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GEOLOGICAL SURVEY

COMPUTER PROGRAM TO SIMULATE THE SALT BALANCE BETWEEN THE NORTH AND SOUTH PARTS OF GREAT SALT LAKE, UTAH

By K. M. Waddell and E. L. Bolke

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INTRODUCTION

This report presents a computer simulation program that was used by Waddell and Bolke (1973) to predict the salt balance between the north and south parts of Great Salt Lake, Utah, for either existing or modified culvert openings (fig. 1). The development of the program, its accuracy and limitations, are described in the above report, which was prepared as part of a study conducted by the U.S. Geological Survey in cooperation with the Utah Geological and Mineral Survey. Users of this program should consider it an addendum to the report by Waddell and Bolke (1973).

Although this program has been tested by its contributor, no warranty, expressed or implied, is made by the contributor or the Government, as to the functioning of the program and related program material, nor shall the fact of distribution constitute any such warranty, and no responsibility is assumed by the contributor or the Government, in connection therewith.

The FORTRAN IV program listing (table 1) defines the constants and variables necessary for understanding the mechanics and the output from the program.

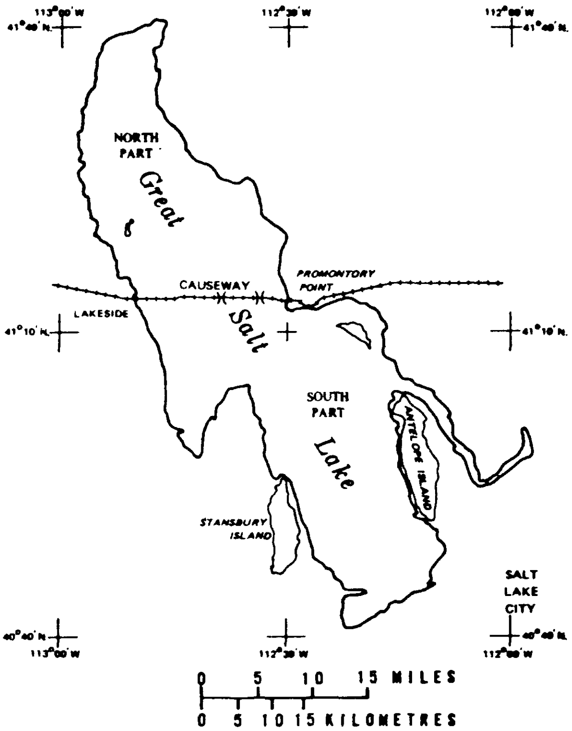

Figure 1.--Map of Great Salt Lake showing the location of the Southern Pacific Transportation Co. causeway.

In order to compute the salt balances for the two parts of the lake, it is necessary to enter the initial values of several parameters governing the causeway flows. This requires entering the initial conditions on the three cards shown in figure 2. The example shown in figure 2 represents conditions existing at the beginning of the 1969 water year. The arrows in table 1 indicate the proper location of the three data-input cards.

Card No. 1

1. CLNPPT - The initial load of salt deposited in the north part, in tons.

2. CLSPPT - The initial load of salt deposited in the south part, in tons.

3. LN - The initial load of salt dissolved in the north part, in tons.

4. LS - The initial load of salt dissolved in the south part, in tons.

5. LSDL - The load of dissolved salt in the deep brine layer in the south part, in tons.

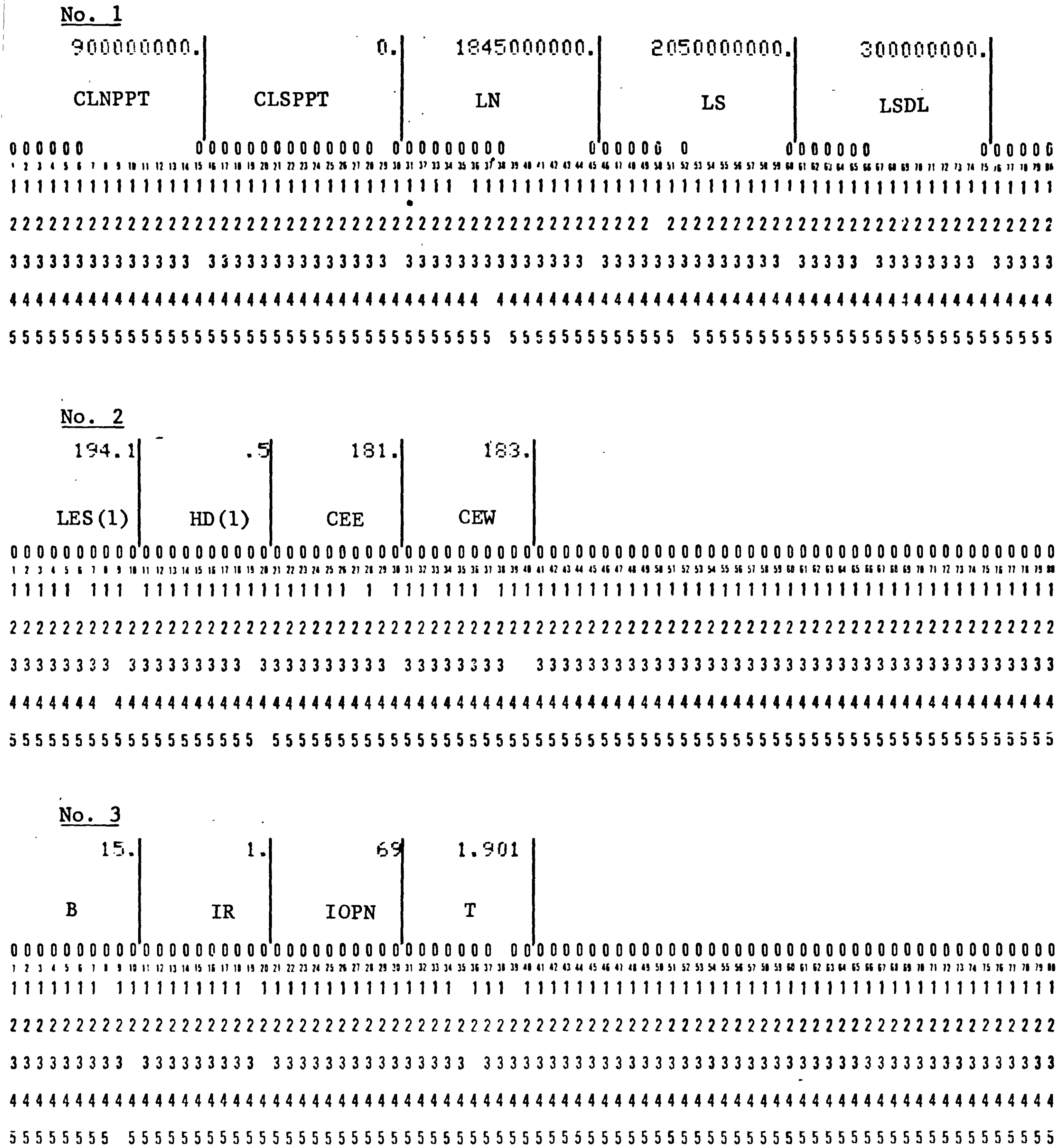

Figure 2.--Data-card input sequence and format used in the program.

Card No. 2

1. LES(1) - The initial altitude in the south part, in feet above a datum of 4,000 feet above mean sea level.

2. HD(1) - The initial difference between the altitude of the water surface in the south and north parts, in feet.

3. CEE - The altitude of the bottom of the east culvert, in feet above a datum of 4,000 feet.

4. CEW - The altitude of the bottom of the west culvert, in feet above a datum of 4,000 feet.

Card No. 3

1. B - The width of culvert, in feet.

2. IR - Ratio of inflow used for the 10-year predictive period to the inflow selected as input to the model (IOPN).

3. IOPN - Net inflow data for the water year to be simulated for a 10-year period. The option exists for selecting any year from 1969 to 1973 (IOPN = 69, 70, 71, 72, and 73). If the 1969-73 water years are chosen as input for a simulated hydrograph rather than extension of any of the individual years for a 10-year period, then enter IOPN = 1.

4. T - Time increment for each cycle through program. For the example shown in table 2, T = 1.901 days.

IOPN is an integer or fixed point variable that is to be entered without a decimal point. All other variables are floating point variables that can be entered with or without decimal notation if the number is right-hand justified on the card.

This program may not be compatible with some computers or compilers. Compatibility should be tested with a trial run. A trial run with the same initial conditions used in this report should generate output that will be similar to the output shown in table 2.

REFERENCE

Waddell, K. M., and Bolke, E. L., 1973, The effects of restricted circulation on the salt balance of Great Salt Lake, Utah: Utah Geol. and Mineral Survey Water-Resources Bull. 18.

Table 1.--Listing of the FORTRAN IV program.

```
// EXEC FORTGCG,REGION.GO=176K,PARM.GO='SIZE=150K'
//FORT.SYSIN DD *
C                          GREAT SALT LAKE SIMULATION MODEL
C      DEVELOPED BY THE U S GEOLOGICAL SURVEY IN COOPERATION WITH THE
C      UTAH GEOLOGICAL AND MINERAL SURVEY
C      THE PURPOSE OF THIS MODEL IS TO COMPUTE THE SALT BALANCE FOR
C       VARIABLE INFLOWS WITH OR WITHOUT MODIFICATION OF THE CULVERTS
C      -------------------------------------------------------------------------
C      SYMBOL       DESCRIPTION                                    UNITS
C      -------------------------------------------------------------------------
C      AN           AREA OF NORTH PART                             ACRES
C      AQENX(I)     EVAPORATION RATE FOR NORTH PART FOR TIME       ACRE-FEET
C                    INTERVAL OF 15.21 DAYS
C      AQESX(I)     EVAPORATION RATE FOR SOUTH PART FOR TIME       ACRE-FEET
C                    INTERVAL OF 15.21 DAYS
C      AQIN(I)      SURFACE INFLOW TO SOUTH PART FOR TIME          ACRE-FEET
C                    INTERVAL OF 15.21 DAYS
C      AS           AREA OF SOUTH PART                             ACRES
C      ASOLN        REDISSOLVED SALT IN NORTH PART                 TONS
C      ASOLS        REDISSOLVED SALT IN SOUTH PART                 TONS
C      B            CULVERT WIDTH                                  FEET
C      CEE          ALTITUDE OF BOTTOM OF EAST CULVERT(DATUM       FEET
C                    IS 4000 FEET ABOVE MEAN SEA LEVEL)
C      CEW          ALTITUDE OF BOTTOM OF WEST CULVERT(DATUM       FEET
C                    IS 4000 FEET ABOVE MEAN SEA LEVEL)
C      CFS          COEFFICIENT OF HEAD LOSS FOR SOUTH-TO-          -
C                   NORTH CULVERT FLOWS
C      CFSS         COEFFICIENT OF HEAD LOSS FOR NORTH-TO-          -
C                   SOUTH CULVERT FLOWS
C      CLNPPT       CUMULATIVE PRECIPITATED SALT LOAD IN           TONS
C                    NORTH PART AT BEGINNING OF NEW TIME
C                    INTERVAL
C      CLSPPT       CUMULATIVE PRECIPITATED SALT LOAD IN           TONS
C                    SOUTH PART AT BEGINNING OF NEW TIME
C                    INTERVAL
C      CN           DISSOLVED-SOLIDS CONCENTRATION IN NORTH        GRAMS/LITRE
C                    PART
C      CS           DISSOLVED-SOLIDS CONCENTRATION IN SOUTH        GRAMS/LITRE
C                    PART
C      DP           DIFFERENCE IN SPECIFIC GRAVITY BETWEEN          -
C                    BRINE NORTH AND SOUTH OF CAUSEWAY
C      F1(I)        SOUTH TO NORTH DISCHARGE THROUGH FILL          CUBIC FEET/SECOND
C      F2(I)        NORTH TO SOUTH DISCHARGE THROUGH FILL          CUBIC FEET/SECOND
C      F1T          SOUTH TO NORTH DISCHARGE THROUGH FILL          ACRE-FEET/DAY
C      F2T          NORTH TO SOUTH DISCHARGE THROUGH FILL          ACRE-FEET/DAY
C      HD(I)        DIFFERENCE BETWEEN ALTITUDE(STAGE) OF          FEET
C                    SOUTH AND NORTH PARTS OF LAKE AT CAUSE-
C                    WAY,AT BEGINNING OF TIME INTERVAL,I
C      I            NUMBER OF ELAPSED TIME INTERVALS DURING         -
C                    SIMULATED PERIOD
```

Table 1--Continued

```
C      IOPN       USER OPTION TO SELECT EITHER THE 69-73 WY   -
C                  INPUT DATA (IOPN=1) OR ANY INDIVIDUAL
C                  YEAR (IOPN=69,70,71,72 OR 73)  .
C      IR         RATIO OF INFLOW USED FOR THE PREDICTIVE     -
C                  PERIOD TO THE INFLOW USED AS INPUT TO
C                  THE MODEL (QIN(I))
C      LEN        ALTITUDE OF WATER SURFACE IN NORTH PART    FEET
C                      AT BEGINNING OF TIME INTERVAL,I
C      LES(I)     ALTITUDE OF WATER SURFACE IN SOUTH PART    FEET
C                  AT BEGINNING OF TIME INTERVAL,I
C      LN         DISSOLVED LOAD IN NORTH PART               TONS
C      LNPPT      PRECIPITATED SALT LOAD IN NORTH PART       TONS
C      LS         DISSOLVED-SOLIDS LOAD IN SOUTH PART        TONS
C      LSDL       DISSOLVED-SOLIDS LOAD IN DEEP BRINE        TONS
C                  LAYER IN SOUTH PART
C      LSPPT      PRECIPITATED SALT LOAD IN SOUTH PART       TONS
C      M          TOTAL DISCHARGE FROM SOUTH TO NORTH        ACRE-FEET/DAY
C                  THROUGH CAUSEWAY
C      NEWLN      TEMPORARY LOAD IN NORTH PART PRIOR TO      TONS
C                  SOLUTION OR PRECIPITATION
C      NN         TOTAL DISCHARGE FROM NORTH TO SOUTH        ACRE-FEET/DAY
C                  THROUGH CAUSEWAY
C      PFT        DENSITY OF FRESHWATER AT TEMPERATURE,TEMX GRAMS/MILLILITRE
C      PF20       DENSITY OF FRESHWATER AT 20 C              GRAMS/MILLILITRE
C      PN         DENSITY OF BRINE IN NORTH PART AT          GRAMS/MILLILITRE
C                  TEMPERATURE,TEMX
C      PS         DENSITY OF BRINE IN SOUTH PART AT          GRAMS/MILLILITRE
C                  TEMPERATURE,TEMX
C      QEN        EVAPORATION FROM NORTH PART                ACRE-FEET
C      QENX(I)    EVAPORATION FROM NORTH PART FOR TIME       FEET/DAY
C                  INTERVAL.I
C      QES        EVAPORATION FROM SOUTH PART                ACRE-FEET
C      QESX(I)    EVAPORATION FROM SOUTH PART FOR TIME       FEET/DAY
C                  INTERVAL,I
C      QIX        SIMULATED NET FRESH-WATER INFLOW TO        ACRE-FEET
C                  SOUTH PART DURING TIME INTERVAL,I
C      QS         NET DISCHARGE THROUGH CAUSEWAY TO NORTH    ACRE-FEET
C                  PART
C      Q1(I)      SOUTH TO NORTH DISCHARGE THROUGH CULVERTS CUBIC FEET/SECOND
C      Q2(I)      NORTH TO SOUTH DISCHARGE THROUGH CULVERTS CUBIC FEET/SECOND
C      Q1T        SOUTH TO NORTH DISCHARGE THROUGH CULVERTS ACRE-FEET/DAY
C      Q2T        NORTH TO SOUTH DISCHARGE THROUGH CULVERTS ACRE-FEET/DAY
C      R1         DEPTH OF UPPER BRINE IN CULVERT AT         FEET
C                  MEASURING SECTION
C      R2         DEPTH OF LOWER BRINE IN CULVERT AT         FEET
C                  MEASURING SECTION
C      SGC        SALINITY CORRECTION FACTOR FOR EVAPORATION -
C                  RATE IN SOUTH PART
```

```
C      SGCB          SALINITY CORRECTION FACTOR FOR SOUTH PART   -
C                     FOR BASE PERIOD USED FOR SIMULATION
C      SGCBN         SALINITY CORRECTION FACTOR FOR NORTH PART   -
C                     FOR BASE PERIOD USED FOR SIMULATION
C      SGCN          SALINITY CORRECTION FACTOR FOR EVAPORATION -
C                     RATE IN NORTH PART
C      S1            SPECIFIC GRAVITY OF BRINE IN SOUTH PART     -
C      S2            SPECIFIC GRAVITY OF BRINE IN NORTH PART     -
C      T             TIME INCREMENT(1.901 DAYS USED IN MODEL)  DAYS
C      TEMX          TEMPERATURE                               DEGREES CELSIUS
C      TL            TOTAL DISSOLVED SALT LOAD IN NORTH AND    TONS
C                     SOUTH PARTS
C      VN            VOLUME OF NORTH PART                      ACRE-FEET
C      VS            VOLUME OF SOUTH PART                      ACRE-FEET
C      UNEW          ALTITUDE OF WATER SURFACE IN SOUTH PART   FEET
C                     AFTER TIME INTERVAL,I
C      V1            MEAN VELOCITY OF SOUTH-TO-NORTH FLOW      FEET/SECOND
C                     THROUGH CULVERTS
C      V2            MEAN VELOCITY OF NORTH-TO-SOUTH FLOW      FEET/SECOND
C                     THROUGH CULVERTS
C      W             EFFECTIVE LENGTH OF CAUSEWAY              FEET
C      XM            NEW VOLUME IN SOUTH PART AT END OF TIME   ACRE-FEET
C                     INTERVAL,I
C      XN            NEW VOLUME IN NORTH PART AT END OF TIME   ACRE-FEET
C                     INTERVAL.I
C      YN            AVERAGE DEPTH OF LOWER BRINE IN FILL      FEET
C      Y1            HEIGHT OF WATER SURFACE IN SOUTH PART     FEET
C                     ABOVE CULVERT BOTTOM
C      Y2            HEIGHT OF WATER SURFACE IN NORTH PART     FEET
C                     ABOVE CULVERT BOTTOM
C      ZZ            ALTITUDE OF WATER SURFACE IN NORTH PART   FEET
C                     AFTER TIME INTERVAL,I

      INTEGER G
      REAL LNPPT,LN,LES,LS,LEN,LNNEW,NN,LSNEW,M,NEWLN,L,NEWV2
     2,LESN,LSDL,LSX,LST,MN,MS,KN,KS,NEWKN,NEWKS
      REAL NB,NK,LSPPT,IR
      DIMENSION LES(2000),HD(2000),Q2(2000),Q1(2000),F1(2000),F2(2000)
     1,QIN(2000),QESX(2000),QENX(2000),AQIN(2000),AQENX(2000),AQESX(2000
     2)
      IAI=0
      XYER=0.
      XMOTH=0.
      Q1C=0
C     COEFFICIENTS FOR EMPIRICAL EQUATIONS
      D1=2.1629
      D2=1290.3
```

Table 1--Continued

```
D3=-113.24
D4=-19649.
D5=-912.81
D6=186.17
D7=195100.
D8=20974.
D9=-1861.6
D10=-18.802
D11=-629690.
D12=-66502.
D13=308.06
D14=-15.187
D15=2865.3
C1=6.9835
C2=-1675.0
C3=158.97
C4=45535.
C5=-3773.3
C6=14.010
C7=-429070.
C8=34904.
C9=-631.20
C10=48.556
C11=1302000.
C12=-105270.
C13=-176.07
C14=-5.4593
C15=3352.1
S1=19.307
S2=242.23
S3=-35.429
S4=-4339.9
S5=407.50
S6=14.332
S7=19021.
S8=-1466.8
S9=-45.647
S10=-3.8069
A=876369.500
BB=9349.313
C=25.07962
D=368644.750
X=4010.910
F=10.98323
READ IN INITIAL CONDITIONS FOR VARIABLES AND FOR CONSTANTS
READ(5,3017)CLNPPT,CLSPPT,LN,LS,LSDL
READ(5,3019)LES(1),HD(1),CEE,CEW
READ(5,3021)B,IR,IOPN,T
```

```
 3021 FORMAT(2F10.0,I10,F10.0)
 3017 FORMAT(5F15.0)
 3019 FORMAT(4F10.0)
      READ(5,9000) N,(AQESX(I),AQENX(I),AQIN(I),I=1,N)
 9000 FORMAT (I5/(4(F6.0,F6.0,F6.0)))
      IF(IOPN.NE.1)GO TO 8998
      GO TO 9994
 8998 N=240
      JJ=1
      IIK=(IOPN-69)*24+1
      JJN=IIK+23
 8999 DO 9991 J=IIK,JJN
      QESX(JJ)=AQESX(J)
      QENX(JJ)=AQENX(J)
      QIN(JJ)=AQIN(J)
      JJ=JJ+1
      IF (JJ.GT.240) GO TO 9995
 9991 CONTINUE
      IF (JJ.LT.240) GO TO 8999
 9994 DO 9993 J=1,N
       QESX(J)=AQESX(J)
      QENX(J)=AQENX(J)
      QIN(J)=AQIN(J)
 9993 CONTINUE
 9995 ASOLN=0.0
      LNPPT=0
      KN=44400000.
      TK=84300000.
      KS=39900000.
      DK=5440000.
      DM =8590000.
      TMG=133400000.
      MS=63100000.
      MN=70200000.
      SUMQEN=0.
      SUMQES=0.
      SUMQIX=0.
      TL=LS+LN
      TXS=LN+LS+LSDL+CLNPPT+CLSPPT
      DO 11 II=1,N
      I=II
      KON= INT(15.21/T)
      DO 9998 JMO=1,KON
      CE=CEE
      J=0
      IC=0
      LEN=LES(I)-HD(I)
```

Table 1--Continued

```
      U=LES(I)
      AS= (509380.-7262.5*U+34.1625*(U)**2-.052836*U**3)*1000.
      AN=(960910.-14644.8*(U-HD(I))+74.3108*(U-HD(I))**2-.12550*(U-HD(I)
     2)**3)*1000.
      VN=(D-X*(U-HD(I))+F*(U-HD(I))**2)*1000.
      VS=(A-BB*U+C*U**2)*1000.
      TEMX=12.5+12.0*SIN(.262*I-3.53)
      PF20=.99823
      PFT= (8*TEMX-(TEMX)**2+132416.)/132432.
      PN=1.000+0.63*(LN*.0007353)/VN
      PS=1.000+.63*(LS*.0007353)/(VS-620000.)
      CN=((PN-1.0)/0.63)*1000.
      CS=((PS-1.0)/0.63)*1000.
      YCN=CN
       YCS=CS
      XCN=CN/PN
      XCS=CS/PS
      PS=PS*PFT/PF20
      PN=PN*PFT/PF20*.996
  791 IC=IC+1
      IF (IOPN.EQ.1.AND.IC.EQ.2) CE=CEW
      IF(IOPN.GT.1.AND.IC.EQ.2)CE=CEW
      Y1=LES(I)-CE
      Y2=Y1-HD(I)
      R1=-6.30*Y2-5.84*(PN-PS)*Y1+7.09*Y1
      R2= 6.39*Y2+5.94*(PN-PS)*Y1-6.23*Y1
      IF(R1.LE.0)R1=0.1
      IF(R2.LE.0)R2=0.1
      CFS=3.55*(Y1-R1-R2)/(Y1-Y2)-1.02
      CFSS= 3.83*(Y1-R1-R2)/(Y1-Y2)-1.19
      IF(CFS.LE.0.)CFS=0.01
      IF(CFSS.LE.0.)CFSS=0.01
      IF (CFSS.GT.3.)CFSS=3.
      IF (CFS.GT.3.)CFS=3.
      IF (I.GT.1) GO TO 7
      V2=0.60
    7 Z=CFS*V2/(1+CFS)
      J=J+1
      Q1(J)=B*R1*(SQRT((Y1-R1-R2-CFS*V2**2/64.4)*64.4/(1+CFS)+Z**2)-Z)
      V1=Q1(J)/(B*R1)
      ZS=CFSS*V1/(1+CFSS)
      TT=((Y2-R2-R1*PS/PN-CFSS*V1**2/64.4)*64.4/(1+CFSS)+ZS**2)
      IF (TT.LE.0.) GO TO 10
      XX=SQRT(TT)-ZS
      IF (XX.LE.0.) GO TO 10
      Q2(J)=B*R2*(SQRT((Y2-R2-R1*PS/PN-CFSS*V1**2/64.4)*64.4/(1+CFSS)+
     3ZS**2)-ZS)
      E=Q2(J)/(B*R2)-V2
```

Table 1--Continued

```
      AE=(.02-ABS(E))
      IF (AE) 8,8,9
    8 NEWV2=(V2+(Q2(J))/(R2*B))/2
      V2=NEWV2
      GO TO 7
   10 CONTINUE
      V2=0
      Z=CFS*V2/(1+CFS)
      Q1(J)=B*R1*(SQRT((Y1-R1-R2-CFS*V2**2/64.4)*64.4/(1+CFS)+Z**2)-Z)
      V1=Q1(J)/(B*R1)
      Q2(J)=0
    9 Q1(I)=Q1(J)
      Q2(I)=Q2(J)
      IF (IC.EQ.2) GO TO 792
      SE=Q1(I)
      SN=Q2(I)
      Q1(I)=0.
      Q2(I)=0.
      J=0
      IF (IC.EQ.1) GO TO 791
  792 Q1(I)=SE+Q1(I)
      Q2(I)=SN+Q2(I)
      IF (IOPN.EQ.1)GO TO 9130
      GO TO 9131
 9130 IF(I.GT.18.AND.I.LT.32)Q1(I)=SE
      IF(I.GT.48.AND.I.LT.60)Q1(I)=SE
      IF(I.GT.70.AND.I.LT.77)Q1(I)=SE
      IF(I.GT.82.AND.I.LT.95)Q1(I)=1.4*SE
 9131 IF(Q2(I).LE.0.)Q2(I)=1.
      IF (Q2(I).LE.0.)Q2(I)=1.
      IF (Q1(I).LE.0.)Q1(I)=1.0
      Q1T=Q1(I)*1.98
      TM=Q1T*T
      Q2T=Q2(I)*1.98
      TN=Q2T*T
      DP=PN-PS
      Q1F=C1+C2*DP+C3*HD(I)+C4*DP**2+C5*DP*HD(I)+C6*(HD(I))**2+
     1C7*DP**3+C8*DP**2*HD(I) +C9*DP*(HD(I))**2+C10*(HD(I))**3+
     2C11*DP**4+C12*DP**3*(HD(I))+C13*DP*HD(I)**3+C14*(HD(I))**4+
     3C15*DP**2*(HD(I))**2
      Q2F=D1+D2*DP+D3*HD(I)+D4*DP**2+D5*DP*HD(I)+D6*(HD(I))**2+
     1D7*DP**3+D8*DP**2*HD(I) +D9*DP*(HD(I))**2+D10*(HD(I))**3+
     2D11*DP**4+D12*DP**3*(HD(I))+D13*DP*HD(I)**3+D14*(HD(I))**4+
     3D15*DP**2*(HD(I))**2
      IF(Q1F.LE.0.)Q1F=0.0
      IF(Q2F.LE.0.)Q2F=0.0
      IF(DP.LE..05.AND.HD(I).GT.0.60)Q2F=0.0
      YN=S1+S2*DP+S3*HD(I)+S4*DP**2+S5*DP*HD(I)+S6*(HD(I))**2+
```

Table 1--Continued

```
     2S7*DP**3+S8*DP**2*HD(I)+S9*DP*(HD(I))**2+S10*(HD(I))**3
      Q2F=(1.-((199.5-LES(I))/YN*1.312))*Q2F
      F1(I)=Q1F*69.3936
      F2(I)=Q2F*69.3936
      FM=F1(I)*1.98*T
      FN=F2(I)*1.98*T
      F1T=F1(I)*1.98
      F2T=F2(I)*1.98
      M=F1T+Q1T
      NN=F2T+Q2T
      QS=FM+TM-TN-FN
      ZZX=IR
      QIX =QIN(I)*ZZX*T
      IF (IOPN.GT.1) GO TO 7736
      IF (IOPN.EQ.1) SGCN=1.
      IF (IOPN.EQ.1) SGC =1.
      IF (IOPN.EQ.1) SGCB=1.
      IF (IOPN.EQ.1) SGCBN=1.
      IF (IR.NE.1)GO TO 7735
      IF (IOPN.EQ.1.AND.B.NE.15.OR.CEE.NE.181.OR.CEW.NE.183.)GO TO 7735
      IF (IOPN.EQ.1)GO TO 7734
 7735 IF (IOPN.EQ.1.AND.I.LT.24)SGCB=0.84
      IF (IOPN.EQ.1.AND.I.GE.24.AND.I.LT.49)SGCB=0.85
      IF (IOPN.EQ.1.AND.I.GT.48.AND.I.LT.73)SGCB= .86
      IF (IOPN.EQ.1.AND.I.GT.72.AND.I.LT.97)SGCB= .88
      IF (IOPN.EQ.1.AND.I.GT.96.AND.I.LT.121)SGCB=.90
      GO TO 7737
 7736 IF (IOPN.EQ.69) SGCB=.84
      IF (IOPN.EQ.70)SGCB=.85
      IF (IOPN.EQ.71)SGCB=.86
      IF (IOPN.EQ.72)SGCB=.88
      IF (IOPN.EQ.73)SGCB=.90
 7737 SGCBN=1.-34.*.00778/1.214
      SGC=1.-0.000778*CS/PS
      SGCN=1.-0.000778*CN/PN
 7734 QEN=QENX(I)*AN*T*(SGCN/SGCBN)
      QES=QESX(I)*AS*T*(SGC/SGCB)
      QET=QES+QEN
      XM= VS-QS+QIX-QES
      VS=XM
      UNEW=SQRT(XM/(C*1000.)-A/C+(0.25)*BB**2/(C**2))+0.5*BB/C
      XN= VN+QS-QEN
      ZZ=SQRT(XN/(F*1000.)-D/F+(0.25)*X**2/F**2)+(X/F)*.5
      VN=XN
      LES(I)=UNEW
      HD(I)=UNEW-ZZ
      IF(HD(I).LE..08)HD(I)=.08
      IF (JMO.EQ.KON)LES(I+1)=UNEW
```

Table 1--Continued

```
      IF (JMO.EQ.KON)HD(I+1)=UNEW-ZZ
      IF (JMO.EQ.KON.AND.HD(I).LE..08)HD(I+1)=.08
      XMOTH=XMOTH + T/30.5
      IF(XMOTH.EQ.13.)XMOTH=0
      XYER=XYER+XMOTH/12.
      NEWKN=T*(M*KS/(VS-620000.)-NN*KN/VN)+KN
      KN=NEWKN
      NEWMN=T*(M*MS/(VS-620000.)-NN*MN/VN)+MN
      MN=NEWMN
      XKS=TK-KN
      KS=XKS
      XMS=TMG-MN
      MS=XMS
      XPKN= (KN*.07353)/(VN*PN)
      XPMN= (MN*.07353)/(VN*PN)
      XPKS=(KS*.07353)/((VS-620000.)*PS)
      XPMS=(MS*.07353)/((VS-620000.)*PS)
      GN=LN
      NEWLN=T*(M*LS/(VS-620000.)-NN*LN/VN)+LN
      LN=NEWLN
      FCN=LN/VN
      IF (FCN.LE.483.) GO TO 16
      LNPPT=LN-483.*VN
      CLNPPT=LNPPT+CLNPPT
      LNNEW=LN-LNPPT
      LN=LNNEW
      ASOLN=0.0
      GO TO 1841
   16 LNPPT=0
      ASOLN= (.01*T/1.901)*(483*VN-LN)
      IF(ASOLN.GT.CLNPPT)ASOLN=CLNPPT
      LN=LN+ASOLN
      CLNPPT=CLNPPT-ASOLN
      IF(CLNPPT.LT.0.)CLNPPT=0.
 1841 TLS=TXS-LN-CLNPPT-LSDL
      UFCS=(VS-620000.)*483.
      IF (TLS.LE.UFCS) GO TO 1840
      LSPPT=TLS-483.*(VS-620000.)
      CLSPPT=LSPPT+CLSPPT
      LS=TLS-CLSPPT
      ASOLS=0.0
      GO TO 119
 1840 LSPPT=0.
    . IF (CLSPPT.EQ.0.)GO TO 119
      LS=TLS-CLSPPT
      ASOLS=(.01*T/1.901)*(483.*(VS-620000.)-LS)
      IF(ASOLS.GT.CLSPPT)ASOLS=CLSPPT
      CLSPPT=CLSPPT-ASOLS
```

Table 1--Continued

```
      LS=LS+ASOLS
      IF(CLSPPT.LT.0.)CLSPPT=0.
 119  IF(JMO.EQ.8) GO TO 113
      GO TO 9998
 113  XXM=XMOTH
      XXY=XYER
      IF(IAI.EQ.51)GO TO 634
      IF (IAI.LT.51.AND.IAI.GT.0) GO TO 538
      WRITE (6,537)
 537  FORMAT (10X18HINITIAL CONDITIONS//)
      WRITE(6,536)CLNPPT,CLSPPT,LN,LS,LSDL,LES(1),HD(1),CEE,CEW,B,IR,
     1IOPN,T
 536  FORMAT (5X8HCLNPPT =F12.0,/,5X8HCLSPPT =F12.0,/,5X4HLN =F12.0,/,
     25X4HLS =F12.0,/,5X6HLSDL =F12.0,/,5X8HLES(1) =F7.3,/,5X7HHD(1) =F7
     3.3,/,5X5HCEE =F5.0,/,5X5HCEW =F5.0,/,5X3HB =F5.0,/,5X5HIR  =F5.3,/
     4,5X6HIOPN =I3,/,5X3HT =F6.4)
 634  WRITE(6,635)
 635  FORMAT(1H1)
      WRITE (6,535)
 535  FORMAT (121H ELAPSED LAKE ALTITUDE        ACCUMULATIVE SALT      DI
     1SSOLVED SALT     DISSOLVED SALT LOAD      CULVERT FLOW    FILL FLO
     2W)
      WRITE (6,534)
 534  FORMAT (66H TIME                                DEPOSITION          CO
     1NCENTRATION)
      WRITE (6,533)
 533  FORMAT (119H (MONTHS)     (FEET)                     (TONS)          (G
     1RAMS/LITRE)           (TONS)                 (CUBIC FEET/SECOND))
      WRITE (6,532)
 532  FORMAT (127H            SOUTH    NORTH      SOUTH         NORTH       SOU
     1TH  NORTH        SOUTH             NORTH           S-N       N-S       S-N
     2    N-S/)
 538  WRITE (6,541)XXM,LES(I),ZZ,CLSPPT,CLNPPT,YCS,YCN,LS,LN,Q1(I),Q2(I)
     1,F1(I),F2(I)
 541  FORMAT (1X,F5.1,2X,2(F6.2,2X),2(F11.0,2X),3X,2(F4.0,2X),3X,2(F11.0
     1,2X),3X,4(F6.0,2X))
      IAI=IAI+1
      IF (IAI.EQ.52)IAI=1
 9998 CONTINUE
   11 CONTINUE
      END
```

Table 1--Continued

```
/*
//GO.SYSIN DD *
                                              0.      1845000000.       2050000000.       300000000.
     900000000.
     194.1          .5         181.       183.
      15.           1.          69       1.901
 120
.0022 .0023  3025 .0010 .0012  4835 .0069 .0062  7300 .0022 .0023  7245
.0000 .0001  8860 .0020 .0018  7300 .0029 .0041 16260 .0063 .0050  9495
.0019 .0018 12030-.0109-.0121  6850-.0005 .0008 12400-.0018 .0011 14460
.0078 .0075 15020 .0150 .0155 15620 .0215 .0211 14910 .0028 .0241  7460
.0290 .0077   -50 .0180 .0180  8650 .0356 .0207  5280 .0094 .0245  4580
.0249 .0250  6200 .0218 .0216  2840 .0271 .0174  3330 .0058 .0153  1740
.0123 .0125 11950 .0139 .0141 14965 .0141 .0141 12630 .0091 .0090 10790
.0010 .0010  5430 .0041 .0055  7450 .0024 .0023 11830 .0094 .0095 17020
.0135 .0135 15410 .0106 .0106 10030 .0069 .0066  4870 .0089 .0115  6665
.0082 .0078  3665 .0084 .0087 10430 .0138 .0140 10865 .0156 .0157 11210
.0154 .0142 11170 .0207 .0203  5580 .0210 .0172  4035 .0161 .0160   250
.0174 .0171    25 .0121 .0119 -1540 .0087 .0066 -1790 .0034 .0062   460
.0110 .0110  8120 .0048 .0047  8010 .0013 .0012 10590 .0022 .0023 10255
.0081 .0081 14630 .0039 .0039  7680 .0079 .0077 17235 .0100 .0113 24465
.0132 .0128 22425 .0172 .0158 21735 .0210 .0208 22655 .0168 .0164 22750
.0135 .0144 23645 .0129 .0130 25055 .0115 .0112 26330 .0159 .0157 21545
.0191 .0189 21825 .0300 .0304 17515 .0306 .0308 16715 .0243 .0244  6700
.0160 .0156 -1270 .0057 .0061  1395 .0121 .0121  1475-.0105-.0108  2760
.0065 .0060 10115 .0226 .0229 22855 .0175 .0181 24005 .0198 .0199 27815
.0040 .0035 16145-.0050-.0053  8380-.0035-.0034  8705 .0000 .0003 11040
.0083 .0084 16815 .0006 .0004 16255 .0081 .0038 17350 .0147 .0145 22445
.0284 .0289 42310 .0252 .0257 37355 .0202 .0204 25060 .0345 .0344 32885
.0356 .0354 26610 .0278 .0276 17770 .0262 .0263  8485 .0232 .0235  4285
.0227 .0228  2835 .0161 .0159  1300 .0100 .0101  1085 .0080 .0080  3000
-.0050-.0050  915. .0108.0108 15770.-.0035-.0029 7689..00574.0058512060.
.00633.00621 9589..00495.0047913214.-.0022-.002510257..00373.0033414167.
.00292.0033517450..00394.0031919720. .0162 .017132360..032  .033  29723.
.0316 .033  37433..0396 .0404 41942..0467 .0462 45960..0394 .0375 45750.
.0339 .0325 29440..0231 .0232 20260..0222 .0195 13250..0204 .0206 7274.
.0228 .0231  6634..0166 .0162  5588..0175 .0174 14489..026  .026  25430.
/*
//
```

Table 2.--Example of the program output.

Lake altitude: 4,000 feet should be added to all readings.

ELAPSED TIME (MONTHS)	LAKE ALTITUDE (FEET)		ACCUMULATIVE SALT DEPOSITION (TONS)		DISSOLVED SALT CONCENTRATION (GRAMS/LITRE)		DISSOLVED SALT LOAD (TONS)		CULVERT FLOW (CUBIC FEET/SECOND)		FILL FLOW (CUBIC FEET/SECOND)	
	SOUTH	NORTH	SOUTH	NORTH	SOUTH	NORTH	SOUTH	NORTH	S-N	N-S	S-N	N-S
0.5	194.11	193.68	0.	911864320.	255.	355.	2049999872.	1840734720.	528.	119.	763.	437.
1.0	194.22	193.76	0.	911649536.	253.	354.	2049999872.	1847138304.	563.	105.	854.	415.
1.5	194.31	193.79	0.	912730112.	251.	355.	2049999872.	1855380992.	670.	68.	1000.	388.
2.0	194.45	193.91	0.	912604672.	249.	355.	2049999872.	1866833920.	713.	60.	1082.	391.
2.5	194.67	194.09	0.	912039424.	246.	353.	2049999872.	1880437760.	798.	40.	1213.	392.
3.0	194.80	194.23	0.	911015424.	243.	353.	2049999872.	1893973248.	733.	66.	1148.	439.
3.5	195.18	194.41	0.	909783808.	238.	352.	2049999872.	1913666304.	1107.	5.	1845.	399.
4.0	195.26	194.58	0.	908334592.	236.	352.	2049999872.	1934316544.	937.	31.	1489.	484.
4.5	195.50	194.78	0.	906552832.	232.	351.	2049999872.	1952450048.	997.	28.	1620.	518.
5.0	195.78	195.15	0.	903022336.	228.	346.	2049999872.	1969190912.	823.	73.	1315.	597.
5.5	196.08	195.33	0.	898135808.	223.	344.	2049999872.	1987134720.	1004.	45.	1665.	598.
6.0	196.41	195.56	0.	892659456.	218.	343.	2049999872.	2010453760.	1172.	26.	2038.	633.