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QUANTITATIVE ASSESSMENT OF ENVIRONMENTAL IMPACTS IN THE AQUATIC--ETC(U)

JAN 82 R RIGGINS, E HERRICKS, M J SALE

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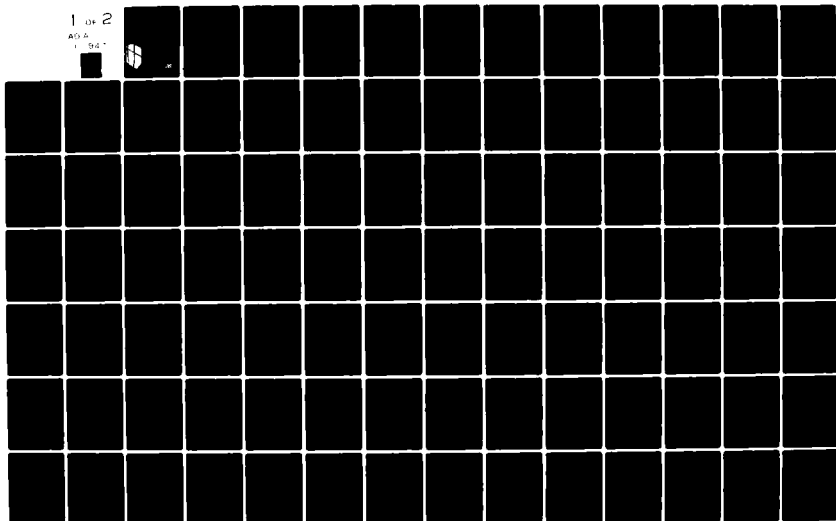
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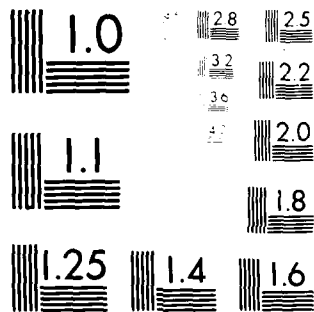
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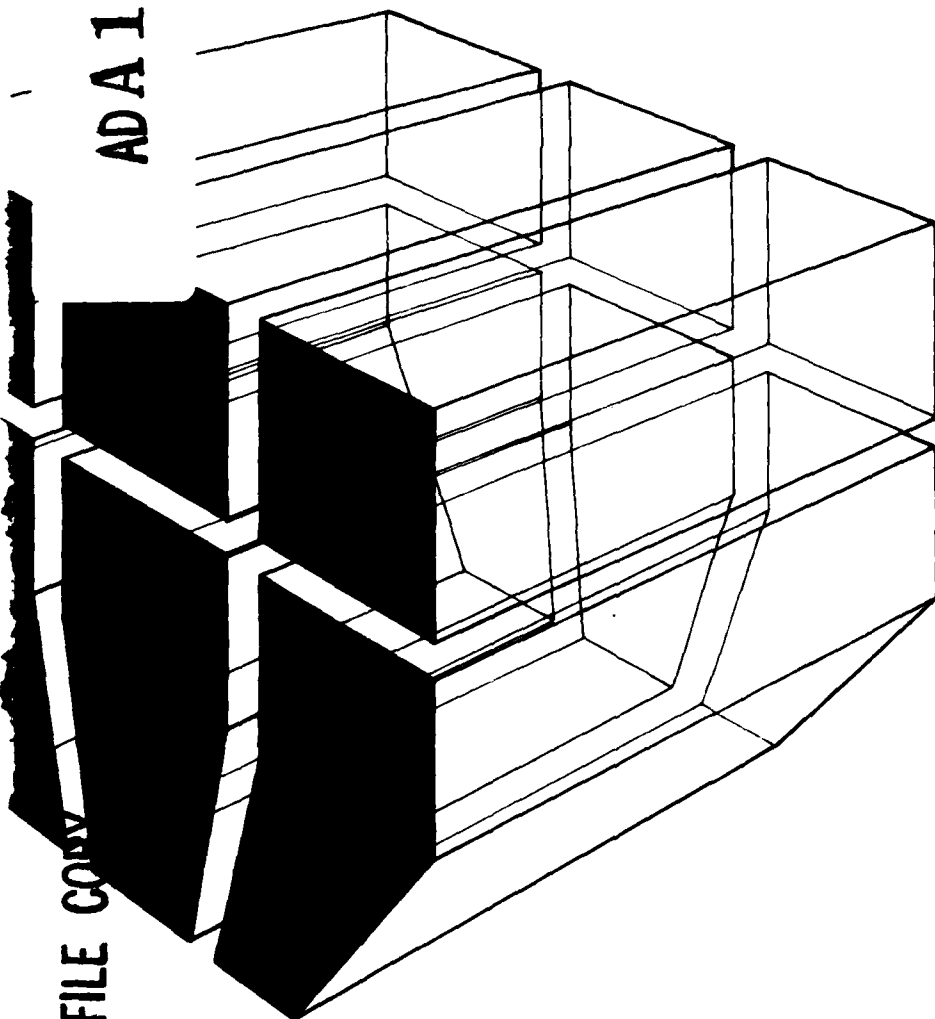


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Technical Report N-114
December 1981
Water Quality Model System

QUANTITATIVE ASSESSMENT OF ENVIRONMENTAL
IMPACTS IN THE AQUATIC ENVIRONMENT

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by
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FOREWORD

This study was performed for the Directorate of Military Programs, Office of the Chief of Engineers (OCE) under Project 4A762720A896, "Environmental Quality for Construction and Operation of Military Facilities"; Task A, "Environmental Impact Monitoring, Management, Assessment, and Planning"; Work Unit 022, "Water Quality Model System." The work was performed by personnel in the Civil Engineering Department of the University of Illinois, under Contract DACA 88-78-R-006, for the Environmental Division (EN) of the U.S. Army Construction Engineering Research Laboratory (CERL). Mr. Paul Carmichael, DAEN-MPE-T, was the OCE Technical Monitor.

The work was performed by the Environmental (EN) Division of the U.S. Army Construction Engineering Research Laboratory (CERL). Mr. R. E. Riggins was the CERL Principal Investigator. Dr. R. K. Jain is Chief of CERL-EN.

COL Louis J. Circeo is Commander and Director of CERL, and Dr. L. R. Shaffer is Technical Director.



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QUANTITATIVE ASSESSMENT OF ENVIRONMENTAL IMPACTS IN THE AQUATIC ENVIRONMENT

1 INTRODUCTION

Background

During the first decade of legislated environmental assessment of governmental activities, there have been changes in approaches and attitudes toward the National Environmental Policy Act (NEPA), as well as implementation of new legislation and administrative guidelines requiring new forms of environmental planning. New terminology, such as "scoping," "fate and effect," "hazard evaluation," etc., has appeared, and new methodologies have been developed for environmental planning and management. Unfortunately, legislative acts and rhetoric tend to grow faster than do the tools to carry them out. As a result, quantifying and measuring the significance of environmental impacts still remains an elusive target during planning, and flexible and efficient tools are needed to predict, evaluate, and mitigate these impacts. To meet this need, the U.S. Army Construction Engineering Research Laboratory (CERL) has developed a prototype package of computerized impact evaluation procedures called the Rational Impact Assessment System (RIAS) which use site-specific quantification routines to answer such questions as, "How bad will the impact be?" or "Will the impact be significant?"

Objective

The objective of this report is to document the development of RIAS as an impact evaluation tool.

Approach

Because the mechanisms of environmental impacts can be extremely complex and varied, it is difficult to construct one comprehensive simulation tool for predicting them. For this reason, the computer software developed to support RIAS consists of a series of independent modules which can be used either as separate programs or together as subroutines within a larger control program. The number of modules used depends entirely on the decision-maker's needs and the types of impacts identified through initial scoping.

Data collection, processing, and impact simulation carried out in RIAS proceed through the use of three general procedures: Filter Questions (FQUES), Water Quality Simulation (SIMWQ), and Rational Threshold Value Test (RTVTEST) (see Figure 1). Appendix C provides program listings for these three systems. FQUES collects and organizes relevant environmental setting and project information data through a computerized format of filter questions. SIMWQ simulates primary impacts on the physical/chemical attributes of

the aquatic receiving system over both temporal and spatial dimensions. RTVTEST is a set of rational threshold values (RTV) models which predict the significance of the primary and secondary impacts listed by SIMWQ. This series of analyses simulates the impact chain of events and provides a uniform method for environmental data handling.

Chapters 2 and 3 document the development of RIAS as an impact significance evaluation tool, describing these three supporting modules and providing user information for application of RIAS to the quantitative assessment of impacts on aquatic ecosystems. Four example applications of RIAS (Chapter 4) and user information for data collection and organization are presented (Chapter 5).

Mode of Technology Transfer

The information in this report will be issued as a DA Pamphlet in the 200 series and as the module called RIAS in the remote terminal ADP system entitled Environmental Technical Information System (ETIS).

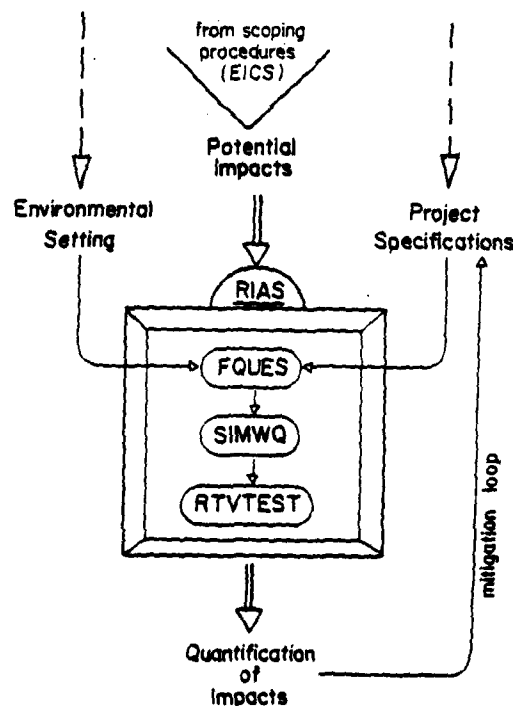


Figure 1. General design and information flow for the RIAS.

2 FILTER QUESTIONS

FQUES has been developed to execute a program which asks a series of questions about a specific project's environmental setting and organizes the information obtained into a data file. The data file is then used as input for simulations and other evaluation protocols.

FQUES can be used to set up a new data file or to revise an existing data file. Output from FQUES stores data related to such things as number of stream reaches, number of conservative and nonconservative water quality attributes, tributary inputs, point source discharges, hydraulic rating parameters, boundary conditions, and biological parameters.

3 WATER QUALITY SIMULATIONS (SIMWQ)

The development of SIMWQ has been restricted to one-dimensional, non-dispersive, steady-state, plug flow models for receiving streams. Whenever possible, rate equations have been limited to first-order reaction kinetics. This results in linear rate equations which provide analytical solutions. In addition, it avoids the necessity of using complicated numerical solution techniques for sets of differential equations and produces a much more usable model.

SIMWQ considers two types of sources or sinks for water quality constituents. First-order decay or accumulation terms, similar to the form of the Streeter-Phelps equation, are used to represent most biological activity in the stream. These terms can also be used for distributed sources or sinks which affect the stream equally along a longitudinal gradient. Examples of these terms are benthic oxygen demand or nonpoint source runoff. The receiving watershed is represented by a series of stream reaches within which all model parameters are constant. At the end of each reach, new model parameters are calculated, based on local environmental data and point source inputs. These results are combined with upstream values based on conservation of mass and assuming complete mix. This modeling approach is not new; however, it is an efficient, flexible system for tracing changes in water quality.

One major addition to the computer program which is the basis for SIMWQ is the capability to handle branched watersheds. This required coding the boundary conditions for reaches rather than a modification of the analytical solutions.

Figure 2 shows the general conceptual design of SIMWQ and the variables it can analyze. Tables 1 and 2 define the model's variables and parameters, respectively. Table 3 presents the rate equations which represent the heart of the model. Table 4 lists the analytical solutions derived from the equations provided in Table 3. These solutions assume time-constant model parameters and apply only within reaches. Tributaries and any applicable point source inputs between reaches are accounted for by Eq 1:

$$C = \frac{Q_1 C_1 + Q_2 C_2}{Q_1 + Q_2} \quad [\text{Eq 1*}]$$

where C denotes concentration, Q is flow, and subscripts 1 and 2 refer to the different flows being combined.

Several simplifying assumptions were used to reduce the system of rate equations to the desired forms, including:

1. Algae concentrations will be relatively constant for a given reach and a given season of the year.
2. Higher organisms, such as fish and invertebrates, do not significantly affect the rate of concentration change for any of the attributes considered.

*Variables for all equations in text are defined in Table 2.

3. For the purpose of SIMWQ, certain water quality attributes can effectively be considered conservative substances (e.g., TDS, hardness, pH, total alkalinity).

These, and other assumptions involved with steady-state and nondispersive models, must be reevaluated in each application of SIMWQ.

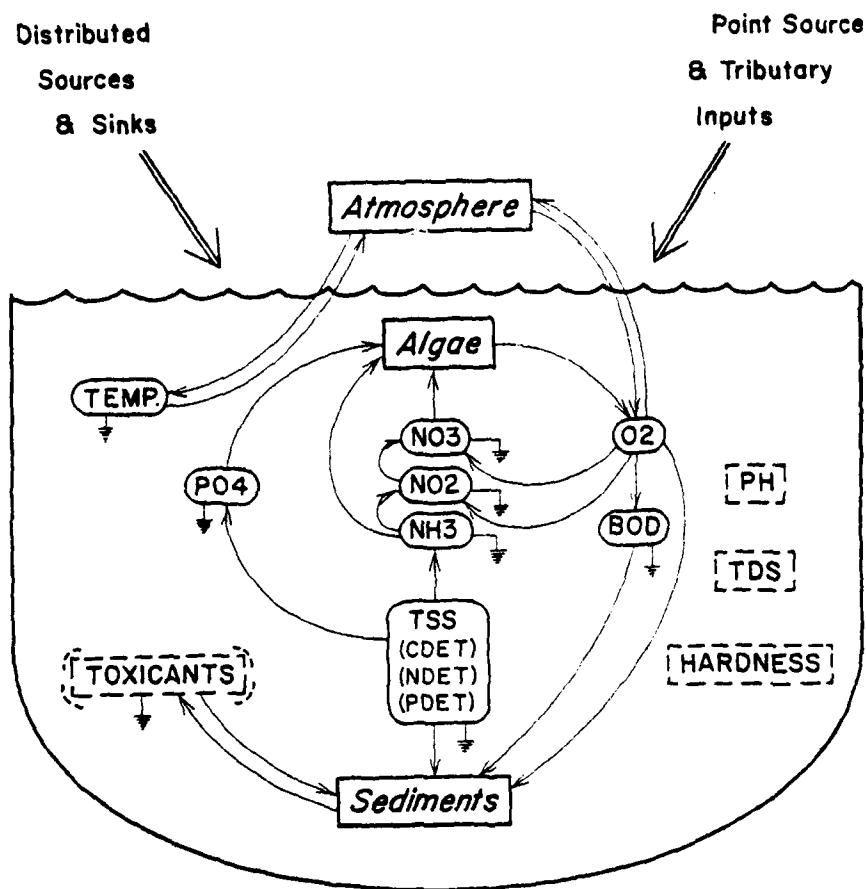


Figure 2. Conceptual organization of interactions between water quality attributes within each stream reach in SIMWQ.

Table 1
SIMWQ Variable Listing

Symbol	Definition	Units
ALK	Total alkalinity as CaCO_3	mg/ℓ
C	Total dissolved inorganic carbon	mg/ℓ
CDET	Carbon content of detritus in water column	mg/ℓ
CO2	Dissolved carbon dioxide	mg/ℓ
COLI	Coliform bacteria concentration	#/100 mL
CONSi	i th additional conservative water quality constituent	mg/ℓ
D	Dissolved oxygen saturation deficit	mg/ℓ
HARD	Water hardness as CaCO_3	mg/ℓ
L ⁱ	Biochemical oxygen demand (BOD ₅)	mg/ℓ
NCONi	i th additional nonconservative water quality constituent	mg/ℓ
NDET	Nitrogen content of detritus	mg/ℓ
NH3	Total ammonia nitrogen	mg/ℓ
NO2	Nitrite nitrogen	mg/ℓ
NO3	Nitrate nitrogen	mg/ℓ
O2	Dissolved oxygen	mg/ℓ
PDET	Phosphorus content of detritus	mg/ℓ
pH	pH of surface water ($-\log_{10} [\text{H}^+]$)	--
PO4	Phosphate-phosphorus	mg/ℓ
TW	Temperature of water	°C
TSS	Total suspended solids	mg/ℓ
TDS	Total dissolved solids	mg/ℓ

Table 2
SIMWQ Parameter Listing

Symbol	Definition	Values	Sources*
<u>1. Distributed Sources/Sinks</u>			
S_L	Scour/runoff of BOD_5		
S_{NCONi}	Nonpoint sources of non-conservative pollutants		
S_{NH3}	Surface runoff of NH_3		
S_{NO3}	Surface runoff of NO_3		
S_{O2}	Daily mean net l^0 production		
S_{PO4}	Surface runoff of PO_4		
S_{SOD}	Sediment oxygen demand		
S_{SS}	Scour/erosional inputs of suspended solids		
S_T	Natural heat inputs from atmosphere		
<u>2. Reaction Rates</u> ($K_i^T = 0_i^{T-2} \cdot K_i^{20^{\circ}C}$)			
k_{ANH3}^T	Algal uptake of NH_3	0.1 to 4.0	
k_{AN03}^T	Algal uptake of NO_3	0.1 to 4.0	White & Dracup
k_{APO4}^T	Algal uptake of PO_4	0.005 to 0.5	White & Dracup
k_L^T	Decomposition of BOD_5	0.01 to 2.5	HEC, Zison
k_{LS}^T	Bottom exchange of BOD_5	0.0 to 2.0	

*See References, pp 32-33.

Table 2 (Cont'd)

Symbol	Definition	Values	Sources*
k_{NCONi}^T	Biodegradation/decay of ith nonconservative pollutant	attribute dependent	
k_{NDET}^T	Mineralization/dissolu- tion of nitrogen portion of detritus	0.001 to 0.02	HEC
k_{NH3}^T	Microbial conversion of NH_3	0.01 to 2.5	Zison, pp 188-197 HEC
k_{NO2}^T	Microbial conversion of NO_2	0.020 to 0.5 0 to 10.0	Miller & Jennings White & Dracup HEC
k_{NO3}^T	Microbial conversion of NO_3	≈ 0.001	Miller & Jennings
k_{PDET}^T	Mineralization/dissolu- tion of phosphorus portion of detritus	0.001 to 0.02	HEC
k_{PO4}^T	Decay of phosphates due to microbial uptake/ conversion	(0.01) 0.005 to 0.5	White & Dracup
k_R^T	Reaeration of dissolved oxygen	$k_R^{20} = a U^b H^c$	Covar
k_{SS}^T	Decay of suspended solids (mineralization/ biotic breakdown)	0.001 to 0.02	HEC
k_{SSS}^T	Settling of suspended solids	0 to 2.0	HEC

*See References pp 32, 33.

Table 2 (Cont'd)

Symbol	Definition	Values	Sources [*]
k_T	Heat exchange with atmosphere	(See Temp. Model in the Computer Listing)	
k_{TSS}^T	Overall decay of suspended solids ($k_{TSS}^T = k_{SS}^T + k_{SSS}^T/\text{depth}$)	$k_{SS}^T + k_{SSS}^T/\text{depth}$	

*See References pp 32, 33.

Table 3
SIMWQ Rate Equations*

Rate Equations (within reaches, excluding point sources)

1. Temperature

$$\frac{dT}{dt} = S_T - k_T T_t$$

2. BOD

$$\frac{dL}{dt} = -(k_L^T + k_{LS}^T) L_t + S_L$$

3. Suspended Solids

$$\frac{dTSS}{dt} = -k_{TSS}^T \cdot TSS_t + S_{SS} = -(k_{SS}^T + \frac{k_{SSS}^T}{\text{depth}}) TSS_t + S_{SS}$$

4. Phosphate-Phosphorus

$$\frac{dPO_4}{dt} = -k_{PO_4}^T \cdot PO_4_t + k_{PDET}^T \cdot PDET_t + S_{PO_4} + k_{APO_4}^T \cdot A$$

5. Ammonia-Nitrogen

$$\frac{dNH_3}{dt} = -k_{NH_3}^T \cdot NH_3_t + k_{NDET}^T \cdot NDET_t + S_{NH_3} + k_{ANH_3}^T \cdot A$$

6. Nitrite-Nitrogen

$$\frac{dNO_2}{dt} = -k_{NO_2}^T \cdot NO_2_t + k_{NH_3}^T \cdot NH_3_t$$

* Equation variables are defined in Table 2.

Table 3 (Cont'd)

7. Nitrate-Nitrogen

$$\frac{dNO_3}{dt} = k_{NO_2}^T \cdot NO_{2t} - k_{NO_3}^T \cdot NO_3 + S_{NO_3} + k_{ANO_3}^T \cdot A$$

8. Dissolved Oxygen Deficit

$$\frac{dD}{dt} = -k_L^T \cdot L_t + k_{NH_3}^T \cdot L_t^{NH_3} + k_{NO_2}^T \cdot L_t^{NO_2} - k_R^T D_t - S_{O_2} + S_{SOD}$$

9. Conservative Constituents

$$\frac{dCON_i}{dt} = 0$$

10. Nonconservative Constituents

$$\frac{dNCON_i}{dt} = -k_{NCON_i}^T \cdot NCON_i + S_{NCON_i}$$

Table 4

Analytical Solutions to Table 3*
(These equations apply only within stream reaches
which have constant model parameters.)

1. Biochemical Oxygen Demand (L)

$$L_t = (L_0 - \frac{L}{K_1}) \exp(-(k_L^T + k_{LS}^T)t) + \frac{L}{K_1}$$

$$\text{where } \frac{L}{K_1} = \frac{S_L}{(k_L^T + k_{LS}^T)}$$

2. Total Dissolved Solids (TSS)

$$TSS_t = (TSS_0 - \frac{TSS}{K_1}) \exp(-(k_{SS}^T + \frac{k_{SSS}^T}{\text{depth}})t) + \frac{TSS}{K_1}$$

$$\text{where } \frac{TSS}{K_1} = \frac{S_{SS}}{(k_{SS}^T + k_{SS}^T + k_{SSS}^T \text{depth})}$$

3. Suspended Solids Portioning

$$CDET_t = PC(TSS_t)$$

$$NDET_t = PN(TSS_t)$$

$$PDET_t = PP(TSS_t)$$

4. NH3

$$NH3_t = (NH3_0 - \frac{n}{K_1} - \frac{n}{K_2}) \exp(-k_{NH3}^T t) + \frac{n}{K_1} \exp(-k_{SS}^T t) + \frac{n}{K_2}$$

* Equation variables are defined in Table 2.

Table 4 (Cont'd)

$$\text{where } \bar{K}_1^n = \frac{[k_{\text{NDET}}^T \cdot \text{PN}(\text{TSS}_0 - \bar{K}_1^{\text{TSS}})]}{(k_{\text{NH3}}^T - k_{\text{SS}}^T)}$$

$$\bar{K}_2^n = (k_{\text{NDET}}^T \cdot \text{PN} \cdot \bar{K}_1^{\text{TSS}} + S_{\text{NH3}} - k_{\text{ANH3A}})/k_{\text{NH3}}^T$$

5. NO2

$$\begin{aligned} \text{NO2}_t &= (\text{NO2}_0 - \bar{N}_1 - \bar{N}_2 - \bar{N}_3) \exp(-k_{\text{NO2}}^T t) + \bar{N}_1 \exp(-k_{\text{NH3}}^T t) \\ &\quad + \bar{N}_2 \exp(-k_{\text{SS}}^T t) + \bar{N}_3 \end{aligned}$$

$$\text{where } \bar{N}_1 = \frac{k_{\text{NH3}}^T (\text{NH3}_0 - \bar{K}_1^n - \bar{K}_2^n)}{k_{\text{NO2}}^T - k_{\text{NH3}}^T}$$

$$\bar{N}_2 = \frac{k_{\text{NH3}}^T \bar{K}_1^n}{k_{\text{NO2}}^T - k_{\text{SS}}^T}$$

$$\bar{N}_3 = \frac{k_{\text{NH3}}^T \bar{K}_2^n}{k_{\text{NO2}}^T}$$

6. NO3

$$\text{NO3}_t = \text{NO3}_0 + \bar{K}_1^{\text{no}} - \bar{K}_2^{\text{no}} \exp(-k_{\text{NO2}}^T t) - \bar{K}_3^{\text{no}} \exp(-k_{\text{NH3}}^T t) - \bar{K}_4^{\text{no}} \exp(-k_{\text{SS}}^T t)$$

Table 4 (Cont'd)

$$\text{where } \underline{K}_1^{no} = (k_{NO2}^T \underline{N}_3 + S_{NO3} - k_{ANO3}^T A)t$$

$$\underline{K}_2^{no} = NO2_0 - \underline{N}_1 - \underline{N}_2 - \underline{N}_3$$

$$\underline{K}_3^{no} = \frac{k_{NO2}^T}{k_{NH3}^T} \underline{N}_1$$

$$\underline{K}_4^{no} = \frac{k_{NO2}^T}{k_{SS}^T} \underline{N}_2$$

7. P04

$$P04_t = (P04_0 - \underline{K}_1^P - \underline{K}_2^P) \exp(-k_{P04}^T t) + \underline{K}_1^P \exp(-k_{SS}^T t) + \underline{K}_2^P$$

$$\text{where } \underline{K}_1^P = \frac{k_{PDET}^T (PP(TSS_0 - \underline{K}_1^{TSS}))}{k_{P04}^T - k_{SS}^T}$$

$$\underline{K}_2^P = \frac{k_{P04}^T \cdot PP \cdot \underline{K}_1^{TSS} + Sp04 - k_{AP04} \cdot A}{k_{P04}^T}$$

8. Dissolved Oxygen (O₂)

$$O2_t = O2SAT_t^T - D_t$$

$$L_{NH3}^t = 3.43 \cdot NH3_t$$

Table 4 (Cont'd)

$$L_t^{NO2} = 1.14 \cdot NO2_t$$

$$D_t = (D_0 - \frac{D}{K_1} - \frac{D}{K_2} - \frac{D}{K_3} - \frac{D}{K_4} - \frac{D}{K_5}) \exp(-k_R^T t)$$

$$+ \frac{D}{K_1} \exp(-(k_L^T + k_{LS}^T)t) + \frac{D}{K_2} \exp(-k_{NH3}^T t)$$

$$+ \frac{D}{K_3} \exp(-k_{NO2}^T t) + \frac{D}{K_4} \exp(-k_{SS}^T t)$$

$$+ \frac{D}{K_5}$$

$$\text{where } \frac{D}{K_1} = \frac{k_L^T (L_0 - \frac{L}{K_1})}{k_R^T - (k_L^T + k_{LS}^T)}$$

$$\frac{D}{K_2} = \frac{3.43 k_{NH3}^T (NH3_0 - \frac{n}{K_1} - \frac{n}{K_2}) + 1.14 k_{NO2}^T \bar{N}_1}{k_R^T - k_{NH3}^T}$$

$$K_3^D + \frac{1.14 k_{NO2}^T (NO2_0 - \bar{N}_1 - \bar{N}_2 - \bar{N}_3)}{k_R^T - k_{NO2}^T}$$

$$K_4^D = \frac{3.43 k_{NH3}^T \frac{n}{K_1} + 1.14 k_{NO2}^T \bar{N}_2}{k_R^T - k_{SS}^T}$$

Table 4 (Cont'd)

$$\underline{K}_5^D = (k_L^T \underline{K}_1^L + 3.43 k_{NH_3}^T \underline{K}_2^n + 1.14 k_{NO_2}^T \underline{N}_3 - S_{O_2}^T + S_{SOD}^T) / k_R^T$$

9. Conservative Attributes

$$CONSi_t = CONSi_o$$

10. Nonconservative Attributes

$$NCONi_t = (NCONi_o - \frac{S_{NCONi}}{k_{NCONi}^T} \exp(-k_{NCONi}^T t) + \frac{S_{NCONi}}{k_{NCONi}^T}$$

11. Temperature

$$T_t = (T_o - \underline{K}^T) \exp(-k_T t) + \underline{K}^T$$

where

$$k_T = 1.17 \times 10^{-3} + \rho L(a + bV)(\beta_j + 6.1 \times 10^{-4} p)$$

$$\begin{aligned} K^T = & (q_{SN} + q_{at} - 7.36 \times 10^{-2} - \rho L(a + bV)(\alpha_j - e_a \\ & - 6.1 \times 10^{-4} p \cdot AT) / k_T \end{aligned}$$

4 RATIONAL THRESHOLD VALUE TEST MODELS

An analytical approach such as that provided by RIAS requires measurable indicators of impact significance. To determine such significance, threshold values must be established. Therefore, it is necessary to develop concepts for using RTVs to measure the significance of impacts within the aquatic environment. The RTVTEST models used to develop RIAS are a subset of available models.¹ Impacts can be analyzed at three levels of effect by applying one or more of the following tests:

1. WQRTV -- Assessment of the extent of predicted violation of existing ambient water quality standards.
2. SIRTIV -- Assessment of the effect of organic pollution on the microbial community.
3. TURTV -- Assessment of the expected concentrations of toxic compounds on overall environmental toxicity of receiving system (species-specific).

The flexibility of RIAS allows these RTVTESTs to be used singly or in conjunction with each other.

Water Quality Standard Assessments (WQRTV)

This RTVTEST quantifies the magnitude of water quality violations which will be caused by the impacts of the project being evaluated. This test is relatively straightforward, comparing existing stream standards to the output of pertinent SIMWQ attributes. Impact is quantified in terms of the degree of violation (mg/l) at specific points in the WQ (i,j,k) profile, the spatial extent of violations (mg/l/miles), and the temporal extent of violations. The RTV level in this case is the existing water quality standard.

Saprobic Indices (SIRTIV)

This system² was developed as an empirical relationship between aquatic organisms and organic water pollution. This relationship has been termed the Saprobian system and uses the concept of an indicator species. The application of the empirical relationships of the Saprobian system in a quantitative index was introduced by Pantle and Buck³ and expanded by Sladeczek.⁴ They

¹ E. E. Herricks and M. J. Sale, Development of Rational Threshold Values for Aquatic Ecosystems (University of Illinois, 1978).

² R. Kolwitz and M. Marsson, "Okologie der Pflanzlichen Saprobien," Ber. Dt. Bot. Ges., Vol 26A (1908), pp 505-519.

³ R. Pantle and H. Buck, "Die Biologische Überwachung der Gewässer und die Darstellung der Ergebnisse," Gas. Wass. Fach., Vol 96, No. 604 (1955).

⁴ V. Sladeczek, "The Measures of Saprobity," Vern. Int. Ver. Limnol., Vol 17 (1969), pp 546-559; and V. Sladeczek, "System of Water Quality from the Biological Point of View," Erg. Limnol., Vol 7 (1973), pp 1-218.

describe the Saprobic index S as ranging between 1 and 4 and 1 and 8, respectively. Other literature has shown the relationship between the Saprobic index and BOD_5 in the stream.⁵ Table 5 gives the relative values of S and BOD_5 .⁶ Saprobic indices have generally been used as a classification scheme in Europe, but have not been widely used in the United States.

The Saprobic index can easily be calculated⁷ using BOD_5 concentrations provided by SIMWQ:

$$SI(i,k) = \frac{1.075(L(i,k)) - 0.473}{0.218(L(i,k)) + 0.904} \quad [Eq\ 3]$$

if $0 \leq L(i,k) \leq 50\text{ mg/l}$

$$= \frac{0.0189(L(i,k)) - 7.938}{0.0021(L(i,k)) - 1.882}$$

if $L(i,k) > 50\text{ mg/l}$

where $SI(i,k)$ is the Saprobic index in i^{th} point in space and k^{th} point in time.

The values of $SI(i,k)$ can then be used to interpret the impact of organic effluents on the community structure of the receiving stream. For example, RTV levels can be set at $SI(i,k) < 2.0$ for no significant impact and at $2 < SI(i,k) < 3$ for minimal impact; then the output from the SIRT routine can be used to quantify the extent of temporal and spatial impacts within the aquatic environment.

Environmental Toxicity (TURT)

The toxicity unit concept⁸ has proven to be a useful tool for integrating biological response to both primary toxicants and modifying factors (e.g., dissolved oxygen [DO], temperature, pH, etc.). This index has been used successfully⁹ to assess the biological significance of water pollution impacts. A toxic unit of a specific pollutant is simply a concentration equal to the

⁵ J. Rothschein, "Saprobity as a Criterion of Oxygen Regime" (in Slovakian with English summary), Pr. Stud. VUVH Bratislava, Vol 63 (1972), pp 1-134; and V. Sladecek and F. Tucek, "Relation of the Saprobic Index to BOD_5 ," Water Res., Vol 9 (1975), pp 791-794.

⁶ V. Sladecek, "The Measures of Saprobity"; and "System of Water Quality from the Biological Point of View."

⁷ V. Sladecek and F. Tucek, "Relation of the Saprobic Index to BOD_5 ."

⁸ K. S. Lubinski, R. E. Sparks, and L. A. Jahn, Development of Toxicity Indices for Assessing the Quality of the Illinois River, Research Report No. 96, UIIU-WRC-74-0096 (University of Illinois, 1974).

⁹ W. V. Brigham, D. A. McCormick, and M. J. Wetzel, The Watersheds of Northeastern Illinois: Quality of Aquatic Environment Based Upon Water Quality and Fishery Data, Staff Paper No. 31, NIPC (Illinois Natural History Survey, 1978).

96-hour LC_{50} for a target organism.* Toxic units are calculated as the ratio of simulated ambient concentrations of an attribute divided by its LC_{50} . This ratio is also analogous to a pollutant's application factor,¹⁰ and a threshold level can be specified to ensure protection for target organisms (e.g., requiring a toxic unit ≤ 0.01 would be equivalent to an application factor of 100, which is used for many chlorinated hydrocarbons). Toxic units can also be accumulated (summed) for all potential toxicants to obtain an overall index of environmental toxicity. Experience has indicated acceptable levels of total toxicity units,¹¹ but one must remember that this index is just a first approximation of biological response.

The problems involved with measuring environmental toxicity include adjusting for the effects of environmental modifiers and predicting synergistic effects of various pollutant combinations. Information on the effects of combinations of toxicants is available for only a few species, but more data are being collected daily. However, despite these limitations, the toxic unit model is still the best general model now available for impact assessment. When toxicity data are available at multiple trophic levels, the toxic units can also be used at various levels to measure the sensitivity of aquatic communities.

* LC_{50} is a measure of the concentration level of the toxic material that will kill 50 percent of the species being used in the test within a given time interval (e.g., 96 hours).

¹⁰ Quality Criteria for Water (U.S. Environmental Protection Agency [USEPA], 1976).

¹¹ R. Lloyd and D. H. M. Jordan, "Predicted and Observed Toxicities of Several Sewage Effluents to Rainbow Trout," J. and Proc. Inst. Sew. Purif. (Brit.), Vol 2 (1963), pp 183-186.

Table 5

Values of S and BOD_5 (=L) for Upper Limits of Individual Saprobic Degrees*

Degree	S	L	Note
Katharobity	-0.5	0.0	Purest water
Zernosaprobity	0.5	1.0	Very clean
Oligosaprobity	1.5	2.5	Clean
Beta-mesosaprobity	2.5	5.0	Mild pollution
Alpha-mesosaprobity	3.5	10.0	Pollution
Polysaprobity	4.5	50.0	Heavy pollution
Isosaprobity	6.5	400.0	Sewage
Metasaprobity	6.5	700.0	Septic
Hypersaprobity	7.5	2,000.0	Putrefaction
Ultrasaprobity	8.5	120,000.0	Lifeless liquors

*From V. Sladeczek, "The Measures of Saprobity," Verh. Int. Ver. Limnol., Vol 17 (1969), pp 546-559; and V. Sladeczek "System of Water Quality from the Biological Point of View," Erg. Limnol., Vol 7 (1973), pp 1-218.

5 APPLICATIONS

This chapter provides a series of application scenarios which demonstrate the utility of RIAS. Appendices A and B provide sample output of the RIAS system application. These examples concentrate on problems pertinent to current Army activities, but are not meant to be exhaustive. The role of RIAS or a similarly designed methodology in improving impact planning will become apparent in this discussion.

The general framework for decision-making using RIAS should be envisioned as an iterative process using the three computerized procedures -- FQUES, SIMWQ, and RTVTEST -- as the central tools. Adequate methods for impact scoping presently exist in the form of matrix methodology such as the Environmental Impact Computer System (EICS),¹² a computerized system to help environmental planners identify and mitigate impacts of proposed Army projects or activities. However, a shortcoming of matrix methodology is that it is not a data-handling tool and provides little, if any, quantification potential. This is the purpose of developing secondary algorithms like RIAS for impact assessment. While computer-based matrix methodologies work well for specifying a project's potential impacts, they cannot detect small changes in project specifications which may mean the difference between significant or nonsignificant impacts. RIAS, which has this capability, uses quantitative procedures to integrate impacts according to changes in project specifications. Environmental setting data are used to predict impact magnitudes. Subsequent to initial use of these procedures, project specifications can be changed, allowing impact assessment of various alternatives to be done easily and inexpensively. In this way, the RIAS methodology provides a truly quantitative tool for impact management.

Besides quantification, another major advantage of RIAS is standardization. The computer-based algorithms define the organization of environmental information and specify its use in a consistent, repeatable protocol. At this time, the links between primary-level impact assessment (i.e., scoping activities like EICS) and secondary procedures such as RIAS should be via paper ties only. This could be in the form of RAMIT (ramification/mitigation) statements output from EICS, descriptor package writeups, and user manuals such as the appendices to this report. Ultimately, if a system such as RIAS received broad-based support, data sets specifying environmental setting could be assembled for all Army bases, providing "off the shelf" assessment capability whenever new missions altered base operations. Since the goals of impact modeling should be flexibility and easily usable prediction tools coupled to readily available data sets, RIAS can be seen as a design prototype for this type of methodology.

The following sections provide examples of how RIAS can be applied to assessing environmental impacts resulting from Army projects.

¹²R. Baran and R. D. Webster, Interactive Environmental Impact Computer System (EICS) User Manual, Technical Report N-80/ADA074890 (U.S. Army Construction Engineering Research Laboratory [CERL], September 1979).

Example 1

The impacts occurring in aquatic receiving systems which are the most frequently studied originate from point source discharges of domestic sewage effluents. This type of effect must be considered in environmental impact statements and/or assessments of Army activities. Receiving stream impacts caused by organic pollution occur when mission changes alter sewage treatment plant loadings or treatment efficiencies or when old sewage treatment plants are upgraded. RIAS provides an assessment tool for analyzing these situations. The BOD/DO models within RIAS are only a subset of a more general model. The outputs from both WQRTV and SIRTIV quantify these types of impacts and place impact predictions in easily understandable terms. (See Appendix B, Part 3.)

Example 2

Waste discharges from many Army industrial or laboratory activities contain toxic components which can adversely affect aquatic biota. The magnitude and spatial extent of these impacts are largely a function of environmental setting, such as watershed dilution capacity, ambient water quality, and local target species. The TURTIV routine in RIAS provides a consistent method of considering such information and quantifying impact magnitude using the toxic unit concept. (See Appendix A, Part 3, Section C.)

Example 3

Vehicle maintenance activities account for point source discharges of many potentially harmful water quality attributes, including suspended solids, detergents, oils and greases, and general BOD. While washrack facilities are being redesigned and relocated, the impacts of these facilities within a watershed context could be evaluated using the RTVTESTs in RIAS. Thus, site-specific design activities could be made more efficient by considering the watershed assimilation capacity of sensitivity (Appendix B, Part 3) as shown by RIAS.

Example 4

Impacts from landfill leachate are increasingly affecting the aquatic environment. The significance of these impacts depends on many factors, including the water body's assimilative capacity and the sensitivity of biota in the receiving watershed. RIAS is an excellent tool for evaluating the severity of these impacts. If leachate rates and initial concentrations can be estimated and isolated in a watershed, a simulated point source discharge can be created to represent leachate inputs. (See Appendix B, Part 3.)

6 USER'S GUIDE TO RIAS

Organization of Information Inputs

The first step in using the RIAS computer routines for an impact assessment is organizing the data sources and describing the problem. This requires several stages of data collection and organization, including: (1) identification of the control parameters for simulation and assessments, (2) collection of data on boundary conditions for the analysis, and (3) estimation of kinetic rate coefficients and source/sink terms for the water quality simulations.

The first step is determining the impact types to be considered and the geometric description of the watershed to be analyzed. Potential impacts must have already been identified by some type of scoping procedure (e.g., EICS). Physical and chemical water quality attributes are required at this point, as well as environmental modifiers which might be important in weighing impact significance. This information is used to specify the attributes to be modeled in SIMWQ. The watershed description consists of identifying reach lengths, drainage areas upstream from the top of each stream reach, tributary and effluent locations, and bifurcation structure. (Chapter 2 provides criteria for specifying reaches.) Drainage areas are calculated using standard U.S. Geological Survey maps.

The technique to be used for numbering reaches, bifurcations, tributaries, and effluents is:

1. Numbering reaches: Number reaches beginning at the top of the most upstream minor branch of the stream to be modeled. Proceed downstream until a confluence is encountered. Skip to the top of the next most upstream minor branch and continue downstream to the next confluence. When no more minor branches remain, proceed down the main branch from upstream to downstream.

2. Numbering bifurcations: Each channel bifurcation (confluence location) is designated by a real number consisting of digits in the tens, ones, tenths, and hundredths places. For example, for "10.05," the whole number part of the indicator ("10" in this example) represents the receiving reach downstream of the confluence. The fractional part of the indicator ("5" in this example) represents the last reach of the minor branch which is entering a higher-order stream.

3. Numbering tributary inputs: Using the numbering system described above, number upstream tributaries first, doing the more minor branches first. This convention is not critical, but will provide more consistency. Remember that the inputs at the top reach of each branch must be designated as a tributary in order to set boundary conditions for the simulation model. The index of each tributary designates the stream reach into which it empties, not simply its number.

4. Numbering effluent inputs: Using the numbering system described above, number effluents in an upstream to downstream manner. As with tributaries, the index number of an effluent represents the number of the reach into which it empties, not the number of the effluent.

The second stage of data organization is specifying boundary conditions of water quality attributes at tributaries and effluents within the watershed. Techniques for doing mass balances on Army installations are available which are adequate for describing effluents.¹³ Another source of effluent information is the National Pollutant Discharge Elimination System (NPDES) permits for point source discharges. Many sources are available that describe information on tributary inputs.¹⁴ However, when no information on boundary conditions is available, field data must be collected.

The last stage of data organization is specifying the kinetic terms in SIMWQ equations. This is the most important requirement for ensuring accurate impact assessment. The structure used in SIMWQ takes advantage of a class of widely used simulation models (steady-state, plug flow) whose parameters are well understood. The review of Zison, et al., is a good primary source of information on the state of the art of estimating these model parameters.¹⁵ Table 2 provides a range of values experienced for all model terms and references to previous modeling work in which they were used.

Example Problem

To illustrate the use of all the RIAS routines, Appendix B provides an example impact assessment. Figure 3 shows the layout of a hypothetical Army post where the potential impacts from four point sources of pollutants on aquatic receiving systems will be analyzed. Pre-analysis information has already been organized, and the example begins as FQUES is executed to build up the project specification/environmental setting data base. All user responses in the computer output have been underlined.

¹³G. W. Schanche, et al., Water/Wastewater Survey Guidelines, Technical Report N-11/ADA033223 (CERL, 1976).

¹⁴E. E. Herricks and M. J. Sale, Development of Rational Threshold Values for Aquatic Ecosystems (University of Illinois, 1978).

¹⁵S. W. Zison, et al., Rates, Constants and Kinetic Formulations in Surface Water Quality Modeling, EPA-600/3-78-105 (USEPA, 1978).

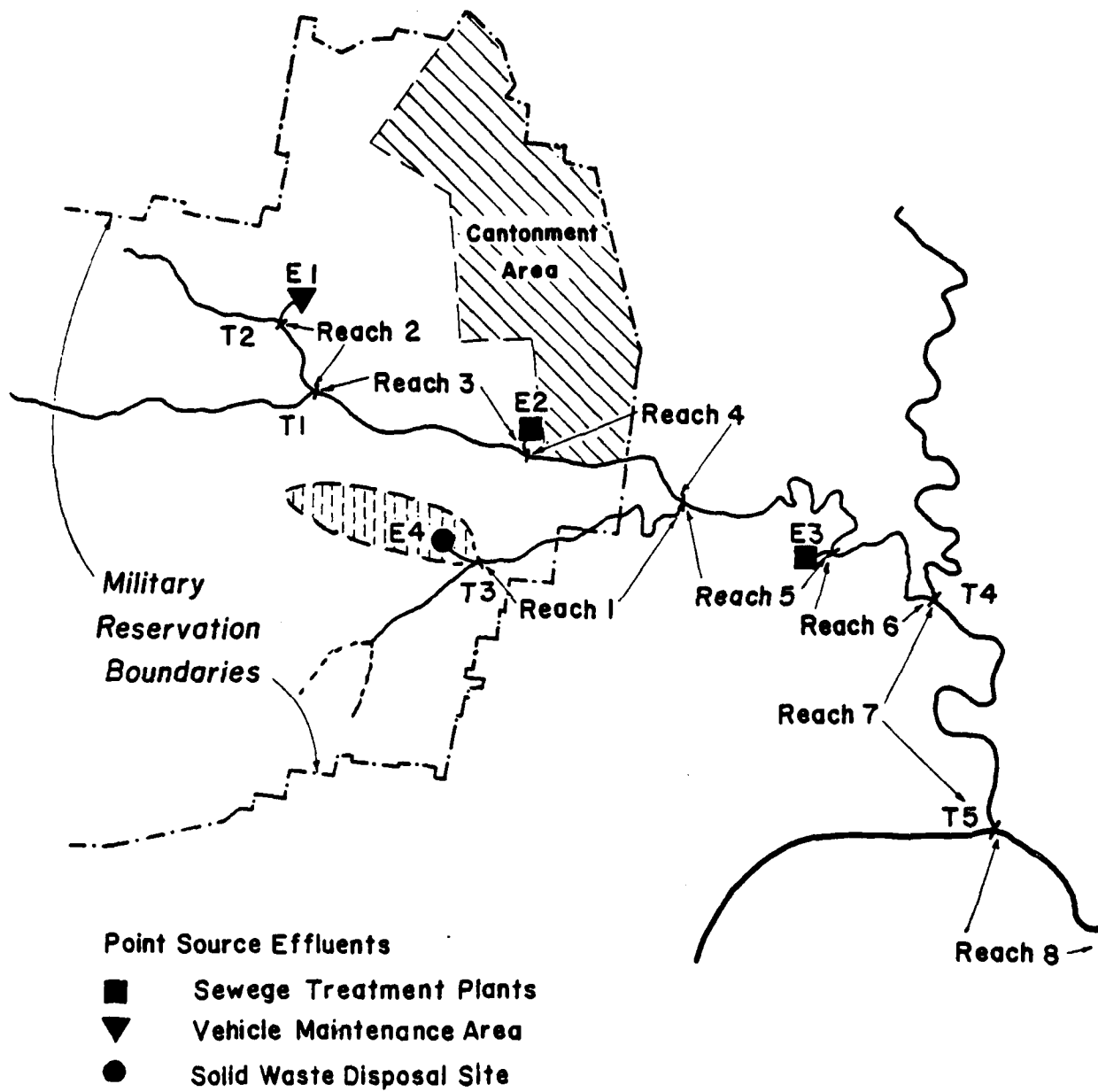


Figure 3. Physical layout for example problem.

7 CONCLUSION

This report has described the framework and demonstrated the utility of RIAS, a computerized technique which uses the concept of rational threshold values to determine impact significance. This system uses a rigorous set of analysis procedures to identify significant effects resulting from Army activities on aquatic ecosystems.

REFERENCES

- Baran, R., and R. D. Webster, Interactive Environmental Impact Computer System (EICS) User Manual, Technical Report N-80/ADA074890 (U.S. Army Construction Engineering Research Laboratory [CERL], September 1979).
- Brigham, W. V., D. A. McCormick, and M. J. Wetzel, The Watersheds of Northeastern Illinois: Quality of Aquatic Environment Based Upon Water Quality and Fishery Data, Staff Paper No. 31, NIPC (Illinois Natural History Survey, 1978).
- Herricks, E. E., and M. J. Sale, Development of Rational Threshold Values for Aquatic Ecosystems (University of Illinois, 1978).
- Kolwitz, R., and M. Marsson, "Ökologie der Pflanzlichen Saprobien," Ber. Dt. Bot. Ges., Vol 26A (1908), pp 505-519.
- Lloyd, R., and D. H. M. Jordan, "Predicted and Observed Toxicities of Several Sewage Effluents to Rainbow Trout," J. and Proc. Inst. Sew. Purif. (Brit.), Vol 2 (1963), pp 183-186.
- Lubinski, K. S., R. E. Sparks, and L. A. Jahn, Development of Toxicity Indices for Assessing the Quality of the Illinois River, Research Report No. 96, UIIU-WRC-74-0096 (University of Illinois, 1974).
- Pantle, R., and H. Buck, "Die Biologische Überwachung der Gewässer und die Darstellung der Ergebnisse," Gas. Wass. Fach., Vol 96, No. 604 (1955).
- Quality Criteria for Water (U.S. Environmental Protection Agency [USEPA], 1976).
- Rothschein, J., "Saprobity as a Criterion of Oxygen Regime" (in Slovakian with English summary), Pr. Stud. VUVH Bratislava, Vol 63 (1972), pp 1-134.
- Schanche, G. W., et al., Water/Wastewater Survey Guidelines, Technical Report N-11/ADA033223 (CERL, 1976).
- Sladeczek, V., "The Measures of Saprobity," Verh. Int. Ver. Limnol., Vol 17 (1969), pp 546-559.
- Sladeczek, V., "System of Water Quality from the Biological Point of View," Erg. Limnol., Vol 7 (1973), pp 1-218.
- Sladeczek, V., and F. Tucek, "Relation of the Saprobic Index to BOD₅," Water Res., Vol 9 (1975), pp 791-794.
- Thomann, R. V., Systems Analysis and Water Quality Management, (McGraw-Hill, 1972).
- Zison, S. W., et al., Rates, Constants and Kinetic Formulations in Surface Water Quality Modeling, EPA-600/3-78-105 (USEPA, 1978).

UNCITED REFERENCES

- Bansal, M. K., "Nitrification in Natural Streams," J. Water Poll. Control Fed., Vol 48, No. 10 (1976), pp 2380-2393.
- Bansal, M. K., "Deoxygenation in Natural Streams," Water Res. Bull., Vol 11, No. 3 (1975), pp 491-504.
- Covar, A. P., "Selecting the Proper Reaeration Coefficient for Use in Water Quality Models," Environmental Modeling and Simulation, W. R. Oh (ed.), EPA 600/9-76-016 (USEPA, 1976).
- Kolwitz, R., and M. Marsson, "Grundsätze für die Biologische Beurteilung des Wassers Nach Seiner Flora und Fauna," Mitt. Fruf. Anst. Wass. Versorg. Abwasserbeseit. Berl., Vol 1 (1902), pp 33-72.
- Lloyd, R., and D. H. M. Jordan, "Predicted and Observed Toxicities of Several Sewage Effluents to Rainbow Trout: A Further Study," J. and Proc. Inst. Sew. Purif. (Brit.), Vol 2 (1964), pp 167-173.
- Water Quality for River Reservoir Systems: Generalized Computer Programs, 401-F2-L2100 and 401-F2-L2100A (U.S. Army Corps of Engineers, Hydrologic Engineering Center, 1975).
- White, J. D., and J. A. Dracup, "Water Quality Modeling of a High Mountain Stream," J. Water Poll. Control Fed., Vol 49 (1977), pp 2179-2189.
- Miller, J. E., and M. E. Jennings. "Modeling Nitrogen, Oxygen, Chattahoochee River, GA," ASCE Jour. Environ. Eng., Vol 105, No. EE4 (1979), pp 641-653.

APPENDIX A:

ANALYTICAL SOLUTIONS USED IN SIMWQ

The general solution used in the SIMWQ equations is demonstrated here for a simple steady-state situation of coupled water quality attributes.* The equations developed here are used only within a stream reach in which all model parameters are constant. Implicit assumptions are:

1. Nondispersive, plug flow
2. Temporal steady-state conditions at all upstream loading points, source/sink terms, and stream discharge
3. First-order reaction kinetics.

The initial system of coupled reaction is given by:

$$\frac{dA_t}{dt} = -k_1 A_t + S_A \quad [\text{Eq A1}]$$

$$\frac{dB_t}{dt} = -k_2 B_t + k_3 A_t + S_B$$

where:

A_t = concentration of attribute A at time t

B_t = concentration of attribute B at time t

The general solution is:

$$A_t = S_A k_1 + (A_0 - \frac{S_A}{k_1}) \exp(-k_1 t) \quad [\text{Eq A2}]$$

$$B_t = [\frac{k_3 S_A}{k_1 k_2} + \frac{S_B}{k_2}] +$$

$$[B_0 + \frac{k_3 S_A}{k_1(k_2 - k_1) - \frac{k_3 A_0}{k_2 - 1} - \frac{k_3 S_A}{k_1 k_2} - \frac{S_B}{k_2}}] \exp(-k_2 t)$$

$$+ [\frac{k_3 A_0}{(k_2 - k_1) - \frac{k_3 S_A}{k_1(k_2 - k_1)}}] \exp(-k_1 t)$$

* A more detailed discussion of this type of equation development can be found in Chapters 4 and 5 of R. V. Thomann, Systems Analysis and Water Quality Management (McGraw-Hill, 1972).

Generally, this type of solution takes on the form:

$$C_t = \alpha + \sum_{i=1}^n \beta_i \exp(-\gamma_i t) \quad [\text{Eq A3}]$$

where α , β_i , and γ_i are constants within a reach which can be calculated from data inputs, and C_t is the concentration of any attribute at time t .

In some cases, this analytical solution degenerates; i.e., if k_2 is input as zero or if $k_2 = k_1$, the result will be an illegal arithmetic operation. Therefore, contingencies have been made in the FORTRAN code to avoid this type of solution breakdown. Using the coupled system defined initially, four conditions can be identified which cause a breakdown:

1. $k_1 = 0$, k_2 nonzero
2. $k_2 = 0$, k_1 nonzero
3. $k_1 = k_2 = 0$
4. $k_2 = k_1 \neq 0$.

The solutions used to avoid blowup in SIMWQ can be derived as follows:

Condition 1 ($k_1 = 0$, $k_2 \neq 0$):

$$A_t = a_0 + S_A t \quad [\text{Eq A4}]$$

$$B_t = \left[\frac{k_3 A_0}{k_2} + \frac{S_B}{k_2} \right] + \left(B_0 - \frac{k_3 A_0 + S_B}{k_2} \right) \exp(-k_2 t) + \frac{1}{2} k_3 S_A t^2$$

Condition 2 ($k_2 = 0$, $k_1 \neq 0$):

$$A_t = \frac{S_A}{k_1} + \left(A_0 - \frac{S_A}{k_1} \right) \exp(-k_1 t) \quad [\text{Eq A5}]$$

$$B_t = \left[\frac{S_A}{k_1} - \frac{k_3 A_0}{k_1} \right] \exp(-k_1 t) + \left[S_B + \frac{k_3 S_A}{k_1} \right] t$$

Condition 3 ($k_1 = k_2 = 0$):

$$A_t = A_0 + S_A t \quad [\text{Eq A6}]$$

$$B_t = B_0 + S_B t$$

Condition 4 ($k_1 = k_2 \neq 0$):

$$A_t = \frac{S_A}{k_1} + (A_0 - \frac{S_A}{k_1}) \exp(-k_1 t) \quad [\text{Eq A7}]$$

$$B_t = (\frac{k_3 S_A}{k_1 k_2} + \frac{S_B}{k_2}) + (B_0 - \frac{k_3 S_A}{k_2 k_1} - \frac{S_B}{k_2}) \exp(-k_2 t) \\ + k_3 (A_0 - \frac{S_A}{k_1}) t \exp(-k_1 t)$$

This same type of logic and equation formulation is applied to all sets of coupled equations in SIMWQ. Because of the additional terms compounded in t , the form of the general solution is expanded to

$$C = \alpha + \sum_{i=1}^n \beta_i \exp(-\gamma_i t) + \delta t + \epsilon t \exp(\rho t) \quad [\text{Eq A8}]$$

As before, all the constant terms, $\alpha, \beta, \gamma, \delta, \epsilon, \rho$, can be calculated based on input for each reach and C could be the concentration of any attribute. These terms are all calculated in the subprogram APARAM, which also includes the logic to avoid unnecessary breakdowns in the computer software codes. This logic increases the usability of the final product and requires a minimum of user expertise.

APPENDIX B:

RIAS USE EXAMPLE

Part 1: New Data File Creation

TERMINAL: 257
79/12/18. 10.32.43.
UNIVERSITY OF ILLINOIS CYBER 175. NOS 1.3 - 485/485.

SIGNON: 341447562

PASSWORD

00000000

TERMINAL: 257, TTY

RECOVER/ CHARGE: bill.ceusa.ps7770

LAST RECORDED SIGNON AT 10:23 12/18/79

/-fques

```
#####  
#  
#           THIS PROGRAM ALLOWS  
#   THE USER TO BUILD UP A NEW  
#   DATA FILE OR TO REVISE AN OLD DATA  
#   FILE FOR SUBSEQUENT CONTROL AND  
#   INPUT FOR WATER QUALITY SIM-  
#   ULATIONS UNDER 'RIAS'  
#  
#####
```

DO YOU WISH TO BEGIN CREATING A NEW DATA FILE
(ANS: YES OR NO) ? y

```
=====
TIME INVARIANT PARAMETERS
=====
```

I) TYPE IN THE NAME OF THE DATA SET
? example no. 1

II) ANSWER THE FOLLOWING QUESTIONS ABOUT SIMULATION
CONTROL PARAMETERS.

HOW MANY REACHES (ANS: 1-20) ? 8
HOW MANY TIME PERIODS (ANS: 1-12) ? 2
HOW MANY ADDITIONAL CONSERVATIVE WATER QUALITY
ATTRIBUTES BEYOND THE CORE ATTRIBUTES
(ANS: 0-12) ? 3
HOW MANY ADDITIONAL NONCONSERVATIVE ATTRIBUTES
(ANS: 0-4) ? 2
INPUT THE NAMES OF THESE ADDITIONAL PARAMETERS.
CONSERVATIVE ATTRIBUTES:
ATT. NO. 9) ? hard.
ATT. NO. 10) ? ph
ATT. NO. 11) ? zn
NONCONSERVATIVE ATTRIBUTES:
ATT. NO. 12) ? chl
ATT. NO. 13) ? po4
INPUT THE MODELING CODES FOR THE EIGHT CORE
ATTRIBUTES (ANS: 0 OR 1)
? 0,1,1,1,1,1,1,1

III) INPUT THE PARAMETERS DESCRIBING THE WATERSHED
STRUCTURE FOR THIS SIMULATION.

HOW MANY TRIBUTARY INPUTS ? 5
INPUT CODES:
1) ? 3
2) ? 2
3) ? 1
4) ? 7
5) ? 8
HOW MANY POINT SOURCE DISCHARGES ? 4
INPUT CODES:
1) ? 2
2) ? 4
3) ? 6
4) ? 1
HOW MANY MAIN BRANCH BIFURCATIONS ? 1
BIFURCATION CODES:
1) ? 5,0

INPUT THE LENGTH OF EACH REACH AND THE
DRAINAGE AREA UPSTREAM FROM THE
TOP OF EACH REACH (ANS: MILES AND
SQUARE MILES).

1) ? 3.2, 1.8
2) ? .8, .3
3) ? 2.5, 4.9
4) ? 2.2, 6.3
5) ? 3.5, 11.1
6) ? 2.1, 3.0
7) ? 5.7, 32.
8) ? 20., 990.

IV) INDICATE HOW YOU WISH TO MODEL STREAM
HYDRAULICS.

0) MEAN DEPTH AND VELOCITY SPECIFIED
FOR EACH REACH AND TIME PERIOD.
1) HYDRAULIC RATING PARAMETERS USED FOR
EACH REACH.
(ANS: USE EITHER 0 OR 1) ? 0

ZERO TIME VARIANT PARAMETERS FIRST (Y OR N) ? n

=====

TIME VARIANT PARAMETERS FOR TIME PERIOD NO. 1

=====

I) HYDRAULIC PARAMETERS.

INPUT MEAN VELOCITIES FOR EACH REACH.

? .28,.17,.23,.25,.29,.3,.38,.93

INPUT MEAN DEPTHS FOR EACH REACH.

? .16,.14,.2,.22,.25,.....

22,.25,... < ERROR, RETYPE RECORD AT THIS FIELD

? .25,.33,.8

II) BOUNDARY CONDITIONS AT TRIBUTARIES.

INPUT AMBIENT WATER QUALITY CONDITIONS FOR

TRIBUTARIES 1 THROUGH 5

TEMP. ? 20.1,20.1,20.1,25.2,25.2, *DEL*

20.1,20.1,20.1,25.2,27

BOD5	? <u>.5,.5,.5,.1,.0,.1,2</u>
TSS	? <u>10.,10.,11.6,21.,25.</u>
NH3	? <u>0.0,0.0,0.0</u>
NO2	? <u>0.0,0.0,0.0</u>
NO3	? <u>1.3,1.3,.5,2.6,2.8</u>
PO4	? <u>.05,.05,.05,.5,.5</u>
D.O.	? <u>8.25,8.25,8.25,7.6,7.9</u>
HARD.	? <u>220,220,220,295,295</u>
PH	? <u>7.9,7.9,7.75,7.9,7.9</u>
ZN	? <u>0.,0.,0.0,0</u>
CL2	? <u>0.0,0.0,0</u>
COLI.	? <u>0.0,0.0,0</u>

MEAN DISCHARGE? .03,.09,.05,.5,28

III) BOUNDARY CONDITIONS AT EFFLUENT DISCHARGES.

INPUT AMBIENT WATER QUALITY CONDITIONS FOR

EFFLUENTS 1 THROUGH 4

TEMP.	? <u>27.,25.4,22.,25</u>
BOD5	? <u>5.9,180,200,.5</u>
TSS	? <u>8,124,250,12</u>
NH3	? <u>.5,22.6,.1,5,10.</u>
NO2	? <u>0.0,0.0,0.</u>
NO3	? <u>9.8,0.2,0.,0.</u>
PO4	? <u>6.1,10.,12.,0.</u>
D.O.	? <u>7.8,6.,1,3.2,0.2</u>
HARD.	? <u>150,150,450,300</u>
PH	? <u>7.6,7.6,6.6,6.0</u>
ZN	? <u>0.5,0.2,.1,4,2.5</u>
CL2	? <u>1.5,1.0,0.,0.</u>
COLI.	? <u>100.,100.,0.0.</u>

MEAN DISCHARGE? 2.3...2

IV) REACTION RATE COEFFICIENTS.

INPUT THE INDICATED RATE COEFFICIENT FOR
REACHES 1 THROUGH 8

KANH3 ? .05,.05,.05,.05...05,.05,.05,.05
,.05,.05. < ERROR, RETYPE RECORD AT THIS FIELD
? .05
? .05
? .05
? .05
? .05
KANQ3 ? .05,.05,.05,.05,.05,.05,.05,.05
KAPO4 ? .01,.01,.01,.01,.01,.01,.01,.01
KL ? .16,.16,.16,.16,.16,.16,.16,.16
KLS ? .01,.01,.01,.01,.01,.01,.01,.01
KNDET ? .02,.02,.02,.02,.02,.02,.02,.02
KNH3 ? .65,.65,.65,.65,.65,.65,.65,.65
KNQ2 ? 2.5,2.5,2.5,2.5,2.5,2.5,2.5,2.5
KNQ3 ? .001,.001,.001,.001,.001,.001,.001,.001
KPDET ? .02,.02,.02,.02,.02,.02,.02,.02
KPO4 ? .2,.2,.2,.2,.2,.2,.2,.2
KR ? 0,0,0,0,0,0,0,0
KSS ? .01,.01,.01,.01,.01,.01,.01,.01
KSSS ? 0,0,0,0,0,0,0,0
KT ? 0,0,0,0,0,0,0,0
KTSS ? .02,.02,.02,.02,.02,.02,.02,.02
KNCA1 ? 0,0,0,0,0,0,0,0
KNCA2 ? 0,0,0,0,0,0,0,0

V) DISTRIBUTED SOURCE/SINK PARAMETERS.

INPUT THE INDICATED SOURCE/SINK TERM FOR
REACHES 1 THROUGH 8

Part 2: Data File Revision

TERMINAL: 46
79/12/18. 13.42.04.
UNIVERSITY OF ILLINOIS CYBER 175. NOS 1.3 - 485/485.

SIGNON: 341447562.bang
TERMINAL: 46, TTY
RECOVER/ CHARGE: 5111.ceusa.ps7770
LAST RECORDED SIGNON AT 11:55 12/18/79
/get,tape9
/-fques

JOB ACTIVE.

```
#####  
#  
#           THIS PROGRAM ALLOWS  
#   THE USER TO BUILD UP A NEW  
#   DATA FILE OR TO REVISE AN OLD DATA  
#   FILE FOR SUBSEQUENT CONTROL AND  
#   INPUT FOR WATER QUALITY SIM-  
#   ULATIONS UNDER 'RIAS'  
#  
#####
```

DO YOU WISH TO BEGIN CREATING A NEW DATA FILE
(ANS: YES OR NO) ? n

DO YOU WISH TO REVIEW AND/OR REVISE THE EXISTING
DATA FILE
(ANS: YES OR NO) ? y

=====

```
REVIEW OF CONTENTS OF CURRENT DATA FILE
```

=====

THE CURRENT CONTENTS OF YOUR DATA FILE HAVE THE
TITLE:

EXAMPLE NO. 1

THIS DATA SET SPECIFIES SIMULATION OF THE
FOLLOWING WATER QUALITY ATTRIBUTES:

TEMP.	BOD5	TSS	NH3	NO2
NO3	PO4	D.O.	HARD.	PH
ZN	CL2	COLI.		

SIMULATIONS WILL BE RUN FOR 2 TIME PERIODS
FOR A TOTAL OF 8 STREAM REACHES.

?

THE SPECIFIED WATERSHED STRUCTURE IS AS FOLLOWS:

REACH NO.	LENGTH (MI.)	DRAINAGE (SQ.MI.)	INPUTS	
			EFF.	TRIB.
1	3.200	1.800	4	3
2	.800	1.300	1	2
3	2.500	4.900	**	1
4	2.200	6.300	2	**
5	3.500	11.100	**	**
6	2.100	13.000	3	**
7	5.700	32.000	**	4
8	20.000	990.000	**	5

THE NUMBER OF MAJOR BIFURCATIONS OF THE MAIN
CHANNEL OF THIS RECEIVING STREAM IS 1

BRANCH NO. 1 INCLUDES REACHES 1 TO 1

THE MAIN CHANNEL INCLUDES REACHES 2 TO 8

HYDRAULIC MODELING WILL BE DONE USING MEAN
VELOCITIES AND DEPTHS FOR EACH REACH AND TIME
PERIOD.

NONE OF THE ABOVE PARAMTERS CAN BE ALTERED WITHOUT
CREATING A TOTALLY NEW DATA SET (I.E., BY
STARTING OVER WITH 'FQUES').

DO YOU WANT TO CONTINUE (ANS: YES OR NO)? y

WHICH TIME PERIOD DO YOU WANT TO REVIEW ? 2

INDICATE WHICH OF THE FOLLOWING PARAMETERS YOU
WANT TO REVIEW (RESPOND WITH THE PROPER NUMBER)

- 1) HYDRAULIC PARAMETERS
- 2) INITIAL CONDITIONS IN TRIBUTARIES
- 3) INITIAL CONDITIONS IN EFFLUENTS
- 4) KINETIC PARAMETERS
- 5) DISTRIBUTED SOURCE/SINK PARAMETERS
- 6) BIOLOGICAL PARAMETERS

? 4

INDICATE THE INDEX NUMBER OF THE KINETIC PARAMETER
YOU ARE INTERESTED IN REVIEWING

- 1) KANH3
- 2) KANO3
- 3) KAPO4
- 4) KL
- 5) KLS
- 6) KNDDET
- 7) KWH3
- 8) KNO2
- 9) KNO3
- 10) KPDET
- 11) KPO4
- 12) KR
- 13) KSS
- 14) KSSS
- 15) KT
- 16) KTSS
- 17) KNCA1
- 18) KNCA2

WHICH ONE ? 18

THE VALUES CURRENTLY SPECIFIED FOR KACA2 WILL
BE LISTED BELOW BY REACH. TO CHANGE A VALUE
RESPOND TO THE TRAILING '?' WITH THE NEW
VALUE.

- 1) 0.? .002
- 2) 0.? .002
- 3) 0.? .002
- 4) 0.? .002
- 5) 0.? .002
- 6) 0.? .002
- 7) 0.? .002
- 8) 0.? .002

REVIEW ANOTHER RATE COEFFICIENT (ANS: YES OR NO)? n

CONTINUE FOR THIS TIME PERIOD (ANS: YES OR NO)? n

REVIEW ANOTHER TIME PERIOD (ANS: YES OR NO)? y

WHICH TIME PERIOD DO YOU WANT TO REVIEW? 1

INDICATE WHICH OF THE FOLLOWING PARAMETERS YOU
WANT TO REVIEW (RESPOND WITH THE PROPER NUMBER)

- 1) HYDRAULIC PARAMETERS
- 2) INITIAL CONDITIONS IN TRIBUTARIES
- 3) INITIAL CONDITIONS IN EFFLUENTS
- 4) KINETIC PARAMETERS
- 5) DISTRIBUTED SOURCE/SINK PARAMETERS
- 6) BIOLOGICAL PARAMETERS

? 5

INDICATE THE INDEX NUMBER OF THE DISTRIBUTED
SOURCE/SINK TERM YOU WISH TO REVIEW

- 1) SL
- 2) SNH3
- 3) SNO3
- 4) SO2
- 5) SPO4
- 6) SSOD
- 7) SSS
- 8) ST
- 9) SAT1
- 10) SAT2
- 11) SAT3
- 12) SAT4
- 13) SAT5

? 6

THE VALUES CURRENTLY SPECIFIED FOR SSOD WILL
BE LISTED BELOW BY REACH. TO CHANGE A VALUE
RESPOND TO THE TRAILING '?' WITH THE NEW
VALUE.

- 1) 0.? .6
- 2) 0.?
- 3) 0.?
- 4) 0.? .6
- 5) 0.? .6
- 6) 0.? .6
- 7) 0.? .9
- 8) 0.? .2

REVIEW ANOTHER SOURCE/SINK TERM (ANS: YES OR NO)? n

CONTINUE FOR THIS TIME PERIOD (ANS: YES OR NO)? n

REVIEW ANOTHER TIME PERIOD (ANS: YES OR NO)? y

WHICH TIME PERIOD DO YOU WANT TO REVIEW? 2

INDICATE WHICH OF THE FOLLOWING PARAMETERS YOU
WANT TO REVIEW (RESPOND WITH THE PROPER NUMBER)

- 1) HYDRAULIC PARAMETERS
- 2) INITIAL CONDITIONS IN TRIBUTARIES
- 3) INITIAL CONDITIONS IN EFFLUENTS
- 4) KINETIC PARAMETERS
- 5) DISTRIBUTED SOURCE/SINK PARAMETERS
- 6) BIOLOGICAL PARAMETERS

? 5

INDICATE THE INDEX NUMBER OF THE DISTRIBUTED
SOURCE/SINK TERM YOU WISH TO REVIEW

- 1) SL
- 2) SNH3
- 3) SNH3
- 4) SO2
- 5) SP04
- 6) SSOD
- 7) SSS
- 8) ST
- 9) SAT1
- 10) SAT2
- 11) SAT3
- 12) SAT4
- 13) SAT5

? 6

THE VALUES CURRENTLY SPECIFIED FOR SSOD WILL
BE LISTED BELOW BY REACH. TO CHANGE A VALUE
RESPOND TO THE TRAILING '?' WITH THE NEW
VALUE.

- 1) 0.?
- 2) 0.?
- 3) 0.?
- 4) 0.?.6
- 5) 0.?.6
- 6) 0.?.6
- 7) 0.?.8
- 8) 0.?.1.2

REVIEW ANOTHER SOURCE/SINK TERM (ANS: YES OR NO)? n

CONTINUE FOR THIS TIME PERIOD (ANS: YES OR NO)? n

REVIEW ANOTHER TIME PERIOD (ANS: YES OR NO)? n

YOUR DATA SET IS STORED IN THE FILE 'TAPE9'.
REMEMBER TO SAVE OR REPLACE IT IF YOU WANT TO
USE IT IN A LATER SESSION.

NOTE!!!
/replace.tape9

Part 3: RTV Test Using Data File Created and Revised

SIMULATIONS HAVE BEEN STARTED
USING THE FILE 'TAPE9' AS
CONTROL INPUT.

SIMULATED WATER QUALITY PROFILES HAVE BEEN
OUTPUT TO 'TAPE33' FOR 2 TIME
PERIOD(S) FOR THE FOLLOWING WATER
QUALITY ATTRIBUTES:

- 1) TEMP.
- 2) BOD5
- 3) TSS
- 4) NH3
- 5) NO2
- 6) NO3
- 7) PO4
- 8) D.O.
- 9) HARD.
- 10) PH
- 11) ZN
- 12) CL2
- 13) COLI.

WATER QUALITY SIMULATIONS COMPLETE.
YOU MAY NOW PROCEED TO RTV TESTING.
REMEMBER TO SAVE OR REPLACE 'TAPE33' IF
YOU PLAN TO USE IT IN LATER SESSIONS.

NOTE!!!

/replace,tape33
/-wqrtv

LOADER INFORMATION.
MAP OPTIONS = OFF
GLOBAL LIBRARY SET IS -
GCSALPH

+ THIS RTV ROUTINE TESTS FOR VIOLATIONS OF AMBIENT +
+ WATER QUALITY STANDARDS AND QUANTIFIES THE +
+ SPACIAL EXTENT OF THESE VIOLATIONS +

EXAMPLE NO. 1

INDICATE WHICH WATER QUALITY ATTRIBUTE(S) ARE
TO BE ANALYZED.

- | | |
|-----------|---------|
| 1) TEMP. | 5) NO2 |
| 2) BOD5 | 6) NO3 |
| 3) TSS | 7) PO4 |
| 4) NH3 | 8) D.O. |
| 9) HARD. | |
| 10) PH | |
| 11) ZN | |
| 12) CL2 | |
| 13) COLI. | |

RESPOND WITH THE TOTAL NUMBER OF ATTRIBUTES
FOLLOWED BY THE APPROPRIATE INDEX NUMBERS
? 5,2,3,4,8,11

Section A: Violation Test

INPUT LOCAL AMBIENT WATER QUALITY STANDARDS

TIME PERIOD NO. 1

BOD5
UPPER LEVEL STANDARD ? 10
LOWER LEVEL STANDARD ?

TSS
UPPER LEVEL STANDARD ? 12
LOWER LEVEL STANDARD ?

NH3
UPPER LEVEL STANDARD ? 1.5
LOWER LEVEL STANDARD ?

D.O.
UPPER LEVEL STANDARD ?
LOWER LEVEL STANDARD ? 6.

ZN
UPPER LEVEL STANDARD ? 1.0
LOWER LEVEL STANDARD ?

STANDARDS CONSTANT OVER TIME (Y OR N) ? y

=====

REPORT ON WATER QUALITY VIOLATIONS

=====

1) TOTAL RIVER MILES IN VIOLATION OF STANDARDS.

ATTRIBUTE	TIME PERIOD					
	1	2	3	4	5	6
BOD5	33.5	13.5				
TSS	33.5	33.5				
NH3	16.7	10.3				
D.O.	0.0	0.0				
ZN	3.2	0.0				

DO YOU WANT A GRAPHICAL OUTPUT FOR ANY ATTRIBUTE
PROFILES (ANS: YES OR NO)? y

TIME PERIOD ? 1

```

120 +
+
C110 +      00
0100 +      0 00      00
N 90 +      0 000      0 00
C 80 +      0      0000      000
. 70 +      0      000000
+      0      00
( 60 +      0      0
M 50 +      0      0
G 40 +      0      0
/ 30 +      0      0
L 20 +      0      0
) +      0      0000000000000000
10 +
0 0000000 +-----S
0 0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40
      DISTANCE DOWNSTREAM (MILES)

```

TIME PERIOD ? 2

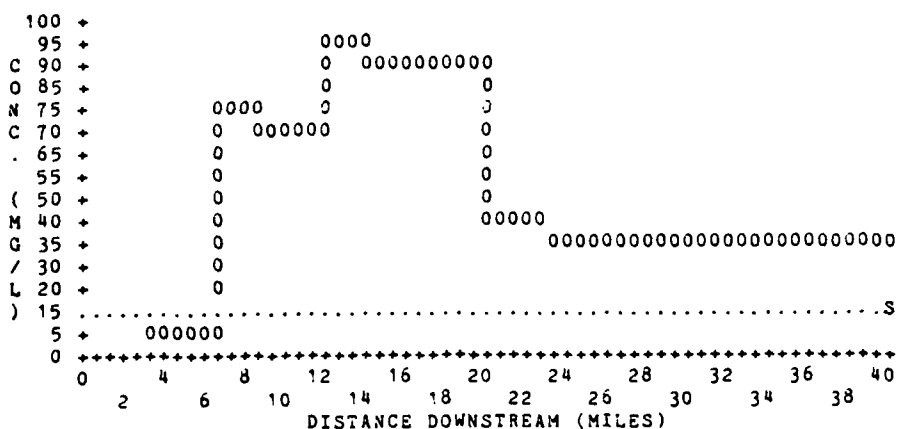
[illegible]

PLOT BOD5 FOR ANOTHER TIME PERIOD ? n
 PLOT ANOTHER WATER QUALITY ATTRIBUTE ? y

ATTRIBUTE NUMBER ? 3

TIME PERIOD ? 1

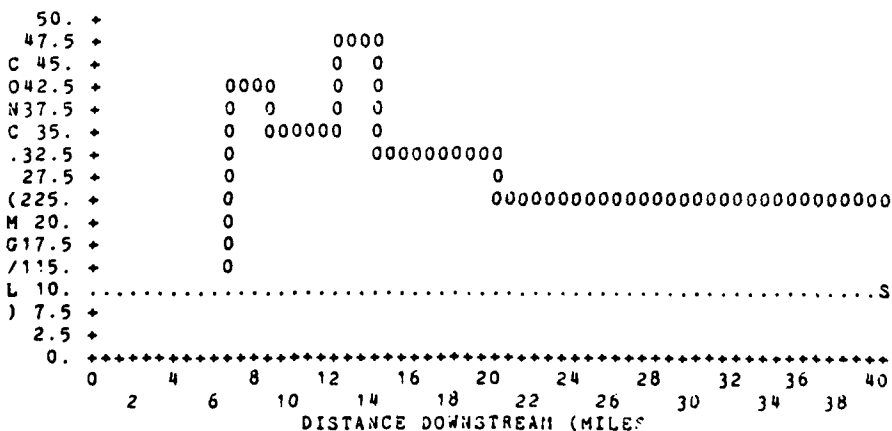
TSS : TIME PERIOD NO. 1



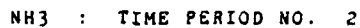
PLOT TSS FOR ANOTHER TIME PERIOD ? y

TIME PERIOD ? 2

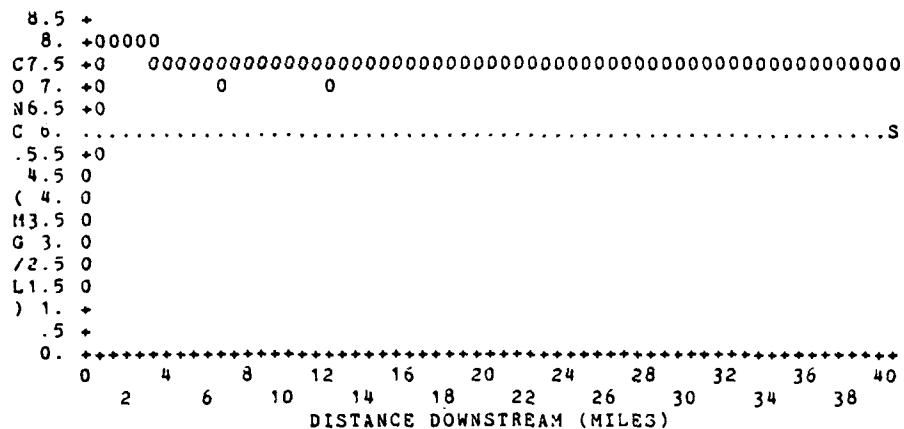
TSS : TIME PERIOD NO. 2



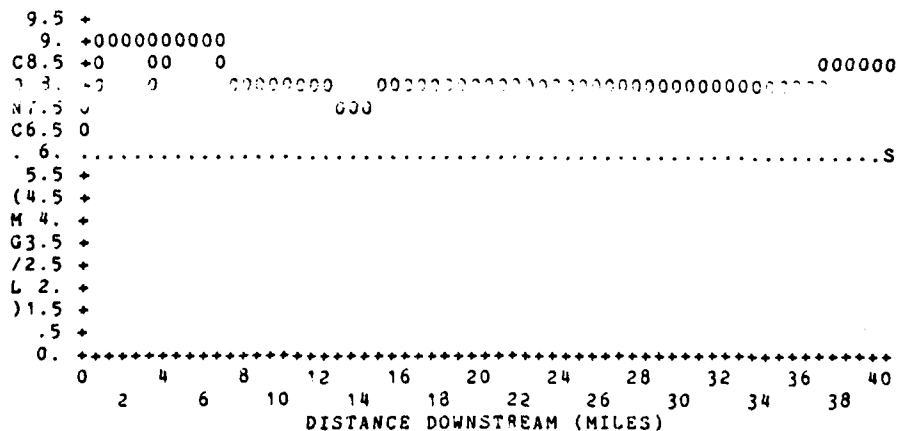
NH3 : TIME PERIOD NO. 1



TIME PERIOD ? 1 D.O. : TIME PERIOD NO. 1



PLUT D.O. FOR ANOTHER TIME PERIOD ? y
TIME PERIOD ? 2 D.O. : TIME PERIOD NO. 2

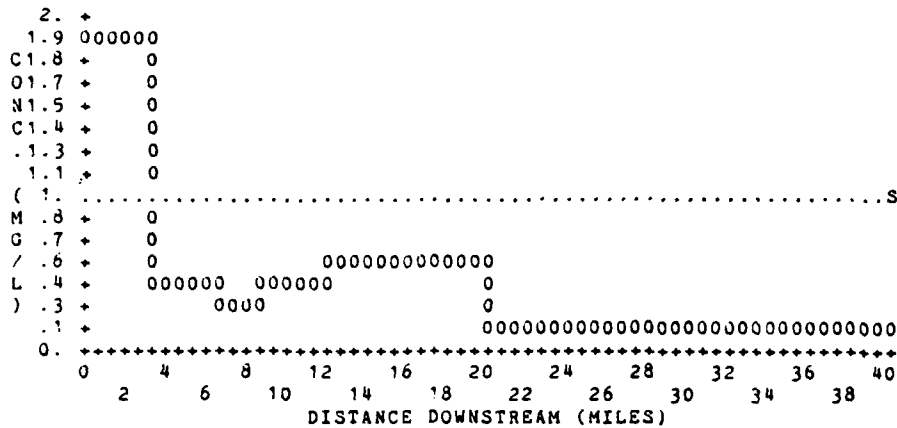


PLOT D.O. FOR ANOTHER TIME PERIOD ? n
 PLOT ANOTHER WATER QUALITY ATTRIBUTE ? y

ATTRIBUTE NUMBER ? 11

TIME PERIOD ? 1

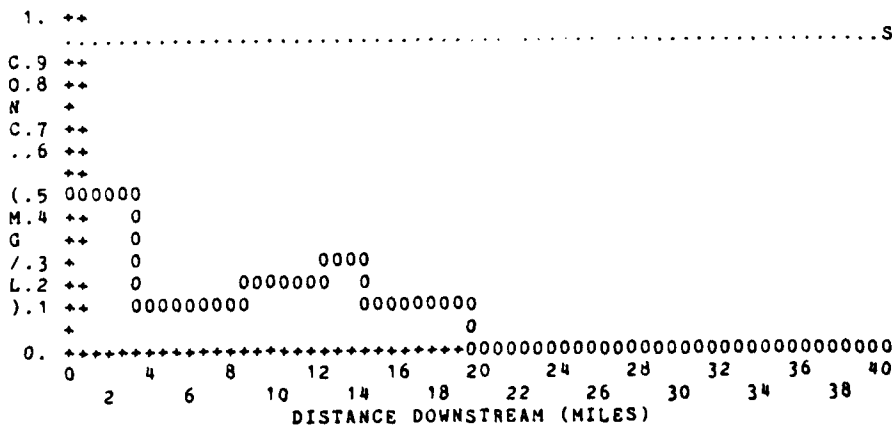
ZN : TIME PERIOD NO. 1



PLOT ZN FOR ANOTHER TIME PERIOD ? y

TIME PERIOD ? 2

ZN : TIME PERIOD NO. 2



PLOT ZN FOR ANOTHER TIME PERIOD ? n
 PLOT ANOTHER WATER QUALITY ATTRIBUTE ? n

 THIS CONCLUDES 'WQRTV'. YOU MAY EXECUTE MORE
 RTV ROUTINES NOW. BEGIN A MITIGATION
 LOOP OR SIGNOFF.

 2.993 CP SECONDS EXECUTION TIME

Section B: Saprobiic Index Analysis

/-sirtv

```
=====
SAPROBIC INDEX ANALYSIS
FOR
EXAMPLE NO. 1
=====
```

WATER QUALITY DESIGNATION	RIVER MILES IN TIME PERIOD					
	1	2	3	4	5	6
PUREST WATER	0.0	0.0				
CLEAN WATER	3.2	26.5				
MILD POLLUTION	2.5	0.0				
POLLUTED	6.8	0.0				
HEAVILY POLLUTED	14.0	10.0				
RAW SEWAGE	13.5	2.7				
SEPTIC CONDITION	0.0	0.0				

DO YOU WANT FURTHER QUANTIFICATION OF THIS
(ANS: YES OR NO) ? y

INPUT TIME PERIOD OF INTEREST ? 1

THIS SECTION ISN'T OPERATIONAL YET, BUT THE
OUTPUT WILL BE LOCATIONS OF ZONES IN EACH
WATER QUALITY DESIGNATION FOR THE SPECIFIED
TIME PERIOD.
.038 CP SECONDS EXECUTION TIME

Section C: Environmental Toxicity

/-turtv

LOADER INFORMATION.
MAP OPTIONS = OFF
GLOBAL LIBRARY SET IS -
GCSALPH

+++++
+ THIS RTV ROUTINE TESTS ENVIRONMENTAL TOXICITY +
+++++

EXAMPLE NO. 1

INDICATE WHICH WATER QUALITY ATTRIBUTE(S) ARE
TO BE ANALYZED FOR THEIR TOXIC EFFECTS.

- | | |
|-----------|---------|
| 1) TEMP. | 5) NO2 |
| 2) BOD5 | 6) NO3 |
| 3) TSS | 7) PO4 |
| 4) NH3 | 8) D.O. |
| 9) HARD. | |
| 10) PH | |
| 11) ZN | |
| 12) CL2 | |
| 13) COLI. | |

RESPOND WITH THE TOTAL NUMBER OF TOXICANTS
FOLLOWED BY THE APPROPRIATE INDEX NUMBERS

? 3,4,11,12

SPECIFY TARGET SPECIES:

DESIGNATE STREAM TYPE (W=WARM WATER,C=COLD WATER) ? W

REPRESENTATIVE SPECIES LIST:

- 1) FATHEAD MINNOW
- 2) CARP
- 3) BLUEGILL
- 4) CHANNEL CAT
- 5) LARGEMOUTH BASS

RESPOND WITH NUMBER OF TARGET SPECIES DESIRED AND
WITH THEIR APPROPRIATE INDEX NUMBER(S).

? 1,3

INPUT THE 96 HOUR LC50'S FOR THE FOLLOWING SPECIES
AND POTENTIAL TOXICANTS:

BLUEGILL

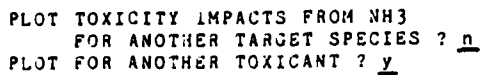
NH3	? <u>.6</u>
ZN	? <u>8.</u>
CL2	? <u>.2</u>

SPECIFY TIME PERIOD OF INTEREST ? 1

MAXIMUM AND MEAN (IN PARENTHESES) TOXICITY UNITS				
TARGET SPECIES	TOTAL	TOXICANT NH3	ZN	CL2
BLUEGILL	28.136	22.238	.250	7.177
	(4.272)	(4.272)	(.054)	(2.903)

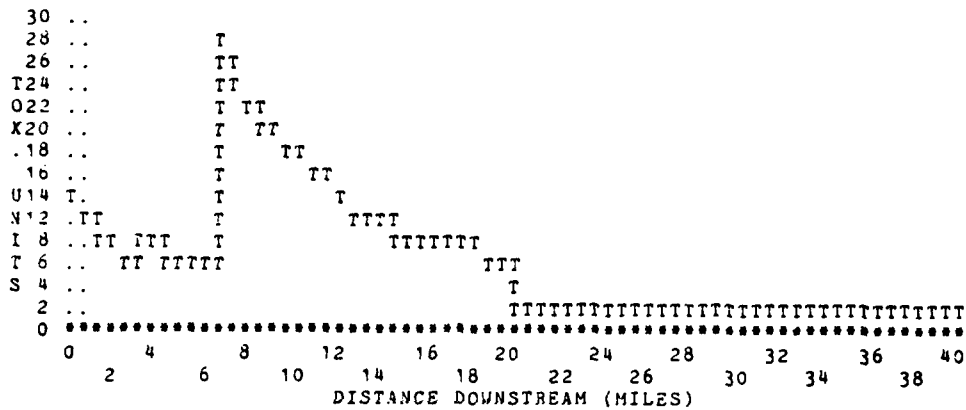
- 1) NH_3
- 2) Zn
- 3) Cl_2

BLUEGILL ; NH3 ; TIME PERIOD 1
(T=TOTAL T.U.'S; * =T.U.'S FROM SPECIFIED ATT.)



INPUT TARGET SPECIES INDEX ? 1

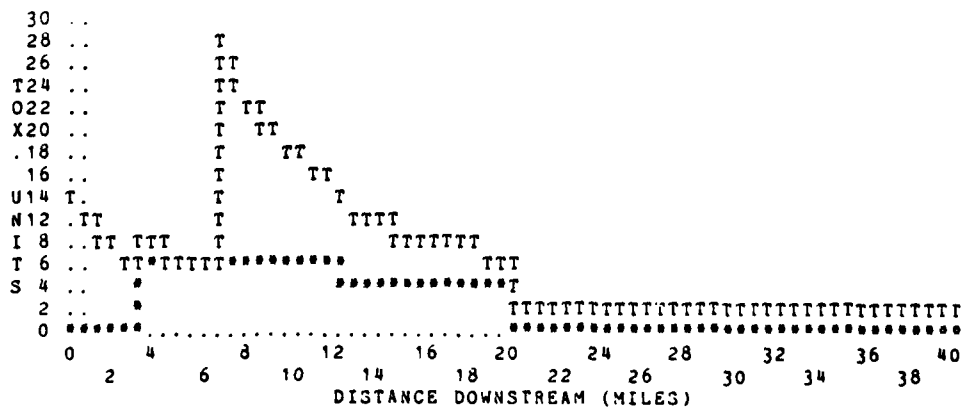
BLUEGILL ; EN ; TIME PERIOD 1
(T=TOTAL T.U.'S; * =T.U.'S FROM SPECIFIED ATT.)



PLOT TOXICITY IMPACTS FROM ZN
FOR ANOTHER TARGET SPECIES ? n
PLOT FOR ANOTHER TOXICANT ? y

INPUT TARGET SPECIES INDEX ? 1

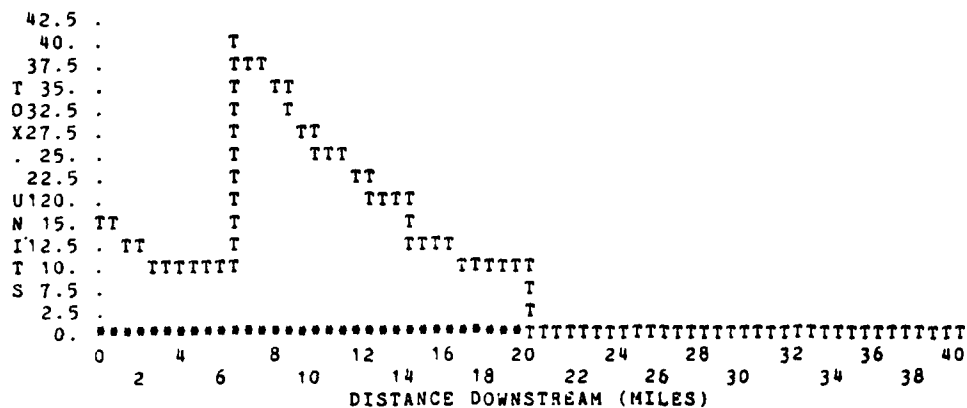
BLUEGILL ; CL2 ; TIME PERIOD 1
(T=TOTAL T.U.'S; * =T.U.'S FROM SPECIFIED ATT.)



INPUT TOXICANT NUMBER ? 2

INPUT TARGET SPECIES INDEX ? 1

BLUEGILL ; ZN ; TIME PERIOD 2
(T=TOTAL T.U.'S; * =T.U.'S FROM SPECIFIED ATT.)

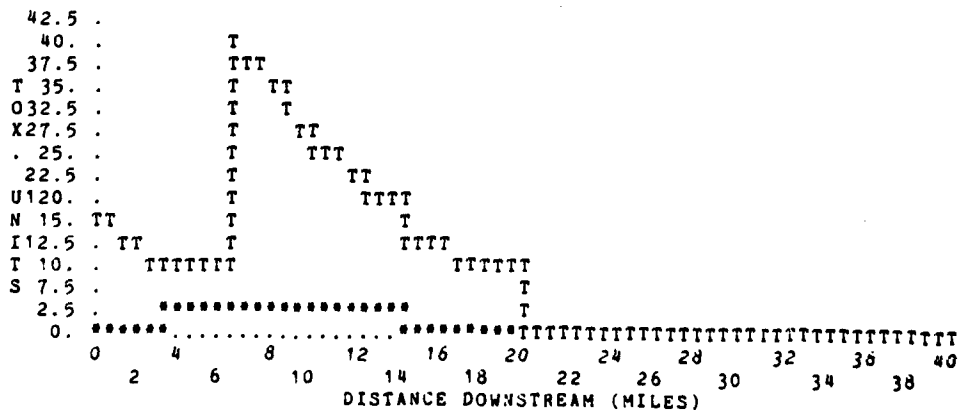


PLOT TOXICITY IMPACTS FROM ZN
FOR ANOTHER TARGET SPECIES ? n
PLOT FOR ANOTHER TOXICANT ? y

INPUT TOXICANT NUMBER ? 3

INPUT TARGET SPECIES INDEX ? 1

BLUEGILL ; CL2 ; TIME PERIOD 2
(T=TOTAL T.U.'S; * =T.U.'S FROM SPECIFIED ATT.)



PLOT TOXICITY IMPACTS FROM CL2
FOR ANOTHER TARGET SPECIES ? n
PLOT FOR ANOTHER TOXICANT ? n

DO YOU WISH TO CONTINUE ANALYSES FOR ANOTHER TIME
PERIOD (ANS: Y OR N) ? n

=====

THIS CONCLUDES 'TURTV'. YOU MAY EXECUTE MORE
RTV ROUTINES NOW, BEGIN A MITIGATION
LOOP OR SIGNOFF.

=====

2.004 CP SECONDS EXECUTION TIME

bye

3KVN9RS COSTS: 690.570 SRUS AT \$.0068 = \$4.70

RIAS SOURCE PROGRAMS

```
NOTE.! *  
NOTE.! *  
NOTE.! * WELCOME TO THE  
NOTE.! * RATIONAL IMPACT EVALUATION SYSTEM  
NOTE.! *  
NOTE.! * U.S.A.C.E.  
NOTE.! * CONSTRUCTION ENGINEERING RESEARCH  
NOTE.! * LABORATORY  
NOTE.! *  
NOTE.! * VERSION 1.2  
NOTE.! * NOVEMBER '979  
NOTE.! *  
NOTE.! *****  
NOTE.!  
NOTE.!  
NOTE.! THIS COMPUTER BASED IMPACT ASSESSMENT SYSTEM  
NOTE.! CAN BE ACTIVATED BY EXECUTING A SERIES OF  
NOTE.! PROCEDURE FILES WHICH ARE DESCRIBED BELOW:  
NOTE.!  
NOTE.! 1) -FQUES  
NOTE.!  
NOTE.! THIS PROC FILE EXECUTES A PROGRAM WHICH ASKES  
NOTE.! A SERIES OF QUESTIONS ABOUT THE ENVIRONMENTAL  
NOTE.! SETTING FOR A SPECIFIC PROJECT AND ORGANIZES  
NOTE.! THE INFORMATION OBTAINED INTO A DATA FILE  
NOTE.! WHICH IS USED AS INPUT FOR SIMULATIONS AND  
NOTE.! OTHER EVALUATION PROTOCOLS. 'FQUES' CAN BE  
NOTE.! USED TO SETUP A NEW DATA FILE OR TO REVISE  
NOTE.! AN EXISTING DATA FILE. OUTPUT FROM 'FQUES'  
NOTE.! IS TO A MASS STORAGE FILE CALLED 'TAPE9'.  
NOTE.!  
NOTE.! 2) -SIMWQ  
NOTE.!  
NOTE.! THIS PROC FILE EXECUTES A WATER QUALITY  
NOTE.! SIMULATION MODEL WHICH PREDICTS PRIMARY  
NOTE.! PHYSICAL AND CHEMICAL IMPACTS IN THE AQUATIC  
NOTE.! ENVIRONMENT BASED ON THE ENVIRONMENTAL  
NOTE.! SETTING AND PROJECT SPECIFICATION INFORMA-  
NOTE.! TION STORED IN THE OUTPUT FROM 'FQUES'.  
NOTE.! OUTPUT FROM 'SIMWQ' IS TO A MASS STORAGE  
NOTE.! FILE CALLED 'TAPE33'.  
NOTE.!  
NOTE.! 3) -RTVS  
NOTE.!  
NOTE.! THIS PROC CALLS A LISTING OF A SERIES OF  
NOTE.! PROGRAMS WHICH QUANTIFY ENVIRONMENTAL IMPACTS  
NOTE.! IN THE AQUATIC ECOSYSTEM. THE USER CAN  
NOTE.! THEN CHOOSE WHICH RTV MODELS ARE APPLICABLE  
NOTE.! AND CAN EXECUTE EACH WITH THE APPROPRIATE  
NOTE.! PROC CALL. ALL RTV MODELS REQUIRE INPUT  
NOTE.! FROM 'TAPE9' AND/OR 'TAPE33'.  
NOTE.!  
NOTE.! ***** YOU MAY BEGIN *****  
NOTE.!  
NOTE.!
```

```

type,-rfques/g

GET,BFQUES/ID=341447562.
RWF.
BFQUES.
NOTE!!!
NOTE!!!
NOTE!!!
NOTE!!!
NOTE!!      YOUR DATA SET IS STORED IN THE FILE 'TAPE9'.
NOTE!!      REMEMBER TO SAVE OR REPLACE IT IF YOU WANT TO
NOTE!!      USE IT IN A LATER SESSION.
NOTE!!!
/

```

```

type,simwq/g
NOTE!!!
NOTE!!!
NOTE!!!
NOTE!!      SIMULATIONS HAVE BEEN STARTED
NOTE!!      USING THE FILE 'TAPE9' AS
NOTE!!      CONTROL INPUT.
GET,BSIMWQ/ID=341447562.
RWF.
BSIMWQ.
NOTE!!!
NOTE!!!
NOTE!!!
NOTE!!!
NOTE!!      WATER QUALITY SIMULATIONS COMPLETE.
NOTE!!      YOU MAY NOW PROCEED TO RTV TESTING.
NOTE!!      REMEMBER TO SAVE OR REPLACE 'TAPE33' IF
NOTE!!      YOU PLAN TO USE IT IN LATER SESSIONS.
NOTE!!!
/

```

```

type,rtvs/g

NOTE!!      THE FOLLOWING RATIONAL THRESHOLD EVALUATIONS
NOTE!!      MAY BE INITIATED AT THIS TIME BY EXECUTION OF
NOTE!!      OF THE APPROPRIATE 'PROC' FILES:
NOTE!!!
NOTE!!      -WQRTV
NOTE!!      ASSESSMENT OF OVERALL WATER QUALITY IMPACTS.
NOTE!!      -SIRTV
NOTE!!      ASSESSMENT OF IMPACTS OF ORGANIC ENRICHMENT.
NOTE!!      -TURTIV
NOTE!!      ASSESSMENT OF ENVIRONMENTAL TOXICITY IMPACTS.
NOTE!!!
NOTE!!      REMEMBER TO HAVE 'TAPE9' AND 'TAPE33' AVAILABLE
NOTE!!      AS LOCAL FILES BEFORE EXECUTION.
NOTE!!!
/

```

type,turtv/g

GET,BTURTIV/ID=341447562.
RWF.
GRAB,GCSALPH/F.
BTURTIV.
/

type *DEL*
type,sturtv/g

type,wqrtv/g

GET,BWQRTIV/ID=341447562.
GRAB,GCSALPH/F.
RWF.
BWQRTIV.
/

type,sirtv/g

GET,BSIRTIV/ID=341447562.
RWF.
BSIRTIV.
/

SOURCE LISTING FOR FQWES

```

PROGRAM FILTERQ(INPUT,OUTPUT,TAPE1=INPUT,TAPE2=OUTPUT,TAPE9)
COMMON/NAMES/TITLE(8),CNAME(20),SNAME(20),KNAME(20)
COMMON/CNTRL/NR,NTP,NWQC,NB,NIT,NIE,IT(15),IE(15),HCODE,
+ HCODE(8),NCWQC,NNCWQC,NTWQC,NS,NK
COMMON/IWQC/TWQ(15,20),EWQ(15,20),TQ(15),EQ(15)
COMMON/KDATA/K20(20,20)
COMMON/SDATA/S20(20,20)
COMMON/MDATA/LR(20),DA(20),DEPTH(20),VEL(20),BCODE(15),
+ HAV(20),HBV(20),HAD(20),HBD(20)
COMMON/BDATA/A(20)
INTEGER TITLE,CNAME,HCODE,KNAME,SNAME
INTEGER DINDEX(125),CNTRLS(8)
REAL LR,K20
DATA (CNAME(I),I=1,8)/"TEMP","BOD5","TSS","NH3","NO2","NO3",
+ "PO4","D.O."/
DATA (KNAME(I),I=1,20)/"KANH3","KANO3","KAP04","KL","KLS",
+ "KNDET","KNH3","KNO2","KNO3","KPDET","KPO4","KR","KSS",
+ "KSSS","KT","KTSS","KNCA1","KNCA2","KNCA3","KNCA4"/
DATA (SNAME(I),I=1,20)/"SL","SNH3","SNO3","SO2","SPO4",
+ "SSOD","SSS","ST","SAT1","SAT2","SAT3","SAT4","SAT5","SAT6",
+ "SAT7","SAT8","SAT9","SAT10","SAT11","SAT12"/
PRINT*," "
PRINT*," "
PRINT*," "
PRINT*," "
PRINT*," #####"
PRINT*," #
PRINT*," # THIS PROGRAM ALLOWS #
PRINT*," # THE USER TO BUILD UP A NEW #
PRINT*," # DATA FILE OR TO REVISE AN OLD DATA #
PRINT*," # FILE FOR SUBSEQUENT CONTROL AND #
PRINT*," # INPUT FOR WATER QUALITY SIM- #
PRINT*," # ULATONS UNDER 'RIAS' #
PRINT*," #
PRINT*," #####"
PRINT*," "
PRINT*," "
PRINT*," "
PRINT*," "
PRINT*," "
CALL OPENMS(9,DINDEX,125,0)
PRINT*," DO YOU WISH TO BEGIN CREATING A NEW DATA FILE"
10 PRINT*," (ANS: YES OR NO) ",
READ(1,901) IANS1
IF(EOF(1)) 10,11
11 IF(IANS1.NE."Y".AND.IANS1.NE."N") GO TO 10
IF(IANS1.EQ."N") GO TO 500
PRINT*," "
PRINT*," =====
PRINT*," TIME INVARIANT PARAMETERS"
PRINT*," =====
PRINT*," "
PRINT*," "
20 PRINT*," I) TYPE IN THE NAME OF THE DATA SET"
READ(1,911) (TITLE(I),I=1,8)

```

```

21  IF(EOF(1)) 20,21
    PRINT*, " "
    PRINT*, "      II) ANSWER THE FOLLOWING QUESTIONS ABOUT SIMULATION"
    PRINT*, "          CONTROL PARAMETERS."
    PRINT*, " "
30  PRINT*, "          HOW MANY REACHES (ANS:1-20) ",
    READ(1,*) NR
    IF(EOF(1)) 30,31
31  PRINT*, "          HOW MANY TIME PERIODS (ANS:1-12) ",
    READ(1,*) NTP
    IF(EOF(1)) 31,32
32  PRINT*, "          HOW MANY ADDITIONAL CONSERVATIVE WATER QUALITY"
    PRINT*, "          ATTRIBUTES BEYOND THE CORE ATTRIBUTES"
    PRINT*, "          (ANS: 0-12) ",
    READ(1,*) NCWQC
    IF(EOF(1)) 32,33
33  PRINT*, "          HOW MANY ADDITIONAL NONCONSERVATIVE ATTRIBUTES"
    PRINT*, "          (ANS: 0-4) ",
    READ(1,*) NNCWQC
    IF(EOF(1)) 33,34
34  NTWQC=8+NCWQC+NNCWQC
    NWQC=8
    NK=16+NNCWQC
    NS=NTWQC
    IF(NTWQC.LE.8) GO TO 70
    PRINT*, "          INPUT THE NAMES OF THESE ADDITIONAL PARAMETERS."
    IF(NCWQC.LT.1) GO TO 51
    PRINT*, "          CONSERVATIVE ATTRIBUTES:"
    DO 50 I=1,NCWQC
49  PRINT*, "          ATT. NO. ",I+8,")",
    READ(1,913) CNAME(8+I)
    IF(EOF(1)) 49,50
    CONTINUE
    IF(NNCWQC.LT.1) GO TO 70
51  PRINT*, "          NONCONSERVATIVE ATTRIBUTES:"
    DO 60 I=1,NNCWQC
59  PRINT*, "          ATT. NO. ",I+8+NCWQC,")",
    READ(1,913) CNAME(8+NCWQC+I)
    IF(EOF(1)) 59,60
    CONTINUE
70  PRINT*, "          INPUT THE MODELING CODES FOR THE EIGHT CORE"
    PRINT*, "          ATTRIBUTES (ANS: 0 OR 1) "
    PRINT*, " "
    READ(1,*) (MCODE(I),I=1,8)
    IF(EOF(1)) 70,71
71  PRINT*, " "
    PRINT*, "      III) INPUT THE PARAMETERS DESCRIBING THE WATERSHED"
    PRINT*, "          STRUCTURE FOR THIS SIMULATION."
    PRINT*, " "
100 PRINT*, "          HOW MANY TRIBUTARY INPUTS ",
    READ(1,*) NIT
    IF(EOF(1)) 100,101
101 IF(NIT.LT.1) GO TO 120
    PRINT*, "          INPUT CODES:"
    DO 111 I=1,NIT
110 PRINT*, "          ",I,")",
    READ(1,*) IT(I)
    IF(EOF(1)) 110,111
    CONTINUE
120 PRINT*, "          HOW MANY POINT SOURCE DISCHARGES ",
    READ(1,*) NIE
    IF(EOF(1)) 120,121
121 IF(NIE.LT.1) GO TO 141
    PRINT*, "          INPUT CODES:"

```

```

DO 140 I=1,NIE
130 PRINT*, "                                ",I,")",
    READ(1,*) IE(I)
    IF(EOF(1)) 130,140
140 CONTINUE
141 PRINT*, "                                HOW MANY MAIN BRANCH BIFURCATIONS ",
    READ(1,*) NB
    IF(EOF(1)) 141,142
142 IF(NB.LT.1) GO TO 151
    PRINT*, "                                BIFURCATION CODES:"
    DO 150 I=1,NB
145 PRINT*, "                                ",I,")",
    READ(1,915) BCODE(I)
    IF(EOF(1)) 145,150
150 CONTINUE
151 PRINT*, " "
160 PRINT*, "                                INPUT THE LENGTH OF EACH REACH AND THE"
    PRINT*, "                                DRAINAGE AREA UPSTREAM FROM THE "
    PRINT*, "                                TOP OF EACH REACH (ANS: MILES AND"
    PRINT*, "                                SQUARE MILES)."
    DO 170 IR=1,NR
161 PRINT*, "                                ",IR,")",
    READ(1,*) LR(IR),DA(IR)
    IF(EOF(1)) 161,170
170 CONTINUE
    PRINT*, " "
    PRINT*, "                                IV) INDICATE HOW YOU WISH TO MODEL STREAM "
    PRINT*, "                                HYDRAULICS."
    PRINT*, "                                0) MEAN DEPTH AND VELOCITY SPECIFIED"
    PRINT*, "                                FOR EACH REACH AND TIME PERIOD."
    PRINT*, "                                1) HYDRAULIC RATING PARAMETERS USED FOR"
    PRINT*, "                                EACH REACH."
180 PRINT*, "                                (ANS: USE EITHER 0 OR 1)",
    READ(1,914) HCODE
    IF(EOF(1)) 180,181
181 IF(HCODE.LT.1) GO TO 300
    PRINT*, "                                INPUT THE HYDRAULIC RATING PARAMETERS FOR EACH"
    PRINT*, "                                REACH; RESPOND WITH FOUR PARAMETERS IN "
    PRINT*, "                                THE FOLLOWING ORDER: AV,BV,AD,BD."
    DO 190 I=1,NR
189 PRINT*, "                                ",I,")",
    READ(1,*) HAV(I),HBV(I),HAD(I),HBD(I)
    IF(EOF(1)) 189,190
190 CONTINUE
    PRINT*, " "
    PRINT*, " "
300 PRINT*, " "
    CALL LOADTIP(ITP)
    DO 450 ITP=1,NTP
    PRINT*, " "
    PRINT*, "===== "
    PRINT*, " TIME VARIANT PARAMETERS FOR TIME PERIOD NO. ",ITP
    PRINT*, "===== "
    PRINT*, " "
    PRINT*, " "
    IF(HCODE.GT.0) GO TO 221
    PRINT*, "                                I) HYDRAULIC PARAMTERS."
    PRINT*, " "
    PRINT*, "                                INPUT MEAN VELOCITIES FOR EACH REACH."
    PRINT*, "                                ",
210 READ(1,*) (VEL(II),II=1,NR)
    IF(EOF(1)) 210,211
211 PRINT*, " "
    PRINT*, "                                INPUT MEAN DEPTHS FOR EACH REACH."

```

```

220 PRINT*, " ",
    READ(1,*) (DEPTH(II), II=1, NR)
    IF (EOF(1)) 220, 221
221 PRINT*, " "
    PRINT*, " II) BOUNDARY CONDITIONS AT TRIBUTARIES."
    PRINT*, " "
    PRINT*, " ...T AMBIENT WATER QUALITY CONDITIONS FOR"
    PRINT*, " TRIBUTARIES 1 THROUGH ", NIT
    DO 225 IC=1, NTWQC
224 PRINT*, " ", CNAME(IC), ":",
    READ(1,*) (TWQ(IIT, IC), IIT=1, NIT)
    IF (EOF(1)) 224, 225
225 CONTINUE
    PRINT*, " "
226 PRINT*, " MEAN DISCHARGE:",
    READ(1,*) (TQ(IIT), IIT=1, NIT)
    IF (EOF(1)) 226, 227
227 PRINT*, " "
    PRINT*, " III) BOUNDARY CONDITIONS AT EFFLUENT DISCHARGES."
    PRINT*, " "
    PRINT*, " ...UT AMBIENT WATER QUALITY CONDITIONS FOR"
    PRINT*, " EFFLUENTS 1 THROUGH ", NIE
    DO 235 IC=1, NTWQC
234 PRINT*, " ", CNAME(IC), ":",
    READ(1,*) (EWQ(IIE, IC), IIE=1, NIE)
    IF (EOF(1)) 234, 235
235 CONTINUE
    PRINT*, " "
236 PRINT*, " MEAN DISCHARGE:",
    READ(1,*) (EQ(IIE), IIE=1, NIE)
    IF (EOF(1)) 236, 237
237 PRINT*, " "
    PRINT*, " IV) REACTION RATE COEFFICIENTS."
    PRINT*, " "
    PRINT*, " INPUT THE INDICATED RATE COEFFICIENT FOR"
    PRINT*, " REACHES 1 THROUGH ", NR
    PRINT*, " "
    DO 250 IK=1, NK
249 PRINT*, " ", KNAME(IK),
    READ(1,*) (K20(IR, IK), IR=1, NR)
    IF (EOF(1)) 249, 250
250 CONTINUE
    PRINT*, " "
    PRINT*, " V) DISTRIBUTED SOURCE/SINK PARAMETERS."
    PRINT*, " "
    PRINT*, " INPUT THE INDICATED SOURCE/SINK TERM FOR"
    PRINT*, " REACHES 1 THROUGH ", NR
    PRINT*, " "
    DO 260 IS=1, NS
259 PRINT*, " ", SNAME(IS),
    READ(1,*) (S20(IR, IS), IR=1, NR)
    IF (EOF(1)) 259, 260
260 CONTINUE
    PRINT*, " "
    PRINT*, " VI) BIOLOGICAL PARAMETERS."
    PRINT*, " "
    PRINT*, " INPUT ESTIMATED ALGAL BIOMASS FOR REACHES"
    PRINT*, " 1 THROUGH ", NR
    PRINT*, " "
271 READ(1,*) (A(IR), IR=1, NR)
    IF (EOF(1)) 271, 450
450 CALL LOADVPS(ITP)
    CALL CLOSMS(9)

```

```

500  PRINT*, " "
      PRINT*, " "
      PRINT*, " "
      PRINT*, " "
      PRINT*, " "
      PRINT*, "      DO YOU WISH TO REVIEW AND/OR REVISE THE EXISTING"
      PRINT*, "      DATA FILE "
510  PRINT*, "      (ANS: YES OR NO)",
      READ(1,901) IANS2
      IF(EOF(1)) 510,511
511  IF(IANS2.NE."Y".AND.IANS2.NE."N") GO TO 510
      IF(IANS2.EQ."N") GO TO 898
      IF(IANS1.EQ."N") GO TO 519
      CALL OPENMS(9,DINDEX,125,0)
519  CALL UNLOAD(ITP)
520  PRINT*, " "
      PRINT*, " "
600  CALL DSUM
901  FORMAT(1A1)
902  FORMAT(1I1)
903  FORMAT(8A10)
911  FORMAT(8A10)
913  FORMAT(1A5)
914  FORMAT(1I1)
915  FORMAT(1F5.2)
923  FORMAT(8F10.3)
898  CONTINUE
999  STOP

```

.....

INDEX FOR ALL VARIABLES AND PARAMETERS USED IN 'SIMWQ'

•	A(IR)	ALGAL CONCENTRATIONS IN REACH 'IR' (MG/L)	•
•	ALPHA(IC)	PARAMETER FOR ANALYTICAL WQ SOLUTION (MG/L)	•
•	ATT	KEY FOR MASS STORAGE OF WQ VECTOR	•
•	BCODE(IB)	BIFURACTION CODE DEFINING WATERSHED BRANCHES	•
•	BETA(IC,I)	PARAMETER FOR ANALYTICAL WQ SOLUTION (MG/L)	•
•	BQ(IB)	DISCHARGE AT MINOR TRIBUTARY AT IB'TH	•
•		BIFURCATION (FT**3/SEC)	•
•	BWQ(IB,IC)	WQ VECTOR AT MINOR TRIBUTARY AT IB'TH BIFURCATION	•
•	CNAME(IC)	ALPHABETIC NAMES OF WATER QUALITY ATTRIBUTES	•
•	CNTRLS(8)	ARRAY HOLDING SIMULATION CONTROL PARAMETERS FOR	•
•		TRANSFER TO AND FROM MASS STORAGE	•
•		(NR,NTP,NTWQC,ETC.)	•
•	DA(IR)	DRAINAGE AREA UPSTREAM FROM IR'TH REACH (MILES**2)	•
•	DELTA(IC,I)	PARAMETER FOR ANALYTICAL WQ SOLUTION	•
•	DEPTH(IR)	MEAN DEPTH OF IR'TH REACH (FEET)	•
•	DINDEX(I)	MASTER INDEX FOR MASS STORAGE OF SIMULATION DATA	•
•	EPSIL(IC,I)	PARAMETER FOR ANALYTICAL WQ SOLUTION	•
•	ZQ(IE)	DISCHARGE AT IE'TH POINT SOURCE EFFLUENT INPUT (FT**3/SEC)	•
•	EWQ(IE,IC)	WATER QUALITY VECTOR AT IE'TH EFFLUENT INPUT	•
•	GAMMA(IC,I)	PARAMETER FOR ANALYTICAL WQ SOLUTIONS	•
•	HAD(IR)	HYDRAULIC RATING PARAMETER FOR MEAN DEPTHS	•
•	HAV(IR)	HYDRAULIC RATING PARAMETER FOR MEAN VELOCITIES	•
•	HBD(IR)	HYDRAULIC RATING PARAMETER FOR MEAN DEPTHS	•
•	HBV(IR)	HYDRAULIC RATING PARAMETER FOR MEAN VELOCITIES	•
•	HCODE	SWITCH FOR SPECIFYING MODELING CHOICE FOR DEPTH VEL	•
•	IATT	ATTRIBUTE INDEX (1 TO 20)	•
•	I3	BIFURACTION INDEX (1 TO 5)	•
•	IC	WQ CONSTITUENT INDEX (1 TO 20); SAME AS IATT	•
•	IE(IE2)	EFFLUENT INPUT INDEX (1 TO 15)	•
•	INUM	INDEX FOR SPECIFICATION OF RECORD KEY FOR MASS STORAGE	•
•		OF WQ VECTORS	•
•	IP	SAME AS IPP	•

• IPP	INDEX OF PROFILE POINT IN SIMULATION RESULTS (1 TO 200)	•
• IR	INDEX OF REACH (1 TO 20)	•
• IREC	RECORD KEY INDEX FOR MASS STORAGE OUTPUT OF WQ VECTOR	•
• IRECIP	INDEX OF RECEIVING REACH (DOWNSTREAM) OF IB' TH BIFURCATION	•
• IT(IIT)	INDEX OF INPUT LOCATION OF TRIBUTARIES	•
• ITOP	INDEX SPECIFYING TOP OF SUPERIOR CHANNEL BRANCHES	•
• ITP	INDEX OF TIME PERIOD (1 TO 12)	•
• IWQC	INDEX OF WATER QUALITY CONSTITUENTS (1 TO 20)	•
• KT	TEMPERATURE ADJUSTED KINETIC RATE COEFFICIENT (1/DAY)	•
• K20	KINETIC RATE COEFFICIENT AT 20 DEGREES C (1/DAY)	•
• LR(IR)	LENGTH OF IR' TH REACH (MILES)	•
• MCODE(IC)	MODELING CODE FOR IC' TH ATTRIBUTE	•
• NAATTS	NUMBER OF WQ ATTRIBUTES	•
• NB	NUMBER OF BIFURCATIONS OF STREAM CHANNEL (0<NB<5)	•
• NCWQC	NUMBER OF CONSERVATION WQ CONSTITUENTS (0<NCWQC<12-NNCWQC)	•
• NIE	NUMBER OF POINT SOURCE EFFLUENT INPUTS (0<NIE<15)	•
• NIT	NUMBER OF TRIBUTARY INPUTS (1<NIT<15)	•
• NK	NUMBER OF RATE COEFFICIENTS NECESSARY FOR SIMULATION	•
• NNCWQC	NUMBER OF NON-CONSERVATION WQ CONSTITUENTS	•
• NPP	NUMBER OF PROFILE POINTS IN SIMULATION OF CURRENT	•
• NR	NUMBER OF REACHES IN CURRENT SIMULATION (1<NR<20)	•
• NS	NUMBER OF SOURCE/SINK TERMS IN SIMULATION (0<NS<20)	•
• NTP	NUMBER OF TIME PERIODS IN SIMULATION RUN (1<NTP<12)	•
• NTWQC	NUMBER OF TOTAL WQ CONSTITUENTS IN SIMULATION (NTWQC<20)	•
• NWQC	NUMBER OF CORE WATER QUALITY CONSTITUENTS IN SIMULATION	•
• PN	PERCENT OF NITROGEN IN SUSPENDED SOLIDS (1/100)	•
• PP	PERCENT OF PHOSPHORUS IN SUSPENDED SOLIDS (1/100)	•
• Q(IPP)	STREAM DISCHARGE AT IPP' TH POINT OF OUTPUT PROFILE (FT**3/SEC)	•
• QB	DISCHARGE INPUT FROM BIFURCATION TO CURRENT REACH (CFS)	•
• QE	DISCHARGE INPUT FROM TRIBUTARIES TO CURRENT REACH (CFS)	•
• QINDEX(I)	MASTER INDEX FOR MASS STORAGE OF SIMULATED WQ PROFILES	•
• QT	DISCHARGE INPUT FROM TRIBUTARIES TO CURRENT REACH (CFS)	•
• Q0	DISCHARGE AT TOP OF CURRENT REACH AFTER DILUTIONS (CFS)	•
• Q10K(IK)	TEMPERATURE CORRECTION FACTOR FOR IK' TH RATE COEFFICIENT	•
• Q10S(IS)	TEMPERATURE CORRECTION FACTOR FOR IS' TH SOURCE/SINK TERM	•
• ST(IR,IS)	TEMPERATURE CORRECTED SOURCE/SINK TERM FOR IR' TH REACH	•
• S20(IR,IS)	SOURCE/SINK TERM AT 20 DEGREES C (MG/L/DAY)	•
• TEMP	WATER TEMPERATURE (DEGREES C)	•
• TITLE(3)	SIMULATION NAME	•
• TLR	TOTAL LENGTH OF STREAM TO BE SIMULATED (MILES)	•
• TQ(IT)	DISCHARGE IN IT' TH TRIBUTARY (CFS)	•
• TTWR	TOTAL TIME OF TRAVEL WITHIN CURRENT REACH (DAYS)	•
• TWQ(IT,IC)	WATER QUALITY VECTOR FOR IT' TH TRIBUTARY INPUT	•
• VEL(IR)	MEAN VELOCITY IN IR' TH REACH (MILES/DAY)	•
• WQ(IPP)	WATER QUALITY VECTOR AT IPP' TH POINT IN SIMULATION	•
• WQB(IB,IC)	WATER QUALITY VECTOR FOR IB' TH BIFURCATION INPUT	•
• WQE(IE,IC)	WATER QUALITY VECTOR FOR IE' TH EFFLUENT INPUT	•
• WQT(IT,IC)	WATER QUALITY VECTOR FOR IT' TH TRIBUTARY INPUT	•
• WQ0(IC)	WATER QUALITY VECTOR AT TOP OF CURRENT REACH AFTER	•
• X(IPP,3)	DISTANCE ARRAY SPECIFYING DISTANCE DOWNSTREAM, REACH	•
• XIB	INDEX OF LOCATION ON WATERSHED BRANCHES	•
• XINC	INCREMENT BETWEEN PROFILE POINTS IN SIMULATION OUTPUT	•
• XIR	INDEX OF LOCATION IN TERMS OF STREAM REACH	•
• XLAST	DISTANCE AT TOP OF CURRENT REACH	•
• XWR	DISTANCE FROM TOP OF CURRENT REACH	•
• ZETA	PARAMETER FOR ANALYTICAL WQ SOLUTION	•

END

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C=====
SUBROUTINE DSUM
C=====
COMMON/NAMES/TITLE(8),CNAME(20),SNAME(20),KNAME(20)
COMMON/CTRL/NR,NTP,NWQC,NB,NIT,NIE,IT(15),IE(15),HCODE,
+ MCODE(8),NCWQC,NNCWQC,NTWQC,NS,NK
COMMON/IWQC/TWQ(15,20),EWQ(15,20),TQ(15),EQ(15)
COMMON/KDATA/K20(20,20)
COMMON/SDATA/S20(20,20)
COMMON/MDATA/LR(20),DA(20),DEPTH(20),VEL(20),BCODE(15),
+ HAV(20),HBV(20),HAD(20),HBD(20)
COMMON/BDATA/A(20)
REAL K20,LR
INTEGER TITLE,CNAME,HCODE,KNAME,SNAME
INTEGER TINPUT,EINPUT,START
PRINT*," "
PRINT*,"=====
PRINT*," REVIEW OF CONTENTS OF CURRENT DATA FILE"
PRINT*,"=====
PRINT*," "
PRINT*," THE CURRENT CONTENTS OF YOUR DATA FILE HAVE THE"
PRINT*," TITLE:"
PRINT*," "
PRINT*," ",(TITLE(I),I=1,5)
PRINT*," ",(TITLE(I),I=6,8)
PRINT*," "
PRINT*," THIS DATA SET SPECIFIES SIMULATION OF THE"
PRINT*," FOLLOWING WATER QUALITY ATTRIBUTES:"
PRINT*," ",(CNAME(I),I=1,5)
PRINT*," ",(CNAME(I),I=6,10)
IF(NTWQC.LT.11) GO TO 10
PRINT*," ",(CNAME(I),I=11,15)
IF(NTWQC.LT.16) GO TO 10
PRINT*," ",(CNAME(I),I=16,20)
10 PRINT*," "
PRINT*," SIMULATIONS WILL BE RUN FOR ",NTP," TIME PERIODS"
PRINT*," FOR A TOTAL OF ",NR," STREAM REACHES."
CALL WAIT
PRINT*," THE SPECIFIED WATERSHED STRUCTURE IS AS FOLLOWS:"
PRINT*," "
PRINT*," REACH LENGTH DRAINAGE INPUTS"
PRINT*," NO. (MI.) (SQ.MI.) EFF. TRIB."
PRINT*," "
DO 30 IR=1,NR
EINPUT=" "
DO 23 IIT=1,NIT
IF(IT(IIT).EQ.IR) TINPUT=IT(IIT)
23 CONTINUE
DO 26 IIE=1,NIE
IF(IE(IIE).EQ.IR) EINPUT=IE(IIE)
26 CONTINUE
30 PRINT(1,900) IR,LR(IR),DA(IR),EINPUT,TINPUT
900 FORMAT(7X,1I2,3X,2(1F10.3,2X),7X,1I2,6X,1I2)
PRINT*," "
PRINT*," THE NUMBER OF MAJOR BIFURCATIONS OF THE MAIN"
PRINT*," CHANNEL OF THIS RECEIVING STREAM IS ",NB
IF(NB.LE.0) GO TO 40
START=1
PRINT*," "
DO 39 INB=1,NB
IEND=BCODE(INB)*100-IFIX(BCODE(INB))*100
PRINT*," BRANCH NO. ",INB," INCLUDES REACHES ".START," TO ",
+ IEND

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39  START=IEND+1
   PRINT*, " "
   PRINT*, "      THE MAIN CHANNEL INCLUDES REACHES ", START, " TO ", NR
   CALL WAIT
40  IF(HCODE.GT.0) GO TO 50
   PRINT*, "      HYDRAULIC MODELING WILL BE DONE USING MEAN "
   PRINT*, "      VELOCITIES AND DEPTHS FOR EACH REACH AND TIME"
   PRINT*, "      PERIOD."
   GO TO 60
50  PRINT*, "      HYDRAULIC MODELLING WILL BE DONE USING HYDRAULIC "
   PRINT*, "      RATING PARAMETERS RELATING MEAN VELOCITY AND "
   PRINT*, "      DEPTHS TO DISCHARGE IN A REACH."
60  CONTINUE
   PRINT*, " "
   PRINT*, "      NONE OF THE ABOVE PARAMTERS CAN BE ALTERED WITHOUT"
   PRINT*, "      CREATING A TOTALLY NEW DATA SET (I.E., BY"
   PRINT*, "      STARTING OVER WITH 'FQUES')."
70  PRINT*, "      DO YOU WANT TO CONTINUE (ANS: YES OR NO)",
   READ(1,901) IANS
901  FORMAT(1A1)
   IF(EOF(1)) 70,71
71  IF(IANS.NE."Y".AND.IANS.NE."N") GO TO 70
   IF(IANS.EQ."Y") GO TO 100
   RETURN
100 PRINT*, " "
   PRINT*, "      WHICH TIME PERIOD DO YOU WANT TO REVIEW",
   READ(1,*) ITP
   IF(EOF(1)) 100,101
   IF(ITP.LT.0.OR.ITP.GT.NTP) GO TO 100
101  CALL UNLTVPS(ITP)
   PRINT*, " "
110  PRINT*, "      INDICATE WHICH OF THE FOLLOWING PARAMETERS YOU"
   PRINT*, "      WANT TO REVIEW (RESPOND WITH THE PROPER NUMBER)"
113  PRINT*, "      1) HYDRAULIC PARAMETERS"
   PRINT*, "      2) INITIAL CONDITIONS IN TRIBUTARIES"
   PRINT*, "      3) INITIAL CONDITIONS IN EFFLUENTS"
   PRINT*, "      4) KINETIC PARAMETERS"
   PRINT*, "      5) DISTRIBUTED SOURCE/SINK PARAMETERS"
   PRINT*, "      6) BIOLOGICAL PARAMETERS"
111  PRINT*, "      ",
   READ(1,*) IPARAM
   IF(EOF(1)) 111,112
112  IF(IPARAM.LT.1.OR.IPARAM.GT.6) GO TO 111
   GO TO (150,200,250,300,350,400),IPARAM
150  PRINT*, " "
   IF(HCODE.NE.1) GO TO 151
   PRINT*, "      THIS DATA SET USES HYDRAULIC RATING PARAMETERS"
   PRINT*, "      THEREFORE NO MEAN VALUES FOR VELOCITY"
   PRINT*, "      OR DEPTH ARE NEEDED."
   PRINT*, " "
   GO TO 500
151  PRINT*, "      THE CURRENT VALUES FOR MEAN VELOCITIES AND DEPTHS"
   PRINT*, "      FOR EACH REACH DURING TIME PERIOD ", ITP, " ARE"
   PRINT*, "      LISTED BELOW. TO CHANGE THE CURRENT VALUES"
   PRINT*, "      RESPOND TO TRAILING '?' BY THE NEW VALUES."
   PRINT*, "      (NO. REACH, VELOCITY, DEPTH)"
   DO 170 IR=1,NR
   PRINT*, "      ", IR, " " , VEL(IR), DEPTH(IR),
   READ(1,*) VEL(IR), DEPTH(IR)
   IF(EOF(1)) 169,170
169  CONTINUE
170  CONTINUE

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```

GO TO 500
200 PRINT*, " "
    PRINT*, "      INDICATE WHICH WATER QUALITY ATTRIBUTE YOU ARE"
    PRINT*, "      INTERESTED IN:"
209 DO 210 IC=1,NTWQC
210 PRINT*, "          ",IC," ) ",CNAME(IC)
    PRINT*, "          ",NTWQC+1," ) DISCHARGE"
    PRINT*, "          "
211 READ(1,*) IWQC
    IF(EOF(1)) 211,212
212 IF(IWQC.EQ.NTWQC+1) GO TO 230
    PRINT*, "      THE VALUES FOR ",CNAME(IWQC)," FOR TIME PERIOD "
    PRINT*, "      ",ITP," ARE LISTED BELOW BY TRIBUTARY."
    PRINT*, "      TO CHANGE A VALUE RESPOND TO THE TRAILING '?' "
    PRINT*, "      WITH THE NEW VALUE."
    DO 220 IIT=1,NIT
    PRINT*, "          ",IIT," ) ",TWQ(IIT,IWQC),
    READ(1,*) TWQ(IIT,IWQC)
    IF(EOF(1)) 220,219
219 CONTINUE
220 CONTINUE
    PRINT*, " "
    GO TO 241
230 PRINT*, "      THE VALUES FOR TRIBUTARY DISCHARGE FOR TIME PERIOD",
    PRINT*, "      ",ITP," ARE LISTED BY TRIBUTARY BELOW. TO"
    PRINT*, "      CHANGE A VALUE RESPOND TO THE TRAILING '?' BY"
    PRINT*, "      THE NEW VALUE."
    DO 240 IIT=1,NIT
    PRINT*, "          ",IIT," ) ",TQ(IIT),
    READ(1,*) TQ(IIT)
    IF(EOF(1)) 240,240
239 CONTINUE
240 CONTINUE
241 PRINT*, " "
    PRINT*, "      REVIEW ANOTHER TRIBUTARY ATTRIBUTE (ANS: YES OR NO)",
    READ(1,901) IANS4
    IF(EOF(1)) 241,242
242 IF(IANS4.NE."N".AND.IANS4.NE."Y") GO TO 241
    IF(IANS4.EQ."N") GO TO 500
243 PRINT*, "      WHICH ATTRIBUTE",
    READ(1,*) IWQC
    IF(EOF(1)) 243,244
244 IF(IWQC.LT.1.OR.IWQC.GT.NTWQC+1) GO TO 209
    GO TO 212
250 PRINT*, " "
    PRINT*, "      INDICATE WHICH WATER QUALITY ATTRIBUTE YOU ARE"
    PRINT*, "      INTERESTED IN:"
259 DO 260 IC=1,NTWQC
260 PRINT*, "          ",IC," ) ",CNAME(IC)
    PRINT*, "          ",NTWQC+1," ) DISCHARGE"
    PRINT*, "          "
261 READ(1,*) IWQC
    IF(EOF(1)) 261,262
262 IF(IWQC.EQ.NTWQC+1) GO TO 280
    PRINT*, "      THE VALUES FOR ",CNAME(IWQC)," FOR TIME PERIOD "
    PRINT*, "      ",ITP," ARE LISTED BELOW BY EFFLUENT."
    PRINT*, "      TO CHANGE A VALUE RESPOND TO THE TRAILING '?' "
    PRINT*, "      WITH THE NEW VALUE."
    DO 270 IIE=1,NIE
    PRINT*, "          ",IIE," ) ",EWQ(IIE,IWQC),
    READ(1,*) EWQ(IIE,IWQC)
    IF(EOF(1)) 270,269
269 CONTINUE
270 CONTINUE
    PRINT*, " "
    GO TO 291

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280 PRINT*, "      THE VALUES FOR EFFLUENT DISCHARGE FOR TIME PERIOD"
PRINT*, "      ", ITP, " ARE LISTED BY EFFLUENT BELOW. TO"
PRINT*, "      CHANGE A VALUE RESPOND TO THE TRAILING '?' BY"
PRINT*, "      THE NEW VALUE."
DO 290 IIE=1, NIE
PRINT*, "      ", IIE, " ) ", EQ(IIE),
READ(1, *) EQ(IIE)
IF(EOF(1)) 289, 290
289 CONTINUE
290 CONTINUE
291 PRINT*, " "
PRINT*, "      REVIEW ANOTHER EFFLUENT ATTRIBUTE (ANS: YES OR NO)",
READ(1, 901) IANS4
IF(EOF(1)) 291, 292
292 IF(IANS4.NE."N".AND.IANS4.NE."Y") GO TO 291
IF(IANS4.EQ."N") GO TO 500
293 PRINT*, "      WHICH ATTRIBUTE",
READ(1, *) IWQC
IF(EOF(1)) 293, 294
294 IF(IWQC.LT.1.OR.IWQC.GT.NTWQC+1) GO TO 259
GO TO 262
300 PRINT*, " "
PRINT*, "      INDICATE THE INDEX NUMBER OF THE KINETIC PARAMETER"
PRINT*, "      YOU ARE INTERESTED IN REVIEWING"
309 DO 310 IK=1, NK
310 PRINT*, "      ", IK, " ) ", KNAME(IK)
311 PRINT*, "      ",
READ(1, *) IK
IF(EOF(1)) 311, 312
312 IF(IK.LT.1.OR.IK.GT.NK) GO TO 311
PRINT*, " "
313 PRINT*, "      THE VALUES CURRENTLY SPECIFIED FOR ", KNAME(IK), "WILL"
PRINT*, "      BE LISTED BELOW BY REACH. TO CHANGE A VALUE"
PRINT*, "      RESPOND TO THE TRAILING '?' WITH THE NEW"
PRINT*, "      VALUE."
DO 320 IR=1, NR
PRINT*, "      ", IR, " ) ", K20(IR, IK),
READ(1, *) K20(IR, IK)
IF(EOF(1)) 319, 320
319 CONTINUE
320 CONTINUE
321 PRINT*, "      REVIEW ANOTHER RATE COEFFICIENT (ANS: YES OR NO)",
READ(1, 901) IANS5
IF(EOF(1)) 321, 322
322 IF(IANS5.NE."Y".AND.IANS5.NE."N") GO TO 321
IF(IANS5.EQ."N") GO TO 500
330 PRINT*, "      WHICH ONE",
READ(1, *) IK
IF(EOF(1)) 330, 331
331 IF(IK.LT.1.OR.IK.GT.NK) GO TO 309
GO TO 313
350 PRINT*, " "
PRINT*, "      INDICATE THE INDEX NUMBER OF THE DISTRIBUTED"
PRINT*, "      SOURCE/SINK TERM YOU WISH TO REVIEW"
359 DO 360 IS=1, NS
360 PRINT*, "      ", IS, " ) ", SNAME(IS)
361 PRINT*, "      ",
READ(1, *) IS
IF(EOF(1)) 361, 362
362 IF(IS.LT.1.OR.IS.GT.NS) GO TO 361
363 PRINT*, " "
PRINT*, "      THE VALUES CURRENTLY SPECIFIED FOR ", SNAME(IS), "WILL"
PRINT*, "      BE LISTED BELOW BY REACH. TO CHANGE A VALUE"
PRINT*, "      RESPOND TO THE TRAILING '?' WITH THE NEW"
PRINT*, "      VALUE."

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DO 370 IR=1,NR
PRINT*, "      ",IR," " ,S20(IR,IS),
READ(1,*) S20(IR,IS)
IF(EOF(1)) 369,370
369 CONTINUE
370 CONTINUE
371 PRINT*, "      REVIEW ANOTHER SOURCE/SINK TERM (ANS: YES OR NO)",
READ(1,901) IANS6
IF(EOF(1)) 371,372
372 IF(IANS6.NE."N".AND.IANS6.NE."Y") GO TO 371
IF(IANS6.EQ."N") GO TO 500
380 PRINT*, "      WHICH ONE",
READ(1,*) IS
IF(EOF(1)) 380,381
381 IF(IS.LT.1.OR.IS.GT.NS) GO TO 359
GO TO 363
400 PRINT*, " "
PRINT*, "      THE CURRENT VALUES FOR MEAN ALGAL CONCENTRATIONS"
PRINT*, "      ARE LISTED BELOW BY REACH AND FOR TIME PERIOD"
PRINT*, "      ",ITP,". TO CHANGE A VALUE RESPOND TO THE "
PRINT*, "      TRAILING '?' BY THE NEW VALUE."
DO 410 IR=1,NR
PRINT*, "      ",IR," " ,A(IR),
READ(1,*) A(IR)
IF(EOF(1)) 409,410
409 CONTINUE
410 CONTINUE
PRINT*, " "
500 PRINT*, " "
PRINT*, "      CONTINUE FOR THIS TIME PERIOD (ANS: YES OR NO)",
501 READ(1,901) IANS1
IF(EOF(1)) 501,502
502 IF(IANS1.NE."Y".AND.IANS1.NE."N") GO TO 501
IF(IANS1.EQ."N") GO TO 510
PRINT*, " "
508 PRINT*, "      INDICATE PARAMETER TYPE ",
READ*,IPARAM
IF(EOF(1)) 508,509
509 IF(IPARAM.LT.0.OR.IPARAM.GT.6) GO TO 113
GO TO (150,200,250,300,350,400),IPARAM
510 PRINT*, " "
PRINT*, "      REVIEW ANOTHER TIME PERIOD (ANS: YES OR NO)",
511 READ(1,901) IANS2
IF(EOF(1)) 511,512
512 IF(IANS2.NE."Y".AND.IANS2.NE."N") GO TO 511
CALL LOADVPS(ITP)
IF(IANS2.EQ."Y") GO TO 100
RETURN
END

```

```

C=====
SUBROUTINE LOADTIP(ITP)
C=====
COMMON/NAMES/TITLE(8),CNAME(20),SNAME(20),KNAME(20)
COMMON/CNTRL/NR,NTP,NWQC,NB,NIT,NIE,IT(15),IE(15),HCODE,
+ MCODE(8),NCWQC,NNCWQC,NTWQC,NS,NK
COMMON/IWQC/TWQ(15,20),EWQ(15,20),TQ(15),EQ(15)
COMMON/KDATA/K20(20,20)
COMMON/SDATA/S20(20,20)
COMMON/MDATA/LR(20),DA(20),DEPTH(20),VEL(20),BCODE(15),
+ HAV(20),HBV(20),HAD(20),HBD(20)
COMMON/BDATA/A(20)
REAL LR,K20
INTEGER TITLE,HCODE,CNAME
INTEGER DINDEX(125),CNTRLS(8)
DATA (CNAME(I),I=1,8)/"TEMP","TSS","NH3","NO2","NO3",
+ "PO4","D.O."/
C-----> LOAD DATA INTO MASS STORAGE FILE
CALL WRITMS(9,TITLE,8,1,-1)
CNTRLS(1)=NR
CNTRLS(2)=NTP
CNTRLS(3)=NCWQC
CNTRLS(4)=NNCWQC
CNTRLS(5)=HCODE
CNTRLS(6)=NB
CNTRLS(7)=NIT
CNTRLS(8)=NIE
CALL WRITMS(9,CNTRLS,8,2,-1)
CALL WRITMS(9,MCODE,8,3,-1)
NAATTS=NCWQC+NNCWQC
IF(NAATTS.LE.0) GO TO 570
CALL WRITMS(9,CNAME,NTWQC,4,-1)
570 CALL WRITMS(9,BCODE,NB,5,-1)
CALL WRITMS(9,IT,NIT,6,-1)
CALL WRITMS(9,IE,NIE,7,-1)
CALL WRITMS(9,LR,NR,8,-1)
CALL WRITMS(9,DA,NR,9,-1)
IF(HCODE.EQ.0) GO TO 580
CALL WRITMS(9,HAV,NR,10,-1)
CALL WRITMS(9,HBV,NR,11,-1)
CALL WRITMS(9,HAD,NR,12,-1)
CALL WRITMS(9,HBD,NR,13,-1)
580 RETURN
ENTRY LOADVPS
NTWQC=8+NCWQC+NNCWQC
NK=16+NNCWQC
NS=NTWQC
II=13+(ITP-1)*9
IF(HCODE.EQ.1) GO TO 585
INUM=II+1
CALL WRITMS(9,VEL,NR,INUM,-1)
INUM=II+2
CALL WRITMS(9,DEPTH,NR,INUM,-1)
585 NUM=NIT*NTWQC
INUM=II+3
CALL WRITMS(9,TWQ,300,INUM,-1)
INUM=II+4
CALL WRITMS(9,TQ,NIT,INUM,-1)
NUM=NIE*NTWQC
INUM=II+5

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CALL WRITMS(9,EWQ,300,INUM,-1)
INUM=II+6
CALL WRITMS(9,EQ,NIE,INUM,-1)
NUM=NK*NR
INUM=II+7
CALL WRITMS(9,K20,400,INUM,-1)
NUM=NS*NR
INUM=II+8
CALL WRITMS(9,S20,400,INUM,-1)
INUM=II+9
CALL WRITMS(9,A,NR,INUM,-1)
RETURN
END
C=====
SUBROUTINE UNLOAD(ITP)
C=====
COMMON/NAMES/TITLE(8),CNAME(20),SNAME(20),KNAME(20)
COMMON/CNTRL/NR,NTP,NWQC,NB,NIT,NIE,IT(15),IE(15),HCODE,
+ MCODE(8),NCWQC,NNCWQC,NTWQC,NS,NK
COMMON/IWQC/TWQ(15,20),EWQ(15,20),TQ(15),EQ(15)
COMMON/XDATA/K20(20,20)
COMMON/SDATA/S20(20,20)
COMMON/HDATA/LR(20),DA(20),DEPTH(20),VEL(20),BCODE(15),
+ HAV(20),HBV(20),HAD(20),HBD(20)
COMMON/BDATA/A(20)
REAL LR,K20
INTEGER TITLE,HCODE,CNAME
INTEGER JINDEX(125),CNTRLS(8)
C-----> UNLOAD DATA FROM MASS STORAGE FILE
CALL READMS(9,TITLE,8,1)
CALL READMS(9,CNTRLS,8,2)
NR=CNTRLS(1)
NTP=CNTRLS(2)
NCWQC=CNTRLS(3)
NNCWQC=CNTRLS(4)
HCODE=CNTRLS(5)
NB=CNTRLS(6)
NIT=CNTRLS(7)
NIE=CNTRLS(8)
NWQC=8
NK=16+NNCWQC
NS=8+NNCWQC+NCWQC
NTWQC=8+NCWQC+NNCWQC
CALL READMS(9,MCODE,8,3)
NAATTS=NCWQC+NNCWQC
IF(NAATTS.LE.0) GO TO 570
CALL READMS(9,CNAME,NTWQC,4)
570 CALL READMS(9,BCODE,NB,5)
CALL READMS(9,IT,NIT,6)
CALL READMS(9,IE,NIE,7)
CALL READMS(9,LR,NR,8)
CALL READMS(9,DA,NR,9)
IF(HCODE.EQ.0) GO TO 580
CALL READMS(9,HAV,NR,10)
CALL READMS(9,HBV,NR,11)
CALL READMS(9,HAD,NR,12)
CALL READMS(9,HBD,NR,13)
580 RETURN

```

```

ENTRY UNLTVPS
II=13+(ITP-1)*9
IF(HCODE.EQ.1) GO TO 585
INUM=II+1
CALL READMS(9,VEL,NR,INUM)
INUM=II+2
CALL READMS(9,DEPTH,NR,INUM)
585 NUM=NIT*NTWQC
INUM=II+3
CALL READMS(9,TWQ,300,INUM)
INUM=II+4
CALL READMS(9,TQ,NIT,INUM)
NUM=NIE*NTWQC
INUM=II+5
CALL READMS(9,SWQ,300,INUM)
INUM=II+6
CALL READMS(9,EQ,NIE,INUM)
NUM=NK*NR
INUM=II+7
CALL READMS(9,K20,400,INUM)
NUM=NS*NR
INUM=II+8
CALL READMS(9,S20,400,INUM)
INUM=II+9
CALL READMS(9,A,NR,INUM)
RETURN
END

```

```

C=====
SUBROUTINE WAIT
C=====
READ*,DUMMY
IF(EOF(1))1,2
1 GO TO 2
2 DO 3 I=1,5
3 PRINT*, " "
RETURN
END

```

SOURCE LISTING OF SIMWQ

```

PROGRAM WQMAIN(OUTPUT,TAPE4=OUTPUT,TAPE9,TAPE33)
COMMON/NAMES/TITLE(8),CNAME(20)
COMMON/CNTRL/NR,NTP,NWQC,NB,NIT,NIE,IT(15),IE(15),HCODE,
+ MCODE(8),IR,IB,IPP,NCWQC,NNCWQC,NTWQC,NPP
COMMON/IWQC/TWQ(15,20),EWQ(15,20),TQ(15),EQ(15),
+ BWQ(5,20),BQ(5)
COMMON/KDATA/K20(20,20),KT(20)/QDATA/Q10K(20),Q10S(20)
COMMON/SDATA/S20(20,20),ST(20)
COMMON/MDATA/LR(20),DA(20),DEPTH(20),VEL(20),BCODE(5),
+ HAV(20),HBV(20),HAD(20),HBD(20)
COMMON/BDATA/PN,PP,A(20)
COMMON/APARAM/ALPHA(20),BETA(20,5),GAMMA(20,5),DELTA(20),
+ EPSIL(20,5),ZETA(20)
DIMENSION WQ(200,20),Q(200),X(200,3)
REAL K20,KT,LR
INTEGER TITLE,HCODE,CNAME,DINDEX(125)
DATA Q10K/20*1.0/,Q10S/20*1.0/,PP/0.05/,PN/0.10/
DATA (CNAME(I),I=1,8)/"TEMP","TSS","BOD","NH3","NO2","NO3",
+ "PO4","D.O."/

C
C-----> INPUT DATA FROM 'TAPE9'
C
      CALL OPENMS(9,DINDEX,125,0)
      CALL LOADDAT(ITP)

C
C-----> BEGIN SIMULATIONS FOR DISCRETE TIME PERIODS
C
      DO 100 ITP=1,NTP
      CALL LOADTVP(ITP)

C
C-----> WATER QUALITY SIMULATIONS
C
      CALL SIMWQ(WQ,Q,X)

C
C-----> OUTPUT RESULTS TO 'WQFLS'
C
      CALL WQOUTMS(WQ,Q,X,ITP)
100  CONTINUE
C
      PRINT*,"===== "
      PRINT*," "
      PRINT*,"      SIMULATED WATER QUALITY PROFILES HAVE BEEN"
      PRINT*,"      OUTPUT TO 'TAPE33' FOR ",ITP-1," TIME"
      PRINT*,"      PERIOD(S) FOR THE FOLLOWING WATER"
      PRINT*,"      QUALITY ATTRIBUTES:"
      PRINT*," "
      DO 200 IATT=1,NTWQC
200  PRINT*,"      ",IATT," ) ",CNAME(IATT)
      PRINT*," "
      PRINT*,"===== "
      CALL CLOSMS(9)
      STOP

```

INDEX FOR ALL VARIABLES AND PARAMETERS USED IN 'SIMWQ'	
A(IR)	ALGAL CONCENTRATIONS REACH 'IR' (MG/L)
ALPHA(IC)	PARAMETER FOR ANALYTICAL WQ SOLUTION (MG/L)
ATT	KEY FOR MASS STORAGE OF WQ VECTOR
BCODE(IB)	BIFURACTION CODE DEFINING WATERSHED BRANCHES
BETA(IC,I)	PARAMETER FOR ANALYTICAL WQ SOLUTION (MG/L)
BQ(IB)	DISCHARGE AT MINOR TRIBUTARY AT IB'TH BIFURCATION (FT**3/SEC)
BWQ(IB,IC)	WQ VECTOR AT MINOR TRIBUTARY AT IB'TH BIFURCATION
CHANE(IC)	ALPHABETIC NAMES OF WATER QUALITY ATTRIBUTES
CNTRL(S)	ARRAY HOLDING SIMULATION CONTROL PARAMETERS FOR TRANSFER TO AND FROM MASS STORAGE (NR,NTP,NTWQC,ETC.)
DA(IR)	DRAINAGE AREA UPSTREAM FROM IR'TH REACH (MILES**2)
DELTA(IC,I)	PARAMETER FOR ANALYTICAL WQ SOLUTION
DEPTH(IR)	MEAN DEPTH OF IR'TH REACH (FEET)
DINDEX(I)	MASTER INDEX FOR MASS STORAGE OF SIMULATION DATA
EPSIL(IC,I)	PARAMETER FOR ANALYTICAL WQ SOLUTION
EQ(IE)	DISCHARGE AT IE'TH POINT SOURCE EFFLUENT INPUT (FT**3/SEC)
EWQ(IE,IC)	WATER QUALITY VECTOR AT IE'TH EFFLUENT INPUT
GAMMA(IC,I)	PARAMETER FOR ANALYTICAL WQ SOLUTIONS
HAD(IR)	HYDRAULIC RATING PARAMETER FOR MEAN DEPTHS
HAV(IR)	HYDRAULIC RATING PARAMETER FOR MEAN VELOCITIES
HBD(IR)	HYDRAULIC RATING PARAMETER FOR MEAN DEPTHS
HBV(IR)	HYDRAULIC RATING PARAMETER FOR MEAN VELOCITIES
HCODE	SWITCH FOR SPECIFYING MODELING CHOICE FOR DEPTH VEL
IATT	ATTRIBUTE INDEX (1 TO 20)
IB	BIFURACTION INDEX (1 TO 5)
IC	WQ CONSTITUENT INDEX (1 TO 20); SAME AS IATT
IE(IE)	EFFLUENT INPUT INDEX (1 TO 15)
INUM	INDEX FOR SPECIFICATION OF RECORD KEY FOR MASS STORAGE OF WQ VECTORS
IP	SAME AS IPP
IPP	INDEX OF PROFILE POINT IN SIMULATION RESULTS (1 TO 200)
IR	INDEX OF REACH (1 TO 20)
IREC	RECORD KEY INDEX FOR MASS STORAGE OUTPUT OF WQ VECTOR
IRECIP	INDEX OF RECEIVING REACH (DOWNSTREAM) OF IB'TH BIFURCATION
IT(IIT)	INDEX OF INPUT LOCATION OF TRIBUTARIES
ITOP	INDEX SPECIFYING TOP OF SUPERIOR CHANNEL BRANCHES
ITP	INDEX OF TIME PERIOD (1 TO 12)
IWQC	INDEX OF WATER QUALITY CONSTITUENTS (1 TO 20)
KT	TEMPERATURE ADJUSTED KINETIC RATE COEFFICIENT (1/DAY)
K20	KINETIC RATE COEFFICIENT AT 20 DEGREES C (1/DAY)
LR(IR)	LENGTH OF IR'TH REACH (MILES)
MCODE(IC)	MODELING CODE FOR IC'TH ATTRIBUTE
NAATTS	NUMBER OF WQ ATTRIBUTES
NB	NUMBER OF BIFURCATIONS OF STREAM CHANNEL (0<NB<5)
NCWQC	NUMBER OF CONSERVATION WQ CONSTITUENTS (0<NCWQC<12-NNCWQC)
NIE	NUMBER OF POINT SOURCE EFFLUENT INPUTS (0<NIE<15)
NIT	NUMBER OF TRIBUTARY INPUTS (1<NIT<15)
NK	NUMBER OF RATE COEFFICIENTS NECESSARY FOR SIMULATION
NNCWQC	NUMBER OF NON-CONSERVATION WQ CONSTITUENTS
NPP	NUMBER OF PROFILE POINTS IN SIMULATION OF CURRENT
NR	NUMBER OF REACHES IN CURRENT SIMULATION (1<NR<20)
NS	NUMBER OF SOURCE/SINK TERMS IN SIMULATION (0<NS<20)
NTP	NUMBER OF TIME PERIODS IN SIMULATION RUN (1<NTP<12)
NTWQC	NUMBER OF TOTAL WQ CONSTITUENTS IN SIMULATION (NTWQC<20)
NWQC	NUMBER OF CORE WATER QUALITY CONSTITUENTS IN SIMULATION
PN	PERCENT OF NITROGEN IN SUSPENDED SOLIDS (%/100)
PP	PERCENT OF PHOSPHORUS IN SUSPENDED SOLIDS (%/100)

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* Q(IPP)      STREAM DISCHARGE AT IPP'TH POINT OF OUTPUT PROFILE (FT**3/SEC)
* QB         DISCHARGE INPUT FROM BIFURCATION TO CURRENT REACH (CFS)
* QE         DISCHARGE INPUT FROM TRIBUTARIES TO CURRENT REACH (CFS)
* QINDEX(I)  MASTER INDEX FOR MASS STORAGE OF SIMULATED WQ PROFILES
* QT         DISCHARGE INPUT FROM TRIBUTARIES TO CURRENT REACH (CFS)
* QO         DISCHARGE AT TOP OF CURRENT REACH AFTER DILUTIONS (CFS)
* Q10K(IK)   TEMPERATURE CORRECTION FACTOR FOR IK'TH RATE COEFFICIENT
* Q10S(IS)   TEMPERATURE CORRECTION FACTOR FOR IS'TH SOURCE/SINK TERM
* ST(IR,IS)  TEMPERATURE CORRECTED SOURCE/SINK TERM FOR IR'TH REACH
* S20(IR,IS) SOURCE/SINK TERM AT 20 DEGREES C (MG/L/DAY)
* TEMP       WATER TEMPERATURE (DEGREES C)
* TITLE(8)   SIMULATION NAME
* TLR        TOTAL LENGTH OF STREAM TO BE SIMULATED (MILES)
* TQ(IT)     DISCHARGE IN IT'TH TRIBUTARY (CFS)
* TTWR       TOTAL TIME OF TRAVEL WITHIN CURRENT REACH (DAYS)
* TWQ(IT,IC) WATER QUALITY VECTOR FOR IT'TH TRIBUTARY INPUT
* VEL(IR)    MEAN VELOCITY IN IR'TH REACH (MILES/DAY)
* WQ(IPP)    WATER QUALITY VECTOR AT IPP'TH POINT IN SIMULATION
* WQB(IB,IC) WATER QUALITY VECTOR FOR IB'TH BIFURCATION INPUT
* WQE(IE,IC) WATER QUALITY VECTOR FOR IE'TH EFFLUENT INPUT
* WQT(IT,IC) WATER QUALITY VECTOR FOR IT'TH TRIBUTARY INPUT
* WQO(IC)    WATER QUALITY VECTOR AT TOP OF CURRENT REACH AFTER
* X(IPP,3)   DISTANCE ARRAY SPECIFYING DISTANCE DOWNSTREAM, REACH
* XIB        INDEX OF LOCATION ON WATERSHED BRANCHES
* XINC       INCREMENT BETWEEN PROFILE POINTS IN SIMULATION OUTPUT
* XIR        INDEX OF LOCATION IN TERMS OF STREAM REACH
* XLAST      DISTANCE AT TOP OF CURRENT REACH
* XWR        DISTANCE FROM TOP OF CURRENT REACH
* ZETA       PARAMETER FOR ANALYTICAL WQ SOLUTION

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END

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C=====
C----- SUBROUTINE ASOLN(TTWR,WQ)
C=====
COMMON/CNTRL/NR,NTP,NWQC,NB,NIT,NIE,IT(15),IE(15),HCODE,
+ MCODE(8),IR,IB,IPP,NCWQC,NNCWQC,NTWQC,NPP
COMMON/APARAM/ALPHA(20),BETA(20,5),GAMMA(20,5),DELTA(20),
+ EPSIL(20,5),ZETA(20)
DIMENSION NE(20),WQ(200,20)
DATA (NE(I),I=1,20)/3*1,2,2*3,2,5,12*1/
DOSAT(TEMP)=14.652-0.41022*TEMP+0.007991*TEMP**2
+ -0.00007774*TEMP**3
C
C----- DOWNSTREAM PROFILE CALCULATION OF WATER QUALITY
C
DO 899 J=1,NTWQC
WQ(IPP,J)=ALPHA(J)+DELTA(J)*TTWR+ZETA(J)*TTWR**2
II=NE(J)
DO 799 K=1,II
WQ(IPP,J)=WQ(IPP,J)+BETA(J,K)*EXP(-GAMMA(J,K)*TTWR)
WQ(IPP,J)=WQ(IPP,J)+EPSIL(J,K)*TTWR*EXP(-GAMMA(J,K)*TTWR)
799 CONTINUE
899 CONTINUE
WQ(IPP,8)=DOSAT(WQ(IPP,1))-WQ(IPP,8)
RETURN
END

```

```

C=====
      SUBROUTINE DILUTE(WQ,WQ0,Q0)
C=====
      COMMON/CNTRL/NR,NTP,NWQC,NB,NIT,NIE,IT(15),IE(15),HCODE,
+ HCODE(8),IR,IB,IPP,NCWQC,NNCWQC,NTWQC,NPP
      COMMON/IWQC/TWQ(15,20),EWQ(15,20),TQ(15),EQ(15),
+ BWQ(5,20),BQ(5)
      COMMON/MDATA/LR(20),DA(20),DEPTH(20),VEL(20),BCODE(5),
+ HAV(20),HBV(20),HAD(20),HBD(20)
      DIMENSION WQE(20),WQT(20),WQB(20),WQ(200,20),WQ0(20),Q0(20)
      REAL LR

C
C-----> ZERO TRIBUTARY AND EFFLUENT INPUTS
C
101  QT=0.0
      QE=0.0
      QB=0.0
      DO 102 I=1,NTWQC
          WQB(I)=0.0
          WQE(I)=0.0
102  WQT(I)=0.0
C
C-----> SELECT TRIBUTARY INPUTS FOR CURRENT REACH
C
      DO 110 I=1,NIT
          IF(IT(I).NE.IR) GO TO 110
          QT=TQ(I)
          DO 105 J=1,NTWQC
105   WQT(J)=TWQ(I,J)
          GO TO 111
110  CONTINUE
C
C-----> SELECT POINT SOURCE EFFLUENT INPUTS FOR CURRENT REACH
C
111  DO 120 I=1,NIE
          IF(IE(I).NE.IR) GO TO 120
          QE=EQ(I)
          DO 115 J=1,NTWQC
115   WQE(J)=EWQ(I,J)
          GO TO 121
120  CONTINUE
C
C-----> SELECT INPUTS FROM BIFURCATIONS
C
121  DO 130 I=1,NB
          IRECIP=INT(BCODE(I))
          IF(IRECIP.NE.IR) GO TO 130
          QB=BQ(I)
          DO 125 J=1,NTWQC
125   WQB(J)=BWQ(I,J)
          GO TO 131
130  CONTINUE
C
C-----> DILUTE WATER QUALITY VARIABLES
C
131  IF(IR.EQ.1) GO TO 140
      DO 135 I=1,NB
          ITOP=BCODE(I)*100.-INT(BCODE(I))*100+1
          IF(ITOP.EQ.IR) GO TO 140
135  CONTINUE
      Q0(IR)=QT+QB+Q0(IR-1)
      GO TO 150
140  Q0(IR)=QE+QT
      DO 145 K=1,NTWQC
145  WQ0(K)=(QE*WQE(K)+QT*WQT(K))/Q0(IR)
      GO TO 210
150  DO 200 K=1,NTWQC
200  WQ0(K)=(QE*WQE(K)+QT*WQT(K)+QB*WQB(K)+Q0(IR-1)*
+ WQ(IPP-1,K))/Q0(IR)
210  CONTINUE
      RETURN
      END

```

```

C=====
SUBROUTINE LOADDAT(ITP)
C=====
REAL LR,K20
COMMON/NAMES/TITLE(8),CNAME(20)
COMMON/CNTRL/NR,NTP,NWQC,NB,NIT,NIE,IT(15),IE(15),HCODE,
+ HCODE(8),IR,IS,IPP,NCWQC,NNCWQC,NTWQC,NPP
COMMON/LWQC/TWQ(15,20),EWQ(15,20),TQ(15),EQ(15),
+ BWQ(5,20),BQ(5)
COMMON/KDATA/K20(20,20),KT(20)/QDATA/Q10K(20),Q103(20)
COMMON/SDATA/S20(20,20),ST(20)
COMMON/MDATA/LR(20),DA(20),DEPTH(20),VEL(20),BCODE(5),
+ HAV(20),HBV(20),HAD(20),HBD(20)
COMMON/BDATA/PN,PP,A(20)
INTEGER TITLE,HCODE,CNAME,DINDEX(125),CNTRLS(8)
C-----> UNLOAD DATA FROM MASS STORAGE FILE
CALL READMS(9,TITLE,8,1)
CALL READMS(9,CNTRLS,8,2)
NR=CNTRLS(1)
NTP=CNTRLS(2)
NCWQC=CNTRLS(3)
NNCWQC=CNTRLS(4)
HCODE=CNTRLS(5)
NB=CNTRLS(6)
NIT=CNTRLS(7)
NIE=CNTRLS(8)
NWQC=8
NK=16+NNCWQC
NS=8+NNCWQC+NCWQC
NTWQC=8+NCWQC+NNCWQC
CALL READMS(9,HCODE,8,3)
HAATTS=NCWQC+NNCWQC
IF(HAATTS.LE.0) GO TO 570
CALL READMS(9,CNAME,NTWQC,4)
570 CALL READMS(9,BCODE,NB,5)
CALL READMS(9,IT,NIT,6)
CALL READMS(9,IE,NIE,7)
CALL READMS(9,LR,NR,8)
CALL READMS(9,DA,NR,9)
IF(HCODE.EQ.0) GO TO 580
CALL READMS(9,HAV,NR,10)
CALL READMS(9,HBV,NR,11)
CALL READMS(9,HAD,NR,12)
CALL READMS(9,HBD,NR,13)
580 RETURN
ENTRY LOADTVP
II=13+(ITP-1)*9
IF(HCODE.EQ.1) GO TO 585
INUM=II+1
CALL READMS(9,VEL,NR,INUM)
INUM=II+2
CALL READMS(9,DEPTH,NR,INUM)
585 INUM=II+3
CALL READMS(9,TWQ,300,INUM)
INUM=II+4
CALL READMS(9,TQ,NIT,INUM)
INUM=II+5
CALL READMS(9,EWQ,300,INUM)
INUM=II+6
CALL READMS(9,EQ,NIE,INUM)
INUM=II+7
CALL READMS(9,K20,400,INUM)
INUM=II+8
CALL READMS(9,S20,400,INUM)
INUM=II+9
CALL READMS(9,A,NR,INUM)
CONTINUE
RETURN
END

```

```

C=====
  SUBROUTINE PCALC(WQ0)
C=====
  COMMON/APARAM/ALPHA(20),BETA(20,5),GAMMA(20,5),DELTA(20),
  + EPSIL(20,5),ZETA(20)
  COMMON/CTRL/NR,NTP,NWQC,NB,NIT,NIE,IT(15),IE(15),HCODE,
  + HCODE(8),IR,IB,IPP,NCWQC,NNCWQC,NTWQC,NPP
  COMMON/KDATA/K20(20,20),KT(20)/QDATA/Q10K(20),Q10S(20)
  COMMON/SDATA/S20(20,20),ST(20)
  COMMON/BDATA/PN,PP,A(20)
  COMMON/MDATA/LR(20),DA(20),DEPTH(20),VEL(20),BCODE(5),
  + HAV(20),HBV(20),HAD(20),HBD(20)
  DIMENSION WQ0(20)
  REAL KT,K20,LR
  DATA (DELTA(I),I=1,20)/20*0.0/
  DATA ((EPSIL(I,J),I=1,20),J=1,5)/100*0.0/
  DATA (ZETA(I),I=1,20)/20*0.0/
  DOSAT(TEMP)=14.652-0.41022*TEMP+0.007991*TEMP**2
  + -0.00007774*TEMP**3
C
C---- TEMPERATURE PARAMETERS
C
100  GAMMA(1,1)=KT(15)
     IF(GAMMA(1,1).EQ.0.0) GO TO 150
     ALPHA(1)=ST(8)/GAMMA(1,1)
     BETA(1,1)=WQ0(1)-ALPHA(1)
     GO TO 200
150  DELTA(1)=ST(8)
     ALPHA(1)=WQ0(1)
     BETA(1,1)=0.0
C
C---- BOD PARAMETERS
C
200  GAMMA(2,1)=KT(4)+KT(5)
     IF(GAMMA(2,1).EQ.0.0) GO TO 220
     ALPHA(2)=ST(1)/GAMMA(2,1)
     BETA(2,1)=WQ0(2)-ALPHA(2)
     GO TO 300
220  DELTA(2)=ST(1)
     ALPHA(2)=WQ0(2)
     BETA(2,1)=0.0
C
C---- TOTAL SUSPENDED SOLIDS PARAMETERS
C
300  GAMMA(3,1)=KT(13)
     IF(DEPTH(IR).GT.0.0) GAMMA(3,1)=GAMMA(3,1)+KT(14)/DEPTH(IR)
     IF(GAMMA(3,1).EQ.0.0) GO TO 340
310  ALPHA(3)=ST(7)/GAMMA(3,1)
     BETA(3,1)=WQ0(3)-ALPHA(3)
     GO TO 400
340  DELTA(3)=ST(7)
     ALPHA(3)=WQ0(3)
     BETA(3,1)=0.0
C
C---- AMMONIA PARAMETERS
C
400  GAMMA(4,1)=GAMMA(3,1)
     GAMMA(4,2)=KT(7)
     IF(GAMMA(4,1).EQ.0.0) GO TO 430
     (GAMMA(4,2).EQ.0.0) GO TO 460
     ALPHA(4)=(KT(6)*PN*ALPHA(3)+ST(2)-KT(1)*A(IR))/GAMMA(4,2)
     IF(GAMMA(4,1).EQ.GAMMA(4,2)) GO TO 410
     BETA(4,1)=(KT(6)*PN*BETA(4,1))/(GAMMA(4,2)-GAMMA(4,1))
     GO TO 490
410  BETA(4,1)=0.0
     EPSIL(4,1)=KT(6)*PN*ALPHA(3)
     GO TO 490

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430 IF(GAMMA(4,1).EQ.GAMMA(4,2)) GO TO 450
ALPHA(4)=(KT(6)*PN*ALPHA(3)+ST(2)-KT(1)*A(IR))/GAMMA(4,2)
BETA(4,1)=0.0
ZETA(4)=KT(6)*PN*ST(7)/2
GO TO 490
460 BETA(4,1)=KT(6)*PN*ALPHA(3)/GAMMA(4,1)
ALPHA(4)=0.0
DELTA(4)=ST(2)-KT(1)*A(IR)+(KT(6)*PN*ST(7))/GAMMA(3,1)
GO TO 500
480 DELTA(4)=ST(2)
ALPHA(4)=WQO(4)
BETA(4,1)=0.0
BETA(4,2)=0.0
GO TO 500
490 BETA(4,2)=WQO(4)-ALPHA(4)-BETA(4,1)
C
C---- NITRITE PARAMETERS
C
500 GAMMA(5,1)=GAMMA(3,1)
GAMMA(5,2)=GAMMA(4,2)
GAMMA(5,3)=KT(8)
IF(GAMMA(5,3).EQ.0.0) GAMMA(5,3)=.00001
ALPHA(5)=GAMMA(4,2)*ALPHA(4)/GAMMA(5,3)
IF(GAMMA(5,3).EQ.GAMMA(5,1)) GO TO 510
BETA(5,1)=GAMMA(4,2)*BETA(4,1)/(GAMMA(5,3)-GAMMA(5,1))
502 IF(GAMMA(5,3).EQ.GAMMA(5,2)) GO TO 520
BETA(5,2)=GAMMA(5,2)*BETA(4,2)/(GAMMA(5,3)-GAMMA(5,2))
506 BETA(5,3)=WQO(5)-ALPHA(5)-BETA(5,1)-BETA(5,2)
GO TO 600
510 BETA(5,1)=0.0
EPSIL(5,1)=GAMMA(4,2)*BETA(4,1)
GO TO 502
520 BETA(5,2)=0.0
EPSIL(5,2)=GAMMA(5,2)*BETA(4,2)
GO TO 506
C
C---- NITRATE PARAMETERS
C
600 GAMMA(6,1)=GAMMA(3,1)
IF(GAMMA(6,1).EQ.0.0) GAMMA(6,1)=.00001
GAMMA(6,2)=GAMMA(4,2)
IF(GAMMA(6,2).EQ.0.0) GAMMA(6,2)=.00001
GAMMA(6,3)=GAMMA(5,3)
ALPHA(6)=WQO(6)
BETA(6,1)=GAMMA(5,3)*BETA(5,1)/GAMMA(6,1)
BETA(6,2)=GAMMA(5,3)*BETA(5,2)/GAMMA(6,2)
BETA(6,3)=BETA(5,3)
DELTA(6)=KT(8)*ALPHA(5)+ST(3)-KT(2)*A(IR)
C
C---- PHOSPHATE PARAMETERS
C
700 GAMMA(7,1)=GAMMA(3,1)
GAMMA(7,2)=KT(11)
IF(GAMMA(7,1).EQ.0.0) GO TO 730
IF(GAMMA(7,2).EQ.0.0) GO TO 760
ALPHA(7)=(KT(10)*PP*ALPHA(3)+ST(5)-KT(3)*A(IR))/KT(11)
IF(GAMMA(7,1).EQ.GAMMA(7,2)) GO TO 710
BETA(7,1)=(KT(10)*PP*BETA(3,1))/(GAMMA(7,2)-GAMMA(3,1))
GO TO 790
710 BETA(7,1)=0.0
EPSIL(7,1)=KT(10)*PP*ALPHA(3)
GO TO 790
730 IF(GAMMA(7,1).EQ.GAMMA(7,2)) GO TO 730
ALPHA(7)=(KT(10)*PP*ALPHA(3)+ST(5)-KT(3)*A(IR))/KT(11)
BETA(7,1)=0.0
ZETA(7)=KT(10)*PP*ST(7)/2
GO TO 790
760

```

```

700 DELTA(7,1)=DELTA(7,1)+PP*ALPHA(7)/GAMMA(7,1)
    ALPHA(7)=0.0
    DELTA(7)=ST(7)-KT(3)*A(IR)+(KT(10)*PP*ST(7))/GAMMA(7,1)
    GO TO 300
730 DELTA(7)=ST(7)
    ALPHA(7)=WQO(7)
    BETA(7,1)=0.0
    BETA(7,2)=0.0
    GO TO 800
790 BETA(7,2)=WQO(7)-ALPHA(7)-BETA(7,1)
C
C----- DISSOLVED OXYGEN PARAMETERS
C
800 GAMMA(8,1)=GAMMA(3,1)
    GAMMA(8,2)=GAMMA(5,3)
    GAMMA(8,3)=GAMMA(4,2)
    GAMMA(8,4)=GAMMA(2,1)
    GAMMA(8,5)=KT(12)
    ALPHA(8)=(KT(4)*ALPHA(2)+3.43*KT(7)*ALPHA(4)+1.14*KT(3)*ALPHA(5)-
+ ST(5)+ST(6))/KT(12)
    IF(GAMMA(8,5).EQ.GAMMA(3,1)) GO TO 810
    BETA(8,1)=(3.43*GAMMA(4,2)*BETA(4,1)+1.14*GAMMA(5,3)*BETA(5,1))/
+ (GAMMA(8,5)-GAMMA(3,1))
802 IF(GAMMA(8,5).EQ.GAMMA(5,3)) GO TO 820
    BETA(8,2)=(1.14*GAMMA(5,3)*BETA(5,3))/(GAMMA(8,5)-GAMMA(5,3))
804 IF(GAMMA(8,5).EQ.GAMMA(4,2)) GO TO 830
    BETA(8,3)=(3.43*GAMMA(4,2)*BETA(5,2))/(GAMMA(8,5)-GAMMA(4,2))
806 IF(GAMMA(8,5).EQ.GAMMA(2,1)) GO TO 840
    BETA(8,4)=(GAMMA(2,1)-KT(5))*BETA(2,1)/(GAMMA(8,5)-GAMMA(2,1))
808 BETA(8,5)=(DOSAT(WQO(1))-WQO(8))-ALPHA(8)-BETA(8,1)-BETA(8,2)
+ -BETA(8,3)-BETA(8,4)
    GO TO 900
810 BETA(8,1)=0.0
    EPSIL(8,1)=3.43*GAMMA(4,2)*BETA(4,1)+1.14*GAMMA(5,3)*BETA(5,1)
    GO TO 804
820 BETA(8,2)=0.0
    EPSIL(8,2)=1.14*GAMMA(5,3)*BETA(5,1)
    GO TO 806
830 BETA(8,3)=0.0
    EPSIL(8,3)=3.43*GAMMA(4,2)*BETA(4,1)
    GO TO 808
840 BETA(8,4)=0.0
    EPSIL(8,4)=GAMMA(2,1)-KT(5)*BETA(2,1)
    GO TO 808
C
C----- CONSERVATIVE WQ CONSTITUENTS
C
900 IF(NCWQC.LT.1) GO TO 950
    DO 930 I=1,NCWQC
        ALPHA(8+I)=WQO(8+I)
        BETA(8+I,1)=0.0
        GAMMA(8+I,1)=0.0
930 DELTA(8+I)=ST(8+I)
C
C----- NONCONSERVATIVE WQ CONSTITUENTS
C
950 IF(NNCWQC.LT.1) GO TO 999
    DO 970 I=1,NNCWQC
        GAMMA(8+NCWQC+I,1)=KT(8+NCWQC+I)
        IF(GAMMA(8+NCWQC+I,1).EQ.0.0) GO TO 960
        ALPHA(8+NCWQC+I)=ST(8+NCWQC+I)/GAMMA(8+NCWQC+I,1)
        BETA(8+NCWQC+I)=WQO(8+NCWQC+I)-ALPHA(8+NCWQC+I)
        GO TO 970
960 DELTA(8+NCWQC+I)=ST(8+NCWQC+I)
    ALPHA(8+NCWQC+I)=WQO(8+NCWQC+I)
    BETA(8+NCWQC+I,1)=0.0
970 CONTINUE
C
C
C
999 RETURN
    END

```

```

C=====
SUBROUTINE RCALC(TEMP)
C=====
COMMON/CNTRL/NR,NTP,NWQC,NB,NIT,NIE,IT(15),IE(15),HCODE,
+ MCODE(3),IR,IB,IPP,NCWQC,NNCWQC,NTWQC,NPP
COMMON/KDATA/K20(20,20),KT(20)/QDATA/Q10K(20),Q10S(20)
COMMON/SDATA/S20(20,20),ST(20)
REAL K20,KT

C
C-----> Q10 CONVERSIONS OF RATE CONSTANTS
C
      NK=16+NNCWQC
      NS=8+NCWQC+NNCWQC
      DO 100 I=1,NK
100    KT(I)=K20(IR,I)*Q10K(I)**(TEMP-20)
      DO 200 I=1,NS
200    ST(I)=S20(IR,I)*Q10S(I)**(TEMP-20)
C
      RETURN
      END
C=====
SUBROUTINE SIMWQ(WQ,Q,X)
C=====
COMMON/CNTRL/NR,NTP,NWQC,NB,NIT,NIE,IT(15),IE(15),HCODE,
+ MCODE(3),IR,IB,IPP,NCWQC,NNCWQC,NTWQC,NPP
COMMON/MDATA/LR(20),DA(20),DEPTH(20),VEL(20),BCODE(5),
+ HAV(20),HBV(20),HAD(20),HBD(20)
COMMON/IWQC/TWQ(15,20),ZWQ(15,20),TQ(15),EQ(15),
+ BWQ(5,20),BQ(5)
DIMENSION WQ(20),WQ(200,20),Q(20),Q(200),X(200,3)
REAL LR
INTEGER HCODE

C
C-----> CALCULATE DISTANCE BETWEEN PROFILE POINTS FOR OUTPUT
C
      TLR=0.0
      DO 10 IR=1,NR
10    TLR=TLR+LR(IR)
      XINC=0.1
      DO 20 I=1,5
20    NPP=TLR/XINC+2*NR
      IF(NPP.LE.200) GO TO 25
      XINC=I*0.5
C
C-----> CALCULATE WATER QUALITY PROFILE FOR A FIXED TIME PERIOD
C
25    IPP=0
      XIB=NB
      XLAST=0.0
100   DO 500 IR=1,NR
      XIR=IR
      XWR=0.0
      IPP=IPP+1

C
      CALL DILUTE(WQ,WQ,Q)
C
      DO 110 IWQC=1,NTWQC
110   WQ(IPP,IWQC)=WQ(IWQC)
      Q(IPP)=Q(IR)
      X(IPP,1)=XLAST
      X(IPP,2)=XIR
      X(IPP,3)=XIB

C
      IF(HCODE.LT.1) GO TO 150
      VEL(IR)=HAV(IR)*Q(IR)**HBV(IR)
      DEPTH(IR)=HAD(IR)*Q(IR)**HBD(IR)

C
150   CALL RCALC(WQ(1))
C

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      CALL PCALC(WQ)
C
200  IPP=IPP+1
      XWR=XWR+XINC
      IF(XWR.GE.LR(IR)) GO TO 300
      X(IPP,1)=XLAST+XWR
      X(IPP,2)=XIR
      X(IPP,3)=XIB
      Q(IPP)=QO(IR)
      TTWR=XWR/VEL(IR)
C
      CALL ASOLN(TTWR,WQ)
C
      Q(IPP)=QO(IR)
      GO TO 200
300  XWR=LR(IR)
      X(IPP,1)=XLAST+XWR
      X(IPP,2)=XIR
      X(IPP,3)=XIB
      Q(IPP)=QO(IR)
      TTWR=XWR/VEL(IR)
C
      CALL ASOLN(TTWR,WQ)
3
      IF(NB.LT.1.OR.XIB.EQ.0.) GO TO 500
      DO 400 I=1,NB
      IEND=BCODE(I)*100.-INT(BCODE(I))*100.
      IF(IEND.NE.IR) GO TO 400
      XIB=XIB-1
      BQ(I)=Q(IPP)
      DO 350 IC=1,NTWQC
350  BWQ(I,IC)=WQ(IPP,IC)
400  CONTINUE
500  XLAST=X(IPP,1)
      NPP=IPP
      RETURN
      END
C=====
      SUBROUTINE WQOUTMS(WQ,Q,X,ITP)
C=====
      COMMON/CTRL/NR,NTP,NWQC,NB,NIT,NIS,IT(15),IE(15),HCODE,
+ MCODE(8),IR,IB,IPP,NCWQC,NWCWQC,NTWQC,NPP
      INTEGER CNAME,TITLE,HCODE
      IF(ITP.GT.1) GO TO 10
      CALL OPENMS(33,QINDEX,277,0)
10  IREC=23*(ITP-1)+1
      CALL WRITMS(33,NPP,1,IREC)
      IREC=23*(ITP-1)+2
      CALL WRITMS(33,X,600,IREC)
      IREC=23*(ITP-1)+3
      CALL WRITMS(33,Q,NPP,IREC)
      DO 30 IC=1,NTWQC
      DO 20 IP=1,NPP
20  ATT(IP)=WQ(IP,IC)
      IREC=23*(ITP-1)+IC+3
30  CALL WRITMS(33,ATT,NPP,IREC)
      IF(ITP.LT.NTP) GO TO 100
      CALL CLOGMS(33)
100  RETURN
      END

```

```

PROGRAM WQTEST(INPUT,OUTPUT,TAPE3=INPUT,TAPE4=OUTPUT,
+ TAPE9,TAPE33)
COMMON/NAMES/TITLE(8),CNAME(20)
COMMON/CNTRL/NR,NTP,NWQC,NB,NIT,NIE,IT(15),IE(15),
+ MCODE(8),NCWQC,NNCWQC,NTWQC,NPP
COMMON/MDATA/LR(20),DA(20),BCODE(15)
DIMENSION X(200,3),WQ(240),PTS(2),XWQSV(20,12),UWQS(20,12),
+ LWQS(20,12),XX(240),IATTS(20)
REAL LR,LWQS,LS
INTEGER TITLE,CNAME
DATA (CNAME(I),I=1,8)/"TEMP","BOD5","TSS","NH3","NO2","NO3",
+ "PO4","D.O."/
DATA XWQSV/240*0.0/,UWQS/240*9999./,LWQS/240*0.0/,IOPEN/0/
PRINT*," "
PRINT*," "
PRINT*," "
PRINT*," "
PRINT*," "
PRINT*,"+=====+"
PRINT*,"+ THIS RTV ROUTINE TESTS FOR VIOLATIONS OF AMBIENT + "
PRINT*,"+ WATER QUALITY STANDARDS AND QUANTIFIES THE + "
PRINT*,"+ SPACIAL EXTENT OF THESE VIOLATIONS + "
PRINT*,"+=====+"
PRINT*," "
C-----> READ DATA FROM 'TAPE9'
CALL DATINMS
C-----> DESIGNATE ATTRIBUTES OF INTEREST
PRINT*,"-----"
PRINT*," ",(TITLE(I),I=1,8)
PRINT*,"-----"
PRINT*," "
PRINT*," INDICATE WHICH WATER QUALITY ATTRIBUTE(S) ARE"
PRINT*," TO BE ANALYZED."
DO 40 I=1,4
PRINT*," ",I,") ",CNAME(I)," ",I+4,") ",CNAME(I+4)
40 IF(NTWQC.LE.8) GO TO 45
DO 42 I=9,NTWQC
PRINT*," ",I,") ",CNAME(I)
42 PRINT*," RESPOND WITH THE TOTAL NUMBER OF ATTRIBUTES "
PRINT*," FOLLOWED BY THE APPROPRIATE INDEX NUMBERS"
45 PRINT*," ",
READ(3,*) NATTS,(IATTS(I),I=1,NATTS)
IF(EOF(3)) 999,46
46 IF(NATTS.GT.NTWQC) GO TO 45
PRINT*," "
C-----> SPECIFY EXISTING WATER QUALITY STANDARDS
PRINT*,"-----"
PRINT*," INPUT LOCAL AMBIENT WATER QUALITY STANDARDS "
PRINT*,"-----"
PRINT*," "
PRINT*," "
ITP=1
52 PRINT*," "
PRINT*," TIME PERIOD NO. ",ITP
DO 59 IC=1,NATTS
IWQC=IATTS(IC)
PRINT*," "
PRINT*," ",CNAME(IWQC)
PRINT*," UPPER LEVEL STANDARD ",
READ(3,*) UWQS(IWQC,ITP)
IF(EOF(3))56,56

```

```

50  PRINT*, "      LOWER LEVEL STANDARD ",
    READ(3,*) LWQS(IWQC,ITP)
    IF(EOF(3)) 59,59
59  CONTINUE
    IF(ITP.EQ.1) GO TO 60
    ITP=ITP+1
    IF(ITP.GT.NTP) GO TO 69
    GO TO 52
60  PRINT*, " "
    PRINT*, "      STANDARDS CONSTANT OVER TIME (Y OR N)",
    READ(3,940) IANS
    IF(EOF(3)) 60,61
61  IF(IANS.EQ."N") GO TO 52
    DO 68 ITP=2,NTP
    DO 66 IC=1,NATTS
    IWQC=IATTS(IC)
    UWQS(IWQC,ITP)=UWQS(IWQC,1)
66  LWQS(IWQC,ITP)=LWQS(IWQC,1)
68  CONTINUE
C-----> READ DATA FROM 'TAPE33'
69  DO 100 ITP=1,NTP
    DO 99 IC=1,NATTS
    IWQC=IATTS(IC)
    CALL INWQMS(IWQC,ITP,X,WQ,NPP)
    DO 90 IPP=1,NPP
    IF(IPP.EQ.1) GO TO 90
    IF(WQ(IPP).LT.UWQS(IWQC,ITP).AND.WQ(IPP).GT.LWQS(IWQC,ITP))
    * GO TO 90
    XWQSV(IC,ITP)=XWQSV(IC,ITP)+(X(IPP,1)-X(IPP-1,1))
90  CONTINUE
99  CONTINUE
100 CONTINUE
    PRINT*, " "
    PRINT*, " "
    PRINT*, " "
    PRINT*, "===== "
    PRINT*, "      REPORT ON WATER QUALITY VIOLATIONS"
    PRINT*, "===== "
    PRINT*, " "
    PRINT*, " "
    PRINT*, "      1) TOTAL RIVER MILES IN VIOLATION OF STANDARDS."
    PRINT*, " "
    PRINT*, " "
    PRINT*, "      TIME PERIOD"
    PRINT*, "      ATTRIBUTE      1      2      3      4      5      6"
    PRINT*, "      -----      ---      ---      ---      ---      ---      ---"
    DO 300 IC=1,NATTS
    IWQC=IATTS(IC)
    NEND=6
    IF(NTP.LT.6) NEND=NTP
    PRINT(4,930) CNAME(IWQC),(XWQSV(IC,J),J=1,NEND)
300 CONTINUE
    IF(NTP.LE.6) GO TO 399
    PRINT*, " "
    CALL PAUSE
    PRINT*, " "
    PRINT*, "      TIME PERIOD"
    PRINT*, "      ATTRIBUTE      7      8      9     10     11     12"
    PRINT*, "      -----      ---      ---      ---      ---      ---      ---"
    DO 310 IC=1,NATTS
    IWQC=IATTS(IC)
    PRINT(4,930) CNAME(IWQC),(XWQSV(IC,J),J=6,NTP)
310 CONTINUE
    PRINT*, " "
    PRINT*, " "
    PRINT*, " "
    CALL PAUSE

```

```

C-----> ASK FOR GRAPHICAL OUTPUT
399 PRINT*, " "
    PRINT*, " "
    PRINT*, " "
    PRINT*, " DO YOU WANT A GRAPHICAL OUTPUT FOR ANY ATTRIBUTE"
400 PRINT*, " PROFILES (ANS: YES OR NO)",
    READ(3,940) IANS
    IF(IANS.NE."Y".AND.IANS.NE."N") GO TO 400
    IF(IANS.EQ."N") GO TO 899
    CALL USTART
410 CALL UBELL
    PRINT*, " "
    PRINT*, " ATTRIBUTE NUMBER ",
    READ(3,*) IWQC
    IF(EOF(3)) 410,411
411 IF(IWQC.GT.NTWQC) GO TO 410
420 PRINT*, " "
    PRINT*, " TIME PERIOD ",
    READ(3,*) ITP
    IF(EOF(3)) 420,421
421 IF(ITP.GT.NTP) GO TO 420
    CALL INWQMS(IWQC,ITP,X,WQ,NPP)
    DO 430 IC=1,NATTS
    IF(IATTS(IC).NE.IWQC) GO TO 430
    US=UWQS(IWQC,ITP)
    LS=LWQS(IWQC,ITP)
    GO TO 431
430 CONTINUE
431 IF(US.LT.9999.) GO TO 460
    WQ(NPP+1)=LS
    WQ(NPP+2)=LS
    GO TO 470
460 WQ(NPP+1)=US
    WQ(NPP+2)=US
470 DO 479 I=1,NPP
479 XX(I)=X(I,1)
    XX(NPP+1)=0.0
    XX(NPP+2)=XX(NPP)
    PTS(1)=NPP
    PTS(2)=2
    PRINT(4,910) CNAME(IWQC),ITP
    CALL GOPLOT1(XX,WQ,PTS,IWQC)
    PRINT*, " "
    PRINT*, " "
    PRINT*, " "
    PRINT*, " PLOT ",CNAME(IWQC)," FOR ANOTHER TIME PERIOD ",
480 READ(3,940) IANS
    IF(EOF(3)) 480,481
481 IF(IANS.NE."Y".AND.IANS.NE."N") GO TO 480
    IF(IANS.EQ."Y") GO TO 420
    PRINT*, " PLOT ANOTHER WATER QUALITY ATTRIBUTE ",
490 READ(3,940) IANS
    IF(EOF(3)) 490,491
491 IF(IANS.NE."Y".AND.IANS.NE."N") GO TO 490
    IF(IANS.EQ."Y") GO TO 410
    CALL UEND
940 FORMAT(1A1)
910 FORMAT(25X,1A5," : TIME PERIOD NO. ",1I2)
930 FORMAT(4X,1A5,9X,6(1F5.1,2X))
899 PRINT*, " "
    PRINT*, " "
    PRINT*, " "
    PRINT*, " "
    PRINT*, " "
999 PRINT*, " "
    PRINT*, "=====
    PRINT*, " THIS CONCLUDES 'WQRTV'. YOU MAY EXECUTE MORE"
    PRINT*, " RTV ROUTINES NOW, BEGIN A MITIGATION"
    PRINT*, " LOOP OR SIGNOFF."
    PRINT*, "=====
    STOP
    END

```

```

SUBROUTINE DATINMS
COMMON/NAMES/TITLE(8),CNAME(20)
COMMON/CNTRL/NR,NTP,NWQC,NB,NIT,NIE,IT(15),IE(15),
* HCODE(8),NCWQC,NNCWQC,NTWQC,NPP
COMMON/MOATA/LR(20),DA(20),BCODE(15)
REAL LR
INTEGER TITLE,HCODE,CNAME
INTEGER DINDEX(125),CNTRLS(8)
C-----> UNLOAD DATA FROM MASS STORAGE FILE
CALL OPENMS(9,DINDEX,125,0)
CALL READMS(9,TITLE,8,1)
CALL READMS(9,CNTRLS,8,2)
NR=CNTRLS(1)
NTP=CNTRLS(2)
NCWQC=CNTRLS(3)
NNCWQC=CNTRLS(4)
HCODE=CNTRLS(5)
NB=CNTRLS(6)
NIT=CNTRLS(7)
NIE=CNTRLS(8)
NWQC=8
NK=16+NNCWQC
NS=8+NNCWQC+NCWQC
NTWQC=8+NCWQC+NNCWQC
NAATTS=NCWQC+NNCWQC
IF(NAATTS.LE.0) GO TO 570
CALL READMS(9,CNAME,NTWQC,4)
570 CALL READMS(9,BCODE,NB,5)
CALL READMS(9,IT,NIT,6)
CALL READMS(9,IE,NIE,7)
CALL READMS(9,LR,NR,8)
CALL READMS(9,DA,NR,9)
RETURN
END
SUBROUTINE GOPLOT1(X,Y,PTS,IWQC)
COMMON/NAMES/TITLE(8),CNAME(20)
INTEGER TITLE,CNAME,OPTS(2)
DIMENSION X(240),Y(240),PTS(2)
DATA OPTS/"LO","DS"/
CALL UDIMEN(7.,5.25)
CALL USET("EDGEAXES")
CALL UPSET("CHARACTER","+")
CALL USET("XBOTH")
CALL USET("YBOTH")
CALL UPSET("XLABEL","DISTANCE DOWNSTREAM (MILES);")
CALL UPSET("YLABEL","CONC. (MG/L);")
CALL UBELL
CALL UPLLOT(X,Y,2.,PTS,OPTS)
CALL UFLUSH
CALL UPAUSE
CALL UERASE
RETURN
END
SUBROUTINE PAUSE
PRINT*,"CONTINUE",
READ(3,*) DUM
IF(EOF(3))10,10
10 CONTINUE
RETURN
END

```

```

SUBROUTINE INWQMS(IATT,ITP,X,ATT,NPP)
DIMENSION WQ(200),X(200,3)
INTEGER QINDEX(277)
IF(IOPEN.GT.0) GO TO 10
CALL OPENMS(33,QINDEX,277,0)
10  IREC1=23*(ITP-1)+1
    CALL READMS(33,NPP,1,IREC1)
    IREC2=23*(ITP-1)+2
    CALL READMS(33,X,600,IREC2)
    IREC3=23*(ITP-1)+3+IATT
    CALL READMS(33,ATT,NPP,IREC3)
    IOPEN=1
    RETURN
END
/

```

type,ssirtv/g

```

PROGRAM SIMAIN(INPUT,OUTPUT,TAPE1=INPUT,TAPE2=OUTPUT,TAPE9,
+ TAPE33)
COMMON/NAMES/TITLE(8),CNAME(20)
COMMON/CNTRL/NR,NTP,NWQC,NB,NIT,NIE,IT(15),IE(15),
+ MCODE(3),NCWQC,NNCWQC,NTWQC,NPP
COMMON/MDATA/BCODE(15)
DIMENSION X(200,3),BOD5(200),SI(200,12),XSI(10,12),SIT(7)
INTEGER TITLE,CNAME,SNAME(7,2)
DATA XSI/120*0.0/,SIT/-.5,1.5,2.5,3.5,4.5,5.5,6.5/
DATA SNAME/"PUREST W","CLEAN WA","MILD POL","POLLUTED",
+ "HEAVILY ","RAW SEWA","SEPTIC C","ATER ",
+ "TER ","LUTION ","","POLLUTED",
+ "GE ","ONDITION"/
CALL DATINMS
DO 100 ITP=1,NTP
CALL INWQMS(2,ITP,X,BOD5,NPP)
DO 90 IPP=1,NPP
IF(BOD5(ITP).GT.50.) GO TO 20
SI(IPP,ITP)=(1.0747*BOD5(IPP)-0.4729)/(0.90408+0.218*BOD5(IPP))
GO TO 21
20 SI(IPP,ITP)=(0.0189*BOD5(IPP)+7.938)/(1.882-0.0021*BOD5(IPP))
21 IF(IPP.EQ.1) GO TO 90
DO 50 I=1,7
IF(SI(IPP,ITP).GT.SIT(I)) GO TO 50
XSI(I,ITP)=XSI(I,ITP)+X(IPP,1)-X(IPP-1,1)
GO TO 90
50 CONTINUE
90 CONTINUE
100 CONTINUE
PRINT*," "
PRINT*," ====="
PRINT*," SAPROBIC INDEX ANALYSIS"
PRINT*," FOR"
PRINT*," ",(TITLE(I),I=1,4)
PRINT*," ",(TITLE(I),I=5,8)
PRINT*," ====="
PRINT*," "
PRINT*," "
NEND=6
IF(NTP.LT.6)NEND=NTP
PRINT*," WATER QUALITY RIVER MILES IN TIME PERIOD"
PRINT*," DESIGNATION 1 2 3 4 5 6"
PRINT*," -----"
+ " -----"
PRINT*," "
DO 150 I=1,7
PRINT(2,901) (SNAME(I,J),J=1,2),(XSI(I,ITP),ITP=1,NEND)
150 CONTINUE
PRINT*," -----"
+ " -----"
PRINT*," "
IF(NTP.LE.6) GO TO 200
NEND=12
IF(NTP.LT.12)NEND=NTP
NEND=6
PRINT*," WATER QUALITY RIVER MILES IN TIME PERIOD"
PRINT*," DESIGNATION 7 8 9 10 11 12"
PRINT*," -----"
+ " -----"
PRINT*," "
DO 160 I=1,7
PRINT(2,901) (SNAME(I,J),J=1,2),(XSI(I,ITP),ITP=1,NEND)
160 CONTINUE
PRINT*," -----"
+ " -----"

```

```

200  CONTINUE
    PRINT*, " "
    PRINT*, "      DO YOU WANT FURTHER QUANTIFICATION OF THIS"
201  PRINT*, "      (ANS: YES OR NO)",
    READ(1,902) IANS
    IF(EOF(1)) 201,202
202  IF(IANS.NE."N".AND.IANS.NE."Y") GO TO 201
    IF(IANS.EQ."N") GO TO 300
    PRINT*, " "
    PRINT*, " "
    PRINT*, "      INPUT TIME PERIOD OF INTEREST ",
210  READ(1,*) ITP
    IF(EOF(1)) 210,211
211  IF(ITP.GT.NTP) GO TO 210
    PRINT*, " "
    PRINT*, "      THIS SECTION ISN'T OPERATIONAL YET, BUT THE"
    PRINT*, "      OUTPUT WILL BE LOCATIONS OF ZONES IN EACH"
    PRINT*, "      WATER QUALITY DESIGNATION FOR THE SPECIFIED"
    PRINT*, "      TIME PERIOD."
300  CONTINUE
901  FORMAT(4X,2A8,3X,6(1X,1F5.1))
902  FORMAT(1A1)
    STOP
    END
C=====
    SUBROUTINE DATINMS
C=====
    COMMON/NAMES/TITLE(8),CNAME(20)
    COMMON/CNTRL/NR,NTP,NWQC,NB,NIT,NIE,IT(15),IE(15),
    + MCODE(8),NCWQC,NNCWQC,NTWQC,NPP
    COMMON/MDATA/LR(20),DA(20),BCODE(15)
    REAL LR
    INTEGER TITLE,HCODE,CNAME
    INTEGER DINDEXT(125),CNTRLS(8)
C-----> UNLOAD DATA FROM MASS STORAGE FILE
    CALL OPENMS(9,DINDEX,125,0)
    CALL READMS(9,TITLE,8,1)
    CALL READMS(9,CNTRLS,8,2)
    NR=CNTRLS(1)
    NTP=CNTRLS(2)
    NCWQC=CNTRLS(3)
    NNCWQC=CNTRLS(4)
    HCODE=CNTRLS(5)
    NB=CNTRLS(6)
    NIT=CNTRLS(7)
    NIE=CNTRLS(8)
    NWQC=8
    NK=16+NNCWQC
    NS=8+NNCWQC+NCWQC
    NTWQC=8+NCWQC+NNCWQC
    NAATTS=NCWQC+NNCWQC
    IF(NAATTS.LE.0) GO TO 570
    CALL READMS(9,CNAME,NTWQC,4)
570  CALL READMS(9,BCODE,NB,5)
    CALL READMS(9,IT,NIT,6)
    CALL READMS(9,IE,NIE,7)
    RETURN
    END

```

```

C=====
      SUBROUTINE INWQMS(IATT,ITP,X,ATT,NPP)
C=====
      DIMENSION WQ(200),X(200,3)
      INTEGER QINDEX(277)
      IF(ITP.GT.1) GO TO 10
      CALL OPENMS(33,QINDEX,277,0)
10    IREC1=23*(ITP-1)+1
      CALL READMS(33,NPP,1,IREC1)
      IREC2=23*(ITP-1)+2
      CALL READMS(33,X,600,IREC2)
      IREC3=23*(ITP-1)+3+IATT
      CALL READMS(33,ATT,NPP,IREC3)
      RETURN
      END

```

```

PROGRAM TUTEST(INPUT,OUTPUT,TAPE3=INPUT,TAPE4=OUTPUT,
+ TAPE9,TAPE33)
COMMON/NAMES/TITLE(8),CNAME(20)
COMMON/CNTRL/NR,NTP,NWQC,NB,NIT,NIE,
+ MCODE(8),NCWQC,NNCWQC,NTWQC,NPP
COMMON/MDATA/LR(20),DA(20),BCODE(15)
DIMENSION X(200,3),WQ(200),PTS(2),TU('0,5,200'),MAXTU(10,5),
+ MEANTU('0,5),SPNAME('0,2),TNAME(10),XX(400),LC50('0,5),
+ ITOX(10),ISP('0),C(400),TOTTU(5,200),ISO(10)
REAL LR,LC50,MAXTU,MEANTU,MAXTTU(5),MEANTTU(5)
INTEGER TITLE,CNAME,TNAME,SPNAME
DATA (CNAME(I),I=1,8)/"TEMP.", "BOD5", "TSS", "NH3", "NO2", "NO3",
+ "PO4", "D.O." /
DATA (SPNAME(1,I),I=1,2)/"FATHEAD MI", "NNOW"
DATA (SPNAME(2,I),I=1,2)/"CARP", " "
DATA (SPNAME(3,I),I=1,2)/"BLUEGILL", " "
DATA (SPNAME(4,I),I=1,2)/"CHANNEL CA", "T"
DATA (SPNAME(5,I),I=1,2)/"LARGEMOUTH", "BASS"
DATA (SPNAME(6,I),I=1,2)/"BROOK TROU", "T"
DATA (SPNAME(7,I),I=1,2)/"RAINBOW TR", "OUT"
DATA (SPNAME(8,I),I=1,2)/"COHO SALMO", "N"
DATA ISO/5*1.5*-1/
DATA TOTTU/'000*0.0/
PRINT*, " "
PRINT*, " "
PRINT*, " "
PRINT*, " "
PRINT*, " "
PRINT*, "+++++ "
PRINT*, " THIS RTV ROUTINE TESTS ENVIRONMENTAL TOXICITY + "
PRINT*, "+++++ "
PRINT*, " "
C-----> READ DATA FROM 'TAPE9'
CALL DATINMS
C-----> DESIGNATE ATTRIBUTES OF INTEREST
PRINT*, "-----"
PRINT*, " ", (TITLE(I),I=1,8)
PRINT*, "-----"
PRINT*, " "
PRINT*, " INDICATE WHICH WATER QUALITY ATTRIBUTE(S) ARE"
PRINT*, " TO BE ANALYZED FOR THEIR TOXIC EFFECTS."
DO 10 I=1,4
10 PRINT*, " ", I, " ", CNAME(I), " ", I+4, " ", CNAME(I+4)
IF(NTWQC.LE.8) GO TO 15
DO 12 I=9,NTWQC
12 PRINT*, " ", I, " ", CNAME(I)
PRINT*, " RESPOND WITH THE TOTAL NUMBER OF TOXICANTS "
PRINT*, " FOLLOWED BY THE APPROPRIATE INDEX NUMBERS"
15 PRINT*, " "
READ(3,*) NTOX, (ITOX(I),I=1,NTOX)
IF(EOF(3)) 999,16
16 IF(NTOX.GT.NTWQC) GO TO 15
DO 18 I=1,NTOX
IF(ITOX(I).LE.NTWQC) GO TO 18
PRINT*, " BAD INPUT; TRY AGAIN!"
GO TO 15
18 TNAME(I)=CNAME(ITOX(I))
PRINT*, " "
20 PRINT*, " "

```

```

PRINT*, "      SPECIFY TARGET SPECIES:"
PRINT*, " "
21 PRINT*, "      DESIGNATE STREAM TYPE (W=WARM WATER,C=COLD WATER) ",
  READ(3,940) ISTRM
  IF(EOF(3)) 21,22
22 IF(ISTRM.NE."C".AND.ISTRM.NE."W") GO TO 21
C SPECIFICATION OF TARGET SPECIES
PRINT*, " "
PRINT*, "      REPRESENTATIVE SPECIES LIST:"
DO 25 I=1,8
  IF(ISTRM.EQ."W".AND.ISO(I).LT.0.OR.
+ ISTRM.EQ."C".AND.ISO(I).GT.0) GO TO 25
PRINT*, "      ",I," ",(SPNAME(I,J),J=1,2)
25 CONTINUE
PRINT*, "      RESPOND WITH NUMBER OF TARGET SPECIES DESIRED AND"
PRINT*, "      WITH THEIR APPROPRIATE INDEX NUMBER(S)."
26 PRINT*, "      ",
  READ(3,*) NSP,(ISP(I),I=1,NSP)
  IF(EOF(3)) 26,30
C SPECIFY LC50'S FOR TARGET SPECIES
30 PRINT*, " "
PRINT*, "      INPUT THE 96 HOUR LC50'S FOR THE FOLLOWING SPECIES"
PRINT*, "      AND POTENTIAL TOXICANTS:"
DO 35 IS=1,NSP
PRINT*, "      ",
PRINT*, "      ",(SPNAME(ISP(IS),J),J=1,2)
DO 33 IT=1,NTOX
PRINT*, "      ",TNAME(IT),
32 READ(3,*) LC50(IT,IS)
  IF(EOF(3)) 32,33
33 CONTINUE
35 CONTINUE
CALL USTART
PRINT*, " "
69 PRINT*, "      SPECIFY TIME PERIOD OF INTEREST ",
70 READ(3,*) ITP
  IF(EOF(3)) 70,71
71 IF(ITP.GT.NTP) GO TO 70
PRINT*, " "
DO 99 IS=1,NSP
DO 95 IT=1,NTOX
SUMTU=0.0
SUMTTU=0.0
MAXTU(IT,IS)=0.
IC=ITOX(IT)
CALL INWQMS(IC,ITP,X,WQ,NPP)
DO 90 IPP=1,NPP
TU(IT,IS,IPP)=WQ(IPP)/LC50(IT,IS)
IF(MAXTU(IT,IS).LT.TU(IT,IS,IPP))MAXTU(IT,IS)=TU(IT,IS,IPP)
TOTTU(IS,IPP)=TOTTU(IS,IPP)+TU(IT,IS,IPP)
90 SUMTU=SUMTU+TU(IT,IS,IPP)
  MEANTU(IT,IS)=SUMTU/NPP
  MAXTTU(IS)=0.0
DO 92 IPP=1,NPP
  IF(MAXTTU(IS).LT.TOTTU(IS,IPP)) MAXTTU(IS)=TOTTU(IS,IPP)
92 SUMTTU=SUMTTU+TOTTU(IS,IPP)
  MEANTTU(IS)=SUMTTU/NPP
95 CONTINUE
99 CONTINUE
PRINT*, " "
PRINT*, " "
PRINT*, " "
PRINT*, "-----"
PRINT*, "      REPORT ON TOXICITY IMPACTS IN TIME PERIOD ",ITP
PRINT*, "-----"

```

AD-A111 947

ILLINOIS UNIV AT URBANA DEPT OF CIVIL ENGINEERING

F/G 13/2

QUANTITATIVE ASSESSMENT OF ENVIRONMENTAL IMPACTS IN THE AQUATIC--ETC(U)

JAN 82 R RIGGINS, E HERRICKS, M J SALE

DACA88-78-R-006

NL

UNCLASSIFIED

CERL-TR-N-114

2 OF 2

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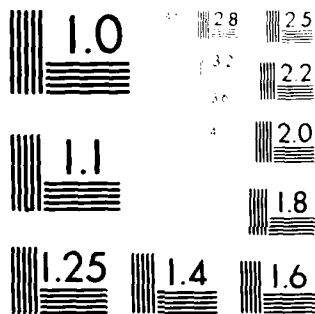
END

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DTIC



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

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PRINT*, " "
PRINT*, " "
PRINT*, "      MAXIMUM AND MEAN (IN PARENTHESES) TOXICITY UNITS"
PRINT*, " "
PRINT*, "      TOXICANT"
NEND=5
IF(NTOX.LT.5) NEND=NTOX
PRINT(3,911) (TNAME(IT),IT=1,NEND)
DO 300 IS=1,NSP
PRINT(4,930) (SPNAME(ISP(IS),J),J=1,2),MAXTTU(IS),
+ (MAXTU(I,IS),I=1,NEND)
PRINT(4,931) MEANTU(IS),(MEANTU(I,IS),I=1,NEND)
300 CONTINUE
PRINT*, " "
PRINT*, " "
PRINT*, " "
C-----> ASK FOR GRAPHICAL OUTPUT
399 PRINT*, " "
PRINT*, " "
PRINT*, " "
PRINT*, "      DO YOU WANT A GRAPHICAL OUTPUT FOR TOXICITY UNITS"
400 PRINT*, "      VS. LOCATION DOWNSTREAM (ANS: YES OR NO)",
READ(3,940) IANS
IF(IANS.NE."X".AND.IANS.NE."N") GO TO 400
IF(IANS.EQ."N") GO TO 899
410 CALL UBELL
PRINT*, " "
PRINT*, "      INPUT TOXICANT NUMBER ",
READ(3,*) IT
IF(EOF(3)) 412,411
411 IF(IT.LE.NTOX) GO TO 420
412 DO 415 IT=1,NTOX
415 PRINT*, "      ",IT," ) ",TNAME(IT)
PRINT*, "      ",
READ(3,*) IT
IF(EOF(3)) 412,411
420 PRINT*, " "
PRINT*, "      INPUT TARGET SPECIES INDEX ",
READ(3,*) IS
IF(EOF(3)) 422,421
421 IF(IS.LE.NSP) GO TO 449
422 DO 425 IS=1,NSP
425 PRINT*, "      ",IS," ) ",(SPNAME(ISP(IS),J),J=1,2)
PRINT*, "      ",
READ(3,*) IS
IF(EOF(3)) 422,426
426 IF(IS.GT.NSP) GO TO 420
449 DO 450 IPP=1,NPP
XX(IPP)=X(IPP,1)
C(IPP)=TU(IT,IS,IPP)
XX(IPP+NPP)=X(IPP,1)
450 C(IPP+NPP)=TOTTU(IS,IPP)
PTS(1)=NPP
PTS(2)=NPP
PRINT*, " "
PRINT*, " "
PRINT*, " "
PRINT(4,910) (SPNAME(ISP(IS),J),J=1,2),TNAME(IT),ITP
PRINT*, "      (T=TOTAL T.U.'S; * =T.U.'S FROM SPECIFIED ATT.)"
CALL GOPL0T1(XX,C,PTS)
PRINT*, " "
PRINT*, " "
PRINT*, " "
PRINT*, "      PLOT TOXICITY IMPACTS FROM ",TNAME(IT)
PRINT*, "      FOR ANOTHER TARGET SPECIES ",

```

```

480 READ(3,940) IANS
IF(EOF(3)) 480,481
481 IF(IANS.NE."Y".AND.IANS.NE."N") GO TO 480
IF(IANS.EQ."Y") GO TO 420
PRINT*,"      PLOT FOR ANOTHER TOXICANT ",
490 READ(3,940) IANS
IF(EOF(3)) 490,491
491 IF(IANS.NE."Y".AND.IANS.NE."N") GO TO 490
IF(IANS.EQ."Y") GO TO 410
PRINT*,"      DO YOU WISH TO CONTINUE ANALYSES FOR ANOTHER TIME"
PRINT*,"      PERIOD (ANS: Y OR N)",
500 READ(3,940) IANS
IF(EOF(3)) 500,501
501 IF(IANS.NE."Y".AND.IANS.NE."N") GO TO 500
PRINT*," "
IF(IANS.EQ."Y") GO TO 69
CALL UEND
903 FORMAT('I2)
910 FORMAT('5X,2A10," ; ",1A5," ; TIME PERIOD ",1I2)
911 FORMAT(3X,"TARGET SPECIES",8X,"TOTAL",3X,5(2X,1A5,2X),/,
+ 'X,20("-"),2X,6("-----",1X))
930 FORMAT('X,2A10,1X,6(1X,1F7.3,1X))
931 FORMAT(22X,5(1X,"(",1F6.3,")")
940 FORMAT(1A1)
899 PRINT*," "
PRINT*," "
PRINT*," "
PRINT*," "
PRINT*," "
999 PRINT*," "
PRINT*,"=====
PRINT*,"      THIS CONCLUDES 'TURTIV'. YOU MAY EXECUTE MORE"
PRINT*,"      RTV ROUTINES NOW, BEGIN A MITIGATION"
PRINT*,"      LOOP OR SIGNOFF."
PRINT*,"=====
STOP
END
SUBROUTINE DATINMS
COMMON/NAMES/TITLE(8),CNAME(20)
COMMON/CNTRL/NR,NTP,NWQC,NB,NIT,NIE,
+ MCODE(8),NCWQC,NNCWQC,NTWQC,NPP
COMMON/MDATA/LR(20),DA(20),BCODE(15)
REAL LR
INTEGER TITLE,HCODE,CNAME
INTEGER DINDEX(125),CNTRLS(8)
C-----> UNLOAD DATA FROM MASS STORAGE FILE
CALL OPENMS(9,DINDEX,125,0)
CALL READMS(9,TITLE,8,1)
CALL READMS(9,CNTRLS,8,2)
NR=CNTRLS(1)
NTP=CNTRLS(2)
NCWQC=CNTRLS(3)
NNCWQC=CNTRLS(4)
HCODE=CNTRLS(5)
NB=CNTRLS(6)
NIT=CNTRLS(7)
NIE=CNTRLS(8)
NWQC=8
NK=16+NNCWQC
NS=8+NNCWQC+NCWQC
NTWQC=8+NCWQC+NNCWQC
NAATTS=NCWQC+NNCWQC
IF(NAATTS.LE.0) GO TO 570
CALL READMS(9,CNAME,NTWQC,4)
570 CALL READMS(9,BCODE,NB,5)
CALL READMS(9,IT,NIT,6)
CALL READMS(9,IE,NIE,7)

```

```

CALL READMS(9,LR,NR,8)
CALL READMS(9,DA,NR,9)
RETURN
END
SUBROUTINE GOPLOT1(X,Y,PTS)
COMMON/NAMES/TITLE(8),CNAME(20)
INTEGER TITLE,CNAME,OPTS(2)
DIMENSION X(400),Y(400),PTS(2)
DATA OPTS/"L*","LT"/
CALL UDIMEN(7.5,5.20)
CALL USET("EDGEAXES")
CALL UPSET("CHARACTER",".")
CALL USET("XBOTH")
CALL USET("YBOTH")
CALL UPSET("XLABEL","DISTANCE DOWNSTREAM (MILES);")
CALL UPSET("YLABEL","TOX. UNITS;")
CALL UBELL
CALL UPLOT(X,Y,2.,PTS,OPTS)
CALL UFLUSH
CALL UPAUSE
CALL UERASE
RETURN
END
SUBROUTINE PAUSE
PRINT*,"CONTINUE",
READ(3,*) DUM
IF(EOF(3))10,10
CONTINUE
RETURN
END
SUBROUTINE INWQMS(IATT,ITP,X,ATT,NPP)
DIMENSION WQ(200),X(200,3)
INTEGER QINDEX(277)
IF(IOPEN.GT.0) GO TO 10
CALL OPENMS(33,QINDEX,277,0)
10 IREC1=23*(ITP-1)+1
CALL READMS(33,NPP,1,IREC1)
IREC2=23*(ITP-1)+2
CALL READMS(33,X,600,IREC2)
IREC3=23*(ITP-1)+3+IATT
CALL READMS(33,ATT,NPP,IREC3)
IOPEN=1
RETURN
END
/

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