

**EPA 440-9-73-004**

AUTO-QUAL MODELLING SYSTEM

Supplement I

MODIFICATION FOR NON-POINT SOURCE LOADINGS

by

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## I. INTRODUCTION

The purpose of this supplement is to document some changes and additions made to the "AUTØ-QUAL MODELLING SYSTEM" [1]. Only the additions and changes to the original AUTØ-QUAL models will be discussed here, therefore, it is essential that the reader first read technical Report No. 54 [1] before reading this report.

The major additions to the original models are the inclusion of non-point sources and loads into the solution. These additions represent a new capability of the system, but do not change the original operating procedures in any way. Thus if one made the changes to the original source decks that are presented here, one could continue to use the models in exactly the same manner as before, even if the new options were not used.

No attempt is made here to present methods for catagorizing and quantifying non-point source flows and loads. Instead the method of inclusion of these data into the existing models is presented. The user may find that these changes to the models will make them a viable tool for use in the determination of non-point source loads.

The descriptions, operating instructions and sensitivity runs presented here should be viewed as supplemental to those presented in T.R. 54 and not definitive. Complete program listings are given here to give the reader a quick reference to the existing programs.

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[1] R. L. Crim, N. L. Lovelace, "AUTØ-QUAL Modelling System" Technical Report No. 54, Environmental Protection Agency, Region III, Annapolis Field Office, March 1973.

## II. DESCRIPTION OF METHODS

The inclusion of non-point source flows and loads into the AUT0-QUAL models primarily represents an input-output modification. There was no need to change either the structure of the programs or the computational methods used in them. Both models required the same changes, therefore, they will not be discussed separately at this point.

### General:

The non-point source flows and loads are referenced to river miles and entered as a rate per mile of stream. These data are linearly interpolated to define values over the entire segment being modelled. This interpolation procedure is identical to the one described in T.R. 54. The non-point source data are considered as junction parameters and have a default value of zero.

Once values are established for each junction, they are multiplied by the channel length to obtain an equivalent point source flow or load. After the non-point source parameters have been reduced to effective point source data they are combined with the existing point sources and the solution proceeds exactly has presented in T.R. 54.

### Non-Point Source Flows:

This parameter represents the net non-point source inflow (excluding rainfall) or non-point loss (excluding evaporation). It has the units of  $(ft^3/sec)/mile$  and may assume either a positive or negative value. A positive value represents an inflow while a negative one is a loss. The variable defaults to zero.

The non-point source inflows and/or non-point losses are distinguished from the point source inflows and diversions during input and output operations. However, they are combined for internal computations.

Non-Point Source Quality Parameters:

This parameter(s) represents the non-point source contribution of whatever parameter(s) is being modelled. Both models have the capability to have non-point source inputs for all the quality parameters that they are designed to model (CBOD, NBOD, DO and conservatives). The non-point source values have the units of (lbs/day)/mile and default to zero if nothing is entered.

Once values have been established for each junction (linear interpolation), a mass loading rate (lbs/day) is computed for each junction by multiplying the non-point source value by the channel length. This mass loading rate is then combined with the non-point and point source inflows to give a inflow concentration. It is also combined with any point source inflow concentrations. If there are no inflows (point or non-point) at a junction then a fictitious one of 0.001 cfs is assigned for the purpose of assigning an inflow concentration to the non-point source loading. This fictitious inflow will not influence the resulting quality predictions, it did, however, greatly simplify the program modifications. Also this method enables the model to handle non-point flow losses while having non-point source mass loadings.

### III. OPERATION AND RUNNING INSTRUCTION

Both models may be used in precisely the same manner as before, however, the user now has the option of entering non-point source flows and loads. Again, only the additions and modifications to the original operating instructions (T.R. 54) will be discussed here.

#### Entering Data:

The non-point parameters are entered as physical data in both models. Since entering physical data (SUBROUTINE NETDAT) is the same in both models, there is no need for distinction. Physical data is entered under the program control card "DATA". The following new data codes have been added for the non-point parameters:

Data Code	Definition
NOPNFLW	-non-point source inflows (excluding rainfall) and/or non-point flow losses (excluding evaporation). (cfs/mile)
NOPPCBOD	-non-point source ultimate carbonaceous oxygen demand. (lbs CBOD/day)/mile
NOPNBOD	-non-point source ultimate (lbs NBOD/day)/mile
NOPD0	-non-point source oxygen. (excluding reaeration and photosynthesis). This O <sub>2</sub> contribution is usually associated with runoff or rainfall. (lbs O <sub>2</sub> /day)/mile
NOP (4 letter name of conservative parameter)	-non-point source contributions of whatever conservative constituent is being modelled. (lbs/day)/mile

The card formats and method of entry for these new variables is the same as for other physical data (see T.R. 54).

Running Instructions:

The basic running instructions for both models remain unchanged. However, computational data entered under the control cards FLØW, CBØD, NBØD, DØ and the 4 letter conservative card are now strictly point source data. The non-point source parameters are entered under the "DATA" control card. Following are two general examples to demonstrate the use of the program control cards with the new options:

Example 1 (AUTØSS)

PROBLEM; Run TDS, CBØD and DØ under flow condition No. 1 with one set of non-point parameters. Then run CBØD, NBØD and DØ under flow condition No. 2 with a different set of non-point parameters. The control card set up for this problem would be;

DATA - enter physical data and first set of non-point parameters.

FLØW - enter point source inflows and diversions for flow condition 1.

TDS - enter point source TDS inflow concentrations and boundary conditions - compute solution.

CBØD - enter point source CBØD concentrations and boundary conditions - compute solution.

DØ - enter point source DØ concentrations and boundary conditions - compute solution. .

DATA - enter new non-point parameters (there is no need to re-enter other physical data unless it is to be changed).

FLØW - enter point source inflows and diversions for flow condition no. 2.

CBØD - enter inflow CBØD - compute solution.

NBØD - enter inflow NBØD - compute solution.

DØ - enter inflow DØ - compute solution.

HALT.

Example 2 (AUTØQD)

PROBLEM: Run CBØD, NBØD and DØ for the period of 01/01/1972 through 02/01/1972. Assume there are three flow regimes during this period (01/01 - 01/10, 01/11 - 01/20, 01/21 - 02/01) and that the non-point parameters are constant for the period of 01/01 - 01/20 and change for the period 01/21 - 02/01. The control card set up for this problem would be;

DATA - enter physical data and non-point parameters for the period 01/01 - 01/20.

FLØW - enter point source inflows and diversions for 01/01/1972 - 01/10/1972.

DØ - enter point source CBØD, NBØD and DØ inflow concentrations and boundary conditions for 01/01/1972 through 01/10/1972.

FLØW - enter point source inflows and diversion for 01/11/1972- 01/20/1972.

DØ - enter point source inflow concentrations for 01/11/1972- 01/20/1972.

DATA - enter new non-point parameters for 01/21/1972 - 02/01/72.

FLØW - enter point source inflows and diversions for 01/21/1972- 02/01/1972.

DØ - enter point source inflow concentrations for 01/21/1972- 02/01/1972.

HALT.

#### IV. OUTPUT DESCRIPTIONS AND LISTINGS

##### AUT~~O~~SS

As already discussed, the input operations for AUT~~O~~SS and AUT~~O~~QD have not been significantly changed, except for the additional parameters. The program output has the same basic structure, however, some new data are printed:

Under the heading "Estuary/Stream Data" the non-point source input data and other physical data is printed.

Under the heading "Steady State Flow Conditions" the point source inflows and/or diversions, the non-point source inflows and/or non-point losses, and the channel flows are printed. The non-point losses, and the channel flows are printed. The non-point inflows or non-point losses printed here are the equivalent junction inflows or diversions (the non-point source value multiplied by the channel length).

Under the heading "Steady State (Constituent Name) Input Conditions" the point source inflow concentrations and equivalent non-point source loadings are printed. The non-point source loading is the total for the junction (non-point source value multiplied by the channel length).

The following new variables have been added to the program:

###### Variable

CBDNP (J)      CB~~O~~D non-point source loading for junction J  
(lbs. CB~~O~~D/day)/mile

C~~O~~NNP (J)      Conservative constituent non-point source loading  
for function J (lbs/day)/mile

$\emptyset XYNP(J)$        $O_2$  non-point source contribution (1bs  $O_2$ /day)/mile  
 $QINP(J)$       Non-point source inflow to junction J (cfs)  
 $QIP(J)$       Point source inflow to junction J (cfs)  
 $QNP(J)$       Non-point source inflow or non-point source loss  
                  at junction J (cfs/mile)  
 $Q\emptyset NP(J)$       Non-point flow loss at junction J (cfs)  
 $XNBNP(J)$       NB $\emptyset D$  non-point source loading for junction J  
                  (1bs NB $\emptyset D$ /day)/mile

Program Listing:

Following is a complete listing of program AUT $\emptyset SS$ . New or changed cards are marked by an arrow.

## Main Program

```

***** PROGRAM AUTOSS - STEADY STATE WATER QUALITY *****

***** WRITTEN BY R.L. CRIM AND N.L. LOVELACE *****

***** ENVIRONMENTAL PROTECTION AGENCY, REGION III *****
***** ANNAPOLIS FIELD OFFICE *****
***** TECHNICAL DEVELOPMENT SECTION *****
***** ANNAPOLIS SCIENCE CENTER, ANNAPOLIS, MD. 21401 *****
***** PHONE: 301-268-5038 OR 202-261-2410 *****

***** COMMON QIN(250),QOUT(250),Q(250),A1(250),A2(250),A3(250),
1      WIDTH(250),AS(250),V(250),TEMP(250),EVAP(250),RMJ(250),
2      PHOTC(250),SEDMT(250),Z(250),DK1(250),DK2(250),XNOD(250),
3      REAIR(250),DOS(250),CBODI(250),CBOD(250),XNODII(250),
4      OXY(250),CS(250),A(250),VOL(250),CIN(250),C(250),
5      ALPHA(20),ALPHA(250,3),DVD(250),NFS(250),RMC(250),
6      ,CBDNP(250),XNBNP(250),CONN(250),QNP(250),OXYNP(250)
***** COMMON NC,NJ,XLEN,NOJFX,RMUP,RMDWN,RMFRR,NSECSS,XMIL,LCONS,K2FL,
1      NRD,NWR,NVT
1      DATA LCB0/4HCHOD/,LNHD/4HNBD/,LDO/4HDDO /,LHALT/4HHALT/,LFLW/4HFLOW/,LUDATA/4HDATA/
1      NRD=1
1      NWR=6
1      NVT=0
1      READ(NRD,10)(ALPHA(K),K=1,20)
1      FORMAT(20A4)
1      READ(NRD,20)RMDWN,KMUP,RMFRR,NSECSS
10     FORMAT(20A4)

```

## Main Program (Cont'd)

## Main Program (Cont'd)

```

C(J)=CBODI(J)
70 CONTINUE
CALL QUALIN
CALL QALCMP
CALL SOLVEX
DO 80 J=1,NJ
CBOD(J)=C(J)
80 CONTINUE
GO TO 1000
90 IF(LTYPE•NE•LNHD) GO TO 120
LCONS=LTYPE
DO 100 J=1,NJ
C(J)=XNODI(J)
100 CONTINUE
CALL QUALIN
CALL QALCMP
CALL SOLVEX
DO 110 J=1,NJ
XNOD(J)=C(J)
110 CONTINUE
GO TO 1000
120 IF(LTYPE•NE•LPO) GO TO 140
LCONS=LTYPE
DO 130 J=1,NJ
C(J)=OXY(J)
130 CONTINUE
CALL QUALIN
CALL DOCMP
CALL SOLVEX
DO 135 J=1,NJ
CBOD(J)=0.0
XNOD(J)=0.0
135 CONTINUE
GO TO 1000
140 IF(LTYPE•NE•LFFLOW) GO TO 150

```

## Main Program (Cont'd)

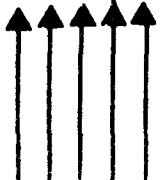
```
CALL FLOWS
GO TO 1000
150 IF (LTYPE.EQ.LHALT) GO TO 2000
      LCONS=LTYPE
      DO 160 J=1,NJ
      C(J)=CS(J)
160 CONTINUE
      CALL QUALIN
      CALL QALCMP
      CALL SOLVEX
      GO TO 1000
2000 STOP
      END
```

## Subroutine SETUP

```

SUBROUTINE SETUP
COMMON QIN(250),QOUT(250),Q(250),A1(250),A2(250),A3(250),
      WIDTH(250),AS(250),V(250),TEMP(250),EVAP(250),RMJ(250),
      PHOTO(250),SEDMT(250),Z(250),DK1(250),DK2(250),XNOD(250),
      REAIR(250),DOS(250),CBODI(250),CBOD(250),XNODI(250),
      OXY(250),CS(250),A(250),VOL(250),CIN(250),C(250),
      LALPHA(20),ALPHA(250,3),DVD(250),NFS(250),RMC(250),
      *CHDNP(250),XNBNP(250),CONN(250),QNP(250),OXYNP(250)
      COMMON NC,NJ,XLEN,NOJFX,RMUP,RMDWN,RMFRR,NSECS,XMIL,LCONS,K2FL,
      NRD,NWR,NVT
      1 NC=NSECS
      NJ=NSECS+1
      XMIL=(RMUP-RMDWN)/FLOAT(NC)
      XLEN=XMIL*5285.0
      RMJ(1)=RMDWN
      DO 10 J=2,NJ
      RMJ(J)=RMJ(J-1)+XMIL
10  CONTINUE
      RMC(1)=RMDWN+(XMIL/2.0)
      DO 20 N=2,NC
      RMC(N)=RMC(N-1)+XMIL
20  CONTINUE
      DO 30 J=1,NJ
      CHDNP(J)=0.0
      XNBNP(J)=0.0
      CONNP(J)=0.0
      QNP(J)=0.0
      OXYNP(J)=0.0
      QOUT(J)=0.0
      CIN(J)=0.0
      DVD(J)=0.0
      Q(J)=0.0
      A(J)=0.0
      Z(J)=0.0
      CIN(J)=0.0

```



## Subroutine SETUP (Cont'd)

```
C(J)=0.0
REAIR(J)=0.0
VOL(J)=0.0
PHOTO(J)=0.0
EVAP(J)=0.0
AS(J)=0.0
SEDMT(J)=0.0
DOS(J)=0.0
V(J)=0.0
WIDTH(J)=0.0
A1(J)=0.0
A2(J)=0.0
A3(J)=0.0
TEMP(J)=20.0
DK1(J)=0.0
DK2(J)=0.0
CBODI(J)=0.0
CBOD(J)=0.0
XNODI(J)=0.0
XNOD(J)=0.0
OXY(J)=0.0
CS(J)=0.0
NFS(J)=0
DO 30 K=1,3
  ALPHA(J,K)=0.0
CONTINUE
END
30
```

## Subroutine NETDAT

```

SUBROUTINE NETDAT
COMMON QIN(250),QOUT(250),Q(250),A1(250),A2(250),A3(250),
      WIDTH(250),AS(250),V(250),TEMP(250),EVAP(250),RMJ(250),
      PHOTO(250),SEDMT(250),Z(250),DK1(250),DK2(250),XNOD(250),
      REAIR(250),DOS(250),CBOD1(250),CBOD(250),XNOD1(250),
      OXY(250),CS(250),A(250),VOL(250),CIN(250),C(250),
      LALPHA(20),ALPHA(250,3),DVD(250),NFS(250),RMC(250)
      •CHDNP(250),XNBNP(250),CONNP(250),QNP(250),OYNP(250)
      COMMON NC,NJ,XLEN,NOJFX,RMUP,RMDWN,RMFR,NSECS,XMIL,LCONS,K2FL,
      NRD,NWR,NVT
      DATA LVAR1/4HJUNC/,LVAR2/4HCHAN/
      DATA LSTOP/4HSSTOP/,LA1/4HA1 '/,LA2/4HA2 '/,LA3/4HA3 '/',
      LWIDT/4HWIDT/,LVEL/4HVEL0/,LTTEMP/4HTEMP/,LVAP/4HEVAP '/',
      LPHOTO/4HPHOT/,LSEDMT/4HSEDI/,LDISP/4HDISP/,LDK1/4HCDEC/,*
      LDK2/4HNDEC/,LREAI/4HREAE/,LDOS/4HSATD/,LINIT/4HINIT/,*
      LCBD/4HCBOD/,LNBD/4HNBD/,LOXY/4HDO /,LCSA/4HC-SA/,*
      LCK2/4HC-RE/,LNON/4HNONP/,LFLO/4HFLOW/,*
      DATA VAPFAC/1.86224E07/,CVFAC/3.28075E00/
      DIMENSION X(250),Y(250)
      K2FL=0
      WRITE(NWR,10)
      10 FORMAT(1H1,130(1H*),/,1H ,130(1H*),/,1H ,35(1H*),61X,34(1H*),/,1H
      1•35(1H*)•5X•49HE S T U A R Y / S T R E A M I N P U T D A T A ,
      26X,34(1H*),/,1H ,35(1H*),61X,34(1H*),/,1H ,130(1H*),/,1H ,130(1H*)
      3)
      1000 READ(NRD,20)LABEL,LCST,NPTS
      20 FORMAT(2A4,2X,I5)
      IF(LABEL.EQ.LSTOP)GO TO 5000
      IF(NPTS.EQ.0) GO TO 45
      DO 40 J=1,NPTS
      READ(NRD,30)I,X(J),Y(J)
      30 FORMAT(I5,5X,2F10.0)
      40 CONTINUE
      * →
      45 IF(LABEL.NE.LAI) GO TO 60
      CALL INTER(A1,NC,X,Y,NPTS,RMC)

```

\* This change is indicated in the errata for T.R. 54

## Subroutine NETDAT (Cont'd)

```

      WRITE(NWR,50)
50 FORMAT(1H0,20(1H*),5X,32HA1 COEFFICIENT FOR FLOW EQUATION,5X,20(1H
1*)
      ) CALL OUTGO(ILVAR2,NC,RMC,A1)
      GO TO 1000
60 IF(LABEL.NE.LA2) GO TO 80
      CALL INTER(A2,NC,X,Y,NPTS,RMC)
      WRITE(NWR,70)
70 FORMAT(1H0,20(1H*),5X,32HA2 COEFFICIENT FOR FLOW EQUATION,5X,20(1H
1*)
      ) CALL OUTGO(ILVAR2,NC,RMC,A2)
      GO TO 1000
80 IF(LABEL.NE.LA3) GO TO 100
      CALL INTER(A3,NC,X,Y,NPTS,RMC)
      WRITE(NWR,90)
90 FORMAT(1H0,20(1H*),5X,79HA3 COEFFICIENT FOR FLOW EQUATION - RERESE
INTS DEPTH OF FLOW IF A1 AND/OR A2 ARE ,5X,20(1H*),/,1H ,20(1H*),5X
2,27HNOT SPECIFIED (OR ARE ZERO) •57X,20(1H*))
      CALL OUTGO(ILVAR2,NC,RMC,A3)
      GO TO 1000
100 IF(LABEL.NE.LWIDT)GO TO 120
      CALL INTER(WIDTH,NC,X,Y,NPTS,RMC)
      WRITE(NWR,110)
110 FORMAT(1H0,20(1H*),5X,19HCHANNEL WIDTHS (FT),5X,20(1H*))
      CALL OUTGO(ILVAR2,NC,RMC,WIDTH)
      AS(1)=WIDTH(1)*XLEN
      AS(NJ)=WIDTH(NC)*XLEN
      DO 112 J=2,NC
      AS(J)=XLEN*0.5*(WIDTH(J)+WIDTH(J-1))
112 CONTINUE
      WRITE(NWR,114)
114 FORMAT(1H0,20(1H*),5X,29HJUNCTION SURFACE AREAS (SQFT),5X,20(1H*))
      CALL OUTGO(ILVAR1,NJ,RMJ,AS)
      GO TO 1000
120 IF(LABEL.NE.LVEL) GO TO 150

```

## Subroutine NETDAT (Cont'd)

```

NVT=1
CALL INTER(V,NC,X,Y,NPTS,RMC)
DO 130 N=1,NC
  IF (RMC(N) .GT. RMFR) V(N)=0.0
130 CONTINUE
WRITE(NWR,140)
140 FORMAT(1H0,20(1H*),5X,41HAVERAGE CHANNEL TIDAL VELOCITIES (FT/SEC)
      1,5X,20(1H*))
CALL OUTGO(LVAR2,NC,RMC,V)
GO TO 1000
150 IF (LABEL.NE.LTEMP) GO TO 170
CALL INTER(TEMP,NJ,X,Y,NPTS,RMJ)
WRITE(NWR,160)
160 FORMAT(1H0,20(1H*),5X,35HJUNCTION WATER TEMPERATURES (DEG-C),5X,20
      1(1H*))
CALL OUTGO(LVARI,NJ,RMJ,TEMP)
GO TO 1000
170 IF (LABEL.NE.LVAP) GO TO 200
CALL INTER(EVAP,NJ,X,Y,NPTS,RMJ,EVAP)
WRITE(NWR,180)
180 FORMAT(1H0,20(1H*),5X,34HNET EVAPORATION - RAINFALL (IN/MO),5X,20(
      11H*))
CALL OUTGO(LVARI,NJ,RMJ,EVAP)
DO 190 J=1,NJ
  EVAP(J)=EVAP(J)/VAPFAC
190 CONTINUE
GO TO 1000
200 IF (LABEL.NE.LPHOTO) GO TO 230
CALL INTER(PHOTO,NJ,X,Y,NPTS,RMJ)
WRITE(NWR,210)
210 FORMAT(1H0,20(1H*),5X,61HAVERAGE DAILY PHOTOSYNTHESIS-RESPIRATION
      1RATE (GM O2/SQM/DAY),5X,20(1H*))
CALL OUTGO(LVARI,NJ,RMJ,PHOTO)
DO 220 J=1,NJ
  PHOTO(J)=PHOTO(J)*CVFAC/85400.0

```

## Subroutine NETDAT (Cont'd)

```

220 CONTINUE
GO TO 1000
230 IF(LABEL.NE.LSEDMT) GO TO 260
CALL INTER(SEDMT,NJ,X,Y,NPTS,RMJ)
WRITE(NWR,240)
240 FORMAT(1H0,20(1H*),5X,42H OXYGEN UPTAKE OF SEDIMENTS (GM 02/SQM/DAY
1),5X,20(1H*))
CALL OUTGO(LVARI,NJ,RMJ,SEDMT)
DO 250 J=1,NJ
SEDMT(J)=SEDMT(J)*CVFAC/86400.0
250 CONTINUE
GO TO 1000
260 IF(LABEL.NE.LDISP) GO TO 280
CALL INTER(Z,NC,X,Y,NPTS,RMC)
WRITE(NWR,270)
270 FORMAT(1H0,20(1H*),5X,34H DISPERSION COEFFICIENTS (SQFT/SEC),5X,20(
1H*))
CALL OUTGO(LVAR2,NC,RMC,Z)
GO TO 1000
280 IF(LABEL.NE.LDK1) GO TO 310
CALL INTER(DK1,NJ,X,Y,NPTS,RMJ)
DO 285 J=1,NJ
DK1(J)=DK1(J)*1.047**((TEMP(J)-20.0)
285 CONTINUE
WRITE(NWR,290)
290 FORMAT(1H0,20(1H*),5X,52HC BOD DECAY RATES CORRECTED TO STREAM TEMP
1S -(1/DAY),5X,20(1H*))
CALL OUTGO(LVARI,NJ,RMJ,DK1)
DO 300 J=1,NJ
DK1(J)=DK1(J)/86400.0
300 CONTINUE
GO TO 1000
310 IF(LABEL.NE.LDK2) GO TO 340
CALL INTER(DK2,NJ,X,Y,NPTS,RMJ)
DO 315 J=1,NJ

```

## Subroutine NETDAT (Cont'd)

```

      DK2(J)=DK2(J)*1.015***(TEMP(J)-20.0)
315  CONTINUE
      WRITE(NWR,320)
320  FORMAT(1H0,20(1H*),5X,52HNBNOD DECAY RATES CORRECTED TO STREAM TEMP
      1S - (1/DAY)*5X,20(1H*))
      CALL OUTGO(LVARI,NJ,RMJ,DK2)
      DO 330 J=1,NJ
      DK2(J)=DK2(J)/86400.0
330  CONTINUE
      GO TO 1000
340  IF (LABEL•NE•LREAI) GO TO 370
      CALL INTER(REAIR,NJ,X,Y,NPTS,RMJ)
      DO 345 J=1,NJ
      REAIR(J)=REAIR(J)*1.024***(TEMP(J)-20.0)
345  CONTINUE
      WRITE(NWR,350)
350  FORMAT(1H0,20(1H*),5X,58HINPUT REAERATION RATES CORRECTED TO STREAM
      1M TEMPS - (1/DAY)*5X,20(1H*))
      CALL OUTGO(LVARI,NJ,RMJ,REAIR)
      DO 360 J=1,NJ
      REAIR(J)=REAIR(J)/86400.0
360  CONTINUE
      GO TO 1000
370  IF (LABEL•NE•LDOS) GO TO 390
      CALL INTER(DOS,NJ,X,Y,NPTS,RMJ)
      WRITE(NWR,380)
380  FORMAT(1H0,20(1H*),5X,46HINPUTTED OXYGEN SATURATION CONCENTRATIONS
      1(PPM),5X,20(1H*))
      CALL OUTGO(LVARI,NJ,RMJ,DOS)
      GO TO 1000
390  IF (LABEL•NE•LINIT) GO TO 470
      IF (LCST•NE•LCBD) GO TO 410
      CALL INTER(CBODI,NJ,X,Y,NPTS,RMJ)
400  FORMAT(1H0,20(1H*),5X,33HINITIAL CBOD CONCENTRATIONS (PPM),5X,20(1
      1H*))

```

## Subroutine NETDAT (Cont'd)

```

      WRITE(NWR,400)
      CALL OUTGO(LVARI,NJ,RMJ,CBODI)
      GO TO 1000
 410  IF(LCST.NE.LNBD) GO TO 430
      CALL INTER(XNODI,NJ,X,Y,NPTS,RMJ)
      WRITE(NWR,420)
      FORMAT(1H0,20(1H*),5X,33HINITIAL NBOD CONCENTRATIONS (PPM),5X,20(1
      1H*))
      CALL OUTGO(LVARI,NJ,RMJ,XNODI)
      GO TO 1000
 430  IF(LCST.NE.LOXY) GO TO 450
      CALL INTER(OXY,NJ,X,Y,NPTS,RMJ)
      WRITE(NWR,440)
      FORMAT(1H0,20(1H*),5X,45HINITIAL DISSOLVED OXYGEN CONCENTRATIONS (
      1PPM),5X,20(1H*))
      CALL OUTGO(LVARI,NJ,RMJ,OXY)
      GO TO 1000
 450  CALL INTER(CS,NJ,X,Y,NPTS,RMJ)
      WRITE(NWR,460)LCST
 460  FORMAT(1H0,20(1H*),5X,8HINITIAL ,A4,21H CONCENTRATIONS (PPM),5X,20
      1(1H*))
      CALL OUTGO(LVARI,NJ,RMJ,CS)
      GO TO 1000
 470  IF(LABEL.NE.LCSA) GO TO 500
      DO 480 J=1,NJ
      DOS(J)=14.62-0.367*TEMP(J)+0.0045*(TEMP(J)**2.0)
 480  CONTINUE
      WRITE(NWR,490)
 490  FORMAT(1H0,20(1H*),5X,47HCOMPUTED OXYGEN SATURATION CONCENTRATIONS
      1(PPM),5X,20(1H*))
      CALL OUTGO(LVARI,NJ,RMJ,DOS)
      GO TO 1000
 500  IF(LABEL.NE.LCK2) GO TO 510
      K2FL=1
      GO TO 1000
 510  IF(LABEL.NE.LNON) GO TO 610
      →

```

## Subroutine NETDAT (Cont'd)

```

      IF(LCST.NE.LCBD) GO TO 530
      CALL INTER(CBDNP,NJ,X,Y,NPTS,RMJ)
      WRITE(NWR,520)
      520 FORMAT(1H0,20(1H*),5X,63HCBD NONPOINT SOURCE CONTRIBUTION (LBS CB
     10D/DAY/MILE OF STREAM),5X,20(1H*))
      CALL OUTGO(LVARI1,NJ,RMJ,CBDNP)
      GO TO 1000

      530 IF(LCST.NE.LNBD) GO TO 550
      CALL INTER(XNBNP,NJ,X,Y,NPTS,RMJ)
      WRITE(NWR,540)
      540 FORMAT(1H0,20(1H*),5X,63HNBD NONPOINT SOURCE CONTRIBUTION (LBS NB
     10D/DAY/MILE OF STREAM),5X,20(1H*))
      CALL OUTGO(LVARI1,NJ,RMJ,XNBNP)
      GO TO 1000

      550 IF(LCST.NE.LOXY) GO TO 570
      CALL INTER(OXYNP,NJ,X,Y,NPTS,RMJ)
      WRITE(NWR,560)
      560 FORMAT(1H0,20(1H*),5X,60HO2 NONPOINT SOURCE CONTRIBUTIONS (LBS 02/
     1DAY/MILE OF STREAM),5X,20(1H*))
      CALL OUTGO(LVARI1,NJ,RMJ,OXYNP)
      GO TO 1000

      570 IF(LCST.NE.LFL0) GO TO 590
      CALL INTER(QNP,NJ,X,Y,NPTS,RMJ)
      WRITE(NWR,580)
      580 FORMAT(1H0,20(1H*),5X,41HNONPOINT SOURCE FLOW (CFS/MILE OF STREAM)
     1,5X,20(1H*))
      CALL OUTGO(LVARI1,NJ,RMJ,QNP)
      GO TO 1000

      590 CALL INTER(CONNP,NJ,X,Y,NPTS,RMJ)
      WRITE(NWR,600)
      600 FORMAT(1H0,20(1H*),5X,A4,35H NONPOINT SOURCE CONTRIBUTION (LBS ,A4
     1,20H/DAY/MILE OF STREAM),5X,20(1H*))
      CALL OUTGO(LVARI1,NJ,RMJ,CONN)
      GO TO 1000

      610 WRITE(NWR,620)LABEL

```

## Subroutine NETDAT (Cont'd)

```
→ 620 FORMAT(1H1•130(1H?)•/,1H •130(1H?)•/,1H •20(1H?)•5X•10HDATA CODE ,
1A4•36H DOES NOT EXIST - PROGRAM TERMINATES,/,1H ,130(1H?),/,1H ,
2130(1H?))
      STOP
5000 RETURN
      END
```

## Subroutine FLOWS

```

SUBROUTINE FLOWS
COMMON QIN(250),QOUT(250),Q(250),A1(250),A2(250),A3(250),
      WIDTH(250),AS(250),V(250),TEMP(250),EVAP(250),RMJ(250),
      PHOTO(250),SEDMT(250),Z(250),DK1(250),DK2(250),XNODI(250),
      REAIR(250),DOS(250),CBODI(250),CBOD(250),XNODI(250),
      OXY(250),CS(250),A(250),VOL(250),CIN(250),C(250),
      LALPHA(20),ALPHA(250,3),DVD(250),NFS(250),RMC(250)
      ,CRDNP(250),XNBNP(250),CONNP(250),QNP(250),OXYNP(250)
      COMMON NC,NJ,XLEN,NOJFX,RMUP,RMDWN,RMFR,NSECS,XMIL,LCONS,K2FL,
      NRD,NWR,NVT
      1 DIMENSION QINP(250),QONP(250)
      DATA LVAR1/4HJUNC/,LVAR2/4HCHAN/
      DATA LSTOP/4HSTOP/
      DO 10 J=1,NJ
      Q(J)=0.0
      QOUT(J)=0.0
      QIN(J)=0.0
      IF (QNP(J)*LE.0.0) GO TO 5
      QINP(J)=QNP(J)*XMIL
      QONP(J)=0.0
      GO TO 10
      QONP(J)=-QNP(J)*XMIL
      QINP(J)=0.0
      10 CONTINUE
      20 READ(NRD,30)LABEL,DIST,QN,QAUT
      30 FORMAT(A4,6X,3F10.0)
      IF (LABEL.EQ.LSTOP) GO TO 40
      JUNC=JKFND(NJ,XMIL,DIST,RMDWN)
      QIN(JUNC)=QIN(JUNC)+QN
      QOUT(JUNC)=QOUT(JUNC)+QAUT
      GO TO 20
      40 Q(NC)=-QIN(NJ)-QINP(NJ)+EVAP(NJ)*AS(NJ)
      DO 50 N=2,NC
      NCHAN=NJ-N
      NCP=NCHAN+1

```

## Subroutine FLOWS (Cont'd)

```

Q(NCHAN)=Q(NCP)-QIN(NCP)-QINP(NCP)+QOUT(NCP)+QONP(NCP)+EVAP(NCP) *
      1AS(NCP)
 50  CONTINUE
    CALL FLOCMP
    SUMIN=0.0
    SUMOUT=0.0
DO 70 J=1,NJ
    SUMIN=SUMIN+QIN(J)+QINP(J)
    SUMOUT=SUMOUT+QOUT(J)+QONP(J)
    IF (EVAP(J).LT.0.0) GO TO 60
    SUMOUT=SUMOUT+EVAP(J)*AS(J)
    GO TO 70
60  SUMIN=SUMIN-EVAP(J)*AS(J)
70  CONTINUE
    IF (SUMOUT.GT.SUMIN) GO TO 80
    QOUT(1)=QOUT(1)+SUMIN-SUMOUT
    GO TO 90
80  QIN(1)=QIN(1)+SUMOUT-SUMIN
90  WRITE(NWR,100) SUMIN,SUMOUT,QOUT(1)
100 FORMAT(1H1,130(1H*),/ ,1H ,130(1H*),/ ,1H ,25(1H*),5X,28HSTEADY STAT
1E FLOW CONDITIONS,47X,25(1H*),/ ,1H ,25(1H*),80X,<(1H*),/ ,1H ,25(1
2H*),5X,15HTOTAL INFLOWS =,F10.1,4H CFS,46X,25(1H*),/ ,1H ,25(1H*),
35X,18HTOTAL DIVERIONS =,F10.1,4H CFS,43X,25(1H*),/ ,1H ,25(1H*),
45X,32HOUTFLOW AT DOWNSTREAM JUNCTION =,F10.1,4H CFS,29X,25(1H*),/ ,
51H ,130(1H*),/ ,1H ,130(1H*)
    WRITE(NWR,110)
110 FORMAT(1H0,20(1H*),5X,26HPOINT SOURCE INFLows (CFS),5X,20(1H*))
    CALL OUTGO(LVARI,NJ,RMJ,QIN)
    WRITE(NWR,120)
120 FORMAT(1H0,20(1H*),5X,50HNONPOINT SOURCE INFLows (CFS) (EXCLUDING
1RAINFALL),5X,20(1H*))
    CALL OUTGO(LVARI,NJ,RMJ,QINP)
    WRITE(NWR,130)
130 FORMAT(1H0,20(1H*),5X,22HPOINT DIVERsions (CFS),5X,20(1H*))
    CALL OUTGO(LVARI,NJ,RMJ,QOUT)

```

## Subroutine FLOWS (Cont'd)

```
      WRITE(NWR,140)
140  FORMAT(1H0,20(1H*),5X,59HNONPOINT DIVERSIONS OR LOSSES (CFS) (EXCL
IUDING EVAPORATION),5X,20(1H*))
      CALL OUTGO(LVAR1,NJ,RM1,QONP)
      WRITE(NWR,150)
150  FORMAT(1H0,20(1H*),5X,19HCHANNEL FLOWS (CFS),5X,20(1H*))
      CALL OUTGO(LVAR2,NC,RMC,Q)
      DO 160 J=1,NJ
      QIN(J)=QIN(J)+QINP(J)
      QOUT(J)=QOUT(J)+QONP(J)
160  CONTINUE
      RETURN
      END
```

## Subroutine FLOCMP

```

SUBROUTINE FLOCMP
COMMON QIN(250),QOUT(250),Q(250),A1(250),A2(250),A3(250),
1      WIDTH(250),AS(250),V(250),TEMP(250),EVAP(250),RMJ(250),
2      PHOTO(250),SEDMT(250),Z(250),DK1(250),DK2(250),XNOD(250),
3      REAIR(250),DOS(250),CBODI(250),CBOD(250),XNODI(250),
4      OXY(250),CS(250),A(250),VOL(250),CIN(250),C(250),
5      LALPHA(20),ALPHA(250,3),DVD(250),NFS(250),RMC(250),
6      ,CBDNP(250),XNBNP(250),CONN(250),QNP(250),OXYNP(250)
COMMON NC,NJ,XLEN,NOJFX,RMUP,RMDWN,RMFR,NSECS,XMIL,LCONS,K2FL,
1      NRD,NWR,NVT
DATA LVAR1/4HJUNC/,LVAR2/4HCHAN/
DIMENSION DEPTH(250),RN(250)
DO 10 N=1,NC
DEPTH(N)=A3(N)
IF(A1(N) .EQ. 0.0.OR.Q(N) .EQ. 0.0)GO TO 5
DEPTH(N)=DEPTH(N)+A1(N)*ABS(Q(N))*A2(N)
5   A(N)=DEPTH(N)*WIDTH(N)
IF(NVT.EQ.1.AND.RMC(N).LE.RMFR)GO TO 10
IF(A(N).EQ.0.0)GO TO 8
V(N)=ABS(Q(N))/A(N)
GO TO 10
8   WRITE(NWR,9)N
9   FORMAT(1H1,130(1H?),/,1H ,20(1H?),21HZERO AREA IN CHANNEL ,13,44H
1DEPTH OR WIDTH IS ZERO - PROGRAM TERMINATES )
STOP
10  CONTINUE
      VOL(1)=XLEN*A(1)
      VOL(NJ)=XLEN*A(NC)
      NL=NJ-1
      DO 20 J=2,NL
      VOL(J)=XLEN*0.5*(A(J-1)+A(J))
20  CONTINUE
      WRITE(NWR,30)
30  FORMAT(1H1,130(1H?),/,1H ,130(1H?)*,1H ,25(1H?)*,1H ,25(1H?)*,5X,38HDEPTH OR VE
1LOCITY DEPENDENT VARIABLES,38X,25(1H?),/,1H ,130(1H?)*,1H ,130(1H

```

## Subroutine FLOCMP (Cont'd)

```

3*) )
      WRITE(NWR,40)
40 FORMAT(1H0,20(1H*),5X,38HCROSSSECTIONAL AREAS OF CHANNELS (SQFT),
      15X,20(1H*))
      CALL OUTGO(LVAR2,NC,RMC,A)
      WRITE(NWR,50)
50 FORMAT(1H0,20(1H*),5X,19HCHANNEL DEPTHS (FT),5X,20(1H*))
      CALL OUTGO(LVAR2,NC,RMC,DEPTH)
      WRITE(NWR,60)
60 FORMAT(1H0,20(1H*),5X,27HCHANNEL VELOCITIES (FT/SEC),5X,20(1H*))
      CALL OUTGO(LVAR2,NC,RMC,V)
      WRITE(NWR,70)
70 FORMAT(1H0,20(1H*),5X,23HJUNCTION VOLUMES (CUFT),5X,20(1H*))
      CALL OUTGO(LVARI,NJ,RMJ,VOL)
      IF(K2FL•NE•1) GO TO 140
      DO 80 N=1,NC
      RN(N)= (12.9*(V(N)*0.5)) / (DEPTH(N)**1.5)
80 CONTINUE
      REAIR(NJ)=RN(NC)
      REAIR(1)=RN(1)
      DO 90 J=2,NL
      REAIR(J)=0.5*(RN(J)+RN(J-1))
90 CONTINUE
      DO 100 J=1,NJ
      XT=TEMP(J)-20.0
      XF=1.024**XT
      REAIR(J)=REAIR(J)*XF
100 CONTINUE
      WRITE(NWR,120)
120 FORMAT(1H0,20(1H*),5X,33HCOMPUTED REAERATION RATES (1/DAY),5X,20(1
      1H*))
      CALL OUTGO(LVARI,NJ,RMJ,REAIR)
      DO 130 J=1,NJ
      REAIR(J)=REAIR(J)/86400.0
130 CONTINUE
      140 RETURN
      END

```

## Subroutine QUALIN

```

SUBROUTINE QUALIN
COMMON QIN(250),QOUT(250),Q(250),A1(250),A2(250),A3(250),
1      WIDTH(250),AS(250),V(250),TEMP(250),EVAP(250),RMJ(250),
2      PHOTO(250),SEDMT(250),Z(250),DK1(250),DK2(250),XNOD(250),
3      REAIR(250),DOS(250),CBODI(250),CBOD(250),XNOD1(250),
4      OXY(250),CS(250),A(250),VOL(250),CIN(250),C(250),
5      LALPHA(20),ALPHA(250,3),DVD(250),NFS(250),RMC(250)
6      ,CBDNP(250),XNBNP(250),CONN(250),QNP(250),OYNP(250)
COMMON NC,NJ,XLEN,NOJFX,RMUP,RMDWN,RMFR,NSECS,XMIL,LCONS,K2FL,
NRD,NWR,NVT
1      DATA LSTOP/4HSTOP/,LFIXE/4HFIXE/
DATA LVAR1/4HJUNC/,LVAR2/4HCHAN/
DATA LNBD/4HNBD0/,LCBD/4HCBD0/,LDO/4HDO/
DIMENSION QIP(250)
NOJFX=0
DO 5 K=1,250
NFS(K)=0
5 CONTINUE
DO 10 J=1,NJ
CIN(J)=0.0
QIN(J)=AMAX1(0.001,QIN(J))
QIP(J)=0.0
10 CONTINUE
1000 READ(NRD,20)LABEL,DIST,QN,CN,CST
20 FORMAT(A4,6X,4F10.0)
IF(LABEL.EQ.LSTOP) GO TO 30
JUNC=JKFND(NJ,XMIL,DIST,RMDWN)
QIP(JUNC)=QIP(JUNC)+QN
CIN(JUNC)=CN*QN+CIN(JUNC)
IF(LABEL.NE.LFIXE) GO TO 1000
NOJFX=NOJFX+1
NFS(NOJFX)=JUNC
C(JUNC)=CST
GO TO 1000
30 DO 50 J=1,NJ

```

## Subroutine QUALIN (Cont'd)

```

      IF (QIN(J) .EQ. 0.0.AND.CIN(J) .NE. 0.0) GO TO 60
      IF (QIP(J) .EQ. 0.0.AND.CIN(J) .EQ. 0.0) GO TO 40
      CIN(J)=CIN(J)/QIP(J)
      GO TO 50
 40  CIN(J)=0.0
 50  CONTINUE
      GO TO 80
 60  WRITE(NWR,70)J,RMJ(J)
 70  FORMAT(1H1,130(1H?)•,1H •130(1H?)•/,1H0,10(1H?)•5X,33HAN INFLOW W
 1AS READ IN AT JUNCTION ,14,12H(RIVER MILE ,F7.2,54H) IN THE QUALIT
 2Y INPUT, BUT NOT IN THE HYDRAULIC INPUT,/,1H0,10(1H?)•5X,18HPROGRA
 3M TERMINATES )
      STOP
 80  WRITE(NWR,90)LCONS
 90  FORMAT(1H1,130(1H?)•/,1H •130(1H?)•/,1H •25(1H?)•80X,25(1H?)•/,1H
 1.25(1H?)•5X,13HSTEADY STATE ,A4,27H INPUT CONDITIONS
 2,25(1H?)•/,1H •25(1H?)•80X,25(1H?)•/,1H •130(1H?)•/,1H •130(1H?)•/
 3,1H0 )
      WRITE(NWR,95)
 95  FORMAT(1H0,20(1H?)•5X,40HPOINT SOURCE INFLOW CONCENTRATIONS (PPM),
 15X,20(1H?) )
      CALL OUTGO(LVARI,NJ,RMJ,CIN)
      WRITE(NWR,200)
 200 FORMAT(1H0,20(1H?)•5X,31HNONPOINT SOURCE LOADS (LBS/DAY),5X,20(1H?
 1) )
      IF (LCONS.NE.LCBD)GO TO 230
      DO 210 J=1,NJ
      CBDNP(J)=CBDNP(J)*XMIL
 210 CONTINUE
      CALL OUTGO(LVARI,NJ,RMJ,CBDNP)
      DO 220 J=1,NJ
      IF (CBDNP(J) .LE. 0.0)GO TO 215
      CIN(J)=(CBDNP(J)/(5.3936*QIN(J)))+CIN(J)*QIP(J)/QIN(J)
      CBDNP(J)=CBDNP(J)/XMIL
 220 GO TO 220

```

## Subroutine QUALIN (Cont'd)

```

215 CIN(J)=CIN(J)*QIP(J)/QIN(J)
220 CONTINUE
220 GO TO 320
230 IF (LCONS*NE.LNBD) GO TO 260
230 DO 240 J=1,NJ
230 XNBNP(J)=XNBNP(J)*XMIL
240 CONTINUE
240 CALL OUTGO(LVARI,NJ,RMJ,XNBNP)
240 DO 250 J=1,NJ
240 IF (XNBNP(J)*LE.0.0) GO TO 245
240 CIN(J)=(XNBNP(J)/(5.3936*QIN(J)))*CIN(J)*QIP(J)/QIN(J)
240 XNBNP(J)=XNBNP(J)/XMIL
240 GO TO 250
245 CIN(J)=CIN(J)*QIP(J)/QIN(J)
250 CONTINUE
250 GO TO 320
260 IF (LCONS*NE.LD0) GO TO 290
260 DO 270 J=1,NJ
260 OXYNP(J)=OXYNP(J)*XMIL
270 CONTINUE
270 CALL OUTGO(LVARI,NJ,RMJ,OXYNP)
270 DO 280 J=1,NJ
270 IF (OXYNP(J)*LE.0.0) GO TO 275
270 CIN(J)=(OXYNP(J)/(5.3936*QIN(J)))*CIN(J)*QIP(J)/QIN(J)
270 OXYNP(J)=OXYNP(J)/XMIL
270 GO TO 280
275 CIN(J)=CIN(J)*QIP(J)/QIN(J)
280 CONTINUE
280 GO TO 320
290 DO 300 J=1,NJ
290 CONNP(J)=CONNP(J)*XMIL
290 CONTINUE
290 CALL OUTGO(LVARI,NJ,RMJ,CONNPs)
290 DO 310 J=1,NJ
290 IF (CONNPs(J)*LE.0.0) GO TO 305

```

## Subroutine QUALIN (Cont'd)

```

      CIN(J)=(CONNP(J)/(5.3936*QIN(J)))*CIN(J)*QIP(J)/QIN(J)
      CONNP(J)=CONNP(J)/XMIL
      GO TO 310
      305 CIN(J)=CIN(J)*QIP(J)/QIN(J)
      310 CONTINUE
      320 IF(NOJFX.EQ.0)GO TO 2000
      WRITE(NWR,100)
100  FORMAT(1H0,25(1H*),5X,15HFIXED JUNCTIONS,/,,1H0)
      DO 130 J=1,NOJFX
      K=NFS(J)
      WRITE(NWR,120)K,RMJ(K),C(K)
120  FORMAT(1H,25(1H.),5X,9HJUNCTION ,I3,13H, RIVER MILE ,F7.2,14H, I
      1S FIXED AT ,1PE11.4,6H (PPM) )
      130 CONTINUE
      2000 RETURN
      END

```

## Subroutine QALCMP

```

SUBROUTINE QALCMP
COMMON QIN(250),QOUT(250),V(250),A1(250),A2(250),A3(250),
1      WIDTH(250),AS(250),TEMP(250),EVAP(250),RMJ(250),
2      PHOTO(250),SEDMT(250),Z(250),DK1(250),DK2(250),XNOD(250),
3      REAIR(250),DOS(250),CBODI(250),CBOD(250),XNODI(250),
4      OXY(250),CS(250),A(250),VOL(250),CIN(250),C(250),
5      LALPHA(20),ALPHA(250,3),DVD(250),NFS(250),KMC(250),
6      *CBDNP(250),XBNP(250),CONN(250),QNP(250),OXYNP(250)
COMMON NC,NJ,XLEN,NOJFX,RMUP,RMDWN,RMFR,NSECS,XMIL,LCONS,K2FL,
1      NRD,NWR,NVT
DATA LCBD/4HCBOD/,LNBD/4HNBD/
DIMENSION DECRY(250)
IF(LCONS.NE.LCBD)GO TO 20
DO 10 J=1,NJ
DECRY(J)=DK1(J)
10 CONTINUE
60 TO 60
20 IF(LCONS.NE.LNBD) GO TO 40
DO 30 J=1,NJ
DECRY(J)=DK2(J)
30 CONTINUE
60 TO 60
40 DO 50 J=1,NJ
DECRY(J)=0.0
50 CONTINUE
60 ALPHA(1,3)=QIN(1)*CIN(1)
ALPHA(NJ,3)=QIN(NJ)*CIN(NJ)
DVD(1)=-QOUT(1)-DECRY(1)*VOL(1)
DVD(NJ)=-QOUT(NJ)-DECRY(NJ)*VOL(NJ)
DO 1000 J=2,NC
IF(NOJFX.EQ.0) GO TO 80
DO 70 K=1,NOJFX
IF(NFS(K).EQ.J) GO TO 1000
70 CONTINUE
80 DVD(J)=-QOUT(J)-DECRY(J)*VOL(J)

```

## Subroutine QALCMP (Cont'd)

```

ALPHA(J,3)=QIN(J)*CIN(J)
JM1=J-1
IF(Q(JM1).LT.0.0) GO TO 90
ALPHA(J,1)=ABS(Q(JM1))+A(JM1)*Z(JM1)/XLEN
DVD(J)=DVD(J)-A(JM1)*Z(JM1)/XLEN
GO TO 100
90 ALPHA(J,1)=Z(JM1)*A(JM1)/XLEN
DVD(J)=DVD(J)-ABS(Q(JM1))-A(JM1)*Z(JM1)/XLEN
100 IF(Q(J).GT.0.0) GO TO 110
ALPHA(J,2)=ABS(Q(J))+A(J)*Z(J)/XLEN
DVD(J)=DVD(J)-A(J)*Z(J)/XLEN
GO TO 120
110 ALPHA(J,2)=Z(J)*A(J)/XLEN
DVD(J)=DVD(J)-ABS(Q(J))-A(J)*Z(J)/XLEN
120 CONTINUE
1000 CONTINUE
IF(Q(NC).LT.0.0) GO TO 130
ALPHA(NJ,1)=ABS(Q(NC))+A(NC)*Z(NC)/XLEN
DVD(NJ)=DVD(NJ)-A(NC)*Z(NC)/XLEN
GO TO 140
130 ALPHA(NJ,1)=Z(NC)*A(NC)/XLEN
DVD(NJ)=DVD(NJ)-ABS(Q(NC))-A(NC)*Z(NC)/XLEN
140 IF(Q(1).GT.0.0) GO TO 150
ALPHA(1,1)=ABS(Q(1))+A(1)*Z(1)/XLEN
DVD(1)=DVD(1)-A(1)*Z(1)/XLEN
GO TO 160
150 ALPHA(1,1)=Z(1)*A(1)/XLEN
DVD(1)=DVD(1)-ABS(Q(1))-A(1)*Z(1)/XLEN
160 CALL DIVCK(NERR)
IF(NERR.EQ.0) GO TO 2000
WRITE(NWR,170)LCONS
170 FORMAT(1H1,130(1H?),1H *130(1H?)*,1H *1H0,20(1H?)*,5X,16HZERO DIVISO
1R IN ,A4,37H SOLUTION MATRIX - PROGRAM TERMINATES )
STOP
2000 RETURN
END

```

## Subroutine DOCMP

```

SUBROUTINE DOCMP
COMMON QIN(250),QOUT(250),Q(250),A1(250),A2(250),A3(250),
      WIDTH(250),AS(250),V(250),TEMP(250),EVAP(250),RMJ(250),
      PHOTO(250),SEDMT(250),Z(250),DK1(250),DK2(250),XNOD(250),
      REAIR(250),DOS(250),CBODI(250),CBOD(250),XNODI(250),
      OXY(250),CS(250),A(250),VOL(250),CIN(250),C(250),
      LALPHA(20),ALPHA(250,3),DVD(250),NFS(250),RMC(250)
      ,CBDNP(250),XNBNP(250),CONNP(250),QNP(250),OXYNP(250)
      COMMON NC,NJ,XLEN,NOJFX,RMUP,RMDWN,RMFR,NSECS,XMIL,LCONS,K2FL,
      NRD,NWR,NVT
      1   DVD(1)=-QOUT(1)-REAIR(1)*VOL(1)-EVAP(1)*AS(1)
      DVD(NJ)=-QOUT(NJ)-REAIR(NJ)*VOL(NJ)-EVAP(NJ)*AS(NJ)
      ALPHA(1,3)=QIN(1)*CIN(1)+PHOTO(1)-(DK1(1)*CBOD(1)+DK2(1)*XNOD(1))*
      VOL(1)-SEDMT(1)*AS(1)+REAIR(1)*DOS(1)*VOL(1)
      ALPHA(NJ,3)=QIN(NJ)*CIN(NJ)+PHOTO(NJ)-(DK1(NJ)*CBOD(NJ)+DK2(NJ)*
      1XNOD(NJ))*VOL(NJ)-SEDMT(NJ)*AS(NJ)+REAIR(NJ)*DOS(NJ)*VOL(NJ)
      DO 1000 J=2,NC
      IF (NOJFX.EQ.0) GO TO 20
      DO 10 K=1,NOJFX
      IF (NFS(K).EQ.J) GO TO 1000
      10 CONTINUE
      20 DVD(J)=-QOUT(J)-REAIR(J)*VOL(J)-EVAP(J)*AS(J)
      ALPHA(J,3)=QIN(J)*CIN(J)+PHOTO(J)*AS(J)-(DK1(J)*CBOD(J)+DK2(J)*
      1XNOD(J))*VOL(J)-SEDMT(J)*AS(J)+REAIR(J)*DOS(J)*VOL(J)
      JM1=J-1
      IF (Q(JM1).LT.0.0) GO TO 30
      ALPHA(J,1)=ABS(Q(JM1))+A(JM1)*Z(JM1)/XLEN
      DVD(J)=DVD(J)-A(JM1)*Z(JM1)/XLEN
      GO TO 40
      30 ALPHA(J,1)=Z(JM1)*A(JM1)/XLEN
      DVD(J)=DVD(J)-ABS(Q(JM1))-A(JM1)*Z(JM1)/XLEN
      40 IF (Q(J).GT.0.0) GO TO 50
      ALPHA(J,2)=ABS(Q(J))+A(J)*Z(J)/XLEN
      DVD(J)=DVD(J)-A(J)*Z(J)/XLEN
      GO TO 60
      50 ALPHA(J,2)=Z(J)*A(J)/XLEN
      *
```

\* This change is indicated in the errata for T.R. 54

## Subroutine DOCMP (Cont'd)

```

DVD(J)=DVD(J)-AJS(Q(J))-A(J)*Z(J)/XLEN
60 CONTINUE
1000 CONTINUE
      IF(Q(NC).LT.0.0) GO TO 70
      ALPHA(NJ,1)=ABS(Q(NC))+A(NC)*Z(NC)/XLEN
      DVD(NJ)=DVD(NJ)-A(NC)*Z(NC)/XLEN
      GO TO 80
70 ALPHA(NJ,1)=Z(NC)*A(NC)/XLEN
      DVD(NJ)=DVD(NJ)-ABS(Q(NC))-A(NC)*Z(NC)/XLEN
30 IF(Q(1).GT.0.0) GO TO 90
      ALPHA(1,1)=ABS(Q(1))+A(1)*Z(1)/XLEN
      DVD(1)=DVD(1)-A(1)*Z(1)/XLEN
      GO TO 100
90 ALPHA(1,1)=Z(1)*A(1)/XLEN
      DVD(1)=DVD(1)-ABS(Q(1))-A(1)*Z(1)/XLEN
100 CALL DIVCK(NERR)
      IF(NERR.EQ.0) GO TO 2000
      WRITE(NWR,110)LCONS
110 FORMAT(1H1,130(1H?),/,1H ,130(1H?)*,/1H0,20(1H?)*,5X,16HZERO DIVISO
     1R IN ,A4,37H SOLUTION MATRIX - PROGRAM TERMINATES )
      STOP
2000 RETURN
END

```

## Subroutine SOLVEX

```

SUBROUTINE SOLVEX
COMMON QIN(250),QOUT(250),A1(250),A2(250),A3(250),
      WIDTH(250),AS(250),V(250),TEMP(250),EVAP(250),RMJ(250),
      PHOT(250),SEDM(250),Z(250),DK1(250),DK2(250),XNOD(250),
      REAIR(250),DOS(250),CS(250),C800(250),C800(250),XNOD(250),
      QXY(250),CIN(250),C(250),C(250),C(250),
      LALPHA(20),ALPHA(250,3),DVD(250),NFS(250),HMC(250)
      ,CBDNP(250),NBNP(250),CONN(250),QNP(250),OYNP(250)
      COMMON NC,NJ,XLEN,RGJFX,RMUP,RMDWN,RMFR,NSECS,XML,LCONS,K2FL,
      NRD,NWR,NVT
      1 RELAX=1.0
      MAXCYC=1000
      DELMAX=0.0001
      DO 1000 IT=1,MAXCYC
      BIG=0.0
      DO 30 J=2,NC
      IF(N0JFX.EQ.0) GO TO 20
      DO 10 K=1,NOJFX
      IF(J.EQ.NFS(K)) GO TO 30
      10 CONTINUE
      20 CNEW=0.0
      CNEW=CNEW-ALPHA(J,1)*C(J-1)/DVD(J)
      CNEW=CNEW-ALPHA(J,2)*C(J+1)/DVD(J)
      CNEW=CNEW-ALPHA(J,3)/DVD(J)
      DELC=CNEW-C(J)
      C(J)=C(J)+RELAX*DELC
      IF(ABS(DELC).LT.BIG) GO TO 30
      BIG=ABS(DELC)
      CHNG=DELC
      NBIG=J
      30 CONTINUE
      IF(N0JFX.EQ.0) GO TO 50
      DO 40 K=1,NOJFX
      IF(NJ.EQ.NFS(K)) GO TO 60
      40 CONTINUE

```

## Subroutine SOLVEX (Cont'd)

```

50 CNEW=-ALPHA(NJ,1)*C(NJ)/DVD(NJ)
  CNEW= CNEW - ALPHA(NJ,3)/DVD(NJ)
  DELC= CNEW-C(NJ)
  C(NJ)=C(NJ)+RELAX*DELC
  IF(ABS(DELC).LT.BIG) GO TO 60
  BIG=ABS(DELC)
  CHNG=DELC
  NBIG=NJ
60 IF(CNOJFX.EQ.0) GO TO 80
  DO 70 K=1,NOJFX
    IF(1.EQ.NFS(K)) GO TO 90
70 CONTINUE
80 CNEW =-ALPHA(1,1)*C(2)/DVD(1)
  CNEW =CNEW-ALPHA(1,3)/DVD(1)
  DELC =CNEW-C(1)
  C(1)=C(1)+RELAX*DELC
  IF(ABS(DELC).LT.BIG) GO TO 100
  BIG = ABS(DELC)
  CHNG=DELC
  NBIG=1
90 CONTINUE
100 CONTINUE
  IF(BIG.LE.DELMAX) GO TO 120
1000 CONTINUE
  WRITE(NWR,110) MAXCYC,CHNG,NBIG
110 FORMAT(1H *18HNO CONVERGENCE IN ,14,26H CYCLES,
     1E15,3,13H AT JUNC NO. ,14,19H PROGRAM CONTINUING
     1,14H
  GO TO 140
120 WRITE(NWR,130) IT
130 FORMAT(1H *15HCONVERGENCE IN ,14,7H CYCLES
  140 CALL QALOUT
  RETJRN
  END

```

## Subroutine INTER

## Subroutine TABU

```

      SUBROUTINE TABU(NDIM, NPTS, X(NPTS), Y(NPTS),
     1                  F(X), G(X), H(X))
      DIMENSION X(1:NPTS), Y(1:NPTS)
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      DATA TAU/6.28318530717958647692/
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      DATA SQRT2/1.41421356237309504880/
      DATA SQRT3/1.73205080756887729352/
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      DATA SQRT6/2.44948974278317809819/
      DATA SQRT7/2.64575131106459059050/
      DATA SQRT8/2.82842712474683064795/
      DATA SQRT9/3.00000000000000000000/
      DATA SQRT10/3.16227766016837943750/
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      DATA SQRT288/35.93571387290872103000/
      DATA SQRT289/36.05357134258996890000/
      DATA SQRT290/36.17142881227121677000/
      DATA SQRT291/36.28927628195246464000/
      DATA SQRT292/36.40712338658356722000/
      DATA SQRT293/36.52497063433083010000/
      DATA SQRT294/36.64281788207809297000/
      DATA SQRT295/36.76066513082535584000/
      DATA SQRT296/36.87851363065865619000/
      DATA SQRT297/36.99636110043989006000/
      DATA SQRT298/37.11420687706714445000/
      DATA SQRT299/37.23205412581440732000/
      DATA SQRT300/37.35000000000000000000/
      DATA SQRT301/37.46785640322747316000/
      DATA SQRT302/37.58571387290872103000/
      DATA SQRT303/37.69999999999999999999/
      DATA SQRT304/37.81785640322747316000/
      DATA SQRT305/37.93571387290872103000/
      DATA SQRT306/38.05357134258996890000/
      DATA SQRT307/38.17142881227121677000/
      DATA SQRT308/38.28927628195246464000/
      DATA SQRT309/38.40712338658356722000/
      DATA SQRT310/38.52497063433083010000/
      DATA SQRT311/38.64281788207809297000/
      DATA SQRT312/38.76066513082535584000/
      DATA SQRT313/38.87851363065865619000/
      DATA SQRT314/38.99636110043989006000/
      DATA SQRT315/39.11420687706714445000/
      DATA SQRT316/39.23205412581440732000/
      DATA SQRT317/39.35000000000000000000/
      DATA SQRT318/39.46785640322747316000/
      DATA SQRT319/39.58571387290872103000/
      DATA SQRT320/39.69999999999999999999/
      DATA SQRT321/39.81785640322747316000/
      DATA SQRT322/39.93571387290872103000/
      DATA SQRT323/40.05357134258996890000/
      DATA SQRT324/40.17142881227121677000/
      DATA SQRT325/40.28927628195246464000/
      DATA SQRT326/40.40712338658356722000/
      DATA SQRT327/40.52497063433083010000/
      DATA SQRT328/40.64281788207809297000/
      DATA SQRT329/40.76066513082535584000/
      DATA SQRT330/40.87851363065865619000/
      DATA SQRT331/40.99636110043989006000/
      DATA SQRT332/41.11420687706714445000/
      DATA SQRT333/41.23205412581440732000/
      DATA SQRT334/41.35000000000000000000/
      DATA SQRT335/41.46785640322747316000/
      DATA SQRT336/41.58571387290872103000/
      DATA SQRT337/41.69999999999999999999/
      DATA SQRT338/41.81785640322747316000/
      DATA SQRT339/41.93571387290872103000/
      DATA SQRT340/42.05357134258996890000/
      DATA SQRT341/42.17142881227121677000/
      DATA SQRT342/42.28927628195246464000/
      DATA SQRT343/42.40712338658356722000/
      DATA SQRT344/42.52497063433083010000/
      DATA SQRT345/42.64281788207809297000/
      DATA SQRT346/
```

## Subroutine OUTGO

```

SUBROUTINE OUTGO(LVAR,NP,X,Y)
COMMON QIN(250),QOUT(250),Q(250),A1(250),A2(250),A3(250),
      WIDTH(250),AS(250),V(250),TEMP(250)*EVAP(250)*RMJ(250),
      PHUTO(250)*SEUMI(250),Z(250),DK1(250)*DK2(250)*XNOD(250),
      REAIR(250)*DOS(250)*CBODI(250)*CBUD(250)*XNODI(250),
      OXY(250),CS(250),A(250),VOL(250),CIN(250),C(250),
      LALPHA(20)*ALPHA(250,3)*DVD(250)*NFS(250)*RMC(250),
      *CDONP(250)*XNBNP(250)*CONP(250)*QNP(250)*OXYNP(250)
COMMON NC,NJ,KLEN,NOJF,X,RMUP,RMDWN,RMFR,NSECS,XMIL,LCONS,K2FL,
      NRD,NWR,NVT
      1  DIMENSION X(250),Y(250)
      ILINE=NP/4
      IEXTA=NP-4*ILINE
      WRITE(NWR,10)LVAR,LVAR,LVAR
10  FORMAT(1H0,3X,A4,4X,5HRIVER,18X,A4,4X,5HRIVER,18X,A4,4X,5HRIVER,18
      IX,A4,4X,5HRIVER,/,1H,4X,2HNO,5X,4HMILE,7X,5HVALUE,8X,2HNO,5X,4HM
      ILE,7X,5HVALUE,8X,2HNO,5X,4HMILE,7X,5HVALUE,8X,2HNO,5X,4HMILE,7X,5H
      3VALUE)
      DO 30 I=1,ILINE
      I2=I+ILINE+IEXTA
      I3=I2+ILINE
      I4=I3+ILINE
      WRITE(NWK,20)I,X(I),Y(I),I2,X(I2),Y(I2),I3,X(I3),Y(I3),I4,X(I4),
      Y(I4)
20  FORMAT(1H,3X,13,4X,F6,2,4X,1PE10,3,4X,13,4X,0PF6,2,4X,1PE10,3,
      14X,13,4X,0PF6,2,4X,1PE10,3,4X,13,4X,0PF6,2,4X,1PE10,3)
30  CONTINUE
      IF(IEXTA.EQ.0)GO TO 60
      IEND=ILINE+IEXTA
      IBEG=ILINE+1
      DO 50 I=IBEG,IEND
      WRITE(NWR,40)I,X(I),Y(I)
40  FORMAT(1H,3X,13,4X,F6,2,4X,1PE10,3)
50  CONTINUE
60  RETURN
END

```

## Subroutine DIVCK

```

SUBROUTINE DIVCK(NERR)
COMMON QIN(250),QOUT(250),Q(250),A1(250),A2(250),A3(250),
      WIDTH(250),AS(250),V(250),TEMP(250),EVAP(250),RMJ(250),
      PHOT(250),SEDM(250),Z(250),DK1(250),DK2(250),XNOD(250),
      REAIR(250),DOS(250),CB001(250),CB002(250),XNODE(250),
      OXY(250),CS(250),A(250),VOL(250),CIN(250),C(250),
      LAPHA(20),ALPHA(250),DVD(250),NFS(250),RMC(250),
      ,CB0NP(250),XNBNP(250),CONN(250),QNP(250),OXYNP(250)
COMMON NC,NJ,XLEN,NOJFX,RMUP,RMDWN,RMFN,NSEC5,XNL,LCONS,K2FL,
      NRU,NWR,NVI
1      NERR=0
      DO 10 J=1,NJ
      IF(NOJFX.EQ.0) GO TO 11
      DO 20 K=1,NOJFX
      IF(J.EQ.NFS(K)) GO TO 10
20    CONTINUE
      11 IF(DVD(J).NE.0.0) GO TO 10
      WRITE(NWR,30)J
30    FORMAT(1H,20(1H?),5X,23HZERO DIVIDE AT JUNCTION,15)
      NERR=NERR+1
      10 CONTINUE
      RETURN
      END

```



## Function JKFND

```
FUNCTION JKFND(NJ,XMIL,DIST,RMUP,RMDWN)
NSET=1+IF(X(((DIST-RM)WN)/XMIL)+0.5)
IF(DIST.LT.RMDWN) NSET=1
IF(DIST.GT.RMUP) NSET=NJ
JKFD=NSET
RETURN
END
```

## Subroutine QALOUT

```

SUBROUTINE QALOUT
COMMON QIN(250),QOUT(250),Q(250),A1(250),A2(250),A3(250),
1      WIDTH(250),AS(250),V(250),TEMP(250),EVAP(250),RMJ(250),
2      PHOTO(250),SEDMT(250),Z(250),DK1(250),DK2(250),XNOD(250),
3      REAIR(250),DOS(250),CBODI(250),CBOD(250),XNODI(250),
4      OXY(250),CS(250),A(250),VOL(250),CIN(250),CL(250),
5      LALPHA(20),ALPHA(250+3),DV0(250),NFS(250),RMC(250)
6      •CBDNP(250),XNBNP(250),CONNP(250),QNP(250),OXYNP(250)
COMMON NC,NJ,XLEN,NCJFX,RMUP,RMDWN,RMFR,NSECS,XMIL,LCONS,K2FL,
    NRD,NWR,NVT
1      DATA LCBD/4HCBOD/,LNBD/4HNBD/,LDD/4HDO /
DATA LVARI/4HJUNC/,LVAR2/4HCHAN/
WRITE(NWR,10) (LALPHA(K),K=1,20),LCONS,QOUT(1)
10 FORMAT(1H1,130(1H*),/,1H*130(1H*),/,1H*130(1H*),/,1H*20(1H*
1)•/•1H*130(1H*),/,1H*20(1H*),/•1H*20(1H*),/•1H*20(1H*),
2ATIONS (PPM),47X,20(1H*),/•1H*20(1H*),/•1H*20(1H*),
35X,27HOUTFLOW AT DOWNSTREAM END =,F10.1,4H CFS,44X,20(1H*),/•1H*
4130(1H*),/•1H*130(1H*))
WRITE(NWR,20)
20 FORMAT(1H0,50X,20HCONCENTRATIONS (PPM) )
XCK=1.0E-10
DO 25 J=1,NJ
IF(C(J).LT.XCK)C(J)=0.0
25 CONTINUE
CALL OUTGO(LVARI,NJ,RMJ,C)
IF(LCONS.EQ.LCBD.OR.LCONS.EQ.LNBD.OR.LCONS.EQ.LDU) GO TO 30
GO TO 40
30 BOTTOM=0.0
GO TO 60
40 BOTTOM=1.0E25
DO 50 J=1,NJ
IF(C(J).LT.BOTTOM) BOTTOM=C(J)
50 CONTINUE
IF(BOTTOM.LT.0.0) BOTTOM=0.0
IHOT=IFIX(BOTTOM)

```

## Subroutine QALOUT (Cont'd)

```
BOTTOM=FLOAT(IROT)
50 TOP=0.0
DO 70 J=1,NJ
  IF(C(J).GT.TOP)TOP=C(J)
70 CONTINUE
  ITOP=IFIX(TOP+1.0)
  TOP=FLOAT(ITOP)
  WRITE(NWR,80)LCONS
80 FORMAT(1H1,12HX=RIVER MILE,85X,3HY= ,A4,21H CONCENTRATIONS (PPM),
1/•140)
  CENT=0.0
  NSKIP=0
  CALL GRAPH(BOTTOM, TOP, NJ, RMJ, C, CENT, NSKIP, NWR)
  RETURN
END
```

## Subroutine GRAPH

```

SUBROUTINE GRAPH(BOTTOM, TOP, NP, X, Y, CENT, NSKIP, NWK)
DIMENSION X(NP), Y(NP), IPLT(100)
DATA LCNT, LPLUS, IH, IH*, / 
DATA LR0, LRSTAR, LRPT, LR0/IH, IH*, IH*-IH0/
INDEX=NSKIP

LINEZ=IABS(NSKIP)
IF (INDEX.LT.1) INDEX=1
40 WRITE(NWK, 330) BOTTOM, TOP
330 FORMAT(IH*.8X, 1PE8.1, 9IX, E8.1)
WRITE(NWK, 310)

310 FORMAT(IH*.4X, IH*.5X, 10I(IH*.5X, IHY))
YS=(TOP-BOTTOM)/100.0
NCENT=(CENT-BOTTOM)/YS
DO 50 JFK=1,NP,INDEX
DO 60 LY=1,100
IPLT(LY)=LRB
IPLT(LY)=LRB
60 CONTINUE
IF (NSKIP.GE.0) GO TO 3
IF (NCENT.GT.0) IPLT(NCENT)=LCNT
DO 5 LBJ=1,LINEZ
WRITE(NWK, 6) IPLT
6 FORMAT(IH*.10X, IH*, 100A1, IH*)
5 CONTINUE
3 NPOT=(Y(JFK)-POTOM)/YS
IF (NPOT.GT.100) NPOT=100
IF (NPOT.LT.1) NPOT=1
IF (NCENT.GT.100) GO TO 550
IF (NCENT.LE.0) GO TO 550
IF (NPOT.LT.NCENT) GO TO 500
LIMIT=NPOT-1
IF (LIMIT.LT.1) GO TO 550
DO 400 LL=NCENT,LIMIT
IPLT(LL)=LPLUS
400 CONTINUE
IPLT(NCENT)=LCNT

```

## Subroutine GRAPH (Cont'd)

```
GO TO 550
500 LIMIT=NPOT+1
      DO 501 LL=LIMIT,NCENT
           IPLT(LL)=LRPT
501  CONTINUE
           IPLT(NCENT)=LCNT
550  CONTINUE
           2 IPLT(NPOT)=LRSTAR
           4 WRITE(NWR,320) X(JFK),IPLT,Y(JFK)
           320 FORMAT(1H , 1PE8.1,1X,1H.,100A1,1H., E8.1)
           50 CONTINUE
           WRITE(NWR,350)
           350 FORMAT(1H ,10X,101(1H.))
           RETURN
           END
```

**AUTØQD:**

The program output has the same basic format with the following additions:

Under the heading "Estuary/Stream Data" the non-point source input data and other physical data is printed.

Under the heading "Flow Conditions for the Period (Month-Day-Year) through (Month-Day-Year)" the point source inflows and/or diversions, the non-point source inflows and/or non-point losses and the channel flows are printed. The non-point values printed here are the equivalent junction inflows and/or diversions (non-point source value multiplied by channel length)"

Under the heading "Input Conditions for (Month-Day-Year) through (Month-Day-Year)" the point source inflow concentrations and the equivalent non-point source loadings are printed.

The non-point source loading is the total mass loading due to non-point sources for the junctions (non-point source value multiplied by channel length).

The same new variables have been added to program AUTØQD that were added to AUTØSS.

**Program Listing**

Following is a complete listing of Program AUTØQD. New or changed cards are marked by arrows.

## Main PROGRAM

```

***** PROGRAM AUTOQD - QUASI-DYNAMIC WATER QUALITY *****

***** WRITTEN BY R.L. CRIM AND N.L. LOVELACE *****

***** ENVIRONMENTAL PROTECTION AGENCY, REGION III *****

***** ANNAPOLIS FIELD OFFICE *****

***** TECHNICAL DEVELOPMENT SECTION *****

***** ANNAPOLIS SCIENCE CENTER, ANNAPOLIS, MD. 21401 *****

***** PHONE: 301-268-5038 OR 202-261-2410 *****

***** COMMON QIN(250),QOUT(250),Q(250),Z(250),XNUIN(250), *****
***** CBDIN(250),OXIN(250),CIN(250),C(250),REAIK(250),VOL(250), *****
***** PHOTO(250),EVAP(250),AS(250),SEDMT(250),DUS(250),V(250), *****
***** WIDTH(250),AI(250),A2(250),A3(250),TEMP(250),DK1(250), *****
***** DK2(250),CBOD(250),XNOD(250),OKY(250),CS(250),NFS(250), *****
***** XMAS(250),XMAS(250),XCMAS(250),XOMAS(250),MFS(250,3), *****
***** RMJ(250),RMC(250),LALPHA(20), *****
***** CBJNP(250),XNBNP(250),CONNRP(250),OXYNP(250),QNP(250) *****
***** COMMON NJ,NC,XLEN,NOJFX,RMUP,RMDWN,RMFR,DELT,DELT2,DELTD,NPRT, *****
***** NOCYC,NSECS,XMIL,NBEG,NEND,IMOB,IMOB,IMUE,IMUE,IDAYE, *****
***** IYHE,NDAYS,K2FL,LTYPE,LCBD,LNBD,LSTOP,LVARI,LVAR2, *****
***** LFIXE,NRD,NWR,NVT *****
***** DATA LBD/4HCBOD/,LND/4HNBD/,LO/4HDD/,LSI/0/4HSSTOP/, *****
***** LJU/4HJUNC/,LCH/4HCHAN/,LFX/4HFIXE/,LFL0/4HFLOW/, *****
***** LDATA/4HDATA/,LHALT/4HHALT/ *****
***** LCBD=LBD *****
***** LND=LND *****
***** LDO=LDO *****
***** STOP=STO *****

```

**AUTØQD:**

The program output has the same basic format with the following additions:

Under the heading "Estuary/Stream Data" the non-point source input data and other physical data is printed.

Under the heading "Flow Conditions for the Period (Month-Day-Year) through (Month-Day-Year)" the point source inflows and/or diversions, the non-point source inflows and/or non-point losses and the channel flows are printed. The non-point values printed here are the equivalent junction inflows and/or diversions (non-point source value multiplied by channel length)"

Under the heading "Input Conditions for (Month-Day-Year) through (Month-Day-Year)" the point source inflow concentrations and the equivalent non-point source loadings are printed.

The non-point source loading is the total mass loading due to non-point sources for the junctions (non-point source value multiplied by channel length).

The same new variables have been added to program AUTØQD that were added to AUTØSS.

**Program Listing**

Following is a complete listing of Program AUTØQD. New or changed cards are marked by arrows.

## Main PROGRAM

```

C*** PROGRAM AUTOQD - QUASI-DYNAMIC WATER QUALITY
C*** WRITTEN BY R.L. CRIM AND N.L. LOVELACE
C*** ENVIRONMENTAL PROTECTION AGENCY, REGION III
C*** ANNAPOLIS FIELD OFFICE
C*** TECHNICAL DEVELOPMENT SECTION
C*** ANNAPOLIS SCIENCE CENTER, ANNAPOLIS, MD. 21401
C*** PHONE: 301-268-5038 OR 202-261-2410
C*** COMMON QIN(250),QOUT(250),Q(250),Z(250),XNDIN(250),
C*** C8DIN(250),OXIN(250),CIN(250),C(250),REAIK(250),VOL(250),
C*** PHO(250),EVAP(250),AS(250),SEDMT(250),DUS(250),V(250),
C*** WIDTH(250),AI(250),A2(250),A3(250),TEMP(250),DK1(250),
C*** DR2(250),CBOD(250),XNOD(250),OKY(250),CS(250),NFS(250),
C*** XMAS(250),XMAS(250),XOMAS(250),MFS(250),3),
C*** RMJ(250),RMC(250),L_ALPHA(20)
C*** CHDNP(250),XNBNP(250),CONN(250),OXYNP(250),GNP(250)
C*** COMMON NJ,NC,XLEN,NOJFX,RMUP,RMDWN,RMFR,DELT2,DELT0,NPRT,
C*** NOCYC,INSECS,XMIL,NBEG,NEND,IM09,IDAY8,LYRA,IMUE,IDIAYE,
C*** IYRE,NDAYS,K2FL,LTYPE,LCBD,LNAD,LDO,LS10P,LVARI,LVAR2,
C*** LFIXE,NRD,NWR,NVT
C*** DATA LBD/4HCB00/,LND/4HNBD0/,LO/4HDO/,LST0/4HS10P/,
C*** LJU/4HJUNC/,LCH/4HCHAN/,LFX/4HFIXE/,LFL0/4HFLOW/,,
C*** LDATA/4HDATA/,LHALT/4HALT/
C*** LCBD=LBD
C*** LNBD=LND
C*** LDO=L0
C*** LSTOP=LST0

```

## Main Program (Cont'd)

```

LVAR1=LJU
LVAR2=LCH
LFIXE=LFX
NRD=1
NWR=6
NVT=0
READ(NRD,10) (LALPHA(K),K=1,20)
10 FORMAT(20A4)
READ(NRD,20) RMDWN,RMUP,RMFR,NSECS
20 FORMAT(3F10.0,1I0)
WRITE(NWR,30)
30 FORMAT(1H,1I30(1H*),/,1H,130(1H*),/,1H,13X,3HAAA,1IX,3HUUU,9X,3H
1UUU,5X,15(1HT),7X,11(1HO),9X,11(1HQ),7X,13(1HD),/,1H,12X,5HAAAA,
210X,3HUUU,9X,3HUUU,5X,15(1HT),6X,13(1HO),7X,13(1HQ),6X,14(1HD),/,1
3H,11X,7(1HA),9X,3HUUU,9X,3HAAA,5X,15(1HT),5X,15(1HO),5X,15(1HQ),5
4X,15(1HD),/,1H,10X,3HAAA,3X,3HUUU,8X,3HUUU,9X,3HUUU,1IX,3HTTT,1X
5,3H000,9X,3H000,
6 5X,3HQQQ,9X,3HQQQ,5X,3HDDD,9X,3HDDD,/,1H,9X,3HAAA,5X,3HAAA
7,7X,3HUUU,9X,3HUUU,1IX,3HTTT,1IX,3H000,9X,3H000,5X,3HQQQ,9X,3HQQQ,
85X,3HDDD,9X,3HDDD,/,1H,8X,3HAAA,7X,3HAAA,6X,3HUUU,9X,3HUUU,1IX,3H
9TTT,1IA,3H000,9X,3H000,5X,3HQQQ,5X,7HQQQ,9X,3HDDD,9X,3HDDD,
WRITE(NWR,40)
40 FORMAT(1H,7X,15(1HA),5X,3HUUU,9X,3HUUU,1IX,3HTTT,1IX,3H000,9X,3H
100,5X,3HQQQ,6X,6HQQQQQ,5X,3HDDD,9X,3HDDD,/,1H,7X,15(1HA),5X,15(1
2HU),1IX,3HTTT,1IX,15(1HO),5X,15(1HQ),5X,15(1HD),/,1H,7X,3HAAA,9X,
33HAAA,6X,13(1HU),12X,3HTTT,12X,13(1HO),7X,14(1HQ),5X,14(1HD),/,1H
4,7X,3HAAA,9X,3HAAA,7X,11(1HU),13X,3HTTT,13X,11(1HO),9X,13(1HQ),5X,
5,13(1HD),/,1H,130(1H*),/,1H,130(1H*)
WRITE(NWR,50) (LALPHA(K),K=1,20),RMDWN,RMUP,RMFR,NSECS
50 FORMAT(1H,20(1H*),5X,3HQQUASI-DYNAMIC WATER QUALITY MODEL,/,1H,2
10(1H*),/,1H,20(1H*),5X,14HRUN TITLE,•••,20A4,/,1H,20(1H*),/,1H
2,20(1H*),/,1H,20(1H*),5X,18HBASIC NETWORK DATA,/,1H,20(1H*),5X,3
31HRIVER MILE AT DOWNSTREAM END,•••F10.2,/,1H,20(1H*),5X,31HRIVER
4MILE AT UPSTREAM END,•••F10.2,/,1H,20(1H*),5X,31HRIVER MILE OF
5FALL LINE,••••••,F10.2,/,1H,20(1H*),5X,31HNUMBER OF SECTIONS•••

```

## Main PROGRAM (Cont'd)

```

6.....110 )
CALL SETUP
1000 READ(NRD,10)LTYP
IF(LTYP.EQ.LHALT)GO TO 2000
IF(LTYP.EQ.LDATA)GO TO 60
CALL NETDAT
GO TO 1000
60 IF(LTYP.NE.LCBD)GO TO 80
DO 70 J=1,NJ
C(J)=CBOD(J)
70 CONTINUE
CALL VAULIN
CALL VALCMP
DO 75 J=1,NJ
CBOD(J)=C(J)
75 CONTINUE
GO TO 1000
80 IF(LTYP.NE.LNBD)GO TO 100
DO 90 J=1,NJ
C(J)=XNOD(J)
90 CONTINUE
CALL VAULIN
CALL VALCMP
DO 95 J=1,NJ
XNOD(J)=C(J)
95 CONTINUE
GO TO 1000
100 IF(LTYP.NE.LD0)GO TO 110
CALL VDOIN
CALL VDOCP
GO TO 1000
110 IF(LTYP.NE.LFL0)GO TO 120
CALL FLOWS
GO TO 1000
120 DO 130 J=1,NJ

```

## Main PROGRAM (Cont'd)

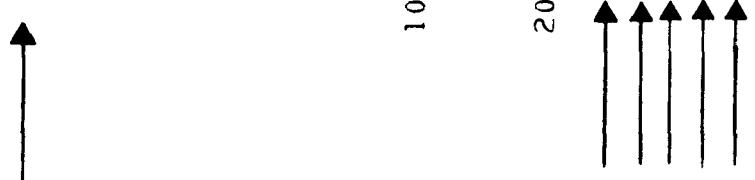
```
C(J)=CS(J)
130 CONTINUE
      CALL VAULIN
      CALL VALCMP
      DO 135 J=1,NJ
      CS(J)=C(J)
135 CONTINUE
      GO TO 1000
2000 STOP
      END
```

## Subroutine SETUP

```

SUBROUTINE SETUP
COMMON QIN(250),QOUT(250),Q(250),A(250),Z(250),XNDIN(250),
      CRDIN(250),OXIN(250),CIN(250),C(250),REAIR(250),VOL(250),
      1   PHOTO(250),EVAP(250),AS(250),SEDMT(250),DOS(250),V(250),
      2   WIDTH(250),A1(250),A2(250),A3(250),TEMP(250),DK1(250),
      3   DK2(250),CBOD(250),XNOD(250),OXY(250),CS(250),NFS(250),
      4   XMASS(250),XNMAS(250),XCMAS(250),XOMAS(250),MFS(250,3),
      5
      6   RMJ(250),RMC(250),LALPHA(20)
      7   ,CBDNP(250),XNBNP(250),CONNP(250),OXYNP(250),QNP(250)
COMMON NJ,NC,XLEN,NOJFX,RMUP,RMDWN,RMFN,DELT,DELT2,DELT3,NPRT,
      1   NQCYC,NSECS,XMIL,NBEG,NEND,IMOB,IYRB,IMOE,IDAYE,
      2   IYRE,NDAYS,K2FL,LTYPE,LCBD,LNBD,LSTOP,LVAR1,LVAR2,
      3   LFIXE,NRD,NWR,NVT
      NC=NSECS

      NJ=NSECS+1
      XMIL=(RMUP-RMDWN)/FLOAT(NC)
      XLEN=XMIL*5285.0
      RMJ(1)=RMDWN
      DO 10 J=2,NJ
      RMJ(J)=RMJ(J-1)+XMIL
      10 CONTINUE
      RMC(1)= RMDWN+(XMIL/2.0)
      DO 20 N=2,NC
      RMC(N)=RMC(N-1)+XMIL
      20 CONTINUE
      DO 30 J=1,NJ
      CBDNP(J)=0.0
      XNBNP(J)=0.0
      QNP(J)=0.0
      CONNP(J)=0.0
      OXYNP(J)=0.0
      QIN(J)=0.0
      QOUT(J)=0.0
      Q(J)=0.0
      A(J)=0.0
      
```



## Subroutine SETUP (Cont'd)

```
Z(J)=0.0
XNDIN(J)=0.0
CBDIN(J)=0.0
OXIN(J)=0.0
CIN(J)=0.0
C(J)=0.0
REAIR(J)=0.0
VOL(J)=0.0
PHOTO(J)=0.0
EVAP(J)=0.0
AS(J)=0.0
SEDMT(J)=0.0
DOS(J)=0.0
V(J)=0.0
WIDTH(J)=0.0
A1(J)=0.0
A2(J)=0.0
A3(J)=0.0
TEMP(J)=20.0
DK1(J)=0.0
DK2(J)=0.0
CBOD(J)=0.0
XNOD(J)=0.0
OXY(J)=0.0
CS(J)=0.0
NFS(J)=0
XMAS(S(J))=0.0
XNMAS(S(J))=0.0
XCMAS(S(J))=0.0
XOMAS(S(J))=0.0
DO 30 K=1,3
MFS(J,K)=0
30 CONTINUE
RETURN
END
```

## Subroutine NEDAT

```

SUBROUTINE NETDAT
COMMON QIN(250),QOUT(250),Q(250),A(250),Z(250),X,UIN(250),
     1      CHDIN(250),OXIN(250),CIN(250),C(250),REAI(250),VOL(250),
     2      PHOTO(250),EVAP(250),AS(250),SEDMT(250),DUS(250),V(250),
     3      WIDTH(250),A1(250),A2(250),A3(250),TEMP(250),DK1(250),
     4      DK2(250),CBOD(250),XNOD(250),OXY(250),CS(250),NFS(250),
     5      XMASS(250),XNMAS(250),XCMAS(250),XOMAS(250),MFS(250,3),
     6      RMJ(250),RMC(250),LALPHA(20),
     7      • C5DNP(250),XNBNP(250),CONNP(250),OXYNP(250),QNP(250)
COMMON NJ,NC,XLEN,NOJFX,RMUP,RMDWN,RMFR,DELT,DELTC,DELTD,NPRT,
     1      NQCYC,NSECS,XMIL,NHEG,NEND,IMOB,IDAYB,IYRB,IMUE,IDAYE,
     2      IYRE,NDAYS,K2FL,LTYPE,LCBD,LNBD,LDU,LSTOP,LVAR1,LVAR2,
     3      LFIXE,NRD,JWR,NVT
DATA LA1/4HA1/,LA2/4HA2/,LA3/4HA3/,LWIDT/4HWIDT/,
     1      LVEL/4HVEL0/,LTEMP/4HTEMP/,LVAP/4HEVAP/,LPHT0/4HPHOT/,
     2      LSEDMT/4HSEDI/,LDISP/4HDISP/,LDK1/4HCDEC/,LUK2/4HNDEC/,,
     3      LREAI/4HREAE/,LDOS/4HSATD/,LINIT/4HINIT/,LOXY/4HDO /,
     4      LCSA/4HC-SA/,LCK2/4HC-RE/,LFL0/4HFLOW/,LNON/4HNONP/
DATA VAPFAC/1.86224E07/,CVFAC/3.28075E00/
DIMENSION X(250),Y(250)
K2FL=0
WRITE(NWR,10)
10 FORMAT(1H1,130(1H*),/,1H  •130(1H*),/,1H  •35(1H*),•61X,34(1H*),•/,1H
     1•35(1H*),•6X•49HE S T U A R Y / S T R E A M   I N P U T   D A T A ,
     26X•34(1H*),/,1H  •35(1H*),•61X,34(1H*),/,1H  •130(1H*),•/,1H  •130(1H*)
     3)
1000 READ(NRD,20)LABEL,LCST,NPTS
20 FORMAT(2A4•2X,15)
     IF(LABEL•EQ•LSTOP)GO TO 5000
     IF(NPTS•EQ•0) GO TO 45
     DO 40 J=1,NPTS
     READ(NRD,30)I,X(J),Y(J)
     30 FORMAT(15,5X,2F10.0)
     40 CONTINUE
     45 IF(LABEL•NE•LAI) GO TO 60

```

\* This change is indicated in the errata for T.R. 54

## Subroutine NEDAT (Cont'd)

```

CALL INTER(A1,NC,X,Y,NPTS,RMC)
WRITE(NWR,50)
50 FORMAT(1H0,20(1H*),5X,32HA1 COEFFICIENT FOR FLOW EQUATION,5X,20(1H
1*))
      CALL OUTGO(LVAR2,NC,RMC,A1)
      GO TO 1000
60 IF(LABEL.NE.LA2) GO TO 80
      CALL INTER(A2,NC,X,Y,NPTS,RMC)
      WRITE(NWR,70)
70 FORMAT(1H0,20(1H*),5X,32HA2 COEFFICIENT FOR FLOW EQUATION,5X,20(1H
1*))
      CALL OUTGO(LVAR2,NC,RMC,A2)
      GO TO 1000
80 IF(LABEL.NE.LA3) GO TO 100
      CALL INTER(A3,NC,X,Y,NPTS,RMC)
      WRITE(NWR,90)
90 FORMAT(1H0,20(1H*),5X,79HA3 COEFFICIENT FOR FLOW EQUATION - REVERSE
INTS DEPTH OF FLOW IF A1 AND/OR A2 ARE ,5X,20(1H*),/,1H ,20(1H*),5X
2,27HNOT SPECIFIED (OR ARE ZERO),57X,20(1H*))
      CALL OUTGO(LVAR2,NC,RMC,A3)
      GO TO 1000
100 IF(LABEL.NE.LWIDT) GO TO 120
      CALL INTER(WIDTH,NC,X,Y,NPTS,RMC)
      WRITF(NWR,110)
110 FORMAT(1H0,20(1H*),5X,19HCHANNEL WIDTHS (FT),5X,20(1H*))
      CALL OUTGO(LVAR2,NC,RMC,WIDTH)
      AS(1)=WIDTH(1)*XLEN
      AS(NJ)=WIDTH(NJ)*XLEN
      DO 112 J=2,NC
      AS(J)=XLEN*0.5*(WIDTH(J)+WIDTH(J-1))
112 CONTINUE
      WRITE(NWR,114)
114 FORMAT(1H0,20(1H*),5X,29HJUNCTION SURFACE AREAS (SQFT),5X,20(1H*))
      CALL OUTGO(LVAR1,NJ,RMJ,AS)
      GO TO 1000
120 IF(LABEL.NE.LVEL) GO TO 150

```

## Subroutine NETDAT (Cont'd)

```

NVT=1
CALL INTER(V,NC,X,Y,NPTS,RMC)
DO 130 N=1,NC
IF (RMC(N) .GT. RMFR) V(N)=0.0
130 CONTINUE
WRITE(NWR,140)
140 FORMAT(1H0,20(1H*) ,5X,41HAVERAGE CHANNEL TIDAL VELOCITIES (FT/SEC)
1.5X,20(1H*) )
CALL OUTGO(ILVAR2,NC,RMC,V)
GO TO 1000
150 IF(LABEL.NE.LTEMP) GO TO 170
CALL INTER(TEMP,NJ,X,Y,NPTS,RMJ)
WRITE(NWR,160)
160 FORMAT(1H0,20(1H*) ,5X,35HJUNCTION WATER TEMPERATURES (DEG-C) ,5X,20(
1(1H*) )
CALL OUTGO(ILVAR1,NJ,RMJ,TEMP)
GO TO 1000
170 IF(LABEL.NE.LVAP) GO TO 200
CALL INTER(EVAP,NJ,X,Y,NPTS,RMJ,EVAP)
WRITE(NWR,180)
180 FORMAT(1H0,20(1H*) ,5X,34HNET EVAPORATION - RAINFALL (IN/MO) ,5X,20(
11H*) )
CALL OUTGO(ILVAR1,NJ,RMJ,EVAP)
DO 190 J=1,NJ
EVAP(J)=EVAP(J)/VAPFAC
190 CONTINUE
GO TO 1000
200 IF(LABEL.NE.LPHOTO) GO TO 230
CALL INTER(PHOTO,NJ,X,Y,NPTS,RMJ)
WRITE(NWR,210)
210 FORMAT(1H0,20(1H*) ,5X,61HAVERAGE DAILY PHOTOSYNTHESIS-RESPIRATION
IRATE (GM O2/SQM/DAY) ,5X,20(1H*) )
CALL OUTGO(ILVAR1,NJ,RMJ,PHOTO)
DO 220 J=1,NJ
PHOTO(J)=PHOTO(J)*CVFAC/86400.0

```

## Subroutine NETDAT (Cont'd)

```

220 CONTINUE
GO TO 1000
230 IF (LABEL•NE•LSEDMT) GO TO 260
CALL INTER(LSEDMT,NJ,X,Y,NPTS,RMJ)
WRITE(NWR•240)
240 FORMAT(1H0,20(1H*),5X,42H OXYGEN UPTAKE OF SEDIMENTS (GM 02/SQM/DAY
1)*5X,20(1H*))
CALL OUTGO(ILVAR1•NJ,RMJ,SEDMT)
DO 250 J=1,NJ
SEDMT(J)=SEDMT(J)*CVFAC/86400.0
250 CONTINUE
GO TO 1000
260 IF (LABEL•NE•LDISP) GO TO 280
CALL INTER(Z,NC,X,Y,NPTS,RMC)
WRITE(NWR•270)
270 FORMAT(1H0,20(1H*),5X,34H DISPERSION COEFFICIENTS (SQFT/SEC),5X,20(
1H*))
CALL OUTGO(ILVAR2,NC,RMC,Z)
GO TO 1000
280 IF (LABEL•NE•LDK1) GO TO 310
CALL INTER(DK1•NJ,X,Y,NPTS,RMJ)
DO 285 J=1,NJ
DK1(J)=DK1(J)*1.047** (TEMP(J)-20.0)
285 CONTINUE
WRITE(NWR•290)
290 FORMAT(1H0,20(1H*),5X,52H CHOD DECAY RATES CORRECTED TO STREAM TEMP
1S - (1/DAY)*5X,20(1H*))
CALL OUTGU(ILVAR1•NJ,RMJ,DK1)
DO 300 J=1,NJ
DK1(J)=DK1(J)/86400.0
300 CONTINUE
GO TO 1000
310 IF (LABEL•NE•LDK2) GO TO 340
CALL INTER(DK2•NJ,X,Y,NPTS,RMJ)
DO 315 J=1,NJ

```

## Subroutine NETDAT (Cont'd)

```

315 CONTINUE
      WRITE(NWR,320)
320 FORMAT(1H0,20(1H*),5X,52HNBOD DECAY RATES CORRECTED TO STREAM TEMP
1S - (1/DAY)*5X,20(1H*))
      CALL OUTGO(LVARI,NJ,RMJ,DK2)
      DO 330 J=1,NJ
      DK2(J)=DK2(J)/86400.0
330 CONTINUE
      GO TO 1000
340 IF(LABEL.NE.LREAL) GO TO 370
      CALL INTER(REAIR,NJ,X,Y,NPTS,RMJ)
      DO 345 J=1,NJ
      REAIR(J)=REAIR(J)*1.024**((TEMP(J)-20.0)
345 CONTINUE
      WRITE(NWR,350)
350 FORMAT(1H0,20(1H*),5X,58HINPUT REAERATION RATES CORRECTED TO STREAM
1M TEMPS - (1/DAY)*5X,20(1H*))
      CALL OUTGO(LVARI,NJ,RMJ,REAIR)
      DO 360 J=1,NJ
      REAIR(J)=REAIR(J)/86400.0
360 CONTINUE
      GO TO 1000
370 IF(LABEL.NE.LDOS) GO TO 390
      CALL INTER(DOS,NJ,X,Y,NPTS,RMJ)
      WRITE(NWR,380)
380 FORMAT(1H0,20(1H*),5X,46HINPUT OXYGEN SATURATION CONCENTRATIONS
1(PPM),5X,20(1H*))
      CALL OUTGO(LVAPI,NJ,RMJ,DOS)
      GO TO 1000
390 IF(LABEL.NE.LINIT) GO TO 470
      IF(LCST1.NE.LCSD) GO TO 410
      CALL INTER(CBOD,NJ,X,Y,NPTS,RMJ)
      WRITE(NWR,400)
400 FORMAT(1H0,20(1H*),5X,33HINITIAL CBOD CONCENTRATIONS (PPM),5X,20(1

```

## Subroutine NETDAT (Cont'd)

```

1H*) )
CALL OUTGO(LVARI,NJ,RMJ,CHOD)
GO TO 1000
410 IF (LCST.NE.LNRD) GO TO 430
CALL INTER(XNOD,NJ,X,Y,NPTS,RMJ)
WRITE(NWR,420)
420 FORMAT(1H0,20(1H*),5X,33HINITIAL NBOD CONCENTRATIONS (PPM),5X,20(1
1H*))
CALL OUTGO(LVARI,NJ,RMJ,XNOD)
GO TO 1000
430 IF (LCST.NE.LOXY) GO TO 450
CALL INTER(OXY,NJ,X,Y,NPTS,RMJ)
WHITE(NWR,440)
440 FORMAT(1H0,20(1H*),5X,45HINITIAL DISSOLVED OXYGEN CONCENTRATIONS (
1PPM),5X,20(1H*))
CALL OUTGO(LVARI,NJ,RMJ,OXY)
GO TO 1000
450 CALL INTER(CS,NJ,X,Y,NPTS,RMJ)
WRITE(NWR,460)L CST
460 FORMAT(1H0,20(1H*),5X,8HINITIAL ,A4,21H CONCENTRATIONS (PPM),5X,20
1(1H*))
CALL OUTGO(LVARI,NJ,RMJ,CS)
GO TO 1000
470 IF (LABEL.NE.LCSA) GO TO 500
DO 480 J=1,NJ
DOS(J)=14.62-J*367*TEMP(J)+0.0045*(TEMP(J)**2.0)
480 CONTINUE
WRITE(NWR,490)
490 FORMAT(1H0,20(1H*),5X,47HCOMPUTED OXYGEN SATURATION CONCENTRATIONS
1 (PPM),5X,20(1H*))
CALL OUTGO(LVARI,NJ,RMJ,DOS)
GO TO 1000
500 IF (LABEL.NE.LCK2) GO TO 510
K2FL=1
GO TO 1000

```

## Subroutine NETDAT (Cont'd)

```

      510 IF (LABEL.NE.LNON) GO TO 610
      510 IF (LCST.NE.LCSD) GO TO 530
      510 CALL INTER(CBOND, NJ, X, Y, NPTS, RMJ)
      510 WRITE(NWR, 520)
      520 FORMAT(1H0,20(1H*)•5X,63HCBD0 NONPOINT SOURCE CONTRIBUTION (LBS CB
      10D/DAY/MILE OF STREAM)•5X•20(1H*))
      520 CALL OUTGO(LVARI, NJ, RMJ, CBNDP)
      520 GO TO 1000
      530 IF (LCST.NE.LNBD) GO TO 550
      530 CALL INTER(XNBDP, NJ, X, Y, NPTS, RMJ)
      530 WRITE(NWR, 540)
      540 FORMAT(1H0,20(1H*)•5X,63HNBD0 NONPOINT SOURCE CONTRIBUTION (LBS NB
      10D/DAY/MILE OF STREAM)•5X•20(1H*))
      540 CALL OUTGO(LVARI, NJ, RMJ, XNBDP)
      540 GO TO 1000
      550 IF (LCST.NE.LOXY) GO TO 570
      550 CALL INTER(OXYNP, NJ, X, Y, NPTS, RMJ)
      550 WRITE(NWR, 560)
      560 FORMAT(1H0,20(1H*)•5X,60HO2 NONPOINT SOURCE CONTRIBUTIONS (LBS O2/
      1DAY/MILE OF STREAM)•5X•20(1H*))
      560 CALL OUTGO(LVARI, NJ, RMJ, OXYNP)
      560 GO TO 1000
      570 IF (LCST.NE.LFLO) GO TO 590
      570 CALL INTER(QNP, NJ, X, Y, NPTS, RMJ)
      570 WRITE(NWR, 580)
      580 FORMAT(1H0,20(1H*)•5X,41HNPOINT SOURCE FLOW (CR>MILE OF STREAM)
      1,5X•20(1H*))
      580 CALL OUTGO(LVARI, NJ, RMJ, JNP)
      580 GO TO 1000
      590 CALL INTER(CQNP, NJ, X, Y, NPTS, RMJ)
      590 WRITE(NWR, 600)LCST,LCST
      600 FORMAT(1H0,20(1H*)•5X•A4,35H NONPOINT SOURCE CONTRIBUTION (LBS ,A4
      1,20H/DAY/MILE OF STREAM)•5X•20(1H*))
      600 CALL OUTGO(LVARI, NJ, RMJ, CQNNP)
      600 GO TO 1000

```

## Subroutine NETDAT (Cont'd)

```
► 610 WRITE(NWR,620)LABEL
► 620 FORMAT(1H1,130(1H?),/,1H ,130(1H?),/,1H •20(1H?)•5X,10HDATA CODE ,
1A4,36H DOES NOT EXIST - PROGRAM TERMINATES,/,1H •130(1H?)•/,1H ,
2130(1H?))
STOP
5000 RETURN
END
```

## Subroutine FLOWS

```

SUBROUTINE FLOWS
COMMON QIN(250),QOUT(250),0(250),A(250),Z(250),XINDIN(250),
      CRDIN(250),OXIN(250),CIN(250),REAIR(250),VOL(250),
      PHOTO(250),EVAP(250),AS(250),SEDMT(250),DU5(250),V(250),
      WIDTH(250),AI(250),A2(250),A3(250),TEMP(250),DK1(250),
      DK2(250),CBOD(250),XNOD(250),OXY(250),CS(250),NFS(250),
      XMAS(250),XNMAS(250),XCMAS(250),XOMAS(250),MFS(250,3),
      RMJ(250),RMC(250),LALPHA(20),
      •CBDNP(250),XNBNP(250),CONN(250),OYNP(250),QNP(250),
      COMMON NJ,NC,XLEN,NOJFX,RMUP,RMDWN,RMFR,DELT,DELTD,NPRT,
      1      NQCYC,NSEC5,XMIL,NBEG,NEND,IMOB,IDAYB,IYRB,IMOE,IDAYE,
      2      IYRE,NDAYS,K2FL,LTYPE,LCBD,LNBD,LDO,LSTOP,LVAR1,LVAR2,
      3      LFIXE,NRD,NWR,NVT
      DIMENSION LMN(12),QINP(250),QONP(250)
      DATA LMN(1)/4HJAN./,LMN(2)/4HFEB./,LMN(3)/4HMAR./,LMN(4)/4HAPR./,
      1      LMN(5)/4HMAY/,LMN(6)/4HJUNE/,LMN(7)/4HJULY/,LMN(8)/4HAUG./,
      2      LMN(9)/4HSEP./,LMN(10)/4HOCT./,LMN(11)/4HNNOV./,
      3      LMN(12)/4HDEC./
      DO 10 J=1,NJ
      QIN(J)=0.0
      QOUT(J)=0.0
      Q(J)=0.0
      IF(QNP(J).LE.0.0)GO TO 5
      QINP(J)=QNP(J)*XMIL
      QONP(J)=0.0
      GO TO 10
      5 QONP(J)=-QNP(J)*XMIL
      QINP(J)=0.0
      10 CONTINUE
      READ(NRD,15)IMOB,IDAYB,IYRB,IMOE,IDAYE,IYRE
      15 FORMAT(12,IX,I2,IX,I4,5X,I2,IX,I2,IX,I4)
      IYB=IYRB-1900
      IYE=IYRE-1900
      CALL SERIAL(IDAYE,IMOE,IYE,NEND)
      CALL SERIAL(IDAYB,IMOB,IYB,NBEG)

```

## Subroutine FLOWS

```

NDAYS=NEND-NBEG+1
20 READ(NRD, 30) LABEL,DIST,QN,QAUT
30 FORMAT(A4,6X,3F10.0)
IF (LABEL.EQ.LSTOP) GO TO 40
JUNC=JKFND(NJ,XMIL,DIST,RMUP,RMDWN)
QIN(JUNC)=QIN(JUNC)+QN
QOUT(JUNC)=QOUT(JUNC)+QAUT
GO TO 20

        40 Q(NC)=-QIN(NJ)-QINP(NJ)+EVAP(NJ)*AS(NJ)
DO 50 N=2,NC
NCHAN=NJ-N
NCP=NCHAN+1
Q(NCHAN)=Q(NCP)-QIN(NCP)-QINP(NCP)+QOUT(NCP)+QONP(NCP)+EVAP(NCP) *
IAS(NCP)
50 CONTINUE
CALL FLOCMP
SUMIN=0.0
SUMOUT=0.0
DO 70 J=1,NJ
SUMIN=SUMIN+QIN(J)+QINP(J)
SUMOUT=SUMOUT+QOUT(J)+QONP(J)
IF (EVAP(J).LT.0.0) GO TO 60
SUMOUT=SUMOUT+EVAP(J)*AS(J)
GO TO 70
60 SUMIN=SUMIN-EVAP(J)*AS(J)
70 CONTINUE
IF (SUMOUT.GT.SUMIN) GO TO 80
QOUT(1)=QOUT(1)+SUMIN-SUMOUT
GO TO 90
80 QIN(1)=QIN(1)+SUMOUT-SUMIN
90 WRITE(NWR,100) LMN(IMOB),IDAYB,IYR,B,LMN(IMOE),IDAYE,IYRE,NDAYS,
*           SUMIN,SUMOUT,QOUT(1)
100 FORMAT(1H1,130(1H*),/1H,130(1H*),/1H,25(1H*),5X,21HFLOW CONDIT
IONS FOR ,A4,1X,12,2H,*14,1X,4HTHRU,1X,A4,1X,12,2H,*14,22X,25(1
2H*),/1H,25(1H*),80X,25(1H*),/1H,25(1H*),5X,32HNUMBER OF DAYS I

```

## Subroutine FLOWS (Cont'd)

```

3N THIS PERIOD = '14.39X,25(1H*),/,1H ,25(1H*),5X,16HTOTAL INFLOWS
4= ,F10.2,4H CFS,45X,25(1H*),/,1H ,25(1H*),5X,19HTOTAL DIVERSSIONS =
5 ,F10.2,4H CFS,42X,25(1H*),/,1H ,25(1H*),5X,33HOUTFLOW AT DOWNTRE
6AM JUNCTION = ,F10.2,4H CFS,28X,25(1H*),/,1H ,130(1H*),/,1H ,130(1
7H*))

      WRITE (NWR,110)
      110 FORMAT(1H0,20(1H*),5X,26HPOINT SOURCE INFLOWS (CFS),5X,20(1H*))
      CALL OUTGO(LVARI,NJ,RMJ,QIN)

      WRITE (NWR,120)
      120 FORMAT(1H0,20(1H*),5X,50HNONPOINT SOURCE INFLOWS (CFS) (EXCLUDING
     1RAINFALL),5X,20(1H*))
      CALL OUTGO(LVARI,NJ,RMJ,QINP)

      WRITE (NWR,130)
      130 FORMAT(1H0,20(1H*),5X,22HPOINT DIVERSIONS (CFS),5X,20(1H*))
      CALL OUTGO(LVARI,NJ,RMJ,QOUT)

      WRITE (NWR,140)
      140 FORMAT(1H0,20(1H*),5X,59HNONPOINT DIVERSIONS OR LOSSES (CFS) (EXCL
     1UDING EVAPORATION),5X,20(1H*))
      CALL OUTGO(LVARI,NJ,RMJ,QONP)

      WRITE (NWR,150)
      150 FORMAT(1H0,20(1H*),5X,19HCHANNEL FLOWS (CFS),5X,<0(1H*))
      CALL OUTGO(LVARI,NJ,RMJ,Q)

DO 160 J=1,NJ
QIN(J)=QIN(J)+QINP(J)
QOUT(J)=QOUT(J)+QONP(J)
CONTINUE
      160 RETURN
END

```

## Subroutine FLOCMP

```

SUBROUTINE FLOCMP
COMMON QIN(250),QOUT(250),Q(250),A(250),Z(250),XWVIN(250),
      CBDIN(250),OXIN(250),CIN(250),C(250),REAIK(250),VOL(250),
      PHOT(250),EVAP(250),AS(250),SEDMT(250),DUS(250),V(250),
      WIDTH(250),A1(250),A2(250),A3(250),TEMP(250),DK1(250),
      DK2(250),CBOD(250),XNOD(250),OXY(250),CS(250),NFS(250),
      XMASS(250),XNMAS(250),XCMAS(250),XOMAS(250),MFS(250),
      RMJ(250),RMC(250),LALPHA(20)
      ,CBDNP(250),XNBNP(250),CONNP(250),OYNP(250),QNP(250)
      ,NJ,NC,XLEN,NOJFX,RMUP,RMDWN,RMFR,DELT,DELT2,DELTD,NPRT,
      NQCYC,NSECS,XMIL,NBEG,NEND,IMOB,IYRB,IMOE,IDAYE,
      IYRE,NDAYS,K2FL,LTYPE,LCBD,LNBD,LDO,LSTOP,LVAR1,LVAR2,
      LFIXE,NRD,NWR,NVT
      DIMENSION LMN(12)
      DATA LMN(1)/4HJAN./,LMN(2)/4HFEB./,LMN(3)/4HMAR./,LMN(4)/4HAPR./,
      1 LMN(5)/4HMY./,LMN(6)/4HJUNE./,LMN(7)/4HJULY/,LMN(8)/4HAUG./,
      2 LMN(9)/4HSEP./,LMN(10)/4HOCT./,LMN(11)/4HNNOV./,
      3 LMN(12)/4HDEC./
      DIMENSION DEPTH(250),RN(250)
      DO 10 N=1,NC
      DEPTH(N)=A3(N)
      IF(A1(N).EQ.0.0.OR.Q(N).EQ.0.0)GO TO 5
      DEPTH(N)=DEPTH(N)+A1(N)*ABS(Q(N))*A2(N)
      5 A(N)=DEPTH(N)*WIDTH(N)
      IF(NVT.EQ.1.AND.RMC(N).LE.RMFR)GO TO 10
      IF(A(N).EQ.0.0)GO TO 8
      V(N)=ABS(Q(N))/A(N)
      GO TO 10
      8 WRITE(NWR,9)N
      9 FORMAT(1H1,130(1H?),/01H • 20(1H?)• 21HZERO AREA 1 CHANNEL ,I3,44H
      1DEPTH OR WIDTH IS ZERO - PROGRAM TERMINATES )
      STOP
      10 CONTINUE
      VOL(1)=XLEN*A(1)
      VOL(NJ)=XLEN*A(NC)

```



## Subroutine FLOCMP (Cont'd)

```

NL=NJ-1
DO 20 J=2,NL
  VOL(J)=XLEN*0.5*(A(J-1)+A(J))
20 CONTINUE
  WRITE(NWR,30)LMN(IMOB),IDAYB,IYRB,LMN(IMOE),IDAYE,IYRE
30 FORMAT(1H1,130(1H*),/1H,130(1H*),/1H,25(1H*),5X,38HDEPTH OR VE
  ILOCITY DEPENDENT VARIABLES,38X,25(1H*),/1H,25(1H*),5X,30HBASED O
  2N FLOWS FOR THE PERIOD ,A4,1X,12,2H, *14,6H THRU ,A4,1X,12,2H, ,14
  3,13X,25(1H*),/1H,130(1H*),/1H,130(1H*))
  WRITE(NWR,40)
40 FORMAT(1H0,20(1H*),5X,38HCROSSECTIONAL AREAS OF CHANNELS (SQFT),
  15X,20(1H*))
  CALL OUTGO(LVAR2,NC,RMC,A)
  WRITE(NWR,50)
50 FORMAT(1H0,20(1H*),5X,19HCHANNEL DEPTHS (FT),5X,<0(1H*))
  CALL OUTGO(LVAR2,NC,RMC,DEPTH)
  WRITE(NWR,60)
60 FORMAT(1H0,20(1H*),5X,27HCHANNEL VELOCITIES (FT/SEC),5X,20(1H*))
  CALL OUTGO(LVAR2,NC,RMC,V)
  WRITE(NWR,70)
70 FORMAT(1H0,20(1H*),5X,23HJUNCTION VOLUMES (CUFT),5X,20(1H*))
  CALL OUTGO(LVAR1,NJ,RMJ,VOL)
  IF(K2FL.NE.1) GO TO 140
  DO 80 N=1,NC
    RN(N)=(12.9*(V(N)**0.5))/(UEPTH(N)**1.5)
80 CONTINUE
  REAIR(NJ)=RN(NC)
  REAIR(1)=RN(1)
  DO 90 J=2,NL
    REAIR(J)=0.5*(RN(J)+RN(J-1))
90 CONTINUE
  DO 100 J=1,NJ
    XT=TEMP(J)-20.0
    XF=1.024**XT
    REAIR(J)=REAIR(J)*XF

```

## Subroutine FLOCMP (Cont'd)

```

100 CONTINUE
      WRITE(NWR,120)
120 FORMAT(1H0,20(1H*),5X,33HCOMPUTED REAERATION RATES (1/DAY),5X,20(1
1H*))
      CALL OUTGO(LVARI,NJ,RMJ,REAIR)
      DO 130 J=1,NJ
      REAIR(J)=REAIR(J)/86400.0
130 CONTINUE
      VT=86400.0
      DO 150 N=1,NC
      VL=ABS(XLEN/V(N))
      IF(VL.LE.VT) VT=VL
150 CONTINUE
      DT=VT/3600.0
      IF(DT.GE.24.0) DT=24.0
      IF(DT.GE.12.0.AND.DT.LT.12.0) DT=12.0
      IF(DT.GE.8.0.AND.DT.LT.8.0) DT=8.0
      IF(DT.GE.6.0.AND.DT.LT.6.0) DT=6.0
      IF(DT.GE.4.0.AND.DT.LT.4.0) DT=4.0
      IF(DT.GE.3.0.AND.DT.LT.3.0) DT=3.0
      IF(DT.GE.2.0.AND.DT.LT.2.0) DT=2.0
      IF(DT.GE.1.5.AND.DT.LT.1.5) DT=1.5
      IF(DT.GE.1.0.AND.DT.LT.1.5) DT=1.0
      IF(DT.GE.0.75.AND.DT.LT.1.0) DT=0.75
      IF(DT.GE.0.50.AND.DT.LT.0.75) DT=0.50
      IF(DT.GE.0.25.AND.DT.LT.0.50) DT=0.25
      IF(DT.GE.0.125.AND.DT.LT.0.25) DT=0.125
      IF(DT.GE.0.0675.AND.DT.LT.0.125) DT=0.0675
      IF(DT.LT.0.0675) DT=0.0675
      DELTD=DT
      RETURN
END

```



\* This change is indicated in the errata for T.R. 54

## Subroutine VAULIN

```

SUBROUTINE VAULIN
COMMON QIN(250),QOUT(250),Q(250),A(250),Z(250),XNWIN(250),
      CBDIN(250),OXIN(250),CIN(250),C(250),REAIK(250),VOL(250),
      PHOTO(250),EVAP(250),AS(250),SEDMT(250),DUS(250),V(250),
      WIDTH(250),A1(250),A2(250),A3(250),TEMP(250),DK1(250),
      DK2(250),CBOD(250),XNOD(250),OXY(250),CS(250),NFS(250),
      XMASS(250),XNMAS(250),XCMAS(250),XOMAS(250),MFS(250,3),
      RMJ(250),RMC(250),LALPHA(20),
      CHDNP(250),XNBNP(250),CONNP(250),QNP(250),
      COMMON NJ,NC,XLEN,NOJFX,RMUP,RMDWN,RMFR,DELT,DELT2,DELT0,NPRT,
      NQCYC,NSECS,XMIL,NBEG,NEND,IMOB,IYRB,IMOE,IDAYE,
      IYRE,NDAYS,K2FL,LTYPE,LCBD,LNBD,LSTOP,LVAR1,LVAR2,
      LFIXE,NRD,NWR,NVT
      DIMENSION QIP(250)
      DIMENSION LMN(12)
      DATA LMN(1)/4HJAN./,LMN(2)/4HFEB./,LMN(3)/4HMAR./,LMN(4)/4HAPR./,
      1   LMN(5)/4HMAY./,LMN(6)/4HJUNE./,LMN(7)/4HJULY./,LMN(8)/4HAUG./,
      2   LMN(9)/4HSEP./,LMN(10)/4HOCT./,LMN(11)/4HNNOV./,
      3   LMN(12)/4HDEC./
      NOJFX=0
      DO 10 J=1,NJ
      NFS(J)=0
      CIN(J)=0
      QIN(J)=AMAX1(0.001,QIN(J))
      QIP(J)=0.0
      CONTINUE
      10 READ(NRD,20)IMOB,IYRB,IMOE,IDAYE,IYRE,NPRT,T
      IF(NPRT.EQ.0)NPRT=1
      20 FORMAT(12,1X,12,1X,14,5X,12,1X,12,1X,14,5X,15,5X,F10.0)
      IF(T.NE.0.0)DELT0=T
      IF(DELT0.GT.24.0)DELT0=24.0
      NQCYC=(24.0/DELT0)*0.5
      DELT=DELT0*3600.0
      DELT2=DELT/2.0
      IYB=IYRB-1900

```

## Subroutine VAULIN (Cont'd)

```

IYE=IYRE-1900
CALL SERIAL(IDAYE,IMOE,IYE,NEND)
CALL SERIAL(IDAYB,IMOB,IYB,NBEG)
N DAYS=NEND-NBEG+1
1000 READ(NRD,30)LABEL,DIST,QN,CN,CST
30 FORMAT(A4,6X,4F10.0)
IF (LABEL.EQ.LSTOP) GO TO 40
JUNC=JKFND(NJ,XMIL,DIST,RMUP,RMDWN)
CIN(JUNC)=CIN(JUNC)+QN*CN
QIP(JUNC)=QIP(JUNC)+QN
IF (LABEL.NE.LFIXE) GO TO 1000
NOJFX=NOJFX+1
NFS(NOJFX)=JUNC
C(JUNC)=CST
GO TO 1000
40 DO 60 J=1,NJ
XMASS(J)=C(J)*VOL(J)
IF (QIN(J).EQ.0.0.AND.CIN(J).NE.0.0) GO TO 70
IF (QIP(J).EQ.0.0.AND.CIN(J).EQ.0.0) GO TO 50
CIN(J)=CIN(J)/QIP(J)
GO TO 60
50 CIN(J)=0.0
60 CONTINUE
GO TO 90
70 WRITE(NWR,80)J,RMJ(J)
80 FORMAT(1H1,130(1H?),/,1H ,130(1H?),/,1H0,10(1H?),/,1H0,10(1H?),5X,33HAN INFLOW W
1AS READ IN AT JUNCTION • 14, 12H(RIVER MILE ,F7.2,34H) IN THE QUALIT
2Y INPUT, BUT NOT IN THE HYDRAULIC INPUT,/,1H0,10(1H?),5X,18HPROGRA
3M TERMINATES )
STOP
90 WRITE(NWR,100)LTYPE,LMN(IMOB),IDAYB,IYRB,LMN(IMOE),IDAYE,IYRE
100 FORMAT(1H1,130(1H*),/,1H ,130(1H*),/,1H ,25(1H*),80X,25(1H*),/,1H
1•25(1H*),5X,A4•26H INPUT CONDITIONS FOR ,A4•1X,12•2H , ,14•6H T
2HRU ,A4•1X,12•2H , ,14,13X,25(1H*),/,1H ,25(1H*),80X,25(1H*),/,1H ,
3130(1H*),/,1H ,130(1H*))

```

## Subroutine VAULIN (Cont'd)

```

      WRITE(NWR,105)
105 FORMAT(1H0,20(1H*),5X,40HPOINT SOURCE INFLOW CONCENTRATIONS (PPM),
15X,20(1H*))
      CALL OUTGO(LVARI,NJ,RMJ,CIN)
      WRITE(NWR,200)
200 FORMAT(1H0,20(1H*),5X,31HNONPOINT SOURCE LOADS (LBS/DAY),5X,20(1H*
1) )
      IF(LCONS.NE.LCBD) GO TO 230
      DO 210 J=1,NJ
      CBDNP(J)=CBDNP(J)*XMIL
      CONTINUE
      CALL OUTGO(LVARI,NJ,RMJ,CBDNP)
      DO 220 J=1,NJ
      IF(CBDNP(J).LE.0.0) GO TO 215
      CIN(J)=(CBDNP(J)/(5.3936*QIN(J)))*CIN(J)*QIP(J)/QIN(J)
      CBDNP(J)=CBDNP(J)/XMIL
      GO TO 220
      CIN(J)=CIN(J)*QIP(J)/QIN(J)
215 CONTINUE
      GO TO 320
220 CONTINUE
      DO 230 IF(LCONS.NE.LNBD) GO TO 290
      IF(XNBNP(J).LE.0.0) GO TO 245
      XNBNP(J)=XNBNP(J)*XMIL
      CONTINUE
      CALL OUTGO(LVARI,NJ,RMJ,XNBNP)
      DO 250 J=1,NJ
      IF(XNBNP(J).LE.0.0) GO TO 245
      CIN(J)=(XNBNP(J)/(5.3936*QIN(J)))*CIN(J)*QIP(J)/QIN(J)
      XNBNP(J)=XNBNP(J)/XMIL
      GO TO 250
      CIN(J)=CIN(J)*QIP(J)/QIN(J)
245 CONTINUE
      GO TO 320
250 CONTINUE
      DO 290 CONNP(J)=CONNP(J)*XMIL
      CONTINUE
      GO TO 300
290 CONTINUE
      GO TO 300
300 CONTINUE

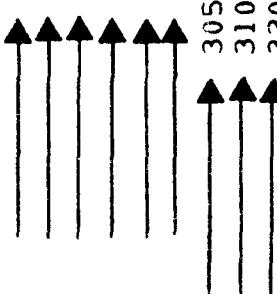
```

## Subroutine VAULIN (Cont'd)

```

CALL OUTGO(LVARI,NJ,RMJ,CONNP)
DO 310 J=1,NJ
IF (CONNP(J)*LE.0.0) GO TO 305
CIN(J)=(CONNP(J)/(5.3936*QIN(J))+CIN(J)*QIP(J)/QIN(J)
CONNP(J)=CONNP(J)/XMIL
GO TO 310
305 CIN(J)=CIN(J)*QIP(J)/QIN(J)
310 CONTINUE
320 IF (NOJFX.EQ.0) GO TO 2000
WRITE(NWR,110)
110 FORMAT(1H0,25(1H*),5X,15H FIXED JUNCTIONS )
DO 130 J=1,NOJFX
K=NFS(J)
WRITE(NWR,120)K,RMJ(K),C(K)
120 FORMAT(1H,25(1H*),5X, 9H JUNCTION ,13,13H, RIVER MILE ,F7.2,14H, I
1S FIXED AT ,1PE11.4,6H (PPM) )
130 CONTINUE
2000 WRITE(NWR,135)(ALPHA(K),K=1,20)
135 FORMAT(1H1,130(1H*),/ ,1H *130(1H*),/ ,1H *25(1H*),20A4,25(1H*)
WRITE(NWR,140)LTYPE,LMN(IM06),IDAYB,IYRB,LMN(IM0E),IDAYE,IYRE,
*          NDAYS,DELTD
*          1H *130(1H*),/ ,1H *25(1H*),80(
140 FORMAT(
1X,25(1H*),/ ,1H ,25(1H*),5X,A4,31H CONCENTRATIONS FOR THE PERIOD ,
2A4,1X,12,2H, ,14,6H THRU ,A4,1X,12,2H, ,14, 8X,25(1H*),/ ,1H *25(1H
3*),5X,32H NUMBER OF DAYS IN THIS PERIOD = ,14,39X,25(1H*),/ ,1H ,25(
41H*),5X,21H TIME STEP IN HOURS = ,F6.3,48X,25(1H*),/ ,1H ,25(1H*),80
5X,25(1H*),/ ,1H ,130(1H*),/ ,1H ,130(1H*),/ ,1H ,130(1H*),/ ,1H ,130(1H*)
RETJRN
END

```



## Subroutine VALCMP

```

SUBROUTINE VALCMP
COMMON QIN(250),QOUT(250),Q(250),A(250),Z(250),XNUIN(250),
      CBDIN(250),OXIN(250),CIN(250),C(250),REAIK(250),VOL(250),
      PHOT(250),EVAP(250),AS(250),SEDMT(250),DOS(250),V(250),
      WIDTH(250),A1(250),A2(250),A3(250),TEMP(250),DK1(250),
      DK2(250),CBOD(250),XNOD(250),OXY(250),CS(250),NFS(250),
      XMASS(250),XNMAS(250),XCMAS(250),XOMAS(250),MFS(250,3),
      RMJ(250),RMC(250),LALPHA(20),
      *CHDNP(250),XNBNP(250),CONNP(250),OXYNP(250),QNP(250)
      COMMON NJ,NC,XLEN,NOJFX,RMUP,RMDWN,RMFR,DELT,DELT2,DELTD,NPRT,
      1   NQCYC,NSECS,XMIL,NBEG,NEND,IMOB,IDAYB,IYRB,IMOE,IDAYE,
      2   IYRE,NDAYS,K2FL,LTYPE,LCBD,LNBD,LDO,LSTOP,LVAR1,LVAR2,
      3   LFIXE,NRD,NWR,NVT
      DIMENSION LMN(12)
      DATA LMN(1)/4HJAN./,LMN(2)/4HFEB./,LMN(3)/4HMAR./,LMN(4)/4HAPR./,
      1   LMN(5)/4HMAY./,LMN(6)/4HJUNE./,LMN(7)/4HJULY./,LMN(8)/4HAUG./,
      2   LMN(9)/4HSEP./,LMN(10)/4HOCT./,LMN(11)/4HNNOV./,
      3   LMN(12)/4HDEC./
      DIMENSION DS1(250),DS2(250),DECAY(250)
      INTEGER D,YA
      IF(LTYPE.NE.LCBD) GO TO 20
      DO 10 J=1,NJ
      DECAY(J)=DK1(J)
10  CONTINUE
      GO TO 60
20  IF(LTYPE.NE.LNBD) GO TO 40
      DO 30 J=1,NJ
      DECAY(J)=DK2(J)
30  CONTINUE
      GO TO 60
40  DO 50 J=1,NJ
      DECAY(J)=0.0
50  CONTINUE
60  KPRT=1
      DO 150 LBJ=1,NDAYS
      DO 130 LCYC=1,NQCYC

```



## Subroutine VALCMP (Cont'd)

```

CALL CDERIV(DECAY,DS1)
DO 90 J=1,NJ
IF (NOJFX.LE.0) GO TO 80
DO 70 K=1,NOJFX
IF (NFS(K).EQ.J) GO TO 90
CONTINUE
70   C(J)=(XMASS(J)*(DS1(J)*DELT2))/VOL(J)
     IF (C(J).LT.0.0) C(J)=0.0
90   CONTINUE
     CALL CDERIV(DECAY,DS2)
DO 120 J=1,NJ
IF (NOJFX.LE.0) GO TO 110
DO 100 K=1,NOJFX
IF (NFS(K).EQ.J) GO TO 120
100  CONTINUE
110  SLPE=(DS1(J)+DS2(J))/2.0
XMASS(J)=XMASS(J)+SLPE*DELT
C(J)=XMASS(J)/VOL(J)
IF (C(J).LT.0.0) C(J)=0.0
120  CONTINUE
130  CONTINUE
     IF (LBJ.NE.KPRT) GO TO 150
JD=NBEGLBJ-1
KPRT=KPRT+NPRT
CALL CALEN(JD,D,M,YA)
YA=YA+1900
WRITE (NWR,140)LTYPE,LMN(M),D,YA
140  FORMAT (1H0,10(1H*),5X,A4,26H CONCENTRATIONS (PPM) ON ,A4,1X,I2,2H
1. *I4)
     CALL OUTGO (LVAR1,NJ,RMJ,C)
150  CONTINUE
     IF (LTYPE.NE.LCBD) GO TO 170
DO 160 J=1,NJ
CBOD(J)=C(J)
160  CONTINUE

```

## Subroutine VALCMP (Cont'd)

```
GO TO 2000
170 IF (LTYPE•NE•LNBD) GO TO 190
DO 180 J=1,NJ
  XNOD(J)=C(J)
180 CONTINUE
  GO TO 2000
190 DO 200 J=1,NJ
  CS(J)=C(J)
200 CONTINUE
2000 RETURN
      END
```

## Subroutine CDERIV

```

SUBROUTINE CDERIV(DECAY,DXDT)
COMMON QIN(250),QOUT(250),Q(250),A(250),Z(250),XNU)IN(250),
      CBDIN(250),OXIN(250),CIN(250),C(250),REAIK(250),VOL(250),
      PHOTO(250),EVAP(250),AS(250),SEDMT(250),DOS(250),V(250),
      WIDTH(250),A1(250),A2(250),A3(250),TEMP(250),DK1(250),
      DK2(250),CBOD(250),XNOD(250),OXY(250),CS(250),NFS(250),
      XMASS(250),XMAS(250),XCMAS(250),XOMAS(250),MFS(250,3),
      RMJ(250),RMC(250),LALPHA(20)
      *CBDNP(250)*XNBNP(250),CONNP(250),OYNP(250),UNP(250)
      COMMON NJ,NC,XLEN,NOJFX,RMUP,RMDWN,RMFR,DELT,DELT2,DELT3,NPR,
      1 NQCYC,NSECS,XMIL,NBEG,NEND,IMOB,IDAYB,IYRS,IMOE,IDAYE,
      2 IYRE,NUDAYS,K2FL,LTYPE,LCBD,LNBD,LDO,LSTOP,LVARI,LVAR2,
      3 LFIXE,NRD,NWR,NVT
      DIMENSION DXDT(250),DECAY(250)
      DO 10 J=1,NJ
      DXDT(J)=DECAY(J)*VOL(J)-C(J)*QOUT(J)+QIN(J)*CIN(J)
10  CONTINUE
      DO 40 N=1,NC
      NL=N
      NH=N+1
      IF(Q(N).LE.0.0)GO TO 20
      CBAR=C(NL)
      GO TO 30
20  CBAR=C(NH)
      30 DCDX=(C(NL)-C(NH))/XLEN
      FLOWQ=CBAR*Q(N)
      DIFFQ=Z(N)*A(N)*DCDX
      DXDT(NH)=DXDT(NH)+FLOWQ+DIFFQ
      DXDT(NL)=DXDT(NL)-FLOWQ-DIFFQ
      40 CONTINUE
      RETURN
      END

```



Subroutine VDOIN Cont'd

```

DELT=DELTID*3600.0
DELT2=DELT/2.0
IYB=IYRB-1900
IYE=IYRE-1900
CALL SERIAL (IDAYE,IMOE,IYE,NEND)
CALL SERIAL (IDAYB,IMOB,IYB,NBEG)
NDAYS=NEND-NBEG+1
1000 READ(NRD,30)LABEL,DIST,QN,CN,XN,ON,CNS,XNS,ONS
      30 FORMAT(A4,6X,2F10.0,6F7.0)
      IF (LABEL.EQ.LSTOP) GO TO 60
      JUNC=JKFND(NJ,XMIL,DIST,RMUP,RMDWN)
      CBDIN (JUNC)=QN*CN+CBDIN (JUNC)
      XNDIN (JUNC)=QN*XN+XNDIN (JUNC)
      OXIN (JUNC)=QN*ON+OXIN (JUNC)
      QIP (JUNC)=QIP (JUNC)+QN
      IF (LABEL.EQ.LFIXE) GO TO 1000
      NOJFX=NOJFX+1
      NFS(NoJFX)=JUNC
      IF (CNS.EQ.0.0) GO TO 40
      CBOD (JUNC)=CNS
      MFS(NoJFX,1)=1
      40 IF (XNS.EQ.0.0) GO TO 50
      XNOD (JUNC)=XNS
      MFS(NoJFX,2)=1
      50 IF (ONS.EQ.0.0) GO TO 1000
      OXY (JUNC)=ONS
      MFS(NoJFX,3)=1
      GO TO 1000
      60 DO 70 J=1,NJ
      XCMAS (J)=CBOD (J)*VOL (J)
      XNMAS (J)=XNOD (J)*VOL (J)
      XOMAS (J)=UXY (J)*VOL (J)
      IF (QIN (J).EQ.0.0) GO TO 65
      IF (QIP (J).EQ.0.0) GO TO 66
      CRDIN (J)=CBDIN (J)/QIP (J)

```

Subroutine VDOIN Con't

```

XNDIN(J)=XNDIN(J)/QIP(J)
OXIN(J)=OXIN(J)/QIP(J)
GO TO 70
65 IF(CBDIN(J).NE.0.0.OR.XNDIN(J).NE.0.0) GO TO 80
   GO TO 70
66 CBDIN(J)=0.0
XNDIN(J)=0.0
OXIN(J)=0.0
70 CONTINUE
   GO TO 100
80 WRITE(NWR,90) J,RMJ(J)
90 FORMAT(1H1,130(1H?),/,1H ,10(1H?)*5X,33HAN INFLOW WAS READ IN AT J
1UNCTION ,I4*12H(RIVER MILE ,F7.2*54H) IN THE QUALITY INPUT, BUT NO
2T IN THE HYDRAULIC INPUT,/,1H0,10(1H?),5X,18HPROGRAM TERMINATES )
STOP
100 WRITE(NWR,110)LCBD,LNBD,LU0,LMN(IMOB),IDAYB,IYRB,LMN(IMOE),IDAYE,
*          IYRE
110 FORMAT(1H1,130(1H?),/,1H ,130(1H?)/,1H ,25(1H?)*80X,25(1H?)/,1H
1,25(1H?)*5X,A4*2H, *A4*5H AND *A4*17H INPUT COND. FOR *A4*1X,12,2H
2, *I4,6H THRU *A4,1X,I2,2H, *I4,7X,25(1H?)/,1H ,25(1H?)*80X,25(1H
3?)/,1H ,130(1H?)/,1H ,130(1H?))
DO 300 J=1,NJ
XBNP(J)=XBNP(J)*XMIL
OYNP(J)=OYNP(J)*XMIL
300 CONTINUE
   WRITE(NWR,310)LCBD
310 FORMAT(1H0,25(1H?)*5X,A4*41H POINT SOURCE INFLOW CONCENTRATIONS (P
1PM),5X,25(1H?))
   CALL OUTGO(LVARI,NJ,RMJ,CBDIN)
   WRITE(NWR,320)LCBD
320 FORMAT(1H0,25(1H?)*5X,A4*32H NONPOINT SOURCE LOADS (LBS/DAY),5X,25
1(1H?))
   CALL OUTGO(LVARI,NJ,RMJ,CBDNP)
   WRITE(NWR,310)LNBD

```

Subroutine VDOIN (Cont'd)

Subroutine VDOIN Con't

```

CALL OUTGO(LVAR1,NJ,RMJ,XNDIN)
WRITE(NWR,320)LNBD
CALL OUTGO(LVAR1,NJ,RMJ,XNENP)
WRITE(NWR,310)LDO
CALL OUTGO(LVAR1,NJ,RMJ,OXIN)
WRITE(NWR,320)L02
CALL OUTGO(LVAR1,NJ,RMJ,OXYNP)
DO 330 J=1,NJ
    CBDIN(J)=(CBDNP(J)/(5.3936*QIN(J)))*CBDIN(J)*QIP(J)/QIN(J)
    XNDIN(J)=(XNBNP(J)/(5.3936*QIN(J)))*XNDIN(J)*QIP(J)/QIN(J)
    OXIN(J)=(OXYNP(J)/(5.3936*QIN(J)))*OXIN(J)*QIP(J)/QIN(J)
    CBDNP(J)=CBDNP(J)/XMIL
    XNBNP(J)=XNBNP(J)/XMIL
    OXYNP(J)=OXYNP(J)/XMIL
CONTINUE
IF (NOJFX.EQ.0) GO TO 195
WRITE(NWR,130)
130 FORMAT(1H0,25(1H*),5X,15HFIXED JUNCTIONS )
DO 190 J=1,NOJFX
    JK=NFS(J)
    IF (MFS(J,1).EQ.0) GO TO 150
    WRITE(NWR,140)JK,RMJ(JK),CBD(JK)
140 FORMAT(1H,25(1H.),5X,9HJUNCTION ,I3,13H, RIVER MILE ,F7.2,18H CB
    1D IS FIXED AT ,1PE11.4,6H (PPM))
    150 IF (MFS(J,2).EQ.0) GO TO 170
    WRITE(NWR,160)JK,RMJ(JK),XNOD(JK)
    160 FORMAT(1H,25(1H.),5X,9HJUNCTION ,I3,13H, RIVER MILE ,F7.2,18H NBO
    1D IS FIXED AT ,1PE11.4,6H (PPM))
    170 IF (MFS(J,3).EQ.0) GO TO 190
    WRITE(NWR,180)JK,RMJ(JK),OXY(JK)
    180 FORMAT(1H,25(1H.),5X,9HJUNCTION ,I3,13H, RIVER MILE ,F7.2,16H DO
    1IIS FIXED AT ,1PE11.4,6H (PPM))
190 CONTINUE
195 WRITE(NWR,194)(LALPHA(K),K=1,20)
194 FORMAT(1H1,130(1H*),/•1H ,130(1H*),/•1H •25(1H*),20A4,25(1H*))

```

Subroutine VDOIN Con'd

```
      WRITE(NWR,200)LCBD,LNBD,LDO,LMN(IMOB),IDAYB,IYRB,LMN(IMOE),IDAYE,  
*  
      IYRE,NDAYS,DELTD  
      1H ,130(1H*),/,1H ,25(1H*),80  
 200 FORMAT(  
 1X,25(1H*),/,1H ,25(1H*),5X,A4,2H, ,A4,5H AND ,A4,21H CONC FOR THE  
2PERIOD ,A4,1X,12,2H, ,14,6H THRU ,A4,1X,12,2H, ,14,3X,25(1H*),/,1H  
3 ,25(1H*),5X,32HNUMBER OF DAYS IN THIS PERIOD = ,14,39X,25(1H*),/,1H  
41H ,25(1H*),5X,21HTIME STEP IN HOURS = ,F6.3,48X,25(1H*),/,1H ,25(1H*),  
51H*),80X,25(1H*),/,1H ,130(1H*),/,1H ,130(1H*),/,1H ,130(1H* )  
2000 RETURN  
END
```

Subroutine VDOIN (Cont'd)

## Subroutine VDOCP

```

SUBROUTINE VDOCP
COMMON QIN(250),QOUT(250),Q(250),A(250),Z(250),XNIN(250),
1      CBDIN(250),OXIN(250),CIN(250),C(250),REAIK(250),VOL(250),
2      PHOTO(250),EVAP(250),AS(250),SEDMT(250),DUS(250),V(250),
3      WIDTH(250),A1(250),A2(250),A3(250),TEMP(250),DK1(250),
4      DK2(250),CBOD(250),XNOD(250),OXY(250),CS(250),NFS(250),
5      XMASS(250),XMAS(250),XCMAS(250),XOMAS(250),MFS(250,3),
6      RMJ(250),RMC(250),LALPHA(20)
7      CBDNP(250),XBNP(250),CONN(250),QXNP(250),QNP(250)
COMMON NJ,NC,XLEN,NOJFX,RMUP,RMDWN,RMFR,DELT,DELT2,DELT3,NPRT,
1      NQCYC,NSECS,XMIL,NBEG,NEND,IMOB,IDAY,B,IYRB,IMOE,IDAYE,
2      IYRE,NDAYS,K2FL,LTYPE,LCBD,LNBD,LDO,LSTOP,LVAR1,LVAR2,
3      LFIXE,NRD,NWR,NVT
DIMENSION LMN(12)
DATA LMN(1)/4HJAN./,LMN(2)/4HFEB./,LMN(3)/4HMAR./,LMN(4)/4HAPR./,
1      LMN(5)/4HMAY./,LMN(6)/4HJUNE./,LMN(7)/4HJULY./,LMN(8)/4HAUG./,
2      LMN(9)/4HSEP./,LMN(10)/4HOCT./,LMN(11)/4HNNOV./,
3      LMN(12)/4HDEC./
DIMENSION D01(250),DC1(250),DN1(250),D02(250),DC2(250),DN2(250)
INTEGER D,YA
KPRT=1
DO 150 LB=1,NDAYS
DO 125 LCYC=1,NQCYC
CALL ODERIV(D01,DC1,DN1)
DO 60 J=1,NJ
IF (NOJFX.EQ.0) GO TO 50
DO 40 L=1,NOJFX
JK=NFS(L)
IF (J.NE.JK) GO TO 40
IF (MFS(L,1).EQ.1) GO TO 10
CBOD(J)=(XCMAS(J)+(DC1(J)*DELT2))/VOL(J)
10 IF (MFS(L,2).EQ.1) GO TO 20
XNOD(J)=(XNMAS(J)+(DN1(J)*DELT2))/VOL(J)
20 IF (MFS(L,3).EQ.1) GO TO 30
OXY(J)=(XOMAS(J)+(D01(J)*DELT2))/VOL(J)

```



## Subroutine VDOCP (Cont'd)

```

SUBROUTINE VDOCP CONT'D
30 GO TO 55
40 CONTINUE
50 CBOD(J)=(XCMAS(J)+(DC1(J)*DELT2))/VOL(J)
  XNOD(J)=(XNMAS(J)+(DN1(J)*DELT2))/VOL(J)
  OXY(J)=(XOMAS(J)+(DO1(J)*DELT2))/VOL(J)
55 IF(CBOD(J).LT.0.0)CBOD(J)=0.0
  IF(XNOD(J).LT.0.0)XNOD(J)=0.0
  IF(OXY(J).LT.0.0)OXY(J)=0.0
60 CONTINUE
  CALL ODERIV(D02,DC2,DN2)
  DO 120 J=1,NJ
  IF(N0JFX.EQ.0)GO TO 110
  DO 100 L=1,N0JFX
    JK=NFS(L)
    IF(J.NE.JK)GO TO 100
    IF(MFS(L,1).EQ.1)GO TO 70
    S=(DC1(J)+DC2(J))/2.0
    XCMAS(J)=XCMAS(J)+S*DELT
    CBOD(J)=XCMAS(J)/VOL(J)
70  IF(MFS(L,2).EQ.1)GO TO 80
    S=(DN1(J)+DN2(J))/2.0
    XNMAS(J)=XNMAS(J)+S*DELT
    XNOD(J)=XNMAS(J)/VOL(J)
80  IF(MFS(L,3).EQ.1)GO TO 90
    S=(D01(J)+D02(J))/2.0
    XOMAS(J)=XOMAS(J)+S*DELT
    OXY(J)=XOMAS(J)/VOL(J)
90  GO TO 115
100 CONTINUE
110 S=(DC1(J)+DC2(J))/2.0
  XCMAS(J)=XCMAS(J)+S*DELT
  CBOD(J)=XCMAS(J)/VOL(J)
  S=(DN1(J)+DN2(J))/2.0
  XNMAS(J)=XNMAS(J)+S*DELT
  XNOD(J)=XNMAS(J)/VOL(J)

```

Subroutine VDOCP CON'T

```
S=(D01(J)+D02(J))/2.0
XOMAS(J)=XOMAS(J)+S*DELT
OXY(J)=XOMAS(J)/VOL(J)
115 IF(CBOD(J).LT.0.0)CBOD(J)=0.0
IF(XNOD(J).LT.0.0)XNOD(J)=0.0
IF(OXY(J).LT.0.0)OXY(J)=0.0
120 CONTINUE
125 CONTINUE
IF(LBJ.NE.KPRT)GO TO 150
JD=NBE6+LBJ-1
KPRT=KPRT+NPRT
CALL CALEN(JD,D,M,YA)
YA=YA+1900
WRITE(NWR,130)LCBD,LNBD,LDO,LMN(M),D,YA
130 FORMAT(1H0,10(1H*),5X,A4,2H ,A4,5H AND ,A4,19H CONCENTRATIONS ON
1,A4,1X,I2,2H, ,I4 )
WRITE(NWR,140)LCBD
140 FORMAT(1H0,10(1H*),5X,A4,21H CONCENTRATIONS (PPM) )
CALL OUTGO(LVAR1,NJ,RMJ,CBOD)
WRITE(NWR,140)LNBD
CALL OUTGO(LVAR1,NJ,RMJ,XNOD)
WRITE(NWR,140)LDO
CALL OUTGO(LVAR1,NJ,RMJ,OXY)
150 CONTINUE
RETURN
END
```

Subroutine VDOCP (Cont'd)

## Subroutine ODERIV

84

```

SUBROUTINE ODERIV(DD0T,DCDT,DNDT)
COMMON QIN(250),QOUT(250),Q(250),A(250),Z(250),XINJIN(250),
      CBDIN(250),OXIN(250),CIN(250),C(250),KEAIR(250),VOL(250),
      1   PHOTO(250),EVAP(250),AS(250),SEDMT(250),DOS(250),V(250),
      2   WIDTH(250),A1(250),A2(250),A3(250),TEMP(250),DK1(250),
      3   DK2(250),CBOD(250),XNOD(250),OXY(250),CS(250),NFS(250),
      4   XMASS(250),XNMAS(250),XCMAS(250),XOMAS(250),MFS(250),3,
      5   RMJ(250),RMC(250),LALPHA(20),
      6   CBONP(250),XNBNP(250),CONNP(250),QXNP(250),
      7   COMMON NJ,NC,XLEN,NOJFX,RMUP,RMDWN,RMFR,DELT,DELT2,DELTD,NPRT,
      1   NQCYC,NSECSC,XMIL,NBEG,NEND,IMOB,IYAYB,IYRB,IMOE,IDAYE,
      2   IYRE,NDAYS,K2FL,LTYPE,LCBO,LNBD,LDO,LSTOP,LVAR1,LVAR2,
      3   LFIXE,NRD,NWR,NVT
DIMENSION DD0T(250),DCDT(250),DNDT(250)
DO 10 J=1,NJ
DKC=DK1(J)
IF(OXY(J).LE.0.0)DKC=0.0
DKN=DK2(J)
CO=0.05*DOS(J)
IF(OXY(J).LE.CO)DKN=0.0
DCDT(J)=-DKC*VOL(J)*CBOD(J)-CBOD(J)*QOUT(J)+QIN(J)*CBDIN(J)
DNDT(J)=-DKN*VOL(J)*XNOD(J)-XNOD(J)*QOUT(J)+QIN(J)*XNDIN(J)
DDT(J)=OXIN(J)*QIN(J)-OXY(J)*QOUT(J)+REAIR(J)*VOL(J)*(DOS(J)-OXY(
1J))-(DKN*XNOD(J)+DKC*CBOD(J))*VOL(J)+(PHOTO(J)-SEUMT(J)-EVAP(J))*O
2Y(J))*AS(J)
10 CONTINUE
DO 40 N=1,NC
NL=N
NH=N+1
IF(Q(N).LE.0.0)GO TO 20
OBAR=OXY(NL)
CBAR=CBOD(NL)
XBAR=XNOD(NL)
GO TO 30
20 OBAR=OXY(NH)

```

SUBROUTINE ODERIV C)N'T

```
CRAR=CBOD(NH)
XBAR=XNOD(NH)
30 DDX=(OXY(NL)-OXY(NH))/XLEN
DCDX=(CBOD(NL)-CBOD(NH))/XLEN
DNDX=(XNOD(NL)-XNOD(NH))/XLEN
FLQ0=OBAR*Q(N)
FLQC=CBAR*Q(N)
FLQN=XBAR*Q(N)
DFQ0=Z(N)*A(N)*DODX
DFQC=Z(N)*A(N)*DCDX
DFQN=Z(N)*A(N)*DNDX
DODT(NH)=DODT(NH)+FLQ0+DFQ0
DCDT(NH)=DCDT(NH)+FLQC+DFQC
DNDT(NH)=DNDT(NH)+FLQN+DFQN
DODT(NL)=DODT(NL)-FLQ0-DFQ0
DCDT(NL)=DCDT(NL)-FLQC-DFQC
DNDT(NL)=DNDT(NL)-FLQN-DFQN
40 CONTINUE
      RETURN
      END
```

Subroutine ODERIV (Cont'd)

### Function JKFDN

86

```
FUNCTION JKFDN(NJ,XMIL,DIST,RMUP,RMDWN)
NSET=1+IFIX(((DIST-RMDWN)/XMIL)+0.5)
IF(DIST.LT.RMDWN) NSET=1
IF(DIST.GT.RMUP) NSET=NJ
JKFDN=NSET
RETURN
END
SUBROUTINE SERIAL(D,M,YA,K)
INTEGER D,M,K,N,YA,XA
IF(M.GT.2) GO TO 10
N=M+9
XA=YA-1
GO TO 20
10 N=M-3
XA=YA
20 K=(1461*XA)/4+(153*N+2)/5*D
RETURN
END
```

## Subroutine TABU

87

```
SUBROUTINE TABU(X,Y,XPT,NPTS,YPT)
DIMENSION X(NPTS),Y(NPTS)
IF (NPTS.EQ.1) GO TO 10
NPM1=NPTS-1
IF (XPT.LE.X(1)) GO TO 10
IF (XPT.GE.X(NPTS)) GO TO 20
DO 30 J=1,NPM1
IF (XPT.GE.X(J).AND.XPT.LE.X(J+1)) GO TO 40
CONTINUE
30 S=(XPT-X(J))/(X(J+1)-X(J))
YPT=Y(J)+(Y(J+1)-Y(J))*S
GO TO 50
20 YPT=Y(NPTS)
GO TO 50
10 YPT=Y(1)
50 RETURN
END
```

**Subroutine INTER**

88

```
SUBROUTINE INTER (REVAL,NMAT,X,Y,NPTS,RM)
DIMENSION REVAL(NMAT),X(NPTS),Y(NPTS),RM(NMAT)
DO 21 I=1,NPTS
TEST=X(I)
JTMP=I
DO 22 J=I,NPTS
IF (X(J) .GE. TEST) GO TO 22
TEST=X(J)
JTMP=J
22 CONTINUE
XTMP=X(I)
YTMP=Y(I)
X(I)=X(JTMP)
Y(I)=Y(JTMP)
XTMP=X(JTMP)
Y(JTMP)=YTMP
21 CONTINUE
DO 10 J=1,NMAT
XPT=R4(J)
CALL TABU (X,Y,XPT,NPTS,YPT)
REVAL(J)=YPT
10 CONTINUE
RETURN
END
```

**Subroutine CALEN**

```
SUBROUTINE CALEN (K,D,M,YA)
INTEGER K,D,M,YA
YA=(4*K-1)/1461
D= 4*K-1-1461*YA
D=(D+4) /4
M= (5*D-3)/153
D= 5*D-3-153*M
D=(D+5) /5
IF (M.LT.10) GO TO 20
M=M-9
YA=YA+1
GO TO 30
20 M=M+3
30 RETURN
END
```

Subroutine OUTGO

90

```

SUBROUTINE OUTGO(LVAR,NP,X,Y)
COMMON QIN(250),QOUT(250),Q(250),A(250),Z(250),XNDIN(250),
1      CBDIN(250),OXIN(250),CIN(250),C(250),REAIK(250),VOL(250),
2      PHOTO(250),EVAP(250),AS(250),SEDMT(250),DUS(250),V(250),
3      WIDTH(250),A1(250),A2(250),A3(250),TEMP(250),DK1(250),
4      DK2(250),CBOD(250),XNOD(250),OXY(250),CS(250),NFS(250),
5      XMASS(250),XNMAS(250),XCMAS(250),XOMAS(250),MFS(250),3,
6      RMJ(250),RMC(250),RALPHA(20)
7      *CBDNP(250),XNBNP(250),CONNP(250),OXYNP(250),QNP(250)
COMMON NJ,NC,XLEN,NOJFX,RMUP,RMDWN,RMFR,DELT,DELT2,DELT0,NPRT,
1      NOCYC,NSECS,XMIL,NBEG,NEND,IMOB,IMOB,IMOE,IMOE,IMUE,IMUE,
2      IYRE,NDAYS,K2FL,LTYPE,LCBD,LNND,LDU,LSTOP,LVAR1,LVAR2,
3      LFIXE,NRD,NWR,NVT
DIMENSION X(250),Y(250)

C
C
      ILINE= NP/4
      IEXTA= NP-4*IILINE
      WRITE(NWR,10)LVAR,LVAR,LVAR
10     FORMAT(1H0,3X,A4,4X,5HRIVER,1X,A4,4X,5HRIVER,18
           1X,A4,4X,5HRIVER,/,1H,4X,2HNO,5X,4HMILE,7X,5HVALUE,8X,2HNO,5X,4HM
           2LE,7X,5HVALUE,8X,2HNO,5X,4HMILE,7X,5HVALUE,8X,2HNU,5X,4HMILE,7X,5H
           3VALUE )
      DO 30 I=1,ILINE
      I2=I+ILINE+IEXTA
      I3=I2+ILINE
      I4=I3+ILINE
      WRITE(NWR,20)I,X(I),Y(I),I2,X(I2),Y(I2),I3,X(I3),Y(I3),I4,X(I4),
1      Y(I4)
1      20 FORMAT(1H,3X,I3,4X,F6.2,4X,1PE10.3,4X,I3,4X,0PF6.2,4X,1PE10.3,
           14X,I3,4X,0PF6.2,4X,1PE10.3,4X,I3,4X,0PF6.2,4X,1PE10.3)
30     CONTINUE
      IF(IEXTA.EQ.0)GO TO 60
      IEND=ILINE+IEXTA
      IREG=ILINE+1

```

### Subroutine OUTGO (Cont'd)

91

```
DO 50 I=IBEG,IEND
      WRITE(NWR,40) I,X(I),Y(I)
40   FORMAT(1H ,3X,I3,4X,F6.2,4X,1PE10.3)
50   CONTINUE
60   RETURN
END
```

## V. EXAMPLE RUNS AND SENSITIVITY

The following figures illustrate the sensitivity of the AUTO-QUAL models to variations in the non-point variables. Sensitivities to other variables are shown in T.R. 54. The sensitivity to various factors will depend on the physical and biochemical properties of a given system. Therefore, the user is urged to experiment with his own systems before drawing any definite conclusions about a variable.

AUTOS was generally used for the sensitivity runs. The effects are the same in AUTOQD as in AUTOS. Figures 9,10 and 11 shows the convergence of the AUTOQD solution to the AUTOS solution over time.

A hypothetical estuary/stream (see figure 1) was used for the sensitivity runs. The following data values were assigned to the example estuary/stream;

Mile of Upstream end = 100.0

Mile of Downstream end = 0.0

Mile of fall line = 50.0

Number of Sections = 100

### PHYSICAL DATA;

$A_1$ ;

Miles 0.0 through 48.0

$A_1 = 0.0$

@ Mile 50.0

$A_1 = 0.06$

@ Mile 100.0

$A_1 = 0.04$

$A_2$ ;

Miles 0.0 through 48.0	$A_2 = 0.0$
@ Mile 50.0	$A_2 = 0.6$
Miles 50.0 through 100.0	$A_2 = 0.6$

$A_3$ ;

@ Mile 0.0	$A_3 = 20.0$
@ Mile 50.0	$A_3 = 10.0$
Miles 50.1 through 100.0	$A_3 = 0.0$

WIDTHS;

@ Mile 0.0	Width = 5,000.0 ft.
@ Mile 50.0	Width = 500.0 ft.
Miles 50.0 through 100.0	Width = 500.0 ft.

DISPERSION COEFFICIENTS;

@ Mile 0.0	$E = 5,000.0 \text{ ft}^2/\text{sec.}$
@ Mile 50.0	$E = 100.0 \text{ ft}^2/\text{sec.}$
Miles 50.0 through 100.0	$E = 100.0 \text{ ft}^2/\text{sec.}$

CBOD decay rate (@ 20°C);

Miles 0.0 through 100.0	$CDECAY = 0.4^{-1}/\text{day}$
-------------------------	--------------------------------

NBOD decay rate (@ 20°C);

Miles 0.0 through 100.0	$NDECAY = 0.3^{-1}/\text{day}$
-------------------------	--------------------------------

Non-point source CBOD;

Miles 0.0 through 100.0	$NONPCBD = 200.0 \text{ (lbs/day)/mile}$
-------------------------	--

Reaeration Rate (@ 20° C)

Miles 0.0 through 100.0	$REAER = 0.4^{-1}/\text{day}$
-------------------------	-------------------------------

Non-point source NBOD;

Miles 0.0 through 100.0

$NPNPBOD = 200.0$   
(lbs/day)/mile

Non-point source TDS;

Miles 0.0 through 100.0

$NPNPTDS = 400.0$   
(lbs/day)/mile

Non-point source  $O_2$ ;

Miles 0.0 through 100.0

$NPNPD\bar{O} = 50.0$   
(lbs/day)/mile

Non-point source Flows;

Miles 0.0 through 100.0

$NPNPFL\bar{W} = +1.0$  cfs/mile

Computed Oxygen Saturation Concentrations.

All other physical data assumes its respective default value.

Where point values are specified the program will interpolate  
linearly between the points for intermediate values.

#### COMPUTATIONAL DATA;

The following point source inflows and concentrations were  
specified.

Mile 100.0; 500.0 cfs

5.0 ppm CBOD

4.0 ppm NBOD

20.0 ppm TDS

9.0 ppm D $\bar{O}$

Mile 95.0; 50.0 cfs

30.0 ppm CBOD

40.0 ppm NBOD

200.0 ppm TDS

0.0 ppm D $\bar{O}$

Mile 25.0;                    300.0 cfs  
                                  30.0 ppm CBOD  
                                  60.0 ppm NBOD  
                                  400.0 ppm TDS  
                                  0.0 ppm DO

These data constitute the base condition upon which the sensitivity runs were made.

Following is the data deck used for running the base condition on AUTOSST;

POINT AND NPN-PENT BASE CONDITION ** AUTOPSS	
0.0	100.0
100.0	50.0
100.0	100.0
DATA	
A1	
1	3
2	48.0
3	50.0
	0.0
A2	
1	3
2	48.0
3	50.0
	0.0
A3	
1	3
2	48.0
3	50.0
	0.0
WIDTH	
1	3
2	2
3	1
	0.0
DISP	
1	2
2	1
	0.0





**DESCRIPTION OF SENSITIVITY FIGURES;**

**Figure 1** -schematic of example. streams/estuary.

**Figure 2** -base condition for sensitivity runs.

**Figure 3** -base condition for sensitivity runs with all non-point parameters set to zero.

**Figure 4** -base condition with varied non-point source inflows and non-point losses.

**Figure 5** -base condition with varied non-point source CBOD loadings.

**Figure 6** -base condition with varied non-point source NBOD loadings.

**Figure 7** -base condition with varied non-point source O<sub>2</sub> contributions.

**Figure 8** -base condition with varied non-point source TDS loadings.

**Figure 9** -AUT<sub>0</sub>SS and AUT<sub>0</sub>QD CBOD comparison. Ran with base condition input values. The AUT<sub>0</sub>QD CBOD starting concentrations were set at 3.4 ppm for the entire network.

**Figure 10** -AUT<sub>0</sub>SS and AUT<sub>0</sub>QD NBOD comparison. Ran with base condition input values. NBOD starting concentrations were uniformly set at 3.5 ppm.

**Figure 11** -AUT<sub>0</sub>SS and AUT<sub>0</sub>QD D<sub>0</sub> comparison. Ran with base condition input values. D<sub>0</sub> starting concentrations were uniformly set at 6.0 ppm.

FIGURE 1

## EXAMPLE STREAM/ESTUARY

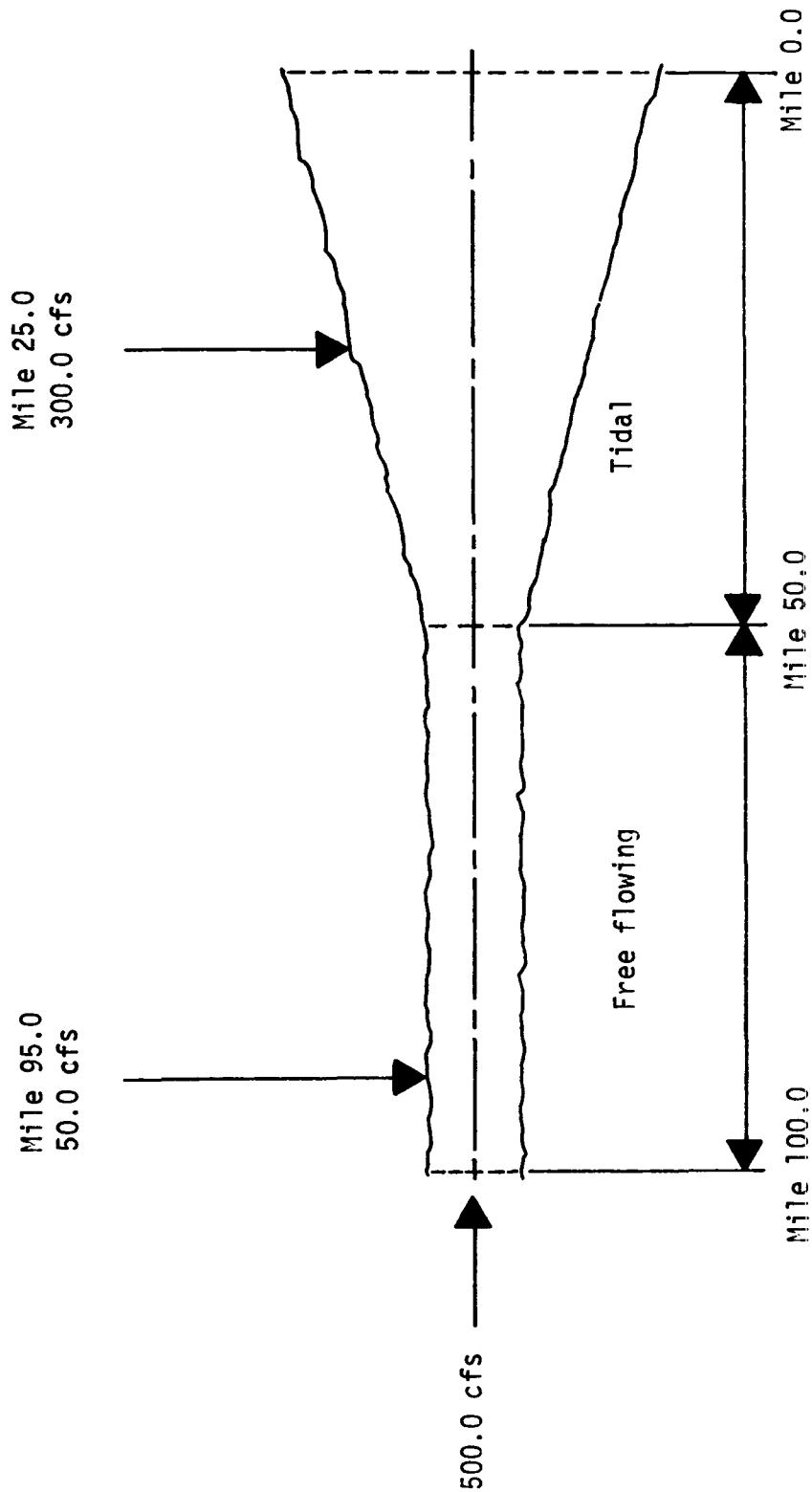


FIGURE 2

Example stream/estuary with point and non-point input parameters. Basic condition for sensitivity runs.

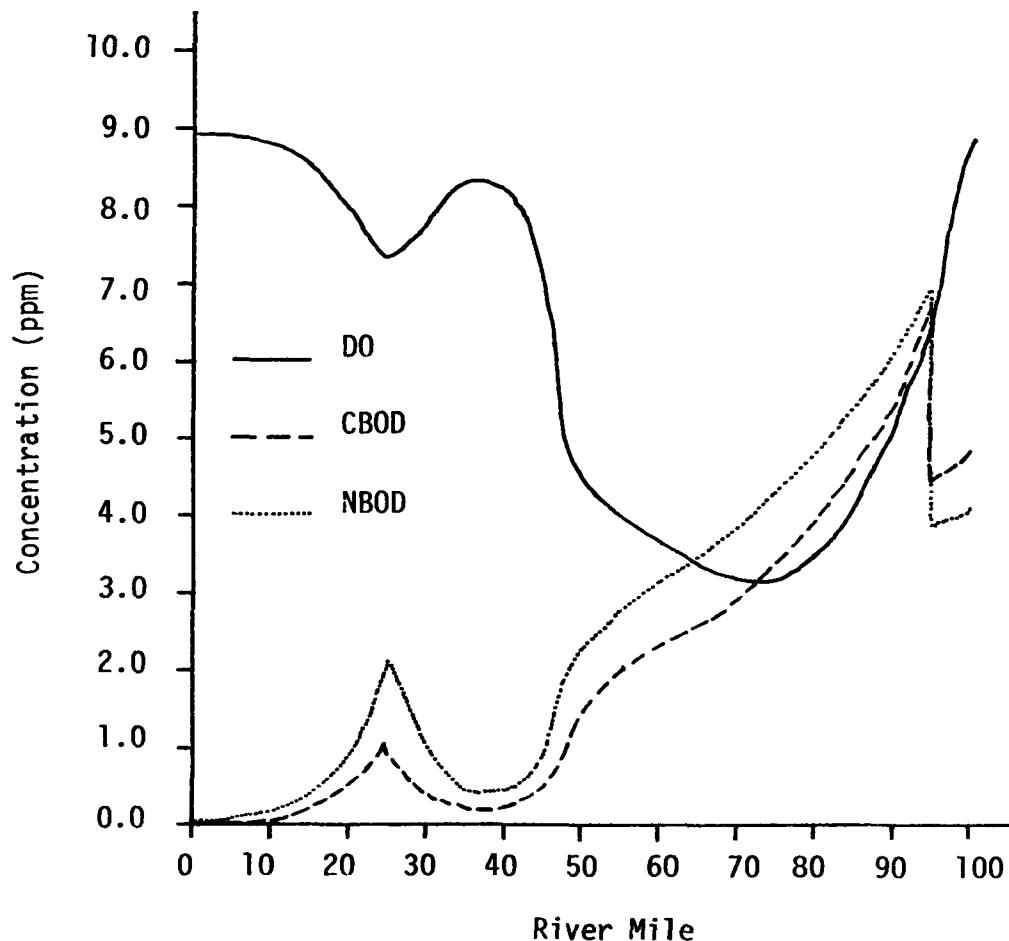
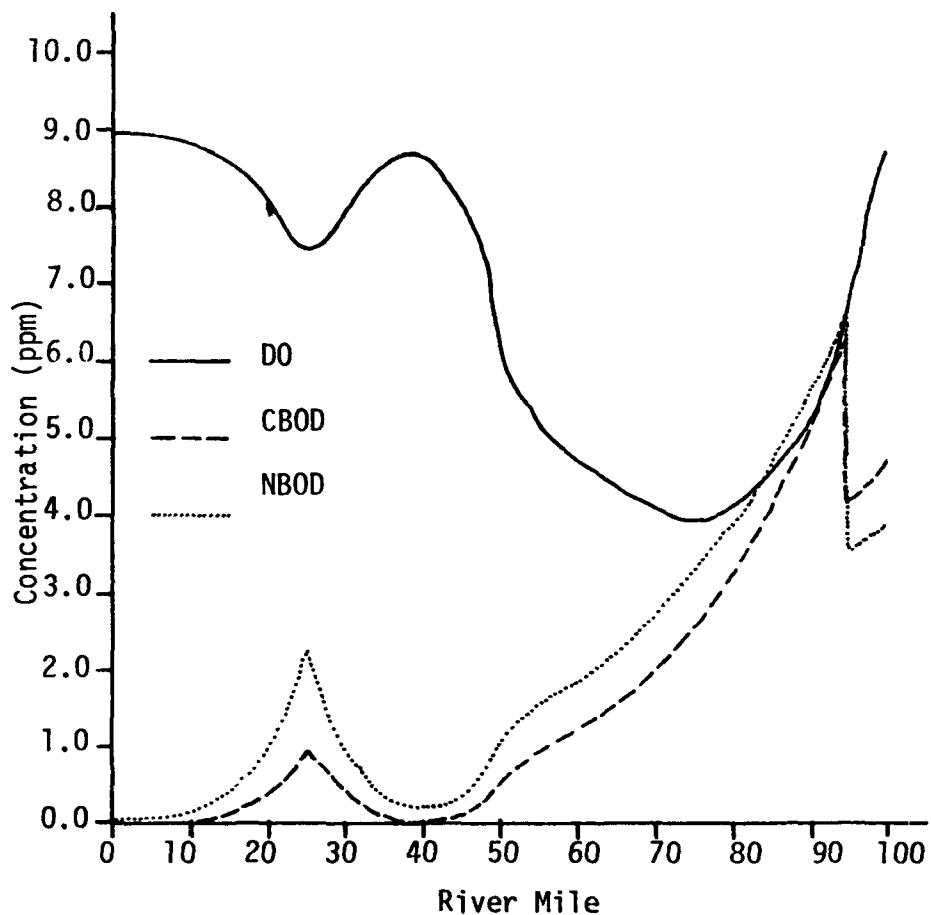


FIGURE 3

Example stream/estuary with only point source input parameters.



**FIGURE 4**

Sensitivity to non-point source inflows and non-point losses.

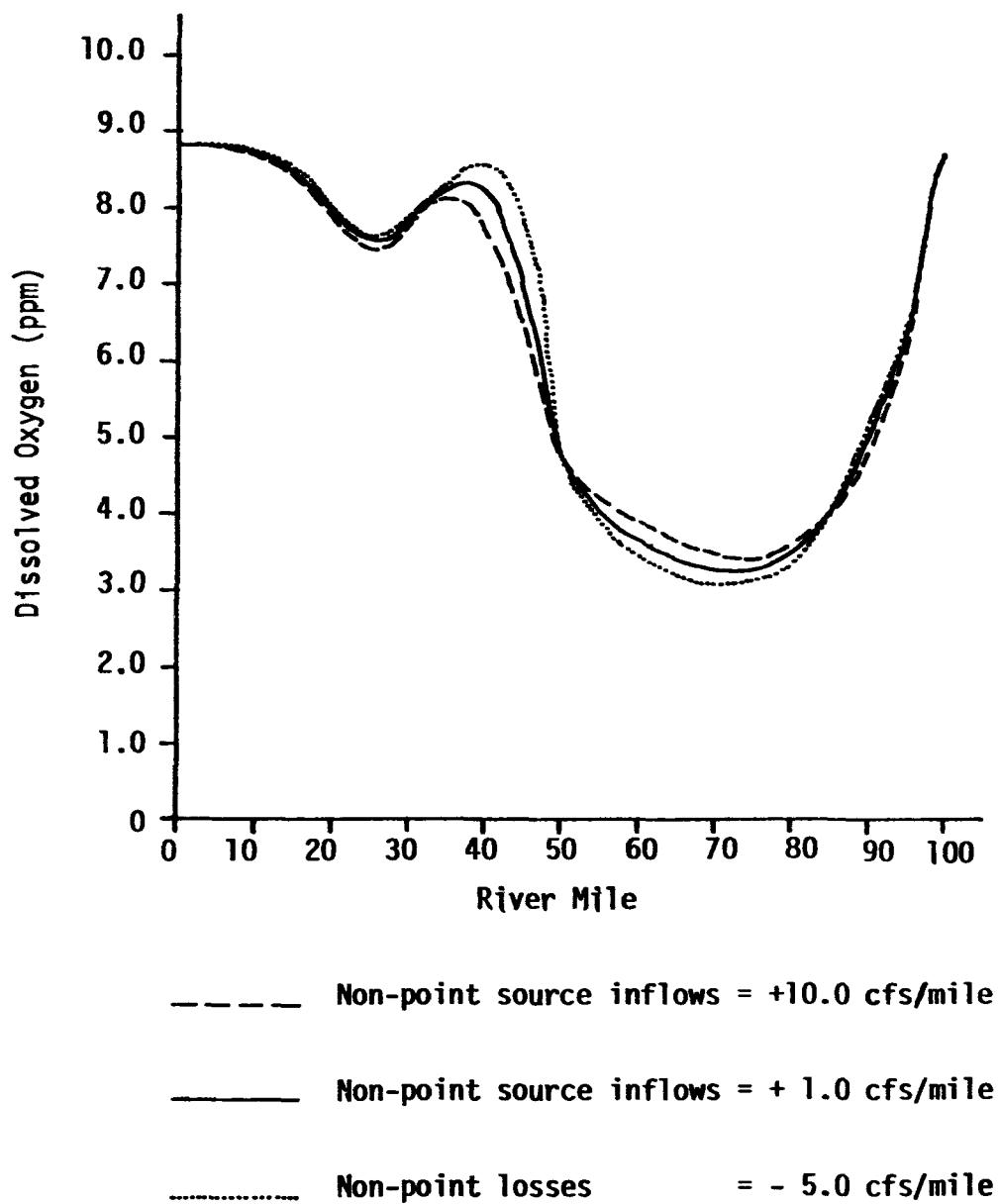


FIGURE 5

Sensitivity to a non-point source  
carbonaceous oxygen demand loading

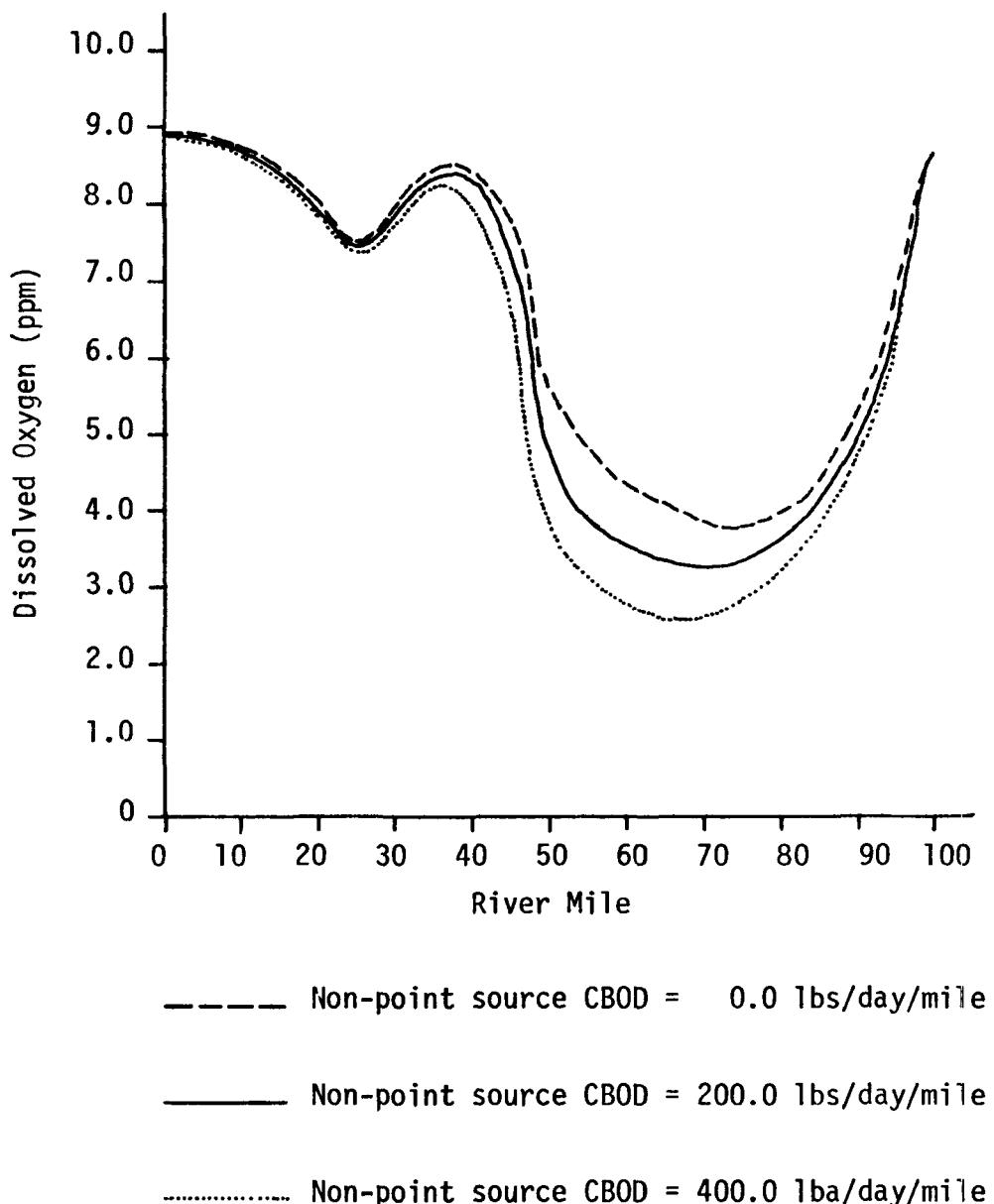


FIGURE 6

Sensitivity to a non-point source  
nitrogenous oxygen demand loading

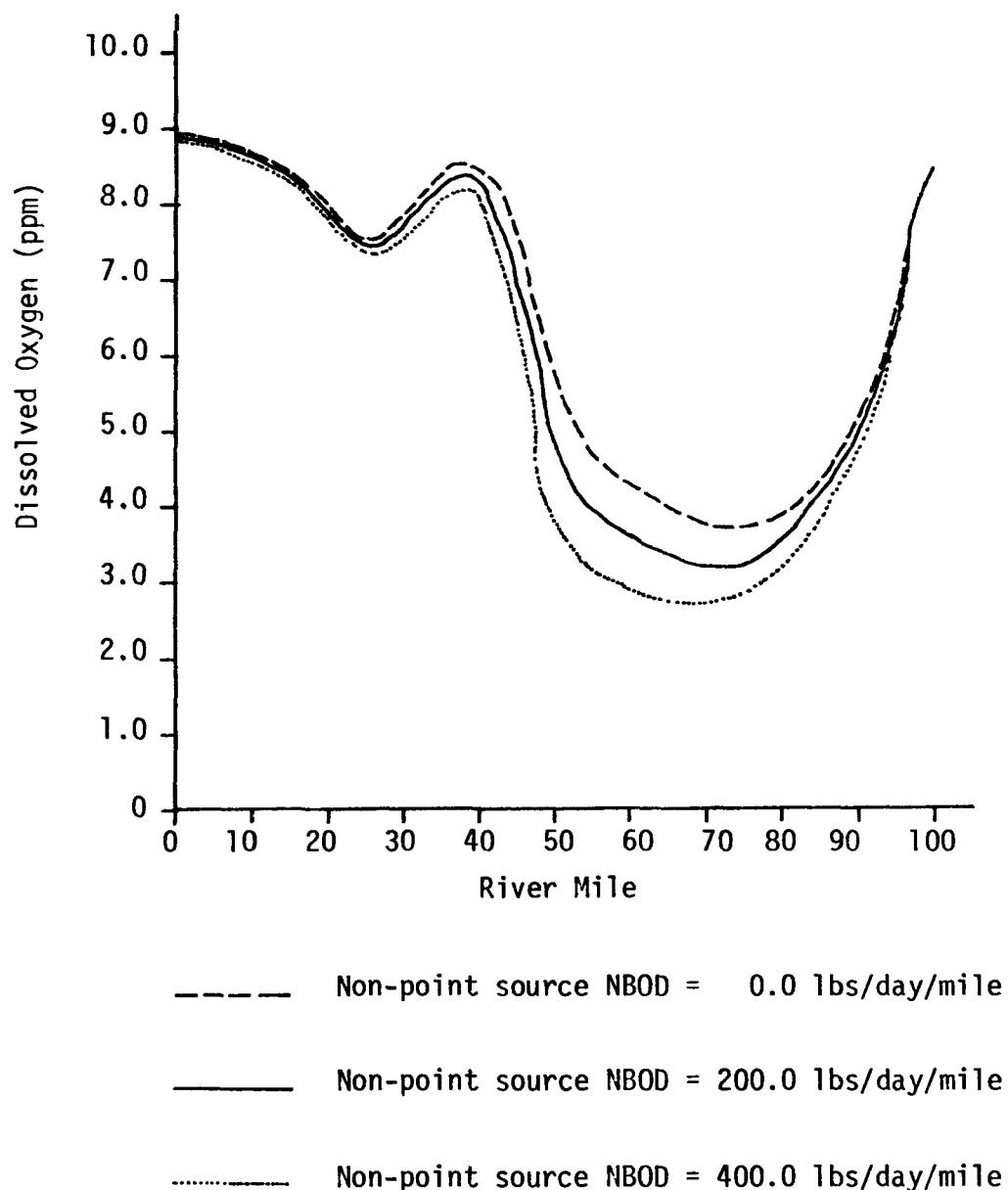


FIGURE 7

Sensitivity to a non-point source  
 $O_2$  contribution

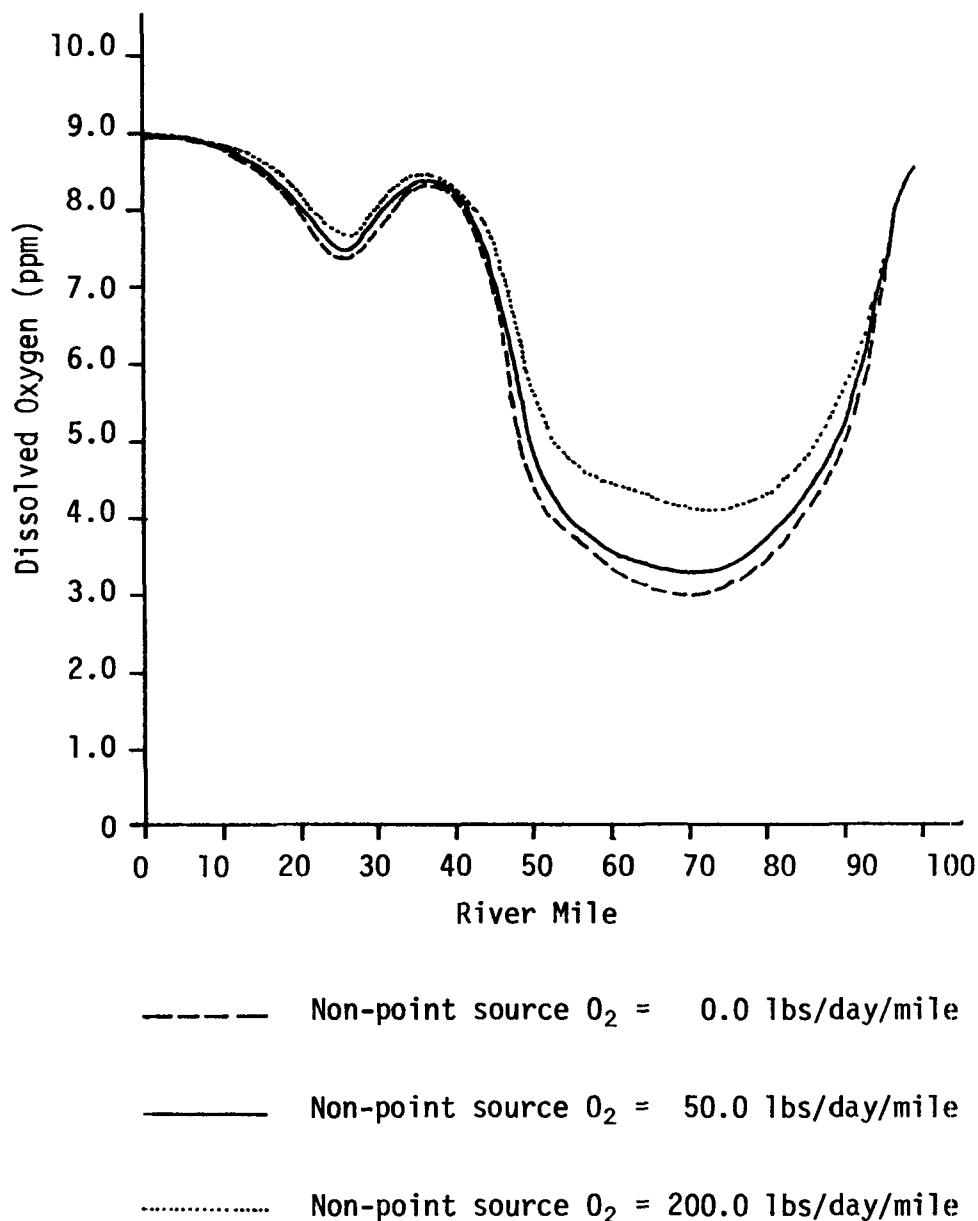


FIGURE 8

Sensitivity to a conservative parameter  
non-point source loading

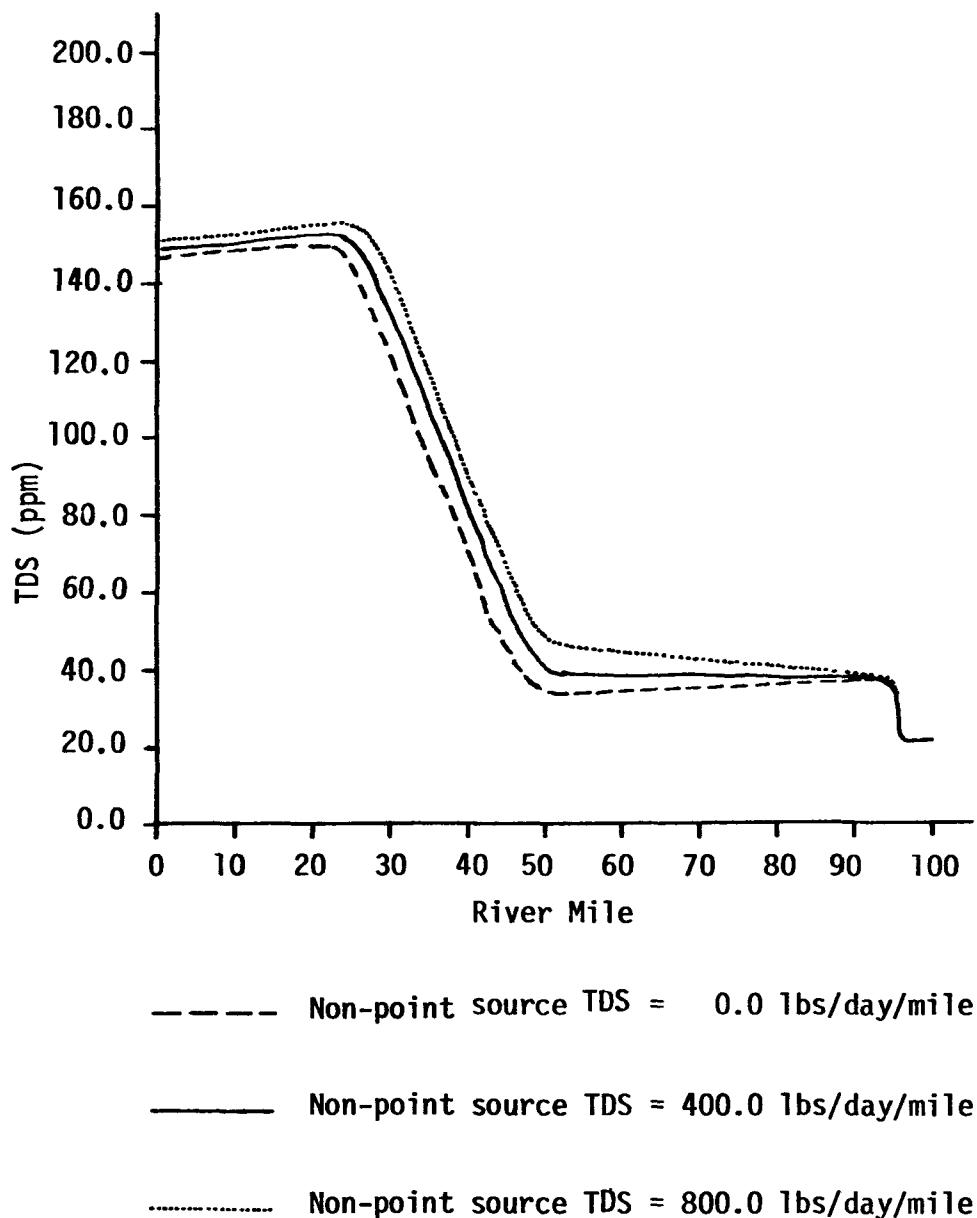


FIGURE 9

AUTØSS and AUTØQD Comparison  
Carbonaceous Oxygen Demand  
at selected miles

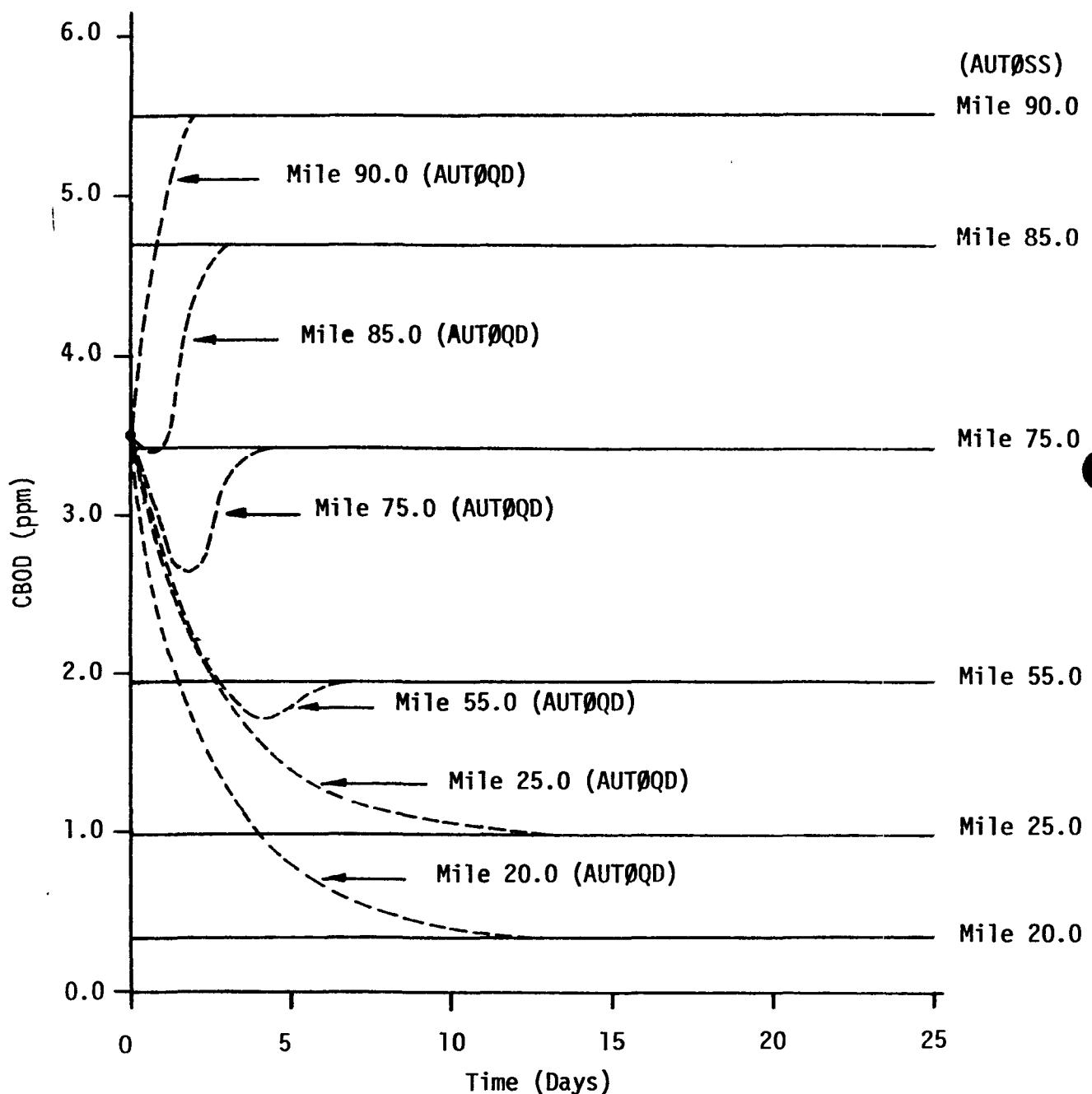


FIGURE 10

AUTØSS and AUTØQD Comparison  
Nitrogenous Oxygen Demand  
at selected miles

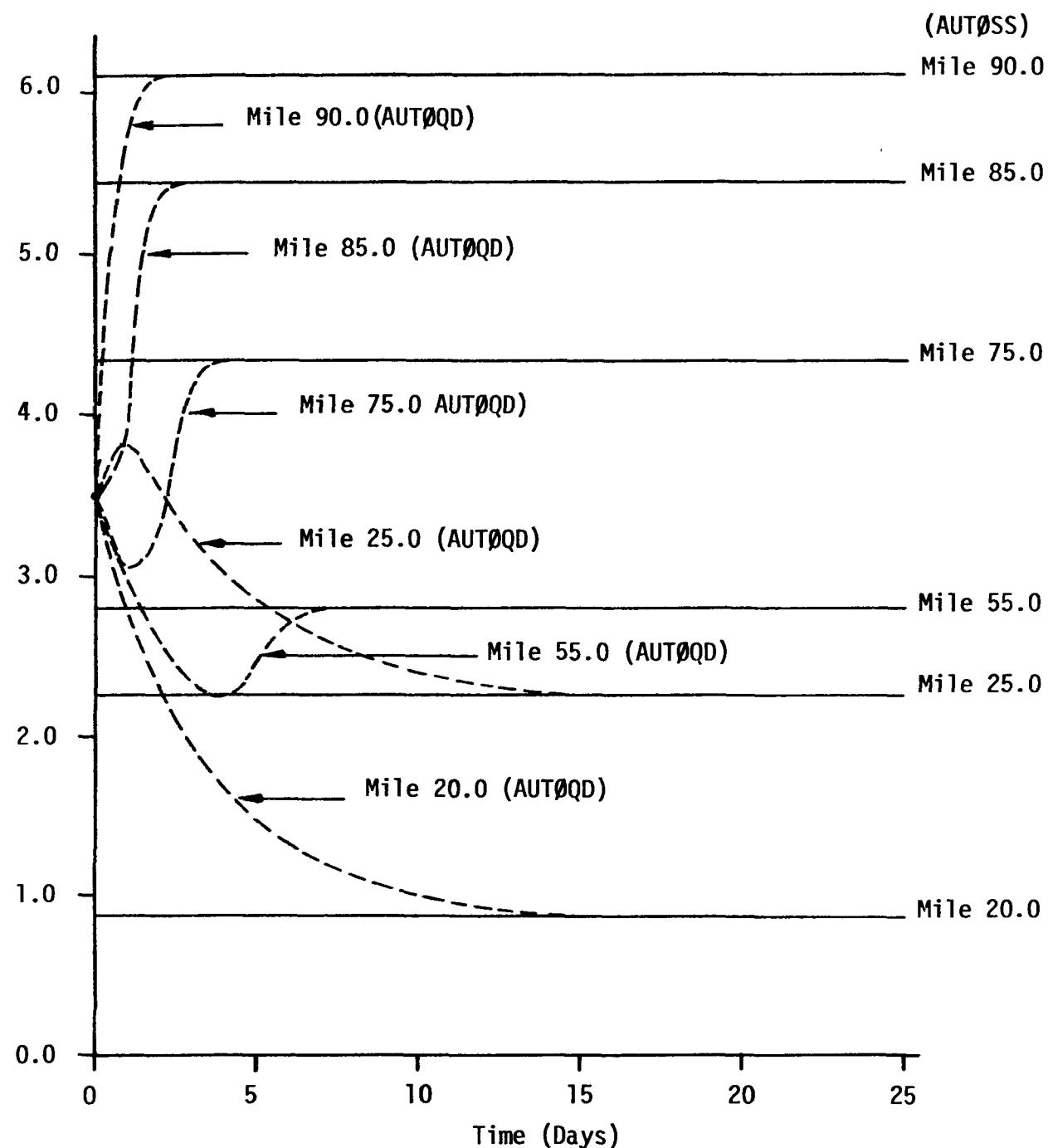


FIGURE 11

AUTØSS and AUTØQD Comparison  
Dissolved Oxygen at selected miles