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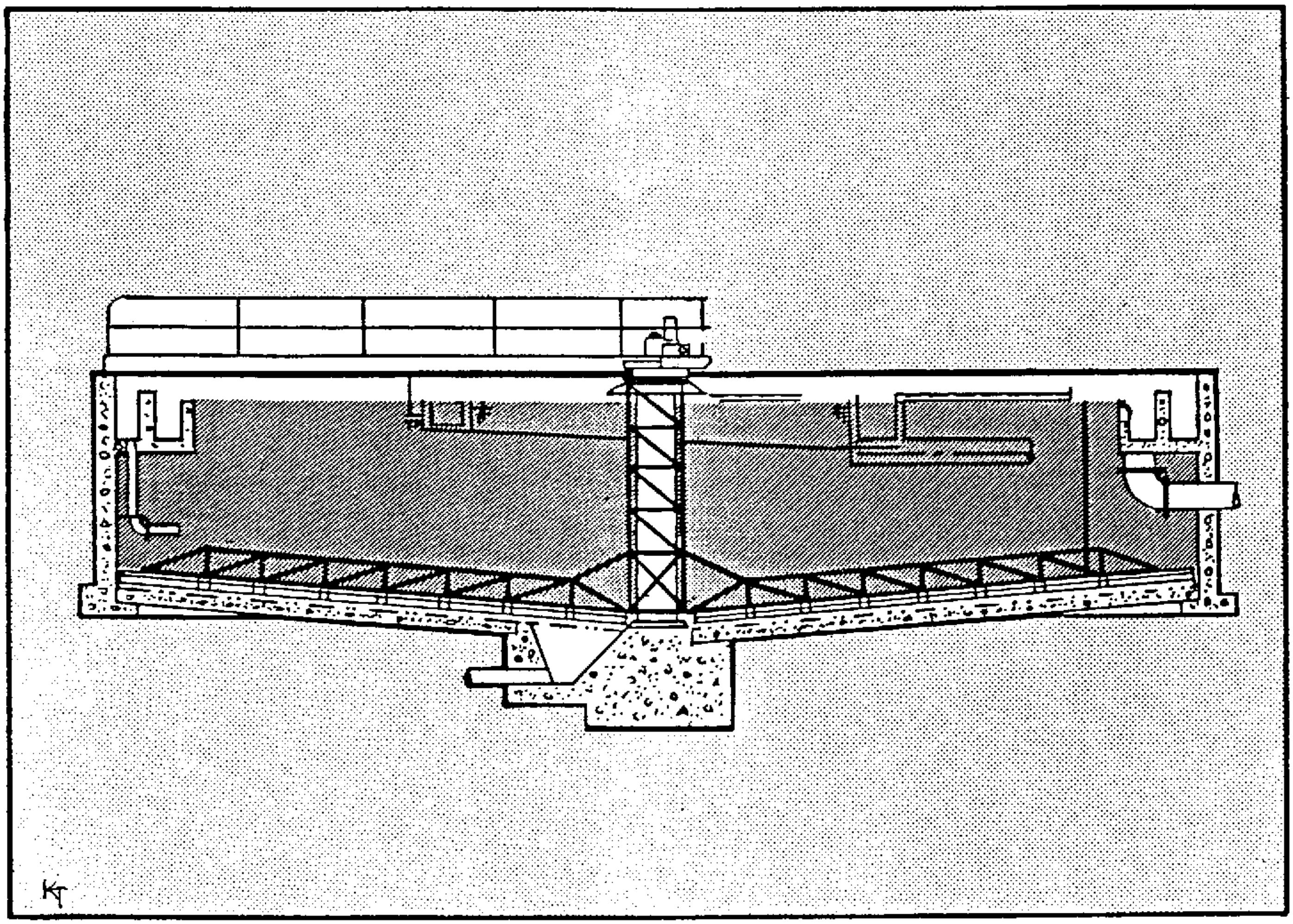
# UPPER BLACKSTONE

## Water Pollution Abatement District
## Wasteload Allocation - 1983



Massachusetts Department of Environmental Quality Engineering

## DIVISION of WATER POLLUTION CONTROL

Thomas C. McMahon, Director

# UPPER BLACKSTONE WATER POLLUTION ABATEMENT DISTRICT

## WASTELOAD ALLOCATION

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# INTRODUCTION

The Upper Blackstone Water Pollution Abatement District is located on the Millbury-Worcester boundary and currently discharges a polished secondary treatment effluent to the Blackstone River. The river has been classified under the Massachusetts Water Quality Standards[1], as a Class C river from its source in Worcester to the outlet of Fisherville Pond in Grafton and Class B for the remainder of the Massachusetts portion. The lower portion has also been designated for use as a warm water fishery and for primary and secondary contact recreation.

The wastewater treatment facility currently averages approximately 30.0 million gallons per day (MGD) and has a design flow of 56.0 MGD. Treatment processes include bar rack, aerated grit chamber, primary settling, aeration tanks, secondary settling, chlorination, and belt filter press for sludge dewatering followed by landfilling. The current NPDES permit limits are as follows:

| | April 1 - Oct 1 | Oct 1 - April 1 |
|---|---|---|
| Flow (MGD) | 56.0 | 56.0 |
| $BOD_5$ | 15.0 | 30.0 |
| Total Suspended Solids (mg/l) | 15.0 | 30.0 |
| Settleable Solids (ml/l) | 0.1 | 0.1 |
| Total Phosphorus as P (mg/l) | 1.0 | -- |
| Dissolved Oxygen (mg/l) | not less than 5.0 | |
| Fecal Coliform Bacteria per 100 mnl | 200 | 200 |
| Total Coliform Bacteria per 100 ml | 1000 | 1000 |

This report summarizes the procedure and assumptions taken in the waste load allocation process utilizing the Stream 7B water quality model.

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## BACKGROUND

Three intensive water quality surveys were conducted on the Blackstone River in June, August, and October 1980. These surveys were deisgned to gather data needed to calibrate and verify the Stream 78 model. A brief summary of each survey is as follows:

June 9-13, 1980

Twenty eight water quality stations were sampled six times daily yielding two 24-hour composite samples for chemical analyses and 19 dissolved oxygen samples per station. Water quality stations included 23 on the Blackstone main stem and one each on Mill Brook and the Quinsigamond, Mumford, West, and Mill Rivers. Each station was sampled for dissolved oxygen, temperature, chemical oxygen demand, biochemical oxygen demand, nitrogen series, total and ortho-phosphorus, solids, chloride, pH, turbidity, and total and fecal coliform bacteria. Discharge monitoring and instream flow measurements were also conducted at this time. (See Appendix I for survey data.)

August 4-8, 1980

This survey consisted of the same 28 stations as in June. All parameters previously noted were collected once again as were instream flow measurements and discharge data.

October 15-16, 1980

This survey was conducted for one 24-hour period and incorporated 18 mainstem stations from Webster Street in Worcester (BS08) to the USGS Water Quality Monitor in Millville (BS18). Measurements were made once again for the same parameters as in the two previous surveys with the addition of total volatile solids, settleable solids, and hardness. Discharge data and flow measurements were also collected. (Refer to Table 1 for station locations.)

TABLE 1

BLACKSTONE RIVER 1980 SURVEY

LOCATION OF SAMPLING STATIONS

| STATION NUMBER | | RIVER MILE |
|---|---|---|
| BS01 | Waite Pond Outlet, Chapel St., Leicester | 59.3 |
| BS02 | Auburn St., Leicester | 58.2 |
| BS03 | Bridge below Elfskin Corp., Leicester | 57.4 |
| BS04 | Bridge on James St., Worcester | 55.9 |
| BS05 | Stoneville Pond Outlet, Oxford St., Worcester | 55.0 |
| BS06 | Sword St., Auburn | 53.5 |
| BS07 | Leesville Pond Outlet, Oxford St., Worcester | 52.7 |
| BS08 | Bridge on Webster St., Worcester | 51.3 |
| BS09B | Above Dam off Millbury St., Worcester | 48.9 |
| BS09 | Bridge on Millbury St., Worcester | 47.9 |
| BS10 | Bridge on McCracken Rd., Millbury | 46.0 |
| BS11 | Bridge on Riverlin St., Millbury | 43.6 |
| BS12 | Above Singing Dam, Sutton | 42.2 |
| BS13A | Bridge on Pleasant St. Canal, Grafton | 40.6 |
| BS13 | Bridge on 122A, at Fisherville Dam, Grafton | 39.7 |
| BS14 | Bridge on Sutton St., Northbridge | 36.8 |
| BS15 | Riverdale St., Northbridge | 35.0 |
| BS16 | Rice City Pond Outlet, Hartford Ave., Uxbridge | 31.3 |
| BS17A | Route 16 Bridge, Uxbridge | 30.0 |
| BS17 | Route 122 Bridge, Uxbridge | 27.9 |
| BS18 | At Water Quality Monitor off Route 122, Millville | 23.7 |
| BS19 | Howard St., Blackstone | 21.0 |
| BS20 | Singleton St., Woonsocket, R.I. | 20.0 |

Tributaries

| | | |
|---|---|---|
| MB01 | Behind Starr Scrap Co., Mill Brook, Worcester | 48.8, 0.0 |
| QR05 | Pleasant St. Bridge, Quinsigamond River, Grafton | 39.7, 1.7 |
| MF07 | Bridge behind Emile Bernat, Mumford River, Uxbridge | 29.7, 0.4 |
| WR05 | Hecla St. Bridge, West River, Uxbridge | 28.7, 0.5 |
| ML06 | Rt. 114A Bridge, Mill River, Woonsocket, R.I. | 17.5, 3.0 |

## Stream 7B Water Quality Model

The Stream 7B Water Quality Model was used in the calibration, verification, and projection to low flow conditions. Fourteen reaches were calibrated using October 1980 data and verified with June 1980 and August 1980 data. Reaches began at the wastewater treatment plant and extended to the USGS Water Quality Gage in Millville, Massachusetts. Preliminary investigations indicated that the impact of the treatment plant would occur at or before Rice City Pond in Northbridge. Dissolved oxygen data obtained during all surveys in 1980 indicated that the oxygen sag due to the WWTP occurred in Rice City Pond. After this point the dissolved oxygen begins to recover due to dam aeration, dilution from the Mumford and West rivers, and the fact that almost all of the loading from upstream sources has been assimilated. Figures 1 and 2 show the average and minimum dissolved oxygen concentrations for the 1980 surveys respectively. Reach descriptions can be found in Table 2.

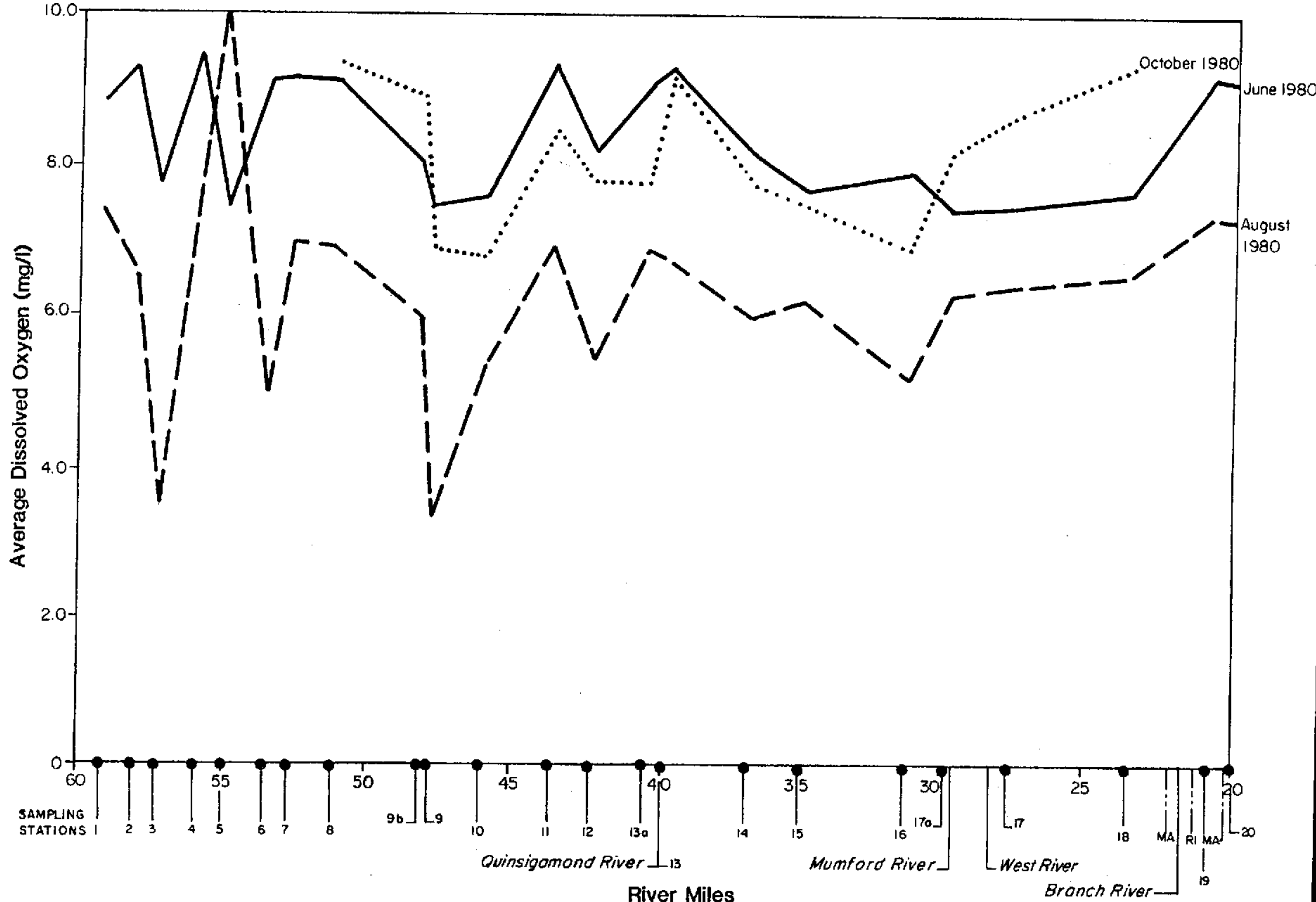


Figure 1– BLACKSTONE RIVER 1980 SURVEY AVERAGE DISSOLVED OXYGEN

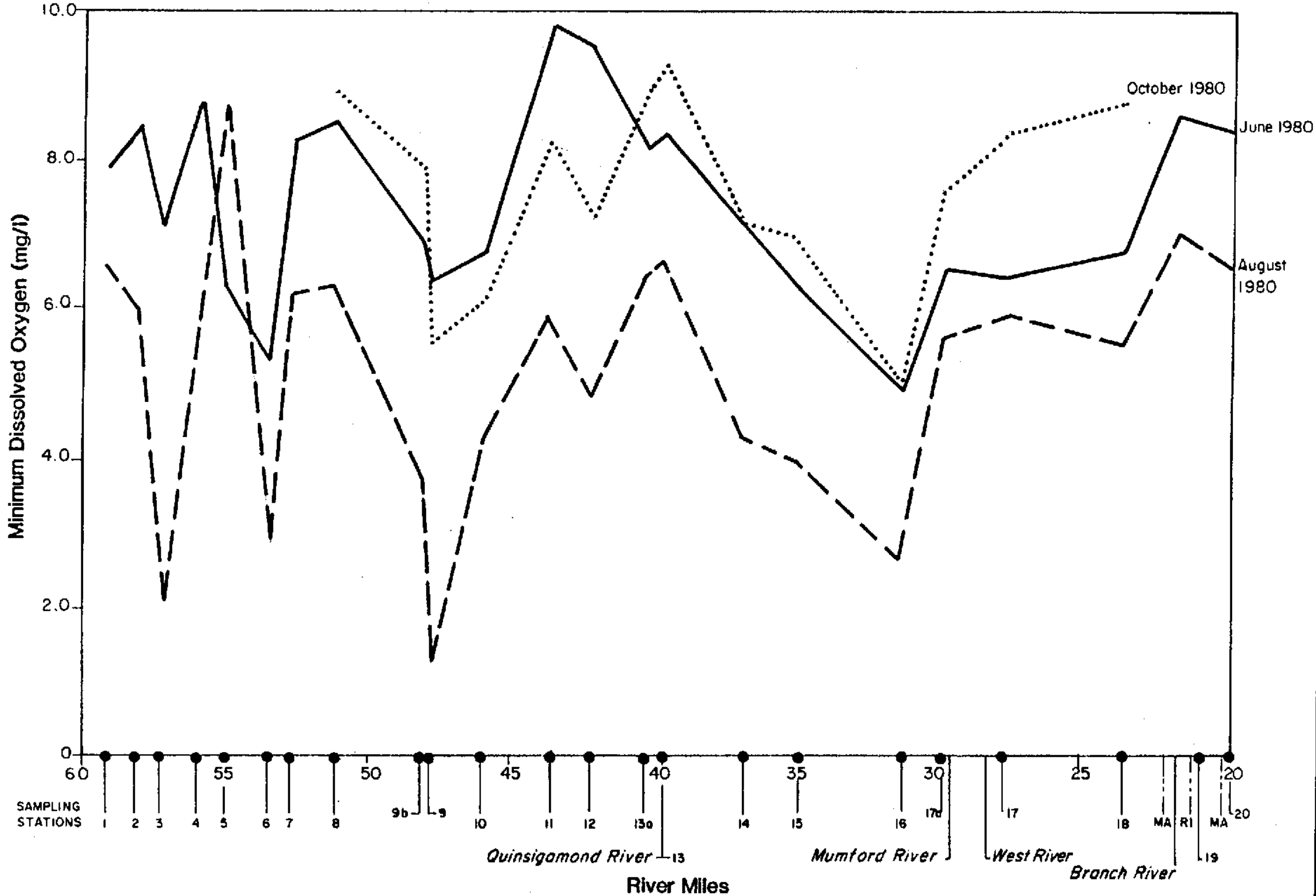


Figure 2- BLACKSTONE RIVER 1980 SURVEY MINIMUM DISSOLVED OXYGEN

TABLE 2

BLACKSTONE RIVER 1980 SURVEY

MODEL REACHES

| REACH | DESCRIPTION | RIVER MILES |
|---|---|---|
| 1 | Upper Blackstone Water Pollution Abatement District to McCracken Road, Millbury | 46.6-46.0 |
| 2 | McCracken Road, Millbury to Riverlin Street, Millbury | 46.0-43.6 |
| 3 | Riverlin Street, Millbury to Millbury WWTP | 43.6-42.8 |
| 4 | Millbury WWTP to Singing Dam, Sutton | 42.8-42.2 |
| 5 | Singing Dam, Sutton to Pleasant Street, Grafton | 42.2-40.6 |
| 6 | Pleasant Street, Grafton to Fisherville Dam, Grafton | 40.6-39.8 |
| 7 | Fisherville Dam, Grafton to Grafton WWTP | 39.8-38.8 |
| 8 | Grafton WWTP to Riverdale Street, Northbridge | 38.8-35.0 |
| 9 | Riverdale Street to Northbridge WWTP | 35.0-32.4 |
| 10 | Northbridge WWTP to outlet of Rice City Pond, Northbridge | 32.4-31.1 |
| 11 | Outlet of Rice City Pond Northbridge to Route 16, Uxbridge | 31.1-30.0 |
| 12 | Route 16, Uxbridge to Mumford River, Uxbridge | 30.0-29.5 |
| 13 | Mumford River, Uxbridge to West River, Uxbridge | 29.5-28.7 |
| 14 | West River Uxbridge to Water Quality Monitor, Millville | 28.7-23.7 |

## CALIBRATION, VERIFICATION AND LOW FLOW PREDICTIONS

Data obtained from the October 1980 survey was used for calibration and was verified using June and August data. Both June and August data were used in verification for two reasons. The first is that the $BOD_5$ in June had large variations probably due to the runoff from heavy rain on June 8 and 10. Therefore, August data were used in verifying the carbonaceous BOD. Secondly, data collected in August at the Upper Blackstone Water Pollution Abatement District revealed that the plant was achieving nitrification and therefore, the instream data reflected this condition. This situation will be discussed in greater detail later in the report.

For simplicity, the modeling process will be discussed under the following subtitles:

1. Hydrology
   a) Flow Factors
   b) Flow
2. Discharge Data
3. Tributary Data
4. Time of Travel
5. Carbonaceous Biochemical Oxygen Demand (CBOD)
   a) Transfer Coefficients for Carbonaceous BOD at 20°C
   b) Background Concentration
   c) Projected STP Effluent Concentrations
   d) Deoxygenation Rate ($K_d$)
6. Nitrogenous Biochemical Oxygen Demand (NBOD)
   a) Background Concentration
   b) Projected STP Ammonia-Nitrogen Concentrations
   c) Nitrogenous Disappearance Rate ($K_N$)

7. Dissolved Oxygen

   a) Background

   b) Projected STP Dissolved Oxygen Concentrations

   c) Aeration Rate ($K_2$)

8. Photosynthesis and Respiration

9. Bottom Sludge

1. Hydrology

The Blackstone River from the Upper Blackstone Water Pollution Abatement District to the Massachusetts-Rhode Island state line can generally be described, excluding impounded areas, as a swift, moderately shallow uniform stream over most of its length. A brief description of the modeled reaches are as follows:

Reach 1 & 2 - From Upper Blackstone Water Pollution Abatement District to Riverlin Street, Millbury - These reaches are characterized by rapids with a rocky stream bed over most of its length with areas of sand and gravel. During all the surveys in 1980 the depths in these reaches were observed to be approximately 1.0 to 1.5 feet.

Reach 3 - Riverlin Street to Millbury Wastewater Treatment Plant - This section is deeper than the previous reaches but still has a fairly swift flow. Depths in this reach were measured to be 2.5 to 3.0 feet in 1980 at Riverlin Street which is typical of the whole reach.

Reach 4 - Millbury WWTP to Singing Dam - The Singing Dam creates the first impoundment below the Upper Blackstone facility and has a depth of approximately 4.0 feet and a channel width of 60 to 70 feet. The time of travel is short through the impoundment due to moderate velocities in the channel.

Reach 5 - Singing Dam to Pleasant Street, Grafton - This reach is similar to Reach 1 and 2 and was estimated at 2.0-2.5 feet in depth.

Reach 6 - Pleasant Street, Grafton to Fishervile Dam - As expected in an impounded section there is a noticeable decrease in velocity. It must be noted, however, that an estimated 90 percent of the flow in the Blackstone River reaches Fisherville impoundment via the canal and not the river. This is important in the modeling of the river since the canal enters the impoundment just upstream of the dam and causes a short circuiting effect in the impoundment. It was also assumed that any dilution of the Blackstone River generated by the Quinsigamond River is not noticed until downstream of the impoundment. For this reason the Quinsigamond River was input at the beginning of Reach 7 instead of Reach 6. Depths at the dam in the impoundment were found to be 8 to 10 feet in channeled sections (2) but were observed to be no more than 4.0 to 5.0 feet in the canal itself.

Reach 7 - Fisherville Dam to Grafton WWTP - This reach is also impounded caused by the dam at Farnumsville. Depths were measured at approximately 5.0 feet at Route 122A during 1980 but were generally considered to average from 3.0 to 4.0 feet over the entire reach.

Reach 8 - Grafton WWTP to Riverdale Street, Northbridge - Upon leaving the Farnumsville impoundment the Blackstone River is once again free-flowing with increased velocities. Flow measurements made at Sutton Street in Northbridge revealed a depth of 4.5 to 5.0 feet at this location. The writer feels that the depth of the location is not representative of the entire reach since the bridge abutments create backwater and pooling. Observed depths in the remainder of the reach were estimated at approximately 3.0 to 3.5 feet. These estimates were used for modeling purposes.

Reach 9 & 10- Riverdale Street to the outlet of Rice City Pond - Downstream of Riverdale Street the Blackstone River widens noticeably and the depth decreases slightly. The effects of the impoundment are reflected in decreased velocities and increased time of travel through both reaches. Rice City Pond itself is very shallow (approximately 3.0 feet) but has a large impact on water quality particularly due to photosynthesis and respiration. During all the surveys in 1980 it was found that the oxygen sag due to the Upper Blackstone Water Pollution Abatement Facility was at a maximum in this impoundment.

Reaches 11, 12, 13 and 14 - Rice City Pond to USGS Water Quality Gage, Millville - With the exception of Reach 11 the Blackstone River became narrow and fast flowing in the last four reaches and had observed average depths of 2.5 to 3.0 feet. Reaches 12, 13, and 14 also receive dilution and increased flows from the Mumford and West Rivers. Reach 11 from Rice City Pond to Route 16 in Uxbridge is shallow (approximately 2.5 to 3.0 feet) but much wider and therefore exhibits reduced velocities.

a) Flow Factors

Flow factors for each survey were obtained by using calculated drainage areas and measured flows at Riverlin Street in Millbury, Sutton Street, in Northbrige, Route 16 in Uxbridge, and the USGS flow gage in Woonsocket, Rhode Island. The general equation for calculating flow factors and survey flow factors are as follows:

$$\text{Flow Factor (cfs/mi}^2) = \frac{\text{Q (Downstream) - Q (Upstream) - inputs}}{\text{Drainage area (downstream) - Drainage area (upstream)}}$$

June 1980 - Riverlin Street, Millbury to Sutton Street, Northbridge

$Q_d$ = 147.0 cfs $DA_d$ = 139.0 $mi^2$

$Q_u$ = 111.5 cfs $DA_u$ = 76.5 $mi^2$

Inputs = 0.71 cfs (Millbury WWTP) + 0.75 cfs (Grafton WWTP) = 1.46 cfs

therefore,

$$\text{Flow Factor} = \frac{147.0 \text{ cfs} - 111.5 \text{ cfs} - 1.46 \text{ cfs}}{139 \text{ mi}^2 - 76.5 \text{ mi}^2} = 0.545 \text{ cfs/mi}^2$$

- Sutton Street, Northbridge to Route 16, Uxbridge

$Q_d$ = 156.0 cfs        $DA_d$ = 148.3 $mi^2$

$Q_u$ = 147.0 cfs        $DA_u$ = 139.0 $mi^2$

Inputs = 2.03 cfs (Northbridge WWTP)

therefore,

$$\text{Flow Factor} = \frac{156.0 \text{ cfs} - 147.0 \text{ cfs} - 2.03 \text{ cfs}}{148.3 \text{ mi}^2 - 139.0 \text{ mi}^2} = 0.7495 \text{ cfs/mi}^2$$

<u>August 1980</u> - Riverlin Street, Millbury to Sutton Street, Northbridge

$Q_d$ = 116.5 cfs        $DA_d$ = 139.0 $mi^2$

$Q_u$ = 93.4 cfs        $DA_u$ = 76.5 $mi^2$

Inputs = 0.882 cfs (Millbury WWTP) - 0.586 cfs (Grafton WWTP)
= 1.468 cfs

therefore,

$$\text{Flow Factor} = \frac{116.5 \text{ cfs} - 93.4 \text{ cfs} - 1.468 \text{ cfs}}{139.0 \text{ mi}^2 - 76.5 \text{ mi}^2} = 0.346 \text{ cfs/mi}^2$$

- Downstream data unavailable due to a control structure above the USGS gage in Woonsocket, R.I., therefore, the same flow factor from Riverlin Street to Sutton Street was applied.

<u>October 1980</u> - Riverlin Street, Millbury to Sutton Street, Northbridge

$Q_d$ = 121.97 cfs        $DA_d$ = 139.0 $mi^2$

$Q_u$ = 65.91 cfs        $DA_u$ = 76.5 $mi^2$

Inputs = 0.769 cfs (Millbury WWTP) + 0.557 cfs (Grafton WWTP)
= 1.325 cfs

therefore,

$$\text{Flow Factor} = \frac{121.97 \text{ cfs} - 65.91 \text{ cfs} - 1.326 \text{ cfs}}{139.0 \text{ mi}^2 - 76.5 \text{ mi}^2} = 0.876 \text{ cfs/mi}^2$$

- Sutton Street, Northbridge to USGS gage, Woonsocket, R.I.

$Q_d$ = 209.5 cfs        $DA_d$ = 416.0 $mi^2$

$Q_u$ = 121.97 cfs        $DA_u$ = 139.0 $mi^2$

Inputs = 1.08 cfs (Northbridge WWTP) + 0.445 cfs (Uxbridge WWTP)
+ 0.06 cfs (Douglas WWTP) + 1.5 cfs (Hayward Shuster, Inc.)
+ 0.02 cfs (Whitin Machine) + 0.39 cfs (Emil Barnat, Inc.)
+ 0.15 cfs (Upton WWTP)
= 3.645 cfs

therefore,

$$\text{Flow Factor} = \frac{209.5 \text{ cfs} - 121.97 \text{ cfs} - 3.645 \text{ cfs}}{416.0 \text{ mi}^2 - 139.0 \text{ mi}^2} = 0.303 \text{ cfs/mi}^2$$

7-day 10-year Low Flow

At Woonsocket USGS gage $Q_{7-10}$ = 101.012 cfs, DA = 416.0 $mi^2$

Inputs = 0.15 cfs (Worcester Spinning & Finishing)
+ 0.19 cfs (New England Plating) + 46.0 cfs (UBWPAD)
+ 0.03 cfs (High Carbon Wire) + 0.85 cfs (Millbury WWTP)
+ 0.71 cfs (Grafton WWTP) + 1.9 cfs (Northbridge WWTP)
+ 0.46 cfs (Stanley Woolen Co.) + 0.45 cfs (Uxbridge WWTP)
+ 0.01 cfs (Blackston Potatoe Chip) + 0.23 cfs (Wyman Gordon Co.) + 1.08 cfs (Douglas WWTP) + 1.55 cfs (Hayward Shuster Co.) + 0.03 cfs (Whitin Machine)
+ 0.37 cfs (Emil Barnart) + 0.15 cfs (Upton WWTP) + 0.46 cfs (Hopedale WWTP)
= 54.61 cfs

therefore,

$$Q_{7-10} \text{ Flow Factor} = \frac{101.012 \text{ cfs} - 54.61 \text{ cfs}}{416.0 \text{ mi}^2} = 0.11 \text{ cfs/mi}^2$$

This flow factor was then checked against the calculated flow factor at the Kettle Brook USGS gage in the upper reaches as follows:

$Q_{7-10}$ at Kettle Brook = 4.51 cfs     DA = 31.3 $mi^2$

Inputs = 0.15 cfs (Worcester Spinning & Finishing)

therefore,

$$\text{Flow Factor} = \frac{4.51 \text{ cfs} - 0.15 \text{ cfs}}{31.3 \text{ mi}^2} = 0.14 \text{ cfs/mi}^2 \sim 0.11 \text{ cfs/mi}^2$$

b) Flow

Background flows in the Blackstone River immediately upstream of the Upper Blackstone Water Pollution Abatement District were calculated for each survey using the measured flows at Riverlin Street in Millbury and the calculated flow factors as follows:

June 1980 - Q at Riverlin Street = 111.5 cfs          DA = 76.5 $mi^2$

Q (UBWPAD) = 46.0 cfs          DA = 67.3 $mi^2$

therefore,

Background Q = 111.5 cfs - 46.0 cfs - (0.545 cfs/$mi^2$)(76.5 $mi^2$ - 67.3 $mi^2$)
= 60.49 cfs

August 1980 - Q at Riverlin Street = 93.4 cfs          DA = 76.5 $mi^2$

Q (UBWPAD) = 46.03 cfs          DA = 67.3 $mi^2$

therefore,

Background Q = 93.4 cfs - 46.03 cfs - (0.346 cfs/$mi^2$)(76.5 $mi^2$ - 67.3 $mi^2$)
= 44.19 cfs

October 1980 - Q at Riverlin Street = 65.91 cfs          DA = 76.5 $mi^2$

Q (UBWPAD) = 40.69 cfs          DA = 67.3 $mi^2$

therefore,

Background Q = 65.91 cfs - 40.69 cfs - (0.876 cfs/$mi^2$)(76.5 $mi^2$ - 67.3 $mi^2$) = 17.16 cfs

$Q_{7-10}$ - The $Q_{7-10}$ at the Upper Blackstone Water Pollution Abatement District was calculated multiplying 7-day 10-year flow factor of 0.11 cfs/mi times the drainage area at the treatment facility. Flows from the Worcester Spinning & Finishing Co. and New England Plating were also added since these discharges are upstream of the Upper Blackstone discharge.

therefore,

Background Q = (0.11 cfs/$mi^2$ x 67.3 $mi^2$) + 0.46 cfs
= 7.86 cfs

Tributary Flows

The Quinsigamond, Mumford and West rivers provide a large amount of dilution to the Blackstone River and therefore, were input into the model as a point source. Since these tributaries were not flow gaged during the surveys, flows were calculated by applying the appropriate flow factor to the drainage area of each tributary at its confluence with the Blackstone River. In the case of the Mumford and West rivers, all wastewater discharge flows were also added.

The hydraulic inputs for the calibration, verification and low flow models are summarized in Tables 3, 4, 5 and 6.

TABLE 3

HYDRAULIC INPUTS

CALIBRATION (October 1980)

| REACH | FLOW FACTOR ($cfs/mi^2$) | DISCHARGE FLOW (cfs) | TRIBUTARY FLOW (cfs) | FLOW INTO REACH (cfs) | AVERAGE FLOW OF REACH (cfs) | AVERAGE DEPTH OF REACH (ft.) |
|---|---|---|---|---|---|---|
| 1 | 0.876 | 40.69 | -- | 57.85 | 57.98 | 1.3 |
| 2 | | -- | -- | 58.11 | 62.01 | 1.2 |
| 2 | | -- | -- | 65.91 | 68.72 | 2.6 |
| 4 | | 0.769 | -- | 72.29 | 72.90 | 4.0 |
| 5 | | -- | -- | 73.51 | 80.39 | 2.0 |
| 6 | | -- | -- | 87.26 | 87.43 | 4.9 |
| 7 | | -- | 29.96 | 117.57 | 118.19 | 3.0 |
| 8 | 0.590 | 0.557 | -- | 119.36 | 120.83 | 3.0 |
| 9 | 0.303 | -- | -- | 122.30 | 123.12 | 2.6 |
| 10 | | 1.08 | -- | 125.02 | 125.13 | 3.0 |
| 11 | | -- | -- | 125.23 | 125.42 | 2.5 |
| 12 | | -- | -- | 125.60 | 125.68 | 2.5 |
| 13 | | -- | 20.94 | 146.69 | 146.78 | 2.5 |
| 14 | | 0.445 | 15.79 | 163.11 | 164.98 | 3.0 |

TABLE 4

HYDRAULIC INPUTS

VERIFICATION (June 1980)

| REACH | FLOW FACTOR ($cfs/mi^2$) | DISCHARGE FLOW (cfs) | TRIBUTARY FLOW (cfs) | FLOW INTO REACH (cfs) | AVERAGE FLOW OF REACH (cfs) | AVERAGE DEPTH OF REACH (ft.) |
|---|---|---|---|---|---|---|
| 1 | 0.545 | 46.0 | -- | 106.49 | 106.54 | 1.5 |
| 2 | | -- | -- | 106.65 | 109.08 | 1.4 |
| 3 | | -- | -- | 111.50 | 113.24 | 3.0 |
| 4 | | 0.71 | -- | 115.70 | 115.73 | 4.0 |
| 5 | | -- | -- | 116.46 | 120.74 | 2.4 |
| 6 | | -- | -- | 125.02 | 125.13 | 5.0 |
| 7 | | -- | 18.64 | 143.88 | 144.26 | 3.7 |
| 8 | | 0.753 | -- | 145.39 | 146.76 | 3.2 |
| 9 | 0.7495 | -- | -- | 148.12 | 150.14 | 2.8 |
| 10 | | 2.03 | -- | 154.20 | 154.46 | 3.3 |
| 11 | | -- | -- | 154.72 | 155.17 | 2.7 |
| 12 | | -- | -- | 156.08 | 156.64 | 3.0 |
| 13 | | -- | 48.9 | 206.10 | 206.33 | 3.0 |
| 14 | | 0.49 | 38.82 | 245.86 | 250.51 | 3.5 |

TABLE 5

HYDRAULIC INPUTS

VERIFICATION (August 1980)

| REACH | FLOW FACTOR ($cfs/mi^2$) | DISCHARGE FLOW (cfs) | TRIBUTARY FLOW (cfs) | FLOW INTO REACH (cfs) | AVERAGE FLOW OF REACH (cfs) | AVERAGE DEPTH OF REACH (ft.) |
|---|---|---|---|---|---|---|
| 1 | 0.3461 | 46.03 | -- | 90.22 | 90.27 | 1.4 |
| 2 | | -- | -- | 90.32 | 91.86 | 1.3 |
| 3 | | -- | -- | 93.40 | 94.51 | 2.8 |
| 4 | | 0.882 | -- | 96.50 | 96.75 | 4.0 |
| 5 | | -- | -- | 96.99 | 99.71 | 2.2 |
| 6 | | -- | -- | 102.42 | 102.49 | 4.5 |
| 7 | | -- | 11.84 | 114.40 | 114.64 | 3.0 |
| 8 | | 0.586 | -- | 115.47 | 116.30 | 3.0 |
| 9 | | -- | -- | 117.20 | 118.13 | 2.6 |
| 10 | | 1.86 | -- | 120.93 | 121.05 | 3.0 |
| 11 | | -- | -- | 121.17 | 121.38 | 2.5 |
| 12 | | -- | -- | 121.59 | 121.68 | 2.5 |
| 13 | | -- | 23.64 | 145.40 | 145.50 | 2.5 |
| 14 | | 0.49 | 18.01 | 164.00 | 166.26 | 3.0 |

TABLE 6

HYDRAULIC INPUTS

Q7-10

| REACH | FLOW FACTOR (cfs/mi$^2$) | DISCHARGE FLOW (cfs) | TRIBURARY FLOW (cfs) | FLOW INTO REACH (cfs) | AVERAGE FLOW OF REACH (cfs) | AVERAGE DEPTH OF REACH (ft.) |
|---|---|---|---|---|---|---|
| 1 | 0.11 | 86.6 | -- | 94.46 | 94.47 | 1.3 |
| 2 | | -- | -- | 94.49 | 94.98 | 1.2 |
| 3 | | -- | -- | 95.47 | 95.82 | 2.4 |
| 4 | | 3.09 | -- | 99.26 | 99.96 | 4.0 |
| 5 | | -- | -- | 100.66 | 101.52 | 1.9 |
| 6 | | -- | -- | 102.39 | 102.41 | 4.0 |
| 7 | | -- | 3.99 | 106.42 | 107.12 | 2.1 |
| 8 | | 6.0 | -- | 113.82 | 114.10 | 2.5 |
| 9 | | -- | -- | 114.37 | 114.67 | 2.1 |
| 10 | | 2.78 | -- | 117.74 | 117.78 | 2.5 |
| 11 | | -- | -- | 117.82 | 117.89 | 2.1 |
| 12 | | -- | -- | 118.41 | 118.49 | 1.8 |
| 13 | | -- | 8.01 | 126.59 | 126.63 | 2.0 |
| 14 | | 3.87 | 5.91 | 136.44 | 137.12 | 2.5 |

## 2. Discharge Data

The Upper Blackstone Water Pollution Abatement District, Millbury WWTP, Grafton WWTP, Northbridge WWTP and Uxbridge WWTP on the main stem of the Blackstone River were sampled during each survey in 1980. Additional sampling was also conducted at Worcester Spinning and Finishing, New England High Carbon Wire Co., Polyfoam Inc., and Blackstone Potato Chip Co. during these surveys. Of particular importance, however, are the data collected at the Upper Blackstone facility. Samples were collected every hour and composited over a 24-hour period and analyzed for chemical oxygen demand, $BOD_5$, pH, total alkalinity, total solids, suspended solids, settleable solids, turbidity, TKN, $NH_3$-N, $NO_3$-N, total phosphorus, ortho-phosphorus and total and fecal coliform. Samples were also analyzed for total volatile solids and hardness in October 1980. All data collected at the Upper Blackstone plant are summarized in Table 7. As previously noted the effluent data reveal nitrification had taken place within the facility during the August survey. This is evidenced by ammonia-nitrogen concentrations of 1.7 mg/l and 3.0 mg/l while nitrate-nitrogen concentrations rose to 8.0 mg/l and 6.9 mg/l respectively. Also of note are the flows from the treatment facility. These flows accounted for approximately 43 percent of the instream flow during June, 51 percent in August, and 70 percent in October. During $Q_{7-10}$ conditions in the river and design flows at the Upper Blackstone facility, the wastewater treatment facility will contribute approximately 92 percent of the instream flow immediately downstream of the wastewater treatment facility.

## 3. Tributary Data

The Quinsigamond, Mumford and West rivers contribute flow to the main stem of the Blackstone River at river miles 39.8, 29.5 and 28.7 respectively. All three rivers were sampled for water quality during the 1980 surveys. Stream flow gaging was not conducted. Flows for these rivers were calculated by multiplying the flow factor times the drainage area of each river and adding all flows from industrial and municipal wastewater discharges. These calculations showed that the three rivers were responsible for 29 to 39 percent of the main stem flow during the 1980 surveys. When projected to the 7-day 10-year low flow, the dilution from these rivers was decreased to approximately 12 percent but is still felt to be significant.

Water quality data obtained for each survey is presented in Appendix I. These data combined with the calculated flows were used in the calibration and verification process. Low flow predictions for carbonaceous BOD, nitrogenous BOD and dissolved oxygen are presented in Table 8 and are consistent with data collected in August of 1977 and 1980 which were taken at approximately the same temperature as that in the low flow model.

TABLE 7

UPPER BLACKSTONE WATER POLLUTION ABATEMENT DISTRICT

WASTEWATER TREATMENT PLANT

RESULTS OF LABORATORY ANALYSES (mg/l)

(24-hour composite)

| DATE OF COLLECTION: | EFFLUENT 10/2-3/79 | EFFLUENT 10/3-4/79 | EFFLUENT 6/9-10/80 | EFFLUENT 6/10-11/80 | EFFLUENT 8/4-5/80 | EFFLUENT 8/5-6/80 | EFFLUENT 10/15-16/80 |
|---|---|---|---|---|---|---|---|
| PARAMETER | | | | | | | |
| COD | 54 | 48 | 91 | 67 | 59 | 39 | 90 |
| $BOD_5$ | 2.0 | 4.0 | 3.3 | 3.3 | 6.9 | 4.5 | 8.7 |
| pH (Standard Units) | 7.7 | 7.6 | 7.4 | 7.7 | 7.3 | 7.5 | 7.6 |
| Total Alkalinity | 76 | 62 | 30 | 60 | 20 | 28 | 94 |
| Suspended Solids | 3.5 | 5.0 | 9.0 | 6.5 | 8.5 | 3.5 | 7.0 |
| Settleable Solids (ml/l) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 |
| Total Solids | 262 | 250 | 322 | 282 | 308 | 298 | 312 |
| Total Volatile Solids | -- | -- | -- | -- | -- | 74 | 74 |
| Turbidity (NTU) | 5.2 | 5.9 | 4.1 | 3.7 | 3.3 | 3.1 | 2.7 |
| Total Hardness | -- | -- | -- | -- | -- | 54 | 54 |
| Total Kjeldahl-Nitrogen | 9.1 | 7.4 | 9.3 | 10 | 3.6 | 5.2 | 13 |
| Ammonia-Nitrogen | 7.8 | 5.6 | 9.1 | 9.2 | 1.7 | 3.0 | 12 |
| Nitrate-Nitrogen | 1.5 | 1.2 | 0.6 | 0.4 | 8.0 | 6.9 | 1.0 |
| Total Phosphorus | 2.0 | 1.0 | 1.7 | 1.7 | 1.9 | 1.4 | 2.2 |
| Ortho-Phosphorus | -- | -- | 1.7 | 0.85 | 1.4 | 0.86 | 1.7 |
| Chloride | -- | -- | -- | -- | -- | 79 | 79 |
| Total Coliform/100 ml | -- | -- | -- | 100 | 400 | -- | -- |
| Fecal Coliform/100 ml | -- | -- | -- | 5 | 20 | -- | -- |
| Flow (MGD) | 35.2 | 41.2 | 31.8 | 29.2 | 30.0 | 29.0 | 26.2 |
| $BOD_1$ | -- | -- | -- | -- | 3.0 | -- | -- |
| $BOD_7$ | -- | -- | -- | -- | 7.8 | -- | -- |
| $BOD_{14}$ | -- | -- | -- | -- | 21 | -- | -- |

TABLE 8

TRIBUTARY INPUTS

$Q_{7-10}$

| PARAMETER | QUINSIGAMOND RIVER | MUMFORD RIVER | WEST RIVER |
|---|---|---|---|
| $NH_3$-N (mg/l) | 0.02 | 0.05 | 0.05 |
| $NH_3$-N x 4.57 (mg/l) | 0.9 | 0.23 | 0.23 |
| $CBOD_5$ (mg/l) | 2.4 | 2.4 | 2.7 |
| $CBOD_u$ ($K_1$ = 0.23) | 3.5 | 3.5 | 3.97 |
| Dissolved Oxygen (mg/l) | 6.7 | 7.0 | 6.0 |

4. Time of Travel

Time of travel studies were conducted on the main stem of the Blackstone River in 1964, 1970 and 1973. Additional data were collected in 1981 from the Farnumsville Dam to the Riverdale Dam due to the breaching of the Rockdale Dam between 1970 and 1973. Flows during each survey were calculated using data obtained from the USGS gages at Kettle Brook, Quinsigamond River, West River and on the main stem at Northbridge, MA and Woonsocket, R.I. In 1981 the flows were measured in the field during the time of travel study. Calculations were then made to obtain values for $Q_{coef}$ and $Q_{exp}$ (Stream 7A Manual, page 2-43). Predictions of the time of travel for each reach during the 1980 surveys and $Q_{7-10}$ flow regime were then made using the following equation:

$$T_N \text{ (Hours)} = \frac{Q_{coef}}{Q_N{}^{Q_{exp}}}$$

where $T_N$ = time of travel in hours for an average flow of $Q_N$ in cfs
$Q_N$ = average flow of the reach in cfs

It should be noted that flows during the time of travel studies in 1964, 1970, 1973 and 1981 varied from approximately 71 cfs to 673 cfs at Sutton Street in Northbridge, and thus should define values for $Q_{exp}$ and $Q_{coef}$ from a wide range of flow regimes.

5. Carbonaceous Biochemical Oxygen Demand (CBOD)

a) Transfer Coefficients for Carbonaceous BOD at 20°C

Carbonaceous loadings for Stream 7B are input as ultimate loadings and do not require direct input of the transfer coefficient (i.e. $K_1$, $K_{1N}$, $K_{1T}$ and $K_{1P}$ as in Stream 7A). These rates are however, used in calculating all the ultimate loadings before input and are therefore, still necessary. Coefficients were calculated using long term BOD data obtained instream during the June 1980 survey and at the wastewater treatment facilities during the August 1980 survey. It was also assumed that these rates remained constant during all of the 1980 surveys.

b) Background Concentration

Data collected in 1980 at Station BS09 (Millbury Street Bridge, Worcester) were used in the calibration and verification process. The $BOD_5$ concentrations at this station were very high due to the high organic loadings originating from Mill Brook in Worcester which receives combined sewer overflows. It should be noted however, that at the present time monies are being spent to alleviate this problem in the form of sewer separation and a stormwater collection and treatment facility.

Therefore, when projecting to low flow conditions a $BOD_5$ of 3.0 mg/l was chosen as a background concentration which is consistent with data collected at Station BS09B (above dam off Millbury Street, Worcester), which is upstream of Mill Brook. A transfer coefficient of 0.23/day was then assumed to obtain an ultimate CBOD of 4.4 mg/l.

c) Projected WWTP Effluent Concentrations

As previously noted, sampling was conducted at all wastewater treatment facilities which discharge to the Blackstone River in 1980. The results of these surveys were then used in the calibration and verification process. When projecting to $Q_{7-10}$ conditions, all loadings from the wastewater treatment facilities excluding the Upper Blackstone plant were held constant at their current NPDES permit limits. The loading from the Upper Blackstone facility was then varied using a projected design flow of 86.6 cfs (56.0 MGD) and the current flow of 46.0 cfs (30.0 MGD). Effluent $BOD_5$ concentrations of 5.0 (advanced waste treatment), 10.0, and 15.0 (advanced secondary treatment) were then used in the model. A transfer coefficient ($K_1$) of 0.17 day$^{-1}$ was assumed for advanced treatment to achieve ultimate CBOD concentrations of 8.73 mg/l, 17.46 mg/l and 22.1 mg/l for $BOD_5$ concentrations of 5.0 mg/l, 10.0 mg/l and 15.0 mg/l respectively.

Additional analyses were also conducted assuming secondary effluent at the Upper Blackstone facility ($BOD_5$ = 30.0 mg/l, $K_1$ = 0.23 day$^{-1}$, $NH_3$-N = 10.0 mg/l, D.O. = 5.0 mg/l) and advanced treatment at Millbury, Grafton, Northbridge and Uxbridge. The results of which will be discussed later in this report and can be found in the sensitivity analyses.

d) Deoxygenation Rate ($K_d$)

Utilizing the selected ultimate CBOD's and calculated time of travel data a total CBOD removal rate ($K_R$) was calculated for Reaches 1 through 6 and then again for Reaches 7 through 14. Since suspended solids data did not reveal that any significant settling was occuring (i.e. $K_s$ = 0.0) the writer feels that the primary means of CBOD removal was through oxidation. Therefore, the total removal rate was set equal to the deoxygenation rate ($K_R = K_d$). Analysis of the 1980 data also revealed that the majority of the carbonaceous BOD is removed before Reach 7 and from that point on the nitrogenous BOD disappearance is the controlling factor within the river. These same rates were then applied to the August 1980 data in which nitrification at the Upper Blackstone facility was evident and was found to verify the instream results quite well. For this reason the same rates were used when projecting to low flow conditons.

6. Nitrogenous Biochemical Oxygen Demand (NBOD)

a) Background Concentration

As with the carbonaceous BOD, the nitrogenous BOD background concentrations were obtained from data recorded at Station BS09 (Millbury Street, Worcester) for the calibration and verification process. These concentrations were then converted to ultimate NBOD loadings by using the following stoichiometric relationship.

$$(NH_3\text{-}N)(4.57) = \text{Ultimate NBOD load (mg/l)}$$

When projecting to $Q_{7\text{-}10}$ conditions it was again assumed that the loadings from Mill Brook will be eliminated in the near future and an ammonia-nitrogen concentration of 0.06 mg/l was assumed and is consistent with Station BS09B upstream of Mill Brook. This concentration was then converted to an ultimate NBOD demand of 0.27 mg/l using the preceeding stoichiometric relationship.

b) Project WWTP Ammonia-Nitrogen Concentrations

Ammonia-nitrogen data collected at the wastewater treatment facilities during the 1980 surveys were converted to ultimate NBOD loadings and used for calibration and verification purposes. When projecting to low flow conditions, effluent $NH_3$-N concentrations at the Upper Blackstone facility were varied from 10.0 mg/l (secondary treatment without nitrification) to 1.0 mg/l (with nitrification) in order to determine if nitrification is necessary and if so to what extent. As with the carbonaceous BOD, all other wastewater treatment facilities were held constant at their current NPDES permit limits. The analysis was also extended to incorporate current flows as well as deisgn flows from the Upper Blackstone plant.

c) Nitrogenous Disappearance Rate ($K_N$)

The rate constant $K_N$ is a measure of the nitrogenous biochemical oxygen demand (NBOD) decay rate during the process of nitrification. As previously noted, wastewater treatment plant data collected at the Upper Blackstone facility revealed that nitrification was taking place within the facility during the August 1980 survey. This was a unique situation which gave us the opportunity to assess the instream reactions to such a condition. The other two surveys in 1980 (June and October) were conducted under normal conditions at the wastewater facility, thus reflecting instream reactions without nitrification at the Upper Blackstone facility.

Analysis of the 1980 data revealed that without nitrification at the Upper Blackstone plant, instream nitrogen disappearance did not commence until downstream of Fisherville Impoundment. Once instream nitrification had begun, the disappearance of ammonia-nitrogen occurred at a very rapid rate ($K_N$ = 1.2 $day^{-1}$, base e at 20°C) all the way to the USGS water quality monitor in Millville, Massachusetts. During the August 1980 survey when nitrification at the Upper Blackstone plant was evident, ammonia-nitrogen disappearance was found to begin further upstream, below the Singing Dam impoundment in Sutton, Massachusetts and continued all the way to the U.S.G.S. water quality gage in Millville. The rate of $NH_3$-N disappearance when back calculated to 20°C was found to equal the rates calculated for October and June ($K_N$ = 1.2 $day^{-1}$, base e).

Instream temperatures during the 1980 surveys were highly variable ranging from 57°F in October to 78°F in August. The writer feels that the higher temperature combined with the nitrification at the Upper Blackstone plant during the August 1980 survey was responsible for the $NH_3$-N disappearance taking place further upstream than in the June or October surveys. Since design conditions of $Q_{7-10}$, temperature of 77°F and nitrification at the Upper Blackstone plant were used in projecting to future loadings and are all very close to the instream conditions during the survey in August 1980, it is expected that the stream will react the same. For this reason, a $K_N$ of 1.2 $day^{-1}$ was used for Reaches 5 through 14 in the low flow model.

7. <u>Dissolved Oxygen</u>

a) Background Concentration

Average dissolved oxygen concentrations recorded at Station BS09 (Millbury Street, Worcester) were used for calibration and verification of the 1980 models. A dissolved oxygen concentration of 7.0 mg/l for the 7-day 10-year low flow projection was selected and is consistent with concentrations measured at Stations BS08 and BS09A above Mill Brook during August 1980 and August 1977 at approximately the same temperature.

b) Projected WWTP's Dissolved Oxygen Concentrations

The following concentrations were used for effluent dissolved oxygen during the calibration and verification process. Data were obtained from past compliance monitoirng reports or from estimates obtained from field observations.

| FACILITY | CONCENTRATION (mg/l) |
|---|---|
| Upper Blackstone WWTP | 4.0 |
| Millbury WWTP | 2.0 |
| Grafton WWTP | 3.0 |
| Northbridge WWTP | 5.0 |
| Uxbridge WWTP | 5.0 |

For the low flow projections, effluent concentrations of 5.0 mg/l and 6.0 mg/l were examined at the Upper Blackstone plant while holding all other facilities constant at the calibrated/verified concentrations. It should also be noted that additional runs assuming a dissolved oxygen concentration of 5.0 mg/l at Upper Blackstone and advanced treatment with a D.O. = 6.0 mg/l at all the other facilities were also made and can be found in the sensitivity analysis.

c) Reaeration Rate Constant ($K_2$)

Methods for choosing the reaeration rates for each reach are presented in Table 9. These methods were used for all the 1980 surveys and for the $Q_{7-10}$ with design flows from the Upper Blackstone plant.

TABLE 9

REAERATION RATE ($K_2$)

METHODS

| REACH | METHOD |
|---|---|
| 1, 9, 10, 11, 12, 13 | Covar (model chooses best $K_2$ based on hydraulics) |
| 2, 4 | Churchill |
| 3, 6, 7, 14 | O'Connors Deep |
| 5, 8 | Owens (input directly into the model) |

8. Photosynthesis and Respiration

Analysis of the 1980 dissolved oxygen data revealed that photosynthesis and respiration had an impact on dissolved oxygen concentrations generally from Station BS13 (Route 122A, Grafton) to BS16 (outlet of Rice City Pond). A "Simplified Diurnal Curve Analysis" (Erdmann, John, B., presented at the ASCE Convention & Exposition, Boston, MA, April 2-6, 1979) was utilized to determine the total photosynthesis between each station from BS13 to BS16. Respiration according to this method was not used since the total respiration includes BOD exertion (heterotrophic microbial respiration), sediment oxygen demand (benthic microbial respiration), respiration of algae and other plants, and deoxygenation due to nitrification. Algal respiration was set at 10 percent of the photosynthesis as documented by Bain(3)

It should also be noted that inclusion of photosynthesis in the August 1980 model gave abnormally high D.O. concentrations which approached saturation values and at times became super saturated. The writer then felt that exclusion of the photosynthesis and respiration in this model would represent a "worst case" condition in which oxygen depletion was due mainly to nitrification from the Upper Blackstone nitrogen loadings. Results revealed that the predicted dissolved oxygen concentration, although still high, fell within the diurnal variations at each station and therefore, was considered acceptable.

When projecting to the 7-day 10-year low flow condition, photosynthesis and respiration were not included in the model since we are only concerned with the impact on the receiving waters from the wastewater facility and should not artificially inflate or deflate the dissolved oxygen concentrations.

9. Bottom Sludge

Due to the lack of equipment and personnel, the benthic demand in Fisherville impoundment was estimated by the writer. A rate of 2.5 gm/m$^2$/day was used as suggested by Tetra Tech(4). It should also be noted that variations of $\pm$ 50 percent in the oxygen demand and percent coverage of sludge during the sensitivity analysis changed the minimum dissolved oxygen less than 0.1 mg/l thus indicating little impact on the wasteload allocation.

The calibrated and verified modeling results for dissolved oxygen based on the 1980 data are presented in Tables 10, 11, and 12, and in Figures 3, 4, and 5. Also included are the corresponding carbonaceous and nitrogenous BOD models for each of the 1980 surveys. The carbonaceous BOD models can be found in Tables 13 and 14 and in Figures 6 and 7. The nitrogen models are described in Tables 15, 16, and 17, and Figures 8, 9, and 10.

TABLE 10

CALIBRATED (October 1980)

MODEL RESULTS

| STATION | CALCULATED TIME OF TRAVEL FROM THE UBWPAD (hrs.) | AVERAGE D.O. RECORDED (mg/l) | D.O. RANGE RECORDED (mg/l) | PREDICTED D.O. FROM MODEL (mg/l) |
|---|---|---|---|---|
| BS10 | 1.64 | 6.7 | 6.0-7.0 | 6.82 |
| BS11 | 5.33 | 8.5 | 8.2-8.8 | 8.57 |
| BS12 | 12.22 | 7.8 | 7.3-8.7 | 7.62 |
| BS13A | 15.26 | 9.2 | 8.8-9.5 | 8.83 |
| BS13 | 18.13 | 9.4 | 9.3-9.5 | 9.73 |
| BS14 | 25.11 | 7.8 | 7.1-8.7 | 7.41 |
| BS15 | 28.03 | 7.7 | 7.0-8.7 | 6.93 |
| BS16 | 44.91 | 6.9 | 5.0-8.1 | 6.90 |
| BS17A | 50.03 | 8.1 | 7.6-8.3 | 7.52 |
| BS17 | 52.36 | 8.6 | 8.1-9.2 | 8.34 |
| BS18 | 58.37 | 9.3 | 8.8-10.1 | 8.62 |

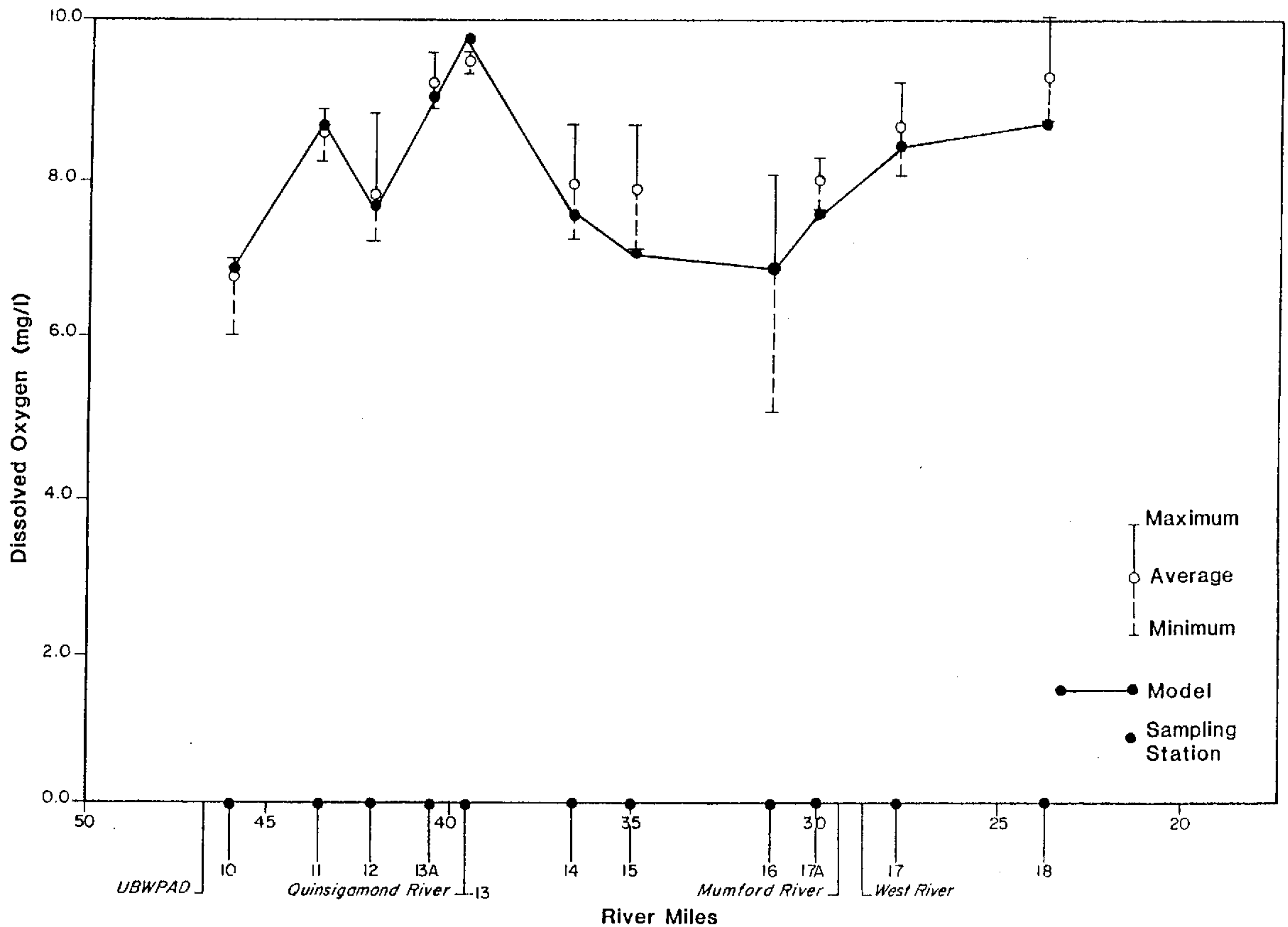


FIGURE 3 - BLACKSTONE RIVER, CALIBRATED MODEL RESULTS, DISSOLVED OXYGEN (OCTOBER 1980)

TABLE 11

VERIFICATION W/O NITRIFICATION

AT THE UBWPAD (June 1980)

MODEL RESULTS

| STATION | CALCULATED TIME OF TRAVEL FROM THE UBWPAD (hrs.) | AVERAGE D.O. RECORDED (mg/l) | D.O. RANGE RECORDED (mg/l) | PREDICTED D.O. FROM MODEL (mg/l) |
|---|---|---|---|---|
| BS10 | 1.21 | 7.5 | 6.7-8.9 | 7.11 |
| BS11 | 4.29 | 8.8 | 8.2-9.6 | 8.46 |
| BS12 | 10.15 | 8.1 | 7.6-8.6 | 8.02 |
| BS13A | 12.79 | 9.0 | 8.2-9.6 | 8.87 |
| BS13 | 15.60 | 9.3 | 8.3-10.2 | 9.11 |
| BS14 | 21.95 | 7.9 | 7.2-8.9 | 7.74 |
| BS15 | 24.56 | 7.7 | 6.3-9.2 | 7.40 |
| BS16 | 39.30 | 8.1 | 4.9-11.5 | 9.09 |
| BS17A | 44.02 | 7.3 | 6.5-8.3 | 8.51 |
| BS17 | 46.27 | 7.4 | 6.4-8.3 | 8.54 |
| BS18 | 51.99 | 7.6 | 6.7-8.7 | 8.34 |

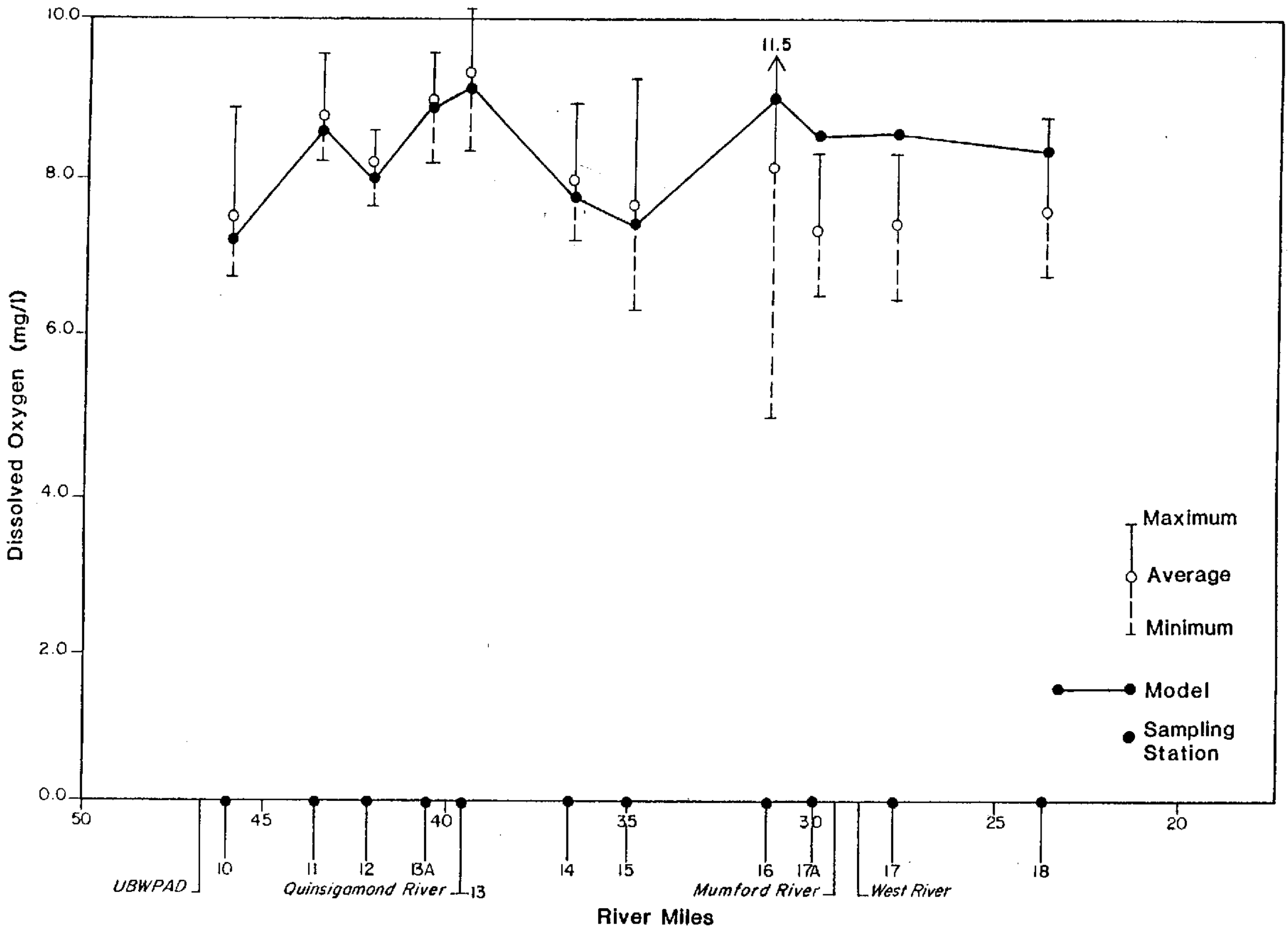


FIGURE 4 - BLACKSTONE RIVER, VERIFIED MODEL RESULTS, DISSOLVED OXYGEN (JUNE 1980)

TABLE 12
VERIFICATION WITH NITRIFICATION
AT THE UBWPAD (August 1980)
MODEL RESULTS

| STATION | CALCULATED TIME OF TRAVEL FROM THE UBWPAD (hrs.) | AVERAGE D.O. RECORDED (mg/l) | D.O. RANGE RECORDED (mg/l) | PREDICTED D.O. FROM MODEL (mg/l) |
|---|---|---|---|---|
| BS10 | 1.31 | 5.1 | 4.1-6.3 | 5.42 |
| BS11 | 4.56 | 6.9 | 5.9-7.7 | 7.13 |
| BS12 | 10.79 | 5.4 | 4.9-6.6 | 6.51 |
| BS13A | 13.61 | 6.9 | 6.4-7.7 | 6.80 |
| BS13 | 16.60 | 6.8 | 6.6-7.3 | 6.86 |
| BS14 | 23.68 | 6.0 | 4.3-7.8 | 7.01 |
| BS15 | 26.69 | 6.2 | 4.0-9.1 | 6.98 |
| BS16 | 44.00 | 5.2 | 2.7-8.3 | 6.83 |
| BS17A | 49.18 | 6.2 | 5.4-7.5 | 7.22 |
| BS17 | 51.51 | 6.2 | 3.4-7.4 | 7.32 |
| BS18 | 57.51 | 6.5 | 5.5-8.3 | 7.58 |

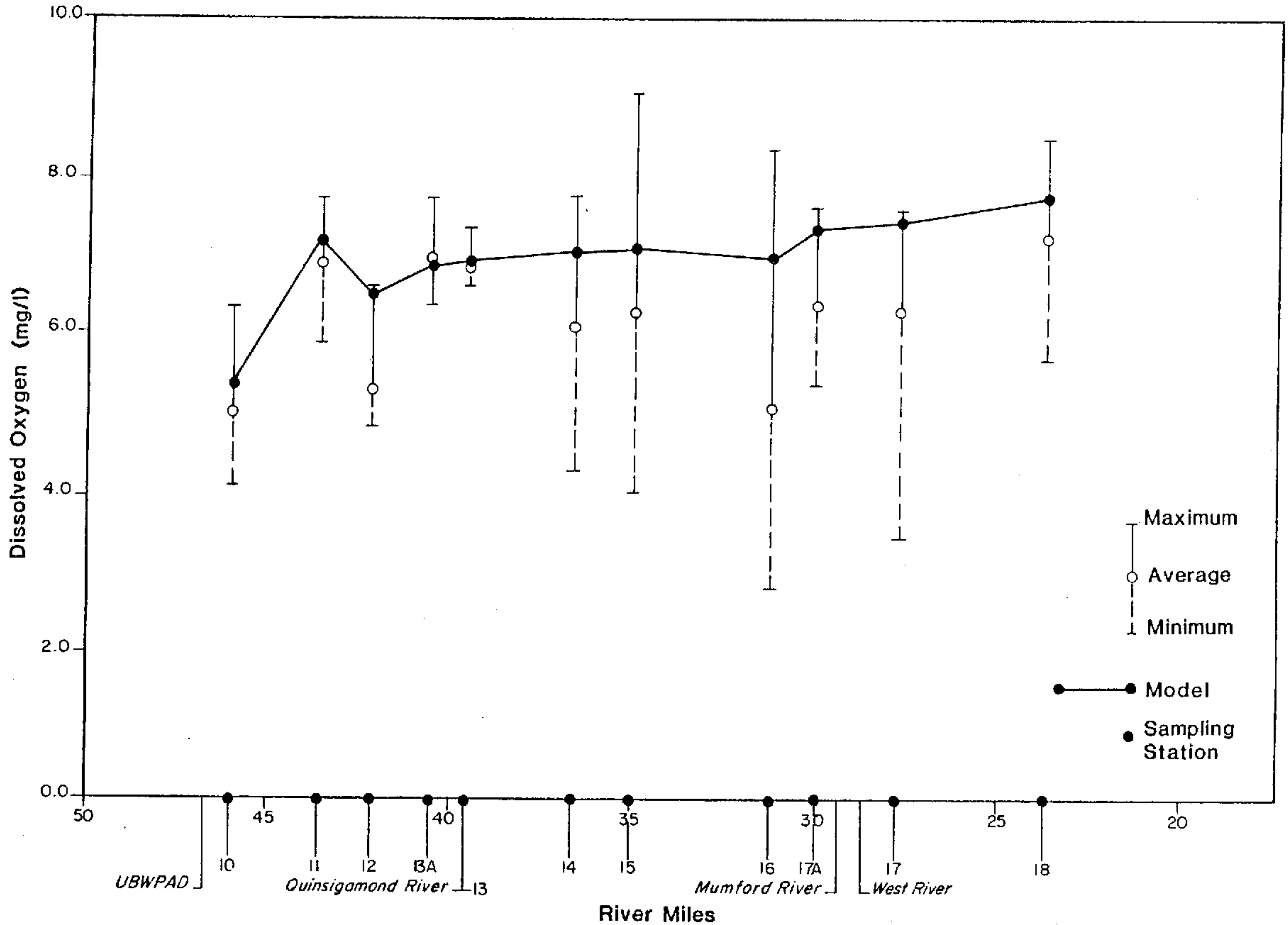


FIGURE 5 - BLACKSTONE RIVER, VERIFIED MODEL RESULTS, DISSOLVED OXYGEN (AUGUST 1980)

TABLE 13
CALIBRATED (OCTOBER 1980)
ULTIMATE CARBONACEOUS BOD
MODEL RESULTS

| STATION | CALCULATED TIME OF TRAVEL FROM THE UBWPAD (hrs.) | ULTIMATE CBOD FROM FIELD DATA (mg/l) | ULTIMATE CBOD FROM MODEL (mg/l) |
|---|---|---|---|
| BS10 | 1.64 | 10.12 | 9.86 |
| BS11 | 5.33 | 6.2 | 8.6 |
| BS12 | 12.22 | 6.89 | 7.28 |
| BS13A | 15.26 | 6.22 | 6.51 |
| BS13 | 18.13 | 6.53 | 5.91 |
| BS14 | 25.11 | 5.60 | 5.69 |
| BS15 | 28.03 | 5.30 | 5.59 |
| BS16 | 44.91 | 3.76 | 5.12 |
| BS17A | 50.03 | 5.00 | 4.98 |
| BS17 | 52.36 | 4.38 | 4.72 |
| BS18 | 58.37 | 4.32 | 4.59 |

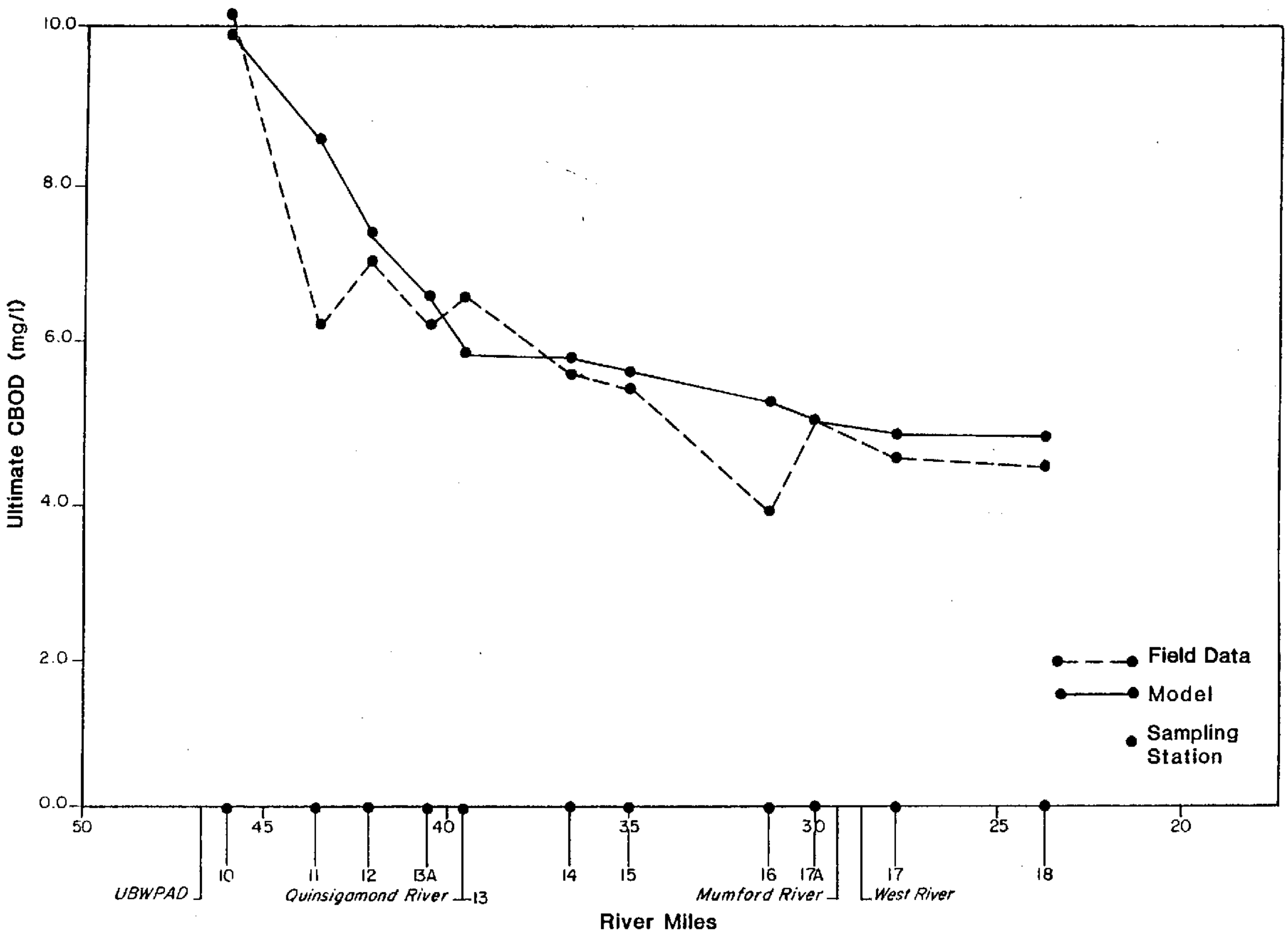


FIGURE 6 – BLACKSTONE RIVER, CALIBRATED ULTIMATE CARBONACEOUS BOD (OCTOBER 1980)

TABLE 14

VERIFIED (AUGUST 1980)

ULTIMATE CARBONACEOUS BOD

MODEL RESULTS

| STATION | CALCULATED TIME OF TRAVEL FROM THE UBWPAD (hrs.) | ULTIMATE CBOD FROM FIELD DATA (mg/l) | ULTIMATE CBOD FROM MODEL (mg/l) |
|---|---|---|---|
| BS10 | 1.31 | 6.89 | 6.53 |
| BS11 | 4.56 | 3.93 | 5.93 |
| BS12 | 10.79 | 4.35 | 5.15 |
| BS13A | 13.61 | 4.35 | 4.77 |
| BS13 | 16.6 | 3.42 | 4.11 |
| BS14 | 23.68 | 4.35 | 3.98 |
| BS15 | 26.69 | 4.25 | 3.87 |
| BS16 | 44.00 | 3.33 | 3.43 |
| BS17A | 49.18 | 3.13 | 3.32 |
| BS17 | 51.51 | 2.40 | 3.47 |
| BS18 | 57.51 | 2.98 | 3.38 |

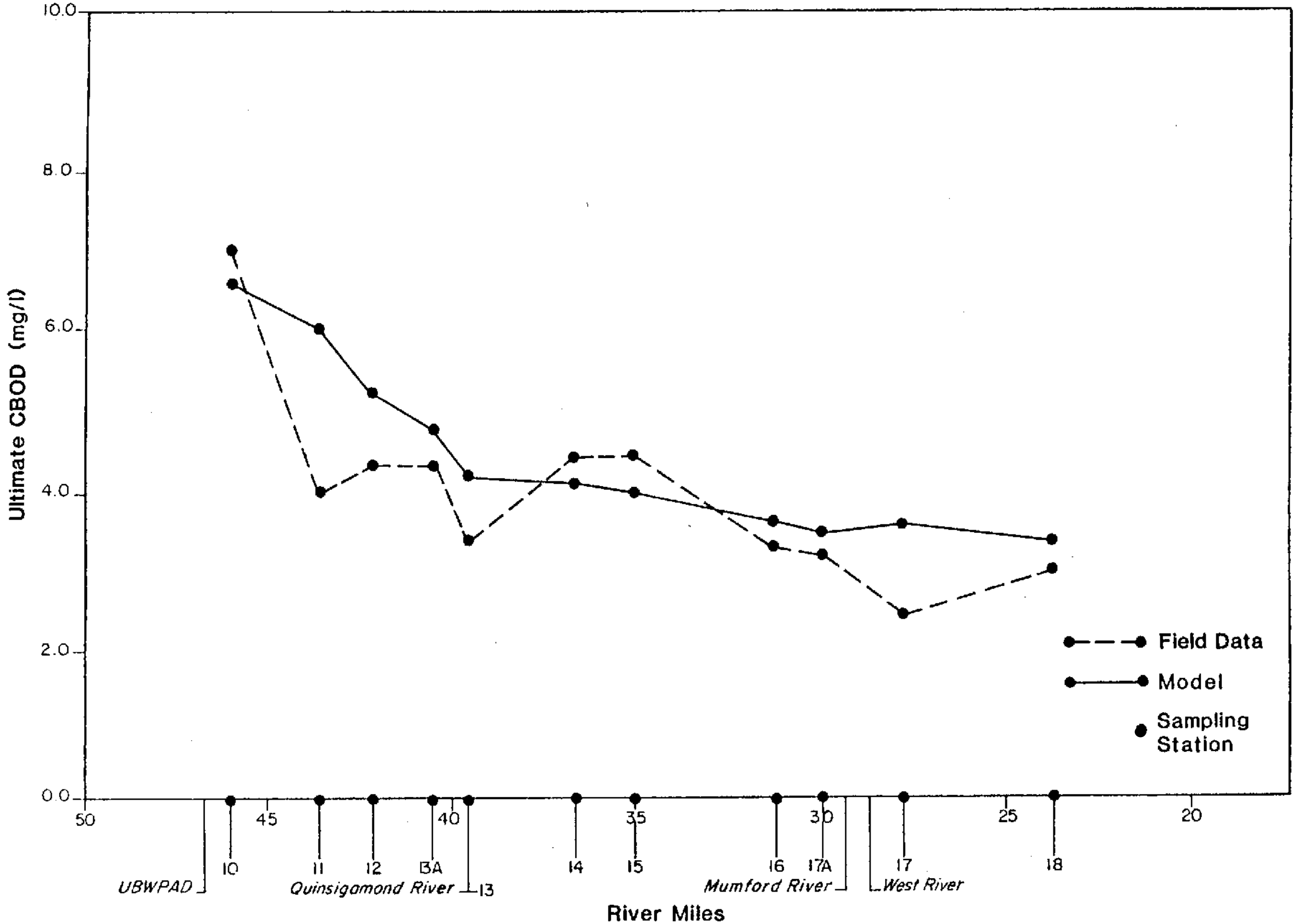


FIGURE 7 - BLACKSTONE RIVER, VERIFIED ULTIMATE CARBONACEOUS BOD (AUGUST 1980)

TABLE 15

CALIBRATED (OCTOBER 1980)

ULTIMATE NITROGENOUS BOD

MODEL RESULTS

| STATION | CALCULATED TIME OF TRAVEL FROM THE UBWPAD (hrs.) | ULTIMATE NBOD FROM FIELD DATA (mg/l) | ULTIMATE NBOD FROM MODEL (mg/l) |
|---|---|---|---|
| BS10 | 1.64 | 36.56 | 39.42 |
| BS11 | 5.33 | 27.88 | 34.76 |
| BS12 | 12.22 | 26.96 | 32.89 |
| BS13A | 15.26 | 24.22 | 27.70 |
| BS13 | 18.13 | 19.19 | 20.66 |
| BS14 | 25.11 | 14.62 | 14.90 |
| BS15 | 28.03 | 12.34 | 13.00 |
| BS16 | 44.91 | 5.48 | 6.44 |
| BS17A | 50.03 | 5.94 | 5.17 |
| BS17 | 52.36 | 3.11 | 3.77 |
| BS18 | 58.37 | 1.65 | 2.84 |

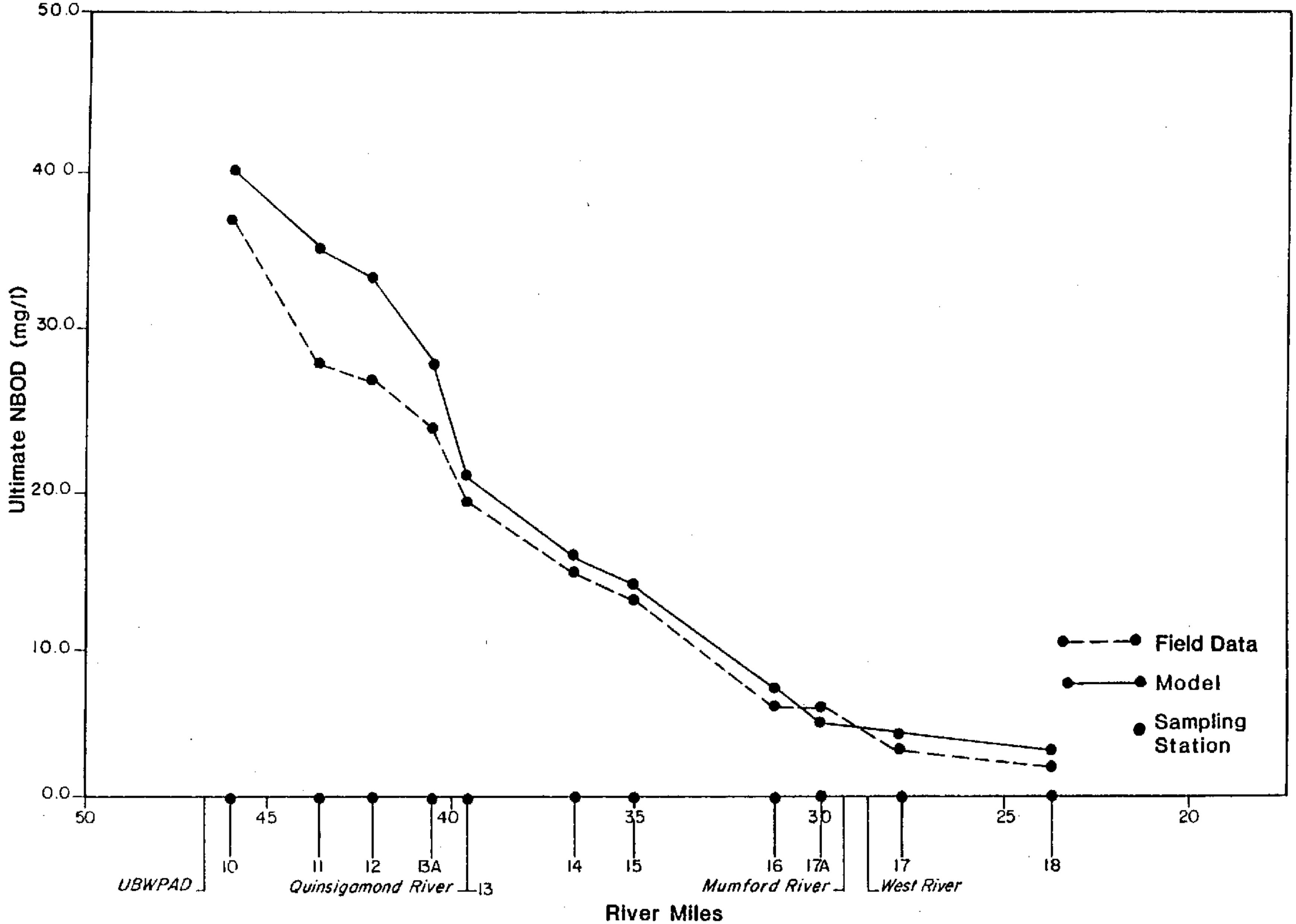


FIGURE 8 - BLACKSTONE RIVER, CALIBRATED NITROGENOUS BOD ($NH_3$-N x 4.57) (OCTOBER 1980)

TABLE 16

VERIFIED (JUNE 1980)

ULTIMATE NITROGENOUS BOD

MODEL RESULTS

| STATION | CALCULATED TIME OF TRAVEL FROM THE UBWPAD (hrs.) | ULTIMATE NBOD FROM FIELD DATA (mg/l) | ULTIMATE NBOD FROM MODEL (mg/l) |
|---|---|---|---|
| BS10 | 1.21 | 19.65 | 20.44 |
| BS11 | 4.29 | 19.19 | 19.55 |
| BS12 | 10.15 | 22.39 | 18.88 |
| BS13A | 12.79 | 20.56 | 17.59 |
| BS13 | 15.60 | 19.19 | 15.41 |
| BS14 | 21.95 | 12.80 | 11.39 |
| BS15 | 24.56 | 9.14 | 9.91 |
| BS16 | 39.30 | 7.31 | 5.06 |
| BS17A | 44.02 | 3.40 | 4.05 |
| BS17 | 46.27 | 2.83 | 2.66 |
| BS18 | 51.99 | 1.78 | 1.93 |

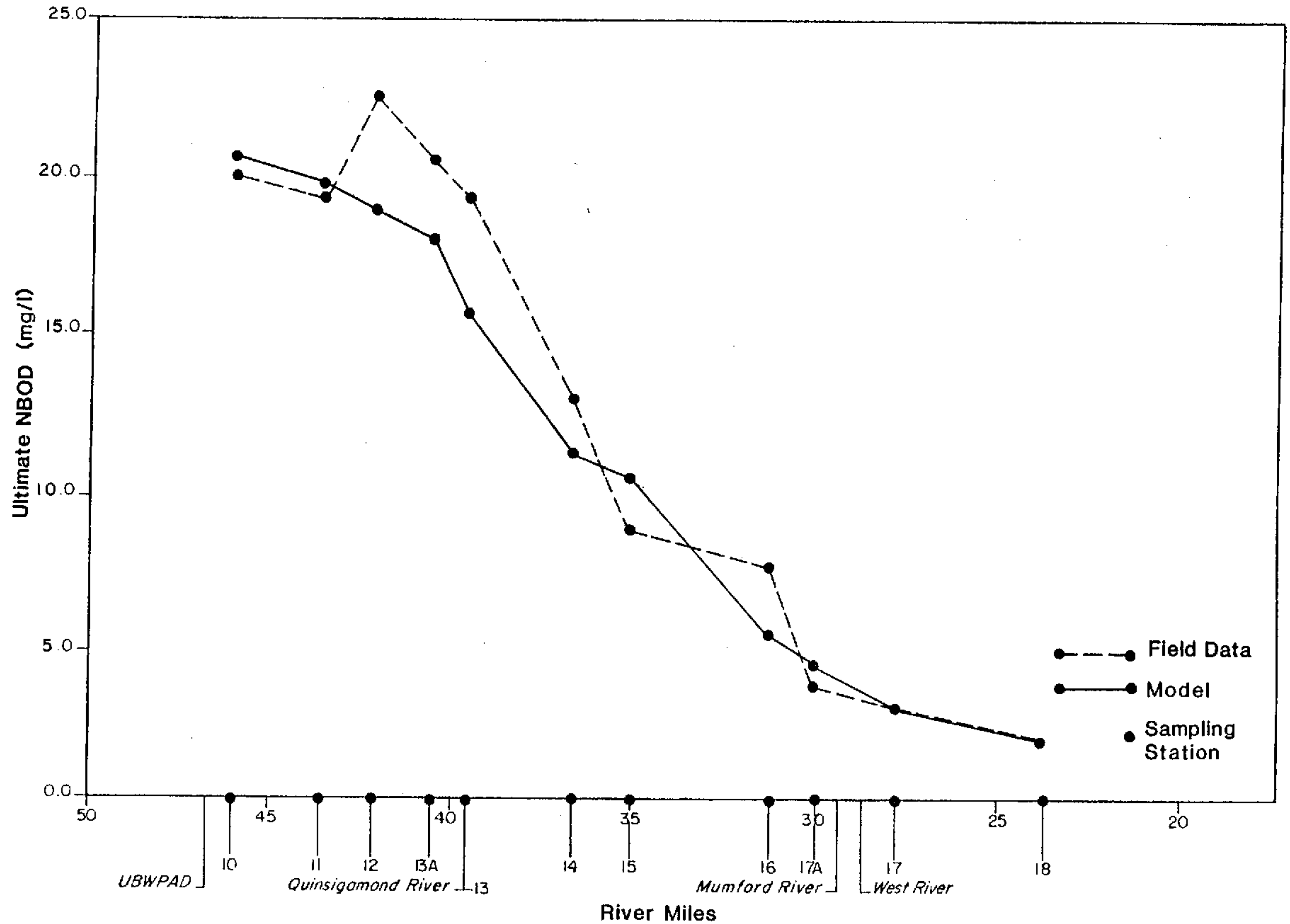


FIGURE 9 - BLACKSTONE RIVER, VERIFIED NITROGENOUS BOD ($NH_3-N \times 4.57$)
(JUNE 1980, WITHOUT NITRIFICATION AT THE UBWPAD)

TABLE 17

VERIFIED (AUGUST 1980)

ULTIMATE NITROGENOUS BOD

MODEL RESULTS

| STATION | CALCULATED TIME OF TRAVEL FROM THE UBWPAD (hrs.) | ULTIMATE NBOD FROM FIELD DATA (mg/l) | ULTIMATE NBOD FROM MODEL (mg/l) |
|---|---|---|---|
| BS10 | 1.31 | 5.03 | 5.72 |
| BS11 | 4.56 | 4.57 | 5.53 |
| BS12 | 10.79 | 3.34 | 6.05 |
| BS13A | 13.61 | 3.34 | 4.91 |
| BS13 | 16.6 | 2.15 | 3.78 |
| BS14 | 23.68 | 0.64 | 2.52 |
| BS15 | 26.69 | 0.87 | 2.10 |
| BS16 | 44.00 | 0.87 | 1.02 |
| BS17A | 49.18 | 0.78 | 0.76 |
| BS17 | 51.51 | 0.27 | 0.62 |
| BS18 | 57.51 | 0.27 | 0.43 |

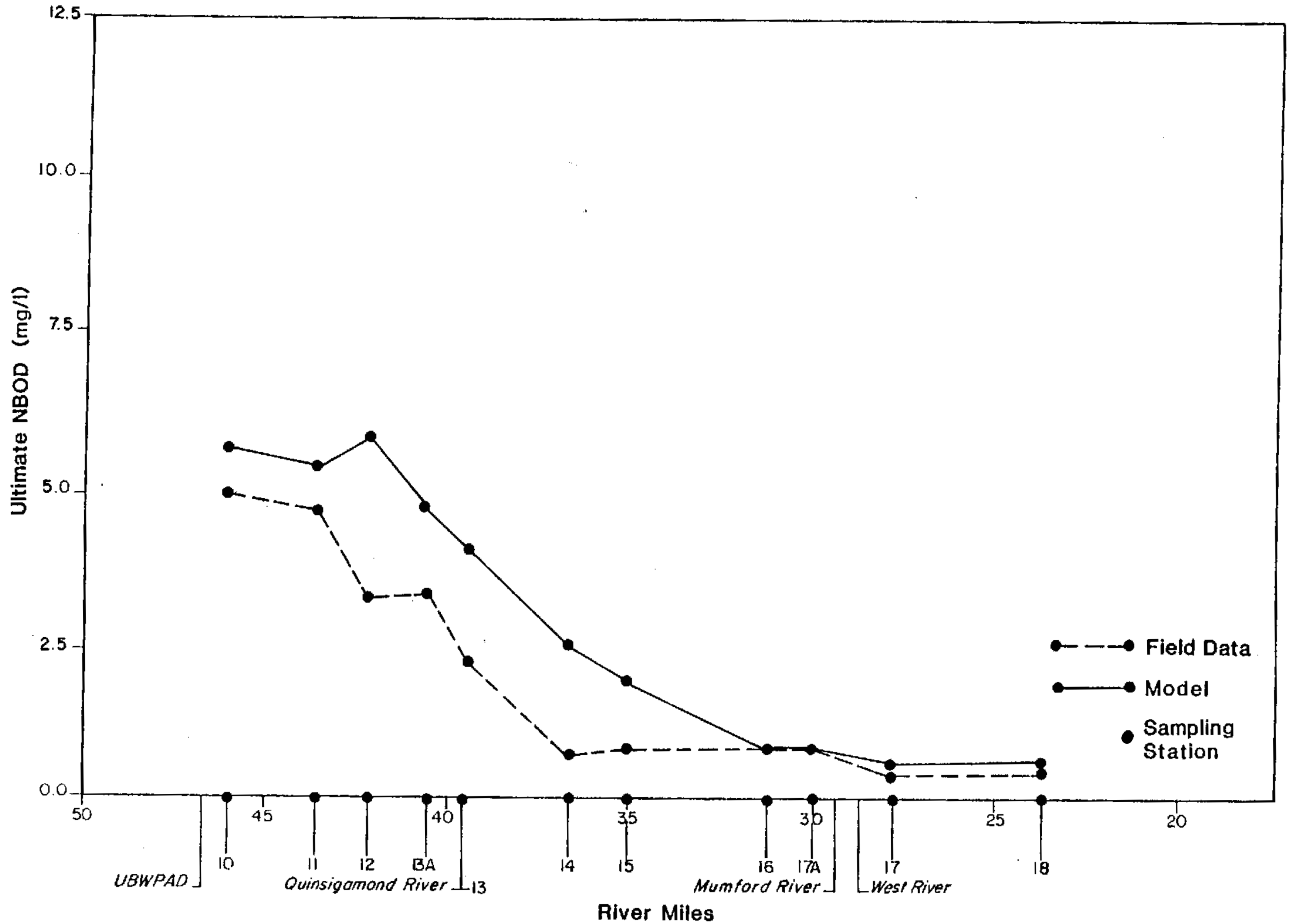


FIGURE 10 - BLACKSTONE RIVER, VERIFIED NITROGENOUS BOD ($NH_3$- N x 4.57)
(AUGUST 1980, WITH NITRIFICATION AT THE UBWPAD)

## AMMONIA TOXICITY

Water Quality Standards for instream ammonia levels are given in Quality Criteria for Water (EPA, 1976, p. 10).(5) For low flow conditions, temperature is defined as 25°C. pH is also required for the analysis. To obtain a representative pH, an average concentration was calculated for Station BS10 (downstream of the Upper Blackstone plant) using 1980 and 1977 DWPC data. With a pH of 7.2 (standard units) and a temperature of 25°C, the maximum allowable ammonia concentration obtained from Table 18 is approximately 2.5 mg/l.

TABLE 18

CONCENTRATIONS OF TOTAL AMMONIA*

| | pH VALUE | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| TEMPERATURE (°C) | 6.0 | 6.5 | 7.0 | 7.5 | 8.0 | 8.5 | 9.0 | 9.5 | 10.0 |
| 5 | 160.0 | 51.0 | 16.0 | 5.1 | 1.6 | 0.53 | 0.18 | 0.071 | 0.036 |
| 10 | 110.0 | 34.0 | 11.0 | 3.4 | 1.1 | 0.36 | 0.13 | 0.054 | 0.031 |
| 15 | 73.0 | 23.0 | 7.3 | 2.3 | 0.75 | 0.25 | 0.093 | 0.043 | 0.027 |
| 20 | 50.0 | 16.0 | 5.1 | 1.6 | 0.52 | 0.18 | 0.070 | 0.036 | 0.025 |
| 25 | 35.0 | 11.0 | 3.5 | 1.1 | 0.37 | 0.13 | 0.055 | 0.031 | 0.024 |
| 30 | 25.0 | 7.9 | 2.5 | 0.81 | 0.27 | 0.099 | 0.045 | 0.028 | 0.022 |

* Allowable instream total ammonia concentrations ($NH_3$ + $NH_4^+$) which contain an un-ionized ammonia ($NH_3$) concentration of 0.02 mg/l.

A secondary plant effluent of 10.0 mg/l $NH_3$-N was then mixed with a background concentration of 0.06 mg/l $NH_3$-N to determine whether ammonia removal for reasons of toxicity is necessary at the treatment plant.

$$\frac{(7.86 \text{ cfs})(0.06 \text{ mg/l}) + (86.6 \text{ cfs})(10.0 \text{ mg/l})}{94.46 \text{ cfs}} = 9.17 \text{ mg/l}$$

Since the maximum allowable concentration of 2.5 mg/l is less than the projected instream concentration of 9.17 mg/l, then ammonia removal for reasons of toxicity is necessary. The maximum concentration allowable from the Upper Blackstone facility during these conditions was then calculated to be 2.72 mg/l as illustrated in the following equation:

$$\frac{(7.86 \text{ cfs})(0.06 \text{ mg/l}) + (86.6 \text{ cfs})(X)}{94.46} = 2.5 \text{ mg/l}$$

$$X = 2.72 \text{ mg/l}$$

The maximum allowable concentration from the Upper Blackstone plant with an average flow of 46.0 cfs was calculated to be 2.92 mg/l.

## SENSITIVITY ANALYSIS

A sensitivity analysis was performed on the low flow model. The parameters varied were: Background concentrations of CBOD and $NH_3$-N, bottom sludge in Reach 6, percent coverage of sludge in Reach 6, $K_d$ (CBOD deoxygenation), $K_N$ (NBOD disappearance), $K_2$ (reaeration), and time of travel. Each parameter was varied $\pm$ 50 percent with the exception of the background concentrations for CBOD and $NH_3$-N. These concentrations were changed to average concentrations found during 1980 at Station BS09 which is influenced by the Mill Brook combined sewer. It was found that a decrease of 50 percent in $K_2$ was responsible for a decrease of the predicted minimum dissolved oxygen concentration of 1.15 mg/l. Further analysis also revealed that the percent of time modeled which violates the dissolved oxygen standard of 5.0 mg/l increased from 5.6 percent to 77.9 percent. The writer feels that these percentages are very misleading since the original model predicted dissolved oxygen concentrations between 5.0 mg/l and 6.0 mg/l most of the time and, with a decrease in $K_2$, these concentrations were shifted between 4.0 mg/l to 5.0 mg/l and thus drastically increased the percent of time in violation. Therefore, the writer recommends that the change in the minimum dissolved oxygen concentration be used to assess the actual sensitivity of the model. The sensitivity analysis can be found in Table 19.

As previously noted, additional runs were also made by assuming secondary treatment at the Upper Blackstone plant ($BOD_5$ = 30.0 mg/l, $NH_3$-N = 10.0 mg/l, D.O. = 5.0 mg/l) and advanced treatment at Millbury, Grafton, Northbridge and Uxbridge ($BOD_5$ = 10.0 mg/l, $NH_3$-N = 1.0 mg/l, D.O. = 6.0 mg/l). Flows from the Upper Blackstone plant were varied once again from design (86.6 cfs) to existing flows (46.0 cfs). Results showed that in both cases the projected minimum dissolved oxygen was 0.0 mg/l and that the percent of time that water quality standards were violated was 27 percent for the existing flow and 85.2 percent for the design flow, thus indicating the need for advanced treatment at the Upper Blackstone facility only.

TABLE 19
SENSITIVITY ANALYSES*

| PARAMETER** | PERCENT VARIED | PREDICTED MIN. D.O. (mg/l) | CHANGE IN D.O. (mg/l) | PERCENT TIME 5.0 mg/l IS VIOLATED | NUMBER MILES IN VIOLATION |
|---|---|---|---|---|---|
| Background - $CBOD_u$=7.16 mg/l $NH_3$-$N_u$=3.88 mg/l | -- | 3.69 | -0.09 | 10.6 | 1.1 |
| Bottom Sludge ($g/m^2$/day) | +50 | 3.70 | -0.08 | 5.6 | 0.6 |
| | -50 | 3.86 | +0.08 | 5.6 | 0.6 |
| Percent coverage of Sludge | +50 | 3.70 | -0.08 | 5.6 | 0.6 |
| | -50 | 3.86 | +0.08 | 5.6 | 0.6 |
| $K_d$ ($day^{-1}$) | +50 | 3.11 | -0.67 | 16.7 | 2.7 |
| | -50 | 4.72 | +0.94 | 1.3 | 0.2 |
| Kn ($day^{-1}$) | +50 | 3.01 | -0.77 | 9.1 | 1.4 |
| | -50 | 4.70 | -0.92 | 1.3 | 0.2 |
| $K_2$ ($day^{-1}$) | +50 | 4.46 | +0.68 | 1.3 | 0.2 |
| | -50 | 2.63 | -1.15 | 77.9 | 16.5 |
| Time of Travel (hours) | +50 | 2.95 | -0.83 | 11.6 | 1.6 |
| | -50 | 4.93 | +1.15 | 3.0 | 0.3 |

* Original values assume UBWPAD loadings of Q = 86.6 cfs, $CBOD_5$ = 10.0 mg/l, $NH_3$-N = 2.0 mg/l, D.O. = 6.0 mg/l predicted min. D.O. = 3.78 mg/l, % time violated = 5.6, number of miles in violation = 0.6

** base e

## WASTELOAD ALLOCATION

Upon completion of the calibrated and verified models, projections to the 7-day 10-year low flow condition were made. The Upper Blackstone flows of 86.6 cfs (design) and 46.0 cfs (present flow) were analyzed with effluent concentrations varying from the current permit limits to advanced waste treatment with aeration. The results of the analysis indicated that advanced waste treatment ($BOD_5$ = 5.0 mg/l, $NH_3$-N = 1.0 mg/l and D.O. = 5.0 mg/l) is necessary to maintain a minimum dissolved oxygen concentration of 5.0 mg/l instream but also that an advanced secondary effluent $BOD_5$ = 10.0 mg/l, $NH_3$-N = 2.0 mg/l, D.O. = 6.0 mg/l) could achieve water quality standards over approximately 96 percent of the time modeled, and would only violate 5.0 mg/l D.O. for 0.6 miles through Fisherville impoundment (minimum D.O. = 3.83 mg/l). It should also be noted once again that the model assumes that the problem of the Mill Brook combined sewer has been eliminated. Table 20 summarizes these results and illustrates the need for nitrification and aeration to maintain water quality standards.

### Seasonal Analysis

Secondary effluent limits at the Upper Blackstone facility were analyzed for the months of May, October and November using the design flow at the WWTP. The STREAM 7B model was run incorporating average monthly flows calculated from the U.S.G.S. gage on the Quinsagamond River (gage 01110000) for the period of 1974 through 1982. Instream temperatures were set equal to the average temperature collected at the U.S.G.S. water quality gage in Millville, Massachusetts (gage 01111230) during the same period. Depths in all but the impounded reaches were assumed to vary up to 1.5 times the depths used in the October 1980 model before the banks overflow making the width the controlling factor. In the impounded reaches, the depths were varied to a much lesser extent since the width is already the controlling parameter.

Results of the analysis are summarized in Table 21. From these results, it can be seen that in a "dry month" during May or particularly in October, water quality standards may be violated. the writer, therefore, recommends that seasonal limits of $BOD_5$ = 30.0 mg/l, $NH_3$-N = 10.0 mg/l and dissolved oxygen of 6.0 mg/l be allowed from November 1 to May 15 of each year.

TABLE 20

WASTELOAD ALLOCATION

LOW FLOW ANALYSIS (Q7-10)

Background Conditions

$Q$ = 7.86 cfs
$CBOD_5$ = 3.0 mg/l
$NH_3$-N = 0.06 mg/l

Temperature = 25.0°C
D.O. = 7.0 mg/l

| UBWPAD EFFLUENT | | | | INSTREAM | | |
|---|---|---|---|---|---|---|
| FLOW (cfs) | $CBOD_5$ (mg/l) | $NH_3$-N (mg/l) | D.O. (mg/l) | MINIMUM D.O. PREDICTED (mg/l) | RIVER MILES IN VIOLATION OF 5.0 mg/l | PERCENT OF TOTAL TIME MODELED IN VIOLATION |
| 86.6 | 15.0 | 10.0 | 5.0 | 0.0 | 18.1 | 82.7 |
| | 15.0 | 5.0 | 5.0 | 0.71 | 12.5 | 69.0 |
| | 5.0 | 10.0 | 5.0 | 0.0 | 16.5 | 76.3 |
| | 5.0 | 2.0 | 5.0 | 4.77 | 0.2 | 1.3 |
| | 10.0 | 2.0 | 6.0 | 3.83 | 0.6 | 3.9 |
| | 5.0 | 1.0 | 5.0 | 5.63 | 0.0 | 0.0 |
| | 10.0 | 1.0 | 5.0 | 4.66 | 0.4 | 2.6 |
| 46.0 | 15.0 | 10.0 | 5.0 | 0.0 | 7.3 | 32.51 |
| | 15.0 | 5.0 | 5.0 | 1.59 | 1.8 | 11.4 |
| | 5.0 | 10.0 | 5.0 | 0.0 | 5.5 | 26.4 |
| | 5.0 | 2.0 | 5.0 | 4.95 | 0.2 | 1.2 |
| | 10.0 | 2.0 | 6.0 | 4.24 | 0.3 | 1.8 |
| | 5.0 | 1.0 | 5.0 | 5.71 | 0.0 | 0.0 |
| | 10.0 | 1.0 | 5.0 | 5.0 | 0.0 | 0.0 |

TABLE 21

SEASONAL ANALYSIS

WWTP conditions: $BOD_5$ = 30.0 mg/l, D.O. = 6.0 mg/l
$NH_3$-N = 10.0 mg/l, Flow = 86.6 cfs

| MONTH | MINIMUM D.O. PREDICTED (mg/l) | RIVER MILES IN VIOLATION of 5.0 mg/l | PERCENT OF TOTAL TIME MODELED IN VIOLATION |
|---|---|---|---|
| May | 4.98 | 0.4 | 0.1 |
| October | 3.63 | 3.1 | 24.4 |
| November | 5.30 | 0.0 | 0.0 |

The following are the recommended effluent limitations for the Upper Blackstone Water Pollution Abatement District:

TABLE 22

RECOMMENDED EFFLUENT LIMITS[1]

| PARAMETER | MAY 15 to NOVEMBER 1 | NOVEMBER 1 to May 15 |
|---|---|---|
| Flow (MGD) | 56.0 | 56.0 |
| $BOD_5$ at 20°C | 10.0 | 30.0 |
| Total Suspended Solids | 15.0 | 30.0 |
| Ammonia-Nitrogen | 2.0[2] | 10.0 |
| Fecal Coliform Bacteria per 100 ml | 200 | 200 |
| Total Coliform Bacteria per 100 mnl | 1000 | 1000 |
| Dissolved Oxygen | Not less than 6.0 | |
| Total Phosphorus (as P) | To be assessed at a later date | |

[1]mg/l except if otherwise noted
[2]for reasons of toxicity as well as dissolved oxygen

## REFERENCES


1. Commonwealth of Massachusetts, Water Resources Commission, Division of Water Pollution Control, Massachusetts Water Quality Standards, April 7, 1978. Page 33.

2. McGinn, Joseph, M. A Sediment Control Plan for the Blackstone River, prepared for the Massachusetts Department of Environmental Quality Engineering, Office of Planning and Program Management, July 1981.

3. Bain, Richard C. "Predicting DO variations caused by algae," J. San. Eng. Div. 94: 867-881.

4. Tetra Tech, Rates, Constants and Kinetics Formulations in Surface Water Quality Modeling, U.S. EPA, 1978, pages 199-208.

5. U.S. Environmental Protection Agency, Quality Criteria for Water, July 1976, page 10.

# APPENDIX 1

# BLACKSTONE RIVER 1980

# WATER QUALITY SURVEY

TABLE A-1

BLACKSTONE RIVER JUNE 1980 SURVEY

DISSOLVED OXYGEN (mg/l) - TIME - TEMPERATURE ($^{o}$F)

| | 6/9 | | | | | | 6/10 | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| STATION | RUN 1 | RUN 2 | RUN 3 | RUN 4 | RUN 5 | RUN 6 | RUN 7 | RUN 8 | RUN 9 | RUN 10 |
| | | | | | BLACKSTONE RIVER | | | | | |
| BS01 | *1002 | 1355 | 1808 | 2200 | 0155 | 0545 | 0951 | 1345 | 1807 | 2158 |
| | **61.0 | 64.0 | 63.0 | 64.0 | 63.0 | 60.0 | 61.0 | 67.0 | 64.0 | 61.0 |
| | ***8.3 | 8.9 | 8.1 | 8.7 | 7.9 | 7.8 | 8.5 | 8.5 | 8.6 | 10.0 |
| BS02 | 1006 | 1403 | 1814 | 2206 | 0202 | 0548 | 0956 | 1353 | 1812 | 2207 |
| | 55.0 | 60.0 | 56.0 | 58.0 | 56.0 | 55.0 | 56.0 | 60.0 | 59.0 | 56.0 |
| | 9.4 | 9.6 | 8.5 | 9.4 | 8.3 | 8.5 | 9.1 | 8.5 | 8.4 | 13.5 |
| BS03 | 1010 | 1407 | 1819 | 2215 | 0208 | 0553 | 1002 | 1400 | 1819 | 2215 |
| | 55.0 | 62.0 | 59.0 | 58.0 | 58.0 | 55.0 | 58.0 | 62.0 | 61.0 | 58.0 |
| | 7.6 | 7.9 | 7.3 | 8.1 | 7.6 | 7.7 | 8.8 | 7.3 | 7.2 | 9.0 |
| BS04 | 1025 | 1415 | 1830 | 2227 | 0217 | 0600 | 1011 | 1407 | 1835 | 2224 |
| | 57.0 | 59.0 | 56.0 | 58.0 | 56.0 | 55.0 | 57.0 | 60.0 | 59.0 | 55.0 |
| | 9.6 | 9.6 | 8.8 | 9.9 | 8.7 | 9.2 | 9.6 | 9.3 | 8.9 | 9.8 |
| BS05 | 1035 | 1420 | 1839 | 2240 | 0225 | 0604 | 1019 | 1413 | 1838 | 2230 |
| | 61.0 | 62.0 | 63.0 | 60.0 | 62.0 | 59.0 | 60.0 | 61.0 | 62.0 | 60.0 |
| | 6.8 | 7.9 | 6.7 | 6.9 | 6.8 | 6.3 | 7.2 | 7.3 | 7.4 | 7.9 |
| BS06 | 1042 | 1427 | 1846 | 2248 | 0230 | 0610 | 1037 | 1419 | 1848 | 2239 |
| | 60.0 | 63.0 | 61.0 | 59.0 | 59.0 | 57.0 | 59.0 | 63.0 | 63.0 | 61.0 |
| | 8.0 | 11.0 | 10.9 | 10.2 | 7.5 | 5.3 | 7.7 | 10.7 | 11.9 | 9.8 |
| BS07 | 1048 | 1433 | 1853 | 2254 | 0238 | 0614 | 1038 | 1425 | 1854 | 2247 |
| | 60.0 | 62.0 | 60.0 | 60.0 | 60.0 | 59.0 | 59.0 | 61.0 | 61.0 | 60.0 |
| | 8.4 | 8.5 | 8.6 | 9.1 | 8.5 | 9.4 | 9.0 | 8.9 | 9.1 | 9.8 |

*Time
**Temperature
***Dissolved Oxygen

TABLE A-1 (CONTINUED)

| | 6/11 | | | | | | 6/12 | | |
|---|---|---|---|---|---|---|---|---|---|
| STATION | RUN 11 | RUN 12 | RUN 13 | RUN 14 | RUN 15 | RUN 16 | RUN 17 | RUN 18 | RUN 19 |
| BS01 | 0151 | 0600 | 0956 | 1447 | 1807 | 2158 | 0158 | 0552 | 0945 |
| | 61.0 | 58.0 | 62.0 | 67.0 | 64.0 | 61.0 | 62.0 | 58.0 | 62.0 |
| | 8.5 | 8.5 | 9.5 | 8.5 | 9.0 | 9.2 | 9.3 | 8.4 | 8.4 |
| BS02 | 0157 | 0603 | 1002 | 1453 | 1814 | 2205 | 0204 | 0556 | 0950 |
| | 54.0 | 52.0 | 55.0 | 60.0 | 60.0 | 55.0 | 55.0 | 50.0 | 56.0 |
| | -- * | -- * | 9.3 | 8.9 | 8.5 | 8.7 | 9.3 | -- * | 8.8 |
| BS03 | 0202 | 0608 | 1012 | 1458 | 1820 | 2211 | 0209 | 0600 | 0956 |
| | 57.0 | 54.0 | 58.0 | 62.0 | 62.0 | 57.0 | 58.0 | 54.0 | 60.0 |
| | 7.8 | 7.9 | 8.7 | 7.1 | 7.3 | 7.6 | 8.2 | 7.9 | 7.4 |
| BS04 | 0209 | 0614 | 1020 | 1506 | 1834 | 2220 | 0217 | 0606 | 1003 |
| | 54.0 | 51.0 | 57.0 | 61.0 | 60.0 | 53.0 | 54.0 | 51.0 | 55.0 |
| | 9.2 | 9.5 | 10.9 | 9.5 | 9.0 | 9.2 | 10.1 | 9.9 | 9.7 |
| BS05 | 0213 | 0619 | 1042 | 1512 | 1840 | 2227 | 0222 | 0610 | 1011 |
| | 60.0 | 58.0 | 62.0 | 64.0 | 64.0 | 60.0 | 61.0 | 58.0 | 62.0 |
| | 7.2 | 7.2 | 9.1 | 7.9 | 8.5 | 8.1 | 7.8 | 7.4 | 8.2 |
| BS06 | 0220 | 0624 | 1035 | 1517 | 1848 | 2233 | 0228 | 0616 | 1015 |
| | 59.0 | 55.0 | 60.0 | 63.0 | 65.0 | 59.0 | 60.0 | 56.0 | 58.0 |
| | 7.6 | 6.2 | 8.4 | 11.1 | 11.7 | 10.9 | 8.5 | 7.2 | 7.2 |
| BS07 | 0225 | 0630 | 1049 | 1523 | 1852 | 2240 | 0234 | 0620 | 1020 |
| | 60.0 | 58.0 | 61.0 | 61.0 | 62.0 | 60.0 | 61.0 | 58.0 | 61.0 |
| | 8.2 | 9.4 | 9.4 | 9.3 | 9.1 | 9.8 | 9.4 | 9.4 | 9.4 |

* Color interference from Worcester Spinning and Finishing Co. discharge

TABLE A-1 (CONTINUED)

| | 6/9 | | | | 6/10 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| STATION | RUN 1 | RUN 2 | RUN 3 | RUN 4 | RUN 5 | RUN 6 | RUN 7 | RUN 8 | RUN 9 | RUN 10 |
| BS08 | 1055 | 1438 | 1900 | 2303 | 0242 | 0617 | 1042 | 1430 | 1900 | 2254 |
| | 60.0 | 60.0 | 60.0 | 60.0 | 60.0 | 58.0 | 60.0 | 63.0 | 63.0 | 60.0 |
| | 9.1 | 9.2 | 8.5 | 9.8 | 8.8 | 8.6 | 8.8 | 8.8 | 8.8 | 9.7 |
| BS09B | 1125 | 1450 | 1911 | 2351 | 0250 | 0624 | 1053 | 1440 | 1907 | 2304 |
| | 60.0 | 62.0 | 60.0 | 59.0 | 59.0 | 57.0 | 59.0 | 64.0 | 62.0 | 59.0 |
| | 8.1 | 8.4 | 7.4 | 9.4 | 7.4 | 6.9 | 7.7 | 8.5 | 8.5 | 8.9 |
| BS09 | 1137 | 1500 | 1931 | 2340 | 0304 | 0634 | 1106 | 1455 | 1923 | 2323 |
| | 60.0 | 61.0 | 60.0 | 60.0 | 59.0 | 57.0 | 60.0 | 64.0 | 61.0 | 60.0 |
| | 8.5 | 7.9 | 6.4 | 7.6 | 7.2 | 7.8 | 7.4 | 7.5 | 6.5 | 7.2 |
| BS10 | 1143 | 1507 | 1937 | 0002 | 0313 | 0640 | 1114 | 1504 | 1933 | 2332 |
| | 61.0 | 62.0 | 61.0 | 61.0 | 61.0 | 59.0 | 62.0 | 65.0 | 63.0 | 60.0 |
| | 8.9 | 8.9 | 7.2 | 7.3 | 7.3 | 6.9 | 7.8 | 7.7 | 7.3 | 8.3 |
| BS11 | 1152 | 1515 | 1946 | 0008 | 0321 | 0648 | 1121 | 1515 | 1940 | 2342 |
| | 62.0 | 63.0 | 60.0 | 60.0 | 61.0 | 58.0 | 62.0 | 65.0 | 63.0 | 60.0 |
| | 8.9 | 9.3 | 8.6 | 9.1 | 7.8 | 8.9 | 9.0 | 8.9 | 8.6 | 9.6 |
| BS12 | 1200 | 1527 | 1956 | 0022 | 0328 | 0653 | 1130 | 1520 | 1952 | 2352 |
| | 61.0 | 60.0 | 61.0 | 59.0 | 59.0 | 59.0 | 62.0 | 62.0 | 62.0 | 60.0 |
| | 8.1 | 8.6 | 7.6 | 8.5 | 7.9 | 7.6 | 8.1 | 8.3 | 8.1 | 8.5 |
| BS13A | 1222 | 1535 | 2007 | 0034 | 0340 | 0700 | 1138 | 1530 | 2000 | 0002 |
| | 61.0 | 61.0 | 61.0 | 60.0 | 59.0 | 58.0 | 61.0 | 64.0 | 63.0 | 60.0 |
| | 8.9 | 9.1 | 8.2 | 8.9 | 9.1 | 9.2 | 9.1 | 8.9 | 8.5 | 9.2 |

TABLE A-1 (CONTINUED)

| | 6/11 | | | | | | 6/12 | | |
|---|---|---|---|---|---|---|---|---|---|
| STATION | RUN 11 | RUN 12 | RUN 13 | RUN 14 | RUN 15 | RUN 16 | RUN 17 | RUN 18 | RUN 19 |
| BS08 | 0228 | 0637 | 1053 | 1527 | 1859 | 2245 | 0238 | 0623 | 1024 |
| | 62.0 | 57.0 | 61.0 | 62.0 | 62.0 | 59.0 | 60.0 | 57.0 | 62.0 |
| | 9.0 | 9.2 | 8.9 | 9.1 | 8.8 | 9.4 | 9.7 | 9.2 | 9.3 |
| BS09B | 0235 | 0640 | 1130 | 1537 | 1907 | 2307 | 0246 | 0630 | 1036 |
| | 58.0 | 56.0 | 60.0 | 63.0 | 65.0 | 59.0 | 57.0 | 54.0 | 59.0 |
| | 7.0 | 7.3 | 8.5 | 9.1 | 8.6 | 9.1 | 7.0 | 7.5 | 7.9 |
| BS09 | 0247 | 0650 | 1116 | 1548 | 1920 | 2321 | 0301 | 0639 | 1044 |
| | 60.0 | 56.0 | 61.0 | 61.0 | 62.0 | 58.0 | 59.0 | 55.0 | 59.0 |
| | 6.7 | 7.7 | 7.4 | 6.8 | 6.4 | 7.3 | 7.4 | 7.7 | 7.8 |
| BS10 | 0252 | 0655 | 1123 | 1554 | 1929 | 2330 | 0309 | 0643 | 1050 |
| | 62.0 | 58.0 | 63.0 | 62.0 | 63.0 | 59.0 | 60.0 | 57.0 | 61.0 |
| | 6.7 | 6.7 | 8.0 | 8.1 | 7.1 | 6.7 | 6.9 | 7.3 | 7.9 |
| BS11 | 0259 | 0702 | 1134 | 1601 | 1940 | 2340 | 0314 | 0650 | 1057 |
| | 60.0 | 57.0 | 63.0 | 63.0 | 62.0 | 58.0 | 60.0 | 57.0 | 63.0 |
| | 8.9 | 8.5 | 9.0 | 8.8 | 8.9 | 8.3 | 9.1 | 8.5 | 9.0 |
| BS12 | 0304 | 0708 | 1140 | 1606 | 1952 | 2347 | 0320 | 0653 | 1105 |
| | 60.0 | 58.0 | 62.0 | 63.0 | 64.0 | 58.0 | 60.0 | 56.0 | 61.0 |
| | 7.6 | 8.0 | 8.4 | 8.1 | 8.0 | 7.9 | 8.3 | 8.3 | 7.8 |
| BS13A | 0312 | 0714 | 1147 | 1614 | 2000 | 2357 | 0330 | 0700 | 1111 |
| | 59.0 | 57.0 | 62.0 | 61.0 | 62.0 | 59.0 | 59.0 | 55.0 | 61.0 |
| | 8.8 | 9.2 | 9.5 | 8.7 | 8.6 | 8.9 | 9.3 | 9.6 | 9.2 |

TABLE A-1 (CONTINUED)

| STATION | RUN 1 | RUN 2 | RUN 3 | RUN 4 | RUN 5 | RUN 6 | RUN 7 | RUN 8 | RUN 9 | RUN 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 6/9 | | | | | 6/10 | | | 6/11 |
| BS13 | 1240 | 1550 | 2029 | 0054 | 0350 | 0715 | 1151 | 1545 | 2018 | 0019 |
| | 61.0 | 60.0 | 60.0 | 60.0 | 60.0 | 58.0 | 62.0 | 65.0 | 62.0 | 60.0 |
| | 8.8 | 9.9 | 8.3 | 9.7 | 9.3 | 10.2 | 8.8 | 8.8 | 9.0 | 9.4 |
| BS14 | 1258 | 1600 | 2041 | 0104 | 0403 | 0722 | 1213 | 1553 | 2030 | 0028 |
| | 64.0 | 62.0 | 59.0 | 59.0 | 59.0 | 60.0 | 62.0 | 64.0 | 62.0 | 60.0 |
| | 8.7 | 8.8 | 7.4 | 7.5 | 7.4 | 7.6 | 8.7 | 8.7 | 7.3 | 7.4 |
| BS15 | 1305 | 1607 | 2048 | 0134 | 0410 | 0730 | 1220 | 1600 | 2035 | 0036 |
| | 64.0 | 62.0 | 58.0 | 60.0 | 59.0 | 60.0 | 63.0 | 64.0 | 61.0 | 59.0 |
| | 9.2 | 8.8 | 7.3 | 7.2 | 6.9 | 7.1 | 8.9 | 9.0 | 7.4 | 7.0 |
| BS16 | 1325 | 1622 | 2113 | 0150 | 0425 | 0750 | 1234 | 1615 | 2054 | 0051 |
| | 65.0 | 65.0 | 61.0 | 60.0 | 59.0 | 58.0 | 63.0 | 68.0 | 63.0 | 59.0 |
| | 10.5 | 9.9 | 8.9 | 6.4 | 5.0 | 5.7 | 10.8 | 11.5 | 9.0 | 7.2 |
| BS17A | 1341 | 1638 | 2130 | 0206 | 0440 | 0802 | 1250 | 1630 | 2110 | 0110 |
| | 61.0 | 64.0 | 62.0 | 61.0 | 60.0 | 59.0 | 62.0 | 64.0 | 62.0 | 60.0 |
| | 7.6 | 8.3 | 7.3 | 7.0 | 7.2 | 6.7 | 7.9 | 7.5 | 7.8 | 7.7 |
| BS17 | 1403 | 1653 | 2218 | 0222 | 0500 | 0814 | 1304 | 1647 | 2130 | 0126 |
| | 63.0 | 64.0 | 62.0 | 61.0 | 60.0 | 59.0 | 62.0 | 64.0 | 62.0 | 60.0 |
| | 7.5 | 8.0 | 7.4 | 7.7 | 7.7 | 7.0 | 7.6 | 8.3 | 7.2 | 7.3 |
| BS18 | 1414 | 1704 | 2230 | 0236 | 0510 | 0823 | 1315 | 1655 | 2145 | 0137 |
| | 62.0 | 63.0 | 61.0 | 61.0 | 61.0 | 59.0 | 61.0 | 63.0 | 61.0 | 60.0 |
| | 8.7 | 8.2 | 7.5 | 8.0 | 7.3 | 7.1 | 7.7 | 8.1 | 7.8 | 7.4 |

TABLE A-1 (CONTINUED)

| STATION | RUN 11 | RUN 12 | RUN 13 | RUN 14 | RUN 15 | RUN 16 | RUN 17 | RUN 18 | RUN 19 |
|---|---|---|---|---|---|---|---|---|---|
| | | | 6/11 | | | | 6/12 | | |
| BS13 | 0323 | 0726 | 1159 | 1624 | 2017 | 0013 | 0343 | 0709 | 1125 |
| | 60.0 | 57.0 | 61.0 | 61.0 | 63.0 | 60.0 | 60.0 | 56.0 | 60.0 |
| | 9.1 | 9.2 | 9.3 | 9.2 | 8.8 | 9.2 | 9.7 | 9.7 | 9.9 |
| BS14 | 0329 | 0730 | 1215 | 1631 | 2027 | 0022 | 0350 | 0715 | 1137 |
| | 59.0 | 58.0 | 64.0 | 62.0 | 61.0 | 58.0 | 60.0 | 56.0 | 63.0 |
| | 7.2 | 8.0 | 8.9 | 8.5 | 7.7 | 7.6 | 7.2 | 7.2 | 8.2 |
| BS15 | 0335 | 0737 | 1222 | 1637 | 2042 | 0029 | 0356 | 0719 | 1145 |
| | 60.0 | 58.0 | 65.0 | 63.0 | 61.0 | 57.0 | 58.0 | 56.0 | 64.0 |
| | 6.3 | 7.0 | 8.6 | 8.8 | 7.1 | 6.9 | 6.4 | 7.0 | 8.9 |
| BS16 | 0348 | 0749 | 1335 | 1652 | 2057 | 0045 | 0409 | 0730 | 1158 |
| | 59.0 | 57.0 | 65.0 | 63.0 | 62.0 | 58.0 | 58.0 | 55.0 | 64.0 |
| | 4.9 | 6.7 | 10.5 | 10.6 | 8.5 | 5.4 | 5.9 | 5.2 | 10.5 |
| BS17A | 0400 | 0807 | 1350 | 1705 | 2115 | 0101 | 0424 | 0745 | 1216 |
| | 59.0 | 57.0 | 64.0 | 62.0 | 62.0 | 60.0 | 60.0 | 55.0 | 62.0 |
| | 6.6 | 6.5 | 7.7 | 7.6 | 7.2 | 7.6 | 7.0 | 6.9 | 7.4 |
| BS17 | 0410 | 0819 | 1401 | 1717 | 2133 | 0119 | 0436 | 0757 | 1230 |
| | 58.0 | 58.0 | 63.0 | 61.0 | 62.0 | 59.0 | 59.0 | 57.0 | 61.0 |
| | 6.4 | 7.1 | 7.7 | 7.5 | 7.3 | 7.1 | 7.4 | 6.8 | 7.8 |
| BS18 | 0420 | 0827 | 1412 | 1725 | 2150 | 0131 | 0445 | 0800 | 1238 |
| | 58.0 | 58.0 | 63.0 | 61.0 | 62.0 | 58.0 | 60.0 | 56.0 | 62.0 |
| | 6.7 | 6.9 | 8.2 | 8.3 | 7.4 | 7.3 | 6.7 | 6.7 | 7.9 |

TABLE A-1 (CONTINUED)

| STATION | RUN 1 | RUN 2 | RUN 3 | RUN 4 | RUN 5 | RUN 6 | RUN 7 | RUN 8 | RUN 9 | RUN 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 6/9 | | | | 6/10 | | | | 6/11 |
| BS19 | 1425 | 1711 | 2242 | 0250 | 0518 | 0829 | 1326 | 1704 | 2200 | 0150 |
| | 64.0 | 64.0 | 62.0 | 61.0 | 61.0 | 60.0 | 63.0 | 64.0 | 61.0 | 60.0 |
| | 9.0 | 9.1 | 8.6 | 9.7 | 9.4 | 9.0 | 9.2 | 9.1 | 8.8 | 9.3 |
| BS20 | 1437 | 1718 | 2252 | 0259 | 0524 | 0834 | 1330 | 1710 | 2207 | 0158 |
| | 63.0 | 64.0 | 62.0 | 62.0 | 62.0 | 60.0 | 62.0 | 64.0 | 61.0 | 59.0 |
| | 8.6 | 9.4 | 8.5 | 9.0 | 9.2 | 8.9 | 9.3 | 9.0 | 9.0 | 9.7 |
| | | | | | TRIBUTARIES | | | | | |
| MB01 | 1120 | 1453 | 1923 | 2326 | 0258 | 0628 | 1056 | 1444 | 1912 | 2314 |
| | 61.0 | 61.0 | 60.0 | 60.0 | 60.0 | 60.0 | 63.0 | 64.0 | 62.0 | 60.0 |
| | 7.0 | 7.0 | 6.0 | 8.5 | 6.4 | 7.5 | 6.7 | 8.4 | 3.9 | 6.8 |
| QR05 | 1229 | 1541 | 2015 | 0044 | 0346 | 0706 | 1147 | 1535 | 2006 | 0011 |
| | 64.0 | 64.0 | 61.0 | 60.0 | 60.0 | 59.0 | 62.0 | 65.0 | 62.0 | 60.0 |
| | 7.7 | 8.5 | 7.7 | 8.6 | 8.4 | 7.8 | 8.5 | 8.8 | 7.7 | 8.3 |
| MF07 | 1335 | 1634 | 2123 | 0159 | 0435 | 0744 | 1245 | 1625 | 2105 | 0103 |
| | 64.0 | 65.0 | 63.0 | 62.0 | 62.0 | 60.0 | 64.0 | 67.0 | 63.0 | 61.0 |
| | 9.1 | 9.0 | 8.7 | 8.9 | 9.0 | 8.7 | 9.3 | 9.3 | 8.8 | 8.9 |
| WR05 | 1350 | 1644 | 2140 | 0213 | 0445 | 0808 | 1257 | 1636 | 2119 | 0117 |
| | 62.0 | 62.0 | 59.0 | 61.0 | 60.0 | 59.0 | 62.0 | 63.0 | 60.0 | 59.0 |
| | 9.1 | 8.7 | 8.4 | 9.1 | 9.4 | 8.5 | 8.6 | 8.5 | 8.1 | 8.9 |
| ML06 | 1445 | 1726 | 2302 | 0308 | 0530 | 0842 | 1339 | 1720 | 2222 | 0206 |
| | 65.0 | 65.0 | 61.0 | 62.0 | 62.0 | 61.0 | 63.0 | 63.0 | 62.0 | 60.0 |
| | 9.5 | 9.3 | 9.0 | 9.3 | 9.1 | 9.5 | 9.8 | 9.2 | 8.8 | 9.5 |

TABLE A-1 (CONTINUED)

| STATION | RUN 11 | RUN 12 | 6/11 RUN 13 | RUN 14 | RUN 15 | RUN 16 | 6/12 RUN 17 | RUN 18 | RUN 19 |
|---|---|---|---|---|---|---|---|---|---|
| BS19 | 0429 | 0833 | 1423 | 1733 | 2158 | 0137 | 0452 | 0806 | 1246 |
| | 60.0 | 58.0 | 64.0 | 61.0 | 62.0 | 59.0 | 60.0 | 58.0 | 63.0 |
| | 8.9 | 9.1 | 9.0 | 9.6 | 8.6 | 9.4 | 9.4 | 9.2 | 9.3 |
| BS20 | 0435 | 0837 | 1426 | 1737 | 2207 | 0145 | 0456 | 0810 | 1253 |
| | 60.0 | 58.0 | 64.0 | 66.0 | 61.0 | 59.0 | 60.0 | 58.0 | 62.0 |
| | 9.0 | 9.1 | 9.3 | 9.0 | 8.9 | 9.2 | 9.5 | 9.1 | 9.1 |
| | | | | TRIBUTARIES | | | | | |
| MB01 | 0239 | 0643 | 1106 | 1542 | 1914 | 2314 | 0256 | 0634 | 1037 |
| | 61.0 | 59.0 | 62.0 | 60.0 | 61.0 | 60.0 | 61.0 | 58.0 | 61.5 |
| | 6.2 | 6.9 | 6.4 | 5.7 | 4.9 | 6.4 | 4.2 | 6.3 | 5.4 |
| QR05 | 0317 | 0719 | 1152 | 1618 | 2007 | 0004 | 0337 | 0703 | 1117 |
| | 60.0 | 57.0 | 64.0 | 62.0 | 62.0 | 59.0 | 59.0 | 55.0 | 63.0 |
| | 7.5 | 7.7 | 8.7 | 8.6 | 7.1 | 6.7 | 7.0 | 7.6 | 9.1 |
| MF07 | 0355 | 0803 | 1342 | 1701 | 2110 | 0057 | 0418 | 0742 | 1213 |
| | 61.0 | 58.0 | 65.0 | 64.0 | 65.0 | 60.0 | 61.0 | 58.0 | 62.0 |
| | 8.8 | 9.0 | 9.3 | 9.0 | 9.0 | 9.1 | 9.1 | 9.2 | 9.4 |
| WR05 | 0404 | 0813 | 1357 | 1710 | 2122 | 0111 | 0428 | 0749 | 1224 |
| | 59.0 | 57.0 | 64.0 | 60.0 | 60.0 | 57.0 | 58.0 | 55.0 | 61.0 |
| | 9.0 | 8.5 | 9.3 | 9.9 | 8.1 | 8.9 | 9.1 | 8.8 | 8.6 |
| ML06 | 0443 | 0844 | 1434 | 1745 | 2215 | 0154 | 0503 | 0815 | 1259 |
| | 61.0 | 60.0 | 66.0 | 63.0 | 63.0 | 60.0 | 61.0 | 59.0 | 66.0 |
| | 9.3 | 9.8 | 9.2 | 8.9 | 8.9 | 9.8 | 9.3 | 9.7 | 9.3 |

TABLE A-2

BLACKSTONE RIVER AUGUST 1980 SURVEY

DISSOLVED OXYGEN (mg/l) - TIME - TEMPERATURE ($^{o}$F)

| STATION | RUN 1 | 8/4<br>RUN 2 | RUN 3 | RUN 4 | RUN 5 | RUN 6 | 8/5<br>RUN 7 | RUN 8 | RUN 9 | RUN 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | BLACKSTONE RIVER | | | | | |
| BS01 | *0954 | 1350 | 1755 | 2145 | 0205 | 0545 | 1000 | 1400 | 1759 | 2150 |
| | **76.0 | 84.0 | 81.0 | 78.0 | 76.0 | 76.0 | 82.0 | 83.0 | 86.0 | 83.0 |
| | ***7.1 | 7.0 | 8.0 | 7.8 | 7.3 | 7.2 | 6.6 | 7.9 | 8.6 | 8.0 |
| BS02 | 1000 | 1353 | 1801 | 2150 | 0216 | 0550 | 1007 | 1406 | 1804 | 2155 |
| | 73.0 | 80.0 | 76.0 | 76.0 | 73.0 | 69.0 | 72.0 | 76.0 | 77.0 | 77.0 |
| | 7.0 | 6.5 | 6.6 | 6.4 | 6.5 | 7.6 | 6.4 | 6.5 | 10.0 | 6.0 |
| BS03 | 1004 | 1358 | 1808 | 2155 | 0218 | 0558 | 1014 | 1408 | 1807 | 2200 |
| | 74.0 | 82.0 | 79.0 | 77.0 | 75.0 | 74.0 | 78.0 | 85.0 | 85.0 | 78.0 |
| | 4.2 | 3.9 | 3.3 | 6.7 | 2.8 | 2.1 | 3.8 | 3.2 | 6.7 | 3.4 |
| BS04 | 1011 | 1404 | 1814 | 2200 | 0228 | 0605 | 1019 | 1416 | 1814 | 2207 |
| | 72.0 | 80.0 | 76.0 | 75.0 | 72.0 | 67.0 | 72.0 | 77.0 | 76.0 | 75.0 |
| | 7.7 | 7.8 | 7.0 | 3.1 | 6.7 | 7.0 | 8.3 | 8.2 | 7.8 | 7.0 |
| BS05 | 1017 | 1410 | 1817 | 2205 | 0235 | 0615 | 1025 | 1422 | 1818 | 2212 |
| | 76.0 | 83.0 | 80.0 | 76.0 | 75.0 | 76.0 | 79.0 | 85.0 | 84.0 | 82.0 |
| | 8.8 | 9.9 | 10.8 | 10.8 | 10.2 | 9.7 | 10.3 | 10.6 | 9.8 | 11.3 |
| BS06 | 1023 | 1416 | 1823 | 2210 | 0242 | 0620 | 1030 | 1426 | 1823 | 2217 |
| | 76.0 | 83.0 | 78.0 | 76.0 | 76.0 | 74.0 | 78.0 | 80.0 | 82.0 | 80.0 |
| | 4.3 | 6.6 | 7.5 | 6.0 | 4.1 | 2.9 | 4.2 | 6.4 | 7.3 | 5.8 |

*Time
**Temperature
***Dissolved Oxygen
†Color Interference (couldn't read end point)

TABLE A-2 (CONTINUED)

BLACKSTONE RIVER AUGUST 1980 SURVEY

DISSOLVED OXYGEN (mg/l) - TIME - TEMPERATURE ($^{o}$F)

| STATION | RUN 11 | RUN 12 | RUN 13 | RUN 14 | RUN 15 | RUN 16 | RUN 17 | RUN 18 | RUN 19 |
|---|---|---|---|---|---|---|---|---|---|
| | 8/6 | | | | | | 8/7 | | |
| BS01 | *0204 | 0555 | 0958 | 1400 | 1758 | 2150 | 0200 | 0631 | 0958 |
| | **77.0 | 80.0 | 82.0 | 87.0 | 85.0 | 80.0 | 77.0 | 77.0 | 78.0 |
| | ***7.8 | 7.1 | 7.8 | 8.0 | 7.9 | 7.8 | 7.4 | 7.3 | 6.8 |
| BS02 | 0210 | 0600 | 1004 | 1404 | 1801 | 2154 | 0206 | 0637 | 1002 |
| | 75.0 | 74.0 | 75.0 | 79.0 | 78.0 | 76.0 | 75.0 | 70.0 | 74.0 |
| | 7.9 | 6.0 | 6.4 | 7.7 | 5.9 | 6.2 | 6.3 | 7.6 | 6.2 |
| BS03 | 0215 | 0610 | 1007 | 1407 | 1804 | 2158 | 0210 | 0643 | 1007 |
| | 77.0 | 77.0 | 78.0 | 82.0 | 80.0 | 78.0 | 75.0 | 72.0 | 74.0 |
| | 2.8 | 2.7 | 3.4 | 3.4 | 2.9 | 2.7 | 3.2 | 2.9 | 3.3 |
| BS04 | 0221 | 0617 | 1014 | 1415 | 1813 | 2203 | 0217 | 0652 | 1013 |
| | 73.0 | 72.0 | 73.0 | 76.0 | 76.0 | 73.0 | 73.0 | 68.0 | 71.0 |
| | 6.6 | 6.6 | 6.4 | 5.1 | 7.4 | 6.6 | 6.8 | 6.9 | 6.5 |
| BS05 | 0228 | 0624 | 1019 | 1422 | 1816 | 2206 | 0223 | 0659 | 1018 |
| | 77.0 | 78.0 | 82.0 | 85.0 | 84.0 | 80.0 | 76.0 | 76.0 | 77.0 |
| | 8.9 | 9.6 | 10.3 | 10.8 | 10.5 | 9.9 | 9.5 | 8.7 | 9.4 |
| BS06 | 0233 | 0627 | 1023 | 1427 | 1821 | 2210 | 0228 | 0704 | 1023 |
| | 76.0 | 78.0 | 80.0 | 81.0 | 82.0 | 80.0 | 75.0 | 75.0 | 76.0 |
| | 4.1 | 2.9 | 3.6 | 6.4 | 6.4 | 5.1 | 3.6 | 3.0 | 3.5 |

*Time
**Temperature
***Dissolved Oxygen

TABLE 2-A (CONTINUED)

| | 8/4 | | | | 8/5 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| STATION | RUN 1 | RUN 2 | RUN 3 | RUN 4 | RUN 5 | RUN 6 | RUN 7 | RUN 8 | RUN 9 | RUN 10 |
| BS07 | 1028 | 1421 | 1827 | 2215 | 0248 | 0625 | 1034 | 1433 | 1828 | 2222 |
| | 76.0 | 82.0 | 79.0 | 75.0 | 76.0 | 76.0 | 80.0 | 83.0 | 84.0 | 81.0 |
| | 7.1 | 6.9 | 7.2 | 7.1 | 7.1 | 6.4 | 7.2 | 7.0 | 7.3 | 7.5 |
| BS08 | 1033 | 1426 | 1832 | 2220 | 0253 | 0630 | 1039 | 1440 | 1831 | 2225 |
| | 77.0 | 83.0 | 79.0 | 76.0 | 75.0 | 76.0 | 80.0 | 82.0 | 82.0 | 80.0 |
| | 7.2 | 7.1 | 7.4 | 6.6 | 6.7 | 6.7 | 7.4 | 7.2 | 6.6 | 6.2 |
| BS09B | 1043 | 1437 | 1841 | 2228 | 0259 | 0650 | 1049 | 1452 | 1840 | 2233 |
| | 76.0 | 83.0 | 79.0 | 76.0 | 77.0 | 74.0 | 77.0 | 80.0 | 84.0 | 81.0 |
| | 6.0 | 7.9 | 7.8 | 5.6 | 6.4 | 4.4 | 5.5 | 7.7 | 7.8 | 5.6 |
| BS09 | 1055 | 1450 | 1849 | 2238 | 0313 | 0705 | 1058 | 1457 | 1849 | 2245 |
| | 75.0 | 82.0 | 78.0 | 75.0 | 76.0 | 73.0 | 77.0 | 79.0 | 80.0 | 79.0 |
| | 5.8 | 5.2 | 3.5 | 2.7 | 3.6 | 4.5 | 3.7 | 2.5 | 2.6 | 2.4 |
| BS10 | 1100 | 1455 | 1854 | 2245 | 0319 | 0710 | 1104 | 1504 | 1855 | 2250 |
| | 75.0 | 81.0 | 77.0 | 75.0 | 75.0 | 73.0 | 77.0 | 77.0 | 79.0 | 78.0 |
| | 5.6 | 5.5 | 5.5 | 4.7 | 4.4 | 4.6 | 6.0 | 6.3 | 4.7 | 4.1 |
| BS11 | 1108 | 1507 | 1900 | 2250 | 0327 | 0720 | 1111 | 1512 | 1900 | 2257 |
| | 75.0 | 85.0 | 78.0 | 74.0 | 75.0 | 73.0 | 77.0 | 82.0 | 80.0 | 78.0 |
| | 7.3 | 6.6 | 7.2 | 6.8 | 6.4 | 6.7 | 7.5 | 7.2 | 7.1 | 6.3 |
| BS12 | 1114 | 1520 | 1906 | 2256 | 0335 | 0730 | 1116 | 1517 | 1905 | 2302 |
| | 76.0 | 82.0 | 78.0 | 76.0 | 75.0 | 73.0 | 76.0 | 81.0 | 82.0 | 79.0 |
| | 5.7 | 6.5 | 5.3 | 5.2 | 5.6 | 5.4 | 5.7 | 6.6 | 6.2 | 5.4 |
| BS13A | 1121 | 1528 | 1912 | 2300 | 0343 | 0740 | 1123 | 1525 | 1912 | 2310 |
| | 75.0 | 83.0 | 78.0 | 76.0 | 74.0 | 73.0 | 76.0 | 80.0 | 81.0 | 78.0 |
| | 7.2 | 6.5 | 7.0 | 6.8 | 6.8 | 7.3 | 7.3 | 7.2 | 6.4 | 6.9 |

TABLE A-2 (CONTINUED)

| STATION | RUN 11 | RUN 12 | 8/6<br>RUN 13 | RUN 14 | RUN 15 | RUN 16 | RUN 17 | 8/7<br>RUN 18 | RUN 19 |
|---|---|---|---|---|---|---|---|---|---|
| BS07 | 0238 | 0635 | 1028 | 1431 | 1825 | 2215 | 0232 | 0709 | 1028 |
| | 76.0 | 78.0 | 81.0 | 82.0 | 80.0 | 79.0 | 75.0 | 76.0 | 77.0 |
| | 7.4 | 7.0 | 7.1 | 7.2 | 7.0 | 7.0 | 6.8 | 6.8 | 6.1 |
| BS08 | 0240 | 0640 | 1032 | 1435 | 1829 | 2217 | 0235 | 0714 | 1031 |
| | 76.0 | 77.0 | 80.0 | 82.0 | 79.0 | 78.0 | 75.0 | 75.0 | 76.0 |
| | 7.0 | 6.6 | 6.8 | 7.5 | 6.7 | 6.7 | 6.4 | 6.9 | 7.1 |
| BS09B | 0248 | 0648 | 1039 | 1444 | 1837 | 2225 | 0243 | 0723 | 1039 |
| | 76.0 | 76.0 | 78.0 | 81.0 | 81.0 | 79.0 | 75.0 | 74.0 | 75.0 |
| | 6.9 | 3.6 | 4.2 | 7.0 | 7.6 | 5.2 | 6.5 | 4.7 | 4.4 |
| BS09 | 0258 | 0700 | 1046 | 1454 | 1846 | 2235 | 0253 | 0725 | 1047 |
| | 76.0 | 76.0 | 78.0 | 80.0 | 80.0 | 78.0 | 74.0 | 73.0 | 77.0 |
| | 3.4 | 4.0 | 3.8 | 3.0 | 1.6 | 1.2 | 2.0 | 4.6 | 1.6 |
| BS10 | 0305 | 0705 | 1051 | 1458 | 1850 | 2238 | 0258 | 0740 | 1053 |
| | 76.0 | 76.0 | 79.0 | 79.0 | 78.0 | 78.0 | 74.0 | 73.0 | 76.0 |
| | 4.2 | 4.7 | 5.5 | 6.3 | 5.2 | 5.3 | 4.7 | 4.5 | 5.6 |
| BS11 | 0210 | 0715 | 1101 | 1520 | 1856 | 2245 | 0304 | 0750 | 1105 |
| | 75.0 | 77.0 | 79.0 | 83.0 | 80.0 | 78.0 | 73.0 | 73.0 | 78.0 |
| | 6.5 | 5.9 | 7.2 | 7.5 | 6.9 | 7.0 | 7.0 | 6.2 | 7.7 |
| BS12 | 0316 | 0720 | 1106 | 1524 | 1900 | 2250 | 0310 | 0755 | 1109 |
| | 75.0 | 77.0 | 78.0 | 82.0 | 81.0 | 78.0 | 73.0 | 74.0 | 76.0 |
| | 5.3 | 4.9 | 5.2 | 6.6 | 5.7 | 5.5 | 5.3 | 5.9 | 14.0 |
| BS13A | 0325 | 0730 | 1112 | 1531 | 1906 | 2255 | 0315 | 0805 | 1115 |
| | 75.0 | 76.0 | 79.0 | 81.0 | 82.0 | 78.0 | 74.0 | 73.0 | 76.0 |
| | 6.7 | 6.7 | 6.9 | 6.9 | 6.7 | 6.5 | 6.7 | 7.1 | 7.7 |

TABLE A-2 (CONTINUED)

| | 8/4 | | | | 8/5 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| STATION | RUN 1 | RUN 2 | RUN 3 | RUN 4 | RUN 5 | RUN 6 | RUN 7 | RUN 8 | RUN 9 | RUN 10 |
| BS13 | 1132 | 1543 | 1924 | 2313 | 0355 | 0755 | 1133 | 1542 | 1921 | 2319 |
| | 76.0 | 85.0 | 78.0 | 76.0 | 75.0 | 74.0 | 78.0 | 79.0 | 81.0 | 80.0 |
| | 7.3 | 6.6 | 7.3 | 5.9 | 6.8 | 6.7 | 7.1 | 7.3 | 7.1 | 6.8 |
| BS14 | 1140 | 1550 | 1931 | 2320 | 0403 | 0800 | 1140 | 1548 | 1927 | 2325 |
| | 76.0 | 83.0 | 77.0 | 75.0 | 75.0 | 75.0 | 81.0 | 83.0 | 80.0 | 78.0 |
| | 7.3 | 6.5 | 6.3 | 5.2 | 5.2 | 5.9 | 7.5 | 7.8 | 6.2 | 5.2 |
| BS15 | 1145 | 1556 | 1937 | 2325 | 0413 | 0810 | 1145 | 1553 | 1933 | 2333 |
| | 77.0 | 84.0 | 78.0 | 75.0 | 75.0 | 74.0 | 80.0 | 83.0 | 82.0 | 78.0 |
| | 7.5 | 7.1 | 6.7 | 4.9 | 5.2 | 5.7 | 7.8 | 9.1 | 7.7 | 5.0 |
| BS16 | 1200 | 1611 | 1950 | 2337 | 0433 | 0828 | 1158 | 1608 | 1946 | 2345 |
| | 77.0 | 85.0 | 77.0 | 75.0 | 75.0 | 74.0 | 80.0 | 85.0 | 81.0 | 79.0 |
| | 5.7 | 6.7 | 6.0 | 4.1 | 2.8 | 2.7 | 6.4 | 8.3 | 7.1 | 4.8 |
| BS17A | 1214 | 1623 | 2036 | 2350 | 0445 | 0845 | 1211 | 1621 | 1956 | 2355 |
| | 77.0 | 83.0 | 76.0 | 76.0 | 75.0 | 75.0 | 77.0 | 81.0 | 80.0 | 80.0 |
| | 6.0 | 5.9 | 7.3 | 6.3 | 5.4 | 5.8 | 5.9 | 7.3 | 7.5 | 6.5 |
| BS17 | 1226 | 1637 | 2048 | 2400 | 0459 | 0900 | 1221 | 1632 | 2006 | 0005 |
| | 77.0 | 82.0 | 76.0 | 76.0 | 74.0 | 75.0 | 78.0 | 80.0 | 80.0 | 78.0 |
| | 6.3 | 6.1 | 6.6 | 6.0 | 5.8 | 6.0 | 6.5 | 3.4 | 7.4 | 6.4 |
| BS18 | 1236 | 1647 | 2102 | 0008 | 0516 | 0910 | 1230 | 1642 | 2014 | 0014 |
| | 79.0 | 83.0 | 76.0 | 76.0 | 74.0 | 75.0 | 77.0 | 80.0 | 80.0 | 78.0 |
| | 6.7 | 6.5 | 7.0 | 5.9 | 5.5 | 5.9 | 6.4 | 7.2 | 7.0 | 6.7 |

TABLE A-2 (CONTINUED)

| | 8/6 | | | | | | 8/7 | | |
|---|---|---|---|---|---|---|---|---|---|
| STATION | RUN 11 | RUN 12 | RUN 13 | RUN 14 | RUN 15 | RUN 16 | RUN 17 | RUN 18 | RUN 19 |
| BS13 | 0335 | 0745 | 1123 | 1542 | 1916 | 2303 | 0326 | 0820 | 1126 |
| | 76.0 | 78.0 | 80.0 | 80.0 | 81.0 | 78.0 | 75.0 | 75.0 | 77.0 |
| | 7.0 | 6.8 | 6.7 | 7.2 | 6.8 | 7.2 | 6.7 | 5.1 | 6.7 |
| BS14 | 0341 | 0753 | 1129 | 1548 | 1923 | 2310 | 0333 | 0825 | 1133 |
| | 76.0 | 79.0 | 82.0 | 81.0 | 80.0 | 78.0 | 75.0 | 76.0 | 79.0 |
| | 4.9 | 5.3 | 7.6 | 7.2 | 5.3 | 4.5 | 4.3 | 5.0 | 7.2 |
| BS15 | 0345 | 0801 | 1134 | 1553 | 1927 | 2315 | 0338 | 0831 | 1137 |
| | 75.0 | 78.0 | 81.0 | 82.0 | 80.0 | 78.0 | 74.0 | 76.0 | 79.0 |
| | 4.4 | 5.1 | 7.4 | 8.0 | 6.4 | 4.7 | 4.0 | 4.9 | 6.7 |
| BS16 | 0400 | 0821 | 1145 | 1607 | 1939 | 2325 | 0351 | 0844 | 1147 |
| | 76.0 | 79.0 | 82.0 | 83.0 | 81.0 | 78.0 | 74.0 | 76.0 | 80.0 |
| | 2.8 | 3.5 | 6.1 | 7.8 | 6.0 | 4.1 | 3.3 | 4.5 | 6.8 |
| BS17A | 0410 | 0837 | 1155 | 1619 | 1949 | 2336 | 0402 | 0900 | 1158 |
| | 76.0 | 79.0 | 79.0 | 81.0 | 80.0 | 78.0 | 75.0 | 76.0 | 78.0 |
| | 5.8 | 5.7 | 5.9 | 6.8 | 6.4 | 6.0 | 5.9 | 5.8 | 6.1 |
| BS17 | 0421 | 0852 | 1206 | 1628 | 2000 | 2345 | 0414 | 0911 | 1207 |
| | 75.0 | 79.0 | 81.0 | 80.0 | 80.0 | 78.0 | 74.0 | 77.0 | 78.0 |
| | 6.0 | 6.2 | 6.6 | 6.9 | 6.4 | 5.9 | 6.2 | 6.1 | 6.7 |
| BS18 | 0430 | 0900 | 1214 | 1637 | 2007 | 2350 | 0423 | 0920 | 1214 |
| | 75.0 | 79.0 | 80.0 | 79.0 | 79.0 | 79.0 | 74.0 | 76.0 | 78.0 |
| | 6.1 | 6.0 | 6.9 | 8.3 | 6.7 | 6.2 | 5.7 | 5.8 | 6.8 |

TABLE A-2 (CONTINUED)

| | 8/4 | | | | 8/5 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| STATION | RUN 1 | RUN 2 | RUN 3 | RUN 4 | RUN 5 | RUN 6 | RUN 7 | RUN 8 | RUN 9 | RUN 10 |
| BS19 | 1244 | 1653 | 2113 | 0015 | 0524 | 0921 | 1236 | 1648 | 2020 | 0020 |
| | 78.0 | 84.0 | 77.0 | 76.0 | 75.0 | 78.0 | 80.0 | 80.0 | 79.0 | 80.0 |
| | 7.7 | 7.4 | 7.3 | 7.1 | 7.2 | 7.0 | 7.6 | 7.5 | 7.4 | 7.3 |
| BS20 | 1248 | 1658 | 2117 | 0020 | 0527 | 0927 | 1243 | 1652 | 2025 | 0025 |
| | 79.0 | 83.0 | 77.0 | 76.0 | 75.0 | 78.0 | 81.0 | 80.0 | 80.0 | 79.0 |
| | 7.6 | 7.0 | 6.6 | 7.2 | 7.2 | 7.5 | 7.4 | 7.8 | 7.8 | 7.1 |
| Tributaries | | | | | | | | | | |
| MB01 | 1048 | 1442 | 1844 | 2233 | 0306 | 0657 | 1053 | 1449 | 1845 | 2235 |
| | 74.0 | 77.0 | 77.0 | 73.0 | 75.0 | 72.0 | 75.0 | 81.0 | 77.0 | 78.0 |
| | 4.4 | 5.5 | 4.2 | 3.9 | 2.5 | 4.6 | 3.4 | 4.4 | 3.8 | 4.1 |
| QR05 | 1126 | 1535 | 1916 | 2307 | 0350 | 0745 | 1128 | 1531 | 1916 | 2313 |
| | 77.0 | 85.0 | 79.0 | 77.0 | 76.0 | 76.0 | 81.0 | 84.0 | 84.0 | 81.0 |
| | 8.2 | 8.4 | 7.2 | 5.1 | 5.2 | 6.0 | 8.8 | 9.1 | 7.4 | 5.3 |
| MF07 | 1208 | 1618 | 2030 | 2345 | 0440 | 0837 | 1207 | 1616 | 1954 | 2352 |
| | 78.0 | 85.0 | 76.0 | 76.0 | 75.0 | 76.0 | 80.0 | 82.0 | 82.0 | 79.0 |
| | 7.4 | 6.9 | 7.3 | 7.3 | 7.2 | 7.3 | 7.3 | 7.3 | 7.9 | 7.1 |
| WR05 | 1219 | 1630 | 2041 | 2355 | 0452 | 0850 | 1215 | 1624 | 2001 | 2400 |
| | 77.0 | 81.0 | 76.0 | 75.0 | 75.0 | 75.0 | 77.0 | 78.0 | 78.0 | 78.0 |
| | 6.2 | 4.8 | 6.4 | 6.4 | 6.3 | 6.5 | 6.0 | -- | 7.2 | 6.4 |
| ML06 | 1255 | 1705 | 2125 | 0025 | 0535 | 0935 | 1251 | 1657 | 2031 | 0033 |
| | 80.0 | 84.0 | 78.0 | 76.0 | 75.0 | 80.0 | 81.0 | 79.0 | 79.0 | 78.0 |
| | 7.3 | 4.5 | 6.4 | 7.1 | 7.3 | 7.7 | 6.9 | 7.5 | 7.8 | 7.6 |

TABLE A-2 (CONTINUED)

| STATION | RUN 11 | RUN 12 | RUN 13 | RUN 14 | RUN 15 | RUN 16 | RUN 17 | RUN 18 | RUN 19 |
|---|---|---|---|---|---|---|---|---|---|
| | | | 8/6 | | | | | 8/7 | |
| BS19 | 0436 | 0908 | 1220 | 1643 | 2014 | 2356 | 0430 | 0928 | 1219 |
| | 75.0 | 79.0 | 80.0 | 80.0 | 80.0 | 78.0 | 75.0 | 78.0 | 80.0 |
| | 7.1 | 7.4 | 7.4 | 7.5 | 7.2 | 7.3 | 7.1 | 7.3 | 7.6 |
| BS20 | 0440 | 0914 | 1224 | 1647 | 2017 | 2400 | 0433 | 0934 | 1223 |
| | 76.0 | 79.0 | 82.0 | 80.0 | 79.0 | 79.0 | 75.0 | 77.0 | 79.0 |
| | 7.1 | 7.3 | 7.4 | 7.7 | 7.0 | 7.1 | 7.0 | 7.5 | 7.8 |
| MB01 | 0254 | 0652 | 1042 | 1447 | 1840 | 2230 | 0247 | 0727 | 1042 |
| | 75.0 | 75.0 | 77.0 | 75.0 | 76.0 | 77.0 | 74.0 | 73.0 | 75.0 |
| | 4.6 | 5.2 | 3.0 | 4.4 | 2.5 | 2.6 | 2.7 | 4.1 | 4.7 |
| QR05 | 0329 | 0738 | 1117 | 1535 | 1910 | 2258 | 0320 | 0811 | 1120 |
| | 76.0 | 78.0 | 82.0 | 83.0 | 83.0 | 80.0 | 75.0 | 76.0 | 79.0 |
| | 4.7 | 5.4 | 8.8 | 9.2 | 6.1 | 5.1 | 4.5 | 5.8 | 8.8 |
| MF07 | 0407 | 0830 | 1153 | 1616 | 1946 | 2334 | 0358 | 0855 | 1155 |
| | 75.0 | 80.0 | 81.0 | 81.0 | 87.0 | 78.0 | 75.0 | 77.0 | 80.0 |
| | 7.2 | 7.2 | 7.2 | 7.3 | 7.0 | 7.1 | 7.0 | 7.6 | 7.2 |
| WR05 | 0415 | 0842 | 1200 | 1623 | 1953 | 2340 | 0405 | 0905 | 1200 |
| | 75.0 | 78.0 | 78.0 | 79.0 | 77.0 | 76.0 | 73.0 | 75.0 | 78.0 |
| | 6.7 | 6.4 | 6.1 | 6.6 | 5.9 | 6.2 | 5.9 | 6.2 | 6.2 |
| ML06 | 0445 | 0925 | 1230 | 1653 | 2024 | 0005 | 0440 | 0944 | 1230 |
| | 76.0 | 80.0 | 82.0 | 81.0 | 80.0 | 79.0 | 75.0 | 80.0 | 81.0 |
| | 7.5 | 7.5 | 7.4 | 7.2 | 7.1 | 7.3 | 7.2 | 7.7 | 7.6 |

TABLE A-3

BLACKSTONE RIVER OCTOBER 1980 SURVEY

DISSOLVED OXYGEN (mg/l) - TIME - TEMPERATURE ($^{o}$F)

| | 10/15/80 | | | | 10/16/80 | |
|---|---|---|---|---|---|---|
| STATION | RUN 1 | RUN 2 | RUN 3 | RUN 4 | RUN 5 | RUN 6 |
| BS08 | *0958 | 1404 | 1800 | 2200 | 0208 | 0558 |
| | **50.0 | 54.0 | 53.0 | 54.0 | 52.0 | 50.0 |
| | ***9.6 | 9.2 | 9.5 | 9.6 | 9.0 | 9.5 |
| BS09B | 1016 | 1412 | 1810 | 2210 | 0218 | 0615 |
| | 53.0 | 49.0 | 51.0 | 53.0 | 52.0 | 50.0 |
| | 8.3 | 9.8 | 9.6 | 9.5 | 9.0 | 7.9 |
| MB01 | 1012 | 1418 | 1820 | 2215 | 0221 | 0630 |
| | 57.0 | 60.0 | 57.0 | 60.0 | 58.0 | 58.0 |
| | 4.2 | 4.5 | 6.2 | 5.1 | 5.1 | 6.4 |
| BS09 | 1022 | 1426 | 1830 | 2220 | 0233 | 0640 |
| | 54.0 | 54.0 | 53.0 | 54.0 | 55.0 | 54.0 |
| | 7.8 | 6.9 | 7.8 | 7.0 | 5.9 | 5.5 |
| BS10 | 1035 | 1431 | 1838 | 2225 | 0240 | 0648 |
| | 62.0 | 59.0 | 59.0 | 60.0 | 59.0 | 57.0 |
| | 7.0 | 7.0 | 6.9 | 6.6 | 6.7 | 6.0 |
| BS11 | 1050 | 1437 | 1848 | 2232 | 0247 | 0655 |
| | 58.0 | 58.0 | 57.0 | 57.0 | 56.0 | 56.0 |
| | 8.8 | 8.6 | 8.4 | 8.5 | 8.5 | 8.2 |

*Time
**Temperature
***Dissolved Oxygen

TABLE A-3 (CONTINUED)

| STATION | RUN 1 (10/15/80) | RUN 2 (10/15/80) | RUN 3 (10/15/80) | RUN 4 (10/15/80) | RUN 5 (10/16/80) | RUN 6 (10/16/80) |
|---|---|---|---|---|---|---|
| BS12 | 1058 | 1443 | 1900 | 2240 | 0255 | 0710 |
| | 58.0 | 57.0 | 56.0 | 57.0 | 55.0 | 55.0 |
| | 8.7 | 7.9 | 7.7 | 7.5 | 7.5 | 7.3 |
| BS13A | 1105 | 1450 | 1910 | 2248 | 0303 | 0720 |
| | 57.0 | 56.0 | 55.0 | 55.0 | 55.0 | 54.0 |
| | 9.4 | 9.0 | 9.1 | 8.8 | 9.5 | 8.8 |
| QR05 | -- | 1454 | 1920 | 2255 | 0310 | 0725 |
| | -- | 53.0 | 53.0 | 53.0 | 50.0 | 50.0 |
| | -- | 10.7 | 10.0 | 11.4 | 9.7 | 10.1 |
| BS13 | 1115 | 1502 | 1930 | 2300 | 0320 | 0730 |
| | 56.0 | 54.0 | 54.0 | 55.0 | 53.0 | 53.0 |
| | 9.5 | 9.4 | 9.4 | 9.5 | 9.3 | 9.4 |
| BS14 | 1130 | 1510 | 1940 | 2307 | 0330 | 0745 |
| | 58.0 | 55.0 | 54.0 | 53.0 | 51.0 | 53.0 |
| | 8.4 | 8.7 | 7.8 | 7.5 | 7.3 | 7.1 |
| BS15 | 1138 | 1517 | 1950 | 2315 | 0335 | 0755 |
| | 57.0 | 54.0 | 54.0 | 53.0 | 51.0 | 52.0 |
| | 8.2 | 8.7 | 7.8 | 7.5 | 7.0 | 7.2 |
| BS16 | 1255 | 1529 | 2005 | 2325 | 0350 | 0810 |
| | 56.0 | 54.0 | 53.0 | 53.0 | 50.0 | 51.0 |
| | 6.8 | 7.8 | 7.6 | 8.1 | 6.0 | 5.0 |

TABLE A-3 (CONTINUED)

| | 10/15/80 | | | | 10/16/80 | |
|---|---|---|---|---|---|---|
| STATION | RUN 1 | RUN 2 | RUN 3 | RUN 4 | RUN 5 | RUN 6 |
| MF07 | 1208 | 1539 | 2020 | 2345 | 0400 | 0820 |
| | 56.0 | 54.0 | 52.0 | 53.0 | 50.0 | 51.0 |
| | 10.4 | 10.3 | 10.3 | 10.4 | 10.1 | 10.1 |
| BS17A | 1215 | 1543 | 2025 | 2350 | 0405 | 0825 |
| | 52.0 | 53.0 | 52.0 | 52.0 | 50.0 | 51.0 |
| | 8.3 | 8.3 | 8.3 | 8.0 | 7.9 | 7.6 |
| WR05 | 1225 | 1549 | 2030 | 2355 | 0410 | 0830 |
| | 49.0 | 51.0 | 51.0 | 52.0 | 48.0 | 49.0 |
| | 10.0 | 10.0 | 9.9 | 9.0 | 9.7 | 10.1 |
| BS17 | 1235 | 1553 | 2040 | 2400 | 0420 | 0840 |
| | 52.0 | 53.0 | 52.0 | 52.0 | 51.0 | 51.0 |
| | 9.2 | 8.8 | 8.7 | 8.7 | 8.2 | 8.1 |
| BS18 | 1245 | 1602 | 2055 | 0010 | 0430 | 0850 |
| | 51.0 | 51.0 | 52.0 | 51.0 | 49.0 | 51.0 |
| | 9.0 | 9.2 | 10.1 | 9.8 | 8.8 | 8.8 |

TABLE A-4

BLACKSTONE RIVER 1980 SURVEY

SUMMARY OF DISSOLVED OXYGEN mg/1

| | JUNE | | | AUG. | | | OCT. | | |
|---|---|---|---|---|---|---|---|---|---|
| STATION | MAX. | MIN. | AVG. | MAX. | MIN. | AVG. | MAX. | MIN. | AVG. |
| BS01 | 10.0 | 7.8 | 8.7 | 8.6 | 6.6 | 7.5 | -- | -- | -- |
| BS02 | 13.5 | 8.3 | 9.2 | 10.0 | 5.9 | 6.8 | -- | -- | -- |
| BS03 | 9.0 | 7.1 | 7.8 | 6.7 | 2.1 | 3.5 | -- | -- | -- |
| BS04 | 10.9 | 8.7 | 9.5 | 8.3 | 3.1 | 6.8 | -- | -- | -- |
| BS05 | 9.1 | 6.3 | 7.5 | 11.3 | 8.7 | 10.0 | -- | -- | -- |
| BS06 | 11.9 | 5.3 | 9.0 | 7.5 | 2.9 | 4.9 | -- | -- | -- |
| BS07 | 9.8 | 8.2 | 9.1 | 7.5 | 6.1 | 7.0 | -- | -- | -- |
| BS08 | 9.8 | 8.5 | 9.1 | 7.5 | 6.2 | 6.9 | 9.6 | 9.0 | 9.4 |
| BS09B | 9.4 | 6.9 | 8.1 | 7.9 | 3.6 | 6.0 | 9.8 | 7.9 | 9.0 |
| BS09 | 9.0 | 6.4 | 7.4 | 5.8 | 1.2 | 3.2 | 7.8 | 5.5 | 6.8 |
| BS10 | 8.9 | 6.7 | 7.5 | 6.3 | 4.1 | 5.1 | 7.0 | 6.0 | 6.7 |
| BS11 | 9.6 | 8.2 | 8.8 | 7.7 | 5.9 | 6.9 | 8.8 | 8.2 | 8.5 |
| BS12 | 8.6 | 7.6 | 8.1 | 14.0 | 4.9 | 5.4 | 8.7 | 7.3 | 7.8 |
| BS13A | 9.6 | 8.2 | 9.0 | 7.7 | 6.4 | 6.9 | 9.4 | 8.8 | 7.8 |
| BS13 | 10.2 | 8.3 | 9.3 | 7.3 | 6.6 | 6.8 | 9.5 | 9.3 | 9.4 |
| BS14 | 8.9 | 7.2 | 7.9 | 7.8 | 4.3 | 6.0 | 8.7 | 7.1 | 7.8 |
| BS15 | 9.2 | 6.3 | 7.7 | 9.1 | 4.0 | 6.2 | 8.7 | 7.0 | 7.7 |
| BS16 | 11.5 | 4.9 | 8.1 | 8.3 | 2.7 | 5.2 | 8.1 | 5.0 | 6.9 |
| BS17A | 8.3 | 6.5 | 7.3 | 7.5 | 5.4 | 6.2 | 8.3 | 7.6 | 8.1 |
| BS17 | 8.3 | 6.4 | 7.4 | 7.4 | 3.4 | 6.2 | 9.2 | 8.1 | 8.6 |
| BS18 | 8.7 | 6.7 | 7.6 | 8.3 | 5.5 | 6.5 | 10.1 | 8.8 | 9.3 |
| BS19 | 9.7 | 8.6 | 9.1 | 7.7 | 7.0 | 7.3 | -- | -- | -- |
| BS20 | 9.7 | 8.5 | 9.1 | 7.8 | 6.6 | 7.3 | -- | -- | -- |
| **Tributaries** | | | | | | | | | |
| MB01 | 8.5 | 3.9 | 6.3 | 5.5 | 2.5 | 3.5 | 6.4 | 4.2 | 5.3 |
| QR05 | 9.1 | 6.7 | 8.0 | 9.2 | 4.5 | 6.8 | 11.4 | 9.7 | 10.4 |
| MF07 | 9.4 | 8.7 | 9.0 | 7.9 | 6.9 | 7.3 | 10.4 | 10.1 | 10.3 |
| WF05 | 9.9 | 8.1 | 8.8 | 7.2 | 0.0* | 5.9 | 10.1 | 9.0 | 9.8 |
| ML06 | 9.8 | 8.8 | 9.3 | 7.8 | 4.5 | 7.2 | -- | -- | -- |

TABLE A-5

BLACKSTONE RIVER 1980 SURVEY

SUMMARY OF TEMPERATURE DATA ($F^{O}$)

| STATION | JUNE MAX. | JUNE MIN. | JUNE AVG. | AUG. MAX. | AUG. MIN. | AUG. AVG. | OCT. MAX. | OCT. MIN. | OCT. AVG. |
|---|---|---|---|---|---|---|---|---|---|
| BS01 | 67 | 58 | 62 | 87 | 76 | 80 | -- | -- | -- |
| BS02 | 60 | 50 | 56 | 80 | 69 | 75 | -- | -- | -- |
| BS03 | 62 | 54 | 58 | 85 | 72 | 78 | -- | -- | -- |
| BS04 | 61 | 51 | 56 | 80 | 67 | 74 | -- | -- | -- |
| BS05 | 64 | 58 | 61 | 85 | 75 | 80 | -- | -- | -- |
| BS06 | 65 | 55 | 60 | 83 | 74 | 78 | -- | -- | -- |
| BS07 | 62 | 58 | 60 | 84 | 75 | 79 | -- | -- | -- |
| BS08 | 63 | 57 | 60 | 83 | 75 | 78 | 54 | 50 | 52 |
| BS09B | 65 | 54 | 60 | 84 | 74 | 78 | 53 | 49 | 51 |
| BS09 | 64 | 55 | 60 | 82 | 73 | 77 | 55 | 53 | 54 |
| BS10 | 63 | 57 | 61 | 81 | 73 | 77 | 62 | 57 | 59 |
| BS11 | 65 | 57 | 61 | 85 | 73 | 78 | 58 | 56 | 57 |
| BS12 | 64 | 56 | 60 | 82 | 73 | 77 | 58 | 55 | 56 |
| BS13A | 64 | 55 | 60 | 83 | 73 | 77 | 57 | 54 | 55 |
| BS13 | 65 | 56 | 60 | 85 | 74 | 78 | 56 | 53 | 54 |
| BS14 | 65 | 56 | 61 | 83 | 75 | 78 | 58 | 51 | 54 |
| BS15 | 65 | 56 | 61 | 84 | 74 | 78 | 57 | 51 | 54 |
| BS16 | 68 | 55 | 61 | 85 | 74 | 79 | 56 | 50 | 53 |
| BS17A | 64 | 55 | 61 | 83 | 75 | 78 | 53 | 50 | 52 |
| BS17 | 64 | 57 | 61 | 82 | 74 | 78 | 53 | 51 | 52 |
| BS18 | 63 | 56 | 61 | 83 | 74 | 77 | 52 | 49 | 51 |
| BS19 | 64 | 58 | 61 | 84 | 75 | 79 | -- | -- | -- |
| BS20 | 66 | 58 | 61 | 83 | 75 | 79 | -- | -- | -- |
| Tributaries | | | | | | | | | |
| MB01 | 64 | 58 | 61 | 81 | 72 | 76 | 60 | 57 | 58 |
| QR05 | 65 | 55 | 61 | 85 | 75 | 80 | 53 | 50 | 52 |
| MF07 | 67 | 58 | 62 | 87 | 75 | 79 | 56 | 50 | 53 |
| WR05 | 64 | 55 | 60 | 81 | 73 | 77 | 52 | 48 | 50 |
| ML06 | 66 | 59 | 62 | 84 | 75 | 79 | -- | -- | -- |

TABLE A-6

BLACKSTONE RIVER 1980 SURVEY

CHEMICAL OXYGEN DEMAND (mg/1)

| STATION | 6/9 | 6/10 | AVG. | 8/4 | 8/5 | AVG | 10/15-16 |
|---|---|---|---|---|---|---|---|
| BS01 | -- | -- | -- | 29 | 22 | 26 | -- |
| BS02 | -- | -- | -- | 29 | 109 | 69 | -- |
| BS03 | -- | -- | -- | 106 | 76 | 91 | -- |
| BS04 | -- | -- | -- | 73 | 54 | 64 | -- |
| BS05 | -- | -- | -- | 44 | 33 | 39 | -- |
| BS06 | -- | -- | -- | 48 | 27 | 38 | -- |
| BS07 | -- | -- | -- | 44 | 33 | 39 | -- |
| BS08 | -- | -- | -- | 44 | 33 | 39 | 39 |
| BS09B | 47 | 38 | 43 | 44 | 33 | 39 | 27 |
| BS09 | 106 | 72 | 89 | 48 | 39 | 44 | 73 |
| BS10 | -- | 77 | -- | 68 | 54 | 61 | 62 |
| BS11 | -- | 57 | -- | 53 | 33 | 43 | 52 |
| BS12 | 23 | 57 | 40 | 63 | 49 | 56 | 44 |
| BS13A | 47 | 33 | 40 | 48 | 65 | 57 | 48 |
| BS13 | -- | -- | -- | 29 | 59 | 44 | 39 |
| BS14 | -- | -- | -- | 48 | 59 | 54 | 48 |
| BS15 | -- | -- | -- | 485 | 54 | 270 | 34 |
| BS16 | -- | -- | -- | 58 | 54 | 56 | 34 |
| BS17A | -- | -- | -- | 27 | 43 | 35 | 39 |
| BS17 | -- | -- | -- | 22 | 43 | 33 | 58 |
| BS18 | -- | -- | -- | 33 | 43 | 38 | 25 |
| BS19 | -- | -- | -- | 27 | 49 | 38 | -- |
| BS20 | -- | 3.9 | -- | 27 | 38 | 33 | -- |
| **Tributaries** | | | | | | | |
| MB01 | -- | -- | -- | 87 | 82 | 85 | 154 |
| QR05 | -- | -- | -- | 48 | 38 | 43 | 28 |
| MF07 | -- | -- | -- | 22 | 38 | 30 | 12 |
| WR05 | -- | -- | -- | 38 | 59 | 49 | 23 |
| ML06 | -- | 2.4 | -- | 38 | 43 | 41 | -- |

TABLE A-7

BLACKSTONE RIVER 1980 SURVEY

5-DAY BIOCHEMICAL OXYGEN DEMAND (mg/l)

| STATION | 6/9 | 6/10 | AVG. | 8/4 | 8/5 | AVG. | 10/15-16 |
|---|---|---|---|---|---|---|---|
| BS01 | 8.4 | 4.8 | 6.6 | 5.4 | 4.2 | 4.8 | -- |
| BS02 | 4.5 | 1.5 | 3.0 | 1.2 | 2.7 | 2.0 | -- |
| BS03 | 4.2 | 4.2 | 4.2 | 10.8 | 10.2 | 10.5 | -- |
| BS04 | 3.6 | 1.8 | 2.7 | 1.5 | 2.7 | 2.1 | -- |
| BS05 | 3.6 | 3.0 | 3.3 | 2.7 | 3.3 | 3.0 | -- |
| BS06 | 2.1 | 2.4 | 2.3 | 0.9 | 2.4 | 1.7 | -- |
| BS07 | 2.4 | 2.7 | 2.6 | 3.9 | 3.3 | 3.6 | -- |
| BS08 | 2.7 | 3.3 | 3.0 | 2.7 | 3.6 | 3.2 | 4.5 |
| BS09B | 3.6 | 1.8 | 2.7 | 2.7 | 3.0 | 2.9 | 5.7 |
| BS09 | 7.2 | 6.9 | 7.1 | 4.8 | 9.0 | 6.9 | 22 |
| BS10 | -- | 3.9 | 3.9 | 3.9 | 5.4 | 4.7 | 6.9 |
| BS11 | -- | 3.6 | 3.6 | 2.1 | 5.4 | 3.8 | 6.0 |
| BS12 | 5.1 | 4.8 | 5.0 | 3.0 | 5.7 | 4.4 | 6.6 |
| BS13A | 6.9 | 6.6 | 6.8 | 3.0 | 5.4 | 4.2 | 6.0 |
| BS13 | 5.1 | 5.4 | 5.3 | 3.6 | 3.0 | 3.3 | 6.3 |
| BS14 | 6.9 | 5.2 | 6.1 | 3.9 | 4.5 | 4.2 | 5.4 |
| BS15 | 8.7 | 7.2 | 8.0 | 4.2 | 3.9 | 4.1 | 5.1 |
| BS16 | 6.6 | 6.0 | 6.3 | 2.7 | 3.6 | 3.2 | 3.6 |
| BS17A | 9.6 | 6.9 | 8.3 | 2.7 | 3.3 | 3.0 | 4.8 |
| BS17 | 7.2 | 7.5 | 7.4 | 1.8 | 2.7 | 2.3 | 4.2 |
| BS18 | 7.2 | 3.9 | 5.6 | 2.4 | 3.3 | 2.9 | 4.2 |
| BS19 | 4.5 | -- | 4.5 | 2.4 | 2.7 | 2.6 | -- |
| BS20 | 3.6 | 3.9 | 3.8 | 0.9 | 2.4 | 1.7 | -- |
| | | | | Tributaries | | | |
| MB01 | 19.2 | -- | -- | 20.0 | 19.0 | 19.5 | 1.3 |
| QR05 | 3.0 | 1.8 | 2.4 | 0.6 | 1.5 | 1.1 | 3.6 |
| MF07 | 2.7 | 2.1 | 2.4 | 2.1 | 2.7 | 2.4 | 2.4 |
| WR05 | 1.5 | 1.8 | 1.7 | 3.0 | 2.4 | 2.7 | 3.0 |
| ML06 | 2.7 | 2.4 | 2.6 | 3.9 | 4.2 | 4.1 | -- |

TABLE A-8

BLACKSTONE RIVER 1980 SURVEY

KJELDAHL-N (mg/1)

| STATION | 6/9 | 6/10 | AVG. | 8/4 | 8/5 | AVG. | 10/15-16 |
|---|---|---|---|---|---|---|---|
| BS01 | 0.93 | 1.2 | 1.1 | 1.2 | 1.4 | 1.3 | -- |
| BS02 | 1.6 | 2.3 | 2.0 | 0.77 | 0.78 | 0.78 | -- |
| BS03 | 2.3 | 1.1 | 1.7 | 2.2 | 1.6 | 1.9 | -- |
| BS04 | 0.68 | 0.59 | 0.64 | 0.79 | 0.46 | 0.63 | -- |
| BS05 | 0.73 | 0.88 | 0.81 | 0.80 | 0.18 | 0.49 | -- |
| BS06 | 0.64 | 0.77 | 0.71 | 0.58 | 0.18 | 0.38 | -- |
| BS07 | 0.75 | 0.77 | 0.76 | 0.61 | 0.92 | 0.77 | -- |
| BS08 | 0.75 | 0.80 | 0.78 | 0.75 | 0.78 | 0.77 | 1.1 |
| BS09B | 0.64 | 0.72 | 0.68 | 0.72 | 0.68 | 0.70 | 1.1 |
| BS09 | 1.8 | 1.7 | 1.8 | 1.3 | 2.8 | 2.1 | 2.8 |
| BS10 | -- | 6.8 | -- | 2.2 | 2.2 | 2.2 | 8.3 |
| BS11 | -- | 6.3 | -- | 2.0 | 2.5 | 2.3 | 6.1 |
| BS12 | 12 | 4.0 | 8.0 | 1.9 | 2.9 | 2.4 | 6.5 |
| BS13A | 5.3 | 4.5 | 4.9 | 1.5 | 1.8 | 1.7 | 5.8 |
| BS13 | 8.9 | 5.4 | 7.2 | 1.2 | 2.0 | 1.6 | 4.9 |
| BS14 | 2.6 | 3.5 | 3.1 | 0.89 | 1.4 | 1.1 | 3.6 |
| BS15 | 2.1 | 2.4 | 2.3 | 0.90 | 1.4 | 1.2 | 4.0 |
| BS16 | 1.5 | 2.0 | 1.8 | 1.1 | 1.3 | 1.2 | 2.7 |
| BS17A | 1.2 | 0.48 | 0.84 | 0.86 | 0.11 | 0.49 | 2.7 |
| BS17 | 1.0 | 1.0 | 1.0 | 0.72 | 1.1 | 0.91 | 1.8 |
| BS18 | 0.87 | 0.90 | 0.89 | 0.80 | 0.98 | 0.89 | 1.3 |
| BS19 | 0.66 | 0.67 | 0.67 | 0.70 | 1.0 | 0.85 | -- |
| BS20 | 0.72 | 0.59 | 0.66 | 0.65 | 0.98 | 0.82 | -- |
| | | | | Tributaries | | | |
| MB01 | 3.7 | 2.9 | 3.3 | 2.7 | 2.7 | 2.7 | 5.8 |
| QR05 | 0.83 | 0.63 | 0.73 | 0.52 | 0.68 | 0.60 | 0.94 |
| MF07 | 0.83 | 0.16 | 0.50 | 0.69 | 0.86 | 0.78 | 0.63 |
| WR05 | 0.63 | 0.19 | 0.41 | 0.66 | 1.6 | 1.1 | 0.80 |
| ML06 | 0.61 | 0.42 | 0.52 | 0.88 | 0.84 | 0.86 | -- |

TABLE A-9

BLACKSTONE RIVER 1980 SURVEY

AMMONIA-N (mg/l)

| STATION | 6/9 | 6/10 | AVG. | 8/4 | 8/5 | AVG. | 10/15-16 |
|---|---|---|---|---|---|---|---|
| BS01 | 0.08 | 0.07 | 0.08 | 0.08 | 0.06 | 0.07 | -- |
| BS02 | 0.06 | 0.08 | 0.07 | 0.05 | 0.12 | 0.09 | -- |
| BS03 | 0.34 | 0.31 | 0.33 | 0.08 | 0.16 | 0.12 | -- |
| BS04 | 0.09 | 0.07 | 0.08 | 0.08 | 0.08 | 0.08 | -- |
| BS05 | 0.26 | 0.27 | 0.27 | 0.06 | 0.03 | 0.05 | -- |
| BS06 | 0.19 | 0.16 | 0.18 | 0.01 | 0.06 | 0.04 | -- |
| BS07 | 0.27 | 0.22 | 0.25 | 0.03 | 0.06 | 0.05 | -- |
| BS08 | 0.25 | 0.22 | 0.24 | 0.05 | 0.06 | 0.06 | 0.27 |
| BS09B | 0.22 | 0.26 | 0.24 | 0.13 | 0.14 | 0.14 | 0.37 |
| BS09 | 1.4 | 0.37 | 0.89 | 0.05 | 0.07 | 0.06 | 0.76 |
| BS10 | -- | 4.3 | -- | 1.1 | 1.05 | 1.1 | 8.0 |
| BS11 | -- | 4.2 | -- | 1.0 | 0.99 | 1.0 | 6.1 |
| BS12 | 5.7 | 4.0 | 4.9 | 1.0 | 1.03 | 1.0 | 5.9 |
| BS13A | 5.2 | 3.8 | 4.5 | 0.69 | 0.76 | 0.73 | 5.3 |
| BS13 | 3.7 | 4.7 | 4.2 | 0.40 | 0.53 | 0.47 | 4.2 |
| BS14 | 2.4 | 3.1 | 2.8 | 0.21 | 0.07 | 0.14 | 3.2 |
| BS15 | 1.6 | 2.4 | 2.0 | 0.15 | 0.22 | 0.19 | 2.7 |
| BS16 | 1.3 | 1.9 | 1.6 | 0.19 | 0.15 | 0.17 | 1.2 |
| BS17A | 1.1 | 0.40 | 0.75 | 0.10 | 0.02 | 0.06 | 1.3 |
| BS17 | 0.53 | 0.71 | 0.62 | 0.05 | 0.06 | 0.06 | 0.68 |
| BS18 | 0.33 | 0.44 | 0.39 | 0.04 | 0.08 | 0.06 | 0.36 |
| BS19 | 0.26 | 0.27 | 0.27 | 0.06 | 0.07 | 0.07 | -- |
| BS20 | 0.24 | 0.27 | 0.26 | 0.04 | 0.10 | 0.07 | -- |
| | | | | Tributaries | | | |
| MB01 | 0.87 | 0.58 | 0.73 | 0.01 | 0.02 | 0.02 | 1.6 |
| QR05 | 0.18 | 0.24 | 0.21 | 0.02 | 0.23 | 0.13 | 0.08 |
| MF07 | 0.12 | 0.15 | 0.14 | 0.04 | 0.06 | 0.05 | 0.10 |
| WR05 | 0.11 | 0.12 | 0.12 | 0.04 | 0.06 | 0.05 | 0.06 |
| ML06 | 0.03 | 0.07 | 0.05 | 0.04 | 0.08 | 0.06 | -- |

TABLE A-10

BLACKSTONE RIVER 1980 SURVEY

NITRATE-N (mg/l)

| STATION | 6/9 | 6/10 | AVG. | 8/4 | 8/5 | AVG. | 10/15-16 |
|---|---|---|---|---|---|---|---|
| BS01 | 0.0 | 0.0 | 0.0 | 0.9 | 0.0 | 0.5 | -- |
| BS02 | 0.2 | 0.1 | 0.2 | 0.1 | 0.2 | 0.2 | -- |
| BS03 | 0.3 | 0.3 | 0.3 | 0.2 | 0.4 | 0.3 | -- |
| BS04 | 0.5 | 0.5 | 0.5 | 0.4 | 0.3 | 0.4 | -- |
| BS05 | 0.2 | 0.2 | 0.2 | 0.4 | 0.0 | 0.2 | -- |
| BS06 | 0.4 | 0.4 | 0.4 | 0.1 | 0.2 | 0.2 | -- |
| BS07 | 0.3 | 0.3 | 0.3 | 0.2 | 0.1 | 0.2 | -- |
| BS08 | 0.3 | 0.3 | 0.3 | 0.2 | 0.2 | 0.2 | 0.0 |
| BS09B | 0.3 | 0.3 | 0.3 | 0.2 | 0.2 | 0.2 | 0.3 |
| BS09 | 0.4 | 0.5 | 0.5 | 0.3 | 0.4 | 0.4 | 0.1 |
| BS10 | -- | 0.4 | -- | 4.1 | 4.3 | 4.2 | 0.6 |
| BS11 | -- | 0.5 | -- | 3.9 | 3.7 | 3.8 | 0.7 |
| BS12 | 0.7 | 0.7 | 0.7 | 3.5 | 4.0 | 3.8 | 0.9 |
| BS13A | 0.8 | 0.9 | 0.9 | 3.4 | 4.0 | 3.7 | 1.3 |
| BS13 | 0.8 | 0.9 | 0.9 | 2.8 | 3.0 | 2.9 | 1.1 |
| BS14 | 1.1 | 1.2 | 1.2 | 2.8 | 4.0 | 3.4 | 1.6 |
| BS15 | 1.2 | 1.3 | 1.3 | 2.4 | 3.0 | 2.7 | 1.9 |
| BS16 | 1.5 | 1.6 | 1.6 | 2.3 | 3.0 | 2.7 | 3.1 |
| BS17A | 1.7 | 1.8 | 1.8 | 2.5 | 1.9 | 2.2 | 3.1 |
| BS17 | 1.3 | 1.4 | 1.4 | 1.4 | 1.0 | 1.2 | 2.4 |
| BS18 | 1.2 | 1.5 | 1.4 | 1.5 | 0.9 | 1.2 | 1.8 |
| BS19 | 0.9 | 1.0 | 1.0 | 1.1 | 0.7 | 0.9 | -- |
| BS20 | 0.9 | 1.0 | 1.0 | 1.1 | 0.8 | 1.0 | -- |
| | | | Tributaries | | | | |
| MB01 | 0.2 | 0.6 | 0.4 | 0.5 | 0.7 | 0.6 | 0.0 |
| QR05 | 0.6 | 0.6 | 0.6 | 2.0 | 0.2 | 1.1 | 0.7 |
| MF07 | 0.2 | 0.2 | 0.2 | 0.3 | 1.0 | 0.7 | 0.2 |
| WR05 | 0.2 | 0.2 | 0.2 | 0.2 | 0.1 | 0.2 | 0.0 |
| ML06 | 0.2 | 0.3 | 0.3 | 0.2 | 0.1 | 0.2 | -- |

TABLE A-11

BLACKSTONE RIVER 1980 SURVEY

TOTAL PHOSPHORUS (mg/l)

| STATION | 6/9 | 6/10 | AVG. | 8/4 | 8/5 | AVG. | 10/15-16 |
|---|---|---|---|---|---|---|---|
| BS01 | 0.12 | 0.14 | 0.13 | 0.22 | 0.04 | 0.13 | -- |
| BS02 | 0.95 | 1.1 | 1.0 | 1.2 | 1.4 | 1.3 | -- |
| BS03 | 0.80 | 0.64 | 0.72 | 1.0 | 0.86 | 0.93 | -- |
| BS04 | 0.22 | 0.22 | 0.22 | 0.32 | 0.20 | 0.26 | -- |
| BS05 | 0.15 | 0.11 | 0.13 | 0.09 | 0.02 | 0.06 | -- |
| BS06 | 0.12 | 0.08 | 0.10 | 0.07 | 0.02 | 0.05 | -- |
| BS07 | 0.11 | 0.07 | 0.09 | 0.08 | 0.10 | 0.09 | -- |
| BS08 | 0.10 | 0.11 | 0.11 | 0.11 | 0.12 | 0.12 | 0.12 |
| BS09B | 0.09 | 0.08 | 0.09 | 0.13 | 0.14 | 0.14 | 0.17 |
| BS09 | 0.32 | 0.25 | 0.29 | 0.24 | 0.55 | 0.40 | 0.65 |
| BS10 | -- | 0.85 | -- | 1.2 | 0.60 | 0.90 | 1.4 |
| BS11 | -- | 0.65 | -- | 1.0 | 0.58 | 0.79 | 1.0 |
| BS12 | 2.8 | 0.67 | 1.74 | 1.1 | 0.64 | 0.87 | 1.1 |
| BS13A | 0.85 | 0.60 | 0.73 | 1.1 | 0.54 | 0.82 | 1.0 |
| BS13 | 0.52 | 0.57 | 0.55 | 0.79 | 0.62 | 0.71 | 0.98 |
| BS14 | 0.44 | 0.59 | 0.52 | 0.77 | 0.74 | 0.76 | 0.92 |
| BS15 | 0.46 | 0.58 | 0.52 | 0.76 | 0.76 | 0.76 | 0.86 |
| BS16 | 0.32 | 0.52 | 0.42 | 0.74 | 0.74 | 0.74 | 0.70 |
| BS17A | 0.31 | 1.7 | 1.01 | 0.66 | 0.72 | 0.69 | 0.74 |
| BS17 | 0.27 | 0.27 | 0.27 | 0.39 | 0.34 | 0.37 | 0.45 |
| BS18 | 0.21 | 0.24 | 0.23 | 0.38 | 0.30 | 0.34 | 0.37 |
| BS19 | 0.14 | 0.16 | 0.15 | 0.30 | 0.28 | 0.29 | -- |
| BS20 | 0.13 | 0.12 | 0.13 | 0.24 | 0.26 | 0.25 | -- |
| | | | **Tributaries** | | | | |
| MB01 | 0.60 | 0.50 | 0.55 | 0.58 | 0.65 | 0.62 | 1.5 |
| QR05 | 0.08 | 0.08 | 0.08 | 0.17 | 0.08 | 0.13 | 0.06 |
| MF07 | 0.07 | 0.58 | 0.33 | 0.12 | 0.10 | 0.11 | 0.07 |
| WR05 | 0.07 | 0.02 | 0.05 | 0.13 | 0.10 | 0.12 | 0.06 |
| ML06 | 0.07 | 0.07 | 0.07 | 0.08 | 0.12 | 0.10 | -- |

TABLE A-12

BLACKSTONE RIVER 1980 SURVEY

ORTHO-PHOSPHORUS (mg/1)

| STATION | 6/9 | 6/10 | AVG. | 8/4 | 8/5 | AVG | 10/15-16 |
|---|---|---|---|---|---|---|---|
| BS01 | 0.02 | 0.02 | 0.02 | 0.03 | 0.04 | 0.04 | -- |
| BS02 | 0.87 | 1.0 | 0.94 | 1.2 | 0.30 | 0.75 | -- |
| BS03 | 0.63 | 0.60 | 0.62 | 0.78 | 0.77 | 0.78 | -- |
| BS04 | 0.21 | 0.21 | 0.21 | 0.21 | 0.19 | 0.20 | -- |
| BS05 | 0.09 | 0.08 | 0.09 | 0.04 | 0.02 | 0.03 | -- |
| BS06 | 0.05 | 0.04 | 0.05 | 0.04 | 0.02 | 0.03 | -- |
| BS07 | 0.05 | 0.04 | 0.05 | 0.05 | 0.05 | 0.05 | -- |
| BS08 | 0.05 | 0.04 | 0.05 | 0.05 | 0.11 | 0.08 | 0.04 |
| BS09B | 0.06 | 0.04 | 0.05 | 0.06 | 0.11 | 0.09 | 0.08 |
| BS09 | 0.25 | 0.10 | 0.17 | 0.09 | 0.08 | 0.09 | 0.23 |
| BS10 | -- | 0.52 | -- | 0.93 | 0.56 | 0.75 | 1.2 |
| BS11 | -- | 0.50 | -- | 0.86 | 0.42 | 0.64 | 0.97 |
| BS12 | 0.63 | 0.60 | 0.62 | 0.88 | 0.51 | 0.70 | 0.97 |
| BS13A | 0.77 | 0.55 | 0.66 | 0.83 | 0.51 | 0.67 | 0.97 |
| BS13 | 0.50 | 0.46 | 0.48 | 0.63 | 0.48 | 0.56 | 0.81 |
| BS14 | 0.41 | 0.48 | 0.45 | 0.58 | 0.61 | 0.60 | 0.79 |
| BS15 | 0.38 | 0.47 | 0.43 | 0.59 | 0.58 | 0.59 | 0.76 |
| BS16 | 0.32 | 0.42 | 0.37 | 0.57 | 0.52 | 0.55 | 0.59 |
| BS17A | 0.31 | 0.40 | 0.36 | 0.51 | 0.48 | 0.50 | 0.60 |
| BS17 | 0.21 | 0.25 | 0.23 | 0.26 | 0.25 | 0.26 | 0.39 |
| BS18 | 0.19 | 0.20 | 0.20 | 0.24 | 0.28 | 0.26 | 0.33 |
| BS19 | 0.13 | 0.12 | 0.13 | 0.17 | 0.22 | 0.20 | -- |
| BS20 | 0.12 | 0.12 | 0.12 | 0.15 | 0.22 | 0.19 | -- |
| | | | Tributaries | | | | |
| MB01 | 0.36 | 0.20 | 0.28 | 0.19 | 0.52 | 0.36 | 0.55 |
| QR05 | 0.02 | 0.02 | 0.02 | 0.03 | 0.08 | 0.06 | 0.05 |
| MF07 | 0.03 | 0.02 | 0.03 | 0.04 | 0.08 | 0.06 | 0.06 |
| WR05 | 0.03 | 0.02 | 0.03 | 0.06 | 0.10 | 0.08 | 0.05 |
| ML06 | 0.05 | 0.03 | 0.04 | 0.03 | 0.09 | 0.06 | -- |

TABLE A-13

BLACKSTONE RIVER 1980 SURVEY

SUSPENDED SOLIDS (mg/1)

| STATION | 6/9 | 6/10 | AVG. | 8/4 | 8/5 | AVG. | 10/15-16 |
|---|---|---|---|---|---|---|---|
| BS01 | 2.0 | 5.0 | 3.5 | 6.5 | 4.5 | 5.5 | -- |
| BS02 | 3.0 | 9.0 | 6.0 | 2.5 | 8.5 | 5.5 | -- |
| BS03 | 11 | 16 | 14 | 18 | 15 | 17 | -- |
| BS04 | 5.0 | 5.0 | 5.0 | 4.0 | 7.0 | 5.5 | -- |
| BS05 | 3.0 | 4.0 | 3.5 | 4.0 | 7.5 | 5.8 | -- |
| BS06 | 1.5 | 12 | 6.8 | 3.0 | 2.5 | 2.8 | -- |
| BS07 | 3.0 | 2.0 | 2.5 | 5.0 | 4.5 | 4.8 | -- |
| BS08 | 5.0 | 4.0 | 4.5 | 6.5 | 7.5 | 7.0 | 6.0 |
| BS09B | 6.0 | 3.0 | 4.5 | 7.5 | 6.0 | 6.8 | 4.5 |
| BS09 | 11 | 10 | 11 | 13 | 8.5 | 11 | 19 |
| BS10 | -- | 5.0 | -- | 7.0 | 7.0 | 7.0 | 6.5 |
| BS11 | -- | 5.0 | -- | 7.0 | 6.0 | 6.5 | 5.0 |
| BS12 | 8.0 | 7.0 | 7.5 | 5.5 | 6.0 | 5.8 | 7.0 |
| BS13A | 7.0 | 6.0 | 6.5 | 6.0 | 5.5 | 5.8 | 6.0 |
| BS13 | 4.0 | 4.0 | 4.0 | 7.5 | 5.5 | 6.5 | 4.0 |
| BS14 | 6.5 | 5.0 | 5.8 | 8.0 | 7.0 | 7.5 | 5.0 |
| BS15 | 7.5 | 6.0 | 6.8 | 11 | 6.5 | 9.8 | 5.0 |
| BS16 | 9.0 | 7.0 | 8.0 | 18 | 15 | 17 | 7.0 |
| BS17A | 9.0 | 8.0 | 8.5 | 15 | 12 | 14 | 6.0 |
| BS17 | 8.0 | 5.0 | 6.5 | 15 | 9.0 | 12 | 5.5 |
| BS18 | 13 | 11 | 12 | 13 | 13 | 13 | 4.5 |
| BS19 | 7.5 | 3.0 | 5.3 | 8.5 | 11 | 9.8 | -- |
| BS20 | 9.0 | 3.0 | 6.0 | 6.0 | 8.5 | 7.3 | -- |
| | | | | Tributaries | | | |
| MB01 | 27 | 29 | 28 | 28 | 42 | 35 | 49 |
| QR05 | 4.0 | 0.0 | 2.0 | 2.0 | 1.0 | 1.5 | 1.5 |
| MF07 | 5.0 | 1.5 | 3.3 | 11 | 5.5 | 8.3 | 4.0 |
| WR05 | 1.0 | 1.0 | 1.0 | 4.0 | 4.0 | 4.0 | 3.0 |
| ML06 | 8.0 | 7.0 | 7.5 | 3.5 | 5.5 | 4.5 | -- |

TABLE A-14

BLACKSTONE RIVER 1980 SURVEY

TOTAL SOLIDS (mg/l)

| STATION | 6/9 | 6/10 | AVG. | 8/4 | 8/5 | AVG. | 10/15-16 |
|---|---|---|---|---|---|---|---|
| BS01 | 54 | 106 | 80 | 16 | 8.0 | 12 | -- |
| BS02 | 214 | 426 | 320 | 320 | 608 | 464 | -- |
| BS03 | 264 | 276 | 270 | 360 | 320 | 340 | -- |
| BS04 | 202 | 214 | 208 | 218 | 248 | 233 | -- |
| BS05 | 136 | 152 | 144 | 68 | 92 | 80 | -- |
| BS06 | 156 | 160 | 158 | 46 | 64 | 55 | -- |
| BS07 | 142 | 166 | 154 | 40 | 128 | 84 | -- |
| BS08 | 144 | 186 | 165 | 100 | 130 | 115 | 158 |
| BS09B | 154 | 164 | 159 | 106 | 140 | 123 | 244 |
| BS09 | 224 | 236 | 230 | 174 | 228 | 201 | 564 |
| BS10 | -- | 276 | -- | 202 | 242 | 220 | 340 |
| BS11 | -- | 262 | -- | 210 | 254 | 232 | 260 |
| BS12 | 220 | 248 | 233 | 198 | 242 | 220 | 262 |
| BS13A | 206 | 296 | 251 | 186 | 242 | 214 | 264 |
| BS13 | 170 | 226 | 198 | 174 | 216 | 195 | 244 |
| BS14 | 174 | 218 | 196 | 182 | 192 | 187 | 234 |
| BS15 | 178 | 212 | 195 | 196 | 198 | 197 | 234 |
| BS16 | 172 | 200 | 186 | 204 | 172 | 188 | 214 |
| BS17A | 168 | 296 | 232 | 198 | 184 | 191 | 212 |
| BS17 | 128 | 192 | 160 | 146 | 110 | 128 | 174 |
| BS18 | 118 | 138 | 128 | 156 | 126 | 141 | 168 |
| BS19 | 88 | 96 | 92 | 118 | 82 | 100 | -- |
| BS20 | 84 | 98 | 91 | 108 | 90 | 99 | -- |
| | | | | *Tributaries* | | | |
| MB01 | 364 | 350 | 357 | 108 | 300 | 204 | 396 |
| QR05 | 142 | 162 | 152 | 132 | 126 | 129 | 188 |
| MF07 | 52 | 222 | 137 | 64 | 48 | 61 | 60 |
| WR05 | 74 | 172 | 123 | 80 | 66 | 73 | 156 |
| ML06 | 54 | 62 | 58 | 80 | 74 | 77 | -- |

TABLE A-15

BLACKSTONE RIVER 1980 SURVEY

CHLORIDE (mg/l)

| STATION | 6/9 | 6/10 | AVG | 8/4 | 8/5 | AVG. | 10/15-16 |
|---|---|---|---|---|---|---|---|
| BS01 | 9 | 8 | 9 | 11 | 6 | 9 | -- |
| BS02 | 65 | 192 | 129 | 165 | 330 | 248 | -- |
| BS03 | 66 | 107 | 87 | 165 | 170 | 168 | -- |
| BS04 | 65 | 82 | 74 | 110 | 125 | 118 | -- |
| BS05 | 39 | 39 | 39 | 50 | 30 | 40 | -- |
| BS06 | 47 | 42 | 45 | 49 | 43 | 46 | -- |
| BS07 | 42 | 44 | 43 | 40 | 42 | 41 | -- |
| BS08 | 39 | 41 | 40 | 36 | 38 | 37 | 43 |
| BS09B | 39 | 38 | 39 | 185 | 39 | 112 | 44 |
| BS09 | 66 | 66 | 66 | 60 | 81 | 71 | 80 |
| BS10 | -- | 74 | -- | 62 | 13 | 38 | 85 |
| BS11 | -- | 68 | -- | 60 | 68 | 64 | 68 |
| BS12 | 65 | 66 | 66 | 56 | 70 | 63 | 72 |
| BS13A | 57 | 62 | 60 | 53 | 69 | 61 | 67 |
| BS13 | 54 | 56 | 55 | 48 | 62 | 55 | 62 |
| BS14 | 48 | 51 | 50 | 49 | 56 | 53 | 60 |
| BS15 | 48 | 54 | 51 | 49 | 54 | 52 | 60 |
| BS16 | 49 | 50 | 50 | 49 | 46 | 48 | 56 |
| BS17A | 50 | 49 | 50 | 48 | 48 | 48 | 56 |
| BS17 | 38 | 36 | 37 | 34 | 27 | 31 | 47 |
| BS18 | 36 | 33 | 35 | 38 | 27 | 33 | 43 |
| BS19 | 24 | 26 | 25 | 27 | 21 | 24 | -- |
| BS20 | 25 | 24 | 25 | 26 | 22 | 24 | -- |
| | | | | **Tributaries** | | | |
| MB01 | 10 | 107 | 59 | 120 | 100 | 110 | 115 |
| QR05 | 41 | 42 | 42 | 43 | 43 | 43 | 51 |
| MF07 | 11 | 9 | 10 | 9 | 7 | 8 | 10 |
| WR05 | 18 | 20 | 19 | 15 | 17 | 16 | 61 |
| ML06 | 12 | 11 | 12 | 12 | 13 | 13 | -- |

TABLE A-16

BLACKSTONE RIVER 1980 SURVEY

pH (Std. Units)

| STATION | 6/9 | 6/10 | 8/4 | 8/5 | 10/15-16 |
|---|---|---|---|---|---|
| BS01 | 6.5 | 7.4 | 6.4 | -- | -- |
| BS02 | 7.4 | 7.4 | 6.9 | 7.2 | -- |
| BS03 | 7.3 | 7.5 | 8.0 | 7.1 | -- |
| BS04 | 7.5 | 7.2 | 6.9 | 7.0 | -- |
| BS05 | 7.4 | 7.5 | 7.5 | 7.4 | -- |
| BS06 | 7.5 | 7.4 | 7.0 | 6.8 | -- |
| BS07 | 7.7 | 7.9 | 6.9 | 7.1 | -- |
| BS08 | 7.6 | 7.9 | 7.0 | 6.9 | 6.6 |
| BS09B | 7.4 | 7.5 | 7.1 | 7.0 | 7.1 |
| BS09 | 7.5 | 7.2 | 6.6 | 6.7 | 7.0 |
| BS10 | -- | 7.6 | 7.2 | 6.8 | 7.3 |
| BS11 | -- | 7.9 | 6.9 | 7.2 | 7.6 |
| BS12 | 7.6 | 7.5 | 7.3 | 7.1 | 7.6 |
| BS13A | 7.7 | 7.9 | 7.1 | 7.1 | 7.4 |
| BS13 | 7.7 | 7.6 | 7.2 | 7.3 | 7.3 |
| BS14 | 7.5 | 7.8 | 6.8 | 7.0 | 7.3 |
| BS15 | 7.5 | 7.6 | 7.3 | 7.0 | 7.4 |
| BS16 | 7.5 | 7.5 | 6.7 | 7.2 | 7.3 |
| BS17A | 7.4 | 7.8 | 6.6 | 7.0 | 7.3 |
| BS17 | 7.5 | 7.5 | 6.6 | 6.8 | 7.0 |
| BS18 | 7.3 | 7.3 | 6.7 | 6.8 | 7.0 |
| BS19 | 7.2 | 7.3 | 6.6 | 6.7 | -- |
| BS20 | 7.4 | 7.2 | 7.0 | 6.8 | -- |
| Tributaries | | | | | |
| MB01 | 7.4 | 7.2 | 6.4 | 6.5 | 6.9 |
| QR06 | 7.2 | 7.4 | 7.0 | 7.3 | 7.3 |
| MF07 | 6.8 | 7.6 | 6.3 | 6.8 | 6.6 |
| WR05 | 6.7 | 7.1 | 6.2 | 6.2 | 6.9 |
| ML06 | 6.7 | 7.4 | 6.7 | 6.9 | -- |

TABLE A-17

BLACKSTONE RIVER 1980 SURVEY

TURBIDITY (NTU)

| STATION | 6/9 | 6/10 | AVG | 8/4 | 8/5 | AVG | 10/15-16 |
|---|---|---|---|---|---|---|---|
| BS01 | 1.7 | 1.9 | 1.8 | 5.4 | 2.0 | 3.7 | -- |
| BS02 | 1.9 | 1.4 | 1.7 | 1.4 | 1.1 | 1.3 | -- |
| BS03 | 7.2 | 9.0 | 8.1 | 16 | 14 | 15 | -- |
| BS04 | 4.9 | 4.7 | 4.8 | 5.9 | 6.0 | 6.0 | -- |
| BS05 | 7.4 | 8.0 | 7.7 | 4.6 | 4.1 | 4.4 | -- |
| BS06 | 4.3 | 4.9 | 4.6 | 3.2 | 3.2 | 3.2 | -- |
| BS07 | 5.1 | 5.7 | 5.4 | 3.7 | 3.2 | 3.5 | -- |
| BS08 | 4.4 | 5.0 | 4.7 | 4.3 | 5.3 | 4.8 | 1.4 |
| BS09B | 4.7 | 5.7 | 5.2 | 4.8 | 5.4 | 5.7 | 2.4 |
| BS09 | 8.9 | 10 | 9.5 | 6.5 | 7.7 | 7.1 | 3.8 |
| BS10 | -- | 8.3 | -- | 5.6 | 6.4 | 6.8 | 5.1 |
| BS11 | -- | 8.3 | -- | 4.9 | 5.3 | 5.1 | 3.3 |
| BS12 | 6.8 | 8.9 | 7.4 | 5.2 | 5.7 | 5.5 | 3.3 |
| BS13A | 5.0 | 7.9 | 6.5 | 3.9 | 4.8 | 4.4 | 2.9 |
| BS13 | 3.8 | 7.1 | 5.5 | 3.3 | 4.3 | 3.8 | 2.3 |
| BS14 | 4.0 | 6.8 | 4.9 | 3.4 | 3.4 | 3.4 | 1.9 |
| BS15 | 3.9 | 6.9 | 5.4 | 3.3 | 3.4 | 3.4 | 1.7 |
| BS16 | 5.4 | 7.4 | 6.4 | 5.5 | 5.8 | 5.7 | 1.7 |
| BS17A | 4.2 | 5.7 | 5.0 | 4.0 | 4.2 | 4.1 | 1.6 |
| BS17 | 3.0 | 4.0 | 3.5 | 3.1 | 2.7 | 2.9 | 1.3 |
| BS18 | 2.9 | 4.0 | 3.5 | 3.3 | 3.9 | 3.6 | 2.3 |
| BS19 | 2.6 | 3.4 | 3.0 | 2.6 | 2.5 | 2.6 | -- |
| BS20 | 2.7 | 3.4 | 3.1 | 2.4 | 2.6 | 2.5 | -- |
| | | | | Tributaries | | | |
| MB01 | 22 | 17 | 20 | 9.4 | 7.4 | 8.4 | 11 |
| QR05 | 1.4 | 1.8 | 1.6 | 1.2 | 1.2 | 1.2 | 0.5 |
| MF07 | 1.7 | 2.2 | 2.0 | 2.2 | 1.9 | 2.1 | 0.4 |
| WR05 | 1.2 | 1.3 | 1.3 | 1.5 | 1.3 | 1.4 | 0.4 |
| ML06 | 2.0 | 2.4 | 2.2 | 4.8 | 2.6 | 3.7 | -- |

TABLE A-18

BLACKSTONE RIVER 1980 SURVEY

OCTOBER 15-16, 1980

| STATION | TOTAL VOLATILE SOLIDS(mg/l) | SETTLEABLE SOLIDS (ml/l) | HARDNESS (mg/l) |
|---|---|---|---|
| BS08 | 48 | 0.0 | 44 |
| BS09B | 52 | 0.0 | 43 |
| BS09 | 68 | 0.1 | 47 |
| BS10 | 62 | 0.0 | 54 |
| BS11 | 62 | 0.0 | 45 |
| BS12 | 58 | 0.0 | 40 |
| BS13A | 62 | 0.0 | 37 |
| BS13 | 50 | 0.0 | 57 |
| BS14 | 54 | 0.0 | 42 |
| BS15 | 54 | 0.0 | 45 |
| BS16 | 56 | 0.0 | 20 |
| BS17A | 46 | 0.0 | 3.6 |
| BS17 | 50 | 0.0 | 31 |
| BS18 | 56 | 0.0 | 42 |
| | Tributaries | | |
| MB01 | 118 | 1.5 | 52 |
| QR05 | 40 | 0.0 | 47 |
| MF07 | 28 | 0.0 | 32 |
| WR05 | 42 | 0.0 | 31 |

TABLE A-19

BLACKSTONE RIVER 1980 SURVEY

COLIFORM DATA (COLIFORM/100 ml)

| STATION | 6/10/80 TOTAL | 6/10/80 FECAL | 6/11/80 TOTAL | 6/11/80 FECAL | GEOMETRIC MEAN TOTAL | GEOMETRIC MEAN FECAL | 8/4/80 TOTAL | 8/4/80 FECAL | 10/15-16 TOTAL | 10/15-16 FECAL |
|---|---|---|---|---|---|---|---|---|---|---|
| BS01 | 300 | 10 | 100 | 5 | 170 | 7 | 200 | 20 | -- | -- |
| BS02 | 24,000 | 24,000 | 10,000 | 3,000 | 15,000 | 8,500 | 90,000 | 10,000 | -- | -- |
| BS03 | 45,000 | 4,000 | 32,000 | 12,000 | 38,000 | 6,900 | 11,000 | 1,000 | -- | -- |
| BS04 | 5,700 | 1,600 | 6,500 | 1,000 | 6,100 | 1,300 | 60,000 | 18,000 | -- | -- |
| BS05 | 200 | <5 | 30 | 30 | 80 | -- | 1,200 | 100 | -- | -- |
| BS06 | 400 | 40 | 40 | 40 | 130 | 40 | 2,400 | 80 | -- | -- |
| BS07 | 300 | <5 | 60 | 30 | 130 | -- | 900 | 100 | -- | -- |
| BS08 | 18,000 | 1,000 | 16,000 | 1,200 | 17,000 | 1,100 | 100,000 | 14,000 | 150,000 | 16,000 |
| BS09B | 12,000 | 1,100 | 8,000 | 1,100 | 9,800 | 1,100 | 74,000 | 7,000 | 25,000 | 8,000 |
| BS09 | 170,000 | 10,000 | 30,000 | 1,600 | 71,000 | 4,000 | 900,000 | 200,000 | 300,000 | 21,000 |
| BS10 | 100 | <5 | 700 | <5 | 260 | 5 | 140 | 10 | 600 | 50 |
| BS11 | 6,800 | 400 | 2,200 | 900 | 3,900 | 600 | 98,000 | 4,000 | 2,400 | 220 |
| BS12 | 5,400 | 240 | 100 | <5 | 730 | -- | 14,000 | 1,100 | 3,000 | 60 |
| BS13A | 18,000 | 280 | 18,000 | 240 | 18,000 | 260 | 18,000 | 1,400 | 5,800 | 240 |
| BS13 | 14,000 | 400 | 16,000 | 800 | 15,000 | 570 | 5,000 | 700 | 10,000 | 800 |
| BS14 | 18,000 | 1,200 | 19,000 | 140 | 19,000 | 410 | 5,000 | 200 | 6,200 | 380 |
| BS15 | 20,000 | 1,400 | 10,000 | 120 | 14,000 | 410 | 13,000 | 700 | 4,000 | 180 |
| BS16 | 2,000 | 110 | 5,800 | 320 | 3,400 | 190 | 42,000 | 6,000 | 4,500 | 100 |