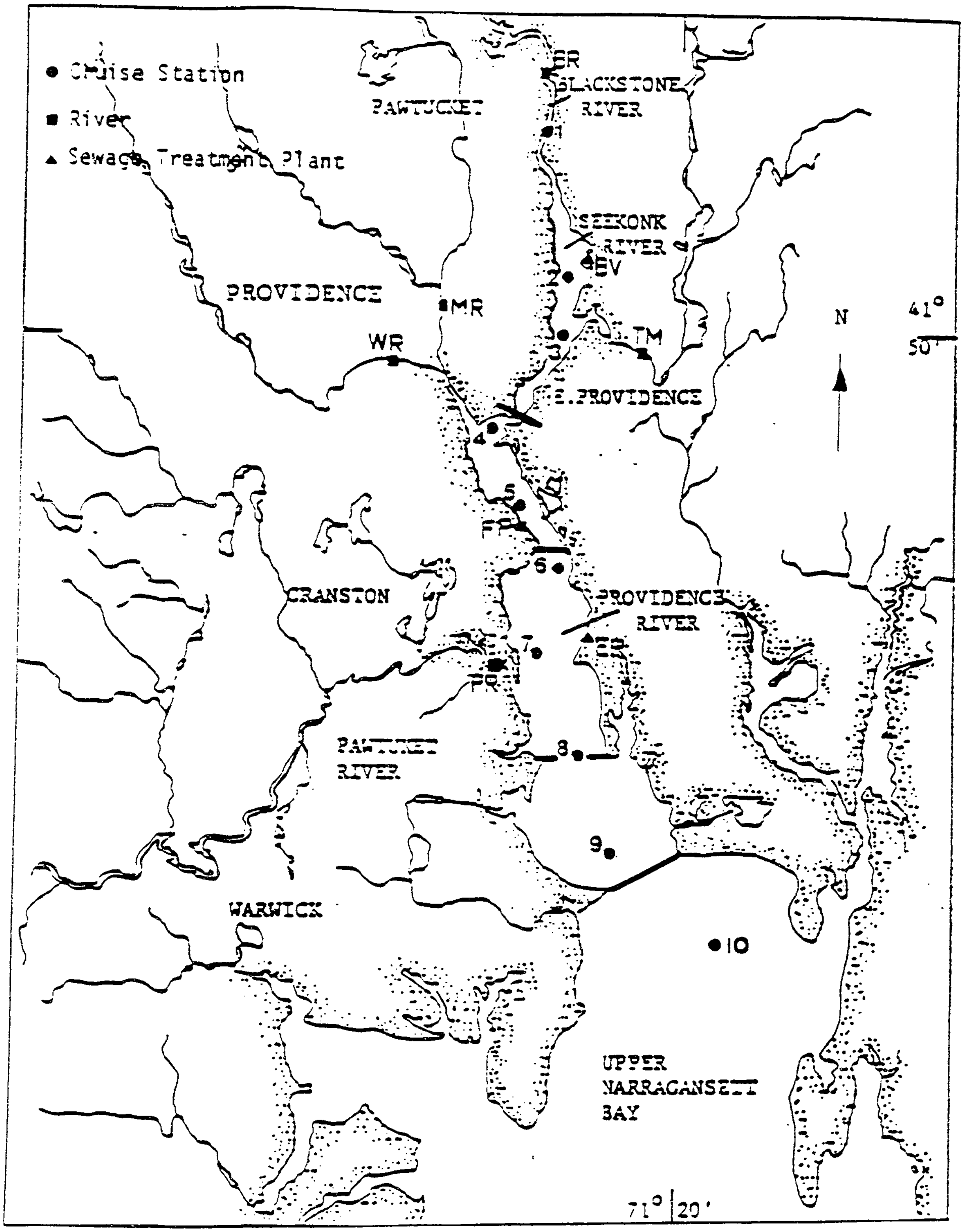


Figure G.6 Sampling Locations for the 1986/87 URI SPRAY Study (Doering et al. 1989)

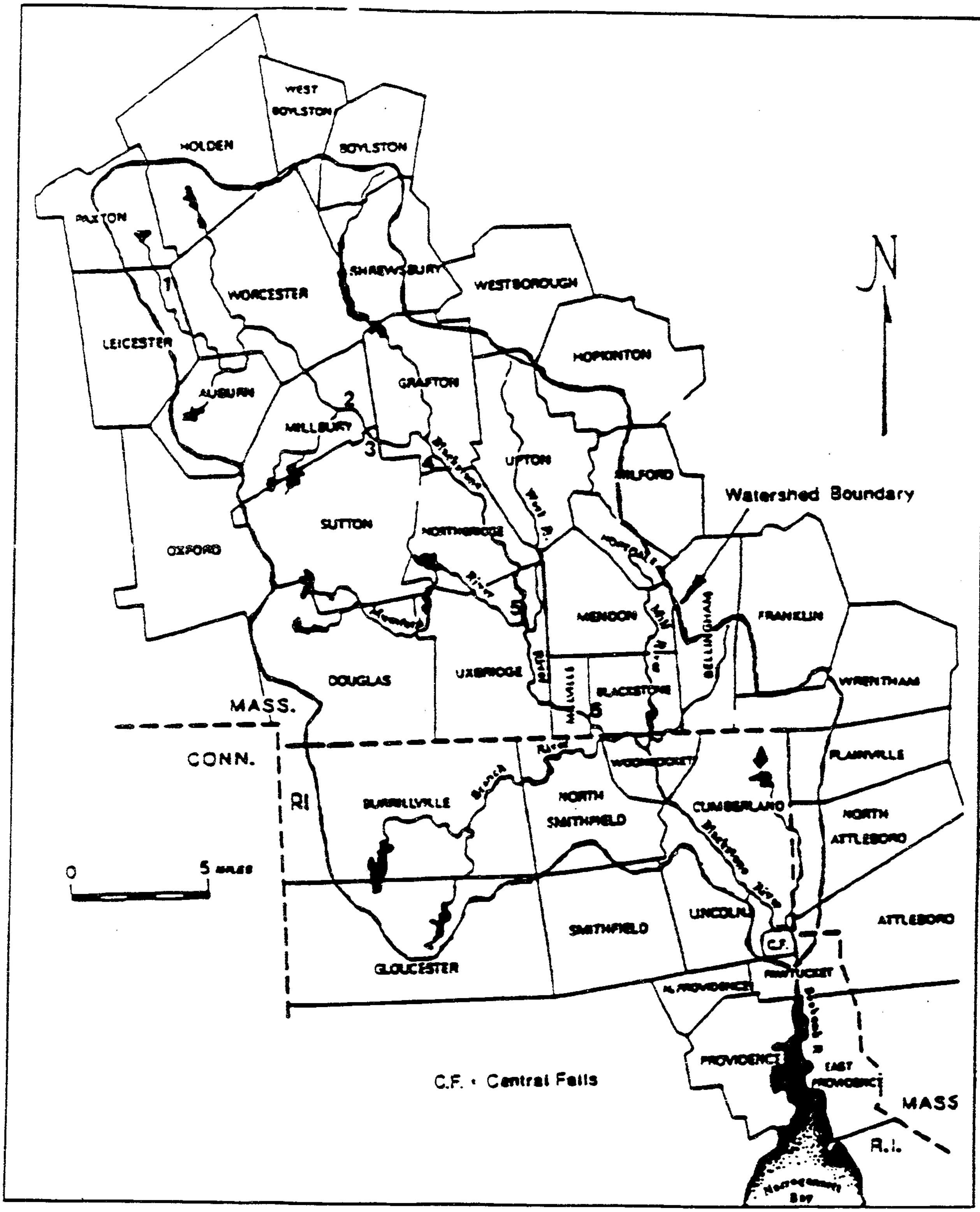


Figure G.7 Sampling Locations for the 1989 MA DEP Study (Lewis and Brubaker 1990)