TRAFFIC NOISE LEVEL PREDICTOR COMPUTER PROGRAM

MICHIGAN HIGHWAY RESEARCH LABORATORY SECTION

MICHIGAN DEPARTMENT OF STATE HIGHWAYS

TRAFFIC NOISE LEVEL PREDICTOR COMPUTER PROGRAM

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ABSTRACT

This report contains an expansion of the noise level predictor computer program described in Research Report No. R-890. In addition to the L_{10} and L_{50} noise levels the L_{eq}, L_{np}, and TNI indices are calculated.

Research Report R-890 contained an update of the original State of Michigan computer program of the NCHRP Report 117 noise prediction model. The original program was distributed to all of the State Highway Departments by the Federal Highway Administration (FHWA) in 1972.

This method for predicting L_{10} (dbA) noise levels due to highway sources was approved by the FHWA in PPM 90-2, "Noise Standards and Procedures," effective January 29, 1973.

Input parameter definitions, flow charts, a listing, and example problems have been included for the user.

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Prospective users are strongly urged to carefully study references (1, 4, 5) prior to using the computer program. These reports present all of the practical and theoretical considerations required to acquaint newcomers to traffic noise prediction techniques.

Subjective Noise Level Indices

The basic model of NCHRP Reports 117 and 144 calculates both the L_{50} and L_{10} dbA noise levels. However, much interest has developed in the use of other noise level indices such as L_{eq}, L_{np}, and TNI in order to describe the subjective response towards highway traffic noise. Therefore, the previous noise model was modified in such a way as to allow predictions of these additional indices. The basic question to be answered was, "What is the relation between the L_{50}, L_{10} indices and the L_{eq}, L_{np}, and TNI indices?"

By assuming that the noise levels are normally (Gaussian) distributed, the sought after relations (2, 6, 7) can be stated as follows:

$$L_{eq} = L_{50} + 0.07(L_{10} - L_{50})^2$$

$$L_{np} = L_{50} + 2(L_{10} - L_{50}) + 0.07(L_{10} - L_{50})^2$$

$$TNI = L_{50} + 7(L_{10} - L_{50}) - 30$$

The above assumption of normally distributed noise levels holds for freely flowing dense traffic (8). The range of geometric and traffic parameters over which this assumption holds was given more precisely (7) in terms of the A parameter of Figure B10 (1, 3, 4) as: $A = \frac{VD_E}{S} > 200$.

The relationship among these various subjective response noise level indices are shown graphically in Figure 1.

Input Parameters

The input parameters required are described below. The geometric parameters of Figure 2 can be used as a visual aid in determining their values for a specific noise level prediction. The program has been set up such that only the data required for a given site geometry will be requested by the program.

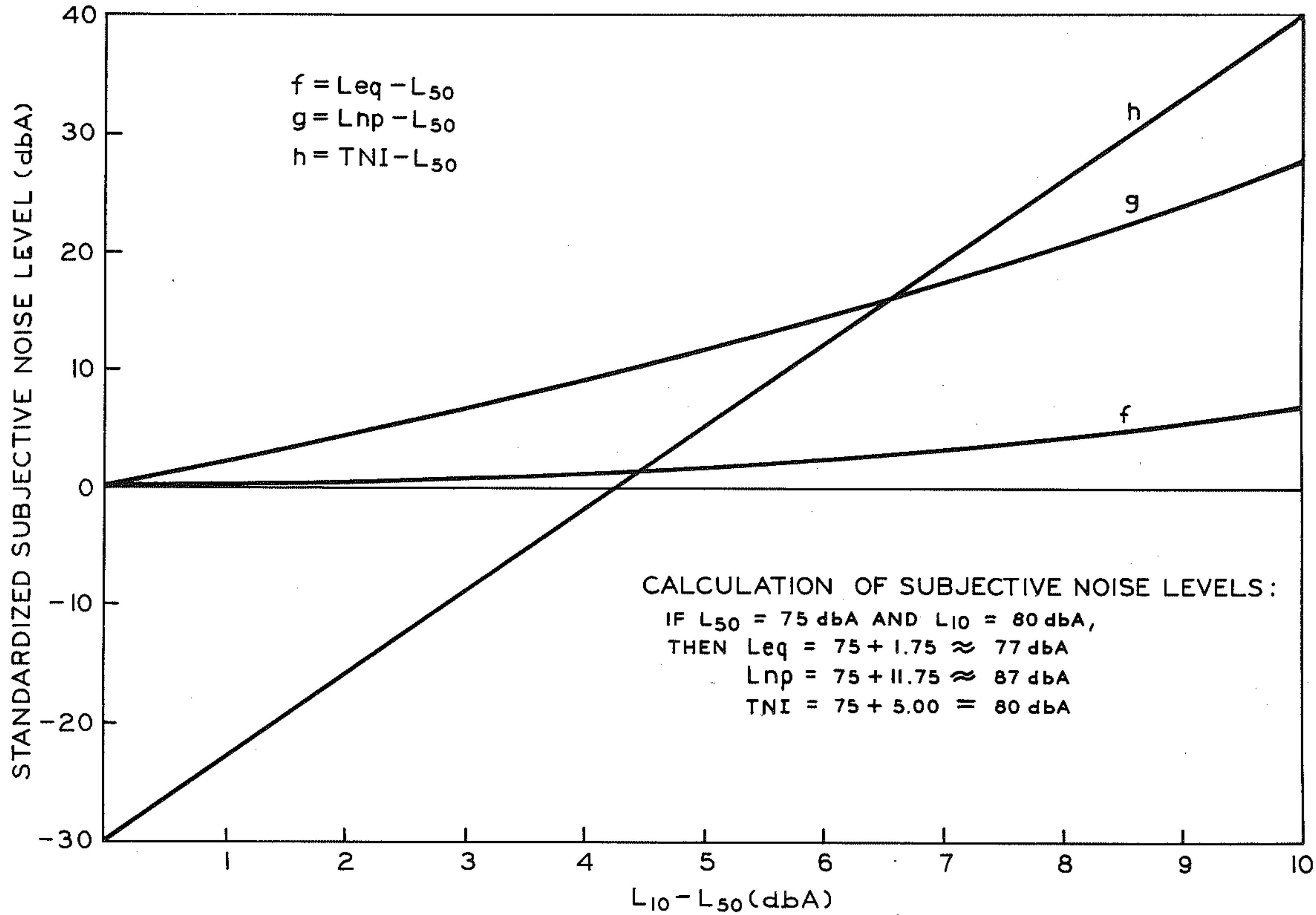

Figure 1. Subjective Noise Level Indices.

COMPUTER PROGRAM FOR THE NOISE PREDICTION METHOD OF NCHRP REPORT NO. 117 AND 144

Flow charts of the mainline program (Fig. A1) and the five subprograms (Figs. A2 through A4) and the entire program listing are included in this appendix.

Assuming that time share capability is not available to all users, the program can be modified to run on batch processing.

The file statement at the beginning will need to be changed to the proper card reader and printer numbers for the user's system. The WRITE and FORMAT statements which request the insertion of certain traffic and geometric data can be deleted for batch processing. Care should be taken when deleting WRITE statements having line numbers that are addressed from other parts of the program. Multiple statements per card or line exist such as a FORMAT followed by a READ, thus only the FORMAT portion should be removed. The free field format (/) on the READ statements must be modified.

Since this was written for a Burroughs B5500, other CPU's will require the usual changes to cover the few differences in the many versions of FORTRAN IV that exist.

Inquiries regarding this program should be directed to:

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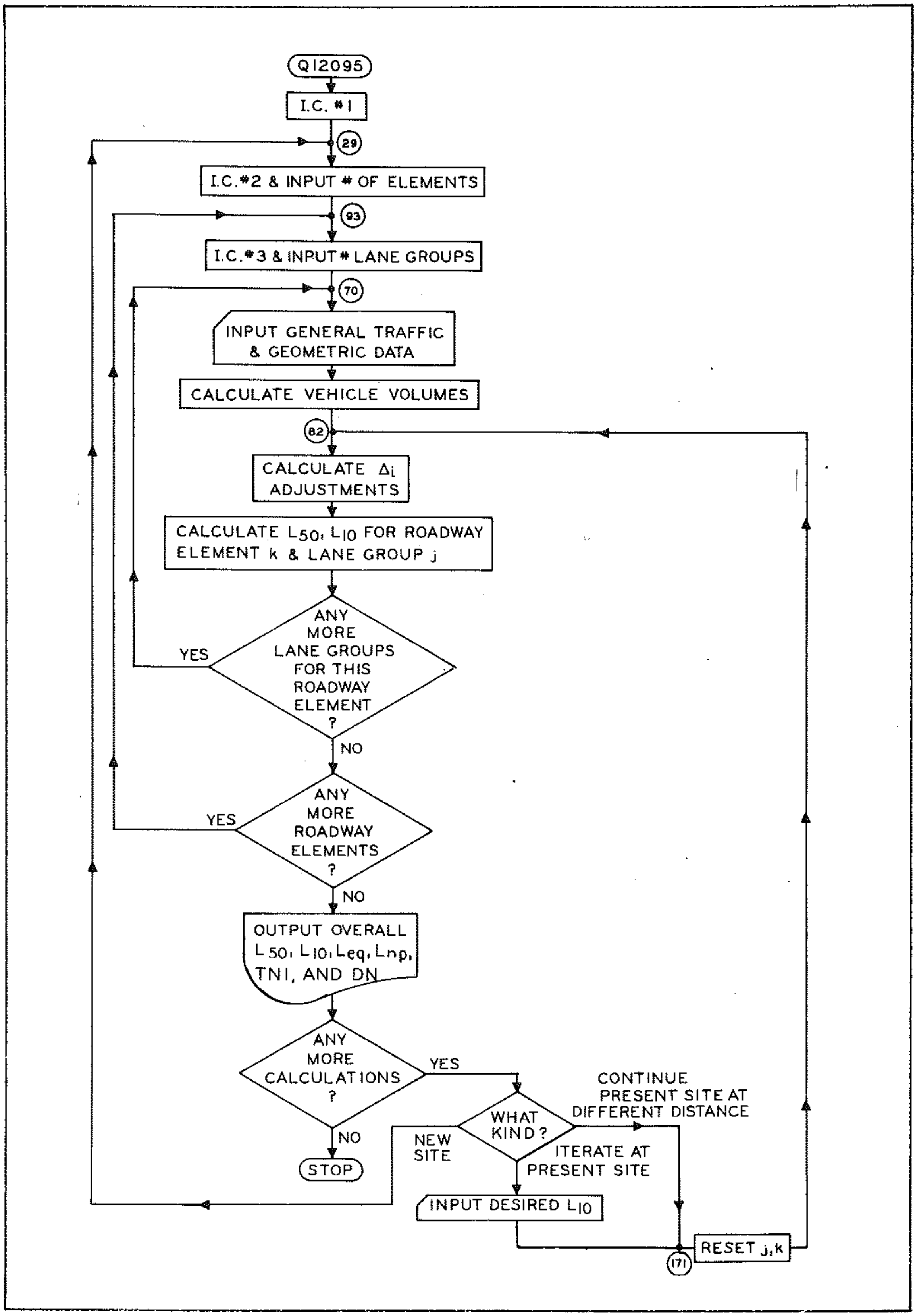

Figure A1. Mainline flow diagram for calculating highway noise levels.

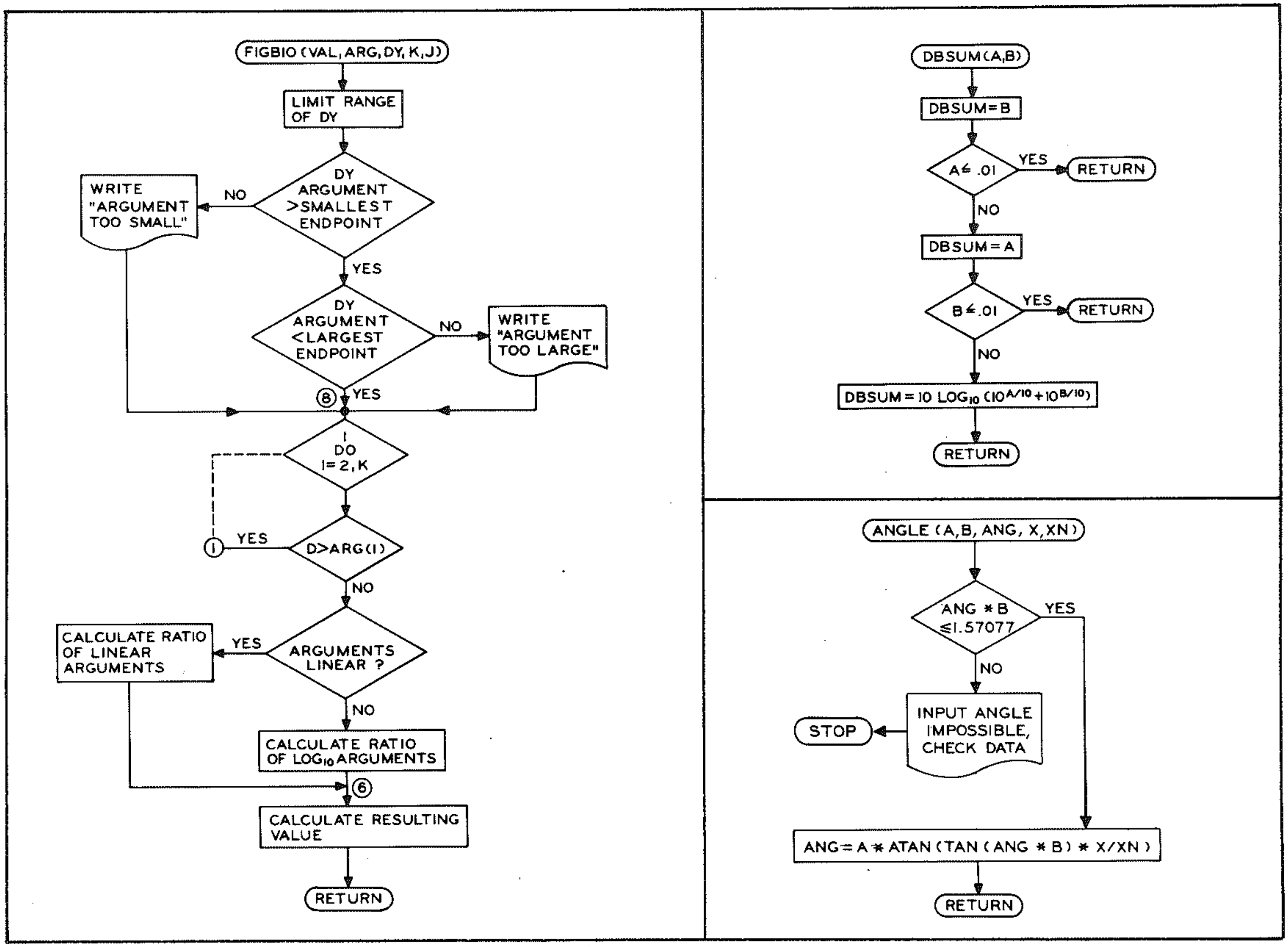

Figure A2. Flow diagrams for subprograms FIGB10, DBSUM and ANGLE. At left is the "Table Look-up" function, above right the "db Sum" function and below right the "angle increment" subroutine.

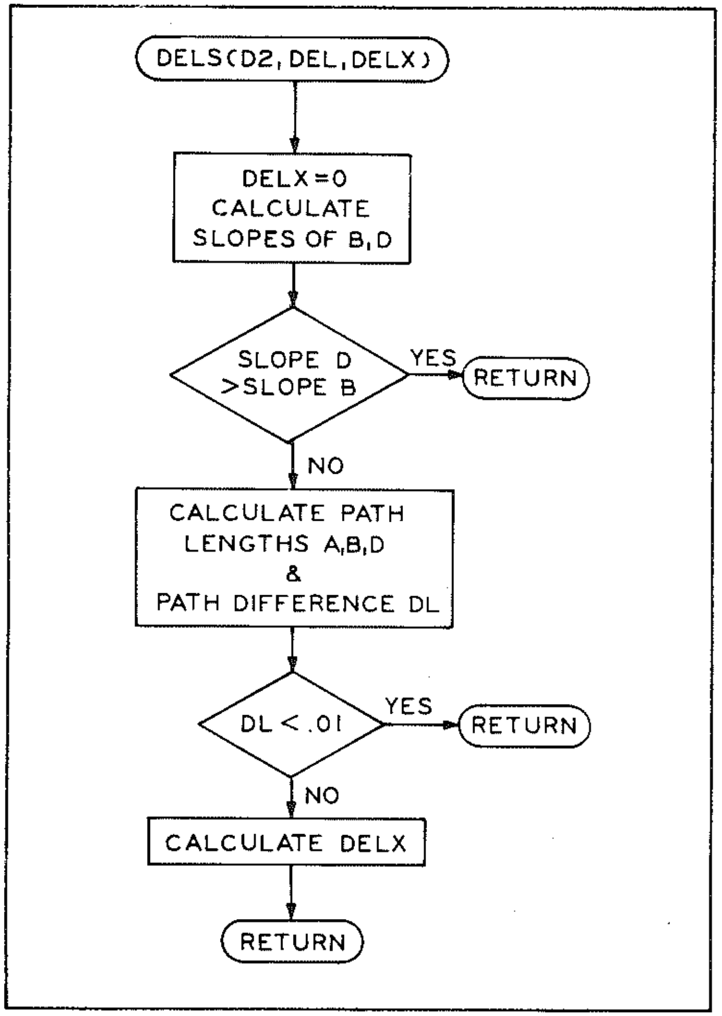

Figure A3. Flow diagram for subprogram DELS which is an elevation and shielding correction subroutine.

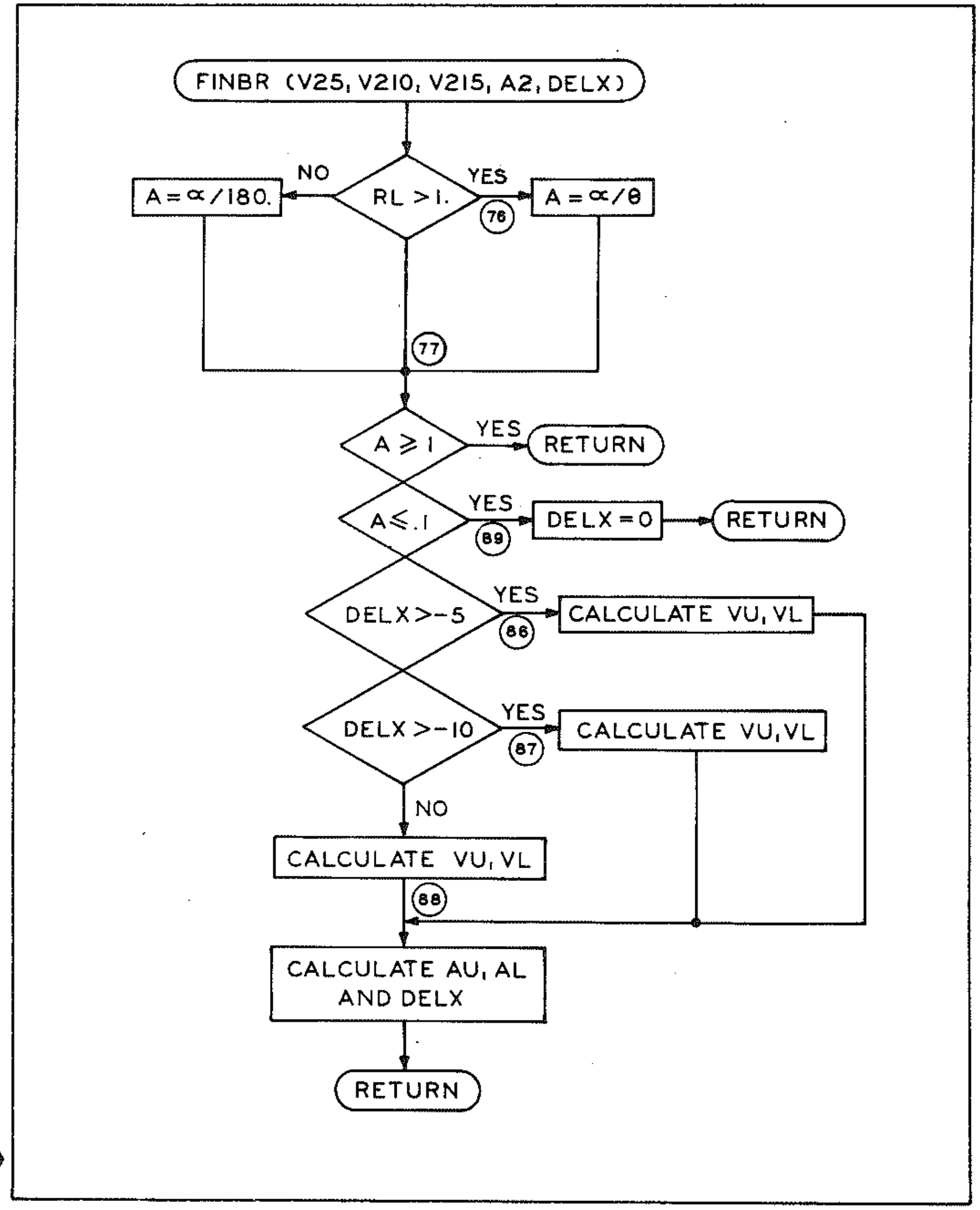

Figure A4. Flow diagram for subprogram FINBR, which performs the finite barrier length correction.

```
FILE  2=Q12OUT,UNIT=REMOTE
 COMMON/BLK1/H3,H4,H5,D3,D4,DE
 COMMON/BLK3/RL,ALPHA,THETA
 DIMENSION VAL(12),ARG(12),D2(7),DEL(7),HEL(4),P(4)
 DIMENSION A2(10),V25(10),V210(10),V215(10)
 DIMENSION Q(4),TMIX(4),ST(4),SA(4),VA(4),VT(4),DNXX(3)
 REAL MED
 DATA (VAL(I),I=1,12)/13.1,12.8,12.,10.87,8.19,5.63,
- 4.,3.,2.13,1.5,1.26,1.13/
 DATA (ARG(I),I=1,12)/20.,100.,200.,300.,600.,1500.,3000.,6000.,
- 15000.,40000.,100000.,800000./
 DATA(A2(I),I=1,10)/.1,.2,.3,.4,.5,.6,.7,.8,.9,1./
 DATA(V25(I),I=1,10)/0.,3*-1.,2*-2.,-3.,2*-4.,-5./
 DATA(V210(I),I=1,10)/0.,2*-1.,-2.,2*-3.,-4.,-6.,-7.,-10./
 DATA(V215(I),I=1,10)/0.,-1.,2*-2.,-3.,-4.,-5.,-7.,-10.,-15./
 DATA (DEL(I),I=1,7)/.01,.03,.1,.3,1.,4.,30./
 DATA (D2(I),I=1,7)/-5.,-5.63,-6.88,-8.28,-10.62,-15.,-15./
 WRITE(2,85)
 85 FORMAT("*****  *****  *****  *****  *****  *****",
-  "  *****"/"* METHOD APPROVED IN FHPM 7-7-3.READ RESEARCH *"
- /"* REPORT R-942. PROGRAM VERSION #10, 10/1/74. *"/
- "*****  *****  *****  *****  *****  *****  *****")
C-
C- PLEASE REPORT ANY PROBLEMS TO G.H.GROVE
C- AT THE MICHIGAN DEPT OF STATE HIGHWAYS
C- RESEARCH LAB IN LANSING. THANK YOU.
 ICON=0
```

```
29 INRE=1;ICONB=0
C3=.0087265;C4=114.59156
WRITE(2,91)
91 FORMAT(/"INSERT NRE= # OF ROADWAY ELEMENTS")
READ(2,/)NRE
93 J=1
DEL2=0;DEL3=0;DEL4=0;DL4=0;DEL5=0;DEL6=0;DL6=0;DEL7=0
WRITE(2,13)INRE
13 FORMAT(/"INSERT N= # OF LANE GROUPS FOR ROAD ELEMENT #",I2)
READ(2,/)N
70 IF(ICON.EQ.2)GO TO 414
WRITE(2,12)J
12 FORMAT(/"INSERT Q,TMIX,ST,SA,HE,DN,RL,BL,P,ID FOR LANE GROUP ",I2)
READ(2,/)Q(J),TMIX(J),ST(J),SA(J),HEL(J),DN,RL,BL,P(J),ID
IF(ID.EQ.0)GO TO 976
WRITE(2,975)
975 FORMAT("INSERT DEL3,DEL5,DEL7");READ(2,/)DEL3,DEL5,DEL7
976 IF(N.NE.2)GO TO 98
WRITE(2,99)
99 FORMAT("INSERT MED")
READ(2,/)MED
98 CONTINUE
C- CALC. VEHICLE VOLUMES.
V=ABS(Q(J))
VT(J)=V*TMIX(J)*.01
VA(J)=V-VT(J)
IF(J.GT.1.AND.ICON.EQ.0)DNXX(J-1)=DN-DN1
```

```
C- DEL2 - ELEMENT CORRECTION.
 414 IF(J.EQ.1)DN1=DN
 82 HE=HEL(J);IF(RL.EQ.1)GO TO 42
 IF(J.EQ.1.AND.ICON.EQ.0)GO TO 160
 CALL ANGLE(C4,C3,THETA,DN1,DN)
 GO TO 41
 160 WRITE(2,32)
 32 FORMAT("INSERT THETA");READ(2,/)THETA
 THET=THETA
 41 DEL2=10.*ALOG10(THETA/180.)
C- DF - EQUIVALENT LANE DISTANCE CALC.
 42 DF=DN+12.*P(J)-12.
 DE=SQRT(DN*DF)
 IF(ICON.NE.0.AND.J.EQ.1)THET=THETA
 IF(J.EQ.1)DN1=DN
C- DEL1 - DISTANCE CORRECTION.
 DEL1=-15.*ALOG10(.01*DE)
C- DEL4 - VERTICAL CORRECTION.
 61 IF(HE.EQ.0.AND.BL.EQ.0.OR.J.NE.1.OR.ICON.NE.0) GO TO 120
 WRITE(2,119)
 119 FORMAT("INSERT HO");READ(2,/)HO
 120 IF(HE)44,48,53
 53 IF(J.GT.1.OR.ICON.NE.0) GO TO 110
 WRITE(2,14)
 14 FORMAT("INSERT DS")
 READ(2,/)DS
 110 IF(J.EQ.1.AND.ICON.NE.0)DS=DS+DNX;IF(BL.NE.0)GO TO 48
```

```
 H3=0.;H4=HE-HO;H5=H4;D3=DE-DS;D4=DS
CALL DELS(D2,DEL,DEL4)
H3=8.;H5=H5+8.
CALL DELS(D2,DEL,DL4)
GO TO 48
44 IF(J.GT.1.OR.ICON.NE.0) GO TO 111
WRITE(2,11)
11 FORMAT("INSERT DC")
READ(2,/)DC
111 IF(J.EQ.1.AND.ICON.NE.0)DC=DC+DNX;IF(BL.NE.0)GO TO 48
H3=HE;H4=-HO;H5=-HO+HE;D3=DE-DC;D4=DC
CALL DELS(D2,DEL,DEL4)
H3=H3+8.;H5=H5+8.
CALL DELS(D2,DEL,DL4)
C- DEL6 - BARRIER CORRECTION.
48 IF(BL.EQ.0.)GO TO 33
IF(J.GT.1.OR.ICON.EQ.1) GO TO 112
IF(ICON.EQ.2)GO TO 412
WRITE(2,39)
39 FORMAT("INSERT H,DB")
READ(2,/)H,DB
412 DBN=DB
112 IF(J.EQ.1.AND.ICON.NE.0)DB=DB+DNX
D3=DE-DB;D4=DB;IF(HE)201,202,206
202 H3=-H;H4=H-HO;H5=-HO
CALL DELS(D2,DEL,DEL6)
H3=H3+8.;H5=H5+8.
```

```
CALL DELS(D2,DEL,DL6)
GO TO 205
201 H3=HE-H;H4=H-HO;H5=HE-HO
GO TO 204
206 H3=-H;H4=HE-HO+H;H5=HE-HO
204 CALL DELS(D2,DEL,DEL6)
H3=H3+8.;H5=H5+8.
CALL DELS(D2,DEL,DL6)
205 IF(BL.NE.2.)GO TO 33
IF(J.EQ.1.AND.ICON.EQ.0)GO TO 113
IF(J.GT.1)GO TO 38
CALL ANGLE(C4,C3,ALPHA,DBN,DB);DB=DBN
GO TO 38
113 WRITE(2,73)
73 FORMAT("INSERT ALPHA");READ(2,/)ALPHA
38 CALL FINBR(V25,V210,V215,A2,DEL6)
CALL FINBR(V25,V210,V215,A2,DL6)
C- CALC. L50 & L10.
33 S=DEL1+DEL2+DEL7
SDEL=S+AMAX1(DEL4+DEL6,-20.)+DEL5
SDELT=S+DEL3+AMAX1(DL4+DL6,-20.)
YA=.119*VA(J)/SA(J)
UA=VA(J)*SA(J)*SA(J)*TANH(YA)
AL50A=10.*ALOG10(UA)-1.+SDEL
AA=VA(J)*DE/SA(J)
AL10A=FIGB10(VAL,ARG,AA,12,0)
OL10A=AL50A+AL10A
```

```
YT=.119*VT(J)/ST(J)
UT=VT(J)*TANH(YT)/ST(J)
AL50T=10.*ALOG10(UT)+65.+SDELT
AT=VT(J)*DE/ST(J)
AL10T=FIGB10(VAL,ARG,AT,12,0)
OL10T=AL50T+AL10T
IF(Q(J).GT.0.)GO TO 51
OL10A=OL10A+2.
OL10T=OL10T+4.
51 AL50=DBSUM(AL50A,AL50T)
AL10=DBSUM(OL10A,OL10T)
IF(ICON.EQ.1)GO TO 974
WRITE(2,973)OL10A,OL10T,AL10,INRL,J
973 FORMAT("L10A=",F4.0," L10T=",F4.0," L10=",F4.0,
- " FOR ELEM. #",I2,", LANE GRP. #",I2)
C- CHECK IF ANY MORE LANE GROUPS.
974 IF(N.EQ.1)GO TO 72
IF(J.EQ.1)GO TO 65
AL50=DBSUM(AL50,XX)
AL10=DBSUM(AL10,YY)
IF(J.EQ.N)GO TO 72
65 XX=AL50;YY=AL10
J=J+1
IF(RL.NE.1)THETA=THET
IF(J.GT.1.AND.ICON.NE.0)DN=DN1+DNXX(J-1)
IF(N.NE.2)GO TO 70
IF(ICON.GE.1)GO TO 414
```

```
DN=DN+MFD+12.*P(J)
WRITE(2,333)
333 FORMAT(/"INSERT #2 Q,TMIX,ST,SA")
READ(2,/)Q(J),TMIX(J),ST(J),SA(J);GO TO 98
C- CHECK IF ANY MORE ROADWAY ELEMENTS.
72 IF(NRE.EQ.1)GO TO 92
IF(INRE.EQ.1)GO TO 67
AL50=DBSUM(AL50,RODL5)
AL10=DBSUM(AL10,RODL1)
IF(INRE.EQ.NRE)GO TO 92
67 RODL5=AL50;RODL1=AL10
INRE=INRE+1
GO TO 93
C- OUTPUT RESULTING L50 & L10 VALUES.
92 IF(ICON.EQ.1)GO TO 161
Z=AL10-AL50
GEQ=AL50+.07*Z*Z
GNP=GEQ+2.*Z;TNI=6.*Z+AL10-30.
WRITE(2,23)AL50,AL10,NRE,DN1,GEQ,GNP,TNI
23 FORMAT(/"********************"/"L50=",F4.0,"  L10=",
- F4.0,"  DN1(TO ELEMENT #",I2,")=",F6.0/
- "LEQ=",F4.0,"  LNP=",F4.0,"  TNI=",F4.0/
- "********************"/)
C- CHECK IF ANY MORE PROBLEMS TO BE SOLVED.
WRITE(2,26)
26 FORMAT("INSERT 2,1,0,-1 FOR CONTINUE,ITERATE,NEW,STOP")
READ(2,/)ICON
```

```
IF(ICON.GT.1)GO TO 187
IF(ICON)28,29,30
30 IF(NRF.EQ.1.AND.N.LE.2)GO TO 945
WRITE(2,940)
940 FORMAT(/"SITE TOO COMPLICATED TO ITERATE");GO TO 28
945 WRITE(2,141)
141 FORMAT("INSERT DESIRED L10");READ(2,/)AL10D
DX=0.;DELDN=100.
161 DXN=AL10-AL10D
IF(ABS(DXN).LT..1)GO TO 162
IF(DELDN.LT.2.)GO TO 162
IF(DXN*DX.LT.0.)DELDN=.5*DELDN
DXX=SIGN(DELDN,DXN)
DNN=DN1+DXX
XXX=DNN
IF(HE)144,145,146
144 DCN=DC+DXX
XXX=DCN
GO TO 145
146 DSN=DS+DXX
XXX=DSN
145 IF(BL.EQ.0.)GO TO 181
DBN=DB+DXX;XXX=DBN
181 IF(XXX.LE.0.)GO TO 180
DN=DNN;DX=DXN;DNX=DXX
GO TO 171
162 ICON=0;ICONR=1
```

```
GO TO 92
180 WRITE(2,203)
203 FORMAT("TRY CLUSER L10 AFTER RESET OF SITE DATA")
ICON=0
GO TO 29
187 IF(NRE.EQ.1)GO TO 942
WRITE(2,941)
941 FORMAT(/"SITE TOO COMPLICATED TO CONTINUE",/,
- "SET UP COMPLETE DATA FOR NEW DN")
GO TO 28
942 WRITE(2,17)
17 FORMAT("INSERT NEW DN");READ(2,/)DN
DNX=DN-DN1
171 IF(RL.NE.1.)THETA=THET
J=1;INRE=1;GO TO 82
28 STOP
END
FUNCTION FIGB10(VAL,ARG,DY,K,J)
DIMENSION VAL(1),ARG(1)
C- INTERPOLATES ON EITHER A LINEAR OR SEMILOG GRID.
C- IN THE CALL, SET J=1 FOR LINEAR, =0 FOR SEMILOG.
D=AMAX1(AMIN1(DY,ARG(K)),ARG(1))
IF(DY.GE.ARG(1)) GO TO 7
WRITE(2,20)
20 FORMAT("*** ARGUMENT LIMITED AT LOW END ***")
WRITE(2,22)DY,ARG(1),ARG(K)
22 FORMAT("DY=",F10.2," ARG(1)=",F6.2," ARG(K)=",F10.2)
```

```
GO TO 8
7 IF(DY.LE.ARG(K)) GO TO 8
WRITE(2,21)
21 FORMAT("*** ARGUMENT LIMITED AT HIGH END ***")
WRITE(2,22)DY,ARG(1),ARG(K)
8 DO 1 I=2,K
IF(D.GT.ARG(I)) GO TO 1
IF(J.EQ.1) GO TO 9
FIGB10=ALOG10(D)-ALOG10(ARG(I-1))
F=ALOG10(ARG(I))-ALOG10(ARG(I-1))
6 FIGB10=FIGB10*(VAL(I)-VAL(I-1))/F+VAL(I-1)
RETURN
9 FIGB10=D-ARG(I-1)
F=ARG(I)-ARG(I-1)
GO TO 6
1 CONTINUE
RETURN
END
FUNCTION DBSUM(A,B)
C- CALCULATES THE DB SUM OF A & B.
DBSUM=B
IF(A.LE..01)RETURN
DBSUM=A
IF(B.LE..01)RETURN
DBSUM=10.*ALOG10(10.**(.1*A)+10.**(.1*B))
RETURN
END
```

```
      SUBROUTINE ANGLE(A,B,ANG,X,XN)
C- CALCULATES NEW ANGLE.
   20 FORMAT("INPUT ANGLE PHYSICALLY IMPOSSIBLE,CHECK DATA.")
      IF(ANG*B.LE.1.57077)GO TO 10
      WRITE(2,20);STOP
   10 ANG=A*ATAN(TAN(ANG*B)*X/XN)
      RETURN
      END
      SUBROUTINE DELS(D2,DEL,DELX)
C- CALCULATES SHIELDING EFFECTS.
      DIMENSION D2(7),DEL(7)
      COMMON/BLK1/H3,H4,H5,D3,D4,DE
      DELX=0.
      SB=H4/D4;SD=H5/DE
      IF(SD.GT.SB)RETURN
      A=SQRT(H3*H3+D3*D3)
      B=SQRT(H4*H4+D4*D4)
      D=SQRT(H5*H5+DE*DE)
      DL=A+B-D
      IF(DL.LT..01)RETURN
      DELX=FIGB10(D2,DEL,DL,7,0)
      RETURN
      END
      SUBROUTINE FINBR(V25,V210,V215,A2,DELX)
C- CALCULATES FINITE BARRIER ATTENUATION.
      DIMENSION A2(10),V25(10),V210(10),V215(10)
      COMMON/BLK3/RL,ALPHA,THETA
```

```
IF(RL.GT.1.)GO TO 76
A=ALPHA/180.
GO TO 77
76 A=ALPHA/THETA
77 IF(A.GE.1.)RETURN
IF(A.LE..1)GO TO 89
IF(DELX.GT.-5.)GO TO 86
IF(DELX.GT.-10.)GO TO 87
VU=FIGB10(V210,A2,A,10,1)
VL=FIGB10(V215,A2,A,10,1)
GO TO 88
89 DELX=0.
RETURN
86 VU=0.
VL=FIGB10(V25,A2,A,10,1)
GO TO 88
87 VU=FIGB10(V25,A2,A,10,1)
VL=FIGB10(V210,A2,A,10,1)
88 AL=.1*AINT(10.*A)
AU=AL+.1
DELY=(A-AL)*(VL-VU)/(AU-AL)+VU
RETURN
END
```

APPENDIX B

EXAMPLE PROBLEMS

Example Problem 1

The physical configuration of the roadway selected for this example is such that it is best approximated by a single finite length element with two lane groups each (Fig. B1).

Each lane group consists of four lanes, separated by a 26-ft median, depressed 10 ft with less than 2 percent grade and a rough surface.

The near lane group traffic data consists of free flowing 4,000 vehicles/hour with a 10 percent truck mix and 55 mph truck and 65 mph car speeds. The far lane group traffic data consists of free flowing 4,200 vehicles/hour with a 9 percent truck mix and 50 mph truck and 55 mph car speeds.

There is a 100-ft observer distance, 5-ft observer height, 64-ft cut distance and roadway element angle of 50°.

The objective is to find the L_{10} noise level at the observer point for the given geometry and traffic data. If this L_{10} exceeds 70 dbA, then determine the observer distances for the 70 dbA and 65 dbA limits.

The problem can be solved as shown on the facsimile of the computer printout (Fig. B2).

Example Problem 2

This example consists of three roadway elements with the following traffic parameters:

Element No. 1: Free flowing 3,300 vehicles/hour, 10 percent truck mix, 50 mph truck and 60 mph car speeds on a non-divided four-lane pavement.

Element No. 2: Interrupted flow of 1,500 vehicles/hour with 11 percent truck mix at 45 mph truck and 50 mph car speeds on the near lane group. Interrupted flow of 1,800 vehicles/hour with 9 percent truck mix at 45 mph truck and 50 mph car speeds on the far lane group.

Element No. 3: Same as for element No. 1 except at 50 mph truck and 55 mph car speeds.

The roadway geometry is illustrated in Figure B3.

The problem being to determine the L_{10} dbA noise level expected at the observer location. This problem can be solved as indicated on the computer printout (Fig. B4).

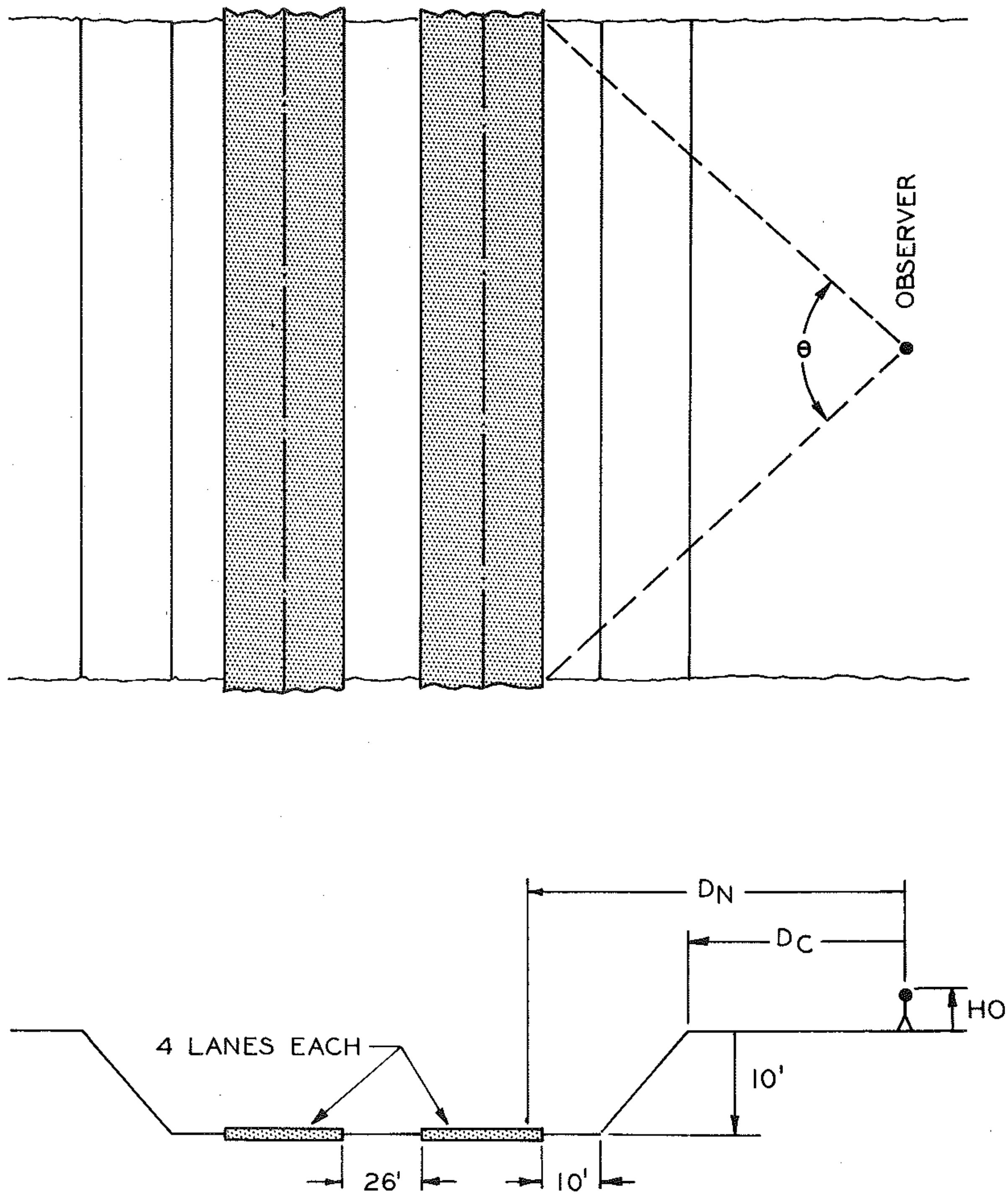

Figure B1. Roadway geometry for example problem 1.

```
*****  *****  *****  *****  *****  *****  *****
* METHØD APPRØVED IN FHPM 7-7-3.READ RESEARCH *
* REPØRT R-942. PRØGRAM VERSIØN #10, 10/1/74. *
*****  *****  *****  *****  *****  *****  *****

INSERT NRE= # ØF RØADWAY ELEMENTS
?1←

INSERT N= # ØF LANE GRØUPS FØR RØAD ELEMENT # 1
?2←

INSERT Q,TMIX,ST,SA,HE,DN,RL,BL,P,ID FØR LANE GRØUP  1
?4000,10,55,65,-10,100,3,0,4,1←
INSERT DEL3,DEL5,DEL7
?0,5,0←
INSERT MED
?26←
INSERT THETA
?50←
INSERT HØ
?5←
INSERT DC
?64←
L10A= 65. L10T= 73. L10= 73. FØR ELEM. # 1, LANE GRP. # 1

INSERT #2 Q,TMIX,ST,SA
?4200,9,50,55←
L10A= 62. L10T= 72. L10= 72. FØR ELEM. # 1, LANE GRP. # 2

********************
L50= 69.  L10= 76.  DNI(TØ ELEMENT # 1)=  100.
LEQ= 72.  LNP= 85.  TNI= 84.
********************

INSERT 2,1,0,-1 FØR CØNTINUE,ITERATE,NEW,STØP
?1←
INSERT DESIRED L10
?70←

********************
L50= 65.  L10= 70.  DNI(TØ ELEMENT # 1)=  163.
LEQ= 67.  LNP= 77.  TNI= 72.
********************

INSERT 2,1,0,-1 FØR CØNTINUE,ITERATE,NEW,STØP
?1←
INSERT DESIRED L10
?65←

********************
L50= 60.  L10= 65.  DNI(TØ ELEMENT # 1)=  244.
LEQ= 62.  LNP= 71.  TNI= 63.
********************

INSERT 2,1,0,-1 FØR CØNTINUE,ITERATE,NEW,STØP
?-1←

 END Q12095 4.7 SEC.
```

Figure B2. Facsimile of computer printout for example problem 1.

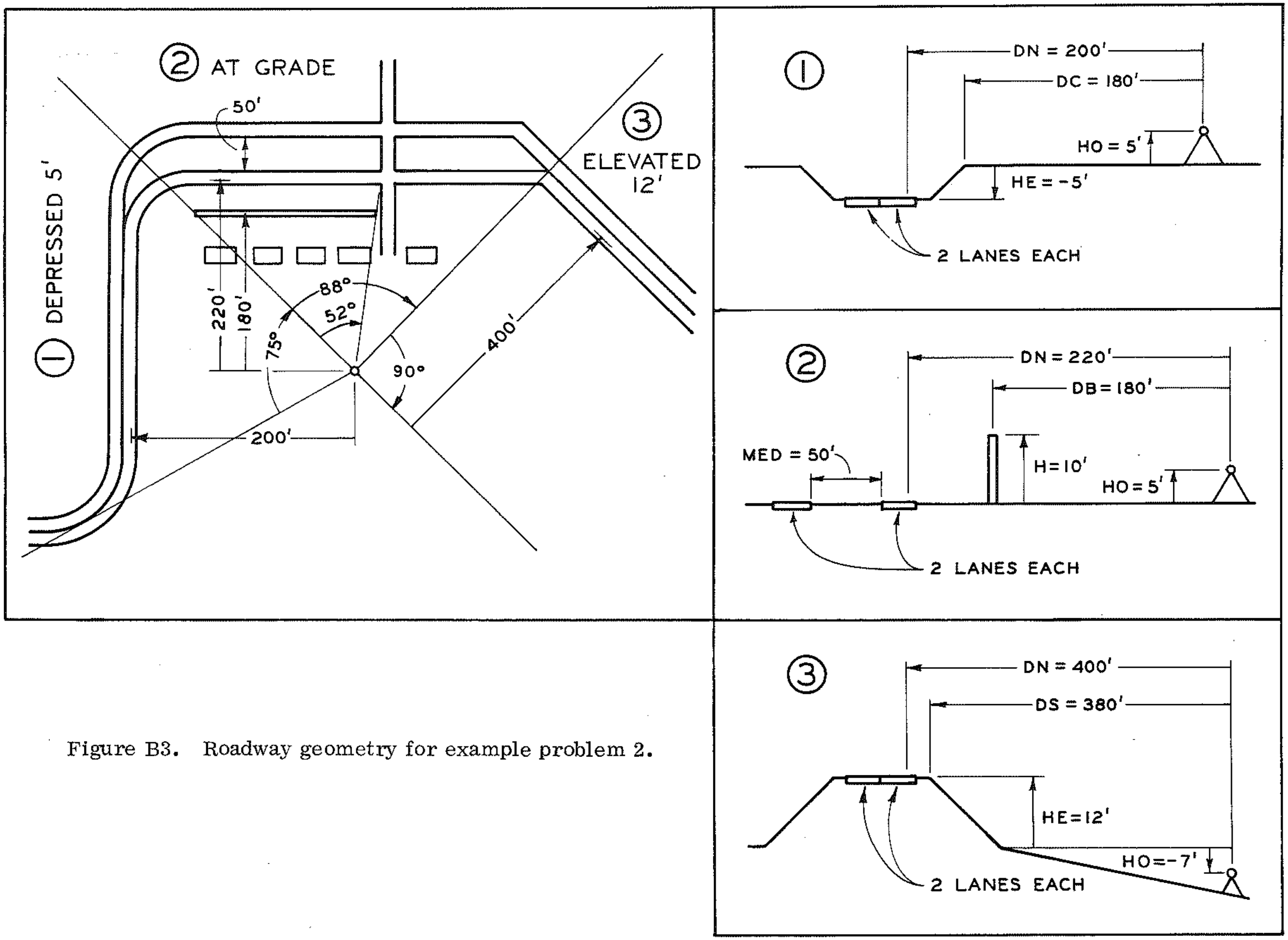

Figure B3. Roadway geometry for example problem 2.

```
***** ***** ***** ***** ***** ***** *****
* METHØD APPRØVED IN FHPM 7-7-3.READ RESEARCH *
* REPØRT R-942. PRØGRAM VERSIØN #10, 10/1/74. *
***** ***** ***** ***** ***** ***** *****

INSERT NRE= # ØF RØADWAY ELEMENTS
?3←

INSERT N= # ØF LANE GRØUPS FØR RØAD ELEMENT # 1
?1←

INSERT Q,TMIX,ST,SA,HE,DN,RL,BL,P,ID FØR LANE GRØUP  1
?3300,10,50,60,-5,200,3,0,4,1←
INSERT DEL3,DEL5,DEL7
?2,-5,0←
INSERT THETA
?75←
INSERT HØ
?5←
INSERT DC
?180←
L10A= 50. L10T= 70. L10= 70. FØR ELEM. # 1, LANE GRP. # 1

INSERT N= # ØF LANE GRØUPS FØR RØAD ELEMENT # 2
?2←

INSERT Q,TMIX,ST,SA,HE,DN,RL,BL,P,ID FØR LANE GRØUP  1
?-1500,11,45,50,0,220,3,2,2,1←
INSERT DEL3,DEL5,DEL7
?2,5,-4.5←
INSERT MED
?50←
INSERT THETA
?88←
INSERT HØ
?5←
INSERT H,DB
?10,180←
INSERT ALPHA
?52←
L10A= 57. L10T= 64. L10= 65. FØR ELEM. # 2, LANE GRP. # 1

INSERT #2 Q,TMIX,ST,SA
?-1800,9,45,50←
L10A= 57. L10T= 61. L10= 63. FØR ELEM. # 2, LANE GRP. # 2

INSERT N= # ØF LANE GRØUPS FØR RØAD ELEMENT # 3
?1←

INSERT Q,TMIX,ST,SA,HE,DN,RL,BL,P,ID FØR LANE GRØUP  1
?3300,10,50,55,12,400,2,0,4,0←
INSERT THETA
?90←
INSERT HØ
?-7←
INSERT DS
?380←
L10A= 52. L10T= 63. L10= 64. FØR ELEM. # 3, LANE GRP. # 1

********************
L50= 66.  L10= 73.  DNI(TØ ELEMENT # 3)=  400.
LEQ= 69.  LNP= 81.  TNI= 79.
********************

INSERT 2,1,0,-1 FØR CØNTINUE,ITERATE,NEW,STØP
?-1←

 END Q12095 4.0 SEC.
```

Figure B4. Facsimile of computer printout for example problem 2.

APPENDIX C

ADDITION OF NOISE LEVELS

ADDITION OF DECIBEL LEVELS

The addition of decibel levels is accomplished by use of the graph as follows:

1. Call the larger level A, the smaller B.
2. Find the numerical difference between A and B, i.e., A - B.
3. Enter the graph on the absicissa (x) at A - B. On the ordinate (y) read C.
4. Add the numerical sum of A plus C to obtain the true combined decibel level, D.

EXAMPLE:

1. A = 83 dbA, B = 77 dbA
2. A - B = 6 dbA
3. C = 1 dbA
4. D = A + C = 83 + 1 = 84 dbA

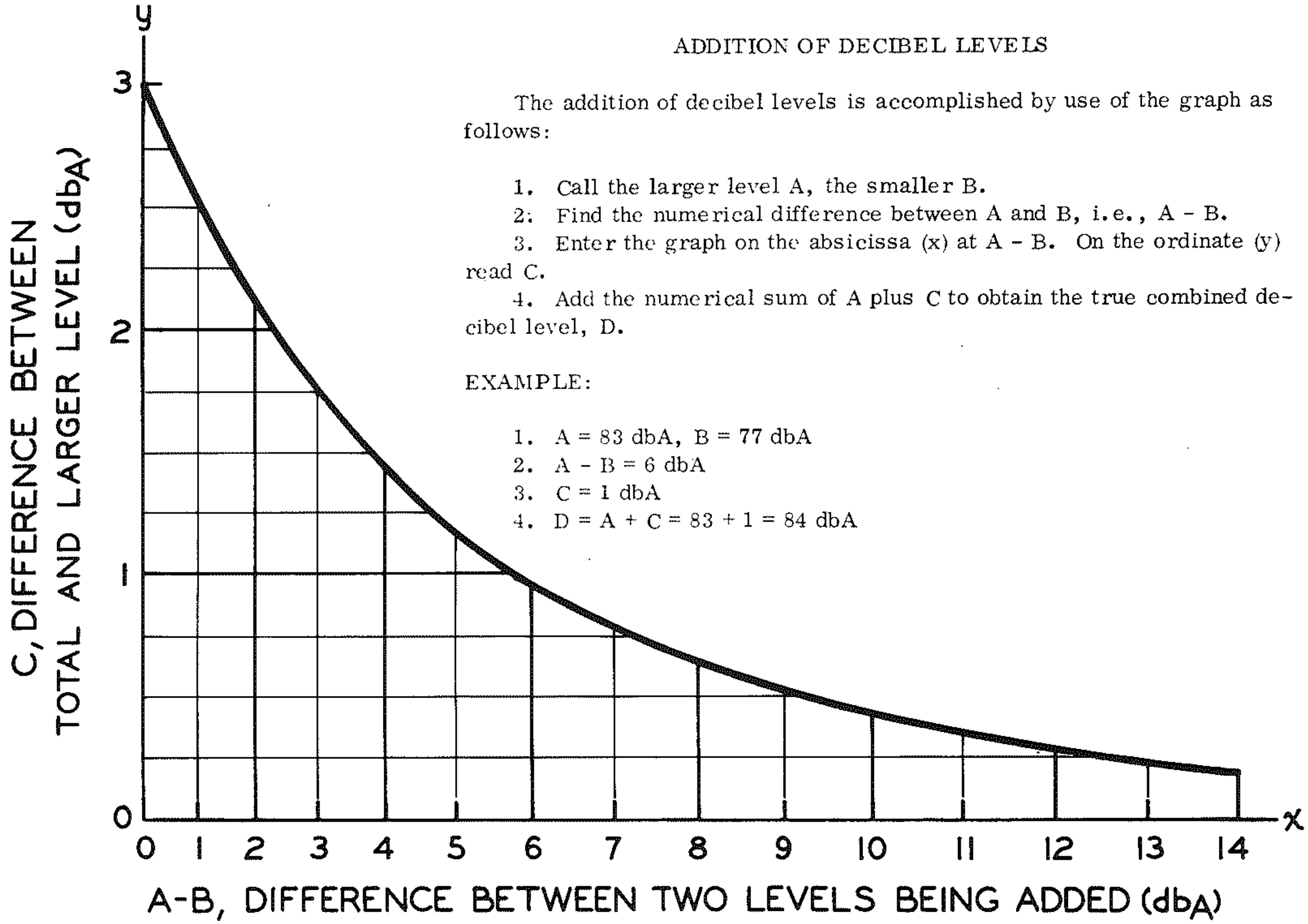

Figure C1. Summing Decibel Levels