

APPENDIX F

COMPUTER PROGRAM FOR CALCULATING UNSATURATED HYDRAULIC
CONDUCTIVITIES USING THE METHODS OF MILLINGTON AND QUIRK

The program reads in soil water characteristic data and saturated hydraulic conductivity. It calculates unsaturated hydraulic conductivity values and matches the calculated values at saturation.

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C      UNSATURATED CONDUCTIVITY ESTIMATES
C      MILLINGTON AND QUIRK METHOD
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      DIMENSION HL(1000)
      DIMENSION CON(1000)
      DIMENSION COND(1000),HH(1000),TH(1000),HEAD(1000)
C      INPUT DATA
CARD 1: 16 CHARACTER IDENTIFIER
CARD 2: NUMBER OF DATA POINTS, SATURATED CONDUCTIVITY (CM/HR)
CARD 3: MOISTURE CONTENT, TENSION (CM)
CARD 4- END   : BEGIN AT LOWEST MOISTURE CONTENT
      READ(1,1101)A1,A2,A3
      READ (1,75) NUM,CONS
      READ (1,80) (TH(I),HL(I),I=1,NUM)
      DO 799 I=1,NUM
      HH(I)=-HL(I)
799  CONTINUE
      QUIRK=270.0
      EXPONT=1.3333
      I=1
      X1=1000.*TH(1)+0.1
      X2=1000.*TH(NUM)+0.1
      N1=X1
      N2=X2
      HEAD(N2)=HH(NUM)
      N2M=N2-1
      DO 20 J=N1,N2M
      AJ=J
      GO TO 15
10  I=I+1
15  ATH=1000.*TH(I)
      ATH1=1000.0*TH(I+1)
      IF (AJ.GE.ATH1) GO TO 10
      ITH=ATH
      ITH1=ATH1
      HEAD(J)=HH(I)+(AJ-ATH)*(HH(I+1)-HH(I))/(ATH1-ATH)
20  CONTINUE
25  NUM=(N2-N1)/10
      CLASN=NUM
      K=N2-N1-10*NUM

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N11=N1+K
DO 30 I=N11,N2,10
L=(I-N11)/10+1
XX=I
TH(L)=XX/1000.
HH(L)=HEAD(I)
30 CONTINUE
C    NOW HAVE INCREMENTS AT INTERVALS OF WATER CONTENT OF 0.1.
NUM=NUM+1
DO 40 I=2,NUM
XI=I
SUM=0.0
DO 35 J=2,I
XJ=J
35 SUM=SUM+(2.0*(XI-XJ)+1)/((HH(J)+HH(J-1))**2/4.0)
40 CON (I)=QUIRK*TH(I)**EXPONT*SUM/CLASN**2
CON (1)=CON (2)
DO 5 I=1,NUM
COND(I)=(CON(I)/CON(NUM))*CONS
5 CONTINUE
WRITE(6,2000)A1,A2,A3
WRITE(6,3000)
WRITE(6,70) (HH(I),TH(I),COND(I),I=1,NUM)
75 FORMAT(I2,8X,F10.4)
80 FORMAT (F10.5,10X,F10.5)
1101 FORMAT(3A4)
2000 FORMAT('1 UNSATURATED HYDRAULIC CONDUCTIVITY FOR THE ',3A4/
*' SOIL CALCULATED BY THE MILLINGTON AND QUIRK PROCEDURE.'//)
3000 FORMAT(10X,'HEAD',15X,'THETA',10X,'COND-CM/HR')
STOP
END
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SAMPLE INPUT FOR MILLINGTON AND QUIRK

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MUCK-TOPSOIL
12      22.0
0.22      15000.
0.470     400.
0.498     200.
0.514     150.
0.536     100.
0.545     80.
0.556     60.
0.572     40.
0.582     30.
0.596     20.
0.615     10.
0.630     0.

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SAMPLE OUTPUT FOR MILLINGTON AND QUIRK

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1 UNSATURATED HYDRAULIC CONDUCTIVITY FOR THE MUCK-TOPSOIL
SOIL CALCULATED BY THE MILLINGTON AND QUIRK PROCEDURE.

HEAD	THETA	COND-CM/HR
-15000.0000	0.220000	0.000000135
-14416.0000	0.230000	0.000000135
-13832.0000	0.240000	0.000000583
-13248.0000	0.250000	0.000001422
-12664.0000	0.260000	0.000002740
-12080.0000	0.270000	0.000004638
-11496.0000	0.280000	0.000007233
-10912.0000	0.290000	0.000010660
-10328.0039	0.300000	0.000015076
-9744.00391	0.310000	0.000020664
-9160.00391	0.320000	0.000027642
-8576.00391	0.330000	0.000036267
-7992.00391	0.340000	0.000046851
-7408.00391	0.350000	0.000059773
-6824.00391	0.360000	0.000075502
-6240.00391	0.370000	0.000094627
-5656.00391	0.380000	0.000117904
-5072.00391	0.390000	0.000146329
-4488.00391	0.400000	0.000181246
-3904.00391	0.410000	0.000224548
-3320.00391	0.420000	0.000279021
-2736.00391	0.430000	0.000349034
-2152.00391	0.440000	0.000442077
-1568.00391	0.450000	0.000572789
-984.003906	0.460000	0.000776973
-400.000000	0.470000	0.001196608
-328.571289	0.480000	0.002387781
-257.142822	0.490000	0.005178787
-193.749893	0.500000	0.010693349
-162.499435	0.510000	0.020814657
-136.363220	0.520000	0.038058840
-113.636215	0.530000	0.065824747
-91.111099	0.540000	0.109461069
-70.908890	0.550000	0.178303480
-54.999771	0.560000	0.289049685
-42.499969	0.570000	0.470757961
-32.000000	0.580000	0.775007665
-24.285706	0.590000	1.29601192
-17.894730	0.600000	2.20772743
-12.631579	0.610000	3.85943031
-6.666613	0.620000	7.22694683
0.0	0.630000	22.0000000

