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Blackstone River Initiative

Phase 1: Dry Weather Assessment
Interim Report of Data 1991

APPENDICES

Prepared by:
The U.S. EPA Region 1 and the
Massachusetts Division of Water Pollution Control
in cooperation with the
Rhode Island Dept. of Environmental Management
and The University of Rhode Island

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1991 BLACKSTONE RIVER SURVEY

Phase 1: Dry Weather Assessment

Appendix A

1991 BLACKSTONE RIVER SURVEY

CHEMISTRY AND TOXICITY OF DISCHARGERS

Edward G. Foree, Ph.D., P.E.

John S. Tapp, Ph.D., P.E., L.S.

COMMONWEALTH TECHNOLOGY, INC.

Environmental and Natural Resources Consulting and Analytical Services

Lexington, Kentucky Louisville, Kentucky Grayson, Kentucky

BIOMONITORING JOB NO: 4006/EPA 4086 - Chronic Study
SAS 1109

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I. INTRODUCTION

Facility: Region I **NPDES Permit No:** N/A

Contact: Ms. Cindy Schreyer **Phone No:** (703) 519-1386

Receiving Stream: N/A **Contact:** Billie Rogers

Laboratory: Commonwealth Technology, Inc.
2520 Regency Road
Lexington, Kentucky 40503-2961
(606) 276-3506

O.K/AS OF JUL 4 1991.

II. SAMPLES (EFFLUENT AND DILUTION WATER)

1. **Effluent**
   Sample Point: Final Effluent
   Collection Dates and Times: 06/03/91/7:25AM; 06/05/91/7:45AM; 06/07/91/12:25AM
   Collection Method: 24 Hour Composite
   Physical and Chemical Data: See Attached Data Sheet in Appendix A

2. **Dilution Water**
   The water used for dilutions and control was a moderately hard reconstituted water adjusted to pH 7.8. The physical and chemical data of the dilution water is reported in Appendix A.

III. TEST METHODS

Test Method: "Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms" EPA/600/4-89/001.

Deviations from methods, if any, and explanation: After warming the samples to 25°C the samples with dissolved oxygen (D.O.) readings greater than 100 percent saturation were aerated slowly until D.O. was less than 100%.

Date and Time Test Started: 06/04/91 (6:30PM); 06/04/91 (6:00PM)
Date and Time Test Terminated: 06/12/91 (7:15PM); 06/11/91 (5:00PM)
Test Chambers: Refer to Table 1
Volume used per Chamber: Refer to Table 1
Number of Organisms per Chamber: Refer Table 1
Number of Replicates per Concentrations: Refer to Table 1
Acclimation of Organisms: Refer to Table 1
Test Temperature (mean and range): Cultured at test temperature, 25° ± 1°C

IV. TEST ORGANISMS

Name: *Ceriodaphnia dubia*; *Pimephales promelas*

Age: Less than 24 hours; 2 days

Source: Stock N; Stock F

Life Stage: Neonate; Juvenile

Mean Length and Weight (if applicable): N/A

V. QUALITY ASSURANCE

Standard Toxicant: Sodium Chloride

Date and Time of Most Recent Test:

Ceriodaphnia dubia 06/12/91 (5:30PM)
Pimephales promelas 06/06/91 (1:00PM)

Dilution Water Used: Reconstituted Water, 10% Perrier Water

Results: *Ceriodaphnia dubia* - LC_{50} (48 hrs) = 2846 mg/l NaCl
Pimephales promelas - LC_{50} (96 hrs) = 6587 mg/L NaCl

Results are in acceptable range as determined by laboratory's testing program.

VI. RESULTS

NOEC - C ≥ 11% (RWC) LC50 ≥ 100%

State Permit Limits: N/A; **NOEL:** N/A

Test Results: Toxicity was indicated with the *Ceriodaphnia dubia* and the fathead minnow. The NOEC for the *Ceriodaphnia dubia* was 6.25% effluent concentration. The NOEC for the fathead minnow was 50% effluent concentration. The LOEC, EC_{50}, and the Chronic Values are presented in Table 2.

Data Tables and Analysis: Presented in Table 2

Indicate Statistical Methods Used: Presented in Table 2

Raw Data: Bench Sheet Data is Presented in Appendix A.

TABLE 1
SUMMARY OF TEST CONDITIONS FOR CHRONIC TOXICITY TEST
METHOD: EPA 600/4-89/001

		Ceriodaphnia dubia **Method: 1002.0**	*Pimephales promelas* **Method: 1000.0**
1.	**Test Type:**	Static-Renewal	Static-Renewal
2.	**Temperature:**	25° ± 1°C	25° ± 1°C
3.	**Light Quality:**	Ambient laboratory illumination (cool white)	Ambient laboratory illumination (cool white)
4.	**Light Intensity:**	Approx. 100 ft-c	Approx. 100 ft-c
5.	**Photoperiod:**	8 hrs. dark, 16 hrs. light	8 hrs. dark, 16 hrs. light
6.	**Test Chamber Size:**	30 mls	270 ml
7.	**Test Solution Volume:**	15 ml/replicate	200 ml/replicate
8.	**Renewal of Test Concentrations:**	Daily	Daily
9.	**Age of Test Organism:**	Less than 24 hours	1-2 days
10.	**No. of Test Organisms per Chamber:**	1	10
11.	**No. of Replicate Chambers per Concentration:**	10	3
12.	**Feeding Regime:**	Fed YCT (yeast suspension) & *Selenastrum minutum* (algae) suspension daily.	Fed brine shrimp nauplii in a concentrated suspension twice daily.
13.	**Aeration:**	Samples with D.O. greater than 100% saturation were aerated	Samples with D.O. greater than 100% than 100% saturation were aerated
14.	**Dilution Water:**	Reconstituted water (10% Perrier water)	Reconstituted water (10% Perrier water)
15.	**Effluent Concentrations:**	100%, 50%, 25%, 12.5%, 6.25%	100%, 50%, 25%, 12.5%, 6.25%
16.	**Test Duration:**	7 days or until 60% of the the control females have 3 broods	7-days
17.	**Effects Measured:**	Survival and Reproduction	Survival and Growth
18.	**Test Acceptability:**	80% or greater survival in the control concentration	80% or greater survival in the control concentration

TABLE 2

SUMMARY OF CHRONIC BIOMONITORING RESULTS
SAMPLES COLLECTED JUNE 3, 5, and 7, 1991
EPA NO: 4086

Test Organism	Sample ID	Test Concentration (%)	Survival Data Analysis: % Survival by Days 1	2	3	4	5	6	7	8	Tox.	Method	Reproduction Data Analysis: Average # Young Produced	Tox.	Method
Ceriodaphnia dubia	Control	---	100	100	100	100	100	100	100	100	---	---	25	---	---
	Final Effluent	6.25	100	100	100	100	100	90	90	90	No	Inspection	37	No	Inspection
		12.5	100	100	100	100	100	100	100	100	No	Inspection	11	Yes	Dunnett's
		25	100	100	100	100	100	100	100	100	No	Inspection	6	Yes	Dunnett's
		50	100	100	100	80	0	0	0	0	Yes	Inspection	N/A	N/A	N/A
		100	0	0	0	0	0	0	0	0	Yes	Inspection	N/A	N/A	N/A

Finding: NOEC = 6.25% Effluent Concentration,
LOEC = 12.5% Effluent Concentration,
ChV = 8.8% Effluent Concentration,
EC_{50} = 35% Effluent Concentration,
Toxicity

Test Organism	Sample ID	Test Concentration (%)	Survival Data Analysis: % Survival by Days 1	2	3	4	5	6	7	Tox.	Method	Growth Data Analysis: Average Wt. per Larvae (mg)	Tox.	Method
Fathead Minnow	Control	---	100	100	100	97	93	87	80	---	---	0.29	---	---
	Final Effluent	6.25	100	100	100	100	97	93	83	No	Inspection	0.36	No	Inspection
		12.5	100	100	100	100	100	100	97	No	Inspection	0.36	No	Inspection
		25	100	100	97	97	97	97	97	No	Inspection	0.34	No	Inspection
		50	100	100	100	97	90	90	90	No	Inspection	0.25	No	Dunnett's
		100	63	37	10	10	3	0	0	Yes	Inspection	N/A	N/A	N/A

Finding: NOEC = 50% Effluent Concentration,
LOEC = 100% Effluent Concentration,
ChV = 71% Effluent Concentration,
EC_{50} = 65%Effluent Concentration,
Toxicity

Blackstone River Survey
Worcester Finishing, Leicester, Ma.

CHEMICAL ANALYSIS OF TOXICITY SAMPLES
24-hr time-composite samples

ANALYTICAL RESULTS

PARAMETERS	Collection Dates 06/03/91	06/05/91	06/09/91
Al	1.1	0.95	1.0
Cd	ND	0.005	0.009
Ca	1.6	2.1	4.8
Cr	ND	ND	ND
Cu	0.775	0.700	0.900
Pb	0.001	0.001	0.002
Mg	2.5	2.8	2.8
Ni	ND	ND	0.02
Zn	0.082	0.067	0.086
N-NH4	0.66	0.54	0.760
TS	5,800	5,900 6,000D	6,100
TSS	39	32 31D	30
TOC	76	73	89
Alk.(as mg/l $CaCO_3$)	340	350	350

NOTES: D= Sample Duplicate
TS= Total Solids
ND= Below minimum detectable level
TOC= Total Organic Carbons
Alk.= Alkalinity
TSS= Total Suspensed Solids

Edward G. Foree, Ph.D., P.E.

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COMMONWEALTH TECHNOLOGY, INC.

Environmental and Natural Resources Consulting and Analytical Services

Lexington, Kentucky Louisville, Kentucky Grayson, Kentucky

BIOMONITORING JOB NO: 4006/EPA 4090 - Chronic Study
SAS 1109

New England Plastics
Worcester, MA

JUL 4 1991

O.K. AS OF

I. INTRODUCTION

Facility: Region I **NPDES Permit No:** N/A

Contact: Ms. Cindy Schreyer **Phone No:** (703) 519-1386

Receiving Stream: N/A **Contact:** Billie Rogers

Laboratory: Commonwealth Technology, Inc.
2520 Regency Road
Lexington, Kentucky 40503-2961
(606) 276-3506

II. SAMPLES (EFFLUENT AND DILUTION WATER)

1. **Effluent**
   Sample Point: Final Effluent
   Collection Dates and Times: 06/03/91/9:30AM; 06/04/91/11:45PM; 06/06/91/11:00PM
   Collection Method: 24 Hour Composite
   Physical and Chemical Data: See Attached Data Sheet in Appendix A

2. **Dilution Water**
   The water used for dilutions and control was a moderately hard reconstituted water adjusted to pH 7.8. The physical and chemical data of the dilution water is reported in Appendix A.

III. TEST METHODS

Test Method: "Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms" EPA/600/4-89/001.

Deviations from methods, if any, and explanation: Samples with dissolved oxygen greater than 100 percent saturation, after warming, were aerated slowly until D.O. was below 100%.

Date and Time Test Started: 06/04/91 (7:15PM); 06/04/91 (7:30PM)
Date and Time Test Terminated: 06/12/91 (5:55PM); 06/11/91 (6:00PM)
Test Chambers: Refer to Table 1
Volume used per Chamber: Refer to Table 1
Number of Organisms per Chamber: Refer Table 1
Number of Replicates per Concentrations: Refer to Table 1
Acclimation of Organisms: Refer to Table 1
Test Temperature (mean and range): Cultured at test temperature, 25° ± 1°C

TABLE 1
SUMMARY OF TEST CONDITIONS FOR CHRONIC TOXICITY TEST
METHOD: EPA 600/4-89/001

		Ceriodaphnia dubia Method: 1002.0	*Pimephales promelas* Method: 1000.0
1.	Test Type:	Static-Renewal	Static-Renewal
2.	Temperature:	25° ± 1°C	25° ± 1°C
3.	Light Quality:	Ambient laboratory illumination (cool white)	Ambient laboratory illumination (cool white)
4.	Light Intensity:	Approx. 100 ft-c	Approx. 100 ft-c
5.	Photoperiod:	8 hrs. dark, 16 hrs. light	8 hrs. dark, 16 hrs. light
6.	Test Chamber Size:	30 mls	270 ml
7.	Test Solution Volume:	15 ml/replicate	200 ml/replicate
8.	Renewal of Test Concentrations:	Daily	Daily
9.	Age of Test Organism:	Less than 24 hours	1-2 days
10.	No. of Test Organisms per Chamber:	1	10
11.	No. of Replicate Chambers per Concentration:	10	3
12.	Feeding Regime:	Fed YCT (yeast suspension) & Selenastrum minutum (algae) suspension daily.	Fed brine shrimp nauplii in a concentrated suspension twice daily.
13.	Aeration:	Samples with D.O. greater than 100% saturation were aerated.	Samples with D.O. greater than 100% saturation were aerated.
14.	Dilution Water:	Reconstituted water (10% Perrier water)	Reconstituted water (10% Perrier water)
15.	Effluent Concentrations:	100%, 50%, 25%, 12.5%, 6.25%	100%, 50%, 25%, 12.5%, 6.25%
16.	Test Duration:	7 days or until 60% of the control females have 3 broods	7-days
17.	Effects Measured:	Survival and Reproduction	Survival and Growth
18.	Test Acceptability:	80% or greater survival in the control concentration	80% or greater survival in the control concentration

IV. TEST ORGANISMS

Name: *Ceriodaphnia dubia*; *Pimephales promelas*

Age: Less than 24 hours; 1 day

Source: Stock N; Stock F

Life Stage: Neonate; Juvenile

Mean Length and Weight (if applicable): N/A

V. QUALITY ASSURANCE

Standard Toxicant: Sodium Chloride

Date and Time of Most Recent Test:

Ceriodaphnia dubia 06/12/91 (5:30PM)
Pimephales promelas 06/06/91 (1:00PM)

Dilution Water Used: Reconstituted Water, 10% Perrier Water

Results: *Ceriodaphnia dubia* - LC_{50} (48 hrs) = 2846 mg/l NaCl
Pimephales promelas - LC_{50} (96 hrs) = 6176 mg/L NaCl

Results are in acceptable range as determined by laboratory's testing program.

VI. RESULTS

NOEC-C: LC50:

State Permit Limits: N/A; **NOEL:** N/A

Test Results: Toxicity was indicated with the *Ceriodaphnia dubia* and the fathead minnow. The NOEC for the *Ceriodaphnia dubia* was <6.25% effluent concentration. The NOEC for the fathead minnow was 50% effluent concentration. The LOEC, EC_{50}, and the Chronic Values are presented in Table 2.

Data Tables and Analysis: Presented in Table 2

Indicate Statistical Methods Used: Presented in Table 2

Raw Data: Bench Sheet Data is Presented in Appendix A.

TABLE 2

SUMMARY OF CHRONIC BIOMONITORING RESULTS
SAMPLES COLLECTED JUNE 3, 4, and 6, 1991
EPA NO: 4090

Test Organism	Sample ID	Test Concentration (%)	Survival Data Analysis: % Survival by Days 1	2	3	4	5	6	7	8	Tox.	Method	Reproduction Data Analysis: Average # Young Produced	Tox.	Method
Ceriodaphnia dubia	Control	---	100	100	100	100	100	100	100	100	---	---	N/A	---	---
	Final Effluent	6.25	100	70	70	70	70	70	70	60	Yes	Fisher's	N/A	N/A	N/A
		12.5	100	0	0	0	0	0	0	0	Yes	Inspection	N/A	N/A	N/A
		25	100	0	0	0	0	0	0	0	Yes	Inspection	N/A	N/A	N/A
		50	0	0	0	0	0	0	0	0	Yes	Inspection	N/A	N/A	N/A
		100	0	0	0	0	0	0	0	0	Yes	Inspection	N/A	N/A	N/A

Finding: **NOEC < 6.25% Effluent Concentration,**
LOEC > 6.25% Effluent Concentration,
ChV > 6.25% Effluent Concentration,
EC_{50} < 6.25% Effluent Concentration,
Toxicity

Test Organism	Sample ID	Test Concentration (%)	Survival Data Analysis: % Survival by Days 1	2	3	4	5	6	7	Tox.	Method	Growth Data Analysis: Average Wt. per Larvae (mg)	Tox.	Method
Fathead Minnow	Control	---	100	100	100	100	93	87	87	---	---	0.29	---	---
	Final Effluent	6.25	100	100	100	97	97	93	93	No	Inspection	0.26	No	Inspection
		12.5	100	100	97	97	97	93	93	No	Inspection	0.27	No	Inspection
		25	100	97	97	97	97	93	97	No	Inspection	0.36	No	Inspection
		50	100	100	100	90	90	87	87	No	Inspection	0.37	No	Inspection
		100	67	20	17	17	17	17	17	Yes	Inspection	N/A	N/A	N/A

Finding: **NOEC = 50% Effluent Concentration,**
LOEC = 100% Effluent Concentration,
ChV = 71% Effluent Concentration,
EC_{50} > 100% Effluent Concentration,
Toxicity

Blackstone River Survey
New England Plating, Worcester, Ma.

CHEMICAL ANALYSIS OF TOXICITY SAMPLES
24-hr time-composite samples

ANALYTICAL RESULTS
(mg/l unless otherwise noted)

PARAMETERS	Collection Dates 06/03/91	06/04/91	06/06/91
Al	0.02	0.05 0.01D	ND
Cd	0.017	ND 0.005D	ND
Ca	320	140 140D	120
Cr	0.021	ND NDD	ND
Cu	0.080	0.083 0.078D	0.065
Pb	0.001	0.001 NDD	ND
Mg	0.98	2.2 2.2D	0.065
Ni	0.44	0.23 0.25D	0.22
Zn	0.743	0.757 0.789D	0.871
N-NH4	8.1	12	7.4
TS	2500	3,200	2,700
TSS	4.0	5.7	7.0
TOC	31	23	23
Alk.(as $CaCO_3$)	110	110	90

NOTES: D= Sample Duplicate
TS= Total Solids
ND= Below minimum detectable level
TOC= Total Organic Carbons
Alk.= Alkalinity
TSS= Total Suspensed Solids

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Lexington, Kentucky Louisville, Kentucky Grayson, Kentucky

UBWPAD

BIOMONITORING JOB NO: 4006/EPA 4089 - Chronic Study
SAS 1109

Upper Blackstone WPAD
Millbury MA

O.K. to DF JUL 4 1991

I. INTRODUCTION

Facility: Region I **NPDES Permit No:** N/A

Contact: Ms. Cindy Schreyer **Phone No:** (703) 519-1386

Receiving Stream: N/A **Contact:** Billie Rogers

Laboratory: Commonwealth Technology, Inc.
2520 Regency Road
Lexington, Kentucky 40503-2961
(606) 276-3506

II. SAMPLES (EFFLUENT AND DILUTION WATER)

1. **Effluent**
   Sample Point: Final Effluent
   Collection Dates and Times: 06/03/91/8:27AM; 06/05/91/8:15AM; 06/07/91/12:30AM
   Collection Method: 24 Hour Composite
   Physical and Chemical Data: See Attached Data Sheet in Appendix A

2. **Dilution Water**
   The water used for dilutions and control was a moderately hard reconstituted water adjusted to pH 7.8. The physical and chemical data of the dilution water is reported in Appendix A.

III. TEST METHODS

Test Method: "Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms" EPA/600/4-89/001.

Deviations from methods, if any, and explanation: Samples with dissolved oxygen readings greater than 100 percent saturation, after warming, were aerated slowly until D.O. was below 100%.

Date and Time Test Started: 06/04/91 (7:30PM); 06/04/91 (7:00PM)
Date and Time Test Terminated: 06/12/91 (6:33PM); 06/11/91 (6:00PM)
Test Chambers: Refer to Table 1
Volume used per Chamber: Refer to Table 1
Number of Organisms per Chamber: Refer Table 1
Number of Replicates per Concentrations: Refer to Table 1
Acclimation of Organisms: Refer to Table 1
Test Temperature (mean and range): Cultured at test temperature, 25° ± 1°C

TABLE 1
SUMMARY OF TEST CONDITIONS FOR CHRONIC TOXICITY TEST
METHOD: EPA 600/4-89/001

		Ceriodaphnia dubia Method: 1002.0	*Pimephales promelas* Method: 1000.0
1.	**Test Type:**	Static-Renewal	Static-Renewal
2.	**Temperature:**	25° ± 1°C	25° ± 1°C
3.	**Light Quality:**	Ambient laboratory illumination (cool white)	Ambient laboratory illumination (cool white)
4.	**Light Intensity:**	Approx. 100 ft-c	Approx. 100 ft-c
5.	**Photoperiod:**	8 hrs. dark, 16 hrs. light	8 hrs. dark, 16 hrs. light
6.	**Test Chamber Size:**	30 mls	270 ml
7.	**Test Solution Volume:**	15 ml/replicate	200 ml/replicate
8.	**Renewal of Test Concentrations:**	Daily	Daily
9.	**Age of Test Organism:**	Less than 24 hours	1-2 days
10.	**No. of Test Organisms per Chamber:**	1	10
11.	**No. of Replicate Chambers per Concentration:**	10	3
12.	**Feeding Regime:**	Fed YCT (yeast suspension) & *Selenastrum minutum* (algae) suspension daily.	Fed brine shrimp nauplii in a concentrated suspension twice daily.
13.	**Aeration:**	Samples with D.O. greater than 100% saturation were aerated.	Samples with D.O. greater than 100% saturation were aerated.
14.	**Dilution Water:**	Reconstituted water (10% Perrier water)	Reconstituted water (10% Perrier water)
15.	**Effluent Concentrations:**	100%, 50%, 25%, 12.5%, 6.25%	100%, 50%, 25%, 12.5%, 6.25%
16.	**Test Duration:**	7 days or until 60% of the control females have 3 broods	7-days
17.	**Effects Measured:**	Survival and Reproduction	Survival and Growth
18.	**Test Acceptability:**	80% or greater survival in the control concentration	80% or greater survival in the control concentration

IV. TEST ORGANISMS

Name: *Ceriodaphnia dubia*; *Pimephales promelas*

Age: Less than 24 hours; 1 day

Source: Stock N; Stock F

Life Stage: Neonate; Juvenile

Mean Length and Weight (if applicable): N/A

V. QUALITY ASSURANCE

Standard Toxicant: Sodium Chloride

Date and Time of Most Recent Test:

Ceriodaphnia dubia 06/12/91 (5:30PM)
Pimephales promelas 06/06/91 (1:00PM)

Dilution Water Used: Reconstituted Water, 10% Perrier Water

Results: *Ceriodaphnia dubia* - LC_{50} (48 hrs) = 2846 mg/l NaCl
Pimephales promelas - LC_{50} (96 hrs) = 6587 mg/L NaCl

Results are in acceptable range as determined by laboratory's testing program.

VI. RESULTS

State Permit Limits: N/A; **NOEL:** N/A

Test Results: No toxicity was indicated with the *Ceriodaphnia dubia* or the fathead minnow. The NOEC values for the *Ceriodaphnia dubia* and the fathead minnow were >100% effluent concentration. The LOEC, EC_{50}, and the Chronic Values are presented in Table 2.

Data Tables and Analysis: Presented in Table 2

Indicate Statistical Methods Used: Presented in Table 2

Raw Data: Bench Sheet Data is Presented in Appendix A.

TABLE 2

SUMMARY OF CHRONIC BIOMONITORING RESULTS
SAMPLES COLLECTED JUNE 3, 5, and 7, 1991
EPA NO: 4089

			Survival Data Analysis										Reproduction Data Analysis		
			% Survival by Days												
Test Organism	Sample ID	Test Concentration (%)	1	2	3	4	5	6	7	8			Average # Tox. Produced	Method	YoungTox.Mthd
Ceriodaphnia dubia	Control	---	100	100	100	100	100	100	100	100	---	---	25	---	---
	Final Effluent	6.25	100	90	90	80	80	80	80	80	No	Inspection	20	No	Inspection
		12.5	100	100	100	100	100	100	100	100	No	Inspection	30	No	Inspection
		25	100	100	100	90	90	90	90	90	No	Inspection	23	No	Inspection
		50	100	90	90	90	90	90	80	80	No	Inspection	21	No	Inspection
		100	90	90	90	80	80	80	80	70	No	Inspection	18	No	Dunnett's

Finding: NOEC > 100% Effluent Concentration,
LOEC > 100% Effluent Concentration,
ChV = 100% Effluent Concentration,
EC_{50} > 100% Effluent Concentration,
No Toxicity

			Survival Data Analysis									Growth Data Analysis		
			% Survival by Days											
Test Organism	Sample ID	Test Concentration (%)	1	2	3	4	5	6	7	Tox.	Method	Average Wt. per Larvae (mg)	Tox.	Method
Fathead Minnow	Control	---	97	97	97	97	97	90	90	---	---	0.26	---	---
	Final Effluent	6.25	97	97	97	97	97	93	90	No	Inspection	0.19	No	Inspection
		12.5	93	93	93	93	93	93	90	No	Inspection	0.25	No	Inspection
		25	97	97	90	90	90	90	90	No	Inspection	0.19	No	Inspection
		50	100	100	97	93	93	93	90	No	Inspection	0.16	No	Inspection
		100	97	93	93	93	93	90	90	No	Inspection	0.25	No	Dunnett's

Finding: NOEC > 100% Effluent Concentration,
LOEC > 100% Effluent Concentration,
ChV = 100% Effluent Concentration,
EC_{50} > 100% Effluent Concentration,
No Toxicity

Edward G. Foree, Ph.D., P.E.

John S. Tapp, Ph.D., P.E., L.S.

COMMONWEALTH TECHNOLOGY, INC.

Environmental and Natural Resources Consulting and Analytical Services

Lexington, Kentucky Louisville, Kentucky Grayson, Kentucky

BIOMONITORING JOB NO: 4006/EPA 4189 - Chronic Study
SAS 1109

Upper Blackstone Water Pollution Abatement District

I. INTRODUCTION

Facility: Region I **NPDES Permit No:** N/A

Contact: Ms. Cindy Schreyer **Phone No:** (703) 519-1386

Receiving Stream: N/A **Contact:** Billie Rogers

Laboratory: Commonwealth Technology, Inc.
2520 Regency Road
Lexington, Kentucky 40503-2961
(606) 276-3506

II. SAMPLES (EFFLUENT AND DILUTION WATER)

1. **Effluent**
   Sample Point: Final Effluent
   Collection Dates and Times: 08/05/91/6:55AM; 08/07/91/5:40AM; 08/09/91/5:40AM
   Collection Method: 24 Hour Composite
   Physical and Chemical Data: See Attached Data Sheet in Appendix A

2. **Dilution Water**
   The water used for dilutions and control was a moderately hard reconstituted water adjusted to pH 7.8. The physical and chemical data of the dilution water is reported in Appendix A.

III. TEST METHODS

Test Method: "Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms" EPA/600/4-89/001.

Deviations from methods, if any, and explanation: After warming the samples to 25°C the samples with dissolved oxygen (D.O.) readings greater than 100 percent saturation were aerated slowly until D.O. was less than 100%.

Date and Time Test Started: 08/06/91 (4:00PM); 08/06/91 (4:00PM)
Date and Time Test Terminated: 08/13/91 (4:20PM); 08/13/91 (4:00PM)
Test Chambers: Refer to Table 1
Volume used per Chamber: Refer to Table 1
Number of Organisms per Chamber: Refer Table 1
Number of Replicates per Concentrations: Refer to Table 1
Acclimation of Organisms: *Refer to Table 1*
Test Temperature (mean and range): Cultured at test temperature, 25° ± 1°C

TABLE 1
SUMMARY OF TEST CONDITIONS FOR CHRONIC TOXICITY TEST
METHOD: EPA 600/4-89/001

		Ceriodaphnia dubia Method: 1002.0	*Pimephales promelas* Method: 1000.0
1.	**Test Type:**	Static-Renewal	Static-Renewal
2.	**Temperature:**	25° ± 1°C	25° ± 1°C
3.	***Light Quality:***	Ambient laboratory illumination (cool white)	Ambient laboratory illumination (cool white)
4.	**Light Intensity:**	Approx. 100 ft-c	Approx. 100 ft-c
5.	**Photoperiod:**	8 hrs. dark, 16 hrs. light	8 hrs. dark, 16 hrs. light
6.	**Test Chamber Size:**	30 mls	270 ml
7.	**Test Solution Volume:**	15 ml/replicate	200 ml/replicate
8.	**Renewal of Test Concentrations:**	Daily	Daily
9.	**Age of Test Organism:**	Less than 24 hours	1-2 days
10.	**No. of Test Organisms per Chamber:**	1	10
11.	**No. of Replicate Chambers per Concentration:**	10	3
12.	**Feeding Regime:**	Fed YCT (yeast suspension) & *Selenastrum minutum* (algae) suspension daily.	Fed brine shrimp nauplii in a concentrated suspension twice daily.
13.	**Aeration:**	Samples with D.O. greater than 100% saturation were aerated	Samples with D.O. greater than 100% saturation were aerated
14.	**Dilution Water:**	Reconstituted water (10% Perrier water)	Reconstituted water (10% Perrier water)
15.	**Effluent Concentrations:**	100%, 50%, 25%, 12.5%, 6.25%	100%, 50%, 25%, 12.5%, 6.25%
16.	**Test Duration:**	7 days or until 60% of the control females have 3 broods	7-days
17.	**Effects Measured:**	Survival and Reproduction	Survival and Growth
18.	**Test Acceptability:**	80% or greater survival in the control concentration	80% or greater survival in the control concentration

IV. TEST ORGANISMS

Name: *Ceriodaphnia dubia*; *Pimephales promelas*

Age: Less than 24 hours; 2 days

Source: Stock N; Stock F

Life Stage: Neonate; Juvenile

Mean Length and Weight (if applicable): N/A

V. QUALITY ASSURANCE

Standard Toxicant: Sodium Chloride

Date and Time of Most Recent Test:

Ceriodaphnia dubia 08/05/91 (1:00PM)
Pimephales promelas 08/06/91 (9:00AM)

Dilution Water Used: Reconstituted Water, 10% Perrier Water

Results: *Ceriodaphnia dubia* - LC_{50} (48 hrs) = 2261 mg/l NaCl
Pimephales promelas - LC_{50} (96 hrs) = 7227 mg/L NaCl

Results are in acceptable range as determined by laboratory's testing program.

VI. RESULTS

State Permit Limits: N/A; **NOEL:** N/A

Test Results: Toxicity was indicated with the *Ceriodaphnia dubia*. No toxicity was indicated with the fathead minnow. The NOEC for the *Ceriodaphnia dubia* was 50% effluent concentration. The NOEC for the fathead minnow was >100% effluent concentration. The LOEC, EC_{50}, and the Chronic Values are presented in Table 2.

Data Tables and Analysis: Presented in Table 2

Indicate Statistical Methods Used: Presented in Table 2

Raw Data: Bench Sheet Data is Presented in Appendix A.

TABLE 2

SUMMARY OF CHRONIC BIOMONITORING RESULTS
SAMPLES COLLECTED AUGUST 5, 7, AND 9, 1991
EPA NO: 4189

			Survival Data Analysis									Reproduction Data Analysis		
			% Survival by Days											
Test Organism	Sample ID	Test Concentration (%)	1	2	3	4	5	6	7	Tox.	Method	Average # Young Produced	Tox.	Method
Ceriodaphnia dubia	Control	---	100	100	100	100	100	100	100	---	---	22	---	---
	Final Effluent	6.25	100	100	100	100	100	100	100	No	Inspection	34	No	Inspection
		12.5	100	100	100	100	100	100	90	No	Inspection	29	No	Inspection
		25	100	100	100	100	100	100	100	No	Inspection	30	No	Inspection
		50	100	100	100	100	100	100	100	No	Inspection	28	No	Inspection
		100	100	100	100	100	100	100	70	No	Inspection	14	Yes	Inspection

Finding: **NOEC = 50% Effluent Concentration,**
LOEC = 100% Effluent Concentration,
ChV = 70.7% Effluent Concentration,
EC_{25} > 100% Effluent Concentration,
Toxicity

			Survival Data Analysis									Growth Data Analysis		
			% Survival by Days											
Test Organism	Sample ID	Test Concentration (%)	1	2	3	4	5	6	7	Tox.	Method	Average Wt. per Larvae (mg)	Tox.	Method
Fathead Minnow	Control	---	100	100	100	97	97	90	90	---	---	0.42	---	---
	Final Effluent	6.25	100	100	100	93	93	93	93	No	Inspection	0.50	No	Inspection
		12.5	100	100	100	93	93	93	93	No	Inspection	0.50	No	Inspection
		25	100	100	100	97	97	97	97	No	Inspection	0.54	No	Inspection
		50	100	100	97	93	93	93	93	No	Inspection	0.34	No	Dunnett's
		100	100	100	97	97	97	97	97	No	Inspection	0.34	No	Dunnett's

Finding: **NOEC > 100% Effluent Concentration,**
LOEC > 100% Effluent Concentration,
ChV = 100% Effluent Concentration,
EC_{25} > 100%Effluent Concentration,
No Toxicity

Blackstone River Survey
Upper Blackstone WPAD, Millbury, Ma.

CHEMICAL ANALYSIS OF TOXICITY SAMPLES
24-hr time-composite samples

ANALYTICAL RESULTS
(mg/l unless otherwise noted)

PARAMETERS	Collection Dates 06/03/91	06/05/91	06/07/91	08/05/91	08/07/91	09/09/91
Al	0.05	0.05	0.08	0.043	0.039	<0.020
Cd	ND	0.005	0.005	0.019	0.0044	0.022
Ca	19	19	26	19	20	21
Cr	ND	ND	ND	<0.0050	<0.0050	0.0050
Cu	0.038	0.043	0.048	0.037	0.041	0.036
Pb	0.005	ND	0.004	0.0025	0.0033	0.0020
Mg	3.5	4.9	3.8	2.7	3.0	3.1
Ni	0.02	0.03	0.03	0.042	0.067	0.17
Zn	0.041	0.054	0.070	0.12	0.12	0.10
N-NH4	1.3	0.72 0.72D	0.77	0.26	0.34	0.16
TS	300	320	370	300	320	340
TSS	4.0	5.0	6.0	<5	<5	<5
TOC	8.9	9.1	8.2	8.1	11	8.8
Alk.(mg/l $CaCO_3$)	40	36	36	31	39	30

Notes: ND= Below minimum detectable level(MDL)

D= Sample Duplicate Alk.= Alkalinity

TS= Total Solids TSS= Total Suspensed Solids

TOC= Total Organic Carbons

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COMMONWEALTH TECHNOLOGY, INC.

Environmental and Natural Resources Consulting and Analytical Services

Lexington, Kentucky | Louisville, Kentucky | Grayson, Kentucky

BIOMONITORING JOB NO: 4006/EPA 4088 - Chronic Study Milbury MA WWTF
SAS 1109

I. INTRODUCTION

Facility: Region I **NPDES Permit No:** N/A

Contact: Ms. Cindy Schreyer **Phone No:** (703) 519-1386

Receiving Stream: N/A **Contact:** Billie Rogers

O.K. AS OF JUL 4 19

Laboratory: Commonwealth Technology, Inc.
2520 Regency Road
Lexington, Kentucky 40503-2961
(606) 276-3506

II. SAMPLES (EFFLUENT AND DILUTION WATER)

1. **Effluent**
   Sample Point: Final Effluent
   Collection Dates and Times: 06/03/91/9:03AM; 06/05/91/8:50AM; 06/07/91/10:20AM
   Collection Method: Grab
   Physical and Chemical Data: *See Attached Data Sheet in Appendix A*

2. **Dilution Water**
   The water used for dilutions and control was a moderately hard reconstituted water adjusted to pH 7.8. The physical and chemical data of the dilution water is reported in Appendix A.

III. TEST METHODS

Test Method: "Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms" *EPA/600/4-89/001.*

Deviations from methods, if any, and explanation: Samples with dissolved oxygen (D.O.) greater than 100 percent saturation, after warming to 25°C, were aerated slowly until D.O. was less than 100%.

Date and Time Test Started: 06/04/91 (7:30PM); 06/04/91 (7:00PM)
Date and Time Test Terminated: 06/12/91 (7:00PM); 06/11/91 (6:34PM)
Test Chambers: Refer to Table 1
Volume used per Chamber: Refer to Table 1
Number of Organisms per Chamber: Refer Table 1
Number of Replicates per Concentrations: Refer to Table 1
Acclimation of Organisms: Refer to Table 1
Test Temperature (mean and range): Cultured at test temperature, 25° ± 1°C

TABLE 1
SUMMARY OF TEST CONDITIONS FOR CHRONIC TOXICITY TEST
METHOD: EPA 600/4-89/001

		Ceriodaphnia dubia Method: 1002.0	*Pimephales promelas* Method: 1000.0
1.	Test Type:	Static-Renewal	Static-Renewal
2.	Temperature:	25° ± 1°C	25° ± 1°C
3.	Light Quality:	Ambient laboratory illumination (cool white)	Ambient laboratory illumination (cool white)
4.	Light Intensity:	Approx. 100 ft-c	Approx. 100 ft-c
5.	Photoperiod:	8 hrs. dark, 16 hrs. light	8 hrs. dark, 16 hrs. light
6.	Test Chamber Size:	30 mls	270 ml
7.	Test Solution Volume:	15 ml/replicate	200 ml/replicate
8.	Renewal of Test Concentrations:	Daily	Daily
9.	Age of Test Organism:	Less than 24 hours	1-2 days
10.	No. of Test Organisms per Chamber:	1	10
11.	No. of Replicate Chambers per Concentration:	10	3
12.	Feeding Regime:	Fed YCT (yeast suspension) & *Selenastrum minutum* (algae) suspension daily.	Fed brine shrimp nauplii in a concentrated suspension twice daily.
13.	Aeration:	Samples with D.O. greater than 100% saturation were aerated	Samples with D.O. greater than 100% saturation were aerated
14.	Dilution Water:	Reconstituted water (10% *Perrier water*)	Reconstituted water (10% Perrier water)
15.	Effluent Concentrations:	100%, 50%, 25%, 12.5%, 6.25%	100%, 50%, 25%, 12.5%, 6.25%
16.	Test Duration:	7 days or until 60% of the the control females have 3 broods	7-days
17.	Effects Measured:	Survival and Reproduction	Survival and Growth
18.	Test Acceptability:	80% or greater survival in the control concentration	80% or greater survival in the control concentration

IV. TEST ORGANISMS

Name: *Ceriodaphnia dubia*; *Pimephales promelas*

Age: Less than 24 hours; 2 days

Source: Stock N; Stock F

Life Stage: Neonate; Juvenile

Mean Length and Weight (if applicable): N/A

V. QUALITY ASSURANCE

Standard Toxicant: Sodium Chloride

Date and Time of Most Recent Test:

Ceriodaphnia dubia 06/12/91 (5:30PM)
Pimephales promelas 06/06/91 (1:00PM)

Dilution Water Used: Reconstituted Water, 10% Perrier Water

Results: *Ceriodaphnia dubia* - LC_{50} (48 hrs) = 2846 mg/l NaCl
Pimephales promelas - LC_{50} (96 hrs) = 6587 mg/L NaCl

Results are in acceptable range as determined by laboratory's testing program.

VI. RESULTS

State Permit Limits: N/A; **NOEL:** N/A

Test Results: Toxicity was indicated with the *Ceriodaphnia dubia*. The NOEC was 50% effluent concentration. No toxicity was indicated with the fathead minnow. The NOEC was >100% effluent concentration. The LOEC, EC_{50}, and the Chronic Values are presented in Table 2.

Data Tables and Analysis: Presented in Table 2

Indicate Statistical Methods Used: Presented in Table 2

Raw Data: Bench Sheet Data is Presented in Appendix A.

TABLE 2

SUMMARY OF CHRONIC BIOMONITORING RESULTS
SAMPLES COLLECTED JUNE 3, 5, and 7, 1991
EPA NO: 4088

Test Organism	Sample ID	Test Concentration (%)	Survival Data Analysis: % Survival by Days 1	2	3	4	5	6	7	8	Tox.	Method	Reproduction Data Analysis: Average # Young Produced	Tox.	Method
Ceriodaphnia dubia	Control	---	100	100	100	100	100	100	100	100	---	---	25	---	---
	Final Effluent	6.25	100	100	100	100	100	100	90	90	No	Inspection	40	No	Inspection
		12.5	100	100	100	100	100	100	100	90	No	Inspection	38	No	Inspection
		25	100	100	100	100	100	100	100	90	No	Inspection	38	No	Inspection
		50	100	100	100	100	100	100	90	90	No	Inspection	31	N/A	Inspection
		100	100	100	100	100	80	30	30	30	Yes	Fisher's	N/A	N/A	N/A

Finding: **NOEC = 50% Effluent Concentration,**
LOEC = 100% Effluent Concentration,
ChV = 71% Effluent Concentration,
EC_{50} = 82% Effluent Concentration,
Toxicity

Test Organism	Sample ID	Test Concentration (%)	Survival Data Analysis: % Survival by Days 1	2	3	4	5	6	7	Tox.	Method	Growth Data Analysis: Average Wt. per Larvae (mg)	Tox.	Method
Fathead Minnow	Control	---	100	100	100	97	93	87	80	---	---	0.29	---	---
	Final Effluent	6.25	100	100	97	97	97	93	90	No	Inspection	0.25	No	Inspection
		12.5	100	100	100	100	100	97	97	No	Inspection	0.23	No	Inspection
		25	100	100	100	100	97	90	90	No	Inspection	0.21	No	Inspection
		50	100	97	93	93	90	83	83	No	Inspection	0.29	No	Inspection
		100	100	100	80	70	67	60	60	No	Dunnett's	0.28	No	Dunnett's

Finding: **NOEC > 100% Effluent Concentration,**
LOEC > 100% Effluent Concentration,
ChV = 100% Effluent Concentration,
EC_{50} > 100% Effluent Concentration,
No Toxicity

Blackstone River Survey
Millbury WWTP, Millbury, Ma.

CHEMICAL ANALYSIS OF TOXICITY SAMPLES
24-hr time-composite samples

ANALYTICAL RESULTS
(mg/l unless otherwise noted)

PARAMETERS	Collection Dates 06/03/91	06/05/91	06/07/91
Al	0.13	0.15	0.14
Cd	ND	ND	0.004
Ca	18	16	18
Cr	ND	ND	ND
Cu	0.088	0.083	0.078
Pb	0.011	0.006	0.004
Mg	3.3	3.0	3.3
Ni	ND	ND	0.01
Zn	0.056	0.144	0.109
N-NH4	4.0	39	20
TS	400	500	510
TSS	14	19	21
TOC	28	35	34
Alk.(as $CaCO_3$)	62	90 90D	64

NOTES: D= Sample Duplicate

TS= Total Solids

ND= Below minimum detectable level

TOC= Total Organic Carbons

TSS= Total Suspensed Solids

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COMMONWEALTH TECHNOLOGY, INC.

Environmental and Natural Resources Consulting and Analytical Services

Lexington, Kentucky Louisville, Kentucky Grayson, Kentucky

BIOMONITORING JOB NO: 4006/EPA 4087 - Chronic Study
SAS 1109

GRAFton MA WWTP JUL 4 1991

O.K. AS OF

I. INTRODUCTION

Facility: *Region I* **NPDES Permit No:** N/A

Contact: Ms. Cindy Schreyer **Phone No:** (703) 519-1386

Receiving Stream: N/A **Contact:** Billie Rogers

Laboratory: Commonwealth Technology, Inc.
2520 Regency Road
Lexington, Kentucky 40503-2961
(606) 276-3506

II. SAMPLES (EFFLUENT AND DILUTION WATER)

1. **Effluent**
   Sample Point: Final Effluent
   Collection Dates and Times: 06/03/91/9:35AM; 06/05/91/10:45AM; 06/07/91/11:10AM
   Collection Method: Composite
   Physical and Chemical Data: See Attached Data Sheet in Appendix A

2. **Dilution Water**
   The water used for dilutions and control was a moderately hard reconstituted water adjusted to pH 7.8. The physical and chemical data of the dilution water is reported in Appendix A.

III. TEST METHODS

Test Method: "Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms" EPA/600/4-89/001.

Deviations from methods, if any, and explanation: Samples with dissolved oxygen (D.O.) greater than 100 percent saturation after warming, were aerated slowly until D.O. was below 100%.

Date and Time Test Started: 06/04/91 (7:30PM); 06/04/91 (6:30PM)
Date and Time Test Terminated: 06/12/91 (6:45PM); 06/11/91 (5:30PM)
Test Chambers: *Refer to Table 1*
Volume used per Chamber: Refer to Table 1
Number of Organisms per Chamber: Refer Table 1
Number of Replicates per Concentrations: *Refer to Table 1*
Acclimation of Organisms: Refer to Table 1
Test Temperature (mean and range): Cultured at test temperature, 25° ± 1°C

TABLE 1
SUMMARY OF TEST CONDITIONS FOR CHRONIC TOXICITY TEST
METHOD: EPA 600/4-89/001

		Ceriodaphnia dubia Method: 1002.0	*Pimephales promelas* Method: 1000.0
1.	**Test Type:**	Static-Renewal	Static-Renewal
2.	**Temperature:**	25° ± 1°C	25° ± 1°C
3.	**Light Quality:**	Ambient laboratory illumination (cool white)	Ambient laboratory illumination (cool white)
4.	**Light Intensity:**	Approx. 100 ft-c	Approx. 100 ft-c
5.	**Photoperiod:**	8 hrs. dark, 16 hrs. light	8 hrs. dark, 16 hrs. light
6.	**Test Chamber Size:**	30 mls	270 ml
7.	**Test Solution Volume:**	15 ml/replicate	200 ml/replicate
8.	**Renewal of Test Concentrations:**	Daily	Daily
9.	**Age of Test Organism:**	Less than 24 hours	1-2 days
10.	**No. of Test Organisms per Chamber:**	1	10
11.	**No. of Replicate Chambers per Concentration:**	10	3
12.	**Feeding Regime:**	Fed YCT (yeast suspension) & *Selenastrum minutum* (algae) suspension daily.	Fed brine shrimp nauplii in a concentrated suspension twice daily.
13.	**Aeration:**	Samples with D.O. greater than 100% saturation were aerated	Samples with D.O. greater than 100% saturation were aerated
14.	**Dilution Water:**	Reconstituted water (10% Perrier water)	Reconstituted water (10% Perrier water)
15.	**Effluent Concentrations:**	100%, 50%, 25%, 12.5%, 6.25%	100%, 50%, 25%, 12.5%, 6.25%
16.	**Test Duration:**	7 days or until 60% of the control females have 3 broods	7-days
17.	**Effects Measured:**	Survival and Reproduction	Survival and Growth
18.	**Test Acceptability:**	80% or greater survival in the control concentration	80% or greater survival in the control concentration

IV. TEST ORGANISMS

Name: *Ceriodaphnia dubia*; *Pimephales promelas*

Age: Less than 24 hours; 2 days

Source: Stock N; Stock F

Life Stage: Neonate; Juvenile

Mean Length and Weight (if applicable): N/A

V. QUALITY ASSURANCE

Standard Toxicant: Sodium Chloride

Date and Time of Most Recent Test:

Ceriodaphnia dubia 06/12/91 (5:30PM)
Pimephales promelas 06/06/91 (1:00PM)

Dilution Water Used: Reconstituted Water, 10% Perrier Water

Results: *Ceriodaphnia dubia* - LC_{50} (48 hrs) = 2846 mg/l NaCl
Pimephales promelas - LC_{50} (96 hrs) = 6587 mg/L NaCl

Results are in acceptable range as determined by laboratory's testing program.

VI. RESULTS

State Permit Limits: N/A; **NOEL:** N/A

Test Results: Toxicity was indicated with the *Ceriodaphnia dubia*. The NOEC for the *Ceriodaphnia dubia* was 25% effluent concentration. No toxicity was indicated with the fathead minnow. The NOEC was >100% effluent concentration. The LOEC, EC_{50}, and Chronic Values are presented in Table 2.

Data Tables and Analysis: Presented in Table 2

Indicate Statistical Methods Used: Presented in Table 2

Raw Data: Bench Sheet Data is Presented in Appendix A.

TABLE 2

SUMMARY OF CHRONIC BIOMONITORING RESULTS
SAMPLES COLLECTED JUNE 3, 5, and 7, 1991
EPA NO: 4087

Test Organism	Sample ID	Test Concentration (%)	Survival Data Analysis: % Survival by Days 1	2	3	4	5	6	7	8	Tox.	Method	Reproduction Data Analysis: Average # Young Produced	Tox.	Method
Ceriodaphnia dubia	Control	---	100	100	100	100	100	100	100	100	---	---	25	---	---
	Final Effluent	6.25	100	90	90	70	70	70	70	70	No	Fisher's	19	No	Dunnett's
		12.5	100	100	90	70	70	70	70	70	No	Inspection	15	No	Dunnett's
		25	100	100	90	90	90	90	90	90	No	Inspection	18	No	Dunnett's
		50	100	80	70	60	60	60	60	60	No	Inspection	6	Yes	Dunnett's
		100	100	100	100	80	70	70	70	70	No	Fisher's	3	Yes	Inspection

Finding: NOEC = 25% Effluent Concentration,
LOEC = 50% Effluent Concentration,
ChV = 35% Effluent Concentration,
EC_{50} > 100% Effluent Concentration,
Toxicity

Test Organism	Sample ID	Test Concentration (%)	Survival Data Analysis: % Survival by Days 1	2	3	4	5	6	7	Tox.	Method	Growth Data Analysis: Average Wt. per Larvae (mg)	Tox.	Method
Fathead Minnow	Control	---	100	100	100	97	93	87	80	---	---	0.29	---	---
	Final Effluent	6.25	100	100	100	97	87	83	77	No	Inspection	0.34	No	Inspection
		12.5	100	100	100	93	93	93	90	No	Inspection	0.33	No	Inspection
		25	100	100	100	97	83	80	80	No	Inspection	0.30	No	Inspection
		50	100	100	100	100	97	93	87	No	Inspection	0.28	No	Inspection
		100	100	100	100	97	97	80	77	No	Dunnett's	0.27	No	Dunnett's

Finding: NOEC > 100% Effluent Concentration,
LOEC > 100% Effluent Concentration,
ChV = 100% Effluent Concentration,
EC_{50} > 100% Effluent Concentration,
No Toxicity

Blackstone River Survey
Grafton WWTP, Grafton, Ma.

CHEMICAL ANALYSIS OF TOXICITY SAMPLES
24-hr time-composite samples

ANALYTICAL RESULTS
(mg/l unles otherwise noted)

PARAMETERS	Collection Dates 06/03/91	06/05/91	06/07/91
Al	0.10	0.13	0.28
Cd	ND	0.003	0.004
Ca	16	16	17
Cr	ND	ND	ND
Cu	0.018	0.033	0.035
Pb	0.004	ND	0.001
Mg	3.5	3.5	3.0
Ni	0.01	ND	ND
Zn	0.049	0.050	0.058
N-NH4	1.5	1.5	3.0
TS	390	370	400
TSS	4.8	6.6	20
TOC	11	13 12D	16
Alk.(as $CaCO_3$)	64	70	78

NOTES: D= Sample Duplicate
TOC= Total Organic Carbons
TS= Total Solids
ND= Below minimum detectable level
TSS= Total Suspensed Solids

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COMMONWEALTH TECHNOLOGY, INC.

Environmental and Natural Resources Consulting and Analytical Services

Lexington, Kentucky Louisville, Kentucky Grayson, Kentucky

BIOMONITORING JOB NO: 4006/EPA 4190 - Chronic Study
SAS 1109

NORTHBRIDGE POTW, MA

I. INTRODUCTION

Facility: Region I **NPDES Permit No:** N/A

Contact: Ms. Cindy Schreyer **Phone No:** (703) 519-1386

Receiving Stream: N/A **Contact:** Billie Rogers

Laboratory: Commonwealth Technology, Inc.
2520 Regency Road
Lexington, Kentucky 40503-2961
(606) 276-3506

II. SAMPLES (EFFLUENT AND DILUTION WATER)

1. **Effluent**
   Sample Point: Final Effluent
   Collection Dates and Times: 08/05/91/7:37AM; 08/07/91/6:35AM; 08/09/91/6:00AM
   Collection Method: 24 Hour Composite
   Physical and Chemical Data: See Attached Data Sheet in Appendix A

2. **Dilution Water**
   The water used for dilutions and control was a moderately hard reconstituted water adjusted to pH 7.8. The physical and chemical data of the dilution water is reported in Appendix A.

III. TEST METHODS

Test Method: "Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms" EPA/600/4-89/001.

Deviations from methods, if any, and explanation: After warming the samples to 25°C the samples with dissolved oxygen (D.O.) readings greater than 100 percent saturation were aerated slowly until D.O. was less than 100%. The samples were dechlorinated with sodium thiosulfate because their chlorine concentration was >0.02 mg/L.

Date and Time Test Started: 08/06/91 (3:15PM); 08/06/91 (3:45PM)
Date and Time Test Terminated: 08/13/91 (3:30PM); 08/13/91 (4:00PM)
Test Chambers: Refer to Table 1
Volume used per Chamber: Refer to Table 1
Number of Organisms per Chamber: Refer Table 1
Number of Replicates per Concentrations: Refer to Table 1
Acclimation of Organisms: Refer to Table 1
Test Temperature (mean and range): Cultured at test temperature, 25° ± 1°C

TABLE 1
SUMMARY OF TEST CONDITIONS FOR CHRONIC TOXICITY TEST
METHOD: EPA 600/4-89/001

		Ceriodaphnia dubia **Method: 1002.0**	*Pimephales promelas* **Method: 1000.0**
1.	**Test Type:**	Static-Renewal	Static-Renewal
2.	**Temperature:**	25° ± 1°C	25° ± 1°C
3.	**Light Quality:**	Ambient laboratory illumination (cool white)	Ambient laboratory illumination (cool white)
4.	**Light Intensity:**	Approx. 100 ft-c	Approx. 100 ft-c
5.	**Photoperiod:**	8 hrs. dark, 16 hrs. light	8 hrs. dark, 16 hrs. light
6.	**Test Chamber Size:**	30 mls	270 ml
7.	**Test Solution Volume:**	15 ml/replicate	200 ml/replicate
8.	**Renewal of Test Concentrations:**	Daily	Daily
9.	**Age of Test Organism:**	Less than 24 hours	1-2 days
10.	**No. of Test Organisms per Chamber:**	1	10
11.	**No. of Replicate Chambers per Concentration:**	10	3
12.	**Feeding Regime:**	Fed YCT (yeast suspension) & *Selenastrum minutum* (algae) suspension daily.	Fed brine shrimp naupiii in a concentrated suspension twice daily.
13.	**Aeration:**	Samples with D.O. greater than 100% saturation were aerated	Samples with D.O. greater than 100% saturation were aerated
14.	**Dilution Water:**	Reconstituted water (10% Perrier water)	Reconstituted water (10% Perrier water)
15.	**Effluent Concentrations:**	100%, 50%, 25%, 12.5%, 6.25%	100%, 50%, 25%, 12.5%, 6.25%
16.	**Test Duration:**	7 days or until 60% of the control females have 3 broods	7-days
17.	**Effects Measured:**	Survival and Reproduction	Survival and Growth
18.	**Test Acceptability:**	80% or greater survival in the control concentration	80% or greater survival in the control concentration

IV. TEST ORGANISMS

Name: *Ceriodaphnia dubia*; *Pimephales promelas*

Age: Less than 24 hours; 2 days

Source: Stock N; Stock F

Life Stage: Neonate; Juvenile

Mean Length and Weight (if applicable): N/A

V. QUALITY ASSURANCE

Standard Toxicant: Sodium Chloride

Date and Time of Most Recent Test:

Ceriodaphnia dubia 08/05/91 (1:00PM)
Pimephales promelas 08/06/91 (9:00AM)

Dilution Water Used: Reconstituted Water, 10% Perrier Water

Results: *Ceriodaphnia dubia* - LC_{50} (48 hrs) = 2261 mg/l NaCl
Pimephales promelas - LC_{50} (96 hrs) = 7227 mg/L NaCl

Results are in acceptable range as determined by laboratory's testing program.

VI. RESULTS

State Permit Limits: N/A; **NOEL:** N/A

Test Results: Toxicity was indicated with the *Ceriodaphnia dubia*. No toxicity was indicated with the fathead minnow. The NOEC for the *Ceriodaphnia dubia* was 6.25% effluent concentration. The NOEC for the fathead minnow was >100% effluent concentration. The LOEC, EC_{50}, and the Chronic Values are presented in Table 2.

Data Tables and Analysis: Presented in Table 2

Indicate Statistical Methods Used: Presented in Table 2

Raw Data: Bench Sheet Data is Presented in Appendix A.

TABLE 2

SUMMARY OF CHRONIC BIOMONITORING RESULTS
SAMPLES COLLECTED AUGUST 5, 7, AND 9, 1991
EPA NO: 4190

Test Organism	Sample ID	Test Concentration (%)	Survival Data Analysis: % Survival by Days 1	2	3	4	5	6	7	Tox.	Method	Reproduction Data Analysis: Average # Young Produced	Tox.	Method
Ceriodaphnia dubia	Control	---	100	100	100	100	100	100	100	---	---	22	---	---
	Final Effluent	6.25	100	100	100	100	100	100	100	No	Inspection	17	No	T-Test
		12.5	100	100	100	100	100	100	100	No	Inspection	13	Yes	T-Test
		25	100	100	100	100	100	100	90	No	Inspection	9	Yes	T-Test
		50	100	100	90	80	80	80	80	No	Inspection	11	Yes	T-Test
		100	100	100	90	90	90	90	90	No	Inspection	11	Yes	T-Test

Finding: NOEC = 6.25% Effluent Concentration,
LOEC = 12.5% Effluent Concentration,
ChV = 8.8% Effluent Concentration,
EC_{50} > 100% Effluent Concentration,
Toxicity

Test Organism	Sample ID	Test Concentration (%)	Survival Data Analysis: % Survival by Days 1	2	3	4	5	6	7	Tox.	Method	Growth Data Analysis: Average Wt. per Larvae (mg)	Tox.	Method
Fathead Minnow	Control	---	100	100	100	97	97	90	90	---	---	0.42	---	---
	Final Effluent	6.25	100	100	100	100	100	100	100	No	Inspection	0.53	No	Inspection
		12.5	97	97	97	93	93	93	93	No	Inspection	0.52	No	Inspection
		25	100	100	100	100	100	100	100	No	Inspection	0.49	No	Inspection
		50	100	100	97	93	90	90	90	No	Inspection	0.46	No	Inspection
		100	100	100	100	100	100	100	100	Yes	Inspection	0.46	No	Inspection

Finding: NOEC > 100% Effluent Concentration,
LOEC > 100% Effluent Concentration,
ChV = 100% Effluent Concentration,
EC_{50} > 100% Effluent Concentration,
No Toxicity

Blackstone River Survey
Northbridge WWTF, Northbridge, Ma.

CHEMICAL ANALYSIS OF TOXICITY SAMPLES
24 hr time-composite samples

ANALYTICAL RESULTS
(mg/l unless otherwise noted)

PARAMETERS	Collection Dates 08/05/91	08/07/91	08/09/91
Al	0.14	0.050	0.070
Cd	<0.015	<0.0030	<0.015
Ca	10	9.5	9.2
Cr	<0.025	<0.0050	<0.0050
Cu	0.080	0.073	0.075
Pb	0.0048	0.0069	0.0065
Mg	1.8	1.7	1.7
Ni	0.051	0.018	0.012
Zn	0.13	0.13	0.14
N-NH4	5.1	7.3	5.5
TS	280	290	300
TSS	<5	<5	<5
TOC	10	11	11
Alk.(as $CaCO_3$)	60	60	66

NOTES: D= Sample Duplicate
TS= Total Solids
ND= Below minimum detectable level
TOC= Total Organic Carbons
Alk.= Alkalinity
TSS= Total Suspensed Solids

Edward G. Foree, Ph.D., P.E.

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COMMONWEALTH TECHNOLOGY, INC.

Environmental and Natural Resources Consulting and Analytical Services

Lexington, Kentucky | Louisville, Kentucky | Grayson, Kentucky

BIOMONITORING JOB NO: 4006/EPA 4191 - Chronic Study
SAS 1109

UXBRIDGE POTW, MA

I. INTRODUCTION

Facility: Region I **NPDES Permit No:** N/A

Contact: *Ms. Cindy Schreyer* **Phone No:** (703) 519-1386

Receiving Stream: N/A **Contact:** *Billie Rogers*

Laboratory: Commonwealth Technology, Inc.
2520 Regency Road
Lexington, Kentucky 40503-2961
(606) 276-3506

II. SAMPLES (EFFLUENT AND DILUTION WATER)

1. **Effluent**
   Sample Point: Final Effluent
   Collection Dates and Times: 08/05/91/8:20AM; 08/07/91/7:55AM; 08/09/91/7:05AM
   Collection Method: 24 Hour Composte
   Physical and Chemical Data: *See Attached Data Sheet in Appendix A*

2. **Dilution Water**
   The water *used for dilutions and control* was a moderately hard reconstituted water adjusted to pH 7.8. The physical and chemical data of the dilution water is reported in Appendix A.

III. TEST METHODS

Test Method: "Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms" EPA/600/4-89/001.

Deviations from methods, if any, and explanation: After warming the samples to 25°C the samples with dissolved oxygen (D.O.) readings *greater than* 100 percent saturation were aerated slowly until D.O. was less than 100%.

Date and Time Test Started: 08/06/91 (4:00PM); 08/06/91 (3:50PM)
Date and Time Test Terminated: 08/13/91 (4:00PM); 08/13/91 (4:00PM)
Test Chambers: Refer to Table 1
Volume used per Chamber: Refer to Table 1
Number of Organisms per Chamber: Refer Table 1
***Number of* Replicates per Concentrations:** Refer to Table 1
Acclimation of Organisms: Refer to Table 1
Test Temperature (mean and range): *Cultured at test temperature*, 25° ± 1°C

TABLE 1
SUMMARY OF TEST CONDITIONS FOR CHRONIC TOXICITY TEST
METHOD: EPA 600/4-89/001

		Ceriodaphnia dubia Method: 1002.0	*Pimephales promelas* Method: 1000.0
1.	Test Type:	Static-Renewal	Static-Renewal
2.	Temperature:	25° ± 1°C	25° ± 1°C
3.	Light Quality:	Ambient laboratory illumination (cool white)	Ambient laboratory illumination (cool white)
4.	Light Intensity:	Approx. 100 ft-c	Approx. 100 ft-c
5.	Photoperiod:	8 hrs. dark, 16 hrs. light	8 hrs. dark, 16 hrs. light
6.	Test Chamber Size:	30 mls	270 ml
7.	Test Solution Volume:	15 ml/replicate	200 ml/replicate
8.	Renewal of Test Concentrations:	Daily	Daily
9.	Age of Test Organism:	Less than 24 hours	1-2 days
10.	No. of Test Organisms per Chamber:	1	10
11.	No. of Replicate Chambers per Concentration:	10	3
12.	Feeding Regime:	Fed YCT (yeast suspension) & *Selenastrum minutum* (algae) suspension daily.	Fed brine shrimp nauplii in a concentrated suspension twice daily.
13.	Aeration:	Samples with D.O. greater than 100% saturation were aerated	Samples with D.O. greater than 100% saturation were aerated
14.	Dilution Water:	Reconstituted water (10% Perrier water)	Reconstituted water (10% Perrier water)
15.	Effluent Concentrations:	100%, 50%, 25%, 12.5%, 6.25%	100%, 50%, 25%, 12.5%, 6.25%
16.	Test Duration:	7 days or until 60% of the control females have 3 broods	7-days
17.	Effects Measured:	Survival and Reproduction	Survival and Growth
18.	Test Acceptability:	80% or greater survival in the control concentration	80% or greater survival in the control concentration

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COMMONWEALTH TECHNOLOGY, INC.

Environmental and Natural Resources Consulting and Analytical Services

Lexington, Kentucky Louisville, Kentucky Grayson, Kentucky

JUL 18 1991

BIOMONITORING JOB NO: 4006/EPA 4093 - Chronic Study
SAS 1109

GUILFORD INDUSTRIES
DOUGLAS, MA

I. INTRODUCTION

Facility: Region I **NPDES Permit No:** N/A

Contact: Ms. Cindy Schreyer **Phone No:** (703) 519-1386

Receiving Stream: N/A **Contact:** Billie Rogers

Laboratory: Comm wealth Technology, Inc.
2520 i ..gency Road
Lexington, Kentucky 40503-2961
(606) 276-3506

II. SAMPLES (EFFLUENT AND DILUTION WATER)

1. **Effluent**
   Sample Point: Final Effluent
   Collection Dates and Times: 06/17/91/8:45AM; 06/19/91/7:50AM; 06/21/91/7:50AM
   Collection Method: 24 Hour Composite
   Physical and Chemical Data: See Attached Data Sheet in Appendix A

2. **Dilution Water**
   The water used for dilutions and control was a moderately hard reconstituted water adjusted to pH 7.8. The physical and chemical data of the dilution water is reported in Appendix A.

III. TEST METHODS

Test Method: "Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms" EPA/600/4-89/001.

Deviations from methods, if any, and explanation: After warming the samples to 25°C the samples with dissolved oxygen (D.O.) readings greater than 100 percent saturation were aerated slowly until D.O. was less than 100%.

Date and Time Test Started: 06/18/91 (2:10PM); 06/18/91 (2:30PM)
Date and Time Test Terminated: 06/26/91 (2:20PM); 06/25/91 (2:00PM)
Test Chambers: Refer to Table 1
Volume used per Chamber: Refer to Table 1
Number of Organisms per Chamber: Refer Table 1
Number of Replicates per Concentrations: Refer to Table 1
Acclimation of Organisms: Refer to Table 1
Test Temperature (mean and range): Cultured at test temperature, 25° ± 1°C

TABLE 1
SUMMARY OF TEST CONDITIONS FOR CHRONIC TOXICITY TEST
METHOD: EPA 600/4-89/001

		Ceriodaphnia dubia Method: 1002.0	*Pimephales promelas* Method: 1000.0
1.	Test Type:	Static-Renewal	Static-Renewal
2.	Temperature:	25° ± 1°C	25° ± 1°C
3.	Light Quality:	Ambient laboratory illumination (cool white)	Ambient laboratory illumination (cool white)
4.	Light Intensity:	Approx. 100 ft-c	Approx. 100 ft-c
5.	Photoperiod:	8 hrs. dark, 16 hrs. light	8 hrs. dark, 16 hrs. light
6.	Test Chamber Size:	30 mls	270 ml
7.	Test Solution Volume:	15 ml/replicate	200 ml/replicate
8.	Renewal of Test Concentrations:	Daily	Daily
9.	Age of Test Organism:	Less than 24 hours	1-2 days
10.	No. of Test Organisms per Chamber:	1	10
11.	No. of Replicate Chambers per Concentration:	10	3
12.	Feeding Regime:	Fed YCT (yeast suspension) & *Selenastrum minutum* (algae) suspension daily.	Fed brine shrimp nauplii in a concentrated suspension twice daily.
13.	Aeration:	Samples with D.O. greater than 100% saturation were aerated	Samples with D.O. greater than 100% saturation were aerated
14.	Dilution Water:	Reconstituted water (10% Perrier water)	Reconstituted water (10% Perrier water)
15.	*Effluent Concentrations:*	100%, 50%, 25%, 12.5%, 6.25%	100%, 50%, 25%, 12.5%, 6.25%
16.	Test Duration:	7 days or until 60% of the the control females have 3 broods	7-days
17.	Effects Measured:	Survival and Reproduction	Survival and Growth
18.	Test Acceptability:	80% or greater survival in the control concentration	80% or greater survival in the control concentration

IV. TEST ORGANISMS

Name: *Ceriodaphnia dubia*; *Pimephales promelas*

Age: Less than 24 hours; 2 days

Source: Stock N; Stock F

Life Stage: Neonate; Juvenile

Mean Length and Weight (if applicable): N/A

V. QUALITY ASSURANCE

Standard Toxicant: Sodium Chloride

Date and Time of Most Recent Test:

Ceriodaphnia dubia 08/05/91 (1:00PM)
Pimephales promelas 08/06/91 (9:00AM)

Dilution Water Used: Reconstituted Water, 10% Perrier Water

Results: *Ceriodaphnia dubia* - LC_{50} (48 hrs) = 2261 mg/l NaCl
Pimephales promelas - LC_{50} (96 hrs) = 7227 mg/L NaCl

Results are in acceptable range as determined by laboratory's testing program.

VI. RESULTS

State Permit Limits: N/A; **NOEL:** N/A

Test Results: No toxicity was indicated with the *Ceriodaphnia dubia* or the fathead minnow. The NOEC for both the *Ceriodaphnia dubia* and the fathead minnow was >100% effluent concentration. The LOEC, EC_{50}, and the Chronic Values are presented in Table 2.

Data Tables and Analysis: Presented in Table 2

Indicate Statistical Methods Used: *Presented in Table 2*

Raw Data: Bench Sheet Data is Presented in Appendix A.

TABLE 2

SUMMARY OF CHRONIC BIOMONITORING RESULTS
SAMPLES COLLECTED AUGUST 5, 7, AND 9, 1991
EPA NO: 4191

Test Organism	Sample ID	Test Concentration (%)	Survival Data Analysis: % Survival by Days 1	2	3	4	5	6	7	Tox.	Method	Reproduction Data Analysis: Average # Young Produced	Tox.	Method
Ceriodaphnia dubia	Control	---	90	90	90	90	90	90	90	---	---	22	---	---
	Final Effluent	6.25	100	100	100	90	90	90	90	No	Inspection	22	No	Inspection
		12.5	90	90	90	90	90	90	90	No	Inspection	26	No	Inspection
		25	100	100	100	100	100	100	100	No	Inspection	27	No	Inspection
		50	90	90	90	90	90	90	90	No	Inspection	25	No	Inspection
		100	100	100	100	100	100	100	100	No	Inspection	19	No	Inspection

Finding: NOEC > 100% Effluent Concentration,
LOEC > 100% Effluent Concentration,
ChV = 100% Effluent Concentration,
EC_{25} > 100% Effluent Concentration,
No Toxicity

Test Organism	Sample ID	Test Concentration (%)	Survival Data Analysis: % Survival by Days 1	2	3	4	5	6	7	Tox.	Method	Growth Data Analysis: Average Wt. per Larvae (mg)	Tox.	Method
Fathead Minnow	Control	---	100	100	100	100	100	100	100	---	---	0.36	---	---
	Final Effluent	6.25	100	100	100	100	100	100	100	No	Inspection	0.39	No	Inspection
		12.5	100	100	100	93	90	90	90	No	Inspection	0.50	No	Inspection
		25	100	100	100	100	97	97	97	No	Inspection	0.48	No	Inspection
		50	100	100	100	100	100	97	97	No	Inspection	0.47	No	Inspection
		100	100	100	100	100	100	100	100	No	Inspection	0.39	No	Inspection

Finding: NOEC > 100% Effluent Concentration,
LOEC > 100% Effluent Concentration,
ChV = 100% Effluent Concentration,
EC_{25} > 100% Effluent Concentration,
No Toxicity

Blackstone River Survey
Uxbridge WWTF, Uxbridge, Ma

CHEMICAL ANALYSIS OF TOXICITY SAMPLES
24-hr time-composite samples

ANALYTICAL RESULTS
(mg/l unless otherwise noted)

PARAMETERS	Collection Dates 08/05/91	08/07/91	08/09/91
Al	0.041	0.024	0.047
Cd	<0.0030	<0.0030	<0.0030
Ca	15	15	16
Cr	<0.0050	<0.0050	<0.0050
Cu	0.052	0.067	0.067
Pb	0.0028	0.0020	0.0020
Mg	2.3	2.2	2.4
Ni	0.012	0.019	0.012
Zn	0.11	0.19	0.13
N-NH4	0.32	0.15	0.22
TS	320	340	330
TSS	10	5	<5
TOC	13	11	12
Alk.(mg/l as $CaCO_3$)	13	8	16

NOTES: D= Sample Duplicate
TS= Total Solids
ND= Below minimum detectable level
TOC= Total Organic Carbons
Alk.= Alkalinity
TSS= Total Suspensed Solids

IV. TEST ORGANISMS

Name: *Ceriodaphnia dubia*; *Pimephales promelas*

Age: *Less than 24 hours; 2 days*

Source: Stock N; Stock F

Life Stage: Neonate; Juvenile

Mean Length and Weight (if applicable): N/A

V QUALITY ASSURANCE

Standard Toxicant: Sodium Chloride

Date and Time of Most Recent Test:

Ceriodaphnia dubia 06/12/91 (5:30PM)
Pimephales promelas 06/22/91 (3:30PM)

Dilution Water Used: Reconstituted Water, 10% Perrier Water

Results: *Ceriodaphnia dubia* - LC_{50} (48 hrs) = 2846 mg/l NaCl
Pimephales promelas - LC_{50} (96 hrs) = 6295 mg/L NaCl

Results are in acceptable range as determined by laboratory's testing program.

VI. RESULTS

State Permit Limits: N/A; **NOEL:** N/A

Test Results: Toxicity was indicated with the *Ceriodaphnia dubia*. No toxicity was indicated with the fathead minnow. The NOEC for the *Ceriodaphnia dubia* was 50% effluent concentration. The NOEC for the fathead minnow was >100% effluent concentration. The LOEC, EC_{50}, and the Chronic Values are presented in Table 2.

Data Tables and Analysis: Presented in Table 2

Indicate Statistical Methods Used: Presented in Table 2

Raw Data: Bench Sheet Data is Presented in Appendix A.

TABLE 2

SUMMARY OF CHRONIC BIOMONITORING RESULTS
SAMPLES COLLECTED JUNE 17, 19, AND 21, 1991
EPA NO: 4093

Test Organism	Sample ID	Test Concentration (%)	Survival Data Analysis: % Survival by Days 1	2	3	4	5	6	7	8	Tox.	Method	Reproduction Data Analysis: Average # Young Produced	Tox.	Method
Ceriodaphnia dubia	Control	---	100	100	100	80	80	80	80	80	---	---	30	---	---
	Final Effluent	6.25	100	100	90	90	80	80	80	80	No	Inspection	42	No	Inspection
		12.5	100	100	100	100	90	90	90	90	No	Inspection	44	No	Inspection
		25	100	100	100	100	100	100	100	100	No	Inspection	41	No	Inspection
		50	100	100	100	90	80	80	80	80	No	Inspection	23	No	Inspection
		100	100	100	100	100	100	100	100	80	No	Inspection	3	Yes	Inspection

Finding: NOEC = 50% Effluent Concentration,
LOEC = 100% Effluent Concentration,
ChV = 70.7% Effluent Concentration,
EC_{50} > 100% Effluent Concentration,
Toxicity

Test Organism	Sample ID	Test Concentration (%)	Survival Data Analysis: % Survival by Days 1	2	3	4	5	6	7	Tox.	Method	Growth Data Analysis: Average Wt. per Larvae (mg)	Tox.	Method
Fathead Minnow	Control	---	100	93	87	87	87	87	80	---	---	0.42	---	---
	Final Effluent	6.25	100	97	97	93	93	93	93	No	Inspection	0.43	No	Inspection
		12.5	83	83	80	80	73	73	70	No	Inspection	0.61	No	Inspection
		25	97	97	97	97	87	87	80	No	Inspection	0.48	No	Inspection
		50	97	97	97	97	97	97	97	No	Inspection	0.50	No	Inspection
		100	87	83	80	77	77	73	73	No	Dunnett's	0.49	No	Inspection

Finding: NOEC > 100% Effluent Concentration,
LOEC > 100% Effluent Concentration,
ChV = 100% Effluent Concentration,
EC_{50} > 100%Effluent Concentration,
No Toxicity

Blackstone River Survey
Guilford Industries, East Douglas, Ma.

CHEMICAL ANALYSIS OF TOXICITY SAMPLES
24-hr time-composite samples

ANALYTICAL RESULTS
(mg/l unless otherwise noted)

PARAMETERS	Collection Dates 06/17/91	06/19/91	06/21/91
Al	0.02	0.02	0.04
Cd	ND	ND	0.007
Ca	5.5	5.7	5.6
Cr	ND	0.004	0.011
Cu	0.005	ND	ND
Pb	ND	ND	ND
Mg	1.3	1.3	1.2
Ni	ND	ND	ND
Zn	0.003	0.294	0.315
N-NH4	0.16	0.09	0.11
TS	280	280	250
TSS	12	11	13
TOC	51	48	44
Alk.(as $CaCO_3$)	38	34	34

NOTES: D= Sample Duplicate
TS= Total Solids
ND= Below minimum detectable level
TOC= Total Organic Carbons
Alk.= Alkalinity
TSS= Total Suspensed Solids

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COMMONWEALTH TECHNOLOGY, INC.

Environmental and Natural Resources Consulting and Analytical Services

Lexington, Kentucky Louisville, Kentucky Grayson, Kentucky

BIOMONITORING JOB NO: 4006/EPA 4192 - Chronic Study
SAS 1109

DOUGLAS POTW, MA

I. INTRODUCTION

Facility: Region I **NPDES Permit No:** N/A

Contact: Ms. Cindy Schreyer **Phone No:** (703) 519-1386

Receiving Stream: N/A **Contact:** Billie Rogers

Laboratory: Commonwealth Technology, Inc.
2520 Regency Road
Lexington, Kentucky 40503-2961
(606) 276-3506

II. SAMPLES (EFFLUENT AND DILUTION WATER)

1. **Effluent**
   Sample Point: Final Effluent
   Collection Dates and Times: 08/05/91/9:00AM; 08/07/91/8:55AM; 08/09/91/8:30AM
   Collection Method: 24 Hour Composite
   Physical and Chemical Data: See Attached Data Sheet in Appendix A

2. **Dilution Water**
   The water used for dilutions and control was a moderately hard reconstituted water adjusted to pH 7.8. The physical and chemical data of the dilution water is reported in Appendix A.

III. TEST METHODS

Test Method: "Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms" EPA/600/4-89/001.

Deviations from methods, if any, and explanation: None Performed.

Date and Time Test Started: 08/06/91 (2:00PM); 08/06/91 (2:00PM)
Date and Time Test Terminated: 08/13/91 (2:30PM); 08/13/91 (4:00PM)
Test Chambers: Refer to Table 1
Volume used per Chamber: Refer to Table 1
Number of Organisms per Chamber: Refer Table 1
Number of Replicates per Concentrations: Refer to Table 1
Acclimation of Organisms: Refer to Table 1
Test Temperature (mean and range): Cultured at test temperature, 25° ± 1°C

TABLE 1
SUMMARY OF TEST CONDITIONS FOR CHRONIC TOXICITY TEST
METHOD: EPA 600/4-89/001

		Ceriodaphnia dubia Method: 1002.0	*Pimephales promelas* Method: 1000.0
1.	Test Type:	Static-Renewal	Static-Renewal
2.	Temperature:	25° ± 1°C	25° ± 1°C
3.	Light Quality:	Ambient laboratory illumination (cool white)	Ambient laboratory illumination (cool white)
4.	Light Intensity:	Approx. 100 ft-c	Approx. 100 ft-c
5.	Photoperiod:	8 hrs. dark, 16 hrs. light	8 hrs. dark, 16 hrs. light
6.	Test Chamber Size:	30 mls	270 ml
7.	Test Solution Volume:	15 ml/replicate	200 ml/replicate
8.	Renewal of Test Concentrations:	Daily	Daily
9.	Age of Test Organism:	Less than 24 hours	1-2 days
10.	No. of Test Organisms per Chamber:	1	10
11.	No. of Replicate Chambers per Concentration:	10	3
12.	Feeding Regime:	Fed YCT (yeast suspension) & *Selenastrum minutum* (algae) suspension daily.	Fed brine shrimp nauplii in a concentrated suspension twice daily.
13.	Aeration:	None	None
14.	Dilution Water:	Reconstituted water (10% Perrier water)	Reconstituted water (10% Perrier water)
15.	Effluent Concentrations:	100%, 50%, 25%, 12.5%, 6.25%	100%, 50%, 25%, 12.5%, 6.25%
16.	Test Duration:	7 days or until 60% of the control females have 3 broods	7-days
17.	Effects Measured:	Survival and Reproduction	Survival and Growth
18.	Test Acceptability:	80% or greater survival in the control concentration	80% or greater survival in the control concentration

IV. TEST ORGANISMS

Name: *Ceriodaphnia dubia*; *Pimephales promelas*

Age: Less than 24 hours; 2 days

Source: Stock N; Stock F

Life Stage: Neonate; Juvenile

Mean Length and Weight (if applicable): N/A

V. QUALITY ASSURANCE

Standard Toxicant: Sodium Chloride

Date and Time of Most Recent Test:

Ceriodaphnia dubia 08/05/91 (1:00PM)
Pimephales promelas 08/06/91 (9:00AM)

Dilution Water Used: Reconstituted Water, 10% Perrier Water

Results: *Ceriodaphnia dubia* - LC_{50} (48 hrs) = 2261 mg/l NaCl
Pimephales promelas - LC_{50} (96 hrs) = 7227 mg/L NaCl

Results are in acceptable range as determined by laboratory's testing program.

VI. RESULTS

State Permit Limits: N/A; **NOEL:** N/A

Test Results: Toxicity was indicated with the *Ceriodaphnia dubia* and the fathead minnow. The NOEC for the *Ceriodaphnia dubia* was 25% effluent concentration. The NOEC for the fathead minnow was 50% effluent concentration. The LOEC, EC_{50}, and the Chronic Values are presented in Table 2.

Data Tables and Analysis: Presented in Table 2

Indicate Statistical Methods Used: Presented in Table 2

Raw Data: Bench Sheet Data is Presented in Appendix A.

TABLE 2

SUMMARY OF CHRONIC BIOMONITORING RESULTS
SAMPLES COLLECTED AUGUST 5, 7, AND 9, 1991
EPA NO: 4192

Test Organism	Sample ID	Test Concentration (%)	Survival Data Analysis: % Survival by Days 1	2	3	4	5	6	7	Tox.	Method	Reproduction Data Analysis: Average # Young Produced	Tox.	Method
Ceriodaphnia dubia	Control	---	90	90	90	90	90	90	90	---	---	22	---	---
	Final Effluent	6.25	100	100	100	100	100	100	100	No	Inspection	26	No	Inspection
		12.5	100	100	100	100	100	100	100	No	Inspection	30	No	Inspection
		25	100	100	100	100	100	100	100	No	Inspection	21	No	Inspection
		50	80	80	80	80	60	60	60	No	Inspection	10	Yes	Inspection
		100	70	30	20	20	10	10	0	Yes	Inspection	N/A	N/A	N/A

Finding: NOEC = 25% Effluent Concentration,
LOEC = 50% Effluent Concentration,
ChV = 35.4% Effluent Concentration,
EC_{50} = 62% Effluent Concentration,
Toxicity

Test Organism	Sample ID	Test Concentration (%)	Survival Data Analysis: % Survival by Days 1	2	3	4	5	6	7	Tox.	Method	Growth Data Analysis: Average Wt. per Larvae (mg)	Tox.	Method
Fathead Minnow	Control	---	100	100	100	100	100	100	100	---	---	0.36	---	---
	Final Effluent	6.25	100	100	100	100	100	100	100	No	Inspection	0.38	No	Inspection
		12.5	100	100	100	100	100	100	100	No	Inspection	0.47	No	Inspection
		25	100	93	93	93	90	90	90	No	Inspection	0.42	No	Inspection
		50	97	97	97	97	97	97	97	No	Inspection	0.32	No	Inspection
		100	0	0	0	0	0	0	0	Yes	Inspection	N/A	N/A	N/A

Finding: NOEC = 50% Effluent Concentration,
LOEC = 100% Effluent Concentration,
ChV = 70.7% Effluent Concentration,
EC_{50} = 68% Effluent Concentration,
Toxicity

Blackstone River Survey
Douglas WWTP, East Douglas, Ma.

CHEMICAL ANALYSIS OF TOXICITY SAMPLES
24-hr time-composite 8/5/91 and 8/9/91
Grab sample collected on 8/7/91

ANALYTICAL RESULTS
(mg/l unless otherwise noted)

PARAMETERS	Collection Dates 08/05/91	08/07/91(G)	08/09/91
Al	0.98	0.10	0.11
Cd	<0.0030	<0.0030	<0.0030
Ca	18	17	16
Cr	<0.0050	<0.0050	<0.0050
Cu	0.23	0.046	0.039
Pb	0.020	0.0034	0.039
Mg	3.0	2.1	1.9
Ni	<0.0050	0.016	<0.0050
Zn	0.20	0.10	0.079
N-NH4	31	29	25
TS	560	370	380
TSS	240	27	35
TOC	35	22	32
Alk.(as $CaCO_3$)	230	80	210

NOTES: D= Sample Duplicate
TS= Total Solids
ND= Below minimum detectable level
*= ppm CaCO3
TOC= Total Organic Carbons
Alk.= Alkalinity
TSS= Total Suspensed Solids
(G)= Grab samples Taken

Edward G. Foree, Ph.D., P.E.

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COMMONWEALTH TECHNOLOGY, INC.

Environmental and Natural Resources Consulting and Analytical Services

Lexington, Kentucky | Louisville, Kentucky | Grayson, Kentucky

JUL 18 1991

BIOMONITORING JOB NO: 4006/EPA 4094 - Chronic Study
SAS 1109

WOONSOCKET POTW, RI

I. INTRODUCTION

Facility: Region I

NPDES Permit No: N/A

Contact: Ms. Cindy Schreyer

Phone No: (703) 519-1386

Receiving Stream: N/A

Contact: Billie Rogers

Laboratory: Commonwealth Technology, Inc.
2520 Regency Road
Lexington, Kentucky 40503-2961
(606) 276-3506

II. SAMPLES (EFFLUENT AND DILUTION WATER)

1. **Effluent**
   Sample Point: Final Effluent
   Collection Dates and Times: 06/17/91/7:20AM; 06/19/91/9:20AM; 06/21/91/9:20AM
   Collection Method: *Composite*
   Physical and Chemical Data: See Attached Data Sheet in Appendix A

2. **Dilution Water**
   The water used for dilutions and control was a moderately hard reconstituted water adjusted to pH 7.8. The physical and chemical data of the dilution water is reported in Appendix A.

III. TEST METHODS

Test Method: "Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms" EPA/600/4-89/001.

Deviations from methods, if any, and explanation: Samples with dissolved oxygen (D.O.) greater than 100 percent saturation after warming, were aerated slowly until D.O. was below 100%.

Date and Time Test Started: 06/18/91 (2:15PM); 06/18/91 (3:00PM)
Date and Time Test Terminated: 06/26/91 (2:30PM); 06/25/91 (3:30PM)
Test Chambers: Refer to Table 1
Volume used per Chamber: Refer to Table 1
Number of Organisms per Chamber: Refer Table 1
Number of Replicates per Concentrations: Refer to Table 1
Acclimation of Organisms: Refer to Table 1
Test Temperature (mean and range): Cultured at test temperature, 25° ± 1°C

TABLE 1
SUMMARY OF TEST CONDITIONS FOR CHRONIC TOXICITY TEST
METHOD: EPA 600/4-89/001

		Ceriodaphnia dubia Method: 1002.0	*Pimephales promelas* Method: 1000.0
1.	**Test Type:**	Static-Renewal	Static-Renewal
2.	**Temperature:**	25° ± 1°C	25° ± 1°C
3.	**Light Quality:**	Ambient laboratory illumination (cool white)	Ambient laboratory illumination (cool white)
4.	**Light Intensity:**	Approx. 100 ft-c	Approx. 100 ft-c
5.	**Photoperiod:**	8 hrs. dark, 16 hrs. light	8 hrs. dark, 16 hrs. light
6.	**Test Chamber Size:**	30 mls	270 ml
7.	**Test Solution Volume:**	15 ml/replicate	200 ml/replicate
8.	**Renewal of Test Concentrations:**	Daily	Daily
9.	**Age of Test Organism:**	Less than 24 hours	1-2 days
10.	**No. of Test Organisms per Chamber:**	1	10
11.	**No. of Replicate Chambers per Concentration:**	10	3
12.	**Feeding Regime:**	Fed YCT (yeast suspension) & *Selenastrum minutum* (algae) suspension daily.	Fed brine shrimp nauplii in a concentrated suspension twice daily.
13.	**Aeration:**	Samples with D.O. greater than 100% saturation were aerated	Samples with D.O. greater than 100% saturation were aerated
14.	**Dilution Water:**	Reconstituted water (10% Perrier water)	Reconstituted water (10% Perrier water)
15.	**Effluent Concentrations:**	100%, 50%, 25%, 12.5%, 6.25%	100%, 50%, 25%, 12.5%, 6.25%
16.	**Test Duration:**	7 days or until 60% of the control females have 3 broods	7-days
17.	**Effects Measured:**	Survival and Reproduction	Survival and Growth
18.	**Test Acceptability:**	80% or greater survival in the control concentration	80% or greater survival in the control concentration

IV. TEST ORGANISMS

Name: *Ceriodaphnia dubia*; *Pimephales promelas*

Age: Less than 24 hours; 2 days

Source: Stock N; Stock F

Life Stage: Neonate; Juvenile

Mean Length and Weight (if applicable): N/A

V. QUALITY ASSURANCE

Standard Toxicant: Sodium Chloride

Date and Time of Most Recent Test:

Ceriodaphnia dubia 06/12/91 (5:30PM)
Pimephales promelas 06/22/91 (3:30PM)

Dilution Water Used: Reconstituted Water, 10% Perrier Water

Results: *Ceriodaphnia dubia* - LC_{50} (48 hrs) = 2846 mg/l NaCl
Pimephales promelas - LC_{50} (96 hrs) = 6295 mg/L NaCl

Results are in acceptable range as determined by laboratory's testing program.

VI. RESULTS

State Permit Limits: N/A; **NOEL:** N/A

Test Results: Toxicity was indicated with the *Ceriodaphnia dubia* and the fathead minnow. The NOEC for both the *Ceriodaphnia dubia* and the fathead minnow was 50% effluent concentration. The LOEC, EC_{50}, and the Chronic Values are presented in Table 2.

Data Tables and Analysis: Presented in Table 2

Indicate Statistical Methods Used: Presented in Table 2

Raw Data: Bench Sheet Data is Presented in Appendix A.

TABLE 2

SUMMARY OF CHRONIC BIOMONITORING RESULTS
SAMPLES COLLECTED JUNE 17, 19, and 21, 1991
EPA NO: 4094

Test Organism	Sample ID	Test Concentration (%)	Survival Data Analysis: % Survival by Days 1	2	3	4	5	6	7	8	Tox.	Method	Reproduction Data Analysis: Average # Young Produced	Tox.	Method
Ceriodaphnia dubia	Control	---	100	100	100	80	80	80	80	80	---	---	30	---	---
	Final Effluent	6.25	100	100	100	100	100	100	100	100	No	Inspection	51	No	Inspection
		12.5	100	100	100	100	100	100	100	100	No	Inspection	39	No	Inspection
		25	100	100	100	100	100	100	100	100	No	Inspection	47	No	Inspection
		50	100	100	100	100	100	100	90	90	No	Inspection	32	No	Inspection
		100	70	20	20	20	0	0	0	0	Yes	Inspection	N/A	N/A	N/A

Finding: NOEC = 50% Effluent Concentration,
LOEC = 100% Effluent Concentration,
ChV = 70.7% Effluent Concentration,
EC_{50} = 66% Effluent Concentration,
Toxicity

Test Organism	Sample ID	Test Concentration (%)	Survival Data Analysis: % Survival by Days 1	2	3	4	5	6	7	Tox.	Method	Growth Data Analysis: Average Wt. per Larvae (mg)	Tox.	Method
Fathead Minnow	Control	---	100	93	87	87	87	87	80	---	---	0.42	---	---
	Final Effluent	6.25	100	100	100	97	97	93	93	No	Inspection	0.46	No	Dunnett's
		12.5	97	93	93	93	93	93	93	No	Inspection	0.38	No	Dunnett's
		25	87	87	87	87	87	87	87	No	Inspection	0.36	No	Dunnett's
		50	90	87	87	87	83	83	83	No	Inspection	0.39	No	Dunnett's
		100	87	27	10	0	0	0	0	Yes	Inspection	N/A	N/A	N/A

Finding: NOEC = 50% Effluent Concentration,
LOEC = 100% Effluent Concentration,
ChV = 70.7% Effluent Concentration,
EC_{50} = 63% Effluent Concentration,
Toxicity

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BIOMONITORING JOB NO: 4006/EPA 4193 - Chronic Study
SAS 1109

WOONSOCKET POTW, RI

I. INTRODUCTION

Facility: Region I

NPDES Permit No: N/A

Contact: Ms. Cindy Schreyer

Phone No: (703) 519-1386

Receiving Stream: N/A

Contact: Billie Rogers

Laboratory: Commonwealth Technology, Inc.
2520 Regency Road
Lexington, Kentucky 40503-2961
(606) 276-3506

II. SAMPLES (EFFLUENT AND DILUTION WATER)

1. ***Effluent***
   Sample Point: Final Effluent
   Collection Dates and Times: 08/05/91/10:00AM; 08/07/91/10:30AM; 08/09/91/9:55AM
   Collection Method: *24 Hour Composite*
   Physical and Chemical Data: See Attached Data Sheet in Appendix A

2. **Dilution Water**
   The water used for dilutions and control was a moderately hard reconstituted water adjusted to pH 7.8.
   The physical and chemical data of the dilution water is reported in Appendix A.

III. TEST METHODS

Test Method: "Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms" EPA/600/4-89/001.

Deviations from methods, if any, and explanation: After warming the samples to 25°C the samples with dissolved oxygen (D.O.) readings greater than 100 percent saturation were aerated slowly until D.O. was less than 100%.

Date and Time Test Started: 08/06/91 (3:00PM); 08/06/91 (4:00PM)
Date and Time Test Terminated: 08/13/91 (2:30PM); 08/13/91 (4:00PM)
Test Chambers: Refer to Table 1
Volume used per Chamber: Refer to Table 1
Number of Organisms per Chamber: *Refer* Table 1
Number of Replicates per Concentrations: Refer to Table 1
Acclimation of Organisms: Refer to Table 1
Test Temperature (mean and range): *Cultured at test temperature,* 25° ± 1°C

TABLE 1
SUMMARY OF TEST CONDITIONS FOR CHRONIC TOXICITY TEST
METHOD: EPA 600/4-89/001

		Ceriodaphnia dubia Method: 1002.0	*Pimephales promelas* Method: 1000.0
1.	**Test Type:**	Static-Renewal	Static-Renewal
2.	**Temperature:**	25° ± 1°C	25° ± 1°C
3.	**Light Quality:**	Ambient laboratory illumination (cool white)	Ambient laboratory illumination (cool white)
4.	**Light Intensity:**	Approx. 100 ft-c	Approx. 100 ft-c
5.	**Photoperiod:**	8 hrs. dark, 16 hrs. light	8 hrs. dark, 16 hrs. light
6.	**Test Chamber Size:**	30 mls	270 ml
7.	**Test Solution Volume:**	15 ml/replicate	200 ml/replicate
8.	**Renewal of Test Concentrations:**	Daily	Daily
9.	**Age of Test Organism:**	Less than 24 hours	1-2 days
10.	**No. of Test Organisms per Chamber:**	1	10
11.	**No. of Replicate Chambers per Concentration:**	10	3
12.	**Feeding Regime:**	Fed YCT (yeast suspension) & *Selenastrum minutum* (algae) suspension daily.	Fed brine shrimp nauplii in a concentrated suspension twice daily.
13.	**Aeration:**	Samples with D.O. greater than 100% saturation were aerated.	Samples with D.O. greater than 100% saturation were aerated.
14.	**Dilution Water:**	Reconstituted water (10% Perrier water)	Reconstituted water (10% Perrier water)
15.	**Effluent Concentrations:**	100%, 50%, 25%, 12.5%, 6.25%	100%, 50%, 25%, 12.5%, 6.25%
16.	**Test Duration:**	7 days or until 60% of the control females have 3 broods	7-days
17.	**Effects Measured:**	Survival and Reproduction	Survival and Growth
18.	**Test Acceptability:**	80% or greater survival in the control concentration	80% or greater survival in the control concentration

IV. TEST ORGANISMS

Name: *Ceriodaphnia dubia; Pimephales promelas*

Age: Less than 24 hours; 2 days

Source: Stock N; Stock F

Life Stage: Neonate; Juvenile

Mean Length and Weight (if applicable): N/A

V. QUALITY ASSURANCE

Standard Toxicant: Sodium Chloride

Date and Time of Most Recent Test:

Ceriodaphnia dubia 08/05/91 (1:00PM)
Pimephales promelas 08/06/91 (9:00AM)

Dilution Water Used: Reconstituted Water, 10% Perrier Water

Results: *Ceriodaphnia dubia* - LC_{50} (48 hrs) = 2261 mg/l NaCl
Pimephales promelas - LC_{50} (96 hrs) = 7227 mg/L NaCl

Results are in acceptable range as determined by laboratory's testing program.

VI. RESULTS

State Permit Limits: N/A; **NOEL:** N/A

Test Results: Toxicity was indicated with the *Ceriodaphnia dubia*. No toxicity was indicated with the fathead minnow. The NOEC for the *Ceriodaphnia dubia* was 25% effluent concentration. The NOEC for the fathead minnow was >100% effluent concentration. The LOEC, EC_{50}, and the Chronic Values are presented in Table 2.

Data Tables and Analysis: Presented in Table 2

Indicate Statistical Methods Used: Presented in Table 2

Raw Data: Bench Sheet Data is Presented in Appendix A.

TABLE 2

SUMMARY OF CHRONIC BIOMONITORING RESULTS
SAMPLES COLLECTED AUGUST 5, 7, AND 9, 1991
EPA NO: 4193

Test Organism	Sample ID	Test Concentration (%)	Survival Data Analysis: % Survival by Days 1	2	3	4	5	6	7	Tox.	Method	Reproduction Data Analysis: Average # Young Produced	Tox.	Method
Ceriodaphnia dubia	Control	---	100	100	100	100	100	100	100	---	---	22	---	---
	Final Effluent	6.25	100	100	90	90	70	60	60	No	Inspection	15	No	Inspection
		12.5	100	100	100	100	100	90	90	No	Inspection	23	No	Inspection
		25	100	100	100	100	100	70	70	No	Inspection	18	No	Inspection
		50	100	100	100	100	0	0	0	Yes	Inspection	N/A	N/A	N/A
		100	100	100	100	0	0	0	0	Yes	Inspection	N/A	N/A	N/A

Finding: NOEC = 25% Effluent Concentration,
LOEC = 50% Effluent Concentration,
ChV = 35.4% Effluent Concentration,
EC_{50} = 29% Effluent Concentration,
Toxicity

Test Organism	Sample ID	Test Concentration (%)	Survival Data Analysis: % Survival by Days 1	2	3	4	5	6	7	Tox.	Method	Growth Data Analysis: Average Wt. per Larvae (mg)	Tox.	Method
Fathead Minnow	Control	---	100	100	97	97	97	97	97	---	---	0.45	---	---
	Final Effluent	6.25	100	100	100	100	100	100	100	No	Inspection	0.52	No	Inspection
		12.5	97	97	97	93	93	93	93	No	Inspection	0.52	No	Inspection
		25	100	100	100	100	100	100	100	No	Inspection	0.43	No	Inspection
		50	100	100	100	93	93	93	93	No	Inspection	0.52	No	Inspection
		100	100	100	97	93	93	90	90	No	Inspection	0.46	No	Inspection

Finding: NOEC > 100% Effluent Concentration,
LOEC > 100% Effluent Concentration,
ChV = 100% Effluent Concentration,
EC_{50} > 100% Effluent Concentration,
No Toxicity

Blackstone River Survey
Woonsocket POTW, Woonsocket, RI

CHEMICAL ANALYSIS OF TOXICITY SAMPLES
24-hr time-composite samples

ANALYTICAL RESULTS
(mg/l unless otherwise noted)

PARAMETERS	Collection Dates 06/17/91	06/19/91	06/21/91	08/05/91	08/07/91	08/09/91
Al	0.20	0.15	0.22	0.15	0.20	0.13
Cd	ND	0.005	0.004	<0.0030	0.0059	0.0038
Ca	23	17	18	20	18	19
Cr	ND	ND	ND	<0.0050	0.015	0.0086
Cu	0.085	0.043	0.065	0.044	0.075	0.52
Pb	0.004	0.005	0.009	0.0090	0.015	0.0089
Mg	3.0	2.5	3.3	3.7	3.3	3.4
Ni	ND	0.01	0.01	0.0065	0.030	0.0089
Zn	0.039	0.092	0.106	0.097	0.140	0.16
N-NH4	20	14	15	13	7.5	7.9
TS	540	870	900	450	890	830
TSS	15	10	32	58	37	24
TOC	28	40	54	18	44	34
Alk.(mg/l $CaCO_3$)	130	130	150	92	110	120

Notes: ND= Below minimum detectable level

D= Sample Duplicate Alk.= Alkalinity

TS= Total Solids TSS= Total Suspensed Solids

TOC= Total Organic Carbons

Edward G. Foree, Ph.D., P.E.

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COMMONWEALTH TECHNOLOGY, INC.

Environmental and Natural Resources Consulting and Analytical Services

Lexington, Kentucky Louisville, Kentucky Grayson, Kentucky

JUL 18 1991

BIOMONITORING JOB NO: 4006/EPA 4095 - Chronic Study
SAS 1109

OKONITE
ASHTON, RI

I. INTRODUCTION

Facility: Region I **NPDES Permit No:** N/A

Contact: Ms. Cindy Schreyer **Phone No:** (703) 519-1386

Receiving Stream: N/A **Contact:** Billie Rogers

Laboratory: Commonwealth Technology, Inc.
2520 Regency Road
Lexington, Kentucky 40503-2961
(606) 276-3506

II. SAMPLES (EFFLUENT AND DILUTION WATER)

1. **Effluent**
   Sample Point: Final Effluent
   Collection Dates and Times: 06/17/91/11:45AM; 06/19/91/11:20AM; 06/21/91/11:20AM
   Collection Method: 24 Hour Composte
   Physical and Chemical Data: See Attached Data Sheet in Appendix A

2. **Dilution Water**
   The water used for dilutions and control was a moderately hard reconstituted water adjusted to pH 7.8. The physical and chemical data of the dilution water is reported in Appendix A.

III. TEST METHODS

Test Method: "Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms" EPA/600/4-89/001.

Deviations from methods, if any, and explanation: After warming the samples to 25°C the samples with dissolved oxygen (D.O.) readings greater than 100 percent saturation were aerated slowly until D.O. was less than 100%. The samples were dechlorinated with sodium thiosulfate because their chlorine concentration was >0.02 mg/L.

Date and Time Test Started: 06/18/91 (2:00PM); 06/18/91 (2:30PM)
Date and Time Test Terminated: 06/26/91 (2:15PM); 06/25/91 (3:00PM)
Test Chambers: Refer to Table 1
Volume used per Chamber: Refer to Table 1
Number of Organisms per Chamber: Refer Table 1
Number of Replicates per Concentrations: Refer to Table 1
Acclimation of Organisms: Refer to Table 1
Test Temperature (mean and range): Cultured at test temperature, 25° ± 1°C

TABLE 1
SUMMARY OF TEST CONDITIONS FOR CHRONIC TOXICITY TEST
METHOD: EPA 600/4-89/001

		Ceriodaphnia dubia Method: 1002.0	*Pimephales promelas* Method: 1000.0
1.	Test Type:	Static-Renewal	Static-Renewal
2.	Temperature:	25° ± 1°C	25° ± 1°C
3.	Light Quality:	Ambient laboratory illumination (cool white)	Ambient laboratory illumination (cool white)
4.	Light Intensity:	Approx. 100 ft-c	Approx. 100 ft-c
5.	Photoperiod:	8 hrs. dark, 16 hrs. *light*	8 hrs. dark, 16 hrs. *light*
6.	Test Chamber Size:	30 mls	270 ml
7.	Test Solution Volume:	15 ml/replicate	200 ml/replicate
8.	Renewal of Test Concentrations:	Daily	Daily
9.	Age of Test Organism:	Less than 24 hours	1-2 days
10.	No. of Test Organisms per Chamber:	1	10
11.	No. of Replicate Chambers per Concentration:	10	3
12.	Feeding Regime:	Fed YCT (yeast suspension) & *Selenastrum minutum* (algae) suspension daily.	Fed brine shrimp nauplii in a concentrated suspension twice daily.
13.	Aeration:	Samples with D.O. greater than 100% saturation were aerated	Samples with D.O. greater than 100% saturation were aerated
14.	Dilution Water:	Reconstituted water (10% *Perrier water)*	Reconstituted water (10% Perrier water)
15.	Effluent Concentrations:	100%, 50%, 25%, 12.5%, 6.25%	100%, 50%, 25%, 12.5%, 6.25%
16.	Test Duration:	7 days or until 60% of the the control females have 3 broods	7-days
17.	Effects Measured:	Survival and Reproduction	Survival and Growth
18.	Test Acceptability:	80% or greater survival in the control concentration	80% or greater survival in the control concentration

IV. TEST ORGANISMS

Name: *Ceriodaphnia dubia*; *Pimephales promelas*

Age: Less than 24 hours; 2 days

Source: Stock N; Stock F

Life Stage: Neonate; Juvenile

Mean Length and Weight (if applicable): N/A

V. QUALITY ASSURANCE

Standard Toxicant: Sodium Chloride

Date and Time of Most Recent Test:

Ceriodaphnia dubia 06/12/91 (5:30PM)
Pimephales promelas 06/22/91 (3:30PM)

Dilution Water Used: Reconstituted Water, 10% Perrier Water

Results: *Ceriodaphnia dubia* - LC_{50} (48 hrs) = 2846 mg/l NaCl
Pimephales promelas - LC_{50} (96 hrs) = 6295 mg/L NaCl

Results are in acceptable range as determined by laboratory's testing program.

VI. RESULTS

State Permit Limits: N/A; **NOEL:** N/A

Test Results: No toxicity was indicated with the *Ceriodaphnia dubia* or the fathead minnow. The NOEC for both the *Ceriodaphnia dubia* and the fathead minnow was >100% effluent concentration. The LOEC, EC_{50}, and the Chronic Values are presented in Table 2.

Data Tables and Analysis: Presented in Table 2

Indicate Statistical Methods Used: Presented in Table 2

Raw Data: Bench Sheet Data is Presented in Appendix A.

TABLE 2

SUMMARY OF CHRONIC BIOMONITORING RESULTS
SAMPLES COLLECTED JUNE 17, 19, and 21, 1991
EPA NO: 4095

Test Organism	Sample ID	Test Concentration (%)	Survival Data Analysis: % Survival by Days 1	2	3	4	5	6	7	8	Tox.	Method	Reproduction Data Analysis: Average # Young Produced	Tox.	Method
Ceriodaphnia dubia	Control	---	100	100	100	90	90	90	90	90	---	---	25	---	---
	Final Effluent	6.25	100	100	100	80	60	60	60	60	No	Fisher's	17	No	Inspection
		12.5	100	100	100	100	70	60	60	60	No	Fisher's	18	No	Inspection
		25	100	100	100	100	90	80	80	70	No	Inspection	16	No	Inspection
		50	100	100	100	100	89	89	89	56	No	Fisher's	19	No	Inspection
		100	100	100	100	100	80	80	80	70	No	Inspection	32	No	Dunnett's

Finding: NOEC > 100% Effluent Concentration,
LOEC > 100% Effluent Concentration,
ChV = 100% Effluent Concentration,
EC_{50} > 100% Effluent Concentration,
No Toxicity

Test Organism	Sample ID	Test Concentration (%)	Survival Data Analysis: % Survival by Days 1	2	3	4	5	6	7	Tox.	Method	Growth Data Analysis: Average Wt. per Larvae (mg)	Tox.	Method
Fathead Minnow	Control	---	100	100	97	93	93	90	90	---	---	0.51	---	---
	Final Effluent	6.25	97	93	90	90	83	83	83	No	Dunnett's	0.49	No	Dunnett's
		12.5	100	97	97	97	97	93	93	No	Dunnett's	0.44	No	Dunnett's
		25	100	100	100	100	100	93	93	No	Dunnett's	0.46	No	Dunnett's
		50	97	93	90	90	90	90	90	No	Dunnett's	0.51	No	Dunnett's
		100	97	93	93	93	90	90	90	No	Dunnett's	0.46	No	Dunnett's

Finding: NOEC > 100% Effluent Concentration,
LOEC > 100% Effluent Concentration,
ChV = 100% Effluent Concentration,
EC_{50} > 100% Effluent Concentration,
No Toxicity

Blackstone River Survey

Okonite Industries, Ashton, RI

CHEMICAL ANALYSIS OF TOXICITY SAMPLES
24-hr time-composite samples

ANALYTICAL RESULTS
(mg/l unless otherwise noted)

PARAMETERS	Collection Dates 06/17/91	06/19/91	06/21/91
Al	0.08	0.04	0.10
Cd	ND	ND	ND
Ca	14	13	12
Cr	0.007	ND	ND
Cu	0.018	0.015	0.020
Pb	ND	0.002	0.010
Mg	2.8	2.8	2.3
Ni	ND	ND	ND
Zn	0.058	0.073	0.108
N-NH4	ND	ND	ND
TS	200	150	140
TSS	ND	ND	ND
TOC	15	2.2	2.7
Alk.(as $CaCO_3$)	34	44	28

NOTES: D= Sample Duplicate
TS= Total Solids
ND= Below minimum detectable level
TOC= Total Organic Carbons
Alk.= Alkalinity
TSS= Total Suspensed Solids

Edward G. Foree, Ph.D., P.E.

John S. Tapp, Ph.D., P.E., L.S.

COMMONWEALTH TECHNOLOGY, INC.

JUL 18 1991

Environmental and Natural Resources Consulting and Analytical Services

Lexington, Kentucky Louisville, Kentucky Grayson, Kentucky

BIOMONITORING JOB NO: 4006/EPA 4096 - Chronic Study
SAS 1109

GTE - 001A
CENTRAL FALLS, RI

I. INTRODUCTION

Facility: Region I **NPDES Permit No:** N/A

Contact: Ms. Cindy Schreyer **Phone No:** (703) 519-1386

Receiving Stream: N/A **Contact:** Billie Rogers

Laboratory: Commonwealth Technology, Inc.
2520 Regency Road
Lexington, Kentucky 40503-2961
(606) 276-3506

II. SAMPLES (EFFLUENT AND DILUTION WATER)

1. Effluent
   Sample Point: Final Effluent
   Collection Dates and Times: 06/17/91/2:00PM; 06/19/91/12:30AM; 06/21/91/12:30AM
   Collection Method: 24 Hour Composite
   Physical and Chemical Data: See Attached Data Sheet in Appendix A

2. **Dilution Water**
   The water used for dilutions and control was a moderately hard reconstituted water adjusted to pH 7.8. The physical and chemical data of the dilution water is reported in Appendix A.

III. TEST METHODS

Test Method: "Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms" EPA/600/4-89/001.

Deviations from methods, if any, and explanation: After warming the samples to 25°C the samples with dissolved oxygen (D.O.) readings greater than 100 percent saturation were aerated slowly until D.O. was less than 100%.

Date and Time Test Started: 06/18/91 (2:00PM); 06/18/91 (2:00PM)
Date and Time Test Terminated: 06/26/91 (9:50AM); 06/25/91 (2:15PM)
Test Chambers: Refer to Table 1
Volume used per Chamber: Refer to Table 1
Number of Organisms per Chamber: Refer Table 1
Number of Replicates per Concentrations: Refer to Table 1
Acclimation of Organisms: Refer to Table 1
Test Temperature (mean and range): Cultured at test temperature, 25° ± 1°C

TABLE 1
SUMMARY OF TEST CONDITIONS FOR CHRONIC TOXICITY TEST
METHOD: EPA 600/4-89/001

		Ceriodaphnia dubia Method: 1002.0	*Pimephales promelas* Method: 1000.0
1.	**Test Type:**	Static-Renewal	Static-Renewal
2.	**Temperature:**	25° ± 1°C	25° ± 1°C
3.	**Light Quality:**	Ambient laboratory illumination (cool white)	Ambient laboratory illumination (cool white)
4.	**Light Intensity:**	Approx. 100 ft-c	Approx. 100 ft-c
5.	**Photoperiod:**	8 hrs. dark, 16 hrs. light	8 hrs. dark, 16 hrs. light
6.	**Test Chamber Size:**	30 mls	270 ml
7.	**Test Solution Volume:**	15 ml/replicate	200 ml/replicate
8.	**Renewal of Test Concentrations:**	Daily	Daily
9.	**Age of Test Organism:**	Less than 24 hours	1-2 days
10.	**No. of Test Organisms per Chamber:**	1	10
11.	**No. of Replicate Chambers per Concentration:**	10	3
12.	**Feeding Regime:**	Fed YCT (yeast suspension) & *Selenastrum minutum* (algae) suspension daily.	Fed brine shrimp nauplii in a concentrated suspension twice daily.
13.	**Aeration:**	Samples with D.O. greater than 100% saturation were aerated.	Samples with D.O. greater than 100% saturation were aerated.
14.	**Dilution Water:**	Reconstituted water (10% Perrier water)	Reconstituted water (10% Perrier water)
15.	**Effluent Concentrations:**	100%, 50%, 25%, 12.5%, 6.25%	100%, 50%, 25%, 12.5%, 6.25%
16.	**Test Duration:**	7 days or until 60% of the control females have 3 broods	7-days
17.	**Effects Measured:**	Survival and Reproduction	Survival and Growth
18.	**Test Acceptability:**	80% or greater survival in the control concentration	80% or greater survival in the control concentration

IV. TEST ORGANISMS

Name: *Ceriodaphnia dubia*; *Pimephales promelas*

Age: Less than 24 hours; 2 days

Source: Stock N; Stock F

Life Stage: Neonate; Juvenile

Mean Length and Weight (if applicable): N/A

V. QUALITY ASSURANCE

Standard Toxicant: Sodium Chloride

Date and Time of Most Recent Test:

Ceriodaphnia dubia 06/12/91 (5:30PM)
Pimephales promelas 06/22/91 (3:30PM)

Dilution Water Used: Reconstituted Water, 10% Perrier Water

Results: *Ceriodaphnia dubia* - LC_{50} (48 hrs) = 2846 mg/l NaCl
Pimephales promelas - LC_{50} (96 hrs) = 6295 mg/L NaCl

Results are in acceptable range as determined by laboratory's testing program.

VI. RESULTS

State Permit Limits: N/A; **NOEL:** N/A

Test Results: Toxicity was indicated with the *Ceriodaphnia dubia* and the fathead minnow. The NOEC for the *Ceriodaphnia dubia* was 6.25% effluent concentration. The NOEC for the fathead minnow was 12.5% effluent concentration. The LOEC, EC_{50}, and the Chronic Values are presented in Table 2.

Data Tables and Analysis: Presented in Table 2

Indicate Statistical Methods Used: Presented in Table 2

Raw Data: Bench Sheet Data is Presented in Appendix A.

TABLE 2

SUMMARY OF CHRONIC BIOMONITORING RESULTS
SAMPLES COLLECTED JUNE 17, 19, and 21, 1991
EPA NO: 4096

Test Organism	Sample ID	Test Concentration (%)	Survival Data Analysis: % Survival by Days 1	2	3	4	5	6	7	8	Tox.	Method	Reproduction Data Analysis: Average # Tox. Produced	Method	YoungTox.Mthd
Ceriodaphnia dubia	Control	---	100	100	100	90	90	90	90	90	---	---	37	---	---
	Final Effluent	6.25	90	90	90	90	80	80	80	80	No	Inspection	34	No	Inspection
		12.5	100	100	100	100	90	90	90	90	No	Inspection	17	Yes	Inspection
		25	100	50	40	40	40	40	40	40	Yes	Fisher's	N/A	N/A	N/A
		50	30	0	0	0	0	0	0	0	Yes	Inspection	N/A	N/A	N/A
		100	0	0	0	0	0	0	0	0	Yes	Inspection	N/A	N/A	N/A

Finding: **NOEC = 6.25% Effluent Concentration,**
LOEC = 12.5% Effluent Concentration,
ChV = 8.8% Effluent Concentration,
EC_{50} = 18% Effluent Concentration,
Toxicity

Test Organism	Sample ID	Test Concentration (%)	Survival Data Analysis: % Survival by Days 1	2	3	4	5	6	7	Tox.	Method	Growth Data Analysis: Average Wt. per Larvae (mg)	Tox.	Method
Fathead Minnow	Control	---	100	100	97	93	93	90	90	---	---	0.51	---	---
	Final Effluent	6.25	100	93	93	93	93	90	90	No	Inspection	0.40	No	Dunnett's
		12.5	93	93	93	93	93	93	90	No	Inspection	0.37	No	Dunnett's
		25	37	27	13	13	13	7	7	Yes	Inspection	N/A	N/A	N/A
		50	0	0	0	0	0	0	0	Yes	Inspection	N/A	N/A	N/A
		100	0	0	0	0	0	0	0	Yes	Inspection	N/A	N/A	N/A

Finding: **NOEC = 12.5% Effluent Concentration,**
LOEC = 25% Effluent Concentration,
ChV = 17.7% Effluent Concentration,
EC_{50} = 17% Effluent Concentration,
Toxicity

Blackstone River Survey
GTE, Central Falls, RI

CHEMICAL ANALYSIS OF TOXICITY SAMPLES
24-hr time-composite samples

ANALYTICAL RESULTS
(mg/l unless otherwise noted)

Collection Dates

Outfall:	Outfall 001A			Outfall 001B		
PARAMETERS	06/17/91	06/19/91	06/21/91	06/17/91	06/19/91	06/21/91
Al	0.68	0.53	1.2	0.08	0.10	0.08
Cd	ND	ND	ND	ND	ND	ND
Ca	140	40	42	7.6	7.6	7.4
Cr	0.069	0.073	0.238	0.005	ND	ND
Cu	0.028	0.008	0.028	ND	ND	ND
Pb	0.004	0.012	0.008	0.012	0.046	0.032
Mg	0.28	0.10	0.450	1.5	1.5	1.6
Ni	ND	ND	ND	ND	ND	ND
Zn	ND	0.009	0.073	0.162	0.169	0.185
N-NH4	190	110	280	ND	ND	ND
TS	3,100	2,900	4,500	330	110	110
TSS	43	10	120	6.8	9.0	13
TOC	33	38	30	8.4	5.5	4.0
Alk.(as $CaCO_3$)	46	72	90	18	19	19

NOTES: D= Sample Duplicate
TS= Total Solids
ND= Below minimum detectable level
TOC= Total Organic Carbons
Alk.= Alkalinity
TSS= Total Suspensed Solids

Edward G. Force, Ph.D., P.E.

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COMMONWEALTH TECHNOLOGY, INC.

Environmental and Natural Resources Consulting and Analytical Services

Lexington, Kentucky Louisville, Kentucky Grayson, Kentucky

JUL 18 1991

BIOMONITORING JOB NO: 4006/EPA 4097 - Chronic Study
SAS 1109

GTE - 001B
CENTRAL FALLS, RI

I. INTRODUCTION

Facility: Region I **NPDES Permit No:** N/A

Contact: Ms. Cindy Schreyer **Phone No:** (703) 519-1386

Receiving Stream: N/A **Contact:** Billie Rogers

Laboratory: Commonwealth Technology, Inc.
2520 Regency Road
Lexington, Kentucky 40503-2961
(606) 276-3506

II. SAMPLES (EFFLUENT AND DILUTION WATER)

1. **Effluent**
   Sample Point: Final Effluent
   Collection Dates and Times: 06/17/91/3:30PM; 06/19/91/1:40PM; 06/21/91/1:40PM
   Collection Method: 24 Hour Composite
   Physical and Chemical Data: See Attached Data Sheet in Appendix A

2. **Dilution Water**
   The water used for dilutions and control was a moderately hard reconstituted water adjusted to pH 7.8. The physical and chemical data of the dilution water is reported in Appendix A.

III. TEST METHODS

Test Method: "Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms" EPA/600/4-89/001.

Deviations from methods, if any, and explanation: After warming the samples to 25°C the samples with dissolved oxygen (D.O.) readings greater than 100 percent saturation were aerated slowly until D.O. was less than 100%.

Date and Time Test Started: 06/18/91 (3:00PM); 06/18/91 (4:30PM)
Date and Time Test Terminated: 06/26/91 (3:10PM); 06/25/91 (5:00PM)
Test Chambers: Refer to Table 1
Volume used per Chamber: Refer to Table 1
Number of Organisms per Chamber: Refer Table 1
Number of Replicates per Concentrations: Refer to Table 1
Acclimation of Organisms: Refer to Table 1
Test Temperature (mean and range): Cultured at test temperature, 25° ± 1°C

TABLE 1
SUMMARY OF TEST CONDITIONS FOR CHRONIC TOXICITY TEST
METHOD: EPA 600/4-89/001

		Ceriodaphnia dubia Method: 1002.0	*Pimephales promelas* Method: 1000.0
1.	Test Type:	Static-Renewal	Static-Renewal
2.	Temperature:	25° ± 1°C	25° ± 1°C
3.	Light Quality:	Ambient laboratory illumination (cool white)	Ambient laboratory illumination (cool white)
4.	Light Intensity:	Approx. 100 ft-c	Approx. 100 ft-c
5.	Photoperiod:	8 hrs. dark, 16 hrs. light	8 hrs. dark, 16 hrs. light
6.	Test Chamber Size:	30 mls	270 ml
7.	Test Solution Volume:	15 ml/replicate	200 ml/replicate
8.	Renewal of Test Concentrations:	Daily	Daily
9.	Age of Test Organism:	Less than 24 hours	1-2 days
10.	No. of Test Organisms per Chamber:	1	10
11.	No. of Replicate Chambers per Concentration:	10	3
12.	Feeding Regime:	Fed YCT (yeast suspension) & Selenastrum minutum (algae) suspension daily.	Fed brine shrimp nauplii in a concentrated suspension twice daily.
13.	Aeration:	Samples with D.O. greater than 100% saturation were aerated.	Samples with D.O. greater than 100% saturation were aerated.
14.	Dilution Water:	Reconstituted water (10% Perrier water)	Reconstituted water (10% Perrier water)
15.	Effluent Concentrations:	100%, 50%, 25%, 12.5%, 6.25%	100%, 50%, 25%, 12.5%, 6.25%
16.	Test Duration:	7 days or until 60% of the control females have 3 broods	7-days
17.	Effects Measured:	Survival and Reproduction	Survival and Growth
18.	Test Acceptability:	80% or greater survival in the control concentration	80% or greater survival in the control concentration

IV. TEST ORGANISMS

Name: *Ceriodaphnia dubia*; *Pimephales promelas*

Age: Less than 24 hours; 2 days

Source: Stock N; Stock F

Life Stage: Neonate; Juvenile

Mean Length and Weight (if applicable): N/A

V. QUALITY ASSURANCE

Standard Toxicant: Sodium Chloride

Date and Time of Most Recent Test:

Ceriodaphnia dubia 06/12/91 (5:30PM)
Pimephales promelas 06/22/91 (3:30PM)

Dilution Water Used: Reconstituted Water, 10% Perrier Water

Results: *Ceriodaphnia dubia* - LC_{50} (48 hrs) = 2846 mg/l NaCl
Pimephales promelas - LC_{50} (96 hrs) = 6295 mg/L NaCl

Results are in acceptable range as determined by laboratory's testing program.

VI. RESULTS

State Permit Limits: N/A; **NOEL:** N/A

Test Results: Toxicity was indicated with the *Ceriodaphnia dubia* and the fathead minnow. The NOEC for both the *Ceriodaphnia dubia* and fathead minnow was 50% effluent concentration. The LOEC, EC_{50}, and the Chronic Values are presented in Table 2.

Data Tables and Analysis: Presented in Table 2

Indicate Statistical Methods Used: Presented in Table 2

Raw Data: Bench Sheet Data is Presented in Appendix A.

TABLE 2

SUMMARY OF CHRONIC BIOMONITORING RESULTS
SAMPLES COLLECTED JUNE 17, 19, and 21, 1991
EPA NO: 4097

Test Organism	Sample ID	Test Concentration (%)	Survival Data Analysis: % Survival by Days 1	2	3	4	5	6	7	8	Tox.	Method	Reproduction Data Analysis: Average # Young Produced	Tox.	Method
Ceriodaphnia dubia	Control	---	100	100	80	80	80	80	80	80	---	---	16	---	---
	Final Effluent	6.25	100	100	100	100	100	100	80	80	No	Inspection	18	No	Inspection
		12.5	100	100	100	100	100	100	100	100	No	Inspection	16	No	Inspection
		25	100	100	100	100	100	100	100	100	No	Inspection	15	No	Inspection
		50	100	100	100	90	90	90	90	90	No	Inspection	22	No	Inspection
		100	100	100	90	90	80	70	50	50	No	Fisher's	5	Yes	Inspection

Finding: **NOEC = 50% Effluent Concentration,**
LOEC = 100% Effluent Concentration,
ChV = 70.7% Effluent Concentration,
EC_{50} = 100% Effluent Concentration,
Toxicity

Test Organism	Sample ID	Test Concentration (%)	Survival Data Analysis: % Survival by Days 1	2	3	4	5	6	7	Tox.	Method	Growth Data Analysis: Average Wt. per Larvae (mg)	Tox.	Method
Fathead Minnow	Control	---	100	100	97	97	97	97	93	---	---	0.44	---	---
	Final Effluent	6.25	97	97	93	93	93	93	90	No	Dunnett's	0.44	No	Dunnett's
		12.5	97	97	97	93	90	90	87	No	Dunnett's	0.47	No	Dunnett's
		25	97	97	97	97	97	97	97	No	Dunnett's	0.48	No	Dunnett's
		50	80	77	73	73	73	73	73	No	Dunnett's	0.35	No	Dunnett's
		100	67	17	10	10	10	10	10	Yes	Dunnett's	N/A	N/A	N/A

Finding: **NOEC = 50% Effluent Concentration,**
LOEC = 100% Effluent Concentration,
ChV = 70.7% Effluent Concentration,
EC_{50} = 64% Effluent Concentration,
Toxicity

Appendix B

1991 BLACKSTONE RIVER SURVEY

DATA TABLES AND CONCENTRATION PROFILES

BLACKSTONE RIVER DRY WEATHER STUDY

1991

DATA TABLES AND CONCENTRATION PROFILES

Compiled by

Raymond M. Wright, Rajat Roy Chaudhury, and Eid Alkathib

Department of Civil and Environmental Engineering
University of Rhode Island
Kingston, RI

For

U.S. Environmental Protection Agency
Region I, Boston, MA

MA Department of Environmental Protection
Grafton, MA

RI Department of Enviromental Management
Providence, RI

July 1992

INTRODUCTION

This report is a compilation of the data collected for the Blackstone River Dry Weather Study, 1991. The study was designed to conduct a monitoring program for the Blackstone River, it's major tributaries and the major point sources discharging directly into the river. The data collected in this study will be used to calibrate and validate steady state models for dissolved oxygen (QUAL-2E) and trace metals (PAWTOXIC).

BLACKSTONE RIVER SAMPLING PROGRAM:

The Blackstone River study consisted of three synoptic surveys for water quality and biological studies. The study was conducted cooperatively by the United States Environmental Protection Agency (USEPA), the Massachusetts Department of Environmental Protection (MADEP), Narragansett Bay Project (NBP), Rhode Island Department of Environmental Management (RIDEM) and the Department of Civil Engineering at the University of Rhode Island (CVE).

Twenty one water quality stations were selected for analysis. These included fifteen stations along the mainstem of the river and six major tributaries. Table 1 indicates the sampling locations for the study. Two of the largest point sources were sampled, namely, the Upper Blackstone Water Pollution Abatement District (UBWPAD) facility and the Woonsocket Waste Water Treatment Facility (WWWTF).

SAMPLE CONSTITUENTS AND FREQUENCY

The water quality sampling for each of the surveys was divided into two parts. The first part was the sampling of the point sources by the U.S. EPA. This phase consisted of collecting a 24 hour composite sample for each of the 5 days prior to the three synoptic surveys. The samples were transported to the Environmental Engineering laboratories at CVE.

The second phase was the river water quality sampling. The water quality sampling crews recorded field measurements for dissolved oxygen (DO), temperature, and pH over a 48 hour period at six hour intervals. Water quality samples were taken during the first 24 hours of sampling. Table 2 lists the sampling frequency and the constituents analyzed for water quality. All water samples were transported to the Woonsocket WWTF for processing by CVE personnel.

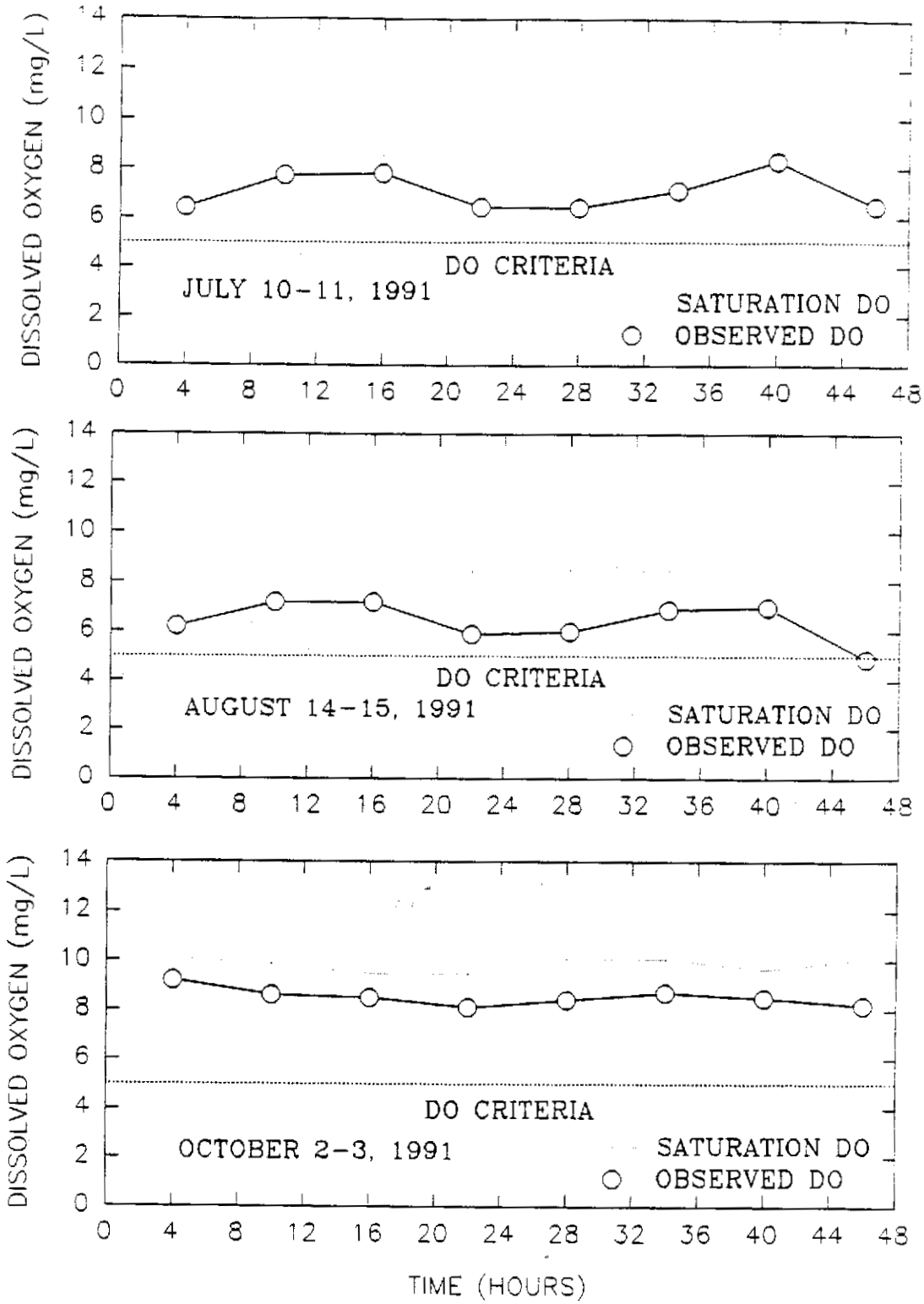
DATA ORGANIZATION

The presentation of the data in this report occurs in two forms. The first is tabular, listing the concentration

of the constituent(s) for each sampling run. The second is graphical, indicating the spatial variation of the constituent(s) concentration. Plots illustrating the temporal variation of DO for the twenty one stations are also presented.

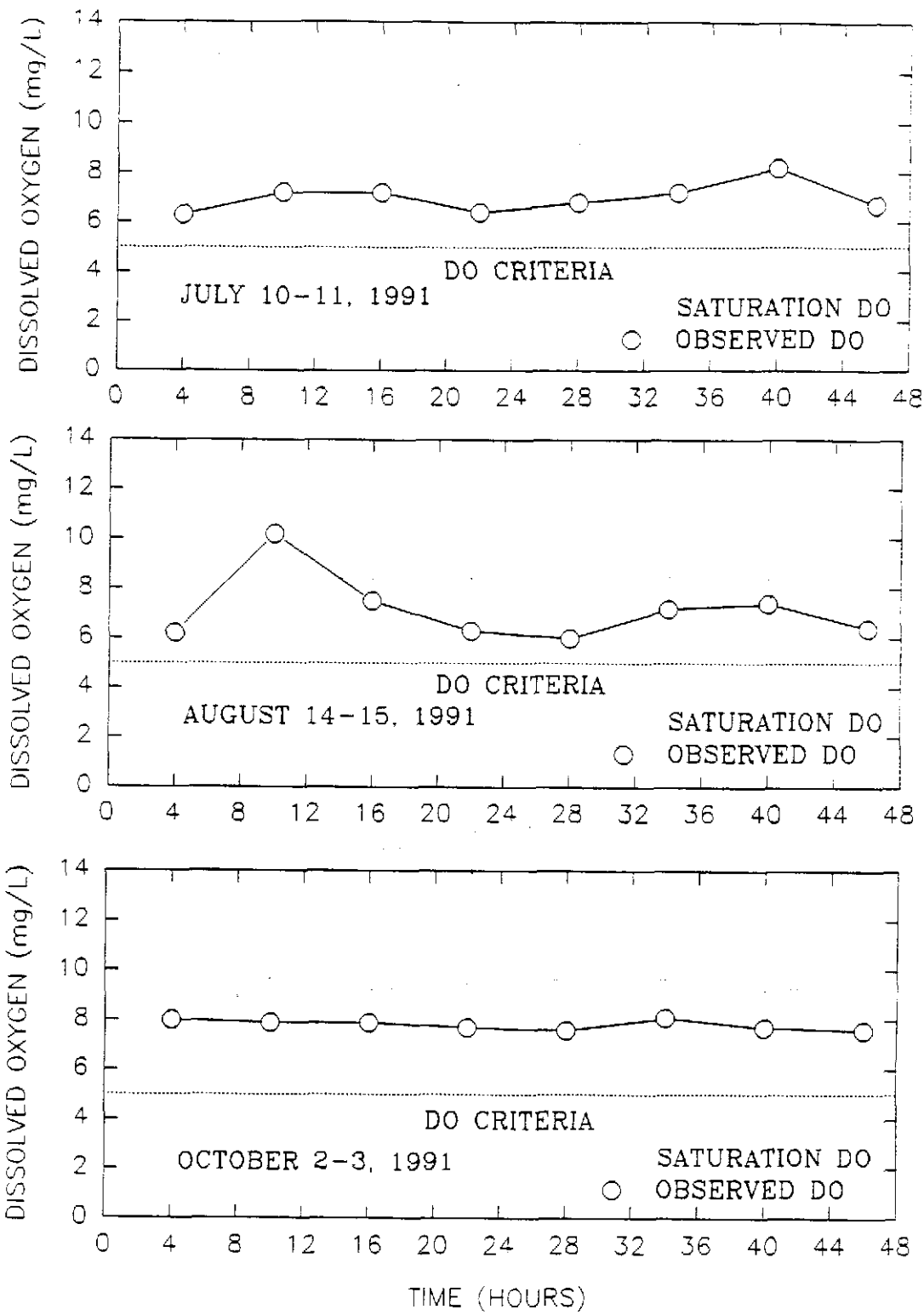
BLACKSTONE RIVER

STATION 1



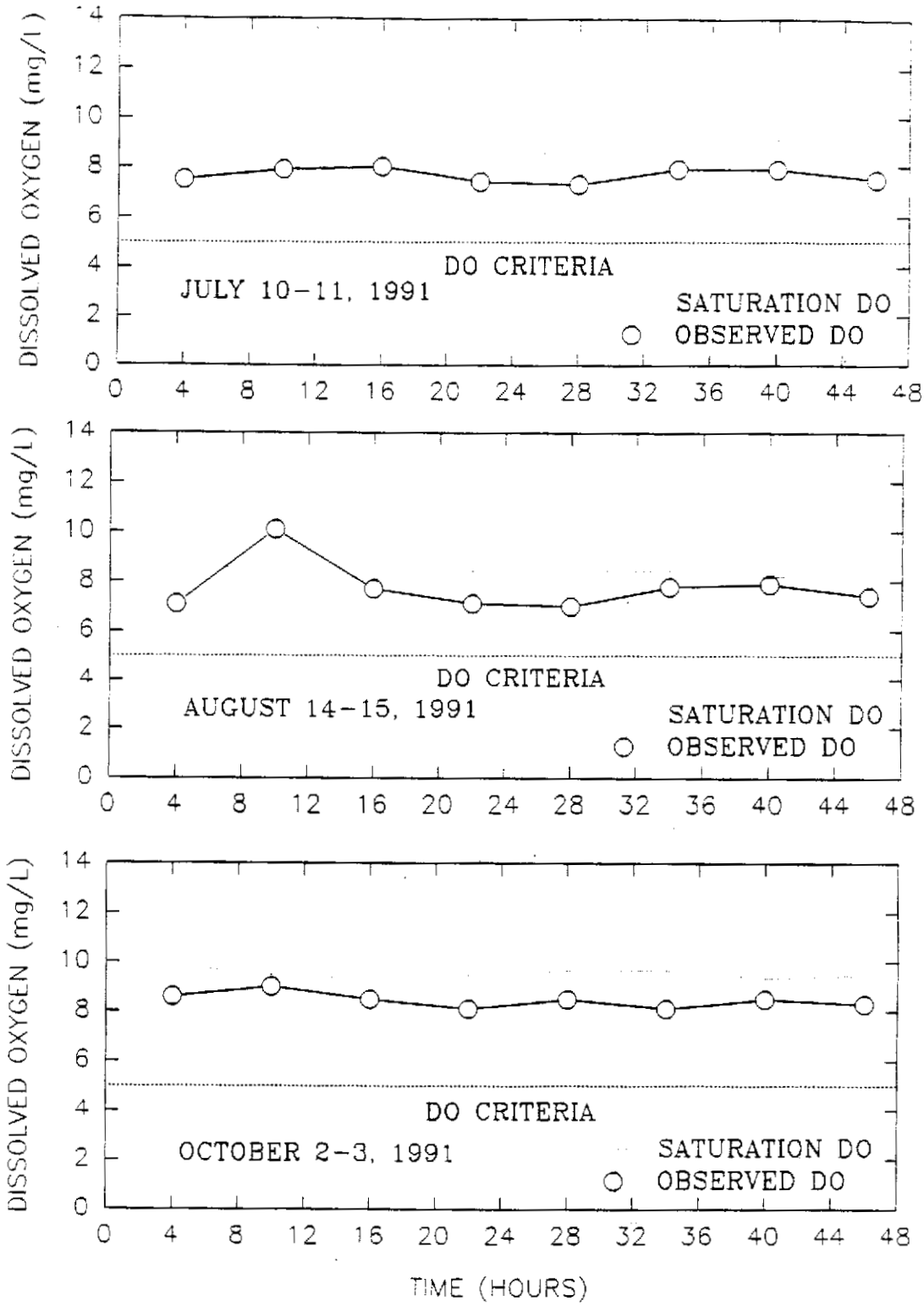
BLACKSTONE RIVER

STATION 2



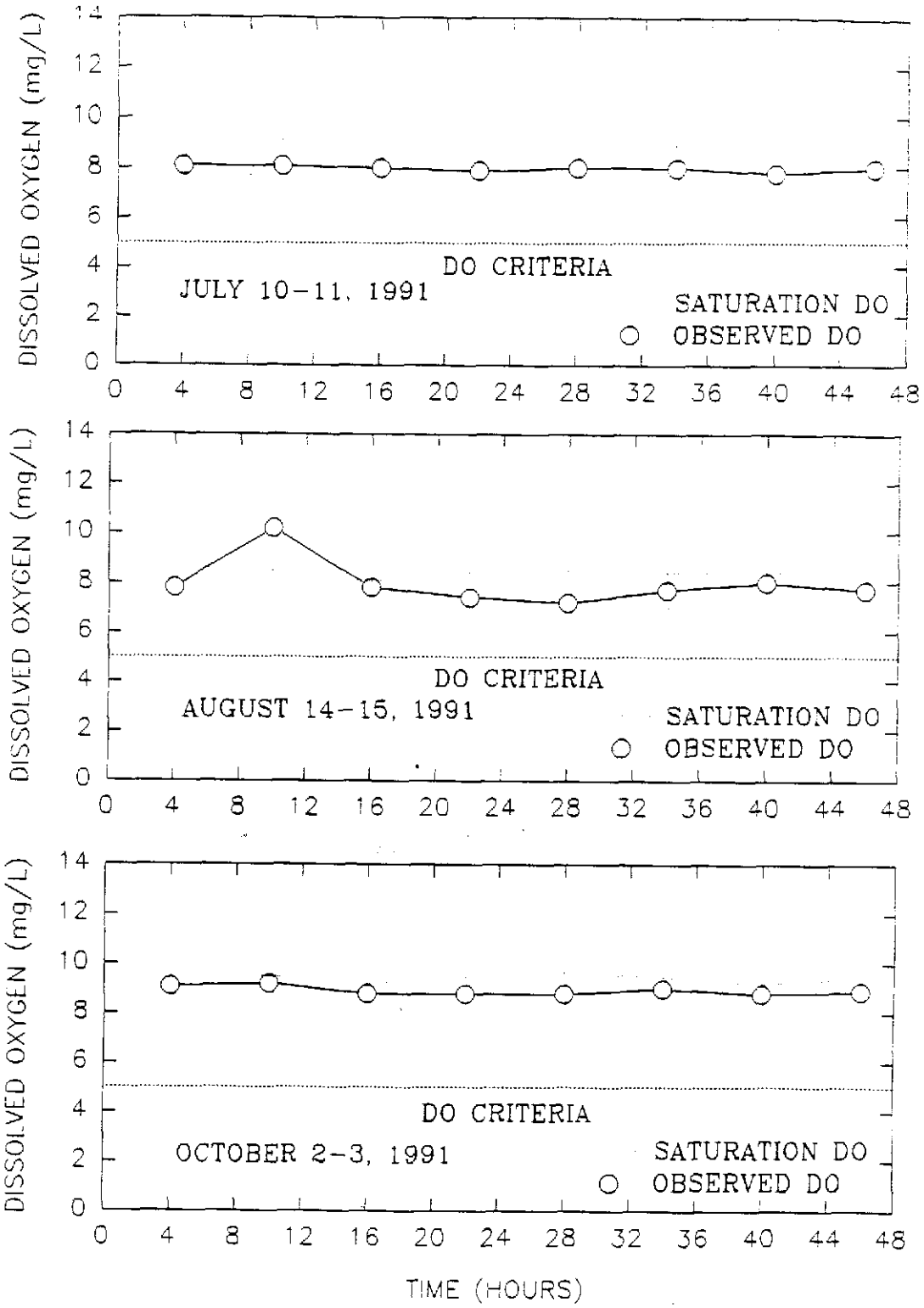
BLACKSTONE RIVER

STATION 3



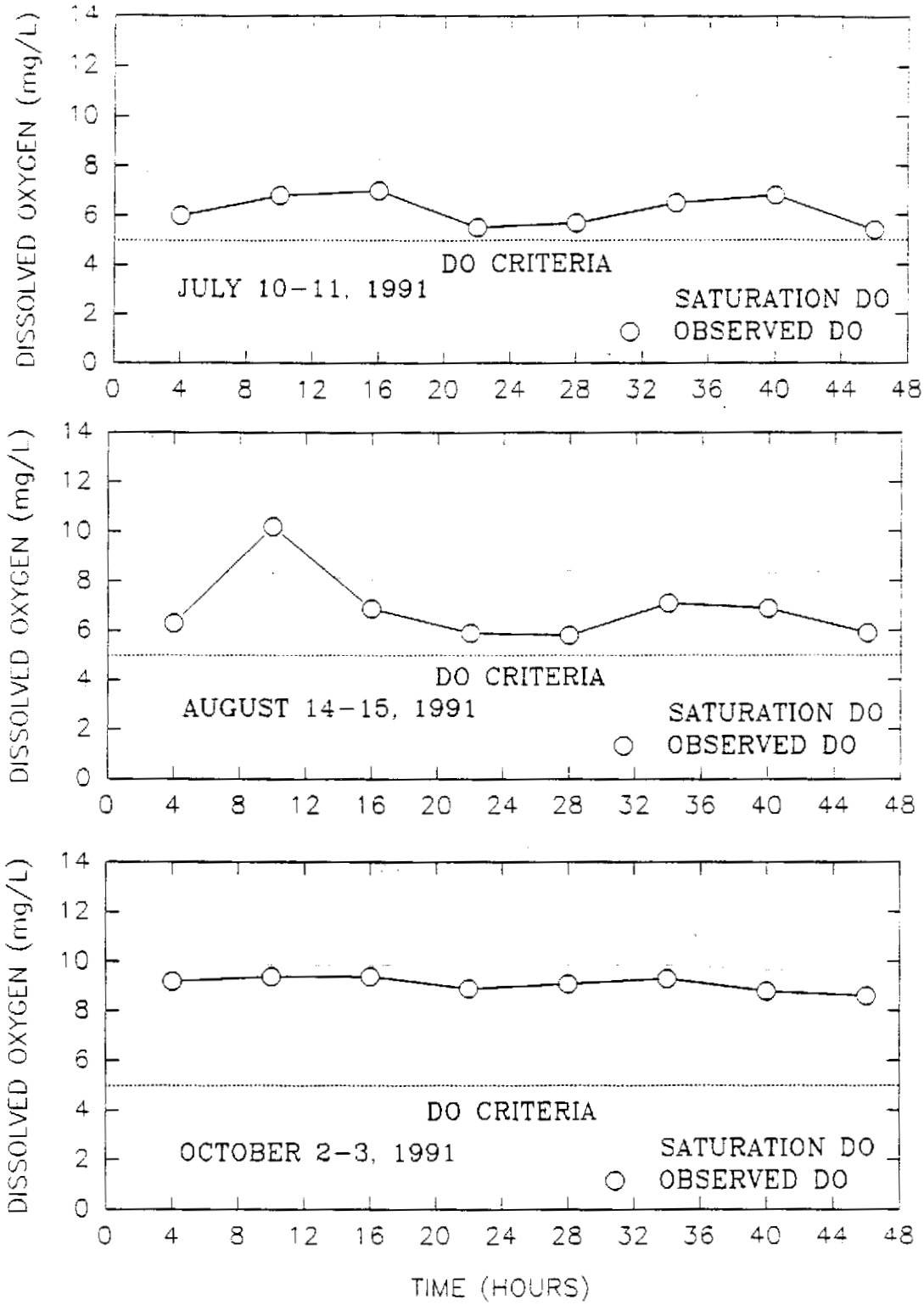
BLACKSTONE RIVER

STATION 4



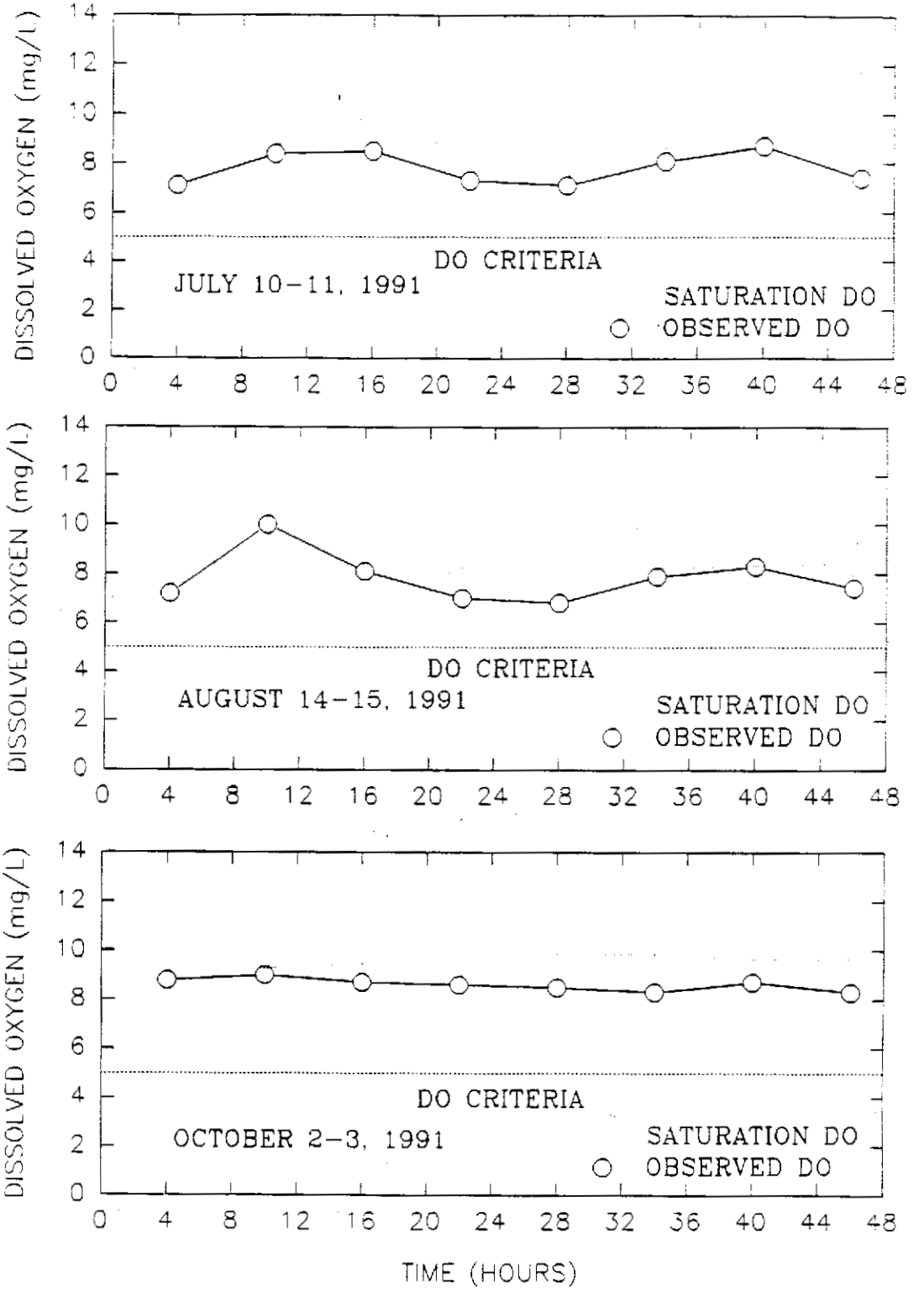
BLACKSTONE RIVER

STATION 5



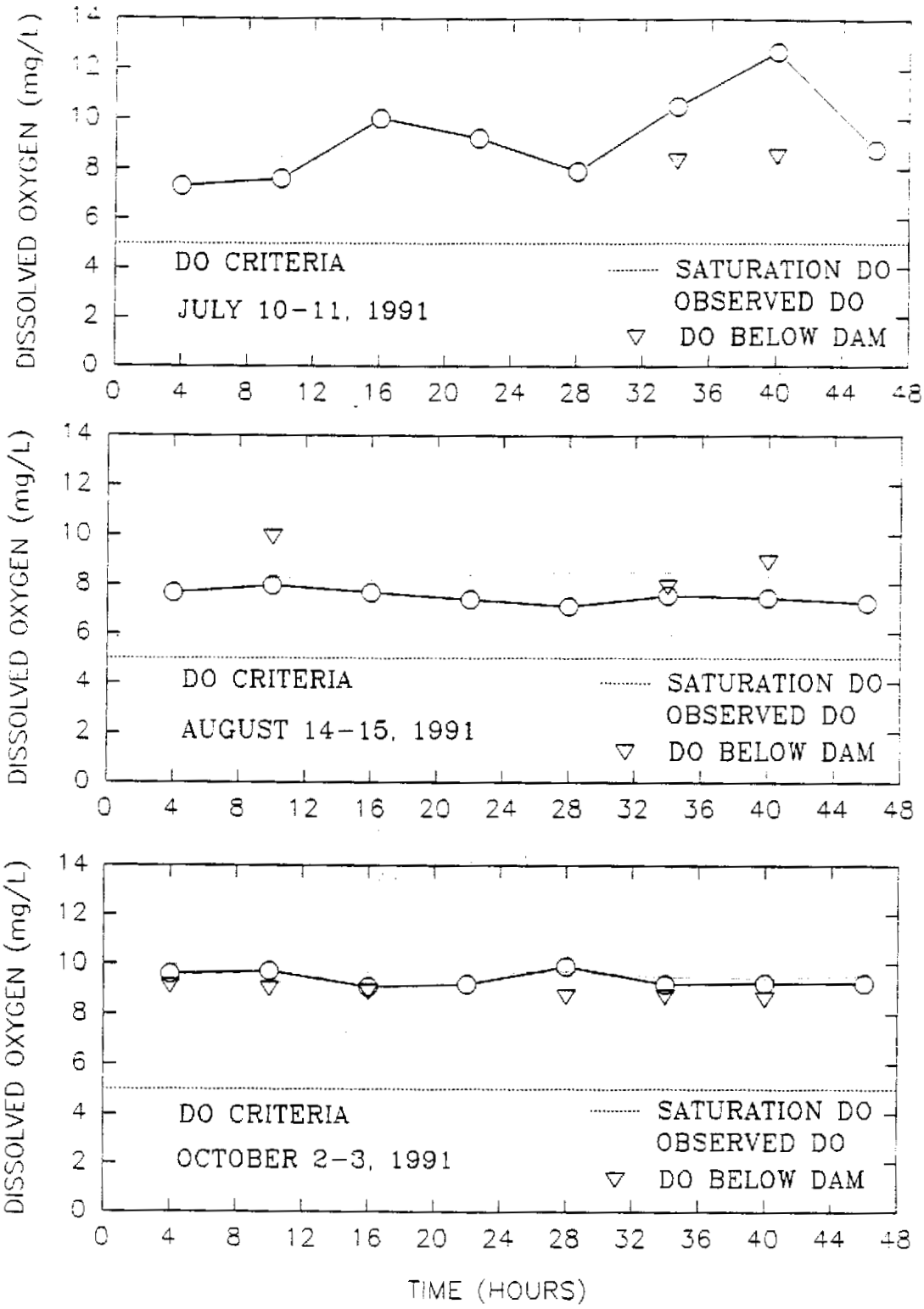
BLACKSTONE RIVER

STATION 6



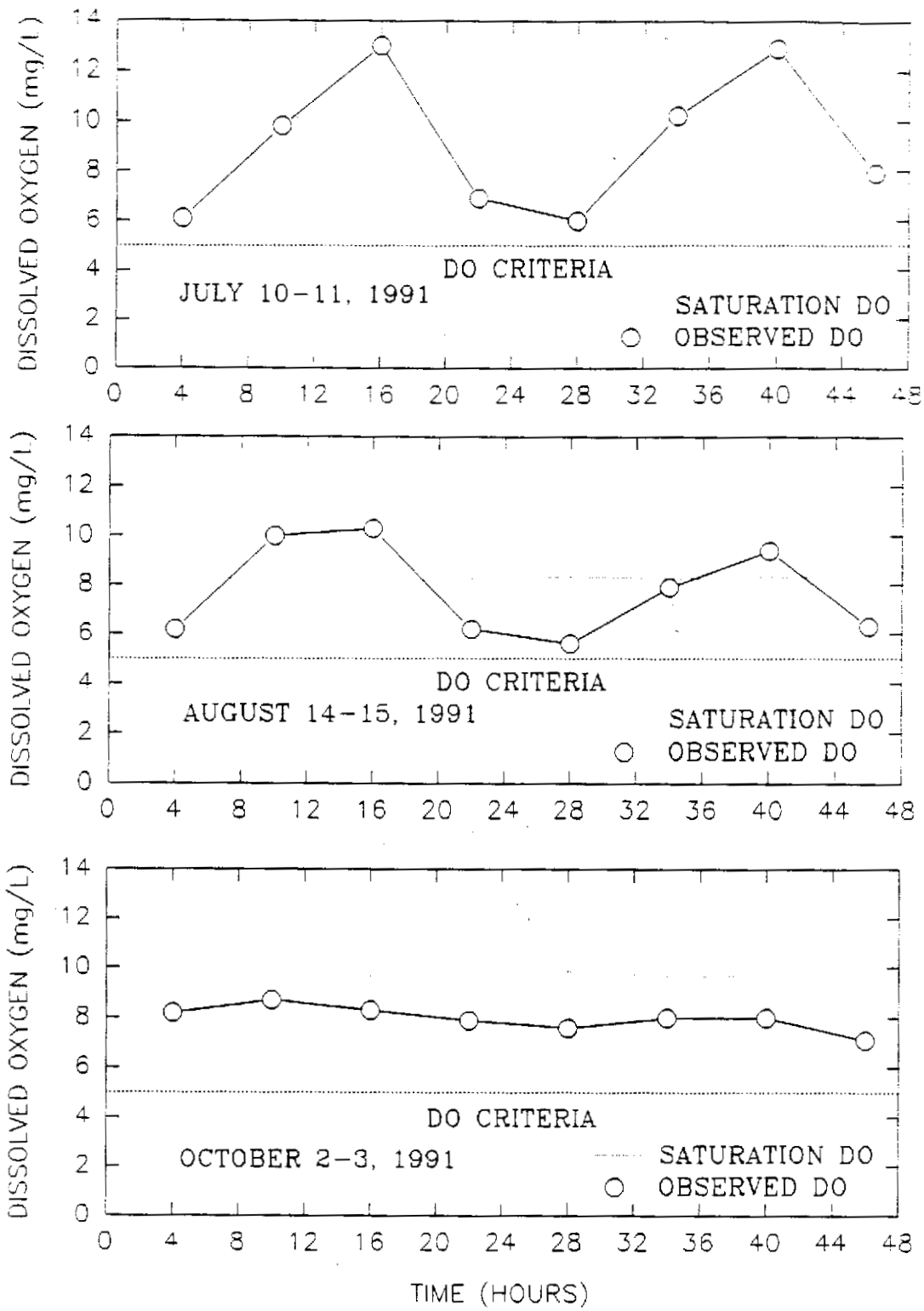
BLACKSTONE RIVER

STATION 7



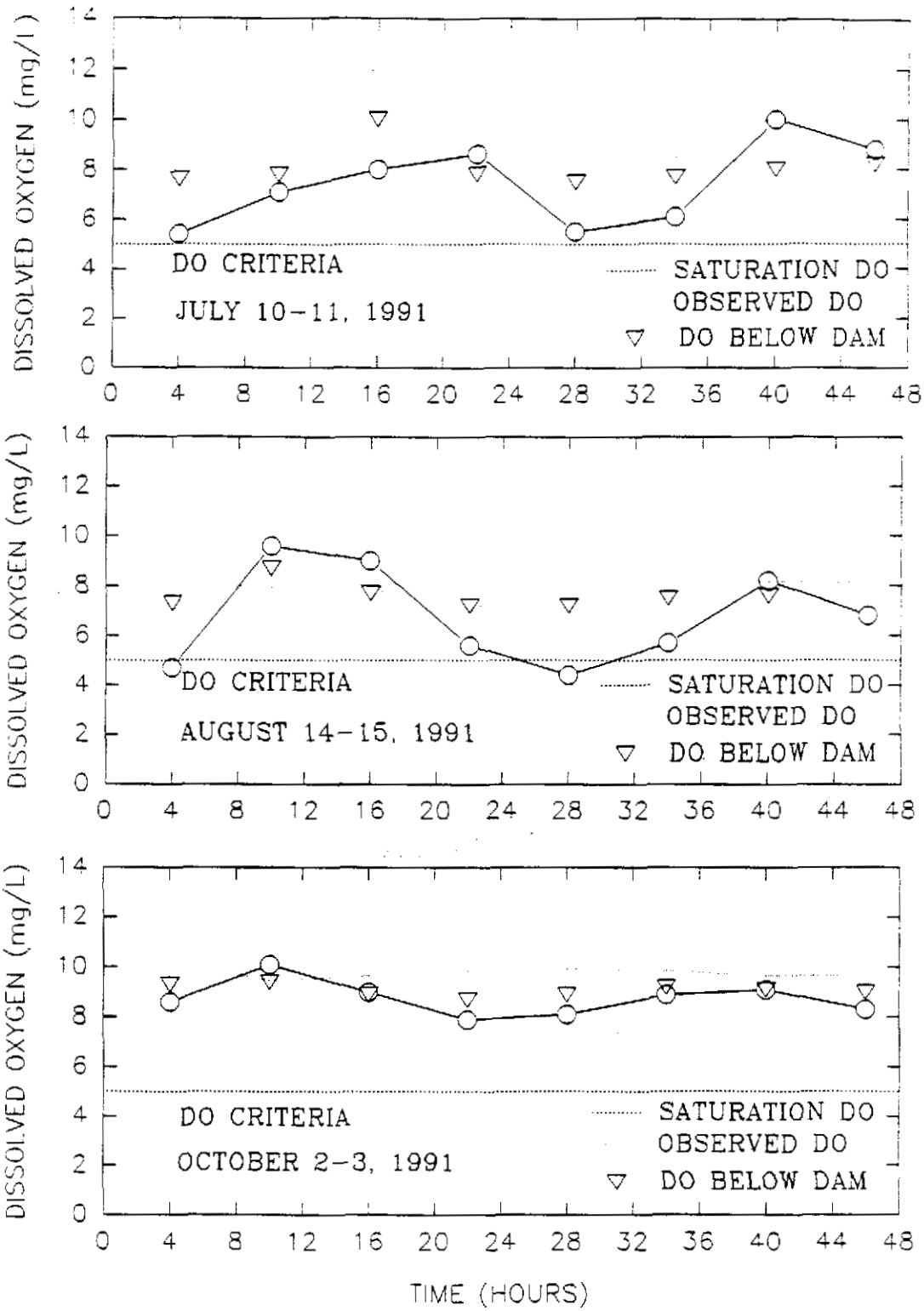
BLACKSTONE RIVER

STATION 8



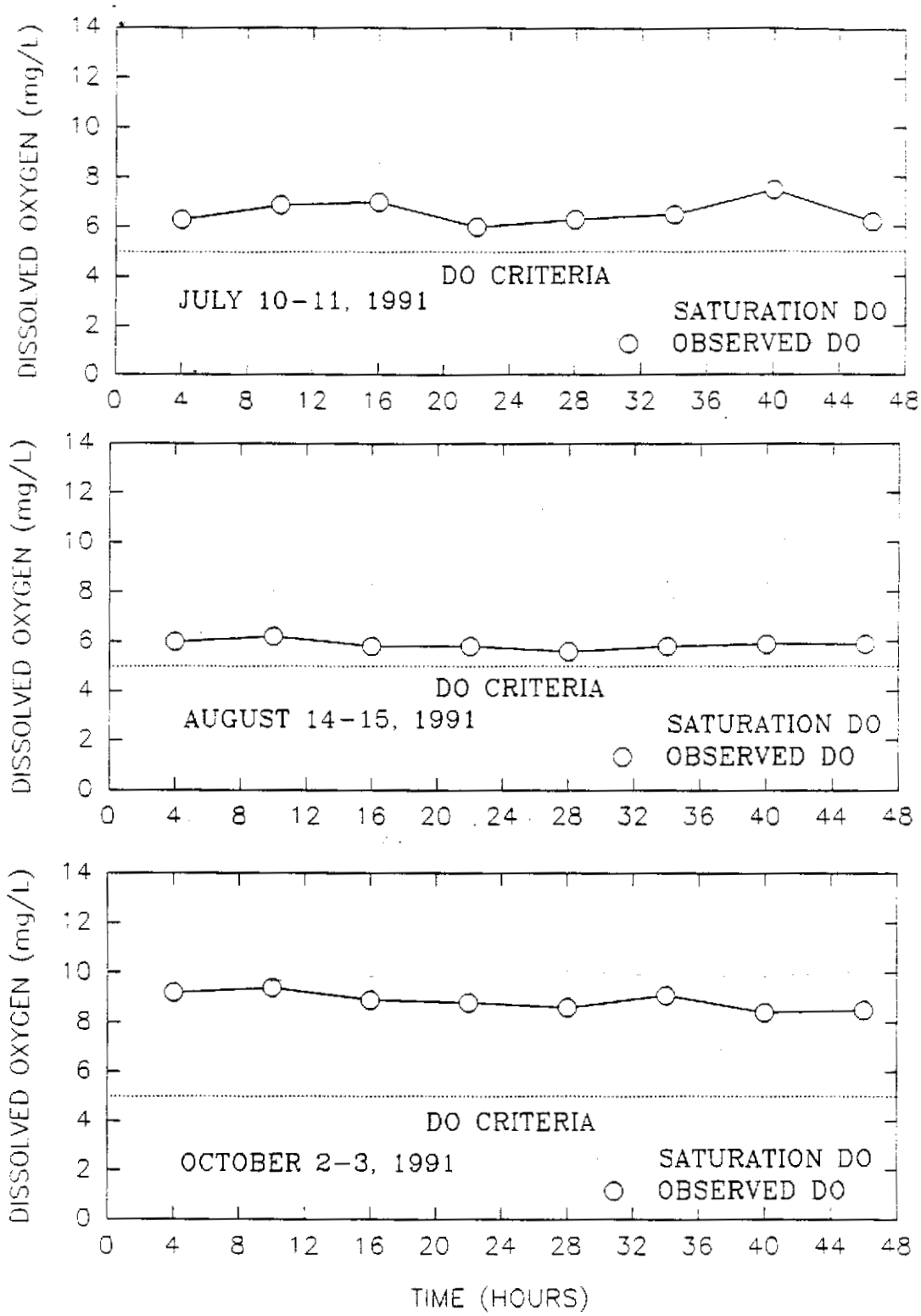
BLACKSTONE RIVER

STATION 9



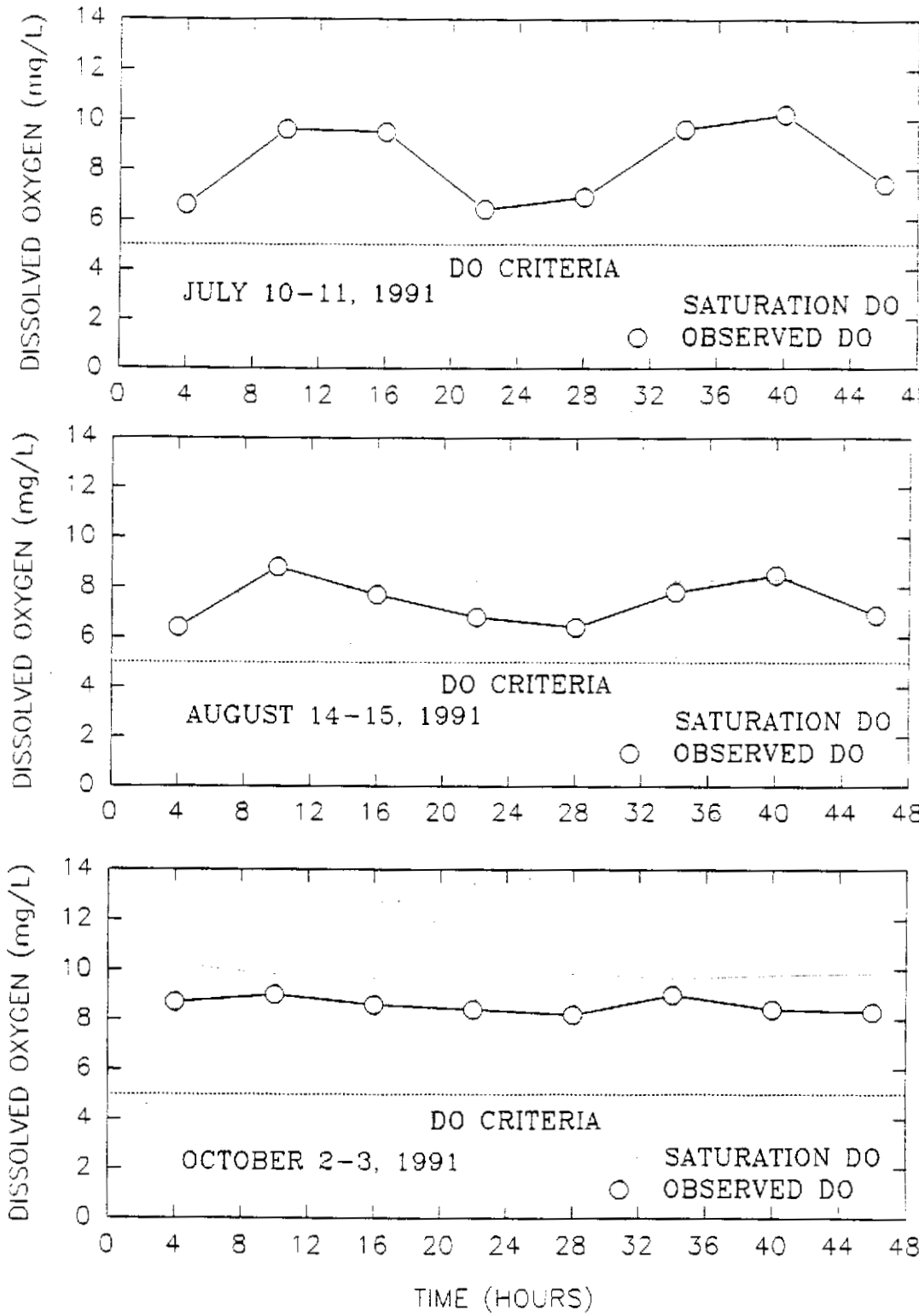
BLACKSTONE RIVER

STATION 10



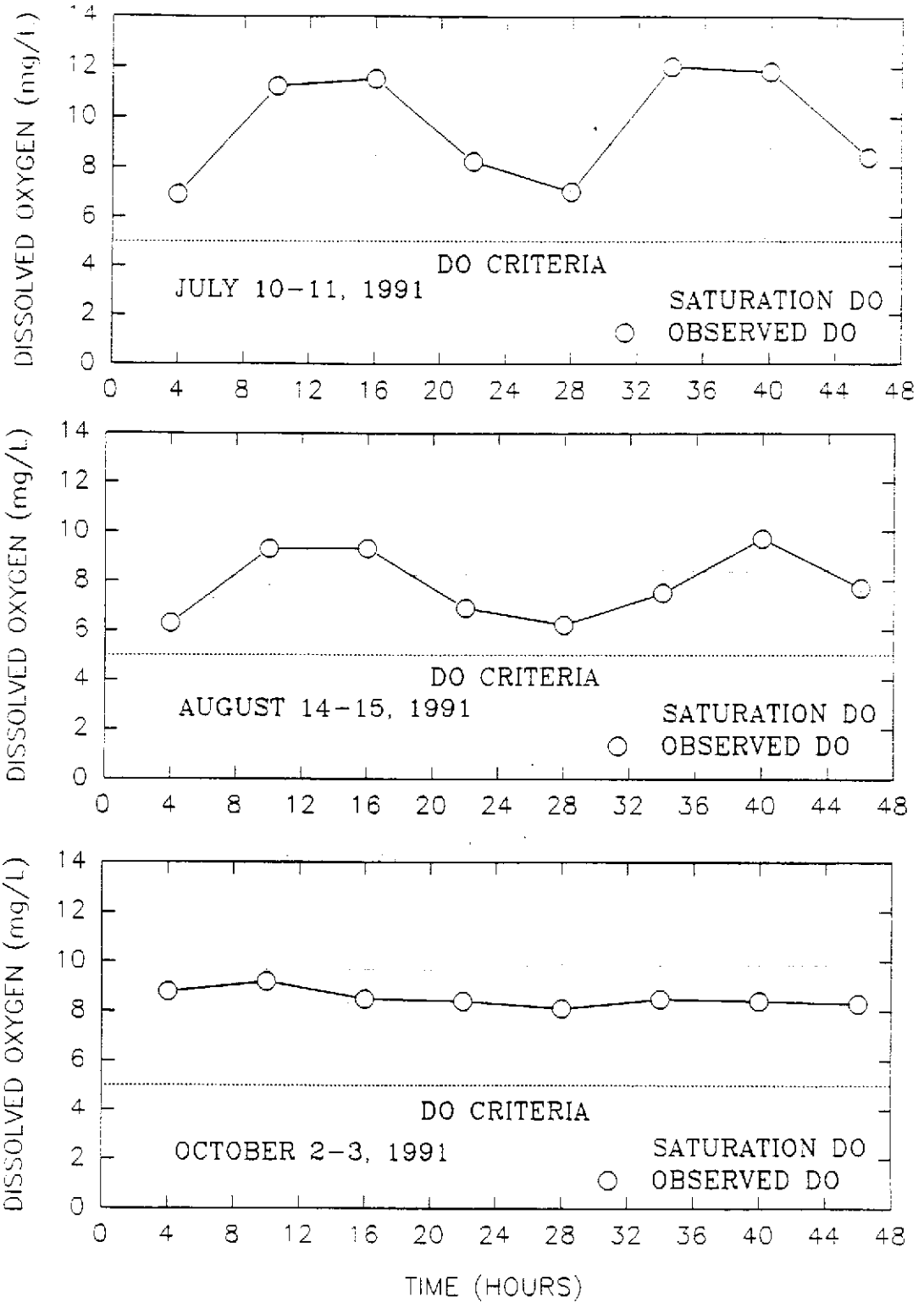
BLACKSTONE RIVER

STATION 11



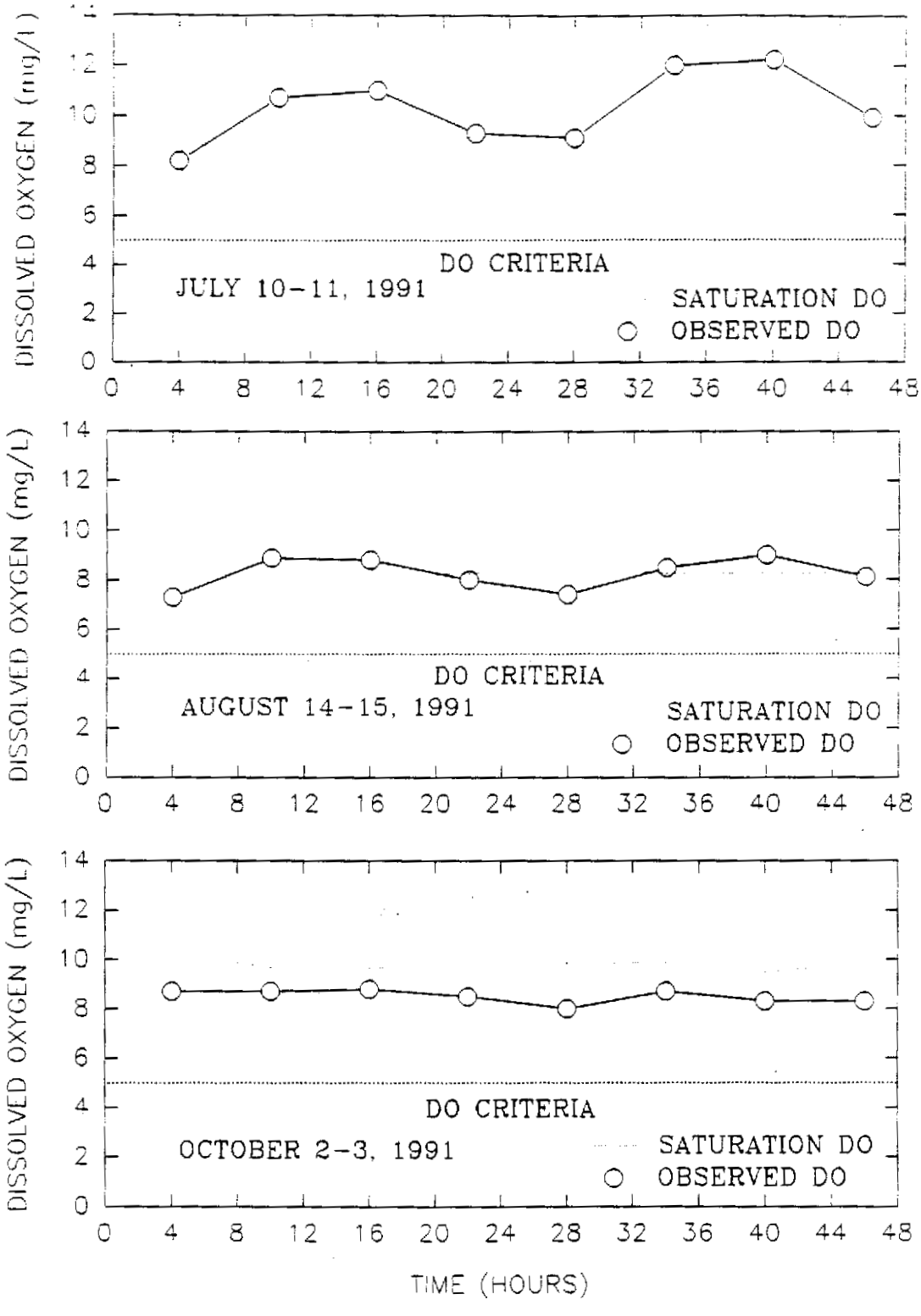
BLACKSTONE RIVER

STATION 12



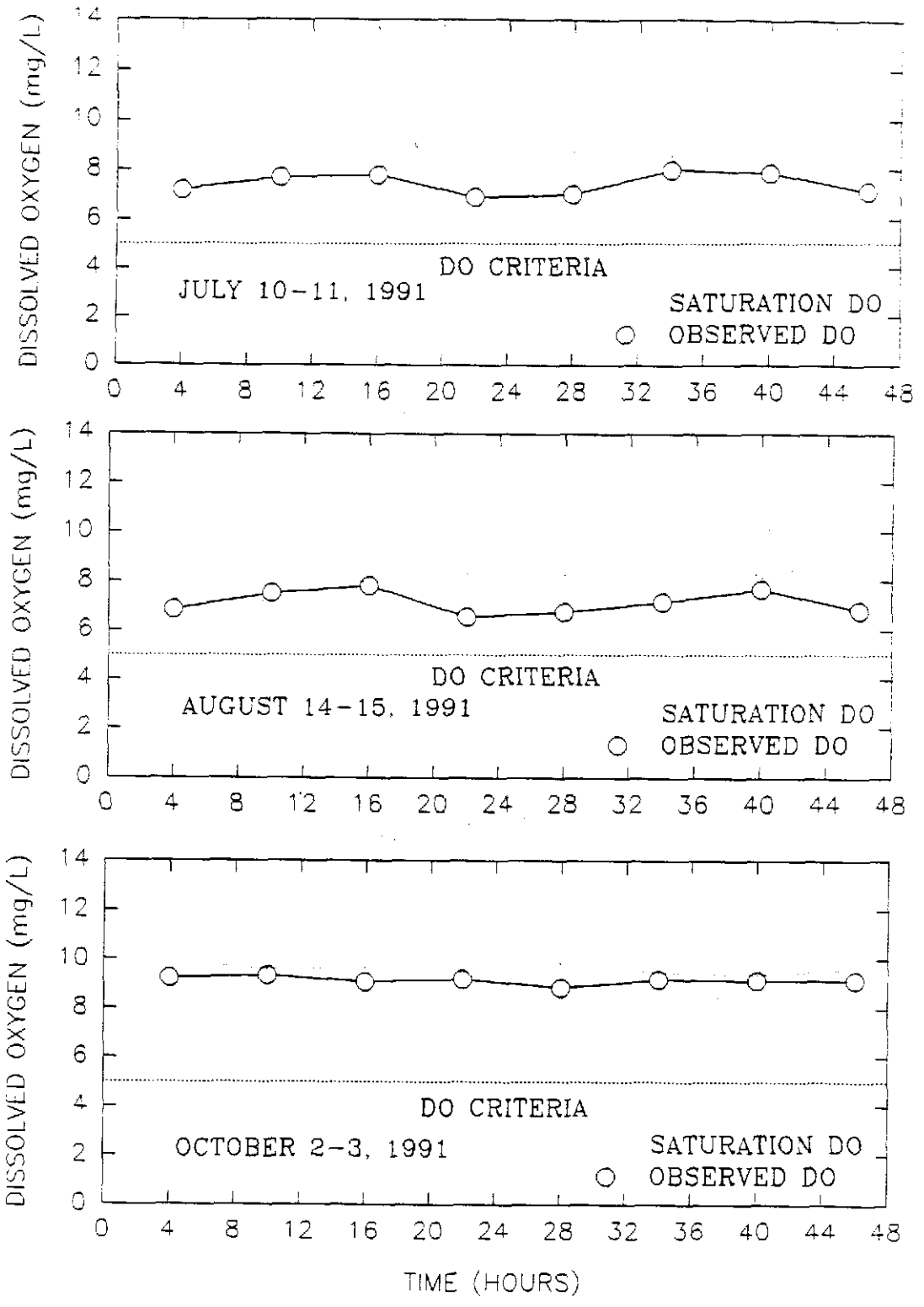
BLACKSTONE RIVER

STATION 13



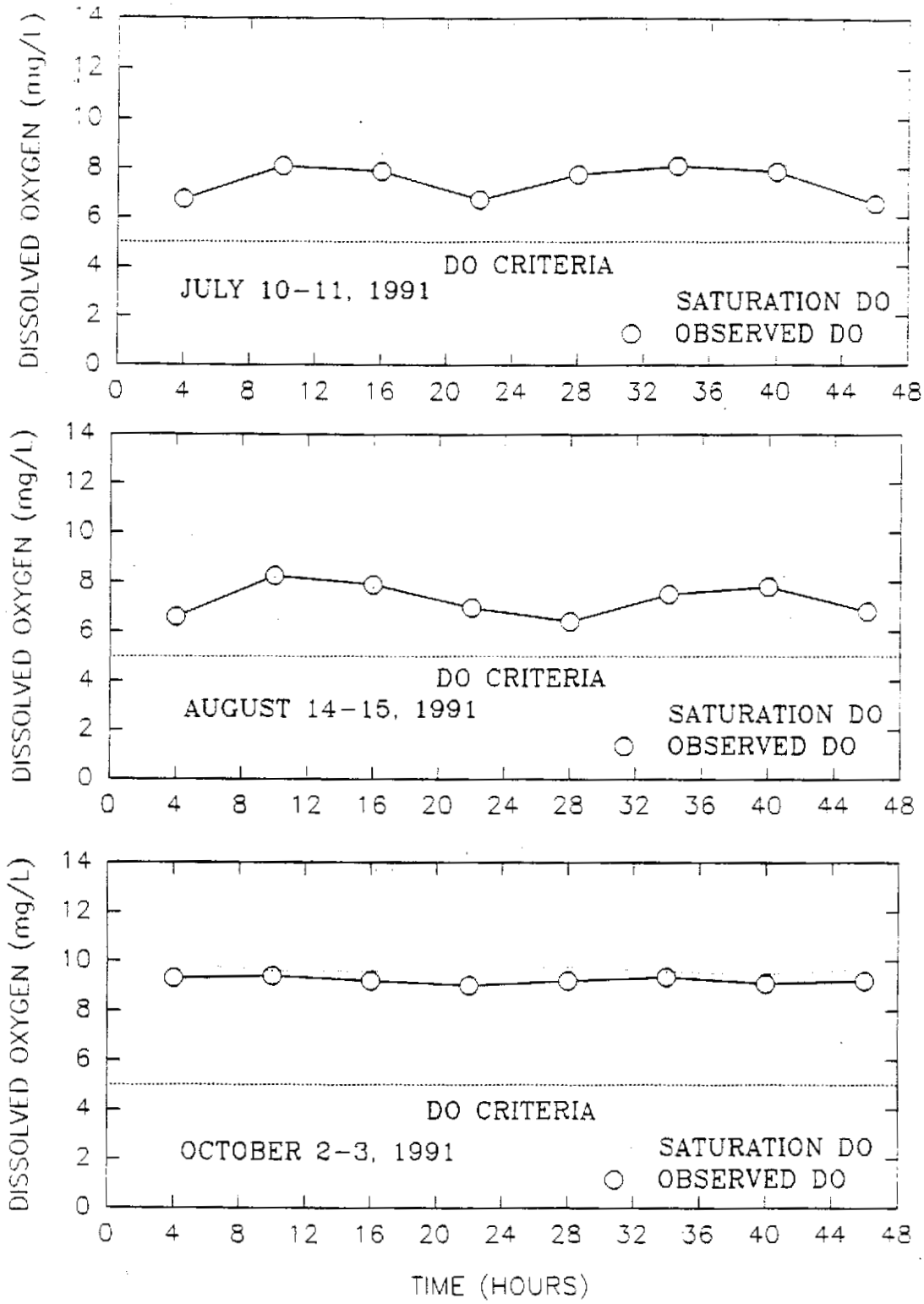
BLACKSTONE RIVER

STATION 14



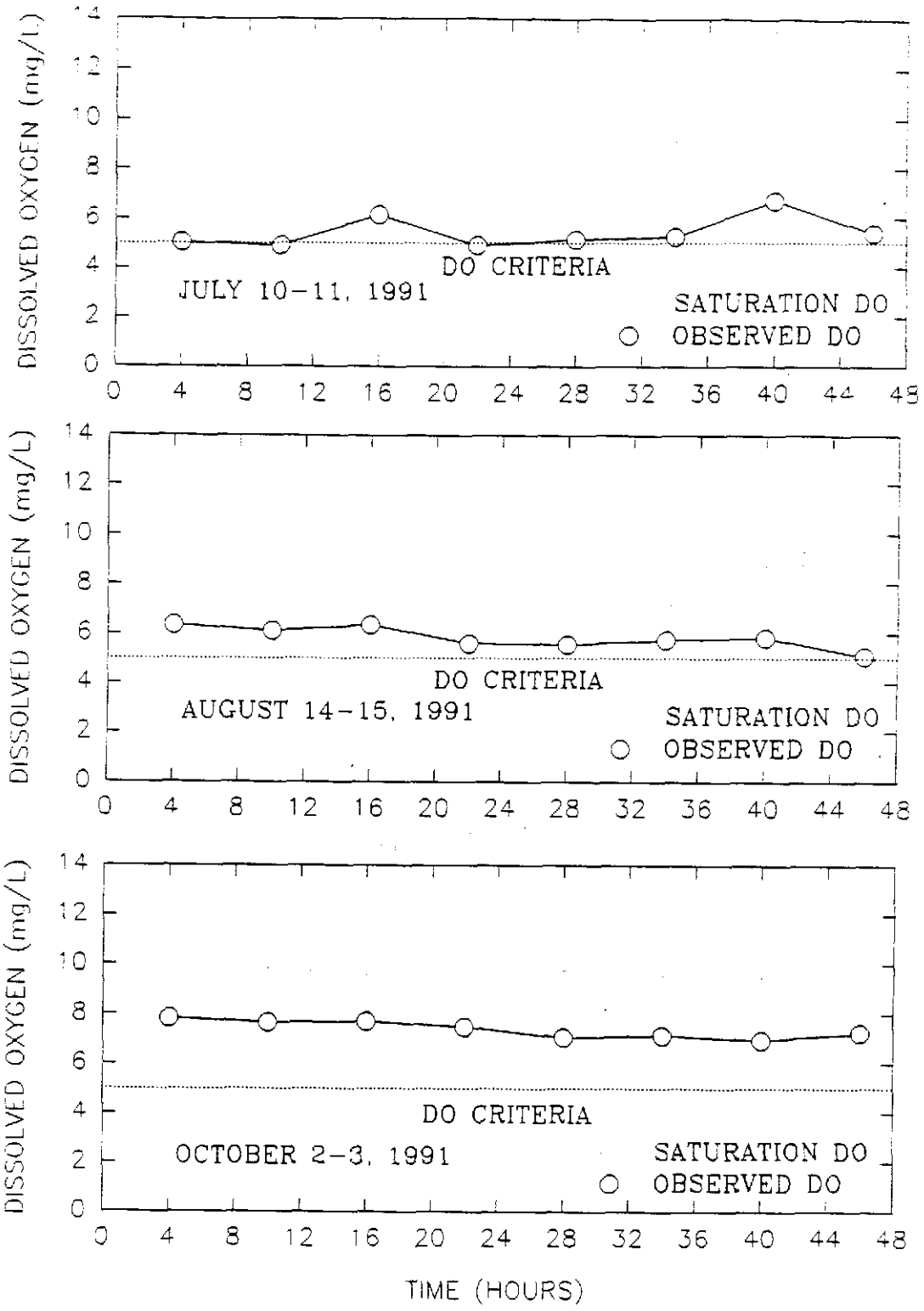
BLACKSTONE RIVER

STATION 15



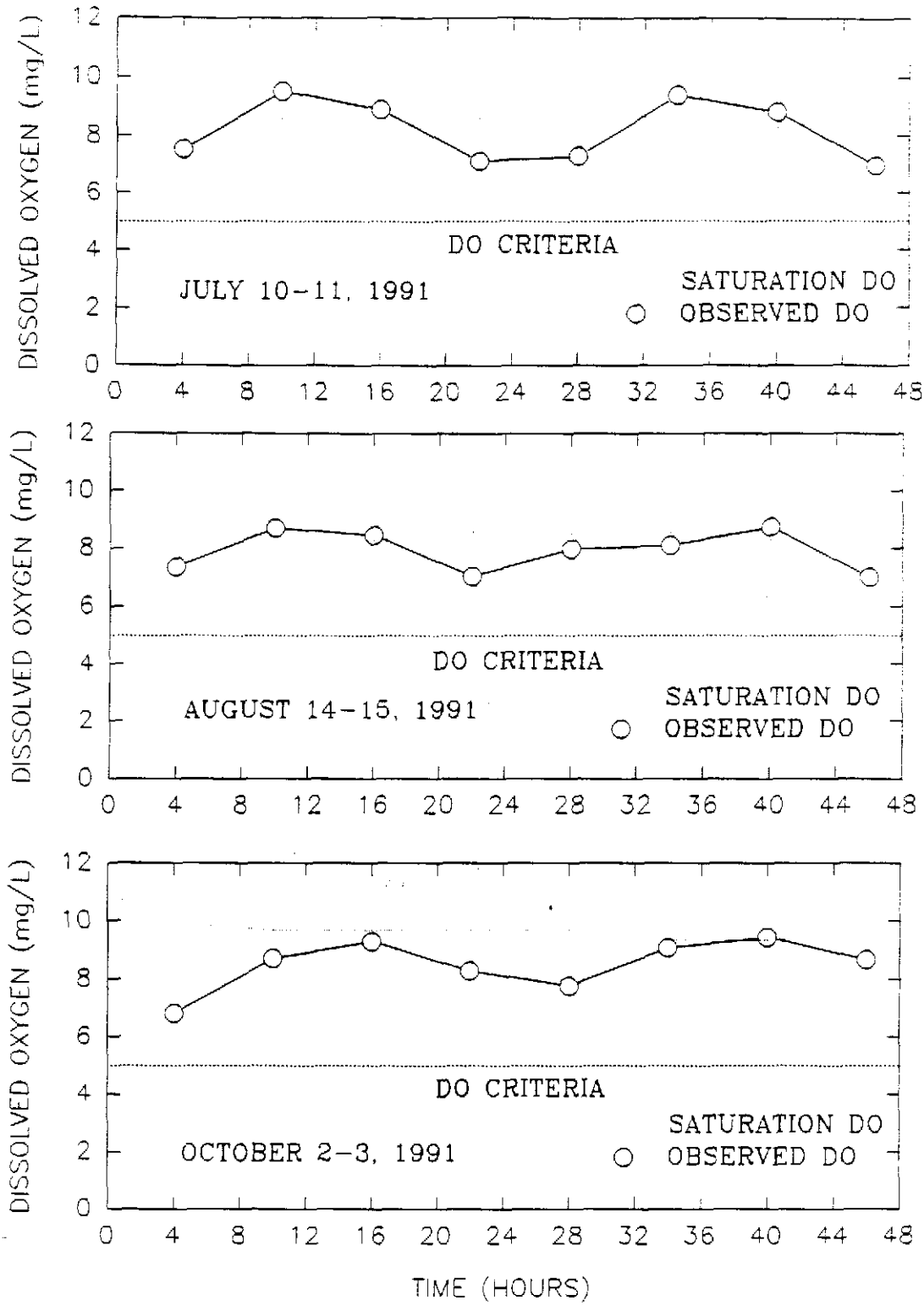
BLACKSTONE RIVER

STATION 16



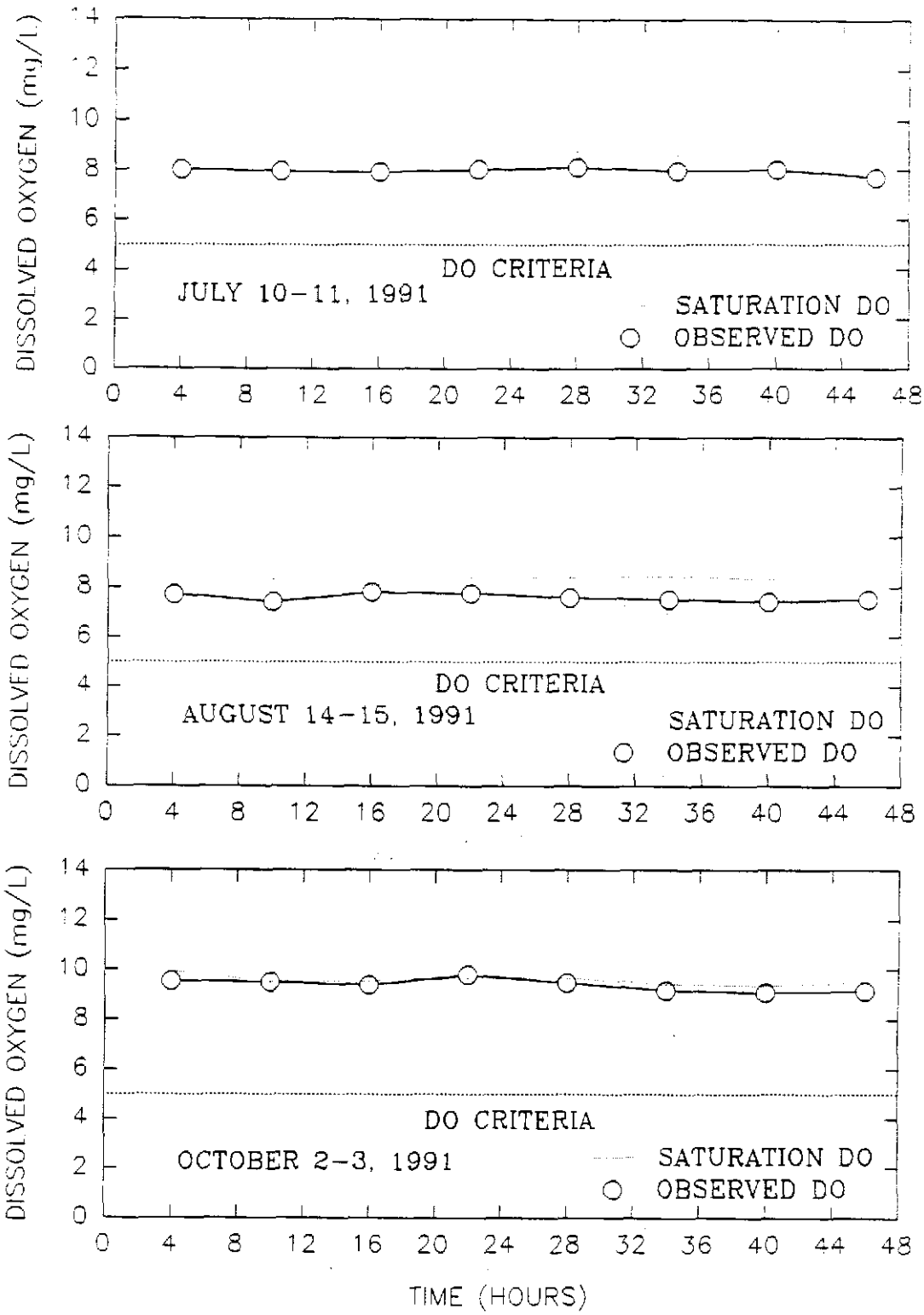
BLACKSTONE RIVER

STATION 17



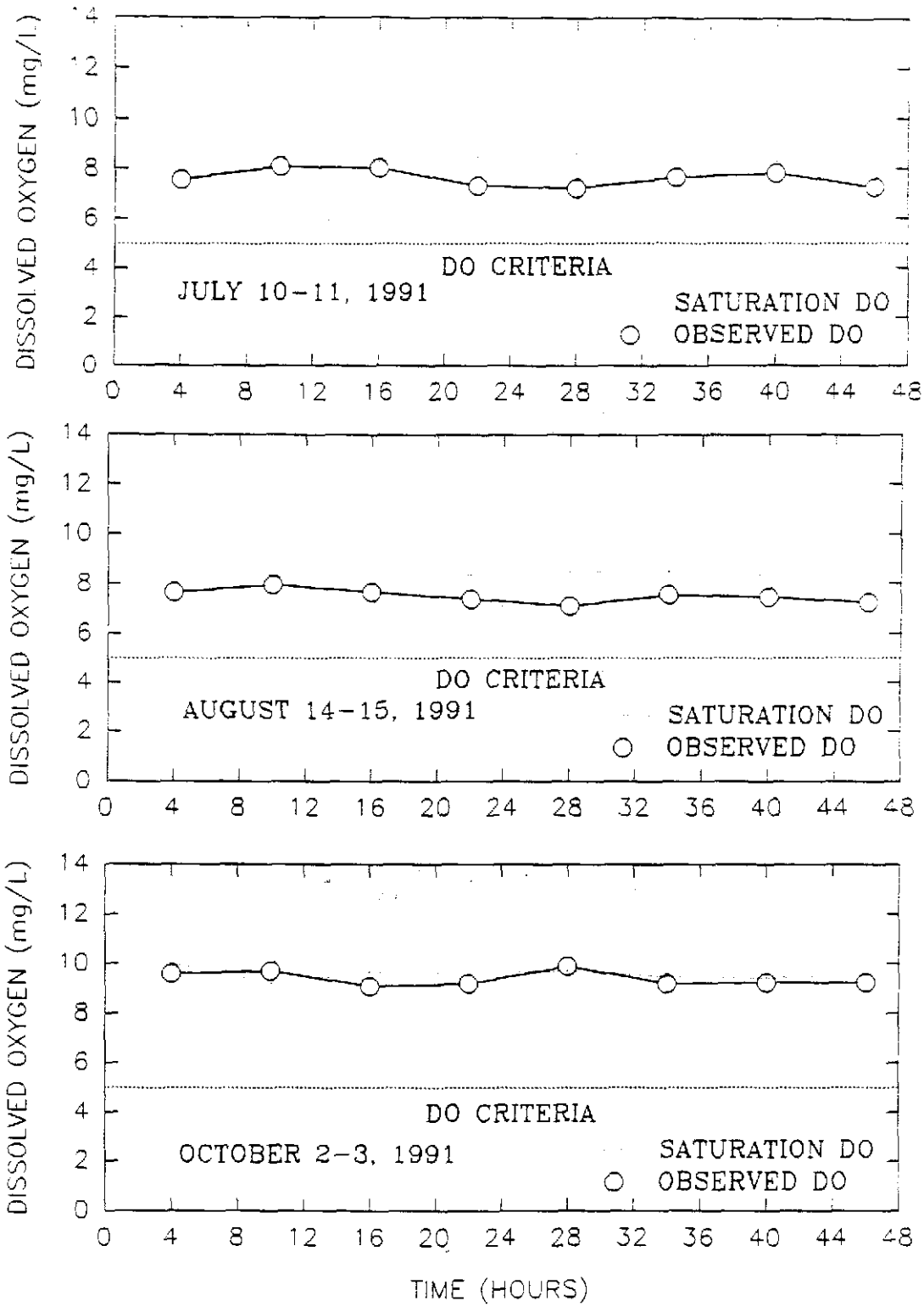
BLACKSTONE RIVER

STATION 18



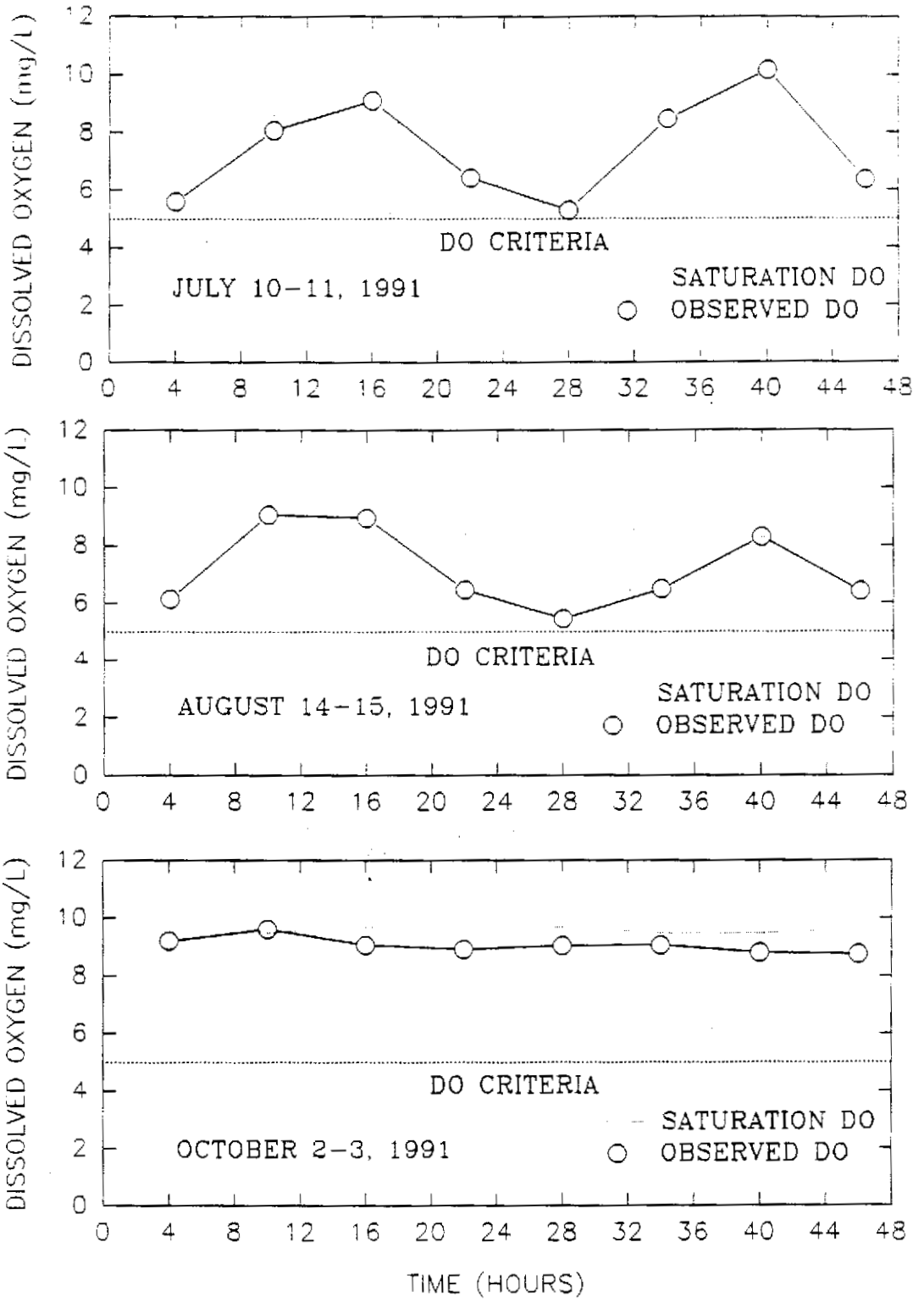
BLACKSTONE RIVER

STATION 19



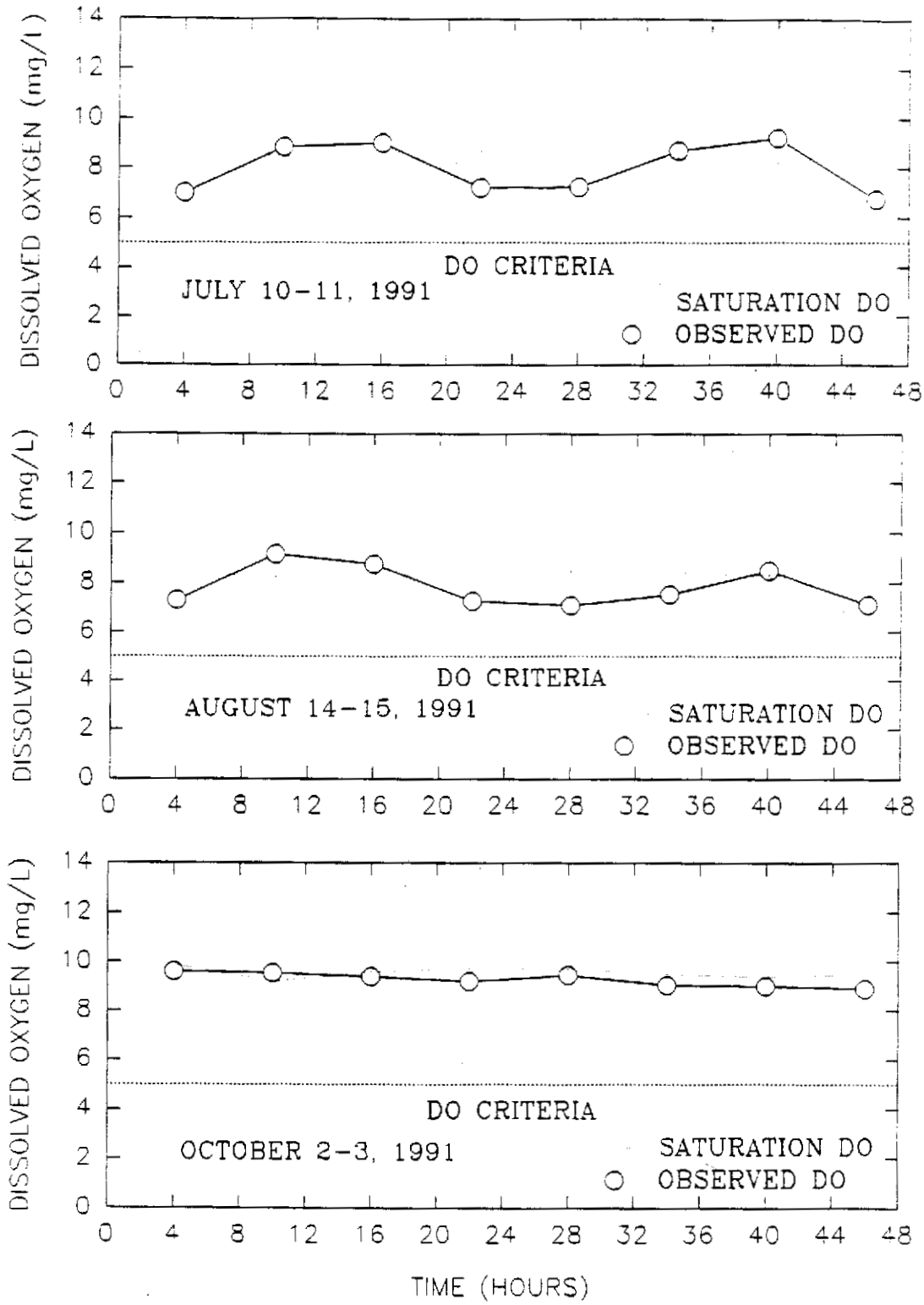
BLACKSTONE RIVER

STATION 20



BLACKSTONE RIVER

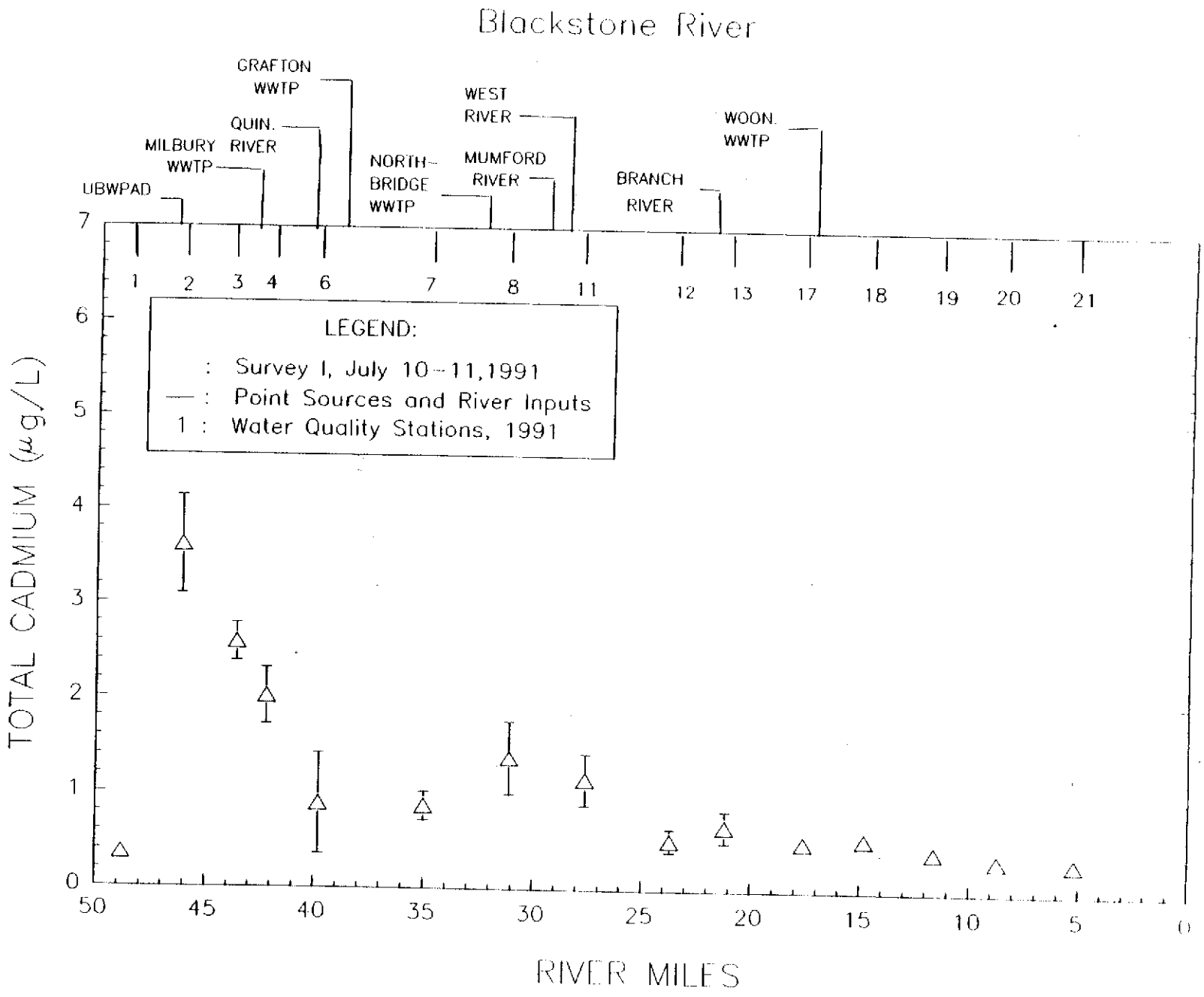
STATION 21



1991 Blackstone River Survey #1
Total (TTM) and Dissolved (DTM) Cadmium
in µg/L

Station	Run #1		Run #2		Run #3		Run #4	
	TTM	DTM	TTM	DTM	TTM	DTM	TTM	DTM
BLK01	0.33	ND	0.32	0.05	0.40	ND	0.38	0.08
BLK02	3.09	2.49	4.34	3.03	3.52	3.45	3.54	3.30
BLK03	2.57	2.14	2.54	1.88	2.87	2.52	2.39	1.54
BLK04	1.95	1.33	2.17	1.59	2.34	1.04	1.64	1.07
BLK05	0.10	ND	0.05	ND	0.09	ND	0.42	0.34
BLK06	1.19	0.47	0.93	0.54	1.21	0.91	1.06	0.77
BLK07	0.77	0.12	0.87	0.25	0.76	0.64	1.09	0.92
BLK08	1.80	0.11	1.05	0.16	1.10	0.28	1.74	0.17
BLK09	0.05	ND	0.16	ND	0.20	ND	0.12	ND
BLK10	0.06	ND	ND	ND	0.33	ND	2.34	ND
BLK11	0.77	0.23	1.20	0.23	1.32	0.28	1.34	0.43
BLK12	0.64	0.36	0.62	0.22	0.39	0.17	0.45	0.08
BLK13	0.92	0.12	0.59	0.13	0.63	0.15	0.56	0.19
BLK14	0.18	ND	0.07	ND	ND	ND	0.11	ND
BLK15	0.05	ND	0.06	ND	0.13	0.09	0.09	ND
BLK16	0.54	0.25	0.09	ND	0.88	0.23	0.29	0.18
BLK17	0.57	0.33	0.40	0.05	0.59	0.26	0.50	0.10
BLK18	0.58	0.16	0.55	0.22	0.55	0.45	0.57	0.23
BLK19	0.35	0.12	0.38	0.13	0.42	0.22	0.47	0.18
BLK20	0.35	0.15	0.24	0.06	0.30	0.21	0.36	0.12
BLK21	0.23	ND	0.29	ND	0.40	0.13	0.38	0.17

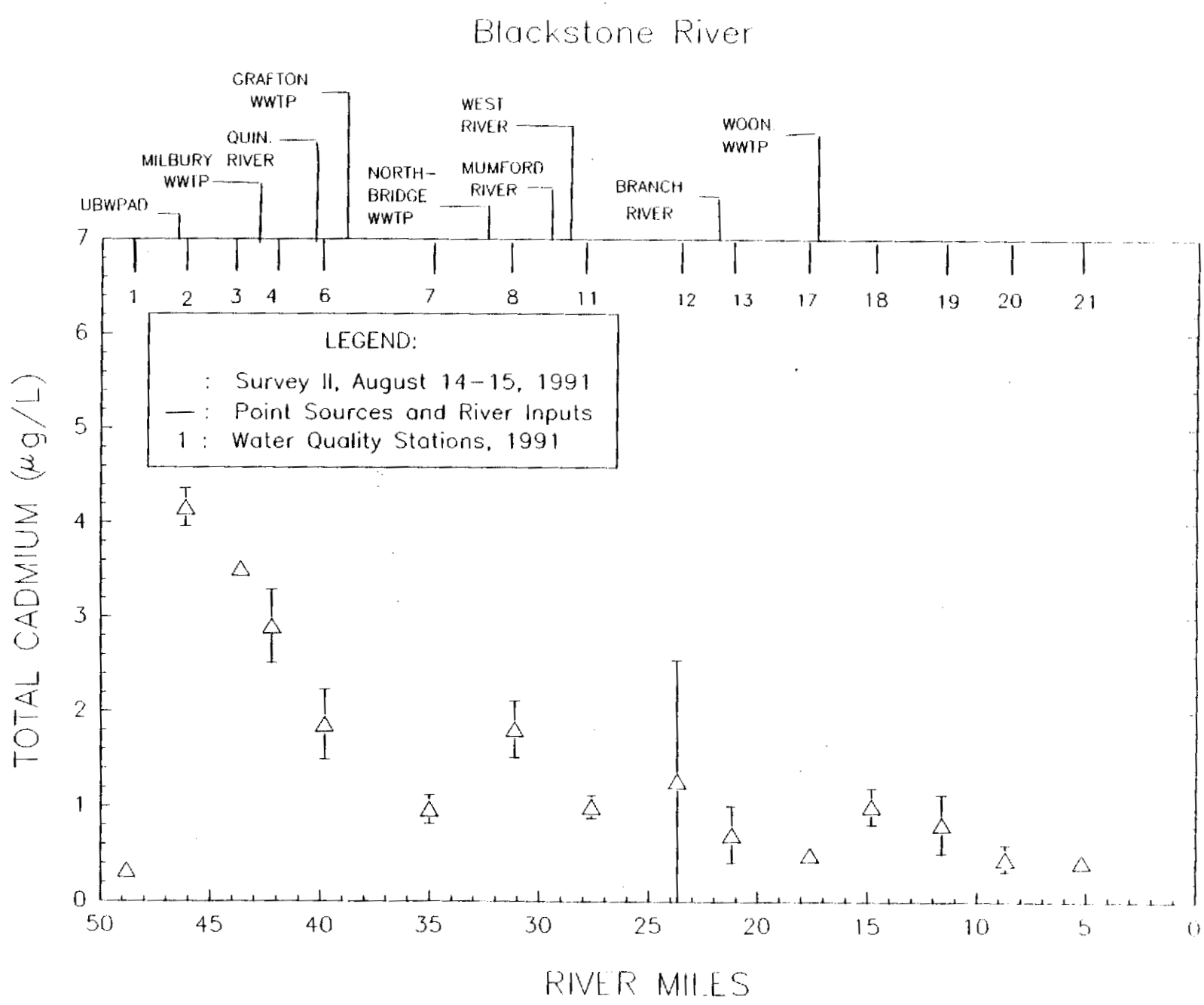
ND = Below the detection limit of 0.05 µg/L.


Blackstone River
GRAFTON WWTP
QUIN. RIVER
MILBURY WWTP
UBWPAD
NORTH-BRIDGE WWTP
WEST RIVER
MUMFORD RIVER
BRANCH RIVER
WOON. WWTP
1 2 3 4 6 7 8 11 12 13 17 18 19 20 21
LEGEND:
: Survey I, July 10-11,1991
— : Point Sources and River Inputs
1 : Water Quality Stations, 1991
TOTAL CADMIUM (µg/L)
0 1 2 3 4 5 6 7
50 45 40 35 30 25 20 15 10 5 0
RIVER MILES

1991 Blackstone River Survey #2
Total (TTM) and Dissolved (DTM) Cadmium
in µg/L

Station	Run #1		Run #2		Run #3		Run #4	
	TTM	DTM	TTM	DTM	TTM	DTM	TTM	DTM
BLK01	0.28	0.22	0.31	0.23	0.38	0.20	0.33	0.34
BLK02	4.15	3.27	4.40	4.11	3.91	3.87	4.16	3.82
BLK03	3.50	2.93	3.61	2.94	3.42	3.25	3.52	3.32
BLK04	2.83	2.10	2.75	2.68	3.46	2.78	2.54	2.15
BLK05	0.15	0.16	0.13	0.12	0.09	0.05	0.11	ND
BLK06	1.73	1.56	1.50	1.43	1.82	1.64	2.38	2.09
BLK07	1.02	0.72	0.78	0.70	0.95	0.74	1.15	1.03
BLK08	2.08	1.29	1.43	1.08	1.70	1.30	2.03	1.37
BLK09	ND	ND	0.35	0.31	0.09	0.07	0.13	ND
BLK10	0.08	0.08	0.17	0.18	0.38	0.17	0.07	0.10
BLK11	0.95	0.42	0.92	0.74	1.18	0.81	0.93	0.67
BLK12	0.78	0.50	0.81	0.82	3.53	1.05	0.86	0.53
BLK13	0.67	0.54	0.48	0.40	1.14	0.99	0.53	0.25
BLK14	0.23	0.21	0.11	0.10	0.34	0.25	0.37	ND
BLK15	0.16	0.08	0.12	ND	0.08	ND	0.35	ND
BLK16	0.16	0.16	0.06	0.05	0.23	0.12	0.14	0.17
BLK17	0.50	0.30	0.38	0.23	0.51	0.21	0.54	0.32
BLK18	0.89	0.76	1.08	0.81	0.82	0.73	1.24	0.70
BLK19	0.57	0.57	0.73	0.57	0.93	0.92	0.15	0.21
BLK20	0.56	0.45	0.49	0.38	0.49	0.30	0.26	0.08
BLK21	0.45	0.42	0.38	0.33	0.47	0.24	0.40	0.43

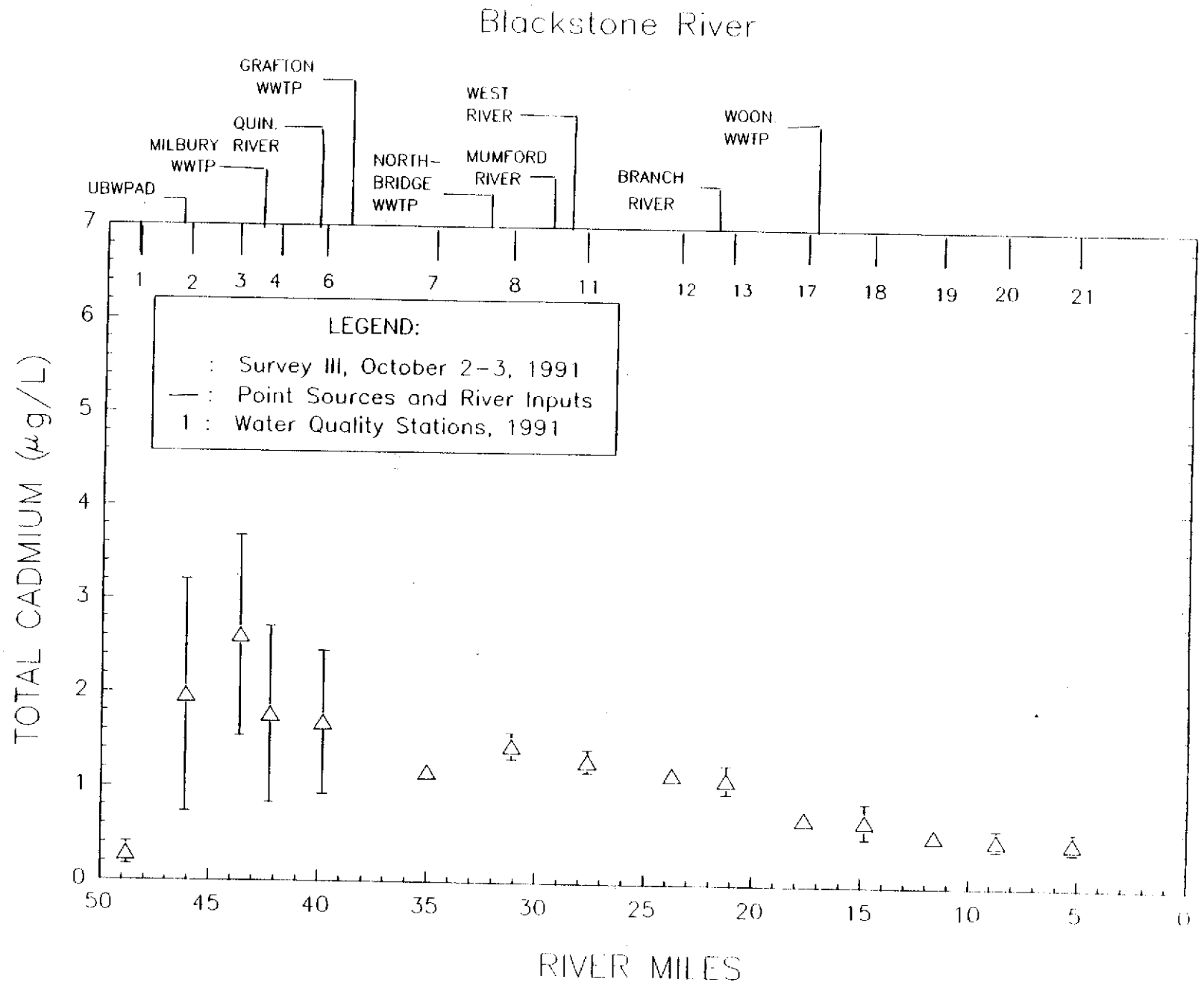
ND = Below the detection limit of 0.05 µg/L.


Blackstone River
GRAFTON WWTP
QUIN. RIVER
MILBURY WWTP
UBWPAD
NORTH-BRIDGE WWTP
WEST RIVER
MUMFORD RIVER
BRANCH RIVER
WOON WWTP
1 2 3 4 6 7 8 11 12 13 17 18 19 20 21
LEGEND:
: Survey II, August 14-15, 1991
— : Point Sources and River Inputs
1 : Water Quality Stations, 1991
TOTAL CADMIUM (µg/L)
0 1 2 3 4 5 6 7
50 45 40 35 30 25 20 15 10 5 0
RIVER MILES

1991 Blackstone River Survey #3
Total (TTM) and Dissolved (DTM) Cadmium
in µg/L

Station	Run #1		Run #2		Run #3		Run #4	
	TTM	DTM	TTM	DTM	TTM	DTM	TTM	DTM
BLK01	0.42	0.28	0.14	0.10	0.23	0.15	0.35	0.11
BLK02	0.52	0.52	1.35	1.17	2.85	2.30	3.14	2.60
BLK03	3.82	3.62	1.21	0.87	2.68	1.64	2.72	2.10
BLK04	1.85	1.01	1.13	0.62	2.11	1.47	2.00	1.37
BLK05	0.09	ND	ND	ND	ND	ND	ND	ND
BLK06	2.79	0.31	1.06	0.58	1.48	1.03	1.43	0.90
BLK07	1.08	1.01	1.18	0.79	1.14	0.80	1.28	0.77
BLK08	1.64	1.04	1.44	0.92	1.30	0.90	1.42	0.96
BLK09	0.12	ND	0.09	ND	0.08	ND	0.13	ND
BLK10	0.20	0.13	0.06	ND	0.07	0.05	ND	ND
BLK11	1.38	0.96	1.39	0.61	1.22	0.71	1.16	0.57
BLK12	1.18	0.68	1.29	0.38	1.16	0.89	1.05	0.57
BLK13	1.28	0.63	1.02	0.55	1.22	0.67	0.96	0.45
BLK14	0.09	0.09	0.06	0.12	0.06	ND	0.10	ND
BLK15	0.05	ND	ND	ND	0.12	ND	ND	ND
BLK16	0.05	ND	0.15	0.22	0.11	ND	ND	ND
BLK17	0.82	0.47	0.53	0.66	0.71	0.41	0.68	0.41
BLK18	0.90	0.49	0.49	0.26	0.68	0.39	0.77	0.15
BLK19	0.56	0.49	0.42	0.19	0.56	0.30	0.64	0.36
BLK20	0.56	0.39	0.37	0.23	0.43	0.35	0.65	0.43
BLK21	0.55	0.07	0.36	0.26	0.43	0.27	0.60	0.41

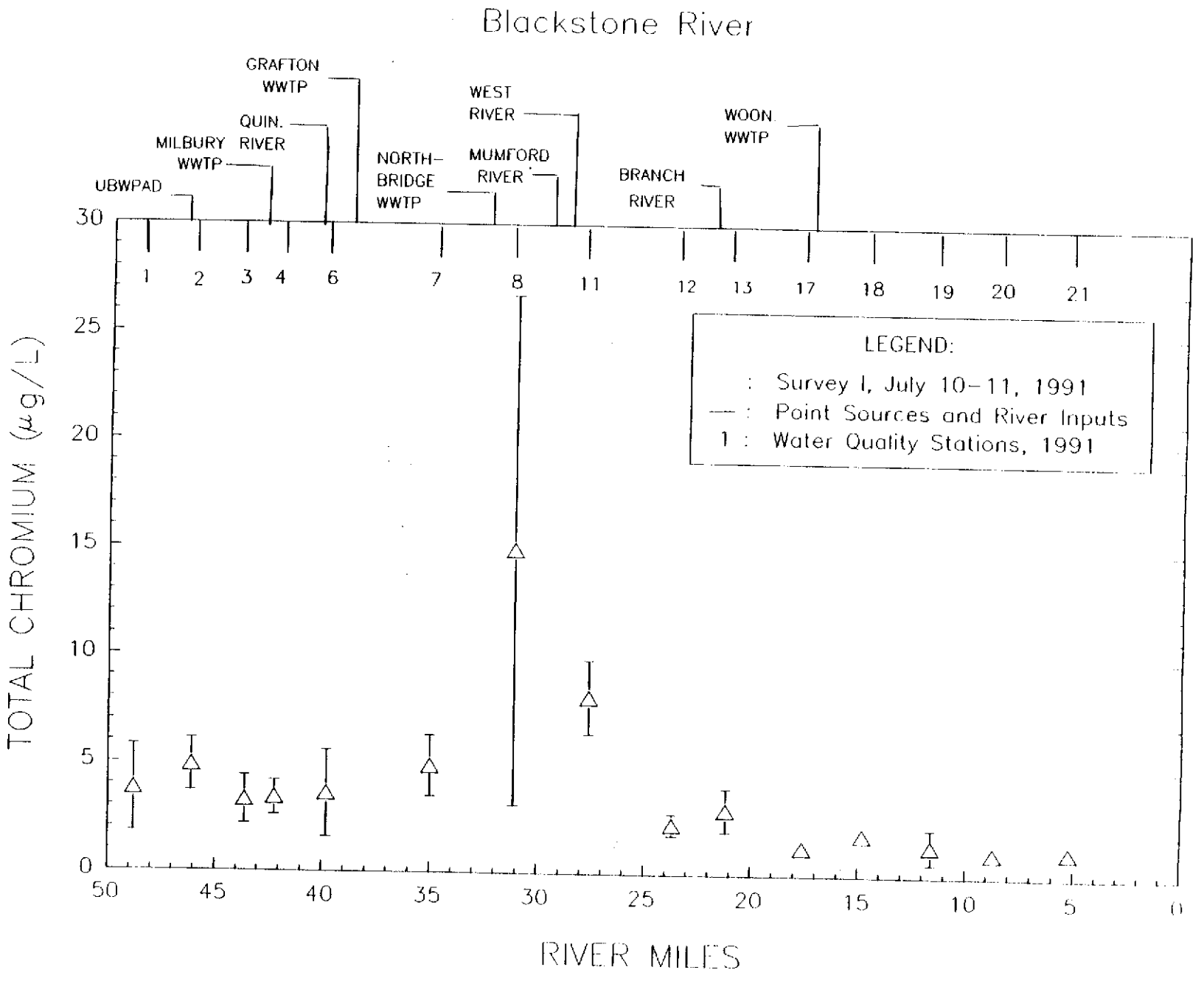
ND = Below the detection limit of 0.05 µg/L.


Blackstone River
GRAFTON WWTP
QUIN. RIVER
MILBURY WWTP
UBWPAD
NORTH-BRIDGE WWTP
WEST RIVER
MUMFORD RIVER
BRANCH RIVER
WOON. WWTP
1 2 3 4 6 7 8 11 12 13 17 18 19 20 21
LEGEND:
: Survey III, October 2-3, 1991
— : Point Sources and River Inputs
1 : Water Quality Stations, 1991
TOTAL CADMIUM (µg/L)
0 1 2 3 4 5 6 7
50 45 40 35 30 25 20 15 10 5 0
RIVER MILES

1991 Blackstone River Survey #1
Total (TTM) and Dissolved (DTM) Chromium
in µg/L

Station	Run #1		Run #2		Run #3		Run #4	
	TTM	DTM	TTM	DTM	TTM	DTM	TTM	DTM
BLK01	4.5	0.4	4.8	2.0	0.8	1.0	5.0	1.4
BLK02	4.7	2.1	5.1	3.5	3.3	2.4	6.3	3.5
BLK03	3.4	3.0	3.7	2.0	1.8	1.6	4.3	2.7
BLK04	3.8	2.1	2.4	1.5	3.2	2.1	4.3	2.7
BLK05	ND	ND	ND	ND	0.2	ND	ND	0.9
BLK06	5.8	1.6	2.6	0.9	1.4	1.2	4.5	1.9
BLK07	6.4	1.1	3.4	0.4	3.9	1.1	5.7	2.9
BLK08	24.5	1.3	6.9	0.8	2.0	2.1	26.3	1.4
BLK09	0.9	0.6	0.5	ND	0.9	0.3	1.4	0.3
BLK10	0.4	ND	2.8	ND	0.7	ND	0.9	ND
BLK11	6.1	1.6	7.4	0.9	8.6	0.8	10.2	1.2
BLK12	2.8	2.0	2.2	0.6	1.7	0.9	2.5	0.7
BLK13	2.2	0.9	4.4	0.6	2.5	0.6	2.7	0.8
BLK14	ND	ND	0.9	0.5	ND	ND	0.8	0.4
BLK15	0.5	0.2	ND	ND	ND	ND	0.3	ND
BLK16	0.6	ND	0.2	0.3	2.1	0.2	0.7	ND
BLK17	1.5	0.6	1.0	0.8	1.2	0.7	1.6	0.4
BLK18	1.9	0.4	2.4	1.0	1.7	1.1	1.6	1.9
BLK19	0.7	0.3	1.5	0.9	1.2	0.5	1.3	1.5
BLK20	1.1	0.3	1.0	0.3	1.0	0.6	1.1	0.4
BLK21	0.9	0.4	1.1	0.3	1.5	1.3	1.4	0.7

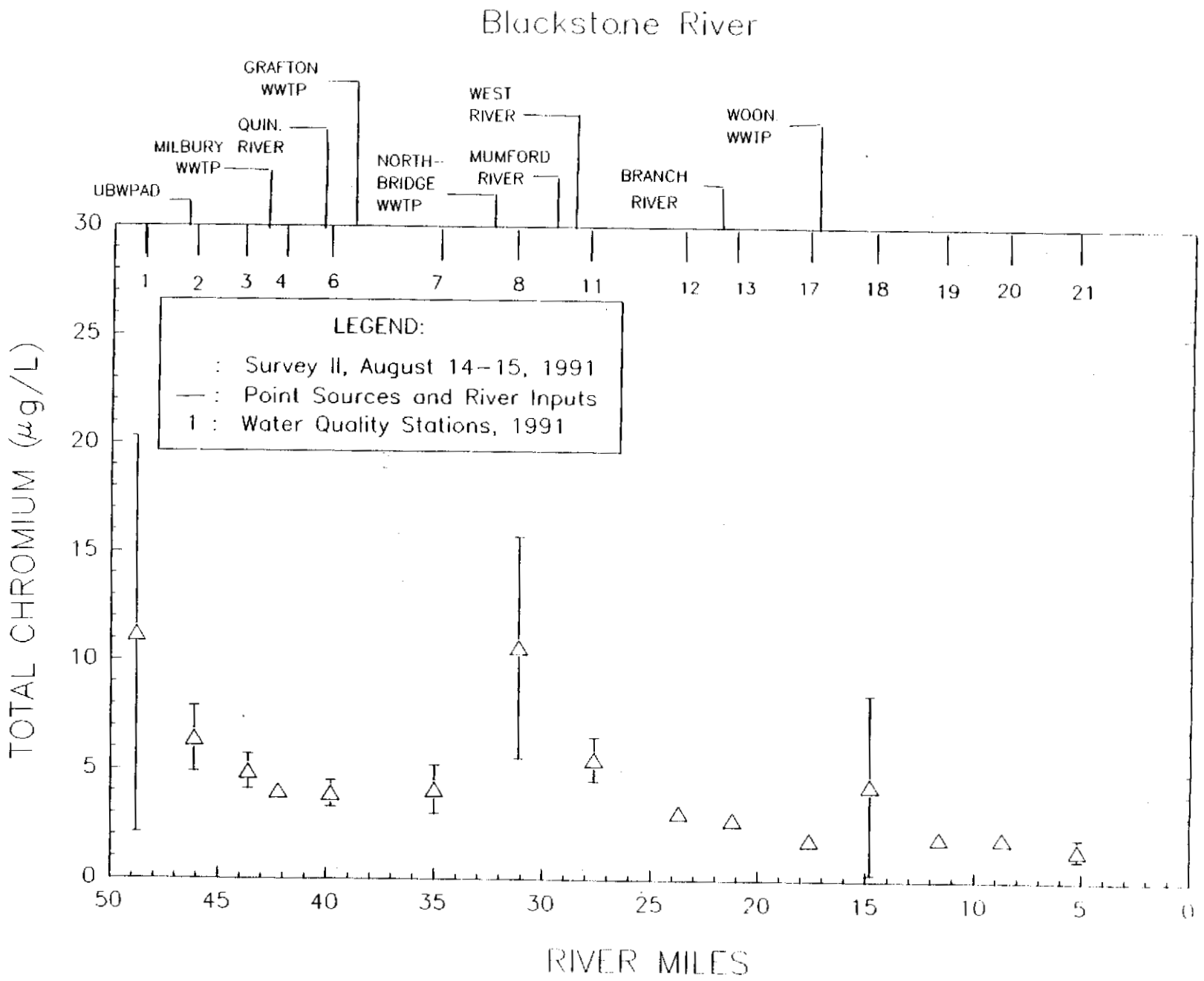
ND = Below the detection limit of 0.2 µg/L.


Blackstone River
GRAFTON WWTP
QUIN. RIVER
MILBURY WWTP
UBWPAD
NORTH-BRIDGE WWTP
WEST RIVER
MUMFORD RIVER
BRANCH RIVER
WOON WWTP
1 2 3 4 6 7 8 11 12 13 17 18 19 20 21
LEGEND:
: Survey I, July 10-11, 1991
— : Point Sources and River Inputs
1 : Water Quality Stations, 1991
TOTAL CHROMIUM (µg/L)
0 5 10 15 20 25 30
50 45 40 35 30 25 20 15 10 5 0
RIVER MILES

1991 Blackstone River Survey #2
Total (TTM) and Dissolved (DTM) Chromium
in µg/L

Station	Run #1		Run #2		Run #3		Run #4	
	TTM	DTM	TTM	DTM	TTM	DTM	TTM	DTM
BLK01	4.9	3.4	9.6	5.9	24.5	11.2	5.9	4.3
BLK02	5.7	4.3	4.9	3.3	6.6	7.8	8.3	6.9
BLK03	4.9	3.3	4.5	3.0	4.2	2.8	6.0	4.8
BLK04	4.3	2.1	4.1	2.9	3.9	2.9	3.6	2.9
BLK05	0.7	ND	1.6	0.4	1.0	0.3	0.4	ND
BLK06	4.2	1.7	3.1	1.9	4.2	2.2	4.2	2.1
BLK07	5.3	1.4	4.6	2.2	3.1	1.7	3.2	1.4
BLK08	14.9	4.1	3.3	1.8	11.4	2.4	12.9	2.6
BLK09	1.4	0.6	1.7	0.7	1.6	0.4	1.2	0.7
BLK10	0.7	ND	0.5	ND	2.0	1.0	0.8	1.1
BLK11	6.0	1.1	4.3	2.3	6.7	1.7	5.1	1.4
BLK12	3.2	1.1	3.3	1.3	3.1	1.0	3.1	1.4
BLK13	3.2	1.5	2.4	1.2	3.1	1.2	2.4	0.7
BLK14	1.1	0.5	1.0	1.1	0.8	0.3	1.2	0.6
BLK15	0.5	0.2	0.5	ND	0.3	ND	0.7	0.3
BLK16	0.6	0.2	0.3	ND	0.4	ND	0.9	0.5
BLK17	1.9	0.8	1.5	0.6	1.9	0.8	2.3	0.8
BLK18	3.2	1.4	2.0	1.3	1.8	1.0	10.5	6.1
BLK19	1.8	0.6	2.5	1.1	2.2	1.0	1.7	1.1
BLK20	1.8	0.9	2.3	0.7	1.8	0.7	2.8	0.9
BLK21	1.7	0.9	1.7	0.7	0.7	0.6	1.7	0.8

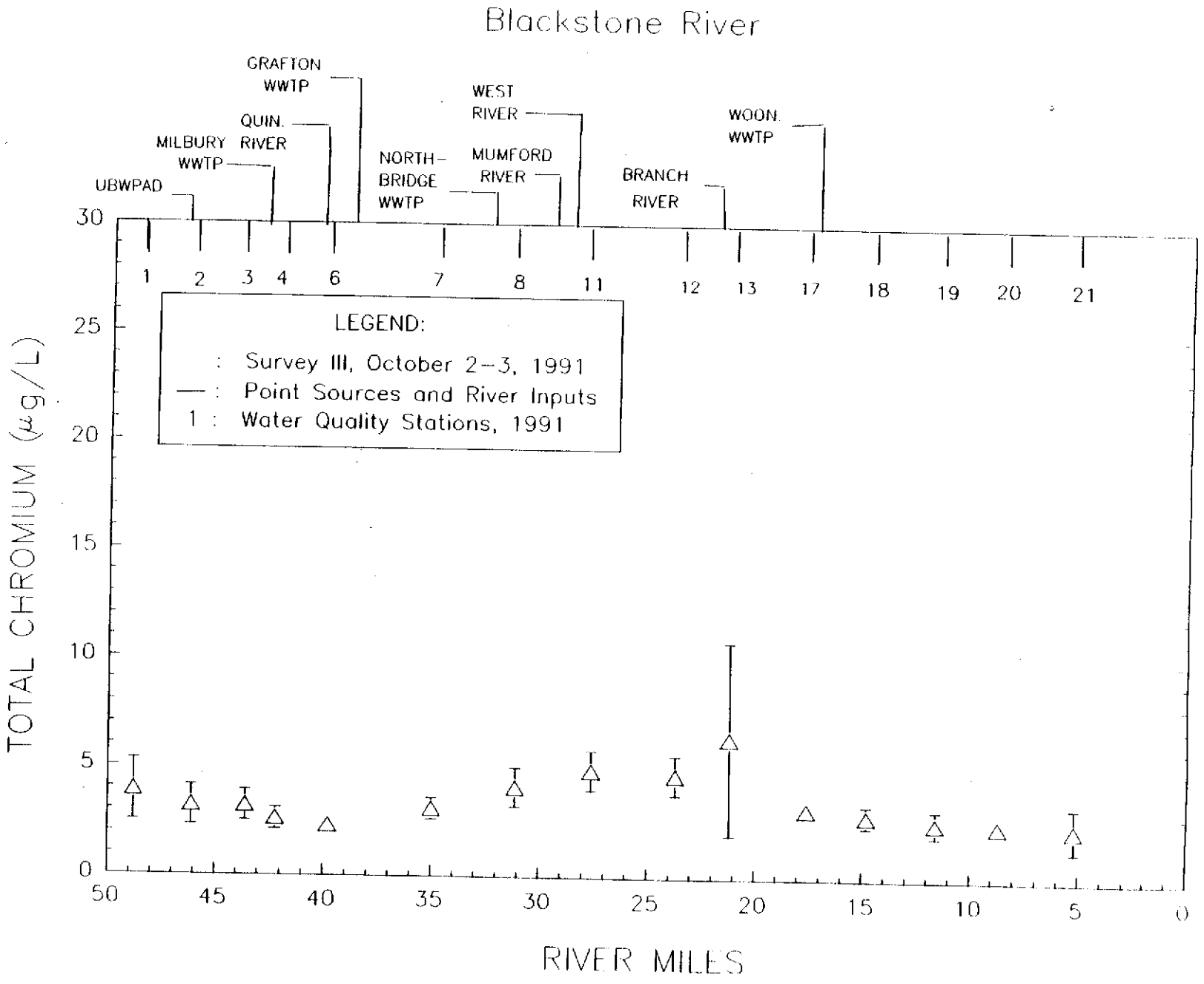
ND = Below the detection limit of 0.2 µg/L.


Blackstone River
GRAFTON WWTP
QUIN. RIVER
MILBURY WWTP
UBWPAD
NORTH-BRIDGE WWTP
WEST RIVER
MUMFORD RIVER
BRANCH RIVER
WOON WWTP
1 2 3 4 6 7 8 11 12 13 17 18 19 20 21
LEGEND:
: Survey II, August 14-15, 1991
— : Point Sources and River Inputs
1 : Water Quality Stations, 1991
TOTAL CHROMIUM (µg/L)
0 5 10 15 20 25 30
50 45 40 35 30 25 20 15 10 5 0
RIVER MILES

1991 Blackstone River Survey #3
Total (TTM) and Dissolved (DTM) Chromium
in µg/L

Station	Run #1		Run #2		Run #3		Run #4	
	TTM	DTM	TTM	DTM	TTM	DTM	TTM	DTM
BLK01	2.8	1.6	2.8	1.1	4.2	2.1	5.7	1.6
BLK02	3.0	1.6	2.3	1.0	2.9	1.5	4.6	2.2
BLK03	3.0	1.7	2.5	0.8	3.2	1.1	4.2	2.0
BLK04	2.9	1.4	2.5	0.6	2.0	0.7	3.0	1.3
BLK05	0.2	ND	0.2	ND	0.2	ND	ND	ND
BLK06	2.4	0.4	2.5	1.0	2.1	0.6	2.3	0.5
BLK07	3.5	2.1	3.1	0.9	2.4	0.7	3.5	0.9
BLK08	5.2	1.3	3.7	1.0	3.2	0.8	4.1	1.4
BLK09	0.9	0.4	1.1	0.4	1.0	0.3	0.9	0.4
BLK10	0.5	ND	0.4	0.6	0.3	ND	0.3	ND
BLK11	5.2	3.4	5.4	0.9	4.6	1.1	4.4	0.6
BLK12	4.6	1.6	5.9	0.8	4.4	1.8	3.9	0.2
BLK13	4.7	1.0	3.8	0.7	4.2	0.6	13.0	1.5
BLK14	0.8	0.3	0.8	0.4	0.3	ND	0.5	ND
BLK15	0.4	ND	0.3	ND	ND	ND	0.2	ND
BLK16	0.3	ND	0.4	ND	ND	ND	ND	ND
BLK17	3.4	1.5	3.2	0.8	2.7	0.8	3.4	0.7
BLK18	3.6	0.9	3.3	0.8	2.5	0.5	3.0	0.7
BLK19	3.5	0.8	2.3	0.7	2.4	0.7	2.2	0.6
BLK20	2.9	0.6	2.3	0.7	2.9	1.3	2.1	0.5
BLK21	3.7	1.2	1.2	1.1	2.5	1.1	2.2	0.6

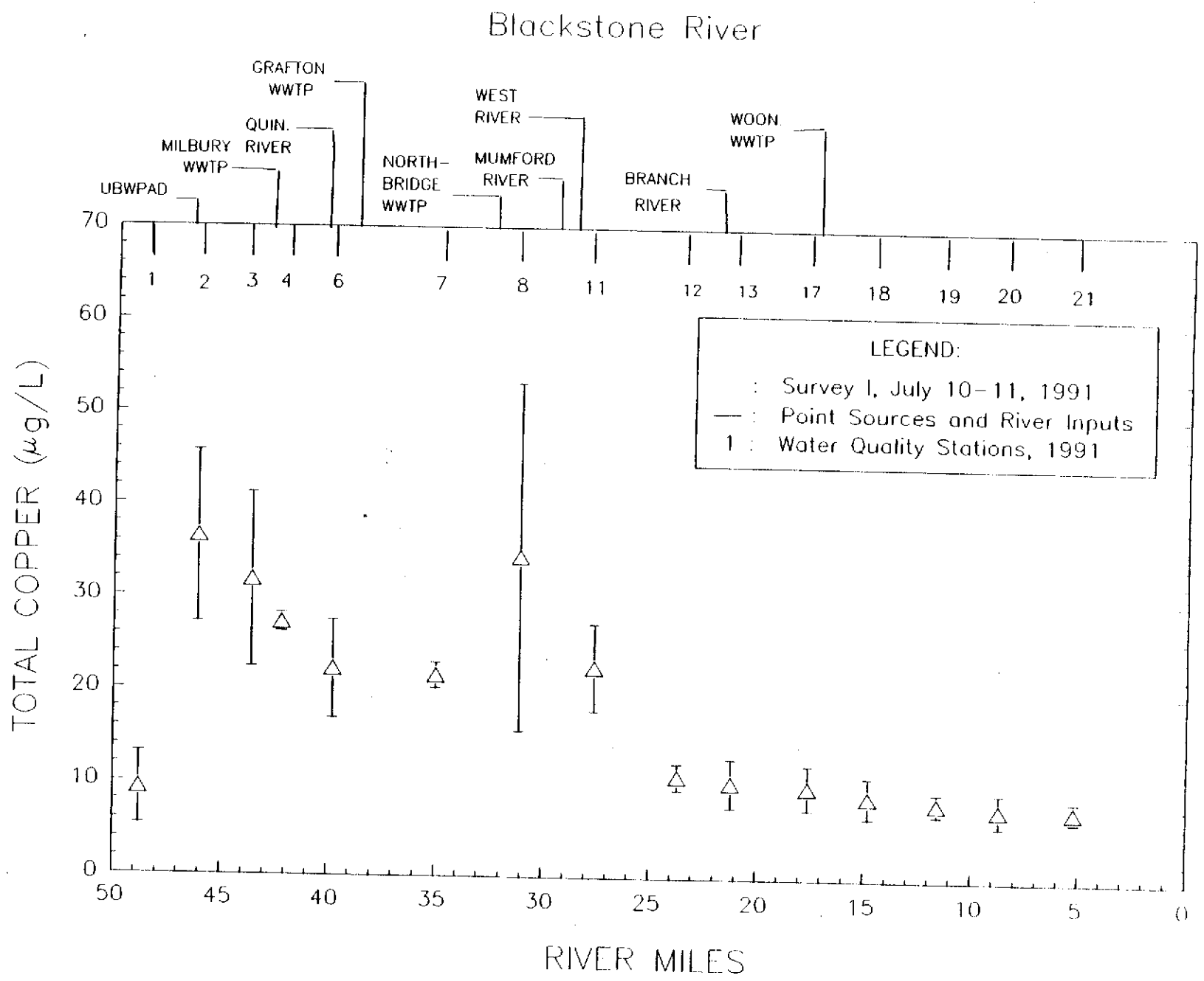
ND = Below the detection limit of 0.2 µg/L.


Blackstone River
GRAFTON WWTP
QUIN. RIVER
MILBURY WWTP
UBWPAD
NORTH-BRIDGE WWTP
WEST RIVER
MUMFORD RIVER
BRANCH RIVER
WOON WWTP
1
2
3
4
6
7
8
11
12
13
17
18
19
20
21
LEGEND:
: Survey III, October 2-3, 1991
— : Point Sources and River Inputs
1 : Water Quality Stations, 1991
TOTAL CHROMIUM (µg/L)
0
5
10
15
20
25
30
50
45
40
35
30
25
20
15
10
5
0
RIVER MILES

1991 Blackstone River Survey #1
Total (TTM) and Dissolved (DTM) Copper
in µg/L

Station	Run #1		Run #2		Run #3		Run #4	
	TTM	DTM	TTM	DTM	TTM	DTM	TTM	DTM
BLK01	15.0	6.1	6.7	1.9	6.9	3.0	8.7	1.4
BLK02	48.8	37.1	38.7	27.2	29.8	26.4	28.8	26.9
BLK03	45.8	22.7	29.0	22.1	25.6	25.2	26.8	21.4
BLK04	28.3	19.9	25.9	20.4	26.9	19.9	27.6	19.5
BLK05	1.3	ND	1.6	ND	1.2	ND	5.4	3.9
BLK06	29.6	15.1	21.7	14.5	17.2	16.9	20.2	14.4
BLK07	22.8	7.9	22.8	8.6	19.9	20.0	21.0	15.1
BLK08	45.5	7.5	24.1	8.3	14.3	10.2	53.8	7.0
BLK09	11.0	ND	9.2	ND	6.6	ND	2.5	ND
BLK10	41.0	1.3	1.4	ND	10.7	ND	23.4	ND
BLK11	15.7	5.1	23.0	6.4	25.5	8.5	25.7	7.6
BLK12	11.9	7.3	11.6	5.2	8.8	8.1	11.4	4.6
BLK13	8.8	5.2	9.9	4.1	14.1	7.1	8.5	2.8
BLK14	7.4	1.2	7.1	2.9	1.8	0.6	6.8	ND
BLK15	4.8	3.1	3.7	ND	4.3	2.2	2.4	ND
BLK16	24.9	14.7	2.9	2.6	37.4	4.6	2.0	ND
BLK17	9.0	4.5	10.4	2.9	13.0	7.2	7.3	1.8
BLK18	6.5	2.3	10.9	3.7	10.7	10.3	7.6	9.4
BLK19	7.5	3.8	6.8	3.2	9.1	6.6	7.1	5.4
BLK20	6.9	3.7	8.7	3.7	7.7	5.2	5.9	2.9
BLK21	6.7	3.4	8.6	3.7	8.5	5.1	6.7	3.8

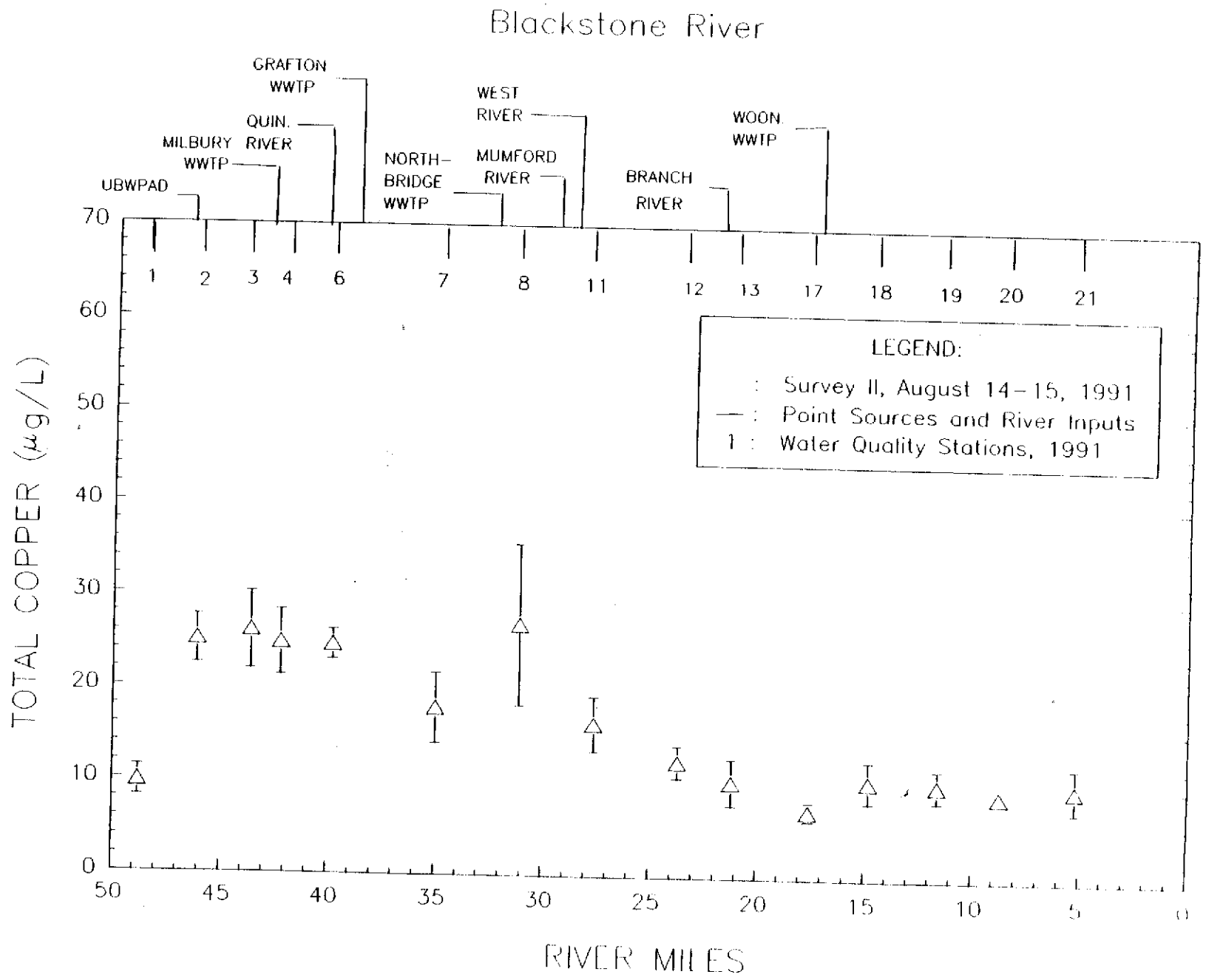
ND = Below the detection limit of 0.2 µg/L.


Blackstone River
GRAFTON WWTP
QUIN. RIVER
MILBURY WWTP
UBWPAD
NORTH-BRIDGE WWTP
WEST RIVER
MUMFORD RIVER
BRANCH RIVER
WOON WWTP
1 2 3 4 6 7 8 11 12 13 17 18 19 20 21
LEGEND:
: Survey I, July 10-11, 1991
— : Point Sources and River Inputs
1 : Water Quality Stations, 1991
TOTAL COPPER (µg/L)
0 10 20 30 40 50 60 70
50 45 40 35 30 25 20 15 10 5 0
RIVER MILES

1991 Blackstone River Survey #2
Total (TTM) and Dissolved (DTM) Copper
in µg/L

Station	Run #1		Run #2		Run #3		Run #4	
	TTM	DTM	TTM	DTM	TTM	DTM	TTM	DTM
BLK01	9.9	6.3	7.6	5.3	11.5	6.0	10.1	9.0
BLK02	26.8	23.2	23.9	20.5	27.7	23.6	22.0	20.3
BLK03	28.3	22.4	22.4	18.0	30.8	26.6	22.7	19.1
BLK04	29.0	24.9	21.2	18.2	26.3	22.1	22.8	19.2
BLK05	2.1	ND	3.4	0.3	3.2	2.5	1.0	ND
BLK06	25.5	18.5	22.3	20.6	26.0	20.0	24.5	18.0
BLK07	20.1	10.8	13.3	10.2	21.9	12.5	16.4	12.4
BLK08	36.8	15.0	16.0	10.3	29.9	17.7	25.2	16.4
BLK09	1.3	ND	2.9	0.5	2.1	0.9	1.3	ND
BLK10	1.0	ND	1.5	0.3	4.8	3.5	3.4	2.7
BLK11	16.3	6.0	14.3	7.2	20.4	11.6	14.2	6.4
BLK12	11.8	7.2	12.2	11.3	14.8	8.8	10.8	5.8
BLK13	10.8	6.0	8.6	5.1	13.5	8.1	8.1	4.1
BLK14	3.4	1.5	2.5	2.3	2.1	1.8	5.2	1.5
BLK15	4.6	1.6	3.3	ND	ND	ND	6.6	ND
BLK16	3.1	0.5	1.2	1.7	3.0	3.1	2.6	2.3
BLK17	7.3	5.4	6.0	3.2	7.4	4.3	8.3	3.9
BLK18	10.4	9.5	10.7	6.7	7.8	5.5	13.1	6.0
BLK19	9.1	6.5	8.7	6.9	9.4	6.9	12.3	5.7
BLK20	8.8	7.8	9.3	5.5	10.6	5.5	9.0	5.6
BLK21	7.7	5.3	11.7	6.7	12.4	6.4	8.1	5.3

ND = Below the detection limit of 0.2 µg/L.

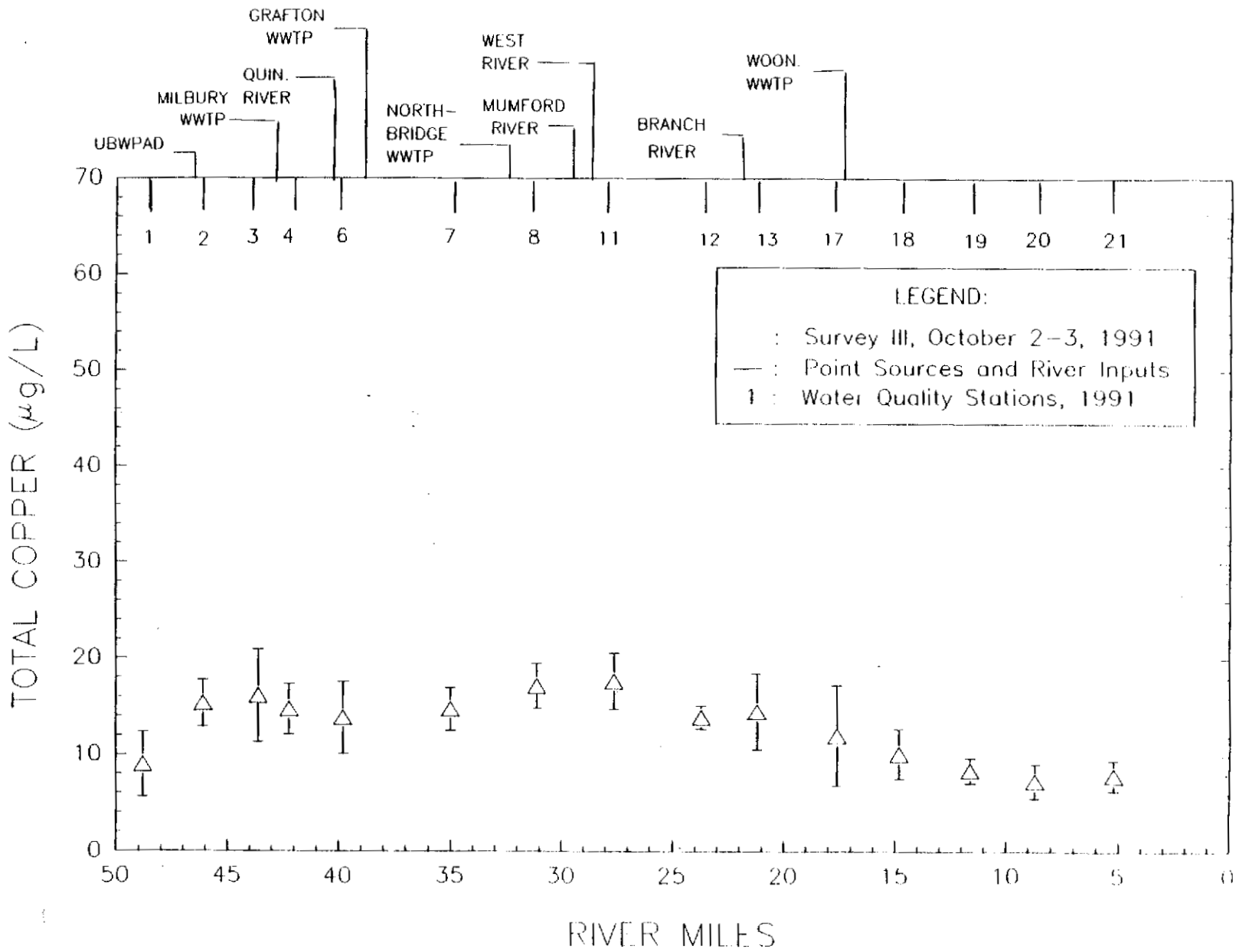

Blackstone River
GRAFTON WWTP
QUIN. RIVER
MILBURY WWTP
UBWPAD
NORTH-BRIDGE WWTP
WEST RIVER
MUMFORD RIVER
BRANCH RIVER
WOON. WWTP
1 2 3 4 6 7 8 11 12 13 17 18 19 20 21
LEGEND:
: Survey II, August 14-15, 1991
— : Point Sources and River Inputs
1 : Water Quality Stations, 1991
TOTAL COPPER (µg/L)
0 10 20 30 40 50 60 70
50 45 40 35 30 25 20 15 10 5 0
RIVER MILES

1991 Blackstone River Survey #3
Total (TTM) and Dissolved (DTM) Copper
in µg/L

Station	Run #1		Run #2		Run #3		Run #4	
	TTM	DTM	TTM	DTM	TTM	DTM	TTM	DTM
BLK01	11.2	5.4	4.3	2.7	8.9	8.6	11.6	4.8
BLK02	14.1	12.3	12.5	8.8	17.2	15.4	17.5	14.5
BLK03	16.8	12.5	9.1	6.8	18.8	13.6	19.5	14.6
BLK04	14.5	12.3	11.0	5.6	16.3	13.5	16.9	15.8
BLK05	1.4	0.8	1.2	1.2	1.3	1.2	2.9	2.5
BLK06	16.9	8.2	8.4	8.0	15.2	10.8	14.6	10.0
BLK07	17.3	13.1	13.5	7.6	12.4	8.6	15.7	12.1
BLK08	19.9	11.0	16.4	11.3	14.4	10.2	17.8	10.2
BLK09	5.2	2.0	2.1	0.8	2.8	1.0	5.3	3.1
BLK10	1.6	1.5	1.7	1.0	2.3	1.0	9.3	2.9
BLK11	16.3	10.6	21.0	6.1	14.3	8.0	18.9	6.6
BLK12	13.0	7.0	15.5	5.0	14.0	10.9	13.1	6.8
BLK13	12.9	7.2	12.3	5.9	20.3	6.9	12.5	5.9
BLK14	4.2	3.6	3.9	3.8	2.1	2.2	4.1	1.8
BLK15	2.7	2.0	2.8	1.8	6.8	1.1	1.8	1.4
BLK16	2.9	2.5	3.3	2.1	3.1	3.2	1.6	0.3
BLK17	9.8	5.1	19.8	15.5	9.2	5.6	9.2	6.1
BLK18	13.3	6.0	8.8	8.2	7.4	5.6	10.9	5.9
BLK19	7.2	4.4	7.4	5.3	10.0	5.8	8.9	6.0
BLK20	4.8	3.4	7.5	4.2	8.1	11.3	8.9	7.6
BLK21	6.4	6.1	6.8	5.3	9.9	5.6	8.5	5.8

ND = Below the detection limit of 0.2 µg/L.

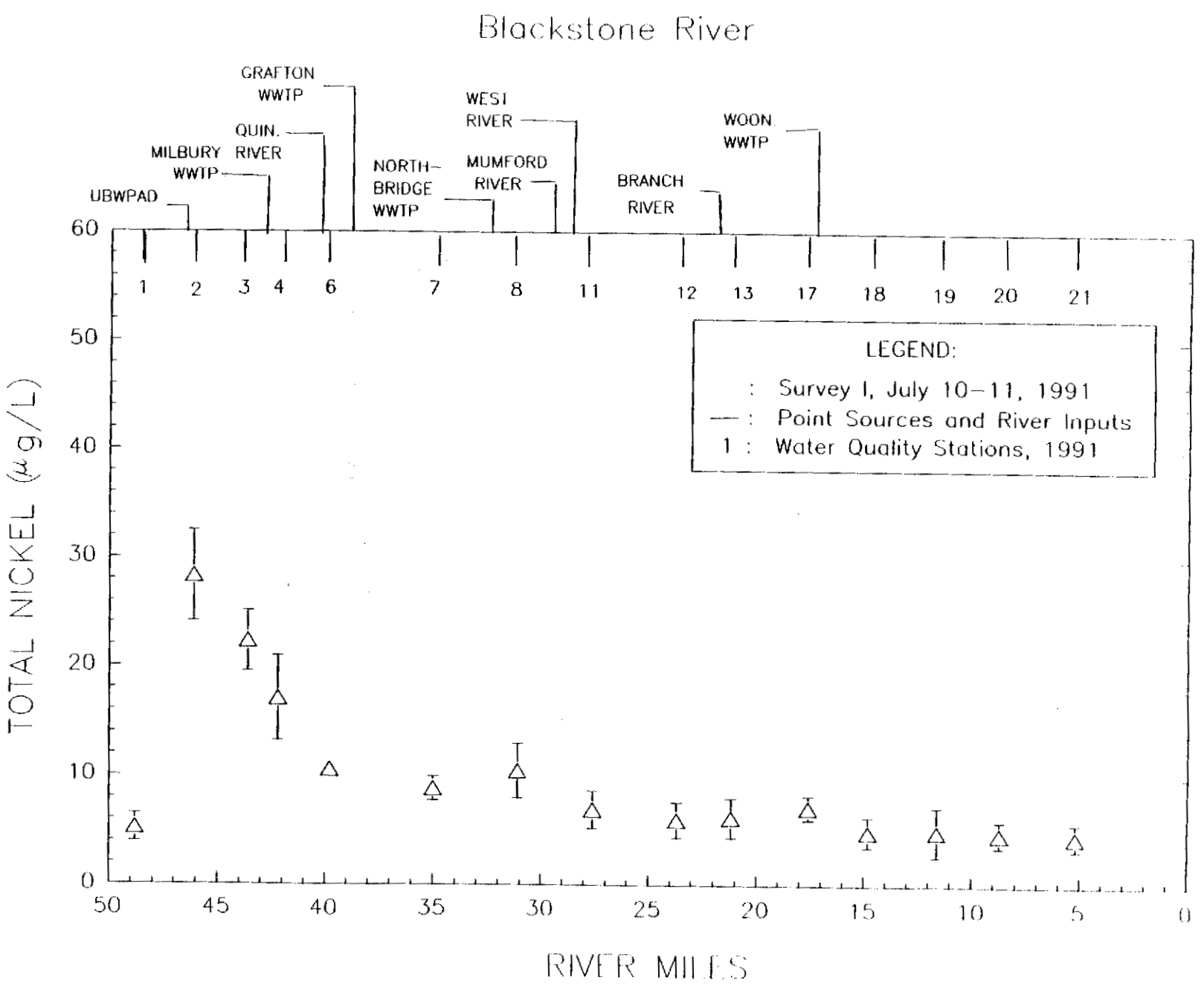
Blackstone River



1991 Blackstone River Survey #1
Total (TTM) and Dissolved (DTM) Nickel
in µg/L

Station	Run #1		Run #2		Run #3		Run #4	
	TTM	DTM	TTM	DTM	TTM	DTM	TTM	DTM
BLK01	4.9	2.8	4.6	3.1	4.1	3.4	7.0	4.6
BLK02	32.9	27.8	30.1	25.6	23.2	23.5	27.1	24.4
BLK03	27.1	20.9	22.8	20.6	22.5	21.3	20.6	17.8
BLK04	11.2	7.6	19.2	18.2	18.8	16.6	18.8	15.8
BLK05	ND	ND	1.5	ND	ND	ND	1.0	1.7
BLK06	9.7	6.9	11.3	7.3	11.0	10.8	11.6	10.6
BLK07	7.6	5.4	9.3	7.5	8.1	8.0	10.1	7.3
BLK08	11.3	6.5	9.3	6.7	7.5	6.1	13.3	5.4
BLK09	ND	ND	1.9	ND	1.3	ND	1.1	ND
BLK10	ND	ND	1.5	ND	7.6	ND	3.5	ND
BLK11	4.7	4.9	8.5	5.4	7.8	5.1	6.8	6.1
BLK12	3.9	2.7	7.9	5.5	6.2	5.8	6.1	4.1
BLK13	3.5	3.1	7.0	4.9	7.0	5.1	7.2	4.5
BLK14	ND	ND	1.3	1.3	1.3	1.3	1.9	ND
BLK15	ND	ND	0.9	ND	1.7	2.0	1.1	ND
BLK16	4.7	1.7	1.5	1.3	9.2	2.7	0.8	ND
BLK17	6.5	4.3	8.7	3.0	6.5	4.5	6.5	3.9
BLK18	2.9	0.5	4.9	3.7	5.9	6.3	6.0	5.5
BLK19	1.6	2.1	5.1	4.4	5.6	5.0	5.8	5.2
BLK20	3.1	1.9	5.1	3.9	4.5	4.5	5.1	3.9
BLK21	3.0	1.9	4.3	2.2	4.9	3.4	5.8	4.2

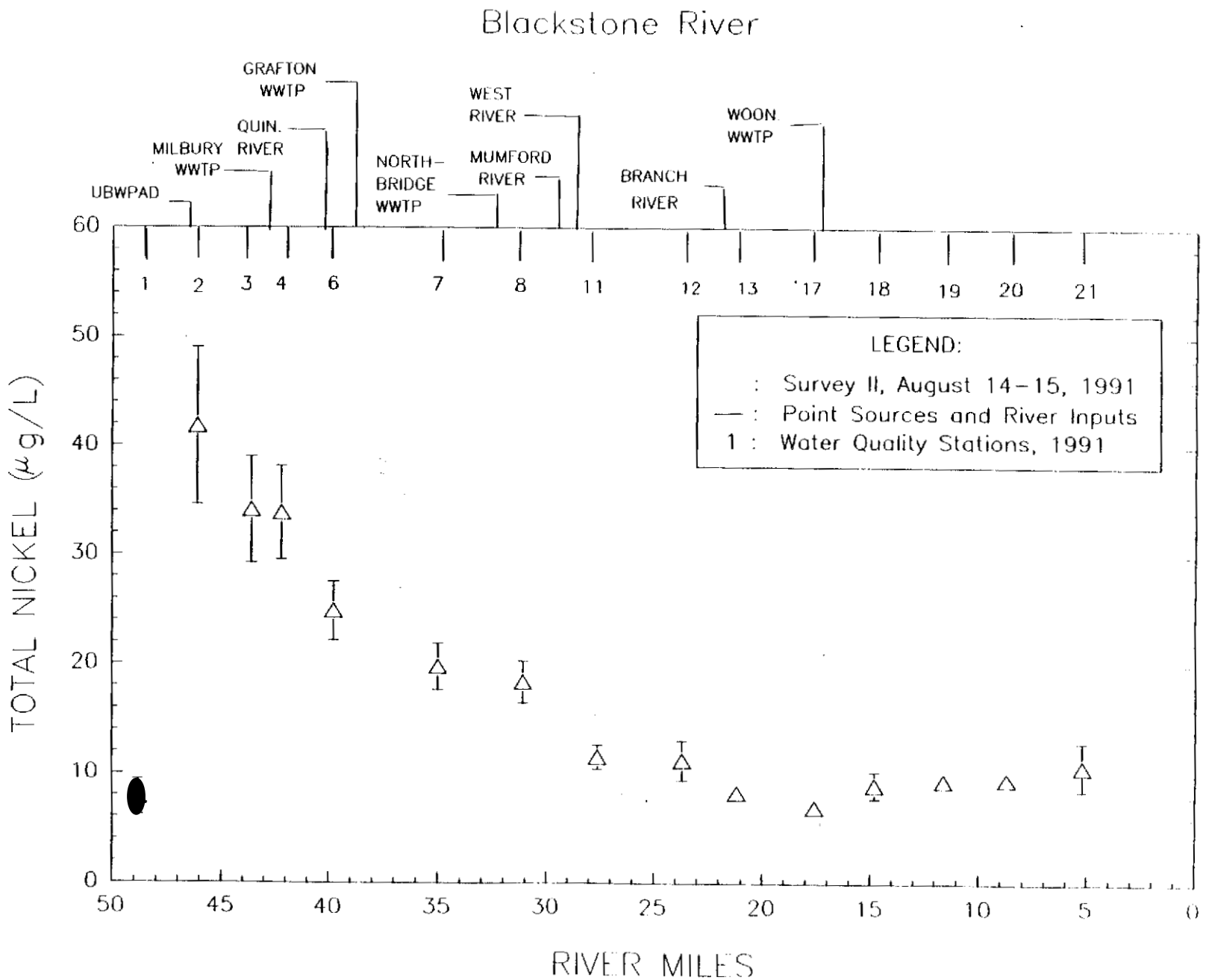
ND = Below the detection limit of 0.2 µg/L.


Blackstone River
GRAFTON WWTP
QUIN. RIVER
MILBURY WWTP
UBWPAD
NORTH-BRIDGE WWTP
WEST RIVER
MUMFORD RIVER
BRANCH RIVER
WOON WWTP
1 2 3 4 6 7 8 11 12 13 17 18 19 20 21
LEGEND:
: Survey I, July 10-11, 1991
— : Point Sources and River Inputs
1 : Water Quality Stations, 1991
TOTAL NICKEL (µg/L)
0 10 20 30 40 50 60
50 45 40 35 30 25 20 15 10 5 0
RIVER MILES

1991 Blackstone River Survey #2
Total (TTM) and Dissolved (DTM) Nickel
in µg/L

Station	Run #1		Run #2		Run #3		Run #4	
	TTM	DTM	TTM	DTM	TTM	DTM	TTM	DTM
BLK01	9.6	8.3	6.6	5.7	6.2	5.8	8.5	8.4
BLK02	41.0	38.5	34.5	32.8	40.1	38.3	51.8	50.3
BLK03	41.4	34.5	31.3	28.5	34.2	33.1	41.1	35.8
BLK04	40.1	30.7	30.7	28.7	32.6	30.3	31.7	30.2
BLK05	2.0	1.2	1.2	0.2	1.9	0.9	0.7	0.4
BLK06	26.6	24.8	20.8	20.9	26.1	25.0	25.8	25.1
BLK07	19.0	18.0	17.1	16.7	21.7	19.1	21.0	20.0
BLK08	19.3	17.1	16.0	14.3	17.7	16.4	20.3	20.6
BLK09	ND	ND	1.1	ND	1.0	0.3	1.0	0.6
BLK10	ND	ND	ND	0.4	1.8	0.7	ND	0.5
BLK11	11.2	8.6	10.2	9.5	12.8	10.9	11.9	10.5
BLK12	10.5	8.6	10.0	9.5	10.4	9.1	13.8	9.8
BLK13	9.1	8.4	7.6	6.4	7.7	6.6	8.6	7.2
BLK14	0.4	0.4	1.0	1.1	0.5	0.5	1.4	0.7
BLK15	0.2	0.4	0.8	0.6	ND	ND	1.6	ND
BLK16	ND	ND	0.2	ND	ND	ND	0.6	0.5
BLK17	7.2	5.9	6.2	6.4	7.2	5.2	7.5	1.4
BLK18	9.4	7.9	9.3	8.1	7.3	7.0	10.0	6.7
BLK19	10.2	9.3	9.1	8.5	9.1	9.2	9.3	8.6
BLK20	9.6	9.3	9.9	8.9	10.0	8.3	10.3	9.2
BLK21	7.9	6.7	13.0	7.8	11.5	7.7	10.1	8.9

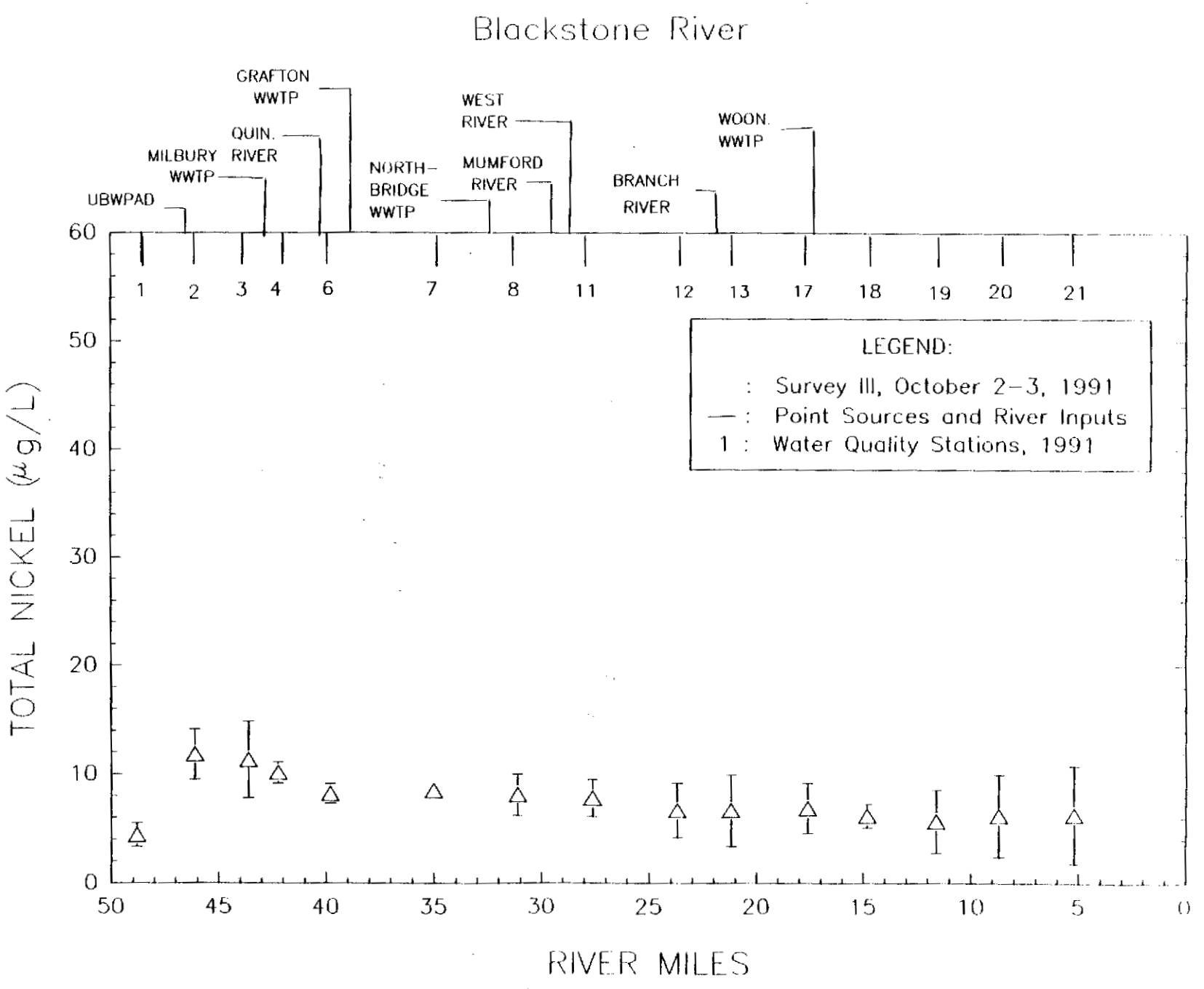
ND = Below the detection limit of 0.2 µg/L.


Blackstone River
GRAFTON WWTP
WEST RIVER
QUIN. RIVER
WOON WWTP
MILBURY WWTP
NORTH-BRIDGE WWTP
MUMFORD RIVER
BRANCH RIVER
UBWPAD
1 2 3 4 6 7 8 11 12 13 17 18 19 20 21
LEGEND:
: Survey II, August 14-15, 1991
— : Point Sources and River Inputs
1 : Water Quality Stations, 1991
TOTAL NICKEL (µg/L)
0 10 20 30 40 50 60
50 45 40 35 30 25 20 15 10 5 0
RIVER MILES

1991 Blackstone River Survey #3
Total (TTM) and Dissolved (DTM) Nickel
in µg/L

Station	Run #1		Run #2		Run #3		Run #4	
	TTM	DTM	TTM	DTM	TTM	DTM	TTM	DTM
BLK01	5.4	4.6	2.8	2.0	4.8	4.3	4.7	3.2
BLK02	12.1	11.3	8.5	5.7	12.7	11.2	13.8	13.4
BLK03	13.1	11.3	6.1	6.3	12.9	11.2	13.2	11.5
BLK04	11.2	10.5	9.3	5.3	11.6	10.7	11.1	10.7
BLK05	0.5	0.5	0.7	0.6	1.2	1.3	1.0	1.4
BLK06	8.4	6.2	8.4	6.6	9.2	7.9	8.8	6.8
BLK07	8.6	7.1	8.5	6.9	8.2	7.5	8.7	9.0
BLK08	8.6	7.6	5.2	3.6	9.1	8.2	9.6	8.3
BLK09	ND	ND	ND	ND	0.7	0.7	6.8	1.1
BLK10	ND	ND	ND	ND	0.8	0.5	1.9	0.7
BLK11	6.6	5.5	6.2	0.9	9.8	8.8	8.3	6.5
BLK12	5.9	4.8	3.7	ND	9.7	9.0	7.4	6.8
BLK13	6.1	4.9	2.7	0.5	10.6	8.6	7.4	5.5
BLK14	1.2	1.5	1.8	1.5	4.6	3.5	2.0	1.2
BLK15	1.6	0.7	1.4	0.5	6.7	5.0	1.6	1.4
BLK16	0.5	0.8	2.2	0.7	5.1	3.8	1.2	1.1
BLK17	4.7	4.0	9.6	8.3	7.8	7.4	5.4	4.4
BLK18	6.0	3.7	6.4	4.9	7.8	7.8	5.1	4.2
BLK19	5.5	4.8	2.6	2.3	9.7	9.6	5.1	4.2
BLK20	5.5	4.8	2.8	2.4	11.7	12.6	4.9	5.1
BLK21	5.2	4.7	2.5	2.1	12.7	10.2	4.6	4.4

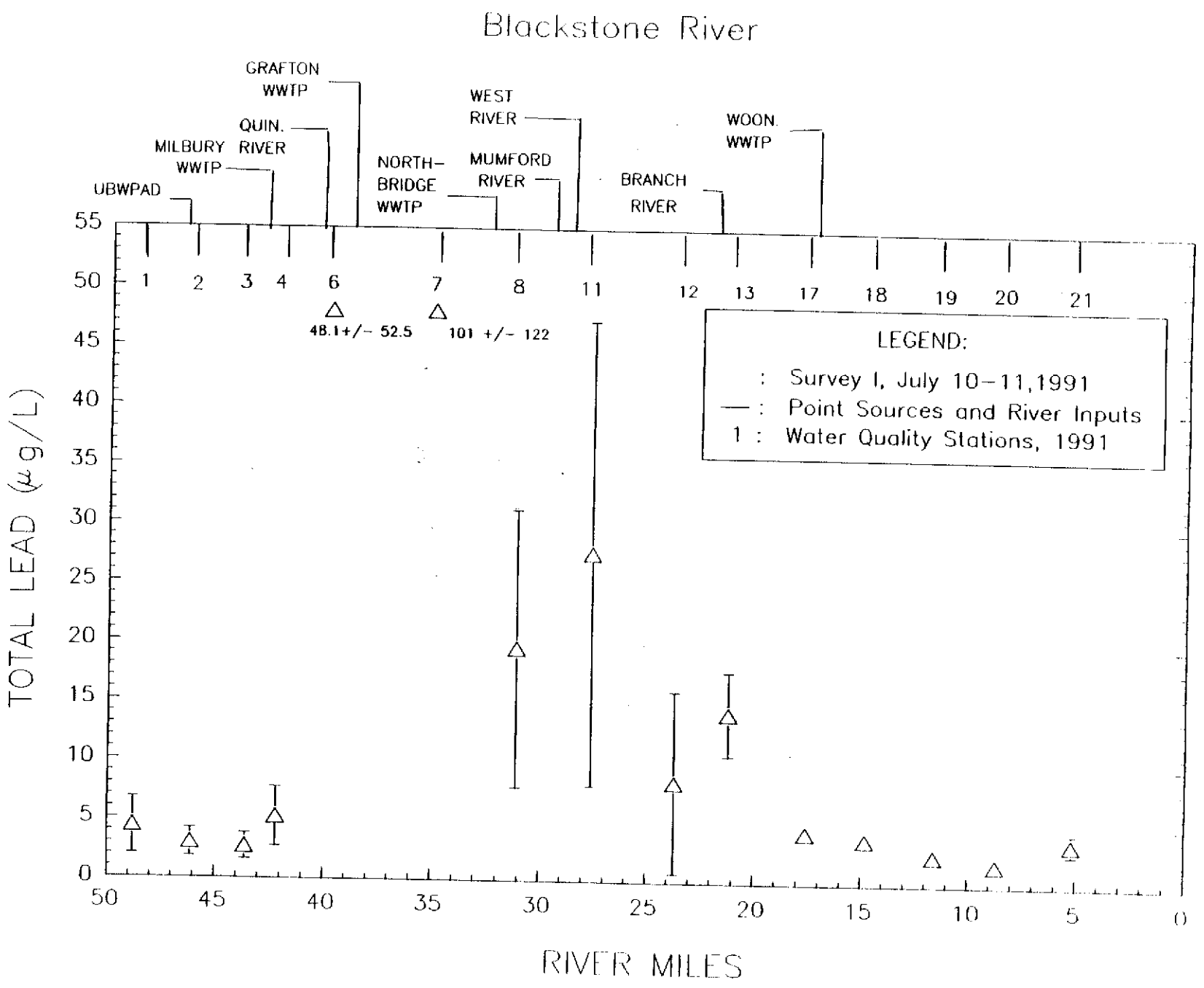
ND = Below the detection limit of 0.2 µg/L.


Blackstone River
GRAFTON WWTP
QUIN. RIVER
MILBURY WWTP
UBWPAD
NORTH-BRIDGE WWTP
WEST RIVER
MUMFORD RIVER
BRANCH RIVER
WOON. WWTP
1 2 3 4 6 7 8 11 12 13 17 18 19 20 21
LEGEND:
: Survey III, October 2-3, 1991
— : Point Sources and River Inputs
1 : Water Quality Stations, 1991
TOTAL NICKEL (µg/L)
0 10 20 30 40 50 60
50 45 40 35 30 25 20 15 10 5 0
RIVER MILES

1991 Blackstone River Survey #1
Total (TTM) and Dissolved (DTM) Lead
in µg/L

Station	Run #1		Run #2		Run #3		Run #4	
	TTM	DTM	TTM	DTM	TTM	DTM	TTM	DTM
BLK01	5.0	1.9	3.9	0.5	1.4	0.7	7.2	1.1
BLK02	3.5	0.6	3.2	ND	1.3	1.1	4.0	3.0
BLK03	3.5	0.4	2.9	0.5	1.0	0.6	3.3	2.4
BLK04	3.0	ND	4.1	0.4	8.8	2.1	5.0	0.2
BLK05	0.9	ND	1.9	ND	1.9	ND	2.8	2.3
BLK06	58.7	5.6	118	94.8	2.8	2.6	13.0	2.0
BLK07	16.7	1.6	274	5.8	98.4	4.7	12.9	5.2
BLK08	23.6	1.8	16.9	3.0	4.8	4.2	32.5	0.9
BLK09	1.1	0.9	3.3	0.2	7.9	0.9	2.8	0.7
BLK10	3.4	0.8	2.2	1.2	3.6	1.6	29.6	1.3
BLK11	9.2	1.2	15.8	3.7	53.3	3.4	32.0	3.6
BLK12	5.1	2.8	19.6	1.3	2.9	2.6	6.1	5.7
BLK13	12.4	1.5	10.3	1.3	18.2	2.1	15.7	0.8
BLK14	23.5	21.2	1.6	1.5	1.0	0.8	2.0	0.2
BLK15	1.7	0.8	1.0	ND	0.5	1.7	1.7	0.4
BLK16	9.4	5.7	3.5	1.3	12.3	3.4	8.9	1.4
BLK17	3.7	0.5	4.0	ND	4.5	2.3	4.7	0.4
BLK18	4.3	0.2	3.2	ND	3.4	2.0	4.2	ND
BLK19	2.2	ND	2.0	ND	2.5	0.8	2.5	0.3
BLK20	2.0	2.1	1.7	ND	1.6	1.5	1.6	ND
BLK21	2.7	0.3	3.3	ND	4.9	1.6	3.4	0.5

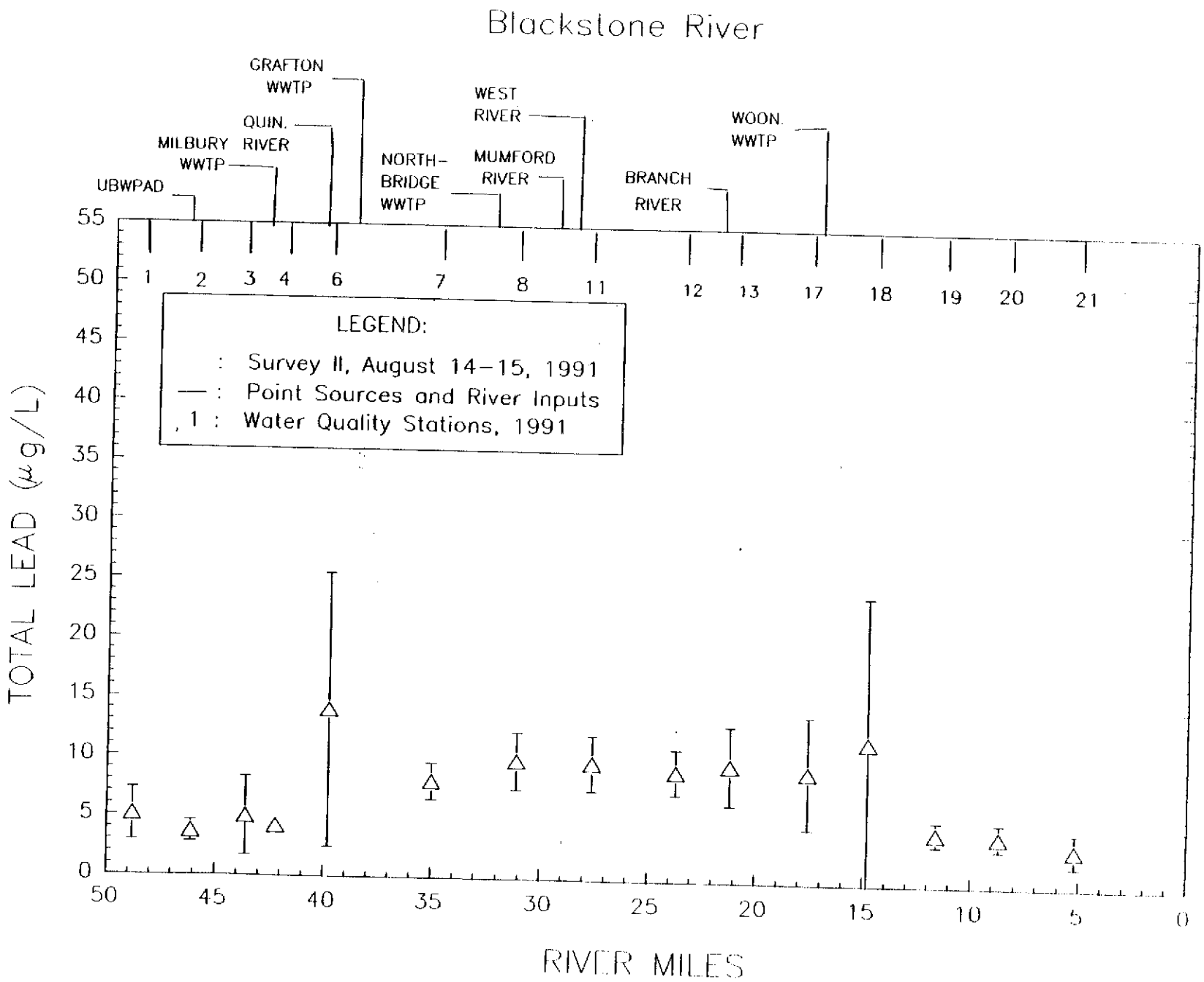
ND = Below the detection limit of 0.2 µg/L.


Blackstone River
GRAFTON WWTP
QUIN. RIVER
MILBURY WWTP
UBWPAD
NORTH-BRIDGE WWTP
WEST RIVER
MUMFORD RIVER
BRANCH RIVER
WOON. WWTP
1
2
3
4
6
7
8
11
12
13
17
18
19
20
21
48.1+/- 52.5
101 +/- 122
LEGEND:
: Survey I, July 10-11,1991
— : Point Sources and River Inputs
1 : Water Quality Stations, 1991
TOTAL LEAD (µg/L)
0
5
10
15
20
25
30
35
40
45
50
55
50
45
40
35
30
25
20
15
10
5
0
RIVER MILES

1991 Blackstone River Survey #2
Total (TTM) and Dissolved (DTM) Lead
in µg/L

Station	Run #1		Run #2		Run #3		Run #4	
	TTM	DTM	TTM	DTM	TTM	DTM	TTM	DTM
BLK01	4.6	2.5	54.3	4.5	19.7	4.5	5.7	4.2
BLK02	4.8	3.1	6.7	2.4	18.7	15.0	3.7	2.5
BLK03	3.5	1.2	8.3	3.2	25.7	22.7	3.2	1.2
BLK04	13.4	4.0	4.7	4.0	6.9	6.6	2.5	1.5
BLK05	6.0	6.1	8.3	3.3	6.2	2.1	0.5	ND
BLK06	9.2	7.2	17.0	11.9	21.3	12.8	6.7	3.9
BLK07	11.7	5.7	13.0	11.5	32.0	21.0	6.4	4.6
BLK08	25.6	13.0	20.4	9.4	37.2	24.5	18.8	11.0
BLK09	1.1	0.4	6.1	4.9	5.1	3.2	1.0	ND
BLK10	1.6	2.0	4.8	3.8	6.3	4.6	1.1	1.3
BLK11	11.4	4.2	11.0	9.2	26.9	17.0	7.8	4.3
BLK12	6.5	2.2	19.2	15.7	13.4	6.0	5.7	3.0
BLK13	8.2	5.5	8.5	10.3	41.2	35.1	6.2	0.8
BLK14	2.8	1.2	2.5	1.3	1.9	0.9	3.1	1.1
BLK15	2.1	1.1	48.8	0.3	1.1	0.2	4.1	0.2
BLK16	2.9	1.7	2.0	0.8	3.9	1.7	8.0	4.3
BLK17	5.0	1.5	4.5	1.3	5.8	1.5	10.2	2.5
BLK18	6.6	5.5	4.5	2.6	4.6	3.5	6.9	1.3
BLK19	3.9	2.5	7.2	5.0	5.8	5.1	6.6	ND
BLK20	3.5	2.3	3.4	0.4	5.0	2.1	ND	ND
BLK21	3.8	2.9	4.9	2.2	5.0	0.7	ND	ND

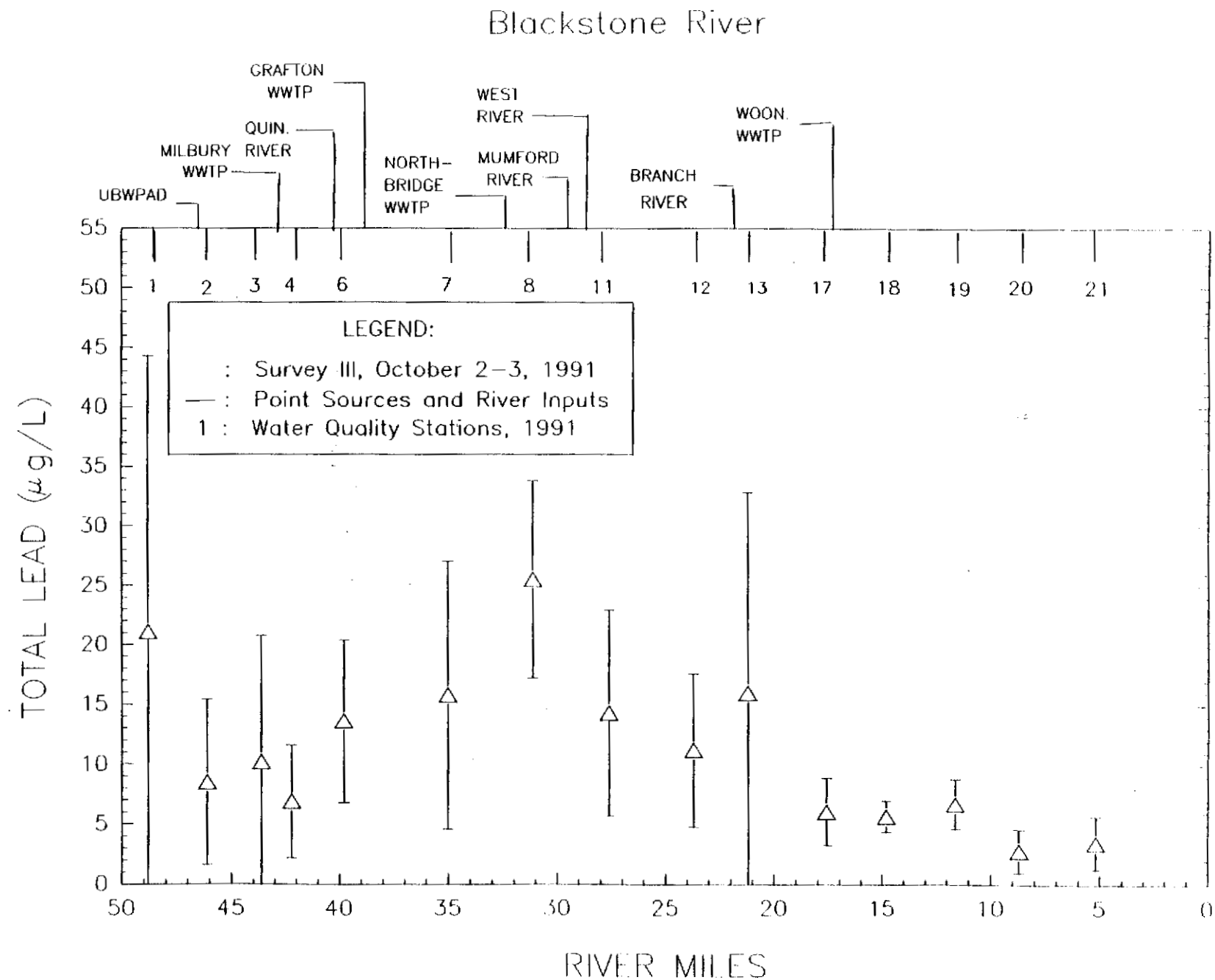
ND = Below the detection limit of 0.2 µg/L.


Blackstone River
GRAFTON WWTP
QUIN. RIVER
MILBURY WWTP
UBWPAD
NORTH-BRIDGE WWTP
WEST RIVER
MUMFORD RIVER
BRANCH RIVER
WOON. WWTP
1 2 3 4 6 7 8 11 12 13 17 18 19 20 21
LEGEND:
: Survey II, August 14-15, 1991
— : Point Sources and River Inputs
, 1 : Water Quality Stations, 1991
TOTAL LEAD (µg/L)
0 5 10 15 20 25 30 35 40 45 50 55
50 45 40 35 30 25 20 15 10 5 0
RIVER MILES

1991 Blackstone River Survey #3
Total (TTM) and Dissolved (DTM) Lead
in µg/L

Station	Run #1		Run #2		Run #3		Run #4	
	TTM	DTM	TTM	DTM	TTM	DTM	TTM	DTM
BLK01	2.6	0.4	4.3	0.9	6.0	2.9	7.6	1.4
BLK02	2.6	0.9	3.3	1.3	4.8	2.0	3.9	2.7
BLK03	2.7	0.3	2.9	0.6	9.7	1.4	4.7	1.4
BLK04	3.9	2.4	3.5	1.5	4.9	1.9	4.3	2.3
BLK05	2.1	0.7	1.4	0.7	0.8	0.4	1.1	1.0
BLK06	8.3	2.3	7.7	2.3	33.6	10.8	6.3	1.7
BLK07	9.8	6.1	6.7	2.9	8.8	2.7	7.0	3.3
BLK08	10.2	3.7	7.7	2.8	8.6	2.5	13.1	5.8
BLK09	2.4	2.4	5.1	1.1	4.9	1.0	4.3	0.6
BLK10	4.6	2.4	2.9	0.9	3.2	1.7	2.4	0.9
BLK11	8.5	5.2	13.1	1.8	9.4	3.4	8.0	1.8
BLK12	7.4	6.7	10.9	1.5	10.8	6.2	7.6	1.7
BLK13	8.2	3.0	9.7	1.8	14.4	3.8	6.9	1.4
BLK14	6.8	5.9	1.3	1.2	1.5	0.7	1.8	0.3
BLK15	3.3	2.5	1.2	0.8	2.3	0.4	1.2	0.5
BLK16	2.5	2.1	3.4	1.9	1.2	1.2	5.0	0.4
BLK17	11.3	9.4	6.6	1.0	4.4	1.4	14.8	2.3
BLK18	9.6	3.1	6.5	1.7	4.7	1.1	29.8	15.3
BLK19	3.7	2.2	4.4	1.5	3.6	1.1	5.7	1.4
BLK20	3.8	0.9	3.9	1.0	5.5	2.3	4.4	1.7
BLK21	5.1	2.1	3.0	1.2	3.0	1.1	4.6	1.9

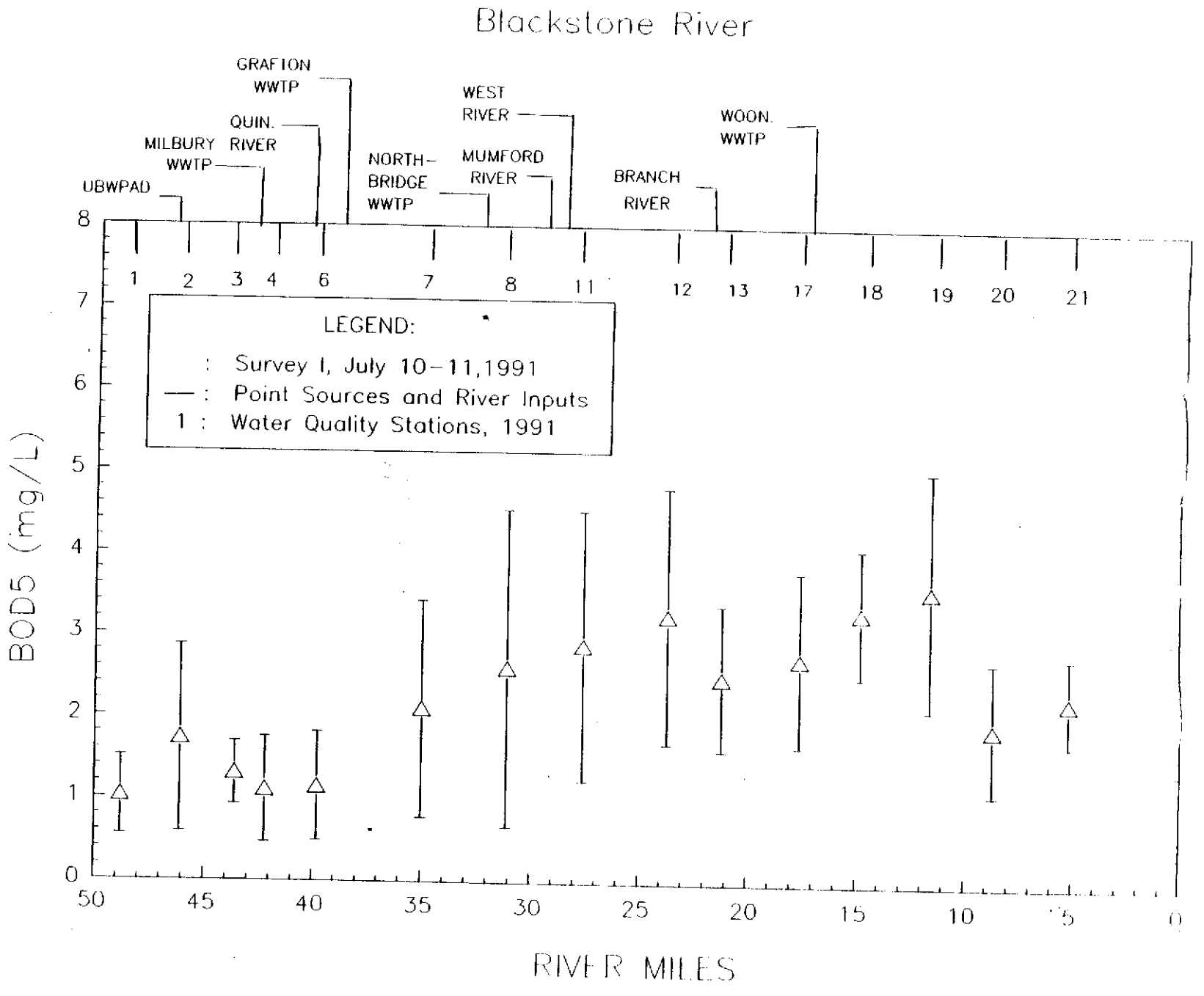
ND = Below the detection limit of 0.2 µg/L.


Blackstone River
GRAFTON WWTP
QUIN. RIVER
MILBURY WWTP
UBWPAD
NORTH-BRIDGE WWTP
WEST RIVER
MUMFORD RIVER
BRANCH RIVER
WOON. WWTP
1 2 3 4 6 7 8 11 12 13 17 18 19 20 21
LEGEND:
: Survey III, October 2-3, 1991
— : Point Sources and River Inputs
1 : Water Quality Stations, 1991
TOTAL LEAD (µg/L)
0 5 10 15 20 25 30 35 40 45 50 55
50 45 40 35 30 25 20 15 10 5 0
RIVER MILES

1991 Blackstone River Survey #1
Five Day Biochemical Oxygen Demand in mg/L

Station	Run #1	Run #2	Run #3	Run #4
BLK01	ND	ND	1.2	1.4
BLK02	1.0	1.3	2.0	2.6
BLK03	1.7	1.2	1.1	1.3
BLK04	ND	ND	1.6	1.4
BLK05	ND	ND	ND	ND
BLK06	ND	ND	1.6	1.4
BLK07	1.2	1.7	3.1	2.4
BLK08	1.6	2.6	4.3	2.0
BLK09	ND	ND	ND	1.0
BLK10	ND	ND	1.0	ND
BLK11	1.5	2.9	3.8	3.4
BLK12	1.9	3.5	4.3	3.4
BLK13	1.7	2.8	3.0	2.6
BLK14	ND	1.0	1.1	1.3
BLK15	ND	ND	1.5	1.5
BLK16	ND	ND	1.2	1.6
BLK17	1.8	2.7	3.4	3.0
BLK18	2.7	3.3	3.9	3.4
BLK19	2.4	4.1	4.5	3.5
BLK20	1.3	1.7	2.3	2.4
BLK21	1.9	2.2	2.7	2.2

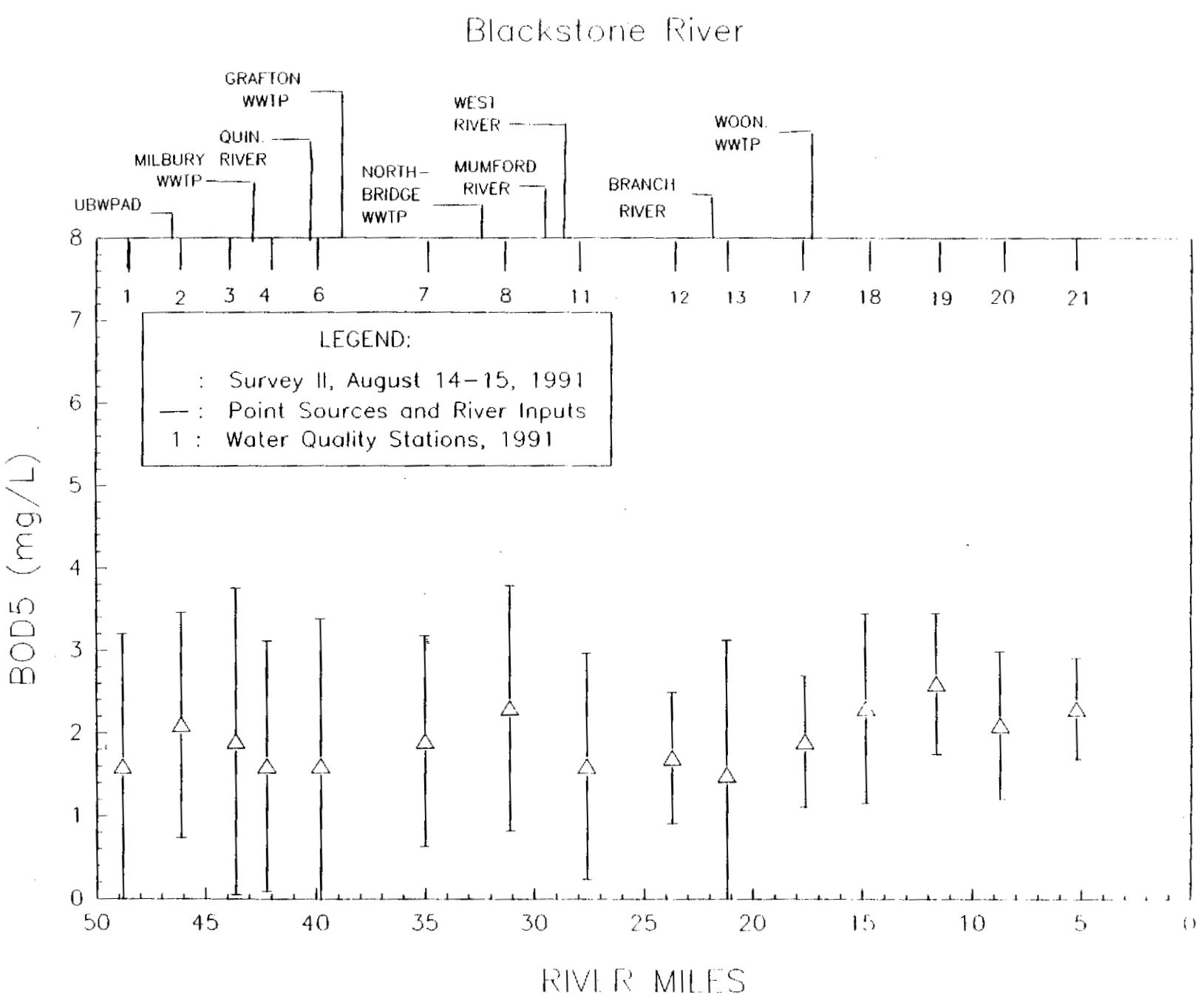
ND = Below the detection limit of 1.0 mg/L.


Blackstone River
GRAFTON WWTP
QUIN. RIVER
MILBURY WWTP
UBWPAD
NORTH-BRIDGE WWTP
WEST RIVER
MUMFORD RIVER
BRANCH RIVER
WOON. WWTP
1 2 3 4 6 7 8 11 12 13 17 18 19 20 21
LEGEND:
: Survey I, July 10-11,1991
— : Point Sources and River Inputs
1 : Water Quality Stations, 1991
BOD5 (mg/L)
0 1 2 3 4 5 6 7 8
50 45 40 35 30 25 20 15 10 5 0
RIVER MILES

1991 Blackstone River Survey #2
Five Day Biochemical Oxygen Demand in mg/L

Station	Run #1	Run #2	Run #3	Run #4
BLK01	2.8	ND	1.3	1.9
BLK02	3.0	1.1	1.4	2.7
BLK03	3.0	1.2	ND	2.9
BLK04	2.4	ND	ND	2.5
BLK05	2.0	ND	ND	ND
BLK06	2.7	ND	ND	2.4
BLK07	3.0	1.2	1.6	1.9
BLK08	2.9	1.4	1.6	3.3
BLK09	1.8	1.2	ND	1.3
BLK10	2.1	ND	ND	1.1
BLK11	2.6	ND	ND	2.1
BLK12	2.3	1.5	1.0	1.9
BLK13	2.7	ND	ND	2.1
BLK14	2.1	ND	1.4	1.6
BLK15	2.9	ND	1.4	2.3
BLK16	1.6	1.3	ND	1.4
BLK17	2.3	2.3	1.2	1.7
BLK18	3.1	2.6	1.3	2.2
BLK19	3.1	2.9	1.9	2.6
BLK20	2.4	2.6	1.3	2.2
BLK21	2.6	2.7	1.8	2.2

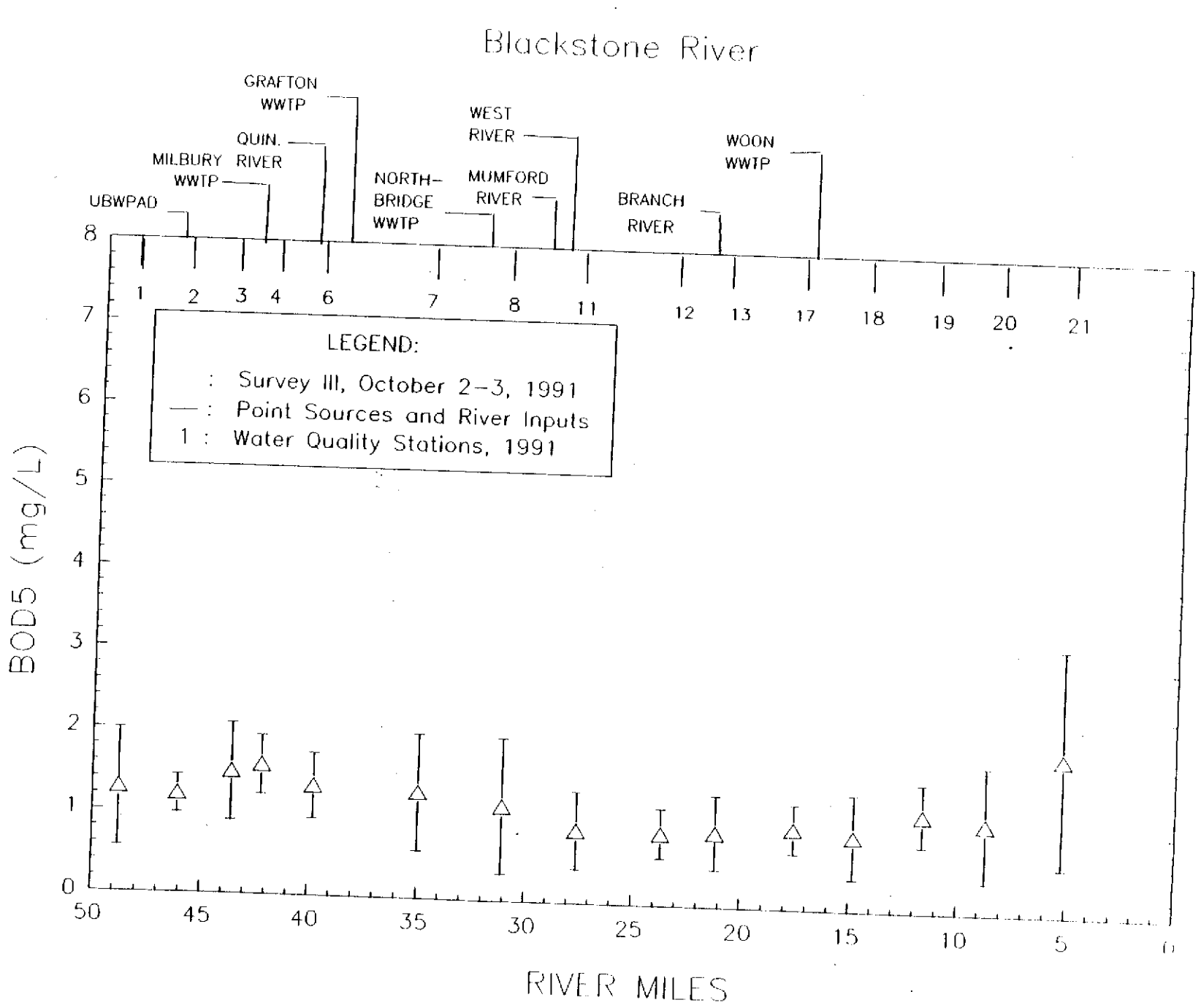
ND = Below the detection limit of 1.0 mg/L.


Blackstone River
GRAFTON WWTP
QUIN. RIVER
MILBURY WWTP
UBWPAD
NORTH-BRIDGE WWTP
WEST RIVER
MUMFORD RIVER
BRANCH RIVER
WOON. WWTP
1 2 3 4 6 7 8 11 12 13 17 18 19 20 21
LEGEND:
: Survey II, August 14-15, 1991
— : Point Sources and River Inputs
1 : Water Quality Stations, 1991
BOD5 (mg/L)
0 1 2 3 4 5 6 7 8
50 45 40 35 30 25 20 15 10 5 0
RIVER MILES

1991 Blackstone River Survey #3
Five Day Biochemical Oxygen Demand in mg/L

Station	Run #1	Run #2	Run #3	Run #4
BLK01	1.4	1.6	ND	1.5
BLK02	1.3	1.3	1.3	1.0
BLK03	1.1	2.0	1.5	1.4
BLK04	1.5	1.8	1.3	1.7
BLK05	ND	1.2	ND	ND
BLK06	1.1	1.3	1.7	1.4
BLK07	1.5	1.8	1.1	ND
BLK08	1.1	1.8	1.2	ND
BLK09	ND	1.4	ND	ND
BLK10	ND	1.1	ND	ND
BLK11	ND	1.3	ND	ND
BLK12	ND	1.1	ND	ND
BLK13	1.1	ND	1.2	ND
BLK14	1.4	ND	ND	ND
BLK15	1.0	ND	ND	1.2
BLK16	1.1	1.2	ND	ND
BLK17	ND	1.0	ND	1.2
BLK18	ND	1.0	ND	1.2
BLK19	1.5	1.0	ND	1.3
BLK20	1.1	ND	ND	1.7
BLK21	2.4	ND	2.4	3.7

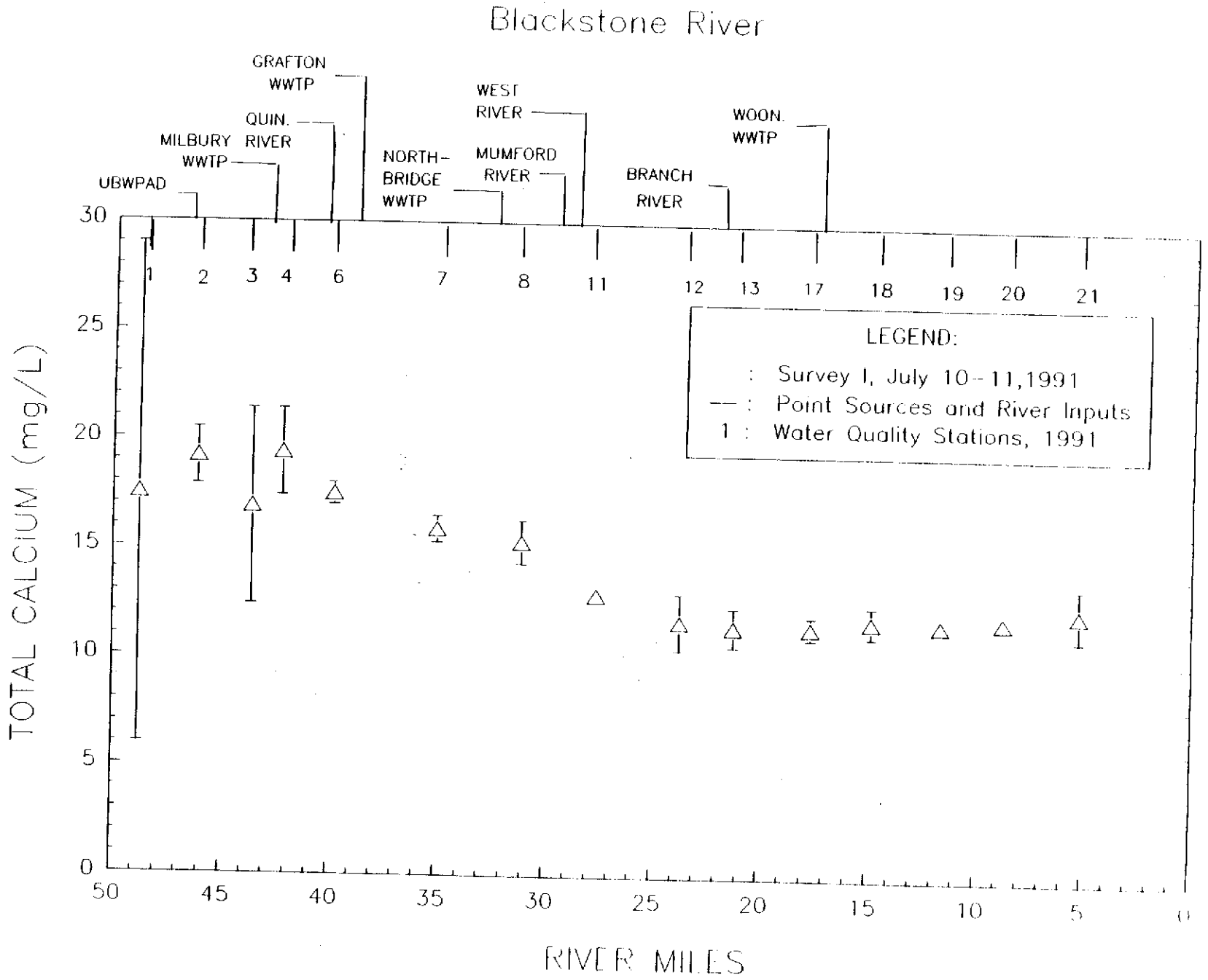
ND = Below the detection limit of 1.0 mg/L.


Blackstone River
GRAFTON WWTP
QUIN. RIVER
MILBURY WWTP
UBWPAD
NORTH-BRIDGE WWTP
WEST RIVER
MUMFORD RIVER
BRANCH RIVER
WOON WWTP
1 2 3 4 6 7 8 11 12 13 17 18 19 20 21
LEGEND:
: Survey III, October 2-3, 1991
— : Point Sources and River Inputs
1 : Water Quality Stations, 1991
BOD5 (mg/L)
0 1 2 3 4 5 6 7 8
50 45 40 35 30 25 20 15 10 5 0
RIVER MILES

1991 Blackstone River Survey #1
Calcium in mg/L

Station	Run #1	Run #2	Run #3	Run #4
BLK01	22.4	23.6	NS	23.7
BLK02	19.2	18.4	20.9	18.1
BLK03	20.3	19.2	10.3	18.1
BLK04	22.3	18.6	19.0	17.8
BLK05	16.9	14.3	15.1	13.8
BLK06	18.0	17.6	17.4	16.9
BLK07	16.6	15.8	16.0	15.1
BLK08	15.5	15.9	16.0	13.9
BLK09	6.3	4.1	5.4	5.2
BLK10	6.6	6.1	5.8	5.8
BLK11	12.8	13.1	13.1	12.6
BLK12	13.6	12.7	12.6	12.2
BLK13	12.8	10.8	10.8	11.4
BLK14	3.4	4.1	3.9	4.3
BLK15	6.7	6.6	6.6	7.1
BLK16	9.8	9.7	10.2	9.9
BLK17	12.2	11.1	11.2	11.5
BLK18	12.7	11.1	12.1	11.4
BLK19	12.0	11.6	11.5	11.7
BLK20	11.9	12.1	11.9	11.6
BLK21	14.0	11.4	11.4	12.2

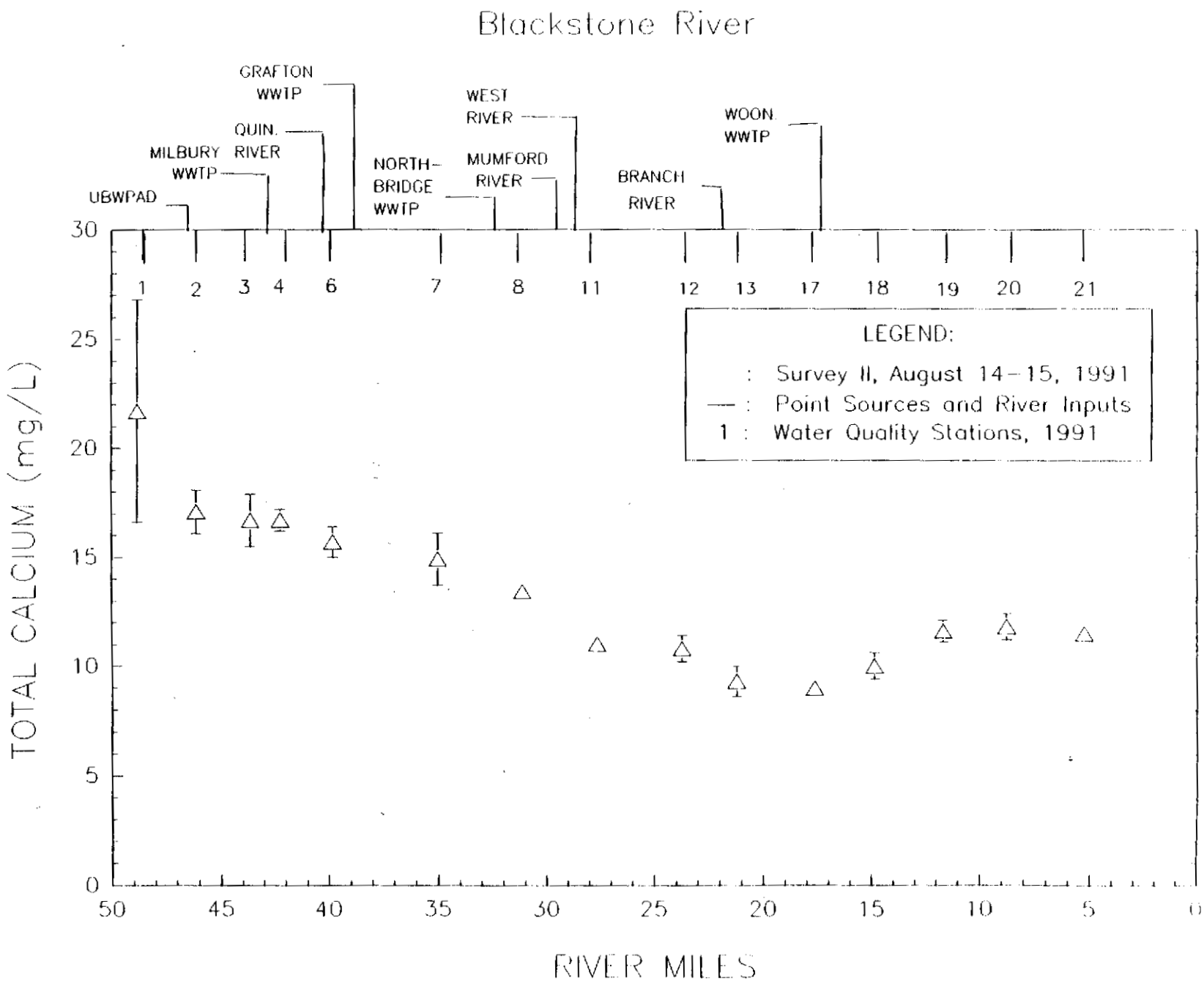
ND = Below the detection limit of 0.1 mg/L; NS = Sample missing.


Blackstone River
GRAFTON WWTP
QUIN. RIVER
MILBURY WWTP
UBWPAD
NORTH-BRIDGE WWTP
WEST RIVER
MUMFORD RIVER
BRANCH RIVER
WOON. WWTP
1 2 3 4 6 7 8 11 12 13 17 18 19 20 21
LEGEND:
: Survey I, July 10-11,1991
-- : Point Sources and River Inputs
1 : Water Quality Stations, 1991
TOTAL CALCIUM (mg/L)
0 5 10 15 20 25 30
50 45 40 35 30 25 20 15 10 5 0
RIVER MILES

1991 Blackstone River Survey #2
Calcium in mg/L

Station	Run #1	Run #2	Run #3	Run #4
BLK01	18.8	19.5	29.3	19.0
BLK02	18.0	15.7	17.5	17.1
BLK03	18.7	16.4	16.2	16.6
BLK04	17.1	16.7	17.0	16.1
BLK05	14.3	12.8	13.0	12.9
BLK06	16.1	14.9	15.3	16.4
BLK07	14.7	13.6	14.9	16.4
BLK08	13.0	13.7	13.4	13.4
BLK09	5.6	5.4	4.6	4.3
BLK10	5.8	5.3	5.2	5.1
BLK11	11.0	11.2	11.0	10.8
BLK12	11.4	10.1	10.6	11.0
BLK13	9.6	8.7	8.6	10.1
BLK14	4.7	7.3	4.2	3.9
BLK15	6.6	6.1	6.0	6.0
BLK16	8.7	7.6	8.5	8.2
BLK17	9.2	9.0	9.0	8.6
BLK18	10.7	10.1	9.7	9.3
BLK19	11.4	11.2	10.4	10.1
BLK20	12.4	12.3	11.4	11.2
BLK21	11.5	11.6	11.7	11.2

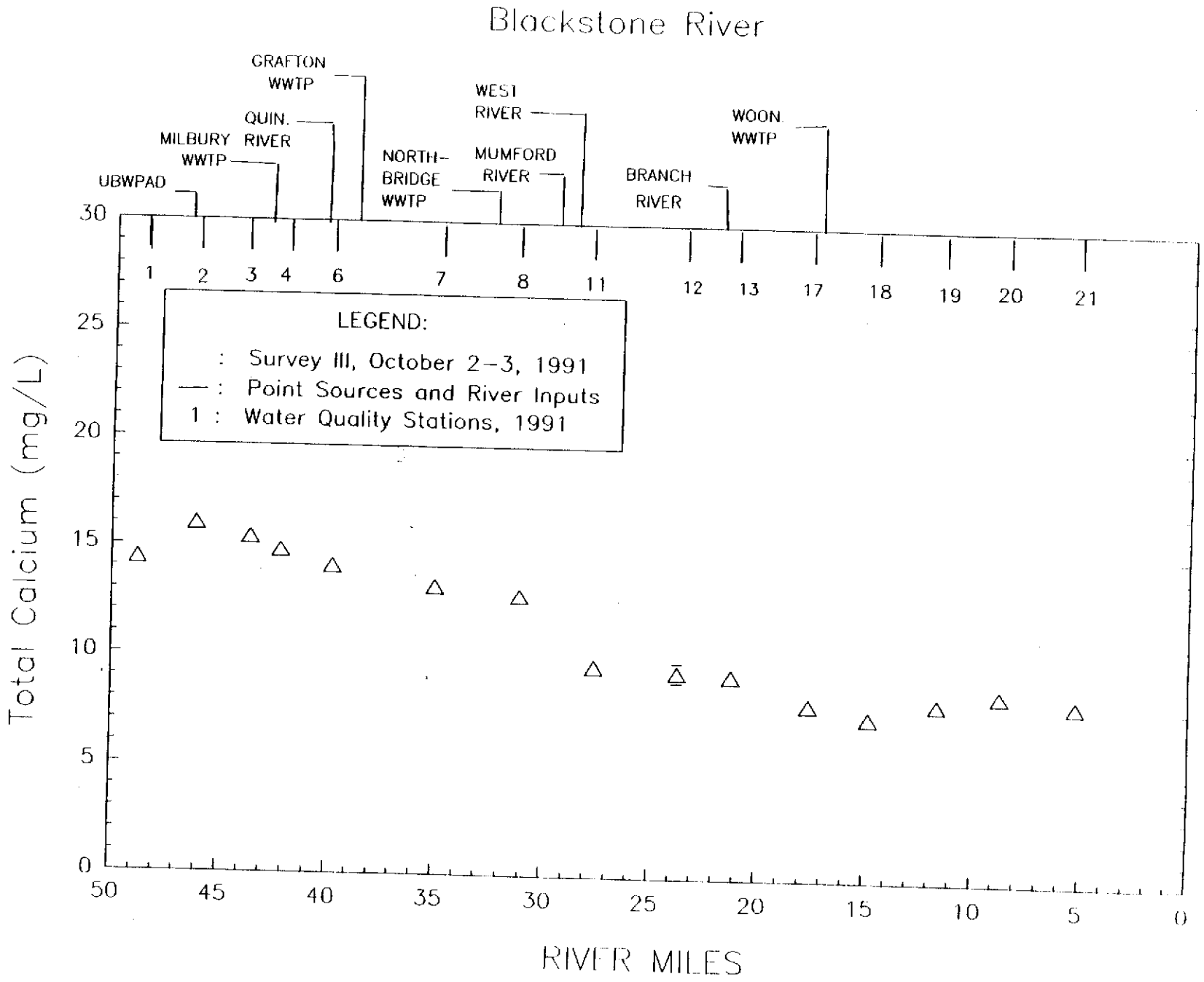
ND = Below the detection limit of 0.1 mg/L.


Blackstone River
GRAFTON WWTP
QUIN. RIVER
MILBURY WWTP
UBWPAD
NORTH-BRIDGE WWTP
WEST RIVER
MUMFORD RIVER
BRANCH RIVER
WOON WWTP
1 2 3 4 6 7 8 11 12 13 17 18 19 20 21
LEGEND:
: Survey II, August 14-15, 1991
— : Point Sources and River Inputs
1 : Water Quality Stations, 1991
TOTAL CALCIUM (mg/L)
0 5 10 15 20 25 30
50 45 40 35 30 25 20 15 10 5 0
RIVER MILES

1991 Blackstone River Survey #3
Calcium in mg/L

Station	Run #1	Run #2	Run #3	Run #4
BLK01	14.4	14.2	14.8	14.2
BLK02	15.9	16.3	16.5	15.5
BLK03	15.6	15.2	15.0	15.8
BLK04	15.2	14.7	14.9	14.5
BLK05	11.8	11.4	11.9	11.7
BLK06	14.1	13.5	14.3	14.4
BLK07	13.2	13.4	13.7	12.7
BLK08	12.3	13.2	12.9	12.8
BLK09	3.8	3.6	3.2	3.1
BLK10	4.1	4.1	4.4	4.2
BLK11	9.9	9.8	9.1	9.4
BLK12	9.7	8.9	8.9	9.9
BLK13	9.7	8.9	9.4	9.1
BLK14	2.4	2.4	2.6	2.5
BLK15	5.1	5.0	5.2	4.8
BLK16	7.5	7.3	7.4	7.9
BLK17	7.9	8.0	7.9	8.3
BLK18	7.8	7.1	7.4	7.7
BLK19	8.0	8.0	8.2	8.4
BLK20	8.3	8.7	8.5	8.9
BLK21	8.1	8.5	8.2	8.1

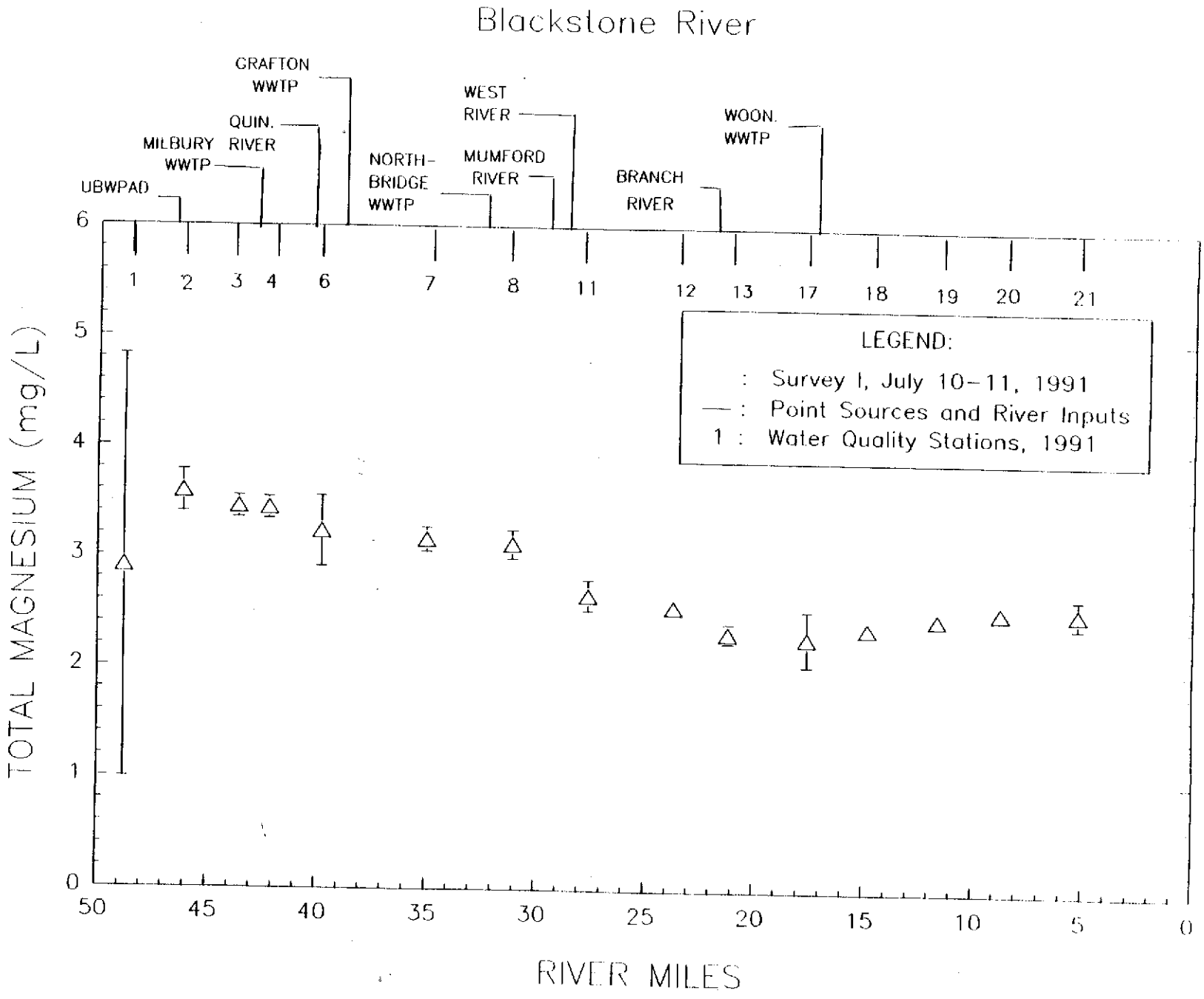
ND = Below the detection limit of 0.1 mg/L.


Blackstone River
GRAFTON WWTP
QUIN. RIVER
MILBURY WWTP
UBWPAD
NORTH-BRIDGE WWTP
WEST RIVER
MUMFORD RIVER
BRANCH RIVER
WOON WWTP
1 2 3 4 6 7 8 11 12 13 17 18 19 20 21
LEGEND:
: Survey III, October 2-3, 1991
— : Point Sources and River Inputs
1 : Water Quality Stations, 1991
Total Calcium (mg/L)
0 5 10 15 20 25 30
50 45 40 35 30 25 20 15 10 5 0
RIVER MILES

1991 Blackstone River Survey #1
Magnesium in mg/L

Station	Run #1	Run #2	Run #3	Run #4
BLK01	3.88	3.82	NS	3.91
BLK02	3.56	3.35	3.66	3.79
BLK03	3.37	3.37	3.48	3.57
BLK04	3.45	3.31	3.58	3.40
BLK05	2.78	2.73	2.92	2.91
BLK06	3.13	2.82	3.48	3.47
BLK07	3.07	3.12	3.31	3.13
BLK08	3.03	3.04	3.09	3.31
BLK09	1.25	1.20	1.20	1.21
BLK10	1.32	1.34	1.35	1.37
BLK11	2.48	2.64	2.81	2.71
BLK12	2.47	2.55	2.64	2.57
BLK13	2.37	2.21	2.32	2.41
BLK14	1.05	1.05	1.06	1.09
BLK15	1.56	1.50	1.56	1.66
BLK16	2.08	2.22	2.28	2.30
BLK17	2.18	2.24	2.31	2.41
BLK18	1.91	2.37	2.48	2.38
BLK19	2.31	2.32	2.44	2.45
BLK20	2.45	2.39	2.49	2.53
BLK21	2.53	2.39	2.70	2.54

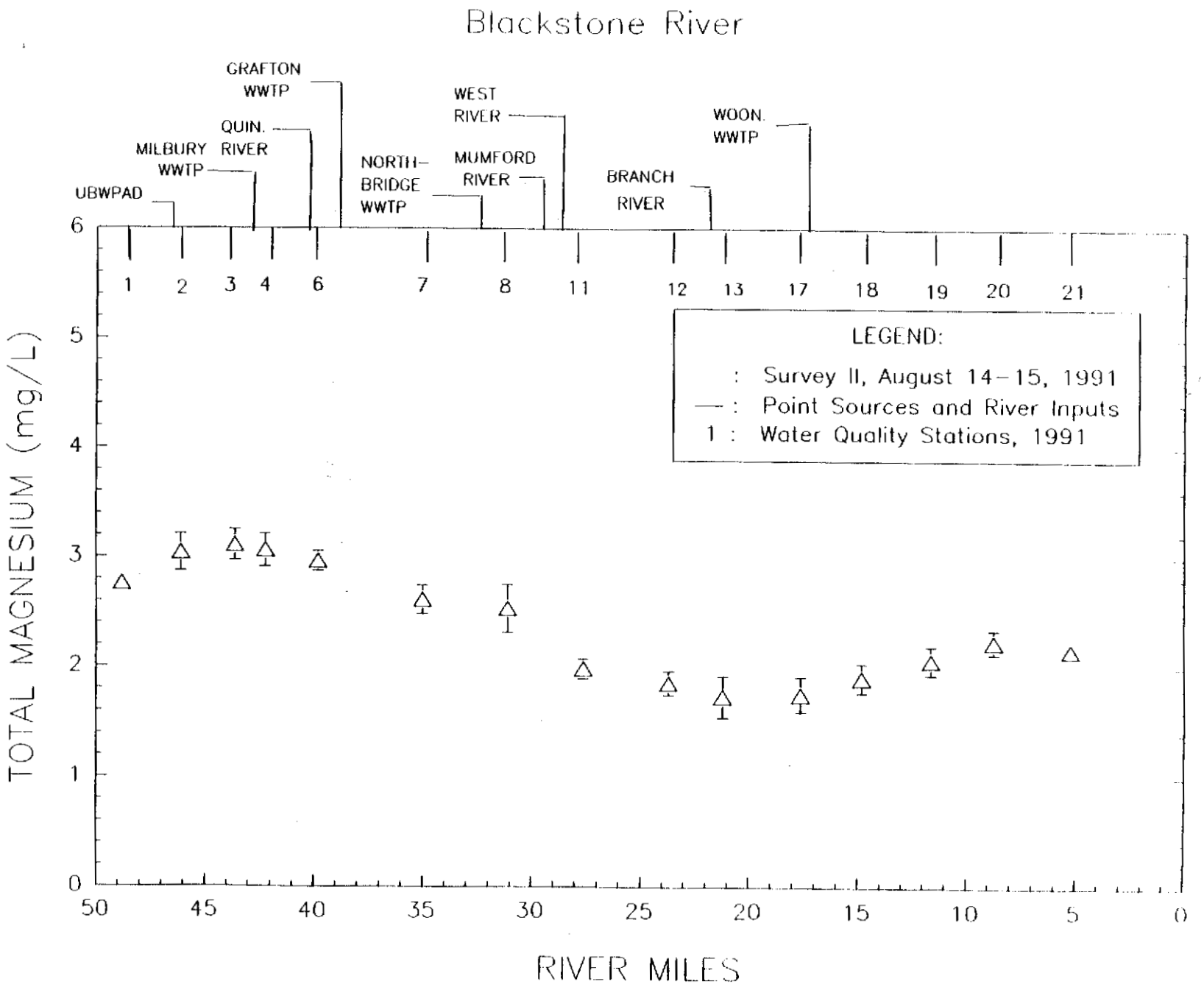
ND = Below the detection limit of 0.05 mg/L; NS = Sample missing.


Blackstone River
GRAFTON WWTP
QUIN. RIVER
MILBURY WWTP
UBWPAD
NORTH-BRIDGE WWTP
WEST RIVER
MUMFORD RIVER
BRANCH RIVER
WOON. WWTP
1 2 3 4 6 7 8 11 12 13 17 18 19 20 21
LEGEND:
: Survey I, July 10-11, 1991
— : Point Sources and River Inputs
1 : Water Quality Stations, 1991
TOTAL MAGNESIUM (mg/L)
0 1 2 3 4 5 6
50 45 40 35 30 25 20 15 10 5 0
RIVER MILES

1991 Blackstone River Survey #2
Magnesium in mg/L

Station	Run #1	Run #2	Run #3	Run #4
BLK01	2.76	2.74	2.67	2.85
BLK02	3.26	2.89	2.93	3.08
BLK03	3.29	3.02	2.99	3.15
BLK04	3.27	3.05	2.93	2.97
BLK05	2.73	2.65	2.61	2.78
BLK06	3.06	2.93	2.98	2.85
BLK07	2.65	2.44	2.75	2.61
BLK08	2.51	2.23	2.68	2.71
BLK09	1.22	0.92	1.10	1.05
BLK10	1.38	1.13	1.21	1.22
BLK11	1.97	1.87	1.99	2.08
BLK12	1.99	1.75	1.88	1.79
BLK13	1.75	1.47	1.79	1.91
BLK14	1.06	0.95	1.08	1.09
BLK15	1.48	1.27	1.42	1.43
BLK16	2.00	1.80	1.92	1.87
BLK17	1.76	1.53	1.83	1.89
BLK18	2.06	1.75	1.90	1.88
BLK19	2.18	1.90	2.01	2.15
BLK20	2.34	2.08	2.22	2.29
BLK21	2.25	2.07	2.13	2.17

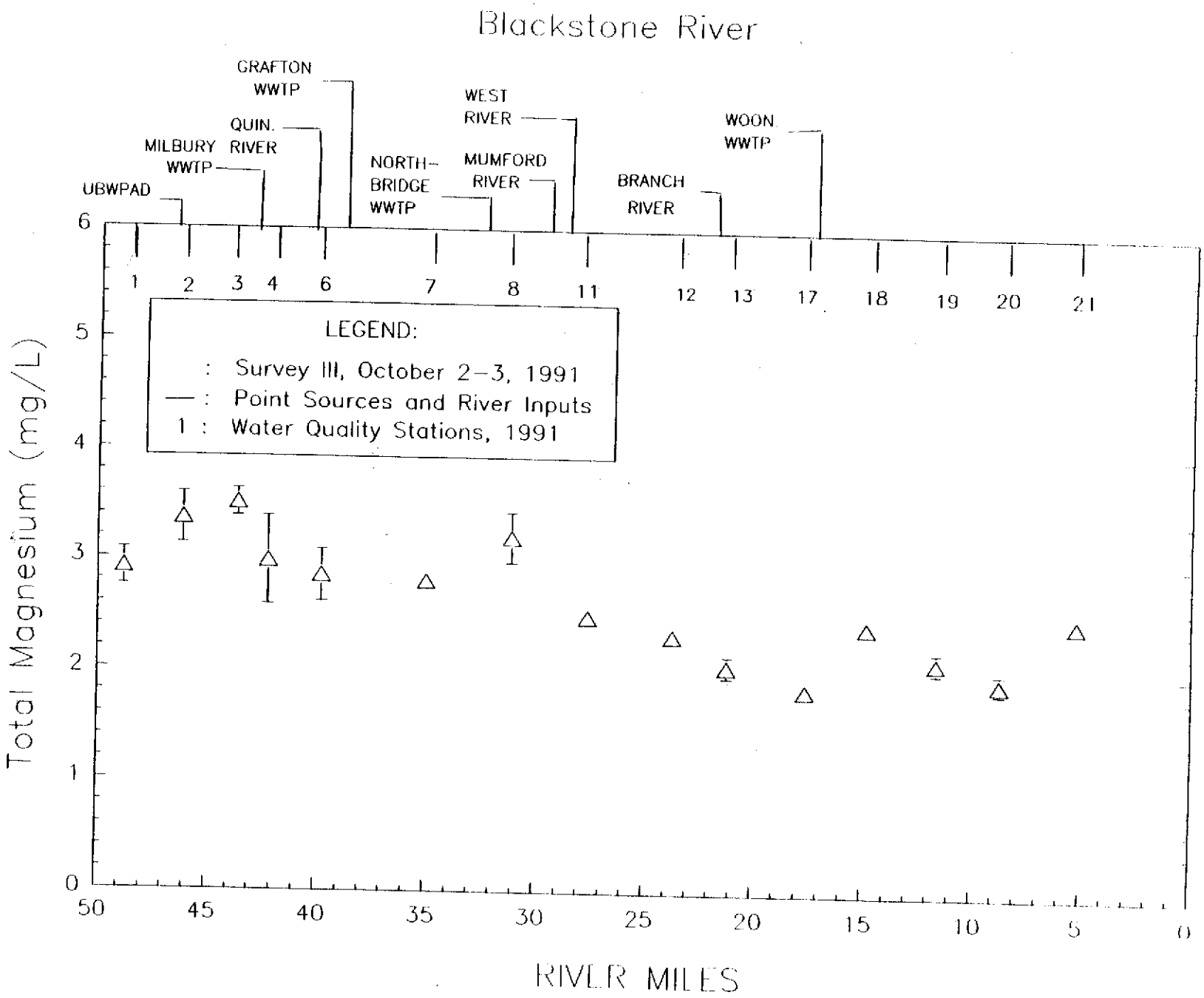
ND = Below the detection limit of 0.05 mg/L.


Blackstone River
GRAFTON WWTP
WEST RIVER
QUIN. RIVER
WOON. WWTP
MILBURY WWTP
NORTH-BRIDGE WWTP
MUMFORD RIVER
BRANCH RIVER
UBWPAD
1 2 3 4 6 7 8 11 12 13 17 18 19 20 21
LEGEND:
: Survey II, August 14-15, 1991
— : Point Sources and River Inputs
1 : Water Quality Stations, 1991
TOTAL MAGNESIUM (mg/L)
0 1 2 3 4 5 6
50 45 40 35 30 25 20 15 10 5 0
RIVER MILES

1991 Blackstone River Survey #3
Magnesium in mg/L

Station	Run #1	Run #2	Run #3	Run #4
BLK01	3.00	3.12	2.67	2.89
BLK02	3.70	3.43	3.06	3.28
BLK03	3.30	3.57	3.63	3.54
BLK04	3.50	3.12	2.39	2.93
BLK05	2.21	2.44	2.79	2.64
BLK06	3.19	2.86	2.53	2.84
BLK07	2.71	2.84	2.89	2.78
BLK08	2.89	3.15	3.53	3.24
BLK09	1.19	1.38	1.34	1.21
BLK10	1.62	1.84	2.01	1.84
BLK11	2.45	2.52	2.43	2.56
BLK12	2.22	2.35	2.30	2.43
BLK13	2.19	2.10	1.98	1.95
BLK14	0.69	1.06	1.03	0.94
BLK15	1.99	1.85	1.77	1.79
BLK16	2.25	2.74	2.78	2.54
BLK17	1.93	1.88	1.78	1.80
BLK18	2.40	2.48	2.30	2.51
BLK19	2.12	2.21	2.15	1.95
BLK20	2.06	1.95	1.87	1.84
BLK21	2.44	2.50	2.41	2.56

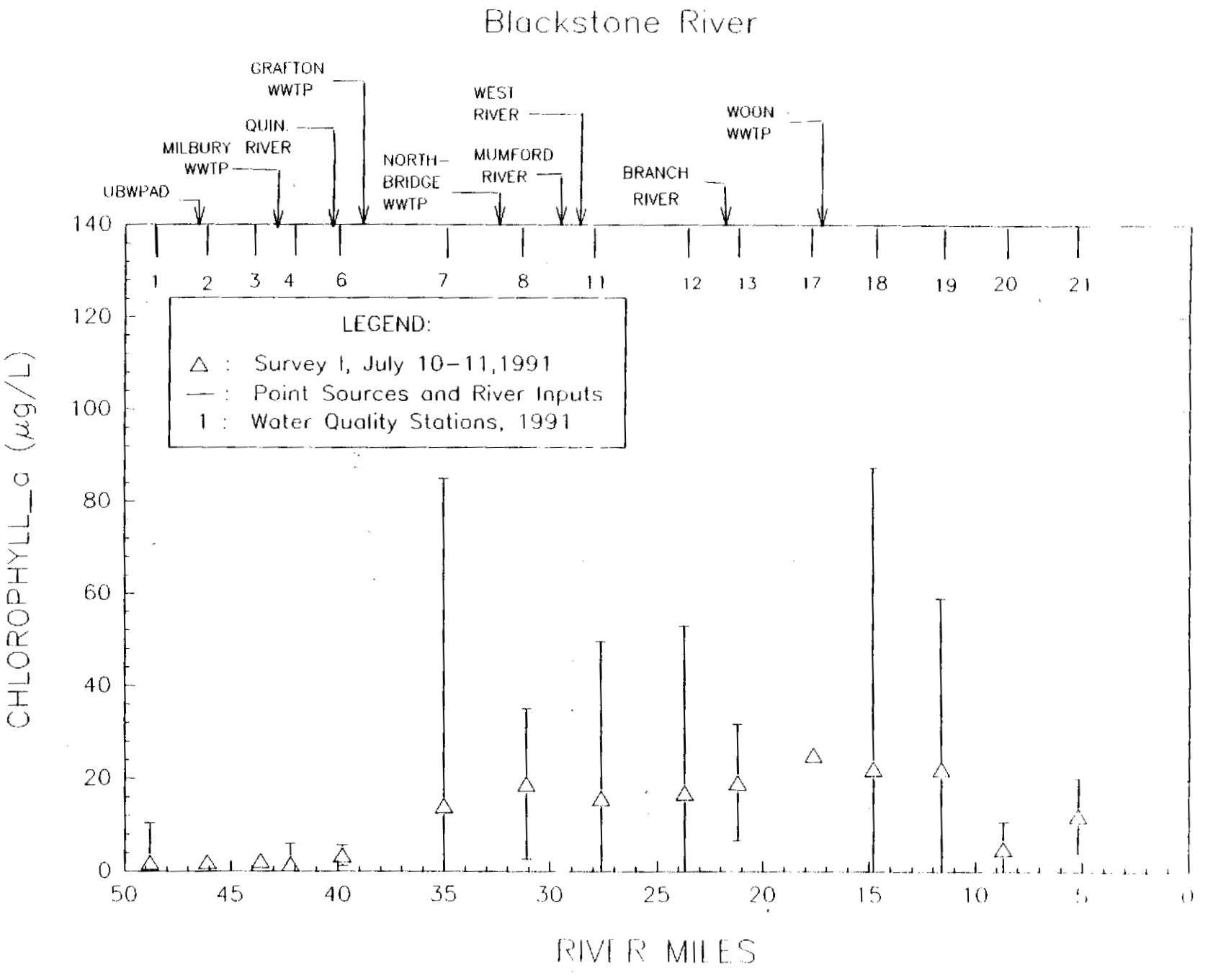
ND = Below the detection limit of 0.05 mg/L.


Blackstone River
GRAFTON WWTP
QUIN. RIVER
MILBURY WWTP
UBWPAD
NORTH-BRIDGE WWTP
WEST RIVER
MUMFORD RIVER
BRANCH RIVER
WOON WWTP
1 2 3 4 6 7 8 11 12 13 17 18 19 20 21
LEGEND:
: Survey III, October 2-3, 1991
— : Point Sources and River Inputs
1 : Water Quality Stations, 1991
Total Magnesium (mg/L)
0 1 2 3 4 5 6
50 45 40 35 30 25 20 15 10 5 0
RIVER MILES

1991 Blackstone River Survey #1
Total Chlorophyll in µg/L

Station	Run #1	Run #2	Run #3	Run #4
BLK01	ND		2.8	
BLK02	2.0		1.9	
BLK03	2.1		2.3	
BLK04	1.0		2.0	
BLK05	NA		NA	
BLK06	3.2		3.7	
BLK07	6.2		22.0	
BLK08	17.0		20.6	
BLK09	NA		NA	
BLK10	NA		NA	
BLK11	12.1		19.6	
BLK12	21.0		13.0	
BLK13	17.8		20.6	
BLK14	NA		NA	
BLK15	NA		NA	
BLK16	2.4		4.8	
BLK17	NA		25.2	
BLK18	15.0		29.5	
BLK19	16.2		29.1	
BLK20	8.2		8.6	
BLK21	13.1		11.3	

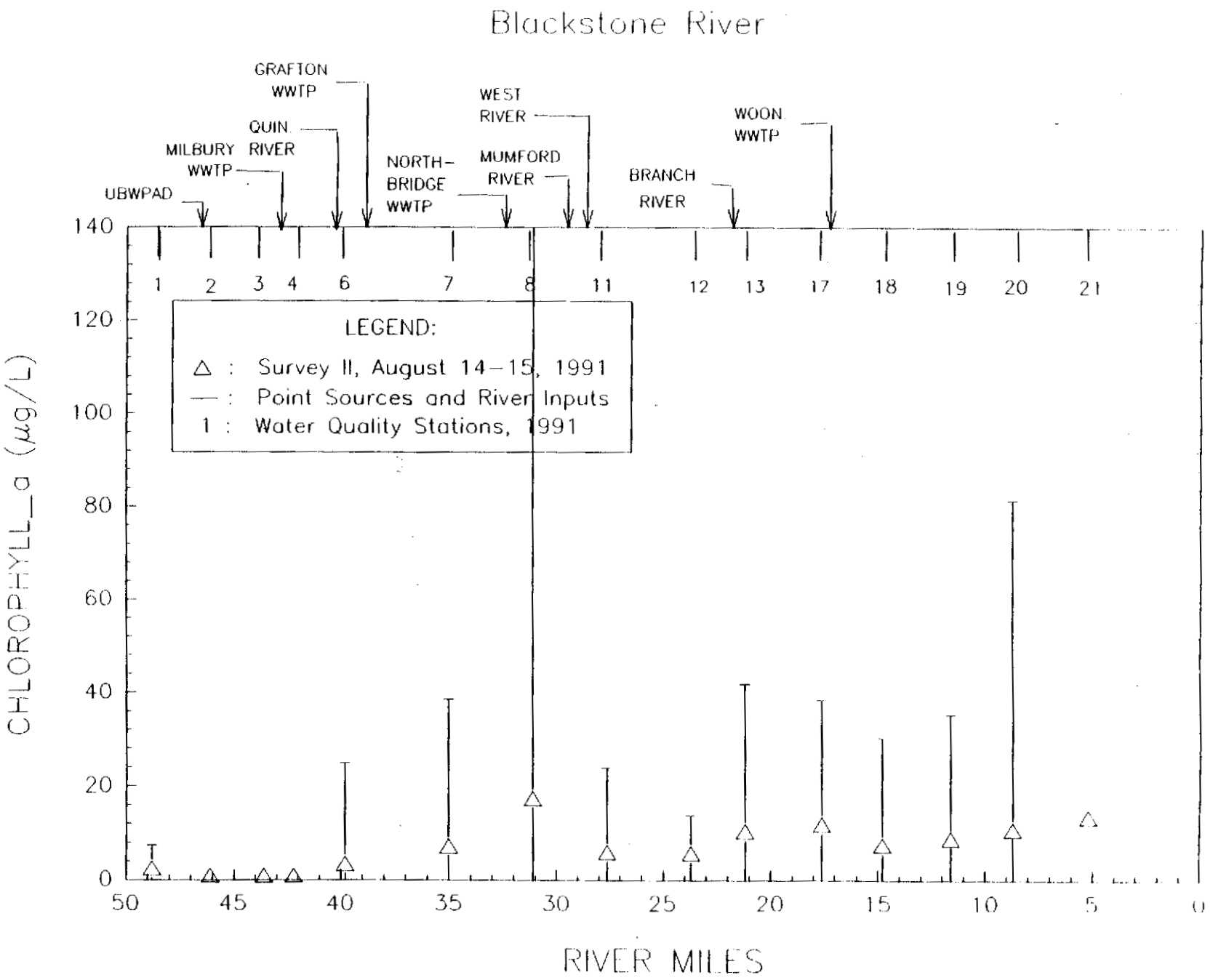
ND = Below the detection limit of 1.0 µg/L.


Blackstone River
GRAFTON WWTP
QUIN. RIVER
MILBURY WWTP
UBWPAD
NORTH-BRIDGE WWTP
WEST RIVER
MUMFORD RIVER
BRANCH RIVER
WOON WWTP
1 2 3 4 6 7 8 11 12 13 17 18 19 20 21
LEGEND:
△ : Survey I, July 10-11,1991
— : Point Sources and River Inputs
1 : Water Quality Stations, 1991
CHLOROPHYLL_a (µg/L)
0 20 40 60 80 100 120 140
50 45 40 35 30 25 20 15 10 5 0
RIVER MILES

1991 Blackstone River Survey #2
Total Chlorophyll in µg/L

Station	Run #1	Run #2	Run #3	Run #4
BLK01	1.9		3.0	
BLK02	ND		1.0	
BLK03	ND		1.0	
BLK04	ND		1.0	
BLK05	1.9		1.1	
BLK06	1.0		5.8	
BLK07	3.7		10.7	
BLK08	3.7		31.7	
BLK09	ND		1.9	
BLK10	1.9		1.0	
BLK11	4.0		8.0	
BLK12	6.7		4.9	
BLK13	7.0		14.0	
BLK14	1.0		3.8	
BLK15	5.3		3.9	
BLK16	1.0		4.1	
BLK17	9.1		15.0	
BLK18	5.0		10.1	
BLK19	6.0		10.4	
BLK20	3.0		15.6	
BLK21	13.8		13.5	

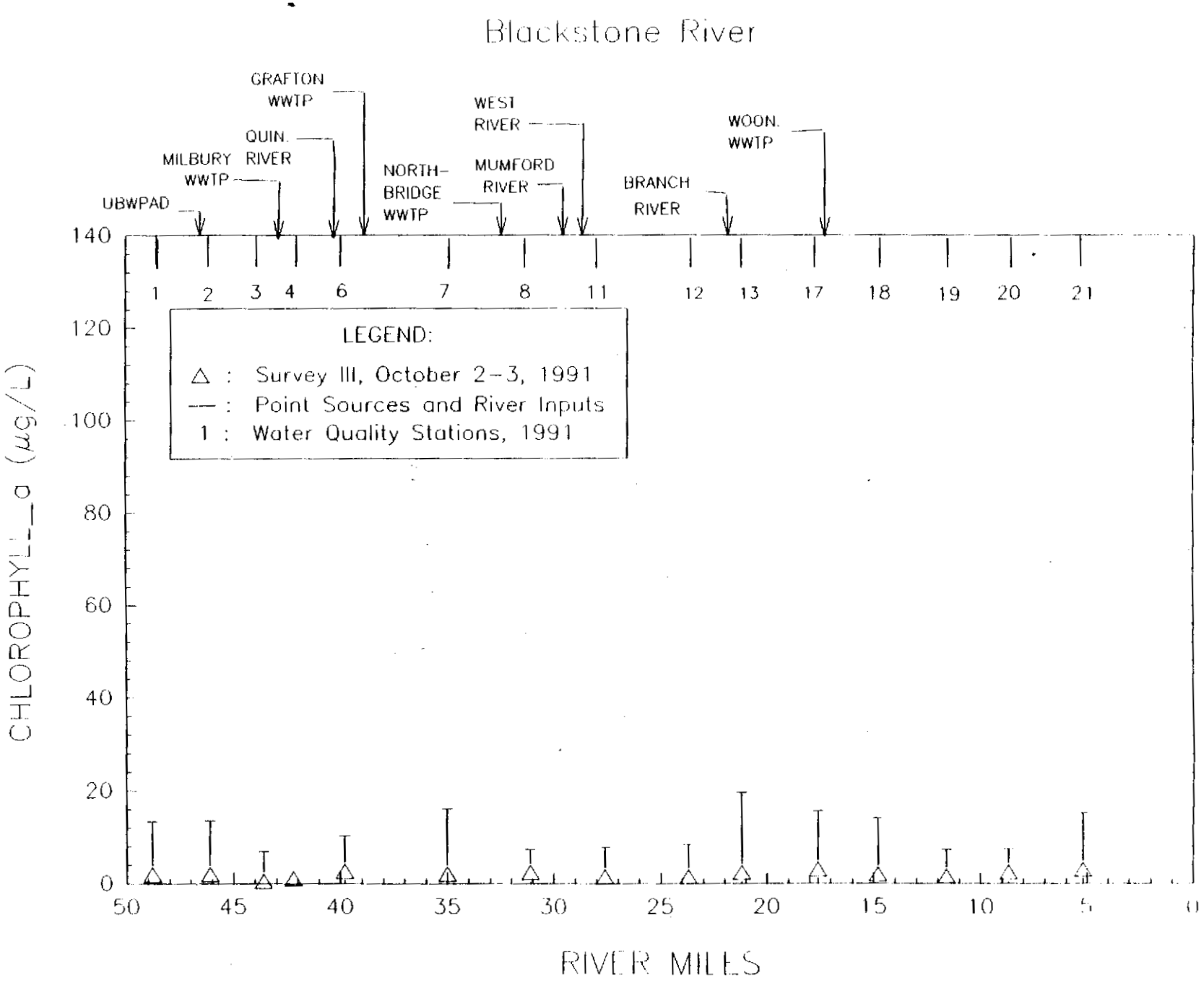
ND = Below the detection limit of 1.0 µg/L; NA = Sample not required.


Blackstone River
GRAFTON WWTP
QUIN RIVER
MILBURY WWTP
UBWPAD
NORTH-BRIDGE WWTP
WEST RIVER
MUMFORD RIVER
BRANCH RIVER
WOON WWTP
1 2 3 4 6 7 8 11 12 13 17 18 19 20 21
LEGEND:
△ : Survey II, August 14-15, 1991
— : Point Sources and River Inputs
1 : Water Quality Stations, 1991
CHLOROPHYLL_a (µg/L)
0 20 40 60 80 100 120 140
50 45 40 35 30 25 20 15 10 5 0
RIVER MILES

1991 Blackstone River Survey #3
Total Chlorophyll in µg/L

Station	Run #1	Run #2	Run #3	Run #4
BLK01	2.8		1.0	
BLK02	2.9		1.1	
BLK03	1.0		ND	
BLK04	1.0		1.1	
BLK05	2.8		4.7	
BLK06	2.0		3.2	
BLK07	ND		3.1	
BLK08	2.8		2.0	
BLK09	2.0		1.0	
BLK10	1.0		3.3	
BLK11	ND		1.9	
BLK12	2.0		ND	
BLK13	3.7		1.0	
BLK14	2.0		4.0	
BLK15	4.0		6.0	
BLK16	ND		ND	
BLK17	2.9		3.1	
BLK18	2.9		1.0	
BLK19	1.1		2.0	
BLK20	2.8		2.0	
BLK21	2.1		4.0	

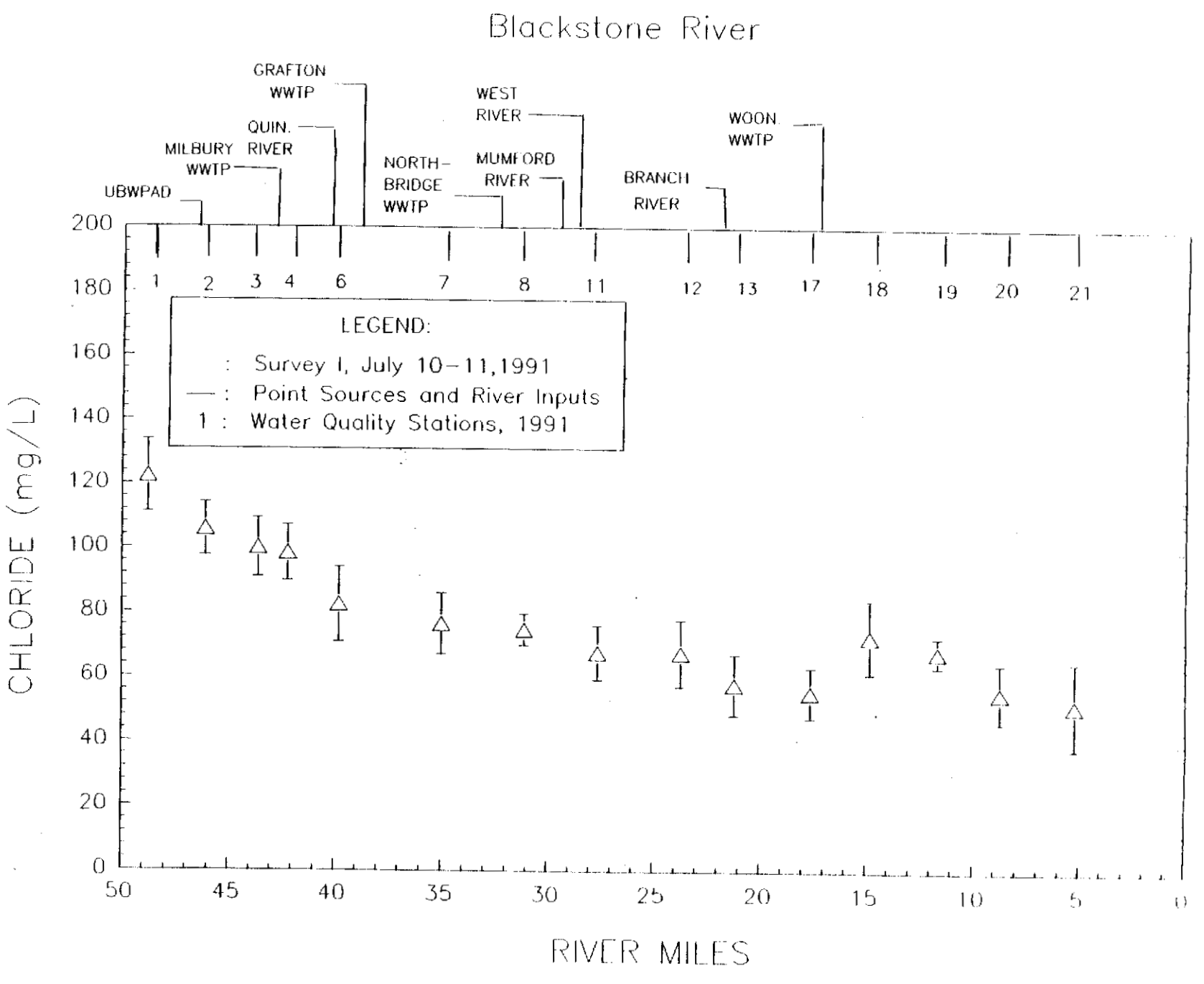
ND = Below the detection limit of 1.0 µg/L.


Blackstone River
GRAFTON WWTP
QUIN. RIVER
MILBURY WWTP
UBWPAD
NORTH-BRIDGE WWTP
WEST RIVER
MUMFORD RIVER
BRANCH RIVER
WOON. WWTP
1 2 3 4 6 7 8 11 12 13 17 18 19 20 21
LEGEND:
△ : Survey III, October 2-3, 1991
— : Point Sources and River Inputs
1 : Water Quality Stations, 1991
CHLOROPHYLL_a (µg/L)
0 20 40 60 80 100 120 140
50 45 40 35 30 25 20 15 10 5 0
RIVER MILES

1991 Blackstone River Survey #1
Chloride in mg/L

Station	Run #1	Run #2	Run #3	Run #4
BLK01	114	114	114	148
BLK02	109	109	NS	100
BLK03	104	105	92	100
BLK04	97	105	92	100
BLK05	67	73	65	68
BLK06	82	82	74	92
BLK07	78	82	68	78
BLK08	75	79	71	74
BLK09	20	22	19	19
BLK10	46	48	35	43
BLK11	67	75	63	65
BLK12	70	75	60	65
BLK13	57	64	50	60
BLK14	22	24	20	21
BLK15	24	24	20	24
BLK16	34	36	30	48
BLK17	57	59	48	57
BLK18	79	79	65	68
BLK19	64	70	68	71
BLK20	52	57	50	63
BLK21	54	85	46	55

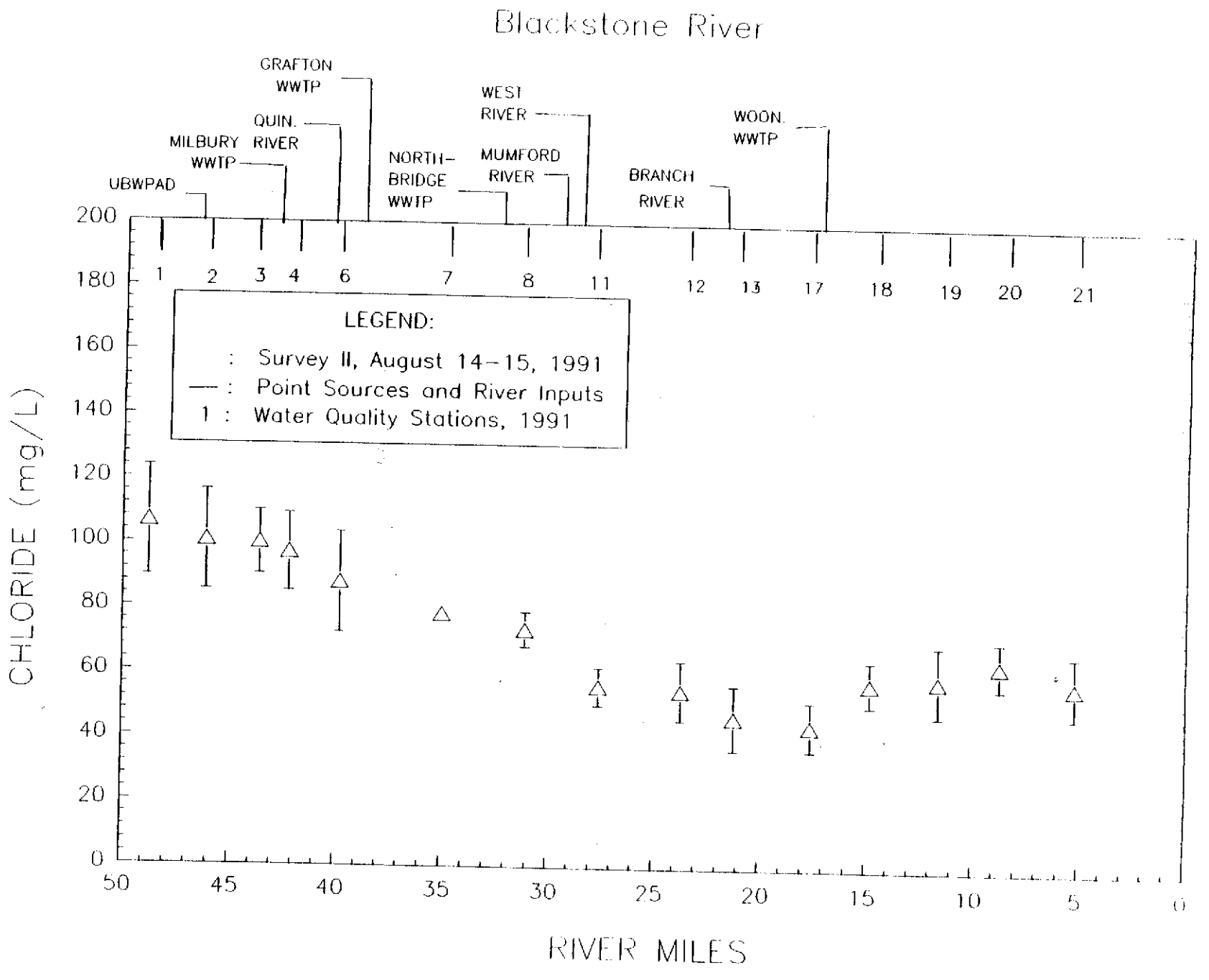
ND = Below the detection limit of 1 mg/L; NS = Sample missing.


Blackstone River
GRAFTON WWTP
QUIN. RIVER
MILBURY WWTP
UBWPAD
NORTH-BRIDGE WWTP
WEST RIVER
MUMFORD RIVER
BRANCH RIVER
WOON WWTP
1 2 3 4 6 7 8 11 12 13 17 18 19 20 21
LEGEND:
: Survey I, July 10-11,1991
— : Point Sources and River Inputs
1 : Water Quality Stations, 1991
CHLORIDE (mg/L)
0 20 40 60 80 100 120 140 160 180 200
50 45 40 35 30 25 20 15 10 5 0
RIVER MILES

1991 Blackstone River Survey #2
Chloride in mg/L

Station	Run #1	Run #2	Run #3	Run #4
BLK01	108	97	106	116
BLK02	105	90	96	113
BLK03	100	94	99	109
BLK04	96	90	95	108
BLK05	72	65	69	78
BLK06	90	77	85	100
BLK07	78	79	78	156
BLK08	76	72	72	140
BLK09	10	19	21	21
BLK10	45	41	42	49
BLK11	56	51	57	66
BLK12	57	48	53	62
BLK13	48	42	42	55
BLK14	30	28	26	29
BLK15	28	25	26	29
BLK16	38	32	35	40
BLK17	48	42	44	236
BLK18	62	54	54	60
BLK19	60	53	54	68
BLK20	68	60	60	68
BLK21	64	56	60	50

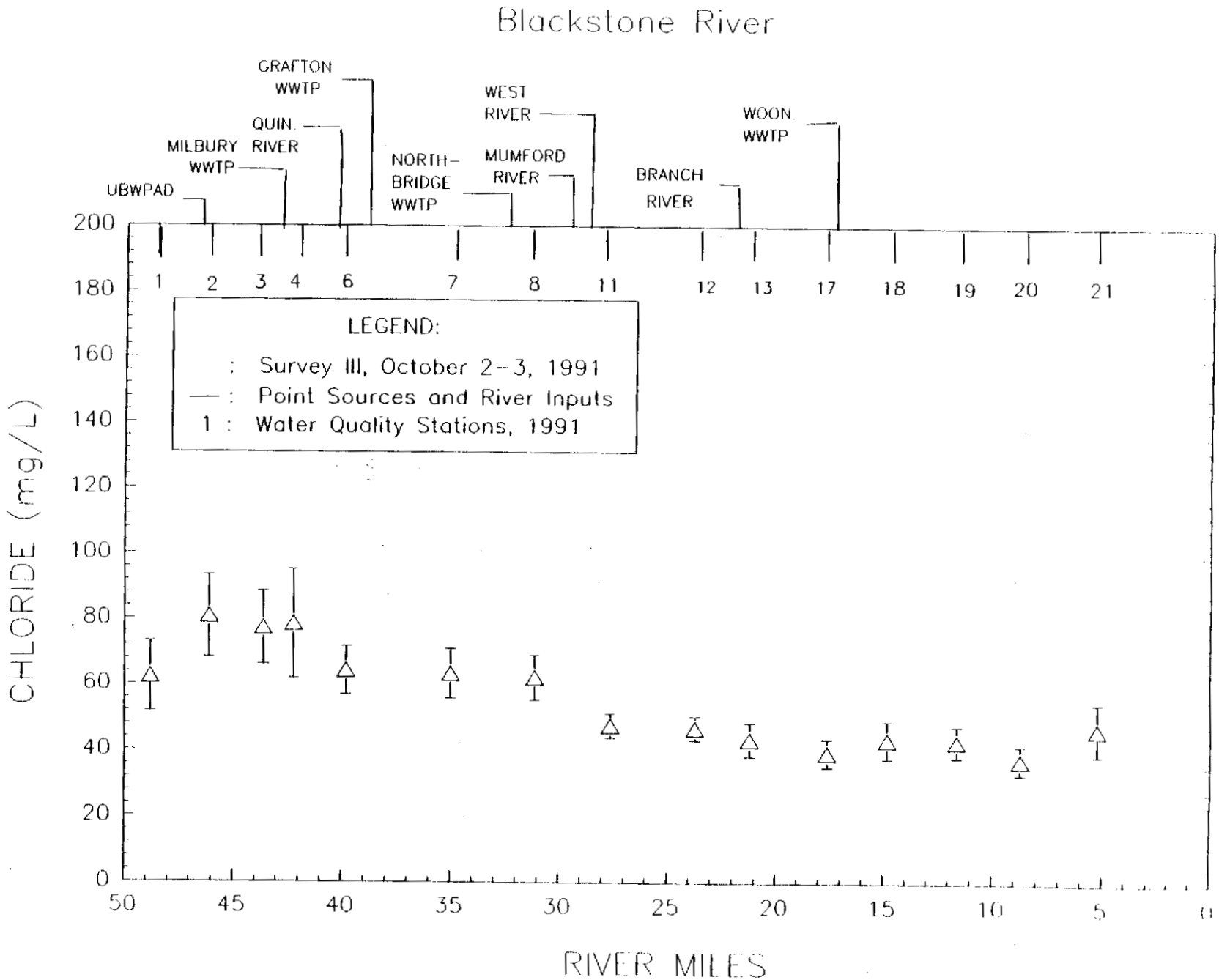
ND = Below the detection limit of 1 mg/L.


Blackstone River
GRAFTON WWTP
QUIN. RIVER
MILBURY WWTP
UBWPAD
NORTH-BRIDGE WWTP
WEST RIVER
MUMFORD RIVER
BRANCH RIVER
WOON. WWTP
1 2 3 4 6 7 8 11 12 13 17 18 19 20 21
LEGEND:
: Survey II, August 14-15, 1991
— : Point Sources and River Inputs
1 : Water Quality Stations, 1991
CHLORIDE (mg/L)
0 20 40 60 80 100 120 140 160 180 200
50 45 40 35 30 25 20 15 10 5 0
RIVER MILES

1991 Blackstone River Survey #3
Chloride in mg/L

Station	Run #1	Run #2	Run #3	Run #4
BLK01	57	59	74	60
BLK02	71	78	93	81
BLK03	70	72	88	79
BLK04	70	68	82	94
BLK05	48	47	70	53
BLK06	66	61	71	59
BLK07	58	62	71	62
BLK08	58	59	69	62
BLK09	14	15	13	18
BLK10	26	27	29	28
BLK11	45	46	51	48
BLK12	44	45	50	48
BLK13	44	43	48	39
BLK14	12	14	14	13
BLK15	28	28	31	28
BLK16	26	27	29	34
BLK17	36	38	43	41
BLK18	40	40	48	46
BLK19	40	40	46	46
BLK20	NS	52	43	55
BLK21	49	41	44	54

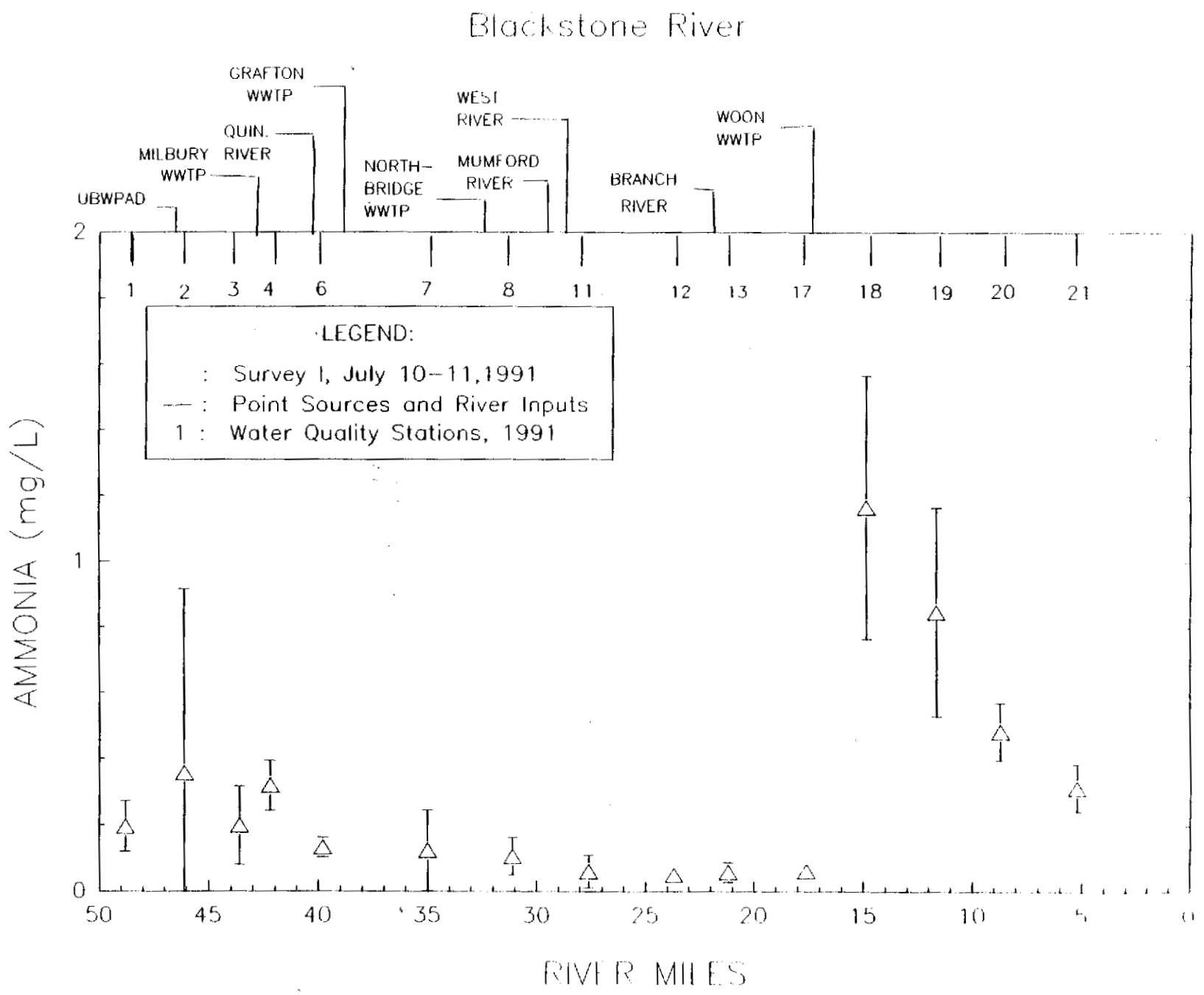
ND = Below the detection limit of 1 mg/L.


Blackstone River
GRAFTON WWTP
WEST RIVER
WOON. WWTP
QUIN. RIVER
MILBURY WWTP
NORTH-BRIDGE WWTP
MUMFORD RIVER
BRANCH RIVER
UBWPAD
1 2 3 4 6 7 8 11 12 13 17 18 19 20 21
LEGEND:
: Survey III, October 2-3, 1991
— : Point Sources and River Inputs
1 : Water Quality Stations, 1991
CHLORIDE (mg/L)
0 20 40 60 80 100 120 140 160 180 200
50 45 40 35 30 25 20 15 10 5 0
RIVER MILES

1991 Blackstone River Survey #1
Ammonia in mg/L

Station	Run #1	Run #2	Run #3	Run #4
BLK01	0.14	0.17	0.24	0.24
BLK02	0.48	0.26	0.24	0.45
BLK03	0.29	0.21	0.11	0.18
BLK04	0.38	0.29	0.28	0.33
BLK05	0.07	0.07	ND	0.08
BLK06	0.12	0.13	0.12	0.16
BLK07	0.21	0.16	0.05	0.08
BLK08	0.12	0.05	0.14	0.11
BLK09	0.09	0.04	ND	0.06
BLK10	0.04	0.04	0.04	0.07
BLK11	0.06	0.06	0.10	0.02
BLK12	0.04	0.05	0.05	0.06
BLK13	0.05	0.06	0.05	0.09
BLK14	0.09	0.12	0.08	0.09
BLK15	0.06	0.04	0.05	0.05
BLK16	0.22	0.26	0.25	0.33
BLK17	0.06	0.05	0.05	0.09
BLK18	1.03	1.54	1.01	1.07
BLK19	1.03	0.61	0.77	0.99
BLK20	0.55	0.50	0.43	0.45
BLK21	0.33	0.31	0.36	0.25

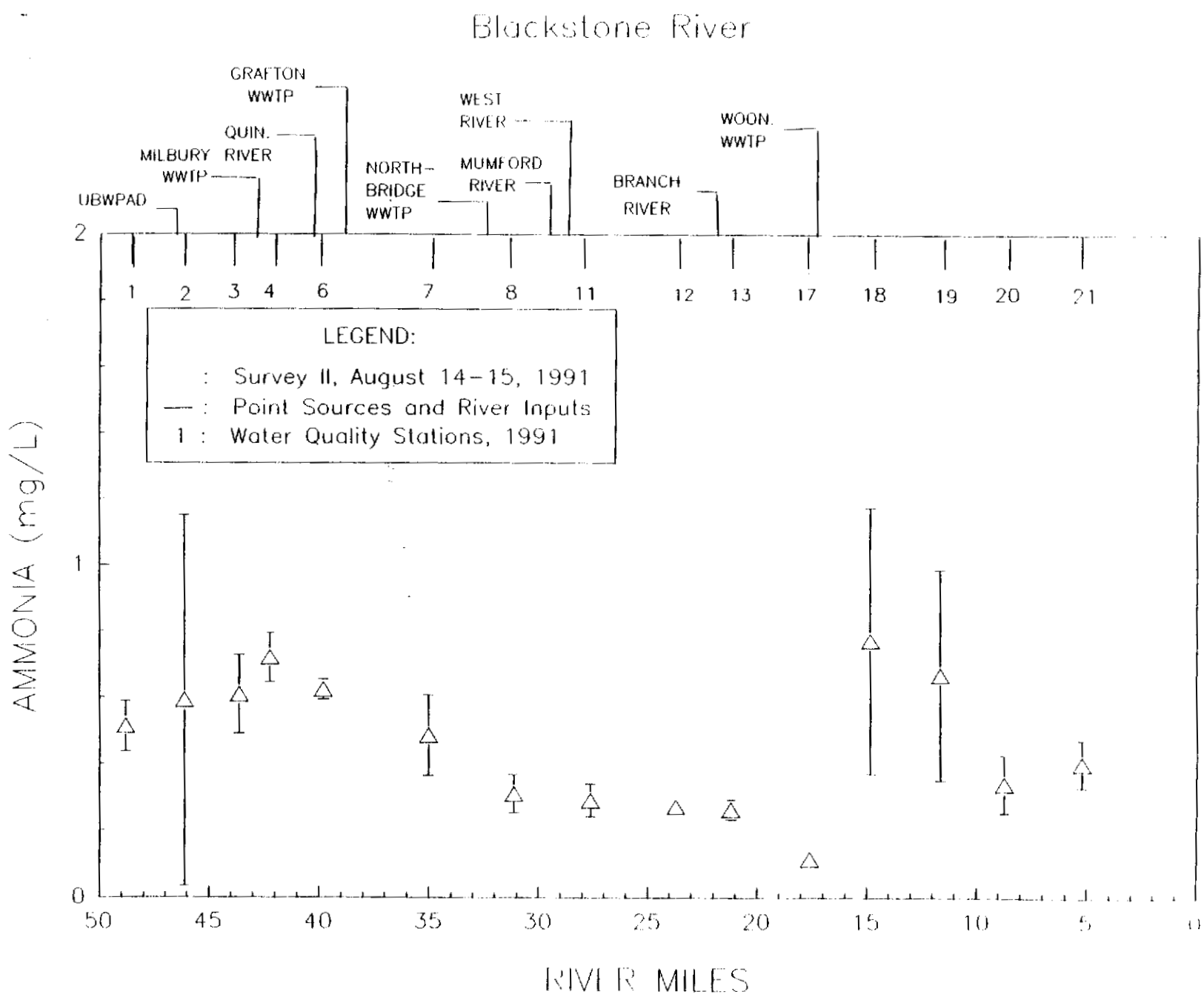
ND = Below the detection limit of 0.02 mg/L.


Blackstone River
GRAFTON WWTP
QUIN. RIVER
MILBURY WWTP
UBWPAD
NORTH-BRIDGE WWTP
WEST RIVER
MUMFORD RIVER
BRANCH RIVER
WOON WWTP
1 2 3 4 6 7 8 11 12 13 17 18 19 20 21
LEGEND:
: Survey I, July 10-11,1991
— : Point Sources and River Inputs
1 : Water Quality Stations, 1991
AMMONIA (mg/L)
0
1
2
50 45 40 35 30 25 20 15 10 5 0
RIVER MILES

1991 Blackstone River Survey #2
Ammonia in mg/L

Station	Run #1	Run #2	Run #3	Run #4
BLK01	1.37	0.65	ND	ND
BLK02	1.62	0.73	ND	ND
BLK03	1.66	0.75	0.03	ND
BLK04	1.72	1.13	0.02	ND
BLK05	0.49	0.32	0.09	ND
BLK06	1.21	0.58	0.69	ND
BLK07	0.58	0.93	0.42	ND
BLK08	0.13	0.78	0.32	ND
BLK09	0.26	0.46	0.15	ND
BLK10	0.55	0.18	0.13	0.13
BLK11	0.09	0.41	0.40	0.26
BLK12	0.13	0.33	0.37	0.27
BLK13	0.08	0.38	0.34	0.26
BLK14	0.22	0.62	0.25	ND
BLK15	0.09	0.26	0.26	0.39
BLK16	0.20	0.28	0.17	0.18
BLK17	ND	0.22	0.10	0.14
BLK18	0.88	1.25	0.22	0.74
BLK19	0.67	0.43	0.75	0.83
BLK20	0.49	0.34	0.04	0.43
BLK21	0.50	0.44	0.64	0.04

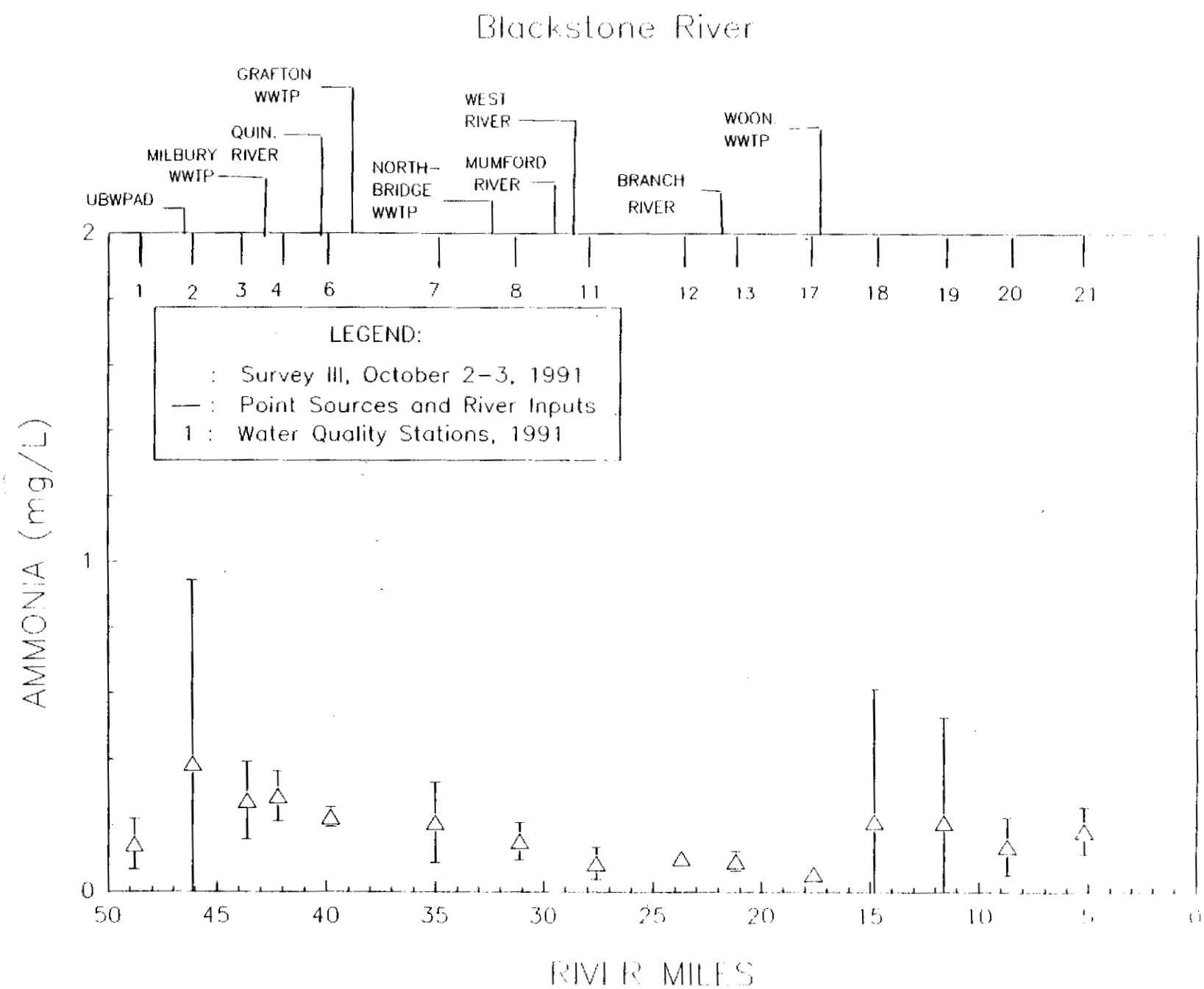
ND = Below the detection limit of 0.02 mg/L.


Blackstone River
GRAFTON WWTP
QUIN. RIVER
MILBURY WWTP
UBWPAD
NORTH-BRIDGE WWTP
WEST RIVER
MUMFORD RIVER
BRANCH RIVER
WOON. WWTP
1 2 3 4 6 7 8 11 12 13 17 18 19 20 21
LEGEND:
: Survey II, August 14-15, 1991
— : Point Sources and River Inputs
1 : Water Quality Stations, 1991
AMMONIA (mg/L)
0
1
2
50 45 40 35 30 25 20 15 10 5 0
RIVER MILES

1991 Blackstone River Survey #3
Ammonia in mg/L

Station	Run #1	Run #2	Run #3	Run #4
BLK01	0.15	0.11	0.15	0.17
BLK02	0.19	0.07	0.75	0.54
BLK03	0.16	0.14	0.24	0.56
BLK04	0.18	0.20	0.32	0.46
BLK05	ND	ND	ND	ND
BLK06	0.21	0.13	0.40	0.16
BLK07	0.14	0.23	0.23	0.24
BLK08	0.07	0.15	0.21	0.18
BLK09	ND	ND	ND	0.03
BLK10	ND	ND	ND	ND
BLK11	0.07	0.09	0.10	0.09
BLK12	0.08	0.12	0.09	0.12
BLK13	0.08	0.10	0.19	ND
BLK14	0.02	0.04	0.07	ND
BLK15	0.06	0.03	0.11	0.08
BLK16	0.06	0.06	0.05	0.04
BLK17	ND	0.77	0.10	0.05
BLK18	0.15	0.16	0.33	0.22
BLK19	0.21	0.20	0.23	0.21
BLK20	0.17	ND	0.21	0.17
BLK21	0.14	0.20	0.25	0.15

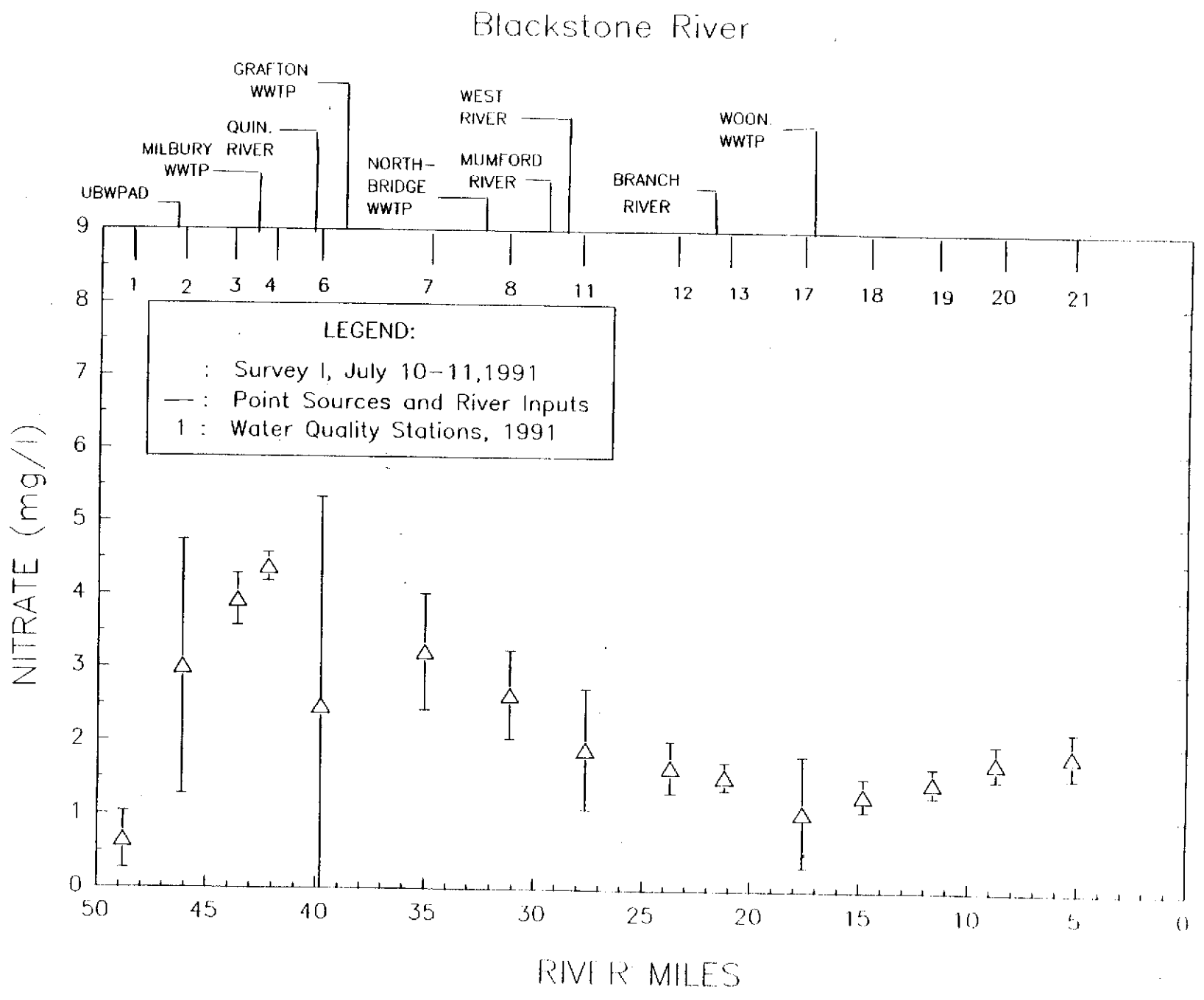
ND = Below the detection limit of 0.02 mg/L.


Blackstone River
GRAFTON WWTP
QUIN. RIVER
MILBURY WWTP
UBWPAD
NORTH-BRIDGE WWTP
MUMFORD RIVER
WEST RIVER
BRANCH RIVER
WOON WWTP
1 2 3 4 6 7 8 11 12 13 17 18 19 20 21
LEGEND:
: Survey III, October 2-3, 1991
— : Point Sources and River Inputs
1 : Water Quality Stations, 1991
AMMONIA (mg/L)
2
1
0
50 45 40 35 30 25 20 15 10
RIVER MILES

1991 Blackstone River Survey #1
Nitrate in mg/L

Station	Run #1	Run #2	Run #3	Run #4
BLK01	0.65	0.51	1.00	0.45
BLK02	2.90	2.57	4.55	2.02
BLK03	4.03	3.64	4.16	3.89
BLK04	4.43	4.20	4.42	4.47
BLK05	0.13	0.08	0.20	4.05
BLK06	2.78	2.64	4.42	0.07
BLK07	2.74	2.85	3.63	3.68
BLK08	2.37	2.29	2.79	3.10
BLK09	0.15	0.14	0.15	3.18
BLK10	0.12	0.03	0.10	0.17
BLK11	1.70	1.52	2.66	1.74
BLK12	1.77	1.39	1.92	1.65
BLK13	1.57	1.50	1.73	1.46
BLK14	0.24	0.22	ND	0.27
BLK15	0.38	0.29	0.20	0.39
BLK16	0.76	0.81	NS	0.77
BLK17	1.28	1.20	0.31	1.46
BLK18	1.23	1.17	1.47	1.41
BLK19	1.40	1.38	1.57	1.62
BLK20	1.64	1.69	1.74	1.98
BLK21	1.59	1.98	2.02	1.90

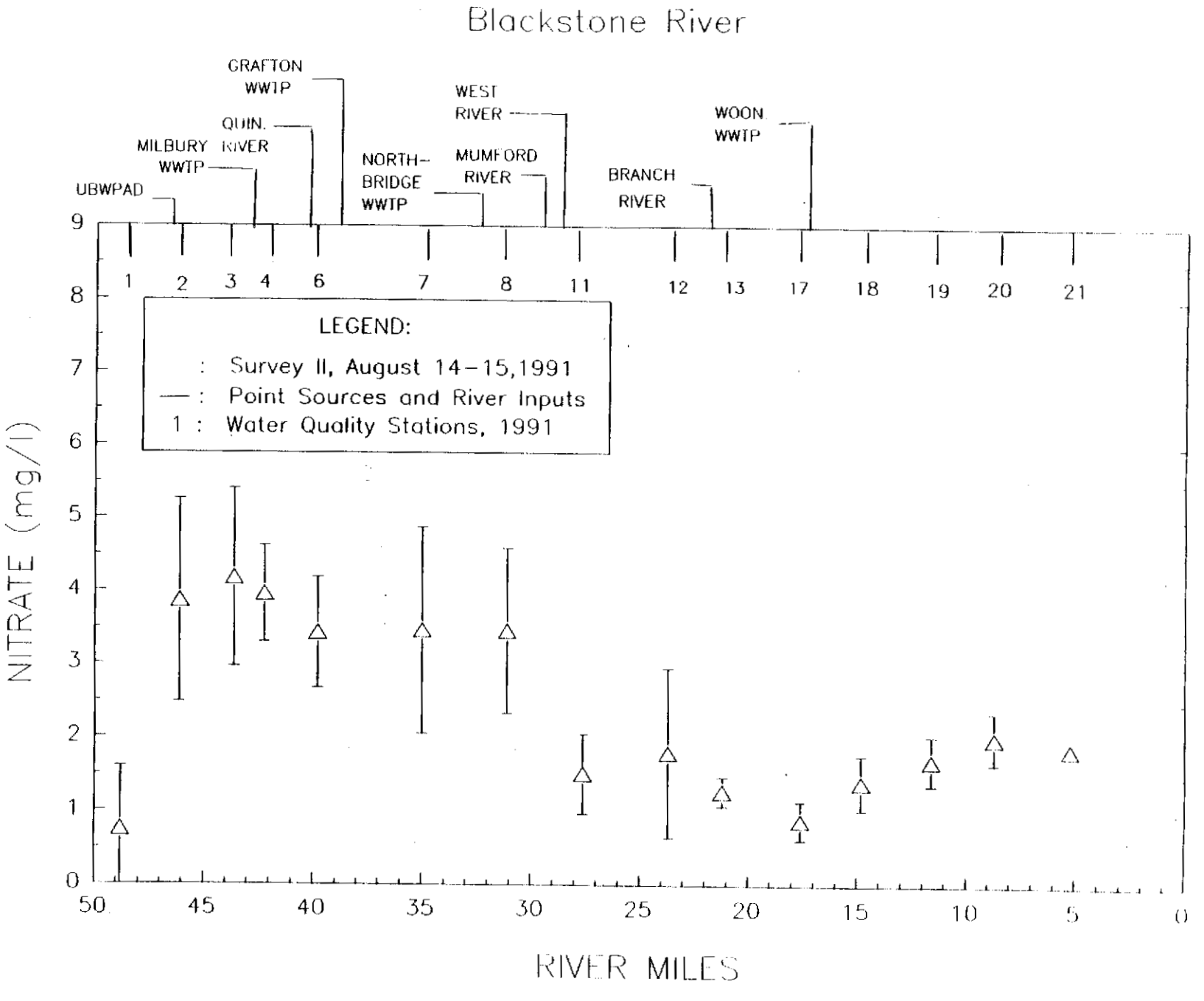
ND = Below the detection limit of 0.02 mg/L; NS = Sample missing.


Blackstone River
GRAFTON WWTP
QUIN. RIVER
MILBURY WWTP
UBWPAD
NORTH-BRIDGE WWTP
WEST RIVER
MUMFORD RIVER
BRANCH RIVER
WOON. WWTP
1 2 3 4 6 7 8 11 12 13 17 18 19 20 21
LEGEND:
: Survey I, July 10-11,1991
— : Point Sources and River Inputs
1 : Water Quality Stations, 1991
NITRATE (mg/l)
0 1 2 3 4 5 6 7 8 9
50 45 40 35 30 25 20 15 10 5 0
RIVER MILES

1991 Blackstone River Survey #2
Nitrate in mg/L

Station	Run #1	Run #2	Run #3	Run #4
BLK01	0.16	1.45	0.71	0.66
BLK02	2.70	3.81	4.18	4.77
BLK03	4.29	3.63	3.57	5.21
BLK04	4.09	4.21	3.35	4.20
BLK05	0.03	0.14	0.13	0.11
BLK06	3.42	2.89	4.05	3.37
BLK07	4.20	2.54	4.24	2.86
BLK08	2.85	4.29	3.80	2.86
BLK09	2.46	0.14	0.04	0.09
BLK10	0.98	0.19	ND	0.09
BLK11	1.41	1.45	2.00	1.20
BLK12	4.52	1.60	2.38	1.32
BLK13	0.97	0.82	2.38	0.95
BLK14	0.25	0.28	1.25	0.31
BLK15	0.25	0.25	0.17	0.89
BLK16	0.56	0.65	0.68	0.95
BLK17	0.79	0.82	0.81	1.14
BLK18	1.43	1.17	4.65	1.52
BLK19	1.76	1.51	1.69	1.97
BLK20	2.03	1.74	1.99	2.29
BLK21	1.67	1.63	1.72	2.41

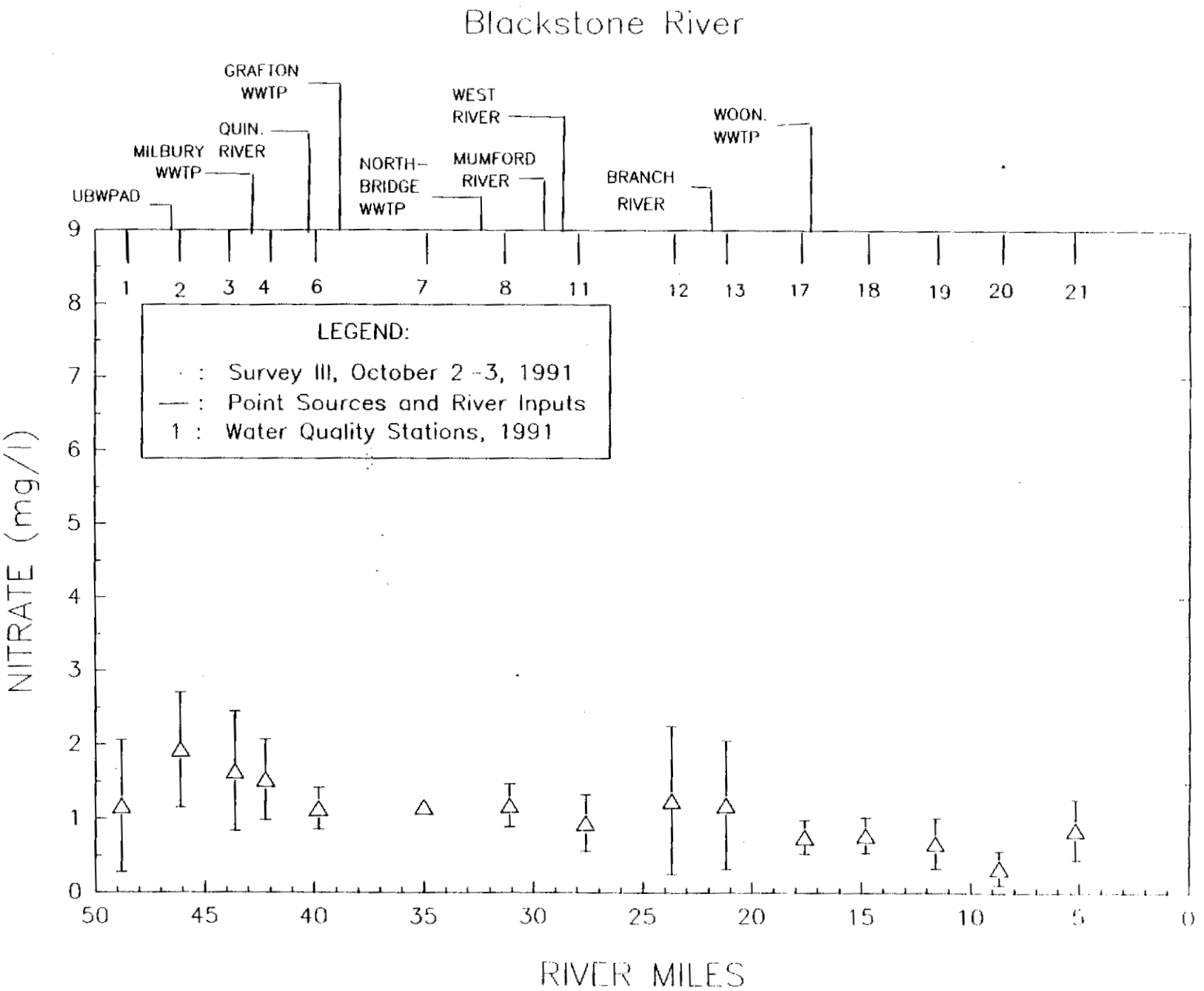
ND = Below the detection limit of 0.02 mg/L.


Blackstone River
GRAFTON WWTP
QUIN. RIVER
MILBURY WWTP
UBWPAD
NORTH-BRIDGE WWTP
WEST RIVER
MUMFORD RIVER
BRANCH RIVER
WOON WWTP
1 2 3 4 6 7 8 11 12 13 17 18 19 20 21
LEGEND:
: Survey II, August 14-15,1991
— : Point Sources and River Inputs
1 : Water Quality Stations, 1991
NITRATE (mg/l)
0 1 2 3 4 5 6 7 8 9
50 45 40 35 30 25 20 15 10 5 0
RIVER MILES

1991 Blackstone River Survey #3
Nitrate in mg/L

Station	Run #1	Run #2	Run #3	Run #4
BLK01	1.55	0.24	2.20	0.74
BLK02	1.24	1.88	2.62	1.99
BLK03	1.27	1.01	2.05	2.21
BLK04	1.13	1.30	1.48	2.21
BLK05	0.06	0.07	0.06	0.03
BLK06	1.32	0.95	0.97	1.33
BLK07	0.80	1.42	1.23	1.20
BLK08	1.23	0.90	1.40	1.20
BLK09	0.09	0.10	0.10	0.10
BLK10	ND	0.03	0.04	0.03
BLK11	1.08	0.64	0.80	1.26
BLK12	2.92	0.67	0.63	1.60
BLK13	2.07	0.77	0.68	1.26
BLK14	0.24	0.16	0.15	0.20
BLK15	0.44	0.16	0.18	0.28
BLK16	0.69	0.43	0.42	0.54
BLK17	1.31	0.56	0.56	0.61
BLK18	0.62	1.02	0.71	0.77
BLK19	1.08	0.25	0.54	0.82
BLK20	0.39	0.15	0.51	0.30
BLK21	1.38	0.79	0.54	0.71

ND = Below the detection limit of 0.02 mg/L.


Blackstone River
GRAFTON WWTP
QUIN. RIVER
MILBURY WWTP
UBWPAD
NORTH-BRIDGE WWTP
WEST RIVER
MUMFORD RIVER
BRANCH RIVER
WOON. WWTP
1 2 3 4 6 7 8 11 12 13 17 18 19 20 21
LEGEND:
· : Survey III, October 2 -3, 1991
— : Point Sources and River Inputs
1 : Water Quality Stations, 1991
NITRATE (mg/l)
0 1 2 3 4 5 6 7 8 9
50 45 40 35 30 25 20 15 10 5 0
RIVER MILES

1991 Blackstone River Survey #1
Orthophosphate in mg/L

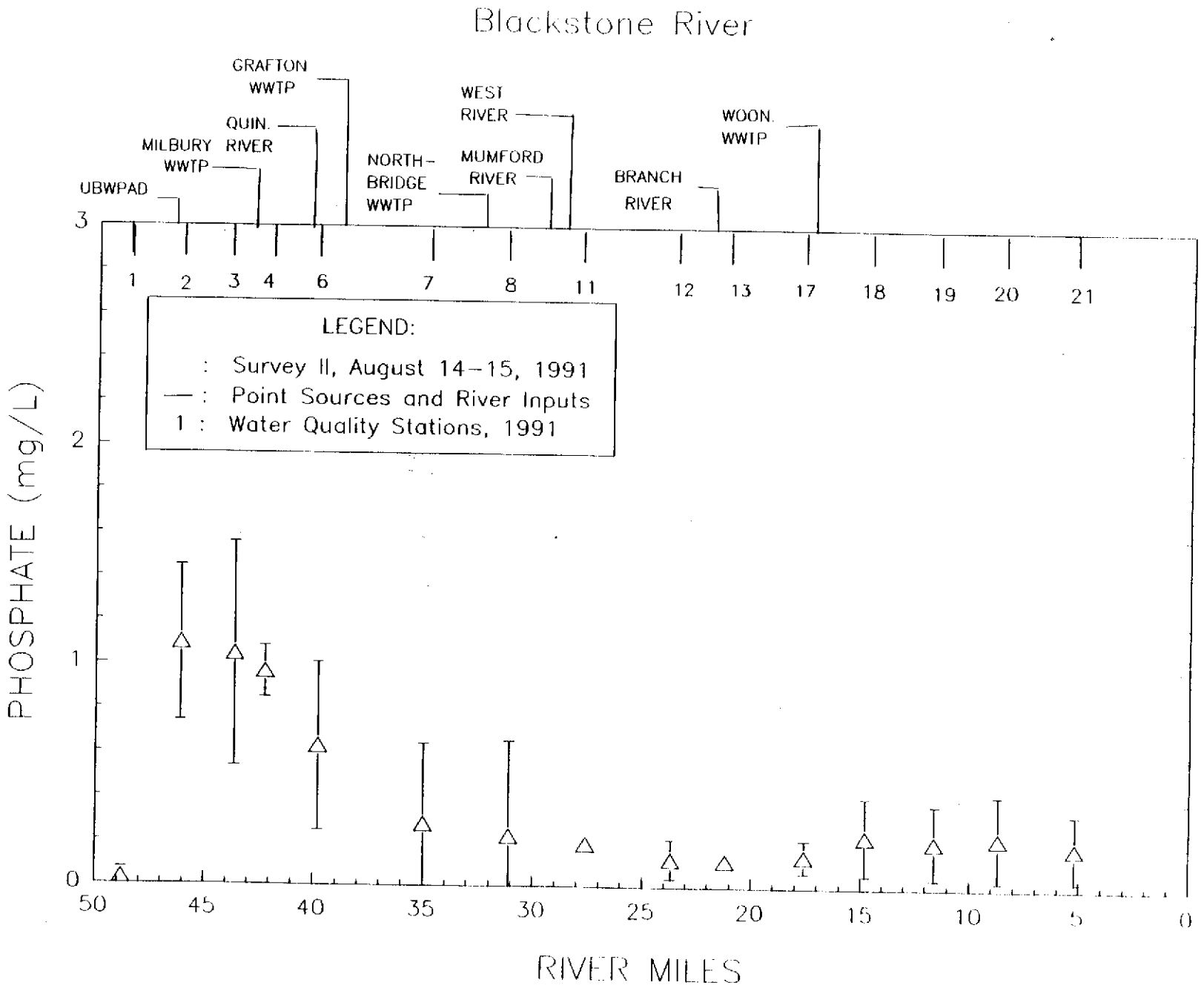
Station	Run #1	Run #2	Run #3	Run #4
BLK01	0.02	ND	ND	ND
BLK02	0.90	1.00	1.15	0.11
BLK03	0.90	0.86	1.07	0.93
BLK04	0.71	0.76	0.85	0.93
BLK05	0.08	0.03	0.08	0.06
BLK06	0.64	0.43	0.47	0.88
BLK07	0.67	0.57	0.52	0.49
BLK08	0.53	0.48	0.41	0.44
BLK09	0.13	0.02	0.07	0.41
BLK10	0.15	0.02	ND	ND
BLK11	0.38	0.24	0.19	0.10
BLK12	0.46	0.24	0.17	0.10
BLK13	0.31	0.38	0.22	0.12
BLK14	ND	0.05	0.14	ND
BLK15	0.02	0.05	0.08	ND
BLK16	0.03	0.05	NS	ND
BLK17	0.13	0.20	0.05	0.06
BLK18	0.10	0.29	0.17	0.13
BLK19	0.19	0.26	0.19	0.07
BLK20	0.12	0.23	0.18	0.07
BLK21	0.10	0.20	0.11	ND

ND = Below the detection limit of 0.02 mg/L; NS = Sample missing.

1991 Blackstone River Survey #2
Orthophosphate in mg/L

Station	Run #1	Run #2	Run #3	Run #4
BLK01	0.05	ND	ND	ND
BLK02	1.20	0.83	1.02	1.34
BLK03	1.04	0.67	1.02	1.46
BLK04	0.81	0.83	0.83	1.40
BLK05	ND	ND	ND	0.06
BLK06	0.65	0.31	0.66	0.90
BLK07	0.32	0.08	0.14	0.58
BLK08	ND	0.04	ND	0.42
BLK09	ND	ND	ND	0.04
BLK10	0.08	ND	ND	0.02
BLK11	ND	ND	ND	0.14
BLK12	0.09	ND	ND	0.17
BLK13	ND	ND	ND	0.12
BLK14	0.06	ND	0.07	0.02
BLK15	ND	ND	0.08	0.02
BLK16	ND	ND	0.06	0.02
BLK17	ND	ND	0.11	0.20
BLK18	1.61	ND	0.18	0.36
BLK19	0.13	ND	0.28	0.33
BLK20	0.10	ND	0.34	0.25
BLK21	0.09	ND	0.28	0.19

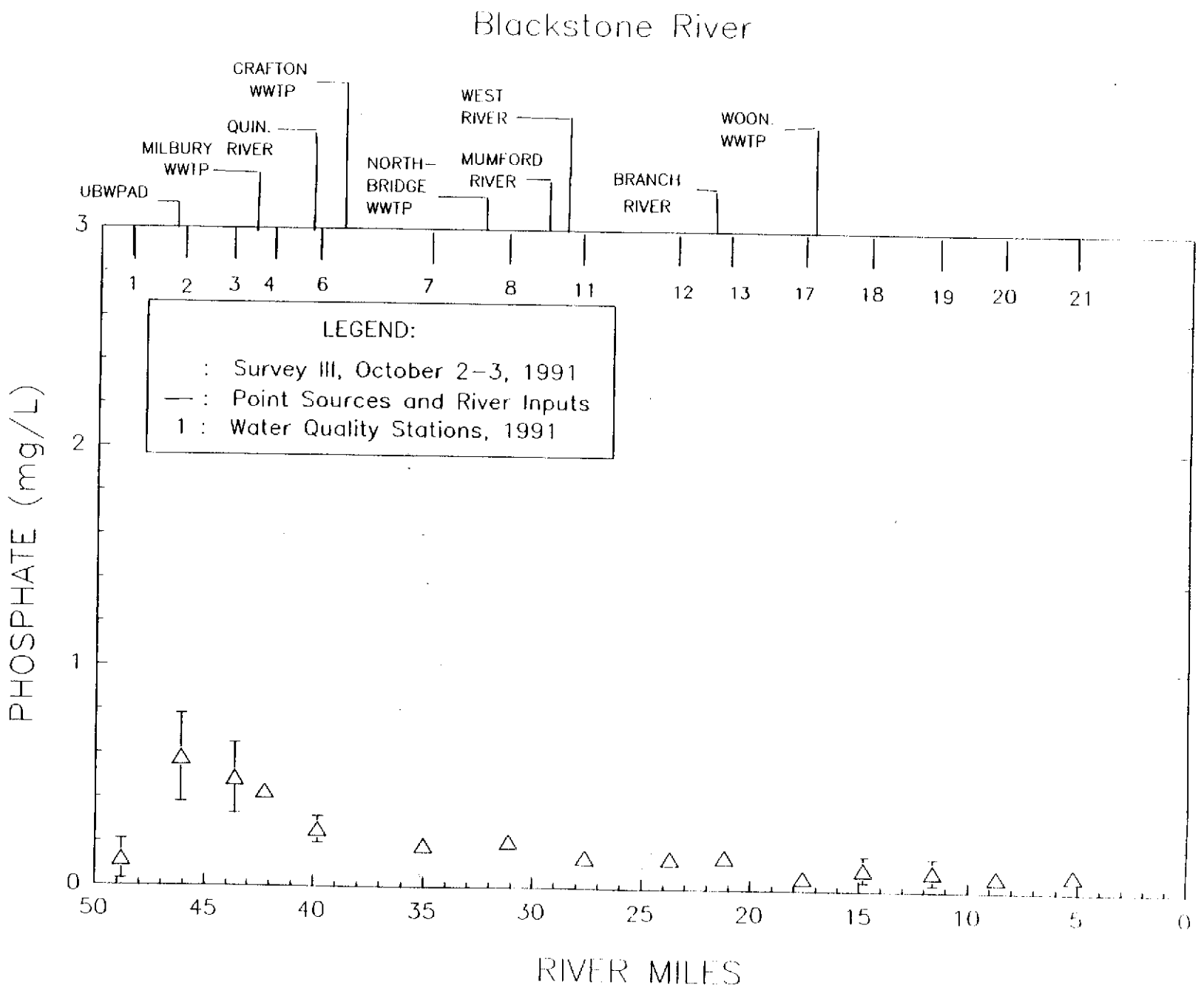
ND = Below the detection limit of 0.02 mg/L.


Blackstone River
GRAFTON WWTP
QUIN. RIVER
MILBURY WWTP
UBWPAD
NORTH-BRIDGE WWTP
WEST RIVER
MUMFORD RIVER
BRANCH RIVER
WOON. WWTP
1 2 3 4 6 7 8 11 12 13 17 18 19 20 21
LEGEND:
: Survey II, August 14-15, 1991
— : Point Sources and River Inputs
1 : Water Quality Stations, 1991
PHOSPHATE (mg/L)
0 1 2 3
50 45 40 35 30 25 20 15 10 5 0
RIVER MILES

1991 Blackstone River Survey #3
Orthophosphate in mg/L

Station	Run #1	Run #2	Run #3	Run #4
BLK01	0.05	0.16	0.20	0.07
BLK02	0.34	0.62	0.56	0.62
BLK03	0.34	0.53	0.49	0.62
BLK04	0.42	0.44	0.42	0.43
BLK05	ND	0.02	0.02	ND
BLK06	0.20	0.26	0.25	0.32
BLK07	0.16	0.26	0.21	0.21
BLK08	0.16	0.21	0.21	0.21
BLK09	ND	0.02	ND	0.10
BLK10	ND	0.02	ND	ND
BLK11	0.21	0.15	0.12	0.15
BLK12	0.25	0.15	0.12	0.15
BLK13	0.16	0.15	0.02	0.15
BLK14	ND	0.03	ND	ND
BLK15	ND	0.03	ND	ND
BLK16	ND	0.03	ND	0.03
BLK17	0.05	0.14	0.05	0.07
BLK18	0.05	0.14	0.14	0.07
BLK19	0.08	0.14	0.11	0.03
BLK20	0.08	0.16	0.08	0.07
BLK21	0.08	0.09	0.08	0.07

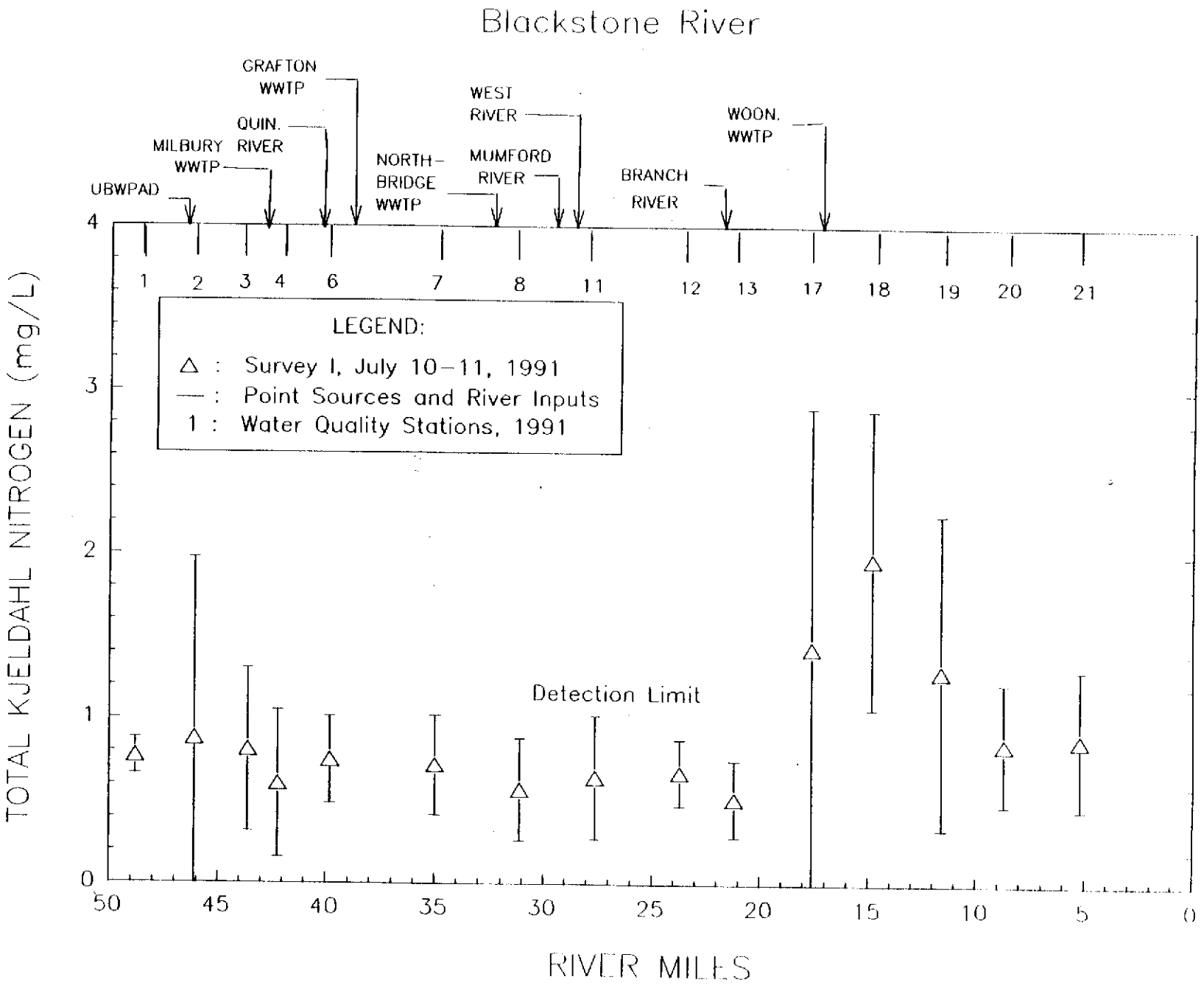
ND = Below the detection limit of 0.02 mg/L.


Blackstone River
CRAFTON WWTP
QUIN. RIVER
MILBURY WWTP
UBWPAD
NORTH-BRIDGE WWTP
WEST RIVER
MUMFORD RIVER
BRANCH RIVER
WOON. WWTP
1 2 3 4 6 7 8 11 12 13 17 18 19 20 21
LEGEND:
: Survey III, October 2-3, 1991
— : Point Sources and River Inputs
1 : Water Quality Stations, 1991
PHOSPHATE (mg/L)
0 1 2 3
50 45 40 35 30 25 20 15 10 5 0
RIVER MILES

1991 Blackstone River Survey #1
Total Kjeldahl Nitrogen in mg/L

Station	Run #1	Run #2	Run #3	Run #4
BLK01	ND	ND	ND	ND
BLK02	1.2	ND	1.7	ND
BLK03	ND	1.1	1.2	ND
BLK04	1.1	ND	ND	ND
BLK05	ND	ND	ND	ND
BLK06	ND	ND	ND	ND
BLK07	ND	ND	ND	ND
BLK08	ND	ND	ND	ND
BLK09	ND	ND	ND	ND
BLK10	ND	ND	ND	ND
BLK11	ND	ND	ND	ND
BLK12	ND	ND	1.2	ND
BLK13	ND	ND	ND	ND
BLK14	ND	ND	ND	ND
BLK15	ND	ND	ND	ND
BLK16	ND	ND	ND	ND
BLK17	ND	ND	ND	ND
BLK18	2.9	1.6	1.7	2.6
BLK19	1.5	1.6	1.6	2.4
BLK20	ND	ND	1.1	ND
BLK21	ND	ND	1.1	1.1

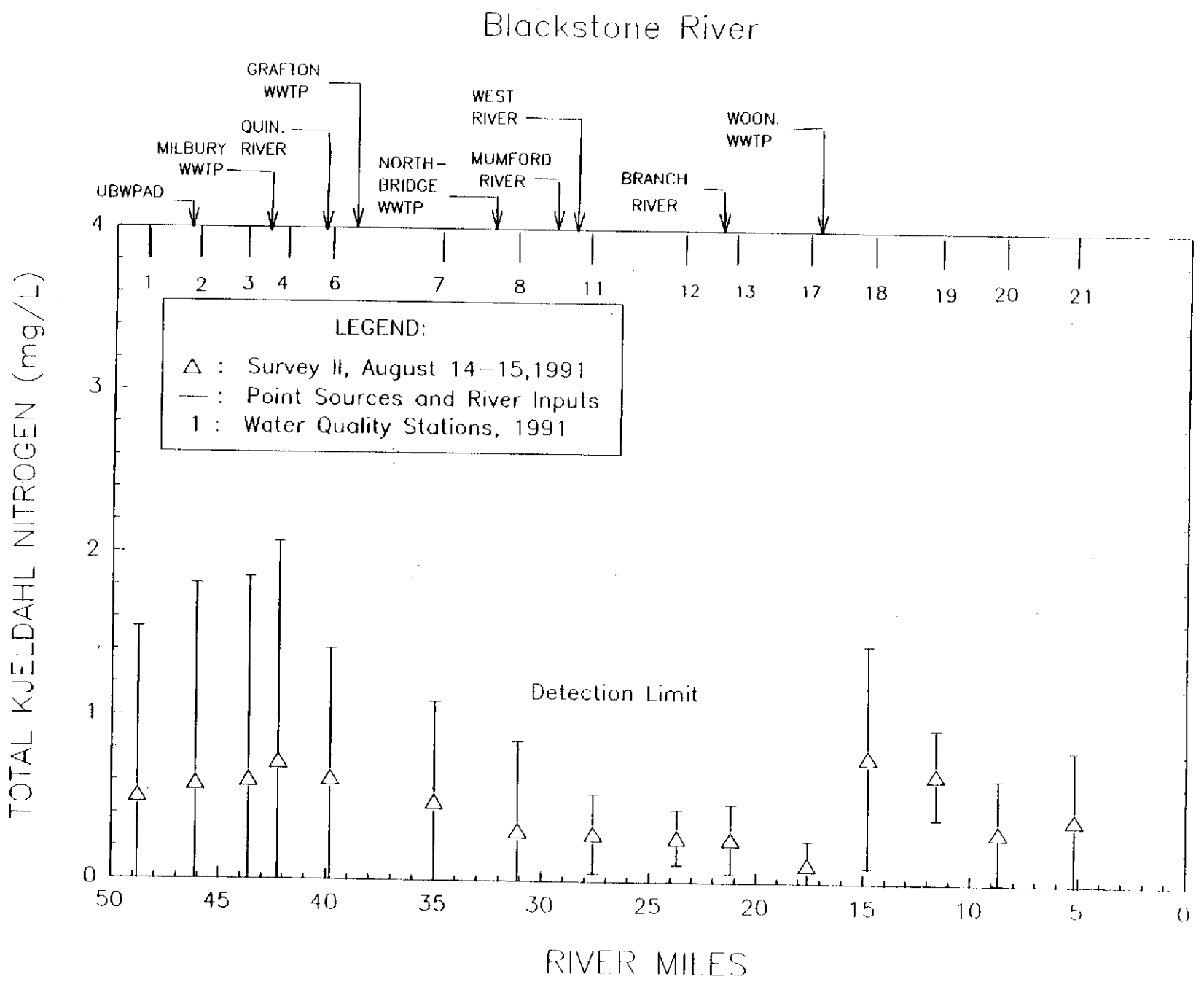
ND = Below the detection limit of 1.0 mg/L.


Blackstone River
GRAFTON WWTP
QUIN. RIVER
MILBURY WWTP
UBWPAD
NORTH-BRIDGE WWTP
WEST RIVER
MUMFORD RIVER
BRANCH RIVER
WOON. WWTP
1 2 3 4 6 7 8 11 12 13 17 18 19 20 21
LEGEND:
△ : Survey I, July 10-11, 1991
— : Point Sources and River Inputs
1 : Water Quality Stations, 1991
Detection Limit
TOTAL KJELDAHL NITROGEN (mg/L)
0 1 2 3 4
50 45 40 35 30 25 20 15 10 5 0
RIVER MILES

1991 Blackstone River Survey #2
Total Kjeldahl Nitrogen in mg/L

Station	Run #1	Run #2	Run #3	Run #4
BLK01	1.4	ND	ND	ND
BLK02	1.6	ND	ND	ND
BLK03	1.7	ND	ND	ND
BLK04	1.7	1.1	ND	ND
BLK05	ND	ND	ND	ND
BLK06	1.2	ND	ND	ND
BLK07	ND	ND	ND	ND
BLK08	ND	ND	ND	ND
BLK09	ND	ND	ND	ND
BLK10	ND	ND	ND	ND
BLK11	ND	ND	ND	ND
BLK12	ND	ND	ND	ND
BLK13	ND	ND	ND	ND
BLK14	ND	ND	ND	ND
BLK15	ND	ND	ND	ND
BLK16	ND	ND	ND	ND
BLK17	ND	ND	ND	ND
BLK18	ND	1.3	ND	ND
BLK19	ND	ND	ND	ND
BLK20	ND	ND	ND	ND
BLK21	ND	ND	ND	ND

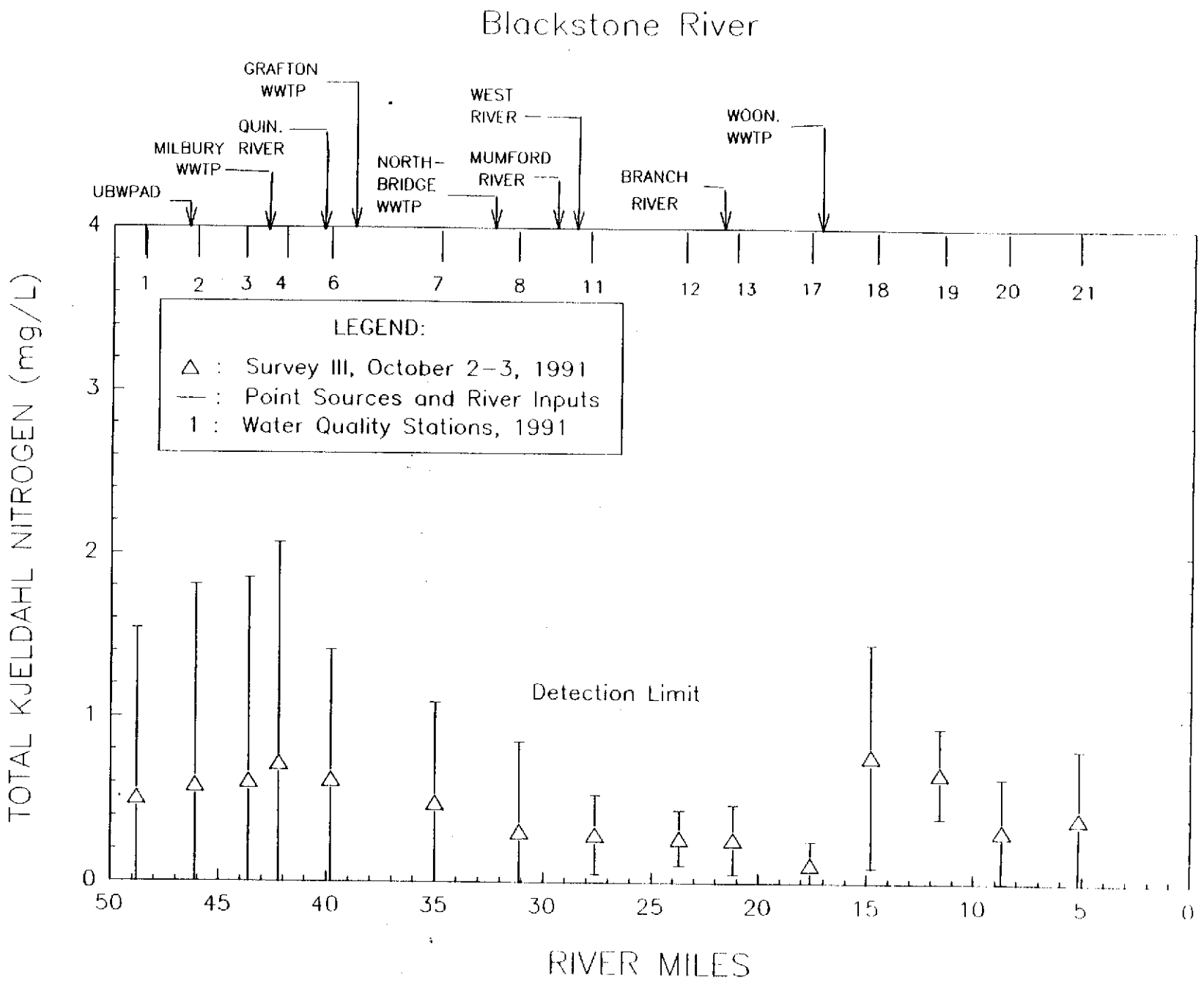
ND = Below the detection limit of 1.0 mg/L.


Blackstone River
GRAFTON WWTP
QUIN. RIVER
MILBURY WWTP
UBWPAD
NORTH-BRIDGE WWTP
WEST RIVER
MUMFORD RIVER
BRANCH RIVER
WOON. WWTP
1 2 3 4 6 7 8 11 12 13 17 18 19 20 21
LEGEND:
△ : Survey II, August 14-15,1991
— : Point Sources and River Inputs
1 : Water Quality Stations, 1991
Detection Limit
TOTAL KJELDAHL NITROGEN (mg/L)
0 1 2 3 4
50 45 40 35 30 25 20 15 10 5 0
RIVER MILES

1991 Blackstone River Survey #3
Total Kjeldahl Nitrogen in mg/L

Station	Run #1	Run #2	Run #3	Run #4
BLK01	ND	ND	ND	ND
BLK02	ND	ND	1.1	ND
BLK03	ND	ND	ND	ND
BLK04	ND	ND	ND	1.0
BLK05	ND	ND	ND	ND
BLK06	ND	ND	ND	ND
BLK07	ND	ND	ND	ND
BLK08	ND	ND	ND	ND
BLK09	ND	ND	ND	ND
BLK10	ND	ND	ND	ND
BLK11	ND	ND	ND	ND
BLK12	ND	ND	ND	ND
BLK13	ND	ND	ND	ND
BLK14	ND	ND	ND	ND
BLK15	ND	ND	ND	ND
BLK16	ND	ND	ND	ND
BLK17	ND	ND	ND	ND
BLK18	ND	ND	ND	ND
BLK19	ND	ND	ND	ND
BLK20	NS	ND	ND	ND
BLK21	ND	ND	ND	ND

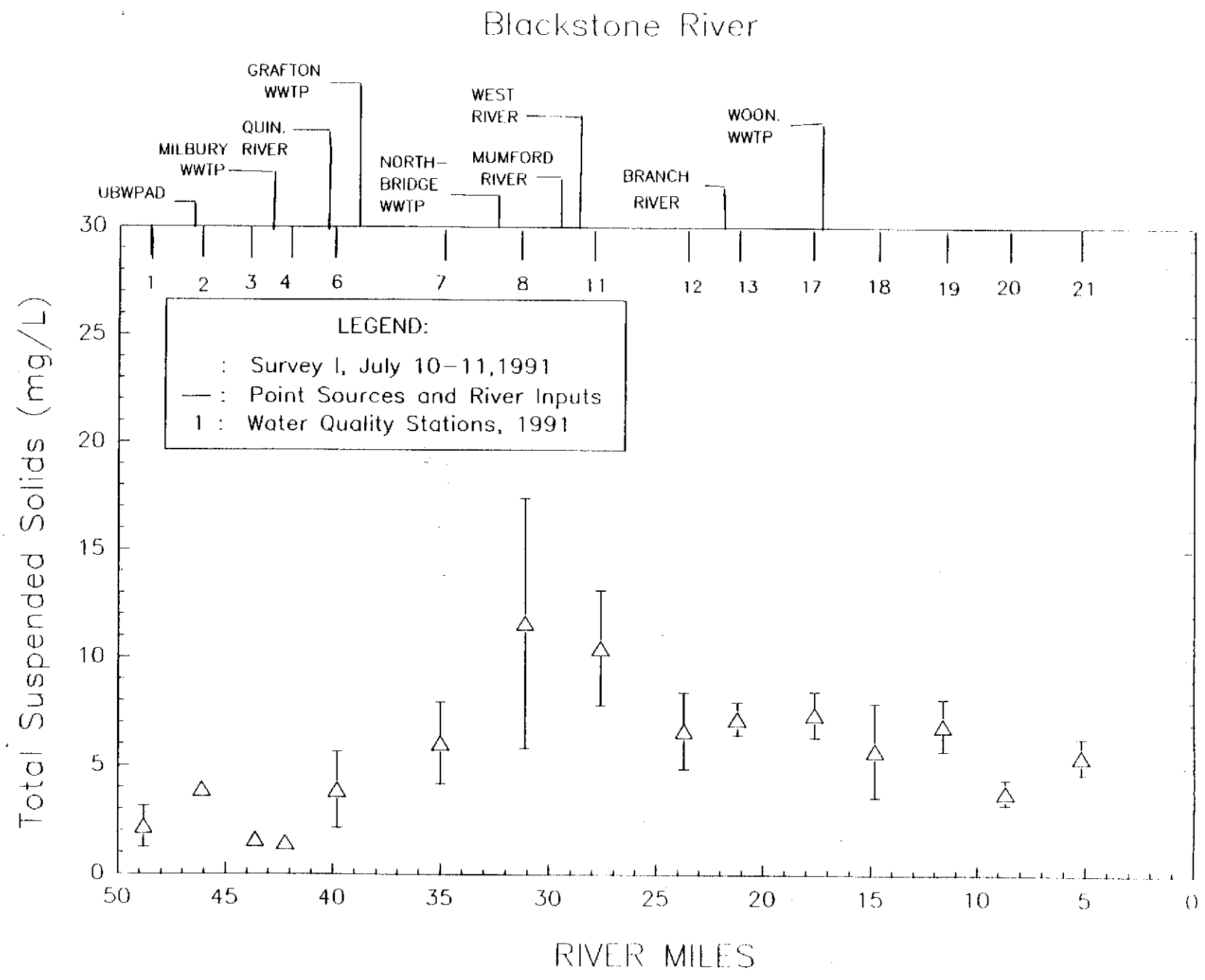
ND = Below the detection limit of 1.0 mg/L; NS = Sample missing

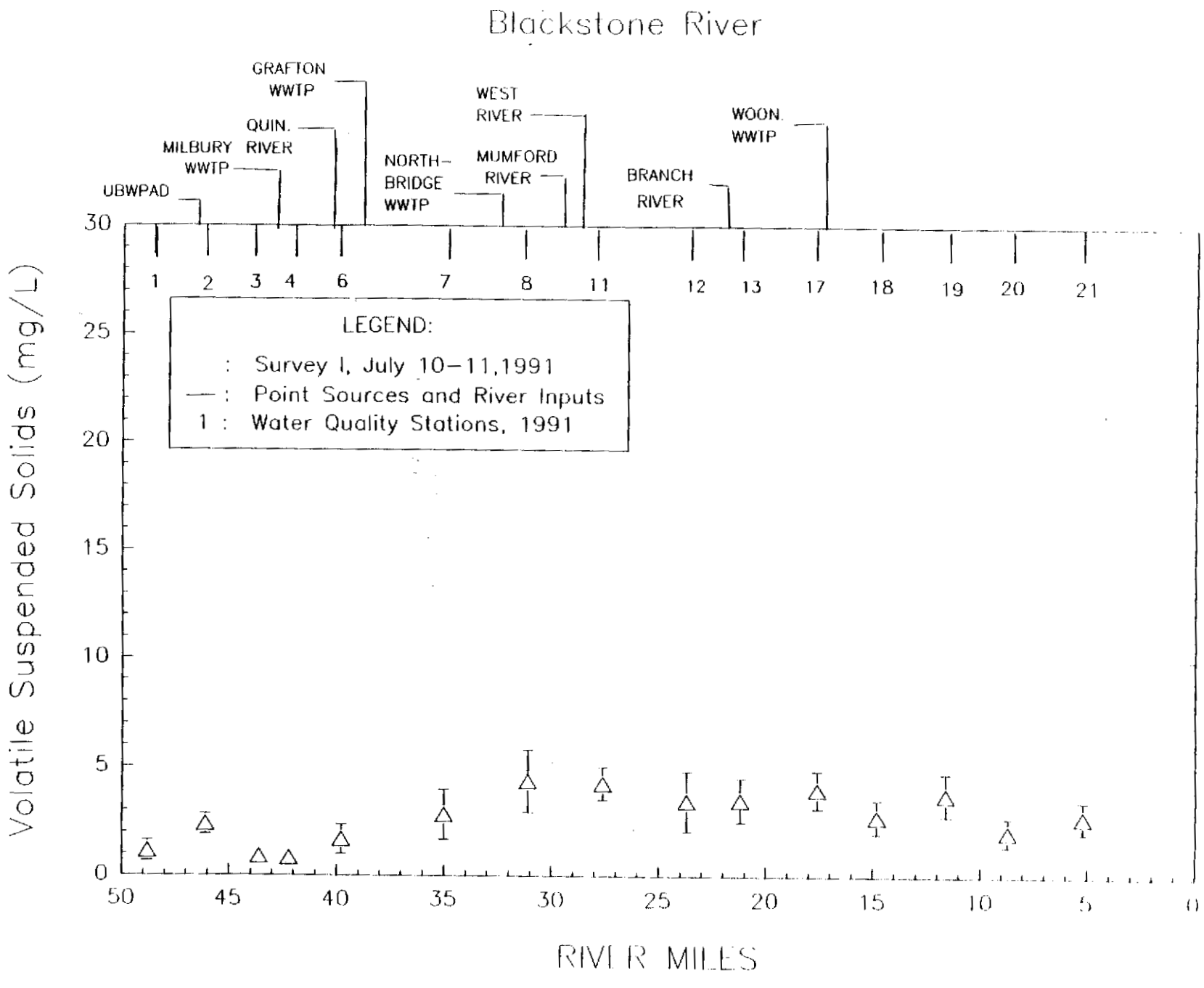

Blackstone River
GRAFTON WWTP
QUIN. RIVER
MILBURY WWTP
UBWPAD
NORTH-BRIDGE WWTP
WEST RIVER
MUMFORD RIVER
BRANCH RIVER
WOON. WWTP
1 2 3 4 6 7 8 11 12 13 17 18 19 20 21
LEGEND:
△ : Survey III, October 2-3, 1991
— : Point Sources and River Inputs
1 : Water Quality Stations, 1991
Detection Limit
TOTAL KJELDAHL NITROGEN (mg/L)
0 1 2 3 4
50 45 40 35 30 25 20 15 10 5 0
RIVER MILES

1991 Blackstone River Survey #1
Total (TSS) and Volatile (VSS) Solids
in mg/L

Station	Run #1		Run #2		Run #3		Run #4	
	TSS	VSS	TSS	VSS	TSS	VSS	TSS	VSS
BLK01	2.4	0.8	2.8	1.8	0.6	ND	3.0	0.8
BLK02	4.6	2.6	3.6	2.0	3.6	3.0	3.8	1.8
BLK03	ND	0.6	1.4	0.6	1.8	1.4	ND	ND
BLK04	1.2	ND	1.4	ND	1.4	0.8	1.8	0.8
BLK05	1.6	1.2	0.6	0.6	ND	ND	0.6	ND
BLK06	6.6	2.6	1.8	ND	3.2	1.4	4.0	1.0
BLK07	4.2	2.0	5.2	2.2	9.2	4.8	5.6	2.2
BLK08	5.0	2.6	6.8	4.0	18.4	6.6	16.2	4.2
BLK09	1.8	1.0	0.6	ND	1.8	0.8	2.6	1.4
BLK10	2.2	1.2	1.2	0.8	1.2	1.0	2.8	0.8
BLK11	9.4	3.8	6.6	3.4	12.4	5.4	13.4	4.4
BLK12	5.0	2.6	9.4	5.4	7.0	4.0	5.2	1.8
BLK13	6.4	3.2	7.2	4.2	8.4	2.0	6.8	4.6
BLK14	1.6	1.0	2.0	1.0	0.6	ND	1.4	0.8
BLK15	2.4	1.2	2.6	1.0	1.8	0.8	4.0	1.4
BLK16	5.4	2.0	5.4	2.2	3.4	1.8	7.0	2.0
BLK17	5.6	2.8	8.2	5.0	7.8	4.6	8.0	3.6
BLK18	8.6	4.0	2.6	2.0	6.4	2.8	5.4	2.2
BLK19	5.8	2.8	8.0	4.4	8.2	5.0	5.6	2.8
BLK20	3.8	1.8	3.2	2.2	4.8	3.0	3.6	1.2
BLK21	4.6	1.8	5.0	3.0	6.8	3.8	5.6	2.4

ND = Below the detection limit of 0.5 mg/L.

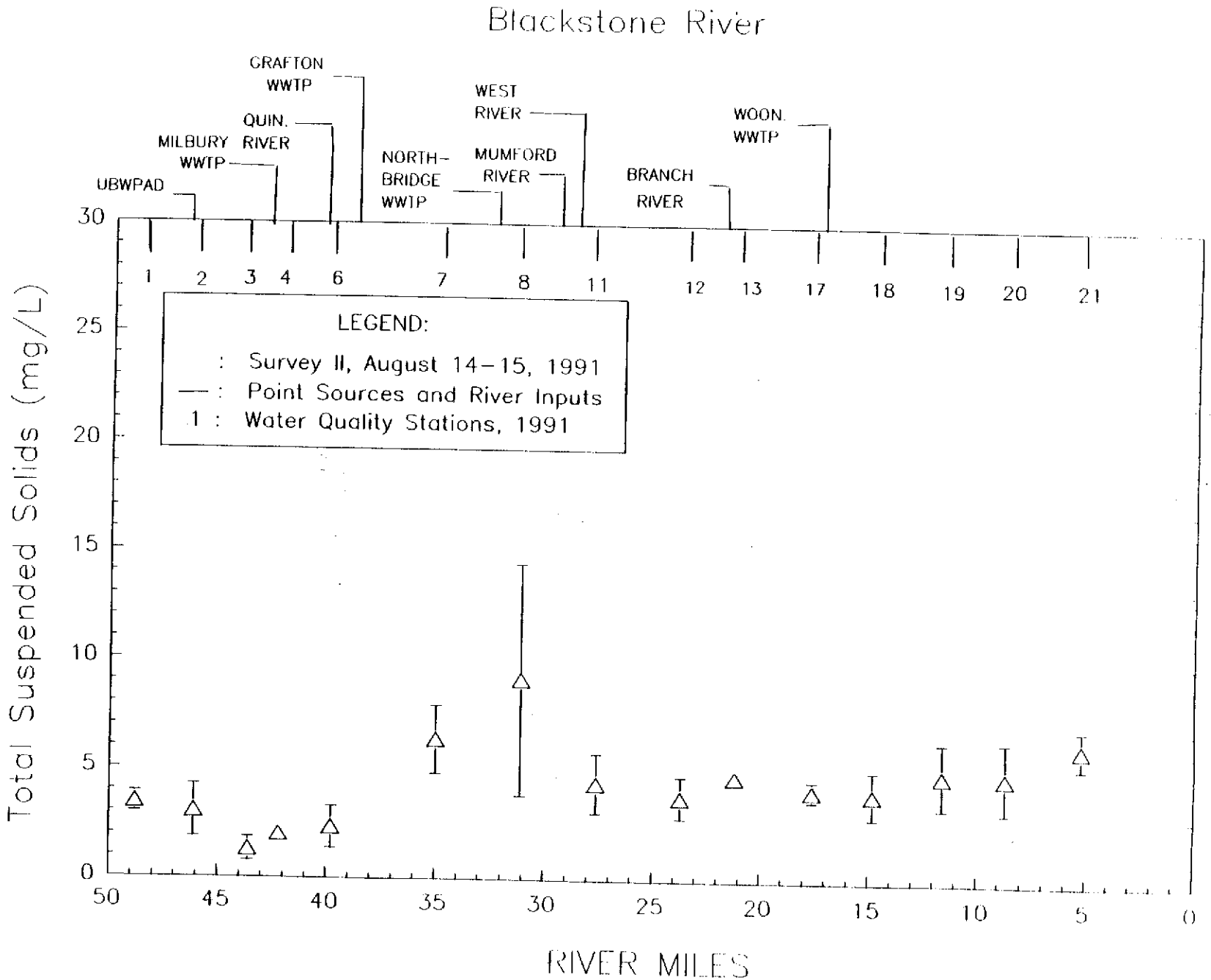

Blackstone River
GRAFTON WWTP
QUIN. RIVER
MILBURY WWTP
UBWPAD
NORTH-BRIDGE WWTP
WEST RIVER
MUMFORD RIVER
BRANCH RIVER
WOON. WWTP
1 2 3 4 6 7 8 11 12 13 17 18 19 20 21
LEGEND:
: Survey I, July 10-11,1991
— : Point Sources and River Inputs
1 : Water Quality Stations, 1991
Total Suspended Solids (mg/L)
0 5 10 15 20 25 30
50 45 40 35 30 25 20 15 10 5 0
RIVER MILES

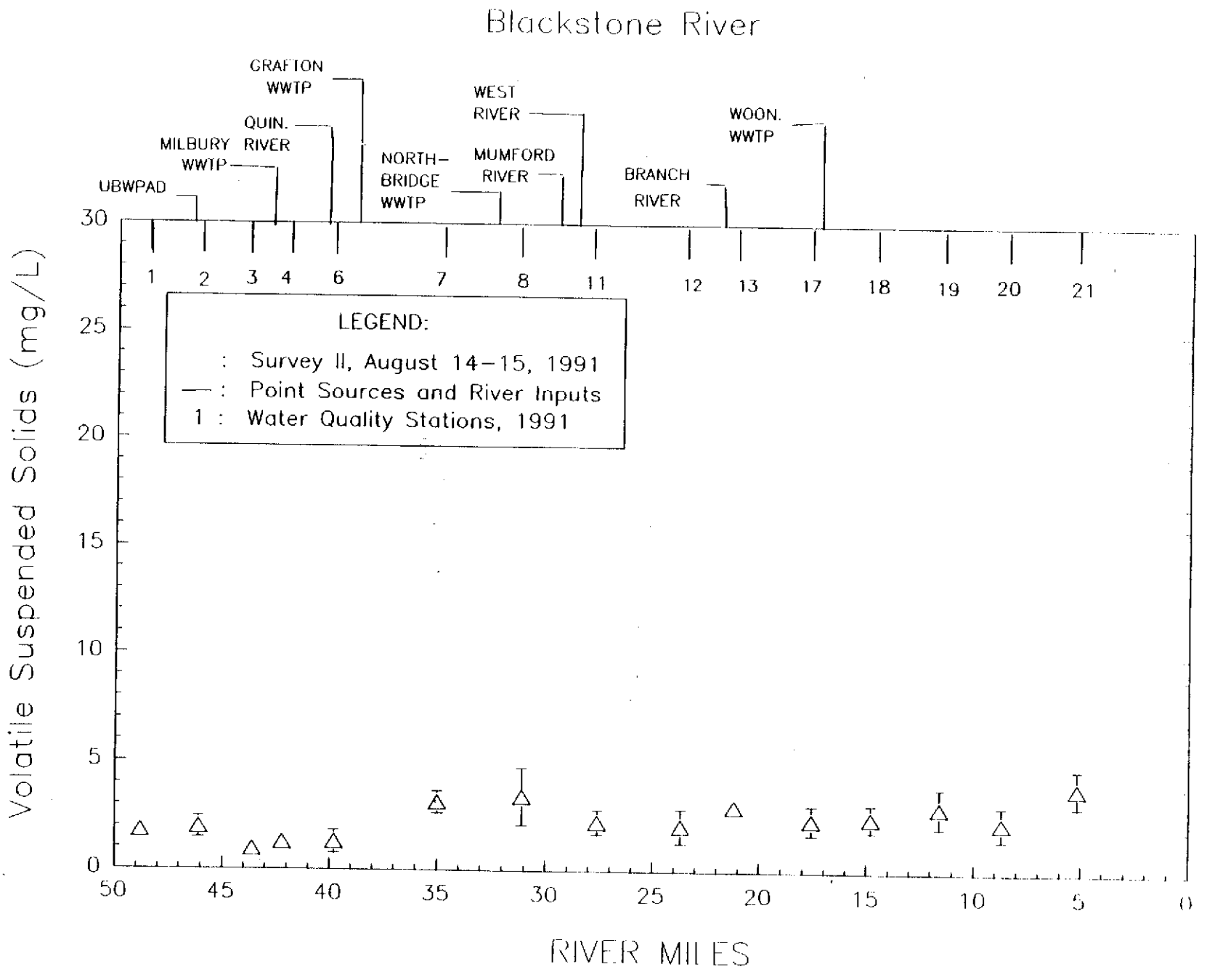

Blackstone River
GRAFTON WWTP
QUIN. RIVER
MILBURY WWTP
UBWPAD
NORTH-BRIDGE WWTP
WEST RIVER
MUMFORD RIVER
BRANCH RIVER
WOON. WWTP
1 2 3 4 6 7 8 11 12 13 17 18 19 20 21
LEGEND:
: Survey I, July 10-11,1991
— : Point Sources and River Inputs
1 : Water Quality Stations, 1991
Volatile Suspended Solids (mg/L)
0 5 10 15 20 25 30
50 45 40 35 30 25 20 15 10 5 0
RIVER MILES

1991 Blackstone River Survey #2
Total (TSS) and Volatile (VSS) Solids
in mg/L

Station	Run #1		Run #2		Run #3		Run #4	
	TSS	VSS	TSS	VSS	TSS	VSS	TSS	VSS
BLK01	3.0	1.6	3.2	1.8	3.4	1.8	4.2	2.0
BLK02	4.8	2.0	3.0	2.6	3.0	2.0	1.4	1.2
BLK03	2.0	1.0	1.0	0.6	1.6	1.2	0.6	ND
BLK04	1.8	0.8	2.6	1.2	1.8	1.4	1.8	1.6
BLK05	1.4	1.0	1.8	0.8	1.6	1.0	ND	ND
BLK06	3.6	1.8	2.8	1.0	1.0	0.6	2.0	1.8
BLK07	8.6	3.2	6.8	3.8	5.6	3.2	4.4	2.4
BLK08	3.8	1.2	6.2	3.6	17.8	4.6	8.6	4.2
BLK09	1.6	1.4	1.6	1.4	1.4	0.8	1.2	ND
BLK10	1.6	0.8	1.4	0.8	1.8	0.6	1.0	0.6
BLK11	5.2	1.8	6.0	3.2	2.4	1.8	4.0	2.2
BLK12	3.6	1.4	5.4	3.4	3.0	2.0	3.2	1.6
BLK13	5.4	3.0	4.4	3.0	4.8	3.4	4.4	2.6
BLK14	2.0	1.4	3.8	2.6	4.0	2.2	2.6	2.0
BLK15	3.8	2.6	5.2	3.2	6.2	4.8	4.0	2.8
BLK16	2.0	1.2	3.2	1.8	5.8	3.0	9.0	3.6
BLK17	3.4	2.2	4.2	1.4	4.4	2.8	4.6	3.2
BLK18	2.4	1.4	5.4	2.8	4.0	3.0	4.2	2.8
BLK19	4.0	2.8	5.8	3.8	6.8	3.8	3.0	1.6
BLK20	2.6	2.2	4.4	1.6	5.4	1.8	7.0	3.6
BLK21	4.8	2.6	7.0	4.2	6.2	5.0	6.8	4.0

ND = Below the detection limit of 0.5 mg/L.

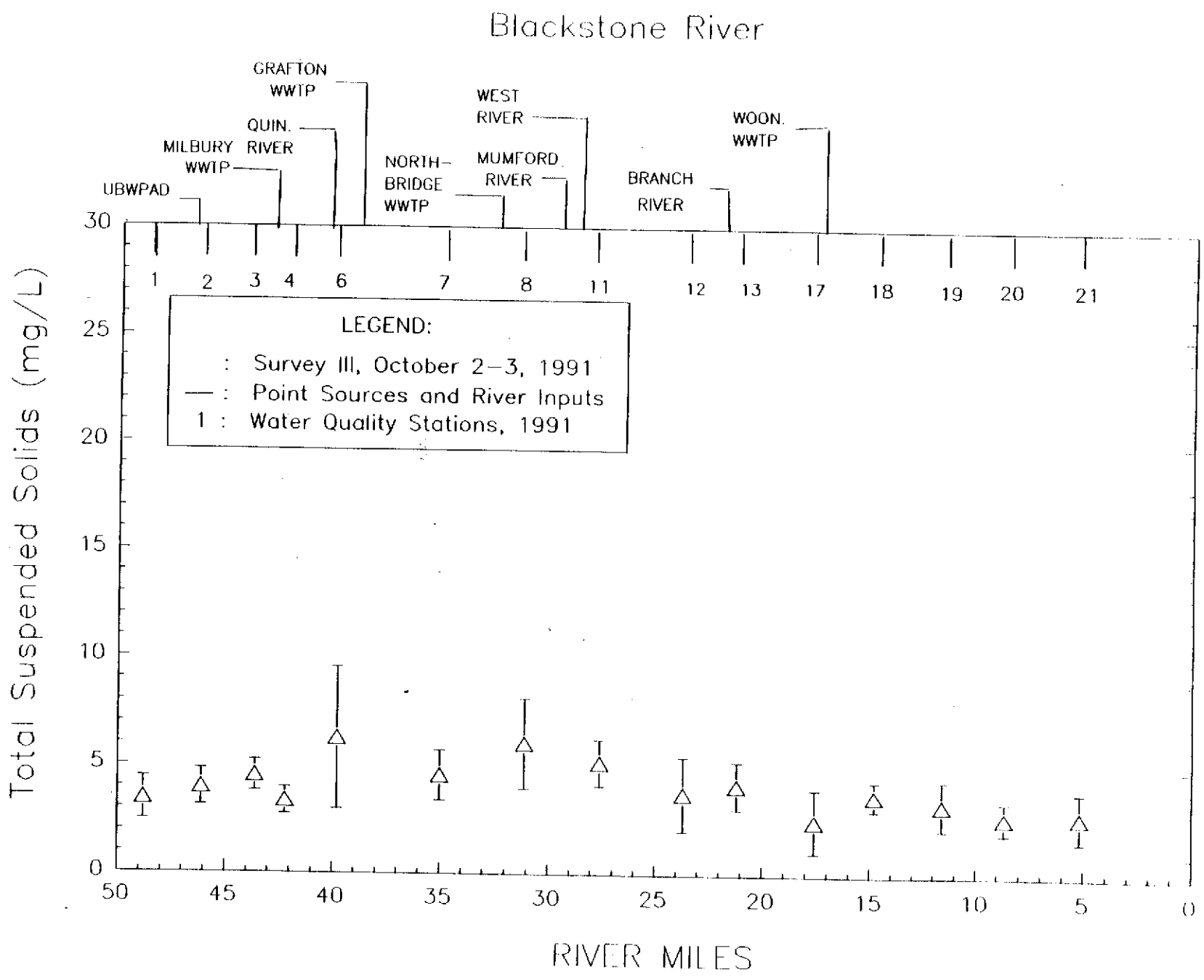

Blackstone River
GRAFTON WWTP
QUIN. RIVER
MILBURY WWTP
UBWPAD
NORTH-BRIDGE WWTP
WEST RIVER
MUMFORD RIVER
BRANCH RIVER
WOON. WWTP
1 2 3 4 6 7 8 11 12 13 17 18 19 20 21
LEGEND:
: Survey II, August 14-15, 1991
— : Point Sources and River Inputs
1 : Water Quality Stations, 1991
Total Suspended Solids (mg/L)
0 5 10 15 20 25 30
50 45 40 35 30 25 20 15 10 5 0
RIVER MILES

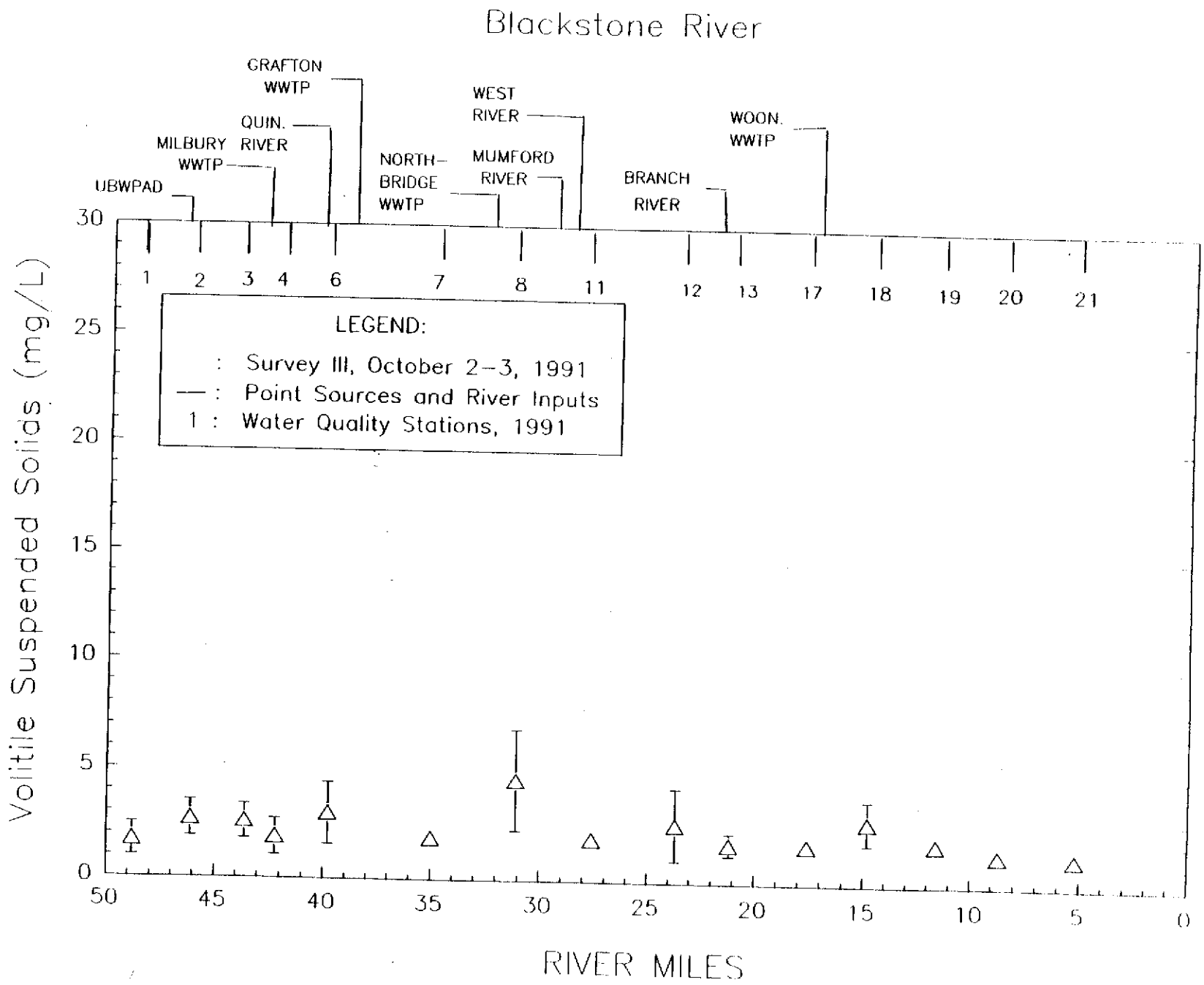

Blackstone River
GRAFTON WWTP
QUIN. RIVER
MILBURY WWTP
UBWPAD
NORTH-BRIDGE WWTP
WEST RIVER
MUMFORD RIVER
BRANCH RIVER
WOON. WWTP
1 2 3 4 6 7 8 11 12 13 17 18 19 20 21
LEGEND:
: Survey II, August 14-15, 1991
— : Point Sources and River Inputs
1 : Water Quality Stations, 1991
Volatile Suspended Solids (mg/L)
0 5 10 15 20 25 30
50 45 40 35 30 25 20 15 10 5 0
RIVER MILES

1991 Blackstone River Survey #3
Total (TSS) and Volatile (VSS) Solids
in mg/L

Station	Run #1		Run #2		Run #3		Run #4	
	TSS	VSS	TSS	VSS	TSS	VSS	TSS	VSS
BLK01	3.2	1.2	4.0	1.2	4.6	2.8	2.0	ND
BLK02	3.4	2.8	3.6	2.0	5.4	4.0	3.4	2.0
BLK03	4.4	2.6	4.4	2.4	5.6	3.8	3.6	1.6
BLK04	3.8	2.4	3.2	1.0	4.0	3.0	2.4	1.2
BLK05	1.2	1.0	1.0	0.8	0.6	ND	0.6	ND
BLK06	4.2	2.0	5.4	2.6	11.8	5.4	3.6	2.0
BLK07	5.0	2.2	6.2	2.4	3.2	1.6	3.8	1.4
BLK08	7.4	2.8	8.4	3.0	3.0	2.4	5.2	1.8
BLK09	1.6	1.2	1.6	0.8	1.4	1.2	ND	ND
BLK10	1.8	1.4	1.8	1.0	1.2	1.0	1.0	0.8
BLK11	5.4	2.2	6.6	2.4	5.0	1.8	3.6	1.4
BLK12	3.4	1.8	6.6	1.8	2.2	1.4	2.8	1.2
BLK13	4.2	2.0	4.6	1.8	5.4	2.4	2.4	1.0
BLK14	3.0	2.0	3.0	1.2	1.6	1.4	1.0	0.8
BLK15	3.6	2.2	3.0	1.2	2.0	1.4	2.0	1.6
BLK16	3.4	2.0	2.4	0.8	1.0	0.8	2.2	1.4
BLK17	4.0	2.0	5.0	1.6	2.4	1.6	3.8	2.0
BLK18	4.6	2.6	4.0	1.4	3.4	2.2	2.8	2.0
BLK19	3.6	2.2	5.0	2.0	2.2	1.4	2.4	2.0
BLK20	NS	NS	3.6	1.3	2.8	1.6	1.8	1.4
BLK21	4.2	2.0	3.6	1.2	2.0	1.2	1.4	1.0

ND = Below the detection limit of 0.5 mg/L; NS = Sample missing.


Blackstone River
GRAFTON WWTP
QUIN. RIVER
MILBURY WWTP
UBWPAD
NORTH-BRIDGE WWTP
WEST RIVER
MUMFORD RIVER
BRANCH RIVER
WOON. WWTP
1 2 3 4 6 7 8 11 12 13 17 18 19 20 21
LEGEND:
: Survey III, October 2-3, 1991
— : Point Sources and River Inputs
1 : Water Quality Stations, 1991
Total Suspended Solids (mg/L)
0 5 10 15 20 25 30
50 45 40 35 30 25 20 15 10 5 0
RIVER MILES


Blackstone River
GRAFTON WWTP
QUIN. RIVER
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BRANCH RIVER
WOON. WWTP
1 2 3 4 6 7 8 11 12 13 17 18 19 20 21
LEGEND:
: Survey III, October 2-3, 1991
— : Point Sources and River Inputs
1 : Water Quality Stations, 1991
Volitile Suspended Solids (mg/L)
0 5 10 15 20 25 30
50 45 40 35 30 25 20 15 10 5 0
RIVER MILES

1991 Blackstone River
Total (TTM) and Dissolved (DTM) Trace Metals
Woonsocket Wastewater Secondary Effluent Pre-Chlorination

Parameter	Survey	Day 1	Day 2	Day 3	Day 4	Day 5
Cadmium TTM (µg/L)	1	3.1	2.1	2.4	2.4	2.4
	2	4.8	3.5	3.8	4.5	11.6
	3B			0.9	1.5	1.9
Cadmium DTM (µg/L)	1	2.2	1.7	1.4	1.5	1.9
	2	4.3	3.0	1.6	3.7	6.5
	3B			0.3	0.6	0.7
Chromium TTM (µg/L)	1	3.9	4.5	2.7	5.1	7.2
	2	9.0	9.1	4.8	5.1	6.0
	3B			0.9	2.7	2.7
Chromium DTM (µg/L)	1	1.6	3.4	ND	2.4	4.6
	2	7.3	5.5	1.6	4.6	4.9
	3B			0.4	1.9	1.9
Copper TTM (µg/L)	1	41.1	33.3	54.1	44.1	32.1
	2	24.6	41.4	36.9	37.8	54.0
	3B			28.2	24.6	21.6
Copper DTM (µg/L)	1	27.1	25.0	31.0	36.5	22.5
	2	13.0	28.0	12.7	32.8	51.1
	3B			5.9	13.0	12.1
Lead TTM (µg/L)	1	5.2	3.6	5.1	5.7	3.9
	2	12.3	10.1	6.9	9.6	18.9
	3B			7.2	5.1	6.9
Lead DTM (µg/L)	1	2.4	1.6	1.6	1.6	1.9
	2	4.7	5.5	ND	7.9	14.5
	3B			1.9	2.2	1.0
Nickel TTM (µg/L)	1	10.5	10.8	18.0	9.0	13.8
	2	9.3	98.7	7.1	9.9	11.4
	3B			18.9	17.1	10.4
Nickel DTM (µg/L)	1	6.8	16.8	8.6	5.7	8.4
	2	14.4	8.1	6.9	6.9	9.3
	3B			16.8	8.4	9.9

1991 Blackstone River
Total (TTM) and Dissolved (DTM) Trace Metals
Woonsocket Wastewater Secondary Effluent Post-Chlorination

Parameter	Survey	Day 1	Day 2	Day 3	Day 4	Day 5
Cadmium TTM (µg/L)	1	3.2	2.7	2.6	3.0	2.7
	2	4.8	4.8	3.3	5.2	5.9
	3B			ND	1.1	1.7
Cadmium DTM (µg/L)	1	2.2	3.1	1.6	1.9	1.9
	2	4.5	3.5	2.9	2.5	4.4
	3B			0.3	0.8	0.7
Chromium TTM (µg/L)	1	4.2	5.4	3.6	3.9	3.9
	2	14.7	9.0	5.7	0.9	4.8
	3B			ND	2.1	3.3
Chromium DTM (µg/L)	1	3.1	1.3	0.4	1.6	3.7
	2	9.1	5.5	3.1	2.2	3.1
	3B			ND	1.0	1.9
Copper TTM (µg/L)	1	38.4	46.2	36.9	39.0	44.4
	2	33.0	43.5	39.0	147.0	39.9
	3B			7.5	9.0	20.0
Copper DTM (µg/L)	1	25.6	32.2	22.0	18.4	30.1
	2	30.1	35.5	31.5	29.5	29.1
	3B			3.4	10.9	9.4
Lead TTM (µg/L)	1	3.9	5.1	3.9	6.3	4.2
	2	10.8	8.7	9.6	21.0	12.3
	3B			3.0	3.9	6.0
Lead DTM (µg/L)	1	1.6	1.6	0.7	1.6	1.3
	2	5.2	5.2	2.5	4.3	6.7
	3B			1.0	2.8	2.2
Nickel TTM (µg/L)	1	205	223	256	263	121
	2	168	196	222	255	210
	3B			16	69	79
Nickel DTM (µg/L)	1	192	207	223	238	120
	2	164	160	205	207	187
	3B			10	71	11

1991 Blackstone River Conventionals Parameters
Upper Blackstone (UBPAD) Wastewater Secondary Effluent
Pre-Chlorination

Parameter	Survey	Day 1	Day 2	Day 3	Day 4	Day 5
Cadmium TTM (µg/L)	1	4.5	4.0	3.6	4.5	5.5
	2	1.2	4.9	4.5	4.9	5.0
	3B			3.0	3.0	3.4
Cadmium DTM (µg/L)	1	4.0	1.9	3.0	3.8	5.8
	2	1.9	4.3	4.3	4.7	4.2
	3B			3.0	2.8	2.6
Chromium TTM (µg/L)	1	5.1	3.3	4.8	6.9	4.5
	2	3.7	3.6	52.8	3.0	3.3
	3B			1.2	1.2	1.8
Chromium DTM (µg/L)	1	4.0	0.7	2.2	5.8	4.3
	2	3.5	2.8	3.7	2.2	2.5
	3B			0.7	0.7	1.3
Copper TTM (µg/L)	1	36.3	36.6	40.2	42.6	43.8
	2	28.2	43.5	18.6	20.1	12.6
	3B			21.0	30.9	29.4
Copper DTM (µg/L)	1	28.3	33.1	35.2	35.5	36.1
	2	26.5	25.0	19.1	13.9	3.9
	3B			14.5	25.2	19.9
Lead TTM (µg/L)	1	6.9	7.4	5.7	6.5	6.6
	2	6.1	4.8	5.1	3.2	3.8
	3B			1.5	1.8	1.8
Lead DTM (µg/L)	1	3.7	4.6	3.7	4.1	3.1
	2	5.9	2.3	3.6	1.4	1.9
	3B			0.4	1.0	0.7
Nickel TTM (µg/L)	1	22.2	18.6	15.6	14.7	32.1
	2	122	79.5	67.5	58.2	44.7
	3B			18.0	20.4	27.3
Nickel DTM (µg/L)	1	22.2	13.2	15.6	15.0	33.3
	2	120	75.3	65.7	55.8	39.9
	3B			15.3	21.0	24.0

1991 Blackstone River Conventionals Parameters
Upper Blackstone (UBPAD) Wastewater Secondary Effluent
Post-Chlorination

Parameter	Survey	Day 1	Day 2	Day 3	Day 4	Day 5
Cadmium TTM (µg/L)	1	4.6	4.4	4.0	4.1	4.2
	2	2.1	6.8	4.5	4.5	5.2
	3B			3.2	2.4	2.5
Cadmium DTM (µg/L)	1	3.5	2.8	3.2	3.1	3.8
	2	1.9	4.7	3.5	3.7	4.9
	3B			2.5	1.7	2.1
Chromium TTM (µg/L)	1	3.9	6.6	6.0	7.2	7.5
	2	5.7	5.1	3.6	6.9	4.5
	3B			2.1	1.5	2.7
Chromium DTM (µg/L)	1	1.6	3.4	2.2	2.8	5.5
	2	4.0	2.5	1.3	1.3	3.1
	3B			0.7	ND	1.3
Copper TTM (µg/L)	1	45.6	43.5	59.4	45.0	61.1
	2	44.7	33.0	24.6	27.6	26.4
	3B			21.6	25.5	41.4
Copper DTM (µg/L)	1	33.1	26.8	31.9	32.5	43.3
	2	46.0	15.4	11.5	19.3	147
	3B			14.8	21.4	32.1
Lead TTM (µg/L)	1	5.4	5.9	6.2	6.8	6.9
	2	8.6	3.9	4.6	4.4	3.2
	3B			2.1	1.8	2.4
Lead DTM (µg/L)	1	3.3	4.5	4.2	3.9	4.2
	2	8.1	1.9	3.2	1.6	1.5
	3B			0.3	2.4	0.9
Nickel TTM (µg/L)	1	27.6	24.0	21.8	21.0	23.7
	2	163	94.8	76.8	66.0	52.2
	3B			17.1	23.2	25.8
Nickel DTM (µg/L)	1	24.0	16.5	17.4	14.7	20.4
	2	150	87.0	69.8	60.0	49.5
	3B			15.9	19.8	21.6

1991 Blackstone River
Woonsocket Wastewater Secondary Effluent Pre-Chlorination

Parameter	Survey	Day 1	Day 2	Day 3	Day 4	Day 5
TSS (mg/L)	1	7.2	10.4	5.0	11.4	8.8
	2	16.4	14.6	8.8	7.6	29.4
	3A	8.0	8.4	22.2	33.2	28.4
	3B			28.6	28.8	38.2
VSS (mg/L)	1	7.8	8.0	3.2	8.8	6.4
	2	10.8	10.4	6.4	5.6	19.2
	3A	6.4	7.0	16.8	25.6	23.6
	3B			20.8	21.6	27.7
Calcium (mg/L)	1	11.0	13.0	12.0	13.0	13.0
	2	12.7	13.8	12.0	14.3	13.7
	3B			13.6	14.3	13.8
Magnesium (mg/L)	1	4.2	4.3	4.1	3.9	3.5
	2	3.8	3.7	3.8	3.9	3.8
	3B			4.0	3.9	4.6
BOD5 (mg/L)	1	3.1	5.0	6.9	6.5	9.9
	2	9.2	7.2	19.1	10.2	10.5
	3A	13.4	10.2	18.6	25.5	21.9
	3B			20.8	22.0	22.0
Chloride (mg/L)	1	125	105	85	247	335
	2	225	200	145	160	263
	3A	258	212	202	240	410
	3B			330	328	159
Ammonia (mg/L)	1	26.6	33.8	28.2	21.5	21.4
	2	15.2	15.0	13.5	12.0	13.2
	3A	6.5	10.8	13.0	13.0	6.1
	3B			12.1	10.5	8.9
PO4 (mg/L)	1	3.6	2.6	3.5	3.1	1.3
	2	3.5	3.6	4.7	4.6	4.7
	3B			4.2	4.6	3.9
Nitrate (mg/L)	1	0.4	0.4	0.4	0.3	0.3
	2	1.7	3.7	29.7	33.2	39.6
	3B			1.6	2.1	3.8
TKN (mg/L)	1	32.1	27.2	38.8	NS	24.3
	2	18.6	15.4	19.5	15.6	17.6
	3A	9.3	8.7	7.7		
	3B			15.1	13.1	11.1

NS = Sample missing or insufficient volume.

1991 Blackstone River
Woonsocket Wastewater Secondary Effluent Post-Chlorination

Parameter	Survey	Day 1	Day 2	Day 3	Day 4	Day 5
TSS (mg/L)	1	6.0	8.2	7.6	NS	7.0
	2	14.6	16.6	8.4	8.8	22.8
	3A	16.9	16.0	15.0	20.4	24.4
	3B			13.2	23.6	26.4
VSS (mg/L)	1	4.8	6.2	7.2	NS	5.2
	2	10.8	12.2	5.2	4.8	15.2
	3A	14.0	12.9	13.3	17.6	19.2
	3B			9.6	17.6	20.0
Calcium (mg/L)	1	11.0	12.0	13.0	11.0	12.0
	2	11.8	13.4	13.1	13.8	12.9
	3B			12.9	14.1	13.4
Magnesium (mg/L)	1	4.0	4.3	4.3	4.7	3.4
	2	3.8	3.6	3.9	3.8	3.7
	3B			3.9	4.1	4.8
BOD5 (mg/L)	1	4.2	7.5	3.7	NS	7.6
	2	8.4	7.5	14.4	12.2	6.2
	3A	11.9	8.7	7.7	13.5	18.5
	3B			14.0	20.0	16.0
Chloride (mg/L)	1	154	114	100	NS	142
	2	290	283	200	175	205
	3A	310	260	232	273	440
	3B			335	210	191
Ammonia (mg/L)	1	28.6	27.7	27.8	28.4	NS
	2	12.9	9.5	12.0	16.8	14.3
	3A	7.7	9.9	15.8	13.8	8.4
	3B			13.2	13.5	10.5
PO4 (mg/L)	1	3.9	3.0	3.5	NS	3.1
	2	3.7	3.7	4.5	ND	4.9
	3B			4.1	4.2	3.7
Nitrate (mg/L)	1	0.9	0.9	0.9	NS	1.0
	2	3.8	2.0	38.8	9.9	58.5
	3B			1.4	2.7	4.7
TKN (mg/L)	1	25.6	13.4	42.0	NS	42.0
	2	13.7	17.1	18.8	17.2	17.8
	3A	6.4	7.5	7.5		
	3B			11.5	13.5	13.7

NS = Sample missing or insufficient volume.

1991 Blackstone River
Upper Blackstone (UBPAD) Wastewater
Secondary Effluent Pre-Chlorination

Parameter	Survey	Day 1	Day 2	Day 3	Day 4	Day 5
TSS (mg/L)	1	2.4	1.8	2.4	2.0	1.8
	2	1.4	4.4	1.8	0.6	3.2
	3A	4.4	5.2	3.6	4.6	7.6
	3B			2.0	1.2	2.4
VSS (mg/L)	1	2.0	0.8	2.2	1.6	1.0
	2	0.8	3.2	1.0	ND	2.6
	3A	3.2	2.8	3.0	4.0	6.0
	3B			1.6	0.8	1.8
Calcium (mg/L)	1	13.0	13.0	12.0	12.5	13.0
	2	12.3	12.8	13.2	11.9	13.2
	3B			13.3	12.7	13.4
Magnesium (mg/L)	1	3.2	3.1	3.0	3.0	3.1
	2	3.3	3.1	3.2	3.1	3.2
	3B			3.4	3.1	3.2
BOD5 (mg/L)	1	3.0	1.8	1.0	3.0	5.0
	2	2.0	3.5	2.3	1.9	ND
	3A	6.7	3.7	3.4	2.9	3.5
	3B			5.2	5.5	3.2
Chloride (mg/L)	1	92	92	78	85	85
	2	74	50	69	103	105
	3A	65	73	95	96	102
	3B			120	115	130
Ammonia (mg/L)	1	0.8	1.0	0.2	0.5	0.2
	2	0.2	0.3	0.2	0.3	0.3
	3A	0.5	0.4	0.2	1.0	0.4
	3B			0.3	0.4	0.2
PO4 (mg/L)	1	2.3	2.0	NS	2.5	1.4
	2	2.0	2.9	2.1	2.1	2.9
	3B			3.1	2.5	2.6
Nitrate (mg/L)	1	6.3	5.7	NS	6.4	6.3
	2	7.2	3.4	26.8	12.3	23.6
	3B			13.0	7.7	10.4
TKN (mg/L)	1	2.0	2.2	2.9	1.0	1.0
	2	1.4	1.1	1.1	1.3	1.3
	3A	ND	ND	ND		
	3B			ND	ND	ND

NS = Sample missing or insufficient volume.

1991 Blackstone River
Upper Blackstone (UBPAD) Wastewater
Secondary Effluent Post-Chlorination

Parameter	Survey	Day 1	Day 2	Day 3	Day 4	Day 5
TSS (mg/L)	1	8.6	4.8	5.0	NS	NS
	2	6.0	2.4	2.4	2.2	20.4
	3A	8.0	2.8	5.8	NS	4.6
	3B			2.8	3.6	3.0
VSS (mg/L)	1	7.0	4.0	3.8	NS	NS
	2	4.4	1.6	2.0	1.2	18.4
	3A	6.8	2.4	4.6	NS	3.8
	3B			1.8	3.2	2.2
Calcium (mg/L)	1	13.0	13.0	13.0	12.0	13.0
	2	11.8	13.1	13.6	11.9	13.2
	3B			12.7	12.4	13.1
Magnesium (mg/L)	1	3.2	3.2	3.0	3.0	3.1
	2	3.4	3.2	3.2	3.3	3.3
	3B			3.5	3.4	3.5
BOD5 (mg/L)	1	5.0	3.3	2.0	2.8	5.0
	2	3.8	4.6	5.7	3.9	NS
	3A	2.9	1.7	3.2	1.9	2.5
	3B			4.5	3.2	4.7
Chloride (mg/L)	1	92	96	92	88	88
	2	89	62	68	98	132
	3A	73	92	111	101	111
	3B			123	125	141
Ammonia (mg/L)	1	1.1	0.6	0.1	0.2	0.2
	2	0.2	0.6	0.1	0.1	NS
	3A	0.8	0.2	0.2	0.4	0.4
	3B			0.2	0.1	0.2
PO4 (mg/L)	1	2.5	2.0	2.4	3.0	1.6
	2	2.1	3.0	1.9	2.2	2.6
	3B			3.3	2.4	3.4
Nitrate (mg/L)	1	6.8	5.7	6.4	7.1	6.4
	2	6.0	26.3	30.9	8.8	31.6
	3B			13.4	9.8	11.8
TKN (mg/L)	1	2.5	2.2	1.6	1.1	1.5
	2	2.3	1.8	1.4	1.4	1.3
	3A	ND	ND	ND		
	3B			ND	ND	1.2

NS = Sample missing or insufficient volume.

Appendix C

1991 BLACKSTONE RIVER SURVEY

QUALITY ASSURANCE/QUALITY CONTROL

MEMORANDUM

Blackstone River 1990 Study
Civil and Environmental Engineering
University of Rhode Island

June 1, 1992

The laboratory procedure used for the analyses of the Blackstone River 1990 survey are in accordance with the Work/Quality Assurance Project Plan prepared for the U. S. Environmental Protection Agency Region I by the Civil and Environmental Engineering Department (CVE) in July 1991. In addition to this document other provisions were required as outlined in the August 2, 1991 memorandum from Carol M. Wood, Quality Assurance Officer for EPA to Katrina Kipp, EPA Project Officer. These provisions were handled in the following manner:

1. The preventive maintenance schedule was expanded to include routine daily and weekly maintenance practices.

2. All samples containing chloroform as a preservative have been retained for disposal in a manner appropriate for wastes containing carcinogens.

3. A comparison was completed for the second round sampling for ammonia analyses of the two effluent stations. Samples were split and analyzed both with and without a distillation step. A copy of those results are attached as Table 1. The results do not appear to be dissimilar. Distillation did not occur for survey 3 ammonia samples.

4. A comparison was completed for the second round sampling for the trace metal analyses of the two effluent stations. Samples were analyzed using the method of acid extraction as well as the method of acid digestion. A copy of those results are attached as Table 2. The results do not appear to be dissimilar. Digestion did not occur for survey 3 metal analyses.

In addition to these provisions a summary of the accuracy, precision and completeness of the data are given in Table 3. Accuracy is represented by the percent mean recovery and precision is represented by the standard error of the mean. The results are in accordance with the expectations given in the QA Project Plan. Accuracy of the BOD test was determined by running five duplicate synthetic water samples containing a 1:1 mixture of glucose and glutamic acid. These data are given in Table 4. The results are in accordance with the expectations given in the QA Project Plan. Trip blanks are summarized in Table 5 and indicate no significant contamination.

Table 1
Comparison Between Ammonia Results of Analyses Using Direct Phenate and Distillation/Phenate Methods

Blackstone River 1990 Survey 2
Woonsocket and UBPAD Effluents

Station	Direct Phenate Method (mg/L)	Distillation Phenate Method (mg/L)	Difference (mg/L)
UBPAD Pre-Cl 1	0.22	0.26	0.04
UBPAD Pre-Cl 2	0.27	0.30	0.03
UBPAD Pre-Cl 3	0.19	0.21	0.02
UBPAD Pre-Cl 4	0.24	0.28	0.04
UBPAD Pre-Cl 5	0.29	0.32	0.03
WOON Pre-Cl 1	15.2	16.5	1.3
WOON Pre-Cl 2	15.0	15.9	0.9
WOON Pre-Cl 3	13.5	14.7	1.2
WOON Pre-Cl 4	12.0	14.2	2.2
WOON Pre-Cl 5	13.2	14.9	1.7

Table 2
Comparison Between Total Trace Metal Results of Analyses Using
Acid Extraction (AE) and Acid Digestion (AD) Methods

Blackstone River 1990 Survey 2
Woonsocket and UBPAD Effluents

Station	Chromium			Cadmium			Copper			Lead			Nickel		
	AE	AD	E-D	AE	AD	E-D	AE	AD	E-D	AE	AD	E-D	AE	AD	E-D
UBPAD Pre-Cl 1	5.7	5.3	0.4	2.1	2.4	-0.3	44.7	46.7	-2.0	8.6	7.5	1.1	163	150	13
UBPAD Pre-Cl 2	5.1	4.7	0.4	6.8	6.3	0.5	33.0	38.9	-5.9	3.9	4.1	-0.2	94.8	89.6	5.2
UBPAD Pre-Cl 3	3.6	3.9	-0.3	4.5	3.9	0.6	24.6	27.3	-2.7	4.6	4.2	0.4	76.8	82.9	- 6.1
UBPAD Pre-Cl 4	6.9	5.9	1.0	4.5	5.0	-0.5	27.6	33.2	-5.6	4.4	4.0	0.4	66.2	67.8	- 1.6
UBPAD Pre-Cl 5	4.5	4.1	0.4	5.2	4.8	0.4	26.4	30.4	-4.0	3.2	2.8	0.4	52.2	55.5	- 3.3
Averages	5.2	4.8		4.7	4.4		31.3	35.3		4.9	4.6		90.6	89.2	
WOON Pre-Cl 1	14.7	13.8	0.9	4.8	4.4	0.4	33.0	29.8	3.2	10.8	9.7	1.1	168	159	9
WOON Pre-Cl 2	9.0	8.4	0.6	4.8	4.9	-0.1	43.5	39.3	4.2	8.7	8.8	-0.1	196	180	16
WOON Pre-Cl 3	5.7	5.3	0.4	3.3	3.9	-0.6	39.0	43.2	-4.2	9.6	8.1	1.5	222	204	18
WOON Pre-Cl 4	0.9	1.3	-0.4	5.2	4.9	0.3	45.2	41.9	3.3	21.0	20.6	0.4	255	224	31
WOON Pre-Cl 5	4.8	4.4	0.4	5.9	6.2	-0.3	39.9	44.2	-4.3	12.3	12.8	-0.5	211	203	8
Averages	7.1	6.6		4.8	4.9		40.1	39.7		12.5	12.0		210	194	

Table 3
Summary of Results for the Quality Assurance Project Plan

Parameter	Accuracy Percent Mean Recovery	Precision Mean Standard Error	Completeness Percent
Ammonia	95.6	0.0	99
BOD_5	-	0.1	100
Calcium	101.5	0.2	99
Chloride	98.2	1.1	99
Chlorophyll a	-	0.7	100
Magnesium	100.5	0.0	100
Nitrate+Nitrite	96.3	0.1	99
Orthophosphate	92.4	0.0	99
TKN	-	0.0	99
Total Cadmium	97.8	0.04	100
Total Chromium	100.1	0.09	100
Total Copper	103.3	0.27	100
Total Lead	95.6	0.32	100
Total Nickel	101.3	0.28	100

TABLE 4

Accuracy Analyses of the Conventional Parameters in Blackstone Study

BOD_5 GLUTAMIC TEST

STM T0heoretical Reference of BOD_5 (mg/L)	Pre-Survey II Measured BOD_5 (mg/L)	Pre-Survey III Measured BOD_5 (mg/L)
2.0	1.8	1.6
5.9	5.9	4.3
14.9	14.1	13.5
19.8	20.5	18.0
198.0	192.6	188.0

NOTES:

Dissolved Oxygen Probe was calibrated by Winkler Method before each Glutamic Test.

STM Reference method is 5210 B.

TABLE 5

Trip Blanks Analyses of the Measured Parameters in Blackstone Study

Parameter	Survey No. I	Survey No. II	Survey No. III
Ammonia, mg/L	NS	ND	ND
BOD_5	NS	ND	ND
Calcium, mg/L	ND	ND	ND
Chloride, mg/L	NS	ND	ND
Magnesium, mg/L	ND	ND	ND
Nitrate+Nitrite, mg/L	NS	ND	ND
Orthophosphate, mg/L	NS	ND	ND
TKN, mg/L	NS	ND	ND
Suspended Solids, (mg/L)			
TSS	NS	ND	ND
VSS	NS	ND	ND
Trace Metals, (ug/L)			
Cadmium	0.04	0.03	0.03
Chromium	0.3	0.3	0.2
Copper	0.5	0.5	0.4
Lead	0.5	0.1	0.2
Nickel	0.2	0.3	0.1

NOTES:

NS = No Sample or insufficient volume.

Represent averages of trip blank samples collected in a survey.

Appendix D

1991 BLACKSTONE RIVER SURVEY

BIO METHODS

APPENDIX D

WHOLE SEDIMENT TOXICITY TESTS USING Hyallela azteca

Age of Organism: Start a test with 2nd or 3rd instar; 2-3 mm in length. To obtain amphipods, leaf material from the cultures are placed on 5-10 mm mesh sieve. The sieve is placed over a collecting pan containing 2 cm culture water. To separate the juvenile amphipods from the larger adults, a stack of sieves with the sizes #30, #40, and #60 is used. The cultures are siphoned onto the stack of sieves which are sitting in a plastic tray with culture water covering the mesh of the bottom sieve. The water and organisms can then be siphoned from the bottom sieve, a standard #60, into a crystallizing dish. The dishes are examined on a light table. The Hyallela are removed using a disposable pipet and counted. They are put into a beaker of culture water, aerated and feed lightly. Keep in the dark until the test starts. They can be held for 24 hours before the test.

Test Vessels: Use four replicate 1-L beakers per treatment with 20 H. azteca per replicate.

Acclimation: If amphipods are cultured in water different from the overlyin/g water, acclimation is necessary. Place animals in a 50:50 mixture of culture water : overlying water for 2 hours. Then for 2 more hours put them in a 25:75 mixture followed by a transfer to 100% overlying water. At this stage the amphipods are considered acclimated to the overlying water and are ready for immediate use. Select organisms randomly with a pipette and place in 30 ml counting beakers that can be floated in the test chambers before the amphipods are introduced into the sample.

Test duration: </= 10 days short-term test

Temperature: 20 ^{0} C (21-25)

Photoperiod: 16:8 light to dark about 50 foot candles (538 lux)

Sample volume: 200 ml sample (about 2 cm in a 1 Liter beaker) with 800

Aeration: The test chambers with sediment and overlying water are left overnight unaerated but aerated for 30 min. before _____ Hyallela are added.

Test Initiation: The test begins when the organisms are added. Inspect the test chambers <2 after amphipods are added to insure that animals are not

trapped in the surface tension of the water. If floaters are detected, they are replaced with new animals.
Feedings: Ground rabbit pellets dispersed in deionized water. Mix with magnetic stirrer to homogenize food. If dissolved oxygen drops to 40% saturation, suspend feeding. If fungus or bacteria grow on the surface sediment, suspend feeding also for a day or two. Feed 6 mg. rabbit pellets per feeding per 20 amphipods in a 1 liter beaker three times weekly for the first week. Increase to 12 mg per feeding during the second week.

Endpoints and Observations:
Make notes of behavioral changes during the conduct of the test (floating on surface, sediment avoidance). At the end of the test, the sediment is screened using a #35 and a # 50 US standard size sieve.
Live and dead amphipods are recorded. At the end of round 3 Hyallela testing, the sieved sediments were preserved with ethanol and sealed for later examination and counting. The recovered Hyallela were counted as live at the end of the test, because they tend to readily decompose after dying during a test.

WHOLE SEDIMENT TOXICITY TESTS USING Chironomus tentans

Age of Organism: A test should be started with 2nd instar larvae. Egg cases are obtained by aspirating adults into a 1000 ml Erlenmeyer flask in the morning. In late afternoon, 300 ml. of culture water is added to the flask. Egg cases are deposited overnight and 1st instar larvae begin to hatch after about 3 days at 20 degrees C. 12-16 days before a test is begun, 3 freshly laid midge cases should be placed in a large flask or enameled rearing pan with water to a depth of 3 cm. No substrate is added to the pan. Fish food flakes (Tetramin) should be added at a rate of 3 ml/day (10 g/100 ml. blended in water). Fresh water should be added as necessary to make up for evaporation. The larvae in the flasks/pans are presumed to be 2nd instars on the 12th day from the time the eggs were laid. Most larvae will remain as 2nd instars until day 16. Larvae > 16 days old should not be used to start a test. Start a rearing pan every 4 days for ongoing toxicity testing.

Handling: Midges should be handled as little as possible. Larvae should be transferred with a 7 mm glass pipet. Midges should be introduced into solutions beneath the air-water interface. Any midges that touch dry surfaces, are dropped or injured during handling should be discarded.

Acclimation: If the midges are cultured in water different from the overlying water or temperature, an acclimation process is necessary. Place animals for 2 hours in a 50:50 mixture of culture water to overlying water, then for 2 hours in a 25:75 mixture of culture water to overlying water, followed by a transfer into 100% overlying water. Midges should be randomly selected from the

acclimation water with a pipette and placed into counting beakers ie. 30 ml beakers that can be floated in the test chambers before the midges are introduced into the exposure system.

Test design: Use 2 liter beakers containing 2 cm of sediment and 1.5 L of overlying water in static testing. Add 20 C. tentans per beaker.

Test Initiation: Sediments should be homogenized and placed in the test chambers on the day before addition of test organisms (Day -1). Test chambers should be covered and overlying water aerated overnight. The test begins when the midges are introduced to the test chambers. Test chambers should be inspected < 2 hours after midges are introduced to insure that animals are not trapped in the surface tension of the water. These floaters do not survive well and should be replaced with healthy animals.

Feeding: Feed 50 mg. fish food flakes (dry weight, administered in a 0.5 ml suspension) daily to each beaker. If food collects on sediment, fungus or bacteria may grow and feeding should be suspended for a day or more. A drop in dissolved oxygen to 40% saturation might indicate that all of the food is not being consumed so feeding should also be suspended.

Endpoints : Larval survival and growth can be assessed by ending the tests between days 10 to day 14 when larvae have reached the 3rd or 4th instar. At this time, the larvae can be removed from sediment using a #35 sieve. The midges can be rinsed from the sieve into collecting pans and pipeted from the rinse water. Growth determinations using dry weight (dried at 60 degrees C) are preferable to length.

Appendix E

1991 BLACKSTONE RIVER SURVEY

BIO TAXA

APPENDIX E

1991 BLACKSTONE RIVER SURVEY

BENTHIC MACROINVERTEBRATE DATA

EPA Station # BI01 (River Mile 44.0)

DWPC Station # BS10

	TOLERANCE VALUE*	ROCK BASKETS			KICK NETS		
		A	B	C	A	B	C
ANNELIDA							
Oligochaeta (Aquatic Earthworms)							
Tubificida							
Tubificidae	10				13	5	1
Hirudinea (Leeches)							
Rhynchobdellida							
Glossiphoniidae							
Helobdella sp.	7					2	
Pharyngobdellida							
Erpobdellidae							
Erpobdella sp.	8		3		1		
ARTHROPODA							
Crustacea							
Isopoda							
Asellidae							
Caecidotea sp.	8	1	2	2			1
Amphipoda							
Gammaridae							
Gammarus sp.	6	1	5	4			
Talitridae							
Hyalella sp.	8				1		
Insecta							
Odonata							
Anisoptera (Dragonflies)							
Aeschnidae							
Boyeria sp.	2			1			
Zygoptera (Damselflies)							
Coenagrionidae							
Argia sp.	6		2	2			
Enallagma sp.	8		3	5	8	3	3
Hydropsychidae							
Cheumatopsyche sp.	5		1				1

APPENDIX E

BENTHIC MACROINVERTEBRATE DATA (Continued)

EPA Station # BI01 (River Mile 44.0)

DWPC Station # BS10

	TOLERANCE VALUE*	ROCK BASKETS			KICK NETS		
		A	B	C	A	B	C
Elmidae (Riffle Beetles)							
Microcylloepus sp.	2		1				
Diptera (True Flies)							
Tipulidae (Crane Flies)							
Tipula sp.	4	1			4	2	5
Ceratopogonidae (Biting Midges)							
Bezzia sp.	6	1					
Simuliidae (Black Flies)							
Simulium sp.	4.5	1	2			3	
Chironomidae (Midges)							
Tanypodinae							
Clinotanypus sp.	8			1			1
Conchapelopia sp.	6	16	19	16	8	10	14
Thienemannimyia sp.	6				1	3	
Orthocladiinae							
Cricotopus sp.	7	2	3	1	1		
Orthocladius sp.	6				1		
Chironominae							
Chironomus sp.	10	1		3	2		
Glyptotendipes sp.	10	1					
Polypedilum sp.	6	72	55	60	52	65	73
Rheotanytarsus sp.	6		1				
Empididae							
Hemerodromia sp.	6	3	3	5	1	3	3
MOLLUSCA							
Gastropoda (Snails)							
Mesogastropoda							
Basomatophora							
Physidae							
Physella sp.	8						1
Total # of Individuals		100	100	100	93	96	103

*Tolerance Value: From Bode, *et al.*, 1991; for taxa not listed in Bode, tolerance values used were taken from DWPC, 1990.

APPENDIX E

1991 BLACKSTONE RIVER SURVEY

BENTHIC MACROINVERTEBRATE DATA

EPA Station # BIO2 (River Mile 39.7)

DWPC Station # BS12

	TOLERANCE VALUE	ROCK BASKETS			KICK NETS		
		A	B	C	A	B	C
ANNELIDA							
Oligochaeta (Aquatic Earthworms)							
Lumbricina	8						2
Tubificida							
Tubificidae							
Limnodrilus sp.	10						2
Hirudinea (Leeches)							
Rhynchobdellida							
Glossiphoniidae							
Helobdella sp.	7				2	1	3
Pharyngobdellida							
Erpobdellidae							
Erpobdella sp.	8	1	2	1	1	2	1
ARTHROPODA							
Crustacea							
Isopoda							
Asellidae							
Caecidotea sp.	8	3	2	3	6	12	9
Amphipoda							
Gammaridae							
Gammarus sp.	6				9	5	6
Insecta							
Ephemeroptera (Mayflies)							
Baetidae							
Baetis sp.	6				1		
Megaloptera							
Corydalidae (Dobsonflies)							
Corydalus sp.	4		2				

APPENDIX E

BENTHIC MACROINVERTEBRATE DATA (Continued)

EPA Station # BIO2 (River Mile 39.7)

DWPC Station # BS12

	TOLERANCE VALUE	ROCK BASKETS			KICK NETS		
		A	B	C	A	B	C
Trichoptera (Caddisflies)							
Hydropsychidae							
Cheumatopsyche sp.	5	6	10	4	14	7	9
Hydropsyche sp.	4	76	78	86	44	48	41
Diptera (True Flies)							
Tipulidae (Crane Flies)							
Tipula sp.	4			1			
Simuliidae (Black Flies)							
Simulium sp.	4.5	2		2	3	7	9
Prosimulium sp.	2		1				
Chironomidae (Midges)							
Tanypodinae							
Ablabesmyia sp.	8				1		
Conchapelopia sp.	6	2	1	1		1	1
Orthocladiinae	3.5						1
Cricotopus sp.	7	2	1		1		2
Nanocladius sp.	3	1	1	1		1	1
Orthocladius sp.	6				2		
Rheocricotopus sp.	6			1			
Chironominae							
Polypedilum sp.	6	7	2		9	13	9
MOLLUSCA							
Gastropoda (Snails)							
Mesogastropoda							
Basomatophora							
Physidae							
Physella sp.	8				2	4	2
Total # of Individuals		100	100	100	95	101	98

APPENDIX E

1991 BLACKSTONE RIVER SURVEY

BENTHIC MACROINVERTEBRATE DATA

EPA Station BIO3 (River Mile 33.6)

DWPC Station # BS14

	TOLERANCE VALUE	ROCK BASKETS			KICK NETS		
		A	B	C	A	B	C
ANNELIDA							
Hirudinea (Leeches)							
Pharyngobdellida							
Erpobdellidae							
Erpobdella sp.	8		1			1	
ARTHROPODA							
Crustacea							
Isopoda							
Asellidae							
Caecidotea sp.	8		1				
Insecta							
Ephemeroptera (Mayflies)							
Baetidae							
Baetis sp.	6					1	
Trichoptera (Caddisflies)							
Hydropsychidae							
Cheumatopsyche sp.	5	30	27	30	23	26	28
Hydropsyche sp.	4	64	62	62	72	62	65
Diptera (True Flies							
Tipulidae (Crane Flies)							
Tipula sp.	4	4					
Chironomidae (Midges)							
Tanypodinae							
Conchapelopia sp.	6	1	8	7		2	
Orthocladiinae	1						
Cardiocladius sp.	5					1	
Cricotopus sp.	7	1			1		2
Nanocladius sp.	3				1		
Orthocladius sp.	6			1	8	9	9
Paracricotopus sp.	4				1		
Chironominae							
Polypedilum sp.	6				2	1	2
Rheotanytarsus sp.	6		1				
Empididae							
Hemerodromia sp.	6						1
Total # of Individuals		100	100	100	108	103	107

APPENDIX E

1991 BLACKSTONE RIVER SURVEY

BENTHIC MACROINVERTEBRATE DATA

EPA Station # BIO4 (River Mile 27.4)

DWPC Station # BS16

	TOLERANCE VALUE	ROCK BASKETS			KICK NETS		
		A	B	C	A	B	C
ANNELIDA							
Hirudinea (Leeches)							
Pharyngobdellida							
Erpobdellidae							
Erpobdella sp.	8	2	1		1	1	
ARTHROPODA							
Crustacea							
Amphipoda							
Gammaridae							
Gammarus sp.	6					1	1
Insecta							
Ephemeroptera (Mayflies)							
Baetidae							
Acentrella sp.	4		1		2	3	2
Megaloptera							
Corydalidae (Dobsonflies)							
Nigronia sp.	0	1		1			
Trichoptera (Caddisflies)							
Hydropsychidae							
Cheumatopsyche sp.	5	57	42	50	63	48	54
Hydropsyche sp.	4	36	50	47	37	39	36
Diptera (True Flies							
Tipulidae (Crane Flies)							
Tipula sp.	4		2	1			
Simuliidae (Black Flies)							
Simulium sp.	4.5						1
Chironomidae (Midges)							
Tanypodinae							
Conchapelopia sp.	6	1	1	1	1		
Orthocladiinae							
Cardiocladius sp.	5						1
Cricotopus sp.	7					1	
Orthocladius sp.	6		1		2	2	1
Chironominae							
Polypedilum sp.	6	1				1	
Rheotanytarsus sp.	6	2					
Tanytarsus sp.	6		2		1		1
Total # of Individuals		100	100	100	107	96	97

APPENDIX E

1991 BLACKSTONE RIVER SURVEY

BENTHIC MACROINVERTEBRATE DATA

EPA Station # BIO6 (River Mile 19.8)

DWPC Station # BS18

	TOLERANCE VALUE	ROCK BASKETS			KICK NETS		
		A	B	C	A	B	C
ARTHROPODA							
Insecta							
Ephemeroptera (Mayflies)							
Baetidae							
Acentrella sp.	4	3	2		3	4	1
Baetis sp.	6						1
Heptageniidae							
Stenonema sp.	3	8	9	14	17	30	25
Odonata							
Anisoptera (Dragonflies)							
Macromiidae							
Macromia sp.	2				1		1
Zygoptera (Damselflies)							
Coenagrionidae							
Argia sp.	6		1	1			
Enallagma sp.	8					1	
Megaloptera							
Corydalidae (Dobsonflies)							
Corydalus sp.	4		1	3			
Nigronia sp.	0	1				1	1
Trichoptera (Caddisflies)							
Hydropsychidae							
Cheumatopsyche sp.	5	68	73	63	54	52	49
Hydropsyche sp.	4	17	13	17	22	15	22
Brachycentridae							
Brachycentrus sp.	0.5	1		1	1		
Coleoptera (Beetles)							
Elmidae (Riffle Beetles)							
Ancyronyx sp.	5		1				
Diptera (True Flies							
Tipulidae (Crane Flies)							
Antocha sp.	3				1		
Tipula sp.	4						1
Chironomidae (Midges)							
Orthocladiinae							
Cricotopus sp.	7				1		1
Orthocladius sp.	6				1		
Tvetenia sp.	5	1		1			
Chironominae							
Rheotanytarsus sp.	6	1					

APPENDIX E

BENTHIC MACROINVERTEBRATE DATA (Continued)

EPA Station # BIO6 (River Mile 19.8)

DWPC Station # BS18

	TOLERANCE VALUE*	ROCK BASKETS			KICK NETS		
		A	B	C	A	B	C
MOLLUSCA							
Gastropoda (Snails)							
Mesogastropoda							
Basomatophora							
Physidae							
Physella sp.	8					1	1
Planorbidae							
Helisoma sp.	6				3	4	
Total # of Individuals:		100	100	100	104	108	103

APPENDIX E

1991 BLACKSTONE RIVER SURVEY

BENTHIC MACROINVERTEBRATE DATA

EPA Station # BIO8 (River Mile 16.5)

DWPC Station # BS19

	TOLERANCE VALUE	ROCK BASKETS			KICK NETS		
		A	B	C	A	B	C
ARTHROPODA							
Insecta							
Ephemeroptera (Mayflies)							
Siphlonuridae							
Isonychia sp.	2	9	4	9	1	1	2
Baetidae							
Acentrella sp.	4	2			5	3	2
Baetis sp.	6	1		3		7	1
Heptageniidae							
Stenonema sp.	3	9	14	24	13	24	15
Odonata							
Zygoptera (Damselflies)							
Coenagrionidae							
Argia sp.	6			1	2		
Megaloptera							
Corydalidae (Dobsonflies)							
Corydalus sp.	4		2	3	2	2	1
Nigronia sp.	0			1	2		1
Trichoptera (Caddisflies)							
Philopotamidae							
Chimarra sp.	4		1	2		2	1
Psychomyiidae							
Psychomyia sp.	2					1	
Hydropsychidae							
Cheumatopsyche sp.	5	44	32	30	29	21	34
Hydropsyche sp.	4	28	36	21	37	35	31
Macrostemum sp.	3	5	11	2	3	4	3
Hydroptilidae							
Leucotrichia sp.	6			1	4	4	6

APPENDIX E

BENTHIC MACROINVERTEBRATE DATA (Continued)

EPA Station # BI08 (River Mile 16.5)

DWPC Station # BS19

	TOLERANCE VALUE*	ROCK BASKETS			KICK NETS		
		A	B	C	A	B	C
Diptera (True Flies)							
Tipulidae (Crane Flies)							
Antocha sp.	3				1		2
Chironomidae (Midges)							
Orthocladiinae							
Cardiocladius sp.	5					1	
Cricotopus sp.	7			2	2		1
Tvetenia sp.	5	1		1	3	2	
Chironominae							
Parachironomus sp.	10	1					
Polypedilum sp.	6				1		
Empididae							
Hemerodromia sp.	6				2		
MOLLUSCA							
Pelecypoda (Bivalves)							
Heterodonta							
Sphaeriidae							
Sphaerium sp.	6					2	2
Total # of Individuals		100	100	100	107	109	102

APPENDIX E

1991 BLACKSTONE RIVER SURVEY

BENTHIC MACROINVERTEBRATE DATA

EPA Station # BIO9 (River Mile 9.8)

DWPC Station # BSRI1

	TOLERANCE VALUE	ROCK BASKETS			KICK NETS		
		A	B	C	A	B	C
ARTHROPODA							
Crustacea							
Amphipoda							
Gammaridae							
Gammarus sp.	6					1	1
Insecta							
Ephemeroptera (Mayflies)							
Baetidae							
Acentrella sp.	4				1	3	1
Baetis sp.	6				1	2	2
Heptageniidae							
Stenonema sp.	3	6	2	3	12	9	12
Odonata							
Zygoptera (Damselflies)							
Coenagrionidae							
Argia sp.	6						1
Megaloptera							
Corydalidae (Dobsonflies)							
Corydalus sp.	4		1	1	1		1
Trichoptera (Caddisflies)							
Hydropsychidae							
Cheumatopsyche sp.	5	53	52	48	25	22	23
Hydropsyche sp.	4	32	39	37	45	50	53
Macrostemum sp.	3		1				
Hydroptilidae							
Leucotrichia sp.	6					1	1
Leptoceridae							
Oecetis sp.	5				1		
Coleoptera (Beetles)							
Hydrophilidae							
Berosus sp.	5					1	1
Diptera (True Flies							
Chironomidae (Midges)							
Orthocladiinae							
Cricotopus sp.	7				1		
Nanocladius sp.	3	1					
Tvetenia sp.	5	1		2	6	8	
Chironominae							
Dicrotendipes sp.	8			2			1
Glyptotendipes sp.	10	7	5	1	6	4	3
Polypedilum sp.	6			6	2	1	2
Rheotanytarsus sp.	6				2		

APPENDIX E

BENTHIC MACROINVERTEBRATE DATA (Continued)

EPA Station # BIO9 (River Mile 9.8)

DWPC Station # BSRI1

	TOLERANCE VALUE	ROCK BASKETS			KICK NETS		
		A	B	C	A	B	C
MOLLUSCA							
Pelecypoda (Bivalves)							
Heterodonta							
Sphaeriidae							
Sphaerium sp.	6				1		1
Total # of individuals		100	100	100	104	102	103

APPENDIX E

1991 BLACKSTONE RIVER SURVEY

BENTHIC MACROINVERTEBRATE DATA

EPA Station BIO10 (River Mile 0.0)

DWPC Station # BSRI2

	TOLERANCE VALUE	ROCK BASKETS			KICK NETS		
		A	B	C	A	B	C
Insecta							
Ephemeroptera (Mayflies)							
Baetidae							
Acentrella sp.	4						2
Baetis sp.	6				1		
Heptageniidae							
Stenonema sp.	3	2	3	1	2	2	
Trichoptera (Caddisflies)							
Hydropsychidae							
Cheumatopsyche sp.	5	81	86	83	82	61	72
Hydropsyche sp.	4	15	8	8	10	20	18
Coleoptera (Beetles)							
Elmidae (Riffle Beetles)							
Macronychus sp.	5	1					
Diptera (True Flies)							
Tipulidae (Crane Flies)							
Antocha sp.	3				1		
Simuliidae (Black Flies)							
Prosimulium sp.	2					1	
Chironomidae (Midges)							
Orthocladiinae							
Cardiocladius sp.	5				1	1	1
Cricotopus sp.	7		1	5	2	10	5
Nanocladius sp.	3		1				1
Orthocladius sp.	6					1	
Tvetenia sp.	5			2	2		
Chironominae							
Glyptotendipes sp.	10	1					
Polypedilum sp.	6			1	1	2	
MOLLUSCA							
Gastropoda (Snails)							
Mesogastropoda							
Basomatophora							
Planorbidae							
Helisoma sp.	6		1				
Pelecypoda (Bivalves)							
Heterodonta							
Sphaeriidae							
Sphaerium sp.	6					4	4
Total # of individuals		100	100	100	102	102	103

APPENDIX E

1991 BLACKSTONE RIVER SURVEY

BENTHIC MACROINVERTEBRATE DATA

EPA Station # BIO5:MR (River Mile 25.5/11.1)

DWPC Station # MF02

	TOLERANCE VALUE	ROCK BASKETS			KICK NETS		
		A	B	C	A	B	C
ARTHROPODA							
Amphipoda							
Talitridae							
Hyalella sp.	8	1			2		1
Insecta							
Ephemeroptera (Mayflies)							
Siphlonuridae							
Isonychia sp.	2	28	8	20	23	25	19
Baetidae							
Acentrella sp.	4				1	1	1
Baetis sp.	6			1			
Heptageniidae							
Stenonema sp.	3	14	4	9	13	14	11
Odonata							
Anisoptera (Dragonflies)							
Aeschnidae							
Boyeria sp.	2	1				1	
Zygoptera (Damselflies)							
Coenagrionidae							
Argia sp.	6				1	1	
Megaloptera							
Corydalidae (Dobsonflies)							
Corydalus sp.	4	4	2	4	4	1	2
Trichoptera (Caddisflies)							
Philopotamidae							
Chimarra sp.	4	21	41	16	10	4	7
Polycentropodidae							
Neureclipsis sp.	7	2	1	3	1	1	
Hydropsychidae	2						
Cheumatopsyche sp.	5	9	7	15	4	11	8
Hydropsyche sp.	12	18	30	30	28	25	34
Leptoceridae							
Oecetis sp.	5					1	

APPENDIX E

BENTHIC MACROINVERTEBRATE DATA (Continued)

EPA Station # BIO5:MR (River Mile 25.5/11.1)

DWPC Station # MF02

	TOLERANCE VALUE	ROCK BASKETS			KICK NETS		
		A	B	C	A	B	C
Lepidoptera (Butterflies and Moths)							
Pyralidae							
Parapoynx sp.	5				1		
Coleoptera (Beetles)							
Elmidae (Riffle Beetles)							
Promoresia sp.	2					2	
Diptera (True Flies)							
Simuliidae (Black Flies)							
Simulium sp.	4.5		4		4	5	2
Chironomidae (Midges)							
Tanypodinae							
Procladius sp.	9				1		
Orthocladiinae							
Nanocladius sp.	3					1	
Orthocladius sp.	6	1				2	
Rheocricotopus sp.	6			1			
Tvetenia sp.	5		1		6	3	6
Chironominae							
Rheotanytarsus sp.	6	1	2	1		1	4
Total # of individuals		100	100	100	99	99	95

APPENDIX E

1991 BLACKSTONE RIVER SURVEY

BENTHIC MACROINVERTEBRATE DATA

EPA Station # BIO7:MI (River Mile 13.3/3.0)

DWPC Station # ML05

	TOLERANCE VALUE	ROCK BASKETS*			KICK NETS**		
		A	B	C	A	B	C
ARTHROPODA							
Insecta							
Ephemeroptera (Mayflies)							
Siphlonuridae							
Isonychia sp.	2	5	7				
Baetidae							
Acentrella sp.	4		1				
Baetis sp.	6	6	7				
Heptageniidae							
Stenonema sp.		25	29				
Plecoptera (Stoneflies)							
Perlidae							
Acroneuria sp.	0	1	1				
Megaloptera							
Corydalidae (Dobsonflies)							
Corydalus sp.	4	1					
Nigronia sp.	0	1					
Trichoptera (Caddisflies)							
Philopotamidae							
Chimarra sp.	4	2	4				
Hydropsychidae							
Cheumatopsyche sp.	5	29	21				
Hydropsyche sp.	4	27	25				
Coleoptera (Beetles)							
Psephenidae (Water Pennies)							
Psephenus sp.	4	1	3				
Chironomidae (Midges)							
Chironominae							
Rheotanytarsus sp.	6	2	2				
Total # of individuals		100	100				

* Only two of the three rock basket samples collected at this station were analyzed.
**Kick-Net samples collected at this station were not analyzed.

Appendix F

1991 BLACKSTONE RIVER SURVEY

SEDIMENT OXYGEN DEMAND

SEDIMENT OXYGEN DEMAND STUDIES OF THE BLACKSTONE RIVER

~ SEPTEMBER 1992 ~

Biology Section
Environmental Services Division
U.S. Environmental Protection Agency
Regional Laboratory
Lexington, Massachusetts

INTRODUCTION

A sediment oxygen demand (SOD) study was undertaken on the Blackstone River in central Massachusetts and Rhode Island, between September 1 and 10, 1992. This investigation was conducted by the U.S. Environmental Protection Agency (EPA) for the purpose of developing data for the mathematical model, QUAL 2E, to determine distinct oxygen regimes in the Blackstone River. The EPA conducted analysis of sediments at ten (10) stations (station #s 92-1, 92-2A, 92-2B, 92-3, 92-4, 92-5, 92-6, 92-7, 92-8, and 92-9, which extended from Singing Dam in Sutton, MA to Albion Dam in Cumberland, RI.

The method developed by the U.S. Environmental Protection Agency Region I Biology Section involves confining a measurable volume of undisturbed sediment and overlying water in a core cylinder and measuring the depletion of dissolved oxygen over time. Sediment oxygen demand is considered the sum of biological and chemical processes that exhibit an oxygen demand by the sediment portion of the sample.

The core sample is collected using a gravity type corer (WILDCO No. 2402) which is equipped with a plunger and a suction flap for use in deep water. In shallow water the sample may be collected by manual coring. The acrylic core cylinder measures 50.5 centimeters in height and 5.1 centimeters, inside diameter. The cylinder is removed from the corer and stoppered at both ends after the sediment sample is retrieved. This provides an undisturbed profile of benthic sediments and overlying water.

Since the corer penetrates the substrate to variable depths depending on sediment composition, both the sediment and water column contained within the core must be precisely measured. Sediment surface area is always a constant in the core cylinder. In cases where the sediment is soft or unconsolidated, the corer can penetrate the sediment entirely. This requires that some of the sediment be carefully bled off the bottom of the cylinder. Overlying water may then be added to fill the cylinder. The water column depth over the sediment is adjusted to a minimum of 35 centimeters. Overlying water is also collected using a 3 L Kemmerer sampler. Five replicate cores are collected at each sample location.

Water column respiration or production is evaluated as follows: Six 300 ml BOD bottles are filled at the sample location. Half are fixed in the field and then titrated in the laboratory according to the Winkler method. This establishes an "Initial Blank" value. The remaining bottles are incubated in a shaded water bath for the duration of the SOD test. Upon completion of the test, these are also titrated, establishing a "Final Blank" value. Any measured difference between the "Initial" and "Final" values are attributed to water column respiration or production and the sediment oxygen demand rates are adjusted accordingly.

The water column height is measured and the cylinder is placed in a temperature controlled water bath. Dissolved oxygen is monitored in each of the core cylinders simultaneously using an Orbisphere five channel dissolved oxygen meter (Model 2601). These five probes are calibrated daily against a Winkler standard. The core tops are modified to accept the dissolved oxygen probes. A self-contained stirring apparatus on each probe insures adequate flow past the sensing head and also gives continuous mixing within the cylinder. Dissolved oxygen concentrations within the cylinder are monitored for approximately three to four hours and recorded every thirty minutes. This includes a one-half to one hour period of temperature stabilization within the cylinder, when necessary. The water temperature maintained in the water bath during this survey was 21 ± 2 degrees Celsius. This is the approximate temperature to be used in the waste load allocation model.

Oxygen depletion is plotted against time. The portion of each graph where oxygen consumption is constant over time is used in the calculation of the SOD rate.

Sediment oxygen demand is calculated using the equation:

$$\text{SOD } gO_2/m^2/day = \frac{((O_i - O_f) - (B_i - B_f))\ (V)}{(SA)\ (T)}$$

O_i = initial dissolved oxygen (DO) mg/L

O_f = final DO mg/L

B_i = initial DO in bottles mg/L

B_f = final DO in bottles mg/L

V = volume of confined water m^3

SA = sediment surface area m^2

T = time days

RESULTS

Table 1 lists the ten sample locations by station number, the location of the station by town, the approximate distance upstream from Slater Mill, the USGS quad sheet on which the station may be located, the mean SOD (sediment oxygen demand per gram of oxygen per meter squared per day) for each station calculated, and a brief description of the sediment type.

Sta. #	Town	Location	River Kilometers	USGS Sheet	SOD (Mean)	Sediment Type
1	Sutton	Upstream from Singing dam	62.40	*Grafton*, MA	6.026	black /oily very fine
2A	Riverdale Pond	Upstream from dam	51.80	Grafton, MA	2.245	fine silt
2B	Riverdale Pond	Upstream from dam	52.90	Grafton, MA	5.777	fine silt
3	Rice City Pond	Upstream from dam	45.45	Blackstone, MA	1.773	black/oily fine w/ sand
4	Rice City Pond	Upstream from dam	44.95	Blackstone, MA	3.190	black /oily very fine
5	Millville	Rt. 122 between RR bridges-S of Millville Ctr.	30.20	Blackstone, MA	1.546	sandy/organic
6	Blackstone	Upstream from Tupperware dam	29.00	Blackstone, MA	1.551	sandy
7	Woonsocket	Downstream from Woonsocket POTW	18.10	Pawtucket, RI	5.789	very sandy
8	Cumberland	Upstream from Manville dam	16.05	Pawtucket, RI	2.317	sandy/organic
9	Cumberland	Upstream from Albion dam	14.08	Pawtucket, RI	2.523	sandy/organic

TABLE 1

Appendix A presents the tables of SOD rate calculations. The mean sediment oxygen demand rate of each of five replicates is given at the end of each block of station information. A standard deviation for this rate has also been calculated. **Appendix B** includes figures which plot DO and temperature for each core over time. Sediment oxygen demand rates for stations 1 - 9 ranged from a low of 1.546 $g/m^2/d$ at station 5 to a high of 6.026 $g/m^2/d$ at station 1. Station locations are identified in Figures 1 through 5 in **Appendix C**. **Appendix D** lists the raw data in tables.

APPENDIX A

Station No. 92-1	1	2	3	4	5
Initial sample Oxygen (mg/L)	7.05	5.47	6.1	7.2	6.17
Final Sample Oxygen (mg/L)	6.03	4.2	3.82	5.5	2.84
Initial Blank Oxygen (ml/L)	7.6	7.6	7.6	7.6	7.6
Final Blank Oxygen (ml/L)	8.2	8.2	8.2	8.2	8.2
Column height (m)	0.355	0.379	0.335	0.425	0.315
Time (Enter hrs.)	4	3	3	4	4
Time (days)	0.166666667	0.125	0.125	0.166666667	0.166666667
Surface Area (m2)	0.002	0.002	0.002	0.002	0.002
Volume (m3)	0.00071	0.000758	0.00067	0.00085	0.0006
minus probe	0.0006	0.000648	0.00056	0.00074	0.00052
SOD g/m2/d =	3.4506	5.66984	7.7184	5.865	7.4277
Mean SOD	6.026308				
Std Dev	1.524102115				

Station No. 92-2A	1	2	3	4	5
Initial sample Oxygen (mg/L)	6.52	6.7	5.78	5.88	5.85
Final Sample Oxygen (mg/L)	5.71	5.65	5.27	5.06	4.04
Initial Blank Oxygen (ml/L)	7	7	7	7	7
Final Blank Oxygen (ml/L)	6.77	6.77	6.77	6.77	6.77
Column height (m)	0.38	0.4	0.39	0.38	0.36
Time (Enter hrs.)	3.5	4	3.5	3.5	2.5
Time (days)	0.145833333	0.166666667	0.145833333	0.145833333	0.104166667
Surface Area	0.002	0.002	0.002	0.002	0.002
Volume	0.00076	0.0008	0.00078	0.00076	0.00072
minus probe	0.00065	0.00069	0.00067	0.00065	0.00061
SOD g/m2/d =	1.511314286	1.968	0.7488	1.537371429	5.46048
Mean SOD	2.245193143				
Std Dev	1.654913158				

Station No. 92-2B	1	2	3	4	5
Initial sample Oxygen (mg/L)	11.97	10.13	10.35	11.06	10.37
Final Sample Oxygen (mg/L)	10.09	8.71	9.07	9.56	8.67
Initial Blank Oxygen (ml/L)	11.03	11.03	11.03	11.03	11.03
Final Blank Oxygen (ml/L)	11.26	11.26	11.26	11.26	11.26
Column height (m)	0.405	0.37	0.25	0.4	0.43
Time (Enter hrs.)	2.5	3	2.5	3	3
Time (days)	0.104166667	0.125	0.104166667	0.125	0.125
Surface Area (m2)	0.002	0.002	0.002	0.002	0.002
Volume (m3)	0.00081	0.00074	0.0005	0.0008	0.00086
minus probe	0.0007	0.00063	0.00039	0.00069	0.00075
SOD g/m2/d =	8.20368	4.884	3.624	5.536	6.6392
Mean SOD	5.777376				
Std Dev	1.557119325				

Station No. 92-3	1	2	3	4	5
Initial sample Oxygen (mg/L)	6.77	7.3	7.42	5.52	7.54
Final Sample Oxygen (mg/L)	6.01	6.43	6.54	5.17	6.45
Initial Blank Oxygen (ml/L)	8.4	8.4	8.4	8.4	8.4
Final Blank Oxygen (ml/L)	8.4	8.4	8.4	8.4	8.4
Column height (m)	0.355	0.365	0.35	0.372	0.365
Time (Enter hrs.)	3	4.5	4.5	2.5	4.5
Time (days)	0.125	0.1875	0.1875	0.104166667	0.1875
Surface Area	0.002	0.002	0.002	0.002	0.002
Volume	0.00071	0.00073	0.0007	0.000744	0.00073
minus probe	0.0006	0.00062	0.00059	0.000634	0.00062
SOD g/m2/d =	2.1584	1.6936	1.642666667	1.24992	2.121866667
Mean SOD	1.773290667				
Std Dev	0.336792076				

Station No. 92-4	1	2	3	4	5
Initial sample Oxygen (mg/L)	5.81	7.71	7.43	6.91	7.02
Final Sample Oxygen (mg/L)	4.57	7.05	6.39	6.28	6.12
Initial Blank Oxygen (ml/L)	8	8	8	8	8
Final Blank Oxygen (ml/L)	8	8	8	8	8
Column height (m)	0.305	0.34	0.32	0.36	0.32
Time (Enter hrs.)	2	3	2.5	3	1.5
Time (days)	0.083333333	0.125	0.104166667	0.125	0.0625
Surface Area	0.002	0.002	0.002	0.002	0.002
Volume	0.00061	0.00068	0.00064	0.00072	0.000[illegible]
minus probe	0.0005	0.00057	0.00053	0.00061	0.00053
SOD g/m2/d =	4.5384	1.7952	3.19488	1.8144	4.608
Mean SOD	3.190176				
Std Dev	1.238278855				

Station No. 92-5	1	2	3	4	5
Initial sample Oxygen (mg/L)	7.84	8.11	8.19	8.03	7.69
Final Sample Oxygen (mg/L)	7.33	7.23	7.5	7.16	6.71
Initial Blank Oxygen (ml/L)	8.2	8.2	8.2	8.2	8.2
Final Blank Oxygen (ml/L)	8.06	8.06	8.06	8.06	8.06
Column height (m)	0.4	0.393	0.377	0.387	0.37
Time (Enter hrs.)	3	4	4	4	4
Time (days)	0.125	0.166666667	0.166666667	0.166666667	0.166666667
Surface Area	0.002	0.002	0.002	0.002	0.002
Volume	0.0008	0.000786	0.000754	0.000774	0.00074
minus probe	0.00069	0.000676	0.000644	0.000664	0.00063
SOD g/m2/d =	1.184	1.74492	1.2441	1.69506	1.8648
Mean SOD	1.546576				
Std Dev	0.277707559				

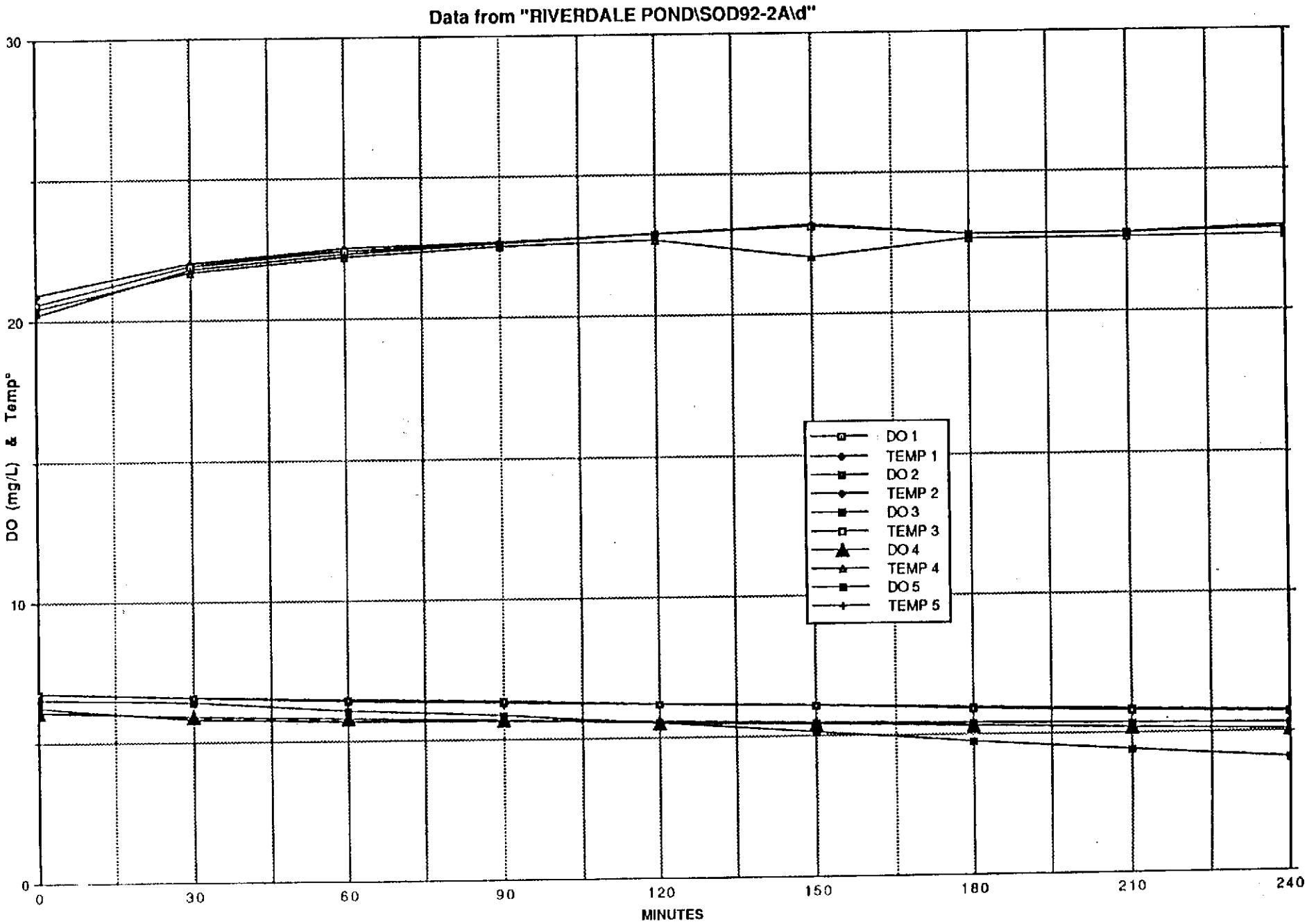
Station No. 92-6	1	2	3	4	5
Initial sample Oxygen (mg/L)	6.67	6.86	7.26	5.81	6.94
Final Sample Oxygen (mg/L)	6.2	6.25	6.76	4.98	6.35
Initial Blank Oxygen (ml/L)	8.2	8.2	8.2	8.2	8.2
Final Blank Oxygen (ml/L)	8.2	8.2	8.2	8.2	8.2
Column height (m)	0.37	0.332	0.343	0.319	0.36
Time (Enter hrs.)	3.5	3.5	3.5	2.5	3.5
Time (days)	0.145833333	0.145833333	0.145833333	0.104166667	0.145833333
Surface Area	0.002	0.002	0.002	0.002	0.002
Volume	0.00074	0.000664	0.000686	0.000638	0.00072
minus probe	0.00063	0.000554	0.000576	0.000528	0.00061
SOD g/m2/d =	1.192457143	1.388708571	1.176	2.541792	1.456457143
Mean SOD	**1.551082971**				
Std Dev	0.507173263				

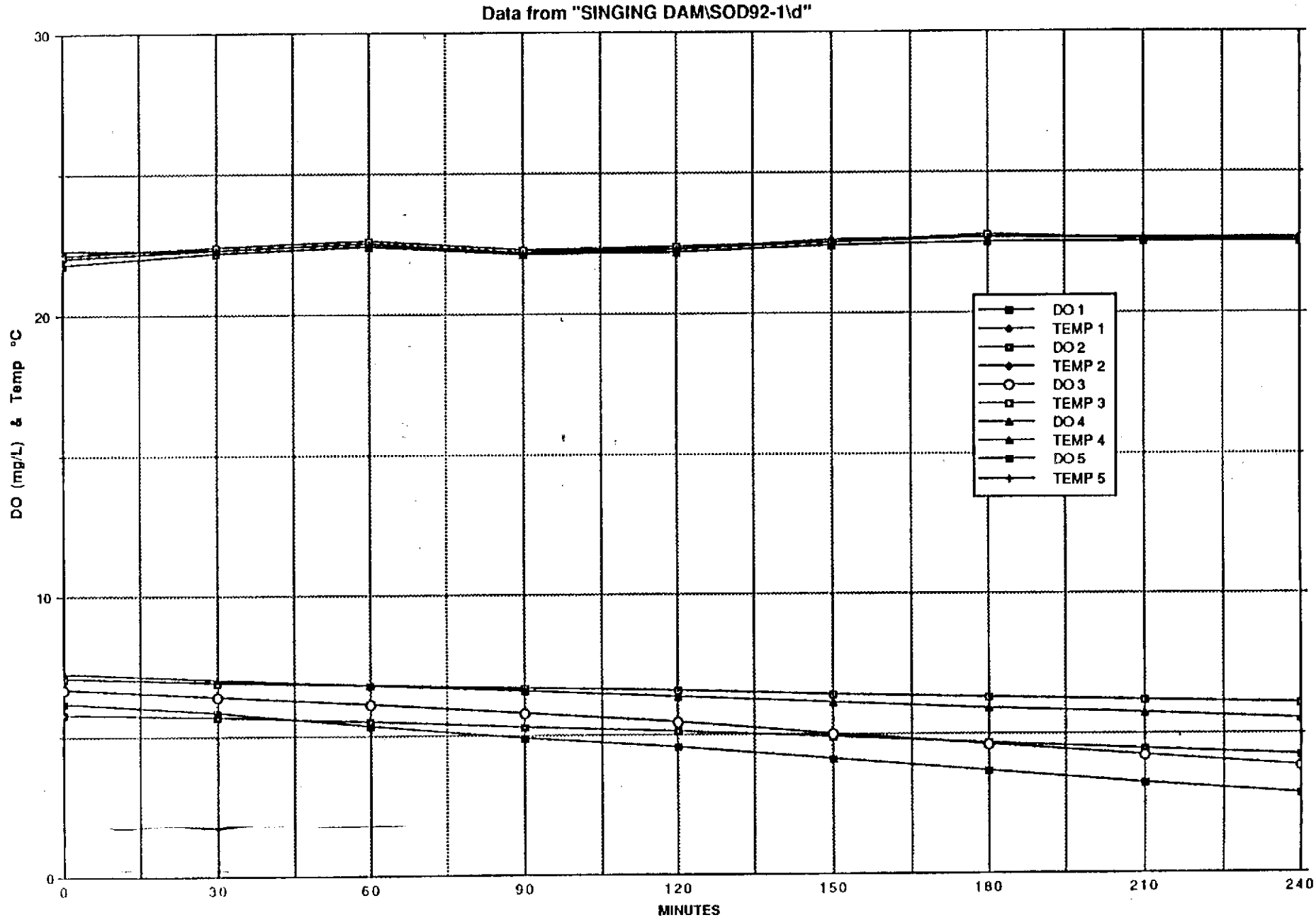
Station No. 92-7	1	2	3	4	5
Initial sample Oxygen (mg/L)	6.12	5.5	6.23	5.58	5.01
Final Sample Oxygen (mg/L)	5.04	4.34	4.7	4.04	3.82
Initial Blank Oxygen (ml/L)	6.3	6.3	6.3	6.3	6.3
Final Blank Oxygen (ml/L)	6.86	6.86	6.86	6.86	6.86
Column height (m)	0.36	0.345	0.394	0.417	0.35
Time (Enter hrs.)	3	3	3	3	2.5
Time (days)	0.125	0.125	0.125	0.125	0.104166667
Surface Area	0.002	0.002	0.002	0.002	0.002
Volume	0.00072	0.00069	0.000788	0.000834	0.0007
minus probe	0.00061	0.00058	0.000678	0.000724	0.00059
SOD g/m2/d =	4.7232	4.7472	6.58768	7.0056	5.88
Mean SOD	**5.788736**				
Std Dev	0.932476577				

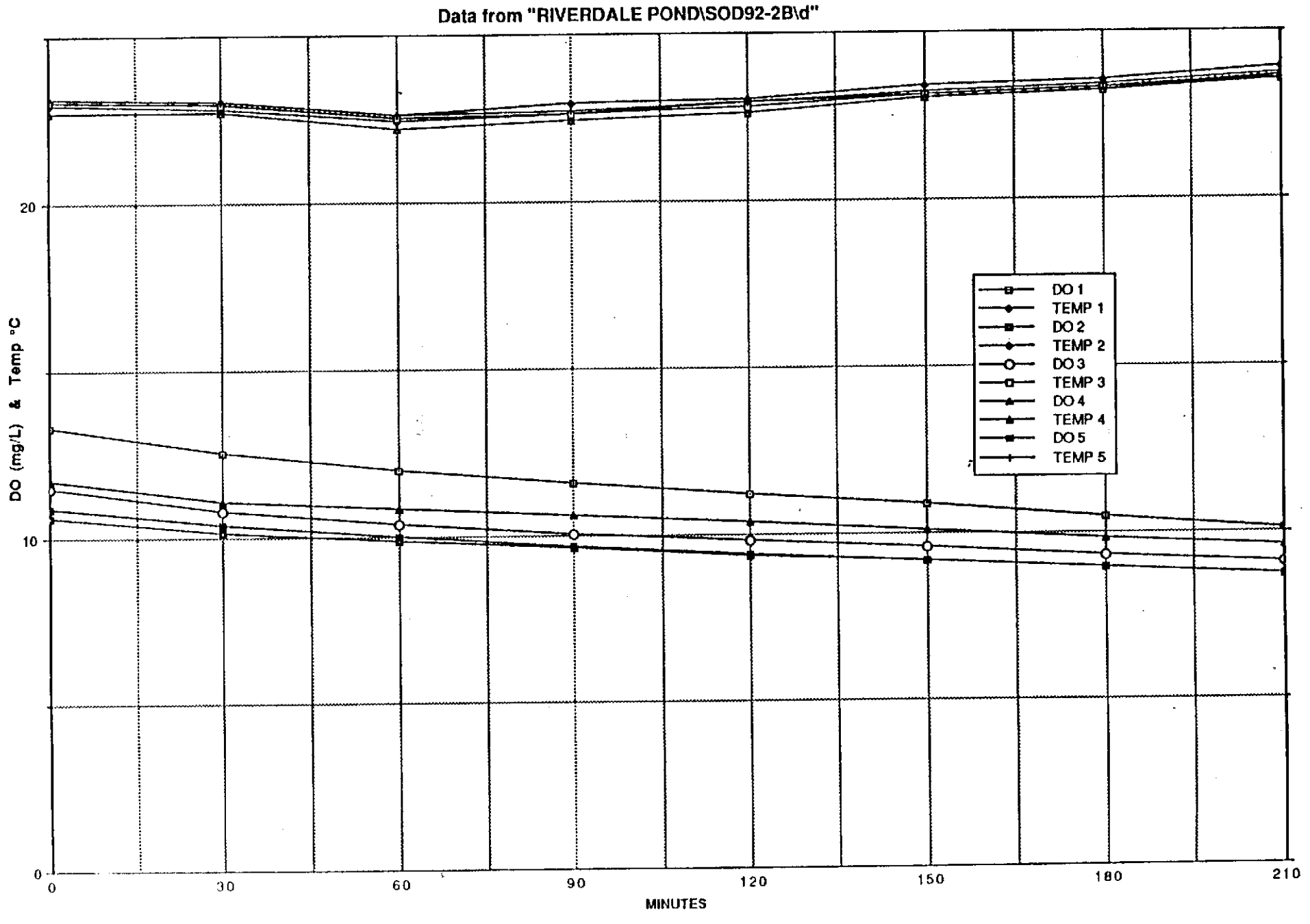
Station No. 92-8	1	2	3	4	5
Initial sample Oxygen (mg/L)	6.59	7.25	6.28	6.33	6.43
Final Sample Oxygen (mg/L)	6.13	6.93	5.54	5.78	5.89
Initial Blank Oxygen (ml/L)	7.1	7.1	7.1	7.1	7.1
Final Blank Oxygen (ml/L)	7.23	7.23	7.23	7.23	7.23
Column height (m)	0.385	0.37	0.39	0.385	0.38
Time (Enter hrs.)	2.5	2.5	2.5	2.5	3
Time (days)	0.104166667	0.104166667	0.104166667	0.104166667	0.125
Surface Area	0.002	0.002	0.002	0.002	0.002
Volume	0.00077	0.00074	0.00078	0.00077	0.00076
minus probe	0.00066	0.00063	0.00067	0.00066	0.00065
SOD g/m2/d =	2.18064	1.5984	3.25728	2.51328	2.0368
Mean SOD	**2.31728**				
Std Dev	0.554282234				

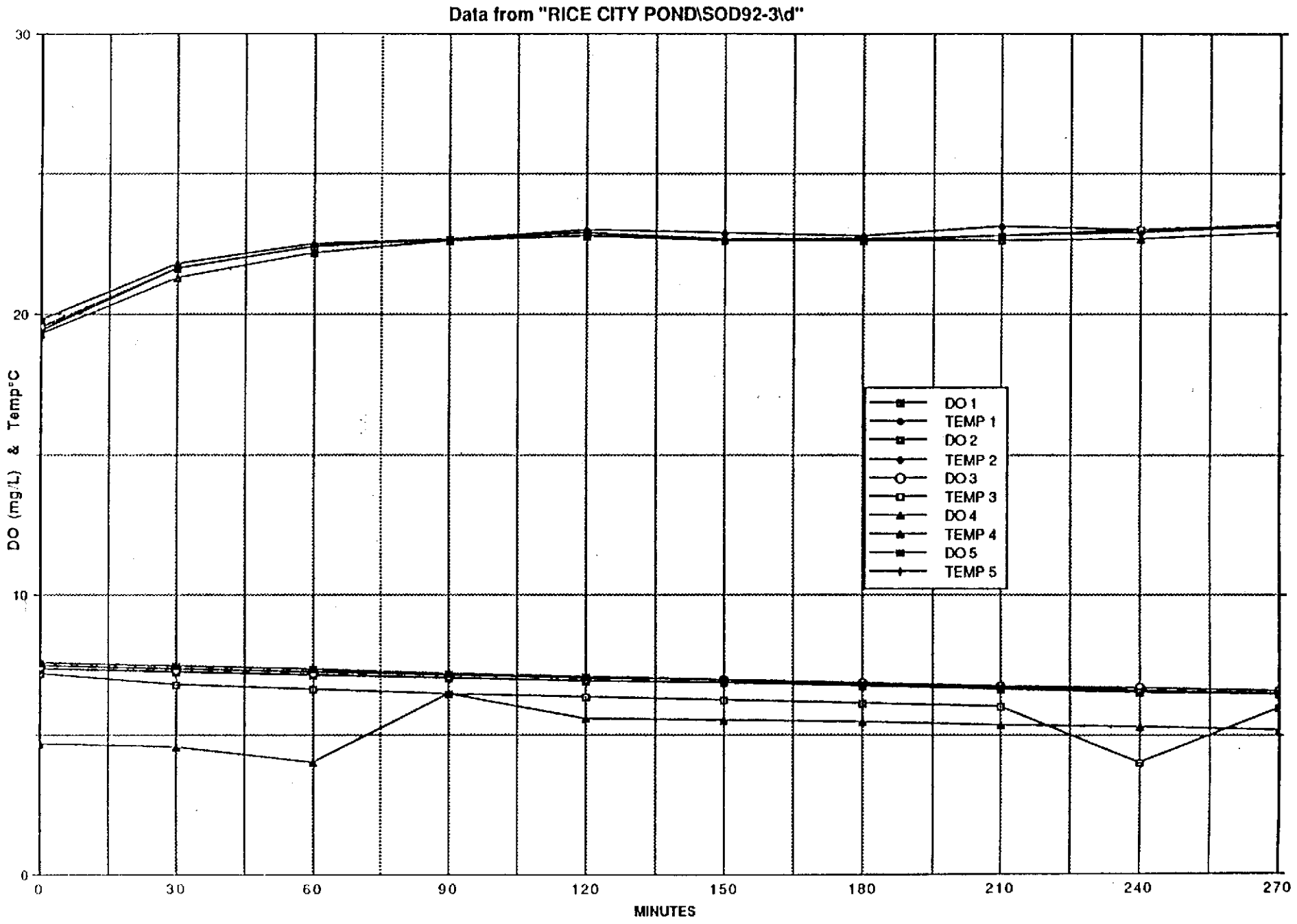
Station No. 92-9	1	2	3	4	5
Initial sample Oxygen (mg/L)	4.9	3.65	1.275	5.08	4.74
Final Sample Oxygen (mg/L)	4.15	2.64	0.289	3.88	3.54
Initial Blank Oxygen (ml/L)	6.7	6.7	6.7	6.7	6.7
Final Blank Oxygen (ml/L)	6.7	6.7	6.7	6.7	6.7
Column height (m)	0.385	0.325	0.355	0.345	0.35
Time (Enter hrs.)	3	2	2.5	2.5	2.5
Time (days)	0.125	0.083333333	0.104166667	0.104166667	0.104166667
Surface Area	0.002	0.002	0.002	0.002	0.002
Volume	0.00077	0.00065	0.00071	0.00069	0.0007
minus probe	0.00066	0.00054	0.0006	0.00058	0.00059
SOD g/m2/d =	2.31	3.939	3.360288	3.9744	4.032
Mean SOD	**3.5231376**				
Std Dev	0.653259988				

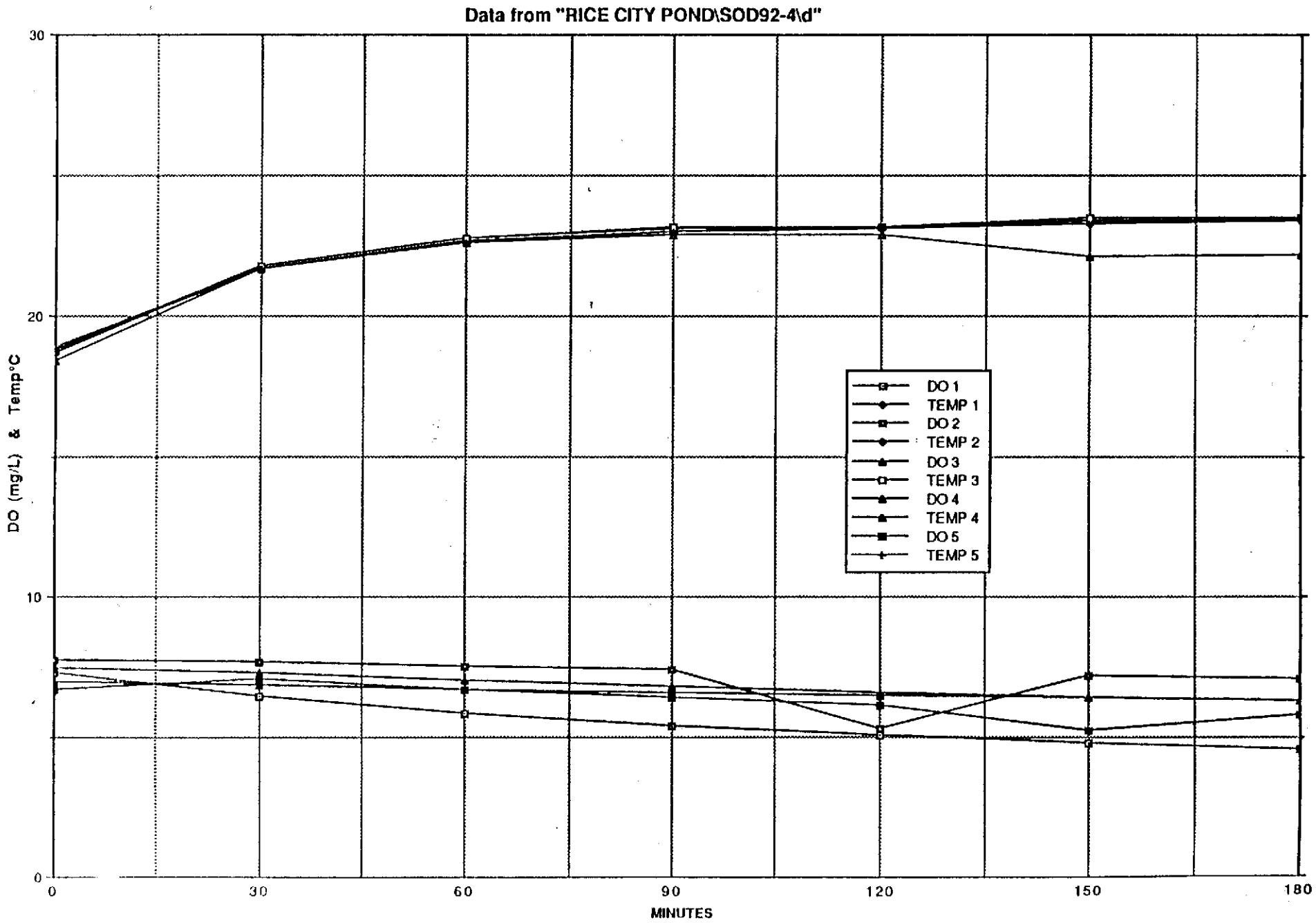
APPENDIX B

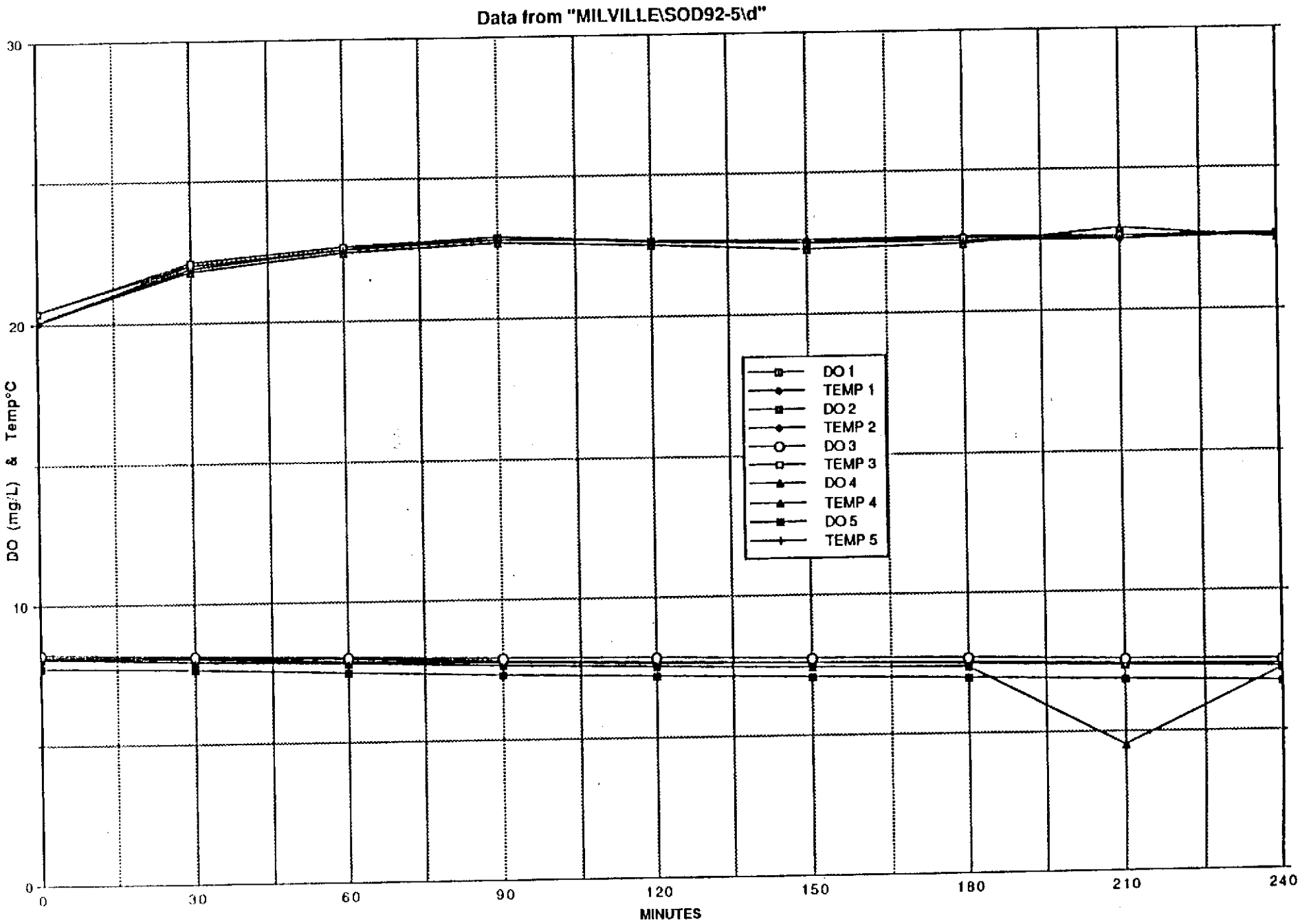

Data from "RIVERDALE POND\SOD92-2A\d"
DO (mg/L) & Temp°
30
20
10
0
0
30
60
90
120
150
180
210
240
MINUTES
DO 1
TEMP 1
DO 2
TEMP 2
DO 3
TEMP 3
DO 4
TEMP 4
DO 5
TEMP 5

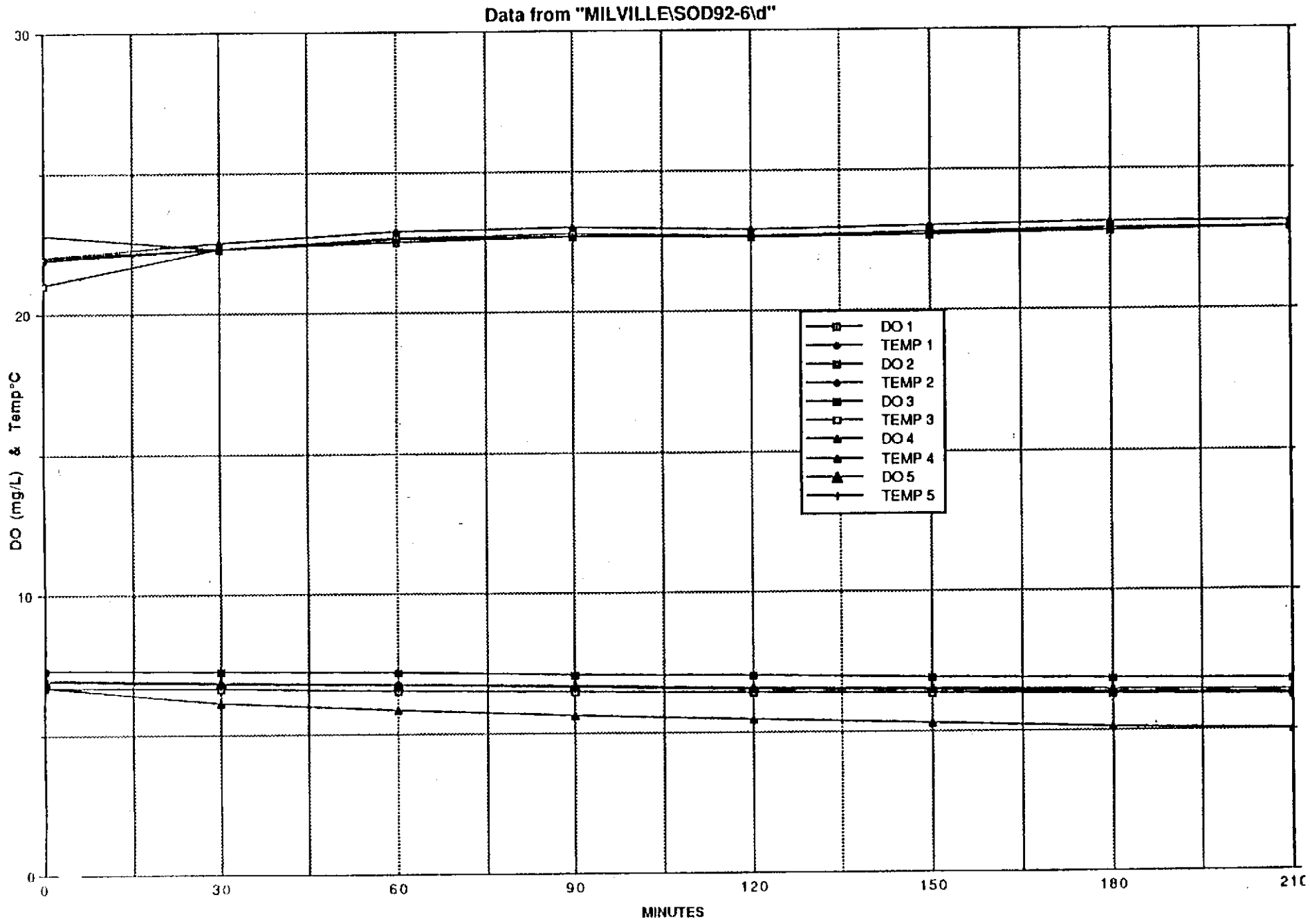

Data from "SINGING DAM\SOD92-1\d"
DO (mg/L) & Temp °C
30
20
10
0
0
30
60
90
120
150
180
210
240
MINUTES
DO 1
TEMP 1
DO 2
TEMP 2
DO 3
TEMP 3
DO 4
TEMP 4
DO 5
TEMP 5

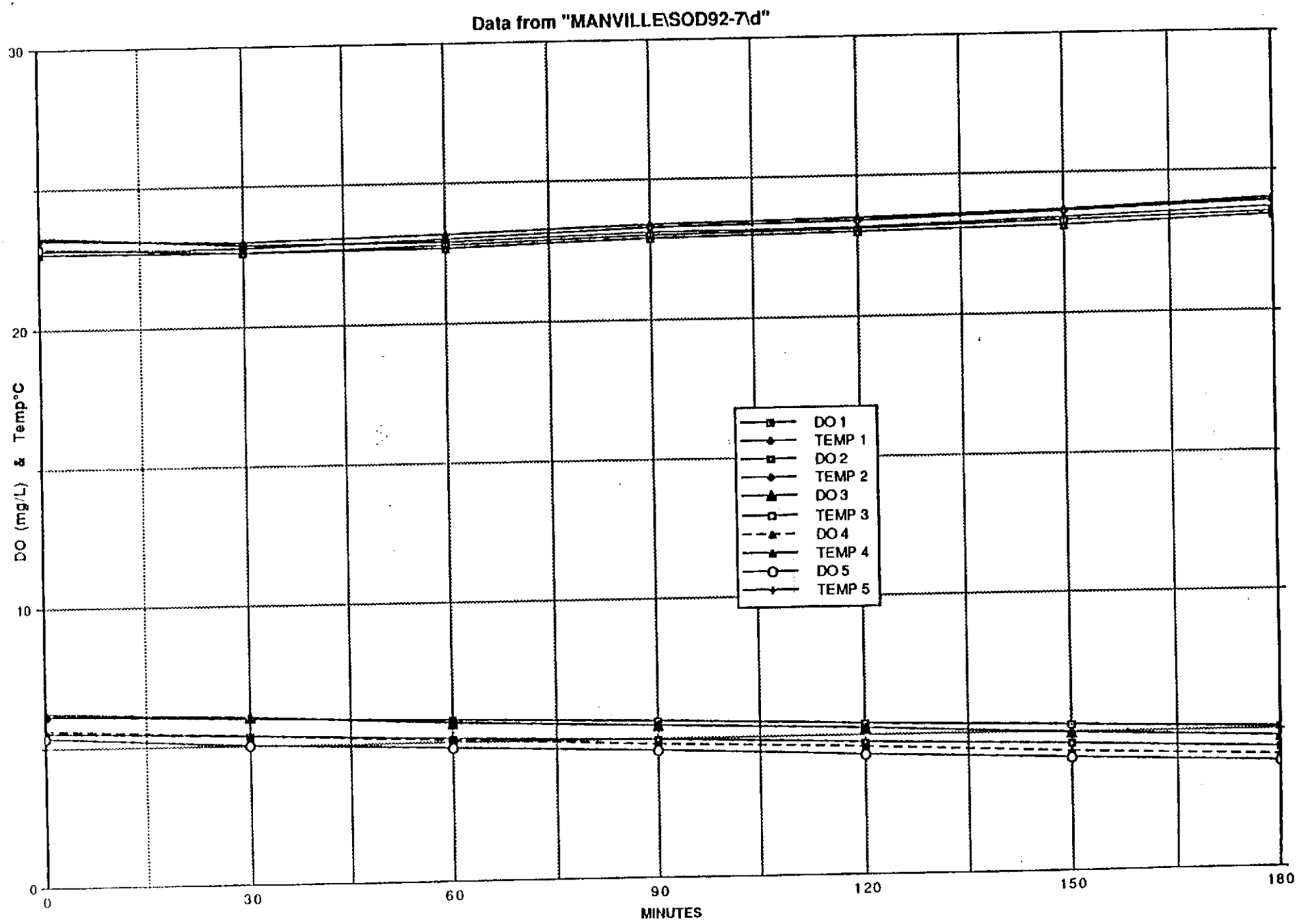

Data from "RIVERDALE POND\SOD92-2B\d"
DO (mg/L) & Temp °C
0
10
20
0
30
60
90
120
150
180
210
MINUTES
DO 1
TEMP 1
DO 2
TEMP 2
DO 3
TEMP 3
DO 4
TEMP 4
DO 5
TEMP 5

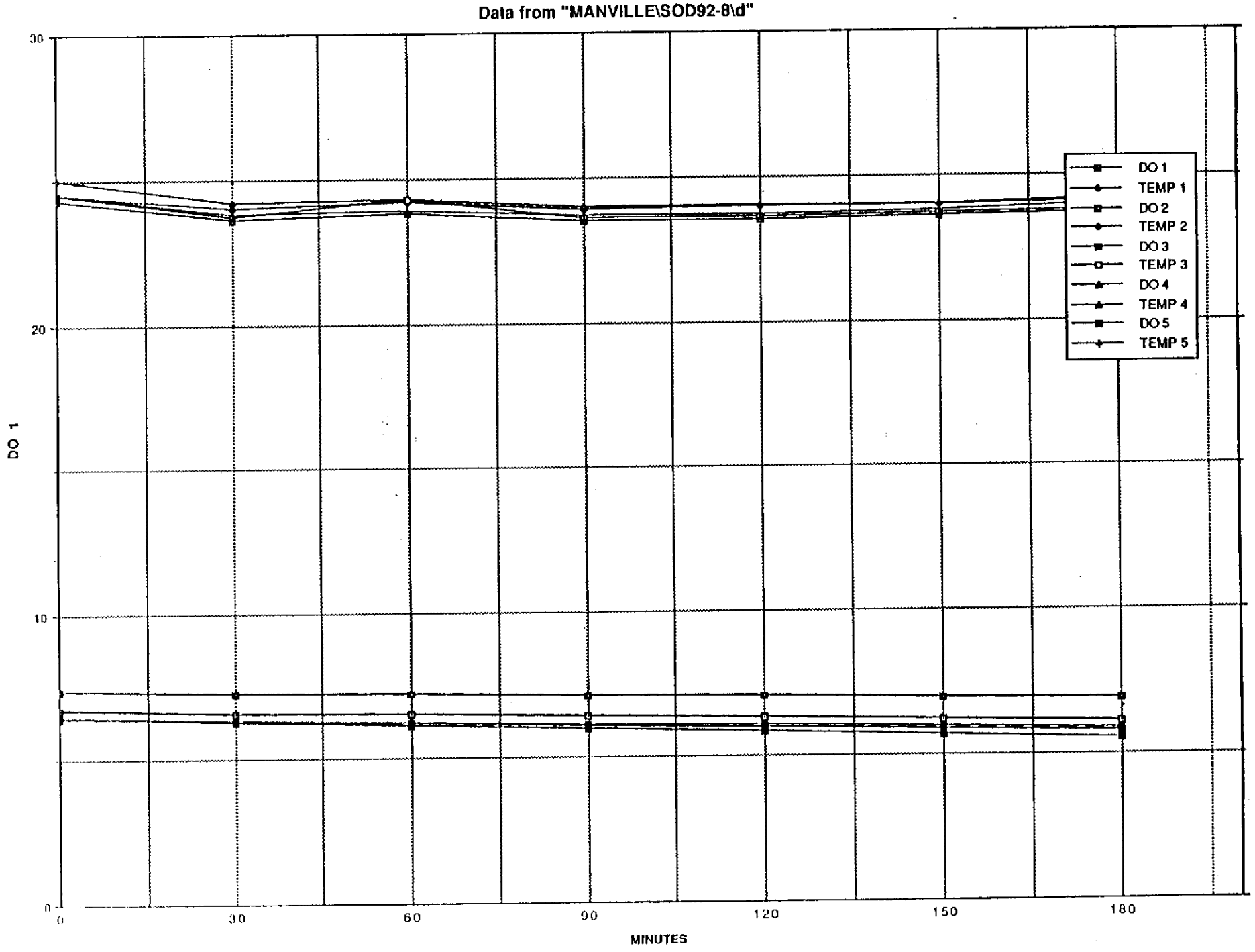

Data from "RICE CITY POND\SOD92-3\d"
DO (mg/L) & Temp°C
30
20
10
0
0
30
60
90
120
150
180
210
240
270
MINUTES
DO 1
TEMP 1
DO 2
TEMP 2
DO 3
TEMP 3
DO 4
TEMP 4
DO 5
TEMP 5

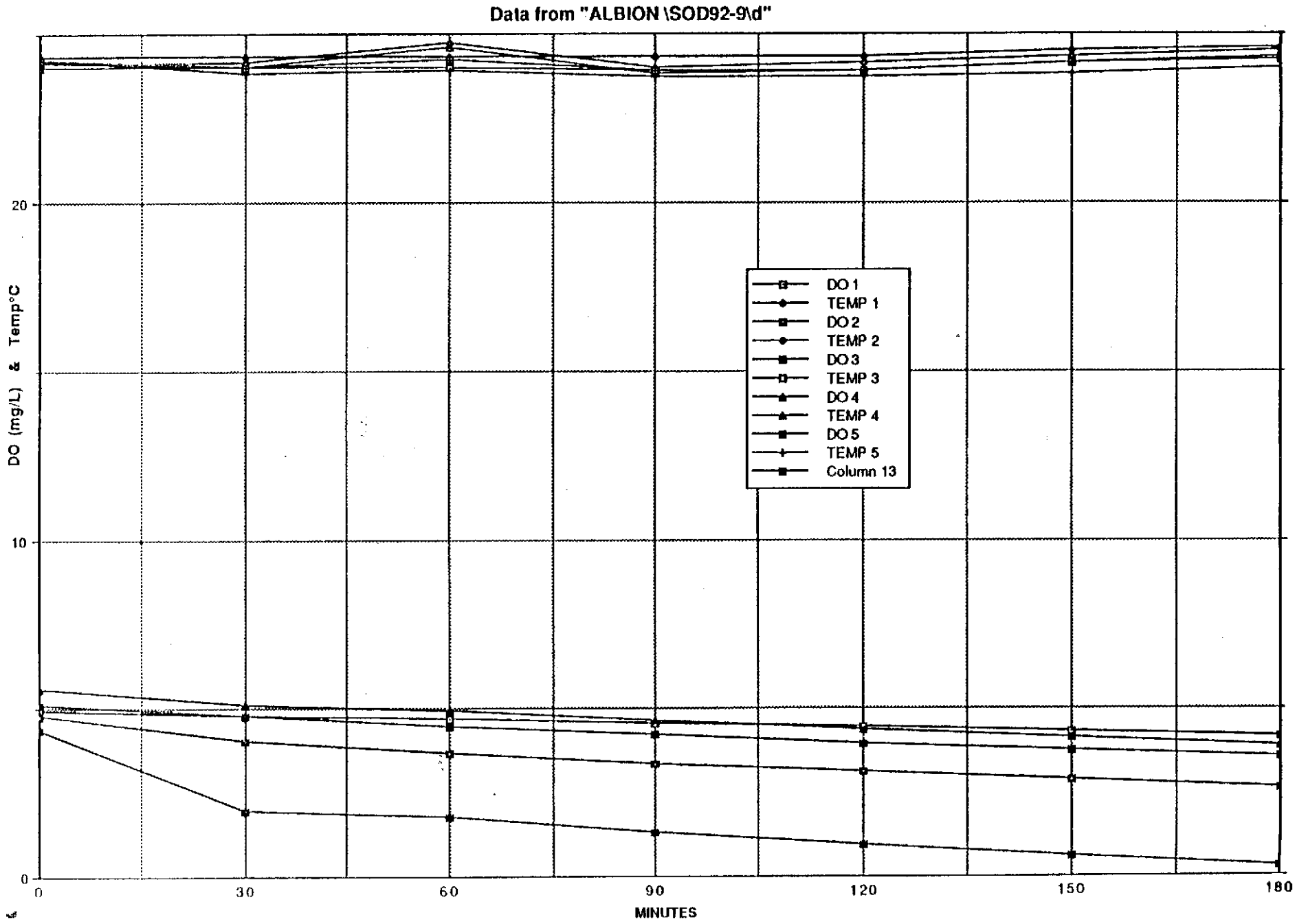

Data from "RICE CITY POND\SOD92-4\d"
DO (mg/L) & Temp°C
30
20
10
0
0
30
60
90
120
150
180
MINUTES
DO 1
TEMP 1
DO 2
TEMP 2
DO 3
TEMP 3
DO 4
TEMP 4
DO 5
TEMP 5


Data from "MILVILLE\SOD92-5\d"
DO (mg/L) & Temp°C
30
20
10
0
0
30
60
90
120
150
180
210
240
MINUTES
DO 1
TEMP 1
DO 2
TEMP 2
DO 3
TEMP 3
DO 4
TEMP 4
DO 5
TEMP 5


Data from "MILVILLE\SOD92-6\d"
DO (mg/L) & Temp°C
30
20
10
0
0
30
60
90
120
150
180
210
MINUTES
DO 1
TEMP 1
DO 2
TEMP 2
DO 3
TEMP 3
DO 4
TEMP 4
DO 5
TEMP 5


Data from "MANVILLE\SOD92-7\d"
DO (mg/L) & Temp°C
30
20
10
0
0
30
60
90
120
150
180
MINUTES
DO 1
TEMP 1
DO 2
TEMP 2
DO 3
TEMP 3
DO 4
TEMP 4
DO 5
TEMP 5


Data from "MANVILLE\SOD92-8\d"
DO 1
30
20
10
0
0
30
60
90
120
150
180
MINUTES
DO 1
TEMP 1
DO 2
TEMP 2
DO 3
TEMP 3
DO 4
TEMP 4
DO 5
TEMP 5


Data from "ALBION \SOD92-9\d"
DO (mg/L) & Temp°C
0
10
20
0
30
60
90
120
150
180
MINUTES
DO 1
TEMP 1
DO 2
TEMP 2
DO 3
TEMP 3
DO 4
TEMP 4
DO 5
TEMP 5
Column 13

APPENDIX C

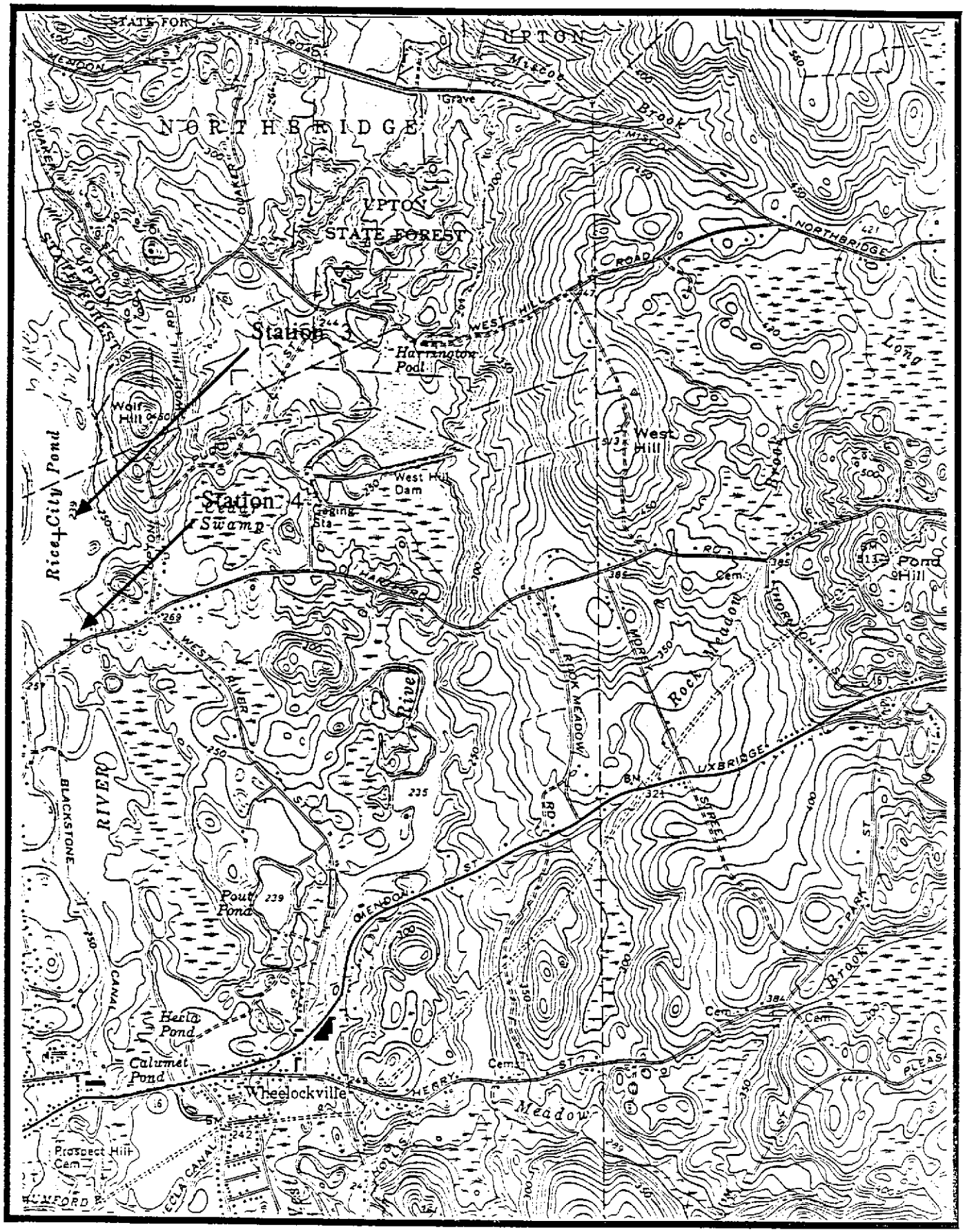


Figure 3. Stations 3 & 4.

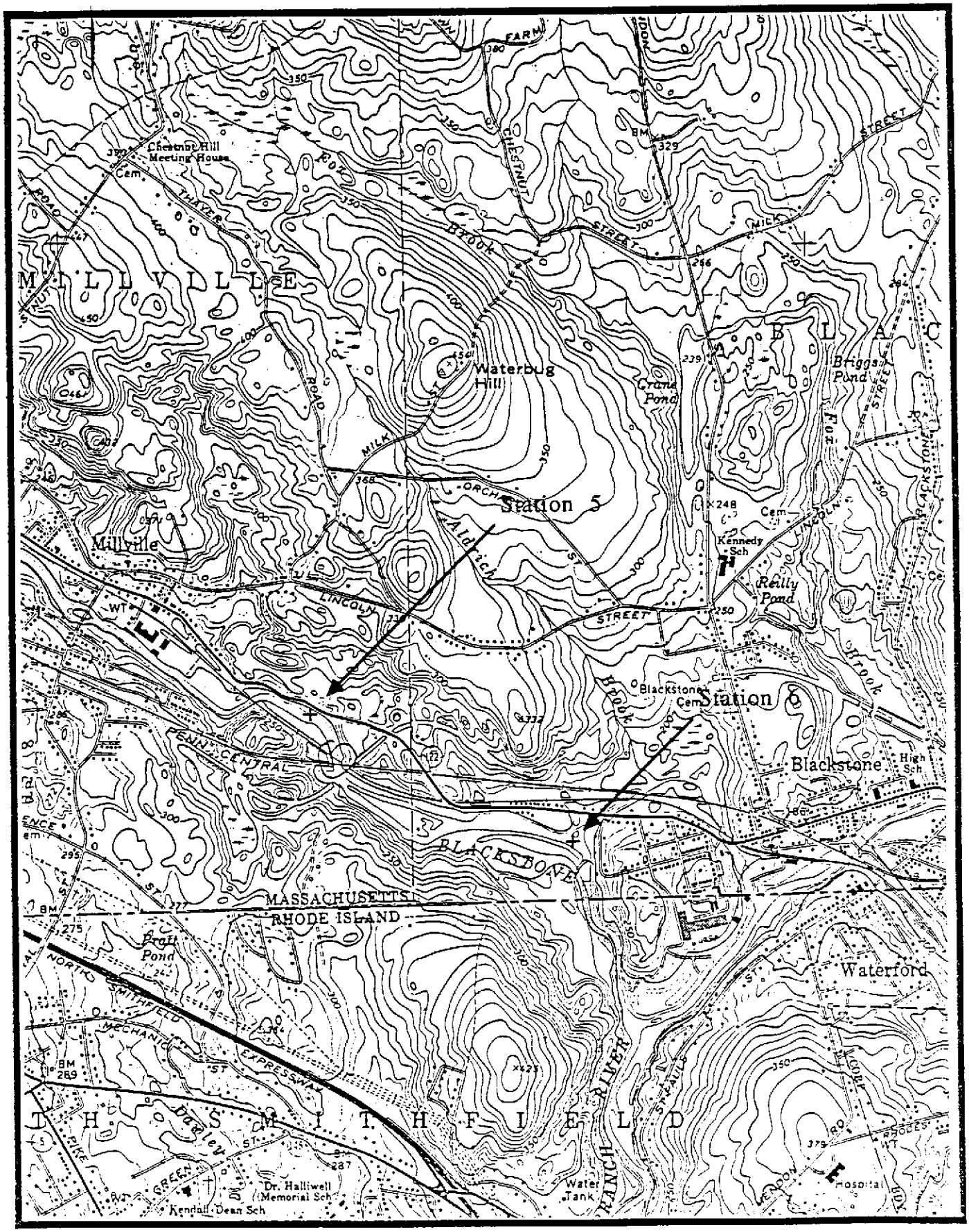


Figure 4. Stations 5 & 6.

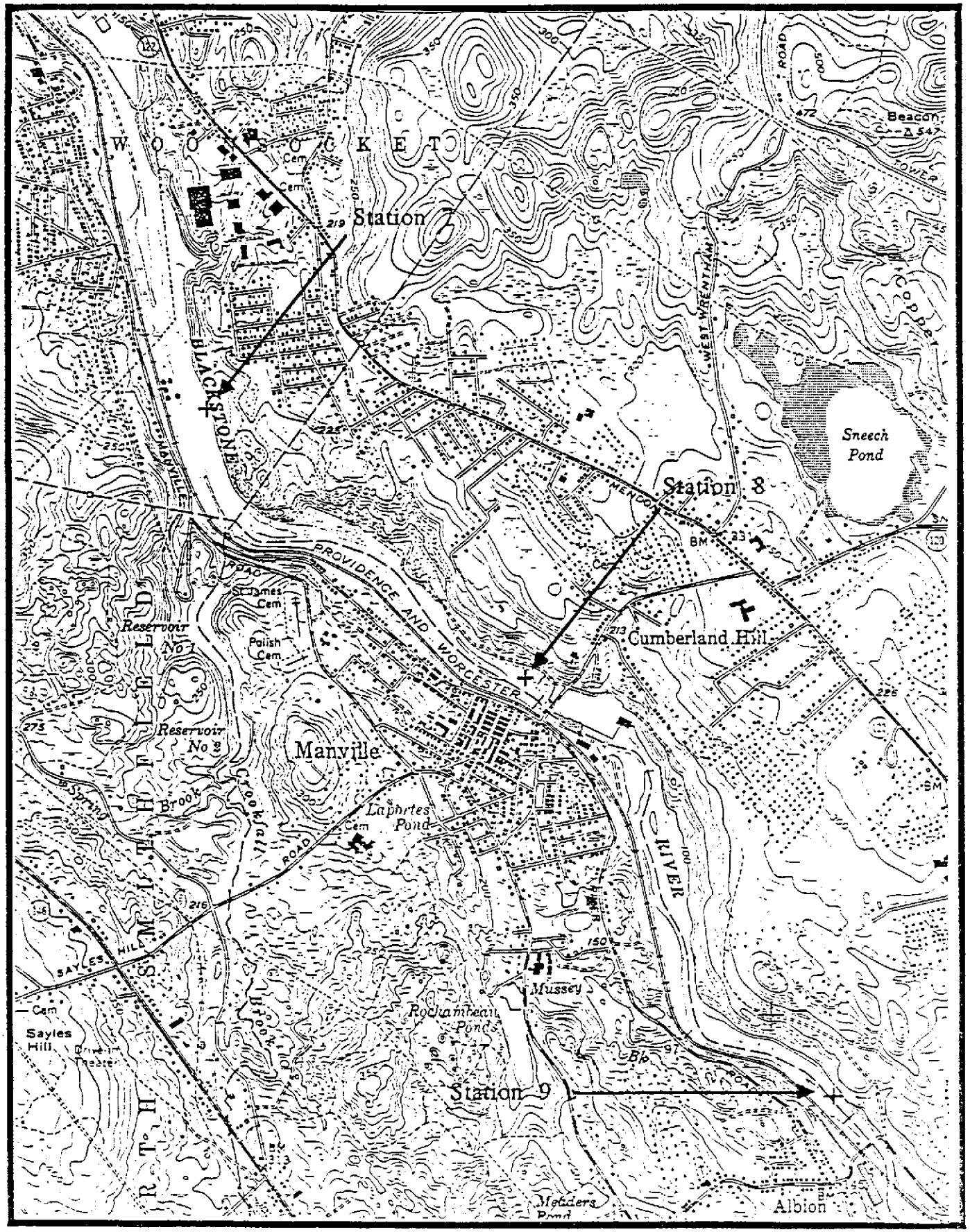


Figure 5. Stations 7, 8, & 9.

APPENDIX D

	TIME	MINUTES	DO 1	TEMP 1	DO 2	TEMP 2	DO 3	TEMP 3	DO 4	TEMP 4	DO 5	TEMP 5
1												
2	Station 1											
3	1030	0	7.050	22.000	5.750	22.100	6.640	22.100	7.200	21.800	6.170	22.300
4	1100	30	6.900	22.300	5.640	22.400	6.360	22.400	6.990	22.200	5.820	22.300
5	1130	60	6.780	22.500	5.470	22.600	6.100	22.600	6.770	22.400	5.330	22.500
6	1200	90	6.650	22.100	5.280	22.300	5.750	22.300	6.530	22.100	4.900	22.200
7	1230	120	6.540	22.300	5.100	22.300	5.420	22.400	6.330	22.200	4.530	22.300
8	1300	150	6.370	22.500	4.870	22.600	5.000	22.500	6.100	22.400	4.130	22.600
9	1330	180	6.250	22.700	4.640	22.700	4.590	22.800	5.900	22.500	3.650	22.700
10	1400	210	6.150	22.600	4.420	22.700	4.210	22.600	5.700	22.500	3.240	22.600
11	1430	240	6.030	22.700	4.200	22.700	3.820	22.500	5.500	22.500	2.840	22.600
12	Station 2A											
13	1035	0	6.700	20.900	6.700	20.900	6.230	20.600	6.040	20.400	6.480	20.200
14	1105	30	6.520	22.000	6.570	22.000	5.780	21.900	5.880	21.700	6.400	21.800
15	1135	60	6.400	22.400	6.440	22.500	5.680	22.400	5.750	22.200	6.070	22.300
16	1205	90	6.280	22.600	6.320	22.700	5.610	22.600	5.630	22.500	5.850	22.600
17	1235	120	6.150	22.900	6.180	22.900	5.530	22.900	5.510	22.700	5.480	22.900
18	1305	150	6.030	23.200	6.050	23.200	5.460	23.100	5.390	22.000	5.080	23.200
19	1335	180	5.910	22.800	5.900	22.800	5.380	22.800	5.270	22.600	4.690	22.800
20	1405	210	5.820	22.800	5.770	22.800	5.330	22.800	5.170	22.600	4.360	22.800
21	1435	240	5.710	22.900	5.650	22.900	5.270	22.900	5.060	22.700	4.040	23.000
22	Station 2B											
23	1500	0	13.330	23.100	10.570	22.900	11.480	23.000	11.700	22.700	10.840	23.100
24	1530	30	12.530	23.000	10.130	22.800	10.750	22.900	11.060	22.700	10.370	23.000
25	1600	60	11.970	22.600	9.830	22.400	10.350	22.500	10.820	22.200	9.980	22.600
26	1630	90	11.570	22.900	9.600	22.600	10.050	22.600	10.590	22.400	9.660	22.700
27	1700	120	11.180	23.000	9.350	22.900	9.780	22.800	10.330	22.600	9.400	22.900
28	1730	150	10.840	23.400	9.150	23.100	9.550	23.100	10.070	23.000	9.160	23.200
29	1800	180	10.450	23.500	8.920	23.300	9.300	23.300	9.810	23.200	8.910	23.400
30	1830	210	10.080	23.900	8.710	23.600	9.070	23.500	9.560	23.500	8.670	23.700
31	Station 3											
32	1040	0	7.150	19.800	7.300	19.500	7.420	19.600	4.680	19.300	7.540	19.400
33	1110	30	6.770	21.800	7.200	21.600	7.320	21.600	4.530	21.300	7.440	21.600
34	1140	60	6.600	22.500	7.110	22.400	7.210	22.400	4.020	22.200	7.300	22.400
35	1210	90	6.450	22.700	6.990	22.700	7.110	22.700	6.460	22.600	7.160	22.700
36	1240	120	6.330	23.000	6.890	22.900	7.000	22.900	5.520	22.800	7.030	22.900
37	1310	150	6.220	22.900	6.800	22.700	6.910	22.600	5.470	22.600	6.910	22.600
38	1340	180	6.100	22.800	6.700	22.700	6.810	22.600	5.420	22.600	6.790	22.600
39	1410	210	6.010	23.100	6.610	22.800	6.720	22.800	5.320	22.600	6.680	22.800
40	1440	240	3.970	23.000	6.510	22.900	6.630	23.000	5.280	22.700	6.560	22.900
41	1510	270	5.950	23.200	6.430	23.200	6.540	23.200	5.170	22.900	6.450	23.100

	TIME	MINUTES	DO 1	TEMP 1	DO 2	TEMP 2	DO 3	TEMP 3	DO 4	TEMP 4	DO 5	TEMP 5
1												
2	Station 4											
3	1530	0	7.250	18.900	7.710	18.700	7.430	18.800	6.910	18.400	6.660	18.800
4	1600	30	6.410	21.700	7.630	21.800	7.270	21.800	6.810	21.700	7.020	21.700
5	1630	60	5.810	22.700	7.510	22.800	7.000	22.800	6.680	22.600	6.680	22.600
6	1700	90	5.390	23.000	7.380	23.100	6.750	23.200	6.560	22.900	6.360	23.000
7	1730	120	5.070	23.100	5.260	23.200	6.560	23.200	6.450	22.900	6.120	23.200
8	1800	150	4.780	23.300	7.130	23.400	6.390	23.500	6.350	22.100	5.190	23.300
9	1830	180	4.570	23.400	7.050	23.400	6.260	23.500	6.280	22.200	5.750	23.500
10	Station 5											
11	1115	0	8.120	20.100	8.110	20.400	8.190	20.400	8.030	20.100	7.690	20.000
12	1145	30	8.000	22.000	8.030	22.000	8.110	22.100	7.900	21.800	7.580	21.900
13	1215	60	7.840	22.500	7.920	22.500	8.000	22.600	7.760	22.400	7.440	22.500
14	1245	90	7.710	22.800	7.780	22.800	7.900	22.900	7.610	22.700	7.270	22.900
15	1315	120	7.620	22.700	7.630	22.700	7.800	22.700	7.500	22.500	7.150	22.600
16	1345	150	7.520	22.500	7.520	22.600	7.700	22.500	7.400	22.300	7.020	22.500
17	1415	180	7.460	22.700	7.420	22.700	7.640	22.600	7.310	22.400	6.910	22.500
18	1445	210	7.380	22.500	7.320	22.600	7.560	22.600	4.480	22.900	6.800	22.500
19	1515	240	7.330	22.600	7.230	22.700	7.500	22.700	7.160	22.500	6.710	22.600
20	Station 6											
21	1500	0	13.330	23.100	10.570	22.900	11.480	23.000	11.700	22.700	10.840	23.100
22	1530	30	12.530	23.000	10.130	22.800	10.750	22.900	11.060	22.700	10.370	23.000
23	1600	60	11.970	22.600	9.830	22.400	10.350	22.500	10.820	22.200	9.980	22.600
24	1630	90	11.570	22.900	9.600	22.600	10.050	22.600	10.590	22.400	9.660	22.700
25	1700	120	11.180	23.000	9.350	22.900	9.780	22.800	10.330	22.600	9.400	22.900
26	1730	150	10.840	23.400	9.150	23.100	9.550	23.100	10.070	23.000	9.160	23.200
27	1800	180	10.450	23.500	8.920	23.300	9.300	23.300	9.810	23.200	8.910	23.400
28	1830	210	10.090	23.900	8.710	23.600	9.070	23.500	9.560	23.500	8.670	23.700
29	Station 7											
30	1030	0	6.120	23.200	5.500	22.800	6.230	22.900	5.580	22.700	5.340	23.300
31	1100	30	5.930	23.000	5.300	22.800	5.970	22.600	5.310	22.600	5.010	22.900
32	1130	60	5.740	23.200	5.090	23.000	5.670	22.800	5.030	22.700	4.770	22.900
33	1200	90	5.580	23.400	4.910	23.300	5.430	23.000	4.790	22.900	4.550	23.100
34	1230	120	5.390	23.500	4.720	23.400	5.190	23.100	4.530	23.000	4.290	23.200
35	1300	150	5.220	23.700	4.530	23.600	4.950	23.300	4.290	23.100	4.050	23.400
36	1330	180	5.040	24.000	4.340	23.900	4.700	23.500	4.040	23.400	3.820	23.700

	TIME	MINUTES	DO 1	TEMP 1	DO 2	TEMP 2	DO 3	TEMP 3	DO 4	TEMP 4	DO 5	TEMP 5
1												
2	Station 8											
3	1530	0	7.250	18.900	7.710	18.700	7.430	18.800	6.910	18.400	6.660	18.800
4	1600	30	6.410	21.700	7.630	21.800	7.270	21.800	6.810	21.700	7.020	21.700
5	1630	60	5.810	22.700	7.510	22.800	7.000	22.800	6.680	22.600	6.680	22.600
6	1700	90	5.390	23.000	7.380	23.100	6.750	23.200	6.560	22.900	6.360	23.000
7	1730	120	5.070	23.100	5.260	23.200	6.560	23.200	6.450	22.900	6.120	23.200
8	1800	150	4.780	23.300	7.130	23.400	6.390	23.500	6.350	22.100	5.190	23.300
9	1830	180	4.570	23.400	7.050	23.400	6.260	23.500	6.280	22.200	5.750	23.500
10	Station 9											
11	1115	0	8.120	20.100	8.110	20.400	8.190	20.400	8.030	20.100	7.690	20.000
12	1145	30	8.000	22.000	8.030	22.000	8.110	22.100	7.900	21.800	7.580	21.900
13	1215	60	7.840	22.500	7.920	22.500	8.000	22.600	7.760	22.400	7.440	22.500
14	1245	90	7.710	22.800	7.780	22.800	7.900	22.900	7.610	22.700	7.270	22.900
15	1315	120	7.620	22.700	7.630	22.700	7.800	22.700	7.500	22.500	7.150	22.600
16	1345	150	7.520	22.500	7.520	22.600	7.700	22.500	7.400	22.300	7.020	22.500
17	1415	180	7.460	22.700	7.420	22.700	7.640	22.600	7.310	22.400	6.910	22.500
18	1445	210	7.380	22.500	7.320	22.600	7.560	22.600	4.480	22.900	6.800	22.500
19	1515	240	7.330	22.600	7.230	22.700	7.500	22.700	7.160	22.500	6.710	22.600