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Modelling water quality in the upper Klip river

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Table D1.4 SLD1 Program Listing and Input Data.

```
//***ACCLU JOB 3,CLISSHE
/*JOBPARM      P=DLK,R=67
//    EXEC FORTXCLG,PARM='NOSOURCE'
//FORT.SYSIN DD *
      REAL *8P,N2,*STG,*2EFF,,N2FKG,N2HFG
      DIMENSION NAME(5)
      INO=5
      K3DT=6
C
      READ(IN,4000)NAME
 4000 FORMAT(5A2)
C
C-------------READ IN DESIGN PARAMETERS--
      READ(IN,5033)AENGY,ASLDG,BSSOX,BO2DX,SRMVL,FMRAT,SNBIO,ALKLF,N2F,
     1PF
 5033 FORMAT(6F5.3,5,2F6.0)
C-------------READ IN CONCENTRATIONS VSS, NVSS--
      READ(IN,5100)XVA,XVU,XVF,XNVF,XNVE
 5100 FORMAT(5F5.3)
C-------------READ IN CONCENTRATIONS S O O AND FLOW RATE--
      READ(IN,5233)SFRESH,SEFFL,QFRESH
 5200 FORMAT(3F5.3)
C
      K=5
      L=6
      M=5
      N=5
C
C--------------CALCULATE SLUDGE RECYCLE RATIO (STEP 1)
C-----------------1. SUBSTRATE REMOVAL RATE CONTROLLING(EQ 5.114)
      RATI = (XVA-ASLDG *SFRESH-SEFFL)*BSSOX*(SFRESH-SEFFL)/SRMVL/(SEFFL
     1+SNBIO)+XVF)/(XVU-XVA)
C-----------------2. OPTIMAL FLOCCULATING CONDNS. CONTROLLING(EQ 5.119)
      RAT2= (XVA- ASLDG*(SFRESH-SEFFL)*BSSOX*SFRESH/FMRAT-XVF)/(XVU-XVA-
     1BSSOX*SEFFL/FMRAT)
C
C--------------CALCULATE COMBINED VSS CONCENTRATIONS(STEP2,EQ 5.96)
C-----------------1. SUBSTRATE REMOVAL RATE CONTROLLING
      SCOM1= (SFRESH*RAT1*SEFFL)/(1.+RAT1)
C-----------------2. OPTIMUM FLOCCULATION CONDNS. CONTROLLING
      SC2=(1.+RESH*RAT2*SEFFL)/(1.+RAT2)
C
C--------------CALCULATE RESIDENCE TIME(STEP 3)
C-----------------1. SUBSTRATE REMOVAL RATE CONTROLLING(EQ 5.100)
      THES1= (SCOM1-SEFFL)/(S*RVL*XVA*(SEFFL-SNBIO))
C-----------------2. OPTIMUM FLOCCULATION CONDNS. CONTROLLING(EQ 5.101)
      THES2= SCOM2/(XVA*FMRAT)
C
C--------------SELECT CONTROLLING CONDITIONS
      IF (THES1-THES2)30,10,20
   10 IF (RAT1-RAT2)20,30,30
   20 RATIO = RAT1
      SCOM = SCOM1
      THES = THES1
      GOTO 40
   30 RATIO = RAT2
      SCOM = SCOM2
      THES = THES2
C
C--------------CHECK F/M RATIO--
   40 FM= SCOM2/(XVA*THES)
      IF (FM-.5)50,50,46
   50 IF (FM-.3)60,70,70
   60 K = 1
C
C--------------CALC. THROUGHPUT RATE & REACTOR VOL(STEP 4,EQ 5.5 & 5.104)
   70 QX =QFRESH*(1.+RATIO)
      VOLR =QX*THES
C
C--------------CALCULATE NET YIELD MLVSS (STEP 5,EQ 5.105)
      DELXV= Q*(ASLDG*BSCOM-SEFFL-BSSOX*XVA*THES)*0.001
C
C--------------MATERIAL BALANCE CHECK--
      XV3= (XVF*RATIO*XVU)/(1.+RATIO)
      IF (ABS(XVA-XV3)*FM,0.001-DELXV1/DELXV*100.-2.)90,90,80
   90 L = 1
C
C--------------CALC. #STAGE 02 ANTT EFFLUENT QI(STEP 6,EQ 5.74 & 5.95)
   10 Q2= (DELXV*0.001*QFRESH*XVF)/(1.001*XVU)
      QI= QFRESH-Q2
C
C--------------CALC. #STAGE NVSS & TOTAL SLUDGE YIELD(STEP 7,EQ 5.72 &
C                                                        5.11)
      DELXNV= (QFRESH*(XNVF+XNVE)+Q2*XNVE)*0.001
      DELXT= DELXV+DELXNV+QFRESH *VF*0.001
C
C--------------CHECK MATERIAL BALANCE FOR NVSS IN EFFLUENT
      XX= ABS((QFRESH*XNVF+Q1*XNVE)*0.001-DELXNV)/(Q1*XNVE*0.001)
      IF (XX*100.-2.)110,110,109
  100 M = 1
C
C--------------CALC. NVSS IN SECONDARY CLARIFIER UNDERFLOW AND
C                                  IN NET EFFLUENT(EQ 5.74)
  110 XNVU= DELXNV/(0.001*Q2)
      ANV0= (XNVF*RATIO*XNVU)/(1.+RATIO)
C
C--------------CALCULATE OXYGEN REQUIREMENTS(STEP 8,EQ 5.64)
      O2REQ= (ASNGY*SCOM3-SEFFL*BO2DX*XVA*VOL)*0.001
C
C--------------CHECK NTUTRALISATION REQUIREMNTS (STEP 10)--
      ALKRTM= (SFRESH - SEFFL)*QFRESH*0.001*3.5
      ALKNTY= ALKLF*QFRESH*0.001
      IF (ALKNTY - ALKRTM)139,130,120
  120 M = 1
C
C--------------EVALUATE NUTRIENT REQUIREMENTS (STEP 11)--
C-----------------1. NITROGEN REQUIREMENTS (EQ 5.116)
  130 N2=STG* 0.12*DELXV
      N2EFFL= 1.*QFRESH*0.001
      N2TKU= N2F*QFRESH*0.001
      WRITE(KOUT,1200)N2,STG,N2EFFL,N2FKG
      IF (N2-N2F)140,150,150
C--------------CALCULATE NITROGEN REQUIRED--
  140 N2RQ = N2-STG-N2EFFL-N2FKG
C     WRITE (KOUT,9911)N2RQ
 9911 FORMAT('0',F10.3)
 9900 FORMAT('1',2F10.3)
C-----------------2. PHOSPHORUS REQUIREMENTS (E  5.117)
  150 P=STG* 0.02*DELXV
      QEFFL= 0.5*QFRESH*0.001
      QFRES= QFF*QFRESH*0.001
      IF (P-QEFFL*PFKG)170,170,160
C--------------CALCULATE PHOSPHORUS REQUIRED
  160 PUP=P-QEFFL*PFKG
C
C
C--------------PROGRAM OUTPUT
C
  170 WRITE(KOUT,9330)AENGY,ASLDG,BSSOX,BO2DX,SRMVL,FMRAT,SNBIO,ALKLF,N2
     1F,PF
 9330 FORMAT('   INPUT DATA1'/3X,10('**')////5X,'AENGY=',F6.3,' ASLDG=',F
     16.3,' BSSOX=',F6.3,' BO2DX=',F6.3,' SRMVL=',F6.3,' FMRAT=',F6.3
     2,' SNBIO=',F6.3,' ALKLF=',F6.0,' N2F=',F6.0,' PF=',F6.0)
      WRITE(KOUT,9500)XVA,XVU,XVF,XNVF,XNVE,SFRESH,SEFFL,QFRESH
 9500 FORMAT('0',3X,' XVA=',F5.0,' XVU=',F5.0,' XVF=',F5.0,' XNVF=',F5.0,'
     1 XNVE=',F5.0,'  SFRESH=',F6.2,' SEFFL=',F6.2,' QFRESH=',
     2F6.0)
C
      WRITE(KOUT,9550)NAME,VOL,O2REQ,T3ES
 9550 FORMAT('1',20X////20X,'REACTOR'//2X,71('**')///3X,'REACTOR VOLUME=',
     117X,'VOL=',F8.1,' CU.M'//3X,'OXYGEN REQUIREMENTS=',10X,'O2REQ=',F8
     2.1,' KG/DAY'//3X,'RESIDENCE TIME',16X,'THES=',F10.1,' DAYS')
C
      WRITE(KOUT,9610)RAT1,RAT2,RATIO
 9600 FORMAT('1'//2X,'RAT1=',F10.4,' RAT2=',F10.4,' COMBINED RES',20X,'
     1VT=',F10.1,' CU.M/DAY'//3X,'RES. EFFLUENT',23X,'QI=',F10.2,' CU.M/DA
     2Y'//2X,'RATIO=',F10.2,' QU=',F10.2,' CU.M/DAY'//3X,'RECYCLE RATIO'
     3RATIO=',F10.3)
C
      WRITE(KOUT,9700)SCOM
 9700 FORMAT('1'//2X,'CONCENTRATIO=S OF SOLUBLE B O D1'/2X,31('**')///3X,
     1'CONSIDERED FEED',15X,'SCOM=',F10.1,' MG/L')
C
      WRITE(KOUT,9800)XVO
 9800 FORMAT('1'//2X,'CONCENTRATIONS OF V S S1'/2X,23('**')///3X,'COMBINE
     1D FEED',15X,'XV=',F10.1,' MG/L')
C
      WRITE(KOUT,9900)XNVO,XNVU
 9900 FORMAT('1'//2X,'CONCENTRATIONS OF N.V.S S1'/2X,23('**')///3X,'COMBI
     1NED FEED',17X,'XNV=',F10.1,' MG/L'//3X,'SECONDARY CLARIFIER',5X,'
```

SLD1 Listing (Continued)

```
L:181        /ANSER*LOA*,15X,*ANVUA*,F10.1,* MG/L*)
L:182 C
L:183         WRITE(KOUT,9930)DELXV,DELAT
L:184  5000  FORMAT(1*1*//2X,*4*STAGE1*/2X,71**1*///3X,*NET YIELD MLVSS IN REACT
L:185       1OR*,13X,*DELAV=*,F10.1,* KG/DAY*//3X,*WASTAGE UP NVSS*,13X,*DELANV=
L:186       2*,F10.1,* KG/DAY*//3X,*TOTAL SLUDGE YIELD*,11X,*DELAT=*,F12.1,* KG
L:187       3/DAY*)
L:188 C
L:189         WRITE(KOUT,6100)
L:190  6100  FORMAT(*1*//2X,*NEUTRALISATION REQUIREMENTS:*/2X,27(*=*))
L:191 C
L:192         IF (N-11130,140,190
L:193   140   WRITE(KOUT,6200)
L:194  6200  FORMAT(*0*///5X,*NO NEUTRALISATION REQUIRED*)
L:195         GOTO 200
L:196   190   WRITE(KOUT,6300)
L:197  6300  FORMAT(*0*///5X,*NEUTRALISATION REQUIRED*)
L:198    200  WRITE(KOUT,6400)ALKENTY,ALKREM
L:199  6400  FORMAT(*0*//3X,*ALKALINITY IN FRESH FEED*,4X,*ALKITY=*,F10.1,* KG/
L:200       1DAY*//3X,*ALKALINITY REMOVED*,10X,*ALKREM=*,F10.1,* KG/DAY*)
L:201 C
L:202         WRITE(KOUT,6500)N2AEQ,P2EQ
L:203  6500  FORMAT(*1*//2X,*NUTRIENT REQUIREMENTS!*/2X,21(*=*)///3X,*NITROGEN
L:204       1R*,2UX,*N=EQ=*,F10.1,* KG/DA Y*//3X,*PHOSPHORUS REQUIREM
L:205       2ENT*,9X,*P=EQ=*,F10.1,* KG/DA Y*)
L:206 C
L:207         IF (K-11220,210,220
L:208   210   WRITE(KOUT,6600)R1P4
L:209  6600  FORMAT(*1*//2X,*N,8, CALCULATED F/M RATIO NOT COMPATIBLE WITH GOO
L:210       1D FLOCCULATION*/10X,*F/M=*,F8.3)
L:211    220  IF (L-13043,230,240
L:212    230  WRITE(KOUT,6700)
L:213  6700  FORMAT(*1*//2X,*N,8, MLVSS MATERIAL BALANCE DOES NOT CHECK*)
L:214    240  IF (M-11)0,260,260
L:215    250  WRITE(KOUT,6800)
L:216  6800  FORMAT(*1*//2X,*N,8, NVSS MATERIAL BALANCE DOES NOT CHECK*)
L:217 C
L:218    260  STOP
L:219         END
L:220 /*
L:221 //GO.SYSIN DD *
L:222  DESIGN PARCEDURE FOR ACTIVATED SLUDGE PLANT (RAMALHO & FJ RUN 7
L:223      .7/  .408   .075    .15 .3161      .5    10.    .0.    .3.    3.
L:224  3830.16300.    .0.    30.    20.
L:225  1200.    43. 9576.
L:226 //
```

TABLE D2.1 KLIP6 PROGRAM INPUT DESCRIPTION

Card Set Repeat	Card Repeat	Symbol	Units	Description	Format	Symbol Repeat on Card
	1	RUN		Simulation run number	I3	1
		IPHO		≠0 Diurnal variation of photosynthesis used =0 Diurnal variation of photosynthesis not used	I2	1
		MNTH		Month of the year (= 1,2,.....,12)	I2	1
		START	hours. mins.	Time of day at start of simulation	X,F4.2	1
	1	NR		Number of homogeneous sub-reaches (maximum of 9)	I2	1
	NR	ENDR( )	km	Chainage at end of reach	F5.3	1
		DFFN( )	km^2/day	Longitudinal dispersion coefficient	F5.2	1
		VEL( )	km/day	Average velocity over reach	F5.2	1
		BODK( )	1/day	Deoxygenation coefficient	F5.2	1
		AERK( )	1/day	Reaeration coefficient	F5.2	1
		SINK( )	mg/l/day	BOD sink (+ve) or source (-ve)	F5.2	1
		SOURCE( )	mg/l/day	DO sink (-ve) or source (+ve)	F5.2	1
		PDO( )	mg/l/day	Photosynthetic DO production (always positive)	F5.2	1
		SINKI( )	mg/l/day	Inert COD sink (+ve) or source (-ve)	F5.2	1
	1	DELX	km	Space interval required for output	F5.3	1
		DELT	hours	Time increment for computation	F7.4	1
		IT		Integer by which DELT must be divided to assure stability of step 2 of calculations	X, I2	1
	1	NL		Number of sampling stations	I3	1
		DOSAT	mg/l	Dissolved oxygen saturation value	2X, F5.2	1
		ICOD		≠0 COD input used =0 COD input not used	I1	1
		DINRT1		Fraction of inert COD for input (Only required if ICOD ≠0)	4X, F5.2	1
		DINRT2		Assumed initial fraction of inert COD at downstream end (Only required if ICOD ≠0)	F5.2	1
NL	1	STN( )		Name or number of sampling station	A4	1
		XSTN( )	km	Chainage of station	X,F5.3	1
		NBOD( )		Number of BOD observed values at station	I2	1
		NDO( )		Number of DO observed values at station	I2	1
	NBOD/8	BOD( )	mg/l	Observed BOD concentration	F5.0	)
		TBOD( )	hours	Time of observed BOD concentration from start of simulation	F5.0	) 8X2)
	NDO/8	DO( )	mg/l	Observed DO concentrations	F5.0	)
		TDO( )	hours	Time of observed DO concentrations from start of simulation	F5.0	) 8X2)
	1	INTBD		≠0 Initial BOD concentrations at sampling stations are to be read in =0 Initial BOD concentrations not read in	I1	1
		INTDO		≠0 Initial DO concentrations of sampling stations are to be read in =0 Initial DO concentrations not read in	I1	1
	0 if INTBD=0 1 if INTBD≠0	BODZRO( )	mg/l	Initial BOD concentrations at sampling stations	F5.2	NL
	0 if INTDO=0 1 if INTDO≠0	DOZRO( ) DOZRO( )	mg/l	Initial DO concentrations at sampling stations	F5.2	NL
	1	NTOUT		Number of output times required	I2	1

TABLE D2.1 (Cont.)

Card Set Repeat	Card Repeat	Symbol	Units	Description	Format	Symbol Repeat on Card
	NTOUT/16	TIMES( )	hours	Times at which output is required in hours from start of simulation	F5.2	16
	1	NBODIN		Number of BOD input values	I2	1
		NDOIN		Number of DO input values	I2	1
	NBODIN/8	BODIN( )	mg/l	Input BOD concentrations at upstream point	F5.0)	8X2
		TBODIN( )	hours	Times of input BOD concentrations	F5.0)	
	NDOIN/8	DOIN( )	mg/l	Input DO concentrations at upstream point	F5.0)	8X2
		TDOIN( )	hours	Times of input DO concentrations	F5.0)	
	1	IPLT		Output requirements =0 No plotted output required =1 Plotted output required =2 No longitudinal output required	I1	1
		IPLT1		=0 Tabulation of results required =1 No tabulation of results required	I1	1
		ISCALE		Scale for BOD concentration on y-axis =1 BOD range 0 - 80 mg/l =2 BOD range 0 - 40 mg/l =3 BOD range 0 - 20 mg/l =4 BOD range 0 - 160 mg/l	I1	1

Table D2.2 KLIP6 Program Input Data

(a) Sample Survey 18 July 1978 - COD

```
L.2021  30 1 3  4.
L.2022  2
L.2023  1.7519.0 24.8  3.35 1.0   3.   8.   3.  -150.
L.2024  3.75  0.4  35.7  1.3  2.7   5.  13.   0.  175.
L.2025  5.2015.3  22.2  1.2  1.0   0.   0.   0.   80.
L.2026      .250  .2043 3
L.2027    4   11.3  1.   4.    0.0
L.2028  6    0.   2.0
L.2029  77.0  2.2  51.0   3.0 36.0   7.5 41.0 10.0 56.0 12.5 61.0 15.0
L.2030  4.4   0.   3.0   2.6  4.3   0.   5.5   7.5  5.0 10.   5.7 12.5  5.0 15.0
L.2031  4       1.60  2.7  7
L.2032  59.0   3.5  66   1.0  81.0   5.2360.0   7.5 86.0  .0.3330.0 12.8356.0  15.0
L.2033  4.4    0.5    2   0.   5.5   0.23 0.0   7.5  6.   10.33 5.5 12.33 5.0 15.0
L.2034  4       3.4    7
L.2035  59.2   2.2341.0   1.2170.0   7.8368.0 13.2330.0 12.8341.0 15.32
L.2036  4.4    0.2  3.3   2.4  3.3   0.23  0.2    7.8 10.33 6.5 12.33 5.0 15.33
L.2037  4       5.3    7
L.2038  59.2   2.2328.2   3.5  65.0   3.6  81.2   8.8 41.0 11.2 10.2  13.2 39.0 17.81
L.2039  4.4    1.5  7.4   1.5  7.7   0.   7.0   0.8  7.2 11.   7.1  13.5  7.7 12.83
L.2040 03
L.2041 19
L.2042  3.0   1.0   2.5   3.0   4.0   5.0   6.0   7.0   8.0   9.0 10.0 11.0 12.0 13.0 14.0 15.0
L.2043    7.7
L.2044  77.0  2.2  51.0   3.0 36.0   7.5 41.0 10.0 56.0 12.5 61.0 15.0
L.2045  4.4    0.   3.0   2.6  4.3   0.   5.5   7.5  5.0 10.   5.7 12.5  5.0 15.0
L.2046 211
```

(b) Sample Survey 21 March 1979 - COD

```
L.201 399 1 3  4.
L.202  2
L.203  1.7519.0 23.4  0.05 2.0 -180.   8.   3.  -150.
L.204  3.75  0.4  37.8   1.3  2.7  330.  10.   0.  175.
L.205  5.2101.0  27.0   3.0  1.0  100.   0.   0.   80.
L.206 0.250   .2043 3
L.207    4    7.141          0.0   3.9
L.208  6    0.   2.520
L.209  90    0.4728:   1.4763:   2.3330:   7.2335:   4.0844:   8.1733:   6.2843:   7.00
L.210  45    3.4728:   4.0534:   5.0534:   6.0534:   7.0534:   8.0534:   9.0534:  10.00
L.211  94    16.0301:  17.0074:  18.0053:  19.9727:  20.0037:  21.2036:  22.3364:  23.33
L.212  45    24.333
L.213  77.0  2.85  0.2   3.7   1.47  3.   2.33  3.2   3.25  4.5   4.00  5.5   5.17  5.5   6.00  6.7   7.02
L.214   3.5   0.33  1.0   0.50  7.8   0.92  1.0011.00  3.8  12.12  3.4  13.58  3.1  15.33  3.3  15.50
L.215   2.0917.03  2.0  18.37  2.7  21.00  2.8  23.03
L.216 0
L.217    4    7.141          0.0   3.9
L.218  6    0.   2.520
L.219  90    0.4728:   1.4763:   2.3330:   7.2335:   4.0844:   8.1733:   6.2843:   7.00
L.220  45    3.4728:   4.0534:   5.0534:   6.0534:   7.0534:   8.0534:   9.0534:  10.00
L.221  94    16.0301:  17.0074:  18.0053:  19.9727:  20.0037:  21.2036:  22.3364:  23.33
L.222  45    24.333
L.223  77.0  2.85  0.2   3.7   1.47  3.   2.33  3.2   3.25  4.5   4.00  5.5   5.17  5.5   6.00  6.7   7.02
L.224   3.5   0.33  1.0   0.50  7.8   0.92  1.0011.00  3.8  12.12  3.4  13.58  3.1  15.33  3.3  15.50
L.225   2.0917.03  2.0  18.37  2.7  21.00  2.8  23.03
L.226 0
L.227    4    7.141          0.0   3.9
L.228  6    0.   2.520
L.229  90    0.4728:   1.4763:   2.3330:   7.2335:   4.0844:   8.1733:   6.2843:   7.00
L.230  45    3.4728:   4.0534:   5.0534:   6.0534:   7.0534:   8.0534:   9.0534:  10.00
L.231  94    16.0301:  17.0074:  18.0053:  19.9727:  20.0037:  21.2036:  22.3364:  23.33
L.232  45    24.333
L.233  77.0  2.85  0.2   3.7   1.47  3.   2.33  3.2   3.25  4.5   4.00  5.5   5.17  5.5   6.00  6.7   7.02
L.234   3.5   0.33  1.0   0.50  7.8   0.92  1.0011.00  3.8  12.12  3.4  13.58  3.1  15.33  3.3  15.50
L.235   2.0917.03  2.0  18.37  2.7  21.00  2.8  23.03
L.236 0
L.237    4    7.141          0.0   3.9
L.238  6    0.   2.520
L.239  90    0.4728:   1.4763:   2.3330:   7.2335:   4.0844:   8.1733:   6.2843:   7.00
L.240  45    3.4728:   4.0534:   5.0534:   6.0534:   7.0534:   8.0534:   9.0534:  10.00
L.241  94    16.0301:  17.0074:  18.0053:  19.9727:  20.0037:  21.2036:  22.3364:  23.33
L.242  45    24.333
L.243  77.0  2.85  0.2   3.7   1.47  3.   2.33  3.2   3.25  4.5   4.00  5.5   5.17  5.5   6.00  6.7   7.02
L.244   3.5   0.33  1.0   0.50  7.8   0.92  1.0011.00  3.8  12.12  3.4  13.58  3.1  15.33  3.3  15.50
L.245   2.0917.03  2.0  18.37  2.7  21.00  2.8  23.03
L.246 131
```

(c) Sample Survey 21 March 1979 - POD

```
L.247 249 1 3  4.
L.248  2
L.249  1.7519.0 23.4  0.0  2.0  77.   10.   3.
L.250  3.75  0.4  37.8  1.3  2.7  330.  10.   0.
L.251  5.2101.0  27.0  3.0  1.0  100.   0.   0.
L.252      .250  .2043 3
L.253    4    7.141          0.0   3.9
L.254  6    0.   2.520
L.255  90    0.4728:   1.4763:   2.3330:   7.2335:   4.0844:   8.1733:   6.2843:   7.00
L.256  45    3.4728:   4.0534:   5.0534:   6.0534:   7.0534:   8.0534:   9.0534:  10.00
L.257  94    16.0301:  17.0074:  18.0053:  19.9727:  20.0037:  21.2036:  22.3364:  23.33
L.258  45    24.333
L.259  77.0  2.85  0.2   3.7   1.47  3.   2.33  3.2   3.25  4.5   4.00  5.5   5.17  5.5   6.00  6.7   7.02
L.260   3.5   0.33  1.0   0.50  7.8   0.92  1.0011.00  3.8  12.12  3.4  13.58  3.1  15.33  3.3  15.50
L.261   2.0917.03  2.0  18.37  2.7  21.00  2.8  23.03
L.262 131
```

Table D2.3 KLIP6 Program Output

(A) Data Listing (for COD)

```
K L I P  R I V E R  S I M U L A T I O N  -RUN 384

REACH NO 1
   END OF REACH          ENDR =  1.73 KM
   MEAN VELOCITY         VEL  = 23.40 KM/DAY
   DISPERSION COEFFT     DPFN = 10.00 KM*2/D
   BOD DECAY COEFFT      BDK  = 0.050 1/DAY
   REAERATION COEFFT     AERK = 2.00  1/DAY
   BOD SOURCES & SINKS   SINK =-150.0 MG/L/DAY
   DO SOURCES & SINKS    SOURCE =   0.0 MG/L/DAY
   PHOTOSYNTHESIS DO     PDO  =   0.0 MG/L/DAY
   INERT SOURCES & SINKS SINK1 =-150.0 MG/L/DAY


REACH NO 2
   END OF REACH          ENDR =  3.75 KM
   MEAN VELOCITY         VEL  = 27.50 KM/DAY
   DISPERSION COEFFT     DPFN =  0.40 KM*2/D
   BOD DECAY COEFFT      BDK  = 1.300 1/DAY
   REAERATION COEFFT     AERK = 2.70  1/DAY
   BOD SOURCES & SINKS   SINK = 350.0 MG/L/DAY
   DO SOURCES & SINKS    SOURCE =  10.0 MG/L/DAY
   PHOTOSYNTHESIS DO     PDO  =   0.0 MG/L/DAY
   INERT SOURCES & SINKS SINK1 = 175.0 MG/L/DAY


REACH NO 3
   END OF REACH          ENDR =  5.30 KM
   MEAN VELOCITY         VEL  = 28.00 KM/DAY
   DISPERSION COEFFT     DPFN = 15.00 KM*2/D
   BOD DECAY COEFFT      BDK  = 3.000 1/DAY
   REAERATION COEFFT     AERK = 3.00  1/DAY
   BOD SOURCES & SINKS   SINK = 100.0 MG/L/DAY
   DO SOURCES & SINKS    SOURCE =   0.0 MG/L/DAY
   PHOTOSYNTHESIS DO     PDO  =   0.0 MG/L/DAY
   INERT SOURCES & SINKS SINK1 =  80.0 MG/L/DAY


INERT FRACTION:  50.00  97.00  %

 DIURNAL VARIATION OF PHOTOSYNTHESIS USED (PDO +VE, IPHO=1)

 DELTA 0.003 DAYS

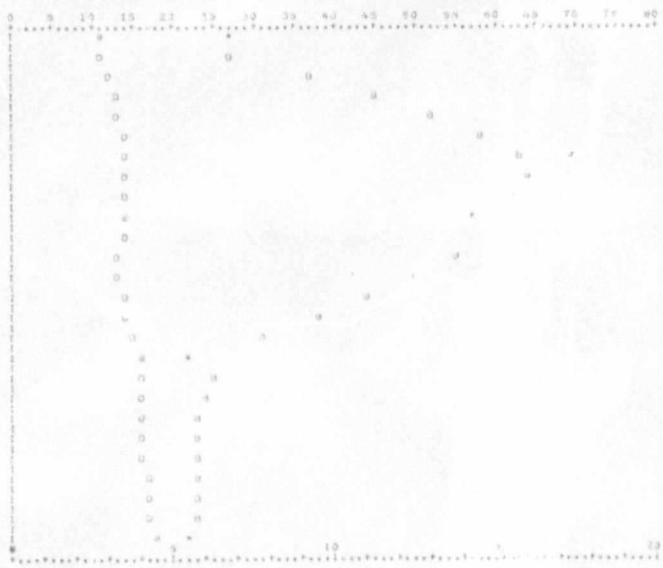
   DELX(1)= 0.203 KM
   DELX(2)= 0.261 KM
   DELX(3)= 0.174 KM

 NO OF SPACE INTERVALS NX = 27
 NO OF TIME INTERVALS  NT = 6125
```

(b) Typical Longitudinal Output

```
K L I P  R I V E R  S I M U L A T I O N  -RUN 384     TIME= 23.00 HRS

  DISTANCE          SIMULATED   OBSERVED
  DOWNSTREAM        BOD    DO   BOD    DO
     STATION NO 2                27.6   2.8
  0.0               27.9   2.8
  0.250             36.6   3.0
  0.500             49.3   3.2
  0.750             52.3   3.3
  1.000             53.4   3.5
  1.250             52.7   3.8
  1.500             52.3   3.8
  1.750             52.4   3.9
     STATION NO 3                57.1   3.6
  2.000             58.8   3.4
  2.250             56.6   3.1
  2.500             49.7   3.3
  2.750             44.0   3.4
  3.000             37.6   3.5
  3.250             33.9   3.7
     STATION NO 4                22.0   4.0
  3.500             24.5   3.9
  3.750             24.0   3.9
  4.000             23.3   4.0
  4.250             22.9   4.1
  4.500             22.9   4.1
  4.750             23.0   4.2
  5.000             23.2   4.2
  5.250             23.3   4.2
     STATION NO (EXI          21.9   4.6
```



(c) Typical Time Variation Output

KLIP RIVER SIMULATION -RUN 386

BOD AND DO VARIATION WITH TIME AT STATION 8

TIME	SIMULATED		OBSERVED	
HRS	BOD	DO	BOD	DO
0.0	57.68	3.58	56.05	3.48
1.04	59.69	3.48	58.00	3.81
2.09	57.55	3.92	58.00	4.00
2.92	53.24	3.65	50.00	4.02
3.95	50.68	3.91	55.00	4.20
5.00	52.24	3.21	58.00	4.50
6.04	52.55	4.47	60.37	4.50
7.09	50.35	4.56	60.00	4.57
7.92	49.75	4.71	58.00	4.62
8.96	49.32	4.76	61.23	4.62
10.00	49.91	4.78	57.62	4.37
11.04	51.86	4.65	59.69	4.25
12.04	55.93	4.48	60.95	4.13
12.92	59.33	4.35	60.17	3.88
13.96	65.50	4.06	60.94	3.81
15.00	68.45	3.76	58.00	3.78
16.04	70.40	3.65	56.90	3.54
17.09	68.38	3.65	54.34	3.34
17.92	65.32	3.54	60.46	3.33
18.96	59.95	3.69	66.55	3.52
20.00	60.98	3.63	57.07	3.60
21.04	49.00	3.63	39.95	3.60
22.08	43.18	3.50	47.13	3.62
22.92	51.33	3.46	53.00	3.64
23.96	54.12	3.43	37.50	3.55
25.00	54.54	3.46	27.76	3.39

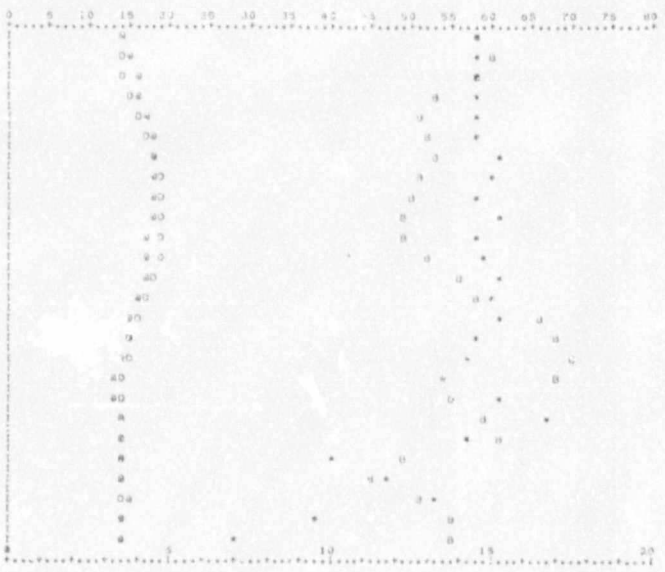


TABLE D2.4 KLIP6 GLOSSARY OF IMPORTANT CONSTANTS, PARAMETERS AND VARIABLES

(a) Constants

NR	Number of homogeneous sub-reaches
ENDR( )	Chainage of end of sub-reach (km)
NL	Number of sampling stations
STN( )	Name or number of sampling station
XST( )	Chainage of sampling station (km)
MNTH	Month during which simulation is run (=1,2,..... ,12)
START	Time of day at which simulation begins (hours.minutes)
VEL( )	Average velocity along sub-reach (km/day)
DOSAT	Dissolved oxygen saturation concentration (km/L)

(b) Computation control constants

IT	Integer by which time step is subdivided into smaller time steps for stability of step 2 computation in the two-step finite difference method
DELT	Time step for step 1 of the two step finite difference method
DELX( )	Space interval for finite difference grid for each sub-reach

(c) Parameters

AERK( )	Reaeration coefficient (1/day) for sub-reach
BODK( )	Deoxygenation coefficient (1/day) for sub-reach
DFFN( )	Longitudinal dispersion coefficient for sub-reach (km^2/d)
DINRT1	Fraction of non-biodegradable COD in input data.

DINRT2	Assumed initial fraction of non-biodegradable COD at downstream end of reach
PDO( )	Daily photosynthetic production of DO (mg/l/d)
SINK( )	BOD source/sink term (mg/l/d)
SINKI( )	Source/sink term for non-biodegradable fraction of COD (mg/l/d)
SOURCE( )	DO source/sink term (mg/l/d)

(d) Input variables

BOD(,)	Observed BOD concentrations (mg/l)
BODIN( )	Forcing BOD concentrations (mg/l)
DO(,)	Observed DO concentrations (mg/l)
DOIN( )	Forcing DO concentrations (mg/l)
NBOD( )	Number of observed BOD concentrations at a station
NDO( )	Number of observed DO concentrations at a station
TBOD(,)	Times of observed BOD concentrations (h)
TBODIN( )	Times of forcing BOD concentrations (h)
TDO(,)	Times of observed DO concentrations (h)
TDOIN( )	Times of forcing DO concentrations (h)

(e) State Variables

BODZRO( )	Initial BOD concentrations at sampling stations (mg/l)
DOZRO( )	Initial DO concentrations at sampling stations (mg/l)
XBOD( )	BOD concentrations along reach/mg/l)
XDO( )	DO concentrations along reach (mg/l)
DPHO( )	Photosynthetic DO production (mg/l/d)

(f) Finite difference variables

A1, A2, A2A B1, B2, DENOM)	Finite difference coefficients for sub-reach

BOD1( )	Initial BOD concentrations at finite difference grid points (mg/l)
DO1( )	Initial DO concentrations at finite difference grid points (mg/l)
CBOD( )	Forcing BOD concentration at each time step (mg/l)
CDO( )	Forcing DO concentration at each time step (mg/l)

(g) Output variables

CBW	Simulated BOD concentrations along reach (mg/l)
CDW	Simulated DO concentrations along reach (mg/l)
PBP	Simulated BOD concentrations at sampling stations (mg/l)
PDP	Simulated DO concentrations at sampling stations (mg/l)

Table D2.5 KLIP6 - Program Listing

```
C.001 //AM**KLIP6Y JOB 5,CLASS=4,MSGLEVEL=(0,0)
C.002 /*JOBPARM  T=0LK=4972
C.003 /*MAIN LINE=40LD
C.004 //        EXEC FITSF,WS=
C.005 //SYSUT1  DD *,DCB=(KLIP01,UNIT=SYSSQ,DISP=(NEW,PASS),
C.006 //            SPACE=(CYL,(1,1))
C.007 //SYSIN  DD *
C.008 *$ ALC(1)
C.009 //        EXEC FORTXCLG,PARM.FORT='NOSOURCE'
C.010 //FORT.SYSIN DD *
C.011       COMMON NUM,NR,ENDRE(10),DFPN(10),VEL(10),BOOK(10),AERK(10),SINK(10)
C.012      1,NJ(10),NL,DELT,NOTA,NL,ISTN(10),KSTN(10),NOOS(10),NJJ(10),KJJ(1
C.013      20,30),TAJJ(10,93),DULL(50),TOJ(10,56),NA,INTHO,(NTDO,(1324)(1)),J
C.014      30K(10(2),30(1(4)2)),NTOUT,(NOT(N(50)),NTNP,JOO(N(52)),TJJ(N(62),(C(32(40
C.015      40),(C2(1(20),KOUT,KOJ(50(2),C(6(50)),CRA,(T,KOJ(50)),NJ,(C(50)),(C(5A
C.016      5X),(T9),(TIME(S(50),TOOT(N(50),BOJ((500),JNK,KIN(5(WT,(OJ(AT(1)L,(1)CA
C.017      6L5,3INGT(,KNT(4,,TANT,(80PT(10,50),(ROUPT(10,50),(OPT(10,53),,C3AP(1
C.018      70,3O2,(TIME(L(3,(O2),M4,(E(50(),(SINK((10),(KIN(5001,(INGT(X(L2),(PNO,(
C.019      8O,(AI(3),,(CO,(PT(15),(CO((3O2),(CO((,(O23),(OAI(50),(CEA),(O2),(T,(JJ,(OP(
C.020      9,(OA1(3OC),,J3,(PLT(,(STOP,(OA1,(CTA1,(OA1,(SOURCE((10)
C.021       XT4= 10
C.022       KA=TS 5
C.023       M10 0
C.024       IST3A=0
C.025 C
C.026 C**********READ IN RUN NO AND REACH PARAMETERS
C.027       READ(KIN, 5002)RUN,IPHO,MSTH,STANT
C.028  5002 FORMAT(I1,,I2,,I2,A,F4.2)
C.029       ISTART= ISTART
C.030       START= ISTART + (START-FLOAT(ISTART))/60.
C.031       READ(KIN,5050)NR
C.032  5050 FORMAT(I2)
C.033       DO 100 L=1,NR
C.034       READ(KIN,5100)ENDRE(L),DFPN(L),VEL(L),BOOK(L),AERK(L),SINK(L),SOURC
C.035      1E(L),POO(L),SINK(L)
C.036       IF(IPHO.NE.0.AND.POO(L).LT.0)WRITE(KWT,5075)
C.037  5075 FORMAT(1X,'//////0X,'*****ERROR** POO MUST BE +VE IF IPHO=1*****')
C.038       IF(IPHO.NE.0.AND.POO(L).LT.0)STOP
C.039   100 CONTINUE
C.040  5100 FORMAT(F5.3,4F5.2)
C.041 C
C.042 C**********READ IN TIME AND SPACE INTERVALS
C.043       READ(KIN,9200)DELR,DELT,IT
C.044  5200 FORMAT(F3.2,F7.4,I4,I2)
C.045       DELT= DELT/24.
C.046 C==========CALCULATE SPACE INTERVALS FOR EACH REACH
C.047       DO 330 L=1,NR
C.048       DEL(L)= VEL(L)*DELT
C.049   330 CONTINUE
C.050 C
C.051 C**********READ IN OBSERVED VALUES
C.052       READ(KIN,9300)NL,(OBSAT(J),J=1,NL)
C.053  5300 FORMAT(I3,,A1,F5.2,11(4X,2F5.2))
C.054       DO 332 L=1,NR
C.055       SINK(L)= SINK(L)
C.056       IF(C(O.NE.0.AND.SINK(L).EQ.0.AND.SINK(L).LE.0)SINK(L)= SINK(L)*(1.+D
C.057      1INAT))
C.058       IF(C(O.NE.3.AND.SINK(L).EQ.0.AND.SINK(L).LT.0)SINK(L)= SINK(L)*DINA
C.059      1T))
C.060   332 CONTINUE
C.061       DO 342 L=1,NL
C.062       READ(KIN,5400)(STN(L),KSTN(L),NBCD(L),NOO(L)
C.063  5400 FORMAT(A3,1X,F5.3,2I2)
C.064       K49 =7
C.065       N = 0
C.066   335 MM= MM+8
C.067       N = N+8
C.068       READ(KIN,3500)(BOO(I,J),T80D(I,J),J=MM,N)
C.069  5500 FORMAT(I(F5.0))
C.070       IF(NAL(,+NOO(L)))GO TO 336
C.071       MM3 =7
C.072       N = 0
C.073   331 MM= MM+8
C.074       N = N+8
C.075       READ(KIN,3503)(JO(I,J),TOJ(I,J),J=MM,N)
C.076       IF(NAL(,+NOJ(L)))GO TO 331
C.077   340 CONTINUE
C.078       DO 347 L=1,NL
C.079       JN(L)=NOJ(L)
C.080       DO 345 J=1,JN(L)
C.081   345 TAJJ(L,J)= TOJ(L,J)/24.
C.082       JNO(L)=NOO(L)
C.083       DO 349 J=1,JNO
C.084       DO(L,J)= OBSAT-OO(L,J)
C.085   349 TOO(L,J)= TOO(L,J)/24.
C.086   347 CONTINUE
C.087 C==========ALLOW ADDITIONAL SAMPLE POINT IF FINAL SAMPLE POINT NOT AT END OF
C.088 C                                                    STUDY REACH
C.089       DEL(NR+1)= DEL(NR)
C.090       DFP(NR+1)= DFP(NR)
C.091       BOK(NR+1)= BOK(NR)
C.092       ENDR(NR+1)= ENDR(NR) + 3.*DEL(NR)
C.093       AER(NR+1)= AER(NR)
C.094       SINK(NR+1)= SINK(NR)
C.095       ROU(NR+1)= ROU(NR)
C.096       SINK(NL+1)=SINK(NR)
C.097       XST(NL+1)= ESTA(NR+1)
C.098 C
C.099 C**********DETERMINE INITIAL VALUES EITHER FROM GIVEN VALUES OR FROM
C.100 C                                                    OBSERVED VALUES
C.101       READ(KIN,9600)INTOO,INTOP
C.102  5600 FORMAT(2I1)
C.103 C==========(A) 3.0.0 INITIAL VALUES
C.104       IF (INTOO).EQ.3)GO TO 350
C.105   349 READ(KIN,5700)(JOO(N),I=1,NL)
C.106  5700 FORMAT(1X,25I3)
C.107       GO TO 380
C.108   350 DO 370 J=1,NL
C.109       BOOA(J)= (BOO(J,1)-BOO(J,2))*T80O(J,2)/(T80O(J,2)-T80O(J,1))+BOO
C.110      1(J,2)
C.111   370 CONTINUE
C.112   240 K=1
C.113       K=1
C.114       Y33= 0
C.115       JJ=0.3
C.116       NK= 0
C.117       J=1
C.118       BOOA(NL+1)= BOOZRO(NL)
C.119   390 DO01(J)=(JOOZRO(K+1)-JOOZRO(K))*(FLOAT(J-1-JJ)*DEL(KK) + XXJ-XSTN
C.120      1(K))/(XSTN(K+1)-XSTN(K))+BOOZRO(K)
C.121       JJ=J
C.122       NK=J
C.123       IF (KK.EQ.NL)NX=JJ+1
C.124       IF (J.EQ.NA*2)+03,430,420
C.125   400 IF((J-1-JJ)*DEL(KK) + XXJ.LT.ENDR(KK))GO TO 405
C.126       IF(KK.EQ.NL)EC=JOO(K)= DEL(K)-(J-1)
C.127       IF(KK.LT.1)ECOMP(KK)= ECOMP(KK-1) + DEL(KK)*(J-1-JJ)
C.128       JJ= J-1
C.129       K=KK+ JJ
C.130       KK=KK+1
C.131       IF(K.GT.1)XXJ=COMPA(KK-1)
C.132   405 IF (FLOAT(J-1-JJ)*DEL(KK) + XXJ-XSTN(K+1))390,410,410
C.133   410 K=K+1
C.134       GO TO 399
C.135 C==========(B) 0.0 INITIAL VALUES
C.136   420 IF(INTOO)430,430,430
C.137   430 READ(KIN,1700)(JOZRO(J),J=1,NL)
C.138       DO 435 J=1,NL
C.139   435 BOZR(J)= BOSAT-BOZRO(J)
C.140       GO TO 450
C.141   440 DO 453 J=1,NL
C.142       BOZR(J)= (DO(J,1)-DO(J,2))*TOO(J,2)/(TOO(J,2)-TOO(J,1))+BOZ(J,2)
C.143   450 CONTINUE
C.144   460 K=1
C.145       K=1
C.146       JJ=0
C.147       KK=0
C.148       J=1
C.149       BOZRO(NL+1)= BOZRO(NL)
C.150   470 DO(J)=(BOZRO(K+1)-BOZR)(K))*(FLOAT(J-1-JJ)*DEL(KK) + XXJ-XSTN(K)
C.151      1)/(XSTN(K+1)-XSTN(K))+BOZRO(K)
C.152       JJ=J
C.153       IF (J.EQ.(NA*2))+83,480,500
C.154   480 IF((J-1-JJ)*DEL(KK) + XXJ.LT.ENDR(KK))GO TO 485
C.155       JJ=J-1
C.156       KK=K+1
C.157       IF(K.GT.1)XXJ= PCOMPA(KK-1)
C.158   485 IF (FLOAT(J-1-JJ)*DEL(KK) + XXJ-XSTN(K+1))470,490,490
C.159   490 K=K+1
C.160       GO TO 473
```

KLIP6 Listing (Continued)

```
      C
      C**********READ IN TIMES AT WHICH OUTPUT IS REQUIRED
        500 READ(KIN,5400)NTOUT
       5400 FORMAT(I2)
            WRITE(KOUT,501)NTOUT
            N = 0
        504 MM= MM+15
            N = N+15
            READ(KIN,5825)(TIMES(J),J=MM,N)
       5825 FORMAT(15F5.2)
            IF(N.LT.NTOUT)GO TO 504
            DO 510 J=1,NTOUT
            TIMES(J)= TIMES(J)/24.
        510 CONTINUE
      C
      C**********READ IN 0 D INPUT DATA AT UPSTREAM POINT
            READ(KIN,5950)NDOIN,NDOIN
       5950 FORMAT(2I2)
            WRITE(KOUT,502)NDOIN,NDOIN
            N = 0
        513 MM= MM+8
            N = N+8
            READ(KIN,5900)(TDOIN(J),TDOIN(J),J=MM,N)
       5900 FORMAT(16F5.2)
            IF(N.LT.NDOIN)GO TO 513
            DO 515 J=1,NDOIN
        515 TDOIN(J)= TDOIN(J)/24.
      C----------CALCULATE NO OF TIME STEPS
            NT= TIMES(NTOUT)/DELT + 1
      C----------INTERPOLATE 0 D INTERMEDIATE INPUT VALUES LINEARLY
            J=1
            C3OD(J)= QOD(1)
            K=1
        520 J=J+1
            IF (FLOAT(J-1)*DELT-TDOIN(K))530,540,540
        530 C3OD(J)= (QDOIN(K)-C8OD(1))*FLOAT(J-1)*DELT/TDOIN(K)   C3OD(1)
            GO TO 550
        540 IF (K+1.LE.NDOIN)GO TO 542
            K= K-1
        542 C3OD(J)= (QDOIN(K+1)-QDOIN(K))*(FLOAT(J-1)*DELT-TDOIN(K))/(TDOIN
           1(K+1)-TDOIN(K)) + QOD(K)
            K=K+1
            IF (J-(NT+1))520,570,570
        550 IF (FLOAT(J-1)*DELT-TDOIN(K+1))540,560,560
        560 K=K+1
            GO TO 542
      C
      C**********READ IN 0 D INPUT DATA AT UPSTREAM POINT
        570 MM= -7
            N = 0
        571 MM= MM+8
            N = N+8
            READ(KIN,5900)(DOIN(J),TDOIN(J),J=MM,N)
            IF(N.LT.NDOIN)GO TO 571
            DO 590 J=1,NDOIN
            TDOIN(J)= TDOIN(J)/24.
        580 TDOIN(J)= TDOIN(J)/24.
      C----------INTERPOLATE 0 D INTERMEDIATE INPUT VALUES LINEARLY
            J=1
            C9OD(J)= DOD(1)
            K=1
        596 J=J+1
            IF (FLOAT(J-1)*DELT-TDOIN(K))600,610,610
        600 C9OD(J)= (DOIN(K)-C9OD(1))*FLOAT(J-1)*DELT/TDOIN(K) + C0O(1)
            GO TO 590
        610 IF(K+1.LE.NDOIN)GO TO 612
            K= K-1
        612 C9OD(J)= (DOIN(K+1)-DOIN(K))*(FLOAT(J-1)*DELT-TDOIN(K))/(TDOIN(K+1
           1)-TDOIN(K)) + DOIN(K)
            J=J+1
            IF (J-(NT+1))630,640,640
        623 IF (FLOAT(J-1)*DELT-TDOIN(K+1))610,630,630
        630 K=K+1
            GO TO 612
      C
      C**********READ PLOTTING REQUIREMENTS
        640 READ(KIN,5950)IPLT,IPLT1,IPCALC
       5950 FORMAT(3I1)
      C
      C**********PRINT DATA
            CALL PRTDTA
      C
      C**********CALL BOD=DO CALCULATIONS
            CALL BODC
            IF(IPLT.GE.1)CALL PLTPT
            STOP
            END
      C
      C*************************************************************
      C
            SUBROUTINE BODCAL
            COMMON RUN,NX,ENDE(10),OPPM(10),VEL(10),BODK(10),AERK(10),SINK(10)
           1,PO3(10),DELX,DELT,NDTA,NO,STH(10),KSTH(10),NBOD(10),NOU(10),STO(1
           20),TSTP(10),DO(10),SO)),NTOUT,DOIN(503),NINP,BODIN(503),CBOD(50
           3)4(10),DU(10503),NTOUT,DOIN(503),NINP,BODIN(503),TBODIN(503),CBOD(50
           401,CO(1600),KOUT,KBOD(503),CBIS(503),COX,HT,XDO(503),ND,CO(503),COX,
           5(4),MET,(1,IN,SI(2),TDJIN(503),BOD(503),KINK,HT,DUMT,IPLT,IPCA
           6LF,2(4),T,XNT(4),START,HBOPT(10,50),ADD1PT(10,50),DUPTE(10,50),DUPTE1
           70,50),TINP(10,50),MD,CI(500),SINK(10),XIN(500),DINRT2,IC30,IPMD,D
           8CL(10),CCUMP(10),CB1(503),CD1(500),CDA(903),CIA(900),IT,JJJ,DPMD
           9,CDA(1600),JJZ,IPLT1,ISTOP,CDAL,CIAI,CBAL,SOURCE(10)
            KOUT= 1
            NO= 1
      C
      C**********SET UP INITIAL VALUES
            JMAX=NX+1
            DO 110 J=1,JMX
            DI(J)= DINRT1 + (DINRT2 - DINRT1)*(J-1)/JMX
            IF(IC30.EQ.0)DINRTX= 0.
            XC3O(J)= BOD1(J)*(1.-DINRTX)
        110 CONTINUE
            CBAL= BOD1(1)*(1.-DINRT1)
      C----------SELECT BOD VALUE AT UPSTREAM END
        114 J1= 1
        120 I=K-1
            L=1
            IF(J1.GT.1)GO TO 140
            CB(1)= C3OD(M)*(1.-DINRT1)
            IF(ICOD.EQ.0)CB(1)= CBODIN(1)
            DO 125 J=2,JMX
            CB(J)= XODD(J)
        125 CONTINUE
      C
      C**********(1) PERFORM CONVECTION STEP
            CB(1)= CBAL
            CBAL1=CBODIN(M+1)*(1.-DINRT1)
            IF(IC30.EQ.0)CB(1)= CBODIN(M+1)
            CBAL= CBAL1
            DO 130 J=1,JMX
            CBAL(J)= CB(J)+C
        130 CONTINUE
      C----------CALCULATE FINITE DIFFERENCE EQUATION COEFFTS FOR REACH
        140 A1= DPPM(L)*DELT/2.*VEL(L)/DELX(L)
            A2= 1.- 1.*DPPM(L)*DELT/DELX(L) + BODK(L)*2.*DELT/IT
            DO 200 J= 1, * 1304(L)*DELT/IT2,
            A3A= 1. + 2.*DPPM(L)/DELX(L)*DELX(L)*DELT/IT
      C
      C**********(2) PERFORM OTHER CALCULATIONS
        150 CBX= (CBAL(M-1)*A1 + CBAL(1)*A2 + CBAL(2)*A1 - SINK(L)*DELT/IT)
           1*DUM
            IF(AERK(L).GT.0.)SAT,AND,SERK(L)*BODSAT*(SOURCE(L)*DPPM),LT,*DDKIL
           1O1*CBAL(1)*CBX+ (CBAL(M-1)*A1 + CBAL(2)*A2A + CBAL(3)*A1 - TA2RK
           2L(3)*BODSAT * (SOURCE(L)*DPM) + SINK(L))*DELT/IT)
            IF(CBX.LT.0.)CBX= 0
            XBIS(1)= CBX
            J=1+1
            IF (J-NX)160,180,180
      C----------CHECK IF NO. CONSTANTS REQUIRED
        160 IF (J-1-ME(L))150,170,150
        170 L=L+1
            GO TO 140
      C----------INTERPOLATE TO GET FINAL POINT
        180 XBIS(NX+1)= 2.*XBOD(NX)-XBOD(NX-1)
            CALL PRSD
            IF(IC30).NE.0.)CALL INCRT
            JJJ= JJJ + 1
            IF (JJJ.GT.ITIS) TO 184
            DO 182 J=2,JMX
            CB(J)= XBOD(J)
        182 CONTINUE
```

KLIP6 Listing (Continued)

```
      GO TO 120
  184 CONTINUE
C
C*********PRINT RESULTS IF REQUIRED
      IF ((FLOAT(INS-1)+.5)*DELT-TIMPS(KOUT)).LE.1E-5) 185,185,185
  185 IF(NS.GE.(NS0+NO*LE.20)CALL WRITE
  189 CALL XHITE
      KOUT= KOUT+1
      IF(KOUT.GT.NTOUT*2)RETURN
  190 DO 191 NR=1,NRCH
      XQ3D(1)=QU0D(NR)*(1.-0.1*RT)
      IF(ITCJD+.4).GT.XQJD(1))= QUOD(NR)
      IF (NS-NS1)195,190,190
  190 RETURN
      END
C
C*************************************************************
C
      SUBROUTINE GOSAG
      COMMON RJN,NR,ENDQ(10),OFFN(10),VEL(10),BOOK(10),AERK(10),SINK(10)
     1,PO(10),DELP,DELT,KUTA,NL,STN(10),XSTN(10),NHOD(10),NQJ(10),NJU(1
     20,33),TOJD(10,53),DO(10,50),TOJD(10,50),NX,INTOO,INTOO,QJDJRO(10),Q
     3QJ(10),TOJD(10,53),DO(10,50),NTOUT,QQIN(30),NINP,QUOIN(50),TQJDIN(50),TJQJIN(50),
     4,CBOD(50),XOUT,XQQD(50),COL50),CBX,NT,XOQ(500),NQ,COX(903),COX,
     5X),NC(3),TIMPS(50),NQ,C(1000),SINK(10),XINC500),JNX,KIN,KNT,QQSAT,IPL,T,ISC
     6LK,SINK(),MNT,,START,,RRQT(10,50),,AQQI9T(10,50),,QQT(10,50),,QQT(1
     70,50),TIMP(10,53),NQ,C(1000),SINK(10),XINC500),JNX,KIN,KNT,QQSAT,IPL,T,ISC
     8
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KLIP6 Listing (Continu

```
L.481      1XX,'TIME= ',F5.2,' HRS')
L.482       IF(IPLT).EQ.0.AND.IPLT.NE.2)WRITE(KWT,6100)
L.483     6100 FORMAT('1',/,'0','DISTANCE',10X,'OBSERVED',/,'0',
L.484     1'REACH',10X,'OBS',10X,'COMP',10X,'OBSERVED',/,'0')
L.485       IF(IPLT.EQ.2)GO TO 703
L.486       IF ((IPLT).EQ.1).OR.(IPLT.EQ.3))GO TO 701
L.487      731 CALL YAXIS(IPLT1,ISCALE,KWRT)
L.488      732 NX1= NX+1
L.489          XX(1)= 0.0
L.490          DO 733 I=2,NX1
L.491          XX(I)= XX(I-1) + DELX(I-1)
L.492      733 CO1(I)= CO1(I) + C1(I-1)
L.493          XW= 1
L.494          JW= 1
L.495          XXJ=0
L.496          XW= 0
L.497          JJ= 0
L.498          KW= 1
L.499          GO TO 713
L.500      710 CW= CO1(JW)
L.501          CW= CO1(JW)
L.502          XW= XJ
L.503      C
L.504      C**********INTERPOLATE TO GET COMPUTED VALUES AT REQUESTED SPACE
L.505      C                                  INTERVALS
L.506          IF(DELP.NE.0.)CALL INTERP(JJ,JW,XXJ,C01,C01,XW)
L.507          IF(DELP.NE.0.)CW=CB1
L.508          IF(DELP.NE.0.)CW=C01
L.509          IF( XW.GT.1)JJ= M(LW-1)
L.510      C
L.511      C**********WRITE AN ID AND PLOT COMPUTED VALUES
L.512          IF((IPLT).EQ.2.AND.(IPLT.NE.2)WRITE(KWT,6200)XW,CW,CW
L.513     6200 FORMAT(' ',4X,F5.2,3(10X,F5.2,2X,F5.2))
L.514          IF(IPLT.EQ.2)GO TO 718
L.515          IF (IPLT).EQ.1).OR.(IPLT.EQ.3))GO TO 711
L.516      711 CALL PLOT(IPLT1,ISCALE,DOSAT,CW,CW,KWRT)
L.517      712 JW= JW+1
L.518          IF(JW.GT.1)XXJ= ECOMPR(LW-1)
L.519      713 XJ= IFLOAT(JW+1)*.5-JJ)*DELX(LW) + XXJ
L.520          IF(ISTOP.NE.0)STOP
L.521          IF(DELP.NE.0.AND.(XW+DELP).LE.XSTN(KW))GO TO 713
L.522          IF(DELP.NE.0.AND.(XW+DELP).LT.XSTN(KW))GO TO 732
L.523          IF(XJ-XSTN(KW))732,720,720
L.524      715 NX1=NX+5
L.525          XJ= 1
L.526          DO 716 JW1=1,NX2
L.527          IF(JW1.GT.M(KJ))XXJ= ECOMPR(K)
L.528          IF(JW1.GT.M(KJ))JJ=M(K)
L.529          IF(JW1.GT.M(K))K=K+1
L.530          LLL=1
L.531          XJ= (JW1-1-JJ)*DELX(LW) + XXJ
L.532          IF(XJA.GT.XSTN(KW))JW= JW1
L.533          IF(XJA.GT.XSTN(KW))GO TO 723
L.534      716 CONTINUE
L.535      C
L.536      C**********INTERPOLATE LINEARLY TO GET OBSERVED VALUES AT OUTPUT TIME
L.537      720 XJJ= (IFLOAT(JW1-2)-JJ)*DELX(LW) + XXJ
L.538          XJA=(IFLOAT(JW1-1)-JJ)*DELX(LW) + XXJ
L.539          IF(KW.GT.1)XJ= XJJ
L.540          LLL=2
L.541      C----------STORE COMPUTED VALUES FOR SUBROUTINE PLTPT
L.542          IF(JW.LE.1)OOPT(KW,MB1)= CO(JW) + C1(JW)
L.543          IF(JW.LE.1)OOPT(KW,MB1)= CO1(JW)
L.544          IF(JW.LE.1)GO TO 717
L.545          OOPT(K)= (XJ-XSTN(KW))*(C1(JW)-C0(JW-1)-C1(JW-1))*(XSTN(KW) -XJ1)/(XJ
L.546         1-XJ1) + (C0(JW-1)+C1(JW-1))
L.547          OOPT(KW,MB)= (C0(JW) - C0(JW-1))*(XSTN(KW) - XJ1)/(XJ-XJ1) + C0
L.548          LL(J=1)
L.549      717 TW= TW/24.
L.550          MTW = 1
L.551          IF (TW.LE.TOO(KW,MTW))GO TO 723
L.552          NN3O= NMOD(KW)
L.553          DO 721 MI=2,NN3O
L.554          IF (TW.LE.TOO(KW,MTW))GO TO 723
L.555      721 CONTINUE
L.556      722 RO3O(KW,MTW) = (TOO(KW,MTW)-TOO(KW,MTW-1))*(TOO(KW,MTW)-TW)/
L.557         1(TOO(KW,MTW)-TOO(KW,MTW-1))
L.558          GO TO 717
L.559      723 IF(RO3O(KW,MTW).EQ.0.)GO TO 718
L.560          RO3O= RO3O(KW)*(TOO(KW,MTW)-TOO(KW,MTW-1))/TOO(KW,MTW)
L.561          GO TO 719
L.562      718 RO3O= RO3ZRO(KW)
L.563      719 TW= TW/24.
L.564          MTW = 1
L.565          IF (TW.LE.TOO(KW,MTW))GO TO 726
L.566          NN3O= NMOD(KW)
L.567          DO 724 MI=2,NN3O
L.568          IF (TW.LE.TOO(KW,MTW))GO TO 725
L.569      724 CONTINUE
L.570      725 RO3O(KW,MTW) = (TOO(KW,MTW)-RO0(KW,MTW-1))*(TOO(KW,MTW)-TW)/(TOO(
L.571         1KW,MTW)-TOO(KW,MTW-1))
L.572          GO TO 727
L.573      726 IF(TOO(KW,MTW).EQ.0.)GO TO 724
L.574          RO3O= RO3(KW) + (RO0(KW,MTW)-RO2RO(KW))*W/TOO(KW,MTW)
L.575          GO TO 727
L.576      728 RO3O= RO0(KW)
L.577      727 RO(I)= OOSAT - RO0
L.578          IF(MPE.NE.1)I= TW
L.579      C----------STORE OBSERVED VALUES FOR SUBROUTINE PLTPT
L.580          RO3PT(KW,MO)= RO3O
L.581          RO3)PT(KW,MO)= RO3O
L.582          IF(IPLT).EQ.3.AND.IPLT.NE.2)WRITE(KWT,6300)STN(KW),MO0,RO3O
L.583     6300 FORMAT(' ',6X,'STATION NO ',4A,10X,F5.2,2X,F5.2)
L.584          IF((IPLT).EQ.2)GO TO 731
L.585          IF ((IPLT).EQ.3).OR.(IPLT.EQ.4))GO TO 730
L.586      730 CALL PLTPT(IPLT1,ISCALE,OOSAT,RO0,RO0,KWRT)
L.587      731 XW= XW+1
L.588          IF(XJ.GE.ENOH(LW))JJ= JW-1
L.589          IF(XJ.GE.ENOH(LW))LW= LW+1
L.590          IF(DELP.EQ.0)GO TO 735
L.591          IF(XW+DELP-XSTN(NL))710,740,740
L.592      735 IF (JJ-1+NX+1))710,740,740
L.593      740 IF((IPLT).EQ.2)GO TO 750
L.594          IF(IPLT).EQ.3.OR.IPLT.EQ.4)GO TO 745
L.595      745 IF((IPLT.NE.2)CALL OOAXIS(IPLT1,ISCALE,KWRT)
L.596      750 RETURN
L.597          END
L.598      C
L.599      C*************************************************************
L.600      C
L.601          SUBROUTINE WRTDTA
L.602          COMMON NQ(4,NR),ENOH(4,NQE(10),OFFN(10),VEL(10),MOOKE(10),AER( 10),SINKE('0)
L.603         1,P30(10),DELP,DELT,KDTA,NL,ISTW(10),XSTN(10),NN30(10),..3U(10),MOPT(
L.604         20,5C),TOJJ(10,50),OO(10,65),TJ3(10,50),ONA,INFWD,INTOJ,333(40(10),3
L.605         3U(40)(10,50),NTOOF,OUTNL(3),NINF,ROO(INT(5),TR2OTN(2),ROO(50
L.606         401,CO3(6033),KOUT,AUTO(1930),CO1(503),C3K(H7,AOO(1503),NO,CO(933),COX,
L.607         8KJ,WE(2,TIMES(150),TOOTN(331),9330(15001),JNX,KINK,KWT,OUSAT,IPLT,1SCA
L.608         6L5,OINWT),KWT=5,START,WMOPT(10,93),NOJJPT(10,93),MOPT(13,93),OOPT(1
L.609         70,93),TI=WE(10,93),RO(2(E(533),STNK(11O),XINK(500),OINWT2,1(25),IMNO(3
L.610         8ELA(13),COMMON(101,CO((3333),CO1(550),CHA(500),C1A(3301,1),333(3PMO
L.611         4,C9A(3CC),,2,IPLT1,ISTOP,C3A(:CIA),C8A(,SOURCE(12)
L.612          WRITE(KWT,6020)RUN
L.613     6020 FORMAT('1',/,'K L I P  R I V E R  S I M U L A T I O N   -RUN ',I3/
L.614         1/)
L.615      C
L.616      C********KLIST REACH DATA
L.617          DO 403 KJTA=1,NR
L.618          WRITE(KWT,6400) KDTA,ENOH(KDTA),VEL(KDTA),OFFN(KDTA),MOOKE(KDTA),A
L.619         1ER(KDTA),SINK(KDTA),SOURCE(KDTA)
L.620     6400 FORMAT('1',,2X,'REACH NO',I2/5X,'END OF REACH  ',4X,'TENOR ',F6.2,'
L.621         1 KM/DAY',5X,'MEAN VELOCITY',10X,'VEL  ',F6.2,' KM/DAY'/5X,'DISPERSION
L.622         2 COEFF',6X,'OFFN ',F6.2,' KM*KM/DAY'/5X,'MOD DECAY COEFF',F6.2,'1/DAY'
L.623         3 ',F6.2,' 1/DAY'/5X,'REAERATION COEFF',6X,'AERK ',F6.2,' 1/DAY'
L.624         4/6X,'OOD SOURCES & SINKS',4X,'SINK ',F6.1,' MG/L/DAY'/6X,'OO SOUR
L.625         5CE) & SINKS',3X,'SOURCE ',F6.1,' MG/L/DAY')
L.626          IF(IPRINT.NE.0)WRITE(KWT,6410)ROO(KDTA)
L.627     6410 FORMAT(' ',                    'ASTOSYNTHESIS OO          ROO  ',F6.1,' MG/L/DAY')
L.628          IF(ICHL.EQ.0)GO TO 403
L.629          WRITE(KWT,6425)SINK(KDTA)
L.630     6425 FORMAT(' ',                    'INTAT SOURCES & SINKS SINK ',F6.1,' MG/L/DAY')
L.631      403 WRITE(KWT,6430)
L.632     6430 FORMAT(' '/////)
L.633          RETURN
L.634          IF (IEND.EQ.0.)GO TO 805
L.635          DIN=1.0/DIN
L.636          DTY=DINT*100.
L.637          WRITE(KWT,5101),DZ
L.638     5475 FORMAT(' ',2X,'INTRV FRACTION=   ',2(F5.2,2X),' %'//)
L.639      5C5 IF(IPHO).EQ.1)WRITE(KWT,5490)
L.640     5490 FORMAT('      JOURNAL VARIATION OF PHOTOSYNTHESIS USED (P30 +VE, IP
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KLIP6 Listing (Continued)

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      IM)*1)*//)
C
C**********PRINT FINITE DIFFERENCE DATA
      WRITE(KW,T,6550)DELT
 6550 FORMAT(1' ',3X,'DELTF ',F5.3,' DAYS'//)
      DO 805 JA=1,NX
      WRITE(KW,6530)JA,DELX(JA)
 6530 FORMAT(' ',7X,'DELX(',I1,')= ',F5.3,' KM')
  805 CONTINUE
      WRITE(KW,T,6450)NX,NT
 6450 FORMAT('0',5X,'NO OF SPACE INTERVALS NX =',I3/6X,'NO OF TIME INTER
     1VALS  NT =',I3)
      RETURN
      END
C
C**************************************************************
C
      SUBROUTINE INTP(JJ,JM,XKJ,CB2,CO2,KZ)
      COMMON NUN,NM,EVORI(10),OPFN(10),VEL(10),BUOK(10),AERK(10),SINK(10)
     1,RO3(10),DELP,DELT,KOTA,NL,STN(12),ASTN(10),NHOO(10),NO3(10),BJOI(
     2,303,TBJOI(2,52),OOI(9,50),TDOI(3,50),NX,INT00,INTDO,JO3  ,LI(1,0
     3DZR(10),DOI(5,50),NTOUT,OOINI(50),NINP,HOOI(450),TWOOINF  ,CO2O(90
     4O1,CO2I(90),KOUT,KOPI(500),CO(500),CONT,KOO(500),NO,  ,O(532),COX,
     5X2,H2O,TIMES(533,T3O1N(50),O2I(500),JNX,KIN,KWT,O2SAT,IPL,ISCA
     6LT,3INT),MAT,,3TART,,BOPT(10,50),BO2PT(10,50),,O3PT(10,50),,O3PT(1
     7O),SO,,IMAT(10,,O2,,IN(10),,SINK(10),,SINK(10),,XIN(500),,SINK(10,,IMO,,O
     8BLK(10),,COMPR(10),,CO(500),,CO(500),,CO(500),,CO(500),,LT,,O,DPHO
     9,CO3(500),,O2,,IPLT,,ISTOP,,CO2(,,CO2(,,CO2(,SOURCE(10)
      IF(JM.GT.1)GO TO 10
      MI=JM+1)*NX+2
      JJ=1
      NK=1
      CO=CONE(1)
      CO2=CO(1)
      KZ=KJ
      RETURN
   10 JJ=JM-1
      KJ=DELP*FLOAT(J2-1)
      DO 20 I2=1,NP
      IF(KJ.LT.ECOMPR(I2))II2=I2
      IF(KJ.LT.ECOMPR(I2))GO TO 30
   20 CONTINUE
      II2=NP
   30 XJ2=0.
      KZ=0.
      JJ=0
      IF(II2.GT.1)JJ=MI(I2-1)
      IF(II2.GT.1)KZ=JJ
      IF(II2.GT.1)XXJ2=ECOMPR(I2-1)
      DO 40 KZ=KZ,NZ
      KJ=(FLOAT(L2-1)-JJ)*DELX(II2) + XXJ2
      IF(KZ.LT.XJ)L2=KZ
      IF(KZ.LT.XJ)GO TO 50
   40 CONTINUE
   50 XJ=(FLOAT(L2)-2.-JJ)*DELX(II2) + XXJ2
      CO=(CO(L2-1) + (CO(L2)-CO(L2-1))*(XJ-XJJ)/(XJ2-XJJ)
      CO2=(CO2(L2-1) + (CO2(L2)-CO2(L2-1))*(XJ-XJJ)/(XJ2-XJJ)
      RETURN
      END
C
C**************************************************************
C
      SUBROUTINE YAXIS(IPLT1,ISCALE,KWRT)
      IF(IPLT1.GT.0)GO TO 813
      GO TO (810,825,835,845),ISCALE
  810 WRITE(KW,T,6650)J,J25,40,5)
 6650 FORMAT('+',49X,'0',16(2X,'3)/50X,'+',16('....+'))
      RETURN
  820 WRITE(KWRT,6700)J,J25,40,5)
 6700 FORMAT('+',49X,'0',8(8X,I2)/50X,'+',8('....+....I'))
      RETURN
  830 WRITE(KWRT,6800)J,J25,20,5)
 6800 FORMAT('+',49X,'0',4(18X,I2)/50X,'+',8('...+...+...+...+...-I'))
      RETURN
  840 WRITE(KWRT,6600) J,J210,180,10)
      RETURN
      ENTRY DUAXIS(IPLT1,ISCALE,KWRT)
      IF(IPLT1.EQ.0)GO TO 130
      IF(IPLT1.NE.0)GO TO 835
  813 GO TO(815,825,835,845),ISCALE
  815 WRITE(KWRT,6850)J,J25,40,5)
 6850 FORMAT('+C',15X,I3/' ',16('....+')
      RETURN
  825 WRITE(KWRT,6750)J,J25,40,5)
 6750 FORMAT('+J',8(8X,I2)/' ',8('....+....I'))
      RETURN
  835 WRITE(KWRT,6850)J,J25,20,5)
 6850 FORMAT('+O',4(18X,I2)/' ',4('...+...+...+...+...+'))
      RETURN
  845 WRITE(KWRT,6600)J,J210,180,10)
      RETURN
      END
C
C**************************************************************
C
      SUBROUTINE PLOT(IPLT1,ISCALE,DOSAT,PCO,PLO,KWRT)
      DATA BLANK,PLOTS,PLOTO,PLOTOO,PLOTOOO,PLOT/' ',1H0,1H0,1H*,1H8,1H*
     1/
      DIMENSION CH(49)
      DO 850 K=1,49
  850 CH(K)=BLANK
C
C**********COMPUTED VALUES
C----------GO PLOTTING POSITION
      CALL PLTPOS(IPLT1,ISCALE,PCO,IP0)
      IF(IP0.LE.0)GO TO 852
      CH(IP0)= PLOTO
C----------GO PLOTTING POSITION
  852 CALL PLOTOOO(IPLT1,ISCALE,PLO,IP0)
      IF(IP0.EQ.0)GO TO 870
      CH(IP0)= PLOTS
      IF (IP0+NE.1)GO TO 870
      CH(IP0)= BLOTS
      CH(IP0-1)= PLOTO
      CH(IP0+1)= PLOTO
      GO TO 870
C
C**********OBSERVED VALUES
      ENTRY PLTOBS(IPLT1,ISCALE,DOSAT,PBCO,PDO,KWRT)
      DO 860 K=1,49
  860 CH(K)=BLANK
C----------GO PLOTTING POSITION
      CALL PLTPOS(IPLT1,ISCALE,PBO,IPBOO5)
      CH(IPBOO5)= PLOTO
C----------GO PLOTTING POSITIONS
      CALL PLOTOO(IPLT1,ISCALE,PDO,IPOOO5)
      CH(IPOOO5)= PLOTOO
      IF (IPOOO5.NE.IPOOO5) GO TO 870
      CH(IPOOO5)= BLOTS
      CH(IPOOO5+1)= PLOTOO
      CH(IPOOO5+1)= PLOTOO
  870 IF(IPLT1.EQ.0)WRITE(KWRT,6900)CH
      IF(IPLT1.NE.0)WRITE(KWRT,6950)CH
 6950 FORMAT('+',49A1)
 6900 FORMAT('0',49A1/'+',90A1/50X,'0')
      RETURN
      END
C
C**************************************************************
C
      SUBROUTINE PLTPOS(IPLT1,ISCALE,C,IPP)
      GO TO (900,910,920,925),ISCALE
  900 IPP= C+1.0
      RETURN
  910 IPP= C*2.+.5
      RETURN
  920 IPP= C*5.+.5
      RETURN
  925 IPP= C*0.5 + .5
      RETURN
      ENTRY PLOTOO(IPLT1,ISCALE,C,IPP)
      GO TO 920
      END
C
C**************************************************************
C
      SUBROUTINE PLTPT
      COMMON NUN,NM,EVORI(10),OPFN(10),VEL(10),BUOK(10),AERK(10),SINK(10)
     1,RO3(10),DELP,DELT,KOTA,NL,STN(12),ASTN(10),NHOO(10),NO3(10),BJOI(
```

KLIP6 Listing (Continued)

```
      2F,5D),T(D2E10,5D),3D610,5D),T0D610,5D),HX,INT00,INT02,3D24T(10),2
      3D2M*(10),5U1(10)),*,T0UT,NO(NI(8),,NINP,MOD(NIN01),T=UD1N501,C030I*9
      4,3I(E3A*(*),*,2UT,*,MODE5D3),COI5D3),CHX,NT,2DU15D3),Nx,,U1D2D1,C(*,
      5X),HC3),,TIMES(5D3),TMD1N153T,WDD1(5D3),DHX*(N)**4T,D29AT,(PLT,,ISCA
      6LE,3)NAT),,WAT,,START,,MODPT(10,5D1,,MOD1PT(10,5C),,MDPT(15,3D),DUPTI
      7D,5D3),,TIMP(10,5D),,MAL(CI(5D0),,SENE(I(3),,NIN5D0),,UINAT2,I5D3),TMP,,D
      8CLK(10),,COMP*(1*),COI(5D0),,CO1(5D0),,CO4(5D3),,CI4(5D3),IT,,DD,,DPM0
      9,C0AI(5D0),,J2,,IPLT1,,I5TOP,,C0A1,,CIA1,,C0A1,,SOURCE(10)
       DATA JLN*,PLT8*,PLTOP,,PLTOP,,PLTOP,,PLTOP/1H ,1H0,,1H0,,1H*,,1H0,,1H*
      1/
       DIMENSION CHRP(80)
C
C**********PRINT RUN NUMBER AND HEADINGS
       DO 940 I=1,NL
       WRITE(K*,*,7010)RUN,STN(I)
 7000 FORMAT(*,*,*K L I O * * V E R S I M U L A T I O N  =RUN  *,I3,//
      1X,*DOD AND DT VARIATION WITH TIME AT STATION *,A4,/)
       IF(IPLT1,EQ.0)WRITE(K*RT,7050)
 7050 FORMAT(*  *--X1,*TIME*,12X,*SIMULATED*,5X,*OBSERVED*//5X,*HMS*,13X,*
      1DD3  D1  DD0  D2*/)
       CALL YAXI(,IPLT1,ISCALE,K*RT)
C
C**********GET*KINF PLOTTING POSITIONS = COMPUTED VALUES
       DO 935 J=1,NFJUT
       DO 933 K=*1,*2
  930 CHRP(KPP)=DLNKP
       MAP= 4D3PT(1,J)
       P0P= 7D5AT - D3PT(I,J)
       CALL PLT3S(IPLT1,ISCALE,P0P,IP0P)
       IF(IP0P.LT.0)GO TO 941
       CHRP(IP0P)= PLT3P
  941  CALL PLOTD(IPLT1,ISCALE,P0P,IP0P)
       IF(IP0P.LT.1)GO TO 942
       CHRP(IP0P)= PLT3P
  942 IF(I.GE.1)IP3P)G3 TO 931
       CHRP(IP0P)= PLTOP
       CHRP(IP0P-1)= PLT3P
       CHRP(IP0P+1)= PLTOP
C
C**********PRINT AND/OR PLOT COMPUTED VALUES
  931 IF(IPLT1.EQ.0)WRITE(K*RT,7100)TIMP(I,J),P0P,P0P,CHRP
 7100 FORMAT(* *,*K*,F*.2,10X,F5.3,2X,F5.2,10X,*(*,80A1)
       IF(IPLT1.*E.0)WRITE(K*RT,7105)CHRP
 7105 F3*4AT(* )*,*5A1)
C
C**********GET*KINF PLOTTING POSITIONS = OBSERVED VALUES
       PHJP= 4D3PT(I,J)
       P03P=4503PT(I,J)
       DO 932 K*P= 1,*2
  932 CHRP(KPP)= DLNKP
       CALL PLT3S(IPLT1,ISCALE,P4OP,IP0OPS)
       CHRP(IP0OPS)= PLTOP
       IF(IPLT1.EQ.0.*WRITE(K*RT,7150)CHRP
 7150 FORMAT(*  *,50A,80A1)
       IF(IPLT1.NE.0)WRITE(K*RT,7155)CHRP
 7155 FORMAT(*  *,*5A)
       DO 933 K=P81,10
  933 CHRP(K*P)= DLNKP
       CALL PLOT-D(IPLT1,ISCALE,P0OP,IP0OPS)
       CHRP(IP0JP)= PLTOP
C
C**********PRINT AND/OR PLOT OBSERVED VALUES
       IF(IPLT1.EQ.0)WRITE(K*RT,7200)P0OP,P0OP,CHRP
 7200 FORMAT(* *,*3X,F5.2,2X,F5.2,4X,80A1/50X,*I*)
       IF(IPLT1.NE.0)WRITE(K*RT,7205)CHRP
 7205 FORMAT(*  *,80A1/)
  935 CONTINUE
       CALL YOAXIS(IPLT1,ISCALE,K*RT)
  940 CONTINUE
       RETJRN
       END
//
//GO.FT10F001 DD DSN=&&KLIP01,DISP=(OLD,DELETE),UNIT=SYSRES
//
```

Table D3.1 Minimum Error Calibration - Data Listing

```
//RAH#CALA JOB 343,CLASS=Q
/*JOBPARM  FORM=6LK4,V373
/*ROUTE  PRINT HOLD
/*OUTPUT JESNPRO23
//  EXEC  H#SX37,TIME.GO=5
//COMB.SYSIN DD *
        PROGRAM
        INITIALZ
        TITLE('XLTP.H CALIBRATION RUN 101  26/01/80')
        MOVE(XDATA,*4CALIDATA*)
        MOVE(XHPNAME,'OJDCAL')
        OPEN#T
        SETUP
        MOVE(XORJ,'ORSU4')
        MOVE(XNN,'4MS')
        OPT=4120
        SOLUTION
        EXIT
        PEND
//GO.SYSIN DD *
NAME            CALIDATA FREE
RDYS
 N   ERSU4
 E   RL107
 E   RL103
 E   RL104
 E   RL105
 E   RL109
 E   RL107
 E   RL108
 E   RL101
 E   RL110
 E   RL111
 E   RL112
 E   RL113
 E   RL114
 E   RL115
 E   RL116
 E   RL117
 E   RL118
 E   RL119
 E   RL120
 E   RL121
 E   RL122
 E   RL123
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 E   RL134
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 E   RL136
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 E   RL144
 E   RL145
 E   RL146
 E   RL147
 E   RL148
 E   RL149
 E   RL150
```

(Continued)

```
 E   RL151
 E   RL152
 E   RL153
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 E   RC315
 E   RC316
 E   RC317
 E   RC318
 E   RC319
 E   RC320
 E   RC321
 E   RC322
 E   RC323
 E   RC324
COLUMNS
    C101    RL101    0.763    RL102    -0.237    1.
    C102    RL102    -0.237   RL103    -0.763    1.
    C103    RL103    -0.237   RL104    -0.763    1.
    C104    RL104    -0.763   RL105    -0.237    1.
    C105    RL105    -0.237   RL106    -0.763    1.
    C106    RL106    -0.763   RL107    -0.237    1.
    C107    RL107    -0.237   RL108    -0.763    1.
    C108    RL108    -0.763   RL109    -0.237    1.
    C109    RL109    -0.237   RL110    -0.763    1.
    C110    RL110    -0.763   RL111    -0.237    1.
    C111    RL111    -0.237   RL112    -0.763    1.
    C112    RL112    -0.763   RL113    -0.237    1.
    C113    RL113    -0.237   RL114    -0.763    1.
    C114    RL114    -0.763   RL115    -0.237    1.
    C115    RL115    -0.237   RL116    -0.763    1.
    C116    RL116    -0.763   RL117    -0.237    1.
    C117    RL117    -0.237   RL118    -0.763    1.
    C118    RL118    -0.763   RL119    -0.237    1.
    C119    RL119    -0.237   RL120    -0.763    1.
    C120    RL120    -0.763   RL121    -0.237    1.
    C121    RL121    -0.237   RL122    -0.763    1.
    C122    RL122    -0.763   RL123    -0.237    1.
    C123    RL123    -0.237   RL124    -0.763    1.
    C124    RL124    -0.763   RL101    -0.237    1.
```

Minimum Error Data (Continued)
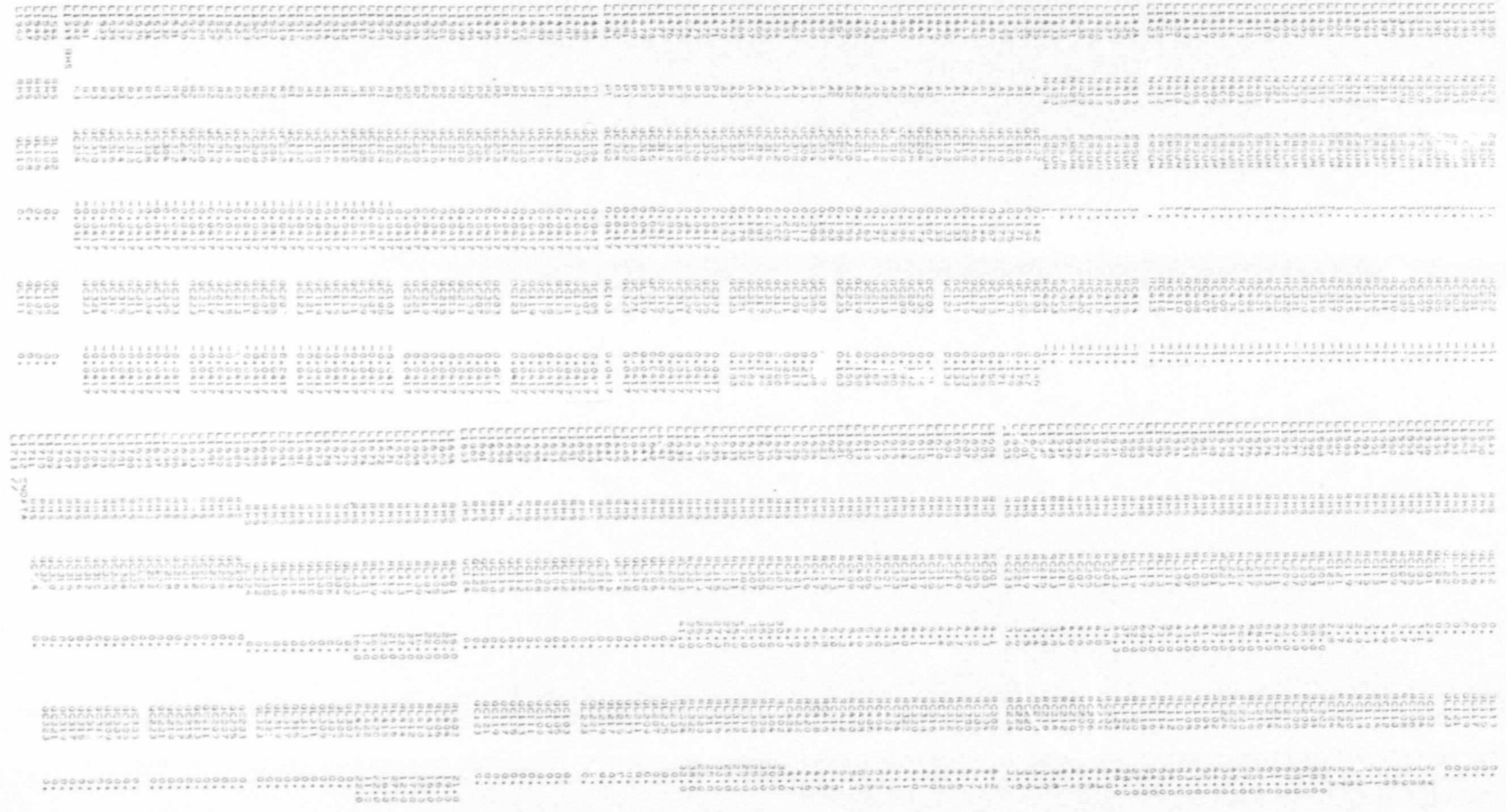
(Continued)

Minimum Error Calibration (Continued)

(Continued)

· Minimum Error Calibration (Continued)

(Continued)



Author Arnold Roderick William
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