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Development of a One-Dimensional Water Quality Model for the Blackstone River; Part 2: Mathematical Modeling 160 pp

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Narragansett Bay Estuary Program

7 Blackstone River

River, not saline

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FINAL REPORT

DEVELOPMENT OF A ONE DIMENSIONAL WATER QUALITY MODEL FOR THE BLACKSTONE RIVER

PART 2: MATHEMATICAL MODELING

BY

RAYMOND M. WRIGHT

CIVIL AND ENVIRONMENTAL ENGINEERING
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SUMMARY

The one dimensional, steady state water quality model, PAWTOXIC, was calibrated to the Blackstone River in Rhode Island for conservative minerals, suspended solids and selected trace metals (cadmium, chromium, copper, lead, nickel). The model was originally developed for the Pawtuxet River with subsequent application in the Pawcatuck River Basin both in Rhode Island.

Intensive field monitoring was performed to characterize the hydraulic and water quality of the system. Specifically, three intensive water quality surveys were conducted in July, August and October 1985. Samples were taken at 9 water quality stations four times in 24 hours and at one municipal sewage treatment plant and 3 industrial dischargers. Dye time of travel studies were performed to define the relationship between flow and average stream velocity.

Flow profiles were based on U.S. Geological Survey gage stations. These profiles were confirmed through successful simulation of a conservative constituent.

The model is capable of simulating the fate of suspended solids and particle reactive contaminants. Sediment transport is defined by an empirical relationship developed by river reach from suspended solids profiles and a knowledge of average stream

velocity. These empirical relationships provide the modeler with an option to adjust sediment transport for other flow periods, such as the critical flow period assigned for the waste load allocation. The model successfully simulated the observed solids profiles.

The model has an option to input an empirical relationship which relates a metal partition coefficient inversely to suspended solids. This provides the modeler with an option to adjust the partition coefficient for different forcing functions that would result in different suspended solids profiles. This option was originally developed during the earlier Pawtuxet River study and was used successfully in the simulation of selected inorganic and organic contaminants. However, statistically significant relationships could not be developed for the Blackstone River study since metal and solids concentrations did not have sufficient spatial variation. The model option for input of partition coefficient by reach was selected and values of the coefficient were averages reported in this study.

The model is calibrated for the selected metals. This statement is not an assertion that the model describes metal-particle interactions as they truly occur. It is, however, a judgement based on sound engineering analysis and scientific evidence which suggests that the model's description of the state of the system agrees well with the description obtained by field sampling and analysis.

The model is recommended for use as a regulatory tool in the conduction of a waste load allocation for the Blackstone River.

It should be noted that the water quality of the Blackstone River as it leaves Massachusetts is clearly the controlling factor governing the water quality of the river in Rhode Island. This will complicate the development of the waste load allocation scenario, since the water quality at the state line is highly variable.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

Appendix B Trace Metal Data

Appendix C Total Dissolved Solids

Appendix D Selected Environmental Parameters

I. INTRODUCTION

The potential hazards associated with anthropogenic contributions of heavy metals to the aquatic environment are well documented (Forstner and Wittmann, 1979; Moore and Ramamoorthy, 1984; Salomons and Forstner, 1984). Ambient water quality criteria have been established in an effort to eliminate these potential problems (USEPA, 1980). Ambient water quality conditions are best represented by the use of a mathematical model, which can predict the ambient concentrations expected to result from existing or future pollutant loadings. Analysis of the predicted concentrations with respect to the established criteria and biosphere response leads to the determination of appropriate levels of treatment for the sources of the contaminants. This method determining allowable pollutant contributions is known as the waste load allocation (WLA) process (Delos, et al., 1984).

The Blackstone River is subject to point source loadings of trace metals and organics from municipal and industrial discharges. The Rhode Island Department of Environmental Management (DEM) has recognized the need for developing a model to be used as a tool in the development of WLA for toxics. A study was undertaken from 1985 to 1986 to conduct the necessary field and laboratory investigations to calibrate and validate the steady-state model PAWTOXIC which simulates the ambient concentrations of selected contaminants.

PAWTOXIC has been used successfully in other streams under the jurisdiction of the DEM (Wright and McCarthy, 1985, Quinn, et al., 1985).

II. LITERATURE REVIEW

The impact of toxics on an aquatic system depends on the chemical and physical characteristics of the system. Callahan et al. (1979), in an extensive literature review, investigated the water-related fate of 129 priority pollutants. Of the processes investigated, sorption phenomena were deemed to have the greatest impact on transport of metals. Woodward et al. (1981), after reviewing factors, which may affect trace metal speciation and transport, postulated that sorption was the key process and that if sediment transport could be modeled, then trace metal movement could be modeled because of their association with the solids. Horowitz (1985) stressed the necessity of considering the role of sediments in investigations of metals in aquatic environments. It is evident that to describe trace metal transport in a river, sediment movement must also be considered and is probably the dominant process, save advection, affecting metal movement. A similar argument can be made for particle reactive organic compounds.

Delos et al. (1984) discussed sediment transport concerns as they relate to toxicant transport. They pointed out that much of the existing knowledge pertains to the larger particles which control the configuration of the stream bed rather than to the smaller particles which are more likely to be involved in adsorption phenomena. They discussed recent works on fine particles which consider deposition and entrainment processes to occur simultaneously. Several proposed water quality models were discussed that use this approach, which involves the estimation of settling and resuspension velocities, parameters which are difficult to measure and must be assumed to apply over large areas.

It is important to consider the purpose of a model and its intended application when it is being developed. In this study, a model was needed which would predict water column exposure concentrations. Therefore, it is not necessary to consider bed load transport or models which define the changing shape of a streambed. An empirical approach can be used which defines a net sediment settling or resuspension rate based on observed water column suspended solids concentrations. By making repeated measurements of these rates, they can be related to average stream velocity. This approach is straightforward and easy to understand. Also, the effort required for data collection and analysis is relatively small.

The extent to which contaminants are sorbed is a primary concern in an attempt to describe their transport. Delos et al. (1984) pointed out that many studies have been performed which relate partitioning to various environmental factors (pH, size and amount of adsorbent, complexing ligands, etc.). However, most of these studies have taken place in laboratory conditions where such factors are under tight control, unlike the natural system. They suggested the empirical derivation of relationships between partition coefficients and environmental conditions from extensive field data. After analysis of a large data base they concluded that the only clear and consistent relationship observed between partition coefficients and environmental variables was with suspended solids. This inverse relationship between the partition coefficient and suspended solids has been observed in other studies on metals and organics (O'Connor and Connolly, 1982; DiToro et al., 1982; DiToro et al., 1986).

An important component of the modeling process is an assessment of model performance via error and sensitivity analyses (McCuen, 1978; Orlob, 1983; Thomann, 1982; Reckhow and Chapra, 1983; Harris, 1984; Beck and van Straten, 1983; Dickson, et al., 1982). Simulation models must undergo confirmatory analyses if inferences drawn from their application are to be meaningful. Use of the term "verification" to describe this step of the process may be misleading, since a state of truth is unattainable (Reckhow and Chapra, 1983). Water quality model performance has traditionally been evaluated qualitatively (Thomann, 1982). There is a trend toward taking a more quantitative approach in model evaluation (Beck and van Straten, 1983). The result of successful testing is at best confirmation or corroboration, which is not truth but rather measured consistency with empirical evidence (Reckhow and Chapra, 1983). Several statistical tests have been suggested for use in model confirmation (Thomann, 1982; Reckhow and Chapra, 1983; Legget and Williams, 1981).

III. MATHEMATICAL MODELING APPROACH

A. Mathematical Formulations

The basic advection-dispersion mass transport equation includes the effects of advection, dispersion, dilution, constituent reaction and interaction related to adsorption and desorption and settling and resuspension of solids. If a steady-state condition is considered for a river where dispersion is small in comparison with advection, the fate of suspended solids is often described by:

$$0 = -\frac{u\,dm_1}{dx} - Ks \cdot m_1 + Ku \cdot m_2 \qquad (1)$$

where u is average stream velocity; m_1 is the concentration of suspended solids in the water column; x is the distance traveled downstream; Ks is a settling coefficient equal to Vs/H where Vs is the settling velocity and H is the average depth of the stream; Ku is a resuspension coefficient equal to Vu/H where Vu is the resuspension velocity; and m_2 is the concentration of solids in the bed. This equation defines a Type II analysis of a mixed interactive bed (O'Connor and Mueller, 1983). Solids are removed from the water column by settling and introduced by resuspension.

The calibration of equation 1 often requires the trial and error estimation of Vs and Vu until a match of observed solids concentration is made. A direct measurement of Vu is not possible. Also, laboratory analysis for m_2 is at best a gross estimation which must be applied as an average value for the entire stream bed in a given modeling reach.

To avoid the problems associated with the estimation of Vs and Vu, equation 1 is rewritten as:

$$0 = -\frac{u\,dm_1}{dx} \pm Kns \cdot m_1 \qquad (2)$$

where Kns is a net sediment transport coefficient. A positive value of Kns indicates a net increase of solids in the water column due to the dominance of resuspension over settling while a negative value of Kns indicates a net decrease in solids due to the dominance of settling over resuspension. The solution to equation 2 is:

$$m_1 = m_o \cdot e^{(\pm Kns \cdot x/u)} \tag{3}$$

where m_o is an initial suspended solids concentration.

With knowledge of river velocity and suspended solids concentrations, a plot of log solids versus river time of travel (x/u) yields a slope equal to Kns. From a number of observations at various stream flows a relationship describing Kns as a function of average stream velocity (u) can be developed. This relationship is of the form:

$$Kns = a + b \cdot u \tag{4}$$

where a and b are empirical constants. This relationship can then be used to forecast Kns with confidence within the range of observed velocities.

The basic equation for any toxic constituent must include the major kinetic components affecting its concentration. It was assumed that the adsorption/desorption process was the most significant factor describing the fate of toxic contaminants in the Blackstone River. The steady-state equations, therefore, are written to describe the transport of the dissolved (c) and particulate (p) components of any toxic as:

$$0 = -\frac{udc}{dx} - K1 \cdot c + K2 \cdot p \qquad (5)$$

$$0 = -\frac{udp}{dx} + K1 \cdot c - K2 \cdot p \pm Kns \cdot p \qquad (6)$$

where K1 and K2 are the adsorption and desorption coefficient, respectively, describing the interaction between the dissolved and particulate fractions of the contaminant. Equation 6 includes the source and sink term associated with the settling and resuspension of solids.

For the total concentration of the contaminant (Ct) the two fractions are added together:

$$Ct = c + p \qquad (7)$$

For the assumption that local equilibrium and complete reversibility occur, combining equations 5 and 6 yields:

$$0 = -\frac{udCt}{dx} \pm Kns \cdot p \qquad (8)$$

The particulate component is equal to the product of the solid phase concentration of the contaminant (r) and the solids concentration:

$$p = r \cdot ml \tag{9}$$

At equilibrium, the ratio of the mass of substance adsorbed per unit mass of adsorbent solids (r) and the dissolved concentration of the substance (c) may be related through a partition coefficient (Kp) for the linear range of the Langmuir isotherm:

$$r = Kp \cdot c \tag{10}$$

The application of equation 10 is appropriate when the adsorption capacity of the solids is much greater than the particulate contaminant concentration. Substitution of equations 9 and 10 into equation 7 yields the total concentration (Ct) in terms of the dissolved concentration (c):

$$Ct = c + Kp \cdot m_1 \cdot c \tag{11}$$

The dissolved fraction (fc) is given by:

$$fc = C/Ct = 1/(1 + Kp \cdot m_1) \tag{12}$$

and the particulate fraction (fp) is given by:

$$fp = p/Ct = (Kp \cdot m_1)/(1 + Kp \cdot m_1) \quad (13)$$

Equation 8 may now be written in terms of Ct:

$$0 = -\frac{udCt}{dx} \pm Kns \cdot fp \cdot Ct \quad (14)$$

B. Model Description

PAWTOXIC is a water quality model applicable to well-mixed river systems. It allows for multiple waste discharges, withdrawals, tributary flows, and incremental inflow. The transport mechanisms are advection and dispersion along the main direction of flow. It should be noted that for Blackstone River application an assumption was made that dispersion was minor and only advection was simulated. This is a reasonable assumption taken routinely when modeling a one-dimensional, shallow stream system.

PAWTOXIC operates as a steady-state model, therefore stream flows in the river basin should essentially be constant and input waste loads must be held constant with time.

PAWTOXIC is designed to simulate a maximum of three conservative parameters, total suspended solids and five non-conservative toxic constituents per simulation. The only kinetic transformation is adsorption/desorption with mixed-interactive bed. Solids, therefore, may settle or resuspend with subsequent transport downstream.

The computational framework of PAWTOXIC was developed by modifying the stream quality model QUAL-II (Roesner et al., 1981). The general form of the input and output remains the same as that of QUAL-II. The method in which the physical system is represented remains intact. The subroutines of QUAL-II which perform oxygen and nutrient balances were deleted. Subroutine RADNI of QUAL-II was modified to perform a materials balance on suspended solids and renamed SOLIDS. A new subroutine, TOXICS, was added to perform a toxic materials balance.

PAWTOXIC permits any branching, one-dimensional stream system to be simulated. The first step involved in approximating the prototype is to subdivide the stream system into reaches, stretches of stream having uniform hydraulic characteristics. Each reach is then divided into computational elements of equal length such that all computational elements in all reaches are the same length. Thus, all reaches must consist of an integer number of computational elements.

After QUAL-II, there are seven different types of computational elements. These are: (1) headwater element; (2)

standard element; (3) element just upstream from a junction; (4) junction element; (5) last element in system; (6) input element; (7) withdrawal element.

Headwater elements begin every tributary as well as the main river and must always be the first element in a reach. A standard element is one that does not qualify as one of the remaining six element types. Since incremental inflow is permitted in all element types, the only input permitted in a standard element is incremental inflow. A type 3 element is used to designate an element on the mainstem that is just upstream from a junction type element which is an element that has a tributary stream entering it. Element type 5 identifies the last computational element in the river system. There should be only one type 5 element. Element types 6 and 7 represent elements which have inputs (waste loads and unsimulated tributaries) and water withdrawals, respectively.

River reaches, which are aggregates of computational elements, are the basis of most data input. Hydraulic data, reaction rate coefficients and incremental inflow data are constant for all computational elements in a reach.

The dimensional limitations of PAWTOXIC are the same as those of QUAL-II. These limitations are: a maximum of 75 reaches; no more than 20 computational elements per reach nor 500 in total; a maximum of 15 headwater elements; a maximum of 15 junction elements; a maximum of 90 input and withdrawal elements in total.

PAWTOXIC is structured as one main program, PAWTOXIC, supported by 11 subroutines. Figure 1 presents an illustration of the functional relationships between the main program and the subroutines.

PAWTOXIC is written in FORTRAN IV and is compatible with the VAX/VMS 11/780 computer system.

The stream is conceptualized as a string of completely-mixed reactors (computational elements) which are linked sequentially to one another via the mechanism of transport. A hydrologic balance is determined around each element by considering flow through the upstream face of the element, external sources and sinks, and outflow through the downstream face of the element. A materials balance is performed involving additions from wasteloads, incremental inflows and internal sources, and removals from internal sinks and water withdrawals.

Subroutine INFLOW was added to perform a flow balance on the system which automatically determines incremental inflows. There is also the option of inputting incremental inflows by reach. Details of the implementation of this and other program options can be found in Wright and McCarthy (1985).

Stream hydraulics are represented as in QUAL-II. The

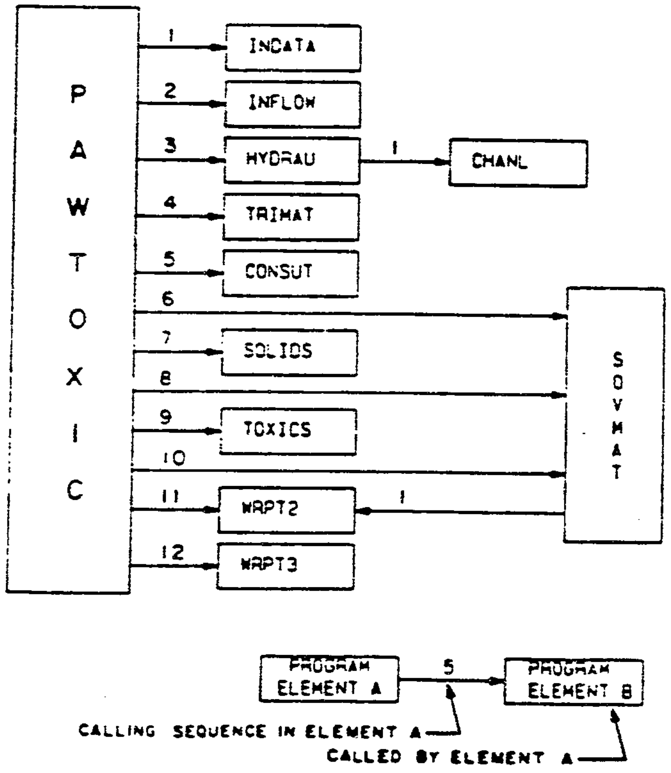

Figure 1 General Structure of the Toxic Substance Model Pawtoxic

option exists to use empirical relationships of the form:

$$u = aQ^b \qquad (15)$$

where Q is stream discharge and a and b are empirically derived constants. The other option is to use trapezoidal approximations of channel dimensions with subsequent calculation of velocities by Manning's formula.

The net sediment transport coefficient (Kns) can be input by reach or an option may be selected which employs empirically derived constants to internally calculate Kns. The same option is present for partition coefficients. They may be input by reach or empirical constants for each toxic may be input with subsequent calculation based on suspended solids concentrations.

The numerical solution technique remains the same as the implicit finite backward difference method of QUAL-II. The solution subroutine SOVMAT found in QUAL-II remains intact in PAWTOXIC.

An example of program output is provide in Appendix C. The first section of the output is an image of the program input.

C. Model Performance Assessment

The success of the model calibration and validation will be determined based on a comparison of spatial plots of model predictions and field observations. Where applicable, 95%

confidence limits representing the environmental variability of the field data will be included in the plots. A model prediction which successfully passes through the majority of the observed confidence limits indicates acceptance.

A weakness of this evaluation is that the single model prediction based on average conditions fail to take into consideration the variability of model inputs. Therefore, the analysis will be extended to an evaluation of the environmental variability of selected input parameters.

A key parameter will be headwater concentrations. Simulations for the upper and lower 95% confidence limits for the headwater concentrations provide a confidence band of model prediction. If the model predicted confidence limits overlap the observed confidence limits for the majority of water quality stations, the simulations are accepted. Where necessary, other inputs such as groundwater or point source variability will be evaluated.

IV. STUDY AREA DESCRIPTION

A. General

The Blackstone River begins in Worcester, Massachusetts and flows southeast into Rhode Island eventually discharging into the Seekonk River in Pawtucket (Figure 2). Several tributaries join the mainstem of the Blackstone River. In Massachusetts, these tributaries include Kettle Brook, and the Quinsigamond, Mumford, West and Mill Rivers and in Rhode Island the Branch

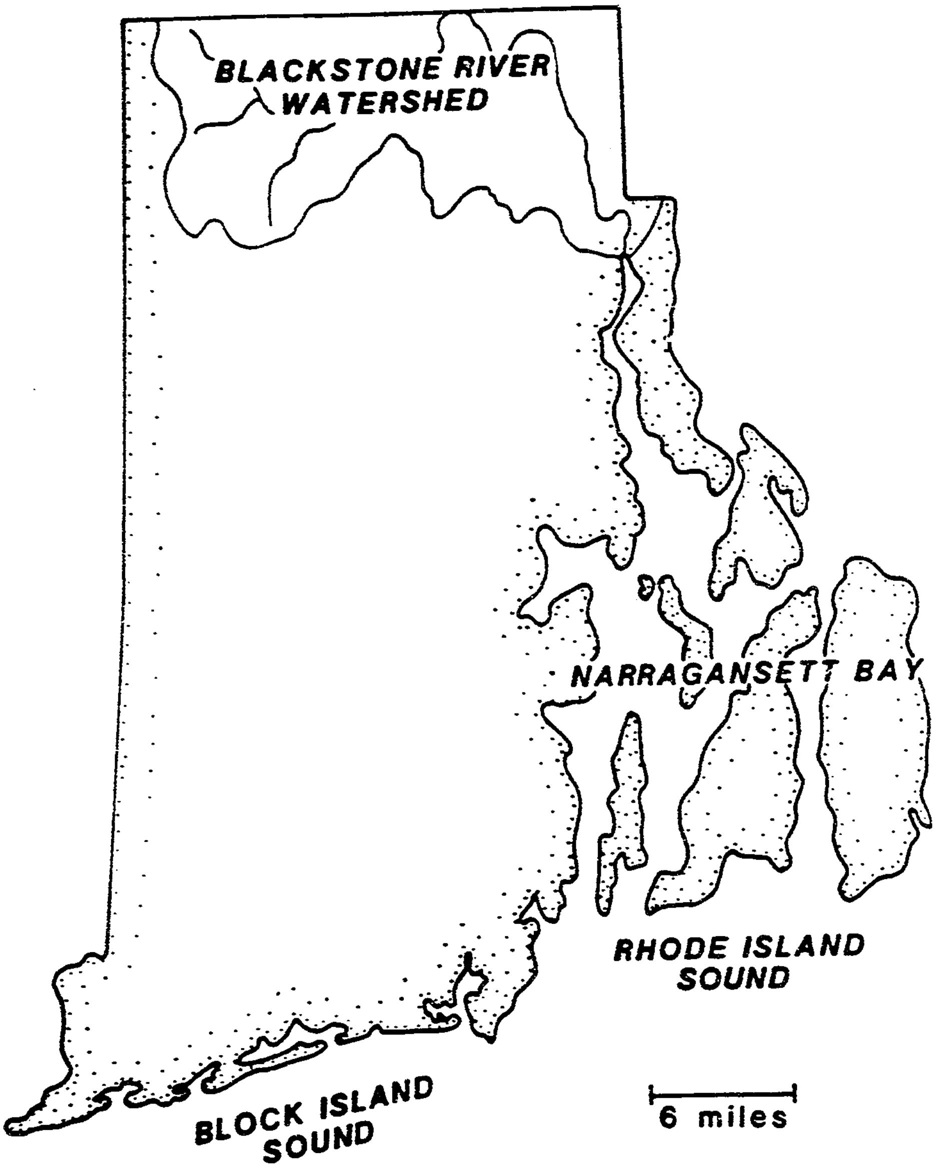

Figure 2 Blackstone River Watershed in Rhode Island

River.

Economic and sociological trends in the basin have impacted the watershed water quality. The most significant trend has included the recent decline in the last decades of the textile industry reducing industrial pollution. However, any major improvements to water quality have been offset by an increasing population in the valley which has resulted in an accompanying increase in domestic wastewater.

The water quality of the Blackstone River in Rhode Island is strongly influenced by the wastewater inputs in Massachusetts. The following is an excerpt from the 1973 Water Quality Analysis Report by the Massachusetts Water Resources Commission (Tennant et al., 1974).

"By a quirk of fate, the location of the city of Worcester is the single most important factor in the pollution of the Blackstone River. Almost without exception, major cities in New England are located on major waterways, either large rivers, such as the Connecticut and Merrimack, or the ocean. This, of course, is due to the fact that the cities were settled at a time when transportation by water was the most practical method of moving goods from industry to market. In addition, the land adjacent to such waterways is generally flat. It was, therefore, easier to lay out a city in such an area. Worcester has neither of these advantages. The Blackstone River is relatively small in the City and could never have been considered navigable due to numerous rapids downstream. The terrain of the City is extremely hilly, as is the surrounding area. Yet, despite this, Worcester grew to become one of the major manufacturing centers of New England. Today, only Boston and Springfield, Massachusetts have larger populations. The result of this is that one of the largest concentrations of domestic and industrial waste in the Commonwealth is discharged into a small stream. Thirty miles below Worcester, at the Massachusetts and Rhode Island state line, the major portion of the flow in the Blackstone is wastes from Worcester. Due to the lack of dilution water available, abatement measures which would prove adequate for waste discharges on major waterways are not enough to solve the problems of the Blackstone River."

Certainly progress has been made between 1973 and the present. However, as the results of this study indicate, the water quality of the Blackstone River in Rhode Island is still strongly influenced by contaminant loadings in Massachusetts.

In Rhode Island there were several wastewater point sources monitored during the course of this study. The major discharge is the secondary treated effluent from the Woonsocket Wastewater Facility. Discharges of minor significance include the industrial effluents from NIFE, Inc., Okonite, Co. and Corning/GTE Products. Locations of these outfalls are given in Figure 3.

The United States Geological Survey (USGS) maintains two Rhode Island stream gaging stations in the basin. Branch River at Forestdale, and Blackstone River at Woonsocket. The Branch

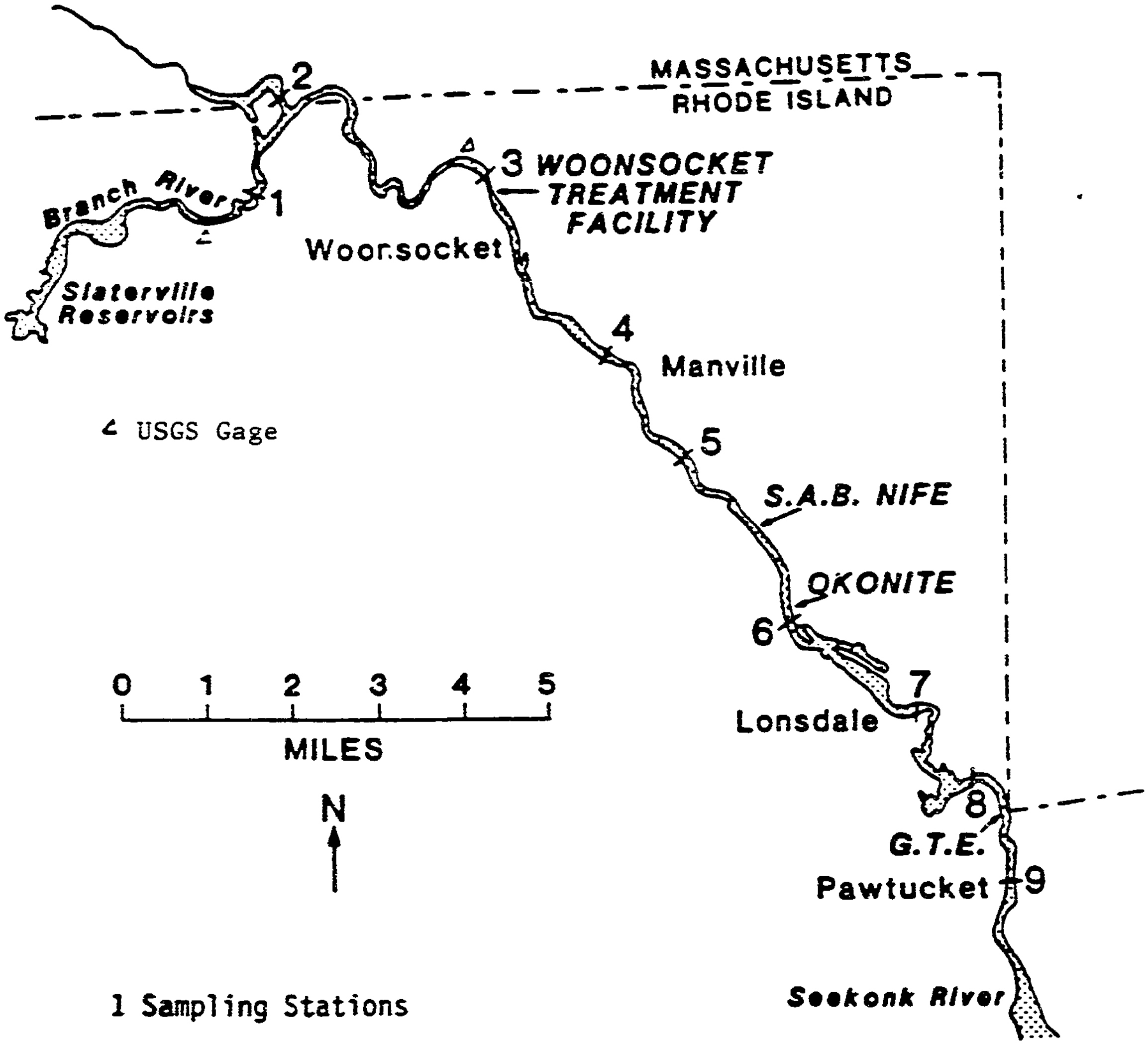

Figure 3 Blackstone River 1985 Water Quality Survey Map

River gage (No. 01111500) is approximately 1.6 miles (2.6 km) upstream from the confluence with the Blackstone River. The gage has an average annual flow of 170 cfs (4.814 cms) for a drainage area of 91.2 sq mi (236.2 sq km). The Blackstone River gage (No. 01112500) has a drainage area of 416 sq mi (1,077 sq km) and an average annual flow of 758 cfs (21.47 cms).

A total of 9 river water quality sampling stations were monitored. Their locations are also noted on Figure 3.

B. Stream Representation in Model Framework

The physical dimensions of the system were determined largely through analysis of USGS quadrangle maps. Mile points and drainage areas for pertinent locations along the river were determined and are presented in Tables 1 and 2. Mileages are given with respect to the distance from the Slaters Mill Dam. Drainage areas are cumulative from the headwaters to the Seekonk River.

To represent the system in the model framework described earlier, the river was divided into reaches. Reach divisions were based on location of dams, water quality stations, point and nonpoint pollution sources and changes in channel geometry. The reach boundaries are presented in Table 3.

Each reach is made up of an integer number of computational elements which are considered completely mixed. All computational elements in the system are 0.2 miles in length. A line diagram of the system (Figure 4) gives the position of reaches, computational elements, water quality stations and

Table 1. River Miles for the Blackstone River in Rhode Island

Location	Water Quality Station	River Miles
	BLACKSTONE RIVER	
Slater Mill Dam	9	0.0
Roosevelt Ave		0.83
Broad St	8	1.92
Lonsdale Ave	7	3.53
Berkley	6	5.63
Albion Dam	5	7.93
Manville Dam	4	9.66
Hamlet Ave	3	12.50
Thundermist Dam		14.02
Canal St		16.25
Confluence (Branch River)		16.58
Main St, Blackstone, MA	2	16.77
	BRANCH RIVER	
Route 146A, N. Smithfield	1	17.76

Table 2. Blackstone River Drainage Area in Rhode Island in Square Miles

Reach	Incremental Drainage Area	Cumulative Drainage Area	Comments
1	0.1	260.6-260.7	Blackstone River/Confluence
2	0.8	95.2-96.0	Forrestdale USGS Gage 91.2 Branch River/Confluence Reference (Army Corps,1971)
3	0.2	356.7-356.9	Confluence
4	11.6	368.5	
5	47.6	416.1	Woonsocket USGS Gage 416.0
6	14.0	430.1	
7	3.6	433.7	
8	6.7	440.4	
9	3.3	443.7	
10	1.3	445.0	
11	28.0	473.0	
12	5.0	478.0	Reference (Army Corps, 1971)

Table 3. Computer Model Reach Divisions for the Blackstone River in Rhode Island

River Reach	River Miles
BLACKSTONE RIVER	
1. Main St, Blackstone, MA to Confluence, Branch River	16.9 - 16.5
3. Confluence to Canal St	16.5 - 16.2
4. Canal St to Thundermist Dam	16.2 - 13.9
5. Thundermist Dam to Hamlet Ave	13.9 - 12.4
6. Hamlet Ave to Manville Dam	12.4 - 9.6
7. Manville Dam to Albion Dam	9.6 - 7.8
8. Albion Dam to Berkley	7.8 - 5.5
9. Berkley to Lonsdale Ave	5.5 - 3.5
10. Lonsdale to Broad St	3.5 - 2.0
11. Broad St to Roosevelt Ave	2.0 - 0.8
12. Roosevelt Ave to Slater Mill Dam	0.8 - 0.0
BRANCH RIVER	
2. Route 146A, N. Smithfield to Confluence, Blackstone River	17.7 - 16.5

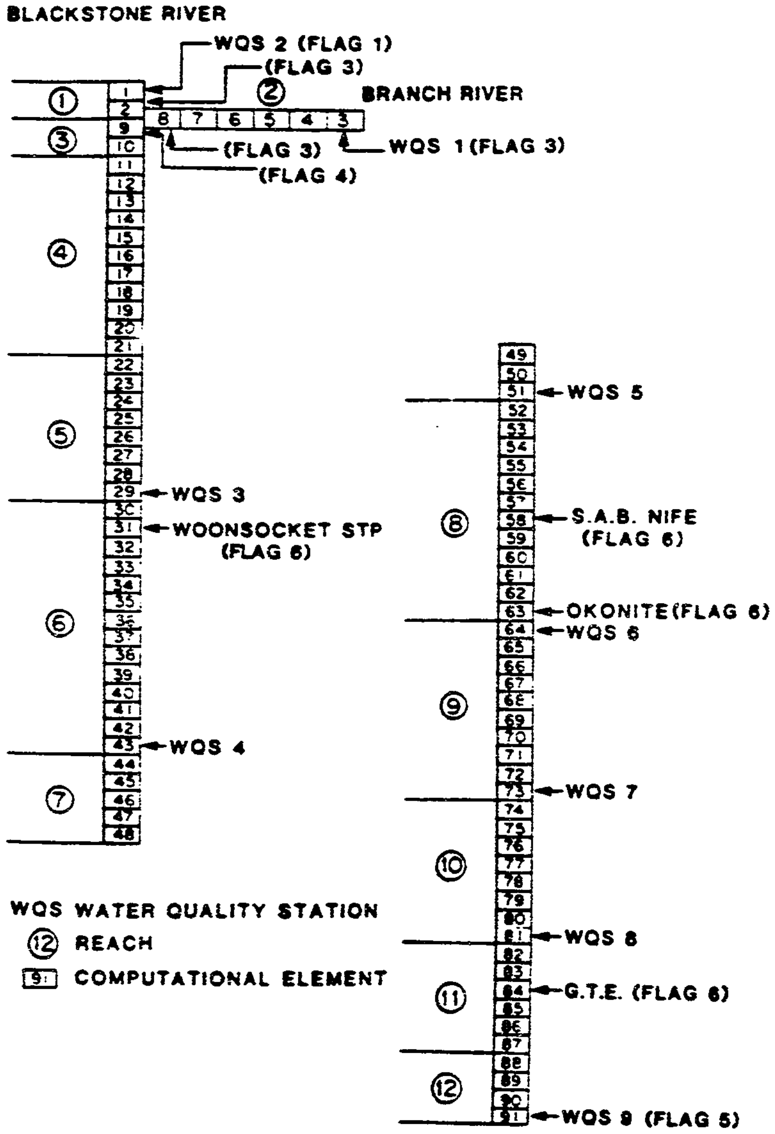

Figure 4 Network of Computational Elements and Reaches for the Blackstone River Model

point and nonpoint pollutant sources in the context of the model. Solution in the model follows the numerical sequence of the computational elements.

V. FIELD AND LABORATORY INVESTIGATIONS

A. Water Quality Sampling and Analysis

Three intensive surveys of water quality were conducted on July 8, August 20 and October 8, 1985. Samples were collected four times over a twenty-four hour period at nine water quality stations (Figure 3). A two liter Teflon container, which had been acid leached and rinsed with methanol and dichloromethane prior to field use, was used to collect samples of surface river water. A four liter sample was transferred to a solvent rinsed amber glass bottle for transportation back to the laboratory. Another portion of the sample was transferred to a Teflon beaker and filtered in the field using acid washed Nuclepore filters. The filter were stored in plastic filter boxes and the filtrate in acid leached polyethylene bottles. Nitric acid was added to each filtrate to obtain a pH of less than 2 for preservation of the samples. Measurements of temperature, pH, and conductivity were taken in the field at the time of sample collection. The pH was measured with an Orion model 399A ionanalyzer and conductivity and temperature were measured with a Yellow Springs Instruments model 33 S-C-T meter.

Samples were collected at the municipal waste water treatment plant hourly using automatic sampling devices and were combined to yield one twenty four hour composite sample. The composite sample was transferred to a polyethylene bottle containing dilute nitric acid for metals determination. Samples of the industrial effluents were grab samples composited over a 6 to 8 hour period and stored in containers similar to those used at the municipal facilities. The municipal and industrial samples were collected by DEM personnel; the river samples were collected by URI personnel.

The four liter river water samples were analyzed separately for suspended solids and then composited for organics determinations. A portion of the filtrate from each sample was analyzed for total dissolved solids. The metals samples were also analyzed separately.

The four liter river samples were filtered through precombusted and preweighed glass fiber filters. After drying to constant weight at room temperature, the filters were reweighed to determine the amount of suspended solids in each sample. After Standard Methods, the filtrate was analyzed for total dissolved solids by evaporating a measured portion of the sample in a precombusted and preweighed porcelain dish. After drying to constant weight the amount of residue in the dishes was determined (USPHA, et al., 1975).

Metals were leached from the particulate substrate with 5% HNO3. The metals were analyzed directly by flame or flameless atomic absorption spectrophotometry (AAS), depending upon the level of metal in the sample. Metals dissolved in the acidified filtrate were analyzed directly by flameless AAS.

The samples were analyzed for suspended solids and metals by personnel of the organic geochemistry laboratory of URI's Graduate School of Oceanography under the direction of Dr. James G. Quinn. Quality assurance was based upon a careful understanding of all controllable uncertainties. Calibration curves, blank determinations, and sources of contamination were all addressed routinely. Samples were analyzed for total dissolved solids at the environmental engineering laboratory of the Department of Civil and Environmental Engineering at URI. A more detailed discussion of sampling and analysis procedures, upon which this discussion is based and the results of the suspended solids and contaminant analyses may be found in Quinn et al., (1986). The results of the total dissolved solids analyses are provided in this report.

B. Hydraulic Characteristics

The use of the advective transport equation requires a knowledge of stream velocities. Average stream velocities are best determined through dye tracer studies. Stream discharge is estimated at the time of the dye experiment and empirical relationships (equation 15) between stream discharge and average stream velocity can be developed. These relationships can be used to predict velocities over a range of stream discharges.

Dye tracer experiments were conducted using a solution of Rhodamine WT dye. The quantity of dye needed for each experiment was estimated such that the instream concentration of the dye would not exceed 10 parts per billion (ppb). An instantaneous release of dye was made in the stream. Samples were taken periodically at downstream locations and analyzed for fluorescence on a Turner Model 111 fluorometer. A plot of dye concentration versus time since injection was constructed for each sampling point. An example of the passage of a dye cloud at Broad Street Blackstone River for August 7, 1985 is presented in Figure 5. The time of travel of the cloud was calculated as the time of passage of the centroid of the cloud, Tc. Time to peak concentrations (Tp) are also indicated.

Three time of travel studies were completed in 1985 to 1986 for the river reaches indicated in Table 4. Flows were calculated using the model PAWTOXIC. The coefficients a and b were defined through simple linear regression following the solution of Equation 15:

$$\ln u = \ln a + b \ln Q \qquad (16)$$

Several of the model reaches described in Table 3 were not evaluated during the dye studies. For these reaches relationships from Table 4 were selected based on similarities

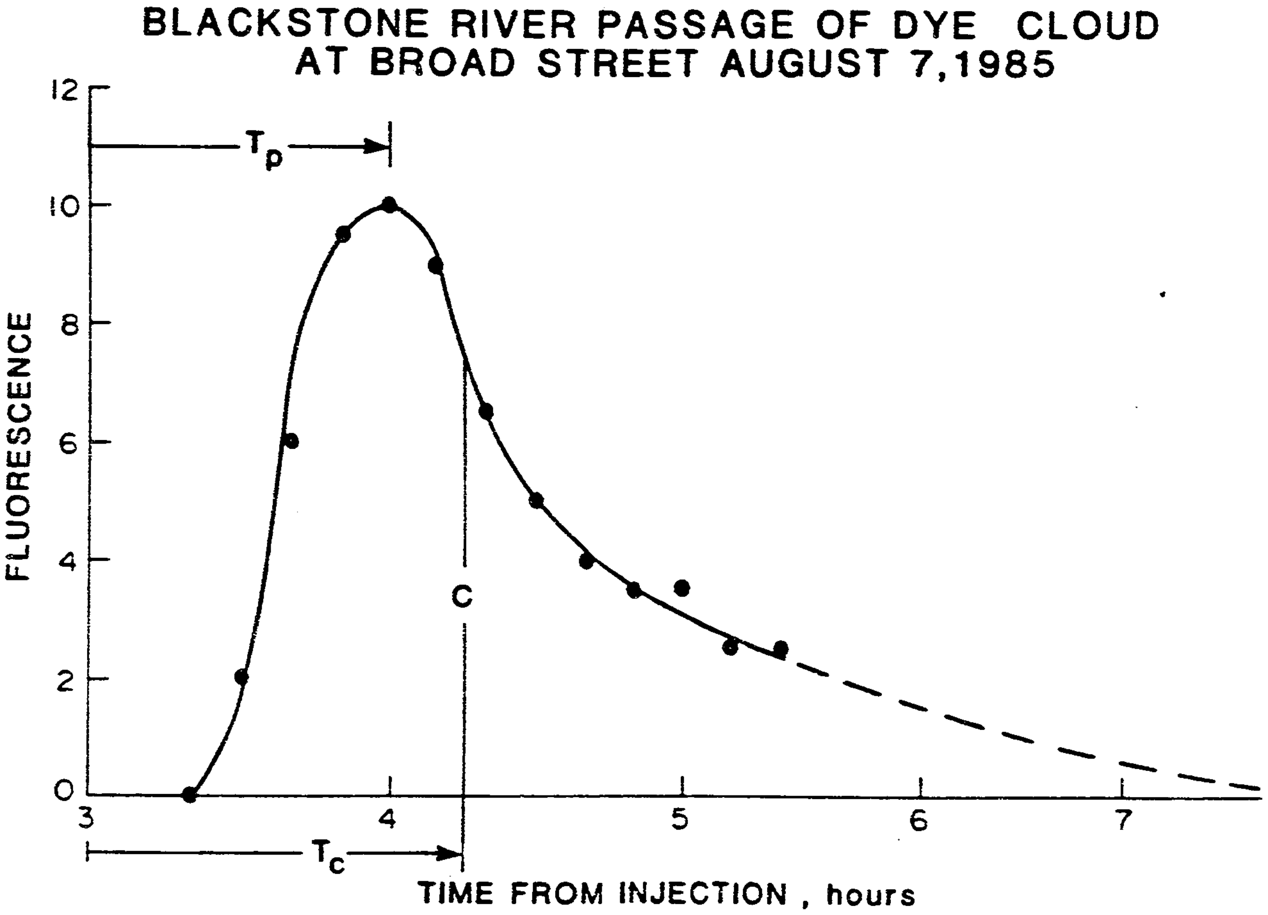

Figure 5 Example of Dye Monitoring During a Time of Travel Study

Table 4. Summary of Time of Travel (TOT) Study and Flow/Velocity Relationships

TOT Reach	Ave Flow (cfs)	Velocity (fps)
Hamlet Ave to Manville Dam	164.0	0.215
	403.3	0.358
$u = 0.0103Q^{0.581}$ $R^2 = 0.8$	244.7	0.223
Manville Dam to Albion Dam	160.7	0.252
	424.0	0.437
$u = 0.012Q^{0.581}$ $R^2 = 0.92$	244.7	0.278
Albion Dam to Martin St	365.0	0.580
	221.4	0.333
$u = 0.0072Q^{0.710}$ $R^2 = 0.89$	140.4	0.296
Martin St to Rte 122	330.2	1.383
	298.8	0.880
$u = 0.008Q^{0.87}$ $R^2 = 0.65$	215.9	0.961
Rte 122 to Broad St	383.7	0.555
	270.4	0.383
$u = 0.0078Q^{0.701}$ $R^2 = 0.91$	192.5	0.343
Broad St to Roosevelt Ave	523.1	0.961
	270.4	0.607
$u = 0.006Q^{0.819}$ $R^2 = 0.96$	244.7	0.492
Roosevelt Ave to Exchange St	458.9	0.763
	244.7	0.477
$u = 0.0156Q^{0.626}$ $R^2 = 0.91$	200.3	0.458

Regression Line: $u = aQ^b$; u = velocity; Q = flow; a, b empirical constants; R^2 = coefficient of determination in stream cross-section and/or slope. A summary of the TOT relationships used in model simulations are presented in Table 5.

VI. MODEL CALIBRATION AND VALIDATION

A. Flow Profiles - TDS Simulations

A summary of the USGS gage flows and the wastewater point source flows are presented in Table 6. Groundwater incremental inflows were estimated by the following equation:

$$q = Q_B/A_B \qquad (17)$$

where q is the incremental groundwater inflow per sq mi; QB is the flow at the Branch River USGS gage; and AB is the drainage area of the gage. The value of q for the 3 surveys were 0.439, 0.395 and 0.965 cfs/sq mi for July 9, August 20 and October 8, 1985, respectively.

The flow profile was developed by applying q along the Branch River from the USGS gage to the confluence with the Blackstone River, along the Blackstone River upstream from the Woonsocket USGS gage to the Massachusetts and Rhode Island state line and downstream from the Woonsocket gage to the Slaters Mill dam.

The flow profile is based on the assumption that the Branch

Table 5. Summary of the Flow/Velocity Relationships used in Model Simulations by River Reach

REACH	a	b
1	0.012	0.581
2	0.071	0.523
3	0.012	0.581
4	0.012	0.581
5	0.071	0.523
6	0.010	0.581
7	0.012	0.581
8	0.007	0.710
9	0.008	0.870
10	0.008	0.701
11	0.006	0.819
12	0.016	0.626

Regression Line: $u = aQ^b$; u = velocity; Q = flow; a, b empirical constants.

Table 6. Summary of the Average Reach Flows in CFS used in Model Simulations

Reach	Water Quality Surveys		
	7/9/85	8/20/85	10/8/85
1	146.2	124.2	534.4
2	40.4	36.0	89.0
3	186.8	160.4	623.9
4	187.3	160.8	625.1
5	194.5	167.3	640.9
6	213.3	184.2	681.9
7	235.2	205.4	713.1
8	236.8	206.1	716.7
9	240.1	209.9	723.7
10	241.4	211.1	726.7
11	244.0	213.4	732.4
12	254.9	223.2	756.2
Woonsocket STP	19.07	15.66	17.64
NIFE	-	-	0.43
Okonite	0.38	0.41	0.29
Corning/GTE	0.07	0.07	0.10
Woonsocket USGS	212	184	680
Forestdale USGS	40.4	36.0	89.0

CFS = cubic feet per second

River USGS gage could be used to adequately define a groundwater inflow term applicable to the entire Blackstone River watershed in RI. Several statements are given in support of this procedure:

1. In general, river flows during dry periods may be used for estimation of groundwater inflow with consideration for external inputs from point sources or diversions. The three Blackstone field survey dates were selected during dry periods to assure steady-state conditions. As a rule, surveys would not take place within 5 days of any rain event. If rain had recently occurred, survey gages (Branch and Woonsocket) were monitored to determine if the flows had returned to pre-rain levels before sampling took place.

2. The Branch River USGS gage is within the watershed and affords the best estimate of groundwater inflow. Although it is downstream of the Slatersville Reservoir, communication from the RI DEM indicates that the reservoir is a run-of-the-river impoundment (RI DEM, 1987) with no regulation. The stage records at the Branch gage for several days prior to each survey were steady also indicating no regulation at the reservoir.

3. The application of the Woonsocket gage to calculate groundwater inflows is not acceptable either as an alternative to the Branch River gage or in addition to it for the following reasons. There exists a considerable number of point sources in Massachusetts upstream of the Woonsocket gage, in contrast to

only one discharge upstream of the Branch USGS gage (Burriville STP). Every point source increases the potential for error in estimating the groundwater contribution. There are also several hydropower operations upstream of the Woonsocket gage and no similar operations upstream of the Branch gage. There is the potential for inpounding or releasing of waters from these operations. Either condition will influence the groundwater calculation.

Flow profiles for the three surveys are presented in Figure 6. Also on Figure 6 is a profile for the 7 day, one in 10 year low flow (7Q10) for comparison. The 7Q10 profile is based on the USGS records for the two gages. The profile was calculated using the method described earlier and average discharges from the point sources.

The flow profiles estimated above are validated through simulation of a conservative parameter such as TDS. A water quality parameter is considered conservative if there are no substantial losses or gains through physical, biological, or chemical transformations. The instream concentrations are a function of headwater levels, pollutant sources and groundwater inflow. If the flow profiles, based on Equation 17, are correct the conservative simulations should be successful.

For the TDS simulations point source concentrations were input as measured. Measurements of TDS in Rhode Island

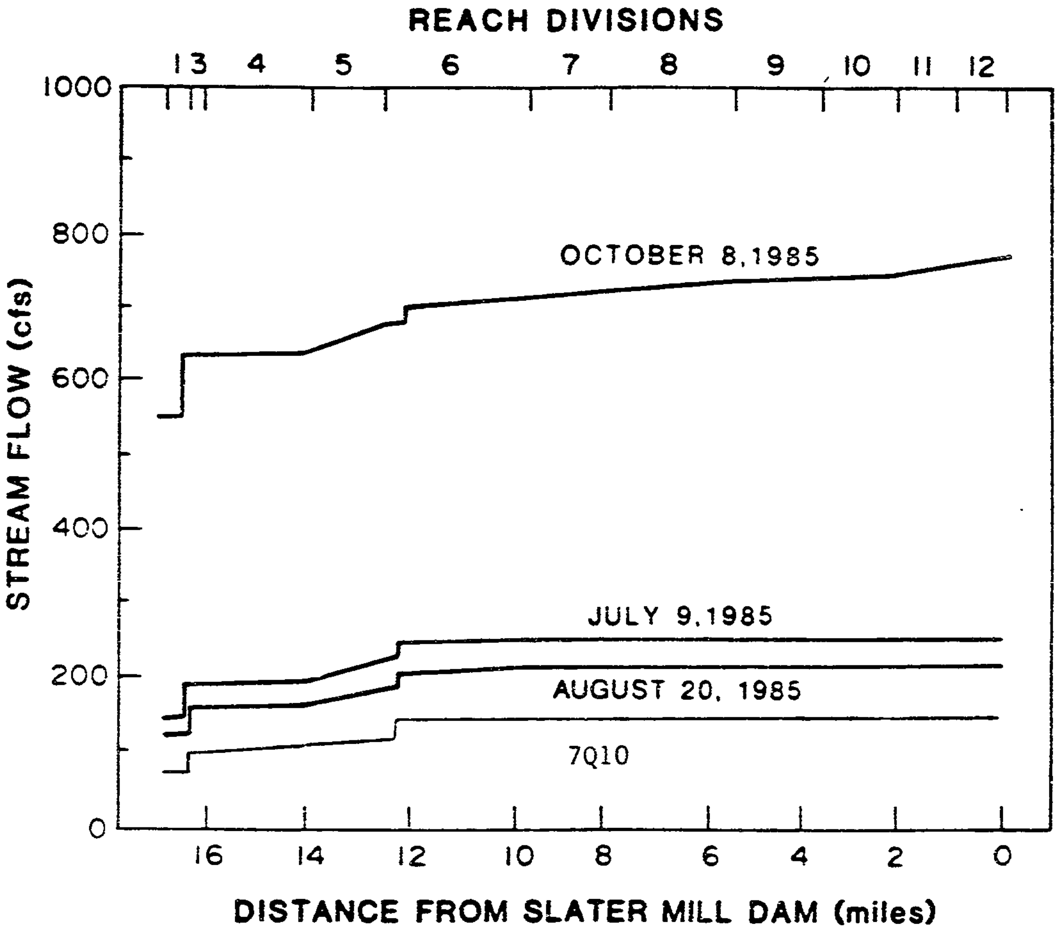

Figure 6 Flow Profiles for the 1985 Blackstone River Water Quality Surveys

groundwater have ranged from 28 to 248 mg/l (Bierschenk, 1958, Gonthier, 1966; Wright and McCarthy, 1985 and Allen, 1956). A TDS concentration of 100 mg/l was used for the incremental inflow for all reaches for the simple reason that this was the same value used in previous modeling efforts on other Rhode Island river systems (Wright and McCarthy, 1985; Wright and McCarthy, 1986). A summary of the TDS simulations are presented in Tables 7-9. For the observations, averages, standard deviations (σ) and 95% confidence limits are reported. The baseline model prediction is given based on average conditions (headwater and point source inputs). In addition, predicted confidence limits were calculated based on the observed confidence limits at the headwater stations. For all stations the range of predictions fall within the range of observations. Therefore, the calibration of the model to TDS was confirmed and the incremental inflow procedure and the resulting flow profiles were accepted.

B. Suspended Solids Simulations

Suspended solids (SS) is a nonconservative constituent, subject to reductions due to settling and increases due to scouring of the streambed. Settling and resuspension are dependent on shear velocities at the sediment and shear velocities may be correlated to average stream velocity. It is logical to expect a net increase in SS with increasing velocity

Table 7. Total Dissolved Solids (mg/l) Simulations for July 9, 1985 with Consideration of Headwater Uncertainty

STATION	OBSERVED	σ	OBSERVED 95% CL	PREDICTED	PREDICTED 95% CL	Y/N
1	56	16	31-81	-[1]	-	
2	165	7	154-176	-	-	
3	128	14	106-150	136	122-150	Y
4	135	8	122-148	152	138-166	Y
5	134	6	125-143	152	138-166	Y
6	133	6	124-142	151	137-165	Y
7	132	5	124-140	151	137-165	Y
8	130	6	121-139	150	137-165	Y
9	129	14	107-151	148	134-162	Y

Point Sources: Woonsocket WWTP 392; Okonite 115; GTE 2,420

---

[1] Model input equals headwater observations. Y/N = Yes/No Does the predicted 95% confidence limit (CL) overlap the observed 95% CL?

Table 9. Total Dissolved Solids (mg/l) Simulations for October 8, 1985 with Consideration of Headwater Uncertainty

STATION	OBSERVED	σ	OBSERVED 95% CL	PREDICTED	PREDICTED 95% CL	Y/N
1	58	12	39-77	-[1]	-	
2	110	10	94-126	-	-	
3	98	10	82-114	103	86-118	Y
4	107	12	88-126	115	99-131	Y
5	102	16	77-127	115	99-131	Y
6	106	14	84-128	114	98-130	Y
7	111	14	89-133	114	100-132	Y
8	111	10	95-127	113	100-132	Y
9	114	5	106-122	112	100-132	Y

Point Sources: Woonsocket WWTP 615; Okonite 132; GTE 3,480

---

[1] Model input equals headwater observations. Y/N = Yes/No Does the predicted 95% confidence limit (CL) overlap the observed 95% CL?

Table 8. Total Dissolved Solids (mg/l) Simulations for August 20, 1985 with Consideration of Headwater Uncertainty

STATION	OBSERVED	σ	OBSERVED 95% CL	PREDICTED	PREDICTED 95% CL	Y/N
1	53	12	34-72	-[1]	-	
2	174	6	165-183	-	-	
3	151	5	147-159	141	130-152	Y
4	167	5	158-175	167	156-178	Y
5	164	5	156-172	166	156-178	Y
6	155	5	147-163	166	155-177	Y
7	160	9	146-174	165	154-176	Y
8	153	9	139-167	165	153-175	Y
9	152	16	127-177	162	151-173	Y

Point Sources: Woonsocket WWTP 500; Okonite 127; GTE 3,870

---

[1] Model input equals headwater observations. Y/N = Yes/No Does the predicted 95% confidence limit (CL) overlap the observed 95% CL?

and a net decrease in SS with decreasing velocity.

The only suspended solids information available, was the for the three profiles collected during this study. Statistically significant equations based on least squares could not be developed from the limited data. For all reaches with one exception the Kns term and velocity had a relationship as described by Equation 4. The equations that were calculated based on two of the three surveys are reported in Table 10. For the one exception (Reaches 11 and 12 (WQS 8-9)) the model option for a constant Kns term was selected and the average based on all three surveys was input (observed: 1.2, 1.64 and 0.82 day^{-1} with an average of 1.22 mg/l).

Figure 7 is a plot of the SS profile for the Blackstone River from WQS 2 to WQS 9. WQS 1 is not plotted since it is located on the Branch River. Tables 11-13 summarize the SS simulations. For the observations, averages, standard deviations and 95% confidence limits are reported. The baseline model prediction is given based on average conditions (headwater and point source inputs). For all stations the predictions fall within the confidence limits of the observations. The model is considered calibrated. It is important to emphasize that the simulations were successful for not only the two surveys which were used in the development of each empirical equation relating Kns to u, but also for the third survey. This third survey is

Table 10. **Summary of the Empirical Equations Relating River Velocity to Net Sediment Transport Coefficients used in the Model Simulations by Reach**

REACH	STATIONS	n	a	b
1	1+2 - 3	2(J,O)	-0.17	0.627
2	1+2 - 3	2(J,O)	-0.33	0.607
3	1+2 - 3	2(J,O)	-0.18	0.602
4	1+2 - 3	2(J,O)	-0.18	0.602
5	1+2 - 3	2(J,O)	-0.21	0.156
6	3 - 4	2(A,O)	-0.31	1.260
7	4 - 5	2(A,O)	-0.46	1.930
8	5 - 6	2(A,O)	-0.65	1.300
9	6 - 7	2(A,O)	-2.28	1.490
10	7 - 8	2(A,O)	-0.84	1.571
11-12	8 - 9	3(J,A,O)	1.22	0.000

J 7/8/85; A 8/20/85; S 10/8/85; n = number of observations; Kns = a + b(velocity); a = intercept; b = slope

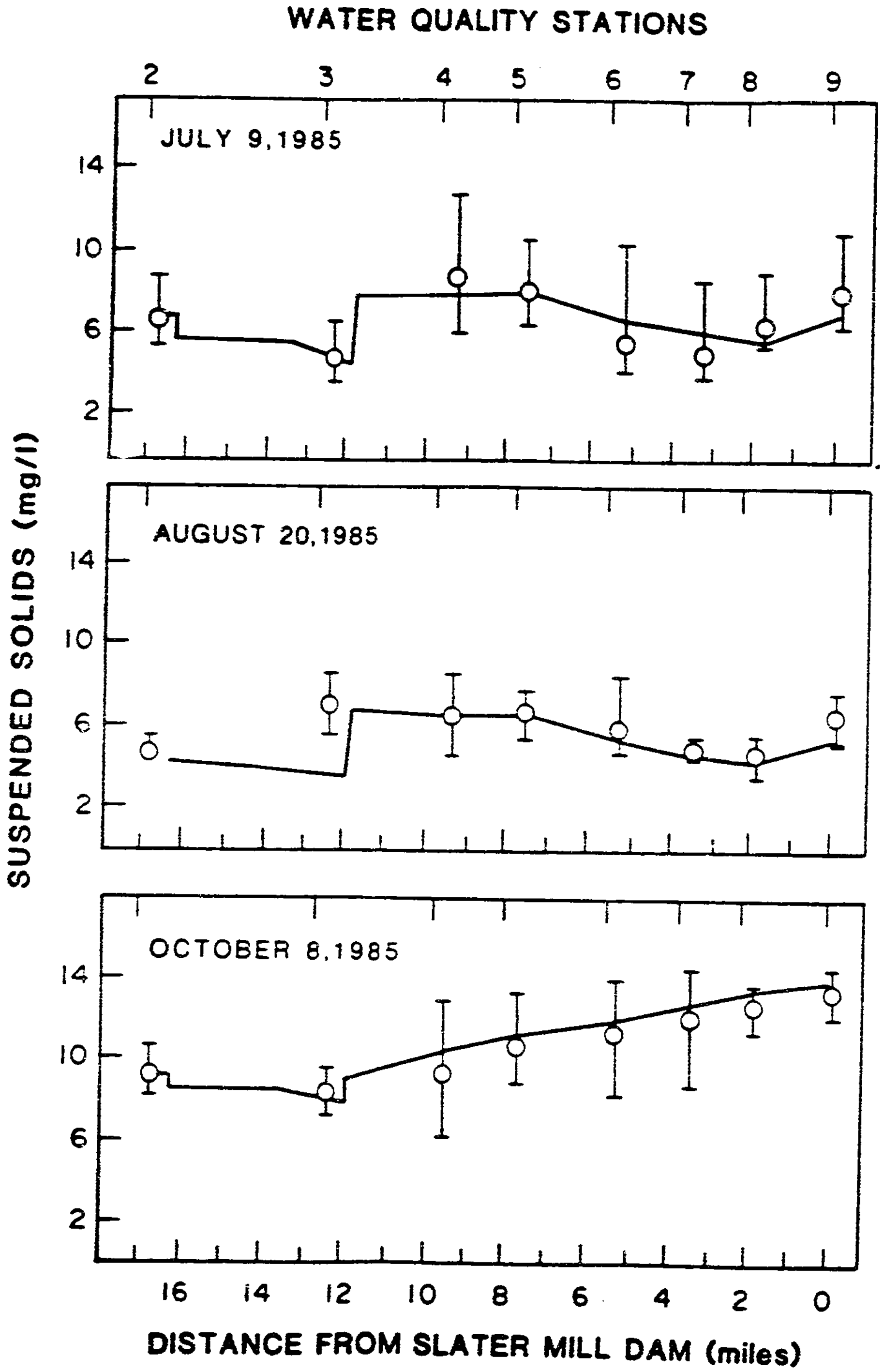

Figure 7 Suspended Solids Profiles with Confidence Limits and Model Simulations

Table 11. Total Suspended Solids (mg/l) Simulations for July 9, 1985

STATION	OBSERVED	σ	OBSERVED 95% CL	PREDICTED	Y/N
1	1.96	0.49	1.18-2.73	-[1]	
2	6.68	1.46	4.36-9.00	-	
3	4.80	1.29	2.74-6.85	4.82	Y
4	8.81	2.45	4.91-12.7	7.59	Y
5	8.09	1.46	5.81-10.4	7.70	Y
6	5.84	2.44	1.96-9.72	6.90	Y
7	5.09	1.95	2.00-8.19	6.16	Y
8	6.62	1.46	4.30-8.94	5.93	Y
9	8.38	1.66	5.78-11.0	7.25	Y

---

[1] Model input equals headwater observations. Y/N = Yes/No Does the model prediction fall within the observed 95% CL?

Table 12. Total Suspended Solids (mg/l) Simulations for August 20, 1985

STATION	OBSERVED	σ	OBSERVED 95% CL	PREDICTED	Y/N
1	2.48	0.58	1.57-3.39	-[1]	
2	4.67	0.48	3.92-5.42	-	
3	7.01	1.20	5.10-8.92	3.49	N
4	6.37	1.59	3.88-8.86	6.39	Y
5	6.50	0.90	5.09-7.91	6.39	Y
6	5.74	1.45	3.47-8.00	5.55	Y
7	4.91	0.30	4.44-5.38	4.78	Y
8	4.45	0.82	3.17-5.73	4.53	Y
9	6.46	0.95	4.97-7.95	5.80	Y

---

[1] Model input equals headwater observations. Y/N = Yes/No Does the model prediction fall within the observed 95% CL?

Table 13. Total Suspended Solids (mg/l) Simulations for October 8, 1985

STATION	OBSERVED	σ	OBSERVED 95% CL	PREDICTED	Y/N
1	2.69	0.27	2.27- 3.11	- [1]	
2	9.28	0.95	7.79-10.76	-	
3	8.11	0.92	6.67- 9.55	8.05	Y
4	9.59	2.35	5.91-13.27	10.02	Y
5	10.77	1.95	7.72-13.82	11.02	Y
6	11.36	2.14	8.01-14.71	11.79	Y
7	12.11	2.23	8.62-15.60	12.54	Y
8	12.59	0.86	11.24-13.94	13.19	Y
9	13.28	1.21	11.39-15.17	14.31	Y

---

[1] Model input equals headwater observations. Y/N = Yes/No Does the model prediction fall within the observed 95% CL?

offered as validation of the procedure and the Kns/u relationships.

C. Metal Simulations

Partition coefficient (Kp) can be calculated with the knowledge of dissolved (c) and particulate (p) metal concentrations and SS (m). Combining equations 9 and 10 yields:

$$Kp = (p/m_1)/c \qquad (18)$$

where Kp has units of (ug/mg)(ug/l). Using the data from all three surveys, Kp was calculated for each constituent at each water quality station. Average values by survey and for the study are presented in Table 14.

An attempt was made to develop statistically significant empirical equations relating suspended solids inversely to the partition coefficient. This has been indicated by others (O'Connor and Connolly, 1982; DiToro et al., 1982; DiToro et al., 1986). It was also successfully done in previous work with the model PAWTOXIC on the Pawtuxet River (Wright and McCarthy, 1984). The attempt with the Blackstone River data failed to result in statistically significant relationships. This failure is attributed to the small variability in suspended solids concentrations in the two calibration surveys (July and August). For these surveys SS concentrations between WQS 2 to 9

Table 14. Summary of Partition Coefficents (ug/mg)/(ug/l) for Selected Trace Metals

Parameter		Water Quality Surveys			Study
		7/8/85	8/20/85	10/8/85	Average
Cadmium	A	0.106	0.096	0.052	0.084
	n	8	9	9	26
	σ	0.027	0.021	0.015	0.032
Chromium	A	1.320	0.325	0.545	0.738
	n	8	8	7	23
	σ	0.875	0.087	0.154	0.682
Copper	A	0.030	0.078	0.069	0.061
	n	7	8	9	24
	σ	0.003	0.026	0.012	0.026
Lead	A	0.441	0.474	0.354	0.436
	n	9	9	8	26
	σ	0.125	0.167	0.043	0.135
Nickel	A	0.023	0.008	0.012	0.015
	n	8	7	8	23
	σ	0.017	0.003	0.001	0.012

A = average; n = number of observations; σ = standard deviation did not vary by more than 4.0 mg/l. In contrast the solids range on the Pawtuxet River was as high as 22 mg/l (Wright and McCarthy, 1984).

As a result of the failure to establish a relationship between SS and Kp, average Kp values by survey were used in all subsequent simulations.

All trace metal data are provided in Appendix B. A test for outliers was performed for each WQS for each survey. Outliers were defined as observations not falling within a 95% confidence limit around the average. If any of the 4 observations per station per survey fell outside the limits, that data point was dropped and a new average, σ and confidence limit were determined. The results of this test are given in Appendix B. If an average was changed as a result of this evaluation, it is clearly indicated in the tables to follow with an asterisk and set in parentheses.

If a headwater station (WQS 1 and 2) had concentrations that were nondetectable, one-half the detectability limit was assumed.

The final model simulations for the dissolved and particulate trace metals are presented in the following tables and figures: cadmium Tables 15-17 and Figure 8; chromium Tables 18-20 and Figure 9; copper Tables 21-23 and Figure 10; lead Tables 24-26 and Figure 11; and nickel Tables 27-29 and Figure 12. The 95% confidence limits for the observations are indicated in both the tables and the figure.

Table 15. Model Simulations for Cadmium (ug/l) for July 9, 1985 including Confidence Limits for Headwater Uncertainty

STATION	STATE	OBSERVED (*)	OBSERVED 95% CL	PREDICTED	PREDICTED 95% CL	Y/N
1	T			0.07		
	D	ND		0.06	0.00-0.21	
	P	0.02	0.00-0.15	0.01	0.00-0.04	Y
2	T	0.86 (0.81)		0.80		
	D	0.43	0.38-0.48	0.47	0.43-0.52	Y
	P	0.43 (0.38)	0.35-0.41	0.33	0.30-0.37	Y
3	T	0.75 (0.50)		0.56		
	D	0.49 (0.29)	0.16-0.42	0.37	0.33-0.43	Y
	P	0.26 (0.21)	0.20-0.22	0.19	0.17-0.22	Y
4	T	0.73 (0.59)		0.53		
	D	0.47 (0.33)	0.20-0.47	0.29	0.26-0.34	Y
	P	0.26	0.11-0.41	0.24	0.21-0.27	Y
5	T	0.46 (0.48)		0.53		
	D	0.26	0.21-0.31	0.29	0.26-0.34	Y
	P	0.20 (0.22)	0.21-0.24	0.24	0.21-0.28	Y
6	T	0.36		0.50		
	D	0.26	0.17-0.34	0.29	0.26-0.33	Y
	P	0.11	0.07-0.16	0.19	0.19-0.24	N
7	T	0.39		0.48		
	D	0.25	0.18-0.32	0.29	0.26-0.33	Y
	P	0.14	0.08-0.21	0.19	0.17-0.22	Y
8	T	0.41		0.47		
	D	0.22	0.17-0.26	0.29	0.26-0.33	Y
	P	0.19	0.14-0.24	0.18	0.16-0.20	Y
9	T	0.36 (0.35)		0.49		
	D	0.18 (0.17)	0.14-0.19	0.28	0.25-0.32	N
	P	0.18	0.12-0.24	0.21	0.19-0.25	Y

T = Total; D = Dissolved; P = Particulate; * Modified average based on observed data falling within the 95% confidence limit (95% CL); Y/N = Yes/No Does the predicted 95% CL overlap the observed 95% confidence limit?; ND = None Detected = $\leq$ 0.1 ug/l (After Quinn et al 1985).

Table 16. Model Simulations for Cadmium (ug/l) for August 20, 1985 including Confidence Limits for Headwater Uncertainty

STATION	STATE	OBSERVED (*)	OBSERVED 95% CL	PREDICTED	PREDICTED 95% CL	Y/N
1	T	0.29 (0.24)		0.24		
	D	0.25 (0.20)	0.20	0.22	0.18-0.25	
	P	0.04	0.02-0.05	0.02	0.04-0.05	Y
2	T	1.02		1.02		
	D	0.65	0.55-0.76	0.70	0.60-0.84	Y
	P	0.37	0.32-0.42	0.32	0.27-0.38	Y
3	T	0.85 (0.80)		0.73		
	D	0.46 (0.41)	0.39-0.44	0.55	0.47-0.64	N
	P	0.39	0.32-0.46	0.18	0.16-0.21	N
4	T	0.81		0.67		
	D	0.53	0.38-0.68	0.42	0.36-0.49	Y
	P	0.28	0.19-0.36	0.25	0.30-0.22	Y
5	T	0.80		0.67		
	D	0.51	0.30-0.71	0.42	0.48-0.36	Y
	P	0.29	0.25-0.33	0.25	0.22-0.30	Y
6	T	0.59 (0.54)		0.63		
	D	0.40 (0.35)	0.32-0.38	0.42	0.36-0.48	Y
	P	0.19	0.18-0.20	0.21	0.19-0.26	Y
7	T	0.58 (0.51)		0.60		
	D	0.42 (0.35)	0.30-0.40	0.41	0.36-0.48	Y
	P	0.16	0.13-0.18	0.19	0.16-0.22	Y
8	T	0.49 (0.44)		0.58		
	D	0.33 (0.31)	0.28-0.36	0.40	0.36-0.48	Y
	P	0.16 (0.14)	0.13-0.15	0.18	0.15-0.20	Y
9	T	0.55 (0.51)		0.61		
	D	0.31 (0.27)	0.23-0.32	0.39	0.34-0.46	N
	P	0.24	0.17-0.31	0.22	0.19-0.25	Y

T = Total; D = Dissolved; P = Particulate; * Modified average based on observed data falling within the 95% confidence limit (95% CL); Y/N = Yes/No Does the predicted 95% CL overlap the observed 95% confidence limit?.

Table 17. Model Simulations for Cadmium (ug/l) for October 8, 1985 including Confidence Limits for Headwater Uncertainty

STATION	STATE	OBSERVED (*)	OBSERVED 95% CL	PREDICTED	PREDICTED 95% CL	Y/N
1	T	0.21		0.21		
	D	0.18	0.12-0.24	0.18	0.11-0.21	Y
	P	0.03	0.01-0.04	0.03	0.02-0.03	Y
2	T	1.55		1.55		
	D	0.97	0.89-1.06	1.04	0.94-1.16	Y
	P	0.58	0.50-0.66	0.51	0.45-0.56	Y
3	T	1.26		1.26		
	D	0.85	0.52-1.[illegible]	0.89	0.79-0.99	Y
	P	0.41	0.33-0.48	0.37	0.33-0.41	Y
4	T	1.31 (1.18)		1.26		
	D	0.83	0.68-0.97	0.83	0.74-0.92	Y
	P	0.48 (0.35)	0.23-0.47	0.43	0.38-0.47	Y
5	T	1.29		1.30		
	D	0.91	0.73-1.09	0.83	0.74-0.92	Y
	P	0.38	0.29-0.47	0.47	0.42-0.52	Y
6	T	1.24		1.33		
	D	0.85	0.68-1.01	0.82	0.73-0.91	Y
	P	0.39	0.31-0.47	0.50	0.45-0.56	Y
7	T	1.31		1.36		
	D	0.91	0.80-1.02	0.82	0.73-0.91	Y
	P	0.40	0.32-0.49	0.54	0.48-0.59	Y
8	T	1.26		1.38		
	D	0.86	0.77-0.95	0.82	0.71-0.87	Y
	P	0.40	0.34-0.45	0.56	0.51-0.63	N
9	T	1.24		1.39		
	D	0.87	0.82-0.92	0.80	0.71-0.88	Y
	P	0.37	0.32-0.42	0.59	0.53-0.66	N

T = Total; D = Dissolved; P = Particulate; * Modified average based on observed data falling within the 95% confidence limit (95% CL); Y/N = Yes/No Does the predicted 95% CL overlap the observed 95% confidence limit?.

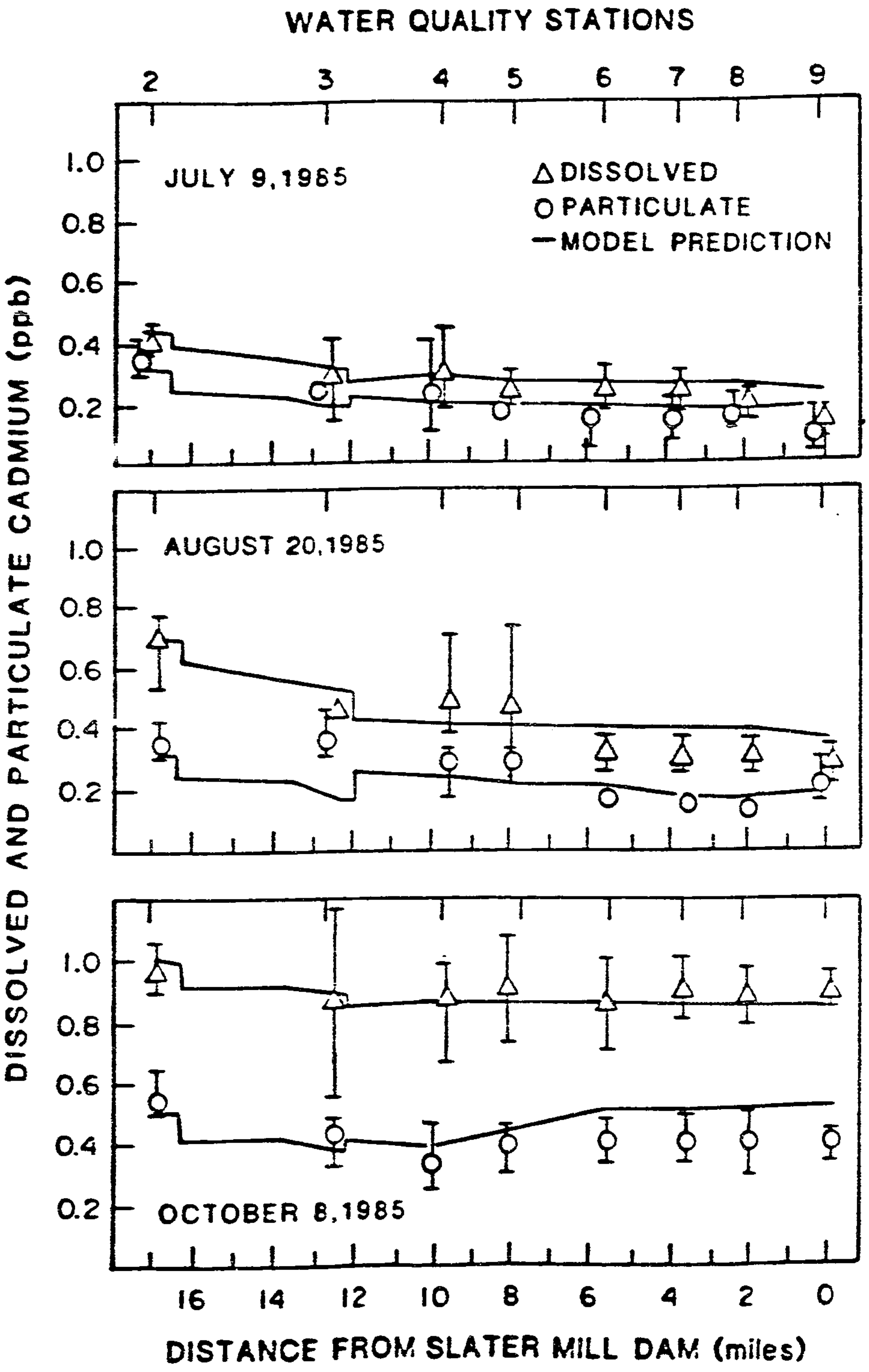

Figure 8 Cadmium Profiles with 95% Confidence Limits and Model Simulations

Table 18. Model Simulations for Chromium (ug/l) for July 9, 1985 including Confidence Limits for Headwater Uncertainty

STATION	STATE	OBSERVED (*)	OBSERVED 95% CL	PREDICTED	PREDICTED 95% CL	Y/N
1	T			1.68		
	D	ND		0.47	0.27-0.67	
	P	1.42 (1.18)	0.98-1.39	1.21	0.71-1.72	Y
2	T			7.76		
	D	ND		0.79	0.30-6.59	
	P	32.81	1.94-63.7	6.97	2.63-57.9	Y
3	T			5.53		
	D	ND		0.75	0.29-5.9	
	P	12.80 (7.30)	1.69-12.9	4.78	1.86-37.8	Y
4	T			5.40		
	D	ND		0.49	0.21-3.64	
	P	9.22 (4.92)	1.17-8.68	4.91	2.14-36.6	Y
5	T			5.53		
	D	ND		0.49	0.21-3.64	
	P	5.79 (3.85)	2.52-5.18	5.04	2.19-37.3	Y
6	T			4.96		
	D	ND		0.49	0.21-3.63	
	P	6.40 (3.53)	0.22-6.85	4.47	1.95-33.1	Y
7	T			4.50		
	D	ND		0.49	0.21-3.63	
	P	14.70	0.00-31.4	4.01	1.75-29.7	Y
8	T			4.23		
	D	ND		0.49	0.21-3.63	
	P	7.02 (3.53)	0.00-8.18	3.74	1.63-27.7	Y
9	T			5.17		
	D	ND		0.49	0.21-3.61	
	P	2.99	0.39-5.58	4.68	2.05-34.5	Y

T = Total; D = Dissolved; P = Particulate; * Modified average based on observed data falling within the 95% confidence limit (95% CL); Y/N = Yes/No Does the predicted 95% CL overlap the observed 95% confidence limit?; ND = None Detected = $\leq$ 1.0 ug/l (After Quinn et al 1985).

Table 19. Model Simulations for Chromium (ug/l) for August 20, 1985 including Confidence Limits for Headwater Uncertainty

STATION	STATE	OBSERVED (*)	OBSERVED 95% CL	PREDICTED	PREDICTED 95% CL	Y/N
1	T			1.10		
	D	ND		0.61	0.14-1.09	
	P	0.60	0.25-0.96	0.49	0.11-0.87	Y
2	T	12.40 (9.20)		9.17		
	D	6.51 (3.70)	0.00-9.18	3.65	2.12-5.89	Y
	P	5.89 (5.50)	5.35-5.65	5.52	3.21-8.90	Y
3	T	7.07 (6.90)		6.27		
	D	1.65 (1.48)	1.35-1.61	2.94	1.67-4.75	N
	P	5.42	4.07-6.76	3.34	1.90-5.40	Y
4	T	5.71 (5.37)		6.20		
	D	1.81 (1.47)	1.07-1.87	2.02	1.24-3.13	Y
	P	3.90	2.08-5.12	4.18	2.57-6.49	Y
5	T	5.12		6.24		
	D	1.32	1.18-1.46	2.01	1.24-3.13	Y
	P	3.80	2.95-4.66	4.23	2.60-6.56	Y
6	T	3.44		5.61		
	D	1.26	1.21-1.31	2.00	1.23-3.11	Y
	P	2.18	1.72-2.65	3.61	2.22-5.60	Y
7	T	3.05		5.13		
	D	1.35	1.04-1.64	2.00	1.23-3.10	Y
	P	1.70	1.34-2.06	3.13	1.93-4.86	Y
8	T	2.73		4.85		
	D	1.18	0.96-1.40	2.00	1.76-3.10	N
	P	1.55	0.97-2.18	2.85	1.23-4.43	Y
9	T	3.79		5.61		
	D	1.29	1.18-1.39	1.95	1.20-3.01	Y
	P	2.50	1.69-3.31	3.66	2.27-5.67	Y

T = Total; D = Dissolved; P = Particulate; * Modified average based on observed data falling within the 95% confidence limit (95% CL); Y/N = Yes/No Does the predicted 95% CL overlap the observed 95% confidence limit?; ND = None Detected = $\leq$ 1.0 ug/l (After Quinn et al 1985).

Table 20. Model Simulations for Chromium (ug/l) for October 8, 1985 including Confidence Limits for Headwater Uncertainty

STATION	STATE	OBSERVED (*)	OBSERVED 95% CL	PREDICTED	PREDICTED 95% CL	Y/N
1	T			1.18		
	D	ND		0.48	0.13-0.82	
	P	0.68	0.33-1.02	0.70	0.20-1.20	Y
2	T	10.03		10.05		
	D	0.99	0.88-1.10	1.66	1.55-1.83	N
	P	9.31	8.52-10.1	8.39	7.87-9.29	Y
3	T	7.91		8.35		
	D	1.02	0.93-1.11	1.55	1.44-1.74	N
	P	6.89	4.82-8.97	6.80	6.28-7.60	Y
4	T	8.62		8.97		
	D	1.24	0.97-1.51	1.41	1.30-1.57	Y
	P	7.38	4.07-10.7	7.56	7.01-8.43	Y
5	T	9.45		9.79		
	D	1.43	1.11-1.74	1.41	1.30-1.56	Y
	P	8.02	4.97-11.1	8.38	7.77-9.34	Y
6	T	8.90		10.40		
	D	1.23	0.85-1.61	1.40	1.30-1.56	Y
	P	7.67	5.56-9.78	9.00	8.34-10.0	Y
7	T	11.31 (9.55)		10.93		
	D	1.43	0.90-1.96	1.40	1.30-1.56	Y
	P	9.88 (8.12)	5.38-10.9	9.53	8.83-10.6	Y
8	T	10.31 (9.74)		11.37		
	D	1.66	0.93-2.38	1.40	1.29-1.55	Y
	P	8.65 (8.08)	6.57-9.59	9.97	9.57-11.5	Y
9	T	10.44		12.25		
	D	2.07	0.92-3.23	1.39	1.29-1.55	Y
	P	8.37	6.85-9.89	10.85	10.1-12.1	N

T = Total; D = Dissolved; P = Particulate; * Modified average based on observed data falling within the 95% confidence limit (95% CL); Y/N = Yes/No Does the predicted 95% CL overlap the observed 95% confidence limit?; ND = None Detected = ≤ 1.0 ug/l (After Quinn et al 1985).

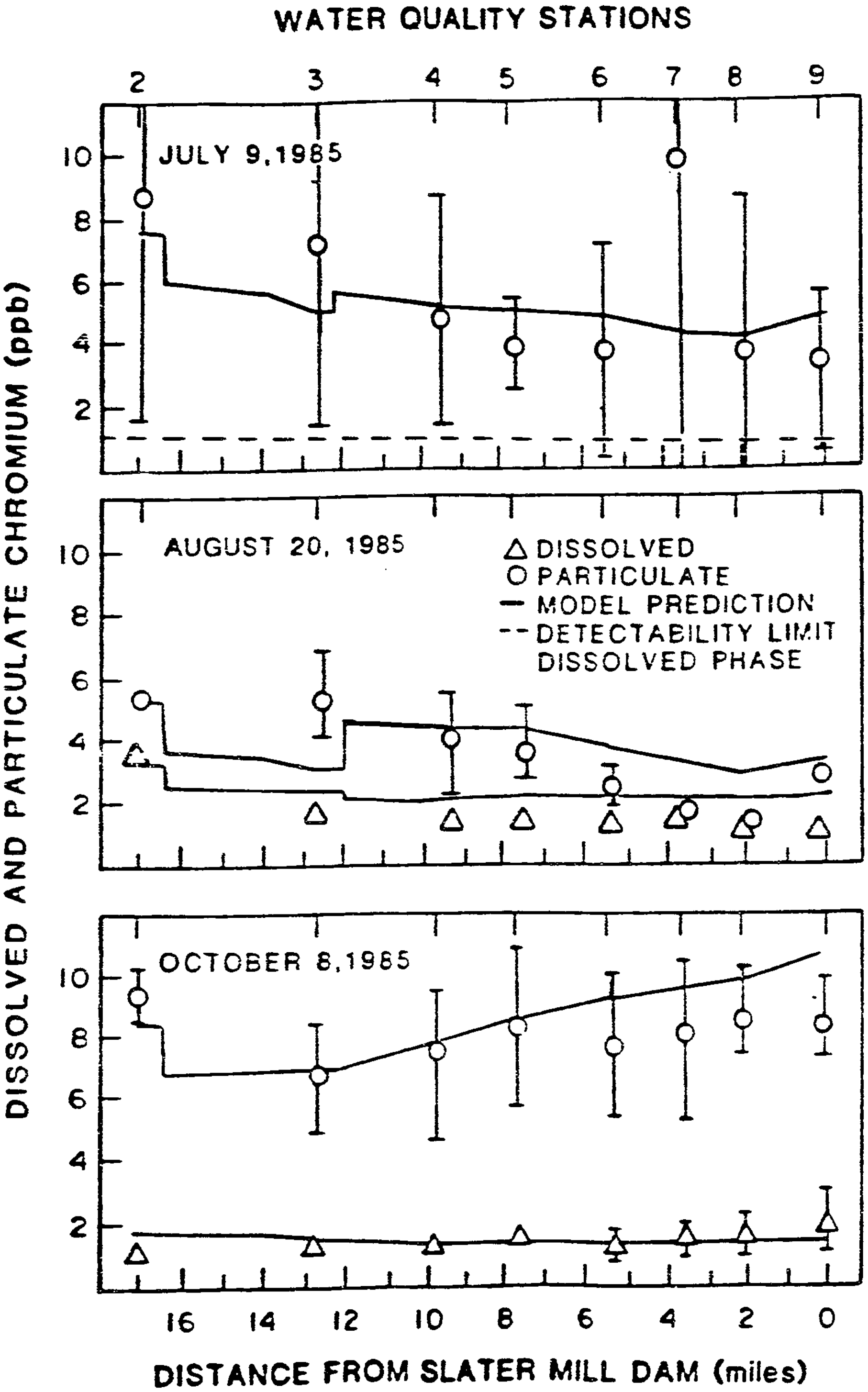

Figure 9 Chromium Profiles with 95% Confidence Limits and Model Simulations

Table 21. Model Simulations for Copper (ug/l) for July 9, 1985 including Confidence Limits for Headwater Uncertainty

STATION	STATE	OBSERVED	(*)	OBSERVED 95% CL	PREDICTED	PREDICTED 95% CL	Y/N
1	T				1.34		
	D	ND			1.27	0.30-2.25	
	P	0.39	(0.35)	0.32-0.38	0.07	0.02-0.13	N
2	T	14.07	(12.95)		12.93		
	D	10.30	(9.18)	8.15-10.2	10.78	9.10-12.4	Y
	P	3.77		2.78-4.77	2.15	1.82-2.48	N
3	T	10.38	(9.69)		9.09		
	D	8.85	(8.16)	8.01-8.31	7.94	6.56-9.28	Y
	P	1.53		1.08-1.98	1.15	0.95-1.34	Y
4	T	12.04	(11.83)		13.41		
	D	9.57	(9.36)	9.07-9.65	10.93	9.77-12.1	N
	P	2.47		1.54-3.40	2.48	2.22-2.74	Y
5	T	10.66	(10.30)		13.40		
	D	8.38	(8.16)	7.78-8.54	10.87	9.71-12.0	N
	P	2.28	(2.14)	1.97-2.32	2.53	2.26-2.79	Y
6	T	10.09	(9.97)		13.04		
	D	8.71	(8.59)	8.37-8.81	10.80	9.66-11.9	N
	P	1.38		1.24-1.39	2.24	2.00-2.47	N
7	T	9.15			12.76		
	D	7.86		7.38-8.35	10.76	9.62-11.9	N
	P	1.29		1.02-1.57	2.00	1.79-2.21	N
8	T	9.39	(9.17)		12.59		
	D	8.00	(7.78)	7.56-8.00	10.73	9.60-11.8	N
	P	1.39		1.29-1.49	1.86	1.66-2.05	N
9	T	9.85	(9.59)		12.44		
	D	8.00		7.16-8.84	10.22	9.14-11.3	N
	P	1.85	(1.59)	1.33-1.86	2.22	1.99-2.45	N

T = Total; D = Dissolved; P = Particulate; * Modified average based on observed data falling within the 95% confidence limit (95% CL) Y/N = Yes/No Does the predicted 95% CL overlap the observed 95% confidence limit?; ND = None Detected = ≤ 2.0 ug/l (After Quinn et al 1985).

Table 22. Model Simulations for Copper (ug/l) for August 20, 1985 including Confidence Limits for Headwater Uncertainty

STATION	STATE	OBSERVED (*)	OBSERVED 95% CL	PREDICTED	PREDICTED 95% CL	Y/N
1	T			1.55		
	D	ND		1.30	0.29-2.31	
	P	0.55	0.35-0.76	0.25	0.06-0.77	Y
2	T	11.38		11.36		
	D	7.86	6.73-8.99	8.33	7.02-9.66	Y
	P	3.52	2.85-4.20	3.02	2.55-3.50	Y
3	T	10.66 (11.22)		7.89		
	D	5.49 (5.68)	5.36-6.02	6.20	5.07-7.34	Y
	P	5.17 (5.54)	4.92-6.15	1.69	1.38-2.00	N
4	T	10.16 (10.5)		13.73		
	D	6.78 (7.12)	6.73-7.51	9.17	8.32-10.0	N
	P	3.38	1.93-4.82	3.56	4.14-4.99	Y
5	T	8.98 (8.84)		13.72		
	D	5.96 (5.82)	5.70-5.93	9.13	8.28-9.98	N
	P	3.02	2.34-3.70	4.60	4.17-5.03	N
6	T	8.18		13.01		
	D	6.29	5.89-6.69	9.08	8.24-9.92	N
	P	1.89	1.49-2.28	3.93	3.56-4.29	N
7	T	9.60 (9.68)		12.45		
	D	7.85	5.59-10.1	9.04	8.21-9.89	Y
	P	1.75 (1.83)	1.75-1.90	3.40	3.09-3.72	N
8	T	7.60		12.13		
	D	5.85	5.22-6.49	9.03	8.19-9.87	N
	P	1.75	1.18-2.32	3.10	2.81-3.39	N
9	T	9.44 (9.13)		12.54		
	D	6.39	5.99-6.79	8.63	7.84-9.43	N
	P	3.05 (2.74)	2.42-3.06	3.90	3.54-4.27	N

T = Total; D = Dissolved; P = Particulate; * Modified average based on observed data falling within the 95% confidence limit (95% CL); Y/N = Yes/No Does the predicted 95% CL overlap the observed 95% confidence limit?; ND = None Detected = $\leq$ 2.0 ug/l (After Quinn et al 1985).

Table 23. Model Simulations for Copper (ug/l) for October 8, 1985 including Confidence Limits for Headwater Uncertainty

STATION	STATE	OBSERVED (*)	OBSERVED 95% CL	PREDICTED	PREDICTED 95% CL	Y/N
1	T			1.63		
	D	ND		1.37	0.30-2.45	
	P	0.63	0.35-0.90	0.26	0.06-0.45	Y
2	T	16.50		16.51		
	D	9.15	8.69-9.61	10.05	9.04-11.1	Y
	P	7.35	6.15-8.55	6.45	5.80-7.10	Y
3	T	13.55		13.38		
	D	8.02	7.45-8.58	8.61	7.65-9.58	Y
	P	5.53	4.11-6.95	4.77	4.23-5.30	Y
4	T	12.84		15.01		
	D	7.26	6.51-8.01	8.93	8.04-9.81	N
	P	5.58	3.06-8.11	6.09	5.48-6.69	Y
5	T	13.13		15.63		
	D	7.79	7.01-8.56	8.90	8.02-9.78	Y
	P	5.34	3.90-6.81	6.73	6.06-7.40	Y
6	T	13.81		16.06		
	D	8.04	7.70-8.38	8.85	7.98-9.73	Y
	P	5.77	5.04-6.48	7.20	6.49-7.91	N
7	T	14.48 (13.3)		16.45		
	D	8.03	7.83-8.23	8.84	7.96-9.71	Y
	P	6.45 (5.30)	4.00-6.60	7.62	6.86-8.37	N
8	T	14.21 (14.5)		16.79		
	D	8.17	7.66-8.68	8.83	7.78-9.49	Y
	P	6.04 (6.38)	5.81-6.95	7.97	7.31-8.91	N
9	T	15.15		17.11		
	D	9.19	7.89-10.5	8.61	7.76-9.40	Y
	P	5.96	5.07-6.84	8.50	7.66-9.34	N

T = Total; D = Dissolved; P = Particulate; * Modified average based on observed data falling within the 95% confidence limit (95% CL); Y/N = Yes/No Does the predicted 95% CL overlap the observed 95% confidence limit?; ND = None Detected = ≤ 2.0 ug/l (After Quinn et al 1985).

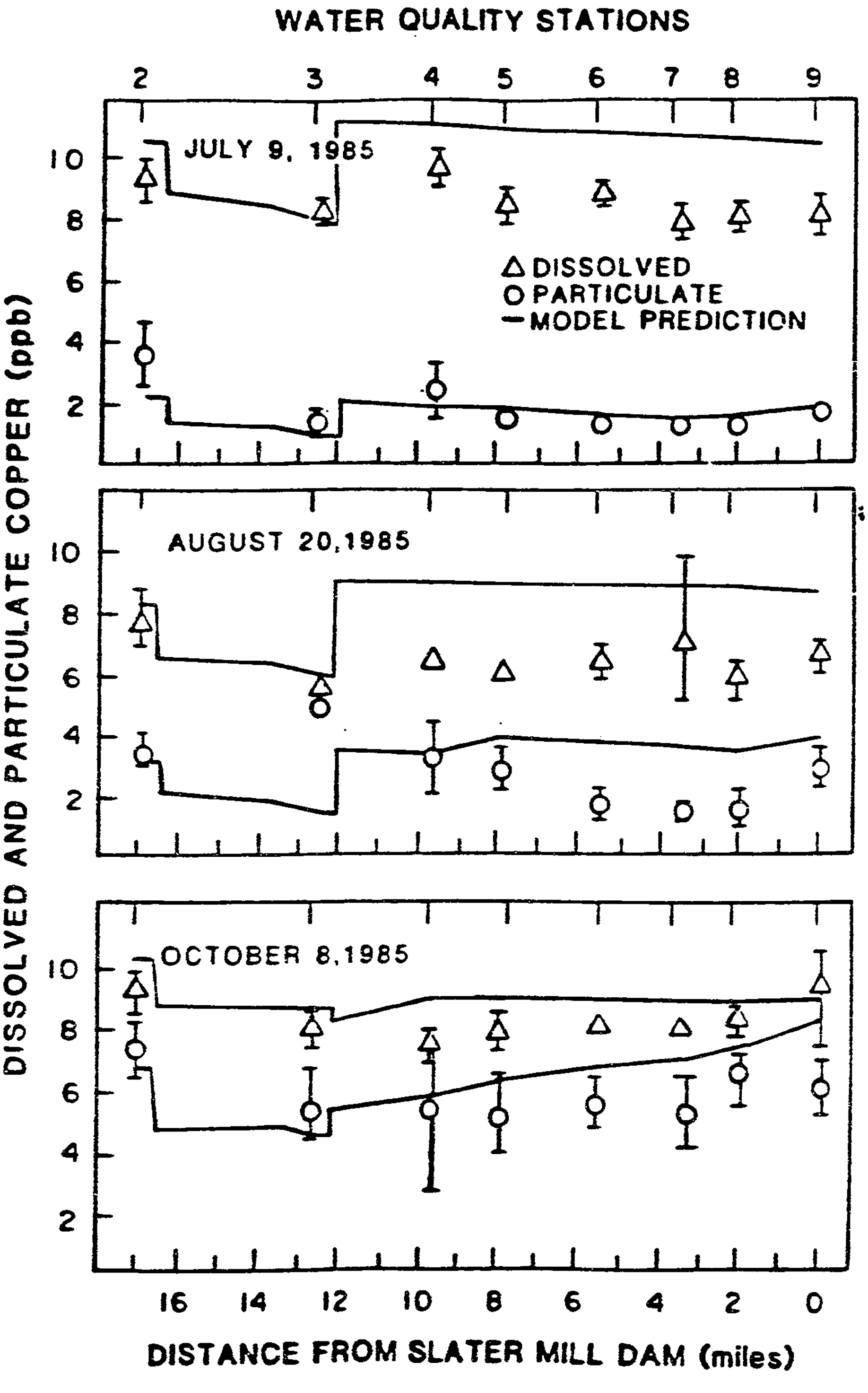

Figure 10 Copper Profiles with 95% Confidence Limits and Model Simulations

Table 24. Model Simulations for Lead (ug/l) for July 9, 1985 including Confidence Limits for Headwater Uncertainty

STATION	STATE	OBSERVED (*)	OBSERVED 95% CL	PREDICTED	PREDICTED 95% CL	Y/N
1	T			0.79		
	D	ND		0.42	0.26-0.58	
	P	0.63 (0.54)	0.48-0.59	0.37	0.22-0.50	Y
2	T			2.10		
	D	ND		0.53	0.39-0.67	
	P	1.85	1.54-2.16	1.56	1.15-1.98	Y
3	T			1.56		
	D	ND		0.50	0.36-0.64	
	P	1.52	1.33-1.72	1.06	0.77-1.36	Y
4	T			1.48		
	D	ND		0.34	0.25-0.43	
	P	1.99 (1.54)	1.23-1.85	1.14	0.84-1.44	Y
5	T			1.51		
	D	ND		0.34	0.25-0.43	
	P	1.60	0.91-2.28	1.17	0.86-1.48	Y
6	T			1.38		
	D	ND		0.34	0.25-0.43	
	P	1.12	0.71-1.53	1.04	0.76-1.31	Y
7	T			1.27		
	D	ND		0.34	0.25-0.43	
	P	0.83	0.34-1.31	0.93	0.69-1.18	Y
8	T			1.21		
	D	ND		0.34	0.25-1.10	
	P	1.24 (0.92)	0.60-1.24	0.87	0.64-0.43	Y
9	T			1.41		
	D	ND		0.34	0.25-0.42	
	P	2.44	1.18-3.68	1.07	0.79-1.36	Y

T = Total; D = Dissolved; P = Particulate; * Modified average based on observed data falling within the 95% confidence limit (95% CL); Y/N = Yes/No Does the predicted 95% CL overlap the observed 95% confidence limit?; ND = None Detected = $\leq$ 0.5 ug/l (After Quinn et al 1985).

Table 25. Model Simulations for Lead (ug/l) for August 20, 1985 including Confidence Limits for Headwater Uncertainty

STATION	STATE	OBSERVED (*)	OBSERVED 95% CL	PREDICTED	PREDICTED 95% CL	Y/N
1	T			1.29		
	D	ND		0.59	0.30-0.65	
	P	1.05 (0.79)	0.66-0.92	0.70	0.36-0.77	Y
2	T			3.36		
	D	ND		1.05	0.13-1.80	
	P	2.87	0.43-5.29	2.31	0.29-3.97	Y
3	T			2.46		
	D	ND		0.93	0.15-1.53	
	P	4.51 (2.56)	1.56-3.57	1.53	0.26-2.54	Y
4	T			2.58		
	D	ND		0.64	0.19-0.99	
	P	3.56 (1.51)	0.06-2.97	1.94	0.58-3.01	Y
5	T			2.60		
	D	ND		0.64	0.19-0.99	
	P	1.96	1.05-2.86	1.96	0.58-3.04	Y
6	T			2.34		
	D	ND		0.65	0.20-1.00	
	P	1.47 (1.26)	0.98-1.53	1.70	0.52-2.62	Y
7	T			2.12		
	D	ND		0.64	0.20-1.00	
	P	1.50	1.05-1.95	1.47	0.45-2.28	Y
8	T			2.99		
	D	ND		0.64	0.20-1.00	
	P	1.10	0.73-1.48	1.34	0.41-2.08	Y
9	T			2.34		
	D	ND		0.62	0.19-0.96	
	P	1.95	1.64-2.26	1.72	0.53-2.65	Y

T = Total; D = Dissolved; P = Particulate; * Modified average based on observed data falling within the 95% confidence limit (95% CL); Y/N = Yes/No Does the predicted 95% CL overlap the observed 95% confidence limit?; ND = None Detected = ≤ 0.5 ug/l (After Quinn et al 1985).

Table 26. Model Simulations for Lead (ug/l) for October 8, 1985 including Confidence Limits for Headwater Uncertainty

STATION	STATE	OBSERVED (*)	OBSERVED 95% CL	PREDICTED	PREDICTED 95% CL	Y/N
1	T	2.16		2.16		
	D	0.34	0.11-0.56	1.11	0.66-1.54	N
	P	1.82	1.19-2.45	1.06	0.63-1.47	Y
2	T	7.95		7.97		
	D	1.81	1.60-2.00	1.86	1.70-2.01	Y
	P	6.14	5.68-6.61	6.11	5.59-6.62	Y
3	T	7.37 (7.20)		6.76		
	D	1.59 (1.47)	1.42-1.47	1.76	1.59-1.93	N
	P	5.78 (5.73)	5.04-6.41	5.00	4.51-5.49	Y
4	T	7.68		7.23		
	D	1.70	1.47-1.92	1.61	1.46-1.76	Y
	P	5.98	4.75-7.20	5.62	5.09-6.15	Y
5	T	7.79 (8.30)		7.83		
	D	1.80	1.45-2.13	1.60	1.45-1.76	Y
	P	5.99 (6.50)	5.66-7.30	6.23	5.64-6.81	Y
6	T	8.19 (9.22)		8.28		
	D	1.77 (1.80)	1.76-1.83	1.60	1.45-1.75	N
	P	6.42	4.55-7.44	6.68	6.05-7.30	Y
7	T	9.99		8.67		
	D	1.83	1.75-1.92	1.60	1.45-1.75	Y
	P	8.16	4.35-12.0	7.07	6.40-7.73	Y
8	T	9.76 (10.56)		9.00		
	D	1.83 (1.75)	1.65-1.86	1.60	1.43-1.73	Y
	P	7.93 (8.81)	7.30-10.3	7.40	6.89-8.32	Y
9	T	9.23 (9.51)		9.58		
	D	1.82	1.71-1.93	1.58	1.43-1.73	Y
	P	7.41 (7.69)	7.29-8.09	8.00	7.24-8.75	Y

T = Total; D = Dissolved; P = Particulate; * Modified average based on observed data falling within the 95% confidence limit (95% CL); Y/N = Yes/No Does the predicted 95% CL overlap the observed 95% confidence limit?; ND = None Detected = ≤ 0.5 ug/l (After Quinn et al 1985).

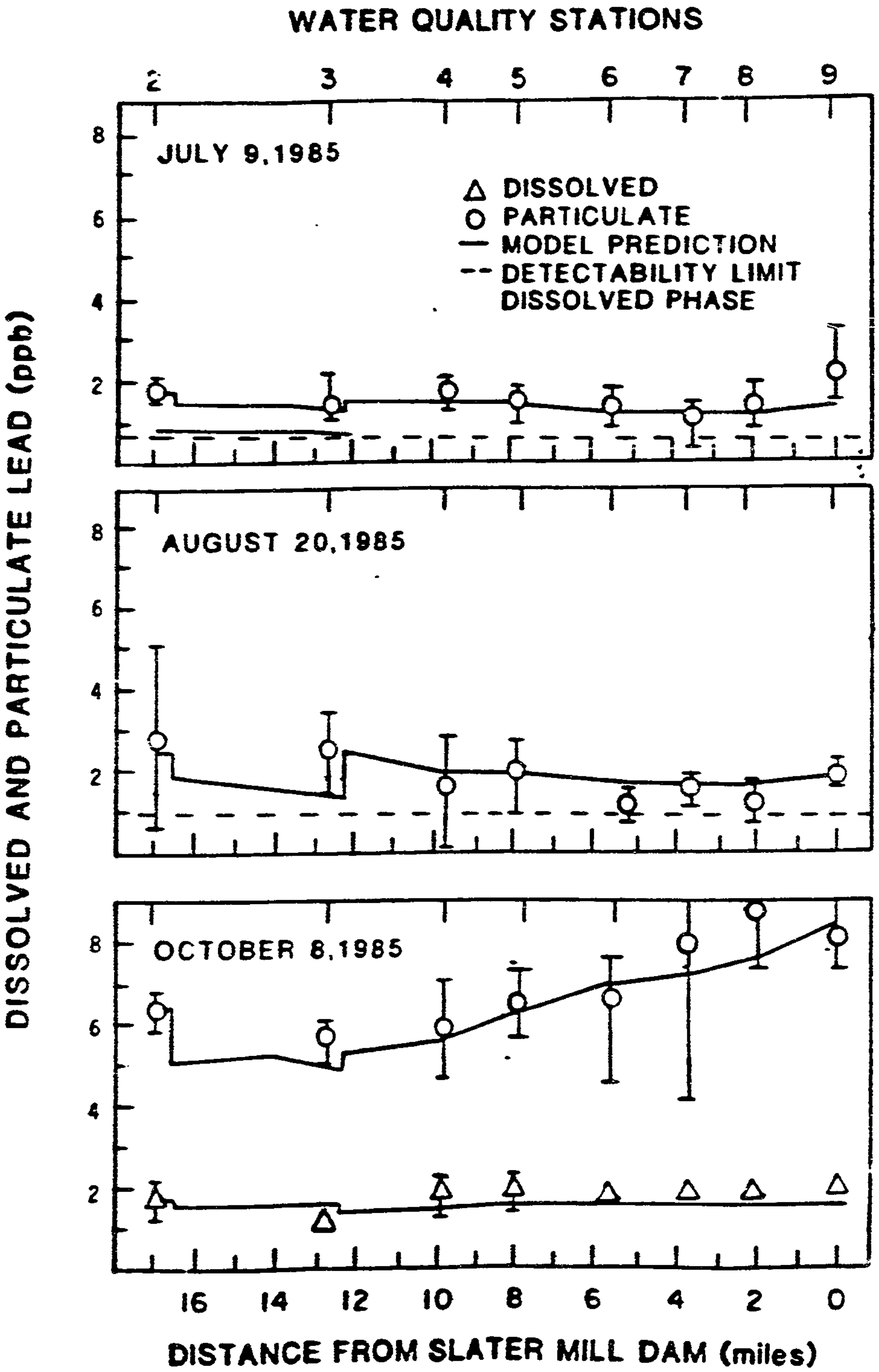

Figure 11 Lead Profiles with 95% Confidence Limits and Model Simulations

Table 27. Model Simulations for Nickel (ug/l) for July 9, 1985 including Confidence Limits for Headwater Uncertainty

STATION	STATE	OBSERVED (*)	OBSERVED 95% CL	PREDICTED	PREDICTED 95% CL	Y/N
1	T			3.00		
	D	ND		2.73	0.00-5.45	
	P	ND		0.27	0.00-0.54	
2	T	34.47		34.42		
	D	29.30	28.5-30.2	30.57	25.9-35.3	Y
	P	5.17	0.75-9.59	3.85	3.27-4.44	Y
3	T	26.83 (23.73)		24.08		
	D	20.40	17.4-23.4	19.97	16.5-23.5	Y
	P	6.43 (3.33)	0.00-8.18	4.11	3.41-4.83	Y
4	T	22.65 (21.93)		22.91		
	D	20.70	18.7-22.7	20.76	17.4-24.2	Y
	P	1.95 (1.23)	0.53-1.94	2.15	1.80-2.51	Y
5	T	21.22 (20.90)		22.83		
	D	19.40	18.6-20.2	20.76	17.4-24.2	Y
	P	1.82 (1.50)	1.21-1.80	2.07	1.73-2.41	Y
6	T	20.33 (19.23)		22.26		
	D	18.40 (17.78)	6.80-18.8	19.89	16.6-23.2	Y
	P	1.93 (1.45)	1.37-1.53	2.37	1.98-2.77	N
7	T	21.27 (19.50)		21.88		
	D	18.50 (16.73)	14.6-18.9	19.19	16.1-22.4	Y
	P	2.77	0.34-5.20	2.69	2.25-3.14	Y
8	T	17.80 (17.35)		21.24		
	D	16.10	15.4-16.8	18.31	15.6-21.8	Y
	P	1.70 (1.25)	0.86-1.63	2.93	2.45-3.41	N
9	T	16.98		21.09		
	D	15.80	12.6-18.9	18.99	15.9-22.1	Y
	P	1.18	0.86-1.50	2.10	1.76-2.45	N

T = Total; D = Dissolved; P = Particulate; * Modified average based on observed data falling within the 95% confidence limit (95% CL); Y/N = Yes/No Does the predicted 95% CL overlap the observed 95% confidence limit?; ND = None Detected = Particulate $\leq$ 1.0 ug/l and Dissolved $\leq$ 5.0 ug/l (After Quinn et al 1985).

Table 28. Model Simulations for Nickel (ug/l) for August 20, 1985 including Confidence Limits for Headwater Uncertainty

STATION	STATE	OBSERVED (*)	OBSERVED 95% CL	PREDICTED	PREDICTED 95% CL	Y/N
1	T	6.84 (5.73)		5.73		
	D	6.42 (5.23)	4.53-5.92	5.45	4.31-6.59	Y
	P	ND		0.28	0.22-0.33	
2	T	34.73 (30.07)		30.03		
	D	33.30 (28.65)	24.7-32.6	27.66	23.9-31.4	Y
	P	1.43	1.33-1.52	2.37	2.05-2.69	N
3	T	24.83 (23.94)		21.31		
	D	22.60 (21.71)	20.5-22.9	19.89	17.1-22.7	Y
	P	2.23	1.77-2.69	1.42	1.22-1.62	N
4	T	26.41		22.12		
	D	25.00	24.1-26.0	21.19	18.7-23.7	N
	P	1.41	0.89-1.92	0.93	0.82-1.04	Y
5	T	27.04		21.99		
	D	25.50	24.4-26.5	21.09	18.6-23.6	N
	P	1.54	1.26-1.81	0.90	0.79-1.01	N
6	T	25.73 (26.03)		21.51		
	D	24.50 (24.86)	23.5-26.2	20.31	17.9-22.7	N
	P	1.23 (1.17)	1.12-1.23	1.20	1.06-1.34	Y
7	T	21.40		21.21		
	D	20.50	19.7-21.4	19.65	17.3-22.0	Y
	P	ND		1.56	1.37-1.74	
8	T	20.95		21.00		
	D	20.20	18.5-22.0	19.27	17.0-21.6	Y
	P	ND		1.73	1.53-1.94	
9	T	21.66 (21.52)		20.19		
	D	20.40	18.6-22.2	19.16	16.9-21.5	Y
	P	1.26 (1.12)	0.92-1.31	1.03	0.91-1.15	Y

T = Total; D = Dissolved; P = Particulate; *** Modified average based on observed data falling within the 95% confidence limit (95% CL);** Y/N = Yes/No Does the predicted 95% CL overlap the observed 95% confidence limit?; ND = None Detected = Particulate ≤ 1.0 ug/l and Dissolved ≤ 5.0 ug/l (After Quinn et al 1985).

Table 29. Model Simulations for Nickel (ug/l) for October 8, 1985 including Confidence Limits for Headwater Uncertainty

STATION	STATE	OBSERVED (*)	OBSERVED 95% CL	PREDICTED	PREDICTED 95% CL	Y/N
1	T			3.00		
	D	ND		2.91	0.00-5.81	
	P	ND		0.09	0.00-0.19	
2	T	25.83		25.82		
	D	22.90	20.9-24.9	23.23	21.0-25.5	Y
	P	2.93	2.47-3.40	2.59	2.35-2.84	Y
3	T	22.81 (22.05)		20.71		
	D	20.45 (19.79)	18.9-20.6	18.89	16.8-21.0	Y
	P	2.36	1.62-3.09	1.82	1.61-2.02	Y
4	T	23.33		20.47		
	D	20.92	19.0-22.9	18.30	16.3-20.3	Y
	P	2.41	1.19-3.62	2.17	1.93-2.41	Y
5	T	25.18		20.62		
	D	22.40	20.4-24.4	18.22	16.2-20.4	Y
	P	2.78	2.02-3.57	2.40	2.13-2.66	Y
6	T	24.54		20.61		
	D	21.52	18.8-24.3	18.06	16.1-20.1	Y
	P	3.02	2.14-3.90	2.55	2.27-2.84	Y
7	T	26.28		20.69		
	D	22.71	21.0-24.4	17.99	16.0-20.0	N
	P	3.57	1.61-5.53	2.70	2.40-3.00	Y
8	T	26.26		20.79		
	D	23.31	21.2-25.5	17.97	15.5-19.3	N
	P	2.95	2.24-3.65	2.82	2.53-3.15	Y
9	T	26.74		20.27		
	D	23.70	20.1-27.3	17.30	15.4-19.2	N
	P	3.04	2.54-3.53	2.97	2.65-3.30	Y

T = Total; D = Dissolved; P = Particulate; * Modified average based on observed data falling within the 95% confidence limit (95% CL); Y/N = Yes/No Does the predicted 95% CL overlap the observed 95% confidence limit?; ND = None Detected = Particulate $\leq$ 1.0 ug/l and Dissolved $\leq$ 5.0 ug/l (After Quinn et al 1985).

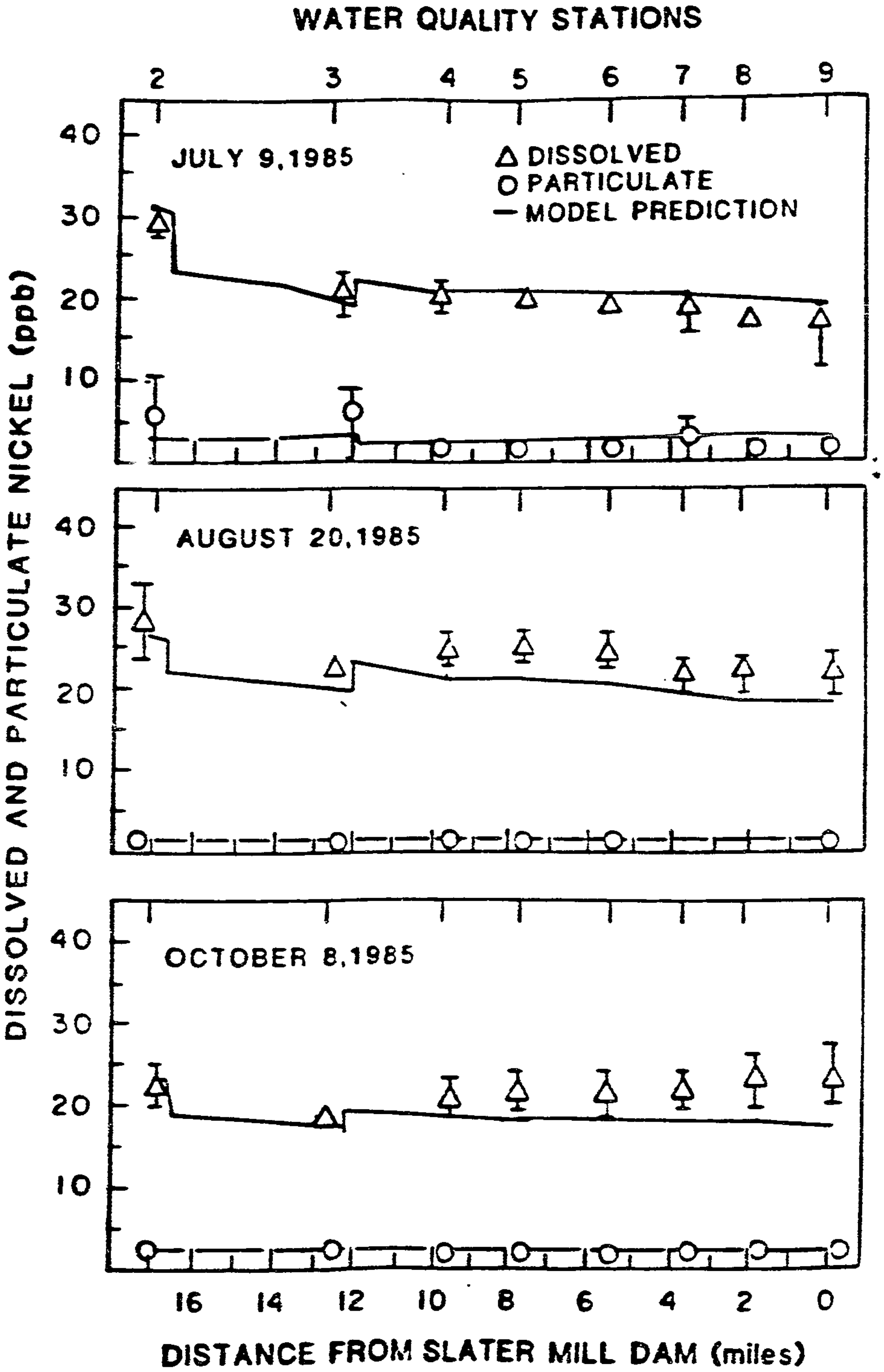

Figure 12 Nickel Profiles with 95% Confidence Limits and Model Simulations

The baseline model prediction is given for average conditions (headwater and point source inputs). The sediment transport coefficients were estimated from the empirical relationships developed previously and the partition coefficients were set equal to the average values reported in Table 14. Concentrations were set to zero in the groundwater inflow.

In addition, the model was run for maximum and minimum headwater concentrations based on the observed 95% confidence limits at WQS 1 and WQS 2. A comparison between the observed and predicted confidence limits is made in each of the tables (Table 15-29). If the range of limits overlap at the majority of stations, the model simulations are accepted and the model is considered calibrated for the specific trace metal.

This occurred for all the trace metals with the exception of copper. For example, cadmium for the July 9, 1985 survey had a total of 17 comparisons (9 particulate and 8 dissolved) with one dissolved sample nondetectable. Of these 15 of 17 indicated an overlap of predicted and observed confidence limits or 88%. For all surveys cadmium indicated 45 of 52 observations overlapped or 87%. For the remaining metals the results were the following: chromium 38 of 43 (88%); copper 23 of 51 (45%); lead 33 of 36 (92%); and nickel 37 of 47 (75%). For the points that were not successful (ie. Did not have limits that overlapped), the majority of limits were within 10%. For instance, nickel for August 20, 1985 at WQS 6 for the dissolved fraction, had an observed lower limit of 23.5 and the predicted upper limit of 22.7 or a 3% difference.

Based on the results of the simulations and the accompanying comparison of confidence limits, the model is considered calibrated for cadmium, chromium, lead and nickel. This is based on the environmental variability at the headwater stations, primarily WQS 2 at the Massachusetts/Rhode Island state line.

The most important process controlling copper's fate and transport is sorption. Copper demonstrates a strong affinity for hydrous iron and manganese oxides, clays, carbonate minerals and organic matter. In unpolluted waters, such as the Branch River, copper's sorption is typically controlled by clay minerals and hydrous iron and manganese oxides. In polluted waters, such as the Blackstone River, sorption will be governed by organic materials (Callahan et al., 1979). This is not unlike all trace metals.

Since the modeling was successful, that is it adequately described the adsorption/desorption mechanism for the other trace metals, it is a reasonable assumption it should have been equally successful for copper. It was not. The model consistently overpredicted copper for all three surveys from WQS 4 to 9. Since this was an overprediction, this does not indicate additional sources of copper, but indicates either a sink other than particulate settling not addressed by the model or problems with respect to input values.

There is no reason to believe a significant sink to copper exists in this area either by field observation, data, literature or previous work in other Rhode Island streams. Therefore, the second possibility was evaluated, that is the environmental variability of the Woonsocket STP.

Model simulations were made with the upper and lower 95% confidence limits for the Woonsocket STP discharge. These results are summarized in Tables 30-32 for the three surveys.

For the water quality stations below the STP (WQS 4 to 9), there are 36 points for comparison (18 particulate and 18 dissolved). For the earlier simulations based on headwater uncertainty 11 of 36 points were acceptable or 31%. For the simulations based on the Woonsocket STP uncertainty there were 26 of 36 or 72% accepted. For the points that were not successful (ie. did not have limits that overlapped), the majority of points had limits within 10%. It is concluded that the failure to simulate copper for the average baseline conditions is a direct result of the high uncertainty at the Woonsocket STP. If this uncertainty is taken into account by 95% confidence limits on the point source discharge, the model provides acceptable simulations for copper.

Table 30. Effect of the Woonsocket STP Uncertainty on the Model Simulations for Copper (ug/l) for July 9, 1985

STATION	STATE	OBSERVED (*)	OBSERVED 95% CL	PREDICTED	PREDICTED W STP 95% Lower CL	Y/N
1	T			1.34		
	D	ND		1.27		
	P	0.39 (0.35)	0.32-0.38	0.07		
2	T	14.07 (12.95)		12.93		
	D	10.30 (9.18)	8.15-10.2	10.78		
	P	3.77	2.78-4.77	2.15		
3	T	10.38 (9.69)		9.09		
	D	8.85 (8.16)	8.01-8.31	7.94		
	P	1.53	1.08-1.98	1.15		
4	T	12.04 (11.83)		13.41		
	D	9.57 (9.36)	9.07-9.65	10.93	8.22	Y
	P	2.47	1.54-3.40	2.48	1.87	Y
5	T	10.66 (10.30)		13.40		
	D	8.38 (8.16)	7.78-8.54	10.87	8.17	Y
	P	2.28 (2.14)	1.97-2.32	2.53	1.90	Y
6	T	10.09 (9.97)		13.04		
	D	8.71 (8.59)	8.37-8.81	10.80	8.14	Y
	P	1.38	1.24-1.39	2.24	1.69	N
7	T	9.15		12.76		
	D	7.86	7.38-8.35	10.76	8.11	Y
	P	1.29	1.02-1.57	2.00	1.51	Y
8	T	9.39 (9.17)		12.59		
	D	8.00 (7.78)	7.56-8.00	10.73	8.09	N
	P	1.39	1.29-1.49	1.86	1.40	Y
9	T	9.85 (9.59)		12.44		
	D	8.00	7.16-8.84	10.22	7.70	Y
	P	1.85 (1.59)	1.33-1.86	2.22	1.68	Y

T = Total; D = Dissolved; P = Particulate; * Modified average based on observed data falling within the 95% confidence limit (95% CL); Y/N = Yes/No Does the predicted 95% Lower CL based on the Woonsocket STP (W STP) uncertainty fall within or below the observed 95% confidence limit?; ND = None Detected = _ 2.0 ug/l (After Quinn et al 1985).

Table 31. Effect of the Woonsocket STP Uncertainty on the Model Simulations for Copper (ug/l) for August 20, 1985

STATION	STATE	OBSERVED (*)	OBSERVED 95% CL	PREDICTED	PREDICTED W STP 95% Lower CL	Y/N
1	T			1.55		
	D	ND		1.30		
	P	0.55	0.35-0.76	0.25		
2	T	11.38		11.36		
	D	7.86	6.73-8.99	8.33		
	P	3.52	2.85-4.20	3.02		
3	T	10.66 (11.22)		7.89		
	D	5.49 (5.68)	5.36-6.02	6.20		
	P	5.17 (5.54)	4.92-6.15	1.69		
4	T	10.16 (10.5)		13.73		
	D	6.78 (7.12)	6.73-7.51	9.17	6.09	Y
	P	3.38	1.93-4.82	3.56	3.03	Y
5	T	8.98 (8.84)		13.72		
	D	5.96 (5.82)	5.70-5.93	9.13	6.06	N
	P	3.02	2.34-3.70	4.60	3.05	Y
6	T	8.18		13.01		
	D	6.29	5.89-6.69	9.08	6.05	Y
	P	1.89	1.49-2.28	3.93	2.62	N
7	T	9.60 (9.68)		12.45		
	D	7.85	5.59-10.1	9.04	6.03	Y
	P	1.75 (1.83)	1.75-1.90	3.40	2.27	N
8	T	7.60		12.13		
	D	5.85	5.22-6.49	9.03	6.01	Y
	P	1.75	1.18-2.32	3.10	2.06	Y
9	T	9.44 (9.13)		12.54		
	D	6.39	5.99-6.79	8.63	5.76	Y
	P	3.05 (2.74)	2.42-3.06	3.90	2.61	Y

T = Total; D = Dissolved; P = Particulate; * Modified average based on observed data falling within the 95% confidence limit (95% CL); Y/N = Yes/No Does the predicted 95% Lower CL based on the Woonsocket STP (W STP) uncertainty fall within or below the observed 95% confidence limit?; ND = None Detected = _ 2.0 ug/l (After Quinn et al 1985).

Table 32. Effect of the Woonsocket STP Uncertainty on the Model Simulations for Copper (ug/l) for October 8, 1985

STATION	STATE	OBSERVED (*)	OBSERVED 95% CL	PREDICTED	PREDICTED W STP 95% Lower CL	Y/N
1	T			1.63		
	D	ND		1.37		
	P	0.63	0.35-0.90	0.26		
2	T	16.50		16.51		
	D	9.15	8.69-9.61	10.05		
	P	7.35	6.15-8.55	6.45		
3	T	13.55		13.38		
	D	8.02	7.45-8.58	8.61		
	P	5.53	4.11-6.95	4.77		
4	T	12.84		15.01		
	D	7.26	6.51-8.01	8.93	8.33	N
	P	5.58	3.06-8.11	6.09	5.68	Y
5	T	13.13		15.63		
	D	7.79	7.01-8.56	8.90	8.31	Y
	P	5.34	3.90-6.81	6.73	6.28	Y
6	T	13.81		16.06		
	D	8.04	7.70-8.38	8.85	8.27	Y
	P	5.77	5.04-6.48	7.20	6.72	N
7	T	14.48 (13.3)		16.45		
	D	8.03	7.83-8.23	8.84	8.25	Y
	P	6.45 (5.30)	4.00-6.60	7.62	7.11	N
8	T	14.21 (14.5)		16.79		
	D	8.17	7.66-8.68	8.83	8.24	Y
	P	6.04 (6.38)	5.81-6.95	7.97	7.44	N
9	T	15.15		17.11		
	D	9.19	7.89-10.5	8.61	8.04	Y
	P	5.96	5.07-6.84	8.50	7.94	N

T = Total; D = Dissolved; P = Particulate; * Modified average based on observed data falling within the 95% confidence limit (95% CL); Y/N = Yes/No Does the predicted 95% Lower CL based on the Woonsocket STP (W STP) uncertainty fall within or below the observed 95% confidence limit?; ND = None Detected = _ 2.0 ug/l (After Quinn et al 1985).

VII. DISCUSSION

The success of the modeling on the Blackstone River may be based on the response to the following question. Does the proposed model adequately represent the state of the natural system it purports to describe given the error and uncertainty associated with defining both the natural system and the model?

The TDS simulations were successful and, therefore, provide the validation of the flow profile and the procedure used to develop it (ie. Branch River USGS). This is not an assertion that the model mimics all aspects and components of the transport mechanisms as they occur naturally. Rather, it is a statement of scientific deduction based on empirical evidence describing both the model's output and the "output" of the natural system. The model could now be developed for simulation of selected nonconservative contaminants.

The sediment transport in this model is based on an empirical relationship between average stream velocity and a net sediment transport coefficient. The equations provide the modeler with the ability to estimate the net sediment transport coefficient at other stream velocities and, therefore, at other flows, such as the WLA low flow.

With respect to suspended solids, the first two surveys (July and August) had very similar solids profiles. The final survey (October) had much higher SS values which coincided with higher river flows and as a result resuspension of sediments in the lower reaches.

The sediment transport relationships were tested by the model's ability to adequately simulate the high and low flows observed during the three surveys. The test is, therefore, by performance and not through statistics, since additional solids data are necessary to statistically test the relationships.

The model adequately describes the suspended solids profiles for the three surveys and can be considered calibrated. This is not to say that the model describes the natural system on a micro scale. Rather, the model's description of the external attributes of the environment agree well with the description obtained by making field measurements of the natural system. With the sediment transport in place the model was extended to the simulation of the selected trace metals.

As discussed previously, several researchers have attempted to relate metal partitioning to environmental factors. The only statistically significant relationship appeared to be an inverse relationship with suspended solids. It would be advantageous to develop these equations, since the partitioning coefficient (Kp) could then be adjusted as stream conditions change. For instance, during the WLA low flow one would expect a change in a solids profile resulting from two opposing factors, an increase of settling and a reduction in dilution. A set of empirical relationships for trace metals was developed successfully during an earlier application of PAWTOXIC on the Pawtuxet River (Wright and McCarthy, 1985). However, in a second study on the Pawcatuck River statistically significant relationships could not be developed (Wright and McCarthy, 1986), because metals and solids concentrations were relatively constant throughout the river. Average partition coefficients were used in that study.

For the Blackstone River the conditions were similar to the Pawcatuck River. Therefore, empirical relationships could not be generated and average values for Kp were used (Table 14). It is recommended that the overall average Kp for the study be used during any future applications of the Blackstone model.

In reference to groundwater contributions of trace metals, in a previous study on the Pawtuxet River groundwater sources were important. Groundwater concentrations were used in the last stage of calibration for final model adjustment. In the Blackstone River the model performed well with only contaminant sources from headwaters and point sources and entrainment from the streambed. Groundwater concentrations were always set to zero. At no time during the model calibration did groundwater contributions appear to be significant.

The following is offered in support of this assumption (ie. Groundwater concentrations = 0.0). It is difficult to estimate average groundwater trace metal concentrations based on a few monitoring wells. A less expensive and perhaps better way to obtain the average quality of groundwater entering streams is to sample perennial tributary streams during periods when all of the streamflow is constituted of groundwater inflow. Streamflow unaffected by releases from water stored in swamps, reservoirs, or snowpack may be assumed to be essentially ground water runoff 3 to 5 days after a rainfall. A sample of baseflow near the outlet of a basin will provide an integrated sample of water from the entire watershed, whereas a well at the same location may not. Observation wells commonly sample relatively narrow flow tubes.

Based on the results of flow profiles in this report, the Blackstone River in Rhode Island appears to be an effluent stream, which by definition receives water from the groundwater. WQS 1 on the Branch River best fits the conditions described above. Although the Branch River receives the discharge from the Burriville STP several miles upstream, this facility provides advanced waste treatment and is relatively small in comparison to the groundwater contribution to the system. At best the STP's presence might provide a more conservative estimate of groundwater concentrations which would be acceptable in a sensitivity analysis.

The two low flow surveys (July and August) were used to establish the groundwater inflow concentrations. These averages are presented in Table 33. The results of the simulations are

Table 33. Branch River WQS 1 Metal Concentrations (μg/l) Used for Background Groundwater Sensitivity Analysis

Metal	6/9/85	8/20/85	Average
Cadmium	0.02	0.24	0.13
Chromium	1.18	0.60	0.89
Copper	0.35	0.55	0.51
Lead	0.54	0.79	0.67
Nickel	0.00	5.73	2.87

presented for each survey in Table 34. The overall average for the Blackstone based on WQS 3-9 are compared for both average baseline conditions with groundwater concentrations set to zero and set to the values of Table 33. The increase to the absolute stream concentration ranged from no increase for copper in August to a high of 0.90 ug/l (3.9%) for nickel in June. The average change in concentration was 0.17 ug/l. All comparisons with respect to the percent increase were in the range from 0.0 to 3.9% with one exception. Lead in June had an increase from 1.40 ug/l to 1.51 ug/l or 7.3%. The average percent increase was 2.1%.

The impact of the groundwater is minor in comparison to the uncertainty in the headwater concentrations. Any gradient that may occur as a function of groundwater entry is hidden by the high headwater concentration and the environmental variability of the system.

Based on the results presented in earlier and the groundwater analysis above, the Blackstone model is considered calibrated for the selected trace metals with consideration to headwater uncertainty and with respect to copper point source uncertainty.

It is important to note that in previous modeling efforts with PAWTOXIC samples were composited in almost all cases. In this survey samples were analyzed independently providing an

Table 34. Sensitivity Analysis with Respect to Groundwater Inflow

Metal	Average[a] Predicted with GW = 0.0	Average[a] Predicted with GW = WQS 1[b]	Difference µg/l (percent)
6/9/85			
Cadmium	0.51	0.53	0.02 (3.8)
Chromium	5.05	5.18	0.13 (2.5)
Copper	12.39	12.46	0.07 (0.6)
Lead	1.40	1.51	0.11 (7.3)
Nickel	21.90	22.80	0.90 (3.9)
8/20/85			
Cadmium	0.64	0.66	0.02 (3.1)
Chromium	5.70	5.82	0.12 (2.1)
Copper	12.21	12.21	0.00 (0.0)
Lead	2.49	2.45	0.05 (1.6)
Nickel	21.33	21.79	0.46 (2.1)
10/8/85			
Cadmium	1.33	1.34	0.01 (0.7)
Chromium	10.29	10.42	0.13 (1.2)
Copper	15.78	15.83	0.05 (0.3)
Lead	8.19	8.29	0.10 (1.2)
Nickel	20.59	20.93	0.34 (1.6)

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a Average Predicted from WQS 3-9

b WQS 1 Branch River Average from Table 33 estimate of the environmental variability by station and a means for interpreting anomalies in the reported averages. On several occasions decisions to eliminate data points from the reported average were based on a statistical test (95% confidence limits).

The statement that the model is calibrated for the selected metals is not an assertion that the model describes metal-particle interactions as they truly occur. It is, however, a judgement based on sound engineering analysis and scientific evidence which suggests that the model's description of the state of the system agrees well with the description obtained by field sampling and analysis.

A comprehensive sensitivity analysis of the PAWTOXIC has been performed elsewhere (Wright and McCarthy, 1985; McCarthy, 1986).

The ideal test of a model would be the superposition of predicted distributions upon observed distributions in a more rigorous manner than completed here. An attempt has been made to do this for the PAWTOXIC model on the Pawtuxet River via Monte Carlo analysis. The results are detailed elsewhere (McCarthy, 1986). Basically, that work concluded that insufficient data was available to define the distributions of the water quality forcing functions, such as variability of contaminant concentration and flow for headwaters, point sources, and nonpoint sources.

If this information were in hand, a hierarchal approach can be taken to better define the factors which influence the predictions of each parameter. That is, effort should be placed first on those forcing functions which the modeler feels have the most impact on the parameter in question with subsequent analysis of less-important functions until an acceptable match of predicted distribution and observed distribution is made. The best approach would be to start with streamflow and move to increasingly complex parameters. It is evident that this approach would be very data-intensive and given the available resources impossible to achieve. However, if the quantifiable measures of model performance are to be obtained rationally and with meaning it is perhaps the only approach which makes sense.

VIII. CONCLUSIONS AND RECOMMENDATIONS

A one dimensional, steady state water quality model has been developed and applied to instream concentrations of conservative minerals, suspended solids and particle reactive substances. Appropriate hydraulic and water quality investigations were performed to provide the data for model calibration and validation to the Blackstone River in Rhode Island. Specifically, the parameters that were successfully simulated included total dissolved solids, suspended solids, cadmium, chromium, copper, lead and nickel. The field investigations were conducted over a 12 month period beginning in July 1985. The three intensive surveys occurred on July 9, August 20 and October 8, 1985.

The success of the model simulations was based on comparison of model prediction to field observation with consideration of the environmental variability of the data.

The model adequately represents the state of the Blackstone River with respect to the constituents analyzed. It is recommended for use as a regulatory tool in the conduction of, a WLA for the Blackstone River.

The water quality of the Blackstone River as it exits Massachusetts is clearly the controlling factor governing the water quality in Rhode Island. This will complicate considerably the development of the WLA scenario, especially, since the water quality at the state line is highly variable.

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Appendix A - User's Guide to PAWTOXIC

MODEL SETUP AND INPUT REQUIREMENTS

All the input data required by the program are in card form. The following paragraphs give details of the data required, with suggested parameter limits and explanations of program requirements.

TITLE DATA CARDS

All 12 cards are required. The first two cards are title cards, and columns 22-80 of these cards may be used to provide descriptive information on the simulation. Title cards 3 through 11 require either a yes or no in columns 10-12, right adjusted.

For each conservative mineral or toxic to be simulated enter the constituent name in columns 49-52 (e.g. TDS); enter the input data units (e.g. mg/l) in columns 57-60.

Card 12 must read ENDTITLE.

PROGRAM ANALYSIS CONTROL DATA

The first five cards control program options. If any characters other than those shown below are inserted in the first four columns of these cards, the action described will <u>not</u> occur.

LIST - Card 1, list the input data

WRIT - Card 2, write the intermediate output report, WRPT2

FLOW - Card 3, use flow augmentation

STEA - Card 4, shows this is a steady-state simulation. If it is <u>not</u> to be a steady-state, write DYNAMIC

SIMULATION and it is automatically a dynamic simulation.

TRAP - Card 5, cross-sectional data will be specified for each reach . If discharge coefficients are to be used for velocity and depth computations, write DISCHARGE COEFFICIENTS, beginning in column 1.

Card 6 specifies whether the user will input and/or output his data in metric units or English units. The value of 1 in card column 35 specifies metric input. The value of 1 in card column 80 specifies metric units for the output. Any value less than or equal to zero will specify English units.

The next four cards describe the stream system. There are two data fields per card, columns 26-35 and 71-80.

Card 7 defines the number of reaches into which the stream is broken down and the number of stream junctions (confluences) within the system.

Card 8 shows the number of headwater sources and the number of inputs or withdrawals within the stream system. The inputs can be small streams, wasteloads, etc. Withdrawals can be municipal water supplies, canals, etc. NOTE: Withdrawals must have a minus sign ahead of the flow in type 9 data and must be specified as withdrawals in type 4 data by setting IFLAG = 7 for that element.

Card 9 contains the time step interval in hours and the length of the computational element in miles (kilometers). For steady-state computations leave the time step interval blank.

The maximum route time for dynamic simulations is on card 10, and represents the approximate time in hours required for a particle of water to travel from the most upstream point in the system to the most downstream point. In steady-state solutions enter the maximum number of iterations required for convergence. Thirty iterations should be sufficient in most cases. Also on card 10 is the time increment in hours for intermediate summary reports of concentration profiles. For the steady-state solutions, leave this blank.

The next three cards control program options. If any characters other than those shown below are inserted in the first four columns of these cards, the action described will not occur.

SIMU - Card 11, the settling/resuspension coefficient, CK6, will be calculated by the program.

GENE - Card 12, Incremental inflow will be calculated from gage and headwater flows. The number of USGS gages is required in columns 71-80.

VARI - Card 13, partition coefficients for the toxic parameters will be calculated by the program.

The last card must read ENDATA1.

REACH IDENTIFICATION AND RIVER MILE DATA

The cards of this group identify the stream reach system by name and river mile by listing the stream reaches from the most upstream point in the system to the most downstream point. When a junction is reached, the order is continued from the upstream point of the tributary. There is one card per reach. The following information is on each card:

Reach order or number	Columns 16-20
Reach identification or name	Columns 26-40
River mile at head of reach	Columns 51-60
River mile at end of reach	Columns 71-80

A very useful feature of QUAL-II pertaining to modifications of reach identification once the system has been coded is: reaches may be subdivided (or added) without renumbering the reaches for the whole system. If, for example, it is desired to subdivide the river reach originally designated as REACH 3 into two reaches, the subdivision is made by calling the upstream portion REACH 3 and the "new reach" downstream REACH 3.1. Up to nine such subdivisions can be made per reach (3.1-3.9); thus REACH 3 (or any other reach) can be subdivided into as many as 10 reaches numbered 3, 3.1-3.9.

This group of cards must end with ENDATA2.

COMPUTATIONAL ELEMENTS FLAG FIELD DATA

This group of cards identifies each type of computational element in each reach. These data allow the proper form of routing equations to be used by the program. There are seven element types allowed, they are listed below.

IFLAG	Type
1	Headwater source element
2	Standard element, incremental inflow only
3	Element on mainstream immediately upstream of a junction
4	Junction element
5	Most downstream element
6	Input element
7	Withdrawal element

Each card in this group (one for each reach), contains the following informtion:

Reach order or number	Columns 16-20
Number of elements in the reach	Columns 26-30
Element type (these are numbers of a set, identifying each element by type)	Columns 41-80

Remember that any of these reaches can be subdivided, if necessary, after the data has been coded without necesitating the renumbering of the reaches (see REACH IDENTIFICATION AND RIVER MILE DATA).

This card group must end with ENDATA3.

HYDRAULIC DATA

Two options are available to describe the hydrologic characteristics of the system. The first option utilizes a functional representation while the second option utilizes a geometric representation. The option desired must be specified on card 5 of the Program Analysis and Control Data Cards.

If the first option is selected, velocity is calculated as $V = aQ^b$ and depth is found by $D = \alpha Q$. Each card represents one reach and contains the values of a, b, α, and β, as described below.

Reach order or number	Columns 16-20
a, coefficient for velocity	Columns 31-40
b, exponent for velocity	Columns 41-50
α, coefficient for depth	Columns 51-60
β, exponent for depth	Columns 61-70
Mannings "n" for reach (Default for Mannings "n" is 0.020)	Columns 71-80

The coefficients should be expressed to relate velocity, depth, and discharge units as follows:

	PARAMETER UNITS		
System	Q	V	D
Metric	m^3/sec	m/sec	m
English	ft^3/sec	ft/sec	ft

If the second option is selected, each reach is represented as a trapezoidal channel. These cards are then used to specify the trapezoidal crossection (bottom width and side slope), the channel slope and the Manning's "n" corresponding to the reach. The program computes the velocity and depth from this data using Manning's Equation and the Newton Raphson (iteration) method. One card must be prepared for each reach as follows:

Reach order or number	Columns 16-20
Side slope 1(run/rise)	Columns 31-40
Side slope 2(run/rise)	Columns 41-50
Bottom width of channel feet (meters)	Columns 51-60
Channel slope, ft/ft (m/m)	Columns 61-70
Manning n (Default: 0.020)	Columns 71-80

This group of cards (TYPE 4 DATA) must end with ENDATA4.

SETTLING/RESUSPENSION AND PARTITION COEFFICIENTS

This group of cards provides the settling/resuspension coefficient if the option is chosen to input this by reach. The slope and intercept of the velocity-settling coefficient relationship are provided if the option is chosen to have the coefficient generated by the program. Partition coefficients for the toxics must be included if the option to provide them externally is chosen. One card must be prepared for each reach as follows:

Reach order or number	Columns 26-30
CK6, Settling/Resuspension Coefficient	Columns 33-38
E, Intercept of velocity-settling Relationship	Columns 39-44
F, Slope of velocity-settling relationship	Columns 45-50
Partition coefficient for toxic 1	Columns 51-56
Partition coefficient for toxic 2	Columns 57-62
Partition coefficient for toxic 3	Columns 63-68
Partition coefficient for toxic 4	Columns 69-74
Partition coefficient for toxic 5	Columns 75-80

This group of cards must end with ENDATA5.

SUSPENDED SOLIDS/PARTITION COEFFICIENT RELATIONSHIP COEFFICIENTS

These cards provide the coefficient and exponent of the suspended solids/partition coeficient relationship for the five toxics. Five cards are prepared as follows:

Toxic reference number	Columns 26-30
Exponent for SS	Columns 31-40
Coefficient for SS	Columns 41-50

This group of cards must end with ENDATA5A.

INCREMENTAL INFLOW DATA

This group of cards, one per reach, accounts for the additional flows into the system not represented by point source inflows or headwaters. These inflows which are assumed to be uniformly distributed over the reach are basically groundwater inflows and/or distributed surface runoff that can be assumed to be approximately constant through time.

Flow rate and conservative mineral concentration of the flow are taken into account. The flow rate is not necessary if the option is chosen to have the model calculate the rate. Each card contains the following information:

Reach order or number	Columns 26-30
Incremental Inflow	Columns 31-35
Conservative I	Columns 41-45
Conservative II	Columns 46-50
Conservative III	Columns 51-55

This group of cards must end with ENDATA6

INCREMENTAL INFLOW FOR SUSPENDED SOLIDS AND TOXICS

This card group provides concentrations of suspended solids and toxics in the incremental inflow for each reach. Each card contains the following information:

Reach order or number	Columns 20-24
Suspended solids	Columns 25-32
Toxic 1	Columns 33-40
Toxic 2	Columns 41-48
Toxic 3	Columns 49-56
Toxic 4	Columns 57-64
Toxic 5	Columns 65-72

This group of cards must end with ENDATA6A

STREAM JUNCTION DATA

This group of cards is required if there are junctions or confluences in the stream system being simulated. Otherwise they may be deleted. The junctions are ordered starting with the most upstream junction. For systems containing a junction(s) on a tributary, the junctions must be ordered in manner indicated on Figure 1. ; that is, the junctions must be ordered so that the element numbers just downstream of the junction are specified in ascending order. In Figure1. , the downstream element number for Junction 1, is 82. There is one card per junction, and the following information is on each card:

Junction order or number	Columns 21-25
Junction name or identification	Columns 35-50
Order number of the last element in the reach immediately upstream of the junction (see Figure 1).	Columns 56-60

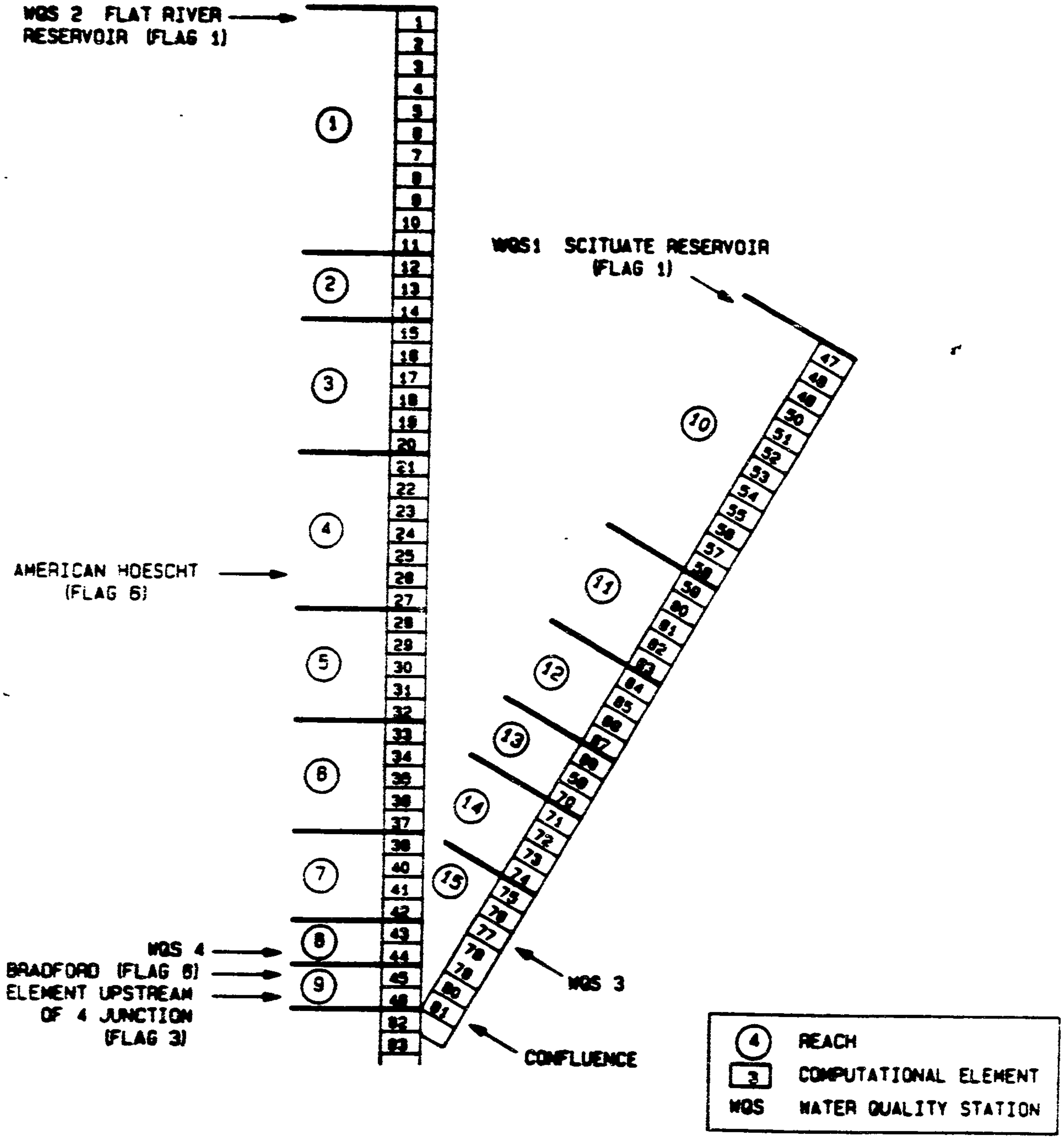

Figure 1. Network of Computational Elements and Reaches for Pawtuxet River North and South Branches

In the example, for Junction 1, the order number of the last element immediately upstream of the junction is number 46.

Order number of the first element in the reach immediately downstream from the junction. It is these numbers that must be arranged in ascending order. Thus for Figure 1 these order numbers are as follows: Columns 66-70

Junction	Downstream Element No.
1	82

Order number of the last element in the last reach of the tributary entering the junction. For Figure 1 this order number for junction 1 is 81. Columns 76-80

This group of cards must end with ENDATA7, even if there are no junctions in the system.

HEADWATER SOURCES DATA

This group of cards, one per headwater, defines the flow and conservative mineral concentrations of the headwater. The following information is on each card:

Headwater order or number Columns 16-20

starting at most upstream point

Headwater name or identification	Columns 25-40
Flow in cfs (m^3/sec)	Columns 41-50
Conservative Mineral I	Columns 56-60
Conservative Mineral II	Columns 61-65
Conservative Mineral III	Columns 66-70

This group of cards must end with ENDATA8.

HEADWATER SOURCES DATA FOR SUSPENDED SOLIDS AND TOXICS

This group of cards, one per headwater, provides headwater concentrations of suspended solids and toxics. The following information is on each card:

Headwater order or number	Columns 20-24
Suspended Solids	Columns 25-32
Toxic 1	Columns 33-40
Toxic 2	Columns 41-48
Toxic 3	Columns 49-56
Toxic 4	Columns 57-64
Toxic 5	Columns 65-72

This group of cards must end with ENDATA9A

POINT SOURCE INPUTS AND WITHDRAWALS DATA

This group of cards is used to define point source inputs to and point withdrawals from the stream system. Point sources include both wasteloads and unsimulated tributary inflows. One is required per inflow or withdrawal which describes the inflow or withdrawal and conservative mineral concentrations. They must be ordered starting at the most upstream point. The following information is on each card:

Point load order number	Columns 11-15
Point load identification or name	Columns 20-35
Point load inflow or withdrawal	Columns 41-50
(A withdrawal must have a (-) sign	
Conservative Mineral I	Columns 56-60
Conservative Mineral II	Columns 61-65
Conservative Mineral III	Columns 66-70

This group of cards must end with ENDATA9.

POINT SOURCE DATA FOR SUSPENDED SOLIDS AND TOXICS

This group of cards provides the wasteload concentrations of suspended solids and toxics. The following information is on each card:

Point load order or number	Columns 20-24
Suspended Solids	Columns 25-32
Toxic 1	Columns 33-40
Toxic 2	Columns 41-48
Toxic 3	Columns 49-56
Toxic 4	Columns 57-64
Toxic 5	Columns 65-72

This group of cards must end with ENDATA9A.

USGS GAGE FLOW DATA

This group of cards provides the flows at the Washington and Cranston gages. The following information is on each card:

Gage number	Columns 16-20
Gage Identification	Columns 21-40
Gage Flow	Columns 41-48

This group of cards must end with ENDATA10.

Appendix B - Trace Metal Data

Cadmium Concentration in the Blackstone River

July 9, 1985

DISSOLVED CADMIUM

	Sampling Run					
Station	A	B	C	D	Ave	M Ave
1	ND	ND	ND	ND	ND	
2	0.4430	0.4061	0.4798	0.3959	0.4312	
3	1.0816	0.3468	0.3263	0.2015	0.4891	0.2915
4	0.8831	0.4082	0.3366	0.2547	0.4707	0.3331
5	0.2219	0.2608	0.3120	0.2608	0.2639	
6	0.2281	0.3140	0.2997	0.1851	0.2567	
7	0.2526	0.2874	0.2690	0.1830	0.2480	
8	0.2003	0.2383	0.2442	0.1810	0.2160	
9	0.1635	0.2196	0.1810	0.1547	0.1797	0.1664
PARTICULATE CADMIUM						
1	0.0484	0.0299	0.0084	0.0115	0.0246	
2	0.3791	0.3928	0.5940	0.3581	0.4310	0.3767
3	0.4392	0.2264	0.1970	0.1920	0.2634	0.2051
4	0.3535	0.3399	0.2177	0.1307	0.2605	
5	0.2195	0.2210	0.1141	0.2318	0.1966	0.2241
6	0.0742	0.1379	0.1460	0.1005	0.1147	
7	0.1500	0.1082	0.1060	0.2111	0.1438	
8	0.2186	0.2298	0.1500	0.1661	0.1911	
9	0.2251	0.1800	0.1993	0.1178	0.1806	

M Ave = Modified average based on data falling withing the 95% confidence limit. Data not falling within this range are underlined.

Cadmium Concentration in the Blackstone River (Continued)

August 20, 1985

DISSOLVED CADMIUM

	Sampling Run					
Station	A	B	C	D	Ave	M Ave
1	0.2000	0.4161	0.2000	0.2000	0.2540	0.2000
2	0.7371	0.6918	0.5905	0.5863	0.6514	
3	0.3990	0.4213	0.4231	0.5884	0.4580	0.4144
4	0.4477	0.4387	0.6729	0.5495	0.5272	
5	0.3179	0.5555	0.4785	0.6729	0.5062	
6	0.3609	0.3336	0.3593	0.5415	0.3988	0.3513
7	0.3528	0.3226	0.3773	0.6184	0.4178	0.3509
8	0.3008	0.3336	0.3008	0.3940	0.3323	0.3117
9	0.2453	0.2810	0.2978	0.4283	0.3131	0.2747

PARTICULATE CADMIUM

1	0.0489	0.0244	0.0345	0.0350	0.0357	
2	0.4155	0.3315	0.3473	0.3725	0.3667	
3	0.3715	0.3500	0.3695	0.4603	0.3878	
4	0.3073	0.2515	0.2038	0.3375	0.2750	
5	0.3267	0.2740	0.2663	0.2848	0.2880	
6	0.1989	0.1916	0.1889	0.1865	0.1915	0.1890
7	0.1798	0.1607	0.1344	0.1607	0.1589	
8	0.1462	0.1411	0.1456	0.2067	0.1599	0.1443
9	0.2145	0.2058	0.2165	0.3140	0.2377	

M Ave = Modified average based on data falling withing the 95% confidence limit. Data not falling within this range are underlined.

Cadmium Concentration in the Blackstone River
(Continued)

October 8, 1987

DISSOLVED CADMIUM

	Sampling Run					
Station	A	B	C	D	Ave	M Ave
1	0.18	0.23	0.19	0.12	0.18	
2	1.06	0.96	0.91	0.96	0.97	
3	1.11	0.99	0.65	0.65	0.85	
4	0.92	0.91	0.77	0.70	0.83	
5	1.08	0.94	0.86	0.77	0.91	
6	0.96	0 92	0.81	0.69	0.85	
7	1.00	0.89	0.94	0.81	0.91	
8	0.88	0.92	0.88	0.77	0.86	
9	0.90	0.90	0.83	0.84	0.87	

PARTICULATE CADMIUM

Station	A	B	C	D	Ave	M Ave
1	0.0190	0.0231	0.0339	0.0339	0.0275	
2	0.5463	0.6530	0.5920	0.5285	0.5800	
3	0.4557	0.4128	0.3278	0.4332	0.4074	
4	0.8690	0.4230	0.3468	0.2884	0.4818	0.3527
5	0.3836	0.4598	0.3074	0.3697	0.3801	
6	0.3294	0.3760	0.4637	0.3976	0.3917	
7	0.4903	0.3836	0.3989	0.3392	0.4030	
8	0.4205	0.3824	0.4344	0.3455	0.3957	
9	0.4027	0.3976	0.3239	0.3506	0.3687	

M Ave = Modified average based on data falling withing the 95% confidence limit. Data not falling within this range are underlined.

Chromium Concentration in the Blackstone River

July 9, 1985

DISSOLVED

(Mean for all stations were not detectable)

PARTICULATE CHROMIUM

	Sampling Run					
Station	A	B	C	D	Ave	M Ave
1	1.0700	1.1845	2.1185	1.2995	1.4181	1.1847
2	59.2000	41.2250	23.5200	7.2800	32.806	
3	29.1200	4.3965	10.7250	6.7900	12.758	7.3038
4	5.3480	22.0850	6.8200	2.6105	9.2159	4.9261
5	3.4950	11.6100	4.7240	3.3475	5.7941	3.8555
6	2.3155	14.9850	5.7050	2.5940	6.3999	3.5381
7	25.2600	5.2980	2.7415	25.5850	14.721	
8	2.2825	17.4650	6.5750	1.7580	7.0201	3.5385
9	3.2165	1.7580	5.5600	1.4140	2.9871	

M Ave = Modified average based on data falling withing the 95% confidence limit. Data not falling within this range are underlined.

Chromium Concentration in the Blackstone River
(Continued)

August 20, 1985

DISSOLVED CHROMIUM

Station	Sampling Run A	B	C	D	Ave	M Ave
1	ND	ND	ND	ND		
2	2.2500	1.5610	7.2820	15.0200	6.5283	3.6977
3	2.1420	1.5610	1.4100	1.4740	1.6468	1.4817
4	1.2590	1.4310	1.7110	2.8310	1.8080	1.4670
5	1.3240	1.2810	1.2160	1.4530	1.3185	
6	1.2810	1.2160	1.2380	1.3020	1.2593	
7	1.5820	1.1080	1.4740	1.2160	1.3450	
8	1.3880	1.1510	1.1730	1.0000	1.1780	
9	1.3240	1.3020	1.3450	1.1730	1.2860	

PARTICULATE CHROMIUM

1	0.9450	0.6008	0.5495	0.3185	0.6035	
2	5.5800	5.4100	5.5150	7.0550	5.8900	5.5017
3	5.6150	4.9975	4.3875	6.6750	5.4188	
4	4.8950	3.5250	2.8750	4.3150	3.9025	
5	4.0750	4.4225	2.9700	3.7475	3.8038	
6	2.6450	1.8323	2.1573	2.0973	2.1830	
7	1.9863	1.7725	1.3533	1.6868	1.6997	
8	1.5585	1.0283	1.4560	2.1488	1.5479	
9	2.2000	1.9605	2.5500	3.3025	2.5033	

M Ave = Modified average based on data falling withing the 95% confidence limit. Data not falling within this range are underlined.

Chromium Concentration in the Blackstone River
(Continued)

October 8, 1985

DISSOLVED CHROMIUM

	Sampling Run					
Station	A	B	C	D	Ave	M Ave
1	ND	ND	ND	ND		
2	1.06	1.02	1.00	0.88	0.990	
3	1.11	0.96	0.98	1.02	1.018	
4	1.44	1.36	1.15	1.01	1.240	
5	1.73	1.48	1.23	1.27	1.428	
6	1.56	1.33	1.08	0.94	1.228	
7	1.85	1.65	1.21	1.02	1.433	
8	2.33	1.81	1.33	1.15	1.655	
9	3.22	2.17	1.50	1.40	2.073	

PARTICULATE CHROMIUM

1	0.4253	0.5007	0.8800	0.8975	0.6759	
2	8.7645	10.1140	9.3240	9.0640	9.3166	
3	8.6727	6.7290	5.0190	7.1590	6.8949	
4	9.7490	9.0240	6.0290	4.7125	7.3786	
5	9.8890	9.9440	5.6840	6.5790	8.0240	
6	9.5293	8.1440	7.0590	5.9390	7.6678	
7	15.1790	9.3240	8.6990	6.3340	9.8840	8.1190
8	10.3740	8.8640	8.2090	7.1590	8.6515	8.0773
9	7.6490	9.6840	8.8640	7.2890	8.3715	

M Ave = Modified average based on data falling withing the 95% confidence limit. Data not falling within this range are underlined.

Copper Concentration in the Blackstone River

July 9, 1985

DISSOLVED COPPER

	Sampling Run					
Station	A	B	C	D	Ave	M Ave
1	ND	ND	ND	ND		
2	9.8590	8.8070	13.5000	8.8880	10.2635	9.1820
3	10.9100	8.2470	8.1598	8.0790	8.8490	8.1619
4	9.2120	9.3330	10.1800	9.5350	9.5650	9.3600
5	7.9980	9.0500	8.4030	8.0790	8.3825	8.1600
6	8.4830	9.0498	8.7260	8.5640	8.7057	8.5910
7	8.2030	8.1130	7.4780	7.6590	7.8633	
8	7.8410	7.7499	8.6570	7.7499	7.9995	7.7802
9	8.5660	8.4756	7.3870	7.5680	7.9992	

PARTICULATE COPPER

1	0.5250	0.3688	0.3321	0.3505	0.3941	0.3505
2	4.5515	4.2210	3.1735	3.1460	3.7730	
3	1.6920	1.8755	1.4255	1.1315	1.5311	
4	2.5460	3.3455	2.2705	1.7285	2.4726	
5	2.1785	2.2245	2.0315	2.6930	2.2819	2.1448
6	1.3980	1.4160	1.2965	1.4070	1.3119	
7	1.5725	1.2875	1.1040	1.2140	1.2945	
8	1.3245	1.4805	1.3425	1.4160	1.3909	
9	2.6015	1.7655	1.5170	1.4990	1.8458	1.5938

M Ave = Modified average based on data falling withing the 95% confidence limit. Data not falling within this range are underlined.

Copper Concentration in the Blackstone River
(Continued)

August 20, 1985

DISSOLVED COPPER

	Sampling Run					
Station	A	B	C	D	Ave	M Ave
1	ND	ND	ND	ND		
2	8.0370	6.9880	8.9110	7.5130	7.8623	
3	4.8910	5.8230	5.4740	5.7650	5.4883	5.6873
4	5.7530	6.8920	7.3350	7.1450	6.7813	7.1240
5	5.8800	5.7530	5.8160	6.3860	5.9588	5.8163
6	6.6880	6.0180	6.3230	6.1400	6.2923	
7	8.2730	10.0000	6.6270	6.5050	7.8513	
8	6.4640	5.7070	5.8810	5.3570	5.8523	
9	6.6970	6.4060	6.4640	5.9980	6.3913	

PARTICULATE COPPER

1	0.7440	0.4860	0.5798	0.3988	0.5522	
2	4.1440	3.6200	3.3475	2.9850	3.5241	
3	5.6175	4.0700	5.1550	5.8375	5.1700	5.5367
4	3.8475	3.0250	2.1033	4.5325	3.3771	
5	3.6700	3.0675	2.5100	2.8325	3.0200	
6	2.2830	1.6660	1.9008	1.6928	1.8857	
7	1.8673	1.8323	1.5088	1.7830	1.7479	1.8275
8	1.9378	1.2485	1.5860	2.2330	1.7513	
9	2.7900	2.5400	2.8925	3.9700	3.0481	2.7408

M Ave = Modified average based on data falling withing the 95% confidence limit. Data not falling within this range are underlined.

Copper Concentration in the Blackstone River
(Continued)

October 8, 1985

DISSOLVED COPPER

Station	Sampling Run A	B	C	D	Ave	M Ave
1	ND	ND	ND	ND		
2	9.17	8.88	9.61	8.93	9.15	
3	8.58	7.65	8.04	7.80	8.02	
4	7.80	7.65	6.82	6.77	7.26	
5	8.58	7.80	7.41	7.36	7.79	
6	8.29	8.09	8.09	7.70	8.04	
7	8.19	7.99	8.09	7.85	8.03	
8	8.09	8.49	8.14	7.95	8.17	
9	10.20	8.34	8.44	9.76	9.19	

PARTICULATE COPPER

Station	A	B	C	D	Ave	M Ave
1	0.4243	0.4903	0.7945	0.7995	0.6272	
2	8.1825	8.0200	6.6100	6.5900	7.3506	
3	6.9200	5.4550	4.4295	5.3300	5.5336	
4	8.0350	5.8500	4.6280	3.8220	5.5838	
5	6.3450	6.1050	4.1170	4.8430	5.3525	
6	6.2733	5.9300	5.7950	5.0350	5.7583	
7	9.8800	5.9700	5.4250	4.5060	6.4453	5.3003
8	6.7250	6.3350	6.0800	5.0000	6.0350	6.3800
9	6.1300	6.6950	5.7550	5.2400	5.9550	

M Ave = Modified average based on data falling withing the 95% confidence limit. Data not falling within this range are underlined.

Lead Concentration in the Blackstone River

July 9, 1985

DISSOLVED LEAD

(Means for all stations were not detectable)

PARTICULATE LEAD

	Sampling Run					
Station	A	B	C	D	Ave	M Ave
1	0.5000	0.5540	0.5540	0.8945	0.6256	0.5360
2	1.6980	1.6250	2.0995	1.9775	1.8500	
3	1.6125	1.4420	1.6735	1.3690	1.5243	
4	1.3690	1.5275	3.3405	1.7220	1.9898	1.5395
5	1.4300	1.0650	1.6370	2.2575	1.5974	
6	0.9235	0.6200	1.4635	1.2680	1.1197	
7	0.3493	0.7855	1.0385	1.1415	0.8287	
8	0.9810	0.7170	2.1870	1.0615	1.2366	0.9198
9	2.8990	1.3825	3.4270	2.0375	2.4365	

M Ave = Modified average based on data falling withing the 95% confidence limit. Data not falling within this range are underlined.

Lead Concentration in the Blackstone River
(Continued)

August 20, 1985

DISSOLVED LEAD

(Means for all stations were not detectable)

PARTICULATE LEAD

	Sampling Run					
Station	A	B	C	D	Ave	M Ave
1	0.7470	0.8715	1.8498	0.7485	1.0542	0.7890
2	5.1230	3.0995	1.7818	1.4560	2.8651	
3	10.3325	1.7283	1.9948	3.9800	4.5089	2.5677
4	9.7063	1.3110	0.8088	2.4255	3.5629	1.5151
5	2.6620	2.1363	1.0848	1.9430	1.9565	
6	2.0850	1.2853	1.4015	1.0918	1.4659	1.2595
7	1.8140	1.3755	1.1048	1.7238	1.5045	
8	1.3498	0.7695	1.0015	1.2983	1.1048	
9	1.7858	2.1108	1.7368	2.1753	1.9522	

M Ave = Modified average based on data falling withing the 95% confidence limit. Data not falling within this range are underlined.

Lead Concentration in the Blackstone River
(Continued)

October 8, 1985

DISSOLVED LEAD

	Sampling Run					
Station	A	B	C	D	Ave	M Ave
1	0.23	0.38	0.55	0.18	0.335	
2	2.00	1.65	1.81	1.76	1.805	
3	1.48	1.49	1.95	1.44	1.590	1.47
4	1.67	1.82	1.82	1.48	1.698	
5	2.01	1.49	1.70	1.98	1.795	
6	1.79	1.82	1.78	1.67	1.765	1.80
7	1.92	1.81	1.82	1.78	1.833	
8	1.82	2.06	1.73	1.71	1.830	1.75
9	1.90	1.82	1.71	1.84	1.818	

PARTICULATE LEAD

1	1.9755	1.3210	1.6100	2.3720	1.8196	
2	5.9260	6.5020	6.3520	5.7920	6.1430	
3	5.9213	5.9820	3.9390	5.2770	5.2798	5.7267
4	6.9270	6.4520	4.9440	5.5770	5.9750	
5	5.9920	6.9270	4.5265	6.5170	5.9906	6.4787
6	6.5747	7.0220	6.2970	5.7520	6.4114	
7	11.4870	8.5620	7.8570	4.7480	8.1635	
8	9.6970	8.7370	7.9870	5.2870	7.9270	8.8070
9	7.5420	7.9520	6.5770	7.5820	7.4133	7.6920

M Ave = Modified average based on data falling withing the 95% confidence limit. Data not falling within this range are underlined.

Nickel Concentration in the Blackstone River

July 9, 1985

DISSOLVED NICKEL

Station	Sampling Run A	B	C	D	Ave	M Ave
1	ND	ND	ND	ND		
2	30.04	29.41	28.58	29.31	29.34	
3	22.62	21.26	20.22	17.50	20.40	
4	21.68	21.99	20.22	18.86	20.69	
5	18.76	19.28	20.22	19.38	19.41	
6	17.19	20.11	17.81	18.34	18.36	17.78
7	23.77	16.98	17.81	15.41	18.49	16.73
8	15.73	15.62	16.56	16.56	16.12	
9	15.83	18.86	14.99	13.43	15.78	

PARTICULATE NICKEL

1	ND	ND	ND	ND		
2	8.4950	7.0850	3.6650	1.4375	5.1706	
3	6.5100	15.71	1.9885	1.5035	6.4280	3.3340
4	1.4595	4.0835	1.4815	0.7755	1.9500	1.2388
5	1.6580	2.7605	1.5255	1.3270	1.8178	1.5035
6	1.5035	3.3560	1.4375	1.4150	1.9280	1.4520
7	4.6130	1.5475	1.0000	3.9075	2.7670	
8	1.3270	3.0470	1.4150	1.0000	1.6973	1.2473
9	1.2390	1.0000	1.4815	1.0000	1.1801	

M Ave = Modified average based on data falling withing the 95% confidence limit. Data not falling within this range are underlined.

Nickel Concentration in the Blackstone River
(Continued)

August 20, 1985

DISSOLVED NICKEL

	Sampling Run					
Station	A	B	C	D	Ave	M Ave
1	5.000	5.000	10.00	5.686	6.420	5.228
2	28.44	26.52	47.19	31.00	33.29	28.65
3	25.07	22.19	20.91	22.03	22.50	21.71
4	24.91	24.11	25.72	25.40	25.04	
5	24.59	25.23	25.72	26.36	25.48	
6	24.43	23.31	24.43	25.72	24.48	24.86
7	21.18	19.70	20.59	20.59	20.52	
8	20.89	21.67	19.26	19.11	20.23	
9	19.11	19.85	22.22	20.44	20.41	

PARTICULATE NICKEL

1	0.9155	0.2608	0.2785	0.2292	0.4210	0.2561
2	1.4505	1.3393	1.4143	1.5008	1.4262	
3	2.5100	1.7772	2.1735	2.4458	2.2266	
4	1.6458	1.2723	0.9485	1.7703	1.4092	
5	1.8078	1.5773	1.3780	1.3968	1.5400	
6	1.3905	1.1913	1.1415	1.1913	1.2287	1.1747
7	1.0150	0.8303	0.8320	0.9343	0.9029	
8	0.7458	0.4120	0.7565	1.0850	0.7498	
9	1.1173	1.0095	1.2303	1.6930	1.2625	1.1190

M Ave = Modified average based on data falling withing the 95% confidence limit. Data not falling within this range are underlined.

Nickel Concentration in the Blackstone River
(Continued)

October 8, 1985

DISSOLVED NICKEL

	Sampling Run					
Station	A	B	C	D	Ave	M Ave
1	ND	ND	ND	ND	ND	
2	24.77	23.28	22.08	21.44	22.89	
3	22.43	20.17	19.96	19.25	20.45	19.79
4	22.38	21.85	19.65	19.80	20.92	
5	23.97	23.29	21.31	21.01	22.39	
6	24.25	21.44	20.93	19.49	21.53	
7	24.32	22.95	22.23	21.37	22.72	
8	25.33	23.74	22.38	21.80	23.31	
9	27.17	24.20	21.60	21.80	23.69	

PARTICULATE NICKEL

1	ND	ND	ND	ND	ND
2	3.2875	3.1535	2.6610	2.6345	2.9341
3	3.0513	2.4215	1.7695	2.1820	2.3561
4	3.4195	2.8605	1.8360	1.5300	2.4115
5	3.7785	3.2595	2.1820	1.9425	2.7906
6	3.5833	3.3000	3.0865	2.1155	3.0213
7	5.4300	3.8450	2.8870	2.1285	3.5726
8	3.0600	3.6055	2.7075	2.4080	2.9453
9	3.0470	3.4195	3.1135	2.5545	3.0336

M Ave = Modified average based on data falling withing the 95% confidence limit. Data not falling within this range are underlined.

Appendix C - Total Dissolved Solids Data

Table C-1. Total Dissolved Solids (mg/l) Results for July 8, 1985

Station	Maximum	Minimum	Average	Standard Deviation
1	75	40	56	16
2	175	157	165	7
3	147	114	128	14
4	154	125	135	8
5	142	128	134	6
6	140	126	133	6
7	137	125	132	5
8	137	124	130	6
9	145	113	129	14

Woonsocket WWTP 392; Okonite 115; GTE 2,420

Table C-2. Total Dissolved Solids (mg/l) Results for August 20, 1985

Station	Maximum	Minimum	Average	Standard Deviation
1	59	36	53	12
2	180	165	174	6
3	159	147	151	5
4	171	159	167	5
5	171	160	164	5
6	161	150	155	5
7	170	149	160	9
8	162	141	153	9
9	169	131	152	16

Woonsocket WWTP 500; Okonite 127; GTE 3,870

Table C-3. Total Dissolved Solids (mg/l) Results for October 8, 1985

Station	Maximum	Minimum	Average	Standard Deviation
1	71	42	58	12
2	123	98	110	10
3	105	84	98	10
4	124	84	107	12
5	117	80	102	16
6	119	86	106	14
7	119	90	111	14
8	118	97	111	10
9	118	109	114	5

Woonsocket WWTP 615 Okonite 132; GTE 3,480

Appendix D - Additional Environmental Parameters

Table D-1 Summary of Selected Environmental Parameters for July 9, 1985

Station-Run	Time	Temperature C	pH	Conductivity umho	Dissolved Oxygen mg/l
1-A	1750	26	6.55	88	8.00
B	2235	24	6.35	82	7.30
C	0605	22.5	6.40	75	7.40
D	1155	26	6.90	80	8.75
2-A	1810	25	6.85	308	7.90
B	2240	24	6.80	270	8.10
C	0630	23	6.65	270	7.30
D	1210	25.5	6.80	270	7.40
3-A	1845	25.5	7.50	228	8.30
B	2310	24	6.90	215	7.60
C	0710	23	6.90	220	7.80
D	1248	26.5	8.30	240	9.35
4-A	1905	25	7.20	230	9.60
B	2330	24	6.75	228	8.60
C	0735	24	6.70	240	8.20
D	1330	27	7.00	250	9.00
5-A	1920	25	7.90	230	10.00
B	2345	24.5	7.15	230	8.90
C	0755	23.5	6.80	225	7.45
D	1345	25	7.10	235	8.90
6-A	1940	25	8.00	230	8.75
B	0000	24	7.00	228	7.60
C	1012	24	6.95	230	7.70
D	1425	27	8.30	240	9.70
7-A	1953	25	6.80	235	9.00
B	0020	24	6.70	228	7.00
C	0838	23.5	6.70	230	7.55
D	1409	27	7.50	245	10.20
8-A	2005	25	8.20	230	11.30
B	0030	24	7.25	230	9.90
C	0853	24	6.60	230	6.60
D	1440	26.5	7.35	245	9.70
9-A	2025	25	7.30	240	8.70
B	0045	24	7.00	230	8.40
C	0915	24	6.95	235	7.90
D	1500	26	7.60	245	8.80

Table D-2. Summary of Selected Environmental Parameters for August 20, 1985

Station-Run	Time	Temperature C	pH	Conductivity umho	Dissolved Oxygen mg/l
1-A	0630	22	6.95	80	7.35
B	1155	23.5	6.80	82	7.70
C	1810	24	6.95	80	7.50
D	2250	22	6.80	80	6.70
2-A	0650	20.5	6.60	285	6.40
B	1215	22.5	6.95	290	6.30
C	1830	21	6.60	300	6.60
D	2300	21	6.50	290	7.90
3-A	0740	20.5	7.15	253	7.80
B	1245	22.5	7.20	248	8.40
C	1855	22.5	6.70	245	8.20
D	2330	21.5	6.60	245	7.30
4-A	0805	21	6.85	272	6.80
B	1305	23.5	7.00	286	7.40
C	1910	22	6.95	280	7.00
D	2350	21	6.90	270	6.40
5-A	0825	20.5	7.10	253	7.40
B	1325	23	7.10	265	8.70
C	1930	22.5	6.70	270	8.50
D	0010	21.5	6.75	270	7.60
6-A	0850	21	7.35	258	8.20
B	1340	24	7.30	260	8.90
C	1950	21.5	6.90	260	8.00
D	0030	22	6.80	245	6.95
7-A	0910	21	7.10	267	7.60
B	1400	24	7.20	255	9.20
C	2005	22.5	6.65	255	7.90
D	0045	22	6.85	255	6.30
8-A	0930	21	6.90	258	6.30
B	1410	24	7.00	275	7.30
C	2020	24	6.90	270	9.20
D	0100	23	6.80	260	8.40
9-A	0950	22	7.10	265	8.30
B	1430	24	7.10	270	8.20
C	2035	23	6.90	285	7.90
D	0120	22	6.60	270	7.70

Table D-3. Summary of Selected Environmental Parameters for October 8, 1985

Station-Run	Time	Temperature C	pH	Conductivity umho	Dissolved Oxygen mg/l
1-A	1815	16	6.70	70	9.70
B	2300	15.5	6.70	70	9.50
C	0630	14.2	6.85	60	9.50
D	1135	15.5	6.80	72	9.90
2-A	1830	14.5	6.20	150	8.70
B	2310	14	6.20	152	8.60
C	0650	13	6.10	150	7.80
D	1155	14	6.10	110	8.20
3-A	1900	15	6.20	140	9.40
B	2340	14.5	6.20	135	9.60
C	0725	13.5	7.00	135	9.60
D	1225	15	6.20	150	10.20
4-A	1915	15.5	6.60	150	9.00
B	2355	14.5	6.60	150	9.00
C	0750	13.5	6.30	140	8.90
D	1245	15	6.85	150	8.80
5-A	1935	15	6.20	140	10.00
B	0010	14.5	6.20	142	10.00
C	0810	13.5	6.35	145	9.85
D	1300	15	6.20	150	10.00
6-A	1955	15	6.20	145	9.90
B	0030	14.5	6.30	145	10.00
C	0830	13.5	6.50	148	9.80
D	1315	15	6.25	153	10.00
7-A	2010	15	6.70	145	9.50
B	0040	14.5	6.70	142	9.80
C	0855	14	6.40	145	9.70
D	1330	15.5	6.30	160	10.20
8-A	2025	15	6.30	150	9.50
B	0055	14.5	6.30	140	9.90
C	0910	14	6.35	148	9.70
D	1345	15.5	6.25	155	10.00
9-A	2040	15	6.30	168	9.70
B	0115	14.5	6.30	150	9.90
C	0930	14	6.40	150	9.90
D	1400	15	6.40	160	10.00

Appendix E - Example Computer Input/Output

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TITLE01               PAWTUXET RIVER - EXAMPLE RUN
TITLE02               AUGUST 2, 1983 AVERAGE FLOW
TITLE03  YES          CONSERVATIVE MINERAL   I     TDS IN MG/L
TITLE04   NO          CONSERVATIVE MINERAL  II
TITLE05   NO          CONSERVATIVE MINERAL III
TITLE06  YES          SUSPENDEDSOLIDS                SS IN MG/L
TITLE07  YES          TOXIC 1                        Ni IN uG/L
TITLE08  YES          TOXIC 2                        Cu IN uG/L
TITLE09  YES          TOXIC 3                        Pb IN uG/L
TITLE10  YES          TOXIC 4                        Cd IN uG/L
TITLE11  YES          TOXIC 5                        Cr IN uG/L
ENDTITLE
LIST DATA INPUT
WRITE OPTIONAL SUMMARY
NO FLOW AUGMENTATION
STEADY STATE
NO TRAP CHANNELS
INPUT ENGLISH            =        0.        OUTPUT ENGLISH           =        0
NUMBER OF REACHES        =       23.        NUMBER OF JUNCTIONS      =        1.
NUM OF HEADWATERS        =        2.        NUMBER OF POINT LOADS    =        5.
TIME STEP (HOURS)        =                  LNTH. COMP. ELEMENT (MI)=         .2
MAXIMUM ROUTE TIME (HRS)=        30.        TIME INC. FOR RPT2 (HRS)=
SIMULATED CK6
GENERATE INCREMENTAL Q                      NO. OF USGS GAGES        =        2.0
VARIABLE PART. COEFFS.
ENDATA1
STREAM REACH     1. RCH= FRR TO LW D       FROM        19.8    TO          17.6
STREAM REACH     2. RCH= LW D TO RT33      FROM        17.6    TO          17.0
STREAM REACH     3. RCH= RT33 TO CMD       FROM        17.0    TO          15.8
STREAM REACH     4. RCH= CMD TO CCD1       FROM        15.8    TO          14.4
STREAM REACH     5. RCH= CCD1 TO CCD2      FROM        14.4    TO          13.4
STREAM REACH     6. RCH= CCD2 TO RT117     FROM        13.4    TO          12.4
STREAM REACH     7. RCH= RT117 TO FAC ST   FROM        12.4    TO          11.4
STREAM REACH     8. RCH= FAC ST TO RT33    FROM        11.4    TO          11.0
STREAM REACH     9. RCH= RT33 TO CONFLU    FROM        11.0    TO          10.6
STREAM REACH    10. RCH= SCIT R TO RT116   FROM         7.0    TO           4.6
STREAM REACH    11. RCH= RT116 TO COL ST   FROM         4.6    TO           3.6
STREAM REACH    12. RCH= COL ST TO ARK D   FROM         3.6    TO           2.8
STREAM REACH    13  RCH= ARK D TO VC D     FROM         2.8    TO           2.2
STREAM REACH    14. RCH= VC D TO PHX D     FROM         2.2    TO           1.4
STREAM REACH    15  RCH= PHX D TO CONFLU   FROM         1.4    TO           0.0
STREAM REACH    16. RCH= CONFLU TO NAT D   FROM        10.6    TO           9.6
STREAM REACH    17. RCH= NAT D TO GRCH A   FROM         9.6    TO           7.2
STREAM REACH    18. RCH= GRCH A TO A CAP   FROM         7.2    TO           6.0
STREAM REACH    19. RCH= A CAP TO BE CAP   FROM         6.0    TO           5.6
STREAM REACH    20. RCH= B CAP TO CR GAG   FROM         5.6    TO           4.4
STREAM REACH    21  RCH= C GAG TO ELM A    FROM         4.4    TO           2.4
STREAM REACH    22. RCH= ELM A TO WARW A   FROM         2.4    TO           1.0
STREAM REACH    23  RCH= WARW A TO PC D    FROM         1.0    TO           0.0
ENDATA2
FLAG FIELD RCH=  1          11          1 2 2 2 2 2 2 2 2 2 2.
FLAG FIELD RCH=  2           3          2 2 2
FLAG FIELD RCH=  3           6          2 2 2 2 2 2
FLAG FIELD RCH=  4           7          2 2 2 2 2 6 2
FLAG FIELD RCH=  5           5          2 2 2 2 2
FLAG FIELD RCH=  6           5          2 2 2 2 2
FLAG FIELD RCH=  7           5          2 2 2 2 2
FLAG FIELD RCH=  8           2          2 2
FLAG FIELD RCH=  9           2          2 3
FLAG FIELD RCH= 10          12          1 2 2 1 2 2 2 2 2 2 2 2
FLAG FIELD RCH= 11           5          2 2 2 2 2
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FLAG FIELD RCH= 12          4            2 2 2 2
FLAG FIELD RCH= 13          3            2 2 2
FLAG FIELD RCH= 14          4            2 2 2 2
FLAG FIELD RCH= 15          7.           2 2 2 2 2 2 2
FLAG FIELD RCH= 16          5.           4 2 2 2 2
FLAG FIELD RCH= 17.        12.           2. 2. 2. 6 2. 2. 2 2. 2. 2. 2. 2.
FLAG FIELD RCH= 18.         6.           2. 2. 2. 2. 2. 2.
FLAG FIELD RCH= 19.         2.           2. 2.
FLAG FIELD RCH= 20.         6.           6. 2. 2. 2. 2. 2.
FLAG FIELD RCH= 21.        10.           2. 6. 2. 2. 2. 2. 2. 2. 2. 2.
FLAG FIELD RCH= 22.         7.           2. 2. 2. 2. 2. 2. 2.
FLAG FIELD RCH= 23.         5.           2. 2. 2. 2. 5.
ENDATA3
HYDRAULICS RCH=  1.            .0026       .882      .228      .632       .040
HYDRAULICS RCH=  2.            .0004      1.69      1.54       .148       .040
HYDRAULICS RCH=  3.            .0024       .882      .228      .632       .040
HYDRAULICS RCH=  4.             .053       .449      .096      .732       .040
HYDRAULICS RCH=  5.             .022       .549      .053      .873       .040
HYDRAULICS RCH=  6.            .0005      1.49      1.01       .262       .040
HYDRAULICS RCH=  7.            .0024       .882      .228      .632       .040
HYDRAULICS RCH=  8.            .0019       .989      .556      .465       .040
HYDRAULICS RCH=  9.             .137       .150      .054      .849       .040
HYDRAULICS RCH= 10.             .012       .871      .590      .335       .040
HYDRAULICS RCH= 11.             .025       .791      .440      .350       .040
HYDRAULICS RCH= 12.             .012       .871      .590      .335       .040
HYDRAULICS RCH= 13.             .012       .871      .590      .335       .040
HYDRAULICS RCH= 14.             .025       .791      .440      .350       .040
HYDRAULICS RCH= 15.             .137       .150      .054      .849       .040
HYDRAULICS RCH= 16.             .137       .150      .054      .849       .040
HYDRAULICS RCH= 17.             .025       .455      .509      .500       .040
HYDRAULICS RCH= 18.            .0005      1.38       .923      .234       .040
HYDRAULICS RCH= 19.            .0005      1.38       .923      .234       .040
HYDRAULICS RCH= 20.            .0005      1.38       .923      .234       .040
HYDRAULICS RCH= 21.            .0053       .932     1.00       .231       .040
HYDRAULICS RCH= 22.            .0070       .821      .923      .234       .040
HYDRAULICS RCH= 23.            .0019       .992     1.72       .163       .040
ENDATA4
OTHER COEFFICIENTS          1.    -.27   -.224  .544   .00345 .0538 0.186 0.020 0.248
OTHER COEFFICIENTS          2.    -.27   -.224  .544   .00345 .0538 0.186 0.020 0.248
OTHER COEFFICIENTS          3.    -.27   -.224  .544    00345 .0538 0.186 0.020 0.248
OTHER COEFFICIENTS          4.    -.2    -.224  .544   .00345 .0538 0.186 0.020 0.248
OTHER COEFFICIENTS          5.    -.7    -.224  .544   .00345 .0538 0.186 0.020 0.248
OTHER COEFFICIENTS          6.    -.27   -.224  .544   .00345 .0538 0.186 0.020 0.248
OTHER COEFFICIENTS          7.    -.27   -.224  .544   .00345 .0538 0.186 0.020 0.248
OTHER COEFFICIENTS          8.    -.27   -.224  .544   .00345 .0538 0.186 0.020 0.248
OTHER COEFFICIENTS          9      .24  -3.22  11.97   .00345 .0538 0.186 0.020 0.248
OTHER COEFFICIENTS         10      .64   -.107 1.59     00345 .0538 0.186 0.020 0.213
OTHER COEFFICIENTS         11.     .64   -.107 1.59    .00345 .0538 0.186 0.020 0.213
OTHER COEFFICIENTS         12.     .64   -.107 1.59    .00345 .0538 0.186 0.020 0.213
OTHER COEFFICIENTS         13      .64   -.107 1.59    .00345 .0538 0.186 0.020 0.231
OTHER COEFFICIENTS         14      .64   - 107 1.59    .00345 .0538 0.186 0.020 0 231
OTHER COEFFICIENTS         15      .24  -3 22  11 97    00345 .0538 0.186 0.020 0.231
OTHER COEFFICIENTS         16      .24  -3 22  11 97   .00345 .0538 0.186 0.020 0.241
OTHER COEFFICIENTS         17      45     -.59 2.95     00345 .0538 0.186 0 020 0 140
OTHER COEFFICIENTS         18     1 52  - 784  2.54     00345 .0538 0.186 0.020 0.388
OTHER COEFFICIENTS         19     1 52  - 784  2 54     00345 .0538 0.186 0.020 0.388
OTHER COEFFICIENTS         20     1 52  -.784  2.54     00345 .0538 0.186 0 020 0.388
OTHER COEFFICIENTS         21    -1 09  -3 24  3.64     00345 .0538 0.186 0.020 0 089
OTHER COEFFICIENTS         22     1 79  -6 86  11 83    00345 .0538 0.186 0.020 0 175
OTHER COEFFICIENTS         23    -2 55  -6 06  9 043    00345 .0538 0 186 0 020 0 112
ENDATA5
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KP-SS COEFF  & EXP          1  -1 35        0 091
KP-SS COEFF  & EXP          2  -2 72        12 72
KP-SS COEFF  & EXP          3  -1 31        2 74
KP-SS COEFF  & EXP          4  -1 34        0 18
KP-SS COEFF  & EXP          5  -0 52        0 56
ENDATA5A
INCREMENTAL INFLOW   RCH=  1                140
INCREMENTAL INFLOW   RCH=  2.               140
INCREMENTAL INFLOW   RCH=  3                140
INCREMENTAL INFLOW   RCH=  4.               140.
INCREMENTAL INFLOW   RCH=  5.               140.
INCREMENTAL INFLOW   RCH=  6.               140.
INCREMENTAL INFLOW   RCH=  7                140.
INCREMENTAL INFLOW   RCH=  8                140.
INCREMENTAL INFLOW   RCH=  9.               140
INCREMENTAL INFLOW   RCH= 10.               140
INCREMENTAL INFLOW   RCH= 11.               140.
INCREMENTAL INFLOW   RCH= 12.               140.
INCREMENTAL INFLOW   RCH= 13                140.
INCREMENTAL INFLOW   RCH= 14.               140.
INCREMENTAL INFLOW   RCH= 15                140.
INCREMENTAL INFLOW   RCH= 16                140.
INCREMENTAL INFLOW   RCH= 17.               140.
INCREMENTAL INFLOW   RCH= 18.               140.
INCREMENTAL INFLOW   RCH= 19.               140.
INCREMENTAL INFLOW   RCH= 20.               140.
INCREMENTAL INFLOW   RCH= 21.               140.
INCREMENTAL INFLOW   RCH= 22.               140.
INCREMENTAL INFLOW   RCH= 23                140.
ENDATA6
INCR INFLOW-2         1.           7.96     3.07    1.26     .38      1.00
INCR INFLOW-2         2.           7.96     3.07    4.59     .38      1.00
INCR INFLOW-2         3            7 96     3.07    4.59     .38      1.00
INCR INFLOW-2         4.   250     7 96   103.0   104.6      .38      1.00
INCR INFLOW-2         5            7 96     3.07    4.59     .38      1.00
INCR INFLOW-2         6.           7 96     3.07    4.59     .38      1.00
INCR INFLOW-2         7            7 96     3.07    4.59     .38      1.00
INCR INFLOW-2         8            7 96     3.07    4.59     .38      1.00
INCR INFLOW-2         9.           7 96     3.07    4.59     .38      1.00
INCR INFLOW-2        10.           7 96     3.07    1.26     .38      1.00
INCR INFLOW-2        11            7.96     3.07    1.26     .38      1.00
INCR INFLOW-2        12            7.96     3.07    1.26     .38      1.00
INCR INFLOW-2        13            7.96     3.07    4.59     .38      1.00
INCR INFLOW-2        14            7 96     3.07    4.59     .38      1.00
INCR INFLOW-2        15.           7 96     3.07    4.59     .38      1 00
INCR INFLOW-2        16            7 96     3.07    4.59     .38      1.00
INCR INFLOW-2        17            7 96     3.07    4.59     .38      1.00
INCR INFLOW-2        18            7.96     3.07    4.59     .38      1.00
INCR INFLOW-2        19          658.0    1500    154.0    250.       15.3
INCR INFLOW-2        20           75 0      6.53    4.59     .59      1.00
INCR INFLOW-2        21           75 0      6 53    7.92     .59      1.00
INCR INFLOW-2        22           75 0      6 53    7 92     59       1 00
INCR INFLOW-2        23           75 0      6 53    7 92     59       1 00
ENDATA6A
STREAM JUNCTION      1         JNC=NORTH-SOUTH          46.        82          81
ENDATA7
HEADWATER        1  HDW= SOUTH BRANCH       80 02   22     44.8
HEADWATER        2  HDW= NORTH BRANCH       104 0   15     52 7
ENDATA8
HEADWATER-2          1     2 48     2 00     0 650   2 000    0 000    1 300
HEADWATER-2          2     0 91     0 60     0 130   1 960    0 000    0 800
ENDATA8A
POINT LOAD  1. PTL= AMERICAN HOESCH       .53    45.0 3634.
POINT LOAD  2. PLT= BRADFORD SOAP         0.3    20.0  139.
POINT LOAD  3. PTL= WEST WARWICK ST      4 14    20.0  399.
POINT LOAD  4. PTL= WARWICK STP          7.38    20.    399.
POINT LOAD  5. PTL= CRANSTON STP        17.38    20.    446.
ENDATA9
POINT LOAD-2   PTL= 1     27.4     52.100 414.000    2.480    0.288    3.450
POINT LOAD-2   PTL= 2.     9.100    3.900   9.600   11.800    0.379    2.470
POINT LOAD-2   PTL= 3.    56.200   26.500  51.800    7.590    0.483   15.600
POINT LOAD-2   PTL= 4.    24.000   74.400  48.500   11.900    0.274   24.900
POINT LOAD-2   PTL= 5.    18.400  230.000  21.700    2.270    0.318    5.590
ENDATA9A
USGS GAGE          1.  WASHINGTON GAGE       84.000
USGS GAGE          2.  CRANSTON GAGE        232.000
ENDATA10
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                      * * * DATA LIST  PAWTUXET RIVER TOXIC MODEL * * *
                         * * * PAWTOXIC/URI-DEM VERSION * * *

 *** (PROBLEM TITLES) ***

CARD TYPE                              PAWTOXIC PROGRAM TITLES
TITLE01                 PAWTUXET RIVER - EXAMPLE RUN
TITLE02                 AUGUST 2, 1983 AVERAGE FLOW
TITLE03  YES            CONSERVATIVE MINERAL   I    TDS IN MG/L
TITLE04   NO            CONSERVATIVE MINERAL  II
TITLE05   NO            CONSERVATIVE MINERAL III
TITLE06  YES            SUSPENDEDSOLIDS                   SS IN MG/L
TITLE07  YES            TOXIC 1                           Ni IN uG/L
TITLE08  YES            TOXIC 2                           Cu IN uG/L
TITLE09  YES            TOXIC 3                           Pb IN uG/L
TITLE10  YES            TOXIC 4                           Cd IN uG/L
TITLE11  YES            TOXIC 5                           Cr IN uG/L
ENDTITLE

 *** DATA TYPE 1 (CONTROL DATA) ***

CARD TYPE                                         CARD TYPE
LIST DATA INPUT               0.00000                                          0.00000
WRITE OPTIONAL SUMMARY        0.00000                                          0.00000
NO FLOW AUGMENTATION          0.00000                                          0.00000
STEADY STATE                  0.00000                                          0.00000
NO TRAP CHANNELS              0.00000                                          0.00000
INPUT ENGLISH            =    0.00000             OUTPUT ENGLISH          =    0.00000
NUMBER OF REACHES        =   23.00000             NUMBER OF JUNCTIONS     =    1.00000
NUM OF HEADWATERS        =    2.00000             NUMBER OF POINT LOADS   =    9.00000
TIME STEP (HOURS)        =    0.00000             LNTH. COMP. ELEMENT (MI)=    0.20000
MAXIMUM ROUTE TIME (HRS)=    30.00000             TIME INC. FOR RPT2 (HRS)=    0.00000
SIMULATED CK6                 0.00000                                          0.00000
GENERATE INCREMENTAL Q        0.00000             NO. OF USGS GAGES       =    2.00000
VARIABLE PART. COEFFS.        0.00000                                          0.00000
ENDATA1                       0.00000                                          0.00000

 *** DATA TYPE 2 (REACH IDENTIFICATION) ***

CARD TYPE           REACH ORDER AND IDENT                 R. MI/KM              R  MI/KM
STREAM REACH      1.0  RCH= FRR TO LW D        FROM        19.8     TO           17.6
STREAM REACH      2.0  RCH= LW D TO RT33       FROM        17.6     TO           17.0
STREAM REACH      3.0  RCH= RT33 TO CMD        FROM        17.0     TO           15.8
STREAM REACH      4.0  RCH= CMD TO CCD1        FROM        15.8     TO           14.4
STREAM REACH      5.0  RCH= CCD1 TO CCD2       FROM        14.4     TO           13.4
STREAM REACH      6.0  RCH= CCD2 TO RT117      FROM        13.4     TO           12.4
STREAM REACH      7.0  RCH= RT117 TO FAC ST    FROM        12.4     TO           11.4
STREAM REACH      8.0  RCH= FAC ST TO RT33     FROM        11.4     TO           11.0
STREAM REACH      9.0  RCH= RT33 TO CONFLU     FROM        11.0     TO           10.6
STREAM REACH     10.0  RCH= SCIT R TO RT116    FROM         7.0     TO            4.6
STREAM REACH     11.0  RCH= RT116 TO COL ST    FROM         4.6     TO            3.6
STREAM REACH     12.0  RCH= COL ST TO ARK D    FROM         3.6     TO            2.8
STREAM REACH     13.0  RCH= ARK D TO VC D      FROM         2.8     TO            2.2
STREAM REACH     14.0  RCH= VC D TO PHX D      FROM         2.2     TO            1.4
STREAM REACH     15.0  RCH= PHX D TO CONFLU    FROM         1.4     TO            0.0
STREAM REACH     16.0  RCH= CONFLU TO NAT D    FROM        10.6     TO            9.6
STREAM REACH     17.0  RCH= NAT D TO GRCH A    FROM         9.6     TO            7.2
STREAM REACH     18.0  RCH= GRCH A TO A CAP    FROM         7.2     TO            6.0
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STREAM REACH    19 0  RCH= A CAP TO BE CAP   FROM        6.0    TO        5.6
STREAM REACH    20 0  RCH= B CAP TO CR GAG   FROM        5.6    TO        4.4
STREAM REACH    21 0  RCH= C GAG TO ELM A    FROM        4.4    TO        2.4
STREAM REACH    22 0  RCH= ELM A TO WARW A   FROM        2.4    TO        1.0
STREAM REACH    23.0  RCH= WARW A TO PC D    FROM        1.0    TO        0.0
ENDATA2          0 0                                     0 0              0 0

 *** DATA TYPE 3 (COMPUTATIONAL REACH FLAG FIELD) ***

CARD TYPE        REACH ELEMENTS/REACH              COMPUTATIONAL FLAGS
FLAG FIELD         1.        11          1.2.2.2.2.2.2.2.2.2.2.0 0.0.0.0.0.0.0.0.
FLAG FIELD         2          3.         2.2.2.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.
FLAG FIELD         3          6.         2.2.2.2.2.2.0.0.0.0.0.0.0.0.0.0.0.0.0.0.
FLAG FIELD         4          7.         2.2.2.2.2.6.2 0.0.0.0.0.0.0 0.0.0.0.0.0.
FLAG FIELD         5          5.         2.2.2.2.2.0.0.0.0.0.0.0.0.0 0.0.0.0.0.0.
FLAG FIELD         6.         5.         2.2.2.2.2.0.0.0.0.0.0.0.0 0 0.0.0.0.0.0.
FLAG FIELD         7.         5.         2.2.2.2.2.0 0.0.0.0.0.0.0.0.0.0.0.0.0.0.
FLAG FIELD         8.         2.         2.2.0.0.0.0.0.0.0.0.0.0.0.0.0 0.0.0.0.0.
FLAG FIELD         9.         2.         6.3.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.
FLAG FIELD        10.        12.         1.2.2.2.2.2.2.2.2.2.2.2.0.0.0.0.0.0.0.0.
FLAG FIELD        11.         5.         2.2.2.2.2.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.
FLAG FIELD        12.         4.         2.2.2.2.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.
FLAG FIELD        13          3.         2.2.2.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.
FLAG FIELD        14.         4.         2.2.2.2.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.
FLAG FIELD        15.         7.         2.2.2.2.2.2.2.0.0.0.0.0.0.0.0.0.0.0.0.0.
FLAG FIELD        16.         5.         4.2.2.2.2.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.
FLAG FIELD        17.        12.         2.2.2.6.2.2.2.2.2.2.2.2 0 0 0.0.0.0.0 0.
FLAG FIELD        18.         6.         2.2.2.2.2.2.0.0.0.0.0.0.0.0.0.0.0.0.0.0.
FLAG FIELD        19          2.         2.2.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.
FLAG FIELD        20.         6.         6.2.2.2.2.2.0.0.0.0.0.0.0.0.0.0.0.0.0.0.
FLAG FIELD        21.        10.         2.6.2.2.2.2.2.2.2.2.0.0.0.0.0.0.0.0.0.0.
FLAG FIELD        22          7.         2.2.2.2.2.2.2.-0.0.0.0.0.0.0.0.0.0.0.0.0.
FLAG FIELD        23.         5.         2.2.2.2.5.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.
ENDATA3            0          0.         0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.

 *** DATA TYPE 4 (HYDRAULIC DATA FOR DETERMINING VELOCITY AND DEPTH) ***

CARD TYPE        REACH               COEFQV     EXPOQV     COEFQH    EXPOQH      CHANN
HYDRAULICS         1                 0.003      0.882      0.228     0.632       0.040
HYDRAULICS         2                 0.000      1.690      1.540     0.148       0.040
HYDRAULICS         3                 0.002      0.882      0.228     0.632       0.040
HYDRAULICS         4.                0.053      0.449      0.096     0.732       0.040
HYDRAULICS         5.                0.022      0.549      0.053     0.873       0.040
HYDRAULICS         6                 0.001      1.490      1.010     0.262       0.040
HYDRAULICS         7                 0.002      0.882      0.228     0.632       0.040
HYDRAULICS         8                 0.002      0.989      0.556     0.465       0.040
HYDRAULICS         9.                0.137      0.150      0.054     0.849       0.040
HYDRAULICS        10                 0.012      0.871      0.590     0.335       0.040
HYDRAULICS        11.                0.025      0.791      0.440     0.350       0.040
HYDRAULICS        12.                0.012      0.871      0.590     0.335       0.040
HYDRAULICS        13                 0.012      0.871      0.590     0.335       0.040
HYDRAULICS        14.                0.025      0.791      0.440     0.350       0.040
HYDRAULICS        15.                0.137      0.150      0.054     0.849       0.040
HYDRAULICS        16.                0.137      0.150      0.054     0.849       0.040
HYDRAULICS        17.                0.025      0.455      0.509     0.500       0.040
HYDRAULICS        18                 0.001      1.380      0.923     0.234       0.040
HYDRAULICS        19.                0.001      1.380      0.923     0.234       0.040
HYDRAULICS        20                 0.001      1.380      0.923     0.234       0.040
HYDRAULICS        21                 0.005      0.932      1.000     0.231       0.040
HYDRAULICS        22                 0 007      0 821      0.923     0 234       0 040
HYDRAULICS        23                 0 002      0 992      1 720     0 163       0 040
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ENDATA4            0.               0.000      0.000      0.000      0.000      0.000

 *** DATA TYPE 5 (OTHER COEFFICIENTS) ***

CARD TYPE                   REACH    CK6       E         F       PC1      PC2      PC3      PC4      PC5
OTHER COEFFICIENTS             1.  -0.270  -0.224    0.544    0.003    0.054    0.186    0.020    0.248
OTHER COEFFICIENTS             2.  -0.270  -0.224    0.544    0.003    0.054    0.186    0.020    0.248
OTHER COEFFICIENTS             3.  -0.270  -0.224    0.544    0.003    0.054    0.186    0.020    0.248
OTHER COEFFICIENTS             4.  -0.200  -0.224    0.544    0.003    0.054    0.186    0.020    0.248
OTHER COEFFICIENTS             5.  -0.700  -0.224    0.544    0.003    0.054    0.186    0.020    0.248
OTHER COEFFICIENTS             6.  -0.270  -0.224    0.544    0.003    0.054    0.186    0.020    0.248
OTHER COEFFICIENTS             7.  -0.270  -0.224    0.544    0.003    0.054    0.186    0.020    0.248
OTHER COEFFICIENTS             8.  -0.270  -0.224    0.544    0.003    0.054    0.186    0.020    0.248
OTHER COEFFICIENTS             9.   0.240  -3.220   11.970    0.003    0.054    0.186    0.020    0.248
OTHER COEFFICIENTS            10.   0.640  -0.107    1.590    0.003    0.054    0.186    0.020    0.213
OTHER COEFFICIENTS            11.   0.640  -0.107    1.590    0.003    0.054    0.186    0.020    0.213
OTHER COEFFICIENTS            12.   0.640  -0.107    1.590    0.003    0.054    0.186    0.020    0.213
OTHER COEFFICIENTS            13.   0.640  -0.107    1.590    0.003    0.054    0.186    0.020    0.231
OTHER COEFFICIENTS            14.   0.640  -0.107    1.590    0.003    0.054    0.186    0.020    0.231
OTHER COEFFICIENTS            15.   0.240  -3.220   11.970    0.003    0.054    0.186    0.020    0.231
OTHER COEFFICIENTS            16.   0.240  -3.220   11.970    0.003    0.054    0.186    0.020    0.241
OTHER COEFFICIENTS            17.   0.450  -0.590    2.950    0.003    0.054    0.186    0.020    0.140
OTHER COEFFICIENTS            18.   1.520  -0.784    2.540    0.003    0.054    0.186    0.020    0.308
OTHER COEFFICIENTS            19.   1.520  -0.784    2.540    0.003    0.054    0.186    0.020    0.308
OTHER COEFFICIENTS            20.   1.520  -0.784    2.540    0.003    0.054    0.186    0.020    0.308
OTHER COEFFICIENTS            21.  -1.090  -3.240    3.640    0.003    0.054    0.186    0.020    0.089
OTHER COEFFICIENTS            22.   1.790  -6.860   11.830    0.003    0.054    0.186    0.020    0.175
OTHER COEFFICIENTS            23.  -2.550  -6.060    9.043    0.003    0.054    0.186    0.020    0.112
ENDATA5                        0.   0.000   0.000    0.000    0.000    0.000    0.000    0.000    0.000

 ** DATA TYPE 5A (TOX. PART. COEFFICIENTS) ***

CARD TYPE                    TOXIC        EXPON      COEFF.
KP-SS COEFF. & EXP.            1.       -1.35000    0.09100
KP-SS COEFF. & EXP.            2.       -2.72000   12.72000
KP-SS COEFF. & EXP.            3.       -1.31000    2.74000
KP-SS COEFF. & EXP.            4.       -1.34000    0.18000
KP-SS COEFF. & EXP.            5.       -0.92000    0.56000
ENDATA5A                       0.        0.00000    0.00000


*** Q VALUES TO BE GENERATED BY PROGRAM AND PRINTED
          AS INTERMEDIATE OUTPUT ***


 *** DATA TYPE 8 (INCREMENTAL INFLOW  CONDITIONS) ***
CARD TYPE                   REACH      Q                CM-1       CM-2       CM-3
INCREMENTAL INFLOW             1.     ****               0.0        0.0        0.0
INCREMENTAL INFLOW             2.     ****               0.0        0.0        0.0
INCREMENTAL INFLOW             3.     ****               0.0        0.0        0.0
INCREMENTAL INFLOW             4.     ****               0.0        0.0        0.0
INCREMENTAL INFLOW             5.     ****               0.0        0.0        0.0
INCREMENTAL INFLOW             6.     ****               0.0        0.0        0.0
INCREMENTAL INFLOW             7      ****               0.0   ...  0.0        0.0
INCREMENTAL INFLOW             8.     ****               0.0        0.0        0.0
INCREMENTAL INFLOW             9.     ****               0.0        0.0        0.0
INCREMENTAL INFLOW            10      ****               0.0        0.0        0.0
INCREMENTAL INFLOW            11      ****               0.0        0.0        0.0
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INCREMENTAL  INFLOW          12       ****                0.0       0.0       0.0
INCREMENTAL  INFLOW          13.      ****                0.0       0.0       0.0
INCREMENTAL  INFLOW          14.      ****                0.0       0.0       0.0
INCREMENTAL  INFLOW          15.      ****                0.0       0.0       0.0
INCREMENTAL  INFLOW          16.      ****                0.0       0.0       0.0
INCREMENTAL  INFLOW          17.      ****                0.0       0.0       0.0
INCREMENTAL  INFLOW          18.      ****                0.0       0.0       0.0
INCREMENTAL  INFLOW          19.      ****                0.0       0.0       0.0
INCREMENTAL  INFLOW          20       ****                0.0       0.0       0.0
INCREMENTAL  INFLOW          21       ****                0.0       0.0       0.0
INCREMENTAL  INFLOW          22       ****                0.0       0.0       0.0
INCREMENTAL  INFLOW          23       ****                0.0       0.0       0.0
ENDATA6                      0                     0.0       0.0       0.0

 *** DATA TYPE 6A (INCREMENTAL INFLOW
 CONDITIONS FOR SUSPENDED SOLIDS AND TOXICCONSTITUENTS) ***

CARD TYPE                 REACH   SUSPS    TOX1     TOX2     TOX3     TOX4     TOX5
INCR INFLOW-2               1.    0.000    7.960    3.070    1.260    0.380    1.000
INCR INFLOW-2               2     0.000    7.960    3.070    4.590    0.380    1.000
INCR INFLOW-2               3.    0.000    7.960    3.070    4.590    0.380    1.000
INCR INFLOW-2               4.  250.000    7.960  103.000  104.600    0.380    1.000
INCR INFLOW-2               5.    0.000    7.960    3.070    4.590    0.380    1.000
INCR INFLOW-2               6.    0.000    7.960    3.070    4.590    0.380    1.000
INCR INFLOW-2               7.    0.000    7.960    3.070    4.590    0.380    1.000
INCR INFLOW-2               8.    0.000    7.960    3.070    4.590    0.380    1.000
INCR INFLOW-2               9.    0.000    7.960    3.070    4.590    0.380    1.000
INCR INFLOW-2              10.    0.000    7.960    3.070    1.260    0.380    1.000
INCR INFLOW-2              11.    0.000    7.960    3.070    1.260    0.380    1.000
INCR INFLOW-2              12.    0.000    7.960    3.070    1.260    0.380    1.000
INCR INFLOW-2              13.    0.000    7.960    3.070    4.590    0.380    1.000
INCR INFLOW-2              14.    0.000    7.960    3.070    4.590    0.380    1.000
INCR INFLOW-2              15.    0.000    7.960    3.070    4.590    0.380    1.000
INCR INFLOW-2              16.    0.000    7.960    3.070    4.590    0.380    1.000
INCR INFLOW-2              17.    0.000    7.960    3.070    4.590    0.380    1.000
INCR INFLOW-2              18.    0.000    7.960    3.070    4.590    0.380    1.000
INCR INFLOW-2              19.    0.000  658.0001500.000  154.000  250.000   18.300
INCR INFLOW-2              20.    0.000   75.000    6.530    4.590    0.590    1.000
INCR INFLOW-2              21.    0.000   75.000    6.530    7.920    0.590    1.000
INCR INFLOW-2              22.    0.000   75.000    6.530    7.920    0.590    1.000
INCR INFLOW-2              23.    0.000   75.000    6.530    7.920    0.590    1.000
ENDATA6A                    0.    0.000    0.000    0.000    0.000    0.000    0.000

 *** DATA TYPE 7 (STREAM JUNCTIONS) ***

CARD TYPE                 JUNCTION ORDER AND IDENT          UPSTRM   JUNCTION    TRIB
STREAM JUNCTION           1.       JNC=NORTH-SOUTH            46.        82.       81.
ENDATA7                   0                                    0.         0         0.


*** SOUTH BRANCH HEADWATER FLOW COMPUTED BY PROGRAM AND PRINTED AS INTERMEDIATE OUTPUT **


 *** DATA TYPE  8 (HEADWATER SOURCES) ***

CARD TYPE           HDWATER ORDER AND IDENT      FLOW              CM-1     CM-2     CM-3
HEADWATER           1    HDW= SOUTH BRANCH       ****              44.00    8.00     0.00
HEADWATER           2    HDW= NORTH BRANCH    104.000              52.00    7.00     0.00
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ENDATA8          0                           0.000           0.00    0.00    0.00

 $$$ DATA TYPE 8A (HEADWATER CONDITIONS
                  FOR SUSPENDED SOLIDS AND TOXIC CONSTITUENTS) $$$

CARD TYPE           HDWATER   SUSPSD   TOXIC1   TOXIC2  TOXIC3  TOXIC4  TOXIC5
HEADWATER-2              1.    2.480    2.000    0.650   2.000   0.000   1.300
HEADWATER-2              2.    0.910    3.600    0.130   1.960   0.000   0.800
ENDATA8A                 0     0.000    0.000    0.000   0.000   0.000   0.000

 $$$ DATA TYPE 9 (POINT SOURCE / POINT SOURCE CHARACTERISTICS) $$$

CARD TYPE  POINT SOURCE ORDER AND ID          FLOW            CM-1   CM-2   CM-3
POINT LOAD   1.  PTL= AMERICAN HOESCH         0.53          3634.0    0.0    0.0
POINT LOAD   2.  PLT= BRADFORD SOAP           0.30           139.0    0.0    0.0
POINT LOAD   3.  PTL= WEST WARWICK ST         4.14           399.0    0.0    0.0
POINT LOAD   4.  PTL= WARWICK STP             7.38           399.0    0.0    0.0
POINT LOAD   5.  PTL= CRANSTON STP           17.38           446.0    0.0    0.0
ENDATA9      0                                0.00             0.0    0.0    0.0

$$$ DATA TYPE 9A (POINT SOURCE CHARACTERISTICS,
                  - SUSPENDED SOLIDS AND TOXIC CONSTITUENTS) $$$

CARD TYPE       POINT SOURCE ORDER AND ID  SUSPSD   TOXIC1  TOXIC2  TOXIC3  TOXIC4  TOXIC5
POINT LOAD-2       1. PTL= AMERICAN HOESCH  27.40    52.10  414.00    2.48    0.29    3.45
POINT LOAD-2       2. PLT= BRADFORD SOAP     9.10     3.90    9.60   11.80    0.38    2.47
POINT LOAD-2       3. PTL= WEST WARWICK ST  56.20    26.50   51.80    7.59    0.48   15.60
POINT LOAD-2       4  PTL= WARWICK STP      24.00    74.40   48.50   11.90    0.27   24.90
POINT LOAD-2       5  PTL= CRANSTON STP     18.40   230.00   21.70    2.27    0.32    5.59
ENDATA9A

 $$$ DATA TYPE 10 (USGS GAGE INFORMATION) $$$

CARD TYPE          USGS GAGE ID         FLOW
USGS GAGE    1.   WASHINGTON GAGE      84.000
USGS GAGE    2.   CRANSTON GAGE       232.000
ENDATA10     0.                         0.000
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****  INCREMENTAL INFLOW DATA  ****

                                  REACH      Q
INCREMENTAL  INFLOW                  1    3.481
INCREMENTAL  INFLOW                  2    0.950
INCREMENTAL  INFLOW                  3    1.899
INCREMENTAL  INFLOW                  4    2.216
INCREMENTAL  INFLOW                  5    1.582
INCREMENTAL  INFLOW                  6    1.582
INCREMENTAL  INFLOW                  7    1.582
INCREMENTAL  INFLOW                  8    0.633
INCREMENTAL  INFLOW                  9    0.633
INCREMENTAL  INFLOW                 10    3.798
INCREMENTAL  INFLOW                 11    1.582
INCREMENTAL  INFLOW                 12    1.266
INCREMENTAL  INFLOW                 13    0.949
INCREMENTAL  INFLOW                 14    1.266
INCREMENTAL  INFLOW                 15    2.215
INCREMENTAL  INFLOW                 16    1.582
INCREMENTAL  INFLOW                 17    3.798
INCREMENTAL  INFLOW                 18    1.899
INCREMENTAL  INFLOW                 19    0.633
INCREMENTAL  INFLOW                 20    1.899
INCREMENTAL  INFLOW                 21    3.165
INCREMENTAL  INFLOW                 22    2.215
INCREMENTAL  INFLOW                 23    1.582

****  SOUTH BRANCH HEADWATER FLOW =   80.519 ****
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                 CONSERVATIVE MINERAL   1    TDS IN MG/L                      ITERATION  1

RCH/CL 1     2      3      4      5      6      7      8      9     10     11     12     13     14     15     16     17     1

  1 43.83 43.66 43.49 43.32 43.15 42.99 42.82 42.66 42.50 42.34 42.18
  2 42.02 41.86 41.70
  3 41 55 41.40 41 24 41.09 40.94 40 79
  4 40.64 40 50 40.35 40.21 40.10 61 26 61.04
  5 60 83 60.61 60.40 60 19 59.98
  6 59.77 59.57 59.36 59.16 58.96
  7 58.76 58.56 58.36 58.16 57.97
  8 57.77 57.58
  9 57 65 57.45
 10 51.84 51.69 51.53 51.37 51.22 51.07 50.92 50.76 50.61 50.46 50.32 50.17
 11 50.02 49.88 49.73 49.59 49.44
 12 49.30 49.16 49.02 48.88
 13 48.74 48.60 48.46
 14 48.32 48.19 48.05 47.92
 15 47.78 47.65 47.52 47.39 47.25 47.12 47.01
 16 51 67 51.60 51.52 51.44 51.37
 17 51.29 51.21 51.17 57.67 57.59 57.50 57.42 57.34 57.25 57.17 57.09 57.01
 18 56.93 56.84 56.76 56.68 56.60 56.52
 19 56.44 56.39
 20 67.24 67.15 67.06 66.97 66.88 66.78
 21 66 76 92.94 92.82 92.71 92.59 92.47 92.36 92.24 92.13 92.01
 22 91 90 91.78 91.67 91.55 91.44 91.33 91.21
 23 91 10 90.99 90.87 90.76 90.65

                 SUSPENDEDSOLIDS             SS IN MG/L                      ITERATION  1

RCH/CL 1     2      3      4      5      6      7      8      9     10     11     12     13     14     15     16     17     1

  1   2.43   2.39   2.34   2.30   2.26   2.22   2.17   2.14   2.10   2.06   2.02
  2   2.03   2.03   2 03
  3   2.00   1.96   1.93   1.89   1.85   1.82
  4   2 72   3.62   4 50   5.38   6.26   7.25   8.10
  5   8 05   7.99   7.93   7.87   7.81
  6   7 79   7 76   7.74   7.71   7.69
  7   7 59   7.46   7.33   7.20   7.08
  8   6.98   6.89
  9   6.89   6 87
 10   0 92   0.94   0.95   0.96   0.98   0.99   1.01   1.02   1.04   1.05   1.07   1.09
 11   1 11   1 12   1.14   1.16   1.18
 12   1 19   1 21   1.23   1.25
 13   1 27   1 28   1.30
 14   1 33   1.35   1.37   1.39
 15   1.39   1.40   1.40   1.40   1.41   1.41   1.42
 16   3 94   4.01   4.07   4 14   4.21
 17   4.25   4 29   4.33   5.37   5.42   5.47   5 53   5.58   5.64   5.69   5.75   5 81
 18   6 03   6 15   6.26   6 38   6.50   6.63
 19   6.75   6 88
 20   7 58   7.72   7.88   8.03   8.19   8.35
 21   8 32   9 02   9.02   9.02   9.02   9.02   9.02   9.02   9.02   9.02
 22   9 14   9.29   9.45   9 60   9 76   9.93  10.10
 23   9 68   9 22   8 78   8 36   7 97

                 TOXIC 1                     Ni IN uG/L                      ITERATION  1

RCH/CL 1     2      3      4      5      6      7      8      9     10     11     12     13     14     15     16     17     1
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 1  2.02  2.04  2.07  2.09  2.11  2.13  2.15  2.18  2.20  2.22  2.24
 2  2.26  2.28  2.30
 3  2 32  2.34  2.36  2.38  2.40  2.42
 4  2.44  2.46  2.48  2.50  2.52  2.83  2.85
 5  2.87  2.89  2.90  2.92  2.94
 6  2.96  2.97  2.99  3.01  3 02
 7  3.04  3.06  3 07  3 08  3.10
 8  3.11  3.13
 9  3.15  3.16
10  3.61  3.63  3.64  3.66  3.67  3.68  3.70  3.71  3.72  3.74  3.75  3.76
11  3 78  3.79  3.80  3.82  3.83
12  3.84  3.85  3.87  3.88
13  3.89  3.90  3.92
14  3.93  3.94  3.95  3.97
15  3.98  3.99  4.00  4.01  4 02  4.04  4.05
16  3.65  3.66  3.67  3.68  3.69
17  3.70  3.71  3.72  4.16  4.16  4.17  4.18  4.19  4.20  4.20  4.21  4.22
18  4.23  4.24  4.25  4.26  4.27  4.28
19  5.21  6.15
20  8.43  8.53  8 63  8.72  8.82  8.92
21  9.04 24.43 24.50 24.56 24.63 24.69 24.76 24.82 24.89 24.95
22 25.03 25.11 25.19 25.27 25.35 25.43 25.51
23 25.52 25.54 25.55 25.56 25.57

                 TOXIC 2                      Cu IN uG/L                      ITERATION  1

RCH/CL 1     2     3     4     5     6     7     8     9    10    11    12    13    14    15    16    17

  1  0.66  0.66  0.67  0.67  0.68  0.69  0.69  0.70  0.70  0.71  0.72
  2  0.73  0.74  0.74
  3  0.75  0.76  0.76  0.77  0.77  0.78
  4  1.15  1.52  1.88  2.25  2.61  5.40  5.75
  5  5.73  5.72  5.70  5.69  5.67
  6  5.66  5.66  5.65  5.64  5.63
  7  5.61  5.58  5.54  5.51  5.48
  8  5.46  5.43
  9  5.44  5.43
 10  0.14  0.15  0.16  0.17  0.18  0.19  0.19  0.20  0.21  0.22  0.23  0.24
 11  0.25  0.26  0.27  0.28  0.29
 12  0.30  0.30  0.31  0.32
 13  0.33  0.34  0.35
 14  0.36  0.37  0.38  0.39
 15  0.39  0.40  0.41  0.42  0.43  0.43  0.45
 16  2.73  2.75  2.77  2.80  2.82
 17  2.84  2.85  2.87  3.81  3.83  3.85  3.86  3.88  3.89  3.91  3.93  3.94
 18  4.00  4.03  4.05  4.08  4.11  4.14
 19  6.30  8.47
 20  9.81  9.86  9.91  9.96 10.00 10.05
 21 10.04 10.85 10.85 10.84 10.84 10.84 10.84 10.83 10.83 10.83
 22 10 86 10.90 10.93 10.96 11.00 11.03 11.06
 23 10 96 10.84 10 72 10.58 10.45

                 TOXIC 3                      Pb IN uG/L                      ITERATION  1

RCH/CL 1     2     3     4     5     6     7     8     9    10    11    12    13    14    15    16    17

  1  1.98  1.97  1.95  1.93  1.92  1.90  1.89  1.87  1.86  1.84  1.83
  2  1 85  1 86  1.87
  3  1 87  1.87  1.87  1.87  1.87  1 86
  4  2 24  2 61  2 97  3 34  3 70  4 05  4.40
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     5  4.40   4.39   4.38   4.37   4.36
     6  4.36   4.36   4.36   4.37   4.37
     7  4.34   4.31   4.27   4.24   4.20
     8  4.18   4.16
     9  4.19   4.19
    10  1.97   1.97   1.98   1.99   2.00   2.00   2.01   2.02   2.03   2.03   2.04   2.05
    11  2.06   2.07   2.08   2.09   2.10
    12  2.11   2.12   2.12   2.13
    13  2.15   2.17   2.19
    14  2.22   2.24   2.26   2.28
    15  2.29   2.30   2.31   2.32   2.33   2.34   2.35
    16  3.21   3.25   3.29   3.33   3.36
    17  3.39   3.41   3.44   3.54   3.57   3.60   3.62   3.65   3.68   3.70   3.73   3.76
    18  3.85   3.90   3.95   4.00   4.05   4.10
    19  4.36   4.63
    20  4.92   4.98   5.04   5.11   5.17   5.23
    21  5.23   5.03   5.04   5.04   5.05   5.06   5.06   5.07   5.08   5.09
    22  5.14   5.19   5.25   5.30   5.36   5.42   5.48
    23  5.35   5.21   5.07   4.93   4.80

                         TOXIC 4                      Cd IN uG/L                       ITERATION  1
RCH/CL 1      2      3      4      5      6      7      8      9      10     11     12     13     14     15     16     17

     1  0.00   0.00   0.00   0.01   0.01   0.01   0.01   0.01   0.01   0.01   0.02
     2  0.02   0.02   0.02
     3  0.02   0.02   0.02   0.02   0.03   0.03
     4  0.03   0.03   0.03   0.03   0.03   0.04   0.04
     5  0.04   0.04   0.04   0.04   0.04
     6  0.04   0.05   0.05   0.05   0.05
     7  0.05   0.05   0.05   0.05   0.05
     8  0.06   0.06
     9  0.06   0.06
    10  0.00   0.00   0.00   0.00   0.01   0.01   0.01   0.01   0.01   0.01   0.01   0.01
    11  0.01   0.02   0.02   0.02   0.02
    12  0.02   0.02   0.02   0.02
    13  0.02   0.03   0.03
    14  0.03   0.03   0.03   0.03
    15  0.03   0.03   0.03   0.03   0.03   0.04   0.04
    16  0.05   0.05   0.05   0.05   0.05
    17  0.05   0.05   0.05   0.06   0.06   0.06   0.06   0.06   0.06   0.06   0.06   0.06
    18  0.07   0.07   0.07   0.07   0.07   0.07
    19  0.42   0.78
    20  0.76   0.77   0.77   0.77   0.77   0.77
    21  0.77   0.74   0.74   0.74   0.74   0.74   0.74   0.74   0.74   0.74
    22  0.74   0.74   0.74   0.74   0.74   0.74   0.74
    23  0.74   0.74   0.73   0.73   0.73

                         TOXIC 5                      Cr IN uG/L                       ITERATION  1
RCH/CL 1      2      3      4      5      6      7      8      9      10     11     12     13     14     15     16     17

     1  1.29   1.28   1.27   1.27   1.26   1.25   1.24   1.24   1.23   1.22   1.21
     2  1.22   1.22   1.22
     3  1.21   1.21   1.20   1.19   1.19   1.18
     4  1.18   1.18   1.18   1.18   1.18   1.19   1.19
     5  1.18   1.18   1.18   1.17   1.17
     6  1.17   1.17   1.17   1.17   1.17
     7  1.16   1.15   1.14   1.13   1.12
     8  1.11   1.11
     9  1.11   1.11
```

10	0.80	0.81	0.81	0.81	0.82	0.82	0.82	0.83	0.83	0.83	0.84	0.84
11	0.85	0.85	0.85	0.86	0.86							
12	0.87	0.87	0.87	0.88								
13	0.88	0.89	0.89									
14	0.90	0.90	0.90	0.91								
15	0.91	0.91	0.91	0.91	0.92	0.92	0.92					
16	1.01	1.02	1.03	1.04	1.05							
17	1.06	1.06	1.07	1.35	1.36	1.37	1.38	1.39	1.39	1.40	1.41	1.42
18	1.45	1.47	1.48	1.50	1.52	1.53						
19	1.57	1.61										
20	2.38	2.41	2.44	2.47	2.50	2.53						
21	2.52	2.74	2.73	2.73	2.73	2.73	2.73	2.73	2.73	2.73		
22	2.76	2.79	2.81	2.84	2.87	2.90	2.93					
23	2.86	2.77	2.69	2.61	2.53							

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STREAM QUALITY SIMULATION                                                OUTPUT PAGE NUMBER     1
PAWTUXET RIVER TOXIC ROUTING MODEL                                     URI/DEM VERSION

***** STEADY STATE SIMULATION *****

 RCH ELT    FROM      TO     FLOW   POINT   INCR      SS     TDS                        Ni      Cu      Pb      Cd      Cr
 NUM NUM    MILE    MILE    (CFS)  SOURCE   FLOW  (MG/L)  (MG/L) (      ) (      ) (uG/L)  (uG/L)  (uG/L)  (uG/L)  (uG/L)
  1   1   1   19.8    19.6    80.83   0.00   0.32    2.43   43.83    0.00     0.00    2.02    0.66    1.98    0.00    1.29
  2   1   2   19.6    19.4    81.15   0.00   0.32    2.39   43.66    0.00     0.00    2.04    0.66    1.97    0.00    1.28
  3   1   3   19.4    19.2    81.47   0.00   0.32    2.34   43.49    0.00     0.00    2.07    0.67    1.95    0.00    1.27
  4   1   4   19.2    19.0    81.78   0.00   0.32    2.30   43.32    0.00     0.00    2.09    0.67    1.93    0.01    1.27
  5   1   5   19.0    18.8    82.10   0.00   0.32    2.26   43.15    0.00     0.00    2.11    0.68    1.92    0.01    1.26
  6   1   6   18.8    18.6    82.42   0.00   0.32    2.22   42.99    0.00     0.00    2.13    0.69    1.90    0.01    1.25
  7   1   7   18.6    18.4    82.73   0.00   0.32    2.17   42.82    0.00     0.00    2.15    0.69    1.89    0.01    1.24
  8   1   8   18.4    18.2    83.05   0.00   0.32    2.14   42.66    0.00     0.00    2.18    0.70    1.87    0.01    1.24
  9   1   9   18.2    18.0    83.37   0.00   0.32    2.10   42.50    0.00     0.00    2.20    0.70    1.86    0.01    1.23
 10   1  10   18.0    17.8    83.68   0.00   0.32    2.06   42.34    0.00     0.00    2.22    0.71    1.84    0.01    1.22
 11   1  11   17.8    17.6    84.00   0.00   0.32    2.02   42.18    0.00     0.00    2.24    0.72    1.83    0.02    1.21
 12   2   1   17.6    17.4    84.32   0.00   0.32    2.03   42.02    0.00     0.00    2.26    0.73    1.85    0.02    1.22
 13   2   2   17.4    17.2    84.63   0.00   0.32    2.03   41.86    0.00     0.00    2.28    0.74    1.86    0.02    1.22
 14   2   3   17.2    17.0    84.95   0.00   0.32    2.03   41.70    0.00     0.00    2.30    0.74    1.87    0.02    1.22
 15   3   1   17.0    16.8    85.27   0.00   0.32    2.00   41.55    0.00     0.00    2.32    0.75    1.87    0.02    1.21
 16   3   2   16.8    16.6    85.58   0.00   0.32    1.96   41.40    0.00     0.00    2.34    0.76    1.87    0.02    1.21
 17   3   3   16.6    16.4    85.90   0.00   0.32    1.93   41.24    0.00     0.00    2.36    0.76    1.87    0.02    1.20
 18   3   4   16.4    16.2    86.22   0.00   0.32    1.89   41.09    0.00     0.00    2.38    0.77    1.87    0.02    1.19
 19   3   5   16.2    16.0    86.53   0.00   0.32    1.85   40.94    0.00     0.00    2.40    0.77    1.87    0.03    1.19
 20   3   6   16.0    15.8    86.85   0.00   0.32    1.82   40.79    0.00     0.00    2.42    0.78    1.86    0.03    1.18
 21   4   1   15.8    15.6    87.16   0.00   0.32    2.72   40.64    0.00     0.00    2.44    1.15    2.24    0.03    1.18
 22   4   2   15.6    15.4    87.48   0.00   0.32    3.62   40.50    0.00     0.00    2.46    1.52    2.61    0.03    1.18
 23   4   3   15.4    15.2    87.80   0.00   0.32    4.50   40.35    0.00     0.00    2.48    1.88    2.97    0.03    1.18
 24   4   4   15.2    15.0    88.11   0.00   0.32    5.38   40.21    0.00     0.00    2.50    2.25    3.34    0.03    1.18
 25   4   5   15.0    14.8    88.43   0.00   0.32    6.26   40.10    0.00     0.00    2.52    2.61    3.70    0.03    1.18
 26   4   6   14.8    14.6    89.28   0.53   0.32    7.25   61.26    0.00     0.00    2.83    5.40    4.05    0.04    1.19
 27   4   7   14.6    14.4    89.59   0.00   0.32    8.10   61.04    0.00     0.00    2.85    5.75    4.40    0.04    1.19
 28   5   1   14.4    14.2    89.91   0.00   0.32    8.05   60.83    0.00     0.00    2.87    5.73    4.40    0.04    1.18
 29   5   2   14.2    14.0    90.23   0.00   0.32    7.99   60.61    0.00     0.00    2.89    5.72    4.39    0.04    1.18
 30   5   3   14.0    13.8    90.54   0.00   0.32    7.93   60.40    0.00     0.00    2.90    5.70    4.38    0.04    1.18
 31   5   4   13.8    13.6    90.86   0.00   0.32    7.87   60.19    0.00     0.00    2.92    5.69    4.37    0.04    1.17
 32   5   5   13.6    13.4    91.18   0.00   0.32    7.81   59.98    0.00     0.00    2.94    5.67    4.36    0.04    1.17
 33   6   1   13.4    13.2    91.49   0.00   0.32    7.79   59.77    0.00     0.00    2.96    5.66    4.36    0.04    1.17
 34   6   2   13.2    13.0    91.81   0.00   0.32    7.76   59.57    0.00     0.00    2.97    5.66    4.36    0.05    1.17
 35   6   3   13.0    12.8    92.13   0.00   0.32    7.74   59.36    0.00     0.00    2.99    5.65    4.36    0.05    1.17
 36   6   4   12.8    12.6    92.44   0.00   0.32    7.71   59.16    0.00     0.00    3.01    5.64    4.37    0.05    1.17
 37   6   5   12.6    12.4    92.76   0.00   0.32    7.69   58.96    0.00     0.00    3.02    5.63    4.37    0.05    1.17
 38   7   1   12.4    12.2    93.08   0.00   0.32    7.59   58.76    0.00     0.00    3.04    5.61    4.34    0.05    1.16
 39   7   2   12.2    12.0    93.39   0.00   0.32    7.46   58.56    0.00     0.00    3.06    5.58    4.31    0.05    1.15
 40   7   3   12.0    11.8    93.71   0.00   0.32    7.33   58.36    0.00     0.00    3.07    5.54    4.27    0.05    1.14
 41   7   4   11.8    11.6    94.02   0.00   0.32    7.20   58.16    0.00     0.00    3.08    5.51    4.24    0.05    1.13
 42   7   5   11.6    11.4    94.34   0.00   0.32    7.08   57.97    0.00     0.00    3.10    5.48    4.20    0.05    1.12
 43   8   1   11.4    11.2    94.66   0.00   0.32    6.98   57.77    0.00     0.00    3.11    5.46    4.18    0.06    1.11
 44   8   2   11.2    11.0    94.97   0.00   0.32    6.89   57.58    0.00     0.00    3.13    5.43    4.16    0.06    1.11
 45   9   1   11.0    10.8    95.59   0.30   0.32    6.89   57.65    0.00     0.00    3.15    5.44    4.19    0.06    1.11
 46   9   2   10.8    10.6    95.91   0.00   0.32    6.87   57.45    0.00     0.00    3.16    5.43    4.19    0.06    1.11
 47  10   1    7.0     6.8   104.32   0.00   0.32    0.92   51.84    0.00     0.00    3.61    0.14    1.97    0.00    0.80
 48  10   2    6.8     6.6   104.63   0.00   0.32    0.94   51.69    0.00     0.00    3.63    0.15    1.97    0.00    0.81
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STREAM QUALITY SIMULATION                                    OUTPUT PAGE NUMBER     2
PAWTUXET RIVER TOXIC ROUTING MODEL                          URI/DEM VERSION

***** STEADY STATE SIMULATION *****

  RCH ELT    FROM      TO    FLOW   POINT   INCR      SS     TDS                        Ni      Cu      Pb      Cd      Cr
  NUM NUM    MILE    MILE   (CFS)  SOURCE   FLOW  (MG/L)  (MG/L)  (      )  (      )  (uG/L)  (uG/L)  (uG/L)  (uG/L)  (uG/L)
49 10   3     6.6     6.4  104.95    0.00   0.32    0.95   51.53    0.00      0.00      3.64    0.16    1.98    0.00    0.81
50 10   4     6.4     6.2  105.27    0.00   0.32    0.96   51.37    0.00      0.00      3.66    0.17    1.99    0.00    0.81
51 10   5     6.2     6.0  105.58    0.00   0.32    0.98   51.22    0.00      0.00      3.67    0.18    2.00    0.01    0.82
52 10   6     6.0     5.8  105.90    0.00   0.32    0.99   51.07    0.00      0.00      3.68    0.19    2.00    0.01    0.82
53 10   7     5.8     5.6  106.22    0.00   0.32    1.01   50.92    0.00      0.00      3.70    0.19    2.01    0.01    0.82
54 10   8     5.6     5.4  106.53    0.00   0.32    1.02   50.76    0.00      0.00      3.71    0.20    2.02    0.01    0.83
55 10   9     5.4     5.2  106.85    0.00   0.32    1.04   50.61    0.00      0.00      3.72    0.21    2.03    0.01    0.83
56 10  10     5.2     5.0  107.16    0.00   0.32    1.05   50.46    0.00      0.00      3.74    0.22    2.03    0.01    0.83
57 10  11     5.0     4.8  107.48    0.00   0.32    1.07   50.32    0.00      0.00      3.75    0.23    2.04    0.01    0.84
58 10  12     4.8     4.6  107.80    0.00   0.32    1.09   50.17    0.00      0.00      3.76    0.24    2.05    0.01    0.84
59 11   1     4.6     4.4  108.11    0.00   0.32    1.11   50.02    0.00      0.00      3.78    0.25    2.06    0.01    0.85
60 11   2     4.4     4.2  108.43    0.00   0.32    1.12   49.88    0.00      0.00      3.79    0.26    2.07    0.02    0.85
61 11   3     4.2     4.0  108.75    0.00   0.32    1.14   49.73    0.00      0.00      3.80    0.27    2.08    0.02    0.85
62 11   4     4.0     3.8  109.06    0.00   0.32    1.16   49.59    0.00      0.00      3.82    0.28    2.09    0.02    0.86
63 11   5     3.8     3.6  109.38    0.00   0.32    1.18   49.44    0.00      0.00      3.83    0.29    2.10    0.02    0.86
64 12   1     3.6     3.4  109.70    0.00   0.32    1.19   49.30    0.00      0.00      3.84    0.30    2.11    0.02    0.87
65 12   2     3.4     3.2  110.01    0.00   0.32    1.21   49.16    0.00      0.00      3.85    0.30    2.12    0.02    0.87
66 12   3     3.2     3.0  110.33    0.00   0.32    1.23   49.02    0.00      0.00      3.87    0.31    2.12    0.02    0.87
67 12   4     3.0     2.8  110.65    0.00   0.32    1.25   48.88    0.00      0.00      3.88    0.32    2.13    0.02    0.88
68 13   1     2.8     2.6  110.96    0.00   0.32    1.27   48.74    0.00      0.00      3.89    0.33    2.15    0.02    0.88
69 13   2     2.6     2.4  111.28    0.00   0.32    1.28   48.60    0.00      0.00      3.90    0.34    2.17    0.03    0.89
70 13   3     2.4     2.2  111.60    0.00   0.32    1.30   48.46    0.00      0.00      3.92    0.35    2.19    0.03    0.89
71 14   1     2.2     2.0  111.91    0.00   0.32    1.33   48.32    0.00      0.00      3.93    0.36    2.22    0.03    0.90
72 14   2     2.0     1.8  112.23    0.00   0.32    1.35   48.19    0.00      0.00      3.94    0.37    2.24    0.03    0.90
73 14   3     1.8     1.6  112.55    0.00   0.32    1.37   48.05    0.00      0.00      3.95    0.38    2.26    0.03    0.90
74 14   4     1.6     1.4  112.86    0.00   0.32    1.39   47.92    0.00      0.00      3.97    0.39    2.28    0.03    0.91
75 15   1     1.4     1.2  113.18    0.00   0.32    1.39   47.78    0.00      0.00      3.98    0.39    2.29    0.03    0.91
76 15   2     1.2     1.0  113.49    0.00   0.32    1.40   47.65    0.00      0.00      3.99    0.40    2.30    0.03    0.91
77 15   3     1.0     0.8  113.81    0.00   0.32    1.40   47.52    0.00      0.00      4.00    0.41    2.31    0.03    0.91
78 15   4     0.8     0.6  114.13    0.00   0.32    1.40   47.39    0.00      0.00      4.01    0.42    2.32    0.03    0.91
79 15   5     0.6     0.4  114.44    0.00   0.32    1.41   47.25    0.00      0.00      4.02    0.43    2.33    0.03    0.92
80 15   6     0.4     0.2  114.76    0.00   0.32    1.41   47.12    0.00      0.00      4.04    0.43    2.34    0.04    0.92
81 15   7     0.2     0.0  115.08    0.00   0.32    1.42   47.01    0.00      0.00      4.05    0.45    2.35    0.04    0.92
82 16   1    10.6    10.4  211.30    0.00   0.32    3.94   51.67    0.00      0.00      3.65    2.73    3.21    0.05    1.01
83 16   2    10.4    10.2  211.62    0.00   0.32    4.01   51.60    0.00      0.00      3.66    2.75    3.25    0.05    1.02
84 16   3    10.2    10.0  211.93    0.00   0.32    4.07   51.52    0.00      0.00      3.67    2.77    3.29    0.05    1.03
85 16   4    10.0     9.8  212.25    0.00   0.32    4.14   51.44    0.00      0.00      3.68    2.80    3.33    0.05    1.04
86 16   5     9.8     9.6  212.57    0.00   0.32    4.21   51.37    0.00      0.00      3.69    2.82    3.36    0.05    1.05
87 17   1     9.6     9.4  212.88    0.00   0.32    4.25   51.29    0.00      0.00      3.70    2.84    3.39    0.05    1.06
88 17   2     9.4     9.2  213.20    0.00   0.32    4.29   51.21    0.00      0.00      3.71    2.85    3.41    0.05    1.06
89 17   3     9.2     9.0  213.52    0.00   0.32    4.33   51.17    0.00      0.00      3.72    2.87    3.44    0.05    1.07
90 17   4     9.0     8.8  217.97    4.14   0.32    5.37   57.67    0.00      0.00      4.16    3.81    3.54    0.06    1.35
91 17   5     9.8     8.6  218.29    0.00   0.32    5.42   57.59    0.00      0.00      4.16    3.83    3.57    0.06    1.36
92 17   6     8.6     8.4  218.61    0.00   0.32    5.47   57.50    0.00      0.00      4.17    3.85    3.60    0.06    1.37
93 17   7     8.4     8.2  218.92    0.00   0.32    5.53   57.42    0.00      0.00      4.18    3.86    3.62    0.06    1.38
94 17   8     9.2     8.0  219.24    0.00   0.32    5.58   57.34    0.00      0.00      4.19    3.88    3.65    0.06    1.39
95 17   9     8.0     7.8  219.56    0.00   0.32    5.64   57.25    0.00      0.00      4.20    3.89    3.68    0.06    1.39
96 17  10     7.8     7.6  219.87    0.00   0.32    5.69   57.17    0.00      0.00      4.20    3.91    3.70    0.06    1.40
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                 STREAM QUALITY SIMULATION                                      OUTPUT PAGE NUMBER      3
                 PAWTUXET RIVER TOXIC ROUTING MODEL                            URI/DEM VERSION

                 ***** STEADY STATE SIMULATION *****

     RCH ELT    FRCM     TO    FLOW   POINT   INCR      SS     TDS                         Ni      Cu      Pb      Cd      Cr
     NUM NUM    MILE   MILE   (CFS)  SOURCE   FLOW  (MG/L)  (MG/L) (       ) (       ) (uG/L)  (uG/L)  (uG/L)  (uG/L)  (uG/L)
  97  17  11     7.6    7.4  220.19    0.00   0.32    5.75   57.09    0.00      0.00    4.21    3.93    3.73    0.06    1.41
  98  17  12     7.4    7.2  220.51    0.00   0.32    5.81   57.01    0.00      0.00    4.22    3.94    3.76    0.06    1.42
  99  18   1     7.2    7.0  220.82    0.00   0.32    6.03   56.93    0.00      0.00    4.23    4.00    3.85    0.07    1.45
 100  18   2     7.0    6.8  221.14    0.00   0.32    6.15   56.84    0.00      0.00    4.24    4.03    3.90    0.07    1.47
 101  18   3     6.8    6.6  221.45    0.00   0.32    6.26   56.76    0.00      0.00    4.25    4.05    3.95    0.07    1.48
 102  18   4     6.6    6.4  221.77    0.00   0.32    6.38   56.68    0.00      0.00    4.26    4.08    4.00    0.07    1.50
 103  18   5     6.4    6.2  222.09    0.00   0.32    6.50   56.60    0.00      0.00    4.27    4.11    4.05    0.07    1.52
 104  18   6     6.2    6.0  222.40    0.00   0.32    6.63   56.52    0.00      0.00    4.28    4.14    4.10    0.07    1.53
 105  19   1     6.0    5.8  222.72    0.00   0.32    6.75   56.44    0.00      0.00    5.21    6.30    4.36    0.42    1.57
 106  19   2     5.8    5.6  223.04    0.00   0.32    6.88   56.39    0.00      0.00    6.15    8.47    4.63    0.78    1.61
 107  20   1     5.6    5.4  230.73    7.38   0.32    7.58   67.24    0.00      0.00    8.43    9.81    4.92    0.76    2.38
 108  20   2     5.4    5.2  231.05    0.00   0.32    7.72   67.15    0.00      0.00    8.53    9.86    4.98    0.77    2.41
 109  20   3     5.2    5.0  231.37    0.00   0.32    7.88   67.06    0.00      0.00    8.63    9.91    5.04    0.77    2.44
 110  20   4     5.0    4.8  231.68    0.00   0.32    8.03   66.97    0.00      0.00    8.72    9.96    5.11    0.77    2.47
 111  20   5     4.8    4.6  232.00    0.00   0.32    8.19   66.88    0.00      0.00    8.82   10.00    5.17    0.77    2.50
 112  20   6     4.6    4.4  232.32    0.00   0.32    8.35   66.78    0.00      0.00    8.92   10.05    5.23    0.77    2.53
 113  21   1     4.4    4.2  232.63    0.00   0.32    8.32   66.76    0.00      0.00    9.04   10.04    5.23    0.77    2.52
 114  21   2     4.2    4.0  250.33   17.38   0.32    9.02   92.94    0.00      0.00   24.43   10.85    5.03    0.74    2.74
 115  21   3     4.0    3.8  250.65    0.00   0.32    9.02   92.82    0.00      0.00   24.50   10.85    5.04    0.74    2.73
 116  21   4     3.8    3.6  250.96    0.00   0.32    9.02   92.71    0.00      0.00   24.56   10.84    5.04    0.74    2.73
 117  21   5     3.6    3.4  251.28    0.00   0.32    9.02   92.59    0.00      0.00   24.63   10.84    5.05    0.74    2.73
 118  21   6     3.4    3.2  251.60    0.00   0.32    9.02   92.47    0.00      0.00   24.69   10.84    5.06    0.74    2.73
 119  21   7     3.2    3.0  251.91    0.00   0.32    9.02   92.36    0.00      0.00   24.76   10.84    5.06    0.74    2.73
 120  21   8     3.0    2.8  252.23    0.00   0.32    9.02   92.24    0.00      0.00   24.82   10.83    5.07    0.74    2.73
 121  21   9     2.8    2.6  252.54    0.00   0.32    9.02   92.13    0.00      0.00   24.89   10.83    5.08    0.74    2.73
 122  21  10     2.6    2.4  252.86    0.00   0.32    9.02   92.01    0.00      0.00   24.95   10.83    5.09    0.74    2.73
 123  22   1     2.4    2.2  253.18    0.00   0.32    9.14   91.90    0.00      0.00   25.03   10.86    5.14    0.74    2.76
 124  22   2     2.2    2.0  253.49    0.00   0.32    9.29   91.78    0.00      0.00   25.11   10.90    5.19    0.74    2.79
 125  22   3     2.0    1.8  253.81    0.00   0.32    9.45   91.67    0.00      0.00   25.19   10.93    5.25    0.74    2.81
 126  22   4     1.8    1.6  254.13    0.00   0.32    9.60   91.55    0.00      0.00   25.27   10.96    5.30    0.74    2.84
 127  22   5     1.6    1.4  254.44    0.00   0.32    9.76   91.44    0.00      0.00   25.35   11.00    5.36    0.74    2.87
 128  22   6     1.4    1.2  254.76    0.00   0.32    9.93   91.33    0.00      0.00   25.43   11.03    5.42    0.74    2.90
 129  22   7     1.2    1.0  255.08    0.00   0.32   10.10   91.21    0.00      0.00   25.51   11.06    5.48    0.74    2.93
 130  23   1     1.0    0.8  255.39    0.00   0.32    9.68   91.10    0.00      0.00   25.52   10.96    5.35    0.74    2.86
 131  23   2     0.8    0.6  255.71    0.00   0.32    9.22   90.99    0.00      0.00   25.54   10.84    5.21    0.74    2.77
 132  23   3     0.6    0.4  256.03    0.00   0.32    8.78   90.87    0.00      0.00   25.55   10.72    5.07    0.73    2.69
 133  23   4     0.4    0.2  256.34    0.00   0.32    8.36   90.76    0.00      0.00   25.56   10.58    4.93    0.73    2.61
 134  23   5     0.2    0.0  256.66    0.00   0.32    7.97   90.65    0.00      0.00   25.57   10.45    4.80    0.73    2.53
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        STREAM QUALITY SIMULATION                                            OUTPUT PAGE NUMBER     4
        PAWTUXET RIVER TOXIC ROUTING MODEL                                  URI/DEM VERSION

        ***** STEADY STATE SIMULATION *****

                                  STREAM STREAM                           Ni         Cu         Pb         Cd         Cr
     RCH ELT    FROM     TO    VEL   DEPTH   CK6      CK6        PART       PART       PART       PART       PART
     ORD NUM    MILE    MILE  (FPS)   (FT)  GIVEN     SIM        COEF       COEF       COEF       COEF       COEF
  1   1   1     19.8    19.6  0.125   3.66  -0.27   -0.16     0.01195    0.21269    0.38198    0.02399    0.25616
  2   1   2     19.6    19.4  0.126   3.67  -0.27   -0.16     0.01195    0.21269    0.38198    0.02399    0.25616
  3   1   3     19.4    19.2  0.126   3.68  -0.27   -0.16     0.01195    0.21269    0.38198    0.02399    0.25616
  4   1   4     19.2    19.0  0.126   3.69  -0.27   -0.16     0.01195    0.21269    0.38198    0.02399    0.25616
  5   1   5     19.0    18.8  0.127   3.70  -0.27   -0.15     0.01195    0.21269    0.38198    0.02399    0.25616
  6   1   6     18.8    18.6  0.127   3.71  -0.27   -0.15     0.01195    0.21269    0.38198    0.02399    0.25616
  7   1   7     18.6    18.4  0.128   3.71  -0.27   -0.15     0.01195    0.21269    0.38198    0.02399    0.25616
  8   1   8     18.4    18.2  0.128   3.72  -0.27   -0.15     0.01195    0.21269    0.38198    0.02399    0.25616
  9   1   9     18.2    18.0  0.129   3.73  -0.27   -0.15     0.01195    0.21269    0.38198    0.02399    0.25616
 10   1  10     18.0    17.8  0.129   3.74  -0.27   -0.15     0.01195    0.21269    0.38198    0.02399    0.25616
 11   1  11     17.8    17.6  0.129   3.75  -0.27   -0.15     0.01195    0.21269    0.38198    0.02399    0.25616
 12   2   1     17.6    17.4  0.719   2.97  -0.27    0.17     0.01195    0.21269    0.38198    0.02399    0.25616
 13   2   2     17.4    17.2  0.724   2.97  -0.27    0.17     0.01195    0.21269    0.38198    0.02399    0.25616
 14   2   3     17.2    17.0  0.728   2.97  -0.27    0.17     0.01195    0.21269    0.38198    0.02399    0.25616
 15   3   1     17.0    16.8  0.121   3.79  -0.27   -0.16     0.01195    0.21269    0.38198    0.02399    0.25616
 16   3   2     16.8    16.6  0.121   3.79  -0.27   -0.16     0.01195    0.21269    0.38198    0.02399    0.25616
 17   3   3     16.6    16.4  0.122   3.80  -0.27   -0.16     0.01195    0.21269    0.38198    0.02399    0.25616
 18   3   4     16.4    16.2  0.122   3.81  -0.27   -0.16     0.01195    0.21269    0.38198    0.02399    0.25616
 19   3   5     16.2    16.0  0.123   3.82  -0.27   -0.16     0.01195    0.21269    0.38198    0.02399    0.25616
 20   3   6     16.0    15.8  0.123   3.83  -0.27   -0.16     0.01195    0.21269    0.38198    0.02399    0.25616
 21   4   1     15.8    15.6  0.394   2.53  -0.20   -0.01     0.01195    0.21269    0.38198    0.02399    0.25616
 22   4   2     15.6    15.4  0.395   2.53  -0.20   -0.01     0.01195    0.21269    0.38198    0.02399    0.25616
 23   4   3     15.4    15.2  0.395   2.54  -0.20   -0.01     0.01193    0.21227    0.38162    0.02396    0.25607
 24   4   4     15.2    15.0  0.396   2.55  -0.20   -0.01     0.00938    0.13061    0.30202    0.01886    0.23336
 25   4   5     15.0    14.8  0.397   2.55  -0.20   -0.01     0.00765    0.08674    0.24799    0.01542    0.21580
 26   4   6     14.8    14.6  0.398   2.57  -0.20   -0.01     0.00628    0.05822    0.20467    0.01267    0.19996
 27   4   7     14.6    14.4  0.399   2.58  -0.20   -0.01     0.00540    0.04300    0.17687    0.01091    0.18871
 28   5   1     14.4    14.2  0.260   2.69  -0.70   -0.08     0.00545    0.04379    0.17844    0.01101    0.18937
 29   5   2     14.2    14.0  0.261   2.70  -0.70   -0.08     0.00551    0.04468    0.18017    0.01112    0.19009
 30   5   3     14.0    13.8  0.261   2.71  -0.70   -0.08     0.00556    0.04558    0.18190    0.01123    0.19082
 31   5   4     13.8    13.6  0.262   2.72  -0.70   -0.08     0.00562    0.04649    0.18365    0.01134    0.19154
 32   5   5     13.6    13.4  0.262   2.72  -0.70   -0.08     0.00567    0.04742    0.18541    0.01145    0.19227
 33   6   1     13.4    13.2  0.418   3.30  -0.27    0.00     0.00570    0.04785    0.18622    0.01150    0.19260
 34   6   2     13.2    13.0  0.420   3.30  -0.27    0.00     0.00572    0.04828    0.18703    0.01155    0.19293
 35   6   3     13.0    12.8  0.423   3.30  -0.27    0.01     0.00575    0.04872    0.18783    0.01160    0.19326
 36   6   4     12.8    12.6  0.425   3.31  -0.27    0.01     0.00577    0.04915    0.18863    0.01165    0.19359
 37   6   5     12.6    12.4  0.427   3.31  -0.27    0.01     0.00580    0.04958    0.18942    0.01171    0.19391
 38   7   1     12.4    12.2  0.131   4.00  -0.27   -0.15     0.00590    0.05131    0.19219    0.01191    0.19519
 39   7   2     12.2    12.0  0.131   4.01  -0.27   -0.15     0.00604    0.05381    0.19705    0.01219    0.19698
 40   7   3     12.0    11.8  0.132   4.02  -0.27   -0.15     0.00618    0.05643    0.20160    0.01248    0.19877
 41   7   4     11.8    11.6  0.132   4.03  -0.27   -0.15     0.00633    0.05915    0.20624    0.01277    0.20057
 42   7   5     11.6    11.4  0.132   4.04  -0.27   -0.15     0.00648    0.06200    0.21096    0.01307    0.20238
 43   8   1     11.4    11.2  0.171   4.61  -0.27   -0.13     0.00660    0.06441    0.21487    0.01332    0.20386
 44   8   2     11.2    11.0  0.172   4.62  -0.27   -0.13     0.00672    0.06665    0.21843    0.01354    0.20520
 45   9   1     11.0    10.8  0.272   2.59   0.24    0.03     0.00672    0.06675    0.21860    0.01355    0.20526
 46   9   2     10.8    10.6  0.272   2.60   0.24    0.03     0.00675    0.06724    0.21937    0.01360    0.20555
 47  10   1      7.0     6.8  0.687   2.80   0.64    0.99     0.01195    0.21269    0.38198    0.02399    0.25616
 48  10   2      6.8     6.6  0.689   2.80   0.64    0.99     0.01195    0.21269    0.38198    0.02399    0.25616
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STREAM QUALITY SIMULATION                                                 OUTPUT PAGE NUMBER    5
PAWTUXET RIVER TOXIC ROUTING MODEL                                       URI/DEM VERSION

***** STEADY STATE SIMULATION *****

                                STREAM  STREAM                             Ni        Cu        Pb        Cd        Cr
   RCH ELT    FROM     TO        VEL    DEPTH    CK6      CK6             PART      PART      PART      PART      PART
   ORD NUM    MILE    MILE      (FPS)    (FT)   GIVEN     SIM             COEF      COEF      COEF      COEF      COEF
49  10   3     6.6     6.4     0.691    2.80    0.64     0.99          0.01195   0.21269   0.38198   0.02399   0.25616
50  10   4     6.4     6.2     0.693    2.81    0.64     0.99          0.01195   0.21269   0.38198   0.02399   0.25616
51  10   5     6.2     6.0     0.695    2.81    0.64     1.00          0.01195   0.21269   0.38198   0.02399   0.25616
52  10   6     6.0     5.8     0.696    2.81    0.64     1.00          0.01195   0.21269   0.38198   0.02399   0.25616
53  10   7     5.8     5.6     0.698    2.82    0.64     1.00          0.01195   0.21269   0.38198   0.02399   0.25616
54  10   8     5.6     5.4     0.700    2.82    0.64     1.01          0.01195   0.21269   0.38198   0.02399   0.25616
55  10   9     5.4     5.2     0.702    2.82    0.64     1.01          0.01195   0.21269   0.38198   0.02399   0.25616
56  10  10     5.2     5.0     0.704    2.82    0.64     1.01          0.01195   0.21269   0.38198   0.02399   0.25616
57  10  11     5.0     4.8     0.705    2.83    0.64     1.01          0.01195   0.21269   0.38198   0.02399   0.25616
58  10  12     4.8     4.6     0.707    2.83    0.64     1.02          0.01195   0.21269   0.38198   0.02399   0.25616
59  11   1     4.6     4.4     1.016    2.27    0.64     1.51          0.01195   0.21269   0.38198   0.02399   0.25616
60  11   2     4.4     4.2     1.018    2.27    0.64     1.51          0.01195   0.21269   0.38198   0.02399   0.25616
61  11   3     4.2     4.0     1.020    2.27    0.64     1.52          0.01195   0.21269   0.38198   0.02399   0.25616
62  11   4     4.0     3.8     1.023    2.27    0.64     1.52          0.01195   0.21269   0.38198   0.02399   0.25616
63  11   5     3.8     3.6     1.025    2.28    0.64     1.52          0.01195   0.21269   0.38198   0.02399   0.25616
64  12   1     3.6     3.4     0.718    2.85    0.64     1.03          0.01195   0.21269   0.38198   0.02399   0.25616
65  12   2     3.4     3.2     0.720    2.85    0.64     1.04          0.01195   0.21269   0.38198   0.02399   0.25616
66  12   3     3.2     3.0     0.722    2.85    0.64     1.04          0.01195   0.21269   0.38198   0.02399   0.25616
67  12   4     3.0     2.8     0.724    2.85    0.64     1.04          0.01195   0.21269   0.38198   0.02399   0.25616
68  13   1     2.8     2.6     0.725    2.86    0.64     1.05          0.01195   0.21269   0.38198   0.02399   0.25616
69  13   2     2.6     2.4     0.727    2.86    0.64     1.05          0.01195   0.21269   0.38198   0.02399   0.25616
70  13   3     2.4     2.2     0.729    2.86    0.64     1.05          0.01195   0.21269   0.38198   0.02399   0.25616
71  14   1     2.2     2.0     1.044    2.29    0.64     1.55          0.01195   0.21269   0.38198   0.02399   0.25616
72  14   2     2.0     1.8     1.046    2.30    0.64     1.56          0.01195   0.21269   0.38198   0.02399   0.25616
73  14   3     1.8     1.6     1.048    2.30    0.64     1.56          0.01195   0.21269   0.38198   0.02399   0.25616
74  14   4     1.6     1.4     1.051    2.30    0.64     1.56          0.01195   0.21269   0.38198   0.02399   0.25616
75  15   1     1.4     1.2     0.278    2.99    0.24     0.11          0.01195   0.21269   0.38198   0.02399   0.25616
76  15   2     1.2     1.0     0.279    3.00    0.24     0.11          0.01195   0.21269   0.38198   0.02399   0.25616
77  15   3     1.0     0.8     0.279    3.01    0.24     0.12          0.01195   0.21269   0.38198   0.02399   0.25616
78  15   4     0.8     0.6     0.279    3.01    0.24     0.12          0.01195   0.21269   0.38198   0.02399   0.25616
79  15   5     0.6     0.4     0.279    3.02    0.24     0.12          0.01195   0.21269   0.38198   0.02399   0.25616
80  15   6     0.4     0.2     0.279    3.03    0.24     0.12          0.01195   0.21269   0.38198   0.02399   0.25616
81  15   7     0.2     0.0     0.279    3.04    0.24     0.12          0.01195   0.21269   0.38198   0.02399   0.25616
82  16   1    10.6    10.4     0.306    5.08    0.24     0.44          0.01195   0.21269   0.38198   0.02399   0.25616
83  16   2    10.4    10.2     0.306    5.09    0.24     0.44          0.01195   0.21269   0.38198   0.02399   0.25616
84  16   3    10.2    10.0     0.306    5.10    0.24     0.44          0.01195   0.21269   0.38198   0.02399   0.25616
85  16   4    10.0     9.8     0.306    5.10    0.24     0.44          0.01195   0.21269   0.38198   0.02399   0.25616
86  16   5     9.8     9.6     0.306    5.11    0.24     0.44          0.01195   0.21269   0.38198   0.02399   0.25616
87  17   1     9.6     9.4     0.287    7.43    0.45     0.26          0.01195   0.21269   0.38198   0.02399   0.25616
88  17   2     9.4     9.2     0.287    7.43    0.45     0.26          0.01195   0.21269   0.38198   0.02399   0.25616
89  17   3     9.2     9.0     0.287    7.44    0.45     0.26          0.01195   0.21269   0.38198   0.02399   0.25616
90  17   4     9.0     8.8     0.290    7.51    0.45     0.26          0.00942   0.13184   0.30339   0.01895   0.23378
91  17   5     8.8     8.6     0.290    7.52    0.45     0.27          0.00930   0.12837   0.29953   0.01870   0.23259
92  17   6     8.6     8.4     0.290    7.53    0.45     0.27          0.00918   0.12500   0.29570   0.01846   0.23141
93  17   7     8.4     8.2     0.290    7.53    0.45     0.27          0.00905   0.12170   0.29192   0.01822   0.23023
94  17   8     8.2     8.0     0.290    7.54    0.45     0.27          0.00894   0.11848   0.28818   0.01798   0.22906
95  17   9     8.0     7.8     0.291    7.54    0.45     0.27          0.00882   0.11535   0.28449   0.01774   0.22788
96  17  10     7.8     7.6     0.291    7.55    0.45     0.27          0.00870   0.11229   0.28083   0.01751   0.22672
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STREAM QUALITY SIMULATION                                        OUTPUT PAGE NUMBER      6
PAWTUXET RIVER TOXIC ROUTING MODEL                             URI/DEM VERSION

***** STEADY STATE SIMULATION *****

                                  STREAM STREAM                        Ni        Cu        Pb        Cd        Cr
     RCH ELT   FROM      TO     VEL   DEPTH    CK6      CK6        PART      PART      PART      PART      PART
     ORD NUM   MILE    MILE   (FPS)    (FT)  GIVEN      SIM        COEF      COEF      COEF      COEF      COEF
  97  17  11    7.6     7.4   0.291    7.55   0.45     0.27     0.00858   0.10931   0.27721   0.01728   0.22555
  98  17  12    7.4     7.2   0.291    7.56   0.45     0.27     0.00847   0.10636   0.27358   0.01705   0.22438
  99  18   1    7.2     7.0   0.859    3.26   1.52     1.40     0.00804   0.09578   0.26012   0.01619   0.21993
 100  18   2    7.0     6.8   0.860    3.26   1.52     1.40     0.00784   0.09103   0.25383   0.01579   0.21780
 101  18   3    6.8     6.6   0.862    3.27   1.52     1.41     0.00764   0.08652   0.24768   0.01540   0.21569
 102  18   4    6.6     6.4   0.864    3.27   1.52     1.41     0.00745   0.08222   0.24168   0.01502   0.21360
 103  18   5    6.4     6.2   0.865    3.27   1.52     1.41     0.00727   0.07813   0.23582   0.01465   0.21153
 104  18   6    6.2     6.0   0.867    3.27   1.52     1.42     0.00708   0.07424   0.23009   0.01428   0.20947
 105  19   1    6.0     5.8   0.869    3.27   1.52     1.42     0.00691   0.07054   0.22449   0.01393   0.20744
 106  19   2    5.8     5.6   0.870    3.27   1.52     1.43     0.00673   0.06698   0.21896   0.01358   0.20539
 107  20   1    5.6     5.4   0.912    3.30   1.52     1.53     0.00591   0.05159   0.19308   0.01194   0.19539
 108  20   2    5.4     5.2   0.914    3.30   1.52     1.54     0.00576   0.04893   0.18824   0.01163   0.19343
 109  20   3    5.2     5.0   0.916    3.30   1.52     1.54     0.00561   0.04642   0.18351   0.01133   0.19148
 110  20   4    5.0     4.8   0.917    3.30   1.52     1.55     0.00547   0.04402   0.17889   0.01104   0.18956
 111  20   5    4.8     4.6   0.919    3.30   1.52     1.55     0.00532   0.04175   0.17438   0.01076   0.18765
 112  20   6    4.6     4.4   0.921    3.30   1.52     1.55     0.00519   0.03960   0.17000   0.01048   0.18576
 113  21   1    4.4     4.2   0.851    3.52  -1.09    -0.14     0.00521   0.03994   0.17069   0.01052   0.18606
 114  21   2    4.2     4.0   0.911    3.58  -1.09     0.08     0.00467   0.03209   0.15363   0.00945   0.17844
 115  21   3    4.0     3.8   0.912    3.58  -1.09     0.08     0.00467   0.03211   0.15366   0.00945   0.17846
 116  21   4    3.8     3.6   0.914    3.58  -1.09     0.09     0.00467   0.03212   0.15369   0.00945   0.17847
 117  21   5    3.6     3.4   0.915    3.58  -1.09     0.09     0.00467   0.03212   0.15370   0.00945   0.17847
 118  21   6    3.4     3.2   0.916    3.59  -1.09     0.09     0.00467   0.03213   0.15370   0.00945   0.17848
 119  21   7    3.2     3.0   0.917    3.59  -1.09     0.10     0.00467   0.03212   0.15370   0.00945   0.17847
 120  21   8    3.0     2.8   0.918    3.59  -1.09     0.10     0.00467   0.03211   0.15368   0.00945   0.17846
 121  21   9    2.8     2.6   0.919    3.59  -1.09     0.10     0.00467   0.03210   0.15365   0.00945   0.17845
 122  21  10    2.6     2.4   0.920    3.59  -1.09     0.11     0.00467   0.03208   0.15360   0.00945   0.17843
 123  22   1    2.4     2.2   0.658    3.37   1.79     0.93     0.00459   0.03092   0.15089   0.00928   0.17717
 124  22   2    2.2     2.0   0.659    3.37   1.79     0.93     0.00449   0.02958   0.14772   0.00908   0.17569
 125  22   3    2.0     1.8   0.659    3.37   1.79     0.94     0.00439   0.02830   0.14459   0.00888   0.17420
 126  22   4    1.8     1.6   0.660    3.37   1.79     0.95     0.00429   0.02706   0.14150   0.00869   0.17271
 127  22   5    1.6     1.4   0.661    3.37   1.79     0.96     0.00420   0.02586   0.13845   0.00849   0.17122
 128  22   6    1.4     1.2   0.662    3.37   1.79     0.97     0.00410   0.02471   0.13545   0.00831   0.16974
 129  22   7    1.2     1.0   0.662    3.38   1.79     0.97     0.00401   0.02361   0.13251   0.00812   0.16827
 130  23   1    1.0     0.8   0.464    4.25  -2.55    -1.86     0.00425   0.02647   0.14001   0.00859   0.17199
 131  23   2    0.8     0.6   0.465    4.25  -2.55    -1.86     0.00454   0.03024   0.14928   0.00917   0.17642
 132  23   3    0.6     0.4   0.465    4.25  -2.55    -1.85     0.00484   0.03452   0.15912   0.00979   0.18095
 133  23   4    0.4     0.2   0.466    4.25  -2.55    -1.85     0.00517   0.03939   0.16956   0.01045   0.18557
 134  23   5    0.2     0.0   0.466    4.25  -2.55    -1.84     0.00552   0.04490   0.18059   0.01115   0.19027
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          STREAM QUALITY SIMULATION                                               OUTPUT PAGE NUMBER      7
          PAWTUXET RIVER TOXIC ROUTING MODEL                                     URI/DEM VERSION

                                          PART     SOLU     PART     SOLU     PART     SOLU     PART     SOLU     PART     SOLU
      RCH ELT   FROM       TO              Ni       Ni       Cu       Cu       Pb       Pb       Cd       Cd       Cr       Cr
      NUM NUM   MILE      MILE           (uG/L)   (uG/L)   (uG/L)   (uG/L)   (uG/L)   (uG/L)   (uG/L)   (uG/L)   (uG/L)   (uG/L)
   1   1   1    19.8      19.6            0.06     1.97     0.22     0.43     0.96     1.03     0.00     0.00     0.50     0.80
   2   1   2    19.6      19.4            0.06     1.99     0.22     0.44     0.94     1.03     0.00     0.00     0.49     0.80
   3   1   3    19.4      19.2            0.06     2.01     0.22     0.45     0.92     1.03     0.00     0.00     0.48     0.80
   4   1   4    19.2      19.0            0.06     2.03     0.22     0.45     0.90     1.03     0.00     0.01     0.47     0.80
   5   1   5    19.0      18.8            0.06     2.06     0.22     0.46     0.89     1.03     0.00     0.01     0.46     0.80
   6   1   6    18.8      18.6            0.05     2.08     0.22     0.47     0.87     1.03     0.00     0.01     0.45     0.80
   7   1   7    18.6      18.4            0.05     2.10     0.22     0.47     0.86     1.03     0.00     0.01     0.44     0.80
   8   1   8    18.4      18.2            0.05     2.12     0.22     0.48     0.84     1.03     0.00     0.01     0.44     0.80
   9   1   9    18.2      18.0            0.05     2.14     0.22     0.49     0.83     1.03     0.00     0.01     0.43     0.80
  10   1  10    18.0      17.8            0.05     2.16     0.22     0.49     0.81     1.03     0.00     0.01     0.42     0.80
  11   1  11    17.8      17.6            0.05     2.19     0.22     0.50     0.80     1.03     0.00     0.01     0.41     0.80
  12   2   1    17.6      17.4            0.05     2.21     0.22     0.51     0.81     1.04     0.00     0.02     0.42     0.80
  13   2   2    17.4      17.2            0.05     2.23     0.22     0.51     0.81     1.05     0.00     0.02     0.42     0.80
  14   2   3    17.2      17.0            0.05     2.25     0.22     0.52     0.82     1.05     0.00     0.02     0.42     0.80
  15   3   1    17.0      16.8            0.05     2.27     0.22     0.53     0.81     1.06     0.00     0.02     0.41     0.80
  16   3   2    16.8      16.6            0.05     2.29     0.22     0.53     0.80     1.07     0.00     0.02     0.40     0.80
  17   3   3    16.6      16.4            0.05     2.31     0.22     0.54     0.79     1.08     0.00     0.02     0.40     0.80
  18   3   4    16.4      16.2            0.05     2.33     0.22     0.55     0.78     1.08     0.00     0.02     0.39     0.80
  19   3   5    16.2      16.0            0.05     2.35     0.22     0.55     0.77     1.09     0.00     0.03     0.38     0.80
  20   3   6    16.0      15.8            0.05     2.37     0.22     0.56     0.76     1.10     0.00     0.03     0.38     0.80
  21   4   1    15.8      15.6            0.08     2.37     0.42     0.73     1.14     1.10     0.00     0.03     0.48     0.69
  22   4   2    15.6      15.4            0.10     2.36     0.66     0.86     1.51     1.09     0.00     0.03     0.57     0.61
  23   4   3    15.4      15.2            0.13     2.36     0.92     0.96     1.88     1.09     0.00     0.03     0.63     0.55
  24   4   4    15.2      15.0            0.12     2.38     0.93     1.32     2.07     1.27     0.00     0.03     0.66     0.52
  25   4   5    15.0      14.8            0.12     2.41     0.92     1.69     2.25     1.45     0.00     0.03     0.68     0.50
  26   4   6    14.8      14.6            0.12     2.71     1.60     3.80     2.42     1.63     0.00     0.03     0.70     0.49
  27   4   7    14.6      14.4            0.12     2.73     1.48     4.26     2.59     1.81     0.00     0.03     0.72     0.47
  28   5   1    14.4      14.2            0.12     2.75     1.49     4.24     2.59     1.81     0.00     0.04     0.72     0.47
  29   5   2    14.2      14.0            0.12     2.77     1.50     4.21     2.59     1.80     0.00     0.04     0.71     0.47
  30   5   3    14.0      13.8            0.12     2.78     1.51     4.19     2.59     1.79     0.00     0.04     0.71     0.47
  31   5   4    13.8      13.6            0.12     2.80     1.52     4.16     2.58     1.79     0.00     0.04     0.71     0.47
  32   5   5    13.6      13.4            0.12     2.81     1.53     4.14     2.58     1.78     0.00     0.04     0.70     0.47
  33   6   1    13.4      13.2            0.13     2.83     1.54     4.13     2.58     1.78     0.00     0.04     0.70     0.47
  34   6   2    13.2      13.0            0.13     2.85     1.54     4.11     2.58     1.78     0.00     0.04     0.70     0.47
  35   6   3    13.0      12.8            0.13     2.86     1.55     4.10     2.58     1.78     0.00     0.04     0.70     0.47
  36   6   4    12.8      12.6            0.13     2.88     1.55     4.09     2.59     1.78     0.00     0.04     0.70     0.47
  37   6   5    12.6      12.4            0.13     2.90     1.55     4.08     2.59     1.78     0.00     0.05     0.70     0.47
  38   7   1    12.4      12.2            0.13     2.91     1.57     4.04     2.58     1.76     0.00     0.05     0.69     0.47
  39   7   2    12.2      12.0            0.13     2.92     1.60     3.98     2.56     1.74     0.00     0.05     0.69     0.47
  40   7   3    12.0      11.8            0.13     2.94     1.62     3.92     2.55     1.72     0.00     0.05     0.68     0.46
  41   7   4    11.8      11.6            0.13     2.95     1.65     3.87     2.53     1.70     0.00     0.05     0.67     0.46
  42   7   5    11.6      11.4            0.14     2.96     1.67     3.81     2.52     1.69     0.00     0.05     0.66     0.46
  43   8   1    11.4      11.2            0.14     2.98     1.69     3.76     2.51     1.67     0.00     0.05     0.65     0.46
  44   8   2    11.2      11.0            0.14     2.99     1.71     3.72     2.50     1.66     0.00     0.05     0.65     0.46
  45   9   1    11.0      10.8            0.14     3.01     1.71     3.73     2.52     1.67     0.01     0.05     0.65     0.46
  46   9   2    10.8      10.6            0.14     3.02     1.72     3.71     2.52     1.67     0.01     0.05     0.65     0.46
  47  10   1     7.0       6.8            0.04     3.57     0.02     0.12     0.51     1.45     0.00     0.00     0.15     0.65
  48  10   2     6.8       6.6            0.04     3.59     0.02     0.12     0.52     1.45     0.00     0.00     0.16     0.65
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         STREAM QUALITY SIMULATION                                           OUTPUT PAGE NUMBER    8
         PAWTUXET RIVER TOXIC ROUTING MODEL                                 URI/DEM VERSION

                                      PART    SOLU    PART    SOLU    PART    SOLU    PART    SOLU    PART    SOLU
     RCH ELT  FRCM      TO             Ni      Ni      Cu      Cu      Pb      Pb      Cd      Cd      Cr      Cr
     NUM NUM  MILE     MILE          (uG/L)  (uG/L)  (uG/L)  (uG/L)  (uG/L)  (uG/L)  (uG/L)  (uG/L)  (uG/L)  (uG/L)
  49  10   3   6.6      6.4           0.04    3.60    0.03    0.13    0.53    1.45    0.00    0.00    0.16    0.65
  50  10   4   6.4      6.2           0.04    3.61    0.03    0.14    0.54    1.45    0.00    0.00    0.16    0.65
  51  10   5   6.2      6.0           0.04    3.63    0.03    0.15    0.54    1.45    0.00    0.01    0.16    0.65
  52  10   6   6.0      5.8           0.04    3.64    0.03    0.15    0.55    1.45    0.00    0.01    0.17    0.65
  53  10   7   5.8      5.6           0.04    3.65    0.03    0.16    0.56    1.45    0.00    0.01    0.17    0.65
  54  10   8   5.6      5.4           0.04    3.66    0.04    0.17    0.57    1.45    0.00    0.01    0.17    0.66
  55  10   9   5.4      5.2           0.05    3.68    0.04    0.17    0.58    1.45    0.00    0.01    0.17    0.66
  56  10  10   5.2      5.0           0.05    3.69    0.04    0.18    0.58    1.45    0.00    0.01    0.18    0.66
  57  10  11   5.0      4.8           0.05    3.70    0.04    0.19    0.59    1.45    0.00    0.01    0.18    0.66
  58  10  12   4.8      4.6           0.05    3.71    0.05    0.20    0.60    1.45    0.00    0.01    0.18    0.66
  59  11   1   4.6      4.4           0.05    3.73    0.05    0.20    0.61    1.45    0.00    0.01    0.19    0.66
  60  11   2   4.4      4.2           0.05    3.74    0.05    0.21    0.62    1.45    0.00    0.02    0.19    0.66
  61  11   3   4.2      4.0           0.05    3.75    0.05    0.22    0.63    1.45    0.00    0.02    0.19    0.66
  62  11   4   4.0      3.8           0.05    3.76    0.05    0.22    0.64    1.45    0.00    0.02    0.20    0.66
  63  11   5   3.8      3.6           0.05    3.78    0.06    0.23    0.65    1.45    0.00    0.02    0.20    0.66
  64  12   1   3.6      3.4           0.05    3.79    0.06    0.24    0.66    1.45    0.00    0.02    0.20    0.66
  65  12   2   3.4      3.2           0.05    3.80    0.06    0.24    0.67    1.45    0.00    0.02    0.21    0.66
  66  12   3   3.2      3.0           0.06    3.81    0.06    0.25    0.68    1.45    0.00    0.02    0.21    0.66
  67  12   4   3.0      2.8           0.06    3.82    0.07    0.25    0.69    1.45    0.00    0.02    0.21    0.67
  68  13   1   2.8      2.6           0.06    3.83    0.07    0.26    0.70    1.45    0.00    0.02    0.22    0.67
  69  13   2   2.6      2.4           0.06    3.85    0.07    0.27    0.72    1.46    0.00    0.02    0.22    0.67
  70  13   3   2.4      2.2           0.06    3.86    0.08    0.27    0.73    1.46    0.00    0.03    0.22    0.67
  71  14   1   2.2      2.0           0.06    3.87    0.08    0.28    0.75    1.47    0.00    0.03    0.23    0.67
  72  14   2   2.0      1.8           0.06    3.88    0.08    0.29    0.76    1.48    0.00    0.03    0.23    0.67
  73  14   3   1.8      1.6           0.06    3.89    0.09    0.29    0.78    1.48    0.00    0.03    0.24    0.67
  74  14   4   1.6      1.4           0.06    3.90    0.09    0.30    0.79    1.49    0.00    0.03    0.24    0.67
  75  15   1   1.4      1.2           0.07    3.91    0.09    0.30    0.79    1.49    0.00    0.03    0.24    0.67
  76  15   2   1.2      1.0           0.07    3.92    0.09    0.31    0.80    1.50    0.00    0.03    0.24    0.67
  77  15   3   1.0      0.8           0.07    3.94    0.09    0.32    0.80    1.50    0.00    0.03    0.24    0.67
  78  15   4   0.8      0.6           0.07    3.95    0.10    0.32    0.81    1.51    0.00    0.03    0.24    0.67
  79  15   5   0.6      0.4           0.07    3.96    0.10    0.33    0.81    1.52    0.00    0.03    0.24    0.67
  80  15   6   0.4      0.2           0.07    3.97    0.10    0.33    0.82    1.52    0.00    0.03    0.24    0.67
  81  15   7   0.2      0.0           0.07    3.98    0.10    0.34    0.83    1.53    0.00    0.04    0.25    0.67
  82  16   1  10.6     10.4           0.16    3.49    1.24    1.48    1.93    1.28    0.00    0.04    0.51    0.50
  83  16   2  10.4     10.2           0.17    3.50    1.27    1.49    1.97    1.28    0.00    0.04    0.52    0.51
  84  16   3  10.2     10.0           0.17    3.50    1.29    1.49    2.00    1.29    0.00    0.04    0.53    0.51
  85  16   4  10.0      9.8           0.17    3.51    1.31    1.49    2.04    1.29    0.00    0.05    0.54    0.51
  86  16   5   9.8      9.6           0.18    3.51    1.33    1.49    2.07    1.29    0.00    0.05    0.55    0.51
  87  17   1   9.6      9.4           0.18    3.52    1.35    1.49    2.10    1.29    0.00    0.05    0.55    0.51
  88  17   2   9.4      9.2           0.18    3.53    1.36    1.49    2.12    1.29    0.00    0.05    0.56    0.51
  89  17   3   9.2      9.0           0.18    3.54    1.38    1.49    2.14    1.30    0.00    0.05    0.56    0.51
  90  17   4   9.0      8.8           0.20    3.96    1.58    2.23    2.19    1.35    0.01    0.05    0.75    0.60
  91  17   5   8.8      8.6           0.20    3.97    1.57    2.26    2.21    1.36    0.01    0.06    0.76    0.60
  92  17   6   8.6      8.4           0.20    3.97    1.56    2.28    2.22    1.37    0.01    0.06    0.77    0.60
  93  17   7   8.4      8.2           0.20    3.98    1.55    2.31    2.24    1.39    0.01    0.06    0.77    0.61
  94  17   8   8.2      8.0           0.20    3.99    1.54    2.33    2.25    1.40    0.01    0.06    0.78    0.61
  95  17   9   8.0      7.8           0.20    4.00    1.53    2.36    2.26    1.41    0.01    0.06    0.78    0.61
  96  17  10   7.8      7.6           0.20    4.00    1.52    2.39    2.28    1.42    0.01    0.06    0.79    0.61
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     STREAM QUALITY SIMULATION                                                   OUTPUT PAGE NUMBER      9
     PAWTUXET RIVER TOXIC ROUTING MODEL                                         URI/DEM VERSION

                                        PART    SOLU    PART    SOLU    PART    SOLU    PART    SOLU    PART    SOLU
    RCH ELT  FROM      TO               Ni      Ni      Cu      Cu      Pb      Pb      Cd      Cd      Cr      Cr
    NUM NUM  MILE     MILE            (uG/L)  (uG/L)  (uG/L)  (uG/L)  (uG/L)  (uG/L)  (uG/L)  (uG/L)  (uG/L)  (uG/L)
 97 17  11    7.6     7.4              0.20    4.01    1.52    2.41    2.29    1.44    0.01    0.06    0.80    0.61
 98 17  12    7.4     7.2              0.20    4.02    1.51    2.44    2.31    1.45    0.01    0.06    0.80    0.62
 99 18   1    7.2     7.0              0.20    4.04    1.46    2.53    2.35    1.50    0.01    0.06    0.83    0.62
100 18   2    7.0     6.8              0.19    4.05    1.44    2.58    2.38    1.52    0.01    0.06    0.84    0.63
101 18   3    6.8     6.6              0.19    4.06    1.42    2.63    2.40    1.55    0.01    0.06    0.85    0.63
102 18   4    6.6     6.4              0.19    4.07    1.40    2.68    2.42    1.57    0.01    0.06    0.87    0.63
103 18   5    6.4     6.2              0.19    4.08    1.38    2.72    2.45    1.60    0.01    0.06    0.88    0.64
104 18   6    6.2     6.0              0.19    4.09    1.36    2.77    2.47    1.62    0.01    0.06    0.89    0.64
105 19   1    6.0     5.8              0.23    4.98    2.03    4.27    2.63    1.73    0.04    0.39    0.92    0.65
106 19   2    5.8     5.6              0.27    5.88    2.67    5.80    2.78    1.85    0.07    0.71    0.94    0.67
107 20   1    5.6     5.4              0.36    8.07    2.76    7.05    2.92    2.00    0.06    0.70    1.42    0.96
108 20   2    5.4     5.2              0.36    8.16    2.70    7.15    2.95    2.03    0.06    0.70    1.44    0.97
109 20   3    5.2     5.0              0.37    8.26    2.65    7.26    2.98    2.06    0.06    0.70    1.47    0.97
110 20   4    5.0     4.8              0.37    8.36    2.60    7.36    3.01    2.10    0.06    0.71    1.49    0.98
111 20   5    4.8     4.6              0.37    8.45    2.55    7.46    3.04    2.13    0.06    0.71    1.51    0.98
112 20   6    4.6     4.4              0.37    8.55    2.50    7.55    3.07    2.16    0.06    0.71    1.54    0.99
113 21   1    4.4     4.2              0.38    8.67    2.51    7.54    3.07    2.16    0.06    0.71    1.53    0.99
114 21   2    4.2     4.0              0.99   23.45    2.44    8.41    2.92    2.11    0.06    0.68    1.69    1.05
115 21   3    4.0     3.8              0.99   23.51    2.44    8.41    2.93    2.11    0.06    0.68    1.69    1.05
116 21   4    3.8     3.6              0.99   23.57    2.43    8.41    2.93    2.11    0.06    0.68    1.69    1.05
117 21   5    3.6     3.4              1.00   23.63    2.43    8.41    2.93    2.12    0.06    0.68    1.69    1.05
118 21   6    3.4     3.2              1.00   23.69    2.43    8.40    2.94    2.12    0.06    0.68    1.69    1.05
119 21   7    3.2     3.0              1.00   23.76    2.43    8.40    2.94    2.12    0.06    0.68    1.69    1.05
120 21   8    3.0     2.8              1.00   23.82    2.43    8.40    2.95    2.13    0.06    0.68    1.69    1.05
121 21   9    2.8     2.6              1.01   23.88    2.43    8.40    2.95    2.13    0.06    0.68    1.69    1.05
122 21  10    2.6     2.4              1.01   23.94    2.43    8.40    2.96    2.13    0.06    0.68    1.69    1.05
123 22   1    2.4     2.2              1.01   24.02    2.39    8.47    2.98    2.16    0.06    0.68    1.71    1.05
124 22   2    2.2     2.0              1.01   24.10    2.35    8.55    3.00    2.19    0.06    0.68    1.73    1.06
125 22   3    2.0     1.8              1.00   24.18    2.31    8.62    3.03    2.22    0.06    0.68    1.75    1.06
126 22   4    1.8     1.6              1.00   24.27    2.26    8.70    3.06    2.25    0.06    0.68    1.77    1.07
127 22   5    1.6     1.4              1.00   24.35    2.22    8.78    3.08    2.28    0.06    0.68    1.80    1.08
128 22   6    1.4     1.2              1.00   24.43    2.17    8.86    3.11    2.31    0.06    0.69    1.82    1.08
129 22   7    1.2     1.0              0.99   24.51    2.13    8.93    3.14    2.34    0.06    0.69    1.85    1.09
130 23   1    1.0     0.8              1.01   24.52    2.24    8.73    3.08    2.27    0.06    0.68    1.78    1.07
131 23   2    0.8     0.6              1.03   24.51    2.36    8.48    3.02    2.19    0.06    0.68    1.72    1.05
132 23   3    0.6     0.4              1.04   24.50    2.49    8.22    2.95    2.11    0.06    0.68    1.65    1.04
133 23   4    0.4     0.2              1.06   24.50    2.62    7.96    2.89    2.04    0.06    0.67    1.59    1.02
134 23   5    0.2     0.0              1.08   24.49    2.75    7.69    2.83    1.97    0.06    0.67    1.53    1.01
```

[a] Sample collection: 7/28, 1030-1430 h; 7/29, 1130-1400 h 7/30, 1200-1500 h. Ambient water temperature.

GM and SD only for days 1 and 2.

[b] Transects: A - Seekonk R; B - Pawtuxet R; C - Moshassuck R.; D - Warren R.

[d] "Boils": B1 - Providence (Field's Point) Sewage Treatment Plant; B2 East Providence Sewage Treatment Plant

[e] ND - no data

[f] ~Approximation because less than half the value were less than the sensitivity of the assay or exceeded the upper counting limit of the method.

[o] Value omitted in calculating mean

7 Blackstone River

River, not saline

Wright.R 1985 URI CVE