Appendix C - Computer Programs Developed for Project

This appendix contains computer programs that were developed during phase two of this project. One exception to this is the GUNNAR5 program, which was developed during phase one of the project. The programs are reproduced here so that the reader can see how the programs worked and the research was completed. Those who have some skill with the FORTRAN computer language may find these programs useful. They use a low level of FORTRAN that should work with all popular FORTRAN compilers (Lahey, Microsoft, and so forth).

Each of the programs included here is discussed in Chapter 6. If the reader has questions regarding these, he/she should feel free to contact the project director.

```
      PROGRAM GUNNAR5
      CHARACTER* 15 INFILE
      CHARACTER* 15 OUTFILE
      COMMON DIST(156,156),O(156),A(156),B(156),D(156),OID(156),DID(156)
      WRITE (*,500)
  500 FORMAT('0',"WHAT IS THE FILE CONTAINING TRAFFIC PRODUCTIONS AND AT
     1TRACTIONS?")
      READ (*,501) INFILE
  501 FORMAT (A15)
      WRITE (*,502)
  502 FORMAT(' ',"WHAT IS THE FILE FOR THE OUTPUT?")
      READ (*,503) OUTFILE
  503 FORMAT (A15)
      OPEN (1,FILE= INFILE, STATUS = 'OLD')
      OPEN (2,FILE='gmdist.prj', STATUS = 'OLD')
      OPEN (3, FILE = OUTFILE, STATUS='NEW')
      WRITE(*,10)
   10 FORMAT('0','INPUT THE NUMBER OF OBSERVATIONS: ')
      READ(*,*) N
C     READ PRODUCTIONS AND ATTRACTIONS
      READ(1,*) (O(I),D(I),I=1,N)
      DO 100 I = 1, N
      DO 100 J = 1, N
  100 READ(2,*) OID(I),DID(J),DIST(I,J)
      WRITE(*,13)
   13 FORMAT(' ',' INPUT AVERAGE SHIPMENT LENGTH: ')
      READ(*,*) COBS
      BETA = -1.0/COBS
      TRIPS = 0.0
      DO 101 I = 1,N
  101 TRIPS = TRIPS + O(I)
      DO 102 I = 1,N
      O(I) = O(I)/TRIPS
  102 D(I) = D(I)/TRIPS
      CALL ENT5(N,BETA,COBS,TRIPS)
      CALL OUT(N,BETA,COBS,TRIPS)
      STOP
      END

      SUBROUTINE OUT(N,BETA,COBS,TRIPS)
      COMMON DIST(156,156),O(156),A(156),B(156),D(156),OID(156),DID(156)
      DIMENSION X(156)
      DIMENSION ITEMP (156)
      WRITE(3,101) BETA
  101 FORMAT(' ',' BETA = ',F8.4/' CELL       ORIGIN TRIPS        VALUE
     1              VALUE          DESTINATION TRIPS')
      DO 10 I = 1,N
      XX = O(I) * TRIPS
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      Y = D(I) * TRIPS
   10 WRITE(3,102) I,XX,A(I),B(I),Y
  102 FORMAT(I5,F13.0,2F20.2,F20.0)
      WRITE(3,103)
  103 FORMAT(' ',' INTERACTION MATRIX')
      XMEAN = 0.0
      DO 30 I = 1,N
      X(I)=TRIPS*O(I)*A(I)
   30 CONTINUE
      DO 31 I = 1,N
      DO 20 J = 1,N
      W = X(I)*B(J)*D(J)*EXP(BETA*DIST(I,J))
      XMEAN = XMEAN+W*DIST(I,J)
   20 ITEMP(J) =IFIX(W+0.5)
      DO 25 J = 1,N
   25 WRITE(3,106) I,J,ITEMP(J),DIST(I,J)
  106 FORMAT(2I6,I10,F10.0)
C  30 WRITE(*,104) I,(ITEMP(J), J=1,N)
   31 CONTINUE
  104 FORMAT(' ',' FROM CELL',I6/(8I9))
      XMEAN = XMEAN/TRIPS
      WRITE(3,105) COBS,XMEAN
  105 FORMAT(' ',' OBSERVED MEAN SHIPMENT COST',F10.5/' MODEL MEAN SHIPM
     1ENT COST',F13.5)
      RETURN
      END

      SUBROUTINE ENT5(N,BETA,COBS,TRIPS)
      COMMON DIST(156,156),O(156),A(156),B(156),D(156),OID(156),DID(156)
      DO 10 I = 1,N
   10 B(I) = 1.0
      DO 110 KK = 1,30
      DO 70 K = 1,30
      SUMA = 0.0
      SUMB = 0.0
      DO 30 I =1,N
      A(I) = 0.0
      DO 20 J =1,N
   20 A(I) = A(I) + B(J) *D(J) * EXP(BETA*DIST(I,J))
      A(I) = 1.0/A(I)
   30 SUMA = SUMA + A(I)
      DO 50 J = 1,N
      B(J) = 0.0
      DO 40 I = 1,N
   40 B(J) = B(J) + O(I) * A(I) * EXP(BETA*DIST(I,J))
      B(J) = 1.0/B(J)
   50 SUMB = SUMB + B(J)
      W = SQRT(SUMB/SUMA)
```

```
      DO 60 I = 1,N
      A(I) = A(I) * W
   60 B(I) = B(I) / W
      IF (ABS(W-1.0) .LT. 0.1) GO TO 80
   70 CONTINUE
   80 C = 0.0
      DO 90 I = 1,N
      DO 90 J = 1,N
   90 C = C+O(I)*A(I)*B(J)*D(J)*EXP(BETA*DIST(I,J))*DIST(I,J)
      IF (KK .EQ. 1) GO TO 100
      W = C-CT
      IF (ABS(W) .LT. COBS * 0.0001) GO TO 120
      W = ((COBS-CT) * BETA-(COBS-C)*BT)/W
      CT = C
      BT = BETA
      BETA = W
      GO TO 110
  100 BT = BETA
      CT = C
      BETA = C/COBS*BETA
  110 CONTINUE
  120 RETURN
      END
```

```
      PROGRAM GUNIN
      CHARACTER* 15 INFILE
      CHARACTER* 15 OUTFILE
      COMMON DIST(156,156),O(156),A(156),B(156),D(156),OID(156),DID(156)
      WRITE (*,500)
  500 FORMAT('0',"WHAT IS THE FILE CONTAINING TRAFFIC PRODUCTIONS AND AT
     1TRACTIONS? ")
      READ (*,501) INFILE
  501 FORMAT (A15)
      WRITE (*,502)
  502 FORMAT(' ',"WHAT IS THE FILE FOR THE OUTPUT? ")
      READ (*,503) OUTFILE
  503 FORMAT (A15)
      OPEN (1,FILE= INFILE, STATUS = 'OLD')
      OPEN (2,FILE='gmdist.prj', STATUS = 'OLD')
      OPEN (3, FILE = OUTFILE, STATUS='NEW')
      WRITE(*,10)
   10 FORMAT('0',"INPUT THE NUMBER OF OBSERVATIONS: ")
      READ(*,*) N
C     READ PRODUCTIONS AND ATTRACTIONS
      READ(1,*) (O(I),D(I),I=1,N)
      DO 100 I = 1, N
      DO 100 J = 1, N
  100 READ(2,*) OID(I),DID(J),DIST(I,J)
      WRITE(*,13)
   13 FORMAT(' ',"INPUT AVERAGE SHIPMENT LENGTH: ")
      READ(*,*) COBS
      BETA = -1.0/COBS
      TRIPS = 0.0
      DO 101 I = 1,N
  101 TRIPS = TRIPS + O(I)
      DO 102 I = 1,N
      O(I) = O(I)/TRIPS
  102 D(I) = D(I)/TRIPS
      CALL ENT5(N,BETA,COBS,TRIPS)
      CALL OUT(N,BETA,COBS,TRIPS)
      STOP
      END

      SUBROUTINE OUT(N,BETA,COBS,TRIPS)
      COMMON DIST(156,156),O(156),A(156),B(156),D(156),OID(156),DID(156)
      DIMENSION X(156)
      DIMENSION ITEMP (156)
      DO 10 I = 1,N
      XX = O(I) * TRIPS
   10 Y = D(I) * TRIPS
      XMEAN = 0.0
      DO 30 I = 1,N
```

```
      X(I)=TRIPS*O(I)*A(I)
   30 CONTINUE
      DO 31 I = 1,N
      DO 20 J = 1,N
      W = X(I)*B(J)*D(J)*EXP(BETA*DIST(I,J))
      XMEAN = XMEAN+W*DIST(I,J)
   20 ITEMP(J) =IFIX(W+0.5)
      DO 25 J = 1,N
   25 WRITE(3,106) I,J,ITEMP(J),DIST(I,J)
  106 FORMAT(2I6,I10,F10.0)
   31 CONTINUE
      XMEAN = XMEAN/TRIPS
      WRITE(*,105) COBS,XMEAN
  105 FORMAT(' ',' OBSERVED MEAN SHIPMENT COST',F10.5/' MODEL MEAN SHIPM
     1ENT COST',F13.5)
C
C     THIS PART OF THE PROGRAM IS FOR THE 1997 INTERMODAL PROJECT. IT
C     CALCULATES THE AVERAGE SHIPPING DISTANCE FOR FLOWS FROM INDIANA
C     FOR COMPARISON WITH THE CENSUS VALUE OF THIS AVERAGE.
C
      REWIND (3)
      TONS = 0
      TONMILES = 0
      N = 0
      DO 40 I = 1,145
      DO 40 J = 1,145
      IF (I .LT. 14) GO TO 40
      IF (I .GT. 105) GO TO 40
      READ (3,*)ORIGIN,DESTIN,FLOW,DISTANCE
      IF (FLOW .EQ. 0.0) GO TO 40
      TONMILES = TONMILES + FLOW * DISTANCE
      N = N+1
      TONS = TONS + FLOW
  40  CONTINUE
      MEANFLO = TONMILES/TONS
      WRITE (*,*) TONS, TONMILES, N, MEANFLO
      RETURN
      END

      SUBROUTINE ENT5(N,BETA,COBS,TRIPS)
      COMMON DIST(156,156),O(156),A(156),B(156),D(156),OID(156),DID(156)
      DO 10 I = 1,N
   10 B(I) = 1.0
      DO 110 KK = 1,30
      DO 70 K = 1,30
      SUMA = 0.0
      SUMB = 0.0
      DO 30 I =1,N
```

```
      A(I) = 0.0
      DO 20 J =1,N
   20 A(I) = A(I) + B(J) *D(J) * EXP(BETA*DIST(I,J))
      A(I) = 1.0/A(I)
   30 SUMA = SUMA + A(I)
      DO 50 J = 1,N
      B(J) = 0.0
      DO 40 I = 1,N
   40 B(J) = B(J) + O(I) * A(I) * EXP(BETA*DIST(I,J))
      B(J) = 1.0/B(J)
   50 SUMB = SUMB + B(J)
      W = SQRT(SUMB/SUMA)
      DO 60 I = 1,N
      A(I) = A(I) * W
   60 B(I) = B(I) / W
      IF (ABS(W-1.0) .LT. 0.1) GO TO 80
   70 CONTINUE
   80 C = 0.0
      DO 90 I = 1,N
      DO 90 J = 1,N
   90 C = C+O(I)*A(I)*B(J)*D(J)*EXP(BETA*DIST(I,J))* DIST(I,J)
      IF (KK .EQ. 1) GO TO 100
      W = C-CT
      IF (ABS(W) .LT. COBS * 0.0001) GO TO 120
      W = ((COBS-CT) * BETA-(COBS-C)*BT)/W
      CT = C
      BT = BETA
      BETA = W
      GO TO 110
  100 BT = BETA
      CT = C
      BETA = C/COBS*BETA
  110 CONTINUE
  120 RETURN
      END
```

```
      PROGRAM NEWMODE
C
C     PROGRAM MODAL WILL ALLOCATE MODAL SHARES BASED ON LENGTH OF HAUL
C     FOR ANY COMMODITY FOR WHICH THE MULTIPLIERS ARE KNOWN (e.g.,SEE
C     NEWMODE.20).  AS WRITTEN THE PROGRAM ALLOCATES FLOW SHARES TO
C     PARCEL SERVICE (e.g., UPS, FEDEX), PRIVATE TRUCKING, FOR HIRE
C     TRUCKING, COMBINED PRIVATE AND FOR HIRE TRUCKING, TRUCK/AIR,
C     TRUCK/RAIL, TRUCK/WATER, [HIGHWAY], RAIL, RAIL/WATER, [RAILWAY],
C     INLAND WATER, GREAT LAKES WATER, INLAND WATER/GREAT LAKES, INLAND
C     WATER/DEEP SEA, [WATERWAY], AIR, [AIRWAY], OTHER, [OTHERWAY], AND
C     [[TOTAL]]. VALUES IN SINGLE BRACKETS ARE THE SUM OF THE CATEGORIES
C     IMMEDIATELY PRECEDING IT.  THE TOTAL VALUE IS THE SUM OF THE
C     VALUES IN BRACKETS.
C
C     WRITTEN BY W.R. BLACK, INDIANA UNIVERSITY, JANUARY 1997
C
      CHARACTER * 15 MODCHOIC
      CHARACTER * 15 FLOWS
      CHARACTER * 15 OUTFILE
      OPEN (5,FILE='CONTROL.CRD',STATUS='OLD')
C
C     PROGRAM EXPECTS 15 SETS OF DATA - TESTING MODE
C
      DO 500 KKK=1,1
      READ (5,501) (MODCHOIC,FLOWS,OUTFILE)
  501 FORMAT (A15,A21,A12)
      INTEGER O,D,FLOW,DIST
      REAL PARCEL,PTRUCK,FHTRUCK,TWOTRUCK,TA,TR,TW,HIGHWAY,RAIL,RW,
      REAL RAILWAY,IW,GL,IWGL,IWDS,WATERWAY,AIR,AIRWAY,OTHER,OTHERWAY,
      REAL TOTAL
C
C     OPEN MODAL SHARE PROPORTIONS MODEL
C
      OPEN (1, FILE= MODCHOIC, STATUS='OLD')
C
C     OPEN FILE WITH ORIGIN, DESTINATION, FLOW VOLUME AND DISTANCE
C
      OPEN (2, FILE= FLOWS,STATUS= 'OLD')
      OPEN (3, FILE= OUTFILE,STATUS = 'NEW')
      WRITE (3,5002) KKK
 5002 FORMAT('DATASET ',I2)
C
C
 5000 DIMENSION A(180)
      WRITE (3,5001)
 5001 FORMAT('     O     D  TONS  DIST     1     2     3     4     5
     1 6     7   HWY     8     9   RWY    10    11    12    13   WWY
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```
    214   AWY    15   OWY CHECK')
      DO 1000 I = 1,180
 1000 READ (1,*) (A(I))
      CLOSE(1)
 6000 READ (2,*,END=9000) O,D,FLOW, DIST
      IF (FLOW .EQ. 0) GO TO 307
      IF (DIST .LE. 49) GO TO 199
      IF (DIST .LE. 99) GO TO 200
      IF (DIST .LE. 249) GO TO 201
      IF (DIST .LE. 499) GO TO 202
      IF (DIST .LE. 749) GO TO 203
      IF (DIST .LE. 999) GO TO 204
      IF (DIST .LE. 1499) GO TO 205
      IF (DIST .LE. 1999) GO TO 206
      IF (DIST .GE. 2000) GO TO 210
C
C     TOTAL FLOW HERE EXCEEDS ACTUAL FLOW SINCE TR, TW, AIR AND PARCEL HAVE
C     BEEN ADDED IN TWICE SINCE THIS WOULD REFLECT ACTUAL CIRCUMSTANCES
C     BETTER, e.g., FREIGHT ARRIVING BY AIR WILL MOST LIKELY BE TRUCKED TO
C     IT ENDPOINT.
C
C     TONS ARE THE UNIT OF MEASURE AND OUTPUT IS TO ONE DECIMAL PLACE
C
  199 PARCEL = A(1) * FLOW
      PTRUCK = A(2) * FLOW
      FHTRUCK = A(3) * FLOW
      TWOTRUCK = A(4) * FLOW
      TA = A(5) * FLOW
      TR = A(6) * FLOW
      TW = A(7) * FLOW
      HIGHWAY = A(8) * FLOW
      RAIL = A(9) * FLOW
      RW = A(10) * FLOW
      RAILWAY = (A(11) * FLOW) + TR
      IW = A(12) * FLOW
      GL = A(13) * FLOW
      IWGL = A(14) * FLOW
      IWDS = A(15) * FLOW
      WATERWAY = (A(16) * FLOW) + TW
      AIR = A(17) * FLOW
      AIRWAY = (A(18) * FLOW) + TA + PARCEL
      OTHER = A(19) * FLOW
      OTHERWAY = A(20) * FLOW
      TOTAL = HIGHWAY+RAILWAY+AIRWAY+WATERWAY+OTHERWAY
      GO TO 207
  200 PARCEL = A(21) * FLOW
      PTRUCK = A(22) * FLOW
      FHTRUCK = A(23) * FLOW
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      TWOTRUCK = A(24) * FLOW
      TA = A(25) * FLOW
      TR = A(26) * FLOW
      TW = A(27) * FLOW
      HIGHWAY = A(28) * FLOW
      RAIL = A(29) * FLOW
      RW = A(30) * FLOW
      RAILWAY = (A(31) * FLOW) + TR
      IW = A(32) * FLOW
      GL = A(33) * FLOW
      IWGL = A(34) * FLOW
      IWDS = A(35) * FLOW
      WATERWAY = (A(36) * FLOW) + TW
      AIR = A(37) * FLOW
      AIRWAY = (A(38) * FLOW) + TA + PARCEL
      OTHER = A(39) * FLOW
      OTHERWAY = A(40) * FLOW
      TOTAL = HIGHWAY+RAILWAY+AIRWAY+WATERWAY+OTHERWAY
      GO TO 207
  201 PARCEL = A(41) * FLOW
      PTRUCK = A(42) * FLOW
      FHTRUCK = A(43) * FLOW
      TWOTRUCK = A(44) * FLOW
      TA = A(45) * FLOW
      TR = A(46) * FLOW
      TW = A(47) * FLOW
      HIGHWAY = A(48) * FLOW
      RAIL = A(49) * FLOW
      RW = A(50) * FLOW
      RAILWAY = (A(51) * FLOW) + TR
      IW = A(52) * FLOW
      GL = A(53) * FLOW
      IWGL = A(54) * FLOW
      IWDS = A(55) * FLOW
      WATERWAY = (A(56) * FLOW) + TW
      AIR = A(57) * FLOW
      AIRWAY = (A(58) * FLOW) + TA + PARCEL
      OTHER = A(59) * FLOW
      OTHERWAY = A(60) * FLOW
      TOTAL = HIGHWAY+RAILWAY+AIRWAY+WATERWAY+OTHERWAY
      GO TO 207
  202 PARCEL = A(61) * FLOW
      PTRUCK = A(62) * FLOW
      FHTRUCK = A(63) * FLOW
      TWOTRUCK = A(64) * FLOW
      TA = A(65) * FLOW
      TR = A(66) * FLOW
      TW = A(67) * FLOW
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      WATERWAY = (A(156) * FLOW) + TW
      AIR = A(157) * FLOW
      AIRWAY = (A(158) * FLOW) + TA + PARCEL
      OTHER = A(159) * FLOW
      OTHERWAY = A(160) * FLOW
      TOTAL = HIGHWAY+RAILWAY+AIRWAY+WATERWAY+OTHERWAY
      GO TO 207
  210 PARCEL = A(161) * FLOW
      PTRUCK = A(162) * FLOW
      FHTRUCK = A(163) * FLOW
      TWOTRUCK = A(164) * FLOW
      TA = A(165) * FLOW
      TR = A(166) * FLOW
      TW = A(167) * FLOW
      HIGHWAY = A(168) * FLOW
      RAIL = A(169) * FLOW
      RW = A(170) * FLOW
      RAILWAY = (A(171) * FLOW) + TR
      IW = A(172) * FLOW
      GL = A(173) * FLOW
      IWGL = A(174) * FLOW
      IWDS = A(175) * FLOW
      WATERWAY = (A(176) * FLOW) + TW
      AIR = A(177) * FLOW
      AIRWAY = (A(178) * FLOW) + TA + PARCEL
      OTHER = A(179) * FLOW
      OTHERWAY = A(180) * FLOW
      TOTAL = HIGHWAY+RAILWAY+AIRWAY+WATERWAY+OTHERWAY
      GO TO 207
  307 PARCEL = 0
      PTRUCK = 0
      FHTRUCK = 0
      TWOTRUCK = 0
      TA = 0
      TR = 0
      TW = 0
      HIGHWAY = 0
      RAIL = 0
      RW = 0
      RAILWAY = 0
      IW = 0
      GL = 0
      IWGL = 0
      IWDS = 0
      WATERWAY = 0
      AIR = 0
      AIRWAY = 0
      OTHER = 0
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```
      OTHERWAY = 0
      TOTAL = 0
  207 WRITE(3,208)O,D,FLOW,DIST,PARCEL,PTRUCK,FHTRUCK,TWOTRUCK,TA,TR,TW,
     1HIGHWAY,RAIL,RW,RAILWAY,IW,GL,IWGL,IWDS,WATERWAY,AIR,AIRWAY,OTHER,
     2OTHERWAY,TOTAL
  208 FORMAT (4I15,21F15.1)
 3000 GO TO 6000
 9000 CLOSE(2)
      CLOSE(3)
  500 CONTINUE
      CLOSE(5)
      CALL EXIT
      END
```

```
      PROGRAM ALLOHWY
      CHARACTER * 15 INFLOW
      CHARACTER * 15 OUTFLOW1
      CHARACTER * 15 OUTFLOW2
      CHARACTER * 15 OUTFLOW3
      DIMENSION O(145),D(145)
      DIMENSION DENSITY(145),DOLLARS(145)
      REAL HWYTONS(145,145),HWYDOLLS(145,145),HWYTRUCK(145,145)
      OPEN (1,FILE='CONTROL.HWY',STATUS='OLD')
      OPEN (4,FILE='NODES',STATUS='OLD')
C
C     READ IN NUMBER OF NODES (N) AND NUMBER OF COMMODITIES (M)
C
      OPEN (5,FILE='NM', STATUS= 'OLD')
      READ (5,*) N,M
C
C     READ IN NODE IDS THAT MATCH NETWORK TO BE USED
C
      DO 5 K = 1,N
      READ (4,*) O(K)
    5 D(K) = O(K)
      CLOSE (4)
      DO 10 I = 1,M
      READ(1,6)(INFLOW,OUTFLOW1,OUTFLOW2,OUTFLOW3,DENSITY(I),DOLLARS(I))
    6 FORMAT (4A15,2F10.0)
      OPEN (2,FILE= INFLOW,STATUS='OLD')
      OPEN (3,FILE= OUTFLOW1,STATUS='NEW')
C
C     UNITS ARE IN TONS
C
      DO 20 J = 1,N
      DO 20 K = 1,N
   20 READ(2,501) HWYTONS(J,K)
  501 FORMAT(100x,65X,F15.1)
      CLOSE (2)
      DO 30 J = 1,N
      DO 30 K = 1,N
      HWYTONS(J,K) = HWYTONS(J,K) + .5
   30 WRITE (3,503) O(J),D(K),HWYTONS(J,K)
  503 FORMAT (2I10,F15.0)
      CLOSE (3)
      OPEN (3,FILE= OUTFLOW2,STATUS='NEW')
C
C     EXPAND BY DOLLAR VALUE PER TON
C
      DO 40 J = 1,N
      DO 40 K = 1,N
   40 HWYDOLLS(J,K) = HWYTONS(J,K) * DOLLARS(I)
```

```
      DO 50 J = 1,N
      DO 50 K = 1,N
   50 WRITE (3,503) O(J),D(K),HWYDOLLS(J,K)
      CLOSE (3)
      OPEN (3,FILE= OUTFLOW3 ,STATUS='NEW')
C
C     DIVIDE BY COMMODITY DENSITY TO GET VEHICLE UNITS
C
      DO 60 J = 1,N
      DO 60 K = 1,N
   60 HWYTRUCK(J,K) = HWYTONS(J,K) / DENSITY(I)
      DO 70 J = 1,N
      DO 70 K = 1,N
   70 WRITE (3,503) O(J),D(K),HWYTRUCK(J,K)
      CLOSE (3)
   10 CONTINUE
      STOP
      END
```

```
      PROGRAM ALLORWY
      CHARACTER * 15 INFLOW
      CHARACTER * 15 OUTFLOW1
      CHARACTER * 15 OUTFLOW2
      CHARACTER * 15 OUTFLOW3
      DIMENSION O(145),D(145),RWYTONS(145,145),RWYDOLLS(145,145)
      DIMENSION RWYCARS(145,145),DENSITY(145),DOLLARS(145)
      OPEN (1,FILE='CONTROL.RWY',STATUS='OLD')
      OPEN (4,FILE='NODES.RWY',STATUS='OLD')
C
C     READ IN NUMBER OF NODES (N) AND NUMBER OF COMMODITIES (M)
C
      OPEN (5,FILE='NM', STATUS= 'OLD')
      READ (5,*) N,M
C
C     READ IN NODE IDS THAT MATCH NETWORK TO BE USED
C
      DO 5 K = 1,N
      READ (4,*) O(K)
    5 D(K) = O(K)
      CLOSE (4)
      DO 10 I = 1,M
      READ(1,6)(INFLOW,OUTFLOW1,OUTFLOW2,OUTFLOW3,DENSITY(I),DOLLARS(I))
    6 FORMAT (4A15,2F10.0)
      OPEN (2,FILE= INFLOW,STATUS='OLD')
      OPEN (3,FILE= OUTFLOW1,STATUS='NEW')
C
C     READ IN TONS
C
      DO 20 J = 1,N
      DO 20 K = 1,N
   20 READ(2,501) RWYTONS(J,K)
  501 FORMAT(105X,105X,F15.1)
      CLOSE (2)
      DO 30 J = 1,N
      DO 30 K = 1,N
      RWYTONS(J,K) = RWYTONS(J,K) + .5
   30 WRITE (3,503) O(J),D(K),RWYTONS(J,K)
  503 FORMAT (2I10,F15.0)
      CLOSE (3)
      OPEN (3,FILE= OUTFLOW2,STATUS='NEW')
C
C     EXPAND BY DOLLAR VALUE PER TON
C
      DO 40 J = 1,N
      DO 40 K = 1,N
   40 RWYDOLLS(J,K) = RWYTONS(J,K) * DOLLARS(I)
      DO 50 J = 1,N
```

```
      DO 50 K = 1,N
   50 WRITE (3,503) O(J),D(K),RWYDOLLS(J,K)
      CLOSE (3)
      OPEN (3,FILE= OUTFLOW3 ,STATUS='NEW')
C
C     DIVIDE BY COMMODITY DENSITY TO GET VEHICLE UNITS
C
      DO 60 J = 1,N
      DO 60 K = 1,N
   60 RWYCARS(J,K) = RWYTONS(J,K) / DENSITY(I)
      DO 70 J = 1,N
      DO 70 K = 1,N
   70 WRITE (3,503) O(J),D(K),RWYCARS(J,K)
      CLOSE (3)
   10 CONTINUE
      STOP
      END
```

```
      PROGRAM GROWTH
      CHARACTER * 15 INFILE
      CHARACTER * 15 OUTFILE1
      CHARACTER * 15 OUTFILE2
C     AS WRITTEN THIS PROGRAM TAKES PRODUCTION AND ATTRACTION VECTORS
C     FOR 15 COMMODITY GROUPS FOR 1993 AND EXPANDS THESE BASED ON
C     PREDICTED GROWTH IN POPULATION AND INDUSTRY FOR INDIANA COUNTIES
C     AND THE STATES OF THE U.S. FOR 2005 AND 2015
C
C     WRITTEN BY WILLIAM R. BLACK, DEPARTMENT OF GEOGRAPHY, INDIANA
C     UNIVERSITY, MAY 1997

      DIMENSION APGROW05(200),APGROW15(200),APDAT1(200),APDAT2(200),
     *APDAT3(200),AIDAT1(200),AIDAT2(200),AIDAT3(200),AIGROW05(200),
     *AIGROW15(200),AMEAN05(200),AMEAN15(200)
      DIMENSION PRODUCT(200),ATTRACT(200),PROD05P(200),PROD05I(200),
     *PROD05M(200), ATTR05P(200),ATTR05I(200),ATTR05M(200)
      DIMENSION PROD15P(200),PROD15I(200),PROD15M(200), ATTR15P(200),
     *ATTR15I(200),ATTR15M(200)
C
      OPEN (1,FILE="EXPECT",STATUS="OLD")
C
C     FILELIST IS THE LIST OF PRODUCTION AND ATTRACTION FILES FOR EACH
C     OF THE 15 INDUSTRY GROUPS
C
      OPEN (2,FILE="FILELIST",STATUS="OLD")
      OPEN (3,FILE="FACTORS",STATUS="OLD")
C
C     READ IN NATIONAL GROWTH RATE FOR STATE POPULATIONS AND INDUSTRIES
C     APNAT05 = POPULATION GROWTH RATE FROM 1993 TO 2005
C     APNAT15 = POPULATION GROWTH RATE FROM 2005 TO 2015
C     AINAT05 = INDUSTRIAL GROWTH RATE FROM 1993 TO 2005
C     AINAT15 = INDUSTRIAL GROWTH RATE FROM 2005 TO 2015
C
      APNAT05 = .1478
      APNAT15 = .089
      AINAT05 = .073
      AINAT15 = .042
C
C     CALCULATE AVERAGE GROWTH AS A FUNCTION OF EXPECTED POPULATION
C     GROWTH AND INDUSTRIAL GROWTH
C
      DO 20 J = 1,13
      APGROW05(J) = APNAT05
      APGROW15(J) = APNAT15
      AIGROW05(J) = AINAT05
      AIGROW15(J) = AINAT15
      AMEAN05(J) = (APGROW05(J) + AIGROW05(J))/2
```

```
      AMEAN15(J) = (APGROW15(J) + AIGROW15(J))/2
      WRITE (3,100)APGROW05(J),APGROW15(J),AIGROW05(J),AIGROW15(J),
     *AMEAN05(J),AMEAN15(J)
   20 CONTINUE
C
C     NOW READ IN INDIANA COUNTY SPECIFIC GROWTH RATES FOR POPULATION
C     AND INDUSTRIES
C
      DO 21 J = 14,105
      READ (1,*)APDAT1(J),APDAT2(J),APDAT3(J),AIDAT1(J),AIDAT2(J),
     * AIDAT3(J)
      APGROW05(J) = ((APDAT2(J)-APDAT1(J))/APDAT1(J))
      APGROW15(J) = ((APDAT3(J)-APDAT2(J))/APDAT2(J))
      AIGROW05(J) = ((AIDAT2(J)-AIDAT1(J))/AIDAT1(J))
      AIGROW15(J) = ((AIDAT3(J)-AIDAT2(J))/AIDAT2(J))
      AMEAN05(J) = (APGROW05(J) + AIGROW05(J))/2
      AMEAN15(J) = (APGROW15(J) + AIGROW15(J))/2
      WRITE (3,100)APGROW05(J),APGROW15(J),AIGROW05(J),AIGROW15(J),
     *AMEAN05(J),AMEAN15(J)
   21 CONTINUE
      CLOSE (1)
C
C     NOW DO THE LAST FORTY AREAL UNITS OF THE 145 UNITS INCLUDED
C     HERE
C
      DO 22 J = 106,145
      APGROW05(J) = APNAT05
      APGROW15(J) = APNAT15
      AIGROW05(J) = AINAT05
      AIGROW15(J) = AINAT15
      AMEAN05(J) = (APGROW05(J) + AIGROW05(J))/2
      AMEAN15(J) = (APGROW15(J) + AIGROW15(J))/2
      WRITE (3,100)APGROW05(J),APGROW15(J),AIGROW05(J),AIGROW15(J),
     *AMEAN05(J),AMEAN15(J)
   22 CONTINUE
      REWIND (3)
      DO 23 I = 1,15
      READ (2,200) (INFILE,OUTFILE1,OUTFILE2)
      OPEN (4,FILE=INFILE, STATUS = "OLD")
      OPEN (5,FILE=OUTFILE1, STATUS = "NEW")
C
C     BEGIN LOOP TO CALCULATE PRODUCTIONS AND ATTRACTIONS FOR 2005
C     THERE ARE THREE SETS OF PRODUCTIONS AND ATTRACTIONS GENERATED
C     FOR 2005.  THE FIRST ASSUMES THE GROWTH WILL FOLLOW POPULATION
C     GROWTH.  THE SECOND ASSUMES GROWTH WILL FOLLOW INDUSTRIAL GROWTH
C     RATES.  THE THIRD ASSUMES EQUAL INFLUENCES ON THE GROWTH FROM
C     BOTH SECTORS
C
```

```
      DO 24 J = 1,145
      READ (4,*) PRODUCT(J),ATTRACT(J)
      READ (3,300) APGROW05(J),AIGROW05(J),AMEAN05(J)
      PROD05P(J) = PRODUCT(J) + PRODUCT(J) * APGROW05(J)
      PROD05I(J) = PRODUCT(J) + PRODUCT(J) * AIGROW05(J)
      PROD05M(J) = PRODUCT(J) + PRODUCT(J) * AMEAN05(J)
      ATTR05P(J) = ATTRACT(J) + ATTRACT(J) * APGROW05(J)
      ATTR05I(J) = ATTRACT(J) + ATTRACT(J) * AIGROW05(J)
      ATTR05M(J) = ATTRACT(J) + ATTRACT(J) * AMEAN05(J)
      WRITE (5,400) PROD05P(J),ATTR05P(J),PROD05I(J),ATTR05I(J),
     *PROD05M(J),ATTR05M(J)
   24 CONTINUE
      CLOSE (5)
      CLOSE (4)
      CLOSE (3)
      OPEN (5,FILE = OUTFILE1, STATUS = "OLD")
      OPEN (6,FILE = OUTFILE2, STATUS = "NEW")
      OPEN (3,FILE = "FACTORS",STATUS = "OLD")
      DO 25 J = 1,145
      READ (5,400) PROD05P(J),ATTR05P(J),PROD05I(J),ATTR05I(J),
     *PROD05M(J),ATTR05M(J)
      READ (3,500) APGROW15(J),AIGROW15(J),AMEAN15(J)
      PROD15P(J) = PROD05P(J) + PROD05P(J) * APGROW15(J)
      PROD15I(J) = PROD05I(J) + PROD05I(J) * AIGROW15(J)
      PROD15M(J) = PROD05M(J) + PROD05M(J) * AMEAN15(J)
      ATTR15P(J) = ATTR05P(J) + ATTR05P(J) * APGROW15(J)
      ATTR15I(J) = ATTR05I(J) + ATTR05I(J) * AIGROW15(J)
      ATTR15M(J) = ATTR05M(J) + ATTR05M(J) * AMEAN15(J)
      WRITE (6,400) PROD15P(J),ATTR15P(J),PROD15I(J),ATTR15I(J),
     *PROD15M(J),ATTR15M(J)
   25 CONTINUE
      REWIND(3)
   23 CONTINUE
  100 FORMAT(6F10.5)
  200 FORMAT (3A15)
  300 FORMAT(F10.5,10X,F10.5,10X,F10.5,10X)
  400 FORMAT(6F10.0)
  500 FORMAT(10X,F10.5,10X,F10.5,10X,F10.5)
      STOP
      END
```

```
      PROGRAM NEWFLOWS
      CHARACTER * 15 INFILE1
      CHARACTER * 15 INFILE2
      CHARACTER * 15 OUTFILE
      DIMENSION DIST (145,145),F(145,145),A(145),B(145),D(145),X(145)
      REAL O(145)
C
C     READ IN BETA AND NAMES OF FILES
C
      OPEN (1,FILE="INSOUTS", STATUS="OLD")
C
      DO 9 I = 1,30
      READ (1,100) BETA,INFILE1,INFILE2,OUTFILE
      OPEN (2,FILE=INFILE1,STATUS ="OLD")
      OPEN (3,FILE=INFILE2,STATUS ="OLD")
      OPEN (4,FILE="GMDIST.PRJ",STATUS="OLD")
      OPEN (5,FILE=OUTFILE,STATUS="NEW")
      OPEN (6,FILE="TRAFCHEK",STATUS = "NEW")
C
C     READ A AND B PARAMETERS OF THE 1993 GRAVITY MODEL CALIBRATIONS
C     AND NEW PRODUCTIONS AND ATTRACTIONS FOR 2005 AND 2015 AS
C     APPROPRIATE
C
      SUMTRIPO = 0.0
      SUMTRIPD = 0.0
      DO 10 J = 1,145
      READ (2,200) A(J),B(J)
      READ (3,300) O(J),D(J)
      SUMTRIPO = SUMTRIPO+O(J)
      SUMTRIPD = SUMTRIPD+D(J)
   10 CONTINUE
      WRITE (6,600) OUTFILE,SUMTRIPO,SUMTRIPD
      CLOSE (2)
      CLOSE (3)
      DO 8 J =1,145
      O(J) = O(J)/SUMTRIPO
    8 D(J) = D(J)/SUMTRIPO
      DO 7 J = 1,145
      X(J) =SUMTRIPO *O(J) *A(J)
    7 CONTINUE
      DO 11 K = 1,145
      DO 11 L = 1,145
      READ (4,400) DIST(K,L)
      F(K,L)= X(K)*B(L)*D(L)*EXP(BETA*DIST(K,L))
      WRITE (5,500) K,L,F(K,L),DIST(K,L)
   11 CONTINUE
      CLOSE (4)
      CLOSE (5)
```

```
      READ (1,100) BETA,INFILE1,INFILE2,OUTFILE
      OPEN (2,FILE=INFILE1,STATUS ="OLD")
      OPEN (3,FILE=INFILE2,STATUS ="OLD")
      OPEN (4,FILE="GMDIST.PRJ",STATUS="OLD")
      OPEN (5,FILE = OUTFILE,STATUS="NEW")
C
C     READ A AND B PARAMETERS OF THE 1993 GRAVITY MODEL CALIBRATIONS
C     AND NEW PRODUCTIONS AND ATTRACTIONS FOR 2005 AND 2015 AS
C     APPROPRIATE
C
      SUMTRIPO = 0.0
      SUMTRIPD = 0.0
      DO 12 J = 1,145
      READ (2,200) A(J),B(J)
      READ (3,301) O(J),D(J)
      SUMTRIPO = SUMTRIPO + O(J)
      SUMTRIPD = SUMTRIPD + D(J)
   12 CONTINUE
      WRITE (6,600)OUTFILE,SUMTRIPO,SUMTRIPD
      CLOSE (2)
      CLOSE (3)
      DO 6 J = 1,145
      O(J) = O(J)/SUMTRIPO
    6 D(J) = D(J)/SUMTRIPO
      DO 5 J = 1,145
      X(J) =SUMTRIPO * O(J)* A(J)
    5 CONTINUE
      DO 13 K = 1,145
      DO 13 L = 1,145
      READ (4,400) DIST(K,L)
      F(K,L)=X(K)*B(L)*D(L)*EXP(BETA*DIST(K,L))
      WRITE (5,500) K,L,F(K,L),DIST(K,L)
   13 CONTINUE
      CLOSE (4)
      CLOSE (5)
      READ (1,100) BETA,INFILE1,INFILE2,OUTFILE
      OPEN (2,FILE=INFILE1,STATUS ="OLD")
      OPEN (3,FILE=INFILE2,STATUS ="OLD")
      OPEN (4,FILE="GMDIST.PRJ",STATUS="OLD")
      OPEN (5,FILE = OUTFILE,STATUS="NEW")
C
C     READ A AND B PARAMETERS OF THE 1993 GRAVITY MODEL CALIBRATIONS
C     AND NEW PRODUCTIONS AND ATTRACTIONS FOR 2005 AND 2015 AS
C     APPROPRIATE
C
      SUMTRIPO = 0.0
      SUMTRIPD = 0.0
      DO 14 J = 1,145
```

```
      READ (2,200) A(J),B(J)
      READ (3,302) O(J),D(J)
      SUMTRIPO = SUMTRIPO + O(J)
      SUMTRIPD = SUMTRIPD + D(J)
   14 CONTINUE
      WRITE (6,600) OUTFILE,SUMTRIPO,SUMTRIPD
      CLOSE (2)
      CLOSE (3)
      DO 4 J = 1,145
      O(J) = O(J) /SUMTRIPO
    4 D(J) = D(J) /SUMTRIPO
      DO 3 J = 1,145
      X(J) = SUMTRIPO * O(J) * A(J)
    3 CONTINUE
      DO 15 K = 1,145
      DO 15 L = 1,145
      READ (4,400) DIST(K,L)
      F(K,L)=X(K)*B(L)*D(L)*EXP(BETA*DIST(K,L))
      WRITE (5,500) K,L,F(K,L),DIST(K,L)
   15 CONTINUE
      CLOSE (4)
      CLOSE (5)
    9 CONTINUE
  100 FORMAT(F10.5,A15,A15,A15)
  200 FORMAT(2F20.0)
  300 FORMAT(2F10.0)
  301 FORMAT(20X,2F10.0)
  302 FORMAT(40X,2F10.0)
  400 FORMAT(22X,F10.0)
  500 FORMAT(I5,I5,F20.0,F10.0)
  600 FORMAT(A15,2F20.0)
      STOP
      END
```