```
FILE: WQARM     FORTRAN  A1  VM/SP HPO REL 4.2 - ELETRONORTE

C           DATA SET WQARM      AT LEVEL 001 AS OF 24/02/87
C*************************************************************
C
C                          WQ-ARM (VERSION 1)
C
C          WATER QUALITY - ANALYSIS FOR RESERVOIR MANAGEMENT
C
C      A MODEL FOR SIMULATION OF THE OXYGEN- AND NUTRIENT BUDGETS
C            AND THE PRIMARY PRODUCTION IN MAN-MADE LAKES
C
C*************************************************************
C
C      DEVELOPED BY:          J.G.C. SMITS   - WQ-ARM
C      INITIATED BY:          J.A. VAN PAGEE - OXY
C                             DELFT HYDRAULICS,
C                             P.O. BOX 177, 2600MH DELFT,
C                             THE NETHERLANDS.
C
C                             PHONE 015-569353
C                             TELEX 38176 HYDEL NL
C
C*************************************************************
C
C      UNITS FOR INPUT/OUTPUT:
C
C               5 - INPUT OF PARAMETERS AND FORCING FUNCTIONS
C               6 - OUTPUT OF INPUT, ERROR MESSAGES,
C                   OUTPUT OF HYDROLOGY, WATER QUALITY,
C                   TEMPERATURE, GEOMETRY AND SUMMARY
C           IFILE - OUTPUT OF HYDROLOGY AND WATER QUALITY
C                   FOR PLOTTING
C
C*************************************************************
C------------------------------------------------ DECLARATIONS ---
C------------------------------------------------ WATER QUALITY ---
C
      DIMENSION  COX(150),COD1(150),COD2(150),CAM(150),CNI(150),
     1           COP(150),CPH(150),CDE(150),TOD(150),SCD(150),
     1           SAS(150),SPS(150),
     1           OC(25),OC0(25),OC1(25),OC2(25),OC3(25),
     1           OD1(25),OD2(25),OD3(25),AM(25),
     1           COXI(24),CDETI(24),CAMI(24),CNII(24),COPI(24)
C
C------------------------------------------- GEOMETRY AND HYDROLOGY ---
C
      DIMENSION  A(150),V(150),VT(150),DEPTH(24),
     1           QI(150),QO(150),QV(150),PREC(24),EVAP(24),
     1           QIN(3,24),QOUT(3,24),GD1(150),GD2(150),GD3(150),
     1           SQI(25),SQO(25),SQI2(25),SQO2(25)
      REAL*8     VS
C
C------------------------------------------- THERMAL STRUCTURE ---
C
      DIMENSION  HEPI(24),HHYPO(24),TEPI(24),THYPO(24),TDEL(24),
     1           TDAM(25)
```

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FILE: WQARM     FORTRAN  A1  VM/SP HPO REL 4.2 - ELETRONORTE


C
C------------------------------------- PHYTOPLANKTON PARAMETERS ---
C
      DIMENSION  RCO2(24),SVOL(24),SEXT(24),SIOP(24)
C
C------------------------------------------- FORCING FUNCTIONS ---
C
      DIMENSION  DISPC(3),WIND(24),TIS(24),DL(24),PRCD(150),BEXT(24)
C
C------------------------------------- AUXILIARY PARAMETERS ---
C
      DIMENSION  IM(25),IOV(25),TEX(80),TEXT(60,10),CDEP(12),IS(150),
     1           BOX(150),BOD1(150),BOD2(150),BAM(150),BNI(150),
     1           BOP(150),BPH(150),BDE(150),TODIO(150),TDR(150)
C
C------------------------------------------------------------ OUTPUT ---
C
      DIMENSION  OUTQI(25,150),OUTQO(25,150),OUTQV(25,150),
     1           OUTOX(25,150),OUTAM(25,150),OUTNI(25,150),
     1           OUTOP(25,150),OUTPH(25,150),OUTDE(25,150),
     1           OUTSOD(25,150),OUTOD1(25,150),OUTCO2(25,150),
     1           OUTBOD(25,150),OUTTON(25,150),OUTTOP(25,150),
     1           OUTTOD(25,150),
     1           OUTH(25),OUTQP(25),OUTQE(25),OUTCM(25),OUTCME(25),
     1           OUTCMH(25),OUTCWM(25),OUTPAN(25),OUTDCE(25),OUTDCH(25),
     1           OUTDCT(25),TMAT(25,150),OXYDEP(25,10)
C
C-----------------------INTRODUCTION OF KEYWORDS FOR PROGRAM CONTROL ---
C
      DATA HYDRAU /4HHYDR/
      DATA TEST   /4HTEST/
      DATA RUN    /4HNEW /
      DATA RIV    /4HRIVE/
      DATA RIV2   /4HR2  /
      DATA RIV3   /4HR3  /
      DATA GO     /4HGO  /
      DATA DEPTHO,HEPIO,HHYPOO,TEPIO,THYPOO /5*0./
C
C------------------------- START OF A NEW RUN FOR ANOTHER RESERVOIR ---
C
    1 NERROR = 0
      NCOUNT = 0
      GOTO 3
C
C---------------------------------- START OF A NEW 2 YEARS-PERIOD ---
C
    2 NCOUNT = NCOUNT+1
    3 CONTINUE
C
C ------------------------------------------ READING OF INPUT DATA ---
C
      READ(5,10) (TEX(I),I= 1,20)
      READ(5,10) (TEX(I),I=21,40)
      READ(5,10) (TEX(I),I=41,60)
      READ(5,50) (TEX(I),I=61,68),IIN
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FILE: WQARM FORTRAN A1 VM/SP HPO REL 4.2 - ELETRONORTE

```
      READ(5,30) (TEXT( 1,I),I=1,8),AMAX,HMAX,GAMMA,EN,AMIN
      READ(5,20) (TEXT( 2,I),I=1,8),STAB,DEZ,DET,MMAX,DET1
      READ(5,30) (TEXT(34,I),I=1,8),TODI1,H1,TODI2,H2,TODI3
      READ(5,30) (TEXT( 3,I),I=1,8),RVEG,TLAG,HVEG,FCD1,FAN,FREF
      READ(5,30) (TEXT( 4,I),I=1,8),SODI,RSODB,ROD1B,ROD2B,RS1
      READ(5,30) (TEXT(31,I),I=1,8),CKL,CKLMIN,REAR,GASVP,DEPTHR
      READ(5,30) (TEXT( 5,I),I=1,8),HOUT1,HOUT2,HOUT3,WIDTH
      READ(5,30) (TEXT( 6,I),I=1,8),DMAX,DMIN,FDISP,FRICH
      READ(5,30) (TEXT(32,I),I=1,8),SA1,SP1,SA2,SP2,SOC,RSAD
      READ(5,30) (TEXT(33,I),I=1,8),SA3,SP3,SD,SN,RNITB,RDEBB
      READ(5,30) (TEXT( 7,I),I=1,8),RCO1,FMOR,FED,RDETB,RS2
      READ(5,30) (TEXT(35,I),I=1,8),CAMP,CNIP,COPP,FAMR,FOPR
      READ(5,50) (TEXT( 8,I),I=1,8),JSTART,MSTART,NLEV,IFILE,LOG
      READ(5,40) TEXT( 9,1),(ODEP(J),J=1,NLEV)
      READ(5,40) TEXT(10,1),(COXI(M),M=1,12)
      READ(5,40) TEXT(10,1),(COXI(M),M=13,24)
      READ(5,40) TEXT(12,1),(CDETI(M),M=1,12)
      READ(5,40) TEXT(12,1),(CDETI(M),M=13,24)
      READ(5,40) TEXT(13,1),(CAMI(M),M=1,12)
      READ(5,40) TEXT(13,1),(CAMI(M),M=13,24)
      READ(5,40) TEXT(14,1),(CNII(M),M=1,12)
      READ(5,40) TEXT(14,1),(CNII(M),M=13,24)
      READ(5,40) TEXT(15,1),(COPI(M),M=1,12)
      READ(5,40) TEXT(15,1),(COPI(M),M=13,24)
      READ(5,40) TEXT(41,1),(PREC(M),M= 1,12)
      READ(5,40) TEXT(41,1),(PREC(M),M=13,24)
      READ(5,40) TEXT(16,1),(EVAP(M),M= 1,12)
      READ(5,40) TEXT(16,1),(EVAP(M),M=13,24)
      READ(5,40) TEXT(17,1),(SVOL(M),M= 1,12)
      READ(5,40) TEXT(17,1),(SVOL(M),M=13,24)
      READ(5,40) TEXT(36,1),(SIOP(M),M= 1,12)
      READ(5,40) TEXT(36,1),(SIOP(M),M=13,24)
      READ(5,40) TEXT(37,1),(SEXT(M),M= 1,12)
      READ(5,40) TEXT(37,1),(SEXT(M),M=13,24)
      READ(5,40) TEXT(38,1),(RCO2(M),M= 1,12)
      READ(5,40) TEXT(38,1),(RCO2(M),M=13,24)
      READ(5,40) TEXT(39,1),(DL(M),M= 1,12)
      READ(5,40) TEXT(39,1),(DL(M),M=13,24)
      READ(5,40) TEXT(40,1),(TIS(M),M= 1,12)
      READ(5,40) TEXT(40,1),(TIS(M),M=13,24)
      READ(5,40) TEXT(42,1),(BEXT(M),M= 1,12)
      READ(5,40) TEXT(42,1),(BEXT(M),M=13,24)
      READ(5,40) TEXT(18,1),(QIN(1,M),M= 1,12)
      READ(5,40) TEXT(18,1),(QIN(1,M),M=13,24)
      READ(5,40) TEXT(19,1),(QIN(2,M),M= 1,12)
      READ(5,40) TEXT(19,1),(QIN(2,M),M=13,24)
      READ(5,40) TEXT(20,1),(QIN(3,M),M=1,12)
      READ(5,40) TEXT(20,1),(QIN(3,M),M=13,24)
      READ(5,40) TEXT(21,1),(DEPTH(M),M=1,12)
      READ(5,40) TEXT(21,1),(DEPTH(M),M=13,24)
      READ(5,40) TEXT(22,1),(HEPI(M),M= 1,12)
      READ(5,40) TEXT(22,1),(HEPI(M),M=13,24)
      READ(5,40) TEXT(23,1),(HHYPO(M),M=1,12)
      READ(5,40) TEXT(23,1),(HHYPO(M),M=13,24)
      READ(5,40) TEXT(24,1),(QOUT(1,M),M= 1,12)
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```
      WRITE(6,33) (TEXT( 7,I),I=1,8),RCO1,FMOR,FED,RDETB,RS2
      WRITE(6,33) (TEXT(35,I),I=1,8),CAMP,CNIP,COPP,FAMR,FCPR
      WRITE(6,51) (TEXT( 8,I),I=1,8),JSTART,MSTART,NLEV,IFILE,LOG
      WRITE(6,41) TEXT( 9,1),(ODEP(J),J=1,NLEV)
      WRITE(6,41) TEXT(10,1),(COXI(M),M=1,12)
      WRITE(6,41) TEXT(10,1),(COXI(M),M=13,24)
      WRITE(6,41) TEXT(12,1),(CDETI(M),M=1,12)
      WRITE(6,41) TEXT(12,1),(CDETI(M),M=13,24)
      WRITE(6,47) TEXT(13,1),(CAMI(M),M=1,12)
      WRITE(6,47) TEXT(13,1),(CAMI(M),M=13,24)
      WRITE(6,47) TEXT(14,1),(CNII(M),M=1,12)
      WRITE(6,47) TEXT(14,1),(CNII(M),M=13,24)
      WRITE(6,47) TEXT(15,1),(COPI(M),M=1,12)
      WRITE(6,47) TEXT(15,1),(COPI(M),M=13,24)
      WRITE(6,41) TEXT(41,1),(PREC(M),M= 1,12)
      WRITE(6,41) TEXT(41,1),(PREC(M),M=13,24)
      WRITE(6,41) TEXT(16,1),(EVAP(M),M= 1,12)
      WRITE(6,41) TEXT(16,1),(EVAP(M),M=13,24)
      WRITE(6,41) TEXT(17,1),(SVOL(M),M= 1,12)
      WRITE(6,41) TEXT(17,1),(SVOL(M),M=13,24)
      WRITE(6,41) TEXT(36,1),(SIOP(M),M= 1,12)
      WRITE(6,41) TEXT(36,1),(SIOP(M),M=13,24)
      WRITE(6,41) TEXT(37,1),(SEXT(M),M= 1,12)
      WRITE(6,41) TEXT(37,1),(SEXT(M),M=13,24)
      WRITE(6,41) TEXT(38,1),(RCO2(M),M= 1,12)
      WRITE(6,41) TEXT(38,1),(RCO2(M),M=13,24)
      WRITE(6,41) TEXT(39,1),(DL(M),M= 1,12)
      WRITE(6,41) TEXT(39,1),(DL(M),M=13,24)
      WRITE(6,41) TEXT(40,1),(TIS(M),M= 1,12)
      WRITE(6,41) TEXT(40,1),(TIS(M),M=13,24)
      WRITE(6,41) TEXT(42,1),(BEXT(M),M= 1,12)
      WRITE(6,41) TEXT(42,1),(BEXT(M),M=13,24)
      WRITE(6,41) TEXT(18,1),(QIN(1,M),M= 1,12)
      WRITE(6,41) TEXT(18,1),(QIN(1,M),M=13,24)
      WRITE(6,41) TEXT(19,1),(QIN(2,M),M= 1,12)
      WRITE(6,41) TEXT(19,1),(QIN(2,M),M=13,24)
      WRITE(6,41) TEXT(20,1),(QIN(3,M),M=1,12)
      WRITE(6,41) TEXT(20,1),(QIN(3,M),M=13,24)
      WRITE(6,41) TEXT(21,1),(DEPTH(M),M=1,12)
      WRITE(6,41) TEXT(21,1),(DEPTH(M),M=13,24)
      WRITE(6,41) TEXT(22,1),(HEPI(M),M= 1,12)
      WRITE(6,41) TEXT(22,1),(HEPI(M),M=13,24)
      WRITE(6,41) TEXT(23,1),(HHYPO(M),M=1,12)
      WRITE(6,41) TEXT(23,1),(HHYPO(M),M=13,24)
      WRITE(6,41) TEXT(24,1),(QOUT(1,M),M= 1,12)
      WRITE(6,41) TEXT(24,1),(QOUT(1,M),M=13,24)
      WRITE(6,41) TEXT(25,1),(QOUT(2,M),M= 1,12)
      WRITE(6,41) TEXT(25,1),(QOUT(2,M),M=13,24)
      WRITE(6,41) TEXT(26,1),(QOUT(3,M),M= 1,12)
      WRITE(6,41) TEXT(26,1),(QOUT(3,M),M=13,24)
      WRITE(6,41) TEXT(27,1),(WIND(M),M= 1,12)
      WRITE(6,41) TEXT(27,1),(WIND(M),M=13,24)
      WRITE(6,41) TEXT(28,1),(TEPI(M),M=1,12)
      WRITE(6,41) TEXT(28,1),(TEPI(M),M=13,24)
      WRITE(6,41) TEXT(29,1),(TDEL(M),M= 1,12)
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      WRITE(6,41) TEXT(29,1),(TDEL(M),M=13,24)
      WRITE(6,41) TEXT(30,1),(TDAM(M),M= 2,13)
      WRITE(6,41) TEXT(30,1),(TDAM(M),M=14,25)
      WRITE(6,71) (TEXT(50,I),I=1,8)
   11 FORMAT (1H1,65X,10HCONTINUE =,I5)
   12 FORMAT (1H ,20A4)
   21 FORMAT (1H ,8A4,3F8.2,I8,2F8.2)
   31 FORMAT (1H ,8A4,6F8.2)
   33 FORMAT (1H ,8A4,6F8.4)
   41 FORMAT (1H ,A4,12F8.2)
   47 FORMAT (1H ,A4,12F8.3)
   51 FORMAT (1H ,8A4,6I8)
   71 FORMAT (1H ,8A4)
   81 FORMAT (1H ,8A4,F8.2,3F8.6,F8.2,F8.6)
   82 FORMAT (1H ,8A4,F8.4,5F8.2)
C
C--------------------------- CHECKS ON AND CONVERSION OF INPUT DATA ---
C
      IF (FAN .LT. 0.05) FAN = 1.0
      IF (DET1 .LT. 0.01) DET1 = DET+0.001
      IF (MMAX .GT. 24) GOTO 9995
      IF (FAMR .LT. 1.0 .OR. FOPR .LT. 1.0) GOTO 9996
      SA1 = SA1/SOC
      SA2 = SA2/SOC
      SA3 = SA3/2.67
      SP1 = SP1/SOC
      SP2 = SP2/SOC
      SP3 = SP3/2.67
      DO 84 J = 1,3
      DO 84 I = 1,24
      QIN(J,I)  = QIN(J,I)*86400.
      QOUT(J,I) = QOUT(J,I)*86400.
   84 CONTINUE
C
C--- DETERMINATION OF THE NUMBER OF TIMESTEPS IN A TWO YEARS-PERIOD ---
C
      NTR = IFIX(MMAX*30.4/DET+2.5)
      IF (TEXT(50,7) .EQ. TEST) NTR = MMAX
C
C----- DETERMINATION OF LAYER NUMBERS FOR OUTLETS AND MAXIMAL LEVEL ---
C
      IHO1 = IFIX(HOUT1/DEZ+0.5)
      IHO2 = IFIX(HOUT2/DEZ+0.5)
      IHO3 = IFIX(HOUT3/DEZ+0.5)
      IMAX = IFIX(HMAX/DEZ+0.5)
      IF (IMAX .GT. 149) GOTO 9991
C
C--------------------------- DETERMINATION OF THE THERMAL STRUCTURE ---
C
      DO 83 I = 1,IMAX
      TMAT(1,I) = TMAT(25,I)
   83 CONTINUE
      MMAX1 = MMAX+1
      DO 91 I = 2,MMAX1
      IH = DEPTH(I-1)
```

```
      IEP= HEPI(I-1)
      IHY= IH -IEP
      TE = TEPI(I-1)
      TH = TE - TDEL(I-1)
      THYPO(I-1) = TH
      DO 90 N = 1,IMAX
      N1 = IMAX-N+1
      Z  = N1*DEZ
      IF (Z .GT. IHY) TMAT(I,N1) = TE
      IF (Z .LE. IHY) TMAT(I,N1) = TH
      IF (Z .GE. IHY .AND. Z .LT. IHY+DEZ) TMAT(I,N1) = 100000.
      IF (Z .GT. IH) TMAT(I,N1) = 0.
   90 CONTINUE
   91 CONTINUE
C
C------------------- DETERMINATION OF THE GEOMETRY OF THE RESERVOIR ---
C
      IF (NCOUNT .GT. 0) GOTO 250
      AMAX = AMAX*1000000.
      A(1) = AMAX*(1.0-GAMMA)**EN
      VO   = AMAX*(1.0-GAMMA)**(EN+1.)*HMAX/(GAMMA*(EN+1.))
      IF (AMIN .LT. 0.01) GOTO 190
      A(1) = 1000000.*AMIN
  190 VT(1) = 0.0
      N = IMAX+2
      DO 200 I=2,N
      Z = (I-1)*DEZ
      A(I) = AMAX*(1.-GAMMA*(1.-Z/HMAX))**EN
      VT(I)  = AMAX*(1.-GAMMA*(1.-Z/HMAX))**(EN+1.)*HMAX/
     1         (GAMMA*(EN+1.))-VO
      V(I-1) = VT(I)-VT(I-1)
  200 CONTINUE
      IF (V(1) .LT. 0.5*A(2)*DEZ) V(1) = 0.5*A(2)*DEZ
C
C-------------------- FIRST INITIALISATION, THE FILLING STARTS, T=0 ---
C------------------------------------ HYDRAULICS AND WATER QUALITY ---
C
      DO 210 I=1,IMAX
      QI(I)   = 0.0
      QO(I)   = 0.0
      QV(I)   = 0.0
      COX(I)  = 0.0
      COD1(I) = 0.0
      COD2(I) = 0.0
      CAM(I)  = 0.0
      CNI(I)  = 0.0
      COP(I)  = 0.0
      CPH(I)  = 0.0
      CDE(I)  = 0.0
      SOD(I)  = 0.0
      TDR(I)  = 0.0
      PROD(I) = 0.0
      IS(I)   = 0
      IF (I*DEZ .LE. H1) TOD(I) = TODI1
      IF (I*DEZ .GT. H1 .AND. I*DEZ .LE. H2) TOD(I) = TODI2
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      IF (I*DEZ .GT. H2) TOD(I) = TODI3
      TODIO(I) = TOD(I)*(1.-FOD1)
      SAS(I)  = SA1
      SPS(I)  = SP1
  210 CONTINUE
      QV(IMAX+1) = 0.0
      QI(1) = QIN(1,1)+QIN(2,1)+QIN(3,1)
      QO(1) = 0.0
      IF (IHO3 .LE. 1) QO(1) = QO(1)+QOUT(3,1)
      IF (IHO2 .LE. 1) QO(1) = QO(1)+QOUT(2,1)
      IF (IHO1 .LE. 1) QO(1) = QO(1)+QOUT(1,1)
      IF (QI(1) .LT. QO(1)) GOTO 9992
      QV(2) = QI(1)-QO(1)
      VS = 0.0
      SQI(1)  = 0.0
      SQO(1)  = 0.0
      COX(1)  = COXI(1)
      COD1(1) = 0.0
      COD2(1) = 0.0
      CAM(1)  = CAMI(1)
      CNI(1)  = CNII(1)
      COP(1)  = COPI(1)
      CPH(1)  = 0.01
      CDE(1)  = CDETI(1)
      SOD(1)  = SODI
      PAN = C.0
C
C------------- BEGIN TIME IS FIXED AT MOMENT FIRST LAYER IS FILLED ---
C
      T = V(1)/((QI(1)-QO(1))*30.4)
C
C------------------------- NUMBER OF MONTH AND NUMBER OF LAYERS ---
C
      M = IFIX(T+DET/60.8+1.0)
      IF (M .NE. 1) GOTO 9993
      MO = M
      IMAXT  = 1
      IOV(1) = 0
C
C------------------------------------------------- OUTPUT, PART 1 ---
C
      OUTH(1)  = DEZ
      OUTQP(1) = PREC(1)*A(2)/(30.4*1000.)
      OUTQE(1) = EVAP(1)*A(2)/(30.4*1000.)
      OC(1)  = 0.0
      OC0(1) = 0.0
      OC1(1) = 0.0
      OC2(1) = 0.0
      OC3(1) = 0.0
      OD1(1) = 0.0
      OD2(1) = 0.0
      OD3(1) = 0.0
      AM(1)  = 0.0
      OUTCM(1)  = COXI(1)
      OUTCME(1) = COXI(1)
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      OUTCMH(1) = 0.0
      OUTCWM(1) = 0.0
      OUTPAN(1) = 0.0
      OUTDCE(1) = 0.0
      OUTDCT(1) = 0.0
      OUTDCH(1) = 0.0
      GOTO 280
C
C---------------- SECOND INITIALISATION ( T>2 YEARS AFTER FILLING ) ---
C------------------------------------ HYDRAULICS AND WATER QUALITY ---
C
  250 DO 260 I=1,IMAX
      QI(I)   = OUTQI(25,I)*86400.
      QO(I)   = OUTQO(25,I)*86400.
      QV(I+1) = OUTQV(25,I)*86400.
      COX(I)  = OUTOX(25,I)
      COD1(I) = OUTOD1(25,I)
      COD2(I) = OUTOD2(25,I)
      CAM(I)  = OUTAM(25,I)/1000.
      CNI(I)  = OUTNI(25,I)/1000.
      COP(I)  = OUTOP(25,I)/1000.
      CPH(I)  = OUTPH(25,I)
      CDE(I)  = OUTDE(25,I)
      SOD(I)  = OUTSOD(25,I)
      TOD(I)  = OUTTOD(25,I)
  260 CONTINUE
      QV(IMAX+1) = OUTQV(25,IMAX+1)
      SQI(1) = SQI(25)
      SQO(1) = SQO(25)
C
C------------------------------------------------ TIME AND NUMBER OF MONTH ---
C
      T = 0.0
      M  = 1
      MO = M
      IOV(1) = IOV(25)
C
C-------------------------------------------------------------- OUTPUT, PART 1 ---
C
      OUTH(1) = OUTH(25)
      OUTQP(1) = OUTQP(25)
      OUTQE(1) = OUTQE(25)
      OC(1)  = OC(25)
      OCO(1) = OCO(25)
      OC1(1) = OC1(25)
      OC2(1) = OC2(25)
      OC3(1) = OC3(25)
      OD1(1) = OD1(25)
      OD2(1) = OD2(25)
      OD3(1) = OD3(25)
      AM(1)  = AM(25)
      OUTCM(1)  = OUTCM(25)
      OUTCME(1) = OUTCME(25)
      OUTCMH(1) = OUTCMH(25)
      OUTCWM(1) = OUTCWM(25)
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      OUTPAN(1) = OUTPAN(25)
      OUTDCE(1) = OUTDCE(25)
      OUTDCT(1) = OUTDCT(25)
      OUTDCH(1) = OUTDCH(25)
C
C-------------------------------------------------- OUTPUT, PART 2 ---
C
  280 DO 290 I=1,IMAX
      OUTQI( 1,I)   = QI(I)/86400.
      OUTQO( 1,I)   = QO(I)/86400.
      OUTQV( 1,I)   = QV(I+1)/86400.
      OUTOX( 1,I)   = COX(I)
      OUTOD1(1,I)   = COD1(I)
      OUTOD2(1,I)   = COD2(I)
      OUTAM( 1,I)   = CAM(I)*1000.
      OUTNI( 1,I)   = CNI(I)*1000.
      OUTOP( 1,I)   = COP(I)*1000.
      OUTPH( 1,I)   = CPH(I)
      OUTDE( 1,I)   = CDE(I)
      OUTSOD(1,I)   = SOD(I)
      OUTTOD(1,I)   = TOD(I)
      OUTBOD(1,I)   = OUTBCD(25,I)
      OUTTON(1,I)   = OUTTCN(25,I)
      OUTTOP(1,I)   = OUTTCP(25,I)
  290 CONTINUE
      NOUT = 1
C
C------------------------------------------------ END OF INITIALIZATION ---
C
C   BEGIN OF COMPUTATIONAL LOOPS DURING TIME (T,T+MM*30.4),
C   WITH TIMESTEPS RESP.  MONTHLY,DET,DETC
C
C------------------------------ BEGIN OF MONTHLY-COMPUTATIONAL LOOP ---
C------------------------------ DETERMINE PARAMETERS FOR REAERATION ---
C
  295 RKL = CKL*(WIND(M)**2)*1.016**(TEPI(M)-20.0)
      IF (RKL .LT. CKLMIN) RKL = CKLMIN*1.016**(TEPI(M)-20.0)
      CSAT = (0.68-0.0006*TEPI(M))*(755.4-0.032*TEPI(M)**2)/
     1       (TEPI(M)+35.)
C
C--------------------------- DETERMINE TEMPERATURE DEPENDENT RATES ---
C
      TAV   = TEPI(M)-0.5*TDEL(M)
      ROD1  = ROD1B*(1.045)**(TAV-20.)
      ROD2  = ROD2B*(1.045)**(TAV-20.)
      RDET  = RDETB*(1.045)**(TAV-20.)
      RSOD  = RSODB*(1.045)**(TAV-20.)
      RNIT  = RNITB*(1.072)**(TAV-20.)
      RDEB  = RDEBB*(1.072)**(TAV-20.)
      RREF  = FREF*RSOD
C
C------------------------------ DETERMINE PARAMETERS FOR PRIM.PROD. ---
C
      RMOR  = FMOR*EXP(0.1*TEPI(M)-3.22)
      RRES  = EXP(RCO1*TEPI(M)-RCO2(M))
```

```
      RRESB = EXP(RCO1*20.-RCO2(M))
      RPMAX = 0.913*(SVOL(M)**(-0.07))*(1.066**TEPI(M)) + RRES
      TIOPT = SIOP(M)*EXP(0.064*(TEPI(M)-20.))
C
C------------------------------- DETERMINE DISPERSION COEFFICIENTS ---
C
      FRIVE = 0.0007*(WIND(M)**1.25)
      DISPO = 86400.*0.4*FRIVE*HEPI(M)/6.0
      DISPE = DISPO
      DISPT = 0.0
      DISPH = 0.0
      IF (TDEL(M) .LE. 0.01) GOTO 298
      DENGR = 0.0143*(TEPI(M)-4.0)*TDEL(M)/(2.*HEPI(M))
      RICHT = 0.0016*DENGR*(HEPI(M)/FRIVE)**2
      DISPT = DISPO/((1+3.33*RICHT)**1.5)
      FGRAD = (5.+0.1*HEPI(M))/HEPI(M)
      IF (FGRAD .GT. 1.0) FGRAD = 1.0
      RICHE = FRICH*FGRAD*(RICHT/3.)
      DISPE = DISPO/((1+3.33*RICHE)**1.5)
      DISPH = FDISP*DISPT
      IF (DISPH .LT. DMIN) DISPH = DMIN
      IF (DISPT .LT. DMIN/FDISP) DISPT = DMIN/FDISP
  298 IF (DISPE .GT. DMAX) DISPE = DMAX
      DISPC(2) = DISPE
      DISPC(3) = DISPT
      DISPC(1) = DISPH
C
C------- CHECK TIMESTEP FOR INNER LOOP FOR PROCESSES AND DISPERSION ---
C---------------------------- CORRECT DET2 IF D > (DZ**2)/(2*DET2) ---
C
      DET2 = DET1
      IF (STAB .LT. 1.02) GOTO 300
      DET2 = DEZ*DEZ/(2.*DISPC(2)*STAB)
      IF (DET2 .GT. DET1) DET2 = DET1
      DET4 = 0.2/(RMOR+RRES)
      IF (DET2 .GT. DET4) DET2 = DET4
      DET5 = 0.5*DEZ/RS1
      IF (DET2 .GT. DET5) DET2 = DET5
C
C------------- BEGIN OF OUTER LOOP FOR HYDRAULICS WITH TIMESTEP DET ---
C
  300 DO 1000 NT=1,NTR
      T = T+DET/30.4
      DET3 = DET1
      IMAXTO = IMAXT
C
C------------- CALCULATE STORAGE VOLUME AND ADJUST NUMBER OF LAYERS ---
C
      QP = PREC(M)*A(IMAXT+1)/(30.4*1000.)
      QE = EVAP(M)*A(IMAXT+1)/(30.4*1000.)
      VS = VS+(QV(IMAXT+1)+QP-QE)*DET
      IOVER = 0
      IF (VS .LT. 0.0) GOTO 392
  391 IF (VS .LT. V(IMAXT+1)) GOTO 400
      IMAXT = IMAXT+1
```

```
      VS = VS-V(IMAXT)
      IF (IMAXT .LE. IMAX) GOTO 391
      IMAXT = IMAX
      IOVER = 1000000
      GOTO 391
  392 IF (DABS(VS) .LT. V(IMAXT)) GOTO 400
      VS = VS+V(IMAXT)
      IMAXT = IMAXT-1
      IF (IMAXT .LE. 1) GOTO 9994
      GOTO 392
  400 CONTINUE
C
C------------------------- NULLIFY THE FLOWS FOR THE EMPTY LAYERS ---
C
      IF (IMAXT .GE. IMAXTO) GOTO 406
      IMAXT1 = IMAXT+1
      DO 405 I=IMAXT1,IMAX
      QI(I) = 0.0
      QO(I) = 0.0
      QV(I) = 0.0
  405 CONTINUE
      QV(IMAX+1) = 0.0
  406 CONTINUE
C
C---- CALCULATE INFLOW FOR EVERY LAYER, DEPENDING OF STRATIFICATION ---
C------------------------------------------ FOR UNSPECIFIED INFLOW ---
C
      DO 412 I=1,IMAXT
      QI(I) = QIN(1,M)*V(I)/VT(IMAXT+1)
      QO(I) = 0.0
  412 CONTINUE
C
C--------------- FOR INFLOW DISTRIBUTED AMONG EPI- AND HYPOLIMNION ---
C
      IHYP = IMAXT-IFIX(HEPI(M)/DEZ+0.5)
      IF (IHYP .LE. 0) IHYP = 0
      IF (IHYP .LE. 1) GOTO 415
      IF (IHYP .EQ. IMAXT) GOTO 415
      VH = VT(IHYP+1)
      IHYP1 = IHYP+1
      DO 413 I=IHYP1,IMAXT
      QI(I) = QI(I)+QIN(2,M)*V(I)/(VT(IMAXT+1)-VH)
  413 CONTINUE
      DO 414 I=1,IHYP
      QI(I) = QI(I)+QIN(3,M)*V(I)/VH
  414 CONTINUE
      GOTO 417
  415 DO 416 I=1,IMAXT
      QI(I) = QI(I)+(QIN(2,M)+QIN(3,M))*V(I)/VT(IMAXT+1)
  416 CONTINUE
  417 CONTINUE
C
C------------------------- CALCULATION OF OUTFLOW FOR EVERY LAYER ---
C----- ACCORDING TO NORMAL DISTRIBUTION AND MAXIMALLY THREE OUTLETS ---
C
```

```
      IF (TDEL(M) .GE. 0.1) GOTO 1400
      W1 = 10.*HMAX
      W2 = 10.*HMAX
      W3 = 10.*HMAX
      GOTO 1401
 1400 RDGR = 0.0000064*(2.0*TEPI(M)-TDEL(M)-8.0)*TDEL(M)/(IMAXT*DEZ/2.)
      CWIDTH = 2.4/(SQRT(WIDTH))
      W1 = CWIDTH*(9.8*RDGR)**(-0.25)*(QOUT(1,M)/86400.)**0.5
      W2 = CWIDTH*(9.8*RDGR)**(-0.25)*(QOUT(2,M)/86400.)**0.5
      W3 = CWIDTH*(9.8*RDGR)**(-0.25)*(QOUT(3,M)/86400.)**0.5
 1401 SUM1 = 0.0
      SUM2 = 0.0
      SUM3 = 0.0
C
C---------- FRACTION CONTRIBUTED TO OUTFLOW BY EACH LAYER, OUTLET 1 ---
C
      DO 1410 I=1,IMAXT
      GD1(I) = 0.0
      IF (IMAXT .LT. IHO1) GOTO 1410
      X1 = 100.
      IF (W1 .GT. 0.01) X1 = ((I-IHO1)*DEZ/W1)**2
      IF (X1 .LE. 6.0)  GD1(I) = EXP(-X1)
      SUM1 = SUM1+GD1(I)
 1410 CONTINUE
C
C------------------------------------------------------------ OUTLET 2 ---
C
      IHO2A = IHO2
      IF (IHO2 .GE. 0) GOTO 1411
      IHO2A = IMAXT+IHO2-1
      IF (IHO2A .LT. 1) IHO2A=1
 1411 DO 1420 I=1,IMAXT
      GD2(I) = 0.0
      IF (IMAXT .LT. IHO2A) GOTO 1420
      X2 = 100.
      IF (W2 .GT. 0.01) X2 = ((I-IHO2A)*DEZ/W2)**2
      IF (X2 .LE. 6.0) GD2(I) = EXP(-X2)
      SUM2 = SUM2+GD2(I)
 1420 CONTINUE
C
C------------------------------------------------------------ OUTLET 3 ---
C
      IHO3A = IHO3
      IF (IHO3 .GE. 0) GOTO 1421
      IHO3A = IMAXT+IHO3-1
      IF (IHO3A .LT. 1) IHO3A = 1
 1421 DO 1430 I=1,IMAXT
      GD3(I) = 0.0
      IF (IMAXT .LT. IHO3A) GOTO 1430
      X3 = 100.
      IF (W3 .GT. 0.01) X3 = ((I-IHO3A)*DEZ/W3)**2
      IF (IHO3 .GE. 0) GOTO 1429
      IF (I .GE. IHO3A) X3 = 0.0
 1429 CONTINUE
      IF (X3 .LE. 6.0) GD3(I) = EXP(-X3)
```

```
      SUM3 = SUM3+GD3(I)
 1430 CONTINUE
C
C------------------------- CALCULATION OF OUTFLOW FOR EVERY LAYER ---
C--- OUTFLOW LAYERS 1-2 TO LAYERS 3-IHO1 TO PREVENT SMALL TIMESTEPS ---
C
      DO 1440 I=1,IMAXT
      IF (SUM1 .GT. 0.000001) QO(I) = QO(I)+GD1(I)*QCUT(1,M)/SUM1
      IF (SUM2 .GT. 0.000001) QO(I) = QO(I)+GD2(I)*QCUT(2,M)/SUM2
      IF (SUM3 .GT. 0.000001) QO(I) = QO(I)+GD3(I)*QCUT(3,M)/SUM3
 1440 CONTINUE
      IF ((15.0*QI(1)+15*QO(1)) .LT. V(1)) GOTO 1445
      IF (IMAXT .LT. IHO1) GOTO 1445
      DO 1442 I=3,IHO1
      QO(I) = QO(I)+(0.9*QO(1)+0.5*QO(2))/(IHO1-2)
 1442 CONTINUE
      QO(1) = 0.1*QO(1)
      QO(2) = 0.5*QO(2)
 1445 CONTINUE
C
C------------------------- CALCULATE VERTICAL FLOW FOR EVERY LAYER ---
C
      DO 1450 I=1,IMAXT
      QV(I+1) = QI(I)-QO(I)+QV(I)
 1450 CONTINUE
C
C------------- CHECK THE TIMESTEP WITH RESPECT TO TOTAL THROUGHFLOW ---
C------------------------------- CORRECT DETC IF V(I) > QTOT*DETC ---
C
      DO 1460 I=1,IMAXT
      IF (STAB .LT. 1.02) GOTO 1460
      DETH = DET1
      QTOT = QI(I)+QO(I)+ABS(QV(I))+ABS(QV(I+1))
      IF (QTOT .GT. 0.01) DETH = V(I)/(QTOT*STAB)
      IF (DETH .LT. DET3) DET3 = DETH
 1460 CONTINUE
      DETH = DET3
      IF (DET2 .LT. DET3) DETH = DET2
      IF (DET1 .LT. DET2) DETH = DET1
      NPT  = IFIX(DET/DETH+0.9)
      DETC = DET/NPT
C
C--- CORRECTION CONCENTRATIONS FOR CHANGE IN TOTAL NUMBER OF LAYERS ---
C
      IF (TEXT(50,5) .EQ. HYDRAU) GOTO 860
      IF (IMAXT .EQ. IMAXTO) GOTO 512
      IF (IMAXT .LE. IMAXTO) GOTO 510
      IMXTO1  = IMAXTO+1
      DO 500 I=IMXTO1,IMAXT
      COX(I)  = COX(IMAXTO)
      COD1(I) = 0.0
      COD2(I) = 0.0
      CAM(I)  = CAMI(M)
      CNI(I)  = CNII(M)
      COP(I)  = COPI(M)
```

```
      CPH(I)  = 0.01
      CDE(I)  = CDETI(M)
      SOD(I)  = SODI
  500 CONTINUE
      GOTO 512
  510 IMAXT1  = IMAXT+1
      IMXTO1  = IMAXTO+1
      DO 511 I=IMAXT1,IMXTO1
      COX(I)  = 0.0
      COD1(I) = 0.0
      COD2(I) = 0.0
      CAM(I)  = 0.0
      CNI(I)  = 0.0
      COP(I)  = 0.0
      CPH(I)  = 0.0
      CDE(I)  = 0.0
      SOD(I)  = 0.0
  511 CONTINUE
  512 CONTINUE
C
C-------------- DETERMINE THE LOWER BOUNDARY OF THE EUPHOTIC LAYER ---
C
      IEUT = IMAXT-IFIX(4.0/(BEXT(M)*DEZ)+2.0)
C
C----------------- BEGIN OF INNER LOOP FOR PROCESSES AND DISPERSION ---
C------------------------------------------- WITH TIMESTEP DETC ---
C
      DO 2000 NP=1,NPT
C
C--------------------- COMPUTE NET PRIMARY PRODUCTION RATE CONSTANT ---
C
      IMOR = MINO(IHYP,IEUT)
      TIZ2 = TIS(M)
      DO 845 I=1,IMAXT
      IR = IMAXT+1-I
      IF (IR .LT. IMOR .OR. COX(IR) .LE. 0.0) GOTO 830
      EXT  = BEXT(M) + SEXT(M)*(CPH(IR)+FED*CDE(IR))/2.67
      TIZ1 = TIZ2
      TIZ2 = TIZ1*EXP(-EXT*DEZ)
      AVEF = DL(M)/(16.*DEZ*EXT)*
     1       (EXP(1-TIZ2/TIOPT) - EXP(1-TIZ1/TIOPT))
      PROD(IR) = AVEF*RPMAX - RRES
      IF ((SA3*CPH(IR)) .LT. 1.0E-07 .OR.
     1    (SP3*CPH(IR)) .LT. 1.0E-07) GOTO 845
      PRODM = (CAM(IR)+CNI(IR))/(SA3*CPH(IR)*DETC)
      IF (PROD(IR) .GT. PRODM) PROD(IR) = PRODM
      PRODM = COP(IR)/(SP3*CPH(IR)*DETC)
      IF (PROD(IR) .GT. PRODM) PROD(IR) = PRODM
      GOTO 845
  830 PROD(IR) = 0.0
      CDE(IR)  = CDE(IR) + CPH(IR)
      CPH(IR)  = 0.0
  845 CONTINUE
C
C------- COMPUTE CONC. INCREMENTS CAUSED BY WATER QUALITY PROCESSES ---
```

```
C
      DO 517  I=1,IMAXT
      FA = 1.0
      FN = 1.0
      FD = 0.0
      FS = 1.0
      IF (COX(I) .LT. 0.0 .AND. CNI(I) .LT. 0.1)   FA = FAN
      IF (COX(I) .LE. 0.1 .OR. CAM(I) .LT. 0.005)  FN = 0.0
      IF (COX(I) .LE. 0.0 .AND. CNI(I) .GT. 0.001) FD = 1.0
      IF (COX(I) .LT. 0.0 .AND. CNI(I) .LT. 0.005) FS = 0.0
      POD1 = FA*ROD1*COD1(I)*V(I)
      POD2 = FA*ROD2*COD2(I)*V(I)
      PDET = FA*RDET*CDE(I)*V(I)
      PSOD = RSOD*SOD(I)*(A(I+1)-A(I))
      PNIT = FN*RNIT*CAM(I)*V(I)
      PDEB = RDEB*CNI(I)*(A(I+1)-A(I))
      PDEN = FD*SD*(POD1+POD2+PDET)
      PPHY = PROD(I)*CPH(I)*V(I)
      PMOR = RMOR*CPH(I)*V(I)
      PSE1 = RS1*(COD1(I+1)-COD1(I))*A(I+1)
      PSE2 = RS1*(COD2(I+1)-COD2(I))*A(I+1)
      PSED = RS2*(CDE(I+1)-CDE(I))*A(I+1)
      PSAD = FS*RSAD*(COP(I+1)-COP(I))*A(I+1)
      FRAC1 = 0.0
      FRAC2 = 0.0
      IF (SA3*PROD(I)*CPH(I) .LT. 1.0E-08) GOTO 518
      FRAC1 = CAM(I)/(SA3*PROD(I)*CPH(I)*DETC)
      IF (FRAC1 .GT. 1.0) FRAC1 = 1.0
      FRAC2 = (1.-FRAC1)
  518 CONTINUE
      BOX(I)   = -(1-FD)*(POD1+POD2+PDET) - PSOD + PPHY - SN*PNIT +
     1           QI(I)*COXI(M)
      BOD1(I) = -POD1 + PSE1
      BOD2(I) = -POD2 + PSE2
      BAM(I)   = SA1*POD1 + SA2*POD2 + SA3*PDET - FRAC1*SA3*PPHY - PNIT +
     1           FAMR*SAS(I)*PSOD*(RSOD+RREF)/RSOD + GI(I)*CAMI(M)
      BNI(I)   = PNIT - PDEN - PDEB - FRAC2*SA2*PPHY + GI(I)*CNII(M)
      BOP(I)   = SP1*POD1 + SP2*POD2 + SP3*PDET - SP3*PPHY + PSAD +
     1           FOPR*SPS(I)*PSOD*(RSOD+RREF)/RSOD + GI(I)*COPI(M)
      BPH(I)   = PPHY - PMOR + QI(I)*0.01
      BDE(I)   = PMOR - PDET + PSED + QI(I)*CDETI(M)
  517 CONTINUE
      BOX(1)       = BOX(1) - RSOD*SOD(1)*A(1)
      BOX(IMAXT)   = BOX(IMAXT) + RKL*(CSAT-COX(IMAXT))*A(IMAXT+1)
      BOD1(IMAXT) = BOD1(IMAXT) - RS1*COD1(IMAXT+1)*A(IMAXT+1)
      BOD2(IMAXT) = BOD2(IMAXT) - RS1*COD2(IMAXT+1)*A(IMAXT+1)
      BAM(IMAXT)   = BAM(IMAXT) + QP*CAMP
      BNI(1)       = BNI(1) - RDEB*CNI(1)*A(1)
      BNI(IMAXT)   = BNI(IMAXT) + QP*CNIP
      BOP(IMAXT)   = BOP(IMAXT) - RSAD*COP(IMAXT+1)*A(IMAXT+1) + QP*COPP
      BDE(IMAXT)   = BDE(IMAXT) - RS2*CDE(IMAXT+1)*A(IMAXT+1)
C
C---------- CALC. SEDIMENT OXYGEN DEMAND, STOCH. COEF. FOR N AND P ---
C
      DO 854 I=1,IMAXT
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      SODO   = SOD(I)
      SOD(I) = SOD(I) + (-(RSOD+RREF)*SOD(I) +
     1         RS1*(COD1(I)+COD2(I)) + RS2*CDE(I))*DETC
      IF (SOD(I) .LE. 0.0) GOTO 854
      SAS(I) = (SAS(I)*SODO + (-FAMR*(RSOD+RREF)*SAS(I)*SODO +
     1         RS1*(SA1*COD1(I)+SA2*COD2(I)) +
     1         RS2*SA3*CDE(I))*DETC)/SOD(I)
      FS = 1.0
      IF (COX(I) .LT. 0.0 .AND. CNI(I) .LT. 0.1)   FS = 0.0
      SPS(I) = (SPS(I)*SODO + (-FOPR*(RSOD+RREF)*SPS(I)*SODO +
     1         RS1*(SP1*COD1(I)+SP2*COD2(I)) +
     1         RS2*SP3*CDE(I) + FS*RSAD*COP(I))*DETC)/SOD(I)
  854 CONTINUE
C
C----- COMPUTE COEFFICIENTS FOR MASS TRANSPORT AND CONC. INCREMENTS ---
C------------------------------------- THE INTERMEDIATE LAYERS ---
C
      IF (IMAXT .LE. 2) GOTO 570
      J = 1
      IF (IHYP .LE. 0) J = 2
      IMAXT2 = IMAXT-1
      DO 560 I=2,IMAXT2
      IF (I .EQ. IHYP .OR. I .EQ. IHYP+1) J = 3
      IF (I .GT. IHYP+1) J = 2
      B1 = DISPC(J)*A(I)/DEZ
      B2 = -DISPC(J)*A(I)/DEZ-QO(I)
      IF (I .EQ. IHYP-1 .OR. I .EQ. IHYP) J = 3
      IF (I .GT. IHYP) J = 2
      B2 = B2-DISPC(J)*A(I+1)/DEZ
      B3 = DISPC(J)*A(I+1)/DEZ
      IF (QV(I) .LT. 0.0) GOTO 520
      B1 = B1+QV(I)
      GOTO 530
  520 B2 = B2+QV(I)
  530 IF (QV(I+1) .LT. 0.0) GOTO 540
      B2 = B2-QV(I+1)
      GOTO 550
  540 B3 = B3-QV(I+1)
  550 CONTINUE
      BOX(I)  = BOX(I) + B1*COX(I-1) + B2*COX(I) + B3*COX(I+1)
      BOD1(I) = BOD1(I) + B1*COD1(I-1) + B2*COD1(I) + B3*COD1(I+1)
      BOD2(I) = BOD2(I) + B1*COD2(I-1) + B2*COD2(I) + B3*COD2(I+1)
      BAM(I)  = BAM(I) + B1*CAM(I-1) + B2*CAM(I) + B3*CAM(I+1)
      BNI(I)  = BNI(I) + B1*CNI(I-1) + B2*CNI(I) + B3*CNI(I+1)
      BOP(I)  = BOP(I) + B1*COP(I-1) + B2*COP(I) + B3*COP(I+1)
      BPH(I)  = BPH(I) + B1*CPH(I-1) + B2*CPH(I) + B3*CPH(I+1)
      BDE(I)  = BDE(I) + B1*CDE(I-1) + B2*CDE(I) + B3*CDE(I+1)
  560 CONTINUE
C
C------------------------------------------- THE UPPER LAYER ---
C
  570 CONTINUE
      IF (IMAXT .EQ. 1) GOTO 700
      B1 = DISPC(2)*A(IMAXT)/DEZ
      B2 = -DISPC(2)*A(IMAXT)/DEZ-QO(IMAXT)-QV(IMAXT+1)
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      IF (QV(IMAXT) .LT. 0.0) GOTO 590
      B1 = B1+QV(IMAXT)
      GOTO 600
  590 B2 = B2+QV(IMAXT)
  600 CONTINUE
      BOX(IMAXT)  = BOX(IMAXT) + B1*COX(IMAXT-1) + B2*COX(IMAXT)
      BOD1(IMAXT) = BOD1(IMAXT) + B1*COD1(IMAXT-1) + B2*COD1(IMAXT)
      BOD2(IMAXT) = BOD2(IMAXT) + B1*COD2(IMAXT-1) + B2*COD2(IMAXT)
      BAM(IMAXT)  = BAM(IMAXT) + B1*CAM(IMAXT-1) + B2*CAM(IMAXT)
      BNI(IMAXT)  = BNI(IMAXT) + B1*CNI(IMAXT-1) + B2*CNI(IMAXT)
      BOP(IMAXT)  = BOP(IMAXT) + B1*COP(IMAXT-1) + B2*COP(IMAXT)
      BPH(IMAXT)  = BPH(IMAXT) + B1*CPH(IMAXT-1) + B2*CPH(IMAXT)
      BDE(IMAXT)  = BDE(IMAXT) + B1*CDE(IMAXT-1) + B2*CDE(IMAXT)
C
C------------------------------------------------- THE LOWER LAYER ---
C
      J = 1
      IF (IHYP .LE. 0) J = 2
      B2 = -DISPC(J)*A(2)/DEZ-QO(1)
      B3 = DISPC(J)*A(2)/DEZ
      IF (QV(2) .LT. 0.0) GOTO 630
      B2 = B2-QV(2)
      GOTO 640
  630 B3 = B3-QV(2)
  640 CONTINUE
      BOX(1)  = BOX(1) + B2*COX(1) + B3*COX(2)
      BOD1(1) = BOD1(1) + B2*COD1(1) + B3*COD1(2)
      BOD2(1) = BOD2(1) + B2*COD2(1) + B3*COD2(2)
      BAM(1)  = BAM(1) + B2*CAM(1) + B3*CAM(2)
      BNI(1)  = BNI(1) + B2*CNI(1) + B3*CNI(2)
      BOP(1)  = BOP(1) + B2*COP(1) + B3*COP(2)
      BPH(1)  = BPH(1) + B2*CPH(1) + B3*CPH(2)
      BDE(1)  = BDE(1) + B2*CDE(1) + B3*CDE(2)
      GOTO 800
C
C------------------------------------- IN CASE OF ONLY ONE LAYER ---
C
  700 CONTINUE
      B2 = -QO(1)-QV(2)
      BOX(1)  = BOX(1) + B2*COX(1)
      BOD1(1) = BOD1(1) + B2*COD1(1)
      BOD2(1) = BOD2(1) + B2*COD2(1)
      BAM(1)  = BAM(1) + B2*CAM(1)
      BNI(1)  = BNI(1) + B2*CNI(1)
      BOP(1)  = BOP(1) + B2*COP(1)
      BPH(1)  = BPH(1) + B2*CPH(1)
      BDE(1)  = BDE(1) + B2*CDE(1)
C
C------------------------------- CALCULATION OF NEW CONCENTRATIONS ---
C------------------- CORRECTION OF NEGATIVE NITRATE CONCENTRATIONS ---
C
  800 CONTINUE
      DO 810 I=1,IMAXT
      COX(I)  = COX(I) + BOX(I)*DETC/V(I)
      COD1(I) = COD1(I) + BOD1(I)*DETC/V(I)
```

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      COD2(I) = COD2(I) + BOD2(I)*DETC/V(I)
      CAM(I)  = CAM(I) + BAM(I)*DETC/V(I)
      CNI(I)  = CNI(I) + BNI(I)*DETC/V(I)
      COP(I)  = COP(I) + BOP(I)*DETC/V(I)
      CPH(I)  = CPH(I) + BPH(I)*DETC/V(I)
      CDE(I)  = CDE(I) + BDE(I)*DETC/V(I)
      IF (CNI(I) .GT. 0.0) GOTO 810
      COX(I)  = COX(I) + CNI(I)/SD
      CNI(I)  = 0.0
  810 CONTINUE
 2000 CONTINUE
C
C------------------------------------------------ END OF INNER LOOP ---
C--- CALC. GRADUAL INCORP. PHYTOMASS IN WATER AND REMAIN. PHYTOMASS ---
C
      DO 850 I=1,IMAXT
      IF (TOD(I) .LE. 0.0) GOTO 851
      AV = (A(I+1)-A(I))/V(IMAXT)
      IF (IMAXTO .GE. IMAXT) GOTO 852
      IF (IS(I) .EQ. 1) GOTO 853
      COD1(I) = COD1(I) + FOD1*TOD(I)*AV
      TOD(I)  = TOD(I)*(1.-FOD1)
      IS(I)   = 1
  853 CONTINUE
      DHVEG = HVEG-(IMAXT+1-I)*DEZ
      IF (DHVEG .LE. 0.0) DHVEG = DEZ
      NIL = IMAXT+1-I
      IF (I .LE. IMAXTO) NIL = 1
      IF (I .EQ. 1 .AND. IMAXTO .EQ. 1) NIL = IMAXT
      COD2(IMAXT) = COD2(IMAXT) + NIL*(DEZ/DHVEG)*TOD(I)*AV
      TOD(I)      = TOD(I) - NIL*(DEZ/DHVEG)*TOD(I)
  852 CONTINUE
      IF (TDR(I) .LT. TLAG .OR. TOD(I) .LE. 0.0) GOTO 851
      COD2(IMAXT) = COD2(IMAXT) + RVEG*(1.-(IMAXT+1-I)*DEZ/HVEG)*
     1              TODIO(I)*DET*AV
      TOD(I)      = TOD(I) - RVEG*(1.-(IMAXT+1-I)*DEZ/HVEG)*
     1              TODIO(I)*DET
  851 CONTINUE
      IF (TOD(I) .LE. 0.0)  TOD(I) = 0.0
      TDR(I) = TDR(I) + DET
  850 CONTINUE
C
C------------------------------- END OF OUTER LOOP FOR HYDRAULICS ---
C------------------- JUMP OUT OF LOOP, WHEN END OF MONTH IS REACHED ---
C
  860 M = IFIX(T+DET/60.8+1.0)
      IF (M .GT. MO) GOTO 899
 1000 CONTINUE
C
C---------------------- CALCULATION VOLUME FRACTION ANAEROBIC WATER ---
C
  899 VAN = 0.
      DO 855 I=1,IMAXT
      IF (COX(I) .LE. 0.0) VAN = VAN+V(I)
  855 CONTINUE
```

```
      PAN = VAN/VT(IMAXT+1)
C
C------------------------------------------------------ PREPARE OUTPUT ---
C------------------------------------ HYDRAULICS AND WATER QUALITY ---
C
      IF (TEXT(50,7) .EQ. TEST) M = NOUT+1
      DO 900 I=1,IMAX
      OUTQI(M,I)  = QI(I)/(86400.*1000.)
      OUTQO(M,I)  = QO(I)/(86400.*1000.)
      OUTQV(M,I)  = QV(I+1)/(86400.*1000.)
      OUTOX(M,I)  = COX(I)
      OUTOD1(M,I) = COD1(I)
      OUTOD2(M,I) = COD2(I)
      OUTAM(M,I)  = CAM(I)*1000.0
      OUTNI(M,I)  = CNI(I)*1000.0
      OUTOP(M,I)  = COP(I)*1000.0
      OUTPH(M,I)  = CPH(I)
      OUTDE(M,I)  = CDE(I)
      OUTSOD(M,I) = SOD(I)
      OUTTOD(M,I) = TOD(I)
      OUTBOD(M,I) = CPH(I)*(1-EXP(-5.*RRESB)) +
     1              CDE(I)*(1-EXP(-5.*RDETB)) +
     1              COD1(I)*(1-EXP(-5.*ROD1B)) +
     1              COD2(I)*(1-EXP(-5.*ROD2B))
      OUTTON(M,I) = (CAM(I) + CNI(I) + (CPH(I)+CDE(I))*SA3 +
     1              COD1(I)*SA1 + COD2(I)*SA2)*1000.
      OUTTOP(M,I) = (COP(I) + (CPH(I)+CDE(I))*SP3 +
     1              COD1(I)*SP1 + COD2(I)*SP2)*1000.
  900 CONTINUE
C
C------------------------------ SPECIAL OUTPUT, AVERAGE CONCENTRATIONS ---
C
      CM  = 0.0
      CME = 0.0
      CMH = 0.0
      SUMOX = 0.0
      DO 901 I=1,IMAXT
      SUMOX = SUMOX+COX(I)*V(I)
      CM  = (CM*(I-1)+COX(I))/I
  901 CONTINUE
      CWM = SUMOX/VT(IMAXT+1)
      DO 902 I=1,IHYP
      CMH = (CMH*(I-1)+COX(I))/I
  902 CONTINUE
      IHYP1 = IHYP+1
      N = 1
      DO 903 I=IHYP1,IMAXT
      N = N+1
      CME = (CME*(N-1)+COX(I))/N
  903 CONTINUE
      OUTH(M) = IMAXT*DEZ
      IOV(M)  = IOVER
      OUTQP(M)  = QP/(86400.*1000.)
      OUTQE(M)  = QE/(86400.*1000.)
      OUTCM(M)  = CM
```

```
      OUTCME(M) = CME
      OUTCMH(M) = CMH
      OUTCWM(M) = CWM
      OUTPAN(M) = PAN
      OUTDCE(M) = DISPC(2)
      OUTDCT(M) = DISPC(3)
      OUTDCH(M) = DISPC(1)
C
C---------------- OUTPUT OF OXYGEN CONC. AT SELECTED DEPTH LEVELS ---
C
      IF (JSTART .EQ. 0) GOTO 999
      DO 910 I=1,NLEV
      IDEP = IFIX(ODEP(I)/DEZ+0.01)
      OXYDEP(M,I) = 0.0
      IF (IDEP .GE. IMAXT) GOTO 910
      OXYDEP(M,I) = OUTOX(M,IMAXT-IDEP)
  910 CONTINUE
  999 CONTINUE
C
C------------------------------ AVERAGE CONCENTRATIONS IN OUTFLOW ---
C
      SQI(M) = 0.0
      SQO(M) = 0.0
      SUMC   = 0.0
      SUMC1  = 0.0
      SUMC2  = 0.0
      SUMC3  = 0.0
      SUMC4  = 0.0
      COUT1  = 0.0
      COUT2  = 0.0
      COUT3  = 0.0
      DO 907 I=1,IMAX
      SQI(M) = SQI(M)+QI(I)
      SQO(M) = SQO(M)+QO(I)
      SUMC   = COX(I)*QO(I)+SUMC
      SUMC1  = COD1(I)*QO(I)+SUMC1
      SUMC2  = COD2(I)*QO(I)+SUMC2
      SUMC3  = (CPH(I)+CDE(I))*QO(I)+SUMC3
      SUMC4  = CAM(I)*QO(I)+SUMC4
      IF (QOUT(1,M-1) .LT. 0.0001) GOTO 908
      COUT1  = COX(I)*GD1(I)/SUM1+COUT1
  908 IF (QOUT(2,M-1) .LT. 0.0001) GOTO 909
      COUT2  = COX(I)*GD2(I)/SUM2+COUT2
  909 IF (QOUT(3,M-1) .LT. 0.0001) GOTO 907
      COUT3  = COX(I)*GD3(I)/SUM3+COUT3
  907 CONTINUE
      IF (SQO(M) .LT. 0.001) GOTO 906
      OC0(M) = SUMC/SQO(M)
      OD1(M) = SUMC1/SQO(M)
      OD2(M) = SUMC2/SQO(M)
      OD3(M) = SUMC3/SQO(M)
      AM(M)  = SUMC4/SQO(M)
  906 OC1(M) = COUT1
      OC2(M) = COUT2
      OC3(M) = COUT3
```

```
C
C-------------------- CORRECTION OXYGEN CONC. FOR REARATION SPILLWAY ---
C
      IF (COUT1 .LT. -1.0) COUT1 = -1.0
      IF (COUT2 .LT. -1.0) COUT2 = -1.0
      IF (COUT3 .LT. -1.0) COUT3 = -1.0
      CREDS = 0.0
      IF (COUT2 .GE. -1.0 .AND. COUT2 .LT. 0.0) CREDS = COUT2
      IF (REAR .GT. 0.9) CREDS = 0.0
      IF (SQO(M) .LT. 0.0001) GOTO 904
      CSPIL = COUT2
      IF (CSPIL .LT. 0.0) CSPIL = 0.0
      COUT2 = CSPIL+REAR*(CSAT-CSPIL)
      CSATP = CSAT*(1+DEPTHR/20.)
      CGASI = 240.*GASVP/100.
      CGAS  = CGASI*(COUT2+CGASI)/(CSATP+CGASI)
      COUT2 = CGAS*CSATP/CGASI+CREDS
      OC(M) = (COUT1*QOUT(1,M-1)+COUT2*QOUT(2,M-1)+COUT3*QOUT(3,M-1))/
     1        SQO(M)
  904 CONTINUE
      SQI(M) = SQI(M)/86400.
      SQO(M) = SQO(M)/86400.
      SQI2(M) = SQI(M)/1000.
      SQO2(M) = SQO(M)/1000.
C
C------------------------------------------------- END OF MONTHLY LOOP ---
C
      IF (M .GT. MMAX) GOTO 3000
      NOUT = NOUT+1
      MO = M
      GOTO 295
 3000 CONTINUE
C
C------------------------------------------------- WRITE OUTPUT ON UNIT 6 ---
C
      MMAX1 = MMAX+1
      IDATE = 100*JSTART+MSTART-1
      DO 1100 I=1,MMAX1
      IM(I) = IDATE+I-1
      IF ((IM(I)-100*JSTART) .GE. 13)  IM(I) = IM(I)+88
      IF ((IM(I)-100*JSTART) .GE. 113) IM(I) = IM(I)+88
 1100 CONTINUE
C
C------------------------------------------------- OXYGEN CONCENTRATIONS ---
C
      WRITE(6,44)
   44 FORMAT (//,1H1,' OXYGEN CONCENTRATION (G/M3)          ',
     1        60X,'MONTH  ---->',/)
      WRITE(6,19) (IM(I),I=1,MMAX1)
   19 FORMAT (6H    Z   ,25I5,/)
      DO 1140 N=1,IMAX
      I = IMAX-N+1
      Z = I*DEZ
      WRITE(6,25) Z,(OUTOX(M,I),M=1,MMAX1)
   25 FORMAT (1H ,F5.1,26F5.1)
```

```
 1140 CONTINUE
C
C------------------------------------------ BIOLOGICAL OXYGEN DEMAND ---
C
      WRITE(6,1900)
 1900 FORMAT (//,1H1,' BIOLOGICAL OXYGEN DEMAND 5/20 (G O2/M3)',
     1         58X,'MONTH  ---->',/)
      WRITE(6,19) (IM(I),I=1,MMAX1)
      DO 1910 N=1,IMAX
      I = IMAX-N+1
      Z = I*DEZ
      WRITE(6,23) Z,(OUTBOD(M,I),M=1,MMAX1)
 1910 CONTINUE
C
C
C------------------------------------------------ SLOW OXYGEN DEMAND ---
C
      WRITE(6,1500)
 1500 FORMAT (//,1H1,' SLOW OXYGEN DEMAND (G O2/M3)                ',
     1         60X,'MONTH  ---->',/)
      WRITE(6,19) (IM(I),I=1,MMAX1)
      DO 1510 N=1,IMAX
      I = IMAX-N+1
      Z = I*DEZ
      WRITE(6,23) Z,(OUTOD1(M,I),M=1,MMAX1)
 1510 CONTINUE
C
C------------------------------------------------ FAST OXYGEN DEMAND ---
C
      WRITE(6,1520)
 1520 FORMAT (//,1H1,' FAST OXYGEN DEMAND (G O2/M3)                ',
     1         60X,'MONTH  ---->',/)
      WRITE(6,19) (IM(I),I=1,MMAX1)
      DO 1530 N=1,IMAX
      I = IMAX-N+1
      Z = I*DEZ
      WRITE(6,23) Z,(OUTOD2(M,I),M=1,MMAX1)
 1530 CONTINUE
C
C------------------------------------------ PHYTOPLANKTON BIOMASS ---
C
      WRITE(6,1720)
 1720 FORMAT (//,1H1,' PHYTOPLANKTON BIOMASS (G O2/M3)             ',
     1         60X,'MONTH  ---->',/)
      WRITE(6,19) (IM(I),I=1,MMAX1)
      DO 1730 N=1,IMAX
      I = IMAX-N+1
      Z = I*DEZ
      WRITE(6,23) Z,(OUTPH(M,I),M=1,MMAX1)
 1730 CONTINUE
C
C------------------------------------------ DETRITUS OXYGEN DEMAND ---
C
      WRITE(6,1740)
 1740 FORMAT (//,1H1,' DETRITUS OXYGEN DEMAND (G O2/M3)            ',
```

```
     1         60X,'MONTH  ---->',/)
      WRITE(6,19) (IM(I),I=1,MMAX1)
      DO 1750 N=1,IMAX
      I = IMAX-N+1
      Z = I*DEZ
      WRITE(6,23) Z,(OUTDE(M,I),M=1,MMAX1)
 1750 CONTINUE
C
C------------------------------------- SEDIMENT ORGANIC MATTER ---
C
      IF (LOG .EQ. 0) GOTO 1135
      WRITE(6,1600)
 1600 FORMAT (//,1H1,' SEDIMENT ORGANIC MATTER (G O2/M2)     ',
     1         60X,'MONTH  ---->',/)
      WRITE(6,19) (IM(I),I=1,MMAX1)
      DO 1610 N=1,IMAX
      I = IMAX-N+1
      Z = I*DEZ
      WRITE(6,1555) Z,(OUTSOD(M,I),M=1,MMAX1)
 1610 CONTINUE
C
C------------------------------------- PHYTOMASS IN STORE ---
C
      WRITE(6,1620)
 1620 FORMAT (//,1H1,' PHYTOMASS IN STORE (G O2/M2)          ',
     1         60X,'MONTH  ---->',/)
      WRITE(6,19) (IM(I),I=1,MMAX1)
      DO 1630 N=1,IMAX
      I = IMAX-N+1
      Z = I*DEZ
      WRITE(6,1555) Z,(OUTTOD(M,I),M=1,MMAX1)
 1630 CONTINUE
C
C------------------------------------- AMMONIUM CONCENTRATION ---
C
      IF (LOG .EQ. 1) GOTO 1135
      WRITE(6,1540)
 1540 FORMAT (//,1H1,' AMMONIUM CONCENTRATION (MG N/M3)      ',
     1         60X,'MONTH  ---->',/)
      WRITE(6,19) (IM(I),I=1,MMAX1)
      DO 1550 N=1,IMAX
      I = IMAX-N+1
      Z = I*DEZ
      WRITE(6,1555) Z,(OUTAM(M,I),M=1,MMAX1)
 1555 FORMAT (1H ,F5.1,26F5.0)
 1550 CONTINUE
C
C------------------------------------- NITRATE CONCENTRATION ---
C
      WRITE(6,1560)
 1560 FORMAT (//,1H1,' NITRATE CONCENTRATION (MG N/M3)       ',
     1         60X,'MONTH  ---->',/)
      WRITE(6,19) (IM(I),I=1,MMAX1)
      DO 1570 N=1,IMAX
      I = IMAX-N+1
```

```
      Z = I*DEZ
      WRITE(6,1555) Z,(OUTNI(M,I),M=1,MMAX1)
 1570 CONTINUE
C
C------------------------------------ TOTAL NITROGEN CONCENTRATION ---
C
      WRITE(6,1920)
 1920 FORMAT (//,1H1,' TOTAL NITROGEN CONCENTRATION (MG N/M3)',
     1         59X,'MONTH  ---->',/)
      WRITE(6,19) (IM(I),I=1,MMAX1)
      DO 1930 N=1,IMAX
      I = IMAX-N+1
      Z = I*DEZ
      WRITE(6,1555) Z,(OUTTON(M,I),M=1,MMAX1)
 1930 CONTINUE
C
C------------------------------ DISSOLVED PHOSPHORUS CONCENTRATION ---
C
      WRITE(6,1580)
 1580 FORMAT (//,1H1,' DISS. PHOSPHORUS CONCENTRATION (MG P/M3)',
     1         58X,'MONTH  ---->',/)
      WRITE(6,19) (IM(I),I=1,MMAX1)
      DO 1590 N=1,IMAX
      I = IMAX-N+1
      Z = I*DEZ
      WRITE(6,1555) Z,(OUTOP(M,I),M=1,MMAX1)
 1590 CONTINUE
C
C------------------------------------ TOTAL PHOSPHORUS CONCENTRATION ---
C
      WRITE(6,1940)
 1940 FORMAT (//,1H1,' TOTAL PHOSPHORUS CONCENTRATION (MG P/M3)',
     1         58X,'MONTH  ---->',/)
      WRITE(6,19) (IM(I),I=1,MMAX1)
      DO 1950 N=1,IMAX
      I = IMAX-N+1
      Z = I*DEZ
      WRITE(6,1555) Z,(OUTTOP(M,I),M=1,MMAX1)
 1950 CONTINUE
C
C------------------------------------------------------ TEMPERATURES ---
C
      IF (LOG .EQ. 2) GOTO 1135
      WRITE(6,46)
   46 FORMAT (//,1H1,' TEMPERATURES (OC)          ',
     1         60X,'MONTH  ---->',/)
      WRITE(6,19) (IM(I),I=1,MMAX1)
      DO 1141 N=1,IMAX
      I = IMAX-N+1
      Z = I*DEZ
      WRITE(6,25) Z,(TMAT(M,I),M=1,MMAX1)
 1141 CONTINUE
C
C------------------------------------------------------------ INFLOWS ---
C
```

```
      IF (LOG .EQ. 3) GOTO 1135
      WRITE(6,18)
   18 FORMAT (//,1H1,' HORIZONTAL INFLOWS (M3/S)/1000 ',
     1        60X,'MONTH  ---->',/)
      WRITE(6,19) (IM(I),I=1,MMAX1)
      DO 1110 N=1,IMAX
      I = IMAX-N+1
      Z = I*DEZ
      WRITE(6,22) Z,(OUTQI(M,I) ,M=1,MMAX1)
   22 FORMAT (1H ,F5.1,26F5.2)
 1110 CONTINUE
C
C------------------------------------------------------ OUTFLOWS ---
C
      WRITE(6,42)
   42 FORMAT (//,1H1,' HORIZONTAL OUTFLOWS (M3/S)/1000 ',
     1        60X,'MONTH  ---->',/)
      WRITE(6,19) (IM(I),I=1,MMAX1)
      DO 1120 N=1,IMAX
      I = IMAX-N+1
      Z = I*DEZ
      WRITE(6,23) Z,(OUTQO(M,I),M=1,MMAX1)
   23 FORMAT (1H ,F5.1,26F5.2)
 1120 CONTINUE
C
C------------------------------------------------------ VERTICAL FLOWS ---
C
      WRITE(6,43)
   43 FORMAT (//,1H1,' VERTICAL FLOWS (M3/S)/1000 ',
     1        60X,'MONTH  ---->',/)
      WRITE(6,19) (IM(I),I=1,MMAX1)
      DO 1130 N=1,IMAX
      I = IMAX-N+1
      Z = I*DEZ
      WRITE(6,24) Z,(OUTQV(M,I),M=1,MMAX1)
   24 FORMAT (1H ,F5.1,26F5.2)
 1130 CONTINUE
C
C------------------------------------------------------ GEOMETRICS ---
C
      IF (LOG .EQ. 4) GOTO 1135
      WRITE(6,59)
   59 FORMAT (1H1, /, ' VOLUMETRIC DISTRIBUTION PER LAYER')
      WRITE(6,19) (IM(I),I=1,MMAX1)
      WRITE(6,52) DEPTHO,(DEPTH(M),M=1,MMAX)
      WRITE(6,62)
   62 FORMAT (//, '  LAYER  ', ' VOL. LAYER   VOL. ACC. UPTO LAYER     '
     1        'AREA ',/)
      DO 1143 N=1,IMAX
      I = IMAX-N+1
      Z = I*DEZ
      WRITE(6,63) Z,V(I),VT(I+1),A(I+1)
   63 FORMAT (1X,F5.1,3X,E12.5,5X,E12.5,5X,E12.5)
 1143 CONTINUE
C
```

```
C------------------------------------ SUMMARY OUTPUT, AVERAGES ---
C
 1135 WRITE(6,45)
   45 FORMAT (///,1H1,' SUMMARY OF RESERVOIR SIMULATION      ',
     1        60X,'MONTH  ----->',/)
      WRITE(6,19) (IM(I),I=1,MMAX1)
      WRITE(6,49) (IOV(M),M=1,MMAX1)
   49 FORMAT (///,1H ,5HSPILL,26I5)
      WRITE(6,52) DEPTHO,(DEPTH(M),M=1,MMAX)
   52 FORMAT (/,1H ,5HPROF ,26F5.1)
      WRITE(6,53) HEPIO,(HEPI(M),M=1,MMAX)
   53 FORMAT (1H ,5HEPI  ,26F5.1)
      WRITE(6,54) HHYPOO,(HHYPO(M),M=1,MMAX)
   54 FORMAT (1H, 5HHYPO ,26F5.1)
      WRITE(6,55) TEPIO,(TEPI(M),M=1,MMAX)
   55 FORMAT (1H ,5HTEPI ,26F5.1)
      WRITE(6,56) THYPOO,(THYPO(M),M=1,MMAX)
   56 FORMAT (1H ,5HTHYPO,26F5.1)
      WRITE(6,27) (SQI2(M),M=1,MMAX1)
   27 FORMAT (/,1H, 5HQIN  ,26F5.1)
      WRITE(6,26) (OUTQP(M),M=1,MMAX1)
   26 FORMAT (1H ,5HQPR  ,26F5.0)
      WRITE(6,28) (OUTQE(M),M=1,MMAX1)
   28 FORMAT (1H ,5HQEV  ,26F5.0)
      WRITE(6,29) (SQO2(M),M=1,MMAX1)
   29 FORMAT (1H ,5HQOUT ,26F5.1)
      WRITE(6,2132) (OUTCWM(M),M=1,MMAX1)
 2132 FORMAT (/,1H ,5HCWM  ,26F5.1)
      WRITE(6,2133) (OUTCM(M),M=1,MMAX1)
 2133 FORMAT (1H ,5HCM   ,26F5.1)
      WRITE(6,2134) (OUTCME(M),M=1,MMAX1)
 2134 FORMAT (1H ,5HCME  ,26F5.1)
      WRITE(6,2135) (OUTCMH(M),M=1,MMAX1)
 2135 FORMAT (1H ,5HCMH  ,26F5.1)
      WRITE(6,2131) (OUTPAN(M),M=1,MMAX1)
 2131 FORMAT (1H ,5HPAN  ,26F5.2)
      WRITE(6,32) (OC(M),M=1,MMAX1)
   32 FORMAT (/,1H ,5HOXY  ,26F5.1)
      WRITE(6,2136) (OCO(M),M=1,MMAX1)
 2136 FORMAT (1H ,5HOXY0 ,26F5.1)
      WRITE(6,2137) (OC1(M),M=1,MMAX1)
 2137 FORMAT (1H ,5HOXY1 ,26F5.1)
      WRITE(6,2138) (OC2(M),M=1,MMAX1)
 2138 FORMAT (1H ,5HOXY2 ,26F5.1)
      WRITE(6,2139) (OC3(M),M=1,MMAX1)
 2139 FORMAT (1H ,5HOXY3 ,26F5.1)
      WRITE(6,132) (OUTDCE(M),M=1,MMAX1)
  132 FORMAT (/,1H ,5HDCE  ,26F5.2)
      WRITE(6,134) (OUTDCT(M),M=1,MMAX1)
  134 FORMAT (1H ,5HDCT  ,26F5.3)
      WRITE(6,133) (OUTDCH(M),M=1,MMAX1)
  133 FORMAT (1H ,5HDCH  ,26F5.2)
      HEPIO  = HEPI(24)
      HHYPOO = HHYPO(24)
      TEPIO  = TEPI(24)
```

```
      THYPOO = THYPO(24)
C
C------------------------------ CALL SUBROUTINE RIVER IF DESIRED ---
C
      TDAM(1)=TDAM(2)
      IF(TEXT(50,3).EQ.RIV) CALL RIVER (TDAM,OC,CD1,CD2,CD3,AM,ROD1B,
     1                          ROD2B,RDETB,RNITB,SN,SA1,SA2,SA3,FAN,
     1                          MMAX,SQO,IM)
C
C------------------------------------------------- USING CUTCM ---
C
      IF(TEXT(50,3).EQ.RIV2) CALL RIVER (TDAM,OUTCM,CD1,CD2,CD3,AM,
     1                          ROD1B,ROD2B,RDETB,RNITB,SN,SA1,SA2,SA3,
     1                          FAN,MMAX,SQO,IM)
C
C ------------------------------------------------- USING OUTCMH ---
C
      IF(TEXT(50,3).EQ.RIV3) CALL RIVER (TDAM,OUTCMH,CD1,CD2,CD3,AM,
     1                          ROD1B,ROD2B,RDETB,RNITB,SN,SA1,SA2,SA3,
     1                          FAN,MMAX,SQO,IM)
C
C ---------------------------------- WRITE OUTPUT ON UNIT IFILE ---
C
      IF (JSTART .LE. 0) GOTO 1201
      DO 1200 M=1,MMAX1
      WRITE(IFILE,79) IM(M),OUTH(M),SQI(M),SQO(M),CD1(M),CD2(M),CD3(M),
     1                AM(M),OUTCWM(M),OUTCM(M),OCO(M),OC(M),
     1                (OXYDEP(M,J),J=1,NLEV)
   79 FORMAT (I4,F5.1,2F7.0,4F5.2,14F6.2 )
 1200 CONTINUE
 1201 CONTINUE
C
C------ DECIDE TO DO ANOTHER TWO YEARS OR ANOTHER RESERVCIR OR STOP ---
C
      IF (TEXT(50,1) .EQ. GO ) GOTO 2
      IF (TEXT(50,1) .EQ. RUN) GOTO 1
      GOTO 9999
C
C------------------------------------------- WRITE ERROR CODE ---
C
 9996 NERROR = NERROR+1
 9995 NERROR = NERROR+1
 9994 NERROR = NERROR+1
 9993 NERROR = NERROR+1
 9992 NERROR = NERROR+1
 9991 NERROR = NERROR+1
      WRITE(6,99) NERROR
   99 FORMAT (20H NUMBER OF ERROR =  ,I5)
C
C------------------------------------------- END OF PROGRAM ---
C
 9999 CONTINUE
      STOP
      END
C
```

```
FILE: WQARM     FORTRAN  A1  VM/SP HPO REL 4.2 - ELETRONORTE

C*************************************************************************
C
C     WQ-ARM DOWNSTREAM:
C     A MODEL FOR CALCULATION OF THE OXYGEN BUDGET OF THE RIVER
C     DOWNSTREAM OF A RESERVOIR (MAN-MADE LAKE), AN OPTIONAL ROUTINE
C
C*************************************************************************
C
      SUBROUTINE RIVER (TDAM,COX,COD1,COD2,CDET,CAM,ROD1B,ROD2B,RDETB,
     1                  RNITB,SN,SA1,SA2,SA3,FAN,MMAX,QI,IM)
C
C------------------------------------------------------ DECLARATIONS ---
C------------------------------------------------------ WATER QUALITY ---
C
      DIMENSION COX(25),COD1(25),COD2(25),CDET(25),CBOD(25),CAM(25),
     1          COXO(11,25,2),COD1O(11,25,2),COD2O(11,25,2),
     1          CDETO(11,25,2),CAMO(11,25,2),CBODO(11,25,2),TDAM(25)
C
C------------------------------------------ HYDRAULICS AND GEOMETRY ---
C
      DIMENSION QI(25),QID(11,25),QIT(11,25),VELO(11,25),DEPT(11,25),
     1          RCHKM(11),AV(11),BV(11),AH(11),BH(11),FLOW(11,25),
     1          DIST(11)
C
C------------------------------------------- AUXILIARY PARAMETERS ---
C
      DIMENSION TEXT(50,8),IOPD(11),IOPT(11),IOPV(11),IM(25),
     1          TIME(11,25)
C
C----------- READ INPUT DATA FOR GEOMETRY, INFLOW AND WATER QUALITY ---
C
      READ(5,10) (TEXT(1,I),I=1,8),NREACH,DAMKM,DELKM,IFILE
      K = 4
      DO 101 N=1,NREACH
      READ(5,20) (TEXT(K,I),I=1,8),RCHKM(N),AV(N),BV(N),AH(N),BH(N),
     1           IOPD(N),IOPT(N),IOPV(N)
      K = K+1
      IF (IOPD(N) .EQ. 0) GOTO 100
      READ(5,30) TEXT(K,1),(QID(N,I),I = 2,13)
      READ(5,30) TEXT(K+1,1),(QID(N,I),I =14,25)
      QID(N,1) = QID(N,2)
      K = K+2
  100 IF (IOPT(N) .EQ. 0) GOTO 101
      READ(5,30) TEXT(K,1),(QIT(N,I),I = 2,13)
      READ(5,30) TEXT(K+1,1),(QIT(N,I),I =14,25)
      QIT(N,1) = QIT(N,2)
      K = K+2
  101 CONTINUE
      READ(5,40) (TEXT(50,I),I=1,8),COXI,CDETI,CAMI,LOG
   10 FORMAT (8A4,I5,2F5.0,I5)
   20 FORMAT (8A4,5F5.0,3I5)
   30 FORMAT (A4,12F6.0)
   40 FORMAT (8A4,3F5.0,I5)
C
C------------------------------------------------- WRITE INPUT DATA ---
```

```
C
      IF = IFILE
      IF (IF .EQ. 0) IF = 6
      WRITE(IF,9)
      WRITE(IF,11) (TEXT(1,I),I=1,8),NREACH,DAMKM,DELKM,IFILE
      K = 4
      DO 105 N=1,NREACH
      WRITE(IF,21) (TEXT(K,I),I=1,8),RCHKM(N),AV(N),BV(N),AH(N),BH(N),
     1             IOPD(N),IOPT(N),IOPV(N)
      K = K+1
      IF (IOPD(N) .EQ. 0) GOTO 104
      WRITE(IF,31) TEXT(K,1),(QID(N,I),I= 2,13)
      WRITE(IF,31) TEXT(K+1,1),(QID(N,I),I=14,25)
      K = K+2
  104 IF (IOPT(N) .EQ. 0) GOTO 105
      WRITE(IF,31) TEXT(K,1),(QIT(N,I),I= 2,13)
      WRITE(IF,31) TEXT(K+1,1),(QIT(N,I),I=14,25)
      K = K+2
  105 CONTINUE
      WRITE(IF,41) (TEXT(50,I),I=1,8),COXI,CDETI,CAMI,LOG
    9 FORMAT (///,1H1,20HDOWNSTREAM-RIVER     ,//)
   11 FORMAT (1H ,8A4,I8,2F8.2,I8)
   21 FORMAT (1H ,8A4,F8.2,4F8.3,3I8)
   31 FORMAT (1H ,A4,12F8.2)
   41 FORMAT (1H ,8A4,3F8.2,I8)
C
C---------------------- BEGIN OF COMPUTATIONAL LOOPS FOR EACH MONTH ---
C--------------------- LOOP L=1 FOR THE "END OF THE MONTH" SITUATION ---
C------------------- LOOP L=2 FOR THE "BEGINNING OF THE MONTH" SITUATION ---
C
      DO 3000 L=1,2
      MMAX2 = MMAX+2-L
      DO 2000 J=1,MMAX2
      M=J-1+L
C
C------------------------------------ SATURATION CONCENTRATION ---
C
      CSAT = (0.68-0.0006*TDAM(M))*(755.4-0.032*TDAM(M)**2)/
     1       (TDAM(M)+35.)
C
C------------------------------------------ DEGRADATION RATES ---
C
      ROD1  = ROD1B*(1.045)**(TDAM(M)-20.)/86400.
      ROD2  = ROD2B*(1.045)**(TDAM(M)-20.)/86400.
      RDET  = RDETB*(1.045)**(TDAM(M)-20.)/86400.
      RNIT  = RNITB*(1.072)**(TDAM(M)-20.)/86400.
C
C---------------------- TOTAL INFLOW AND AVERAGE CONC. FOR REACH 1 ---
C------------------------------------------------ NO TRIBUTARIES ---
C
      COXR  = 0.0
      COD1R = 0.0
      COD2R = 0.0
      CDETR = 0.0
      CAMR  = 0.0
```

```
      IF (IOPT(1) .EQ. 1) GOTO 180
      QIR  = QI(M)
      IF (QIR .LE. 0.1) GOTO 180
      COXR  = COX(J)
      COD1R = COD1(J)
      COD2R = COD2(J)
      CDETR = CDET(J)
      CAMR  = CAM(J)
      GOTO 195
C
C------------------------------ TRIBUTARIES AT BEGINNING OF REACH ---
C
  180 QIR   = QI(M)+QIT(1,M)
      IF (QIR .LE. 0.1) GOTO 195
      COXR  = (COX(J)*QI(M)+COXI*QIT(1,M))/QIR
      COD1R = COD1(J)*QI(M)/QIR
      COD2R = COD2(J)*QI(M)/QIR
      CDETR = (CDET(J)*QI(M)+CDETI*QIT(1,M))/QIR
      CAMR  = (CAM(J)*QI(M)+CAMI*QIT(1,M))/QIR
C
C------------------------------------------------------ DETERMINE BOD ---
C
  195 CBOD(J) = CDETR*(1-EXP(-5.*RDETB)) + COD1R*(1-EXP(-5.*ROD1B)) +
     1          COD2R*(1-EXP(-5.*ROD2B))
C
C---------------------- BEGIN OF COMPUTATIONAL LOOP FOR EACH REACH ---
C------------------------------ INITIALISATION AND CHECK DISCHARGES ---
C
      DO 1000 N=1,NREACH
      QIRT = 0.0
      VELR = 0.0
      DEPR = 0.0
      SUMD = 0.0
      T = 0.0
      IF (QIR .LE. 0.1) GOTO 410
C
C-------------------- TOTAL INFLOW AND CONC. FOR THE OTHER REACHES ---
C------------------------------------------------------ NO TRIBUTARIES ---
C
      IF (N .EQ. 1) GOTO 205
      IF (IOPT(N) .EQ. 1) GOTO 201
      QIR   = FLOW(N-1,M)
      COXR  = COXO(N-1,M,L)
      COD1R = COD1O(N-1,M,L)
      COD2R = COD2O(N-1,M,L)
      CDETR = CDETO(N-1,M,L)
      CAMR  = CAMO(N-1,M,L)
      GOTO 205
C
C------------------------------ TRIBUTARIES AT BEGINNING OF REACH ---
C
  201 QIR   = FLOW(N-1,M)+QIT(N,M)
      COXR  = (COXO(N-1,M,L)*FLOW(N-1,M)+COXI*QIT(N,M))/QIR
      COD1R = COD1O(N-1,M,L)*FLOW(N-1,M)/QIR
      COD2R = COD2O(N-1,M,L)*FLOW(N-1,M)/QIR
```

```
      CDETR = (CDETO(N-1,M,L)*FLOW(N-1,M)+CDETI*QIT(N,M))/QIR
      CAMR  = (CAMO(N-1,M,L)*FLOW(N-1,M)+CAMI*QIT(N,M))/QIR
  205 CONTINUE
      QIRT = QIR
C
C------------------------------------ NUMBER OF SEGMENTS IN REACH ---
C
      NS = IFIX(RCHKM(N)/DELKM+0.1)
      IF (NS .LT. 1) GOTO 410
C
C------------------- TRIBUTARIES OR RUN-OFF DIVIDED AMONG SEGMENTS ---
C
      DQ = 0.0
      IF (IOPD(N) .EQ. 1) DQ = QID(N,M)/FLOAT(NS)
      QIRT1 = QIR
C
C-------------------- BEGIN OF COMPUTATIONAL LOOP FOR EACH SEGMENT ---
C------------------------------------- DETERMINE TOTAL INFLOW ---
C
      DO 400 K=1,NS
      QIRT = QIRT1+DQ
C
C------------------------------ DETERMINE FLOW VELOCITY AND DEPTH ---
C---------------------------------- FUNCTION OF DISCHARGE (IOPV=0) ---
C
      IF (IOPV(N) .EQ. 1) GOTO 208
      VEL = AV(N)*QIRT**BV(N)
      DEP = AH(N)*QIRT**BH(N)
      GOTO 209
C
C----------------------------------- FUNCTION OF GEOMETRY (IOPV=1) ---
C
  208 WID = AV(N)*QIRT**BV(N)
      DEP = AH(N)*QIRT**BH(N)
      VEL = QIRT/(DEP*WID)
C
C-------------------- REAERATION RATE, TIMESTEP, TIME AND SUM-DEPTH ---
C
  209 RK2 = 3.86/86400.*(VEL**0.5)/(DEP**1.5)*1.016**(TDAM(M)-20.0)
      DET = DELKM/VEL*1000.
      T   = T+DET
      SUMD = SUMD + DEP
C
C------------------- CONC. INCREMENTS BY REAERATION AND DEGRADATION ---
C
      FA = 1.0
      FO = 1.0
      COXB = COXR
      IF (COXR .GT. 0.0) GOTO 220
      FA = FAN
      FO = 0.0
      COXB = 0.0
  220 PREA = RK2*(CSAT-COXB)*DET
      POD1 = FA*ROD1*COD1R*DET
      POD2 = FA*ROD2*COD2R*DET
```

```
      PDET = FA*RDET*CDETR*DET
      PNIT = FO*RNIT*CAMR*DET
C
C------------------------------------- CONCENTRATIONS IN OUTFLOW ---
C
      COXR  = (COXR*QIRT1+COXI*DQ)/QIRT + PREA - POD1 - POD2 -
     1        PDET - SN*PNIT
      COD1R = COD1R*QIRT1/QIRT - POD1
      COD2R = COD2R*QIRT1/QIRT - POD2
      CDETR = (CDETR*QIRT1+CDETI*DQ)/QIRT - PDET
      CAMR  = (CAMR*QIRT1+CAMI*DQ)/QIRT + SA1*POD1 + SA2*POD2 +
     1        SA3*PDET - PNIT
      QIRT1 = QIRT
C
C------------------------------------- END OF SEGMENT LOOP ---
C
  400 CONTINUE
C
C------------------------ AVERAGE FLOW VELOCITY AND DEPTH FOR REACH ---
C
      VELR = RCHKM(N)*1000./T
      DEPR = SUMD/FLOAT(NS)
C
C------------------------------------------ DETERMINE BOD ---
C
  410 CBODR = CDETR*(1-EXP(-5.*RDETB)) + COD1R*(1-EXP(-5.*ROD1B)) +
     1        COD2R*(1-EXP(-5.*ROD2B))
C
C------------------------------------ STORAGE OF RESULTS IN OUTPUT ---
C
      COXO(N,M,L)  = COXR
      IF (M .EQ. 1) GOTO 420
      IF (L .EQ. 2 .AND. QI(M-1) .LT. 0.001) COXC(N,M,L) = COXC(N,M,1)
  420 COD1O(N,M,L) = COD1R
      COD2O(N,M,L) = COD2R
      CDETO(N,M,L) = CDETR
      CAMO(N,M,L)  = CAMR
      CBODO(N,M,L) = CBODR
      COXR  = 0.0
      COD1R = 0.0
      COD2R = 0.0
      CDETR = 0.0
      CAMR  = 0.0
      IF (L .NE. 1) GOTO 1000
      FLOW(N,M) = QIRT
      VELO(N,M) = VELR
      TIME(N,M) = 10000.
      IF (VELR .GT. 0.0001) TIME(N,M) = RCHKM(N)/(VELR*86.4)
      DEPT(N,M) = DEPR
C
C------------------------------- END OF LOOPS FOR REACH AND MONTH ---
C
 1000 CONTINUE
 2000 CONTINUE
 3000 CONTINUE
```

```
FILE: WQARM     FORTRAN  A1  VM/SP HPO REL 4.2 - ELETRONORTE


C
C---------------------------------- CALCULATE DISTANCE FOR OUTPUT ---
C
      NR = NREACH+1
      DIST(1) = DAMKM
      DO 500 I=2,NR
      DIST(I) = DIST(I-1)+RCHKM(I-1)
  500 CONTINUE
C
C------------------------------------ WRITING OUTPUT ON FILE IFILE---
C---------------------------------- OXYGEN CONCENTRATION (L=1) ---
C
      MMAX1 = MMAX+1
      WRITE(IF,51) (DIST(I),I=1,NR)
   51 FORMAT (///,1H1,9X,5H   KM,11F6.0)
      WRITE(IF,61)
   61 FORMAT (10H COX (END),/,10H       TIME,/)
      DO 610 M=1,MMAX1
      WRITE(IF,52) IM(M),COX(M),(COXO(N,M,1),N=1,NREACH)
  610 CONTINUE
   52 FORMAT (5X,I5,5X,11F6.1)
C
C---------------------------------- OXYGEN CONCENTRATION (L=2) ---
C
      WRITE(IF,51) (DIST(I),I=1,NR)
      WRITE(IF,69)
   69 FORMAT (12H COX (BEGIN),/,10H       TIME,/)
      DO 690 M=2,MMAX1
      WRITE(IF,52) IM(M),COX(M-1),(COXO(N,M,2),N=1,NREACH)
  690 CONTINUE
C
C---------------------------------- BIOLOGICAL OXYGEN DEMAND ---
C
      WRITE(IF,51) (DIST(I),I=1,NR)
      WRITE(IF,67)
   67 FORMAT (5H BOD ,/,10H       TIME,/)
      DO 670 M=1,MMAX1
      WRITE(IF,52) IM(M),CBOD(M),(CBODO(N,M,1),N=1,NREACH)
  670 CONTINUE
C
C---------------------------------- OD1 CONCENTRATION ---
C
      IF (LOG .LT. 1) GOTO 999
      WRITE(IF,51) (DIST(I),I=1,NR)
      WRITE(IF,62)
   62 FORMAT (5H COD1,/,10H       TIME,/)
      DO 620 M=1,MMAX1
      WRITE(IF,52) IM(M),COD1(M),(COD1O(N,M,1),N=1,NREACH)
  620 CONTINUE
C
C---------------------------------- OD2 CONCENTRATION ---
C
      WRITE(IF,51) (DIST(I),I=1,NR)
      WRITE(IF,63)
   63 FORMAT (5H COD2,/,10H       TIME,/)
```

```
      DO 630 M=1,MMAX1
      WRITE(IF,52) IM(M),COD2(M),(COD2O(N,M,1),N=1,NREACH)
  630 CONTINUE
C
C------------------------------------------ DETRITUS CONCENTRATION ---
C
      WRITE(IF,51) (DIST(I),I=1,NR)
      WRITE(IF,79)
   79 FORMAT (5H CDET,/,10H       TIME,/)
      DO 615 M=1,MMAX1
      WRITE(IF,52) IM(M),CDET(M),(CDETO(N,M,1),N=1,NREACH)
  615 CONTINUE
C
C------------------------------------------ AMMONIUM CONCENTRATION ---
C
      WRITE(IF,51) (DIST(I),I=1,NR)
      WRITE(IF,80)
   80 FORMAT (5H  CAM,/,10H       TIME,/)
      DO 616 M=1,MMAX1
      WRITE(IF,55) IM(M),CAM(M),(CAMO(N,M,1),N=1,NREACH)
  616 CONTINUE
   55 FORMAT (5X,I5,5X,11F6.2)
C
C------------------------------------------------------ DISCHARGES ---
C
      IF (LOG .LT. 2) GOTO 999
      WRITE(IF,51) (DIST(I),I=1,NR)
      WRITE(IF,64)
   64 FORMAT (5H FLOW,/,10H       TIME,/)
      DO 640 M=1,MMAX1
      WRITE(IF,53) IM(M),QI(M),(FLOW(N,M),N=1,NREACH)
  640 CONTINUE
   53 FORMAT (5X,I5,5X,11F6.0)
C
C------------------------------------------------------ FLOW VELOCITY ---
C
      WRITE(IF,51) (DIST(I),I=1,NR)
      WRITE(IF,65)
   65 FORMAT (5H VELO,/,10H       TIME,/)
      DO 650 M=1,MMAX1
      WRITE(IF,54) IM(M),(VELO(N,M),N=1,NREACH)
  650 CONTINUE
   54 FORMAT (5X,I5,11X,10F6.2)
C
C------------------------------------------------------ RETENTION TIME ---
C
      WRITE(IF,51) (DIST(I),I=1,NR)
      WRITE(IF,68)
   68 FORMAT (6H RTIME,/,10H       TIME,/)
      DO 680 M=1,MMAX1
      WRITE(IF,54) IM(M),(TIME(N,M),N=1,NREACH)
  680 CONTINUE
C
C------------------------------------------------------------ DEPTH ---
C
```