Small Area Travel Demand Model Procedures Manual

Prepared for:

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Preface

This model procedures manual (along with the companion Small Area Travel Demand Model Guidelines) recommend a best practice approach for North Carolina, but are not to be viewed as policy that dictates how travel forecast models are to be developed. The default parameters applied in this procedures manual are based on the North Carolina Combined Survey Database (see Appendix D). This database was developed from household travel survey data from five MPO areas or regions across the state. The five MPO areas or regions are Wilmington, Greenville, and Goldsboro MPOs, and the Triangle and Metrolina regions. If local data can be obtained for the study area in question, this is always preferable to the use of default parameters. It is also the case that the analysis of locally collected data may lead to the specification of different model equations and preference for different variables. This deviation from the procedures is acceptable and even preferable to the use of default parameters as locally collected data will better capture any unique travel characteristics that may exist for a given study area.

The purpose of this manual is to outline the steps for the development of a *"best"* practice travel model for large non-MPO areas and small MPO areas in North Carolina which may deviate from what is considered "best" practice in other states or regions. The manual focuses on model development practices and options considered best for North Carolina. Large non-MPO areas can be loosely defined as non-MPO areas with a planning area population in the range of 15,000 and 50,000 and small MPO areas can be loosely defined as MPOs with a population up to approximately 150,000. It should, however, be noted that population alone should not be the criteria for determining whether or not these procedures should be applied to specific areas. Transportation and community issues that are unique to your study area should also be considered to determine if these procedures or a less advanced or more advanced approach would be warranted. Throughout the manual references are made to small areas and large areas. In this context, a small area is generally considered any study area falling within these procedures that is not an MPO. A large area would generally be any study area falling within these procedures that is an MPO. Exceptions to this rule may exist and it is left up to the analysts to make this decision based on their knowledge of the study area in question.

1 Introduction

1.1 Document Overview

This document is intended to serve as a user's guide for the implementation of the NCDOT Model Development Guidelines for large non-MPO areas and small MPO areas. The intended audience covers both midlevel and experienced transportation planning engineers or analysts. The procedures are suitable for midlevel staff familiar with travel forecasting techniques and terminology but unfamiliar with model development for this range of study area size. The procedures are also suitable for the experienced staff member who may need to reference the manual as a refresher for specific steps or modeling components. The greatest ease of use will be experienced by those with strong base level knowledge of TransCAD functionality. The procedures manual includes 12 chapters in addition to this introduction. These chapters are:

Chapter 2	Network and Database Development
Chapter 3	Networks and Shortest Paths
Chapter 4	Trip Generation Submodels
Chapter 5	Trip Generation
Chapter 6	Trip Distribution
Chapter 7	Mode Split
Chapter 8	Commercial Vehicles
Chapter 9	External Trips
Chapter 10	Time of Day
Chapter 11	Highway Assignment
Chapter 12	Overall Model Validation and Reasonableness Checking
Chapter 13	Model Application

1.2 Model Overview

The proposed overall structure of the recommended transportation model system is displayed in Figure 1. This schematic demonstrates that the application of the model begins with two key sets of input: the demographics (including socioeconomic data) and land use information (at the traffic analysis zone level), and the highway networks.

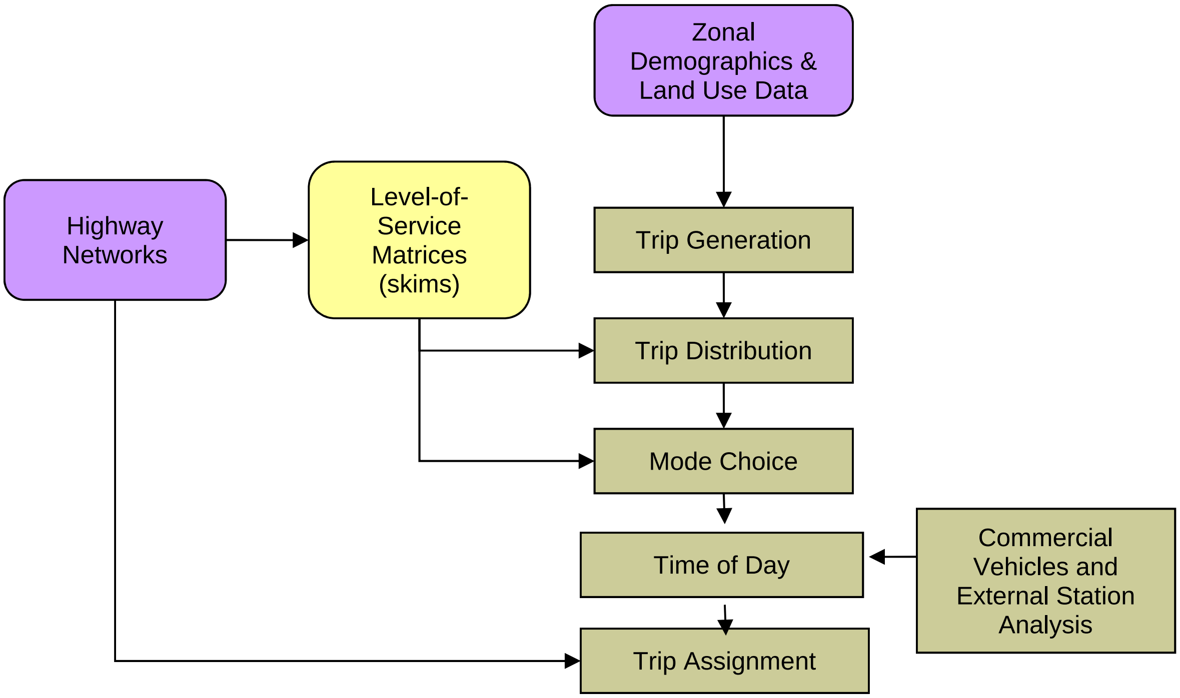


Figure 1 Travel Model System Diagram

The first model in the sequence is the trip generation model. Estimation of the magnitude of trip making is considered in terms of the range of possible types of trip purposes (i.e., Home-Based Work, Home-Based School, etc.). Following trip generation, the linking of trip origins and trip destinations is accomplished by the trip distribution model, while the choice among transportation modes is estimated using a mode choice model. The implementation of a mode choice model is addressed through the application of modal share factors in these procedures. Prior to time-of-day analysis, commercial vehicle trip generation and distribution are performed for commercial autos, pickups and trucks, and external trips are estimated. The next step is estimating the proportion of travel (by trip purpose) occurring in the peak and off-peak periods as determined by a time-of-day factor. The final component of the model system is embodied in the assignment of travel to the highway network.

The NCDOT standard small area model has been set up to run via a Graphical User Interface (GUI) that allows the user to apply each model step once the related input files have been created. This document takes the user through the development of these required input files in addition to providing the steps necessary to apply each model step manually. As such, this document can be used as a stand alone resource for model development and application without a GUI. If the application of the GUI is desired then the Small Area Travel Demand Model Users Guide for Model Application should be referenced.

1.3 Directory Structure and File Naming

Consistency in file naming conventions between various travel demand models facilitates the application of these models by multiple parties. Proper application of the GUI also requires that a specific directory structure and set of file-naming conventions be used. This directory structure uniquely identifies the location of files for each analysis year and alternative. The required directory structure is shown in Figure 2. The user can include other optional directories, such as a support files folder, as desired, but these are not required.

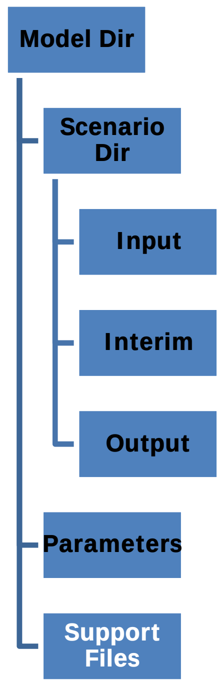


Figure 2 Required Directory Structure Diagram

The required parameter files and a description of those files are provided in Table 1. The parameter files are not specific to a given scenario, but are applied to all scenarios.

Table 1 Parameters Directory File Names and Descriptions

File Name	Model Step(s)	Description
HHDIST.RSC and HHDIST.DBD	Trip Generation	Resource code for the household disaggregate submodel. The disaggregate curve data and seed matrix are embedded in the code. HHDIST.DBD is created after code is compiled.
CAPACITY.BIN	Prepare Network	BIN file with standard capacities for study area
ALPHA.BIN		BIN file with default values for alpha coefficient
NCPRODRATES.BIN	Trip Generation	Default trip production rates
HBW.MOD*		Trip attraction rates/model by trip purpose [***NOTE:** for application of the GUI all *.MOD file parameters are maintained in ncAttrRates.BIN file. See the Small Area Travel Demand Model Users Guide for Model Application for more information.]
HBO.MOD*		
HBSCH.MOD*		
NHBW.MOD*		
NHBO.MOD*		
CV1PROD.MOD*	Commercial Vehicles	Trip production rates/model by commercial vehicle type [Note: all *.MOD file parameters are maintained in cvprodrates.BIN file.]
CV2PROD.MOD*		
CV3PROD.MOD*		
CV1ATTR.MOD*		Trip attraction rates/model by commercial vehicle type [Note: all *.MOD file parameters are maintained in cvattrrates.BIN file.]
CV2ATTR.MOD*		
CV3ATTR.MOD*		
IXATTR.MOD*	External Trips	Trip attraction rates for External-Internal/Internal-External (IX) trips [Note: all IXATTR.MOD file parameters are maintained in ixattrrates.BIN file.]
NC_HOURLY_?.BIN	Time of Day	PA to OD time of day conversions for small areas and large areas. ? indicates large or small.
MODESHARES_*.BIN	Mode Split	Auto mode shares for small and large areas
PEAKFACTORS.BIN	Prepare Network	Peak hour factors for small and large areas used to convert hourly capacity to time period capacity
GAMMACOEFFICIENTS _*.BIN	Trip Distribution, Commercial Vehicle, and External Trips	Default Gamma Coefficients for small and large areas
KFACTORS.MTX		User defined matrix of K-factors (if needed)

User required inputs are shown in Table 2. These inputs are scenario specific and should be placed in the input directory for the given scenario.

Table 2 Scenario Input Files

File Name	Model Step(s)	Description
*_SEDATA.BIN	Trip Generation, Commercial Vehicles, External Trips	Zonal data inputs and external station inputs
BY_HIGHWAY.DBD	Prepare Network, Create Network, Traffic Assignment	Base year highway line layer
*_HIGHWAY.DBD		Any future scenario line layer
*_EETRIPS.MTX	Time of Day	Through trip table for given year or scenario

* Year or scenario

An "Interim" folder is used to store interim files that are created during the model application process. These files are needed for reporting performance measures and running interim steps, but are not necessarily defined as final output.

Table 3 Scenario Interim Files

File Name	Model Step	Description
HBWGC_PATH.MTX	Trip Distribution	Generalized cost skims by trip purpose
HBOGC_PATH.MTX		
NHBGC_PATH.MTX		
BALANCE_PA.BIN	Trip Generation	Initial balance productions and attractions for internal trip purposes prior to adding in NHBW and NHBO trips by non-residents
PER_TRIPS.MTX	Trip Distribution	Person trip table
AUTOPER_TRIPS.MTX	Mode Split	Auto person trip table
CV_TRIPS.MTX	Commercial Vehicles	Commercial vehicle trip table
IX_TRIPS.MTX	External trips	IX trip table
AMVEH_TRIPS.MTX	Time of Day	Auto vehicle trip tables by time of day. AM is morning peak, MD is midday, PM is afternoon peak, OP is off-peak in the morning, and OP2 is off-peak in the afternoon.
MDVEH_TRIPS.MTX		
PMVEH_TRIPS.MTX		
OPVEH_TRIPS.MTX		
OP2VEH_TRIPS.MTX		Interim OP trip table required for combining and processing off-peak time periods.
AMCV_TRIPS.MTX		Commercial vehicle trip tables by time of day
MDCV_TRIPS.MTX		
PMCV_TRIPS.MTX		
OPCV_TRIPS.MTX		
OP2CV_TRIPS.MTX		Interim OP CV trip table required for combining and processing off-peak time periods
AMEE_TRIPS.MTX		Through trip tables by time of day
MDEE_TRIPS.MTX		
PMEE_TRIPS.MTX		
OPEE_TRIPS.MTX		
OP2EE_TRIPS.MTX		Interim OP EE trip table required for combining and processing off-peak time periods
AMIX_TRIPS.MTX		IX trip tables by time of day
MDIX_TRIPS.MTX		
PMIX_TRIPS.MTX		

OPIX_TRIPS.MTX		
OP2IX_TRIPS.MTX		Interim OP IX trip table required for combining and processing off-peak time periods

Final output files for each scenario are maintained in the “output” folder for a given scenario.

Table 4 Scenario Output Files

File Name	Model Step	Description
NETWORK.NET	Create Network	Network file for path building and assignment
SHORTESTPATH.MTX		Skim matrix with zone to zone minimum travel time and associated distances.
GENCOST.MTX		Combined generalized cost matrix used in person trip distribution
BALANCE_PA2.BIN	Trip Generation	Balanced productions and attractions for internal person trips (NHBW and NHBO_NR trips included), CV trips, and IX trips.
BALANCE_CV.BIN		
BALANCE_IX.BIN		
AMTOT_TRIPS.MTX	Time of Day	Total vehicle trip tables by time of day
MDTOT_TRIPS.MTX		
PMTOT_TRIPS.MTX		
OPTOT_TRIPS.MTX		
AM_LINKFLOW.BIN	Traffic Assignment	Total vehicle link flow by time of day
MD_LINKFLOW.BIN		
PM_LINKFLOW.BIN		
OP_LINKFLOW.BIN		
TOTAL_LINKFLOW.BIN		Daily total link flow

There are numerous data support files that are not needed to run the models, but are useful in summarizing, analyzing, and visualizing data. These files can be stored under the Model Directory in a directory called SUPPORT_FILES. This directory can maintain any files not needed for model application, but deemed useful by the user. As a minimum, the files listed in Table 5 should be stored here.

Table 5 Model Support Files

File Name	Description
FINAL_*.DBD	Geographic file showing the extent of the study/planning area. Useful for “clipping” data or creating maps.
*_TRACT	US Census Tract geography for the study area
*_TAZ_FINAL.DBD	Final TAZ layer for the study area
*_SCREENLINES.DBD	Geographic file of model screenlines
*_COUNTS	Geographic file showing traffic count locations

* Study area

2 Network and Database Development

2.1 Purpose

The first step in the model development process is the creation of a robust database and transportation network. These data are the building blocks for all subsequent steps in the process. Several of the development steps are iterative in nature in that they require consideration of each other. A good example of this is with the development of the traffic analysis zones (TAZs) and the highway network. This iterative nature will be noted where necessary.

2.2 Study Area Boundary and Traffic Analysis Zones

The study area boundary reflects the geographic area of analysis. This boundary becomes the "universe" for the traffic analysis zones and all of the roadway facilities that are to be analyzed. The TAZs are geographic areas that divide the study area into homogeneous areas of land use, land activity, and aggregate travel demand.

Step 1: Obtain Geographic Data Layers

GIS data is useful both in defining the study area boundary and in developing the traffic analysis zones. Several sources of geographic data are available including the data on the NCDOT S drive at in S:\Shared\TPB Reference\Comprehensive Transportation Plan\CTP GIS Data Layers.xls. The US Census Bureau website (http://www.census.gov/cgi-bin/geo/shapefiles2010/main) is also as good source of data as is the geographic data CDs provided by Caliper with each copy of TransCAD. Finally, the NCDOT GIS Unit (http://www.ncdot.org/it/gis/) and/or local or county GIS offices can also be utilized for GIS data. At a minimum the following geographic data layers should be obtained from one of these sources [recommended source shown in brackets] for your study area:

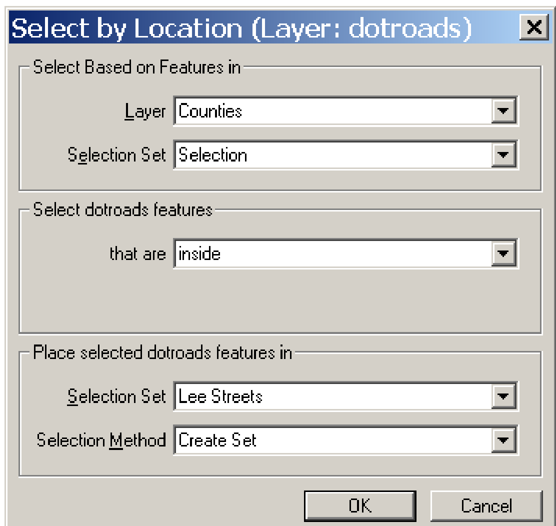
1. Census Tract in S:\Shared\TPB Reference\Comprehensive Transportation Plan\CTP GIS Data Layers.xls
2. Census Block Groups in S:\Shared\TPB Reference\Comprehensive Transportation Plan\CTP GIS Data Layers.xls
3. Census Blocks in S:\Shared\TPB Reference\Comprehensive Transportation Plan\CTP GIS Data Layers.xls
4. Water Features in S:\Shared\TPB Reference\Comprehensive Transportation Plan\CTP GIS Data Layers.xls
5. Roads RD_CHAR_MLPST.shp in S:\Shared\TPB Reference\Comprehensive Transportation Plan\CTP GIS Data Layers.xls
6. Jurisdictional boundaries such as city limits, extra territorial jurisdiction (ETJ), CBD overlay, county boundary in S:\Shared\TPB Reference\Comprehensive Transportation Plan\CTP GIS Data Layers.xls NC Statewide Model TAZs [in S:\Shared\TPB Reference\Comprehensive Transportation Plan\CTP GIS Data Layers.xls
7. NC Statewide Model Layer (TBD on S Drive)

Other useful data that may or may not be available as a geographic data layer includes:

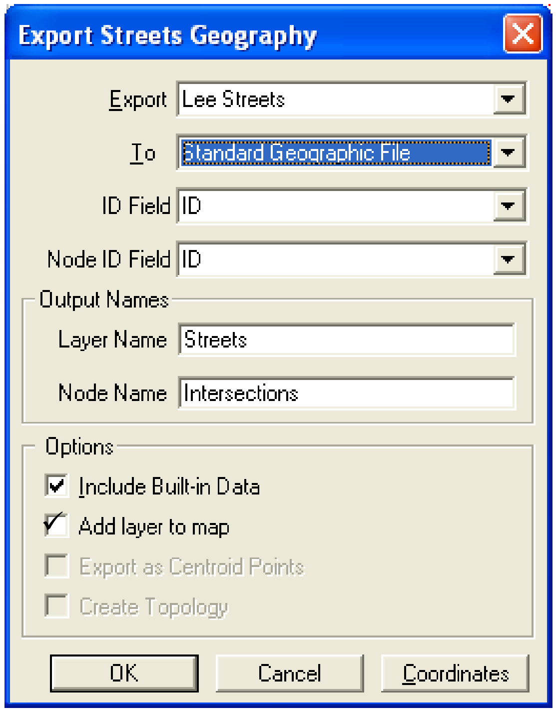
1. Land Use Plan [County or City Planning]
2. Population and Employment Forecast or Growth Plan [County or City Planning]
3. Existing Transportation Plan including programmed projects in S:\Shared\TPB Reference\Comprehensive Transportation Plan\CTP GIS Data Layers.xls

The following steps provide an example of creating a streets layer that can be used for modeling:

1. Access the CTP Data layer sheet from S:\Shared\TPB Reference\Comprehensive Transportation Plan\CTP GIS Data Layers.xls
2. Download the zip file for your area from this spreadsheet and unzip it to your Support Files folder
3. Open the county boundary layer from your support folder called COUNTYBOUNDARYSHORELINE.shp Zoom to county of interest
4. Add layer RD_CHAR_MLPST.shp from your support files folder
5. Use TransCAD **Select by Location** to create a selection set of the streets in the county of interest
    a. With layer County active – **Select by Pointing** - select the county of interest
    b. With layer Streets active – **Select by Location** – CLICK OK

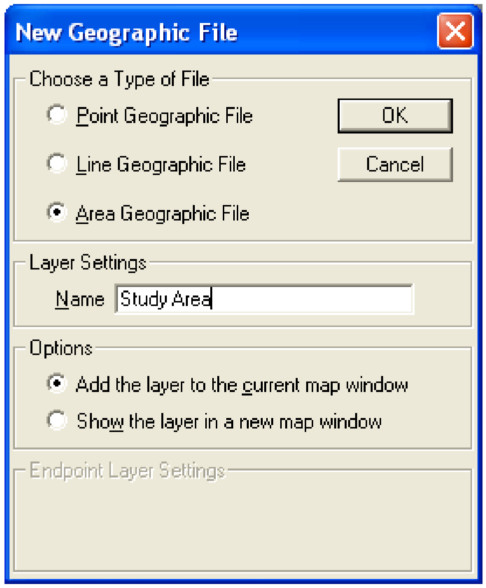


6. **Tools – Export** – CLICK OK then save in your support folder as Lee County Roads.dbd



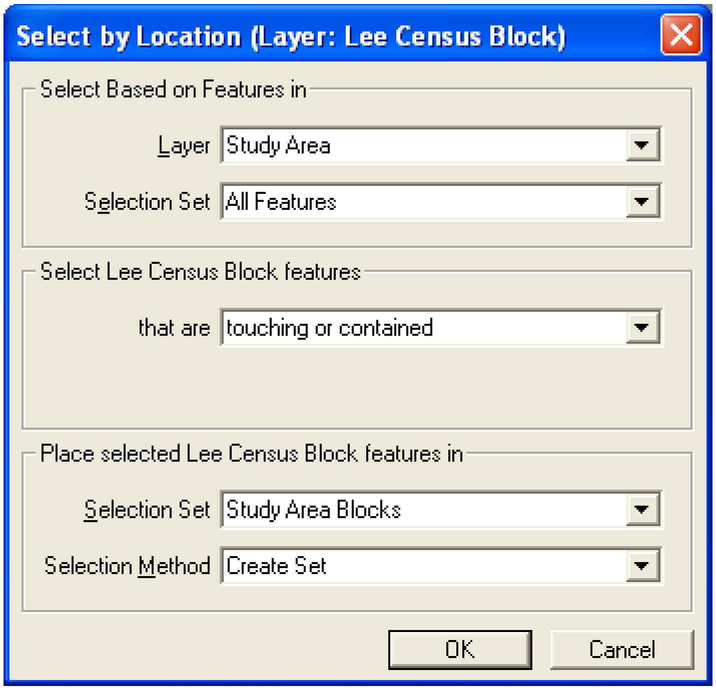
Step 2: Define Study Area Boundary

1. Open available geographic data in TransCAD as data layers in the same Map view
2. Apply the following criteria to determine the extent of the study area boundary (See also Section 2.2 of the Guidelines):
   - Minimization of roadway crossings,
   - Consistency with census geography,
   - Consistency with regional features,
   - Consideration of political boundaries,
   - Consideration of future growth, and
   - Avoidance of highly irregular boundaries.
   - Consistency with NCSTM boundaries
3. Use the TransCAD tools to create a new geographic data layer representing the rough outline of the study area boundary.
   a. **File – New – Geographic File** – CLICK OK
   b. Fill in New Geographic File dialog box



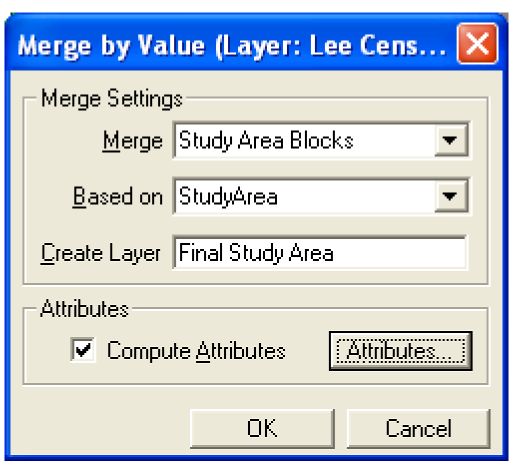
   c. Add a data field called “Draft Study Area”(Integer, 8)
   d. **Save As** – Draft Study Area Boundary – Save
   e. **Tools – Map Editing – Toolbox**
   f. Use the map editing tools to create the new layer that roughly represents the extent of the Study Area. This layer will be used in the next step to identify all of the census blocks that make up the Study Area. The census block layer is used to create the Final Study Area boundary.

4. With the Draft Study Area boundary file open, add the geographic file for the census blocks as well as the NCSTM TAZ layer (if not already open). Use the Draft Study Area to select the census blocks within the study area.
   a. **Selection – Select by Location** – based on Features in Study Area – Select Census Blocks that are touching or contained – place into selection set Study Area Blocks

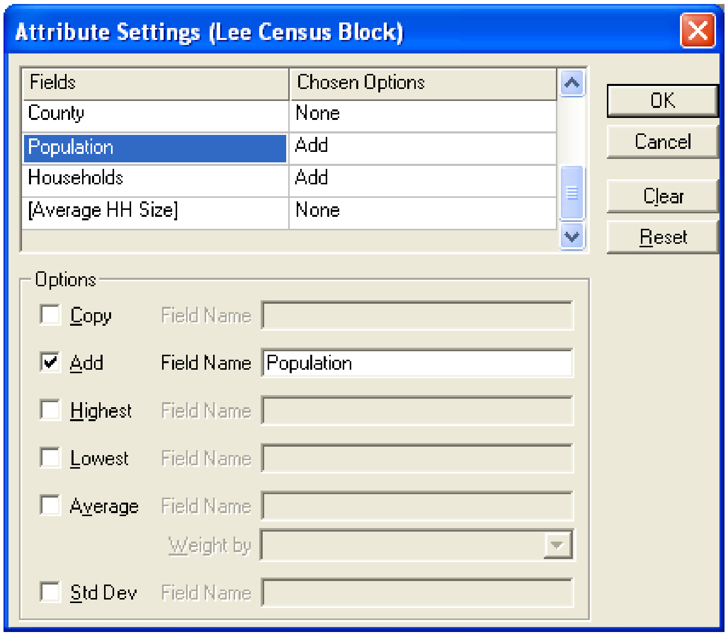


a. Review the edges of the Study Area to be sure that all required census blocks have been selected, or to clean the edges as necessary. Use the NCSTM layer to assure boundaries match and that all census blocks have been included to cover the NCSTM layer.

b. With the Census Block Layer as the active layer – Modify the data view to add field: StudyArea, Integer, 4 bytes
c. Open the data view for the Census Blocks and fill the new field with a value of 1 for the “Study Area Blocks” selection set ONLY
d. Close the data view
e. With the Census Blocks as the active layer – **Tools – Geographic Analysis – Merge by Value**

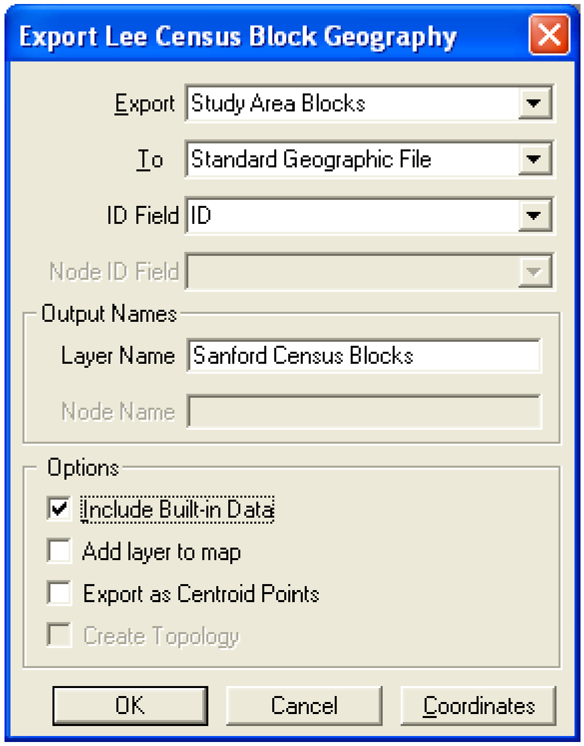


f. Compute attributes for population and households



g. CLICK OK – Save file: [SUPPORT_FILES\FINAL_STUDY_AREA.DBD]

5. Before clearing the selection set of blocks used to create the Final Study Area, export this selection set to use for later editing in the creation of TAZs.
   a. Make the Census Block Layer the active layer
   b. Tools – Export



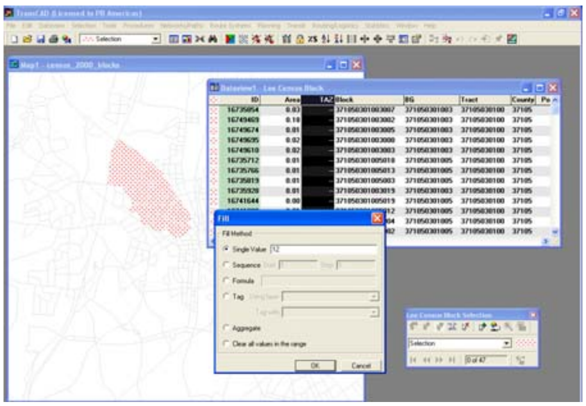
c. CLICK OK – Save as "Sanford" Census Blocks (or appropriate city name)

Step 3: Develop Traffic Analysis Zones

1. With available geographic data still open in TransCAD apply the following criteria to build the TAZs for the study area (see also Section 2.3 of the Guidelines):
   - Consistency with census geography
   - Consistency with regional features
   - Homogeneous land use
   - Consistency with data availability
   - Consideration of future development
   - Consistency with roadway network (**TIP:** the development of the TAZs must be done iteratively with the development of the highway line layer to assure that there is consistency between the level of detail in the network and the level of detail in the TAZ system. Do NOT finalize the TAZ layer until the highway network layer has been finalized.)
2. Use the census block geography created in Step 2 above to build a geographic layer that represents the TAZs
   a. With the census block geography from the TransCAD data CD as the active layer, open the data table and remove all unwanted fields. At a minimum, **maintain** the following fields:
      i. ID
      ii. Area
      iii. Block
      iv. BG
      v. Tract

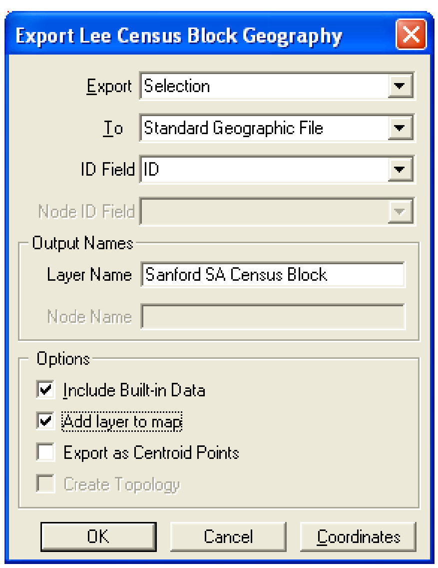
vi. County
vii. Population
viii. Households
ix. Average HH Size

b. Add the following fields
    i. TAZ (Integer, 4 bytes)
    ii. District (Integer, 4 bytes)
c. Use the selection tools to select the census blocks that represent the TAZ you want to create and fill the TAZ field in the data table with the TAZ value.
d. Compare your TAZs to the NCSTM TAZs to check for compatibility where possible.



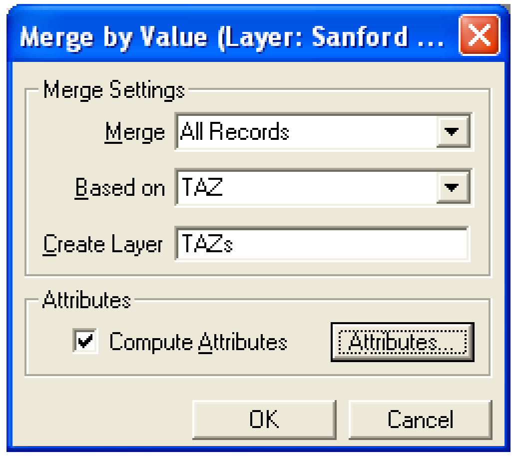
TIP: After creating your first TAZ use a color theme plot to display by the TAZ number so that you can track which block groups you have already included in a TAZ.

e. This step is repeated until all blocks have been given a TAZ value
f. When all blocks have been given a TAZ value, create a selection set of the blocks with a TAZ value [TAZ<>null] and export the census blocks for the planning area only.

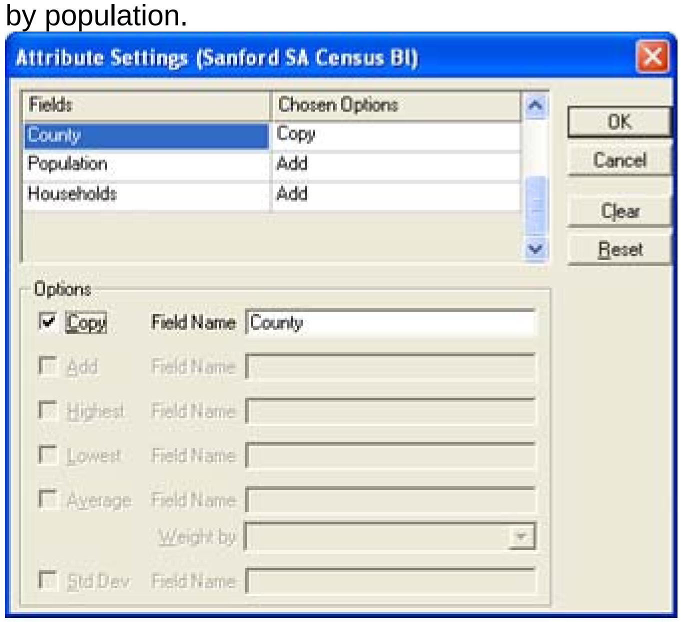


g. The next step is to aggregate the census blocks for the study area into a TAZ layer using the new field TAZ.

i. Tools – Geographic Analysis – Merge by Value



ii. It is **important** to preserve the data fields that are needed for the land use inputs into the model, including population and households. Use the **Compute Attributes** check box to add the data fields for population and households. The field for average HH Size can be averaged and weighted by population.



3. Save TAZ layer as: [SUPPORT_FILES*TAZ_FINAL.DBD], where * represents the name of the study area

Step 4: Create an SEDATA.BIN file for Model Input SE Data

1. With the new TAZ layer as the working layer open the associated Dataview

2. **Dataview – Fields – Clear – Add**:
    a. TAZ
    b. District
    c. Population
    d. Households
3. CLICK OK
4. **Dataview – Sort – Sort by TAZ**
5. **File – Save As** – [**\INPUT*_SEDATA.BIN] – Save

Step 5: Clean TAZ Dataview to Remove SE Data fields

1. With the new TAZ layer as the working layer **Dataview – Modify Table – Drop Fields**:
    a. Population
    b. Households
    c. District
2. CLICK OK – Yes

Step 6: Update SEDATA.BIN to Add Required Fields

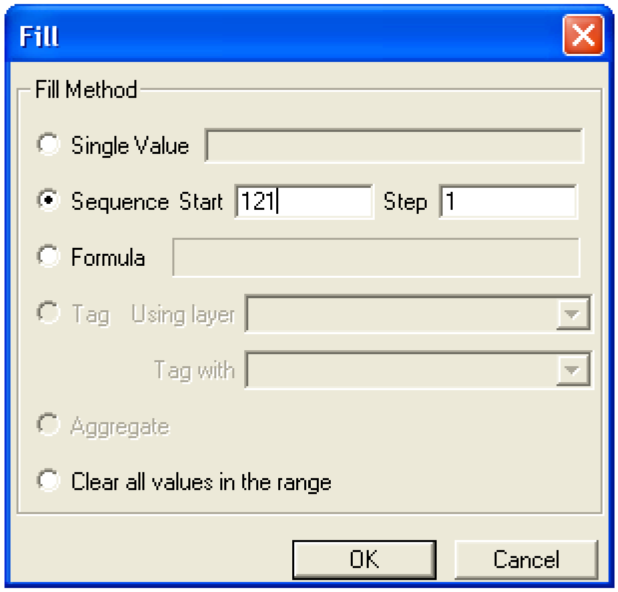
(NOTE: THERE IS AN AUTOMATED TOOL TO CREATE THE NECESSARY FIELDS)

1. **File – Open –** [**\INPUT*_SEDATA.BIN]
2. **Dataview – Modify Table** and add the following data fields:
    - Vehicles (Integer, 4 bytes) (**NOTE:** the term vehicle and auto is used interchangeably in this document)
    - Industry (Integer, 4 bytes)
    - Retail (Integer, 4 bytes)
    - HwyRet (Integer, 4 bytes)
    - Service (Integer, 4 bytes)
    - Office (Integer, 4 bytes)
    - TotEmp (Integer, 4 bytes)
    - Students (Integer, 4 bytes)
    - CV1IND (Integer, 4 bytes)
    - CV2IND (Integer, 4 bytes)
    - CV3IND (Integer, 4 bytes)
    - CV1RET (Integer, 4 bytes)
    - CV2RET (Integer, 4 bytes)
    - CV3RET (Integer, 4 bytes)
    - CV1HWY (Integer, 4 bytes)
    - CV2HWY (Integer, 4 bytes)
    - CV3HWY (Integer, 4 bytes)
    - CV1SER (Integer, 4 bytes)
    - CV2SER (Integer, 4 bytes)
    - CV3SER (Integer, 4 bytes)
    - CV1OFF (Integer, 4 bytes)
    - CV2OFF (Integer, 4 bytes)
    - CV3OFF (Integer, 4 bytes)
    - PopDensity (Real, 8 bytes)
    - HHDensity (Real, 8 bytes)
    - EmpDensity (Real, 8 bytes)
    - hbwp (Real, 8 bytes)
    - hbwa (Real, 8 bytes)

- hbop (Real, 8 bytes)
- hboa (Real, 8 bytes)
- hbschp (Real, 8 bytes)
- hbscha (Real, 8 bytes)
- nhbwp (Real, 8 bytes)
- nhbwa (Real, 8 bytes)
- nhbop (Real, 8 bytes)
- nhboa (Real, 8 bytes)
- cv1p (Real, 8 bytes)
- cv1a (Real, 8 bytes)
- cv2p (Real, 8 bytes)
- cv2a (Real, 8 bytes)
- cv3p (Real, 8 bytes)
- cv3a (Real, 8 bytes)
- ixp (Real, 8 bytes)
- ixa (Real, 8 bytes)
- EEp (Integer, 2 bytes)
- EEa (Integer, 2 bytes)
- CIterations (Integer, 4 bytes)
- HHClosure (Real, 8 bytes)
- hhp1 (Real, 8 bytes)
- hhp2 (Real, 8 bytes)
- hhp3 (Real, 8 bytes)
- hhp4 (Real, 8 bytes)
- hhp5 (Real, 8 bytes)
- hha0 (Real, 8 bytes)
- hha1 (Real, 8 bytes)
- hha2 (Real, 8 bytes)
- hha3 (Real, 8 bytes)
- hhp1a0 (Real, 8 bytes)
- hhp1a1 (Real, 8 bytes)
- hhp1a2 (Real, 8 bytes)
- hhp1a3 (Real, 8 bytes)
- hhp2a0 (Real, 8 bytes)
- hhp2a1 (Real, 8 bytes)
- hhp2a2 (Real, 8 bytes)
- hhp2a3 (Real, 8 bytes)
- hhp3a0 (Real, 8 bytes)
- hhp3a1 (Real, 8 bytes)
- hhp3a2 (Real, 8 bytes)
- hhp3a3 (Real, 8 bytes)
- hhp4a0 (Real, 8 bytes)
- hhp4a1 (Real, 8 bytes)
- hhp4a2 (Real, 8 bytes)
- hhp4a3 (Real, 8 bytes)
- hhp5a0 (Real, 8 bytes)
- hhp5a1 (Real, 8 bytes)
- hhp5a2 (Real, 8 bytes)
- hhp5a3 (Real, 8 bytes)

3. **Edit – Add Records** – Add the number of records needed for your External Stations

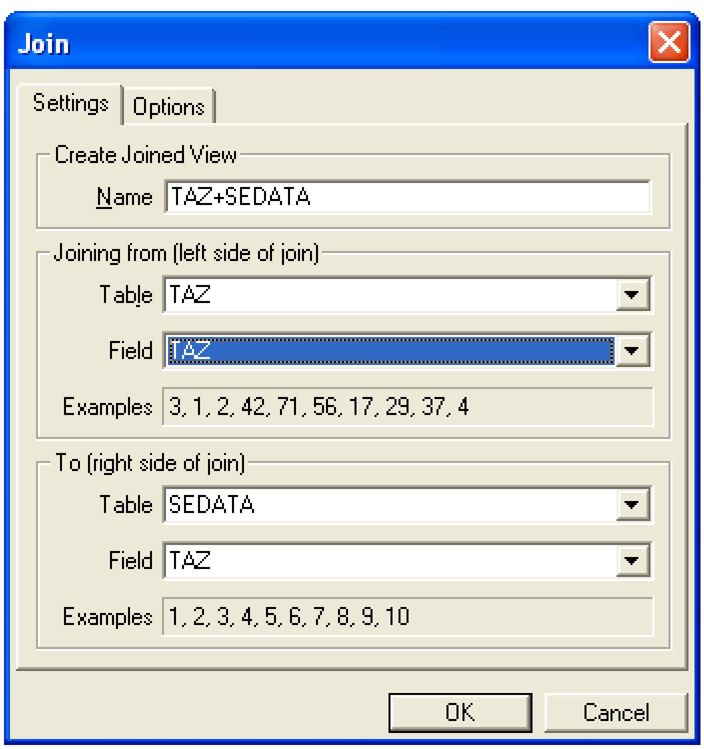
4. Highlight the TAZ field for the NEW records ONLY – **Edit – Fill** – Fill with a sequence starting at your lowest External Station number and stepping by 1 – CLICK OK



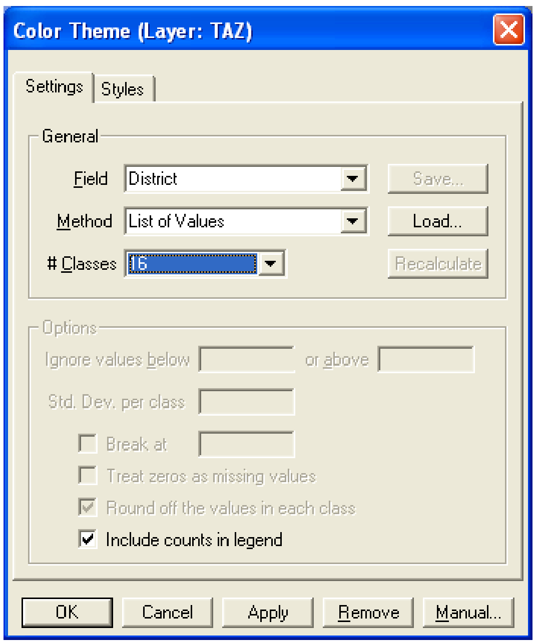
Step 7: Develop District System

Please see the Guidelines document, sections 2.3.2, 2.3.3, and 2.3.4 for detailed information on when and how to create districts.

1. If not already open, open the TAZ geographic file
2. Open the associated Dataview
3. **Dataview – Join** – Join the TAZ Dataview and the SEDATA table using Field TAZ



4. With the TAZ layer active, select the TAZs that represent the District you want to create and fill the District field in the joined data table with the District value (See Guidelines Section 2.3.2 for information on creating districts)
5. This step is repeated until all TAZs have been given a District value
6. To view your new districts you can create a theme using the District field in the Joined Table
    a. **Map – Color Theme** [see screen shot below]



2.3 Land Use and Demographic Data

Land use data such as population and employment, and demographic data such as workers per household and autos per household are key inputs to the modeling process. This section covers the collection and tabulation of such data. It should be noted that the steps outlined below are not the only approach to obtaining such data, but are a common approach to obtaining such data.

Step 1: Tabulate Population and Household Data

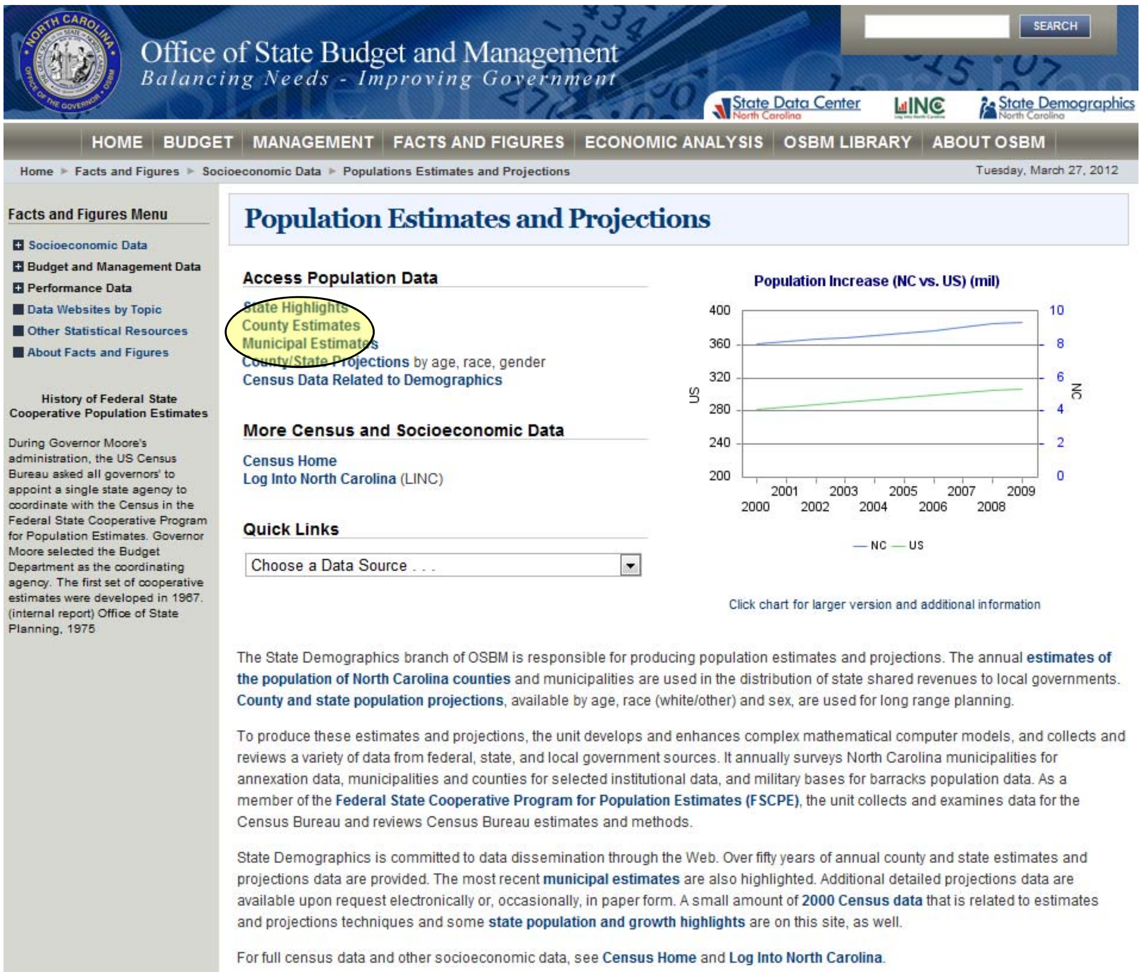
One of the advantages of building a TAZ layer from census block data is that the census data file includes information on population and households. When the blocks are aggregated to create the TAZs the population and household data should be summed resulting in population and household data by TAZ. This data is for the year that the census data was collected and as such must be modified to reflect the base year of the model.

If your base year is 2010 then you do not need to worry about the substeps listed and can go to Step 2.

If you have a different horizon year than 2010 then use the steps listed.

1. With the 2010 population and household layer from the previous steps as your starting point. Obtainthe current population data from the state data center. Or have your local area update the data from 2010 to your horizon year.

   If you are using the state data to develop your new horizon year then use this link to get you to the initial population estimate page location:
http://www.osbm.state.nc.us/ncosbm/facts_and_figures/socioeconomic_data/population_estimates.shtm



2. Click on County or Municipal Estimates at the top of the page(shown with yellow circle in figure and below in zoomed view). The selection of what level you want estimates depends on the size of your area.

Access Population Data

State Highlights
County Estimates
Municipal Estimates
County/State Projections by age, race, gender
Census Data Related to Demographics

3. A new screen appears that shows the current year validated numbers. However, you may have a base year different than what is displayed. Scroll through the page until you find the year you need for your base year of your model development and click on population/growth to get your new population control total.

County Estimates

.......to County/State Projections ....to Municipal Estimates

Most Current Estimates

Updated Note for Data Users: Data by race/sex and age/sex have now been released. The full release including age, race and sex breakdowns will return afte the necessary Census 2010 input data is available and processed (late 2012).

Certified 2010	Population/Growth	Growth Map	Methodology
	Ranked by Size	Fastest Growing	By Total Growth
	MeSA Pop/Growth	MeSA Location Map	
	Female - Race Totals	Male - Race Totals	
	Age Groups-Total	Age Groups-Female	Age Groups-Male

2000-2009 Smoothed Estimates

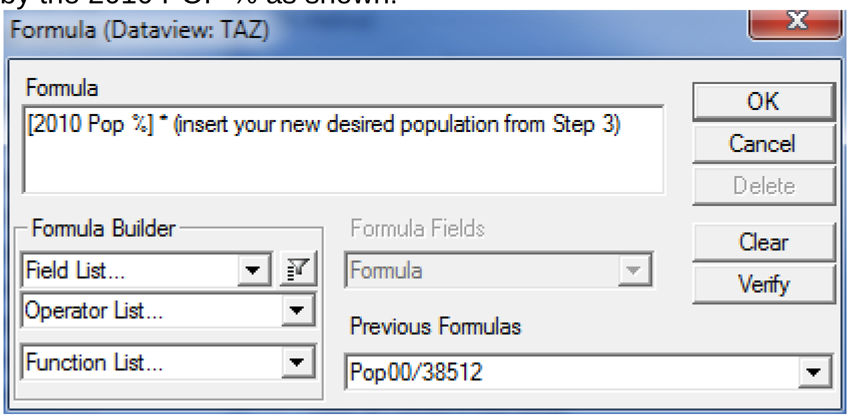
Smoothed 2009	Population/Growth	Growth Map	Methodology
	Female - Race Totals	Male - Race Totals	
Smoothed 2008	Population/Growth	Growth Map	
	Female - Race Totals	Male - Race Totals	
Smoothed 2007	Population/Growth	Growth Map	
	Female - Race Totals	Male - Race Totals	
Smoothed 2006	Population/Growth	Growth Map	
	Female - Race Totals	Male - Race Totals	

4. Distribute the new population in the same proportions as the 2010 census to develop your initial base year population estimate(if your base year is not 2010).
    a. Create a new column called 2010 POP % (Real, 8 bytes)
    b. Fill that column with the percent of HHs as a proportion of the entire study area total. The following formula should be used:
       2010 POP %= Population/(Total Population)

Note: Total Population will have to be summed manually for your entire region before doing this calculation

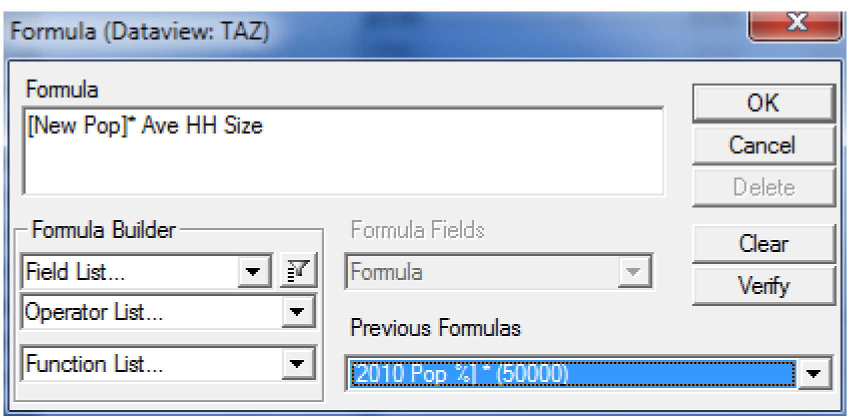
    c. Fill that column with the percent of HHs as a proportion of the entire study area total. The following formula should be used:

5. Create a new column called New Pop (Real, 8 bytes)
6. Fill New Pop by multiplying your new regional population total(determined in Step 3) by the 2010 POP % as shown:



7. You also need a new estimate for the number of households. Create a new column called New HH(Real, 8 bytes)
8. Fill this column by using the Ave HH Size field and multiplying it with your New Pop field:

New HH=Ave HH Size * New Pop



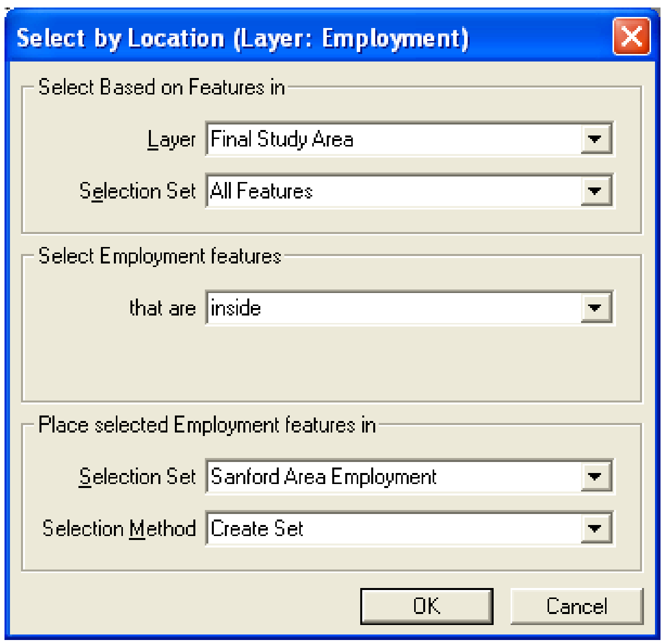
NOTE: if you do not have Ave_HH size in your data you can calculate it by dividing the population with the households for each TAZ.

9. If you believe the distribution has changed since 2010 then you should adjust the population and housing in each TAZ by using building permit data, aerial photography, and/or input from local planners.

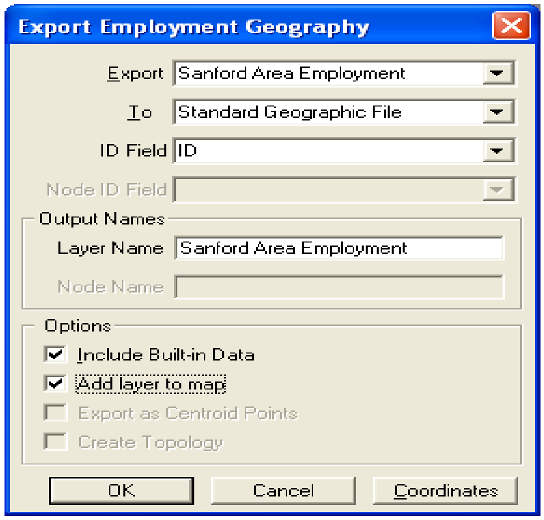
TIP: If you adjust individual TAZs remember your control total for population and HH's should remain the same and should match your original projections.

Step 2: Collect and Tabulate Employment Data

1. Create Employment Data layer for your study area.
    a. Open the Final Study Area layer
    b. Open the InfoUSA database
    c. Selection – Select by Location



    d. Tools – Export



2. Conduct a phone interview for all employers in your study area with greater than 50 employees to verify address information and number of employees at that address. This is also a good time to collect data related to commercial vehicles. **TIP:** If you have very few employers with greater than 50 employees then it is advisable to contact all employers over 50. A review should be conducted of all employment records to be sure that the type of business makes sense with respect to the number of employees listed. If there are data records that appear questionable, then call these employers for verification of the data.

NOTE: *See Step 5: Employment Data Cleaning for additional prodecures and methods to help assure employment data accuracy. This cleaning process may require an iterative process to re-alllocate the data into the 5 employment categories required and discussed below.*

3. Add the following data fields to the working copy of the data:
   a. Industry (Integer, 4 bytes)
   b. Retail (Integer, 4 bytes)
   c. HwyRetail (Integer, 4 bytes)
   d. Service (Integer, 4 bytes)
   e. Office (Integer, 4 bytes)

4. Using the lookup table below, allocate the number of employees for each record to one of the employment categories specified above. **NOTE:** These codes represent the FIRST 3 DIGITS of the NAICS code.
   a. To allocate each record to an employment category add a data field called NAICS_3Digit (Integer, 4 bytes)

b. Fill this field using the following formula:
   NAICS_CODE/100000

c. Fill the data fields from the previous step using the following formulas:

Industry= if (NAICS_3Digit between 111 and 424 or NAICS_3Digit between 481 and 484 or NAICS_3Digit=486 or NAICS_3Digit=488 or NAICS_3Digit between 491 and 493 or NAICS_3Digit=562) then ACTUAL_LOCATION_EMPLOYMENT_SIZE else 0

Retail= if (NAICS_3Digit between 441 and 444 or NAICS_3Digit between 448 and 453 or NAICS_3Digit=446) then ACTUAL_LOCATION_EMPLOYMENT_SIZE else 0

High Traffic Retail= if (NAICS_3Digit=445 or NAICS_3Digit=447 or NAICS_3Digit=722) then ACTUAL_LOCATION_EMPLOYMENT_SIZE else 0

Service =if (NAICS_3Digit between 621 and 624 or NAICS_3Digit between 711 and 713 or NAICS_3Digit between 811 and 814 or NAICS_3Digit=485 or NAICS_3Digit=487 or NAICS_3Digit=532 or NAICS_3Digit=611 or NAICS_3Digit=721) then ACTUAL_LOCATION_EMPLOYMENT_SIZE else 0

Office= if (NAICS_3Digit between 511 and 519 or NAICS_3Digit between 521 and 525or NAICS_3Digit between 921 and 928 or NAICS_3Digit=425 or NAICS_3Digit=454 or NAICS_3Digit=531 or NAICS_3Digit=533 or NAICS_3Digit=541 or NAICS_3Digit=551 or NAICS_3Digit=561) then ACTUAL_LOCATION_EMPLOYMENT_SIZE else 0

Table 6 Employment Groupings for 3-digit 2002 NAICS Code

Recommended Category	NAICS 3-digit codes
Industry	111-115, 211-213, 221, 236-238, 311-339,423, 424, 481-484, 486, 488, 491-493, 562
Retail	441-444, 446, 448-453
High-traffic Retail	445, 447, 722
Service	485, 487, 532, , , 611, 621-624, 711-713, 721, 811- 814
Office	425, 454, 511-519, 521-525, 531, 533, 541,551, 561 921-928

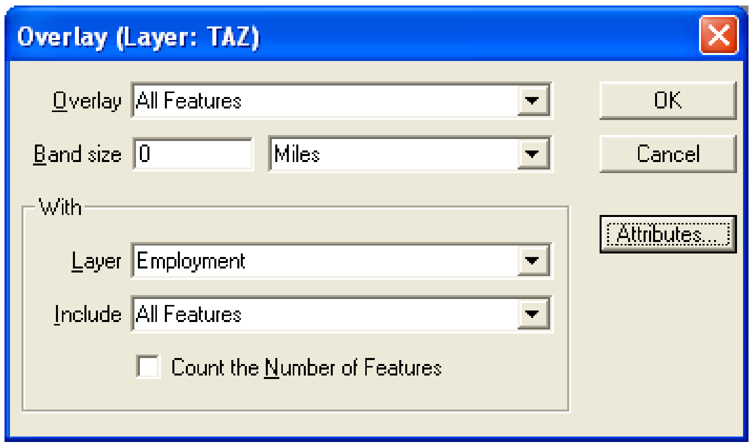
TIP: The guidelines specify a more detailed grouping of the employment data, but that grouping is not followed here due to limitations in the data sets used to create the procedures manual. If more detailed data is available in the future, these procedures should be updated to reflect the more detailed employment groupings as reflected in the guidelines.

TIP: *If the NAICS code is missing for any of the records, the employment description should be used to assert a category. The following webpage provides a breakdown of NAICS codes and descriptions.* *http://www.census.gov/epcd/naics02/naicod02.htm*

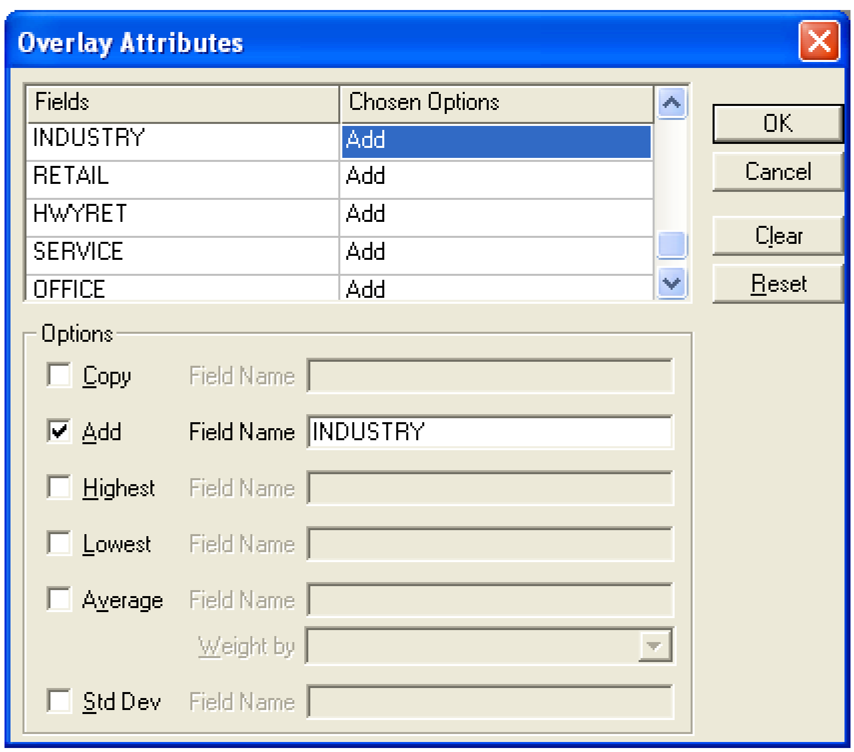
Google can also be used to search on the company name which will often provide information that will help identify the employment type.

TIP: Check to make sure your ACTUAL_LOCATION_EMPLOYMENT_SIZE totals to your 5 employment groupings. Check for code 999 to assure every record has a NAICS code

5. After all of the employment data has been categorized into the appropriate employment groupings, the point level employment data is aggregated to the TAZ layer using the Overlay command in TransCAD.
6. If the TAZ layer is not already open in your Map view, open it now.
7. With the TAZ layer as the active layer:
   a. **Tools – Geographic Analysis – Overlay**



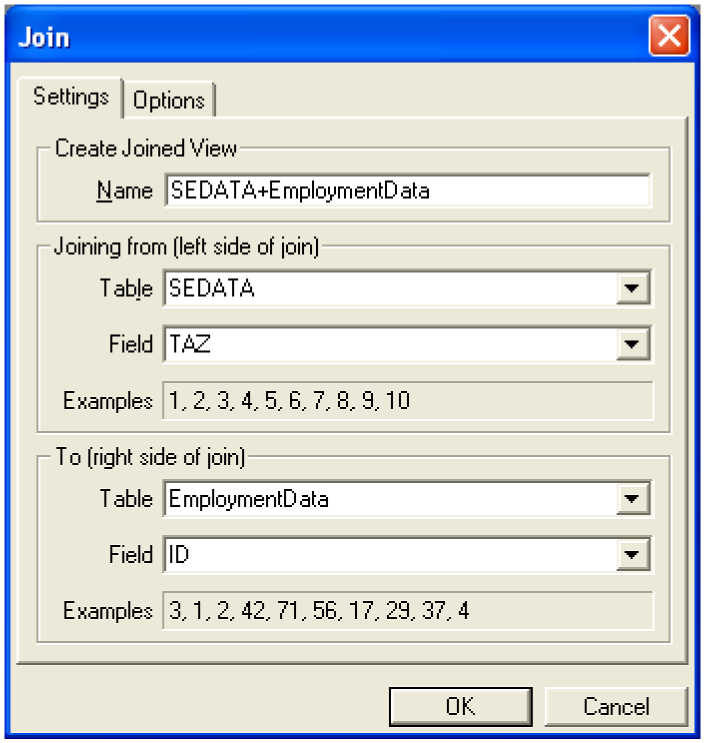
   b. Select the Attributes button and specify "Add" for all of the employment fields



   c. Select OK to return to the Overlay dialog box
   d. Select OK and you will be prompted to save a BIN file of the employment data. The new BIN file is automatically joined to the TAZ layer. Drop the Join as the

EMPLOYMENTDATA.BIN file needs to be joined to the SEDATA.BIN file since this is the file where we are storing all of our model input data.

   e. Open [**\INPUT*_SEDATA.BIN]
   f. Open ["Path name for wherever you are storing your working data"\EMPLOYMENTDATA.BIN]
   g. **Dataview – Join** – SEDATA + EMPLOYMENTDATA – Field TAZ to Field ID (See Dialog Box below) – CLICK OK



   h. Use the **Edit – Fill** command to fill the employment data fields in the SEDATA.BIN file with the respective employment data from the EMPLOYMENTDATA.BIN file.

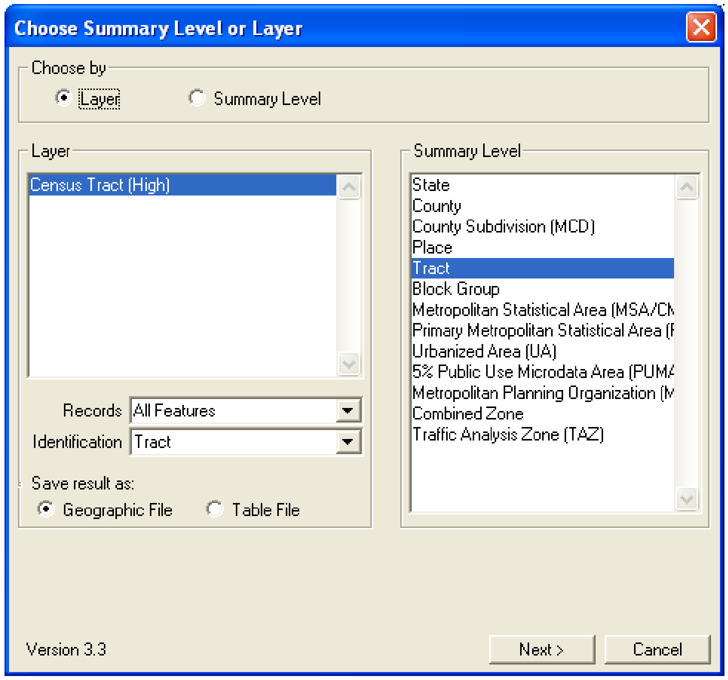
Step 3: Collect and Tabulate Vehicle Data

1. Vehicle data is obtained from US Census data(2010 data is not yet available so the vehicle distribution data is still from 2000. It is anticipated that this distribution has not changed drastically and therefore is still valid for the SAM). Caliper makes available to all TransCAD users census data formatted for use directly in TransCAD. This data can be downloaded from the TransCAD User Center(or from the share drive on your network):
   a. http://www.caliper.com/
   b. Customer Services – TransCAD Users Center

   If this is your first time accessing the Users Center you must first register.
2. After logging into the User Center follow the instructions for downloading CTPP data Part 1 for North Carolina.
3. Once the data has been downloaded you can extract the ZIP file to a folder on your computer. You are now ready to work with the data in TransCAD.
4. In TransCAD
   a. Open the Census Tract data layer from the TransCAD data CD

b. **Planning – Census Utilities – CTPP Part 1** (browse to folder where you stored the data) – CLICK OK

c. **Choose by Layer – Tract – All Features – Tract – Geographic File – Next**



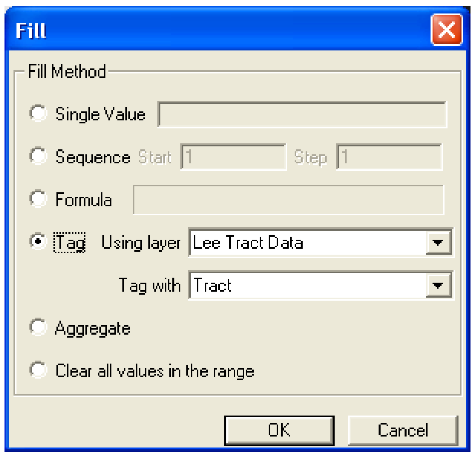
d. Select the following tables:
   - Persons: P1047 – Total number of persons (1)
   - Vehicles: P1063 – Household size (5) by Vehicles available (6)

e. Save File: CTPPbyTract

5. Now we have census data for the entire state, and from this must extract the data for the study area only.
6. Add the TAZ layer for the study area.
7. From the statewide data layer use the select tool to select only those tracts that contain the model TAZs
8. Export this selection set to a new standard geographic file [SUPPORT_FILES*_TRACTS] and include the built in data.
9. Close the statewide data coverage and add to the map the new geographic file for the study area only.
10. Open data table and review the fields – Note that they have smart labels on them. You can also view the data fields using the Dataview – Table Structure
11. The fields needed for vehicle data are:
    a. P1047 – Total persons
    b. P1063_0101 through P1063_0106, Total households | Total vehicles available | Universe: All households
12. This data must be allocated to the TAZs. There are various approaches to doing this, a recommended approach is to allocate based on the proportion of population in the TAZ. This process is described in the next step.

Step 4: Allocate Tract Level Vehicle Data to TAZ

1. Tag each TAZ with a tract code
    a. Add the following fields to the TAZ data view:
        i. TractID (Integer, 16)
        ii. TractPop (Integer)
        iii. TractVehicles (Integer)
    b. Fill the field TractID in the TAZ layer with the Census Tract ID from the Census Tract layer
        i. **Fill – Tag** – Using layer Census Tract – Tag with Tract Code [**NOTE:** Make sure that the data fields are of the same type]



2. Update the fields in the TAZ layer with the data from the Census Tract layer
    a. **Dataview – Join** – From TAZ using field TractID – To Census Tract layer using field Tract – CLICK OK
    b. Fill TAZ field TractPopulation with Census Tract field P1047 (all persons)
    c. Fill TAZ field TractVehicles with the following formula using the Census Tract data fields as specified.

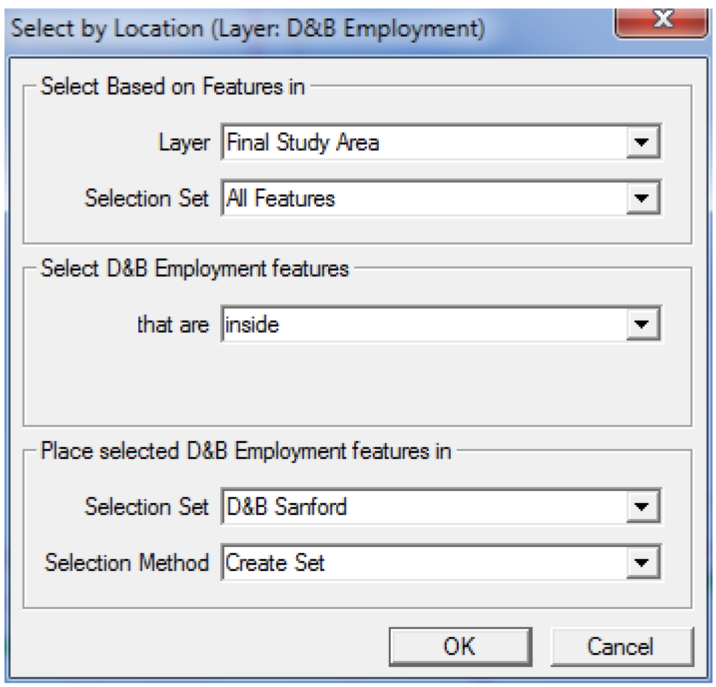
       TIP: The universe for the vehicle data is households; we must therefore use this information about the vehicles per household to calculate total vehicles.
        i. P1063_0103 + (P1063_0104*2) + (P1063_0105*3) + (P1063_0106*4.5)
    d. Drop joined Dataview
3. Use the proportion of the population in each TAZ to proportionally allocate the vehicle data to the TAZ.
    a. Open [**\INPUT*_SEDATA.BIN]
    b. Open the TAZ Dataview
    c. **Dataview – Join** – Join the SEDATA.BIN file to the TAZ Dataview
    d. Fill SEDATA.BIN field vehicles with the following formula:
        i. TractVehicles*(Population/TractPop)
4. **TIP:** As with all other data, this information should be reviewed with the local planning staff.
5. Close all data files.

Step 5: Employment Data Cleaning

Previous steps outlined using the INFOUSA data to get total employees by the various employment categories used in the NCSAM procedures. Those steps assume that the employment data is accurate straight from the vendor(or employment source), an assumption that should not be made. Therefore, the employment data used in every travel demand model should be cleaned and reviewed. This section covers some of the procedures and methods that can and should be used to review, clean and edit the employment data. This does not cover all checks and developers are encouraged to think about additional checks that can be performed on the data.

In addition to calling the locations that have 50 or more employees(as outlined previously) you should follow these additional steps.

1. Create Dunn & Bradstreet (D&B) Employment Data layer for your study area.
    a. Open the Final Study Area layer
    b. Open the D&B database
    c. Selection – Select by Location



    d. Export this selection set to a new standard geographic file [SUPPORT_FILES\D&B Data] and include the built in data.

2. Compare Dunn & Bradstreet Layer(D&B) to InfoUSA
    a. With the new D&B layer open add the INFOUSA layer into the same TransCAD Map
    b. Sort the employment columns for both layers and compare the largest employers between the databases. For D&B sort the Field EmploymentThisSite and for INFOUSA layer sort ACTUAL_LOCATION_EMPLOYMENT_SIZE
        i. Compare # of employees between the databases
        ii. Compare address/locations-D&B addresses use with CAUTION

iii. Compare Names-be cautious of differences in spellings
iv. Compare Employment totals by NAICS code totals for region.

NOTE: you will have to add the 5 employment categories to the D&B database following the same steps as outlined in Step 2: Collect and Tabulate Employment Data

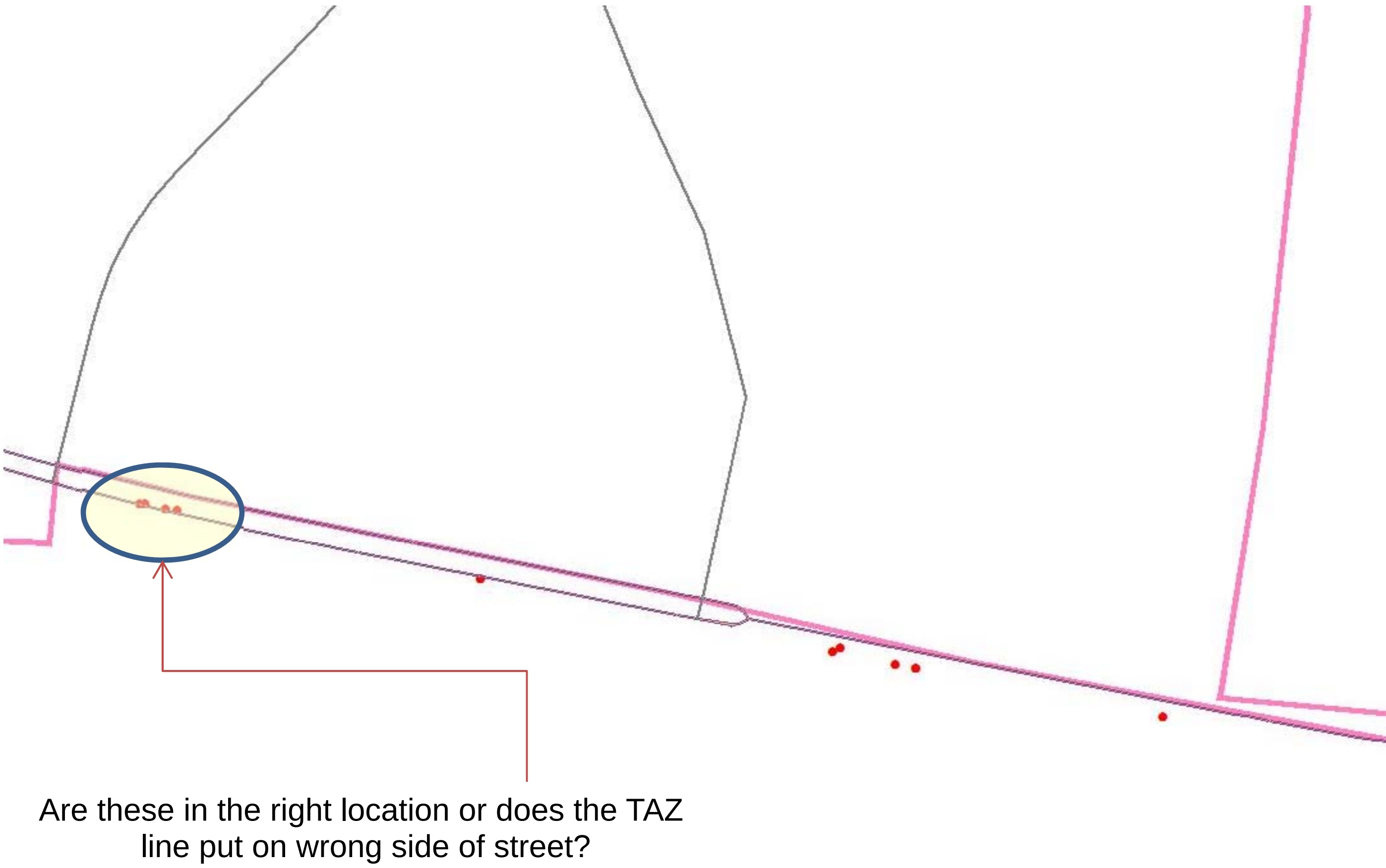
> TIP: Be cautious when reviewing data that you look for issues with “home office locations”. This occurs when all the employees for one business get located at ONE geo-coded point when actually several locations exist in the region but were mistakenly coded to this one location. (ie…Grocery stores, govt employees,etc)

c. If discrepancies are determined then settle on the appropriate employment total and create a new column in your INFOUSA data called:
   New Emp Count (Integer, 4 bytes)
d. Fill New Emp Count with ACTUAL_LOCATION_EMPLOYMENT_SIZE then manually enter the new numbers in this column as you check the dataset.
   i. Calling employers to get updated numbers may be needed as previously described. Websites and other datasets could also be used as a reference to determine the correct data.

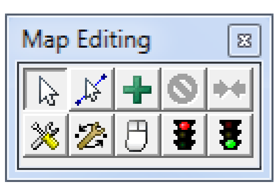
NOTE: It is recommended you create a column to designate which employment numbers you changed and why so that others will understand the data edits.

e. New locations may be added to the INFOUSA database to include employers in other databases or to split up “home office locations”.
   i. This is done by editing the INFOUSA point file with a new record. Refer to editing layer commands in previous sections to complete this operation.
   ii. Make sure to transfer/update/include the NAISC code, the employee count and the name of the business and description if available.

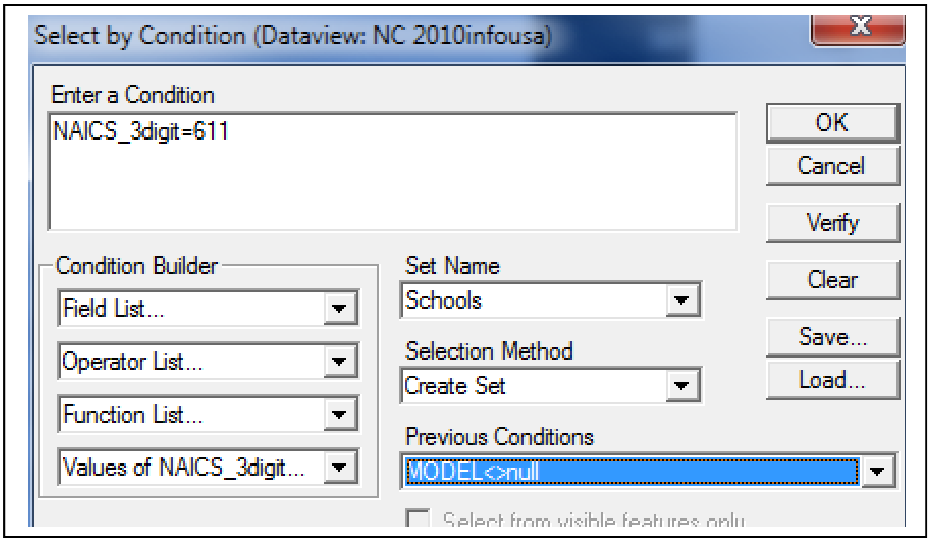
3. Review point locations in the INFOUSA database for accuracy.
   a. Assure that every point has been assigned a TAZ number
   b. Verify that larger employers have been properly geo-coded in the correct TAZ and on the correct side of the roadways. Example shown below:



c. Points can be manually moved to a new geo-code location using Tools →Map Editing→Toolbox command.
d. Drag each point and relocate it to the proper location. Remember to save edits using the green go button.

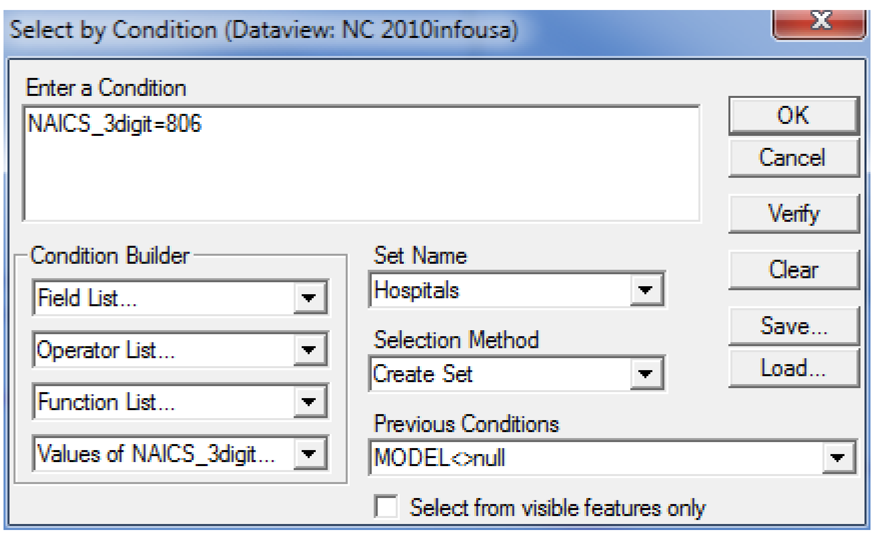


4. Compare Special locations like schools(elementary, middle, high), Universities and Hospitals using other datasets
   a. Open INFOUSA layer
   b. Select-By Condition the schools in the region



c. Compare the school locations to local website for school enrollment if available.University and college websites should be searched in your region to verify locations and employment if noted.
   http://www.lee.k12.nc.us/

d. Select-By Condition the hospitals in the region

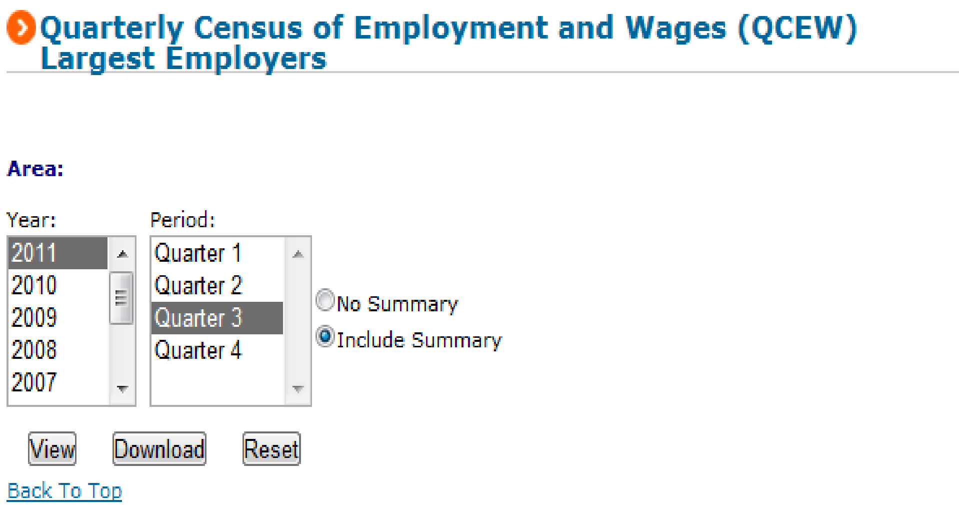


e. Compare the hospital locations to the following websites for location and employment information.

   https://www.ncha.org/nc-hospitals
   http://www.cgia.state.nc.us/

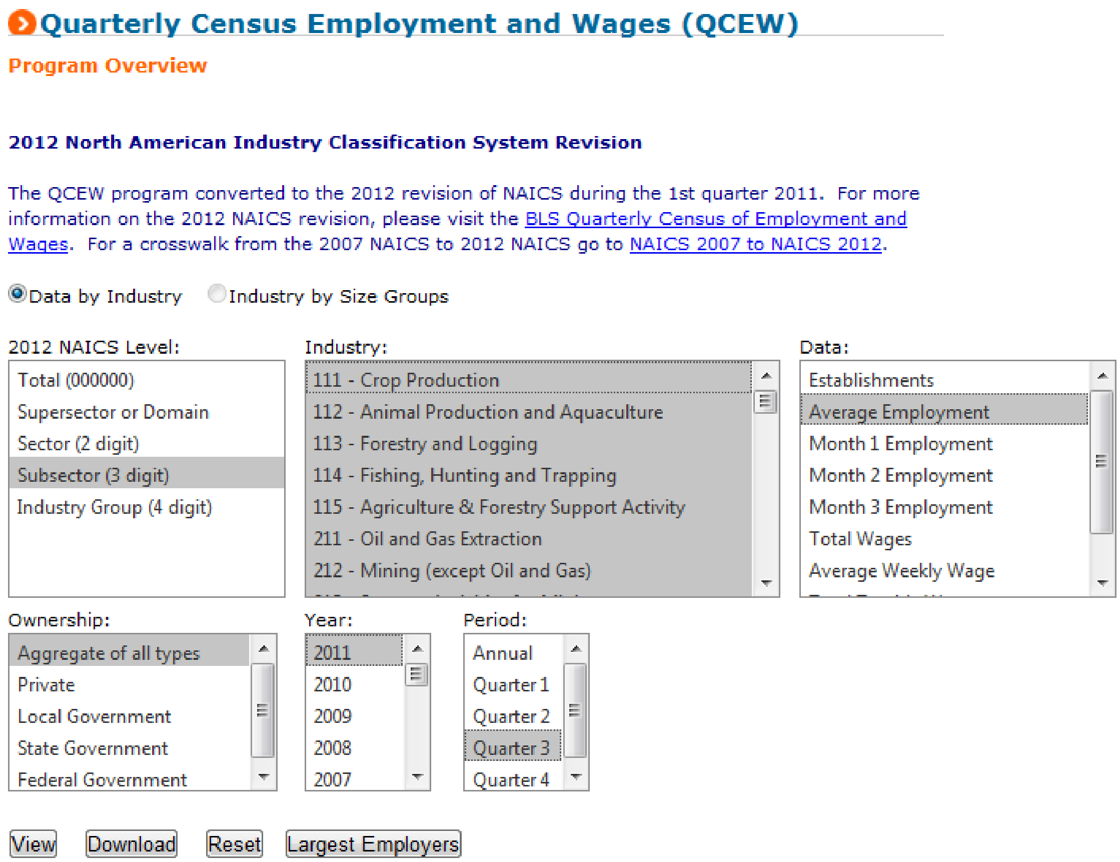
5. Compare Employment Security Data (ESC) to INFOUSA as a check

a. Use ESC data to compare top employers. Click appropriate year and Period for your model base year data http://esesc23.esc.state.nc.us/d4/QCEWLargestEmployers.aspx



b. Use ESC data to look at totals by NAICS grouping

http://esesc23.esc.state.nc.us/d4/QCEWSelection.aspx



a. From the websites select Subsector (3 Digit) in the NAICS level Section
b. Select all industries by holding down the shift key and selecting all industries in the drop down box of the Industry Section
c. Select Average Employment in the Data Section
d. Select Aggregate all types in the Ownership Section
e. Select the appropriate Year and Period

Step 6: Land Use Data Validation

A critical step in the development of land use and demographic data is a review and validation of the data. This process starts with a simple inspection of the data through thematic mapping. Two important land use variables to review are household size and population density. A visual reasonableness check of these variables can often highlight anomalies such as zero population but non-zero households or zero households but non-zero population. A review of density plots can also provide a visual check of reasonable expectation based on knowledge of the study area.

1. Review Employment by Category
2. Review Persons per Household for reasonableness
3. Review Vehicles per Household for reasonableness
4. Review Population to Employment Ratio
5. Review Population Density for Reasonableness
6. Review Employment Density for Reasonableness

2.4 Transportation networks

The transportation network represents the supply side of the system. It is important that the geographic file upon which the transportation network is based be properly coded to accurately capture traffic flow and that a connectivity check has been performed on the line geography. These procedures assume a basic working knowledge of TransCAD and therefore do not cover the details of geographic line file editing. As such many of the steps may lack a certain level of detail considering the working knowledge of the user.

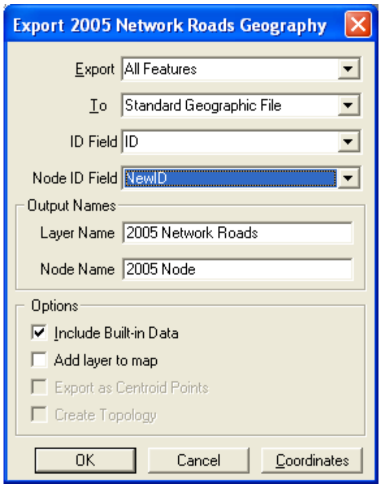
Step 1: Regional Geographic Line File

1. Obtain a streets GIS geographic line layer from one of the following sources: NCDOT S:\Shared\GIS Data\NC GIS Statewide Data\Latest GIS Data\dotData\dotroads.shp, regional or local GIS/planning agency, Census bureau TIGER/Line files, NCDOT GIS Unit or use the NCSTM as a starting point
2. Use the previously developed planning area geography to "clip" or extract from the regional streets layer a new streets layer for the study area only.
3. Apply the following criteria to select from the universe of roadway links only the roadways that will be modeled.
    a. All federally functionally classified facilities collector and above.
    b. Locally classified or unclassified roadways required to provide a reasonable representation of travel patterns and to allow for connectivity.
    c. All facilities that carry a significant level of traffic between TAZs
    d. The network and zone system should be compatible with one another in both scale and coverage. As such, the selection of the modeled roadways should be done iteratively with the selection/development of the TAZ layer to assure compatibility between the two.
4. Edit the line layer to remove all non-modeled roadways.
5. Use the TransCAD line editing tools to check line layer connectivity, build interchanges, set one-way segments, and otherwise edit the line layer such that it represents a close approximation of the highway system for modeling.

Step 2: Build Internal Zone Centroid Connectors and External Station Connectors

1. Prepare Node layer for editing
    a. With the node layer as the active layer **Dataview – Modify Table – Add** the following fields
        - TAZ_ID (Integer)
        - Type (Integer); Field Description: 1=internal, 2=external, "null"=other
    b. After the centroid connector is added to the line layer (see criteria below), make the node layer the active layer and update the TAZ_ID to add the TAZ number or External Station number as appropriate and the Type field to indicate where the node represents an internal centroid or an external station

2. Use the TransCAD line editing tools and the following criteria to build centroid connectors for every internal TAZ.
    a. Utilize available mapping, aerial photography, and knowledge of the area to place the centroid node at the center of activity within each TAZ
    b. Connect the centroid node to multiple points on the network using centroid connector links. These connectors should reflect as closely as possible the available paths of travel from the TAZ to the roadway system being modeled.
    c. While using a single centroid connector is discouraged, for some zones this may be suitable. The decision on whether to use one or more centroid connectors should be based on the underlying roadway system and an assessment of how traffic should load to the network.
    d. Centroid connector should not connect directly to an intersection, but rather should connect at the mid block area, or at a location along the highway link most closely reflecting the true underlying access from the zone to the roadway system. When possible utilize an existing node rather than creating a new node unless the new node is needed to best reflect true access.
    e. Centroid connectors should not be linked directly to access controlled facilities such as freeways.
    f. Only one centroid connector should connect a centroid to the network link between any two intersection nodes.
    g. If a zone is bounded by a barrier, such as a river with no access, or a railroad with no crossing, a centroid connector should not be coded.
3. Use the TransCAD line editing tools and the following criteria to build connectors for external stations.
    a. Connector links are used to connect external stations, which define where trips enter and leave the study area, to the network.
    b. An external station connector link is coded for every modeled roadway that crosses the study area boundary.
    c. The external station connector link is simply a short connector link extending outward from where the roadway intersects the study area boundary and effectively ends. The connector link attributes are similar to those for a centroid connector.
4. Set centroid node numbers equal to the internal TAZ number and the external station numbers equal to the “external TAZ” number.
    a. With the node layer as the active layer **Dataview – Modify Table – Add Field** – NewID
    b. For all centroid nodes fill this field with the TAZ_ID
    c. For all non-centroid nodes fill this field with a Sequence starting at some high number, like 5000 and stepping by 1
    d. Now export the geographic line file to a new standard geographic line file with the NewID as the ID for the node layer: **Tools – Export** – Fill in the Dialog Box



5. The final geographic line layer should now:
    a. reflect the system of roadways to be modeled
    b. contain a centroid node for each TAZ with centroid connectors to the modeled roadway representing how traffic from the TAZ will access the modeled roadway system
    c. contain external station nodes for each external station and connector links from the external station node to the roadway crossing the study area boundary
    d. be free of coding errors with respect to unconnected links, direction of flow, and illogical paths based on link distances

Step 3: Build Link Attribute Table and Populate with Data

NOTE: Automated tool in SAM GUI to do these in practice

1. With the new roadway layer as the working layer select Dataview – Modify Table and if not already present, add the following data fields to the data table.
    a. Posted Speed (Real, 8 bytes) **TIP:** Value is set to real to avoid formula conflict when calculating the travel time.
    b. Facility Type (Character, 24)
    c. FACTYPE_CD (Integer, 4 bytes)
    d. Area Type (Character, 5) **TIP:** Only if this applies, see guidelines Section 2.6.7.
    e. DIVIDED_CD (Integer, 4 bytes)
    f. AB Lanes (Integer, 4 bytes)
    g. BA Lanes (Integer, 4 bytes)
    h. HOV (Integer, 2 bytes) **TIP:** Only if this applies, see guidelines Section 2.6.7.
    i. Toll (Integer, 2 bytes) **TIP:** Only if this applies, see guidelines Section 2.6.7.
    j. Functional Class (Character, 24) **TIP:** Optional Character Field
    k. FUNCL_CD (Integer, 2 bytes) **TRAP:** Integer Field Required
    l. AB_CAPPHPL (Integer, 4 bytes)
    m. BA_CAPPHPL (Integer, 4 bytes)
    n. AB_AMCAP (Integer, 4 bytes)
    o. BA_AMCAP (Integer, 4 bytes)
    p. AB_MDCAP (Integer, 4 bytes)
    q. BA_MDCAP (Integer, 4 bytes)
    r. AB_PMCAP (Integer, 4 bytes)
    s. BA_PMCAP (Integer, 4 bytes)

t. AB_OPCAP (Integer, 4 bytes)
u. BA_OPCAP (Integer, 4 bytes)
v. AB Initial Time (Real, 8 bytes)
w. BA Initial Time (Real, 8 bytes)
x. AB HBWGC (Real, 8 bytes)
y. BA HBWGC (Real, 8 bytes)
z. AB HBOGC (Real, 8 bytes)
aa. BA HBOGC (Real, 8 bytes)
bb. AB NHBGC (Real, 8 bytes)
cc. BA NHBGC (Real, 8 bytes)
dd. Alpha (Integer, 2 bytes)
ee. AB Count (Integer, 4 bytes)
ff. BA Count (Integer, 4 bytes)
gg. DailyCount (Integer, 4 bytes)
hh. Screenline (Integer, 4 bytes)

2. Fill the following fields with data from a field survey or secondary data source:
    a. Posted Speed (Set speed for centroid connectors to 25)
    b. Facility Type and Codes (See Table 7) **TIP:** Fill the FACTYPE_CD field first and then use queries and formulas to fill in the Facility Type name. This will save time and reduce user error.

Table 7 Values for Facility Type (NOTE: Urban Arterial values are entered as capital "I")

Facility Type	FACTYPE_CD	Definition
Freeway	1	Roads with uninterrupted flow and fully restricted access including interstate facilities, freeways, and expressways.
Multi-lane Highway	2	Partial access control two-way facility. No traffic signals or with traffic signals spaced at least 2 miles apart. Directional traffic is divided or with a continuous turn lane.
Two-lane Highway	3	Rural, undivided, two-way highways. Intercity or commuting route serving longer trips in rural areas.
Urban Arterial I	4	Principal arterials of high speed design
Urban Arterial II	5	Most suburban designs, and intermediate designs for principal arterials.
Urban Arterial III	6	Generally urban design for principal arterials, intermediate design for minors
Urban Arterial IV	7	Minor arterials of intermediate or urban design
Collector	8	Urban suburban locations with lower speeds than arterials. Can be rural roadways with low free-flow speed or frequent interruptions.
Local Road	9	Coded to provide connectivity. Low speed collectors
Diamond Ramp	10	
Loop Ramp	11	
Freeway to Freeway Ramp	13	
Centroid Connector	12	

c. Divided and DIVIDED_CD (See Table 8) **TIP:** Fill the DIVIDED_CD field first and then use queries and formulas to fill in the divided name. This will save time and reduce user error.

Table 8 Values for Divided

Type	DIVIDED_CD	Definition
Undivided	1	Undivided roadway and centroid connectors
Divided	2	Divided roadway
CLTL	3	Continuous Left Turn Lane

d. AB Lanes and BA Lanes (Fill with number of lanes in AB direction and number of lanes in BA direction. **TIP:** Set number of lanes per direction for centroid connectors to 1)
e. HOV (Fill with 0/1 to indicate the facility is/is not an HOV facility)
f. Toll (Fill with 0/1 to indicate the facility is/is not a Toll facility)
g. Functional Class and FUNCL_CD (See Table 9). **TIP:** Fill the FUNCL_CD field first and then use queries and formulas to fill in the Functional Class name. This will save time and reduce user error.

Table 9 Values for Functional Classification

Classification Functional	FUNCL_CD
Urban Principal Arterial - Interstate	10
Urban Principal Arterial - Freeway/Expressway	11
Urban Principal Arterial - Other	12
Urban Minor Arterial	13
Urban Collector	14
Urban Local / Urban Centroid Connectors	15
Rural Principal Arterial - Interstate	20
Rural Principal Arterial - Other	21
Rural Minor Arterial	22
Rural Major Collector	23
Rural Minor Collector	24
Rural Local / Rural Centroid Connectors	25
Not Classified	99

3. Calculate Initial Time field using the selection set criteria and formulas show below. This is done for AB direction and the BA direction separately. The formulas are described in Table 10.
    a. Open the Network Roads Dataview
    b. **Selection – Select by Condition** (this is for the AB direction)
        i. ((FACTYPE_CD=1) or (FACTYPE_CD=2 and DIVIDED_CD=2) or (FACTYPE_CD=3 and DIVIDED_CD=2)) and (DIR=0 or DIR=1)
    c. Set Name = Case 1 AB
    d. CLICK OK

e. For selection set Case 1 AB ONLY – **Fill – AB Initial Time** – Formula (use formula from Table 10 for high level facilities) **TIP:** Screen shots below demonstrate the process of Case 1 AB

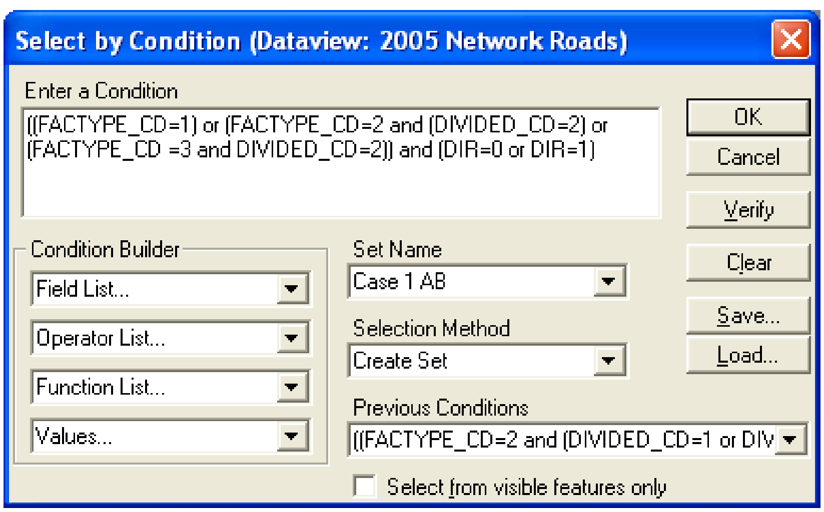
f. **Selection – Select by Condition** (this is for the BA direction)
   i. ((FACTYPE_CD=1) or (FACTYPE_CD=2 and DIVIDED_CD=2) or (FACTYPE_CD=3 and DIVIDED_CD=2)) and (DIR=0 or DIR= -1)

g. Set Name = Case 1 BA

h. CLICK OK

i. For selection set Case 1 BA ONLY – **Fill – BA Initial Time** – Formula (use formula from Table 10 for high level facilities)

j. Repeat steps b through f for CASE 2 and CASE 3
   i. CASE 2 AB Query: ((FACTYPE_CD=2 and (DIVIDED_CD=1 or DIVIDED_CD=3)) or (FACTYPE_CD=3 and (DIVIDED_CD=1 or DIVIDED_CD=3)) or (FACTYPE_CD between 4 and 7)) and (DIR=0 or DIR=1)
   ii. CASE 2 BA Query: ((FACTYPE_CD=2 and (DIVIDED_CD=1 or DIVIDED_CD=3)) or (FACTYPE_CD=3 and (DIVIDED_CD=1 or DIVIDED_CD=3)) or (FACTYPE_CD between 4 and 7)) and (DIR=0 or DIR= -1)
   iii. CASE 3 AB Query: (FACTYPE_CD=12 or FACTYPE_CD=8 or FACTYPE_CD=10 or FACTYPE_CD=11 or FACTYPE_CD=9 or FACTYPE_CD=13) and (DIR=0 or DIR=1)
   iv. CASE 3 BA Query: (FACTYPE_CD=12 or FACTYPE_CD=8 or FACTYPE_CD=10 or FACTYPE_CD=11 or FACTYPE_CD=9 or FACTYPE_CD=13) and (DIR=0 or DIR= -1)



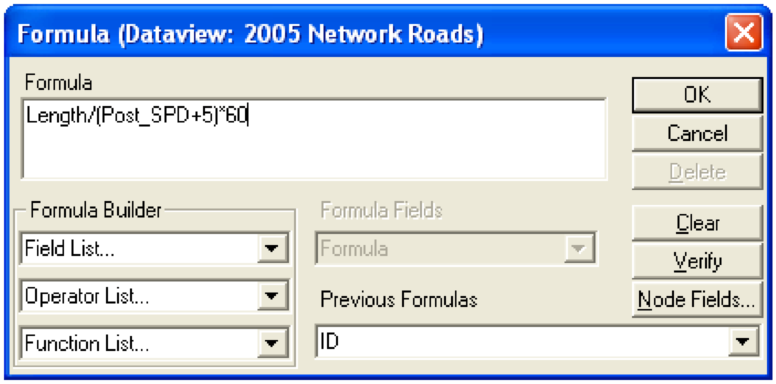


Table 10 Initial Link Travel Time Calculation Criteria

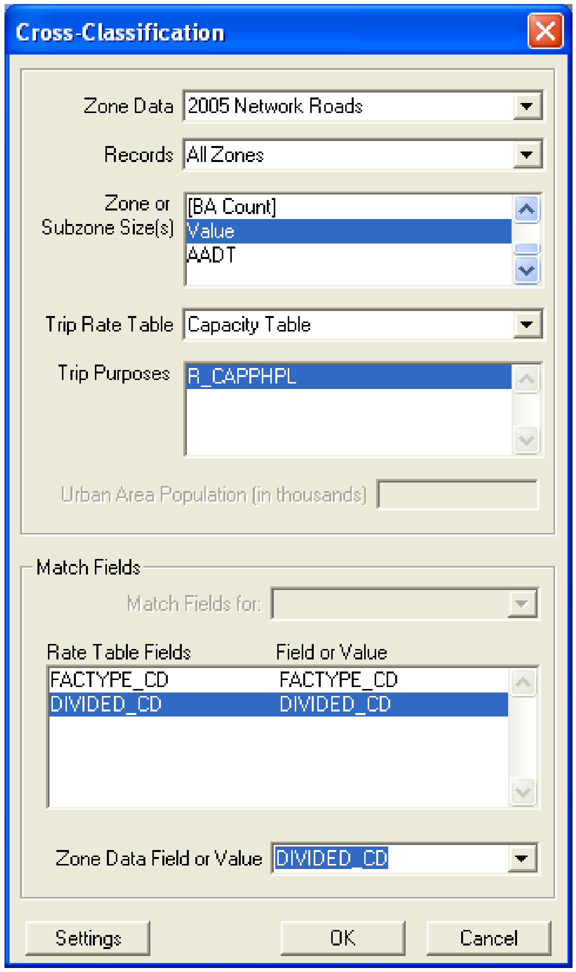
Description	Selection Set	Formula
CASE1: Higher level highways	Where Facility Type = "Freeway" or ((Facility Type = "Multi-lane Highway" or Facility Type = "Two-lane Highway") and Divided = "Divided")	Initial Travel Time = Length/(Posted Speed + 5.0)*60
CASE2: Lower level highways and arterials	((Where Facility Type = "Multi-lane Highway" or Facility Type = "Two-lane Highway") and Divided = "Undivided" or Divided = “CLTL”) or Facility Type contains "Urban Arterial"	Initial Travel Time = Length/(Posted Speed - 5.0)*60
CASE3: Local roads, collectors, ramps and other links	Where Facility Type= "Centroid Connector" or Facility Type= "Collector" or Facility Type= "Diamond Ramp" or Facility Type= "Loop Ramp" or Facility Type= "Local Road" or Facility Type= "Freeway to Freeway Ramp"	Initial Travel Time = Length/Posted Speed*60

4. Create Capacity Lookup Table
    a. Use the NCLOS Tool to estimate an hourly capacity value for each of the unique combinations of facility type/divided/area type (if area type is used) in the line database.
    b. Create a BIN file [PARAMETERS\CAPACITY.BIN] and add the following fields:
        i. FACTYPE_CD (Integer, 4 bytes)
        ii. DIVIDED_CD (Integer, 4 bytes)
        iii. R_CAPPHPL (Integer, 4 bytes)
    c. Populate the data fields with the unique combinations that reflect the roadway facilities in your geographic line file. An example from the Sanford Case Study is provided below. **TRAP:** There must be a capacity value for each unique combination of values for the facility type, divided, and area type (if used) otherwise there will be links without a capacity value. **TIP:** As shown in the example table below there MUST be a data value for centroid connectors.

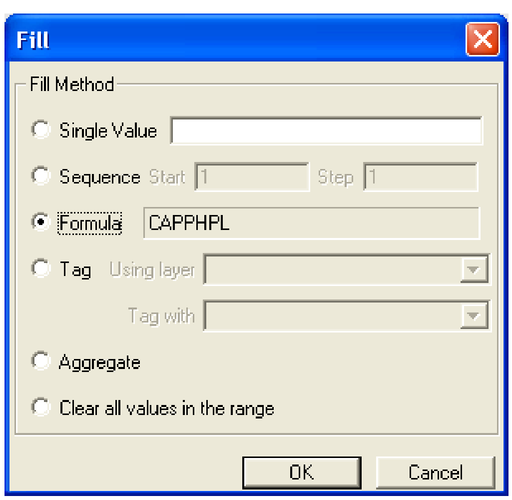
Table 11 Sanford Capacity Lookup Table

FACTYPE_CD	DIVIDED_CD	R_CAPPHPL
1	2	2,100
2	1	1,400
2	2	1,700
3	1	1,000
3	2	1,200
4	1	1,400
4	2	1,500
5	1	1,200
5	2	1,300
6	1	1,100
6	2	1,200
7	1	1,000
7	2	1,100
8	1	600
8	2	600
9	1	600
9	2	600
10	1	1,500
11	2	1,000
12	2	9,999
13	1	2,100

5. Populate the Capacity data field in the roadway layer with values from the Capacity Lookup Table
    a. With Network Roads as the active layer: **Dataview – Modify Table – Add Field** – Value (Integer, 4 bytes) – CLICK OK
    b. Highlight the new field Value – **Edit – Fill – Single Value(=1)** – CLICK OK
    c. If not already open, open the Capacity Lookup Table [PARAMETERS\CAPACITY.BIN]
    d. Next the Cross Classification Procedure will be used to update the Capacity field in the Network Roads Dataview
    e. Planning – Trip Productions – Cross Classification
    f. Populate the fields in the dialog box as shown below:



g. This will create a Joined View – use this joined view to fill the AB Capacity and BA Capacity Fields with the per hour per lane capacity values from the lookup table:
   i. **For AB Direction:** Create a selection set for DIR=0 or DIR=1 and fill AB Capacity field with CAPPHPL
   ii. **For BA Direction:** Create a selection set for DIR=0 or DIR= -1 and fill BA Capacity field with CAPPHPL



h. Drop the Joined View

6. Populate the Alpha field with values from Table 12 or [PARAMETERS\ALPHA.BIN]

Table 12 Alpha Values for Conical Delay Function

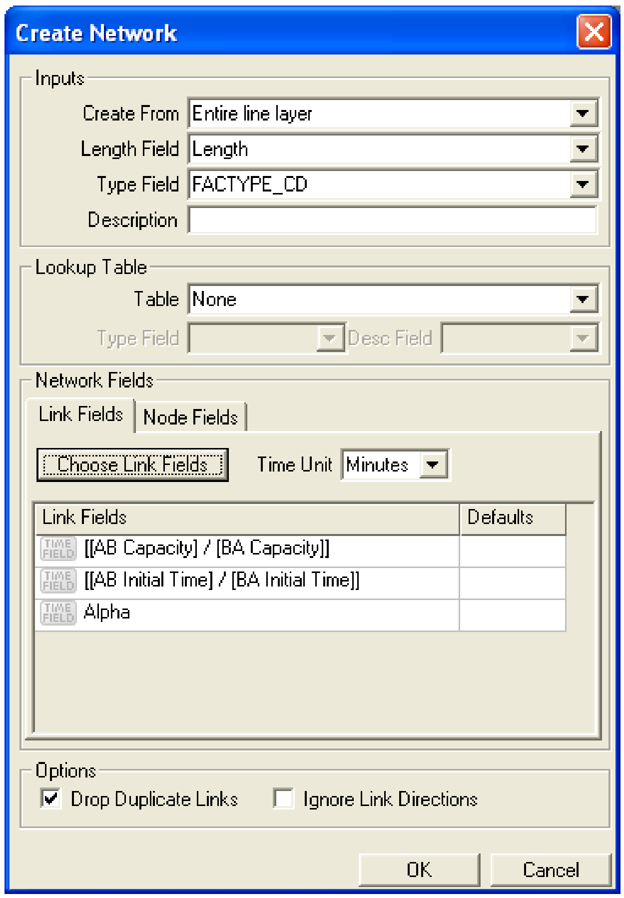
Facility Type	Alpha
Freeway	10
Multi-Lane Highway	8
Two-lane Highway	6
Urban Arterial I	6
Urban Arterial II	6
Urban Arterial III	6
Urban Arterial IV	6
Collector	4
Local Road	4
Diamond Ramp	8
Loop Ramp	8
Freeway to Freeway Ramp	8
Centroid Connector	NA

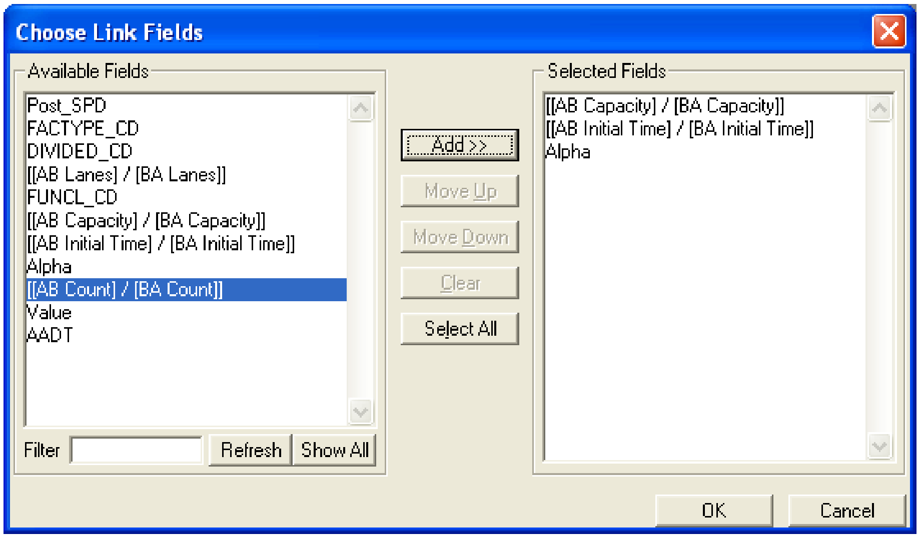
Step 4: Perform Quality Control Checks

1. Color coded plots, with varying degrees of detail, of the following network attributes should be produced and reviewed:
   a. Facility type,
   b. Functional class,
   c. Number of lanes,
   d. Posted speed,
   e. Capacity,
   f. Direction of Flow, and
   g. Initial Time.
2. Run queries to check all two way links to ensure that data values like number of lanes are symmetric
3. **TRAP:** A very important validation check to perform it to review the link direction field with respect to topology (direction in which link was digitized), flow, and the coding of attribute data. The DIR field is a standard field in a TransCAD line layer and is used to represent one-way links. If the flow on a one-way link is in the same direction as the topology, then the DIR field has a value of 1 and link attributes are coded in the AB direction. If the flow on a one-way link is opposite to the link topology, then the DIR field has a value of -1 and the link attributes are coded in the BA direction. Perform the following checks to be sure that AB and BA fields are coded properly.
   a. Create a selection set for DIR=1 and verify that all link attributes are coded in the AB direction

b. Create a selection set for DIR= -1 and verify that all link attributes are coded in the BA direction
c. Create a selection set for DIR=0 and verify that all link attributes are coded in both the AB and BA directions

4. Use the TransCAD Shortest Path Tool to check travel time paths for reasonableness.
   a. **Network/Paths – Create**
   b. CLICK OK
   c. **Save As** – TestNetwork
   d. **Networks/Paths – Shortest Path** – [AB Initial Time]/[BA Initial Time]
   e. Use tool to select origin point and destination point and review results for reasonableness. Repeat this exercise for multiple origins and destinations to confirm that network paths are logical.





i.

2.5 Counts

Traffic count data is essential for model validation. This data is used as a comparison against the model estimated roadway volumes to see how well the highway assignment matches observed conditions.

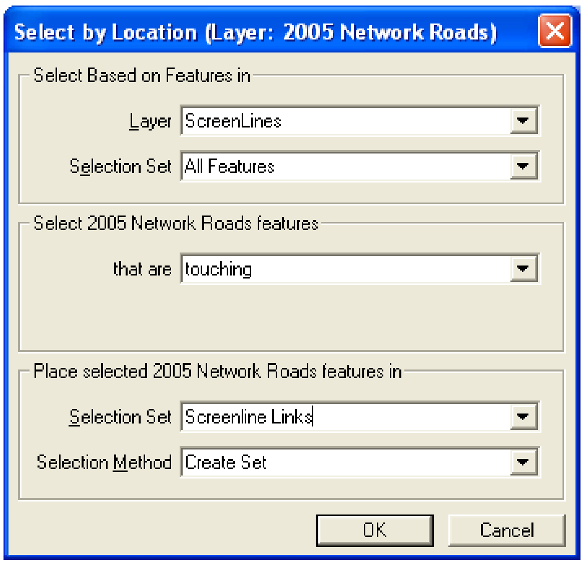
Step 1: Identify Screenlines, Cutlines, and Cordons

1. If not already open, open the highway network geographic line file [**\INPUT\BY_HIGHWAY.DBD]
2. Apply the following criteria to determine the location of the screenlines, and if desired, cutlines:
    a. Screenlines typically run north south and east west from one end of the study area to the other end of the study area
    b. When possible, screenlines should be associated with geographic features such as rivers or railroads in order to minimize the number of roadway crossings
    c. Care should be taken to lay out the screenline in such a way that the true directional flow is captured
    d. Back tracking and crossing the same roadway twice should be avoided.
    e. Passing a screenline through the downtown or central business district (CBD) should be avoided (even if a railroad goes through the center of town)
    f. Cutlines are very similar to screenlines except that they typically do not run form one edge of the study area to another, but are most often used as an effective means of evaluating flows along a particular axis or corridor
3. Apply the following criteria to create an external cordon and any internal cordons desired
    a. The external cordon is the imaginary line that encompasses the study area; this should closely follow the study area boundary.
    b. Internal cordons should be located in such a way as to “cordon off” unique areas within the study area. Good examples include: CBD, college campuses, unique land use districts, or small communities within a multi-community region.
4. Create a new line layer for the Screenlines, Cutlines, and Cordon
    a. **File – New – Geographic File – Line Geographic File** – [SUPPORT_FILES\SCREENLINES.DBD] – add layer to the current map window
    b. Add a field for Screenline (Integer, 4 bytes)

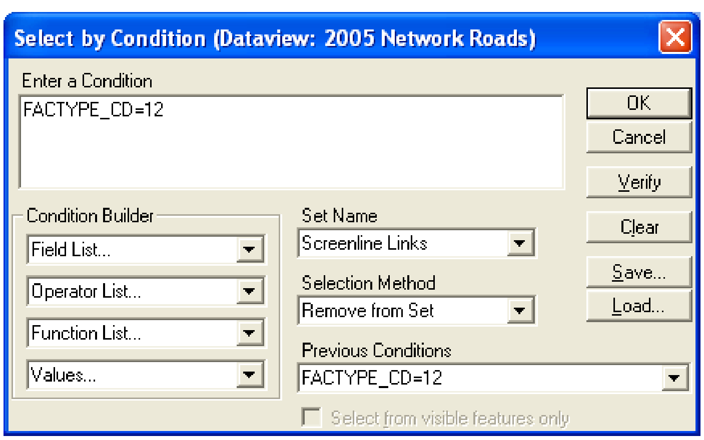
5. Use the TransCAD editing tools to draw the screenlines, cutlines, and cordons giving each a unique ID

Step 2: Update Highway Line Layer with Screenline Layer

1. Create a selection set of all links that intersect a screenline, cutline, or cordon
    - **a.** With the Highway Line Layer as the active layer – **Selection – Select by Location**
    - b. Select Based on Features in Screenlines using All Features
    - c. Select Network Roads that are touching
    - d. Place into a new selection set called Screenline Links

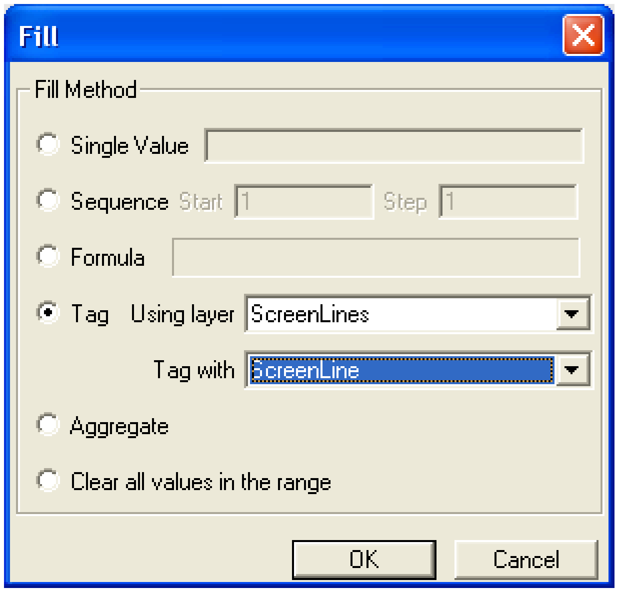


2. Remove all Centroid Connectors from the selection set Screenline Links
    - a. **Selection – Select by Condition** – FACTYPE_CD = 12
    - b. Set Name: Screenline Links
    - c. Selection Method: Remove from Set



3. Open the Dataview associated with the highway line layer

4. Show the records for the Screenline Links selection set only
5. Highlight the field [Screenline] – **Edit – Fill – Tag** – Using Layer Screenlines – Tag with Screenline
6. Close Dataview



Step 3: Locate Counts along Screenlines and Cutlines

1. Create a new point layer for traffic counts
    a. **File – New – Geographic File – Point Geographic File** – [SUPPORT_FILES*_COUNTS.DBD] – add layer to the current map window
    b. Add fields:
        i. Count ID (Integer, 4 bytes)
        ii. Type (Character, 16)
        iii. Route (Character, 24)
        iv. Reference (Character, 36)
        v. Duration (Character, 8)
        vi. Directional (Character, 4)
2. Use the TransCAD editing tools to add a count location at the screenline crossing for every roadway that crosses a screenline or cutline. **TIP:** Here it is helpful to have a street centerline file open as you will want to request traffic counts for all roadways crossing the screenline, not just the modeled roadways crossing the screenline.
3. Populate the data attributes:
    a. Count ID – this should be a unique ID for each count
    b. Type – Daily, Hourly, Class (consider requesting either an hourly or classification count for all US routes and above that cross a screenline)
    c. Route – enter the route name (often both the SR number and the local street name are helpful)
    d. Reference – enter a clear description that will assist the field crew in properly locating your count in the field. For example: North of Baker Road.
    e. Duration – most often this is entered as 48-HR
    f. Directional – indicate whether or not you want a directional count or a two-way count, relevant primarily for divided facilities

Step 4: Locate Counts along the Cordon

1. Use the TransCAD editing tools to add a count location for all roadways crossing the external cordon and any internal cordons.
2. Populate the data attributes:
    a. Count ID – this should be a unique ID for each count
    b. Type – Daily, Hourly, Class (consider requesting either an hourly or classification count for all US routes and above that cross a screenline)
    c. Route – enter the route name (often both the SR number and the local street name are helpful)
    d. Reference – enter a clear description that will assist the field crew in properly locating your count in the field. For example: North of Baker Road.
    e. Duration – most often this is entered as 48-HR
    f. Directional – indicate whether or not you want a directional count or a two-way count, relevant primarily for divided facilities

Step 5: Locate Coverage Counts

1. Use the TransCAD editing tools to add coverage counts such that a good geographic distribution of counts is reflected.
2. Populate the data attributes:
    a. Count ID – this should be a unique ID for each count
    b. Type – Daily, Hourly, Class (consider requesting either an hourly or classification count for all US routes and above that cross a screenline)
    c. Route – enter the route name (often both the SR number and the local street name are helpful)
    d. Reference – enter a clear description that will assist the field crew in properly locating your count in the field. For example: North of Baker Road.
    e. Duration – most often this is entered as 48-HR
    f. Directional – indicate whether or not you want a directional count or a two-way count, relevant primarily for divided facilities

Step 6: Review Count Locations

1. Once all counts have been located, the count file should either be plotted out or mapped on the screen so that a visual check can assure that there is adequate geographic coverage and that no key locations have been missed.

Step 7: Tabulate Count Request and Submit to Traffic Surveys

1. Print or export the data table for the traffic count file; this along with the appropriate mapping will be submitted to the Traffic Surveys Unit.
2. **TIP**: Request that the Traffic Surveys Unit perform all of the factoring and adjustment before providing you with the final count data. Traffic Survey staff are the most qualified to do this work and it will assure consistency with the factoring. **TRAP:** This will, however, require more time and should be figured into the time frame for when the request is submitted and when the final data is required.

Step 8: Update Highway Data Attributes with Count Data

1. Populate the fields Count AB and Count BA with the new traffic count data. It is common to simply divide the 2-way count in half to get the AB and BA direction. If a directional count was requested then the directional values should be added to the appropriate direction, either AB or BA.

Step 9: Validate Count Data

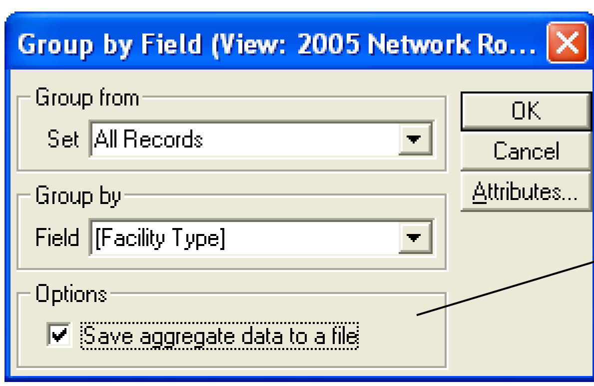
1. Plot or map the count data on the highway network and visually inspect the data to identify count locations that appear inconsistent with other nearby count locations.
2. Review and compare current count data against historic count data (where available) to confirm that growth trends are logical.
3. Create a thematic map showing a count to highway capacity ratio in order to identify counts with very high or very low count to capacity ratio. These locations should be further investigated for reasonableness.

2.6 Reasonableness Checking and Validation

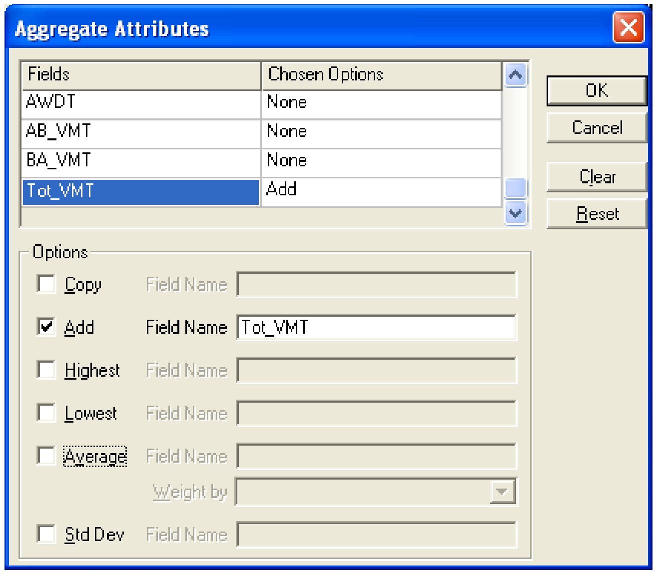
Throughout the model development process, the output from the various steps are reviewed and compared either to observed data from the study area or to secondary sources of data as a means of checking the reasonableness of the model outputs. This section covers various data used for reasonableness checking and model validation that is performed later. However, it is prepared in this section since you are working with the data presently.

Step 1: Vehicle Miles Traveled

1. Use traffic count links to create VMT summaries by facility type
    a. Open Dataview for network roads
    b. Modify Dataview to add the following fields:
        i. AB_VMT (Integer)
        ii. BA_VMT (Integer)
        iii. Tot_VMT (Integer)
    c. Show Dataview fields: Length, Facility Type, AB Count, BA Count, AB_VMT, BA_VMT, Tot_VMT
    d. Fill AB_VMT and BA_VMT with a value of zero
    e. Create a selection set where AB Count <> null
    f. Fill AB_VMT with the formula AB_VMT = length*AB Count
    g. Create a selection set where BA Count <> null
    h. Fill BA_VMT with the formula BA_VMT = length*BA Count
    i. For “All Records” Fill Tot_VMT with the formula AB_VMT + BA_VMT
    j. **Dataview – Group By – Facility Type** – Add Tot_VMT – all other fields are set to None – CLICK OK



Data can be saved to a file



k. Use this data to create a table summarizing the Tot_VMT based on the Count data to be used for later validation comparisons

Table 13 Example Table for VMT

Facility Type	Count VMT
Freeway	171,418
Multilane Highway	222,517
Urban Arterial I	37,129
Urban Arterial II	46,056
Urban Arterial III	24,641
Urban Arterial IV	86,733
Two-lane Highway	28,344
Collector	26,684

2. Another approach is to use the NHTS data as summarized in Step 4 below.

Step 2: Highway Speeds

1. If speed data for the study area exists, use this data to create a table of average speeds by facility type to use for model validation. As shown in Table 14. If data is not available you should perform your own travel time study by driving the key corridors several times during the day. Include peak periods in your study to assure you get the correct speeds.

Table 14 Example Table for Average Speed

<table>
<tr><th>Facility Type</th><th>Average Speed</th></tr>
<tr><td>Freeway</td><td rowspan="8">Populate with observed average speed data by facility type using the “Group By” feature described in Step 1</td></tr>
<tr><td>Multilane Highway</td></tr>
<tr><td>Urban Arterial I</td></tr>
<tr><td>Urban Arterial II</td></tr>
<tr><td>Urban Arterial III</td></tr>
<tr><td>Urban Arterial IV</td></tr>
<tr><td>Two-lane Highway</td></tr>
<tr><td>Collector</td></tr>
</table>

Step 3: Trip Length Data

In Section 2.3, Step 3, the process for extracting census data was covered. In that step the focus was on the tabulation of workers per household and vehicles per household. This step utilizes additional data fields (P1022_0102 through P1022_0116) to develop a profile of travel time to work by all workers in the study area.

1. Open the BIN file with the Tract data [SUPPORT_FILES*_TRACT.BIN]
2. Select the fields of interest
    a. **Dataview – Fields – Clear** – Add fields shown in table below:

Table 15 Tract Data Fields for Reporting Trip Length

Field	Description
P1022_0102	Less than 5 minutes
P1022_0103	5 to 9 minutes
P1022_0104	10 to 14 minutes
P1022_0105	15 to 19 minutes
P1022_0106	20 to 24 minutes
P1022_0107	25 to 29 minutes
P1022_0108	30 to 34 minutes
P1022_0109	35 to 39 minutes
P1022_0110	40 to 44 minutes
P1022_0111	45 to 49 minutes
P1022_0112	50 to 54 minutes
P1022_0113	55 to 59 minutes
P1022_0114	60 to 74 minutes
P1022_0115	75 to 89 minutes
P1022_0116	90 or more minutes

3. Save as a DBF file
    a. **File – Save As** – File Name: “SUPPORT_FILES \TRAVELTIMES.DBF”
4. Close Tract BIN file
5. Open TRAVELTIMES.DBF file
6. Modify field names to be more descriptive
7. **Dataview - Statistics**
8. **Dataview – Fields – Clear – Add Field and Sum** - CLICK OK
9. Graph travel time distribution to get a sense of the travel time distribution for the study area

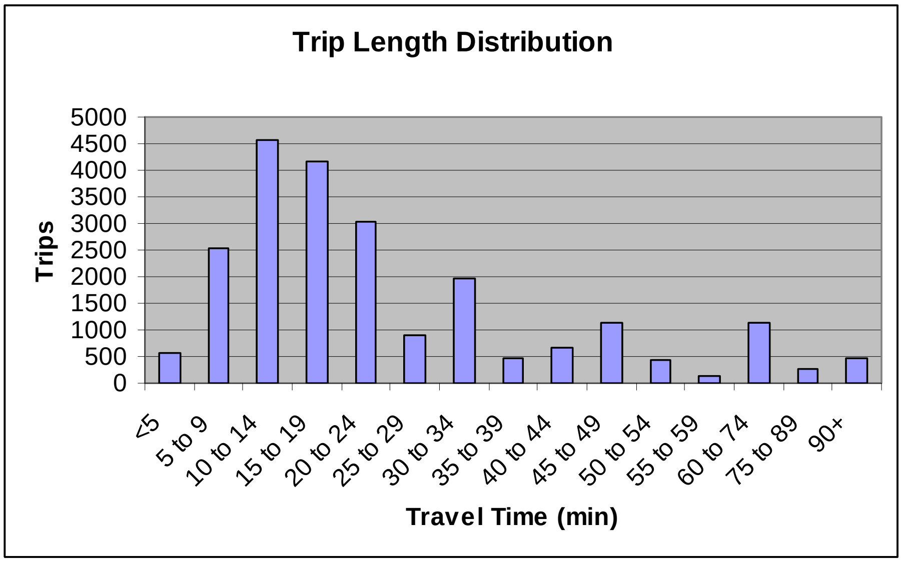


Figure 3 Example Trip Length Distribution Plot

TIP: The DBF file can also be opened in Excel to graph the data since Excel has better graphing capabilities than TransCAD.

3 Networks and Shortest Paths

3.1 Purpose

After the geographic line layer representing the transportation system and its attributes has been completed and error checked the next step is the creation of a network and shortest path matrices. The term network used in this context refers to the special data structure used by TransCAD to store important characteristics of the transportation system needed to evaluate the shortest path. The shortest path represents the route over the transportation network that has the lowest generalized cost, where cost can be a single factor or any combination of factors such as distance, time, or cost of travel.

Before creating a network in TransCAD there are certain calculations that must be performed to prepare the line layer to become a network and to create the shortest paths for the modeled area. Those are covered in Section 3.2 and Section 3.3 .

3.2 Calculate Generalized Cost

In addition, the trip distribution model uses a term called "generalized cost" value for the distribution of trips. The advantage of this approach is that distance is considered as part of the perceived cost of travel. Without the consideration of distance the model tends to be too sensitive to travel time variations. The generalized cost value must be calculated for each link in the highway network so that this value can be skimmed and used in the trip distribution step.

The generalized cost function is specified as follows:

$$\mathbf{C_{ij} = T_{ij} + a * D_{ij}}$$

Where:

C_{ij}	cost matrix
T_{ij}	travel time matrix
a	distance coefficient
D_{ij}	distance matrix
i	origin zone
j	destination zone

The distance coefficient "a" can be computed by assuming a value-of-time for each trip purpose based on widely accepted practice, and considering the perceived cost of driving in cents per mile. The formula to compute the coefficient "a" is specified as follows:

$$a = aoc / [p * wr / 60]$$

Where:

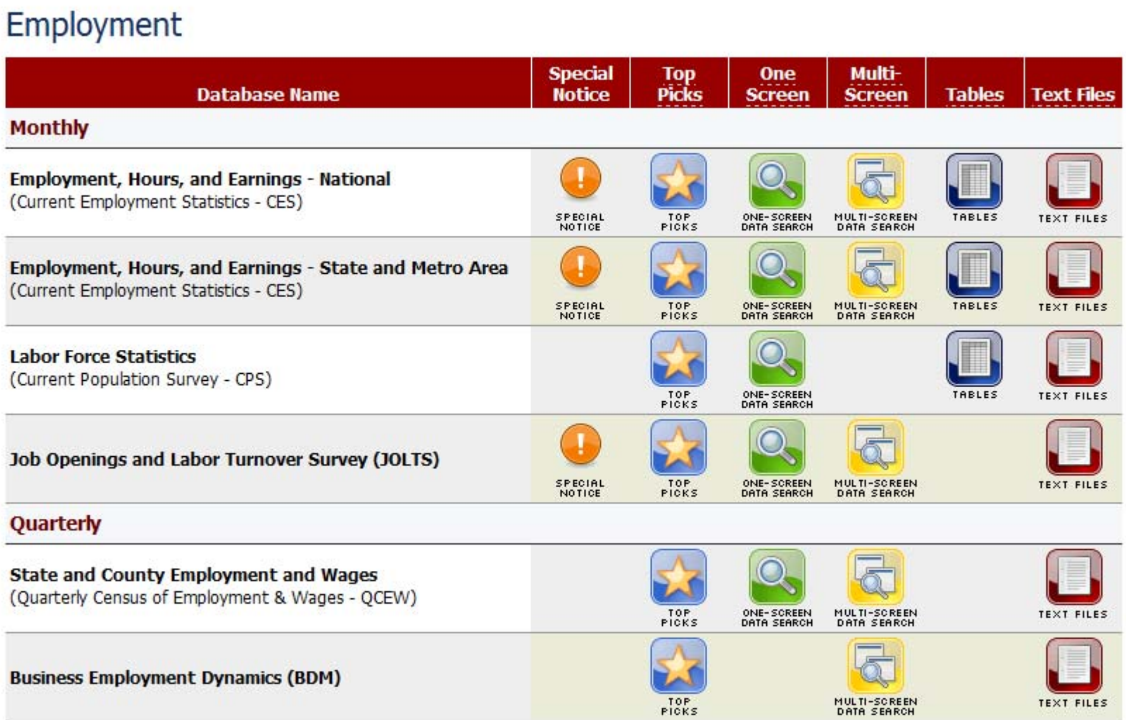
a distance coefficient,
aoc auto operating cost (dollars/mile) ($0.09 used in Sanford due to year of calibration *see Step 1 on the following page to get your operating cost),
p trip purpose factor (0.5 for HBW, 0.25 for HBO, 0.375 for NHB), and

wr average hourly wage rate.

Prior to building shortest paths the link value for the generalized cost must first be calculated.

Step 1: Calculate the Distance Coefficient

1. Access the website http://www.bls.gov/data/ or another data source to obtain the county hourly wage rate. If this site is used then the database tool to use is under Employment → Quarterly → State and County Employment and Wages (as shown below)



Employment

Database Name	Special Notice	Top Picks	One Screen	Multi-Screen	Tables	Text Files
Monthly						
Employment, Hours, and Earnings - National (Current Employment Statistics - CES)	SPECIAL NOTICE	TOP PICKS	ONE-SCREEN DATA SEARCH	MULTI-SCREEN DATA SEARCH	TABLES	TEXT FILES
Employment, Hours, and Earnings - State and Metro Area (Current Employment Statistics - CES)	SPECIAL NOTICE	TOP PICKS	ONE-SCREEN DATA SEARCH	MULTI-SCREEN DATA SEARCH	TABLES	TEXT FILES
Labor Force Statistics (Current Population Survey - CPS)		TOP PICKS	ONE-SCREEN DATA SEARCH		TABLES	TEXT FILES
Job Openings and Labor Turnover Survey (JOLTS)	SPECIAL NOTICE	TOP PICKS	ONE-SCREEN DATA SEARCH	MULTI-SCREEN DATA SEARCH		TEXT FILES
Quarterly						
State and County Employment and Wages (Quarterly Census of Employment & Wages - QCEW)		TOP PICKS	ONE-SCREEN DATA SEARCH	MULTI-SCREEN DATA SEARCH		TEXT FILES
Business Employment Dynamics (BDM)		TOP PICKS		MULTI-SCREEN DATA SEARCH		TEXT FILES

2. Or Access http://www.bls.gov/ro4/qcewnc.htm (Click on Table 2) and select the appropriate county.
3. Calculate average hourly wage right by dividing the weekly average rate by 40
4. Calculate the auto operating cost for your area using the following references:

   a. http://carolinas.aaa.com/media/Documents/NC%202011%20Driving%20Costs.pdf
   This one is specific to 2011 for NC and should be used as the first guide

   b. http://www.bts.gov/publications/national_transportation_statistics/

   NOTE: table 3-17 (Chapter 3 Section B)gives you an estimate by year that you can look at. Keep in mind it is only the variable cost or operating cost you are more concerned with. This only includes Gas, Maintenance and Tires in this table(approx $.18/mile)

5. For each trip purpose calculate the coefficient using the formula for the distance coefficient as defined above. A spreadsheet is useful for this task and can be used for documentation purposes.

Step 2: Calculate Link Generalized Cost

1. If not already open, open the geographic line file representing the transportation system to be modeled. [**\INPUT*_HIGHWAY.DBD].
2. Calculate the AB link generalized cost for each trip purpose using the generalized cost formula and update the link data record.
    a. **Selection – Select by Condition** – (DIR=0 or DIR=1)
    b. **Fill – AB HBWGC – Formula** - [AB Initial Time]+(a * Length) **NOTE:** "a" is the distance coefficient for HBW calculated in Step 1
    c. **Fill – AB HBOGC – Formula** - [AB Initial Time]+(a * Length) **NOTE:** "a" is the distance coefficient calculated for HBO in Step 1
    d. **Fill – AB NHBGC – Formula** - [AB Initial Time]+(a * Length) **NOTE:** "a" is the distance coefficient calculated for NHB in Step 1
3. Calculate the BA link generalized cost for each trip purpose using the generalized cost formula and update the link data record.
    a. **Selection – Select by Condition** – (DIR=0 or DIR= -1)
    b. **Fill – BA HBWGC – Formula** - [BA Initial Time]+(a * Length) **NOTE:** "a" is the distance coefficient for HBW calculated in Step 1
    c. **Fill – BA HBOGC – Formula** - [BA Initial Time]+(a * Length) **NOTE:** "a" is the distance coefficient calculated for HBO in Step 1
    d. **Fill – BA NHBGC – Formula** - [BA Initial Time]+(a * Length) **NOTE:** "a" is the distance coefficient calculated for NHB in Step 1

3.3 Calculate Values for Time Period Capacity

The North Carolina Combined Travel Survey Database was used to create peak hour factors for each of the four time periods evaluated. The survey data was processed to identify the number of weighted vehicle-trips per hour. The periods represent the morning and afternoon peaks (AM and PM) and the midday and off-peaks (MD and OP). For each period, the factor is calculated by first identifying the highest volume hour within the time period, then dividing that volume by the total vehicle-demand volume for the period. During the highway assignment step, and for each period assignment, the hourly link capacity is divided by this factor to represent an equivalent period capacity. Combined with the period demand, the assignment speeds and times are then representative of the peak hour conditions. Using this approach, the following peak hour factors were created:

Table 16 Peak Hour Factors for Small Areas

Period	Peak Hour Factor	Period Limits	Period Length
AM	0.40	6 AM – 10 AM	4 hours
MD	0.24	10 AM – 3 PM	5 hours
PM	0.29	3 PM – 7 PM	4 hours
OP	0.30	7 PM – 6 AM	11 hours

Table 17 Peak Hour Factors for Large Areas

Period	Peak Hour Factor	Period Limits	Period Length
AM	0.37	6 AM – 10 AM	4 hours
MD	0.23	10 AM – 3 PM	5 hours
PM	0.30	3 PM – 7 PM	4 hours
OP	0.35	7 PM – 6 AM	11 hours

Step 1: Update Highway Line Layer

2. Open [**\INPUT**_HIGHWAY.DBD]
3. Open the data table and populate the time period capacity fields with the following formulas: **TRAP:** These are the values for a small study area – the formulas will need to be updated accordingly if procedures are applied to a large area.
    a. For DIR=1 or DIR=0
        i. AB_AMCAP = (AB_CAPPHPL*AB LANES)/0.40
        ii. AB_MDCAP = (AB_CAPPHPL*AB LANES)/0.24
        iii. AB_PMCAP = (AB_CAPPHPL*AB LANES)/0.29
        iv. AB_OPCAP = (AB_CAPPHPL*AB LANES)/0.30
    b. For DIR=-1 or DIR=0
        i. BA_AMCAP = (BA_CAPPHPL*BA LANES)/0.40
        ii. BA_MDCAP = (BA_CAPPHPL*BA LANES)/0.24
        iii. BA_PMCAP = (BA_CAPPHPL*BA LANES)/0.29

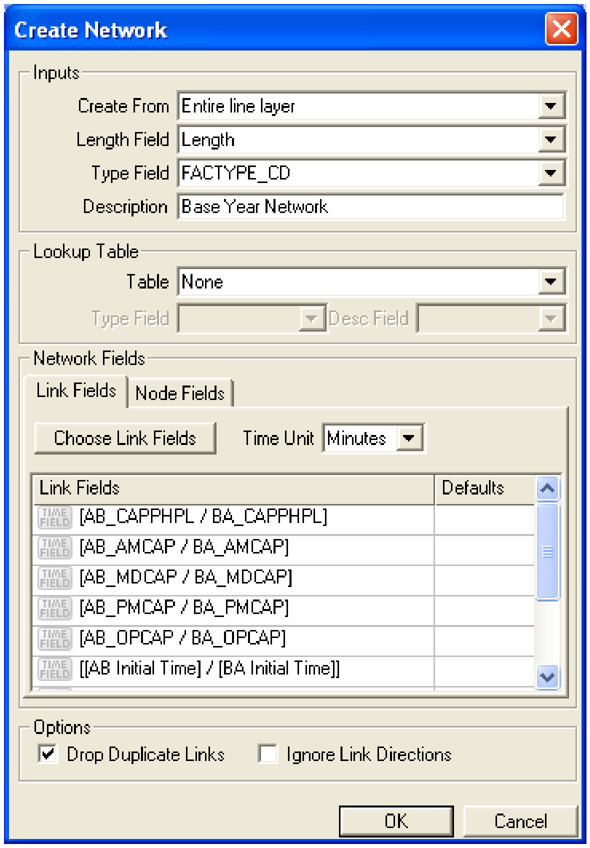
BA_OPCAP = (BA_CAPPHPL*BA LANES)/0.30

3.4 Create Network

A network is a representation of the existing or future transportation system and the related data attributes needed to build travel paths across the network. Transportation networks are used to create level-of-service matrices (skims) which are then used in trip distribution and mode choice (when present).

Step 1: Create Network

1. Make the geographic line file representing the transportation system to be modeled the active layer.
2. Network/Paths – Create – fill out the dialog box with elements needed to specify the network.
    a. NOTE: No node fields are specified in the standard modeling case.
    b. Choose link fields for:
        i. AB/BA CAPPHPL
        ii. AB/BA AMCAP
        iii. AB/BA MDCAP
        iv. AB/BA PMCAP
        v. AB/BA OPCAP
        vi. AB/BA Initial Time
        vii. AB/BA HBWGC
        viii. AB/BA HBOGC
        ix. AB/BA NHBGC
        x. Alpha

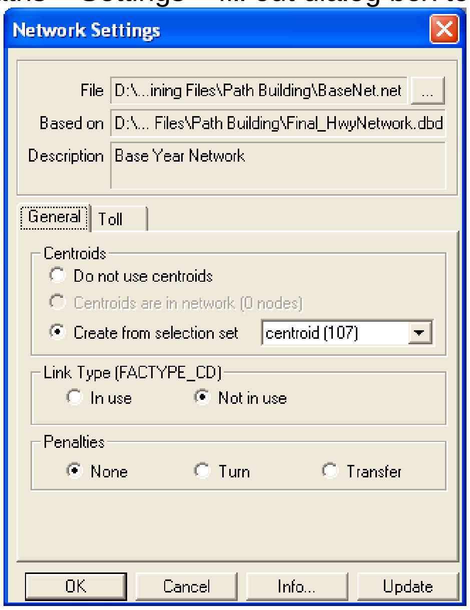


3. CLICK OK – Save Network File – [**\OUTPUT\NETWORK.NET] **TIP:** The path and name of the network is shown in the lower right hand corner of the TransCAD workspace. This is one way to verify that you have a network file open as well as the path and name of the network file.

Step 2: Network Settings

Network settings allow the user to specify conditions about the network such as whether or not to use the centroids as paths, to specify turn penalties, or to set up toll links.

1. With the node layer as the active layer, create a selection of all centroid nodes and name it "centroids". [The set of centroid nodes is unique to a given study area, but you will know this information from your work in Section 2.4].
2. Network/Paths – Settings – fill out dialog box to specify network settings.



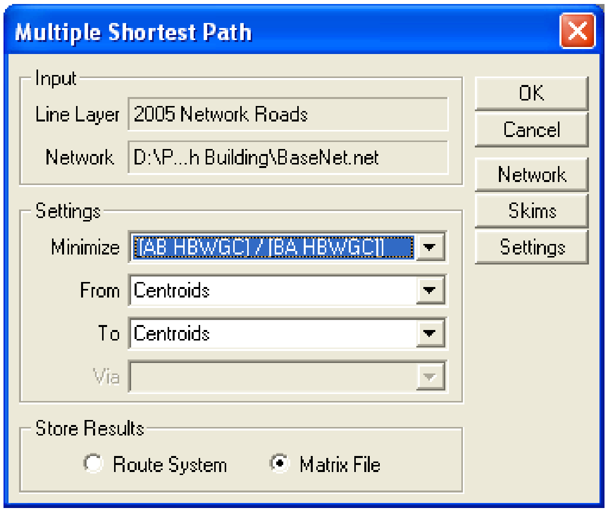
3. CLICK OK

3.5 Build Shortest Path Matrices

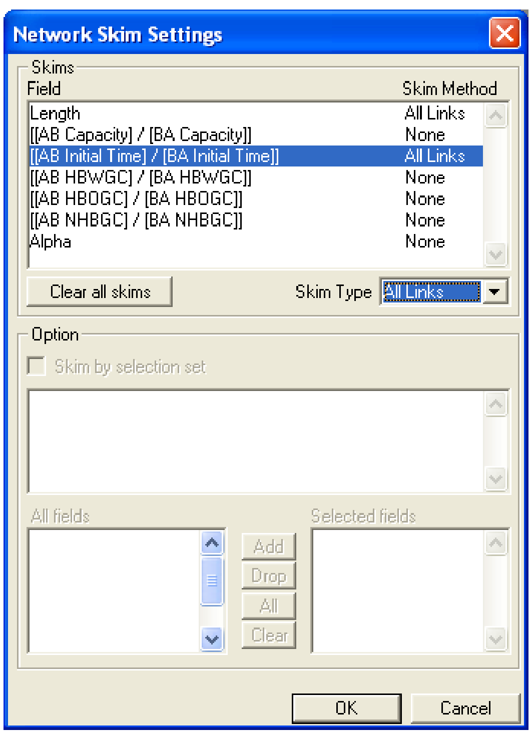
Path building involves finding the minimum path between every TAZ interchange. The minimum path is determined based on the user defined impedance such as time, distance, cost, or a composite impedance function that may include both cost and time, for example. The path can be different depending on the impedance variable that is used.

Step 1: Build Shortest Path Matrices for HBWGC

1. If not already open, open the highway line layer [**\INPUT*_HIGHWAY.DBD] and then the associated network [**\OUTPUT\NETWORK.NET].
2. Network/Paths – Multiple Paths
3. Fill out dialog box to specify skims for the HBW generalized cost impedance (HBWGC).



4. Fill out dialog box to specify path input and settings. **TIP:** The minimum path is based on the skim variable identified in the Network Skim Settings dialog box. Specifying a skim using this dialog box will give you the path value of that skim based on the minimum path identified in the dialog box above. For example, if you select to "Minimize" HBWGC as show in the dialog box above and then request skims of Length and Initial Travel Time the resulting minimum path will be based on HBWGC and the distance and travel time for that path will be output in a separate matrix table. This information is often good for error checking or comparative purposes.

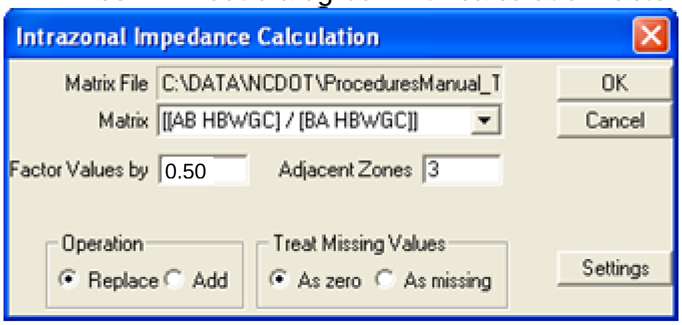


5. CLICK OK – Specify path name – Save Shortest Path matrix [**\INTERIM\HBWGC_PATH.MTX] – CLICK OK

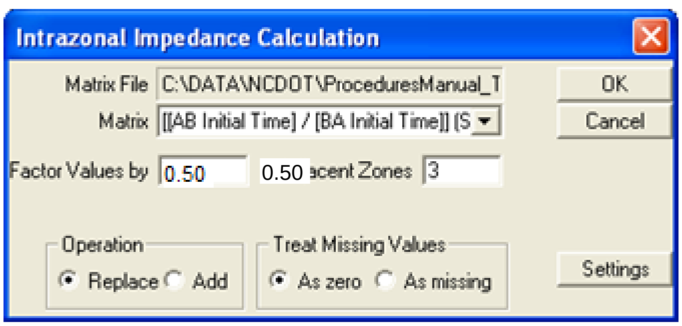
Step 2: Calculate Intrazonal Skim Values for HBWGC Skims

Intrazonal time represents the average time it takes to travel between any two points entirely within a zone. It is not possible to skim this time from the network and therefore intrazonal time must be calculated from the travel time matrix. The recommended approach is to use the average travel time to the 3 nearest neighbors and then multiply that value by 0.50.

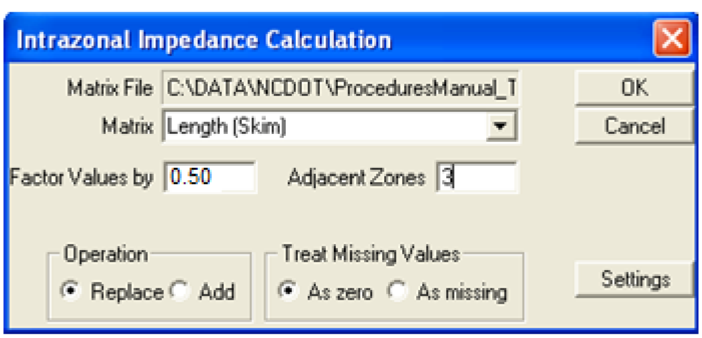
1. With HBWGC as the active matrix – Planning – Trip Distribution – Intrazonal Travel Times – Fill out dialog box with calculation factors – CLICK OK



2. Repeat process for Travel Time (Skim) – CLICK OK



3. Repeat process for Length (Skim) – CLICK OK



Step 3: Build Shortest Path Matrices for HBOGC

1. Network/Paths – Multiple Paths
2. Fill out dialog box to specify skims for the HBO generalized cost impedance (HBOGC).
3. Fill out dialog box to specify path input and settings.
4. CLICK OK – Specify path name – Save Shortest Path matrix [**\INTERIM\HBOGC_PATH.MTX] – CLICK OK

Step 4: Calculate Intrazonal Skim Values for HBOGC Skims

1. With HBOGC as the active matrix – Planning – Trip Distribution – Intrazonal Travel Times – Fill out dialog box with calculation factors – CLICK OK
2. Repeat process for Travel Time (Skim) – CLICK OK
3. Repeat process for Length (Skim) – CLICK OK

Step 5: Build Shortest Path Matrices for NHBGC

1. Network/Paths – Multiple Paths
2. Fill out dialog box to specify skims for the NHB generalized cost impedance (NHBGC).
3. Fill out dialog box to specify path input and settings.
4. CLICK OK – Specify path name – Save Shortest Path matrix [**\INTERIM\NHBGC_PATH.MTX] – CLICK OK

Step 6: Calculate Intrazonal Skim Values for NHBGC Skims

1. With NHBGC as the active matrix – Planning – Trip Distribution – Intrazonal Travel Times – Fill out dialog box with calculation factors – CLICK OK
2. Repeat process for Travel Time (Skim) – CLICK OK
3. Repeat process for Length (Skim) – CLICK OK

Step 7: Build Shortest Path Travel Time and Distance Matrices

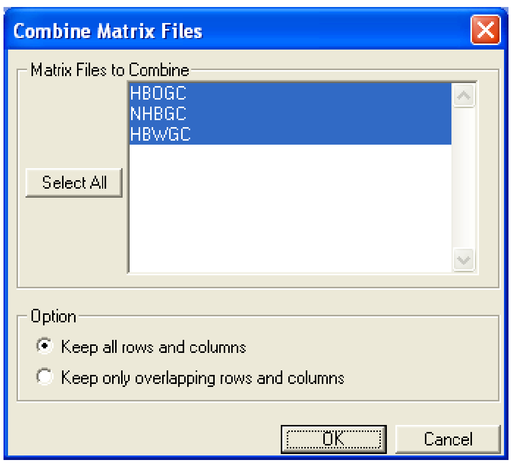
1. Network/Paths – Multiple Paths
2. Fill out dialog box to minimize initial travel time
3. CLICK OK – Specify path name – Save Shortest Path matrix [**\OUTPUT\SHORTESTPATH.MTX] – CLICK OK

3.6 Combine Generalized Cost Matrices

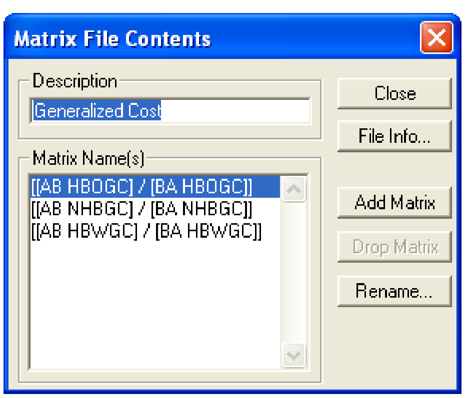
Application of the gravity model only allows for the use of one impedance matrix at a time. To streamline the application process it is helpful to combine the generalized cost matrices for HBW, HBO, and NHB into one matrix before applying the gravity model.

Step 1: Combine Matrices

1. Open the impedance matrices for HBWGC, HBOGC, and NHBGC [**\INTERIM\HBWCG_PATH.MTX, HWOCG_PATH.MTX, and NHBGC_PATH.MTX]. **TIP:** It is often the case that TransCAD uses a default naming convention for certain types of output. As such, it may be the case that all of the impedance matrices are given the same name "Shortest Path". To better differentiate between these tables it is help to rename them.
    a. With the matrix in question as the active matrix – Matrix – Contents – change the matrix name (example HBWGC, HBOGC, NHBGC)
2. Matrix – Combine – Select All – Keep all rows and columns – CLICK OK



3. Name file [**\OUTPUT\GENCOST.MTX] – CLICK OK
4. Close original HBWGC, HBOGC, and NHBGC matrices
5. Matrix – Contents
    a. Description = Generalized Cost
    b. Drop all Length Matrices
    c. Drop all Initial Travel Time Matrices
    d. Close dialog box – Close matrix file



4 Trip Generation Submodels

4.1 Purpose

The cross-classification trip production model requires as an input an estimate of households jointly stratified by household size and auto ownership. A set of trip generation submodels is required prior to the trip generation step to estimate for each zone the number of households in each of the following categories:

- 1 person – 0 autos, 1 auto, 2 autos, or 3+ autos;
- 2 person – 0 autos, 1 auto, 2 autos, or 3+ autos;
- 3 person – 0 autos, 1 auto, 2 autos, or 3+ autos;
- 4 person – 0 autos, 1 auto, 2 autos, or 3+ autos; and
- 5+ persons – 0 autos, 1 auto, 2 autos, or 3+ autos.

The household size data is estimated using a set of curves developed using Census data from the North Carolina MPOs and regions that were the basis of the North Carolina Combined Survey Database. The curves essentially predict the percentage of 1 person, 2 person, 3 person, 4 person, and 5+ person households given an average household size. The number of autos is estimated in a similar manner using a set of curves developed from observed data that predicts the percentage of 0 auto, 1 auto, 2 auto, and 3+ auto households given an average autos per household. A Fratar process is then applied to assure that the total households by household size and total households by auto ownership are balanced. A seed matrix, also developed from observed data, is used as the starting point for the Fratar process.

To standardize this procedure a set of default household size curves, auto ownership curves, and a joint distribution seed matrix were developed using data from the North Carolina Combined Survey Database. The process was automated through the use of a GISDK script that can be run within the TransCAD environment. When applied, this program takes as input zonal households, population, and autos. It produces for each zone the number of households stratified by household size and auto ownership. The steps outlined in this chapter apply the trip generation submodels and result in the zonal household data inputs needed for the trip generation model.

4.2 Run the Trip Generation Submodel Add-In

The trip generation submodel is written in GISDK and is executed within the TransCAD environment. The zonal input data for this program is population, households, and vehicles. If this is the first time the submodel has been run, the following steps must be followed in order to compile the script and then to add the compiled program to the TransCAD Interface.

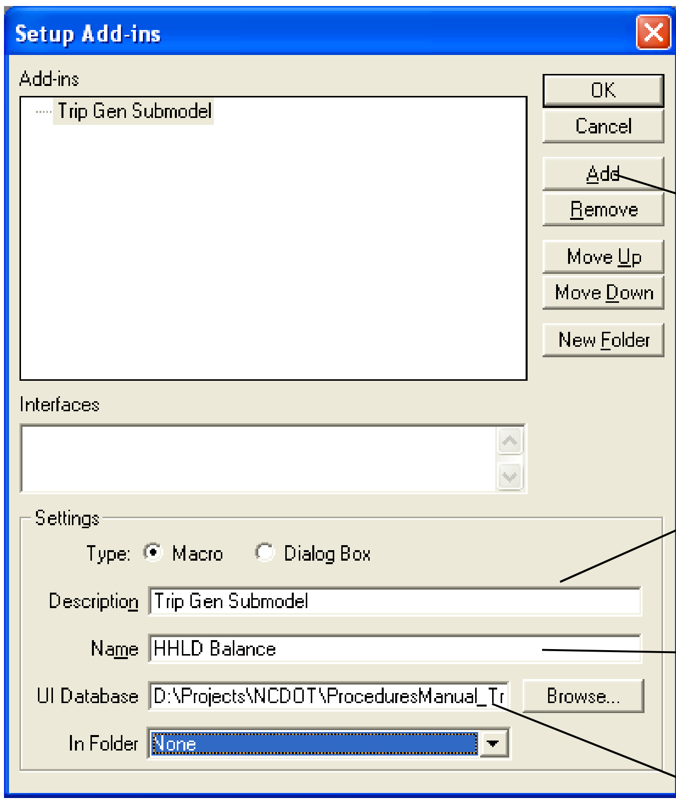
Step 1: Compile Add-In

1. **Tools – GIS Developer's Kit – Compile to UI**
2. Use the window to navigate to [PARAMETERS\HH_DIST.RSC] – **Open – Save As** [PARAMETERS\HHDIST] – Close GISDK Toolbox

Use this button to compile to UI

Step 2: Install Add-In

1. **Tools – Setup Add-Ins**
2. **Add** – Fill out the dialog box as shown below



First select this button to add a new Add-in

You can give the Add-in any name

This MUST be "HHLD Balance" exactly

Browse to the directory were you stored the compiled program [PARAMETERS\HHDIST.DBD]

1. CLICK OK
2. This adds the program to the Add-In list (See Tools – Add-Ins)

Step 3: Run the Submodel

1. **Tools – Add-Ins** – Trip Gen Submodel (**TIP:** this is going to be the name that you provide in **Step 2** above)
2. Choose a folder for the SE data [**\INPUT] – CLICK OK
3. Choose the SE data file [**\INPUT*_SEDATA.BIN] – highlight the file – click on Open **TIP:** Remember that this is the BIN file where all of the model input data is stored.
4. This launches the program which runs in a few seconds. To view the new data you can open [**\INPUT*_SEDATA.BIN] and notice that the fields for household size and auto ownership are now populated. You are now ready to move to the Trip Generation step.

5 Trip Generation

5.1 Purpose

The trip generation model estimates the number of trips produced from and attracted to each zone. Trip productions are estimated using the households stratified by household size and auto ownership and a trip rate reflective of that household type. Trip attractions are estimated using employment by type and/or the number of households -along with a trip rate that reflects the trip attractiveness of the different zonal variables for each trip purpose.

5.2 Estimate, Balance, and Check Internal Zonal Productions and Attractions

To complete this process you will need the zonal data tabulated and estimated in preceding steps, a table of trip production rates, and five trip attraction model files. The trip rate file [NCPRODRATES.BIN] was developed using the North Carolina Combined Survey Database and contains the default production rates for models developed using the procedures outlined herein. The five model files [HBW.MOD], [HBO.MOD], [HBSCH.MOD], [NHBW.MOD], and [NHBO.MOD] were also developed using the North Carolina Combined Survey Database and contain the default attraction rates for models developed using the procedures outlined herein. **NOTE:** For GUI application, these rates are stored in a BIN file; see the Small Area Travel Demand Model Users Guide for Model Application for more information.

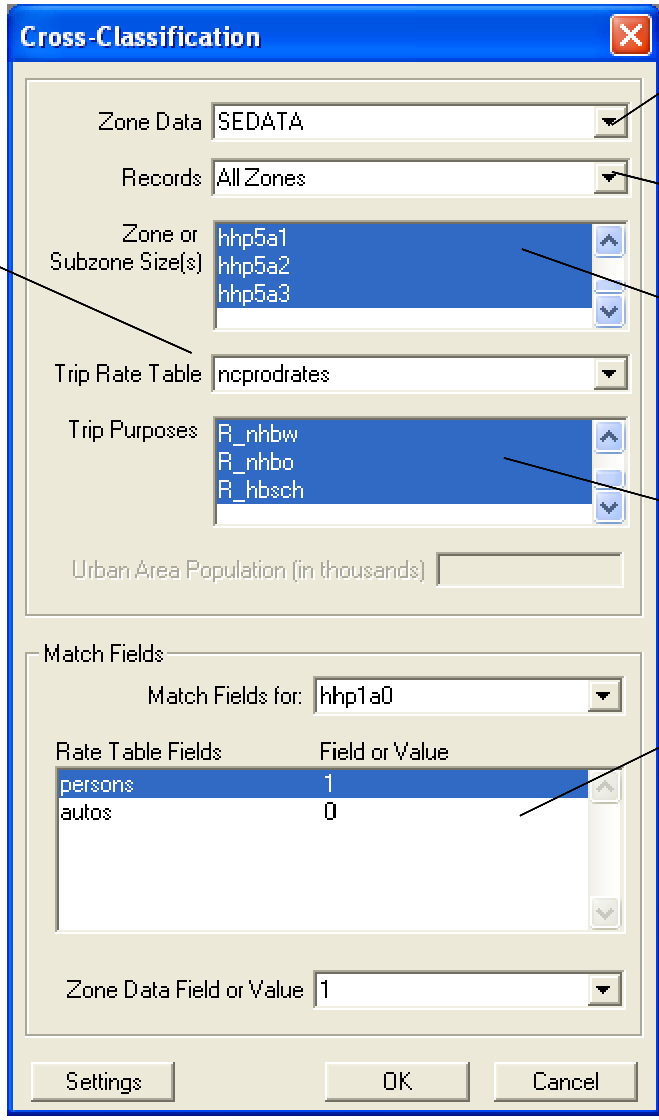
Step 1: Copy all support files to proper locations

If this is the first time you have applied the trip generation model using these procedures you will need to confirm that the production rate file and attraction model files are in the PARAMETERS folder.

Step 2: Calculate Zonal Productions

1. Open the file [**\INPUT*_SEDATA.BIN]
2. Open the trip production rate file [PARAMETERS\NCPRODRATES.BIN]
3. **Planning – Trip Productions – Cross-Classification**
   TIP: If this is the first time you have run the Cross-Classification procedure you will need to manually specify all the settings for the procedure. You can then save these settings into a settings file for use the next time you run the Cross-Classification procedure.
4. The Cross-Classification dialog box fields should be populated as described in the example below:

Trip
rate
table



Name of the SEDATA file containing your demographic data

Calculate productions for all zones

Highlight fields defined in Table 18

Highlight fields in Table 19

The fields/values in the trip rate table must be properly matched to the fields in the SEDATA table. This is done iteratively by first selecting the field name in the "*Match Fields for*" drop down menu and then entering the appropriate value for the Rate Table field position in the "Zone Data Field or Value" box. First highlight persons and then type in the appropriate value in the "Zone Data Field or Value" box. Next highlight autos and type in the appropriate value in the "Zone Data Field or Value" box. See Table 20 for a summary of all matches.

Table 18 SEDATA data fields used for trip productions

Field Name	Description
hhp1a0	1 person, 0 auto households
hhp1a1	1 person, 1 auto households
hhp1a2	1 person, 2 auto households
hhp1a3	1 person, 3+ auto households
hhp2a0	2 person, 0 auto households
hhp2a1	2 person, 1 auto households
hhp2a2	2 person, 2 auto households
hhp2a3	2 person, 3+ auto households
hhp3a0	3 person, 0 auto households
hhp3a1	3 person, 1 auto households
hhp3a2	3 person, 2 auto households
hhp3a3	3 person, 3+ auto households
hhp4a0	4 person, 0 auto households
hhp4a1	4 person, 1 auto households
hhp4a2	4 person, 2 auto households
hhp4a3	4 person, 3+ auto households
hhp5a0	5+ person, 0 auto households
hhp5a1	5+ person, 1 auto households
hhp5a2	5+ person, 2 auto households
hhp5a3	5+ person, 3+ auto households

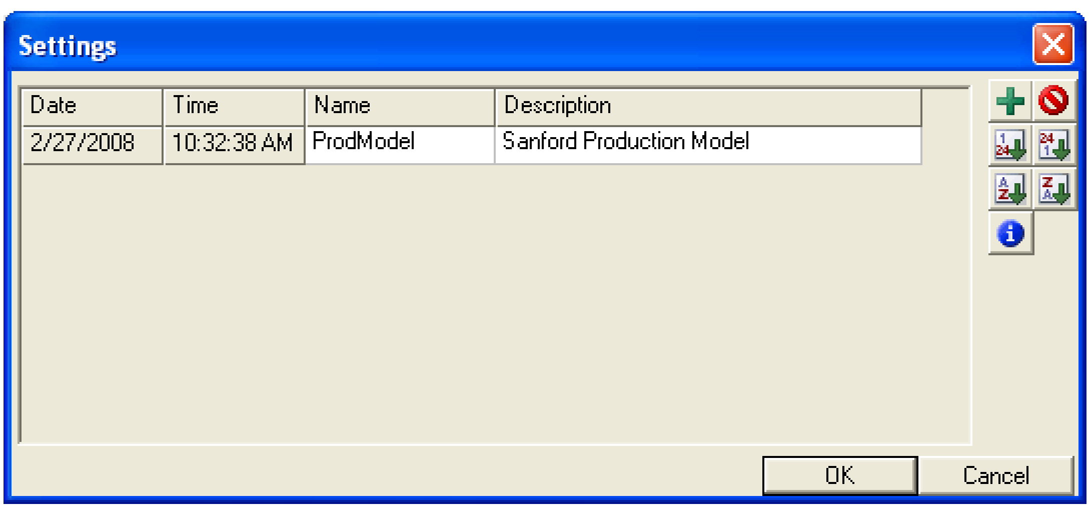
Table 19 Trip Purpose Fields in Trip Rate Table

Field Name	Description
R_hbw	HBW trip rates
R_hbo	HBO trip rates
R_nhbw	NHBW trip rates
R_nhbo	NHBO trip rates
R_hbsch	HBSCH trip rates

Table 20 Field Matches between SEDATA file and Trip Rate File

Match Fields for:	Zone Data Field or Value	
	persons	**autos**
hhp1a0	1	0
hhp1a1	1	1
hhp1a2	1	2
hhp1a3	1	3
hhp2a0	2	0
hhp2a1	2	1
hhp2a2	2	2
hhp2a3	2	3
hhp3a0	3	0
hhp3a1	3	1
hhp3a2	3	2
hhp3a3	3	3
hhp4a0	4	0
hhp4a1	4	1
hhp4a2	4	2
hhp4a3	4	3
hhp5a0	5	0
hhp5a1	5	1
hhp5a2	5	2
hhp5a3	5	3

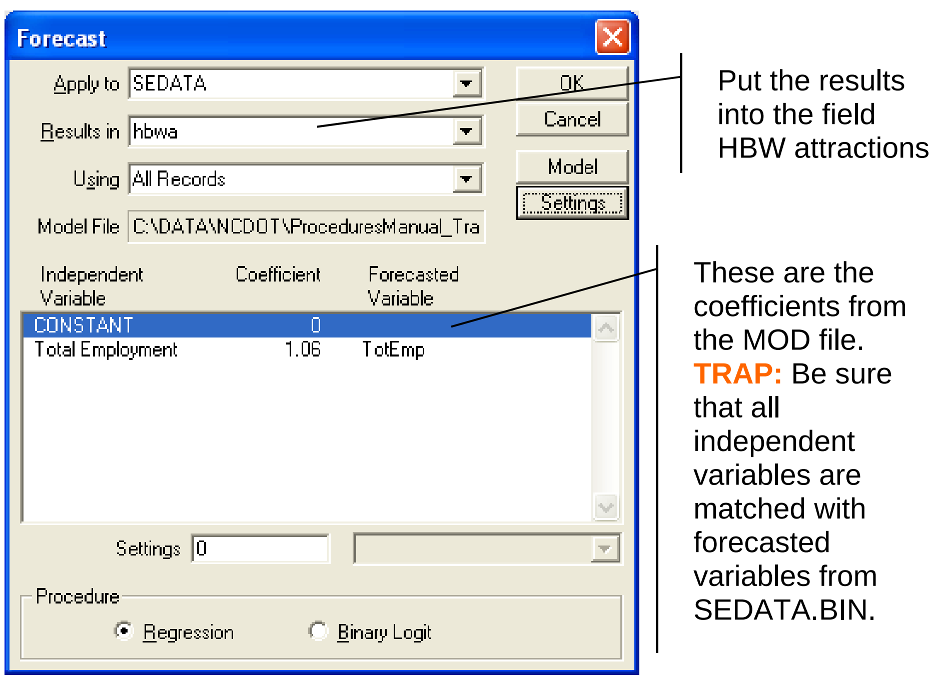
5. Click on **Settings** Tab – Click on the Green Plus Sign to add a new setting – Name the Setting and give it a Description – CLICK OK
   TIP: This saves your settings for later use so that you do not need to manually enter the settings again for the standard NCDOT model.



6. CLICK OK – Specify the output file location and the file name [INTERIM\CROSCLAS.BIN] – CLICK OK
7. Close the results summary dialog box
8. The results of the trip production model are joined to the SEDATA.BIN file. Update the appropriate data fields in the SEDATA file with the trip production results using the fill command:
   a. Highlight field **hbwp** – **Edit - Fill – Formula** – **hbw** – CLICK OK – CLICK OK
   b. Highlight field **hbop** – **Edit - Fill – Formula** – **hbo** – CLICK OK – CLICK OK
   c. Highlight field **hbschp** – **Edit - Fill – Formula** – **hbsch** – CLICK OK – CLICK OK
   d. Highlight field **nhbwp** – **Edit - Fill – Formula** – **nhbw** – CLICK OK – CLICK OK
   e. Highlight field **nhbop** – **Edit - Fill – Formula** – **nhbo** – CLICK OK – CLICK OK
9. Close the joined dataview
10. Close the trip production table [PARAMETERS\NCPRODRATES.BIN]

Step 3: Calculate HBW Zonal Attractions

1. If the SEDATA.BIN file is not already open, open it now
2. **Planning – Trip Attractions – Apply a Model**
3. Select Model File "HBW.MOD"
   TIP: If this is the first time you have run the procedure for HBW you will need to manually specify all the settings for the procedure. You can then save these settings into a settings file for use the next time you run this procedure.
4. The dialog box fields will be populated to match the screen shot below:

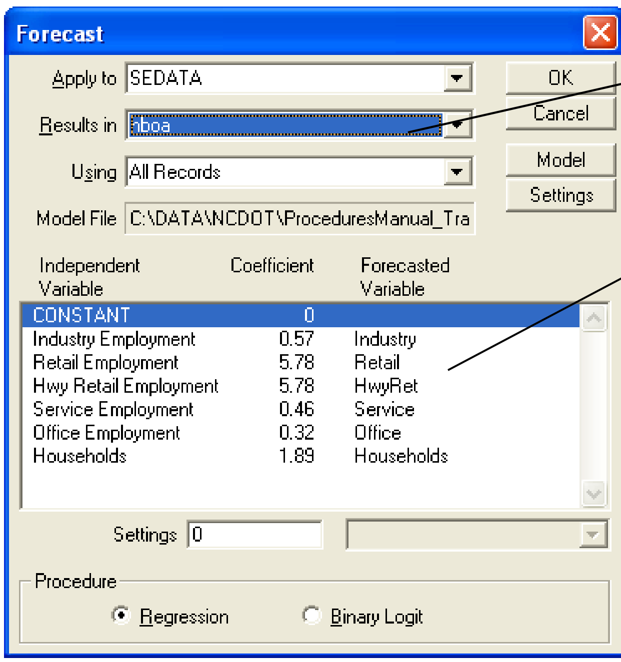


5. Click on the **Settings** Tab – Click on the Green Plus Sign to add a new setting – Name the Setting and give it a Description – CLICK OK
   TIP: This saves your settings for later use so that you do not need to manually enter the settings again for the standard NCDOT model.

6. CLICK OK – the model now runs and the results are output directly to SEDATA.BIN – close the results summary to view the results

Step 4: Calculate HBO Zonal Attractions

1. **Planning – Trip Attractions – Apply a Model**
2. Select Model File "HBO.MOD"
   TIP: If this is the first time you have run the procedure for HBO you will need to manually specify all the settings for the procedure. You can then save these settings into a settings file for use the next time you run this procedure.
3. The dialog box fields will be populated to match the screen shot below:



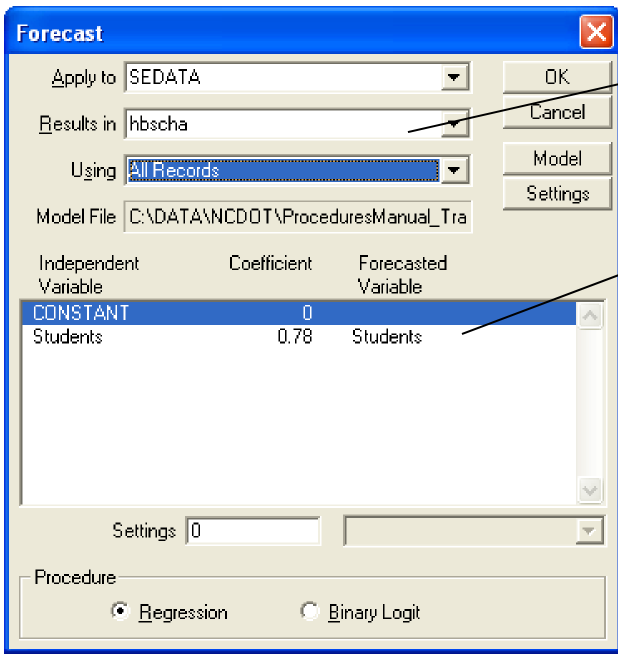
Put the results into the field HBO attractions

These are the coefficients from the MOD file. **TRAP:** Be sure that all independent variables are matched with forecasted variables from SEDATA.BIN.

4. Click on the **Settings** Tab – Click on the Green Plus Sign to add a new setting – Name the Setting and give it a Description – CLICK OK
   TIP: This saves your settings for later use so that you do not need to manually enter the settings again for the standard NCDOT model.
5. CLICK OK – the model now runs and the results are output directly to SEDATA.BIN – close the results summary to view the results

Step 5: Calculate HBSCH Zonal Attractions

1. **Planning – Trip Attractions – Apply a Model**
2. Select Model File "HBSCH.MOD"
   TIP: If this is the first time you have run the procedure for HBSCH you will need to manually specify all the settings for the procedure. You can then save these settings into a settings file for use the next time you run this procedure.
3. The dialog box fields will be populated to match the screen shot below:



Put the results into the field HBSCH attractions

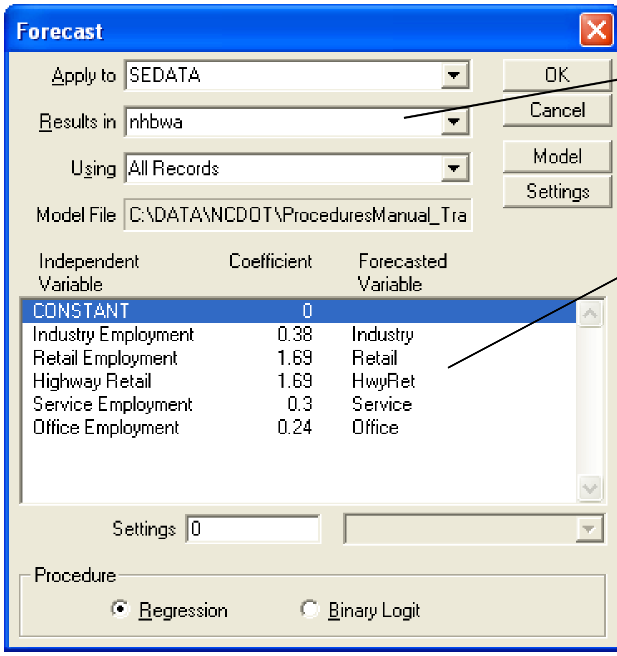
These are the coefficients from the MOD file. **TRAP**: Be sure that all independent variables are matched with forecasted variables from SEDATA.BIN.

4. Click on the **Settings** Tab – Click on the Green Plus Sign to add a new setting – Name the Setting and give it a Description – CLICK OK
   TIP: This saves your settings for later use so that you do not need to manually enter the settings again for the standard NCDOT model.
5. CLICK OK – the model now runs and the results are output directly to SEDATA.BIN – close the results summary to view the results

Step 6: Calculate NHBW Zonal Attractions

1. **Planning – Trip Attractions – Apply a Model**
2. Select Model File "NHBW.MOD"
   TIP: If this is the first time you have run the procedure for NHBW you will need to manually specify all the settings for the procedure. You can then save these settings into a settings file for use the next time you run this procedure.

3. The dialog box fields will be populated to match the screen shot below:



Put the results into the field NHBW attractions

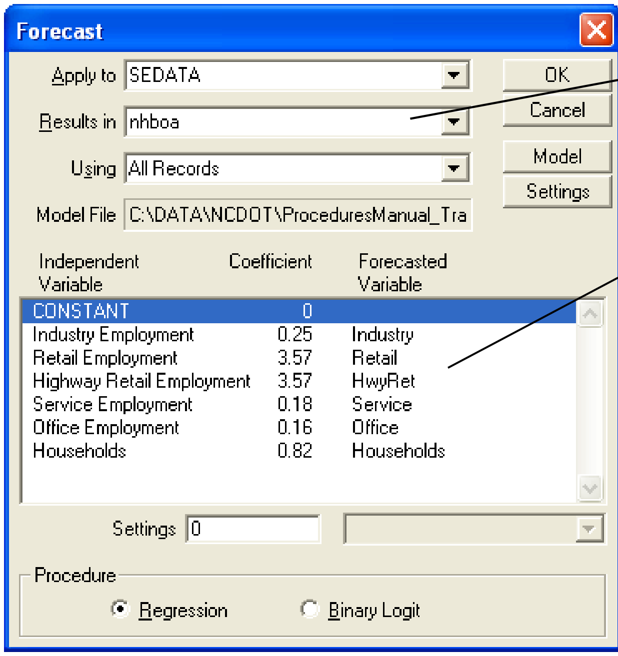
These are the coefficients from the MOD file. **TRAP**: Be sure that all independent variables are matched with forecasted variables from SEDATA.BIN.

4. Click on the **Settings** Tab – Click on the Green Plus Sign to add a new setting – Name the Setting and give it a Description – CLICK OK
   TIP: This saves your settings for later use so that you do not need to manually enter the settings again for the standard NCDOT model.
5. CLICK OK – the model now runs and the results are output directly to SEDATA.BIN – close the results summary to view the results

Step 7: Calculate NHBO Zonal Attractions

1. **Planning – Trip Attractions – Apply a Model**
2. Select Model File "NHBO.MOD"
   TIP: If this is the first time you have run the procedure you will need to manually specify all the settings for the procedure. You can then save these settings into a settings file for use the next time you run this procedure.

3. The dialog box fields will be populated to match the screen shot below:



Put the results into the field NHBO attractions

These are the coefficients from the MOD file. **TRAP:** Be sure that all independent variables are matched with forecasted variables from SEDATA.BIN.

4. Click on the **Settings** Tab – Click on the Green Plus Sign to add a new setting – Name the Setting and give it a Description – CLICK OK
   TIP: This saves your settings for later use so that you do not need to manually enter the settings again for the standard NCDOT model.
5. CLICK OK – the model now runs and the results are output directly to SEDATA.BIN – close the results summary to view the results

Step 8: Reasonableness Checking

NOTE: Before balancing the Productions and Attractions it is important to perform reasonableness checks of the trip generation results.

1. Use the **Compute Statistics** button on the tool bar to create a summary of the trip generation results. A table such as the one shown in Table 21 can be used to review the reasonableness of your model results.

Table 21 Sample Trip Generation Reasonableness Checks Chart

Trip Purpose	Productions	Attractions	Normalization Factor (P/A ratio)	% by Trip Purpose
HBW				
HBO				
HBSCH				
NHBW				
NHBO				
TOTAL				

GUIDELINES:

- *Normalization factor should be between 0.9 and 1.1*
- *Trips by purpose*
  - i. *HBW – 12 to 20%*
  - ii. *HBO – 45 to 55%*
  - iii. *NHB – 20 to 35%*

2. You can also create a thematic map of the productions and attractions by joining the SEDATA.BIN file to the TAZ layer. The thematic map can be evaluated based on your knowledge of the study area to see if you are getting productions and attractions where you would expect based on the land use in the study area.

Step 9: Balance Productions and Attractions

1. **Planning – Balance**
   TIP: If this is the first time you have run the Balancing procedure you will need to manually specify all the settings for the procedure. You can then save these settings into a settings file for use the next time you run the procedure.
2. The dialog box fields shown below should be populated to match the settings shown in Table 22.

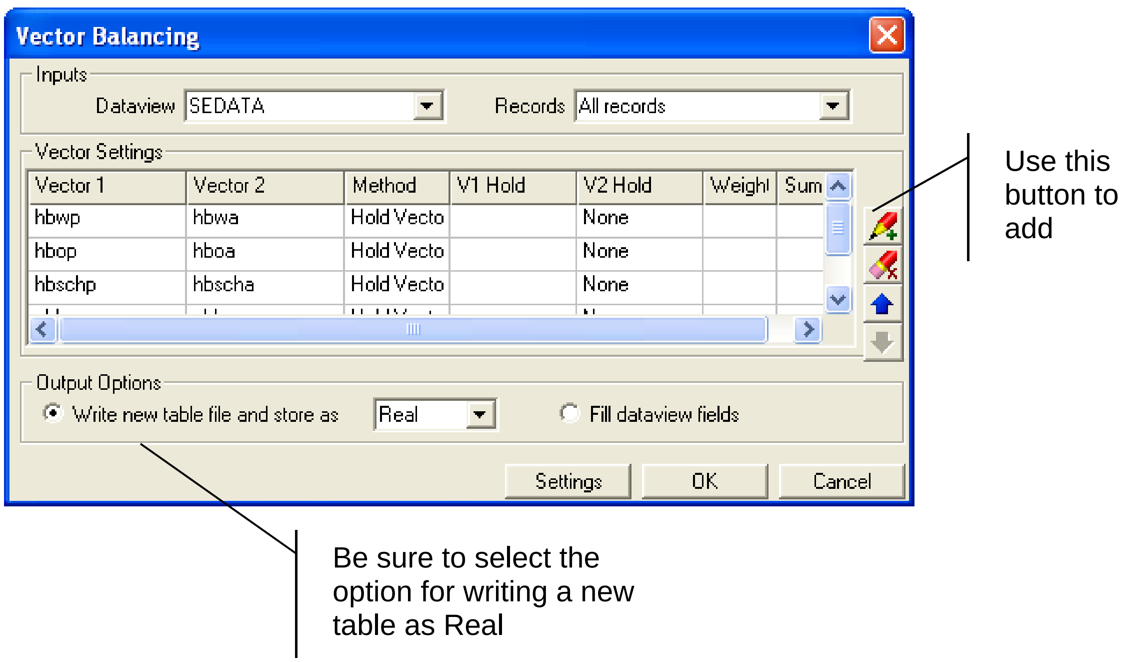


Table 22 Vector Settings for Balancing Productions and Attractions

Vector 1	Vector 2	Method	V2 Hold
hbwp	hbwa	Hold Vector 1	None
hbop	hboa	Hold Vector 1	None
hbschp	hbscha	Hold Vector 1	None
nhbwp	nhbwa	Hold Vector 1	None
nhbop	nhboa	Hold Vector 1	None

3. Click on the **Settings** Tab – Click on the Green Plus Sign to add a new setting – Name the Setting and give it a Description – CLICK OK
   TIP: This saves your settings for later use so that you do not need to manually enter the settings again for the standard NCDOT model.
4. CLICK OK – Save the file as **\INTERIM\BALANCE_PA.BIN

5. Close Results Summary dialog box
6. To verify balancing you can look at the table statistics by selecting the **Compute Statistics** button from the tool bar – the sum of the productions and attractions by trip purpose should now be equal

Step 10: Set NHBW and NHBO productions equal to NHBW and NHBO attractions

1. Open the file [**\INTERIM\BALANCE_PA.BIN]
2. Highlight the field nhbwp – **Edit - Fill – Formula** – nhbwa
3. Highlight the field nhbop – **Edit - Fill – Formula** – nhboa

Step 11: Update NHBW and NHBO with non-resident trips

TIP: A sample spreadsheet [NHB_NR.XLS] is available to assist with these calculations.

1. Completion of this step requires that you first compete Sections 9.2 – 9.4
2. Open [**\INTERIM\BALANCE_PA.BIN]
3. **File – Save As** – [**\OUTPUT\BALANCE_PA2.BIN]
4. **File – Close** [**\INTERIM\BALANCE_PA]
5. Open [**\OUTPUT\BALANCE_PA2.BIN]
6. **Dataview – Modify Table – Add** the following fields:
    a. NHBWNR
    b. NHBONR
7. Highlight the field NHBWNR – **Edit - Fill – Formula**:
    a. (Total NHBWNR trips) * (NHBWP/(Total NHBWP))
    b. **Example:** 1033*(nhbwp/13938)
8. Highlight the field NHBONR – **Edit - Fill – Formula**:
    a. (Total NHBONR trips) * (NHBOP/(Total NHBOP))
    b. **Example:** 1988*(nhbop/26838)
9. Highlight the field NHBWP – **Edit - Fill – Formula**:
    a. NHBWP+ NHBWNR
10. Highlight the field NHBWA – **Edit - Fill – Formula:** NHBWP
11. Highlight the field NHBOP – **Edit - Fill – Formula**:
    a. NHBOP+ NHBONR
12. Highlight the field NHBOA – **Edit - Fill – Formula:** NHBOP
13. **Dataview – Modify Table – Drop** Fields:
    a. NHBWNR
    b. NHBONR
14. CLICK OK
15. **File – Close All**

6 Trip Distribution

6.1 Purpose

The trip distribution model pairs or connects estimated productions and attractions by traffic analysis zone to each other. The resulting output is a trip table or matrix of trips from every zone to every zone for each of the trip purposes specified in the model. In addition to productions and attractions by zone, the trip distribution model also requires zone-to-zone impedances such as the generalized cost estimated in Chapter 3 Networks and Shortest Paths.

6.2 Default Gamma Coefficients

The functional form for estimating friction factors for areas covered by these procedures is the gamma function. The gamma function is specified as:

$$\mathbf{F_{ij} = a \times C_{ij}^{b} \times exp(c \times C_{ij})}$$

where:

F_{ij} = Friction factor between zone I and zone j;
a, b, and c = Gamma coefficients;
C_{ij} = Cost measure between zone I and zone j.

The functional form that TransCAD applies is slightly different as shown below, but yields the same resulting function. The primary difference is that the b and c coefficients do not need to carry a negative sign as is often shown in tabulation of gamma coefficients. Please refer to the TransCAD manual for more detail.

$$f(d_{ij}) = a \times d_{ij}^{-b} \times e^{-c(d_{ij})}$$

where:

$f(d_{ij})$ = Friction factor between zone I and zone j;
d_{ij} = Cost measure between zone i and zone j; and
a, *b*, and *c* = Gamma coefficients.

The North Carolina Combined Survey Database was used to develop an initial set of gamma coefficients to be used for the initial application of the trip distribution model. These gamma coefficients, modified for the gamma function applied in TransCAD, are documented in Table 23.

Table 23 Initial Gamma Function Coefficients based on NC Combined Survey Database

Trip Purpose	a	b	c
HBW (large area)	93.2694	-0.7903	-0.0616
HBW (small area)	10.5936	-1.0250	-0.0000
HBO	811.0232	-1.0645	-0.0832
HBSCH	354.0846	-0.5874	-0.1291
NHBW (large area)	470.3996	-0.9334	-0.0678
NHBW (small area)	2.3286	-0.7694	-0.0000
NHBO (large area)	2983.1686	-1.0461	-0.0782
NHBO (small area)	4.6750	-0.2916	-0.1390

6.3 Application of the Trip Distribution Model

The functional form of the trip distribution model for areas falling under these procedures is the gravity model. The general formulation of the model can be described as follows:

$$T_{ij} = P_i \times \frac{A_j \times F_{ij} \times K_{ij}}{\sum_{k=1}^{zones} (A_k \times F_{ik} \times K_{ik})}$$

where:

T_{ij} = the number of trips from zone i and zone j;

P_i = the number of trip productions in zone I;

A_j = the number of trip attractions in zone j;

F_{ij} = the friction factor associated with the measure of travel impedance from zone i to zone j; and

K_{ij} = an optional factor related to specific socioeconomic or geographic constraints for all movements between zone i and zone j.

To apply the trip distribution model you will need the balanced productions and attractions by zone and the generalized cost shortest path matrices for the HBW, HBO, and NHB trip purposes. The HBO generalized cost is applied for the HBO and HBSCH trip purposes and the NHB generalized cost is applied for the NHBW and NHBO trip purposes.

Step 1: Apply Gravity Model using Default Gamma Coefficients

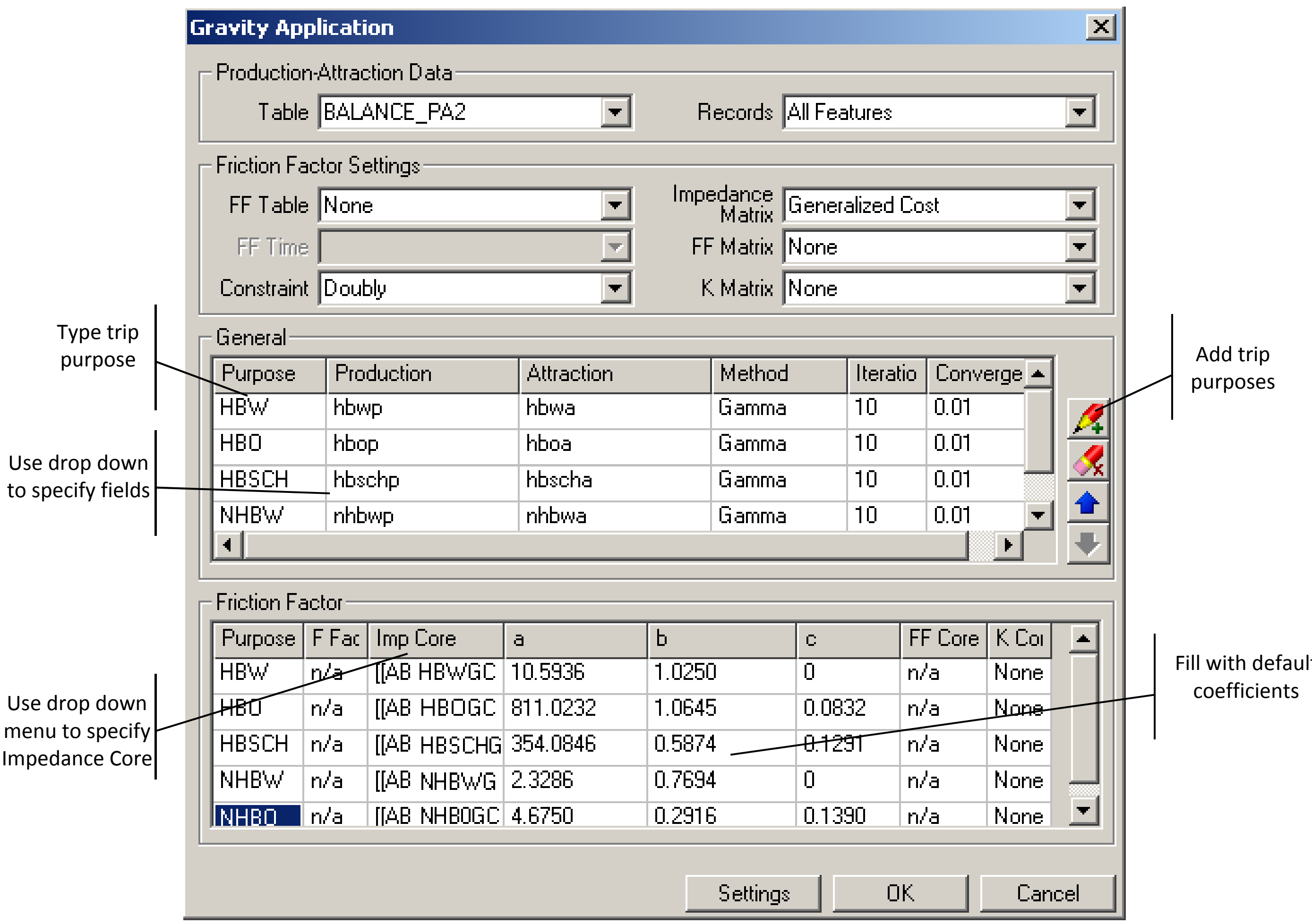
1. If not already open, open the BIN file with the final balanced productions and attractions [**\OUTPUT\BALANCE_PA2.BIN]
2. Open the Generalized Cost Matrix [**\OUTPUT\GENCOST.MTX]
3. **Planning – Trip Distribution – Gravity Application**
4. Fill out the dialog box for the Gravity Application [See Table 24 and Screen Shot below]
    a. Production-Attraction data is in BALANCE_PA2
    b. Impedance Matrix is Generalized Cost
    c. Add a trip purpose for each of the trip purposes in your P-A file
    d. Add the associated impedance core for each trip purpose
        i. HBW: HBWGC
        ii. HBO, HBSCH: HBOGC
        iii. NHBW, NHBO: NHBGC

e. Add the associated gamma coefficients for each trip purpose, for example:
    i. HBW: a = 10.5936, b = 1.0250, c = 0.0
    ii. HBO: a = 811.0232, b = 1.0645, c = 0.0832
    iii. HBSCH: a = 354.0846, b = 0.5874, c = 0.1291
    iv. NHBW: a = 2.3286, b = 0.7694, c = 0.0
    v. NHBO: a = 4.6750, b = 0.2916, c = 0.1390

5. Click on the **Settings Tab** – Click on the Green Plus Sign to add a new setting – Name the Setting and give it a Description – CLICK OK
   TIP: This saves your settings for a later use so that you do not need to manually enter the settings again for the standard NCDOT model.

Table 24 Gravity Application Dialog Box Field Specifications

<table>
<tr><th>Trip Purpose</th><th>Production</th><th>Attraction</th><th>Imp Core</th><th>a</th><th>b</th><th>c</th></tr>
<tr><td>HBW</td><td>hbwp</td><td>hbwa</td><td>[AB HBWGC]/[BA HBWGC]</td><td colspan="3" rowspan="5">See Table 23 for appropriate values for your study</td></tr>
<tr><td>HBO</td><td>hbop</td><td>hboa</td><td>[AB HBOGC]/[BA HBOGC]</td></tr>
<tr><td>HBSCH</td><td>hbschp</td><td>hbscha</td><td>[AB HBOGC]/[BA HBOGC]</td></tr>
<tr><td>NHBW</td><td>nhbwp</td><td>nhbwa</td><td>[AB NHBGC]/[BA NHBGC]</td></tr>
<tr><td>NHBO</td><td>nhbop</td><td>nhboa</td><td>[AB NHBGC]/[BA NHBGC]</td></tr>
</table>



6. CLICK OK – Save as: **\INTERIM\PER_TRIPS.MTX, Label = Person Trip Table
7. Review Results dialog box to see if all trip purposes converged – Close
8. Close Results Summary

The resulting output is a matrix file with a trip table for every trip purpose specified.

6.4 Using K-Factors

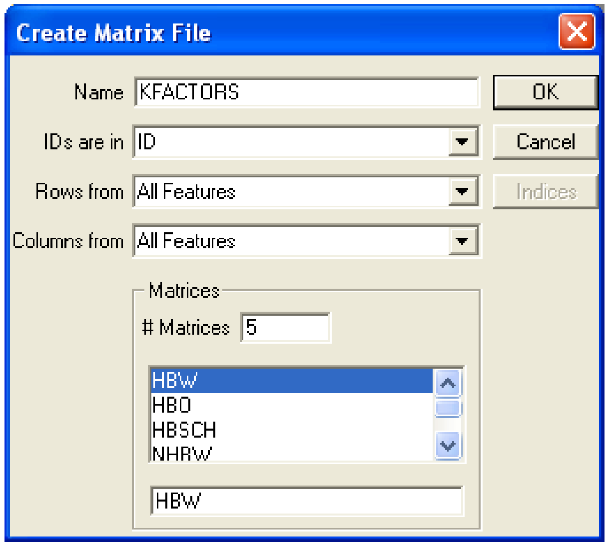
Socioeconomic factors, or K-factors, consider social or economic linkages (such as low wage workers living near high wage jobs) that affect travel behavior but that are, otherwise, difficult to reflect in gravity model application for trip distribution. The need for K-factors is typically not known until after an initial application of the gravity model without K-factors, and even then without observed travel survey data the need for K-factors may not be identified until the trip assignment validation step. The need for K-factors becomes apparent when there is a deficiency of trips between TAZs that cannot be corrected using friction factors alone. With observed survey data this problem is identified by comparing district to district observed trip tables against district to district estimated trip tables. If no observed trip table exists then the problem may become apparent when looking at traffic flows across key screenlines or cutlines that define key districts in the study area. In these instances K-factors can be used to make certain zone interchanges more or less attractive. To make a zone more attractive, a K-factor of greater than 1.0 is applied. To make a zone interchange less attractive then a K-factor of less than 1.0 is applied. **TRAP:** Do not use a negative K-factor since TransCAD treats a negative K-factor as one. If there is ever an instance where trips need to be prohibited then a K-factor of zero could be used.

The subjective nature of K-factors in application tends to reduce the credibility of the forecasts since the factors decrease the sensitivity of the model to variables that may change over time, such as changes in household incomes and skill levels. Some K-factors are justified, but in general, K-factors should be used sparingly and with caution.

In TransCAD K-factors are stored in a zone-to-zone matrix. It is not uncommon to use a different set of K-factors for each trip purpose as the social or economic linkages may affect different trips differently. A K-factor matrix must first be created and then populated with K-factor values for the zone interchanges in question. This is an iterative process of testing various ranges of K-factors in order to achieve acceptable results.

Step 1: Create K-Factor Matrix

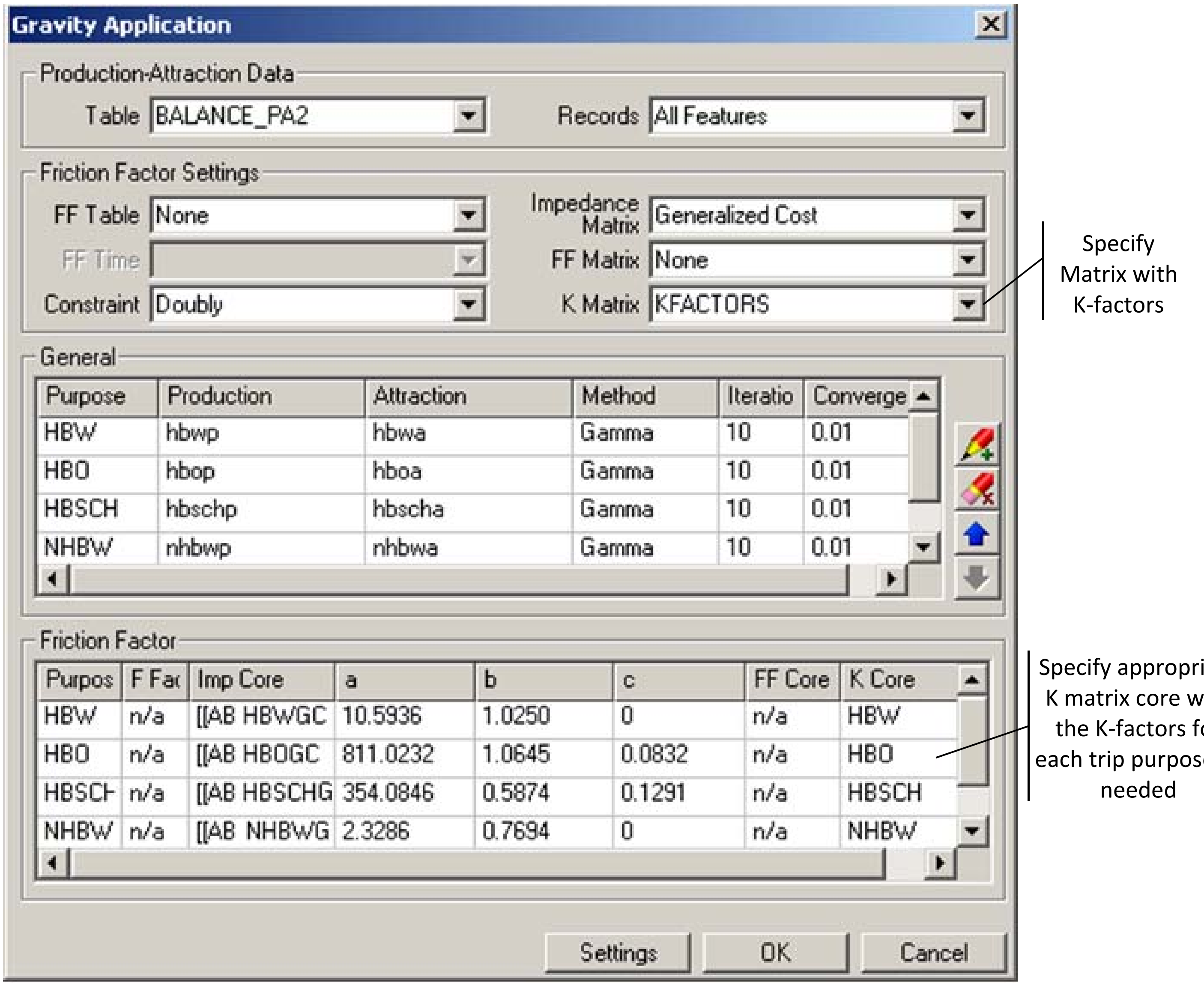
1. Open [\SUPPORT_FILES*TAZ_FINAL.DBD]
2. **File – New – Matrix** – CLICK OK – **Create a New Matrix** – CLICK OK
    a. Matrix Name: KFACTORS
    b. IDs are in ID
    c. Rows from: All Features
    d. Columns from: All Features
    e. Create 5 Matrices:
        i. HBW
        ii. HBO
        iii. HBSCH
        iv. NHBW
        v. NHBO
    f. CLICK OK



3. File should be saved as [\PARAMETERS\KFACTORS.MTX]
4. Populate the zone interchanges that require a K-factor with a K-factor (**TIP:** K-factor greater than one increases attractiveness, K-factor less than one decreases attractiveness)

Step 2: Apply Gravity Model using K-Factors

1. Follow the steps outlined in Section 6.3, Step 1, except in this case specify a K Matrix and in the Friction Factor portion of the dialog box specify the appropriate K Core (see Screen Shot below)



6.5 *Reasonableness Checking*

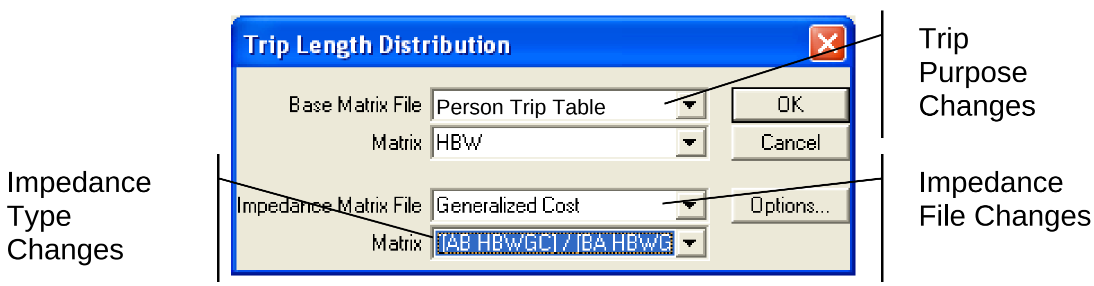
Before moving forward to the next step it is important to review the results of the Gravity Model Application in order to assess the reasonableness of the output. To check the reasonableness of your results the following checks are recommended:

1. Plot and review the trip length distribution for time, distance, and generalized cost;

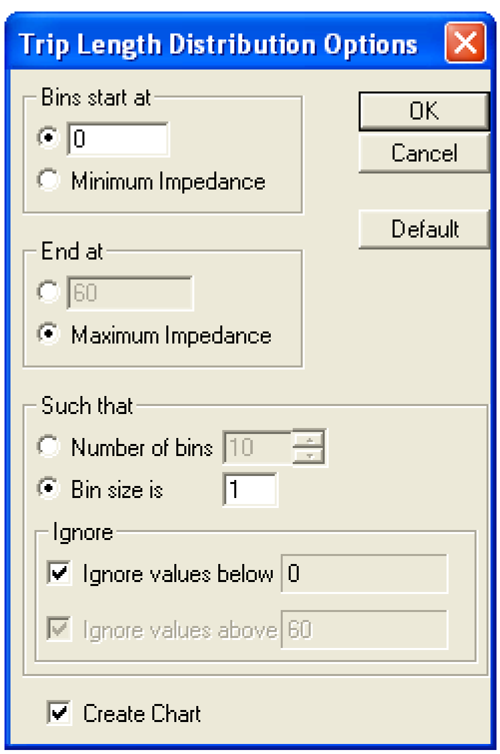
2. Tabulate and review the average trip length by time, distance, and generalized cost; and
3. Calculate and review the percent Intrazonal trips.

Step 1: Trip Length Distribution and Average Trip Length

1. If not already open, open the combined generalized cost matrix. [**\OUTPUT\GENCOST.MTX]
2. Open [**\OUTPUT\SHORTESTPATH.MTX]
3. If not already open, open [**\INTERIM\PER_TRIPS.MTX]
4. **TIP:** The next series of steps is repeated once for each trip purpose (HBW, HBO, HBSCH, NHBW, and NHBO) and impedance type (Generalized Cost, Initial Time, and Length). The values in bold italics will change accordingly.
5. **Planning – Trip Distribution – Trip Length Distribution**
   a. Base Matrix File: Person Trip Table
   b. Matrix: ***HBW***
   c. Impedance Matrix File: ***Generalized Cost***
   d. Matrix: [***AB HBWGC]/[BA HBWGC***]



6. Options



7. CLICK OK – CLICK OK – Save file as [INTERIM***HBW***_TLD_**], where ** changes based on the impedance value used. For example GC (Generalized Cost), TT (Travel Time), and DI (Distance)
8. Click “Show Report” button in Results Summary dialog box and scroll down to the bottom of the report
9. Record values in Table (See Table 25 for an example)
    a. Minimum Trip Length
    b. Maximum Trip Length
    c. Average Trip Length
    d. Standard Deviation
10. CLICK “Close” button
11. Review the Chart for Reasonableness. **TIP:** Data can also be exported to Excel for graphing and review. See examples below.

Table 25 Example Table for Recording Trip Length Data

Purpose	Generalized Cost	Travel Time	Distance	% Intrazonal	Converged (Y/N)	Gamma
HBW	15.78	10.75	5.38	4.4	Y	a = 10.593 b = 1.025 c = 0
HBO	14.01	7.69	3.39	14	Y	a = 811.02 b = 1.0645 c = 0.0832
HBSCH	14.11	7.84	3.37	11.7	Y	a = 354.08 b = 0.5874 c = 0.1291
NHBW	13.95	8.68	4.22	10.3	Y	a = 2.3286 b = 0.7694 c = 0
NHBO	10.93	6.98	3.16	14.7	Y	a = 4.675 b = 0.2916 c = 0.139

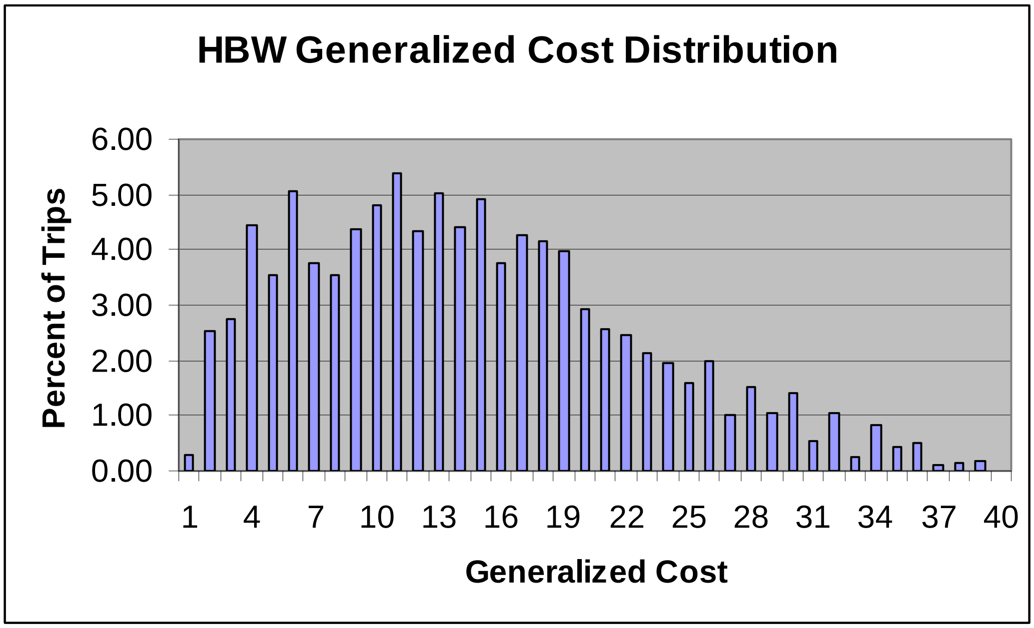


Figure 4 Generalized Cost Distribution Example

Step 2: Calculate Intrazonal Percentages

1. With [**\INTERIM\PER_TRIPS.MTX] as the active file – **Matrix – Statistics**
2. Copy the values for each matrix into a table similar to Table 25.

7 Mode Split

7.1 Purpose

Up to this point we have been working with person trips. Before we assign the trips in the final trip assignment step we must first convert the person trips to person auto trips and then to vehicle auto trips. In more advanced models the conversion from person trips to vehicle auto trips is accomplished through the application of a mode choice model. For areas using these guidelines simple mode split factors will be applied to first convert from person trips to person auto trips. The conversion from person auto trips to vehicle auto trips is covered in the Time-of-Day chapter.

7.2 Mode Split Factors for Internal Trip Purposes

The trip rate factors developed from the North Carolina Combined Travel Survey Database reflect person trip rates. In most small urban areas the majority of the trips are auto trips although there may be a small percentage of person trips that are non-motorized trips (walking and biking) or transit trips. This step is necessary to convert the person trip tables for the internal trip purposes (HBW, HBO, HBSCH, NHBW, and NHBO) to person auto trip tables. The conversion from person trips to person auto trips uses uniform mode share values by trip purpose from the combined travel survey. These mode shares are shown in Table 26.

TRAP: Mode shares are very specific to the availability of transit in a study area and to the walk-ability of a study area. For this reason the mode shares in Table 26 should be used with extreme caution. A more robust approach is to use Census data to determine mode share for your study area.

Table 26 Mode Shares by Trip Purpose

	Small Area		Large Area	
Purpose	**Auto**	**Non-Auto**	**Auto**	**Non-Auto**
HBW	96.9	3.1	96.4	3.6
HBO	93.2	6.8	93.7	6.3
HBSCH	98.4	1.6	93.7	6.3
NHBW	96.3	3.7	94.6	5.4
NHBO	95.8	4.2	95.2	4.8

The person auto trip tables are created by applying the following formulas to the respective person trip tables by purpose:

Small Study Areas:

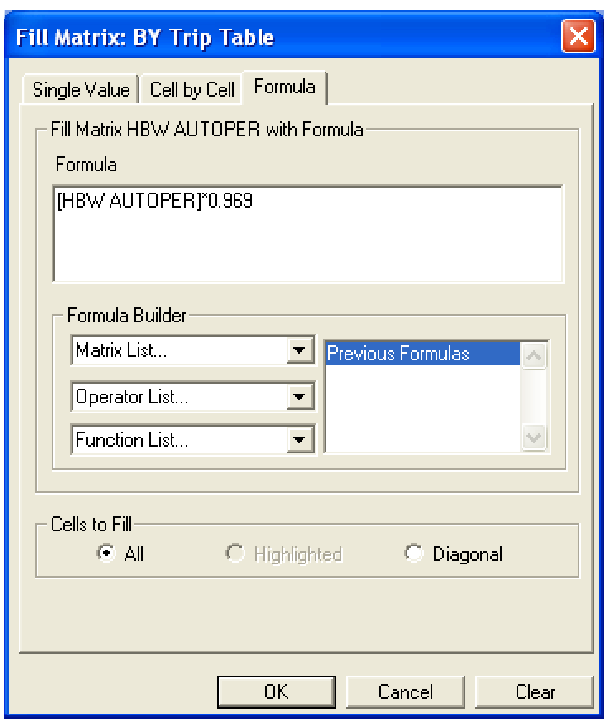
HBW: HBW trips * 0.969
HBO: HBO trips * 0.932
HBSCH: HBSCH trips * 0.984
NHBW: NHBW trips * 0.963
NHBO: NHBO trips * 0.958

Large Study Areas:

HBW:	HBW trips * 0.964
HBO:	HBO trips * 0.937
HBSCH:	HBSCH trips * 0.937
NHBW:	NHBW trips * 0.946
NHBO:	NHBO trips * 0.952

Step 1: Apply Mode Factors to Trip Tables

1. Open [**\INTERIM\PER_TRIPS.MTX]
2. **File – Save As** – File Type: Matrix – [**\INTERIM\AUTOPER_TRIPS.MTX]
3. **File – Close**
4. **File – Open** – [**\INTERIM\AUTOPER_TRIPS.MTX]
5. **Matrix – Contents** – Rename the trip purpose matrices as follows:
    a. HBW rename to: HBW AUTOPER
    b. HBO rename to: HBO AUTOPER
    c. HBSCH rename to: HBSCH AUTOPER
    d. NHBW rename to: NHBW AUTOPER
    e. NHBO rename to: NHBO AUTOPER
6. Close Matrix File Contents dialog box
7. With HBW AUTOPER as the active matrix – **Matrix – Fill – Formula** – fill with the appropriate formula from the list provided above for small and large study areas. An example for a small area is shown in the dialog box below – CLICK OK
8. Repeat this process using the appropriate formula for HBO AUTOPER, HBSCH AUTOPER, NHBW AUTOPER, and NHBO AUTOPER
9. File – Close



NOTE: You should use the Statistics command in TransCAD to assure that the calculations were performed correctly. This will show the total number of trips by purpose which you can calculate to assure accuracy.

8 Commercial Vehicles

8.1 Purpose

Thus far in the procedures we have been dealing only with internal trip purposes, or trips made by households in the study area that stay in the study area. Before proceeding to trip assignment there are two other trip types that we must address – commercial vehicle trips and external trips. Commercial vehicle trips are covered in this chapter and external trips are covered in Chapter 9.

8.2 Commercial Vehicle Trips

Commercial vehicle modeling is designed to capture the trips in the system related to commercial travel. These trips include trips made by commercial autos/vans (CV1), commercial pick-up trucks (CV2), and all other trucks (CV3). The process for commercial vehicle modeling is similar to the trip generation and trip distribution steps followed already for the internal trip purposes.

8.3 Trip Generation

The form of the trip production model and the trip attraction model for commercial vehicles is the regression model. The trip production and attraction rates were provided by NCDOT and were based on a commercial vehicle survey conducted in the Triad Region of North Carolina in the mid-90s. The trip production rates are based on vehicles by vehicle type and employment type and are shown in Table 27. The trip attraction rates are also based on employment by employment type and households for each vehicle type. These rates are shown in Table 28.

Table 27 Commercial Vehicle Trip Production Rates (trips/vehicle)

CV Trip Production Rates	Industry CV	Retail CV	HwyRetail CV	Service CV	Office CV
Autos/Vans (CV1)	2.49	2.89	2.89	3.43	3.43
Pickups (CV2)	4.19	5.81	5.81	4.32	4.32
Trucks (CV3)	6.62	7.86	7.86	7.44	7.44

Table 28 Commercial Vehicle Trip Attraction Rates (trips/employee)

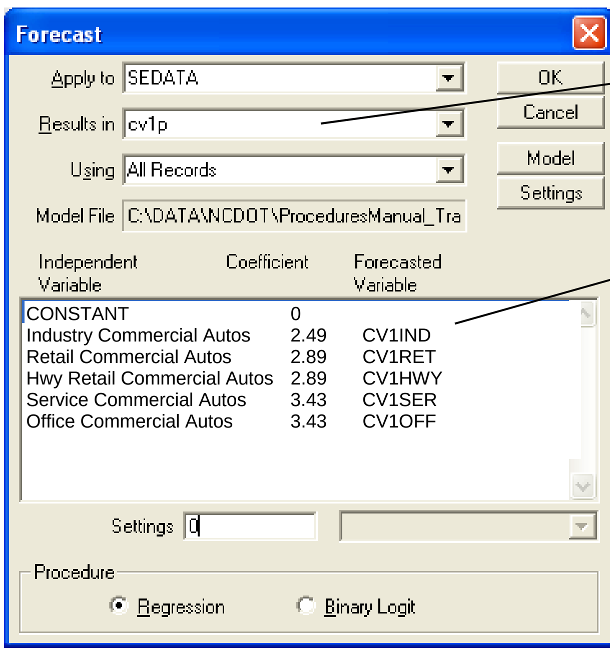
CV Trip Attraction Rates	Industry EMP	Retail EMP	HwyRetail EMP	Service EMP	Office EMP	Households
Autos/Vans (CV1)	0.20	0.33	0.25	0.10	0.12	0.020
Pickups (CV2)	0.30	0.40	0.33	0.25	0.13	0.012
Trucks (CV3)	0.75	0.67	0.50	0.21	0.23	0.039

Step 1: Copy all support files to proper locations

If this is the first time you have applied the trip generation model using these procedures, you will need to confirm that the production and attraction model files are in the PARAMETERS folder.

Step 2: Calculate CV1 Zonal Productions

1. If [**\INPUT*_SEDATA.BIN] is not already open, open it now
2. **Planning – Trip Productions – Apply a Model**
3. Select Model File [PARAMETERS\CV1PROD.MOD]
   TIP: If this is the first time you have run the procedure for CV1, you will need to manually specify all the settings for the procedure. You can then save these settings into a settings file for use the next time you run procedure.
4. The dialog box fields will be populated to match the screen shot below.



Put the results into the field for CV1 productions

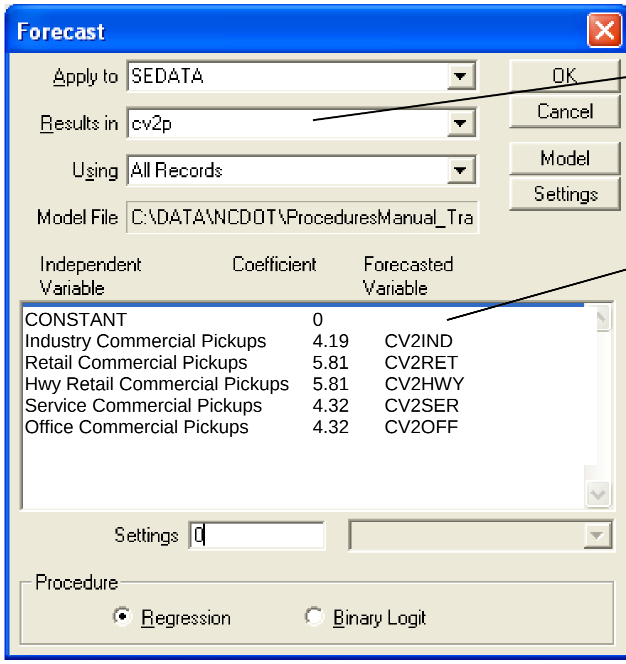
These are the coefficients from the MOD file. **TRAP:** Be sure that all independent variables are matched with forecasted variables from SEDATA.BIN.

5. Click on the **Settings** button – Click on the Green Plus Sign to add a new setting – Name the Setting and give it a Description – CLICK OK
   TIP: This saves your settings for later use so that you do not need to manually enter the settings again for the standard NCDOT model.
6. CLICK OK – the model now runs and the results are output directly to SEDATA.BIN – close the results summary to view the results

Step 3: Calculate CV2 Zonal Productions

1. **Planning – Trip Productions – Apply a Model**
2. Select Model File [PARAMETERS\CV2PROD.MOD]
   TIP: If this is the first time you have run the procedure for CV2, you will need to manually specify all the settings for the procedure. You can then save these settings into a settings file for use the next time you run procedure.

3. The dialog box fields will be populated to match the screen shot below.



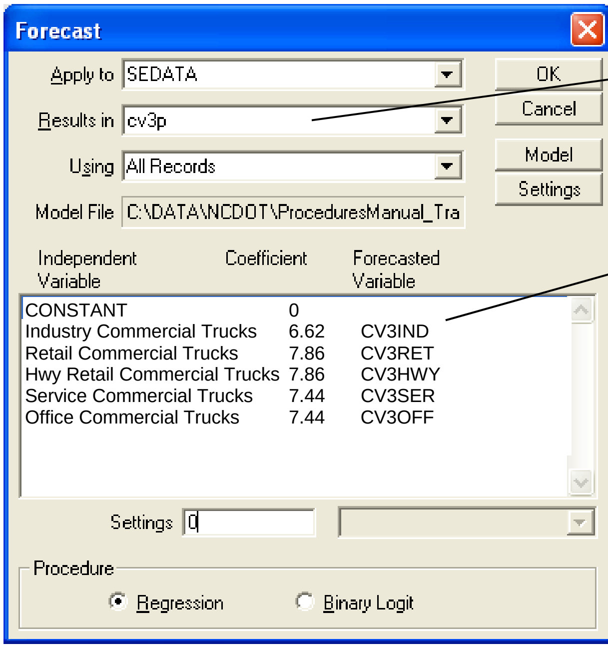
Put the results into the field for CV2 productions

These are the coefficients from the MOD file. **TRAP:** Be sure that all independent variables are matched with forecasted variables from SEDATA.BIN.

4. Click on the **Settings** button – Click on the Green Plus Sign to add a new setting – Name the Setting and give it a Description – CLICK OK
   TIP: This saves your settings for later use so that you do not need to manually enter the settings again for the standard NCDOT model.
5. CLICK OK – the model now runs and the results are output directly to SEDATA.BIN – close the results summary to view the results

Step 4: Calculate CV3 Zonal Productions

1. **Planning – Trip Productions – Apply a Model**
2. Select Model File [PARAMETERS\CV3PROD.MOD]
   TIP: If this is the first time you have run the procedure for CV3, you will need to manually specify all the settings for the procedure. You can then save these settings into a settings file for use the next time you run procedure.
3. The dialog box fields will be populated to match the screen shot below.



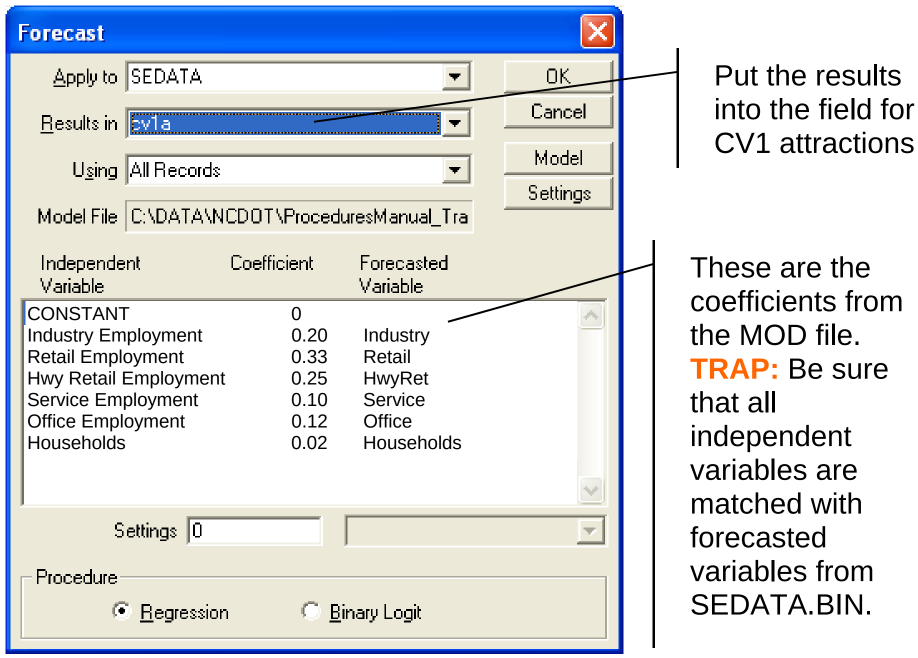
Put the results into the field for CV3 productions

These are the coefficients from the MOD file. **TRAP:** Be sure that all independent variables are matched with forecasted variables from SEDATA.BIN.

4. Click on the **Settings** button – Click on the Green Plus Sign to add a new setting – Name the Setting and give it a Description – CLICK OK
   TIP: This saves your settings for later use so that you do not need to manually enter the settings again for the standard NCDOT model.
5. CLICK OK – the model now runs and the results are output directly to SEDATA.BIN – close the results summary to view the results

Step 5: Calculate CV1 Zonal Attractions

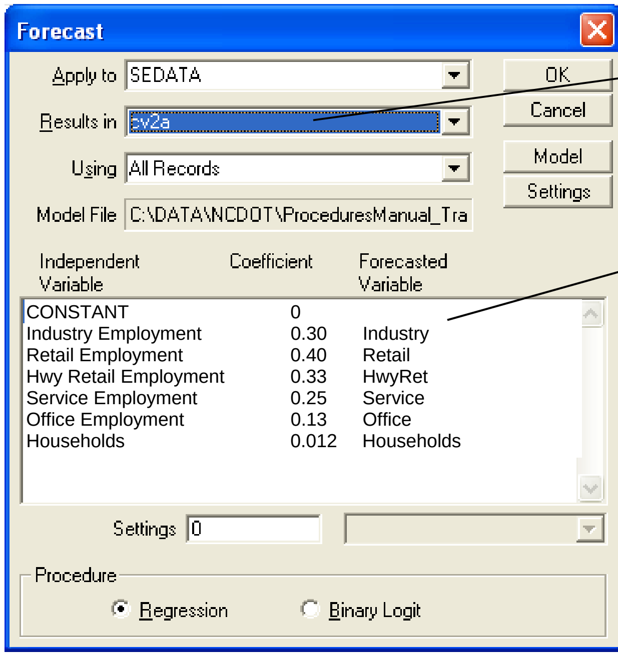
1. **Planning – Trip Attractions – Apply a Model**
2. Select Model File [PARAMETERS\CV1ATTR.MOD]
   TIP: If this is the first time you have run the procedure for CV1, you will need to manually specify all the settings for the procedure. You can then save these settings into a settings file for use the next time you run procedure.
3. The dialog box fields will be populated to match the screen shot below.



4. Click on the **Settings button** – Click on the Green Plus Sign to add a new setting – Name the Setting and give it a Description – CLICK OK
   TIP: This saves your settings for later use so that you do not need to manually enter the settings again for the standard NCDOT model.
5. CLICK OK – the model now runs and the results are output directly to SEDATA.BIN – close the results summary to view the results

Step 6: Calculate CV2 Zonal Attractions

1. **Planning – Trip Attractions – Apply a Model**
2. Select Model File [PARAMETERS\CV2ATTR.MOD]
   TIP: If this is the first time you have run the procedure for CV2, you will need to manually specify all the settings for the procedure. You can then save these settings into a settings file for use the next time you run procedure.
3. The dialog box fields will be populated to match the screen shot below.



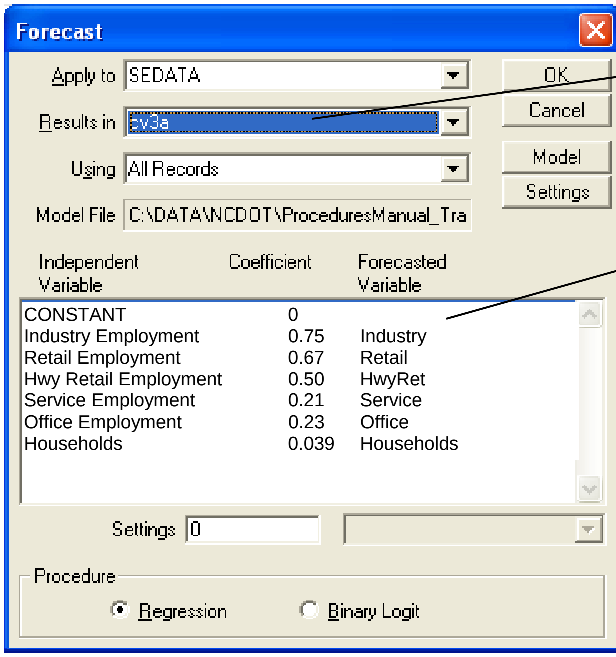
Put the results into the field for CV2 attractions

These are the coefficients from the MOD file. **TRAP:** Be sure that all independent variables are matched with forecasted variables from SEDATA.BIN.

4. Click on the **Settings** button – Click on the Green Plus Sign to add a new setting – Name the Setting and give it a Description – CLICK OK
   TIP: This saves your settings for later use so that you do not need to manually enter the settings again for the standard NCDOT model.
5. CLICK OK – the model now runs and the results are output directly to the SEDATA.BIN – close the results summary to view the results

Step 7: Calculate CV3 Zonal Attractions

1. **Planning – Trip Attractions – Apply a Model**
2. Select Model File [PARAMETERS\CV3ATTR.MOD]
   TIP: If this is the first time you have run the procedure for CV3, you will need to manually specify all the settings for the procedure. You can then save these settings into a settings file for use the next time you run procedure.
3. The dialog box fields will be populated to match the screen shot below.



Put the results into the field for CV3 attractions

These are the coefficients from the MOD file. **TRAP:** Be sure that all independent variables are matched with forecasted variables from SEDATA.BIN.

4. Click on the **Settings** button – Click on the Green Plus Sign to add a new setting – Name the Setting and give it a Description – CLICK OK
   TIP: This saves your settings for later use so that you do not need to manually enter the settings again for the standard NCDOT model.
5. CLICK OK – the model now runs and the results are output directly to SEDATA.BIN – close the results summary to view the results

Step 8: Reasonableness Checking

1. **NOTE:** Before balancing the Productions and Attractions, it is important to perform reasonableness checks of the results.
2. Use the **Compute Statistics** button on the tool bar to create a summary of the trip generation results. A table such as the one shown in Table 29 can be used to review the reasonableness of your model results.

Table 29 Commercial Vehicle Trip Generation Reasonableness Checks

Trip Purpose	Productions	Attractions	Normalization Factor (P/A ratio)
CV1	2270	4784	0.47
CV2	2011	6986	0.29
CV3	4987	13282	0.38
TOTAL	9269	25053	0.37

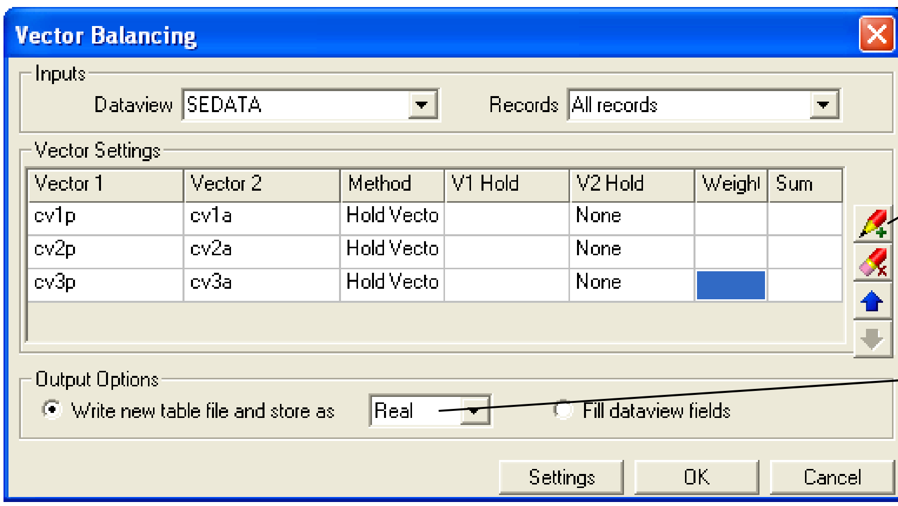
GUIDELINES:

- *Normalization factor should be between 0.9 and 1.1*

3. You can also create a thematic map of the productions and attractions and compare this to your knowledge of the study area to see if you are getting productions and attractions where you would expect based on the land use in the study area.

Step 9: Balance Productions and Attractions

1. **Planning – Balance**
   TIP: If this is the first time you have run the Balancing procedure, you will need to manually specify all the settings for the procedure. You can then save these settings into a settings file for use the next time you run the procedure.
2. The dialog box fields shown below should be populated to match the settings shown in Table 30.



Use this button to add

Be sure to select the option for writing a new table as Real

Table 30 Vector Settings for Commercial Vehicles

Vector 1	Vector 2	Method	V2 Hold
cv1p	cv1a	Hold Vector 1	None
cv2p	cv2a	Hold Vector 1	None
cv3p	cv3a	Hold Vector 1	None

3. Click on the **Settings** Tab – Click on the Green Plus Sign to add a new setting – Name the Setting and give it a Description – CLICK OK
   TIP: This saves your settings for later use so that you do not need to manually enter the settings again for the standard NCDOT model.
4. CLICK OK – Save the file as [**\OUTPUT\BALANCE_CV.BIN]
5. Close Results Summary dialog box
6. To verify balancing you can look at the table statistics by selecting the **Compute Statistics** button from the tool bar – the sum of the productions and attractions by commercial vehicle type should now be equal

8.4 *Trip Distribution*

Trips are distributed using the gravity model, the NHB generalized cost skims, and the NHB default gamma coefficients derived from the North Carolina Combined Survey Database.

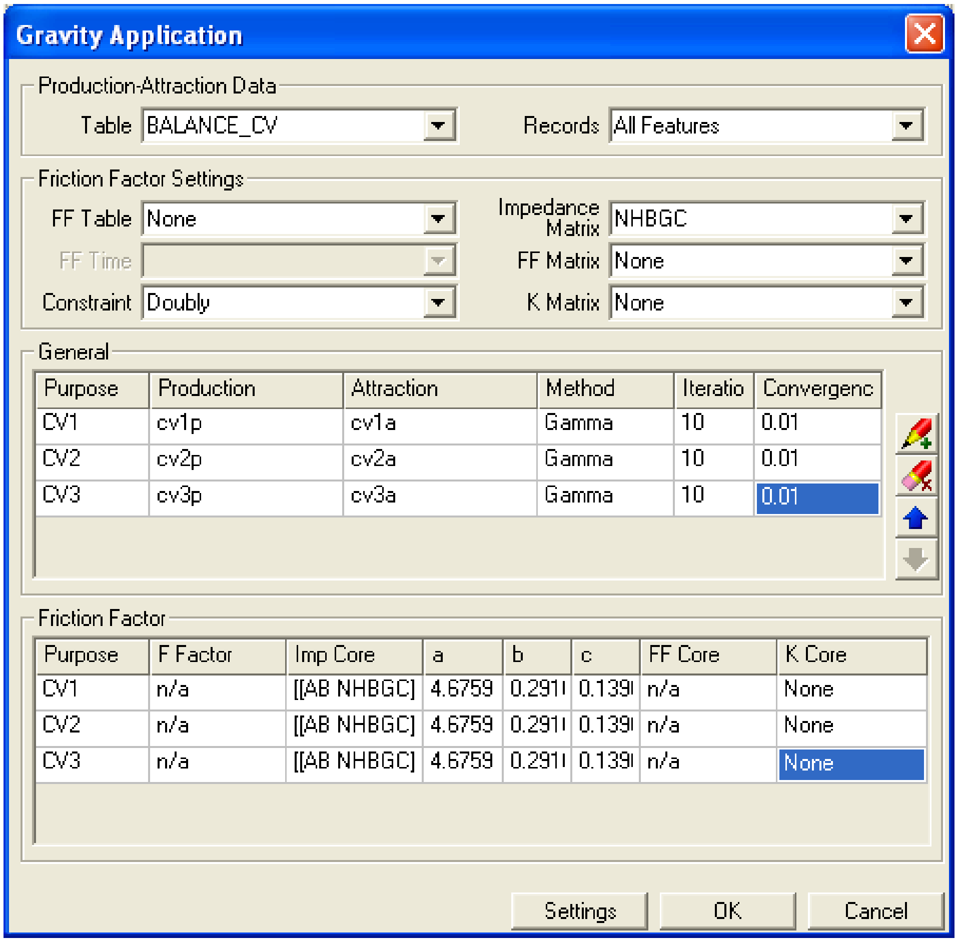
Step 1: Apply Gravity Model for Commercial Vehicles

1. If not already open, open the BIN file with the final balanced productions and attractions [**\OUTPUT\BALANCE_CV.BIN]
2. Open the Generalized Cost Matrix [**\INTERIM\GENCOST.MTX]
3. **Planning – Trip Distribution – Gravity Application**
4. Fill out the dialog box for the Gravity Application [See Table 31 and Screen Shot below]
    a. Production-Attraction data is in BALANCE_CV
    b. Impedance Matrix is NHBGC
    c. Add a trip purpose for each of the trip purposes in your file
    d. Add the associated impedance core for each trip purpose
        i. CV1: NHBGC
        ii. CV2: NHBGC
        iii. CV3: NHBGC
    e. Add the associated gamma coefficients for each trip purpose, for example:
        i. CV1: a = 4.6759, b = 0.2916, c = 0.1390
        ii. CV2: a = 4.6759, b = 0.2916, c = 0.1390
        iii. CV3: a = 4.6759, b = 0.2916, c = 0.1390
5. Click on the **Settings** button – Click on the Green Plus Sign to add a new setting – Name the Setting and give it a Description – CLICK OK
   TIP: This saves your settings for a later use so that you do not need to manually enter the settings again for the standard NCDOT model.

Table 31 Gravity Application Dialog Box Field Specifications for CV

Trip Purpose	Production	Attraction	Impedance Core	a	b	c
CV1	cv1p	cv1a	[AB NHBGC]/[BA NHBGC]	4.6759	0.2916	0.1390
CV2	cv2p	cv2a	[AB NHBGC]/[BA NHBGC]			
CV3	cv3p	cv3a	[AB NHBGC]/[BA NHBGC]			

coefficients



6. CLICK OK – Save as: [**\INTERIM\CV_TRIPS.MTX], Label = CV Trip Table
7. Review Results dialog box to see if all trip purposes converged – Close
8. Close Results Summary
9. The resulting output is a matrix file with a trip table for every trip purpose specified

Step 2: Reasonableness Checking

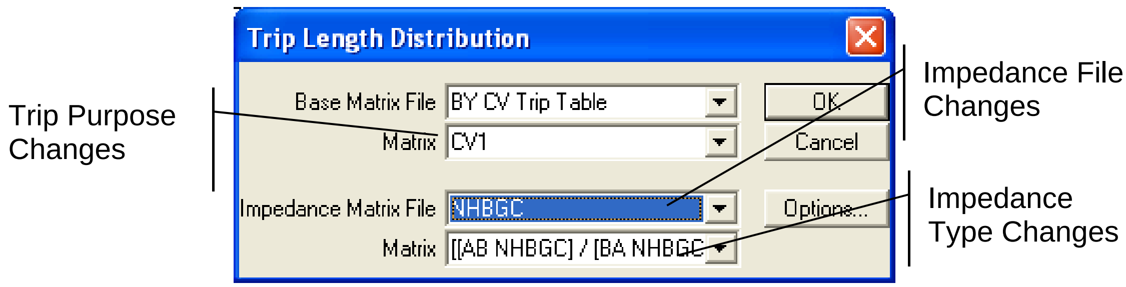
Before moving forward to the next step, it is important to review the results of the Gravity Model Application in order to assess the reasonableness of the output. To check the reasonableness of your results the following checks are recommended:

1. Plot and review the trip length distribution for time, distance, and generalized cost;
2. Tabulate and review the average trip length by time, distance, and generalized cost; and
3. Calculate and review the percent Intrazonal.

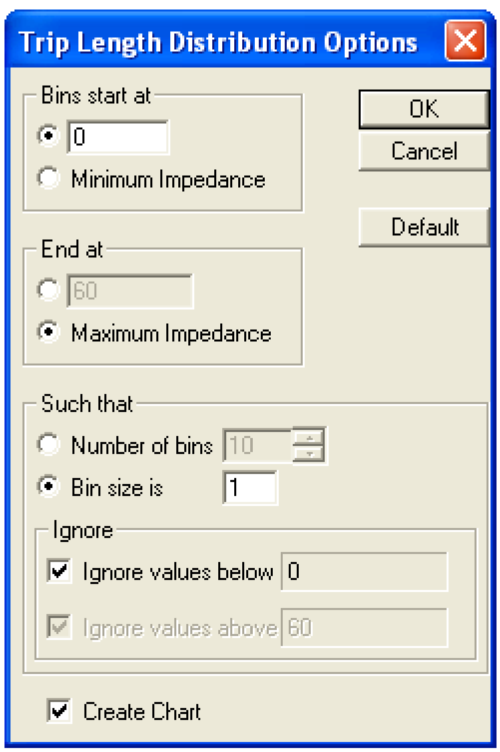
Step 3: Trip Length Distribution and Average Trip Length

1. If not already open, open the NHB generalized cost matrix. [**\INTERIM\NHBGC_PATH.MTX]
2. If not already open, open [**\INTERIM\CV_TRIPS.MTX]

3. TIP: The next series of steps is repeated once for each trip purpose (CV1, CV2, and CV3) and impedance type (Generalized Cost, Initial Time, and Length). The values in bold italics will change accordingly.
4. **Planning – Trip Distribution – Trip Length Distribution**
    a. Base Matrix File: CV Trip Table
    b. Matrix: ***CV1***
    c. Impedance Matrix File: ***NHBGC***
    d. Matrix: [***AB NHBGC]/[BA NHBGC***]



5. Options



6. CLICK OK – CLICK OK – Save file as [**\INTERIM***CV1***_TLD_**], where ** changes based on the impedance value used. For example GC (Generalized Cost), TT (Travel Time), and DI (Distance)
7. Click "Show Report" button in Results Summary dialog box and scroll down to the bottom of the report

8. Record values in Table (See Table 32 for an example)
    a. Minimum Trip Length
    b. Maximum Trip Length
    c. Average Trip Length
    d. Standard Deviation
9. CLICK OK
10. Review the Chart for Reasonableness. **TIP:** Data can also be exported to Excel for graphing and review.

Table 32 Example Table for Recording CV Trip Length Data

Purpose	Generalized Cost	Travel Time	Distance	% Intrazonal	Converged (Y/N)	Gamma
CV1	11.17	7.12	3.21	24%	Y	a = 4.6759 b = 0.2916 c = 0.1390
CV2	11.87	7.54	3.41	27%	Y	a = 4.6759 b = 0.2916 c = 0.1390
CV3	12.06	7.67	3.45	32%	Y	a = 4.6759 b = 0.2916 c = 0.1390

Step 4: Calculate Intrazonal Percentages

1. With [**\INTERIM\CV_TRIPS.MTX] as the active file – **Matrix – Statistics**
2. Copy the values for each matrix into a table similar to Table 32.

9 External Trips

9.1 Purpose

External travel can be defined as through traffic, external-internal traffic, and internal-external traffic. Through traffic is defined as having both trip ends external to the study area. External-internal or internal-external travel is defined as having one trip end external to the study area. For external through travel a base year trip table is created from actual survey data and then "growth factored" to the future. For external-internal and internal-external travel a common approach is to develop a basic two-step model (trip generation and trip distribution) specifically for external travel. Through trips are referred to as EE trips and external-internal/internal-external trips are referred to as IX trips in these procedures.

9.2 Through Trips

In lieu of local survey data the NCDOT SYNTH program is the recommended approach for estimating through trips. This procedure is documented in the NCDOT Technical Report #3 and also in the report *<u>Synthesized Through Trip Table for Small Urban Areas</u>, David G. Modlin, Transportation Research Record 842, Transportation Research Board, National Research Council, Washington, D.C., 1982*.

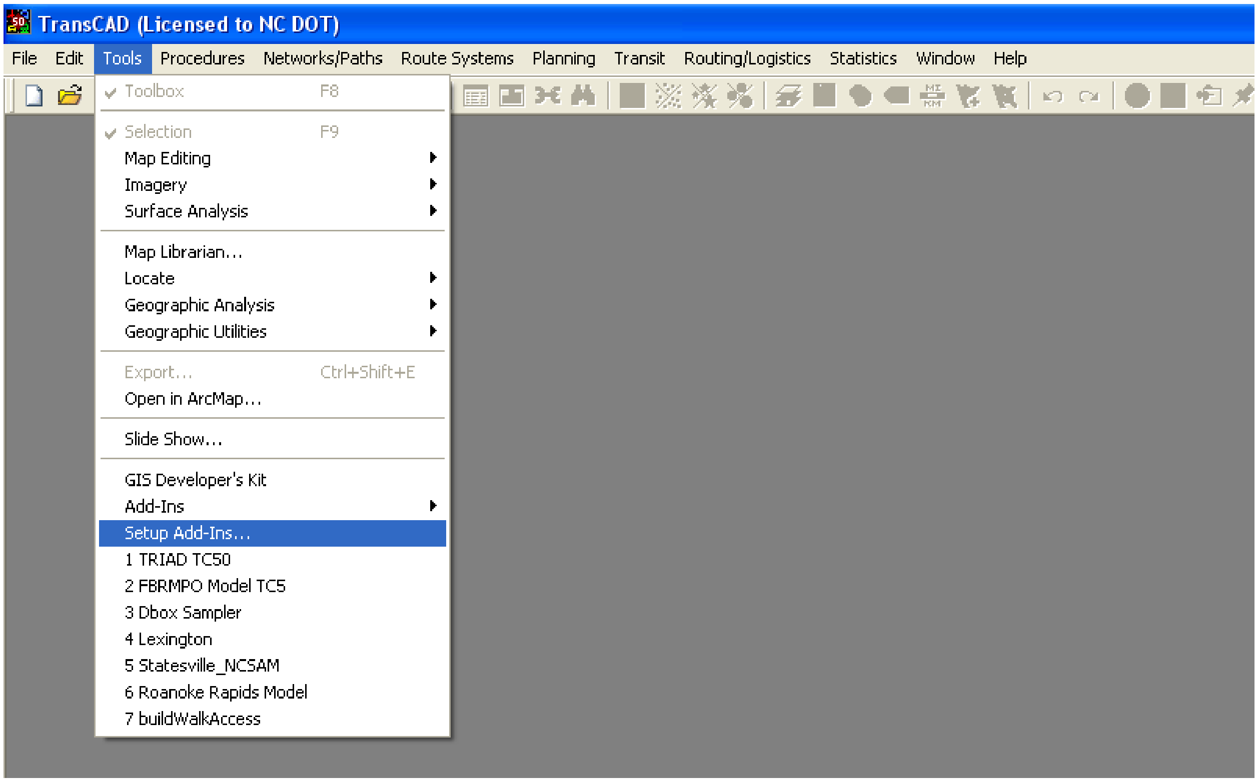
This method is only valid for small urban areas where the population is under 50,000. It should be noted that in areas where the population is less than 8-10,000, the estimated through trips may be incorrect due to the data that was used when the equations were developed. In any case, it is important to understand that the through trip percentages that are estimated from the SYNTH should be used as a starting point of reference and should be adjusted based on your knowledge of the area.

Setup of SYNTH Program

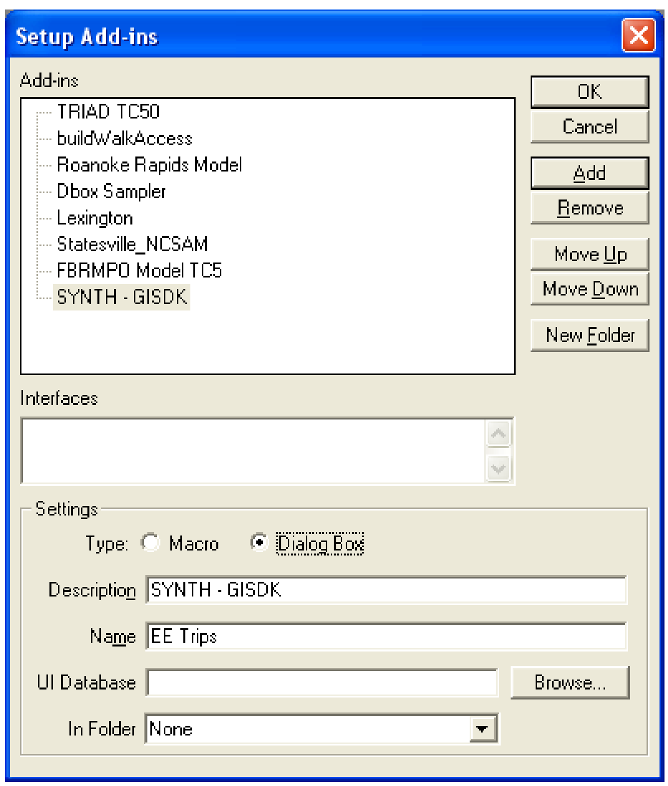
Step 1: Copy and paste seven files: synth.1, synth.2, synth.3, synth.4, synth.5, synth.6, and synth.dbd, into any folder you want (for example, C:\DATA\SYNTH).

Step 2: Setup Add-Ins

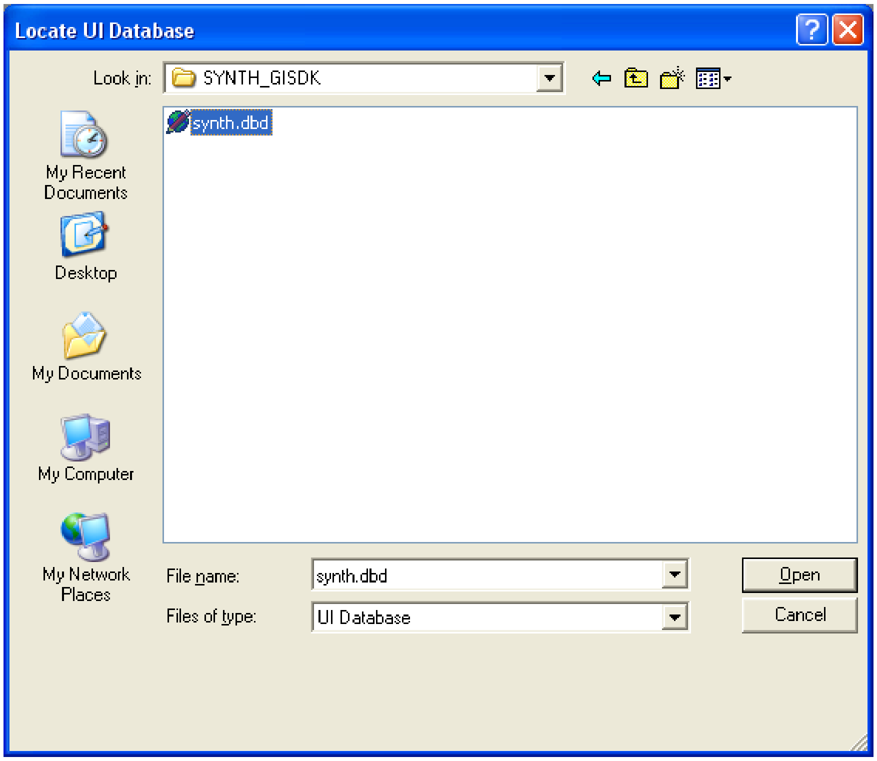
1. ***Tools/ Setup Add-Ins***.
2. Click 'Add' button.
3. Fill the dialog box with the following info:
   a. Type: Dialog Box
   b. Description: SYNTH – GISDK
   c. Name: EE Trips
4. Click 'Browse' button.
5. Browse SYNTH.DBD and click 'Open' button.
6. Click 'OK' button.



Tools/Setup Add-Ins…

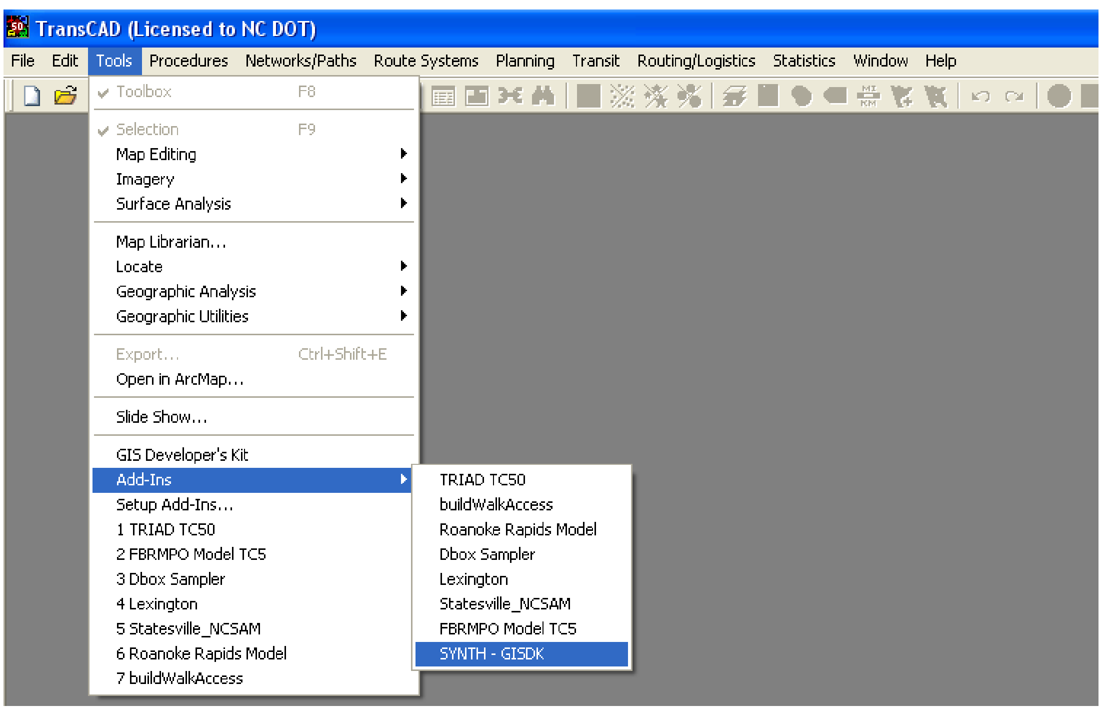


Fill the dialog box and click on ‘Browse’ button



Browse SYNTH.DBD and click ‘Open’ button

After following the steps listed above, SYNTH – GISDK is ready to use. The Add-in should be listed in ***Tools/Add-Ins*** as shown below.



SYNTH – GISDK listed in Add-Ins

Application

The procedure outlined in this section contains two parts:
1)Part 1 is the pre-processing part-This section explains how to prepare the input files needed for SYNTH
2) Part 2 isrunning the SYNTH – GISDK program. This explains how to run the program to produce the necessary output files.

9.3 Pre-processing

SYNTH – GISDK is designed to take user specified socio-economic input data. The following steps guide users on how to properly specify the required input data.

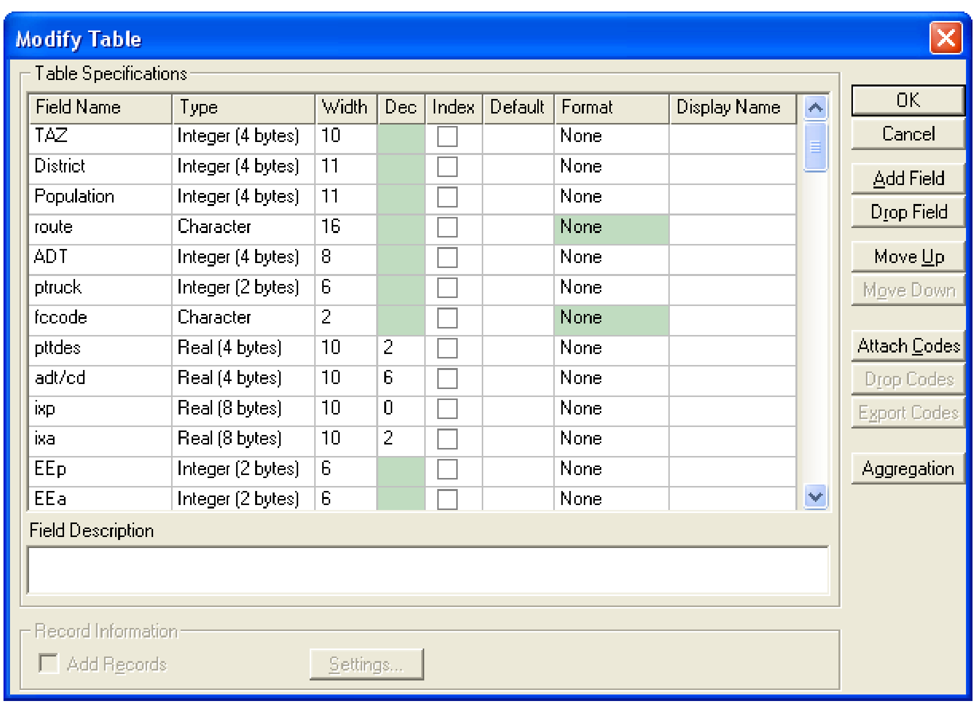
Step 1: Open SE Data in TransCAD.

1. ***File/Open***
2. Change Files of type to Fixed-format Binary (*.bin), Browse SE Data, and click 'Open' button.

Step 2: Add required fields in SE Data

1. ***Dataview/Modify Table…***
2. Click 'Add Field' button to add a field. .
3. Fill 'Field Name,' 'Type,' 'Width,' and 'Decimals.' See Table 33
4. Do 2 and 3 for all fields listed in Table 3.1. If a field already exists in SE Data, then it should not be added again.

Trap: If the SE Data does not include external stations, same number of records as number of external stations needs to be added.



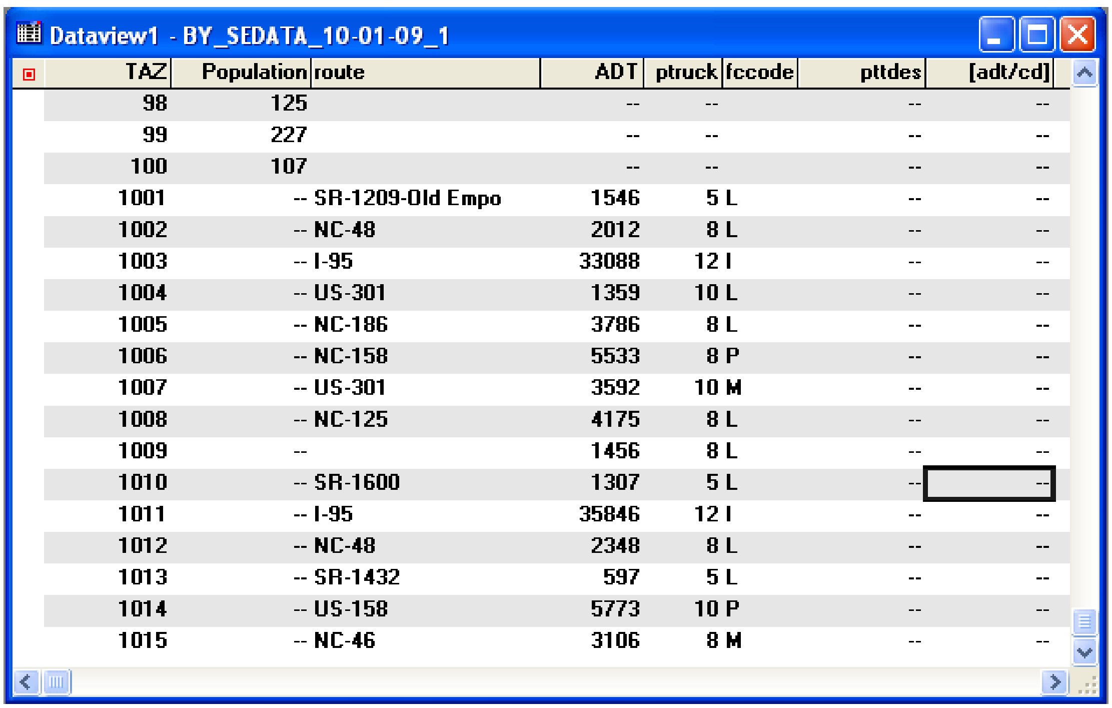
Add fields and fill 'Field Name,' 'Type,' 'Width,' and 'Decimals'

Table 33 Required Fields

Field Name	Type	Width	Dec
fccode	Character	2	
ptruck	Integer (2 bytes)	6	
route	Character	16	
ADT	Integer (4 bytes)	8	
adt/cd	Real (4 bytes)	10	6
pttdes	Real (4 bytes)	10	2
ixp	Real (8 bytes)	10	2
EEp	Integer (2 bytes)	6	

Step 3: Fill *route, ADT, ptruck*, and *fccode* fields added in Step 2.

1. Fill route name (or description) in *route* field for each station.
2. Fill ADT count in *ADT* field for each station.
3. Fill percent of trucks in *ptruck* field for each station.
4. Fill function classification code in *fccode* field for each station. See Table 34 for functional classification code.



Dataview1 - BY_SEDATA_10-01-09_1

TAZ	Population	route	ADT	ptruck	fccode	pttdes	[adt/cd]
98	125		--	--		--	--
99	227		--	--		--	--
100	107		--	--		--	--
1001	--	SR-1209-Old Empo	1546	5	L	--	--
1002	--	NC-48	2012	8	L	--	--
1003	--	I-95	33088	12	I	--	--
1004	--	US-301	1359	10	L	--	--
1005	--	NC-186	3786	8	L	--	--
1006	--	NC-158	5533	8	P	--	--
1007	--	US-301	3592	10	M	--	--
1008	--	NC-125	4175	8	L	--	--
1009	--		1456	8	L	--	--
1010	--	SR-1600	1307	5	L	--	--
1011	--	I-95	35846	12	I	--	--
1012	--	NC-48	2348	8	L	--	--
1013	--	SR-1432	597	5	L	--	--
1014	--	US-158	5773	10	P	--	--
1015	--	NC-46	3106	8	M	--	--

Filling *route, ADT, ptruck*, and *fccode* fields

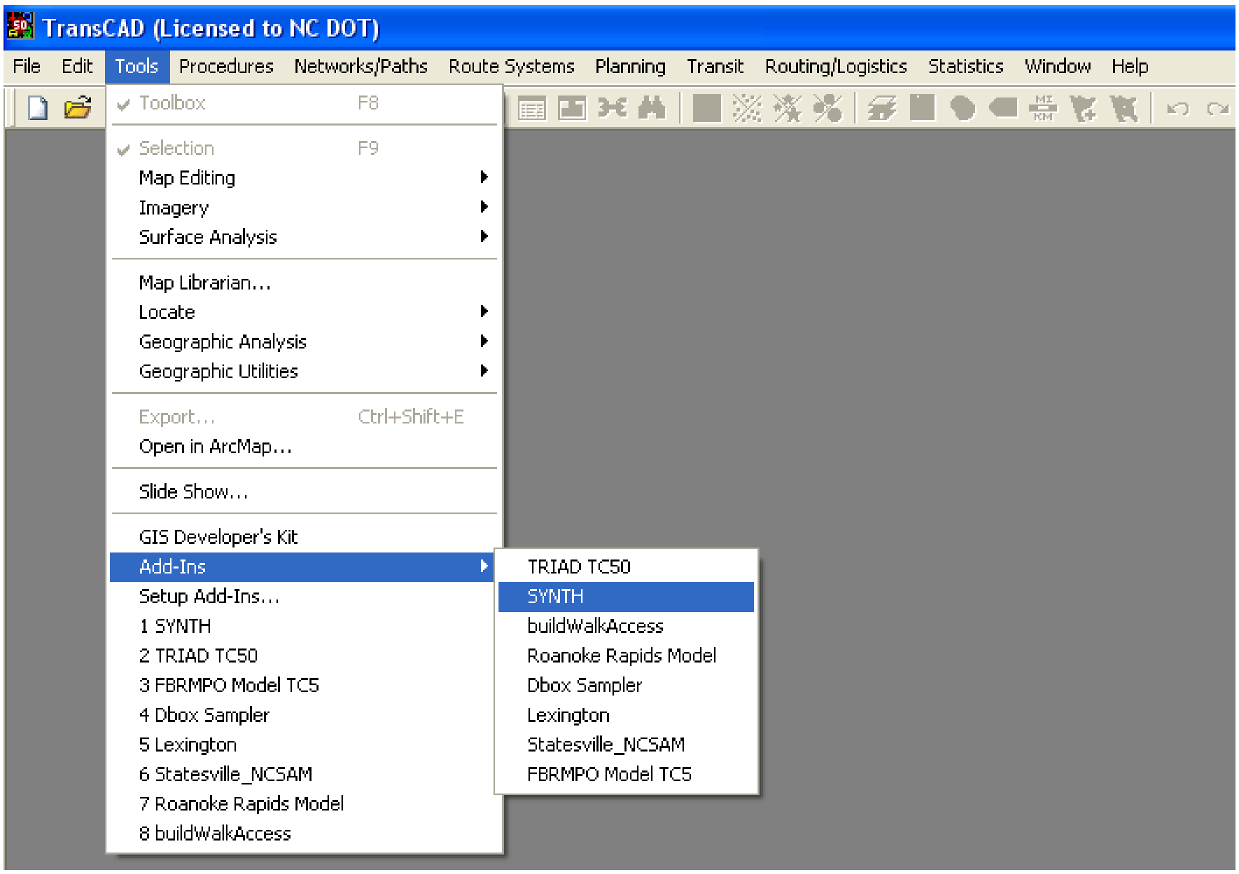
Table 34 SYNTH Functional Classification Codes

Functional Classification	Code
Interstate	I
Principal Arterial	P
Minor Arterial	M
Major Collector	J
Minor Collector/Local Road	L

9.4 *Running SYNTH – GISDK*

Before running SYNTH – GISDK, *ixa* field should be populated. The GUI of SYNTH – GISDK provides three Tabs including Input Tab, % Thru Trips Tab, and Route Continuity Tab. Each Tab needs to be followed in the order of Input Tab, % Thru Trips Tab, and Route Continuity Tab to run SYNTH – GISDK successfully. Following sub-sections are describing steps that users should follow on each Tab.

Step 0: Launch the SYNTH – GISDK -***Tools/Add-Ins/ SYNTH – GISDK.***

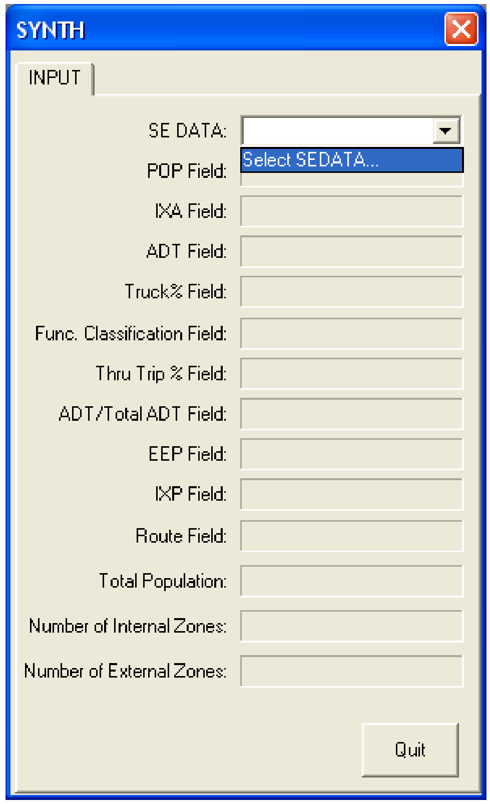


Launch SYNTH – GISDK

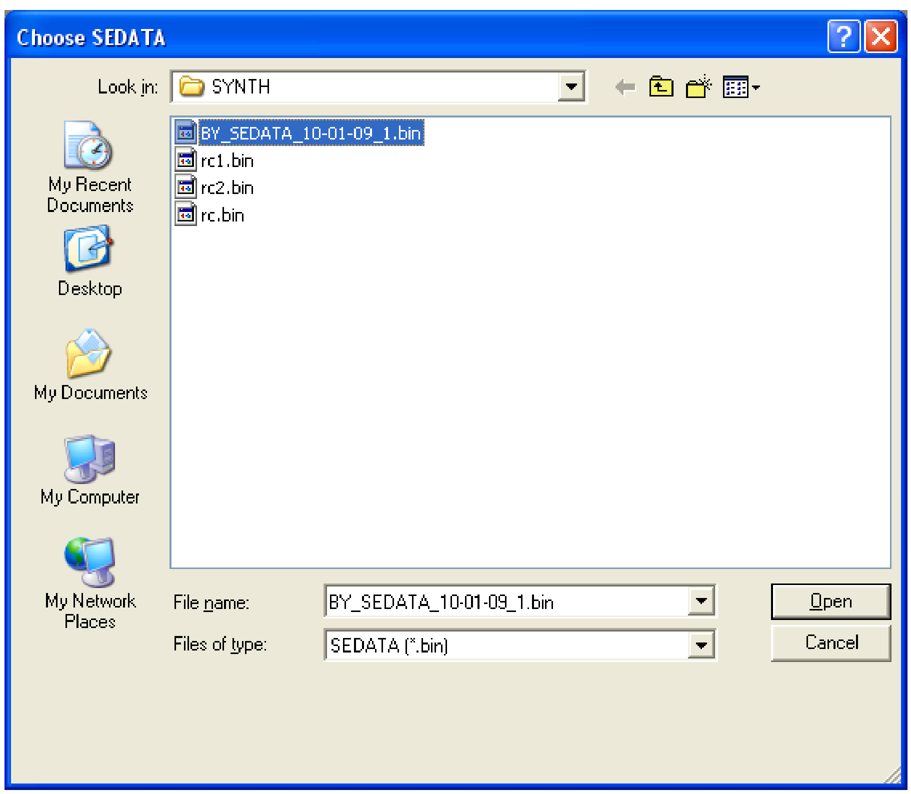
On the Input Tab

Step 1: Open SE Data in the SYNTH – GISDK.

- Use dropdown menu for SE DATA to open SE Data. If SE Data was open before launching the SYNTH – GISDK, then the SE Data will show up in the dropdown list. Otherwise, 'Select SE Data' from the dropdown list should be selected to open SE Data.
- Browse SE Data and click 'Open' button.



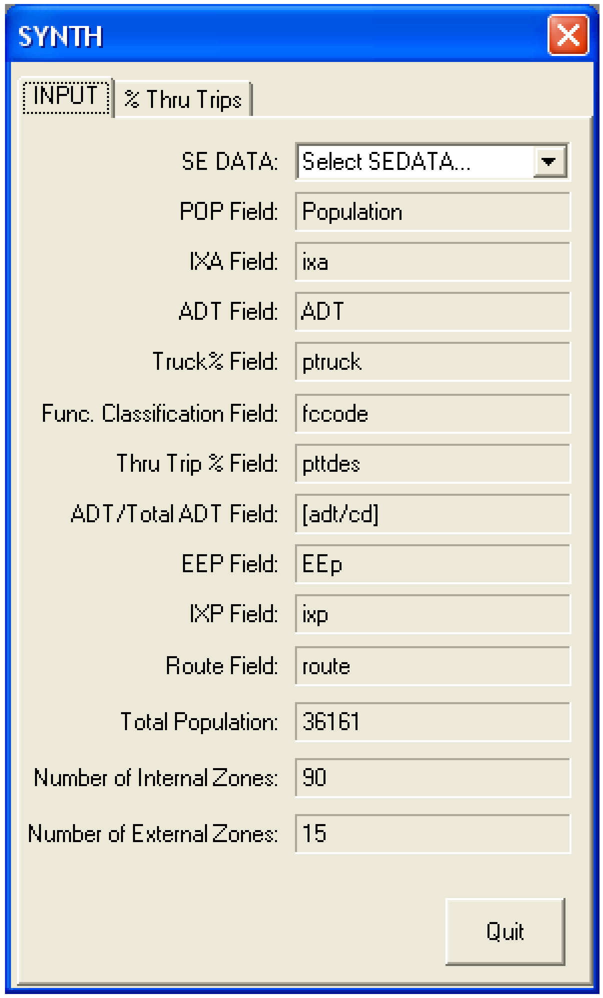
Input Tab on SYNTH – GISDK



Browse SE Data to open

Step 2: Review information on the Input Tab. Once SE Data open, all required information listed on the Input Tab will be automatically populated. Please check each item to see if they are populated correctly

Trap: If *Population* field has '0' for external stations, number of external stations will not be detected correctly. Select those cells and clear '0' values.



Populated Input Tab

On the % Thru Trips Tab

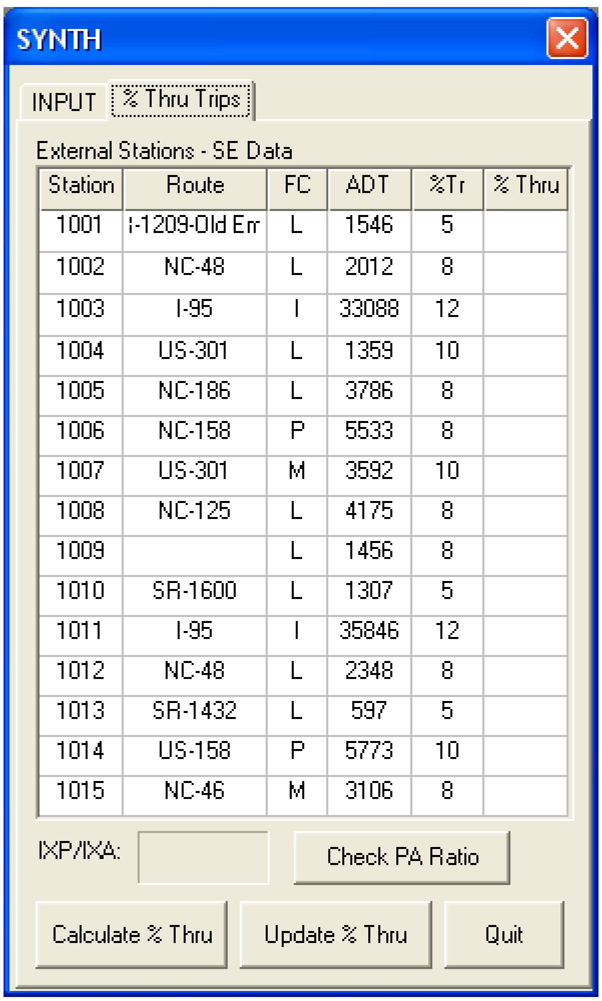
Step 1: Click on the % Thru Trips Tab.

Step 2: Calculate % Thru Trips.

- Click 'Calculate % Thru' button.
- Check IXP/IXA Ratio. If the ratio is close to '1,' then go to the Route Continuity Tab. Otherwise go to Step 3.

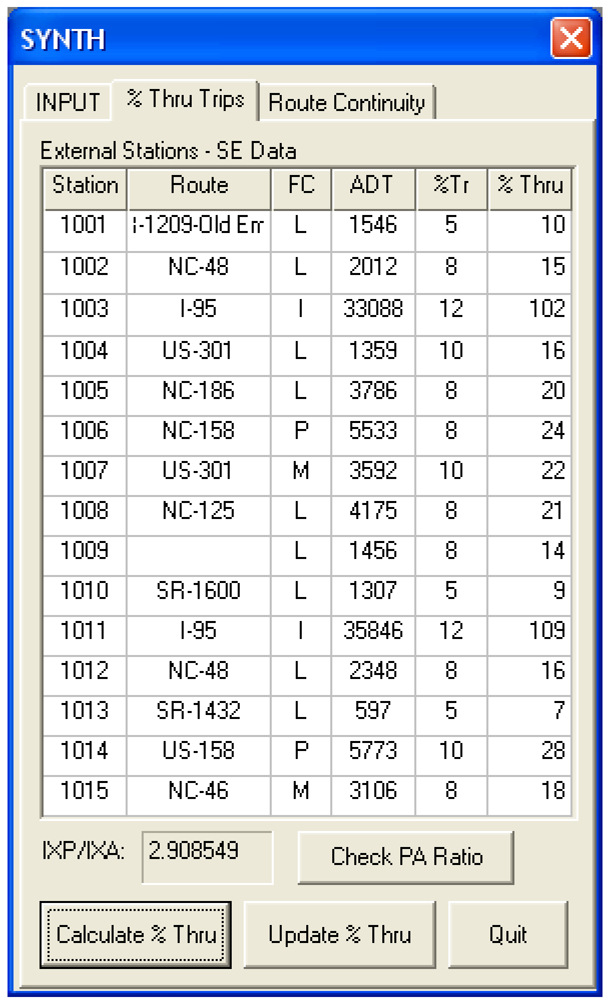
Step 3: Adjust % Thru Trips.

- Click on a cell containing % Thru Trips for an external station and type desired % Thru Trips. If there are several external stations need to be updated with % Thru Trips, change % Thru Trips for all of them before clicking 'Update % Thru' button.
- Click 'Update % Thru' button.
- Check IXP/IXA Ratio. If the ratio is close to '1,' then go to the Route Continuity Tab. Otherwise do Step 3 iteratively until the ratio is close to 1.



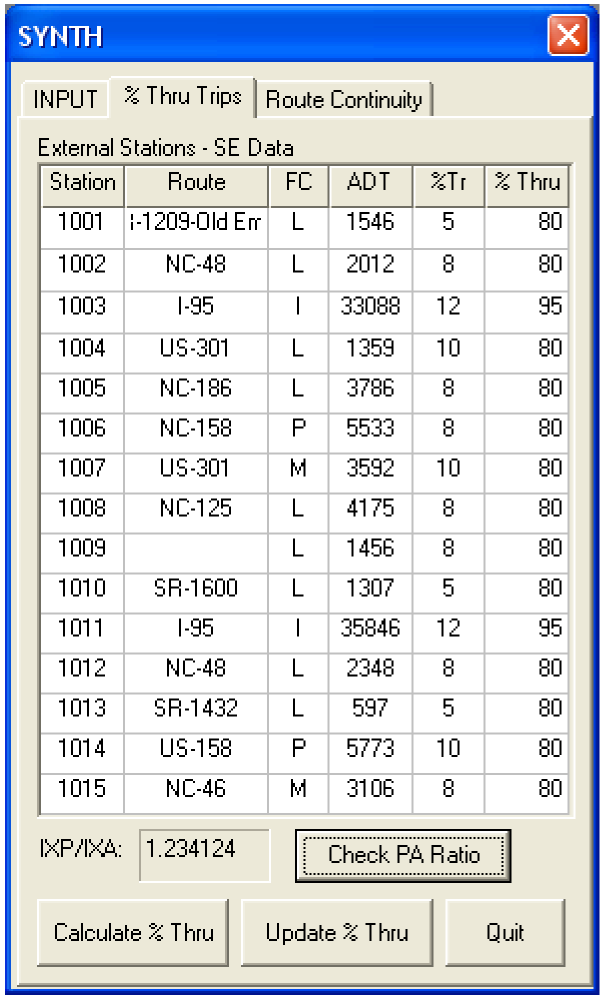
Station	Route	FC	ADT	%Tr	% Thru
1001	I-1209-Old Em	L	1546	5	
1002	NC-48	L	2012	8	
1003	I-95	I	33088	12	
1004	US-301	L	1359	10	
1005	NC-186	L	3786	8	
1006	NC-158	P	5533	8	
1007	US-301	M	3592	10	
1008	NC-125	L	4175	8	
1009		L	1456	8	
1010	SR-1600	L	1307	5	
1011	I-95	I	35846	12	
1012	NC-48	L	2348	8	
1013	SR-1432	L	597	5	
1014	US-158	P	5773	10	
1015	NC-46	M	3106	8	

% Thru Trips Tab



Station	Route	FC	ADT	%Tr	% Thru
1001	I-1209-Old Em	L	1546	5	10
1002	NC-48	L	2012	8	15
1003	I-95	I	33088	12	102
1004	US-301	L	1359	10	16
1005	NC-186	L	3786	8	20
1006	NC-158	P	5533	8	24
1007	US-301	M	3592	10	22
1008	NC-125	L	4175	8	21
1009		L	1456	8	14
1010	SR-1600	L	1307	5	9
1011	I-95	I	35846	12	109
1012	NC-48	L	2348	8	16
1013	SR-1432	L	597	5	7
1014	US-158	P	5773	10	28
1015	NC-46	M	3106	8	18

% Thru Trips Tab with initial % of thru trips



Station	Route	FC	ADT	%Tr	% Thru
1001	i-1209-Old Em	L	1546	5	80
1002	NC-48	L	2012	8	80
1003	I-95	I	33088	12	95
1004	US-301	L	1359	10	80
1005	NC-186	L	3786	8	80
1006	NC-158	P	5533	8	80
1007	US-301	M	3592	10	80
1008	NC-125	L	4175	8	80
1009		L	1456	8	80
1010	SR-1600	L	1307	5	80
1011	I-95	I	35846	12	95
1012	NC-48	L	2348	8	80
1013	SR-1432	L	597	5	80
1014	US-158	P	5773	10	80
1015	NC-46	M	3106	8	80

% Thru Trips Tab with adjusted % of thru trips

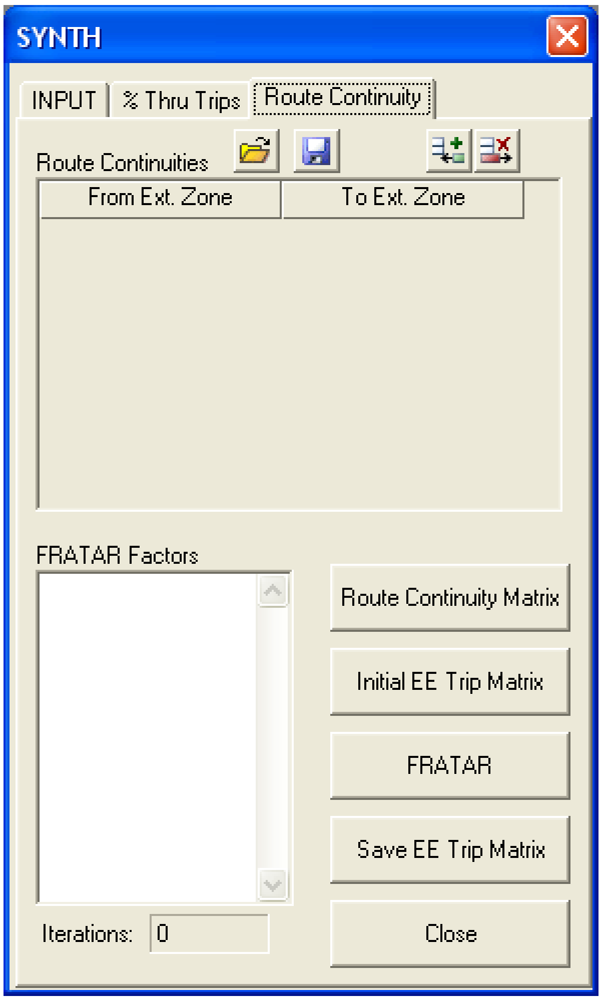
On the Route Continuity Tab

Step 1: Click on the Route Continuity Tab.
Step 2: Populate Route Continuity List. There are two ways to populate this list: ***creating the list from the scratch*** and ***loading from the saved list***.

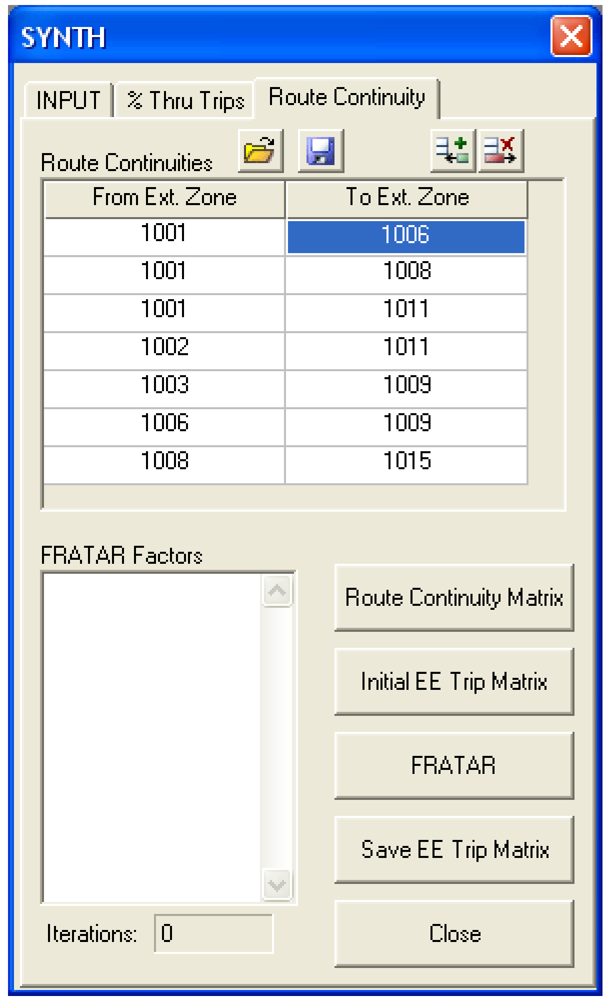
Creating the list

1. Click ‘ ’ button to add empty cells.
2. Click on a cell and Type ‘From External Station Id.’
3. Click on a cell and Type ‘To External Station Id.’
4. To remove unnecessary cells, highlight the cell and click ‘ ’ button.
5. Do 2 and 3 for all route continuities.
6. Save Route Continuity List for future use by clicking ‘ ’ button.
7. Go to Step 3.

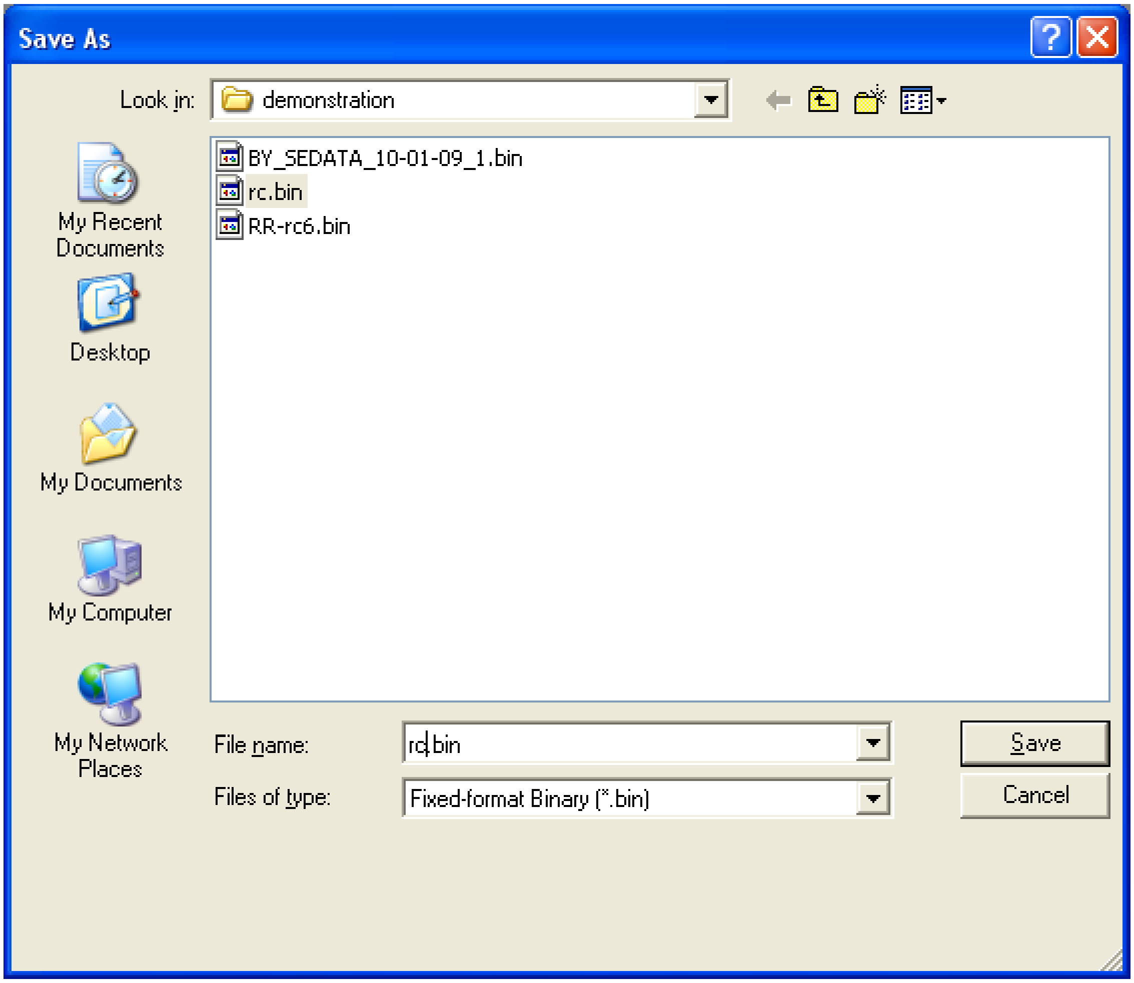
Tip: Once you define route continuity for one direction, it is not required to define the other direction. For example, route continuity from 121 to 126 is defined; route continuity from 126 to 121 will be automatically added.



Route Continuity Tab



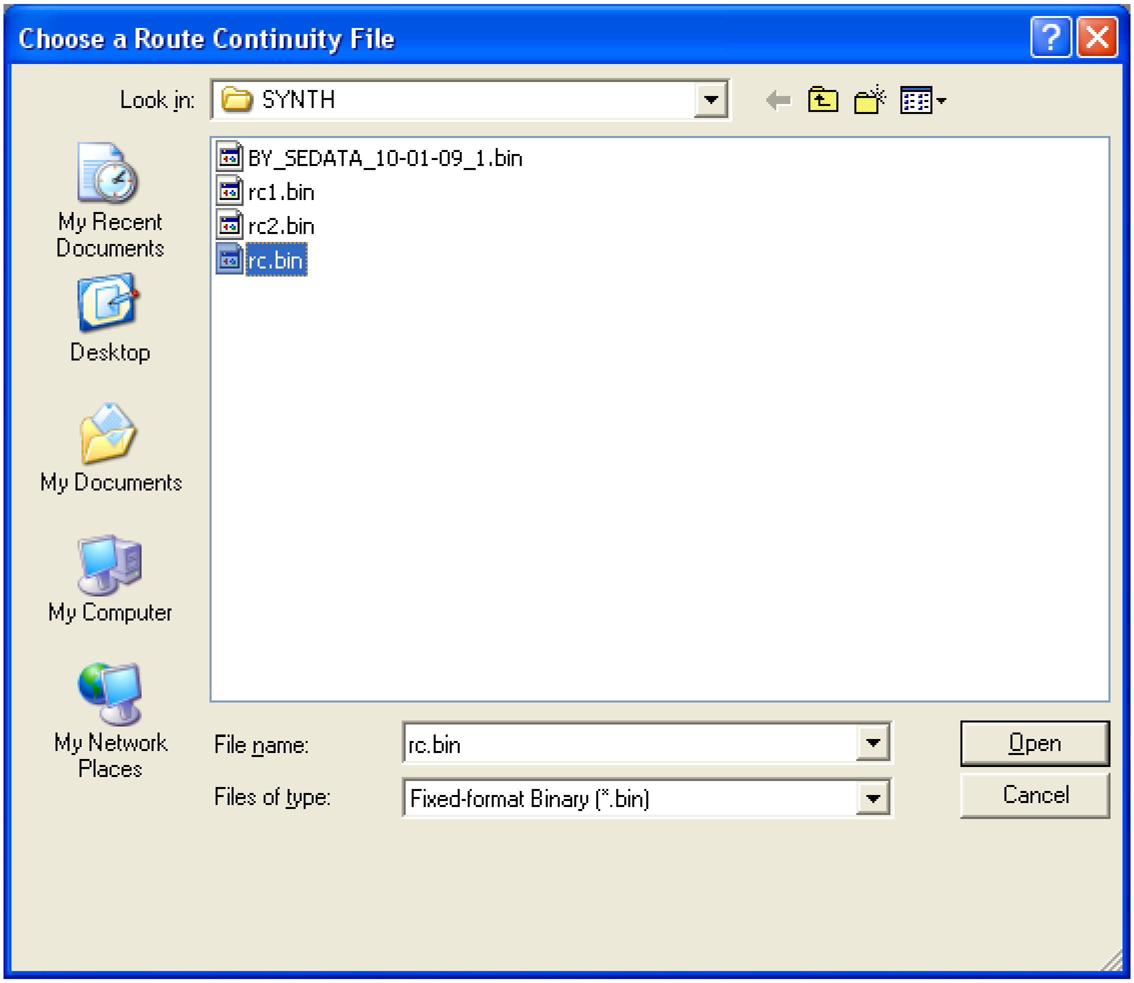
Completed Route Continuity List



Save Route Continuity List

Loading from the saved list

1. Click '' button.
2. Browse the saved list and click 'Open' button.
3. Go to Step 3.

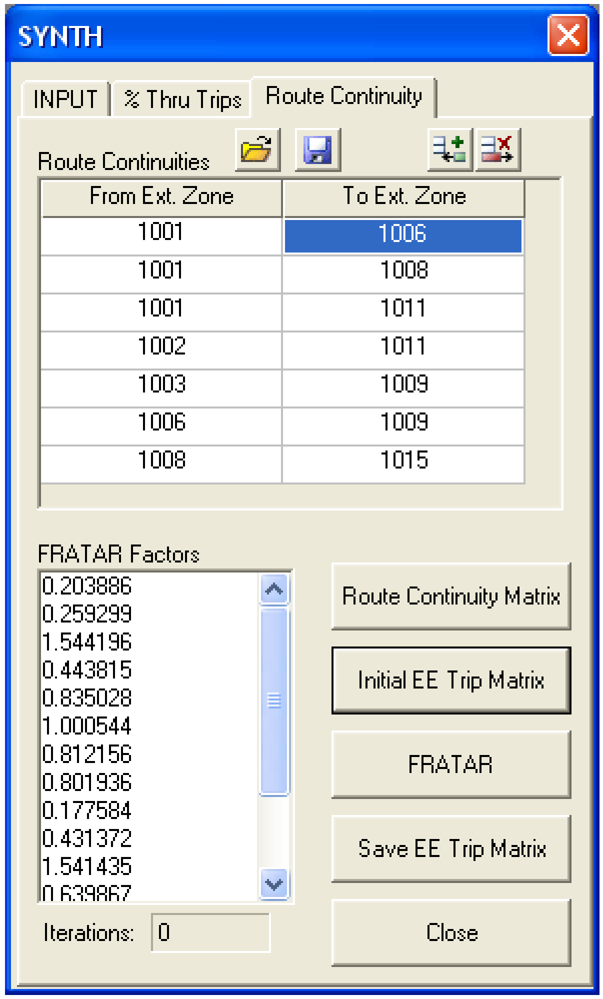


Open the saved Route Continuity List

Step 3: Once Route Continuity List is populated, click ‘Route Continuity Matrix’ button to create a route continuity matrix.

Step 4: Estimate an initial EE Trip matrix and calculate Fratar factors associated with it.

- Click ‘Initial EE Trip Matrix’ button.
- Check Fratar factors generated with the initial EE trip matrix. All factors should be close to ‘1.’ If they are close to ‘1,’ then go to Step 6. Otherwise, go to Step 5.



Fratar Factors after Initial EE Trip Matrix

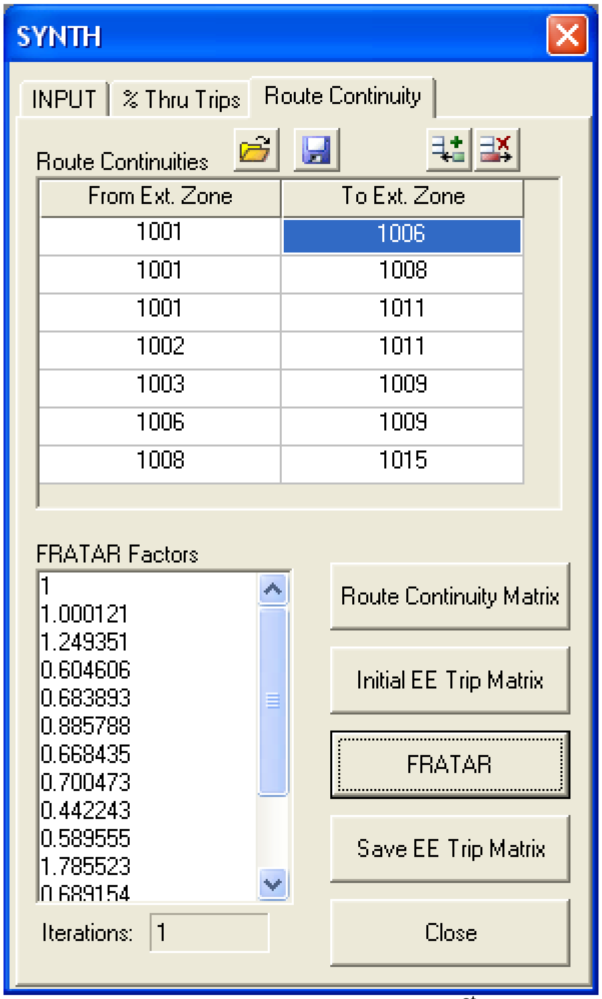
Step 5: Fratar up EE Trip Matrix to desired level.

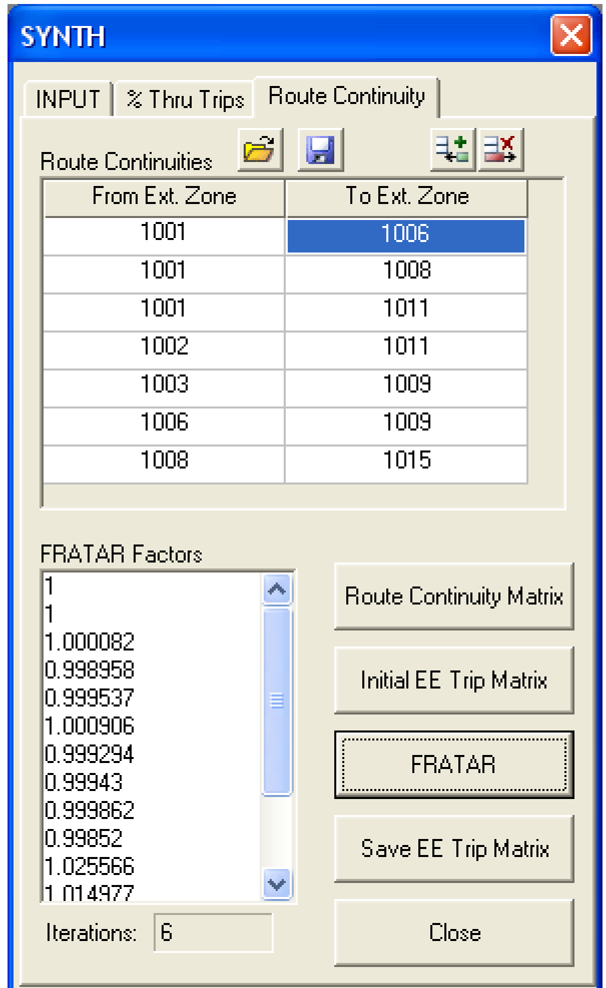
- Click ‘Fratar’ button.
- Check Fratar factors again. If they are close to ‘1,’ then go to Step 6. Otherwise, do 1 and 2 iteratively.

Trap: It is not recommended to iterate more than 5-6 times!!

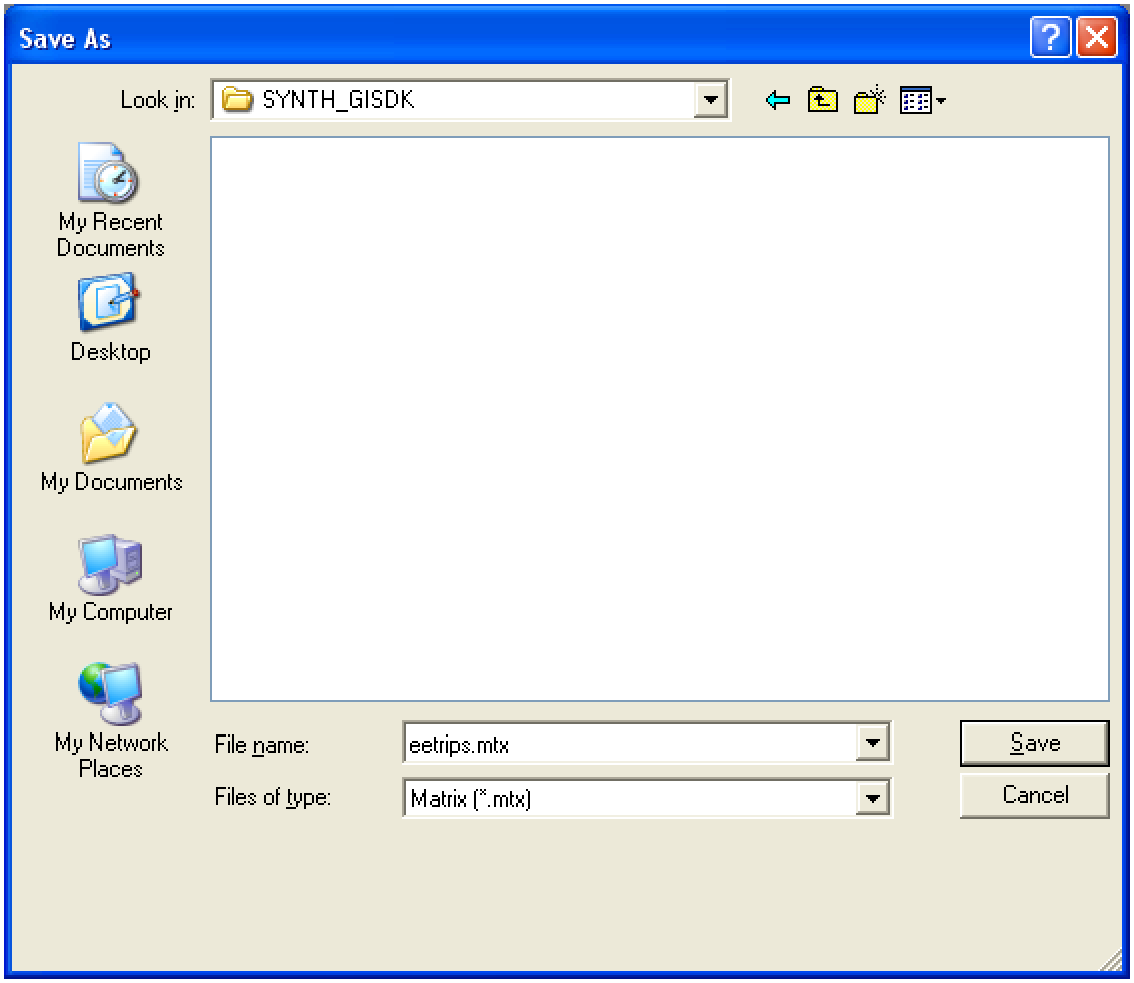
Step 6: Save EE Trip Matrix.

- Click ‘Save EE Trip Matrix’ button.
- Browse to the location where you want to save the EE trip matrix and click ‘Save’ button.
- Close the SYNTH – GISDK.





Fratar Factors at 1st Iteration Fratar Factors at 6th Iteration



Save EE Trip Matrix

1. Reasonableness Checking
   The through trip data can be a big source of error for small study areas as the number of through trips is often under estimated. A good initial check on the through trip estimation coming out of SYNTH is to run an initial calculation of the IX attractions using the default coefficients. These initial attractions can then be compared to the initial productions that result from subtracting the initial through trips from the total counts at the external stations. A spreadsheet should be created to summarize and calculate these values as shown in Table 34.

   Table 27 Sample Spreadsheet for Checking EE and IX trips

Station	Count	Itr1 EE	Itr1 %EE	Itr1 IXP	Itr2 %EE	Itr2 EE	Itr2 IXP
121	20000	12998	65%	7002	90%	18000	2000
122	2400	192	8%	2208	70%	1680	720
123	370	2	1%	368	10%	37	333
124	3000	290	10%	2710	80%	2400	600
Etc.							
…							
Total	110860	52664		58196		96369	14491

   a. Initial IX Attractions = 12830
   b. Iteration 1 IX Productions = 58196
   c. Production/Attraction Ratio = 4.54 -> %EE needs to be adjusted
   d. Adjust %EE until P/A Ratio is closer to 1.0
   e. Iteration 2 IX Productions = 14491
   f. P/A Ratio = 1.1
   g. Rerun SYNTH with the manually adjusted EE Trip Percentages

Step 4: Update **_SEDATA.BIN with EE Trip End Data

1. Open [**\INPUT**_SEDATA.BIN]
2. Populate the fields EEp and EEa with the external station EE trip ends

9.5 *IE/EI (IX) Trip Generation*

Trip productions are based on the external station count minus the through trip volume. The trip attraction model takes the form of a regression equation as shown below:

$$A = a \times HH + b \times IND + c \times RET + d \times HWY + e \times SER + f \times OFF$$

where:

A	=	IX Trip Attraction by TAZ;
HH	=	Number of Households by TAZ;
IND	=	Industrial Employment by TAZ;
RET	=	Retail Employment by TAZ;
HWY	=	High Traffic Retail Employment by TAZ;
SER	=	Service Employment by TAZ;
OFF	=	Office Employment by TAZ; and
a, b, c, d, e, f	=	IX Trip Attraction Coefficients.

No survey data was available to estimate the initial coefficients for the models covered by these procedures. Instead, coefficients were borrowed from work completed in the Triangle Region of North Carolina. These factors, shown in Table 35, are recommended as the initial default factors for the IX trip purpose.

Table 35 External Station Attraction Rates

	Households	Industry	Retail	HwyRetail	Service	Office
IX	0.33	0.34	0.49	0.28	0.28	0.28

Step 1: Copy all support files to proper locations

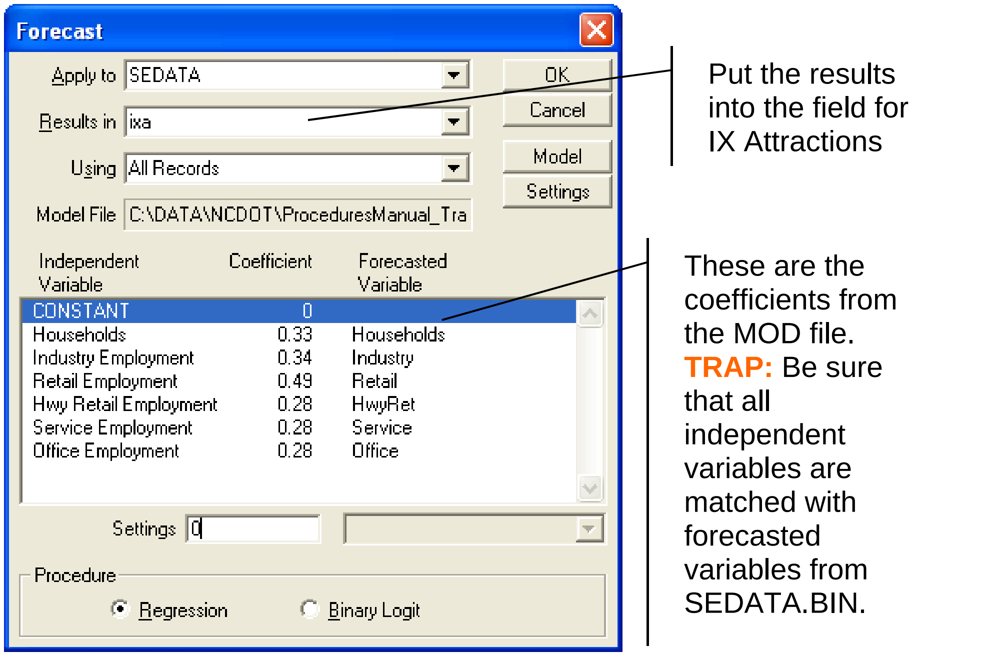
If this is the first time you have applied the trip generation model using these procedures, you will need to confirm that the attraction model file is in the PARAMETERS folder.

Step 2: Update IX Zonal Productions

1. If [**\INPUT*_SEDATA.BIN] is not already open, open it now
2. For each external station enter the value of the IX productions into the field “ixp”. The IX productions are equal to:
   a. Count – (EE From + EE To)

Step 3: Calculate IX Zonal Attractions

1. **Planning – Trip Attractions – Apply a Model**
2. Select Model File [PARAMETERS\IXATTR.MOD]
   TIP: If this is the first time you have run the procedure for External Trips you will need to manually specify all the settings for the procedure. You can then save these settings into a settings file for use the next time you run procedure.
3. The dialog box fields will be populated to match the screen shot below:



4. Click on the **Settings** button – Click on the Green Plus Sign to add a new setting – Name the Setting and give it a Description – CLICK OK
   TIP: This saves your settings for later use so that you do not need to manually enter the settings again for the standard NCDOT model.
5. CLICK OK – the model now runs and the results are output directly to SEDATA.BIN – close the results summary to view the results

Step 4: Reasonableness Checking

1. **NOTE:** Before balancing the Productions and Attractions it is important to perform reasonableness checks of the results.
2. Use the **Compute Statistics** button on the tool bar to create a summary of the IX trip generation results. A table such as the one shown in Table 36 can be used the review the reasonableness of your model results.

Table 36 Example Trip Generation Checks for External Stations

Trip Purpose	Productions	Attractions	Normalization Factor (P/A ratio)
IX	14648	12830	1.1

GUIDELINES: Normalization factor should be between 0.9 and 1.1

Step 5: Balance IX Productions and Attractions

1. **Planning – Balance**
   TIP: If this is the first time you have run the Balancing procedure, you will need to manually specify all the settings for the procedure. You can then save these settings into a settings file for use the next time you run the procedure.
2. The dialog box fields shown below should be populated to match the settings shown in Table 37.

Table 37 Vector Settings for Commercial Vehicles

Vector 1	Vector 2	Method	V2 Hold
ixp	ixa	Hold Vector 1	None

3. Click on the **Settings** button – Click on the Green Plus Sign to add a new setting – Name the Setting and give it a Description – CLICK OK
   TIP: This saves your settings for later use so that you do not need to manually enter the settings again for the standard NCDOT model.
4. CLICK OK – Save the file as [**\OUTPUT\BALANCE_IX.BIN]
5. Close Results Summary dialog box
6. To verify balancing you can look at the table statistics by selecting the **Compute Statistics** button from the tool bar – the sum of the IX productions and attractions should now be equal

9.6 Estimate NHB Trips by Non-Residents

Additional trips made within the study area by non-residents are called non-home based non-resident trips (NHBNR). These trips are estimated as a percentage of External-Internal (EI) trips. It is often assumed that non-residents will make NHB trips at a similar rate as residents. If for example the percentage of NHBW trips within the study area is 15% of the total trips and the NHBO trips within the study area is 23% of the total trips in the study area, then the NHBW-NR trips would equal the EI trips times 0.15 and the NHBO-NR trips would equal the EI trips times 0.23. The resulting totals are allocated to the NHBW and NHBO productions and attractions by zone based on the relative distribution of existing NHBW and NHBO trip ends.

Step 1: Calculate NHB-NR Trips

1. A spreadsheet [NHB_NR.XLS] has been made available to assist with the calculations outlined in this section.
2. Tabulate the total households for the study area.

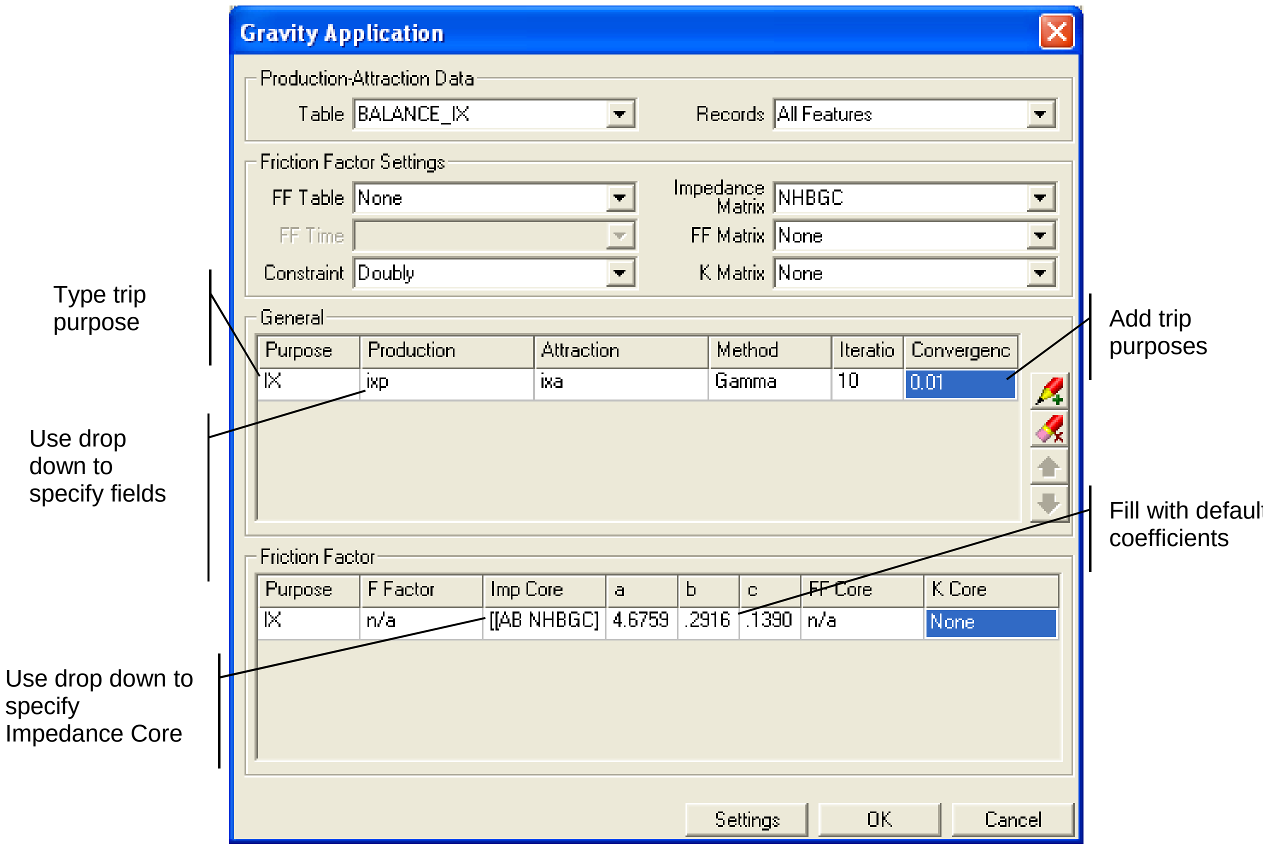
3. Tabulate the IX attraction rate for households found in [PARAMETERS\IXATTR.MOD].
4. Calculate the total IX attractions by households.
5. Recall that IX trips are composed of External-Internal (EI) trips and Internal-External (IE) trips. the percentage of the IX trips that are IE trips. (The default has been set to 90%).
6. Using this percentage, calculate the number of IE trips: (IE = ((Total IX attractions by households) * 0.9)).
7. Tabulate the number of IX productions (Recall that IXP = Count – EE).
8. Calculate the number of EI trips: EI = (IXP – IE).
9. Tabulate the number of NHBW productions (NHBWP).
10. Tabulate the number of NHBO productions (HHBOP).
11. Tabulate the total number of internal trip productions (TOTP).
12. Calculate the percentage of internal trips that are NHBW trips: (NHBWP/TOTP).
13. Calculate the percentage of internal trips that are NHBO trips: (NHBOP/TOTP).
14. Calculate the number of NHBW Non Resident trips: NHBWNR trips = (EI trips * %NHBW trips).
15. Calculate the number of NHBO Non Resident trips: NHBONR trips = (EI trips * %NHBO trips).
16. The NHBWNR trips and NHBONR trips are allocated to the NHBW and NHBO productions and attractions in Section 5.2, Step 11.

9.7 IE/EI Trip Distribution

The IE/EI trip distribution model employs a gravity model using the NHB generalized cost skims and the NHB default gamma coefficients derived from the North Carolina Combined Survey Database.

Step 1: Apply Gravity Model for IX Trips using NHB Default Gamma Coefficients

1. If not already open, open the BIN file with the final balanced productions and attractions [**\OUTPUT\BALANCE_IX.BIN]
2. Open the Generalized Cost Matrix for the NHB trip purpose [**\INTERIM\NHBGC_PATH.MTX]
3. **Planning – Trip Distribution – Gravity Application**
4. Fill out the dialog box for the Gravity Application (See Screen Shot below)
    a. Production-Attraction data is in BALANCE_IX
    b. Impedance Matrix is NHBGC
    c. Add a trip purpose for IX
    d. Impedance core is NHBGC
    e. Add the associated gamma coefficients:
       a = 4.6759, b = 0.2916, c = 0.1390
5. Click on the **Settings** button – Click on the Green Plus Sign to add a new setting – Name the Setting and give it a Description – CLICK OK
   TIP: This saves your settings for a later use so that you do not need to manually enter the settings again for the standard NCDOT model.



6. CLICK OK – Save as: [**\INTERIM\IX_TRIPS.MTX], Label = IX Trip Table
7. Review Results dialog box to see if model converged – Close
8. Close Results Summary
9. The resulting output is a matrix file with a trip table for the IX trip purpose

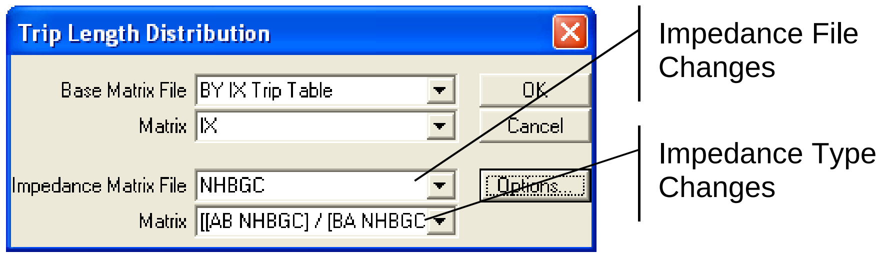
Step 2: Reasonableness Checking

Before moving forward to the next step it is important to review the results of the Gravity Model Application in order to assess the reasonableness of the output. To check the reasonableness of your results for the IX trip table the following checks are recommended:

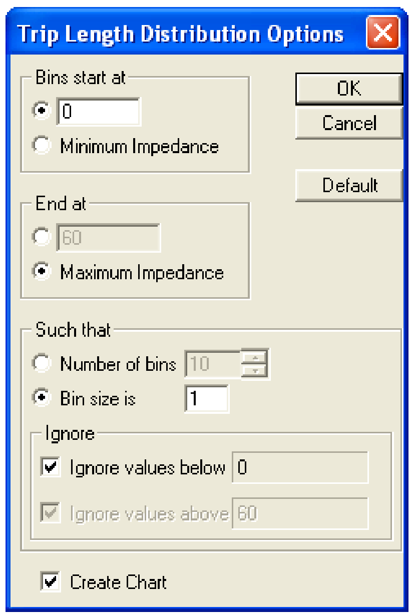
1. Plot and review the trip length distribution for time, distance, and generalized cost.
2. Tabulate and review the average trip length by time, distance, and generalized cost.

Step 3 Trip Length Distribution and Average Trip Length

1. If not already open, open the NHB generalized cost matrix. [**\INTERIM\NHBGC_PATH.MTX]
2. If not already open, open [**\INTERIM\IX_TRIPS.MTX]
3. TIP: The next series of steps is repeated once for impedance type (Generalized Cost, Initial Time, and Length). The values in bold italics will change accordingly.
4. **Planning – Trip Distribution – Trip Length Distribution**
    a. Base Matrix File: IX Trip Table
    b. Matrix: IX
    c. Impedance Matrix File: ***NHBGC***
    d. Matrix: [***AB NHBGC]/[BA NHBGC***]



5. Options



6. CLICK OK – CLICK OK – Save file as [**\INTERIM\\IX_TLD_**], where ** changes based on the impedance value used. For example GC (Generalized Cost), TT (Travel Time), and DI (Distance)
7. Click “Show Report” button in Results Summary dialog box and scroll down to the bottom of the report
8. Record values in Table (See Table 38 for an example)
    a. Minimum Trip Length
    b. Maximum Trip Length
    c. Average Trip Length
    d. Standard Deviation
9. CLICK Close
10. Review the Chart for Reasonableness. **TIP:** Data can also be exported to Excel for graphing and review.
11. Close all files

Table 38 Example Table for Recording Trip Length Data

Purpose	Generalized Cost	Travel Time	Distance	% Intrazonal	Converged (Y/N)	Gamma
IX	19.87	10.98	7.1	0	Y	a = 4.6759 b = 0.2916 c = 0.1390

10 Time-of-Day

10.1 Purpose

The time-of-day step is used to convert the 24 hour Production-Attraction (PA) person auto trip table to an Origin-Destination (OD) vehicle trip table by time of day: AM (6:00 a.m. to 10:00 a.m.), MD (10:00 a.m. to 3:00 p.m.), PM (3:00 p.m. to 7:00 p.m.), and OP (7:00 p.m. to 6:00 a.m.). One advantage of time-of-day assignment over the traditional NCDOT daily assignment is that a time-of-day assignment can reflect the effect of volume delay on route choice and therefore can be used to forecast congested conditions or the effects of increases in highway capacity on traffic congestion.

10.2 NC_HOURLY_SMALL.BIN and NC_HOURLY_LARGE.BIN

The North Carolina Combined Survey Database was analyzed to create departure and return factors by trip purpose for each hour of the day. These factors are used to convert a 24-hour PA trip table to an OD trip table by time of day. Separate factors were estimated for both large and small study areas. There are 24 records in the NC_HOURLY_*.BIN files starting at 0 and ending at 23, where 0 represents the hour from 12 a.m. to 1 a.m. and 23 is the hour from 11 p.m. to 12 a.m. This file is used as an input into the time-of-day procedure. During the time-of-day procedure average auto occupancy factors by time-of-day and trip purpose are applied to convert person auto trips to vehicle auto trips. The auto occupancy factors were developed from the combined survey data and are shown in Table 39.

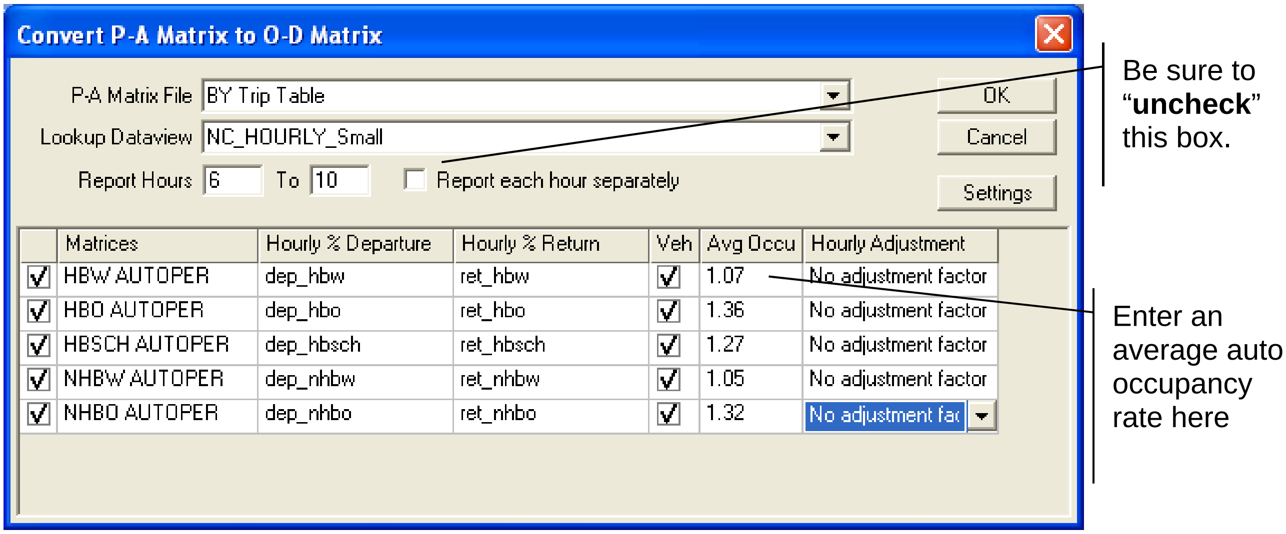
Table 28 Auto Occupancy Factors by Trip Purpose

	Small Area				**Large Area**			
Purpose	**AM**	**MD**	**PM**	**OP**	**AM**	**MD**	**PM**	**OP**
HBW	1.07	1.10	1.07	1.09	1.05	1.07	1.05	1.05
HBO	1.36	1.30	1.43	1.45	1.48	1.31	1.52	1.52
HBSCH	1.27	1.13	1.23	1.30	2.07	1.58	1.99	1.23
NHBW	1.05	1.11	1.08	1.14	1.09	1.18	1.09	1.10
NHBO	1.32	1.27	1.45	1.73	1.57	1.39	1.61	1.73

10.3 Convert Daily PA Trip Table to OD Trip Table by Time-of-Day

Step 1: Apply the TransCAD PA to OD Procedure for AM Trip Table

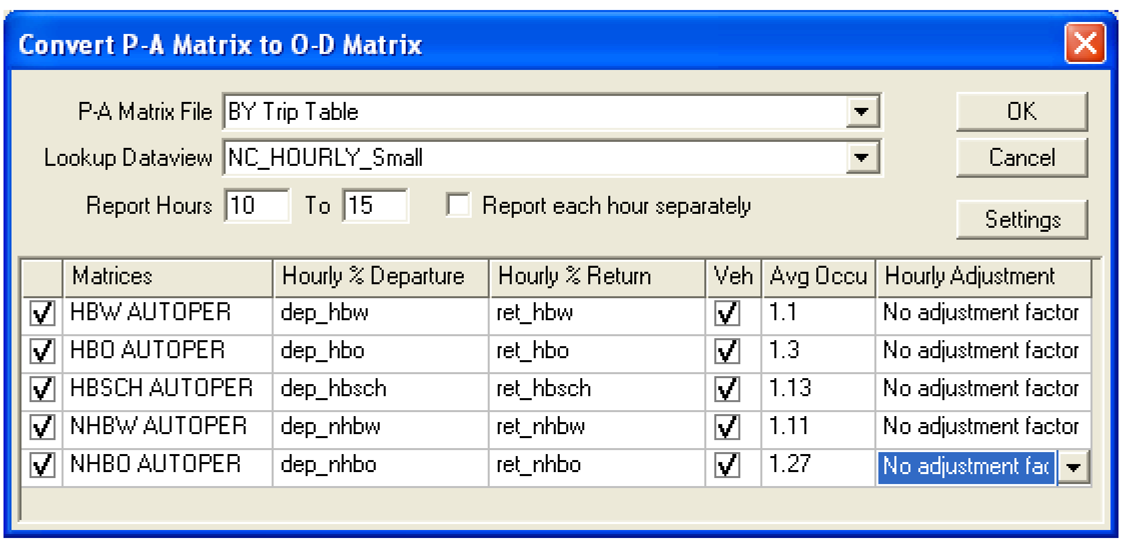
1. Open [**\INTERIM\AUTOPER_TRIPS.MTX]
2. Open [PARAMETERS\NC_HOURLY_*.BIN] (**TIP:** For all time-of-day analysis the * stands for SMALL for small study area application and LARGE for large study area application)
3. **Planning – PA to OD** – Fill out the dialog box as shown below



4. Click OK – Save as [**\INTERIM\AMVEH_TRIPS.MTX]
5. **Matrix – Contents** – Change Description to: AM Trips – Close
6. Close AM trip table

Step 2: Apply the TransCAD PA to OD Procedure for MD Trip Table

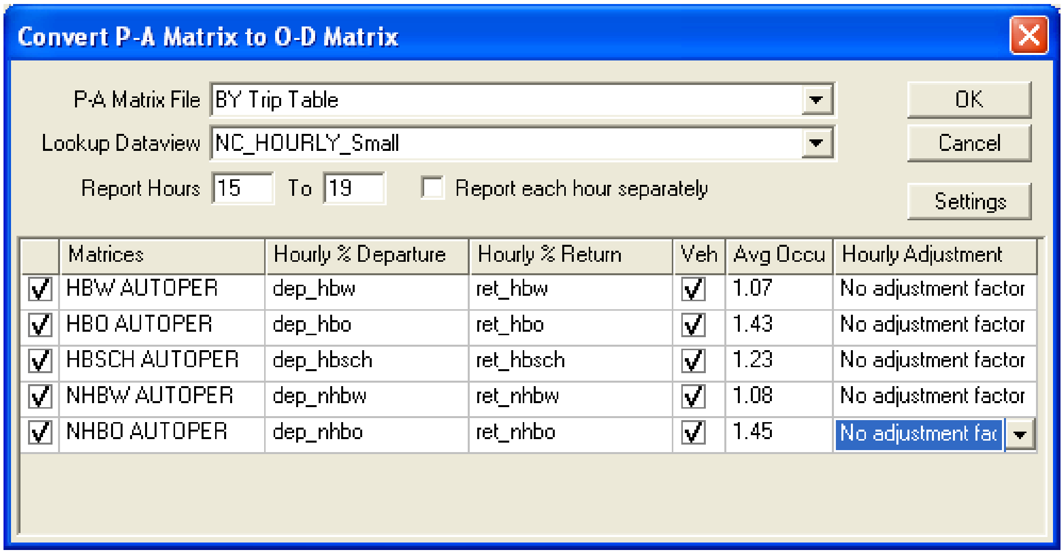
1. **Planning – PA to OD** – Fill out the dialog box as shown below



2. Click OK – Save as [**\INTERIM\MDVEH_TRIPS.MTX]
3. **Matrix – Contents** – Change Description to: MD Trips
4. Close MD trip table

Step 3: Apply the TransCAD PA to OD Procedure for PM Trip Table

1. **Planning – PA to OD** – Fill out the dialog box as shown below

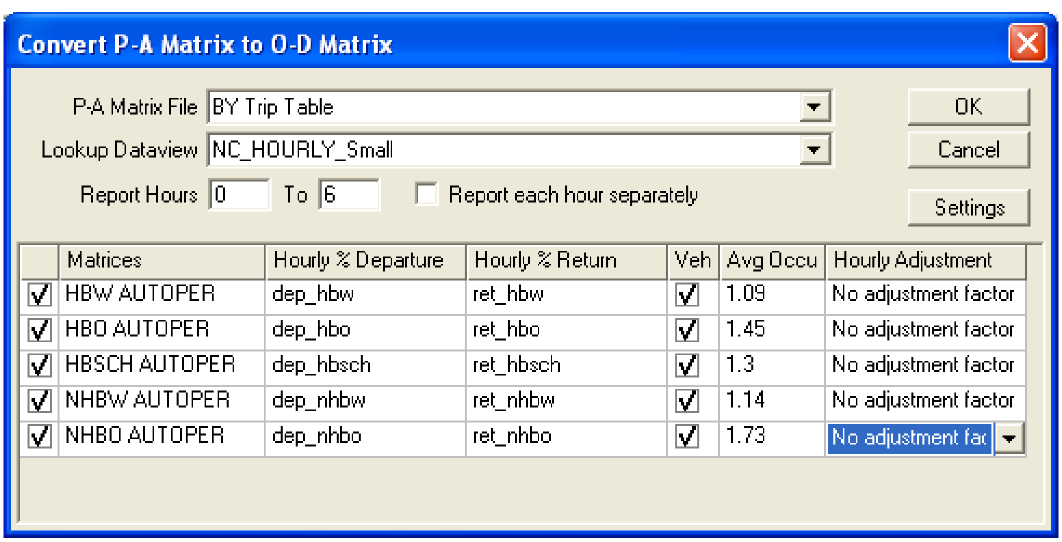


2. Click OK – Save as [**\INTERIM\PMVEH_TRIPS.MTX]
3. **Matrix – Contents** – Change Description to: PM Trips – Close
4. Close PM trip table

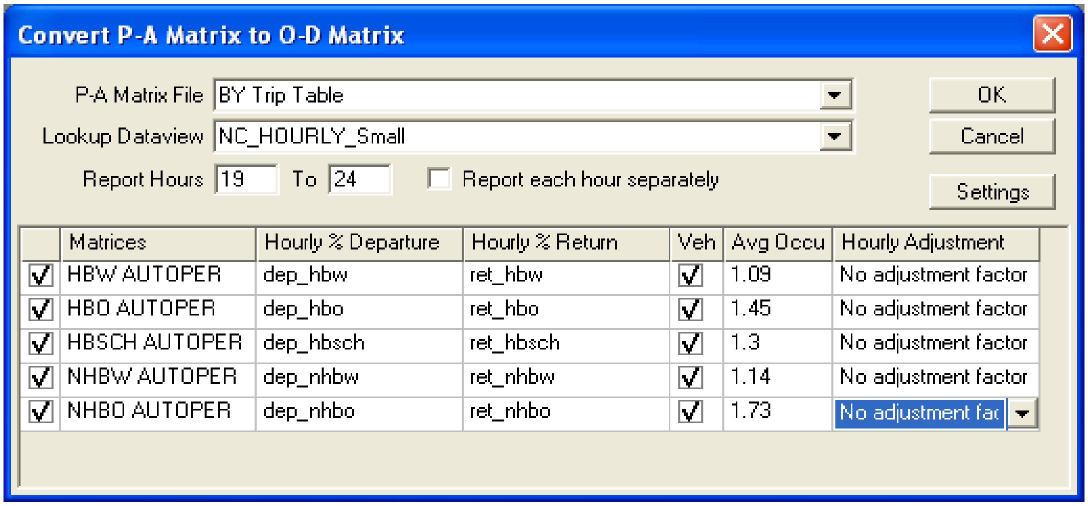
Step 4: Apply the TransCAD PA to OD Procedure for Initial OP Trip Tables

The TransCAD procedure does not allow the ending hour to be less than the starting hour. The off-peak periods reflects the time period between 0 and 6 (12 a.m. to 6 a.m.) and between 19 and 24 (7 p.m. and 12 a.m.). Since we cannot specify a beginning hour of 19 and an ending hour of 6, we must first create two separate off-peak trip tables and then combine two separate trip tables into one final off-peak trip table. The off-peak trips for the two time intervals must be created separately and then added together.

1. **Planning – PA to OD** – Fill out the dialog box as shown below



2. Click OK – Save as [**\INTERIM\OPVEH_TRIPS.MTX]
3. **Matrix – Contents** – Change Description to: OP Trips
4. **Planning – PA to OD** – Fill out the dialog box as shown below



5. Click OK – Save as [**\INTERIM\OP2VEH_TRIPS.MTX]
6. **Matrix – Contents** – Change Description to: OP2 Trips

Step 5: Matrix Manipulation to Create Final OP Trip Table

The next series of steps is a matrix manipulation procedure designed to create a final OP Trip Table.

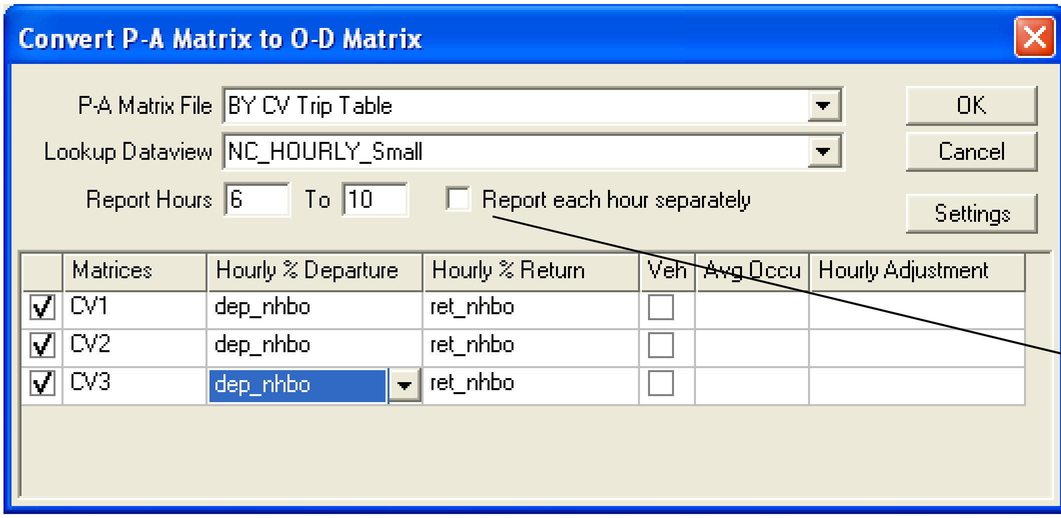
1. Make the first matrix (OP Trips) the active matrix – **Matrix – Append** – Select "OP2 Trips" – OK
2. Close all matrix files [*.MTX] **TIP:** Keep the NC_HOURLY_*.BIN file open so that it can be used in the next step.

10.4 Time-of-Day Conversion for Commercial Vehicles

AM, MD, PM, and OP trip tables for commercial vehicles are created by using the time-of-day factors for the NHBO trip purpose.

Step 1: Apply the TransCAD PA to OD Procedure for AM CV Trip Table

1. Open [**\INTERIM\CV_TRIPS.MTX]
2. **Planning – PA to OD** – Fill out the dialog box as shown below

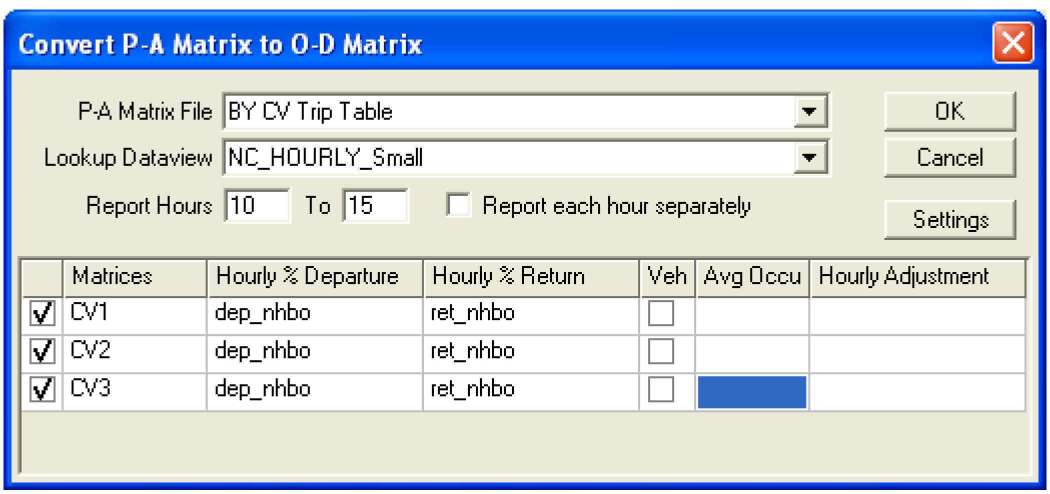


Be sure to "**uncheck**" this box.

3. Click OK – Save as [**\INTERIM\AMCV_TRIPS.MTX]
4. **Matrix – Contents** – Change Description to: AMCV Trips – Close
5. Close AMCV trip table

Step 2: Apply the TransCAD PA to OD Procedure for MD CV Trip Table

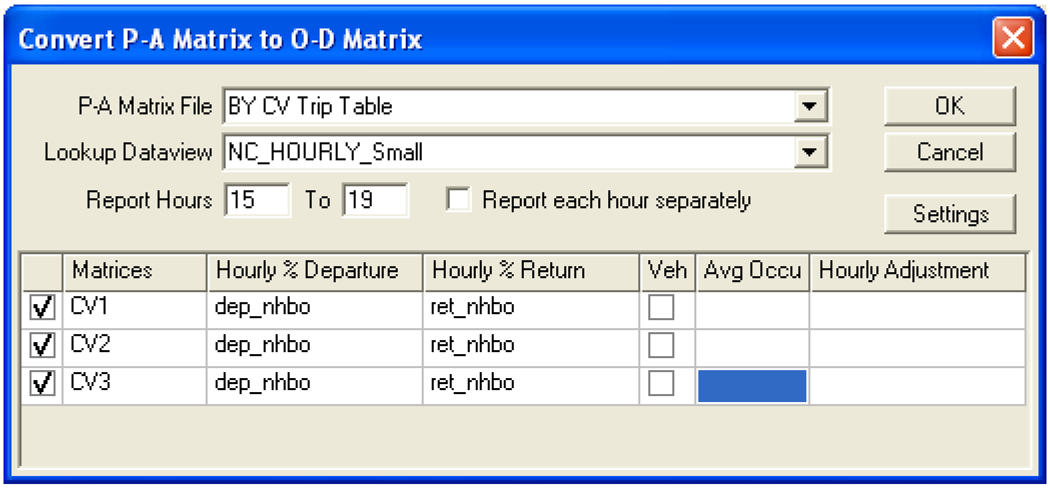
1. **Planning – PA to OD** – Fill out the dialog box as shown below



2. Click OK – Save as [**\INTERIM\MDCV_TRIPS.MTX]
3. **Matrix – Contents** – Change Description to: MDCV Trips – Close
4. Close MDCV trip table

Step 3: Apply the TransCAD PA to OD Procedure for PM CV Trip Table

1. **Planning – PA to OD** – Fill out the dialog box as shown below

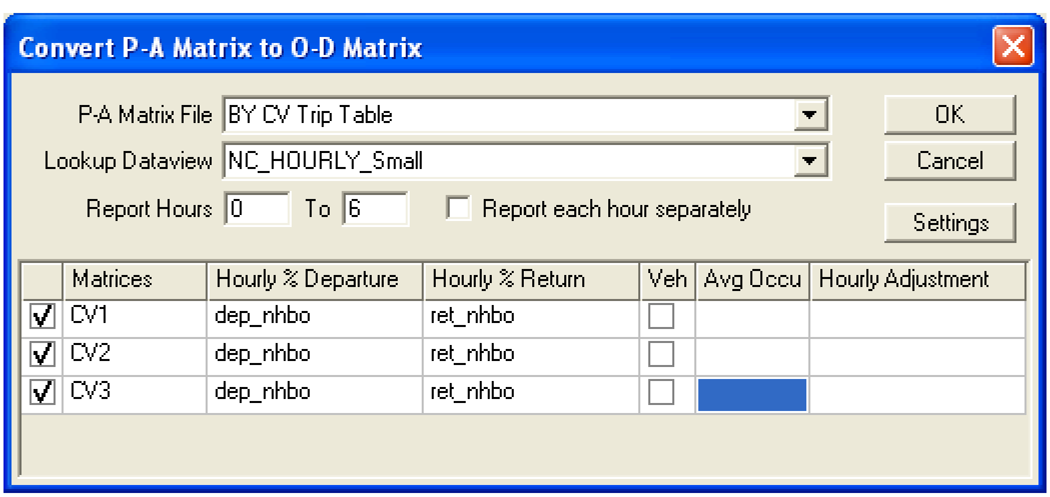


2. Click OK – Save as [**\INTERIM\PMCV_TRIPS.MTX]
3. **Matrix – Contents** – Change Description to: PMCV Trips – Close
4. Close PMCV trip table

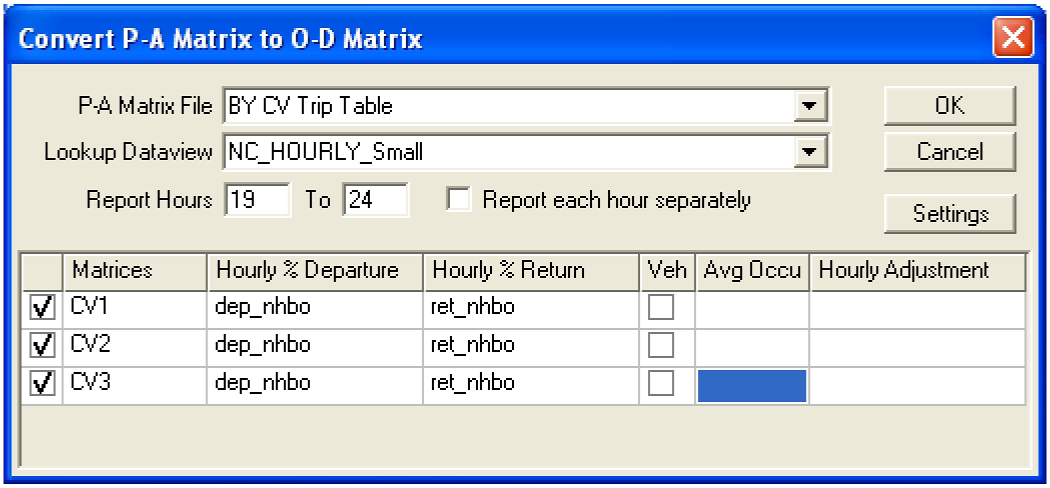
Step 4: Apply the TransCAD PA to OD Procedure for Initial OP CV Trip Tables

The TransCAD procedure does not allow the ending hour to be less than the starting hour. The off-peak period reflects the time period between 0 and 6 (12 a.m. to 6 a.m.) and between 19 and 24 (7 p.m. and 12 a.m.). Since we cannot specify a beginning hour of 19 and an ending hour of 6, we must first create two separate off-peak trip tables and then combine two separate trip tables into one final off-peak trip table. The off-peak trips for the two time intervals must be created separately and then added together.

1. **Planning – PA to OD** – Fill out the dialog box as shown below



2. Click OK – Save as [**\INTERIM\OPCV_TRIPS.MTX]
3. **Matrix – Contents** – Change Description to: OPCV Trips – Close
4. **Planning – PA to OD** – Fill out the dialog box as shown below



5. Click OK – Save as [**\INTERIM\OP2CV_TRIPS.MTX]
6. **Matrix – Contents** – Change Description to: OP2CV Trips – Close

Step 5: Matrix Manipulation to Create Final OPCV Trip Table

The next series of steps is a matrix manipulation procedure designed to create a final OPCV Trip Table.

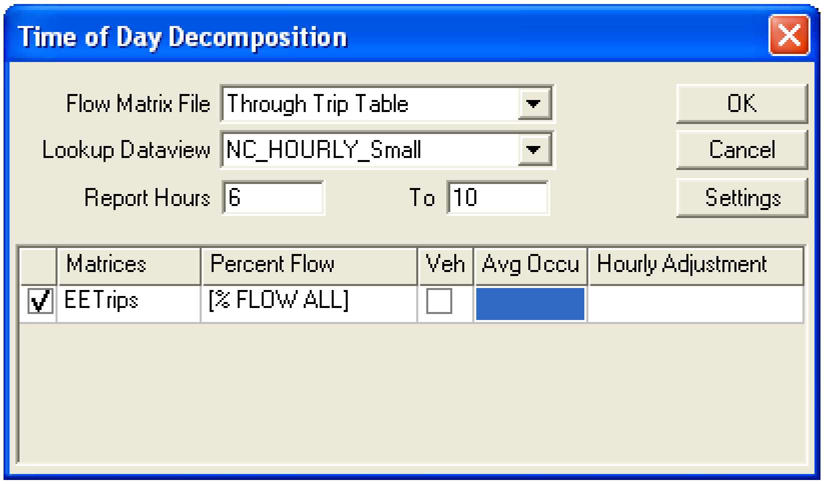
1. Make the first matrix (OPCV Trips) the active matrix – **Matrix – Append** – Select “OP2CV Trips” – CLICK OK
2. Close all matrix files [*.MTX] **TIP:** Keep the NC_HOURLY_*.BIN file open so that it can be used in the next step.

10.5 Time-of-Day Conversion for Through Trips (EE Trips)

AM, MD, PM, and OP trip tables for the EE trip purpose are created using time-of-day factors reflecting the percent flow within each hour, which was estimated using all trips in the North Carolina Combined Survey Database. Since the EE trip table is already in an OD format, there is no need to convert from PA to OD.

Step 1: Apply the TransCAD Time-of-Day Analysis for AM EE Trip Table

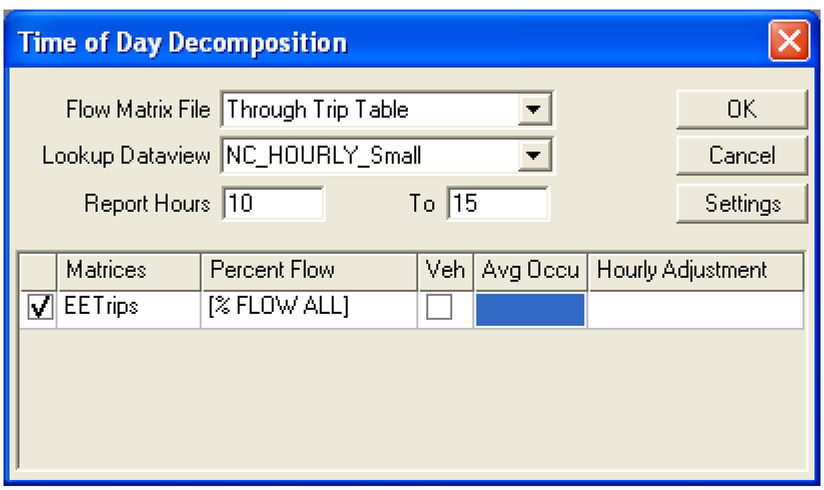
1. Open [**\INPUT\EE_TRIPS.MTX]
2. **Planning – Time of Day Analysis** – Fill out the dialog box as shown below



3. Click OK – Save as [**\INTERIM\AMEE_TRIPS.MTX]
4. **Matrix – Contents** – Change Description to: AMEE Trips – Close
5. Close AMEE trip table

Step 2: Apply the TransCAD Time-of-Day Analysis for MD EE Trip Table

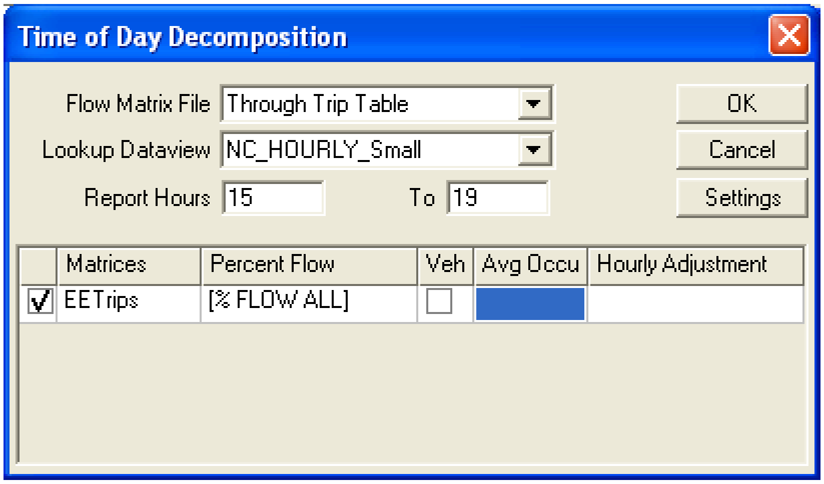
1. **Planning – Time of Day Analysis** – Fill out the dialog box as shown below



2. Click OK – Save as [**\INTERIM\MDEE_TRIPS.MTX]
3. **Matrix – Contents** – Change Description to: MDEE Trips – Close
4. Close MDEE trip table

Step 3: Apply the TransCAD Time-of-Day Analysis for PM EE Trip Table

1. **Planning – Time of Day Analysis** – Fill out the dialog box as shown below

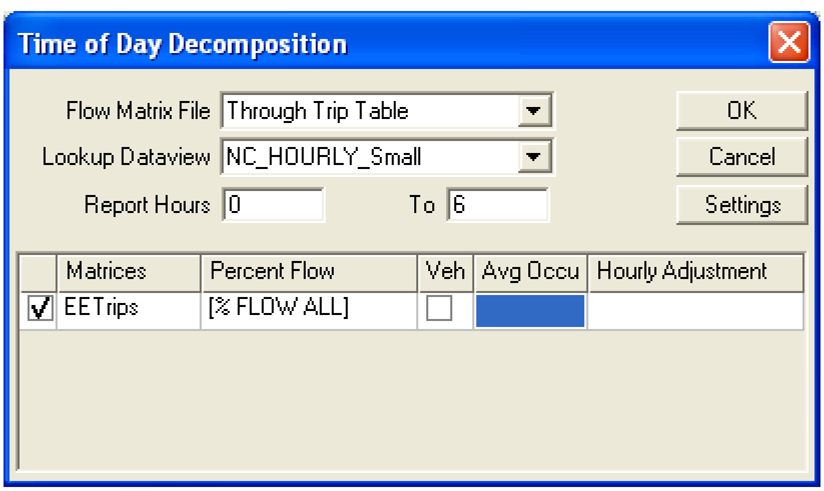


2. Click OK – Save as [**\INTERIM\PMEE_TRIPS.MTX]
3. **Matrix – Contents** – Change Description to: PMEE Trips – Close
4. Close PMEE trip table

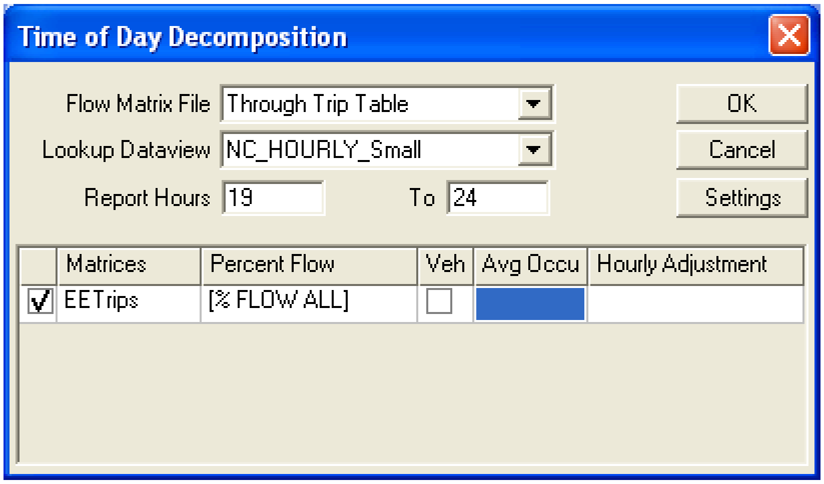
Step 4: Apply the TransCAD Time-of-Day Analysis for Initial OP EE Trip Tables

The TransCAD procedure does not allow the ending hour to be less than the starting hour. The off-peak period reflects the time period between 0 and 6 (12 a.m. to 6 a.m.) and between 19 and 24 (7 p.m. and 12 a.m.). Since we cannot specify a beginning hour of 19 and an ending hour of 6, we must first create two separate off-peak trip tables and then combine two separate trip tables into one final off-peak trip table. The off-peak trips for the two time intervals must be created separately and then added together.

1. **Planning – Time of Day Analysis** – Fill out the dialog box as shown below



2. Click OK – Save as [**\INTERIM\OPEE_TRIPS.MTX]
3. **Matrix – Contents** – Change Description to: OPEE Trips – Close
4. **Planning – Time of Day Analysis** – Fill out the dialog box as shown below



5. Click OK – Save as [**\INTERIM\OP2EE_TRIPS.MTX]
6. **Matrix – Contents** – Change Description to: OP2EE Trips – Close

Step 5: Matrix Manipulation to Create Final OP EE Trip Table

The next series of steps is a matrix manipulation procedure designed to create a final OP EE Trip Table.

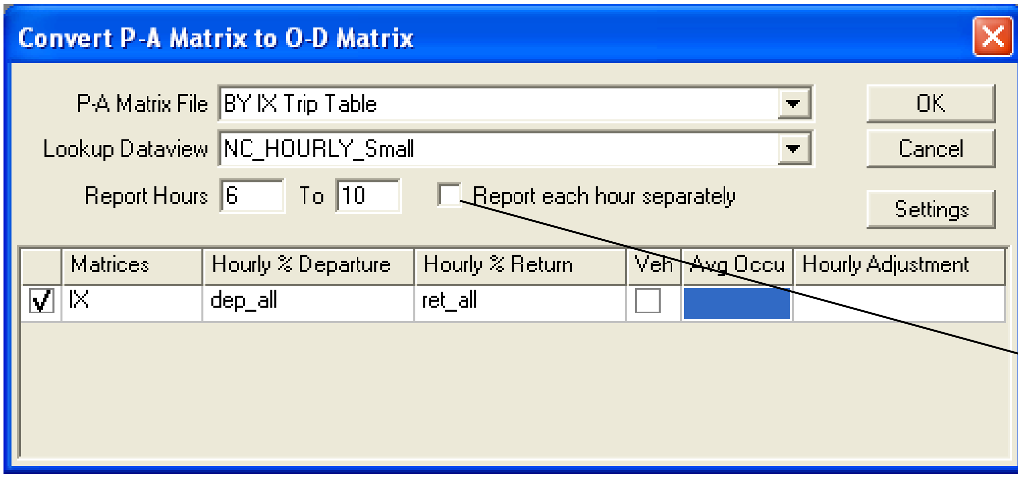
1. Make the first matrix (OPEE Trips) the active matrix – **Matrix – Append** – Select "OP2EE Trips" – CLICK OK
2. Close all matrix files [*.MTX] **TIP:** Keep the NC_HOURLY_*.BIN file open for use in the next step.

10.6 Time-of-Day Conversion for EI/IE Trips (IX Trips)

AM, MD, PM, and OP trip tables for the IX trip purpose are created by applying time-of-day factors that were estimated using the total trips in the North Carolina Combined Survey Database.

Step 1: Apply the TransCAD PA to OD Procedure for AM IX Trip Table

1. Open [**\INTERIM\IX_TRIPS.MTX]
2. **Planning – PA to OD** – Fill out the dialog box as shown below

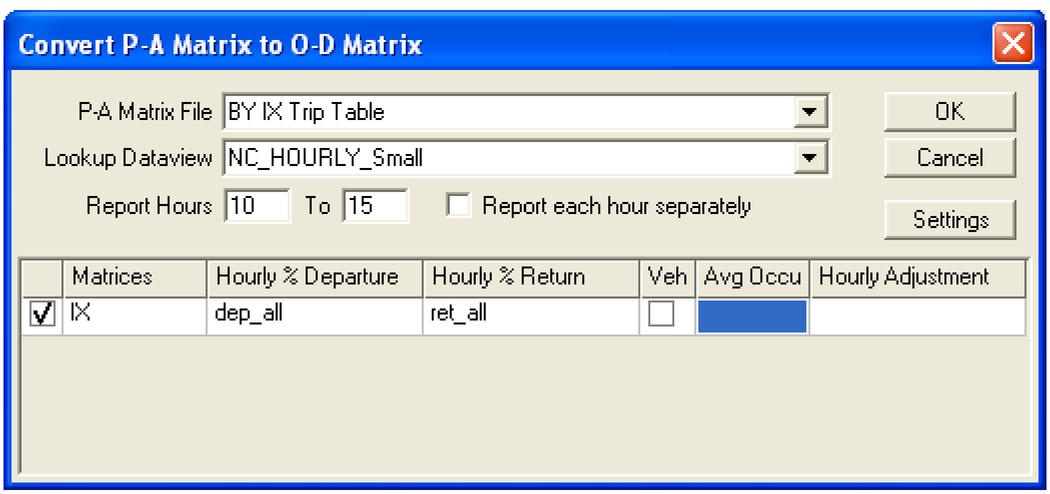


Be sure to "**uncheck**" this box.

3. Click OK – Save as [**\INTERIM\AMIX_TRIPS.MTX]
4. **Matrix – Contents** – Change Description to: AMIX Trips
5. Close AMIX trip table

Step 2: Apply the TransCAD PA to OD Procedure for MD IX Trip Table

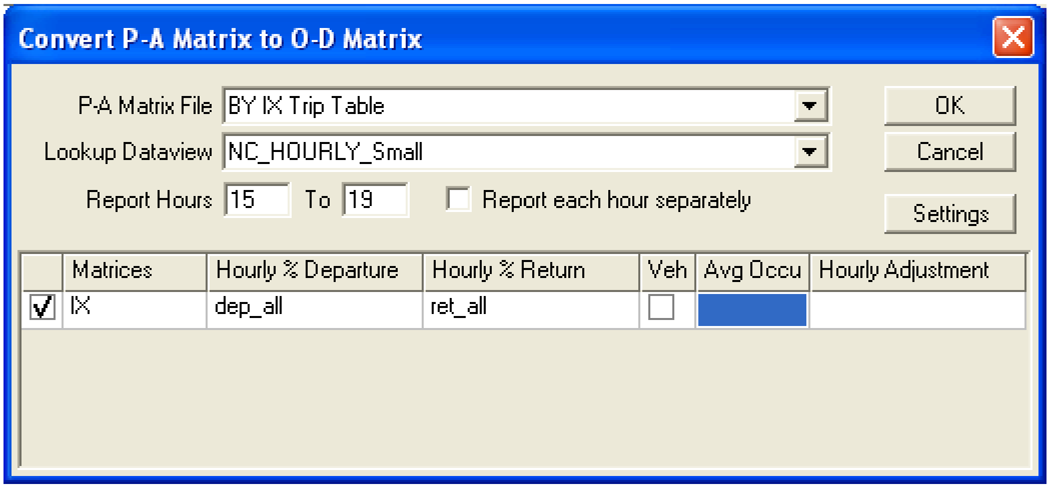
1. **Planning – PA to OD** – Fill out the dialog box as shown below



2. Click OK – Save as [**\INTERIM\MDIX_TRIPS.MTX]
3. **Matrix – Contents** – Change Description to: MDIX Trips – Close
4. Close MDIX trip table

Step 3: Apply the TransCAD PA to OD Procedure for PM IX Trip Table

1. **Planning – PA to OD** – Fill out the dialog box as shown below

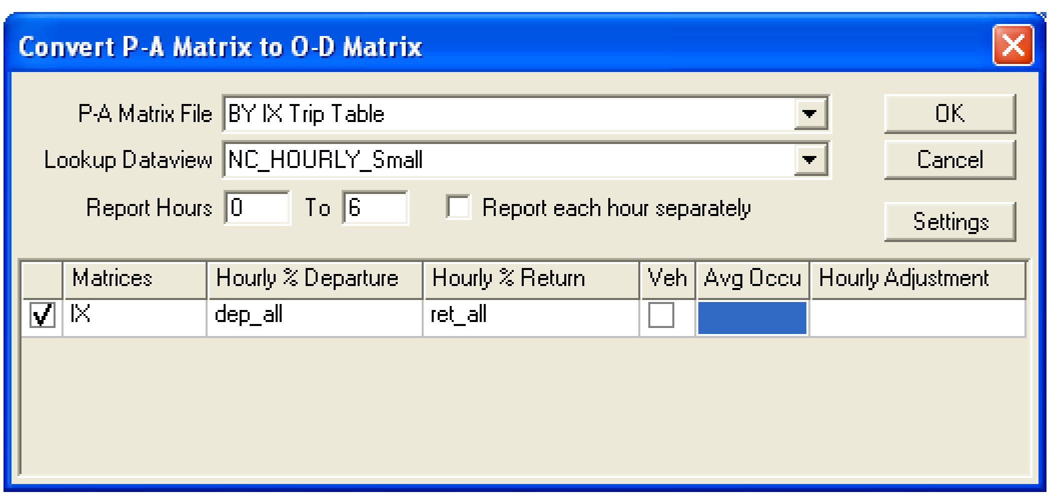


2. CLICK OK – Save as [**\INTERIM\PMIX_TRIPS.MTX]
3. **Matrix – Contents** – Change Description to: PMIX Trips – Close
4. Close PMIX trip table

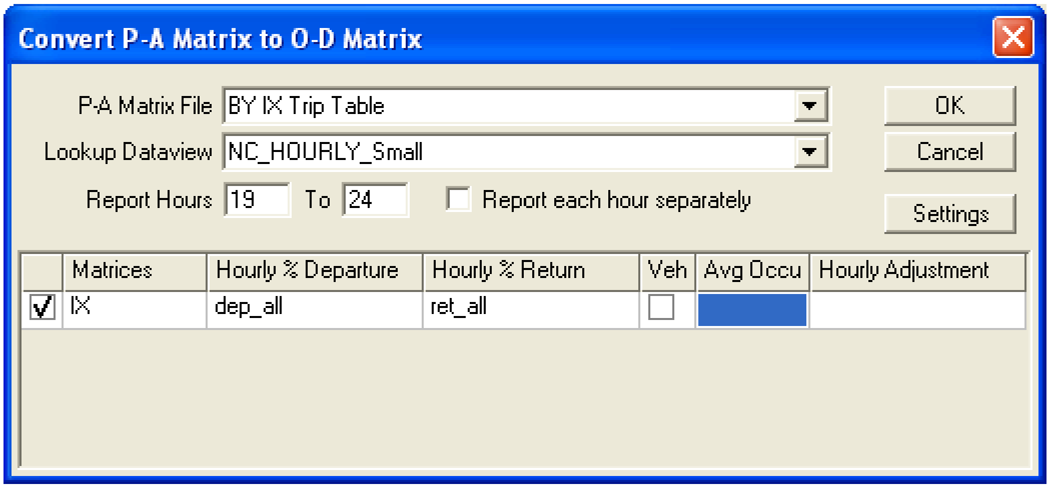
Step 4: Apply the TransCAD PA to OD Procedure for Initial OP IX Trip Tables

The TransCAD procedure does not allow the ending hour to be less than the starting hour. The off-peak period reflects the time period between 0 and 6 (12 a.m. to 6 a.m.) and between 19 and 24 (7 p.m. and 12 a.m.). Since we cannot specify a beginning hour of 19 and an ending hour of 6, we must first create two separate off-peak trip tables and then combine two separate trip tables into one final off-peak trip table. The off-peak trips for the two time intervals must be created separately and then added together.

1. **Planning – PA to OD** – Fill out the dialog box as shown below



2. Click OK – Save as [**\INTERIM\OPIX_TRIPS.MTX]
3. **Matrix – Contents** – Change Description to: OPIX Trips – Close
4. **Planning – PA to OD** – Fill out the dialog box as shown below



5. Click OK – Save as [**\INTERIM\OP2IX_TRIPS.MTX]
6. **Matrix – Contents** – Change Description to: OP2IX Trips – Close

Step 5: Matrix Manipulation to Create Final OP IX Trip Table

The next series of steps is a matrix manipulation procedure designed to create a final OP IX Trip Table.

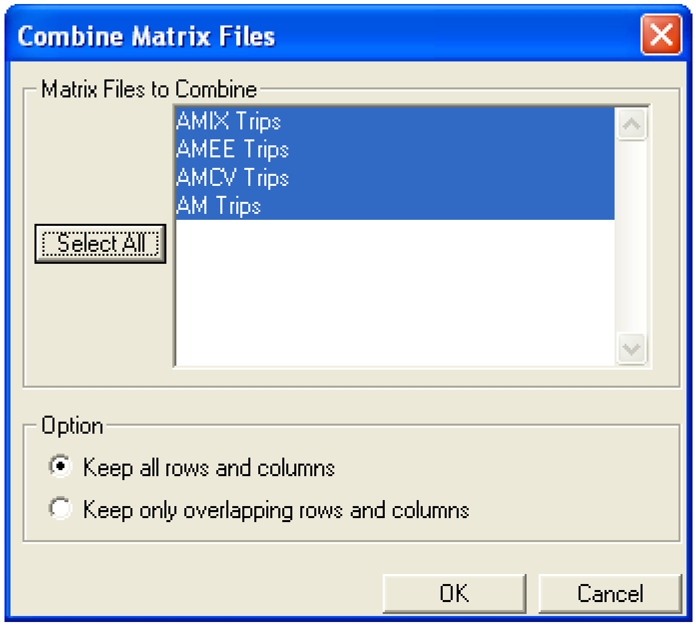
1. Make the first matrix (OPIX Trips) the active matrix – **Matrix – Append** – Select “OP2IX Trips” – CLICK OK
2. Close all files

10.7 Combine all Trip Purposes by Time Period for Assignment

Prior to the assignment the internal trip tables by trip purpose and time-of-day, the commercial vehicle trip tables by time-of-day, the EE trip table by time-of-day, and the IX trip table by time-of-day are combined into a total trip table for each of the four time periods.

Step 1: Combine AM Trip Tables

1. Open [**\INTERIM\AMVEH_TRIPS.MTX]
2. Open [**\INTERIM\AMCV_TRIPS.MTX]
3. Open [**\INTERIM\AMEE_TRIPS.MTX]
4. Open [**\INTERIM\AMIX_TRIPS.MTX]
5. **Matrix – Combine – Select All** – Click OK – Name: [**\OUTPUT\AMTOT_TRIPS.MTX]



6. **Matrix – Contents** – Change Description to: AMTOT Trips – Close
7. **Matrix – QuickSum**
8. **Matrix – Contents** – Rename QuickSum to AMTOT Trips – Close
9. File – Close All

Step 2: Combine MD Trip Tables

1. Open [**\INTERIM\MDVEH_TRIPS.MTX]
2. Open [**\INTERIM\MDCV_TRIPS.MTX]
3. Open [**\INTERIM\MDEE_TRIPS.MTX]
4. Open [**\INTERIM\MDIX_TRIPS.MTX]
5. **Matrix – Combine – Select All** – Click OK – Name: [**\OUTPUT\MDTOT_TRIPS.MTX]
6. **Matrix – Contents** – Change Description to: MDTOT Trips – Close
7. **Matrix – QuickSum**
8. **Matrix – Contents** – Rename QuickSum to MDTOT Trips
9. File – Close All

Step 3: Combine PM Trip Tables

1. Open [**\INTERIM\PMVEH_TRIPS.MTX]
2. Open [**\INTERIM\PMCV_TRIPS.MTX]
3. Open [**\INTERIM\PMEE_TRIPS.MTX]
4. Open [**\INTERIM\PMIX_TRIPS.MTX]
5. **Matrix – Combine – Select All** – Name: [**\OUTPUT\PMTOT_TRIPS.MTX]
6. **Matrix – Contents** – Change Description to: PMTOT Trips – Close
7. **Matrix – QuickSum**
8. **Matrix – Contents** – Rename QuickSum to PMTOT Trips
9. File – Close All

Step 4: Combine Off-peak Trip Tables

1. Open [**\INTERIM\OPVEH_TRIPS.MTX]
2. Open [**\INTERIM\OPCV_TRIPS.MTX]
3. Open [**\INTERIM\OPEE_TRIPS.MTX]
4. Open [**\INTERIM\OPIX_TRIPS.MTX]
5. **Matrix – Combine – Select All** – Click OK – Name: [**\OUTPUT\OPTOT_TRIPS.MTX]
6. **Matrix – Contents** – Change Description to: OPTOT Trips – Close
7. **Matrix – QuickSum**
8. **Matrix – Contents** – Rename QuickSum to OPTOT Trips
9. File – Close All

11 Highway Assignment

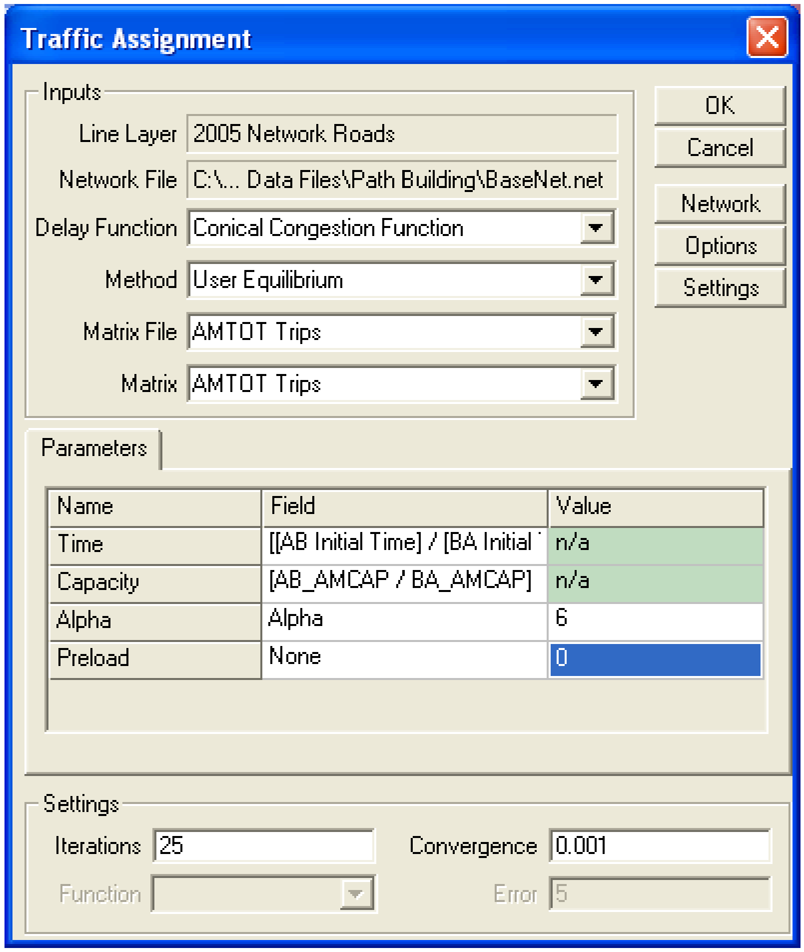
11.1 Purpose

The final step in the 4-step model is trip assignment. This is the process of assigning the zone to zone trips to the individual links in the highway network.

11.2 Highway Assignment

Step 1: AM Trip Assignment

1. Open [**\INPUT*_HIGHWAY.DBD]
2. Open [**\OUTPUT\NETWORK.NET]
3. Open [**\OUTPUT\AMTOT_TRIPS.MTX]
4. Make the Highway Line Layer the active layer – **Planning – Single Class Traffic Assignment – Traffic Assignment**
5. Fill out the dialog box as described below and shown in the screen shot
    a. Delay Function: Conical Congestion Function
    b. Method: User Equilibrium
    c. Matrix file: AMTOT Trips
    d. Matrix: AMTOT Trips
    e. Parameters:
        i. Time: AB/BA Initial Time
        ii. Capacity AB_AMCAP/BA_AMCAP
        iii. Alpha: Alpha
        iv. Preload: None
    f. Settings:
        i. Iterations: 25
        ii. Convergence: 0.001



6. Options – the options TAB can be selected to do the following:
    a. Create V/C themes
    b. Perform Select Link/Zone Analysis
    c. Perform tabulations, skip small values, save link flow, specify warm start for air quality analysis, report turns (a link table must be provided), and create a path file
    d. Perform Cold Start Analysis
    e. Specify Parameters
7. Click OK – Save file as: [**\OUTPUT\AM_LINKFLOW.BIN]
8. Close AMTOT trip table
9. Close Joined View – Network Roads + AM Flow

Step 2: MD Trip Assignment

1. Open [**\OUTPUT\MDTOT_TRIPS.MTX]
2. Make the Highway Line Layer the active layer – **Planning – Single Class Traffic Assignment – Traffic Assignment**
3. Fill out the dialog box as described below
    a. Delay Function: Conical Congestion Function
    b. Method: User Equilibrium
    c. Matrix file: MDTOT Trips

d. Matrix: MDTOT Trips
e. Parameters:
    i. Time: AB/BA Initial Time
    ii. Capacity AB_MDCAP/BA_MDCAP
    iii. Alpha: Alpha
    iv. Preload: None
f. Settings:
    i. Iterations: 25
    ii. Convergence: 0.001

4. Click OK – Save file as: [**\OUTPUT\MD_LINKFLOW.BIN]
5. Close MDTOT trip table
6. Close Joined View – Network Roads + MD Flow

Step 3: PM Trip Assignment

1. Open [**\OUTPUT\PMTOT_TRIPS.MTX]
2. Make the Highway Line Layer the active layer – **Planning – Single Class Traffic Assignment – Traffic Assignment**
3. Fill out the dialog box as described below
    a. Delay Function: Conical Congestion Function
    b. Method: User Equilibrium
    c. Matrix file: PMTOT Trips
    d. Matrix: PMTOT Trips
    e. Parameters:
        i. Time: AB/BA Initial Time
        ii. Capacity AB_PMCAP/BA_PMCAP
        iii. Alpha: Alpha
        iv. Preload: None
    f. Settings:
        i. Iterations: 25
        ii. Convergence: 0.001
4. Click OK – Save file as: [**\OUTPUT\PM_LINKFLOW.BIN]
5. Close PMTOT trip table
6. Close Joined View – Network Roads + PM Flow

Step 4: OP Trip Assignment

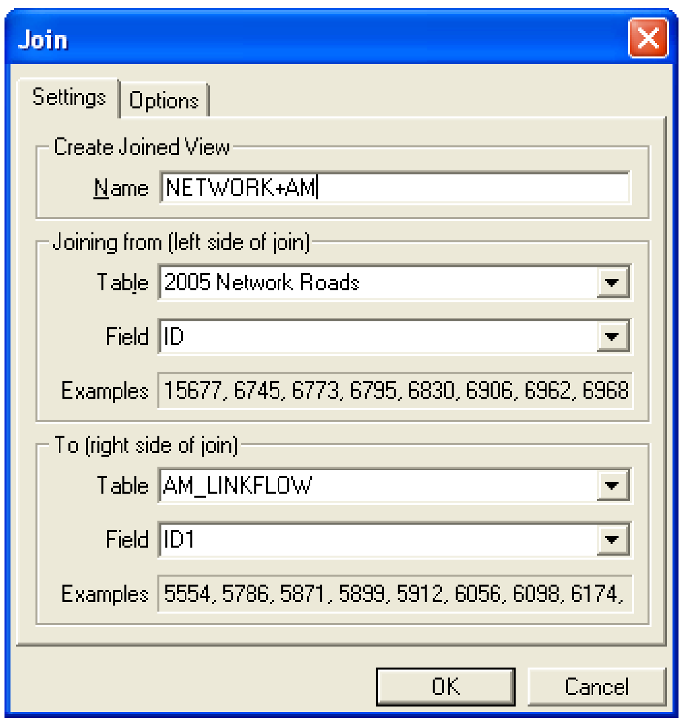
1. Open [**\OUTPUT\OPTOT_TRIPS.MTX]
2. Make the Highway Line Layer the active layer – **Planning – Single Class Traffic Assignment – Traffic Assignment**
3. Fill out the dialog box as described below
    a. Delay Function: Conical Congestion Function
    b. Method: User Equilibrium
    c. Matrix file: OPTOT Trips
    d. Matrix: OPTOT Trips
    e. Parameters:
        i. Time: AB/BA Initial Time
        ii. Capacity AB_OPCAP/BA_OPCAP
        iii. Alpha: Alpha
        iv. Preload: None
    f. Settings:
        i. Iterations: 25

        ii. Convergence: 0.001

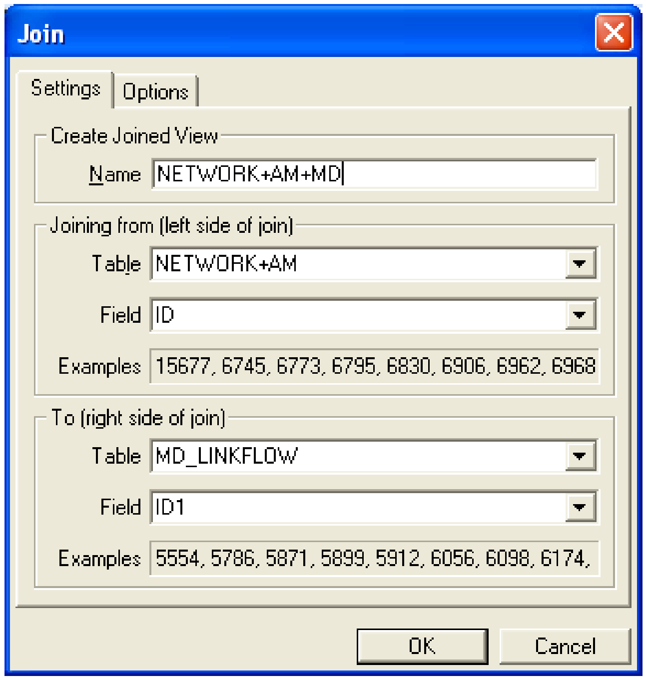
4. Click OK – Save file as: [**\OUTPUT\OP_LINKFLOW.BIN]
5. Close the OPTOT trip table
6. Close Joined View – Network Roads + OP Flow

Step 5: Create a BIN file with all Period Link Flow

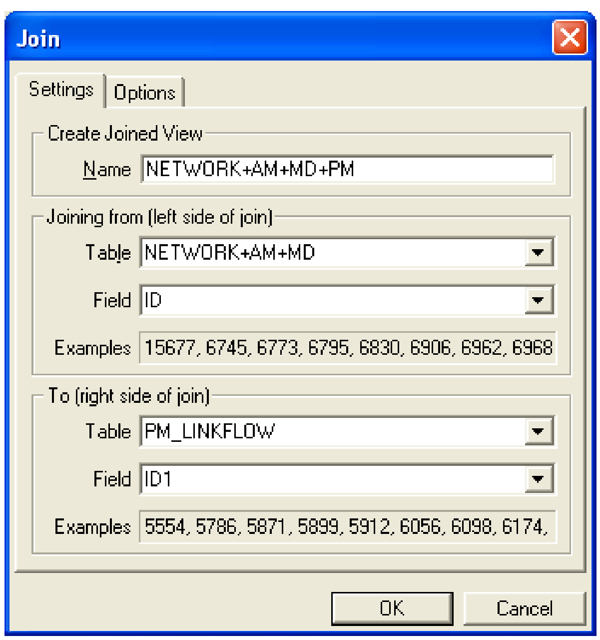
1. Open the Dataview for the highway line layer
2. Open [**\OUTPUT\AM_LINKFLOW.BIN]
3. **Dataview – Modify Table** – Rename the following fields:
    a. AB_Flow to AB_Flow_AM
    b. BA_Flow to BA_Flow_AM
    c. Tot_Flow to Tot_Flow_AM
    d. Tot_VMT to Tot_VMT_AM
4. Click OK
5. **Dataview – Join** – Network Roads using Field ID – to – AM_LINKFLOW using Field ID1 – Name the Joined View: NETWORK+AM – Click OK



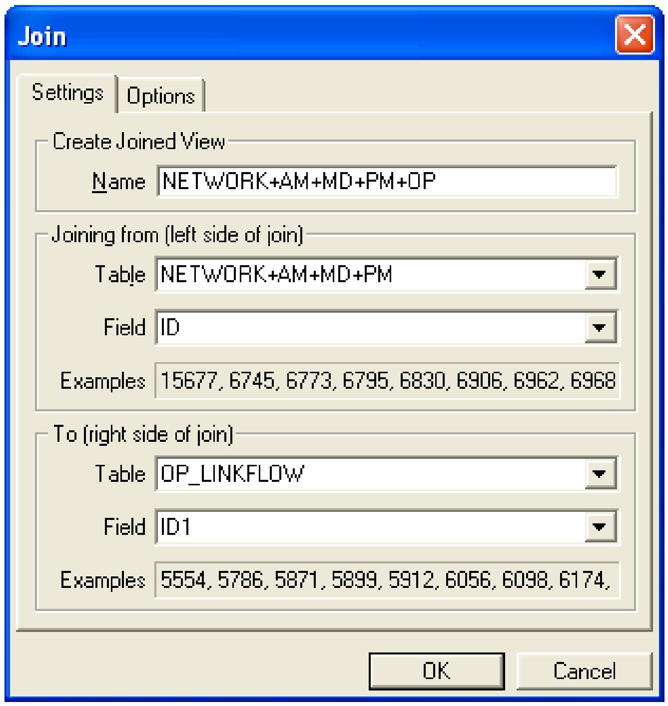
6. Open [**\OUTPUT\MD_LINKFLOW.BIN]
7. **Dataview – Modify Table** – Rename the following fields:
    a. AB_Flow to AB_Flow_MD
    b. BA_Flow to BA_Flow_MD
    c. Tot_Flow to Tot_Flow_MD
    d. Tot_VMT to Tot_VMT_MD
8. Click OK
9. **Dataview – Join** – NETWORK+AM using Field ID – to – MD_LINKFLOW using Field ID1 – Name the Joined View: NETWORK+AM+MD – Click OK



10. Open [**\OUTPUT\PM_LINKFLOW.BIN]
11. **Dataview – Modify Table** – Rename the following fields:
    a. AB_Flow to AB_Flow_PM
    b. BA_Flow to BA_Flow_PM
    c. Tot_Flow to Tot_Flow_PM
    d. Tot_VMT to Tot_VMT_PM
12. Click OK
13. **Dataview – Join** – NETWORK+AM+MD using Field ID – to – PM_LINKFLOW using Field ID1 – Name the Joined View: NETWORK+AM+MD+PM – Click OK



14. Open [**\OUTPUT\OP_LINKFLOW.BIN]
15. **Dataview – Modify Table** – Rename the following fields:
    a. AB_Flow to AB_Flow_OP
    b. BA_Flow to BA_Flow_OP
    c. Tot_Flow to Tot_Flow_OP
    d. Tot_VMT to Tot_VMT_OP
16. Click OK
17. **Dataview – Join** – NETWORK+AM+MD+PM using Field ID – to – OP_LINKFLOW using Field ID1 – Name the Joined View: NETWORK+AM+MD+PM+OP – Click OK



18. Make the Joined table NETWORK+AM+MD+PM+OP the active table – **Dataview – Fields – Clear – Add** the following fields:
    a. ID
    b. AB Count
    c. BA Count
    d. DailyCount
    e. AB_FLOW_AM
    f. BA_FLOW_AM
    g. TOT_FLOW_AM
    h. TOT_VMT_AM
    i. AB_FLOW_MD
    j. BA_FLOW_MD
    k. TOT_FLOW_MD
    l. TOT_VMT_MD
    m. AB_FLOW_PM
    n. BA_FLOW_PM

o. TOT_FLOW_PM
p. TOT_VMT_PM
q. AB_FLOW_OP
r. BA_FLOW_OP
s. TOT_FLOW_OP
t. TOT_VMT_OP

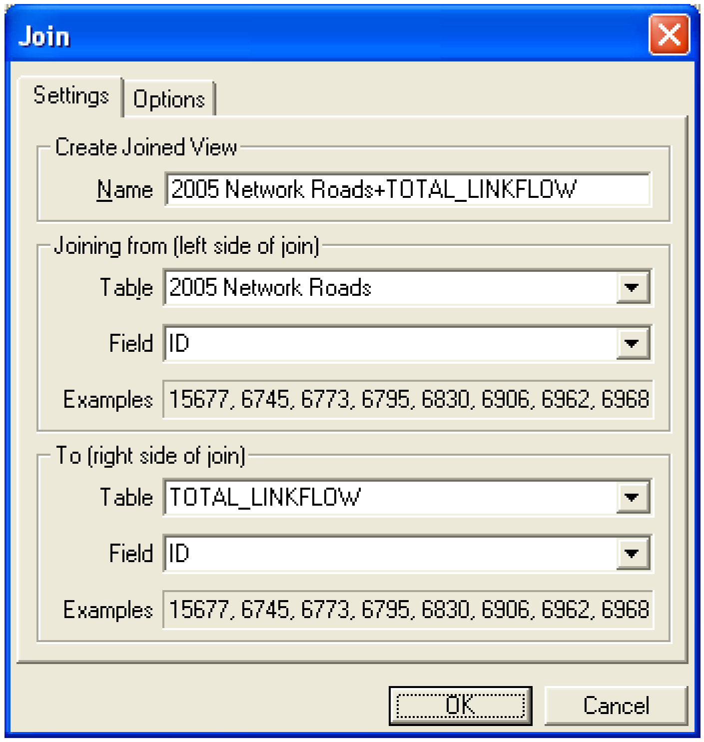
19. Click OK
20. File – Save As – [**\OUTPUT\TOTAL_LINKFLOW.BIN]
21. File – Close All (no need to save changes to any of the Dataviews)

Step 6: Calculate Daily Link Flow and Daily VMT

1. Open [**\OUTPUT\TOTAL_LINKFLOW.BIN]
2. **Dataview – Modify Table – Add** the following fields:
    a. AB_DailyFlow (Real, 8 bytes)
    b. BA_DailyFlow (Real, 8 bytes)
    c. DailyFlow (Real, 8 bytes)
    d. Daily_VMT (Real, 8 bytes)
3. Click OK
4. Open the Dataview and fill the new fields with the following formulas:
    a. AB_DailyFlow = [AB_Flow_AM] + [AB_Flow_MD] + [AB_Flow_PM] + [AB_Flow_OP]
    b. BA_DailyFlow = [BA_Flow_AM] + [BA_Flow_MD] + [BA_Flow_PM] + [BA_Flow_OP]
    c. DailyFlow = [Tot_Flow_AM] + [Tot_Flow_MD] + [Tot_Flow_PM] + [Tot_Flow_OP]
    d. DAILY_VMT = [Tot_VMT_AM] + [Tot_VMT_MD] + [Tot_VMT_PM] + [Tot_VMT_OP]

Step 7: Join TOTAL_LINKFLOW.BIN file to the highway network

1. Open [**\INPUT**_HIGHWAY.DBD]
2. **Dataview – Join** – Network Roads using Field ID – to – TOTAL_LINKFLOW using Field ID – Click OK



You can now create thematic maps, review the assignment, etc. Overall Model Validation and Reasonableness Checking are covered in Chapter 12.

12 Overall Model Validation and Reasonableness Checking

12.1 Purpose

Model validation is the process of comparing model output against observed data that is independently obtained. The comparison of model output against data that was not directly used in the development process, demonstrates the model's ability to match real-world observations, increasing the model's credibility. The process of model validation and reasonableness checking happens at each step in the model development. Following the highway assignment step, estimated volumes are compared to observed traffic counts as an initial check on the overall model performance.

Highway assignment validation includes VMT comparisons, model speed review, screenline/cutline comparisons, and link level comparisons that include percent root mean square error, 2-way plots, and summary comparisons by facility type and volume group. The performance measures outlined below are intended to be used as target values for determining when an acceptable level of highway validation has been achieved. This step will likely require feedback to the preceding steps if validation tolerances are not achieved.

<u>Study Area Vehicle Miles Traveled (VMT)</u>

Total VMT for the study area should generally be within 5% of observed count VMT.

Study Area Average Speeds

Overall average speeds for the entire study area and speeds by facility type will be generated by dividing VMT by VHT. Speeds will be summarized separately by time period (AM, MD, PM, and OP). Average speeds will be compared to observed data if available. If observed data is not available the overall study area average speeds resulting from assignment will be compared to the speeds generated from the initial travel speeds.

Screenlines and Cutlines

Screenline and cutline assigned volumes will be compared to observed volumes. Screenlines and cutlines should generally be within 10% of observed values on a daily basis, although this can vary depending on the total volume crossing the screenline. For low volume screenlines a higher tolerance of error is deemed acceptable.

Link-level Comparisons

At the link level, several measures will be made. The first is the calculation of percent root mean square error by facility type and volume category. In the context of model validation, percent root mean square error is computed as follows:

$$\%RMSE = \frac{\sqrt{\frac{\sum (V_e - V_o)^2}{N-1}} \times N}{\sum V_o} \times 100$$

where:

V_o = Observed Volume for link n;

V_e = Estimated Volume for link n;

N = Number of Observations or number of links; and

$\sum V_o$ = Sum of V_o over all N.

The target %RMSE for study area is in the range of 30-40%, depending upon the number of low-volume roadway segments included in the count sample. The %RMSE by facility type and observed volume range should show a decreasing %RMSE with a higher level of facility type and with increasing observed volume.

Table 29 Target Percent Root Mean Square Error by Facility Type

Facility Type	Approximate % RMSE
Interstate	25%
Freeway/Expressway	40%
Arterials	50%
Collector	65%
Total (Systemwide)	30 – 40%

Table 30 Target Percent Root Mean Square Error by Volume Group

Link Volume	Approximate % RMSE
0 to 4999	120%
5000 to 9999	45%
10000 to 19999	40%
20000 to 39999	35%
40000 to 59999	30%
60000 to 89999	20%

Observed and estimated daily volumes by link will be plotted on a scatter plot. The r-squared statistic will be computed to provide an indication of the degree to which the counts and estimated volumes match. Note that the r-squared value is, in part, a function of the number of observations, so fixed standards regarding acceptable r-squared limits are not appropriate. The r-squared range is between 0 and 1.0, with 1.0 representing a perfect match. So, in general, a high r-squared value is desirable.

Similar link criteria will be applied on a volume basis. The following is a set of FHWA standards of deviation by volume group that will be used:

Table 31 FHWA Standards for Acceptable Deviation by Volume Group

Daily 2-way Volume	Desirable Percent Deviation
< 1,000	60%
1,000 to 2,500	47%
2,500 to 5,000	36%
5,000 to 10,000	29%
10,000 to 25,000	25%
25,000 to 50,000	22%
> 50,000	21%

Model validation and reasonableness checking references are provided below:

Mode Validation and Reasonableness Checking Manual:
http://www.ctre.iastate.edu/educweb/ce451/LECTURES/Validation/finalval.pdf

Calibrating and Adjustment of System Planning Models – December 1990

http://ntl.bts.gov/DOCS/377CAS.html

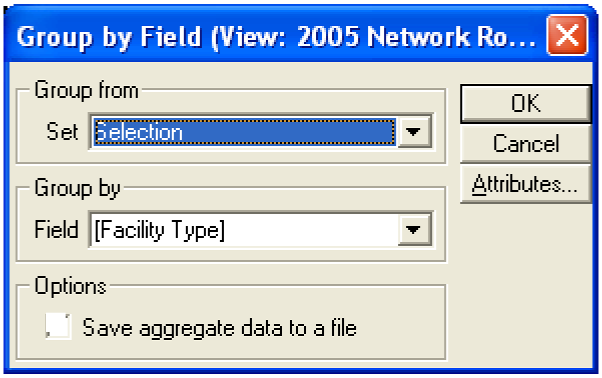
12.2 VMT and Average Speed Summaries

Step 1: Summarize Vehicle Miles Traveled

In Section 2.8, procedures were provided for estimating VMT by facility type using traffic count links. Model VMT will now be summarized for this subset of links.

1. Open the base year highway network [**\INPUT\HIGHWAY.DBD]
2. Open the Dataview for the highway line layer
3. Open [**\OUTPUT\TOTAL_LINKFLOW.BIN]
4. **Dataview** – **Join** - Network Roads to TOTAL_LINKFLOW.BIN using the ID field
5. **Dataview** – **Formula Fields** – Formula: Length * DailyFlow – Formula Fields: Model_VMT

6. **Dataview** – **Formula Fields** – Formula: Length * DailyCount – Formula Fields: Count_VMT
7. With the joined table as the active table – Create a selection set
   a. Formula: DailyCount<>null
8. **Dataview – Group By** – Group from: – Group by: Field Facility Type – Attributes: Add Model_VMT and Count_VMT (all other fields are set to None) – CLICK OK – CLICK OK



9. Record the VMT values in the VMT Summary Table (Example provided below in Table 43) **TIP:** A more efficient way to create these summary tables is when grouping the data in the joined table, select the option to save the aggregate data to a file. This will create a BIN file that can be saved in an Excel format and all data summaries and calculations can be performed in Excel.
10. Calculate % deviation, [((EST-OBS)÷OBS)×100]

Table 32 VMT Summaries (Count Links Only)

Facility Type	Model VMT	Count VMT	% Deviation
Freeway	117,521	171,418	-31
Multilane Highway	155,958	222,517	-30
Urban Arterial I	29,088	37,129	-22
Urban Arterial II	51,243	46,056	-11
Urban Arterial III	21,138	24,641	-14
Urban Arterial IV	68,145	86,733	-21
Two-lane Highway	43,682	28,344	54
Collector	21,939	26,684	-18
All	508,714	643,522	-21

Step 2: Summarize Average Speed

1. **File** - Close All
2. Open the base year highway network [**\INPUT\HIGHWAY.DBD]
3. Open the Dataview for the highway line layer
4. Open [**\OUTPUT\AM_LINKFLOW.BIN]
5. **Dataview** – **Join** - Network Roads to AM_LINKFLOW.BIN using the ID field
6. With the joined table as the active table – **Dataview – Group By –** Group from: All Records – Group by: Facility Type – Attributes: Add AM_LINKFLOW.Tot_VMT and Tot_VHT (all other fields are set to None) – CLICK OK – CLICK OK
7. Record VMT total and VHT total in AM Speed Summary Table (Example provided in Table 44) **TIP:** A more efficient way to create these summary tables is when grouping the data in the joined table, select the option to save the aggregate data to a file.

This will create a BIN file that can be saved in an Excel format and all data summaries and calculations can be performed in Excel.

8. Calculate average speed as AM VMT/AM VHT
9. Drop joined view and close file [AM_LINKFLOW.BIN]

Table 33 AM Speed Summaries (All Links)

Facility Type	AM VMT	AM VHT	AM Avg. Speed
Freeway	68692	1126	61
Multilane Highway	65432	1668	39
Urban Arterial I	19284	521	37
Urban Arterial II	20905	477	44
Urban Arterial III	11852	322	37
Urban Arterial IV	35088	970	36
Two-lane Highway	15603	295	53
Collector	7973	259	31

Step 3: Summarize MD Average Speed

1. Open [**\OUTPUT\MD_LINKFLOW.BIN]
2. **Dataview** – **Join** - Network Roads to MD_LINKFLOW.BIN using the ID field
3. With the joined table as the active table – **Dataview – Group By** – Group from: All Records – Group by: Facility Type – Attributes: Add MD_LINKFLOW.Tot_VMT and Tot_VHT (all other fields are set to None) – CLICK OK – CLICK OK
4. Record VMT total and VHT total in MD Speed Summary Table
5. Calculate average speed as MD VMT/MD VHT
6. Drop joined view and close file [MD_LINKFLOW.BIN]

Step 4: Summarize PM Average Speed

1. Open [**\OUTPUT\PM_LINKFLOW.BIN]
2. **Dataview** – **Join** - Network Roads to PM_LINKFLOW.BIN using the ID field
3. With the joined table as the active table – **Dataview – Group By** – Group from: All Records – Group by: Facility Type – Attributes: Add PM_LINKFLOW.Tot_VMT and Tot_VHT (all other fields are set to None) – CLICK OK – CLICK OK
4. Record VMT total and VHT total in PM Speed Summary Table
5. Calculate average speed as PM VMT/PM VHT
6. Drop joined table and close file [PM_LINKFLOW.BIN]

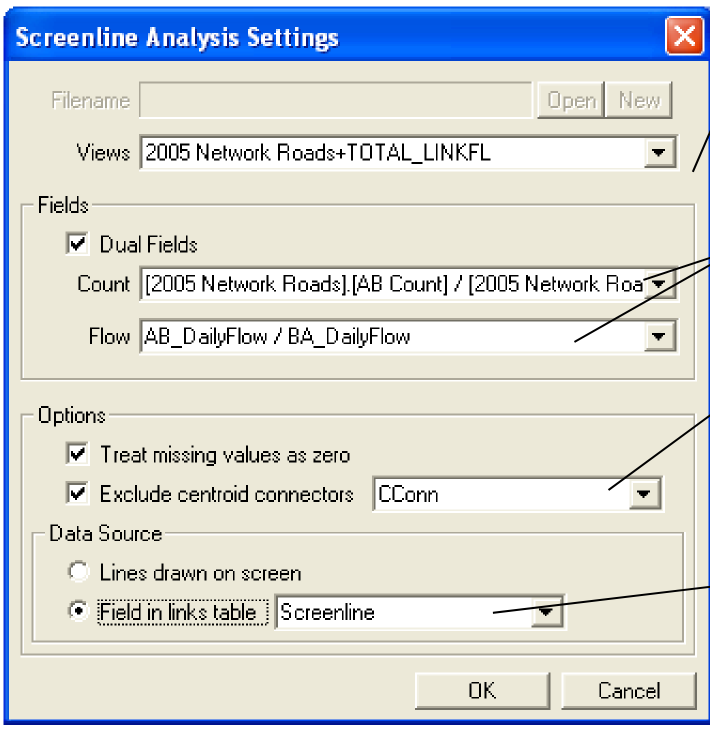
Step 5: Summarize OP Average Speed

1. Open [**\OUTPUT\OP_LINKFLOW.BIN]
2. **Dataview** – **Join** - Network Roads to OP_LINKFLOW.BIN using the ID field
3. With the joined table as the active table – **Dataview – Group By** – Group from: All Records – Group by: Facility Type – Attributes: Add OP_LINKFLOW.Tot_VMT and Tot_VHT (all other fields are set to None) – CLICK OK – CLICK OK
4. Record VMT total and VHT total in OP Speed Summary Table
5. Calculate average speed as OP VMT/OP VHT
6. File – Close All

12.3 Screenline and Cutline Summaries

TransCAD has a built in tool for reporting screenline and cutline summaries.

1. Open the base year highway network [**\INPUT**_HIGHWAY.DBD]
2. Create a selection set for the centroid connectors (FACTYPE_CD=12)
3. Open [**\OUTPUT\TOTAL_LINKFLOW.BIN]
4. **Dataview – Join** – Network Roads to TOTAL_LINKFLOW.BIN using the ID field – CLICK OK
5. With the map file as the active window – **Planning – Assignment Utilities – Screenline Analysis** (See Dialog Box below)



This is the joined view for the network roads and the data table with the link flow

Identity the field for the AB/BA counts and the AB/BA **Daily** Flow

Exclude the centroid connectors by identifying the selection set created previously

Field in links table: Screenline

6. Clicking OK will display the Screenline Editor toolbox. Select the **statistics** button to Calculate Screenline Analysis Results

Use this button to Calculate Screenline Analysis Results

7. A screenline summary report is generated with the following information:
   a. Screenline number
   b. Screenline name
   c. Total Flow
   d. Total Count
   e. Total Ratio
   f. RMSE

g. RelRMSE (% RMSE)

8. Use this data to populate a table similar to Table 45.
9. Close the Screenline summary report and Screenline Editor toolbox

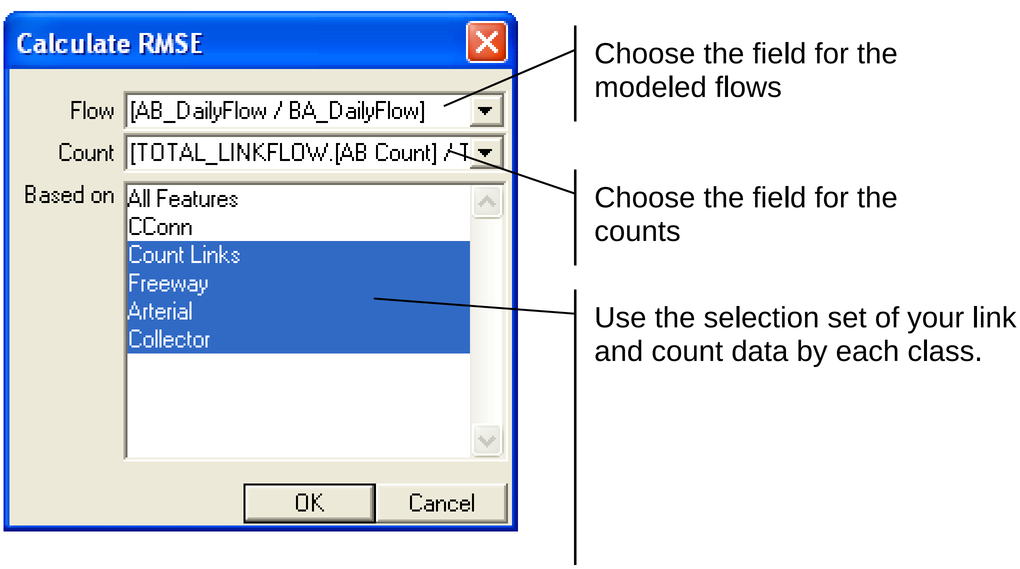
Table 34 Sample Screenline Report

Screenline No.	Screenline Name	Total Flow	Total Count	Total Ratio
1	Name 1	53988	75000	0.72
2	Name 2	55411	76100	0.73
3	Name 3	38775	73900	0.52
4	Name 4	25256	19150	1.32

12.4 Calculate %RMSE and Assignment Summaries

Step 1: Calculate %RMSE for by Functional Classification

1. With the highway line layer as the active layer create the following selection sets:
   a. Count Links (Total): [2005 Network Roads].DailyCount<>null
   b. Interstate: (FUNCL_CD=10 or FUNCL_CD=20) and ([2005 Network Roads].[DailyCount]<>null)
   c. Freeway: (FUNCL_CD=11) and ([2005 Network Roads].[DailyCount]<>null)
   d. Arterial: (FUNCL_CD=21 or FUNCL_CD=22 or FUNCL_CD=12 or FUNCL_CD=13) and ([2005 Network Roads].[DailyCount]<>null)
   e. Collector: (FUNCL_CD=23 or FUNCL_CD=24 or FUNCL_CD=14) and ([2005 Network Roads].[DailyCount]<>null)
   f. **Planning – Assignment Utilities – RMSE Calculator** – this will display the RMSE dialog box – CLICK OK



2. A RMSE summary report is generated with the following information:
   a. Selection Set Name
   b. Observations
   c. RMSE
   d. RelRMSE (% RMSE)
   e. Sum of Counts

    f. Sum of Flows
    g. % Flow/Count
3. Record this information in a table similar to the one shown in Table 46
4. Close RMSE report

Step 2: Calculate %RMSE for Volume Groups

1. Drop the joined view. Using TOTAL_LINKFLOW.BIN, repeat the steps from Step 1 using the following selection sets by volume group:
    a. Less than 5,000: [DailyCount]<5000
    b. 5,000 to 9,999: ([DailyCount] between 5000 and 9999)
    c. 10,000 to19,999: ([DailyCount] between 10000 and 19999)
    d. 20,000 to 39,999: ([DailyCount] between 20000 and 39999)
    e. 40,000 to 59,999: ([DailyCount] between 40000 and 59999)
    f. Greater than or equal to 60,000: ([DailyCount] >= 60000)
2. Record this information in a table similar to the one shown in Table 47

Table 35 Percent Root Mean Square Error by Functional Classification

Facility Type	Observations	Model	Target
Interstate	0	-	25%
Freeway/Expressway	8	44%	40%
Arterials	106	87%	50%
Collectors	106	87%	65%
Total (Systemwide)	262	64%	30-40%

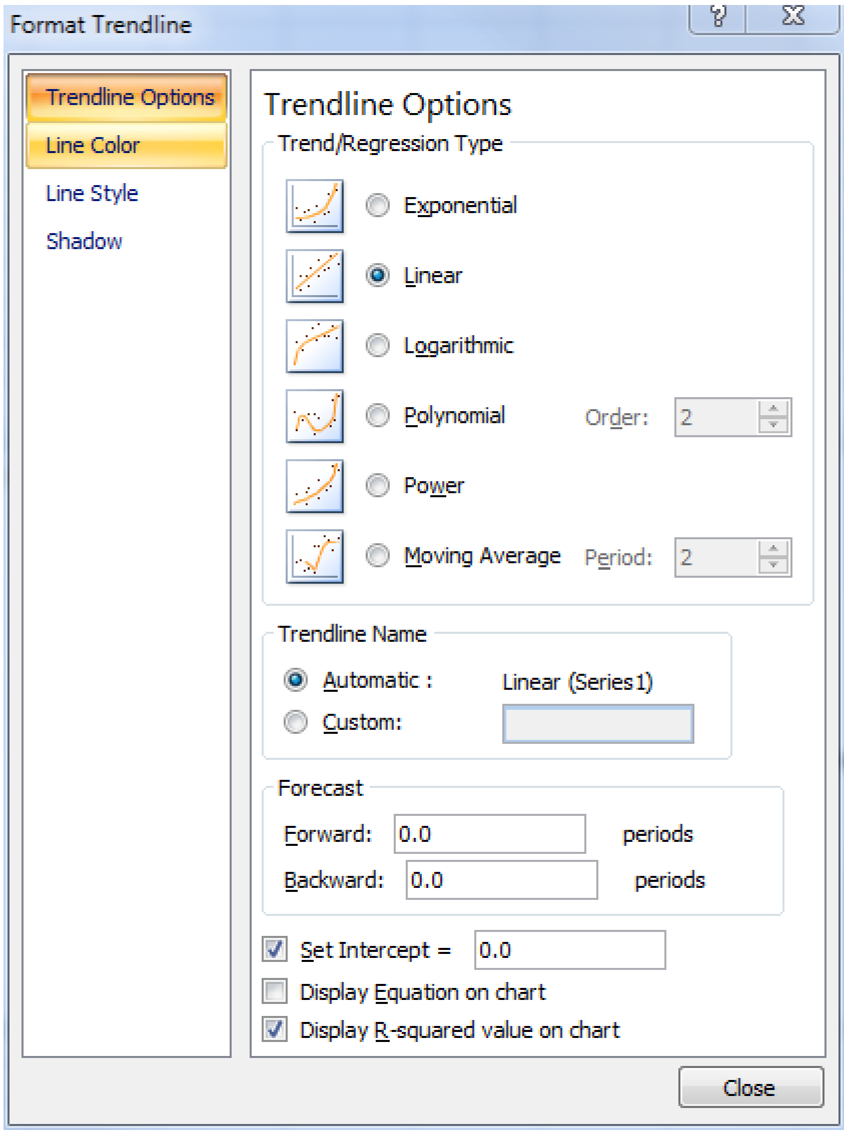
Table 36 Percent Root Mean Square Error by Volume Group

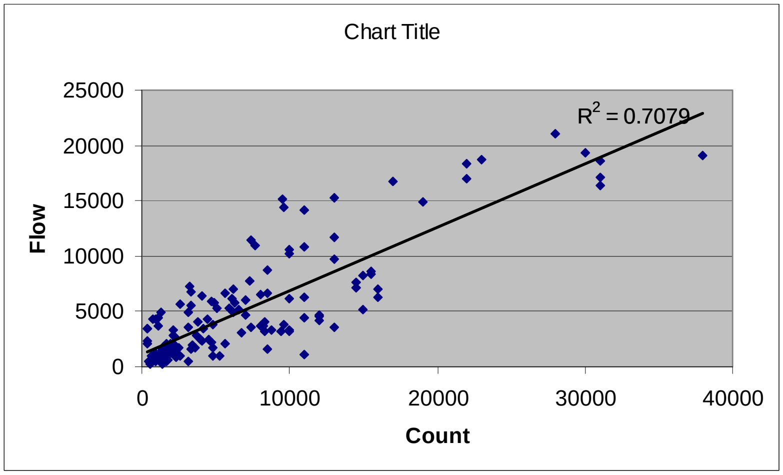
Facility Type	Observations	Model	Target
0 to 4,999	140	80%	120%
5,000 to 9,999	54	49%	45%
10,000 to 19,999	46	50%	40%
20,000 to 39,999	18	40%	35%
40,000 to 59,999	-	-	30%
60,000 and greater	-	-	20%

12.5 Create a Scatter Plot and Calculate R^2

1. Open [**/OUTPUT/TOTAL_LINKFLOW.BIN]
2. Create a selection set of all links with count data:
    a. Formula: [DailyCount]<>null
3. **Dataview – Fields – Clear – Add**: ID, AB Count, BA Count, AB_DAILYFLOW, BA_DAILYFLOW
4. CLICK OK
5. File – Save As – TOTAL_LINKFLOW.DBF
6. Open DBF file in Excel
7. Create a new field for Count and sum the values of the AB Count and BA Count
8. Create a new field for Flow and sum the values of AB_DAILYFLOW and BA_DAILYFLOW

9. Save the file as an Excel file
10. Use the Chart Wizard to create a scatter plot:
    a. Counts should be on the x-axis and flow on the y-axis
11. Select any point on the new scatter plot and left click your mouse – Select Add Trendline
    a. Type = Linear
    b. Options = Display R-squared value on chart
    c. Set intercept to 0
    d. CLICK OK





12.6 Summarize Assignment by Volume Group

1. Open [**/OUTPUT/TOTAL_LINKFLOW.BIN]
2. Create a selection set for each of the volume groups using the following queries:
   a. Less than or equal 1,000: [DailyCount] <= 1000
   b. 1,001 to 2,500: ([DailyCount] between 1001 and 2500)
   c. 2,501 to 5,000: ([DailyCount] between 2501 and 5000)
   d. 5,001 to 10,000: ([DailyCount] between 5001 and 10000)
   e. 10,001 to 25,000: ([DailyCount] between 10001 and 25000)
   f. 25,001 to 50,000: ([DailyCount] between 25001 and 50000)
   g. Greater than 50,000: ([DailyCount] > 50000)
3. For each Volume Group selection set – Compute Statistics – Record the values for the Daily Count and Daily Flow for each volume group in a table similar to Table 48 and calculate the percent difference.

Table 37 Assignment Summary by Volume Group

Facility Type	Daily Count	Daily Flow	Model % Diff	Target % Diff
Less than or equal 1,000	9680	25285	161	60%
1,001 to 2,500	53600	53624	0	47%
2,501 to 5,000	96100	89063	-7	36%
5,001 to 10,000	272600	208687	-23	29%
10,001 to 25,000	368000	234635	-36	25%
25,001 to 50,000	189000	111478	-41	22%
Greater than 50,000	-	-		21%

12.7 Troubleshooting

The following troubleshooting tips were extracted from Calibrating and Adjustment of System Planning Models – December 1990. This document is available online at the following website: *http://ntl.bts.gov/DOCS/377CAS.html*.

Table 38 Troubleshooting Tips

Problem	Possible Solutions
Systemwide volumes are higher than ground counts	a. Raise auto occupancy rates b. Lower trip production rates c. Lower number of households d. Lower average auto ownership e. Lower average trip lengths f. Increase intrazonal trips
Systemwide volumes are lower than ground counts	a. Lower auto occupancy rates b. Raise trip production rates c. Raise number of households d. Raise average auto ownership e. Raise average trip lengths f. Decrease intrazonal trips
Total systemwide volumes match ground counts but specific links do not	a. Verify speed and capacity of roadway section b. Modify local network c. Add or delete nearby centroid connectors d. Check nearby special generators e. Check socioeconomic data of nearby zones
Freeway or Arterial volumes are high	a. Lower the speed or capacity of freeway or arterial links b. Raise the speed or capacity of parallel arterial or collector links c. Adjust nearby centroid connectors
Freeway or Arterial volumes are low	a. Raise the speed or capacity of freeway or arterial links b. Lower the speed or capacity of parallel arterial or collector links c. Adjust nearby centroid connectors
Link speeds are too high	a. Increase initial travel time (decrease initial speed) b. Decrease capacity c. Adjust the traffic assignment coefficient
Link speeds are too low	a. Decrease initial travel time (decrease initial speed) b. Increase capacity c. Adjust the traffic assignment coefficient
General Hints	a. If a specific link is significantly different from the ground count, check the volumes of nearby links and try to trace where the trips are going. Selected link analysis may be useful in pinpointing problem b. Confirm that centroids and centroid connectors are accurately represented in the network c. Check the network to ensure the number of links is compatible with the number of zones d. Strive to make changes that make sense and are predictable in the future – do not be arbitrary

13 Model Application

13.1 Purpose

The purpose of this chapter is to cover model application from the standpoint of scenario inputs versus model parameters, reviews that should be conducted to evaluate the reasonableness of the forecasts, and sensitivity testing.

13.2 Scenario Inputs versus Model Parameters

Proper application of the model is highly dependent upon the proper treatment and differentiation of scenario inputs and model parameters. The scenario inputs typically change from one scenario to another to reflect changes in land use, growth in traffic volumes at the external stations, and proposed changes in the transportation supply. The scenario inputs are located in the INPUT folder for each scenario evaluated and are listed in Table 50.

Table 39 Scenario Inputs

File Name	Description
BY_SEDATA.BIN	Base year zonal land use data inputs
*_SEDATA.BIN	Zonal land use data inputs where * is the name or year of the scenario
BY_HIGHWAY.DBD	Base year highway line layer
*_HIGHWAY.DBD	Any future scenario line layer where * is the name or year of the scenario
*_SEDATA.BIN and BY_EETRIPS.MTX	External zones/stations forecast traffic volumes and base year through trip table used as a seed matrix for forecasting the future year through trip table

Model parameters are set during the model calibration/validation process and should not change from one model application scenario to another. Many of the parameters for the standard small area model were developed using the North Carolina Combined Survey Database. Other parameters, such as average wage rate, will be specific to the area of study, but once set for the base year scenario, will not change for future scenarios. Model parameters needed for the standard small area model are located in the PARAMETERS folder and are described in Table 51.

Table 40 Model Parameters

File Name	Description
CAPACITY.BIN	BIN file with standard capacities for study area
ALPHA.BIN	BIN file with standard values for alpha coefficient
Disaggregate curve data	Distribution of household size and vehicle ownership: HHSize.BIN and Autos.BIN
NCPRODRATES.BIN	Default trip production rates
HBW.MOD	Trip attraction rates/model by trip purpose: ncAttrRates.BIN
HBO.MOD	
HBSCH.MOD	
NHBW.MOD	
NHBO.MOD	
CV1PROD.MOD	Trip production rates/model by commercial vehicle type: cvProdRates.BIN
CV2PROD.MOD	
CV3PROD.MOD	
CV1ATTR.MOD	Trip attraction rates/model by commercial vehicle type: cvAttrRates.BIN
CV2ATTR.MOD	
CV3ATTR.MOD	
IXATTR.MOD	Trip attraction rates for IX trips
NC_HOURLY_SMALL.BIN	PA to OD Time-of-Day conversions for small areas and large areas
NC_HOURLY_LARGE.BIN	
MODESHARES_SMALL.BIN	Auto mode shares for small and large areas
MODESHARES_LARGE.BIN	
PEAKFACTORS.BIN	Peak hour factors for small and large areas used to convert hourly capacity to time period capacity.

Step 1: Highway Modifications

Changes are made to the highway line layer in order to test systemwide strategies as is often done during the development of the long range transportation plan, or to test specific strategies within an identified corridor. Changes may include the addition of new links to represent new roadways or the modification of link attribute data to reflect changing conditions such as widening from a two-lane section to a four-lane divided section.

1. Make a copy of the BY_HIGHWAY.DBD file:
   a. **File – Open** - BY_HIGHWAY.DBD
   b. Tools – Geographic Utilities – Geographic File – Copy
   c. **Save As**: **_HIGHWAY.DBD, where ** represents the year and/or letter of the scenario under development
2. Use the TransCAD editing tools to make the necessary line edits or attribute changes to reflect the scenario under development
3. The procedures in Section 2.4 should be followed when creating a new line layer
4. Apply the validation checks covered in Section 2.4, Step 4 before using the new file as input for a scenario.

Step 2: TAZ and Land Use Modifications

As with the highway modifications, TAZ land use changes can either be made for the entire study area to reflect a future year scenario(s) for the purposes of evaluating and developing a long range transportation plan, or for the purposes of testing localized changes in land use. The TAZ data values that are subject to forecast include:

- Population,
- Households,
- Vehicles (autos),
- Industrial Employment,
- Retail Employment,
- High-traffic Retail Employment,
- Service Employment,
- Office Employment,
- Total Employment,
- Student Enrollment, and
- Commercial Vehicles by Vehicle Type and Employment Type.

Validation checks should be performed against future year land use forecasts in much the same manner as performed for the base year data. An additional validation check that is important for future year forecasts is to compare the dispersion and intensity of growth between the base year and forecast year. Special attention should be given to assuring that there is an adequate jobs-to-housing balance, especially in the portions of the study area that are more rural in nature for the base year condition.

1. Make a copy of BY_SEDATA.BIN and save as **_SEDATA.BIN, where ** represents the year and/or letter of the scenario under development
2. Clear all of the data ranges in the new SEDATA file except for the TAZ and DISTRICT fields.
3. Populate the data fields with the new zonal data values for each forecast variable
4. Conduct validation and reasonableness checks as described in Section 2.3, Step 5 before using the new data file in a model scenario.
5. Compare the dispersion of growth in the model scenario to the base year.
6. Check the balance of housing and employment data, especially in the areas that are rural in the base year, but converting to more suburban development in the future years. The forecasts should be checked to be sure that employment is forecast for these growing areas, especially service employment that will be needed to support the new residential development.

Step 3: External Station Modifications

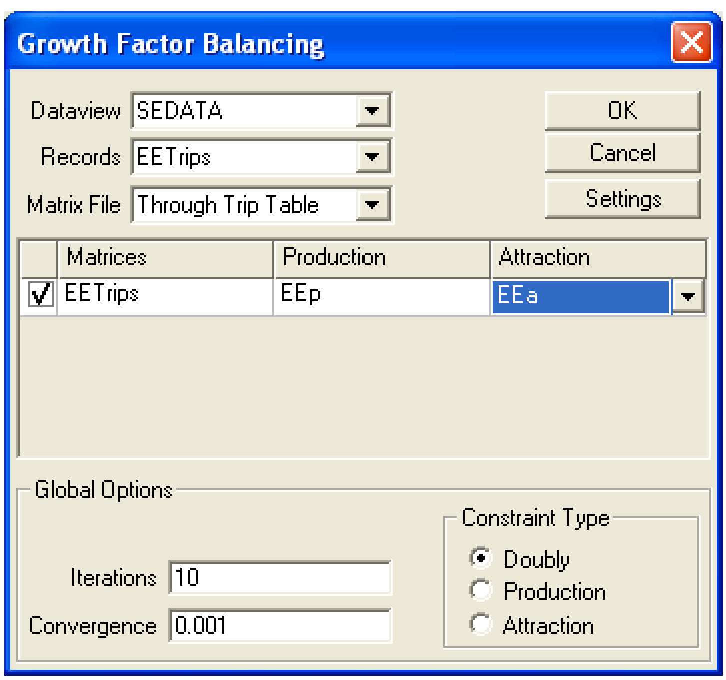
Modifications to the external station data are needed to reflect the growth that is anticipated by trips originating outside of the study area with destinations internal to the study area and vice versa, and also to reflect the growth in trips passing through the study area. The most common approach to forecasting this data is to evaluate historic growth trends and then to apply these trends to the base year AWDT. Other factors should also be taken into consideration such as the overall attractiveness of your study area for neighboring communities, growth patterns for neighboring communities, and the jobs-to-housing balance within your study area.

Once the external station AWDT are forecasted the recommended approach is to apply Fratar Balancing to the base year through trip table using the estimated through trip ends for each of the external stations.

1. Open [“scenario”\INPUT**_SEDATA.BIN]
2. Populate the following data fields with forecasted data:
    a. EEp

    b. EEa
    c. IXp

3. Open [INPUT\BY_EETRIPS.MTX]
4. With the [**_SEDATA.BIN] file as the active file, create a selection set of the external stations and name it EETrips
    a. EEp<>null
5. **Planning – Trip Distribution – Growth Factor Method** – fill out the dialog box as shown below, where:
    a. Dataview = the future year SEDATA file with the forecast EE trip ends
    b. Records = the selection set of external stations EETrips
    c. Matrix File = the base year through trip table
    d. The matrix file is the base year through trip table, the production field to Fratar to is EEp, and the attraction field to Fratar to is EEa
    e. CLICK OK
    f. File should be named **EE_TRIPS.MTX and saved in the forecast year INPUT folder
    g. Before the file can be read by the model GUI, the indices must be updated.
        i. **Matrix – Indices** – highlight Rows Only and Rename as “From” – CLICK OK – highlight Columns Only and Rename as “To” - CLICK OK – Close



13.3 *Examination of Results*

In the model validation chapter, several measures for checking the reasonableness and validation of the model outputs were provided. For the base year, these comparisons are easier because comparisons are made against existing or known conditions. In forecast applications, the analyst must evaluate results based on hypotheses and expected results. Cases where results deviate from what is expected must be evaluated and determinations made as to whether the results are curiously counter-intuitive (but accurately derived), are based on an error in the model application data, or are based on an improper application of the model.

Step 1: Trip Generation Results

1. Review the trip productions and attractions by district and compare to the base year productions and attractions by district. Are the observed changes as expected?
2. Review the unbalanced productions and attractions to see if significant imbalances are present. High imbalances in the production and attraction data may indicate specific problems in the housing and employment planning data relationships.

Step 2: Trip Distribution Results

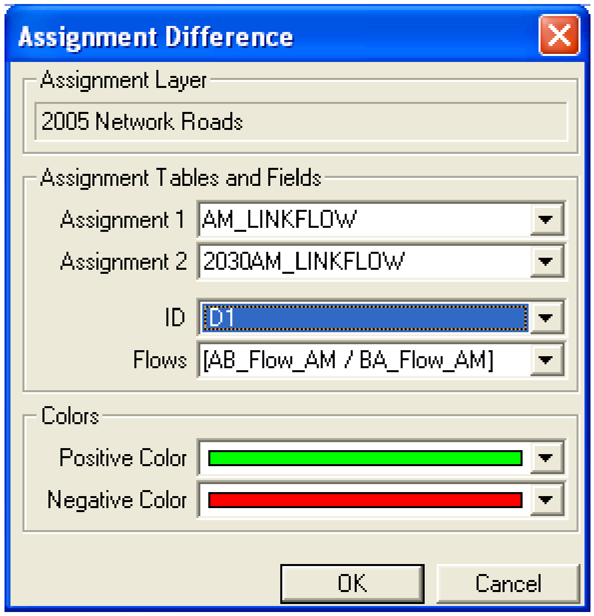
1. Tabulate and review the district to district percent flow by trip purpose and compare to the base year flows. Are the observed changes as expected?
2. Tabulate and review the average trip length by trip purpose and compare to the base year average trip length. Are the observed changes as expected?
3. If used, assess and document the impact of the K-factors.

Step 3: Highway Assignment Results

1. Query the assignment for ZERO volume links and repair if necessary
2. Summarize the VMT and compare to the base year results. Calculate the percent growth in VMT between the base and the scenario. Is it logical with respect to the growth in land use and the available transportation supply?
3. Summarize the speeds by facility type and compare to the base year results. Calculate the percent change in speeds between the base and the scenario. Is it logical with respect to the growth in land use and available transportation supply?
4. Summarize the screenline, cutline, and cordon assignment volumes and compare to the base year results. Are the observed changes as expected?
5. Summarize the assignment by facility type. Calculate the percent growth between the base and the scenario. Is it logical with respect to growth in land use?

Step 4: Comparing Scenarios

1. Open the geographic line layer upon which the two assignments are based.
    a. Example BY_HIGHWAY.DBD
2. Open the assignment BIN file for the first scenario you wish to compare.
    a. Example AM_LINKFLOW.BIN
3. Open the assignment BIN file for the second scenario you wish to compare.
    a. Example 2030AM_LINKFLOW.BIN
4. With the geographic line layer as the active window: **Planning – Assignment Utilities – Assignment Differences** – fill out Dialog Box:



5. CLICK OK – A thematic map of the difference between the two assignments is created – the displayed increases and decreases in volume can be reviewed either for insight into the differences between the two scenarios or as a reasonableness check

14 Reference Materials

David G. Modlin, *Synthesized Through Trip Table for Small Urban Area*, Transportation Research Record 842, Transportation Research Board, Washington, DC, 1982

TransCAD, Transportation GIS Software, Caliper Corporation, Newton, MA, 2000
http://www.Caliper.com

USDOT, Calibrating and Adjustment of System Planning Models, December 1990
http://ntl.bts.gov/DOCS/377CAS.html

USDOT, Model Validation and Reasonableness Checking Manual, February 1997
http://www.ctre.iastate.edu/educweb/ce451/LECTURES/Validation/finalval.pdf

15 Glossary

Calibration – the process of adjusting parameter values until predicted travel matches observed travel

Census Block – the smallest geographic unit used by the US Census Bureau for tabulation of data

Census Block Group – geographical unit between the Census Block and Census Tract used by the US Census for tabulation of data

Census Tract – geographic unit for the tabulation of Census data, can be subdivided into Census Block Groups and Census Blocks

Centroid – a point in space that represents the center of activity in a TAZ

Centroid Connector – a special highway link used to load trips from the centroid to the highway network

Cordon – an imaginary circle around an area designed to capture movement into or out of, such as the external cordon for capturing movements external to the study area

Demographic Data – workers per household, vehicles per household, household income, etc.

Dependent Variable – the “event” expected to change when the independent variable is changed

Estimation – the process of using statistical procedures to find the values of model parameters

Generalized Cost – a cost function used to capture the effect of cost, distance, and travel time on trip distribution

Independent Variable – a variable in a functional relation whose value determines the value or values of other variables

Land Use Data – population and employment

NAICS – North American Industry Classification System

Path Building – finding the minimum path between every TAZ interchange

Reasonableness Checking – checking the outputs of the model against secondary sources of data for generally accepted guidelines in lieu of observed travel data

Screenline – imaginary line used to assist with the validation of the model that typically runs north/south or east/west from one end of the study area to the other

Skim Matrix – final output from the path building process that contains the zone to zone values of path parameters such as travel time or distance

Spatial – pertaining to or occurring in space

TAZ – contiguous geographic areas that divide the study area into homogeneous areas of land use, land activity, and aggregate travel demand

Thematic mapping – a thematic map displays spatial patterns of a theme or series of attributes

Transportation Network – for roadway analysis this is the spatial representation of the roadway network to be modeled and evaluated.   For transit analysis this is the spatial representation of the transit route system to be modeled and evaluated

Trip end – (in the context of an observed attraction record) – represents the destination end of an origin/destination trip record from a household travel survey

Validation – the process of testing the models predictive capabilities, such as comparing modeled highway flows to traffic counts

Appendix A

Default Rates and Parameters

Table A-1 Person Trip Production Rates and Standard Deviation

Field Name	Description	HBW	HBO	HBSCH	NHBW	NHBO
hhp1a0	1 person, 0 auto households	0.222	1.442	0.010	0.101	0.638
	Standard Deviation	0.69	1.28	0.15	0.5	1.88
hhp1a1	1 person, 1 auto households	0.777	1.891	0.033	0.597	1.009
	Standard Deviation	0.96	1.6	0.23	1.18	1.45
hhp1a2	1 person, 2 auto households	0.777	1.891	0.033	0.690	1.009
	Standard Deviation	0.93	1.7	0.1	1.4	1.76
hhp1a3	1 person, 3+ auto households	0.777	1.891	0.033	0.690	1.009
	Standard Deviation	0.86	2	0.36	0.97	1.3
hhp2a0	2 person, 0 auto households	0.609	2.237	0.272	0.168	0.933
	Standard Deviation	1.55	2.14	0.84	0.77	2.6
hhp2a1	2 person, 1 auto households	0.801	3.406	0.272	0.597	1.590
	Standard Deviation	1.18	2.92	0.75	1.3	2.32
hhp2a2	2 person, 2 auto households	1.540	3.406	0.083	0.907	1.590
	Standard Deviation	1.53	2.77	0.39	1.58	2.26
hhp2a3	2 person, 3+ auto households	1.540	3.406	0.043	1.060	1.590
	Standard Deviation	1.48	2.67	0.31	1.63	2.29
hhp3a0	3 person, 0 auto households	0.971	2.327	1.054	0.314	0.933
	Standard Deviation	1.53	2.33	1.95	1.25	1.49
hhp3a1	3 person, 1 auto households	1.077	4.377	1.054	0.919	2.018
	Standard Deviation	1.28	3.32	1.41	1.66	2.91
hhp3a2	3 person, 2 auto households	1.647	4.377	0.735	1.362	2.018
	Standard Deviation	1.37	3.51	0.98	1.68	2.51
hhp3a3	3 person, 3+ auto households	2.211	4.377	0.735	1.458	2.018
	Standard Deviation	1.64	3.27	1.04	2.02	2.44
hhp4a0	4 person, 0 auto households	0.971	2.327	1.679	0.314	0.933
	Standard Deviation	0.82	2.32	2.07	0.71	2.73
hhp4a1	4 person, 1 auto households	1.439	5.281	1.679	0.919	2.097
	Standard Deviation	1.45	4.87	1.76	1.36	4.36
hhp4a2	4 person, 2 auto households	1.647	6.269	1.679	1.362	2.929
	Standard Deviation	1.36	4.46	1.59	1.66	3.6
hhp4a3	4 person, 3+ auto households	2.211	6.269	1.886	1.458	2.929
	Standard Deviation	1.71	4.17	1.67	1.79	3.23
hhp5a0	5+ person, 0 auto households	0.971	4.267	2.669	0.314	0.933
	Standard Deviation	1.61	3.96	2.53	0.62	0.39
hhp5a1	5+ person, 1 auto households	1.439	5.281	2.669	0.919	2.097
	Standard Deviation	1.43	4.21	2.65	1.18	1.73
hhp5a2	5+ person, 2 auto households	1.647	8.087	2.669	1.362	3.545
	Standard Deviation	1.31	6.46	2.47	1.72	4.03
hhp5a3	5+ person, 3+ auto households	2.211	8.087	2.669	1.458	3.545
	Standard Deviation	2.16	5.95	2.42	1.73	4.1

Table A-2 Person Trip Attractions Rates

Employment Type	HBW	HBO	HBSCH	NHBW	NHBO
Total Employment	1.06				
Industry		0.57		0.38	0.25
Retail		5.78		1.69	3.57
Highway Retail		5.78		1.69	3.57
Service		0.46		0.30	0.18
Office		0.32		0.24	1.16
Households		1.89			0.82
Student Enrollment			0.78		

Table A-3 Person Trip Attractions Rates – Standard Deviation

Employment Type	HBW	HBO	HBSCH	NHBW	NHBO
Total Employment	0.027				
Industry		0.11		0.04	0.06
Retail		0.42		0.18	0.24
Highway Retail		0.83		0.36	0.48
Service		0.09		0.04	0.05
Office		0.07		0.14	0.18
Households		0.13			0.07
Student Enrollment			0.10		

Table A-4 Commercial Vehicle Trip Production Rates

	Industry CV	Retail CV	HwyRetail CV	Service CV	Office CV
Autos/Vans (CV1)	2.49	2.89	2.89	3.43	3.43
Pickups (CV2)	4.19	5.81	5.81	4.32	4.32
Trucks (CV3)	6.62	7.86	7.86	7.44	7.44

Table A-5 Commercial Vehicle Trip Attraction Rates

	Industry EMP	Retail EMP	HwyRetail EMP	Service EMP	Office EMP	Households
Autos/Vans (CV1)	0.2	0.33	0.25	0.1	0.12	0.02
Pickups (CV2)	0.3	0.4	0.33	0.25	0.13	0.012
Trucks (CV3)	0.75	0.67	0.5	0.21	0.23	0.039

Table A-6 External Station Trip Attraction Rates

	Households	Industry	Retail	HwyRetail	Service	Office
IX	0.33	0.34	0.49	0.28	0.28	0.28

Table A-7 Initial Gamma Function Coefficients based on NC Combined Survey Database

Trip Purpose	a	b	c
HBW (large area)	93.2694	-0.7903	-0.0616
HBW (small area)	10.5936	-1.0250	-0.0000
HBO	811.0232	-1.0645	-0.0832
HBSCH	354.0846	-0.5874	-0.1291
NHBW (large area)	470.3996	-0.9334	-0.0678
NHBW (small area)	2.3286	-0.7694	-0.0000
NHBO (large area)	2983.1686	-1.0461	-0.0782
NHBO (small area)	4.6750	-0.2916	-0.1390
CV1 (large area)	2983.1686	1.0461	0.0782
CV1 (small area)	4.6750	0.2916	0.1390
CV2 (large area)	2983.1686	1.0461	0.0782
CV2 (small area)	4.6750	0.2916	0.1390
CV3 (large area)	2983.1686	1.0461	0.0782
CV3 (small area)	4.6750	0.2916	0.1390
IX (large area)	2983.1686	1.0461	0.0782
IX (small area)	4.6750	0.2916	0.1390

Table A-8 Mode Shares by Trip Purpose

	Small Area		Large Area	
Purpose	**Auto**	**Non-Auto**	**Auto**	**Non-Auto**
HBW	96.9	3.1	96.4	3.6
HBO	93.2	6.8	93.7	6.3
HBSCH	98.4	1.6	93.7	6.3
NHBW	96.3	3.7	94.6	5.4
NHBO	95.8	4.2	95.2	4.8

Table A-9 Vehicle Occupancy Factors by Trip Purpose

	Small Area				Large Area			
Purpose	**AM**	**MD**	**PM**	**OP**	**AM**	**MD**	**PM**	**OP**
HBW	1.07	1.10	1.07	1.09	1.05	1.07	1.05	1.05
HBO	1.36	1.30	1.43	1.45	1.48	1.31	1.52	1.52
HBSCH	1.27	1.13	1.23	1.30	2.07	1.58	1.99	1.23
NHBW	1.05	1.11	1.08	1.14	1.09	1.18	1.09	1.10
NHBO	1.32	1.27	1.45	1.73	1.57	1.39	1.61	1.73

Appendix B

Example Report – Sanford Case Study Initial Model Results

Calibration/Validation Observations and Action Items

<u>Trip Generation</u>

Table B-1 Internal Trip Generation Statistics

Trip Purpose	Productions	Attractions	Normalization Factor (P/A ratio)	% by Trip Purpose
HBW	19944	25524	0.78	15%
HBO	58319	67004	0.87	45%
HBSCH	10678	1140	9.36	8%
NHBW	13937	14974	0.93	11%
NHBO	26838	34451	0.78	21%
TOTAL	129716	143093	0.91	

GUIDELINES:

- *Normalization factor should be between 0.9 and 1.1*
- *Trips by purpose*
    i. *HBW – 12 to 25%*
    ii. *HBO – 45 to 55%*
    iii. *NHB – 20 to 35%*

Table B-2 Trip Profile Statistics

Measure	Estimated	Surveyed Range of Values http://tmip.fhwa.dot.gov/clearinghouse/docs/mvrcm/mvrcm.pdf
Work trips per household	1.34	1.71 – 2.29
Work trips per worker	1.12	1.29 – 1.40
Trips per person	3.37	3.64 – 3.87

- *17,778 workers from CTPP*
- *14,856 households*
- *38,512 persons*

Observations:

- Imbalance between HBW productions and attractions that may need to be addressed – are there a significant number of external-to-internal work trips?
- % of HBW trips is on the low side, but not by much, and in line with recent trends.
- Ratio for HBSCH trips is way off, but this is a reflection of the data used for this trip purpose (i.e., there was no student enrollment data)
- Imbalance between NHBO productions and attractions that may need to be addressed

Action Items:

- Review the worker data for the planning area. How do the work trips compare to the number of workers. May want to adjust work trips accordingly.
- Evaluate highway assignment to see if other adjustments are warranted.

Table B-3 Commercial Vehicle Trip Generation Statistics

Trip Purpose	Productions	Attractions	Normalization Factor (P/A ratio)
CV1	2270	4784	0.5
CV2	2011	6986	0.3
CV3	4987	13282	0.4
TOTAL	9269	25053	0.4

Observations:

- The P/A ratios are way off showing that based solely on employment data for the attractions and commercial vehicle data for the productions the attractions are too much high for the number of commercial vehicles garaged in Sanford.

Action Items:

- The attraction rates should be scaled back to better match the estimated productions.

Table B-4 External Station Trip Generation Statistics

Trip Purpose	Productions	Attractions	Normalization Factor (P/A ratio)
IX	14648	12829	1.1

Observations:

- Productions and attractions are balanced as they should be given that we controlled to the through trips and the external station count.

Action Items:

- None recommended at this time

Trip Distribution

Table B-5 Trip Length Data for Internal Trip Purposes

Purpose	Generalized Cost	Travel Time	Distance	% Intrazonal	Converged (Y/N)
HBW	15.78	10.75	5.38	4.4	Y
HBO	14.01	7.69	3.39	14	Y
HBSCH	14.11	7.84	3.37	11.7	Y
NHBW	13.95	8.68	4.22	10.3	Y
NHBO	10.93	6.98	3.16	14.7	Y

Observations:

- Trip lengths follow a logical trend with the HBW trip purpose having the longest trip length and the NHBO having the shortest trip length
- Compare against your knowledge of the study area and any travel time data that you may have collected. Check HBW against CTPP average trip length.

Action Items:

- None recommended at this time

Table B-6 Intrazonal Trips for Internal Trip Purposes

Trip Purpose	Total Trips	Intrazonal Trips	Percent Intrazonal
HBW	19944	885	4%
HBO	58319	8202	14%
HBSCH	10678	1252	12%
NHBW	15088	1546	10%
NHBO	28984	4262	14%

Observations:

- Percent of intrazonal trips is much too high. This will likely result in highway assignment that is low in comparison to the traffic counts.

Action Items:

- Consider adjusting the gamma coefficients should to reduce the percent intrazonals.

Table B-7 Trip Length Data for Commercial Vehicle Trip Purposes

Purpose	Generalized Cost	Travel Time	Distance	% Intrazonal	Converged (Y/N)	Gamma
CV1	11.17	7.12	3.21	24%	Y	a = 4.675 b = 0.2916 c = 0.139
CV2	11.87	7.54	3.41	27%	Y	a = 4.675 b = 0.2916 c = 0.139
CV3	12.06	7.67	3.45	32%	Y	a = 4.675 b = 0.2916 c = 0.139

Observations:

- Intrazonal trips are too high

Action Items:

- Adjust gamma coefficients to reduce percent intrazonal

Table B-8 Trip Length Data for External Station Trips

Purpose	Generalized Cost	Travel Time	Distance	% Intrazonal	Converged (Y/N)	Gamma
IX	19.87	10.98	7.1	0	Y	a = 4.675 b = 0.2916 c = 0.139

Observations:

- Trip length appears logical given that these are trips from the external stations that must cover more distance before reaching the heart of the study area

Action Items:

- None recommended at this time

Assignment

Table B-9 VMT Summaries (Count Links Only)

Facility Type	TOT VMT	Count VMT	% Deviation
Freeway	118935	146708	-18
Multilane Highway	159352	222667	-28
Urban Arterial I	28131	41897	-32
Urban Arterial II	49005	46055	6
Urban Arterial III	19838	26812	-26
Urban Arterial IV	64315	85810	-25
Two-lane Highway	43138	28344	52
Collector	20155	26683	-24
All	502869	624976	-20

Observations:

- With the exception of the two-lane highways and Urban Arterial II the modeled VMT is consistently low in comparison to the count VMT
- The magnitude of difference between estimated and observed for the two-lane highway is indicative of an underlying problem with either traffic counts or perhaps the location of centroid connectors in relation to the traffic count locations
- Overall the % Deviation is well out of range of the desired +/- 5%
- Trip generation might be low? Maybe external secondary trips are underestimated?

Action Items:

- Review traffic counts for two-lane highways – verify the accuracy of the data
- Review the centroid connectors in relation to how they assign to the two-lane highways
- Overall low assignment indicates that we are not getting enough trips systemwide.
- **FIRST STEP:** Recall that the intrazonal percentages were much too high. Adjust for the intrazonal percentages (K-factors) and rerun the model to see if the VMT statistics improve.
- **TIP:** When making model adjustments it is wise to make only ONE adjustment at a time and then test the results of that adjustment before making another adjustment.
- **SECOND STEP:** Recall that we had an imbalance in the HBW productions and HBW attractions, where the productions were lower than the attractions. It was also noted that the %HBW trips was lower than what is typically expected. Since we balance to productions we may need to adjust the trip production rates for the HBW trip purpose.

Table B-10 Sample Screenline Report

Screenline No.	Screenline Name	Total Flow	Total Count	% Deviation
1	Name 1	55511	75000	-25
2	Name 2	54360	76100	-28
3	Name 3	38334	73900	-48
4	Name 4	24677	19150	28

Observations:

- With the exception of Screenline 4 the screenline statistics show that the modeled flow is much lower than the observed counts indicating that systemwide we do not have enough trips.

- Screenline 4 is unusually high in comparison to the other screenlines. This screenline should be reviewed more closely to determine why it is trending opposite of the other screenlines. Are there few observed counts? Is one count location contributing to the error more than the others?
- None of the screenlines are within the acceptable range of +/- 10%

Action Items:

- Review Screenline 4 as indicated above
- Apply steps as outlined in VMT section, update model results and revisit performance measures

Table B-11 Percent Root Mean Square Error by Facility Type

Facility Type	Observations	Model	Target
Interstate	0	-	25%
Freeway/Expressway	7	41%	40%
Arterials	78	57%	50%
Collectors	53	82%	65%
Total (Systemwide)	138	62%	30-40%

Observations:

- % RMSE is out of range for all facility type groups.

Action Items:

- Apply steps as outlined in VMT section, update model results and revisit performance measures

Table B-12 Percent Root Mean Square Error by Volume Group

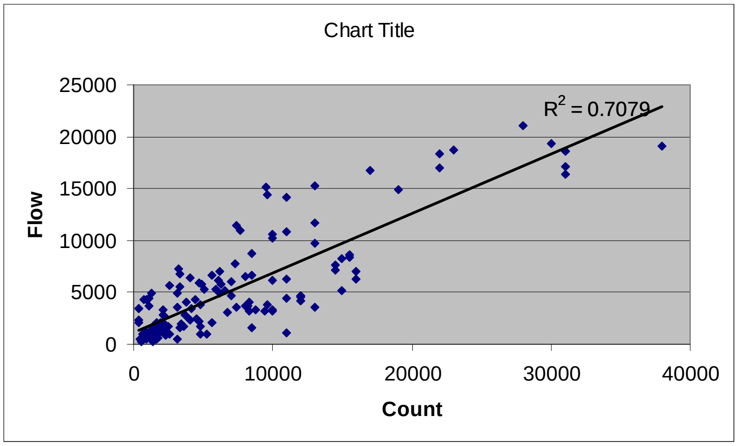
Facility Type	Observations	Model	Target
0 to 4,999	70	73%	120%
5,000 to 9,999	32	50%	45%
10,000 to 19,999	27	50%	40%
20,000 to 39,999	9	38%	35%
40,000 to 59,999	-	-	30%
60,000 and greater	-	-	20%

Observations:

- % RMSE is out of range for all volume groups.

Action Items:

- Apply steps as outlined in VMT section, update model results and revisit performance measures



Observations:

- R-squared value is out of range and observations are scattered

Action Items:

- Apply steps as outlined in VMT section, update model results and revisit performance measures
- After new model run, individually investigate any outliners on the graph

Table B-13 Assignment Summary by Volume Group

Facility Type	Daily Count	Daily Flow	Model % Diff	Target % Diff
Less than or equal 1,000	9680	23699	144	60%
1,001 to 2,500	53600	49224	-8	47%
2,501 to 5,000	96100	84139	-12	36%
5,001 to 10,000	288900	208523	-27	29%
10,001 to 25,000	368000	237255	-35	25%
25,001 to 50,000	189000	114770	-39	22%
Greater than 50,000	-	-	0	21%

Observations:

- Low volume roadways are over-assigned (are these the two-lane highways? Investigate)
- High volume roadways are under-assigned

Action Items:

- Apply steps as outlined in VMT section, update model results and revisit performance measures.

Appendix C

Model Application Check List

Prior to executing a model, the following checklist may be useful for the user to help ensure a valid model run.

- [ ] Create new scenario using the TransCAD user interface
- [ ] Verify the input highway network
- [ ] Verify the input socioeconomic data
- [ ] Verify the input external data
- [ ] Document scenario description and location of input and output files
- [ ] Verify input, interim and output files are specified correctly in user interface
- [ ] Execute Model via TransCAD interface
- [ ] Evaluate and summarize, write summary narrative
- [ ] Archive model files
- [ ] Record model log