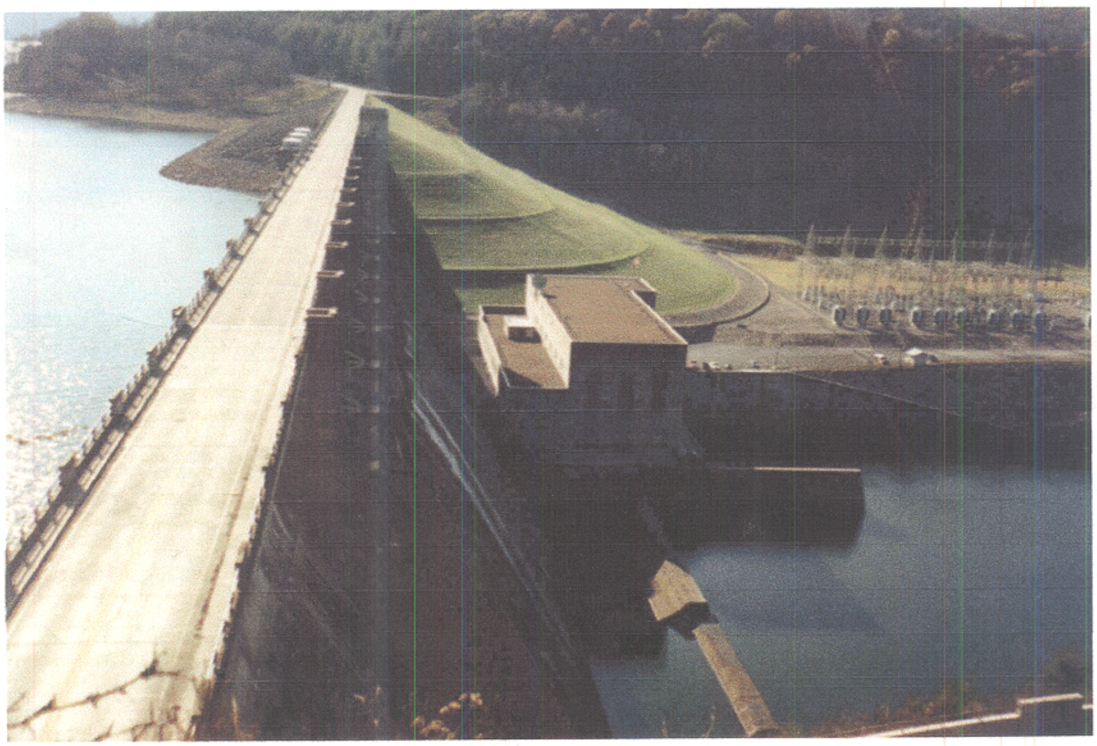
US Army Corps
of Engineers ®
Nashville District

CENTER HILL LAKE
CE-QUAL-W2
WATER QUALITY MODEL



APPENDICES
February 20, 2001

CENTER HILL LAKE
CE-QUAL-W2
WATER QUALITY MODEL

Prepared for

U. S. Army Corps of Engineers
Nashville District

Under Contract
DACW 62-98-D-0002
Delivery Order No. 0011

Prepared by

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APPENDICES
February 20, 2001

APPENDIX A

NPDES Discharges

Table A1. NPDES dischargers registered in Center Hill Lake watershed.

NAME	RECEIVING STREAM	NPDES PERMIT #	DESIGN FLOW (MGD)	EFFLUENT LIMITS	COUNTY
WEST WARREN VIOLA UD STP	KEEL BR-HICKORY	TN0025372		DO, pH, TSS, SOLIDS, NH_3, FECAL, TRC, $CBOD_5$	WARREN
MCMINNVILLE WTP	BARREN FORK RIVE	TN0004316		pH, TSS, SOLIDS, Al TRC	WARREN
SEQUATCHIE VALLEY COAL CORP._RE-80R & 3-80AR, 79-183, 81-143	BALTIMORE BRANCH ROCKY	TN0045951			VAN BUREN
DUROMATIC PRODUCTS-CAMPAIGN	UNKNOWN	TN0057894		ZN, TTO, pH, TSS, O&G, NO_2+NO_3, CN, CD, CR, CU, Pb, Ni	WARREN
TDEC-FALL CREEK FALLS S.P. STP PACKAGE PLANT	TDOC FALL CREEK FALL	TN0057908		DO, pH, TSS, SOLIDS, NH_3-N, FECAL, TRC, $CBOD_5$	VAN BUREN
VAN BUREN CO-COUNTY HS PACKAGE PLANT	0.25ML DITCH TO ML 1.4 UNNAMED TRIBUTARY	TN0065013		DO, pH, TSS, SOLIDS, NH_3-N, FECAL COLIFORM, $CBOD_5$	VAN BUREN
BURROUGHS ROSS COLVILLE CO	BARREN FORK RV	TN0004359		pH, TSS	WARREN
MCMINNVILLE STP	BARREN FORK RV	TN0023591	4.0	BOD_5, FECAL, TRC, DO, pH, TSS, SOLIDS, NH_3-N	WARREN
WARREN CO-DIBRELL SCH PACKAGE PLANT	MOUNTAIN CREEK MILE 9.7	TN0066940		DO, pH, TSS, SOLIDS, FECAL, TRC, $CBOD_5$	WARREN
TVA-GREAT FALLS HYDRO	CANEY FORK RV	TN0027456			WARREN
TDEC-ROCK ISLAND S.P. STP PACKAGE PLANT	CANEY FORK	TN0042111		SOLIDS, DO, pH, BOD_5, TSS, NH_3-N, TRC, FECAL, TRC	WARREN
TVA-GREAT FALLS HYDRO	CANEY FORK RV	TN0027456			WARREN
COOKEVILLE WATER TREAT C'VILLE	ALUM LICK BRANCH	TN0005231		pH, TSS, A1, SOLIDS	PUTNAM
BAXTER STP	MINE LICK CREEK MILE 15.8	TN0021121	0.5	DO, pH, TSS, SOLIDS, NH_3-N, FECAL, TRC, BOD_5	PUTNAM
APPALACHIAN CENTER FOR CRAFTS PACKAGE PLANT	CANEY FORK RI	TN0055409		DO, BOD5, pH, TSS, SOLIDS, FECAL, TRC	DE KALB

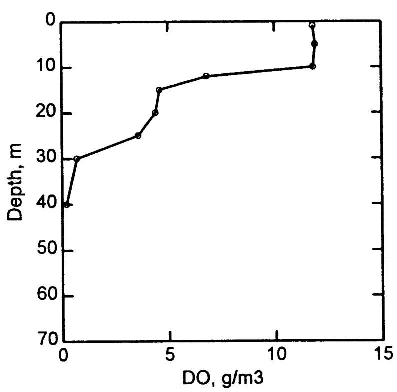
NAME	RECEIVING STREAM	NPDES PERMIT #	DESIGN FLOW (MGD)	EFFLUENT LIMITS	COUNTY
MONTEREY LIMESTONE SUBSIDARY OF LIVINGSTON LIME	TRIB TO SINKING CANE HOLLOW	TN0063487			PUTNAM
CENTER HILL HYDRO POWER PLANT	CANEY FORK RIVER	TN0068128		SOLIDS, PCB	DE KALB
UNION TOOLS	CAIN CREEK	TN0073032		pH, TSS	PUTNAM
TDOT COOKEVILLE	PIGEON ROOST CREEK	TN0074195		pH, TSS, O&G, Pb, C_7H_8, C_6H_6, C_8H_{10}, $C_{24}H_{30}$	PUTNAM
COOKEVILLE STP	PIGEON ROOST CR	TN0024198	6.0	DO, pH, TSS, SOLID (SETTEABLE), NH3-N, CN, FECAL COLIFORM, TRC, $CBOD_5$	PUTNAM
CANE CREEK LAKE & PARK PACKAGE PLANT	CANE CREEK – MI 15	TN0060054		DO, BOD_5, pH, TSS, SOLIDS (SETTABLE), NH_3-N, TRC, FECAL COLIFORM	PUTNAM
SMITHVILLE STP	FALL CREEK MILE 4.7	TN0065358	2.16	DO, pH, TSS, SOLID, SETTABLE, NH_3-N, FECAL, TRC, $CBOD_5$	DE KALB
MONTEREY STP	FALLING CREEK RIVER MILE 4	TN0064638	1.0	Pb, TRC, NO_2+NO_3, $CBOD_5$, TEMPERTURE, TSS, NH3, TKN, PHOSPHORUS, pH, SOLIDS, NH_3-N, DO, N, ORG. NITROGEN, Cd	PUTNAM
SPARTA WWTP	CALFKILER RIVER RM 11.5	TN0061166	1.6	DO, pH, TSS, SOLIDS, NH_3-N, CN, Cd, CR, CU, Pb, Ni, Ag, Zn, FECAL, CCl_4, PHENOLS, $CHCl_3$,C_7H_8, C_6H_6, CH_2Cl_2, C_2Cl_4,$C_2H_3Cl_3$,$C_2H_2Cl_2$, $C_{10}H_8$,C_8H_{10},Hg, $CBOD_5$, TCE, TRC	WHITE
SPENCER, STP	DRY FORK CREEK	TN0074892	0.25	DO, pH, TSS, SOLIDS, NH_3-N, NO_3, FECAL, TRC, CBOD5	VAN BUREN

APPENDIX B

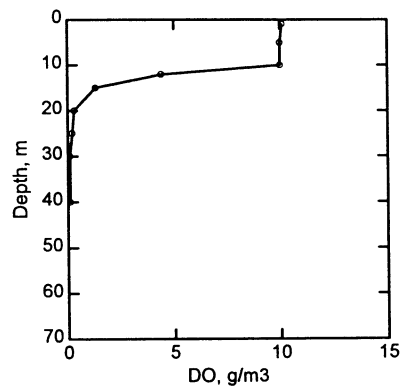
Great Falls Profiles

Great Falls Reservoir at Great Falls Dam

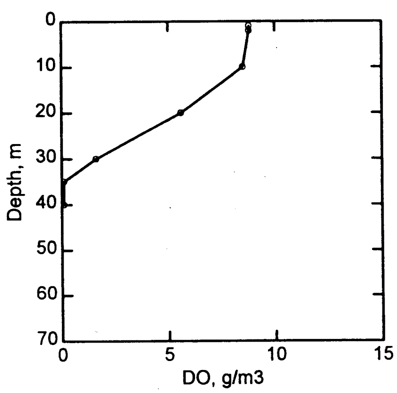
7/16/69



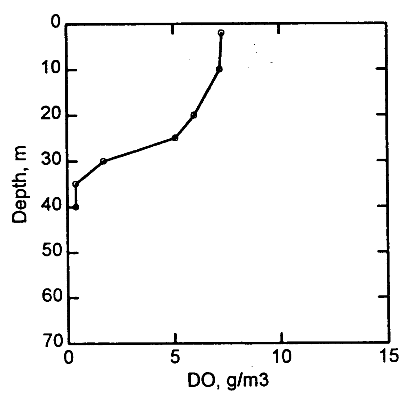
8/12/69



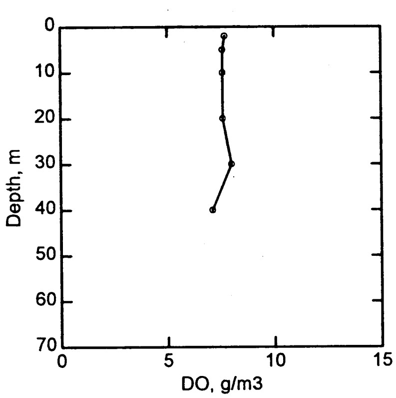
9/17/69



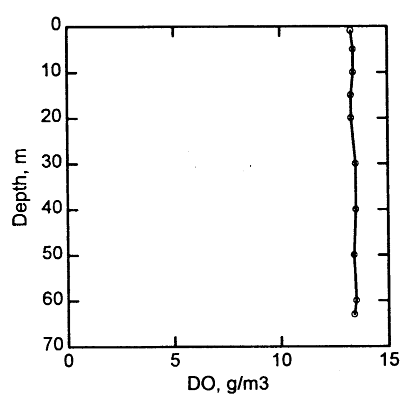
9/26/69



11/5/69

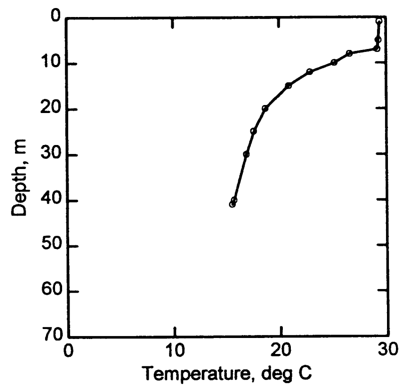


2/11/70

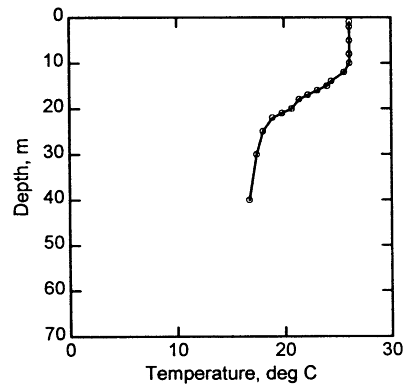


Great Falls Reservoir at Great Falls Dam

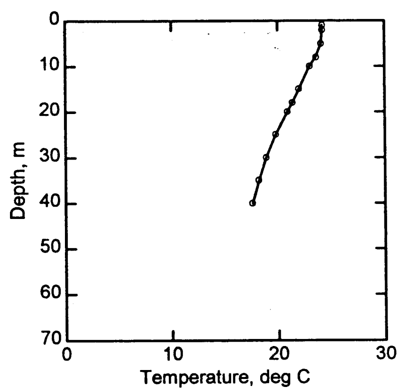
7/16/69



8/12/69



9/17/69



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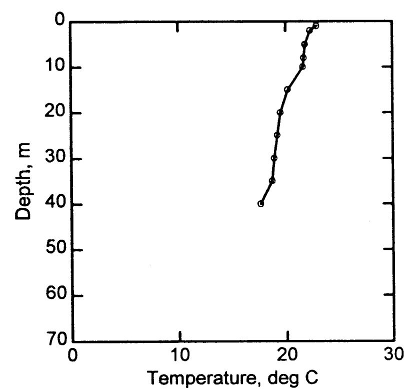
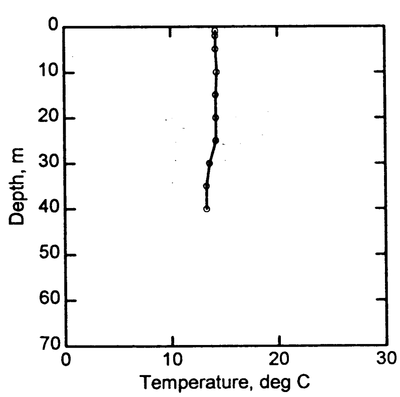
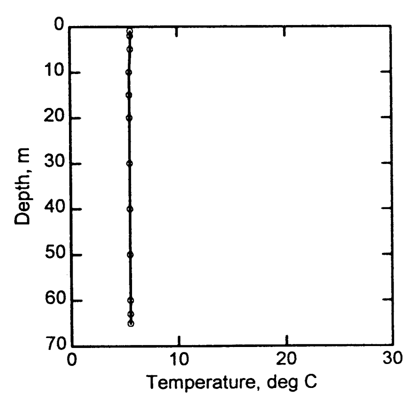


11/5/69

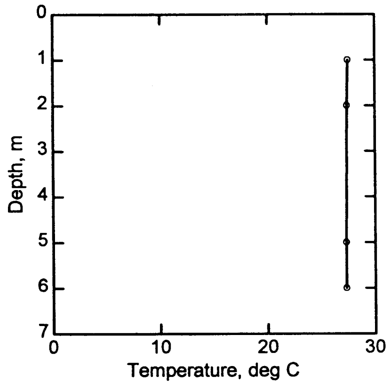


2/11/70

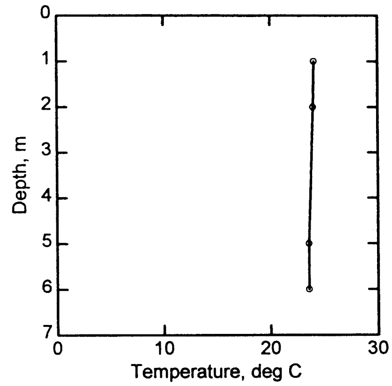


Collins River Mile 5.3

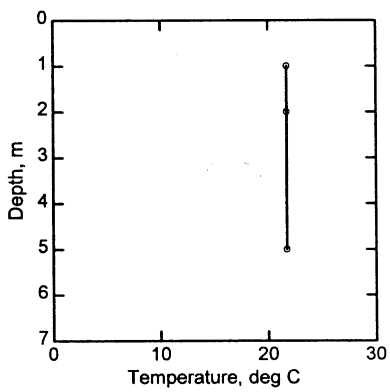
7/16/69



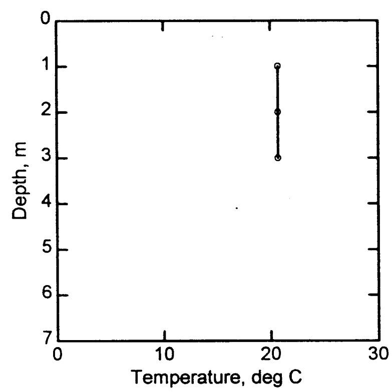
8/12/69



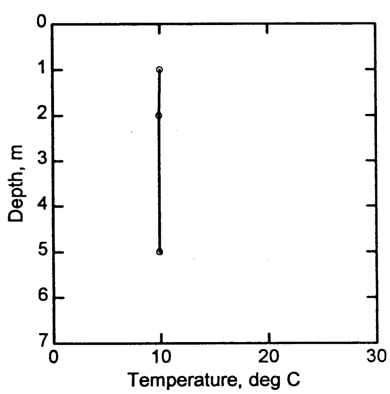
9/18/69



9/26/69

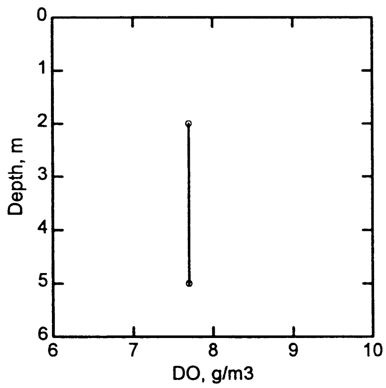


11/5/69

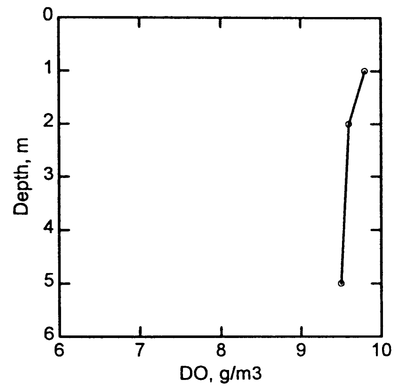


Collins River Mile 5.3

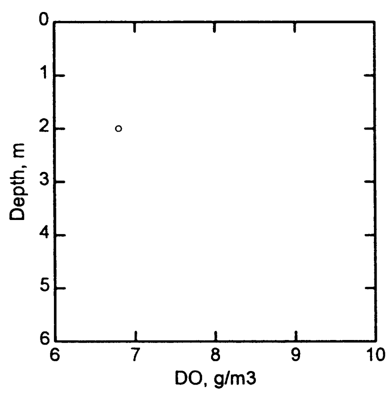
7/16/69



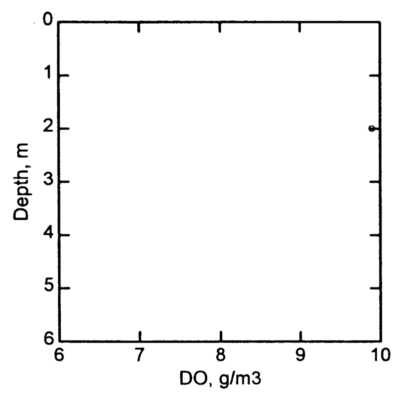
8/12/69



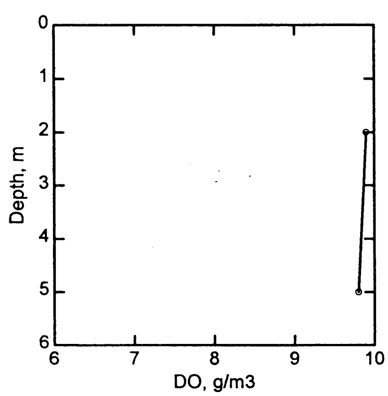
9/18/69



9/26/69

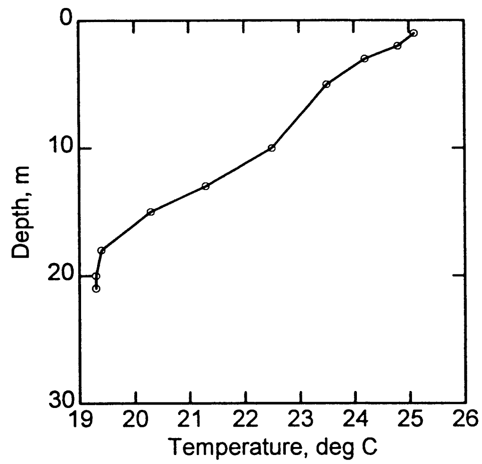


11/5/69

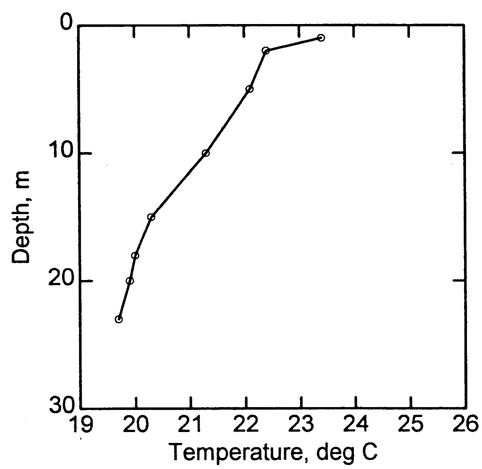


Collins River Mile 0.2

9/17/69

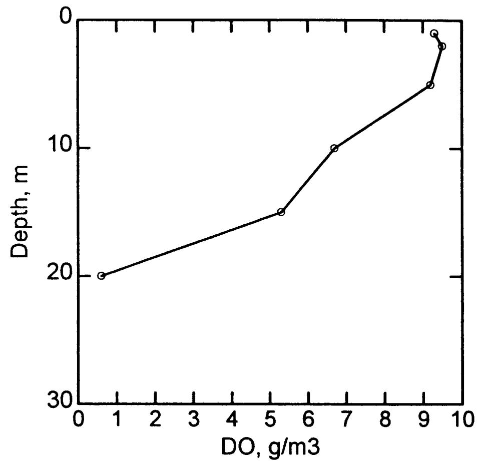


9/26/69

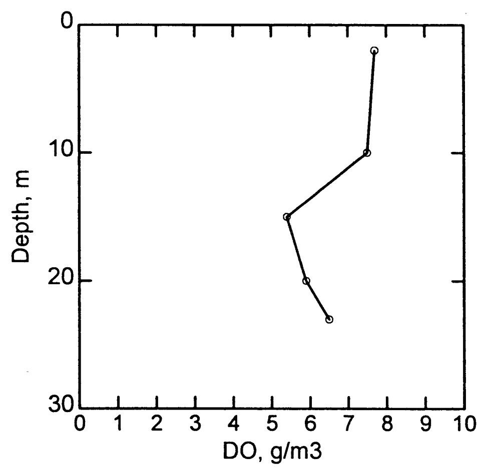


Collins River Mile 0.2

9/17/69



9/26/69



APPENDIX C

CE-QUAL-W2 Revisions Documentation

```
**************************************************************************
**                       Task 1.1: Block Data                           **
**************************************************************************

      BLOCK DATA COMMON_DATA
C       PARAMETER (NCP=21)                                               !5/14/97 FTN
        PARAMETER (NCP=24)                                               !5/14/97 FTN
        INTEGER    SNP
        REAL       NONZERO                                               !5/14/97 FTN
        CHARACTER  CUNIT*6,    CNAME2*17,   HNAME*24
C       DIMENSION  CUNIT(NCP), CNAME2(NCP), HNAME(4)                     !4/16/97 FTN
        DIMENSION  CUNIT(NCP), CNAME2(NCP), HNAME(7)                     !4/16/97 FTN
        COMMON /NAMESC/ HNAME, CNAME2, CUNIT
        COMMON /SNPUC/  SNP
        COMMON /NONZC/  NONZERO                                          !5/14/97 FTN
        DATA HNAME  /' Horizontal_velocity [U]',
     .              '   Vertical_velocity [W]',
     .              '        Temperature [T2]',
     .              'Limiting timestep [NDLT]',
     .              ' Density minus 900 [RHO]',                          !4/16/97 FTN
     .              'Vert eddy viscosity [AZ]',                          !4/16/97 FTN
     .              'Vert eddy diffusiv. [DZ]'/                          !4/16/97 FTN
        DATA CNAME2 /'           Tracer', ' Suspended_solids',
     .              '         Coliform', ' Dissolved_solids',
     .              '       Labile_DOM', '   Refractory_DOM',
C    .              '            Algae', '         Detritus',             !5/13/97 FTN
     .              '           Silica', '         Detritus',             !5/13/97 FTN
     .              '       Phosphorus', '         Ammonium',
     .              '  Nitrate-nitrite', ' Dissolved_oxygen',
     .              '         Sediment', ' Inorganic_carbon',
     .              '       Alkalinity', '               pH',
     .              '   Carbon_dioxide', '      Bicarbonate',
C    .              '        Carbonate', '             Iron',             !1/22/00 FTN
     .              '        Carbonate', '     Age of water',             !1/22/00 FTN
C    .              '             CBOD'/                                 !5/13/97 FTN
     .              '             CBOD', '          Diatoms',             !5/13/97 FTN
     .              '           Greens', '    Cyanobacteria'/            !5/13/97 FTN
C                                                                        !5/13/97 FTN
C       DATA CUNIT /8*'g/m^3', 3*'mg/m^3', 4*'g/m^3', ' ',               !5/13/97 FTN
C    .              3*'g/m^3',   'mg/m^3',   'g/m^3'/                    !5/13/97 FTN
C       DATA CUNIT /2*'g/m^3',  '/100mL', 12*'g/m^3', 'su', 8*'g/m^3'/  !1/19/00 FTN
        DATA CUNIT /2*'g/m^3',  '/100mL', 12*'g/m^3', 'su', 3*'g/m^3',  !1/19/00 FTN
     &                                            'days', 4*'g/m^3'/    !1/19/00 FTN
        DATA SNP   /20/
        DATA NONZERO /1.0E-20/                                           !5/14/97 FTN
      END
```

```
************************************************************************
**                    Task 1.2: Variable Declarations                 **
************************************************************************

      PROGRAM  CE_QUAL_W2
      INCLUDE  'w2.inc'

***** Type declaration

      REAL     MINDLT
      REAL     LAT,     LONG
      REAL     JDAY,    JDMIN
      REAL     JDAYTS                                                    !FORTRAN
      REAL     NH3T1,   NH3T2,    NO3T1,   NO3T2,  NO3K1,  NO3K2,  NH3K1,
     .         NH3K2,   LABDK,    LRFDK,   NH3DK,  NO3DK,  NH3D,   NO3D,
     .         NH3RM,   NO3RM,    NH3REL,  KBOD
      REAL     NXTVD,   NXTMSN,   NXTMTS,  NXTMPR, NXTMCP, NXTMVP, NXTMRS,
     .         NXTMSC,  NXTMSP                                           !1/30/95 FTN
C    .         NXTMSC                                                    !1/30/95 FTN
      REAL     ICETH,   ICESW,    ICETHU,  ICETH1, ICETH2, ICEMIN, ICET2,
     .         ICETHI,  ICE_TOL
      INTEGER CON,      BTH,      RSI,     RSO,    TSR,    PRF,    VPL,
     .        CPL,      VPR,      SNP,     ERR,    WRN
      INTEGER SPR
      INTEGER TSRDP,    SNPDP,    VPLDP,   CPLDP,  PRFDP,  RSODP,  WSCDP,
     .        DLTDP,    SCRDP,    SPRDP
      INTEGER UHS,      DHS,      US,      DS,     CUS
      INTEGER CN,       TRCN,     DTCN,    PRCN,   UHCN,   DHCN
      INTEGER FREQUK, YEAR,       GDAY,    SKTI
      LOGICAL SNAPSHOT,           PROFILE,         TIME_SERIES,
     .        VECTOR,             CONTOUR,         RESTART_IN,
     .        RESTART_OUT,        SPREADSHEET
C                                                                        !10/6/98 FTN
C     Insert lines for AGPM output (from source code sent by G. Hauser) !10/6/98 FTN
      LOGICAL AGPM                                                       !10/6/98 FTN
      CHARACTER*3 APLC                                                   !10/6/98 FTN
      CHARACTER*72 AGPMFN                                                !10/6/98 FTN
      REAL NXTMAP                                                        !10/6/98 FTN
C                                                                        !10/6/98 FTN
      LOGICAL TRIBUTARIES,        DIST_TRIBS,      WITHDRAWALS,
     .        EVAPORATION,        PRECIPITATION
      LOGICAL UP_FLOW,            DN_FLOW,         UP_HEAD,
     .        DN_HEAD,            UH_INTERNAL,     DH_INTERNAL,
     .        UH_EXTERNAL,        DH_EXTERNAL,     HEAD_BOUNDARY
      LOGICAL ISO_TEMP,           VERT_TEMP,       LONG_TEMP,
     .        ISO_CONC,           VERT_CONC,       LONG_CONC
      LOGICAL ADD_LAYER,          SUB_LAYER
      LOGICAL LONG_FORM,          SHORT_FORM
      LOGICAL OPEN_FILES,         OPEN_VPR,        OPEN_LPR
      LOGICAL FRESH_WATER,        SALT_WATER,      SUSP_SOLIDS,
     .        CONSTITUENTS,       LIMITING_FACTOR
      LOGICAL NO_WIND,            NO_INFLOW,       NO_OUTFLOW,
     .        NO_HEAT
      LOGICAL WINTER,             ICE_IN,          ALLOW_ICE,
     .        ICE,                ICE_CALC,        DETAILED_ICE,
     .        TERM_BY_TERM
      LOGICAL INTERP_INFLOW,      INTERP_OUTFLOW,  INTERP_MET,
     .        INTERP_DTRIBS,      INTERP_TRIBS,    INTERP_HEAD,
     .        INTERP_WITHDRWL,    INTERPOLATE
      LOGICAL VOLUME_BALANCE,     MASS_BALANCE
      LOGICAL PLACE_QIN,          PLACE_QTR
      LOGICAL WARNING_OPEN,       VOLUME_WARNING
      LOGICAL SEL_WITHDRAWAL,     POINT_SINK
      LOGICAL END_RUN,            BRANCH_FOUND,    UPWIND,
     .        SHIFT_DEMAND,       LEAP_YEAR,       TRANSPORT,
     .        OXYGEN_DEMAND,      UPDATE_KINETICS, CALL_RATES,
     .        LIMITING_DLT,       SCREEN_OUTPUT
      CHARACTER*1  EXT1
      CHARACTER*2  EXT2
      CHARACTER*3  CPRC,    HPRC,  GDCH,  EXT3,  SCRC
      CHARACTER*3  ACC,     INACC, TRACC, DTACC, PRACC
```

```
      CHARACTER*3  SNPC,   VPLC,  TSRC,  PRFC,  CPLC,  RSOC, RSIC,
     .             SPRC
      CHARACTER*3  INFIC,  OUTIC, TRIC,  DTRIC, WDIC,  HDIC, METIC
      CHARACTER*3  CCC,    PQC,   VBC,   EVC,   ICEC,  PRC,  LIMC,
     .             DTRC,   QINC,  QOUTC, WINDC, HEATC, SWC,  SDC,
     .             MBC,    PQTC
      CHARACTER*3  PRSTYL, TSSTYL, CPSTYL, VPSTYL                    !1/31/95 FTN
      CHARACTER*3  DNPRN                                             !3/27/98 FTN
      CHARACTER*4  LFAC
      CHARACTER*5  FORM,   WTYPE
      CHARACTER*6  CUNIT
      CHARACTER*6  DATE_STRNG                                        !9/24/97 FTN
      CHARACTER*7  BLANK,  CONV,  LFPR
      CHARACTER*8  SLTR,   SINK,  SLICE, SLHEAT
      CHARACTER*8  CTIME                                             !FORTRAN
      CHARACTER*8  CNAME3                                            !9/24/97 FTN
      CHARACTER*9  MONTH
      CHARACTER*9  CONV1,  BLANK1
      CHARACTER*12 RSOFN
      CHARACTER*12 CDATE                                             !FORTRAN
      CHARACTER*17 CNAME1, CNAME2
      CHARACTER*24 HNAME
      CHARACTER*72 TITLE
      CHARACTER*72 RSIFN,  VPRFN, TSRFN, PRFFN, VPLFN, CPLFN, METFN,
     .             QINFN,  TINFN, CINFN, QOTFN, QWDFN, QTRFN, TTRFN,
     .             CTRFN,  QDTFN, TDTFN, CDTFN, PREFN, TPRFN, CPRFN,
     .             EUHFN,  TUHFN, CUHFN, EDHFN, TDHFN, CDHFN, SNPFN,
     .             LPRFN,  BTHFN
      CHARACTER*72 SPRFN
      DOUBLE PRECISION VOLSBR, VOLTBR, VOLEV, VOLPR,  VOLTR,  VOLDT,
     .                 VOLWD,  VOLUH,  VOLDH, VOLIN,  VOLOUT, DLVOL
      DOUBLE PRECISION CMBRS,  CMBRT
      DOUBLE PRECISION BHRHO,  GMA,    BTA,   A,      C,      D,
     .                 V,      F
      DOUBLE PRECISION Z,      SZ,     ZMIN
      DOUBLE PRECISION BTAT,   GMAT,   AT,    CT,     DT,     VT
      DOUBLE PRECISION TADL,   TADV,   CADL,  CADV
      DOUBLE PRECISION AD1L,   AD2L,   AD3L,  AD1V,   AD2V,   AD3V
      DOUBLE PRECISION DX1,    DX2,    DX3,   ALFA
      DOUBLE PRECISION T1L,    T2L,    T3L,   C1L,    C2L,    C3L

***** Dimension statements

      DIMENSION ADMX(KMP,IMP), U(KMP,IMP),   SU(KMP,IMP),   W(KMP,IMP),
     .          SW(KMP,IMP),   AZ(KMP,IMP),  ADMZ(KMP,IMP), DZ(KMP,IMP),
     .          DX(KMP,IMP),   DM(KMP,IMP),  RHO(KMP,IMP),  P(KMP,IMP),
     .          HPG(KMP,IMP),  SB(KMP,IMP),  ST(KMP,IMP),   DZQ(KMP,IMP)
      DIMENSION T1(KMP,IMP),   T2(KMP,IMP),  TSS(KMP,IMP),  QSS(KMP,IMP)
      DIMENSION B(KMP,IMP),    BB(KMP,IMP),  BR(KMP,IMP),   BH(KMP,IMP),
     .          BHR(KMP,IMP),  HSEG(KMP,IMP)
      DIMENSION CONV(KMP,17)
      DIMENSION CONV1(KMP,17)
      DIMENSION NDLT(KMP,IMP)
      DIMENSION HKT1(IMP),     HKT2(IMP),    AVHKT(IMP),    BKT(IMP),
     .          BHKT1(IMP),    BHKT2(IMP),   BHRKT1(IMP),   BHRKT2(IMP),
     .          DLX(IMP),      DLXR(IMP)
      DIMENSION DLXTOT(NBP)                                          !2/11/95 FTN
      DIMENSION KB(IMP),       KBMIN(IMP)
      DIMENSION KTI(IMP),      SKTI(IMP)
      DIMENSION BHRHO(IMP),    A(IMP),       C(IMP),        D(IMP),
     .          F(IMP),        V(IMP),       BTA(IMP),      GMA(IMP),
     .          Z(IMP),        SZ(IMP)
      DIMENSION EV(IMP),       QDT(IMP),     QPR(IMP)
      DIMENSION Q(IMP),        QC(IMP),      QSSUM(IMP)
      DIMENSION ICETH(IMP),    ICE(IMP),     ICESW(IMP)
      DIMENSION SOD(IMP),      SODS(IMP)
      DIMENSION AZMXKT(IMP),   IPRF(IMP),    RN(IMP),       PHIO(IMP)
      DIMENSION ELWS(IMP),     ISPR(IMP)
      DIMENSION H(KMP),        AVH(KMP),     EL(KMP),       TVP(KMP),
     .          AZMAX(KMP)
      DIMENSION QWD(NWP),      TWD(NWP),     IWD(NWP),      KWD(NWP),
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     .          JBWD(NWP)
      DIMENSION QTR(NTP),       TTR(NTP),       JBTR(NTP),       ITR(NTP),
     .          QTRFN(NTP),     TTRFN(NTP),     CTRFN(NTP),      KTTR(NTP),
     .          KBTR(NTP)
      DIMENSION C2I(NCP),       AVCOUT(NCP),    CPRC(NCP),       CNAME1(NCP),
     .          CNAME2(NCP),    CUNIT(NCP),     ACC(NCP),        CN(NCP),
     .          INCN(NCP),      TRCN(NCP),      DTCN(NCP),       PRCN(NCP),
     .          UHCN(NCP),      DHCN(NCP),      INACC(NCP),      TRACC(NCP),
     .          DTACC(NCP),     PRACC(NCP)
      DIMENSION CNAME3(NCP)                                               !9/24/97 FTN
      DIMENSION DTRC(NBP),      SWC(NBP)
      DIMENSION QSUM(NBP),      NOUT(NBP)
      DIMENSION KTQIN(NBP),     KBQIN(NBP)
      DIMENSION ELUH(NBP),      ELDH(NBP),      JBUH(NBP),       JBDH(NBP)
      DIMENSION US(NBP),        CUS(NBP),       DS(NBP),         UHS(NBP),
     .          DHS(NBP)
      DIMENSION QIN(NBP),       PR(NBP),        QPRBR(NBP),      QDTR(NBP),
     .          EVBR(NBP)
      DIMENSION TIN(NBP),       TPR(NBP),       TDTR(NBP)
      DIMENSION VOLEV(NBP),     VOLPR(NBP),     VOLTR(NBP),      VOLDT(NBP),
     .          VOLUH(NBP),     VOLDH(NBP),     VOLIN(NBP),      VOLOUT(NBP),
     .          VOLWD(NBP),     VOLSBR(NBP),    VOLTBR(NBP),     DLVOL(NBP)
      DIMENSION QINFN(NBP),     TINFN(NBP),     CINFN(NBP),      QDTFN(NBP),
     .          TDTFN(NBP),     CDTFN(NBP),     PREFN(NBP),      TPRFN(NBP),
     .          CPRFN(NBP),     EUHFN(NBP),     TUHFN(NBP),      CUHFN(NBP),
     .          EDHFN(NBP),     TDHFN(NBP),     CDHFN(NBP),      QOTFN(NBP)
      DIMENSION UP_FLOW(NBP),       DN_FLOW(NBP),       UP_HEAD(NBP),
     .          DN_HEAD(NBP),       UH_EXTERNAL(NBP), DH_EXTERNAL(NBP),
     .          UH_INTERNAL(NBP),   DH_INTERNAL(NBP), DIST_TRIBS(NBP)
      DIMENSION NSTR(NBP),          KBSW(NSP,NBP)
      DIMENSION QSTR(NSP,NBP),      ESTR(NSP,NBP),    WSTR(NSP,NBP),
     .          SINK(NSP,NBP)
      DIMENSION CIN(NCP,NBP),       CDTR(NCP,NBP),    CPR(NCP,NBP)
      DIMENSION CTR(NCP,NTP),       CWD(NCP,NWP)
      DIMENSION CUH(KMC,NCP,NBP),   CDH(KMC,NCP,NBP)
      DIMENSION CMBRS(NCP,NBP),     CMBRT(NCP,NBP)
C     DIMENSION AGR(KMC,IMC),       ARR(KMC,IMC),     AMR(KMC,IMC),      !5/14/97 FTN
C    .          AER(KMC,IMC),       A1(KMC,IMC),      A2(KMC,IMC),       !5/14/97 FTN
      DIMENSION AGR(KMC,IMC,NAP),   ARR(KMC,IMC,NAP), AMR(KMC,IMC,NAP),  !5/14/97 FTN
     .          AER(KMC,IMC,NAP),   A1(KMC,IMC),      A2(KMC,IMC),       !5/14/97 FTN
     .          A3(KMC,IMC),        DETD(KMC,IMC),    SEDD(KMC,IMC),
     .          ORGD(KMC,IMC),      SO2D(KMC,IMC),    NH3D(KMC,IMC),
     .          NO3D(KMC,IMC),      CBODD(KMC,IMC),   OMRM(KMC,IMC),
C    .          NH3RM(KMC,IMC),     NO3RM(KMC,IMC),   AGRMR(KMC,IMC),    !5/13/97 FTN
     .          NH3RM(KMC,IMC),     NO3RM(KMC,IMC),   AGRMR(KMC,IMC,NAP),!5/13/97 FTN
C    .          AGRMF(KMC,IMC),     SETIN(KMC,IMC),   SETOUT(KMC,IMC),   !5/13/97 FTN
     .          AGRMF(KMC,IMC,NAP),SETIN(KMC,IMC),    SETOUT(KMC,IMC),   !5/13/97 FTN
C    .          LFAC(KMC,IMC),      LFPR(KMC,IMC)                        !5/14/97 FTN
     .          LFAC(KMC,IMC,NAP), LFPR(KMC,IMC,NAP)                     !5/14/97 FTN
      DIMENSION AGT1(NAP), AGT2(NAP), AGT3(NAP), AGT4(NAP),              !5/13/97 FTN
     &          AGK1(NAP), AGK2(NAP), AGK3(NAP), AGK4(NAP),              !5/13/97 FTN
     &          AGROW(NAP), AMORT(NAP), AEXCR(NAP), ARESP(NAP),          !5/13/97 FTN
     &          ASETL(NAP),  AHSP(NAP),  AHSN(NAP), AHSSI(NAP),          !5/13/97 FTN
     &          ASATUR(NAP), ABIOP(NAP), ABION(NAP), ABIOSI(NAP),        !5/13/97 FTN
     &          ABIOC(NAP)                                               !5/13/97 FTN
      DIMENSION COLTERM(3,KMP)                                           !4/14/95 FTN
      DIMENSION QUH1(KMP,NBP),      QUH2(KMP,NBP),    QDH1(KMP,NBP),
     .          QDH2(KMP,NBP),      TUH(KMP,NBP),     TDH(KMP,NBP),
     .          TSSUH1(KMP,NBP),    TSSUH2(KMP,NBP),  TSSDH1(KMP,NBP),
     .          TSSDH2(KMP,NBP),    AKBR(KMP,NBP),    QINF(KMP,NBP),
     .          QOUT(KMP,NBP),      KOUT(KMP,NBP),    QTRF(KMP,NTP)
      DIMENSION FETCHU(IMP,NBP),    FETCHD(IMP,NBP)
      DIMENSION ISO_CONC(NCP),      VERT_CONC(NCP),   LONG_CONC(NCP)
      DIMENSION C1S(KMC,IMC,NCP),   CSSB(KMC,IMC,NCP)
      DIMENSION CVP(KMC,NCP)
      DIMENSION SF1L(IMP),          SF2L(IMP,2),      SF3L(IMP,2),
     .          SF4L(IMP,2),        SF5L(IMP,2),      SF6L(IMP,2),
     .          SF7L(IMP,2),        SF8L(IMP,2),      SF9L(IMP,2),
     .          SF10L(IMP,2),       SF11L(IMP,2),     SF12L(IMP,2),
     .          SF13L(IMP,2)
      DIMENSION SF1V(KMP),          SF2V(KMP,2),      SF3V(KMP,2),
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     .          SF4V(KMP,2),        SF5V(KMP,2),      SF6V(KMP,2),
     .          SF7V(KMP,2),        SF8V(KMP,2),      SF9V(KMP,2),
     .          SF10V(KMP,2)
      DIMENSION DX1(KMP,IMP),       DX2(KMP,IMP),     DX3(KMP,IMP),
     .          AD1L(KMP,IMP),      AD2L(KMP,IMP),    AD3L(KMP,IMP),
     .          AD1V(KMP,IMP),      AD2V(KMP,IMP),    AD3V(KMP,IMP),
     .          TADL(KMP,IMP),      TADV(KMP,IMP)
      DIMENSION CT(KMP,IMP),        AT(KMP,IMP),      BTAT(KMP,IMP)
      DIMENSION VT(KMP),            DT(KMP),          GMAT(KMP)
      DIMENSION CADL(KMC,IMC,NCP),    CADV(KMC,IMC,NCP)
      DIMENSION CSSUH1(KMP,NCP,NBP),  CSSUH2(KMP,NCP,NBP),
     .          CSSDH1(KMP,NCP,NBP),  CSSDH2(KMP,NCP,NBP)
      DIMENSION SNPD(NDP), VPLD(NDP), PRFD(NDP), CPLD(NDP), RSOD(NDP),
     .          TSRD(NDP), DLTD(NDP), WSCD(NDP), SPRD(NDP), SCRD(NDP)
      DIMENSION SNPF(NDP), VPLF(NDP), PRFF(NDP), CPLF(NDP), RSOF(NDP),
     .          TSRF(NDP), DLTF(NDP), SCRF(NDP), SPRF(NDP)
      DIMENSION WSC(NDP),  WFC(NDP),  DLTMAX(NDP)
C     DIMENSION IPR(17),   IPRLF(17), IPRSF(11), TITLE(7),  HNAME(4),   !4/16/97 FTN
      DIMENSION IPR(17),   IPRLF(17), IPRSF(11), TITLE(7),  HNAME(7),   !4/16/97 FTN
C    .          HPRC(4)                                                 !4/16/97 FTN
     .          HPRC(7)                                                 !4/16/97 FTN
      DIMENSION SEL_WITHDRAWAL(NBP),  POINT_SINK(NSP,NBP),  ICE_IN(NBP),
     .          ALLOW_ICE(IMP),       TRANSPORT(NCP)

***** Common declaration

      COMMON /GLOBLC/ JB,     JC,      IU,     ID,     KT,     ELKT,
     .                DLT,    KB,      KTI
      COMMON /GEOMHC/ EL,     H,       HKT1,   HKT2
      COMMON /GEOMBC/ B,      BKT,     BH,     BHKT1,  BHKT2, BHRKT1
      COMMON /NAMESC/ HNAME, CNAME2,   CUNIT
      COMMON /DENITC/ DNPRN                                             !3/27/98 FTN
      COMMON /SNPUC/  SNP
      COMMON /TEMPC/  T1,     T2
      COMMON /ICEC/   ICE,    ICETH,   ICE_CALC
C     COMMON /HYDRC1/ U,      W,       AZ,     RHO,    NDLT             !4/17/97 FTN
      COMMON /HYDRC1/ U,      W,       AZ,     RHO,    NDLT,   DZ       !4/17/97 FTN
      COMMON /HYDRC2/ Z
      COMMON /PRNTC1/ IPR,    IEPR,    KEPR
      COMMON /PRNTC2/ TITLE, CPRC,     HPRC,   CONV
      COMMON /PRNTC3/ CUS,    DS
      COMMON /GRDLGC/ LONG_FORM,       SHORT_FORM,      LIMITING_FACTOR,
     .                OXYGEN_DEMAND
      COMMON /DNSPHC/ FRESH_WATER,     SALT_WATER,      SUSP_SOLIDS
      COMMON /GRTVDC/ CONSTITUENTS,    CN,              NAC
      COMMON /INTERC/ INTERP_INFLOW,   INTERP_OUTFLOW, INTERP_MET,
     .                INTERP_DTRIBS,   INTERP_TRIBS,    INTERP_HEAD,
     .                INTERP_WITHDRWL
      COMMON /TVDDSC/ NO_WIND,         NO_INFLOW,       NO_OUTFLOW,
     .                NO_HEAT
      COMMON /TVDLC1/ PRECIPITATION,   WITHDRAWALS,     TRIBUTARIES,
     .                DIST_TRIBS
      COMMON /TVDLC2/ UP_FLOW,         DN_FLOW,         UH_INTERNAL,
     .                UH_EXTERNAL,     DH_INTERNAL,     DH_EXTERNAL
      COMMON /TVDLC3/ OPEN_FILES,      TERM_BY_TERM
      COMMON /TVDMTC/ TAIR,   TDEW,    CLOUD,  PHI,    ET,     CSHE,
     .                SRO,    LAT,     LONG
      COMMON /FWCOEF/ FW_A0,  FW_A1,   FW_A2                            !1/30/95 FTN
      COMMON /TVDFNC/ METFN,  QWDFN,   QOTFN,  QINFN,  TINFN,  CINFN,
     .                QTRFN,  TTRFN,   CTRFN,  QDTFN,  TDTFN,  CDTFN,
     .                PREFN,  TPRFN,   CPRFN,  EUHFN,  TUHFN,  CUHFN,
     .                EDHFN,  TDHFN,   CDHFN
      COMMON /TVDQC/  QIN,    QTR,     QDTR,   PR,     ELUH,   ELDH,
     .                QOUT,   QWD,     QSUM
      COMMON /TVDTC/  TIN,    TTR,     TDTR,   TPR,    TUH,    TDH
      COMMON /TVDCC1/ CIN,    CTR,     CDTR,   CPR,    CUH,    CDH
      COMMON /TVDCC2/ INCN,   TRCN,    DTCN,   PRCN,   UHCN,   DHCN
      COMMON /TVDCC3/ NACIN,  NACTR,   NACPR,  NACDT
      COMMON /RTMLTC/ OMT1,   OMT2,    NH3T1,  NH3T2,  NO3T1,  NO3T2,
     .                AGT1,   AGT2,    AGT3,   AGT4,   OMK1,   OMK2,
     .                NH3K1,  NH3K2,   NO3K1,  NO3K2,  AGK1,   AGK2,
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     .               AGK3,    AGK4
      COMMON /DKORGC/ DETD,    ORGD
      COMMON /DKSEDC/ SEDD,    SO2D,    SOD
      COMMON /DKNITC/ NH3D,    NO3D
      COMMON /DKBODC/ CBODD
      COMMON /GBLRTC/ OMRM,    NH3RM,   NO3RM,   AGRMR,   AGRMF
      COMMON /GLBLCC/ PALT,    ALGDET,  O2LIM,   WIND,    WSCDP,   WSC
      COMMON /WACHUS/ WSC_MIN,WSC_MAX                                  !1/30/95 FTN
      COMMON /DKMLTC/ A1,      A2,      A3
C     COMMON /CLFRMC/ COLQ10,  COLDK                                   !2/02/95 FTN
      COMMON /CLFRMC/ COLQ10,  COLDK,   COLKL,   CSETL,   COLTERM, CKSEG   !4/23/95 FTN
      COMMON /ORGDKC/ SEDDK,   DETDK,   LABDK,   REFDK,   LRFDK
      COMMON /SETLC1/ SETIN,   SETOUT
      COMMON /SETLC2/ SSETL,   DSETL,   ASETL,   FESETL
      COMMON /PHYTGC/ AGR,     ARR,     AMR,     AER
      COMMON /PHYTC1/ AEXCR,   AMORT,   AGROW,   ARESP,   ASATUR, AHSN,
C    .                AHSP                                             !5/13/97 FTN
     .                AHSP,    AHSSI                                   !5/13/97 FTN
C     COMMON /PHYTC2/ BETA,    EXH2O,   EXINOR, EXORG                  !5/14/97 FTN
      COMMON /PHYTC2/ BETA,    EXH2O,   EXINOR, EXORG, FREQUK, ALGLIT   !6/16/98 FTN
      COMMON /PHYTC3/ ABIOP,   ABION,   ABIOSI, ABIOC                  !5/14/97 FTN
      COMMON /PHOSPC/ PO4REL, BIOP,     PARTP
      COMMON /NITROC/ BION,    PARTN,   NH3DK,   NH3REL, NO3DK
      COMMON /SILICC/ SIREL,   BIOSI                                   !5/16/97 FTN
      COMMON /OXYGNC/ O2ORG,   O2ALG,   O2NH3,   O2RESP
      COMMON /CARBNC/ CO2REL,  BIOC
C     COMMON /IRONC/  FEREL                                            !1/19/00 FTN
      COMMON /CBODC/  KBOD,    TBOD,    RBOD
      COMMON /LFACC/  LFAC,    LFPR
      COMMON /SELWC/  NSTR,    QSTR,    ESTR,    WSTR,    KBSW,    NOUT,
     .                KOUT
      COMMON /GDAYC1/ GDAY,    DAYM,    JDAYG,   LEAP_YEAR
      COMMON /GDAYC2/ MONTH
      COMMON /SCRNC1/ JDAY,    DLTS,    ILOC,    KLOC,    MINDLT, JDMIN,
     .                IMIN,    KMIN,    DLTAV,   NIT,     NV,      YEAR,
     .                ELTMJD
      COMMON /SCRNC2/ NWD,     NTR
      COMMON /SCRNC3/ ZMIN
      COMMON /TVDSWC/ SEL_WITHDRAWAL, POINT_SINK


***** Data statements

        DATA CNAME1 /'Tracer',          'Suspended_solids',
     .               'Coliform',        'Dissolved_solids',
     .               'Labile_DOM',      'Refractory_DOM',
C    .               'Algae',           'Detritus',                    !5/13/97 FTN
     .               'Silica',          'Detritus',                    !5/13/97 FTN
     .               'Phosphorus',      'Ammonium',
     .               'Nitrate-nitrite', 'Dissolved_oxygen',
     .               'Sediment',        'Inorganic_carbon',
     .               'Alkalinity',      'pH',
     .               'Carbon_dioxide',  'Bicarbonate',
C    .               'Carbonate',       'Iron',                        !1/22/00 FTN
     .               'Carbonate',       'Age of water',                !1/22/00 FTN
C    .               'CBOD'/                                           !5/13/97 FTN
     .               'CBOD',            'Diatoms',                     !5/13/97 FTN
     .               'Greens',          'Cyanobacteria'/               !5/13/97 FTN
      DATA CNAME3 /'TRACER', 'TSSMGL', 'COLFRM', 'TDSMGL', 'LABDOM',   !9/24/97 FTN
     &            'REFDOM', 'SILICA', 'DETRIT', 'PHOSPH', 'NH3NH4',   !9/24/97 FTN
     &            'NO2NO3', 'DISSOX', 'SEDMNT', 'TICARB', 'ALKALI',   !9/24/97 FTN
C    &            'PHxxxx', 'CO2xxx', 'HCO3xx', 'CO3xxx', 'IRONxx',   !1/22/00 FTN
     &            'PHxxxx', 'CO2xxx', 'HCO3xx', 'CO3xxx', 'AGExxx',   !1/22/00 FTN
     &            'CBODxx', 'DIATOM', 'GREENS', 'BLUEGR'/             !9/24/97 FTN
      DATA RHOA   /1.25/,  RHOI  /1000.0/,   RHOICE /916.0/,
     .     RK1    /2.12/,  RL1   /333507.0/, RIMT   /0.0/
      DATA G      /9.8/,   VTOL  /1.0E3/,    CP     /4186.0/,
     .     AZDZFR /0.14/,  AZMIN /1.4E-6/,   DZMIN  /1.4E-7/,
     .                     ICE_TOL /0.005/                             !3/01/95 FTN
C    .     DZMAX  /1.0E3/, ICE_TOL /0.005/                             !3/01/95 FTN
      DATA BLANK  /'       '/
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      DATA BLANK1 /'     m    '/
      DATA CON /10/, BTH /11/, RSI /12/, VPR /13/, LPR /14/
      DATA RSO /21/, TSR /22/, PRF /23/, VPL /24/, CPL /25/, WRN /26/,
     .     ERR /27/, SPR /28/
      NB = NBP
```

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***************************************************************************
**                         Task 1.3: Inputs                              **
***************************************************************************

***** Open control file

      CALL TIMER (ISTART)
      OPEN (CON,FILE=CONFN,STATUS='OLD')

***** Read title cards

      READ (CON,*)
      READ (CON,1000) (TITLE(J),J=1,6)

***** Read time control cards

      READ (CON,1010)  TMSTRT, TMEND, YEAR
      READ (CON,1020)  NDT,    DLTMIN
      READ (CON,1030) (DLTD(J),  J=1,NDT)
      READ (CON,1030) (DLTMAX(J),J=1,NDT)
      READ (CON,1030) (DLTF(J),  J=1,NDT)

***** Read grid definition cards

      READ (CON,1040) (US(JB), DS(JB), UHS(JB), DHS(JB),JB=1,NBP)
      READ (CON,1030)  LAT,    LONG,   DATUM

***** Read initial condition cards

      READ (CON,1050)  T2I,    ICETHI, WTYPE
      READ (CON,1060)  VBC,    MBC,    PQC,    PQTC,   EVC,   PRC
      READ (CON,1060)  INFIC,  TRIC,   DTRIC,  HDIC,   OUTIC, WDIC,
     .                 METIC
      READ (CON,1060)  WINDC,  QINC,   QOUTC,  HEATC
      READ (CON,1070)  ICEC,   SLICE,  SLHEAT, ALBEDO, HWI,   BETAI,
     .                 GAMMAI, ICEMIN, ICET2
C                                                                      !3/01/95 FTN
C     Read DZMAX but set it back to Tom Cole's original value if it    !3/01/95 FTN
C     was left blank in the control file.                              !3/01/95 FTN
C                                                                      !3/01/95 FTN
C     READ (CON,1080)  SLTR,   THETA                                   !3/01/95 FTN
      READ (CON,1081)  SLTR,   THETA,  DZMAX                           !3/01/95 FTN
 1081 FORMAT(//8X,A8,2F8.0)                                            !3/01/95 FTN
      IF (DZMAX.LT.1.0E-12) DZMAX = 1.0E3                              !3/01/95 FTN
C                                                                      !1/30/95 FTN
C     Read a min and max value for WSC for adjusting it later based    !1/30/95 FTN
C     on wind direction and the axis of Wachusett Reservoir.           !1/30/95 FTN
C                                                                      !1/30/95 FTN
C     READ (CON,1090)  NWSC                                            !1/30/95 FTN
      READ (CON,1091)  NWSC, WSC_MIN, WSC_MAX                          !1/30/95 FTN
 1091 FORMAT(//(8X,I8,2F8.0))                                          !1/30/95 FTN
C                                                                      !1/30/95 FTN
      READ (CON,1030) (WSCD(J),J=1,NWSC)
      READ (CON,1030) (WSC(J), J=1,NWSC)
      READ (CON,1030) (WFC(J), J=1,NWSC)
C     READ (CON,1030)  AX,     DXI,    CHEZY,  CBHE,   TSED            !1/30/95 FTN
      READ (CON,1030)  AX,     DXI,    CHEZY,  CBHE,   TSED,           !1/30/95 FTN
     &                 FW_A0,  FW_A1,  FW_A2,  SRMULT                  !1/30/95 FTN
C                                                                      !1/30/95 FTN
C     Set wind function coefficients (FW_A0, FW_A1, FW_A2) to default  !1/30/95 FTN
C     values (in SI units) if they were not specified in control file. !1/30/95 FTN
C     Also set solar radiation multiplier (1 - reflectance) to default !1/30/95 FTN
C     value if not specified in the control file.                      !1/30/95 FTN
C                                                                      !1/30/95 FTN
      IF (FW_A1.LT.1.0E-9 .AND. FW_A1.LT.1.0E-9 .AND. FW_A2.LT.1.0E-9) !1/30/95 FTN
     &                                                            THEN !1/30/95 FTN
         FW_A0 = 9.2                                                   !1/30/95 FTN
         FW_A1 = 0.0                                                   !1/30/95 FTN
         FW_A2 = 0.46                                                  !1/30/95 FTN
      END IF                                                           !1/30/95 FTN
      IF (SRMULT.LT.1.0E-9) SRMULT = 0.94                              !1/30/95 FTN
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```
***** Read inflow-outflow cards

      READ (CON,1060) (SWC(JB), JB=1,NBP)
      READ (CON,1090) (NSTR(JB),JB=1,NBP)
      READ (CON,1090)   (KBSW(JS,1), JS=1,NSTR(1))
      DO JB=2,NB
        READ (CON,1130) (KBSW(JS,JB),JS=1,NSTR(JB))
      END DO
      READ (CON,1100)   (SINK(JS,1), JS=1,NSTR(1))
      DO JB=2,NB
        READ (CON,1110) (SINK(JS,JB),JS=1,NSTR(JB))
      END DO
      READ (CON,1030)   (ESTR(JS,1), JS=1,NSTR(1))
      DO JB=2,NB
        READ (CON,1120) (ESTR(JS,JB),JS=1,NSTR(JB))
      END DO
      READ (CON,1030)   (WSTR(JS,1), JS=1,NSTR(1))
      DO JB=2,NB
        READ (CON,1120) (WSTR(JS,JB),JS=1,NSTR(JB))
      END DO
      READ (CON,1090) (NOUT(JB),  JB=1,NBP)
      READ (CON,1090) (KOUT(JO,1),JO=1,NOUT(1))
      DO JB=2,NB
        READ (CON,1130) (KOUT(JO,JB),JO=1,NOUT(JB))
      END DO
      READ (CON,1090)  NWD
      READ (CON,1090) (IWD(JW), JW=1,NWD)
      READ (CON,1090) (KWD(JW), JW=1,NWD)
C                                                                 !4/23/95 FTN
C     Read the maximum segment number into which the distributed trib !4/23/95 FTN
C     should be allowed to enter (dist trib will not be put into any  !4/23/95 FTN
C     segments d/s of MXSEGDTR).  If no value was entered for MXSEGDTR, !4/23/95 FTN
C     then set it to the total number of segments.                  !4/23/95 FTN
C                                                                 !4/23/95 FTN
C     READ (CON,1090)  NTR                                        !4/23/95 FTN
      READ (CON,1090)  NTR, MXSEGDTR                              !4/23/95 FTN
      IF (MXSEGDTR.LT.1) MXSEGDTR = IMP                           !4/23/95 FTN
      READ (CON,1090) (ITR(JT), JT=1,NTP)
      READ (CON,1060) (DTRC(JB),JB=1,NBP)

***** Read output control cards (excluding constituents)

      READ (CON,1150)  SCRC, NSCR
      READ (CON,1030) (SCRD(J),J=1,NSCR)
      READ (CON,1030) (SCRF(J),J=1,NSCR)
C                                                                 !4/17/97 FTN
C     Read variables to indicate whether or not to print densities !4/17/97 FTN
C     and vertical eddy viscosities and diffusivities             !4/17/97 FTN
C                                                                 !4/17/97 FTN
C     READ (CON,1140)  FORM, (HPRC(J),J=1,4)                      !4/17/97 FTN
      READ (CON,1140)  FORM, (HPRC(J),J=1,7)                      !4/17/97 FTN
      READ (CON,1090) (IPRSF(I),I=1,11)
      READ (CON,1090) (IPRLF(I),I=1,17)
      READ (CON,1150)  SNPC, NSNP
      READ (CON,1030) (SNPD(J),J=1,NSNP)
      READ (CON,1030) (SNPF(J),J=1,NSNP)
C     READ (CON,1160)  PRFC, NPRF, NIPRF                          !1/30/95 FTN
      READ (CON,1161)  PRFC, NPRF, NIPRF, PRSTYL                  !1/31/95 FTN
 1161 FORMAT(//13X,A3,2I8,5X,A3)                                  !1/30/95 FTN
      READ (CON,1030) (PRFD(J),J=1,NPRF)
      READ (CON,1030) (PRFF(J),J=1,NPRF)
      READ (CON,1090) (IPRF(J),J=1,NIPRF)
      READ (CON,1160)  SPRC, NSPR, NISPR
      READ (CON,1030) (SPRD(J),J=1,NSPR)
      READ (CON,1030) (SPRF(J),J=1,NSPR)
      READ (CON,1090) (ISPR(J),J=1,NISPR)
C     READ (CON,1150)  TSRC, NTSR                                 !1/30/95 FTN
      READ (CON,1150)  TSRC, NTSR, TSSTYL                         !1/30/95 FTN
      READ (CON,1030) (TSRD(J),J=1,NTSR)
      READ (CON,1030) (TSRF(J),J=1,NTSR)
```

```
C     READ (CON,1150)  VPLC, NVPL                                      !1/30/95 FTN
      READ (CON,1150)  VPLC, NVPL, VPSTYL                              !1/30/95 FTN
      READ (CON,1030) (VPLD(J),J=1,NVPL)
      READ (CON,1030) (VPLF(J),J=1,NVPL)
C     READ (CON,1150)  CPLC, NCPL                                      !1/30/95 FTN
      READ (CON,1150)  CPLC, NCPL, CPSTYL                              !1/30/95 FTN
      READ (CON,1030) (CPLD(J),J=1,NCPL)
      READ (CON,1030) (CPLF(J),J=1,NCPL)
C                                                                      !10/6/98 FTN
C     Insert lines for AGPM output (from source code sent by G. Hauser) !10/6/98 FTN
C     READ ON/OFF SWITCH VALUE, START DAY, FREQUENCY                   !10/6/98 FTN
C                                                                      !10/6/98 FTN
      READ (CON,1150)  APLC                                            !10/6/98 FTN
      READ (CON,1030)  APLD,APLFD,APLFH                                !10/6/98 FTN
      APLF = APLFD + APLFH/24.                                         !10/6/98 FTN
      INTPLD = APLFD                                                   !10/6/98 FTN
      INTPLH = APLFH                                                   !10/6/98 FTN
      AGPM = APLC.EQ.' ON'                                             !10/6/98 FTN
      NXTMAP = APLD                                                    !10/6/98 FTN
C                                                                      !10/6/98 FTN
      READ (CON,1150)  RSOC, NRSO, RSIC
      READ (CON,1030) (RSOD(J),J=1,NRSO)
      READ (CON,1030) (RSOF(J),J=1,NRSO)

***** Read constituent control cards

      READ (CON,1170)  CCC, LIMC, SDC, FREQUK
      READ (CON,1060) (ACC(JC),  JC=1,NCP)
      READ (CON,1030) (C2I(JC),  JC=1,NCP)
C     Make sure that age of water is initialized to zero for whole grid !1/22/00 FTN
      C2I(20) = 1.0E-20                                                !1/22/00 FTN
      READ (CON,1060) (CPRC(JC), JC=1,NCP)
      READ (CON,1060) (INACC(JC),JC=1,NCP)
      READ (CON,1060) (TRACC(JC),JC=1,NCP)
      READ (CON,1060) (DTACC(JC),JC=1,NCP)
      READ (CON,1060) (PRACC(JC),JC=1,NCP)

***** Read kinetics coefficients

C     Read minimum light level for algae as a fraction of the light    !6/16/98 FTN
C     that goes below the surface layer (if available light is less    !6/16/98 FTN
C     than that fraction, algae will be converted to detritus). Set    !6/16/98 FTN
C     this to -999 if no value was specified in the input file.        !6/16/98 FTN
C                                                                      !6/16/98 FTN
C     READ (CON,1030)  EXH2O,  EXINOR, EXORG,  BETA                    !6/16/98 FTN
      READ (CON,1030)  EXH2O,  EXINOR, EXORG,  BETA, ALGLIT            !6/16/98 FTN
      IF (ALGLIT.LE.1.0E-9) ALGLIT = -999.0                            !6/16/98 FTN
C                                                                      !5/09/95 FTN
C     Read the segment number for which components of coliform         !5/09/95 FTN
C     disappearance will be printed in the snapshot file.  If no       !5/09/95 FTN
C     value was specified, use the downstream end of branch 1.         !5/09/95 FTN
C                                                                      !5/09/95 FTN
C     READ (CON,1030)  COLQ10, COLDK                                   !2/02/95 FTN
      READ (CON,1030)  COLQ10, COLDK,  COLKL,  CSETL,  CKSEG           !4/23/95 FTN
      IF (CKSEG.LT.2.0) CKSEG = DS(1)                                  !5/09/95 FTN
      READ (CON,1030)  SSETL
C                                                                      !5/12/97 FTN
C     Read in kinetic rates for each of 3 types of algae. Also, read   !5/12/97 FTN
C     separate values for stoichiometric coeffs for each algae type.   !5/12/97 FTN
C     Then read temperature rate multipliers for each type of algae.   !5/12/97 FTN
C                                                                      !5/12/97 FTN
C     READ (CON,1030)  AGROW,  AMORT,  AEXCR,  ARESP,  ASETL, ASATUR,  !5/12/97 FTN
C    .                 ALGDET                                          !5/12/97 FTN
C     READ (CON,1030)  AGT1,   AGT2,   AGT3,   AGT4,   AGK1,  AGK2,    !5/12/97 FTN
C    .                 AGK3,   AGK4                                    !5/12/97 FTN
      READ (CON,1001)                                                  !5/12/97 FTN
      DO JA=1,NAP                                                      !5/12/97 FTN
        READ (CON,1120) AGROW(JA), AMORT(JA), AEXCR(JA), ARESP(JA),    !5/12/97 FTN
     &                  ASETL(JA),  AHSP(JA),  AHSN(JA), AHSSI(JA),    !5/12/97 FTN
     &                  ASATUR(JA)                                     !5/12/97 FTN
      END DO                                                           !5/12/97 FTN
```

```
      READ (CON,1001)                                                     !5/12/97 FTN
      DO JA=1,NAP                                                         !5/12/97 FTN
        READ (CON,1120) ABIOP(JA), ABION(JA), ABIOSI(JA), ABIOC(JA)       !5/12/97 FTN
      END DO                                                              !5/12/97 FTN
      READ (CON,1001)                                                     !5/12/97 FTN
      DO JA=1,NAP                                                         !5/12/97 FTN
        READ (CON,1120) AGT1(JA), AGT2(JA), AGT3(JA), AGT4(JA),           !5/12/97 FTN
     &                  AGK1(JA), AGK2(JA), AGK3(JA), AGK4(JA)            !5/12/97 FTN
      END DO                                                              !5/12/97 FTN
C                                                                         !5/12/97 FTN
      READ (CON,1030)  LABDK,  LRFDK,  REFDK
C     READ (CON,1030)  DETDK,  DSETL                                      !5/16/97 FTN
      READ (CON,1030)  DETDK,  DSETL,  ALGDET                             !5/16/97 FTN
      READ (CON,1030)  OMT1,   OMT2,   OMK1,   OMK2
      READ (CON,1030)  SEDDK,  FSOD
      READ (CON,1030) (SOD(I),I=1,IMP)
      READ (CON,1030)  KBOD,   TBOD,   RBOD
C     READ (CON,1030)  PO4REL, PARTP,  AHSP                               !5/13/97 FTN
      READ (CON,1030)  PO4REL, PARTP                                      !5/13/97 FTN
C     READ (CON,1030)  NH3REL, NH3DK,  PARTN,  AHSN                       !5/13/97 FTN
      READ (CON,1030)  NH3REL, NH3DK,  PARTN                              !5/13/97 FTN
      READ (CON,1030)  NH3T1,  NH3T2,  NH3K1,  NH3K2
C                                                                         !3/27/98 FTN
C     Read variable to indicate whether or not to print denitrification !3/27/98 FTN
C                                                                         !3/27/98 FTN
C     READ (CON,1030)  NO3DK                                              !3/27/98 FTN
      READ (CON,1031)  NO3DK,  DNPRN                                      !3/27/98 FTN
 1031 FORMAT(//(8X,F8.0,5X,A3))                                           !3/27/98 FTN
      READ (CON,1030)  NO3T1,  NO3T2,  NO3K1,  NO3K2
      READ (CON,1030)  SIREL                                              !5/16/97 FTN
      READ (CON,1030)  CO2REL
C     READ (CON,1030)  FEREL,  FESETL                                     !1/19/00 FTN
      READ (CON,'(//)')                                                   !1/20/00 FTN
      READ (CON,1030)  O2NH3,  O2ORG,  O2RESP, O2ALG, BIOP,  BION,
C    .                 BIOC
     .                 BIOSI,  BIOC
      READ (CON,1030)  O2LIM

***** Read input filenames

      READ (CON,1000)  BTHFN
      READ (CON,1000)  VPRFN
      READ (CON,1000)  LPRFN
      READ (CON,1000)  RSIFN
      READ (CON,1000)  METFN
      READ (CON,1000)  QWDFN
      READ (CON,1000) (QINFN(JB),JB=1,NBP)
      READ (CON,1000) (TINFN(JB),JB=1,NBP)
      READ (CON,1000) (CINFN(JB),JB=1,NBP)
      READ (CON,1000) (QOTFN(JB),JB=1,NBP)
      READ (CON,1000) (QTRFN(JT),JT=1,NTP)
      READ (CON,1000) (TTRFN(JT),JT=1,NTP)
      READ (CON,1000) (CTRFN(JT),JT=1,NTP)
      READ (CON,1000) (QDTFN(JB),JB=1,NBP)
      READ (CON,1000) (TDTFN(JB),JB=1,NBP)
      READ (CON,1000) (CDTFN(JB),JB=1,NBP)
      READ (CON,1000) (PREFN(JB),JB=1,NBP)
      READ (CON,1000) (TPRFN(JB),JB=1,NBP)
      READ (CON,1000) (CPRFN(JB),JB=1,NBP)
      READ (CON,1000) (EUHFN(JB),JB=1,NBP)
      READ (CON,1000) (TUHFN(JB),JB=1,NBP)
      READ (CON,1000) (CUHFN(JB),JB=1,NBP)
      READ (CON,1000) (EDHFN(JB),JB=1,NBP)
      READ (CON,1000) (TDHFN(JB),JB=1,NBP)
      READ (CON,1000) (CDHFN(JB),JB=1,NBP)
C                                                                         !10/6/98 FTN
C     Insert lines for AGPM output (from source code sent by G. Hauser) !10/6/98 FTN
      READ (CON,1000) AGPMFN                                              !10/6/98 FTN

***** Read output filenames
```

```
      READ (CON,1000)  SNPFN
      READ (CON,1000)  TSRFN
      READ (CON,1000)  PRFFN
      READ (CON,1000)  VPLFN
      READ (CON,1000)  CPLFN
      READ (CON,1000)  SPRFN

***** Read bathymetry file

      OPEN (BTH,FILE=BTHFN,STATUS='OLD')
      READ (BTH,*)
      READ (BTH,1180) (DLX(I), I=1,IMP)
      READ (BTH,1180) (ELWS(I),I=1,IMP)
      READ (BTH,1180) (PHI0(I),I=1,IMP)
      READ (BTH,1180) (H(K),   K=1,KMP)
      DO I=1,IMP
        READ (BTH,1180) (B(K,I),K=1,KMP)
      END DO

***** Initialize logical control variables

      CONSTITUENTS = CCC.EQ.' ON'
      RESTART_IN   = RSIC.EQ.' ON'
      ISO_TEMP     = INT(T2I).GE.0
      VERT_TEMP    = INT(T2I).EQ.-1
      LONG_TEMP    = INT(T2I).LT.-1
      OPEN_VPR     = VERT_TEMP
      OPEN_LPR     = LONG_TEMP
      DO JC=1,NCP
        ISO_CONC(JC)  = INT(C2I(JC)).GE.0
        VERT_CONC(JC) = INT(C2I(JC)).EQ.-1
        LONG_CONC(JC) = INT(C2I(JC)).LT.-1
        IF (VERT_CONC(JC)) OPEN_VPR = .TRUE.
        IF (LONG_CONC(JC)) OPEN_LPR = .TRUE.
      END DO

***** Read restart data

      IF (RESTART_IN) THEN
        OPEN (RSI,FILE=RSIFN,STATUS='OLD',FORM='UNFORMATTED')
        READ (RSI) KT,      NIT,     NV,      KMIN,    IMIN
        READ (RSI) DLTDP,   SNPDP,   TSRDP,   VPLDP,   PRFDP,   CPLDP,
     .             RSODP,   WSCDP,   SCRDP
        READ (RSI) JDAY,    JDAYG,   YEAR,    ELTM,    DLT,     DLTAV,
     .             MINDLT,  JDMIN,   CURMAX
        READ (RSI) NXTMSN,  NXTMTS,  NXTMPR,  NXTMCP,  NXTMVP,  NXTMRS,
     .             NXTMSC
        READ (RSI) VOLIN,   VOLOUT,  VOLUH,   VOLDH,   VOLPR,   VOLTR,
     .             VOLDT,   VOLWD,   VOLEV,   VOLSBR,  CMBRT
        READ (RSI) TSSUH2,  TSSDH2,  CSSUH2,  CSSDH2,  QUH2,    QDH2
        READ (RSI) Z,       SZ,      SKTI,    ICE,     ICETH
        READ (RSI) U,       W,       SU,      SW,      AZ,      T1,
     .             T2,      C1,      C2
      END IF

***** Close files

      CLOSE (CON)
      CLOSE (BTH)
      IF (RESTART_IN) CLOSE (RSI)

***** Input FORMATs

 1001 FORMAT(/)
 1000 FORMAT(//(8X,A72))
 1010 FORMAT(//(8X,2F8.0,I8))
 1020 FORMAT(//8X,I8,8F8.0)
 1030 FORMAT(//(8X,9F8.0))
 1040 FORMAT(//(8X,4I8))
 1050 FORMAT(//8X,2F8.0,3X,A5,6(5X,A3))
 1060 FORMAT(//(8X,9(5X,A3)))
```

```
1070 FORMAT(//13X,A3,2A8,6F8.0)
1080 FORMAT(//8X,A8,F8.0,2A8)
1090 FORMAT(//(8X,9I8))
1100 FORMAT(//(8X,9A8))
1110 FORMAT(:8X,9A8)
1120 FORMAT(:8X,9F8.0)
1130 FORMAT(:8X,9I8)
1140 FORMAT(//11X,A5,8(5X,A3))
1150 FORMAT(//13X,A3,I8,5X,A3)
1160 FORMAT(//13X,A3,8I8)
1170 FORMAT(//8X,3(5X,A3),I8)
1180 FORMAT(//(10F8.0))
1190 FORMAT(//(8X,9F8.0))
```

```
****************************************************************************
**                      Task 1.4.1: Zero Variables                       **
****************************************************************************

      DO I=1,17
        DO K=1,KMP
          CONV(K,I)  = BLANK
          CONV1(K,I) = BLANK1
        END DO
      END DO
      DO I=1,IMP
        DO K=1,KMP
C         LFPR(K,I) = BLANK                                         !5/16/97 FTN
          DO JA=1,NAP                                               !5/16/97 FTN
            LFPR(K,I,JA) = BLANK                                    !5/16/97 FTN
          END DO                                                    !5/16/97 FTN
        END DO
      END DO
```

```
************************************************************************
**                   Task 1.4.2: Miscellaneous Variables            **
************************************************************************

***** Logical controls

      OPEN_FILES       = .TRUE.
      VOLUME_WARNING   = .TRUE.
      UPDATE_KINETICS  = .TRUE.
      END_RUN          = .FALSE.
      WARNING_OPEN     = .FALSE.
      TRIBUTARIES      = NTR.GT.0
      WITHDRAWALS      = NWD.GT.0
      PLACE_QIN        = PQC.EQ.' ON'
      EVAPORATION      = EVC.EQ.' ON'
      VOLUME_BALANCE   = VBC.EQ.' ON'
      PRECIPITATION    = PRC.EQ.' ON'
      SCREEN_OUTPUT    = SCRC.EQ.' ON'
      SNAPSHOT         = SNPC.EQ.' ON'
      CONTOUR          = CPLC.EQ.' ON'
      VECTOR           = VPLC.EQ.' ON'
      PROFILE          = PRFC.EQ.' ON'
      SPREADSHEET      = SPRC.EQ.' ON'
      ICE_CALC         = ICEC.EQ.' ON'
      PLACE_QTR        = PQTC.EQ.' ON'
      TIME_SERIES      = TSRC.EQ.' ON'
      RESTART_OUT      = RSOC.EQ.' ON'
      INTERP_TRIBS     = TRIC.EQ.' ON'
      INTERP_HEAD      = HDIC.EQ.' ON'
      INTERP_WITHDRWL  = WDIC.EQ.' ON'
      INTERP_MET       = METIC.EQ.' ON'
      INTERP_INFLOW    = INFIC.EQ.' ON'
      INTERP_DTRIBS    = DTRIC.EQ.' ON'
      INTERP_OUTFLOW   = OUTIC.EQ.' ON'
      LIMITING_DLT     = HPRC(4).EQ.' ON'
      NO_INFLOW        = QINC.EQ.'OFF'
      NO_HEAT          = HEATC.EQ.'OFF'
      NO_WIND          = WINDC.EQ.'OFF'
      NO_OUTFLOW       = QOUTC.EQ.'OFF'
      LONG_FORM        = FORM.EQ.' LONG'
      SHORT_FORM       = FORM.NE.' LONG'
      UPWIND           = SLTR.EQ.'  UPWIND'
      TERM_BY_TERM     = SLHEAT.NE.'      ET'
      DETAILED_ICE     = SLICE.EQ.'  DETAIL'
     .                   .OR.(ICE_CALC.AND.DETAILED_ICE)
      MASS_BALANCE     = CONSTITUENTS.AND.MBC.EQ.' ON'
      SUSP_SOLIDS      = CONSTITUENTS.AND.ACC(2).EQ.' ON'
      OXYGEN_DEMAND    = CONSTITUENTS.AND.ACC(12).EQ.' ON'
      LIMITING_FACTOR  = CONSTITUENTS.AND.ACC(7).EQ.' ON'
     .                   .AND.LIMC.EQ.' ON'
      FRESH_WATER      = CONSTITUENTS.AND.ACC(4).EQ.' ON'
     .                   .AND.WTYPE.EQ.'FRESH'
      SALT_WATER       = CONSTITUENTS.AND.ACC(4).EQ.' ON'
     .                   .AND.WTYPE.EQ.' SALT'
      SHIFT_DEMAND     = CONSTITUENTS.AND.ACC(12).EQ.' ON'
     .                   .AND.SDC.EQ.' ON'
      INTERPOLATE      = INTERP_INFLOW.OR.INTERP_TRIBS.OR.INTERP_DTRIBS
     .                   .OR.INTERP_OUTFLOW.OR.INTERP_WITHDRWL
     .                   .OR.INTERP_HEAD.OR.INTERP_MET
      LEAP_YEAR        = MOD(YEAR,4).EQ.0
      IF (RESTART_IN) THEN
        WINTER = .FALSE.
        IF (JDAY.GT.300.0.OR.JDAY.LT.40.0) WINTER = .TRUE.
      ELSE
        WINTER = .FALSE.
        IF (TMSTRT.GT.300.0.OR.TMSTRT.LT.40.0) WINTER = .TRUE.
      END IF
      DO JC=1,NCP
        TRANSPORT(JC) = .TRUE.
        IF (JC.EQ.13.OR.(JC.GT.15.AND.JC.LT.20)) TRANSPORT(JC) = .FALSE.
      END DO
```

```
      CALL_RATES = .FALSE.                                            !1/20/00 FTN
      DO JC=5,13
        IF (ACC(JC).EQ.' ON') CALL_RATES = .TRUE.
      END DO
      IF (.NOT.CALL_RATES) THEN                                       !5/16/97 FTN
        IF (ACC(03).EQ.' ON') CALL_RATES = .TRUE.                     !5/16/97 FTN
C                                                                     !1/20/00 FTN
C       State variable #20 has been changed from iron to age of water !1/20/00 FTN
C                                                                     !1/20/00 FTN
C       IF (ACC(20).EQ.' ON') CALL_RATES = .TRUE.                     !1/20/00 FTN
        IF (ACC(21).EQ.' ON') CALL_RATES = .TRUE.                     !5/16/97 FTN
        IF (ACC(22).EQ.' ON') CALL_RATES = .TRUE.                     !5/16/97 FTN
        IF (ACC(23).EQ.' ON') CALL_RATES = .TRUE.                     !5/16/97 FTN
        IF (ACC(24).EQ.' ON') CALL_RATES = .TRUE.                     !5/16/97 FTN
      END IF                                                          !5/16/97 FTN
      DO JB=1,NBP
        UP_FLOW(JB)        = UHS(JB).EQ.0
        DN_FLOW(JB)        = DHS(JB).EQ.0
        UP_HEAD(JB)        = UHS(JB).NE.0
        DN_HEAD(JB)        = DHS(JB).NE.0
        UH_INTERNAL(JB)    = UHS(JB).GT.0
        DH_INTERNAL(JB)    = DHS(JB).GT.0
        UH_EXTERNAL(JB)    = UHS(JB).EQ.-1
        DH_EXTERNAL(JB)    = DHS(JB).EQ.-1
        DIST_TRIBS(JB)     = DTRC(JB).EQ.' ON'
        SEL_WITHDRAWAL(JB) = SWC(JB).EQ.' ON'
        DO JS=1,NSTR(JB)
          POINT_SINK(JS,JB) = SINK(JS,JB).EQ.'   POINT'
        END DO
        IF (UH_EXTERNAL(JB).OR.DH_EXTERNAL(JB)) HEAD_BOUNDARY = .TRUE.
      END DO

***** Convert rates from per-day to per-second

      KBOD   = KBOD/86400.0
C     ASETL  = ASETL/86400.0                                          !5/13/97 FTN
      SSETL  = SSETL/86400.0
      DSETL  = DSETL/86400.0
      CSETL  = CSETL/86400.0                                          !4/06/95 FTN
      LABDK  = LABDK/86400.0
      REFDK  = REFDK/86400.0
      LRFDK  = LRFDK/86400.0
      NH3DK  = NH3DK/86400.0
      NO3DK  = NO3DK/86400.0
      DETDK  = DETDK/86400.0
      COLDK  = COLDK/86400.0
      COLKL  = COLKL/86400.0                                          !4/06/95 FTN
      SEDDK  = SEDDK/86400.0
C     AEXCR  = AEXCR/86400.0                                          !5/13/97 FTN
C     AMORT  = AMORT/86400.0                                          !5/13/97 FTN
C     ARESP  = ARESP/86400.0                                          !5/13/97 FTN
C     AGROW  = AGROW/86400.0                                          !5/13/97 FTN
      DO JA=1,NAP                                                     !5/13/97 FTN
        AEXCR(JA) = AEXCR(JA)/86400.0                                 !5/13/97 FTN
        AMORT(JA) = AMORT(JA)/86400.0                                 !5/13/97 FTN
        ARESP(JA) = ARESP(JA)/86400.0                                 !5/13/97 FTN
        AGROW(JA) = AGROW(JA)/86400.0                                 !5/13/97 FTN
        ASETL(JA) = ASETL(JA)/86400.0                                 !5/13/97 FTN
      END DO                                                          !5/13/97 FTN
!5/13/97 FTN
```

```
****************************************************************************
**                           Task 1.5: Outputs                            **
****************************************************************************

***** Open output files (contains Lahey FORTRAN specific I/O)

      IF (RESTART_IN) THEN
        IF (SNAPSHOT)    OPEN (SNP,FILE=SNPFN,
     .                         CARRIAGECONTROL='FORTRAN',                !FORTRAN
     .                         POSITION='APPEND')                        !FORTRAN
        IF (TIME_SERIES) OPEN (TSR,FILE=TSRFN,
     .                         POSITION='APPEND')                        !FORTRAN
        IF (VECTOR)      OPEN (VPL,FILE=VPLFN,
     .                         POSITION='APPEND')                        !FORTRAN
        IF (PROFILE)     OPEN (PRF,FILE=PRFFN,
     .                         POSITION='APPEND')                        !FORTRAN
        IF (SPREADSHEET) OPEN (PRF,FILE=SPRFN,
     .                         POSITION='APPEND')                        !FORTRAN
        IF (CONTOUR)     OPEN (CPL,FILE=CPLFN,
     .                         POSITION='APPEND')                        !FORTRAN
        REWIND (TSR)
        DO J=1,6
          READ (TSR,5000,END=10000)
        END DO
        READ (TSR,5020,END=10000) (CNAME1(CN(JC)),CUNIT(CN(JC)),
     .                             JC=1,NAC)
        READ (TSR,5030,END=10000)  JDAYTS
        DO WHILE (JDAYTS.LT.JDAY)
          READ (TSR,5030,END=10000) JDAYTS
        END DO
      ELSE
        IF (SNAPSHOT)    OPEN (SNP,FILE=SNPFN,STATUS='UNKNOWN',
     .                         CARRIAGECONTROL='FORTRAN')                !FORTRAN
        IF (TIME_SERIES) OPEN (TSR,FILE=TSRFN,STATUS='UNKNOWN')
        IF (VECTOR)      OPEN (VPL,FILE=VPLFN,STATUS='UNKNOWN')
        IF (PROFILE)     OPEN (PRF,FILE=PRFFN,STATUS='UNKNOWN')
        IF (SPREADSHEET) OPEN (SPR,FILE=SPRFN,STATUS='UNKNOWN')
        IF (CONTOUR)     OPEN (CPL,FILE=CPLFN,STATUS='UNKNOWN')
      END IF
10000 CONTINUE
C                                                                        !10/6/98 FTN
C     Insert lines for AGPM output (from source code sent by G. Hauser) !10/6/98 FTN
      IF (AGPM .AND. (.NOT.CONSTITUENTS)) WRITE (*,*) 'ERROR! --> If'// !2/18/99 FTN
     & ' AGPM is turned on, then constituents must also be turned on'  !2/18/99 FTN
      IF (AGPM .AND. CONSTITUENTS .AND. NAC.EQ.0) WRITE (*,*)          !6/01/00 FTN
     & 'ERROR! --> If AGPM is turned on, then at least 1 ' //          !6/01/00 FTN
     & 'constituent must be turned on'                                 !6/01/00 FTN
      IF (AGPM) CALL OPENP(AGPMFN,INTPLD,INTPLH,IMP,KMP,NBP,           !10/6/98 FTN
     X US,DS,EL,DLX,TMEND,NCP,NAC,CN,CPRC)                             !10/6/98 FTN
C                                                                        !10/6/98 FTN
      OPEN (WRN,FILE='wrn.opt',STATUS='UNKNOWN')

***** Plot files

      IF (.NOT.RESTART_IN) THEN
C       IF (PROFILE) THEN                                                !1/30/95 FTN
        IF (PROFILE .AND. PRSTYL.NE.'FTN') THEN                          !1/31/95 FTN
          WRITE (PRF,2500)  TITLE
          WRITE (PRF,2510) (CPRC(JC),JC=1,NCP),' ON'
          WRITE (PRF,2520) (CNAME1(JC),CUNIT(JC),JC=1,NCP),
     .                     'Temperature     ','deg C  '
          WRITE (PRF,2530)  CONSTITUENTS,NAC+1,(CN(JC),JC=1,NAC),22
          WRITE (PRF,2540)  PRFDP,KT,(KB(IPRF(I)),I=1,NIPRF)
          WRITE (PRF,2550)  H
          DO JC=1,NAC
            IF (CPRC(CN(JC)).EQ.' ON') THEN
              DO JPRF=1,NIPRF
                I   = IPRF(JPRF)
                NRS = KB(I)-KT+1
                WRITE (PRF,2560) CN(JC),NRS,(C2(K,I,CN(JC)),K=KT,KB(I))
              END DO
```

```
          END IF
        END DO
        DO JPRF=1,NIPRF
          I   = IPRF(JPRF)
          NRS = KB(I)-KT+1
          WRITE (PRF,2560) 22,NRS,(T2(K,I),K=KT,KB(I))
        END DO
      END IF
      IF (PROFILE .AND. PRSTYL.EQ.'FTN') WRITE (PRF,2505)                !9/24/97 FTN
     &                          (CNAME3(CN(JC)),JC=1,NAC)                !9/24/97 FTN
 2505 FORMAT (51H"DATE$" "JDAY" "SEG" "LAYER"   "ELEVFT"      "TEMP",   !9/24/97 FTN
     &         8X, 21(1H",A6,1H",8X))                                    !9/24/97 FTN
C     IF (TIME_SERIES) THEN                                              !1/30/95 FTN
      IF (TIME_SERIES .AND. TSSTYL.NE.'FTN') THEN                        !1/31/95 FTN
        WRITE (TSR,5000)  TITLE
        WRITE (TSR,5010)  NAC,(CN(JC),JC=1,NAC)
        WRITE (TSR,5020) (CNAME1(CN(JC)),CUNIT(CN(JC)),JC=1,NAC)
      END IF
      IF (TIME_SERIES .AND. TSSTYL.EQ.'FTN') THEN                        !3/30/98 FTN
        IF (ACC(22).EQ.' ON' .AND. ACC(23).EQ.' ON' .AND.                !3/30/98 FTN
     &                             ACC(24).EQ.' ON') THEN                !3/30/98 FTN
C                                                                        !6/22/98 FTN
C         If algae are being simulated, identify the upstream most       !6/22/98 FTN
C         and downstream most profile segments in the main stem          !6/22/98 FTN
C         (branch 1) for time series output at selected segments.        !6/22/98 FTN
C         Also identify the mid-lake station as the first segment        !6/22/98 FTN
C         listed in the control file that is between IPMIN and IPMAX.    !6/22/98 FTN
C                                                                        !6/22/98 FTN
          IPMAX = 0                                                      !3/30/98 FTN
          IPMIN = 99                                                     !3/30/98 FTN
          DO JPRF = 1, NIPRF                                             !3/30/98 FTN
            IF (IPRF(JPRF).LT.IPMIN) IPMIN = IPRF(JPRF)                  !3/30/98 FTN
            IF (IPRF(JPRF).GT.IPMAX .AND.                                !6/22/98 FTN
     &          IPRF(JPRF).LE.DS(1)) IPMAX = IPRF(JPRF)                  !6/22/98 FTN
          END DO                                                         !3/30/98 FTN
          DO JPRF = NIPRF, 1, -1                                         !6/22/98 FTN
            IF (IPRF(JPRF).GT.IPMIN .AND. IPRF(JPRF).LT.IPMAX)           !6/22/98 FTN
     &                             IPML = IPRF(JPRF)                     !6/22/98 FTN
          END DO                                                         !6/22/98 FTN
          WRITE (TSR,2515) (CNAME3(CN(JC)),JC=1,NAC), "ALG1US",          !3/30/98 FTN
     &        "ALG2US", "ALG3US", "ALG1ML", "ALG2ML", "ALG3ML",          !6/22/98 FTN
     &        "ALG1DS", "ALG2DS", "ALG3DS", "HYDOUS", "HYDOML",          !6/22/98 FTN
     &        "HYDODS", "SECCUS", "SECCML", "SECCDS"                     !6/22/98 FTN
        ELSE                                                             !3/30/98 FTN
          WRITE (TSR,2515) (CNAME3(CN(JC)),JC=1,NAC)                     !3/30/98 FTN
        END IF                                                           !3/30/98 FTN
      END IF                                                             !3/30/98 FTN
 2515 FORMAT (42H"YEAR" "JDAY"    "ELEVFT"      "SURFTEMP", 7X,          !9/30/97 FTN
     &         9H"OUTTEMP", 8X, 39(1H",A6,1H",8X))                       !6/22/98 FTN
C     IF (CONTOUR) THEN                                                  !1/30/95 FTN
      IF (CONTOUR .AND. CPSTYL.NE.'FTN') THEN                            !1/31/95 FTN
        WRITE (CPL,5000) TITLE
        WRITE (CPL,8000) NBP
        WRITE (CPL,8000) IMP,KMP
        DO JB=1,NBP
          WRITE(CPL,8010) US(JB),DS(JB)
          WRITE(CPL,8010) (KB(I),I=US(JB),DS(JB))
        END DO
        WRITE (CPL,8020) DLX
        WRITE (CPL,8020) H
        WRITE (CPL,8000) NAC
        WRITE (CPL,8030) (CNAME1(CN(JC)),JC=1,NAC)
      END IF
C     IF (VECTOR) THEN                                                   !1/30/95 FTN
      IF (VECTOR .AND. VPSTYL.NE.'FTN') THEN                             !1/31/95 FTN
        WRITE (VPL,*) TITLE
        WRITE (VPL,*) H,KB,US,DS,DLX
      END IF
    END IF

***** Screen output
```

```
IF (SCREEN_OUTPUT) CALL SCREEN_OPEN
```

```
***************************************************************************
**                          Task 2: Calculations                          **
***************************************************************************

      IF (.NOT.SCREEN_OUTPUT) WRITE (*,*)                                !1/30/95 FTN
      JDPREV = -999                                                      !4/16/97 FTN
      RS_SUM = 0.0                                                       !4/23/95 FTN
      RS_CNT = 0.0                                                       !4/23/95 FTN
      EVAPVOL = 0.0                                                      !4/26/95 FTN
      DO WHILE (.NOT.END_RUN)
        IF (.NOT.SCREEN_OUTPUT) THEN                                     !1/30/95 FTN
          IF (INT(JDAY).GT.JDPREV) THEN                                  !4/17/97 FTN
            WRITE (*,'(A25,I5)') '+...Working on Julian day', INT(JDAY) !4/16/97 FTN
            JDPREV = INT(JDAY)                                           !4/16/97 FTN
          END IF                                                         !1/30/95 FTN
        END IF                                                           !1/30/95 FTN
        IF (JDAY.GE.NXTVD) CALL TIME_VARYING_DATA  (JDAY,NXTVD)
        IF (INTERPOLATE)   CALL INTERPOLATE_INPUTS (JDAY)

***************************************************************************
**                  Task 2.1: Hydrodynamic Sources/Sinks                  **
***************************************************************************

        DO JB=1,NBP
          IU = CUS(JB)
          ID = DS(JB)
          IF (SEL_WITHDRAWAL(JB)) CALL SELECTIVE_WITHDRAWAL
        END DO

******* Timestep violation entry point

10010   CONTINUE
        DO JB=1,NBP
          IU = CUS(JB)
          ID = DS(JB)
          IF (EVAPORATION) THEN
            EVBR(JB) = 0.0
C           FW       = WFC(WSCDP)*(9.2+0.46*WIND*WIND)                   !1/31/95 FTN
C                                                                        !1/31/95 FTN
C           Calculate wind function using coefficients read from         !1/31/95 FTN
C           control file (in SI units).                                  !1/31/95 FTN
C                                                                        !1/31/95 FTN
            FW = WFC(WSCDP) * (FW_A0 + FW_A1*WIND + FW_A2*WIND*WIND)     !1/31/95 FTN
            DO I=IU,ID
              TM    = (T2(KT,I)+TDEW)*0.5
              VPTG  = 0.35+0.015*TM+0.0012*TM*TM
              EV(I) = VPTG*(T2(KT,I)-TDEW)*FW*B(KT,I)*DLX(I)/2.45E9
              IF (EV(I).LT.0.0.OR.ICE(I)) EV(I) = 0.0
              QSS(KT,I) = QSS(KT,I)-EV(I)
              EVBR(JB)  = EVBR(JB)+EV(I)
            END DO
          END IF
          IF (PRECIPITATION) THEN
            QPRBR(JB) = 0.0
            DO I=IU,ID
              QPR(I)    = PR(JB)*B(KTI(I),I)*DLX(I)
              QPRBR(JB) = QPRBR(JB)+QPR(I)
              QSS(KT,I) = QSS(KT,I)+QPR(I)
            END DO
          END IF
          IF (TRIBUTARIES) THEN
            DO JT=1,NTR

************* Inflow fractions

              IF (JB.EQ.JBTR(JT)) THEN
                I = MAX(ITR(JT),IU)
                DO K=KT,KB(I)
                  QTRF(K,JT) = 0.0
                END DO
                IF (PLACE_QTR) THEN
```

```
****************** Inflow layer

                  K     = KT
                  RHOTR = DENSITY (TTR(JT),CTR(2,JT),CTR(4,JT))
                  DO WHILE (RHOTR.GT.RHO(K,I).AND.K.LT.KB(I))
                    K = K+1
                  END DO
                  KTTR(JT) = K
                  KBTR(JT) = K

****************** Layer inflows

                  VQTR  = QTR(JT)*DLT
                  VQTRI = VQTR
                  QTRFR = 1.0
                  INCR  = -1
                  DO WHILE (QTRFR.GT.0.0)
                    IF (K.LE.KB(I)) THEN
                      VOL = BH(K,I)*DLX(I)
                      IF (K.EQ.KT) VOL = BHKT2(I)*DLX(I)
                      IF (VQTR.GT.0.5*VOL) THEN
                       QTRF(K,JT) = 0.5*VOL/VQTRI
                       QTRFR      = QTRFR-QTRF(K,JT)
                       VQTR       = VQTR-QTRF(K,JT)*VQTRI
                        IF (K.EQ.KT) THEN
                          K    = KBTR(JT)
                          INCR = 1
                        END IF
                      ELSE
                        QTRF(K,JT) = QTRFR
                        QTRFR      = 0.0
                      END IF
                      IF (INCR.LT.0) KTTR(JT) = K
                      IF (INCR.GT.0) KBTR(JT) = MIN(KB(I),K)
                      K = K+INCR
                    ELSE
                      QTRF(KT,JT) = QTRFR
                      QTRFR       = 0.0
                    END IF
                  END DO
                ELSE
                  BHSUM = BHKT2(I)
                  DO K=KT+1,KB(I)
                    BHSUM = BHSUM+BH(K,I)
                  END DO
                  QTRF(KT,JT) = BHKT2(I)/BHSUM
                  DO K=KT+1,KB(I)
                    QTRF(K,JT) = BH(K,I)/BHSUM
                  END DO
                  KTTR(JT) = KT
                  KBTR(JT) = KB(I)
                END IF
                DO K=KTTR(JT),KBTR(JT)
                  QSS(K,I) = QSS(K,I)+QTR(JT)*QTRF(K,JT)
                END DO
              END IF
            END DO
          END IF
          IF (DIST_TRIBS(JB)) THEN
            DO I=IU,ID
C                                                                       !2/11/95 FTN
C             Distribute flow from distributed tributary proportional   !2/11/95 FTN
C             to segment lengths (which is representative of shore      !2/11/95 FTN
C             length) rather than surface area.                         !2/11/95 FTN
C             Do not put dist trib flow into segments d/s of MXSEGDTR.  !4/23/95 FTN
C                                                                       !2/11/95 FTN
C             QDT(I)     = QDTR(JB)*B(KT,I)*DLX(I)/AKBR(KT,JB)          !2/11/95 FTN
              IF (I.LE.MXSEGDTR) QDT(I) = QDTR(JB) * DLX(I)/DLXTOT(JB)  !4/23/95 FTN
              QSS(KT,I) = QSS(KT,I)+QDT(I)
            END DO
```

```
  END IF
  IF (WITHDRAWALS) THEN
    DO JW=1,NWD
      IF (JB.EQ.JBWD(JW)) THEN
        I         = IWD(JW)
        K         = MAX(KT,KWD(JW))
        QSS(K,I) = QSS(K,I)-QWD(JW)
      END IF
    END DO
  END IF
  IF (UH_INTERNAL(JB)) THEN
    DO K=KT,KB(IU-1)
      QSS(K,UHS(JB)) = QSS(K,UHS(JB))-QUH2(K,JB)/DLT
    END DO
  END IF
  IF (DH_INTERNAL(JB)) THEN
    DO K=KT,KB(ID+1)
      QSS(K,DHS(JB)) = QSS(K,DHS(JB))+QDH2(K,JB)/DLT
    END DO
  END IF
END DO
```

```
******************************************************************************
**          Task 2.3: Temporal Balance Terms and Temperatures              **
******************************************************************************

        IF (.NOT.NO_HEAT) THEN
          CALL HEAT_EXCHANGE (WFC(WSCDP),JDAY)
          RS = SRO*RHOI*CP
          RS_SUM = RS_SUM + RS                                        !4/23/95 FTN
          RS_CNT = RS_CNT + 1.0                                       !4/23/95 FTN
C         IF (TERM_BY_TERM) CALL RADIATION (RS,RSN,RAN)               !1/31/95 FTN
          IF (TERM_BY_TERM) CALL RADIATION (RS,RSN,RAN,SRMULT)        !1/31/95 FTN
        END IF
        DO JB=1,NBP
          IU = CUS(JB)
          ID = DS(JB)

********* Heat exchange

          IF (.NOT.NO_HEAT) THEN
            DO I=IU,ID

************* Surface

              IF (.NOT.ICE(I)) THEN
                TOTALG = 0.0                                          !5/16/97 FTN
                DO JA=1,NAP                                           !5/16/97 FTN
                  TOTALG = TOTALG + ALGAE(KT,I,JA)                    !5/16/97 FTN
                END DO                                                !5/16/97 FTN
C               GAMMA      = EXH2O+EXINOR*SS(KT,I)+EXORG*(ALGAE(KT,I)  !5/16/97 FTN
                GAMMA      = EXH2O+EXINOR*SS(KT,I)+EXORG*(TOTALG      !5/16/97 FTN
     .                       +DETRIT(KT,I))
                DEPTH      = HKT1(I)
                TSS(KT,I) = TSS(KT,I)-(1.0-BETA)*SRO*EXP(-GAMMA*DEPTH)
     .                       *B(KT,I)*DLX(I)
                IF (TERM_BY_TERM) THEN
                  CALL SURFACE_TERMS (WFC(WSCDP),WIND,T2(KT,I),RB,RE,RC)
                  RN(I)     = (RSN+RAN-RB-RE-RC)
                  TSS(KT,I) = TSS(KT,I)+RN(I)/RHOI/CP*B(KTI(I),I)*DLX(I)
                ELSE
                  TSS(KT,I) = TSS(KT,I)+CSHE*(ET-T2(KT,I))*B(KTI(I),I)
     .                         *DLX(I)
                END IF
                DO K=KT+1,KB(I)
                  TOTALG = 0.0                                        !5/16/97 FTN
                  DO JA=1,NAP                                         !5/16/97 FTN
                    TOTALG = TOTALG + ALGAE(K,I,JA)                   !5/16/97 FTN
                  END DO                                              !5/16/97 FTN
C                 GAMMA    = EXH2O+EXINOR*SS(K,I)+EXORG*(ALGAE(K,I)    !5/16/97 FTN
                  GAMMA    = EXH2O+EXINOR*SS(K,I)+EXORG*(TOTALG       !5/16/97 FTN
     .                       +DETRIT(K,I))
                  TSS(K,I) = TSS(K,I)+(1.0-BETA)*SRO*(EXP(-GAMMA*DEPTH)
     .                       -EXP(-GAMMA*(DEPTH+H(K))))*B(K,I)*DLX(I)
                  DEPTH    = DEPTH+H(K)
                END DO
              END IF
```

```
************************************************************************
**                       Task 2.4:  Constituents                      **
************************************************************************

        IF (CONSTITUENTS) THEN
          PALT = (1.-((EL(KT)-Z(DS(1)))/1000.0)/44.3)**5.25
          DO JB=1,NBP
            IU = CUS(JB)
            ID = DS(JB)

*********** Internal sources/sinks

            IF (UPDATE_KINETICS) THEN
              IF (CALL_RATES) THEN
                CALL RATE_MULTIPLIERS
                CALL DECAY_CONSTANTS
              END IF
              DO JAC=1,NAC
                JC = CN(JAC)
                IF (JC.EQ.2)  CALL SUSPENDED_SOLIDS
                IF (JC.EQ.3)  CALL COLIFORM
                IF (JC.EQ.5)  CALL LABILE_DOM
                IF (JC.EQ.6)  CALL REFRACTORY_DOM
C               IF (JC.EQ.7)  CALL PHYTOPLANKTON                       !5/13/97 FTN
                IF (JC.EQ.7)  CALL SILICA                              !5/13/97 FTN
                IF (JC.EQ.8)  CALL DETRITUS
                IF (JC.EQ.9)  CALL PHOSPHORUS
                IF (JC.EQ.10) CALL AMMONIUM
                IF (JC.EQ.11) CALL NITRATE
                IF (JC.EQ.12) CALL DISSOLVED_OXYGEN
                IF (JC.EQ.13) CALL SEDIMENT
                IF (JC.EQ.14) CALL INORGANIC_CARBON
                IF (JC.EQ.16) CALL PH_CO2
C     Iron has been replaced by age of water as state variable #20     !1/19/00 FTN
C               IF (JC.EQ.20) CALL IRON                                !1/19/00 FTN
C                                                                      !1/24/00 FTN
                IF (JC.EQ.21) CALL BIOCHEMICAL_O2_DEMAND
                IF (JC.EQ.22) CALL PHYTOPLANKTON                       !5/13/97 FTN
              END DO
            END IF
C                                                                      !1/24/00 FTN
C     For age of water (state variable #20), set the source/sink term  !1/24/00 FTN
C     for constituent kinetics (CSSK array) to 1.0 divided by 86400    !1/24/00 FTN
C     (number of seconds in a day) for each cell. In the constituent   !1/24/00 FTN
C     transport equations, the CSSK term gets multiplied directly by   !1/24/00 FTN
C     the time step (DLT). This will effectively increment the age     !1/24/00 FTN
C     of the water by the length of the time step.                     !1/24/00 FTN
C                                                                      !1/24/00 FTN
C     Then set all the boundary concentrations to zero so that the age !1/24/00 FTN
C     of water variable will represent the length of time that a parcel !1/24/00 FTN
C     of water has been in this waterbody (not counting time prior to  !1/24/00 FTN
C     the beginning of the simulation).  Although water coming into    !1/24/00 FTN
C     this waterbody through an external head boundary could be water  !1/24/00 FTN
C     that was already in this waterbody several time steps earlier    !1/24/00 FTN
C     and is now re-entering this waterbody, go ahead and set its age  !1/24/00 FTN
C     to zero to be consistent for all boundary conditions.            !1/24/00 FTN
C                                                                      !1/24/00 FTN
            IF (ACC(20).EQ.' ON') THEN                                 !1/24/00 FTN
              DO I=IU,ID                                               !1/24/00 FTN
                DO K=KT,KB(I)                                          !1/24/00 FTN
                  CSSK(K,I,20) = 1.0/86400.0                           !1/24/00 FTN
                END DO                                                 !1/24/00 FTN
              END DO                                                   !1/24/00 FTN
              IF (TRIBUTARIES) THEN                                    !1/24/00 FTN
                DO JT=1,NTR                                            !1/24/00 FTN
                  CTR(20,JT) = 0.0                                     !1/24/00 FTN
                END DO                                                 !1/24/00 FTN
              END IF                                                   !1/24/00 FTN
              IF (DIST_TRIBS(JB)) CDTR(20,JB) = 0.0                    !1/24/00 FTN
              IF (PRECIPITATION)  CPR(20,JB)  = 0.0                    !1/24/00 FTN
              IF (UP_FLOW(JB))    CIN(20,JB)  = 0.0                    !1/24/00 FTN
```

```
    IF (UP_HEAD(JB)) THEN                                                 !1/24/00 FTN
      DO K=KT,KB(IU)                                                      !1/24/00 FTN
        C1S(K,IU-1,20) = 0.0                                              !1/24/00 FTN
      END DO                                                              !1/24/00 FTN
    END IF                                                                !1/24/00 FTN
    IF (DN_HEAD(JB)) THEN                                                 !1/24/00 FTN
      DO K=KT,KB(ID+1)                                                    !1/24/00 FTN
        C1S(K,ID+1,20) = 0.0                                              !1/24/00 FTN
      END DO                                                              !1/24/00 FTN
    END IF                                                                !1/24/00 FTN
  END IF                                                                  !1/24/00 FTN
  DO JAC=1,NAC
    JC = CN(JAC)
```

```
****************************************************************************
**                      Task 2.8: Output Results                        **
****************************************************************************

******* Snapshots

        IF (SNAPSHOT) THEN
          IF (JDAY.GE.NXTMSN.OR.JDAY.GE.SNPD(SNPDP+1)) THEN
            IF (JDAY.GE.SNPD(SNPDP+1)) THEN
              SNPDP  = SNPDP+1
              NXTMSN = SNPD(SNPDP)
            END IF
            NXTMSN = NXTMSN+SNPF(SNPDP)
            WRITE (SNP,3000) (TITLE(I),I=1,7)
            WRITE (SNP,3010) 'Time Parameters',MONTH,GDAY,YEAR,
     .                       INT(JDAY),(JDAY-INT(JDAY))*24.0,
     .                       INT(ELTMJD),(ELTMJD-INT(ELTMJD))*24.0,
     .                       INT(DLTS),KLOC,ILOC,INT(MINDLT),
     .                       INT(JDMIN),(JDMIN-INT(JDMIN))*24.0,KMIN,
     .                       IMIN
            IF (LIMITING_DLT) WRITE (SNP,3015) KLIM,ILIM
            WRITE (SNP,3016) INT(DLTAV),NIT,NV
            WRITE (SNP,3020) 'Meteorlogical Parameters',TAIR,TDEW,
     .                       WIND/(WSC(WSCDP)+1E-20),PHI,WSC(WSCDP),
     .                       CLOUD,ET,CSHE,SRO
            WRITE (SNP,3030) 'Inflows','Upstream inflows'
            DO JB=1,NBP
              IF (UP_FLOW(JB)) THEN
                WRITE (SNP,3040) JB,KTQIN(JB),KBQIN(JB),QIN(JB),TIN(JB)
              END IF
            END DO
            DO JB=1,NBP
              IF (DIST_TRIBS(JB)) THEN
                WRITE (SNP,3050)
                WRITE (SNP,3060) JB,QDTR(JB),TDTR(JB)
              END IF
            END DO
            IF (TRIBUTARIES) THEN
              WRITE (SNP,3070) (ITR(JT),JT=1,NTR)
              WRITE (SNP,3080) (KTTR(JT),KBTR(JT),JT=1,NTR)
              WRITE (SNP,3090) (QTR(JT),JT=1,NTR)
              WRITE (SNP,3100) (TTR(JT),JT=1,NTR)
            END IF
            DO JB=1,NBP
              IF (DN_FLOW(JB)) THEN
                IF (SEL_WITHDRAWAL(JB)) THEN
                  WRITE (SNP,3105) JB,(QSTR(JS,JB),JS=1,NSTR(JB))
                END IF
                WRITE (SNP,3110) QSUM(JB),(K,K=KT,KB(DS(JB)))
                WRITE (SNP,3120) (QOUT(K,JB),K=KT,KB(DS(JB)))
              END IF
            END DO
            IF (WITHDRAWALS) THEN
              WRITE (SNP,3130) (IWD(JW),JW=1,NWD)
              WRITE (SNP,3140) (KWD(JW),JW=1,NWD)
              WRITE (SNP,3150) (QWD(JW),JW=1,NWD)
            END IF
            IF (CONSTITUENTS) THEN
              WRITE (SNP,3160) 'Constituent Inflow Concentrations'
              DO JB=1,NBP
                IF (UP_FLOW(JB)) THEN
                  WRITE (SNP,3170) JB,(CNAME1(INCN(JC)),
     .                             CIN(INCN(JC),JB),JC=1,NACIN)
                END IF
              END DO
              DO JT=1,NTR
                WRITE (SNP,3180) JT,(CNAME1(TRCN(JC)),CTR(TRCN(JC),JT),
     .                           JC=1,NACTR)
              END DO
              DO JB=1,NBP
                IF (DIST_TRIBS(JB)) THEN
```

```
                WRITE (SNP,3190) JB,(CNAME1(DTCN(JC)),
     .                           CDTR(DTCN(JC),JB),JC=1,NACDT)
              END IF
            END DO
          END IF
C         IF (EVAPORATION.OR.PRECIPITATION) WRITE(SNP,3200) 'Surface',!1/31/95 FTN
C    .                                    ' Calculations'          !1/31/95 FTN
          IF (EVAPORATION.OR.PRECIPITATION) WRITE(SNP,3200) 'Surface' !1/31/95 FTN
     .                                 // ' Calculations'          !1/31/95 FTN
C         IF (EVAPORATION)   WRITE (SNP,3210) (JB,EV(JB),JB=1,NBP)    !4/26/95 FTN
          IF (EVAPORATION)   WRITE (SNP,3210) (JB,EVBR(JB),JB=1,NBP)  !4/26/95 FTN
C         IF (PRECIPITATION) WRITE (SNP,3220) (JB,QPR(JB),JB=1,NBP)   !4/26/95 FTN
          IF (PRECIPITATION) WRITE (SNP,3220) (JB,QPRBR(JB),JB=1,NBP) !4/26/95 FTN
          IF (HEAD_BOUNDARY) THEN
            WRITE (SNP,3230)
            DO JB=1,NBP
              IF (UH_EXTERNAL(JB)) WRITE (SNP,3240) JB,ELUH(JB)
              IF (DH_EXTERNAL(JB)) WRITE (SNP,3250) JB,ELDH(JB)
            END DO
          END IF
          IF (VOLUME_BALANCE) THEN
            WRITE (SNP,3260)
            DO JB=1,NBP
              IF (VOLSBR(JB).NE.0.0) DLVR = (VOLTBR(JB)-VOLSBR(JB))
     .                                      /VOLSBR(JB)
              WRITE (SNP,3270) JB,VOLSBR(JB),VOLTBR(JB),VOLTBR(JB)
     .                         -VOLSBR(JB),DLVR*100.0
            END DO
          END IF
          IF (MASS_BALANCE) THEN
            WRITE (SNP,3290)
            DO JB=1,NBP
              WRITE (SNP,3300) JB
              DO JC=1,NAC
                JAC = CN(JC)
                IF (TRANSPORT(JAC)) THEN
                  IF (CMBRS(JAC,JB).NE.0.0) THEN
                    DLMR = (CMBRT(JAC,JB)-CMBRS(JAC,JB))
     .                     /(CMBRS(JAC,JB)+1.0E-20)
                  END IF
                  WRITE (SNP,3310) CNAME1(JAC),CMBRS(JAC,JB),
     .                             CMBRT(JAC,JB),(CMBRT(JAC,JB)
     .                             -CMBRS(JAC,JB)),DLMR*100.0
                END IF
              END DO
            END DO
          END IF
          IF (CONSTITUENTS .AND. ACC(3).EQ.' ON') THEN                !4/14/95 FTN
            ID = NINT(CKSEG)                                          !4/24/95 FTN
            WRITE (SNP,3330) ID                                       !4/24/95 FTN
            DO K = KT, KB(ID)                                         !4/14/95 FTN
              IF (K.EQ.KT) THEN                                       !4/14/95 FTN
                WRITE (SNP,3340) K, (COLTERM(M,K),M=1,3),             !4/24/95 FTN
     &                           (EL(K)-Z(ID)-HKT2(ID)/2.)/0.3048     !5/05/95 FTN
              ELSE                                                    !4/14/95 FTN
                WRITE (SNP,3340) K, (COLTERM(M,K),M=1,3),             !4/24/95 FTN
     &                           (EL(K)-H(K)/2.)/0.3048               !5/04/95 FTN
              END IF                                                  !4/14/95 FTN
            END DO                                                    !4/14/95 FTN
          END IF                                                      !4/14/95 FTN
          WRITE (SNP,3320) 'Geometry',KT,ELKT,(JB,CUS(JB),JB=1,NBP)
          CALL PRINT_GRID (JDAY,GDAY,MONTH,YEAR)
        END IF
      END IF

******* Vertical profiles

      IF (PROFILE) THEN
        IF (JDAY.GE.NXTMPR.OR.JDAY.GE.PRFD(PRFDP+1)) THEN
          IF (JDAY.GE.PRFD(PRFDP+1)) THEN
            PRFDP  = PRFDP+1
```

```
          NXTMPR = PRFD(PRFDP)
        END IF
        NXTMPR = NXTMPR+PRFF(PRFDP)
        NSPRF  = NSPRF+1
        IF (PRSTYL.NE.'FTN') THEN                                   !1/31/95 FTN
          WRITE (PRF,2570) JDAY,MONTH,GDAY,YEAR,KT,SNGL(Z(DS(1))),
     .                     NSPRF
          DO JC=1,NAC
            IF (CPRC(CN(JC)).EQ.' ON') THEN
              DO JPRF=1,NIPRF
                I   = IPRF(JPRF)
                NRS = KB(I)-KT+1
                WRITE (PRF,2560) CN(JC),NRS,(C2(K,I,CN(JC)),
     .                           K=KT,KB(I))
              END DO
            END IF
          END DO
        END IF                                                      !1/31/95 FTN
        IF (PRSTYL.EQ.'FTN') THEN                                   !9/24/97 FTN
          WRITE (DATE_STRNG(1:2),'(I2.2)') YEAR-1900                !9/24/97 FTN
          WRITE (DATE_STRNG(3:4),'(I2.2)') IMON                     !9/24/97 FTN
          WRITE (DATE_STRNG(5:6),'(I2.2)') GDAY                     !9/24/97 FTN
        END IF                                                      !9/24/97 FTN
        DO JPRF=1,NIPRF
          I   = IPRF(JPRF)
          NRS = KB(I)-KT+1
          IF (PRSTYL.NE.'FTN') THEN                                 !1/31/95 FTN
            WRITE (PRF,2560) 22,NRS,(T2(K,I),K=KT,KB(I))
          ELSE                                                      !1/31/95 FTN
            DO K=KT,KB(I)                                           !2/11/95 FTN
              DO JC=1,NAC                                           !2/11/95 FTN
                IF (C2(K,I,CN(JC)).LT.1.0E-20) C2(K,I,CN(JC)) =     !2/11/95 FTN
     &                                             1.0E-20          !2/11/95 FTN
              END DO                                                !2/11/95 FTN
            END DO                                                  !2/11/95 FTN
            WRITE (PRF,'(1H",A6,1H",F7.2,2I5,23E16.8)') DATE_STRNG, !9/24/97 FTN
     &                JDAY,I,KT, (EL(KT)-Z(I))/0.3048, T2(KT,I),    !9/24/97 FTN
     &                (C2(KT,I,CN(JC)),JC=1,NAC)                    !4/13/95 FTN
            WRITE (PRF,'(1H",A6,1H",F7.2,2I5,23E16.8)') DATE_STRNG, !9/24/97 FTN
     &                JDAY,I,KT, (EL(KT)-Z(I)-HKT2(I)/2.)/0.3048,   !9/24/97 FTN
     &                T2(KT,I), (C2(KT,I,CN(JC)),JC=1,NAC)          !9/24/97 FTN
            DO K=KT+1,KB(I)                                         !1/31/95 FTN
              WRITE (PRF,'(1H",A6,1H",F7.2,2I5,23E16.8)')DATE_STRNG,!9/24/97 FTN
     &                      JDAY, I, K, (EL(K)-H(K)/2.)/0.3048,     !9/24/97 FTN
     &                      T2(K,I), (C2(K,I,CN(JC)),JC=1,NAC)      !9/24/97 FTN
            END DO                                                  !1/31/95 FTN
          END IF                                                    !1/31/95 FTN
        END DO
      END IF
    END IF

******* Spreadsheet

    IF (SPREADSHEET) THEN
      IF (JDAY.GE.NXTMSP.OR.JDAY.GE.SPRD(SPRDP+1)) THEN
        IF (JDAY.GE.SPRD(SPRDP+1)) THEN
          SPRDP  = SPRDP+1
          NXTMSP = SPRD(SPRDP)
        END IF
        NXTMSP = NXTMSP+SPRF(SPRDP)
        DO J=1,NISPR
          KBMAX = MAX(KB(ISPR(J)),KBMAX)
          DO K=KT,KB(ISPR(J))
            WRITE (CONV1(K,J),'(F9.2)') T2(K,ISPR(J))
          END DO
        END DO
        DEPTH = -HKT2(DS(1))*0.5
        DO K=KT,KBMAX
          WRITE (SPR,2565) 'Temperature      ',JDAY,DEPTH,
     .                     (CONV1(K,J),J=1,NISPR)
          DEPTH = DEPTH-H(K+1)
```

```
          END DO
          DO JC=1,NAC
            IF (CPRC(CN(JC)).EQ.' ON') THEN
              DO J=1,NISPR
                DO K=KT,KB(ISPR(J))
                  WRITE (CONV1(K,J),'(1PE9.2)') C2(K,ISPR(J),CN(JC))
                END DO
              END DO
              DEPTH = -HKT2(DS(1))*0.5
              DO K=KT,KBMAX
                WRITE (SPR,2565) CNAME1(CN(JC)),JDAY,DEPTH,
     .                           (CONV1(K,J),J=1,NISPR)
                DEPTH = DEPTH-H(K+1)
              END DO
            END IF
          END DO
        END IF
      END IF

******* Velocity vectors

      IF (VECTOR) THEN
        IF (JDAY.GE.NXTMVP.OR.JDAY.GE.VPLD(VPLDP+1)) THEN
          IF (JDAY.GE.VPLD(VPLDP+1)) THEN
            VPLDP  = VPLDP+1
            NXTMVP = VPLD(VPLDP)
          END IF
          NXTMVP = NXTMVP+VPLF(VPLDP)
          IF (VPSTYL.NE.'FTN') THEN                              !1/31/95 FTN
            WRITE (VPL,*) JDAY,MONTH//GDCH//', ',YEAR,KT,US
            WRITE (VPL,*) Z
            WRITE (VPL,*) U
            WRITE (VPL,*) W
          ELSE                                                   !1/31/95 FTN
            DO JB = 1, 1                                         !5/04/95 FTN
              DO I = CUS(JB), DS(JB)                             !1/31/95 FTN
C                                                                !5/04/95 FTN
C               Then write horizontal and vertical velocity vectors  !5/04/95 FTN
C               for each cell (along with elev of center of cell).   !5/04/95 FTN
C                                                                !5/04/95 FTN
                WRITE (VPL,'(I5,F9.4,2I5,3E16.8)') YEAR, JDAY, I, KT, !6/04/95 FTN
     &               (EL(KT)-Z(I)-HKT2(I)/2.)/0.3048,U(KT,I),W(KT,I) !4/13/95 FTN
                DO K=KT+1,KB(I)                                  !1/31/95 FTN
                  WRITE (VPL,'(I5,F9.4,2I5,3E16.8)') YEAR, JDAY, I,  !6/04/95 FTN
     &                     K, (EL(K)-H(K)/2.)/0.3048, U(K,I), W(K,I)  !1/31/95 FTN
                END DO                                           !1/31/95 FTN
              END DO                                             !1/31/95 FTN
            END DO                                               !1/31/95 FTN
          END IF                                                 !1/31/95 FTN
        END IF
      END IF

******* Contours

      IF (CONTOUR) THEN
        IF (JDAY.GE.NXTMCP.OR.JDAY.GE.CPLD(CPLDP+1)) THEN
          IF (JDAY.GE.CPLD(CPLDP+1)) THEN
            CPLDP  = CPLDP+1
            NXTMCP = CPLD(CPLDP)
          END IF
          NXTMCP = NXTMCP+CPLF(CPLDP)
C         WRITE (CPL,8040) JDAY,MONTH,GDAY,YEAR                  !4/14/95 FTN
          IF (CPSTYL.NE.'FTN') WRITE (CPL,8040) JDAY,MONTH,GDAY,YEAR  !4/14/95 FTN
          DO JB=1,NBP
            IF (CPSTYL.NE.'FTN') THEN                            !1/31/95 FTN
              WRITE(CPL,8010) CUS(JB)
              WRITE(CPL,8010) KT
              WRITE(CPL,8050) QIN(JB),QSUM(JB)
              WRITE(CPL,8050) (Z(I),I=CUS(JB),DS(JB))
              DO I=CUS(JB),DS(JB)
                WRITE (CPL,8050) (T2(K,I),K=KT,KB(I))
```

```
              END DO
              DO JC=1,NAC
                DO I=CUS(JB),DS(JB)
                  IF (CPRC(CN(JC)).EQ.' ON') THEN
                    WRITE (CPL,8050) (C2(K,I,CN(JC)),K=KT,KB(I))
                  END IF
                END DO
              END DO
            ELSE                                                    !1/31/95 FTN
              DO I = CUS(JB), DS(JB)                                !1/31/95 FTN
                DO K=KT,KB(I)                                       !2/11/95 FTN
                  DO JC=1,NAC                                       !2/11/95 FTN
                    IF (C2(K,I,CN(JC)).LT.1.0E-20) C2(K,I,CN(JC)) = !2/11/95 FTN
     &                                                    1.0E-20   !2/11/95 FTN
                  END DO                                            !2/11/95 FTN
                END DO                                              !2/11/95 FTN
                WRITE (CPL,'(I5,F7.2,2I5,23E16.8)') YEAR, JDAY, I,KT, !4/13/95 FTN
     &                   (EL(KT)-Z(I))/0.3048, T2(KT,I),            !4/13/95 FTN
     &                   (C2(KT,I,CN(JC)),JC=1,NAC)                 !4/13/95 FTN
                WRITE (CPL,'(I5,F7.2,2I5,23E16.8)') YEAR, JDAY, I,KT, !1/31/95 FTN
     &                   (EL(KT)-Z(I)-HKT2(I)/2.)/0.3048, T2(KT,I),!4/13/95 FTN
     &                   (C2(KT,I,CN(JC)),JC=1,NAC)                 !4/13/95 FTN
                DO K=KT+1,KB(I)                                     !1/31/95 FTN
                  WRITE (CPL,'(I5,F7.2,2I5,23E16.8)') YEAR, JDAY, I, !1/31/95 FTN
     &                       K, (EL(K)-H(K)/2.)/0.3048, T2(K,I),    !1/31/95 FTN
     &                       (C2(K,I,CN(JC)),JC=1,NAC)              !1/31/95 FTN
                END DO                                              !1/31/95 FTN
              END DO                                                !1/31/95 FTN
            END IF                                                  !1/31/95 FTN
          END DO
        END IF
      END IF
C                                                                   !10/6/98 FTN
C     Insert lines for AGPM output (from source code sent by G. Hauser) !10/6/98 FTN
        IF(AGPM) THEN                                               !10/6/98 FTN
          IF(JDAY.GE.NXTMAP) THEN                                   !10/6/98 FTN
            DO JB=1,NBP                                             !10/6/98 FTN
              IF (DN_FLOW(JB)) THEN                                 !10/6/98 FTN
                AVTOUT = 0.0                                        !10/6/98 FTN
                DO JC=1,NAC                                         !10/6/98 FTN
                  AVCOUT(CN(JC)) = 0.0                              !10/6/98 FTN
                END DO                                              !10/6/98 FTN
                DO K=KT,KB(DS(JB))                                  !10/6/98 FTN
                  AVTOUT = AVTOUT+T2(K,DS(JB))*QOUT(K,JB)           !10/6/98 FTN
                  DO JC=1,NAC                                       !10/6/98 FTN
                    AVCOUT(CN(JC)) = AVCOUT(CN(JC))+QOUT(K,JB)      !10/6/98 FTN
     .                               *C2(K,DS(JB),CN(JC))           !10/6/98 FTN
                  END DO                                            !10/6/98 FTN
                END DO                                              !10/6/98 FTN
                          QSOUT = QSUM(JB)                          !10/6/98 FTN
                IF (QSUM(JB).GT.0.0) THEN                           !10/6/98 FTN
                  AVTOUT = AVTOUT/QSUM(JB)                          !10/6/98 FTN
                  DO JC=1,NAC                                       !10/6/98 FTN
                    AVCOUT(CN(JC)) = AVCOUT(CN(JC))/QSUM(JB)        !10/6/98 FTN
                  END DO                                            !10/6/98 FTN
                END IF                                              !10/6/98 FTN
              END IF                                                !10/6/98 FTN
            END DO                                                  !10/6/98 FTN
            DO I=1,IMP                                              !10/6/98 FTN
              ELWS(I) = EL(KT)-Z(I)                                 !10/6/98 FTN
            END DO                                                  !10/6/98 FTN
            CALL WRITEP(JDAY,MONTH,GDAY,YEAR,KT,KB,CUS,             !10/6/98 FTN
     X      NBP,NAC,NCP,CPRC,CN,C2,T2,U,W,ELKT,IMP,KMP,             !10/6/98 FTN
     X      NXTMAP,QSOUT,AVCOUT,AVTOUT,ELWS,KTI)                    !10/6/98 FTN
            NXTMAP = NXTMAP + APLF                                  !10/6/98 FTN
          END IF                                                    !10/6/98 FTN
        END IF                                                      !10/6/98 FTN

******* Time series

        IF (TIME_SERIES) THEN
```

```
      IF (JDAY.GE.NXTMTS.OR.JDAY.GE.TSRD(TSRDP+1)) THEN
        IF (JDAY.GE.TSRD(TSRDP+1)) THEN
          TSRDP  = TSRDP+1
          NXTMTS = TSRD(TSRDP)
        END IF
        NXTMTS = NXTMTS+TSRF(TSRDP)
        DO JB=1,NBP
          IF (DN_FLOW(JB)) THEN
            AVTOUT = 0.0
            DO JC=1,NAC
              AVCOUT(CN(JC)) = 0.0
            END DO
            ID = DS(JB)                                                !3/14/97 FTN
            DO K=KT,KB(ID)
              AVTOUT = AVTOUT+T2(K,DS(JB))*QOUT(K,JB)
              DO JC=1,NAC
                AVCOUT(CN(JC)) = AVCOUT(CN(JC))+QOUT(K,JB)
     .                           *C2(K,DS(JB),CN(JC))
              END DO
            END DO
            IF (QSUM(JB).GT.0.0) THEN
              AVTOUT = AVTOUT/QSUM(JB)
              DO JC=1,NAC
                AVCOUT(CN(JC)) = AVCOUT(CN(JC))/QSUM(JB)
              END DO
            END IF
          END IF
        END DO
        IF (WITHDRAWALS) THEN
          DO JW=1,NWD
            TWD(JW) = T2(KWD(JW),IWD(JW))
            DO JC=1,NAC
              CWD(CN(JC),JW) = C2(KWD(JW),IWD(JW),CN(JC))
            END DO
          END DO
        END IF
        IF (TSSTYL.NE.'FTN') THEN                                      !1/31/95 FTN
          IF (WITHDRAWALS) THEN
            WRITE (TSR,5030) JDAY,DLT,ELKT,AVTOUT,(AVCOUT(CN(JC)),
     .                       JC=1,NAC),(TWD(JW),JW=1,NWD),
     .                       ((CWD(CN(JC),JW),JC=1,NAC),JW=1,NWD)
          ELSE
            WRITE (TSR,5030) JDAY,DLT,ELKT,AVTOUT,(AVCOUT(CN(JC)),
     .                       JC=1,NAC)
          END IF
        ELSE                                                           !1/31/95 FTN
          IF (RS_CNT.GT.0.0) RS_AVG = RS_SUM / RS_CNT                  !4/24/95 FTN
          RS_SUM = 0.0                                                 !4/24/95 FTN
          RS_CNT = 0.0                                                 !4/24/95 FTN
          DO JC=1,NAC                                                  !2/11/95 FTN
            IF (AVCOUT(CN(JC)).LT.1.0E-20) AVCOUT(CN(JC)) = 1.0E-20 !2/11/95 FTN
          END DO                                                       !2/11/95 FTN
          IF (CONSTITUENTS) THEN                                       !9/30/97 FTN
C                                                                      !6/22/98 FTN
C           If algae is being simulated, print the following extra     !6/22/98 FTN
C           output at the u/s, mid-lake, and d/s profile stations:     !6/22/98 FTN
C           1) avg algae conc in top 2 layers (for each group),        !6/22/98 FTN
C           2) hypolimnetic DO conc 3.5 m above the bottom, and        !6/22/98 FTN
C           3) secchi depth estimated as the depth to which 10% of     !6/22/98 FTN
C           the atmospheric solar radiation penetrates. Calculate      !6/22/98 FTN
C           the extinction coefficients using inorganic suspended      !6/22/98 FTN
C           solids and detritus and algae conc's from top 3 layers. !6/22/98 FTN
C                                                                      !6/22/98 FTN
            IF (ACC(22).EQ.' ON' .AND. ACC(23).EQ.' ON' .AND.          !3/30/98 FTN
     &                             ACC(24).EQ.' ON') THEN              !3/30/98 FTN
              ALG1US = (C2(KT,IPMIN,22) + C2(KT+1,IPMIN,22)) / 2.0     !4/17/98 FTN
              ALG2US = (C2(KT,IPMIN,23) + C2(KT+1,IPMIN,23)) / 2.0     !4/17/98 FTN
              ALG3US = (C2(KT,IPMIN,24) + C2(KT+1,IPMIN,24)) / 2.0     !4/17/98 FTN
              ALG1ML = (C2(KT,IPML,22)  + C2(KT+1,IPML,22) ) / 2.0     !6/22/98 FTN
              ALG2ML = (C2(KT,IPML,23)  + C2(KT+1,IPML,23) ) / 2.0     !6/22/98 FTN
              ALG3ML = (C2(KT,IPML,24)  + C2(KT+1,IPML,24) ) / 2.0     !6/22/98 FTN
```

```
            ALG1DS = (C2(KT,IPMAX,22) + C2(KT+1,IPMAX,22)) / 2.0  !4/17/98 FTN
            ALG2DS = (C2(KT,IPMAX,23) + C2(KT+1,IPMAX,23)) / 2.0  !4/17/98 FTN
            ALG3DS = (C2(KT,IPMAX,24) + C2(KT+1,IPMAX,24)) / 2.0  !4/17/98 FTN
C                                                                 !6/22/98 FTN
            FRACTION_SRO = 0.1                                    !6/22/98 FTN
            LAYERS_TO_AVG = 3                                     !6/22/98 FTN
            DO IP = 1, 3                                          !6/22/98 FTN
              IF (IP.EQ.1) IPROF = IPMIN                          !6/22/98 FTN
              IF (IP.EQ.2) IPROF = IPML                           !6/22/98 FTN
              IF (IP.EQ.3) IPROF = IPMAX                          !6/22/98 FTN
              PARTIC_ORG = 0.0                                    !6/22/98 FTN
              PART_INORG = 0.0                                    !6/22/98 FTN
              DO K = KT, KT-1+LAYERS_TO_AVG                       !6/22/98 FTN
                PARTIC_ORG = PARTIC_ORG + DETRIT(K,IPROF)         !6/22/98 FTN
                PART_INORG = PART_INORG + SS(K,IPROF)             !6/22/98 FTN
                DO JA=1,NAP                                       !6/22/98 FTN
                  PARTIC_ORG = PARTIC_ORG + ALGAE(K,IPROF,JA)     !6/22/98 FTN
                END DO                                            !6/22/98 FTN
              END DO                                              !6/22/98 FTN
              PARTIC_ORG = PARTIC_ORG / REAL(LAYERS_TO_AVG)       !6/22/98 FTN
              PART_INORG = PART_INORG / REAL(LAYERS_TO_AVG)       !6/22/98 FTN
              GAMMA = EXH2O+EXINOR*PART_INORG + EXORG*PARTIC_ORG  !6/22/98 FTN
              SECCHI = LOG (FRACTION_SRO / (1.0-BETA)) / (-GAMMA) !6/22/98 FTN
              IF (IP.EQ.1) SECCUS = SECCHI                        !6/22/98 FTN
              IF (IP.EQ.2) SECCML = SECCHI                        !6/22/98 FTN
              IF (IP.EQ.3) SECCDS = SECCHI                        !6/22/98 FTN
            END DO                                                !6/22/98 FTN
C                                                                 !6/22/98 FTN
            KUS = KB(IPMIN) - 3                                   !6/22/98 FTN
            KML = KB(IPML)  - 3                                   !6/22/98 FTN
            KDS = KB(IPMAX) - 3                                   !6/22/98 FTN
            WRITE (TSR,'(I5,F7.2,42E16.8)') YEAR, JDAY,           !6/23/98 FTN
     &            (EL(KT)-Z(DS(1)))/0.3048, T2(KT,DS(1)), AVTOUT, !3/30/98 FTN
     &            (AVCOUT(CN(JC)),JC=1,NAC), ALG1US, ALG2US,      !3/30/98 FTN
     &            ALG3US, ALG1ML, ALG2ML, ALG3ML, ALG1DS, ALG2DS, !6/22/98 FTN
     &            ALG3DS, C2(KUS,IPMIN,12), C2(KML,IPML,12),      !6/22/98 FTN
     &            C2(KDS,IPMAX,12), SECCUS, SECCML, SECCDS        !6/22/98 FTN
          ELSE                                                    !3/30/98 FTN
            WRITE (TSR,'(I5,F7.2,23E16.8)') YEAR, JDAY,           !9/30/97 FTN
     &            (EL(KT)-Z(DS(1)))/0.3048, T2(KT,DS(1)), AVTOUT, !9/30/97 FTN
     &            (AVCOUT(CN(JC)),JC=1,NAC), RS_AVG, EVAPVOL      !9/30/97 FTN
          END IF                                                  !3/30/98 FTN
        ELSE                                                      !9/30/97 FTN
          WRITE (TSR,'(I5,F7.2, 3E16.8)') YEAR, JDAY,             !9/30/97 FTN
     &          (EL(KT)-Z(DS(1)))/0.3048, T2(KT,DS(1)), AVTOUT    !9/30/97 FTN
        END IF                                                    !9/30/97 FTN
        EVAPVOL = 0.0                                             !4/26/95 FTN
      END IF                                                      !1/31/95 FTN
    END IF
  END IF
```

```
*****************************************************************************
**        S U B R O U T I N E   G R E G O R I A N   D A T E           **
*****************************************************************************

C     SUBROUTINE GREGORIAN_DATE (YEAR)                               !9/24/97 FTN
      SUBROUTINE GREGORIAN_DATE (YEAR, IMON)                         !9/24/97 FTN

******* Variable declaration

        INTEGER   YEAR, GDAY
        LOGICAL   LEAP_YEAR
        CHARACTER MONTH*9

******* Common declaration

        COMMON /GDAYC1/ GDAY, DAYM, JDAYG, LEAP_YEAR
        COMMON /GDAYC2/ MONTH

******* Determine if new year (regular or leap) and increment year

        IF (.NOT.LEAP_YEAR.AND.JDAYG.EQ.365) THEN
          JDAYG     = JDAYG-365
          YEAR      = YEAR+1
          LEAP_YEAR = MOD(YEAR,4).EQ.0
        ELSE IF (JDAYG.EQ.366) THEN
          JDAYG     = JDAYG-366
          YEAR      = YEAR+1
          LEAP_YEAR = .FALSE.
        END IF

******* Determine month and day of year

        IF (LEAP_YEAR) THEN
          IF (JDAYG.GE.0.AND.JDAYG.LT.31) THEN
            GDAY  = JDAYG+1
            DAYM  = 31.0
            MONTH = '  January'
          ELSE IF (JDAYG.GE.31.AND.JDAYG.LT.60) THEN
            GDAY  = JDAYG-30
            DAYM  = 29.0
            MONTH = ' February'
          ELSE IF (JDAYG.GE.60.AND.JDAYG.LT.91) THEN
            GDAY  = JDAYG-59
            DAYM  = 31.0
            MONTH = '    March'
          ELSE IF (JDAYG.GE.91.AND.JDAYG.LT.121) THEN
            GDAY  = JDAYG-90
            DAYM  = 30.0
            MONTH = '    April'
          ELSE IF (JDAYG.GE.121.AND.JDAYG.LT.152) THEN
            GDAY  = JDAYG-120
            DAYM  = 31.0
            MONTH = '      May'
          ELSE IF (JDAYG.GE.152.AND.JDAYG.LT.182) THEN
            GDAY  = JDAYG-151
            DAYM  = 30.0
            MONTH = '     June'
          ELSE IF (JDAYG.GE.182.AND.JDAYG.LT.213) THEN
            GDAY  = JDAYG-181
            DAYM  = 31.0
            MONTH = '     July'
          ELSE IF (JDAYG.GE.213.AND.JDAYG.LT.244) THEN
            GDAY  = JDAYG-212
            DAYM  = 31.0
            MONTH = '   August'
          ELSE IF (JDAYG.GE.244.AND.JDAYG.LT.274) THEN
            GDAY  = JDAYG-243
            DAYM  = 30.0
            MONTH = 'September'
          ELSE IF (JDAYG.GE.274.AND.JDAYG.LT.305) THEN
            GDAY  = JDAYG-273
```

```
      DAYM  = 31.0
      MONTH = '  October'
    ELSE IF (JDAYG.GE.305.AND.JDAYG.LT.335) THEN
      GDAY  = JDAYG-304
      DAYM  = 30.0
      MONTH = ' November'
    ELSE IF (JDAYG.GE.335.AND.JDAYG.LT.366) THEN
      GDAY  = JDAYG-334
      DAYM  = 31.0
      MONTH = ' December'
    END IF
  ELSE
    IF (JDAYG.GE.0.AND.JDAYG.LT.31) THEN
      GDAY  = JDAYG+1
      DAYM  = 31.0
      MONTH = '  January'
    ELSE IF (JDAYG.GE.31.AND.JDAYG.LT.59) THEN
      GDAY  = JDAYG-30
      DAYM  = 29.0
      MONTH = ' February'
    ELSE IF (JDAYG.GE.59.AND.JDAYG.LT.90) THEN
      GDAY  = JDAYG-58
      DAYM  = 31.0
      MONTH = '    March'
    ELSE IF (JDAYG.GE.90.AND.JDAYG.LT.120) THEN
      GDAY  = JDAYG-89
      DAYM  = 30.0
      MONTH = '    April'
    ELSE IF (JDAYG.GE.120.AND.JDAYG.LT.151) THEN
      GDAY  = JDAYG-119
      DAYM  = 31.0
      MONTH = '      May'
    ELSE IF (JDAYG.GE.151.AND.JDAYG.LT.181) THEN
      GDAY  = JDAYG-150
      DAYM  = 30.0
      MONTH = '     June'
    ELSE IF (JDAYG.GE.181.AND.JDAYG.LT.212) THEN
      GDAY  = JDAYG-180
      DAYM  = 31.0
      MONTH = '     July'
    ELSE IF (JDAYG.GE.212.AND.JDAYG.LT.243) THEN
      GDAY  = JDAYG-211
      DAYM  = 31.0
      MONTH = '   August'
    ELSE IF (JDAYG.GE.243.AND.JDAYG.LT.273) THEN
      GDAY  = JDAYG-242
      DAYM  = 30.0
      MONTH = 'September'
    ELSE IF (JDAYG.GE.273.AND.JDAYG.LT.304) THEN
      GDAY  = JDAYG-272
      DAYM  = 31.0
      MONTH = '  October'
    ELSE IF (JDAYG.GE.304.AND.JDAYG.LT.334) THEN
      GDAY  = JDAYG-303
      DAYM  = 30.0
      MONTH = ' November'
    ELSE IF (JDAYG.GE.334.AND.JDAYG.LT.365) THEN
      GDAY  = JDAYG-333
      DAYM  = 31.0
      MONTH = ' December'
    END IF
  END IF
  IF (MONTH.EQ.'  January') THEN                                       !9/24/97 FTN
    IMON = 1                                                           !9/24/97 FTN
  ELSEIF (MONTH.EQ.' February') THEN                                   !9/24/97 FTN
    IMON = 2                                                           !9/24/97 FTN
  ELSEIF (MONTH.EQ.'    March') THEN                                   !9/24/97 FTN
    IMON = 3                                                           !9/24/97 FTN
  ELSEIF (MONTH.EQ.'    April') THEN                                   !9/24/97 FTN
    IMON = 4                                                           !9/24/97 FTN
  ELSEIF (MONTH.EQ.'      May') THEN                                   !9/24/97 FTN
```

```
          IMON = 5                                                        !9/24/97 FTN
        ELSEIF (MONTH.EQ.'      June') THEN                               !9/24/97 FTN
          IMON = 6                                                        !9/24/97 FTN
        ELSEIF (MONTH.EQ.'      July') THEN                               !9/24/97 FTN
          IMON = 7                                                        !9/24/97 FTN
        ELSEIF (MONTH.EQ.'    August') THEN                               !9/24/97 FTN
          IMON = 8                                                        !9/24/97 FTN
        ELSEIF (MONTH.EQ.'September') THEN                                !9/24/97 FTN
          IMON = 9                                                        !9/24/97 FTN
        ELSEIF (MONTH.EQ.'   October') THEN                               !9/24/97 FTN
          IMON = 10                                                       !9/24/97 FTN
        ELSEIF (MONTH.EQ.'  November') THEN                               !9/24/97 FTN
          IMON = 11                                                       !9/24/97 FTN
        ELSEIF (MONTH.EQ.'  December') THEN                               !9/24/97 FTN
          IMON = 12                                                       !9/24/97 FTN
        END IF                                                            !9/24/97 FTN
      END

*****************************************************************************
```

```
*****************************************************************************
**          S U B R O U T I N E   H E A T   E X C H A N G E             **
*****************************************************************************

      SUBROUTINE HEAT_EXCHANGE (WFC,JDAY)
        INCLUDE 'w2.inc'

******* Variable declaration

        REAL      JDAY, LAT, LONG, LONGO
        LOGICAL   LEAP_YEAR
        CHARACTER MONTH*9

******* Dimension declaration

        DIMENSION EQT(12)

******* Common declaration

        COMMON /GLBLCC/ PALT, ALGDET, O2LIM, WIND, WSCDP, WSC(NDP)
        COMMON /TVDMTC/ TAIR, TDEW,   CLOUD, PHI,  ET,    CSHE,
     .                  SRO,  LAT,    LONG
        COMMON /GDAYC1/ GDAY, DAYM,   JDAYG, LEAP_YEAR
        COMMON /FWCOEF/ FW_A0, FW_A1, FW_A2                           !1/31/95 FTN
        COMMON /GDAYC2/ MONTH

******* Data declaration

        DATA EQT /-0.13, -0.23, -0.16, -0.02, 0.06, 0.00, -0.09,
     .            -0.08,  0.06,  0.22,  0.25, 0.10/

******* Month

        IF (MONTH.EQ.'  January') M = 1
        IF (MONTH.EQ.' February') M = 2
        IF (MONTH.EQ.'    March') M = 3
        IF (MONTH.EQ.'    April') M = 4
        IF (MONTH.EQ.'      May') M = 5
        IF (MONTH.EQ.'     June') M = 6
        IF (MONTH.EQ.'     July') M = 7
        IF (MONTH.EQ.'   August') M = 8
        IF (MONTH.EQ.'September') M = 9
        IF (MONTH.EQ.'  October') M = 10
        IF (MONTH.EQ.' November') M = 11
        IF (MONTH.EQ.' December') M = 12

******* English units

        WINDT = WIND*2.23714
        TDEWT = TDEW*9.0/5.0+32.0
        TAIRT = TAIR*9.0/5.0+32.0

******* Solar radiation

        LONGO = 15.0*INT(LONG/15.0)
        D     = 0.409280*COS(0.017214*(172.0-JDAYG))
        X     = (JDAY-JDAYG)*24.0
        H     = 0.261799*(X-(LONG-LONGO)*0.066667+EQT(M)-12.0)
        SINAL = SIN(LAT*.017453)*SIN(D)+COS(LAT*.017453)*COS(D)*COS(H)
        AL    = ASIN(SINAL)
        A0    = 57.2985*AL
        SRO   = 2.044*A0+0.1296*A0**2-0.001941*A0**3+7.591E-6*A0**4
        SRO   = (1.0-0.0065*CLOUD*CLOUD)*SRO*24.0
        IF (A0.LT.0.0) SRO = 0.0

******* Equilibrium temperature and heat exchange coefficient

        ET    = TDEWT
C       FW    = WFC*(70.0+0.7*WINDT*WINDT)                            !1/31/95 FTN
C                                                                     !1/31/95 FTN
C       Calculate wind function using coefficients read from control  !1/31/95 FTN
```

```
C       file (in SI units).  Convert to subroutine units assuming that  !1/31/95 FTN
C       9.2 + 0.46W^2 in SI units is equivalent to 70 + 0.7*W^2 in      !1/31/95 FTN
C       subroutine units.                                               !1/31/95 FTN
C                                                                       !1/31/95 FTN
        FW     = ( (FW_A0*70.0/9.2) + (FW_A1*3.4027)*WINDT +            !1/31/95 FTN
     &             (FW_A2*0.7/0.46)*WINDT*WINDT ) * WFC                 !1/31/95 FTN
        HA     = 3.1872E-08*(TAIRT+460.0)*(TAIRT+460.0)*(TAIRT+460.0)
     .           *(TAIRT+460.0)
        TSTAR = (ET+TDEWT)*0.5
        BETA  = 0.255-(0.0085*TSTAR)+(0.000204*TSTAR*TSTAR)
        CSHE  = 15.7+(0.26+BETA)*FW
        ETP   = (SRO+HA-1801.0)/CSHE+(CSHE-15.7)*(0.26*TAIRT+BETA*TDEWT)
     .           /(CSHE*(0.26+BETA))
        J     = 0
        DO WHILE (ABS(ETP-ET).GT.0.05.AND.J.LT.50)
          ET    = ETP
          TSTAR = (ET+TDEWT)*0.5
          BETA  = 0.255-(0.0085*TSTAR)+(0.000204*TSTAR**2)
          CSHE  = 15.7+(0.26+BETA)*FW
          ETP   = (SRO+HA-1801.0)/CSHE+(CSHE-15.7)*(0.26*TAIRT+BETA
     .            *TDEWT)/(CSHE*(0.26+BETA))
          J     = J+1
        END DO
10000   CONTINUE

******* SI units

        ET   = (ET-32.0)*5.0/9.0
        SRO  = SRO*3.14E-8
        CSHE = CSHE*5.65E-8
      END

************************************************************************
**            S U B R O U T I N E   R A D I A T I O N                **
************************************************************************

C     SUBROUTINE RADIATION (RS,RSN,RAN)                                 !1/31/95 FTN
      SUBROUTINE RADIATION (RS,RSN,RAN,SRMULT)                          !1/31/95 FTN

******* Common declaration

        COMMON /TVDMTC/ TAIR, TDEW, CLOUD, PHI, ET, CSHE, SRO, LAT,
     .                  LONG

******* Data declaration

        DATA SBC /2.0411E-7/

******* Net solar radiation

C       RSN = 0.94*RS                                                   !1/31/95 FTN
        RSN = SRMULT*RS                                                 !1/31/95 FTN

******* Net atmospheric radiation

        T2K = 273.2+TAIR
        FAC = 1.0+0.0017*CLOUD**2
        RAN = 1000.0/3600.0*9.37E-6*SBC*T2K**6*FAC*(1.0-0.03)
      END
```

```
************************************************************************
**          S U B R O U T I N E   P R I N T   G R I D                 **
************************************************************************

      SUBROUTINE PRINT_GRID (JDAY,GDAY,MONTH,YEAR)
        INCLUDE 'w2.inc'

******* Variable declaration

        REAL        JDAY,     ICETH
        INTEGER     SNP,      CN,      YEAR,     GDAY,      BL,
     .              CUS,      DS
        CHARACTER  CPRC*3,   HPRC*3,  LFAC*4,   CONV*7,    HUNIT*6,
     .              CUNIT*6,  LFPR*7,  BLANK*7,  MONTH*9,   CNAME2*17,
     .              HNAME*24, TITLE*72
     &            , CNAME1*13, DNPRN*3                              !3/27/98 FTN
        LOGICAL     CONSTITUENTS,  ICE, ICE_CALC, LONG_FORM, SHORT_FORM,
     .              OXYGEN_DEMAND, LIMITING_FACTOR
        DOUBLE PRECISION Z

******* Dimension declaration

C       DIMENSION HUNIT(4), BL(17)                                  !4/16/97 FTN
        DIMENSION HUNIT(7), BL(17)                                  !4/16/97 FTN
        DIMENSION NH3D(KMC,IMC), NO3D(KMC,IMC)                      !3/27/98 FTN

******* Common declaration

        COMMON /DKNITC/ NH3D, NO3D                                  !3/27/98 FTN
        COMMON /DENITC/ DNPRN                                       !3/27/98 FTN
        COMMON /SNPUC/  SNP
        COMMON /GLOBLC/ JB, JC, IU, ID, KT, ELKT, DLT, KB(IMP), KTI(IMP)
        COMMON /TEMPC/  T1(KMP,IMP),    T2(KMP,IMP)
        COMMON /HYDRC1/ U(KMP,IMP),     W(KMP,IMP),    AZ(KMP,IMP),
C    .                  RHO(KMP,IMP),   NDLT(KMP,IMP)                !4/16/97 FTN
     .                  RHO(KMP,IMP),   NDLT(KMP,IMP), DZ(KMP,IMP)   !4/16/97 FTN
        COMMON /HYDRC2/ Z(IMP)
        COMMON /PRNTC1/ IPR(17),        IEPR,          KEPR
C       COMMON /PRNTC2/ TITLE(7),       CPRC(NCP),     HPRC(4),      !4/16/97 FTN
        COMMON /PRNTC2/ TITLE(7),       CPRC(NCP),     HPRC(7),      !4/16/97 FTN
     .                  CONV(KMP,17)
        COMMON /PRNTC3/ CUS(NBP),       DS(NBP)
C       COMMON /LFACC/  LFAC(KMC,IMC),  LFPR(KMC,IMC)                !5/14/97 FTN
        COMMON /LFACC/  LFAC(KMC,IMC,NAP),  LFPR(KMC,IMC,NAP)        !5/14/97 FTN
        COMMON /DKSEDC/ SEDD(KMC,IMC),  SO2D(KMC,IMC), SOD(IMP)
        COMMON /GRDLGC/ LONG_FORM,      SHORT_FORM,    LIMITING_FACTOR,
     .                  OXYGEN_DEMAND
        COMMON /GRTVDC/ CONSTITUENTS,   CN(NCP),       NAC
        COMMON /CBODC/  KBOD,           TBOD,          RBOD
C       COMMON /NAMESC/ HNAME(4),       CNAME2(NCP),   CUNIT(NCP)    !4/16/97 FTN
        COMMON /NAMESC/ HNAME(7),       CNAME2(NCP),   CUNIT(NCP)    !4/16/97 FTN
        COMMON /ICEC/   ICE(IMP),       ICETH(IMP),    ICE_CALC
        DATA   HUNIT(1) /'m/sec '/, HUNIT(2) /'mm/sec'/,
     .        HUNIT(3) /'deg C '/, HUNIT(4) /'      '/
     .      , HUNIT(5) /'kg/m3 '/, HUNIT(6) /'      '/              !4/16/97 FTN
     .      , HUNIT(7) /'      '/                                   !4/16/97 FTN
        DATA   BLANK    /'       '/

******* Inactive segments

        NBL = 1
        JB  = 1
        DO I=1,IEPR-1
          IF (CUS(JB).GT.IPR(I)) THEN
            BL(NBL) = I
            NBL     = NBL+1
          END IF
          IF (IPR(I+1).GT.DS(JB)) JB = JB+1
        END DO
        NBL = NBL-1
```

```
******* Water surface and ice cover

        DO I=1,IEPR
          WRITE (CONV(1,I),'(F7.4)') Z(IPR(I))
        END DO
        DO JBL=1,NBL
          CONV(1,BL(JBL)) = BLANK
        END DO
        WRITE (SNP,3000) 'Water Surface [Z] (m)',(IPR(I),I=1,IEPR)
        WRITE (SNP,3010) (CONV(1,I),I=1,IEPR)
        IF (ICE_CALC) THEN
          DO I=1,IEPR
            WRITE (CONV(1,I),'(F7.4)') ICETH(IPR(I))
          END DO
          DO JBL=1,NBL
            CONV(1,BL(JBL)) = BLANK
          END DO
          WRITE (SNP,3020) 'Ice Thickness (m)',(CONV(1,I),I=1,IEPR)
        END IF
        IF (CONSTITUENTS) THEN
          DO I=1,IEPR
            WRITE (CONV(1,I),'(F7.2)') SOD(IPR(I))*86400.0
          END DO
          DO JBL=1,NBL
            CONV(1,BL(JBL)) = BLANK
          END DO
          IF (OXYGEN_DEMAND) THEN
            WRITE (SNP,3030) 'Sediment Oxygen Demand [SOD] (g/m^2/day)',
     .                       (CONV(1,I),I=1,IEPR)
          END IF
        END IF

******* Velocities, temperatures, and vertical eddy viscosities

C       DO J=1,4                                                        !4/16/97 FTN
        DO J=1,7                                                        !4/16/97 FTN
          IF (HPRC(J).EQ.' ON') THEN
            DO I=1,IEPR
              DO K=KT,KB(IPR(I))
                IF (J.EQ.1) WRITE (CONV(K,I),'(F7.4)') U(K,IPR(I))
                IF (J.EQ.2) WRITE (CONV(K,I),'(F7.4)') W(K,IPR(I))*1000.
                IF (J.EQ.3) WRITE (CONV(K,I),'(F7.2)') T2(K,IPR(I))
                IF (J.EQ.4) WRITE (CONV(K,I),'(I7)')   NDLT(K,IPR(I))
                IF (J.EQ.5) WRITE (CONV(K,I),'(F7.3)')RHO(K,IPR(I))-900.!4/16/97 FTN
                IF (J.EQ.6) WRITE (CONV(K,I),'(1P,E7.1E1)')AZ(K,IPR(I)) !4/16/97 FTN
                IF (J.EQ.7) WRITE (CONV(K,I),'(1P,E7.1E1)')DZ(K,IPR(I)) !4/16/97 FTN
              END DO
            END DO
            WRITE (SNP,3040) (TITLE(I),I=1,7)
            DO JBL=1,NBL
              DO K=KT,KB(IPR(BL(JBL)))
                CONV(K,BL(JBL)) = BLANK
              END DO
            END DO
            WRITE (SNP,3050)  MONTH,GDAY,YEAR,INT(JDAY),(JDAY-INT(JDAY))
     .                        *24.0
            IF (LONG_FORM)    WRITE (SNP,3060) HNAME(J),HUNIT(J)
            IF (SHORT_FORM)   WRITE (SNP,3070) HNAME(J),HUNIT(J)
            WRITE (SNP,3080) (IPR(I),I=1,IEPR)
            DO K=KT,KEPR
              WRITE (SNP,3090) K,(CONV(K,I),I=1,IEPR)
            END DO
          END IF
        END DO

******* Constituent concentrations

        DO J=1,NAC
          IF (CPRC(CN(J)).EQ.' ON') THEN
C           MULT = 1.0                                                  !5/13/97 FTN
C           IF (CN(J).GE.9.AND.CN(J).LE.11) MULT = 1000.0               !5/13/97 FTN
```

```
          DO I=1,IEPR
            DO K=KT,KB(IPR(I))
              IF (CN(J).EQ.3) THEN                                   !2/11/95 FTN
                WRITE (CONV(K,I),'(I6,1X)') NINT(C2(K,IPR(I),3))     !2/11/95 FTN
              ELSEIF (CN(J).GE.9.AND.CN(J).LE.11) THEN               !5/13/97 FTN
                WRITE (CONV(K,I),'(F7.3)') C2(K,IPR(I),CN(J))        !5/13/97 FTN
              ELSEIF (CN(J).GE.22) THEN                              !5/13/97 FTN
                WRITE (CONV(K,I),'(F7.3)') C2(K,IPR(I),CN(J))        !5/13/97 FTN
              ELSE                                                   !2/11/95 FTN
C               WRITE (CONV(K,I),'(F7.2)') C2(K,IPR(I),CN(J))*MULT   !5/13/97 FTN
                WRITE (CONV(K,I),'(F7.2)') C2(K,IPR(I),CN(J))        !5/13/97 FTN
              END IF                                                 !2/11/95 FTN
            END DO
          END DO
          DO JBL=1,NBL
            DO K=KT,KB(IPR(BL(JBL)))
              CONV(K,BL(JBL)) = BLANK
            END DO
          END DO
          WRITE (SNP,3040) (TITLE(I),I=1,7)
          WRITE (SNP,3050) MONTH,GDAY,YEAR,INT(JDAY),(JDAY-INT(JDAY))
     .                     *24.0
          IF (LONG_FORM)   WRITE (SNP,3120) CNAME2(CN(J)),CUNIT(CN(J))
          IF (SHORT_FORM)  WRITE (SNP,3130) CNAME2(CN(J)),CUNIT(CN(J))
          WRITE (SNP,3080) (IPR(I),I=1,IEPR)
          DO K=KT,KEPR
            WRITE (SNP,3090) K,(CONV(K,I),I=1,IEPR)
          END DO
C                                                                    !3/27/98 FTN
          IF (CN(J).EQ.11 .AND. DNPRN.EQ.' ON') THEN                 !3/27/98 FTN
            DO I=1,IEPR                                              !3/27/98 FTN
              DO K=KT,KB(IPR(I))                                     !3/27/98 FTN
                WRITE (CONV(K,I),'(1P,E7.1E1)') NO3D(K,IPR(I))*86400. !3/31/98 FTN
              END DO                                                 !3/27/98 FTN
            END DO                                                   !3/27/98 FTN
            DO JBL=1,NBL                                             !3/27/98 FTN
              DO K=KT,KB(IPR(BL(JBL)))                               !3/27/98 FTN
                CONV(K,BL(JBL)) = BLANK                              !3/27/98 FTN
              END DO                                                 !3/27/98 FTN
            END DO                                                   !3/27/98 FTN
            WRITE (SNP,3040) (TITLE(I),I=1,7)                        !3/27/98 FTN
            WRITE (SNP,3050) MONTH, GDAY, YEAR, INT(JDAY),           !3/27/98 FTN
     &                     (JDAY-INT(JDAY))*24.0                     !3/27/98 FTN
            IF (LONG_FORM) WRITE(SNP,3120)'  Denitrification','mg/L/d'!3/27/98 FTN
            IF (SHORT_FORM)WRITE(SNP,3130)'  Denitrification','mg/L/d'!3/27/98 FTN
            WRITE (SNP,3080) (IPR(I),I=1,IEPR)                       !3/27/98 FTN
            DO K=KT,KEPR                                             !3/27/98 FTN
              WRITE (SNP,3090) K,(CONV(K,I),I=1,IEPR)                !3/27/98 FTN
            END DO                                                   !3/27/98 FTN
          END IF                                                     !3/27/98 FTN
        END IF
      END DO
      IF (LIMITING_FACTOR) THEN
        DO JA=1,NAP                                                  !5/14/97 FTN
          WRITE (SNP,3040) (TITLE(I),I=1,7)
          WRITE (SNP,3050)  MONTH,GDAY,YEAR,INT(JDAY),(JDAY-INT(JDAY))
     .                      *24.0
          IF (JA.EQ.1) CNAME1 = 'Diatoms'                            !5/14/97 FTN
          IF (JA.EQ.2) CNAME1 = 'Greens'                             !5/14/97 FTN
          IF (JA.EQ.3) CNAME1 = 'Cyanobacteria'                      !5/14/97 FTN
C         IF (LONG_FORM)    WRITE (SNP,3100)                         !5/14/97 FTN
          IF (LONG_FORM)    WRITE (SNP,3100) CNAME1                  !5/14/97 FTN
C         IF (SHORT_FORM)   WRITE (SNP,3110)                         !5/14/97 FTN
          IF (SHORT_FORM)   WRITE (SNP,3110) CNAME1                  !5/14/97 FTN
          WRITE (SNP,3080) (IPR(I),I=1,IEPR)
          DO K=KT,KEPR
C           WRITE (SNP,3090) K,(LFPR(K,IPR(I)),I=1,IEPR)             !5/14/97 FTN
            WRITE (SNP,3090) K,(LFPR(K,IPR(I),JA),I=1,IEPR)          !5/14/97 FTN
          END DO
        END DO                                                       !5/14/97 FTN
      END IF
```

```
******* Snapshot FORMATs

 3000   FORMAT(/3X,A22/
    .          '+',2X,5('_'),1X,7('_')//
    .          3X,17I7)
 3010   FORMAT(3X,17A7/)
 3020   FORMAT(/3X,A17/
    .          '+',2X,3('_'),1X,9('_')//
    .          3X,17A7)
 3030   FORMAT(/3X,A40/
    .          '+',2X,8('_'),1X,6('_'),1X,6('_')//
    .          3X,17A7/)
 3040   FORMAT('1',7(A72/1X))
 3050   FORMAT(1X,A9,I3,', ',I4,'        Julian Date =',I6,' days',F6.2,
    .            ' hours'/)
 3060   FORMAT(47X,A24,1X,A6/)
 3070   FORMAT(22X,A24,1X,A6/)
 3080   FORMAT(2X,17I7)
 3090   FORMAT(1X,I2,17A7)
C3100   FORMAT(45X,'Limiting Factor'/)
 3100   FORMAT(45X,'Limiting Factor for ',A13/)
C3110   FORMAT(20X,'Limiting Factor'/)
 3110   FORMAT(20X,'Limiting Factor for ',A13/)
 3120   FORMAT(45X,A17,1X,A6/)
 3130   FORMAT(20X,A17,1X,A6/)
      END
```

```
************************************************************************
**      S U B R O U T I N E  R A T E   M U L T I P L I E R S         **
************************************************************************

      SUBROUTINE RATE_MULTIPLIERS
        INCLUDE 'w2.inc'

******* Variable declaration

        REAL LAM1,  LAM2,  NH3K1, NH3K2, NO3K1, NO3K2, NH3T1, NH3T2,
     .       NO3T1, NO3T2, NH3RM, NO3RM                               !2/02/95 FTN
C    .       NO3T1, NO3T2, NH3RM, NO3RM, K1,    K2,    K3,    K4      !2/02/95 FTN
        DIMENSION AGT1(NAP), AGT2(NAP), AGT3(NAP), AGT4(NAP),         !5/13/97 FTN
     &            AGK1(NAP), AGK2(NAP), AGK3(NAP), AGK4(NAP)          !5/13/97 FTN

******* Common declaration

        COMMON /GLOBLC/ JB, JC, IU, ID, KT, ELKT, DLT, KB(IMP), KTI(IMP)
        COMMON /RTMLTC/ OMT1,  OMT2,  NH3T1, NH3T2, NO3T1, NO3T2, AGT1,
     .                  AGT2,  AGT3,  AGT4,  OMK1,  OMK2,  NH3K1, NH3K2,
     .                  NO3K1, NO3K2, AGK1,  AGK2,  AGK3,  AGK4
        COMMON /GBLRTC/ OMRM(KMC,IMC),  NH3RM(KMC,IMC), NO3RM(KMC,IMC),
C    .                  AGRMR(KMC,IMC), AGRMF(KMC,IMC)                !5/13/97 FTN
     .                  AGRMR(KMC,IMC,NAP), AGRMF(KMC,IMC,NAP)        !5/13/97 FTN
        COMMON /TEMPC/  T1(KMP,IMP),    T2(KMP,IMP)

******* Rising and falling temperature rate functions

C       FR(TT,TT1,TT2,K1,K2) = K1*EXP(LOG(K2*(1.0-K1)/(K1*(1.0-K2)))   !2/02/95 FTN
C    .                         /(TT2-TT1)*(TT-TT1))                    !2/02/95 FTN
C       FF(TT,TT3,TT4,K3,K4) = K4*EXP(LOG(K3*(1.0-K4)/(K4*(1.0-K3)))   !2/02/95 FTN
C    .                         /(TT4-TT3)*(TT4-TT))                    !2/02/95 FTN
        DO I=IU,ID
          DO K=KT,KB(I)
            LAM1       = FR(T1(K,I),NH3T1,NH3T2,NH3K1,NH3K2)
            NH3RM(K,I) = LAM1/(1.0+LAM1-NH3K1)
            LAM1       = FR(T1(K,I),NO3T1,NO3T2,NO3K1,NO3K2)
            NO3RM(K,I) = LAM1/(1.0+LAM1-NO3K1)
            LAM1       = FR(T1(K,I),OMT1,OMT2,OMK1,OMK2)
            OMRM(K,I)  = LAM1/(1.0+LAM1-OMK1)
C           LAM1       = FR(T1(K,I),AGT1,AGT2,AGK1,AGK2)               !5/13/97 FTN
C           LAM2       = FF(T1(K,I),AGT3,AGT4,AGK3,AGK4)               !5/13/97 FTN
C           AGRMR(K,I) = LAM1/(1.0+LAM1-AGK1)                          !5/13/97 FTN
C           AGRMF(K,I) = LAM2/(1.0+LAM2-AGK4)                          !5/13/97 FTN
            DO JA=1,NAP                                                !5/13/97 FTN
              LAM1 = FR(T1(K,I),AGT1(JA),AGT2(JA),AGK1(JA),AGK2(JA))   !5/13/97 FTN
              LAM2 = FF(T1(K,I),AGT3(JA),AGT4(JA),AGK3(JA),AGK4(JA))   !5/13/97 FTN
              AGRMR(K,I,JA) = LAM1/(1.0+LAM1-AGK1(JA))                 !5/13/97 FTN
              AGRMF(K,I,JA) = LAM2/(1.0+LAM2-AGK4(JA))                 !5/13/97 FTN
            END DO                                                     !5/13/97 FTN
          END DO
        END DO
      END
      REAL FUNCTION FR(TT,TT1,TT2,K1,K2)                               !2/02/95 FTN
        REAL K1, K2                                                    !2/02/95 FTN
        FR = K1*EXP(LOG(K2*(1.0-K1)/(K1*(1.0-K2)))/(TT2-TT1)*(TT-TT1)) !2/02/95 FTN
      END                                                              !2/02/95 FTN
      REAL FUNCTION FF(TT,TT3,TT4,K3,K4)                               !2/02/95 FTN
        REAL K3, K4                                                    !2/02/95 FTN
        FF = K4*EXP(LOG(K3*(1.0-K4)/(K4*(1.0-K3)))/(TT4-TT3)*(TT4-TT)) !2/02/95 FTN
      END                                                              !2/02/95 FTN
```

```
************************************************************************
**       S U B R O U T I N E   D E C A Y   C O N S T A N T S         **
************************************************************************

      SUBROUTINE DECAY_CONSTANTS
        INCLUDE 'w2.inc'

******* Variable declaration

        REAL LRFDK, LABDK, NH3DK, NO3DK, NH3D, NO3D, NH3RM, NH3REL,
     .       NO3RM, KBOD
        DIMENSION ASETL(NAP)                                          !5/13/97 FTN

******* Common declaration

        COMMON /GLOBLC/ JB, JC, IU, ID, KT, ELKT, DLT, KB(IMP), KTI(IMP)
        COMMON /SETLC2/ SSETL, DSETL,   ASETL, FESETL
        COMMON /ORGDKC/ SEDDK, DETDK,   LABDK, REFDK,   LRFDK
        COMMON /NITROC/ BION,  PARTN,   NH3DK, NH3REL,  NO3DK
        COMMON /CBODC/  KBOD,  TBOD,    RBOD
        COMMON /GLBLCC/ PALT,  ALGDET,  O2LIM, WIND,    WSCDP, WSC(NDP)
        COMMON /DKORGC/ DETD(KMC,IMC),  ORGD(KMC,IMC)
        COMMON /DKSEDC/ SEDD(KMC,IMC),  SO2D(KMC,IMC),  SOD(IMP)
        COMMON /DKNITC/ NH3D(KMC,IMC),  NO3D(KMC,IMC)
        COMMON /DKBODC/ CBODD(KMC,IMC)
        COMMON /DKMLTC/ A1(KMC,IMC),    A2(KMC,IMC),    A3(KMC,IMC)
        COMMON /GBLRTC/ OMRM(KMC,IMC),  NH3RM(KMC,IMC), NO3RM(KMC,IMC),
C    .                  AGRMR(KMC,IMC), AGRMF(KMC,IMC)               !5/13/97 FTN
     .                  AGRMR(KMC,IMC,NAP), AGRMF(KMC,IMC,NAP)       !5/13/97 FTN
        COMMON /GEOMHC/ EL(KMP),        H(KMP),         HKT1(IMP),
     .                  HKT2(IMP)
        COMMON /GEOMBC/ B(KMP,IMP),     BKT(IMP),       BH(KMP,IMP),
     .                  BHKT1(IMP),     BHKT2(IMP),     BHRKT1(IMP)
        COMMON /SETLC1/ SETIN(KMC,IMC), SETOUT(KMC,IMC)
        COMMON /TEMPC/  T1(KMP,IMP),    T2(KMP,IMP)

        DO I=IU,ID
          DO K=KT,KB(I)
            A1(K,I)    = (1.0+SIGN(1.0,DO(K,I)-O2LIM))*0.5
            A2(K,I)    = (1.0+SIGN(1.0,O2LIM-DO(K,I)))*0.5
            A3(K,I)    = (1.0+SIGN(1.0,DO(K,I)-1.E-10))*0.5
            ORGD(K,I)  = OMRM(K,I)*(LABDK*LABDOM(K,I)+REFDK
     .                   *REFDOM(K,I))*A3(K,I)
            NH3D(K,I)  = NH3DK*NH3RM(K,I)*NH3(K,I)*A1(K,I)
            NO3D(K,I)  = NO3DK*NO3RM(K,I)*NO3(K,I)*A2(K,I)
            CBODD(K,I) = KBOD*TBOD**(T1(K,I)-20.0)*A3(K,I)
            DETD(K,I)  = DETDK*OMRM(K,I)*DETRIT(K,I)*A3(K,I)
            SEDD(K,I)  = SEDDK*OMRM(K,I)*SEDMNT(K,I)*A3(K,I)
          END DO
        END DO
        DO I=IU,ID
C         SETOUT(KT,I) = (SSETL*SS(KT,I)+FESETL*FE(KT,I))/HKT2(I)     !5/14/97 FTN
C    .                   *A1(KT,I)                                   !5/14/97 FTN
C                                                                    !1/19/00 FTN
C         Remove iron from settling equations because iron is no longer !1/19/00 FTN
C         a state variable (it has been replaced with age of water)     !1/19/00 FTN
C                                                                    !1/19/00 FTN
C         SETOUT(KT,I) = (SSETL*SS(KT,I) + FESETL*FE(KT,I)*A1(KT,I))  !1/19/00 FTN
C    .                   /HKT2(I)                                    !1/19/00 FTN
          SETOUT(KT,I) =  SSETL*SS(KT,I) / HKT2(I)                   !1/19/00 FTN
          SETIN(KT,I)  = 0.0                                         !5/14/98 FTN
          DO K=KT+1,KB(I)
            SETIN(K,I)  = SETOUT(K-1,I)
C           SETOUT(K,I) = (SSETL*SS(K,I)+FESETL*FE(K,I))/H(K)*A1(K,I)  !5/14/97 FTN
C           SETOUT(K,I) = (SSETL*SS(K,I)+FESETL*FE(K,I)*A1(K,I))/H(K)  !1/19/00 FTN
            SETOUT(K,I) =  SSETL*SS(K,I) / H(K)                      !1/19/00 FTN
          END DO
        END DO
        DO I=IU,ID
          SO2D(KT,I) = SOD(I)/BHKT2(I)*OMRM(KT,I)*(B(KTI(I),I)
     .                 -B(KT+1,I))
```

```
    DO K=KT+1,KB(I)-1
      SO2D(K,I) = SOD(I)/BH(K,I)*OMRM(K,I)*(B(K,I)-B(K+1,I))
    END DO
    SO2D(KB(I),I) = SOD(I)/BH(KB(I),I)*OMRM(KB(I),I)*B(KB(I),I)
  END DO
END
```

```
****************************************************************************
**           S U B R O U T I N E   L A B I L E   D O M              **
****************************************************************************

      SUBROUTINE LABILE_DOM
        INCLUDE 'w2.inc'

******* Variable declaration

        REAL LABDK, LRFDK, NH3RM, NO3RM

******* Common declaration

        COMMON /GLOBLC/ JB, JC, IU, ID, KT, ELKT, DLT, KB(IMP), KTI(IMP)
        COMMON /GLBLCC/ PALT,  ALGDET, O2LIM, WIND,  WSCDP, WSC(NDP)
        COMMON /ORGDKC/ SEDDK, DETDK,  LABDK, REFDK, LRFDK
        COMMON /GBLRTC/ OMRM(KMC,IMC),  NH3RM(KMC,IMC), NO3RM(KMC,IMC),
C    .                  AGRMR(KMC,IMC), AGRMF(KMC,IMC)                 !5/13/97 FTN
     .                  AGRMR(KMC,IMC,NAP), AGRMF(KMC,IMC,NAP)         !5/13/97 FTN
        COMMON /DKMLTC/ A1(KMC,IMC),    A2(KMC,IMC),    A3(KMC,IMC)
C       COMMON /PHYTGC/ AGR(KMC,IMC),   ARR(KMC,IMC),   AMR(KMC,IMC),  !5/14/97 FTN
C    .                  AER(KMC,IMC)                                   !5/14/97 FTN
        COMMON /PHYTGC/ AGR(KMC,IMC,NAP), ARR(KMC,IMC,NAP),            !5/14/97 FTN
     .                  AMR(KMC,IMC,NAP), AER(KMC,IMC,NAP)             !5/14/97 FTN

        DO I=IU,ID
          DO K=KT,KB(I)
            DECAY       = OMRM(K,I)*A3(K,I)*(LABDK+LRFDK)*LABDOM(K,I)
C           ALGP        = (AER(K,I)+(1.0-ALGDET)*AMR(K,I))*ALGAE(K,I)  !5/14/97 FTN
            ALGP = 0.0                                                 !5/14/97 FTN
            DO JA=1,NAP                                                !5/14/97 FTN
              ALGP = ALGP + ( AER(K,I,JA) + (1.0-ALGDET)*AMR(K,I,JA) ) !5/14/97 FTN
     &                                           * ALGAE(K,I,JA)       !5/14/97 FTN
            END DO                                                     !5/14/97 FTN
            LDOMSS(K,I) = ALGP-DECAY
          END DO
        END DO
      END

****************************************************************************
**         S U B R O U T I N E   R E F R A C T O R Y   D O M        **
****************************************************************************

      SUBROUTINE REFRACTORY_DOM
        INCLUDE 'w2.inc'

******* Variable declaration

        REAL LRFDK, LABDK, NH3RM, NO3RM

******* Common declaration

        COMMON /GLOBLC/ JB, JC, IU, ID, KT, ELKT, DLT, KB(IMP), KTI(IMP)
        COMMON /ORGDKC/ SEDDK, DETDK, LABDK, REFDK, LRFDK
        COMMON /GBLRTC/ OMRM(KMC,IMC),  NH3RM(KMC,IMC), NO3RM(KMC,IMC),
C    .                  AGRMR(KMC,IMC), AGRMF(KMC,IMC)                 !5/13/97 FTN
     .                  AGRMR(KMC,IMC,NAP), AGRMF(KMC,IMC,NAP)         !5/13/97 FTN
        COMMON /DKMLTC/ A1(KMC,IMC),    A2(KMC,IMC),    A3(KMC,IMC)

        DO I=IU,ID
          DO K=KT,KB(I)
            RDOMSS(K,I) = OMRM(K,I)*(LRFDK*LABDOM(K,I)-REFDK
     .                     *REFDOM(K,I))*A3(K,I)
          END DO
        END DO
      END
```

```
************************************************************************
**          S U B R O U T I N E   P H Y T O P L A N K T O N          **
************************************************************************

      SUBROUTINE PHYTOPLANKTON
        INCLUDE 'w2.inc'

******* Variable declaration

C       REAL      LAM1, LAM2,  LTCOEF, LLIM,  NLIM,  LIMIT, NETSET,  !5/14/97 FTN
        REAL      LAM1, LAM2,  LTCOEF, LLIM,  NLIM,  LIMIT,          !5/14/97 FTN
     .            LAT,  LONG,  NH3DK,  NH3REL, NO3DK, NH3RM, NO3RM
C       CHARACTER LF*3, LFAC*4, LFPR*7                               !5/14/97 FTN
        CHARACTER      LFAC*4, LFPR*7                                !5/14/97 FTN
        INTEGER   FREQUK                                             !5/14/97 FTN
        DIMENSION AGROW(NAP), AMORT(NAP), AEXCR(NAP), ARESP(NAP),    !5/13/97 FTN
     &            ASETL(NAP), AHSP(NAP), AHSN(NAP), AHSSI(NAP),      !5/13/97 FTN
     &            ASATUR(NAP), ABIOP(NAP), ABION(NAP), ABIOSI(NAP),  !5/13/97 FTN
     &            ABIOC(NAP)                                         !5/13/97 FTN

******* Common declaration

        COMMON /PHYTC1/ AEXCR,  AMORT,  AGROW,  ARESP,  ASATUR, AHSN,
C    .                  AHSP                                         !5/13/97 FTN
     .                  AHSP,   AHSSI                                !5/13/97 FTN
C       COMMON /PHYTC2/ BETA,   EXH2O,  EXINOR, EXORG                !5/14/97 FTN
        COMMON /PHYTC2/ BETA,   EXH2O,  EXINOR, EXORG, FREQUK, ALGLIT !6/16/98 FTN
        COMMON /PHYTC3/ ABIOP,  ABION,  ABIOSI, ABIOC                !5/14/97 FTN
        COMMON /SETLC2/ SSETL,  DSETL,  ASETL,  FESETL
        COMMON /GLOBLC/ JB,     JC,     IU,     ID,     KT,     ELKT,
     .                  DLT,    KB(IMP),KTI(IMP)
        COMMON /TVDMTC/ TAIR,   TDEW,   CLOUD,  PHI,    ET,     CSHE,
     .                  SRO,    LAT,    LONG
        COMMON /PHOSPC/ PO4REL, BIOP,   PARTP
        COMMON /NITROC/ BION,   PARTN,  NH3DK,  NH3REL, NO3DK
C       COMMON /PHYTGC/ AGR(KMC,IMC),   ARR(KMC,IMC),   AMR(KMC,IMC),  !5/14/97 FTN
C    .                  AER(KMC,IMC)                                 !5/14/97 FTN
        COMMON /PHYTGC/ AGR(KMC,IMC,NAP), ARR(KMC,IMC,NAP),          !5/14/97 FTN
     .                  AMR(KMC,IMC,NAP), AER(KMC,IMC,NAP)           !5/14/97 FTN
C       COMMON /LFACC/  LFAC(KMC,IMC),  LFPR(KMC,IMC)                !5/14/97 FTN
        COMMON /LFACC/  LFAC(KMC,IMC,NAP),  LFPR(KMC,IMC,NAP)        !5/14/97 FTN
        COMMON /DKMLTC/ A1(KMC,IMC),    A2(KMC,IMC),    A3(KMC,IMC)
        COMMON /GBLRTC/ OMRM(KMC,IMC),  NH3RM(KMC,IMC), NO3RM(KMC,IMC),
C    .                  AGRMR(KMC,IMC), AGRMF(KMC,IMC)               !5/13/97 FTN
     .                  AGRMR(KMC,IMC,NAP), AGRMF(KMC,IMC,NAP)       !5/13/97 FTN
        COMMON /GEOMHC/ EL(KMP),        H(KMP),         HKT1(IMP),
     .                  HKT2(IMP)

C       LTCOEF = (1.0-BETA)*SRO*4.186E6/ASATUR                       !5/14/97 FTN
        DTKU = DLT * REAL(FREQUK)                                    !5/14/97 FTN
        DO I=IU,ID

********* Limiting factor

          TOT_PARTIC_ORG = DETRIT(KT,I)                              !5/14/97 FTN
          DO JA=1,NAP                                                !5/14/97 FTN
            TOT_PARTIC_ORG = TOT_PARTIC_ORG + ALGAE(KT,I,JA)         !5/14/97 FTN
          END DO                                                     !5/14/97 FTN
          GAMMA = EXH2O+EXINOR*SS(KT,I)+EXORG*TOT_PARTIC_ORG         !5/14/97 FTN
C         GAMMA = EXH2O+EXINOR*SS(KT,I)+EXORG*(ALGAE(KT,I)+DETRIT(KT,I))!5/14/97 FTN
          DEPTH = HKT2(I)                                            !5/14/97 FTN
C         LAM1  = LTCOEF                                             !5/14/97 FTN
C         LAM2  = LTCOEF*EXP(-GAMMA*DEPTH)                           !5/14/97 FTN
C         LLIM  = 2.718282*(EXP(-LAM2)-EXP(-LAM1))/(GAMMA*HKT2(I))   !5/14/97 FTN
C         PLIM  = PO4(KT,I)/(PO4(KT,I)+AHSP)                         !5/14/97 FTN
C         NLIM  = (NH3(KT,I)+NO3(KT,I))/(NH3(KT,I)+NO3(KT,I)+AHSN)   !5/14/97 FTN
C         LIMIT = MIN(PLIM,NLIM,LLIM)                                !5/14/97 FTN
C         IF (LIMIT.EQ.PLIM) THEN                                    !5/14/97 FTN
C           WRITE (LFAC(KT,I),'(F4.3)') PLIM                         !5/14/97 FTN
C           LF          = ' P '                                      !5/14/97 FTN
C           LFPR(KT,I) = LF//LFAC(KT,I)                              !5/14/97 FTN
```

```
C        ELSE IF (LIMIT.EQ.NLIM) THEN                                   !5/14/97 FTN
C          WRITE (LFAC(KT,I),'(F4.3)') NLIM                             !5/14/97 FTN
C          LF          = ' N '                                          !5/14/97 FTN
C          LFPR(KT,I) = LF//LFAC(KT,I)                                  !5/14/97 FTN
C        ELSE IF (LIMIT.EQ.LLIM) THEN                                   !5/14/97 FTN
C          WRITE (LFAC(KT,I),'(F4.3)') LLIM                             !5/14/97 FTN
C          LF          = ' L '                                          !5/14/97 FTN
C          LFPR(KT,I) = LF//LFAC(KT,I)                                  !5/14/97 FTN
C        END IF                                                         !5/14/97 FTN
C                                                                       !5/14/97 FTN
         DO JA=1,NAP                                                    !5/14/97 FTN
           LTCOEF = (1.0-BETA) * SRO * 4.186E6 / ASATUR(JA)             !5/14/97 FTN
           LAM1 = LTCOEF                                                !5/14/97 FTN
           LAM2 = LTCOEF * EXP(-GAMMA*DEPTH)                            !5/14/97 FTN
           LLIM = 2.718282 * (EXP(-LAM2)-EXP(-LAM1)) / (GAMMA*HKT2(I)) !5/14/97 FTN
           PLIM = PO4(KT,I) / ( PO4(KT,I)+AHSP(JA)+1.0E-20 )            !5/14/97 FTN
           NLIM = ( NH3(KT,I)+NO3(KT,I) ) /                             !5/14/97 FTN
     &            ( NH3(KT,I)+NO3(KT,I)+AHSN(JA)+1.0E-20 )              !5/14/97 FTN
           SLIM = SI(KT,I) / ( SI(KT,I)+AHSSI(JA)+1.0E-20 )             !5/16/97 FTN
           LIMIT = MIN (PLIM, NLIM, SLIM, LLIM)                         !5/14/97 FTN
           IF (ABS(LIMIT-PLIM).LT.1.0E-9) THEN                          !5/14/97 FTN
             WRITE (LFAC(KT,I,JA),'(F4.3)') PLIM                        !5/14/97 FTN
             LFPR(KT,I,JA) = ' P '//LFAC(KT,I,JA)                       !5/14/97 FTN
           ELSEIF (ABS(LIMIT-NLIM).LT.1.0E-9) THEN                      !5/14/97 FTN
             WRITE (LFAC(KT,I,JA),'(F4.3)') NLIM                        !5/14/97 FTN
             LFPR(KT,I,JA) = ' N '//LFAC(KT,I,JA)                       !5/14/97 FTN
           ELSEIF (ABS(LIMIT-SLIM).LT.1.0E-9) THEN                      !5/14/97 FTN
             WRITE (LFAC(KT,I,JA),'(F4.3)') SLIM                        !5/14/97 FTN
             LFPR(KT,I,JA) = ' S '//LFAC(KT,I,JA)                       !5/14/97 FTN
           ELSEIF (ABS(LIMIT-LLIM).LT.1.0E-9) THEN                      !5/14/97 FTN
             WRITE (LFAC(KT,I,JA),'(F4.3)') LLIM                        !5/14/97 FTN
             LFPR(KT,I,JA) = ' L '//LFAC(KT,I,JA)                       !5/14/97 FTN
           END IF                                                       !5/14/97 FTN

********* Sources/sinks

           ARR(KT,I,JA) = AGRMR(KT,I,JA) * AGRMF(KT,I,JA) * ARESP(JA)  !5/14/97 FTN
     &                                                    * A3(KT,I)   !5/14/97 FTN
           AMR(KT,I,JA) = (AGRMR(KT,I,JA) + 1.0-AGRMF(KT,I,JA))        !5/14/97 FTN
     &                                                    * AMORT(JA)  !5/14/97 FTN
           AA1 = AGRMR(KT,I,JA) * AGRMF(KT,I,JA) * AGROW(JA) * LIMIT   !5/14/97 FTN
           AA2 = PO4(KT,I) / ( ABIOP(JA)*DTKU*ALGAE(KT,I,JA)+1.0E-20 ) !5/14/97 FTN
           AA3 = ( NH3(KT,I)+NO3(KT,I) ) /                             !5/14/97 FTN
     &           ( ABION(JA)*DTKU*ALGAE(KT,I,JA)+1.0E-20 )             !5/14/97 FTN
           AGR(KT,I,JA) = MIN (AA1, AA2, AA3)                          !5/14/97 FTN
           AER(KT,I,JA) = MIN ( (1.0-LLIM)*AEXCR(JA), AGR(KT,I,JA) )   !5/14/97 FTN
           ALGSS(KT,I,JA) = ( AGR(KT,I,JA)                             !5/14/97 FTN
     &                       - ARR(KT,I,JA)                            !5/14/97 FTN
     &                       - AER(KT,I,JA)                            !5/14/97 FTN
     &                       - AMR(KT,I,JA)                            !5/14/97 FTN
     &                       - ASETL(JA)/HKT2(I) ) * ALGAE(KT,I,JA)    !5/14/97 FTN
         END DO                                                        !5/14/97 FTN
C        ARR(KT,I)    = AGRMR(KT,I)*AGRMF(KT,I)*ARESP*A3(KT,I)         !5/14/97 FTN
C        AMR(KT,I)    = (AGRMR(KT,I)+1.0-AGRMF(KT,I))*AMORT            !5/14/97 FTN
C        AGR(KT,I)    = AGRMR(KT,I)*AGRMF(KT,I)*AGROW*LIMIT            !5/14/97 FTN
C        AGR(KT,I)    = MIN(AGR(KT,I),PO4(KT,I)/(BIOP*DLT*ALGAE(KT,I)  !5/14/97 FTN
C    .                  +1.0E-20),(NH3(KT,I)+NO3(KT,I))/(BION*DLT      !5/14/97 FTN
C    .                  *ALGAE(KT,I)+1.0E-20))                         !5/14/97 FTN
C        AER(KT,I)    = MIN((1.0-LLIM)*AEXCR,AGR(KT,I))                !5/14/97 FTN
C        GROWTH       = (AGR(KT,I)-ARR(KT,I)-AER(KT,I)-AMR(KT,I))      !5/14/97 FTN
C    .                 *ALGAE(KT,I)                                    !5/14/97 FTN
C        NETSET       = -ASETL*ALGAE(KT,I)/HKT2(I)                     !5/14/97 FTN
C        ALGSS(KT,I) = GROWTH+NETSET                                   !5/14/97 FTN
         DO K=KT+1,KB(I)

*********** Limiting factor

           TOT_PARTIC_ORG = DETRIT(K,I)                                !5/14/97 FTN
           DO JA=1,NAP                                                 !5/14/97 FTN
             TOT_PARTIC_ORG = TOT_PARTIC_ORG + ALGAE(K,I,JA)           !5/14/97 FTN
           END DO                                                      !5/14/97 FTN
```

```
            GAMMA = EXH2O+EXINOR*SS(K,I)+EXORG*TOT_PARTIC_ORG           !5/14/97 FTN
C           GAMMA = EXH2O+EXINOR*SS(K,I)+EXORG*(ALGAE(K,I)+DETRIT(K,I)) !5/14/97 FTN
C           LAM1  = LTCOEF*EXP(-GAMMA*DEPTH)                            !5/14/97 FTN
C           LAM2  = LTCOEF*EXP(-GAMMA*(DEPTH+H(K)))                     !5/14/97 FTN
C           LLIM  = 2.718282*(EXP(-LAM2)-EXP(-LAM1))/(GAMMA*H(K))       !5/14/97 FTN
C           DEPTH = DEPTH+H(K)                                          !5/14/97 FTN
C           PLIM  = PO4(K,I)/(PO4(K,I)+AHSP)                            !5/14/97 FTN
C           NLIM  = (NH3(K,I)+NO3(K,I))/(NH3(K,I)+NO3(K,I)+AHSN)        !5/14/97 FTN
C           LIMIT = MIN(PLIM,NLIM,LLIM)                                 !5/14/97 FTN
C           IF (LIMIT.EQ.PLIM) THEN                                     !5/14/97 FTN
C             WRITE (LFAC(K,I),'(F4.3)') PLIM                           !5/14/97 FTN
C             LF        = ' P '                                         !5/14/97 FTN
C             LFPR(K,I) = LF//LFAC(K,I)                                 !5/14/97 FTN
C           ELSE IF (LIMIT.EQ.NLIM) THEN                                !5/14/97 FTN
C             WRITE (LFAC(K,I),'(F4.3)') NLIM                           !5/14/97 FTN
C             LF        = ' N '                                         !5/14/97 FTN
C             LFPR(K,I) = LF//LFAC(K,I)                                 !5/14/97 FTN
C           ELSE IF (LIMIT.EQ.LLIM) THEN                                !5/14/97 FTN
C             WRITE (LFAC(K,I),'(F4.3)') LLIM                           !5/14/97 FTN
C             LF        = ' L '                                         !5/14/97 FTN
C             LFPR(K,I) = LF//LFAC(K,I)                                 !5/14/97 FTN
C           END IF                                                      !5/14/97 FTN
            DO JA=1,NAP                                                 !5/14/97 FTN
              LTCOEF = (1.0-BETA) * SRO * 4.186E6 / ASATUR(JA)          !5/14/97 FTN
              LAM1 = LTCOEF * EXP(-GAMMA*DEPTH)                         !5/14/97 FTN
              LAM2 = LTCOEF * EXP(-GAMMA*(DEPTH+H(K)))                  !5/14/97 FTN
              LLIM = 2.718282 * (EXP(-LAM2)-EXP(-LAM1)) / (GAMMA*H(K))  !5/14/97 FTN
              PLIM = PO4(K,I) / ( PO4(K,I)+AHSP(JA)+1.0E-20 )           !5/14/97 FTN
              NLIM = ( NH3(K,I)+NO3(K,I) ) /                            !5/14/97 FTN
     &              ( NH3(K,I)+NO3(K,I)+AHSN(JA)+1.0E-20 )              !5/14/97 FTN
              SLIM = SI(K,I) / ( SI(K,I)+AHSSI(JA)+1.0E-20 )            !5/16/97 FTN
              LIMIT = MIN (PLIM, NLIM, SLIM, LLIM)                      !5/14/97 FTN
              IF (ABS(LIMIT-PLIM).LT.1.0E-9) THEN                       !5/14/97 FTN
                WRITE (LFAC(K,I,JA),'(F4.3)') PLIM                      !5/14/97 FTN
                LFPR(K,I,JA) = ' P '//LFAC(K,I,JA)                      !5/14/97 FTN
              ELSEIF (ABS(LIMIT-NLIM).LT.1.0E-9) THEN                   !5/14/97 FTN
                WRITE (LFAC(K,I,JA),'(F4.3)') NLIM                      !5/14/97 FTN
                LFPR(K,I,JA) = ' N '//LFAC(K,I,JA)                      !5/14/97 FTN
              ELSEIF (ABS(LIMIT-SLIM).LT.1.0E-9) THEN                   !5/14/97 FTN
                WRITE (LFAC(K,I,JA),'(F4.3)') SLIM                      !5/14/97 FTN
                LFPR(K,I,JA) = ' S '//LFAC(K,I,JA)                      !5/14/97 FTN
              ELSEIF (ABS(LIMIT-LLIM).LT.1.0E-9) THEN                   !5/14/97 FTN
                WRITE (LFAC(K,I,JA),'(F4.3)') LLIM                      !5/14/97 FTN
                LFPR(K,I,JA) = ' L '//LFAC(K,I,JA)                      !5/14/97 FTN
              END IF                                                    !5/14/97 FTN

*********** Sources/sinks

              ARR(K,I,JA) = AGRMR(K,I,JA) * AGRMF(K,I,JA) * ARESP(JA)   !5/14/97 FTN
     &                                                  * A3(K,I)       !5/14/97 FTN
              AMR(K,I,JA) = (AGRMR(K,I,JA) + 1.0-AGRMF(K,I,JA))         !5/14/97 FTN
     &                                                  * AMORT(JA)     !5/14/97 FTN
              AA1 = AGRMR(K,I,JA) * AGRMF(K,I,JA) * AGROW(JA) * LIMIT   !5/14/97 FTN
              AA2 = PO4(K,I) / ( ABIOP(JA)*DTKU*ALGAE(K,I,JA)+1.0E-20 ) !5/14/97 FTN
              AA3 = ( NH3(K,I)+NO3(K,I) ) /                             !5/14/97 FTN
     &              ( ABION(JA)*DTKU*ALGAE(K,I,JA)+1.0E-20 )            !5/14/97 FTN
              AGR(K,I,JA) = MIN (AA1, AA2, AA3)                         !5/14/97 FTN
              AER(K,I,JA) = MIN ( (1.0-LLIM)*AEXCR(JA), AGR(K,I,JA) )   !5/14/97 FTN
              ALGSS(K,I,JA) = ( AGR(K,I,JA)                             !5/14/97 FTN
     &                        - ARR(K,I,JA)                             !5/14/97 FTN
     &                        - AER(K,I,JA)                             !5/14/97 FTN
     &                        - AMR(K,I,JA)                             !5/14/97 FTN
     &                        - ASETL(JA)/H(K) ) * ALGAE(K,I,JA)        !5/14/97 FTN
     &                        + ASETL(JA)/H(K) * ALGAE(K-1,I,JA)        !5/14/97 FTN
            END DO                                                      !5/14/97 FTN
C                                                                       !6/16/98 FTN
C           If the available light is below the user specified minimum  !6/16/98 FTN
C           level (e.g., 1%), then set the algae source/sink terms such !6/16/98 FTN
C           that the algae concentrations will go to zero by the next   !6/16/98 FTN
C           time the kinetic routines are updated (assume that algae is !6/16/98 FTN
C           converted to detritus).  Increase the detritus source/sink  !6/16/98 FTN
```

```
C          term to account for the addition of the algae.          !6/16/98 FTN
C                                                                   !6/16/98 FTN
           IF (EXP(-GAMMA*DEPTH).LE.ALGLIT) THEN                    !6/16/98 FTN
             DO JA=1,NAP                                            !6/16/98 FTN
               LFPR(K,I,JA) = ' Detrit'                             !6/16/98 FTN
               ALGSS(K,I,JA) = -ALGAE(K,I,JA)/DTKU                  !6/16/98 FTN
               DETSS(K,I) = DETSS(K,I) + ALGAE(K,I,JA)/DTKU         !6/16/98 FTN
             END DO                                                 !6/16/98 FTN
           END IF                                                   !6/16/98 FTN
           DEPTH = DEPTH+H(K)                                       !5/14/97 FTN
C          ARR(K,I)    = AGRMR(K,I)*AGRMF(K,I)*ARESP*A3(K,I)
C          AMR(K,I)    = (AGRMR(K,I)+1.0-AGRMF(K,I))*AMORT
C          AGR(K,I)    = AGRMR(K,I)*AGRMF(K,I)*AGROW*LIMIT
C          AGR(K,I)    = MIN(AGR(K,I),PO4(K,I)/(BIOP*DLT*ALGAE(K,I)
C    .                   +1.0E-20),(NH3(K,I)+NO3(K,I))/(BION*DLT
C    .                   *ALGAE(K,I)+1.0E-20))
C          AER(K,I)    = MIN((1.0-LLIM)*AEXCR,AGR(K,I))
C          GROWTH      = (AGR(K,I)-ARR(K,I)-AER(K,I)-AMR(K,I))
C    .                   *ALGAE(K,I)
C          NETSET      = ASETL*(ALGAE(K-1,I)-ALGAE(K,I))/H(K)
C          ALGSS(K,I) = GROWTH+NETSET
         END DO
       END DO
     END
```

```
************************************************************************
**                S U B R O U T I N E   D E T R I T U S               **
************************************************************************

      SUBROUTINE DETRITUS
        INCLUDE 'w2.inc'

******* Variable declaration

        REAL NETSET
        DIMENSION ASETL(NAP)                                          !5/13/97 FTN

******* Common declaration

        COMMON /GLOBLC/ JB, JC, IU, ID, KT, ELKT, DLT, KB(IMP), KTI(IMP)
        COMMON /GLBLCC/ PALT,  ALGDET, O2LIM, WIND, WSCDP, WSC(NDP)
        COMMON /SETLC2/ SSETL, DSETL,  ASETL, FESETL
        COMMON /DKORGC/ DETD(KMC,IMC), ORGD(KMC,IMC)
C       COMMON /PHYTGC/ AGR(KMC,IMC),   ARR(KMC,IMC),   AMR(KMC,IMC),  !5/14/97 FTN
C    .                  AER(KMC,IMC)                                   !5/14/97 FTN
        COMMON /PHYTGC/ AGR(KMC,IMC,NAP), ARR(KMC,IMC,NAP),            !5/14/97 FTN
     .                  AMR(KMC,IMC,NAP), AER(KMC,IMC,NAP)             !5/14/97 FTN
        COMMON /GEOMHC/ EL(KMP),       H(KMP),       HKT1(IMP),
     .                  HKT2(IMP)

        DO I=IU,ID
          ALGP = 0.0                                                  !5/14/97 FTN
          DO JA=1,NAP                                                 !5/14/97 FTN
            ALGP = ALGP + ALGDET*AMR(KT,I,JA)*ALGAE(KT,I,JA)          !5/14/97 FTN
          END DO                                                      !5/14/97 FTN
C         ALGP        = ALGDET*AMR(KT,I)*ALGAE(KT,I)                  !5/14/97 FTN
          NETSET      = -DSETL*DETRIT(KT,I)/HKT2(I)
          DETSS(KT,I) = ALGP-DETD(KT,I)+NETSET
          DO K=KT+1,KB(I)
            ALGP = 0.0                                                !5/14/97 FTN
            DO JA=1,NAP                                               !5/14/97 FTN
              ALGP = ALGP + ALGDET*AMR(K,I,JA)*ALGAE(K,I,JA)          !5/14/97 FTN
            END DO                                                    !5/14/97 FTN
C           ALGP       = ALGDET*AMR(K,I)*ALGAE(K,I)                   !5/14/97 FTN
            NETSET     = DSETL*(DETRIT(K-1,I)-DETRIT(K,I))/H(K)
            DETSS(K,I) = ALGP-DETD(K,I)+NETSET
          END DO
        END DO
      END
```

```
************************************************************************
**             S U B R O U T I N E   P H O S P H O R U S             **
************************************************************************

      SUBROUTINE PHOSPHORUS
        INCLUDE 'w2.inc'
        DIMENSION  ABIOP(NAP), ABION(NAP), ABIOSI(NAP), ABIOC(NAP)      !5/14/97 FTN

******* Common declaration

        COMMON /PHOSPC/ PO4REL, BIOP, PARTP
        COMMON /GLOBLC/ JB, JC, IU, ID, KT, ELKT, DLT, KB(IMP), KTI(IMP)
        COMMON /SETLC1/ SETIN(KMC,IMC), SETOUT(KMC,IMC)
        COMMON /DKORGC/ DETD(KMC,IMC),  ORGD(KMC,IMC)
        COMMON /DKSEDC/ SEDD(KMC,IMC),  SO2D(KMC,IMC), SOD(IMP)
        COMMON /DKMLTC/ A1(KMC,IMC),    A2(KMC,IMC),   A3(KMC,IMC)
C       COMMON /PHYTGC/ AGR(KMC,IMC),   ARR(KMC,IMC),   AMR(KMC,IMC),   !5/14/97 FTN
C    .                  AER(KMC,IMC)                                    !5/14/97 FTN
        COMMON /PHYTGC/ AGR(KMC,IMC,NAP), ARR(KMC,IMC,NAP),             !5/14/97 FTN
     .                  AMR(KMC,IMC,NAP), AER(KMC,IMC,NAP)              !5/14/97 FTN
        COMMON /PHYTC3/ ABIOP,  ABION,  ABIOSI, ABIOC                   !5/14/97 FTN

        DO I=IU,ID
          DO K=KT,KB(I)
            ALGPROC = 0.0                                               !5/14/97 FTN
            DO JA=1,NAP                                                 !5/14/97 FTN
              ALGPROC = ALGPROC + (ARR(K,I,JA) - AGR(K,I,JA))           !5/14/97 FTN
     &                          * ALGAE(K,I,JA) * ABIOP(JA)             !5/14/97 FTN
            END DO                                                      !5/14/97 FTN
C           ALGP      = (ARR(K,I)-AGR(K,I))*ALGAE(K,I)                  !5/14/97 FTN
C           PO4SS(K,I) = BIOP*(ALGP+DETD(K,I)+ORGD(K,I)+SEDD(K,I))      !5/14/97 FTN
            PO4SS(K,I) = BIOP*     (DETD(K,I)+ORGD(K,I)+SEDD(K,I))      !5/14/97 FTN
     .                   +PO4REL*SO2D(K,I)*A2(K,I)+PARTP*(SETIN(K,I)
     .                   *PO4(K-1,I)-SETOUT(K,I)*PO4(K,I))
     &                   +ALGPROC                                       !5/14/97 FTN
          END DO
        END DO
      END

************************************************************************
**             S U B R O U T I N E   A M M O N I U M                 **
************************************************************************

      SUBROUTINE AMMONIUM
        INCLUDE 'w2.inc'

******* Variable declaration

        REAL NH3REL, NH3D, NO3D, NH3DK, NO3DK
        REAL ABIOP(NAP), ABION(NAP), ABIOSI(NAP), ABIOC(NAP)            !5/14/97 FTN

******* Common declaration

        COMMON /NITROC/ BION, PARTN, NH3DK, NH3REL, NO3DK
        COMMON /GLOBLC/ JB, JC, IU, ID, KT, ELKT, DLT, KB(IMP), KTI(IMP)
        COMMON /DKMLTC/ A1(KMC,IMC),    A2(KMC,IMC),   A3(KMC,IMC)
        COMMON /DKORGC/ DETD(KMC,IMC),  ORGD(KMC,IMC)
        COMMON /DKSEDC/ SEDD(KMC,IMC),  SO2D(KMC,IMC), SOD(IMP)
        COMMON /DKNITC/ NH3D(KMC,IMC),  NO3D(KMC,IMC)
C       COMMON /PHYTGC/ AGR(KMC,IMC),   ARR(KMC,IMC),   AMR(KMC,IMC),   !5/14/97 FTN
C    .                  AER(KMC,IMC)                                    !5/14/97 FTN
        COMMON /PHYTGC/ AGR(KMC,IMC,NAP), ARR(KMC,IMC,NAP),             !5/14/97 FTN
     .                  AMR(KMC,IMC,NAP), AER(KMC,IMC,NAP)              !5/14/97 FTN
        COMMON /PHYTC3/ ABIOP,  ABION,  ABIOSI, ABIOC                   !5/14/97 FTN

        DO I=IU,ID
          DO K=KT,KB(I)
            FRACNH3 = NH3(K,I) / ( NH3(K,I)+NO3(K,I)+1.0E-20 )          !5/14/97 FTN
            ALGPROC = 0.0                                               !5/14/97 FTN
            DO JA=1,NAP                                                 !5/14/97 FTN
              ALGPROC  = ALGPROC + (ARR(K,I,JA) - AGR(K,I,JA)*FRACNH3)  !5/14/97 FTN
```

```
     &                                      * ALGAE(K,I,JA) * ABION(JA)  !5/14/97 FTN
          END DO                                                         !5/14/97 FTN
C         ALGP        = (ARR(K,I)-AGR(K,I)*NH3(K,I)/(NH3(K,I)            !5/14/97 FTN
C    .                  +NO3(K,I)+1.0E-20))*ALGAE(K,I)                   !5/14/97 FTN
C         NH3SS(K,I) = BION*(ALGP+DETD(K,I)+ORGD(K,I)+SEDD(K,I))         !5/14/97 FTN
          NH3SS(K,I) = BION*     (DETD(K,I)+ORGD(K,I)+SEDD(K,I))         !5/14/97 FTN
     .                  +NH3REL*SO2D(K,I)*A2(K,I)-NH3D(K,I)
     &                  +ALGPROC                                         !5/14/97 FTN
        END DO
      END DO
      END

************************************************************************
**                S U B R O U T I N E   N I T R A T E                 **
************************************************************************

      SUBROUTINE NITRATE
        INCLUDE 'w2.inc'

******* Variable declaration

        REAL NH3D, NO3D, NH3DK, NO3DK, NH3REL
        REAL ABIOP(NAP), ABION(NAP), ABIOSI(NAP), ABIOC(NAP)             !5/14/97 FTN

******* Common declaration

        COMMON /NITROC/ BION, PARTN, NH3DK, NH3REL, NO3DK
        COMMON /GLOBLC/ JB, JC, IU, ID, KT, ELKT, DLT, KB(IMP), KTI(IMP)
        COMMON /DKNITC/ NH3D(KMC,IMC), NO3D(KMC,IMC)
C       COMMON /PHYTGC/ AGR(KMC,IMC),   ARR(KMC,IMC),   AMR(KMC,IMC),    !5/14/97 FTN
C    .                  AER(KMC,IMC)                                     !5/14/97 FTN
        COMMON /PHYTGC/ AGR(KMC,IMC,NAP), ARR(KMC,IMC,NAP),              !5/14/97 FTN
     .                  AMR(KMC,IMC,NAP), AER(KMC,IMC,NAP)               !5/14/97 FTN
        COMMON /PHYTC3/ ABIOP,  ABION,  ABIOSI, ABIOC                    !5/14/97 FTN

        DO I=IU,ID
          DO K=KT,KB(I)
            FRACNO3 = 1.0 - ( NH3(K,I) / (NH3(K,I)+NO3(K,I)+1.0E-20) )  !5/14/97 FTN
            ALGC = 0.0                                                   !5/14/97 FTN
            DO JA=1,NAP                                                  !5/14/97 FTN
              ALGC = ALGC + ABION(JA)*FRACNO3*AGR(K,I,JA)*ALGAE(K,I,JA) !5/14/97 FTN
            END DO                                                       !5/14/97 FTN
C           ALGC        = BION*(1.0-NH3(K,I)/(NH3(K,I)+NO3(K,I)+1.0E-20))
C    .                    *AGR(K,I)*ALGAE(K,I)
            NO3SS(K,I) = NH3D(K,I)-NO3D(K,I)-ALGC
          END DO
        END DO
      END
```

```
****************************************************************************
**        S U B R O U T I N E   D I S S O L V E D   O X Y G E N         **
****************************************************************************

      SUBROUTINE DISSOLVED_OXYGEN
        INCLUDE 'w2.inc'

******* Variable declaration

        REAL    NH3D, KBOD, ICETH, NO3D
        LOGICAL ICE, ICE_CALC

******* Common declaration

        COMMON /GLOBLC/ JB, JC, IU, ID, KT, ELKT, DLT, KB(IMP), KTI(IMP)
        COMMON /GLBLCC/ PALT,   ALGDET, O2LIM, WIND, WSCDP, WSC(NDP)
        COMMON /OXYGNC/ O2ORG,  O2ALG,  O2NH3, O2RESP
        COMMON /CBODC/  KBOD,   TBOD,   RBOD
        COMMON /GEOMHC/ EL(KMP),        H(KMP),        HKT1(IMP),
     .                  HKT2(IMP)
        COMMON /ICEC/   ICE(IMP),       ICETH(IMP),    ICE_CALC
        COMMON /TEMPC/  T1(KMP,IMP),    T2(KMP,IMP)
        COMMON /DKMLTC/ A1(KMC,IMC),    A2(KMC,IMC),   A3(KMC,IMC)
        COMMON /DKORGC/ DETD(KMC,IMC),  ORGD(KMC,IMC)
        COMMON /DKSEDC/ SEDD(KMC,IMC),  SO2D(KMC,IMC), SOD(IMP)
        COMMON /DKNITC/ NH3D(KMC,IMC),  NO3D(KMC,IMC)
C       COMMON /PHYTGC/ AGR(KMC,IMC),   ARR(KMC,IMC),   AMR(KMC,IMC),   !5/14/97 FTN
C    .                  AER(KMC,IMC)                                    !5/14/97 FTN
        COMMON /PHYTGC/ AGR(KMC,IMC,NAP), ARR(KMC,IMC,NAP),             !5/14/97 FTN
     .                  AMR(KMC,IMC,NAP), AER(KMC,IMC,NAP)              !5/14/97 FTN
        COMMON /DKBODC/ CBODD(KMC,IMC)

C       SATO(X) = EXP(7.7117-1.31403*(LOG(X+45.93)))*PALT               !2/02/95 FTN
C                                                                       !2/02/95 FTN
C       Use Kanwischer eqn (eqn B-19 in User Manual) for coefficient of !2/02/95 FTN
C       surface exchange for oxygen.  2E-9 is O2 diffusivity in m2/sec. !2/02/95 FTN
C                                                                       !2/02/95 FTN
C       O2EX    = (0.5+0.05*WIND*WIND)/86400.0                          !2/02/95 FTN
        O2EX    = 2.0E-9 / ( (200. - 60.*WIND**0.5) * 1.0E-6 )          !2/02/95 FTN
        DO I=IU,ID
          DOSS(KT,I) = 0.0
          DO K=KT,KB(I)
            ALGP = 0.0                                                  !5/14/97 FTN
            DO JA=1,NAP                                                 !5/14/97 FTN
              ALGP = ALGP + ( O2ALG*AGR(K,I,JA) - O2RESP*ARR(K,I,JA) )  !5/14/97 FTN
     &                                             * ALGAE(K,I,JA)      !5/14/97 FTN
            END DO                                                      !5/14/97 FTN
C           ALGP       = (O2ALG*AGR(K,I)-O2RESP*ARR(K,I))*ALGAE(K,I)    !5/14/97 FTN
            DOSS(K,I) = ALGP-O2NH3*NH3D(K,I)-O2ORG*(DETD(K,I)+SEDD(K,I))
     .                  -SO2D(K,I)*A3(K,I)-O2ORG*ORGD(K,I)-CBODD(K,I)
     .                  *CBOD(K,I)*RBOD
          END DO
C         SATDO = SATO(T1(KT,I))                                        !2/02/95 FTN
          SATDO = SATO(T1(KT,I),PALT)                                   !2/02/95 FTN
          IF (.NOT.ICE(I)) DOSS(KT,I) = DOSS(KT,I)+(SATDO-DO(KT,I))*O2EX
     .                                  /HKT2(I)
        END DO
      END
      REAL FUNCTION SATO (X,ALTCORR)                                    !2/02/95 FTN
      SATO = EXP(7.7117-1.31403*(LOG(X+45.93)))*ALTCORR                 !2/02/95 FTN
      END                                                               !2/02/95 FTN
```

```
************************************************************************
**              S U B R O U T I N E   S E D I M E N T                **
************************************************************************

      SUBROUTINE SEDIMENT
        INCLUDE 'w2.inc'
        INTEGER FREQUK                                                  !5/16/97 FTN
        DIMENSION ASETL(NAP)                                            !5/13/97 FTN

******* Common declaration

        COMMON /GLOBLC/ JB, JC, IU, ID, KT, ELKT, DLT, KB(IMP), KTI(IMP)
        COMMON /SETLC2/ SSETL,  DSETL,  ASETL,   FESETL
        COMMON /GEOMHC/ EL(KMP),        H(KMP),         HKT1(IMP),
     .                  HKT2(IMP)
        COMMON /GEOMBC/ B(KMP,IMP),     BKT(IMP),       BH(KMP,IMP),
     .                  BHKT1(IMP),     BHKT2(IMP),     BHRKT1(IMP)
        COMMON /DKSEDC/ SEDD(KMC,IMC),  SO2D(KMC,IMC), SOD(IMP)
        COMMON /PHYTC2/ BETA,   EXH2O,  EXINOR, EXORG, FREQUK, ALGLIT   !6/16/98 FTN

        DTKU = DLT * REAL(FREQUK)                                       !5/14/97 FTN
        DO I=IU,ID
          ALGSET = 0.0                                                  !5/16/97 FTN
          DO JA=1,NAP                                                   !5/16/97 FTN
            ALGSET = ALGSET + ASETL(JA)*ALGAE(KT,I,JA)                  !5/16/97 FTN
          END DO                                                        !5/16/97 FTN
C         SETTLE       = (ASETL*ALGAE(KT,I)+DSETL*DETRIT(KT,I))*DLT     !5/16/97 FTN
          SETTLE       =            (ALGSET+DSETL*DETRIT(KT,I))*DLT     !5/16/97 FTN
     .                  /HKT2(I)*(1.0-B(KT+1,I)/BKT(I))
C         SEDMNT(KT,I) = MAX(SEDMNT(KT,I)+SETTLE-SEDD(KT,I)*DLT,0.0)    !5/16/97 FTN
          SEDMNT(KT,I) = MAX(SEDMNT(KT,I)+SETTLE-SEDD(KT,I)*DTKU,0.0)   !5/16/97 FTN
          DO K=KT+1,KB(I)-1
            ALGSET = 0.0                                                !5/16/97 FTN
            DO JA=1,NAP                                                 !5/16/97 FTN
              ALGSET = ALGSET + ASETL(JA)*ALGAE(K,I,JA)                 !5/16/97 FTN
            END DO                                                      !5/16/97 FTN
C           SETTLE      = (ASETL*ALGAE(K,I)+DSETL*DETRIT(K,I))*DLT/H(K) !5/16/97 FTN
            SETTLE      =           (ALGSET+DSETL*DETRIT(K,I))*DLT/H(K) !5/16/97 FTN
     .                  *(1.0-B(K+1,I)/B(K,I))
C           SEDMNT(K,I) = MAX(SEDMNT(K,I)+SETTLE-SEDD(K,I)*DLT,0.0)     !5/16/97 FTN
            SEDMNT(K,I) = MAX(SEDMNT(K,I)+SETTLE-SEDD(K,I)*DTKU,0.0)    !5/16/97 FTN
          END DO
          ALGSET = 0.0                                                  !5/16/97 FTN
          DO JA=1,NAP                                                   !5/16/97 FTN
            ALGSET = ALGSET + ASETL(JA)*ALGAE(KB(I),I,JA)               !5/16/97 FTN
          END DO                                                        !5/16/97 FTN
C         SETTLE          = (ASETL*ALGAE(KB(I),I)+DSETL*DETRIT(KB(I),I))!5/16/97 FTN
          SETTLE          =            (ALGSET+DSETL*DETRIT(KB(I),I))!5/16/97 FTN
     .                      *DLT/H(KB(I))
          SEDMNT(KB(I),I) = MAX(SEDMNT(KB(I),I)+SETTLE-SEDD(KB(I),I)
C    .                      *DLT,0.0)                                   !5/16/97 FTN
     .                      *DTKU,0.0)                                  !5/16/97 FTN
        END DO
      END

************************************************************************
**      S U B R O U T I N E   I N O R G A N I C   C A R B O N        **
************************************************************************

      SUBROUTINE INORGANIC_CARBON
        INCLUDE 'w2.inc'

******* Variable declaration

        LOGICAL ICE, ICE_CALC
        REAL ABIOP(NAP), ABION(NAP), ABIOSI(NAP), ABIOC(NAP)            !5/16/97 FTN

******* Common declaration

        COMMON /CARBNC/ CO2REL, BIOC
        COMMON /GLOBLC/ JB, JC, IU, ID, KT, ELKT, DLT, KB(IMP), KTI(IMP)
```

```
      COMMON /GLBLCC/ PALT, ALGDET, O2LIM, WIND,  WSCDP, WSC(NDP)
      COMMON /GEOMHC/ EL(KMP),       H(KMP),       HKT1(IMP),
     .                HKT2(IMP)
      COMMON /ICEC/   ICE(IMP),      ICETH(IMP),    ICE_CALC
      COMMON /TEMPC/  T1(KMP,IMP),   T2(KMP,IMP)
      COMMON /DKMLTC/ A1(KMC,IMC),   A2(KMC,IMC),   A3(KMC,IMC)
      COMMON /DKORGC/ DETD(KMC,IMC), ORGD(KMC,IMC)
      COMMON /DKSEDC/ SEDD(KMC,IMC), SO2D(KMC,IMC), SOD(IMP)
C     COMMON /PHYTGC/ AGR(KMC,IMC),   ARR(KMC,IMC),   AMR(KMC,IMC),   !5/14/97 FTN
C    .                AER(KMC,IMC)                                    !5/14/97 FTN
      COMMON /PHYTGC/ AGR(KMC,IMC,NAP), ARR(KMC,IMC,NAP),             !5/14/97 FTN
     .                AMR(KMC,IMC,NAP), AER(KMC,IMC,NAP)              !5/14/97 FTN
      COMMON /PHYTC3/ ABIOP,  ABION,  ABIOSI, ABIOC                   !5/16/97 FTN

      CO2EX = (0.5+0.05*WIND*WIND)/86400.0
      DO I=IU,ID
        CSS(KT,I) = 0.0
        DO K=KT,KB(I)
          ALGP = 0.0                                                  !5/16/97 FTN
          DO JA=1,NAP                                                 !5/16/97 FTN
            ALGP = ALGP + (ARR(K,I,JA)-AGR(K,I,JA)) * ALGAE(K,I,JA)   !5/16/97 FTN
     &                                              * ABIOC(JA)       !5/16/97 FTN
          END DO                                                      !5/16/97 FTN
C         ALGP      = (ARR(K,I)-AGR(K,I))*ALGAE(K,I)                  !5/16/97 FTN
C         CSS(K,I) = BIOC*(ALGP+ORGD(K,I)+DETD(K,I)+SEDD(K,I))        !5/16/97 FTN
          CSS(K,I) = BIOC*     (ORGD(K,I)+DETD(K,I)+SEDD(K,I))        !5/16/97 FTN
     .               +CO2REL*SO2D(K,I)*A3(K,I)
     &               +ALGP                                            !5/16/97 FTN
        END DO
        IF (.NOT.ICE(I)) CSS(KT,I) = CSS(KT,I)+CO2EX*(0.286
     .                               *EXP(-0.0314*(T2(KT,I))*PALT)
     .                               -CO2(KT,I))/HKT2(I)
      END DO
      END
```

```
***************************************************************************!5/16/97 FTN
**                 S U B R O U T I N E   S I L I C A                     **!5/16/97 FTN
***************************************************************************!5/16/97 FTN
                                                                           !5/16/97 FTN
      SUBROUTINE SILICA                                                    !5/16/97 FTN
        INCLUDE 'w2.inc'                                                   !5/16/97 FTN
                                                                           !5/16/97 FTN
******* Variable declaration                                               !5/16/97 FTN
                                                                           !5/16/97 FTN
        REAL ABIOP(NAP), ABION(NAP), ABIOSI(NAP), ABIOC(NAP)               !5/16/97 FTN
                                                                           !5/16/97 FTN
******* Common declaration                                                 !5/16/97 FTN
                                                                           !5/16/97 FTN
        COMMON /GLOBLC/ JB, JC, IU, ID, KT, ELKT, DLT, KB(IMP), KTI(IMP)!5/16/97 FTN
        COMMON /GLBLCC/ PALT, ALGDET, O2LIM, WIND,  WSCDP, WSC(NDP)        !5/16/97 FTN
        COMMON /DKSEDC/ SEDD(KMC,IMC),  SO2D(KMC,IMC), SOD(IMP)            !5/16/97 FTN
        COMMON /DKORGC/ DETD(KMC,IMC),  ORGD(KMC,IMC)                      !6/27/97 FTN
        COMMON /PHYTGC/ AGR(KMC,IMC,NAP), ARR(KMC,IMC,NAP),                !5/16/97 FTN
     .                  AMR(KMC,IMC,NAP), AER(KMC,IMC,NAP)                 !5/16/97 FTN
        COMMON /PHYTC3/ ABIOP,  ABION,  ABIOSI, ABIOC                      !5/16/97 FTN
        COMMON /SILICC/ SIREL, BIOSI                                       !5/16/97 FTN
                                                                           !5/16/97 FTN
        DO I=IU,ID                                                         !5/16/97 FTN
          DO K=KT,KB(I)                                                    !5/16/97 FTN
            ALGP = 0.0                                                     !5/16/97 FTN
            DO JA=1,NAP                                                    !5/16/97 FTN
              ALGP = ALGP - AGR(K,I,JA) * ALGAE(K,I,JA) * ABIOSI(JA)       !6/27/97 FTN
            END DO                                                         !5/16/97 FTN
            SEDREL1    = SEDD(K,I) * BIOSI                                 !5/16/97 FTN
            SEDREL0    = SIREL * SO2D(K,I)                                 !5/16/97 FTN
            SILSS(K,I) = SEDREL1 + SEDREL0 + ALGP + ORGD(K,I)*BIOSI        !6/27/97 FTN
          END DO                                                           !5/16/97 FTN
        END DO                                                             !5/16/97 FTN
      END                                                                  !5/16/97 FTN
C                                                                          !10/6/98 FTN
C**************************************************************************!10/6/98 FTN
C                                                                          !10/6/98 FTN
C     Insert lines for AGPM output (from source code sent by G. Hauser) !10/6/98 FTN
C     New OPENP subroutine sent by J. Parsley                              !11/19/98 FTN
      SUBROUTINE OPENP(AGPMFN,INTPLD,INTPLH,IMP,KMP,NBP,US,DS,EL,DLX,
     X TMEND,NCP,NAC,CN,CPRC)
C
C     OPENP SETS OPENS THE AGPM OUTPUT FILE AND SETS UP THE HEADER
C     RECORD.
C
C     THIS VERSION OF OPENP DEALS WITH TWO ISSUES:
C
C     1. CUSTOMIZED CONSTITUENT LISTS IN W2
C     2. COMPUTING AN EXTRA CONSTITUENT FROM OTHER CONSTITUENTS
C
C
C------------
C     OPEN THE PLOT FILE AND WRITE OUT GEOMETRY RELATED INFO
C     ON THE FIRST RECORD.
C------------
C
      DIMENSION EL(KMP),DLX(IMP),INDX(100)
      INTEGER CN(NAC),US(NBP),DS(NBP),XLAT(24)
      CHARACTER*3 CPRC(NCP)
      CHARACTER*72 AGPMFN
      CHARACTER*4 VERSION
      INTEGER NUMDR
C
C     XLAT IS USED TO CONVERT THE W2 CONSTITUENT NUMBERS INTO
C     AGPM CONSTITUENT NUMBERS, BASED ON THE ORDER IN THE FILE
C     CONST.DEF
C
C                                                                          !11/19/98 FTN
C     REMAPPING ARRAY CHANGES 7 TO 26, 8 TO 27                             !11/19/98 FTN
C     22 TO 28, 23 TO 29, AND 24 TO 30                                     !11/19/98 FTN
C                                                                          !11/19/98 FTN
```

```
      DATA XLAT/1,2,3,4,5,6,26,27,9,10,11,12,13,14,15,16,17,           !11/19/98 FTN
     X 18,19,20,21,28,29,30/                                            !11/19/98 FTN
C
C     AGPMFN     NAME OF PLOT FILE
C     INTPLD     OUTPUT INTERVAL FOR PLOT FILE (DAYS)
C     INTPLH     OUTPUT INTERVAL FOR PLOT FILE (HOURS)
C     IMP        NUMBER OF SEGMENTS IN GRID
C     KMP        NUMBER OF ROWS IN GRID
C     NBP        NUMBER OF BRANCHES
C     US         UPSTREAM SEGMENT NUMBER OF BRANCH
C     DS         DOWNSTREAM SEGMENT NUMBER OF BRANCH
C     EL         ELEVATION OF TOP OF LAYER (M)
C     DLX        SEGMENT LENGTH (M)
C     TMEND      ENDING TIME OF RUN (DAY)
C     NCP        MAXIMUM NUMBER OF CONSTITUENTS
C     NAC        NUMBER OF CONSTITUENTS (NOT COUNTING TEMP,VEL)
C     CN         CONSTITUENT NUMBERS OF CONSTITUENTS COMPUTED
C     CPRC       INDICATES WHICH CONSTITUENTS TO OUTPUT
C
      VERSION = "W2V1"
C
C     WE WILL DISCARD THE 1ST AND LAST COLUMNS, WHICH DO
C     NOT HOLD ANY DATA THAT WE NEED TO PLOT. THIS MAKES
C     THE RECORD SIZE (IMP-2)*KMP*4 (IN BYTES)
C
C     NOTE: IN SOME VERSIONS OF DVF COMPILERS, DEPENDING ON
C     COMPILER SWITCH SETTINS, THE RECORD SIZE MAY BE
C     EXPRESSED IN WORDS INSTEAD OF BYTES. IN SUCH CASES
C     REMOVE THE *4 FROM THE OPEN STATEMENT
C
C
      OPEN(88,FILE=AGPMFN,ACCESS='DIRECT',FORM='UNFORMATTED',
     X RECL=(IMP-2)*KMP*4,STATUS='UNKNOWN')
C
C     GET CONSTITUENT NUMBER OF THE ACTIVE CONSTITUENTS THAT
C     WILL BE STORED IN THE PLOT FILE. THESE ARE THE 'W2' CONSTITUENT
C     NUMBERS, NOT THE 'AGPM' NUMBERS. IN AN UNMODIFIED VERSION OF
C     W2 THEY WOULD BE THE SAME.
C
      NOUT = 0
      DO I=1,NAC
         IF(CPRC(CN(I)).EQ.' ON') THEN
           NOUT = NOUT + 1
           INDX(NOUT) = CN(I)
         END IF
      END DO
C
C     IN A VERSION OF W2 WITH A CUSTOMIZED CONSTITUENT LIST, WE
C     MUST REMAP THE INDX VALUES TO POINT TO THE CORRECT ENTRY
C     IN THE CONST.DEF FILE
C
      DO I=1,NOUT
         INDX(I) = XLAT(INDX(I))
      END DO
C
C     NOW LETS ADD AN EXTRA CONSTITUENT THAT WE WILL COMPUTE
C     INTERNALLY. CHLOROPHYLL-A IS NUMBER 31 IN THE CONST.DEF FILE
C
      NOUT = NOUT + 1
      INDX(NOUT) = 31
C
C     NUMDR IS THE SIZE OF THE DAM RELEASE CONSTITUENT ARRAY.
C     IT MUST BE AT LEAST AS LARGE AS THE HIGHEST CONSTITUENT NUMBER
C     THAT IS WRITTEN OUT
C
      NUMDR = 31
C
C     WE WILL REVERSE THE DIRECTION OF THE CONSTITUENT
C     ARRAYS SO THAT DOWNSTREAM COLUMNS ARE ON THE
C     LEFT SIDE.  WE MUST ALSO SUBTRACT 1 FROM
```

```
C     THE STARTING AND ENDING COLUMNS TO ACCOUNT FOR
C     DELETED COLUMNS. THUS COLUMN IMP-1 WILL CHANGE TO
C     COLUMN 1 AND COLUMN 2 WILL BE COLUMN IMP-2.
C     OR MORE GENERALLY: NEWCOLUMN = IMP-OLDCOLUMN
C
C
      WRITE(88,REC=1) VERSION,INTPLD,INTPLH,IMP-2,KMP,NBP,
     X (IMP-US(I),I=1,NBP),(IMP-DS(I),I=1,NBP),
     X EL,(DLX(I), I=IMP-1,2,-1),TMEND,NOUT,(INDX(I),I=1,NOUT),NUMDR
      RETURN
      END

      SUBROUTINE WRITEP(JDAY,MONTH,GDAY,YEAR,KT,KB,CUS,
     X NBP,NAC,NCP,CPRC,CN,C2,T2,U,W,ELKT,IMP,KMP,NXTMAP,
     X QSOUT,AVCOUT,AVTOUT,ELWS,KTI)

      INTEGER CN(NAC),CUS(NBP),KB(IMP),YEAR,GDAY,KTI(IMP),XLAT(24)
      REAL JDAY ,NXTMAP
      CHARACTER*3 CPRC(NCP)
      CHARACTER*9 MONTH
      INTEGER*4 IREC
      DIMENSION T2(KMP,IMP),U(KMP,IMP),W(KMP,IMP),
     X C2(KMP,IMP,NCP),AVCOUT(NCP),ELWS(IMP)
C
C     EXTRA NEEDS TO BE AT LEAST KMPxIMP. IT IS USED TO
C     SET UP INTERNALLY COMPUTED CONSTITUENTS, IN THIS CASE
C     CHLOROPHYLL-A
C
C
      DIMENSION EXTRA(200,200)
C
C     WE ALSO NEED AN ARRAY OF SIZE NUMDR TO HOLD THE
C     DAM RELEASE DATA.
C
      DIMENSION DR(31)
C
      DATA IREC/1/
C                                                                   !11/19/98 FTN
C     REMAPPING ARRAY CHANGES 7 TO 26, 8 TO 27                      !11/19/98 FTN
C     22 TO 28, 23 TO 29, AND 24 TO 30                              !11/19/98 FTN
C                                                                   !11/19/98 FTN
      DATA XLAT/1,2,3,4,5,6,26,27,9,10,11,12,13,14,15,16,17,        !11/19/98 FTN
     X 18,19,20,21,28,29,30/                                        !11/19/98 FTN


C******* Plot file output for AGPM (Concentrations, Temperatures,
C        Velocity vector components)
C
C       WE MUST SET UP THE DR ARRAY SO THAT THE CONSTITUENTS
C       ARE LOCATED IN THE SLOTS WHEN AGPM EXPECTS THEM TO BE.
C       AGPM CONSTITUENT NUMBER I MUST BE IN DR(I). AVCOUT HAS
C       THE CONSTITUENT IN 'W2' ORDER, SO WE USE THE XLAT MAPPING
C       TO PUT THEM IN 'AGPM' ORDER.
C
        DO I=1,24
           DR(XLAT(I)) = AVCOUT(I)
        END DO
C
C       WE MUST COMPUTE CHLOROPHYLL-A AND PUT IT IN DR(31)
C       NOTE:
C
        DR(31) = .015* AVCOUT(22)+.015*AVCOUT(23)+.007*AVCOUT(24)


      IREC = IREC + 1
      WRITE(88,REC=IREC) NXTMAP,JDAY,MONTH,GDAY,YEAR,KT,ELKT,
     X  (IMP-CUS(JB),JB=1,NBP),
     X  (KB(I),I=IMP-1,2,-1),QSOUT,AVTOUT,DR,
     X  (ELWS(I),I=IMP-1,2,-1),
     X  (KTI(I),I=IMP-1,2,-1)
```

```
C     Selected constituents
      DO JC=1,NAC
        IF (CPRC(CN(JC)).EQ.' ON') THEN
           IREC = IREC + 1
           WRITE (88,REC=IREC) ((C2(K,I,CN(JC)),I=IMP-1,2,-1),K=1,KMP)
         END IF
      END DO
C
C     NOW WE MUST SET UP CHLOROPHYLL-A
C
      DO I=1,IMP
      DO K=1,KMP
      EXTRA(K,I) = .015*C2(K,I,22)+.015*C2(K,I,23)+.007*C2(K,I,24)
      END DO
      END DO
      IREC = IREC + 1
      WRITE(88,REC=IREC) ((EXTRA(K,I),I=IMP-1,2,-1),K=1,KMP)

C     Temperature
      IREC = IREC + 1
      WRITE (88,REC = IREC) ((T2(K,I),I=IMP-1,2,-1),K=1,KMP)

C     Horizontal velocity vectors

      IREC = IREC + 1
      WRITE (88,REC=IREC) ((U(K,I),I=IMP-1,2,-1),K=1,KMP)

C     Vertical velocity vectors

      IREC = IREC + 1
      WRITE (88,REC=IREC) ((W(K,I),I=IMP-1,2,-1),K=1,KMP)

      RETURN
      END
```

Center Hill Lake CE-QUAL-W2 Control File

```
TITLE C ............................TITLE..................................
        Center Hill Lake, March 15 through November 5, 1973 (CRL) 02/01/01
        Water quality simulation w/ version 2.05.1
        Density placed inflows, point sink outflows, DLTMAX=1800, DLTF=0.5
        Default hydrodynamic coefficient: AX=1, DX=1, CHEZY=70, CBHE=7.0e-8
        01/31/01 with revised ML & FW TDS


TIME CON  TMSTRT   TMEND    YEAR
           74.49  310.51    1973

DLT CON      NDT  DLTMIN
               1     1.0

DLT DATE    DLTD
            74.5

DLT MAX   DLTMAX
          1800.0

DLT FRN     DLTF
            0.50

BRANCH G      US      DS     UHS     DHS
Br 1           2      39       0       0         Caney Fork River
Br 2          42      43       0      13         Pine Creek
Br 3          46      47       0      17         Fall Creek
Br 4          50      51       0      21         Davies Island Loop
Br 5          54      60       0      22         Falling Water River
Br 6          63      65       0      27         Mine Lick Creek
Br 7          68      69       0      31         Little Hurricane Creek Bend
Br 8          72      73       0      34         Holmes Creek
Br 9          76      77       0      36         Indian Creek

LOCATION     LAT    LONG   DATUM
            36.1    85.8   144.3

INIT CND     T2I  ICETHI  WTYPEC
             -1.     0.0   FRESH

CALCULAT     VBC     MBC     PQC    PQTC     EVC     PRC
              ON      ON      ON      ON     OFF     OFF

INTERPOL   INFIC    TRIC   DTRIC    HDIC  QOUTIC    WDIC   METIC
              ON      ON      ON      ON      ON      ON      ON

DEAD SEA   WINDC    QINC   QOUTC   HEATC
              ON      ON      ON      ON

ICE COVER   ICEC   SLICE  SLHEAT  ALBEDO     HWI   BETAI  GAMMAI  ICEMIN   ICET2
             OFF  DETAIL    TERM    0.25    10.0     0.6    0.07    0.05     3.0

TRANSPORT  SLTRC   THETA   DZMAX
        QUICKEST    0.00    -999
```

WSC NUMB	NWSC	WSC_MIN	WSC_MAX
	1	-999	-999

WSC DATE	WSCD	WSCD
	74.5	

WSC COEF	WSC	WSC
	0.65	

WIND FUNC	WFC
	1.0

HYD COEF	AX	DX	CHEZY	CBHE	TSED	FW_A0	FW_A1	FW_A2	SRMULT
	1.0	1.0	70.0	7.0E-8	15.0	-999	-999	-999	-999

SEL WITH	SWC	SWC	SWC	SWC	SWC	SWC	SWC	SWC	SWC
	ON	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF

N STRUC	NSTR	NSTR	NSTR	NSTR	NSTR	NSTR	NSTR	NSTR	NSTR
	3	0	0	0	0	0	0	0	0

K LIMIT	KLSW	KLSW	KLSW	KLSW	KLSW	KLSW	KLSW	KLSW	KLSW
Br 1	49	63	63						
Br 2									
Br 3									
Br 4									
Br 5									
Br 6									
Br 7									
Br 8									
Br 9									

SINK TYPE	SINK	SINK	SINK	SINK	SINK	SINK	SINK	SINK	SINK
Br 1	POINT	LINE	POINT						
Br 2									
Br 3									
Br 4									
Br 5									
Br 6									
Br 7									
Br 8									
Br 9									

E STRUC	MAIN	LEVL8	LEVL7	LEVL6	LEVL5	LEVL4	LEVL3	LEVL2	LEVL1
Br 1	169.5	197.6	152.1						
Br 2									
Br 3									
Br 4									
Br 5									
Br 6									
Br 7									
Br 8									
Br 9									

W STRUC	WSTR	WSTR	WSTR	WSTR	WSTR	WSTR	WSTR	WSTR	WSTR
Br 1	0.00	143.3	0.00						
Br 2									

```
Br 3
Br 4
Br 5
Br 6
Br 7
Br 8
Br 9

N OUTLET    NOUT    NOUT    NOUT    NOUT    NOUT
               0       0       0       0       0

O LAYER     KOUT
Br 1           0
Br 2           0
Br 3           0
Br 4           0
Br 5           0
Br 6           0
Br 7           0
Br 8           0
Br 9           0

N WDRWAL     NWD
               0

W SEGMNT     CMP    COL1    COL2    COL3    COL4    COL5    COL6    COL7
               0       0       0       0       0       0       0       0

W LAYER      KWD     KWD     KWD     KWD     KWD     KWD     KWD     KWD


N TRIBS      NTR MXSGDTR                                Dist. tribs and Branches
only
               0    -999

TRIB SEG     ITR     ITR
               0

DST TRIB    DTRC    DTRC    DTRC    DTRC    DTRC    DTRC    DTRC    DTRC    DTRC
              ON     OFF     OFF     OFF     OFF     OFF     OFF     OFF     OFF

SCR PRINT   SCRC    NSCR
             OFF       1

SCR DATE    SCRD
            74.5

SCR FREQ    SCRF
             1.0

SNAPSHOT    FORM    UPRN    WPRN    TPRN   DTPRN  RHOPRN   AZPRN   DZPRN
            LONG      ON      ON      ON     OFF     OFF     OFF     OFF

SHRT SEG   IPRSF   IPRSF   IPRSF   IPRSF   IPRSF   IPRSF   IPRSF   IPRSF   IPRSF
               2       9      21      25      28      31      34      38      42
              46      59
```

LONG SEG	IPRLF	IPRLF	IPRLF	IPRLF	IPRLF	IPRLF	IPRLF	IPRLF	IPRLF
	2	5	9	12	17	21	25	28	35
	39	42	46	54	57	60	63	65	
SNP PRINT	SNPC	NSNP							
	ON	14							
SNP DATE	SNPD	SNPD	SNPD	SNPD	SNPD	SNPD	SNPD	SNPD	SNPD
	74.5	75.5	76.5	77.5	78.5	88.5	150.5	177.5	183.5
	190.5	192.5	193.5	195.5	226.5	310.5			
SNP FREQ	SNPF	SNPF	SNPF	SNPF	SNPF	SNPF	SNPF	SNPF	SNPF
	999.0	999.0	999.0	999.0	999.0	999.0	999.0	999.0	999.0
	999.0	999.0	999.0	999.0	999.0	999.0			
PRF PLOT	PRFC	NPRF	NPRS	PRSTYL					
	ON	6	13	FTN					
PRF DATE	PRFD	PRFD	PRFD	PRFD	PRFD	PRFD	PRFD	PRFD	PRFD
	74.5	88.5	150.5	177.5	226.5	310.5			
PRF FREQ	PRFF	PRFF	PRFF	PRFF	PRFF	PRFF	PRFF	PRFF	PRFF
	999.0	999.0	999.0	999.0	999.0	999.0			
PRF SEG	IPRF	IPRF	IPRF	IPRF	IPRF	IPRF	IPRF	IPRF	IPRF
	8	14	46	17	23	55	43	65	39
	35	30	73	77					
SPR PLOT	SPRC	NSPR	NIPRF						
	OFF	1	1						
SPR DATE	SPRD								
	74.5								
SPR FREQ	SPRF								
	999.0								
SPR SEG	ISPR								
	25								
TSR PLOT	TSRC	NTSR	TSSTYL						
	ON	1	FTN						
TSR DATE	TSRD								
	74.5								
TSR FREQ	TSRF								
	1.0								
VPL PLOT	VPLC	NVPL	VPSTYL						
	OFF	1							
VPL DATE	VPLD								
	74.5								
VPL FREQ	VPLF								
	999.0								

CPL PLOT	CPLC	NCPL	CPSTYL						
	OFF	1							
CPL DATE	CPLD								
	74.5								
CPL FREQ	CPLF								
	999.0								
APGM OUT	APLC								
	ON			on/off switch for APGM output					
AGPM OUT2	APLD	APLFD	APLFH						
	74.5	1.0	0.0						
RESTART	RSOC	NRSO	RSIC						
	OFF	0	OFF						
RSO DATE	RSOD								
	999.0								
RSO FREQ	RSOF								
	999.0								
CST COMP	CCC	LIMC	SDC	FREQUK					
	ON	ON	OFF	10					
CST ACT	ACC	ACC	ACC	ACC	ACC	ACC	ACC	ACC	ACC
	ON	ON	OFF	ON	ON	ON	ON	ON	ON
	ON	ON	OFF	OFF	OFF	OFF	OFF	OFF	OFF
	OFF	OFF	ON	ON	ON				
CST ICON	CIC	CIC	CIC	CIC	CIC	CIC	CIC	CIC	CIC
	0.0	16.5	0.0	62.4	0.1	0.16	2.0	0.5	0.02
	0.15	0.37	10.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	-1.	-1.	-1.			
CST PRNT	CPRN	CPRN	CPRN	CPRN	CPRN	CPRN	CPRN	CPRN	CPRN
	ON	ON	OFF	ON	ON	ON	ON	ON	ON
	ON	ON	ON	OFF	OFF	OFF	OFF	OFF	OFF
	OFF	OFF	OFF	ON	ON	ON			
CIN CON	INACC	INACC	INACC	INACC	INACC	INACC	INACC	INACC	INACC
	ON	ON	OFF	ON	ON	ON	ON	ON	ON
	ON	ON	ON	OFF	OFF	OFF	OFF	OFF	OFF
	OFF	OFF	OFF	ON	ON	ON			
CTR CON	TRACC	TRACC	TRACC	TRACC	TRACC	TRACC	TRACC	TRACC	TRACC
	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF
	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF
	OFF	OFF	OFF	OFF	OFF	OFF			
CDT CON	DTACC	DTACC	DTACC	DTACC	DTACC	DTACC	DTACC	DTACC	DTACC
	ON	ON	OFF	ON	ON	ON	ON	ON	ON
	ON	ON	ON	OFF	OFF	OFF	OFF	OFF	OFF
	OFF	OFF	OFF	ON	ON	ON			

CPR CON	PRACC	PRACC	PRACC	PRACC	PRACC	PRACC	PRACC	PRACC	PRACC
	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF
	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF
	OFF	OFF	OFF	OFF	OFF	OFF			
EX COEF	EXH2O	EXINOR	EXORG	BETA	ALGLIT				
	0.45	0.09	0.11	0.48	-99.0				
COLIFORM	COLQ10	COLDK	COLKL	CSETL	CKSEG				
	1.04	0.50	0.005	0.29	999.0				
S SOLIDS	SSETL								
	0.4								
ALGAE	AGROW	AMORT	AEXCR	ARESP	ASETL	AHSP	AHSN	AHSSI	ASATUR
Diatoms	1.20	0.03	0.00	0.07	0.35	0.012	0.06	0.1	125.0
Greens	0.95	0.03	0.00	0.05	0.15	0.010	0.06	0.0	120.0
Cyanobac	1.00	0.03	0.00	0.04	0.08	0.015	0.10	0.0	135.0
ALG STOI	ABIOP	ABION	ABIOSI	ABIOC					
Diatoms	0.004	0.067	0.0	0.5					
Greens	0.004	0.067	0.0	0.5					
Cyanobac	0.004	0.067	0.0	0.5					
ALG RATE	AGT1	AGT2	AGT3	AGT4	AGK1	AGK2	AGK3	AGK4	
Diatoms	5.0	12.0	22.0	35.0	0.1	0.98	0.98	0.1	
Greens	5.0	10.0	25.0	30.0	0.1	0.98	0.98	0.1	
Cyanobac	10.0	25.0	38.0	42.0	0.1	0.98	0.98	0.1	
DISS ORG	LABDK	LRFDK	REFDK						
	0.30	0.001	0.001						
DETRITUS	DETDK	DSETL	ALGDET						
	0.060	0.05	0.80						
ORG RATE	OMT1	OMT2	OMK1	OMK2					
	4.0	20.0	0.1	0.98					
SEDIMENT	SEDDK	FSOD							
	0.06	1.0							
S DEMAND	SOD	SOD	SOD	SOD	SOD	SOD	SOD	SOD	SOD
	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.76
	0.77	0.78	0.79	0.80	0.80	0.80	0.80	0.80	0.80
	0.80	0.80	0.80	0.80	0.80	0.80	0.79	0.79	0.79
	0.78	0.78	0.78	0.77	0.77	0.76	0.76	0.75	0.75
	0.60	0.55	0.50	0.50	2.75	2.75	3.75	3.75	3.80
	3.80	3.80	3.80	1.50	1.50	1.50	1.50	1.90	1.90
	1.95	1.95	2.00	2.40	2.40	2.40	2.40	2.40	2.40
	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
	5.00	5.00	3.00	3.00	5.00	5.00			
CBOD	KBOD	TBOD	RBOD						
	0.05	1.05	2.00						
PHOSPHOR	PO4REL	PARTP							

	0.007	0.1						
AMMONIA	NH3REL	NH3DK	PARTN					
	0.035	0.013	0.01					
NH3 RATE	NH3T1	NH3T2	NH3K1	NH3K2				
	0.1	20.0	0.1	0.98				
NITRATE	NO3DK	DNPRN						
	0.10	OFF						
NO3 RATE	NO3T1	NO3T2	NO3K1	NO3K2				
	5.0	20.0	0.1	0.98				
SILICA	SIREL							
	0.01							
SED CO2	CO2REL							
	0.1							
IRON	FEREL	FESETL						
	0.4	0.0						
STOICHMT	O2NH3	O2ORG	O2RESP	O2ALG	BIOP	BION	BIOSI	BIOC
	3.43	1.4	1.2	1.4	0.004	0.067	0.0	0.1
O2 LIMIT	O2LIM							
	0.2							

BTH FILE..............................BTHFN....................................
p:\projects\1150-040\txtfiles\73test2.prn

VPR FILE..............................VPRFN....................................
p:\projects\1150-040\txtfiles\vpr7302.prn

LPR FILE..............................LPRFN....................................
lpr.npt - not used

RSI FILE..............................RSIFN....................................
rsi.npt - not used

MET FILE..............................METFN....................................
p:\projects\1150-040\txtfiles\1973met2.prn

QWD FILE..............................QWDFN....................................
qwd.npt - not used

QIN FILE..............................QINFN....................................
Br 1 p:\projects\1150-040\txtfiles\gf1973.prn
Br 2 p:\projects\1150-040\txtfiles\73q_pc01.prn
Br 3 p:\projects\1150-040\txtfiles\73q_fc01.prn
Br 4 p:\projects\1150-040\txtfiles\73q_dv01.prn
Br 5 p:\projects\1150-040\txtfiles\73q_fw01.prn
Br 6 p:\projects\1150-040\txtfiles\73q_ml01.prn
Br 7 p:\projects\1150-040\txtfiles\73q_lh02.prn
Br 8 p:\projects\1150-040\txtfiles\73q_hc02.prn
Br 9 p:\projects\1150-040\txtfiles\73q_ic02.prn

```
TIN FILE..............................TINFN.................................
Br 1    p:\projects\1150-040\txtfiles\73t_cf03.prn
Br 2    p:\projects\1150-040\txtfiles\73t_pc01.prn
Br 3    p:\projects\1150-040\txtfiles\73t_fc01.prn
Br 4    p:\projects\1150-040\txtfiles\73t_dv01.prn
Br 5    p:\projects\1150-040\txtfiles\73t_fw02.prn
Br 6    p:\projects\1150-040\txtfiles\73t_ml01.prn
Br 7    p:\projects\1150-040\txtfiles\73t_lh02.prn
Br 8    p:\projects\1150-040\txtfiles\73t_hc02.prn
Br 9    p:\projects\1150-040\txtfiles\73t_ic02.prn

CIN FILE..............................CINFN.................................
Br 1    p:\projects\1150-040\wqin\73c_cf07.prn
Br 2    p:\projects\1150-040\wqin\73c_pc08.prn
Br 3    p:\projects\1150-040\wqin\73c_fc08.prn
Br 4    p:\projects\1150-040\txtfiles\73c_dv01.prn
Br 5    p:\projects\1150-040\wqin\73c_fw07.prn
Br 6    p:\projects\1150-040\wqin\73c_ml10.prn
Br 7    p:\projects\1150-040\txtfiles\73c_lh09.prn
Br 8    p:\projects\1150-040\txtfiles\73c_hc07.prn
Br 9    p:\projects\1150-040\txtfiles\73c_ic07.prn

QOT FILE..............................QOTFN.................................
Br 1    p:\projects\1150-040\txtfiles\outfl73.prn
Br 2    not used
Br 3    not used
Br 4    not used
Br 5    not used
Br 6    not used
Br 7    not used
Br 8    not used
Br 9    not used

QTR FILE..............................QTRFN.................................
Tr 1    not used

TTR FILE..............................TTRFN.................................
Tr 1    not used

CTR FILE..............................CTRFN.................................
Tr 1    not used

QDT FILE..............................QDTFN.................................
Br 1    p:\projects\1150-040\txtfiles\73q_dt02.prn
Br 2    not used
Br 3    not used
Br 4    not used
Br 5    not used
Br 6    not used
Br 7    not used
Br 8    not used
Br 9    not used

TDT FILE..............................TDTFN.................................
Br 1    p:\projects\1150-040\txtfiles\73tpc01a.prn
Br 2    not used
```

```
Br 3    not used
Br 4    not used
Br 5    not used
Br 6    not used
Br 7    not used
Br 8    not used
Br 9    not used

CDT FILE..............................CDTFN..................................
Br 1    p:\projects\1150-040\wqin\73c_dt07.prn
Br 2    not used
Br 3    not used
Br 4    not used
Br 5    not used
Br 6    not used
Br 7    not used
Br 8    not used
Br 9    not used

PRE FILE..............................PREFN..................................
Br 1    pre_br1.npt - not used
Br 2    pre_br2.npt - not used
Br 3    pre_br3.npt - not used
Br 4    pre_br4.npt - not used
Br 5    pre_br5.npt-  not used
Br 6    pre_br6.npt - not used
Br 7    pre_br7.npt - not used
Br 8    pre_br8.npt - not used
Br 9    pre_br9.npt - not used

TPR FILE..............................TPRFN..................................
Br 1    tpr_br1.npt - not used
Br 2    tpr_br2.npt - not used
Br 3    tpr_br3.npt - not used
Br 4    tpr_br4.npt - not used
Br 5    tpr_br5.npt - not used
Br 6    tpr_br6.npt - not used
Br 7    tpr_br7.npt - not used
Br 8    tpr_br8.npt - not used
Br 9    tpr_br9.npt - not used

CPR FILE..............................CPRFN..................................
Br 1    cpr_br1.npt - not used
Br 2    cpr_br2.npt - not used
Br 3    cpr_br3.npt - not used
Br 4    cpr_br4.npt - not used
Br 5    cpr_br5.npt - not used
Br 6    cpr_br6.npt - not used
Br 7    cpr_br7.npt - not used
Br 8    cpr_br8.npt - not used
Br 9    cpr_br9.npt - not used

EUH FILE..............................EUHFN..................................
Br 1    euh_br1.npt - not used
Br 2    euh_br2.npt - not used
Br 3    euh_br3.npt - not used
Br 4    euh_br4.npt - not used
```

Br 5 euh_br5.npt - not used
Br 6 euh_br6.npt - not used
Br 7 euh_br7.npt - not used
Br 8 euh_br8.npt - not used
Br 9 euh_br9.npt - not used

TUH FILE..............................TUHFN...................................
Br 1 tuh_br1.npt - not used
Br 2 tuh_br2.npt - not used
Br 3 tuh_br3.npt - not used
Br 4 tuh_br4.npt - not used
Br 5 tuh_br5.npt - not used
Br 6 tuh_br6.npt - not used
Br 7 tuh_br7.npt - not used
Br 8 tuh_br8.npt - not used
Br 9 tuh_br9.npt - not used

CUH FILE..............................CUHFN...................................
Br 1 cuh_br1.npt - not used
Br 2 cuh_br2.npt - not used
Br 3 cuh_br3.npt - not used
Br 4 cuh_br4.npt - not used
Br 5 cuh_br5.npt - not used
Br 6 cuh_br6.npt - not used
Br 7 cuh_br7.npt - not used
Br 8 cuh_br8.npt - not used
Br 9 cuh_br9.npt - not used

EDH FILE..............................EDHFN...................................
Br 1 edh_br1.npt - not used
Br 2 edh_br2.npt - not used
Br 3 edh_br3.npt - not used
Br 4 edh_br4.npt - not used
Br 5 edh_br5.npt - not used
Br 6 edh_br6.npt - not used
Br 7 edh_br7.npt - not used
Br 8 edh_br8.npt - not used
Br 9 edh_br9.npt - not used

TDH FILE..............................TDHFN...................................
Br 1 tdh_br1.npt - not used
Br 2 tdh_br2.npt - not used
Br 3 tdh_br3.npt - not used
Br 4 tdh_br4.npt - not used
Br 5 tdh_br5.npt - not used
Br 6 tdh_br6.npt - not used
Br 7 tdh_br7.npt - not used
Br 8 tdh_br8.npt - not used
Br 9 tdh_br9.npt - not used

CDH FILE..............................CDHFN...................................
Br 1 tdh_br1.npt - not used
Br 2 tdh_br2.npt - not used
Br 3 tdh_br3.npt - not used
Br 4 tdh_br4.npt - not used
Br 5 tdh_br5.npt - not used
Br 6 tdh_br6.npt - not used

```
Br 7    tdh_br7.npt - not used
Br 8    tdh_br8.npt - not used
Br 9    tdh_br9.npt - not used

AGPM
FILE.............................AGPMFN...................................
        73run.w2p

SNP FILE...............................SNPFN...................................
        snp.opt

TSR FILE...............................TSRFN...................................
        tsr.txt

PRF FILE...............................PRFFN...................................
        prf.txt

VPL FILE...............................VPLFN...................................
        vpl.opt

CPL FILE...............................CPLFN...................................
        cpl.opt

SPR FILE...............................SPRFN...................................
        spr.opt
```

APPENDIX D

Bathymetry Plan

ftn Associates Ltd.
water resources / environmental consultants

MEMORANDUM

DATE: June 21, 2000

TO: Mr. Jackson Brown
USAE Nashville District

FROM: Christina Laurin *CLL*
FTN Associates, Ltd.

SUBJECT: Center Hill Lake Bathymetry Plan
FTN No. 1150-040

This memo fulfills the requirements of Task 3 to develop a plan describing the reservoir bathymetry, inflows, and outflows.

Center Hill Lake Bathymetry

1) The proposed model plan grid is shown in Figure 1. The model consists of a main branch of 42 segments with 4 embayments and 4 null embayments. Embayments are modeled as branches with inflows entering their upstream boundary. Null embayments are water storage areas and are modeled as branches with zero upstream flows. Main branch and embayment cells represent the conveyance channel of the main channel and important tributaries. Volume will be added to null embayments as necessary to ensure that the volume of the model corresponds to the District's elevation-volume curve. Based upon our experience with CE-QUAL-W2, we suspect we may encounter difficulty calibrating as a result of the number of branches in this model. In some applications, the noniterative solution scheme at branch intersections can affect calibration.

2) Embayments will be needed at Mine Lick Creek, Falling Water River, Fall Creek, and Pine Creek. The embayments will consist of 2 to 7 segments. Null embayments will be modeled at Indian Creek, Holmes Creek, Little Hurricane Creek, and Davies Island. The null embayments will have 2 segments. The null embayment at Davies Island will include volume from Sink Creek and Eagle Creek. The null embayment at Little Hurricane Creek will also include volume from Big Hurricane Creek. Volume will not be added to the Holmes Creek null embayment because the District would like to have the option to model it as an embayment in the future.

3) Figure 2 shows the model flow lines and conveyance channel through Center Hill Lake. The flow line locations were chosen based on previous studies and professional judgement. The main branch flow line indicates that water will move through the Narrows in the model. As a result, part of the Caney Fork meander loop around Davies Island will be modeled as a continuation of the Falling Water River branch. The remainder of the Caney Fork meander loop around Davies Island will be included in the model as a null embayment. The main branch flow line also cuts off a meander loop of the Caney Fork River at about mile 8.0, where the Little Hurricane Creek and Second Creek join it. The portion of that meander loop not included in the main branch of the model will be modeled as a null embayment. These null embayments are shown on the proposed model plan grid in Figure 1.

4) Figure 3 shows the expected grid profile for the main branch of the model. Layers will be 1 meter thick. At the dam, layers will extend from elevation 470 ft msl (bottom elevation) to elevation 680 ft msl, close to the reservoir flood pool elevation of 685 ft msl. The grid profile may be modified from that shown in Figure 3 based on transect data and calibration results.

5) The bottom elevations along the flow line in the main branch at the Narrows and Little Hurricane Creek bend are deeper in the model than they are in the reservoir itself. Realistically modeling the bottom elevation along the flow line in the main branch would result in "weirs" that would not allow underflows to move completely through the reservoir. As a result, the modeled hypolimnion flow line is shorter than the actual reservoir hypolimnion flow line, which follows the old stream channel. Based on available reservoir temperature data, underflows rarely occur, so they do not have much affect on the hypolimnion water quality. Generally, inflows to the reservoir would be expected to move as interflows or overflows. Therefore hypolimnion volume should be the most important characteristic affecting hypolimnion water quality. Volume will be added to the null embayments at Davies Island and the Little Hurricane Creek bend to ensure that the hypolimnetic volume of the model matches that of the reservoir.

6) Segments in the main branch are 1 mile long in the lower end of the reservoir and increase to 1.5 miles long above Fall Creek and to 2 miles long above Sink Creek as the reservoir becomes narrower. Increasing the segment length for narrow segments keeps the residence time more similar to wider segments. There are also segments shorter than 1 mile at the Narrows and the dam. The segments at the Narrows are shorter so that the geometry of that area of the reservoir can be more realistically described in the model. At the dam, the 1 mile segment was split so there would be at least 2 segments in the bottom-most layers, as required by the model. Segment lengths in the embayments and null embayments vary from 1 to 3 miles.

7) Cell widths will be developed based on transects collected by the District supplemented with information from pre-impoundment contour maps and fishing maps. Transects will be converted into HEC format and run through GEDA which will output volumes at specified

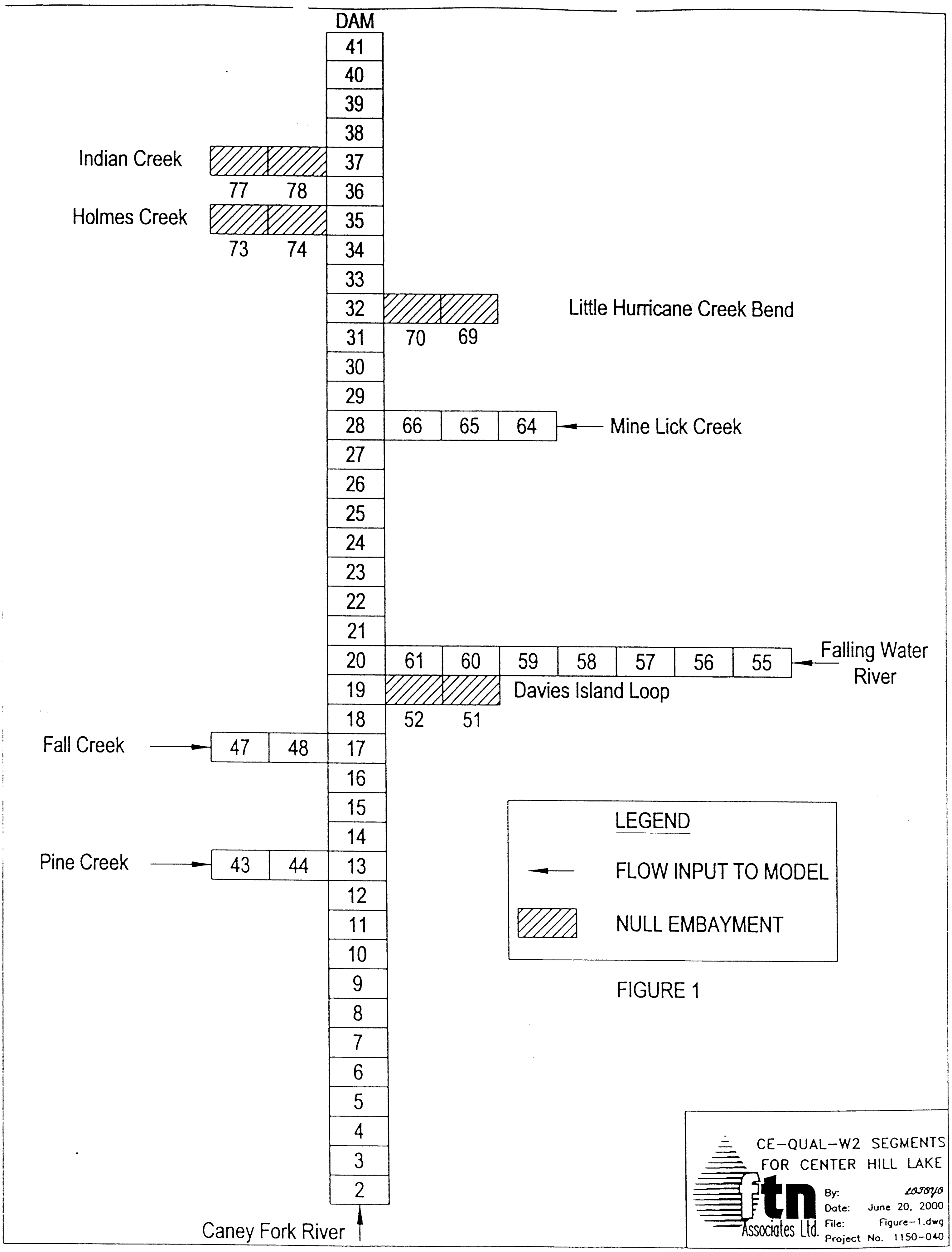
intervals. Average widths for each cell will be calculated from these volumes. The volume of the model bathymetry will be checked against the District area elevation-volume curve.

Center Hill Lake Flows

8) Reservoir inflows that will be included in the model are Caney Fork River, Pine Creek, Fall Creek, Falling Water River, and Mine Lick Creek. In addition, a distributed inflow to the main branch will also be modeled to account for smaller tributaries and direct inflow to the reservoir. Caney Fork River is the only tributary for which measured flow data is available. The Great Falls Dam releases will be used for Caney Fork River inflows. These Caney Fork River flows will be subtracted from the District total inflows and the remaining flow will be divided among the other tributaries and distributed inflow based on watershed size. Negative flows will be corrected by raising the values to a minimum flow based on the 7Q10 reported for Falling Water River, using the District program HECUPD.

9) Center Hill power generation release records will be used for the reservoir outflows. Turbine releases will be modeled as a point sink with a withdrawal centerline elevation of 556 ft msl and a lower withdrawal limit of 524 ft msl. These elevations are based on the District's SELECT simulations. Sluice releases will also be modeled as a point sink with a withdrawal centerline elevation of 499 ft msl. Spillway releases will be modeled as a line sink 470 ft wide with a withdrawal elevation of 648 ft msl. Characterization of the release structures may be modified during the calibration process.

\\FTN\SYS4\WP_FILES\1150-040\M-BROWN3.DOC\DEF


DAM
41
40
39
38
Indian Creek
37
77
78
36
Holmes Creek
35
73
74
34
33
32
Little Hurricane Creek Bend
70
69
31
30
29
28
66
65
64
Mine Lick Creek
27
26
25
24
23
22
21
20
61
60
59
58
57
56
55
Falling Water River
19
Davies Island Loop
52
51
18
Fall Creek
47
48
17
16
15
14
Pine Creek
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3
2
Caney Fork River
LEGEND
FLOW INPUT TO MODEL
NULL EMBAYMENT
CE-QUAL-W2 SEGMENTS FOR CENTER HILL LAKE
ftn Associates Ltd.
By: Lozoya
Date: June 20, 2000
File: Figure-1.dwg
Project No. 1150-040

FIGURE 1

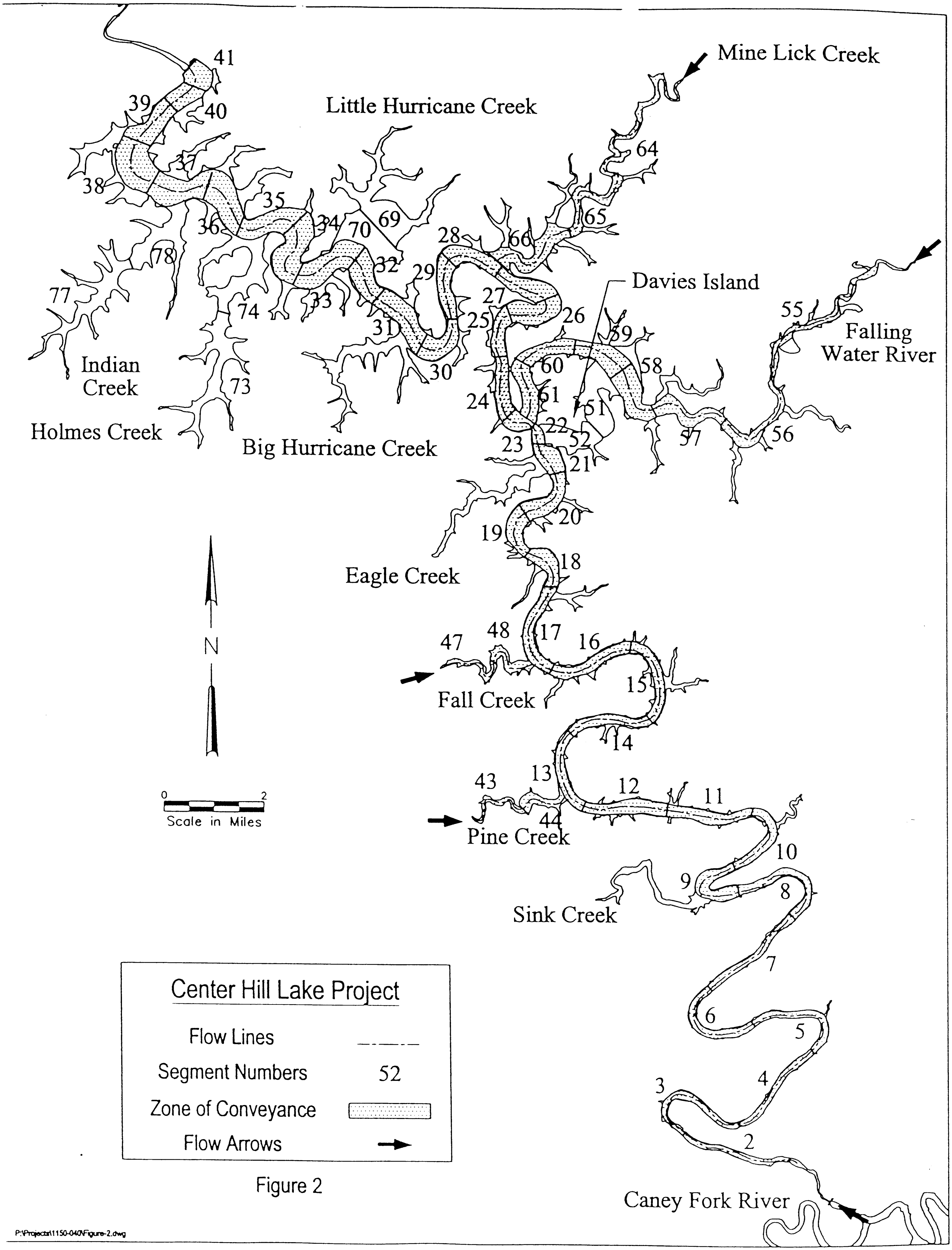


Figure 2

P:\Projects\1150-040\Figure-2.dwg

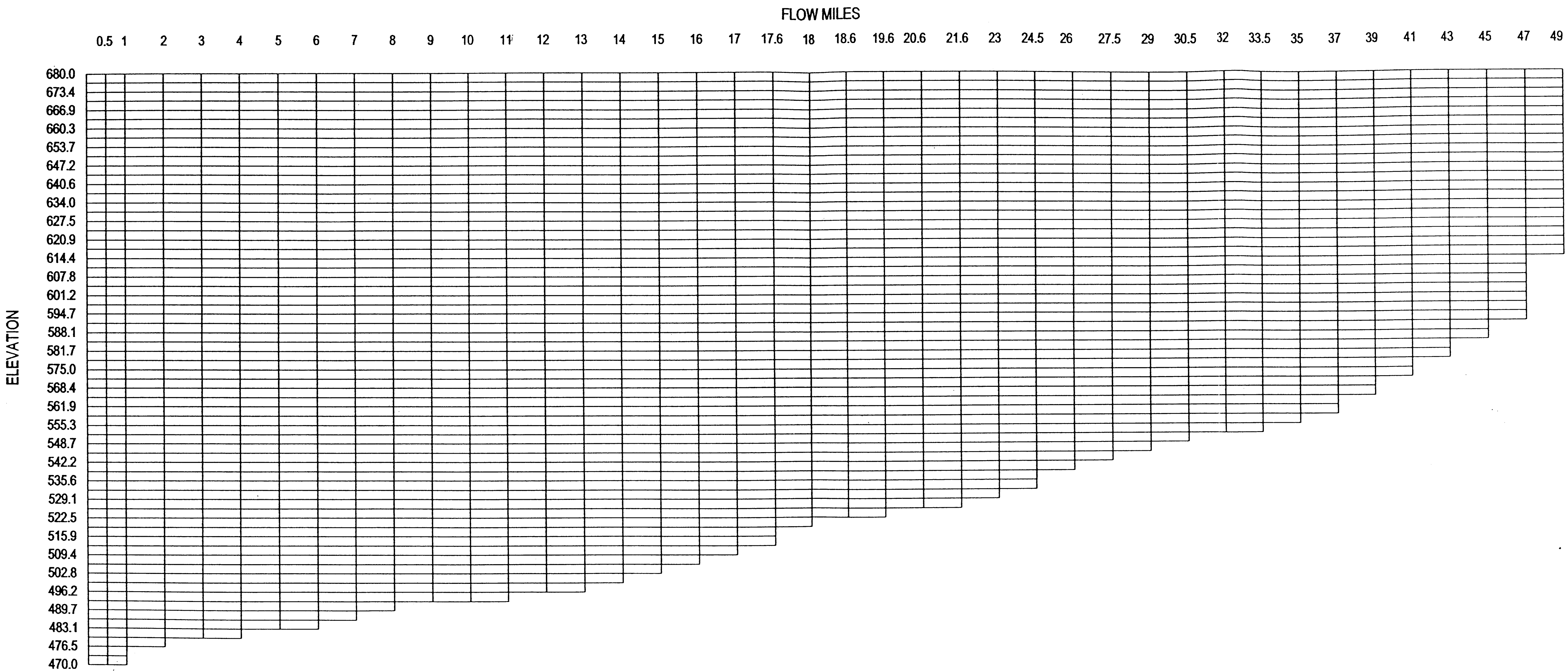


FIGURE 3

CE–QUAL–W2 GRI
FOR CENTER HILL L

ftn Associates Ltd
By:
Date: June 20,
File: Figure–

APPENDIX E

Bathymetry File

Center Hill Lake bathymetry with 9 branches
CRL 10-5-00 combined segs 21 & 22
Delta X (DLX)

3218.7	3218.7	3218.7	3218.7	3218.7	3218.7	3218.7	3218.7	2414.0	2414.0
2414.0	2414.0	2414.0	2414.0	2414.0	2414.0	2414.0	2253.1	1609.3	1609.3
1609.3	965.6	1609.3	1609.3	1609.3	1609.3	1609.3	1609.3	1609.3	1609.3
1609.3	1609.3	1609.3	1609.3	1609.3	1609.3	1609.3	1609.3	1609.3	1609.3
1287.5	1287.5	965.6	965.6	1770.3	1770.3	1287.5	1287.5	1448.4	1448.4
1464.5	1464.5	4345.2	4345.2	3218.7	2414.0	1609.3	1609.3	1609.3	1609.3
1609.3	1882.9	1882.9	3218.7	3218.7	3218.7	1110.4	1110.4	1126.5	1126.5
2043.9	2043.9	3411.8	3411.8	2752.0	2752.0	2912.9	2912.9		

Water Surface Elevation (ELWS) (start jday 74.5)

197.8	197.8	197.8	197.8	197.8	197.8	197.8	197.8	197.8	197.8
197.8	197.8	197.8	197.8	197.8	197.8	197.8	197.8	197.8	197.8
197.8	197.8	197.8	197.8	197.8	197.8	197.8	197.8	197.8	197.8
197.8	197.8	197.8	197.8	197.8	197.8	197.8	197.8	197.8	197.8
197.8	197.8	197.8	197.8	197.8	197.8	197.8	197.8	197.8	197.8
197.8	197.8	197.8	197.8	197.8	197.8	197.8	197.8	197.8	197.8
197.8	197.8	197.8	197.8	197.8	197.8	197.8	197.8	197.8	197.8
197.8	197.8	197.8	197.8	197.8	197.8	197.8	197.8		

Segment Orientation (in radians from due north consistent with wind direction)

1.74	1.74	2.09	4.89	3.80	1.59	1.40	3.98	1.22	4.28
3.93	1.62	1.60	2.97	4.54	2.99	1.33	3.23	2.60	2.97
4.15	2.29	3.02	3.32	5.06	2.11	1.78	6.21	0.87	2.43
2.84	1.17	3.11	1.38	2.58	1.66	2.7	4.22	4.01	4.01
4.54	4.54	4.54	4.54	4.45	4.45	5.24	5.24	2.95	2.95
4.66	4.66	1.05	1.04	0.38	1.83	2.20	2.44	1.54	0.14
0.14	0.38	0.38	0.91	1.40	1.40	0.78	0.78	0.78	0.78
3.3	3.3	3.79	3.79	3.92	3.92	4.05	4.05		

Height (layer thickness)

1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
1.0	1.0	1.0	1.0	1.0					

Segment 1

0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0					

Segment 2

0.0	217.3	213.0	209.1	205.2	201.4	217.3	193.3	190.2	186.9
183.6	179.9	176.6	173.0	169.1	164.9	161.1	156.7	151.5	144.8
123.4	102.9	89.9	80.0	69.9	44.5	25.8	20.0	20.0	20.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		

Segment 3

0.0	211.5	208.3	204.8	201.5	198.2	211.5	191.3	188.4	185.6
182.1	178.8	175.7	172.5	169.5	165.8	160.5	155.4	149.9	144.6
138.3	132.8	126.0	116.6	105.6	86.3	71.8	61.2	55.8	48.7
34.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		

Segment 4

0.0	230.2	227.1	223.6	220.7	217.0	230.2	211.2	208.3	206.9

203.2	201.0	198.3	195.7	192.7	189.1	183.8	177.6	171.2	165.7
158.5	153.6	147.4	141.0	133.9	128.0	121.5	109.9	97.8	86.7
62.2	20.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		

Segment 5

0.0	246.9	243.0	238.8	234.8	230.6	246.9	223.1	220.2	218.5
215.1	212.7	209.9	207.3	204.4	201.7	198.3	194.4	189.8	186.0
181.3	177.0	172.5	168.1	162.6	157.0	150.8	129.8	109.8	100.8
84.8	53.9	26.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		

Segment 6

0.0	247.4	243.0	238.7	234.1	230.0	247.4	221.7	219.1	216.8
213.8	210.8	208.3	205.5	202.7	200.4	198.4	196.2	193.0	190.7
187.5	184.5	180.6	176.8	171.3	165.8	159.5	134.2	110.5	103.1
95.6	77.1	49.2	20.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		

Segment 7

0.0	258.8	254.5	250.6	246.7	242.5	258.8	234.9	231.9	229.4
225.4	222.4	219.4	216.3	213.1	210.4	208.1	206.2	203.5	202.2
198.9	195.5	191.0	185.8	179.6	172.8	161.0	127.5	106.8	100.3
93.9	82.2	66.1	38.5	20.0	20.0	20.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		

Segment 8

0.0	295.6	292.0	288.6	284.5	281.1	295.6	273.8	270.4	267.6
263.2	259.7	255.8	252.6	249.6	246.4	243.8	241.9	240.6	239.5
236.1	231.6	226.6	219.7	212.6	203.4	186.9	149.9	136.4	129.9
114.7	105.0	97.8	81.5	64.9	51.7	24.1	20.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		

Segment 9

0.0	241.6	239.5	237.2	234.7	232.6	241.6	227.6	225.3	223.3
220.5	217.6	215.1	212.7	210.8	208.4	206.4	204.7	203.4	202.1
199.3	196.4	193.2	189.0	184.1	178.3	170.1	154.3	138.3	125.9
105.5	95.3	88.6	82.7	75.8	59.3	24.4	20.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		

Segment 10

0.0	326.0	323.4	320.8	318.8	315.9	326.0	310.7	307.7	305.4
301.4	297.6	295.0	291.5	288.7	285.5	282.4	279.5	276.4	274.4
270.4	267.7	264.2	260.2	254.8	249.9	244.6	235.7	202.1	173.9
144.5	132.3	123.9	115.8	107.3	88.0	49.0	42.2	30.6	20.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		

Segment 11

0.0	336.0	333.9	331.8	329.7	327.6	336.0	323.4	318.8	316.7
311.7	308.3	304.1	300.4	294.9	291.2	286.1	280.7	277.3	274.8
270.2	267.3	263.9	259.3	255.5	250.9	246.3	237.5	203.2	165.1
139.1	132.8	126.9	118.6	108.5	100.5	91.7	80.0	58.2	28.1
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		

Segment 12

0.0	411.4	407.5	403.6	400.4	396.5	411.4	388.7	384.7	381.1
375.7	371.8	367.4	362.4	356.6	350.9	345.1	340.4	336.7	332.8
328.1	323.1	317.8	313.4	307.7	301.6	294.8	288.9	279.1	258.2
225.1	193.2	175.3	165.6	153.3	136.1	127.7	117.4	103.2	86.1
39.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		

Segment 13

0.0	411.4	407.0	402.8	398.5	394.0	411.4	385.4	381.2	377.8
372.5	368.5	364.2	359.5	354.4	349.4	344.1	339.8	335.5	332.3
326.8	322.1	317.7	312.8	307.3	301.2	294.9	288.5	281.8	269.0
242.5	206.6	178.9	159.0	148.3	132.4	125.7	118.4	109.2	99.1
57.7	20.0	20.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		

Segment 14

0.0	398.7	394.1	389.1	383.9	378.9	398.7	369.2	364.5	361.1
355.5	350.8	346.1	341.6	337.1	332.7	328.1	323.9	319.2	316.2
310.6	306.3	302.1	296.9	291.3	284.6	278.4	271.9	265.8	259.7
243.4	214.9	182.6	145.6	135.7	123.1	114.7	109.1	104.1	99.4
75.0	47.1	39.5	20.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		

Segment 15

0.0	386.5	382.1	376.4	371.3	366.3	386.5	355.7	350.5	346.5
340.1	334.1	328.9	323.7	317.9	313.6	309.1	304.5	300.1	296.6
291.8	287.3	282.2	277.0	270.6	263.1	256.0	250.2	242.6	236.6
227.2	215.2	189.4	139.3	127.9	117.6	102.8	95.8	90.8	86.3
80.2	70.5	61.3	36.7	20.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		

Segment 16

0.0	423.0	418.4	415.0	410.4	406.6	423.0	397.4	391.7	386.4
378.7	373.0	366.9	355.5	338.3	333.7	328.4	324.6	320.0	317.0
311.6	305.9	300.9	294.5	287.2	280.3	272.7	264.3	255.9	244.9
231.5	222.0	209.0	173.9	157.9	138.5	112.9	101.8	94.6	88.1
80.5	72.1	66.0	59.1	37.0	22.1	20.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		

Segment 17

0.0	390.2	386.1	382.8	379.1	375.7	390.2	367.6	362.8	359.0
352.9	348.1	343.7	332.1	314.9	310.1	305.8	300.7	296.2	291.8
285.0	279.5	274.5	268.7	263.1	256.8	249.9	242.8	234.1	224.3
211.4	202.3	193.2	175.1	156.6	135.6	104.7	87.1	80.7	74.5
69.7	64.6	60.6	56.7	46.5	37.7	28.5	20.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		

Segment 18

0.0	275.4	273.4	270.6	268.3	265.5	275.4	261.0	257.6	256.1
252.1	249.5	246.2	241.0	233.4	229.0	225.7	222.1	217.8	214.3
208.7	204.6	200.2	197.0	193.1	189.4	185.1	180.0	175.7	170.9
166.3	161.6	155.4	147.5	134.8	116.6	94.9	80.4	75.4	71.3
62.9	57.9	54.7	52.0	48.7	44.5	39.0	27.8	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		

Segment 19

0.0	498.7	494.0	489.8	484.9	480.6	498.7	470.9	466.2	461.0
454.6	448.9	443.4	437.9	430.3	423.0	416.0	409.8	401.7	386.9
369.6	353.7	336.8	321.3	316.2	310.8	306.0	301.4	288.3	278.1
264.1	248.0	239.1	227.3	211.4	182.7	157.9	145.0	138.4	132.2
112.6	96.9	85.5	81.2	76.9	72.1	67.2	58.9	20.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		

Segment 20

0.0	532.8	529.2	525.3	521.1	517.3	532.8	508.4	501.7	498.4
491.4	486.0	479.3	473.8	467.8	461.0	454.8	447.2	440.2	423.7
404.0	385.6	366.6	347.4	337.5	331.1	324.6	316.1	300.3	285.3
266.4	245.0	233.9	220.5	202.0	175.5	146.9	136.5	130.3	125.1
112.2	100.9	86.9	80.8	75.8	69.1	63.0	55.2	43.9	20.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		

Segment 21

0.0	378.6	376.7	373.6	372.9	370.4	378.6	365.9	362.8	358.9
353.8	350.0	346.8	341.7	339.1	335.9	330.8	327.6	322.5	319.9
314.8	309.6	303.9	296.9	288.5	282.1	275.7	268.7	261.7	255.2
245.0	238.0	228.4	218.7	201.4	189.2	176.4	168.1	162.4	155.3
148.9	141.3	126.5	110.6	104.2	97.2	82.5	71.0	60.1	49.8
34.4	26.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		

Segment 22

0.0	485.5	479.4	474.1	467.8	460.7	485.5	449.9	444.9	443.7
438.3	433.3	430.5	427.3	421.3	417.0	414.0	408.2	405.0	401.4
394.9	391.9	386.3	379.4	373.1	369.2	362.7	356.4	350.8	345.8
339.2	331.9	326.2	319.3	312.3	305.5	300.9	293.6	286.6	271.8
236.0	210.5	167.1	125.3	116.4	101.6	97.2	90.8	88.3	75.8
59.9	46.5	35.2	20.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		

Segment 23

0.0	566.6	560.8	554.7	548.4	542.9	566.6	531.6	527.8	525.8
521.1	516.9	512.6	509.6	505.8	500.8	495.9	492.1	487.2	485.2
478.4	472.9	468.0	462.4	455.5	449.7	443.1	432.2	425.8	416.7
403.2	377.6	368.0	362.6	355.8	348.4	342.0	335.6	321.0	305.3
276.6	252.9	214.5	181.0	168.8	144.2	138.0	132.9	128.3	107.6
82.8	63.2	51.8	25.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		

Segment 24

0.0	601.1	596.7	592.8	588.3	583.3	601.1	575.0	571.7	568.9
564.4	560.0	556.7	552.8	549.4	545.5	540.5	537.2	533.9	531.1
525.0	520.0	515.0	507.8	501.7	497.2	485.5	464.4	455.0	436.1
408.9	344.4	330.5	323.9	315.0	307.2	297.8	290.0	261.1	251.1
241.7	228.3	201.7	195.6	181.7	156.1	148.9	143.3	136.1	114.4
90.0	70.0	56.7	34.4	22.8	20.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		

Segment 25

0.0	711.3	708.4	706.7	704.7	703.3	711.3	698.3	694.6	694.3
687.5	684.7	681.3	677.6	665.2	649.5	641.7	636.5	631.2	628.8
622.7	616.7	612.4	605.0	595.6	576.6	538.2	504.5	476.8	445.7
416.8	355.2	340.4	331.5	323.0	315.8	306.2	292.4	244.4	233.8
220.7	204.4	157.9	123.1	112.7	105.3	99.7	93.8	88.4	82.2
77.2	67.2	60.6	54.3	45.4	28.1	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		

Segment 26

0.0	573.8	569.8	566.2	562.7	558.7	573.8	552.2	548.1	545.2
540.0	536.5	533.0	527.8	519.3	509.7	504.0	498.2	493.6	488.5
481.5	475.7	468.8	464.7	456.2	432.9	408.2	397.6	386.5	377.6
366.2	359.3	350.7	343.9	336.9	327.2	319.1	307.2	295.1	288.2
274.5	260.8	232.5	199.9	183.9	169.3	162.3	154.7	129.8	101.4
93.7	87.4	83.5	80.5	70.8	24.1	20.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		

Segment 27

0.0	522.2	518.7	513.0	508.1	503.9	522.2	493.3	489.1	486.4
480.5	474.9	470.7	465.5	457.9	450.2	443.6	438.2	430.5	425.4
418.3	412.3	406.2	399.8	394.9	385.6	375.5	367.7	358.8	352.7
341.8	334.2	326.4	319.7	311.3	304.7	296.8	289.9	280.9	274.2

265.4	255.3	242.0	218.9	203.5	186.5	176.9	168.8	137.8	101.3
89.2	82.4	78.4	76.2	70.3	36.0	20.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		

Segment 28

0.0	483.2	479.5	474.8	470.9	465.6	483.2	457.0	451.5	447.8
441.3	435.8	430.3	425.5	418.9	413.9	408.2	402.7	396.1	391.5
383.4	378.5	373.8	368.8	362.7	359.3	353.6	346.2	339.4	333.9
327.3	319.5	314.2	306.8	300.7	294.2	286.9	279.5	272.2	264.8
256.6	248.4	237.1	214.3	195.6	171.1	149.7	142.0	130.5	119.1
104.1	97.0	91.4	82.9	78.3	68.6	24.5	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		

Segment 29

0.0	616.2	609.7	605.4	599.1	594.9	616.2	583.1	575.9	570.3
560.2	553.7	546.0	538.6	531.4	524.9	518.2	511.5	507.3	502.6
494.1	488.0	482.2	474.3	467.9	459.9	453.5	447.9	441.1	435.2
420.8	405.7	392.7	379.7	368.4	361.0	352.2	341.9	321.3	310.0
300.0	292.9	283.5	258.0	228.8	200.8	178.6	162.0	148.4	131.4
125.0	121.1	113.6	101.5	82.5	66.2	41.1	28.1	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		

Segment 30

0.0	669.8	664.9	658.6	654.0	648.7	669.8	637.6	632.2	628.0
620.6	615.2	609.0	603.8	600.0	596.2	591.0	588.0	583.3	581.6
574.3	569.4	564.5	559.1	553.4	548.8	544.2	540.6	536.7	534.6
528.1	522.7	516.2	508.6	502.5	497.9	493.4	487.0	476.2	470.2
461.2	451.7	440.1	397.3	357.9	328.0	307.2	290.6	271.5	246.5
242.5	236.1	233.3	204.2	137.3	69.5	42.2	28.6	20.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		

Segment 31

0.0	820.1	815.0	809.7	804.4	798.8	820.1	788.9	783.9	781.8
774.8	770.2	766.1	759.6	756.0	750.6	745.6	740.3	735.7	732.4
723.0	715.3	708.6	702.5	694.8	687.4	680.2	667.2	650.5	645.0
637.1	632.1	626.5	620.5	613.9	609.1	602.9	595.4	588.9	584.1
576.1	568.4	557.0	530.5	501.5	486.6	467.9	416.3	371.4	321.8
302.6	279.6	270.9	233.2	151.8	82.2	51.4	43.0	28.9	20.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		

Segment 32

0.0	833.7	828.8	824.5	819.2	814.1	833.7	805.4	801.4	800.1
793.6	789.8	786.5	780.0	775.5	769.2	763.2	757.1	751.5	746.7
736.2	728.0	720.4	713.7	705.8	697.2	688.8	671.6	648.1	640.5
631.4	625.0	618.5	612.5	605.4	599.4	591.8	583.5	577.0	572.1
563.9	557.3	544.5	526.6	504.5	495.5	475.0	406.6	346.7	284.5
256.2	221.5	208.2	179.4	120.6	75.4	54.7	49.5	41.1	20.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		

Segment 33

0.0	691.0	687.7	684.5	681.8	679.3	691.0	672.8	670.5	669.5
665.1	663.0	659.7	655.3	650.5	643.2	636.8	629.4	622.4	617.5
608.3	601.7	595.2	589.2	582.6	568.8	555.6	538.0	513.4	500.8
483.4	462.3	449.7	439.9	430.2	417.7	410.6	403.6	396.4	390.3
382.1	374.3	362.0	346.9	332.4	321.4	298.1	250.4	200.0	148.2
118.4	79.6	66.3	60.8	55.0	51.0	47.4	44.1	39.2	21.9
20.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		

Segment 34

0.0	922.4	918.8	915.5	912.6	908.3	922.4	901.4	896.3	894.7
887.4	881.8	876.7	872.6	863.7	855.8	845.8	833.5	822.8	816.1
805.8	799.8	792.9	784.9	775.5	749.7	722.3	697.5	671.1	643.9
604.8	553.9	518.0	480.0	448.3	414.3	387.3	354.1	340.1	326.4
310.8	298.0	283.4	267.8	254.7	241.3	229.0	216.4	197.9	168.5
144.3	123.0	116.0	110.1	103.5	90.6	79.1	68.5	62.2	57.0
49.9	39.4	28.9	0.0	0.0	0.0	0.0	0.0		

Segment 35

0.0	969.5	967.4	964.0	960.2	958.0	969.5	951.7	948.5	947.4
941.0	937.5	934.7	930.4	926.3	921.8	914.5	908.2	900.7	896.8

887.6	881.5	863.3	826.0	790.7	772.4	755.0	739.4	725.2	710.9
690.1	665.8	642.9	618.4	597.0	560.0	521.0	471.8	446.4	430.4
413.2	398.1	380.5	367.7	352.4	335.9	321.3	312.0	296.0	253.9
184.8	133.0	122.9	111.7	102.4	93.2	83.3	74.6	69.0	63.1
56.6	48.0	37.3	0.0	0.0	0.0	0.0	0.0		

Segment 36

0.0	806.8	802.9	798.6	795.6	790.7	806.8	783.8	780.2	779.8
774.3	770.6	768.1	764.5	759.5	753.9	747.3	739.6	735.1	730.3
720.6	713.9	699.0	665.7	618.1	604.2	597.0	590.6	584.5	580.1
572.8	566.4	560.2	553.0	546.7	530.0	511.6	489.2	476.8	468.6
460.6	453.3	442.7	436.8	429.6	419.8	409.4	399.2	386.6	335.0
246.6	169.7	156.8	145.2	137.3	132.5	126.5	118.6	97.5	76.8
66.1	55.9	34.7	0.0	0.0	0.0	0.0	0.0		

Segment 37

0.0	660.1	656.8	655.8	652.3	650.8	660.1	645.6	643.8	642.7
639.5	637.1	634.0	631.2	627.4	623.9	619.8	615.3	611.8	609.0
604.2	599.9	596.5	589.1	571.5	565.6	562.5	559.4	557.1	555.8
550.6	547.5	544.9	541.5	537.9	536.3	533.1	531.4	528.6	528.5
522.9	517.8	514.4	511.3	508.7	505.3	495.4	483.8	475.2	458.4
431.1	403.7	380.0	350.2	304.0	261.9	207.8	170.4	119.0	77.9
64.8	48.3	24.3	20.0	0.0	0.0	0.0	0.0		

Segment 38

0.0	665.7	663.5	661.5	659.4	657.2	665.7	653.1	650.5	650.5
645.9	643.8	640.4	638.7	636.7	634.6	632.5	631.6	629.5	629.5
626.2	624.9	623.6	621.6	620.7	618.6	618.2	616.5	615.3	616.1
612.8	611.9	609.8	606.4	602.1	599.2	595.7	591.9	588.1	583.4
574.5	566.9	561.4	556.4	551.3	544.9	528.1	515.9	510.0	498.8
485.2	470.2	456.1	433.0	335.5	270.4	182.4	156.8	123.3	82.1
72.1	62.6	46.0	20.0	0.0	0.0	0.0	0.0		

Segment 39

0.0	689.3	686.4	682.7	680.1	676.8	689.3	670.5	668.1	667.6
662.2	660.0	657.6	654.6	652.7	650.2	648.4	646.1	642.5	640.5
635.0	632.7	629.4	626.4	622.2	620.0	615.9	612.9	609.5	606.4
600.8	597.8	594.9	584.9	573.7	559.0	549.8	540.1	530.5	522.5
507.5	486.9	467.3	440.5	418.6	404.9	386.1	376.1	368.4	359.0
354.6	346.8	334.3	315.6	256.8	221.7	162.1	140.7	111.8	68.4
59.7	53.4	42.8	20.0	0.0	0.0	0.0	0.0		

Segment 40

0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		

Segment 41

0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		

Segment 42

0.0	313.5	305.9	297.0	288.0	281.7	272.7	263.8	257.5	251.1
242.2	235.8	226.9	220.5	210.3	202.6	196.3	188.6	181.0	175.9
160.6	122.4	108.3	96.9	95.6	93.0	87.9	73.9	39.5	21.7
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		

Segment 43

0.0	184.1	178.8	174.6	170.3	165.0	160.2	156.0	151.7	147.0
142.7	137.4	133.7	128.9	124.7	122.0	118.3	115.7	113.0	109.3
106.1	103.5	100.3	98.2	94.4	92.3	88.1	78.5	56.8	45.6
29.7	28.7	26.5	24.9	20.7	20.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		

Segment 44

0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		

Segment 45

0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		

Segment 46

0.0	272.4	264.6	256.2	249.1	241.3	233.6	226.5	220.9	215.2
208.9	203.9	196.9	192.0	188.4	184.9	180.0	176.4	171.5	165.8
159.5	151.7	143.3	125.6	115.7	112.2	108.7	103.7	98.8	93.9
88.9	82.6	77.6	73.4	65.6	54.3	36.7	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		

Segment 47

0.0	351.0	341.3	334.6	324.0	315.3	306.6	298.0	291.2	284.5
276.7	268.1	262.3	252.6	246.8	241.1	238.2	234.3	232.4	230.5
225.6	221.8	216.0	211.2	207.3	200.6	194.8	189.0	182.2	175.5
166.8	158.1	151.4	142.7	120.5	88.7	62.7	29.9	21.2	20.0
20.0	20.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		

Segment 48

0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		

Segment 49

0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		

Segment 50

0.0	670.5	659.9	647.7	637.2	625.8	615.1	606.0	600.9	596.9
590.6	585.5	579.5	575.2	570.8	565.4	560.3	553.5	530.3	505.6
483.4	460.8	449.2	438.1	426.3	413.5	396.9	384.1	372.6	359.9
348.0	337.2	326.3	310.8	293.9	272.9	234.3	218.9	191.5	139.1
125.8	119.9	107.3	81.3	78.2	73.9	68.1	58.2	51.2	44.9
34.0	20.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		

Segment		51							
0.0	713.1	700.9	690.1	678.6	667.1	654.8	646.9	641.9	639.0
631.8	627.5	622.5	617.4	611.7	605.2	600.2	590.8	565.6	536.8
512.4	485.7	473.5	458.4	444.7	430.3	408.7	394.3	372.8	344.0
329.6	307.3	289.3	264.1	236.0	208.7	159.0	134.6	119.5	83.5
75.6	71.2	66.9	64.8	61.9	56.8	52.5	44.6	38.9	32.4
20.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		

Segment		52							
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		

Segment		53							
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		

Segment		54							
0.0	973.0	921.8	911.2	892.9	849.8	809.3	810.6	793.9	752.8
736.5	694.2	687.4	674.9	640.3	617.3	571.8	558.8	507.1	478.6
469.0	421.5	402.0	341.7	291.2	145.3	76.2	53.9	36.5	30.0
31.3	31.4	30.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		

Segment		55							
0.0	914.6	864.1	855.0	835.1	795.5	756.2	756.8	740.4	700.3
685.2	644.9	636.9	624.7	588.4	568.9	530.3	533.8	494.8	468.7
463.3	418.7	418.3	383.8	358.0	318.4	306.7	288.5	285.1	256.9
257.4	243.6	208.2	169.4	135.3	116.2	93.1	50.5	29.7	30.7
33.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		

Segment		56							
0.0	1156.9	1093.0	1080.7	1054.4	1002.9	953.6	953.2	934.0	884.3
866.5	816.3	807.0	791.1	738.8	711.9	664.2	669.8	624.3	600.7
597.0	542.6	542.1	504.6	502.5	489.3	487.9	465.1	461.7	410.8
404.0	375.5	324.0	294.5	253.1	237.5	226.9	197.2	168.7	160.6
144.1	107.5	80.2	45.5	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		

Segment		57							
0.0	1890.1	1796.1	1782.2	1750.2	1674.0	1599.1	1608.1	1581.1	1503.7
1477.5	1399.1	1388.7	1368.7	1298.9	1260.5	1184.1	1204.0	1129.8	1081.3
1071.6	975.4	979.8	912.5	907.9	895.9	899.1	846.9	798.2	713.0
713.3	674.8	604.9	580.0	514.9	497.7	486.3	424.6	328.6	300.8
263.6	199.0	169.9	112.4	43.0	32.9	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		

Segment		58							
0.0	2121.5	2019.1	2006.8	1975.4	1891.8	1810.1	1820.7	1791.6	1704.3
1677.8	1585.5	1577.6	1555.9	1482.6	1442.5	1358.9	1383.3	1301.5	1240.7
1229.9	1118.5	1123.1	1046.1	1039.6	1029.8	1034.3	972.3	908.0	817.8
830.0	805.5	743.7	736.4	663.7	650.0	639.3	564.7	428.1	370.2
325.0	256.3	230.9	160.7	126.0	94.8	89.4	87.3	74.4	58.3

45.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		

Segment 59

0.0	1290.1	1222.0	1208.1	1179.6	1122.8	1068.0	1070.9	1047.1	994.9
973.1	919.0	910.0	893.6	847.0	819.1	766.1	774.5	724.1	702.2
700.8	639.9	645.9	605.1	610.6	597.4	593.4	567.5	567.7	526.8
532.9	521.3	487.8	486.6	446.0	432.7	430.0	419.4	366.6	303.0
260.9	226.3	205.9	144.8	145.0	141.5	141.2	146.6	143.3	131.5
101.1	53.8	23.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		

Segment 60

0.0	1444.9	1362.2	1343.4	1309.9	1241.9	1178.2	1177.3	1156.0	1095.8
1075.8	1015.6	1006.4	991.5	937.1	907.1	847.7	858.7	803.4	778.2
778.9	713.0	720.3	677.2	680.6	668.0	667.4	637.7	639.3	593.0
602.8	590.1	550.6	550.9	504.6	494.7	496.4	482.5	447.0	402.1
331.9	262.1	205.0	125.5	124.1	123.3	122.6	134.6	130.6	124.1
100.4	85.7	40.6	14.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		

Segment 61

0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		

Segment 62

0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		

Segment 63

0.0	725.4	687.1	677.7	661.7	628.3	597.6	597.0	582.9	551.1
538.9	505.6	498.5	488.8	460.6	445.2	416.2	422.3	394.6	383.1
379.8	345.0	346.3	322.5	321.9	315.0	313.9	292.8	268.4	211.4
212.1	209.1	194.9	194.6	178.1	175.6	172.7	159.9	138.3	70.3
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		

Segment 64

0.0	812.1	769.0	759.7	742.6	707.0	672.1	672.8	658.3	624.1
609.7	574.8	568.2	556.8	527.7	509.6	478.8	485.6	455.2	442.5
440.8	401.5	404.2	378.7	379.9	374.4	375.4	357.5	345.9	302.4
306.8	301.8	283.5	283.4	260.7	257.5	256.8	242.2	215.7	152.0
91.5	77.5	77.7	68.9	31.9	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		

Segment 65

0.0	1293.0	1224.5	1213.6	1188.5	1133.5	1080.8	1082.5	1060.6	1005.0
984.6	927.9	918.4	900.1	844.1	808.8	753.5	763.2	714.7	689.3
687.2	623.5	627.6	589.9	592.0	581.6	572.7	535.6	538.5	501.7
514.5	507.6	477.6	480.4	445.2	447.2	453.1	442.2	417.4	428.7
446.0	400.9	410.6	376.8	349.3	323.2	246.4	144.9	136.2	104.9
38.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		

Segment 66

0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		

Segment 67

0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		

Segment 68

0.0	4059.6	3868.2	3851.9	3795.9	3640.3	3501.8	3500.6	3411.3	3234.9
3188.4	3019.6	3002.3	2959.2	2816.9	2741.8	2615.0	2612.9	2491.8	2446.0
2443.7	2293.4	2292.0	2225.9	2223.8	2221.4	2217.9	2132.7	2120.8	1981.6
1980.1	1979.8	1881.4	1879.6	1730.5	1726.0	1715.3	1590.4	1483.8	1482.0
1437.4	1223.2	1215.5	1082.8	1068.7	947.3	780.0	623.1	510.5	475.2
403.7	397.7	252.5	248.1	245.7	244.1	233.3	204.0	110.2	108.2
74.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		

Segment 69

0.0	5056.7	4814.8	4791.0	4714.7	4519.8	4343.4	4340.6	4292.4	4088.0
4023.9	3815.0	3795.7	3744.7	3569.1	3482.3	3332.5	3330.7	3186.0	3112.4
3102.0	2831.6	2829.6	2671.3	2669.5	2650.4	2641.4	2531.9	2530.5	2374.9
2373.4	2370.5	2252.5	2252.1	2073.7	2072.1	2064.8	1930.4	1807.6	1806.5
1739.8	1478.2	1433.3	1248.7	1192.2	1047.0	853.1	676.2	556.8	506.6
429.7	413.3	245.4	235.5	194.8	172.0	140.4	139.2	64.7	60.3
56.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		

Segment 70

0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		

Segment 71

0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		

Segment 72

0.0	345.8	341.0	336.2	332.0	326.5	321.7	317.5	315.1	312.7
309.1	306.1	302.5	295.3	289.9	283.9	277.8	271.8	265.2	259.8
253.8	248.4	242.4	236.9	223.1	211.1	203.3	195.4	187.0	179.2
168.4	154.6	139.5	133.5	126.9	118.5	109.5	94.4	59.5	43.3
39.1	31.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		

Segment 73

0.0	288.9	285.8	282.6	279.2	276.3	273.3	270.4	267.7	266.6
262.9	260.9	258.2	252.1	248.2	244.9	239.9	235.1	230.8	227.2
222.2	217.5	213.2	208.0	198.3	189.5	183.1	178.2	173.2	168.0
162.3	157.6	152.4	147.9	142.9	138.1	133.4	126.4	119.4	113.5
106.0	97.0	77.5	67.6	63.3	59.0	55.2	47.5	32.8	31.4
29.8	28.7	27.4	26.2	22.2	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		

Segment 74

0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		

Segment 75

0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		

Segment 76

0.0	314.5	309.1	304.2	298.8	293.4	288.1	283.2	278.7	275.6
269.7	265.7	261.2	249.2	235.7	229.0	222.8	216.5	211.1	205.8
200.0	194.6	189.7	184.3	178.9	174.5	169.1	164.6	159.2	152.1
143.6	130.2	122.1	116.3	111.8	106.5	99.3	93.9	89.0	83.7
75.2	45.6	27.3	26.4	25.1	22.8	20.6	20.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		

Segment 77

0.0	428.2	423.1	418.0	412.5	407.8	402.3	398.5	394.6	391.7
387.4	383.6	380.2	376.8	371.7	367.1	362.8	359.4	353.1	349.2
342.5	338.2	334.0	329.3	324.6	319.1	314.0	309.4	304.7	302.1
294.9	278.8	269.0	261.4	254.2	246.5	239.8	231.3	223.6	216.8
209.2	201.1	194.4	183.3	173.6	164.2	154.5	133.2	113.3	104.0
95.5	89.1	77.2	62.0	54.3	45.8	20.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		

Segment 78

0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		

APPENDIX F

District SELECT Simulations

CELRN-EP-H 14 August 1998

MEMORANDUM FOR FILES

SUBJECT: Center Hill Withdrawal Zone Studies

1. Temperature and DO profiles were collected about 100-150' upstream of the CEN powerhouse during the recent turbine reaeration studies. The depth finder indicated that the bottom elevation immediately in front of the powerhouse was about 524. (This elevation is confirmed by the attached general plan drawing, Q-4/204.2.) I felt this shelf would limit the lower boundary of the withdrawal zone for power releases and decided to check on the bottom elevation used in previous withdrawal zone studies.

2. In the CEN withdrawal zone study I performed in 1979 with an early version of SELECT, I used a bottom elevation of 460. However, the typical discharge distribution curve developed from the study limited the bottom of the withdrawal zone to elevation 490. In the withdrawal zone study conducted by Paula Kee in 1996, she used a bottom elevation of 470. I also found that Paula had used a withdrawal angle of $\pi/2$ (1.57), which is the value for an outlet structure adjacent to a wall. Since the penstocks at CEN are in the middle of the dam, I felt a value of π (3.14) was the appropriate value for the withdrawal angle. (Reference: IR E-87-2, *SELECT: A Numerical One-Dimensional Model for Selective Withdrawal* dated Mar 98, pp. 8 & 9)

3. I decided to perform the withdrawal zone studies again using a bottom elevation of 524 and a withdrawal angle of 3.14. I used version 2.01 of the SELECT program and essentially the same input file that Paula developed. However, I eliminated the 11 Oct 91 data from consideration, since the outflow temperature and DO data appear to be unrepresentative of actual conditions. Results are tabulated on the attached EXCEL printouts.

4. The first two runs were made to determine the sensitivity of the computed withdrawal zone to the withdrawal angle. The "base condition" run used the coefficients Paula had developed (centerline elevation = 558, bottom elevation = 470 & withdrawal angle = 1.57). For the "new angle" run I changed the value for the withdrawal angle to 3.14. As shown by the withdrawal zone limit data for the two runs, the boundaries of the withdrawal zone were narrower with the withdrawal angle set equal to π.

5. Four additional runs were made with the bottom elevation set at 524 and the withdrawal angle maintained at 3.14 to determine the optimum centerline elevation. Results for the temperature computations are summarized below:

Centerline Elevation	Average Error	Standard Error
555	-0.08	0.45
556	-0.02	0.46
557	+0.03	0.48
558	+0.11	0.46

Based on this information I decided to use a value of 556 for the effective centerline elevation. An example input file with the revised coefficients is attached.

6. The following files were used in the study:

Select.exe	-	SELECT executable, version 2.01
Select.in	-	required input file to SELECT
Select.out	-	default SELECT output file
Basecond.in	-	saved input file for base condition run
Basecond.out	-	saved output file for base condition run
Newangle.in	-	saved input file for revised withdrawal angle run
Newangle.out	-	saved output file for revised withdrawal angle run
Run555.in	-	saved input file for 555 centerline elevation run
Run555.out	-	saved output file for 555 centerline elevation run
Run556.in	-	saved input file for 556 centerline elevation run
Run556.out	-	saved output file for 556 centerline elevation run
Run557.in	-	saved input file for 557 centerline elevation run
Run557.out	-	saved output file for 557 centerline elevation run
Run558.in	-	saved input file for 558 centerline elevation run
Run558.out	-	saved output file for 558 centerline elevation run
Cenwz.xls	-	EXCEL file with summary of results

The Run556.out file contains the most accurate withdrawal zone information.

Jackson K. Brown
Hydraulic Engineer

x9827cen.doc

Center Hill Withdrawal Zone Study

Centerline Elev.: 558
Bottom Elev.: 524
Angle: 3.14

Input & Output Files: run558.in + .out

	Hydrologic Data		Temperature Data				D.O. Data				Withdrawal Zone Limit Data			
											Lower		Upper	
Date	Inst. Flow	HW Elev.	Observed Temp.	Computed Temp.	Difference	Diff. Squared	Observed D.O.	Computed D.O.	Difference	Diff. Squared	Above Bottom	Elevation	Above Bottom	Elevation
5/31/73	9000	667.4	13.1	13.1	0.0	0.00	9.0	7.9	-1.1	1.21	0.0	524.0	118.5	642.5
8/15/73	7300	642.1	16.1	16.4	0.3	0.09	4.4	3.8	-0.6	0.36	0.0	524.0	99.0	623.0
4/6/76	11700	650.6	9.5	9.2	-0.3	0.09	9.9	9.2	-0.7	0.49	0.0	524.0	122.8	646.8
10/12/76	11500	641.0	16.6	16.5	-0.1	0.01	2.3	2.0	-0.3	0.09	0.0	524.0	117.0	641.0
6/2/81	7800	643.1	10.2	9.6	-0.6	0.36		--			0.0	524.0	100.7	624.7
7/14/81	10700	641.2	11.5	11.4	-0.1	0.01	8.4	6.8	-1.6	2.56	0.0	524.0	101.9	625.9
5/13/82	3700	645.5	9.7	9.9	0.2	0.04	9.6	--			0.0	524.0	93.7	617.7
8/3/82	13000	639.5	12.0	11.8	-0.2	0.04	5.5	4.7	-0.8	0.64	0.0	524.0	104.9	628.9
9/14/82	7700	639.7	12.0	12.1	0.1	0.01	4.5	2.6	-1.9	3.61	0.0	524.0	94.2	618.2
7/3/85	7100	642.0	10.0	10.2	0.2	0.04	7.1	7.1	0.0	0.00	0.0	524.0	96.6	620.6
6/17/86	3600	642.9	9.8	9.2	-0.6	0.36	8.8	6.9	-1.9	3.61	0.0	524.0	87.1	611.1
5/26/88	3400	640.4	9.4	9.2	-0.2	0.04	8.6	7.6	-1.0	1.00	0.0	524.0	86.6	610.6
7/6/88	7000	636.7	10.1	10.7	0.6	0.36	6.2	5.7	-0.5	0.25	0.0	524.0	91.3	615.3
9/6/89	12200	637.2	18.0	18.8	0.8	0.64	2.0	1.7	-0.3	0.09	0.0	524.0	111.2	635.2
6/27/94	6600	647.0	12.2	12.8	0.6	0.36	6.6	6.2	-0.4	0.16	0.0	524.0	103.6	627.6
9/12/94	7500	632.9	15.4	16.3	0.9	0.81	1.0	0.3	-0.7	0.49	0.0	524.0	95.1	619.1
11/1/94	2200	627.4	15.8	16.1	0.3	0.09	4.7	1.4	-3.3	10.89	0.0	524.0	82.6	606.6
				Avg. Error:	0.11			**Avg. Error:**	-1.01		**Avg.:**	524.0	**Avg:.**	624.4
				Std. Error:	0.46			**Std. Error:**	1.35					

Center Hill Withdrawal Zone Study

Centerline Elev.: 555
Bottom Elev.: 524
Angle: 3.14

Input & Output Files: run555.in + .out

	Hydrologic Data		Temperature Data				D.O. Data				Withdrawal Zone Limit Data			
											Lower		Upper	
Date	Inst. Flow	HW Elev.	Observed Temp.	Computed Temp.	Difference	Diff. Squared	Observed D.O.	Computed D.O.	Difference	Diff. Squared	Above Bottom	Elevation	Above Bottom	Elevation
5/31/73	9000	667.4	13.1	13.0	-0.1	0.01	9.0	7.9	-1.1	1.21	0.0	524.0	116.8	640.8
8/15/73	7300	642.1	16.1	16.3	0.2	0.04	4.4	3.8	-0.6	0.36	0.0	524.0	97.6	621.6
4/6/76	11700	650.6	9.5	9.0	-0.5	0.25	9.9	9.0	-0.9	0.81	0.0	524.0	120.6	644.6
10/12/76	11500	641.0	16.6	16.2	-0.4	0.16	2.3	1.8	-0.5	0.25	0.0	524.0	116.8	640.8
6/2/81	7800	643.1	10.2	9.4	-0.8	0.64		--			0.0	524.0	99.8	623.8
7/14/81	10700	641.2	11.5	11.2	-0.3	0.09	8.4	6.8	-1.6	2.56	0.0	524.0	100.5	624.5
5/13/82	3700	645.5	9.7	9.8	0.1	0.01	9.6	--			0.0	524.0	91.8	615.8
8/3/82	13000	639.5	12.0	11.7	-0.3	0.09	5.5	4.7	-0.8	0.64	0.0	524.0	102.6	626.6
9/14/82	7700	639.7	12.0	11.9	-0.1	0.01	4.5	2.6	-1.9	3.61	0.0	524.0	92.0	616.0
7/3/85	7100	642.0	10.0	9.9	-0.1	0.01	7.1	7.2	0.1	0.01	0.0	524.0	95.2	619.2
6/17/86	3600	642.9	9.8	9.1	-0.7	0.49	8.8	6.9	-1.9	3.61	0.0	524.0	85.2	609.2
5/26/88	3400	640.4	9.4	9.0	-0.4	0.16	8.6	7.6	-1.0	1.00	0.0	524.0	84.8	608.8
7/6/88	7000	636.7	10.1	10.5	0.4	0.16	6.2	5.7	-0.5	0.25	0.0	524.0	90.0	614.0
9/6/89	12200	637.2	18.0	18.7	0.7	0.49	2.0	1.7	-0.3	0.09	0.0	524.0	109.0	633.0
6/27/94	6600	647.0	12.2	12.7	0.5	0.25	6.6	6.2	-0.4	0.16	0.0	524.0	101.5	625.5
9/12/94	7500	632.9	15.4	16.0	0.6	0.36	1.0	0.3	-0.7	0.49	0.0	524.0	92.5	616.5
11/1/94	2200	627.4	15.8	15.6	-0.2	0.04	4.7	1.1	-3.6	12.96	0.0	524.0	78.6	602.6
				Avg. Error:	-0.08			**Avg. Error:**	-1.05		**Avg.:**	524.0	**Avg:.**	622.5
				Std. Error:	0.45			**Std. Error:**	1.41					

Run 556

Center Hill Withdrawal Zone Study

Centerline Elev.: 556
Bottom Elev.: 524
Angle: 3.14

Input & Output Files: run556.in + .out

	Hydrologic Data		Temperature Data				D.O. Data				Withdrawal Zone Limit Data			
											Lower		Upper	
Date	Inst. Flow	HW Elev.	Observed Temp.	Computed Temp.	Difference	Diff. Squared	Observed D.O.	Computed D.O.	Difference	Diff. Squared	Above Bottom	Elevation	Above Bottom	Elevation
5/31/73	9000	667.4	13.1	13.1	0.0	0.00	9.0	7.9	-1.1	1.21	0.0	524.0	117.4	641.4
8/15/73	7300	642.1	16.1	16.4	0.3	0.09	4.4	3.8	-0.6	0.36	0.0	524.0	98.0	622.0
4/6/76	11700	650.6	9.5	9.1	-0.4	0.16	9.9	9.1	-0.8	0.64	0.0	524.0	121.2	645.2
10/12/76	11500	641.0	16.6	16.2	-0.4	0.16	2.3	1.8	-0.5	0.25	0.0	524.0	117.0	641.0
6/2/81	7800	643.1	10.2	9.4	-0.8	0.64		--			0.0	524.0	100.3	624.3
7/14/81	10700	641.2	11.5	11.3	-0.2	0.04	8.4	6.8	-1.6	2.56	0.0	524.0	100.9	624.9
5/13/82	3700	645.5	9.7	9.8	0.1	0.01	9.6	--			0.0	524.0	92.3	616.3
8/3/82	13000	639.5	12.0	11.8	-0.2	0.04	5.5	4.7	-0.8	0.64	0.0	524.0	103.5	627.5
9/14/82	7700	639.7	12.0	11.9	-0.1	0.01	4.5	2.6	-1.9	3.61	0.0	524.0	92.9	616.9
7/3/85	7100	642.0	10.0	10.1	0.1	0.01	7.1	7.1	0.0	0.00	0.0	524.0	95.6	619.6
6/17/86	3600	642.9	9.8	9.1	-0.7	0.49	8.8	6.9	-1.9	3.61	0.0	524.0	85.7	609.7
5/26/88	3400	640.4	9.4	9.0	-0.4	0.16	8.6	7.6	-1.0	1.00	0.0	524.0	85.3	609.3
7/6/88	7000	636.7	10.1	10.5	0.4	0.16	6.2	5.7	-0.5	0.25	0.0	524.0	90.5	614.5
9/6/89	12200	637.2	18.0	18.7	0.7	0.49	2.0	1.7	-0.3	0.09	0.0	524.0	109.9	633.9
6/27/94	6600	647.0	12.2	12.8	0.6	0.36	6.6	6.2	-0.4	0.16	0.0	524.0	102.3	626.3
9/12/94	7500	632.9	15.4	16.1	0.7	0.49	1.0	0.3	-0.7	0.49	0.0	524.0	93.4	617.4
11/1/94	2200	627.4	15.8	15.7	-0.1	0.01	4.7	1.1	-3.6	12.96	0.0	524.0	79.8	603.8
				Avg. Error:	-0.02			**Avg. Error:**	-1.05		**Avg.:**	524.0	**Avg:.**	623.2
				Std. Error:	0.46			**Std. Error:**	1.41					

Center Hill Withdrawal Zone Study

Centerline Elev.: 557

Bottom Elev.: 524

Angle: 3.14

Input & Output Files: run557.int.out

	Hydrologic Data		Temperature Data				D.O. Data				Withdrawal Zone Limit Data			
											Lower		Upper	
Date	Inst. Flow	HW Elev.	Observed Temp.	Computed Temp.	Difference	Diff. Squared	Observed D.O.	Computed D.O.	Difference	Diff. Squared	Above Bottom	Elevation	Above Bottom	Elevation
5/31/73	9000	667.4	13.1	13.1	0.0	0.00	9.0	7.9	-1.1	1.21	0.0	524.0	117.9	641.9
8/15/73	7300	642.1	16.1	16.4	0.3	0.09	4.4	3.8	-0.6	0.36	0.0	524.0	98.5	622.5
4/6/76	11700	650.6	9.5	9.1	-0.4	0.16	9.9	9.1	-0.8	0.64	0.0	524.0	122.2	646.2
10/12/76	11500	641.0	16.6	16.3	-0.3	0.09	2.3	1.9	-0.4	0.16	0.0	524.0	117.0	641.0
6/2/81	7800	643.1	10.2	9.4	-0.8	0.64		--			0.0	524.0	100.7	624.7
7/14/81	10700	641.2	11.5	11.3	-0.2	0.04	8.4	6.8	-1.6	2.56	0.0	524.0	101.4	625.4
5/13/82	3700	645.5	9.7	9.8	0.1	0.01	9.6	--			0.0	524.0	92.8	616.8
8/3/82	13000	639.5	12.0	11.8	-0.2	0.04	5.5	4.7	-0.8	0.64	0.0	524.0	104.0	628.0
9/14/82	7700	639.7	12.0	12.1	0.1	0.01	4.5	2.6	-1.9	3.61	0.0	524.0	93.3	617.3
7/3/85	7100	642.0	10.0	10.1	0.1	0.01	7.1	7.1	0.0	0.00	0.0	524.0	96.1	620.1
6/17/86	3600	642.9	9.8	9.1	-0.7	0.49	8.8	6.9	-1.9	3.61	0.0	524.0	86.2	610.2
5/26/88	3400	640.4	9.4	9.2	-0.2	0.04	8.6	7.6	-1.0	1.00	0.0	524.0	86.2	610.2
7/6/88	7000	636.7	10.1	10.6	0.5	0.25	6.2	5.7	-0.5	0.25	0.0	524.0	90.9	614.9
9/6/89	12200	637.2	18.0	18.8	0.8	0.64	2.0	1.7	-0.3	0.09	0.0	524.0	110.8	634.8
6/27/94	6600	647.0	12.2	12.8	0.6	0.36	6.6	6.2	-0.4	0.16	0.0	524.0	103.2	627.2
9/12/94	7500	632.9	15.4	16.3	0.9	0.81	1.0	0.3	-0.7	0.49	0.0	524.0	94.2	618.2
11/1/94	2200	627.4	15.8	15.7	-0.1	0.01	4.7	1.1	-3.6	12.96	0.0	524.0	81.0	605.0
				Avg. Error:	0.03			**Avg. Error:**	-1.04		**Avg.:**	524.0	**Avg:.**	623.8
				Std. Error:	0.48			**Std. Error:**	1.41					

Center Hill Withdrawal Zone Study

Centerline Elev.: 558 **Input & Output Files:** basecond.in + .out

Bottom Elev.: 470

Angle: 1.57

	Hydrologic Data		Temperature Data				D.O. Data				Withdrawal Zone Limit Data			
											Lower		Upper	
Date	Inst. Flow	HW Elev.	Observed Temp.	Computed Temp.	Difference	Diff. Squared	Observed D.O.	Computed D.O.	Difference	Diff. Squared	Above Bottom	Elevation	Above Bottom	Elevation
5/31/73	9000	667.4	13.1	12.8	-0.3	0.09	9.0	7.8	-1.2	1.44	0.0	470.0	183.7	653.7
8/15/73	7300	642.1	16.1	16.2	0.1	0.01	4.4	3.6	-0.8	0.64	0.0	470.0	163.2	633.2
4/6/76	11700	650.6	9.5	9.2	-0.3	0.09	9.9	9.2	-0.7	0.49	0.0	470.0	180.6	650.6
10/12/76	11500	641.0	16.6	15.8	-0.8	0.64	2.3	2.3	0.0	0.00	0.0	470.0	171.0	641.0
6/2/81	7800	643.1	10.2	9.6	-0.6	0.36		--			0.0	470.0	166.8	636.8
7/14/81	10700	641.2	11.5	11.5	0.0	0.00	8.4	6.9	-1.5	2.25	0.0	470.0	168.0	638.0
5/13/82	3700	645.5	9.7	10.1	0.4	0.16	9.6	--			0.0	470.0	157.2	627.2
8/3/82	13000	639.5	12.0	11.5	-0.5	0.25	5.5	4.4	-1.1	1.21	0.0	470.0	169.5	639.5
9/14/82	7700	639.7	12.0	12.0	0.0	0.00	4.5	2.2	-2.3	5.29	0.0	470.0	164.2	634.2
7/3/85	7100	642.0	10.0	10.1	0.1	0.01	7.1	7.0	-0.1	0.01	0.0	470.0	162.8	632.8
6/17/86	3600	642.9	9.8	9.3	-0.5	0.25	8.8	6.8	-2.0	4.00	0.0	470.0	149.4	619.4
5/26/88	3400	640.4	9.4	9.4	0.0	0.00	8.6	7.6	-1.0	1.00	0.0	470.0	150.3	620.3
7/6/88	7000	636.7	10.1	10.7	0.6	0.36	6.2	5.6	-0.6	0.36	0.0	470.0	158.4	628.4
9/6/89	12200	637.2	18.0	18.0	0.0	0.00	2.0	1.5	-0.5	0.25	0.0	470.0	167.2	637.2
6/27/94	6600	647.0	12.2	12.7	0.5	0.25	6.6	5.6	-1.0	1.00	0.0	470.0	162.9	632.9
9/12/94	7500	632.9	15.4	16.1	0.7	0.49	1.0	0.5	-0.5	0.25	0.0	470.0	162.9	632.9
11/1/94	2200	627.4	15.8	15.8	0.0	0.00	4.7	1.6	-3.1	9.61	28.7	498.7	151.2	621.2
				Avg. Error:	-0.04			**Avg. Error:**	-1.09		**Avg.:**	471.7	**Avg:.**	634.1
				Std. Error:	0.43			**Std. Error:**	1.41					

Center Hill Withdrawal Zone Study

Centerline Elev.: 558
Bottom Elev.: 470
Angle: 3.14

Input & Output Files: newangle.in + .out

	Hydrologic Data		Temperature Data				D.O. Data				Withdrawal Zone Limit Data			
											Lower		Upper	
Date	Inst. Flow	HW Elev.	Observed Temp.	Computed Temp.	Difference	Diff. Squared	Observed D.O.	Computed D.O.	Difference	Diff. Squared	Above Bottom	Elevation	Above Bottom	Elevation
5/31/73	9000	667.4	13.1	12.7	-0.4	0.16	9.0	7.8	-1.2	1.44	0.0	470.0	168.7	638.7
8/15/73	7300	642.1	16.1	16.0	-0.1	0.01	4.4	3.7	-0.7	0.49	14.3	484.3	151.6	621.6
4/6/76	11700	650.6	9.5	8.9	-0.6	0.36	9.9	8.9	-1.0	1.00	0.0	470.0	176.9	646.9
10/12/76	11500	641.0	16.6	16.2	-0.4	0.16	2.3	2.0	-0.3	0.09	1.8	471.8	171.0	641.0
6/2/81	7800	643.1	10.2	9.0	-1.2	1.44		--			0.0	470.0	153.0	623.0
7/14/81	10700	641.2	11.5	10.7	-0.8	0.64	8.4	6.6	-1.8	3.24	0.0	470.0	154.0	624.0
5/13/82	3700	645.5	9.7	9.8	0.1	0.01	9.6	--			5.7	475.7	146.6	616.6
8/3/82	13000	639.5	12.0	11.2	-0.8	0.64	5.5	4.4	-1.1	1.21	0.0	470.0	155.4	625.4
9/14/82	7700	639.7	12.0	11.9	-0.1	0.01	4.5	2.4	-2.1	4.41	0.0	470.0	144.7	614.7
7/3/85	7100	642.0	10.0	9.7	-0.3	0.09	7.1	7.1	0.0	0.00	0.0	470.0	148.7	618.7
6/17/86	3600	642.9	9.8	9.0	-0.8	0.64	8.8	6.9	-1.9	3.61	3.2	473.2	136.9	606.9
5/26/88	3400	640.4	9.4	8.9	-0.5	0.25	8.6	7.6	-1.0	1.00	0.9	470.9	136.3	606.3
7/6/88	7000	636.7	10.1	10.1	0.0	0.00	6.2	5.7	-0.5	0.25	0.0	470.0	143.1	613.1
9/6/89	12200	637.2	18.0	18.3	0.3	0.09	2.0	1.6	-0.4	0.16	5.3	475.3	161.5	631.5
6/27/94	6600	647.0	12.2	12.6	0.4	0.16	6.6	6.1	-0.5	0.25	0.9	470.9	155.6	625.6
9/12/94	7500	632.9	15.4	16.1	0.7	0.49	1.0	0.3	-0.7	0.49	10.1	480.1	147.4	617.4
11/1/94	2200	627.4	15.8	16.1	0.3	0.09	4.7	1.4	-3.3	10.89	42.5	512.5	136.0	606.0
				Avg. Error:	-0.25			**Avg. Error:**	-1.10		**Avg.:**	475.0	**Avg:.**	622.2
				Std. Error:	0.57			**Std. Error:**	1.43					

Example Input File

FILE: example.txt 14 AUG 98 13:17:34

```
CENTER HILL DAM UPDATED SELECTIVE WITHDRAWAL STUDY
DATA SETS     1
PRINT INPUT
CENTER HILL DAM - 31 MAY 1973 PROFILE
ENGLISH
TABLE         01
THICKNESS        3.0
INTERVAL      01
SURFACE        667.4
BOTTOM         524.0
PORT           1
VDIM            17.7
HDIM            17.7
ELEVATION     556.00
FLOW          9000.0
ANGLE           3.14
NUMBER OF TEMP          18
TEMPERATURE DEGREES CENTIGRADE
ELEVATION TEMP
        667.4      22.1
        657.4      20.9
        647.4      18.1
        637.4      17.2
        627.4      16.2
        617.4      15.8
        607.4      15.1
        597.4      14.9
        587.4      14.0
        577.4      13.8
        567.4      13.0
        557.4      12.2
        547.4      12.0
        537.4      11.2
        527.4      10.9
        517.4      10.0
        507.4       9.4
        497.4       9.1
QUALITIES     1
NUMBER OF DISSOLVED OXYGEN         18
ELEVATION DISSOLVED OXYGEN
        667.4       9.9
        657.4      10.0
        647.4       8.3
        637.4       7.6
        627.4       7.4
        617.4       7.5
        607.4       7.5
        597.4       7.6
        587.4       7.7
        577.4       7.8
        567.4       7.9
        557.4       8.1
        547.4       8.1
        537.4       8.1
```

FILE: example.txt

14 AUG 98
13:17:34

55	527.4	8.0
56	517.4	7.7
57	507.4	7.4
58	497.4	7.2
59	STOP	

APPENDIX G

Model Year Selection

CELRN-EP-H 2 February 2000

MEMORANDUM FOR FILES

SUBJECT: Selection of Years to Simulate with CEN W2 Model

1. The purpose of this memo is to describe the procedure used to select the years to simulate with the CE-QUAL-W2 model of CEN. FTN will calibrate and apply the model for the District through a contract. The scope of work states the model is to be calibrated to one wet, one dry and one normal year.

2. CEN was impounded in 1950 but the Water Quality Section did not begin collecting data from the lake until October 1970. For this reason, years 1950-1970 were eliminated from consideration. Thus, the period of record for evaluation was 1971-1999.

3. The goal of the first step was to classify the years as wet, dry, normal or mixed. A mixed year is defined as a year having large monthly variations in flows ranging from wet to dry conditions. Since the period of simulation is expected to be March-November, the months of January, February and December were not considered. Mean monthly inflows calculated from change in storage computations were evaluated to perform the classification. Program 401MDS was used to tabulate the monthly flows and sort them in numerical order. Then, months for individual years were color-coded on the attached spreadsheets. This provided a simple means of comparing flows for a specific year to flows for the other years. This system yielded the results shown in the following table.

Classification of CEN Inflows for March-November Period			
Wet Years	**Dry Years**	**Normal Years**	**Mixed Years**
1973	1980	1972	1971
1975	1981	1974	1976
1979	1985	1991	1977
1989	1986	1996	1978
1994	1987		1982
1997	1988		1983
	1990		1984
			1992
			1995
			1998
			1999

4. The next step consisted of evaluating the suitability of the individual years in terms of availability of data from the lake. The sampling log filed with the field sheets was reviewed to determine when lake sampling trips were made and this information was tabulated in an EXCEL file (CENLOCAL.XLS). It was decided that a year needed to have at least three sampling trips to be considered for calibration. This criterion eliminated the following years: 1974-81, 1983-87, 1989-95 and 1997-99. The remaining seven years are 1971, 1972, 1973, 1982, 1983, 1988 and 1996.

5. Another concern about the availability of data involves when the laboratory capability was developed to begin collecting data for certain parameters. The parameters of most concern are nutrients (total & dissolved phosphorus, ammonia and nitrates+nitrites) and chlorophyll 'a'. A retrieval of these parameters for the period of record from station CEN20002 revealed the following information:

- We began collecting NO_2+NO_3 data in 6/71.
- We began collecting total and dissolved P data in 3/73 with a lower limit of 0.01 mg/l. Data collected earlier were reported as <0.05 mg/l.
- We began collecting NH_3 data in 8/72.
- We began chlorophyll 'a' data in 4/76.

An analysis of this retrieval also revealed the following:

- Total and dissolved P data are missing for the period 5/82 to 6/86.
- Dissolved P data are missing from 3/88 through 9/88.
- Chlorophyll 'a' data were collected below the euphotic zone or are simply missing for several of the 1988 sampling trips.
- Dissolved P data are missing from 7/90 through 8/91.
- Total P data are missing for 6/94.
- Dissolved P data are missing from 6/94 through 9/94.
- Nitrates data are missing for 6/96.

- None of the data from 1998 and 1999 have been entered in the database.

6. Another consideration is inflow data. We have a very limited amount of information from the tributaries, but I assume we have enough for FTN to be able to develop regression equations to allow inflow quality to be estimated for all study years. Generating data for the releases from Great Falls Dam will be more complicated due to the effects of impoundment. At one time TVA monitored scroll case temperature and DO conditions in the Great Falls powerplant. To determine when the temperature data were collected, I performed a retrieval of data using the 1998 Hydrosphere STORET CD. Results are shown in the attached table.

7. After reviewing available information I selected 1973, 1988 and 1996 as the years to be simulated with the model. Reasons for selecting and rejecting the various years are given below:

1996 - 1996 was one of only four years classified as normal years. One of the other normal years did not have nutrient data and the remaining two were sampled only twice. Since the lake was sampled 5 times in 1996 and the nutrient and chlorophyll 'a' data appear to be in fairly good shape, this was an easy choice.

1988 - 1988 was one of seven years classified as dry. The lake was not sampled more than twice in any of the other dry years, but in 1988 it was sampled 9 times. Most of the 1988 data were collected by a contractor, who did not collect any dissolved P data and apparently screwed up the chlorophyll 'a' data. Nonetheless, 1988 was an easy choice for the dry year.

1982 - 1982 was rejected because the lake was sampled only three times during the year and there are no total or dissolved P data. In addition, releases for the March-November period averaged less than normal.

1983 - 1983 was rejected because the lake was sampled only three times during the year and there are no total or dissolved P data.

1971 - 1971 was rejected because of the lack of nutrient and chlorophyll 'a' data and because it was classified as a mixed year.

1972 - Although classified as a normal year, conditions were actually pretty wet and I would have no problem with using 1972 as the wet year. 1972 lost out to 1973 primarily because of the lack of total and dissolved P data.

1973 - 1973 was selected as the wet year for the simulations. On an annual basis it's the wettest year in the period of record. Although no chlorophyll 'a' data are available, data are available for nutrients. Weekly data from the scroll case in the Great Falls powerhouse are available to help define inflow quality.

Jackson K. Brown

Jackson K. Brown
Hydraulic Engineer

x0005yer.doc

Center Hill - Average Monthly Local Inflow

Years: 1971 1972 1973 1974 1975

NO.	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
1	412	2176	1802	1157	708	38	205	109	68	-56	-15	272	1892
2	1327	2382	2320	1715	1092	448	224	141	120	3	69	362	1923
3	1794	2789	2455	2170	1146	454	267	144	136	40	150	504	2097
4	2792	3177	3082	2202	1290	634	276	152	159	62	187	622	2361
5	3019	3191	3558	2253	1308	638	340	159	188	95	205	673	2686
6	3282	3367	3590	2594	1312	671	345	181	199	170	215	699	2697
7	3764	3436	3670	2642	1383	719	363	185	210	219	232	891	2778
8	3773	3550	4522	2745	1444	721	366	212	212	221	278	1020	2779
9	3809	3775	4860	2749	1858	760	373	243	232	245	312	1370	2871
10	3962	3917	5058	2751	2051	788	374	311	259	251	353	2139	2902
11	3994	4111	5564	2868	2116	847	407	316	275	275	399	2278	2919
12	4043	4551	5605	2925	2145	888	443	323	276	287	495	2301	3044
13	4067	4733	5759	3413	2260	901	452	368	309	334	504	2526	3047
14	4093	4851	6001	3456	2543	917	478	374	320	347	540	2795	3101
15	4298	4997	6032	3601	2563	918	496	378	320	349	587	2880	3106
16	4525	5060	6163	3716	2653	1018	500	388	346	414	589	3278	3117
17	4599	5227	6358	3938	2779	1020	511	405	357	433	637	3314	3226
18	4843	5252	6627	4074	2884	1058	526	418	362	458	689	3350	3250
19	4856	5298	6702	4121	2885	1072	546	419	401	473	705	3353	3274
20	5619	5447	6723	4470	2973	1129	557	447	422	499	1343	3429	3396
21	5631	5824	6934	4474	2976	1317	565	485	425	513	1374	3586	3548
22	5792	5856	6938	4653	2980	1365	635	528	427	574	1429	3646	3614
23	5819	6189	7127	4754	2988	1392	705	529	450	606	1494	3791	3636
24	6179	6368	7239	4915	3070	1404	803	561	514	606	1519	3884	3688
25	6197	6414	7407	5088	3096	1477	819	584	516	607	1712	4034	3756
26	6457	6573	7615	5164	3107	1479	829	595	531	611	1726	4171	3880
27	7129	6700	7655	5532	3165	1573	879	663	549	632	1748	4354	3886
28	7129	6817	7817	5647	3244	1600	975	671	634	724	1848	4588	3910
29	7393	7119	7842	5701	3643	1657	978	805	636	790	1911	4969	3941
30	7619	7360	7910	5701	3803	1658	1028	841	655	824	2306	5021	4075
31	7679	7485	8278	5776	3970	1911	1052	972	729	897	2311	5942	4126
32	7858	7758	8309	6200	4009	2072	1173	1064	768	955	2345	6232	4132
33	7979	8068	8519	6599	4073	2111	1244	1160	788	958	2366	6233	4274
34	8127	8074	8552	6680	4150	2142	1352	1197	827	1067	2647	6458	4297
35	8343	8555	8899	7218	4256	2206	1368	1268	844	1084	2761	6654	4303
36	8826	8604	9048	7273	4273	2284	1434	1281	1019	1132	3070	7013	4408
37	9148	9191	9198	7527	4324	2379	1490	1338	1024	1375	3095	7102	4409
38	9712	9563	10362	7608	4408	2594	1581	1354	1025	1491	3554	7565	4484
39	9754	9569	10517	7953	4434	2687	1663	1377	1033	1519	3571	8055	4823
40	9888	9593	10683	7995	4878	2813	1700	1477	1052	1521	3641	8339	4953
41	9893	9916	11376	8878	5354	2837	1891	1525	1254	1539	4230	8722	4977
42	10279	10199	12237	9012	5584	2958	1918	1664	1379	1624	4684	8731	5021
43	10636	12483	12511	9373	6085	3272	2165	1682	1421	1706	4893	8782	5147
44	10892	13641	13157	9892	6283	3476	2681	1715	2147	1756	5126	8796	5177
45	11161	14606	14922	10855	6411	3594	2707	1823	2214	2341	5908	8817	5223
46	12255	14766	15623	11352	7056	4020	2931	1834	2491	3082	6016	9514	5313
47	13463	15444	15827	11650	7064	4051	3126	1855	2624	3166	6565	13439	5619
48	13573	16621	16202	13488	10716	7358	3790	1958	3235	4203	7328	13666	5710
49	19155	17498	18721	13845	12345	8530	5324	2040	3366	4845	9477	16183	5722
50	21893	17855	22607	13975	15688	10025	5770	2654	3392	6455	12040	18253	6321

Center Hill - Average Monthly Local Inflow

Years: 1976 1977 1978 1979 1980

NO.	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
1	412	2176	1802	1157	708	38	205	109	68	-56	-15	272	1892
2	1327	2382	2320	1715	1092	448	224	141	120	3	69	362	1923
3	1794	2789	2455	2170	1146	454	267	144	136	40	150	504	2097
4	2792	3177	3082	2202	1290	634	276	152	159	62	187	622	2361
5	3019	3191	3558	2253	1308	638	340	159	188	95	205	673	2686
6	3282	3367	3590	2594	1312	671	345	181	199	170	215	699	2697
7	3764	3436	3670	2642	1383	719	363	185	210	219	232	891	2778
8	3773	3550	4522	2745	1444	721	366	212	212	221	278	1020	2779
9	3809	3775	4860	2749	1858	760	373	243	232	245	312	1370	2871
10	3962	3917	5058	2751	2051	788	374	311	259	251	353	2139	2902
11	3994	4111	5564	2868	2116	847	407	316	275	275	399	2278	2919
12	4043	4551	5605	2925	2145	888	443	323	276	287	495	2301	3044
13	4067	4733	5759	3413	2260	901	452	368	309	334	504	2526	3047
14	4093	4851	6001	3456	2543	917	478	374	320	347	540	2795	3101
15	4298	4997	6032	3601	2563	918	496	378	320	349	587	2880	3106
16	4525	5060	6163	3716	2653	1018	500	388	346	414	589	3278	3117
17	4599	5227	6358	3938	2779	1020	511	405	357	433	637	3314	3226
18	4843	5252	6627	4074	2884	1058	526	418	362	458	689	3350	3250
19	4856	5298	6702	4121	2885	1072	546	419	401	473	705	3353	3274
20	5619	5447	6723	4470	2973	1129	557	447	422	499	1343	3429	3396
21	5631	5824	6934	4474	2976	1317	565	485	425	513	1374	3586	3548
22	5792	5856	6938	4653	2980	1365	635	528	427	574	1429	3646	3614
23	5819	6189	7127	4754	2988	1392	705	529	450	606	1494	3791	3636
24	6179	6368	7239	4915	3070	1404	803	561	514	606	1519	3884	3688
25	6197	6414	7407	5088	3096	1477	819	584	516	607	1712	4034	3756
26	6457	6573	7615	5164	3107	1479	829	595	531	611	1726	4171	3880
27	7129	6700	7655	5532	3165	1573	879	663	549	632	1748	4354	3886
28	7129	6817	7817	5647	3244	1600	975	671	634	724	1848	4588	3910
29	7393	7119	7842	5701	3643	1657	978	805	636	790	1911	4969	3941
30	7619	7360	7910	5701	3803	1658	1028	841	655	824	2306	5021	4075
31	7679	7485	8278	5776	3970	1911	1052	972	729	897	2311	5942	4126
32	7858	7758	8309	6200	4009	2072	1173	1064	768	955	2345	6232	4132
33	7979	8068	8519	6599	4073	2111	1244	1160	788	958	2366	6233	4274
34	8127	8074	8552	6680	4150	2142	1352	1197	827	1067	2647	6458	4297
35	8343	8555	8899	7218	4256	2206	1368	1268	844	1084	2761	6654	4303
36	8826	8604	9048	7273	4273	2284	1434	1281	1019	1132	3070	7013	4408
37	9148	9191	9198	7527	4324	2379	1490	1338	1024	1375	3095	7102	4409
38	9712	9563	10362	7608	4408	2594	1581	1354	1025	1491	3554	7565	4484
39	9754	9569	10517	7953	4434	2687	1663	1377	1033	1519	3571	8055	4823
40	9888	9593	10683	7995	4878	2813	1700	1477	1052	1521	3641	8339	4953
41	9893	9916	11376	8878	5354	2837	1891	1525	1254	1539	4230	8722	4977
42	10279	10199	12237	9012	5584	2958	1918	1664	1379	1624	4684	8731	5021
43	10636	12483	12511	9373	6085	3272	2165	1682	1421	1706	4893	8782	5147
44	10892	13641	13157	9892	6283	3476	2681	1715	2147	1756	5126	8796	5177
45	11161	14606	14922	10855	6411	3594	2707	1823	2214	2341	5908	8817	5223
46	12255	14766	15623	11352	7056	4020	2931	1834	2491	3082	6016	9514	5313
47	13463	15444	15827	11650	7064	4051	3126	1855	2624	3166	6565	13439	5619
48	13573	16621	16202	13488	10716	7358	3790	1958	3235	4203	7328	13666	5710
49	19155	17498	18721	13845	12345	8530	5324	2040	3366	4845	9477	16183	5722
50	21893	17855	22607	13975	15688	10025	5770	2654	3392	6455	12040	18253	6321

Center Hill - Average Monthly Local Inflow

Years: 1981 1982 1983 1984 1985

NO.	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
1	412	2176	1802	1157	708	38	205	109	68	-56	-15	272	1892
2	1327	2382	2320	1715	1092	448	224	141	120	3	69	362	1923
3	1794	2789	2455	2170	1146	454	267	144	136	40	150	504	2097
4	2792	3177	3082	2202	1290	634	276	152	159	62	187	622	2361
5	3019	3191	3558	2253	1308	638	340	159	188	95	205	673	2686
6	3282	3367	3590	2594	1312	671	345	181	199	170	215	699	2697
7	3764	3436	3670	2642	1383	719	363	185	210	219	232	891	2778
8	3773	3550	4522	2745	1444	721	366	212	212	221	278	1020	2779
9	3809	3775	4860	2749	1858	760	373	243	232	245	312	1370	2871
10	3962	3917	5058	2751	2051	788	374	311	259	251	353	2139	2902
11	3994	4111	5564	2868	2116	847	407	316	275	275	399	2278	2919
12	4043	4551	5605	2925	2145	888	443	323	276	287	495	2301	3044
13	4067	4733	5759	3413	2260	901	452	368	309	334	504	2526	3047
14	4093	4851	6001	3456	2543	917	478	374	320	347	540	2795	3101
15	4298	4997	6032	3601	2563	918	496	378	320	349	587	2880	3106
16	4525	5060	6163	3716	2653	1018	500	388	346	414	589	3278	3117
17	4599	5227	6358	3938	2779	1020	511	405	357	433	637	3314	3226
18	4843	5252	6627	4074	2884	1058	526	418	362	458	689	3350	3250
19	4856	5298	6702	4121	2885	1072	546	419	401	473	705	3353	3274
20	5619	5447	6723	4470	2973	1129	557	447	422	499	1343	3429	3396
21	5631	5824	6934	4474	2976	1317	565	485	425	513	1374	3586	3548
22	5792	5856	6938	4653	2980	1365	635	528	427	574	1429	3646	3614
23	5819	6189	7127	4754	2988	1392	705	529	450	606	1494	3791	3636
24	6179	6368	7239	4915	3070	1404	803	561	514	606	1519	3884	3688
25	6197	6414	7407	5088	3096	1477	819	584	516	607	1712	4034	3756
26	6457	6573	7615	5164	3107	1479	829	595	531	611	1726	4171	3880
27	7129	6700	7655	5532	3165	1573	879	663	549	632	1748	4354	3886
28	7129	6817	7817	5647	3244	1600	975	671	634	724	1848	4588	3910
29	7393	7119	7842	5701	3643	1657	978	805	636	790	1911	4969	3941
30	7619	7360	7910	5701	3803	1658	1028	841	655	824	2306	5021	4075
31	7679	7485	8278	5776	3970	1911	1052	972	729	897	2311	5942	4126
32	7858	7758	8309	6200	4009	2072	1173	1064	768	955	2345	6232	4132
33	7979	8068	8519	6599	4073	2111	1244	1160	788	958	2366	6233	4274
34	8127	8074	8552	6680	4150	2142	1352	1197	827	1067	2647	6458	4297
35	8343	8555	8899	7218	4256	2206	1368	1268	844	1084	2761	6654	4303
36	8826	8604	9048	7273	4273	2284	1434	1281	1019	1132	3070	7013	4408
37	9148	9191	9198	7527	4324	2379	1490	1338	1024	1375	3095	7102	4409
38	9712	9563	10362	7608	4408	2594	1581	1354	1025	1491	3554	7565	4484
39	9754	9569	10517	7953	4434	2687	1663	1377	1033	1519	3571	8055	4823
40	9888	9593	10683	7995	4878	2813	1700	1477	1052	1521	3641	8339	4953
41	9893	9916	11376	8878	5354	2837	1891	1525	1254	1539	4230	8722	4977
42	10279	10199	12237	9012	5584	2958	1918	1664	1379	1624	4684	8731	5021
43	10636	12483	12511	9373	6085	3272	2165	1682	1421	1706	4893	8782	5147
44	10892	13641	13157	9892	6283	3476	2681	1715	2147	1756	5126	8796	5177
45	11161	14606	14922	10855	6411	3594	2707	1823	2214	2341	5908	8817	5223
46	12255	14766	15623	11352	7056	4020	2931	1834	2491	3082	6016	9514	5313
47	13463	15444	15827	11650	7064	4051	3126	1855	2624	3166	6565	13439	5619
48	13573	16621	16202	13488	10716	7358	3790	1958	3235	4203	7328	13666	5710
49	19155	17498	18721	13845	12345	8530	5324	2040	3366	4845	9477	16183	5722
50	21893	17855	22607	13975	15688	10025	5770	2654	3392	6455	12040	18253	6321

Center Hill - Average Monthly Local Inflow

Years: 1986 1987 1988 1989 1990

NO.	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
1	412	2176	1802	1157	708	38	205	109	68	-56	-15	272	1892
2	1327	2382	2320	1715	1092	448	224	141	120	3	69	362	1923
3	1794	2789	2455	2170	1146	454	267	144	136	40	150	504	2097
4	2792	3177	3082	2202	1290	634	276	152	159	62	187	622	2361
5	3019	3191	3558	2253	1308	638	340	159	188	95	205	673	2686
6	3282	3367	3590	2594	1312	671	345	181	199	170	215	699	2697
7	3764	3436	3670	2642	1383	719	363	185	210	219	232	891	2778
8	3773	3550	4522	2745	1444	721	366	212	212	221	278	1020	2779
9	3809	3775	4860	2749	1858	760	373	243	232	245	312	1370	2871
10	3962	3917	5058	2751	2051	788	374	311	259	251	353	2139	2902
11	3994	4111	5564	2868	2116	847	407	316	275	275	399	2278	2919
12	4043	4551	5605	2925	2145	888	443	323	276	287	495	2301	3044
13	4067	4733	5759	3413	2260	901	452	368	309	334	504	2526	3047
14	4093	4851	6001	3456	2543	917	478	374	320	347	540	2795	3101
15	4298	4997	6032	3601	2563	918	496	378	320	349	587	2880	3106
16	4525	5060	6163	3716	2653	1018	500	388	346	414	589	3278	3117
17	4599	5227	6358	3938	2779	1020	511	405	357	433	637	3314	3226
18	4843	5252	6627	4074	2884	1058	526	418	362	458	689	3350	3250
19	4856	5298	6702	4121	2885	1072	546	419	401	473	705	3353	3274
20	5619	5447	6723	4470	2973	1129	557	447	422	499	1343	3429	3396
21	5631	5824	6934	4474	2976	1317	565	485	425	513	1374	3586	3548
22	5792	5856	6938	4653	2980	1365	635	528	427	574	1429	3646	3614
23	5819	6189	7127	4754	2988	1392	705	529	450	606	1494	3791	3636
24	6179	6368	7239	4915	3070	1404	803	561	514	606	1519	3884	3688
25	6197	6414	7407	5088	3096	1477	819	584	516	607	1712	4034	3756
26	6457	6573	7615	5164	3107	1479	829	595	531	611	1726	4171	3880
27	7129	6700	7655	5532	3165	1573	879	663	549	632	1748	4354	3886
28	7129	6817	7817	5647	3244	1600	975	671	634	724	1848	4588	3910
29	7393	7119	7842	5701	3643	1657	978	805	636	790	1911	4969	3941
30	7619	7360	7910	5701	3803	1658	1028	841	655	824	2306	5021	4075
31	7679	7485	8278	5776	3970	1911	1052	972	729	897	2311	5942	4126
32	7858	7758	8309	6200	4009	2072	1173	1064	768	955	2345	6232	4132
33	7979	8068	8519	6599	4073	2111	1244	1160	788	958	2366	6233	4274
34	8127	8074	8552	6680	4150	2142	1352	1197	827	1067	2647	6458	4297
35	8343	8555	8899	7218	4256	2206	1368	1268	844	1084	2761	6654	4303
36	8826	8604	9048	7273	4273	2284	1434	1281	1019	1132	3070	7013	4408
37	9148	9191	9198	7527	4324	2379	1490	1338	1024	1375	3095	7102	4409
38	9712	9563	10362	7608	4408	2594	1581	1354	1025	1491	3554	7565	4484
39	9754	9569	10517	7953	4434	2687	1663	1377	1033	1519	3571	8055	4823
40	9888	9593	10683	7995	4878	2813	1700	1477	1052	1521	3641	8339	4953
41	9893	9916	11376	8878	5354	2837	1891	1525	1254	1539	4230	8722	4977
42	10279	10199	12237	9012	5584	2958	1918	1664	1379	1624	4684	8731	5021
43	10636	12483	12511	9373	6085	3272	2165	1682	1421	1706	4893	8782	5147
44	10892	13641	13157	9892	6283	3476	2681	1715	2147	1756	5126	8796	5177
45	11161	14606	14922	10855	6411	3594	2707	1823	2214	2341	5908	8817	5223
46	12255	14766	15623	11352	7056	4020	2931	1834	2491	3082	6016	9514	5313
47	13463	15444	15827	11650	7064	4051	3126	1855	2624	3166	6565	13439	5619
48	13573	16621	16202	13488	10716	7358	3790	1958	3235	4203	7328	13666	5710
49	19155	17498	18721	13845	12345	8530	5324	2040	3366	4845	9477	16183	5722
50	21893	17855	22607	13975	15688	10025	5770	2654	3392	6455	12040	18253	6321

Center Hill - Average Monthly Local Inflow

Years: 1991 1992 1993 1994 1995

NO.	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
1	412	2176	1802	1157	708	38	205	109	68	-56	-15	272	1892
2	1327	2382	2320	1715	1092	448	224	141	120	3	69	362	1923
3	1794	2789	2455	2170	1146	454	267	144	136	40	150	504	2097
4	2792	3177	3082	2202	1290	634	276	152	159	62	187	622	2361
5	3019	3191	3558	2253	1308	638	340	159	188	95	205	673	2686
6	3282	3367	3590	2594	1312	671	345	181	199	170	215	699	2697
7	3764	3436	3670	2642	1383	719	363	185	210	219	232	891	2778
8	3773	3550	4522	2745	1444	721	366	212	212	221	278	1020	2779
9	3809	3775	4860	2749	1858	760	373	243	232	245	312	1370	2871
10	3962	3917	5058	2751	2051	788	374	311	259	251	353	2139	2902
11	3994	4111	5564	2868	2116	847	407	316	275	275	399	2278	2919
12	4043	4551	5605	2925	2145	888	443	323	276	287	495	2301	3044
13	4067	4733	5759	3413	2260	901	452	368	309	334	504	2526	3047
14	4093	4851	6001	3456	2543	917	478	374	320	347	540	2795	3101
15	4298	4997	6032	3601	2563	918	496	378	320	349	587	2880	3106
16	4525	5060	6163	3716	2653	1018	500	388	346	414	589	3278	3117
17	4599	5227	6358	3938	2779	1020	511	405	357	433	637	3314	3226
18	4843	5252	6627	4074	2884	1058	526	418	362	458	689	3350	3250
19	4856	5298	6702	4121	2885	1072	546	419	401	473	705	3353	3274
20	5619	5447	6723	4470	2973	1129	557	447	422	499	1343	3429	3396
21	5631	5824	6934	4474	2976	1317	565	485	425	513	1374	3586	3548
22	5792	5856	6938	4653	2980	1365	635	528	427	574	1429	3646	3614
23	5819	6189	7127	4754	2988	1392	705	529	450	606	1494	3791	3636
24	6179	6368	7239	4915	3070	1404	803	561	514	606	1519	3884	3688
25	6197	6414	7407	5088	3096	1477	819	584	516	607	1712	4034	3756
26	6457	6573	7615	5164	3107	1479	829	595	531	611	1726	4171	3880
27	7129	6700	7655	5532	3165	1573	879	663	549	632	1748	4354	3886
28	7129	6817	7817	5647	3244	1600	975	671	634	724	1848	4588	3910
29	7393	7119	7842	5701	3643	1657	978	805	636	790	1911	4969	3941
30	7619	7360	7910	5701	3803	1658	1028	841	655	824	2306	5021	4075
31	7679	7485	8278	5776	3970	1911	1052	972	729	897	2311	5942	4126
32	7858	7758	8309	6200	4009	2072	1173	1064	768	955	2345	6232	4132
33	7979	8068	8519	6599	4073	2111	1244	1160	788	958	2366	6233	4274
34	8127	8074	8552	6680	4150	2142	1352	1197	827	1067	2647	6458	4297
35	8343	8555	8899	7218	4256	2206	1368	1268	844	1084	2761	6654	4303
36	8826	8604	9048	7273	4273	2284	1434	1281	1019	1132	3070	7013	4408
37	9148	9191	9198	7527	4324	2379	1490	1338	1024	1375	3095	7102	4409
38	9712	9563	10362	7608	4408	2594	1581	1354	1025	1491	3554	7565	4484
39	9754	9569	10517	7953	4434	2687	1663	1377	1033	1519	3571	8055	4823
40	9888	9593	10683	7995	4878	2813	1700	1477	1052	1521	3641	8339	4953
41	9893	9916	11376	8878	5354	2837	1891	1525	1254	1539	4230	8722	4977
42	10279	10199	12237	9012	5584	2958	1918	1664	1379	1624	4684	8731	5021
43	10636	12483	12511	9373	6085	3272	2165	1682	1421	1706	4893	8782	5147
44	10892	13641	13157	9892	6283	3476	2681	1715	2147	1756	5126	8796	5177
45	11161	14606	14922	10855	6411	3594	2707	1823	2214	2341	5908	8817	5223
46	12255	14766	15623	11352	7056	4020	2931	1834	2491	3082	6016	9514	5313
47	13463	15444	15827	11650	7064	4051	3126	1855	2624	3166	6565	13439	5619
48	13573	16621	16202	13488	10716	7358	3790	1958	3235	4203	7328	13666	5710
49	19155	17498	18721	13845	12345	8530	5324	2040	3366	4845	9477	16183	5722
50	21893	17855	22607	13975	15688	10025	5770	2654	3392	6455	12040	18253	6321

Center Hill - Average Monthly Local Inflow

Years: 1996 1997 1998 1999

NO.	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
1	412	2176	1802	1157	708	38	205	109	68	-56	-15	272	1892
2	1327	2382	2320	1715	1092	448	224	141	120	3	69	362	1923
3	1794	2789	2455	2170	1146	454	267	144	136	40	150	504	2097
4	2792	3177	3082	2202	1290	634	276	152	159	62	187	622	2361
5	3019	3191	3558	2253	1308	638	340	159	188	95	205	673	2686
6	3282	3367	3590	2594	1312	671	345	181	199	170	215	699	2697
7	3764	3436	3670	2642	1383	719	363	185	210	219	232	891	2778
8	3773	3550	4522	2745	1444	721	366	212	212	221	278	1020	2779
9	3809	3775	4860	2749	1858	760	373	243	232	245	312	1370	2871
10	3962	3917	5058	2751	2051	788	374	311	259	251	353	2139	2902
11	3994	4111	5564	2868	2116	847	407	316	275	275	399	2278	2919
12	4043	4551	5605	2925	2145	888	443	323	276	287	495	2301	3044
13	4067	4733	5759	3413	2260	901	452	368	309	334	504	2526	3047
14	4093	4851	6001	3456	2543	917	478	374	320	347	540	2795	3101
15	4298	4997	6032	3601	2563	918	496	378	320	349	587	2880	
16	4525	5060	6163	3716	2653	1018	500	388	346	414	589	3278	3117
17	4599	5227	6358	3938	2779	1020	511	405	357	433	637	3314	3226
18	4843	5252	6627	4074	2884	1058	526	418	362	458	689	3350	3250
19	4856	5298	6702	4121	2885	1072	546	419	401	473	705	3353	3274
20	5619	5447	6723	4470	2973	1129	557	447	422	499	1343	3429	3396
21	5631	5824	6934	4474	2976	1317	565	485	425	513	1374	3586	3548
22	5792	5856	6938	4653	2980	1365	635	528	427	574	1429	3646	3614
23	5819	6189	7127	4754	2988	1392	705	529	450	606	1494	3791	3636
24	6179	6368	7239	4915	3070	1404	803	561	514	606	1519	3884	3688
25	6197	6414	7407	5088	3096	1477	819	584	516	607	1712	4034	3756
26	6457	6573	7615	5164	3107	1479	829	595	531	611	1726	4171	3880
27	7129	6700	7655	5532	3165	1573	879	663	549	632	1748	4354	3886
28	7129	6817	7817	5647	3244	1600	975	671	634	724	1848	4588	3910
29	7393	7119	7842	5701	3643	1657	978	805	636	790	1911	4969	3941
30	7619	7360	7910	5701	3803	1658	1028	841	655	824	2306	5021	4075
31	7679	7485	8278	5776	3970	1911	1052	972	729	897	2311	5942	4126
32	7858	7758	8309	6200	4009	2072	1173	1064	768	955	2345	6232	4132
33	7979	8068	8519	6599	4073	2111	1244	1160	788	958	2366	6233	4274
34	8127	8074	8552	6680	4150	2142	1352	1197	827	1067	2647	6458	4297
35	8343	8555	8899	7218	4256	2206	1368	1268	844	1084	2761	6654	4303
36	8826	8604	9048	7273	4273	2284	1434	1281	1019	1132	3070	7013	4408
37	9148	9191	9198	7527	4324	2379	1490	1338	1024	1375	3095	7102	4409
38	9712	9563	10362	7608	4408	2594	1581	1354	1025	1491	3554	7565	4484
39	9754	9569	10517	7953	4434	2687	1663	1377	1033	1519	3571	8055	4823
40	9888	9593	10683	7995	4878	2813	1700	1477	1052	1521	3641	8339	4953
41	9893	9916	11376	8878	5354	2837	1891	1525	1254	1539	4230	8722	4977
42	10279	10199	12237	9012	5584	2958	1918	1664	1379	1624	4684	8731	5021
43	10636	12483	12511	9373	6085	3272	2165	1682	1421	1706	4893	8782	5147
44	10892	13641	13157	9892	6283	3476	2681	1715	2147	1756	5126	8796	5177
45	11161	14606	14922	10855	6411	3594	2707	1823	2214	2341	5908	8817	5223
46	12255	14766	15623	11352	7056	4020	2931	1834	2491	3082	6016	9514	5313
47	13463	15444	15827	11650	7064	4051	3126	1855	2624	3166	6565	13439	5619
48	13573	16621	16202	13488	10716	7358	3790	1958	3235	4203	7328	13666	5710
49	19155	17498	18721	13845	12345	8530	5324	2040	3366	4845	9477	16183	5722
50	21893	17855	22607	13975	15688	10025	5770	2654	3392	6455	12040	18253	6321

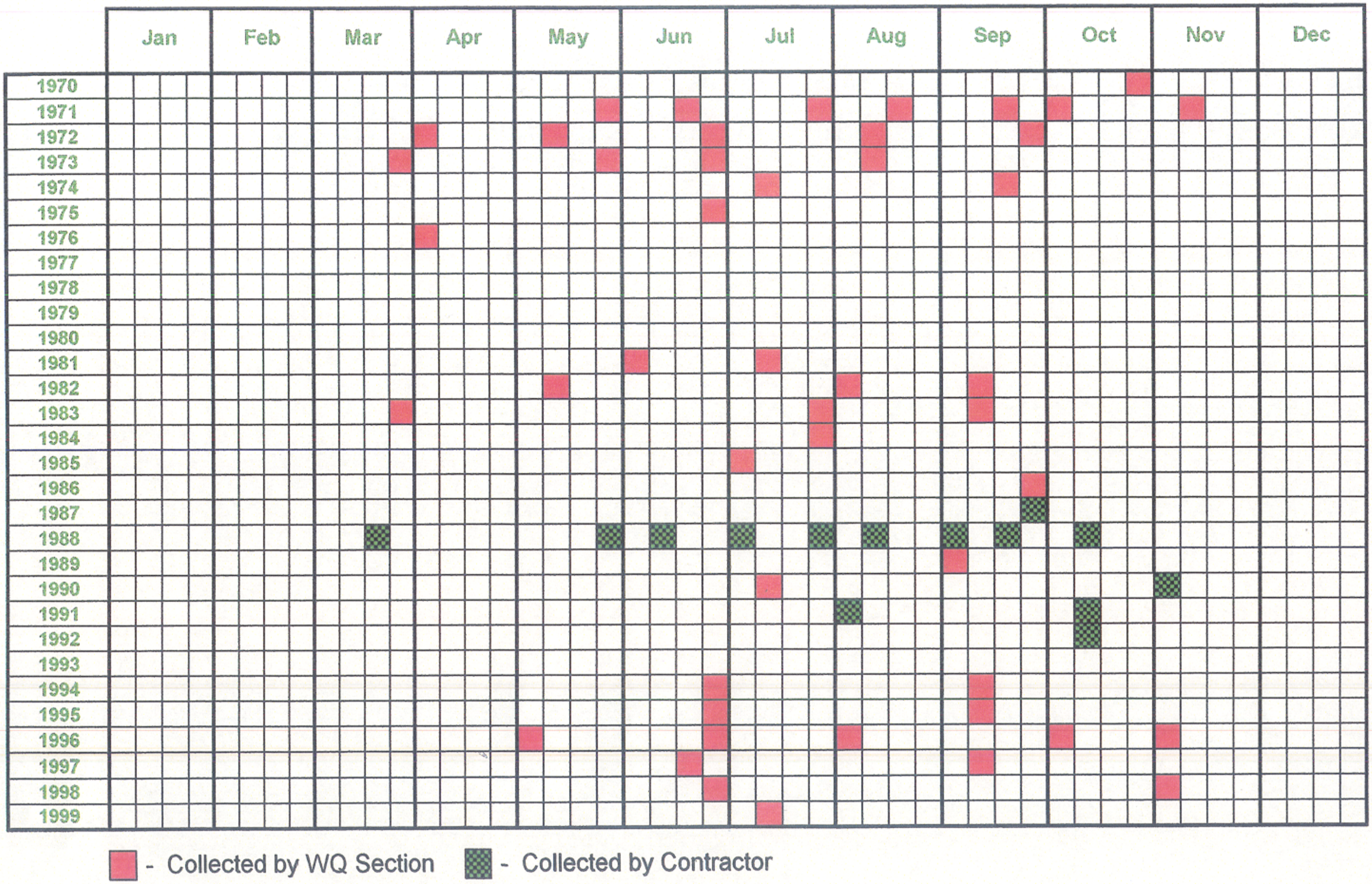
Great Falls Scroll Case Temperatures
Number of Measurements by TVA

CENGFTVA.xls

Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Annual
1970	4	4	5	5	4	4	4	5	5	4	5	4	53
1971	5	3	5	4	4	5	4	5	4	0	1	3	43
1972	5	4	3	5	5	4	3	4	3	5	5	4	50
1973	5	4	4	6	4	4	5	3	2	3	3	3	46
1974	4	5	3	6	5	4	6	5	4	4	4	5	55
1975	4	4	5	5	4	4	5	4	5	5	4	5	54
1976	3	4	5	5	3	5	4	0	3	4	4	5	45
1977	5	4	4	4	5	4	2	5	3	5	5	3	49
1978	5	4	4	4	5	4	3	5	4	2	2	3	45
1979	5	4	4	6	4	4	4	4	2	4	4	4	49
1980	4	4	5	3	4	3	2	2	2	0	3	3	35
1981	4	4	5	4	4	5	4	4	3	2	3	5	47
1982	4	4	5	4	3	3	1	3	3	4	3	4	41
1983	6	3	4	4	6	4	2	1	2	5	4	3	44
1984	5	4	2	4	4	3	1	0	0	2	2	1	28
1985	1	1	1	1	1	2	1	2	1	2	1	0	14
1986	0	0	0	0	0	0	1	0	0	0	0	0	1
1987	1	1	1	1	0	2	1	1	0	0	0	0	8
1988	0	0	1	0	0	0	0	0	0	0	0	0	1
1989	0	0	1	1	1	2	2	3	2	2	1	1	16

Center Hill - Lake Sampling Trips

Cenlocal.xls



APPENDIX H

Printouts of CE-QUAL-W2 Control Files for the Calibrated Models

Center Hill Lake CE-QUAL-W2 Control File

```
TITLE C ..............................TITLE..................................
        Center Hill Lake, March 15 through November 5, 1973 (CRL) 02/01/01
        Water quality simulation w/ version 2.05.1
        Density placed inflows, point sink outflows, DLTMAX=1800, DLTF=0.5
        Default hydrodynamic coefficient: AX=1, DX=1, CHEZY=70, CBHE=7.0e-8
        01/31/01 with revised ML & FW TDS


TIME CON  TMSTRT   TMEND    YEAR
           74.49  310.51    1973

DLT CON      NDT  DLTMIN
               1     1.0

DLT DATE    DLTD
            74.5

DLT MAX   DLTMAX
          1800.0

DLT FRN     DLTF
            0.50

BRANCH G      US      DS     UHS     DHS
Br 1           2      39       0       0           Caney Fork River
Br 2          42      43       0      13           Pine Creek
Br 3          46      47       0      17           Fall Creek
Br 4          50      51       0      21           Davies Island Loop
Br 5          54      60       0      22           Falling Water River
Br 6          63      65       0      27           Mine Lick Creek
Br 7          68      69       0      31           Little Hurricane Creek Bend
Br 8          72      73       0      34           Holmes Creek
Br 9          76      77       0      36           Indian Creek

LOCATION     LAT    LONG   DATUM
            36.1    85.8   144.3

INIT CND     T2I  ICETHI  WTYPEC
             -1.     0.0   FRESH

CALCULAT     VBC     MBC     PQC    PQTC     EVC     PRC
              ON      ON      ON      ON     OFF     OFF

INTERPOL   INFIC    TRIC   DTRIC    HDIC  QOUTIC    WDIC   METIC
              ON      ON      ON      ON      ON      ON      ON

DEAD SEA   WINDC    QINC   QOUTC   HEATC
              ON      ON      ON      ON

ICE COVER   ICEC   SLICE  SLHEAT  ALBEDO     HWI   BETAI  GAMMAI  ICEMIN   ICET2
             OFF  DETAIL    TERM    0.25    10.0     0.6    0.07    0.05     3.0

TRANSPORT  SLTRC   THETA   DZMAX
        QUICKEST    0.00    -999

WSC NUMB    NWSC WSC_MIN WSC_MAX
               1    -999    -999

WSC DATE    WSCD    WSCD
            74.5

WSC COEF     WSC     WSC
            0.65

WIND FUNC    WFC
             1.0

HYD COEF      AX      DX   CHEZY    CBHE    TSED   FW_A0   FW_A1   FW_A2  SRMULT
             1.0     1.0    70.0  7.0E-8    15.0    -999    -999    -999    -999
```

SEL WITH	SWC	SWC	SWC	SWC	SWC	SWC	SWC	SWC	SWC
	ON	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF

N STRUC	NSTR	NSTR	NSTR	NSTR	NSTR	NSTR	NSTR	NSTR	NSTR
	3	0	0	0	0	0	0	0	0

K LIMIT	KLSW	KLSW	KLSW	KLSW	KLSW	KLSW	KLSW	KLSW	KLSW
Br 1	49	63	63						
Br 2									
Br 3									
Br 4									
Br 5									
Br 6									
Br 7									
Br 8									
Br 9									

SINK TYPE	SINK	SINK	SINK	SINK	SINK	SINK	SINK	SINK	SINK
Br 1	POINT	LINE	POINT						
Br 2									
Br 3									
Br 4									
Br 5									
Br 6									
Br 7									
Br 8									
Br 9									

E STRUC	MAIN	LEVL8	LEVL7	LEVL6	LEVL5	LEVL4	LEVL3	LEVL2	LEVL1
Br 1	169.5	197.6	152.1						
Br 2									
Br 3									
Br 4									
Br 5									
Br 6									
Br 7									
Br 8									
Br 9									

W STRUC	WSTR	WSTR	WSTR	WSTR	WSTR	WSTR	WSTR	WSTR	WSTR
Br 1	0.00	143.3	0.00						
Br 2									
Br 3									
Br 4									
Br 5									
Br 6									
Br 7									
Br 8									
Br 9									

N OUTLET	NOUT	NOUT	NOUT	NOUT	NOUT
	0	0	0	0	0

O LAYER	KOUT
Br 1	0
Br 2	0
Br 3	0
Br 4	0
Br 5	0
Br 6	0
Br 7	0
Br 8	0
Br 9	0

N WDRWAL	NWD
	0

W SEGMNT	CMP	COL1	COL2	COL3	COL4	COL5	COL6	COL7
	0	0	0	0	0	0	0	0

```
W LAYER      KWD     KWD     KWD     KWD     KWD     KWD     KWD     KWD

N TRIBS      NTR MXSGDTR                                 Dist. tribs and Branches only
               0    -999

TRIB SEG     ITR     ITR
               0

DST TRIB    DTRC    DTRC    DTRC    DTRC    DTRC    DTRC    DTRC    DTRC    DTRC
              ON     OFF     OFF     OFF     OFF     OFF     OFF     OFF     OFF

SCR PRINT   SCRC    NSCR
             OFF       1

SCR DATE    SCRD
            74.5

SCR FREQ    SCRF
             1.0

SNAPSHOT    FORM    UPRN    WPRN    TPRN   DTPRN  RHOPRN   AZPRN   DZPRN
            LONG      ON      ON      ON     OFF     OFF     OFF     OFF

SHRT SEG   IPRSF   IPRSF   IPRSF   IPRSF   IPRSF   IPRSF   IPRSF   IPRSF   IPRSF
               2       9      21      25      28      31      34      38      42
              46      59

LONG SEG   IPRLF   IPRLF   IPRLF   IPRLF   IPRLF   IPRLF   IPRLF   IPRLF   IPRLF
               2       5       9      12      17      21      25      28      35
              39      42      46      54      57      60      63      65

SNP PRINT   SNPC    NSNP
              ON      14

SNP DATE    SNPD    SNPD    SNPD    SNPD    SNPD    SNPD    SNPD    SNPD    SNPD
            74.5    75.5    76.5    77.5    78.5    88.5   150.5   177.5   183.5
           190.5   192.5   193.5   195.5   226.5   310.5

SNP FREQ    SNPF    SNPF    SNPF    SNPF    SNPF    SNPF    SNPF    SNPF    SNPF
           999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0   999.0
           999.0   999.0   999.0   999.0   999.0   999.0

PRF PLOT    PRFC    NPRF    NPRS  PRSTYL
              ON       6      13     FTN

PRF DATE    PRFD    PRFD    PRFD    PRFD    PRFD    PRFD    PRFD    PRFD    PRFD
            74.5    88.5   150.5   177.5   226.5   310.5

PRF FREQ    PRFF    PRFF    PRFF    PRFF    PRFF    PRFF    PRFF    PRFF    PRFF
           999.0   999.0   999.0   999.0   999.0   999.0

PRF SEG     IPRF    IPRF    IPRF    IPRF    IPRF    IPRF    IPRF    IPRF    IPRF
               8      14      46      17      23      55      43      65      39
              35      30      73      77

SPR PLOT    SPRC    NSPR   NIPRF
             OFF       1       1

SPR DATE    SPRD
            74.5

SPR FREQ    SPRF
           999.0

SPR SEG     ISPR
              25

TSR PLOT    TSRC    NTSR  TSSTYL
              ON       1     FTN
```

```
TSR DATE     TSRD
             74.5

TSR FREQ     TSRF
              1.0

VPL PLOT     VPLC    NVPL  VPSTYL
              OFF       1

VPL DATE     VPLD
             74.5

VPL FREQ     VPLF
            999.0

CPL PLOT     CPLC    NCPL  CPSTYL
              OFF       1

CPL DATE     CPLD
             74.5

CPL FREQ     CPLF
            999.0

APGM OUT     APLC
               ON                        on/off switch for APGM output

AGPM OUT2    APLD   APLFD   APLFH
             74.5     1.0     0.0         start date = APLD, frequency = APLFD + APLFH/24

RESTART      RSOC    NRSO    RSIC
              OFF       0     OFF

RSO DATE     RSOD
            999.0

RSO FREQ     RSOF
            999.0

CST COMP      CCC    LIMC     SDC  FREQUK
               ON      ON     OFF      10

CST ACT       ACC     ACC     ACC     ACC     ACC     ACC     ACC     ACC     ACC
               ON      ON     OFF      ON      ON      ON      ON      ON      ON Names: TRACER  TSSMGL  COLFRM  TDSMGL
LABDOM  REFDOM  SILICA  DETRIT  PHOSPH
               ON      ON      ON     OFF     OFF     OFF     OFF     OFF     OFF         NH3NH4  NO2NO3  DISSOX  SEDMNT
TICARB  ALKALI  PHxxxx  CO2xxx  HCO3xx
              OFF     OFF     OFF      ON      ON      ON                                 CO3xxx  IRONxx  CBODxx  DIATOM
GREENS  BLUEGR

CST ICON      CIC     CIC     CIC     CIC     CIC     CIC     CIC     CIC     CIC
              0.0    16.5     0.0    62.4     0.1    0.16     2.0     0.5    0.02
             0.15    0.37    10.0     0.0     0.0     0.0     0.0     0.0     0.0
              0.0     0.0     0.0     -1.     -1.     -1.

CST PRNT     CPRN    CPRN    CPRN    CPRN    CPRN    CPRN    CPRN    CPRN    CPRN
               ON      ON     OFF      ON      ON      ON      ON      ON      ON
               ON      ON      ON     OFF     OFF     OFF     OFF     OFF     OFF
              OFF     OFF     OFF      ON      ON      ON

CIN CON     INACC   INACC   INACC   INACC   INACC   INACC   INACC   INACC   INACC
               ON      ON     OFF      ON      ON      ON      ON      ON      ON
               ON      ON      ON     OFF     OFF     OFF     OFF     OFF     OFF
              OFF     OFF     OFF      ON      ON      ON

CTR CON     TRACC   TRACC   TRACC   TRACC   TRACC   TRACC   TRACC   TRACC   TRACC
              OFF     OFF     OFF     OFF     OFF     OFF     OFF     OFF     OFF
              OFF     OFF     OFF     OFF     OFF     OFF     OFF     OFF     OFF
              OFF     OFF     OFF     OFF     OFF     OFF

CDT CON     DTACC   DTACC   DTACC   DTACC   DTACC   DTACC   DTACC   DTACC   DTACC
```

	ON	ON	OFF	ON	ON	ON	ON	ON	ON	
	ON	ON	ON	OFF	OFF	OFF	OFF	OFF	OFF	
	OFF	OFF	OFF	ON	ON	ON				
CPR CON	PRACC	PRACC	PRACC	PRACC	PRACC	PRACC	PRACC	PRACC	PRACC	
	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	
	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	
	OFF	OFF	OFF	OFF	OFF	OFF				
EX COEF	EXH2O	EXINOR	EXORG	BETA	ALGLIT					
	0.45	0.09	0.11	0.48	-99.0					
COLIFORM	COLQ10	COLDK	COLKL	CSETL	CKSEG					Not simulating coliforms
	1.04	0.50	0.005	0.29	999.0					
S SOLIDS	SSETL									
	0.4									
ALGAE	AGROW	AMORT	AEXCR	ARESP	ASETL	AHSP	AHSN	AHSSI	ASATUR	
Diatoms	1.20	0.03	0.00	0.07	0.35	0.012	0.06	0.1	125.0	
Greens	0.95	0.03	0.00	0.05	0.15	0.010	0.06	0.0	120.0	
Cyanobac	1.00	0.03	0.00	0.04	0.08	0.015	0.10	0.0	135.0	
ALG STOI	ABIOP	ABION	ABIOSI	ABIOC						
Diatoms	0.004	0.067	0.0	0.5						
Greens	0.004	0.067	0.0	0.5						
Cyanobac	0.004	0.067	0.0	0.5						
ALG RATE	AGT1	AGT2	AGT3	AGT4	AGK1	AGK2	AGK3	AGK4		
Diatoms	5.0	12.0	22.0	35.0	0.1	0.98	0.98	0.1		
Greens	5.0	10.0	25.0	30.0	0.1	0.98	0.98	0.1		
Cyanobac	10.0	25.0	38.0	42.0	0.1	0.98	0.98	0.1		
DISS ORG	LABDK	LRFDK	REFDK							
	0.30	0.001	0.001							
DETRITUS	DETDK	DSETL	ALGDET							
	0.060	0.05	0.80							
ORG RATE	OMT1	OMT2	OMK1	OMK2						
	4.0	20.0	0.1	0.98						
SEDIMENT	SEDDK	FSOD	(SEDDK set for 1st order NH3 & PO4 release from sed)							
	0.06	1.0								
S DEMAND	SOD	SOD	SOD	SOD	SOD	SOD	SOD	SOD	SOD	
	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.76	
	0.77	0.78	0.79	0.80	0.80	0.80	0.80	0.80	0.80	
	0.80	0.80	0.80	0.80	0.80	0.80	0.79	0.79	0.79	
	0.78	0.78	0.78	0.77	0.77	0.76	0.76	0.75	0.75	
	0.60	0.55	0.50	0.50	2.75	2.75	3.75	3.75	3.80	
	3.80	3.80	3.80	1.50	1.50	1.50	1.50	1.90	1.90	
	1.95	1.95	2.00	2.40	2.40	2.40	2.40	2.40	2.40	
	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	
	5.00	5.00	3.00	3.00	5.00	5.00				
CBOD	KBOD	TBOD	RBOD							
	0.05	1.05	2.00							
PHOSPHOR	PO4REL	PARTP								
	0.007	0.1								
AMMONIA	NH3REL	NH3DK	PARTN							
	0.035	0.013	0.01							
NH3 RATE	NH3T1	NH3T2	NH3K1	NH3K2						
	0.1	20.0	0.1	0.98						
NITRATE	NO3DK	DNPRN								
	0.10	OFF								

NO3 RATE	NO3T1	NO3T2	NO3K1	NO3K2				
	5.0	20.0	0.1	0.98				
SILICA	SIREL							
	0.01							
SED CO2	CO2REL							
	0.1							
IRON	FEREL	FESETL						
	0.4	0.0						
STOICHMT	O2NH3	O2ORG	O2RESP	O2ALG	BIOP	BION	BIOSI	BIOC
	3.43	1.4	1.2	1.4	0.004	0.067	0.0	0.1
O2 LIMIT	O2LIM							
	0.2							

BTH FILE...............................BTHFN....................................
p:\projects\1150-040\txtfiles\73test2.prn

VPR FILE...............................VPRFN....................................
p:\projects\1150-040\txtfiles\vpr7302.prn

LPR FILE...............................LPRFN....................................
lpr.npt - not used

RSI FILE...............................RSIFN....................................
rsi.npt - not used

MET FILE...............................METFN....................................
p:\projects\1150-040\txtfiles\1973met2.prn

QWD FILE...............................QWDFN....................................
qwd.npt - not used

QIN FILE...............................QINFN....................................
Br 1 p:\projects\1150-040\txtfiles\gf1973.prn
Br 2 p:\projects\1150-040\txtfiles\73q_pc01.prn
Br 3 p:\projects\1150-040\txtfiles\73q_fc01.prn
Br 4 p:\projects\1150-040\txtfiles\73q_dv01.prn
Br 5 p:\projects\1150-040\txtfiles\73q_fw01.prn
Br 6 p:\projects\1150-040\txtfiles\73q_ml01.prn
Br 7 p:\projects\1150-040\txtfiles\73q_lh02.prn
Br 8 p:\projects\1150-040\txtfiles\73q_hc02.prn
Br 9 p:\projects\1150-040\txtfiles\73q_ic02.prn

TIN FILE...............................TINFN....................................
Br 1 p:\projects\1150-040\txtfiles\73t_cf03.prn
Br 2 p:\projects\1150-040\txtfiles\73t_pc01.prn
Br 3 p:\projects\1150-040\txtfiles\73t_fc01.prn
Br 4 p:\projects\1150-040\txtfiles\73t_dv01.prn
Br 5 p:\projects\1150-040\txtfiles\73t_fw02.prn
Br 6 p:\projects\1150-040\txtfiles\73t_ml01.prn
Br 7 p:\projects\1150-040\txtfiles\73t_lh02.prn
Br 8 p:\projects\1150-040\txtfiles\73t_hc02.prn
Br 9 p:\projects\1150-040\txtfiles\73t_ic02.prn

CIN FILE...............................CINFN....................................
Br 1 p:\projects\1150-040\wqin\73c_cf07.prn
Br 2 p:\projects\1150-040\wqin\73c_pc08.prn
Br 3 p:\projects\1150-040\wqin\73c_fc08.prn
Br 4 p:\projects\1150-040\txtfiles\73c_dv01.prn
Br 5 p:\projects\1150-040\wqin\73c_fw07.prn
Br 6 p:\projects\1150-040\wqin\73c_ml10.prn
Br 7 p:\projects\1150-040\txtfiles\73c_lh09.prn
Br 8 p:\projects\1150-040\txtfiles\73c_hc07.prn
Br 9 p:\projects\1150-040\txtfiles\73c_ic07.prn

QOT FILE...............................QOTFN....................................
Br 1 p:\projects\1150-040\txtfiles\outfl73.prn

Br 2 not used
Br 3 not used
Br 4 not used
Br 5 not used
Br 6 not used
Br 7 not used
Br 8 not used
Br 9 not used

QTR FILE................................QTRFN....................................
Tr 1 not used

TTR FILE................................TTRFN....................................
Tr 1 not used

CTR FILE................................CTRFN....................................
Tr 1 not used

QDT FILE................................QDTFN....................................
Br 1 p:\projects\1150-040\txtfiles\73q_dt02.prn
Br 2 not used
Br 3 not used
Br 4 not used
Br 5 not used
Br 6 not used
Br 7 not used
Br 8 not used
Br 9 not used

TDT FILE................................TDTFN....................................
Br 1 p:\projects\1150-040\txtfiles\73tpc01a.prn
Br 2 not used
Br 3 not used
Br 4 not used
Br 5 not used
Br 6 not used
Br 7 not used
Br 8 not used
Br 9 not used

CDT FILE................................CDTFN....................................
Br 1 p:\projects\1150-040\wqin\73c_dt07.prn
Br 2 not used
Br 3 not used
Br 4 not used
Br 5 not used
Br 6 not used
Br 7 not used
Br 8 not used
Br 9 not used

PRE FILE................................PREFN....................................
Br 1 pre_br1.npt - not used
Br 2 pre_br2.npt - not used
Br 3 pre_br3.npt - not used
Br 4 pre_br4.npt - not used
Br 5 pre_br5.npt- not used
Br 6 pre_br6.npt - not used
Br 7 pre_br7.npt - not used
Br 8 pre_br8.npt - not used
Br 9 pre_br9.npt - not used

TPR FILE................................TPRFN....................................
Br 1 tpr_br1.npt - not used
Br 2 tpr_br2.npt - not used
Br 3 tpr_br3.npt - not used
Br 4 tpr_br4.npt - not used
Br 5 tpr_br5.npt - not used
Br 6 tpr_br6.npt - not used
Br 7 tpr_br7.npt - not used
Br 8 tpr_br8.npt - not used

Br 9 tpr_br9.npt - not used

CPR FILE................................CPRFN.....................................
Br 1 cpr_br1.npt - not used
Br 2 cpr_br2.npt - not used
Br 3 cpr_br3.npt - not used
Br 4 cpr_br4.npt - not used
Br 5 cpr_br5.npt - not used
Br 6 cpr_br6.npt - not used
Br 7 cpr_br7.npt - not used
Br 8 cpr_br8.npt - not used
Br 9 cpr_br9.npt - not used

EUH FILE................................EUHFN.....................................
Br 1 euh_br1.npt - not used
Br 2 euh_br2.npt - not used
Br 3 euh_br3.npt - not used
Br 4 euh_br4.npt - not used
Br 5 euh_br5.npt - not used
Br 6 euh_br6.npt - not used
Br 7 euh_br7.npt - not used
Br 8 euh_br8.npt - not used
Br 9 euh_br9.npt - not used

TUH FILE................................TUHFN.....................................
Br 1 tuh_br1.npt - not used
Br 2 tuh_br2.npt - not used
Br 3 tuh_br3.npt - not used
Br 4 tuh_br4.npt - not used
Br 5 tuh_br5.npt - not used
Br 6 tuh_br6.npt - not used
Br 7 tuh_br7.npt - not used
Br 8 tuh_br8.npt - not used
Br 9 tuh_br9.npt - not used

CUH FILE................................CUHFN.....................................
Br 1 cuh_br1.npt - not used
Br 2 cuh_br2.npt - not used
Br 3 cuh_br3.npt - not used
Br 4 cuh_br4.npt - not used
Br 5 cuh_br5.npt - not used
Br 6 cuh_br6.npt - not used
Br 7 cuh_br7.npt - not used
Br 8 cuh_br8.npt - not used
Br 9 cuh_br9.npt - not used

EDH FILE................................EDHFN.....................................
Br 1 edh_br1.npt - not used
Br 2 edh_br2.npt - not used
Br 3 edh_br3.npt - not used
Br 4 edh_br4.npt - not used
Br 5 edh_br5.npt - not used
Br 6 edh_br6.npt - not used
Br 7 edh_br7.npt - not used
Br 8 edh_br8.npt - not used
Br 9 edh_br9.npt - not used

TDH FILE................................TDHFN.....................................
Br 1 tdh_br1.npt - not used
Br 2 tdh_br2.npt - not used
Br 3 tdh_br3.npt - not used
Br 4 tdh_br4.npt - not used
Br 5 tdh_br5.npt - not used
Br 6 tdh_br6.npt - not used
Br 7 tdh_br7.npt - not used
Br 8 tdh_br8.npt - not used
Br 9 tdh_br9.npt - not used

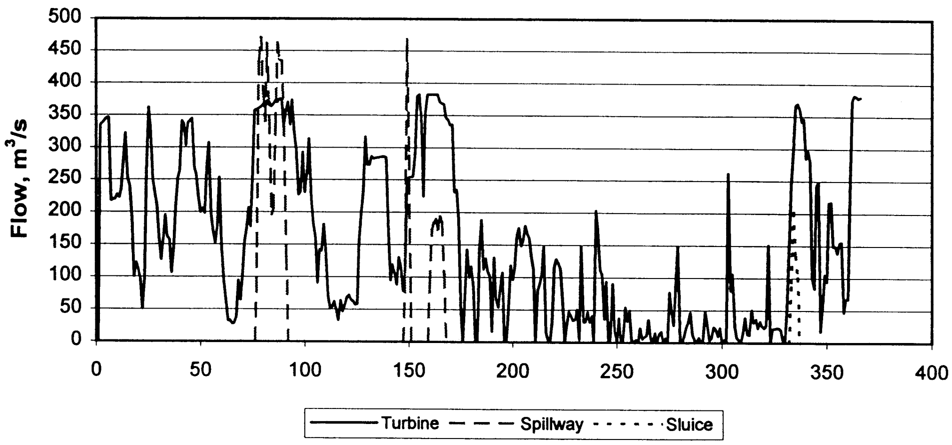
CDH FILE................................CDHFN.....................................
Br 1 tdh_br1.npt - not used
Br 2 tdh_br2.npt - not used

```
Br 3     tdh_br3.npt - not used
Br 4     tdh_br4.npt - not used
Br 5     tdh_br5.npt - not used
Br 6     tdh_br6.npt - not used
Br 7     tdh_br7.npt - not used
Br 8     tdh_br8.npt - not used
Br 9     tdh_br9.npt - not used

AGPM FILE..............................AGPMFN....................................
        73run.w2p

SNP FILE...............................SNPFN.....................................
        snp.opt

TSR FILE...............................TSRFN.....................................
        tsr.txt

PRF FILE...............................PRFFN.....................................
        prf.txt

VPL FILE...............................VPLFN.....................................
        vpl.opt

CPL FILE...............................CPLFN.....................................
        cpl.opt

SPR FILE...............................SPRFN.....................................
        spr.opt
```

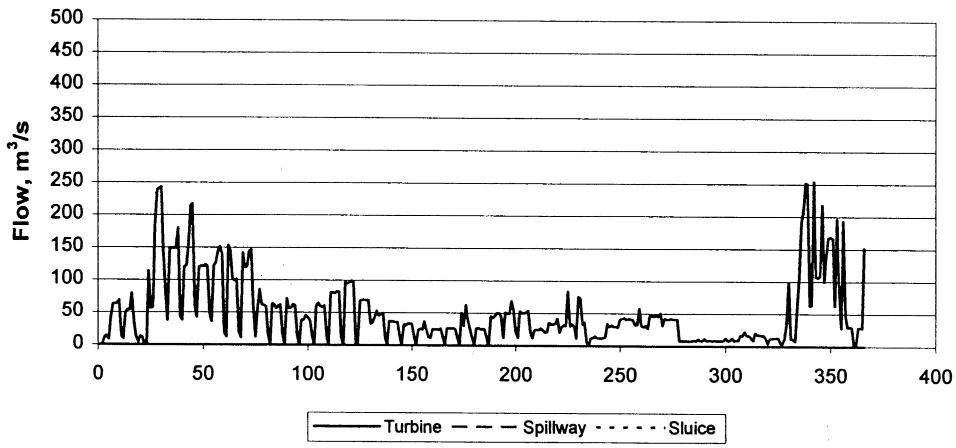
APPENDIX I

Plots of Outflows and Inflows for Center Hill Lake CE-QUAL-W2

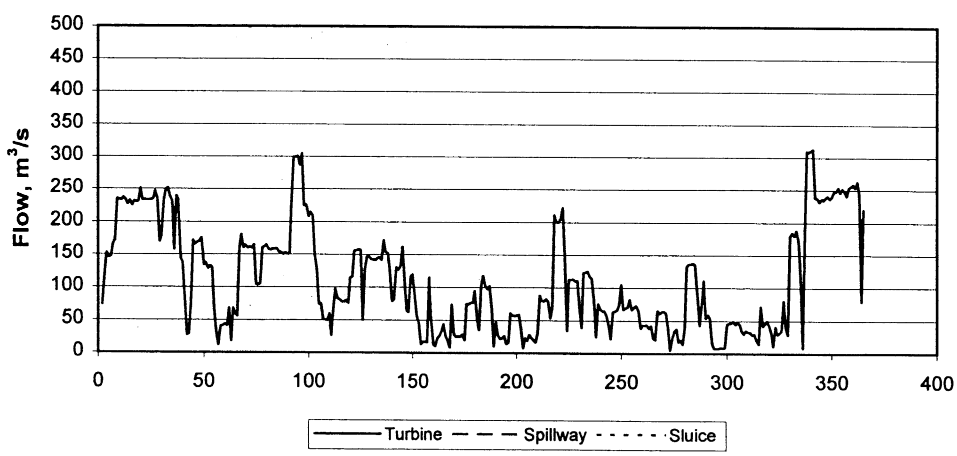
1973 Center Hill Outflow



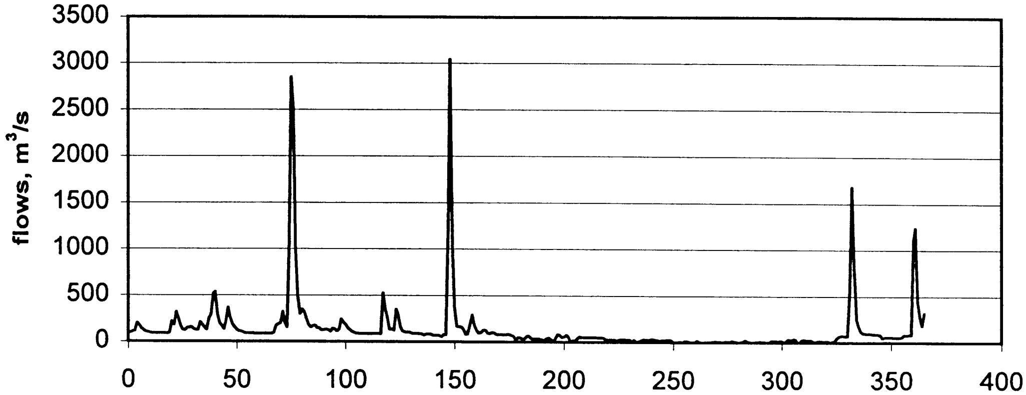
1988 Center Hill Outflow



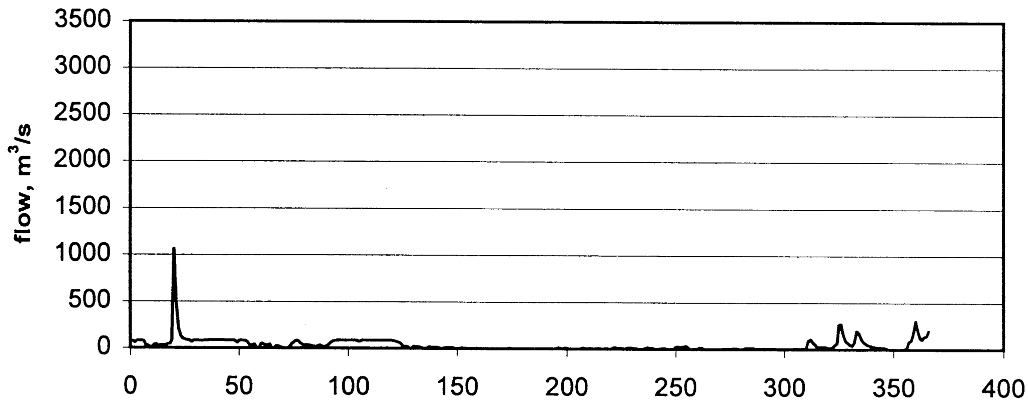
1996 Center Hill Outflow



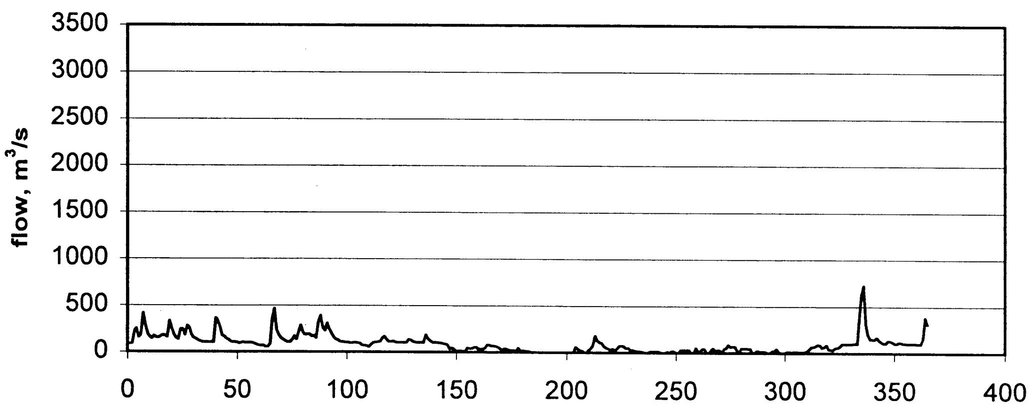
1973 Caney Fork River (Great Falls Dam Releases)



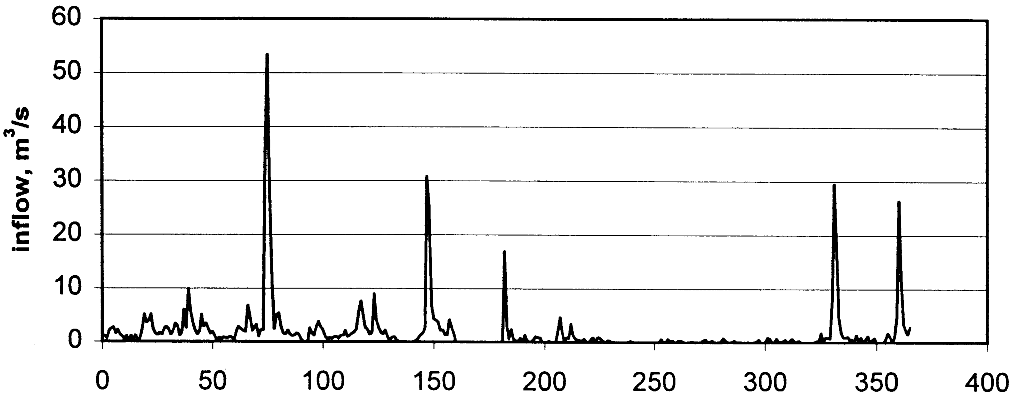
1988 Caney Fork River (Great Falls Dam Releases)



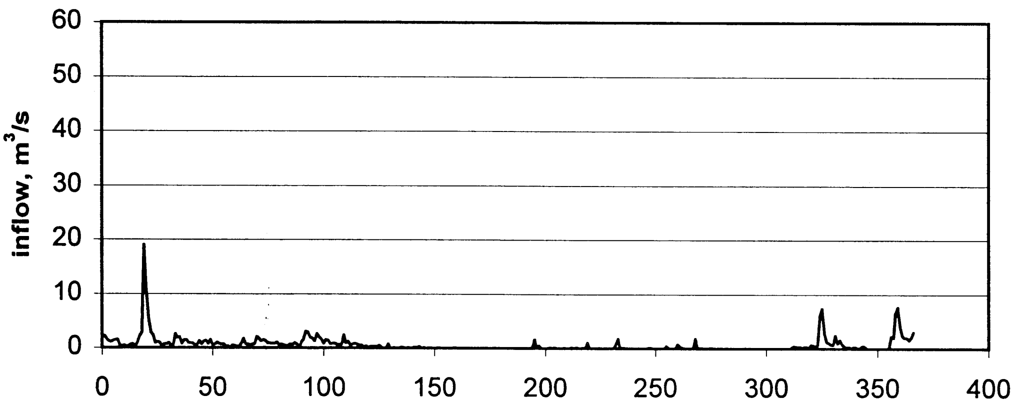
1996 Caney Fork River (Great Falls Dam Releases)



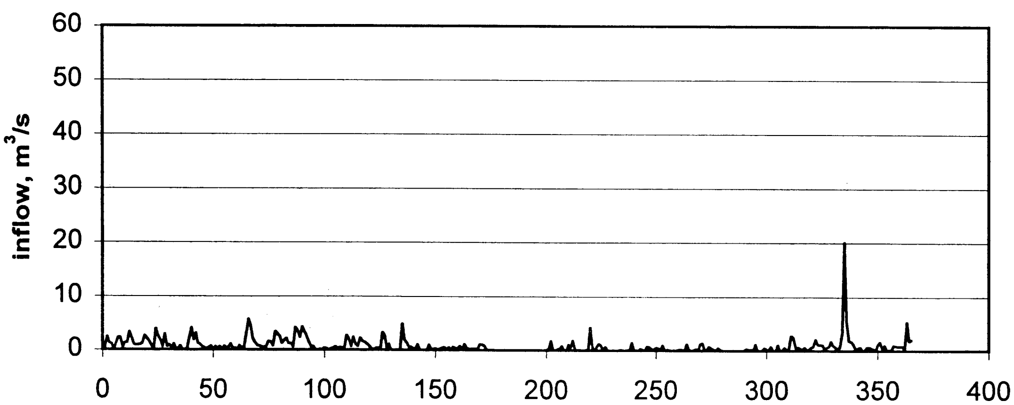
1973 Pine Creek



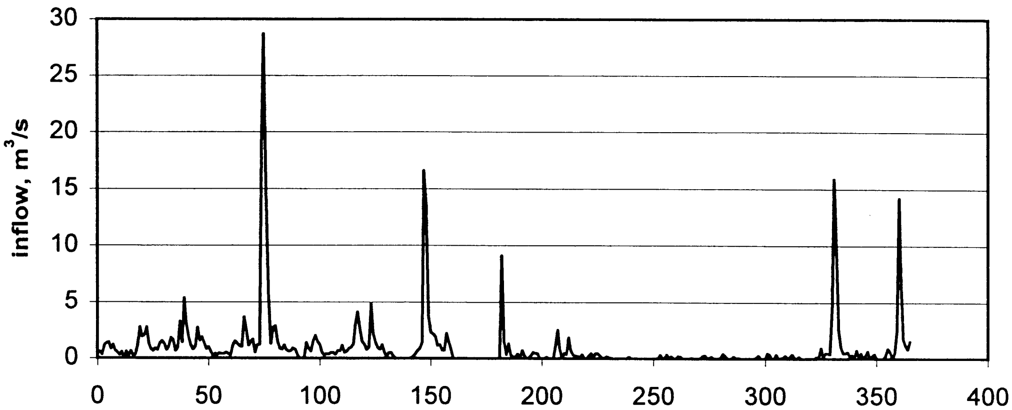
1988 Pine Creek



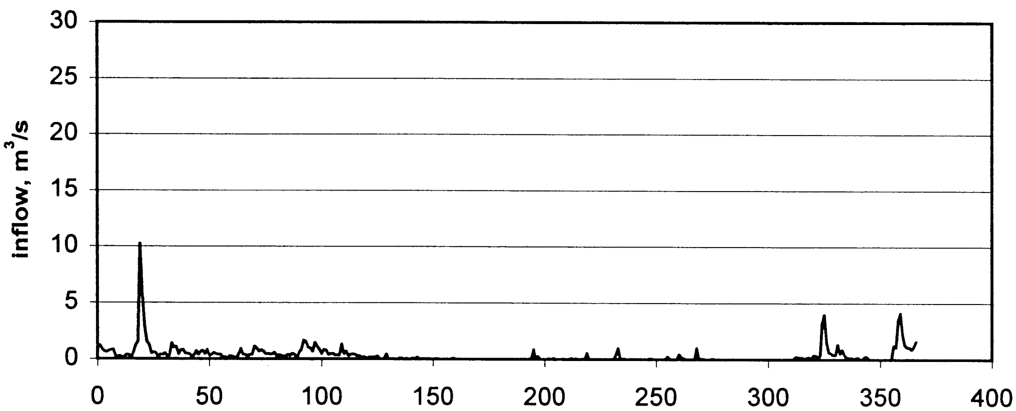
1996 Pine Creek



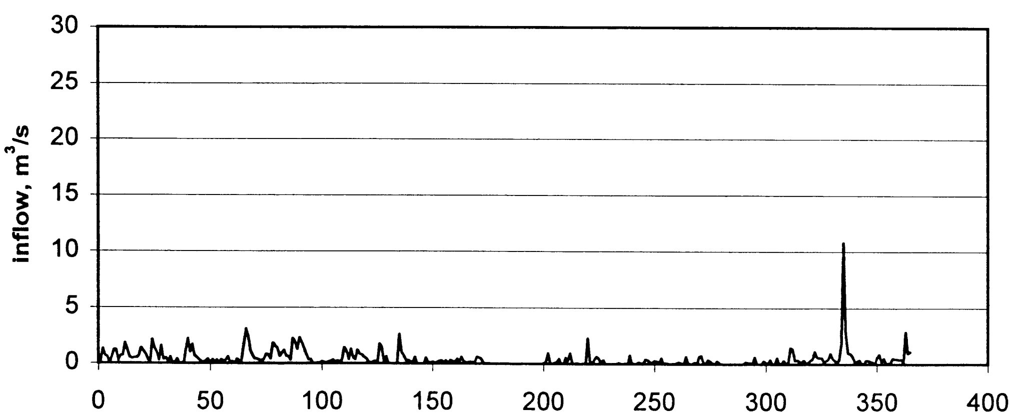
1973 Fall Creek



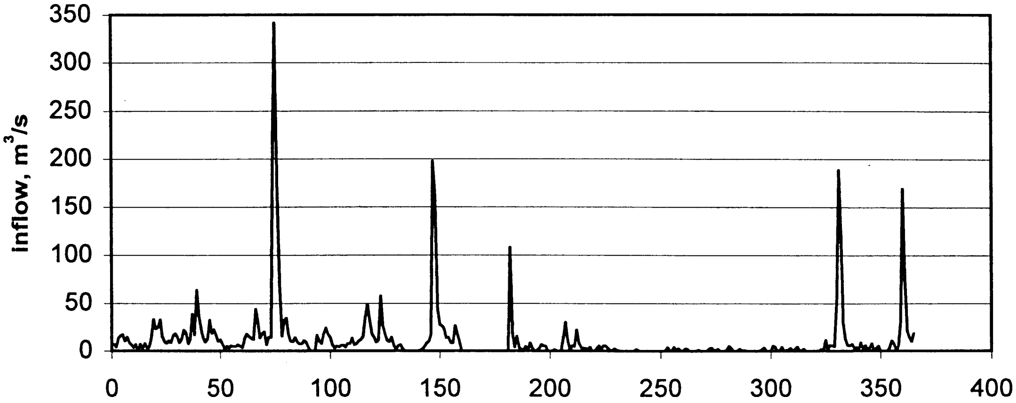
1988 Fall Creek



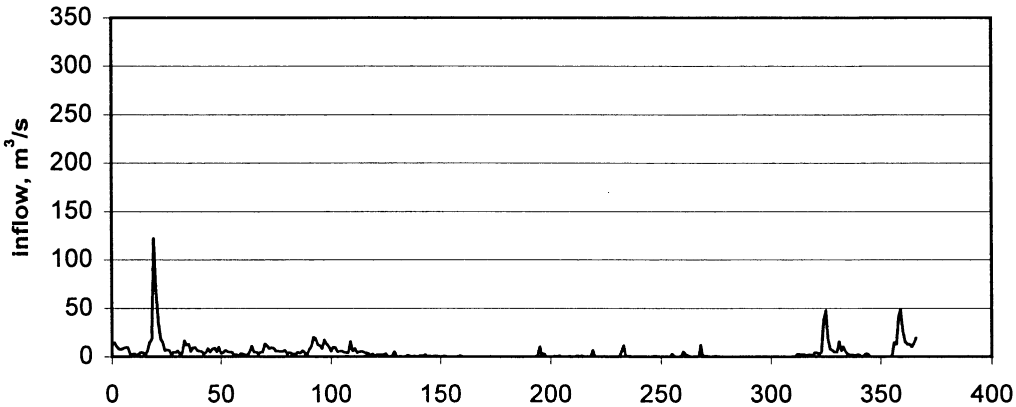
1996 Fall Creek



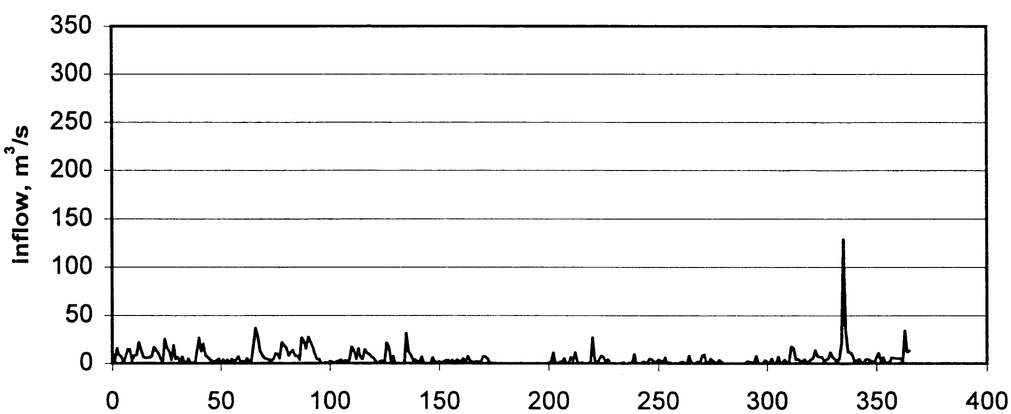
1973 Falling Water River



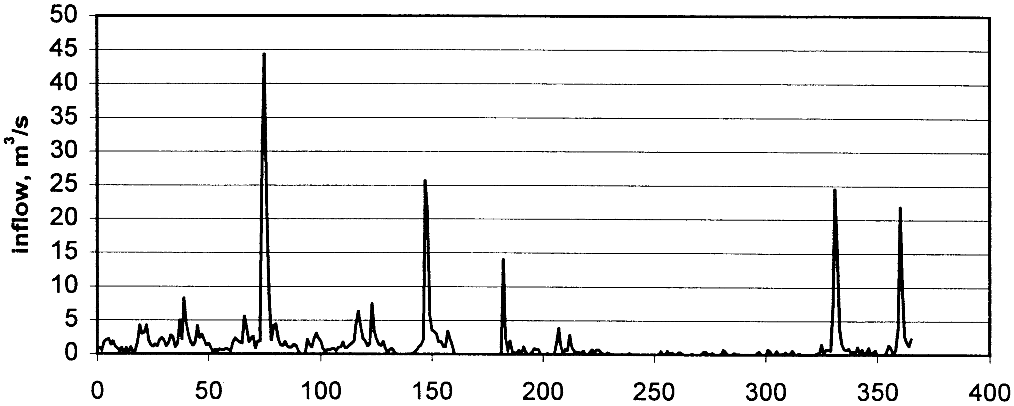
1988 Falling Water River



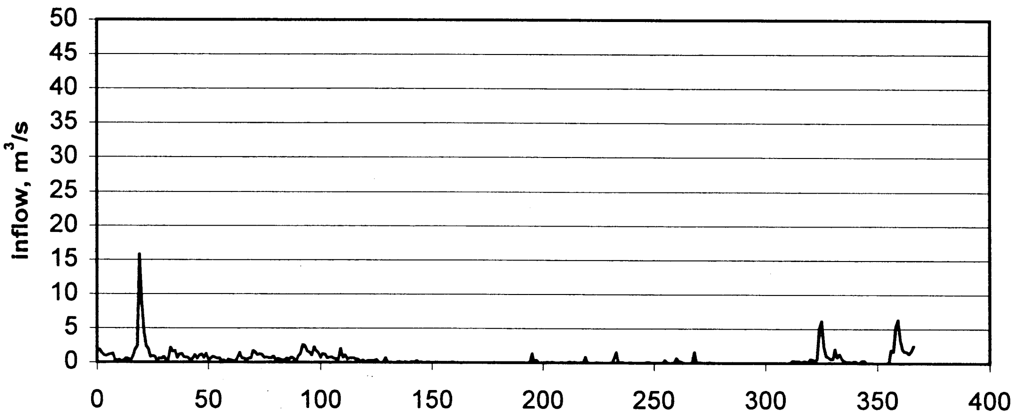
1996 Falling Water River



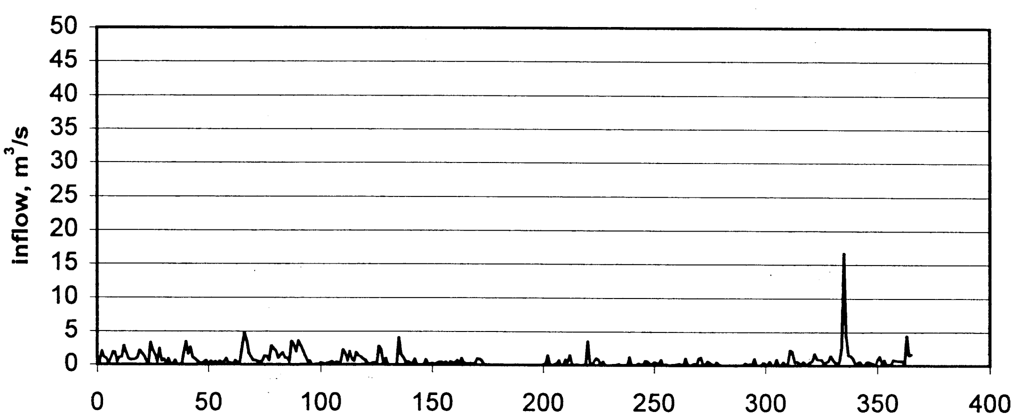
1973 Mine Lick Creek

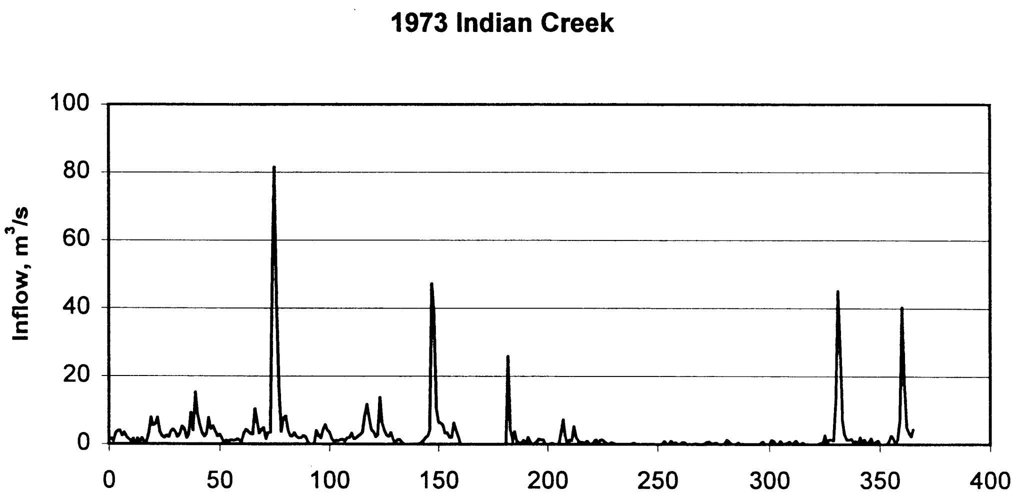


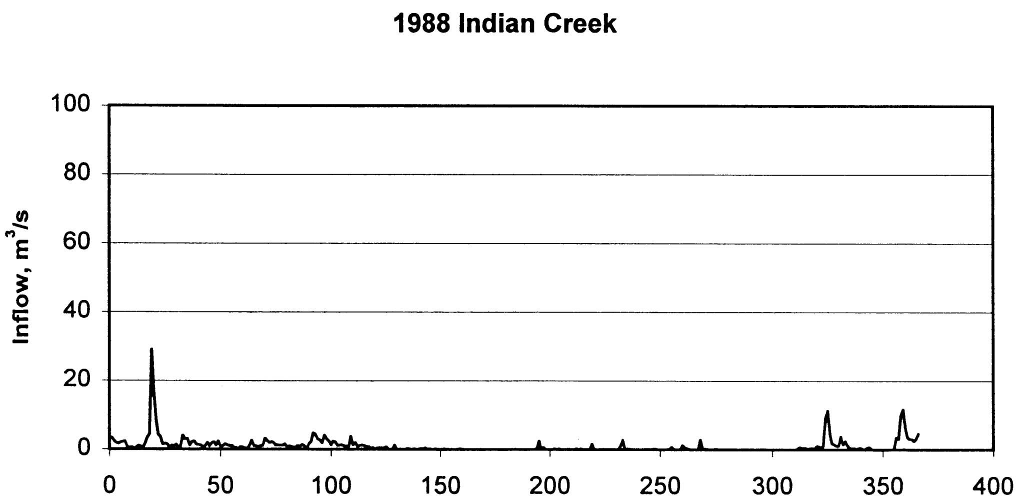
1988 Mine Lick Creek

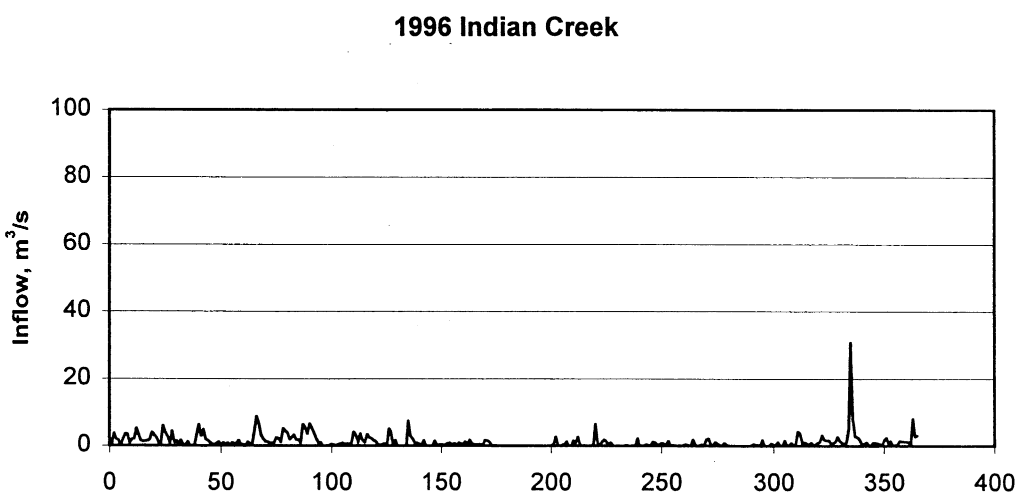


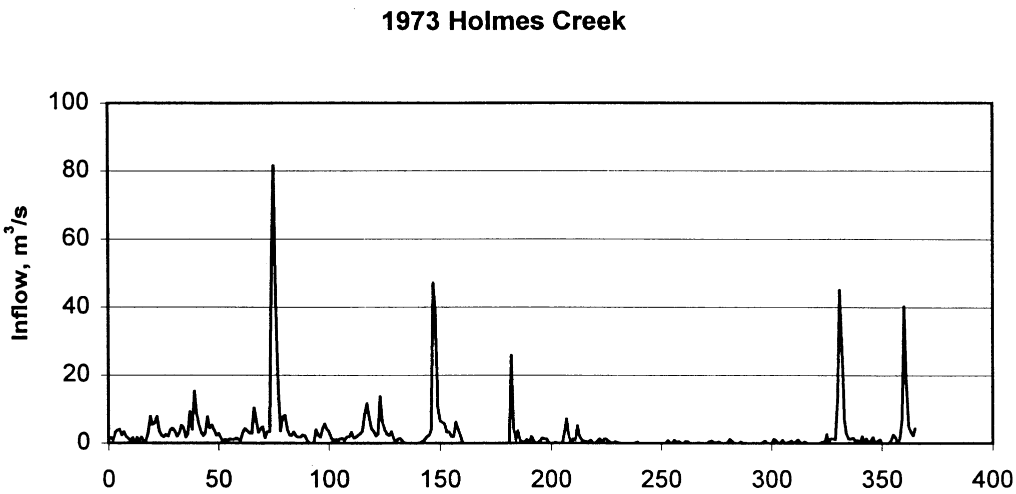
1996 Mine Lick Creek

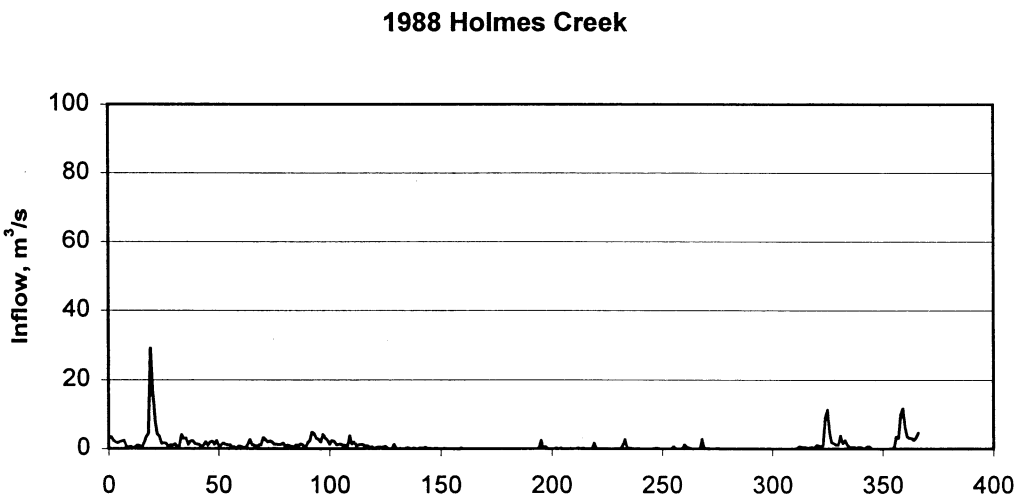


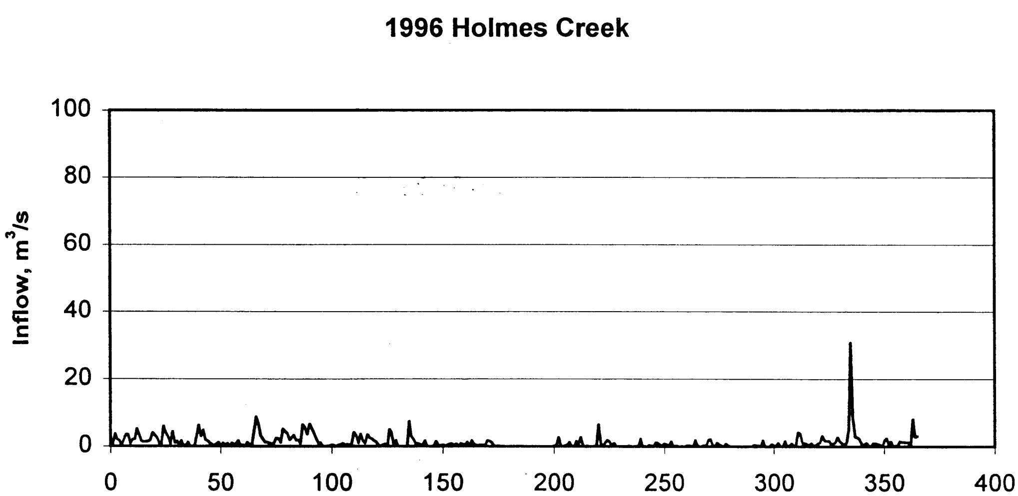

1973 Indian Creek
100
80
60
40
20
0
Inflow, m³/s
0
50
100
150
200
250
300
350
400


1988 Indian Creek
100
80
60
40
20
0
Inflow, m³/s
0
50
100
150
200
250
300
350
400

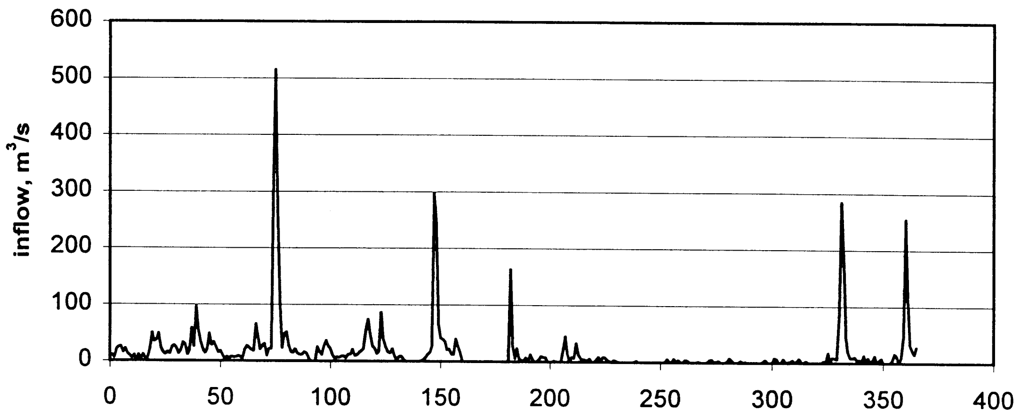

1996 Indian Creek
100
80
60
40
20
0
Inflow, m³/s
0
50
100
150
200
250
300
350
400


1973 Holmes Creek
Inflow, m3/s
0
20
40
60
80
100
0
50
100
150
200
250
300
350
400

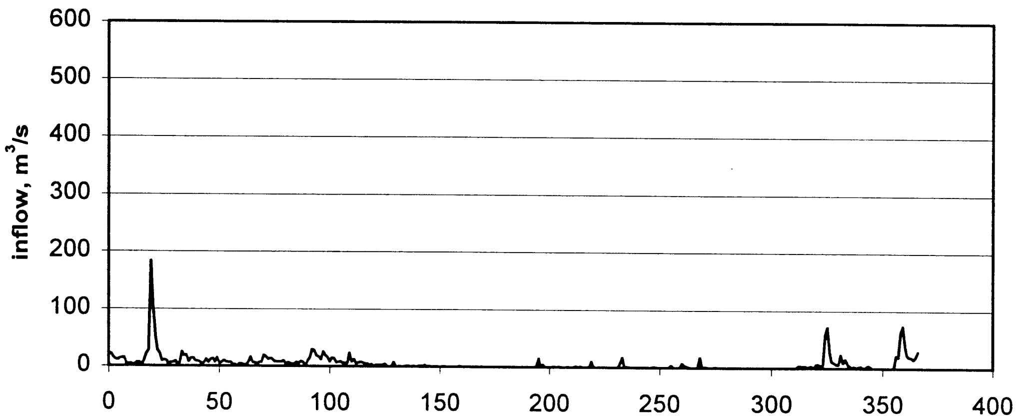

1988 Holmes Creek
Inflow, m3/s
0
20
40
60
80
100
0
50
100
150
200
250
300
350
400


1996 Holmes Creek
Inflow, m3/s
0
20
40
60
80
100
0
50
100
150
200
250
300
350
400

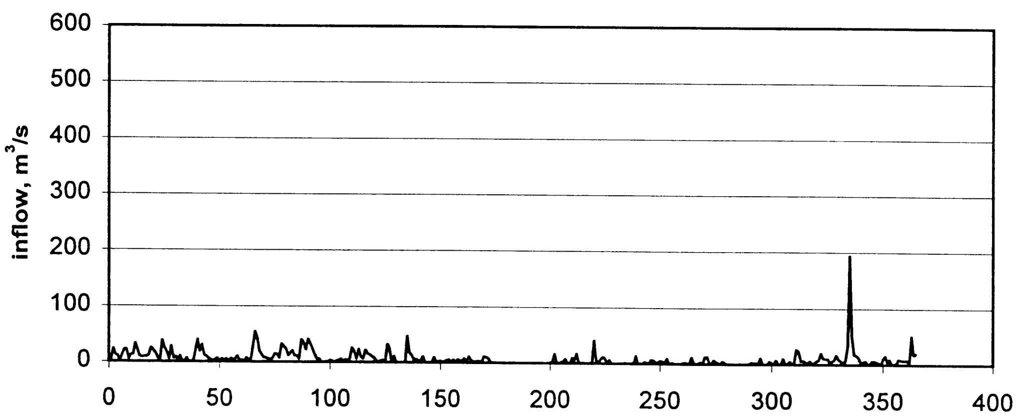
1973 Distributed Tributary



1988 Distributed Tributary



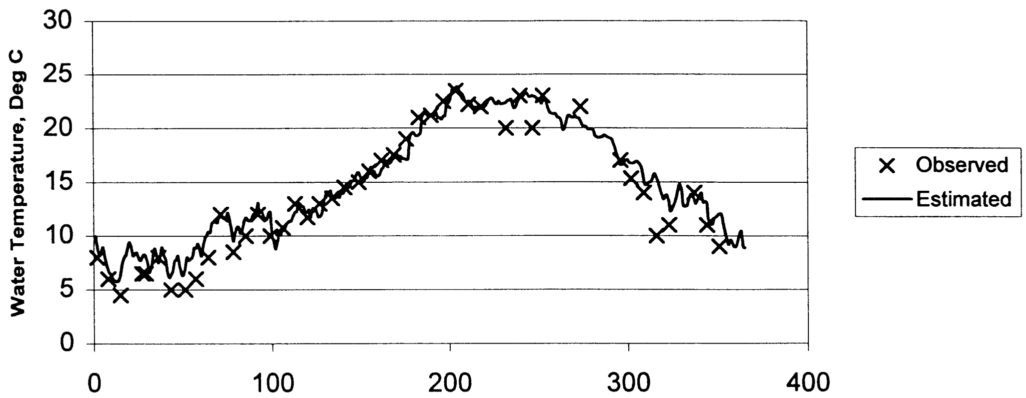
1996 Distributed Tributary



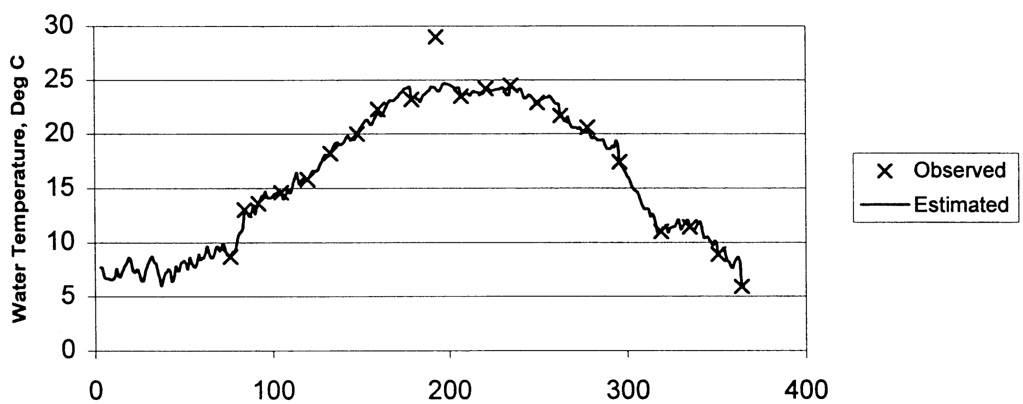
APPENDIX J

Plots of Estimated Water Temperature Inputs for Center Hill Lake CE-QUAL-W2 Model

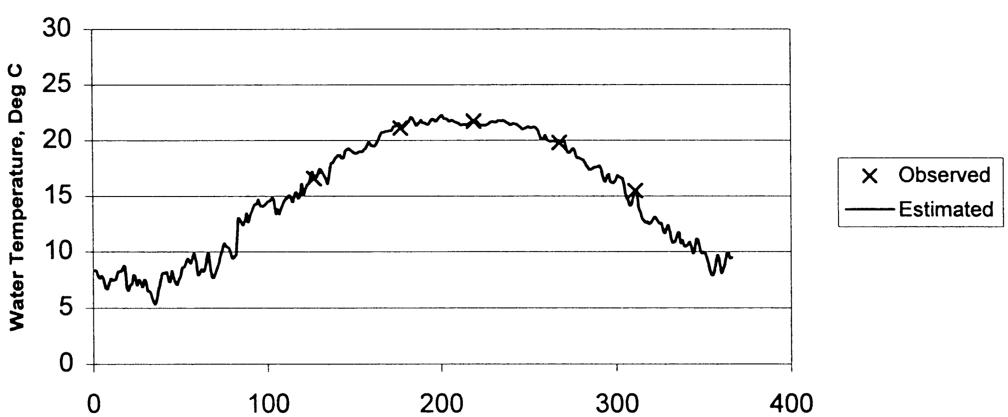
1973 Caney Fork River (Great Falls)

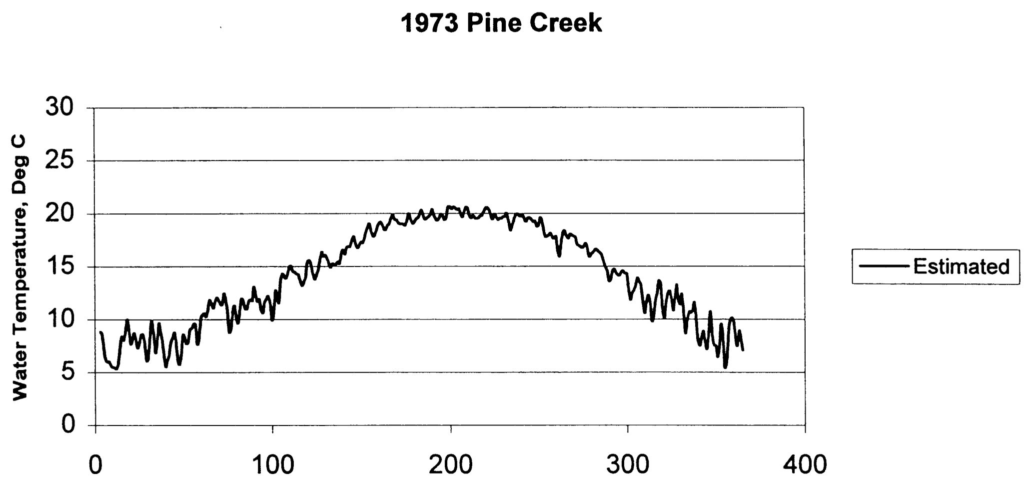


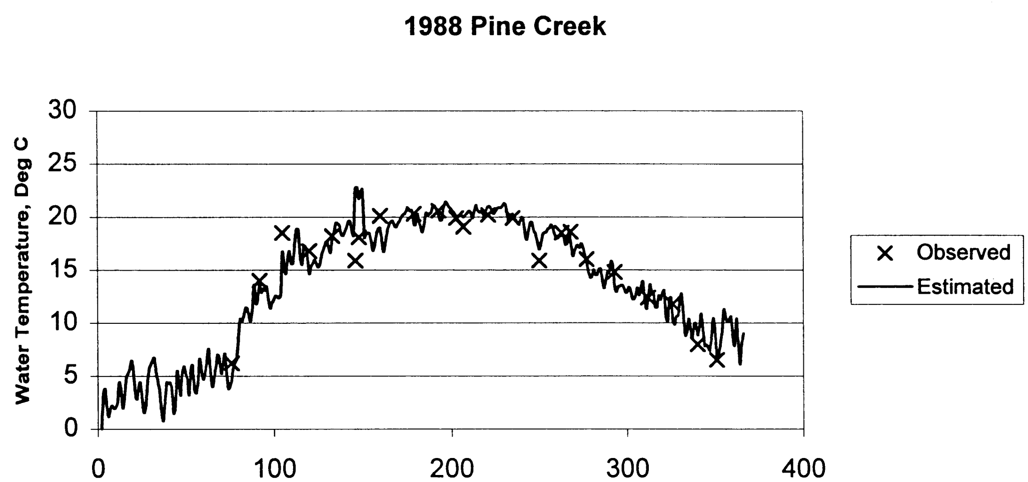
1988 Caney Fork River (Great Falls)

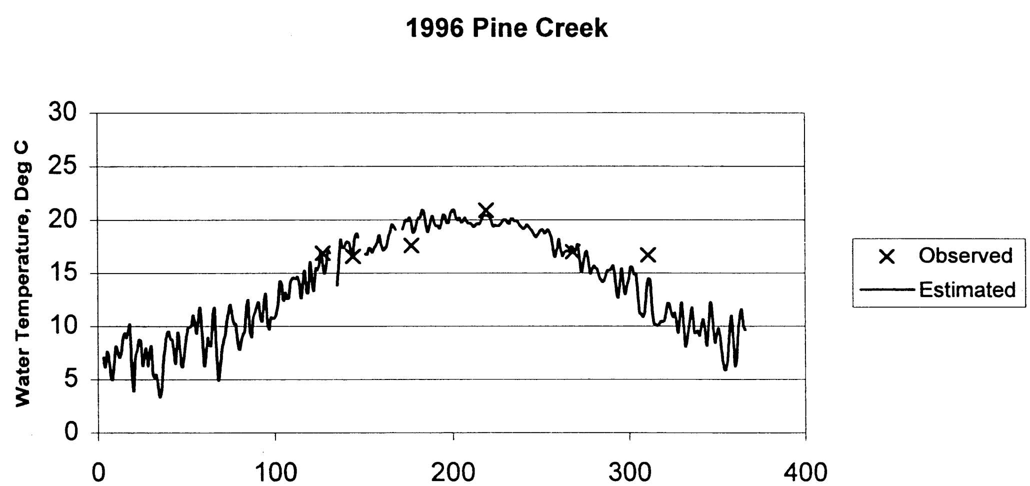


1996 Caney Fork River (Great Falls)

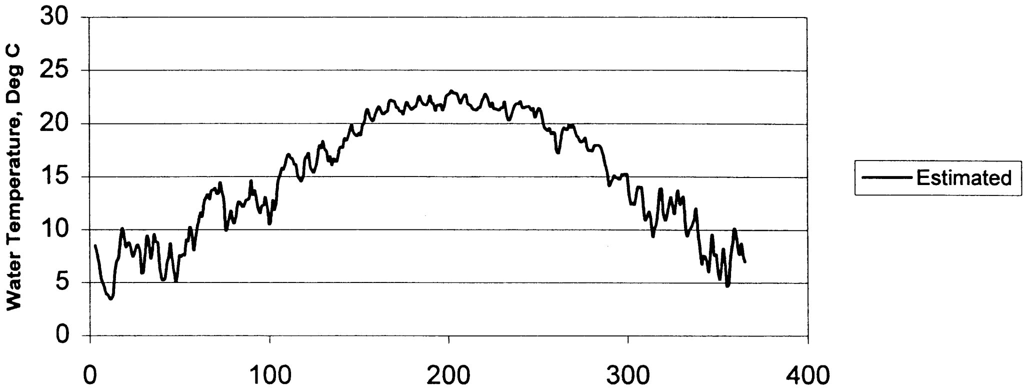



1973 Pine Creek
Water Temperature, Deg C
30
25
20
15
10
5
0
0
100
200
300
400
Estimated

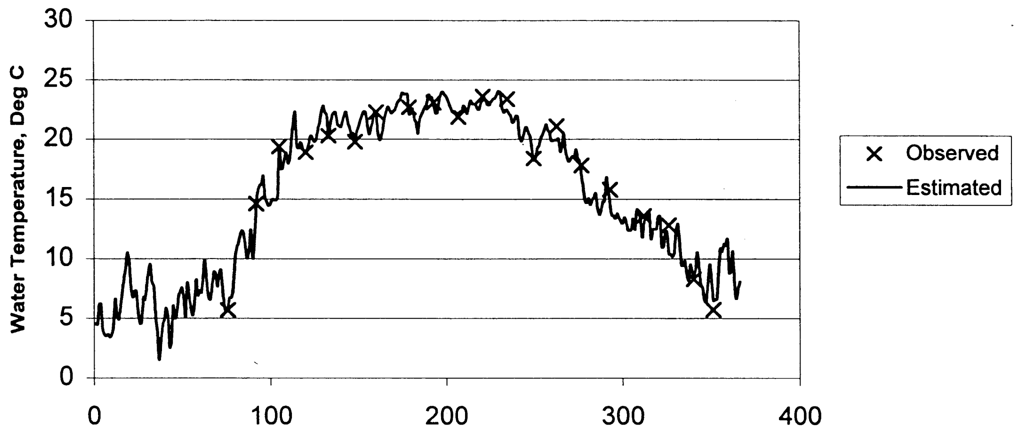

1988 Pine Creek
Water Temperature, Deg C
30
25
20
15
10
5
0
0
100
200
300
400
Observed
Estimated


1996 Pine Creek
Water Temperature, Deg C
30
25
20
15
10
5
0
0
100
200
300
400
Observed
Estimated

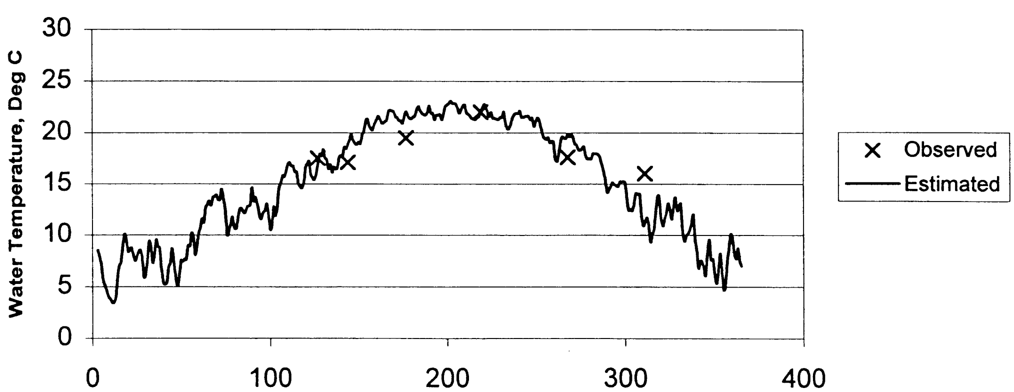
1973 Fall Creek



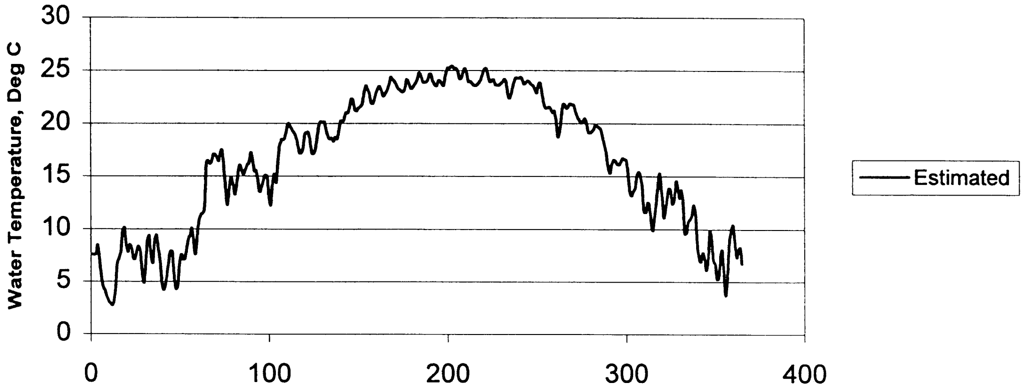
1988 Fall Creek



1996 Fall Creek

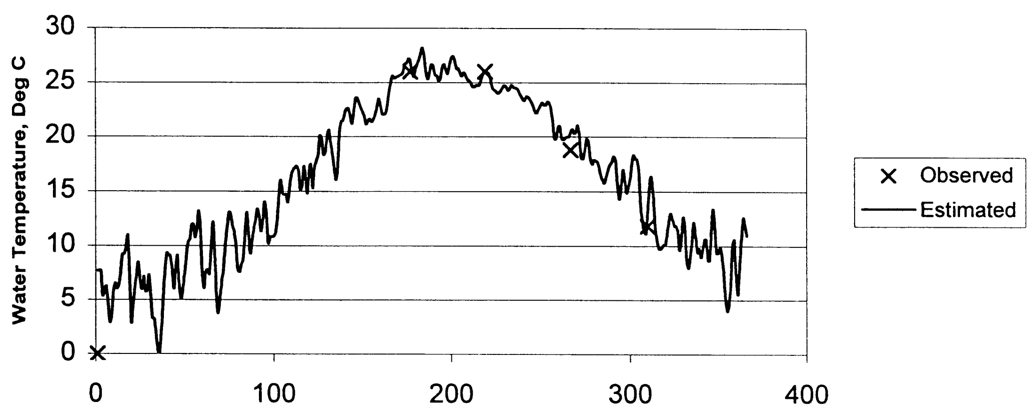


1973 Falling Water River

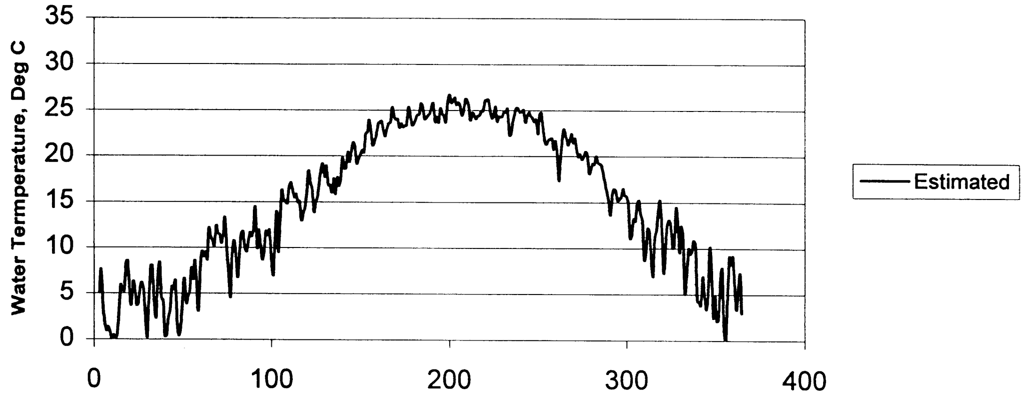


1988 Falling Water River

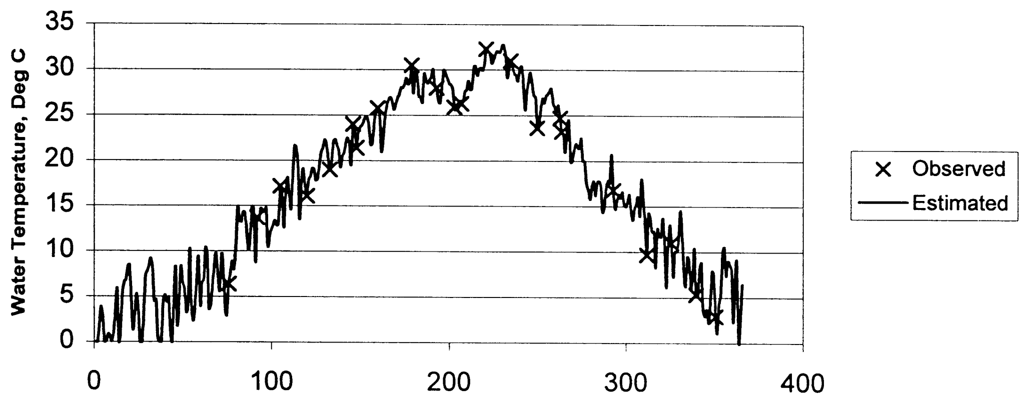
1996 Falling Water River



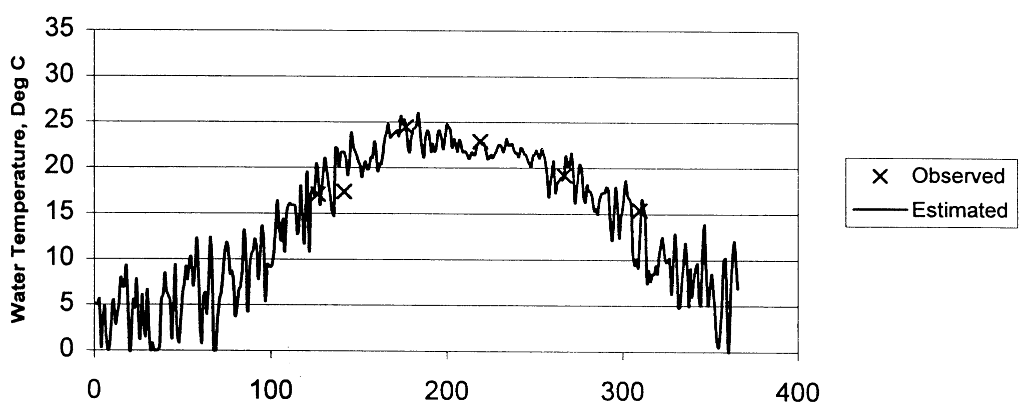
1973 Mine Lick Creek



1988 Mine Lick Creek



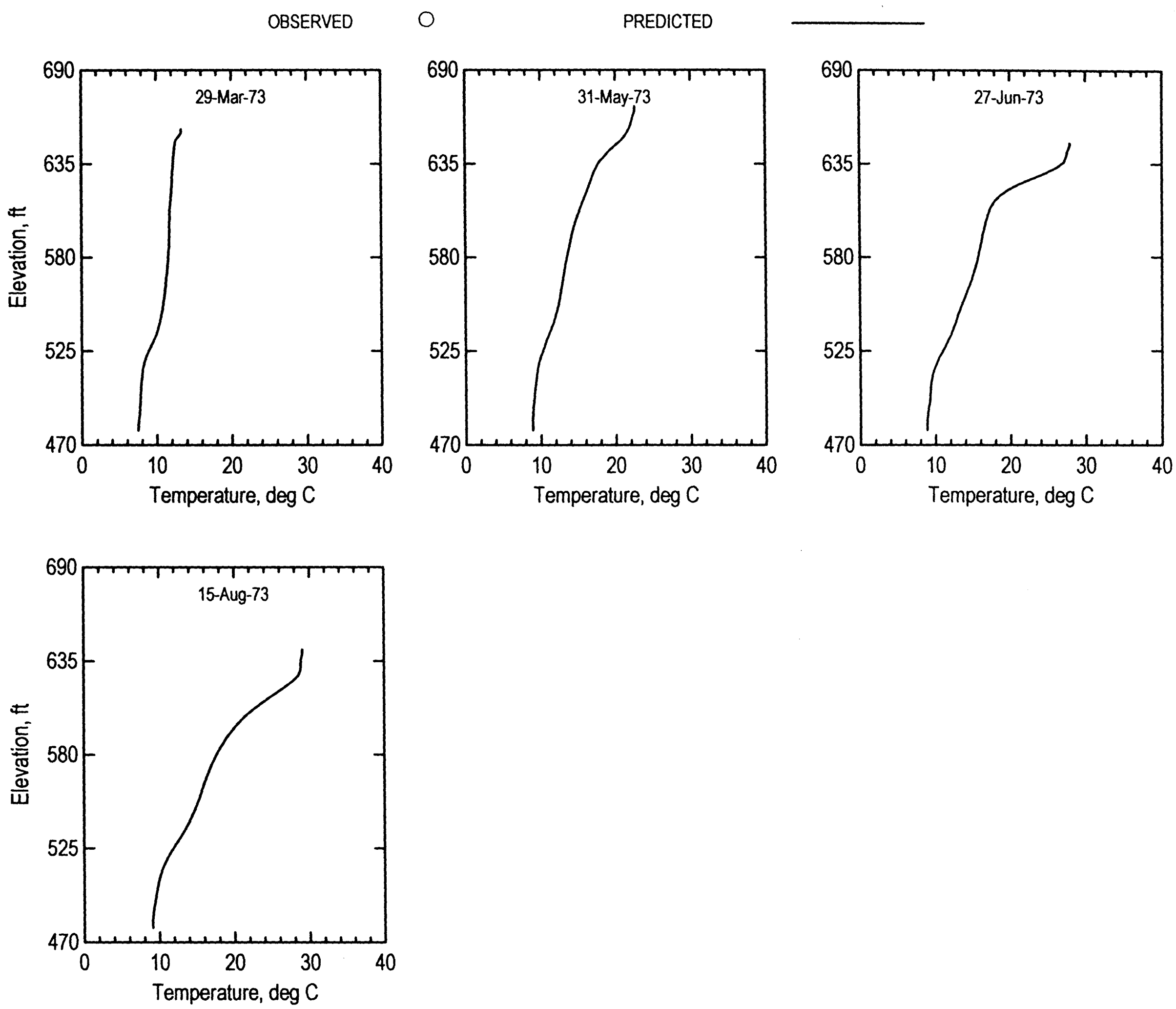
1996 Mine Lick Creek

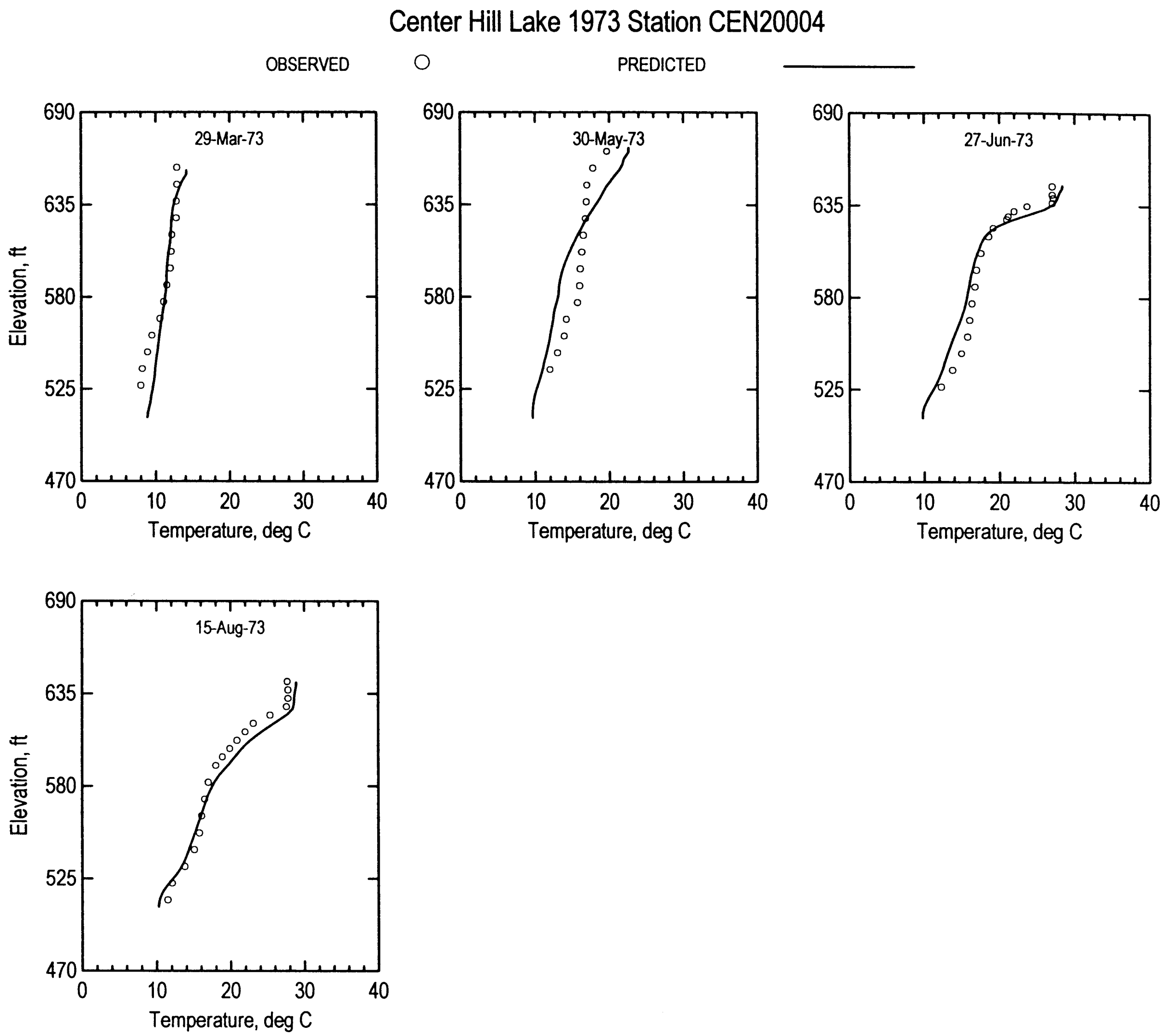


APPENDIX K

Comparison of Measured and Modeled Temperature Profiles at Center Hill Lake Water Quality Monitoring Stations

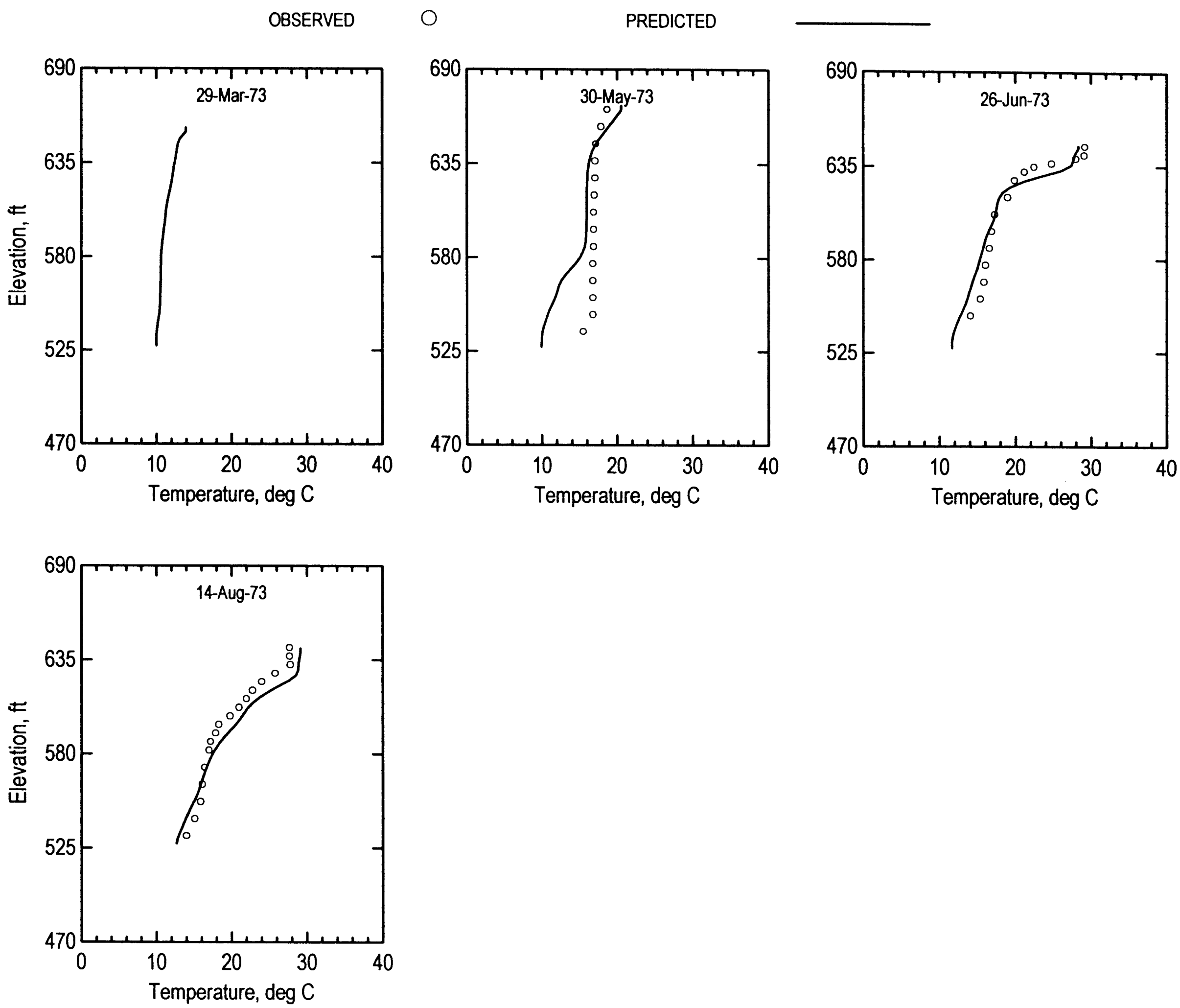
Center Hill Lake 1973 Station CEN20003

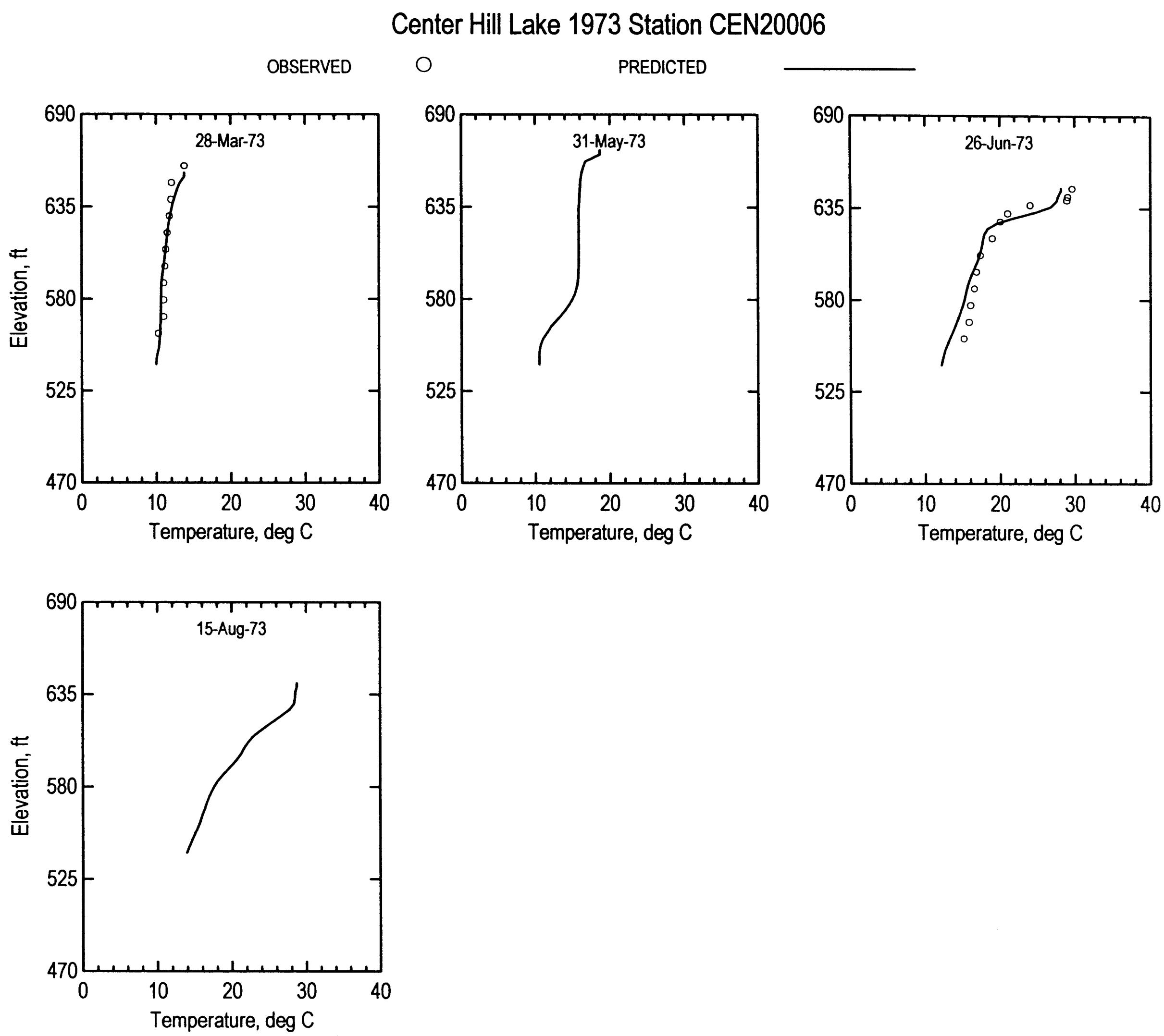




Center Hill Lake 1973 Station CEN20004
OBSERVED
PREDICTED
29-Mar-73
30-May-73
27-Jun-73
15-Aug-73
Elevation, ft
Temperature, deg C
690
635
580
525
470
0
10
20
30
40

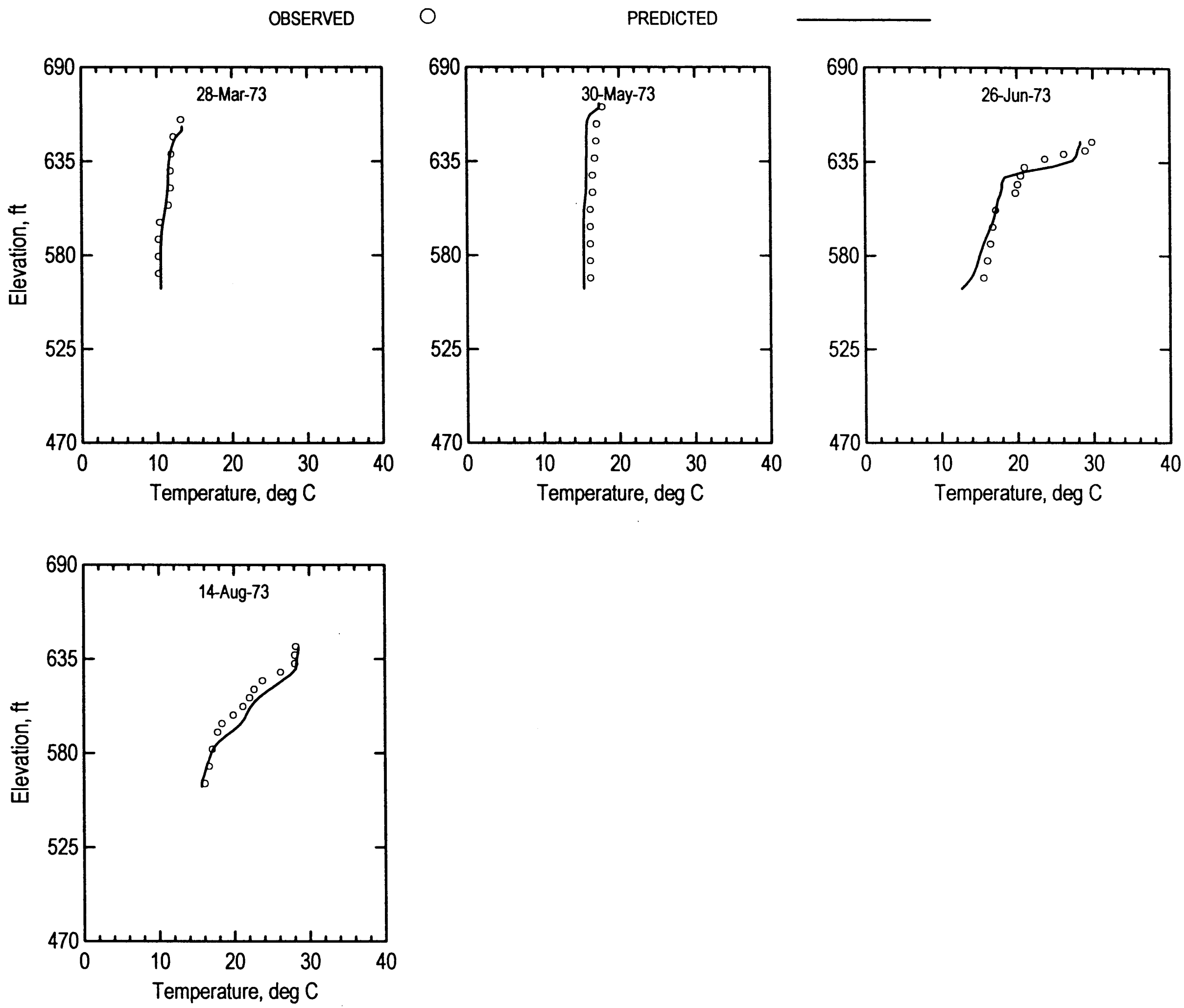
Center Hill Lake 1973 Station CEN20005

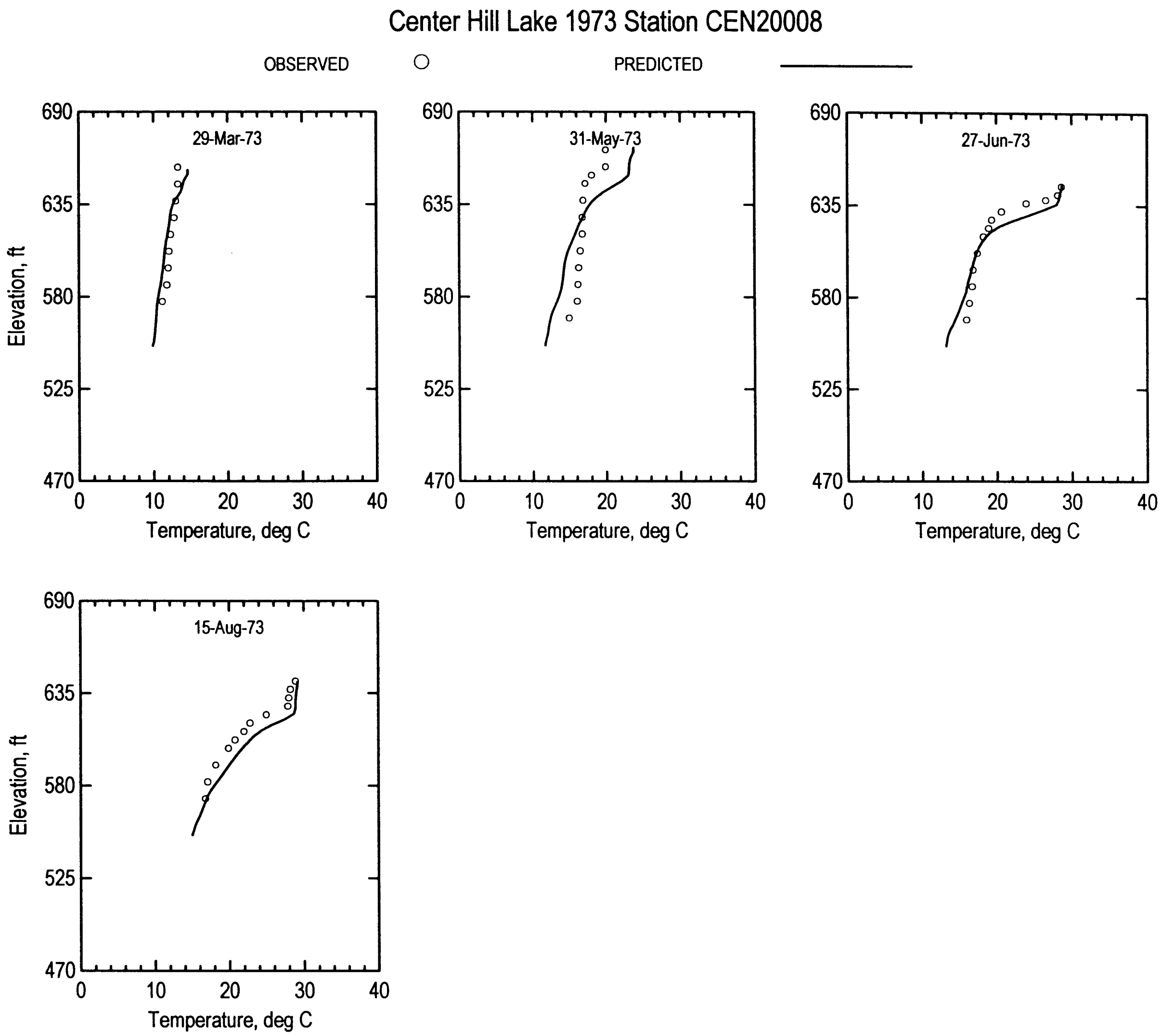




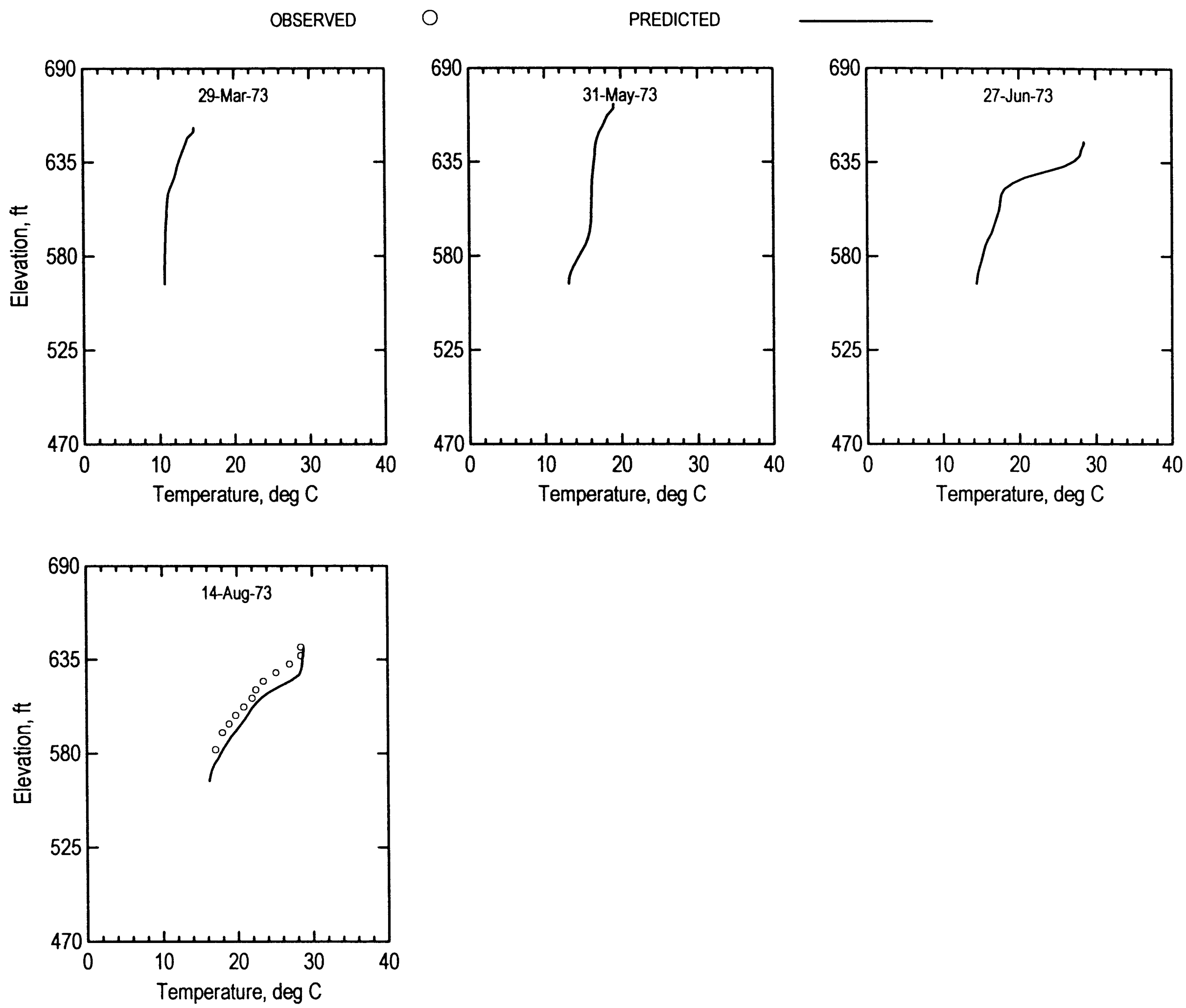
Center Hill Lake 1973 Station CEN20006
OBSERVED
PREDICTED
28-Mar-73
31-May-73
26-Jun-73
15-Aug-73
Elevation, ft
Temperature, deg C
690
635
580
525
470
0
10
20
30
40

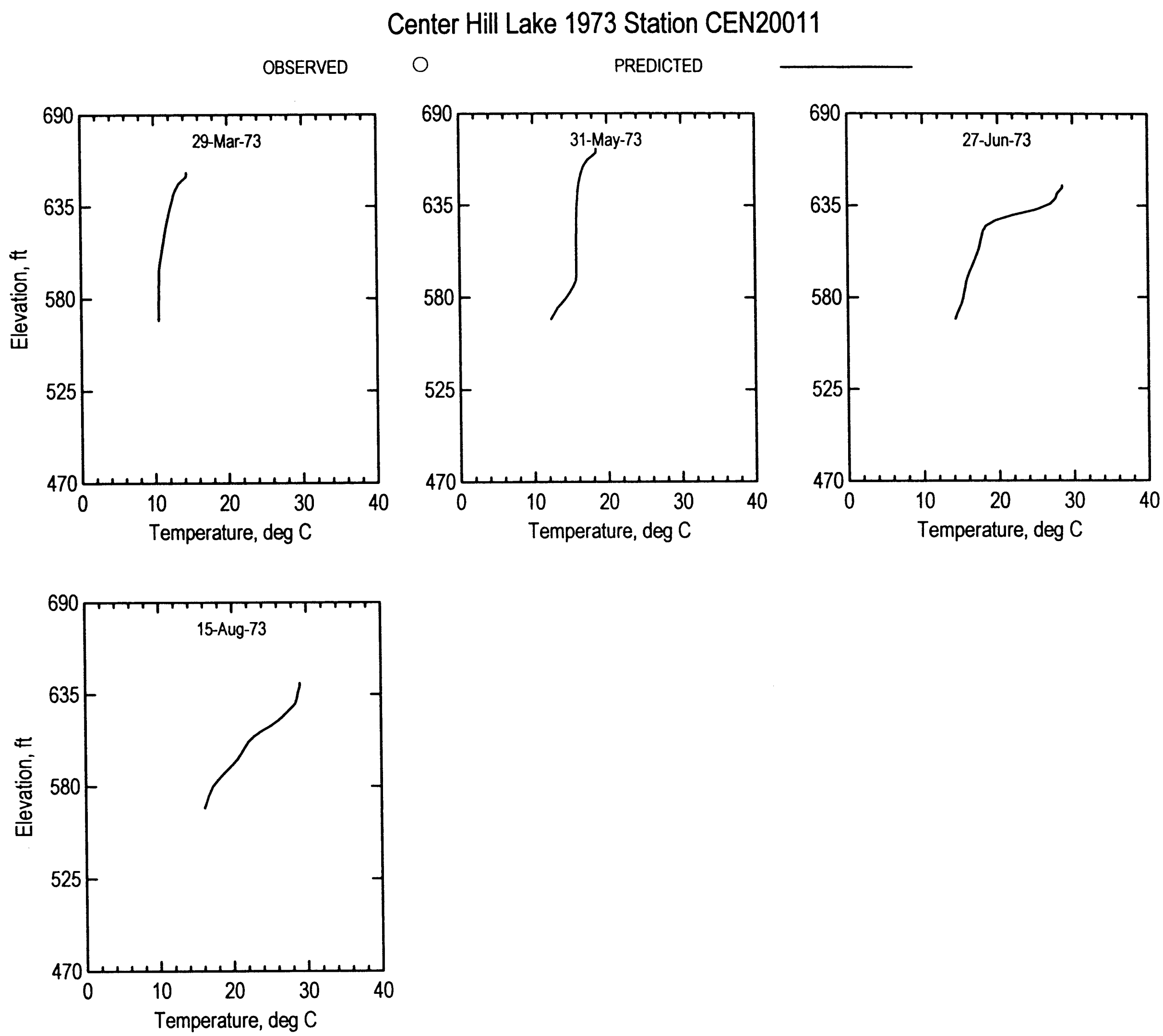
Center Hill Lake 1973 Station CEN20007



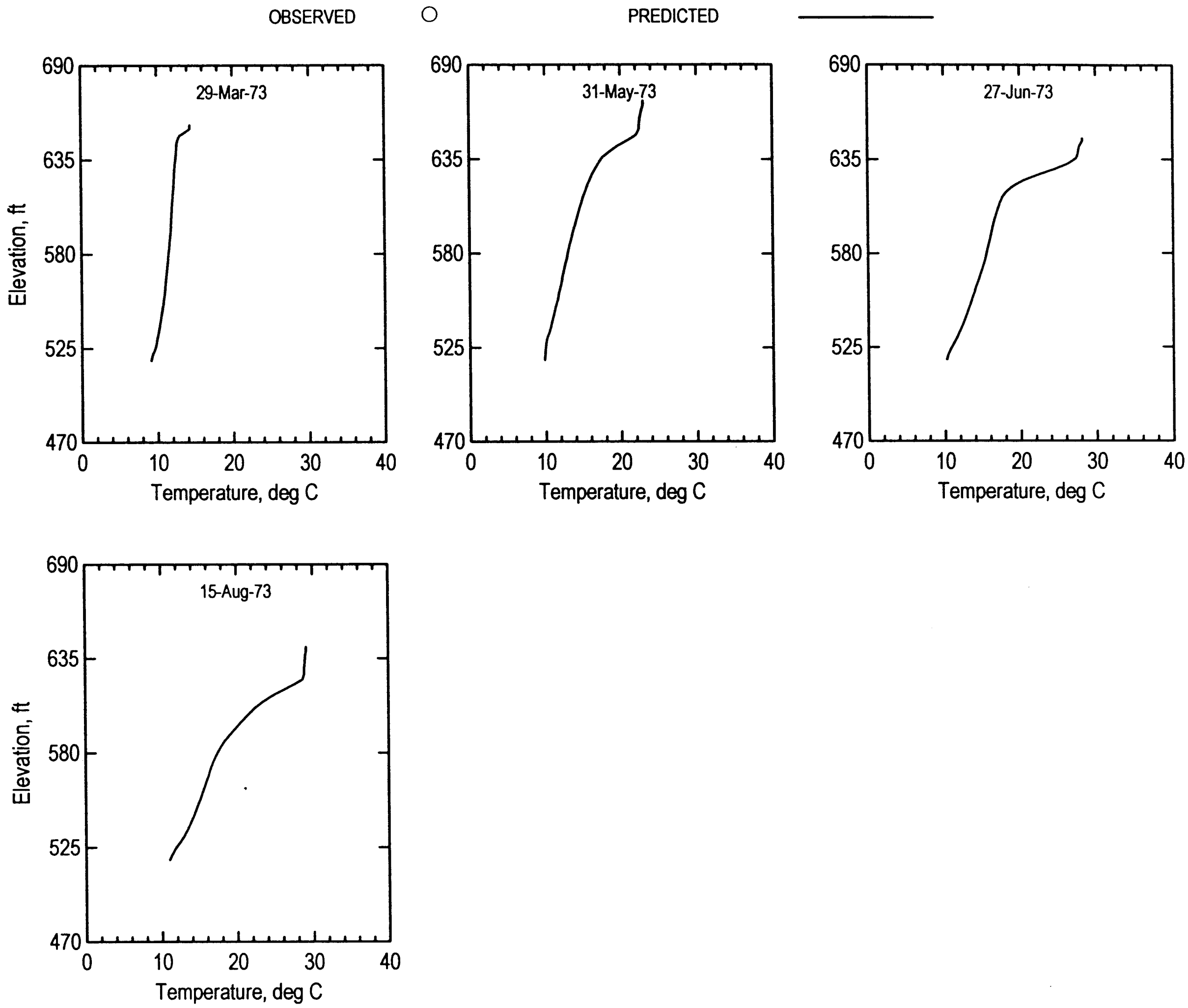

Center Hill Lake 1973 Station CEN20008
OBSERVED
PREDICTED
29-Mar-73
31-May-73
27-Jun-73
15-Aug-73
Elevation, ft
Temperature, deg C
690
635
580
525
470
0
10
20
30
40

Center Hill Lake 1973 Station CEN20010

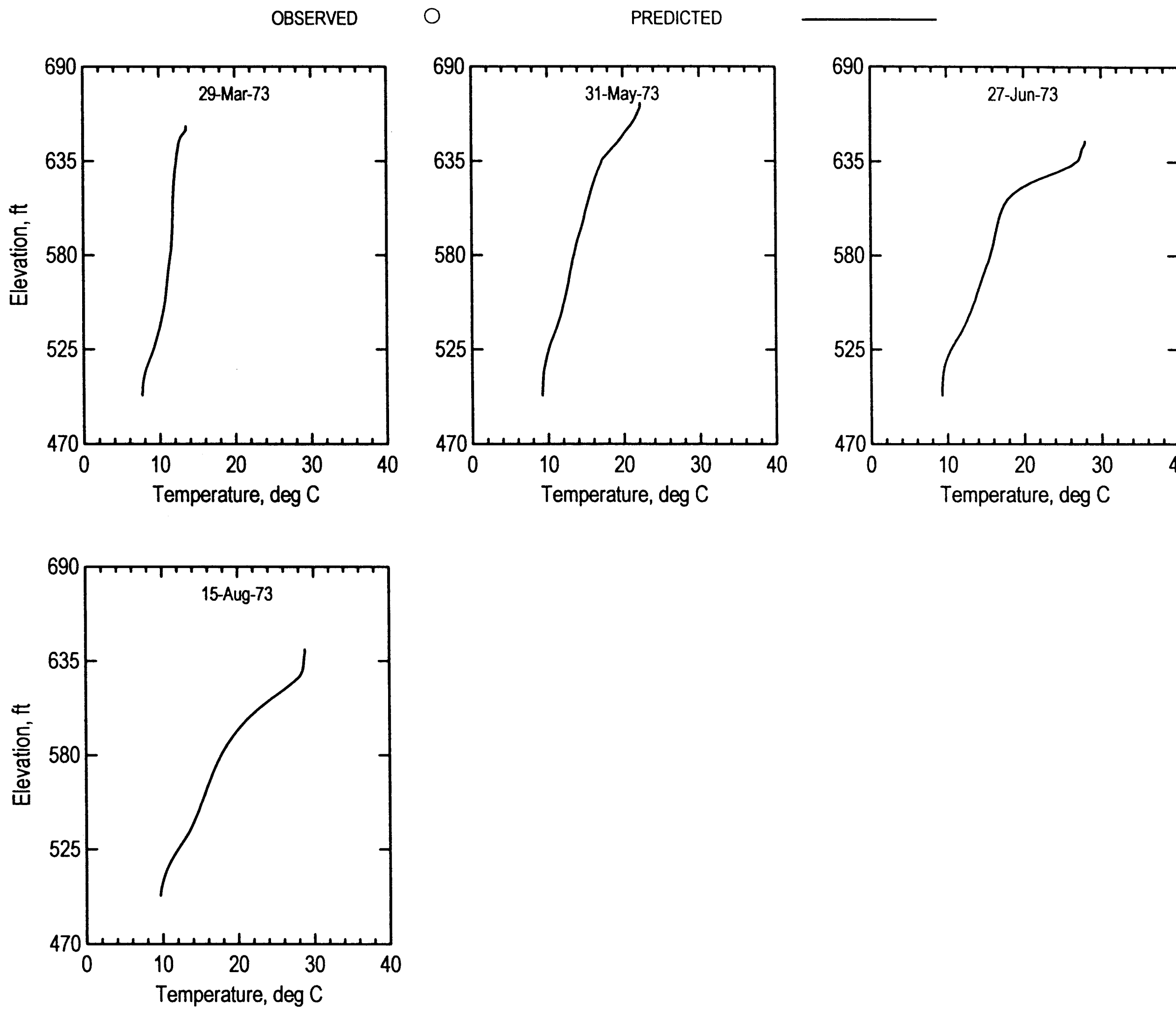



Center Hill Lake 1973 Station CEN20011
OBSERVED
PREDICTED
29-Mar-73
31-May-73
27-Jun-73
15-Aug-73
Elevation, ft
690
635
580
525
470
0
10
20
30
40
Temperature, deg C

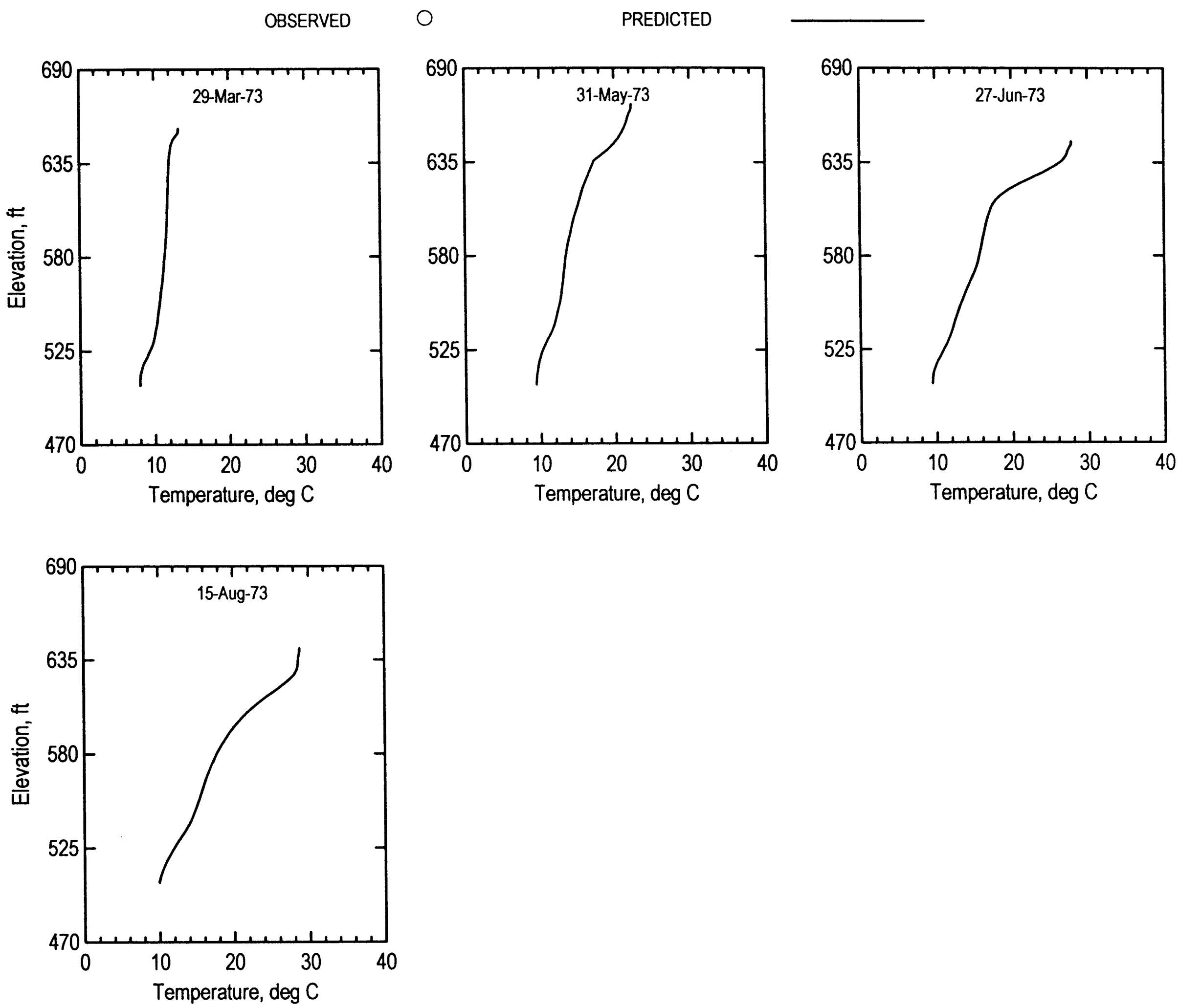
Center Hill Lake 1973 Station CEN20015



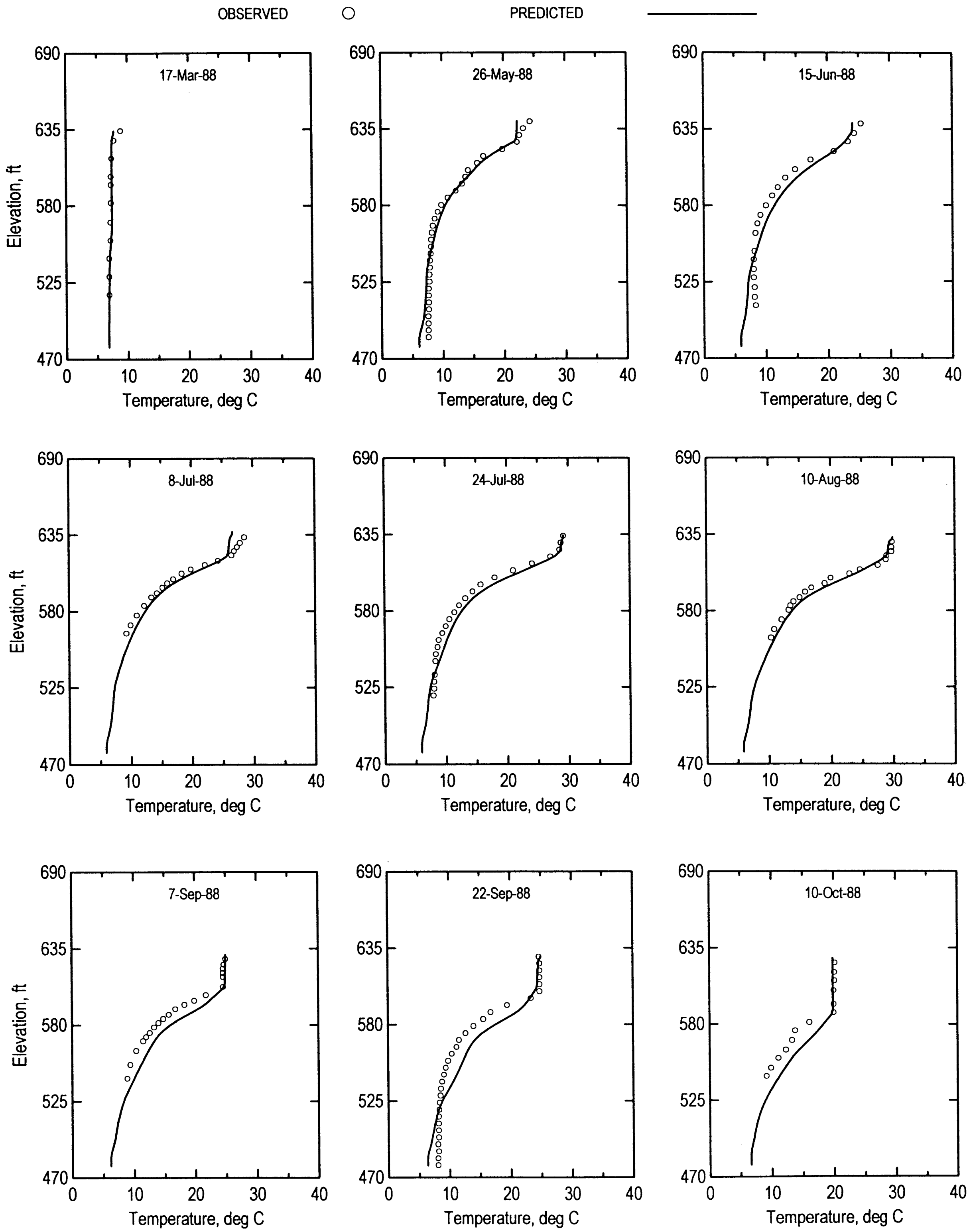
Center Hill Lake 1973 Station CEN20013



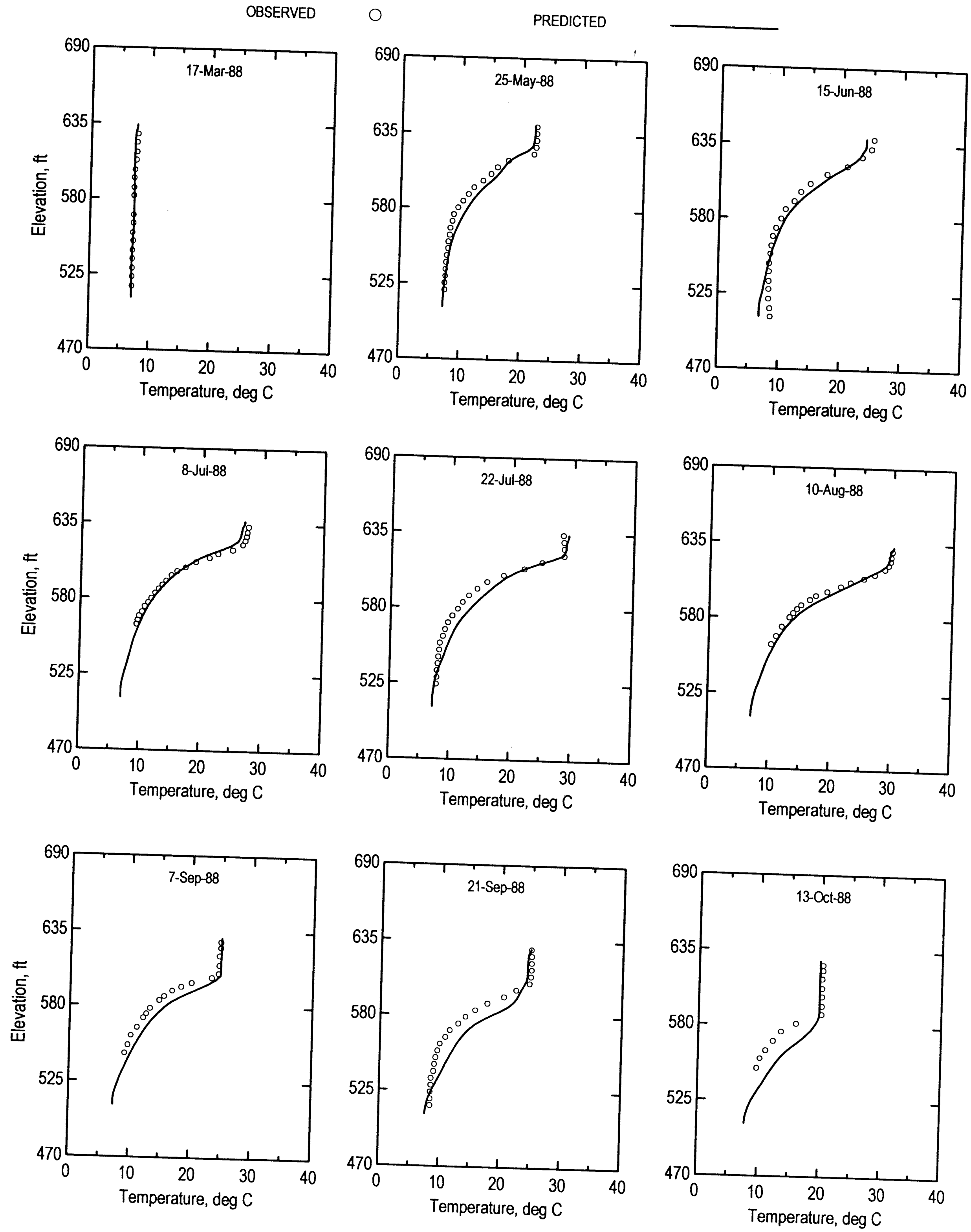
Center Hill Lake 1973 Station CEN20014



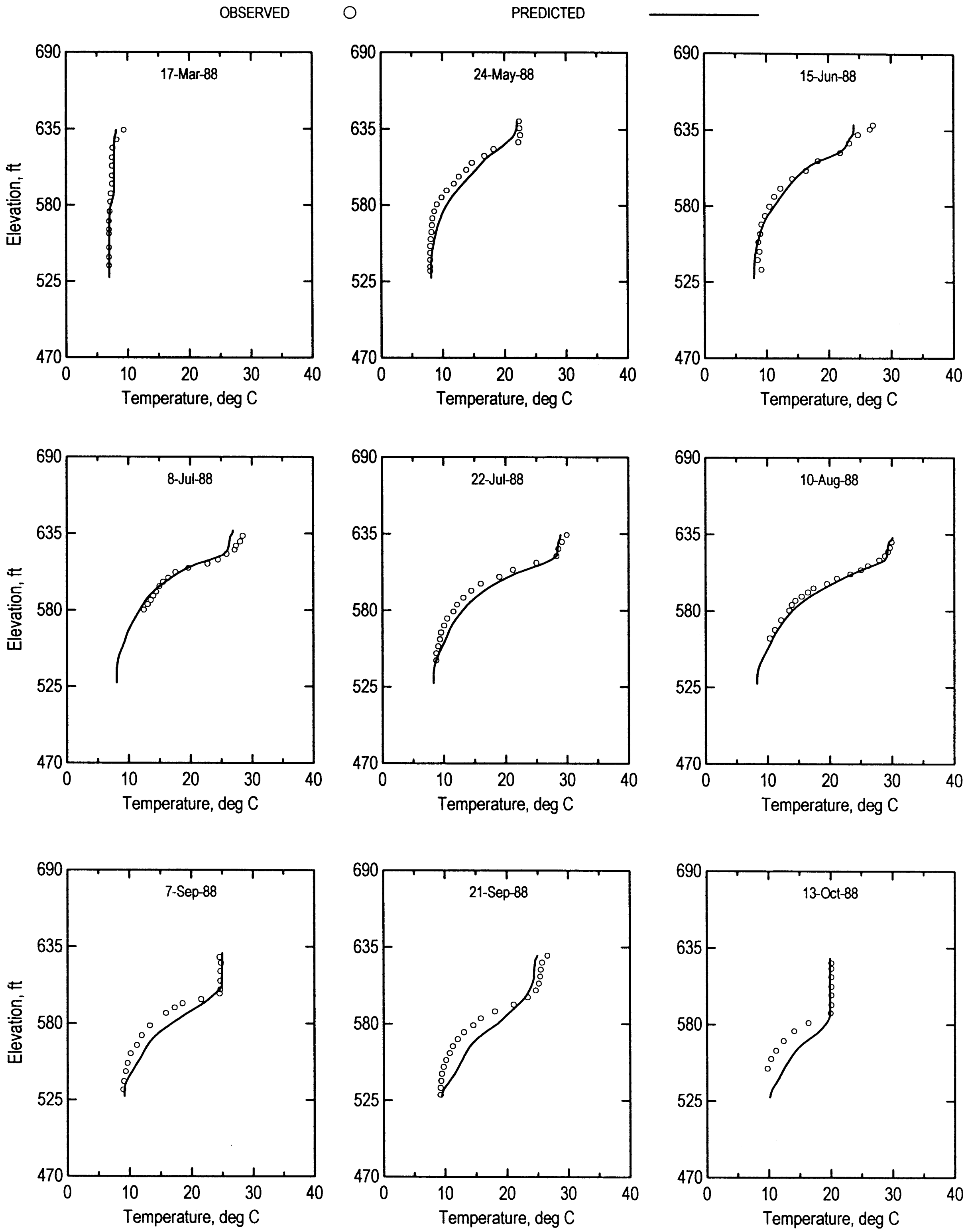
Center Hill Lake 1988 Station CEN20003



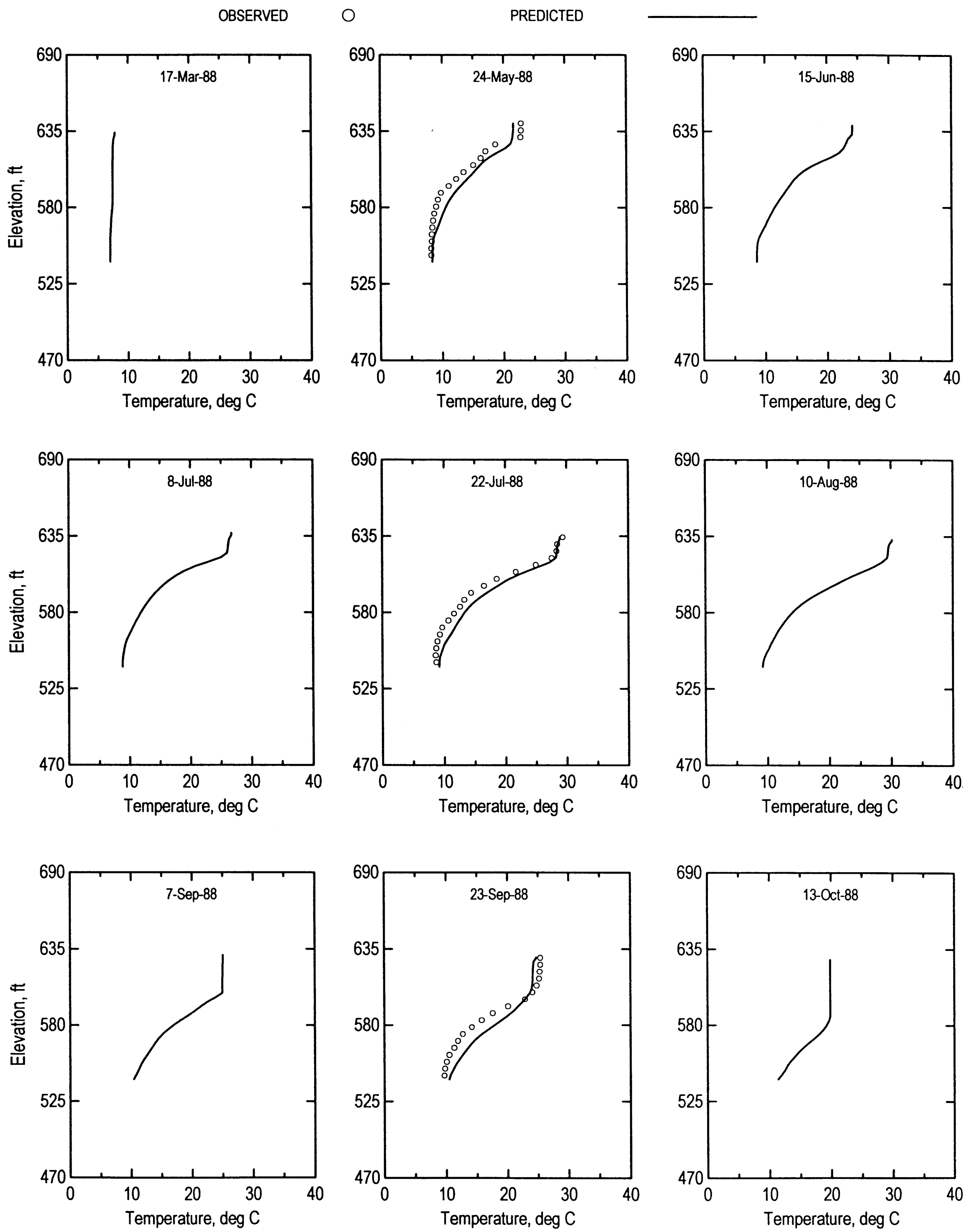
Center Hill Lake 1988 Station CEN20004



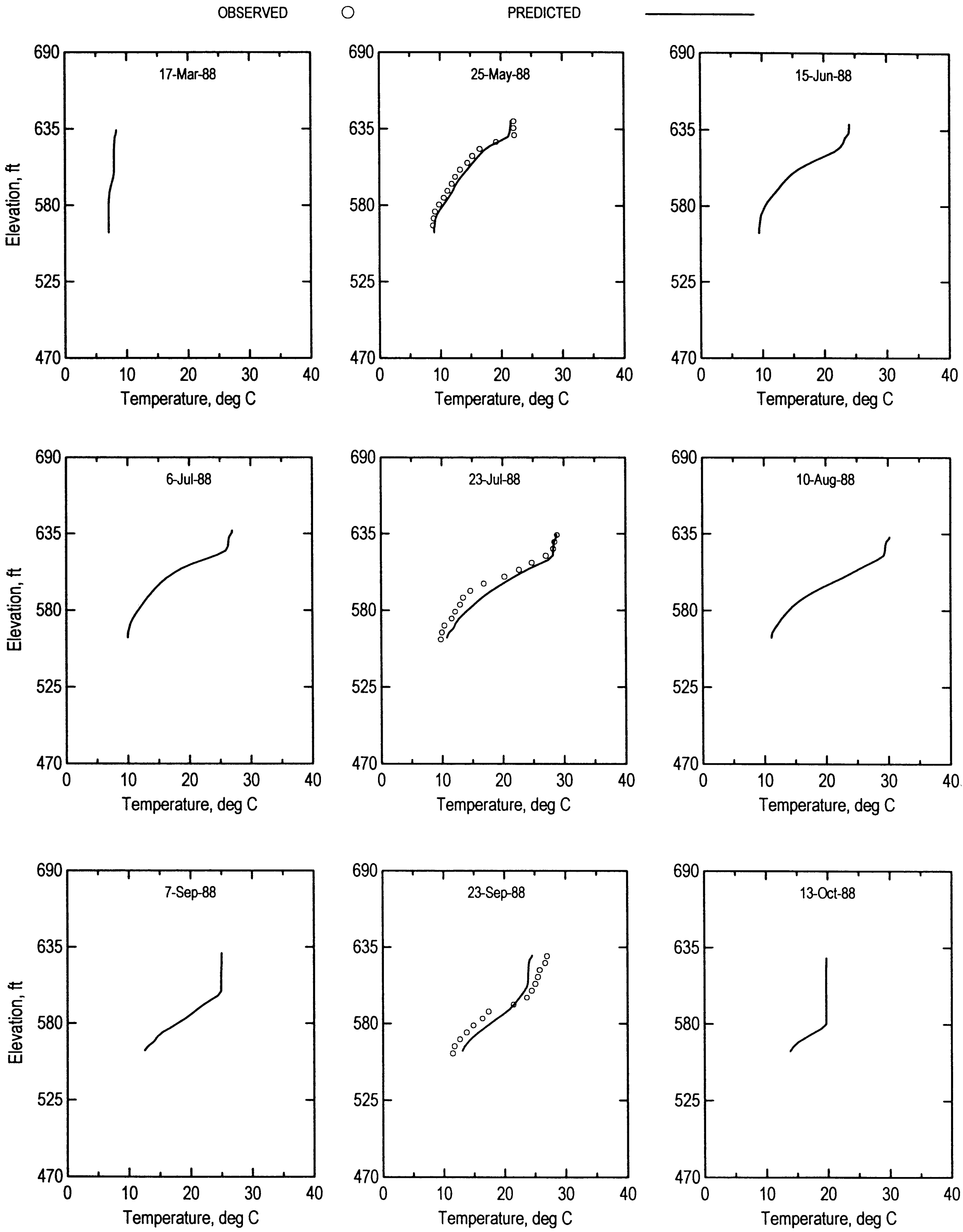
Center Hill Lake 1988 Station CEN20005



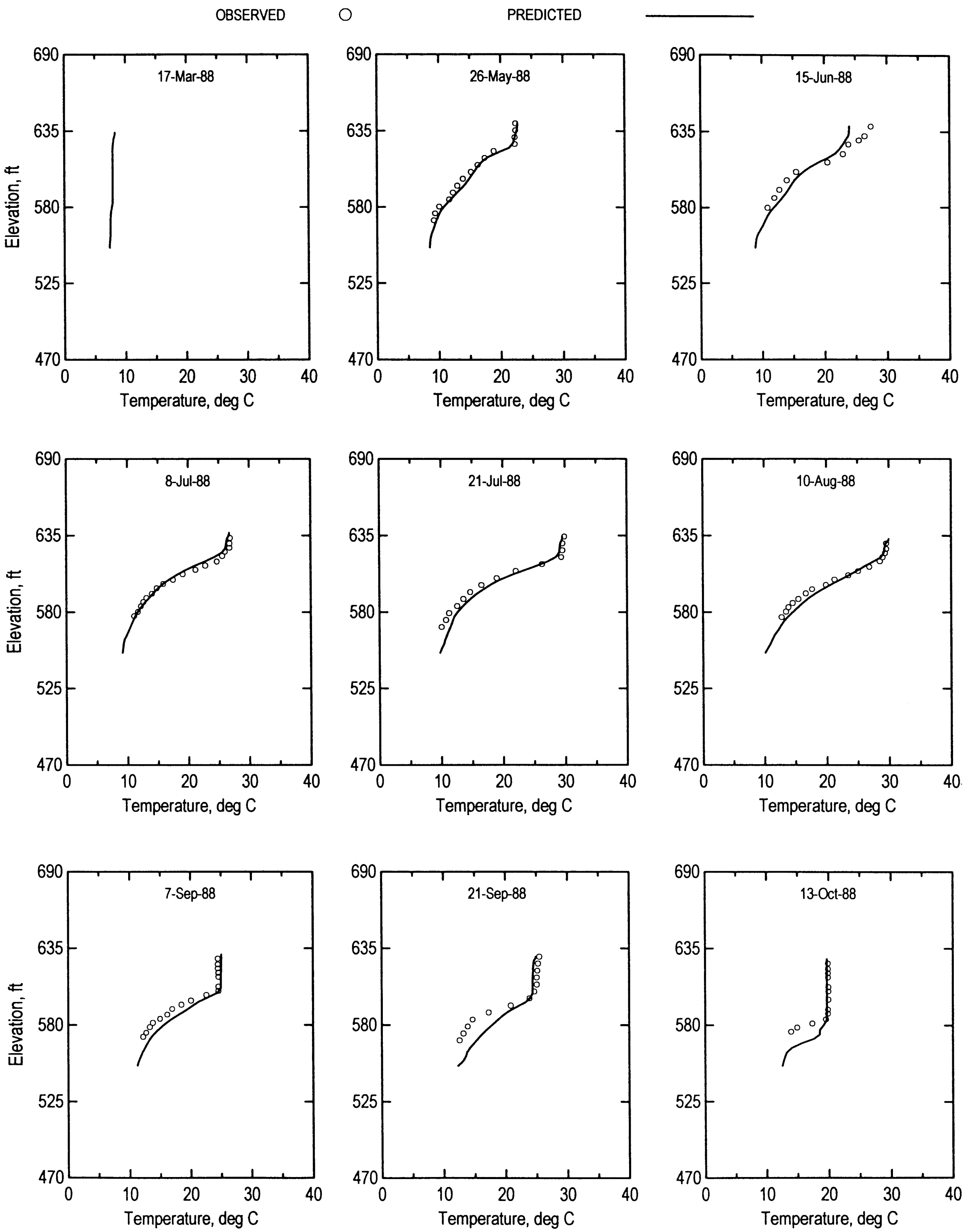
Center Hill Lake 1988 Station CEN20006



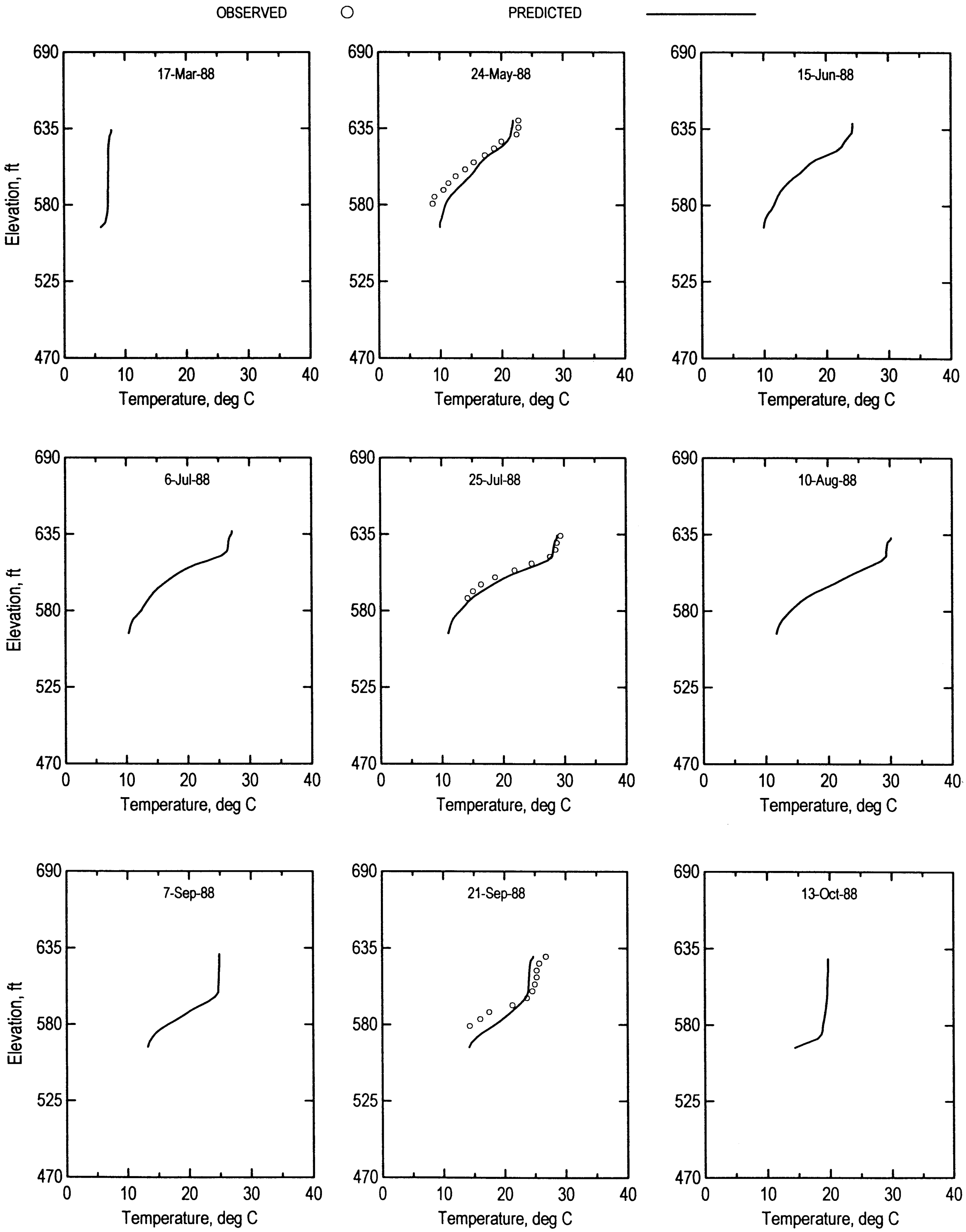
Center Hill Lake 1988 Station CEN20007



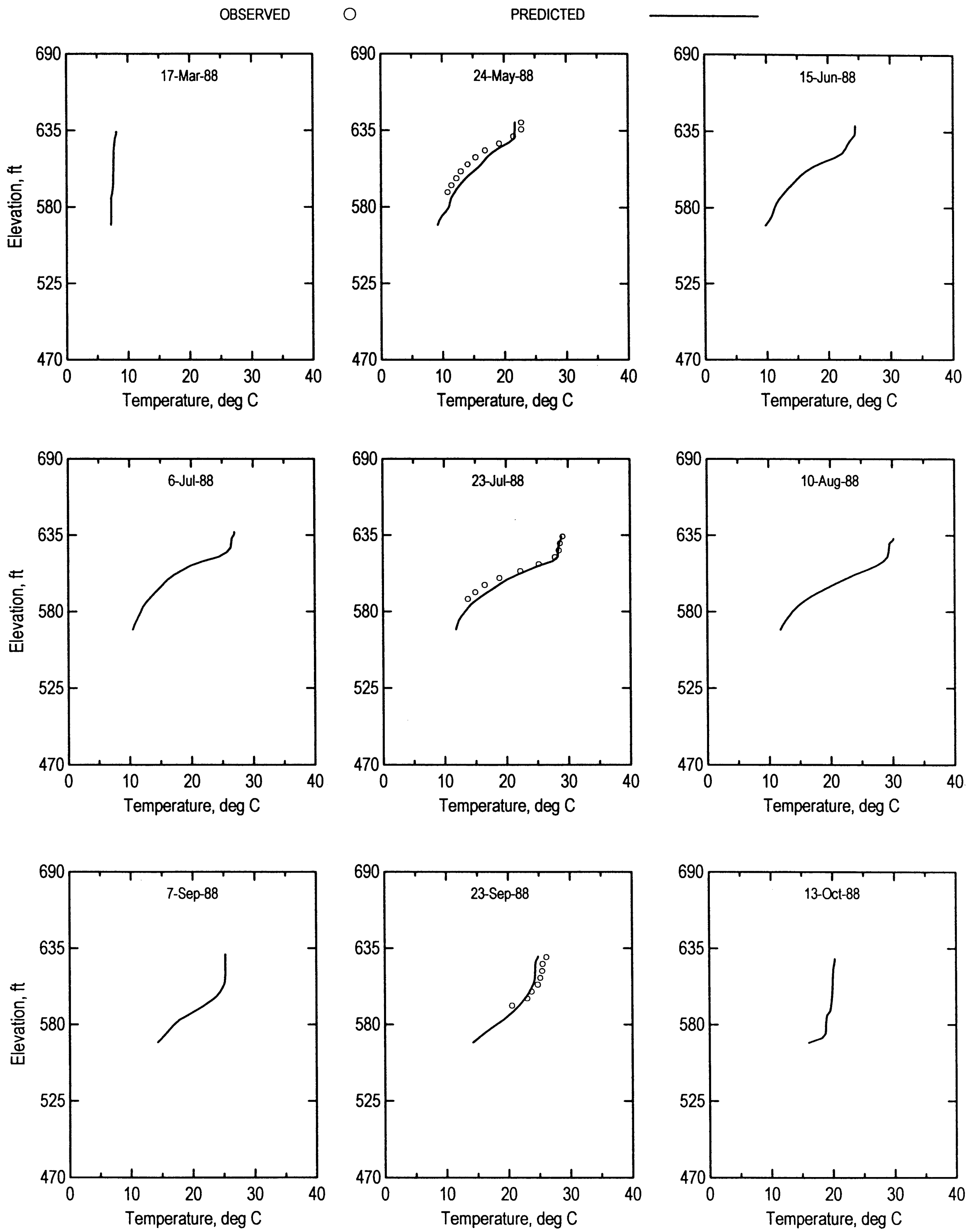
Center Hill Lake 1988 Station CEN20008



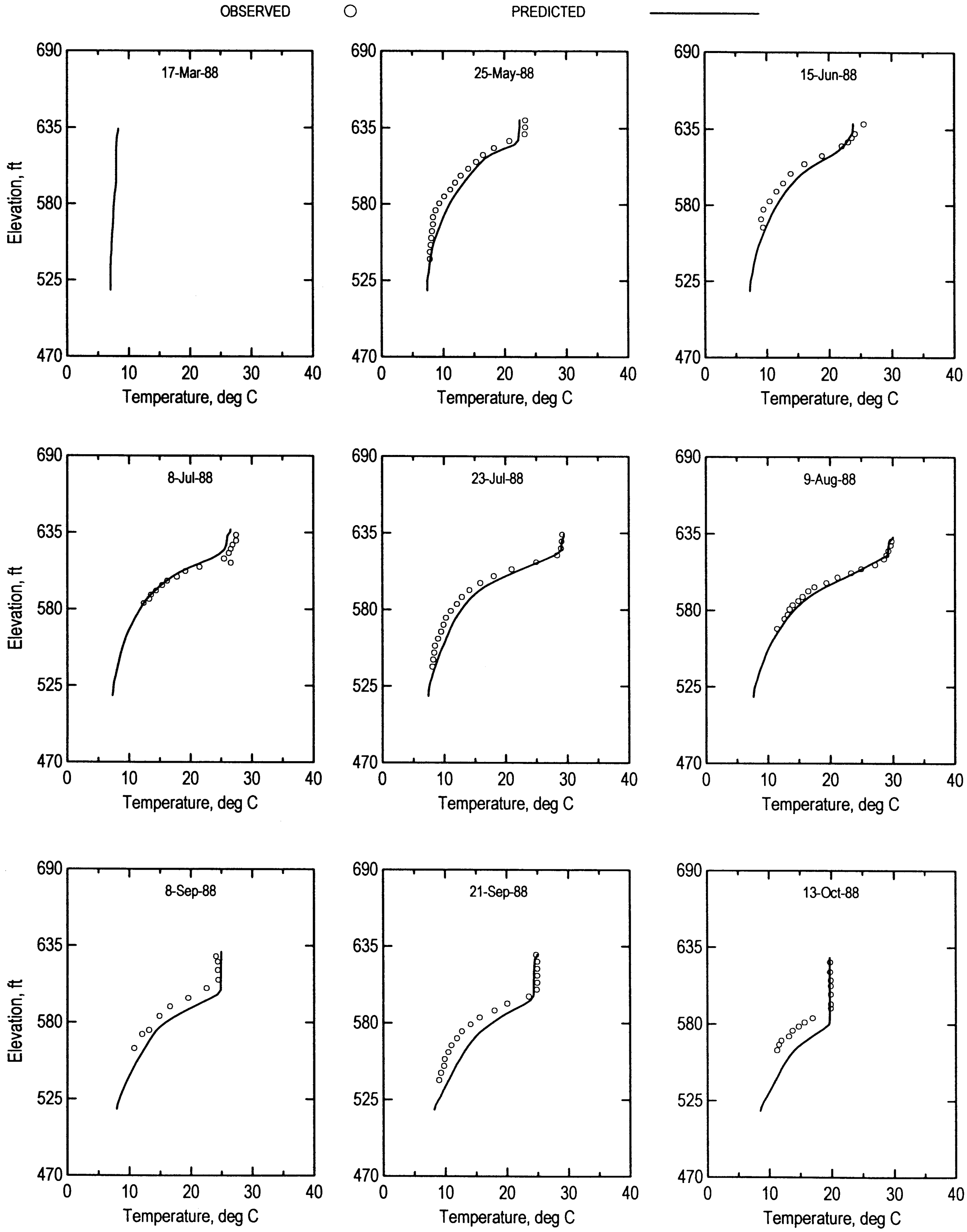
Center Hill Lake 1988 Station CEN20010



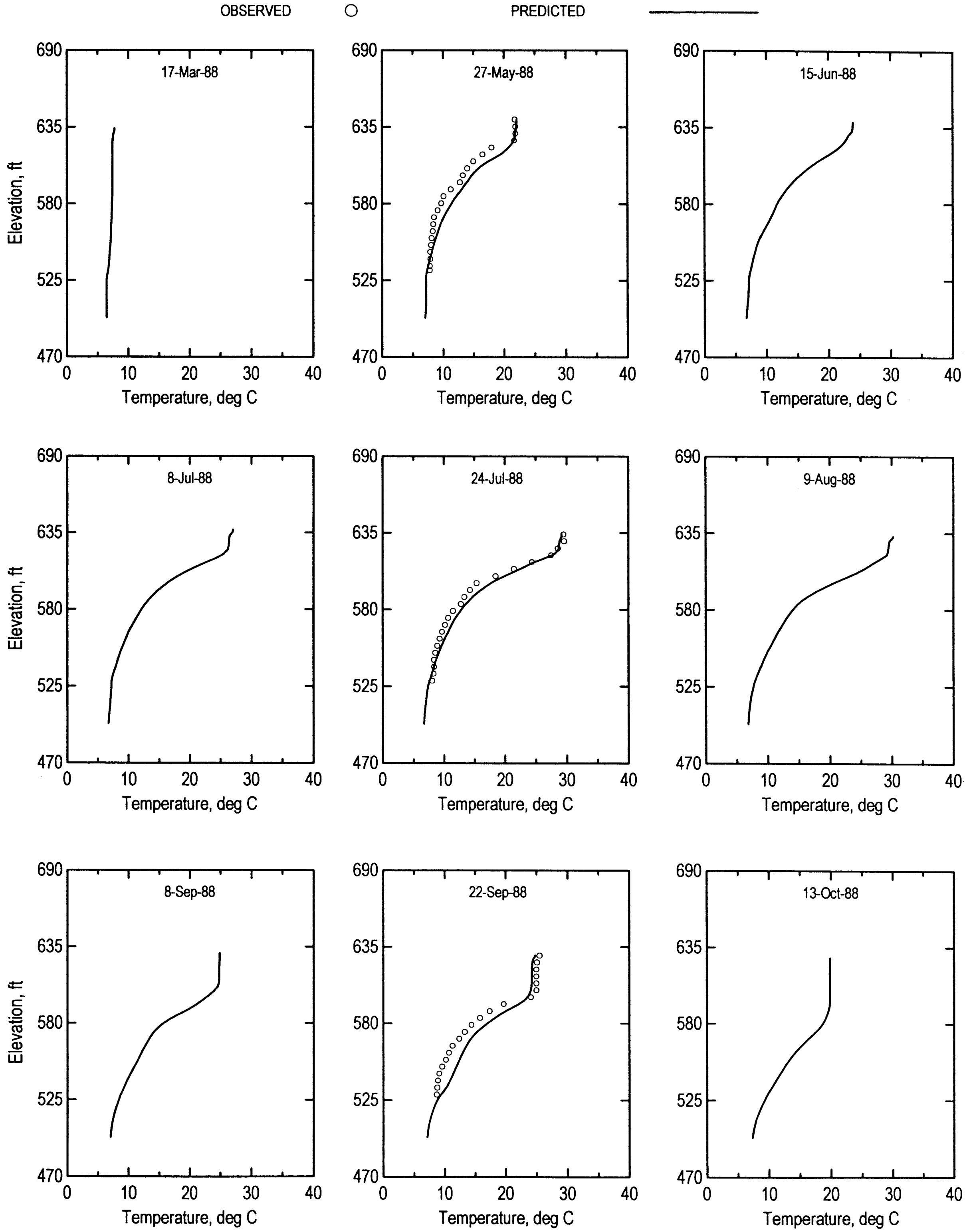
Center Hill Lake 1988 Station CEN20011



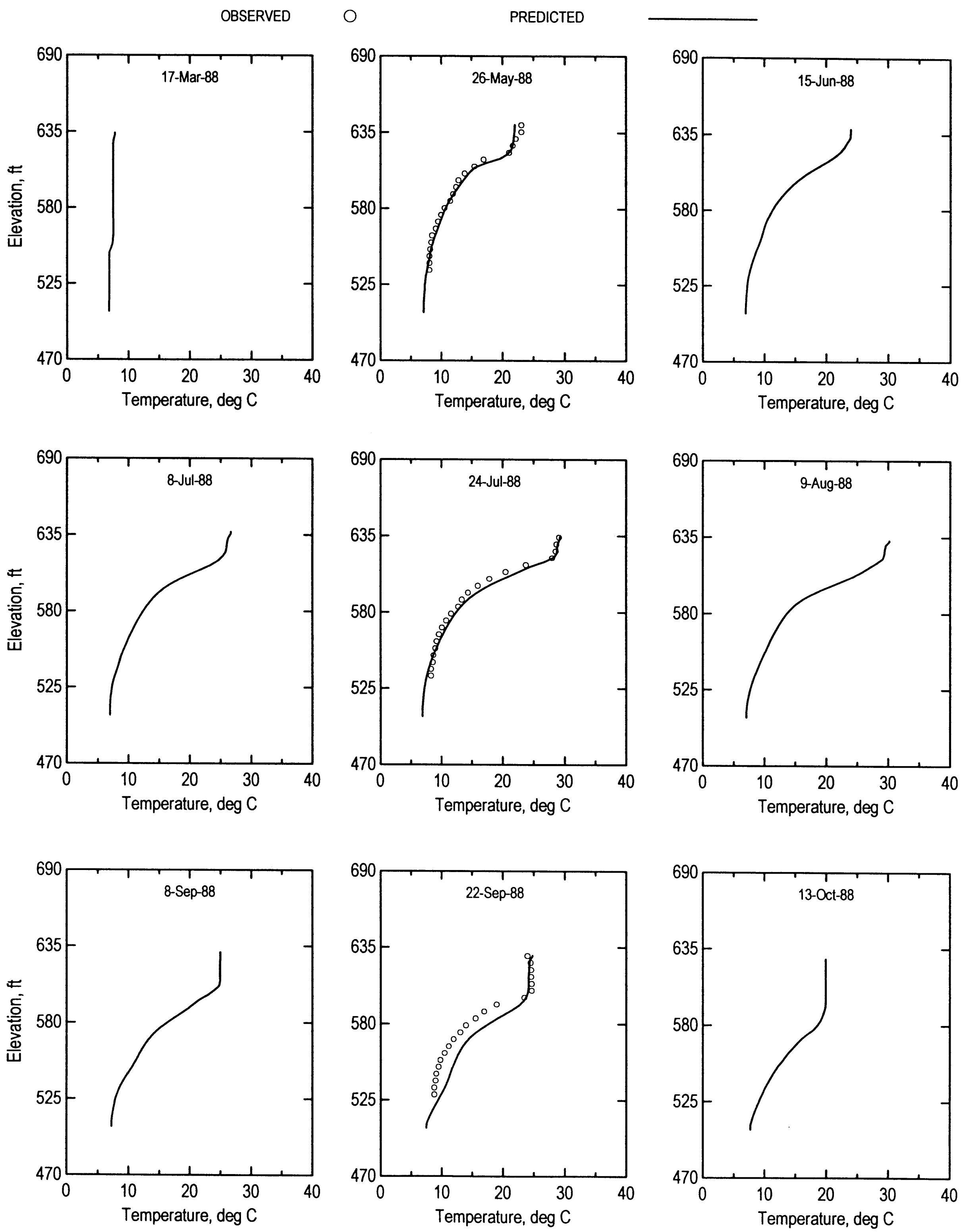
Center Hill Lake 1988 Station CEN20015



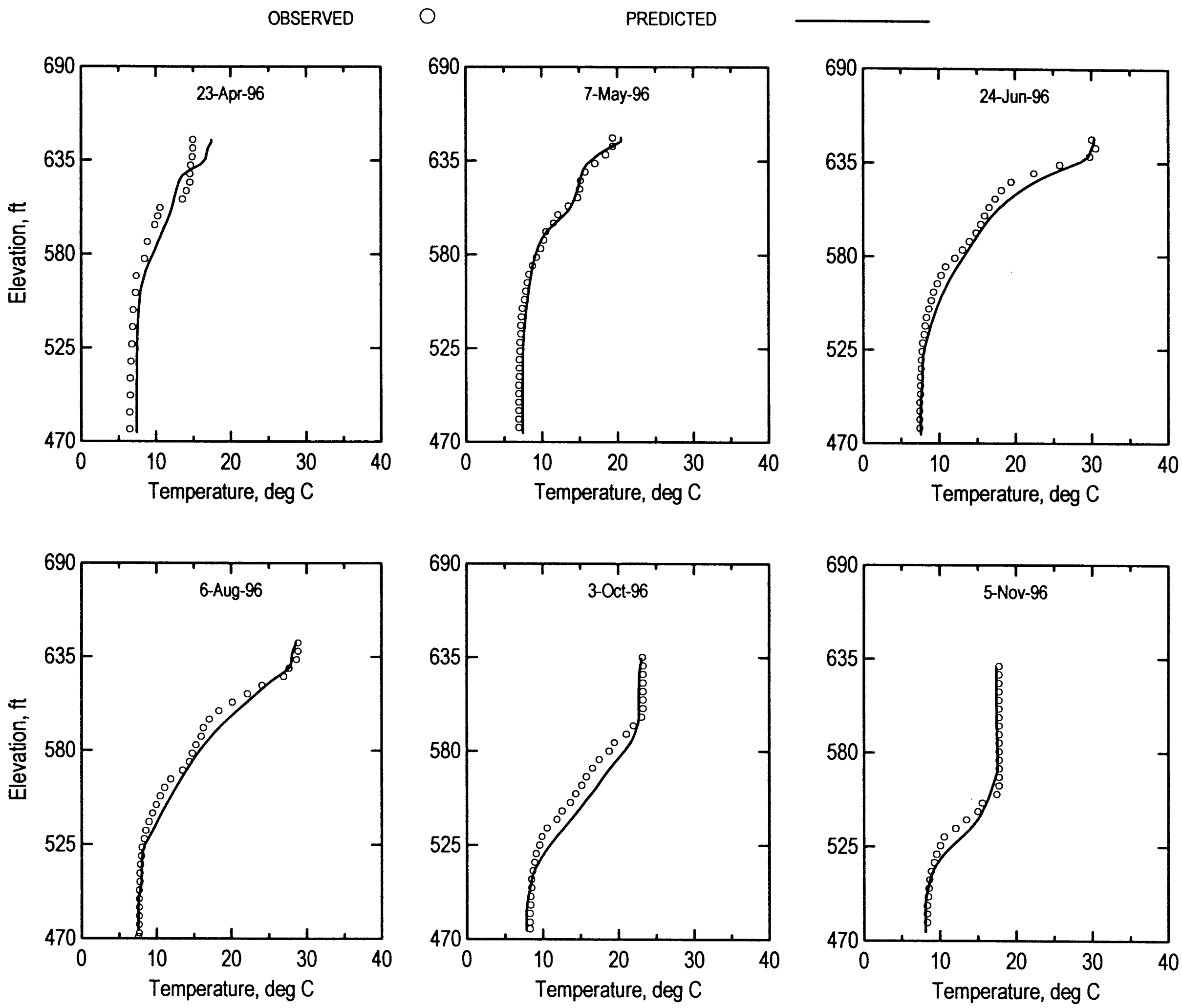
Center Hill Lake 1988 Station CEN20013



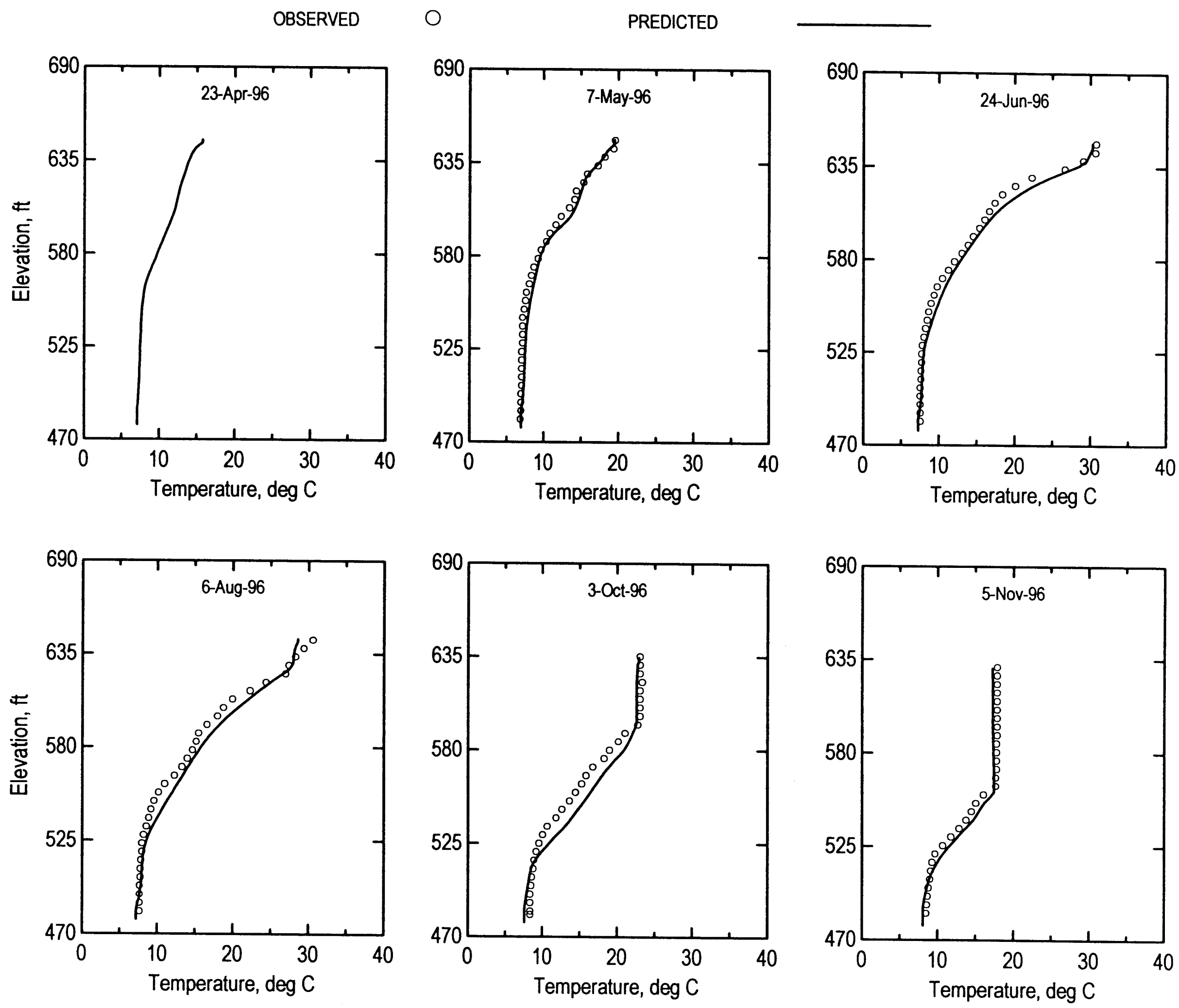
Center Hill Lake 1988 Station CEN20014



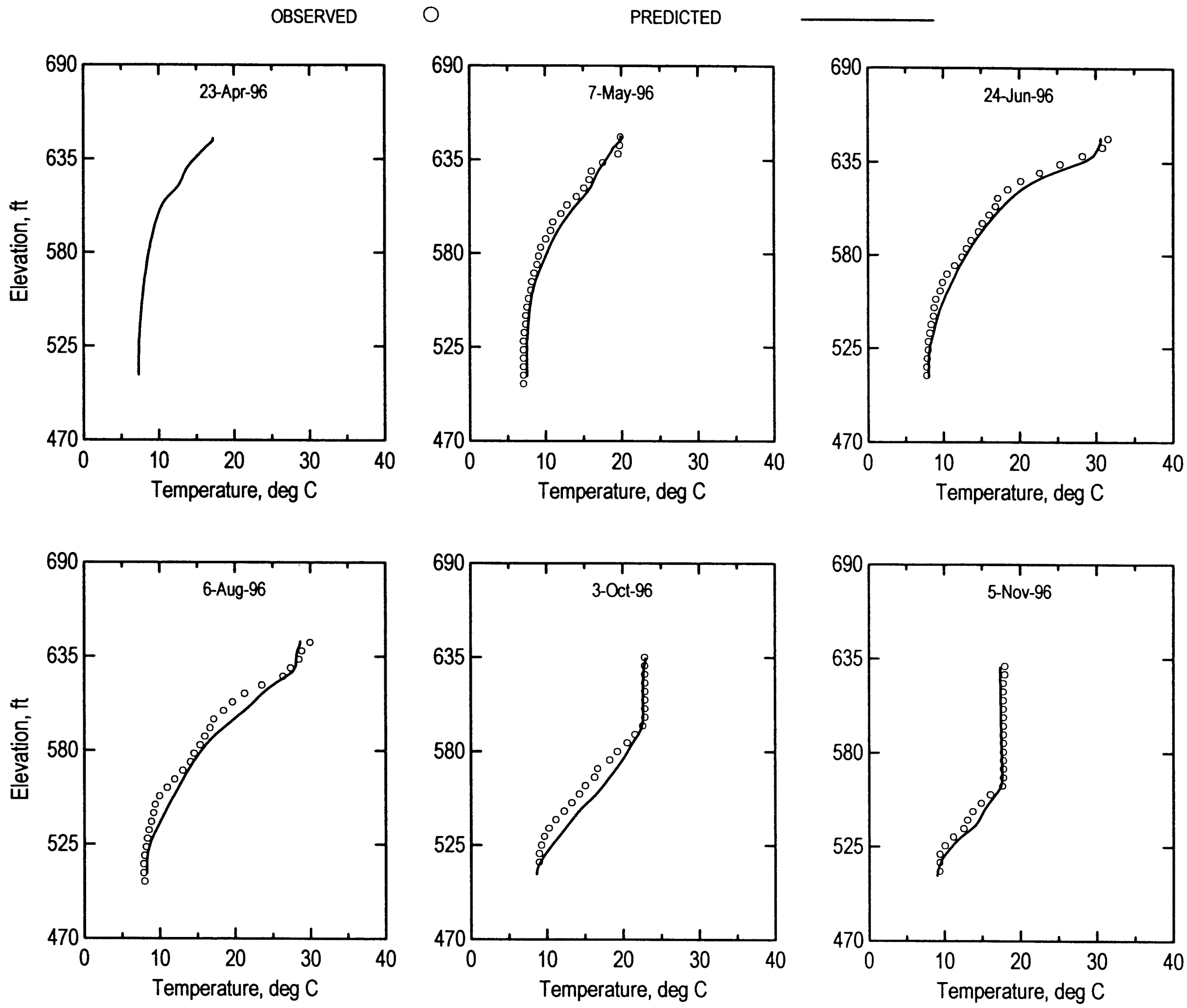
Center Hill Lake 1996 Station CEN20002

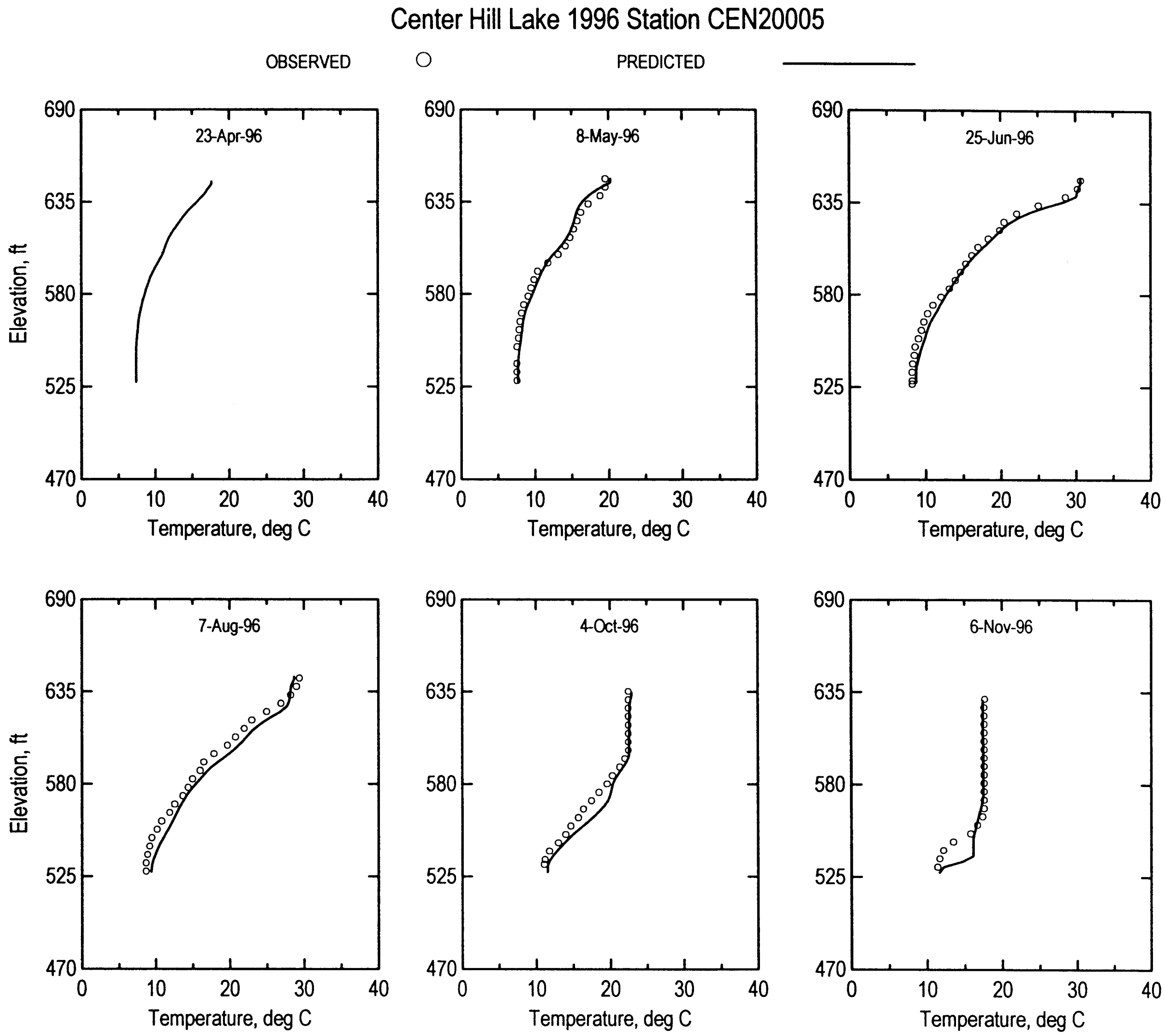


Center Hill Lake 1996 Station CEN20003

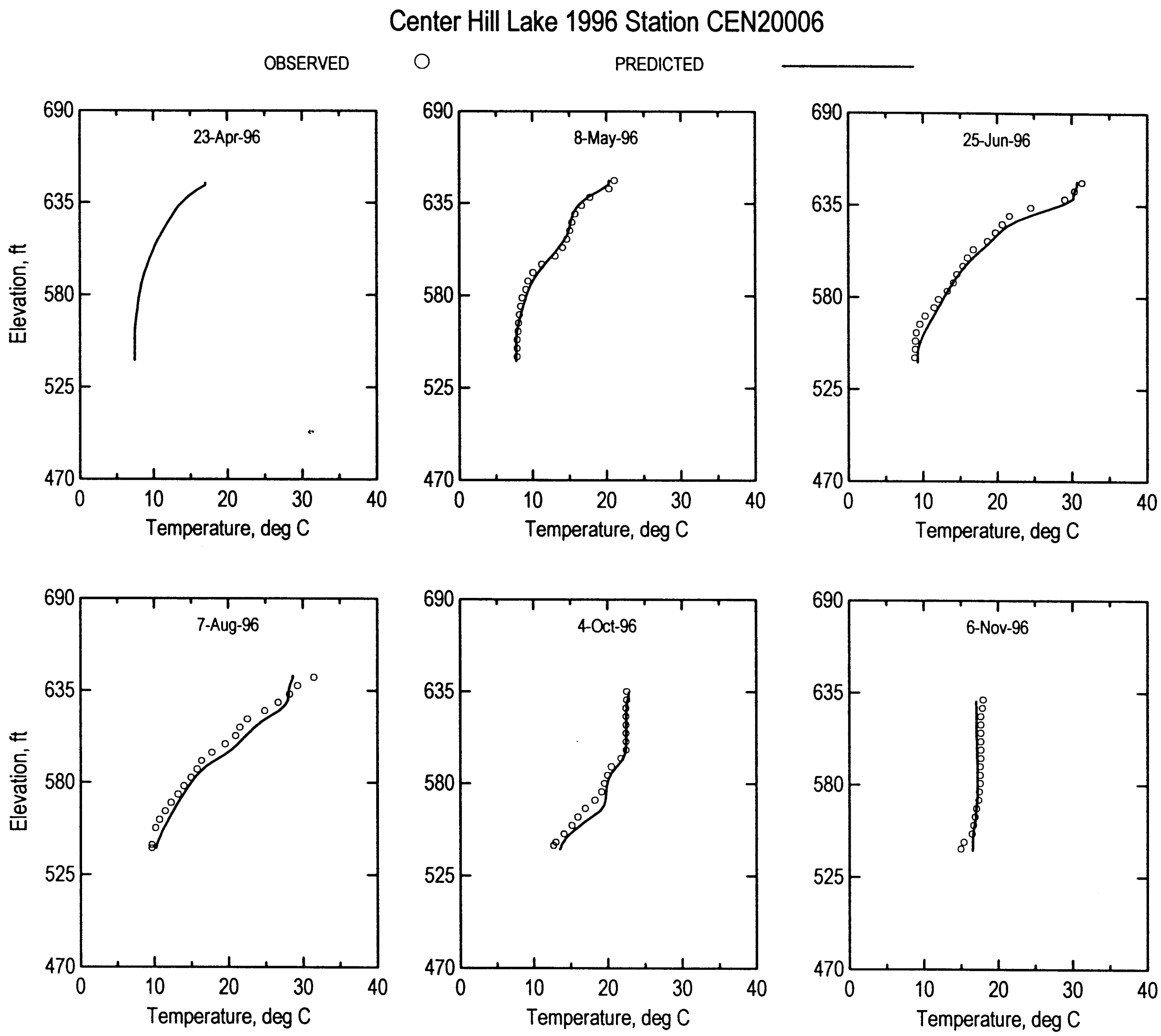


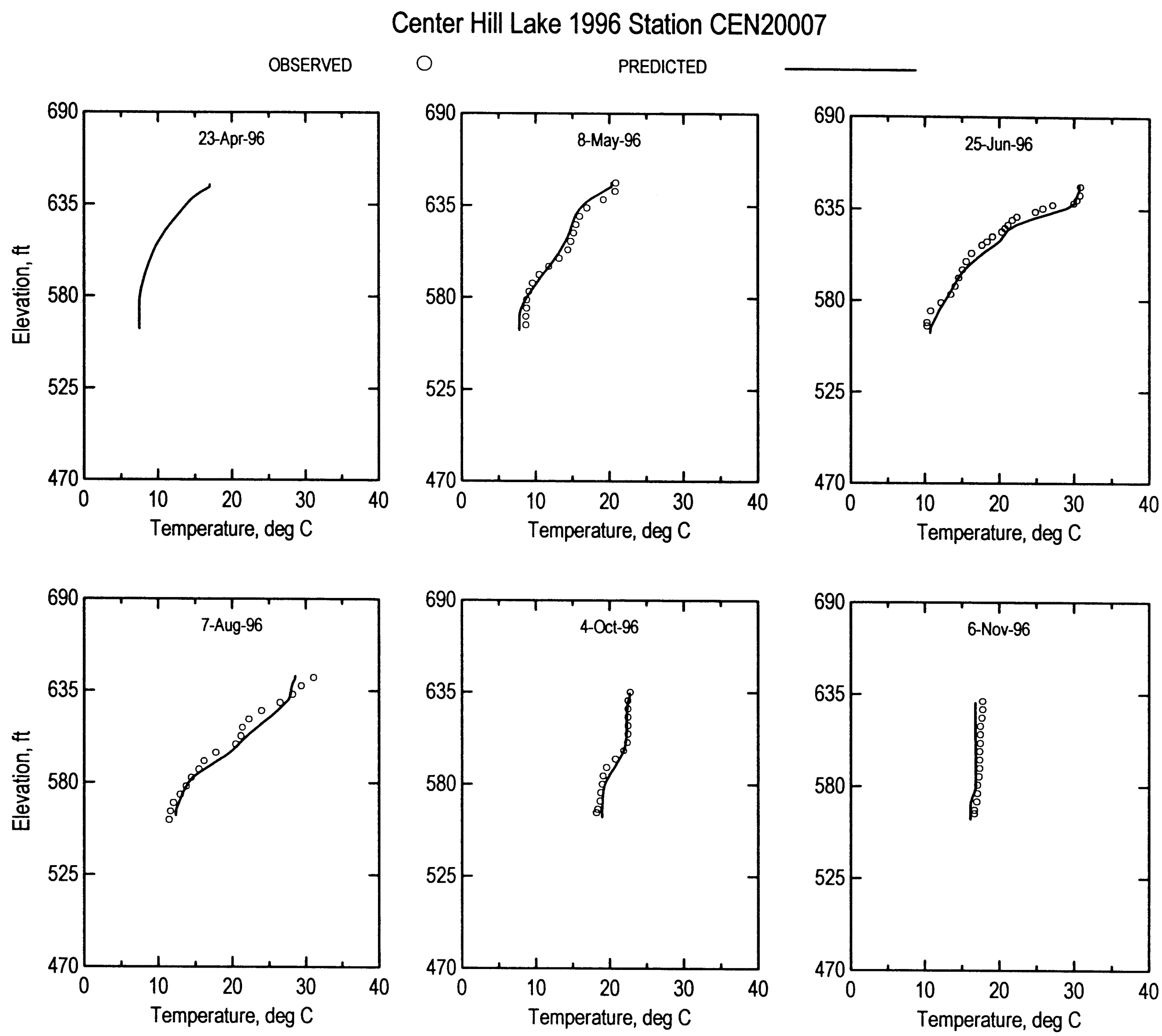
Center Hill Lake 1996 Station CEN20004





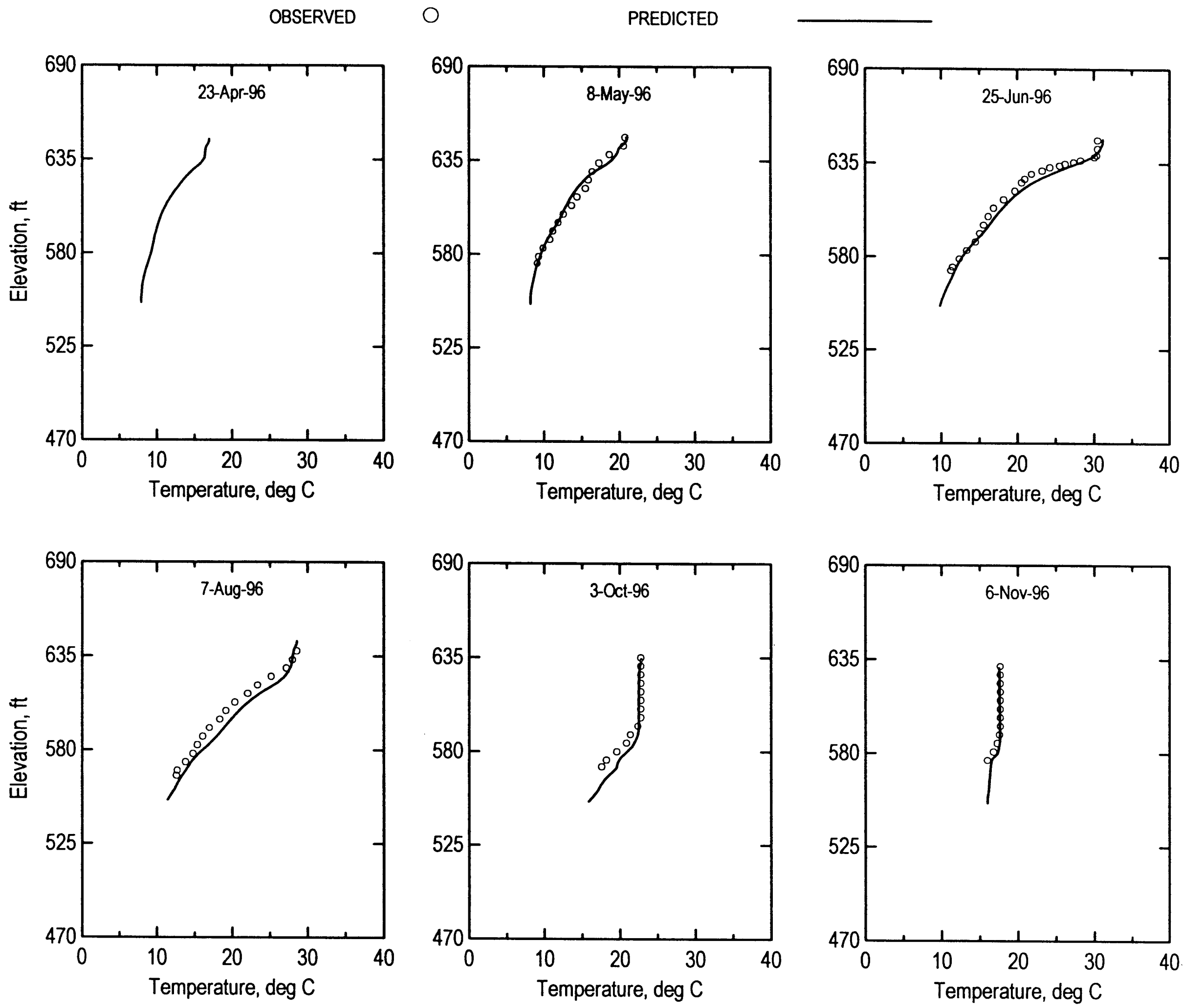
Center Hill Lake 1996 Station CEN20005
OBSERVED
PREDICTED
23-Apr-96
8-May-96
25-Jun-96
7-Aug-96
4-Oct-96
6-Nov-96
Elevation, ft
Temperature, deg C
690
635
580
525
470
0
10
20
30
40


Center Hill Lake 1996 Station CEN20006
OBSERVED
PREDICTED
23-Apr-96
8-May-96
25-Jun-96
7-Aug-96
4-Oct-96
6-Nov-96
Elevation, ft
Temperature, deg C
690
635
580
525
470
0
10
20
30
40

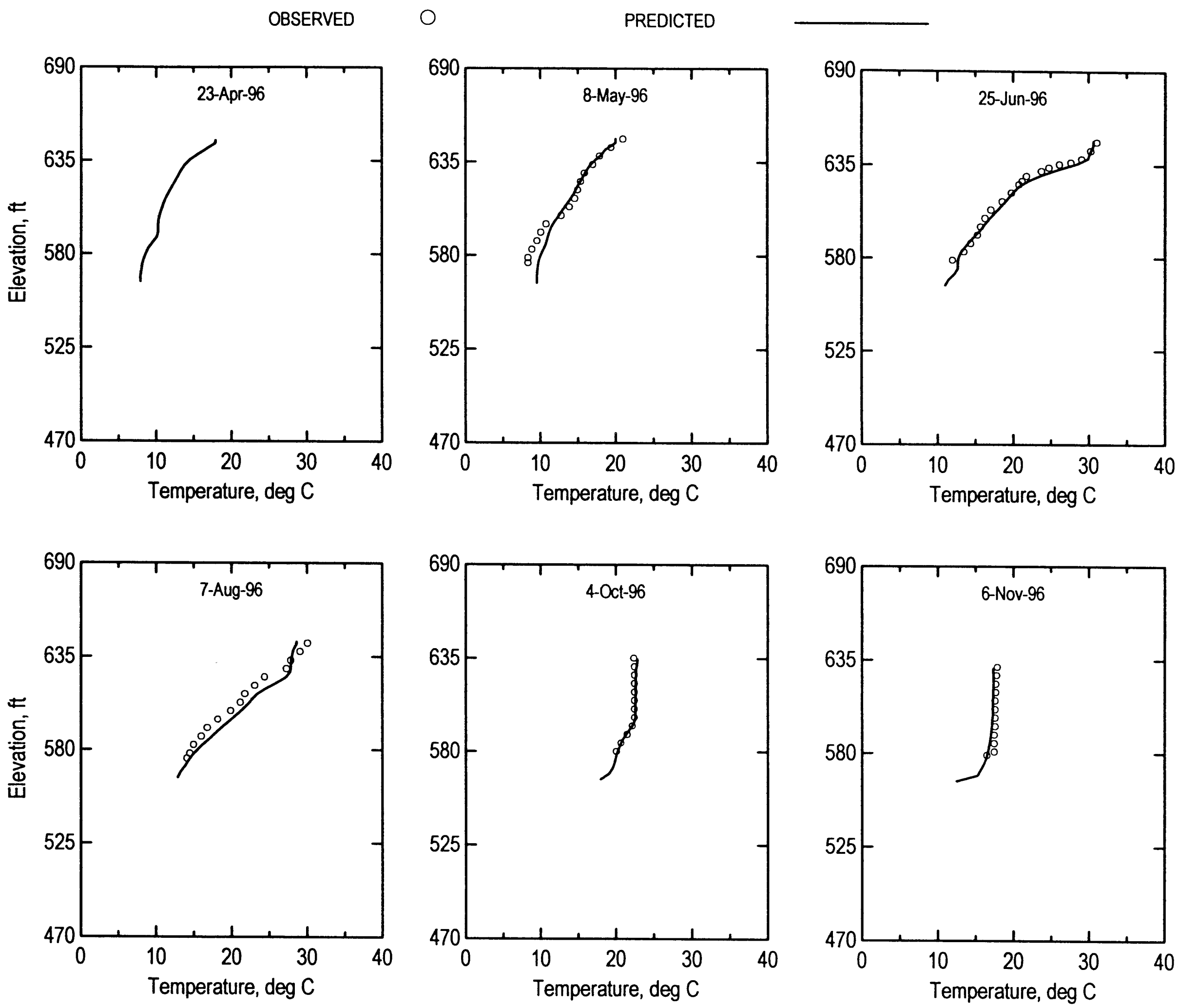


Center Hill Lake 1996 Station CEN20007
OBSERVED
PREDICTED
23-Apr-96
8-May-96
25-Jun-96
7-Aug-96
4-Oct-96
6-Nov-96
Elevation, ft
Temperature, deg C
690
635
580
525
470
0
10
20
30
40

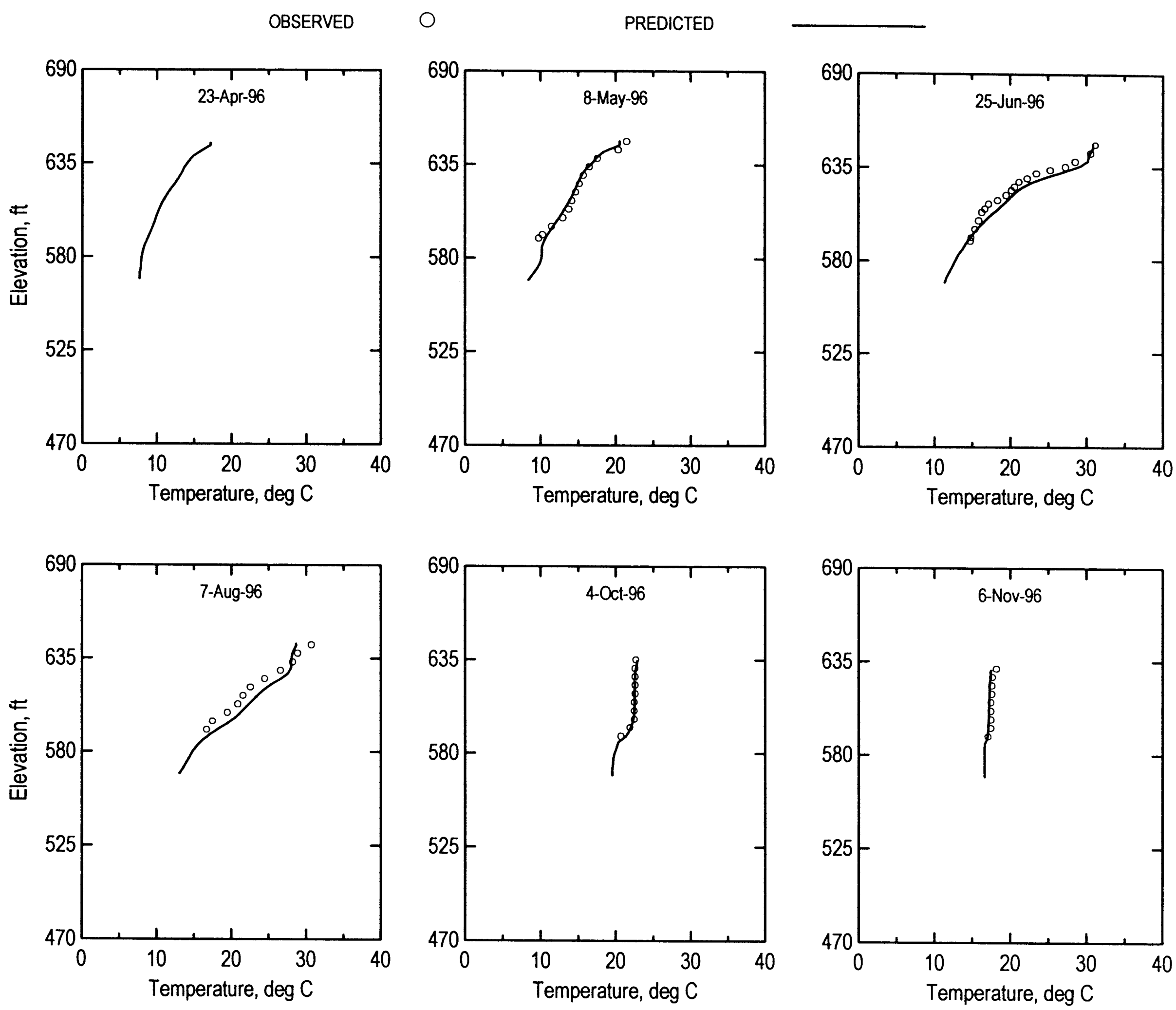
Center Hill Lake 1996 Station CEN20008

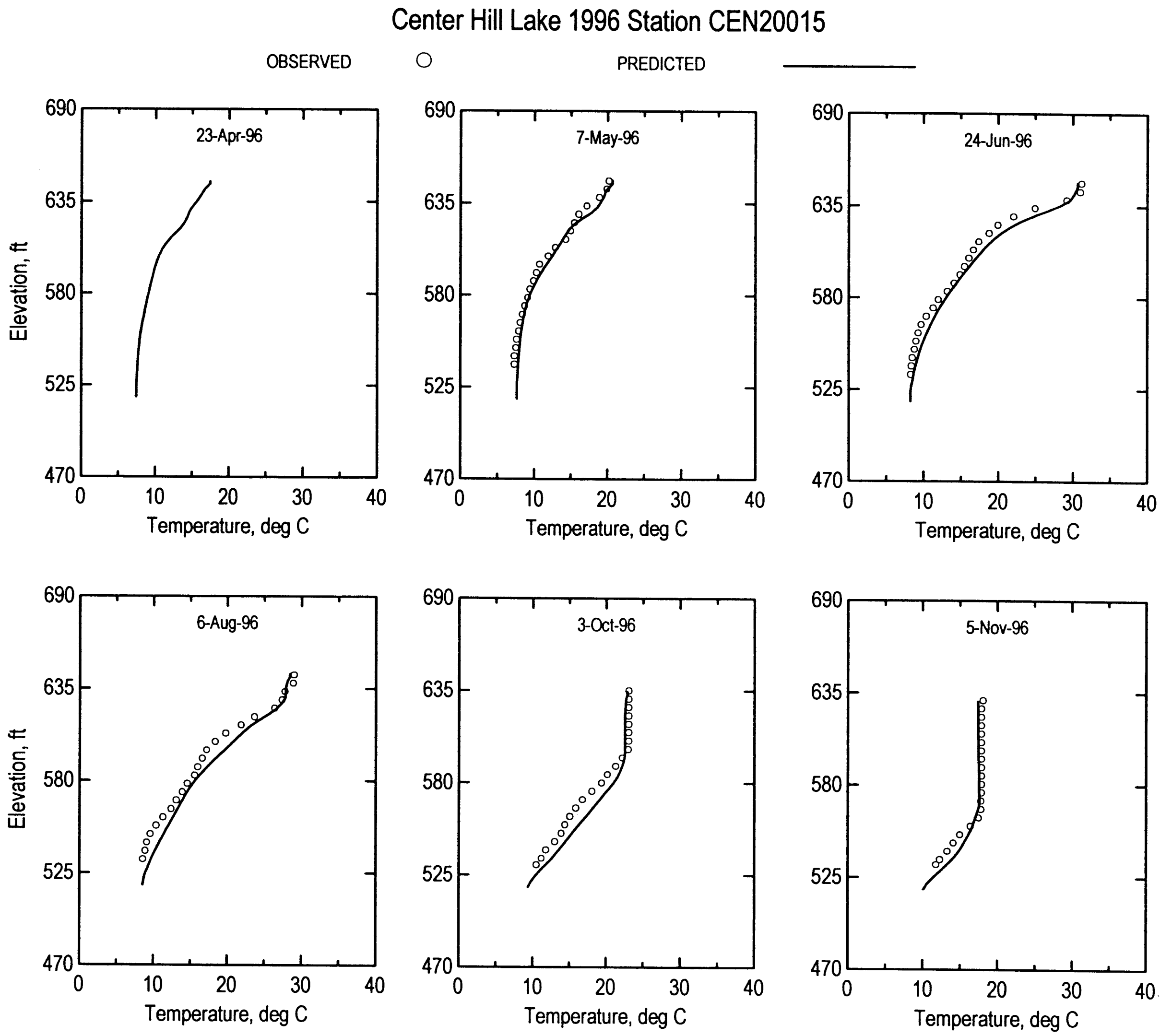


Center Hill Lake 1996 Station CEN20010



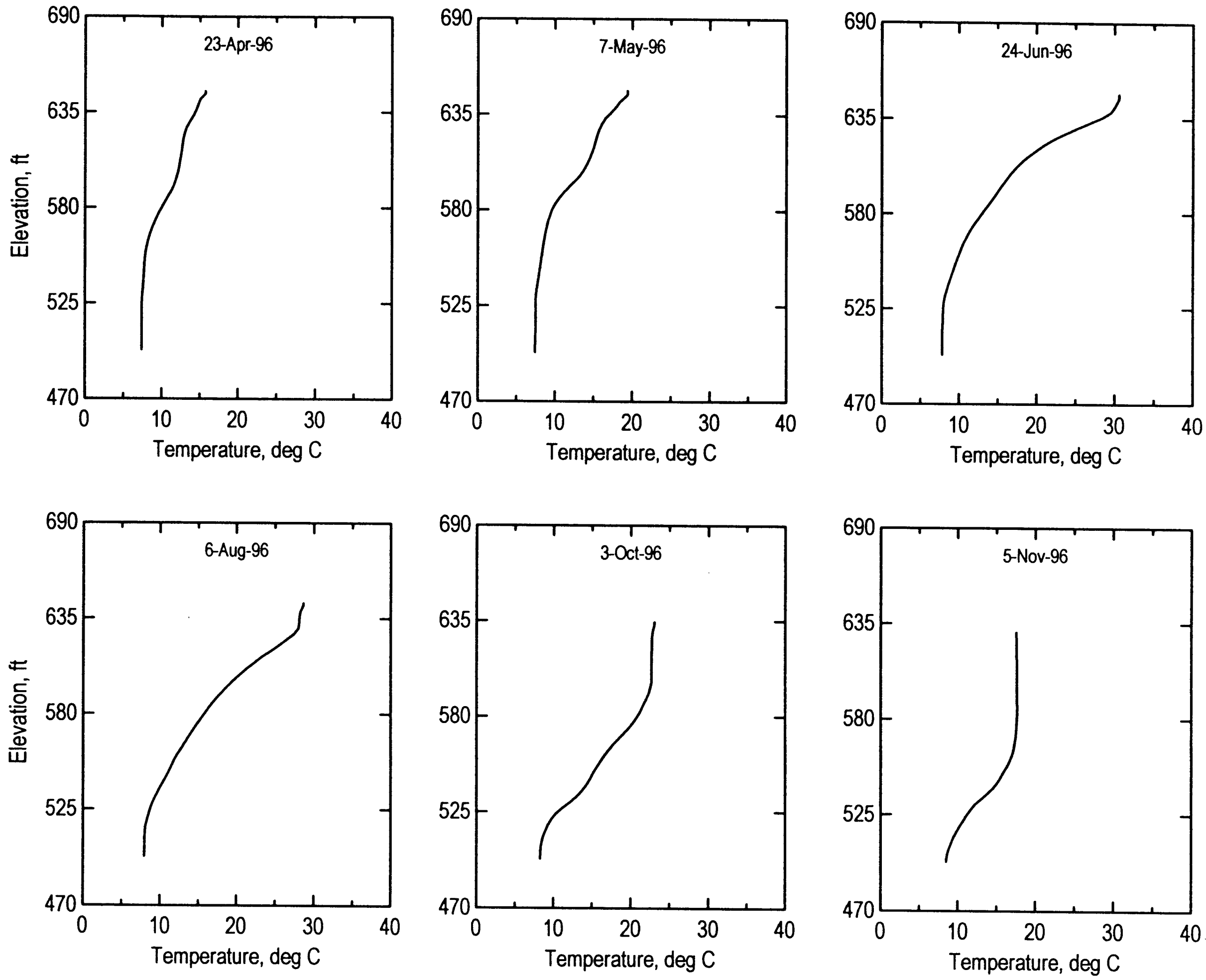
Center Hill Lake 1996 Station CEN20011

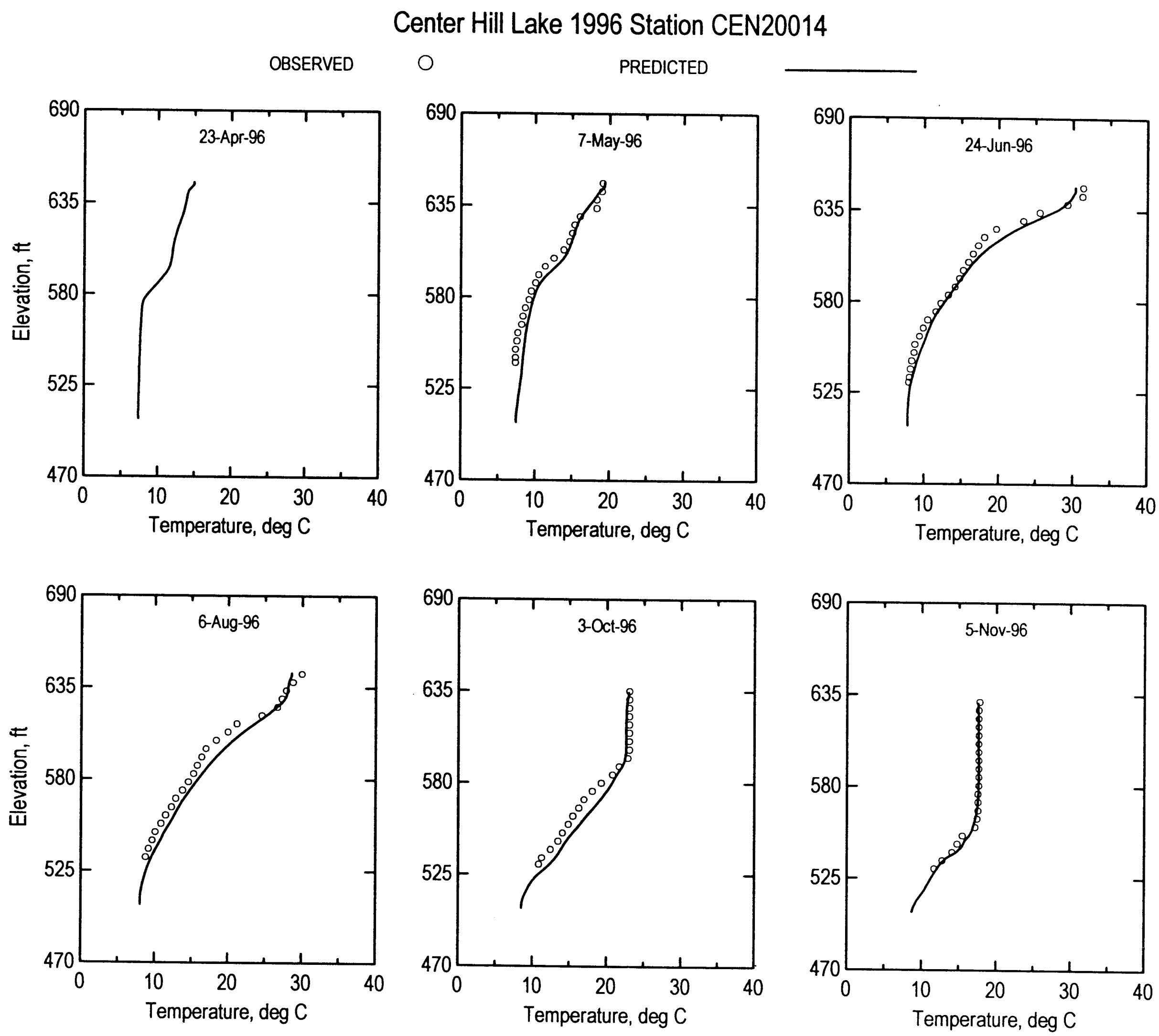



Center Hill Lake 1996 Station CEN20015
OBSERVED
PREDICTED
23-Apr-96
7-May-96
24-Jun-96
6-Aug-96
3-Oct-96
5-Nov-96
Elevation, ft
Temperature, deg C
690
635
580
525
470
0
10
20
30
40

Center Hill Lake 1996 Station CEN20013

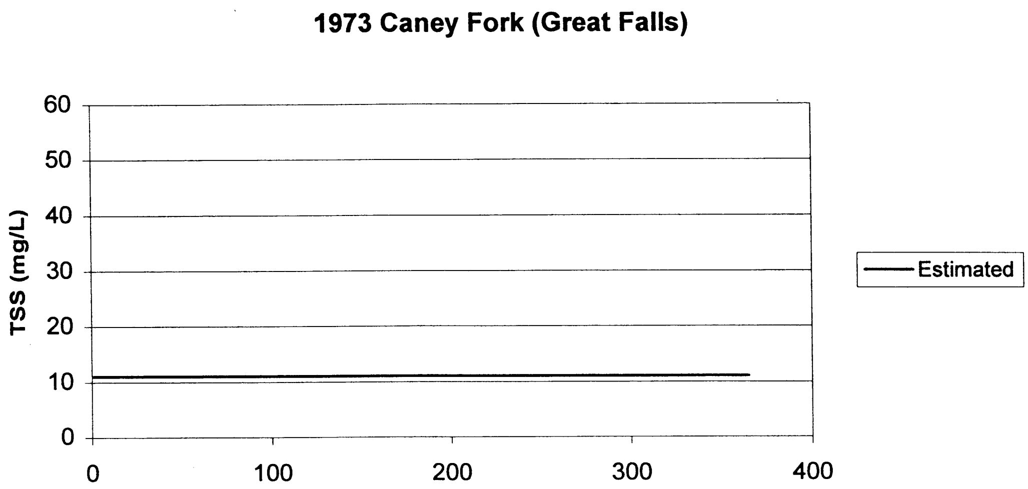
OBSERVED ○ PREDICTED ———

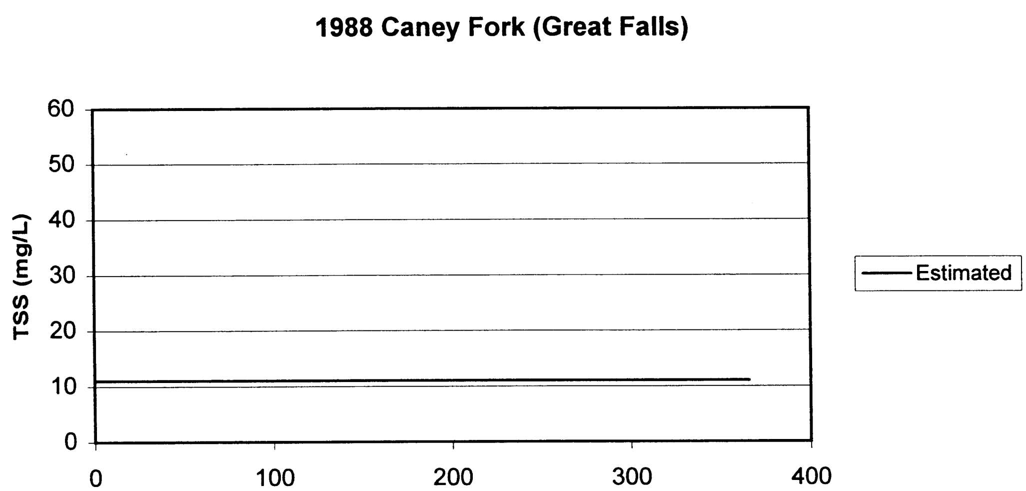


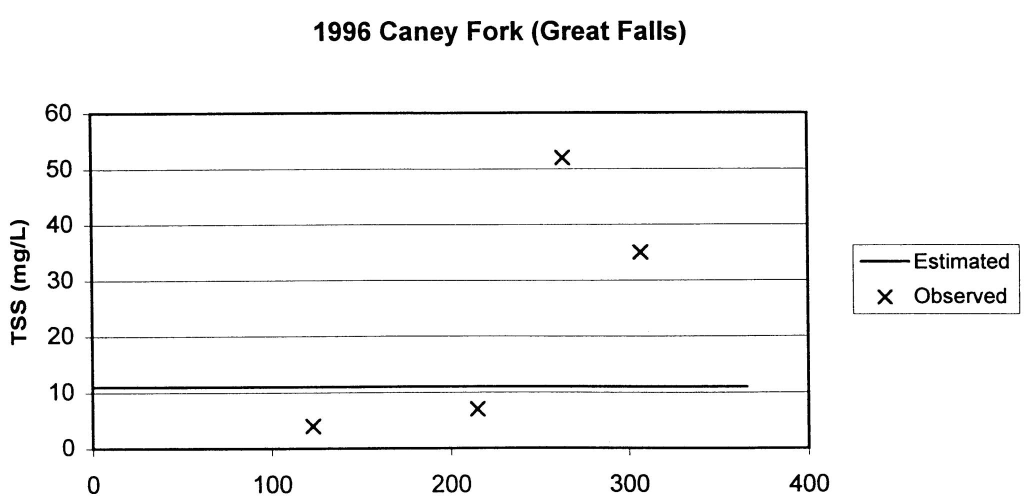

Center Hill Lake 1996 Station CEN20014
OBSERVED
PREDICTED
23-Apr-96
7-May-96
24-Jun-96
6-Aug-96
3-Oct-96
5-Nov-96
Elevation, ft
Temperature, deg C
690
635
580
525
470
0
10
20
30
40

APPENDIX L

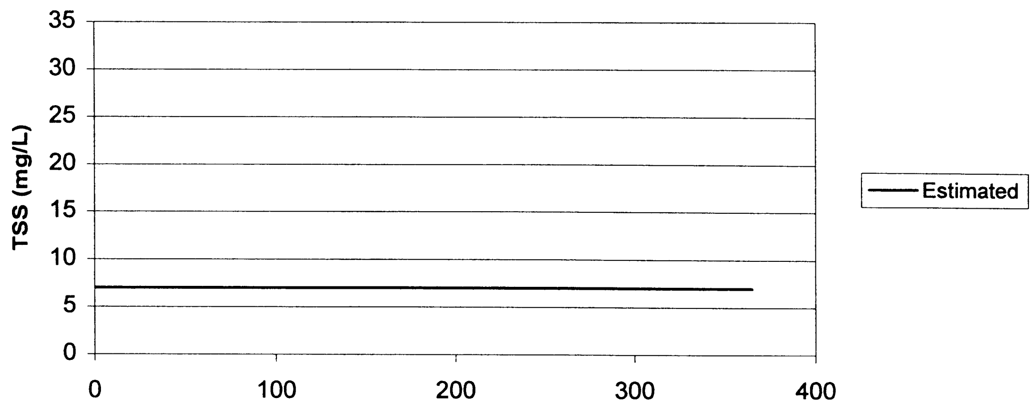
Plots of Estimated Input Water Quality for CE-QUAL-W2


1973 Caney Fork (Great Falls)
TSS (mg/L)
0
10
20
30
40
50
60
0
100
200
300
400
Estimated

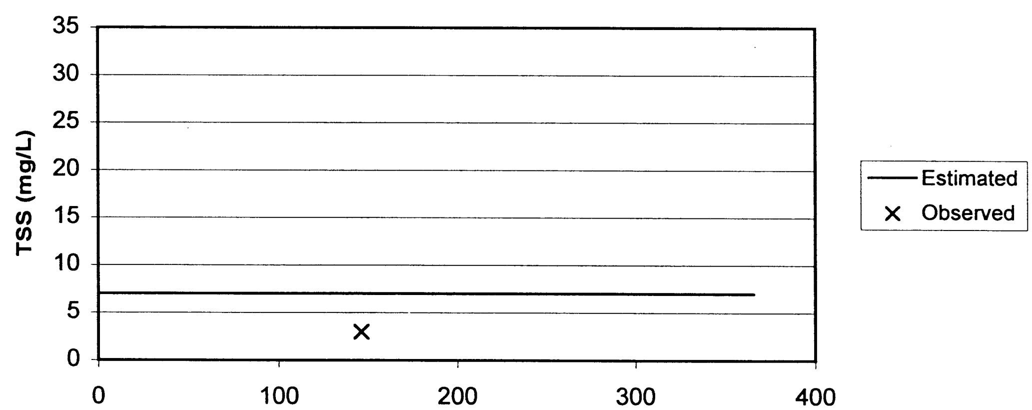

1988 Caney Fork (Great Falls)
TSS (mg/L)
0
10
20
30
40
50
60
0
100
200
300
400
Estimated


1996 Caney Fork (Great Falls)
TSS (mg/L)
0
10
20
30
40
50
60
0
100
200
300
400
Estimated
Observed

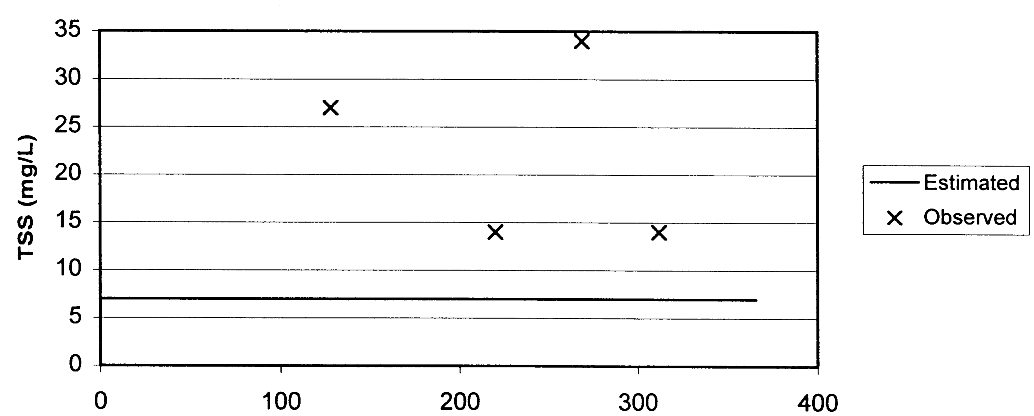
1973 Pine Creek



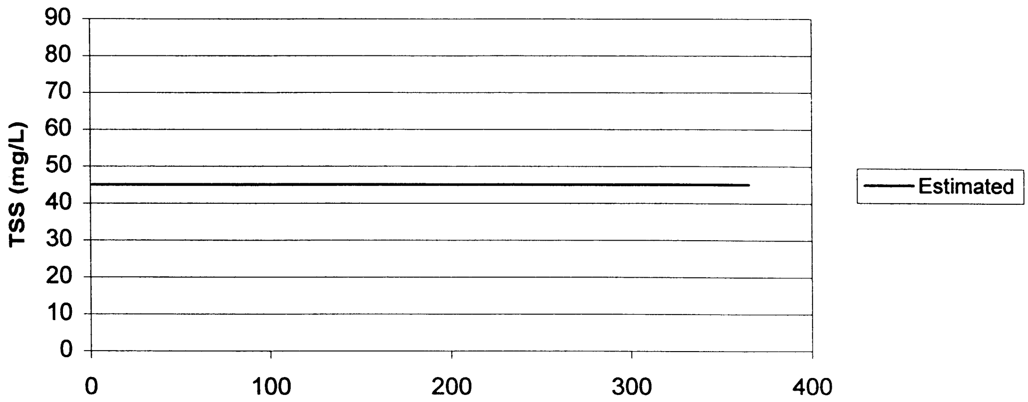
1988 Pine Creek



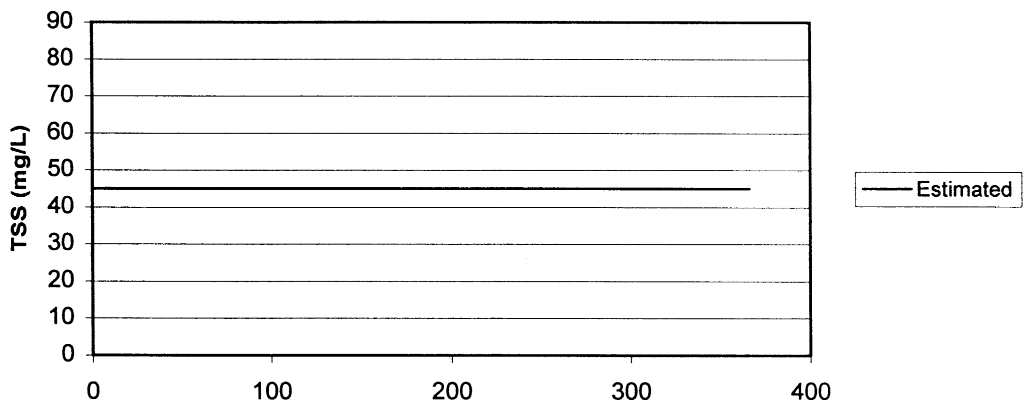
1996 Pine Creek



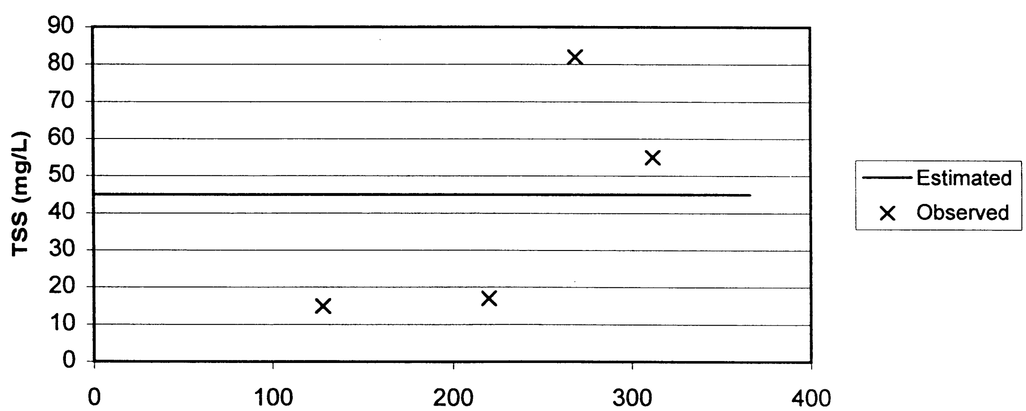
1973 Fall Creek



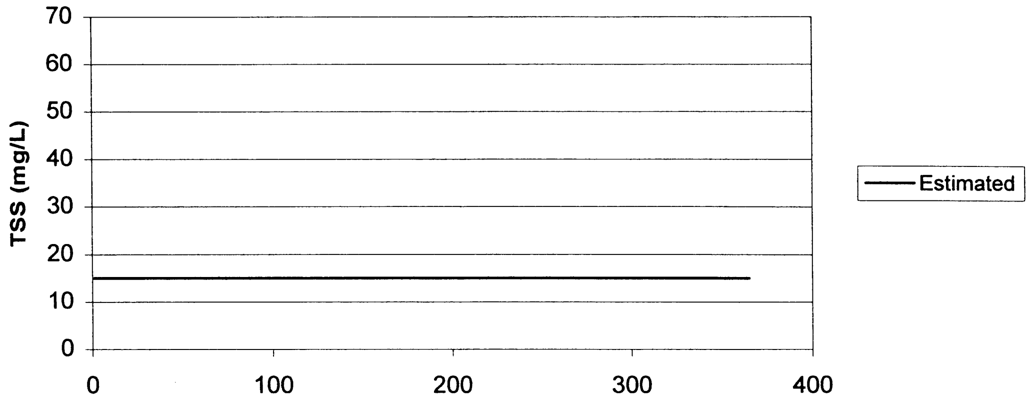
1988 Fall Creek



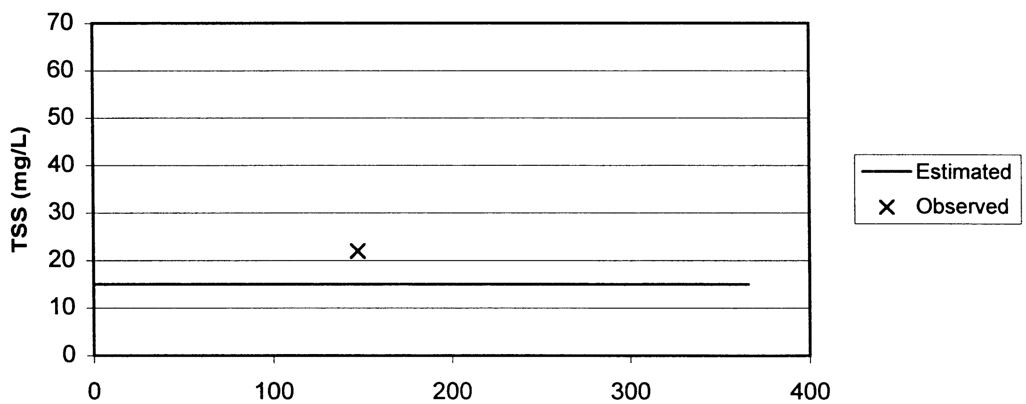
1996 Fall Creek



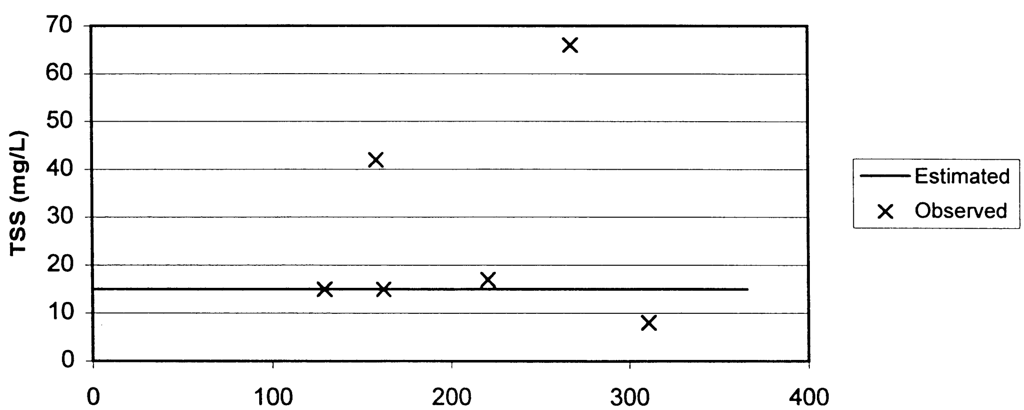
1973 Falling Water River



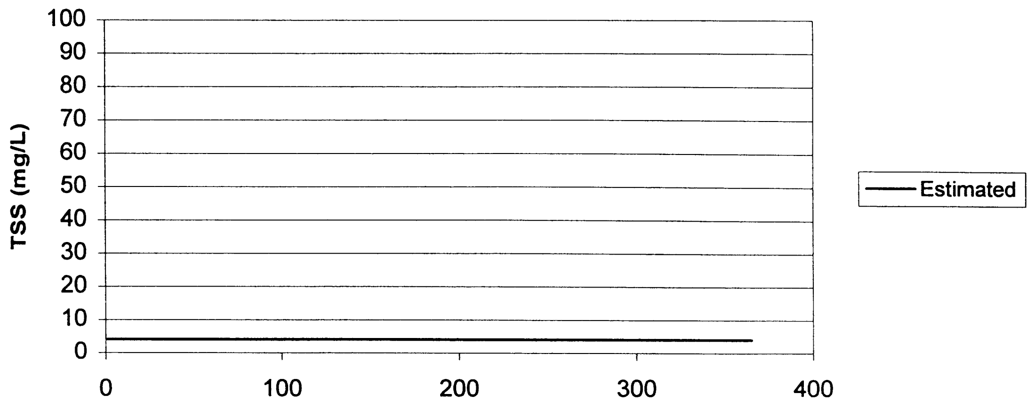
1988 Falling Water River



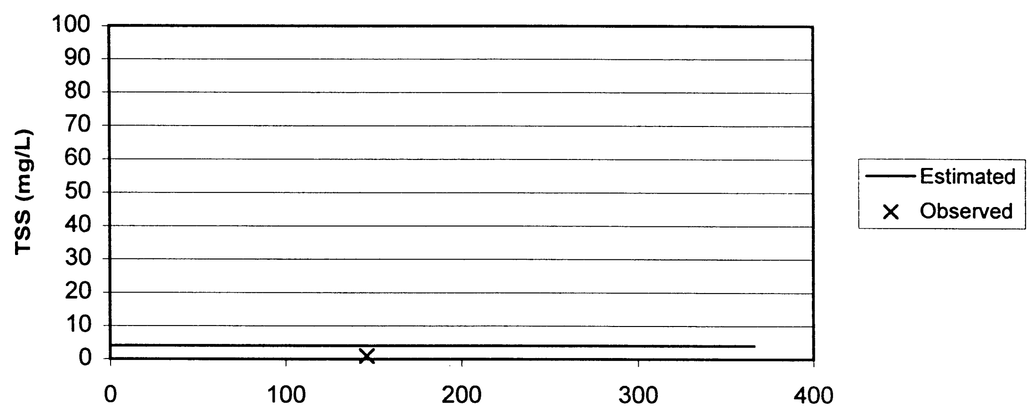
1996 Falling Water River



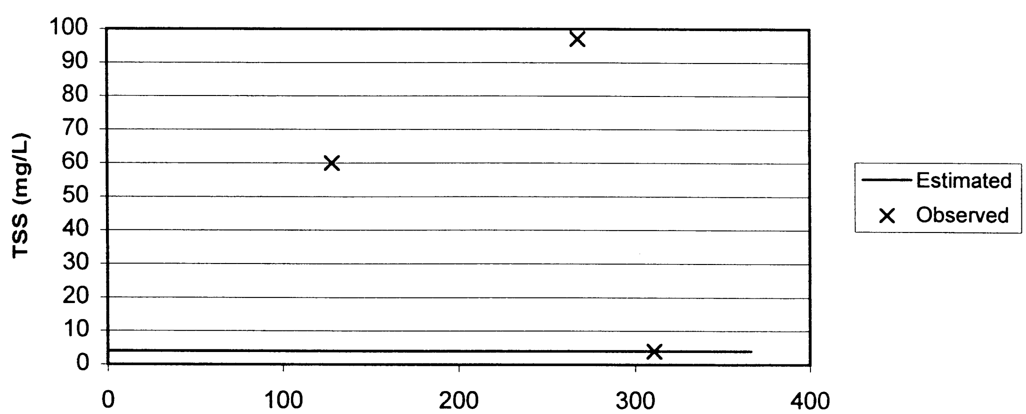
1973 Mine Lick Creek



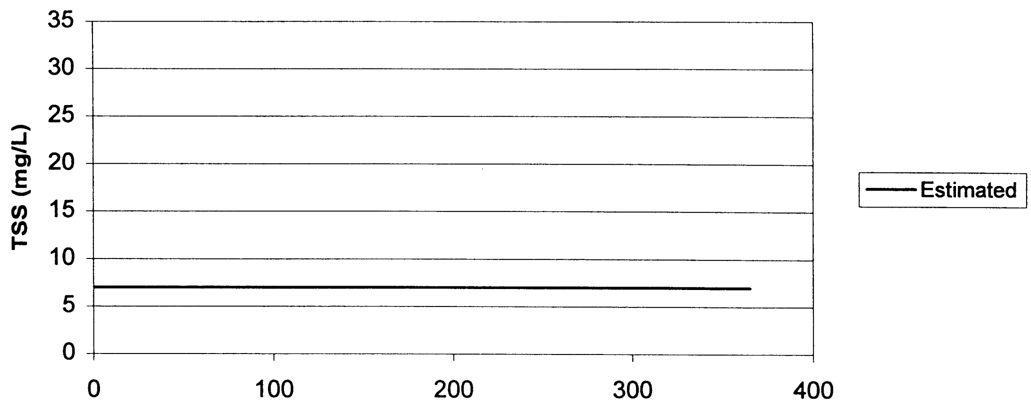
1988 Mine Lick Creek



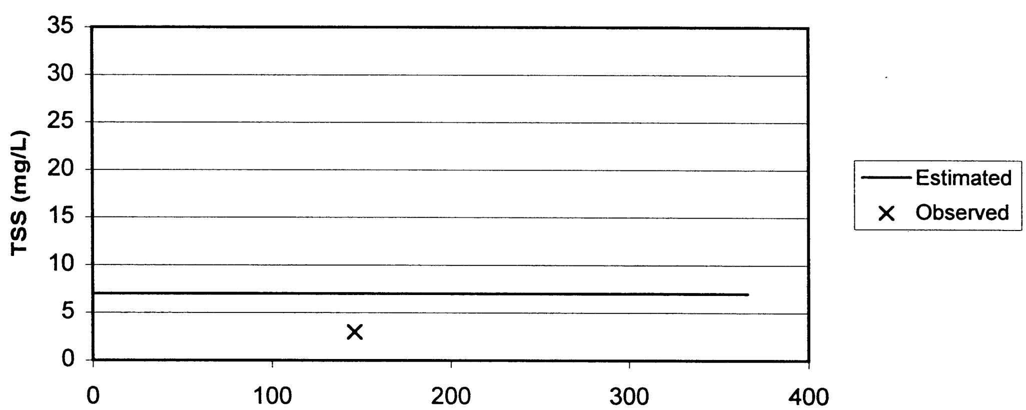
1996 Mine Lick Creek



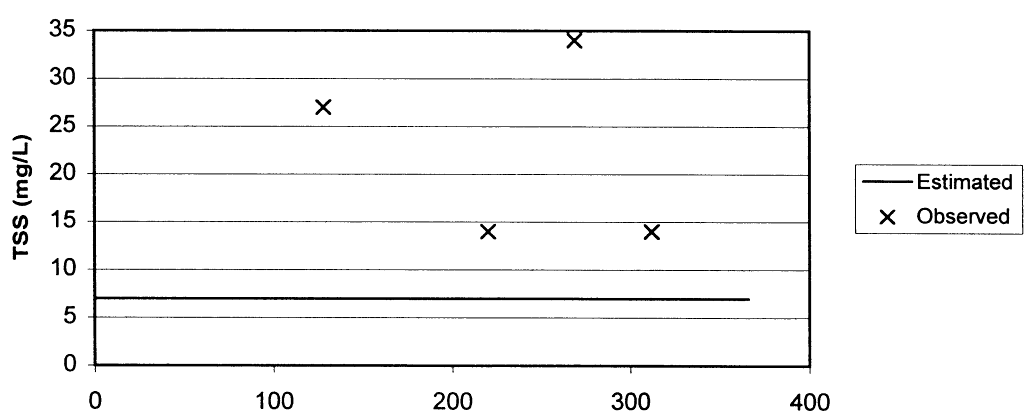
1973 Holmes Creek



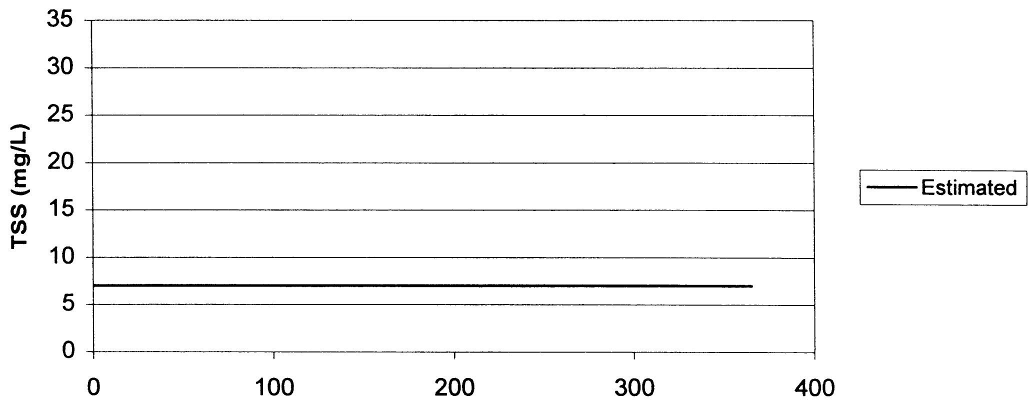
1988 Holmes Creek



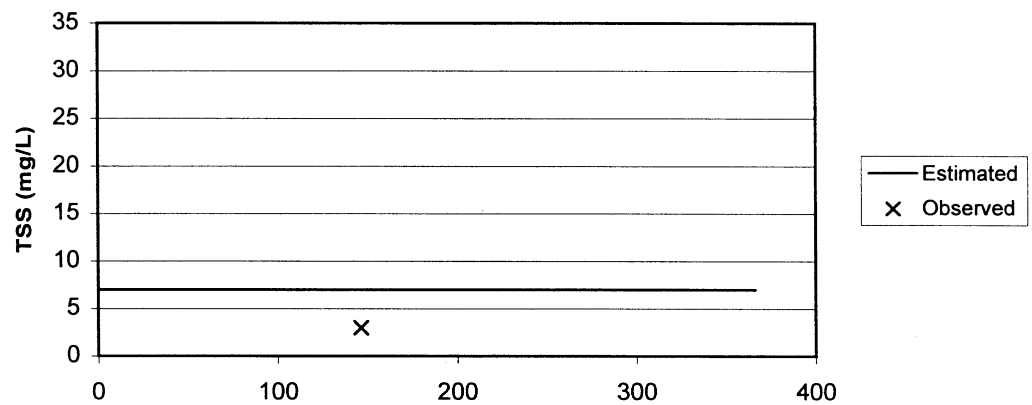
1996 Holmes Creek



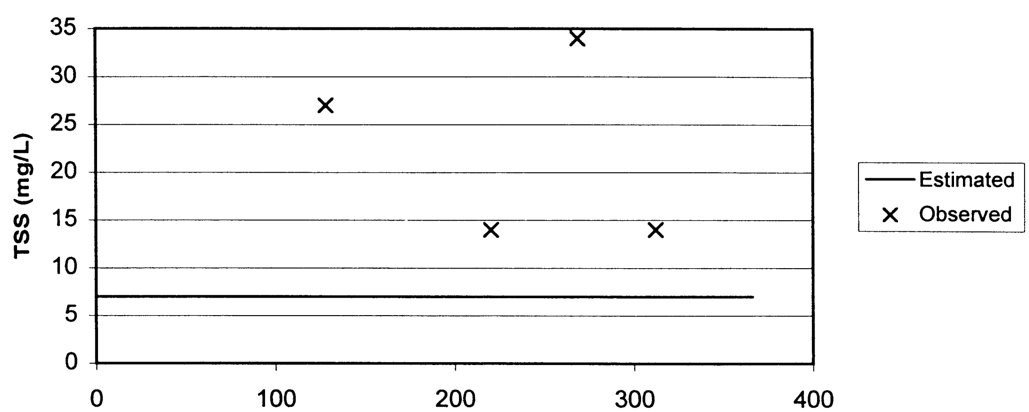
1973 Indian Creek

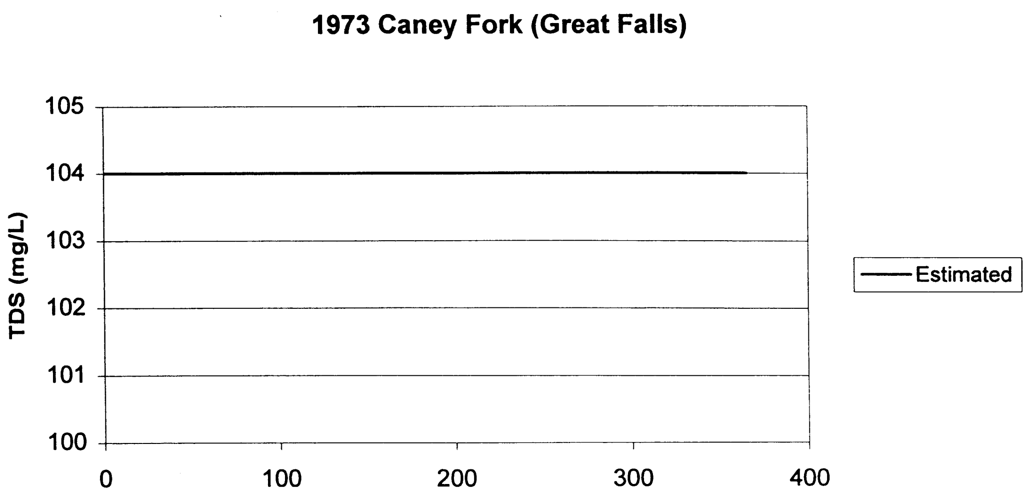


1988 Indian Creek

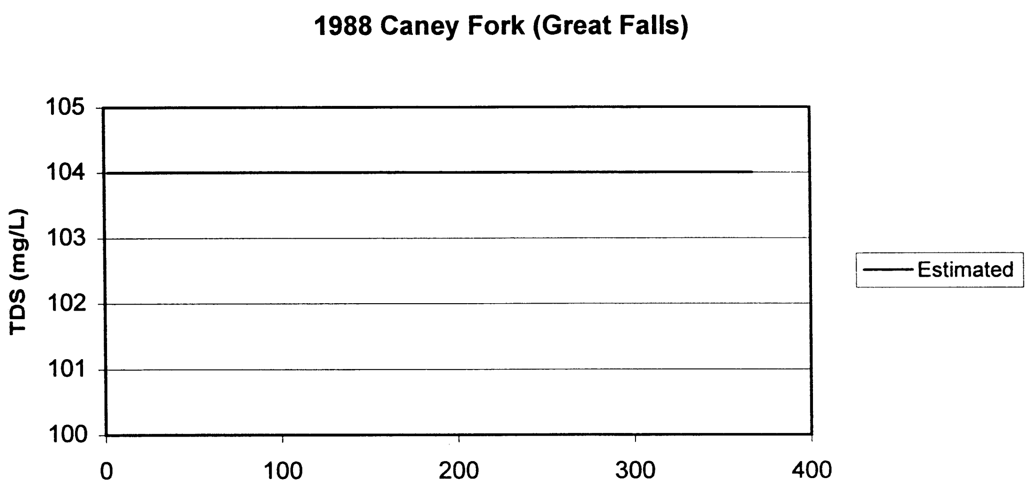


1996 Indian Creek

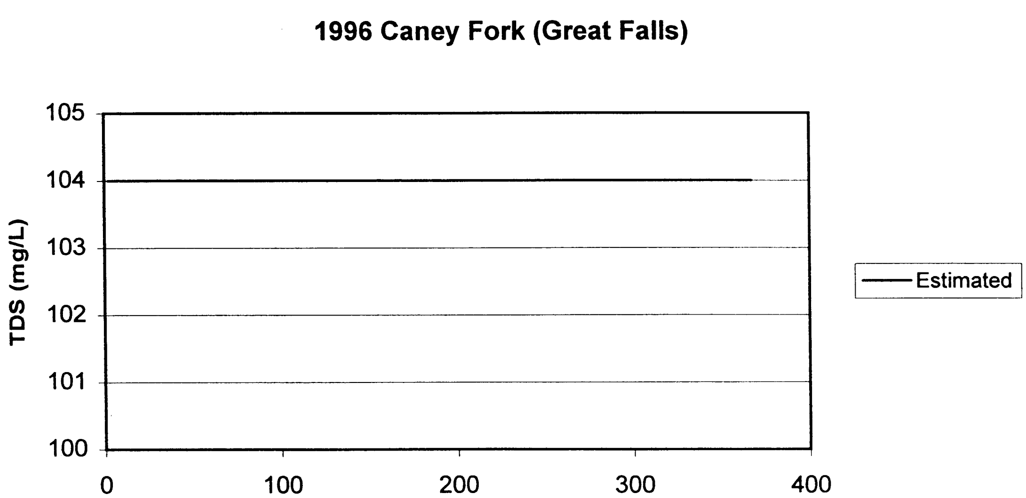




1973 Caney Fork (Great Falls)
105
104
103
102
101
100
TDS (mg/L)
0
100
200
300
400
Estimated

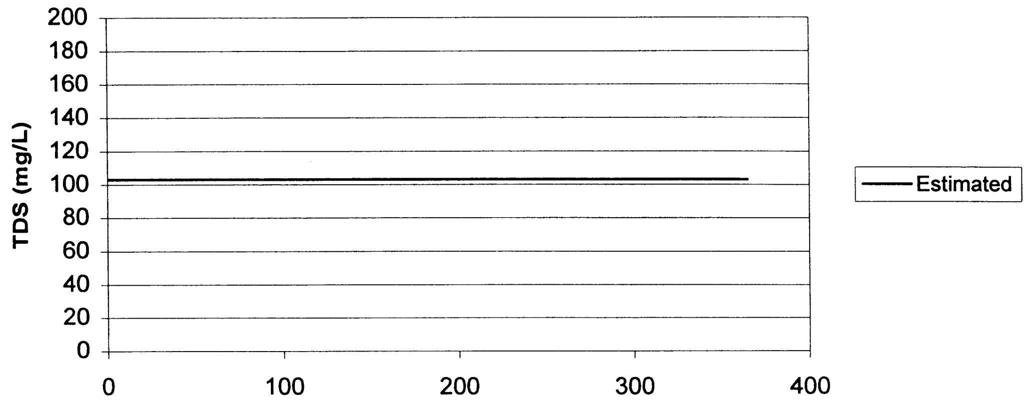


1988 Caney Fork (Great Falls)
105
104
103
102
101
100
TDS (mg/L)
0
100
200
300
400
Estimated

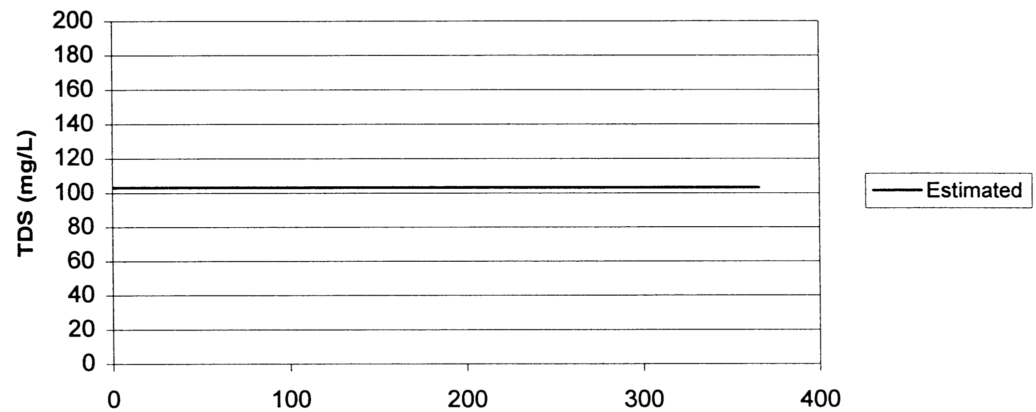


1996 Caney Fork (Great Falls)
105
104
103
102
101
100
TDS (mg/L)
0
100
200
300
400
Estimated

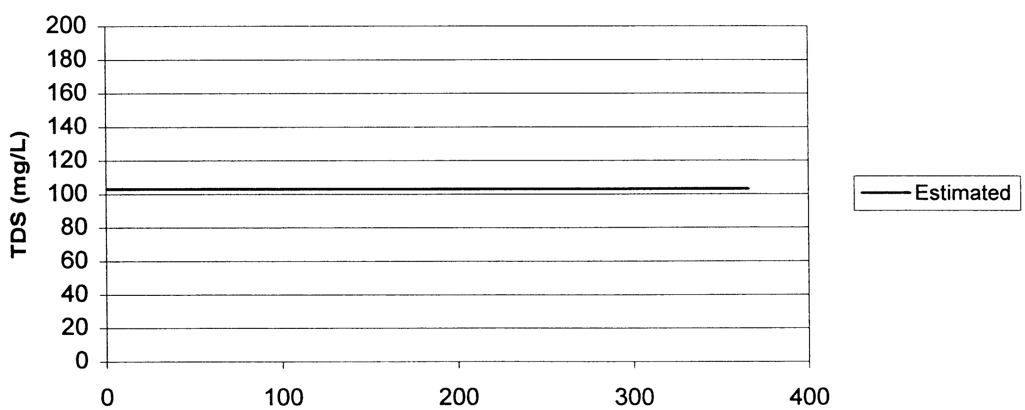
1973 Pine Creek



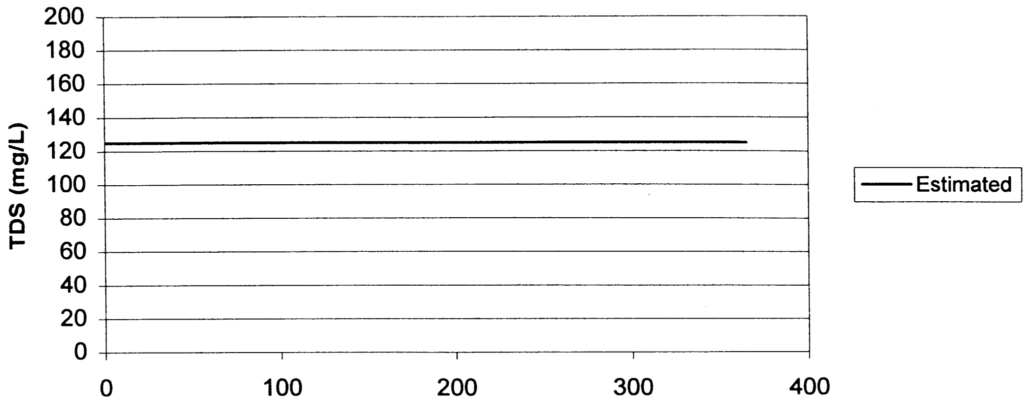
1988 Pine Creek



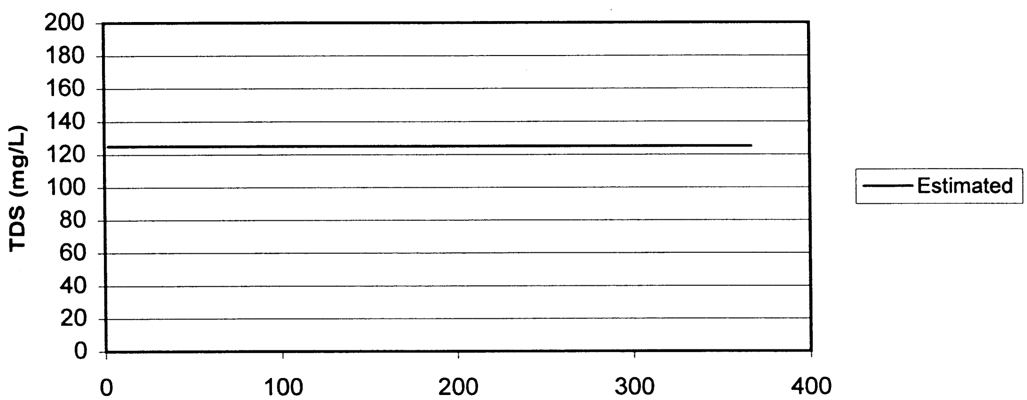
1996 Pine Creek



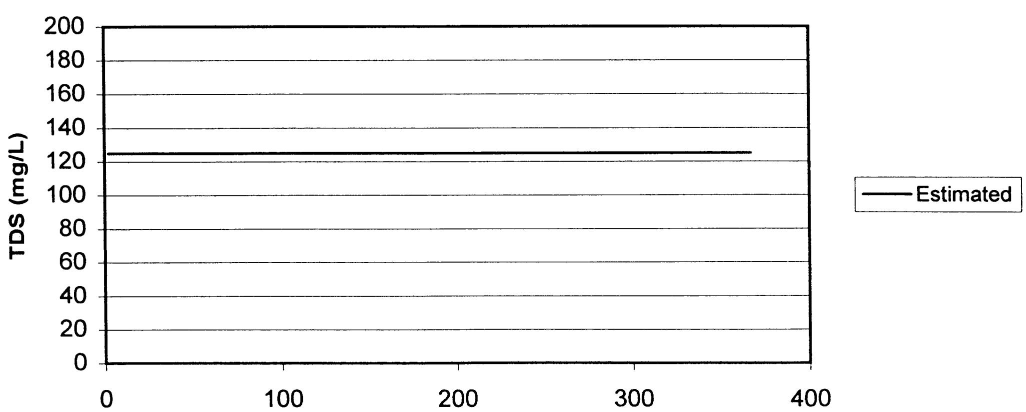
1973 Fall Creek



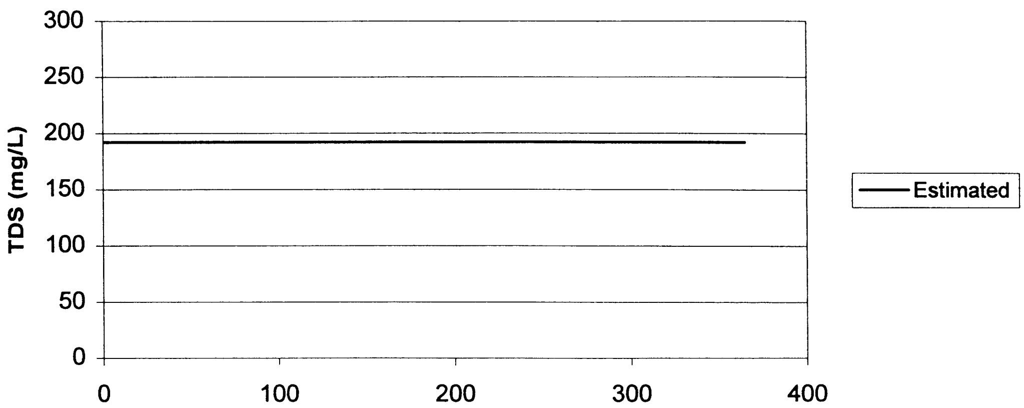
1988 Fall Creek



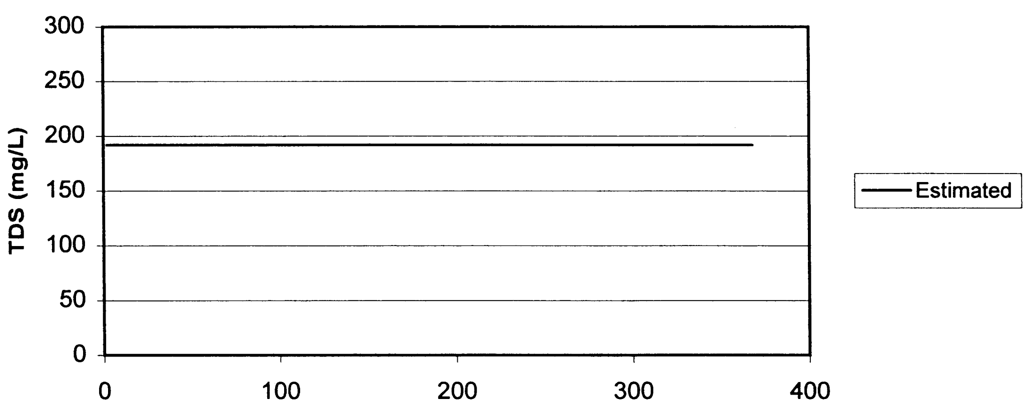
1996 Fall Creek



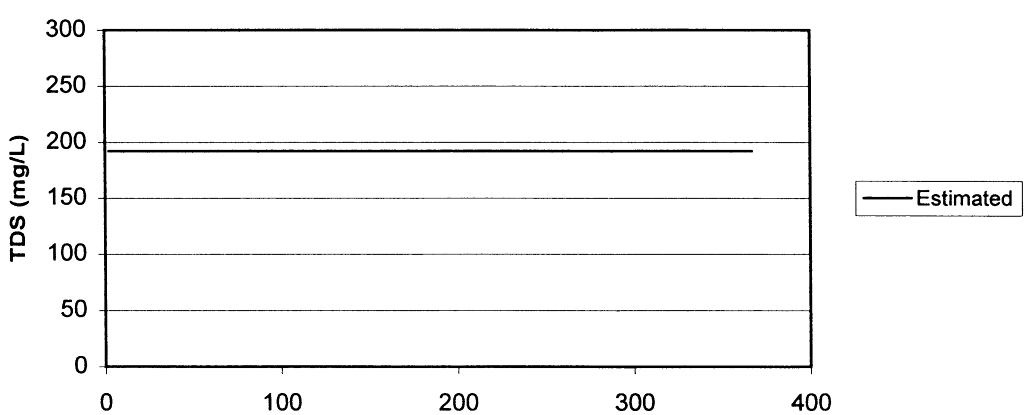
1973 Falling Water River



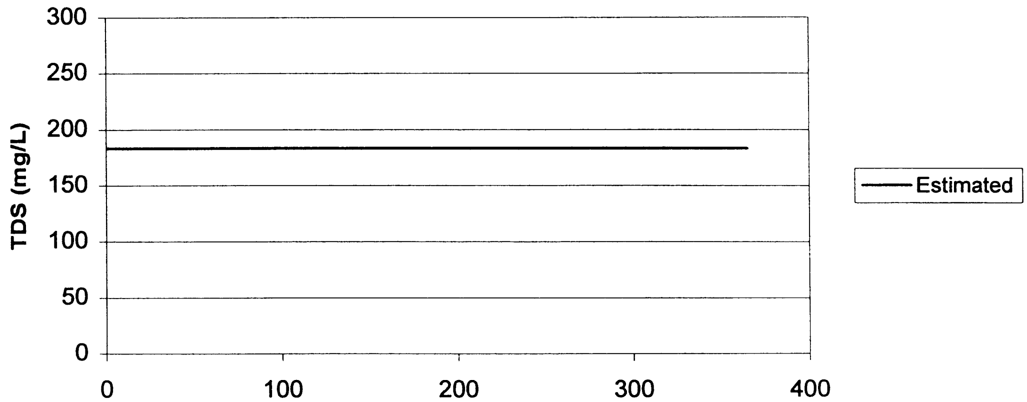
1988 Falling Water River



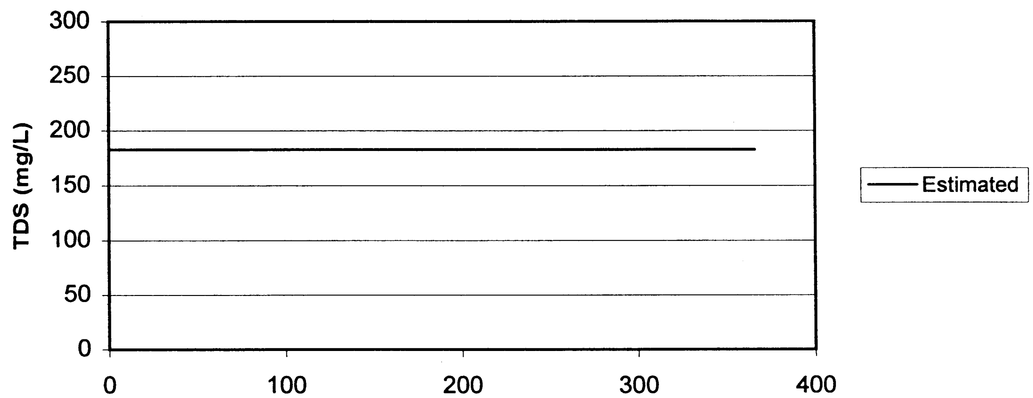
1996 Falling Water River



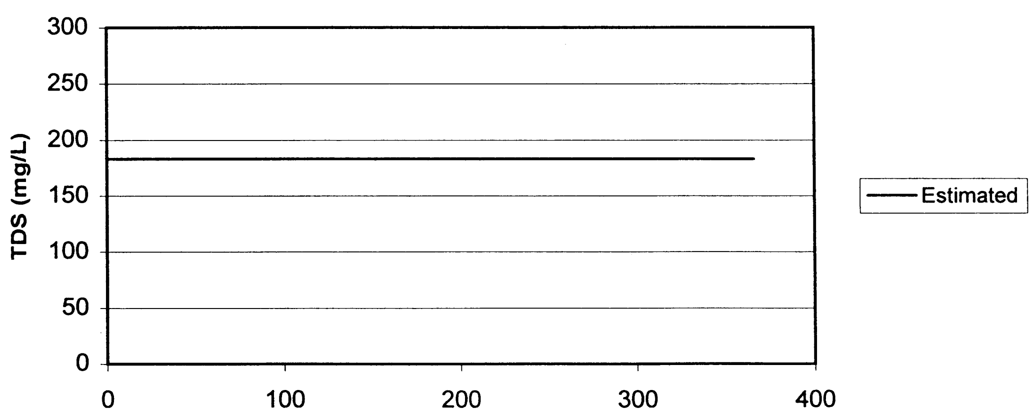
1973 Mine Lick Creek

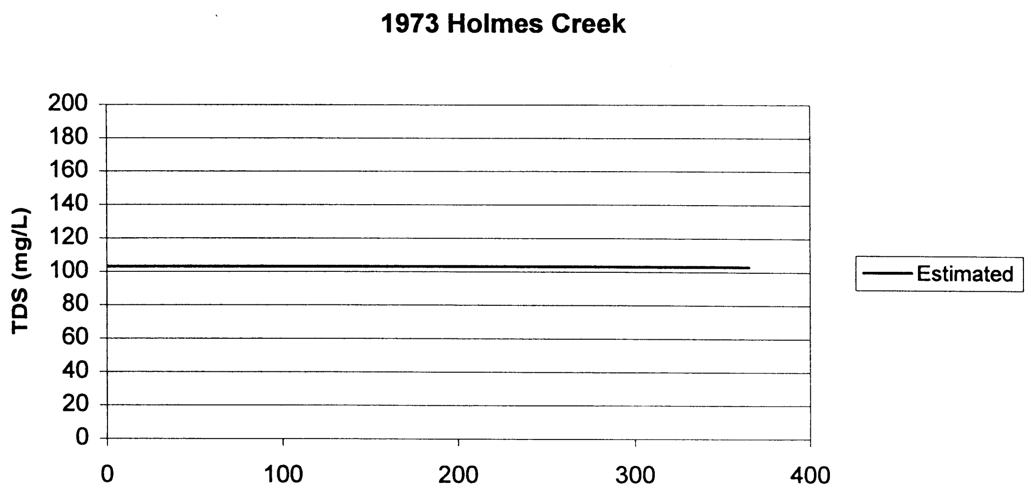


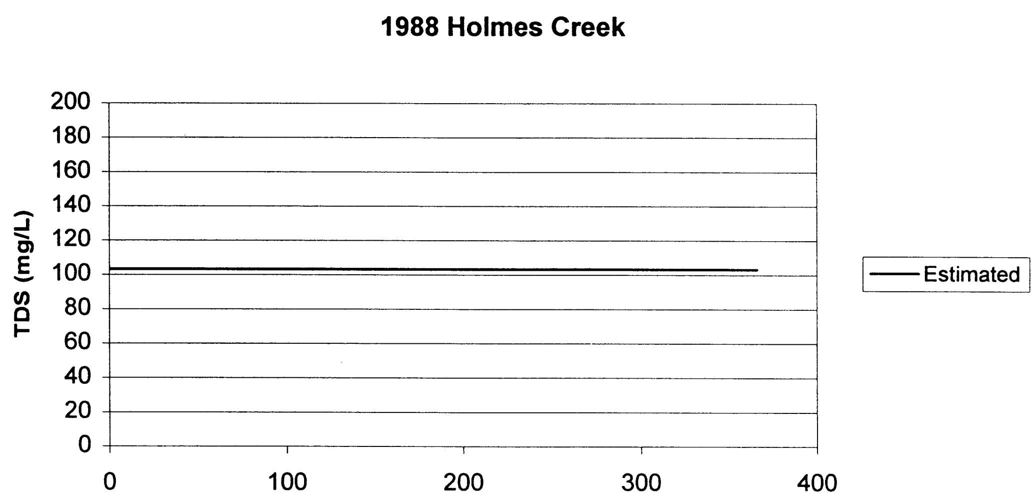
1988 Mine Lick Creek

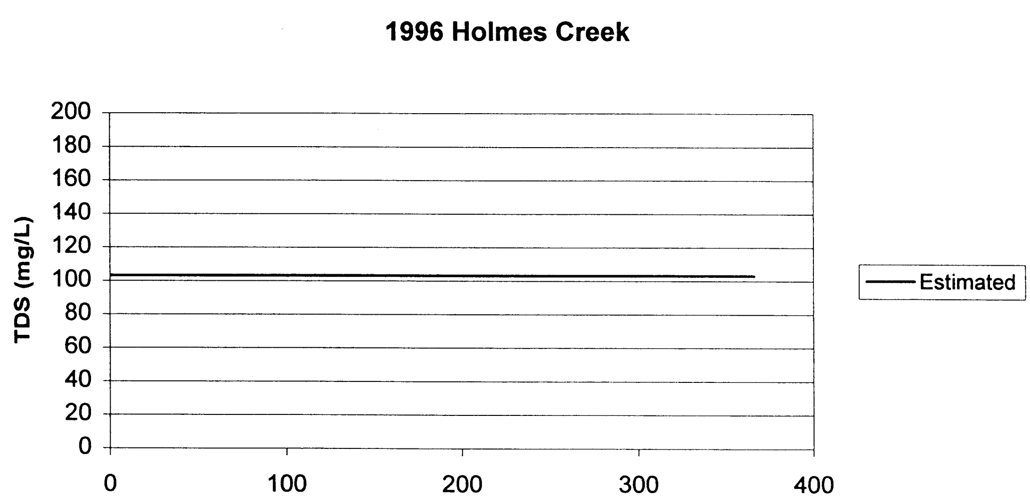


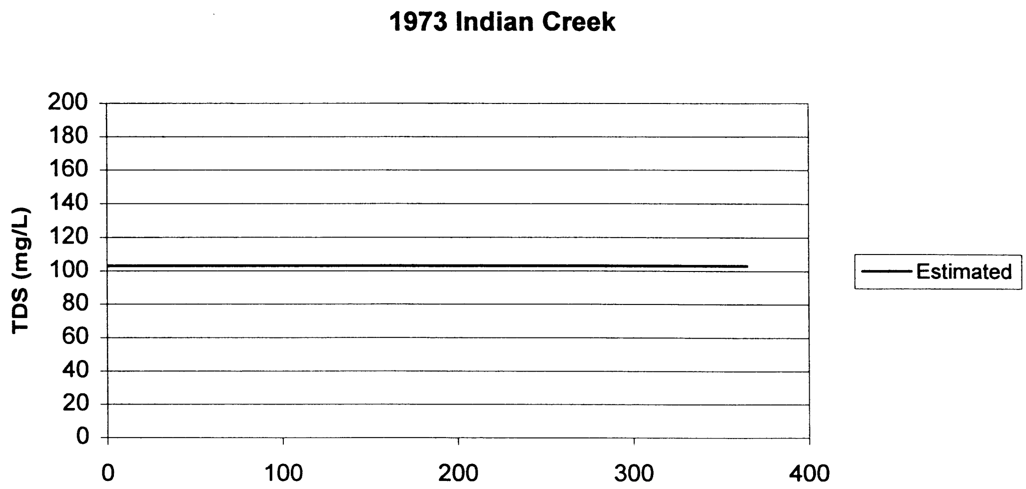
1996 Mine Lick Creek



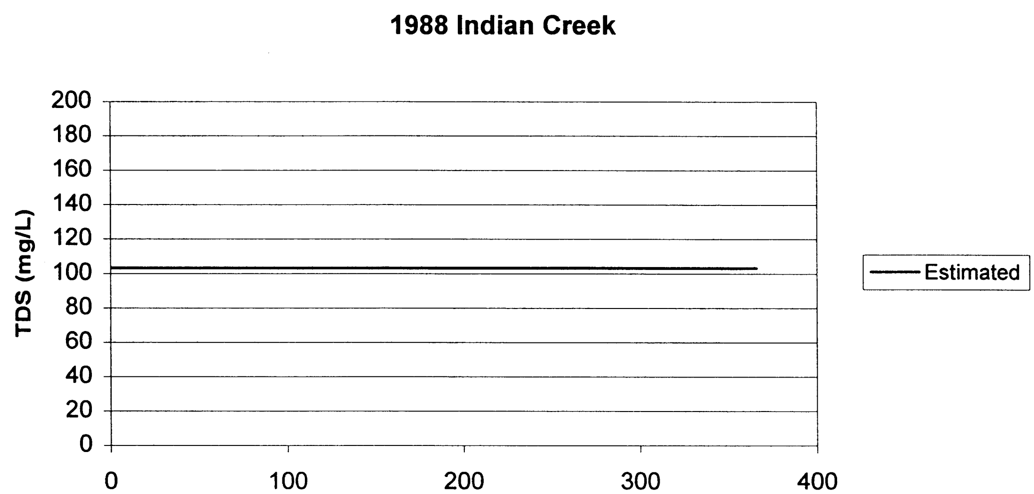

1973 Holmes Creek
TDS (mg/L)
200
180
160
140
120
100
80
60
40
20
0
0
100
200
300
400
Estimated


1988 Holmes Creek
TDS (mg/L)
200
180
160
140
120
100
80
60
40
20
0
0
100
200
300
400
Estimated

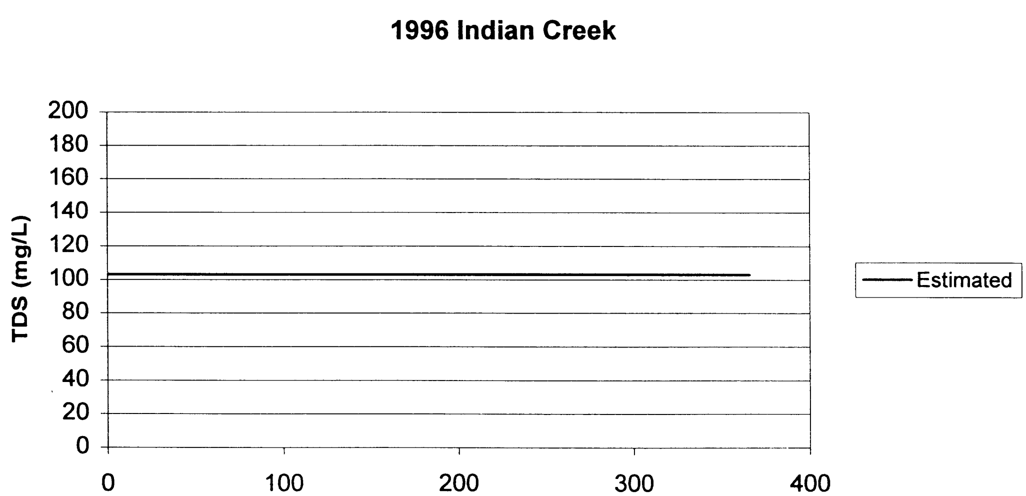

1996 Holmes Creek
TDS (mg/L)
200
180
160
140
120
100
80
60
40
20
0
0
100
200
300
400
Estimated



1973 Indian Creek
TDS (mg/L)
200
180
160
140
120
100
80
60
40
20
0
0
100
200
300
400
Estimated

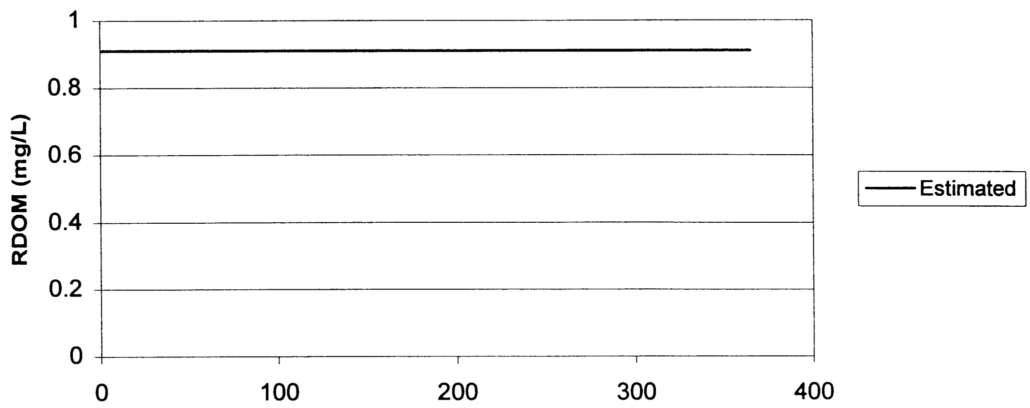


1988 Indian Creek
TDS (mg/L)
200
180
160
140
120
100
80
60
40
20
0
0
100
200
300
400
Estimated

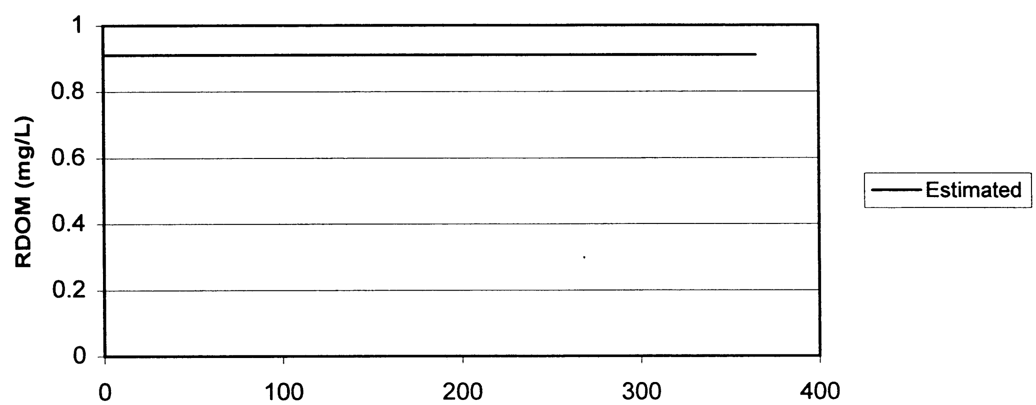


1996 Indian Creek
TDS (mg/L)
200
180
160
140
120
100
80
60
40
20
0
0
100
200
300
400
Estimated

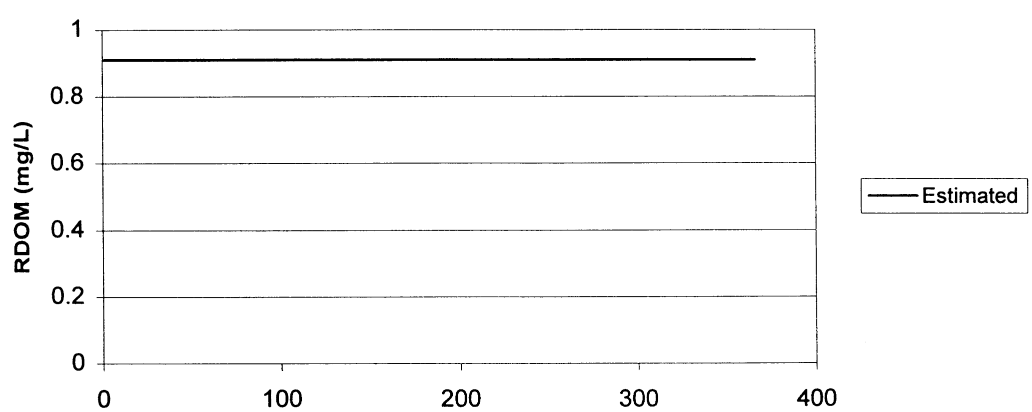
1973 Caney Fork (Great Falls)



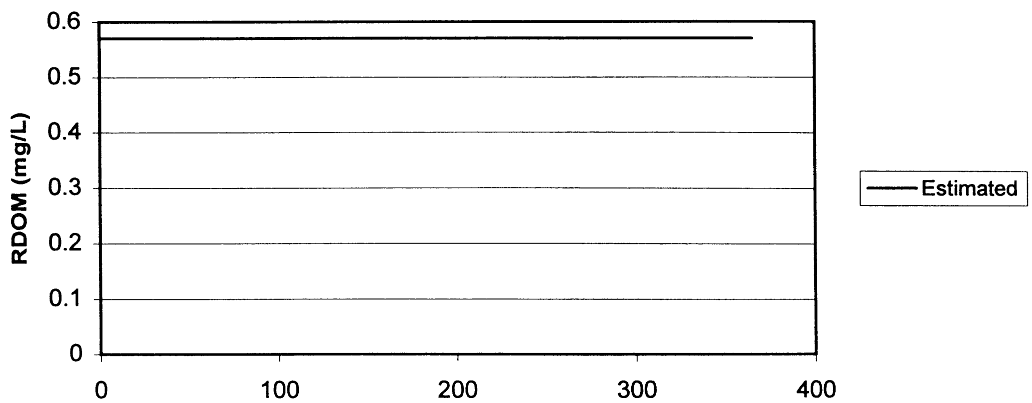
1988 Caney Fork (Great Falls)



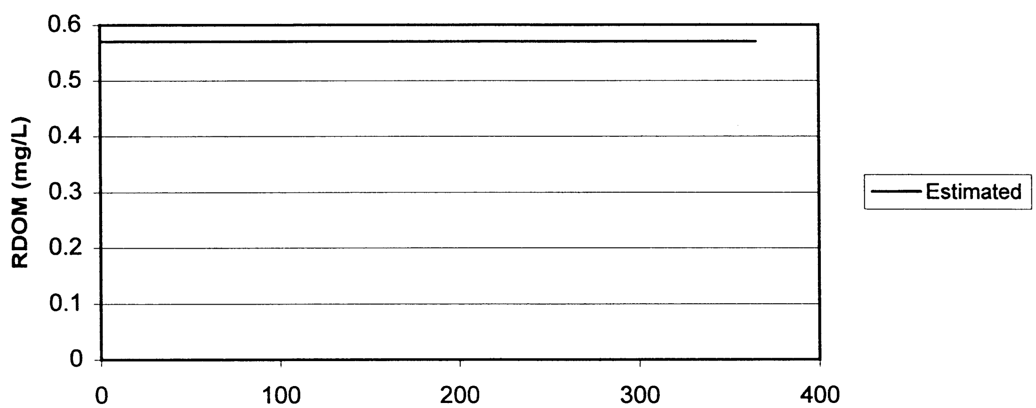
1996 Caney Fork (Great Falls)



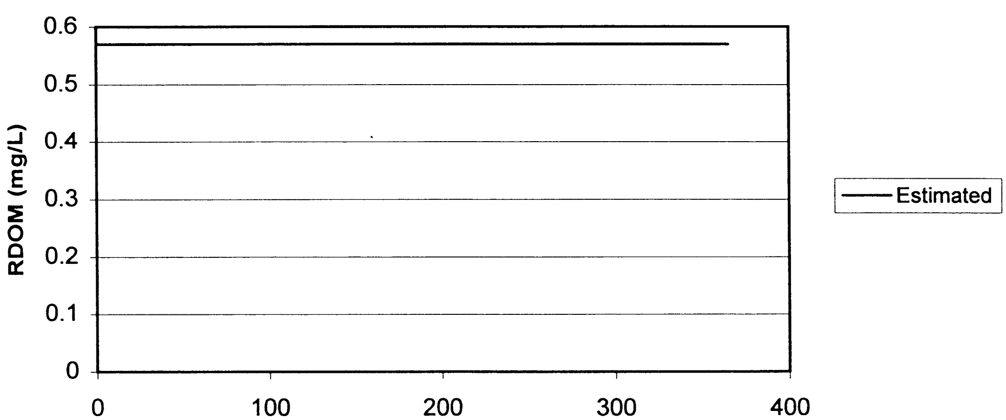
1973 Pine Creek



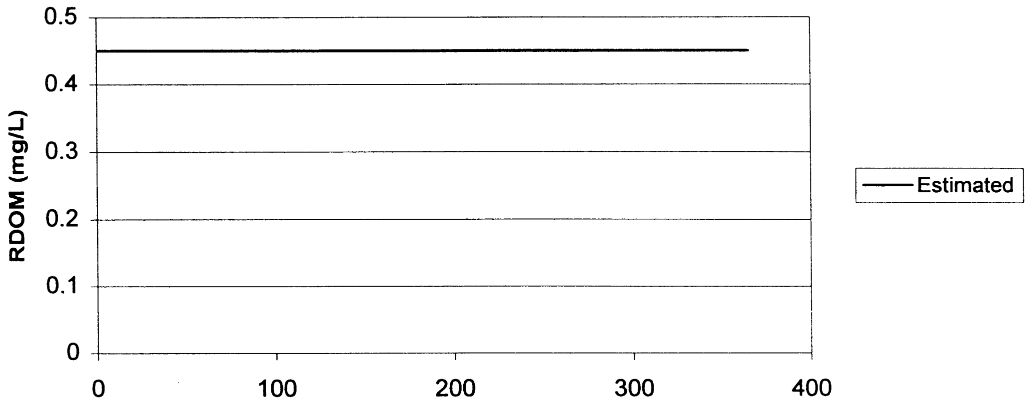
1988 Pine Creek



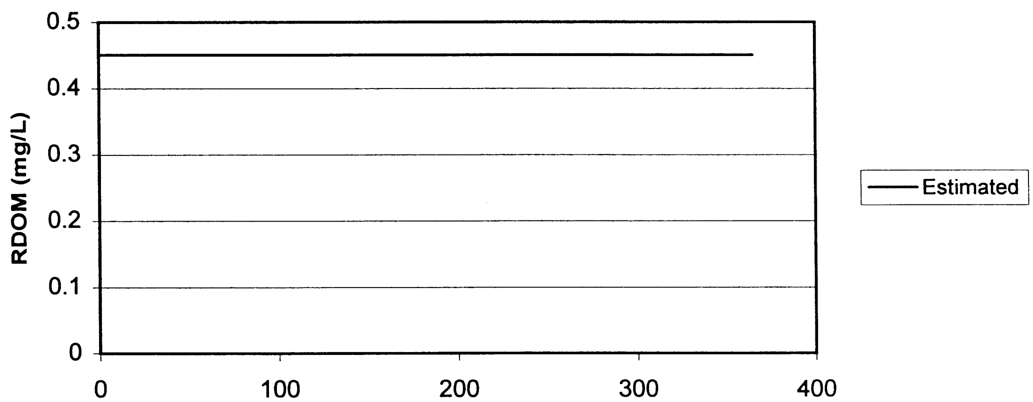
1996 Pine Creek



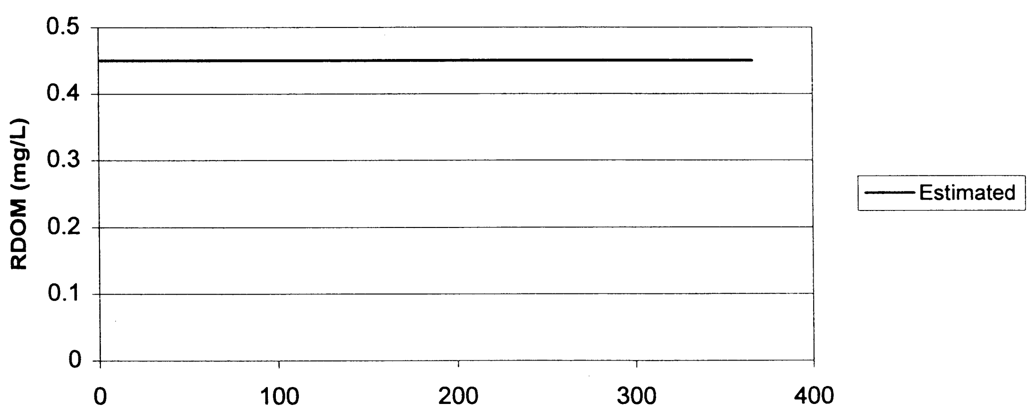
1973 Fall Creek

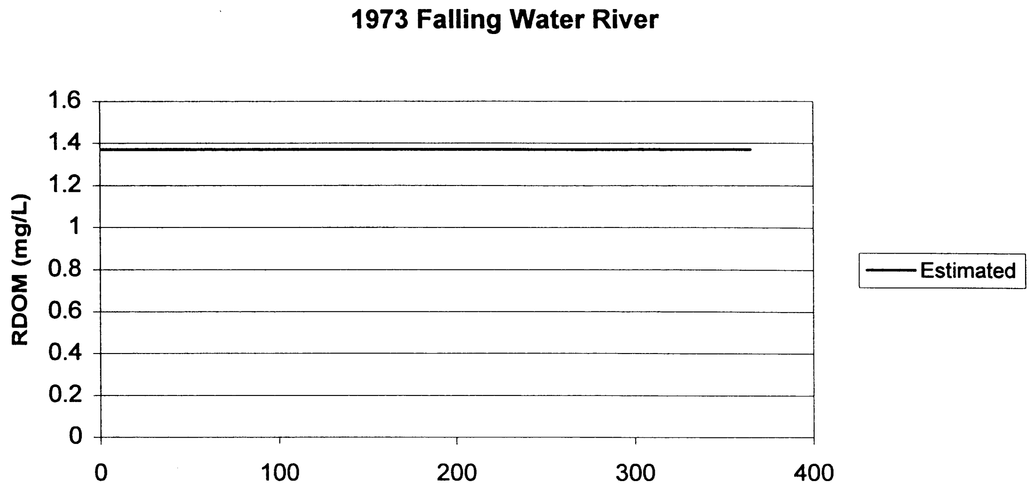


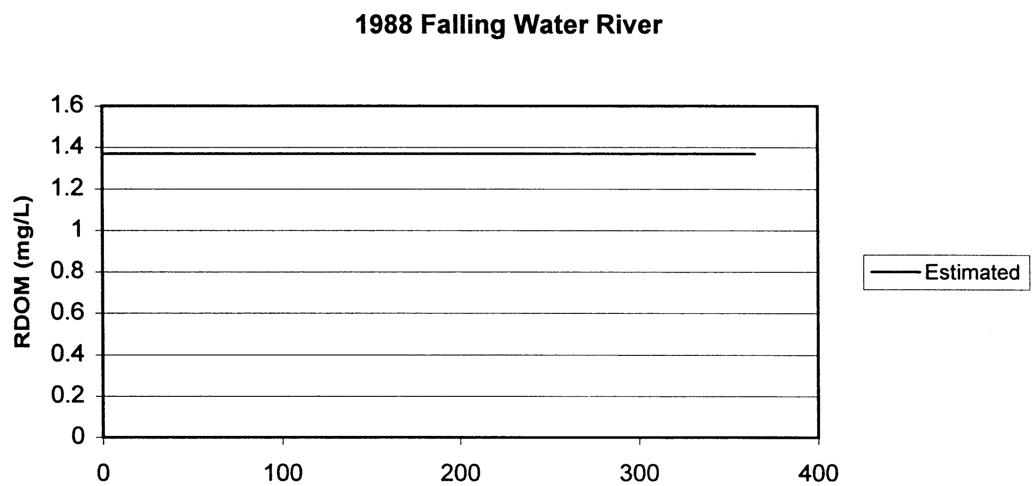
1988 Fall Creek

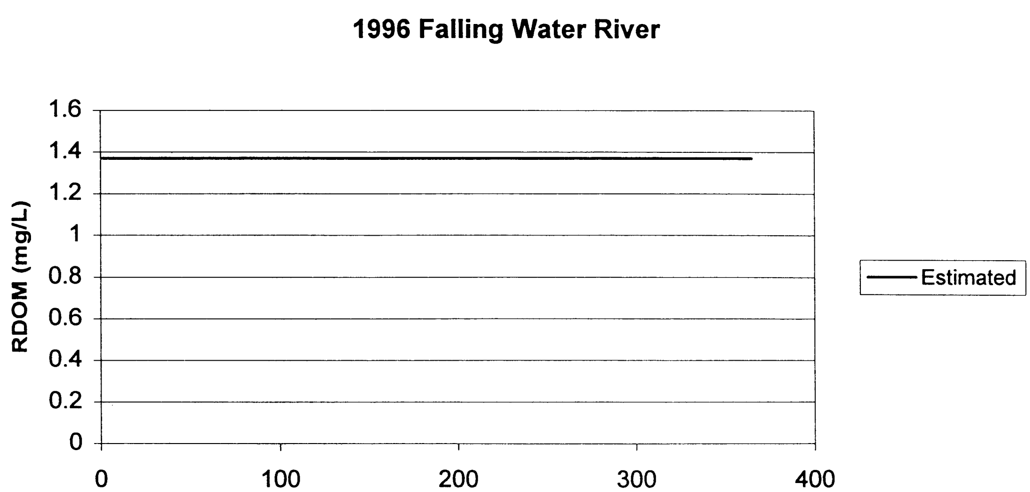


1996 Fall Creek

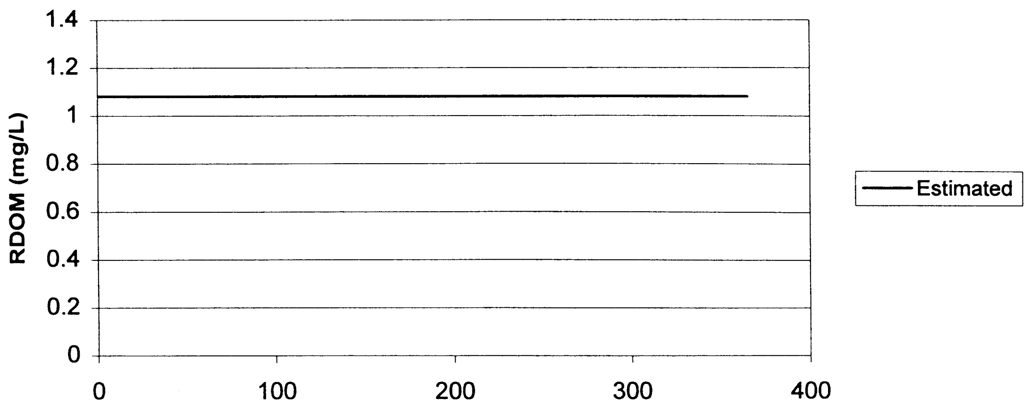



1973 Falling Water River
RDOM (mg/L)
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0
100
200
300
400
Estimated

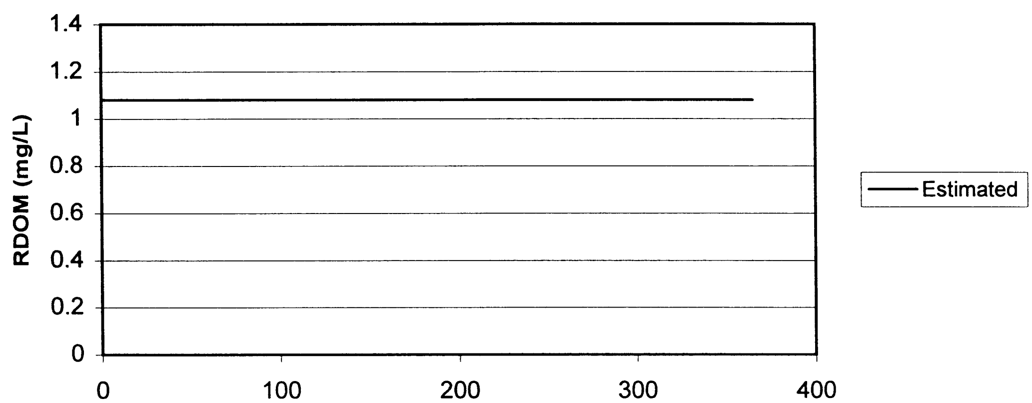

1988 Falling Water River
RDOM (mg/L)
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0
100
200
300
400
Estimated


1996 Falling Water River
RDOM (mg/L)
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0
100
200
300
400
Estimated

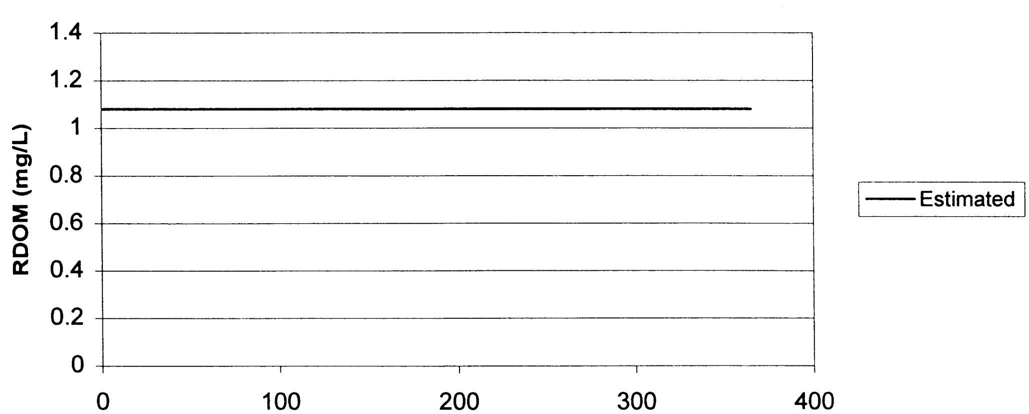
1973 Mine Lick Creek



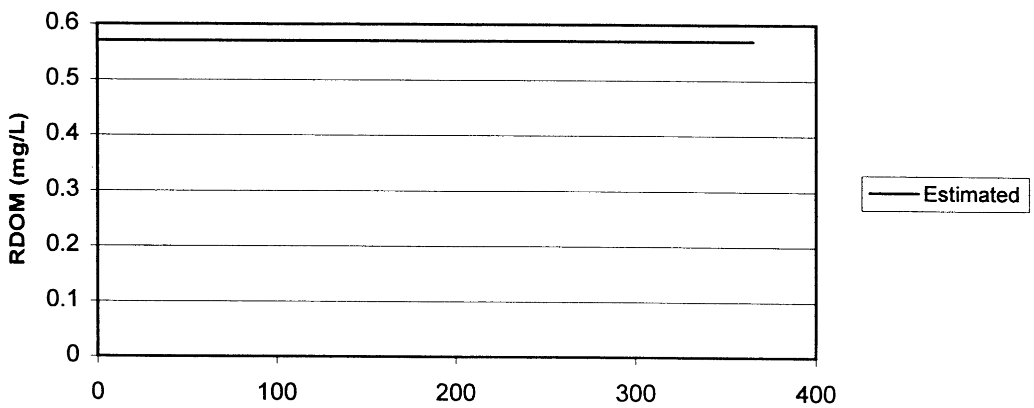
1988 Mine Lick Creek



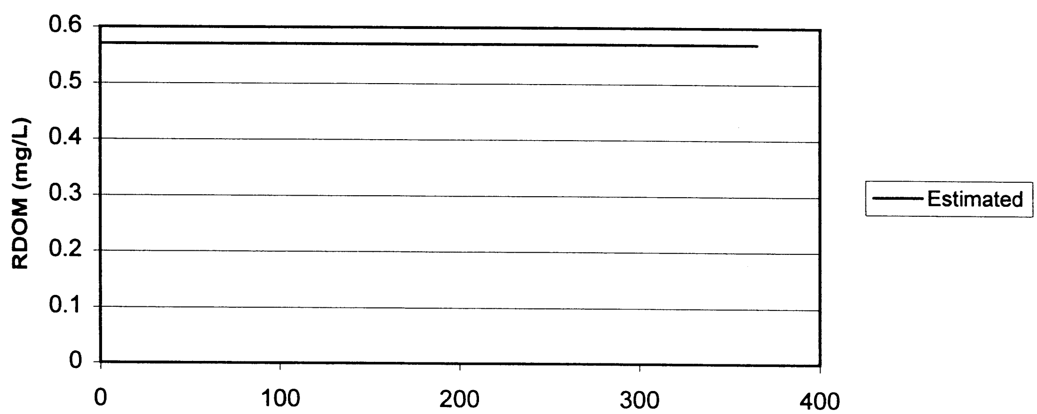
1996 Mine Lick Creek



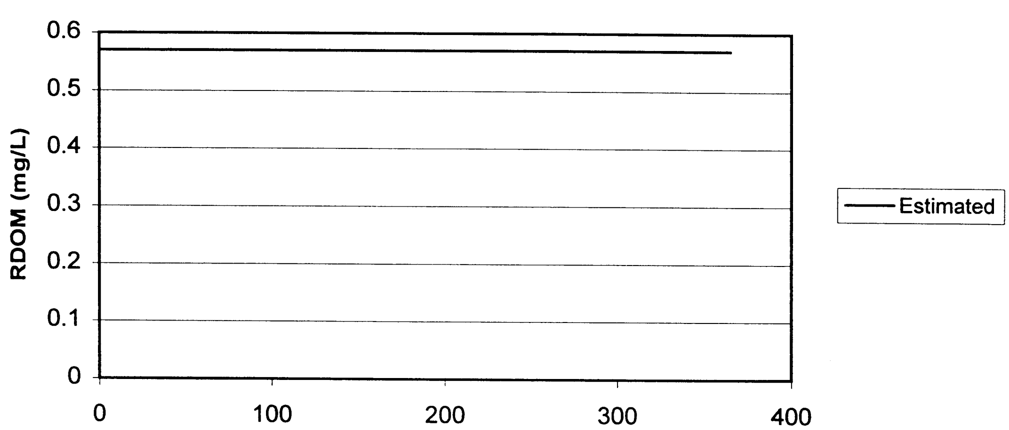
1973 Holmes Creek



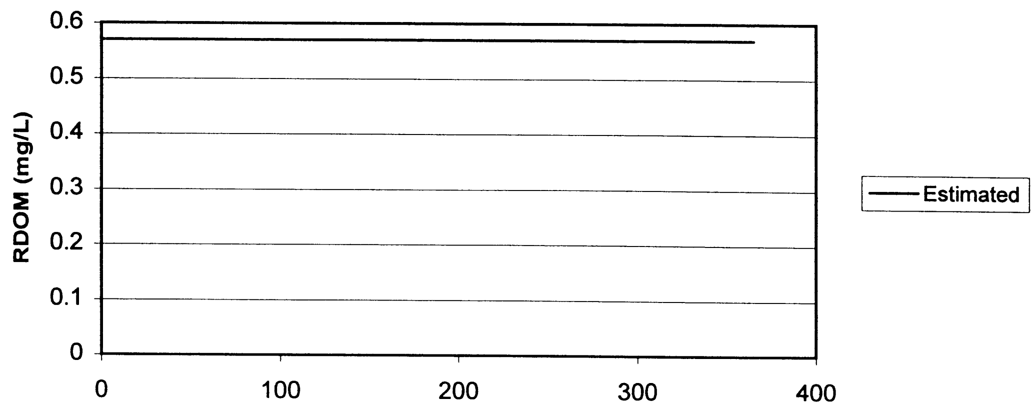
1988 Holmes Creek



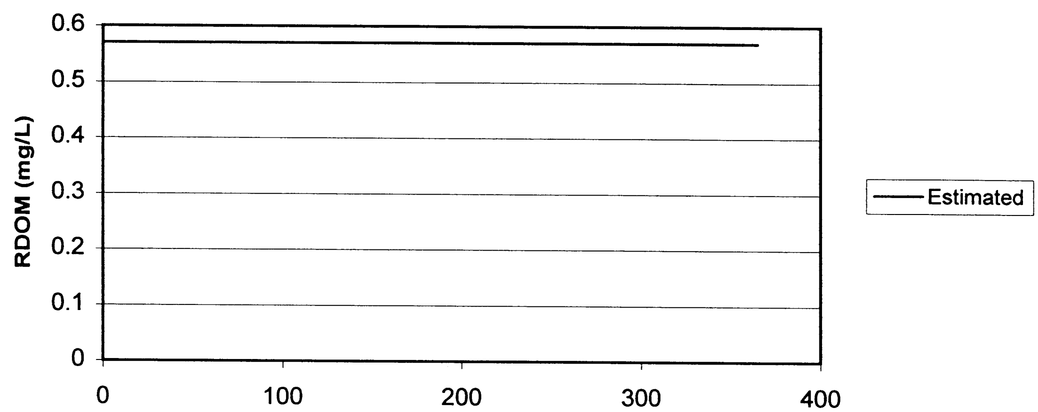
1996 Holmes Creek



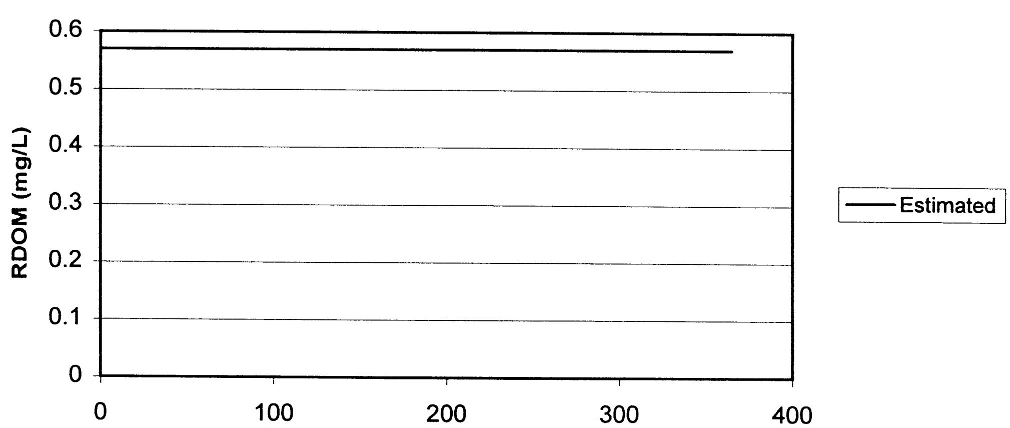
1973 Indian Creek



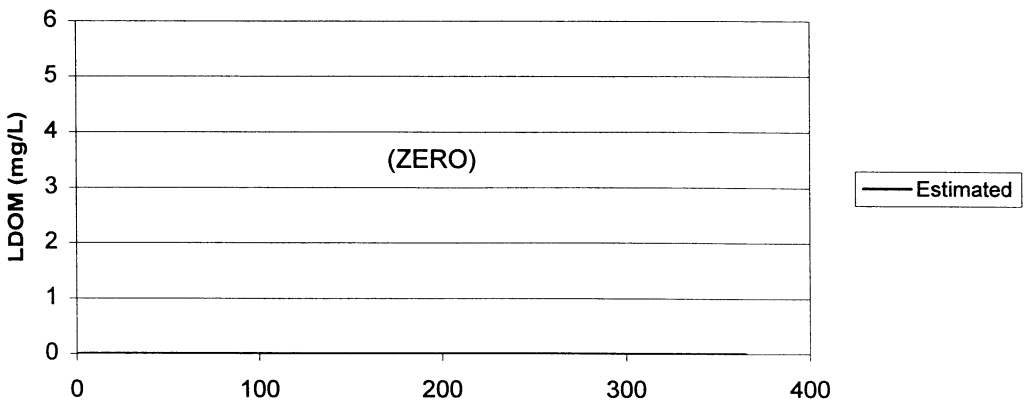
1988 Indian Creek



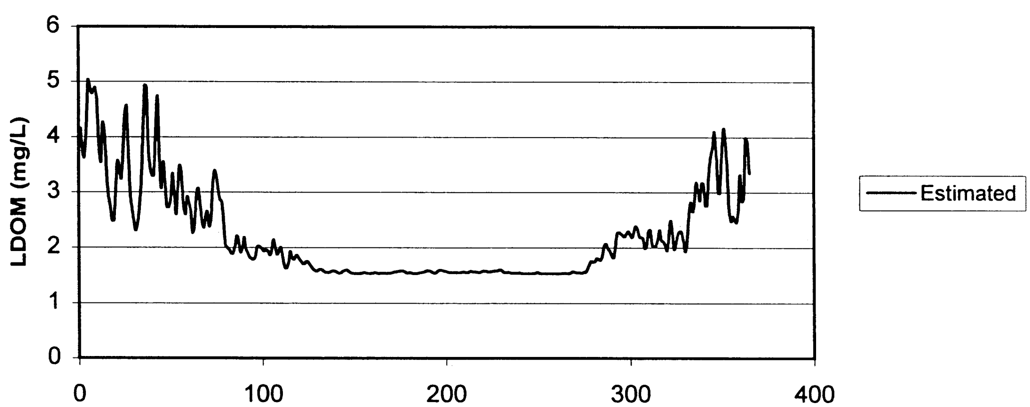
1996 Indian Creek



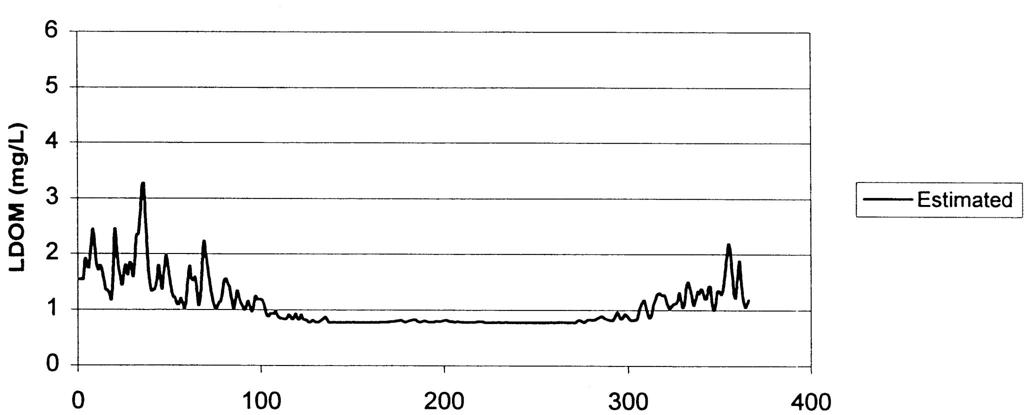
1973 Caney Fork (Great Falls)

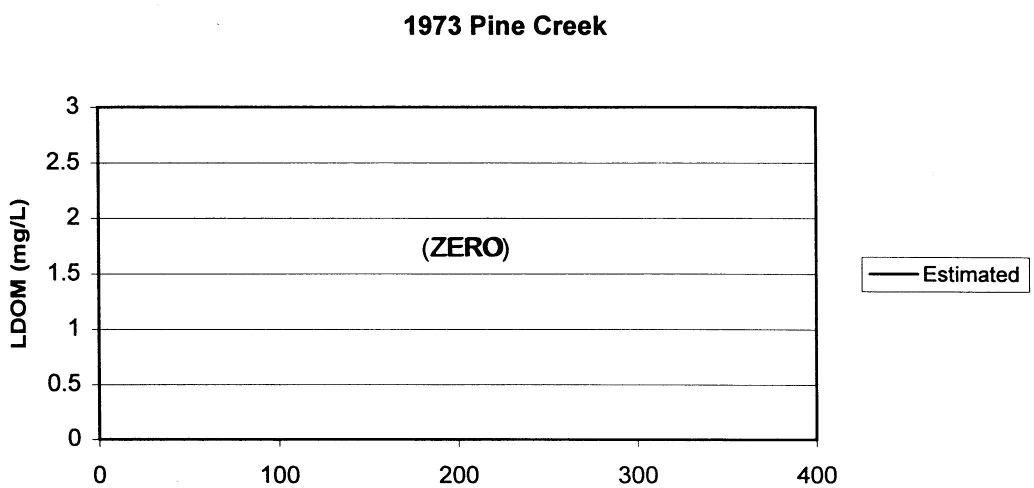


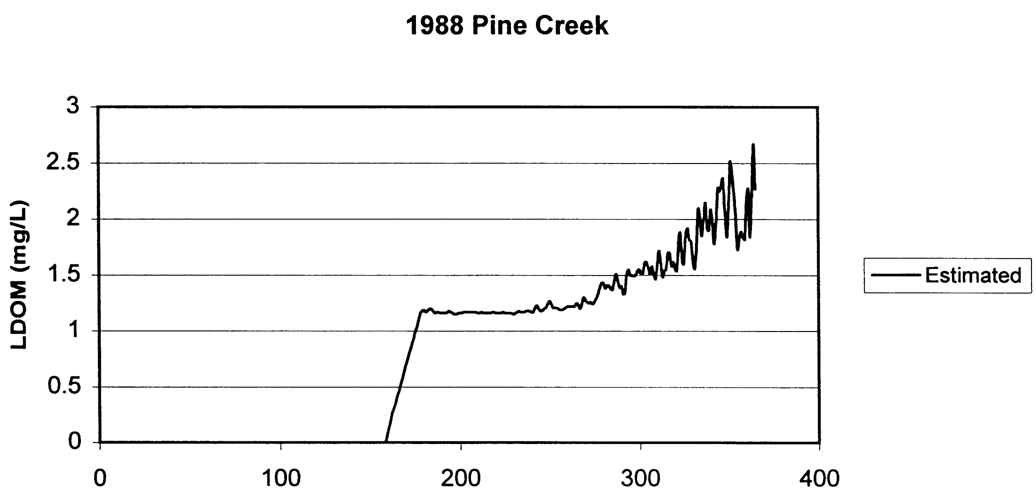
1988 Caney Fork (Great Falls)

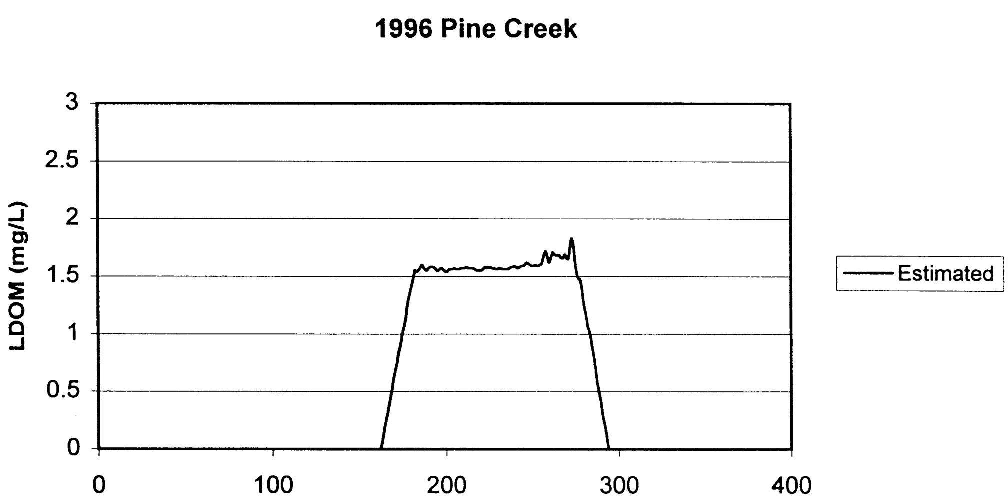


1996 Caney Fork (Great Falls)

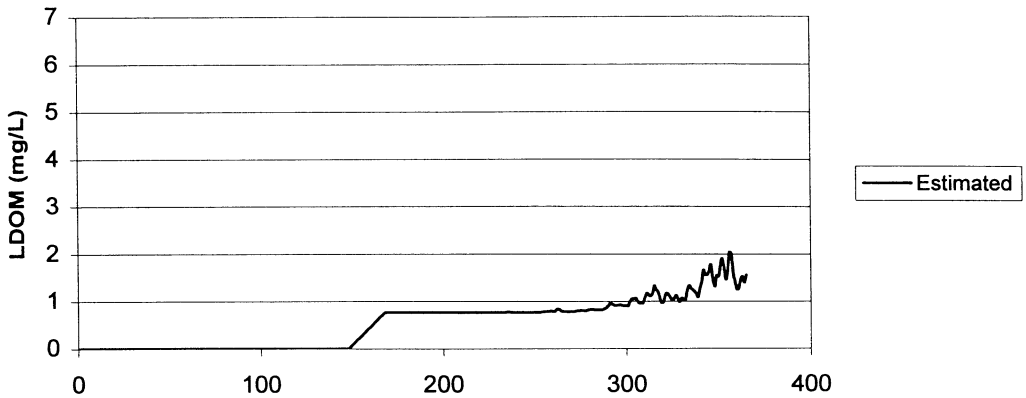



1973 Pine Creek
LDOM (mg/L)
3
2.5
2
1.5
1
0.5
0
0
100
200
300
400
(ZERO)
Estimated

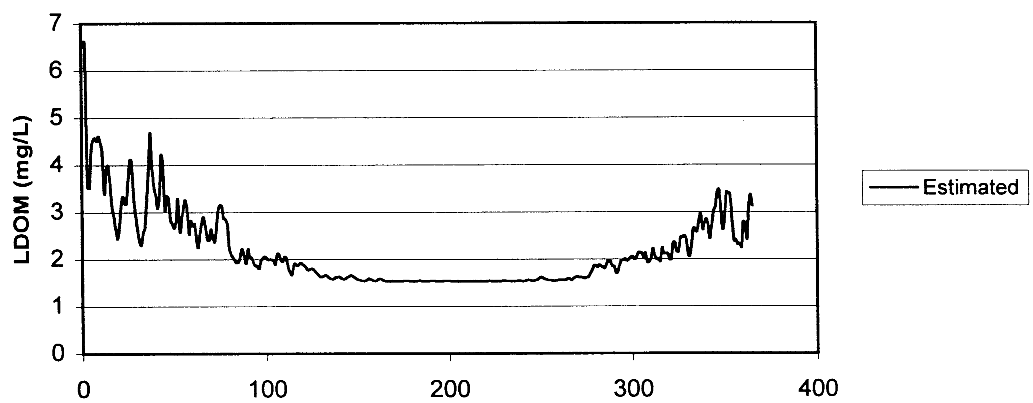

1988 Pine Creek
LDOM (mg/L)
3
2.5
2
1.5
1
0.5
0
0
100
200
300
400
Estimated


1996 Pine Creek
LDOM (mg/L)
3
2.5
2
1.5
1
0.5
0
0
100
200
300
400
Estimated

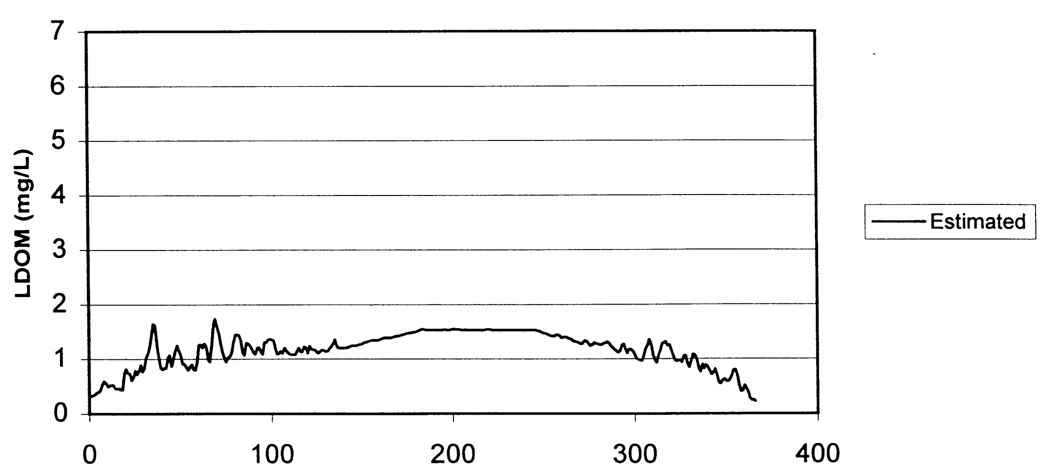
1973 Fall Creek



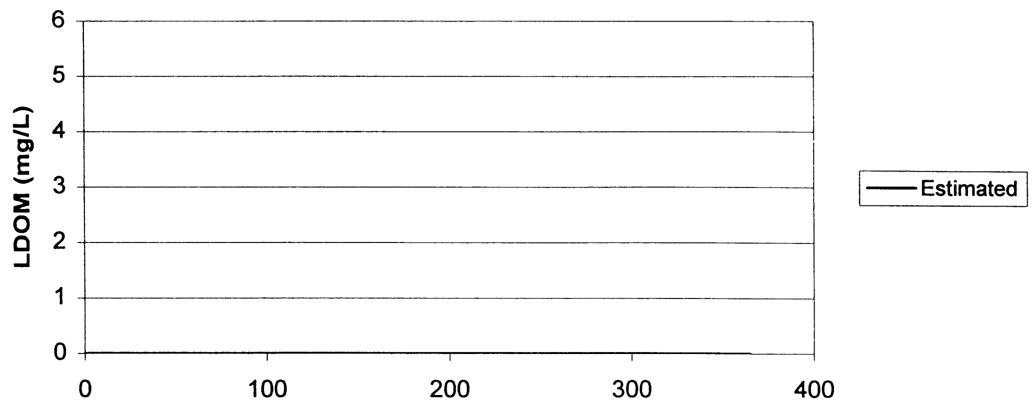
1988 Fall Creek



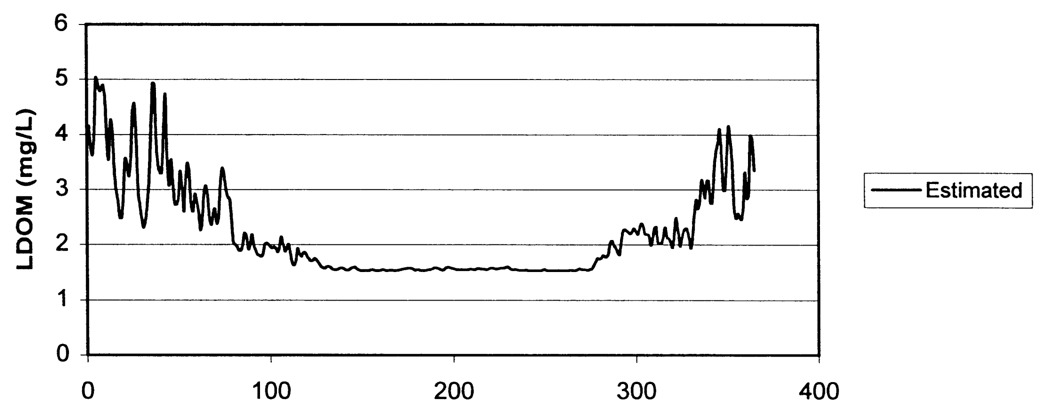
1996 Fall Creek



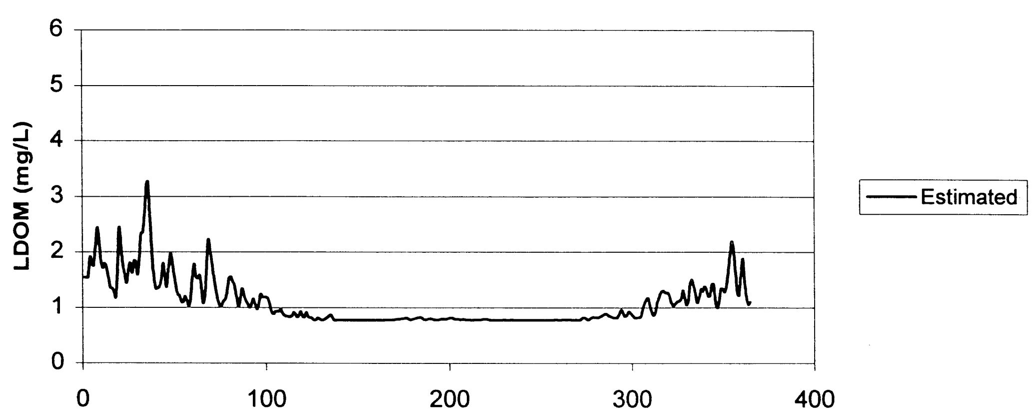
1973 Falling Water River



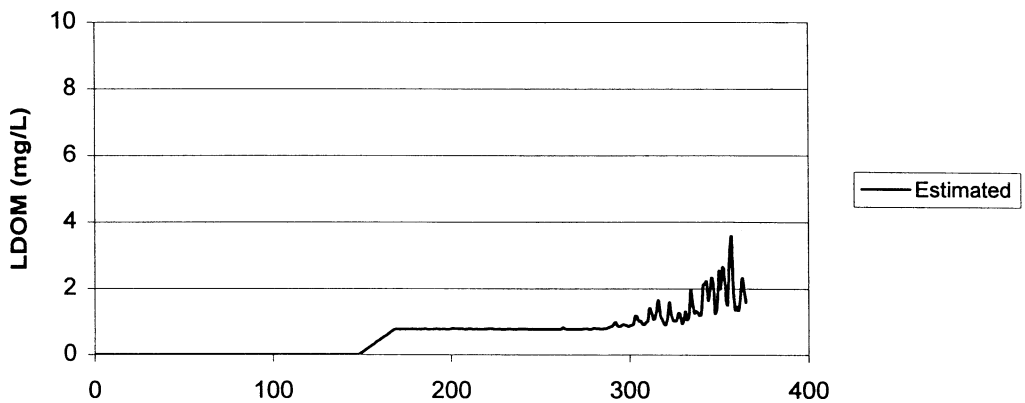
1988 Falling Water River



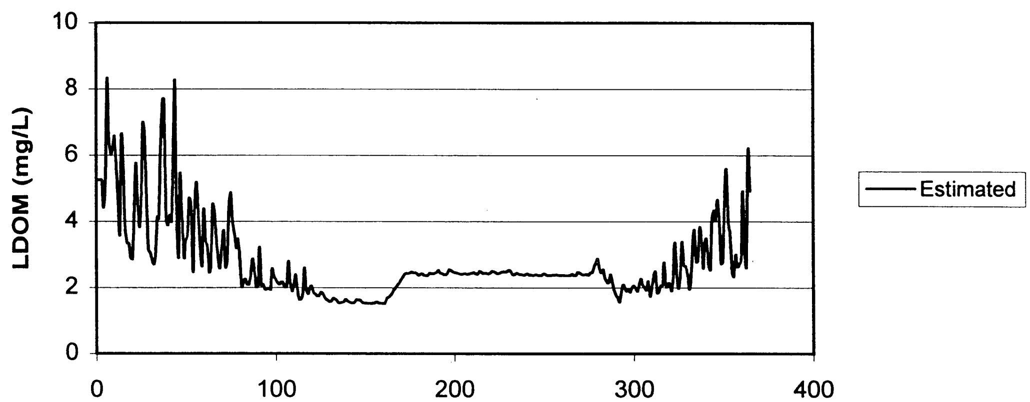
1996 Falling Water River



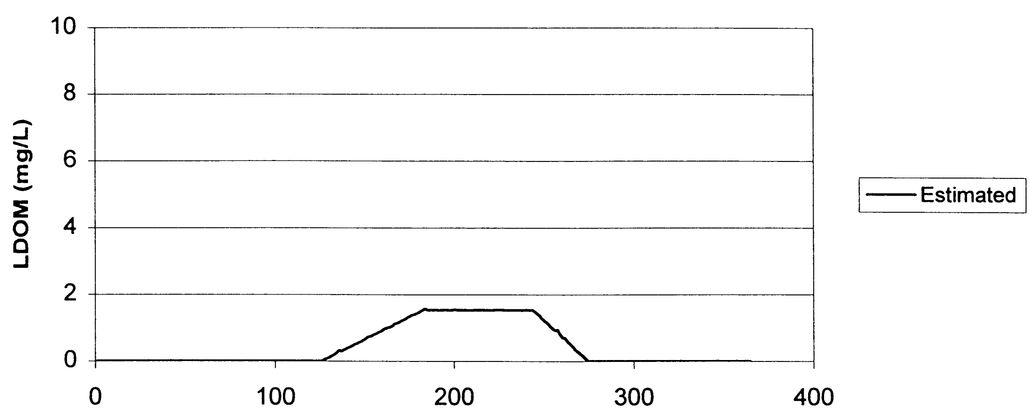
1973 Mine Lick Creek



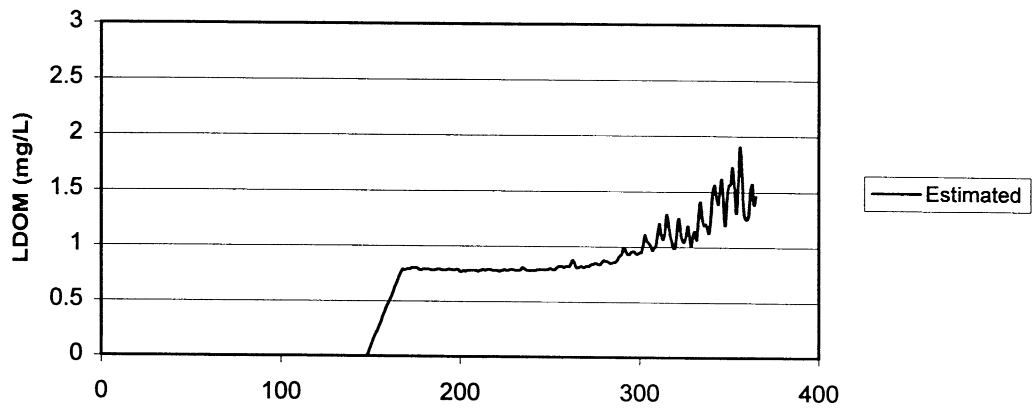
1988 Mine Lick Creek



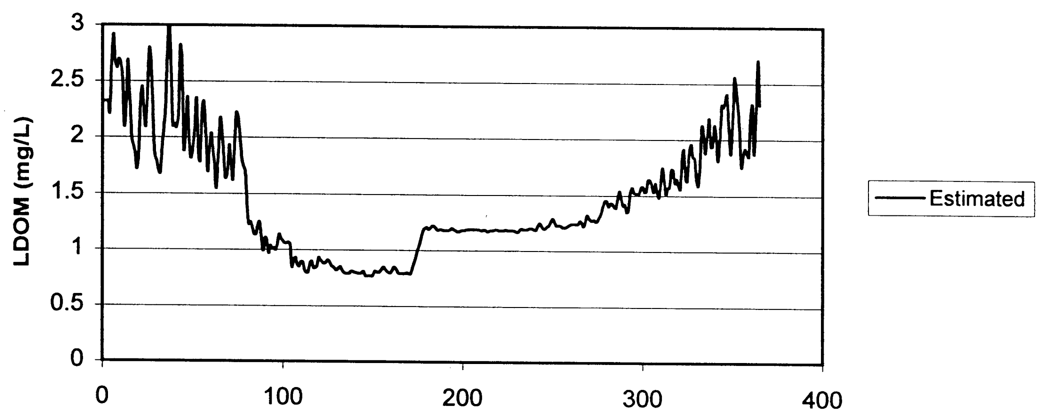
1996 Mine Lick Creek



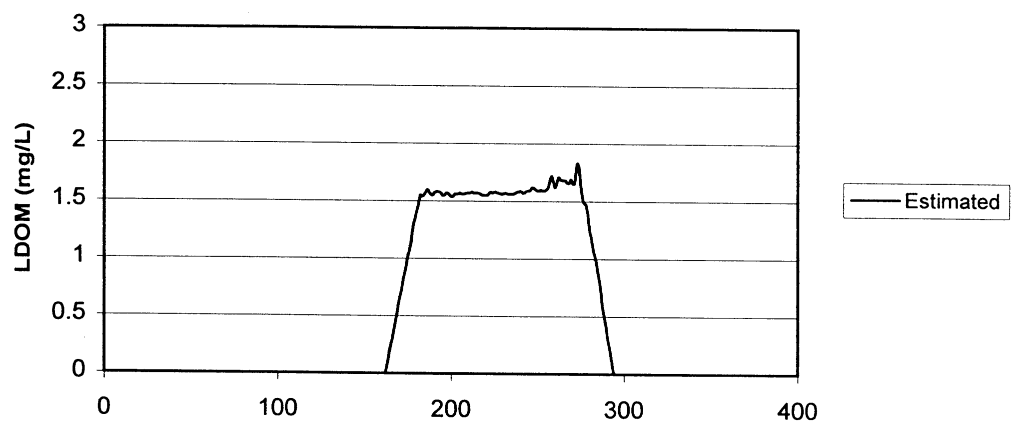
1973 Holmes Creek



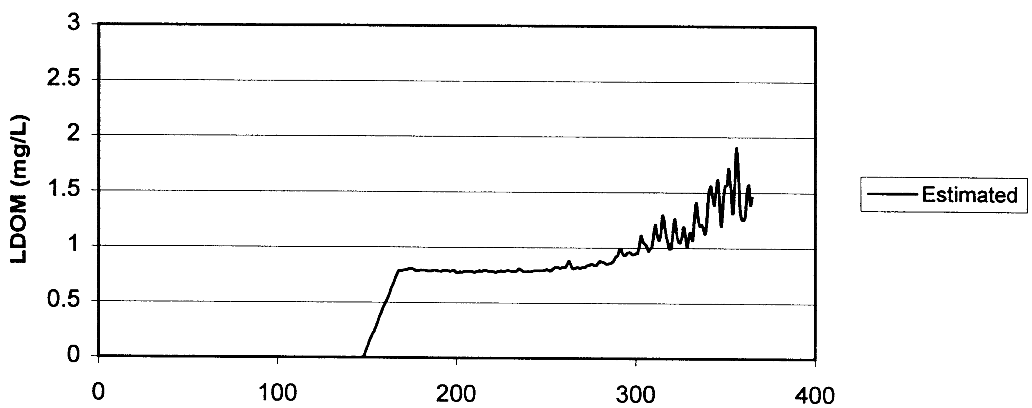
1988 Holmes Creek



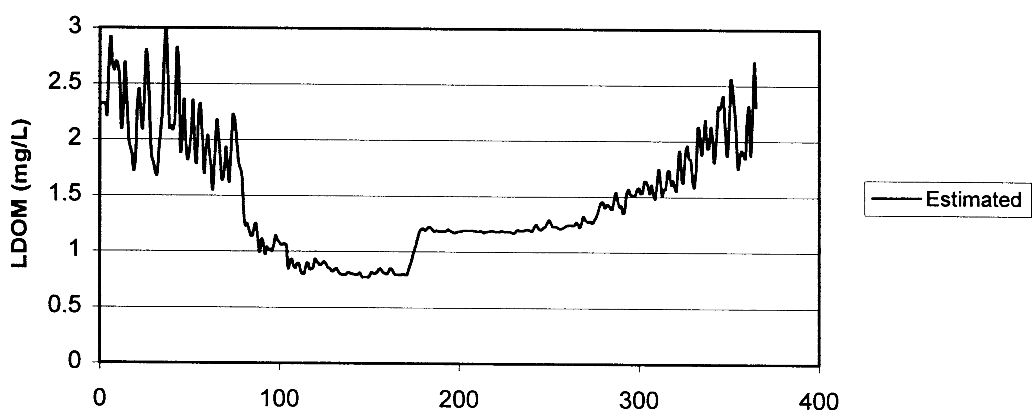
1996 Holmes Creek



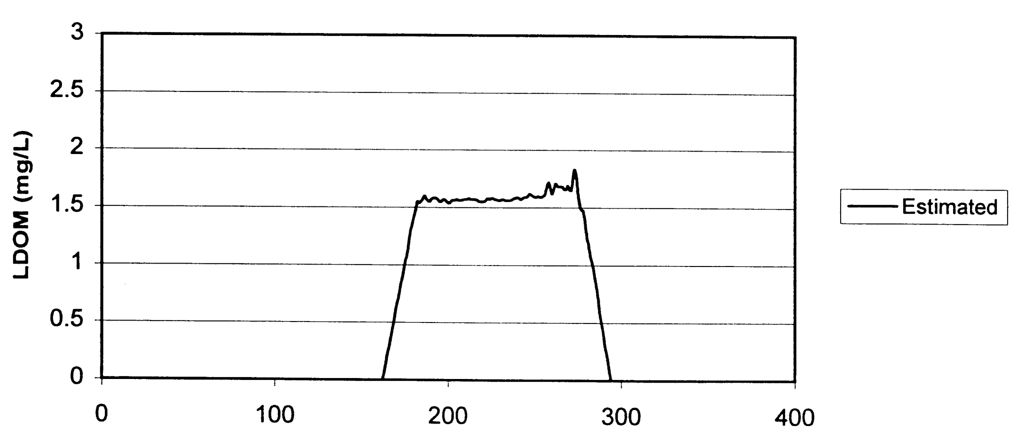
1973 Indian Creek



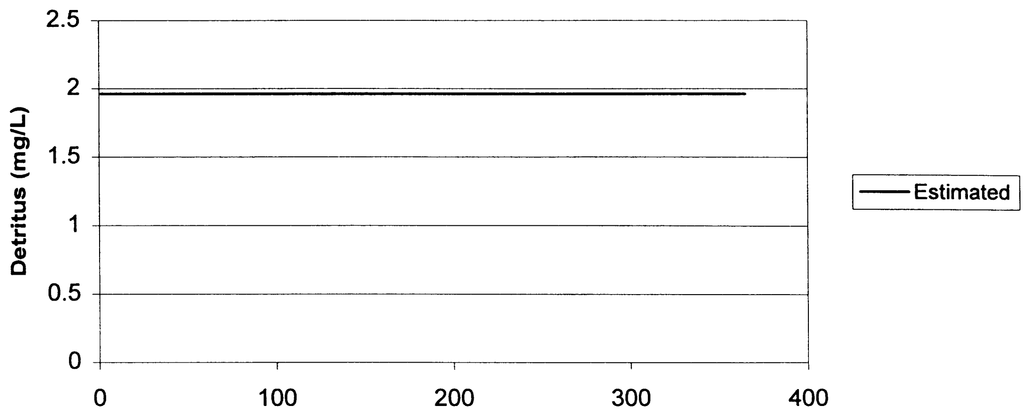
1988 Indian Creek



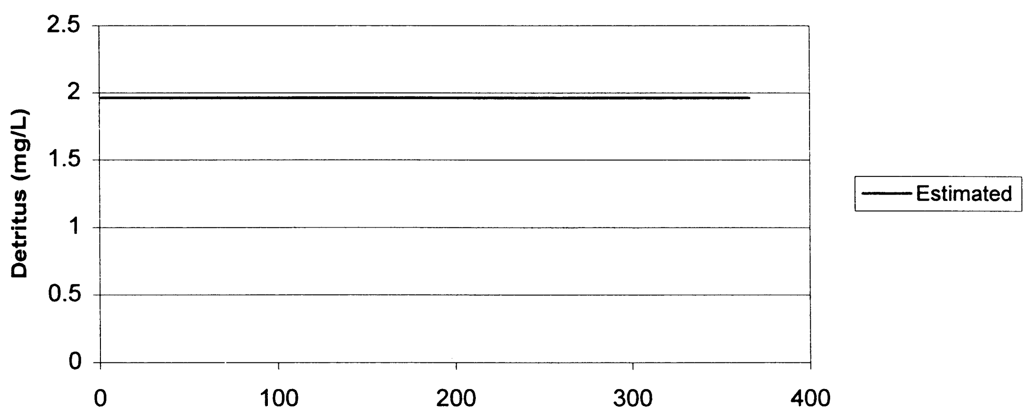
1996 Indian Creek



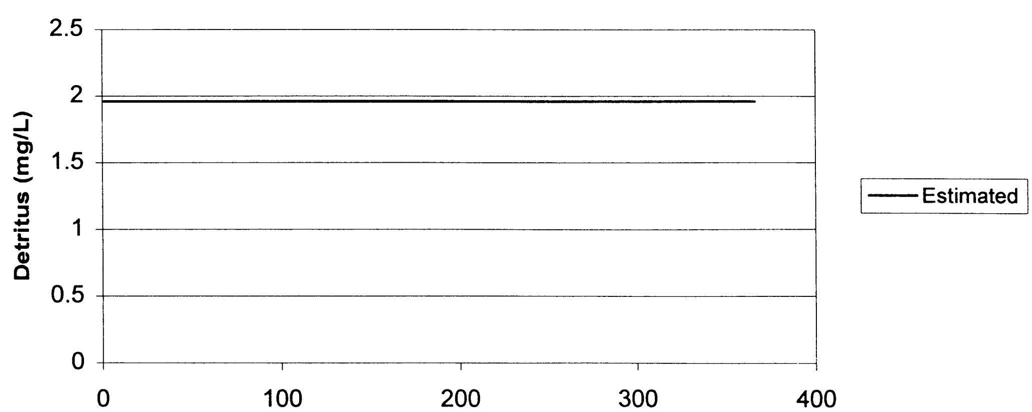
1973 Caney Creek (Great Falls)

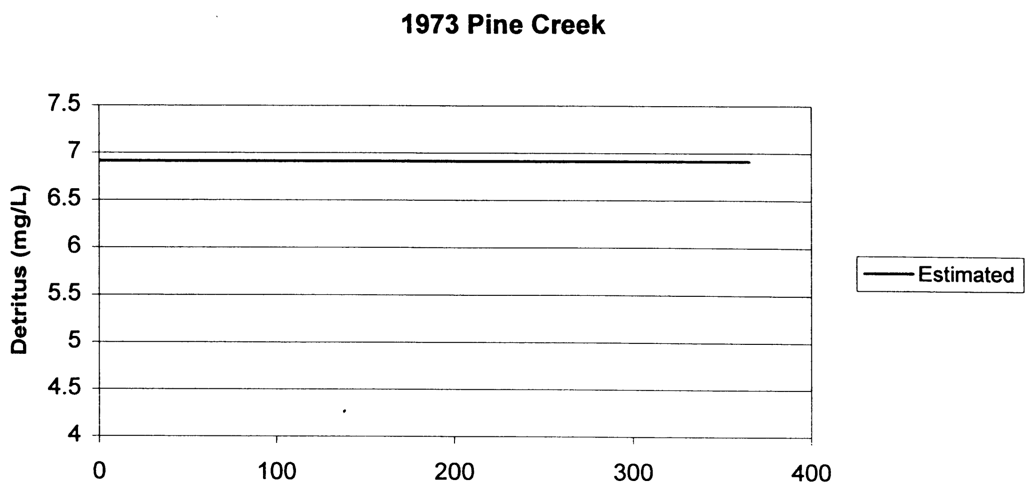


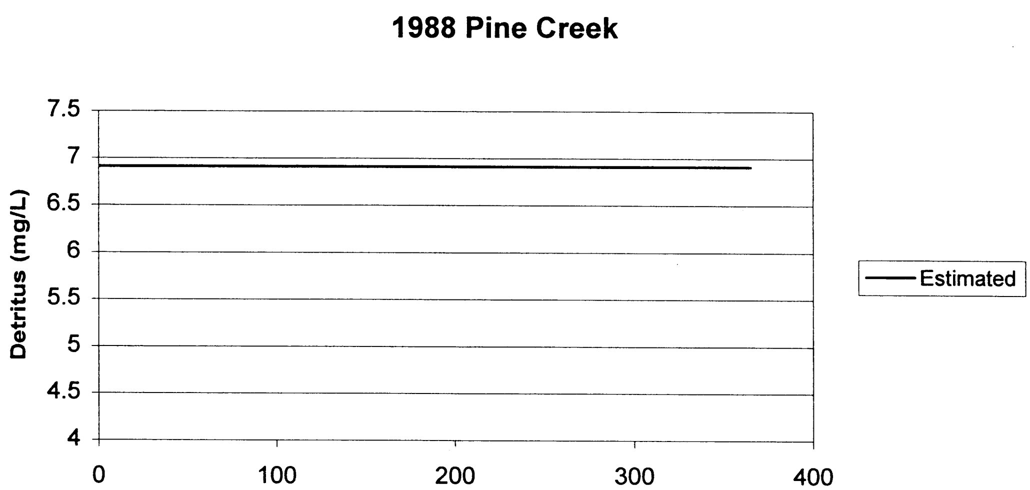
1988 Caney Creek (Great Falls)

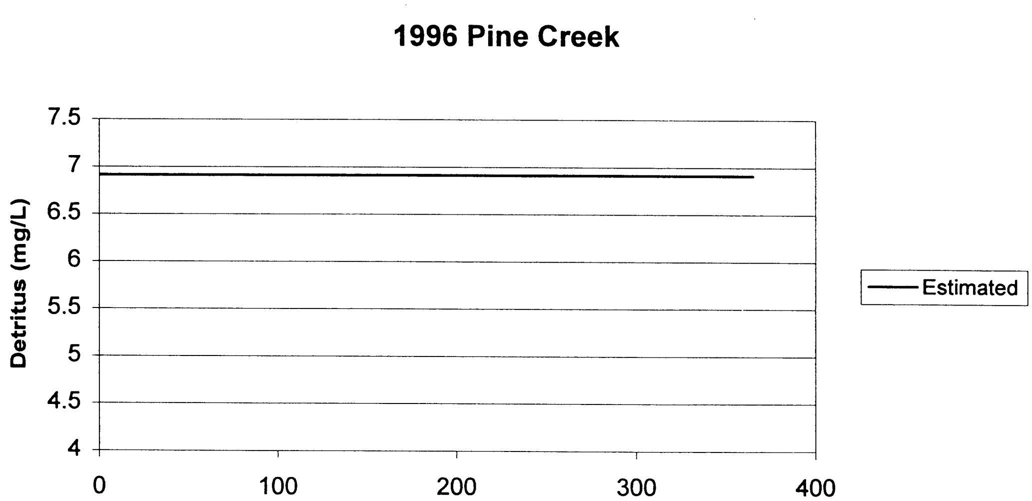


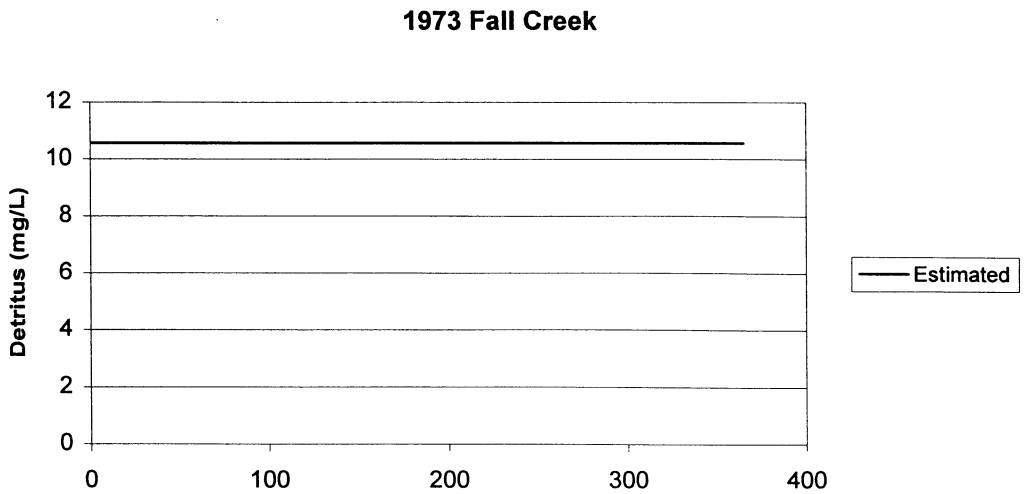
1996 Caney Creek (Great Falls)

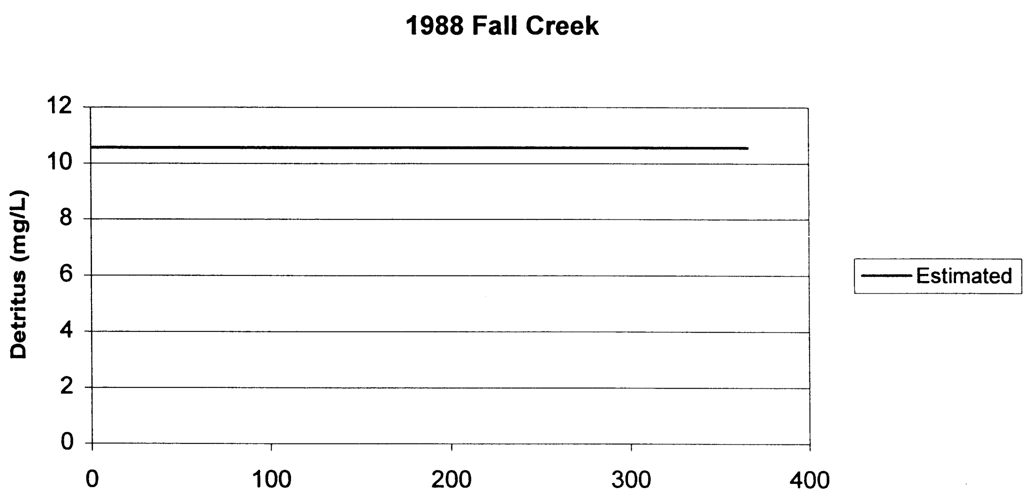


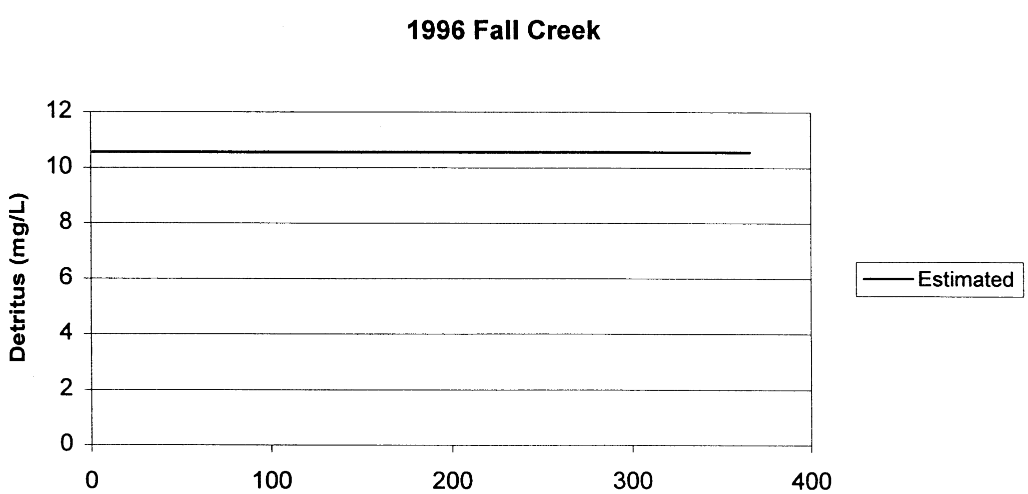

1973 Pine Creek
Detritus (mg/L)
7.5
7
6.5
6
5.5
5
4.5
4
0
100
200
300
400
Estimated


1988 Pine Creek
Detritus (mg/L)
7.5
7
6.5
6
5.5
5
4.5
4
0
100
200
300
400
Estimated

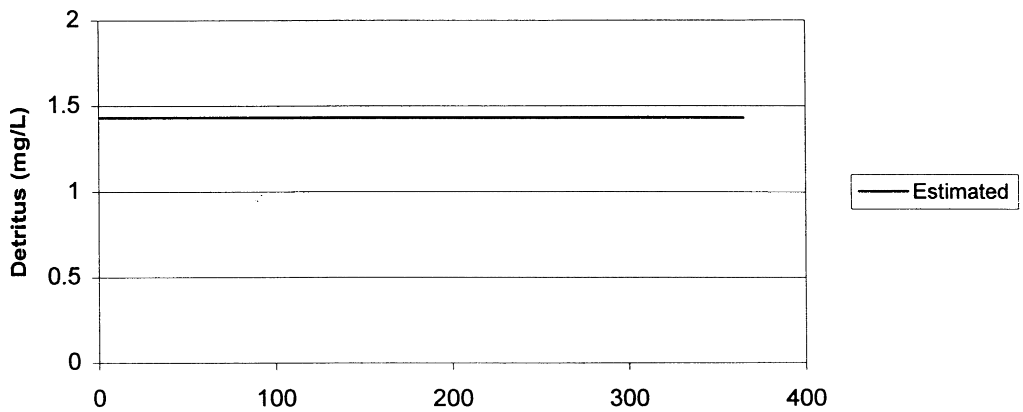

1996 Pine Creek
Detritus (mg/L)
7.5
7
6.5
6
5.5
5
4.5
4
0
100
200
300
400
Estimated


1973 Fall Creek
Detritus (mg/L)
12
10
8
6
4
2
0
0
100
200
300
400
Estimated

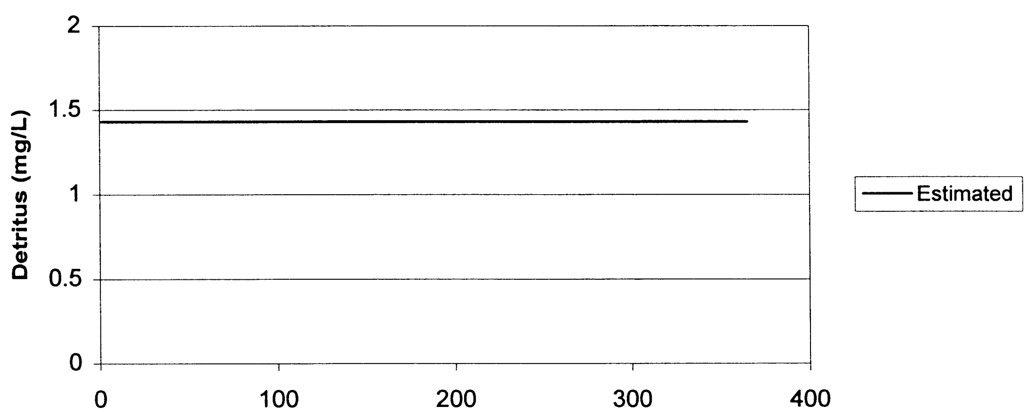

1988 Fall Creek
Detritus (mg/L)
12
10
8
6
4
2
0
0
100
200
300
400
Estimated


1996 Fall Creek
Detritus (mg/L)
12
10
8
6
4
2
0
0
100
200
300
400
Estimated

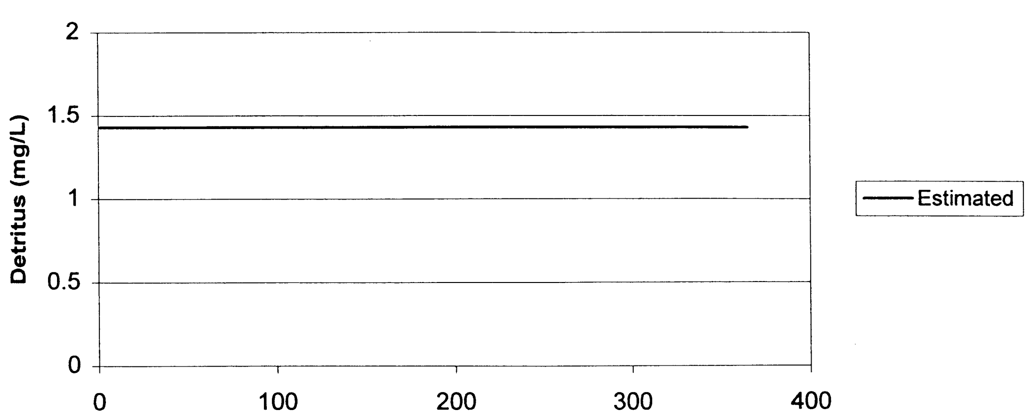
1973 Falling Water River

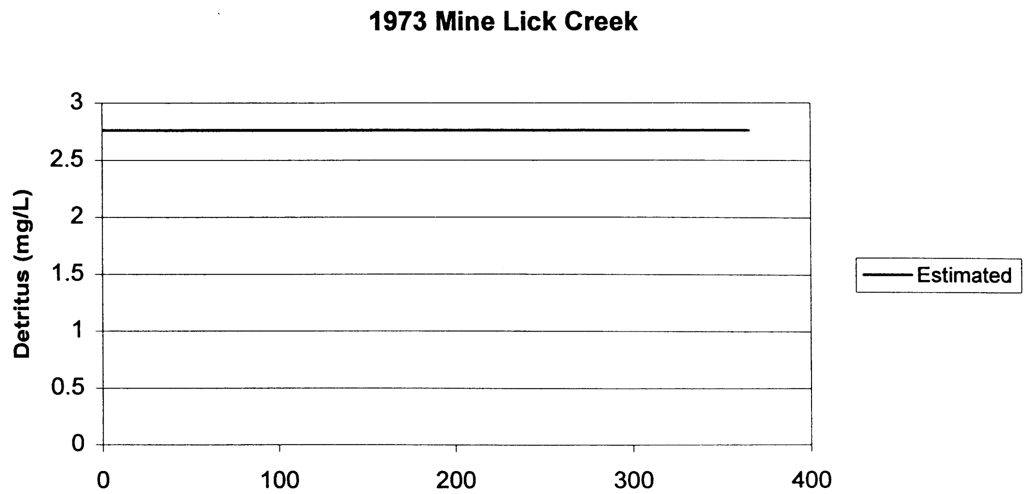


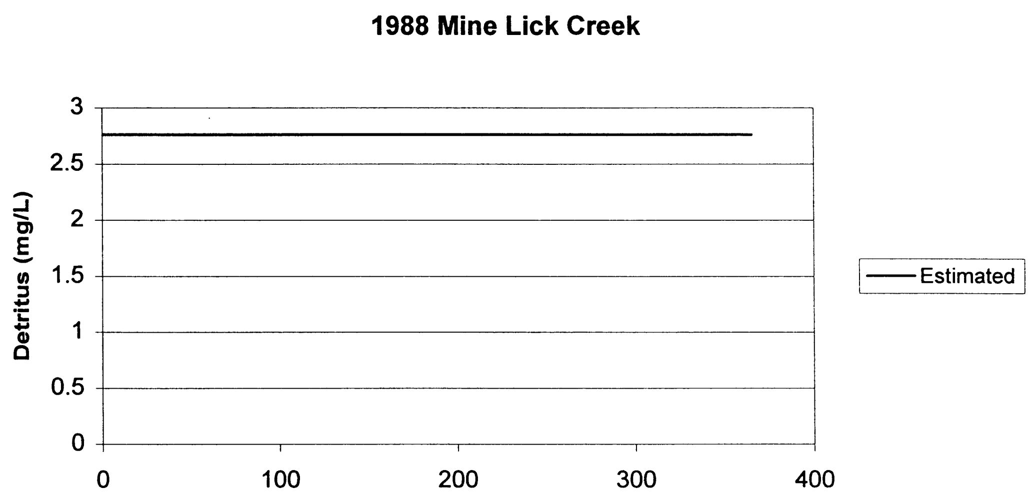
1988 Falling Water River

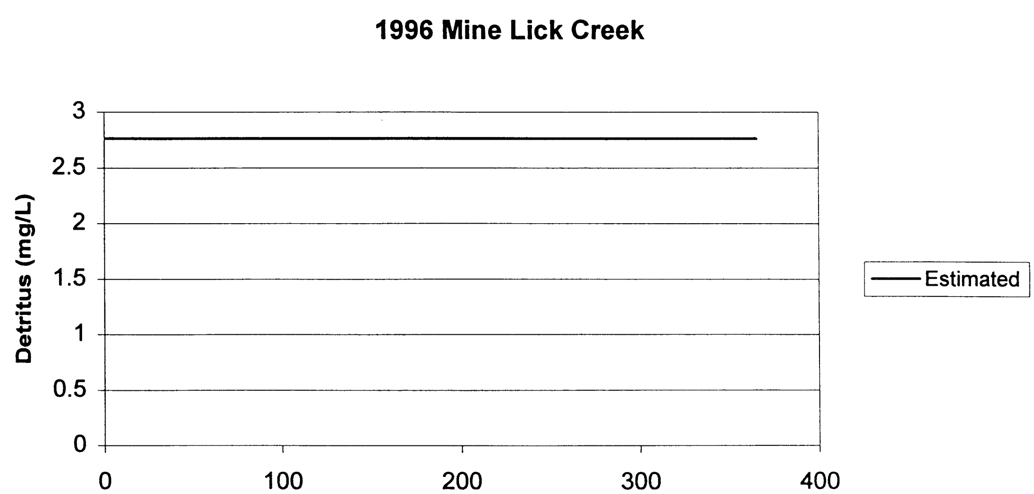


1996 Falling Water River

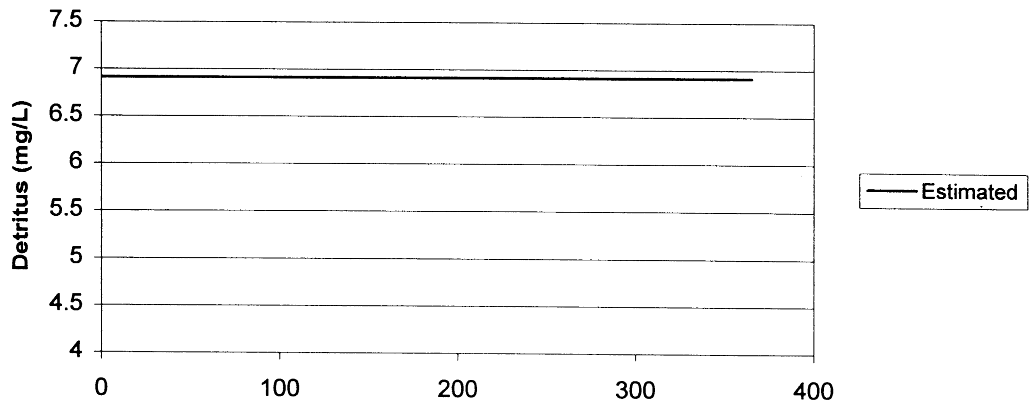



1973 Mine Lick Creek
Detritus (mg/L)
3
2.5
2
1.5
1
0.5
0
0
100
200
300
400
Estimated

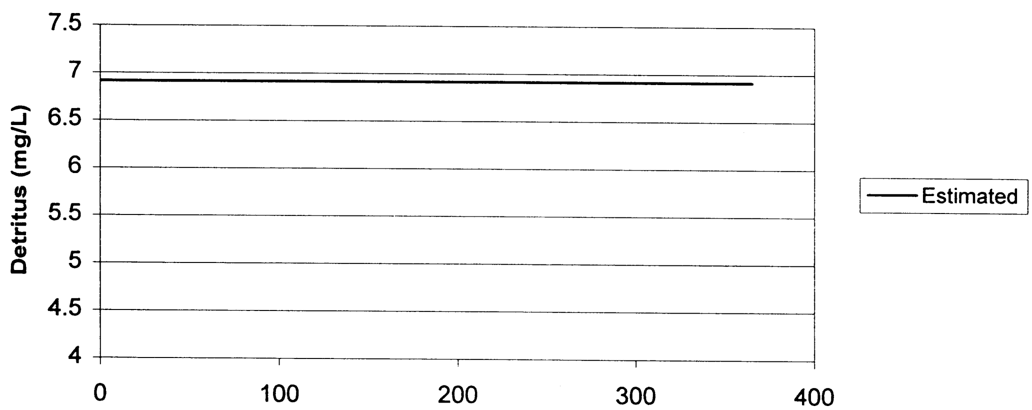

1988 Mine Lick Creek
Detritus (mg/L)
3
2.5
2
1.5
1
0.5
0
0
100
200
300
400
Estimated


1996 Mine Lick Creek
Detritus (mg/L)
3
2.5
2
1.5
1
0.5
0
0
100
200
300
400
Estimated

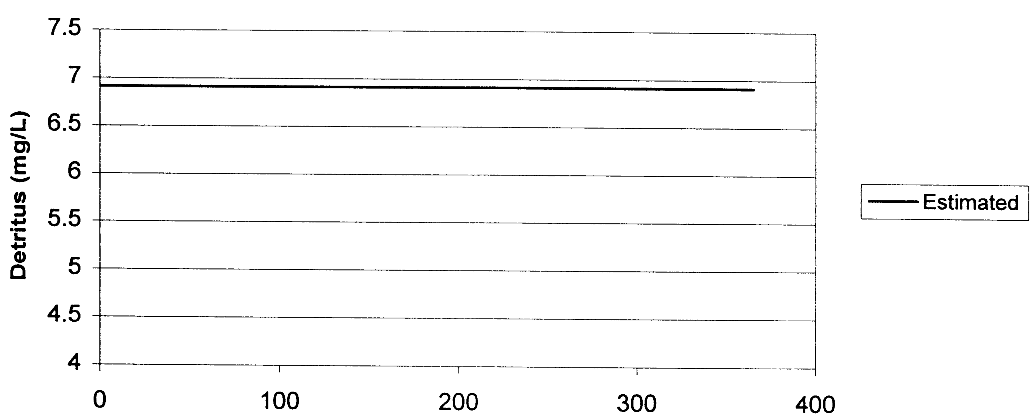
1973 Holmes Creek



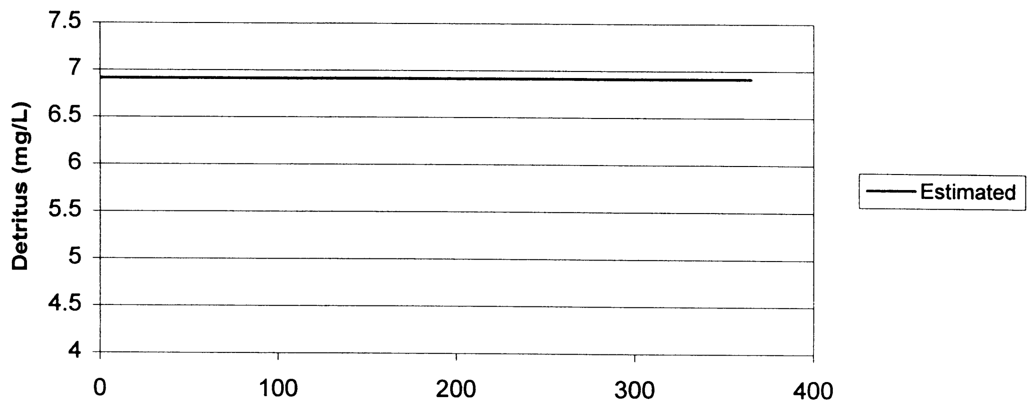
1988 Holmes Creek



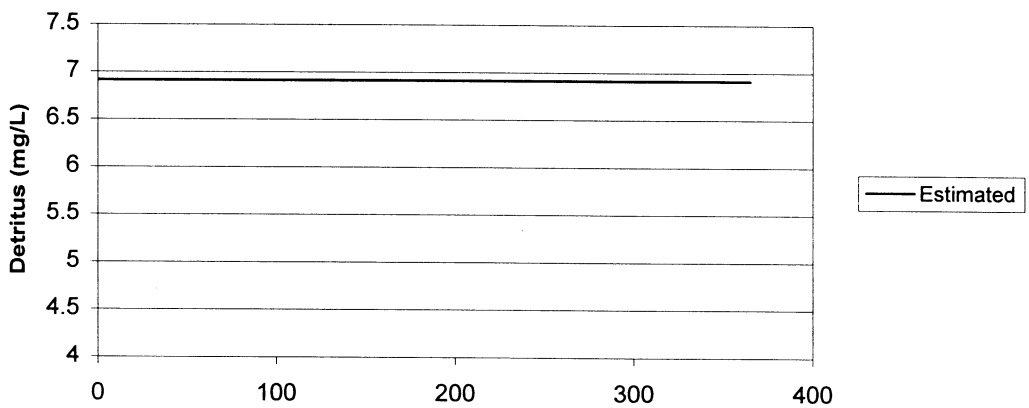
1996 Holmes Creek



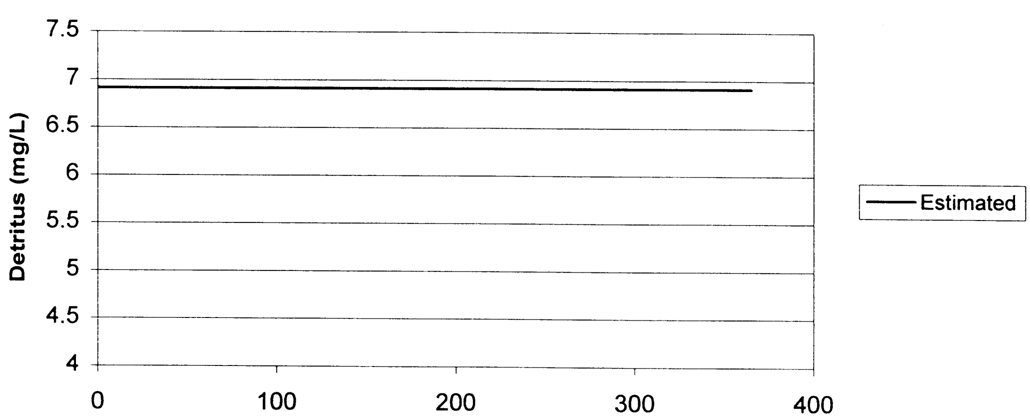
1973 Indian Creek



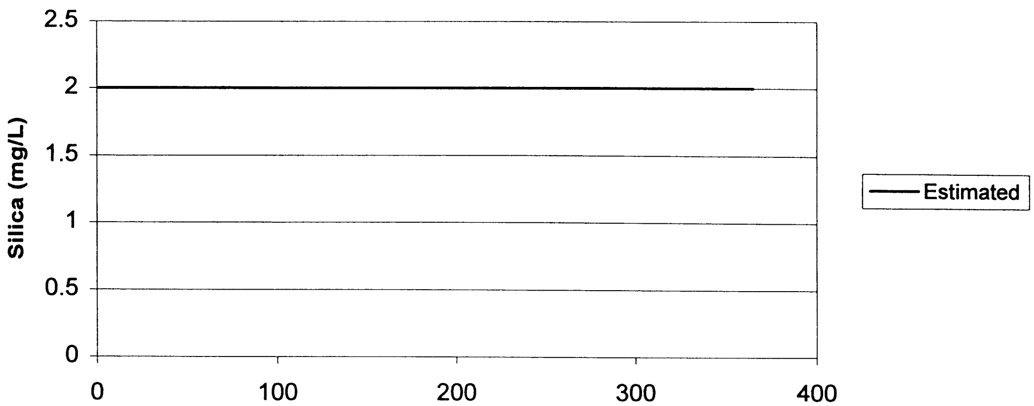
1988 Indian Creek



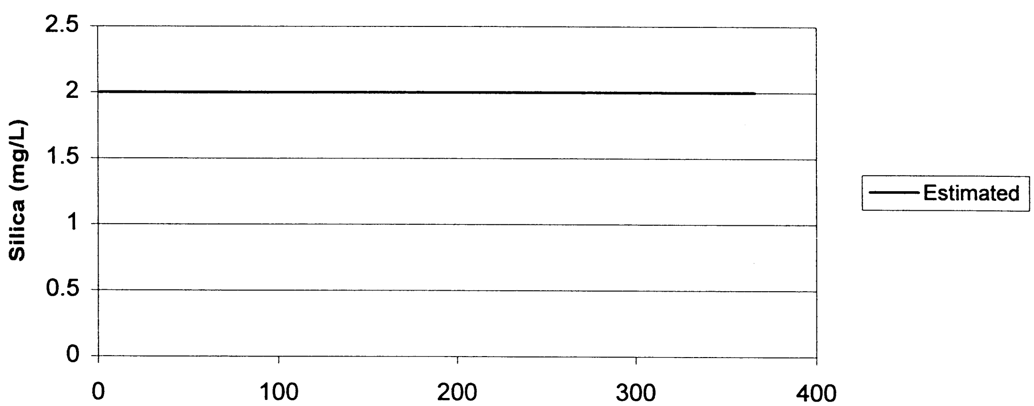
1996 Indian Creek



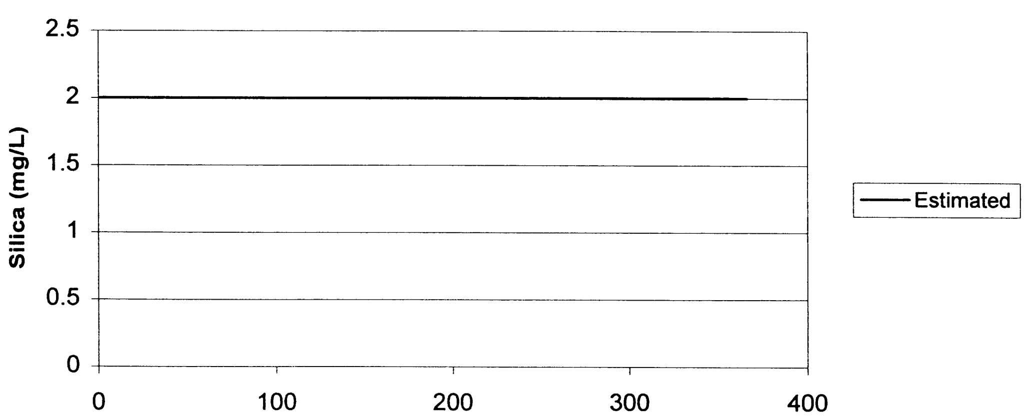
1973 Caney Fork (Great Falls)



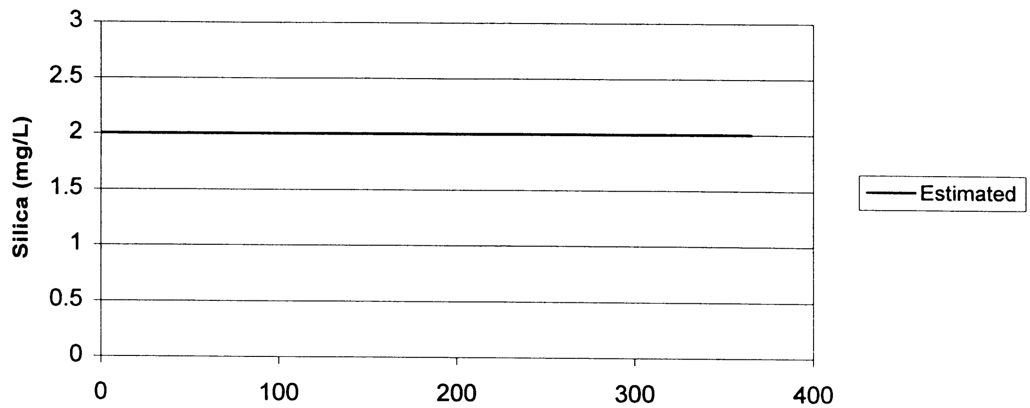
1988 Caney Fork (Great Falls)



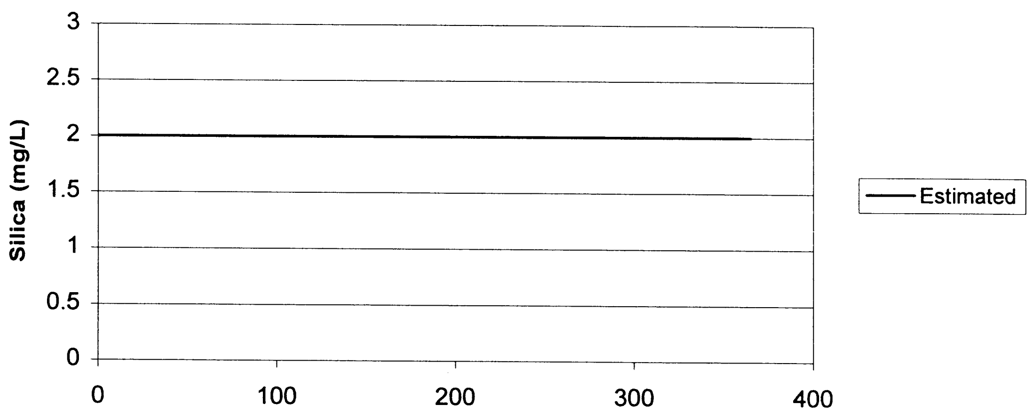
1996 Caney Fork (Great Falls)



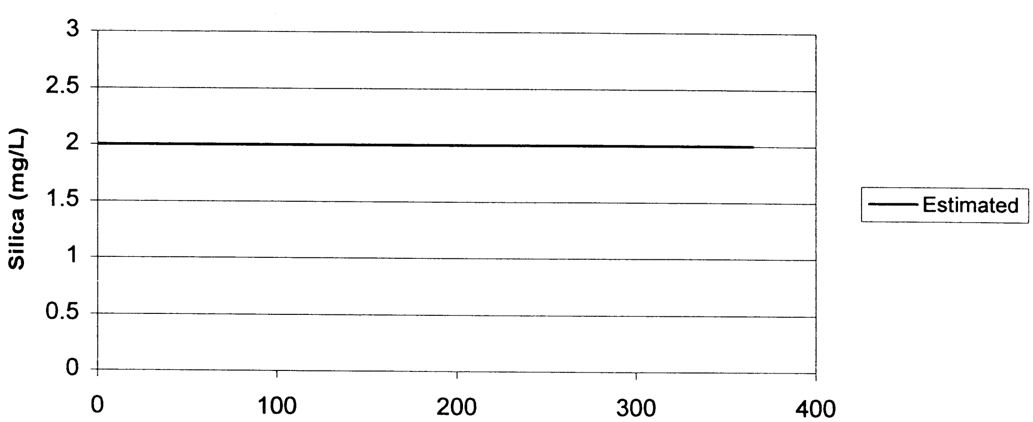
1973 Pine Creek

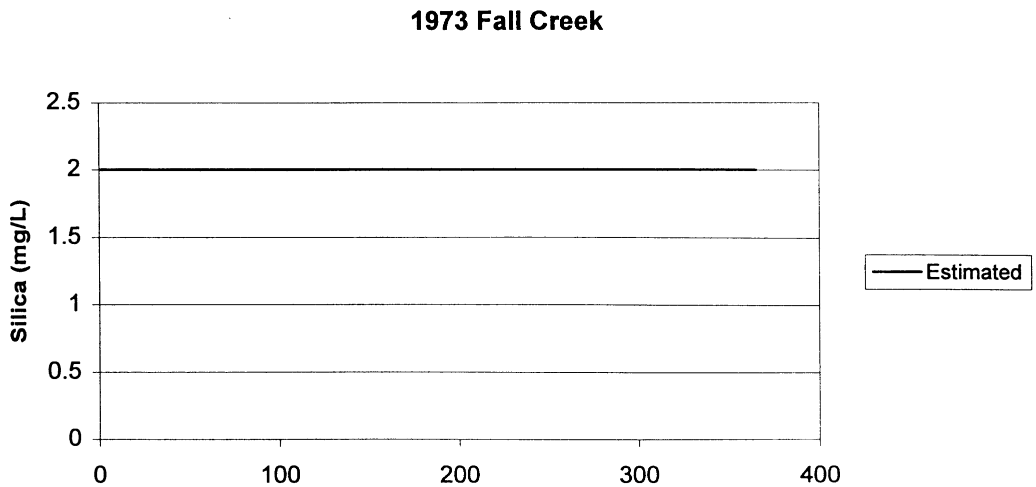


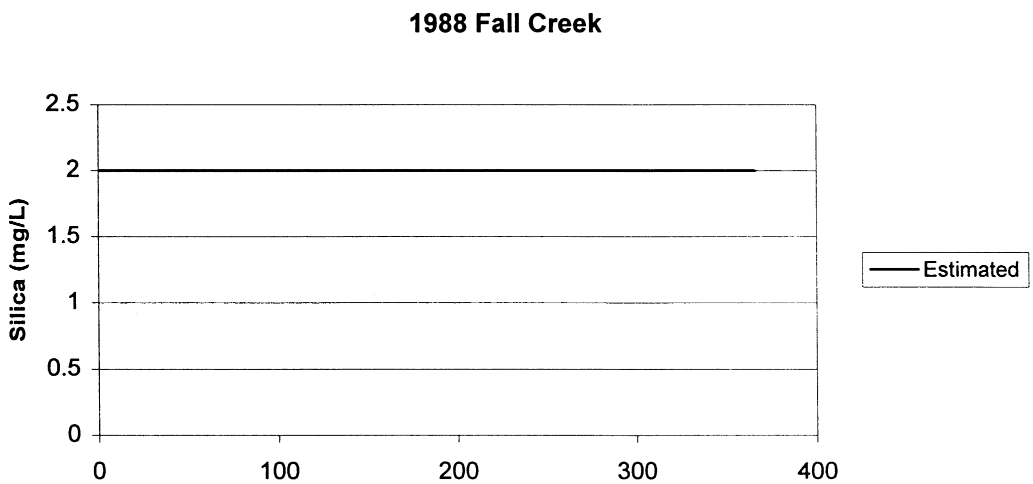
1988 Pine Creek

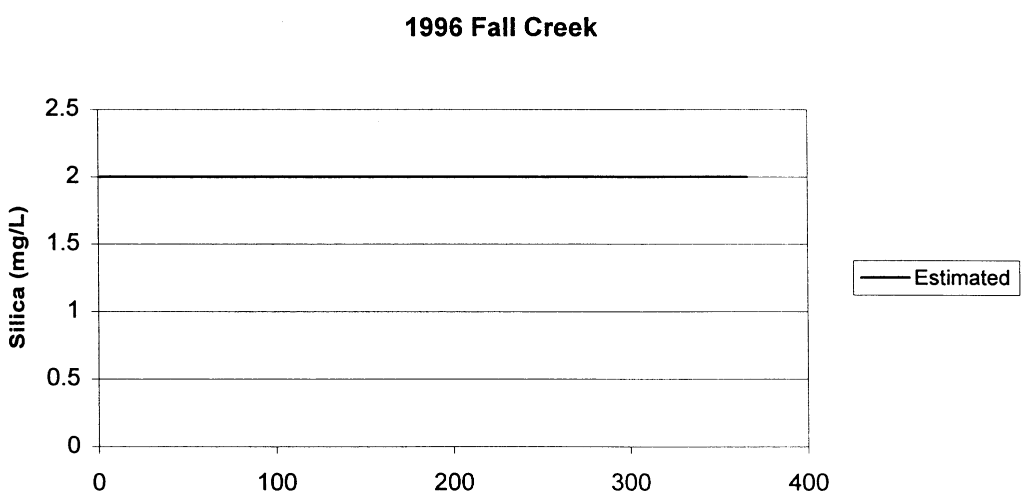


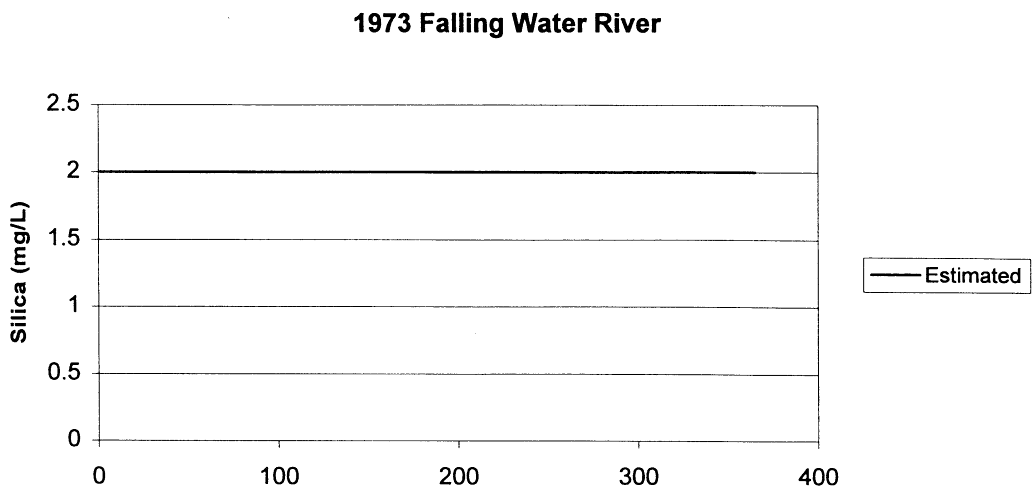
1996 Pine Creek

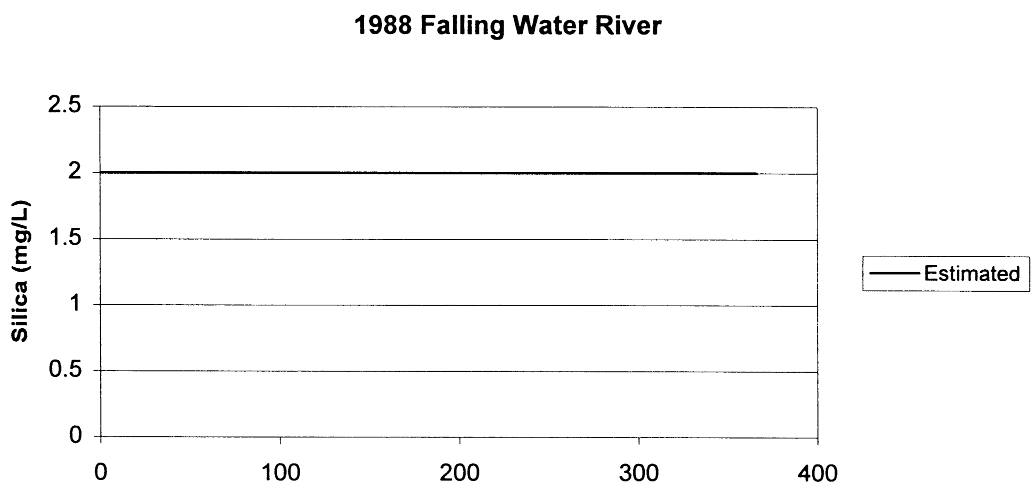


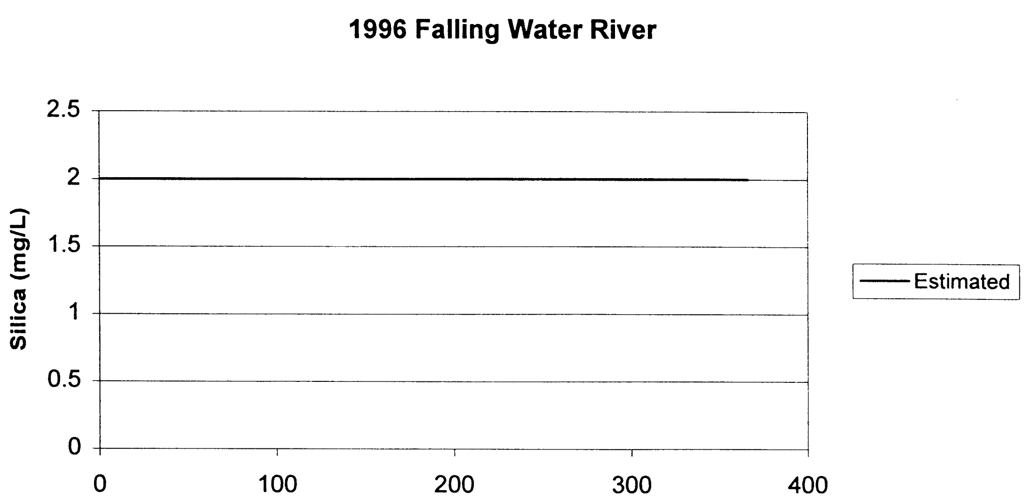

1973 Fall Creek
Silica (mg/L)
2.5
2
1.5
1
0.5
0
0
100
200
300
400
Estimated

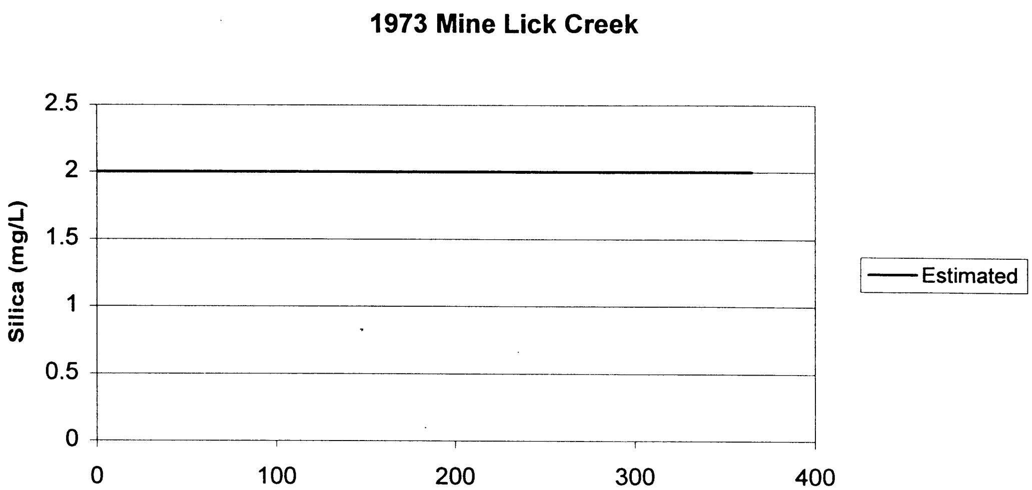

1988 Fall Creek
Silica (mg/L)
2.5
2
1.5
1
0.5
0
0
100
200
300
400
Estimated

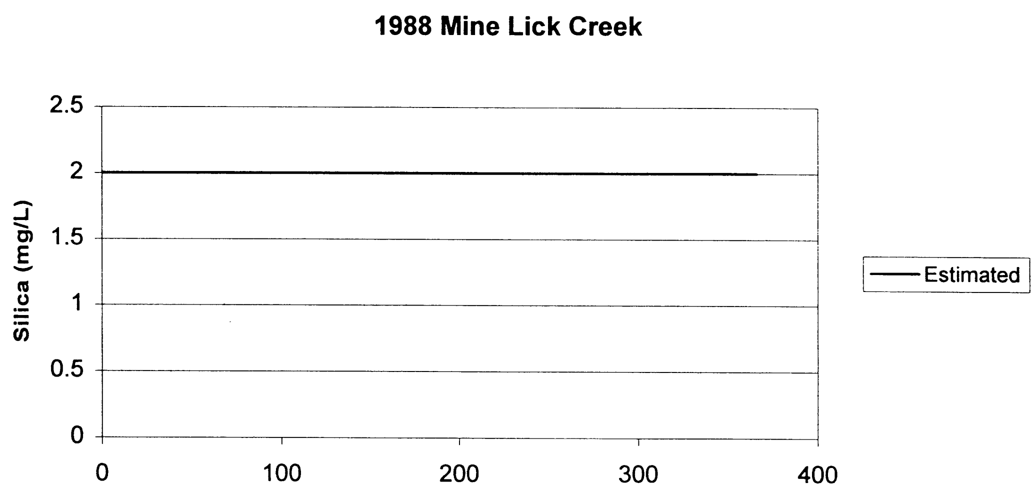

1996 Fall Creek
Silica (mg/L)
2.5
2
1.5
1
0.5
0
0
100
200
300
400
Estimated

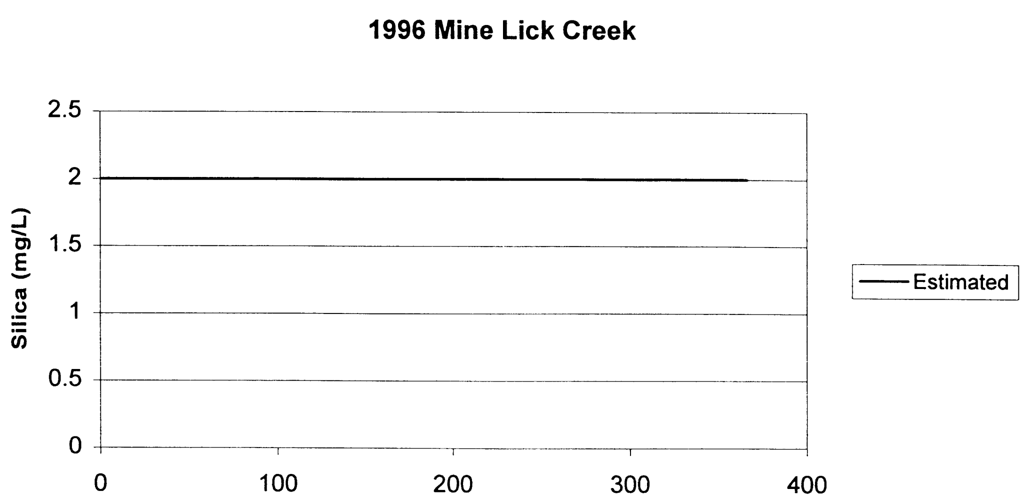

1973 Falling Water River
2.5
2
1.5
1
0.5
0
Silica (mg/L)
0
100
200
300
400
Estimated


1988 Falling Water River
2.5
2
1.5
1
0.5
0
Silica (mg/L)
0
100
200
300
400
Estimated

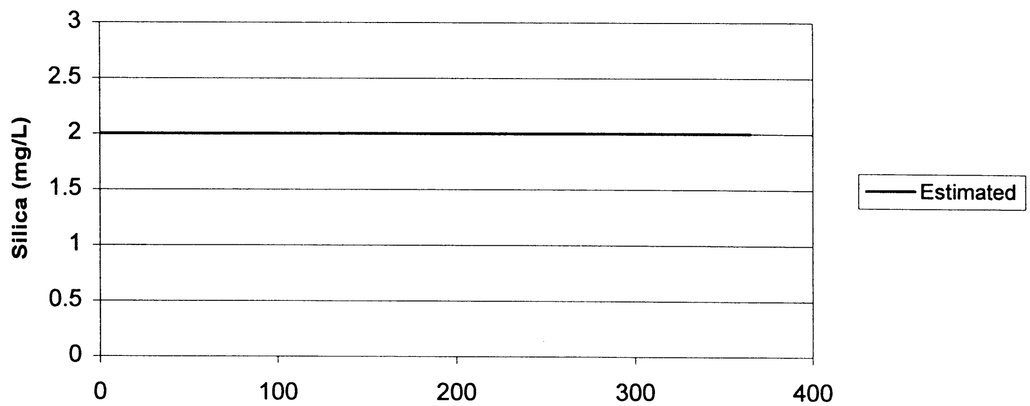

1996 Falling Water River
2.5
2
1.5
1
0.5
0
Silica (mg/L)
0
100
200
300
400
Estimated


1973 Mine Lick Creek
Silica (mg/L)
2.5
2
1.5
1
0.5
0
0
100
200
300
400
Estimated

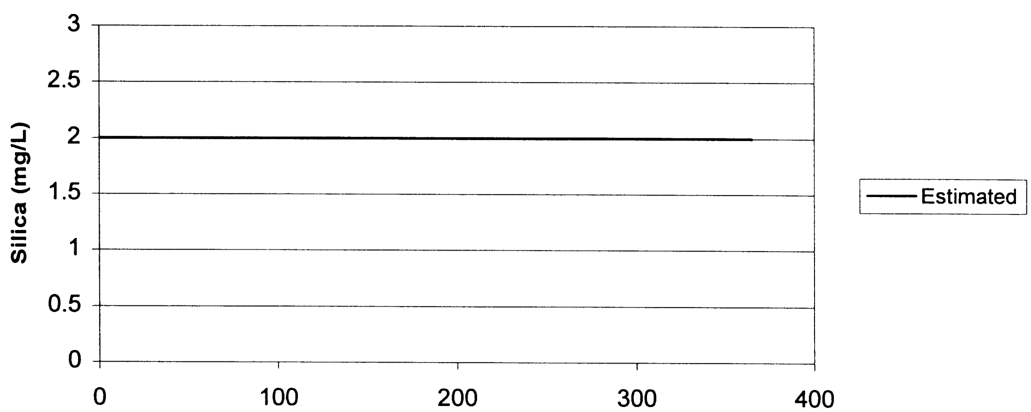

1988 Mine Lick Creek
Silica (mg/L)
2.5
2
1.5
1
0.5
0
0
100
200
300
400
Estimated


1996 Mine Lick Creek
Silica (mg/L)
2.5
2
1.5
1
0.5
0
0
100
200
300
400
Estimated

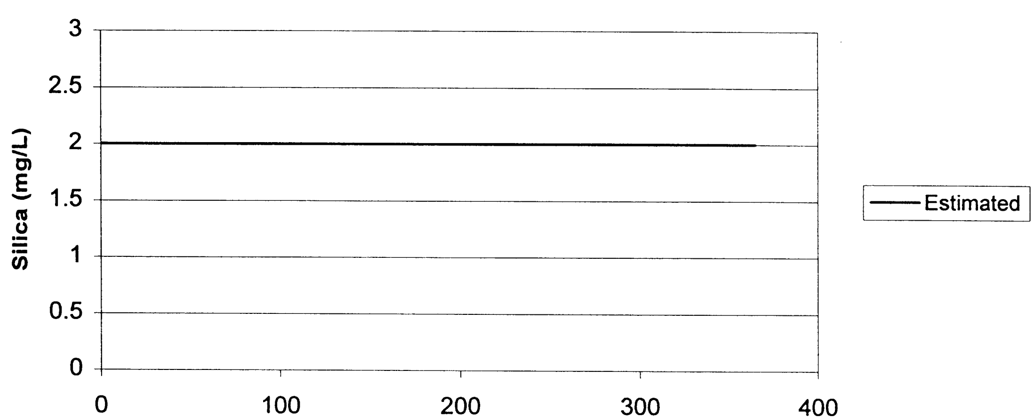
1973 Holmes Creek

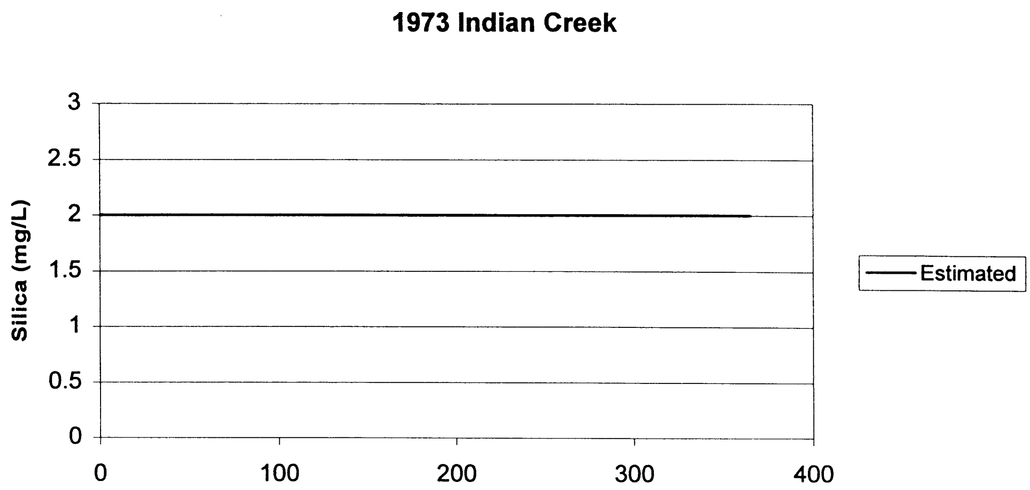


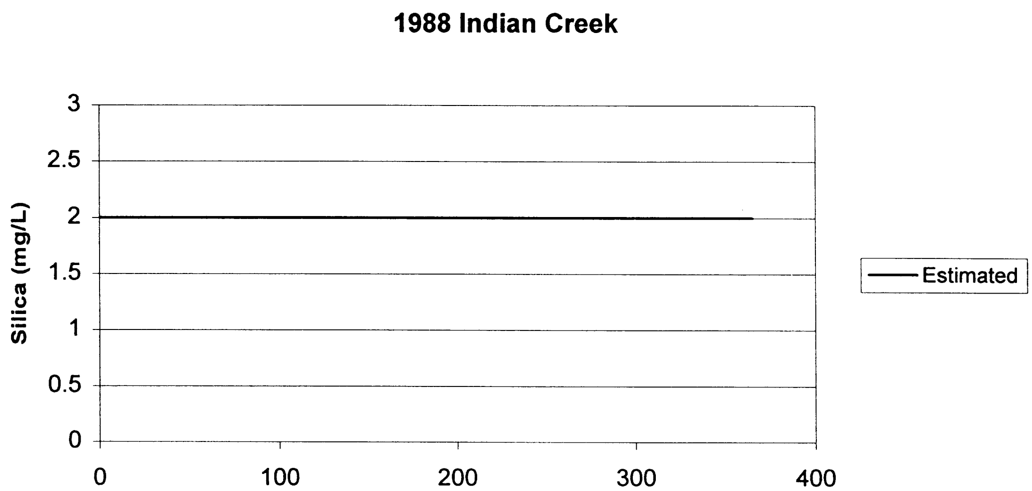
1988 Holmes Creek

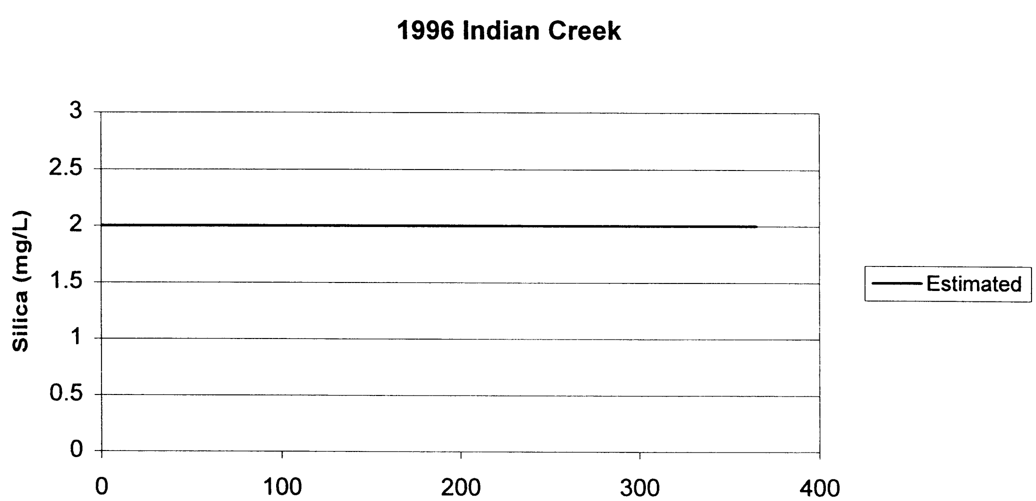


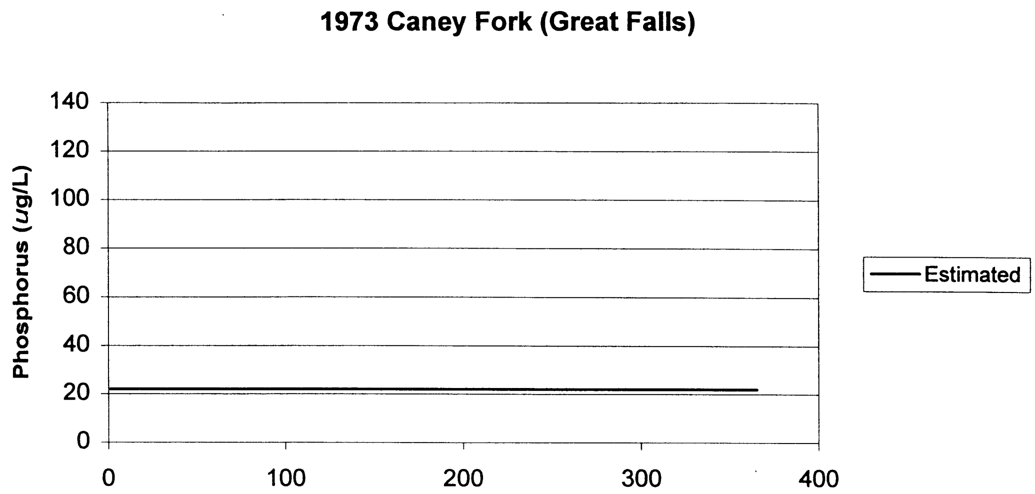
1996 Holmes Creek

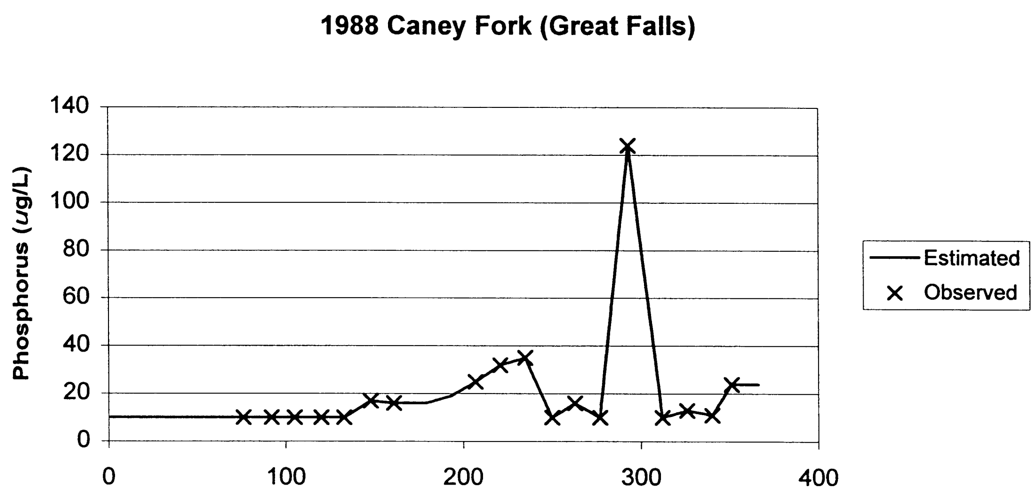


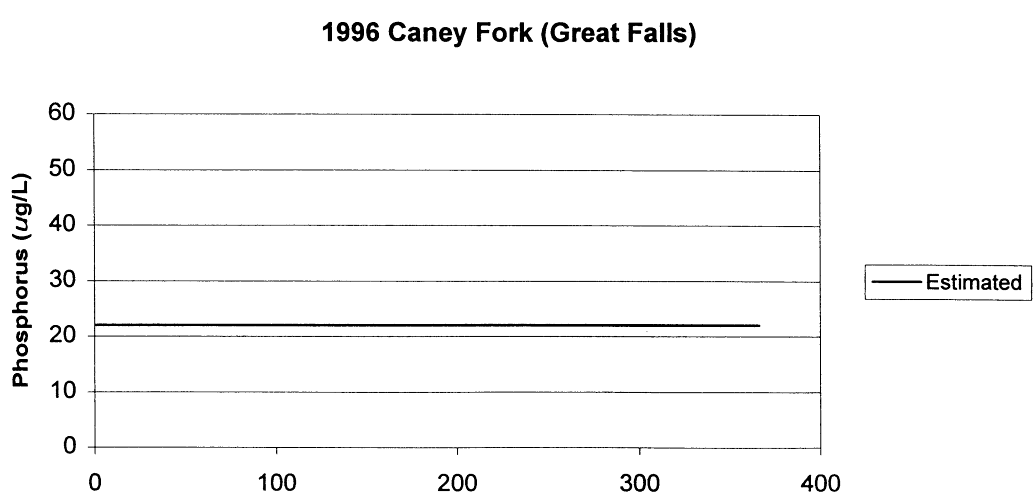

1973 Indian Creek
Silica (mg/L)
3
2.5
2
1.5
1
0.5
0
0
100
200
300
400
Estimated


1988 Indian Creek
Silica (mg/L)
3
2.5
2
1.5
1
0.5
0
0
100
200
300
400
Estimated

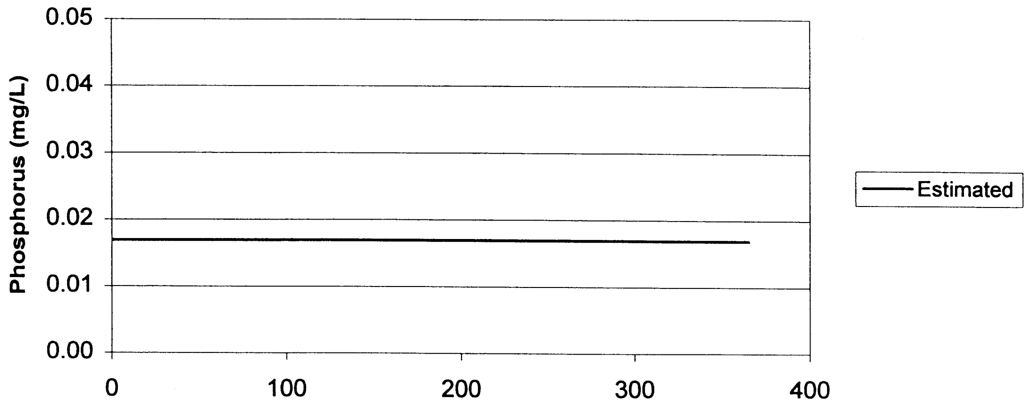

1996 Indian Creek
Silica (mg/L)
3
2.5
2
1.5
1
0.5
0
0
100
200
300
400
Estimated


1973 Caney Fork (Great Falls)
Phosphorus (ug/L)
140
120
100
80
60
40
20
0
0
100
200
300
400
Estimated

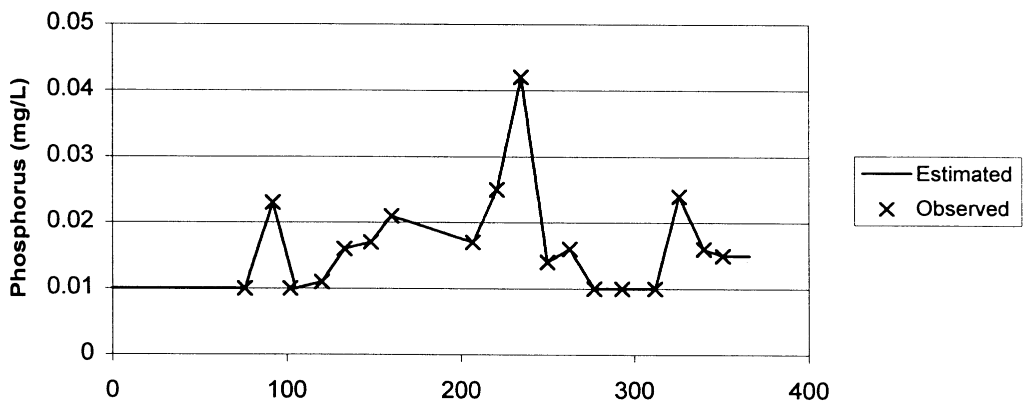

1988 Caney Fork (Great Falls)
Phosphorus (ug/L)
140
120
100
80
60
40
20
0
0
100
200
300
400
Estimated
Observed


1996 Caney Fork (Great Falls)
Phosphorus (ug/L)
60
50
40
30
20
10
0
0
100
200
300
400
Estimated

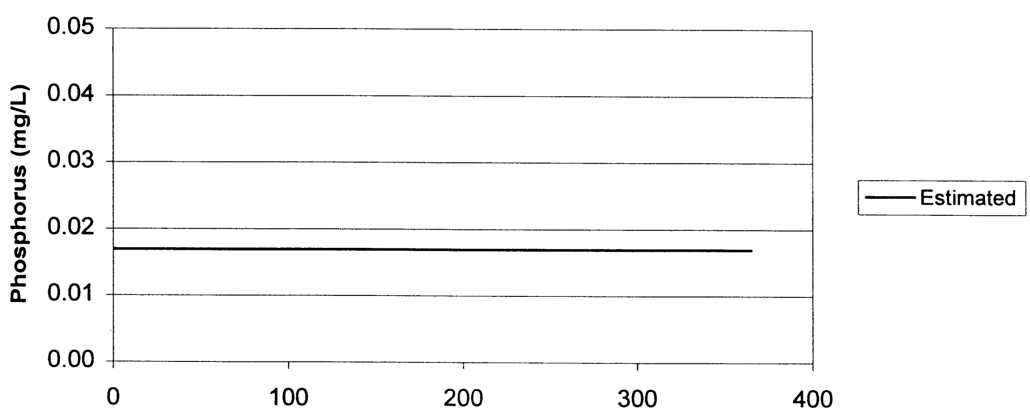
1973 Pine Creek



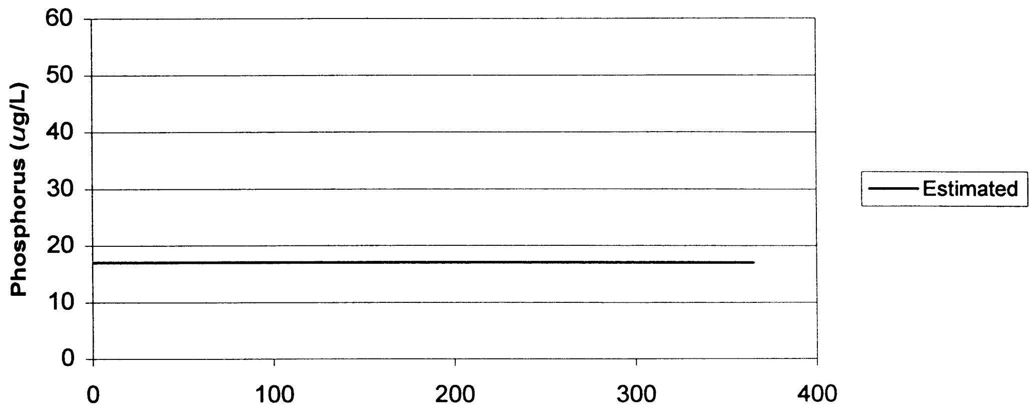
1988 Pine Creek



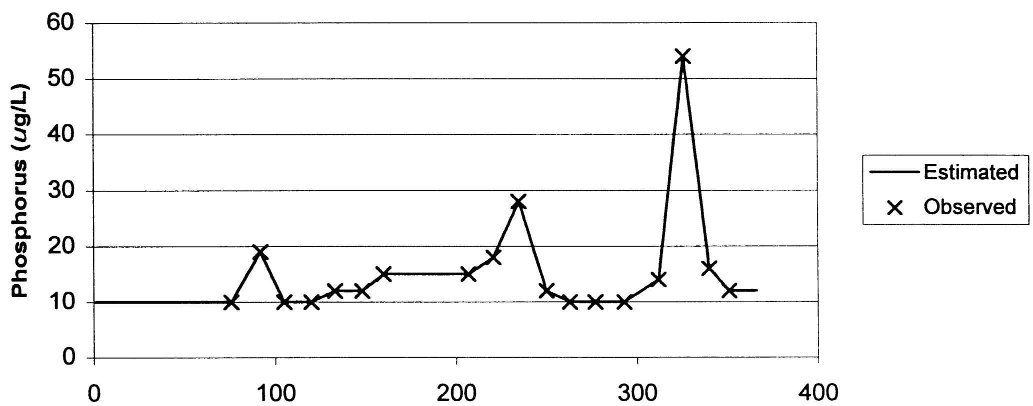
1996 Pine Creek



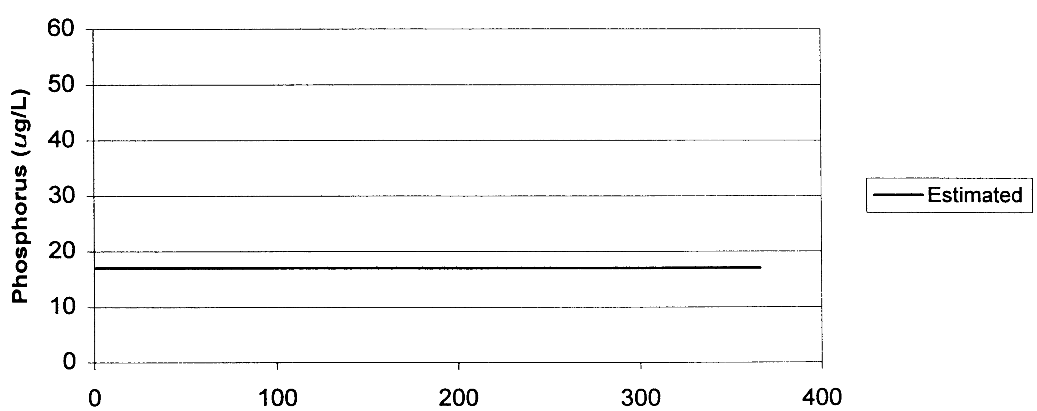
1973 Fall Creek



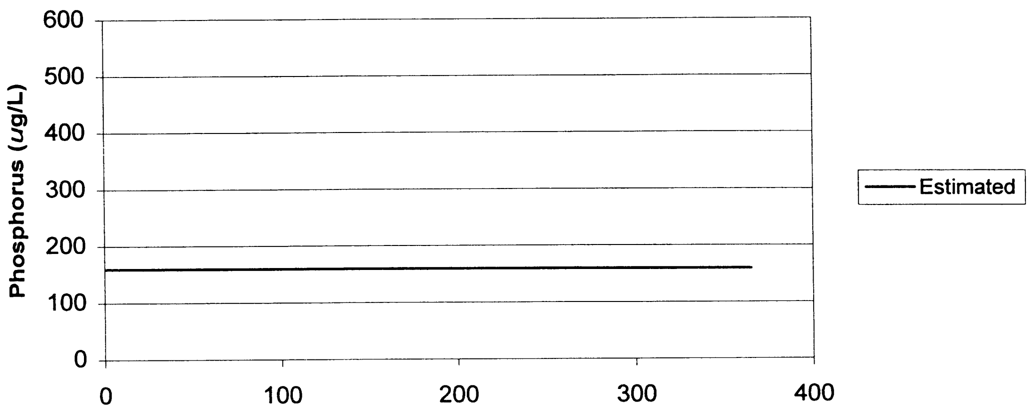
1988 Fall Creek



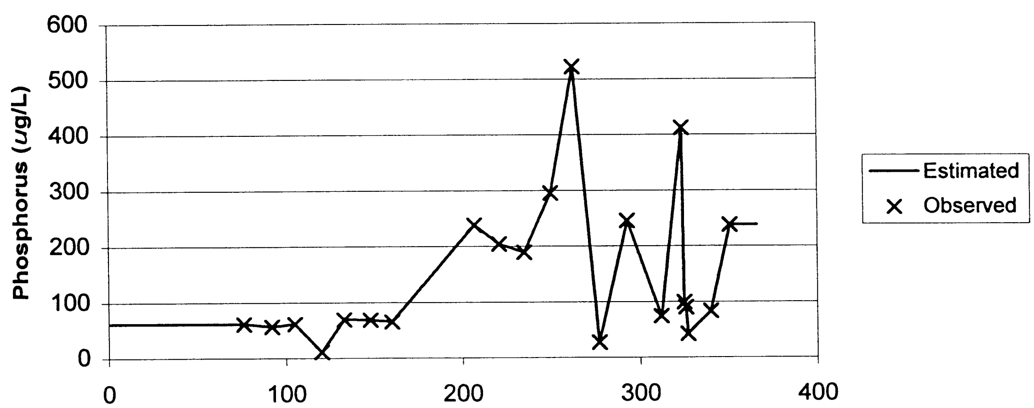
1996 Fall Creek



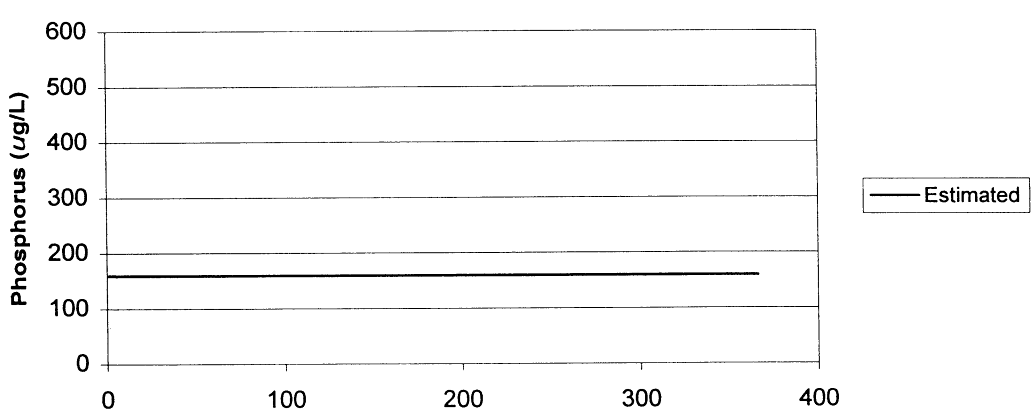
1973 Falling Water River



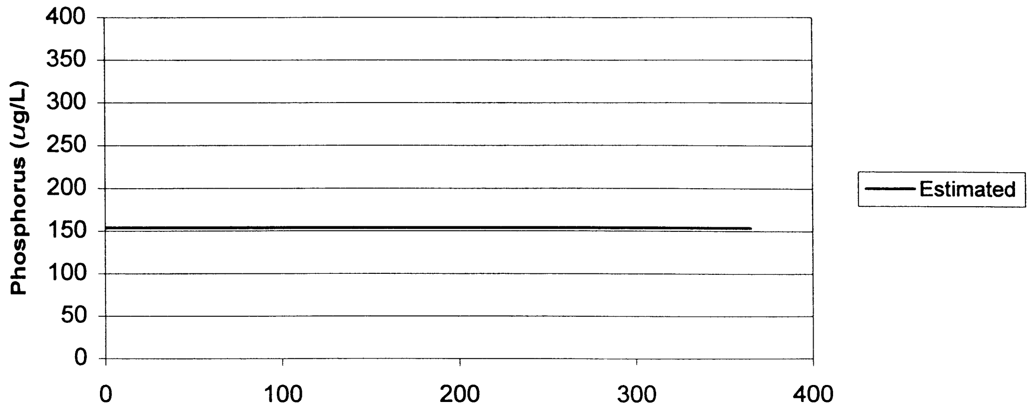
1988 Falling Water River



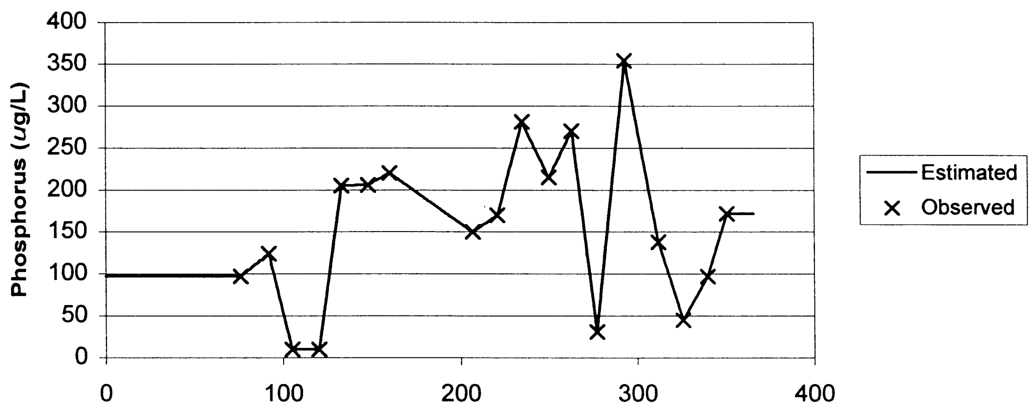
1996 Falling Water River



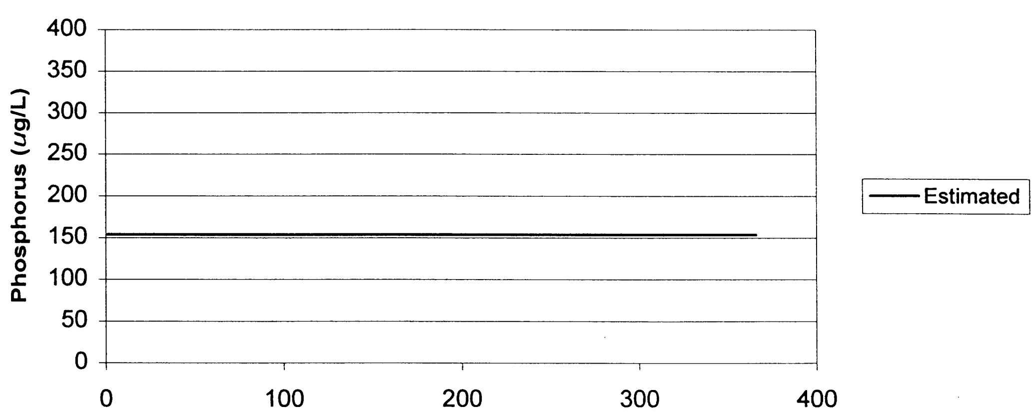
1973 Mine Lick Creek



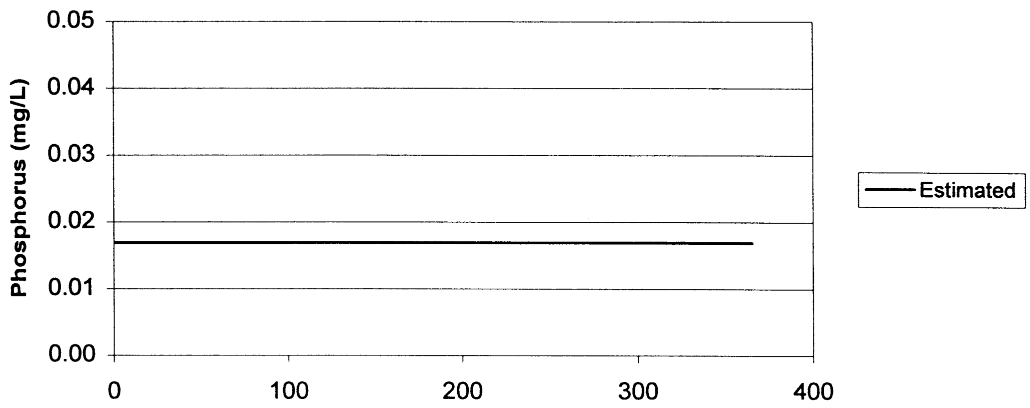
1988 Mine Lick Creek



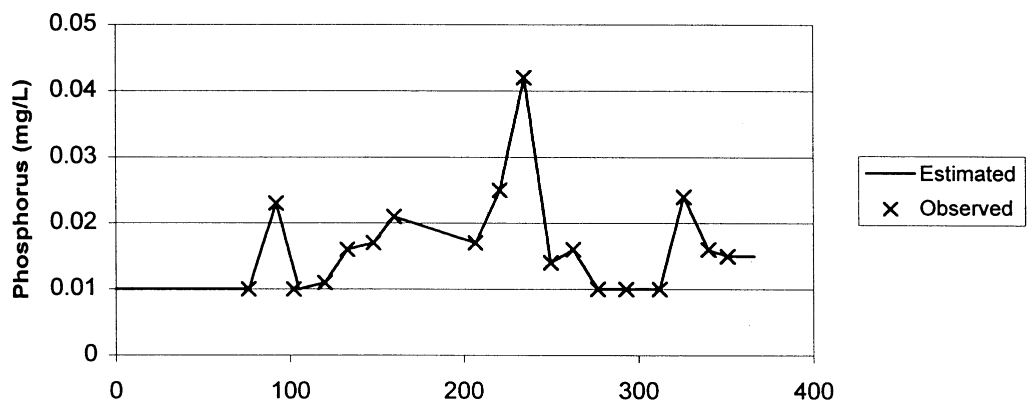
1996 Mine Lick Creek



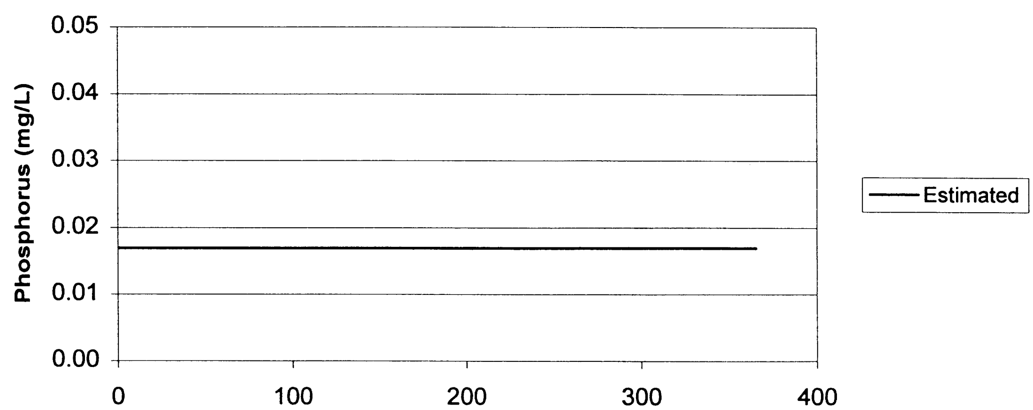
1973 Holmes Creek

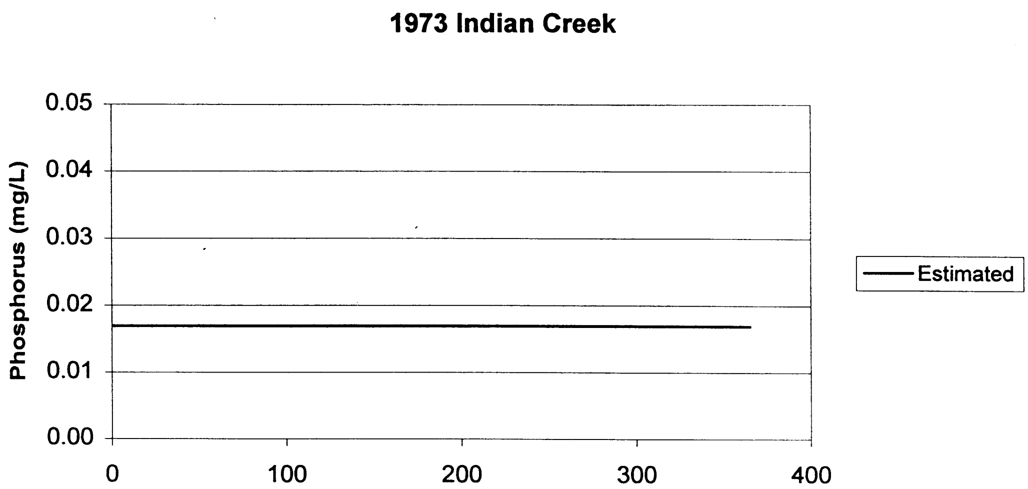


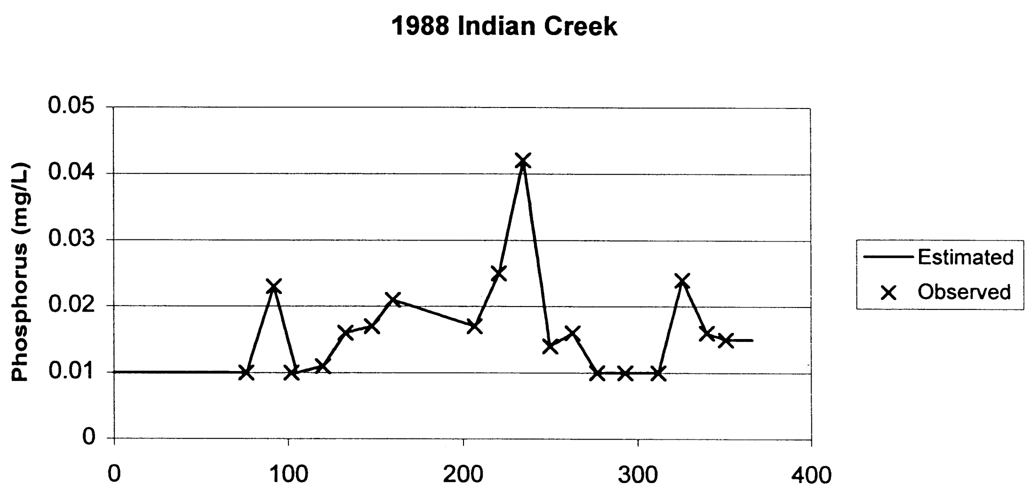
1988 Holmes Creek

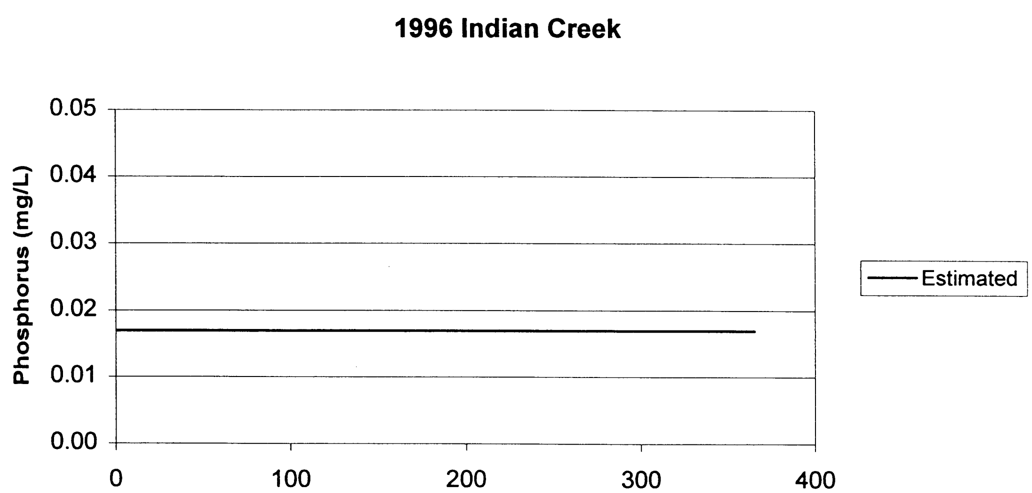


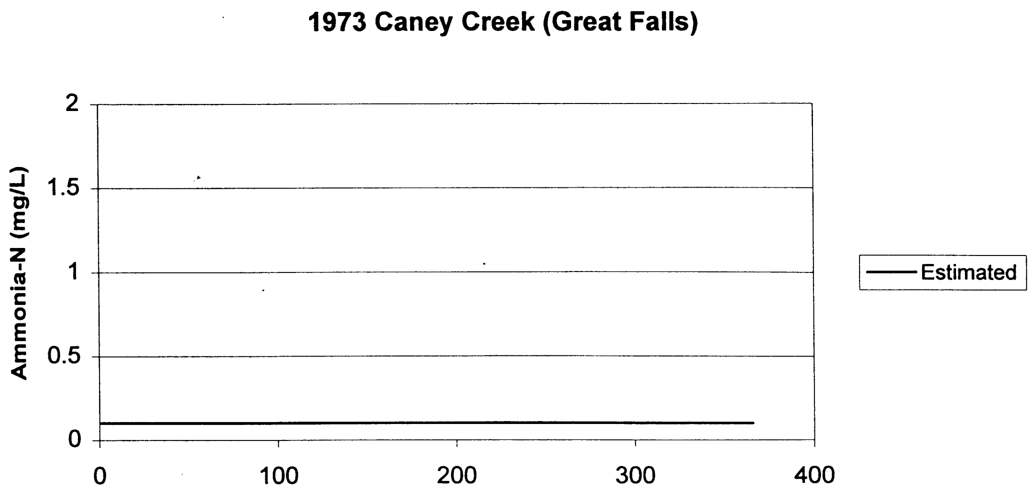
1996 Holmes Creek

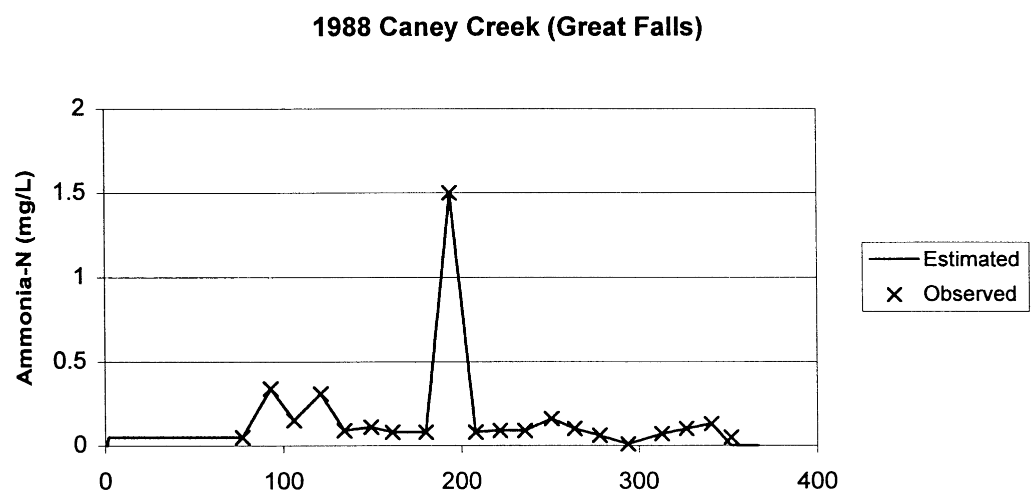


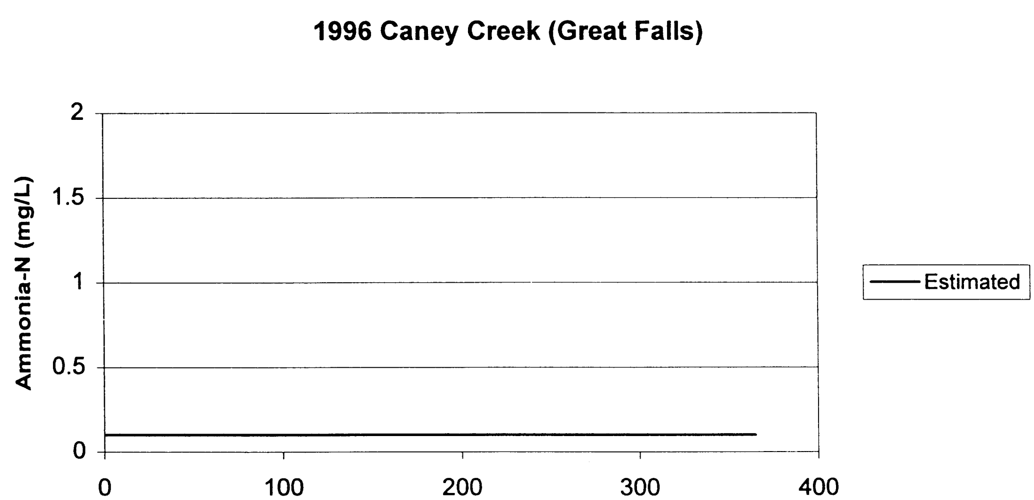

1973 Indian Creek
Phosphorus (mg/L)
0.05
0.04
0.03
0.02
0.01
0.00
0
100
200
300
400
Estimated


1988 Indian Creek
Phosphorus (mg/L)
0.05
0.04
0.03
0.02
0.01
0
0
100
200
300
400
Estimated
Observed

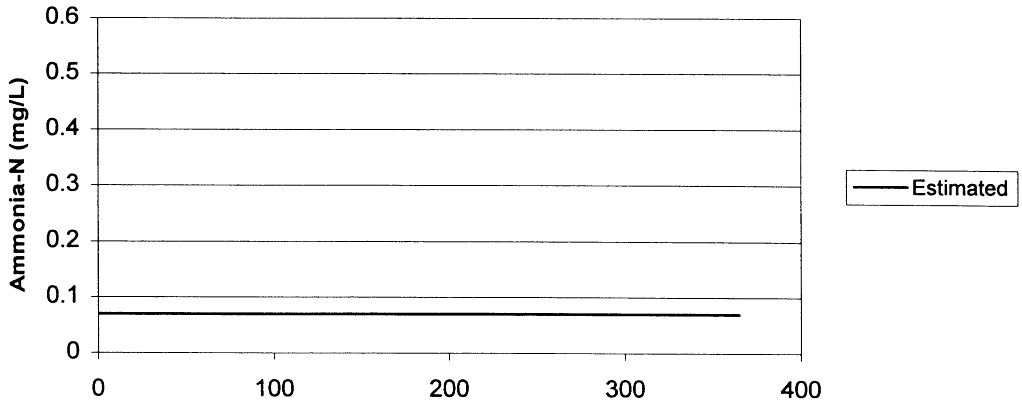

1996 Indian Creek
Phosphorus (mg/L)
0.05
0.04
0.03
0.02
0.01
0.00
0
100
200
300
400
Estimated


1973 Caney Creek (Great Falls)
Ammonia-N (mg/L)
2
1.5
1
0.5
0
0
100
200
300
400
Estimated

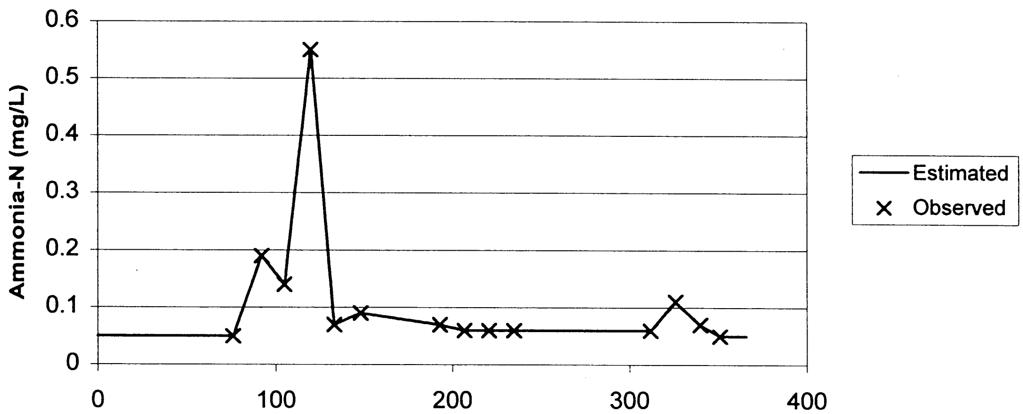

1988 Caney Creek (Great Falls)
Ammonia-N (mg/L)
2
1.5
1
0.5
0
0
100
200
300
400
Estimated
Observed


1996 Caney Creek (Great Falls)
Ammonia-N (mg/L)
2
1.5
1
0.5
0
0
100
200
300
400
Estimated

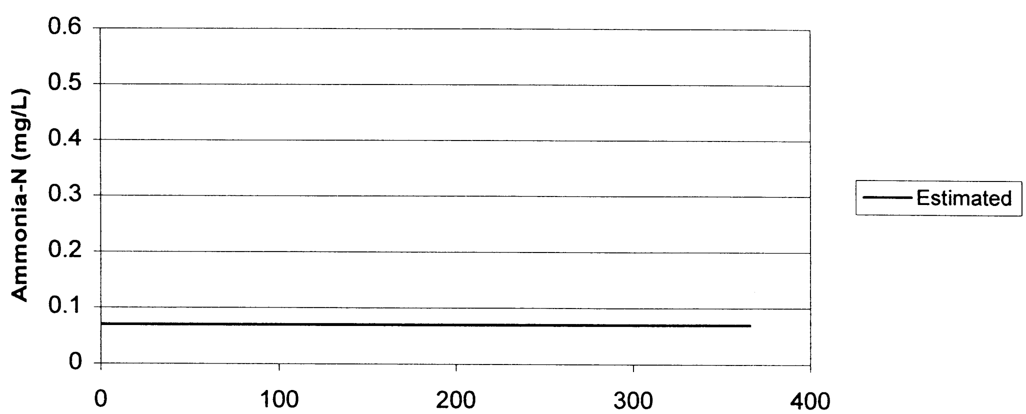
1973 Pine Creek

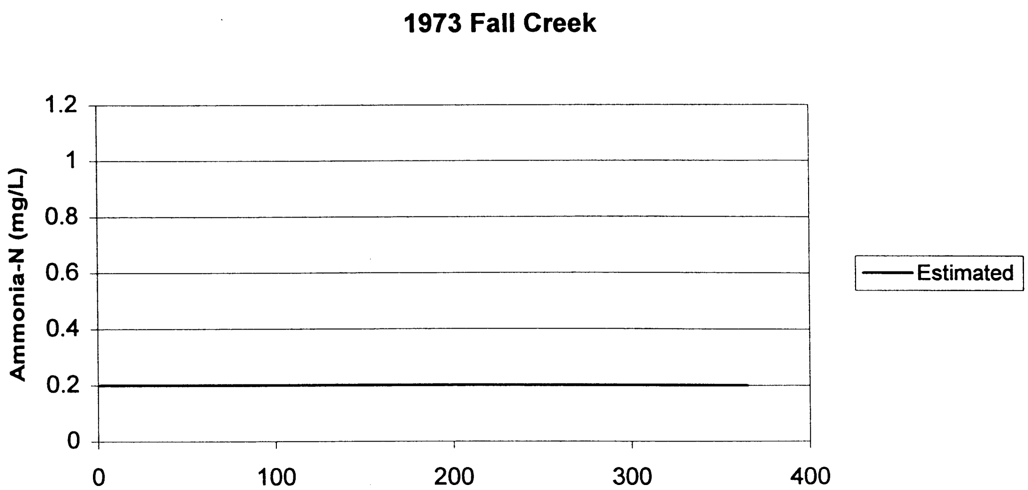


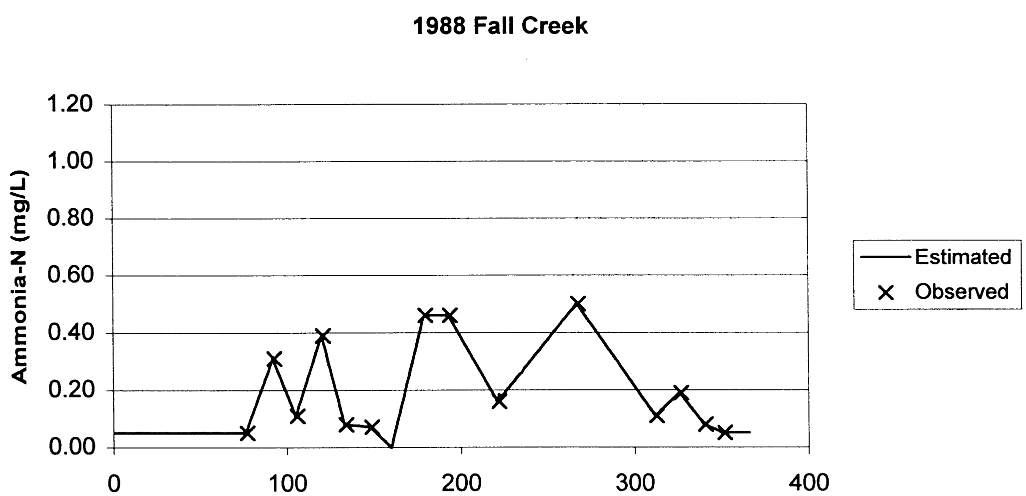
1988 Pine Creek

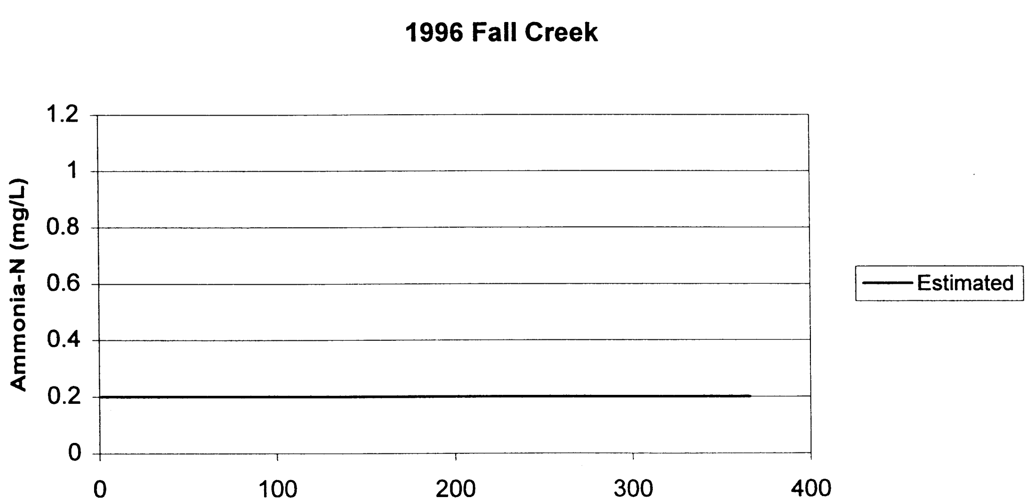


1996 Pine Creek

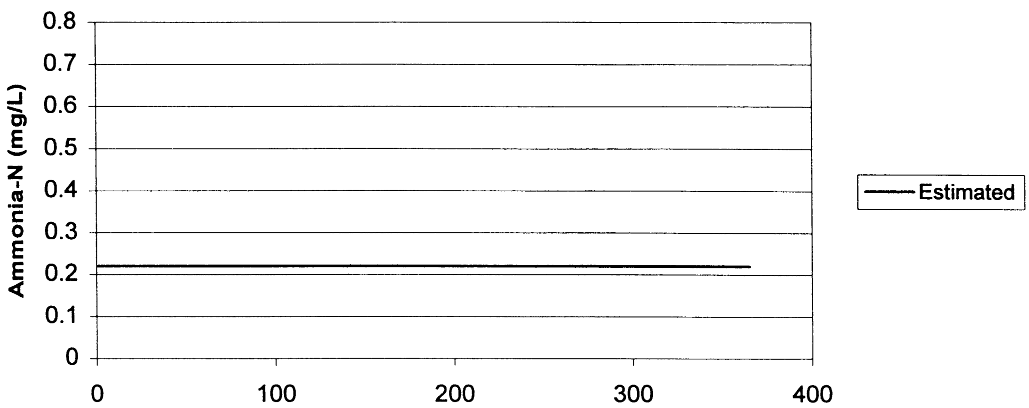



1973 Fall Creek
Ammonia-N (mg/L)
1.2
1
0.8
0.6
0.4
0.2
0
0
100
200
300
400
Estimated

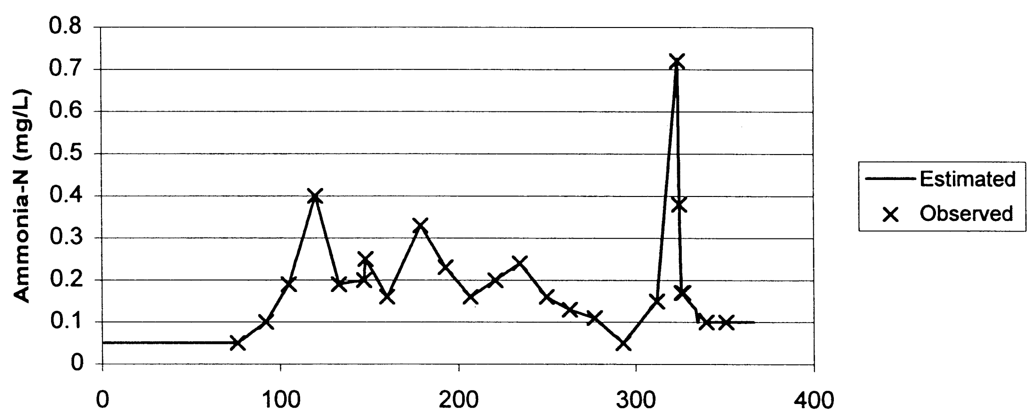

1988 Fall Creek
Ammonia-N (mg/L)
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0
100
200
300
400
Estimated
Observed


1996 Fall Creek
Ammonia-N (mg/L)
1.2
1
0.8
0.6
0.4
0.2
0
0
100
200
300
400
Estimated

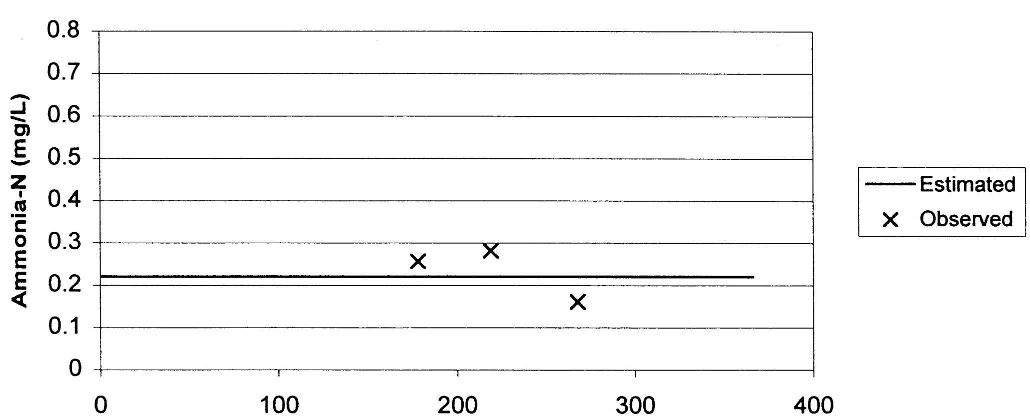
1973 Falling Water River



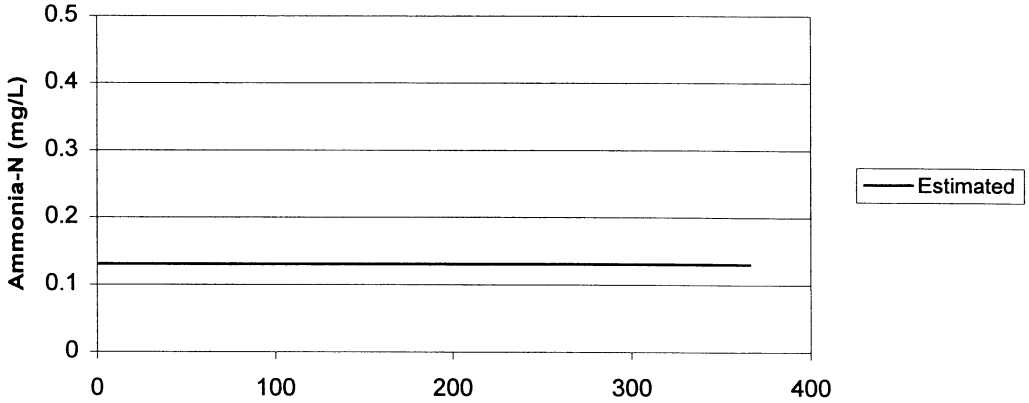
1988 Falling Water River



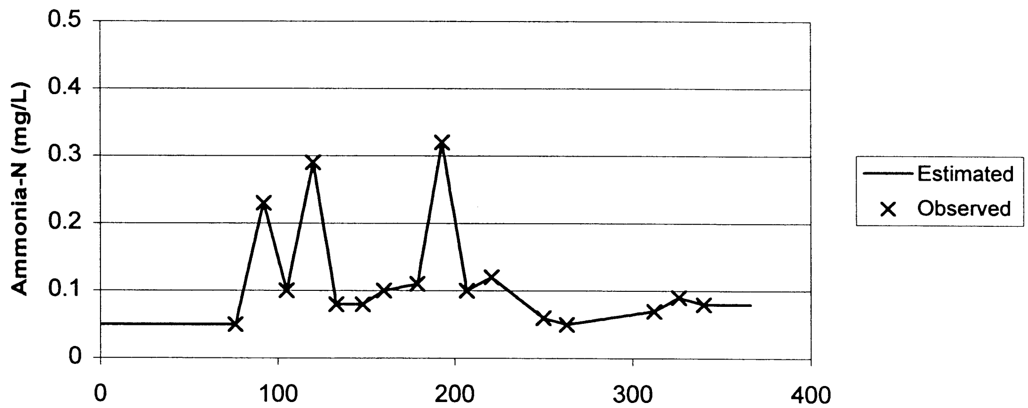
1996 Falling Water River



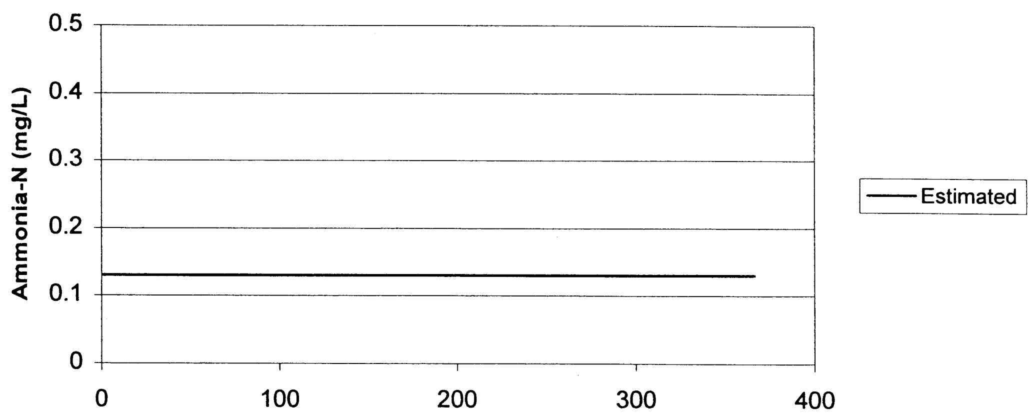
1973 Mine Lick Creek



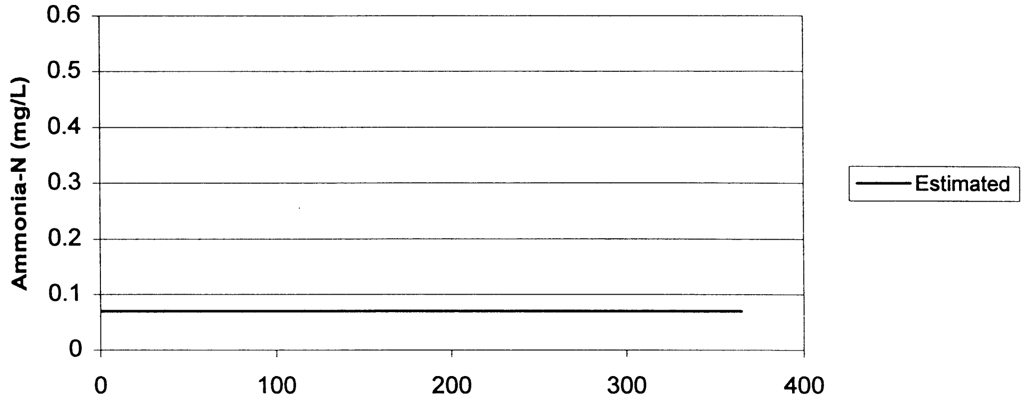
1988 Mine Lick Creek



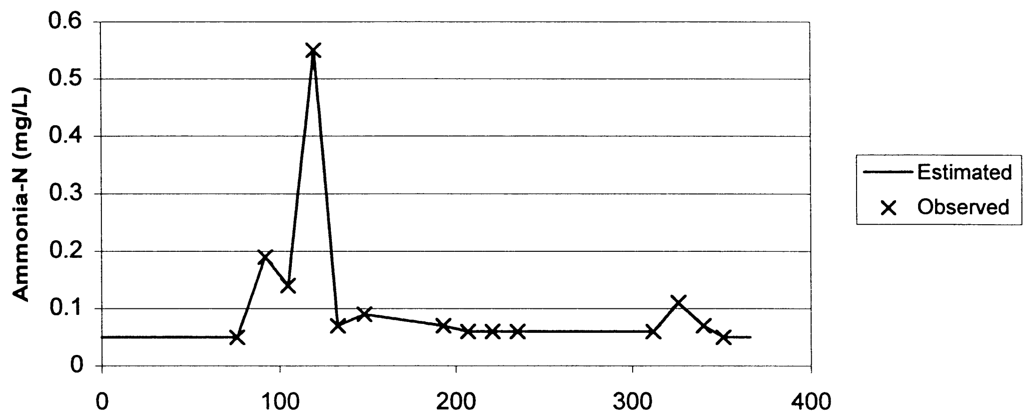
1996 Mine Lick Creek



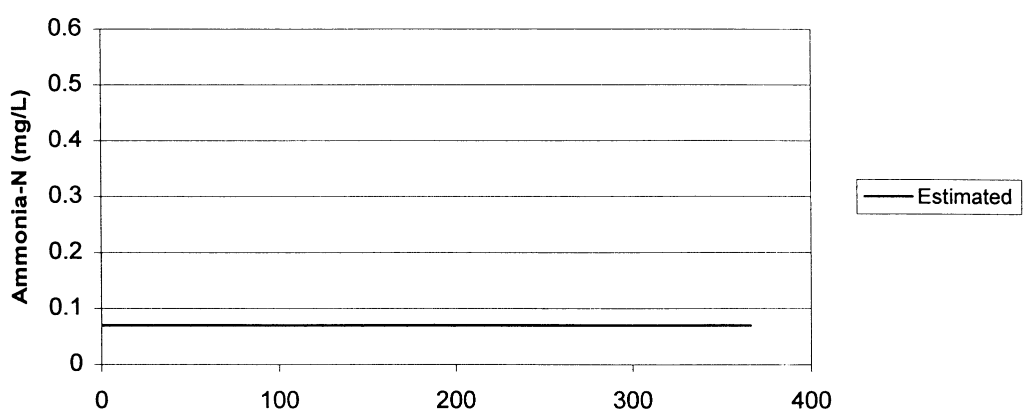
1973 Holmes Creek

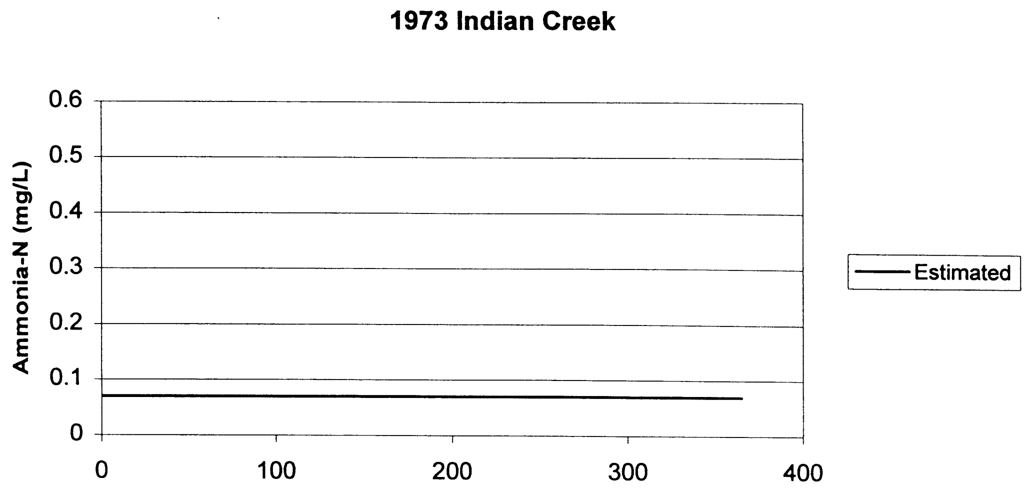


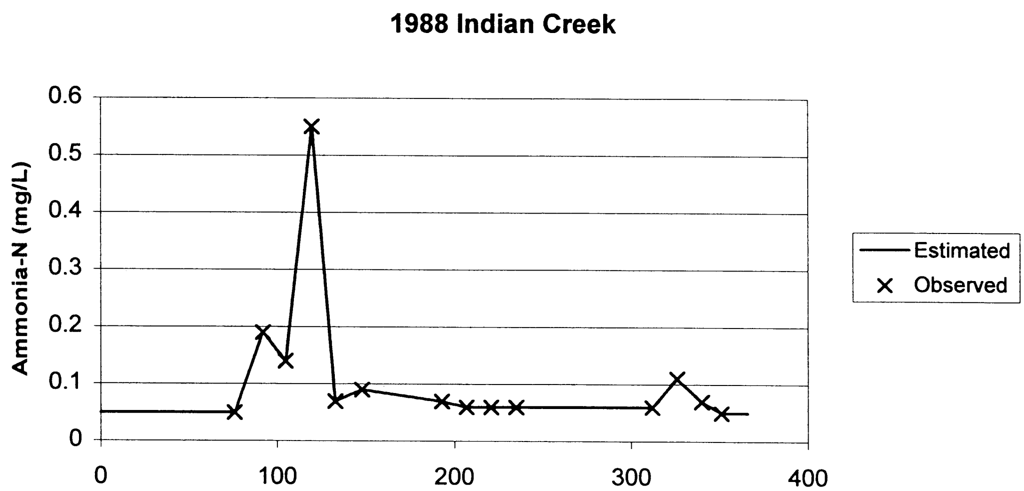
1988 Holmes Creek

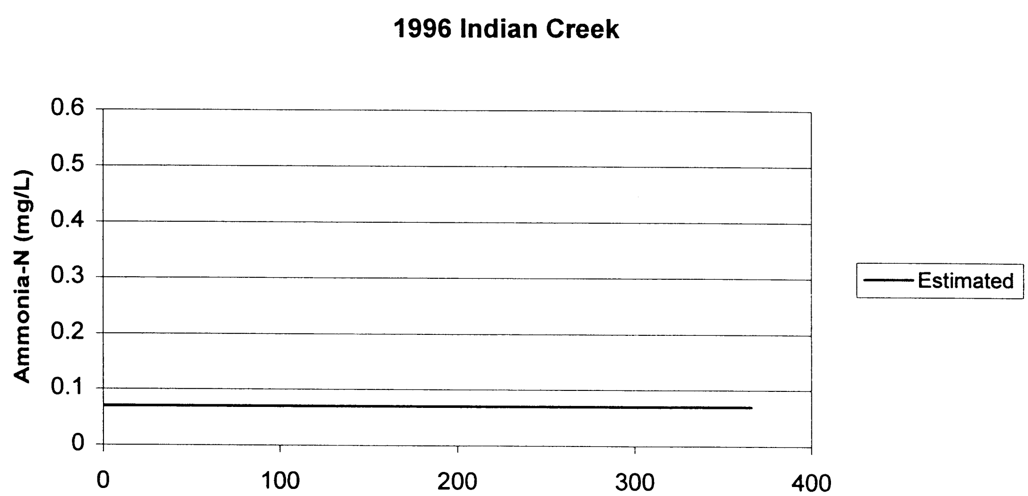


1996 Holmes Creek

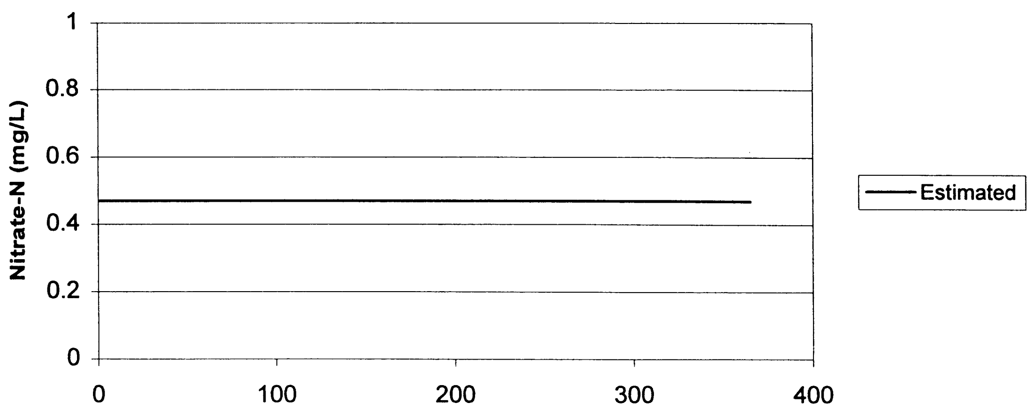



1973 Indian Creek
Ammonia-N (mg/L)
0.6
0.5
0.4
0.3
0.2
0.1
0
0
100
200
300
400
Estimated

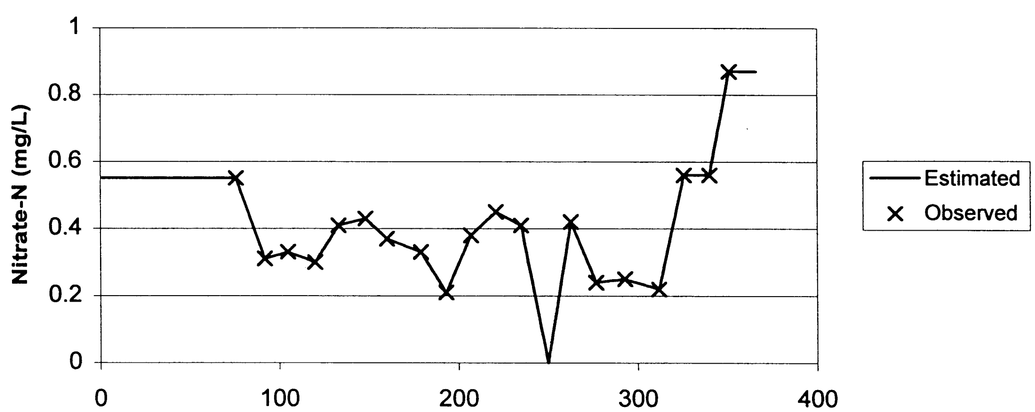

1988 Indian Creek
Ammonia-N (mg/L)
0.6
0.5
0.4
0.3
0.2
0.1
0
0
100
200
300
400
Estimated
Observed


1996 Indian Creek
Ammonia-N (mg/L)
0.6
0.5
0.4
0.3
0.2
0.1
0
0
100
200
300
400
Estimated

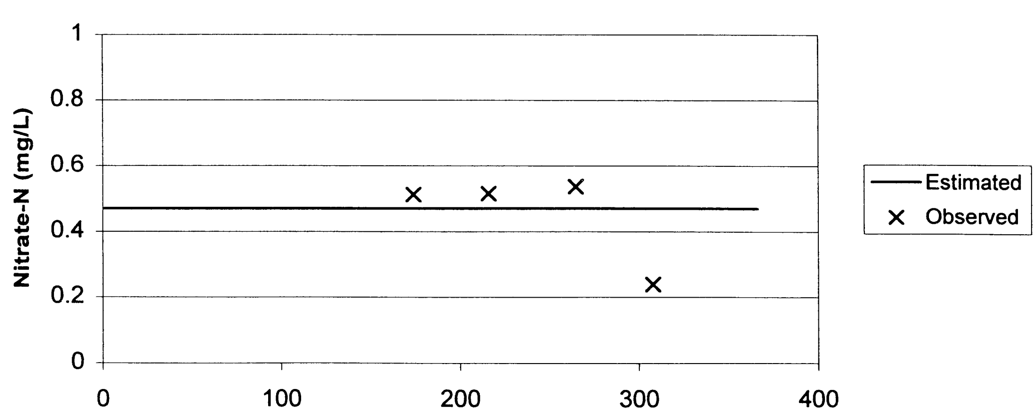
1973 Caney Creek (Great Falls)



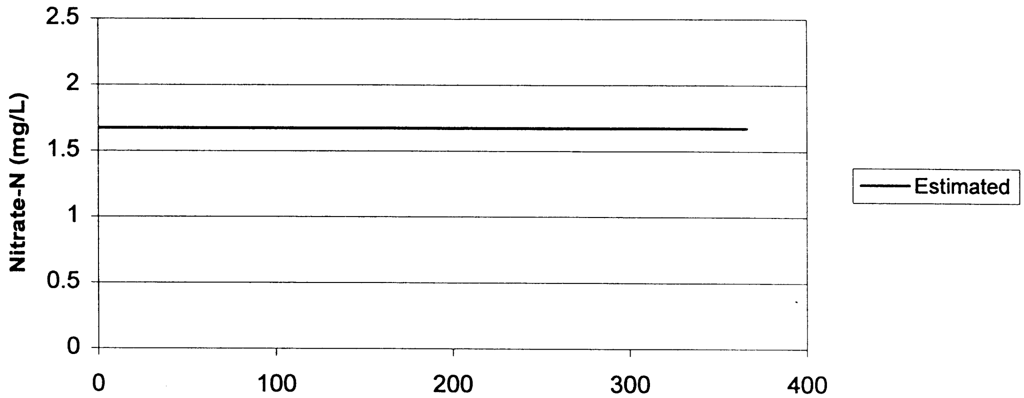
1988 Caney Creek (Great Falls)



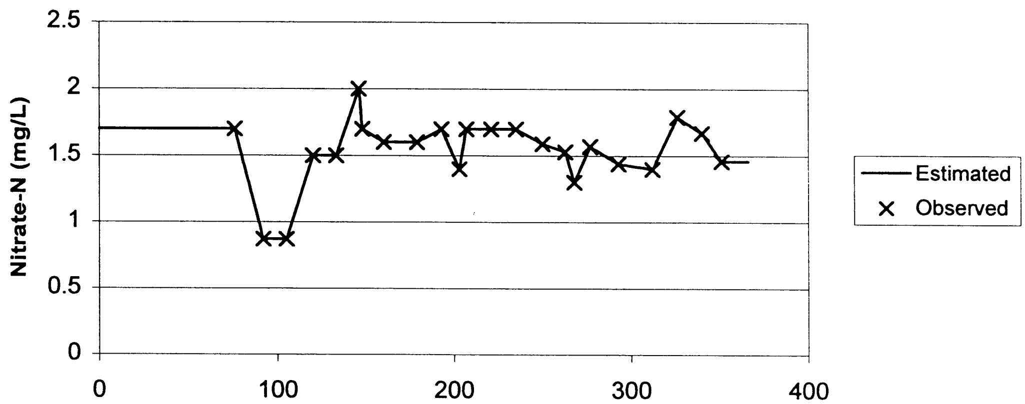
1996 Caney Creek (Great Falls)



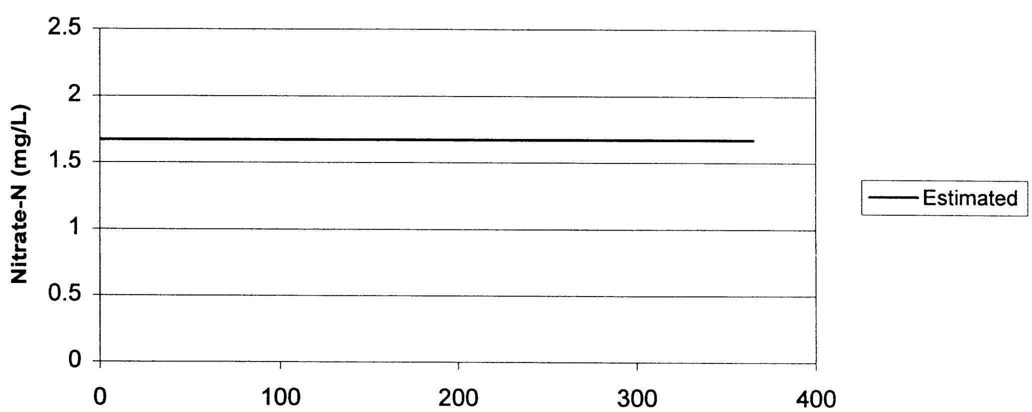
1973 Pine Creek



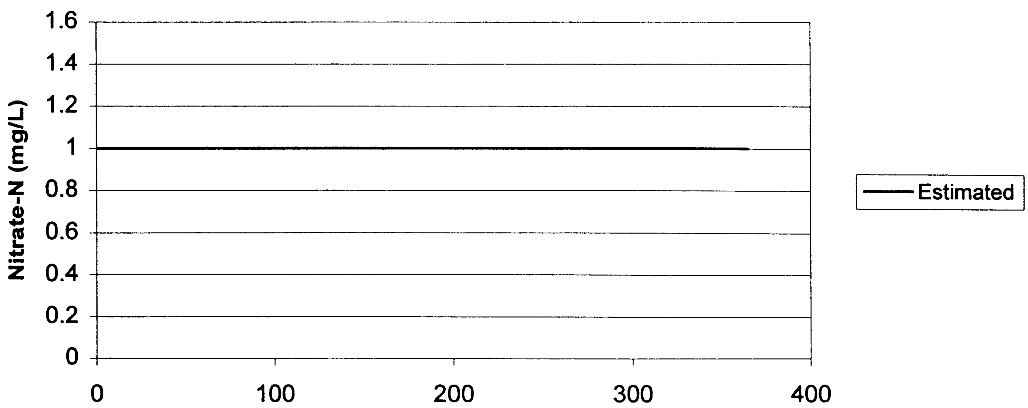
1988 Pine Creek



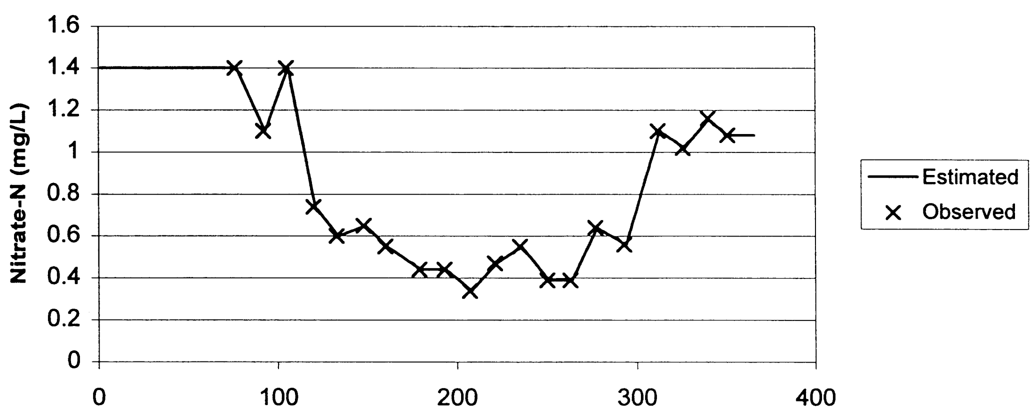
1996 Pine Creek



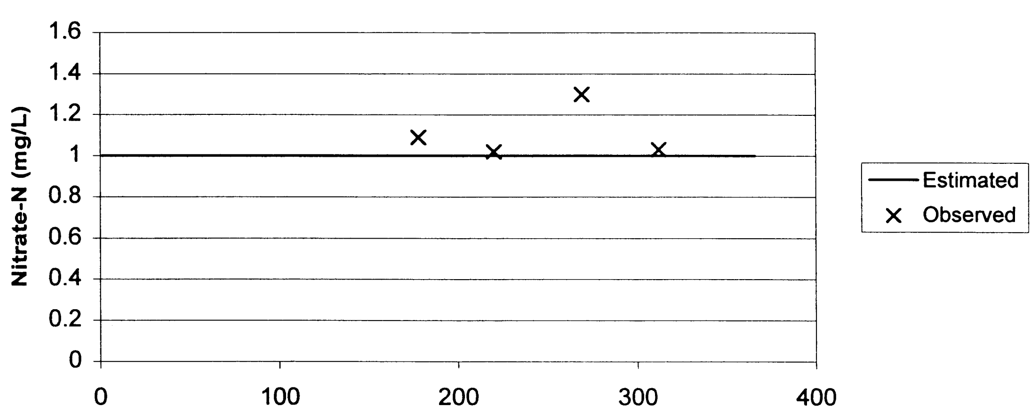
1973 Fall Creek



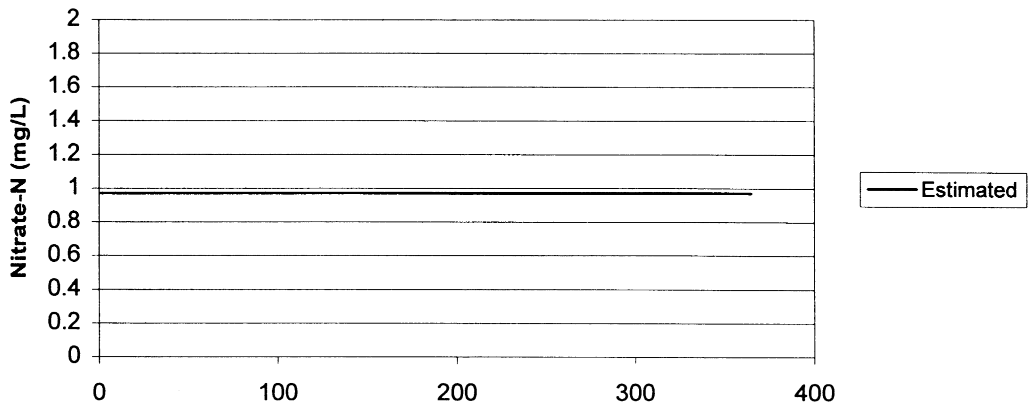
1988 Fall Creek



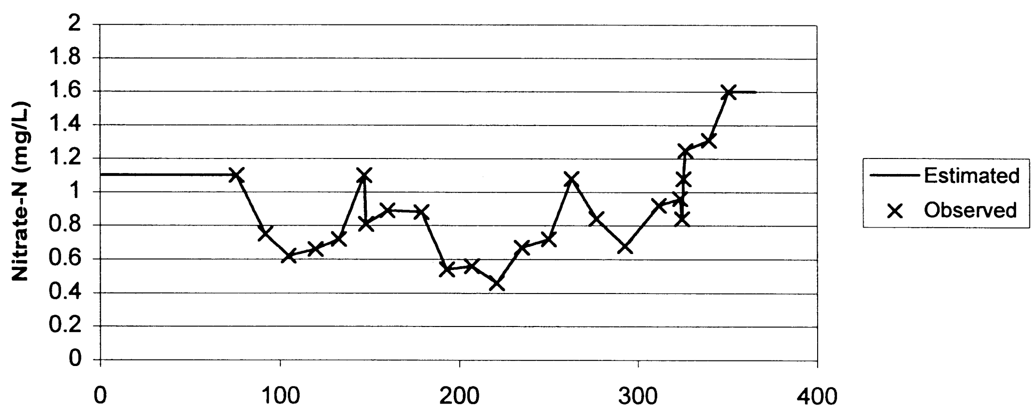
1996 Fall Creek



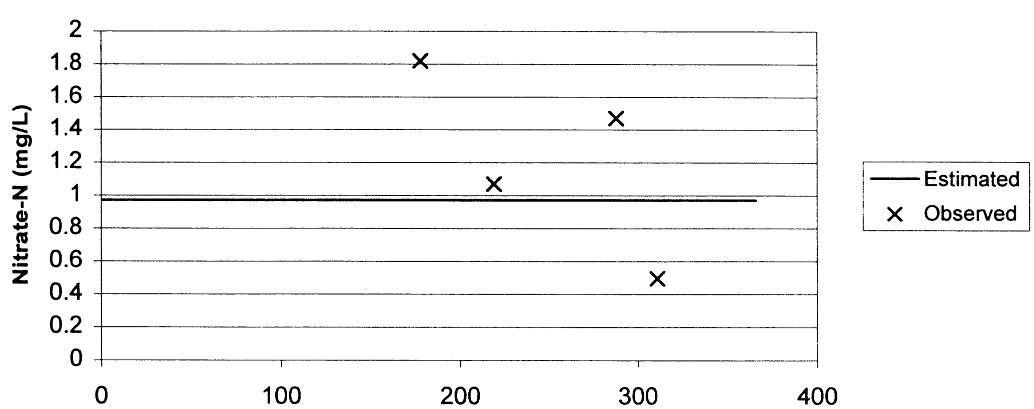
1973 Falling Water River



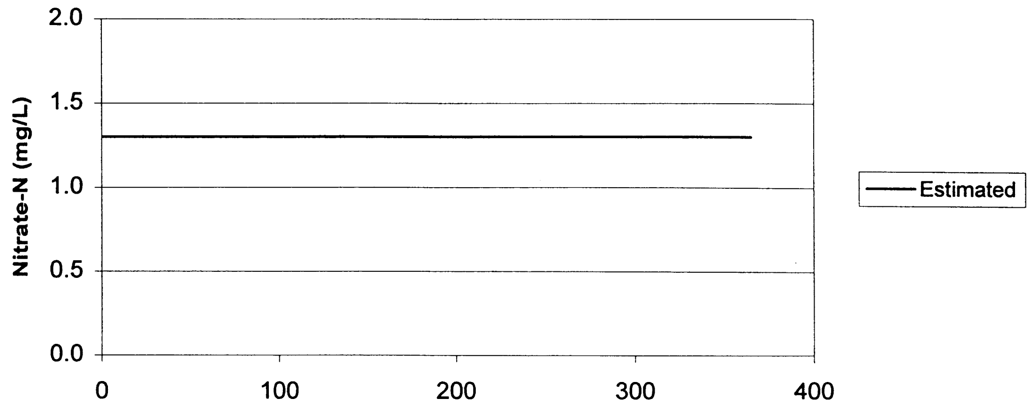
1988 Falling Water River



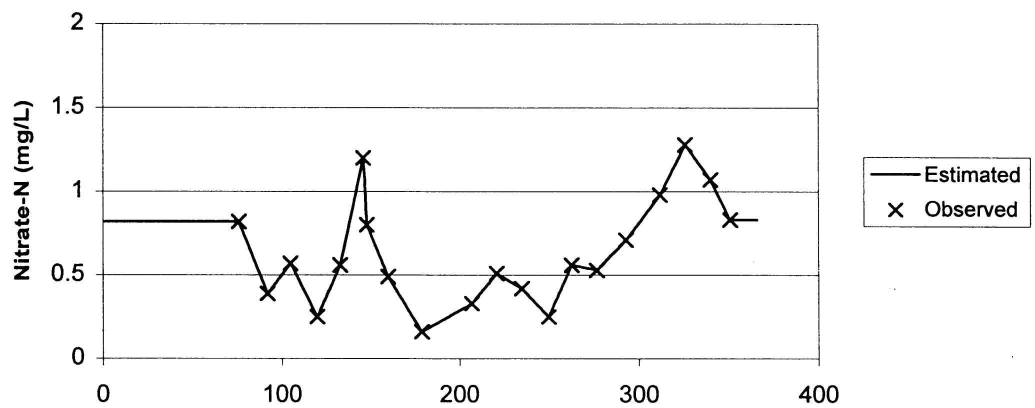
1996 Falling Water River



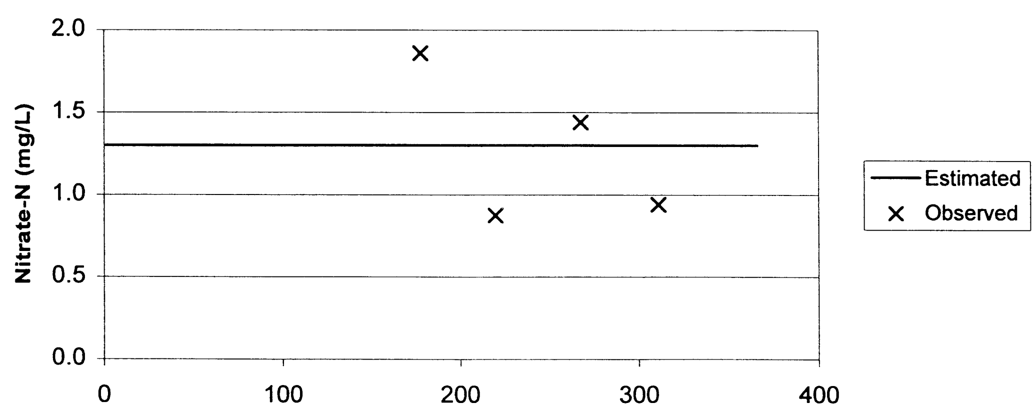
1973 Mine Lick Creek

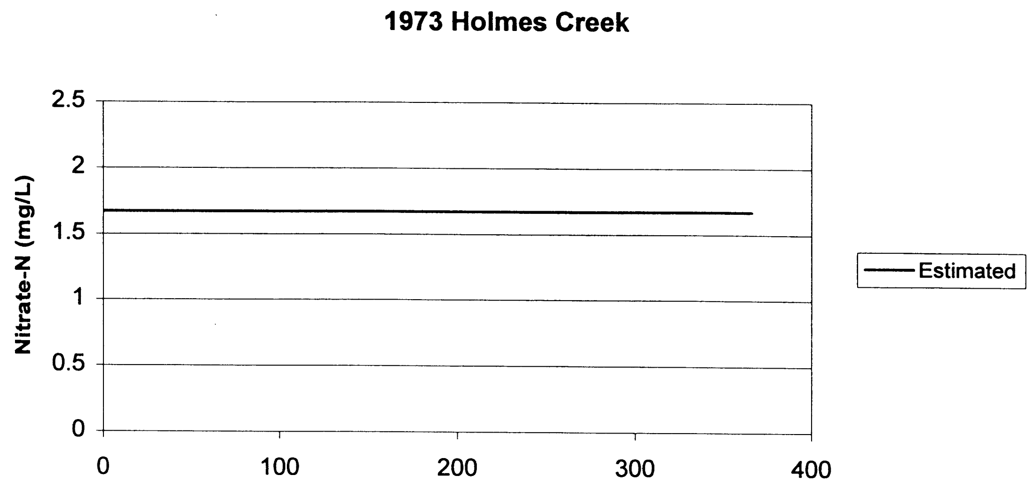


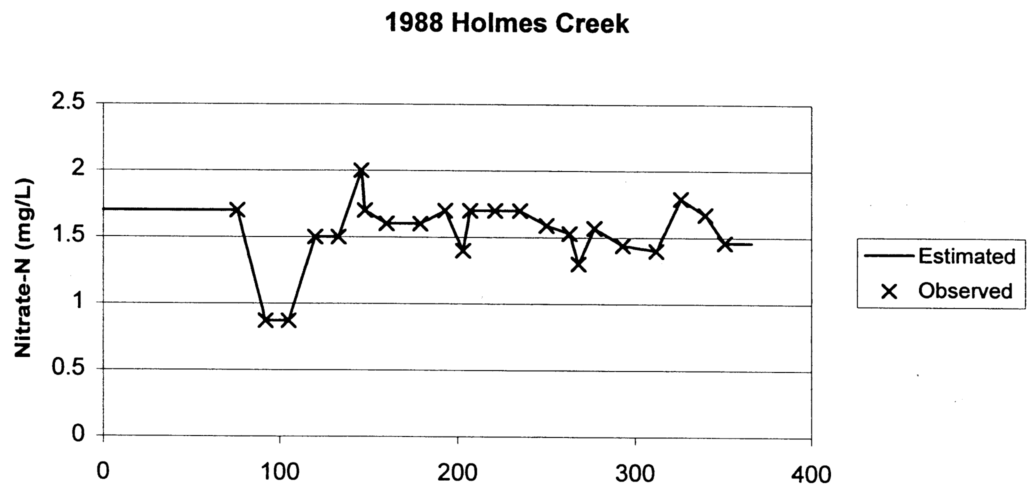
1988 Mine Lick Creek

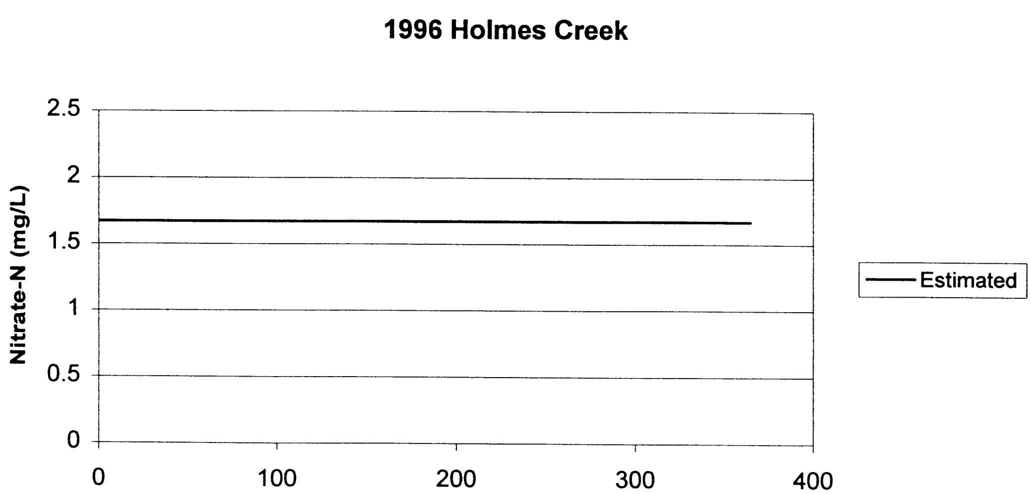


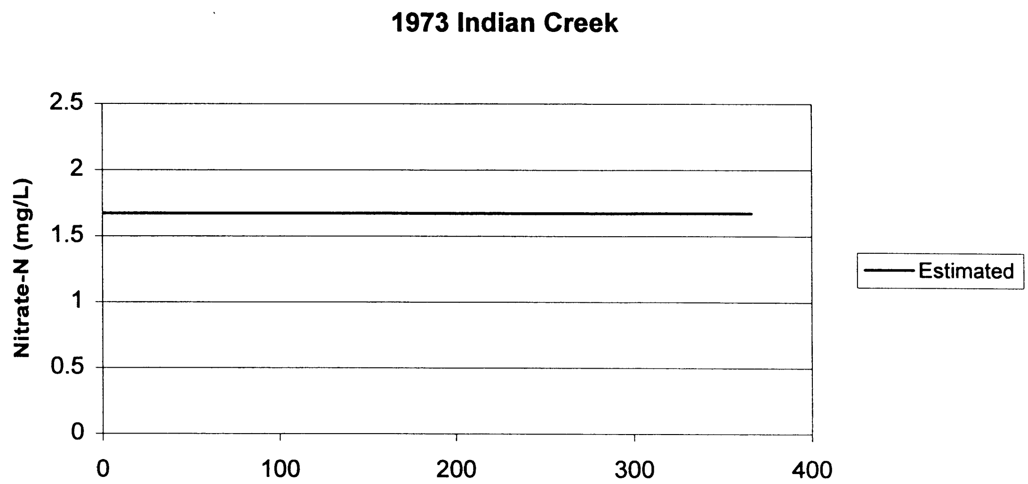
1996 Mine Lick Creek



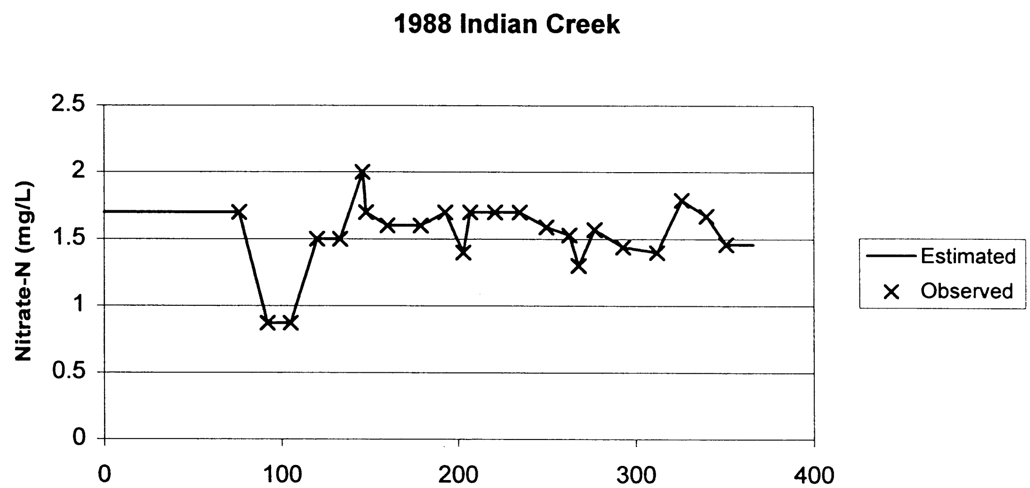

1973 Holmes Creek
Nitrate-N (mg/L)
2.5
2
1.5
1
0.5
0
0
100
200
300
400
Estimated


1988 Holmes Creek
Nitrate-N (mg/L)
2.5
2
1.5
1
0.5
0
0
100
200
300
400
Estimated
Observed

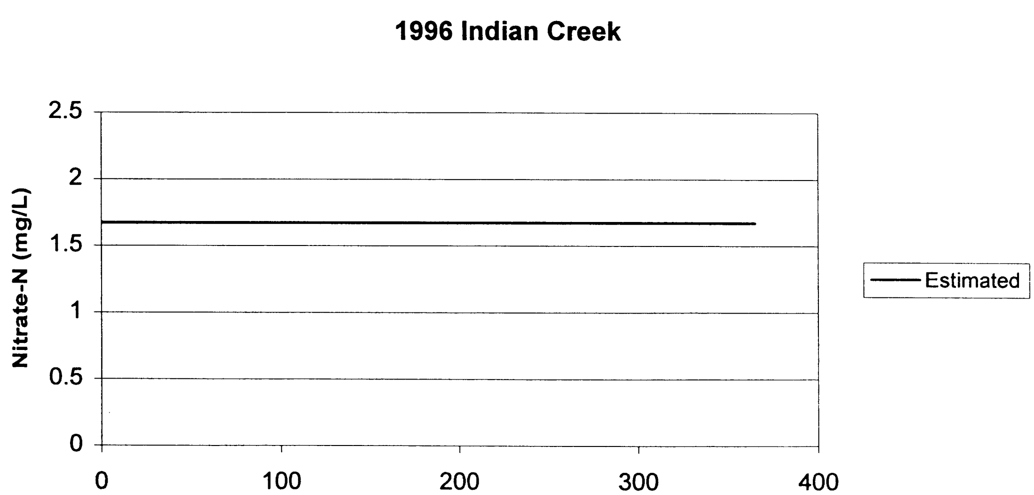

1996 Holmes Creek
Nitrate-N (mg/L)
2.5
2
1.5
1
0.5
0
0
100
200
300
400
Estimated



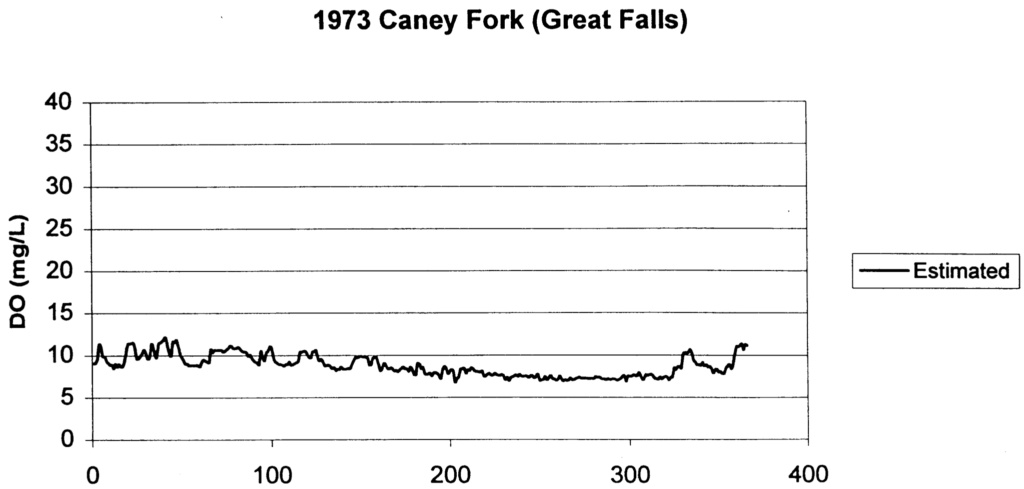
1973 Indian Creek
Nitrate-N (mg/L)
2.5
2
1.5
1
0.5
0
0
100
200
300
400
Estimated

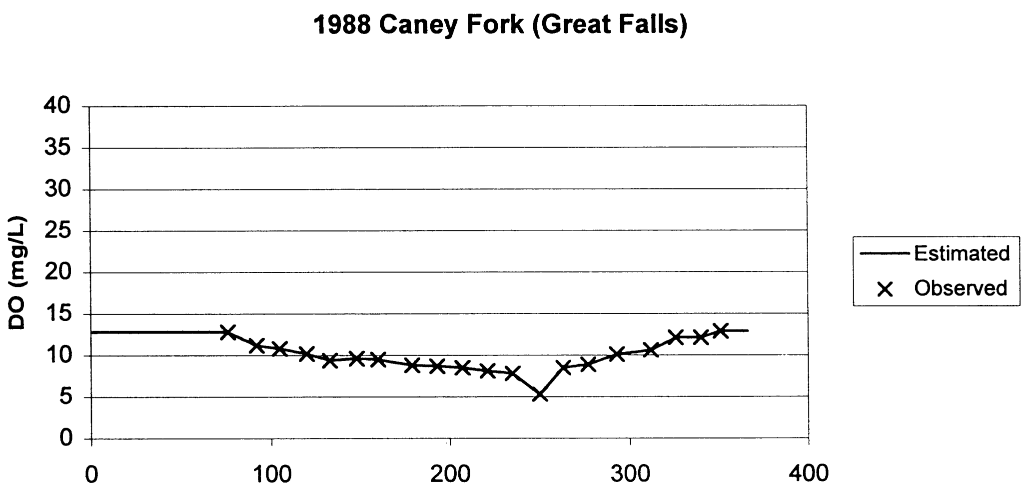


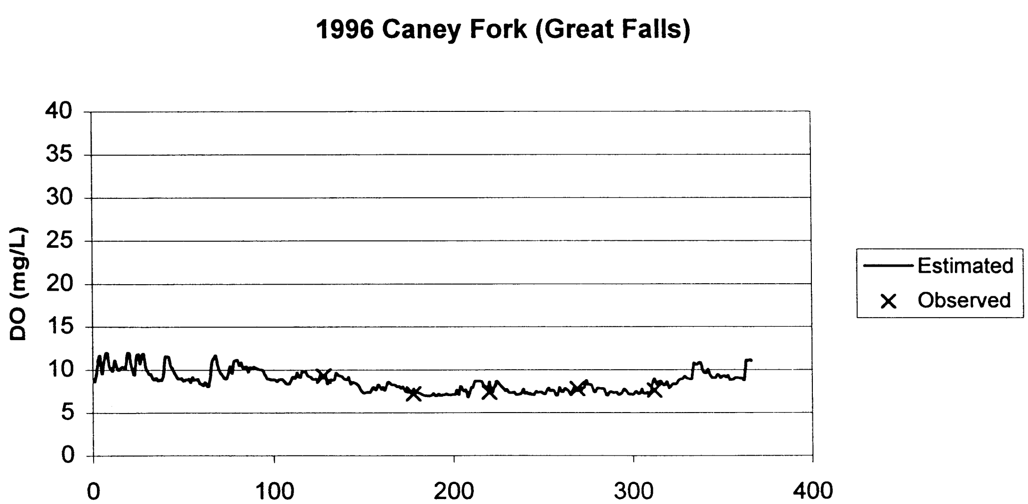
1988 Indian Creek
Nitrate-N (mg/L)
2.5
2
1.5
1
0.5
0
0
100
200
300
400
Estimated
Observed



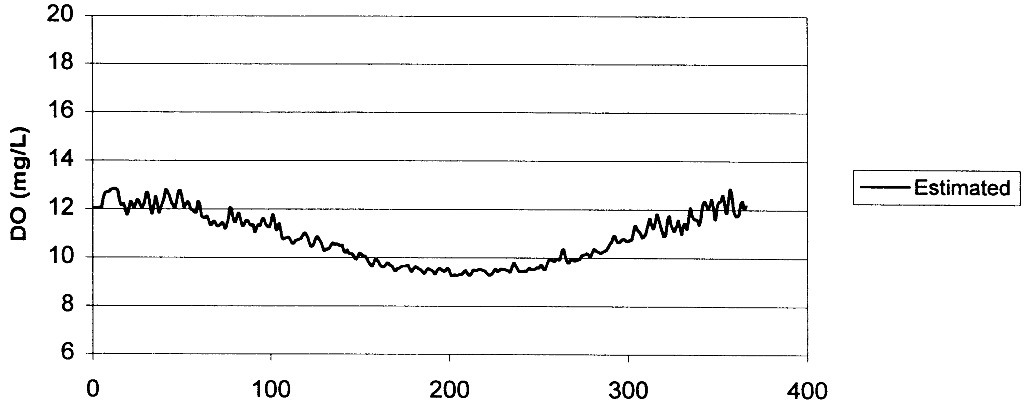
1996 Indian Creek
Nitrate-N (mg/L)
2.5
2
1.5
1
0.5
0
0
100
200
300
400
Estimated


1973 Caney Fork (Great Falls)
DO (mg/L)
40
35
30
25
20
15
10
5
0
0
100
200
300
400
Estimated

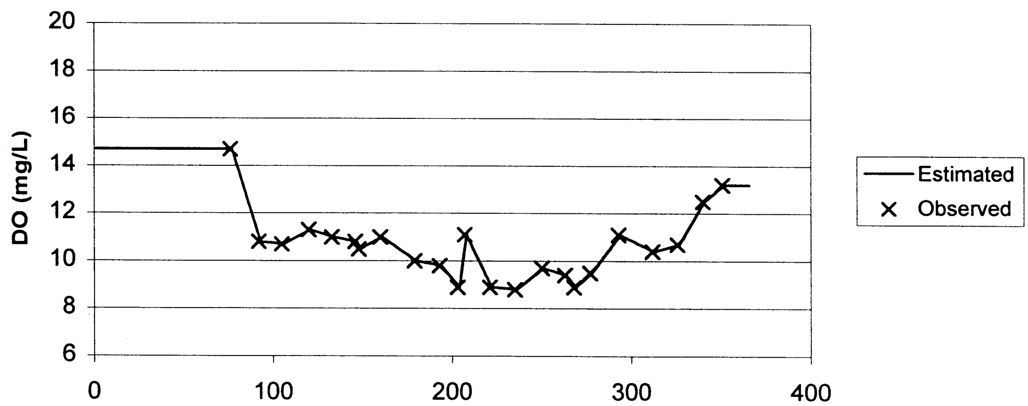

1988 Caney Fork (Great Falls)
DO (mg/L)
40
35
30
25
20
15
10
5
0
0
100
200
300
400
Estimated
Observed


1996 Caney Fork (Great Falls)
DO (mg/L)
40
35
30
25
20
15
10
5
0
0
100
200
300
400
Estimated
Observed

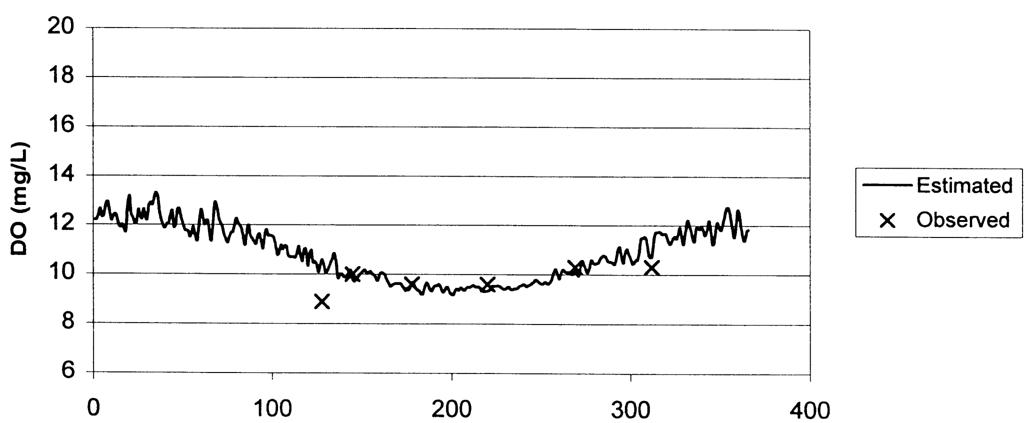
1973 Pine Creek



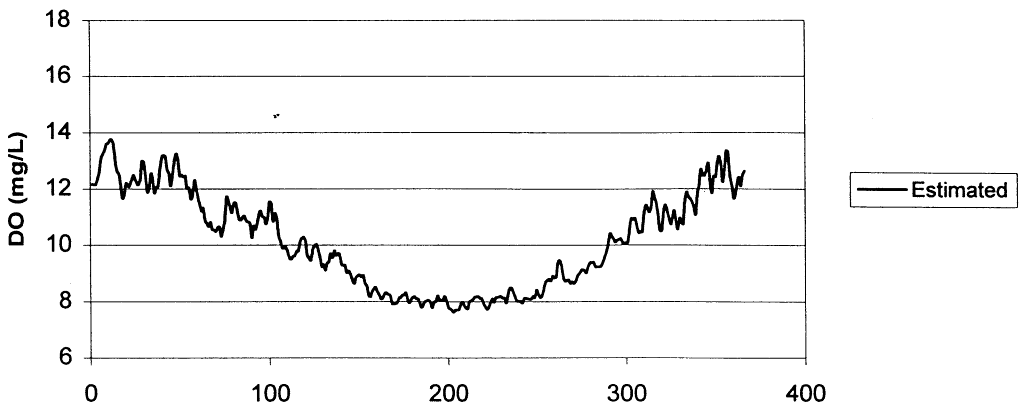
1988 Pine Creek



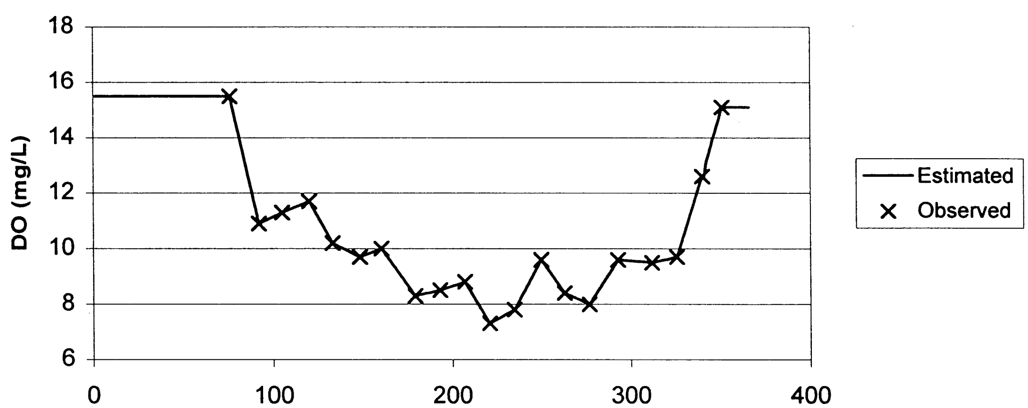
1996 Pine Creek



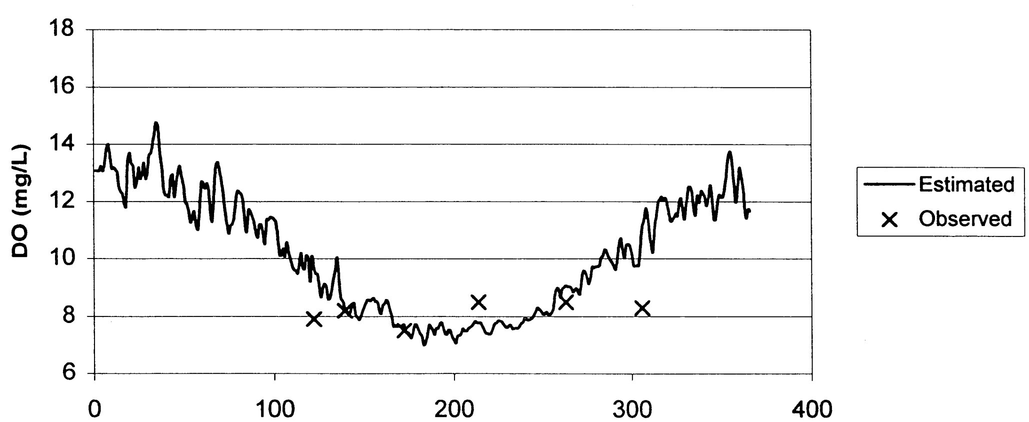
1973 Fall Creek



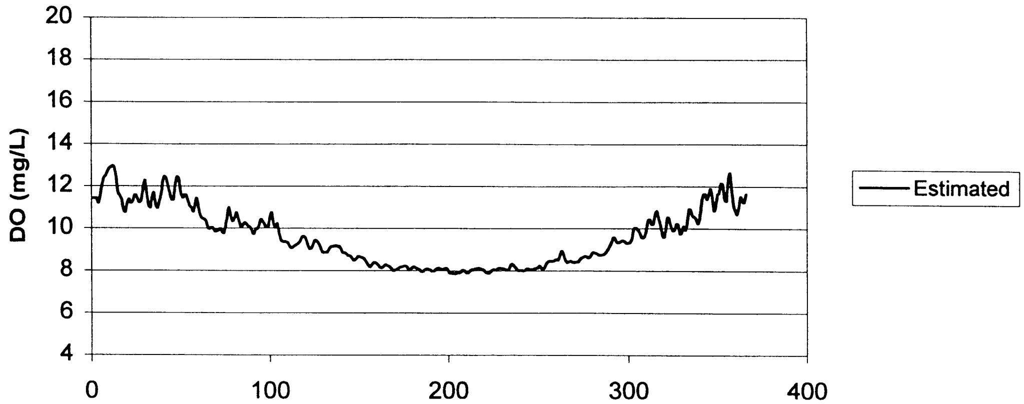
1988 Fall Creek



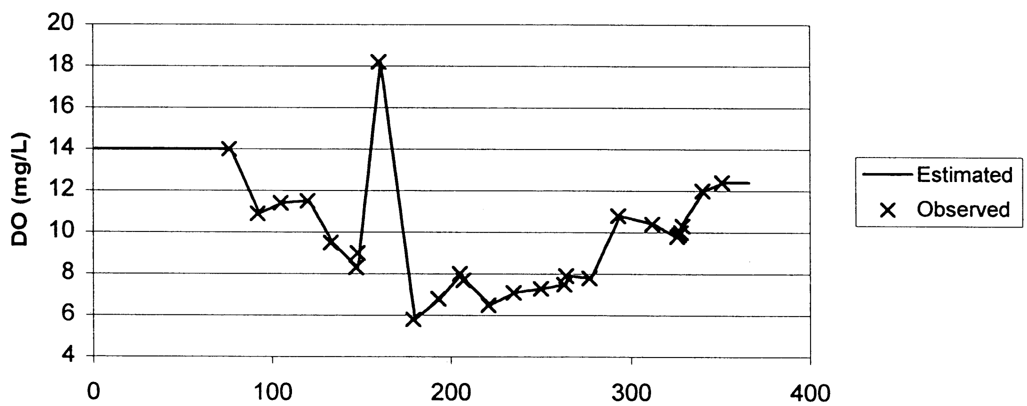
1996 Fall Creek



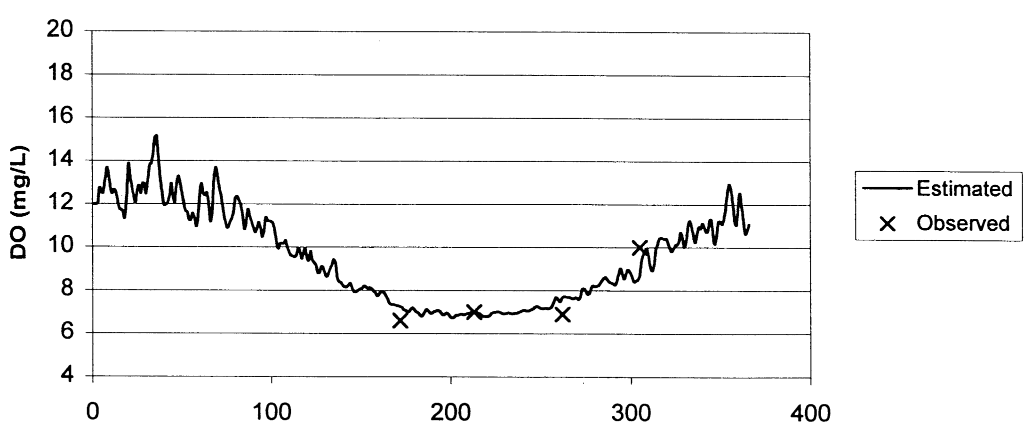
1973 Falling Water River



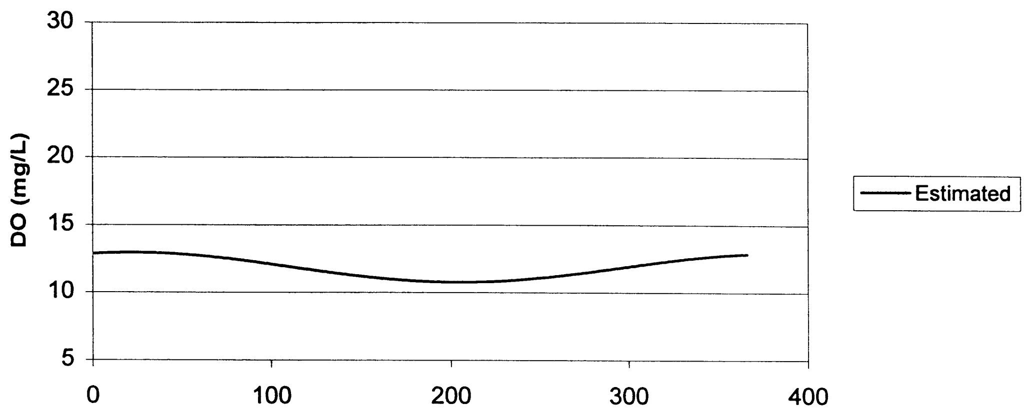
1988 Falling Water River



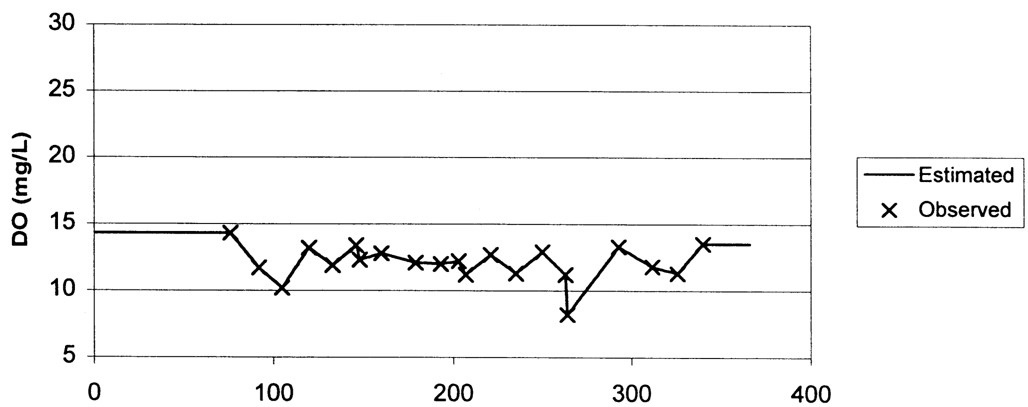
1996 Falling Water River



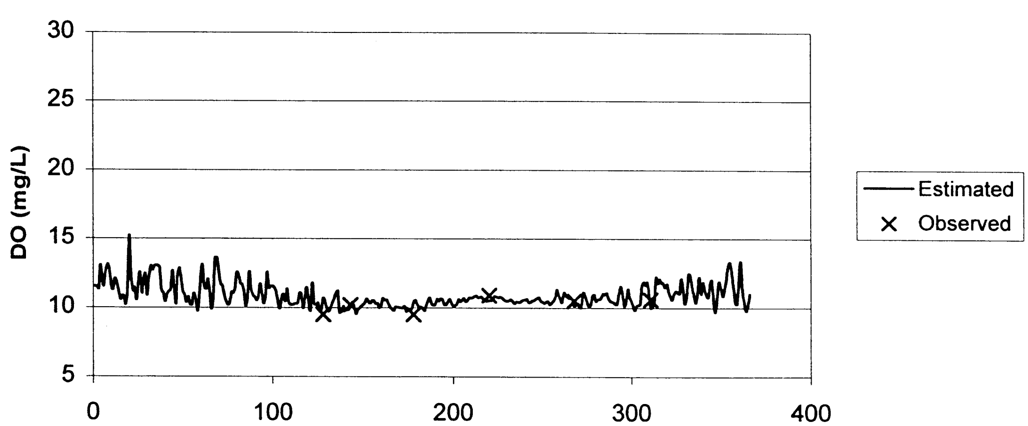
1973 Mine Lick Creek

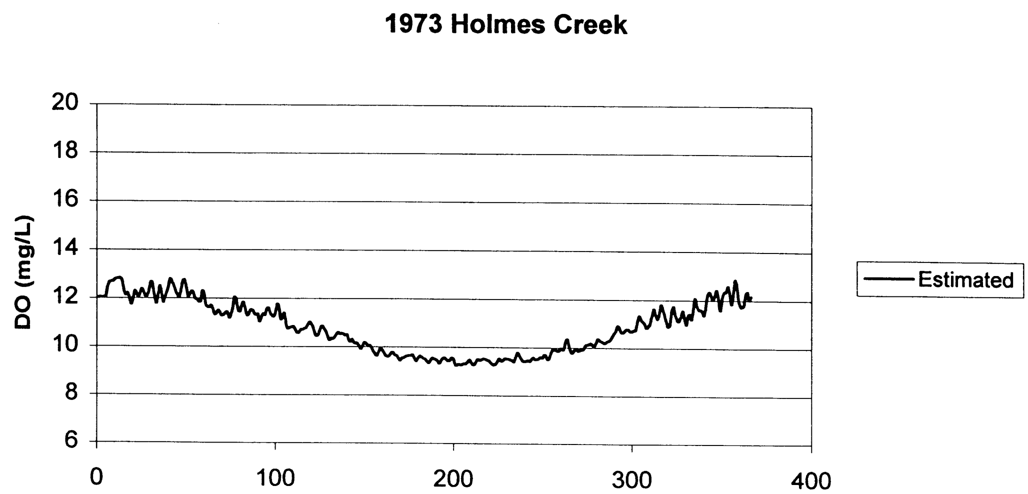


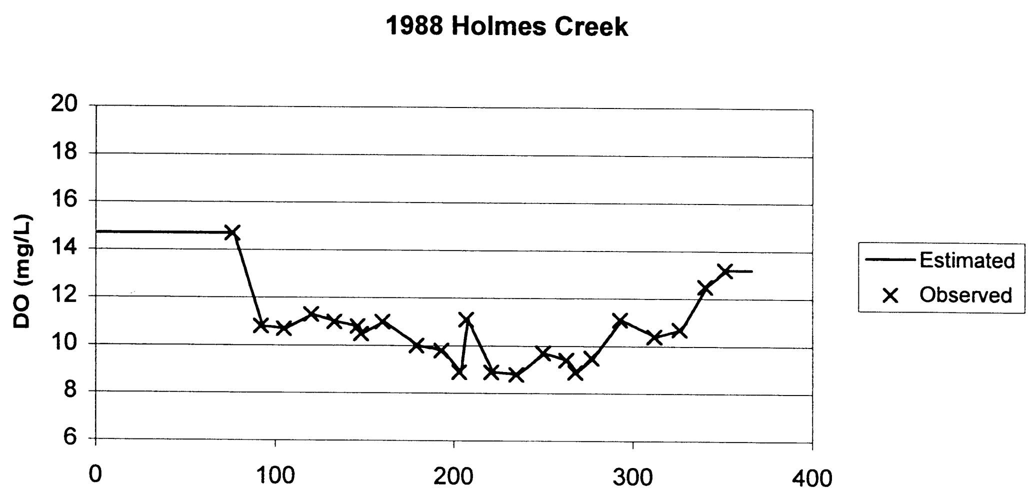
1988 Mine Lick Creek

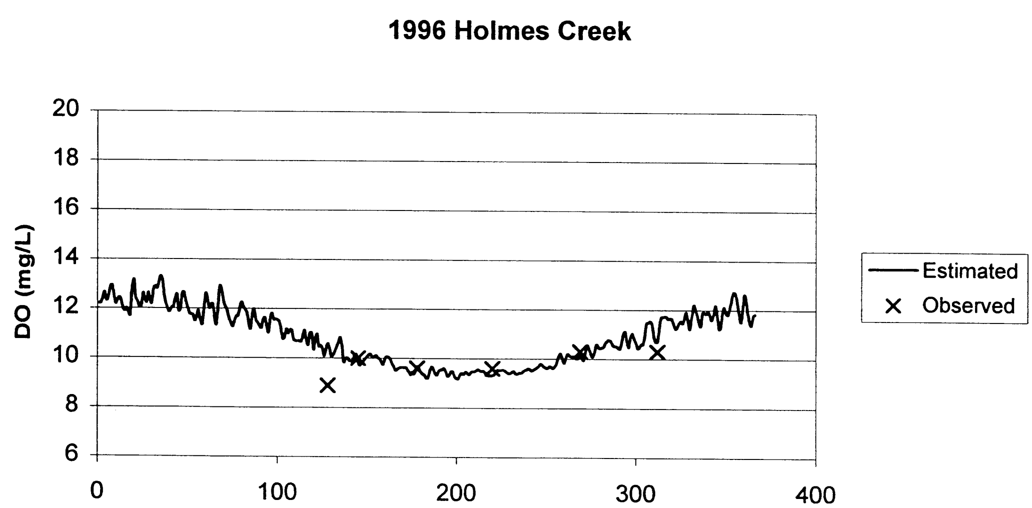


1996 Mine Lick Creek

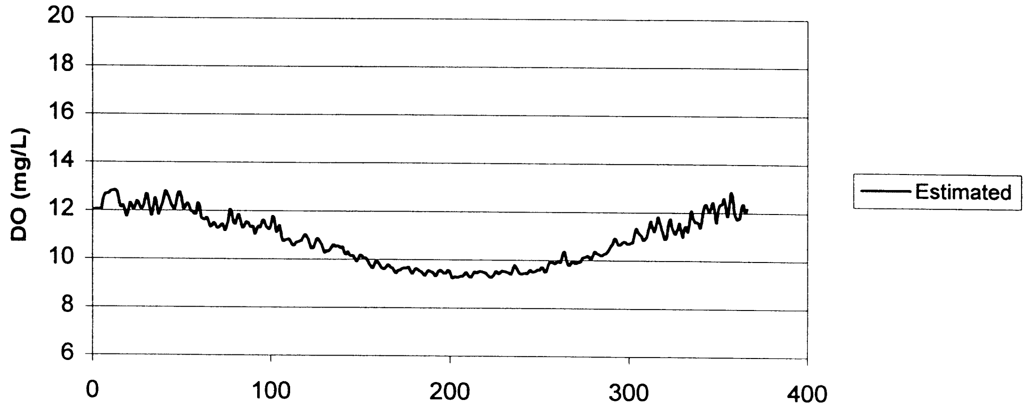



1973 Holmes Creek
DO (mg/L)
20
18
16
14
12
10
8
6
0
100
200
300
400
Estimated

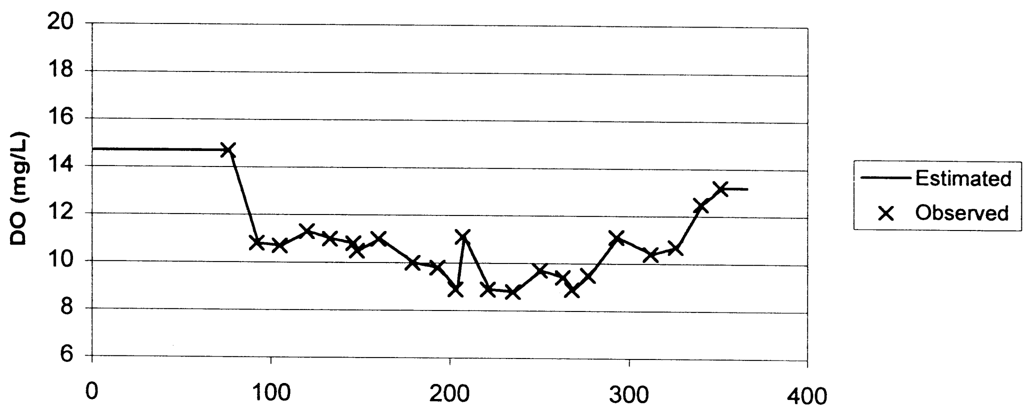

1988 Holmes Creek
DO (mg/L)
20
18
16
14
12
10
8
6
0
100
200
300
400
Estimated
Observed


1996 Holmes Creek
DO (mg/L)
20
18
16
14
12
10
8
6
0
100
200
300
400
Estimated
Observed

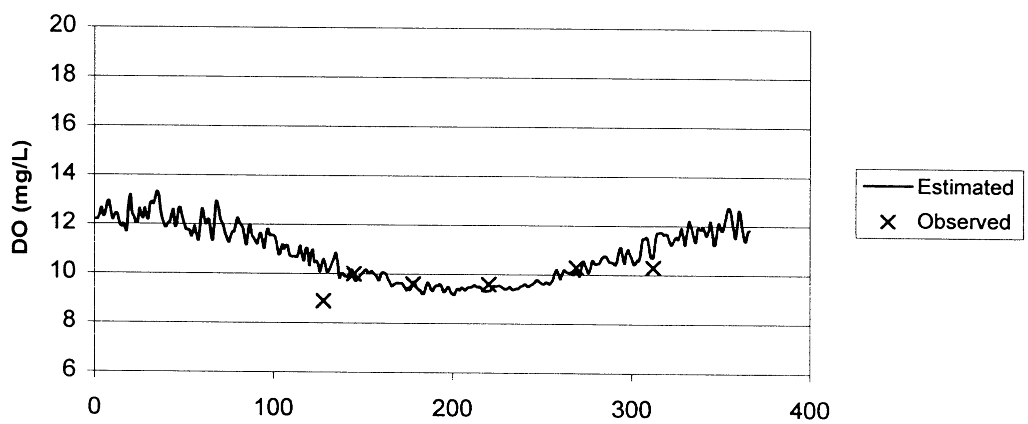
1973 Indian Creek



1988 Indian Creek



1996 Indian Creek

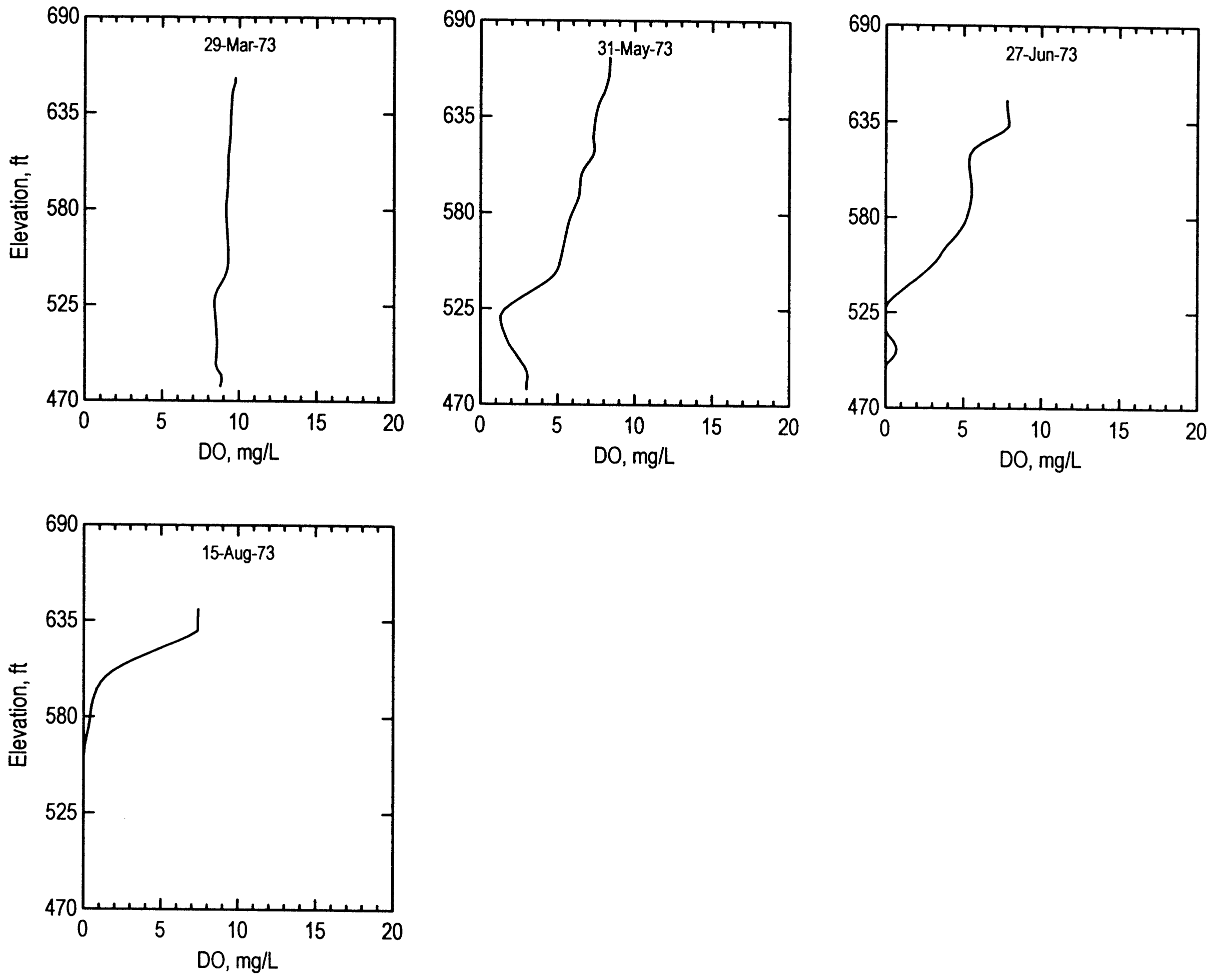


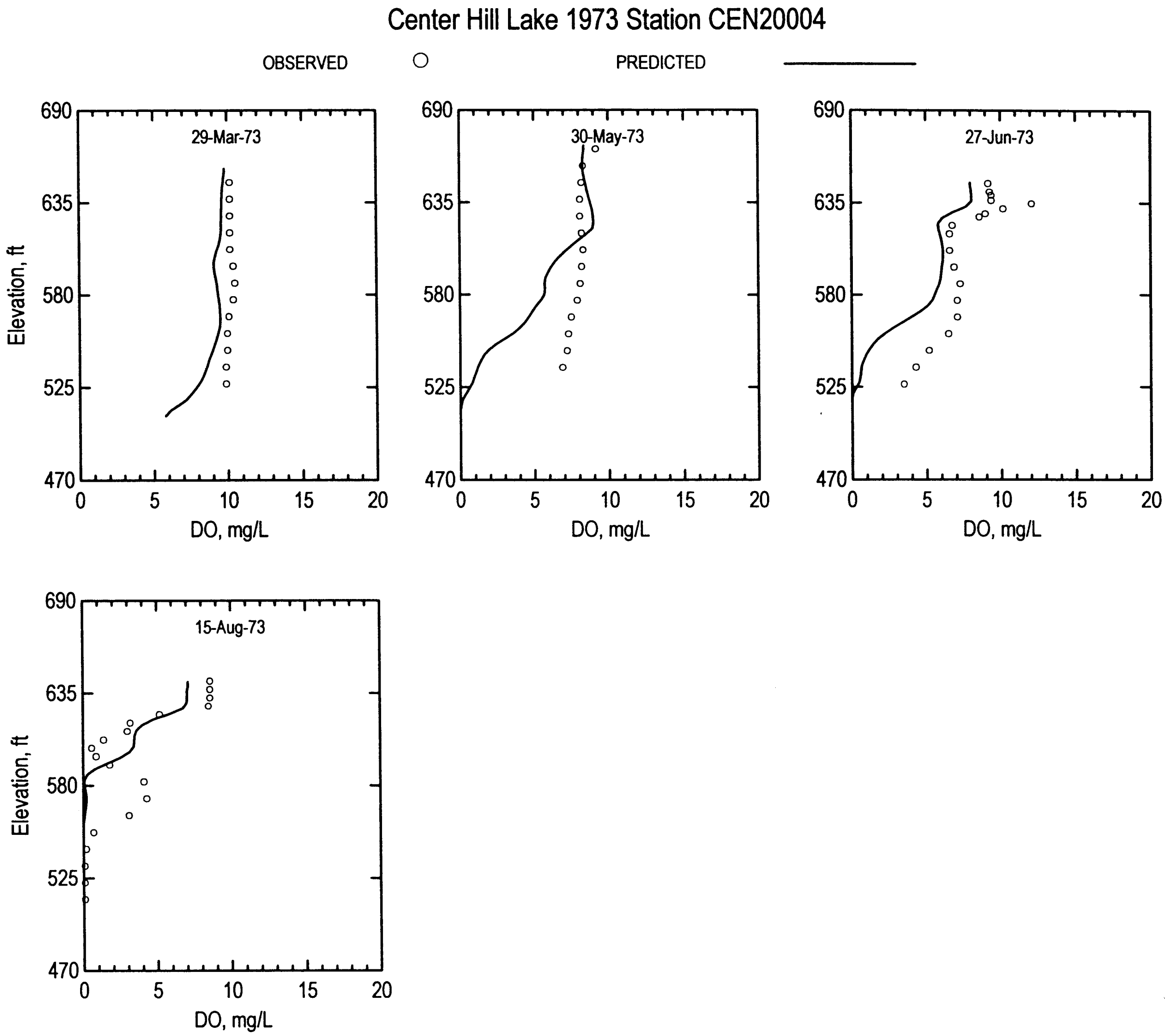
APPENDIX M

Comparison of Measured and Modeled Water Quality at Center Hill Lake Monitoring Stations

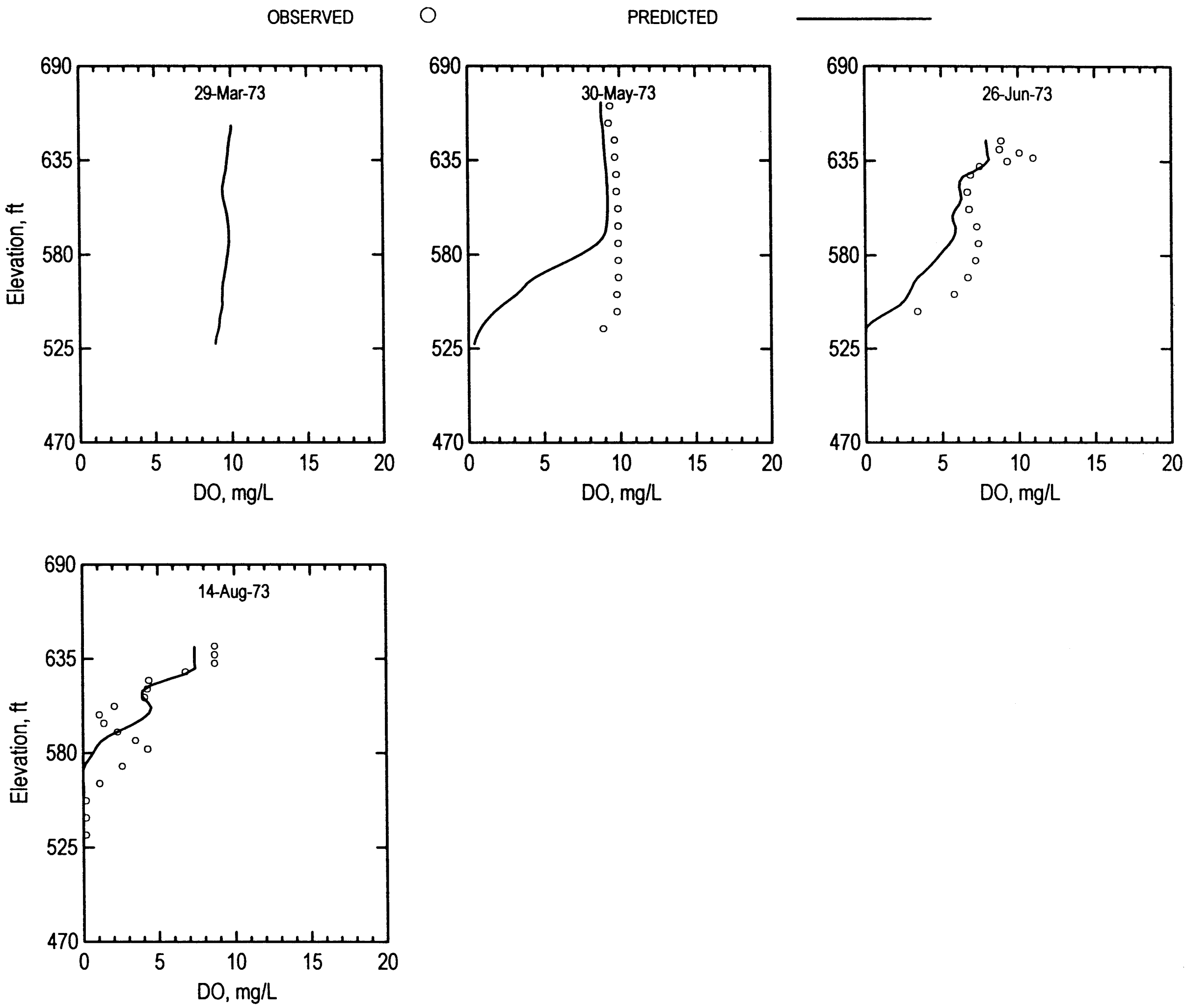
Center Hill Lake 1973 Station CEN20003

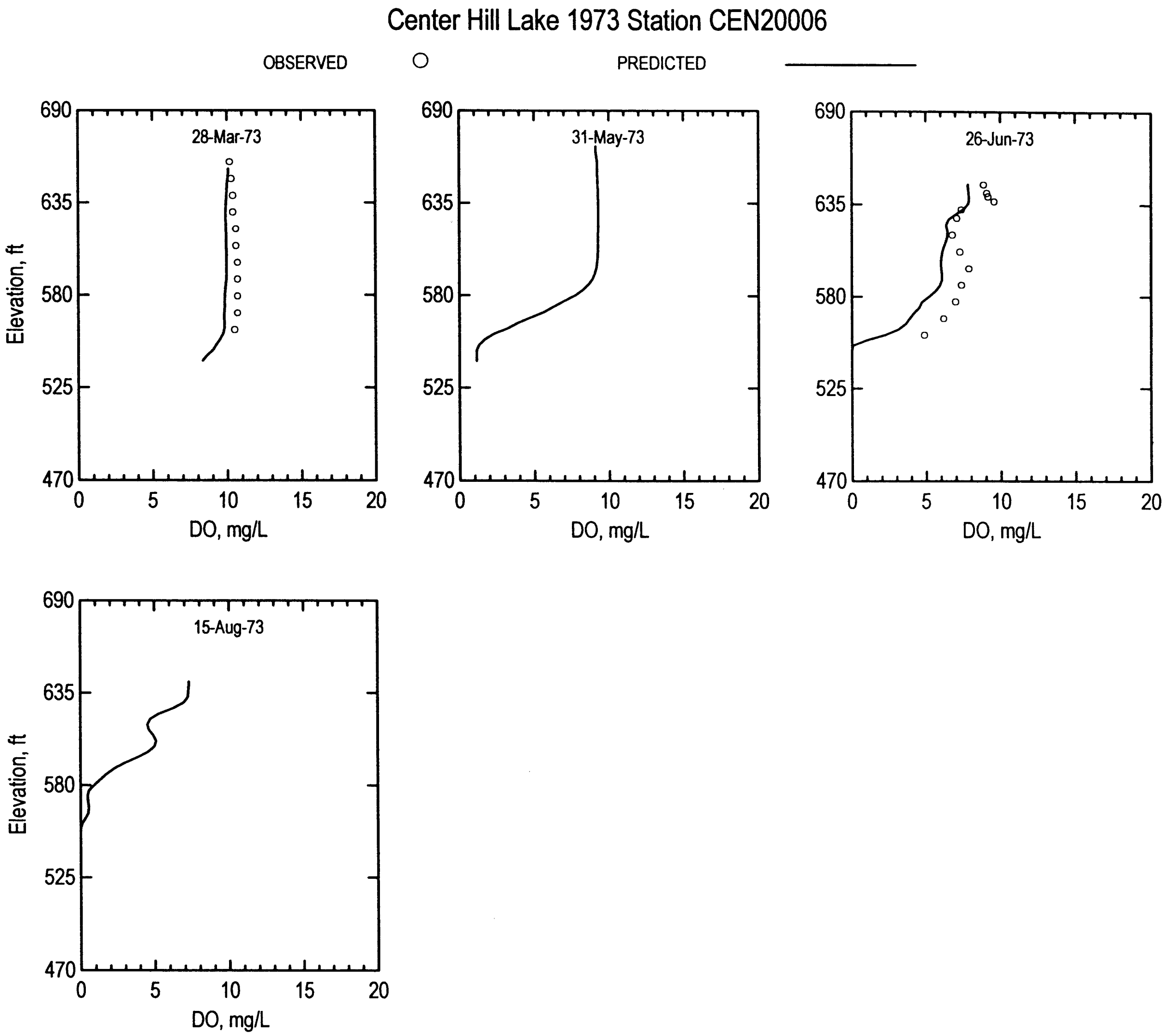
OBSERVED ○ PREDICTED ———




Center Hill Lake 1973 Station CEN20004
OBSERVED
PREDICTED
29-Mar-73
30-May-73
27-Jun-73
15-Aug-73
Elevation, ft
DO, mg/L
690
635
580
525
470
0
5
10
15
20

Center Hill Lake 1973 Station CEN20005

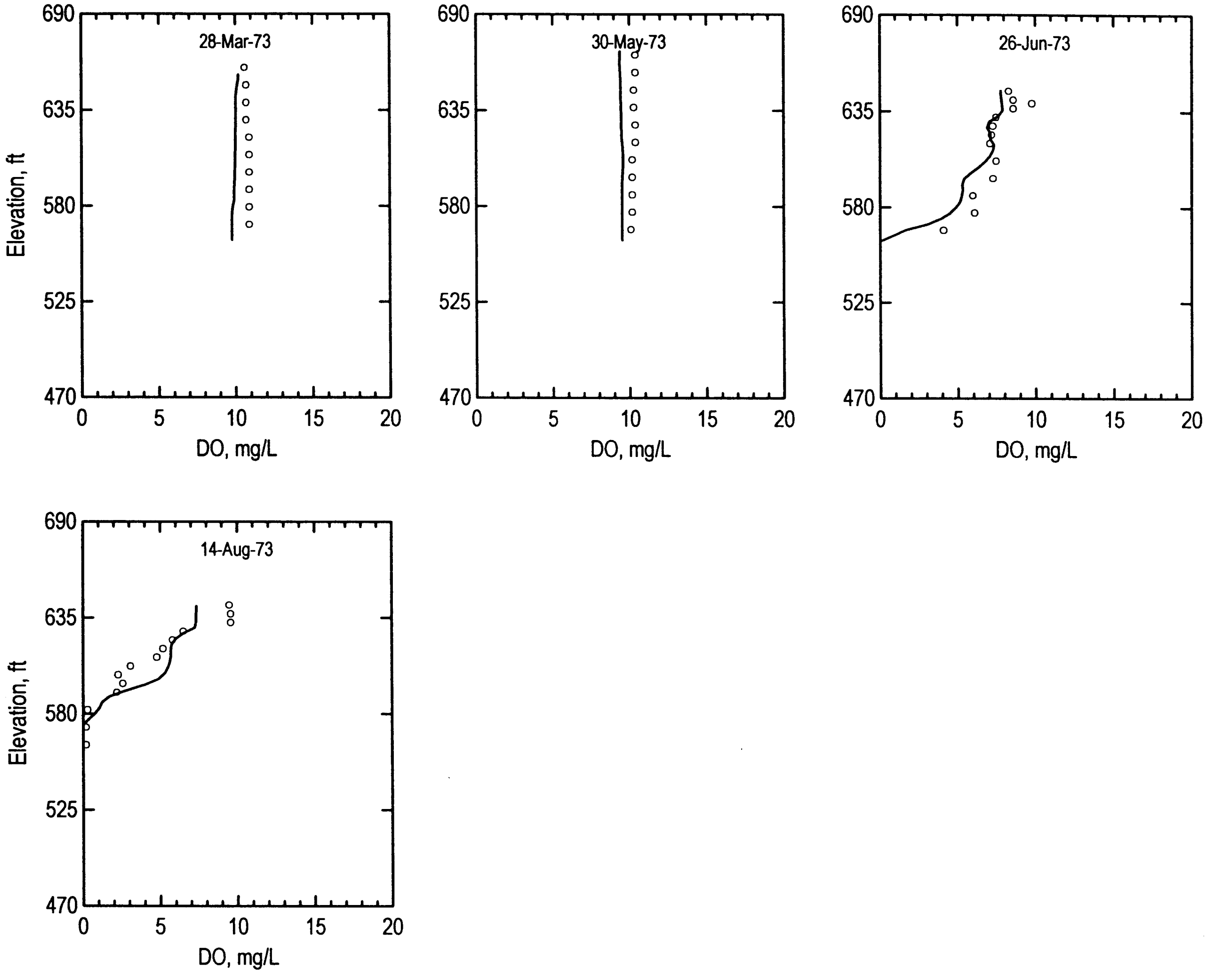




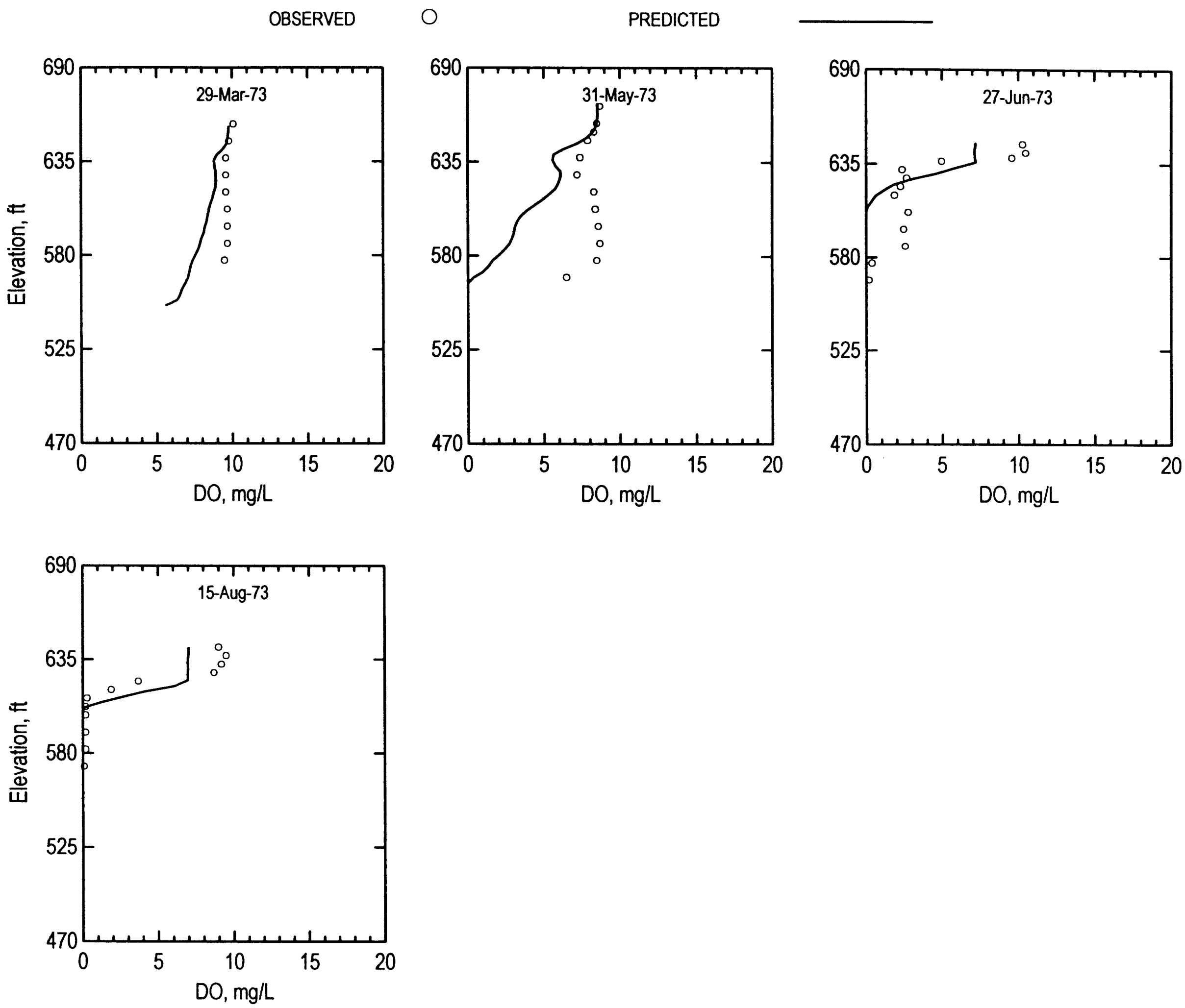
Center Hill Lake 1973 Station CEN20006
OBSERVED
PREDICTED
28-Mar-73
31-May-73
26-Jun-73
15-Aug-73
Elevation, ft
DO, mg/L
690
635
580
525
470
0
5
10
15
20

Center Hill Lake 1973 Station CEN20007

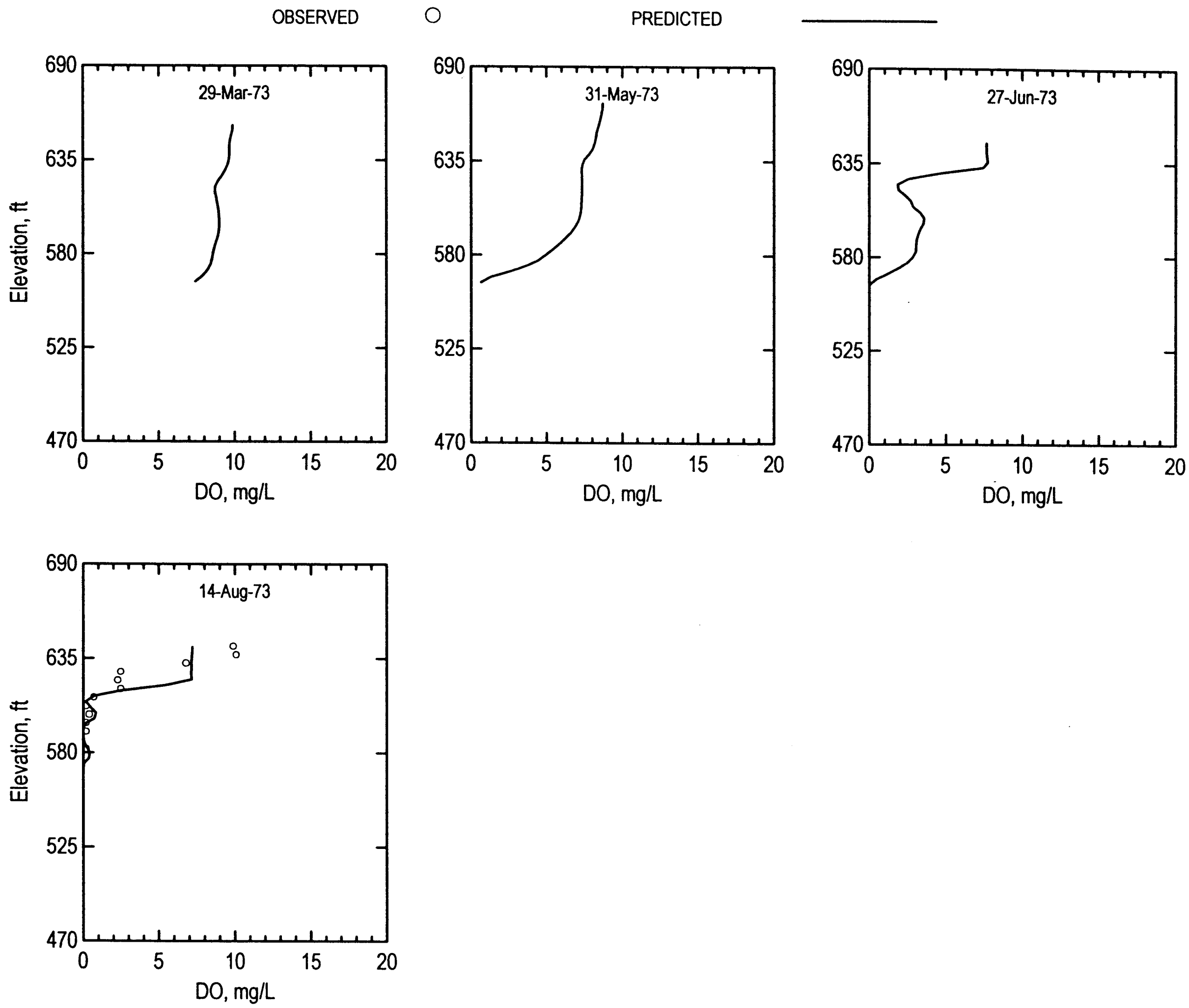
OBSERVED ○ PREDICTED ————



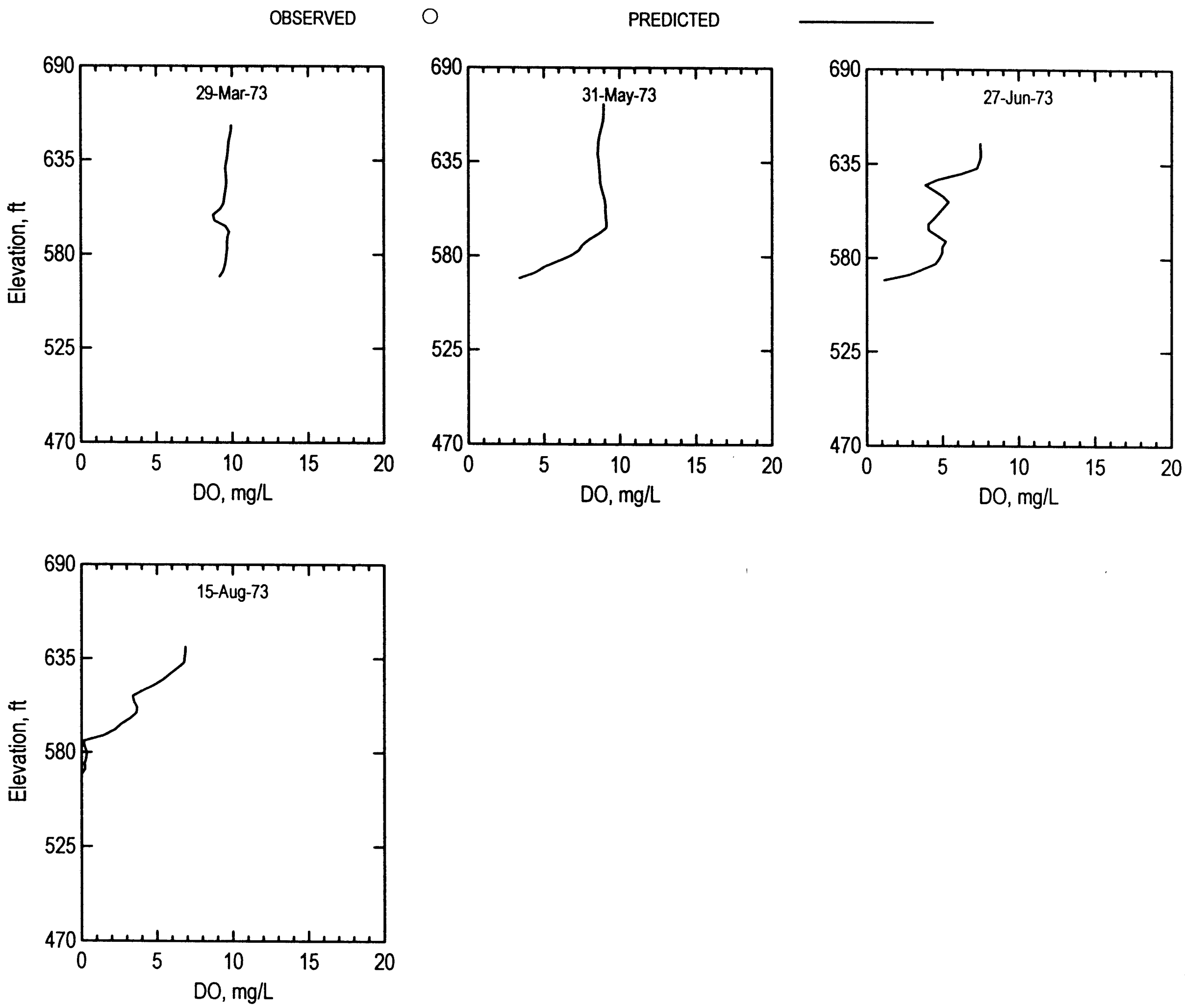
Center Hill Lake 1973 Station CEN20008



Center Hill Lake 1973 Station CEN20010

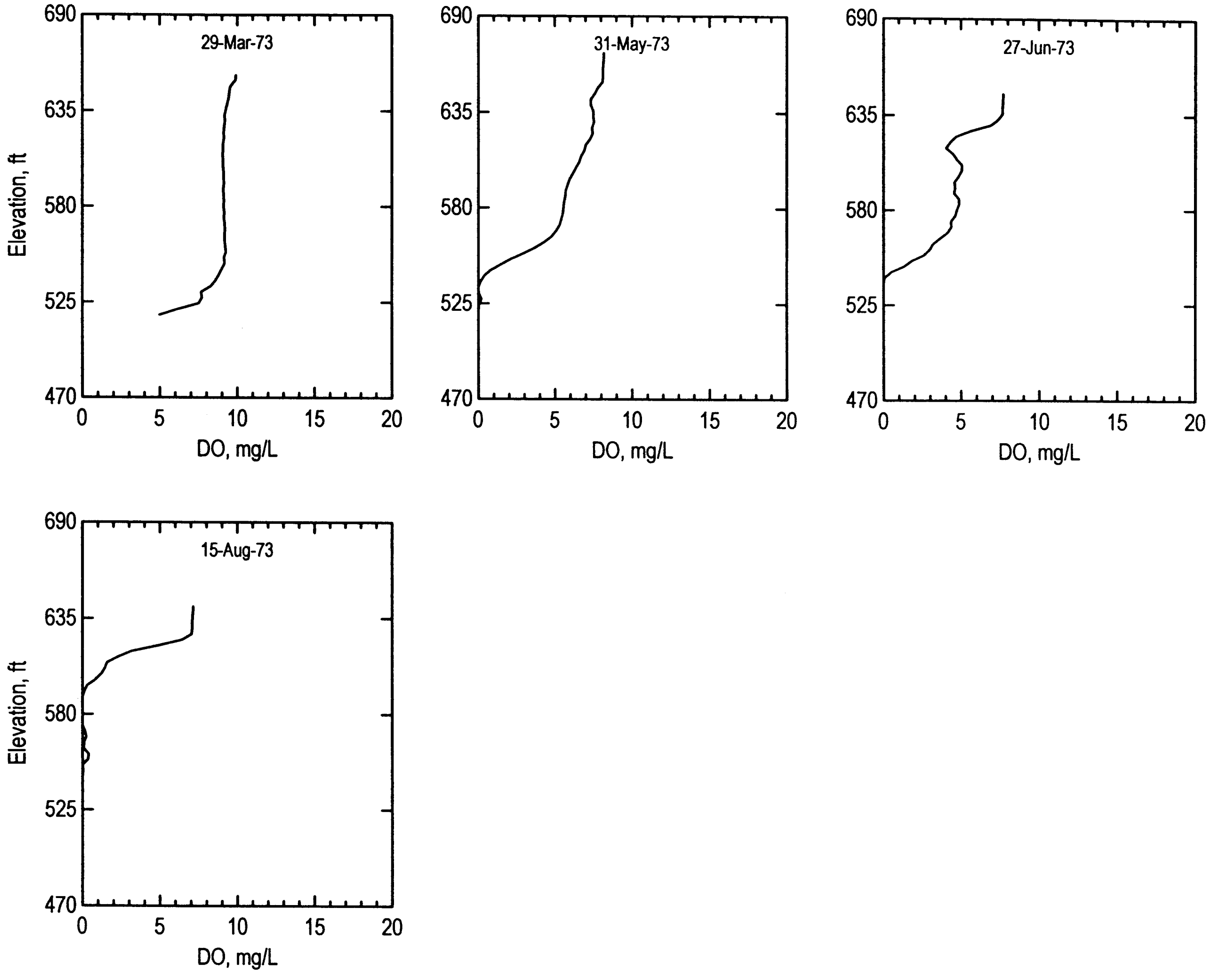


Center Hill Lake 1973 Station CEN20011

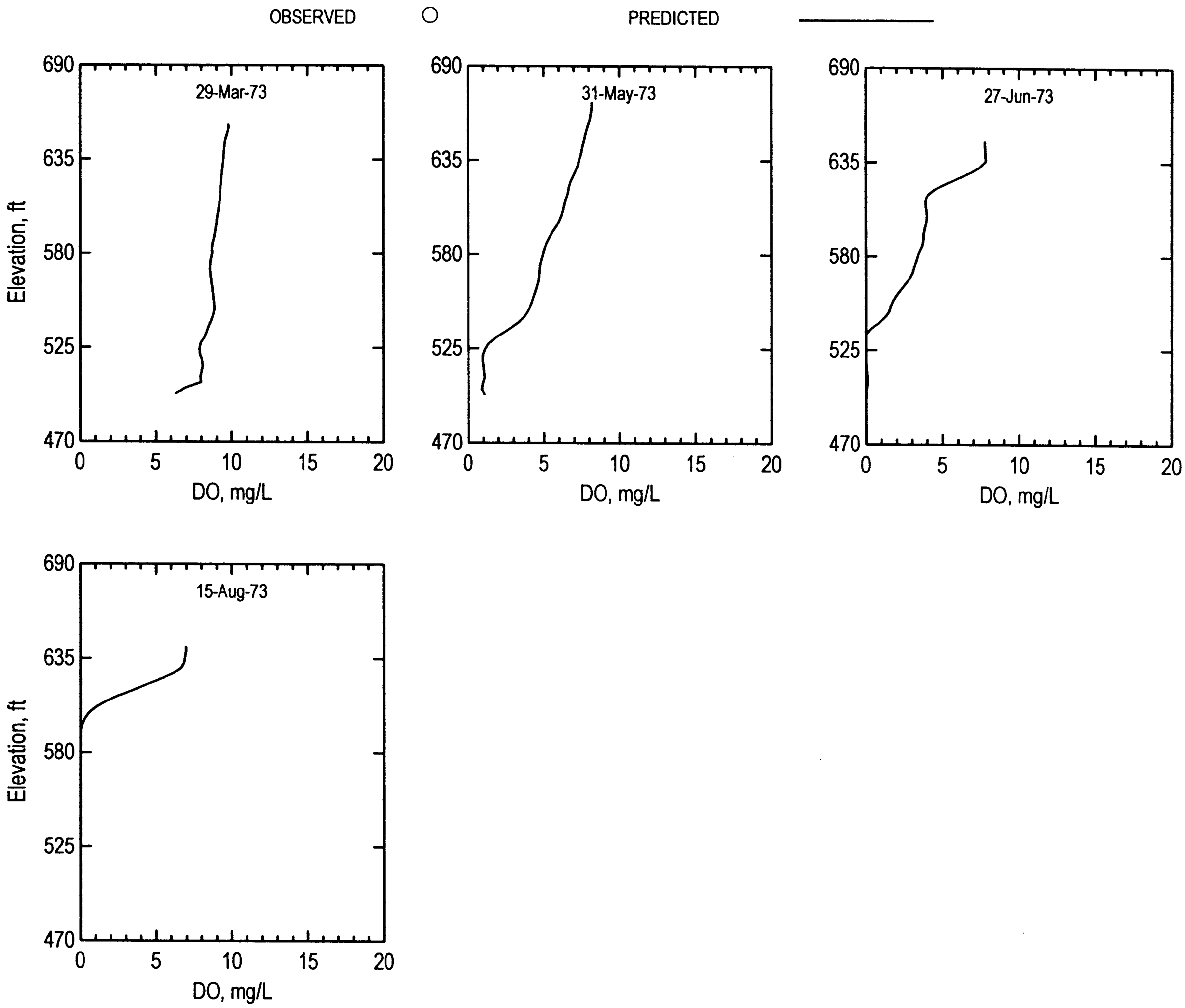


Center Hill Lake 1973 Station CEN20015

OBSERVED ○ PREDICTED ———

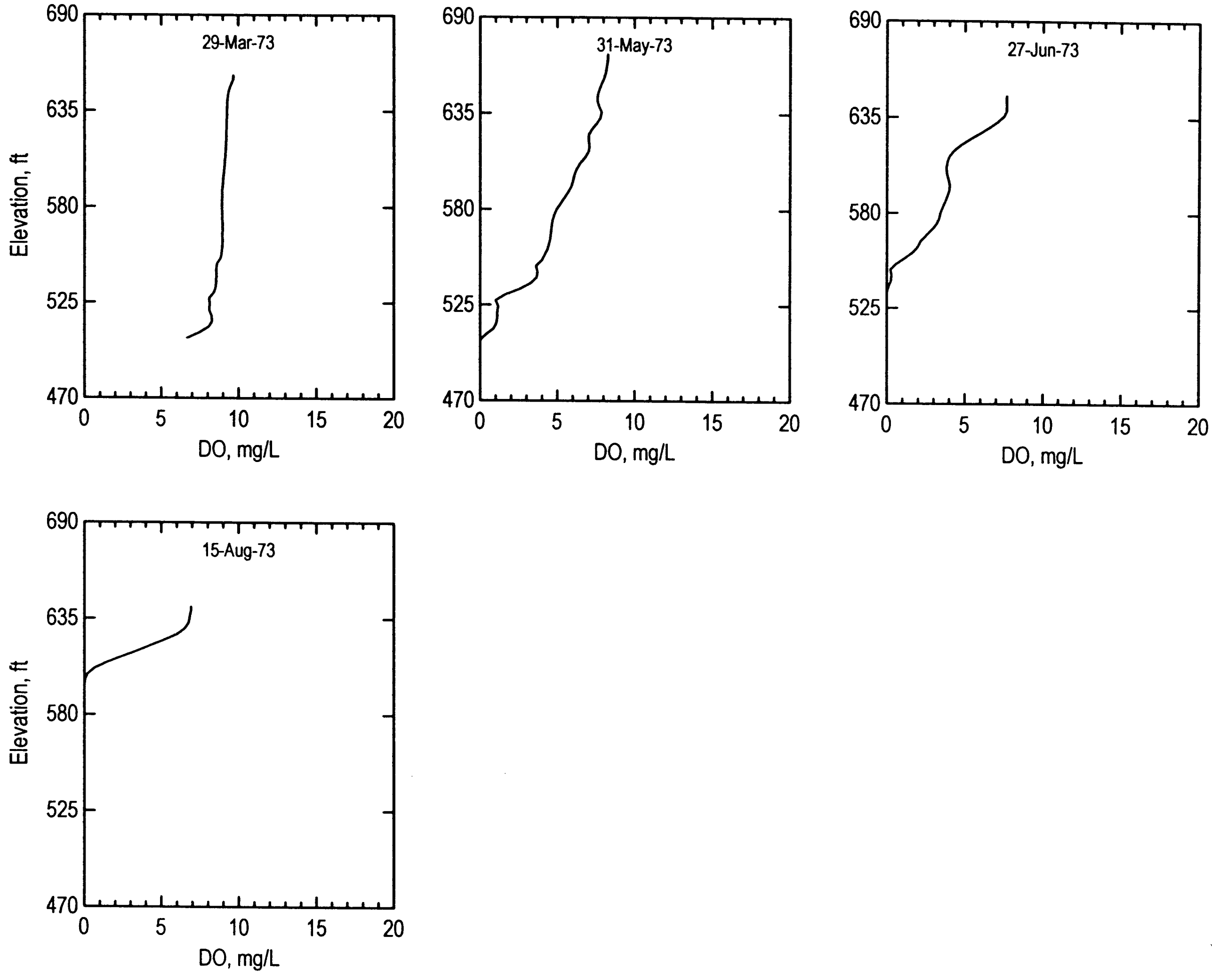


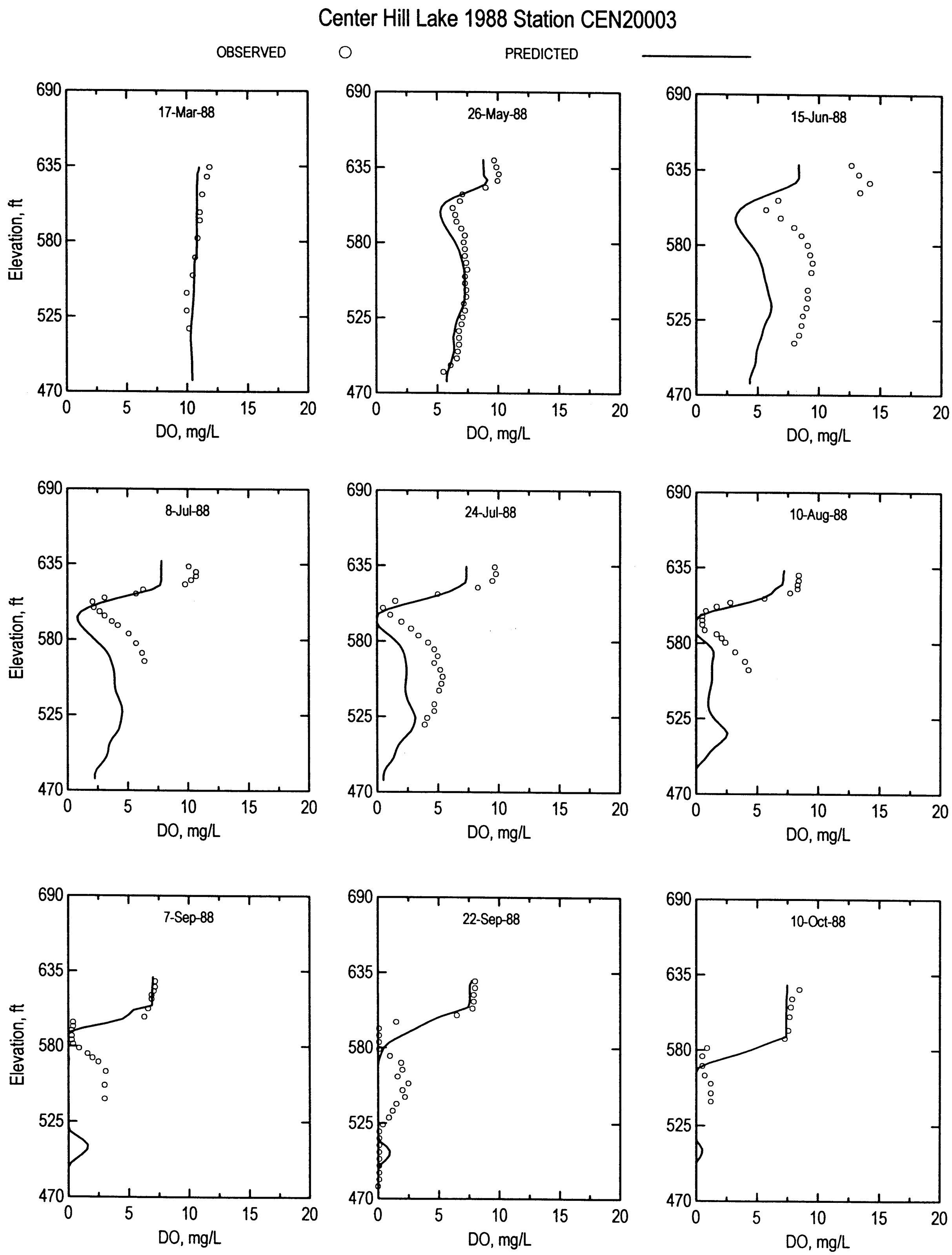
Center Hill Lake 1973 Station CEN20013



Center Hill Lake 1973 Station CEN20014

OBSERVED ○ PREDICTED ———

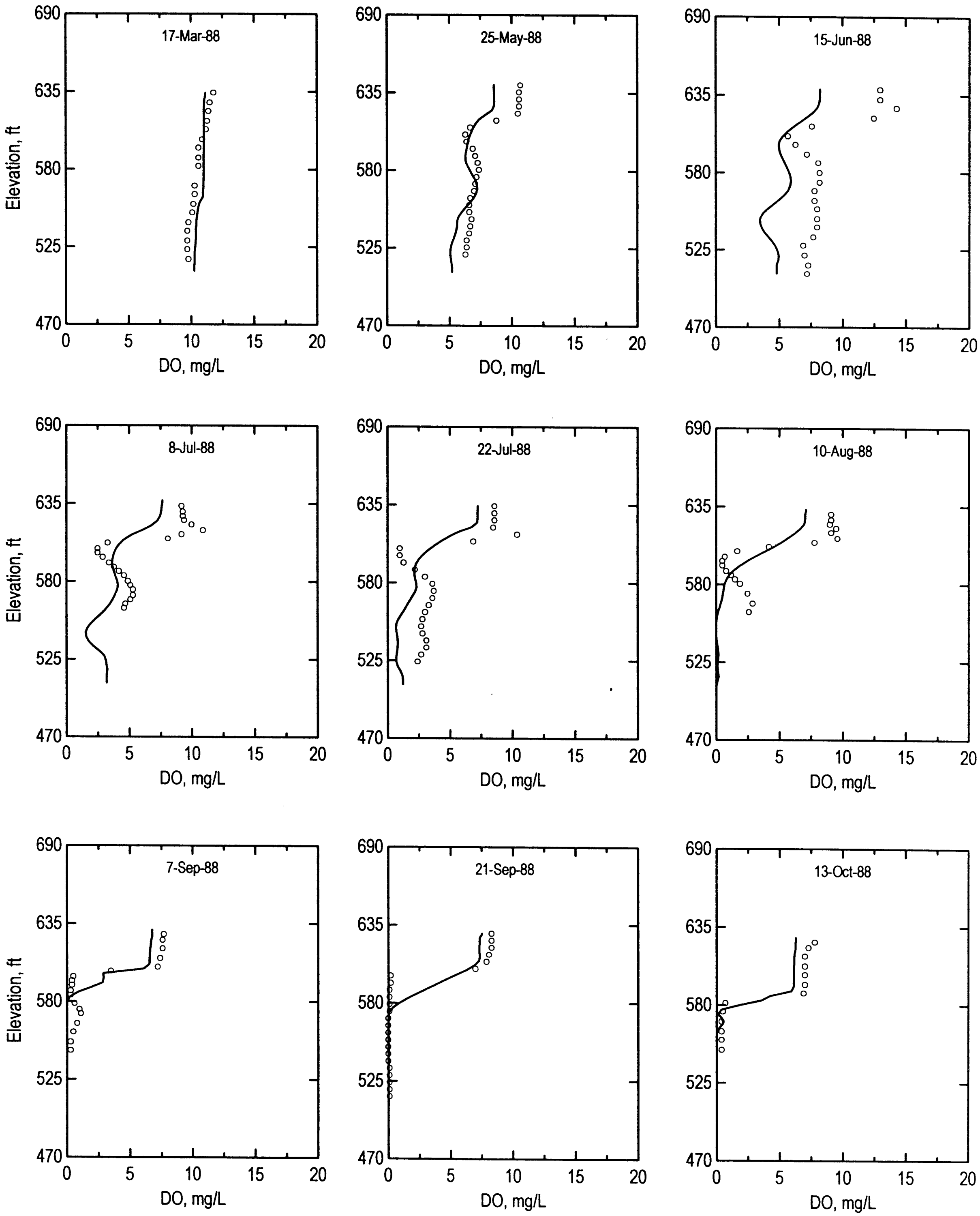




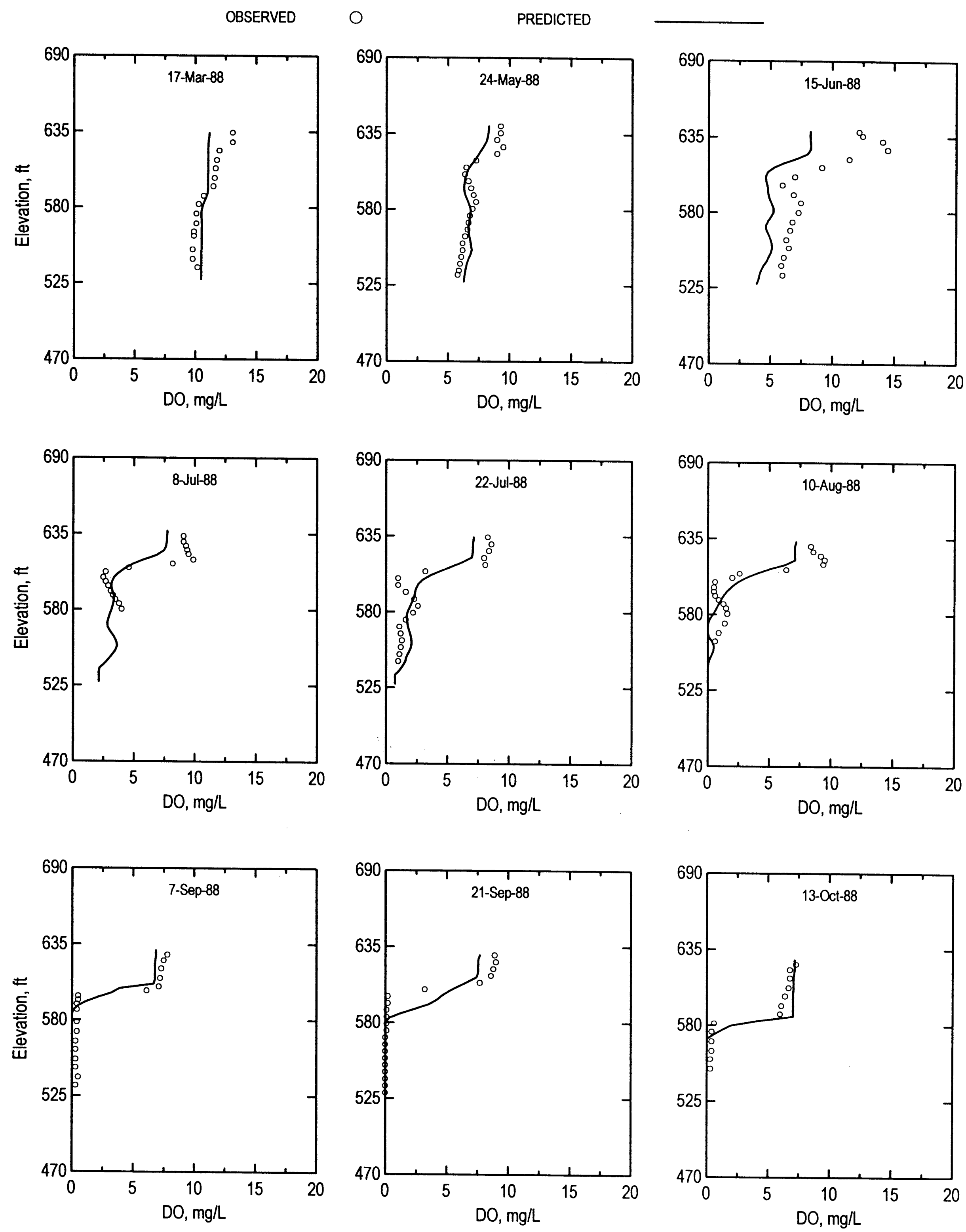
Center Hill Lake 1988 Station CEN20003
OBSERVED ○ PREDICTED
17-Mar-88
26-May-88
15-Jun-88
8-Jul-88
24-Jul-88
10-Aug-88
7-Sep-88
22-Sep-88
10-Oct-88
Elevation, ft
DO, mg/L
690
635
580
525
470
0
5
10
15
20

Center Hill Lake 1988 Station CEN20004

OBSERVED ○ PREDICTED ————

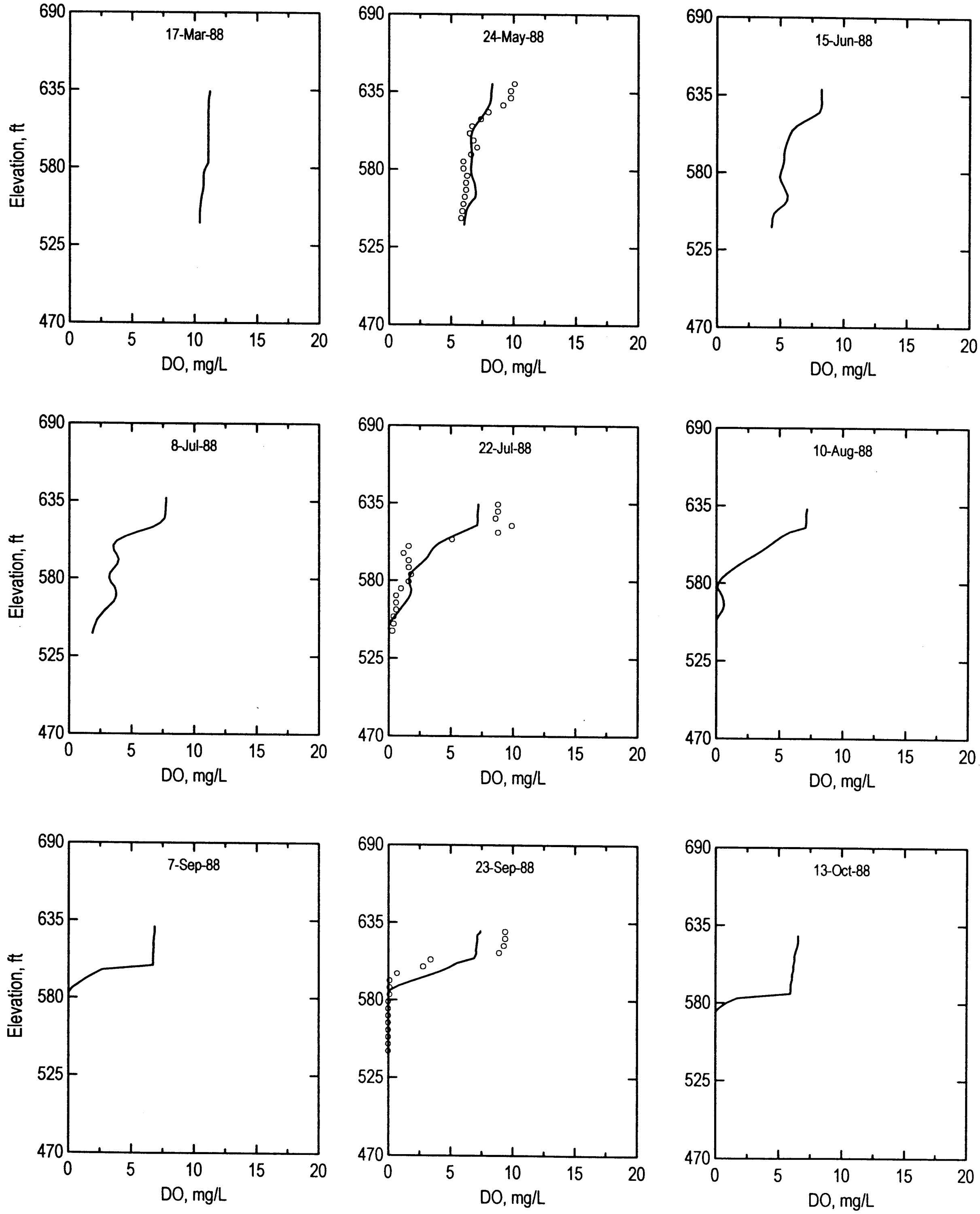


Center Hill Lake 1988 Station CEN20005

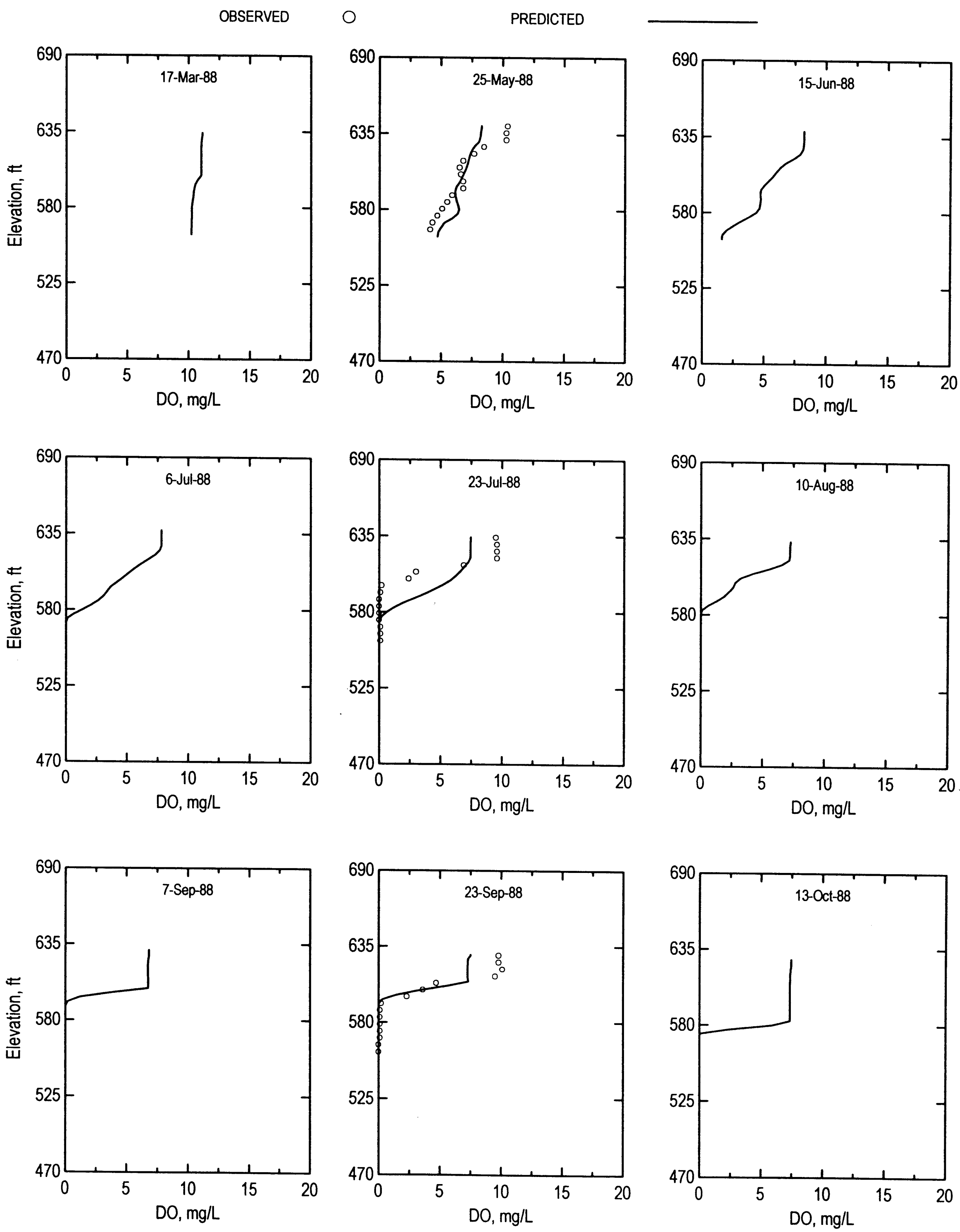


Center Hill Lake 1988 Station CEN20006

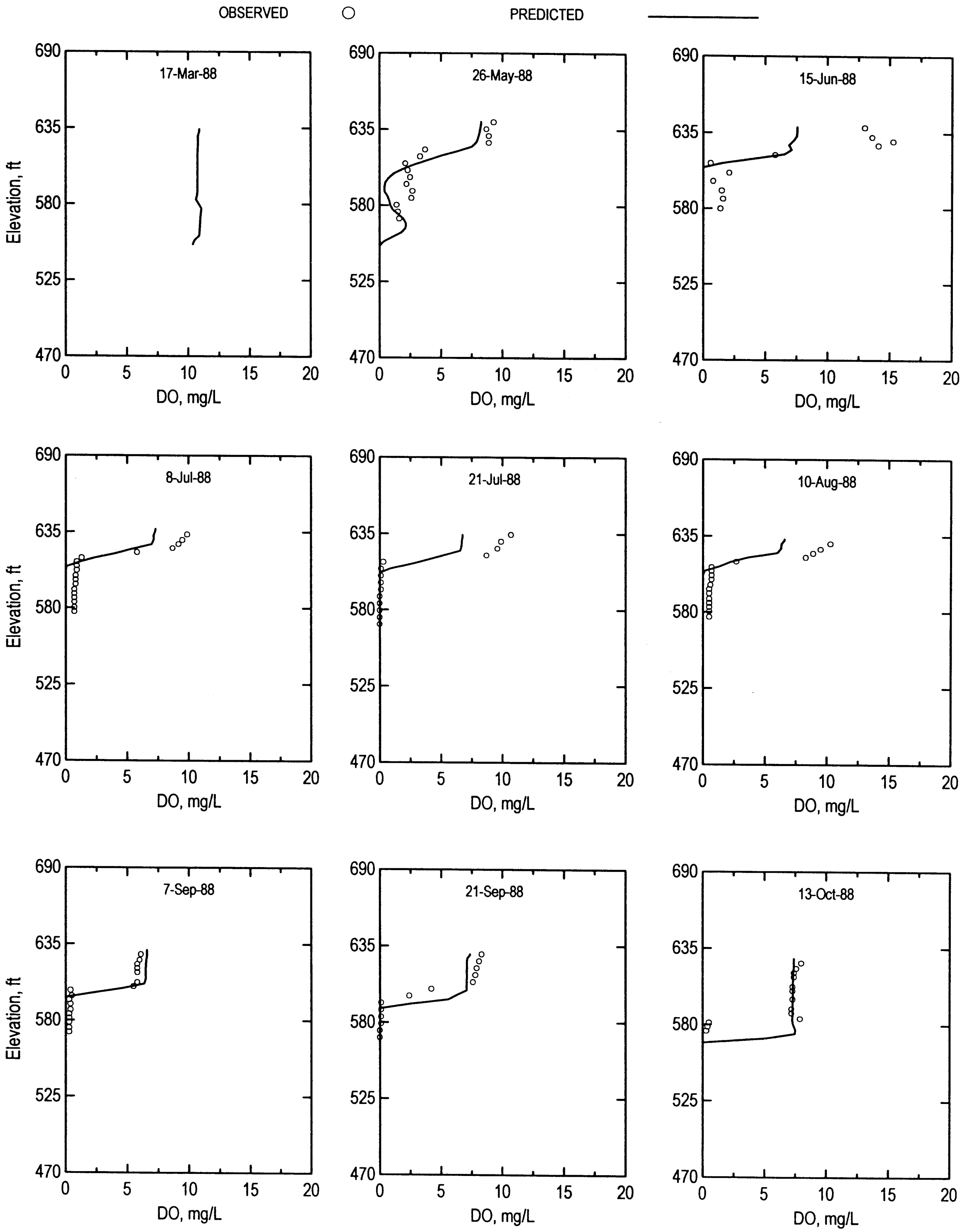
OBSERVED ○ PREDICTED ———



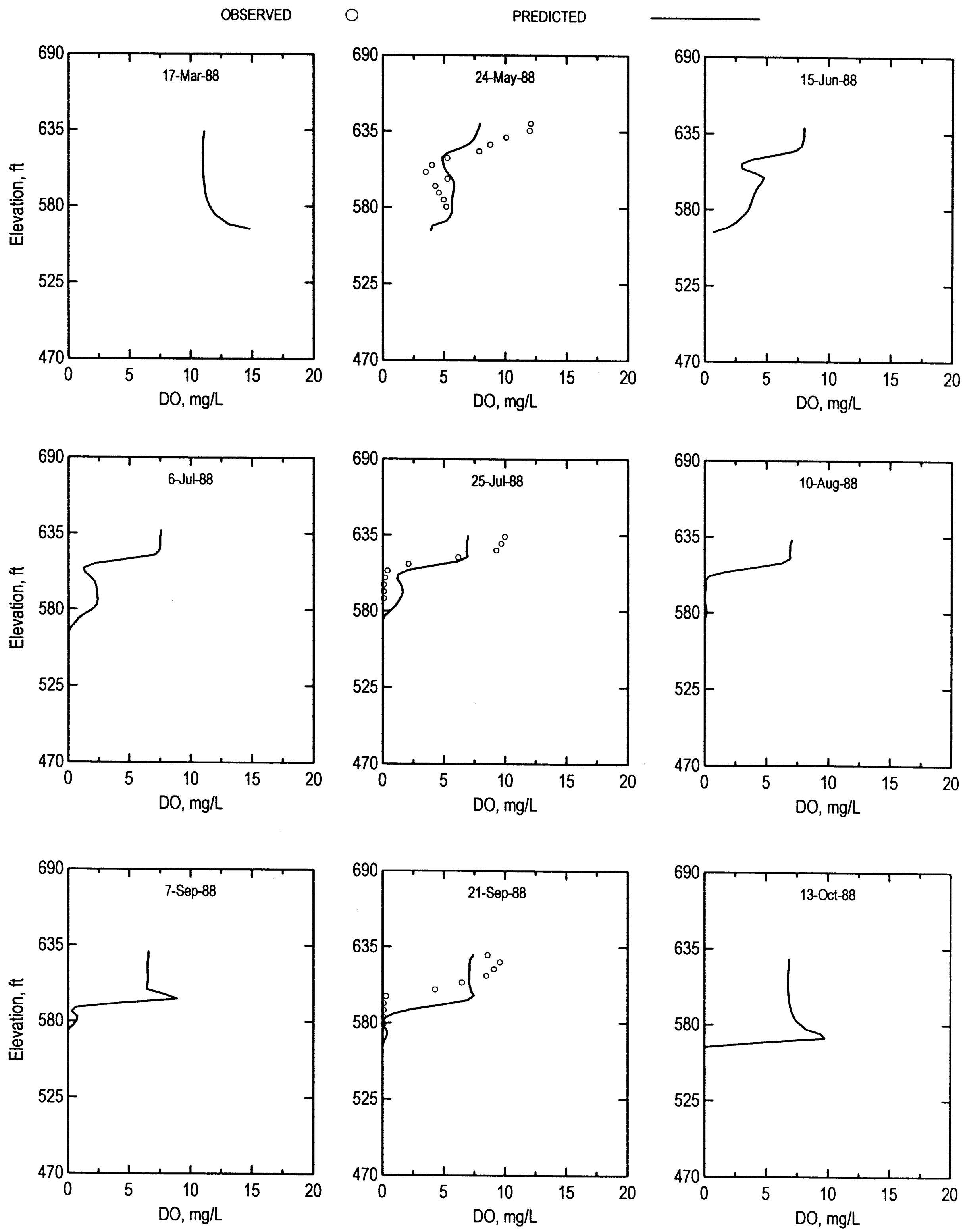
Center Hill Lake 1988 Station CEN20007



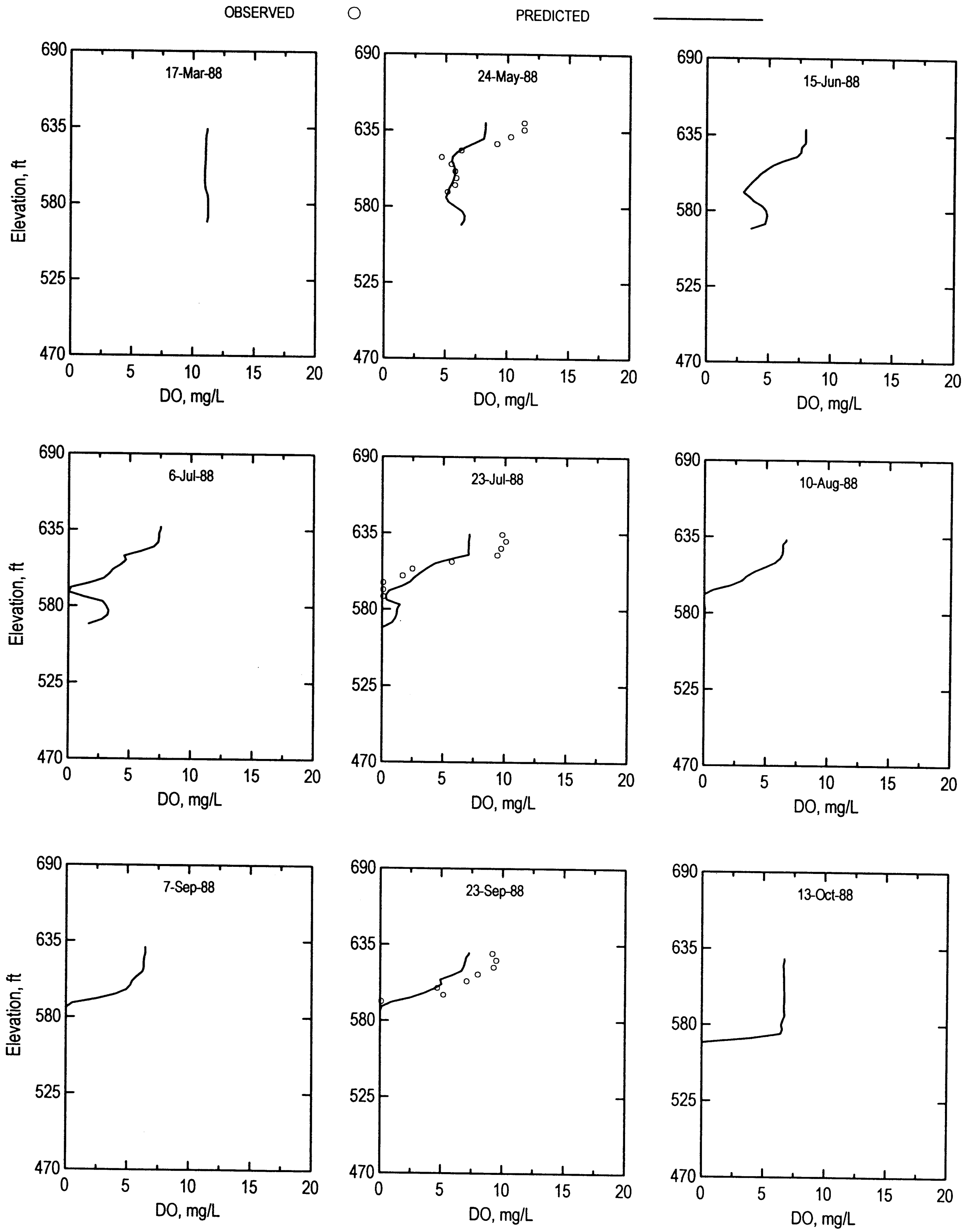
Center Hill Lake 1988 Station CEN20008

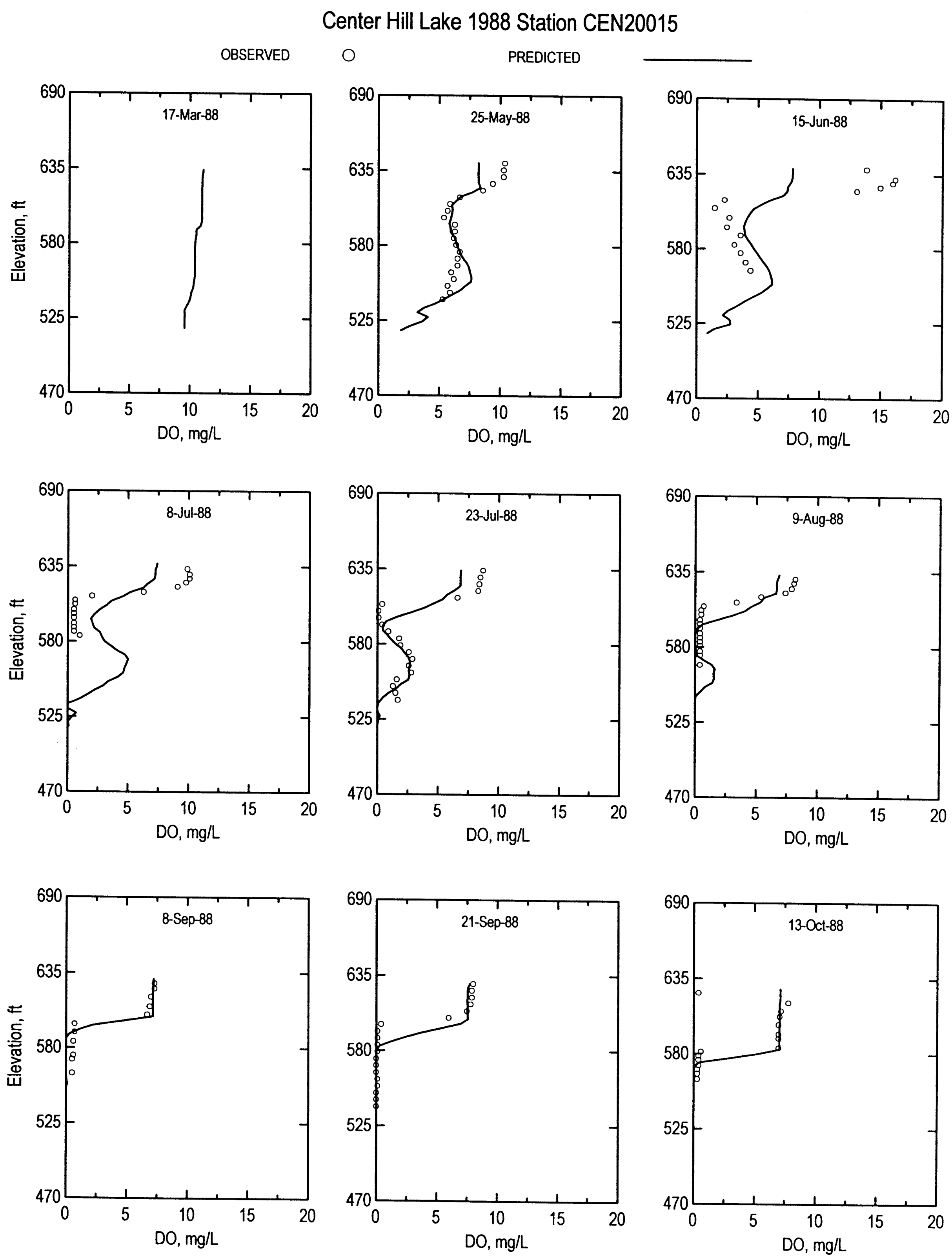


Center Hill Lake 1988 Station CEN20010



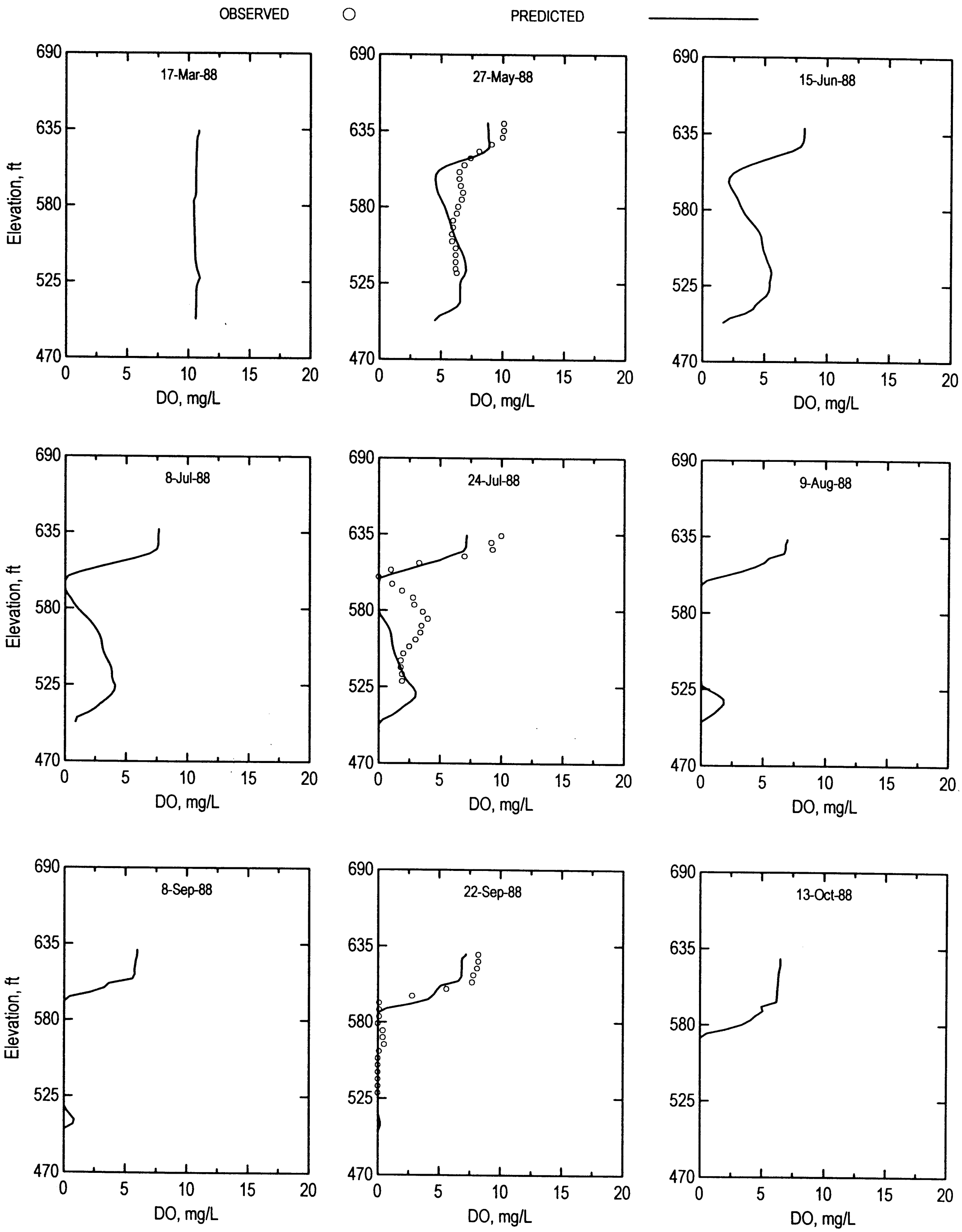
Center Hill Lake 1988 Station CEN20011

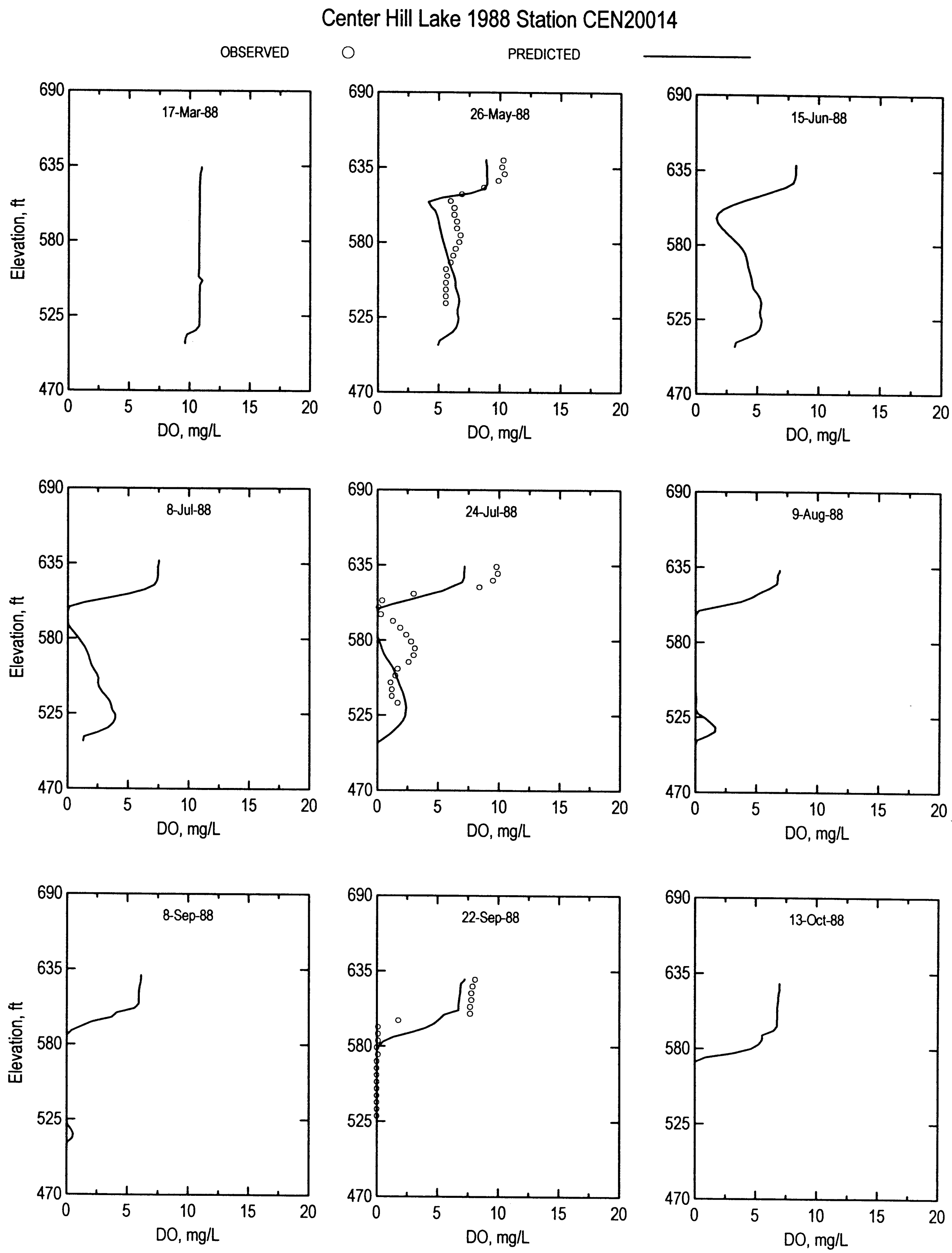




Center Hill Lake 1988 Station CEN20015
OBSERVED
PREDICTED
17-Mar-88
25-May-88
15-Jun-88
8-Jul-88
23-Jul-88
9-Aug-88
8-Sep-88
21-Sep-88
13-Oct-88
Elevation, ft
DO, mg/L
690
635
580
525
470
0
5
10
15
20

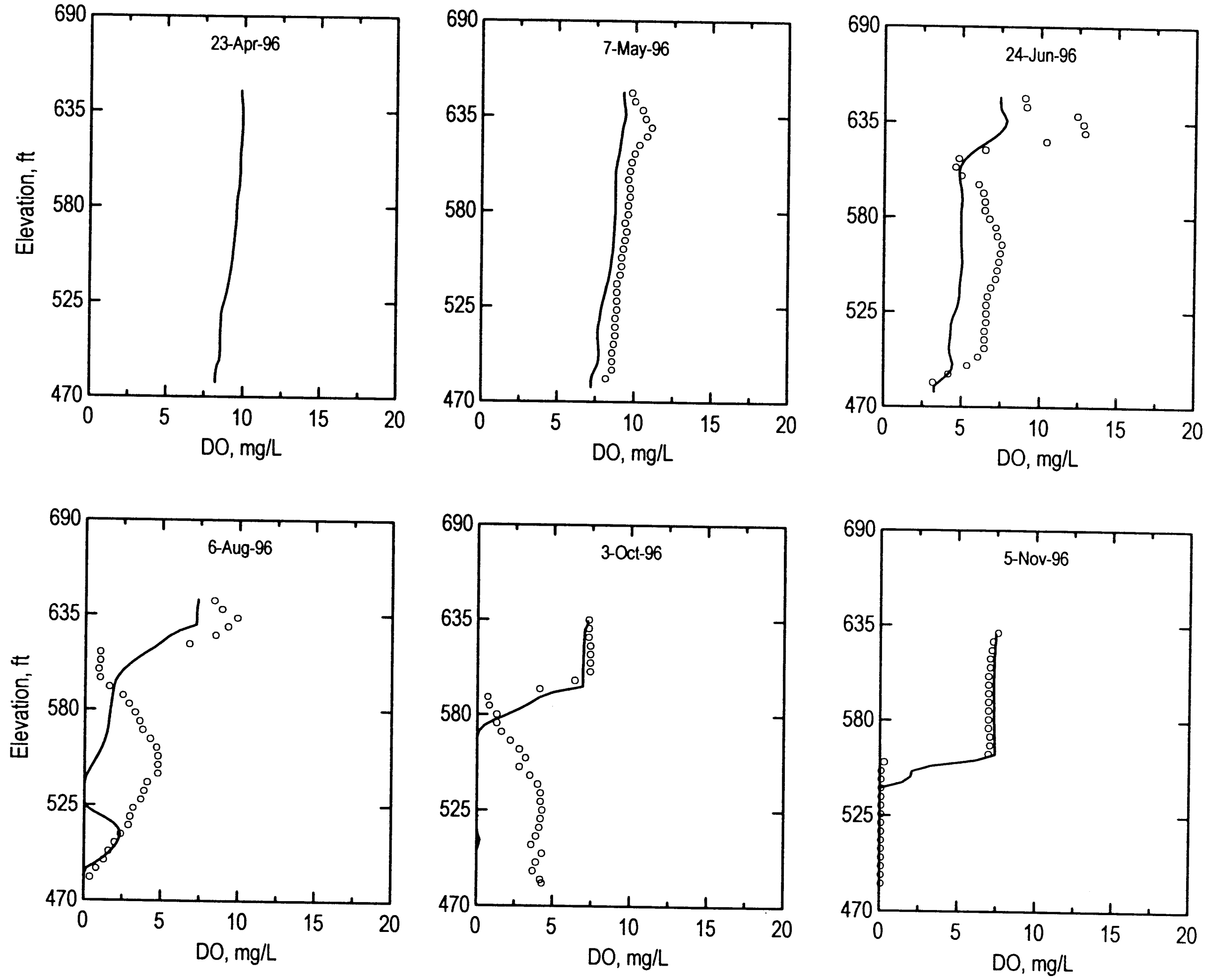
Center Hill Lake 1988 Station CEN20013

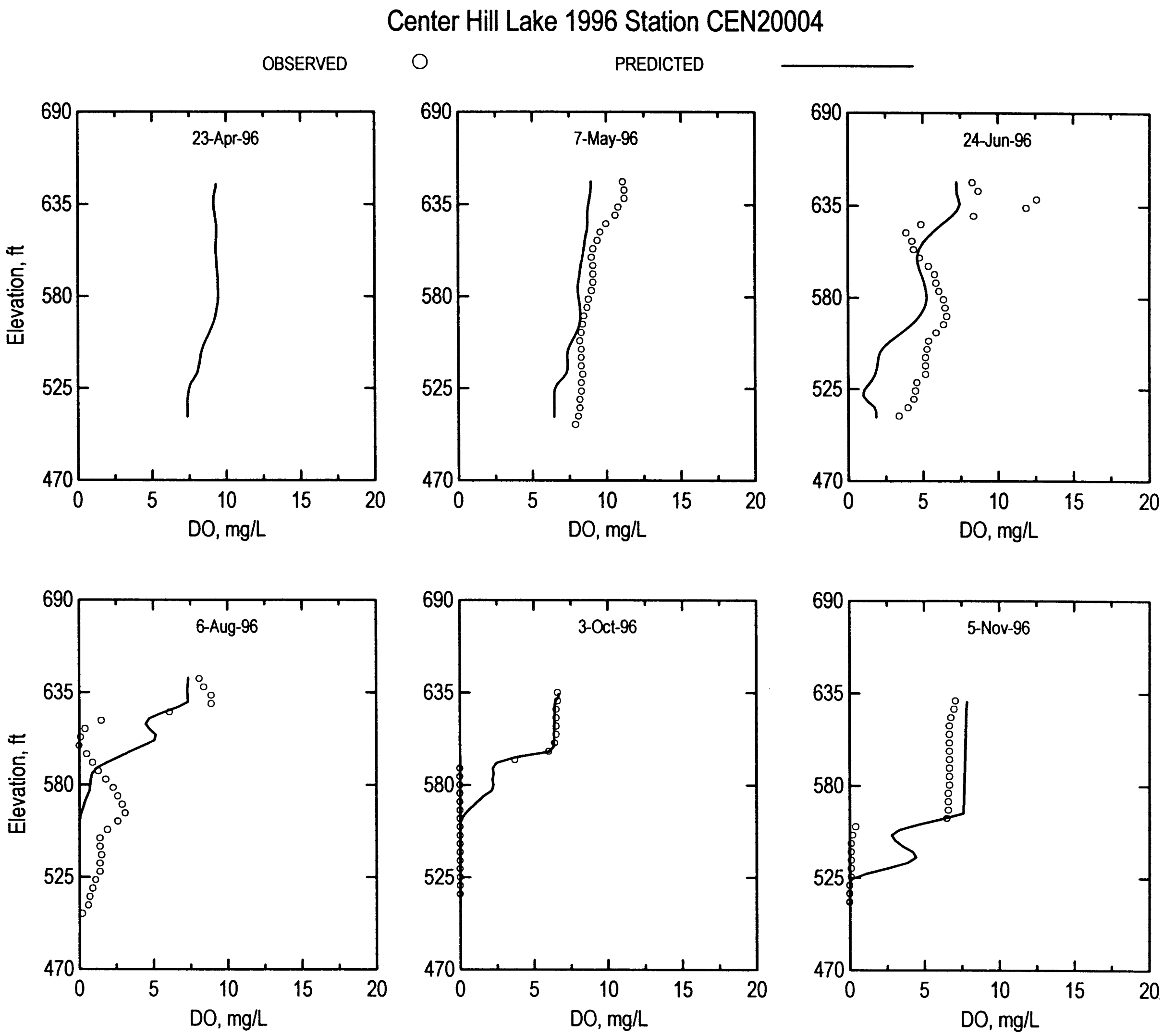



Center Hill Lake 1988 Station CEN20014
OBSERVED
PREDICTED
17-Mar-88
26-May-88
15-Jun-88
8-Jul-88
24-Jul-88
9-Aug-88
8-Sep-88
22-Sep-88
13-Oct-88
Elevation, ft
DO, mg/L
690
635
580
525
470
0
5
10
15
20

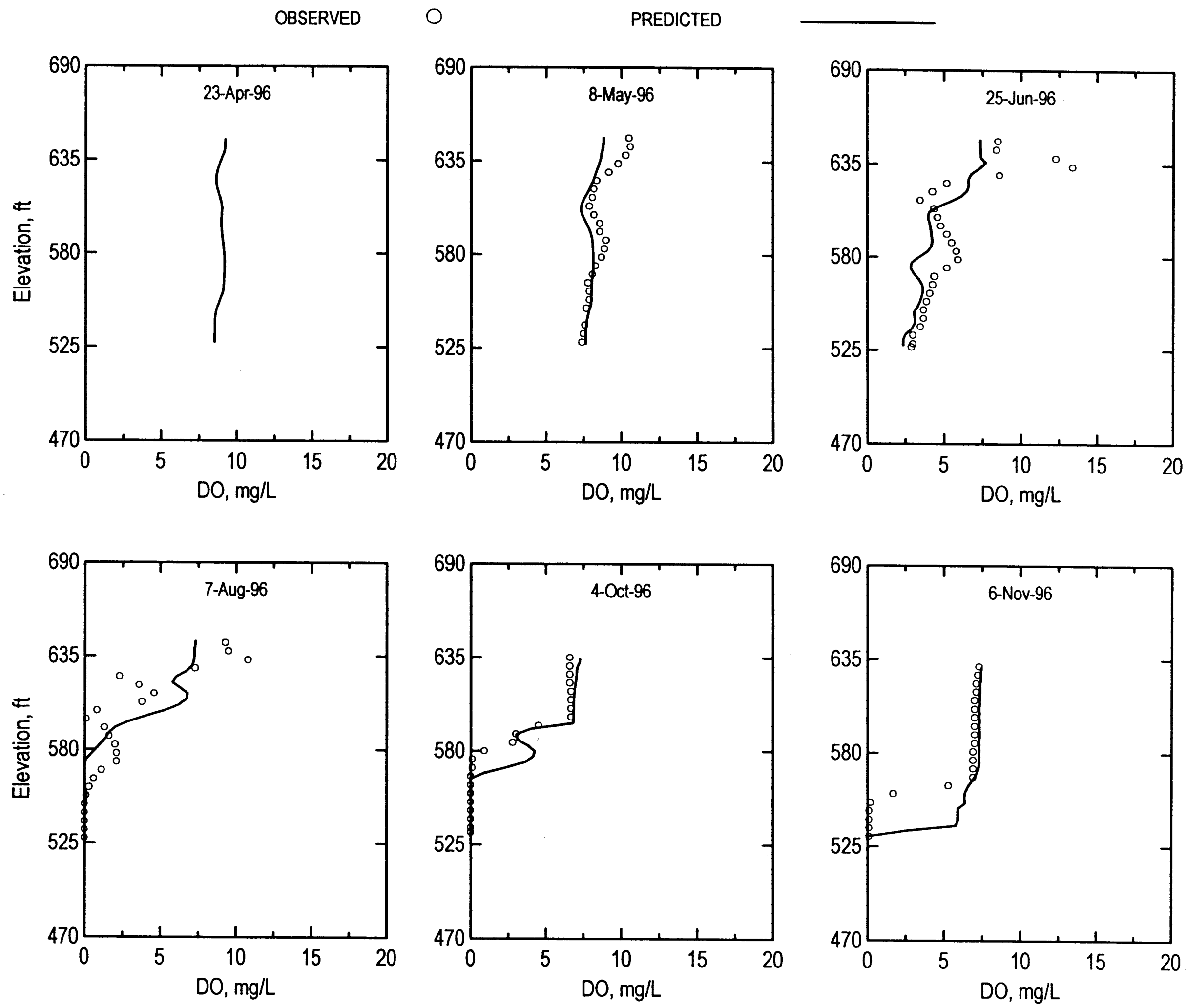
Center Hill Lake 1996 Station CEN20003

OBSERVED ○ PREDICTED ———

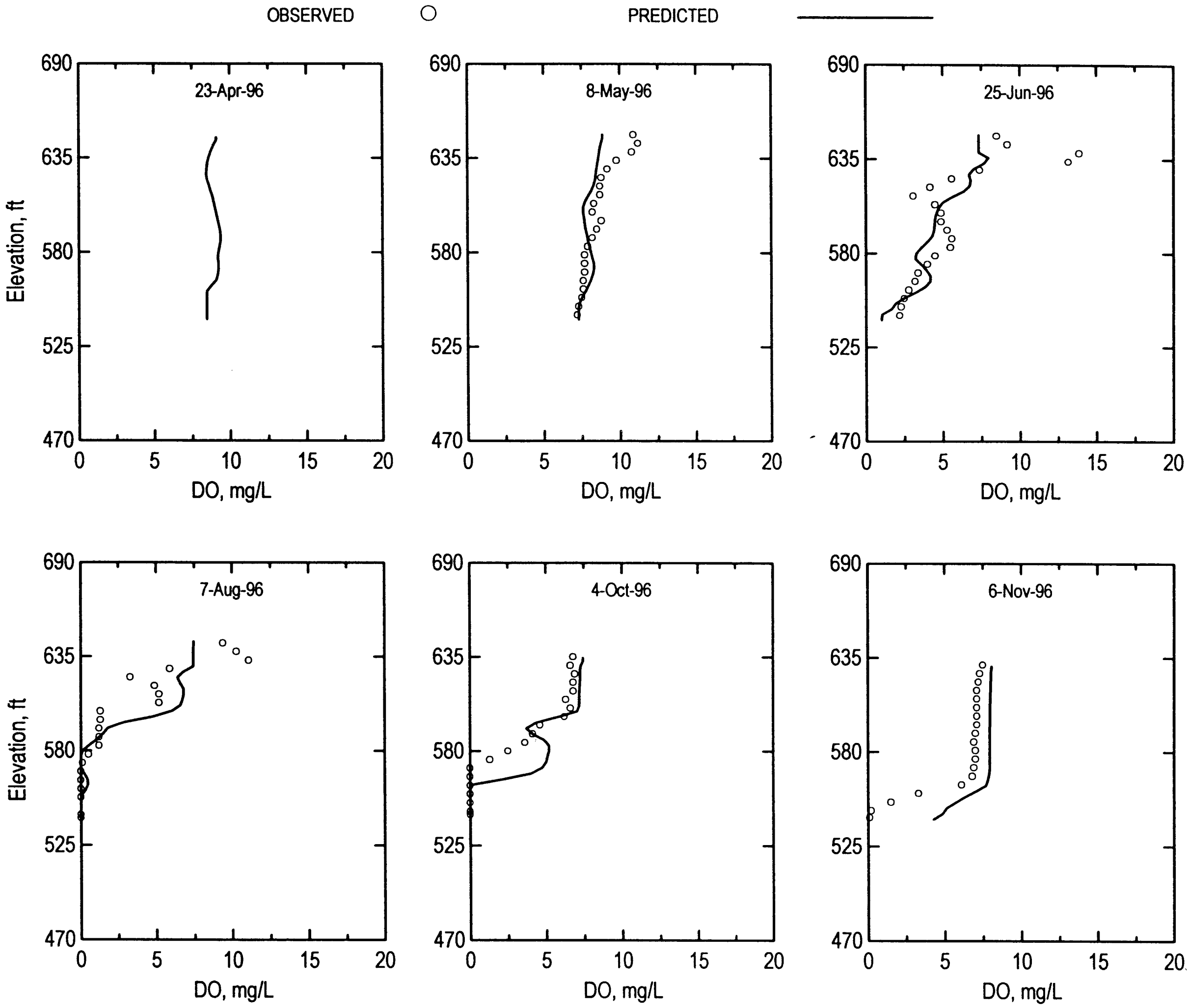



Center Hill Lake 1996 Station CEN20004
OBSERVED
PREDICTED
23-Apr-96
7-May-96
24-Jun-96
6-Aug-96
3-Oct-96
5-Nov-96
Elevation, ft
DO, mg/L
690
635
580
525
470
0
5
10
15
20

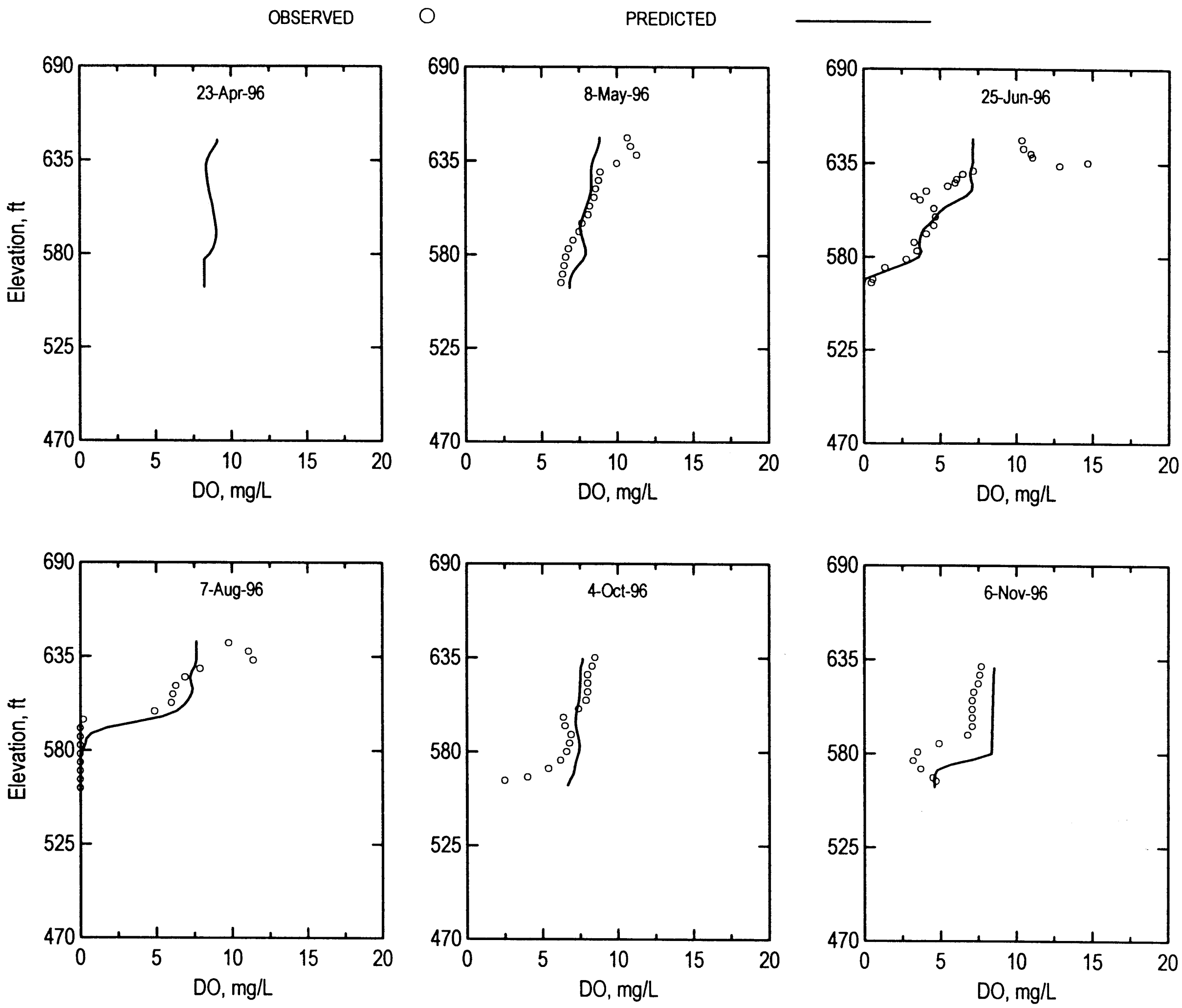
Center Hill Lake 1996 Station CEN20005



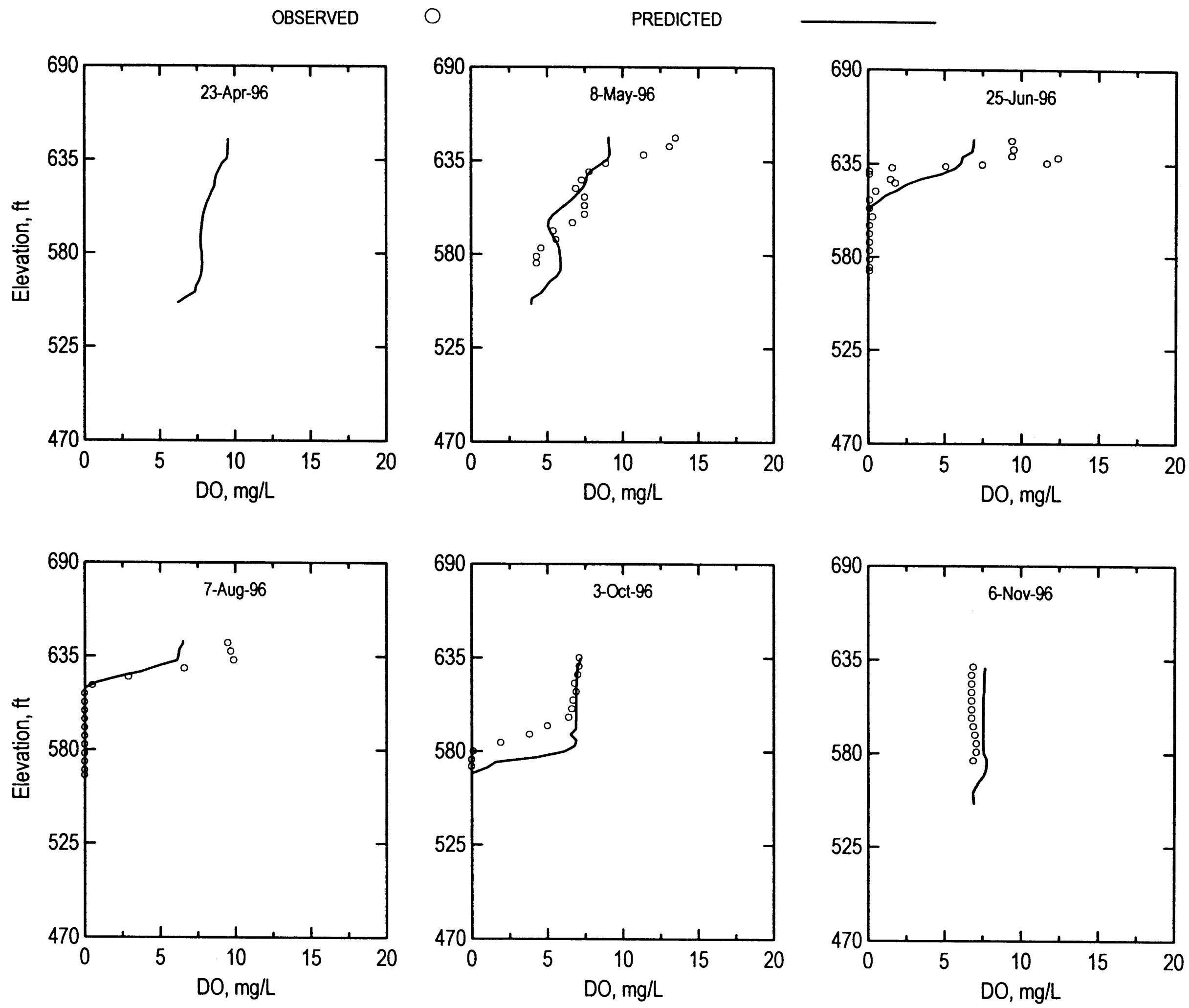
Center Hill Lake 1996 Station CEN20006

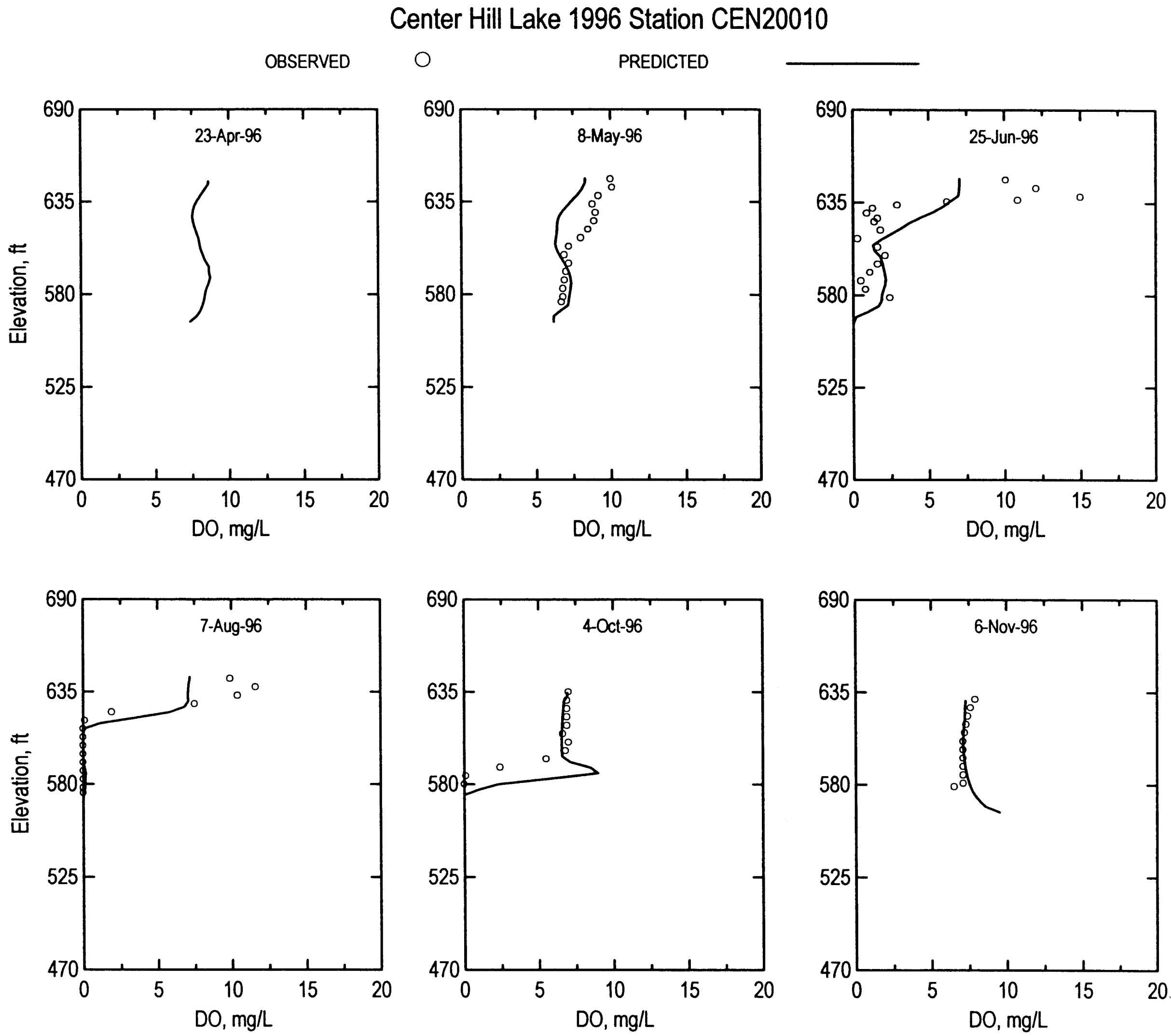


Center Hill Lake 1996 Station CEN20007



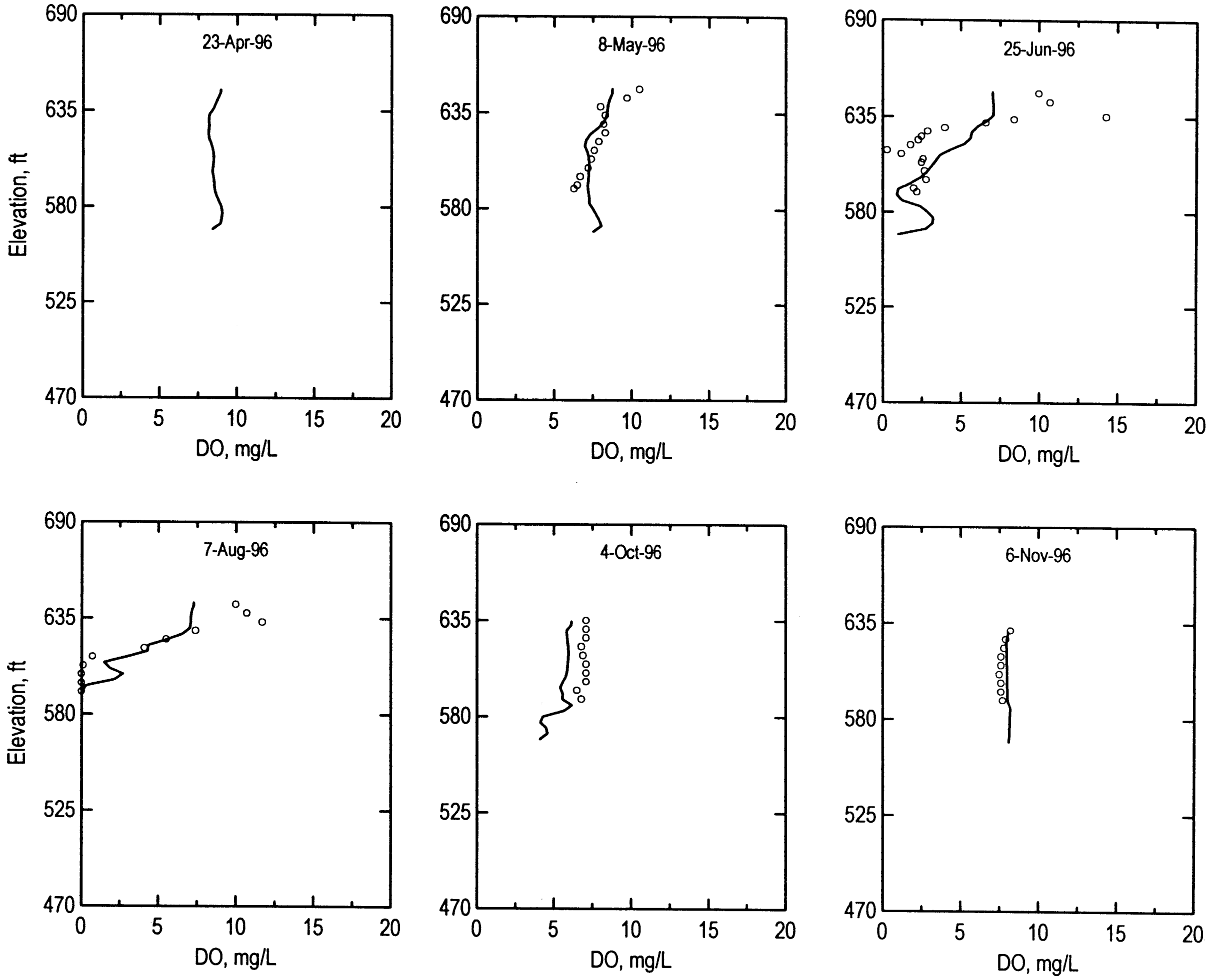
Center Hill Lake 1996 Station CEN20008

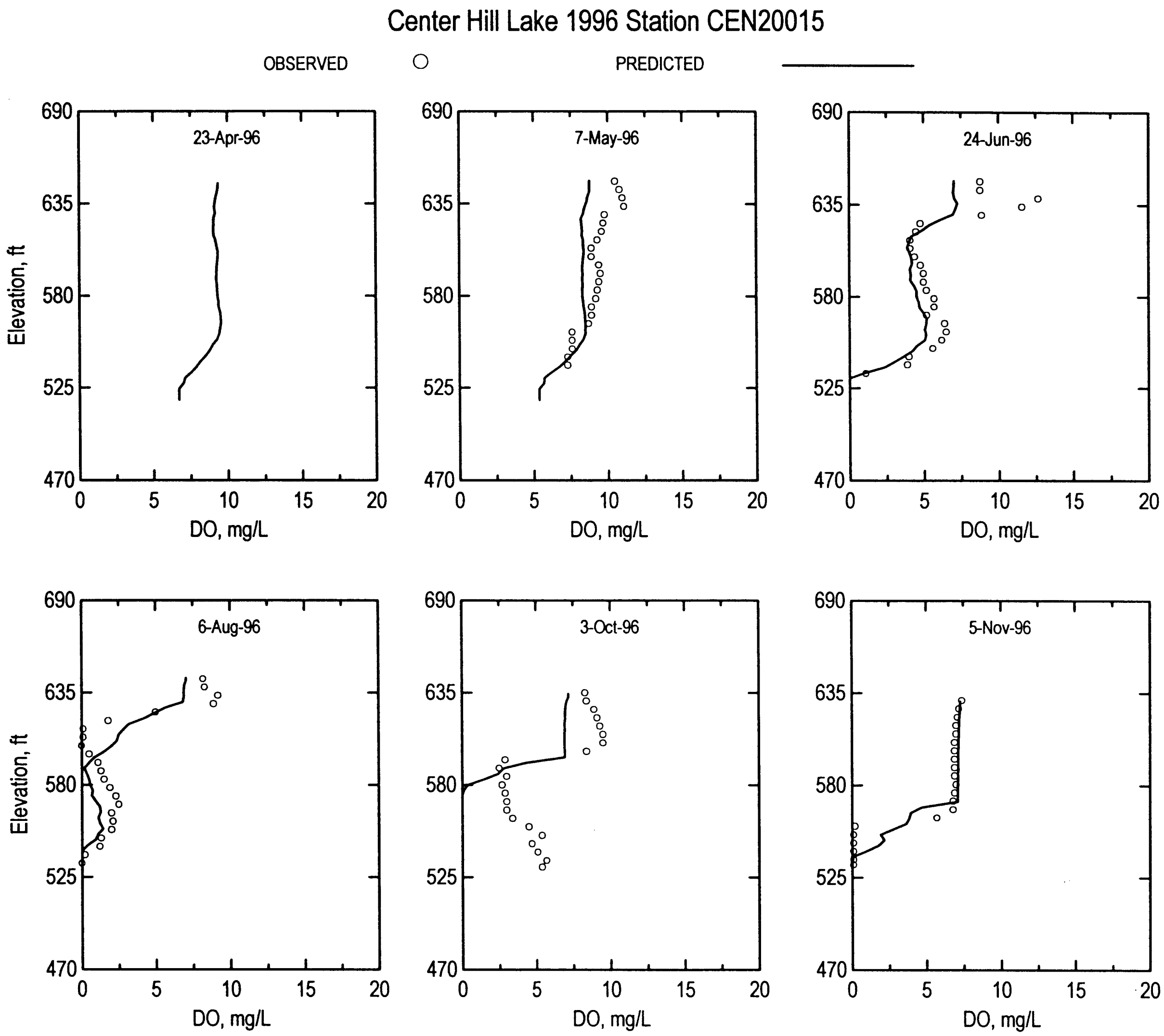



Center Hill Lake 1996 Station CEN20010
OBSERVED
PREDICTED
23-Apr-96
8-May-96
25-Jun-96
7-Aug-96
4-Oct-96
6-Nov-96
Elevation, ft
DO, mg/L
690
635
580
525
470
0
5
10
15
20

Center Hill Lake 1996 Station CEN20011

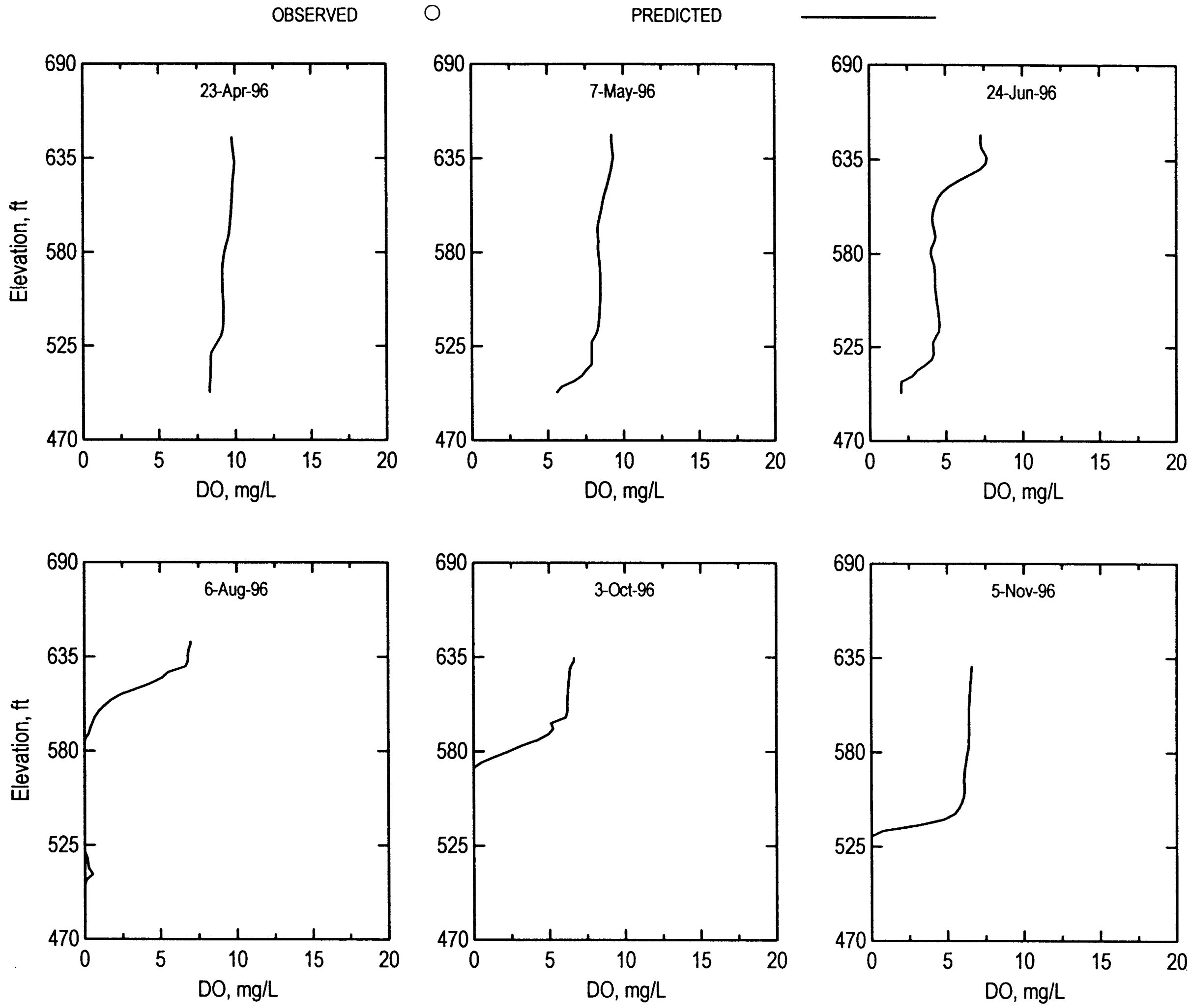
OBSERVED ○ PREDICTED ———

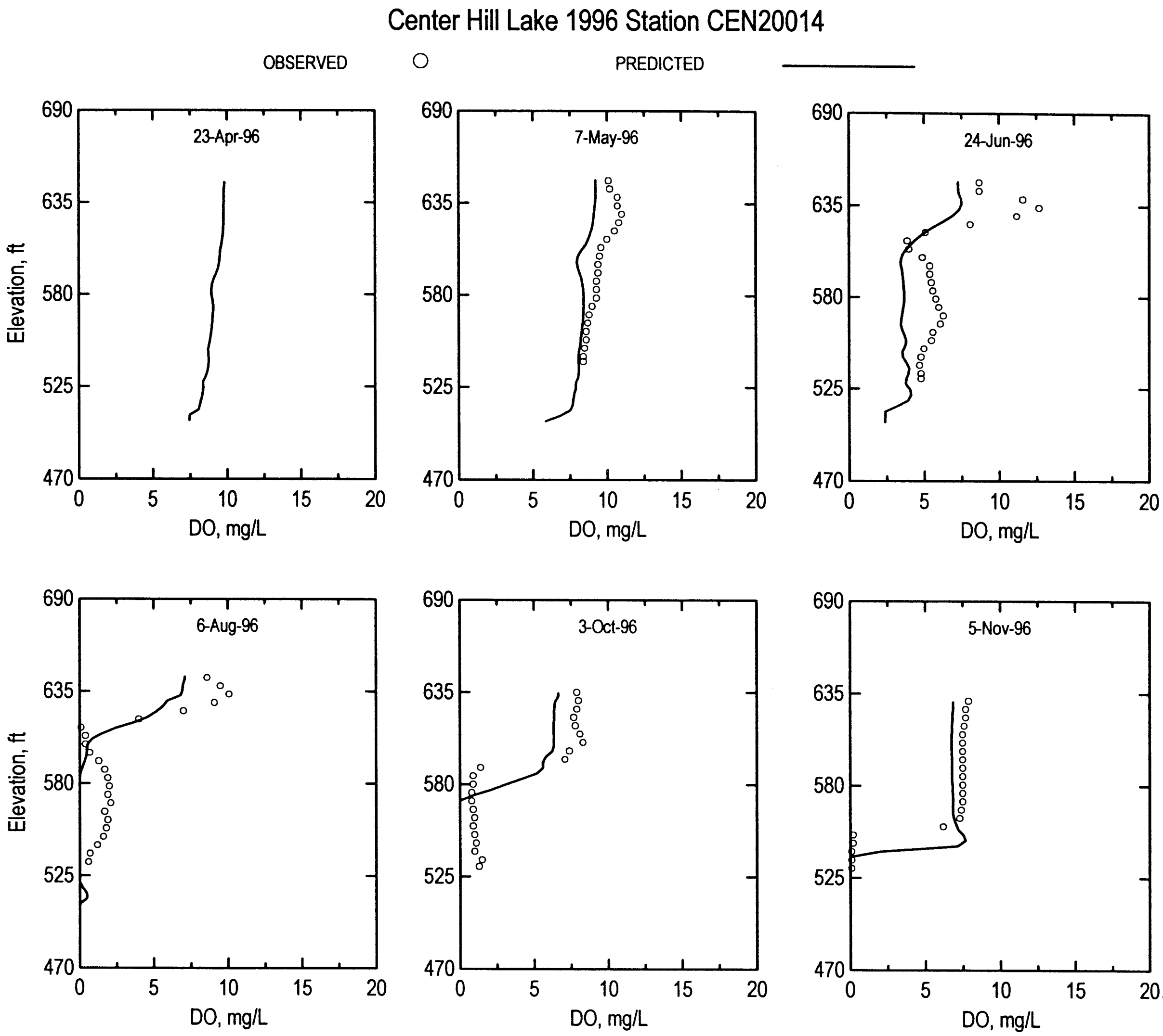




Center Hill Lake 1996 Station CEN20015
OBSERVED
PREDICTED
23-Apr-96
7-May-96
24-Jun-96
6-Aug-96
3-Oct-96
5-Nov-96
Elevation, ft
DO, mg/L
690
635
580
525
470
0
5
10
15
20

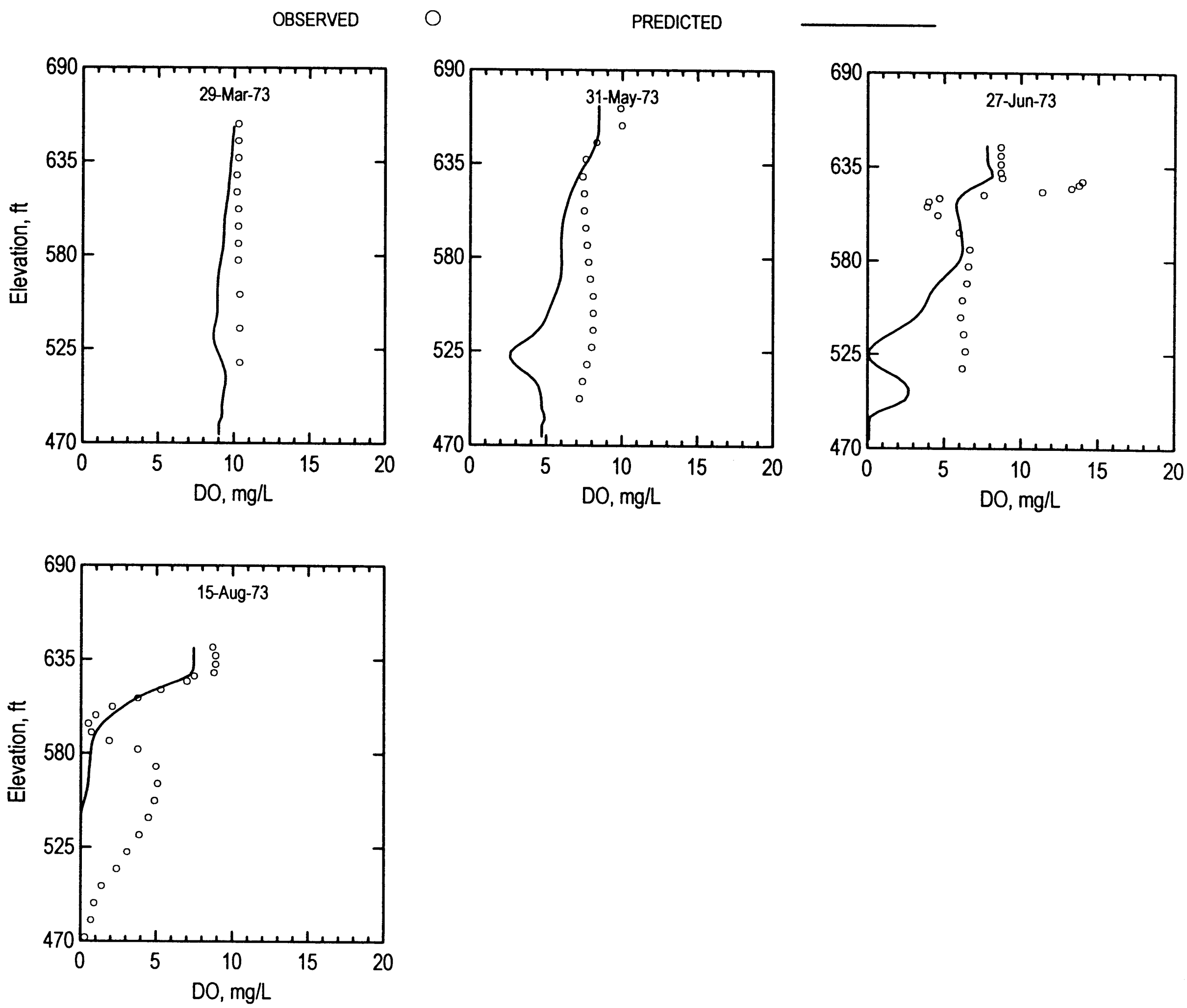
Center Hill Lake 1996 Station CEN20013



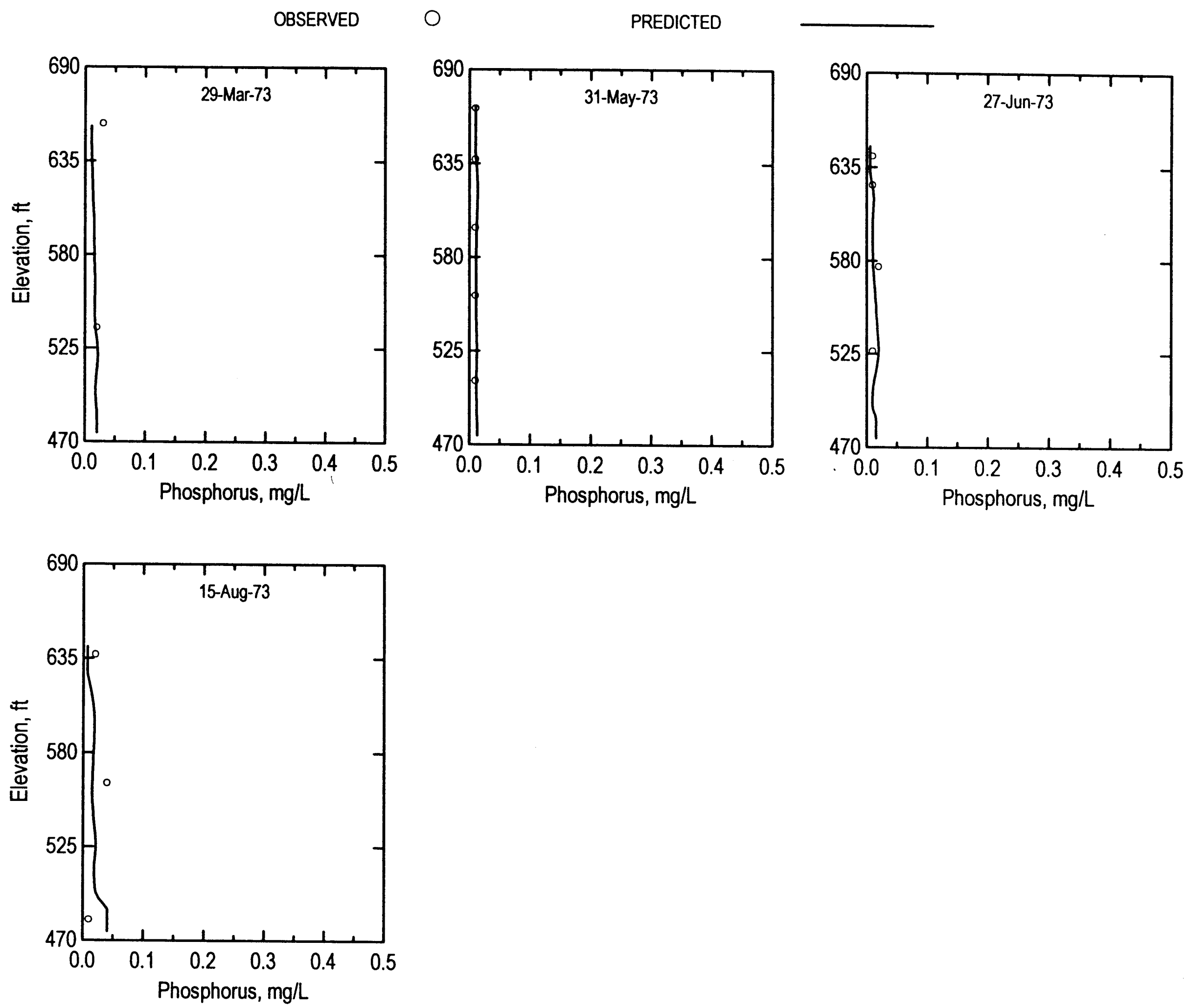


Center Hill Lake 1996 Station CEN20014
OBSERVED
PREDICTED
23-Apr-96
7-May-96
24-Jun-96
6-Aug-96
3-Oct-96
5-Nov-96
Elevation, ft
690
635
580
525
470
DO, mg/L
0
5
10
15
20

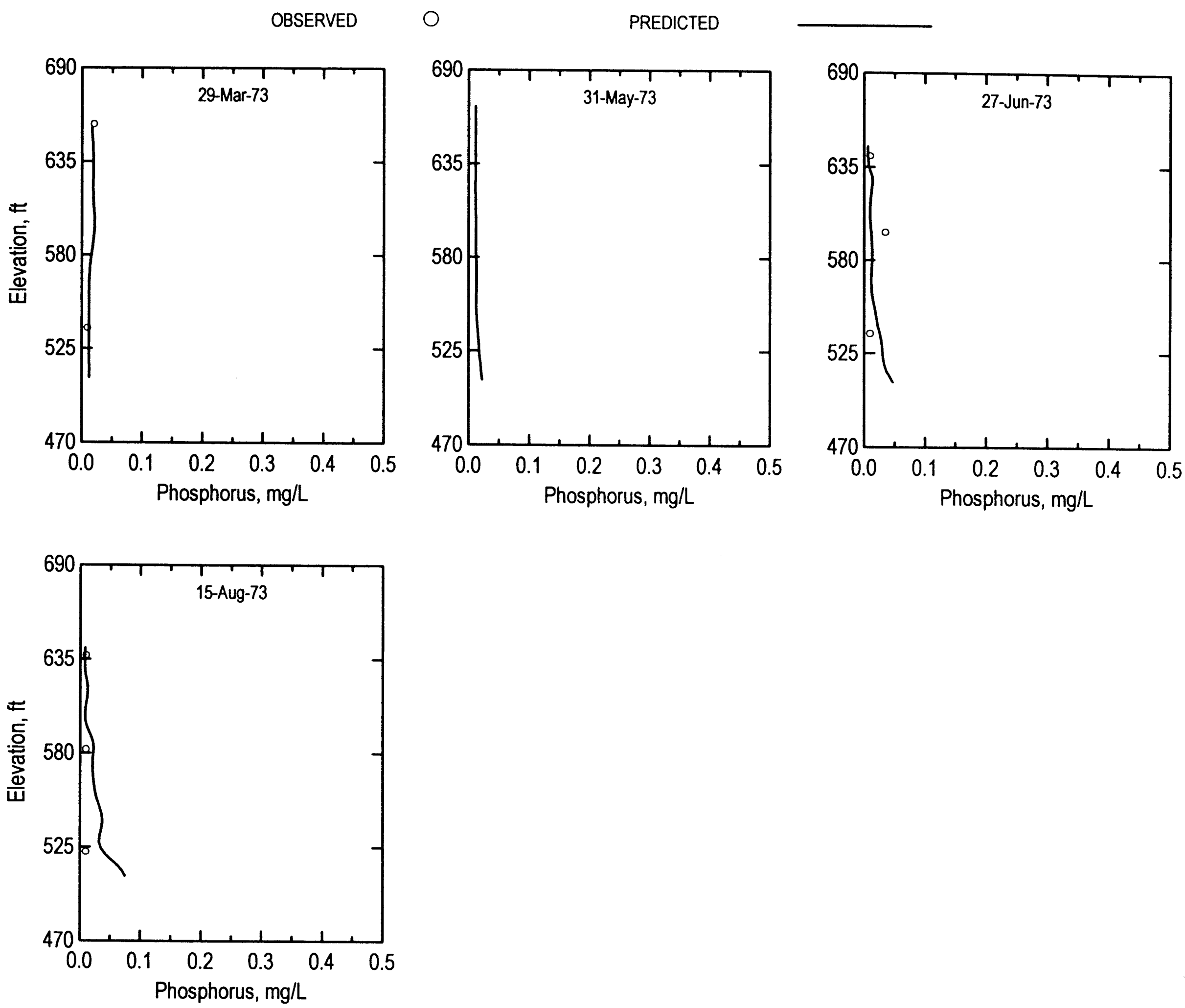
Center Hill Lake 1973 Station CEN20002



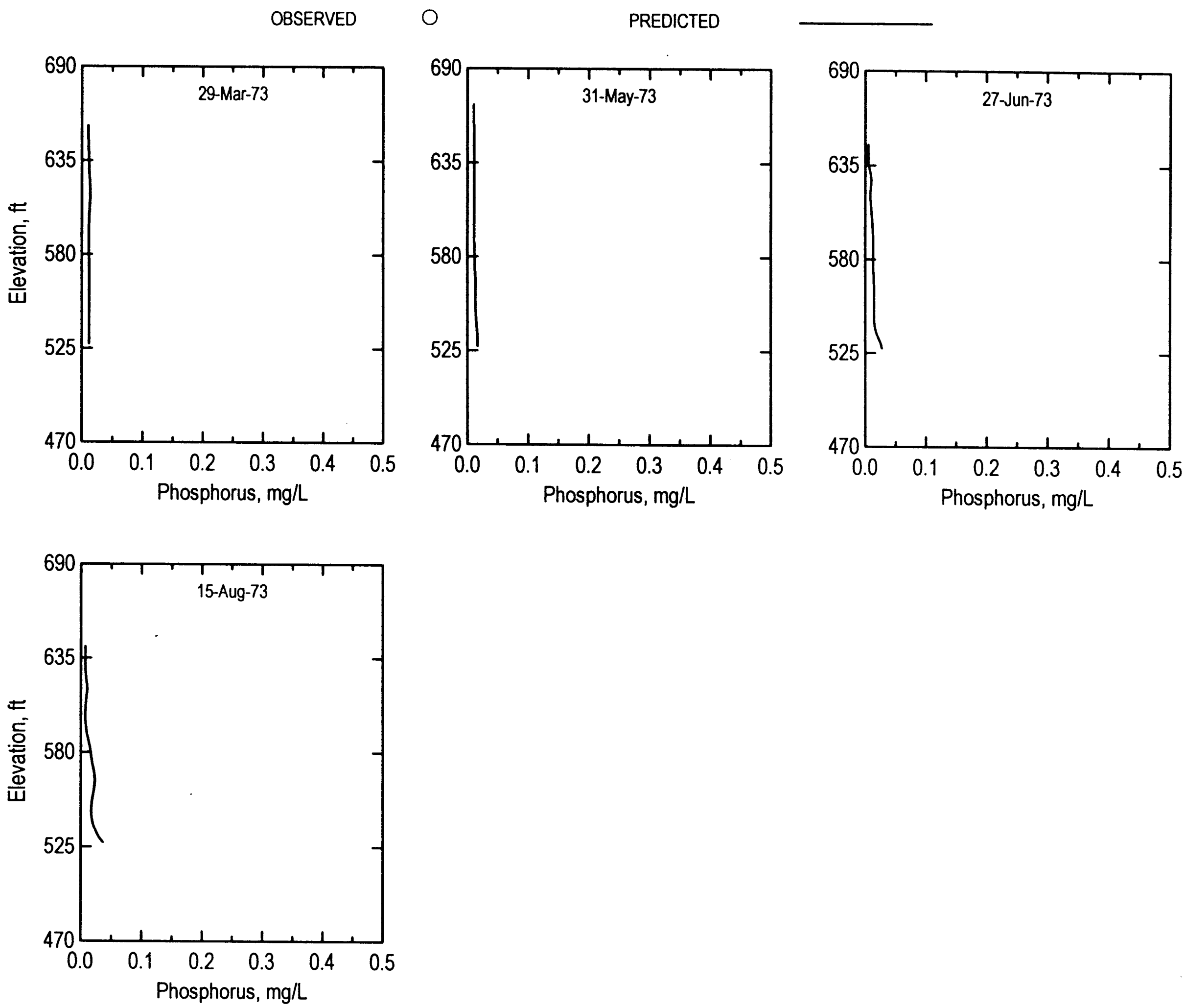
Center Hill Lake 1973 Station CEN20002



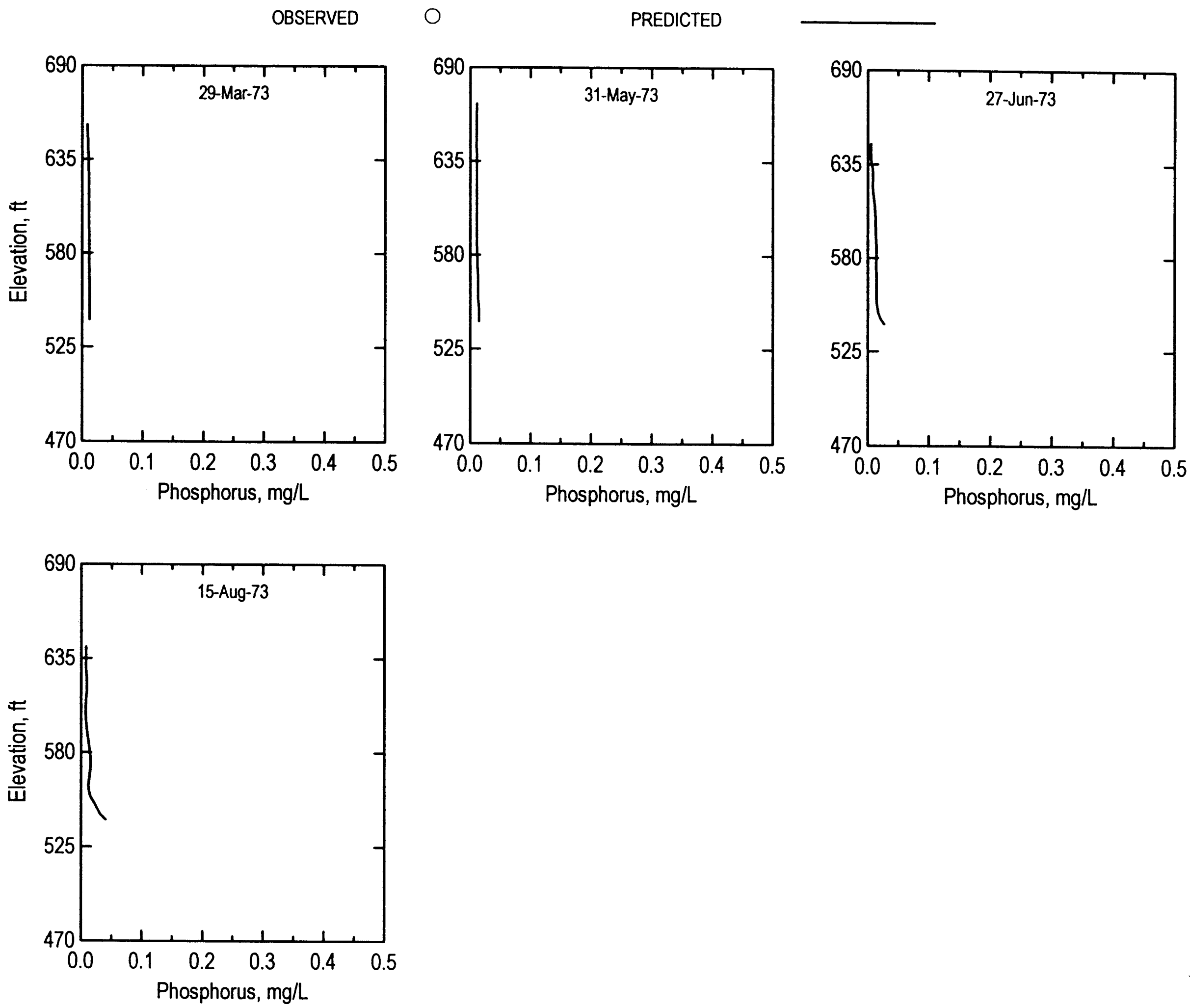
Center Hill Lake 1973 Station CEN20004

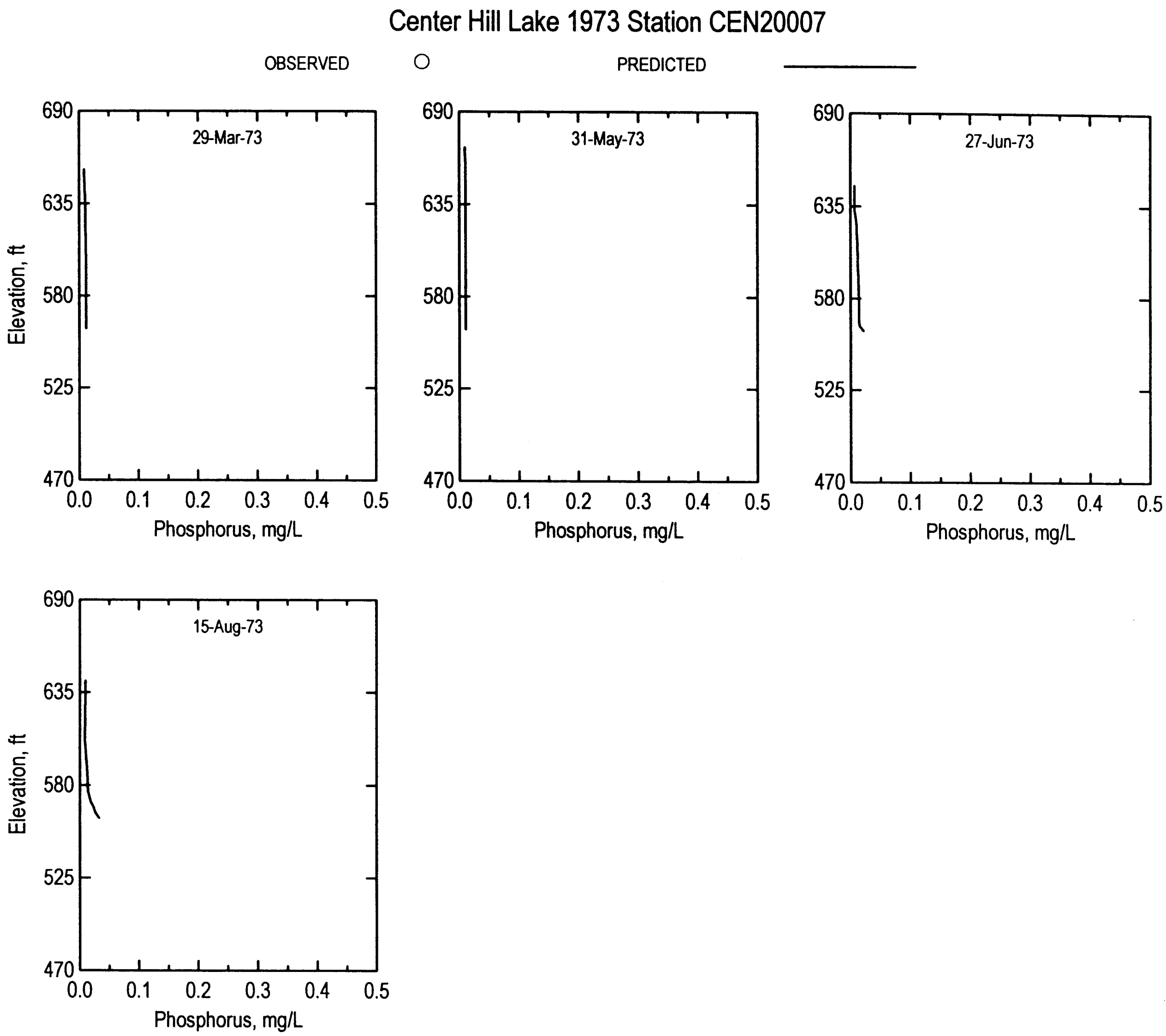


Center Hill Lake 1973 Station CEN20005

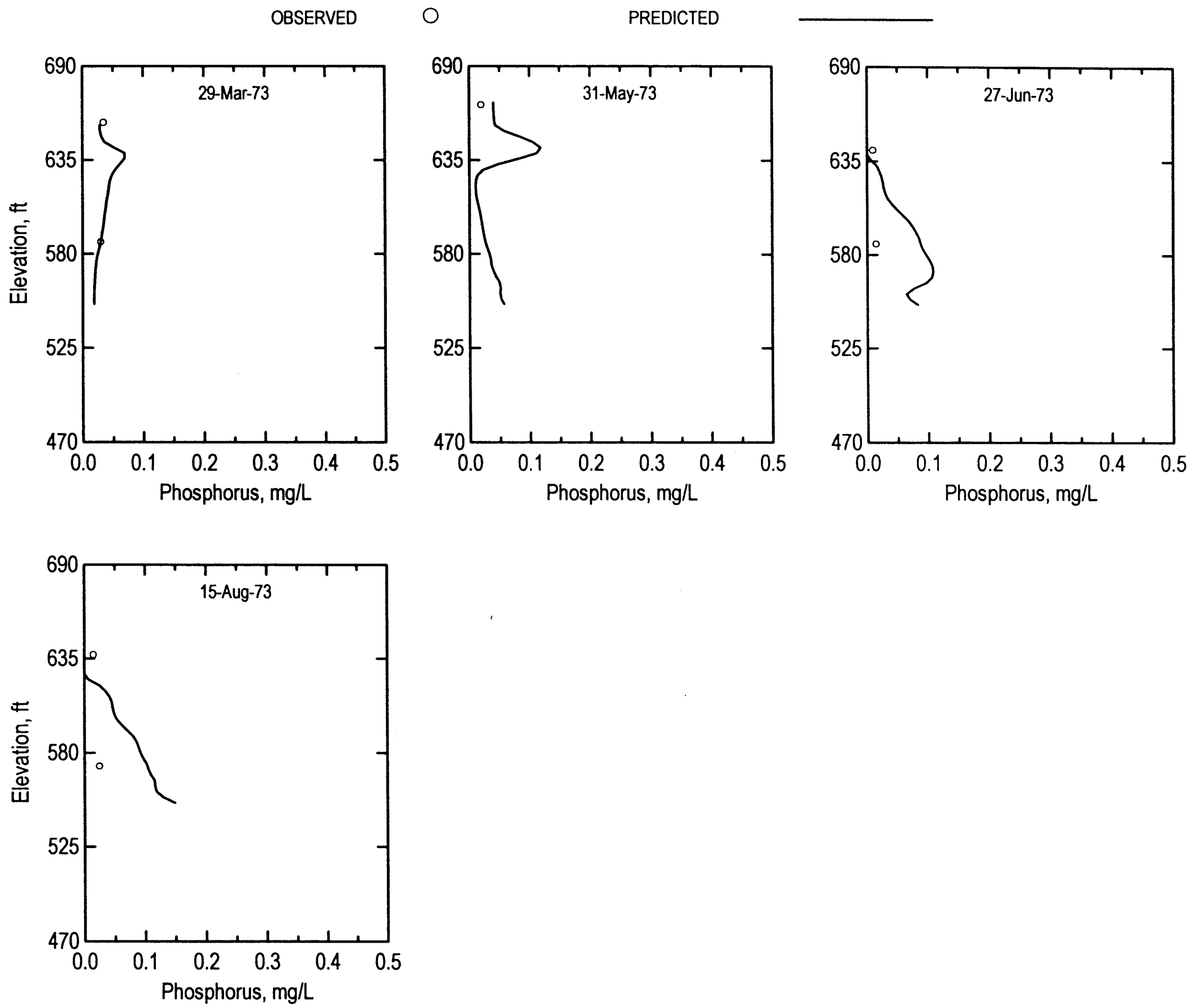


Center Hill Lake 1973 Station CEN20006



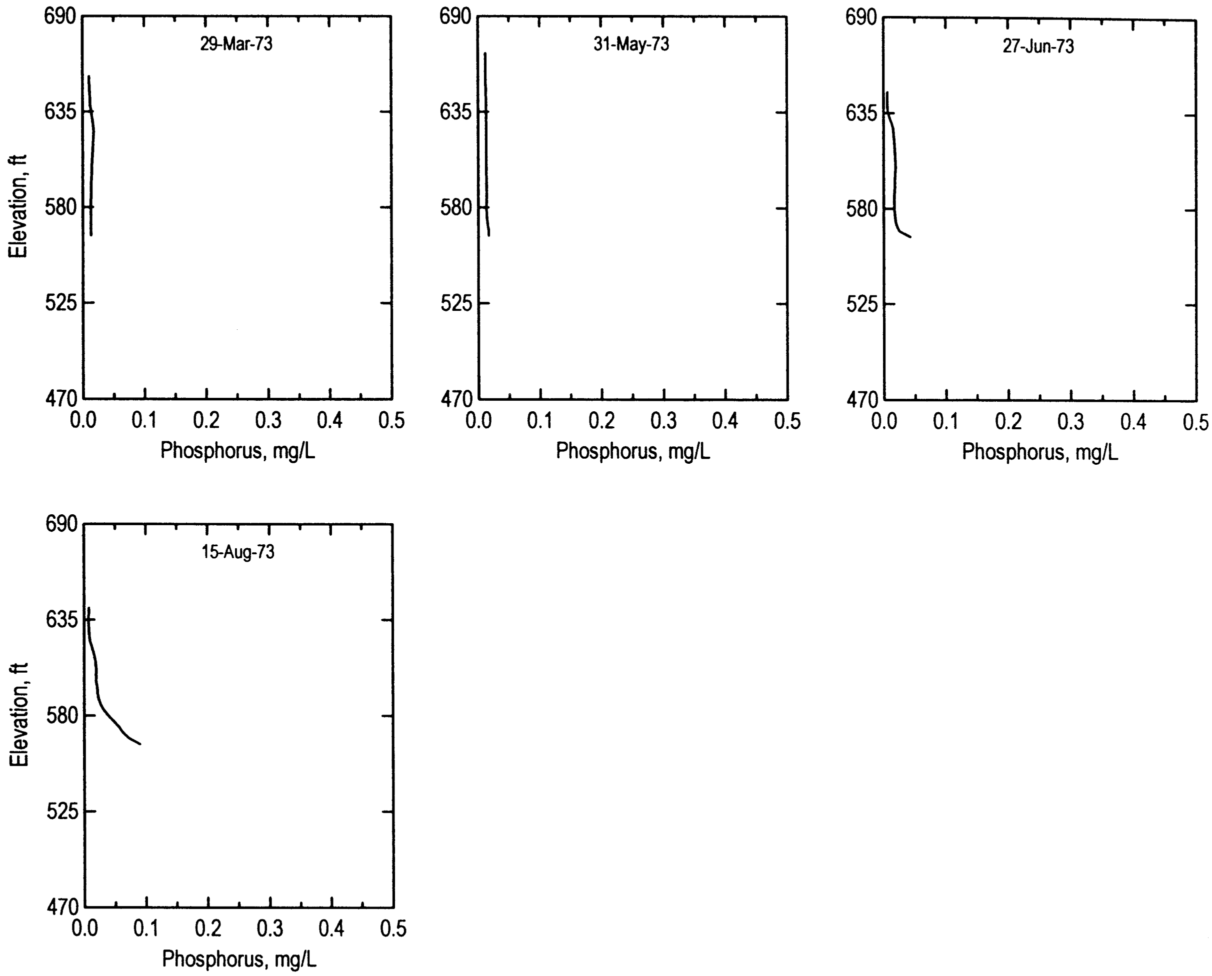

Center Hill Lake 1973 Station CEN20007
OBSERVED
PREDICTED
29-Mar-73
31-May-73
27-Jun-73
15-Aug-73
Elevation, ft
Phosphorus, mg/L
690
635
580
525
470
0.0
0.1
0.2
0.3
0.4
0.5

Center Hill Lake 1973 Station CEN20008



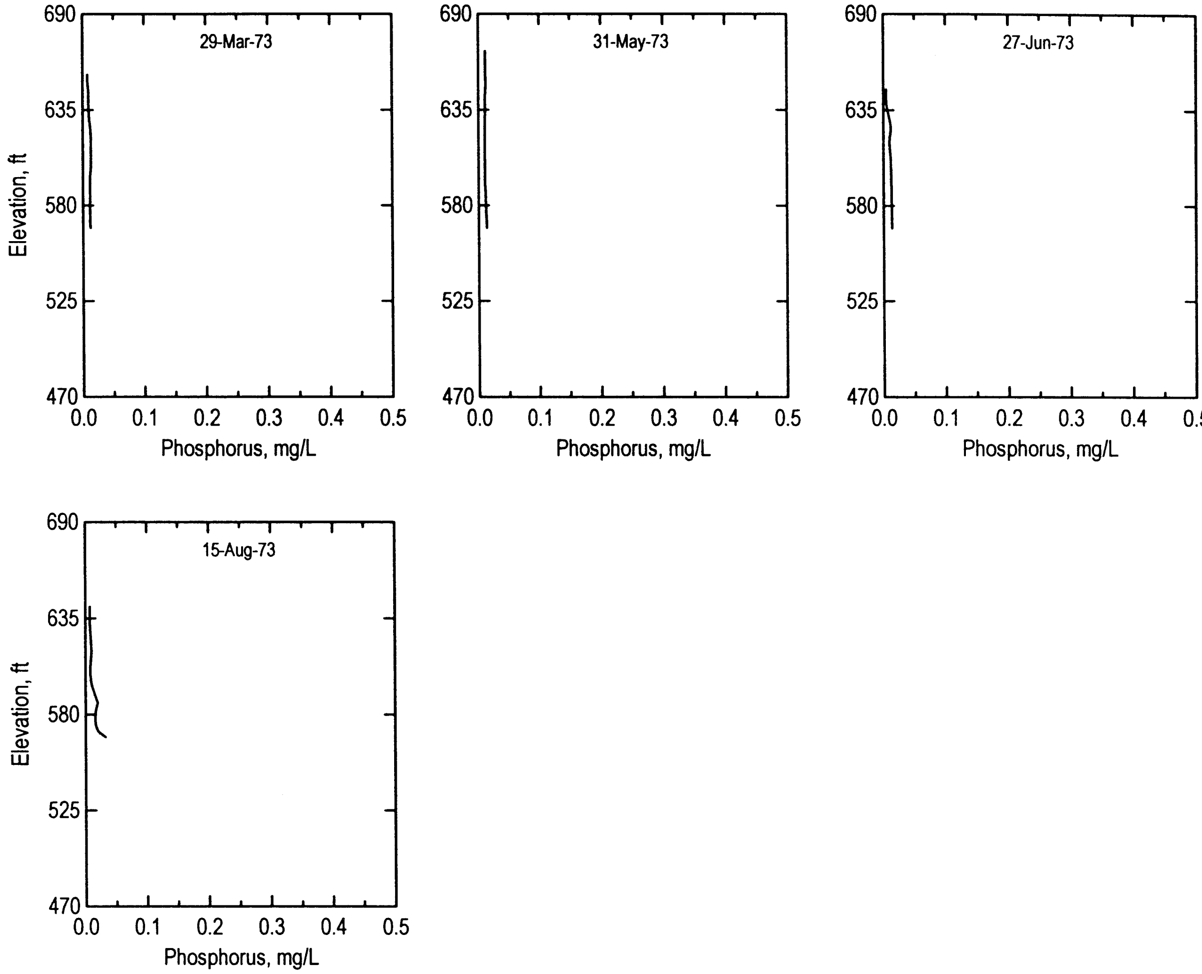
Center Hill Lake 1973 Station CEN20010

OBSERVED ○ PREDICTED ———



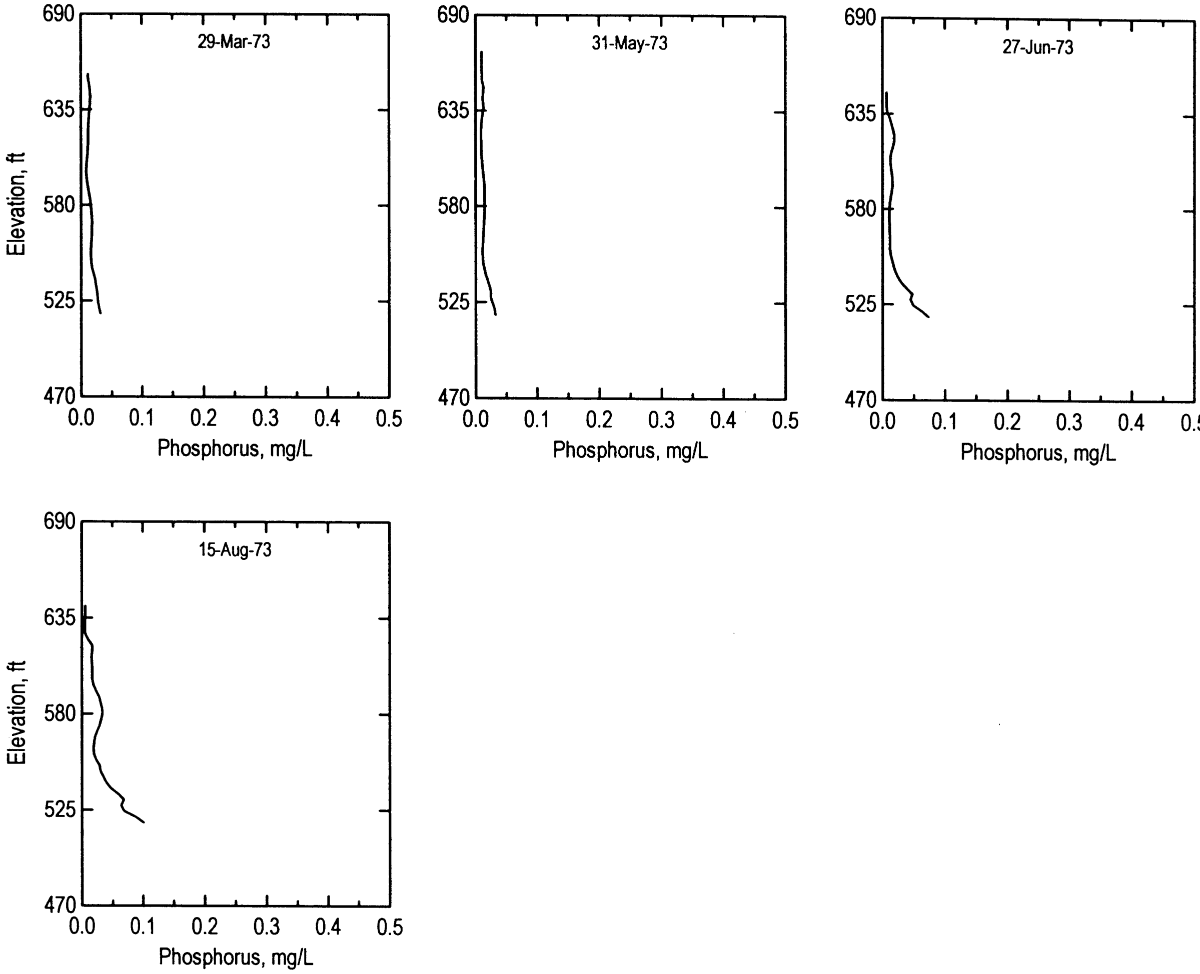
Center Hill Lake 1973 Station CEN20011

OBSERVED ○ PREDICTED ———

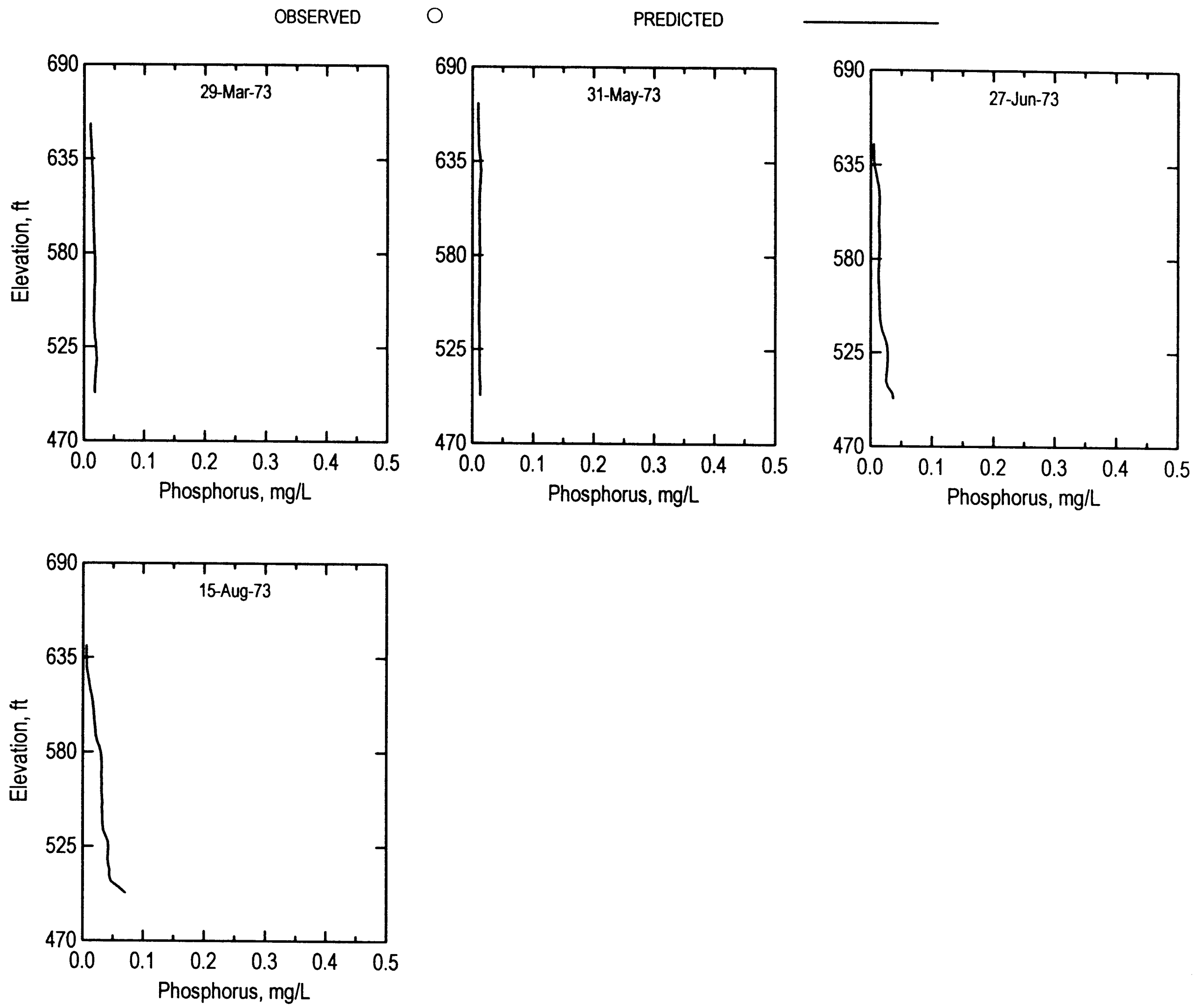


Center Hill Lake 1973 Station CEN20015

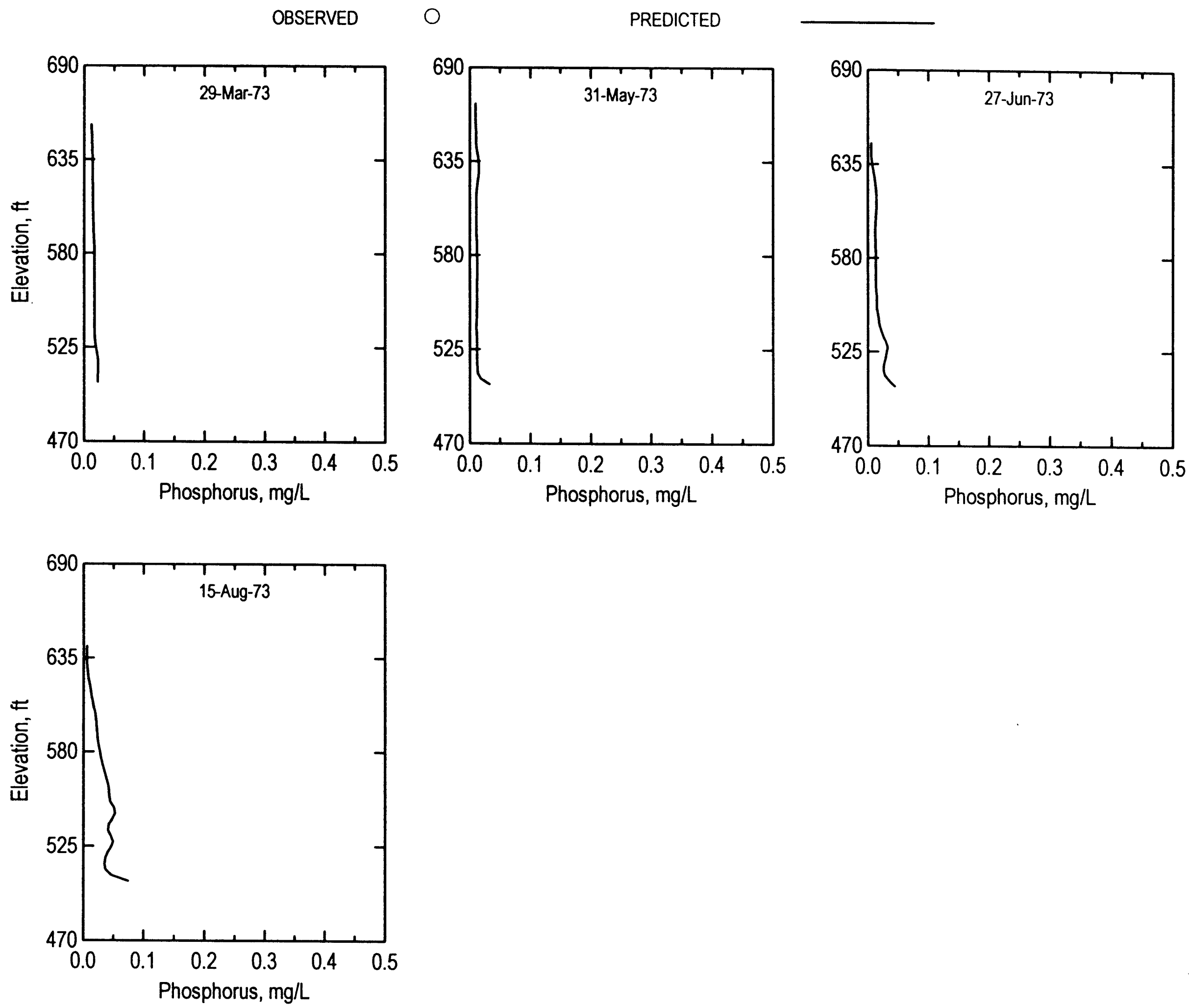
OBSERVED ○ PREDICTED ———



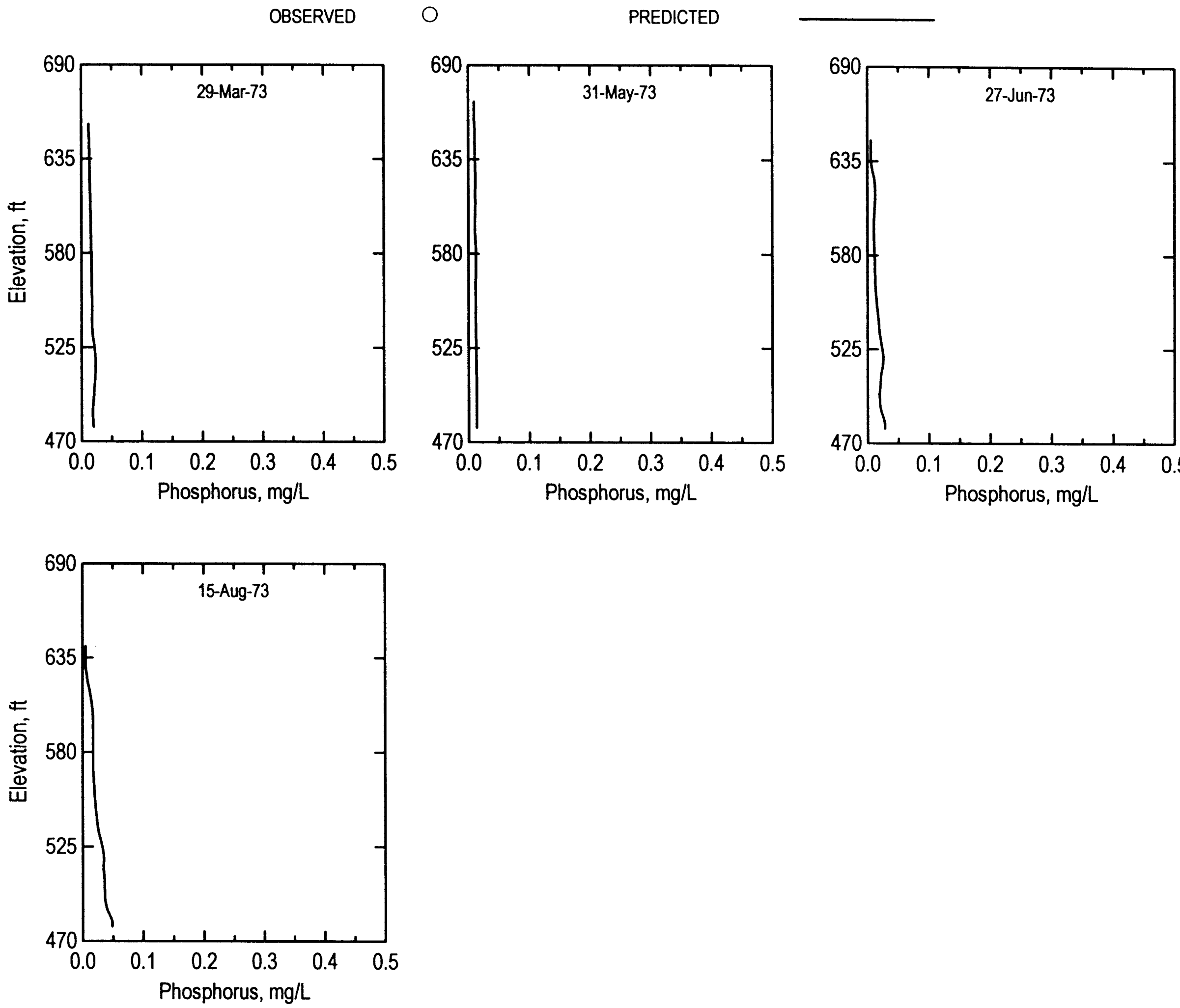
Center Hill Lake 1973 Station CEN20013

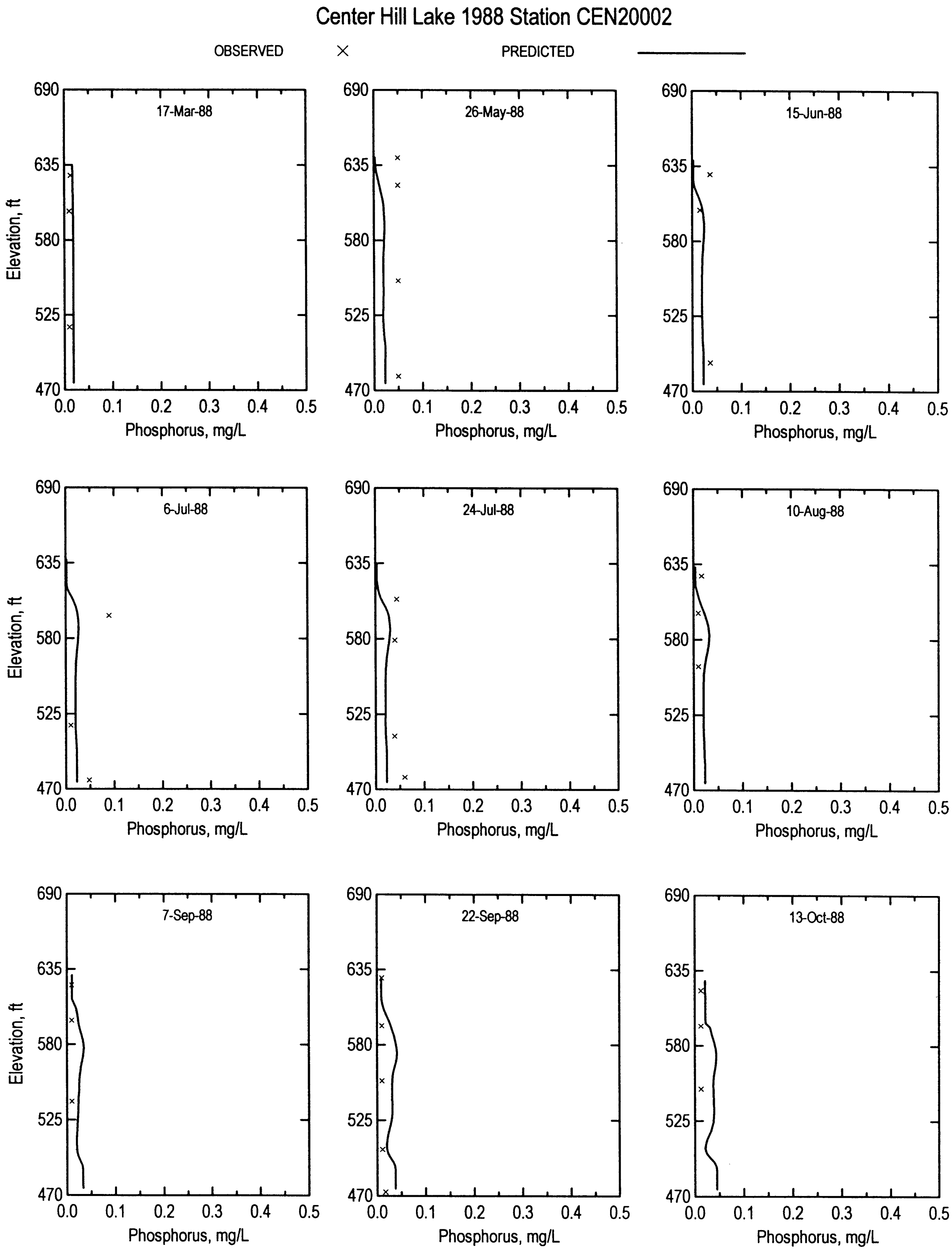


Center Hill Lake 1973 Station CEN20014

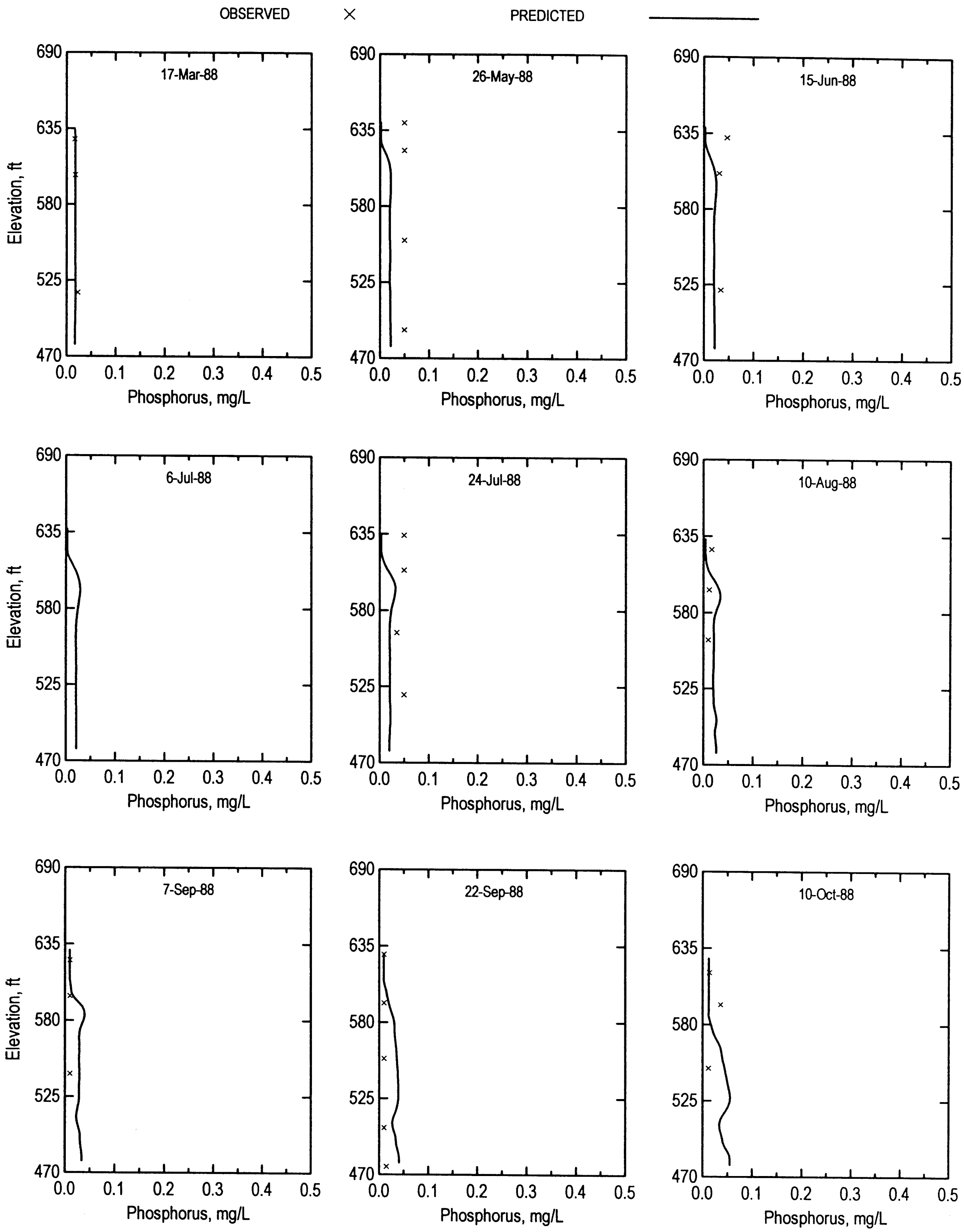


Center Hill Lake 1973 Station CEN20003

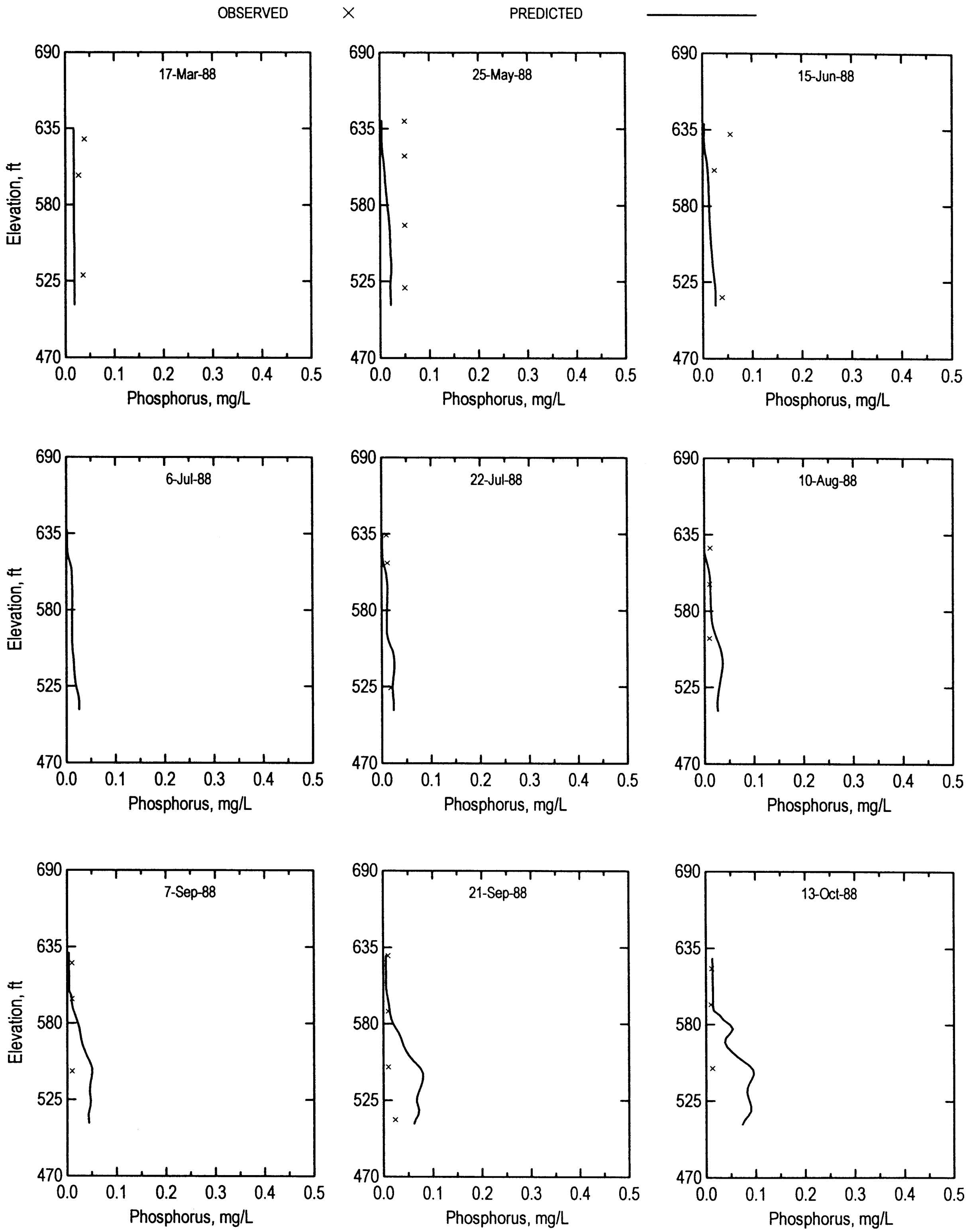



Center Hill Lake 1988 Station CEN20002
OBSERVED
PREDICTED
17-Mar-88
26-May-88
15-Jun-88
6-Jul-88
24-Jul-88
10-Aug-88
7-Sep-88
22-Sep-88
13-Oct-88
Elevation, ft
Phosphorus, mg/L
690
635
580
525
470
0.0
0.1
0.2
0.3
0.4
0.5

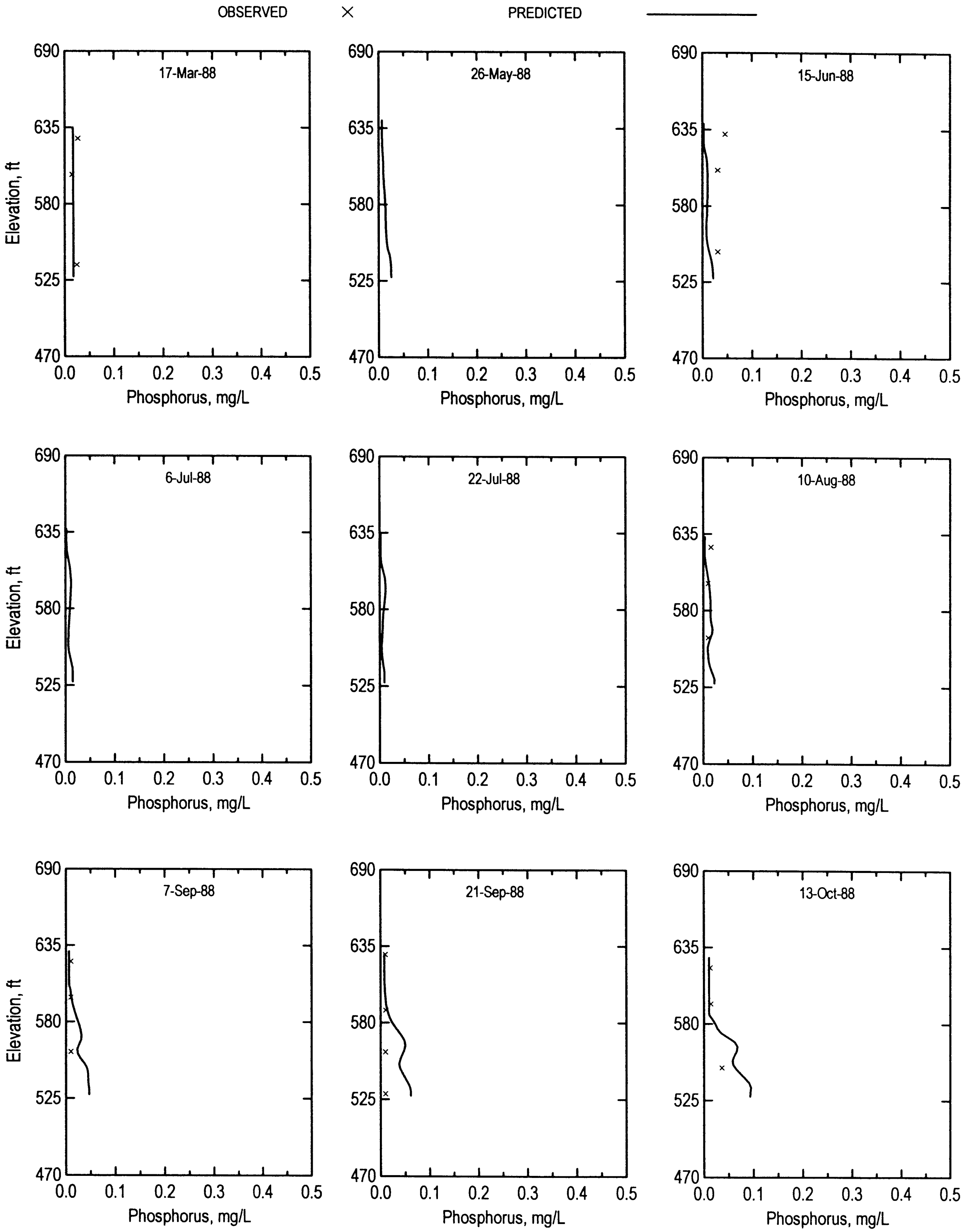
Center Hill Lake 1988 Station CEN20003



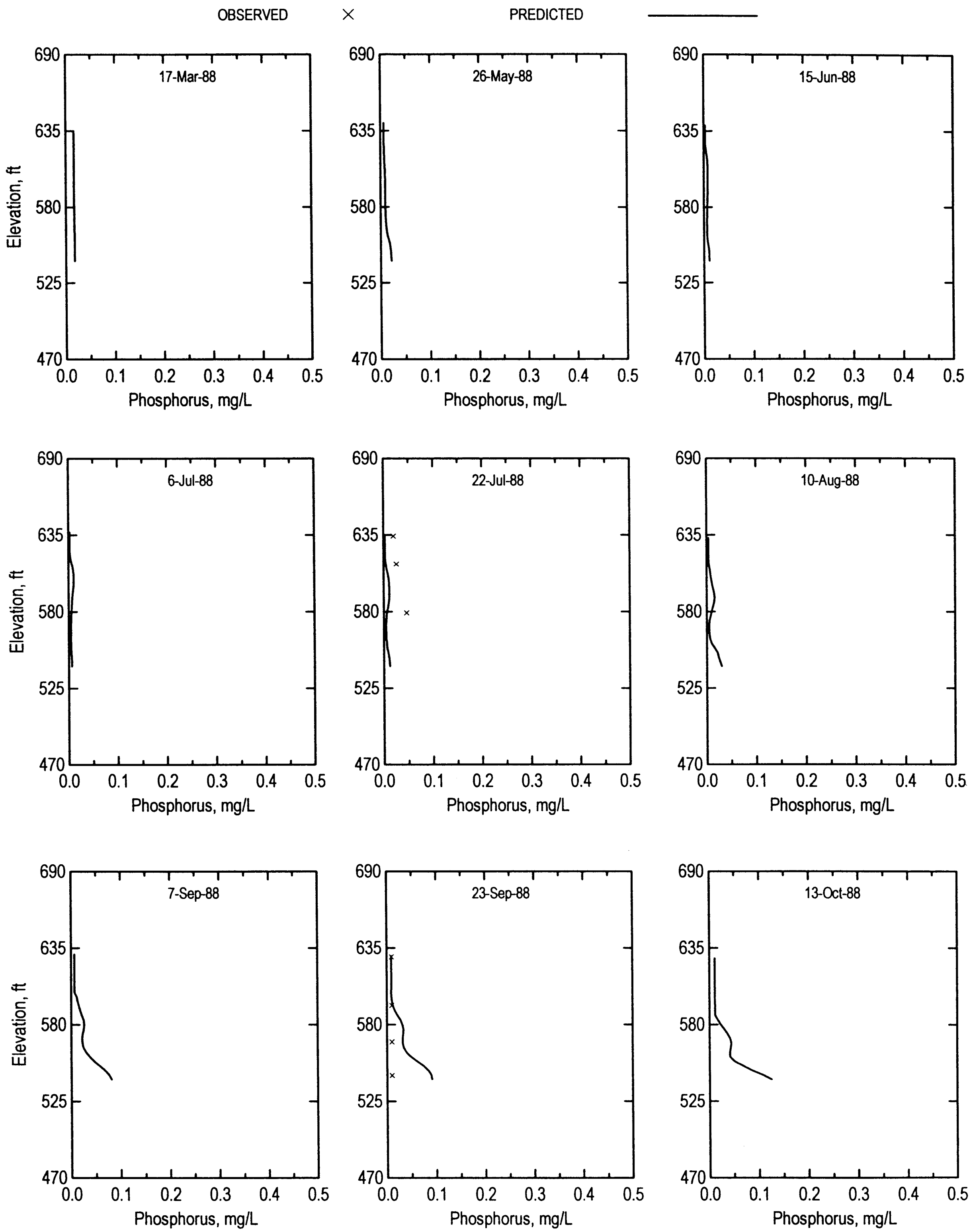
Center Hill Lake 1988 Station CEN20004

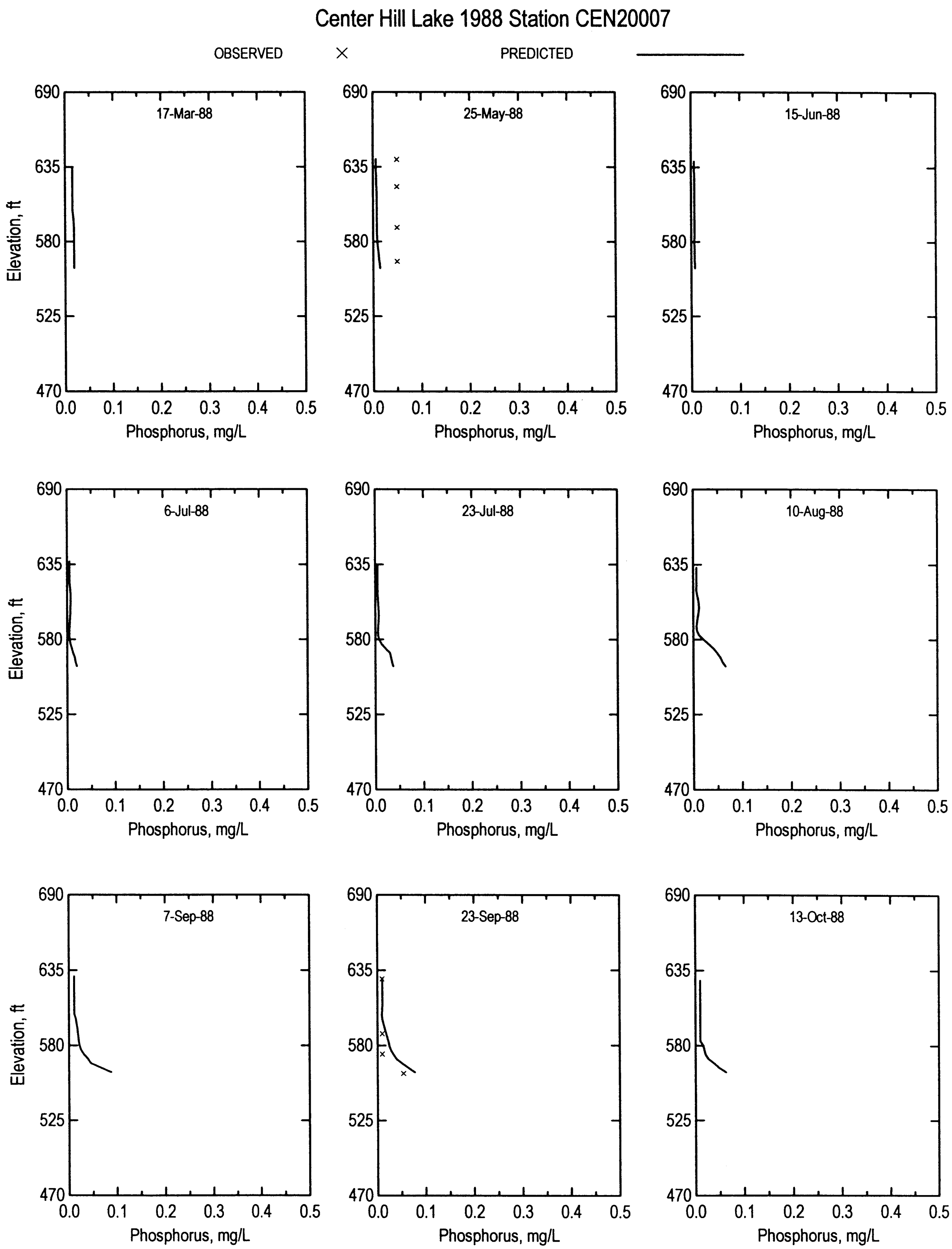


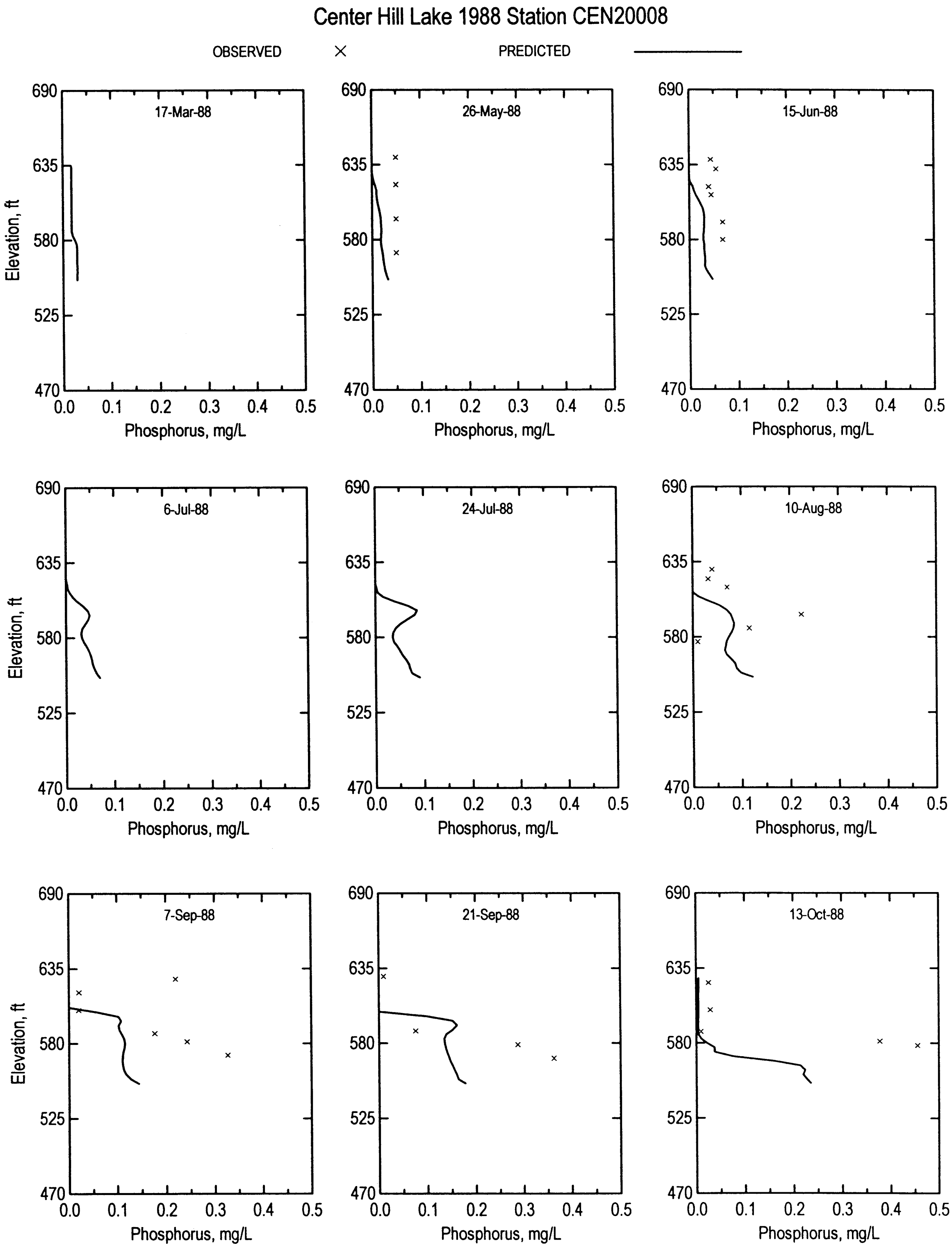
Center Hill Lake 1988 Station CEN20005



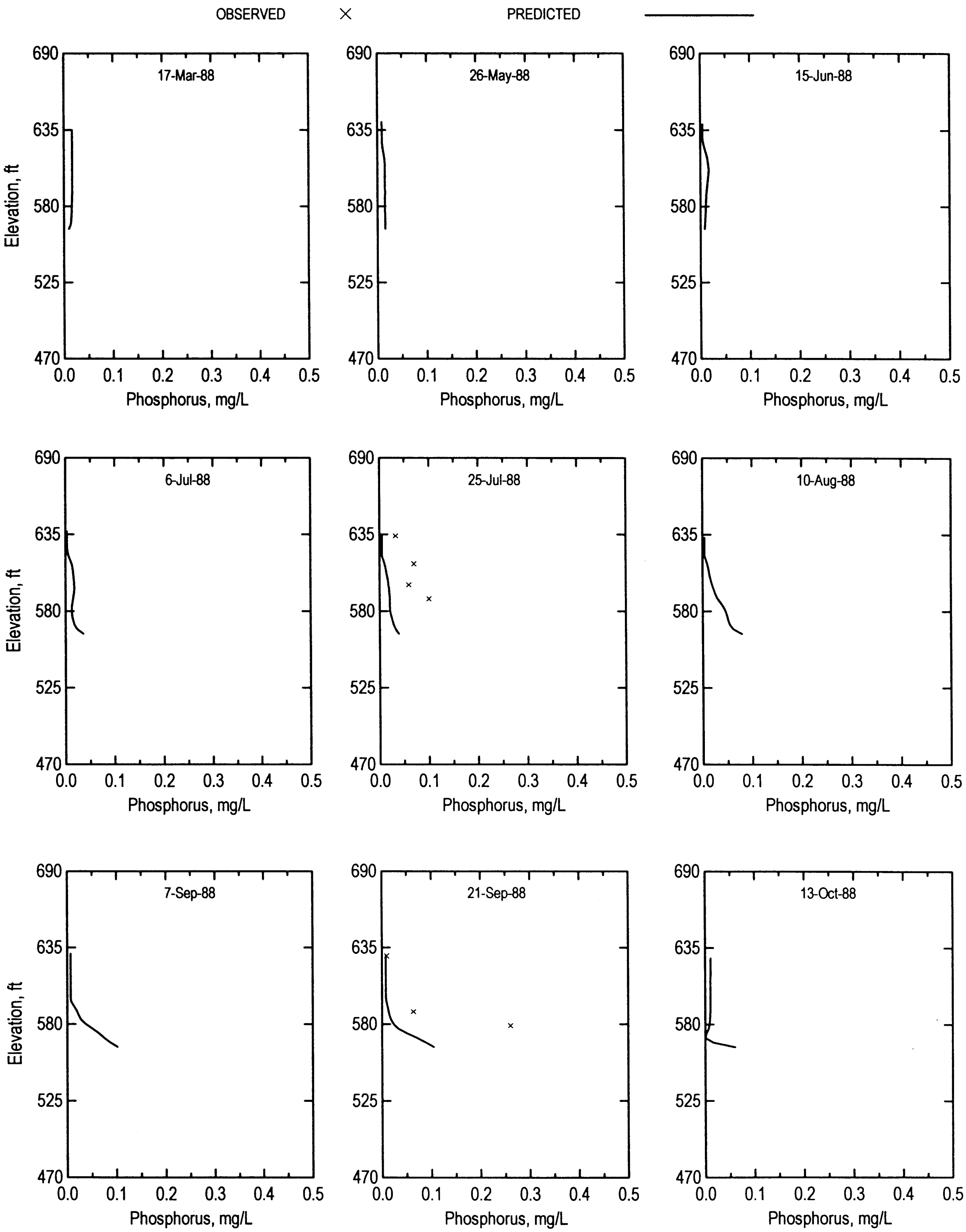
Center Hill Lake 1988 Station CEN20006



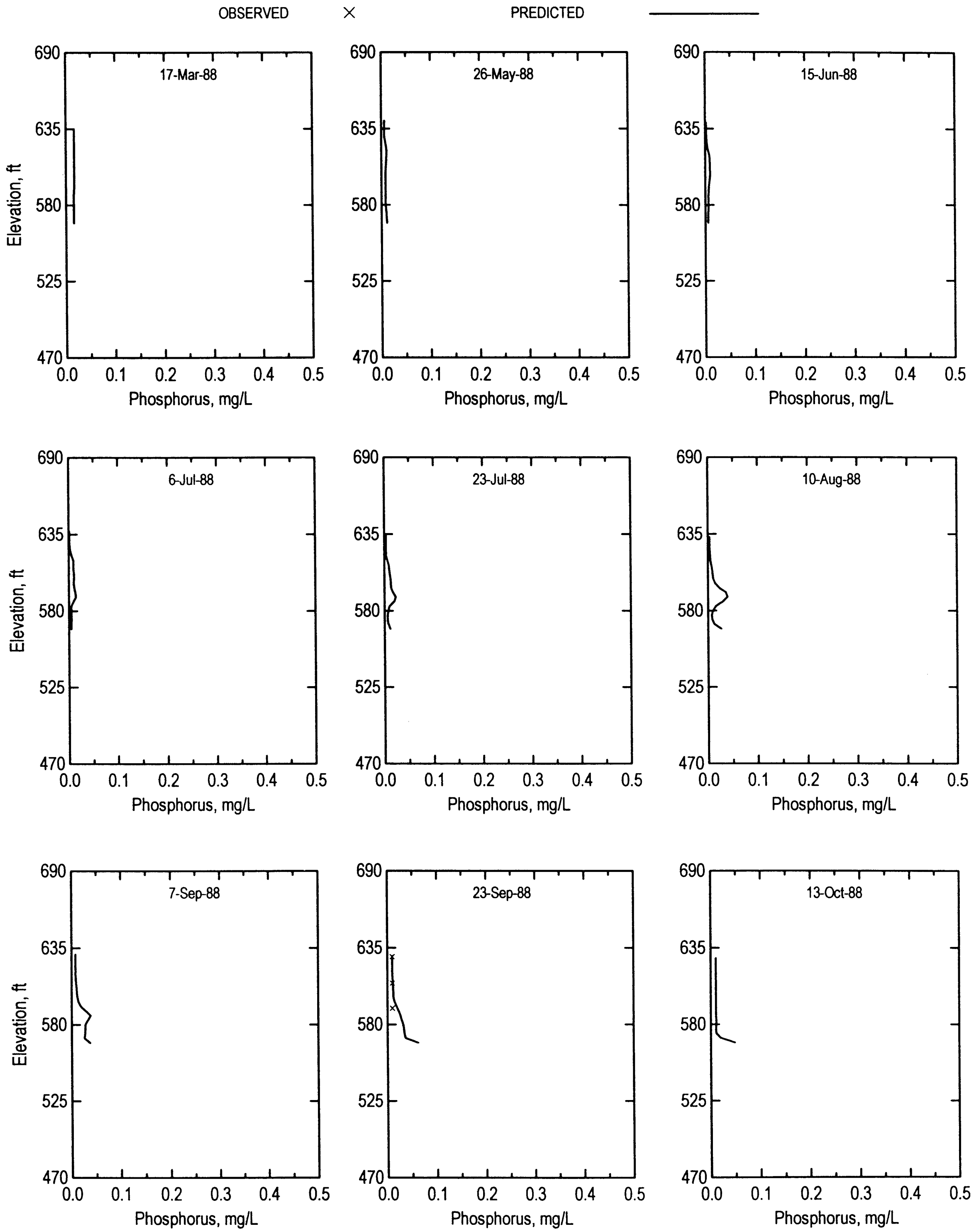

Center Hill Lake 1988 Station CEN20007
OBSERVED
PREDICTED
17-Mar-88
25-May-88
15-Jun-88
6-Jul-88
23-Jul-88
10-Aug-88
7-Sep-88
23-Sep-88
13-Oct-88
Elevation, ft
Phosphorus, mg/L
690
635
580
525
470
0.0
0.1
0.2
0.3
0.4
0.5


Center Hill Lake 1988 Station CEN20008
OBSERVED
PREDICTED
17-Mar-88
26-May-88
15-Jun-88
6-Jul-88
24-Jul-88
10-Aug-88
7-Sep-88
21-Sep-88
13-Oct-88
Elevation, ft
690
635
580
525
470
Phosphorus, mg/L
0.0
0.1
0.2
0.3
0.4
0.5

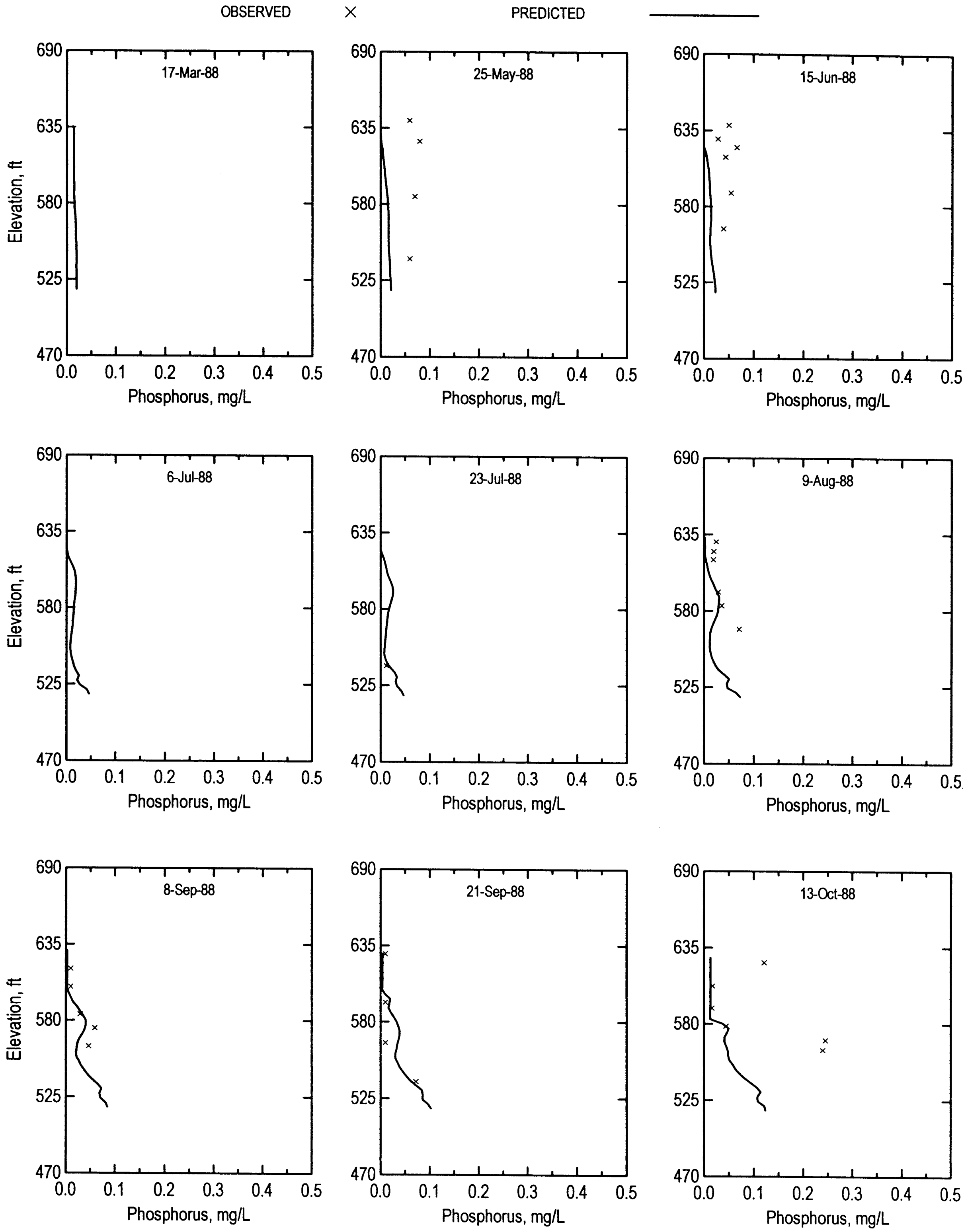
Center Hill Lake 1988 Station CEN20010



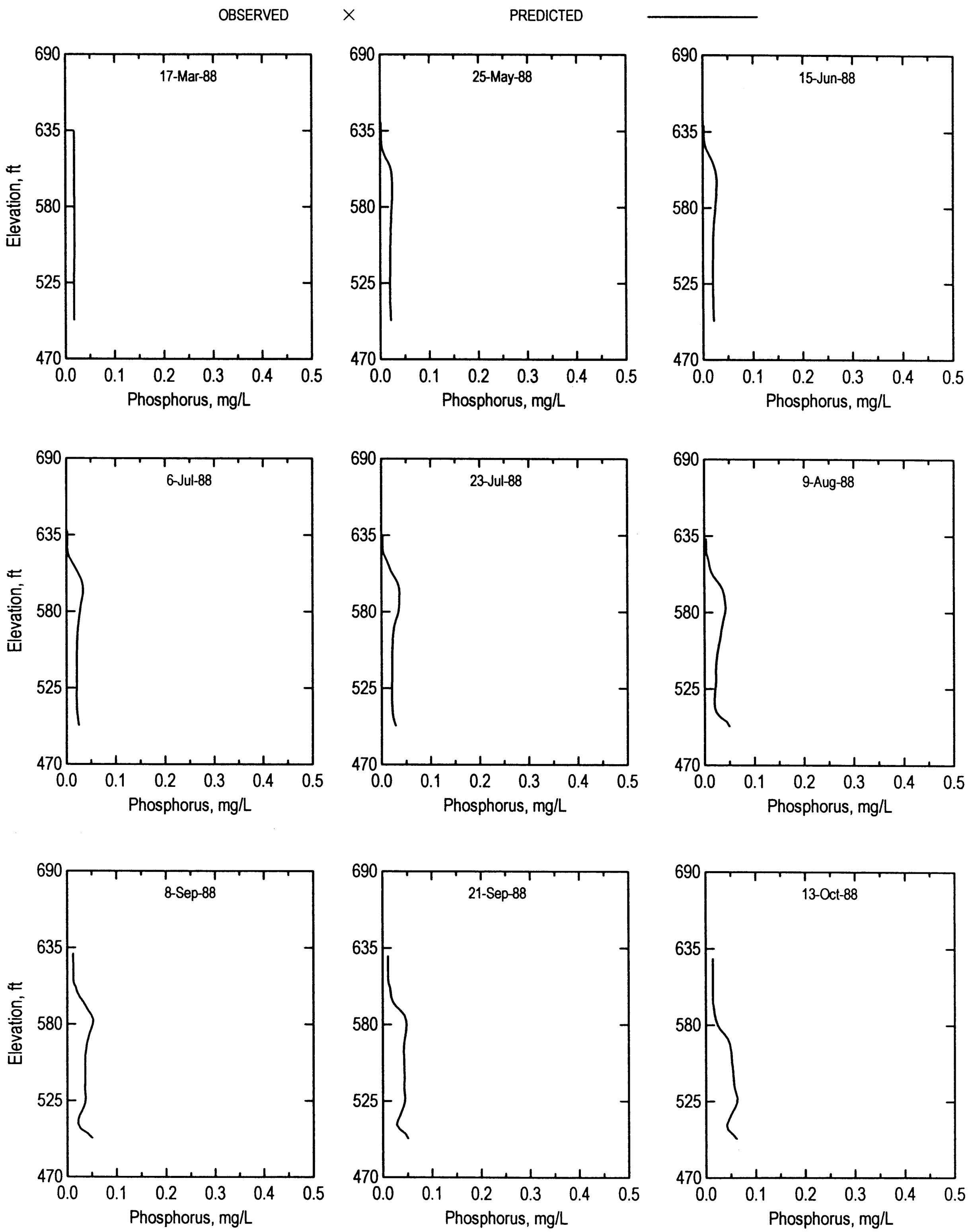
Center Hill Lake 1988 Station CEN20011



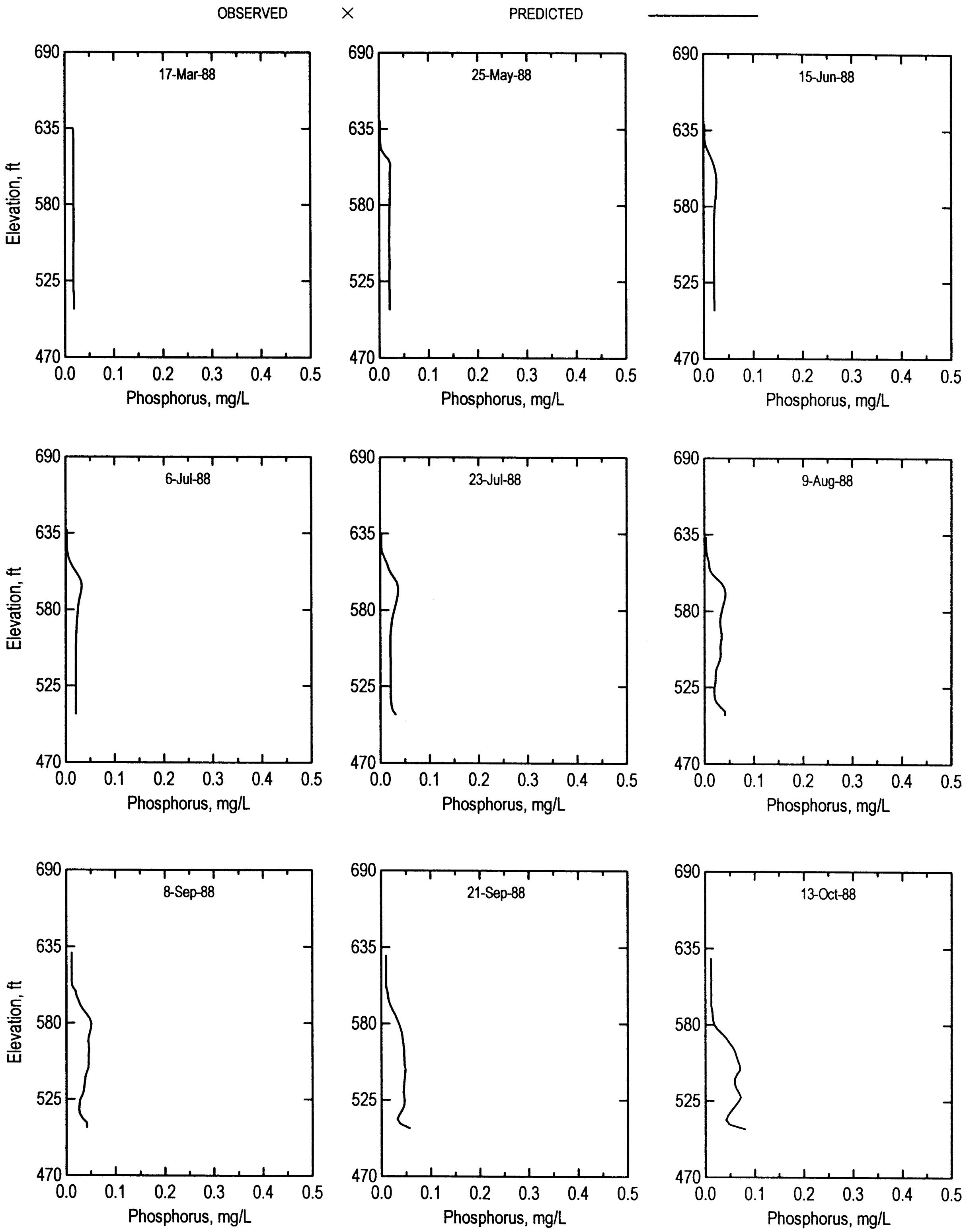
Center Hill Lake 1988 Station CEN20015



Center Hill Lake 1988 Station CEN20013

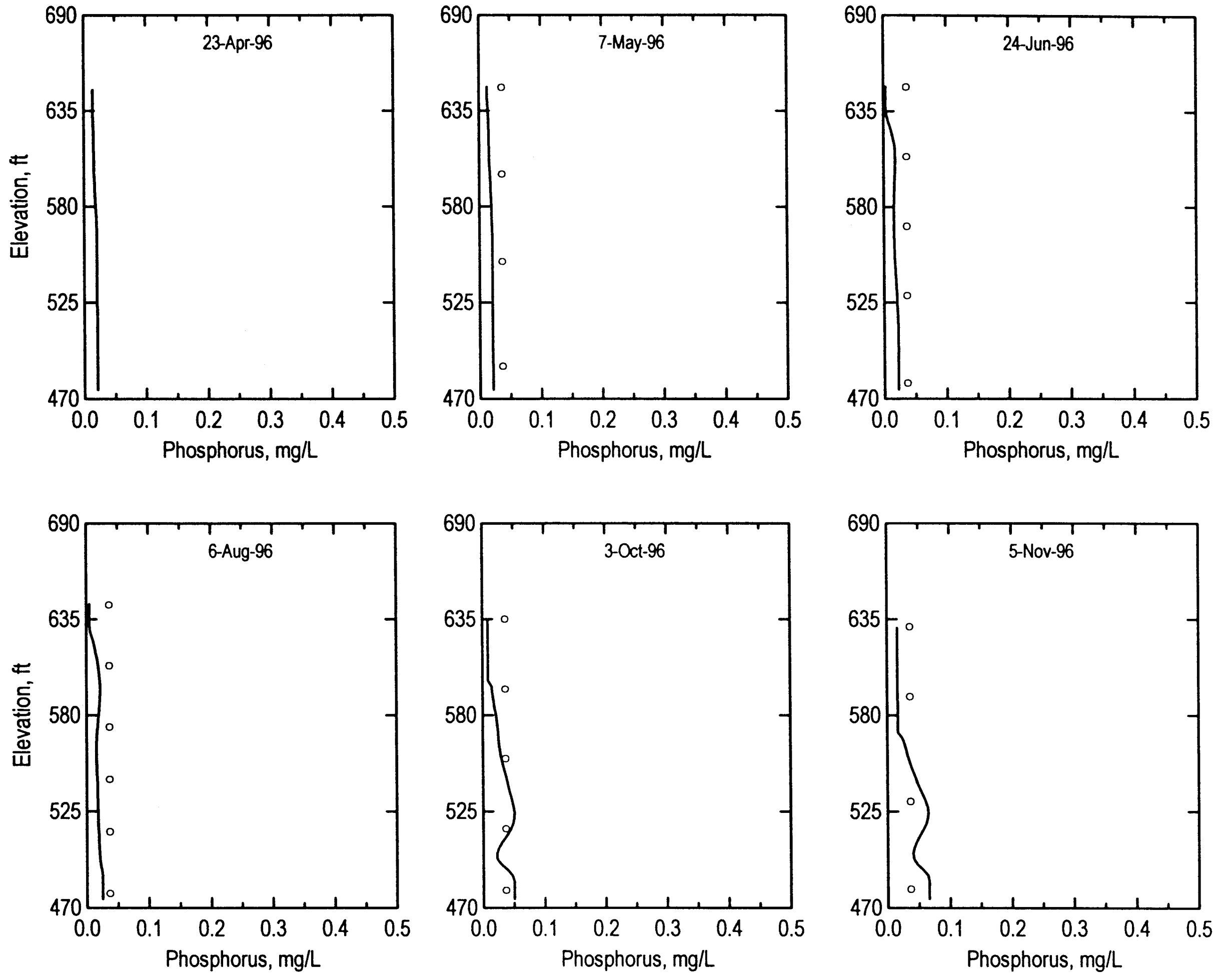


Center Hill Lake 1988 Station CEN20014

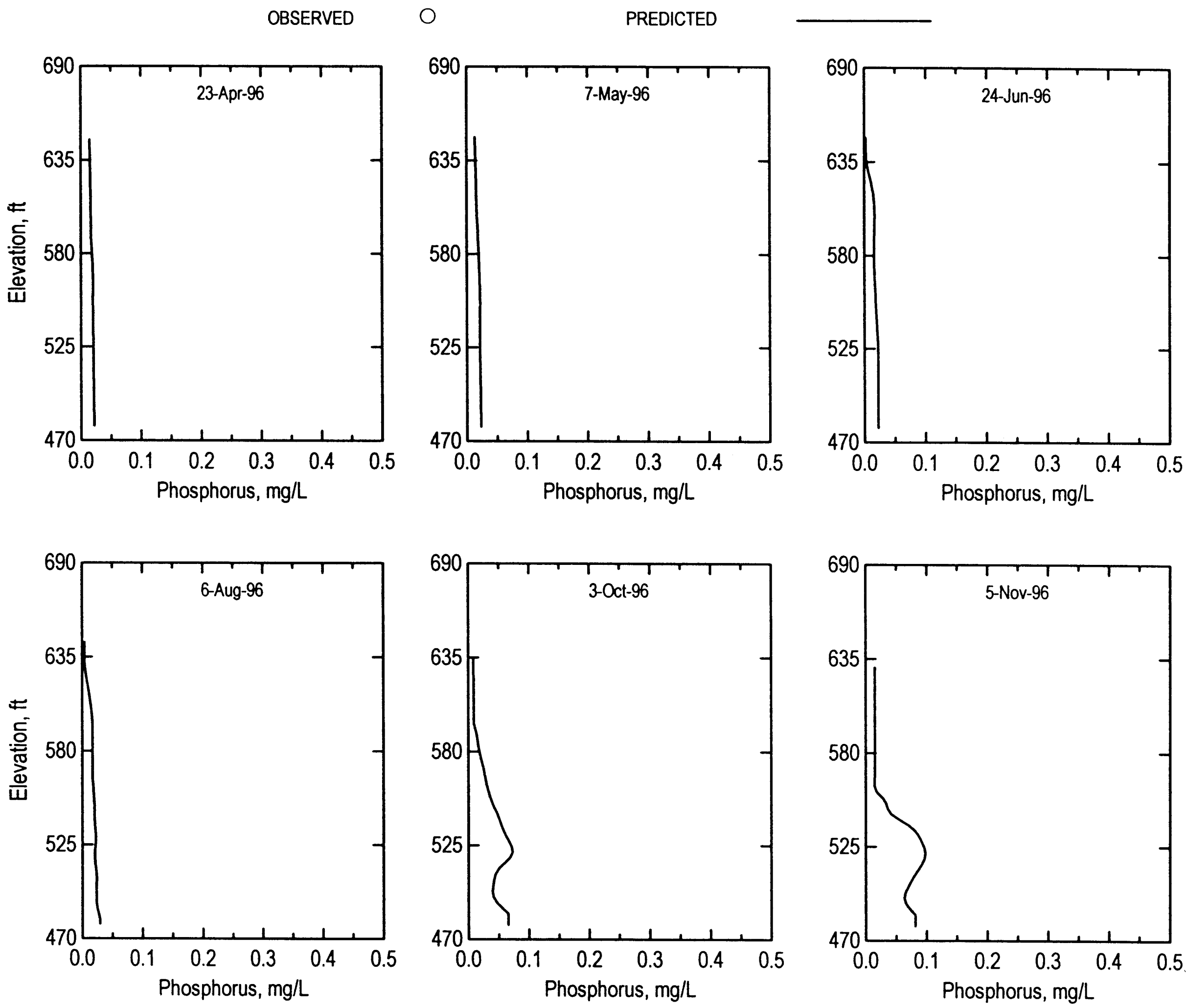


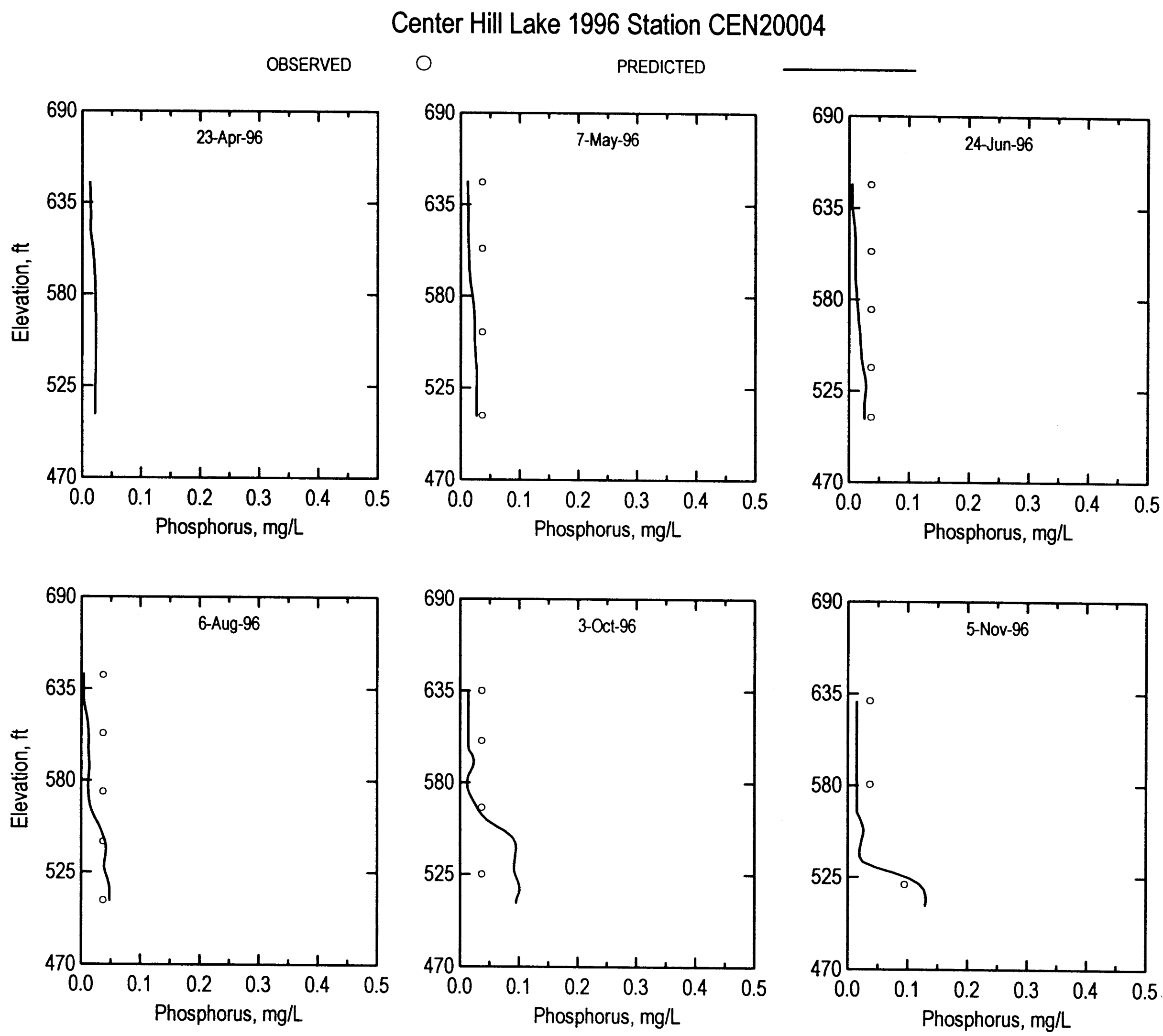
Center Hill Lake 1996 Station CEN20002

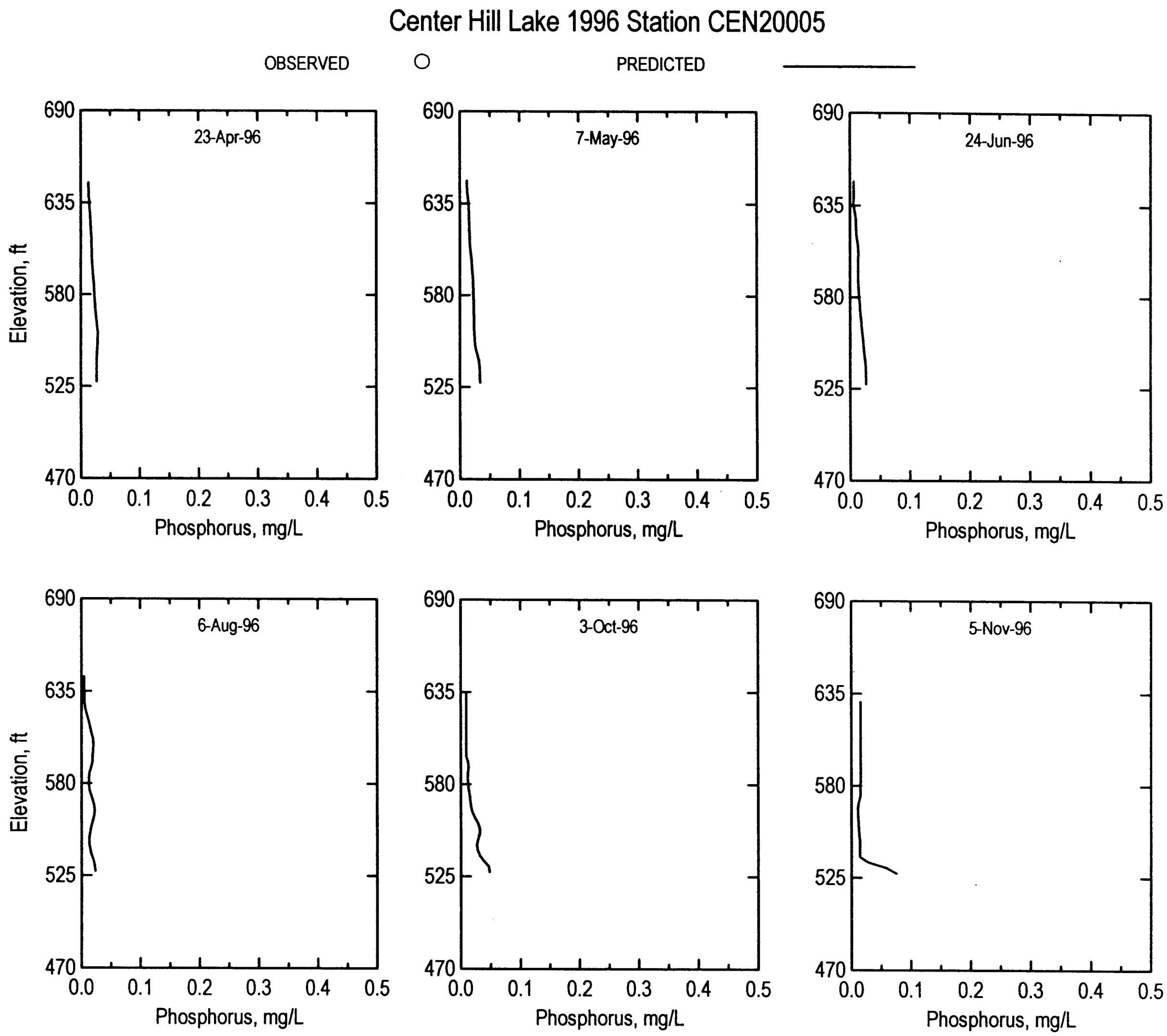
OBSERVED ○ PREDICTED ———



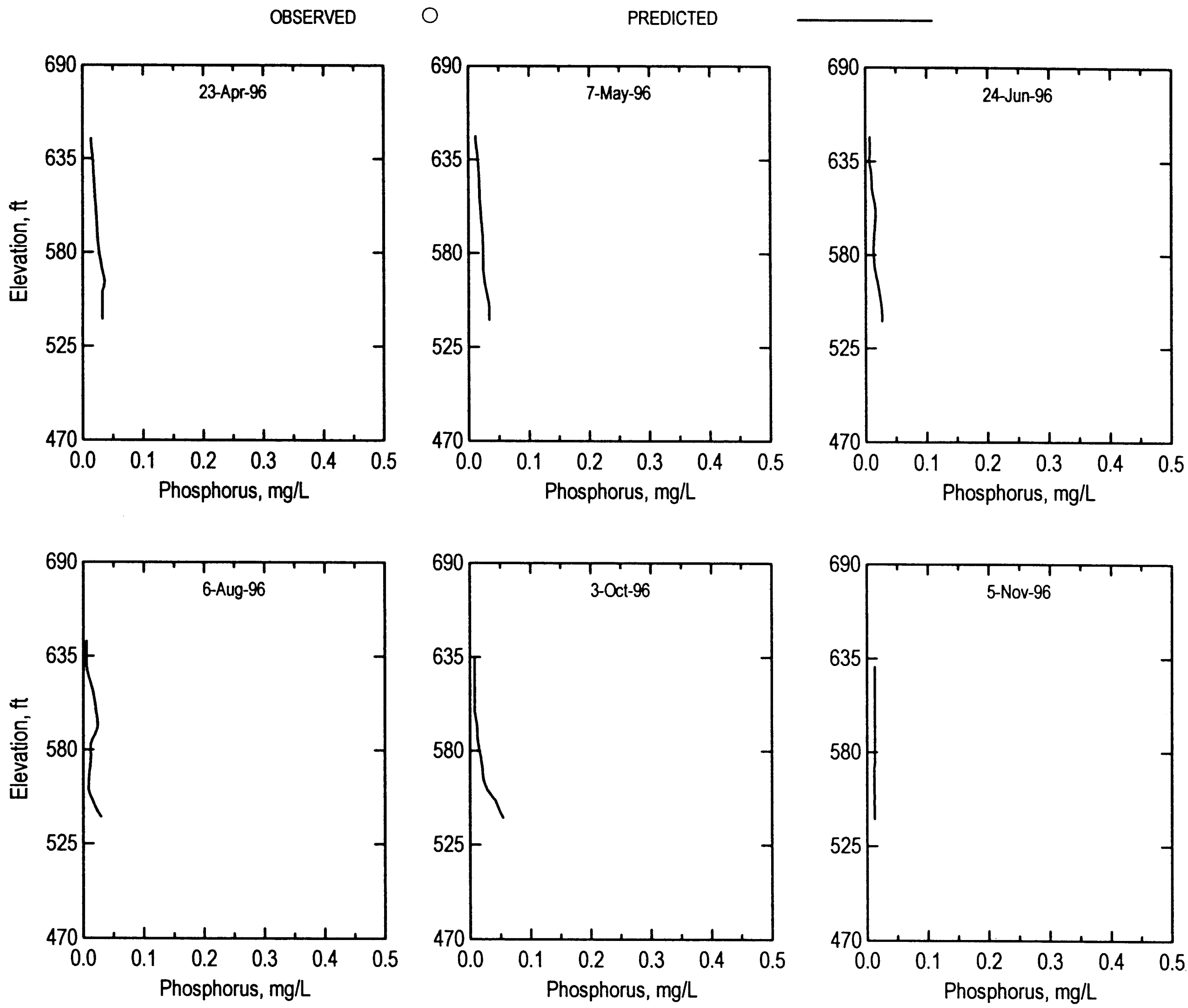
Center Hill Lake 1996 Station CEN20003




Center Hill Lake 1996 Station CEN20004
OBSERVED
PREDICTED
23-Apr-96
7-May-96
24-Jun-96
6-Aug-96
3-Oct-96
5-Nov-96
Elevation, ft
Phosphorus, mg/L
690
635
580
525
470
0.0
0.1
0.2
0.3
0.4
0.5

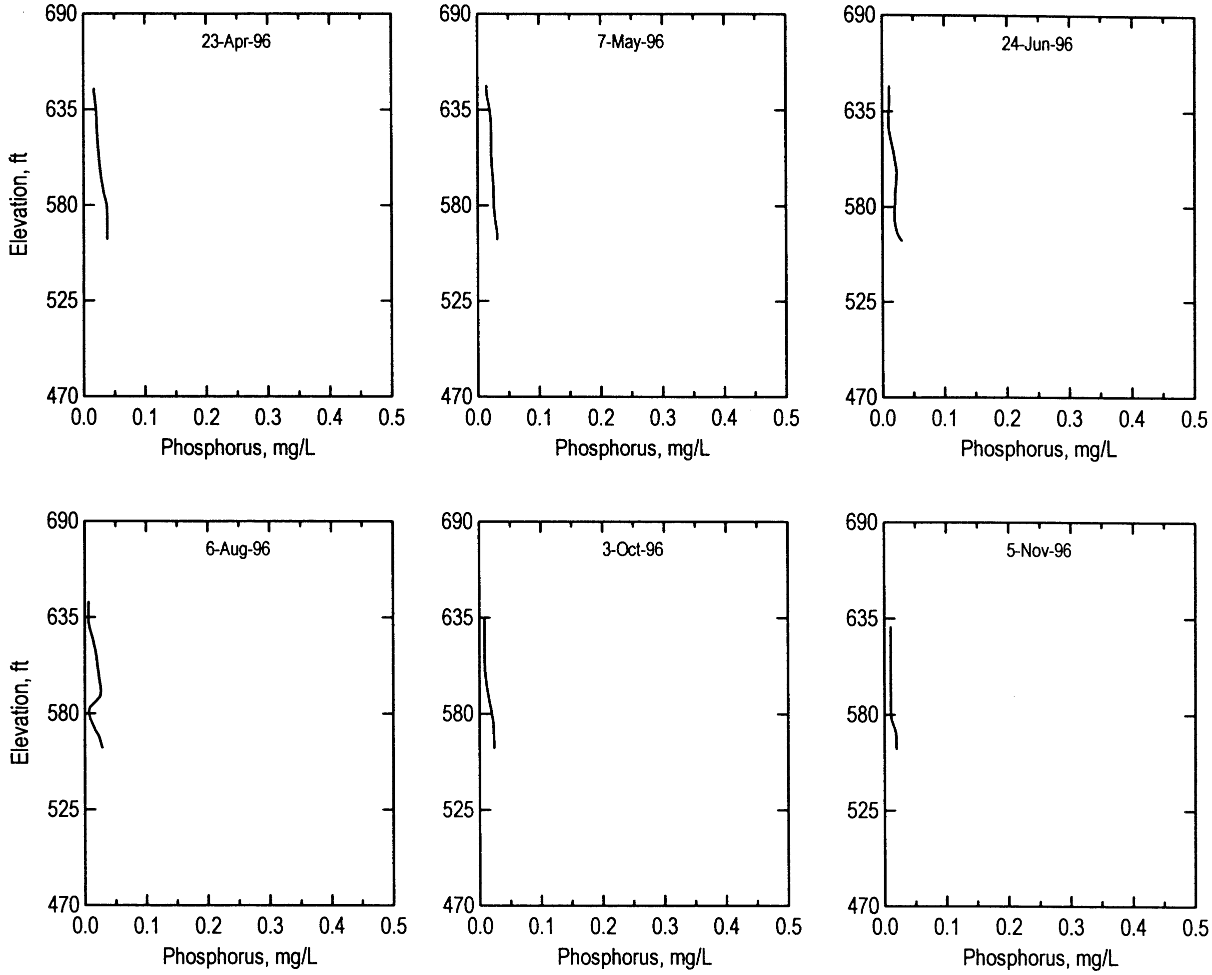

Center Hill Lake 1996 Station CEN20005
OBSERVED
PREDICTED
23-Apr-96
7-May-96
24-Jun-96
6-Aug-96
3-Oct-96
5-Nov-96
Elevation, ft
Phosphorus, mg/L
690
635
580
525
470
0.0
0.1
0.2
0.3
0.4
0.5

Center Hill Lake 1996 Station CEN20006

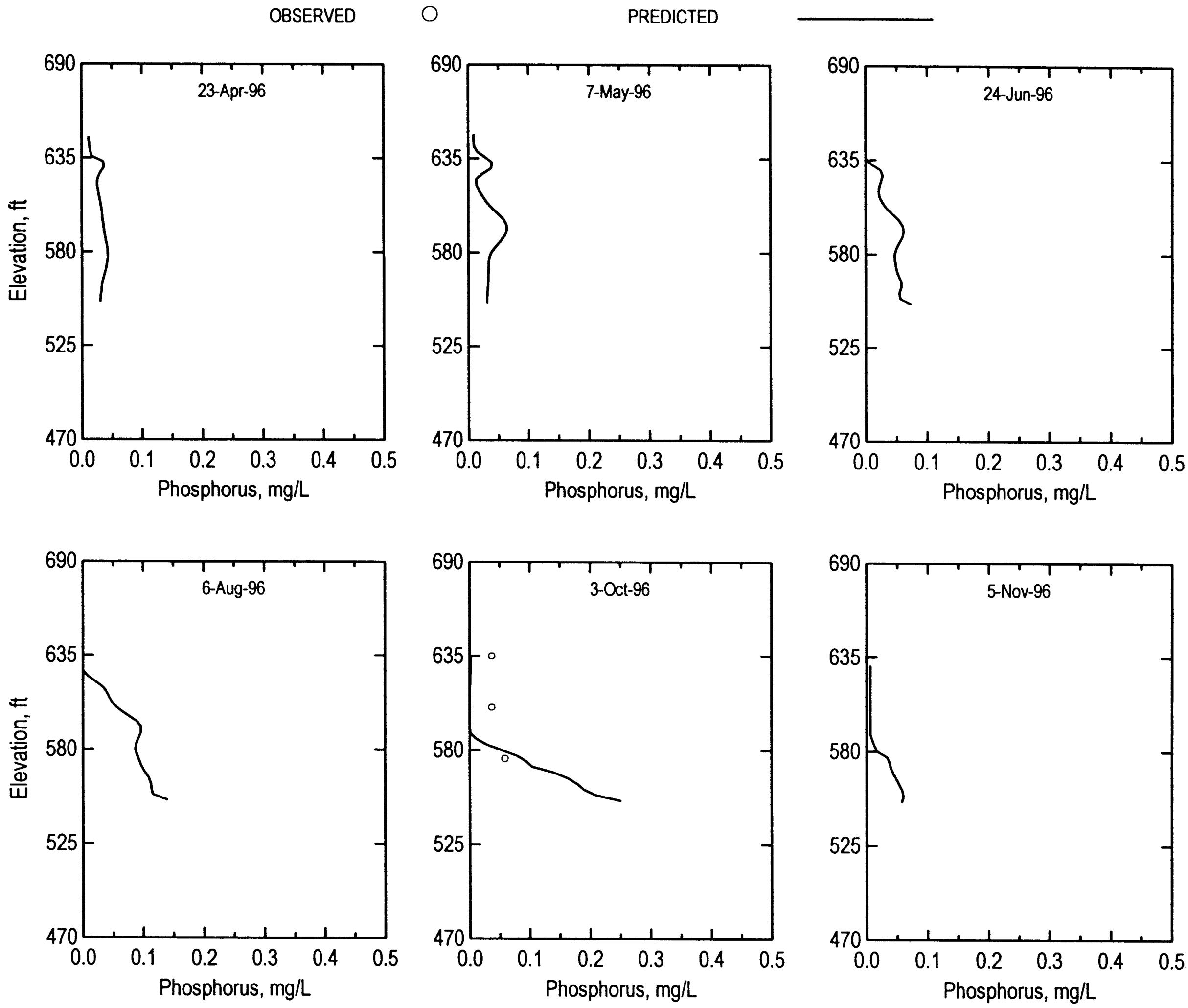


Center Hill Lake 1996 Station CEN20007

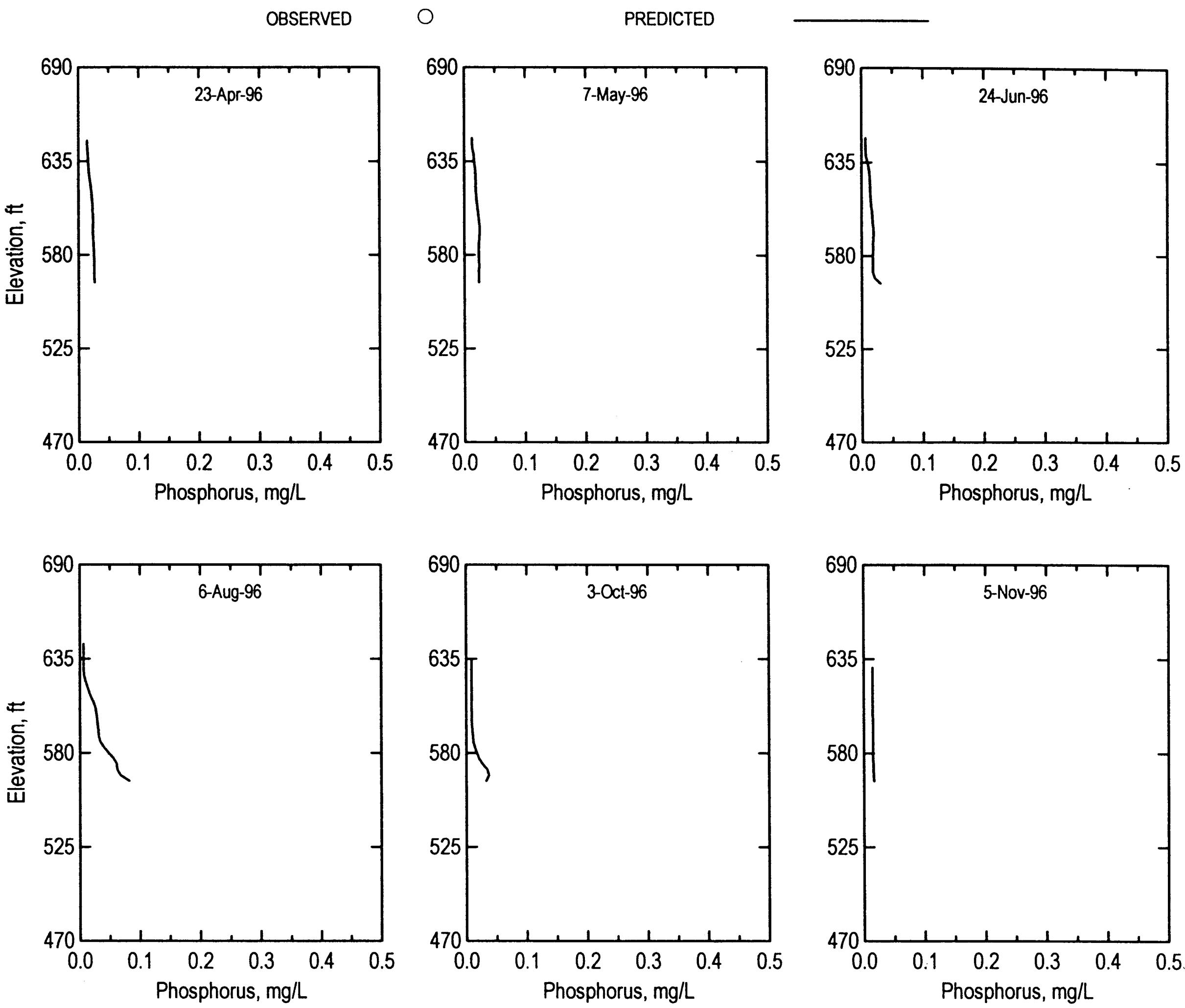
OBSERVED ○ PREDICTED ——

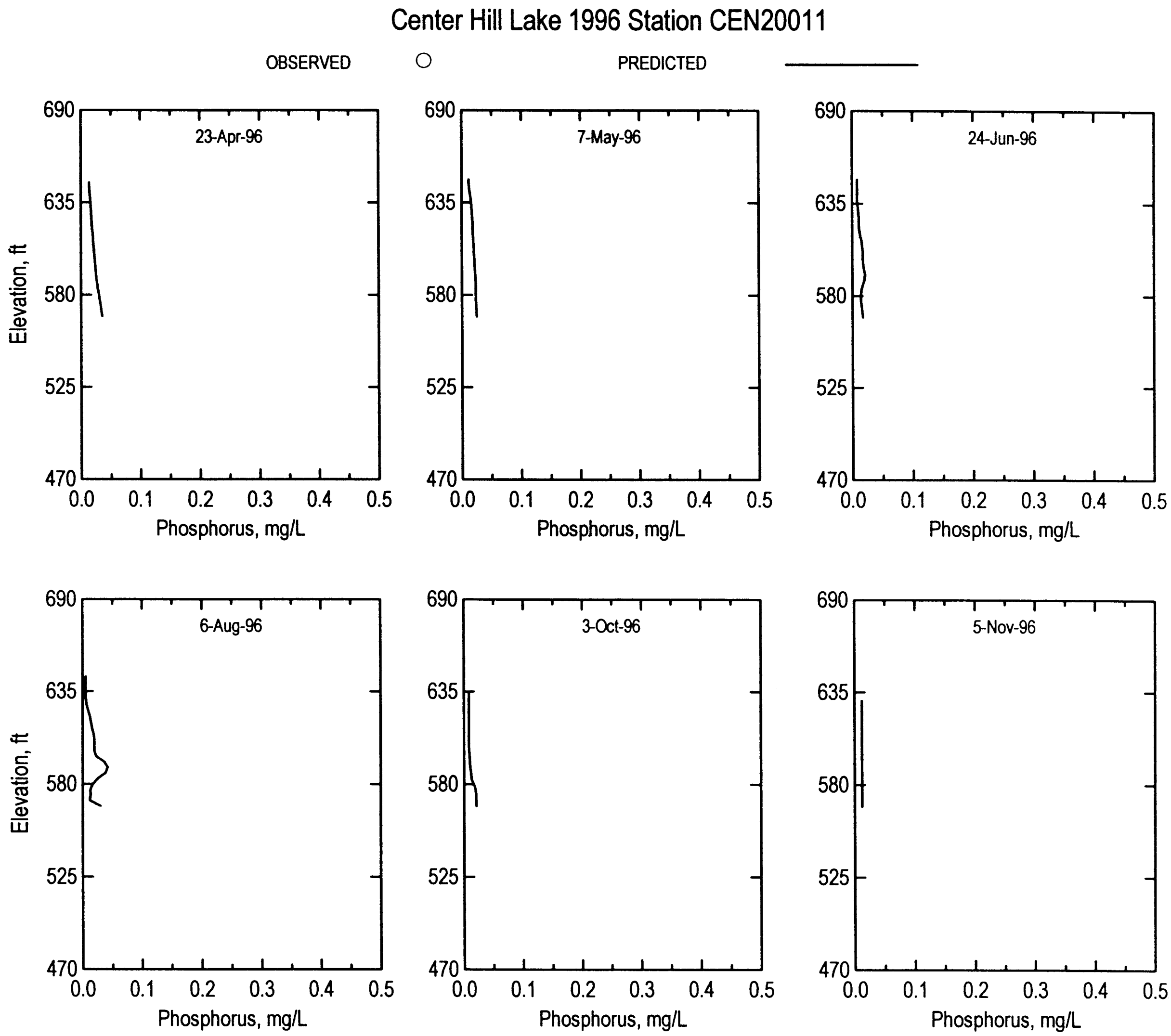


Center Hill Lake 1996 Station CEN20008



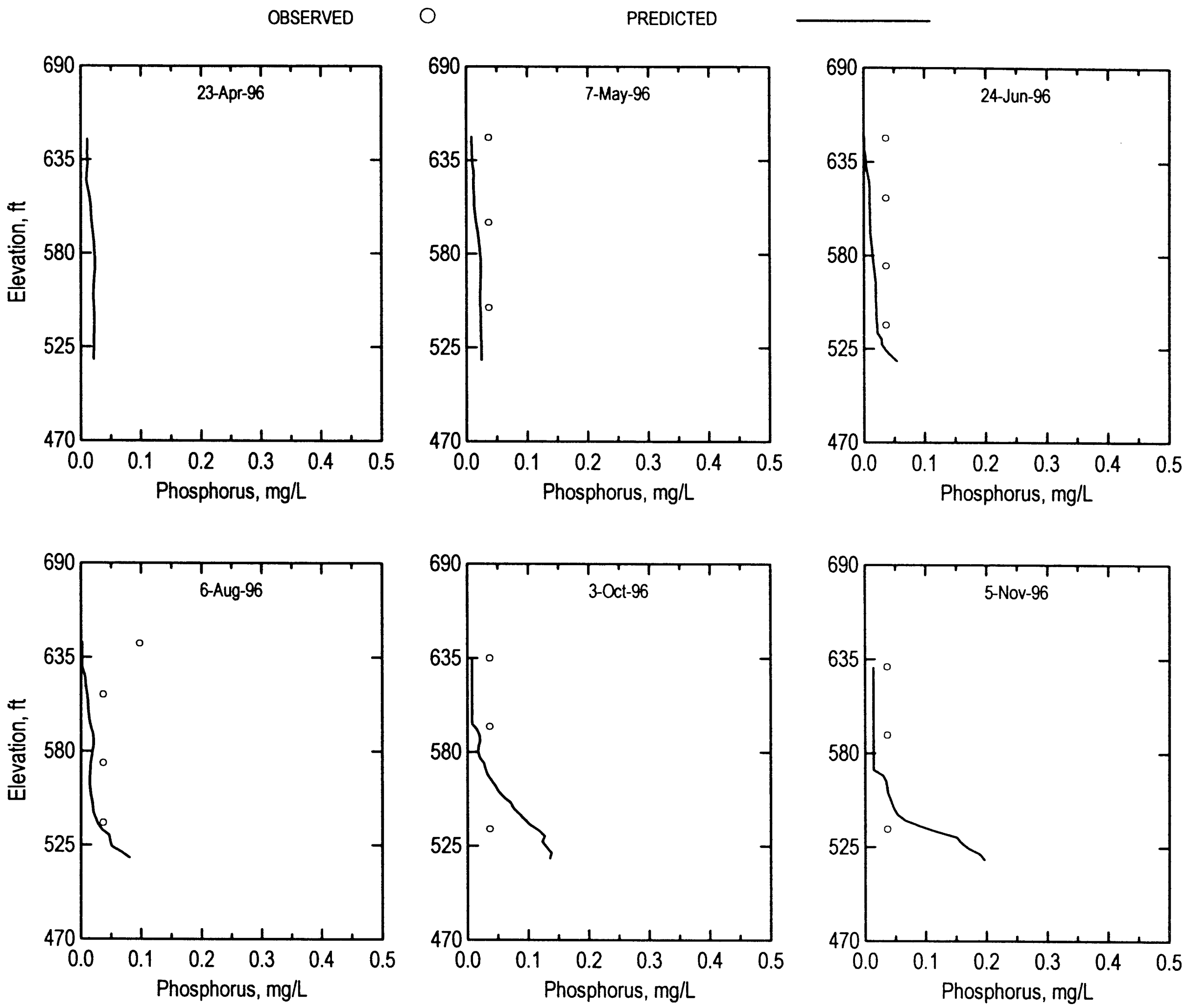
Center Hill Lake 1996 Station CEN20010



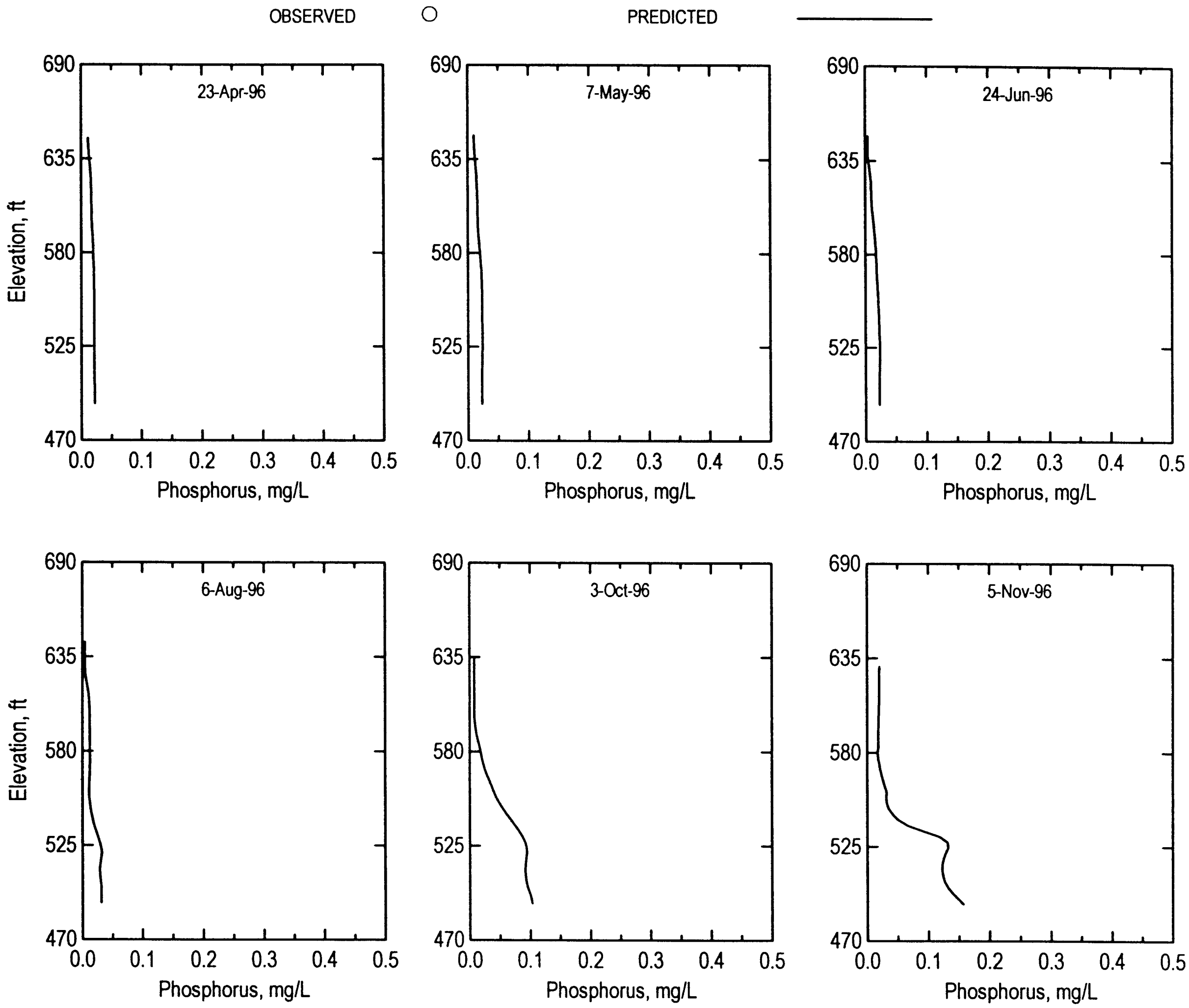


Center Hill Lake 1996 Station CEN20011
OBSERVED
PREDICTED
23-Apr-96
7-May-96
24-Jun-96
6-Aug-96
3-Oct-96
5-Nov-96
Elevation, ft
Phosphorus, mg/L
690
635
580
525
470
0.0
0.1
0.2
0.3
0.4
0.5

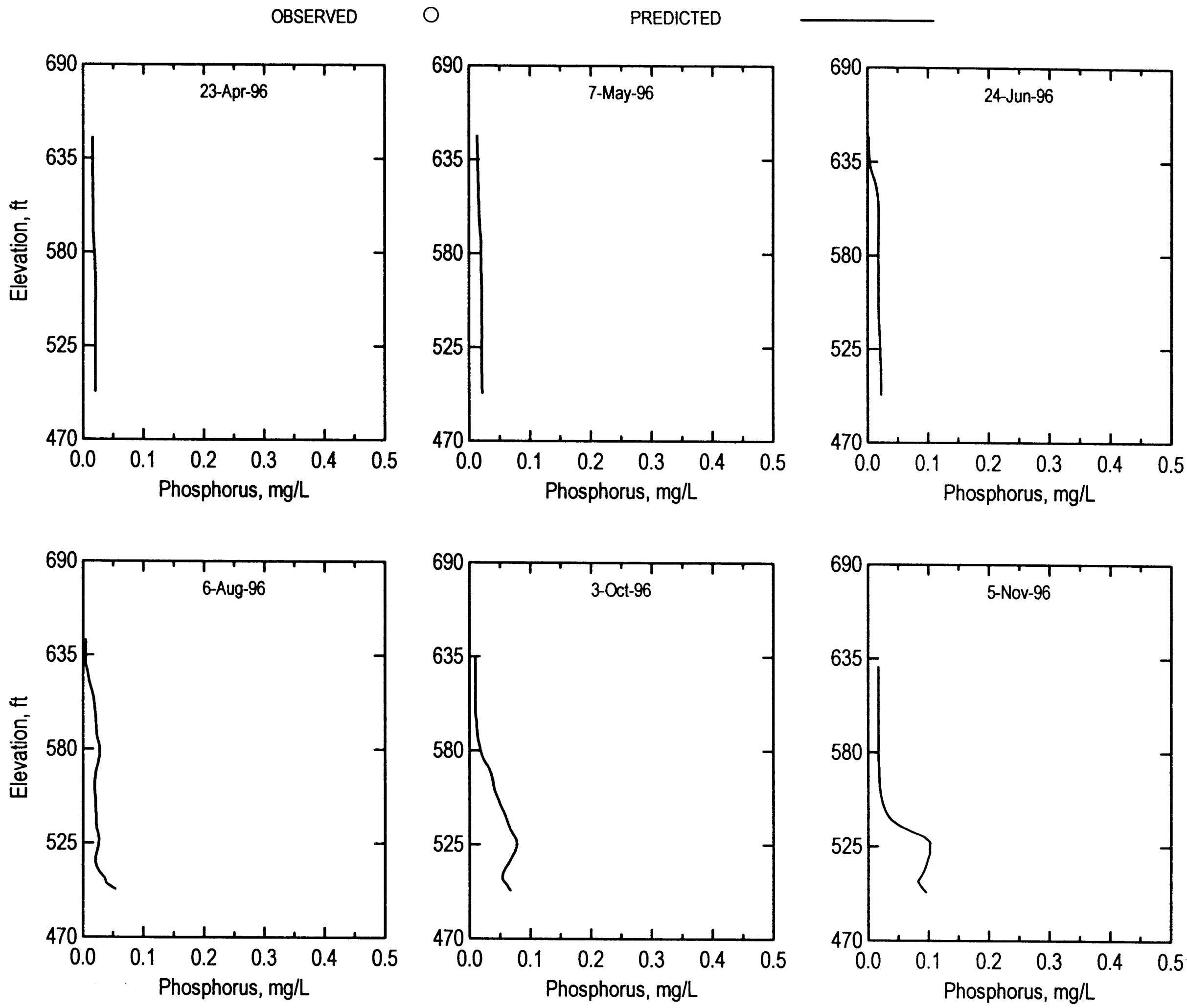
Center Hill Lake 1996 Station CEN20015



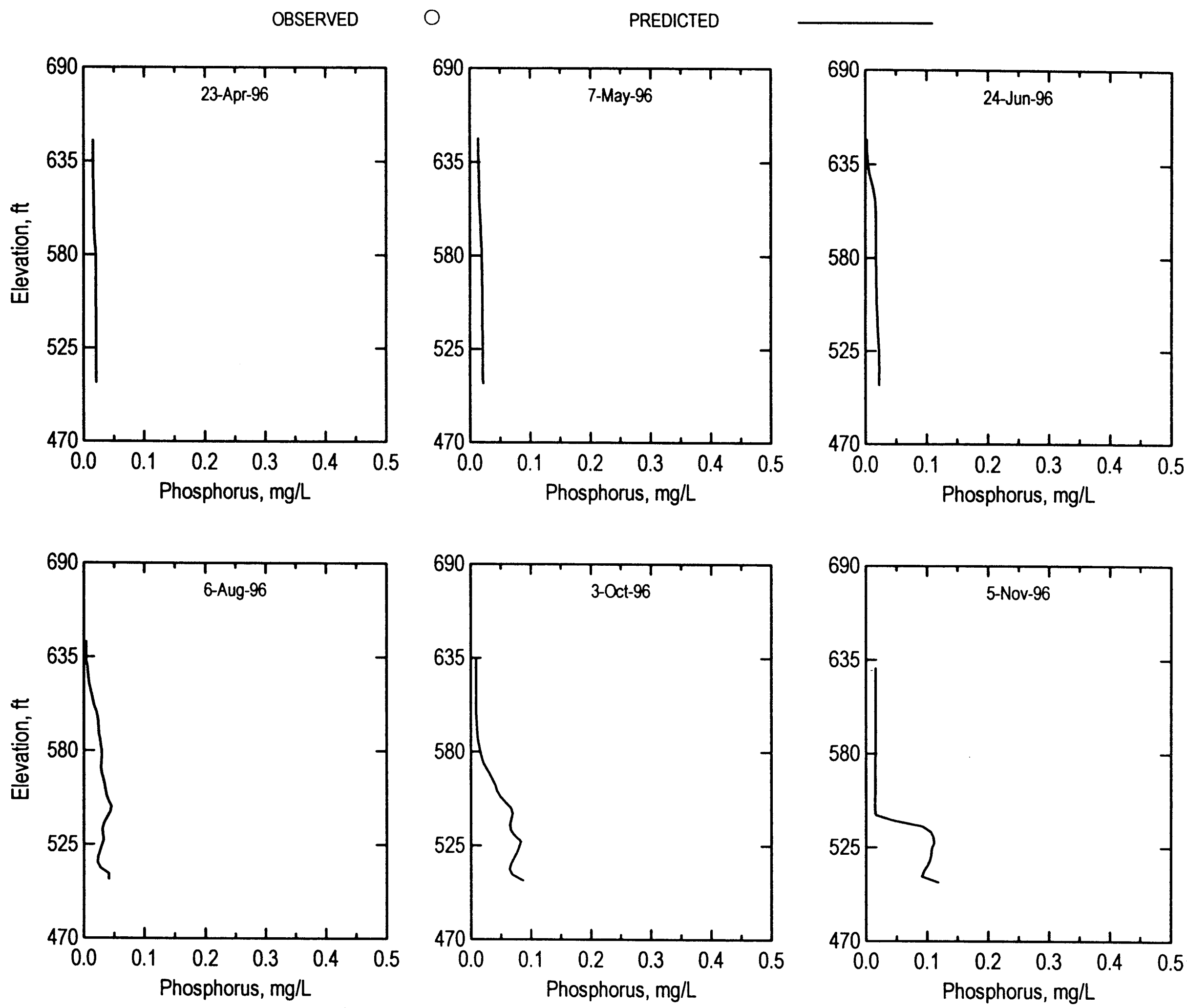
Center Hill Lake 1996 Station CEN20012



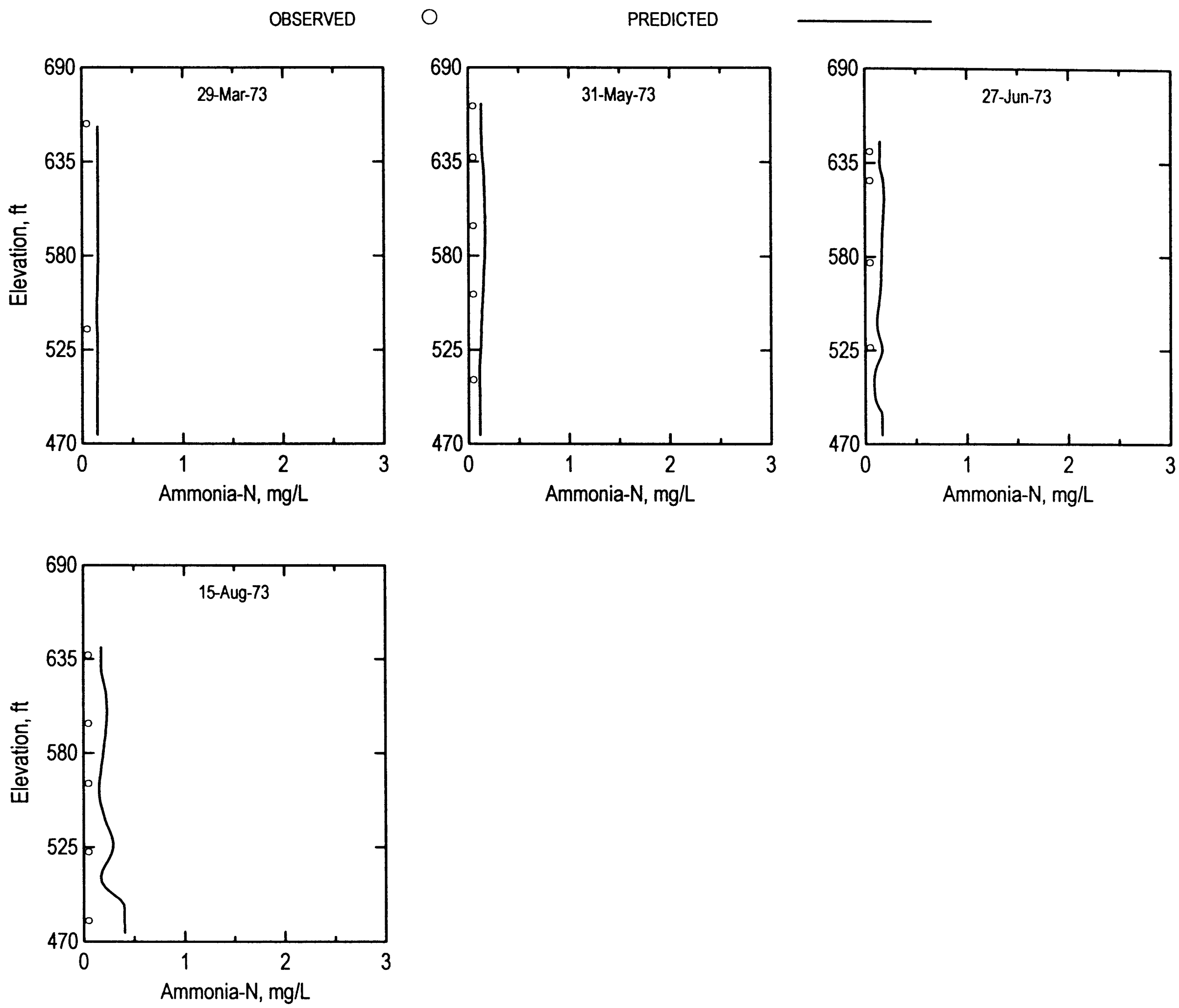
Center Hill Lake 1996 Station CEN20013



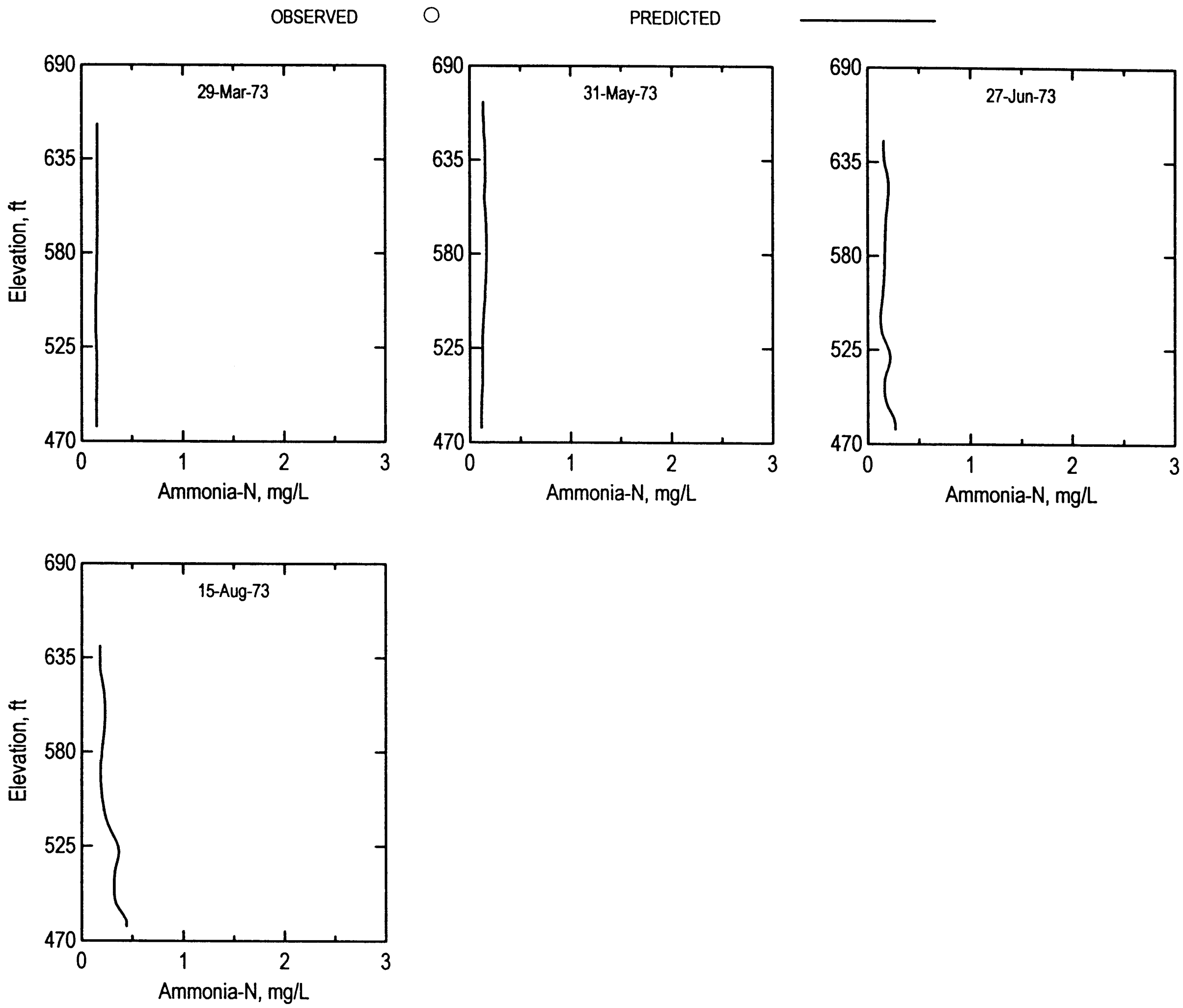
Center Hill Lake 1996 Station CEN20014

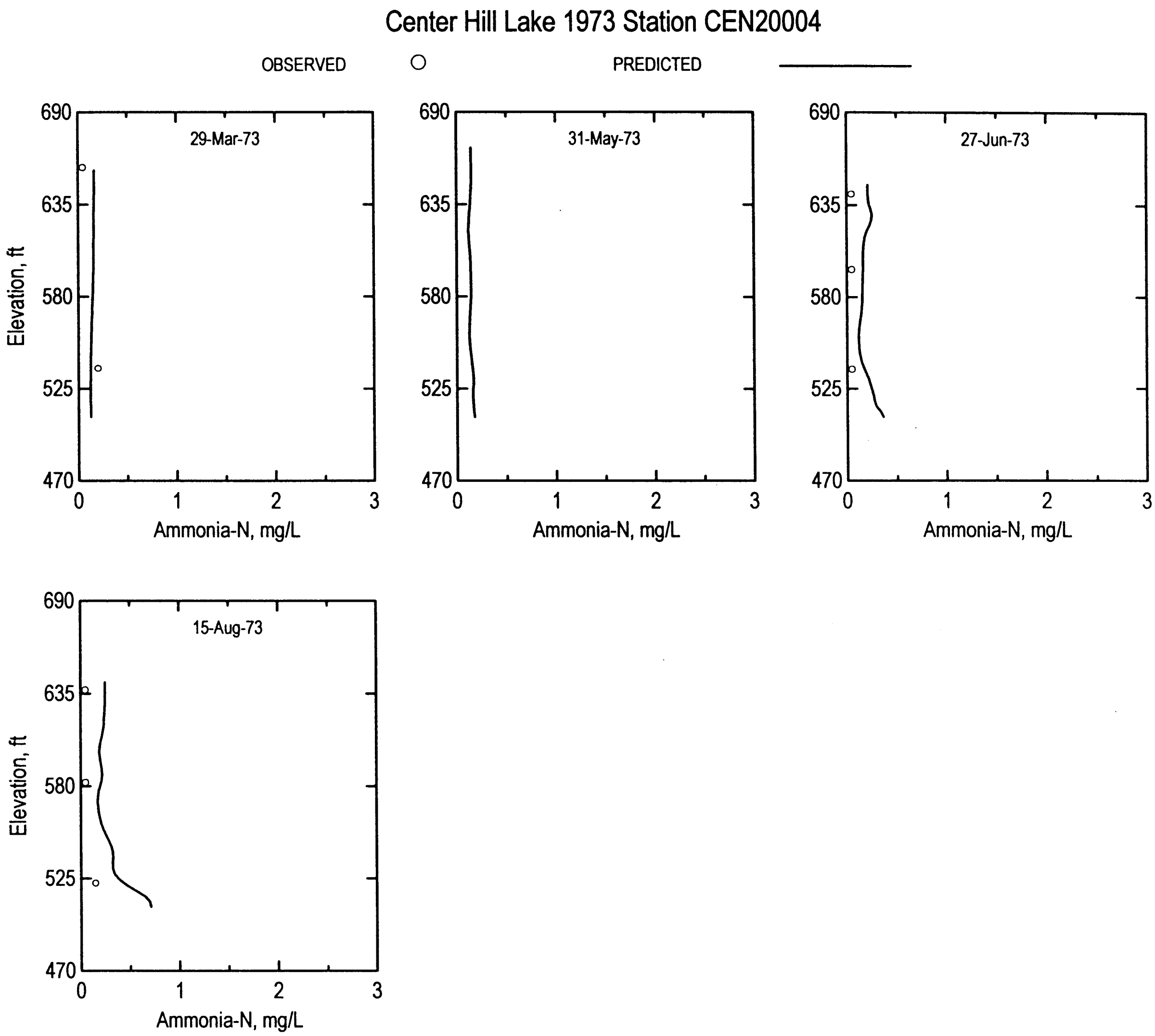


Center Hill Lake 1973 Station CEN20002



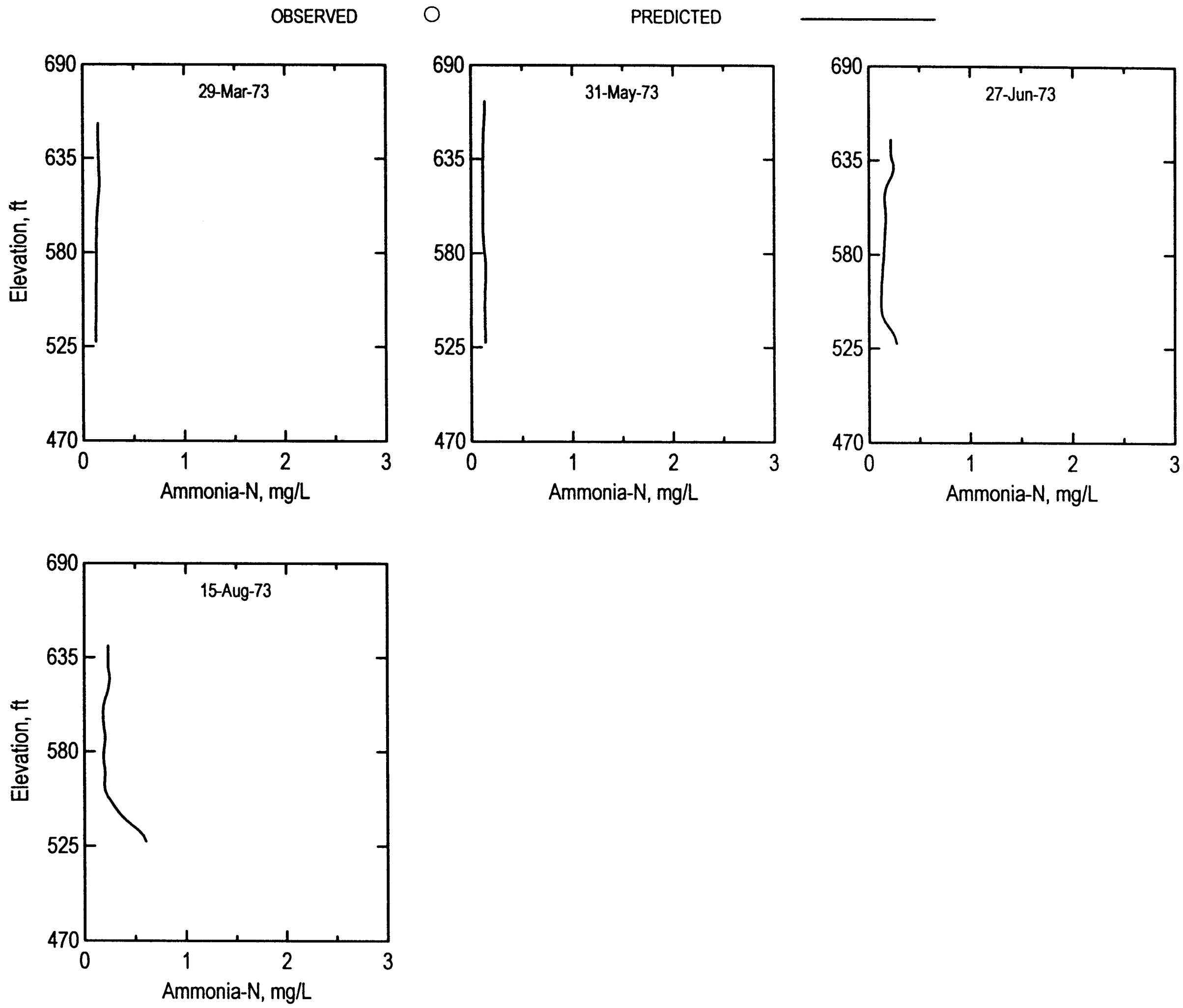
Center Hill Lake 1973 Station CEN20003



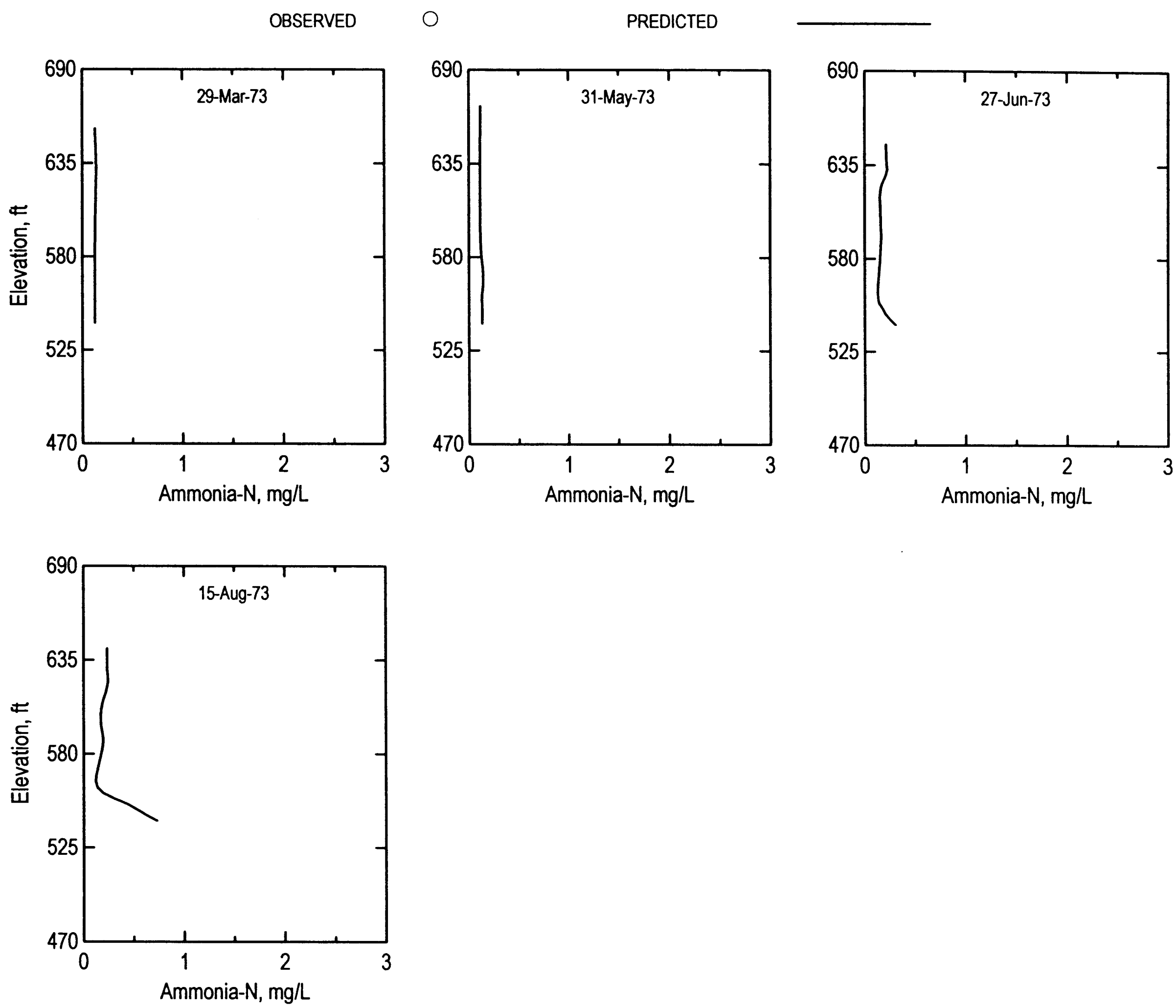


Center Hill Lake 1973 Station CEN20004
OBSERVED
PREDICTED
29-Mar-73
31-May-73
27-Jun-73
15-Aug-73
Elevation, ft
Ammonia-N, mg/L
690
635
580
525
470
0
1
2
3

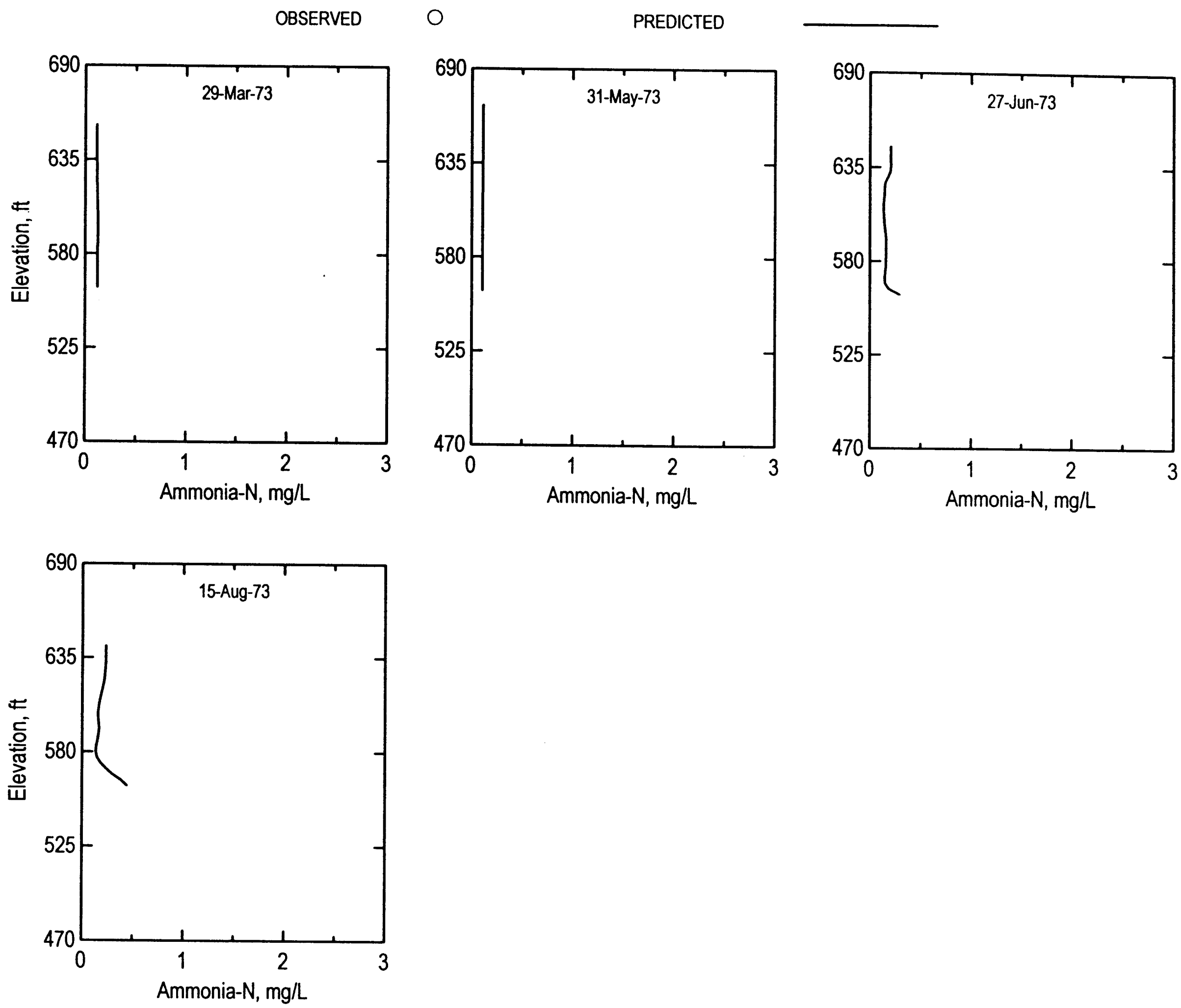
Center Hill Lake 1973 Station CEN20005



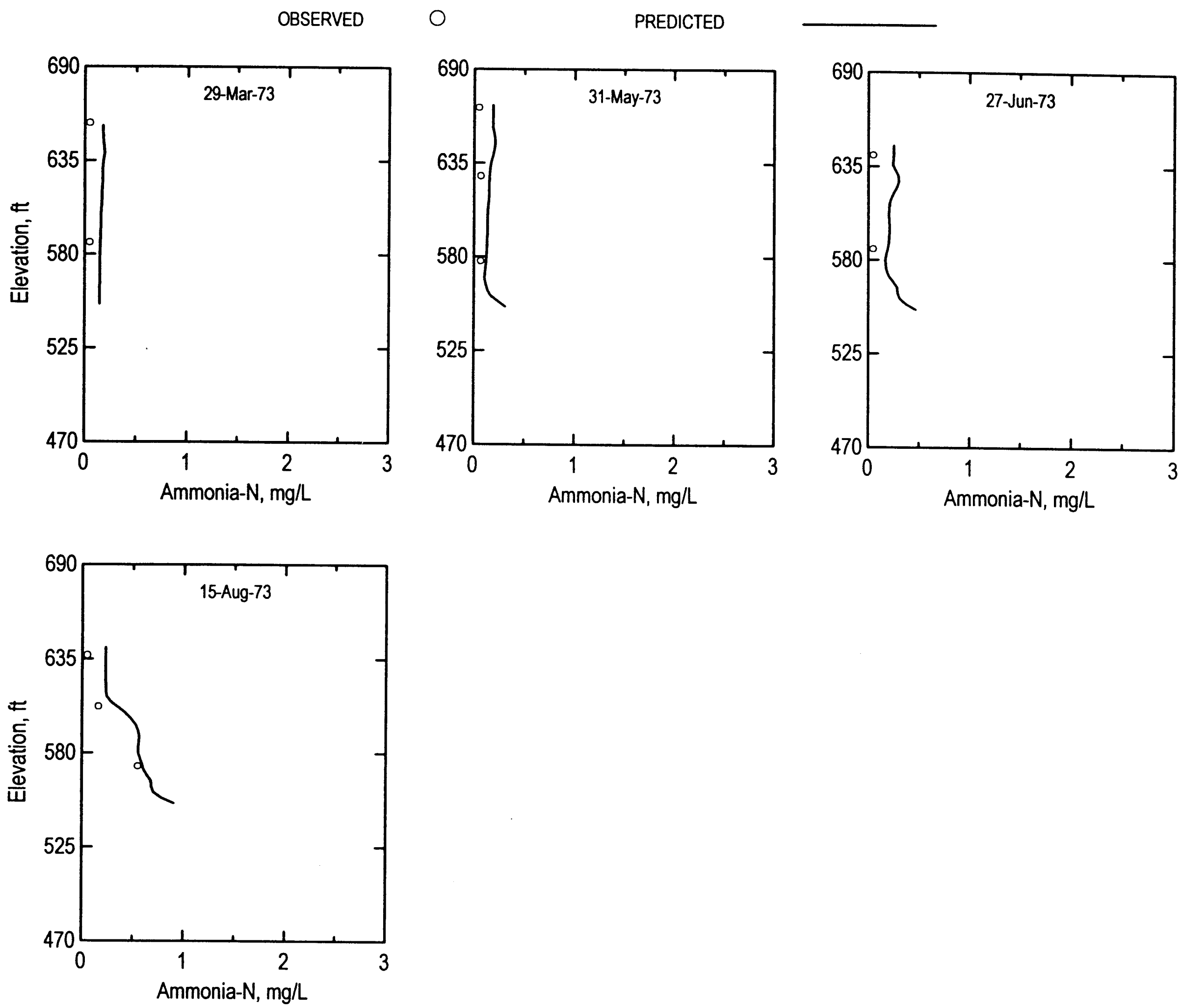
Center Hill Lake 1973 Station CEN20006



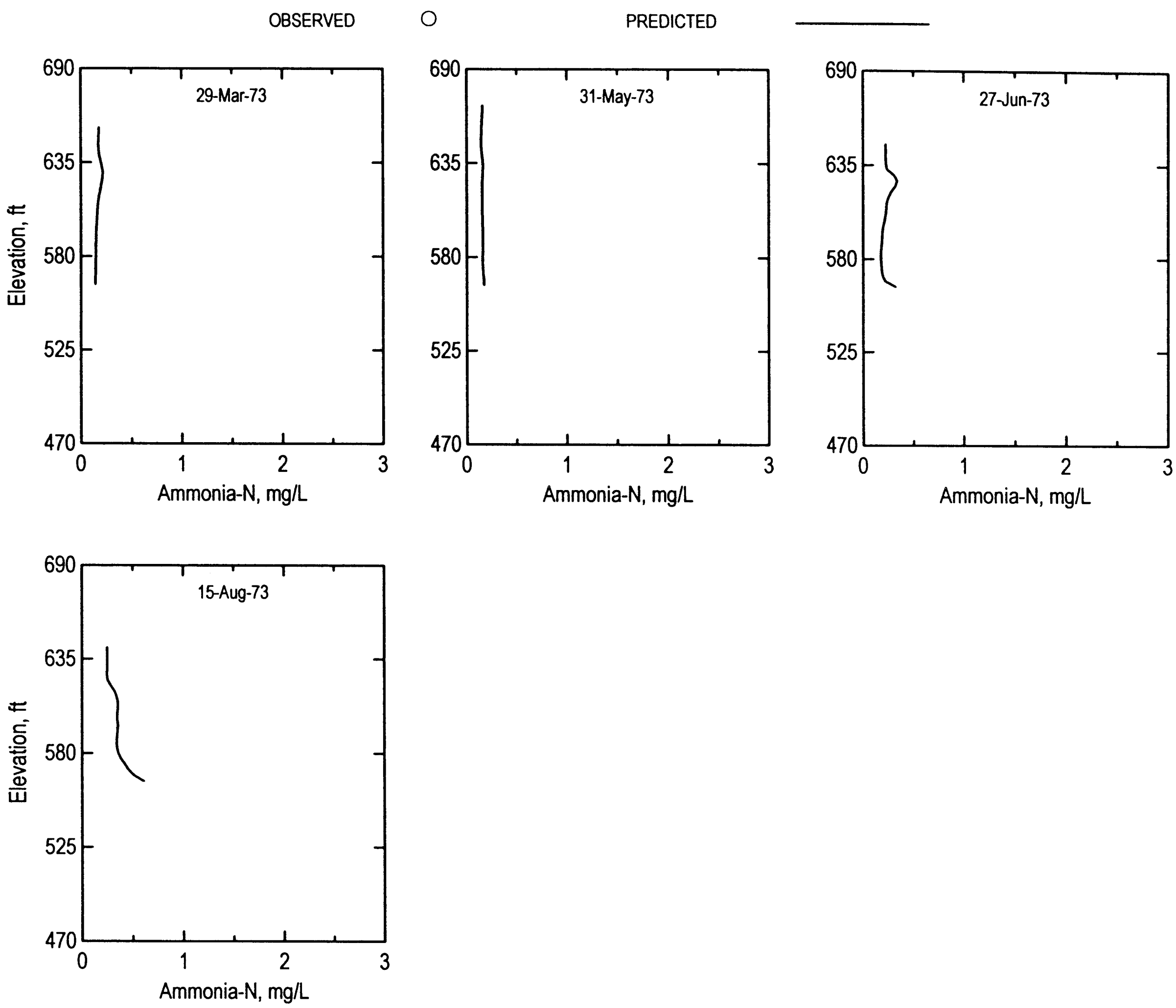
Center Hill Lake 1973 Station CEN20007

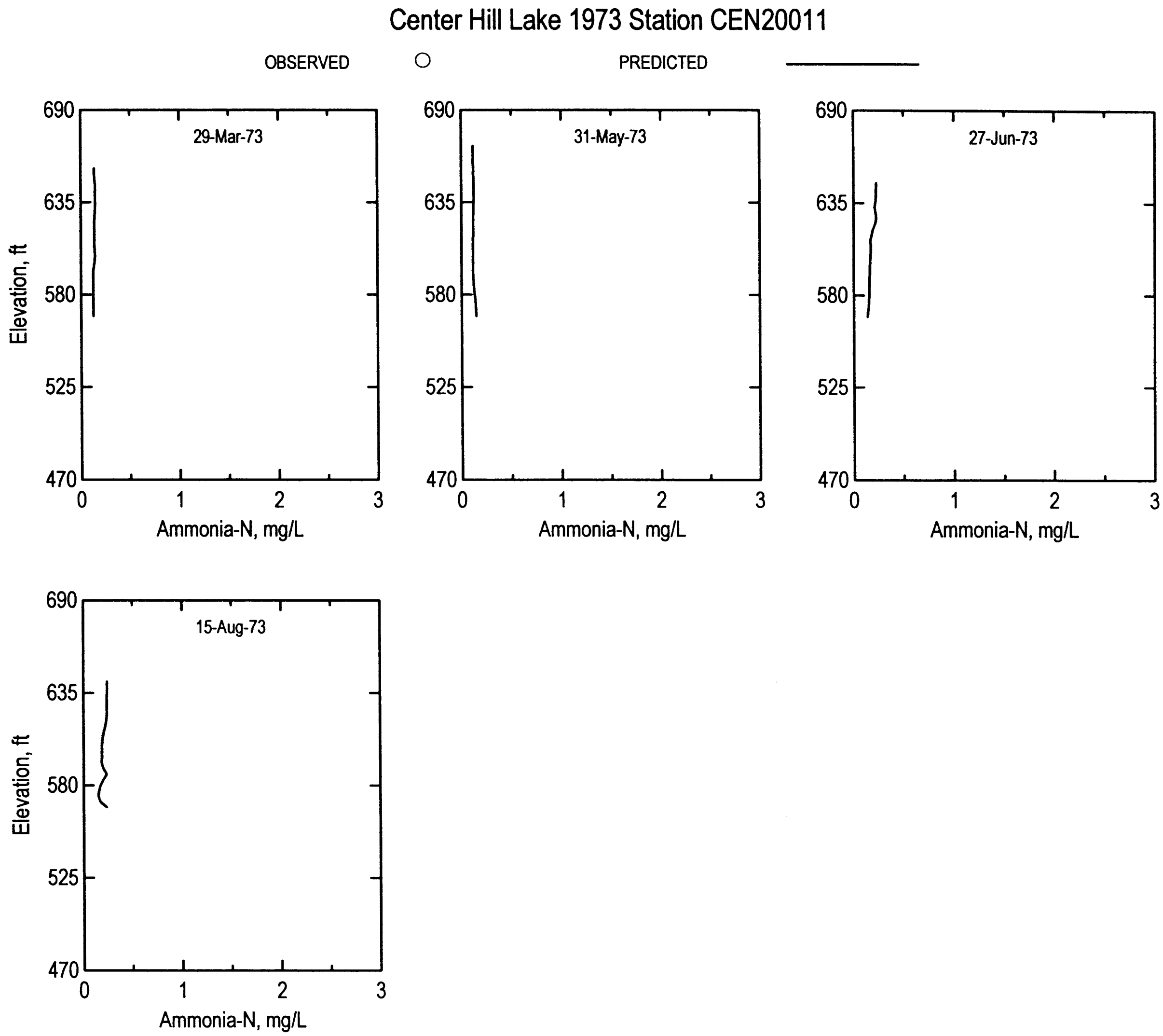


Center Hill Lake 1973 Station CEN20008



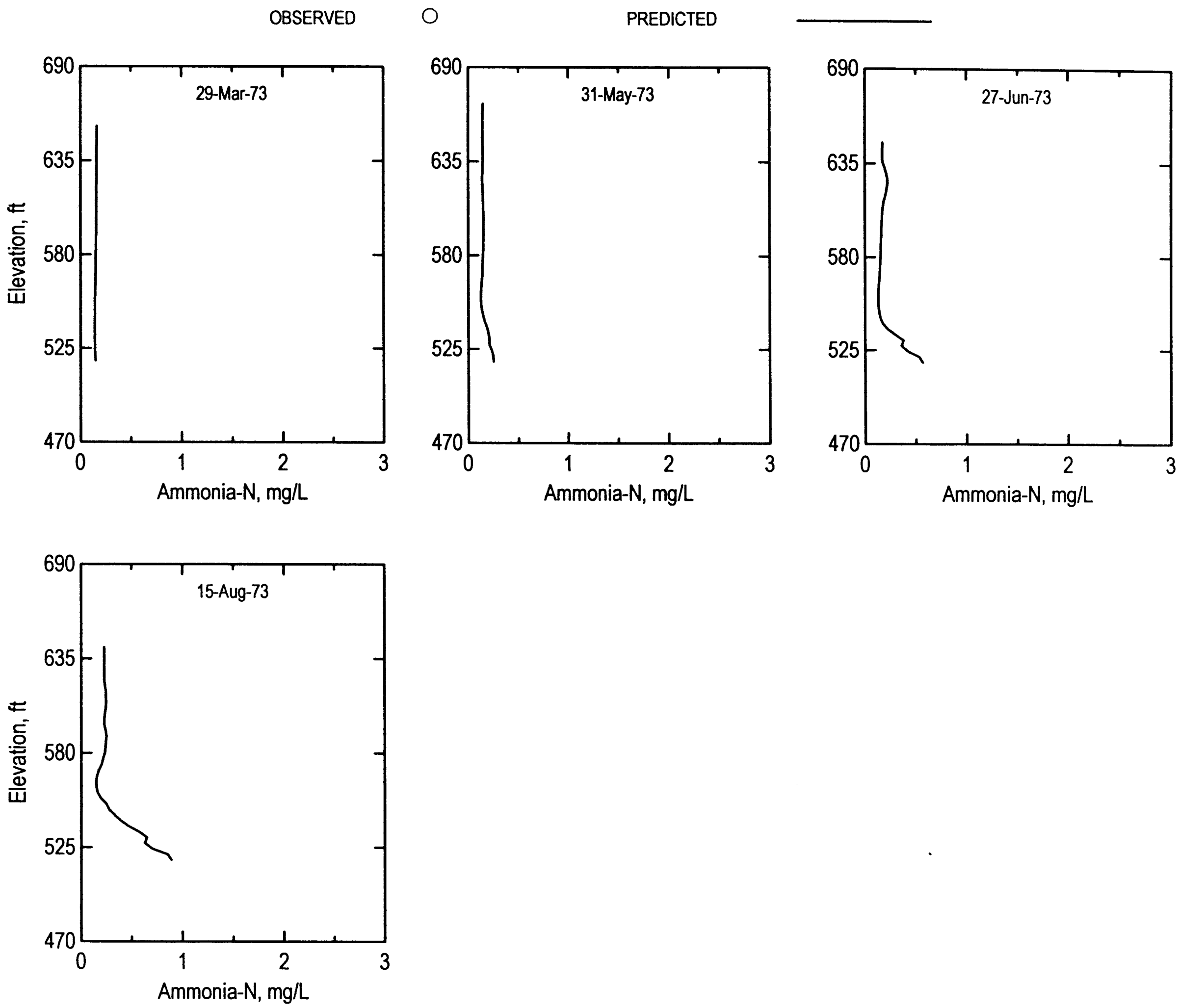
Center Hill Lake 1973 Station CEN20010





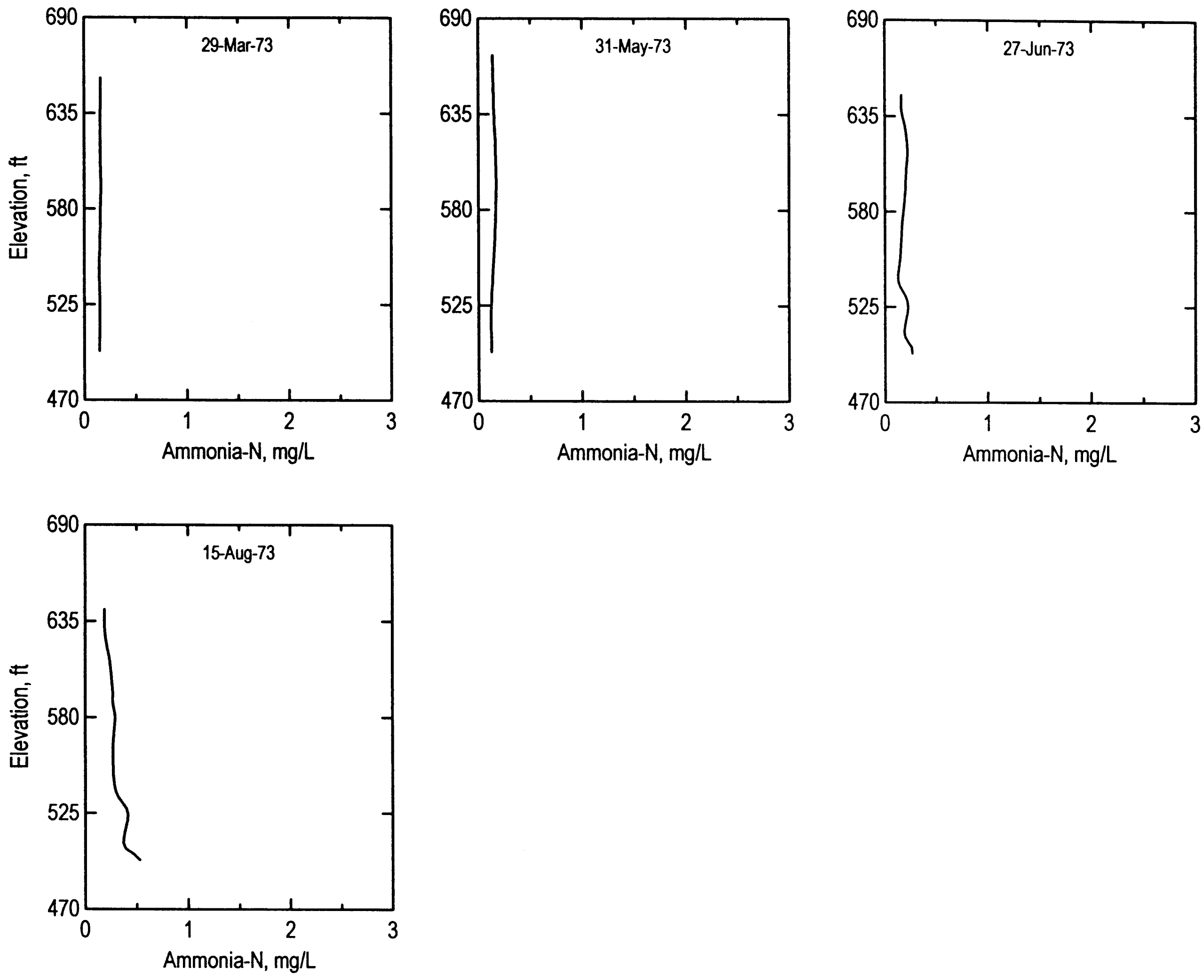
Center Hill Lake 1973 Station CEN20011
OBSERVED
PREDICTED
29-Mar-73
31-May-73
27-Jun-73
15-Aug-73
Elevation, ft
Ammonia-N, mg/L
690
635
580
525
470
0
1
2
3

Center Hill Lake 1973 Station CEN20015

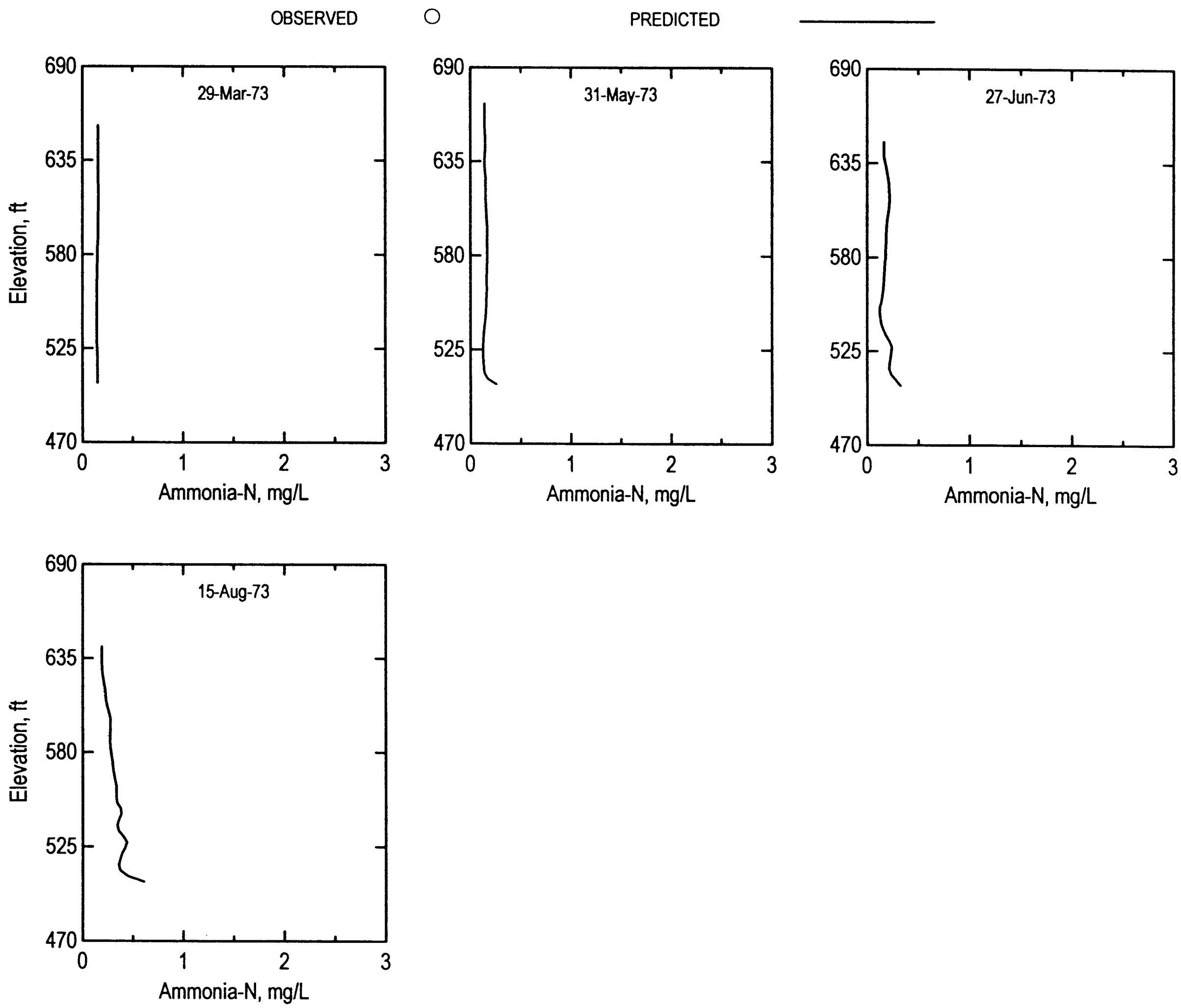


Center Hill Lake 1973 Station CEN20013

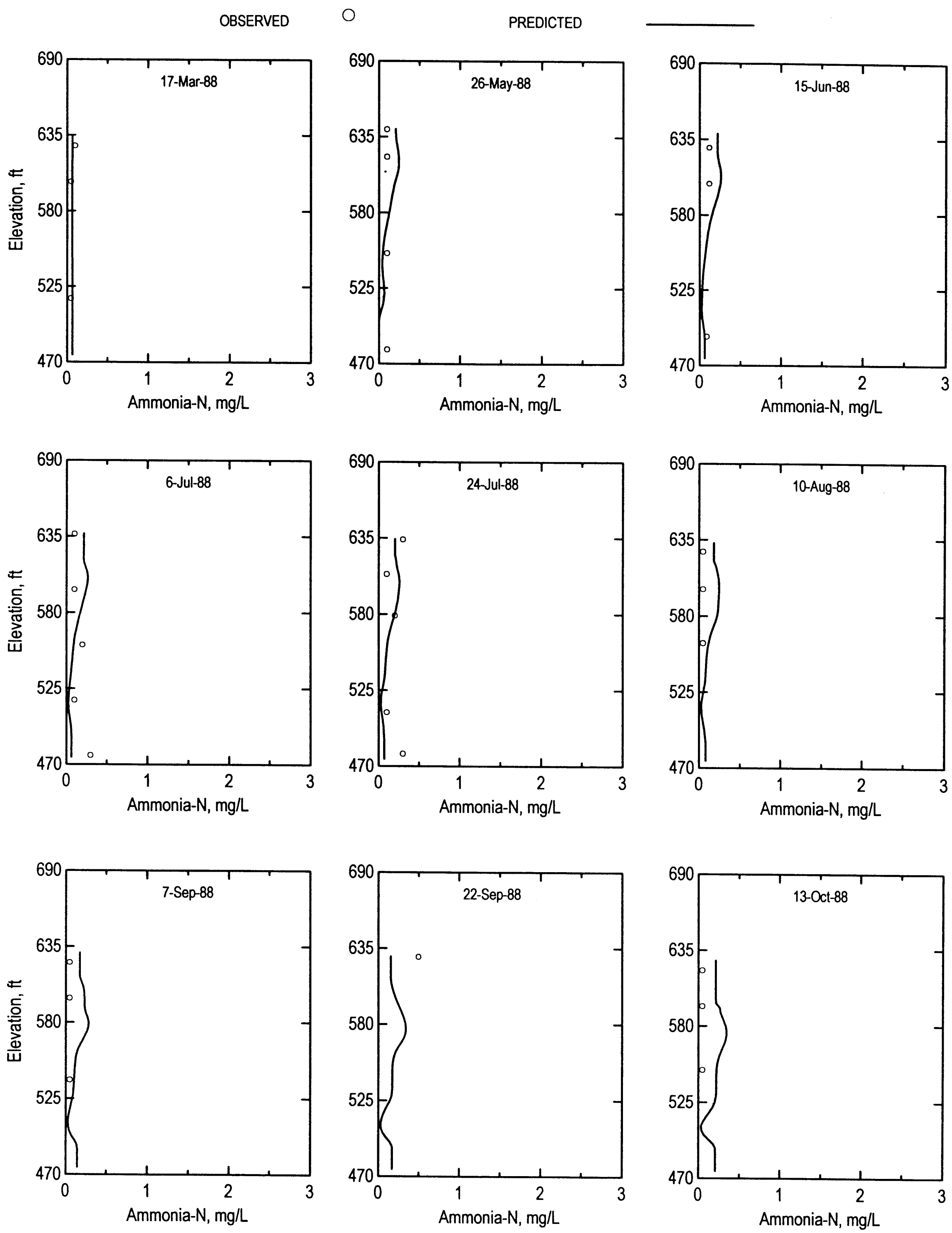
OBSERVED ○ PREDICTED ————



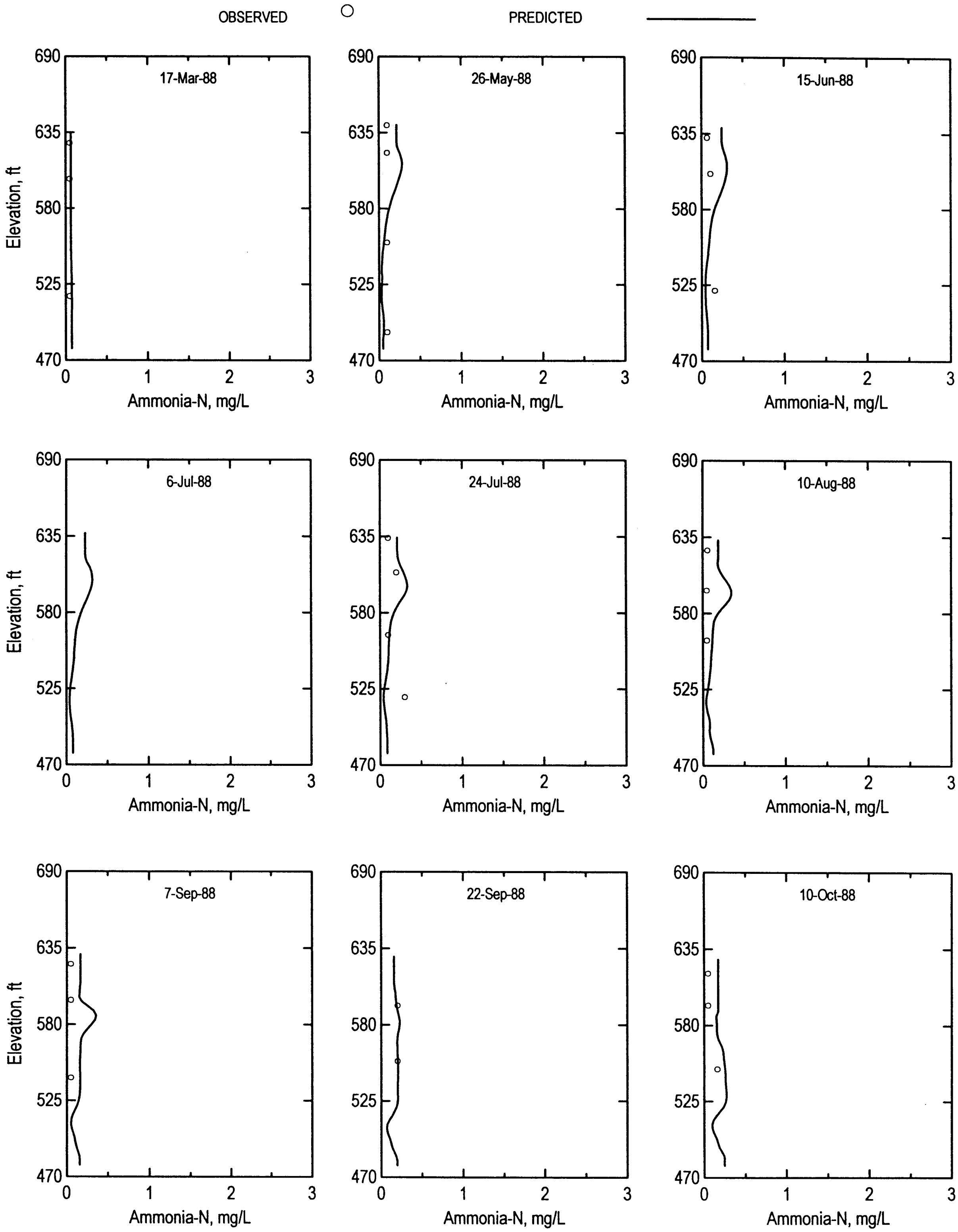
Center Hill Lake 1973 Station CEN20014



Center Hill Lake 1988 Station CEN20002

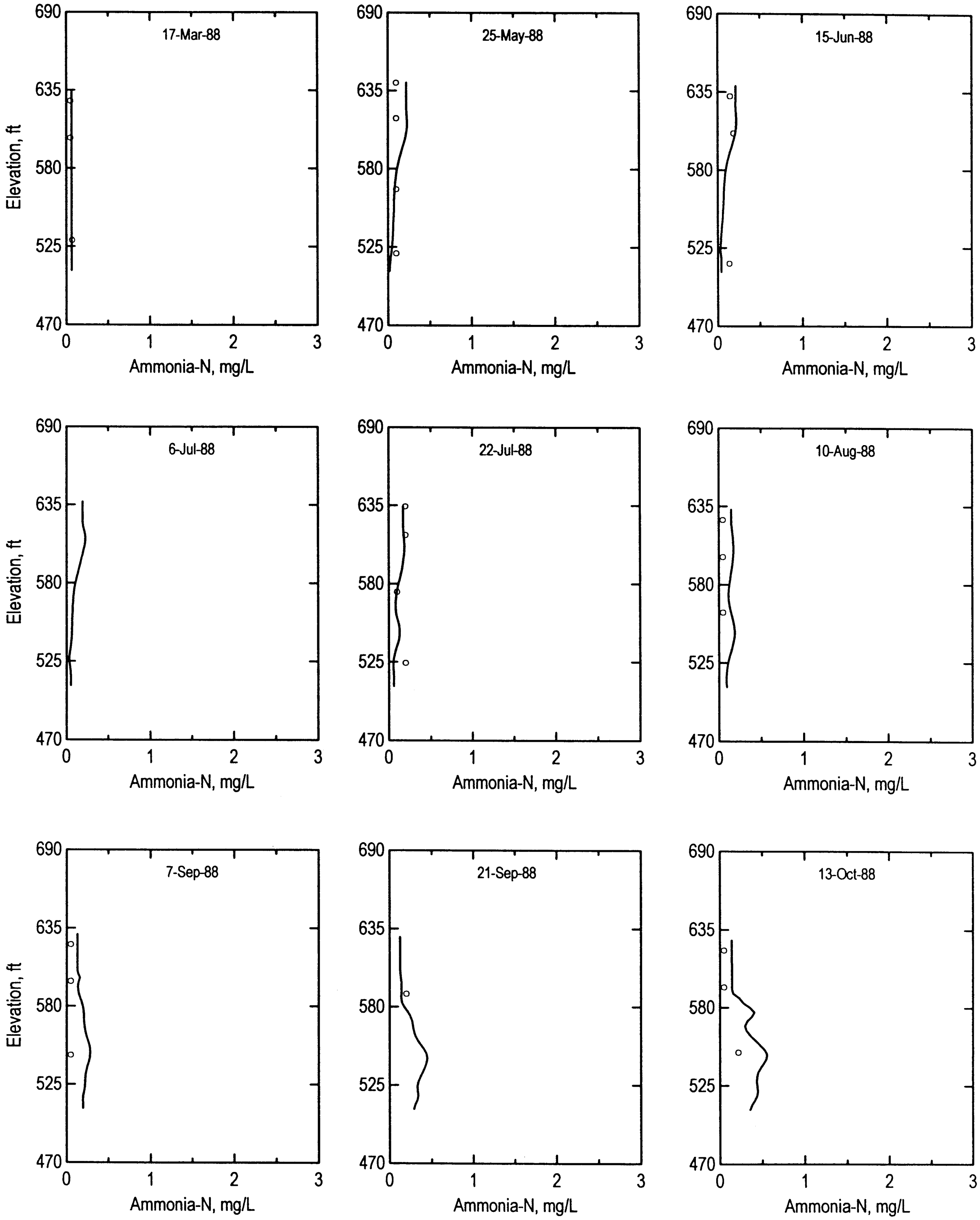


Center Hill Lake 1988 Station CEN20003



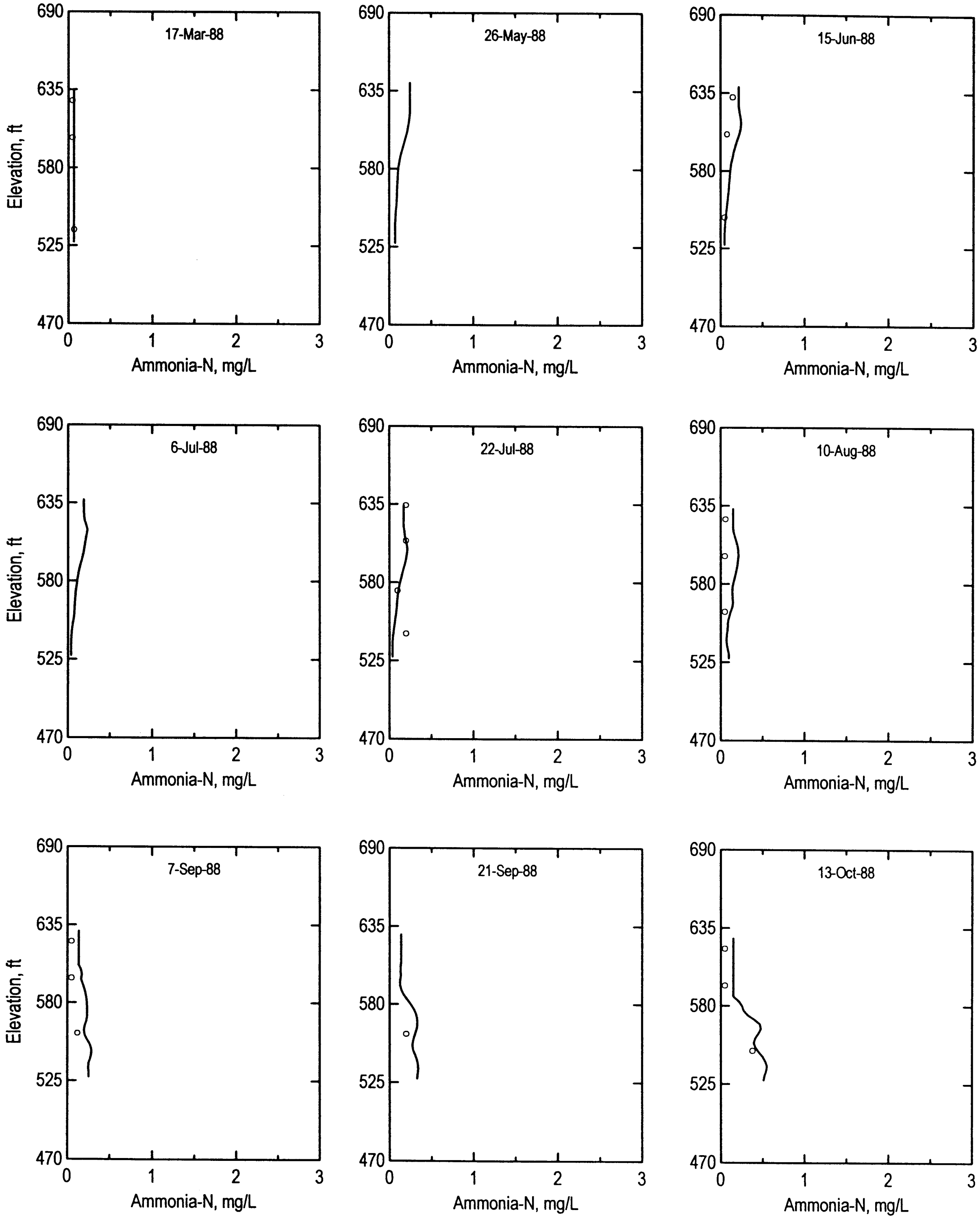
Center Hill Lake 1988 Station CEN20004

OBSERVED ○ PREDICTED ———

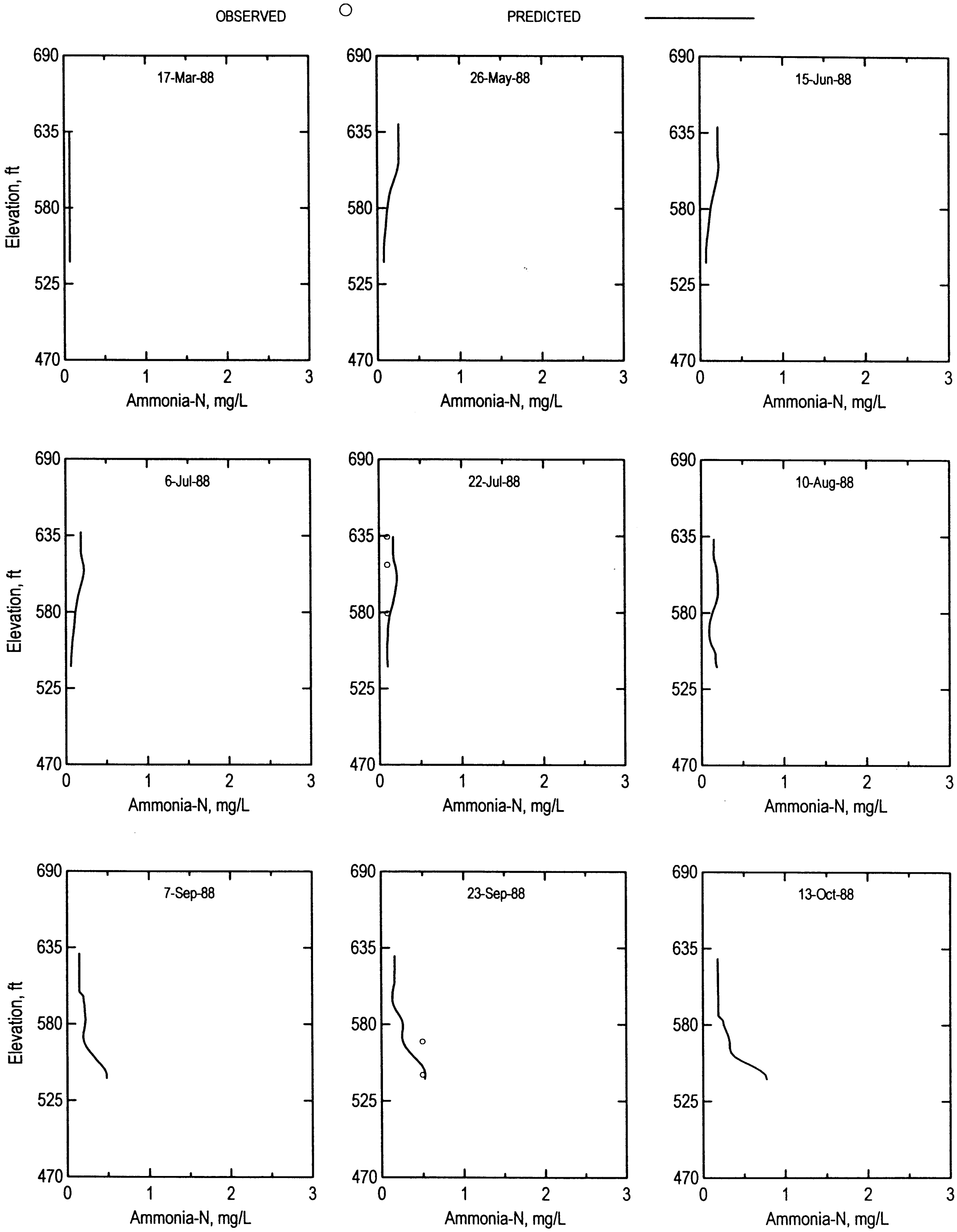


Center Hill Lake 1988 Station CEN20005

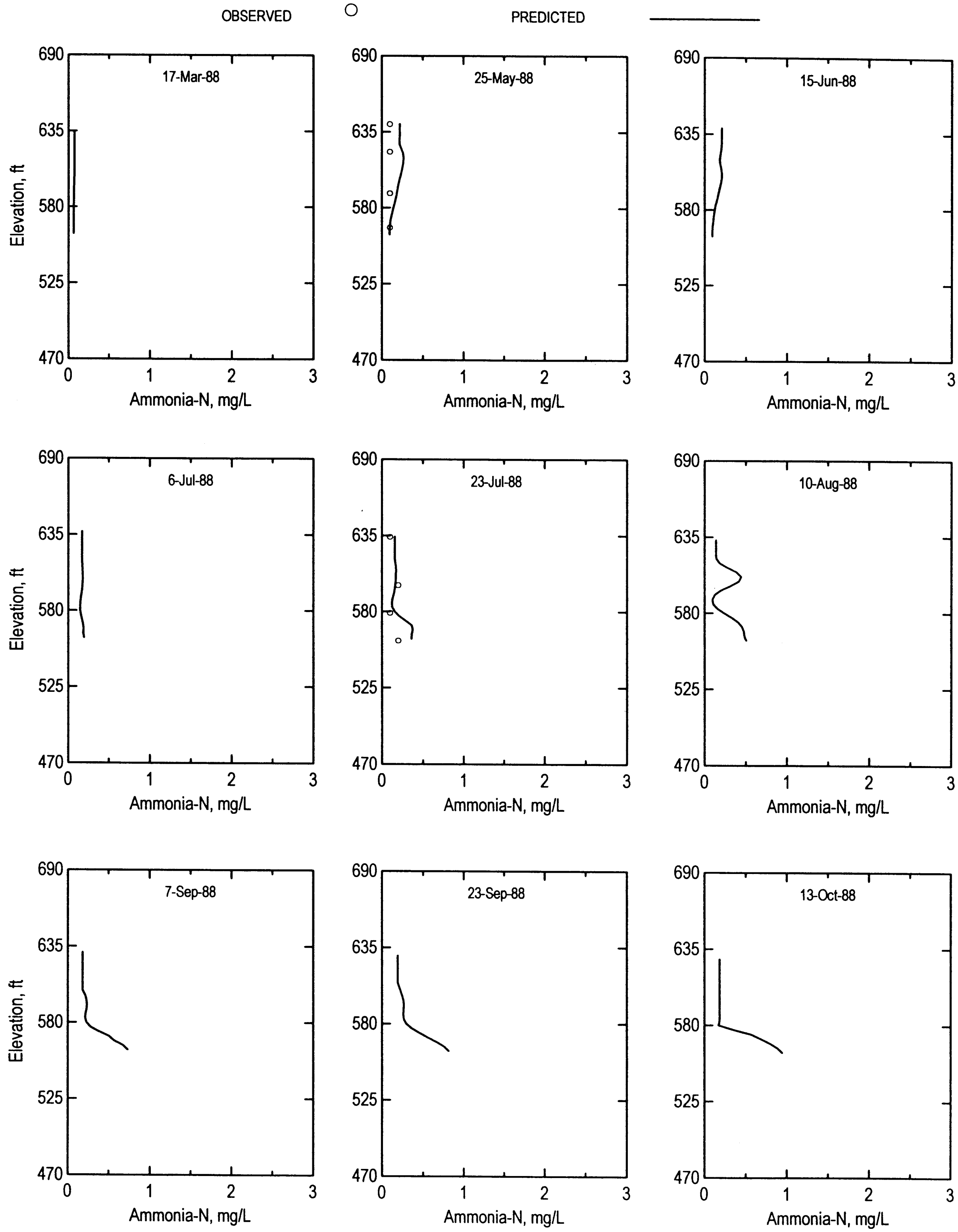
OBSERVED ○ PREDICTED ———



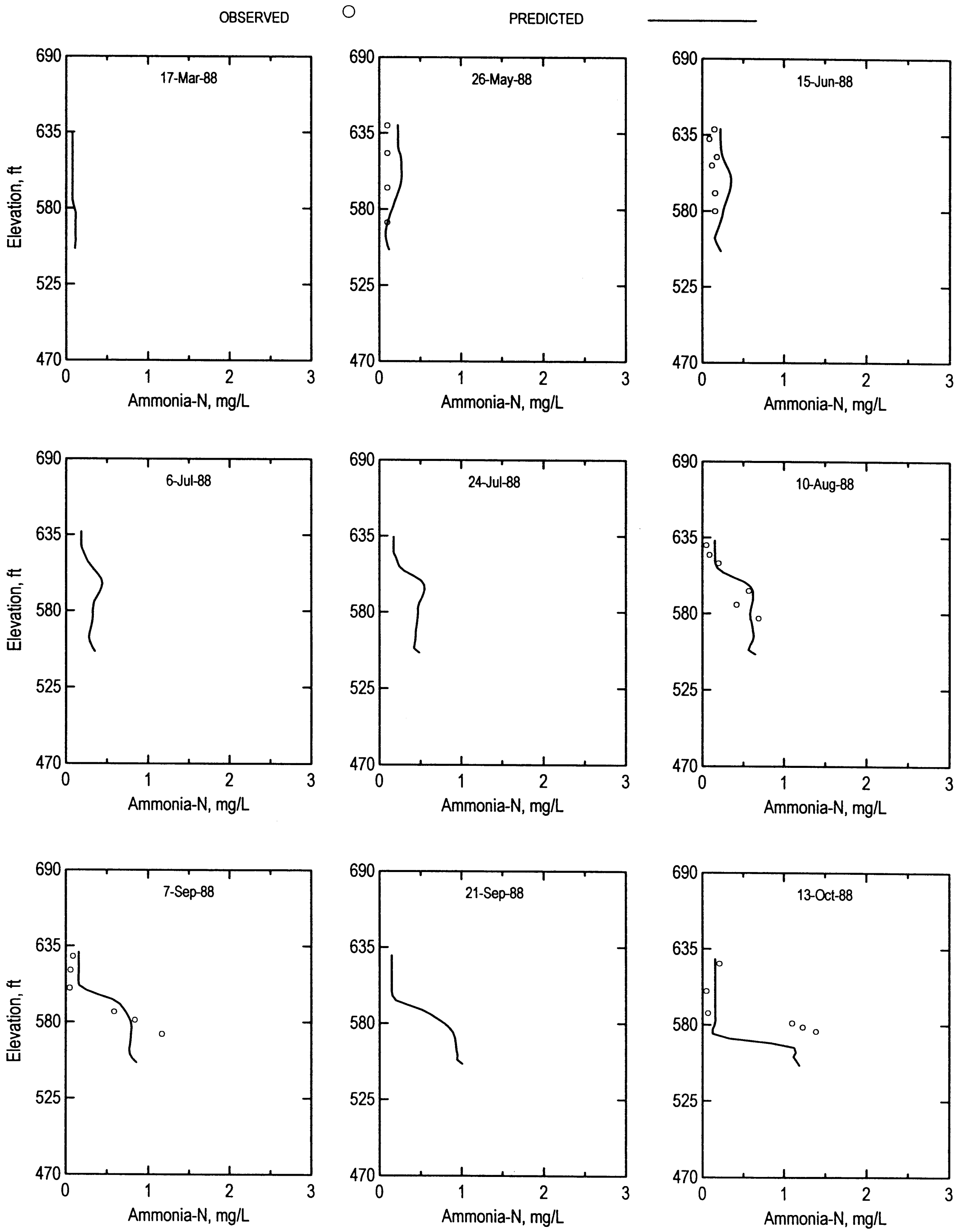
Center Hill Lake 1988 Station CEN20006



Center Hill Lake 1988 Station CEN20007

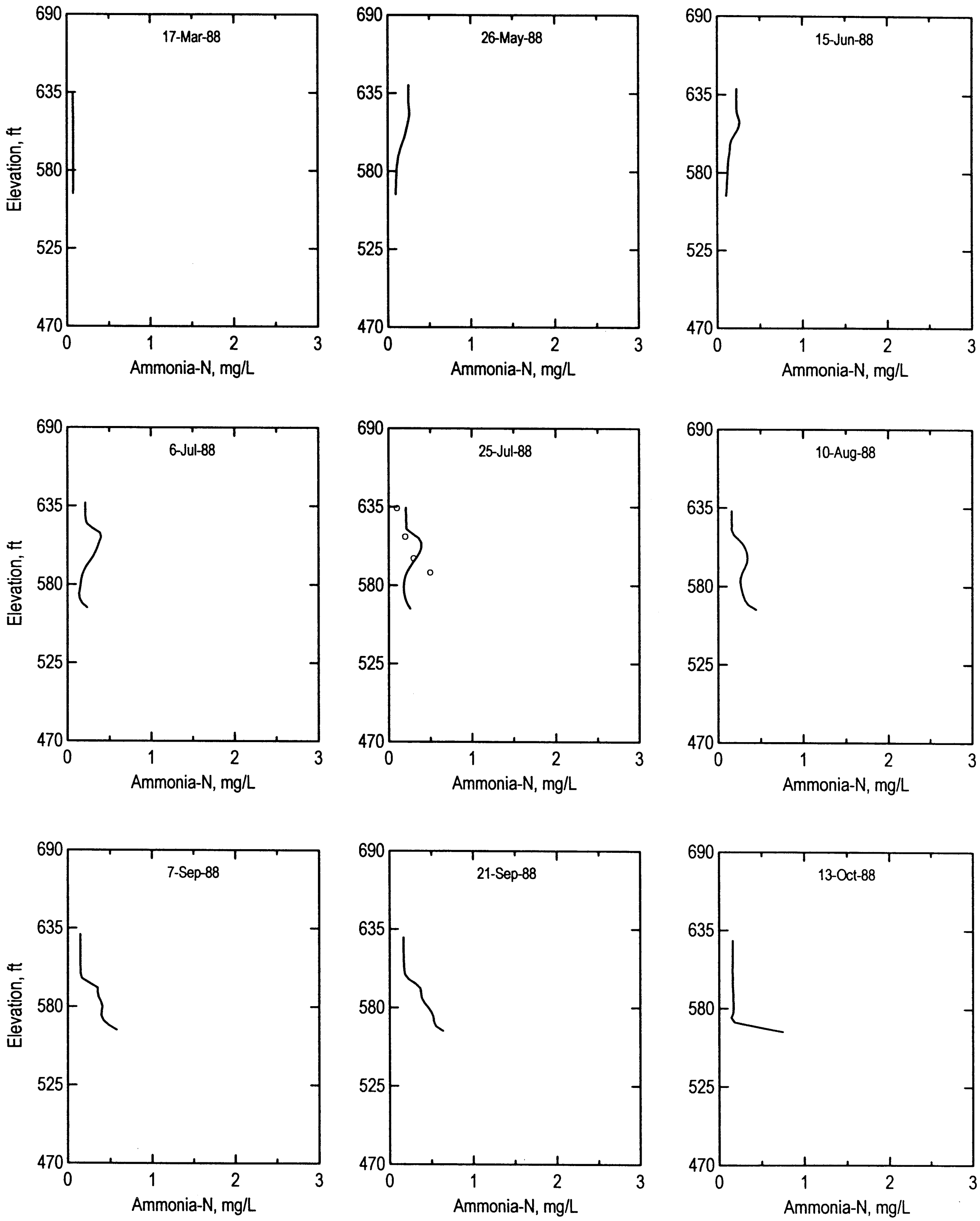


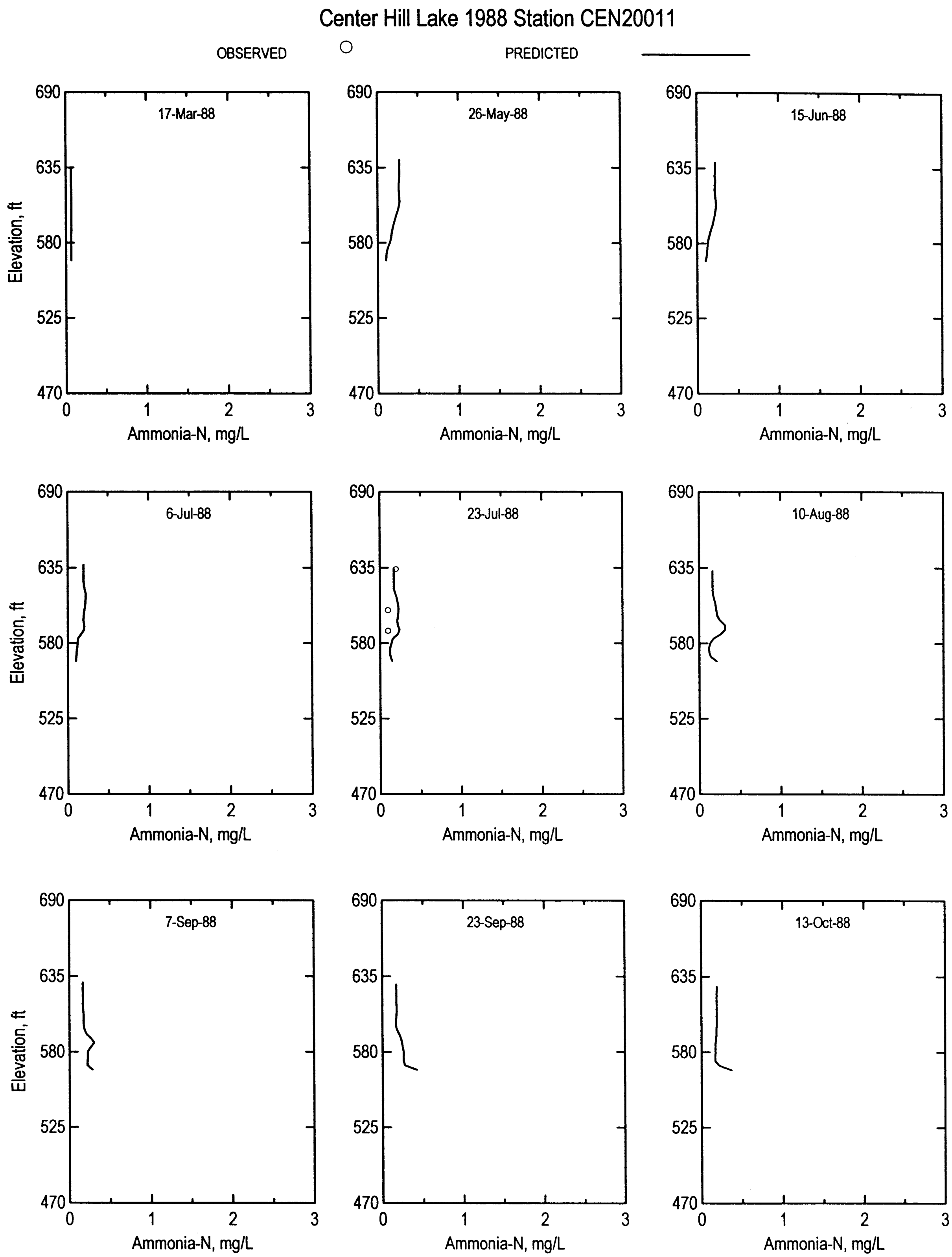
Center Hill Lake 1988 Station CEN20008



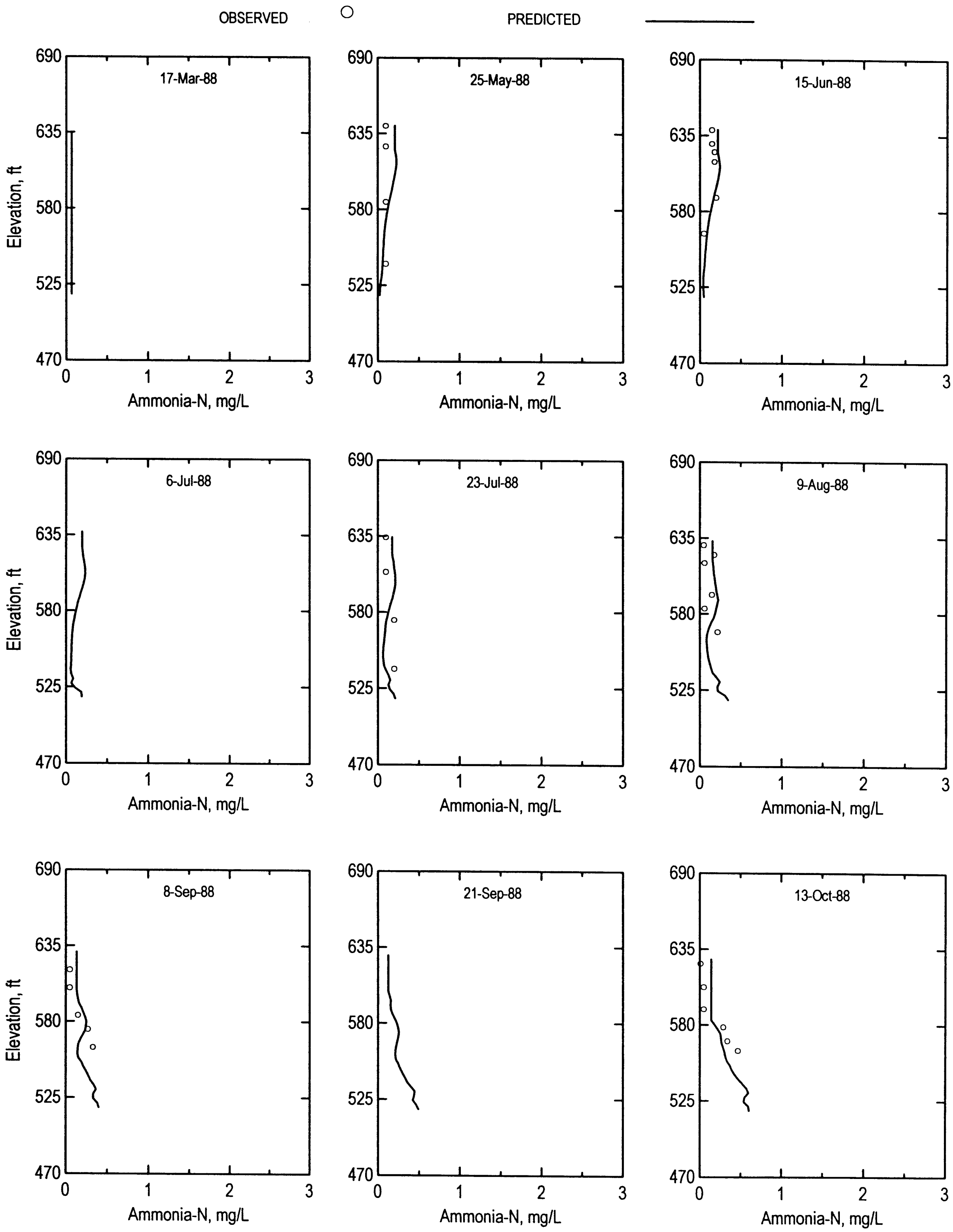
Center Hill Lake 1988 Station CEN20010

OBSERVED ○ PREDICTED ———

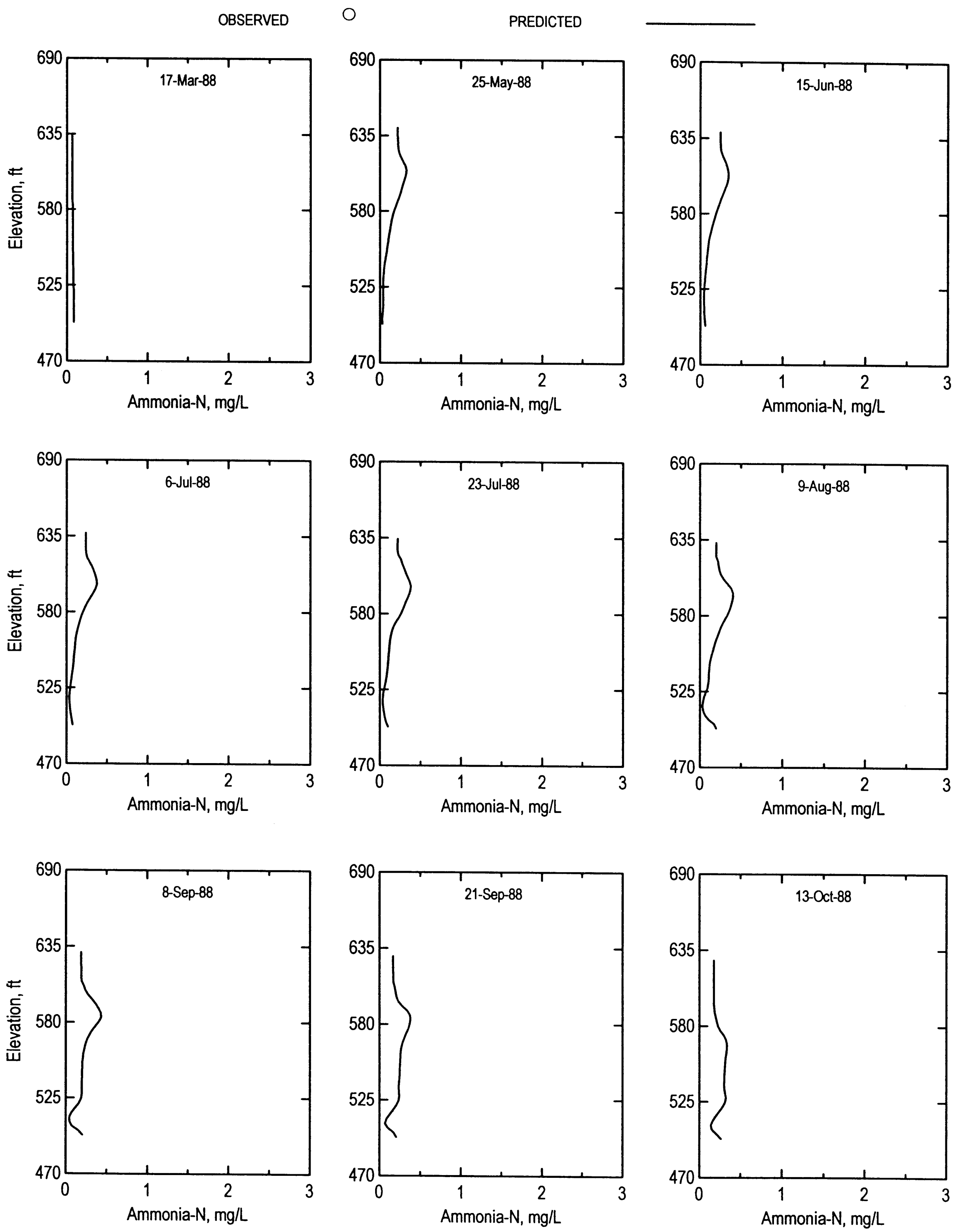



Center Hill Lake 1988 Station CEN20011
OBSERVED
PREDICTED
17-Mar-88
26-May-88
15-Jun-88
6-Jul-88
23-Jul-88
10-Aug-88
7-Sep-88
23-Sep-88
13-Oct-88
Elevation, ft
690
635
580
525
470
0
1
2
3
Ammonia-N, mg/L

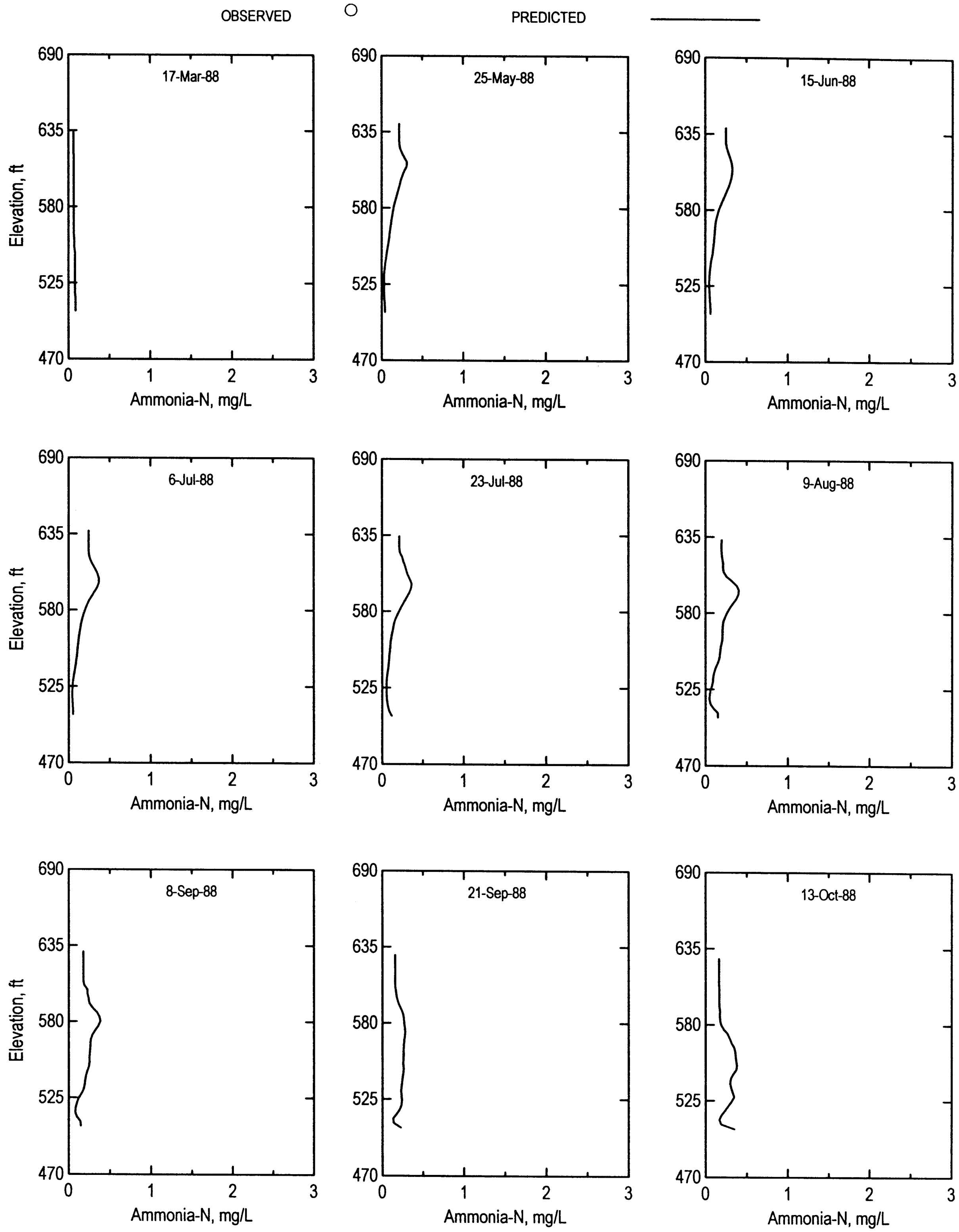
Center Hill Lake 1988 Station CEN20015



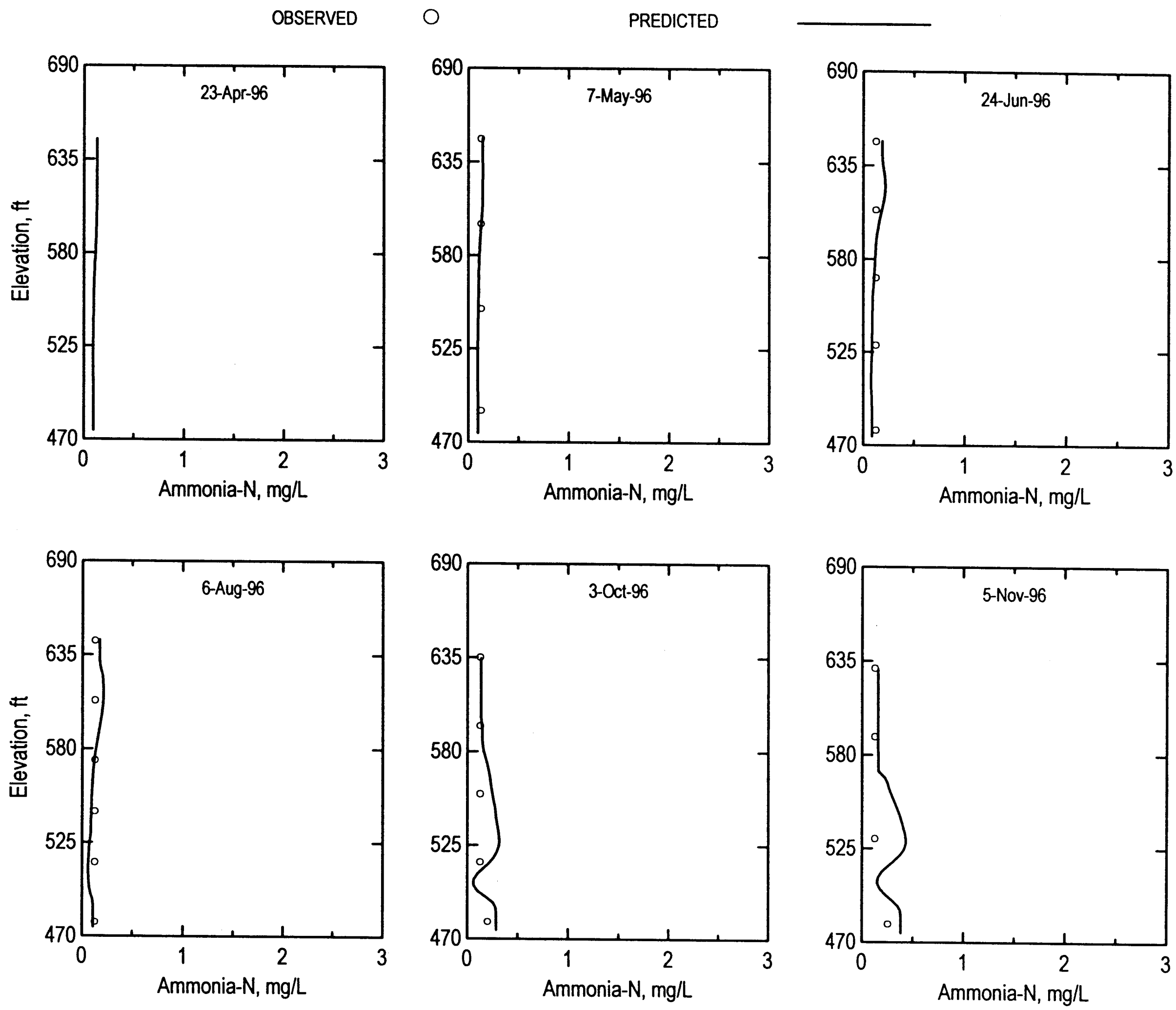
Center Hill Lake 1988 Station CEN20013



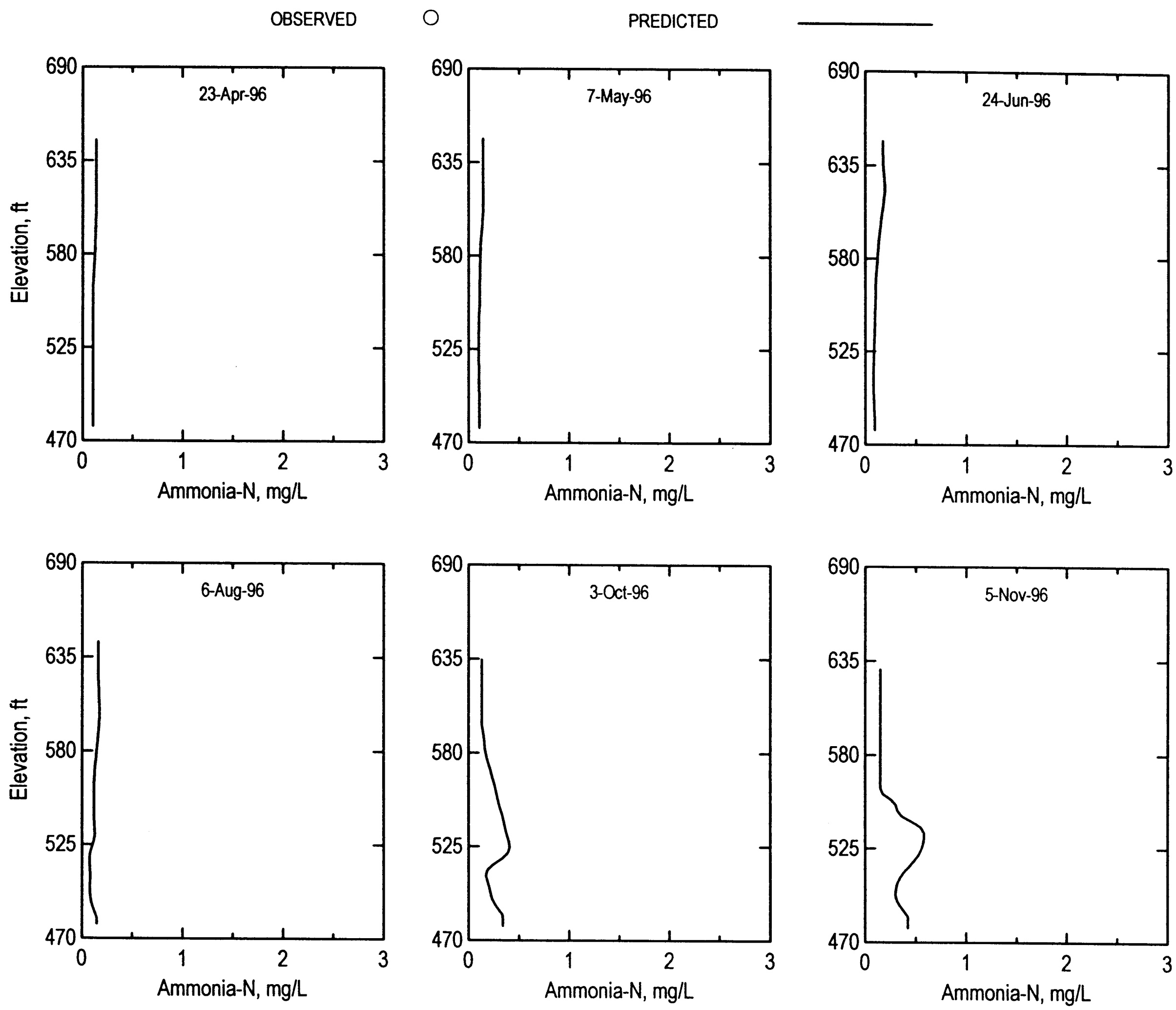
Center Hill Lake 1988 Station CEN20014



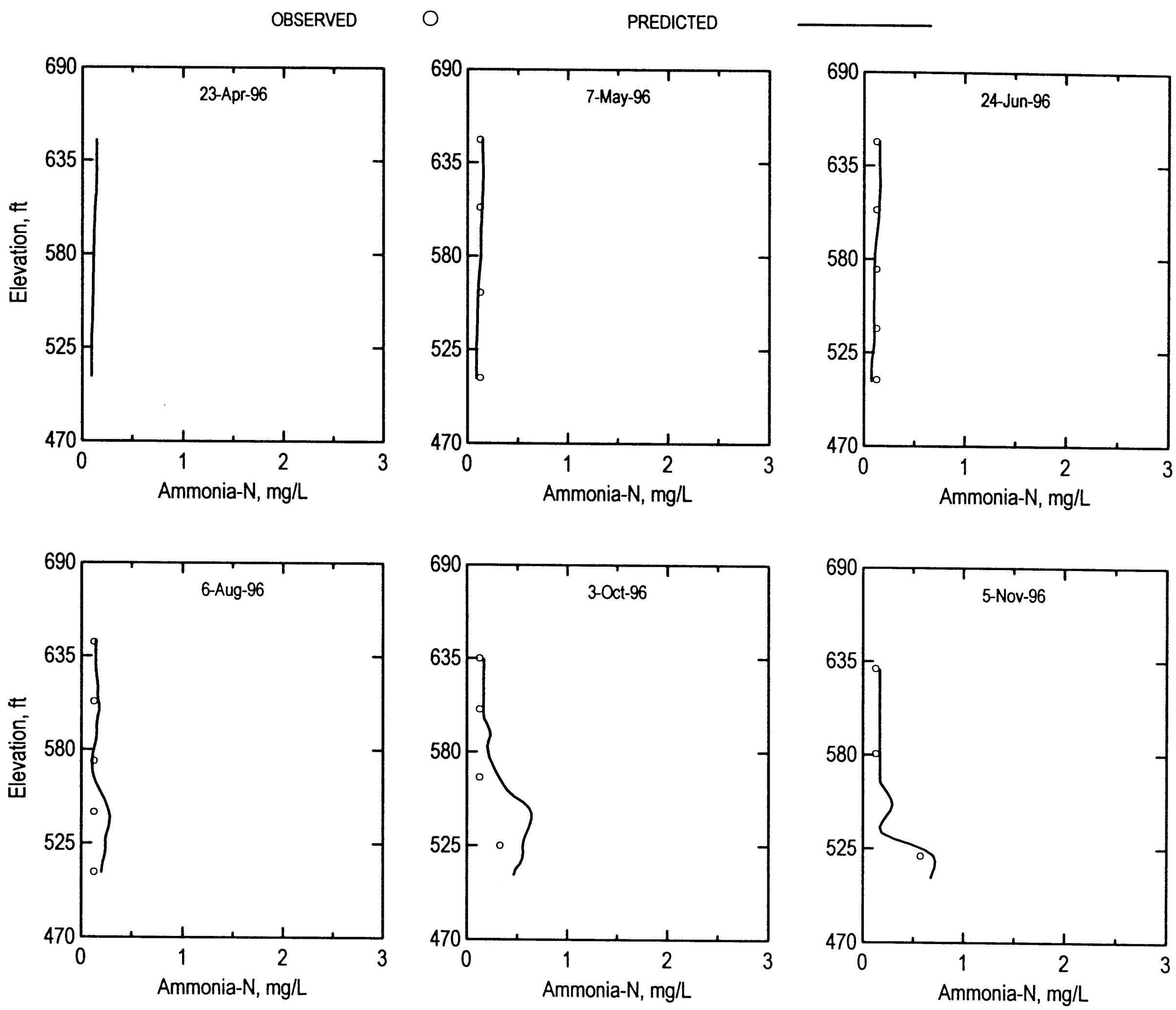
Center Hill Lake 1996 Station CEN20002

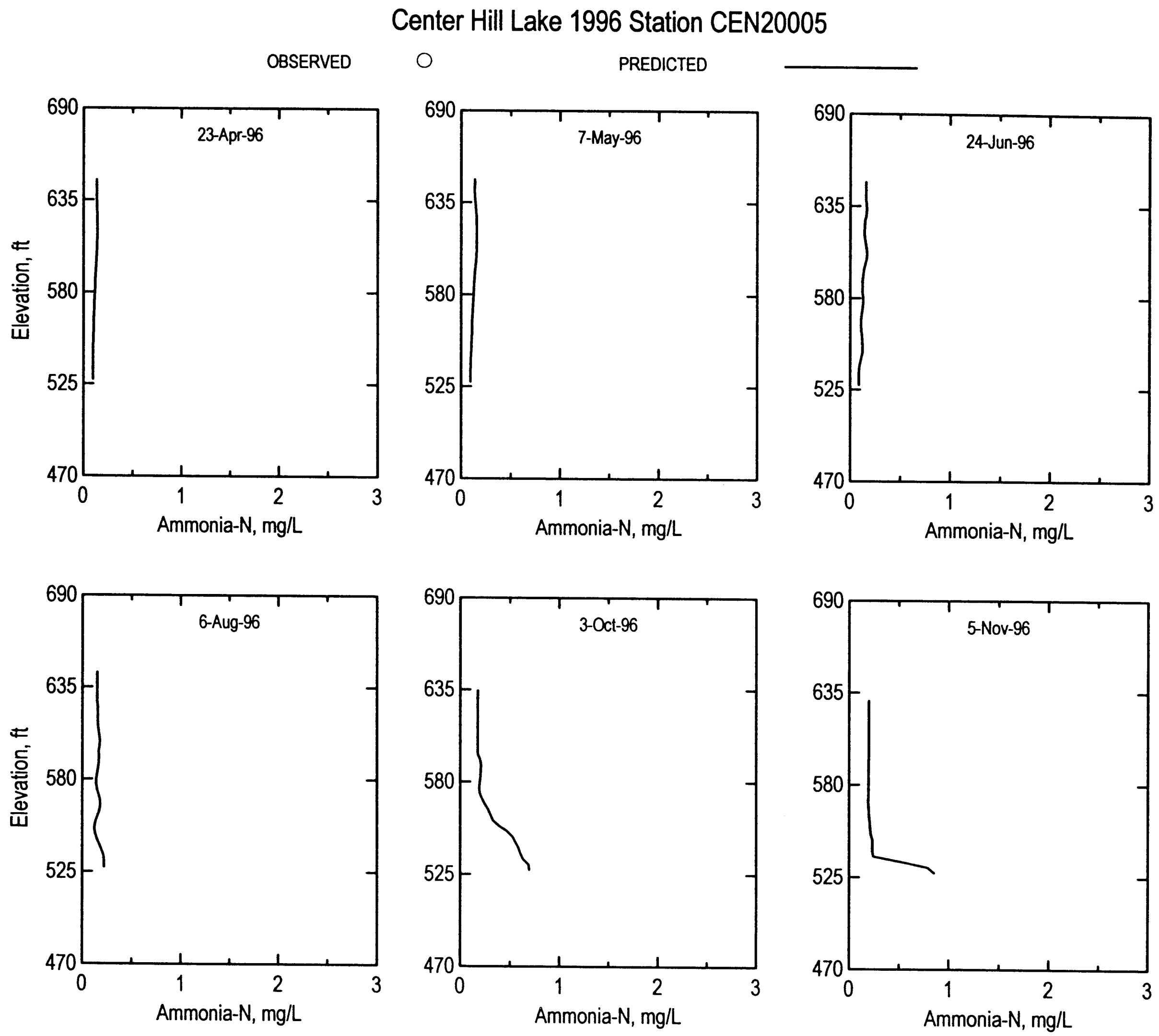


Center Hill Lake 1996 Station CEN20003



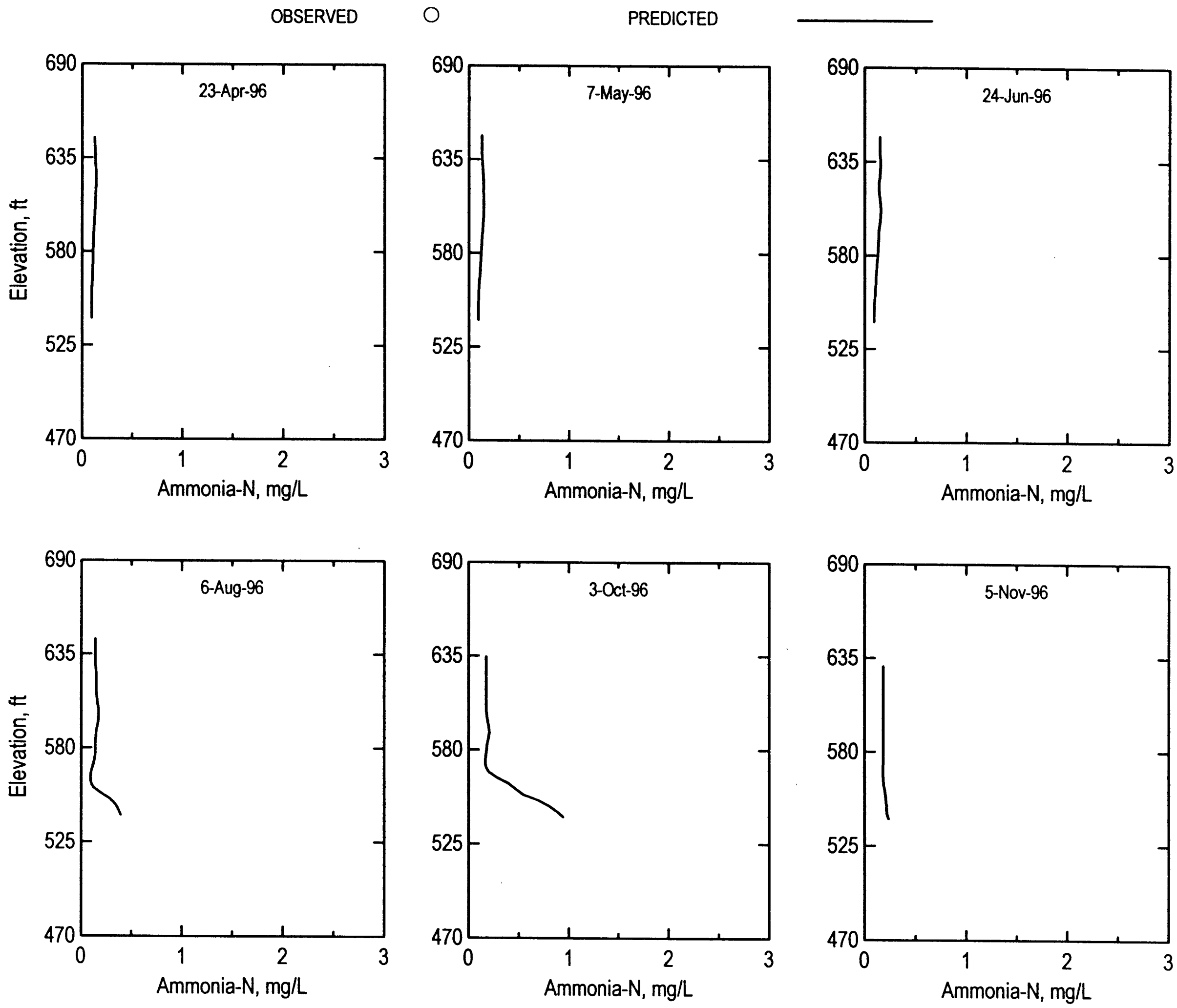
Center Hill Lake 1996 Station CEN20004

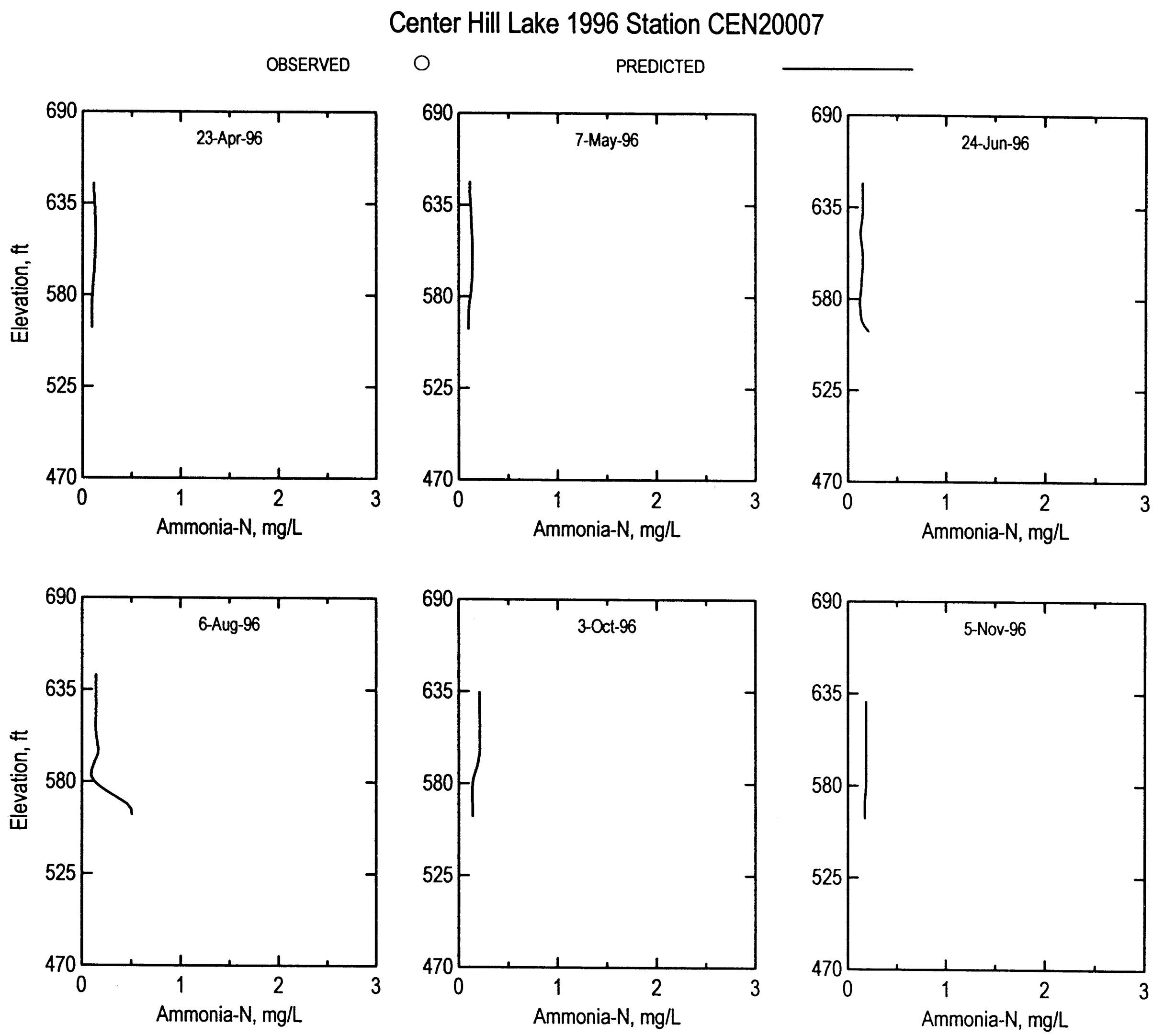


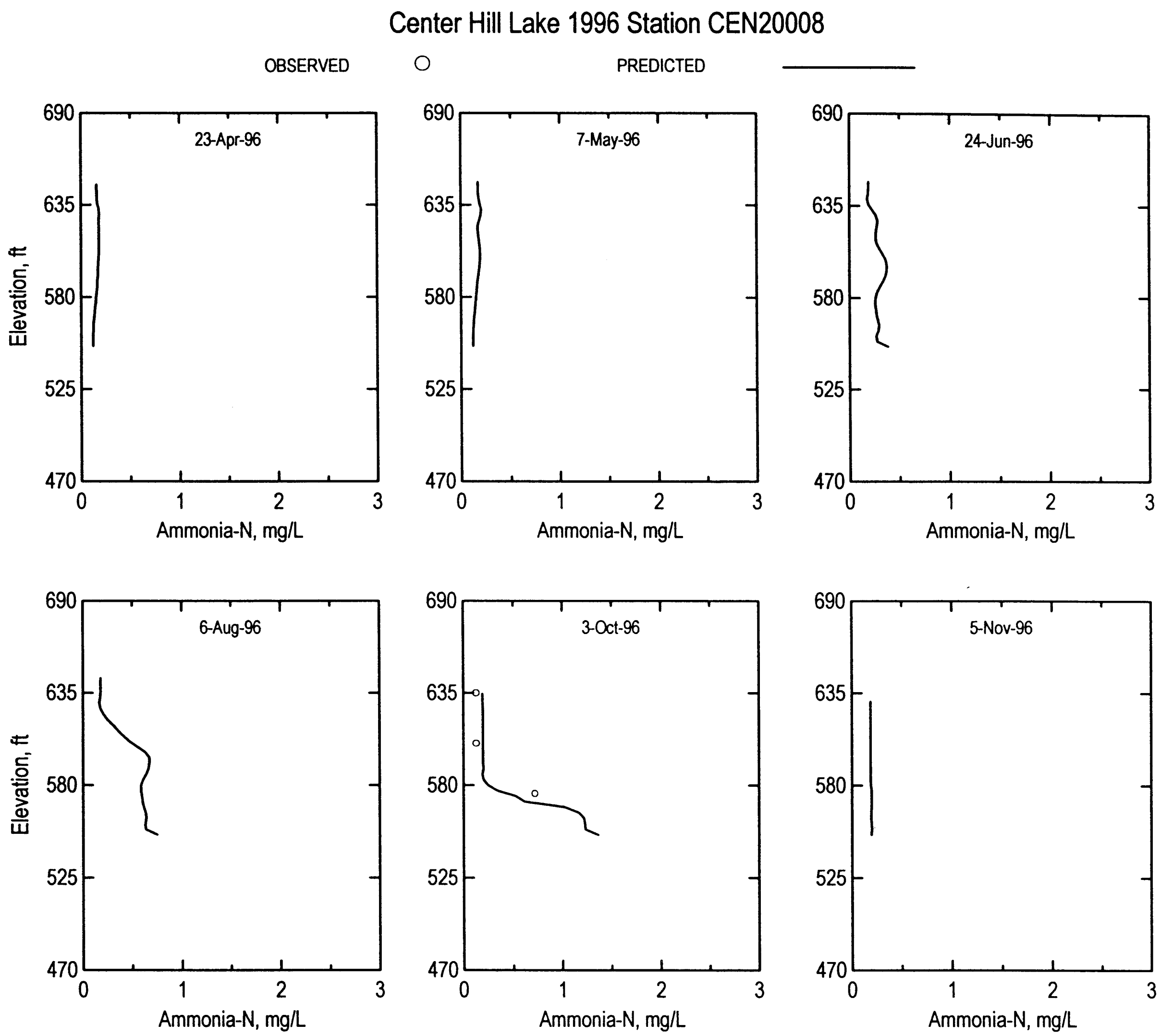


Center Hill Lake 1996 Station CEN20005
OBSERVED
PREDICTED
23-Apr-96
7-May-96
24-Jun-96
6-Aug-96
3-Oct-96
5-Nov-96
Elevation, ft
Ammonia-N, mg/L
690
635
580
525
470
0
1
2
3

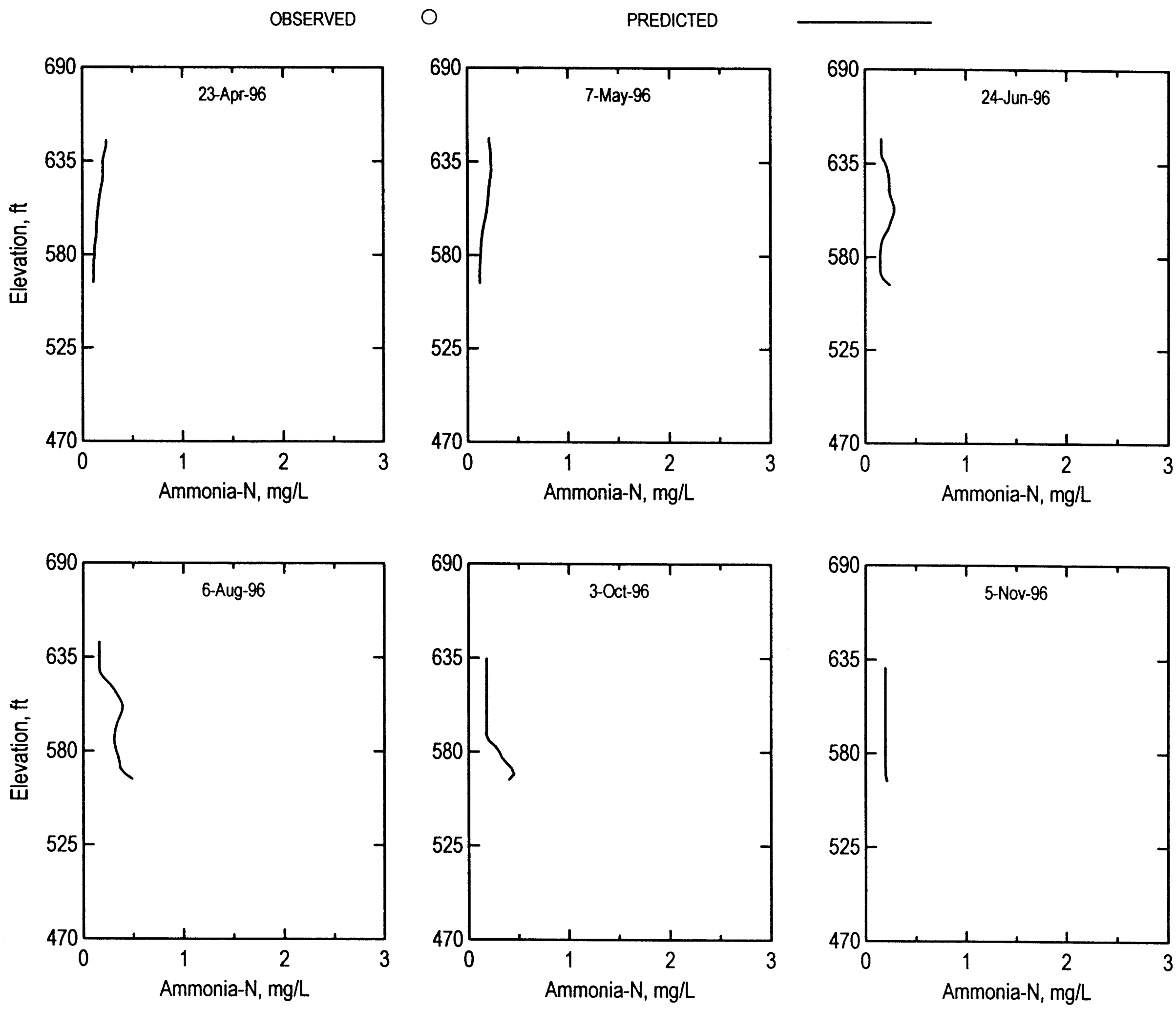
Center Hill Lake 1996 Station CEN20006



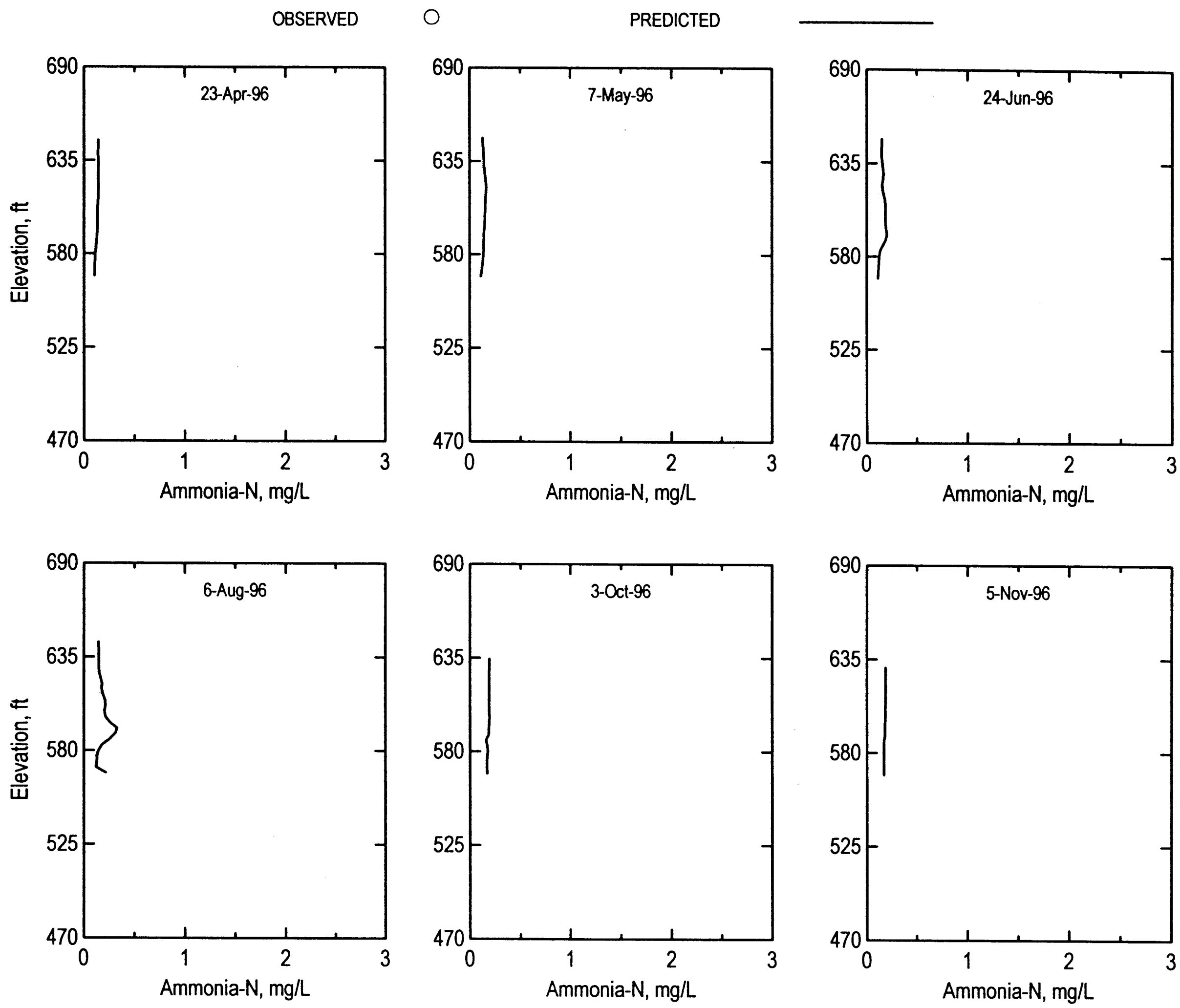

Center Hill Lake 1996 Station CEN20007
OBSERVED
PREDICTED
23-Apr-96
7-May-96
24-Jun-96
6-Aug-96
3-Oct-96
5-Nov-96
Elevation, ft
Ammonia-N, mg/L
690
635
580
525
470
0
1
2
3

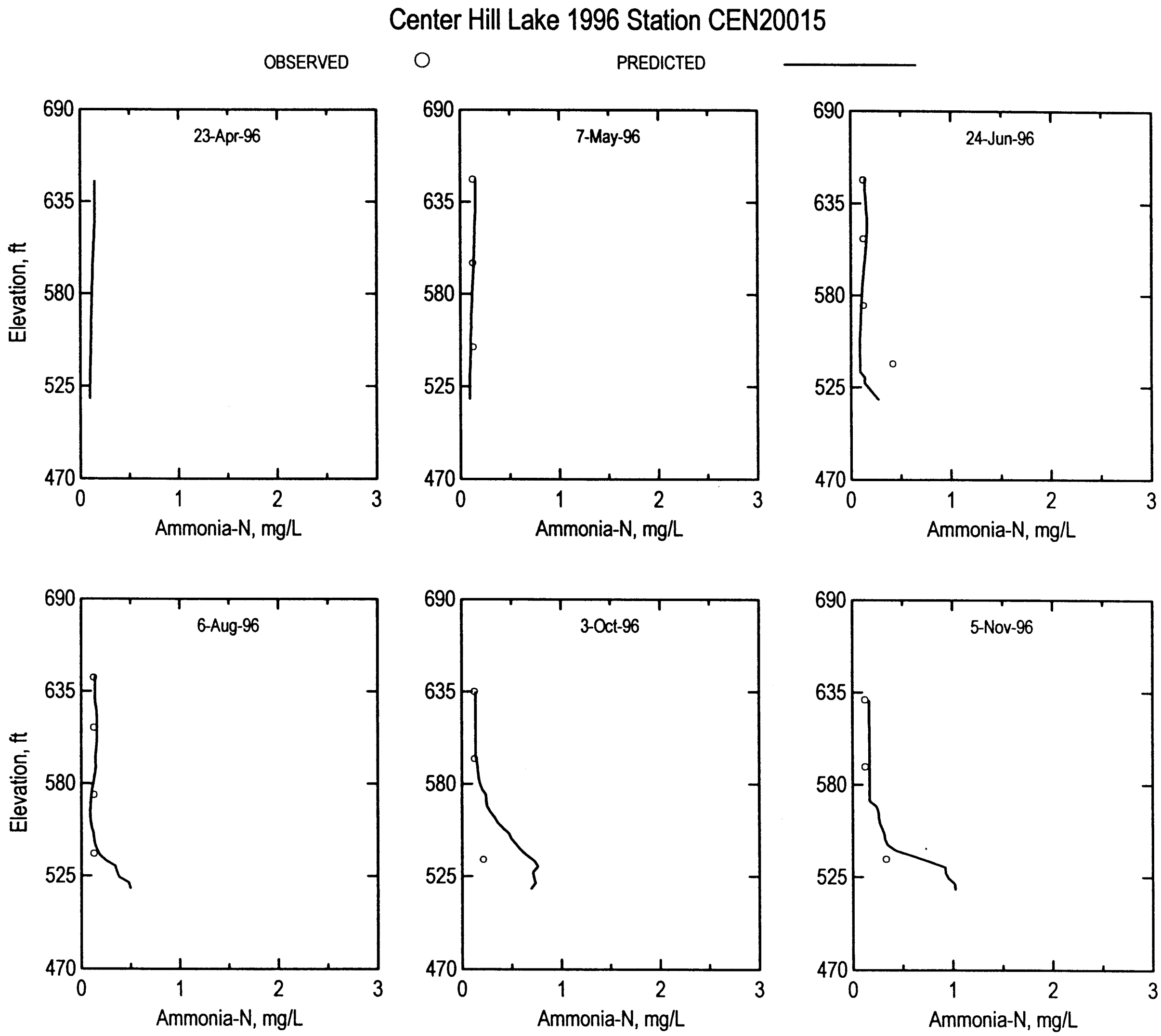

Center Hill Lake 1996 Station CEN20008
OBSERVED
PREDICTED
23-Apr-96
7-May-96
24-Jun-96
6-Aug-96
3-Oct-96
5-Nov-96
Elevation, ft
690
635
580
525
470
0
1
2
3
Ammonia-N, mg/L

Center Hill Lake 1996 Station CEN20010



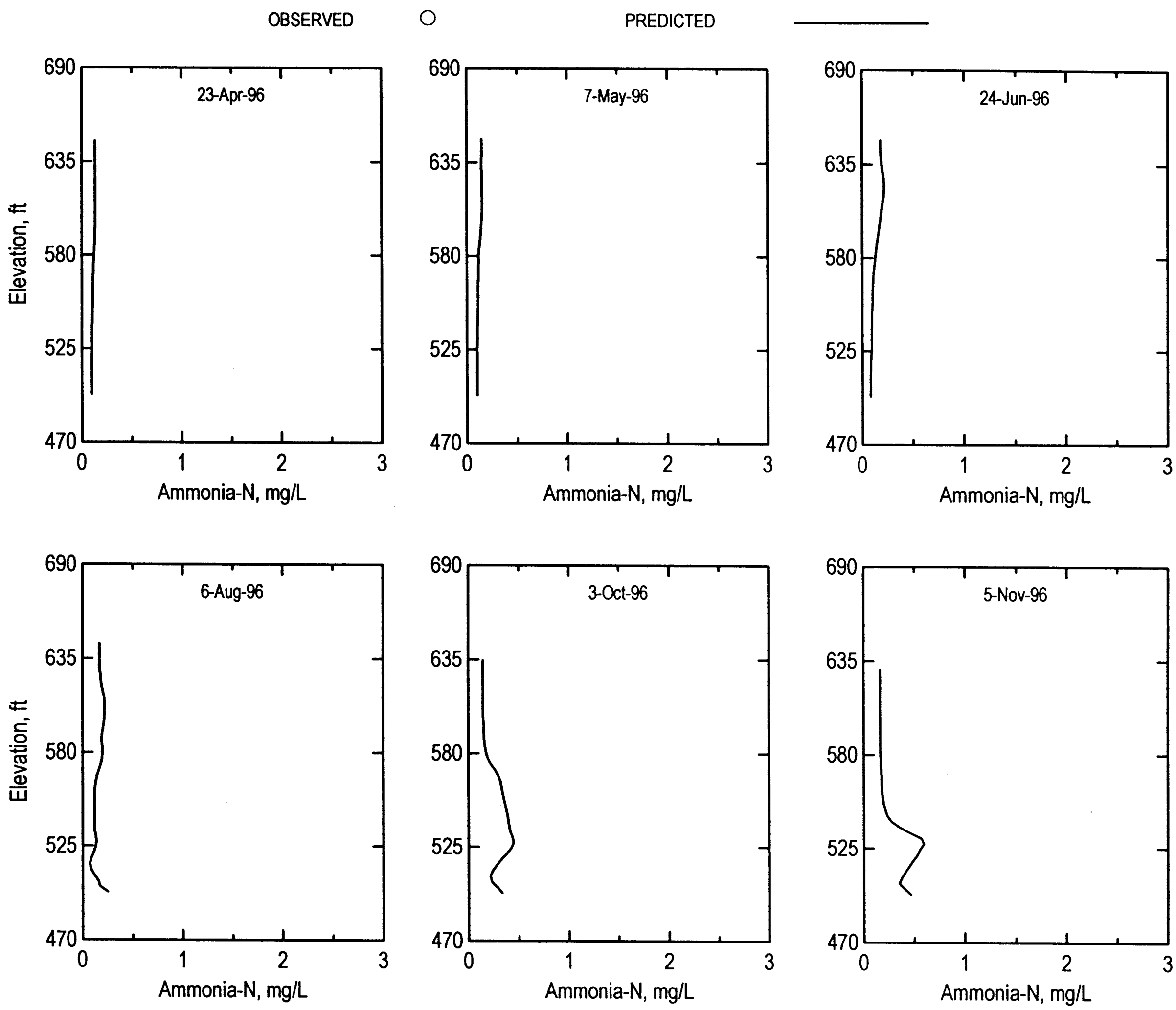
Center Hill Lake 1996 Station CEN20011





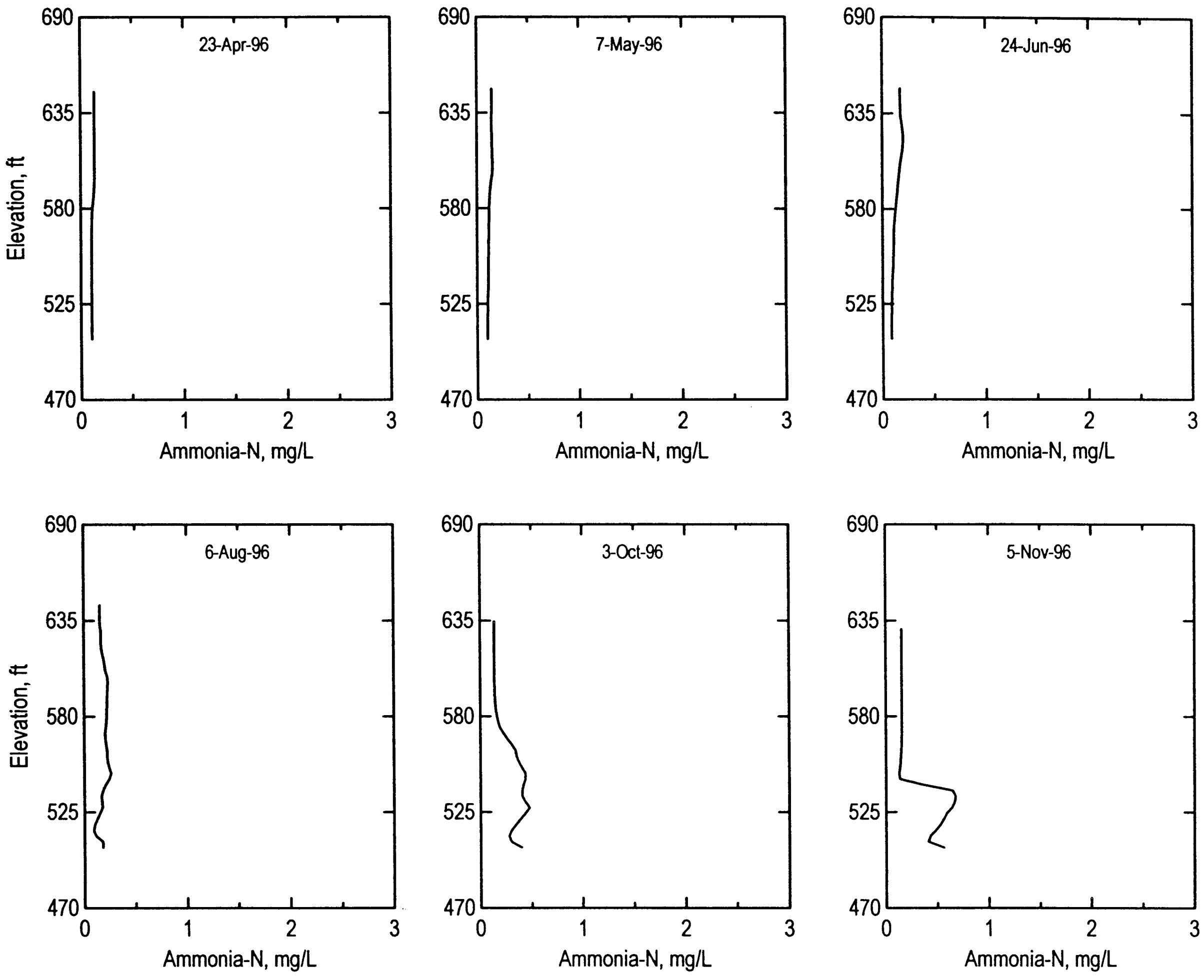
Center Hill Lake 1996 Station CEN20015
OBSERVED
PREDICTED
23-Apr-96
7-May-96
24-Jun-96
6-Aug-96
3-Oct-96
5-Nov-96
Elevation, ft
Ammonia-N, mg/L
690
635
580
525
470
0
1
2
3

Center Hill Lake 1996 Station CEN20013

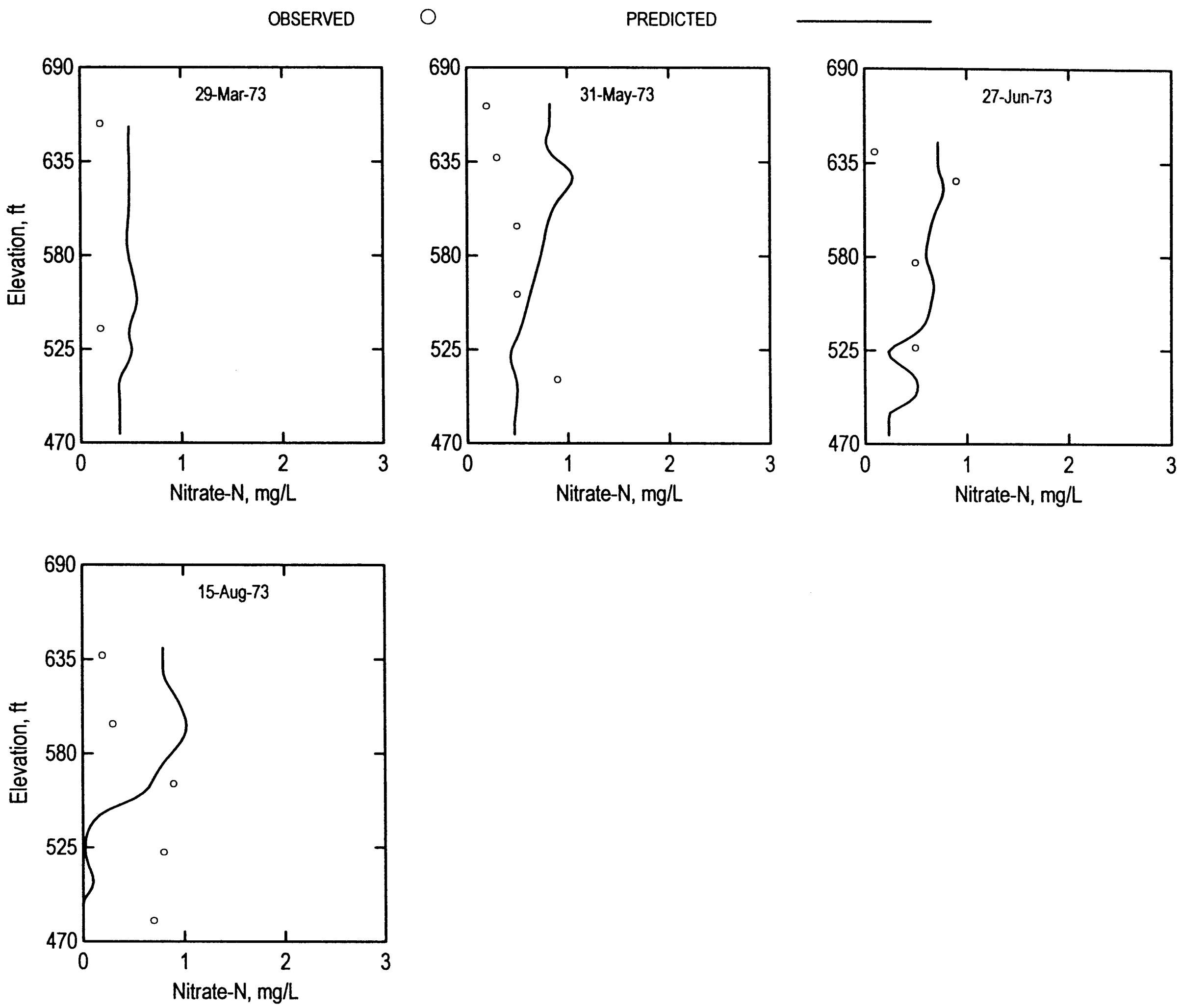


Center Hill Lake 1996 Station CEN20014

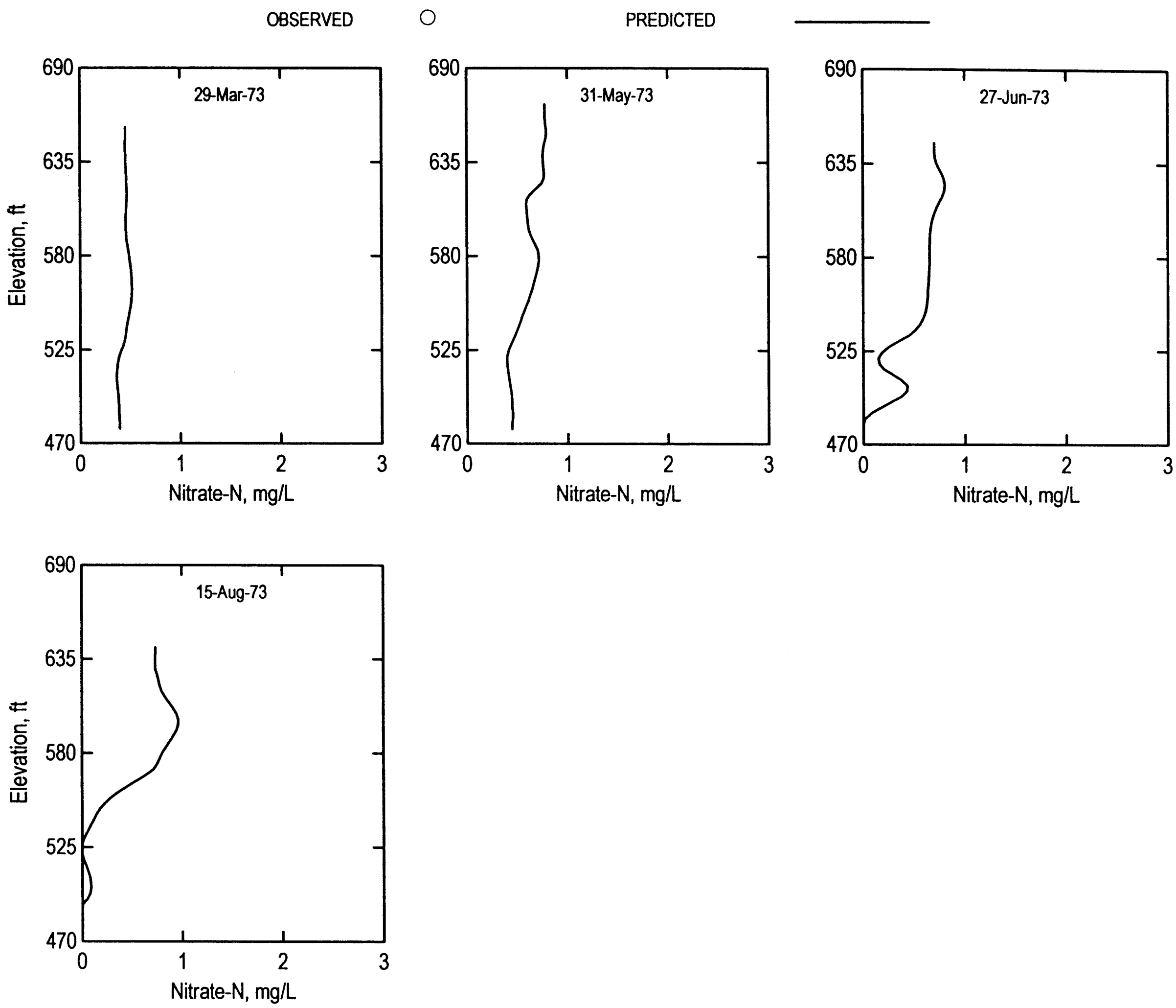
OBSERVED ○ PREDICTED ———



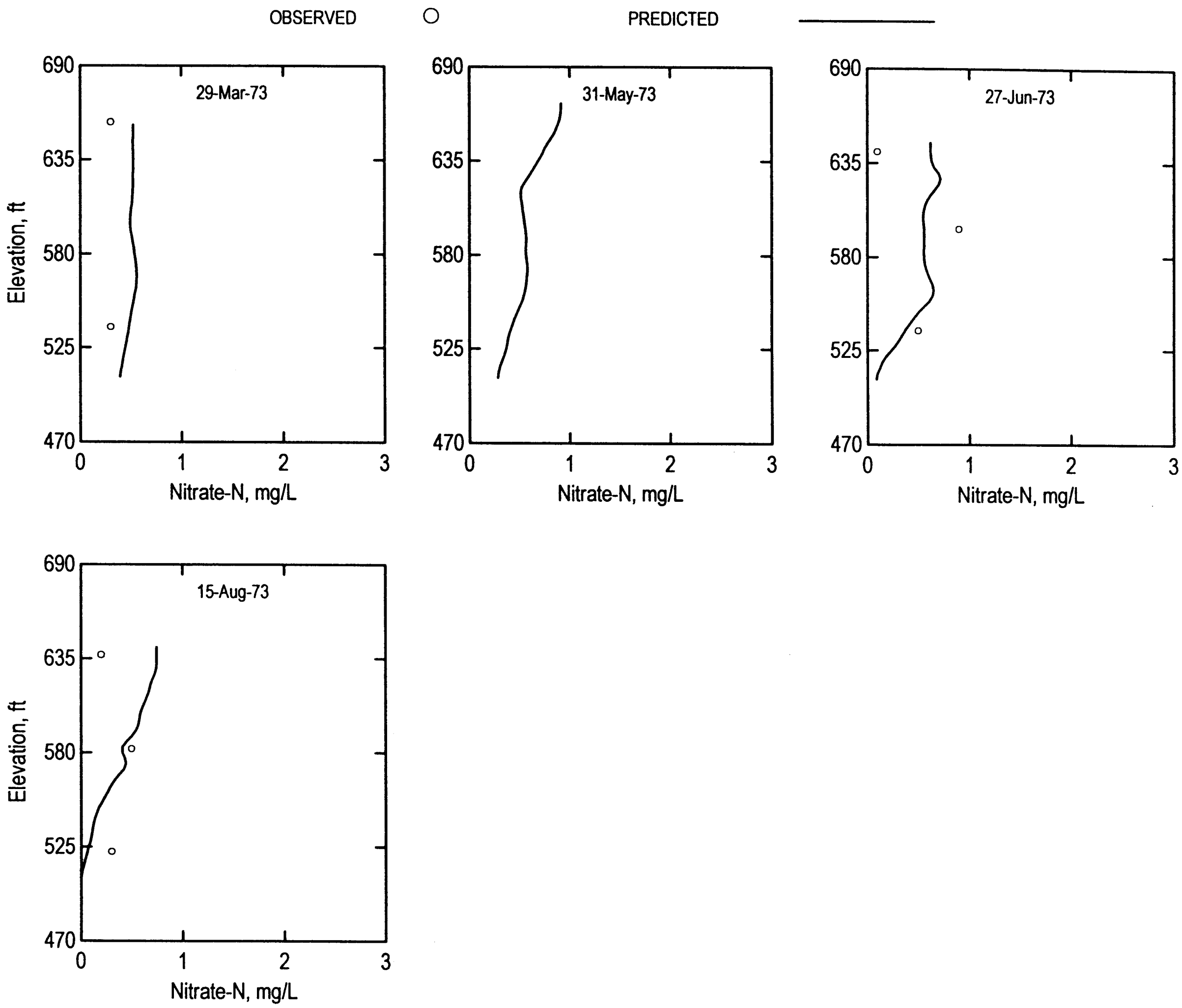
Center Hill Lake 1973 Station CEN20002



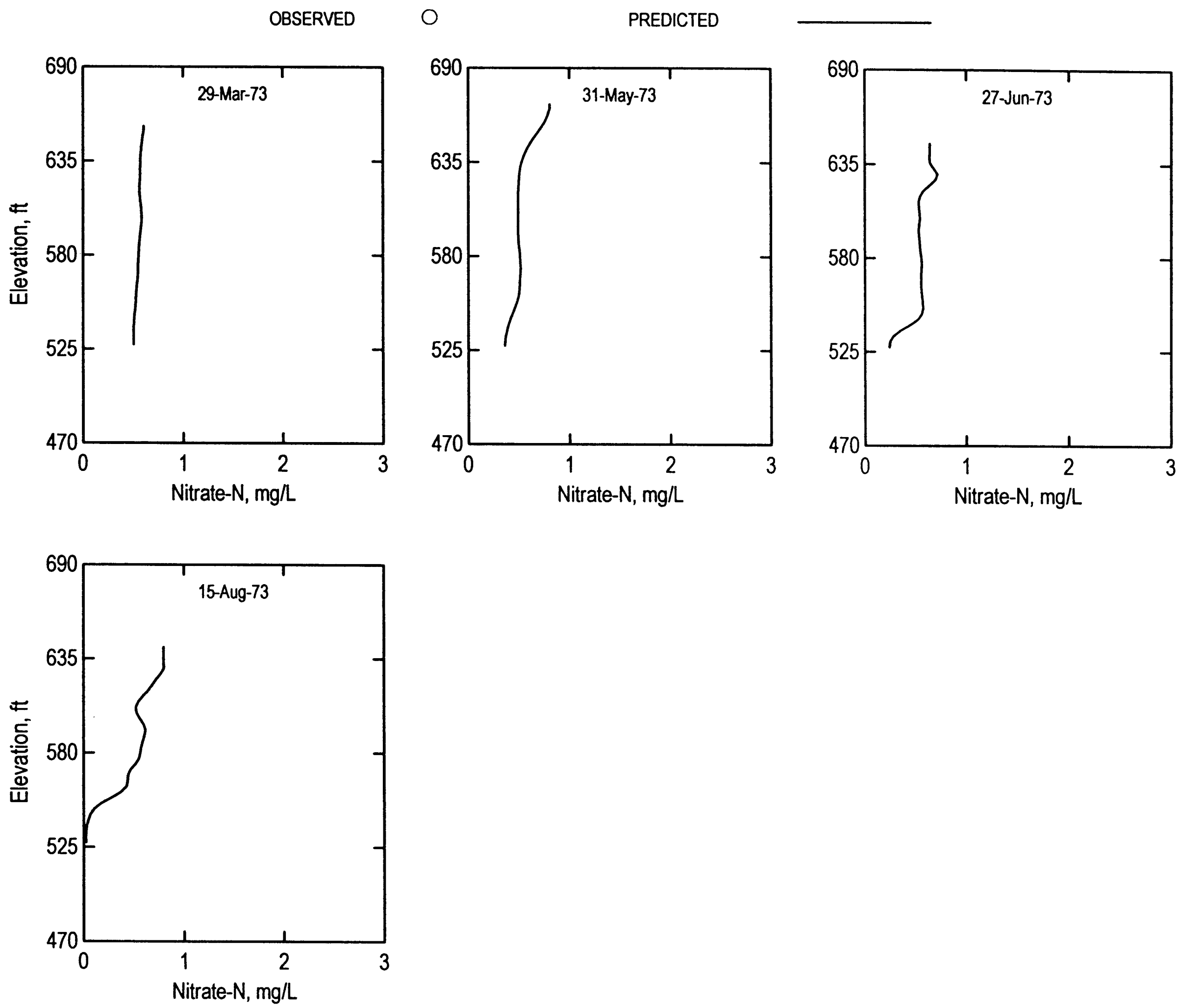
Center Hill Lake 1973 Station CEN20003

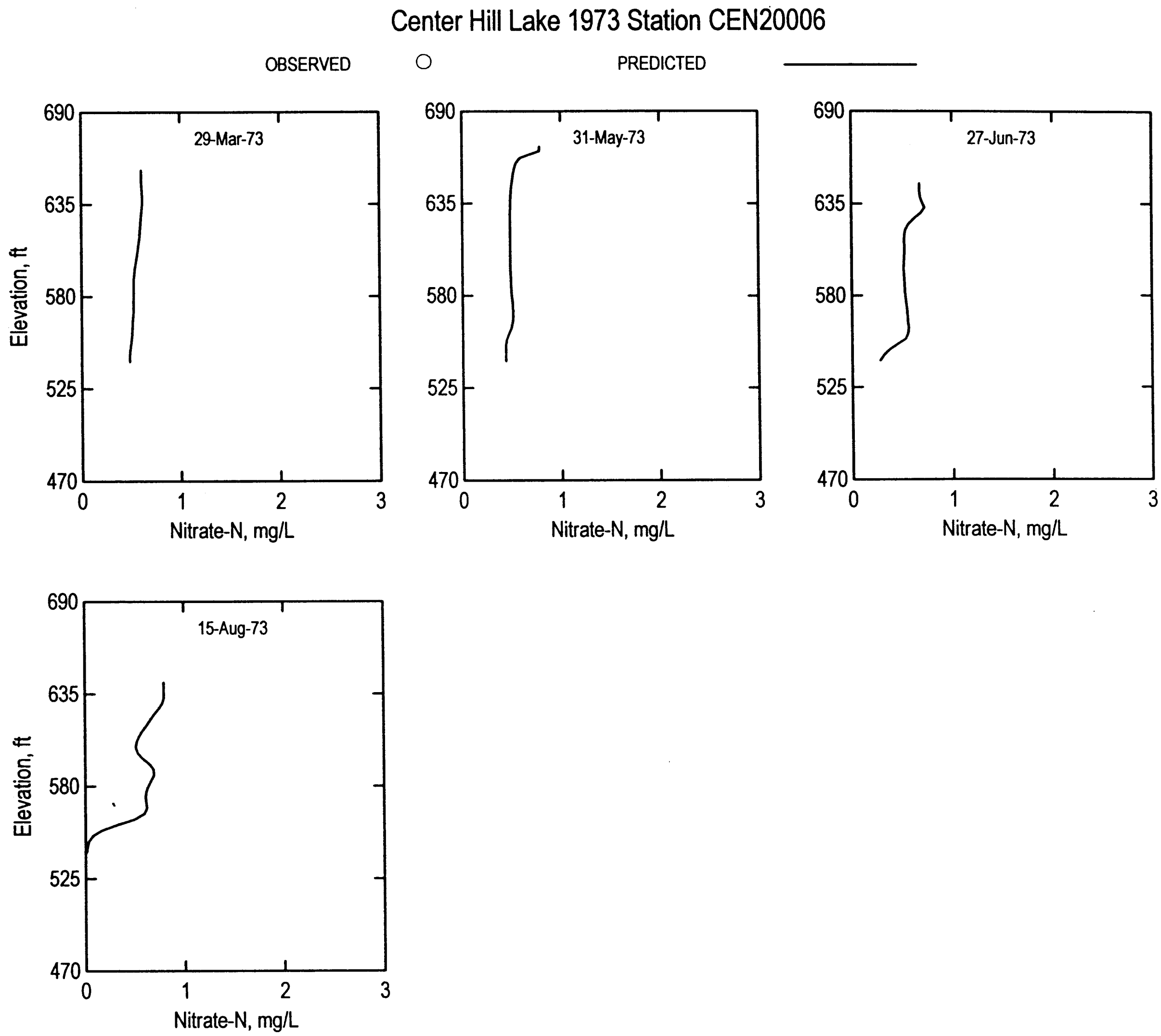


Center Hill Lake 1973 Station CEN20004

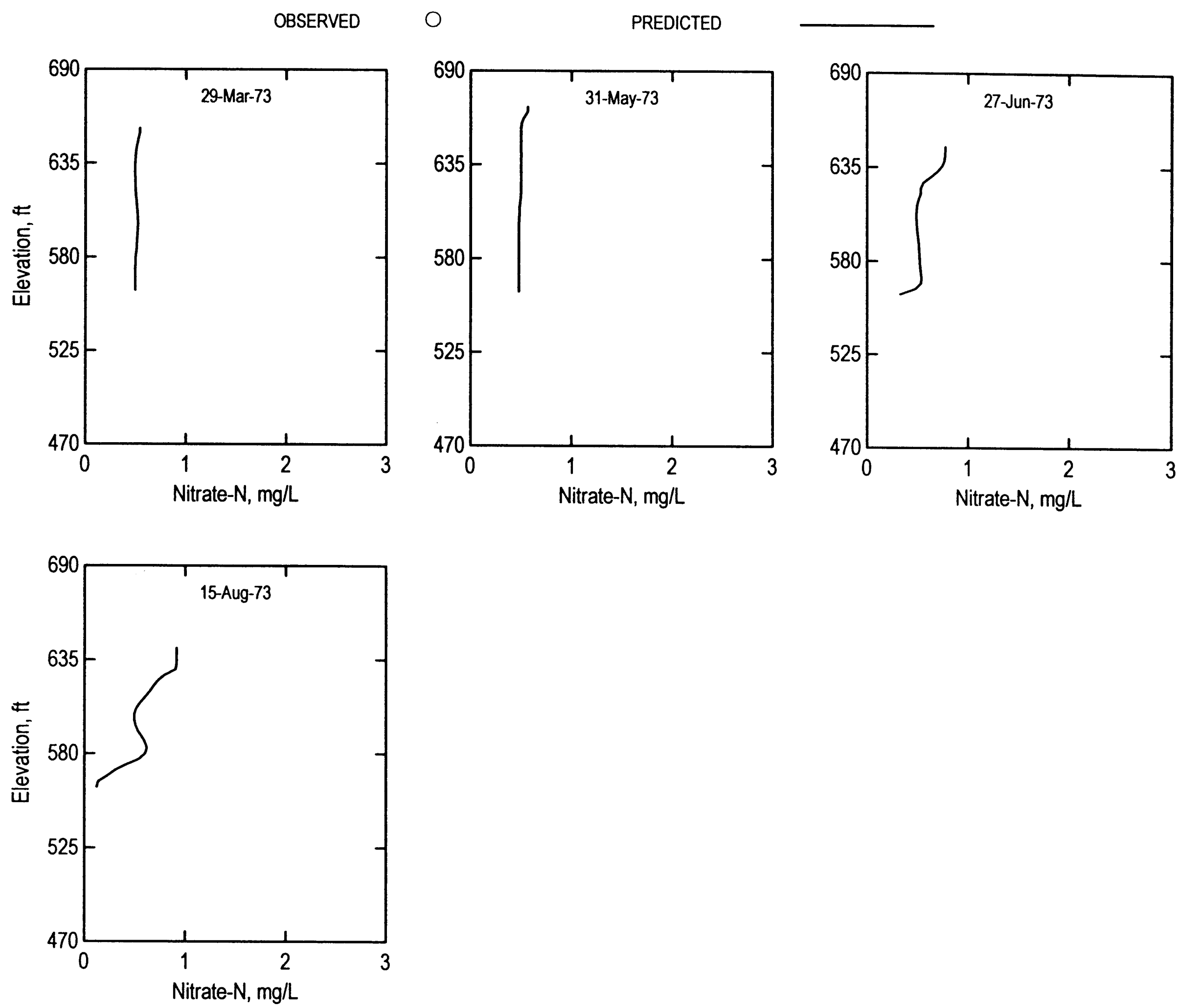


Center Hill Lake 1973 Station CEN20005

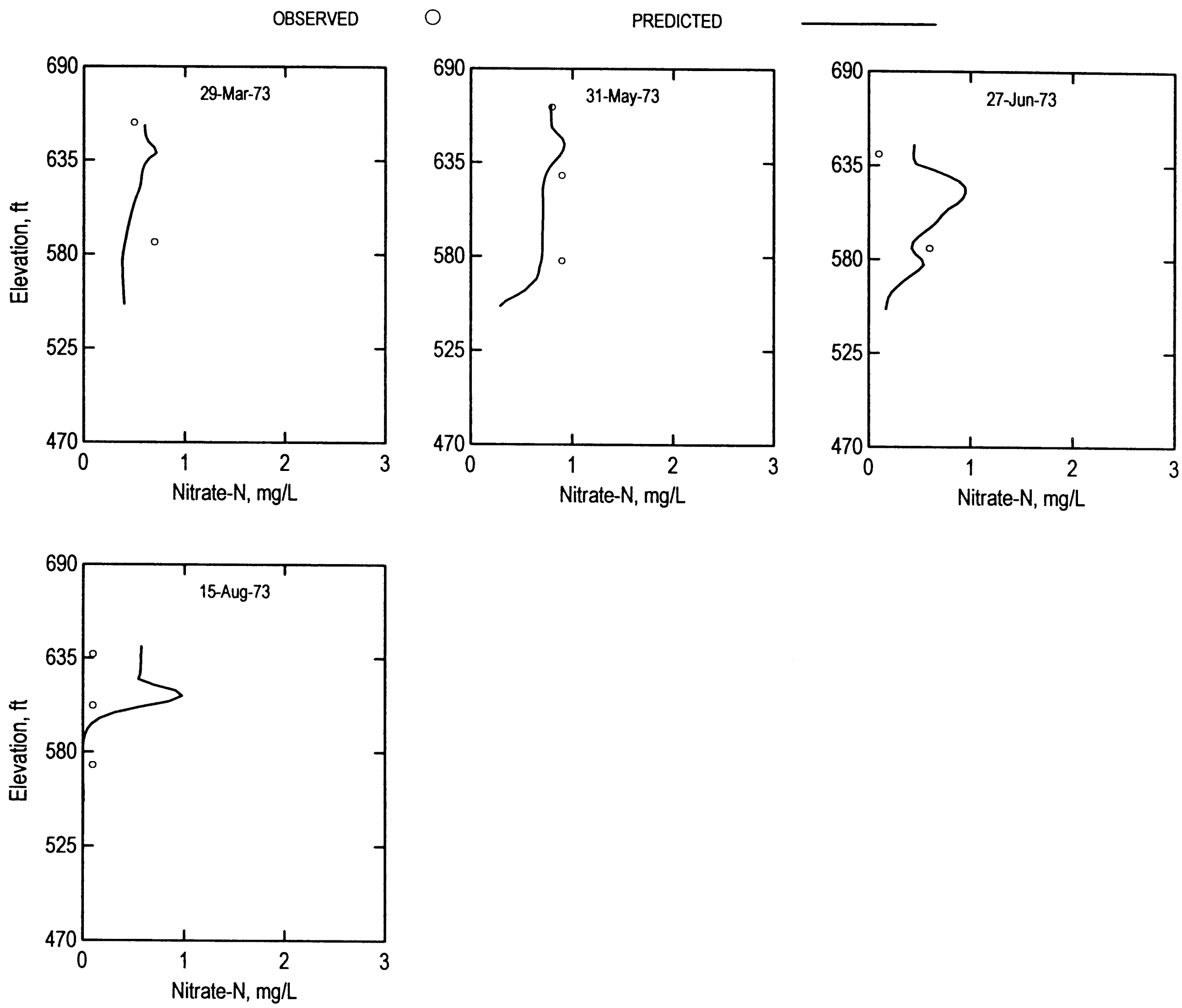


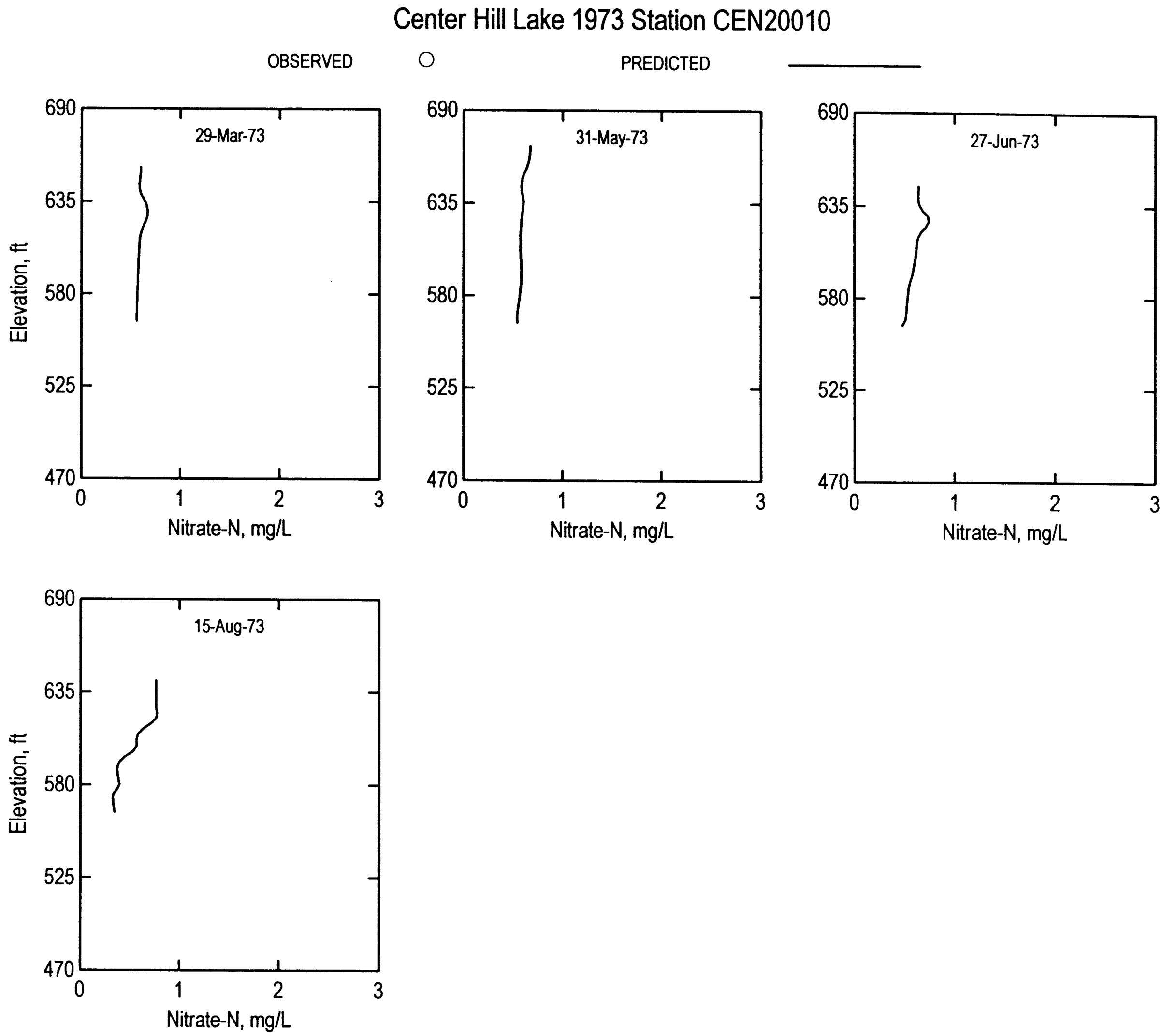

Center Hill Lake 1973 Station CEN20006
OBSERVED
PREDICTED
29-Mar-73
31-May-73
27-Jun-73
15-Aug-73
Elevation, ft
Nitrate-N, mg/L
690
635
580
525
470
0
1
2
3

Center Hill Lake 1973 Station CEN20007



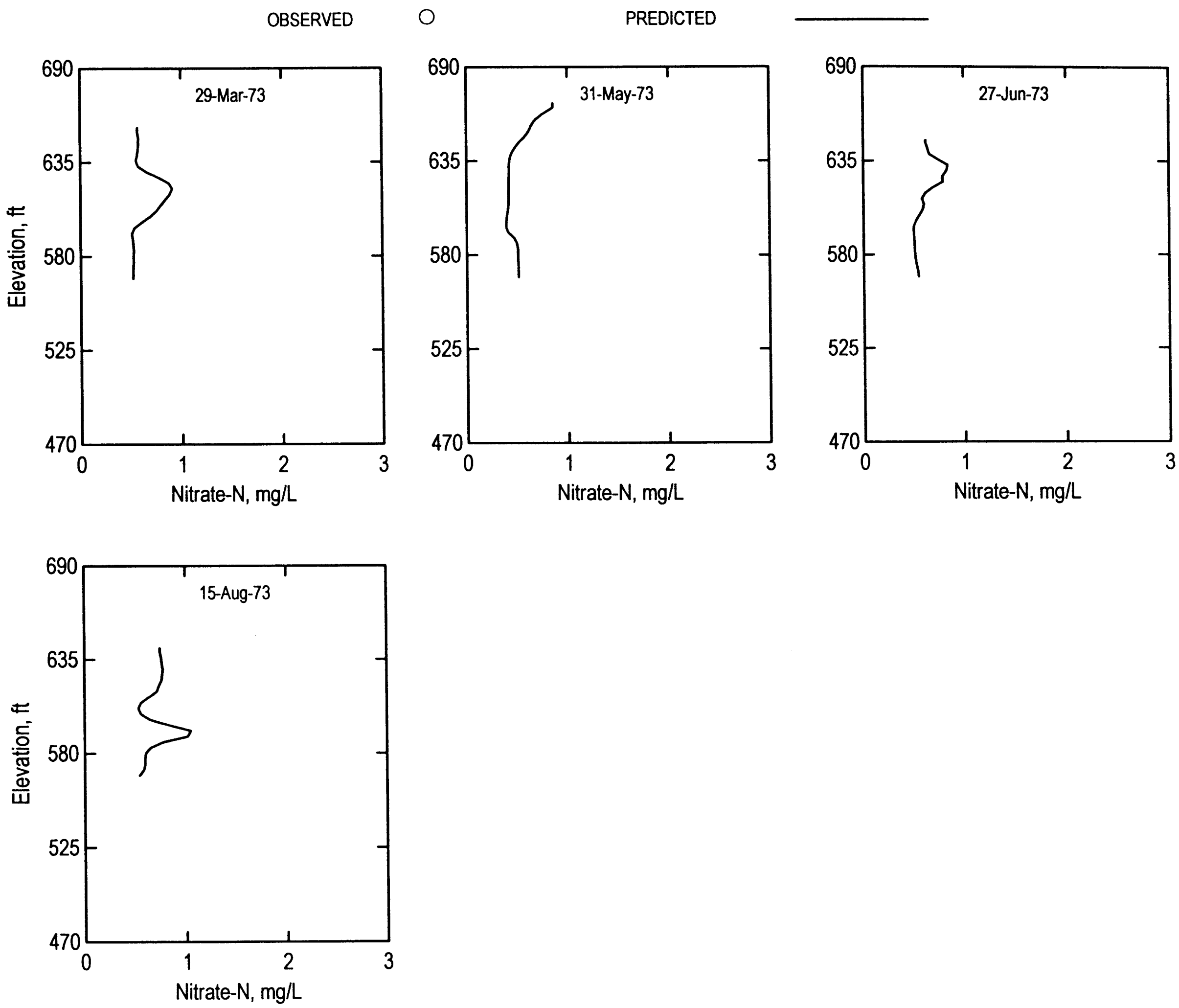
Center Hill Lake 1973 Station CEN20008



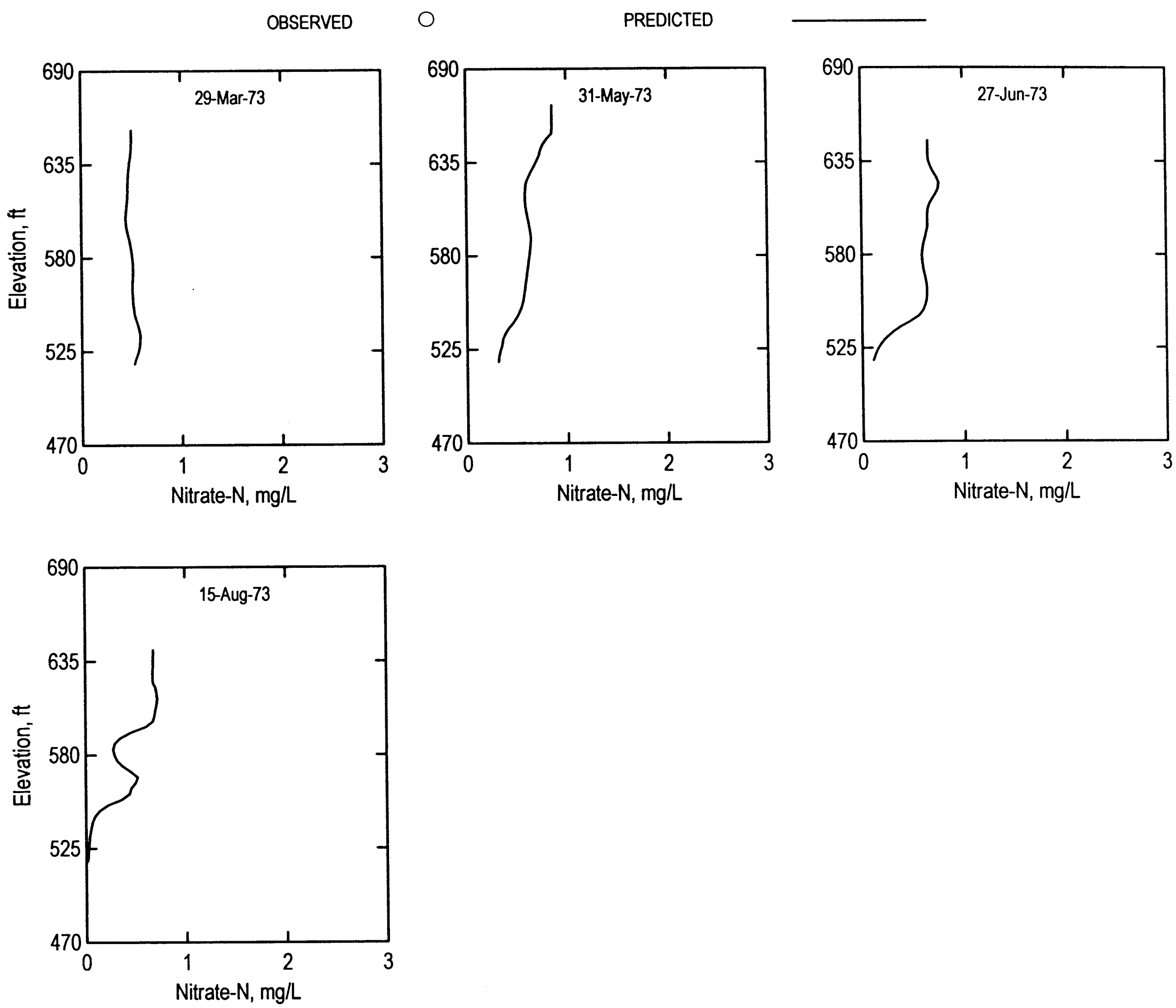


Center Hill Lake 1973 Station CEN20010
OBSERVED
PREDICTED
29-Mar-73
31-May-73
27-Jun-73
15-Aug-73
Elevation, ft
690
635
580
525
470
Nitrate-N, mg/L
0
1
2
3

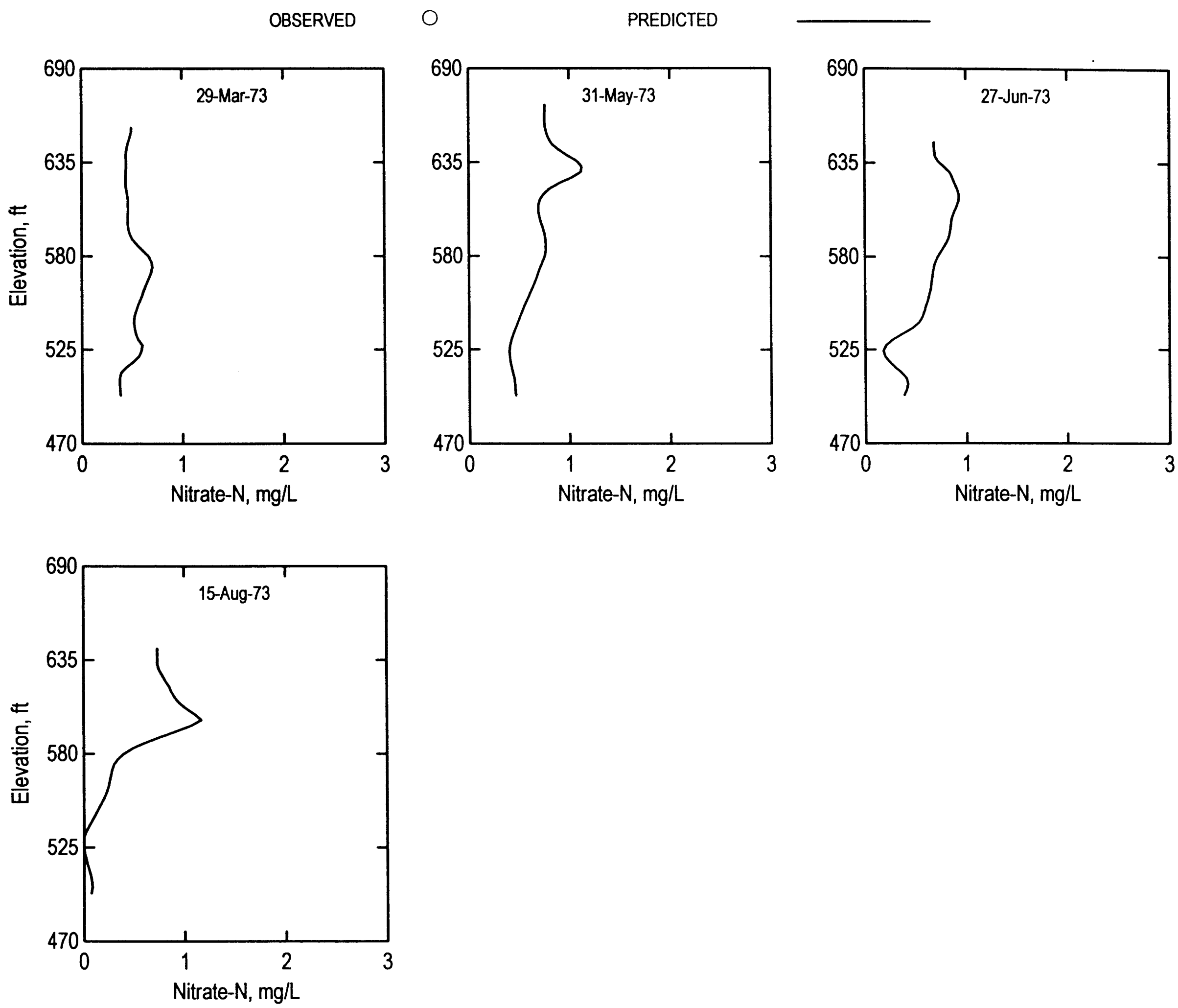
Center Hill Lake 1973 Station CEN20011



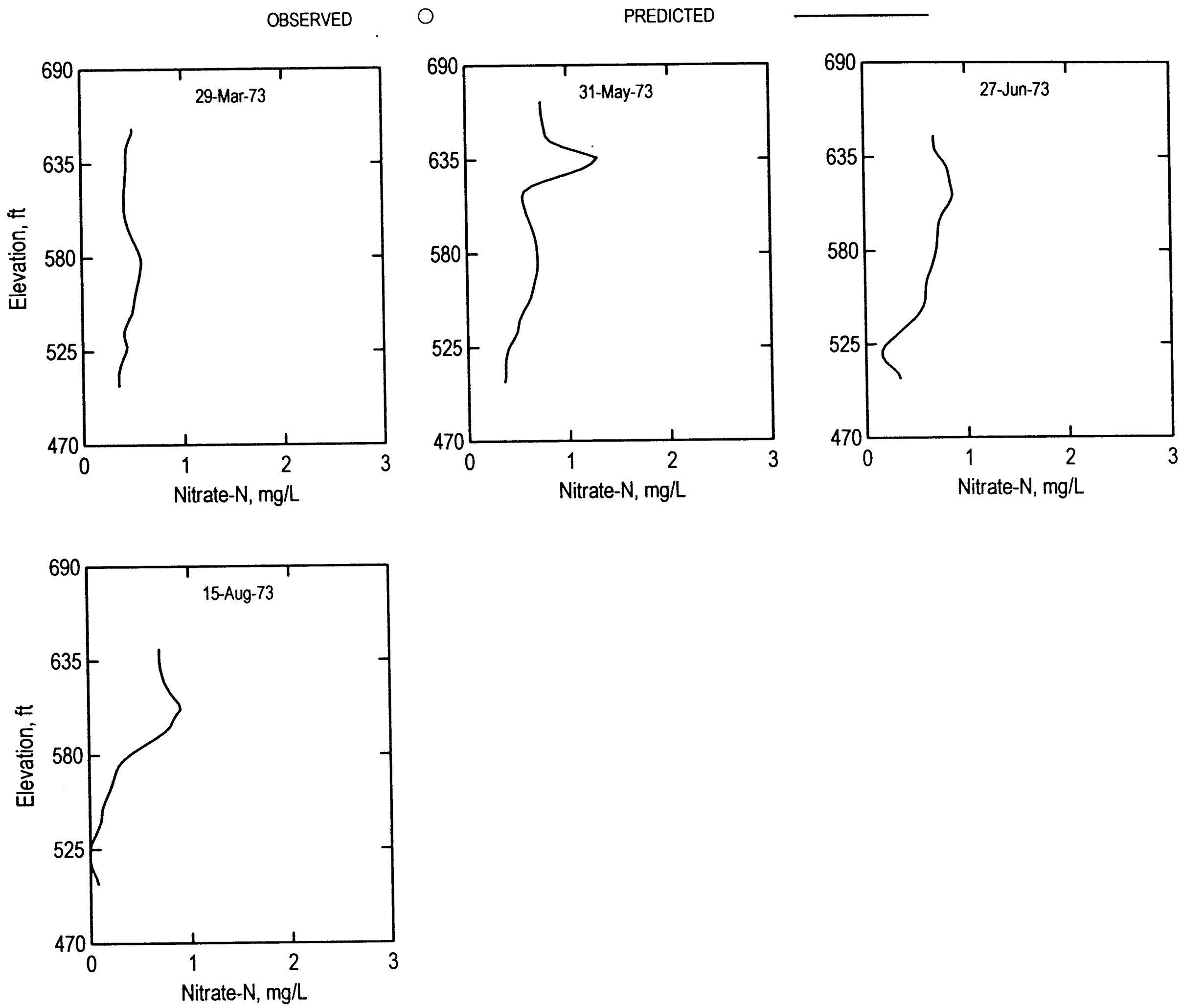
Center Hill Lake 1973 Station CEN20015



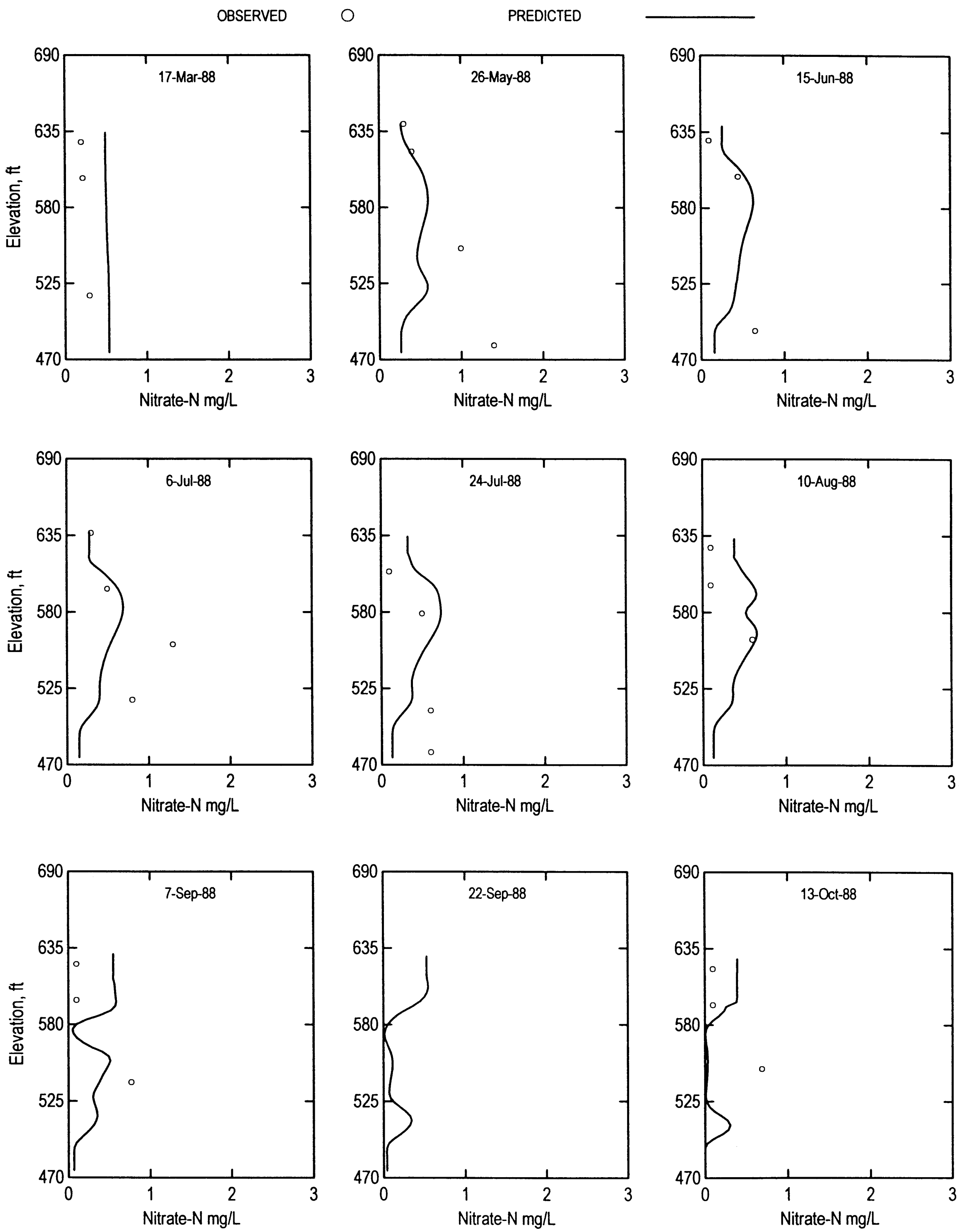
Center Hill Lake 1973 Station CEN20013



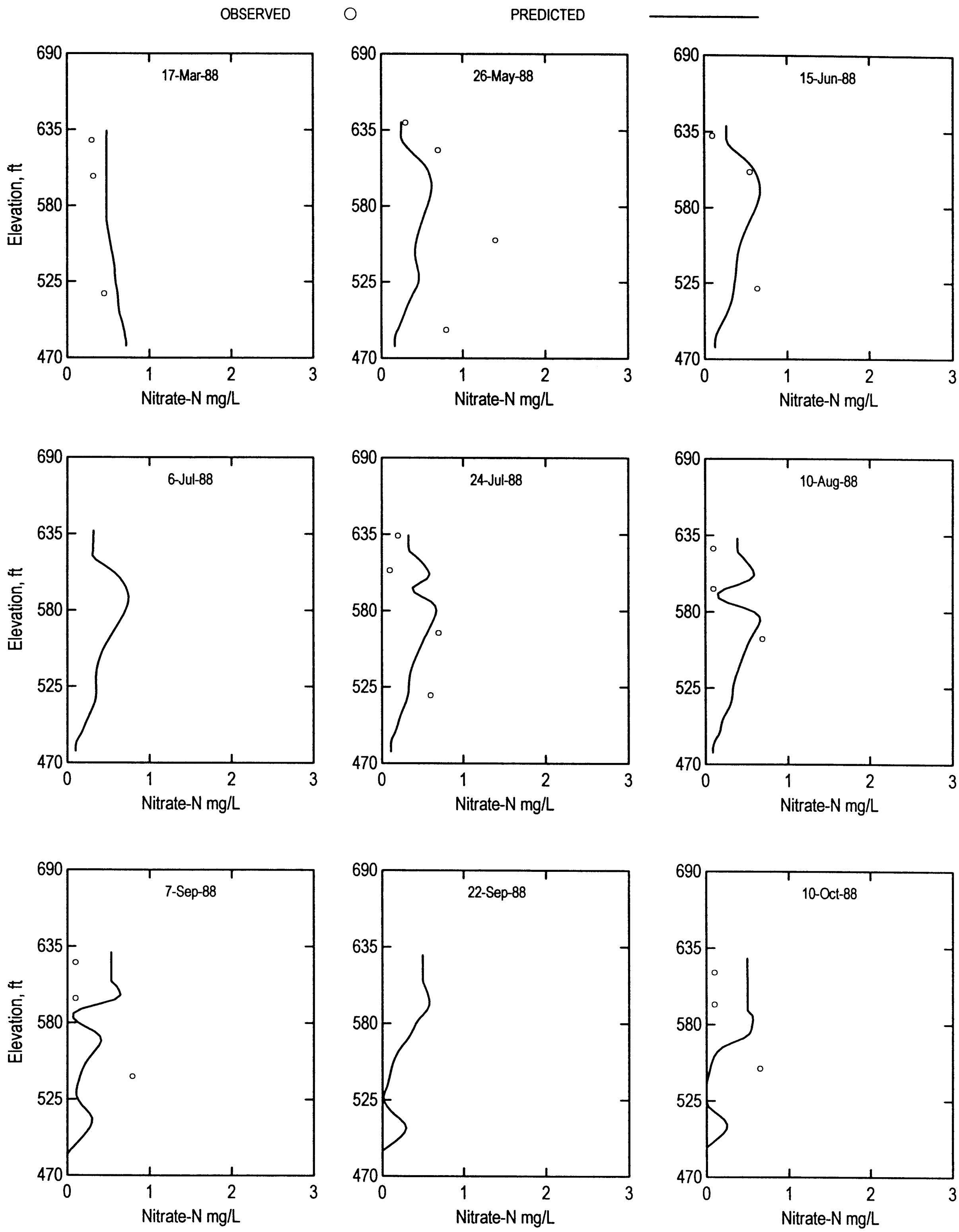
Center Hill Lake 1973 Station CEN20014



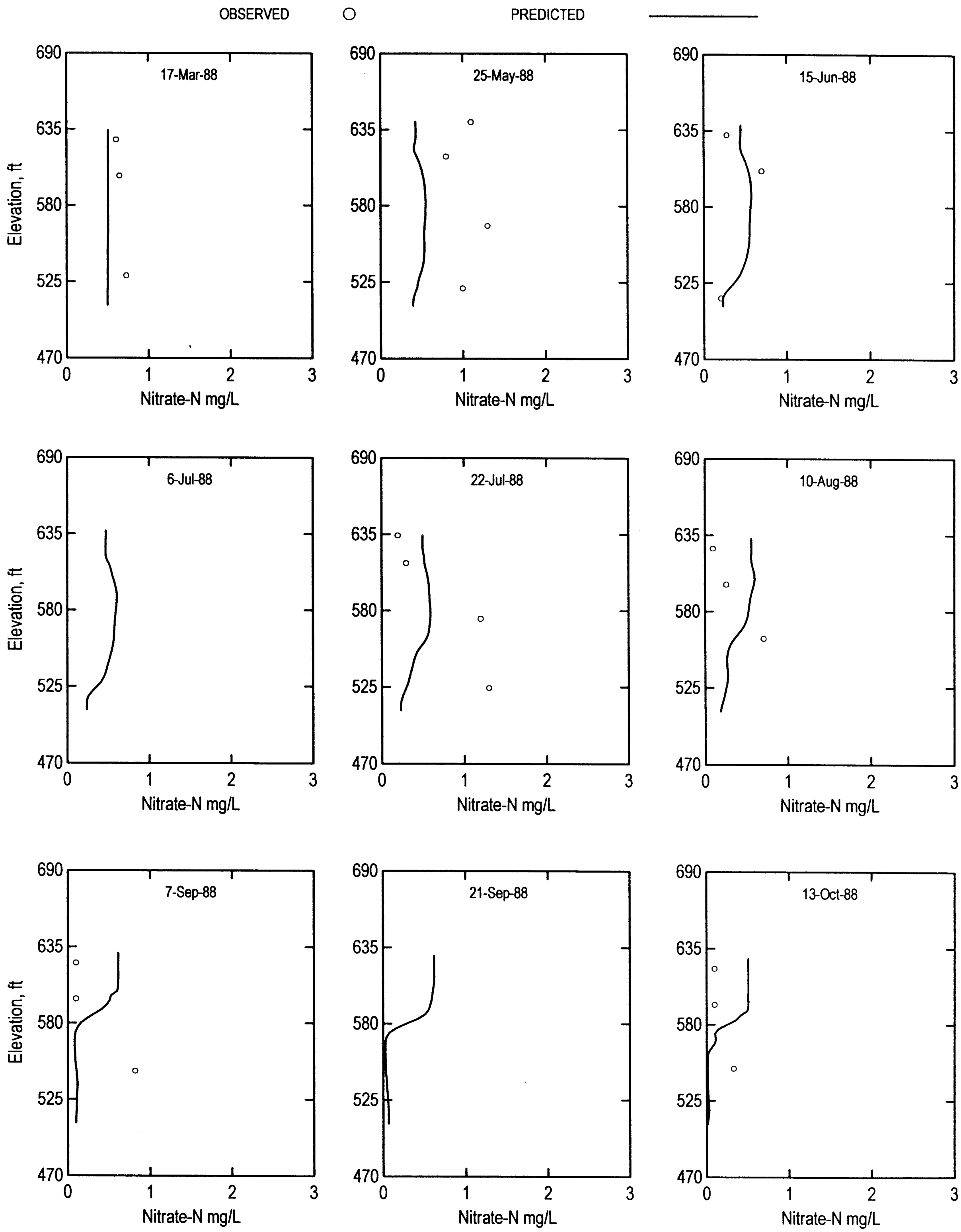
Center Hill Lake 1988 Station CEN20002



Center Hill Lake 1988 Station CEN20003

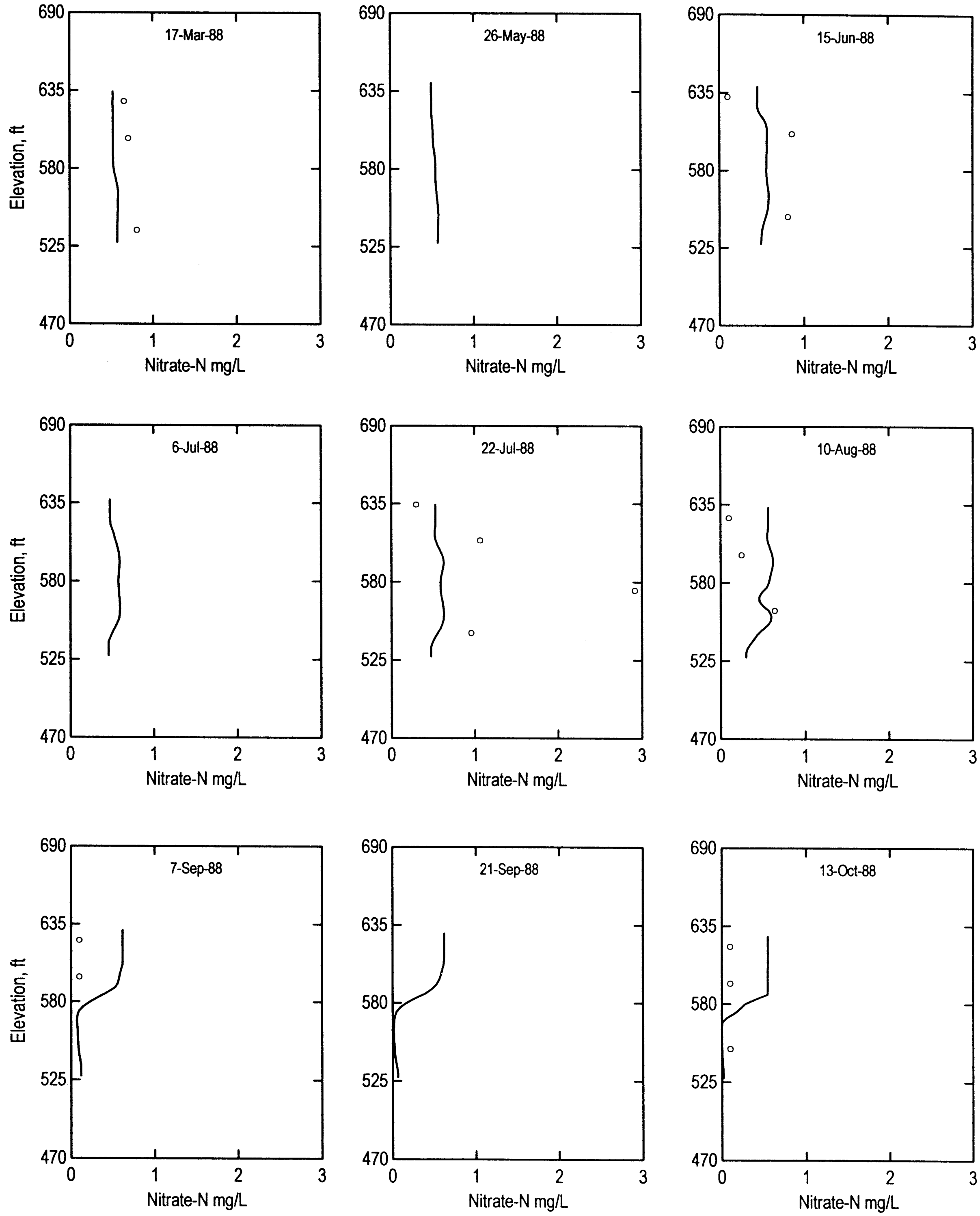


Center Hill Lake 1988 Station CEN20004

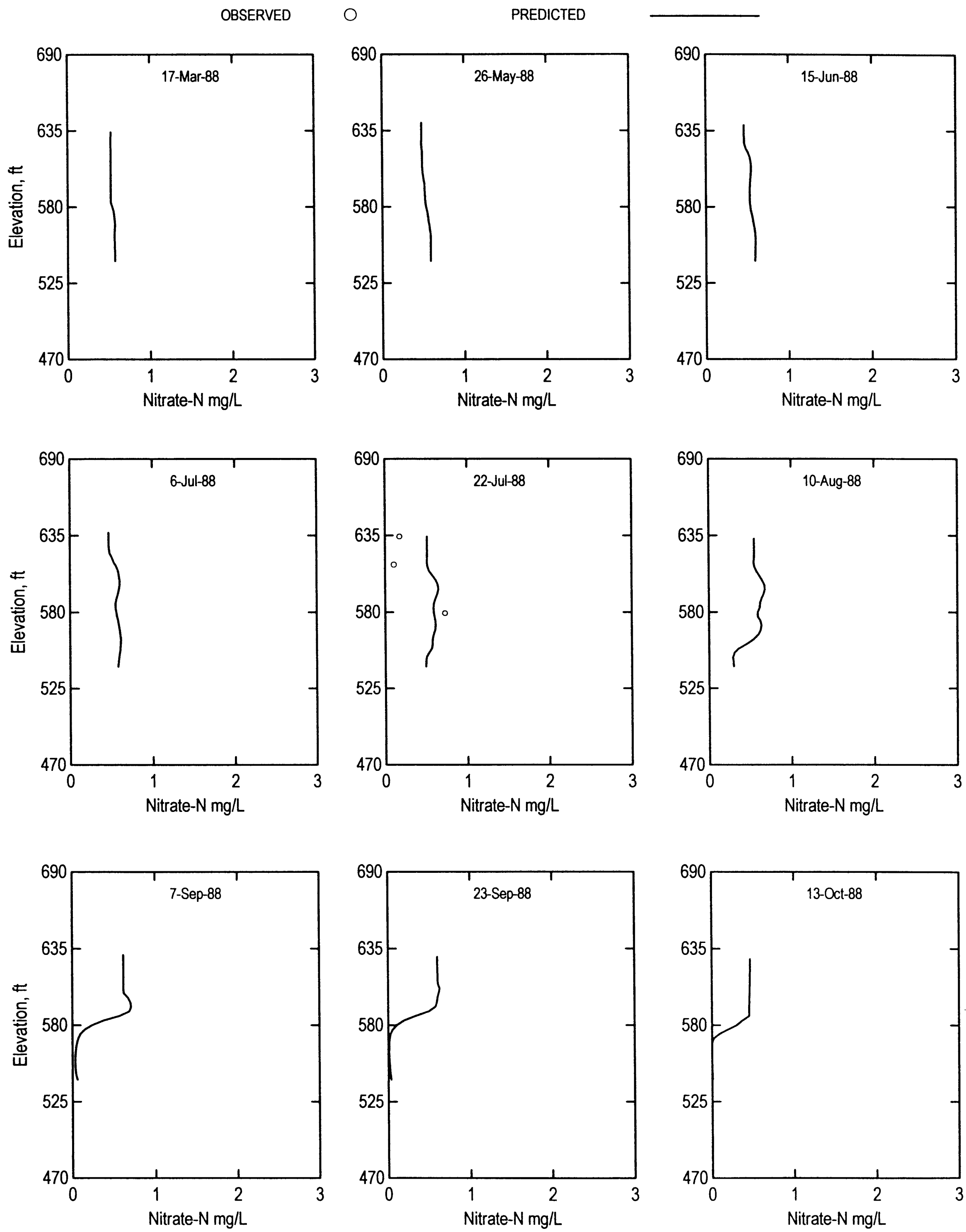


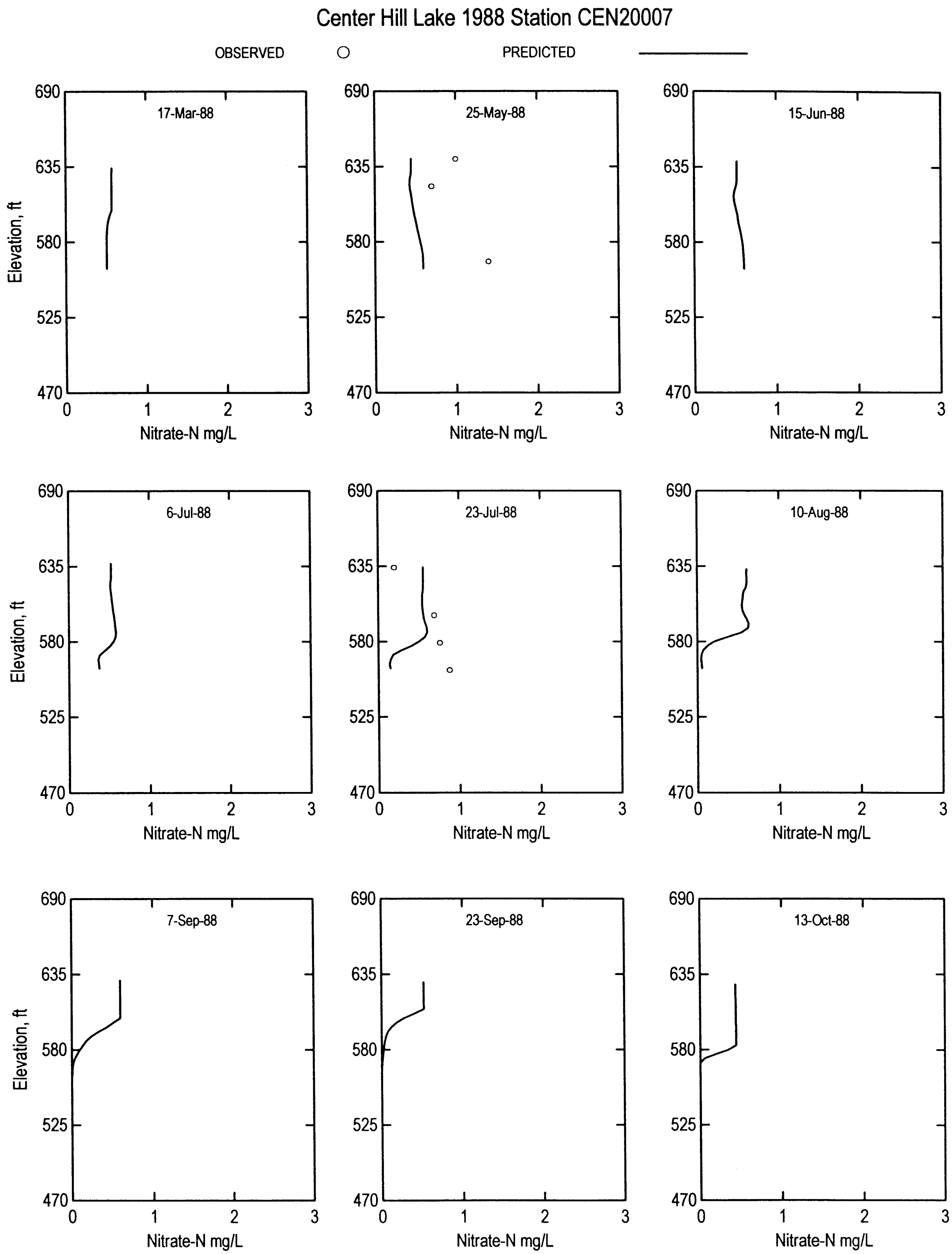
Center Hill Lake 1988 Station CEN20005

OBSERVED ○ PREDICTED ———

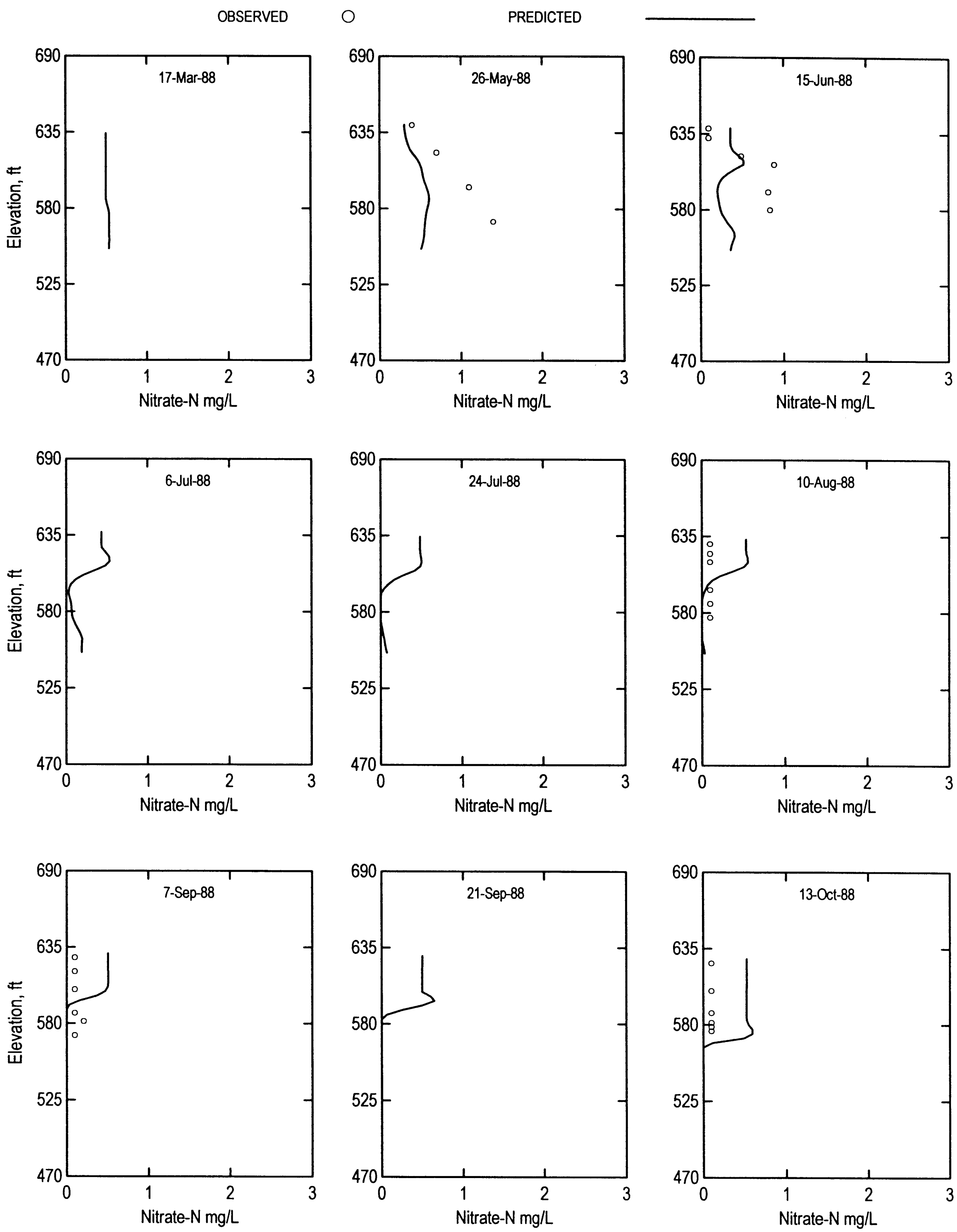


Center Hill Lake 1988 Station CEN20006



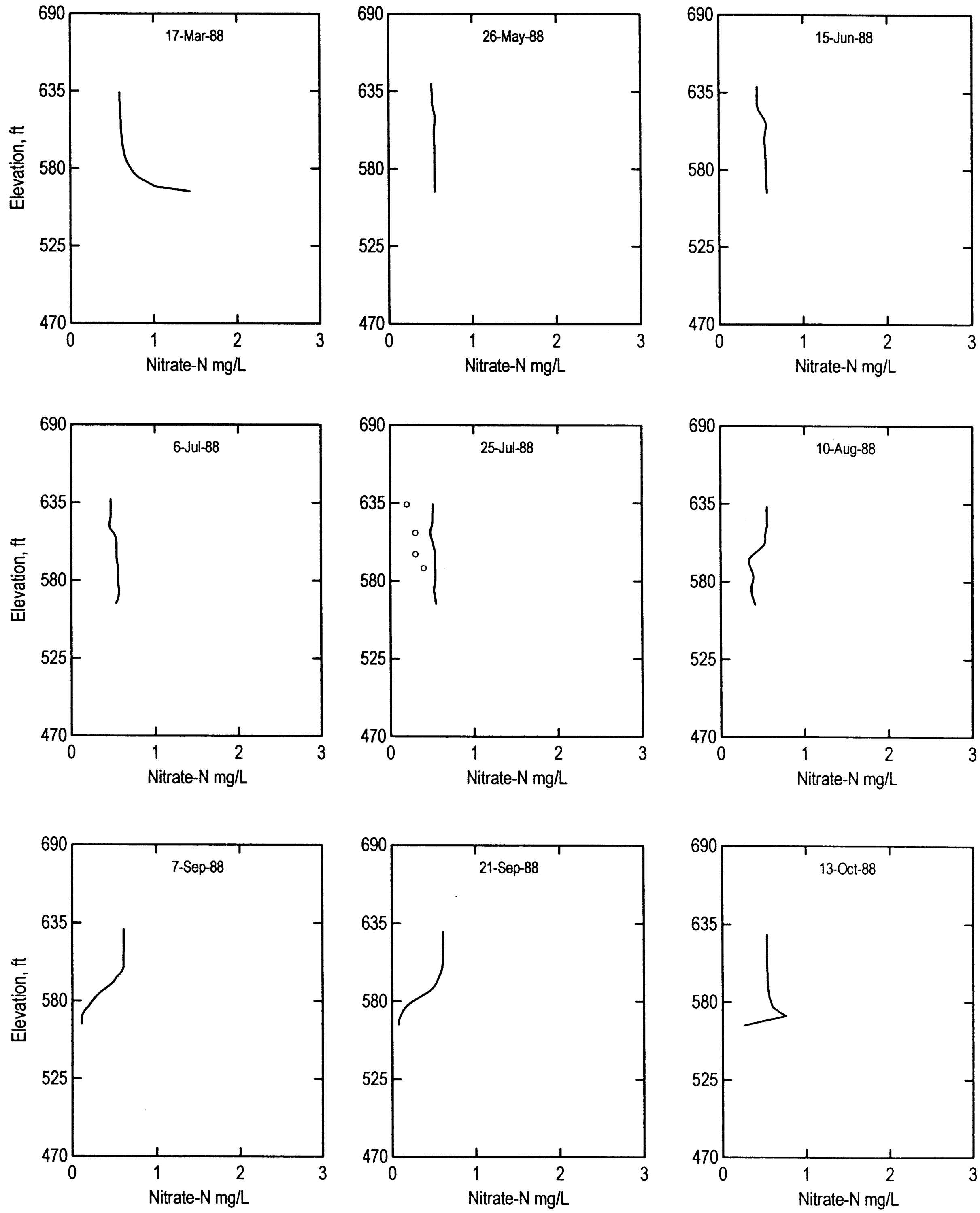

Center Hill Lake 1988 Station CEN20007
OBSERVED
PREDICTED
17-Mar-88
25-May-88
15-Jun-88
6-Jul-88
23-Jul-88
10-Aug-88
7-Sep-88
23-Sep-88
13-Oct-88
Elevation, ft
Nitrate-N mg/L
690
635
580
525
470
0
1
2
3

Center Hill Lake 1988 Station CEN20008

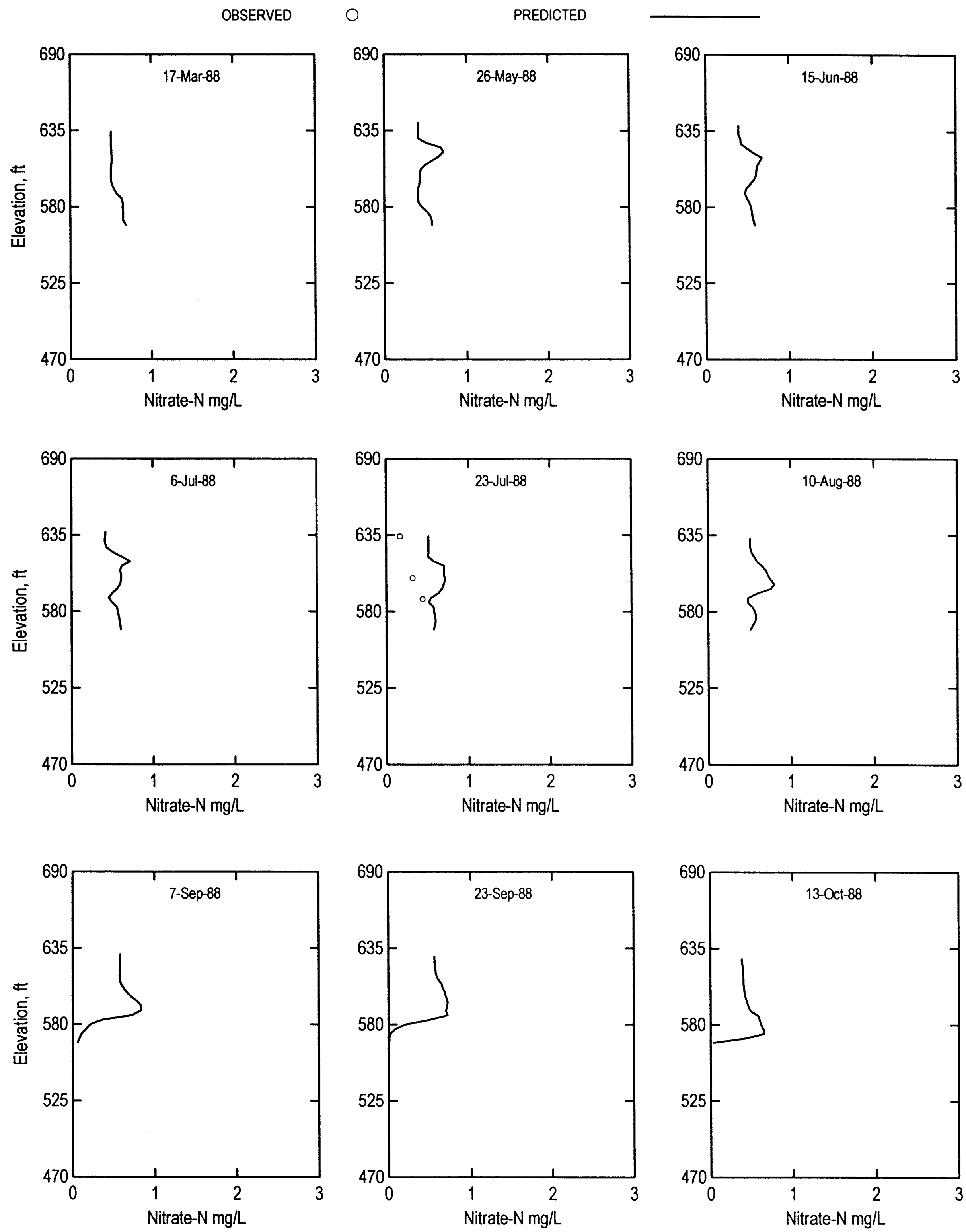


Center Hill Lake 1988 Station CEN20010

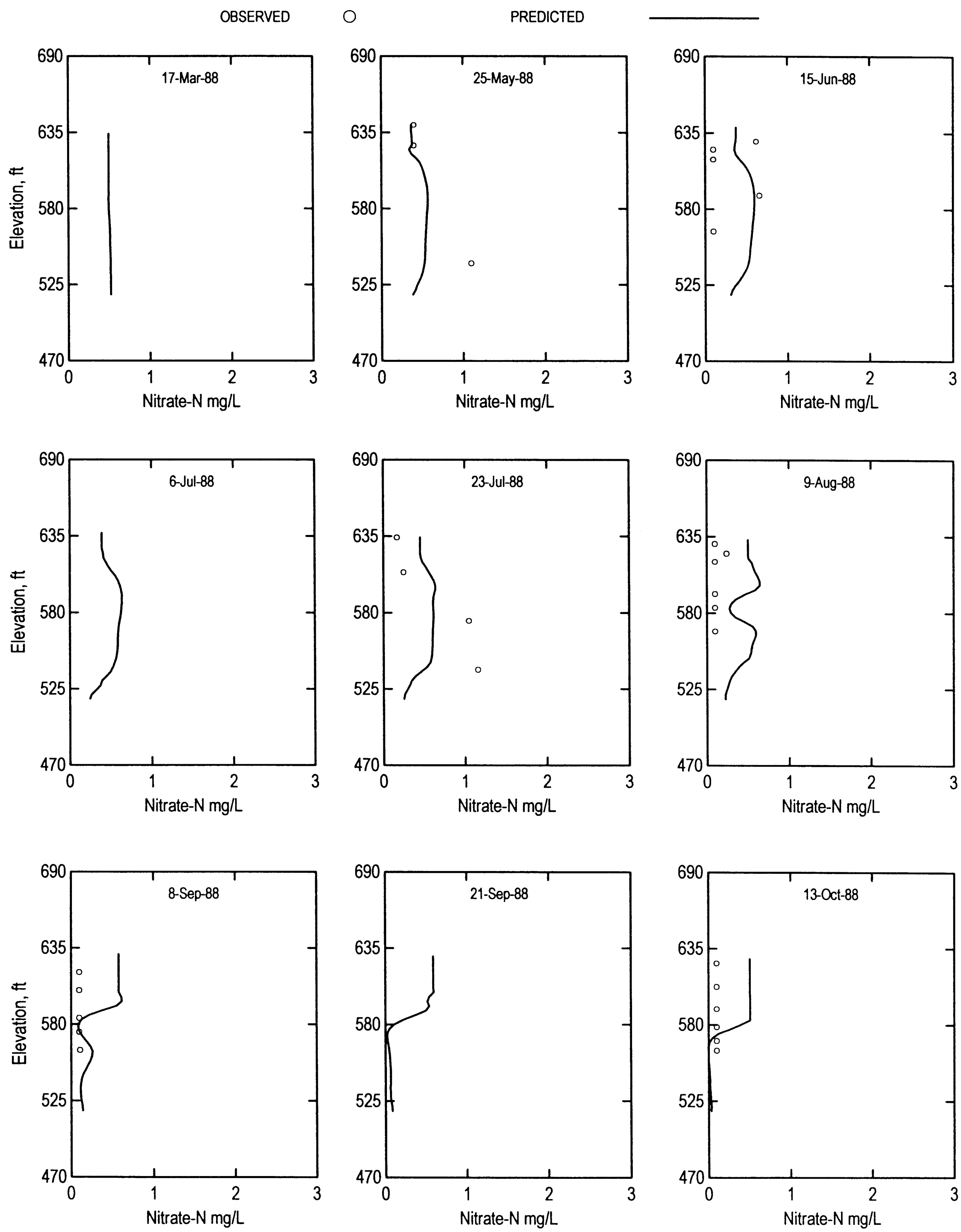
OBSERVED ○ PREDICTED ———



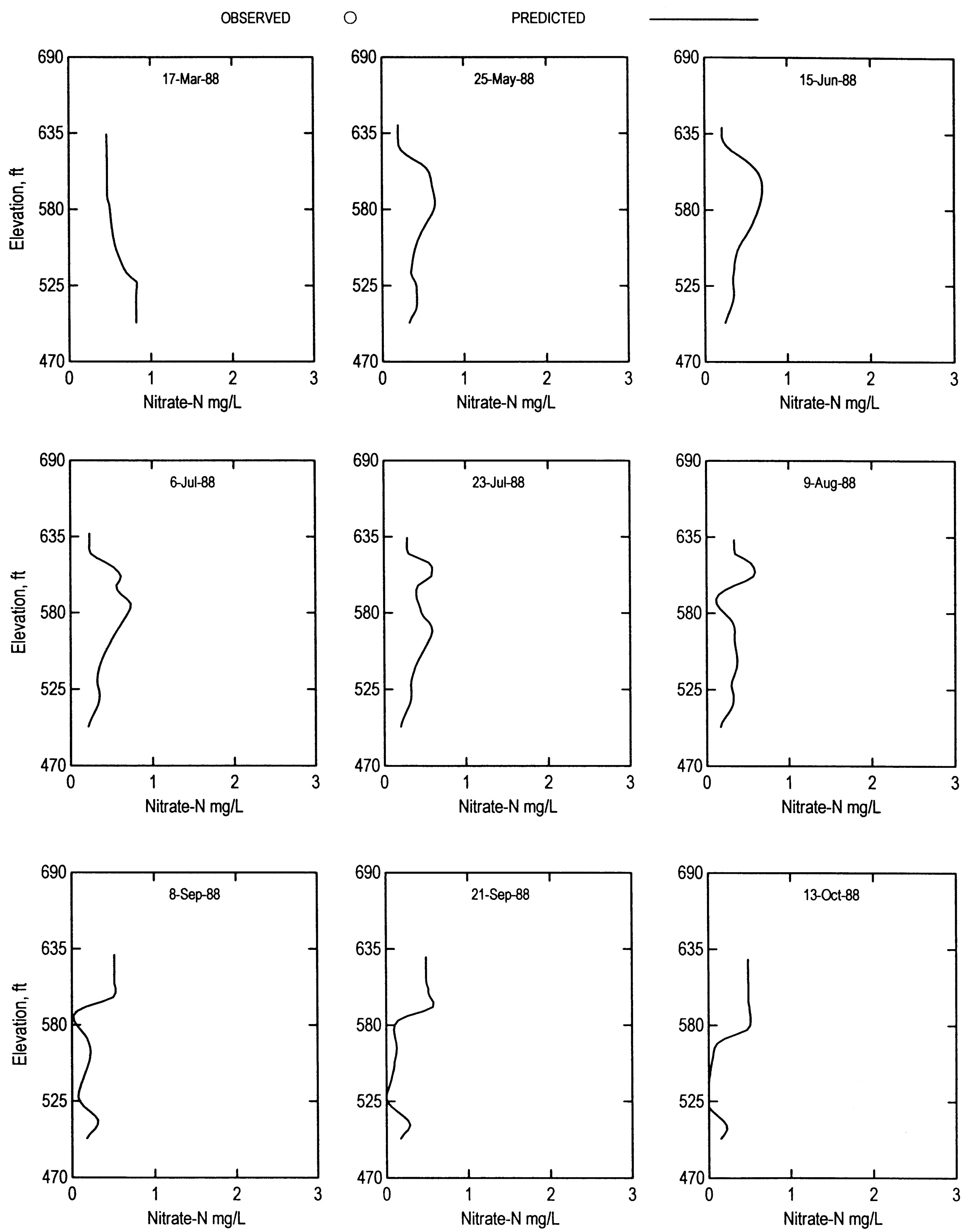
Center Hill Lake 1988 Station CEN20011



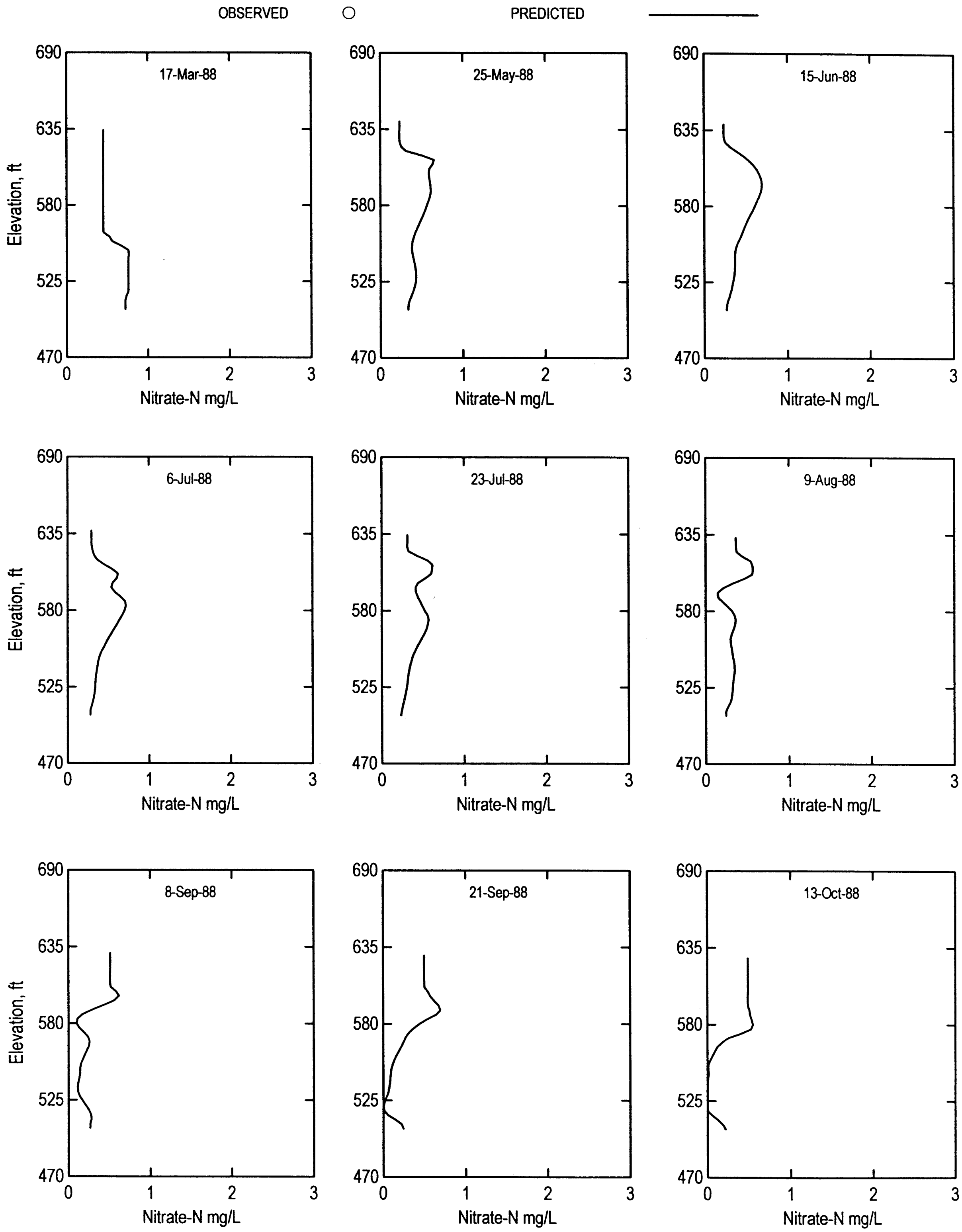
Center Hill Lake 1988 Station CEN20015

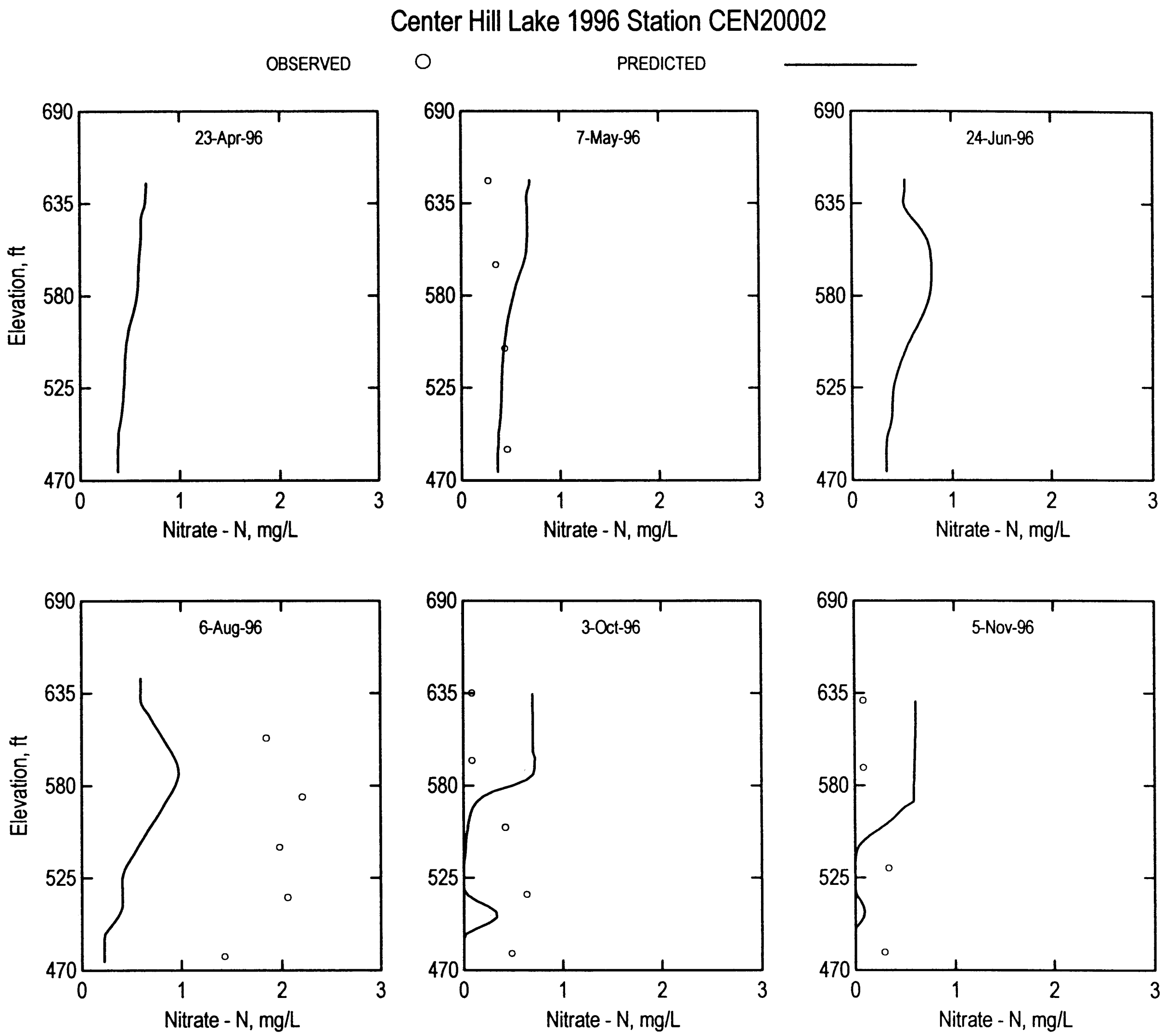


Center Hill Lake 1988 Station CEN20013

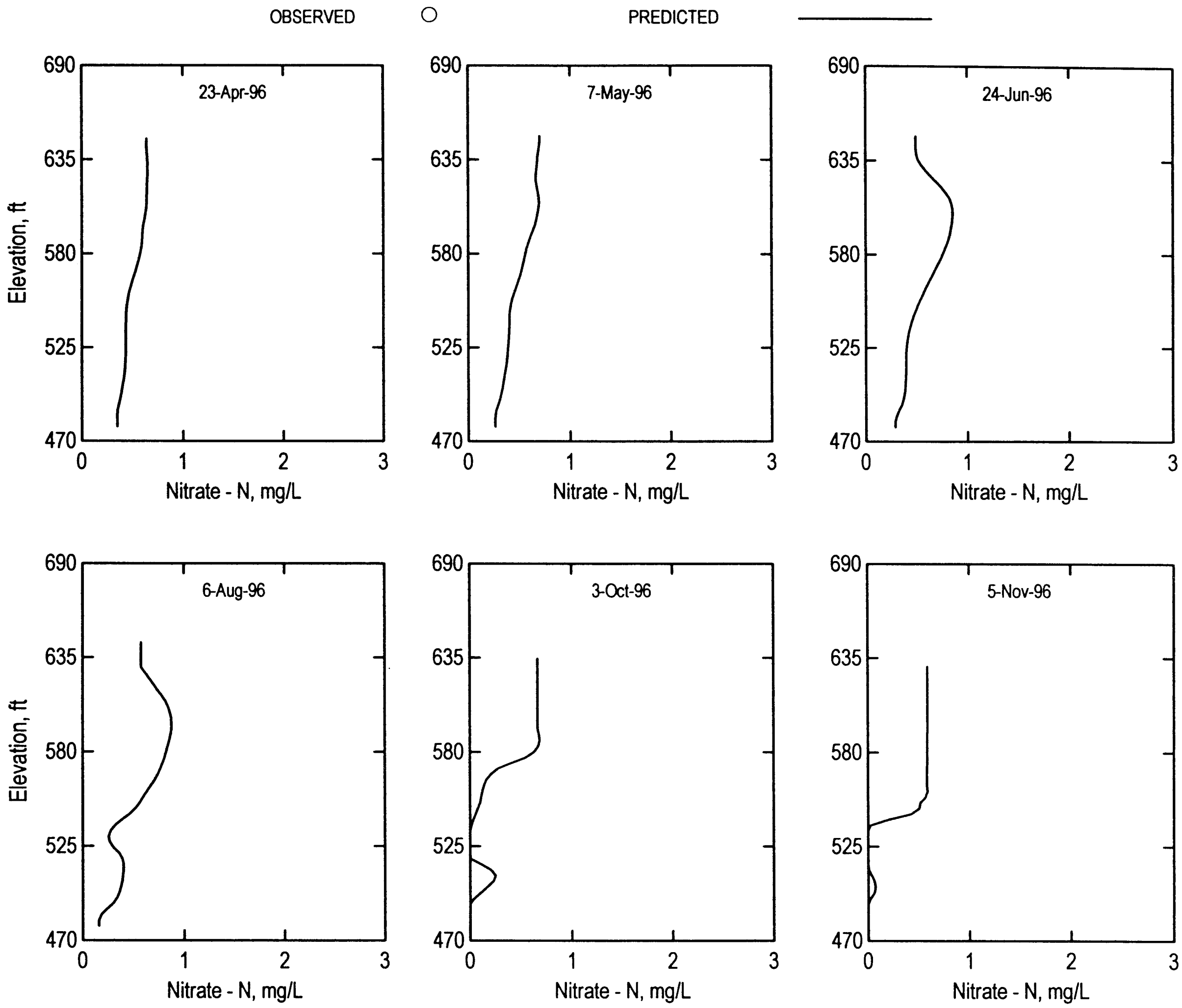


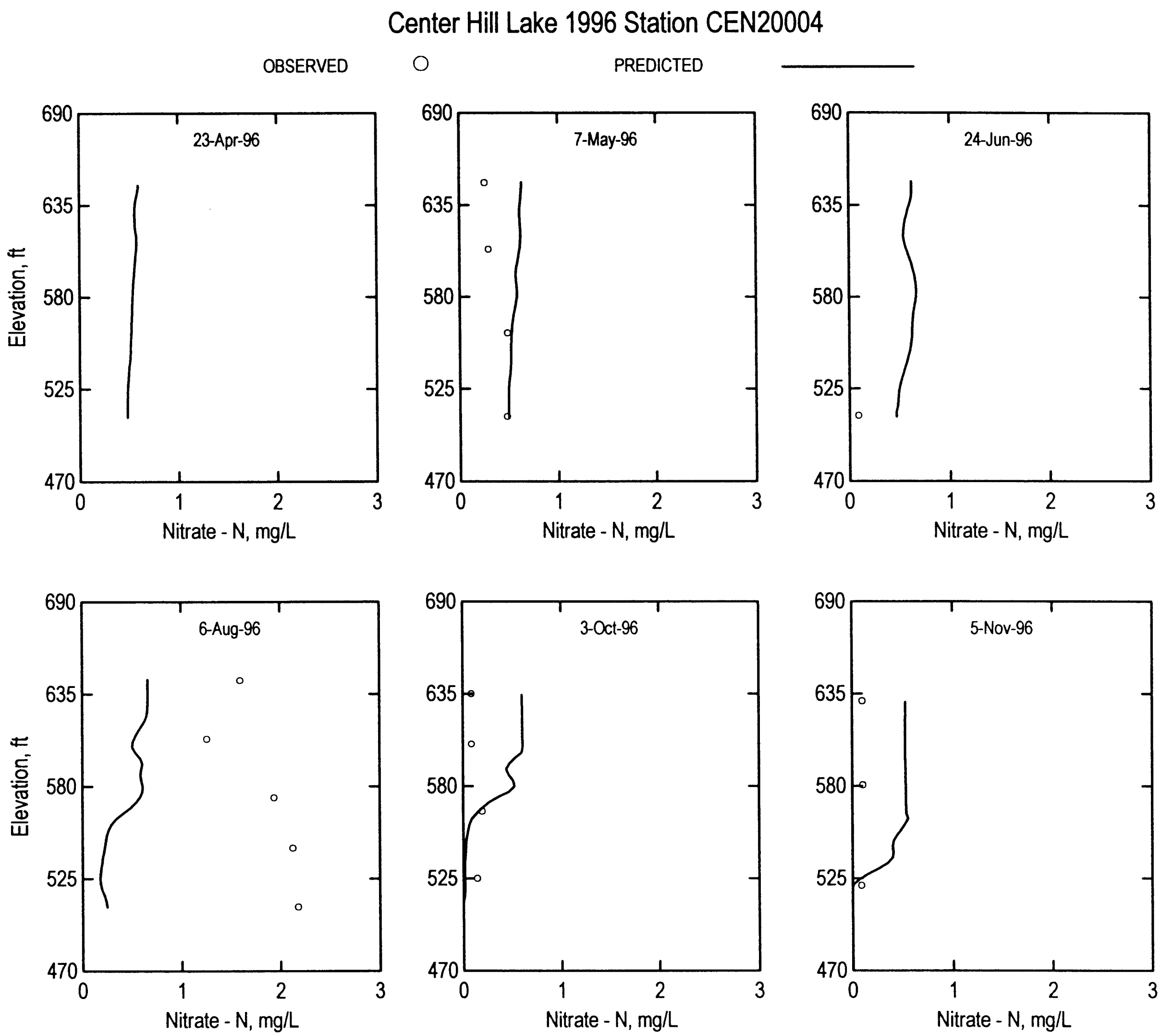
Center Hill Lake 1988 Station CEN20014



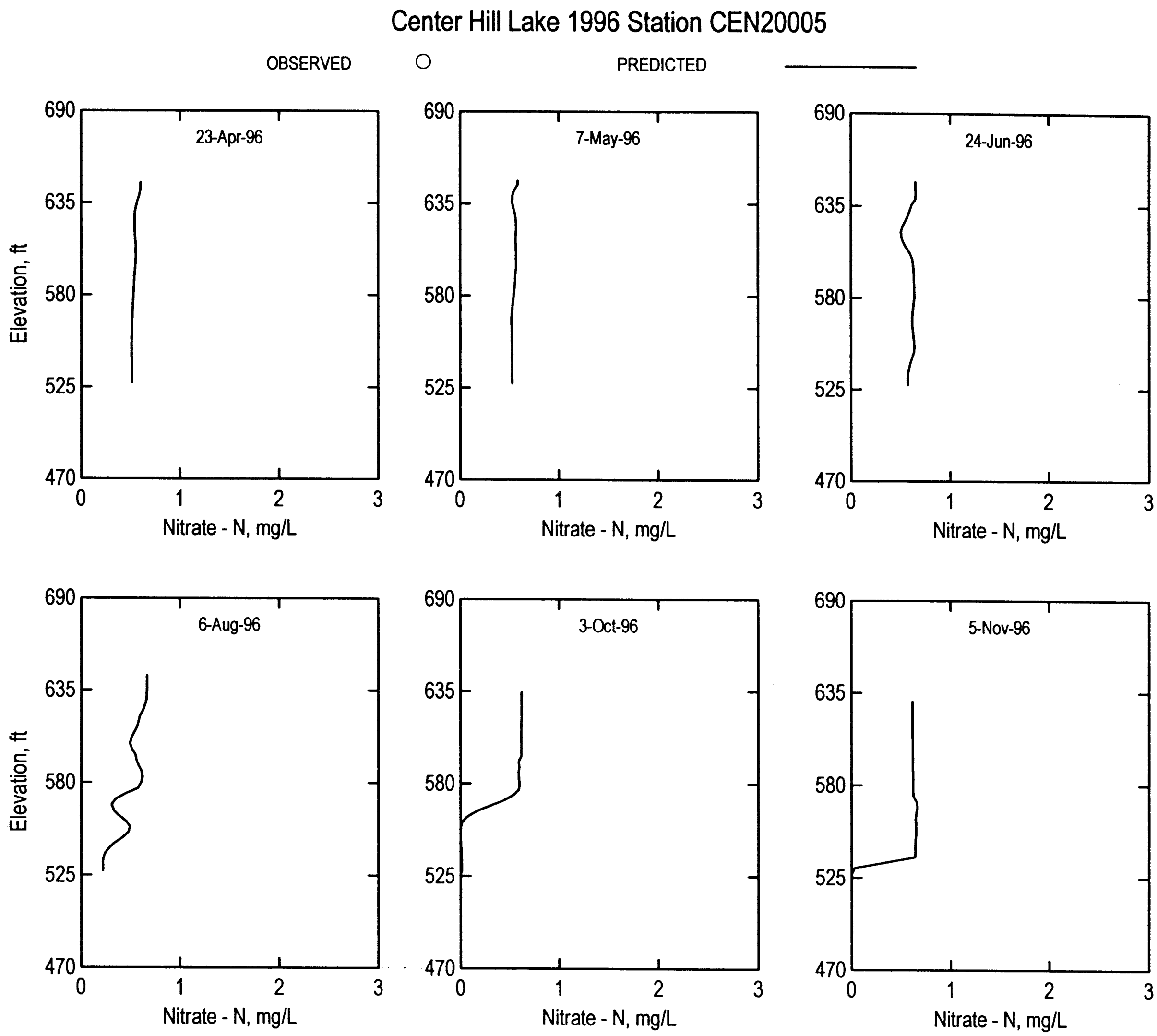

Center Hill Lake 1996 Station CEN20002
OBSERVED
PREDICTED
23-Apr-96
7-May-96
24-Jun-96
6-Aug-96
3-Oct-96
5-Nov-96
Elevation, ft
Nitrate - N, mg/L
690
635
580
525
470
0
1
2
3

Center Hill Lake 1996 Station CEN20003

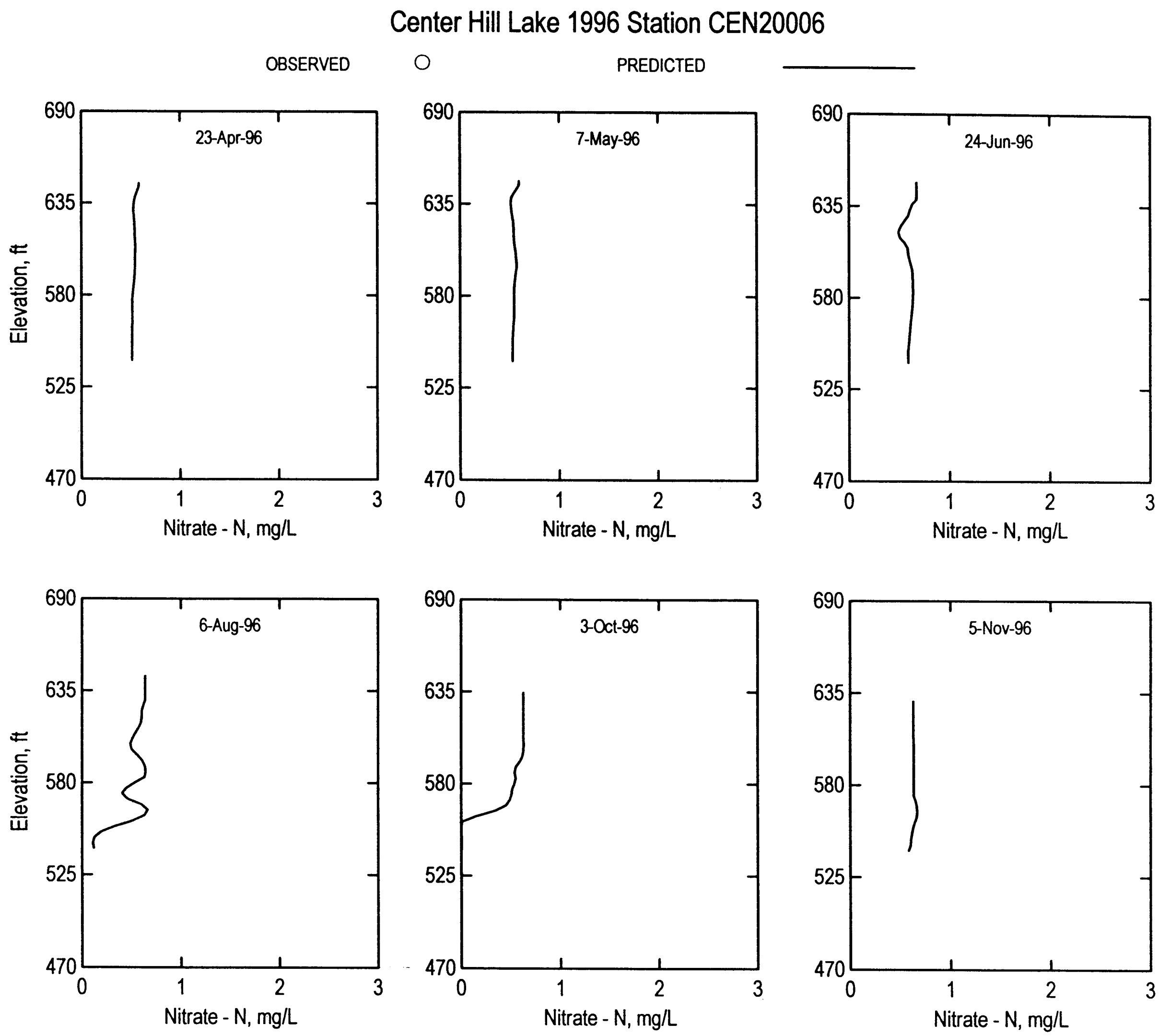




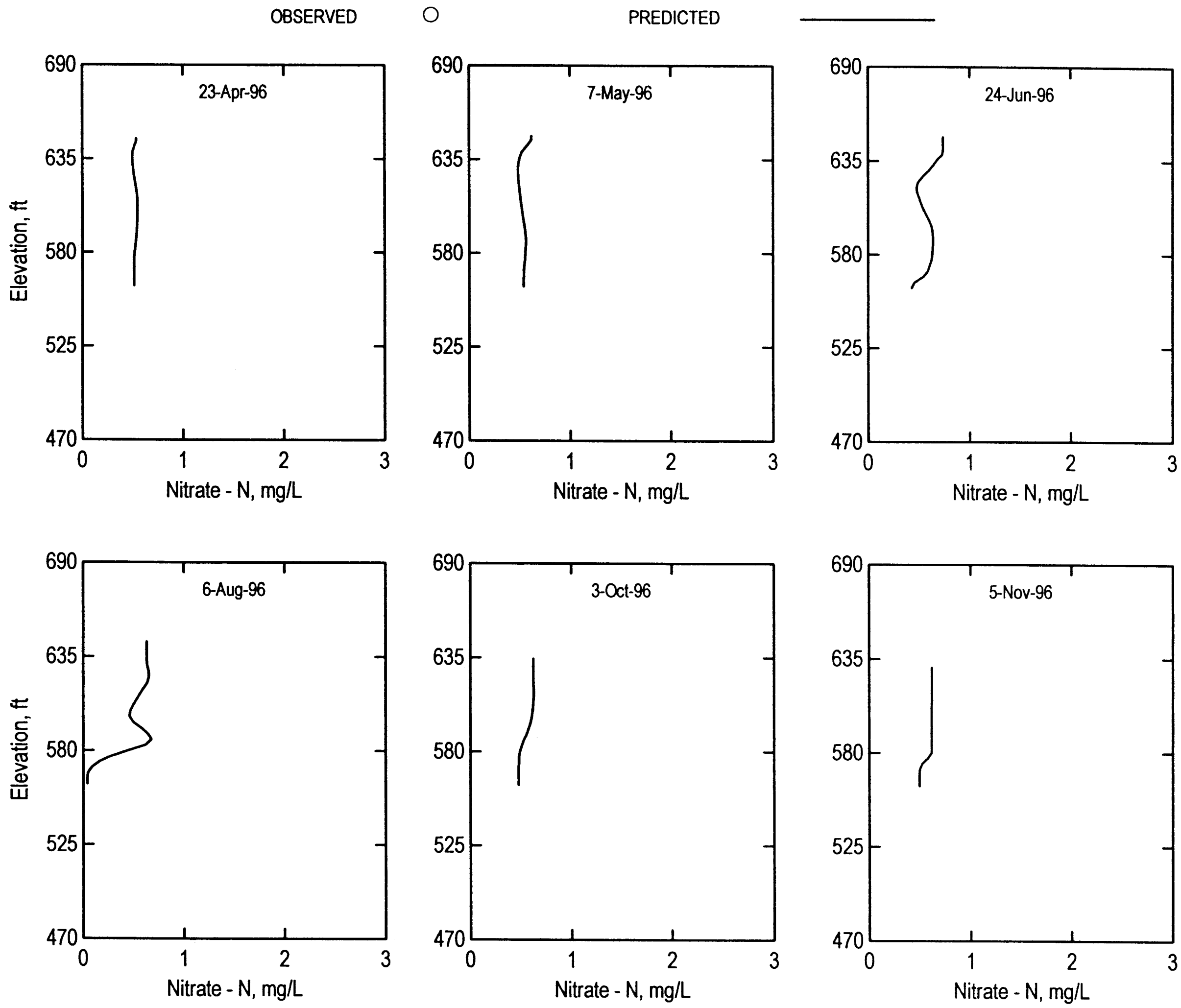
Center Hill Lake 1996 Station CEN20004
OBSERVED
PREDICTED
23-Apr-96
7-May-96
24-Jun-96
6-Aug-96
3-Oct-96
5-Nov-96
Elevation, ft
Nitrate - N, mg/L
690
635
580
525
470
0
1
2
3

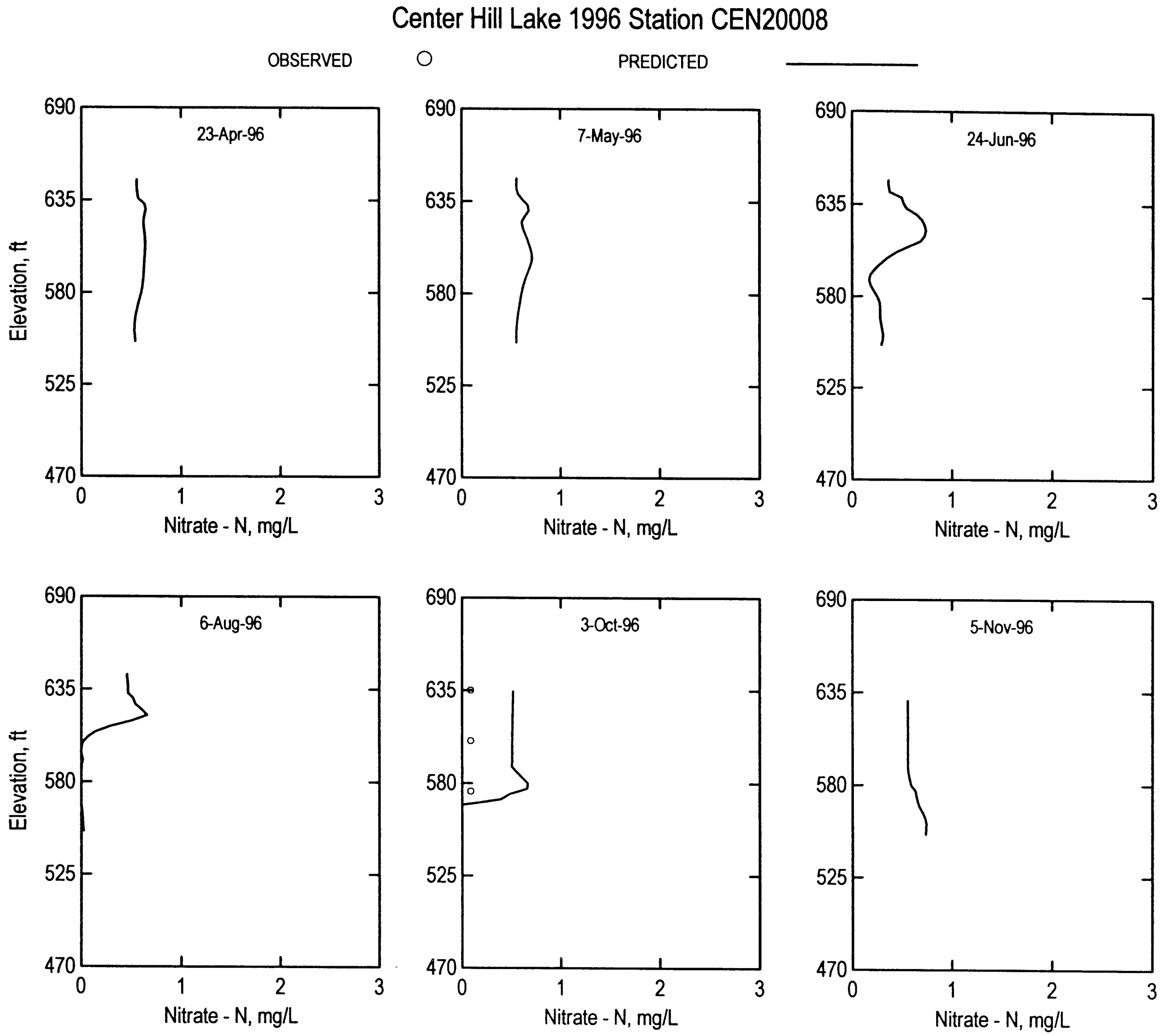


Center Hill Lake 1996 Station CEN20005
OBSERVED
PREDICTED
23-Apr-96
7-May-96
24-Jun-96
6-Aug-96
3-Oct-96
5-Nov-96
Elevation, ft
690
635
580
525
470
0
1
2
3
Nitrate - N, mg/L


Center Hill Lake 1996 Station CEN20006
OBSERVED
PREDICTED
23-Apr-96
7-May-96
24-Jun-96
6-Aug-96
3-Oct-96
5-Nov-96
Elevation, ft
690
635
580
525
470
0
1
2
3
Nitrate - N, mg/L

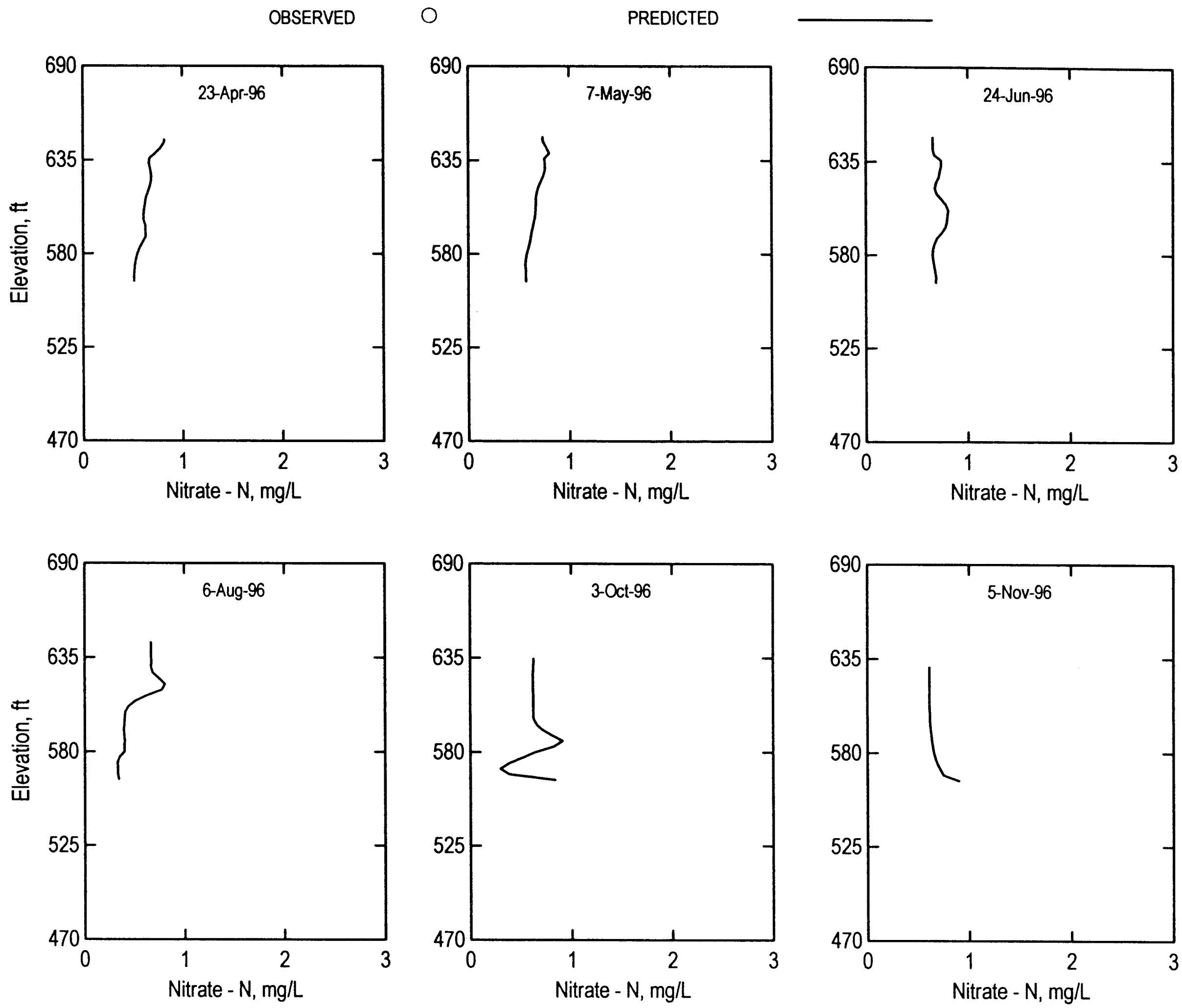
Center Hill Lake 1996 Station CEN20007



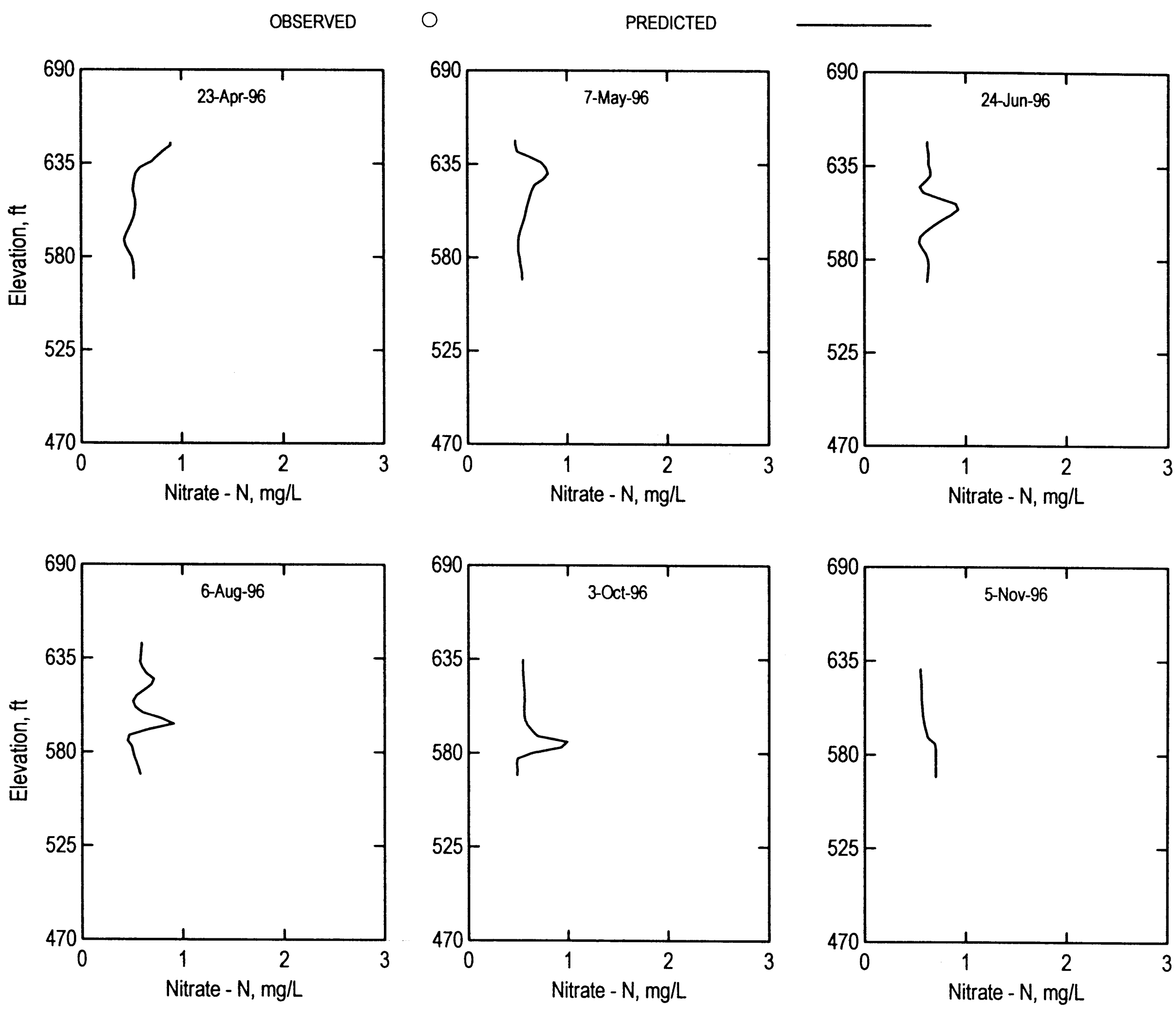


Center Hill Lake 1996 Station CEN20008
OBSERVED
PREDICTED
23-Apr-96
7-May-96
24-Jun-96
6-Aug-96
3-Oct-96
5-Nov-96
Elevation, ft
Nitrate - N, mg/L
690
635
580
525
470
0
1
2
3

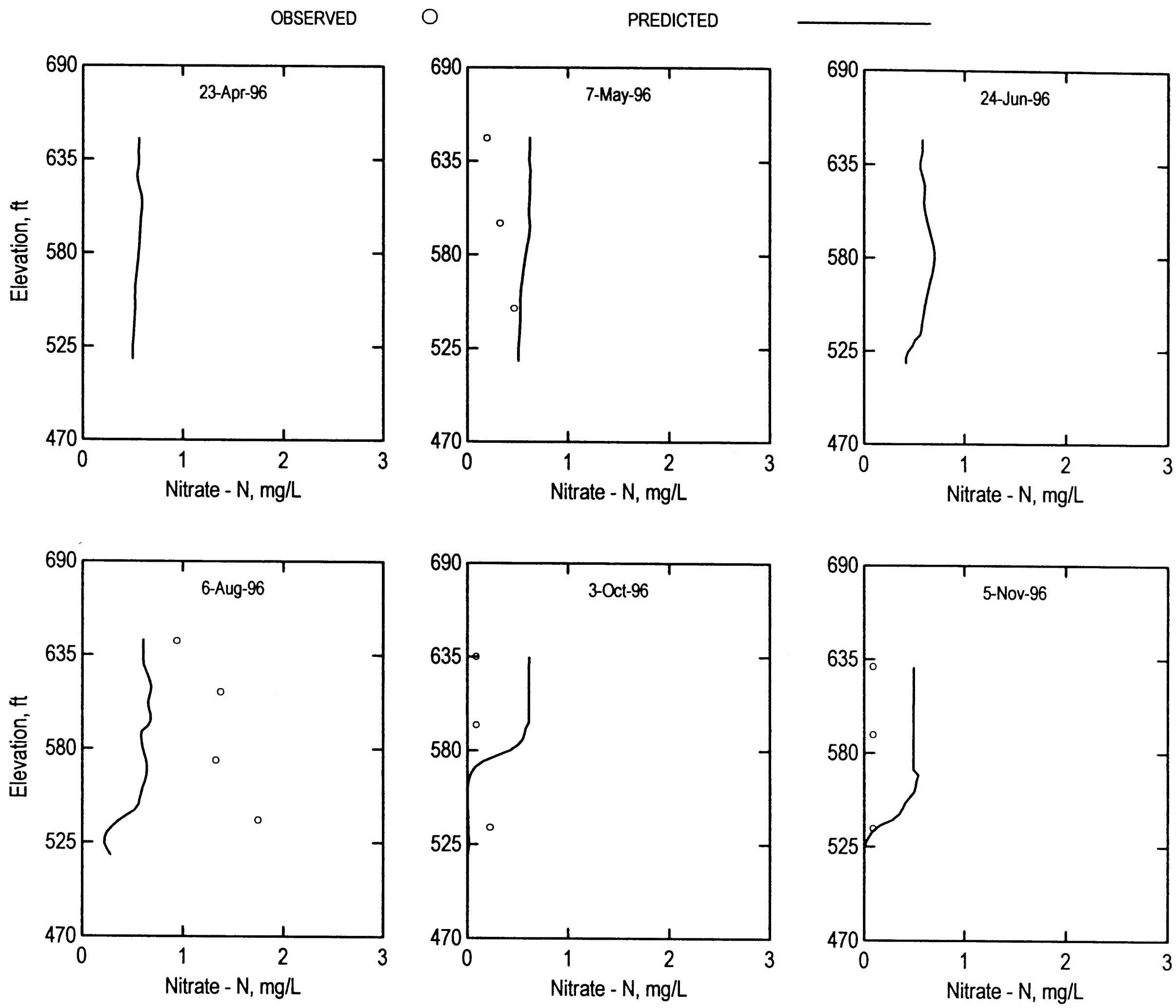
Center Hill Lake 1996 Station CEN20010

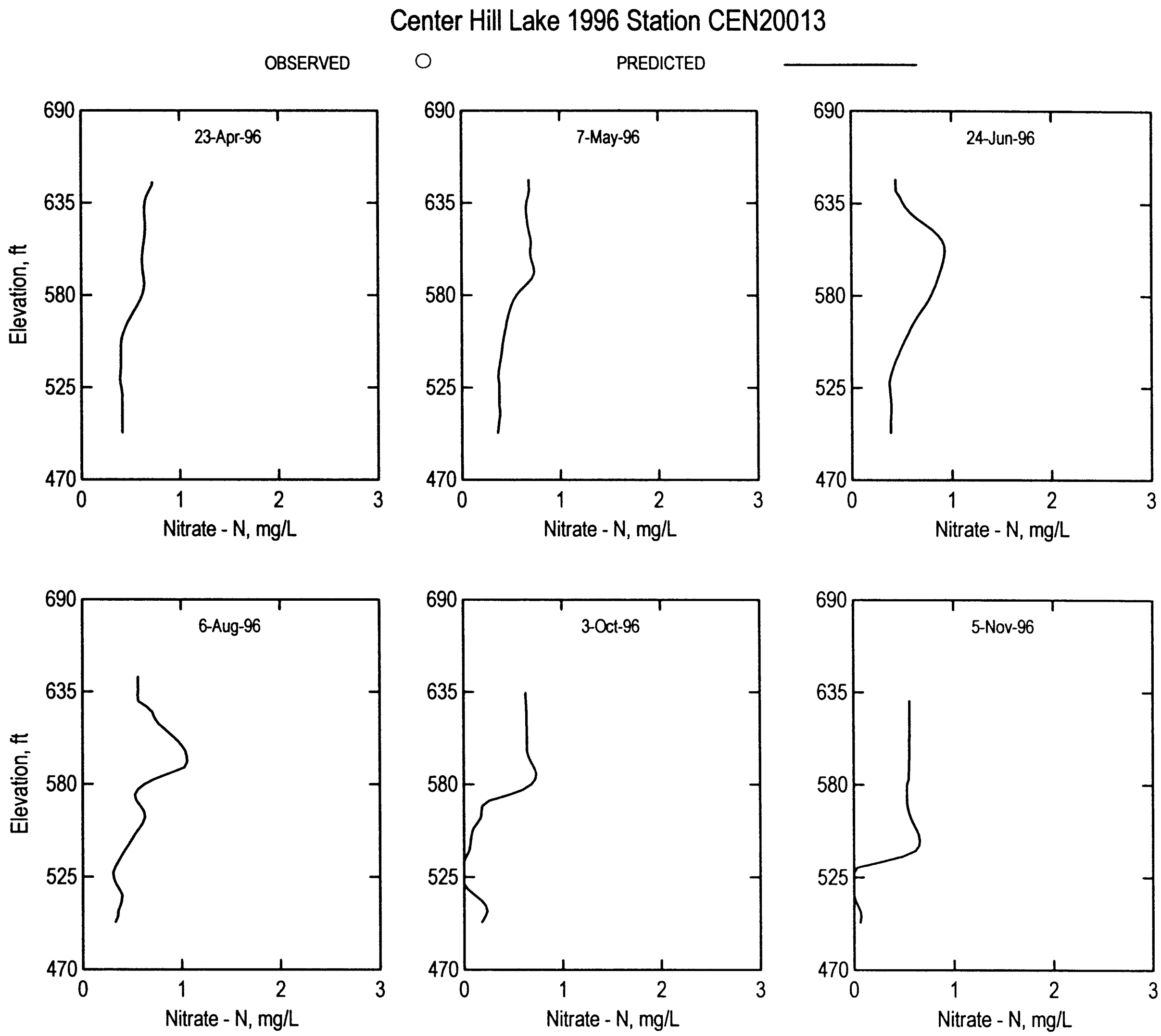


Center Hill Lake 1996 Station CEN20011



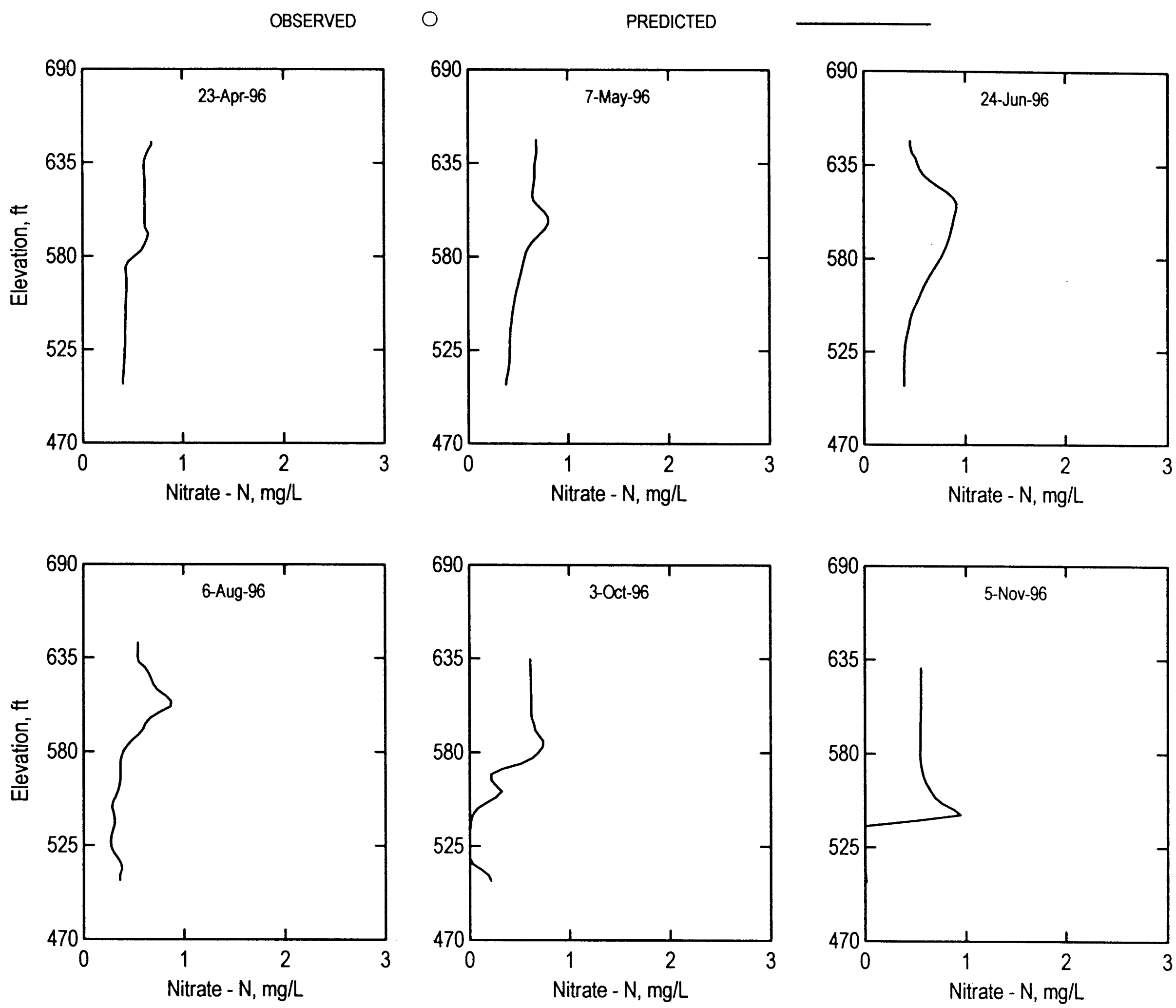
Center Hill Lake 1996 Station CEN20015



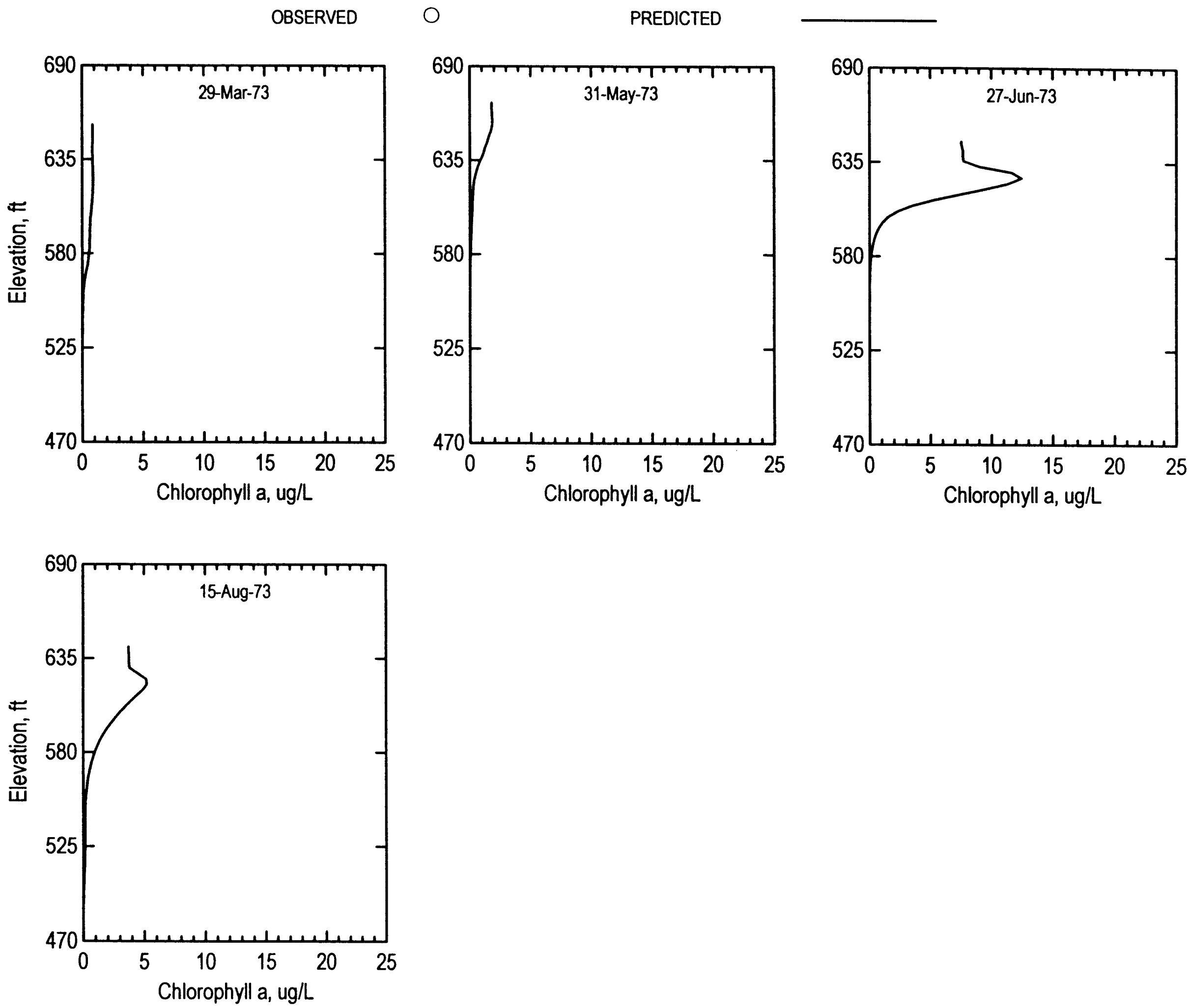


Center Hill Lake 1996 Station CEN20013
OBSERVED
PREDICTED
23-Apr-96
7-May-96
24-Jun-96
6-Aug-96
3-Oct-96
5-Nov-96
Elevation, ft
690
635
580
525
470
0
1
2
3
Nitrate - N, mg/L

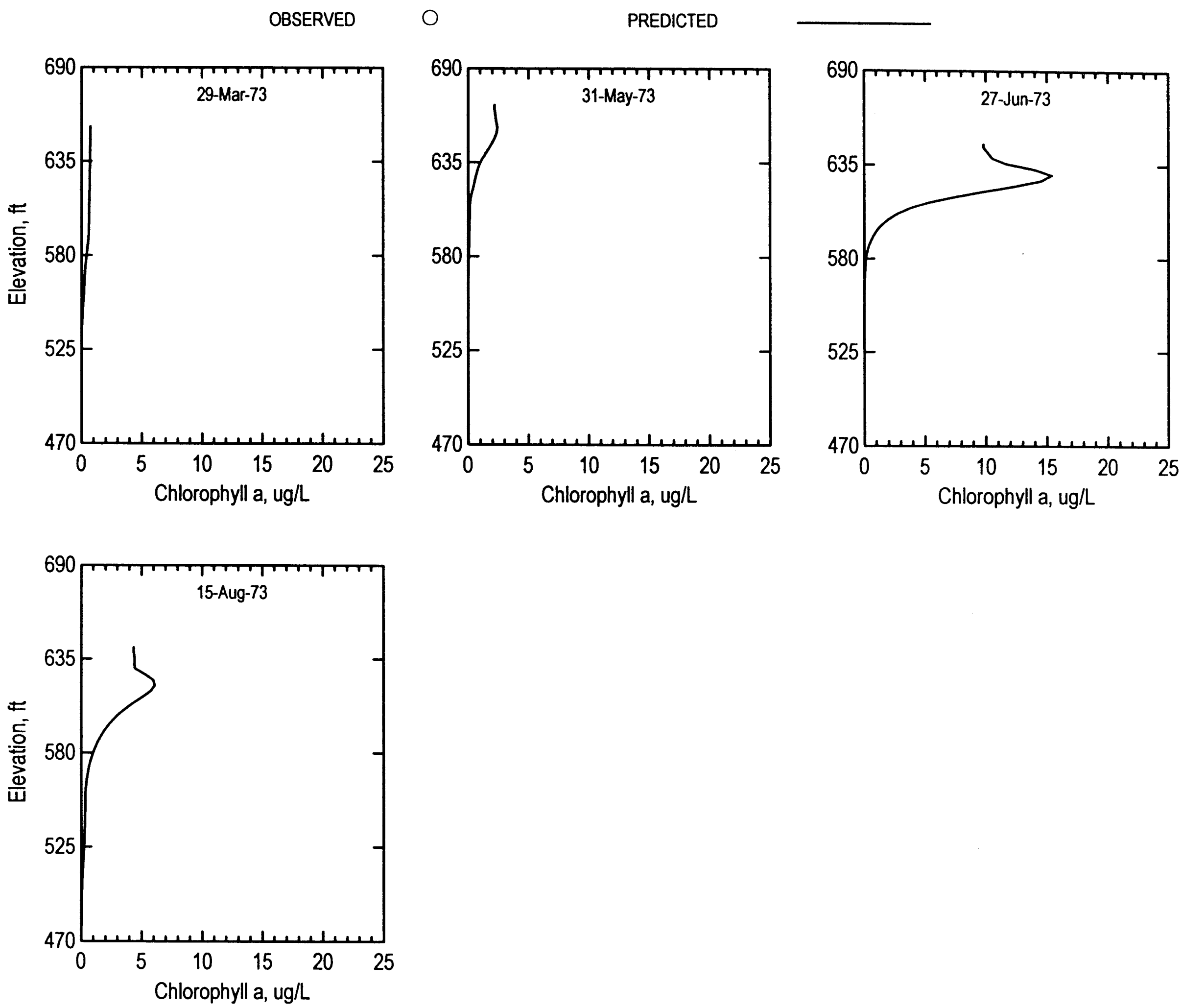
Center Hill Lake 1996 Station CEN20014



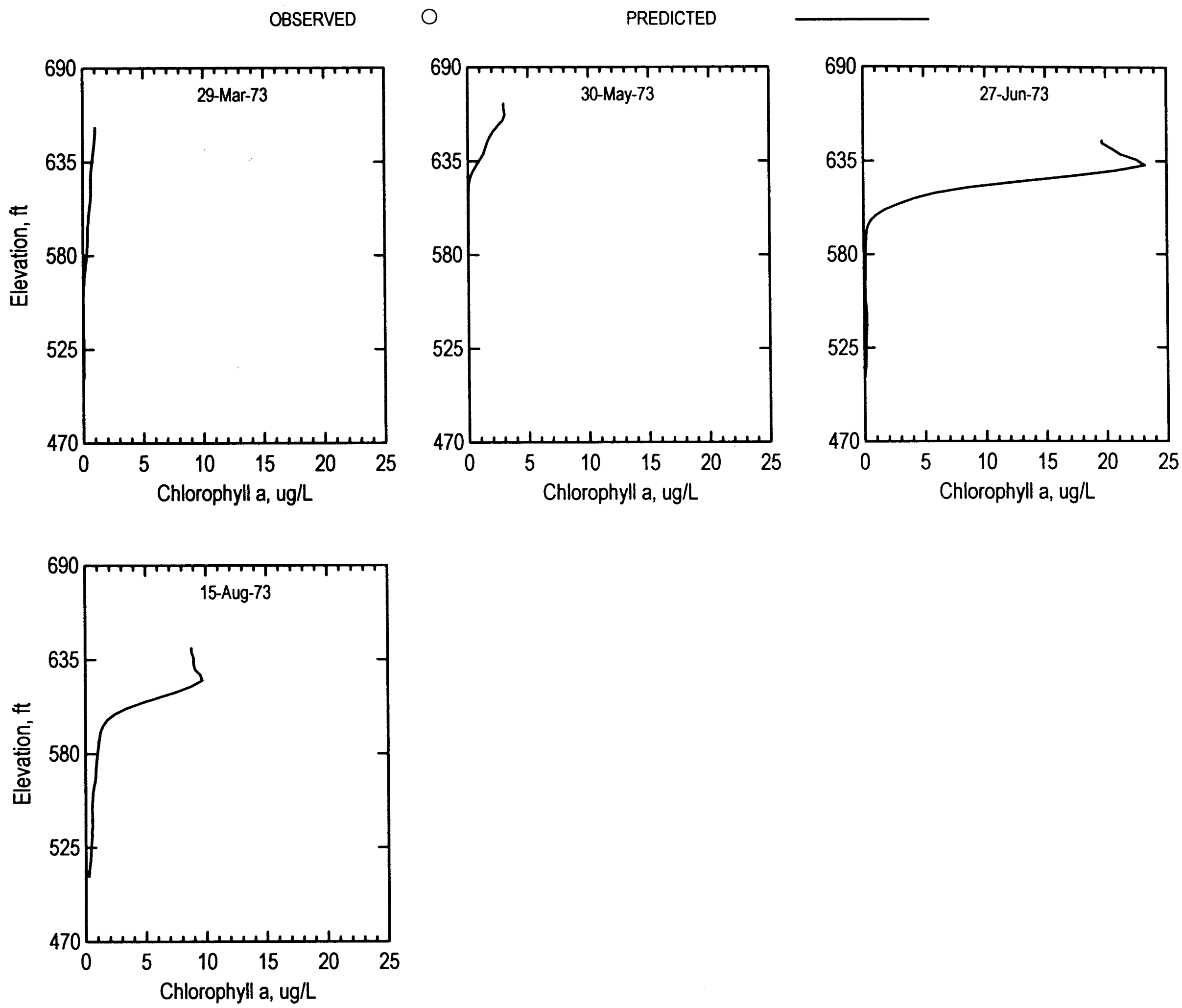
Center Hill Lake 1973 Station CEN20002



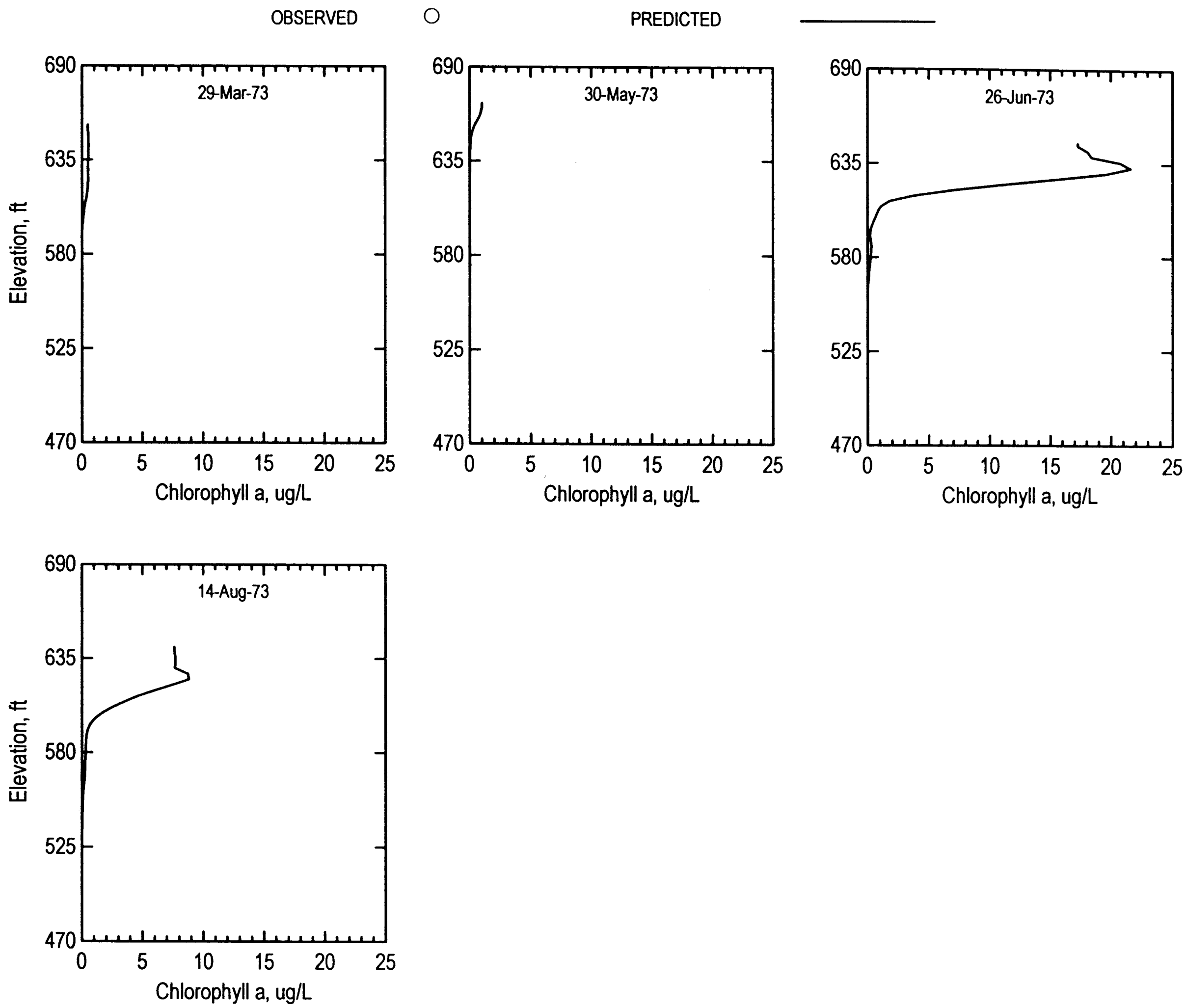
Center Hill Lake 1973 Station CEN20003



Center Hill Lake 1973 Station CEN20004

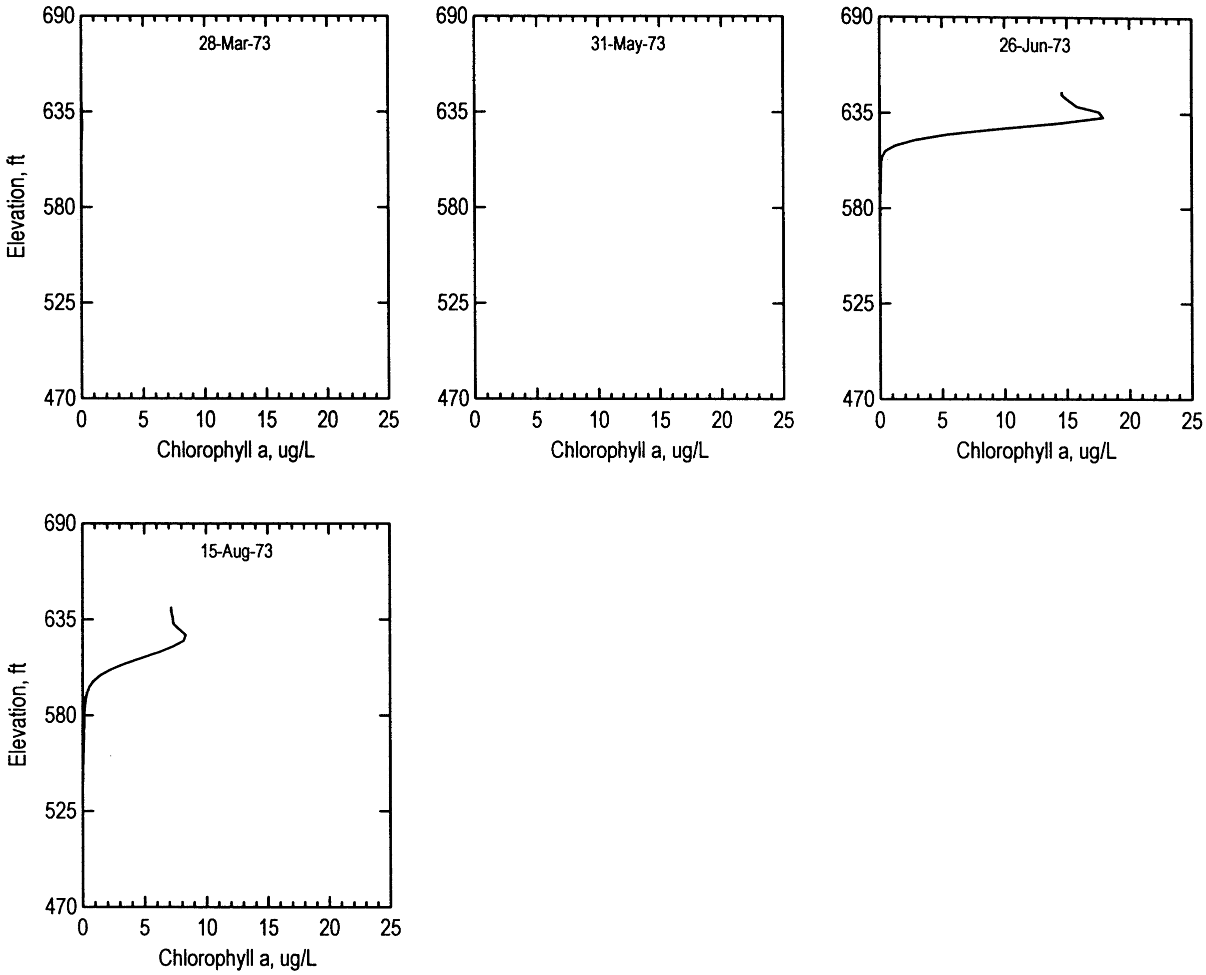


Center Hill Lake 1973 Station CEN20005

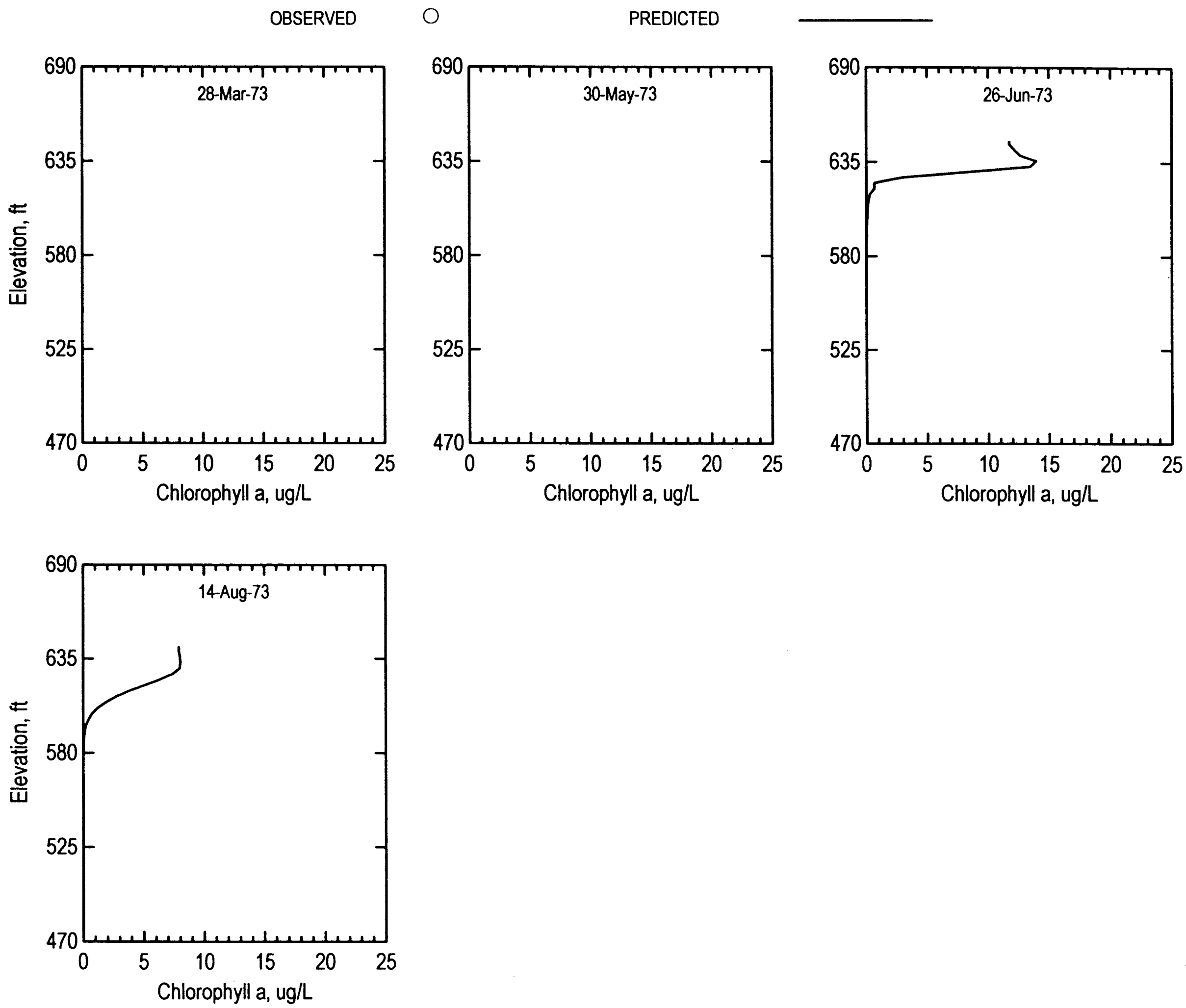


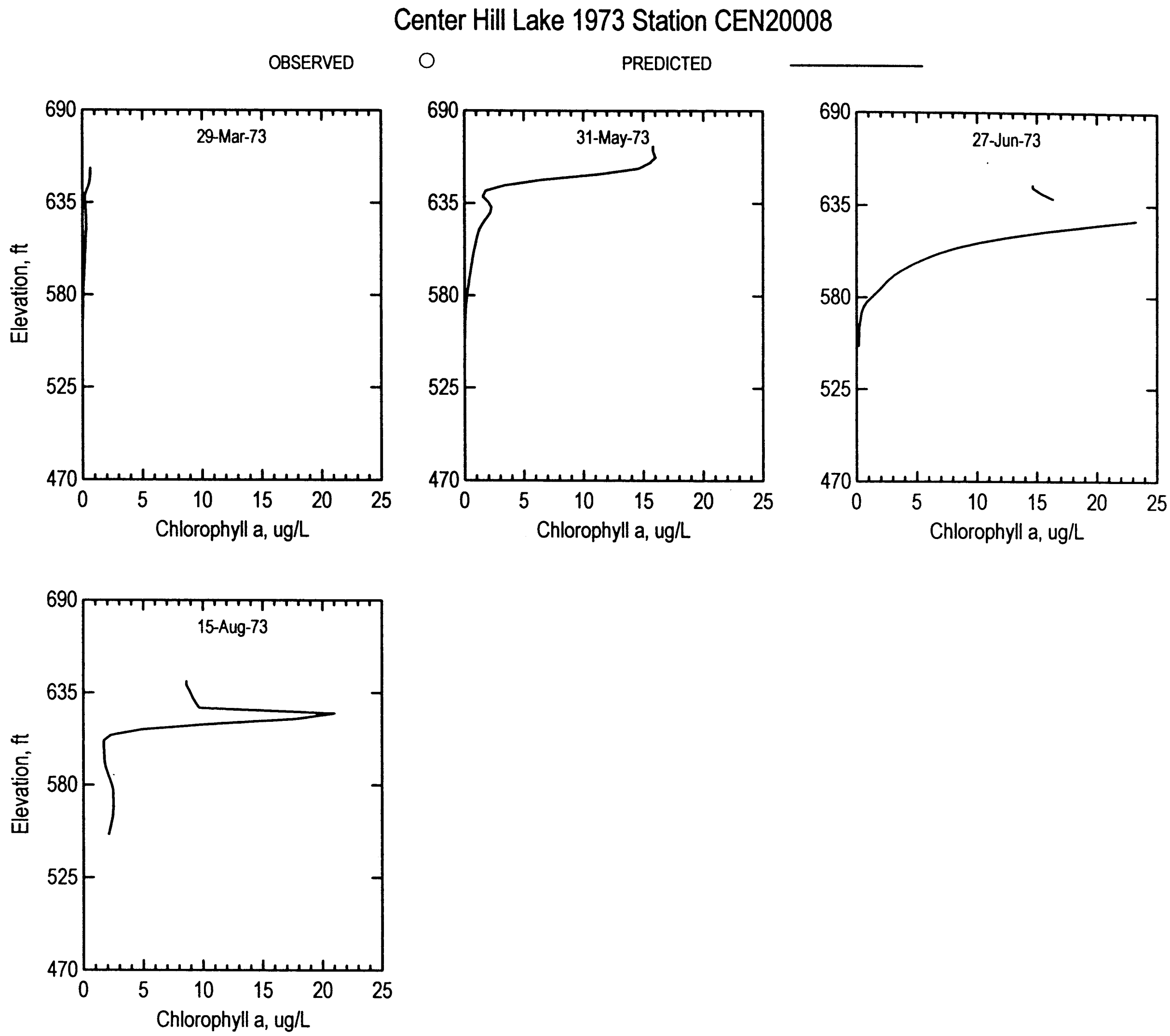
Center Hill Lake 1973 Station CEN20006

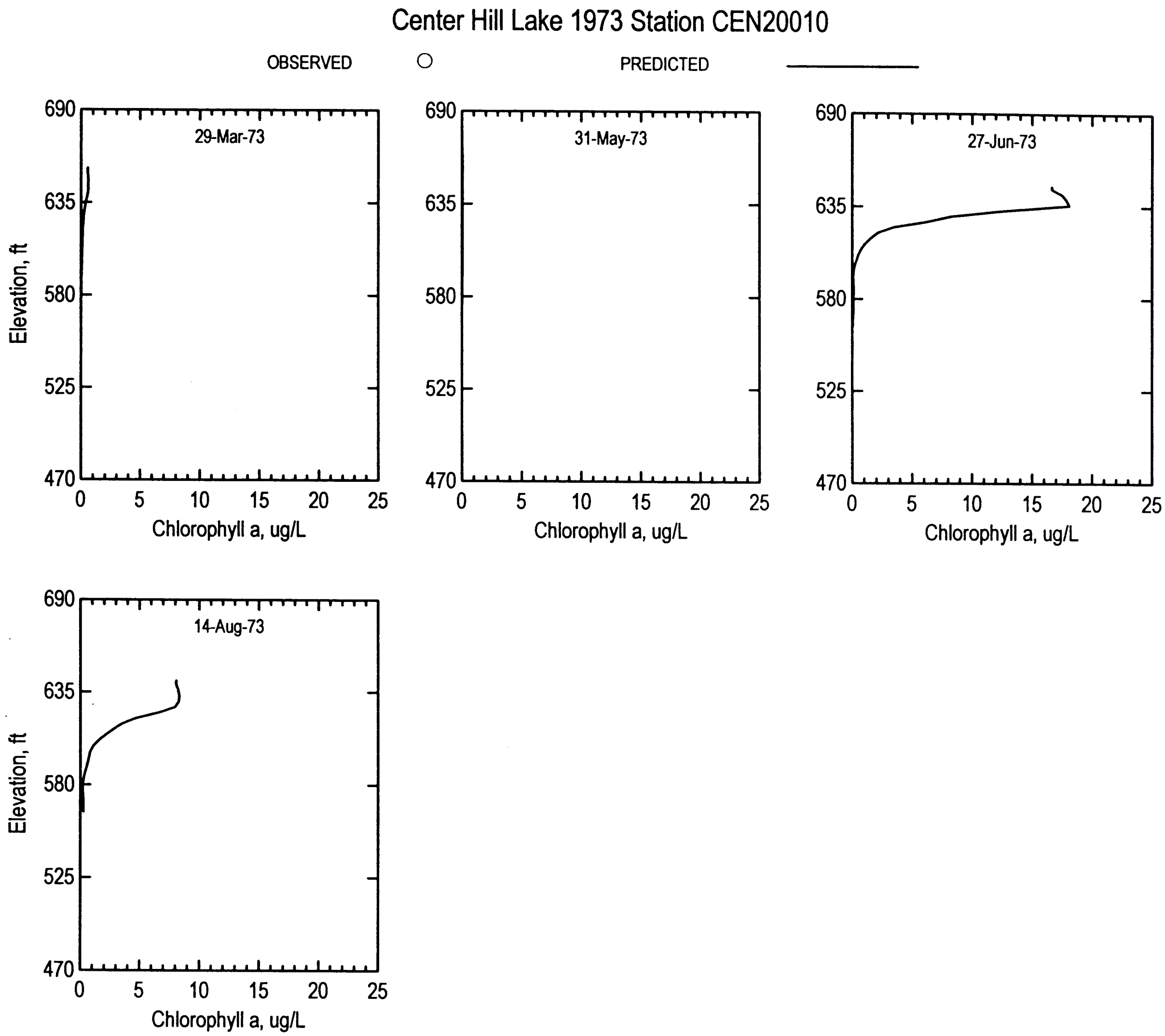
OBSERVED ○ PREDICTED ————



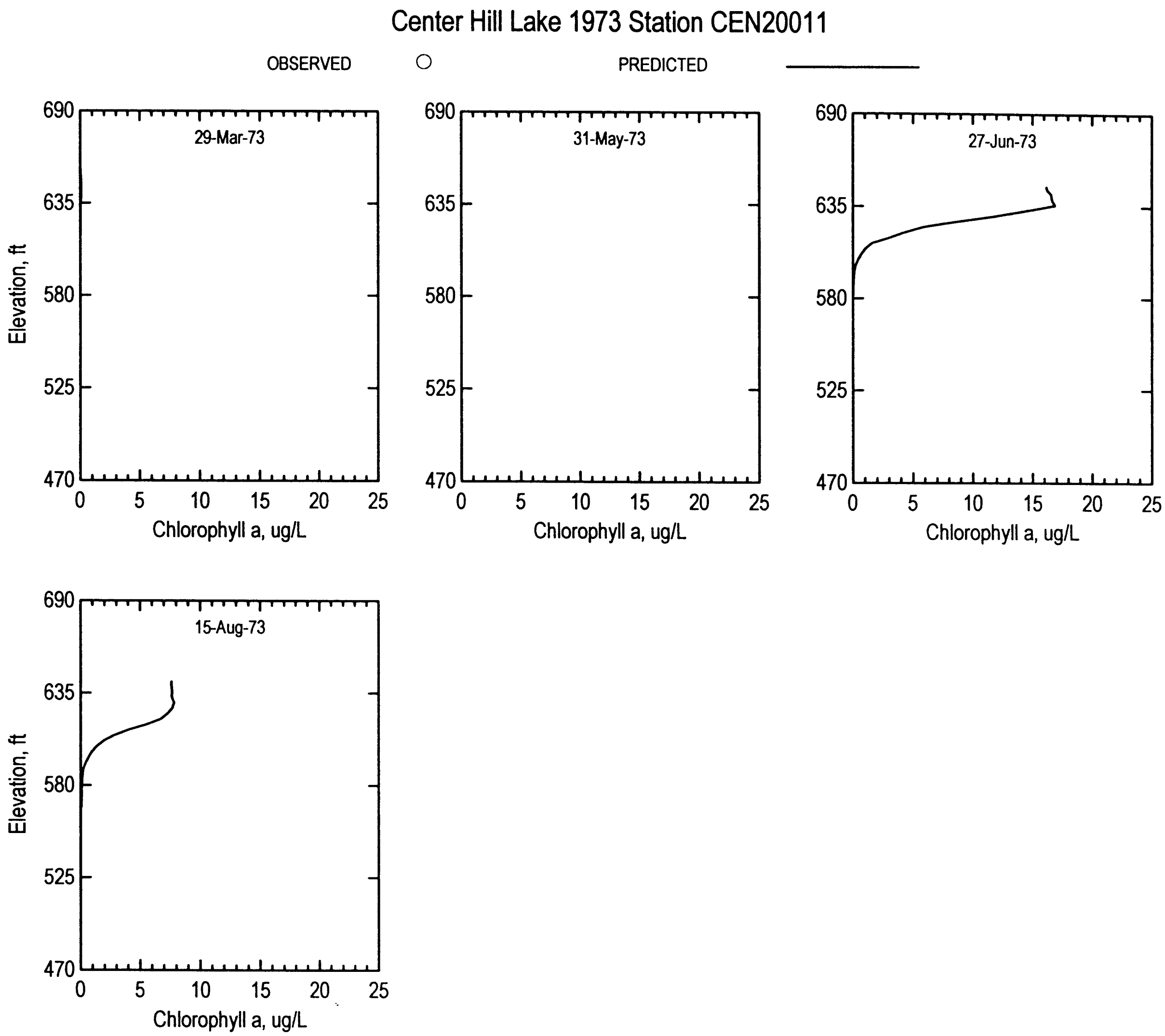
Center Hill Lake 1973 Station CEN20007




Center Hill Lake 1973 Station CEN20008
OBSERVED
PREDICTED
29-Mar-73
31-May-73
27-Jun-73
15-Aug-73
Elevation, ft
Chlorophyll a, ug/L
690
635
580
525
470
0
5
10
15
20
25

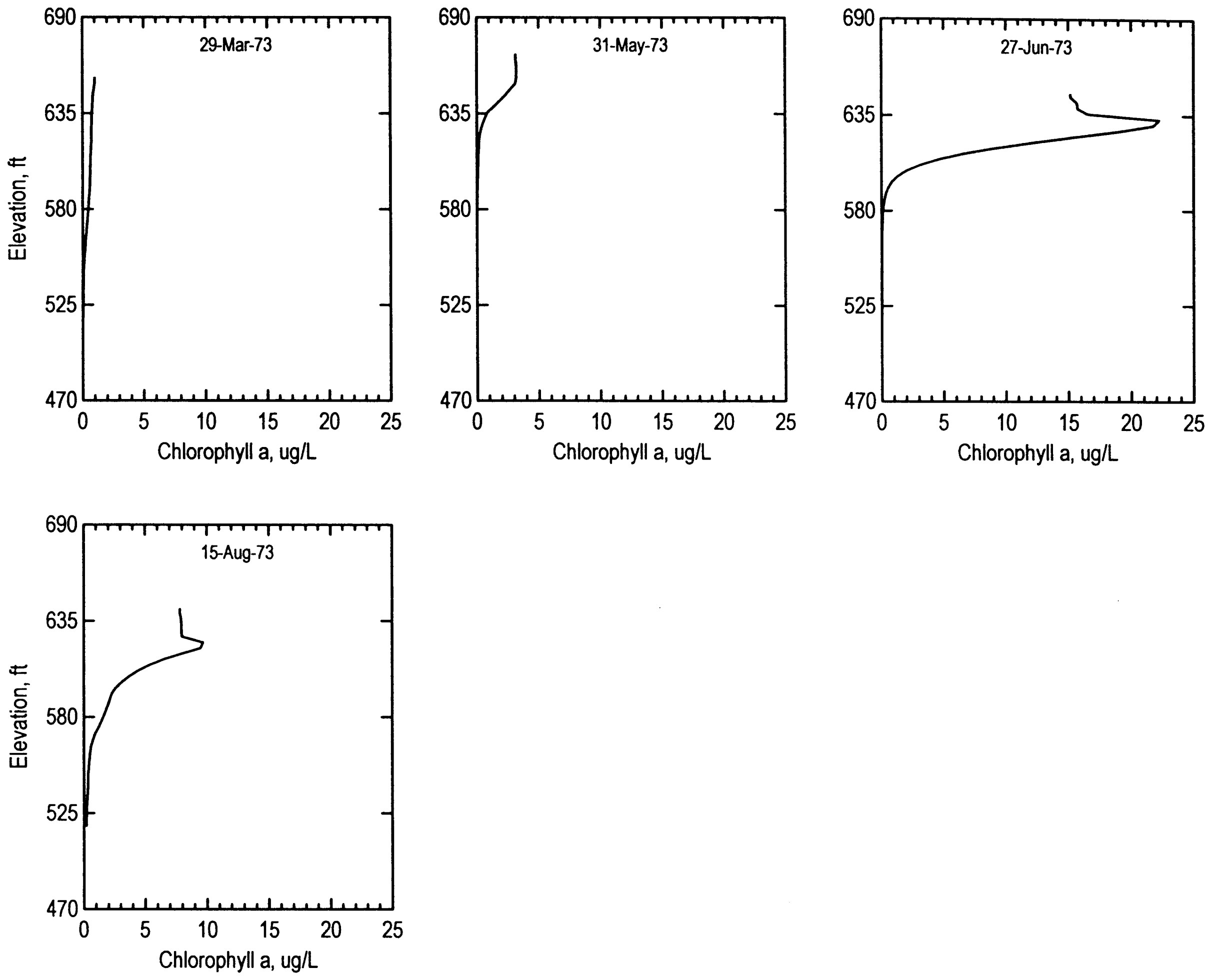


Center Hill Lake 1973 Station CEN20010
OBSERVED
PREDICTED
29-Mar-73
31-May-73
27-Jun-73
14-Aug-73
Elevation, ft
690
635
580
525
470
0
5
10
15
20
25
Chloropyhll a, ug/L

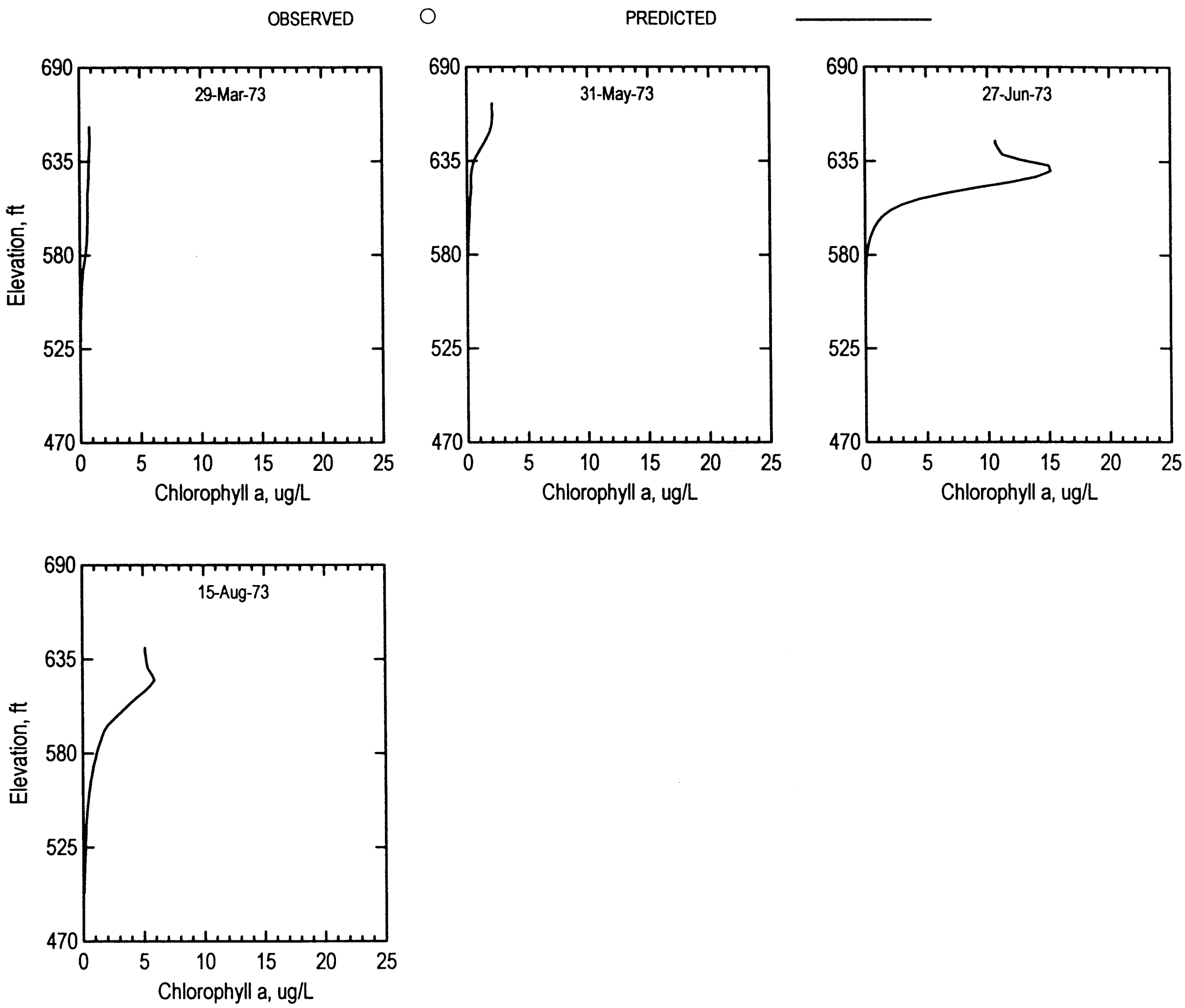

Center Hill Lake 1973 Station CEN20011
OBSERVED
PREDICTED
29-Mar-73
31-May-73
27-Jun-73
15-Aug-73
Elevation, ft
690
635
580
525
470
0
5
10
15
20
25
Chlorophyll a, ug/L

Center Hill Lake 1973 Station CEN20015

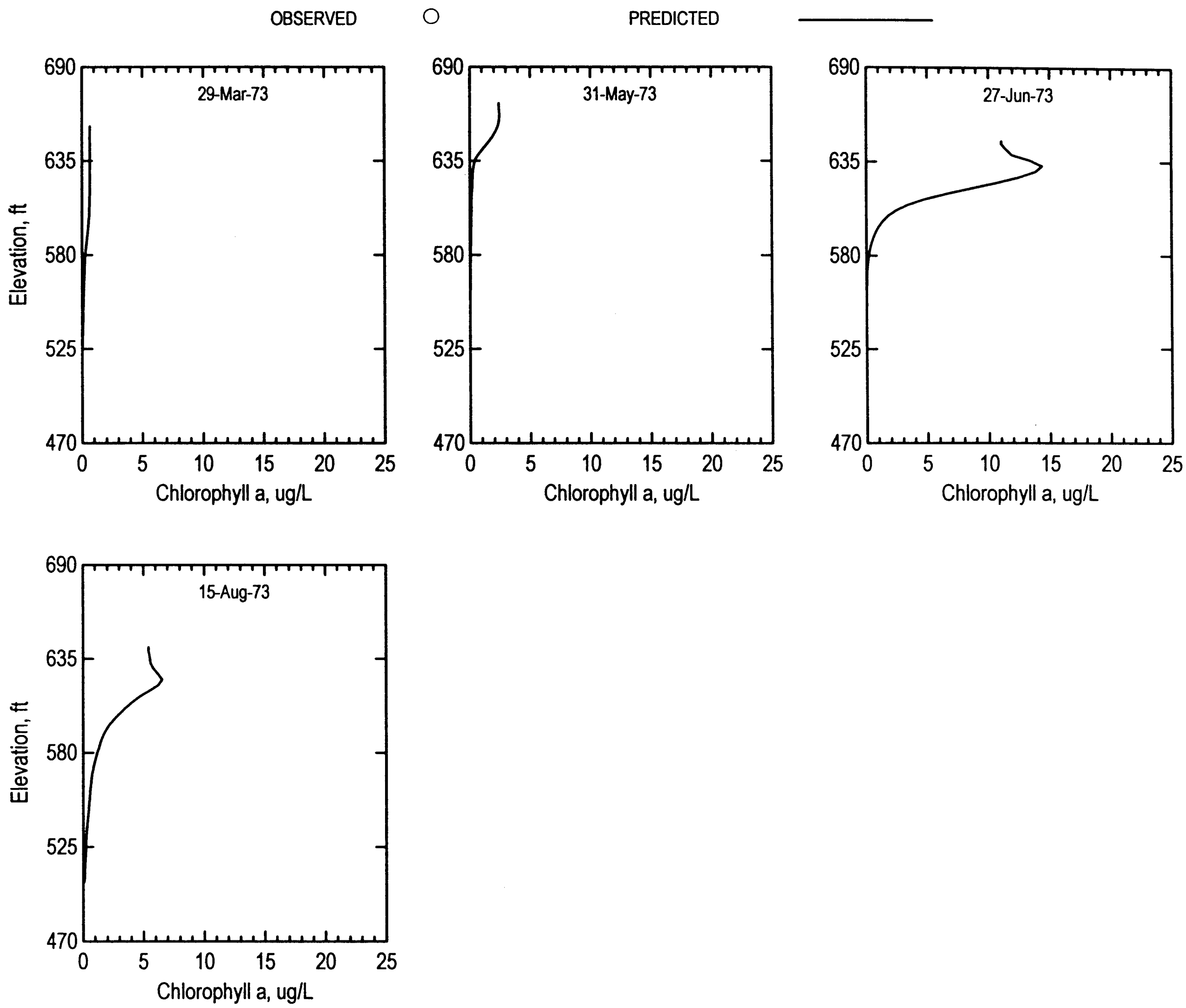
OBSERVED ○ PREDICTED ———

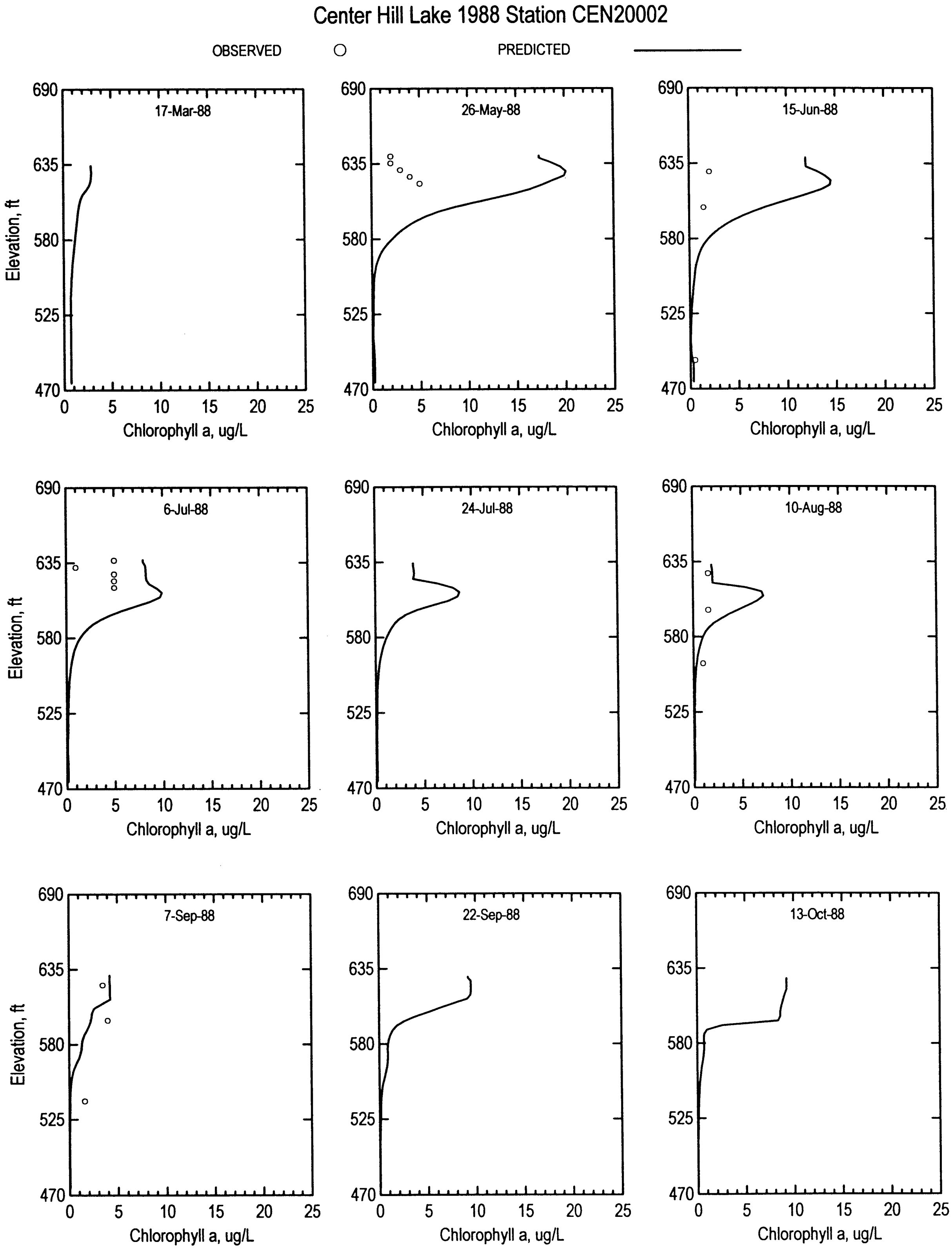


Center Hill Lake 1973 Station CEN20013



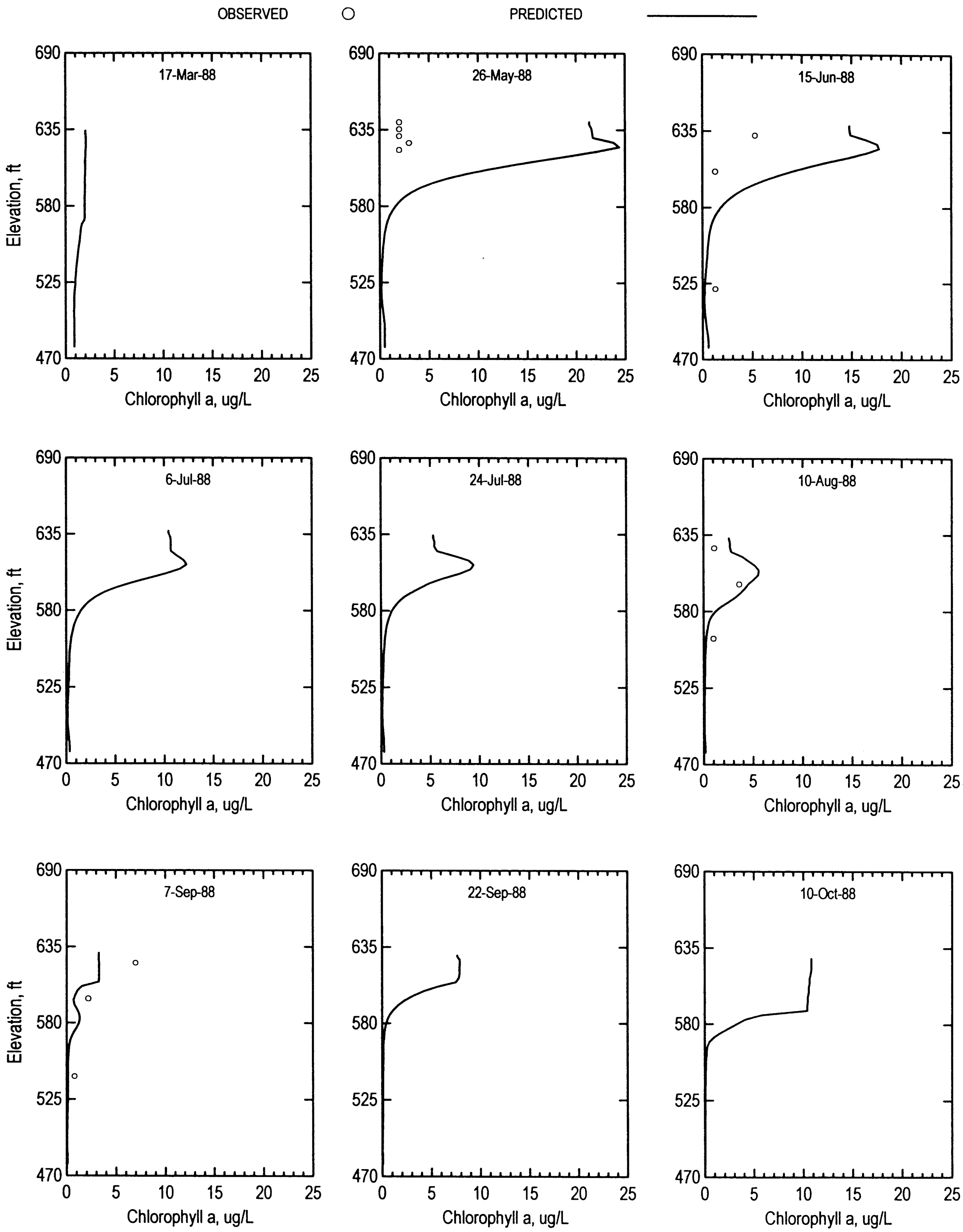
Center Hill Lake 1973 Station CEN20014



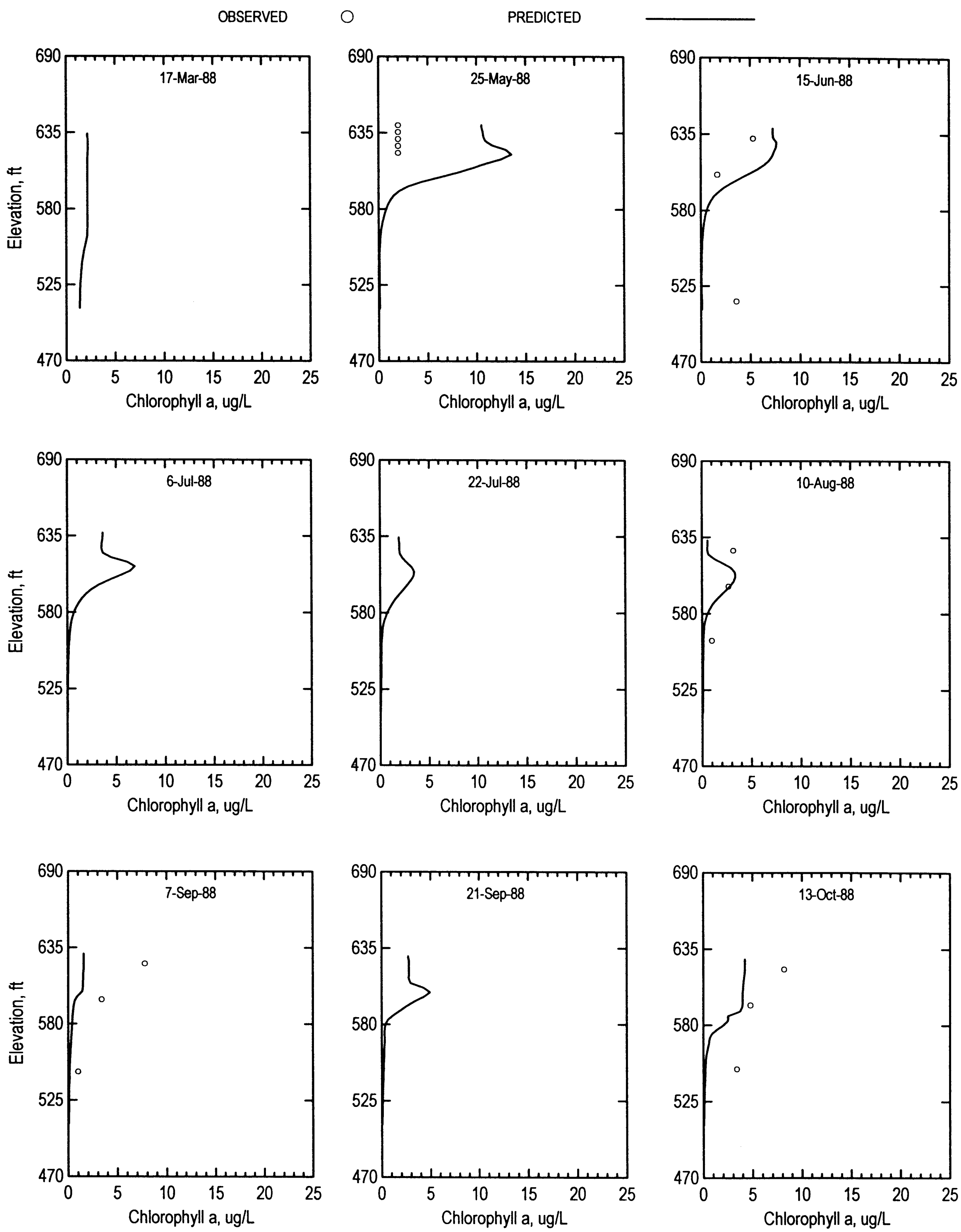


Center Hill Lake 1988 Station CEN20002
OBSERVED
PREDICTED
17-Mar-88
26-May-88
15-Jun-88
6-Jul-88
24-Jul-88
10-Aug-88
7-Sep-88
22-Sep-88
13-Oct-88
Elevation, ft
Chlorophyll a, ug/L
690
635
580
525
470
0
5
10
15
20
25

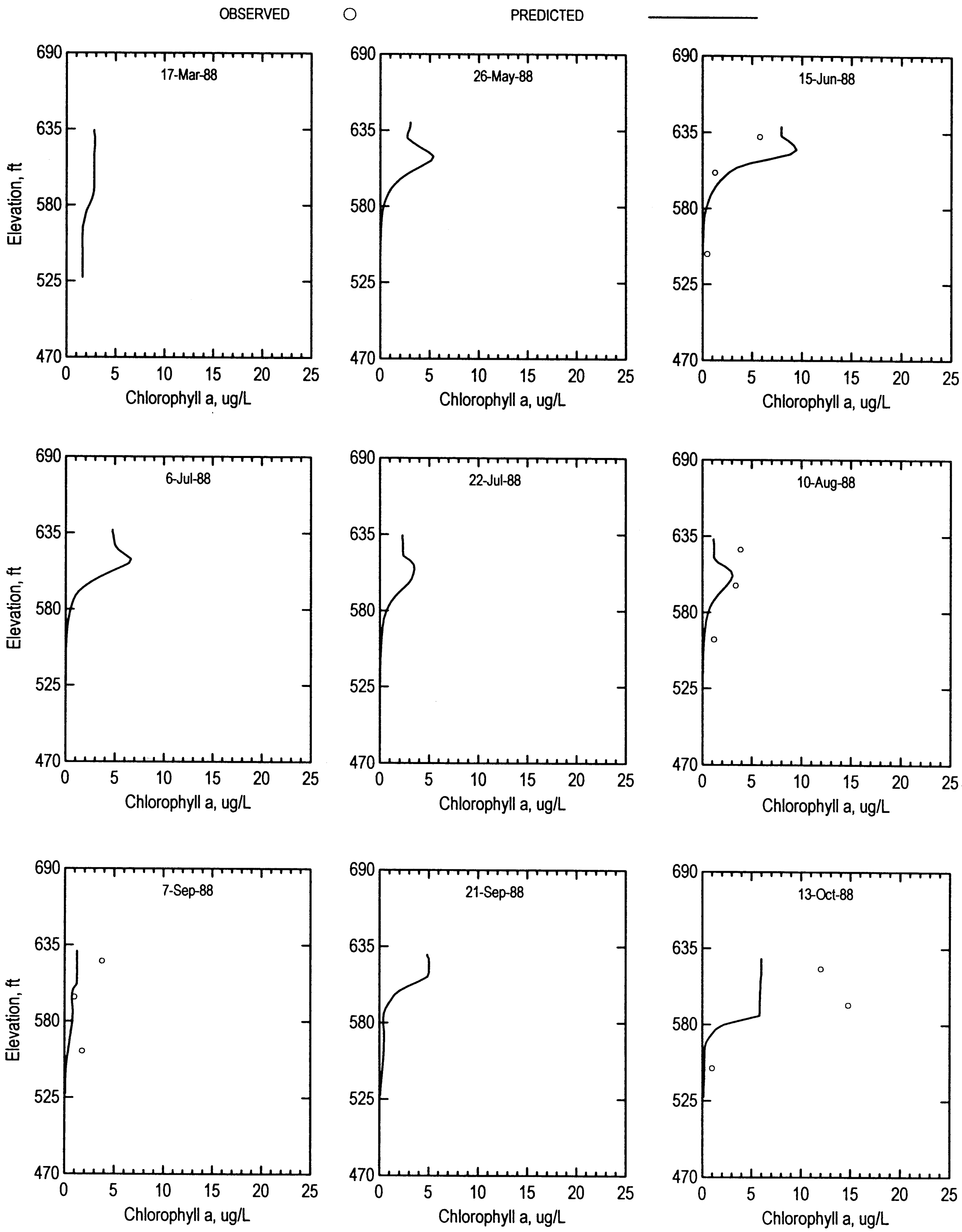
Center Hill Lake 1988 Station CEN20003



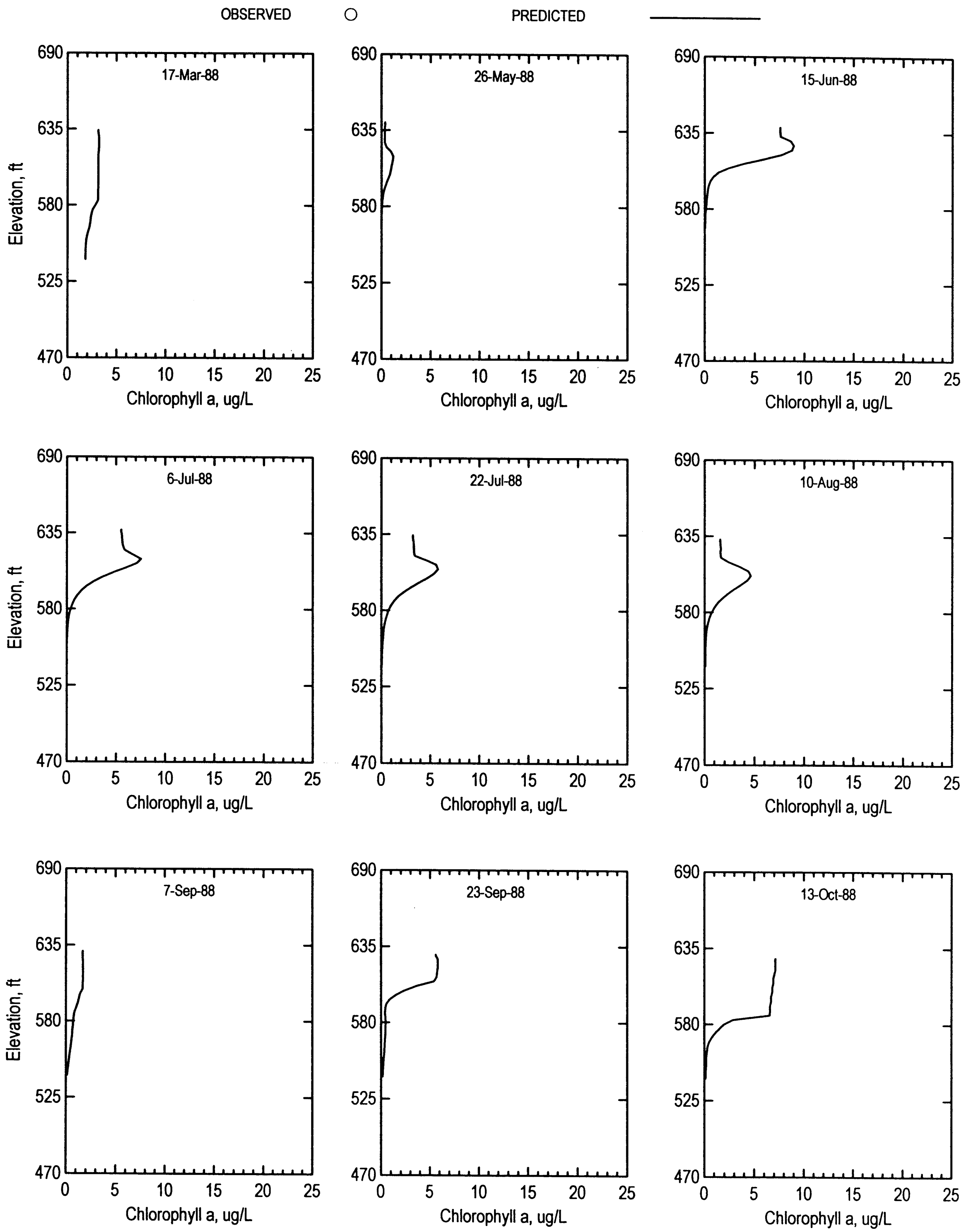
Center Hill Lake 1988 Station CEN20004



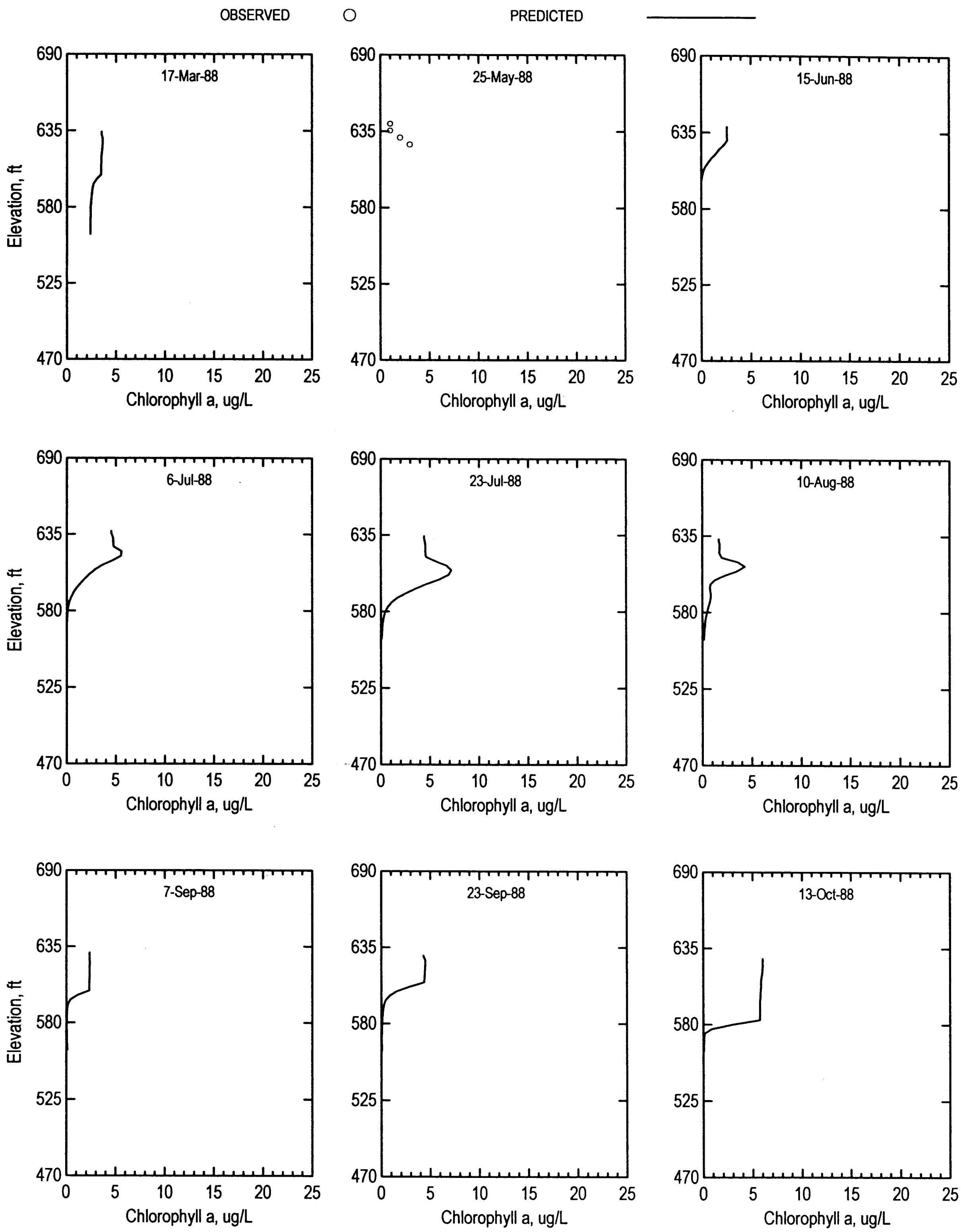
Center Hill Lake 1988 Station CEN20005



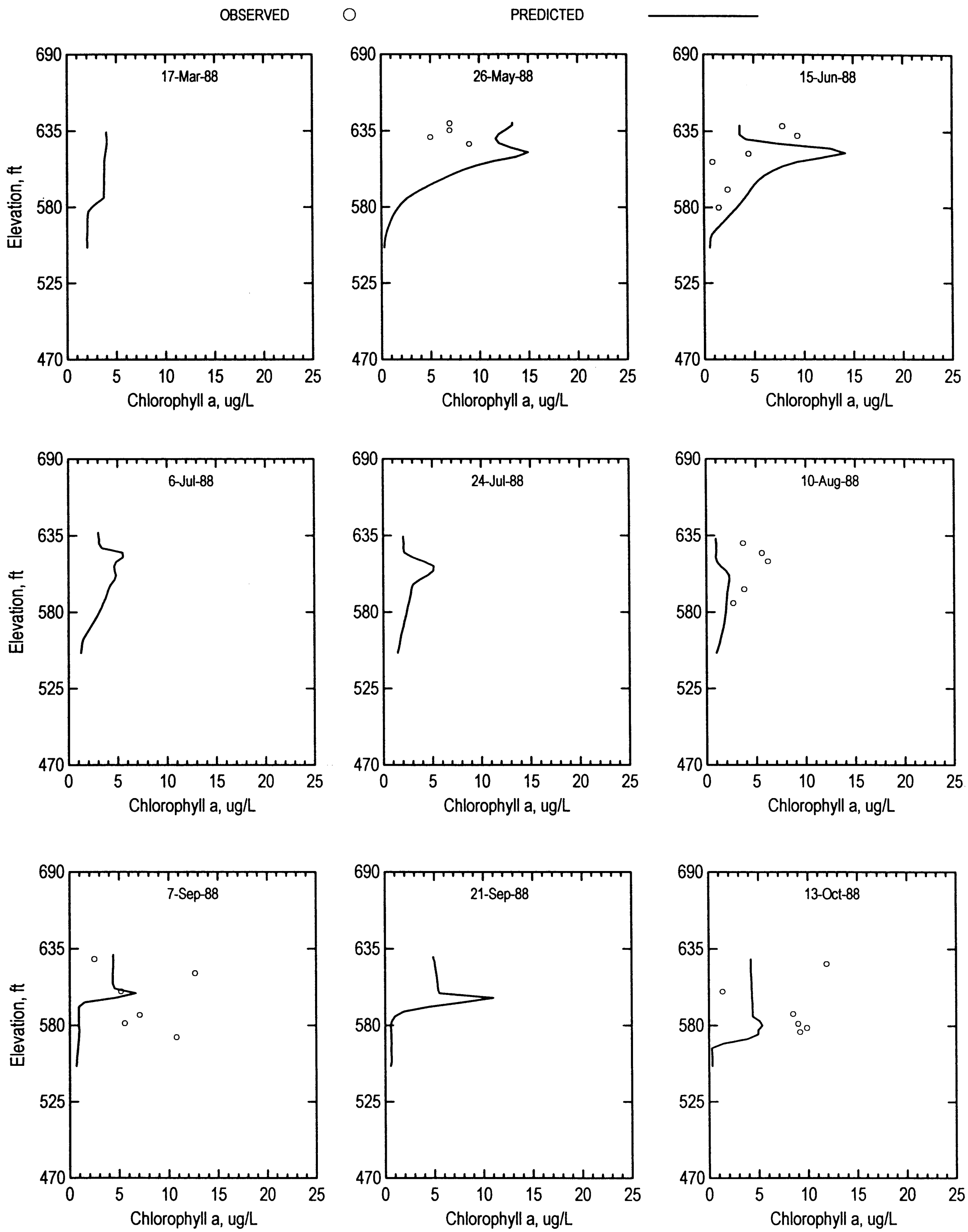
Center Hill Lake 1988 Station CEN20006



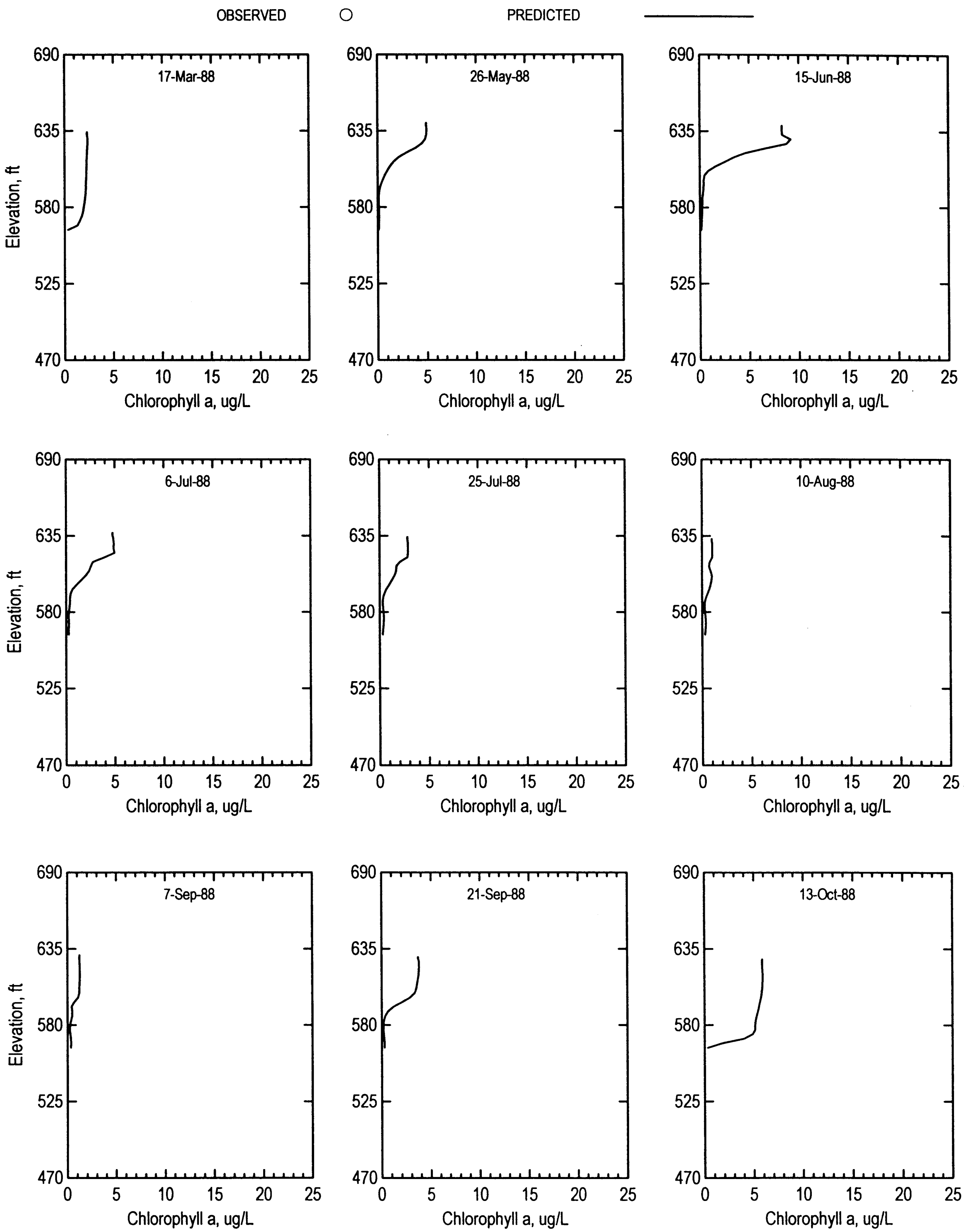
Center Hill Lake 1988 Station CEN20007



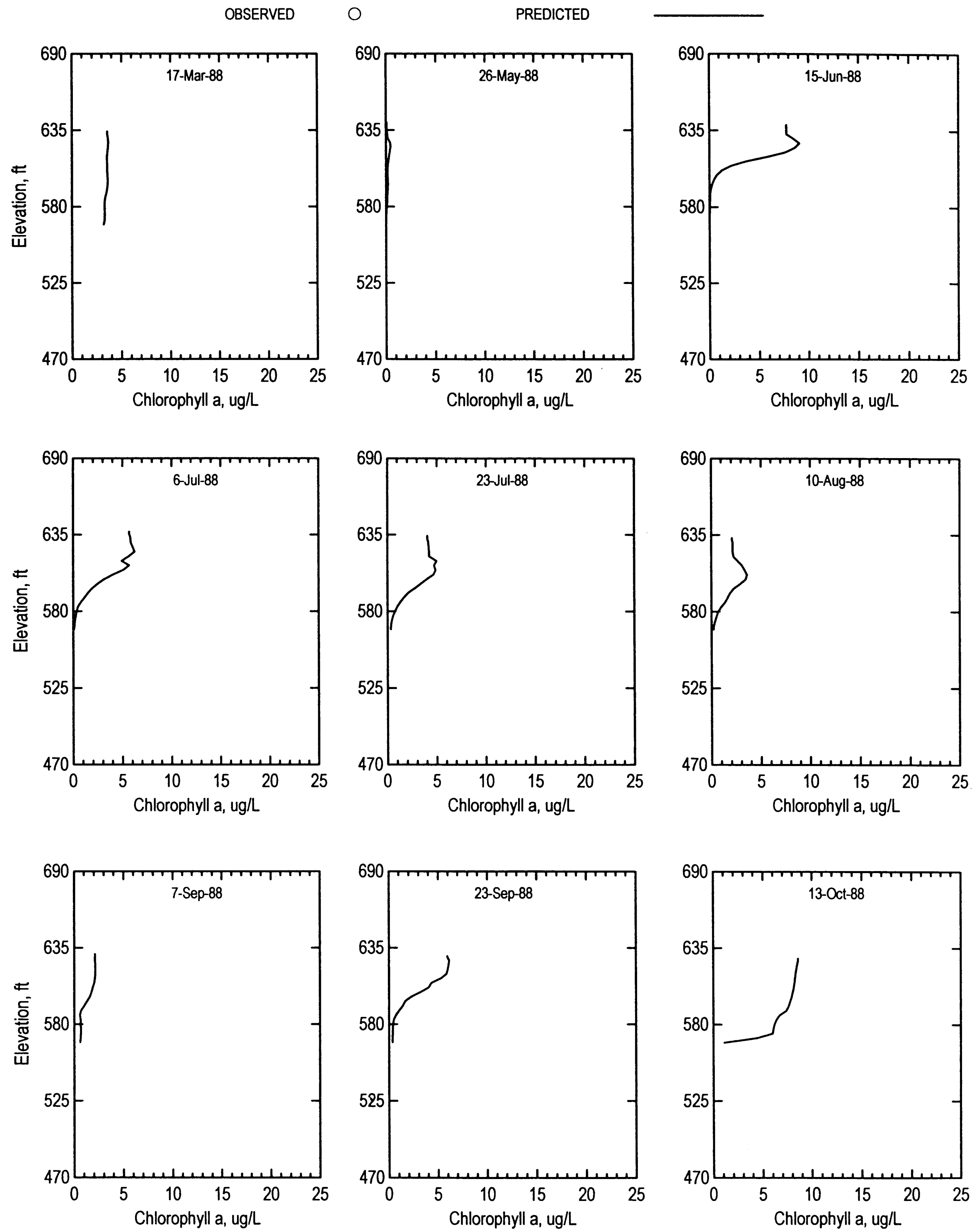
Center Hill Lake 1988 Station CEN20008



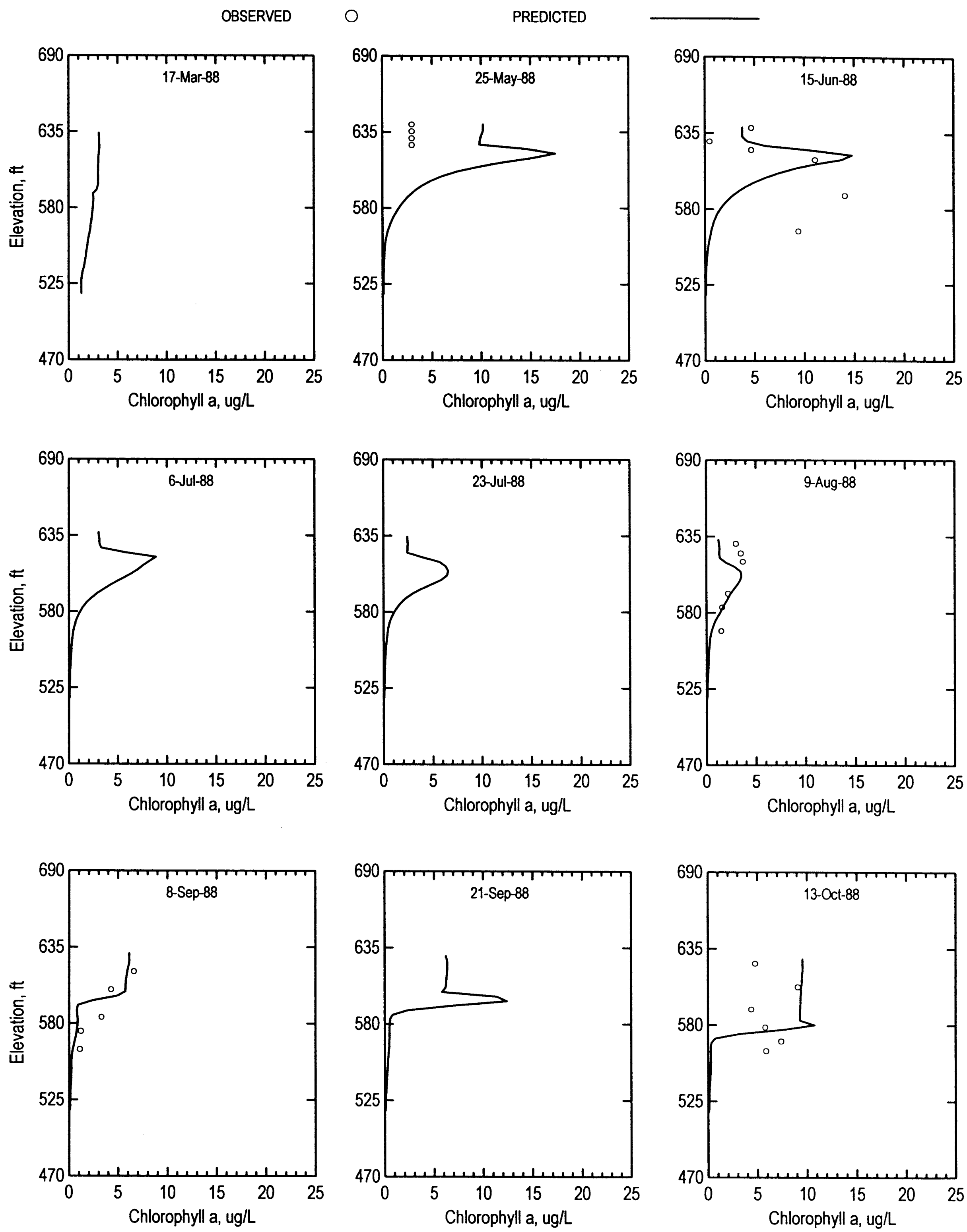
Center Hill Lake 1988 Station CEN20010



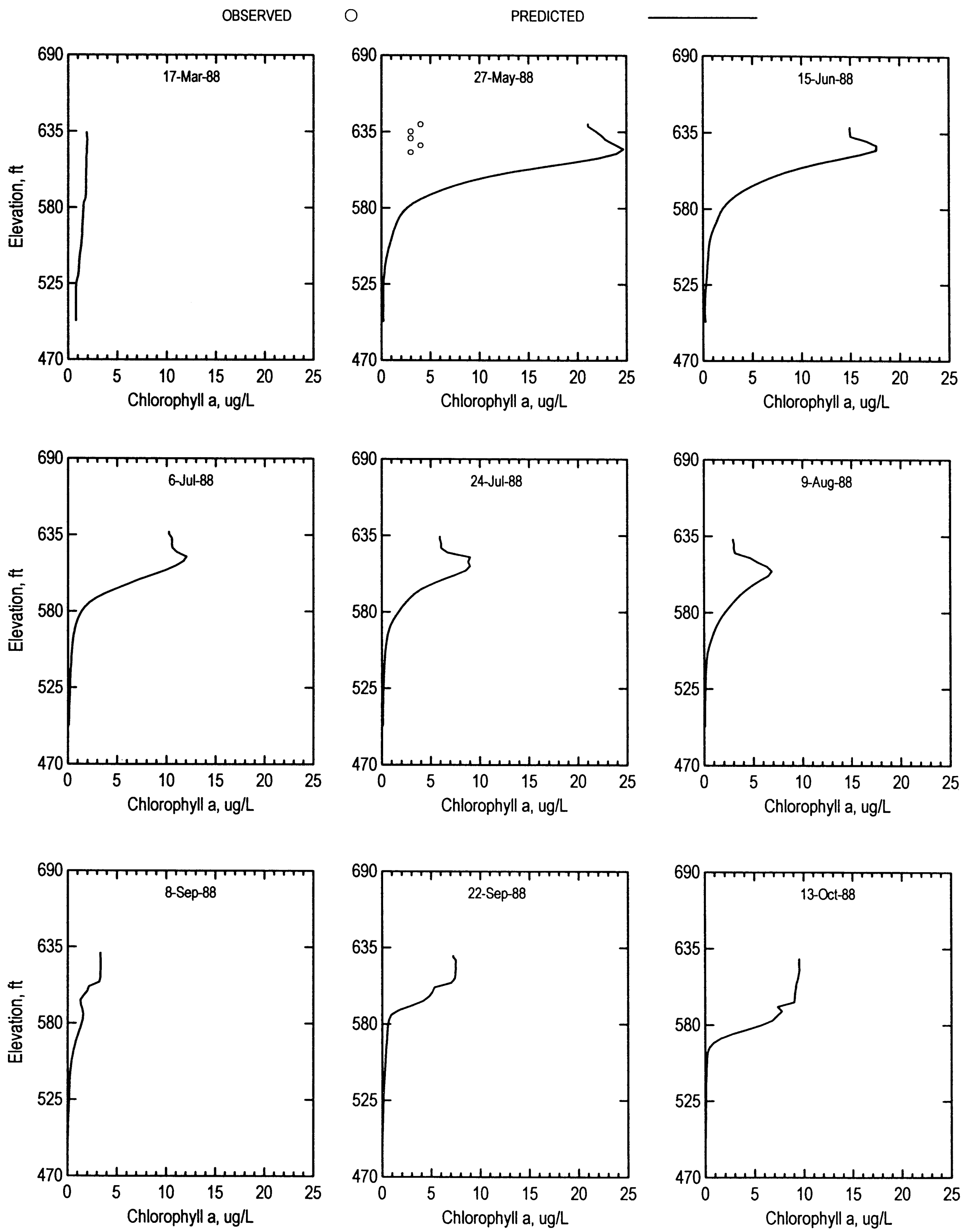
Center Hill Lake 1988 Station CEN20011



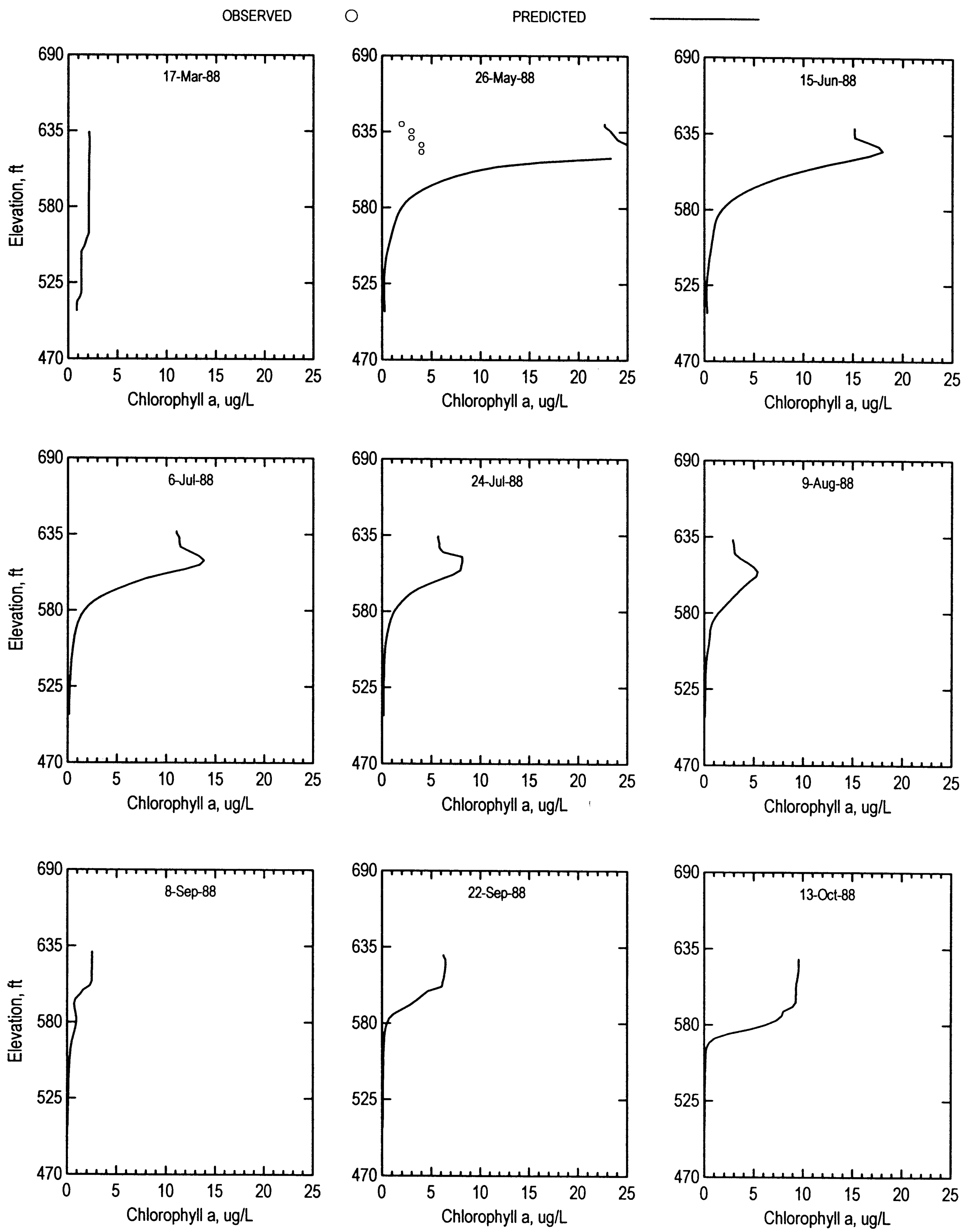
Center Hill Lake 1988 Station CEN20015



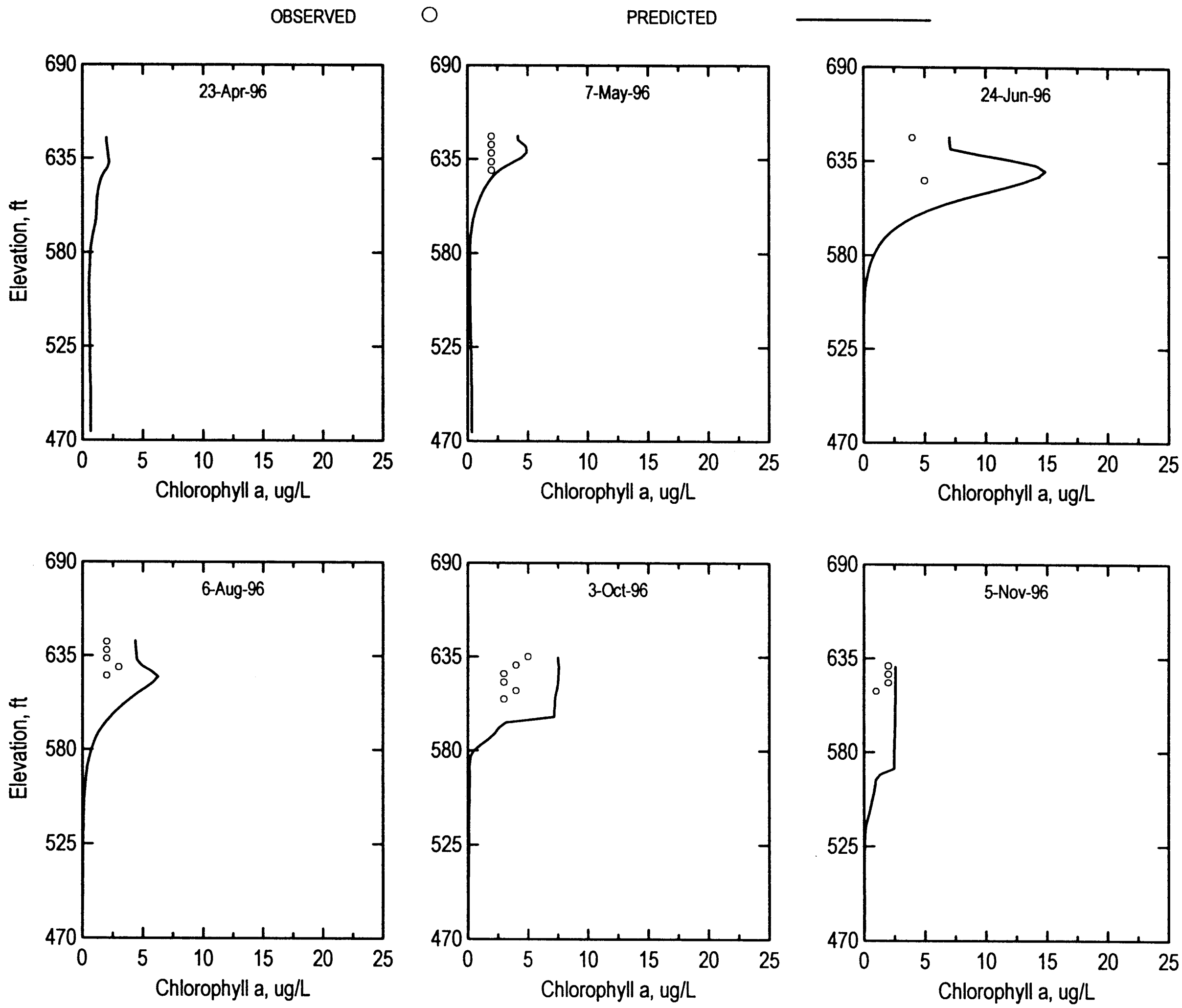
Center Hill Lake 1988 Station CEN20013



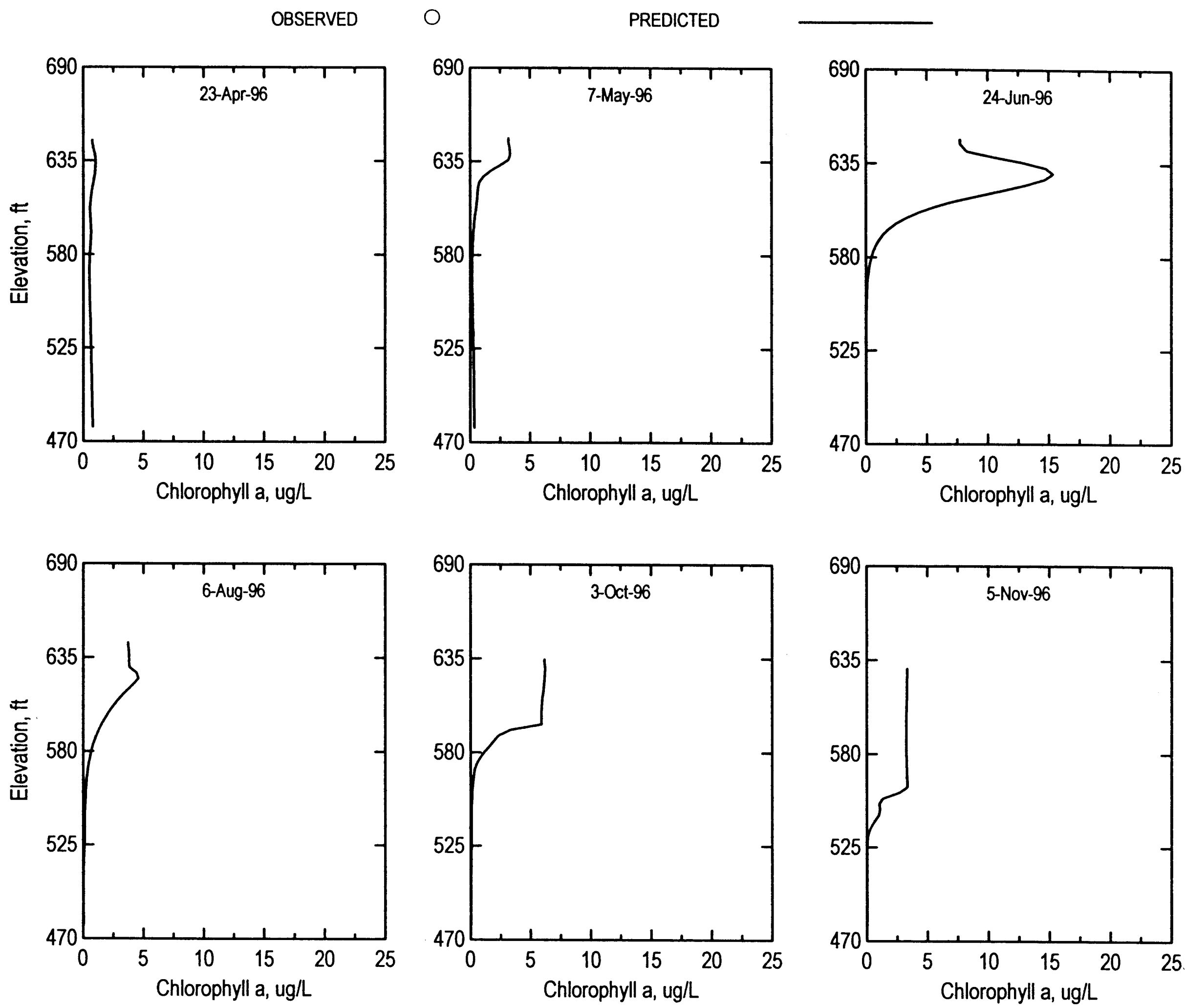
Center Hill Lake 1988 Station CEN20014



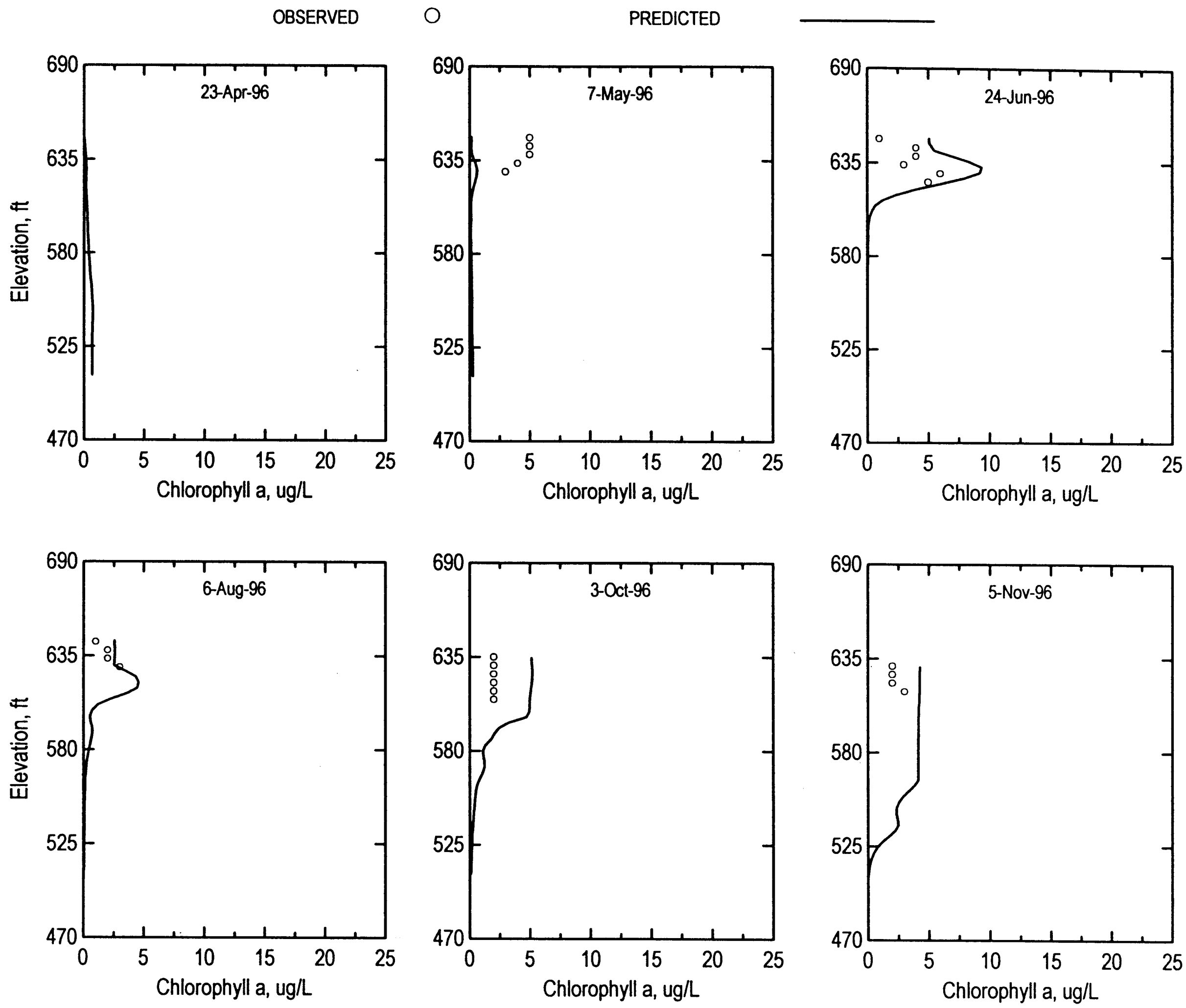
Center Hill Lake 1996 Station CEN20002



Center Hill Lake 1996 Station CEN20003

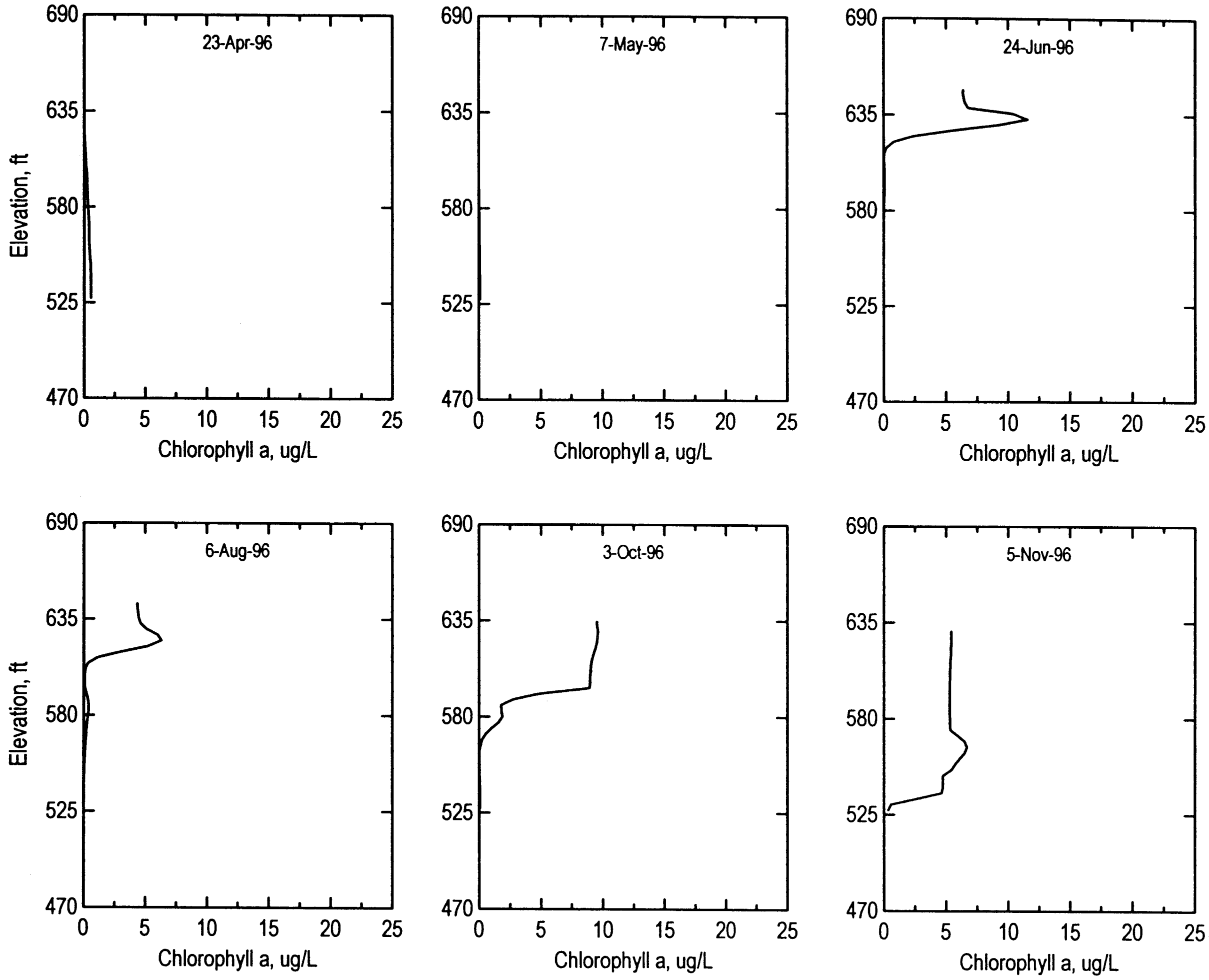


Center Hill Lake 1996 Station CEN20004

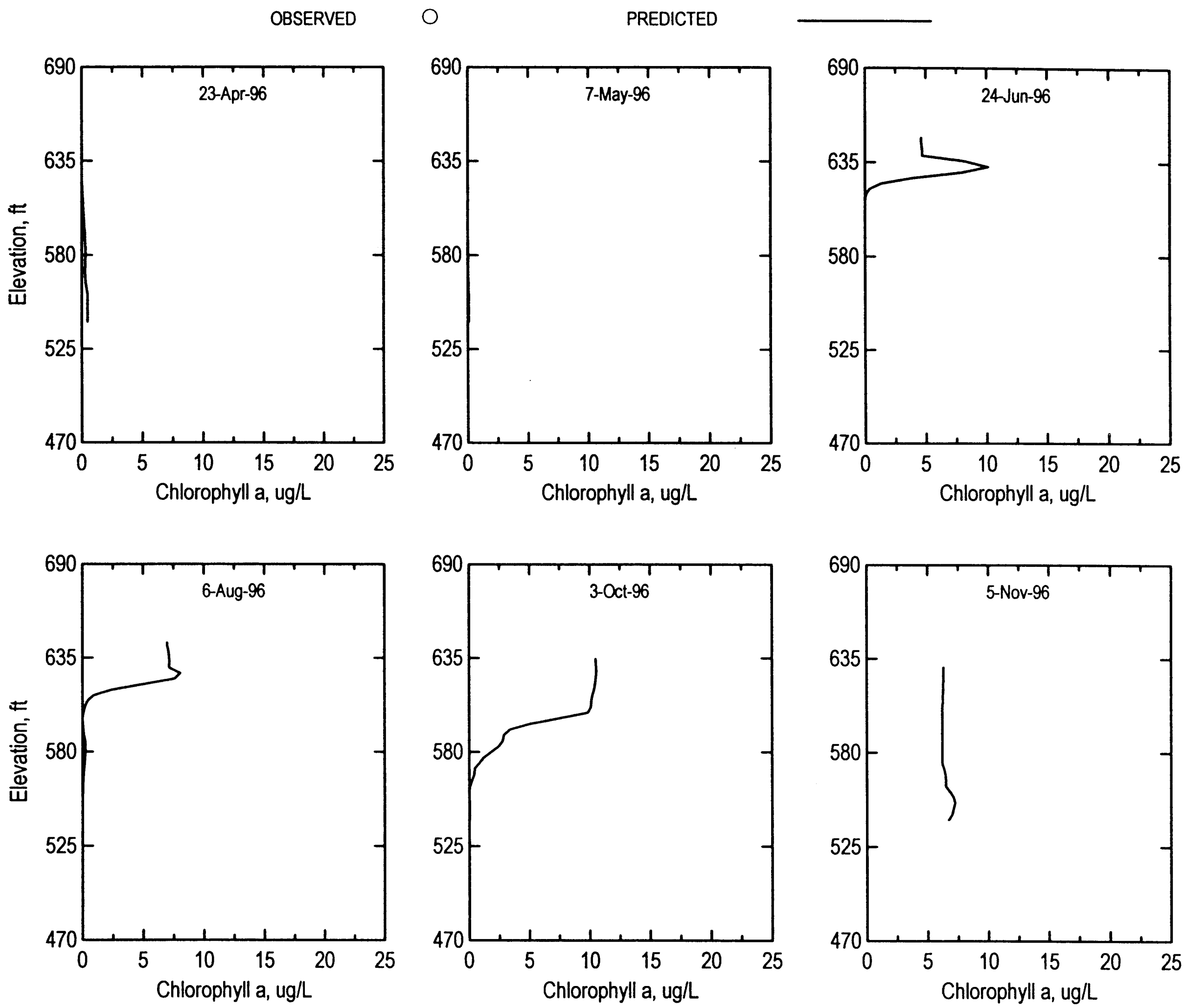


Center Hill Lake 1996 Station CEN20005

OBSERVED ○ PREDICTED ———

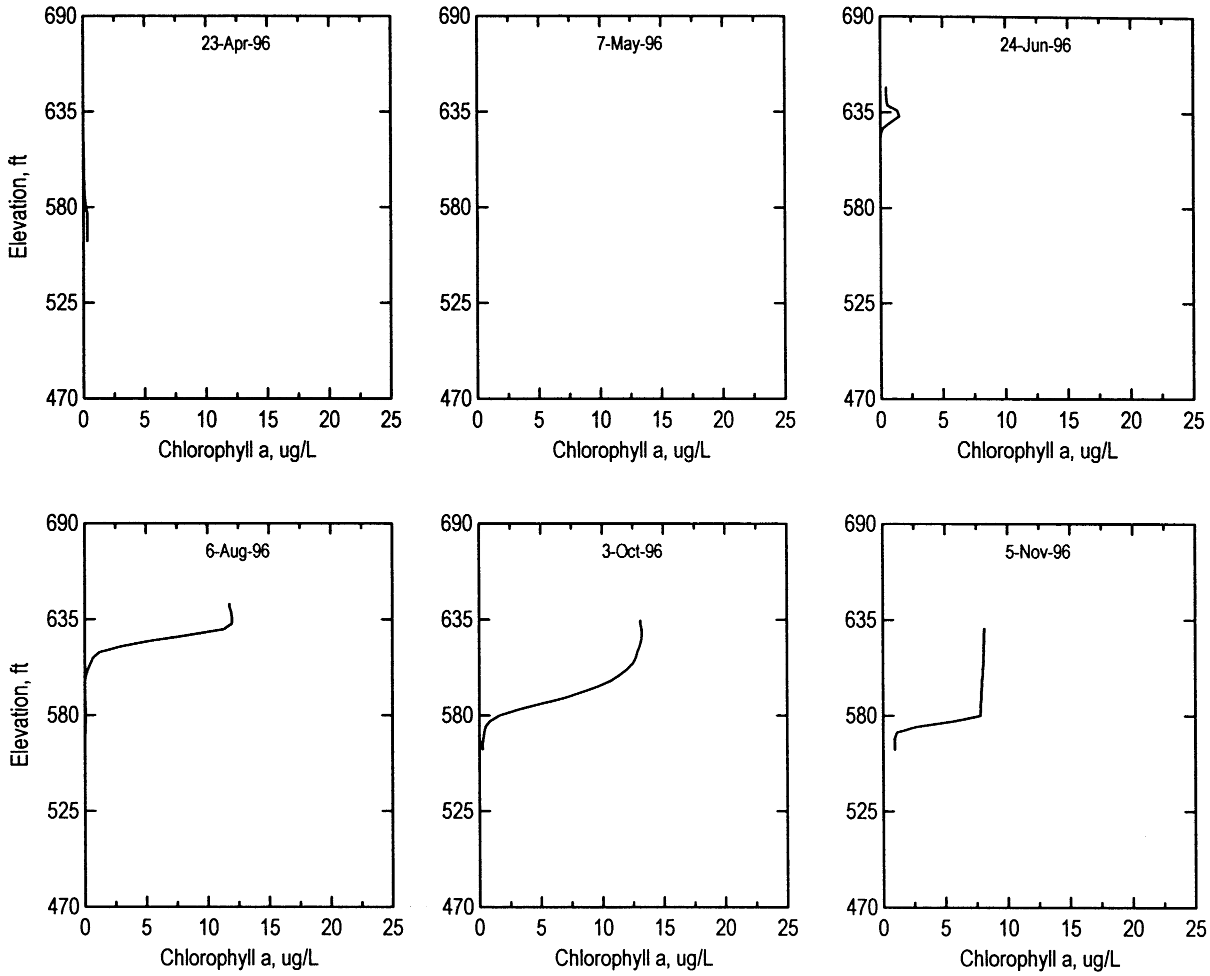


Center Hill Lake 1996 Station CEN20006

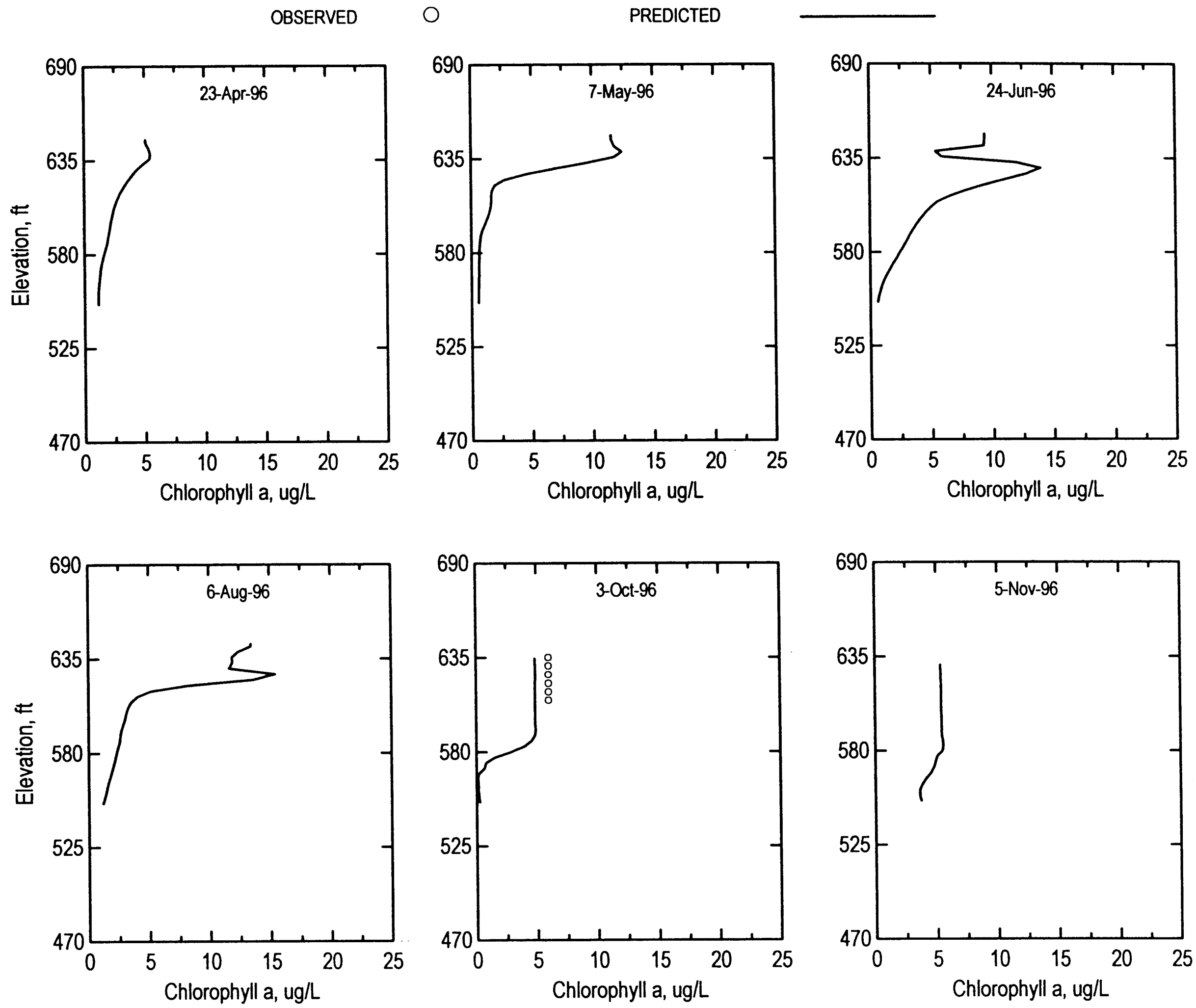


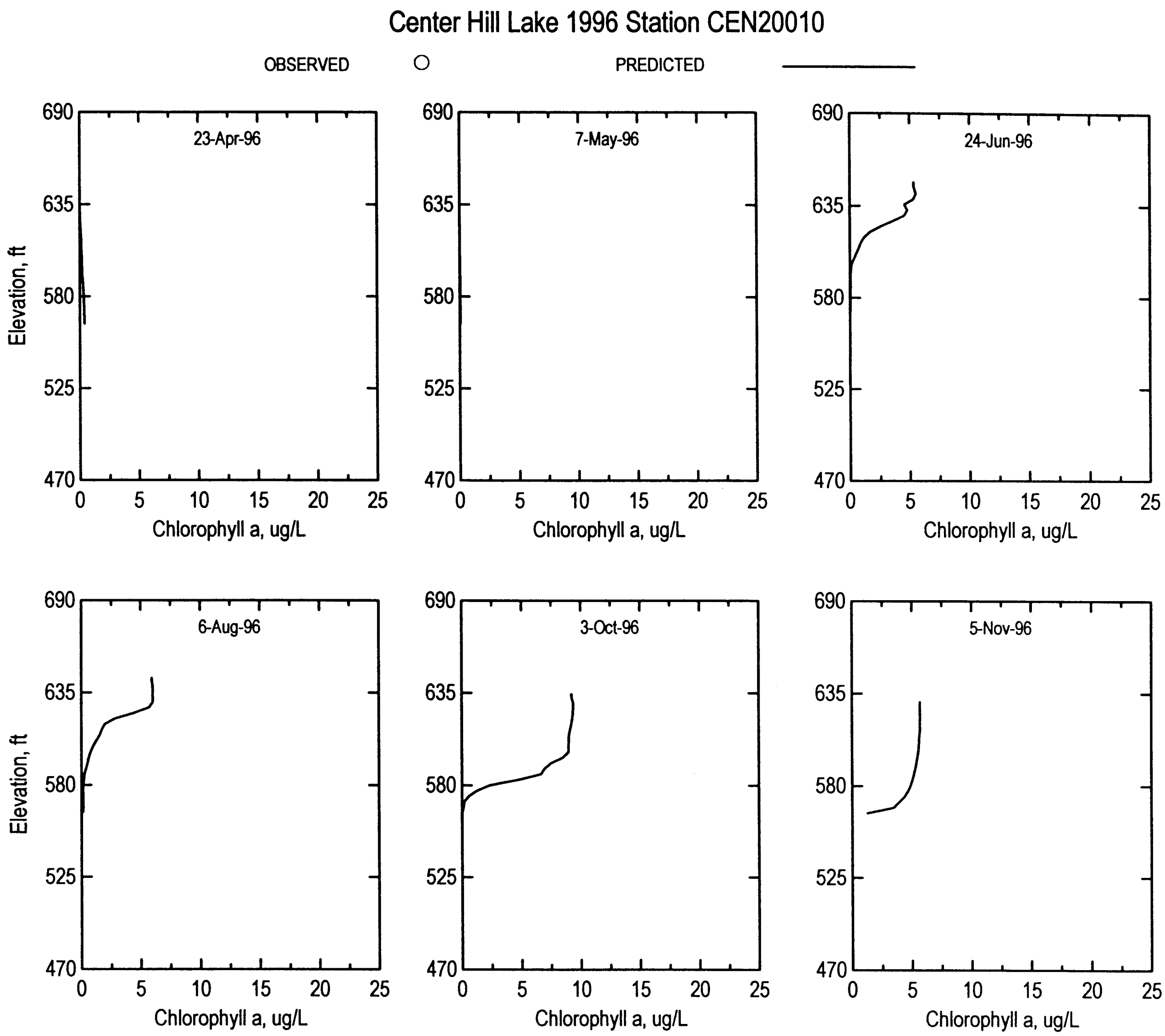
Center Hill Lake 1996 Station CEN20007

OBSERVED ○ PREDICTED ———



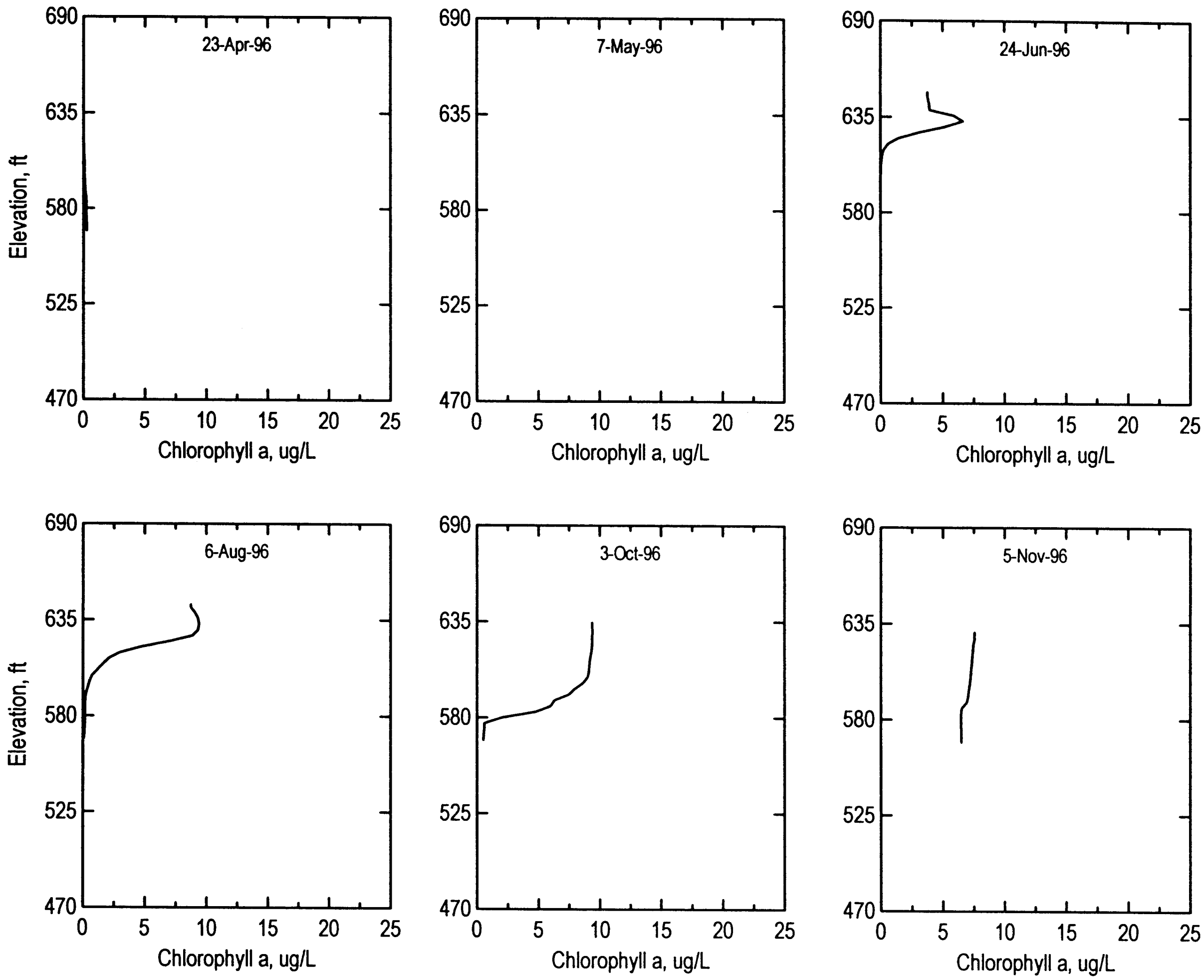
Center Hill Lake 1996 Station CEN20008



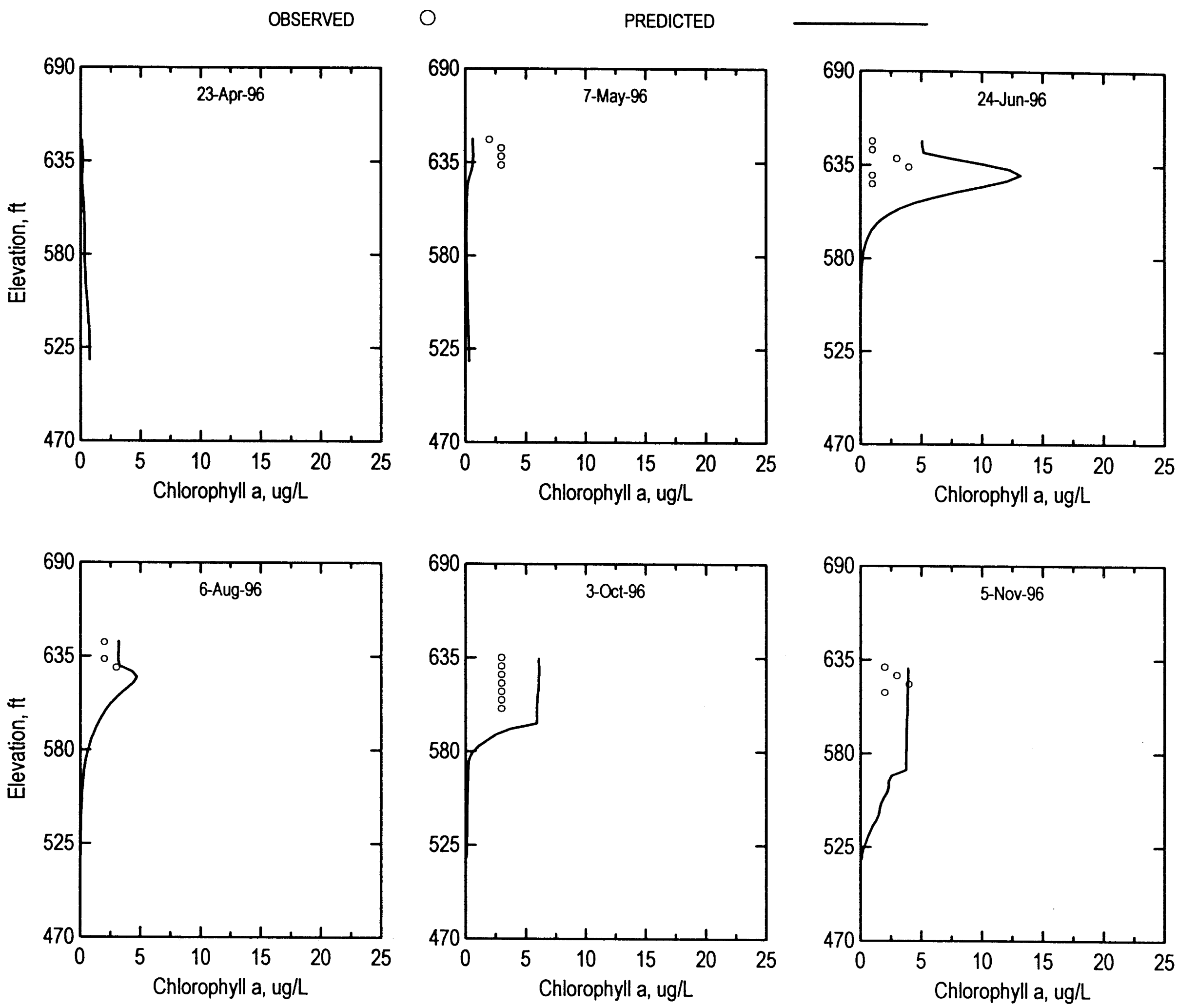

Center Hill Lake 1996 Station CEN20010
OBSERVED
PREDICTED
23-Apr-96
7-May-96
24-Jun-96
6-Aug-96
3-Oct-96
5-Nov-96
Elevation, ft
690
635
580
525
470
0
5
10
15
20
25
Chlorophyll a, ug/L

Center Hill Lake 1996 Station CEN20011

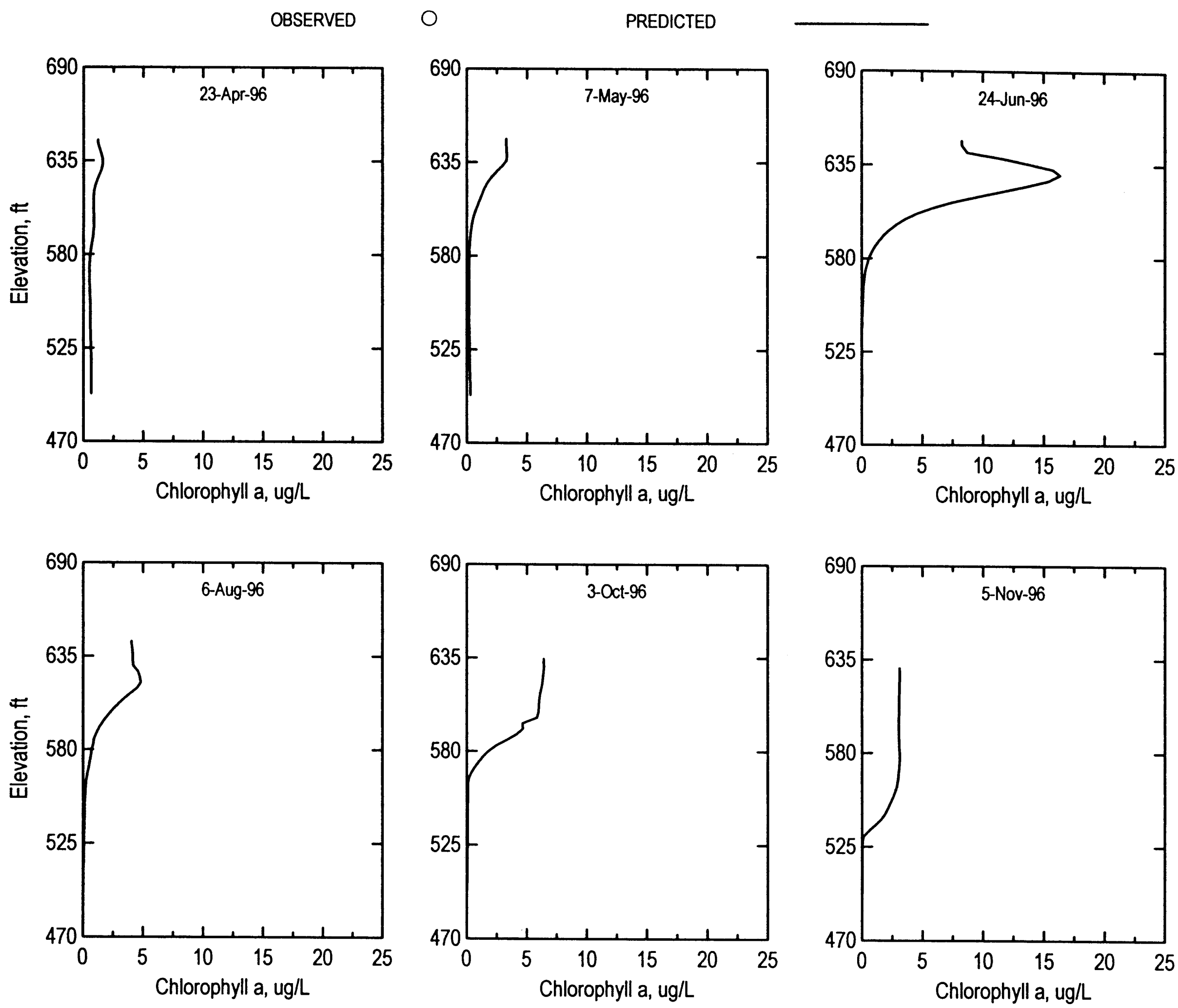
OBSERVED ○ PREDICTED ———



Center Hill Lake 1996 Station CEN20015



Center Hill Lake 1996 Station CEN20013



Center Hill Lake 1996 Station CEN20014