Lincoln MPO
Travel Demand Model

Draft Model Documentation

Prepared for

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INTRODUCTION

This documentation outlines the general procedures and assumptions used to implement the City of Lincoln-Lancaster County (Lincoln MPO) Travel Demand Model in TransCAD Version 4.7. This documentation assumes that the user is familiar with the GIS and modeling tools of TransCAD. For instructions on how to run the model, refer to the "Lincoln MPO Travel Demand Model Interface" guide.

The Lincoln MPO travel demand model was developed in a two step process:

1. Converted Lincoln MPO's current TP+ model to TransCAD Version 4.7.
2. Updated TransCAD model parameters and calibrated the model to current conditions.

The Lincoln MPO TP+model focused primarily on modeling daily vehicle trips. This model was developed with the ability to include non-auto modes of transportation, thus person trips is used as the generation variable. Person trips generated using non-auto modes are separated from the total person trips. The remaining person trips are converted to vehicle trips using auto occupancies. This process is different than the one used in the 1998 model, hence only select results can be compared. Demographics and roadway network consistent with conditions in Year 2004 were used for the calibration process.

Several enhancements were made to the model.

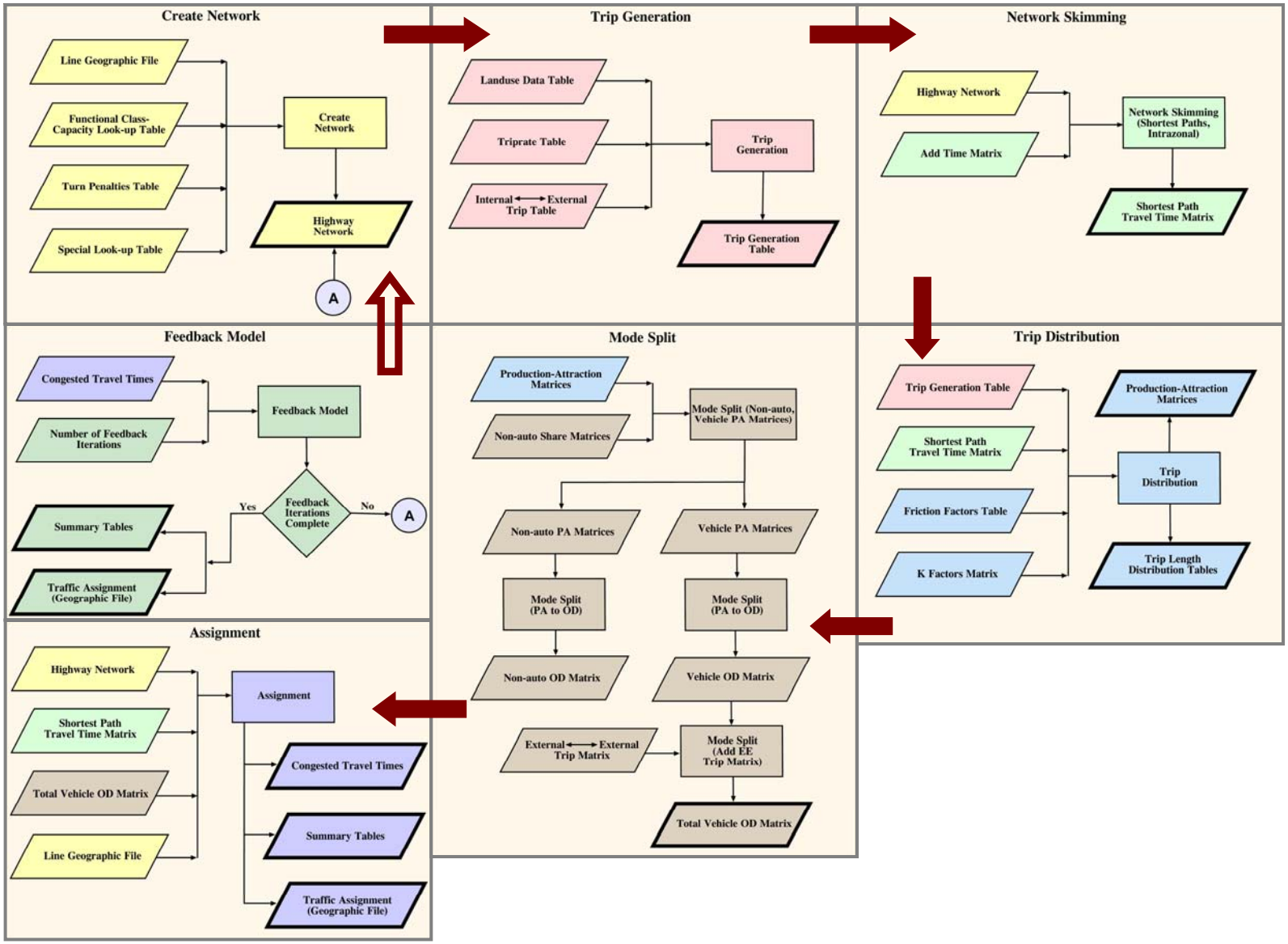
- The model networks and demographics were updated to the 560 zone system.
- Model street networks were vastly improved. Model links were "conflated" to reflect true geographic and link distances.
- Trip production/attraction rates were updated.
- Trip length distribution and friction factor table needed for the trip distribution gravity model were updated.
- Trips generated using non-auto modes were separated from the total person trips.
- A feedback model was added, which feeds congested travel time information generated by the assignment model back into the travel time matrix. The model iterates from trip distribution to assignment several times before finishing with the final results.

Figure 1 is a flow chart displaying the overall modeling process for the Lincoln MPO model. Lincoln MPO model included the following steps:

- Network Creation
- Trip Generation
- Network Skimming (Shortest Paths Matrix)
- Trip Distribution
- Modal Split
- Trip Assignment
- Feedback Model

Each step is described in detail in the later chapters of this document.

FIGURE 1. LINCOLN MPO TRAVEL DEMAND MODEL PROCESS

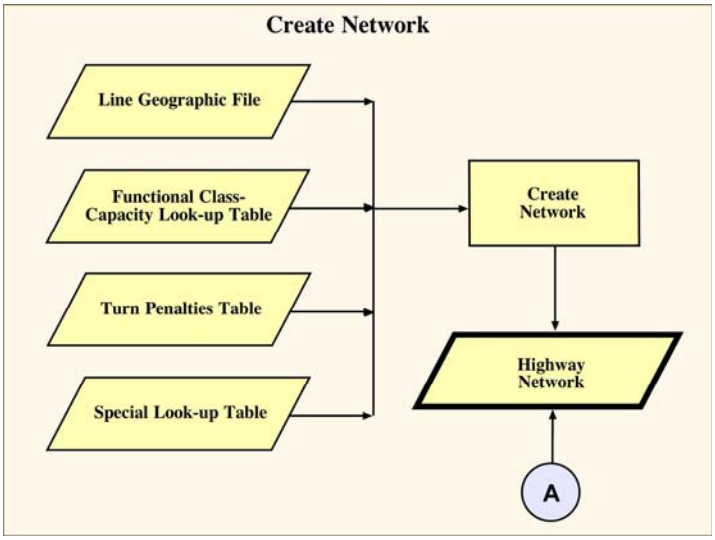


NETWORK (.NET) CREATION

A TransCAD network (.NET) is an abstract representation of the transportation system that holds essential information for analysis in a format required by the TransCAD models. A TransCAD network is defined, derived, and used in conjunction with a geographic line layer and its associated endpoint layer. The network is used for analysis, and the line layer is used to display the results.

Figure 2 shows the process used for creating the TransCAD highway network (.NET).

FIGURE 2. NETWORK CREATION



Line Geographic Database

As mentioned earlier, network creation requires a line geographic file. A line geographic file is a TransCAD GIS database to store the geography and attributes of roadways used in the model. Unlike the "stick" highway networks of previous TP+ model, the geographic file uses shaping between nodes to accurately define both the true geography and true distances of the network links.

Figure 3 displays the base year street network used in the Lincoln MPO model. Table 1 lists all of the database fields in the line geographic file. Some data fields are user populated and some are automatically populated by the Lincoln MPO model interface. Model users should fill the "User populated fields" with valid data to get reasonable model results.

In TransCAD, every line geographic file has an associated node layer file. Table 2 lists the data fields in this node layer. In the node layer table, the first 560 node ID's are designated as

FIGURE 3. BASE YEAR MODEL NETWORK

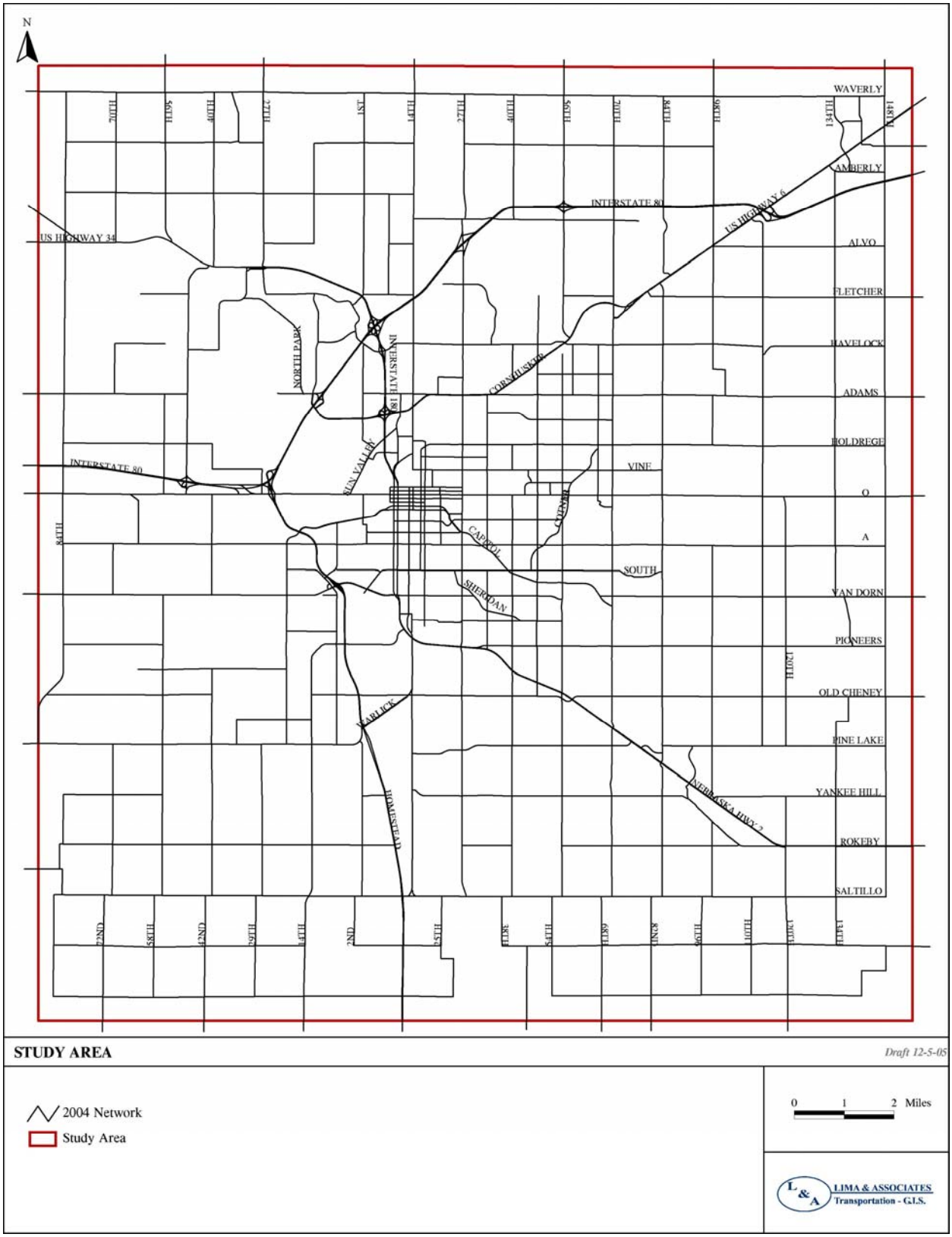


TABLE 1. LINE GEOGRAPHIC FILE DATA FIELDS

	FIELD NAME	DESCRIPTION	TYPE	REQUIRED
Default Fields	ID	Internal ID generated by TransCAD	Integer (4 bytes)	Yes
	Length	Link length determined by TransCAD	Real (8 bytes)	Yes
	Dir	Link direction determined by TransCAD	Integer (2 bytes)	Yes
User Populated Fields	ADJLENGTH	Revised length of link - use if needed	Real (8 bytes)	Yes
	STNAME	Street Name	Character	Optional
	STTYPE	Street Type	Character	Optional
	FUNCLASS	Functional classification code (See Table 4)	Integer (1 byte)	Yes
	FUNCDESC	Functional classification description (See Table 4)	Character	Yes
	AREATYPE	Area type code (See Table 9)	Character	Yes
	AREADESC	Area type description (See Table 9)	Character	Yes
	CountIDcity	Count location ID number	Integer (4 bytes)	Optional
	ABLANES	Number of lanes in AB direction. Eg: ABLANES = NB lanes	Integer (2 bytes)	Yes
	BALANES	Number of lanes in BA direction. Eg: BALANES = SB lanes	Integer (2 bytes)	Yes
	CLANE	Centerlane. 1 = Yes; 0 = No	Integer (2 bytes)	Yes
	TOTLANES	Total number of lanes	Integer (4 bytes)	Optional
	ABMODELSPEED	Link speed used in the model for AB direction	Integer (2 bytes)	Yes
	BAMODELSPEED	Link speed used in the model for BA direction	Integer (2 bytes)	Yes
	ABPOSTEDSPEED	Posted speed limit for AB direction	Integer (4 bytes)	Optional
	BAPOSTEDSPEED	Posted speed limit for BA direction	Integer (4 bytes)	Optional
	ABPARKING	Number of lanes used for parking in AB direction	Integer (2 bytes)	Yes
	BAPARKING	Number of lanes used for parking in BA direction	Integer (2 bytes)	Yes
	UNPAV	1 = Unpaved; 0 = Paved	Integer (2 bytes)	Yes
	TOTCOUNT	Total 24hr count on link	Integer (4 bytes)	Yes
	ABCOUNT	24hr count in AB direction	Integer (4 bytes)	Optional
	BACOUNT	24hr count in BA direction	Integer (4 bytes)	Optional
	SCREENLINE	Screenline number	Integer (1 byte)	Yes
Automatically Populated Fields	AB_CAP_ID	AB capacity ID field (FUNCLASS + "-" + AREATYPE)	Character	Yes
	BA_CAP_ID	BA capacity ID field (FUNCLASS + "-" + AREATYPE)	Character	Yes
	LANECAP	Per lane capacity field (See Table 4)	Integer (4 bytes)	Yes
	ABCAPACITY	Total capacity in AB direction (See Table 4)	Integer (4 bytes)	Yes
	BACAPACITY	Total capacity in BA direction (See Table 4)	Integer (4 bytes)	Yes
	ALPHA	Alpha value	Real (8 bytes)	Yes
	BETA	Beta value	Real (8 bytes)	Yes
	ABTRAVELTIME	Free flow travel time for AB direction	Real (8 bytes)	Yes
	BATRAVELTIME	Free flow travel time for BA direction	Real (8 bytes)	Yes
Model Output Fields	VMT	Total vehicle miles traveled	Real (8 bytes)	Yes
	ABVHT	Vehicle hours traveled in AB direction	Real (8 bytes)	Yes
	BAVHT	Vehicle hours traveled in BA direction	Real (8 bytes)	Yes
	VHT	Total vehicle hours traveled	Real (8 bytes)	Yes
	VOLUME	Model assigned volume	Real (8 bytes)	Yes
	CSPEED	Congested speed on link after traffic assignment	Real (8 bytes)	Yes
	COUNTvVOLUME	Count vs Volume comparison (For use in validation year)	Character	Yes
	VCLOS	VC based LOS	Character	Yes
	SPREDUCTN	Percent reduction in speed after traffic assignment	Real (8 bytes)	Yes
	SPDLOS	LOS based on percent reduction in speed	Character	Yes
	AB_TIME_C_AVG	Congested travel time after traffic assignment in AB direction	Real (8 bytes)	Yes
	BA_TIME_C_AVG	Congested travel time after traffic assignment in BA direction	Real (8 bytes)	Yes

TABLE 2. NODE LAYER DATA FIELDS

	FIELD NAME	DESCRIPTION	TYPE	REQUIRED
Default Fields	ID	Internal ID generated by TransCAD	Integer (4 bytes)	Yes
	Longitude	Longitude value of node generated by TransCAD	Integer (4 bytes)	Yes
	Latitude	Latitude value of node generated by TransCAD	Integer (4 bytes)	Yes
User Fields	TAZ	TAZ number if node is a centroid	Integer (4 bytes)	Yes
	SAVETURNS	Save turn movements at the node. ("yes" = save turns; "no" = don't save turns)	Character	Yes

centroids. There is also a field in the nodes called "TAZ" that contains the taz number for centroids nodes and is missing a value otherwise.

For the Lincoln MPO model, number of lanes and speed data for all roadways was provided by the City of Lincoln, Lancaster County, and Nebraska Department of Roads. Posted speed limits were used as the model network speeds. Figure 4 displays the lane configuration and Figure 5 displays the roadway speed limits for the Lincoln MPO model network.

Functional Class – Capacity Lookup Table

Link capacities for the Lincoln MPO model are based on functional classification and area type. Functional classification data was obtained from the City of Lincoln approved comprehensive plan. Figure 6 displays the functional classification for the model street network. Area type classifications for the model area were provided by the City of Lincoln. Figure 7 shows the area type classification for each roadway in the model network. "Functional Class – Capacity Lookup Table" stores the lane capacity, alpha and beta parameters for each combination of functional classification and area type. This lookup table is linked to the line geographic file table to populate/update capacity fields. In addition, alpha and beta parameters required in the trip assignment step are also populated using this lookup table. Table 3 shows the list of data fields used in the lookup table.

TABLE 3. FUNCTIONAL CLASS – CAPACITY LOOKUP TABLE DATA FIELDS

FIELD NAME	DESCRIPTION	TYPE	REQUIRED
CAP_ID	Capacity ID field (FUNCLASS + "-" + AREATYPE)	Character	Yes
FUNCODE	Functional classification code	Integer (4 bytes)	Yes
FCNAME	Functional classification description	Character	Yes
AREATYPE	Area type code	Integer (4 bytes)	Yes
AREANAME	Area type description	Character	Yes
SPEEDRANGE	Speed range	Character	Optional
CAPACITY	Per lane capacity	Integer (4 bytes)	Yes
ALPHAFC	Alpha value	Real (8 bytes)	Yes
BETAFC	Beta value	Real (8 bytes)	Yes

For the Lincoln MPO model, capacity at Level of Service (LOS) C was used as the threshold capacity. Highway Capacity Manual (HCM) 2000 procedures were used for estimating the capacity for each combination of functional class and area type. First, peak hour lane capacity was calculated after the effects of percent green time, and peak hour factor. Second, the 24 hour lane capacity was calculated using peak hour lane capacity and percent of traffic in the peak hour. Finally, threshold capacity at LOS C was assumed to be 75% of the 24 hour lane capacity. Table 4 shows the calculations used to derive the model capacities.

FIGURE 4. NUMBER OF LANES – 2004 MODEL NETWORK

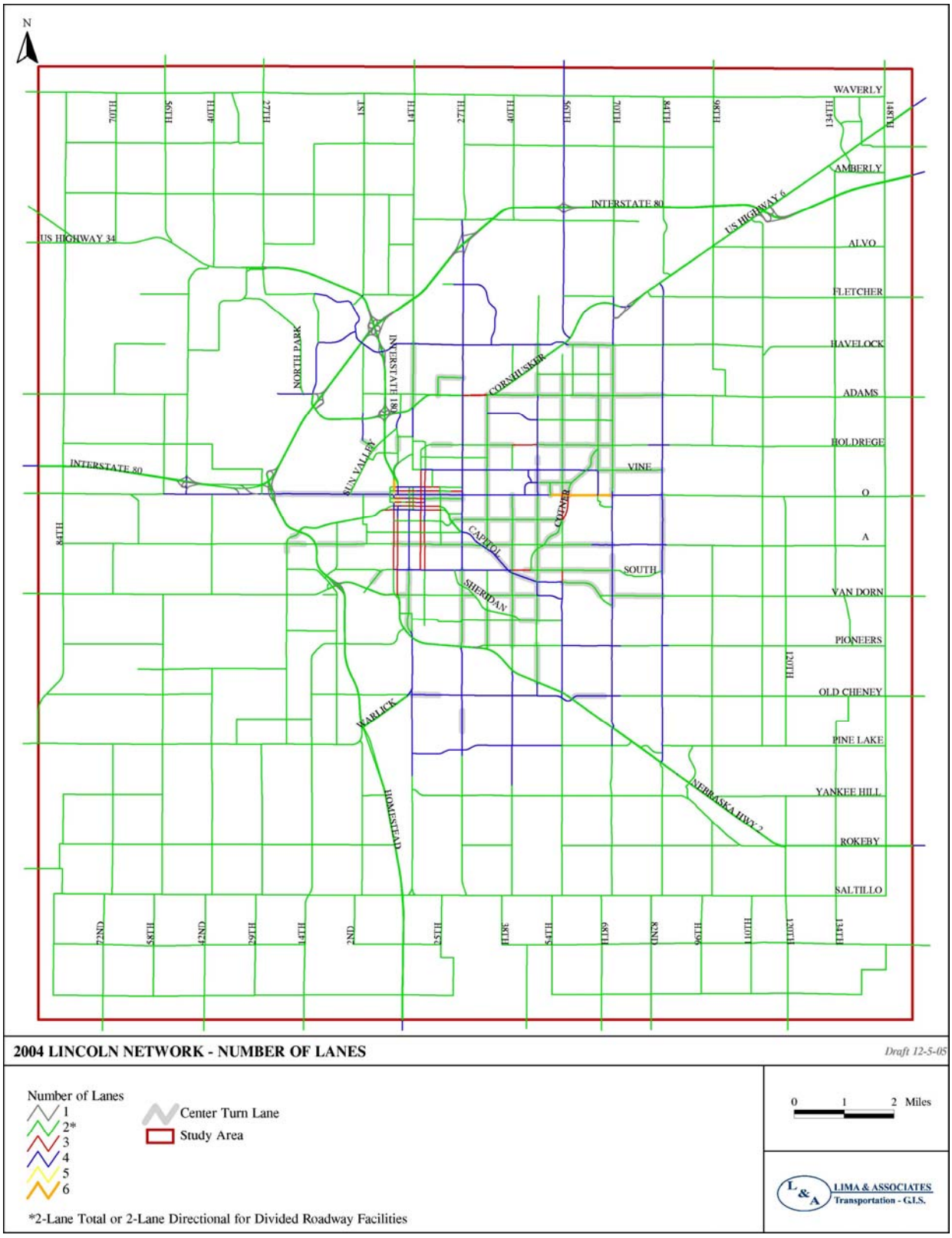


FIGURE 5. SPEED LIMITS – 2004 MODEL NETWORK

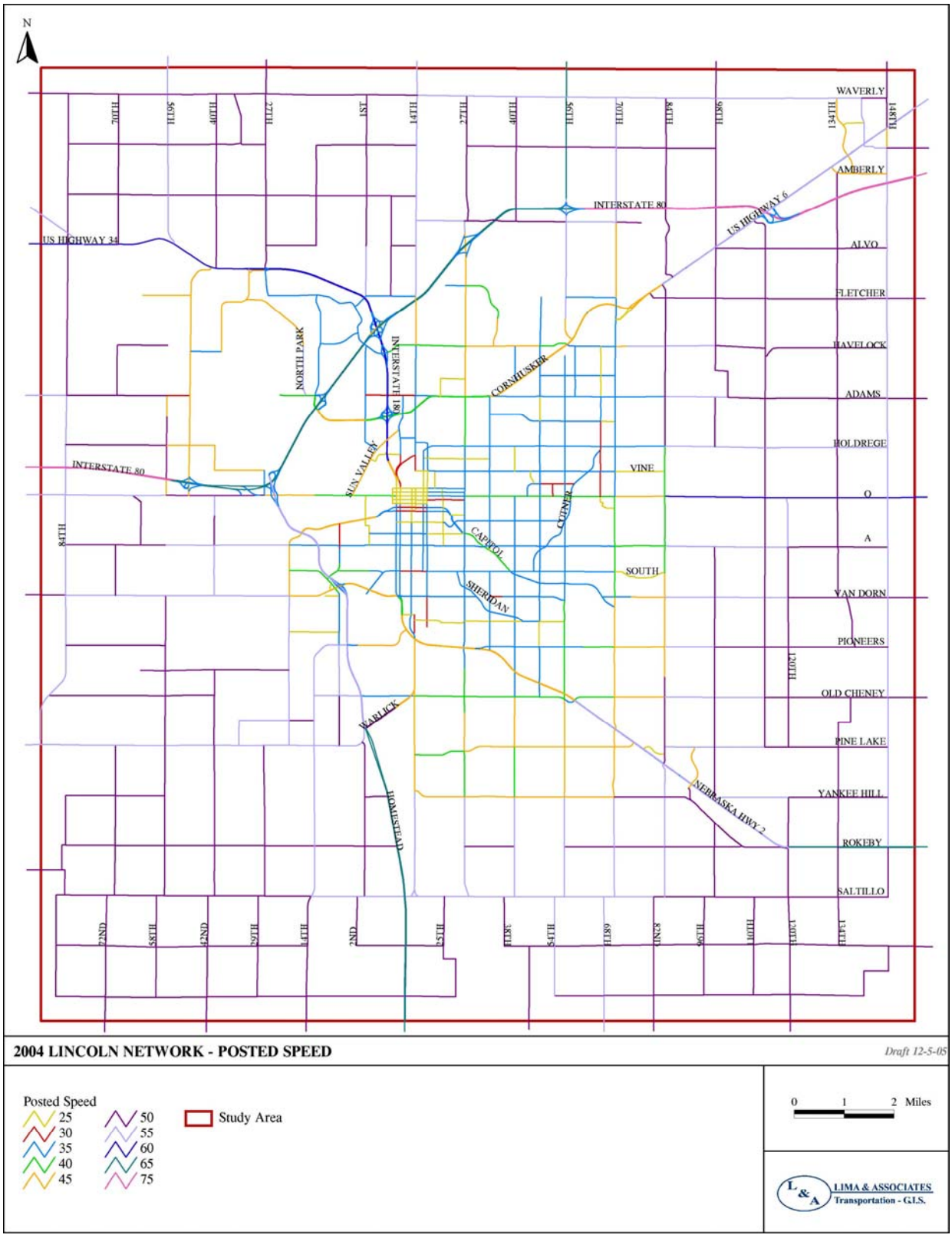


FIGURE 6. FUNCTIONAL CLASSIFICATION – 2004 MODEL NETWORK

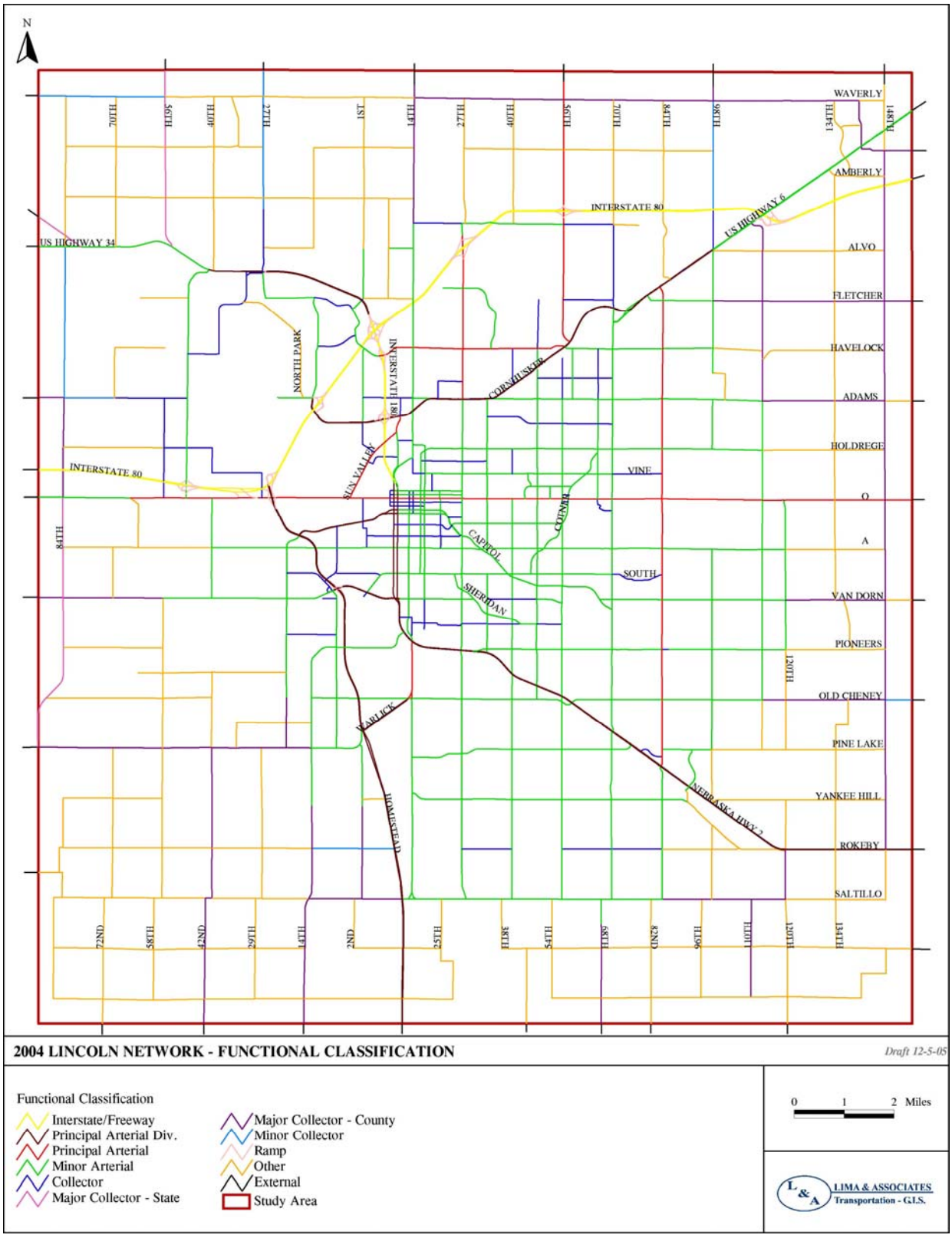


FIGURE 7. AREA TYPE CLASSIFICATION – 2004 MODEL NETWORK

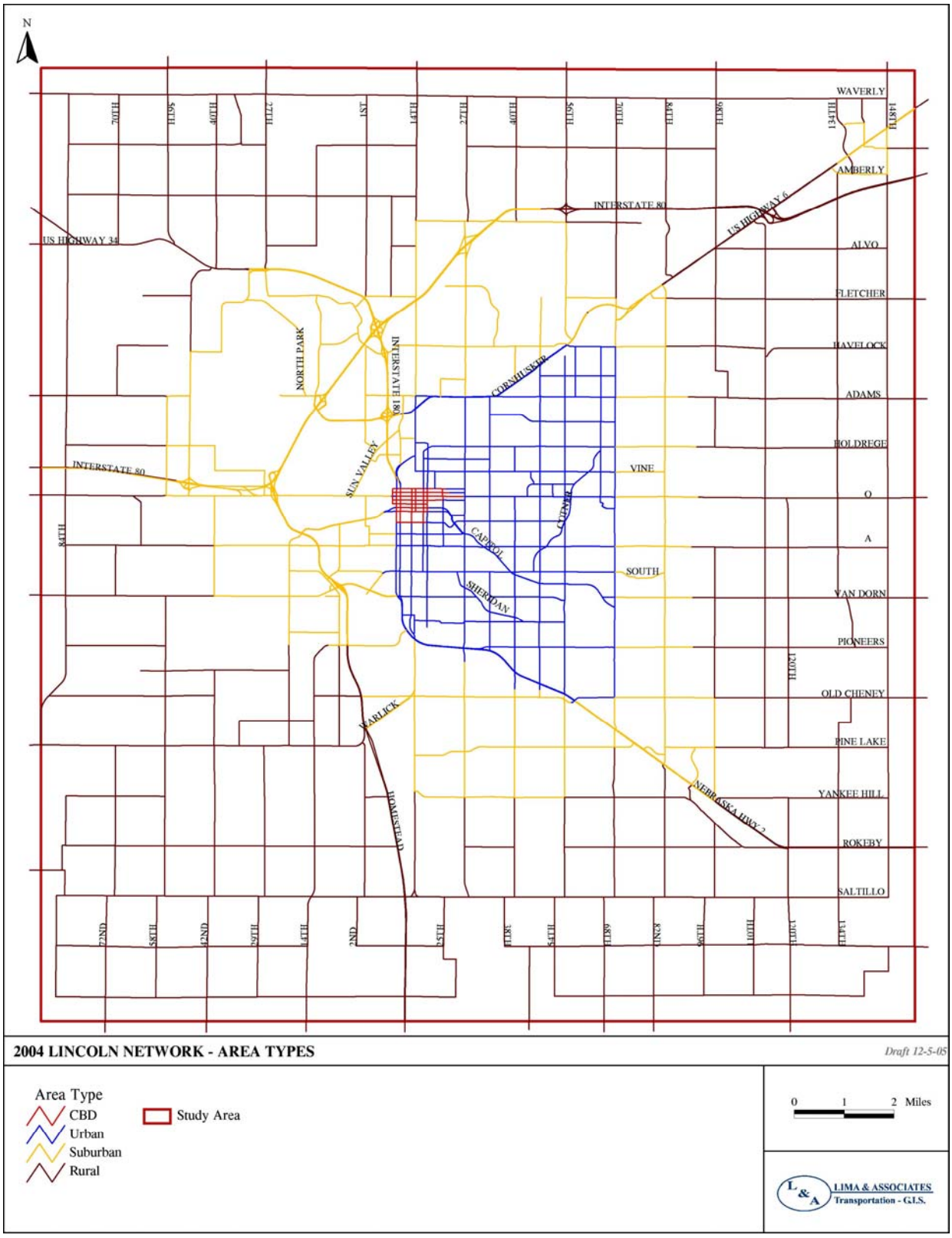


TABLE 4. LANE CAPACITIES USED IN LINCOLN MPO MODEL

Functional Class	FC Code	Area Type Name	Area Type Code	Saturation Lane Capacity	Percent Green Time	Peak Hour Factor	Hourly Lane Capacity	Capacity Added Due to Left Turn Lanes	Total Hourly Lane Capacity (VPH)	Peak-Hour AM & PM Lane Capacity	Percent of Traffic in Peak Hour	Calculated 24-hrs Capacity Max.	24 Hour Approach Lane Capacity (AWDT)	LOS C Percent	24 Hours Lane Capacity LOS C
IH/Freeway	1	CBD	1	2200	100%	0.90	1980	0	1980	1980	0.095	20,842	20,842	75%	15,632
		Urban	2	2200	100%	0.90	1980	0	1980	1980	0.095	20,842	20,842	75%	15,632
		Suburban	3	2200	100%	0.92	2024	0	2024	2024	0.100	20,240	20,240	75%	15,180
		Rural	4	2200	100%	0.92	2024	0	2024	2024	0.110	18,400	18,400	75%	13,800
Expressway	2	CBD	1	2000	60%	0.90	1080	50	1130	1130	0.090	12,556	12,556	75%	9,417
		Urban	2	2000	60%	0.90	1080	50	1130	1130	0.090	12,556	12,556	75%	9,417
		Suburban	3	2000	70%	0.92	1288	50	1338	1338	0.095	14,084	14,084	75%	10,563
		Rural	4	2000	80%	0.95	1520	45	1565	1565	0.110	14,227	14,227	75%	10,670
Principal Arterial (Div)	3	CBD	1	1900	58%	0.90	992	42	1034	1034	0.090	11,487	11,487	75%	8,615
		Urban	2	1900	60%	0.89	1015	42	1057	1057	0.090	11,740	11,740	75%	8,805
		Suburban	3	1900	66%	0.88	1100	42	1142	1142	0.095	12,019	12,019	75%	9,014
		Rural	4	1900	70%	0.90	1197	24	1221	1221	0.110	11,100	11,100	75%	8,325
Principal Arterial	4	CBD	1	1900	53%	0.89	900	38	938	938	0.090	10,425	10,425	75%	7,819
		Urban	2	1900	58%	0.90	987	38	1025	1025	0.095	10,794	10,794	75%	8,095
		Suburban	3	1900	64%	0.88	1066	24	1090	1090	0.095	11,478	11,478	75%	8,609
		Rural	4	1900	68%	0.90	1163	0	1163	1163	0.110	10,571	10,571	75%	7,928
Minor Arterial	5	CBD	1	1900	53%	0.88	886	32	918	918	0.090	10,202	10,202	75%	7,651
		Urban	2	1900	56%	0.88	936	32	968	968	0.095	10,193	10,193	75%	7,645
		Suburban	3	1900	55%	0.86	899	0	899	899	0.100	8,987	8,987	75%	6,740
		Rural	4	1900	55%	0.86	899	0	899	899	0.120	7,489	7,489	75%	5,617
Collector	6	CBD	1	1800	46%	0.86	712	29	741	741	0.095	7,801	7,801	75%	5,851
		Urban	2	1800	37%	0.81	539	0	539	539	0.100	5,395	5,395	75%	4,046
		Suburban	3	1800	37%	0.90	599	0	599	599	0.110	5,449	5,449	75%	4,087
		Rural	4	1800	37%	0.95	633	0	633	633	0.130	4,867	4,867	75%	3,650
Ramp	7	CBD	1	1700	100%	0.83	1411	0	1411	1411	0.090	15,678	15,678	75%	11,758
		Urban	2	1700	100%	0.83	1411	0	1411	1411	0.090	15,678	15,678	75%	11,758
		Suburban	3	1700	100%	0.83	1411	0	1411	1411	0.090	15,678	15,678	75%	11,758
		Rural	4	1700	100%	0.90	1530	0	1530	1530	0.130	11,769	11,769	75%	8,827
Major Collector State	8	Suburban	3	1700	60%	0.85	867	0	867	867	0.100	8,670	8,670	75%	6,503
		Rural	4	1700	60%	0.95	969	0	969	969	0.130	7,454	7,454	75%	5,590
Major Collector County	9	Suburban	3	1700	60%	0.85	867	0	867	867	0.100	8,670	8,670	75%	6,503
		Rural	4	1700	60%	0.95	969	0	969	969	0.130	7,454	7,454	75%	5,590
Minor Collector	10	Rural	4	1700	60%	0.95	969	0	969	969	0.150	6,460	6,460	75%	4,845
Others	11	Rural	4												1,500

Turn Penalties Table

Lincoln MPO model provides the capability of applying penalties or delays when turns are made between certain links in a network. Turn penalties lookup table is used to apply turn penalties or time penalties on links. The table requires that you input the link ID of FROM & TO links and the penalty minutes. If you wish to completely restrict a movement fill the "PENALTY" field with a value of null. Turn penalty table can also used to model delays caused by railroad crossings. Table 5 shows the data structure for the turn penalties table and Appendix A contains the list of turn penalties used in the model.

For the Lincoln MPO model, City of Lincoln staff provided a list of turn penalty movements and locations.

TABLE 5. TURNS PENALTIES

FIELD NAME	DESCRIPTION	TYPE	REQUIRED
FROM_ID	ID of FROM link	Integer (4 bytes)	Required
TO_ID	ID of TO link	Integer (4 bytes)	Required
PENALTY	Penalty value in minutes	Real (8 bytes)	Required

Special Lookup Table

Capacity, alpha, and beta data items are automatically populated using the capacity lookup table. However, there may be some instances when a link's capacity, speed, alpha or beta values need to be changed on a link by link basis. This "Special Lookup Table" can be used for these special situations. The table requires that you input the link ID from the line geographic file along with the data item value (capacity, speed, alpha, or beta) that needs to be changed into the "Special Lookup Table". "Create Network" button in the model interface automatically applies the changes listed in this lookup table. Table 6 shows the data structure of the lookup table.

TABLE 6. SPECIAL LOOKUP TABLE TO MODIFY DEFAULT CAPACITY, SPEED, ALPHA, OR BETA

FIELD NAME	DESCRIPTION	TYPE	REQUIRED
LINKID	Link ID	Integer (4 bytes)	Yes
NLANECAP	New lane capacity	Integer (4 bytes)	Yes
NABMODELSPEED	New AB direction speed	Integer (4 bytes)	Yes
NBAMODELSPEED	New BA direction speed	Integer (4 bytes)	Yes
NALPHA	New alpha value	Real (8 bytes)	Yes
NBETA	New beta value	Real (8 bytes)	Yes

TAZ Geographic Database

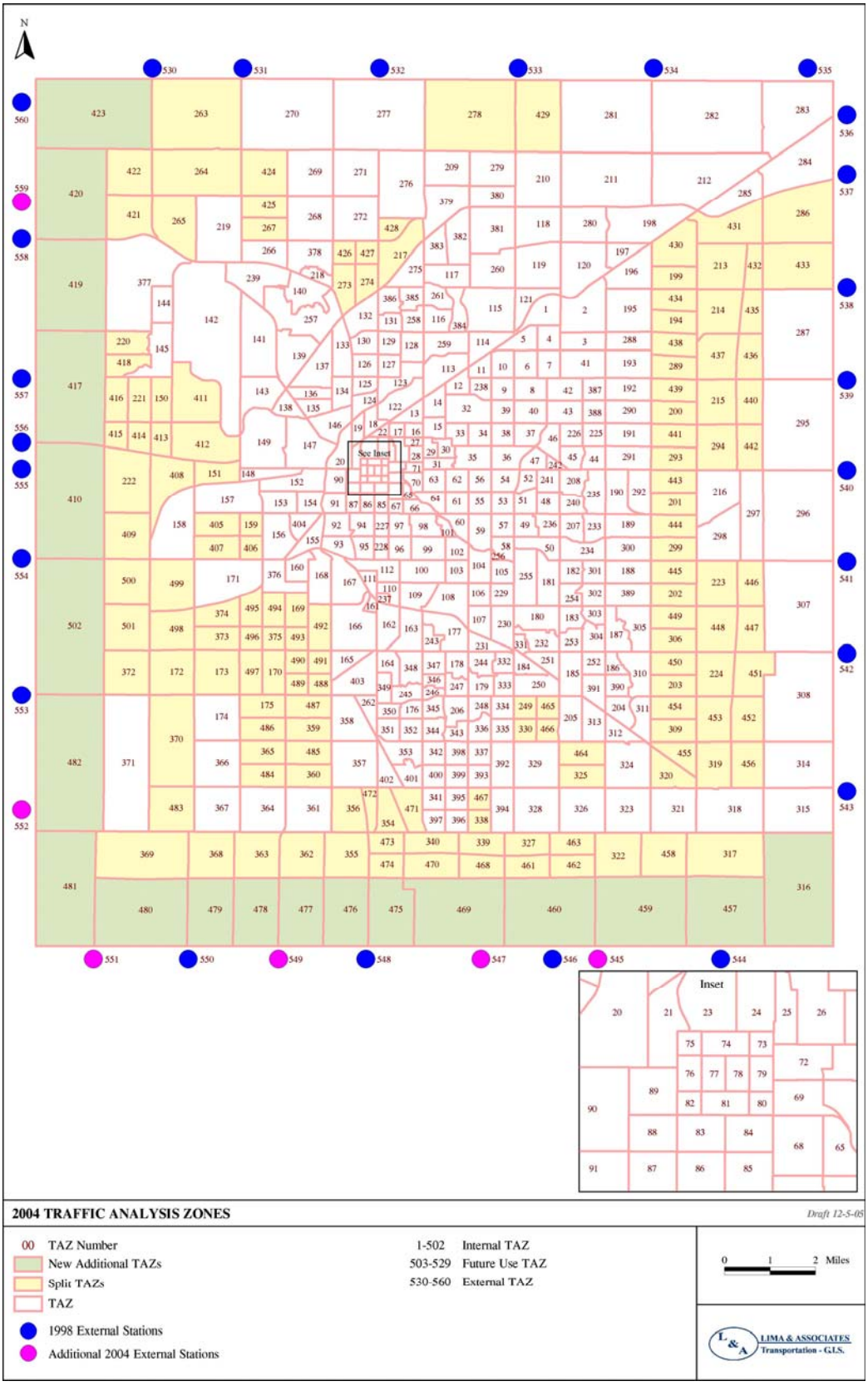
The Lincoln MPO model has a total of 560 traffic analysis zones and the TAZ structure is based upon established census tracks. Of these zones, zone numbers 1 to 502 are internal zones and are displayed in Figure 8. Zone numbers 503 to 527 are extra zones for future use and zone numbers 528 to 560 are external zones. TAZ geographic file is a geographic representation of the zone boundaries in GIS. However, this database is not used in the model run. The TAZ geography exists so that users can link model inputs and outputs (e.g. demographics and output trips) to the files and view results geographically. TAZ structure is based on the previous TP+ model. Expansion of the modeling area to the west and south resulted in new TAZs. Existing TAZs were also revised based on recommendations made by the City of Lincoln staff.

Highway Network (.NET)

From the line geographic file, functional class – capacity lookup table, and turn penalties table a TransCAD network (.NET) file is created. The network uses the fields LENGTH, FUNCLASS, *TRAVELTIME, *CAPACITY, ALPHA, and BETA from the line geographic file. Centroids have also been set in this network.

The model interface includes a button that automatically creates the highway network.

FIGURE 8. TRAFFIC ANALYSIS ZONES (TAZ) STRUCTURE



TRIP GENERATION

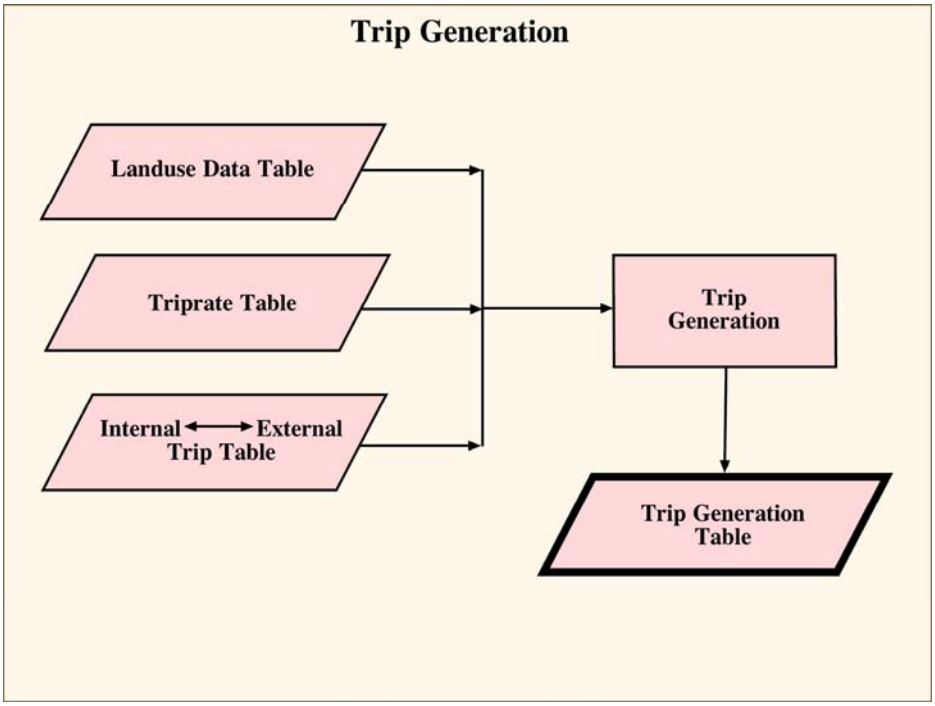
The trip generation process estimates the productions and attractions for each trip purpose. Lincoln MPO model has five trip purposes and are shown in Table 7.

TABLE 7. TRIP PURPOSES USED IN THE LINCOLN MODEL

TRIP PURPOSE	DESCRIPTION
Home Based Work	Work and work-related business
Home Based Shop	Shopping
Home Based Recreational	Vacation, visit friends or relatives, went out to eat, and other social/recreational
Home Based Other	Religious, medical/dental, personal, business, school, take someone or pick up someone, and other
Non Home Based	Any trips that start and end away from home

Trip generation process used in the Lincoln MPO model is shown in Figure 9. Land use data, trip rates by purpose for each land use and the number of internal-external trips are the main inputs for the trip generation process.

FIGURE 9. TRIP GENERATION PROCESS



Land Use Data Table

The Lincoln MPO model has 12 land use categories. Table 8 shows the land use categories and their units.

TABLE 8. LAND USE CATEGORIES

LAND USE TYPE	UNITS
Multi Family	Dwelling Units
Single Family	Dwelling Units
General Retail	1000 SF
Shop Retail	1000 SF
Office	1000 SF
Service	1000 SF
Industrial	Acre
Park	Acre
Elementary	Student
Secondary	Student
College	Student
University	Student

The Lincoln MPO model area is also subdivided into 4 area types. Area type is used to identify different trip making characteristics. For example, trips produced by a rural household are higher than trips produced by an urban household. Also, the speeds on a freeway in urban areas are lower than in a rural setting. Two extra area types were added for this model update to account for special generators and any future reclassification needs. Table 9 shows the area types and the code assigned to each area type in the model.

TABLE 9. AREA TYPES

AREA TYPE	AREA TYPE CODE
Central Business District (CBD)	1
Urban	2
Suburban	3
Rural	4
Other (extra)	5
Other (extra)	6

The land use data table was created in a format required by TransCAD and populated with land use data for each combination of land use type and area type. This data is aggregated at the TAZ level. Previous TP+ model's land use information was used for this purpose. Based on the new TAZ structure and recommended changes by the City of Lincoln staff, that land use data was updated. Table 10 shows the land use data structure used in the Lincoln MPO model. Area type code is added as a suffix to each land use type i.e., a data field with the name MF1 in Table 10 indicates that the field has multifamily dwelling units data for the CBD area type.

TABLE 10. LAND USE DATA TABLE STRUCTURE

FIELD NAME	DESCRIPTION	TYPE	REQUIRED
TAZ	TAZ NUMBER	Integer (4 bytes)	Yes
MF1	MULTI FAMILY 1	Integer (4 bytes)	Yes
MF2	MULTI FAMILY 2	Integer (4 bytes)	Yes
MF3	MULTI FAMILY 3	Integer (4 bytes)	Yes
MF4	MULTI FAMILY 4	Integer (4 bytes)	Yes
MF5	MULTI FAMILY 5	Integer (4 bytes)	Yes
MF6	MULTI FAMILY 6	Integer (4 bytes)	Yes
SF1	SINGLE FAMILY 1	Integer (4 bytes)	Yes
SF2	SINGLE FAMILY 2	Integer (4 bytes)	Yes
SF3	SINGLE FAMILY 3	Integer (4 bytes)	Yes
SF4	SINGLE FAMILY 4	Integer (4 bytes)	Yes
SF5	SINGLE FAMILY 5	Integer (4 bytes)	Yes
SF6	SINGLE FAMILY 6	Integer (4 bytes)	Yes
GenRet1	GEN-RETAIL 1	Integer (4 bytes)	Yes
GenRet2	GEN-RETAIL 2	Integer (4 bytes)	Yes
GenRet3	GEN-RETAIL 3	Integer (4 bytes)	Yes
GenRet4	GEN-RETAIL 4	Integer (4 bytes)	Yes
SG Retail	Special Generator Retail	Integer (4 bytes)	Yes
SGMedCen	Special Generator – Medical Center	Integer (4 bytes)	Yes
ShopRet1	SHOP-RETAIL 1	Integer (4 bytes)	Yes
ShopRet2	SHOP-RETAIL 2	Integer (4 bytes)	Yes
ShopRet3	SHOP-RETAIL 3	Integer (4 bytes)	Yes
ShopRet4	SHOP-RETAIL 4	Integer (4 bytes)	Yes
ShopRet5	SHOP-RETAIL 5	Integer (4 bytes)	Yes
SGMall	Special Generator – Mall	Integer (4 bytes)	Yes
Office1	OFFICE 1	Integer (4 bytes)	Yes
Office2	OFFICE 2	Integer (4 bytes)	Yes
Office3	OFFICE 3	Integer (4 bytes)	Yes
Office4	OFFICE 4	Integer (4 bytes)	Yes
SGPrison	Special Generator - Prison	Integer (4 bytes)	Yes
SGOffice	Special Generator - Office	Integer (4 bytes)	Yes
Service1	SERVICE 1	Integer (4 bytes)	Yes
Service2	SERVICE 2	Integer (4 bytes)	Yes
Service3	SERVICE 3	Integer (4 bytes)	Yes
Service4	SERVICE 4	Integer (4 bytes)	Yes
SGAirport	Special Generator – Airport	Integer (4 bytes)	Yes
SGService	Special Generator – Service	Integer (4 bytes)	Yes
Ind1	INDUSTRIAL 1	Integer (4 bytes)	Yes
Ind2	INDUSTRIAL 2	Integer (4 bytes)	Yes
Ind3	INDUSTRIAL 3	Integer (4 bytes)	Yes
Ind4	INDUSTRIAL 4	Integer (4 bytes)	Yes
Ind5	INDUSTRIAL 5	Integer (4 bytes)	Yes
SGHvyInd	Special Generator – Heavy Industrial	Integer (4 bytes)	Yes
Park1	PARK 1	Integer (4 bytes)	Yes
Park2	PARK 2	Integer (4 bytes)	Yes
Park3	PARK 3	Integer (4 bytes)	Yes
Park4	PARK 4	Integer (4 bytes)	Yes
Park5	PARK 5	Integer (4 bytes)	Yes
Park6	PARK 6	Integer (4 bytes)	Yes
ElemSch1	ELEMENTARY 1	Integer (4 bytes)	Yes
ElemSch2	ELEMENTARY 2	Integer (4 bytes)	Yes
ElemSch3	ELEMENTARY 3	Integer (4 bytes)	Yes
ElemSch4	ELEMENTARY 4	Integer (4 bytes)	Yes
ElemSch5	ELEMENTARY 5	Integer (4 bytes)	Yes
ElemSch6	ELEMENTARY 6	Integer (4 bytes)	Yes
SecSch1	SECONDARY 1	Integer (4 bytes)	Yes
SecSch2	SECONDARY 2	Integer (4 bytes)	Yes
SecSch3	SECONDARY 3	Integer (4 bytes)	Yes
SecSch4	SECONDARY 4	Integer (4 bytes)	Yes
SecSch5	SECONDARY 5	Integer (4 bytes)	Yes
SecSch6	SECONDARY 6	Integer (4 bytes)	Yes
ComCol1	COLLEGE 1	Integer (4 bytes)	Yes
ComCol2	COLLEGE 2	Integer (4 bytes)	Yes
ComCol3	COLLEGE 3	Integer (4 bytes)	Yes
ComCol4	COLLEGE 4	Integer (4 bytes)	Yes
ComCol5	COLLEGE 5	Integer (4 bytes)	Yes
ComCol6	COLLEGE 6	Integer (4 bytes)	Yes
UofN1	UNIVERSITY 1	Integer (4 bytes)	Yes
UofN2	UNIVERSITY 2	Integer (4 bytes)	Yes
UofN3	UNIVERSITY 3	Integer (4 bytes)	Yes
UofN4	UNIVERSITY 4	Integer (4 bytes)	Yes
UofN5	UNIVERSITY 5	Integer (4 bytes)	Yes
SGUnivMain	Special Generator – Univ Main Camp	Integer (4 bytes)	Yes

Special Generators

Special generators are those land uses that do not generate or attract trips at the same rate as other land uses in the same land use category; hence they are assigned a unique trip rate. There are nine special generators in the Lincoln MPO model. Table 11 lists all the special generators

and the TAZs in which they are located. The table also specifies the field names in the land use data table that correspond to these special generators.

TABLE 11. SPECIAL GENERATORS

Special Generator	Units	TAZ (s)	Corresponding Land Use Data Field Name
Airport	Employees	141	SGAirport
Prison	Employees	407, 161	SGPrison
Mall	1000 SF	47, 246	SGMall
Medical Center	Employees	160	SGMedCent
University Main Campus	Students	23	SGUnivMain
Heavy Industrial	Acres	119, 121, 139, 239	SGHvyInd
Low Retail	1000 SF	147,148,149	SGRetail
Low Office	1000 SF	47,147,148,149	SGOffice
Low Service	1000 SF	147,148	SGService

Trip Rate Table

Trip productions for internal residential trips are estimated using a daily trip rate per dwelling unit. Trip attractions for the internal non-residential land uses are estimated using a trip rate per unit (square feet, students, employees, etc.). Trip rates vary depending on the type of land use generating the trips. For example, trip rates for commercial land use type are much higher than parks because commercial establishments attract a lot more trips.

Non-Residential Trip Rates

Non-residential trip rates from the previous TP+ model (based on ITE trips rates) were used as a base for the Lincoln MPO model. These rates were revised using "ITE Trip Generation, 7th Edition". These trip rates were further refined based on the four area types used in the Lincoln MPO model.

Residential Trip Rates

Residential trip rates in the Lincoln MPO model were developed after reviewing trip rates from the 2001 National Highway Travel Survey for Des Moines, MAPA Omaha Council Bluffs, and Mid-America Regional Council (MARC). Additionally, the trip rate for the rural area was developed using Lancaster county survey. For other detailed information please visit the NHTS web site at http://nhts.ornl.gov/2001/index.shtml

Table 12 presents the daily trip rates used in the Lincoln MPO model for each land use and area type combination for each trip purpose. This table includes the trip rates for the special generators.

Table 13 shows the trip rate table structure as required by TransCAD.

TABLE 12. LAND USE TRIP RATES

LAND USE	UNITS	TRIP	PRODUCTION RATES					ATTRACTION RATES				
		RATE	HBW	HBS	HBR	HBO	NHB	HBW	HBS	HBR	HBO	NHB
MULTI FAMILY 1	DU	8.050	0.886	2.069	0.902	1.161	3.035	0.000	0.000	0.000	0.000	0.000
MULTI FAMILY 2	DU	11.730	1.525	2.628	1.372	1.926	4.281	0.000	0.000	0.000	0.000	0.000
MULTI FAMILY 3	DU	12.110	1.635	2.810	1.432	2.119	4.130	0.000	0.000	0.000	0.000	0.000
MULTI FAMILY 4	DU	12.010	1.681	3.063	1.501	2.018	3.735	0.000	0.000	0.000	0.000	0.000
MULTI FAMILY 5	DU	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
MULTI FAMILY 6	DU	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
SINGLE FAMILY 1	DU	10.840	1.192	2.168	1.084	2.461	3.957	0.000	0.000	0.000	0.000	0.000
SINGLE FAMILY 2	DU	13.080	1.449	2.289	1.530	3.309	4.552	0.000	0.000	0.000	0.000	0.000
SINGLE FAMILY 3	DU	13.580	1.901	2.390	1.507	3.381	4.414	0.000	0.000	0.000	0.000	0.000
SINGLE FAMILY 4	DU	18.080	2.531	3.272	2.389	4.484	5.456	0.000	0.000	0.000	0.000	0.000
SINGLE FAMILY 5	DU	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
SINGLE FAMILY 6	DU	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
GEN-RETAIL 1	SQF	55.23	0.000	0.000	0.000	0.000	0.000	2.044	28.885	10.494	3.866	9.941
GEN-RETAIL 2	SQF	68.000	0.000	0.000	0.000	0.000	0.000	3.264	34.000	14.434	5.440	10.880
GEN-RETAIL 3	SQF	65.610	0.000	0.000	0.000	0.000	0.000	3.609	29.787	14.500	6.561	11.154
GEN-RETAIL 4	SQF	50.000	0.000	0.000	0.000	0.000	0.000	2.500	19.550	12.631	5.800	9.500
SGRETAIL	SQF	30.000	0.000	0.000	0.000	0.000	0.000	1.500	11.730	7.578	3.480	5.700
MEDICAL CENTER	SQF	4.430	0.000	0.000	0.000	0.000	0.000	2.658	0.000	0.000	0.443	1.329
SHOP-RETAIL 1	SQF	30.000	0.000	0.000	0.000	0.000	0.000	1.650	13.050	7.350	3.150	4.799
SHOP-RETAIL 2	SQF	45.000	0.000	0.000	0.000	0.000	0.000	3.060	18.540	11.025	4.725	7.650
SHOP-RETAIL 3	SQF	50.000	0.000	0.000	0.000	0.000	0.000	3.500	20.000	12.250	5.250	9.000
SHOP-RETAIL 4	SQF	30.000	0.000	0.000	0.000	0.000	0.000	2.430	11.070	7.350	3.150	6.000
SHOP-RETAIL 5	SQF	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
MALL	SQF	35.000	0.000	0.000	0.000	0.000	0.000	2.450	10.500	8.575	3.675	9.800
OFFICE 1	SQF	11.500	0.000	0.000	0.000	0.000	0.000	2.300	0.000	0.000	2.292	6.912
OFFICE 2	SQF	18.300	0.000	0.000	0.000	0.000	0.000	3.160	0.000	0.000	4.544	10.591
OFFICE 3	SQF	20.000	0.000	0.000	0.000	0.000	0.000	2.654	0.000	0.000	6.582	10.760
OFFICE 4	SQF	16.500	0.000	0.000	0.000	0.000	0.000	2.677	0.000	0.000	5.433	8.394
PRISON	SQF	3.560	0.000	0.000	0.000	0.000	0.000	2.136	0.000	0.000	0.356	1.068
SGOFFICE	SQF	10.000	0.000	0.000	0.000	0.000	0.000	1.623	0.000	0.000	3.293	5.087
SERVICE 1	SQF	16.500	0.000	0.000	0.000	0.000	0.000	2.596	0.000	0.000	7.302	6.602
SERVICE 2	SQF	19.930	0.000	0.000	0.000	0.000	0.000	3.288	0.000	0.000	8.871	7.773
SERVICE 3	SQF	25.000	0.000	0.000	0.000	0.000	0.000	4.375	0.000	0.000	11.525	9.108
SERVICE 4	SQF	22.690	0.000	0.000	0.000	0.000	0.000	3.543	0.000	0.000	10.359	8.743
AIRPORT	SQF	40.600	0.000	0.000	0.000	0.000	0.000	6.090	0.000	28.420	0.000	6.090
SGSERVICE	SQF	10.500	0.000	0.000	0.000	0.000	0.000	1.639	0.000	0.000	4.810	4.046

TABLE 12. LAND USE TRIP RATES (CONTINUED)

LAND USE	UNITS	TRIP RATE	PRODUCTION RATES					ATTRACTION RATES				
			HBW	HBS	HBR	HBO	NHB	HBW	HBS	HBR	HBO	NHB
INDUSTRIAL 1	ACRE	32.500	0.000	0.000	0.000	0.000	0.000	24.380	0.000	0.000	0.000	8.127
INDUSTRIAL 2	ACRE	32.500	0.000	0.000	0.000	0.000	0.000	24.380	0.000	0.000	0.000	8.127
INDUSTRIAL 3	ACRE	25.500	0.000	0.000	0.000	0.000	0.000	19.125	0.000	0.000	0.000	6.375
INDUSTRIAL 4	ACRE	20.000	0.000	0.000	0.000	0.000	0.000	15.000	0.000	0.000	0.000	5.000
INDUSTRIAL 5	ACRE	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
HEAVY INDUSTRIAL	ACRE	20.000	0.000	0.000	0.000	0.000	0.000	18.750	0.000	0.000	0.000	6.250
PARK 1	ACRE	2.500	0.000	0.000	0.000	0.000	0.000	0.126	0.000	2.248	0.000	0.126
PARK 2	ACRE	2.500	0.000	0.000	0.000	0.000	0.000	0.126	0.000	2.248	0.000	0.126
PARK 3	ACRE	2.500	0.000	0.000	0.000	0.000	0.000	0.126	0.000	2.248	0.000	0.126
PARK 4	ACRE	2.500	0.000	0.000	0.000	0.000	0.000	0.126	0.000	2.248	0.000	0.126
PARK 5	ACRE	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
PARK 6	ACRE	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
ELEMENTARY 1	STUDENT	1.820	0.000	0.000	0.000	0.000	0.000	0.178	0.000	0.000	0.732	0.910
ELEMENTARY 2	STUDENT	1.820	0.000	0.000	0.000	0.000	0.000	0.178	0.000	0.000	0.732	0.910
ELEMENTARY 3	STUDENT	1.820	0.000	0.000	0.000	0.000	0.000	0.178	0.000	0.000	0.732	0.910
ELEMENTARY 4	STUDENT	1.820	0.000	0.000	0.000	0.000	0.000	0.178	0.000	0.000	0.732	0.910
ELEMENTARY 5	STUDENT	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
ELEMENTARY 6	STUDENT	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
SECONDARY 1	STUDENT	2.600	0.000	0.000	0.000	0.000	0.000	0.257	0.000	0.000	1.043	1.300
SECONDARY 2	STUDENT	2.600	0.000	0.000	0.000	0.000	0.000	0.257	0.000	0.000	1.043	1.300
SECONDARY 3	STUDENT	2.600	0.000	0.000	0.000	0.000	0.000	0.257	0.000	0.000	1.043	1.300
SECONDARY 4	STUDENT	2.600	0.000	0.000	0.000	0.000	0.000	0.257	0.000	0.000	1.043	1.300
SECONDARY 5	STUDENT	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
SECONDARY 6	STUDENT	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
COLLEGE 1	STUDENT	2.300	0.000	0.000	0.000	0.000	0.000	0.224	0.000	0.000	0.741	0.920
COLLEGE 2	STUDENT	2.300	0.000	0.000	0.000	0.000	0.000	0.224	0.000	0.000	0.741	0.920
COLLEGE 3	STUDENT	2.300	0.000	0.000	0.000	0.000	0.000	0.224	0.000	0.000	0.741	0.920
COLLEGE 4	STUDENT	2.300	0.000	0.000	0.000	0.000	0.000	0.224	0.000	0.000	0.741	0.920
COLLEGE 5	STUDENT	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
COLLEGE 6	STUDENT	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
UNIVERSITY 1	STUDENT	3.500	0.000	0.000	0.000	0.000	0.000	0.350	0.000	0.000	1.365	1.785
UNIVERSITY 2	STUDENT	4.500	0.000	0.000	0.000	0.000	0.000	0.450	0.000	0.000	1.755	2.295
UNIVERSITY 3	STUDENT	3.500	0.000	0.000	0.000	0.000	0.000	0.256	0.000	0.000	1.365	1.785
UNIVERSITY 4	STUDENT	2.500	0.000	0.000	0.000	0.000	0.000	0.256	0.000	0.000	0.975	1.275
UNIVERSITY 5	STUDENT	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
UNIV MAIN CAMPUS	STUDENT	3.650	0.000	0.000	0.000	0.000	0.000	0.365	0.000	0.000	1.424	1.862

TABLE 13. TRIP RATE TABLE STRUCTURE

	FIELD NAME	DESCRIPTION	TYPE	REQUIRED
User Populated Fields	MODEL_ID	Landuse ID	Integer (2 bytes)	Yes
	LANDUSE	Landuse description	Character	Yes
	UNITS	Landuse units	Character	Yes
	RATE	Daily trip rate	Real (4 bytes)	Yes
	PR_HBWP	Percentage of HBW Productions	Real (4 bytes)	Yes
	PR_HBSP	Percentage of HBS Productions	Real (4 bytes)	Yes
	PR_HBRP	Percentage of HBR Productions	Real (4 bytes)	Yes
	PR_HBOP	Percentage of HBO Productions	Real (4 bytes)	Yes
	PR_NHBP	Percentage of NHB Productions	Real (4 bytes)	Yes
	PR_HBWA	Percentage of HBW Attractions	Real (4 bytes)	Yes
	PR_HBSA	Percentage of HBS Attractions	Real (4 bytes)	Yes
	PR_HBRA	Percentage of HBR Attractions	Real (4 bytes)	Yes
	PR_HBOA	Percentage of HBO Attractions	Real (4 bytes)	Yes
	PR_NHBA	Percentage of NHB Attractions	Real (4 bytes)	Yes
Automatically Filled Fields	R_HBWP	HBW productions triprate	Real (4 bytes)	Yes
	R_HBSP	HBS productions triprate	Real (4 bytes)	Yes
	R_HBRP	HBR productions triprate	Real (4 bytes)	Yes
	R_HBOP	HBO productions triprate	Real (4 bytes)	Yes
	R_NHBP	NHB productions triprate	Real (4 bytes)	Yes
	R_HBWA	HBW attractions triprate	Real (4 bytes)	Yes
	R_HBSA	HBS attractions triprate	Real (4 bytes)	Yes
	R_HBRA	HBR attractions triprate	Real (4 bytes)	Yes
	R_HBOA	HBO attractions triprate	Real (4 bytes)	Yes
	R_NHBA	NHB attractions triprate	Real (4 bytes)	Yes

Internal – External Trip Table

As mentioned earlier, the trip generation process estimates the total number of production and attraction trips. Some of these trips are a result of the interaction between the external and internal zones. Internal – External trip table summarizes the number of trips that come into the study area from external zones and the number of trips that go out to the external zones from the study area.

The Lincoln MPO model contains 32 external zones, 7 more than the previous model. Total daily volume on each external zone was split into two categories –

- External to External trips (EE) – these trips do not stop in the model area
- Internal to External trips (IE) & External to Internal trips (EI)

Percentages of EE and IE-EI trips for each external zone were obtained from the previous model. For the newly added external zones, City of Lincoln staff provided the percentage information. Year 2004 count were used at each external station.

Table 14 presents the EE, and EI-IE trip distribution used in the Lincoln MPO model.

TABLE 14. EE & IE-EI TRIPS AT EXTERNAL ZONES

EXTERNAL STATION	LOCATION	2004 ADT	EE TRIPS	IE & EI TRIPS
528	Bennet	500	0	500
529	Hwywood/Bluff Rd	300	0	300
530	56th North - SS79	3585	287	3298
531	27th North	245	0	245
532	14th North	3030	106	2924
533	US 77- 56th North	8125	2356	5769
534	98th North	575	0	575
535	148th North	760	0	760
536	HWY 6 East	5365	574	4791
537	I-80 East	36165	19746	16419
538	Fletcher	470	0	470
539	Adams East	490	0	490
540	US 34 - O Street East	6735	1616	5119
541	Van Dorn East	370	0	370
542	Old Cheney East	540	0	540
543	N2 - Rokeby East	12595	3564	9031
544	120th South	365	0	365
545	82th South	220	0	220
546	68th South	6140	669	5471
547	46th South	660	0	660
548	Homestead Expy - US 77 South	14885	3825	11060
549	14th South	290	0	290
550	42th South	180	0	180
551	72th South	185	13	172
552	Kolbrook	210	15	195
553	Denton West	3000	216	2784
554	Van Dorn West	830	0	830
555	O Street West- HWY 6	3100	471	2629
556	I-80 West	31730	19324	12406
557	Adams West	1000	0	1000
558	Hwy 34 West	4520	1220	3300
559	State Spur 55-M	1575	425	1150
560	Waverly	385	0	385

EI & IE trips are populated in a table formatted to TransCAD requirements and the table structure is shown in Table 15.

TABLE 15. IE & EI TRIP TABLE STRUCTURE

FIELD NAME	DESCRIPTION	TYPE	REQUIRED
TAZ	TAZ number	Integer (4 bytes)	Yes
IEHBWP	HBW - Internal - External trips productions	Integer (4 bytes)	Yes
IEHBWA	HBW - Internal - External trips attractions	Integer (4 bytes)	Yes
IEHBSP	HBS - Internal - External trips productions	Integer (4 bytes)	Yes
IEHBSA	HBS - Internal - External trips attractions	Integer (4 bytes)	Yes
IEHBRP	HBR - Internal - External trips productions	Integer (4 bytes)	Yes
IEHBRA	HBR - Internal - External trips attractions	Integer (4 bytes)	Yes
IEHBOP	HBO - Internal - External trips productions	Integer (4 bytes)	Yes
IEHBOA	HBO - Internal - External trips attractions	Integer (4 bytes)	Yes
IENHBP	NHB - Internal - External trips productions	Integer (4 bytes)	Yes
IENHBA	NHB - Internal - External trips attractions	Integer (4 bytes)	Yes

Trip Generation Table

The Lincoln MPO model interface is used to run the trip generation process using the land use data, trip rate data, and internal-external trips data. Trip productions and attractions are balanced automatically as part of this process. The output trip generation table will have the total productions and attractions for each trip purpose for each TAZ.

Total trips generated in this step are person trips and not vehicle/auto trips. Mode choice step of the Lincoln MPO model separates the auto trips from the non-auto trips. It is for this reason that the trip generation process estimates the total person trips. Table 16 lists the total number of trips generated by each trip purpose for the base year 2004. A comparison of the Lincoln MPO model trip percentages by purpose against the National Household Travel Survey results for "West-North-Central" zone validates the trip generation results of the model.

TABLE 16. TOTAL TRIPS BY PURPOSE FOR BASE YEAR 2004

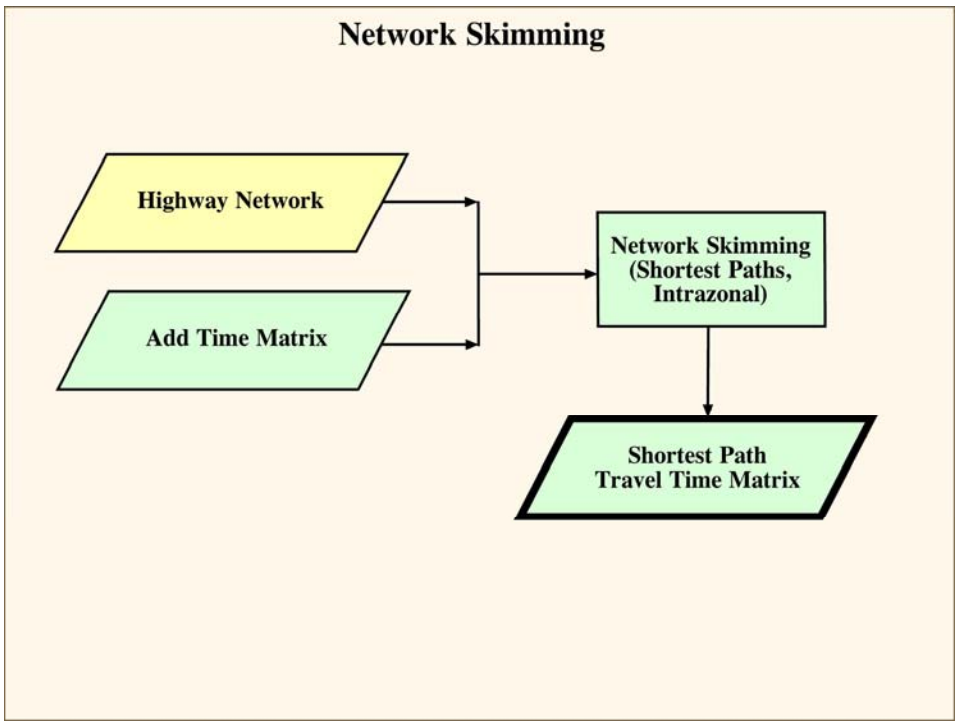
Trip Purpose	Lincoln MPO	Percentage of Trips - Lincoln MPO	Percentage of Trips -West North Central*
Home-based Work	204,025	13.8%	10.9%
Home-based Shopping	302,640	20.5%	21.8%
Home-based Social/Recreational	168,871	11.4%	13.8%
Other Home-based	343,006	23.2%	20.5%
Not Home-based	459,816	31.1%	33.0%
TOTAL	1,478,358	100.0%	100.0%

*Source: National Household Travel Survey(2001), U.S. Department of Transportation, Bureau of Transportation Statistics

NETWORK SKIMMING

Network skimming is a process of identifying the route or travel path on the transportation network that has the lowest "cost" for the traveler. The "cost" can be the travel time, distance or some monetary value. In the Lincoln MPO Model the cost used is travel time. This minimum path value is stored in a matrix called the impedance matrix. This minimum path value results from the "skim tree" that is developed. The skim tree is a table that shows all the possible combinations of links or paths that could be used to go from one zone to another. Figure 10 below shows the network skimming process used for the Lincoln MPO model.

FIGURE 10. NETWORK SKIMMING



The roadway network (.NET) file created in the "Network Creation" process serves as one of the inputs in this process.

Add Time Matrix

Add time matrix is a special matrix created for the Lincoln MPO model. There may be some instances where two external zones are close to each other. In those cases, to prevent trip exchange between the zones, travel time between these zones is increased using the Add time matrix. This matrix can also be used to add time between internal zones, if needed.

For the Lincoln MPO model, a travel time of 60 minutes is added for travel between all external zones using the add time matrix.

Shortest Path Travel Time Matrix

The model uses the highway network and performs highway skims from centroid node to centroid node. The travel time is "minimized" and travel distance is skimmed. After the minimum travel time matrix is calculated, intrazonal travel times are calculated and added. The procedure used for calculating intrazonal travel times was the closest neighbors approach. After skimming, for each row origin, the travel time of its three closest neighbors is found from the matrix. The intrazonal time is then just the average of the three closest neighbors. Add time matrix is then added to create the final shortest path travel time matrix.

Also, if this is the first iteration of feedback model or if the model is run by itself, the network fields ABTRAVELTIME and BATRAVELTIME, which are the free flow travel times, are used. If it is a subsequent feedback iteration, the network fields AB_TIME_C_AVG and BA_TIME_C_AVG, which are the congested times calculated by traffic assignment, are used to create the shortest path travel time matrix.

TRIP DISTRIBUTION

The purpose of trip distribution is to produce a trip table of the estimated number of trips from each TAZ to every other TAZ within the study area. Trip distribution for this study was estimated using the TransCAD Gravity Model program. The Gravity Model assumes that the number of trips between two zones is 1) directly proportional to the trips produced and attracted to both zones, and 2) inversely proportional to the travel time between the zones.

The Gravity Model formulation states that the number of trips between each zone is equal to:

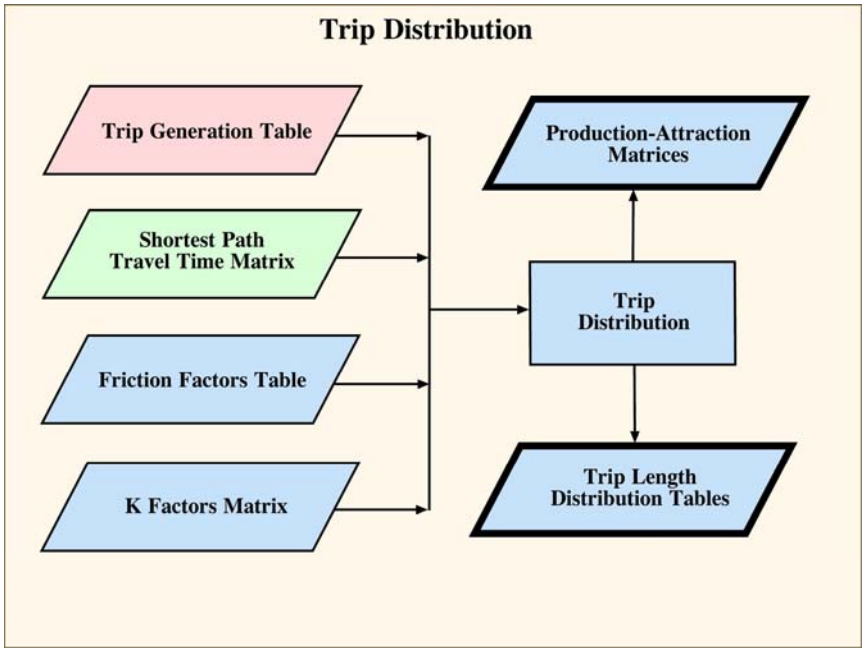
$$T_{ij} = P_i * \frac{A_j F_{ij} K_{ij}}{\sum_{j=1}^{n} (A_j F_{ij} K_{ij})}$$

Where

T_{ij}	=	Number of trips from zone i to zone j
P_i	=	Number of trip productions in zone i
A_j	=	Number of trip attractions in zone j
F_{ij}	=	Friction factor (represents the spatial separation between zone i & zone j
K_{ij}	=	Optional adjustment factor (fudge factor)-not recommended

Figure 11 shows the trip distribution process used for Lincoln MPO model.

FIGURE 11. TRIP DISTRIBUTION



The trip generation table and shortest path travel time matrix files created in previous steps serve as inputs in this process.

Friction Factors Table

Friction factors express the effect that travel time has on the number of trips traveling between two zones. Trips were distributed for the five trip purposes.

For the Lincoln MPO model, friction factors were developed using a gamma function to estimate the friction factors and application of the trip distribution model to identify the best-fit for the average trip length and trip length frequency distributions. The normalized friction factors estimated are presented in Figure 12 by trip purpose. Such plot provides a picture of the traveler's sensitivity to travel time by trip purpose; steeper curves mean more sensitivity to travel time. The gamma functions used to develop these functions used the following equation:

$$Alpha * (I^{Beta} * e^{I * Gamma})$$

Where Alpha, Beta and Gamma are coefficients and I is the impedance, or trip length in minutes.

Initial coefficients in the gamma function were obtained from the NCHRP Report 365 and the final coefficients are provided in Table 17.

FIGURE 12. ESTIMATED FRICTION FACTORS

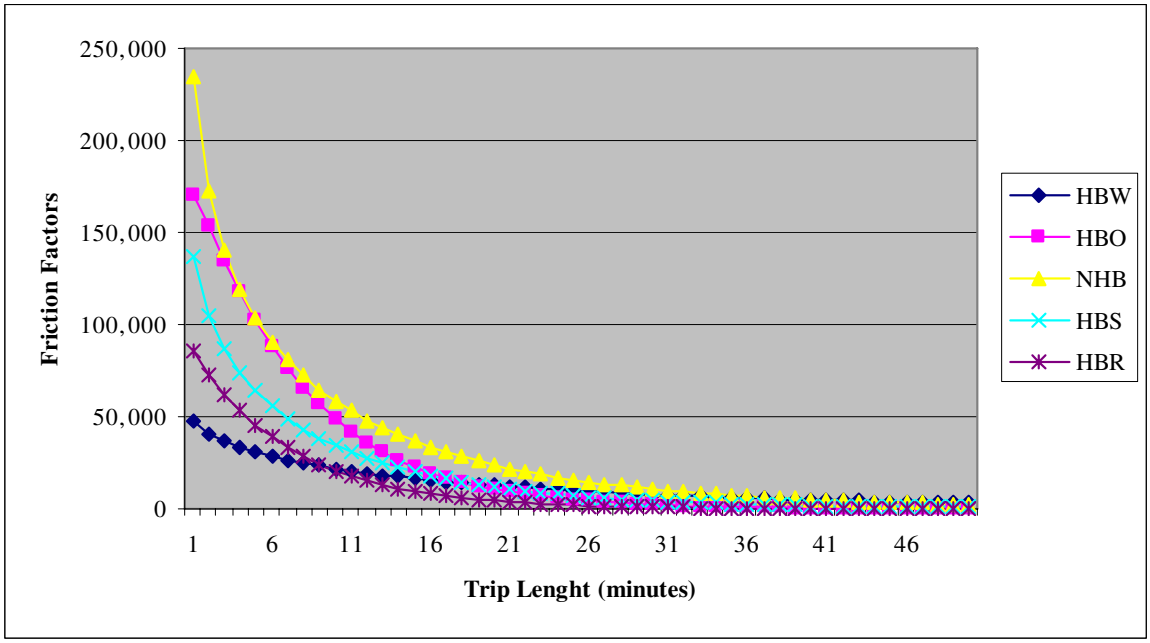


TABLE 17. COEFFICIENTS IN THE GAMMA FUNCTION TO ESTIMATE FRICTION FACTORS

Trip Purpose	Alpha	Beta	Gamma
Home Based Work	50000	-0.0174	-0.0425
Home Based Shop	200000	0.0724	-0.1578
Home Based Recreational	250000	-0.3449	-0.0658
Home Based Other	150000	-0.256	-0.0886
Non Home Based	100000	-0.0056	-0.1556

K Factors Matrix

Sometimes there are special situations where the travel patterns are different from those predicted by the gravity model. These special patterns can be replicated using K factors matrix. However, it is recommended to limit the use of these factors since the same flow patterns might not continue in the future years. For the Lincoln MPO model the K factors matrix is not used. However, it is provided as an option in the model interface for future use, if needed.

Production-Attraction Matrices

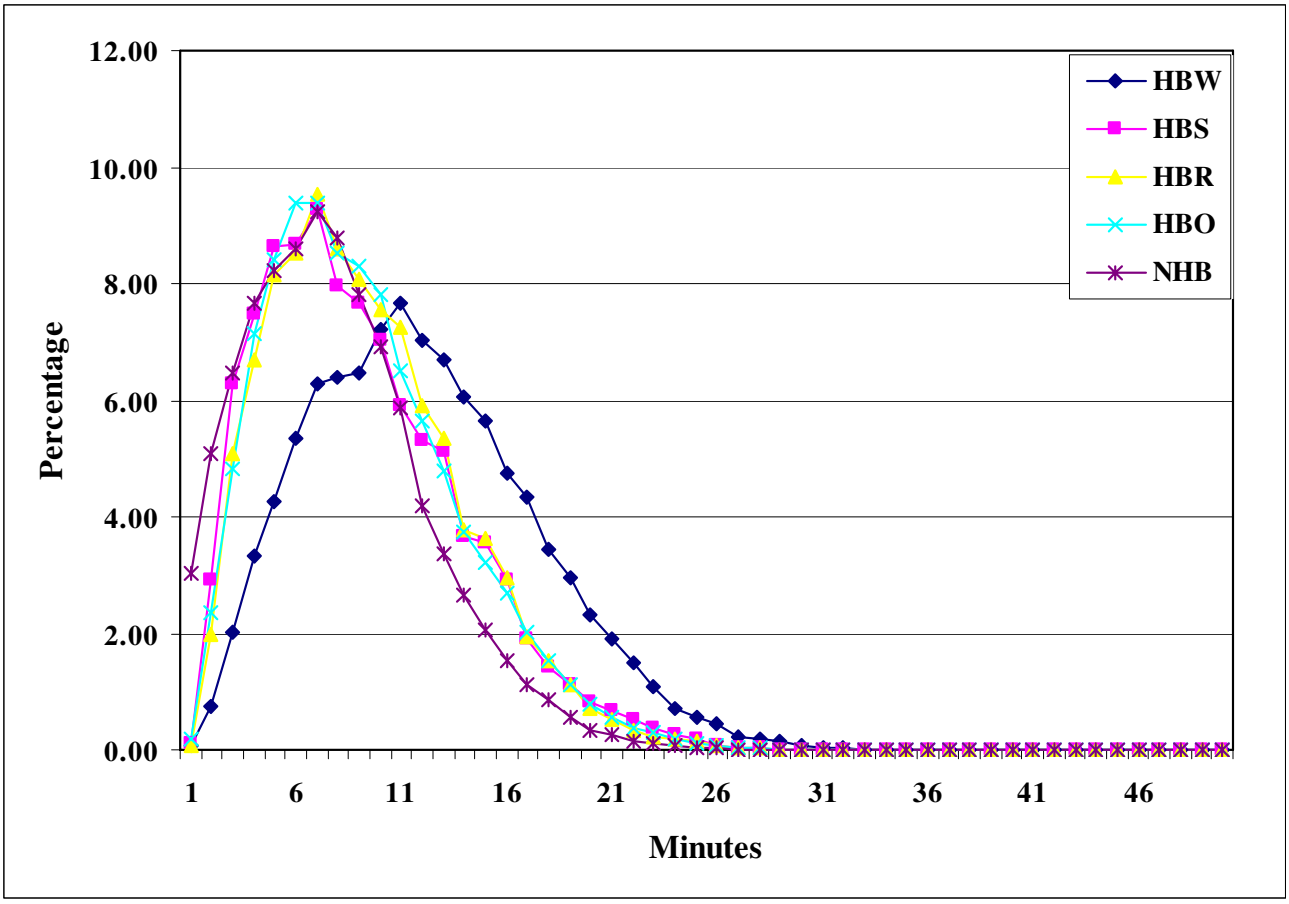
The travel time matrix from highway skims, the productions and attractions table from trip generation and the friction factors are used as input to the gravity model to produce production-attraction matrices for each trip purpose.

Trip Length Distribution Tables

The travel time matrix from highway skimming and PA matrices from the trip distribution process are used to determine the average trip length and the trip length frequency distribution for each trip purpose. Figure 13 shows the trip length distribution results for each trip purpose.

In the Lincoln MPO model, the trip length results are saved to individual matrix files for each trip purpose. TransCAD charting tools can be used to graphically display the trip length distribution results.

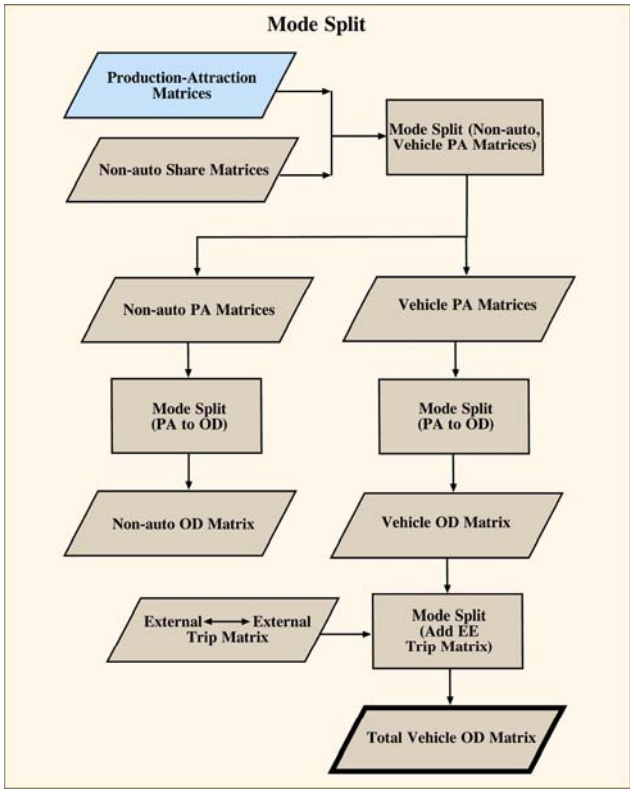
FIGURE 13. TRIP LENGTH DISTRIBUTION



MODE SPLIT

In the mode split step, the input Production/Attraction (PA) matrices are split into auto PA and non-auto PA matrices. The step after mode split transforms the auto PA matrix into auto origin-destination (OD) matrix. Figure 14 shows the process for mode split used in the Lincoln MPO model.

FIGURE 14. MODE SPLIT



External – External Trip Matrix

As mentioned in the trip generation process, some trips originating at an external zone may not stop in the Lincoln MPO model area and exit the model area through another external zone. These trips, however, use the model network to move between one external zone to another. These trips should also be part of the trip assignment procedure. It is for this reason that the trip exchange between external zones is summarized in the external – external trip matrix.

For the Lincoln MPO model, trip exchange information between external zones was provided by the City of Lincoln staff and is shown in Appendix A.

Non-Auto Share Matrix

The non-auto share matrix contains the percentage of trips made using non-auto modes from one TAZ to another TAZ for each trip purpose. Table 18 shows the percentages of total person trips that use non-auto modes for each trip purpose. This data was estimated based on the 2001 National Household Travel Survey (NHTS).

TABLE 18. PERCENTAGE OF NON-AUTO MODE TRIPS

Trip Purpose	Percentage of Non-Auto Mode Trips
Home Based Work	6.0%
Home Based Shop	0.7%
Home Based Recreational	3.4%
Home Based Other	0.9%
Non Home Based	0.5%

Non-Auto OD Matrix

The input PA matrices are multiplied by the non-auto shares matrices to obtain a non-auto PA trip matrices. An all-day PA to OD procedure is performed on the non-auto PA trip matrices to obtain the total non-auto OD matrix. Table 19 shows the number of non-auto trips by purpose.

TABLE 19. NON-AUTO TRIPS BY PURPOSE

Trip Purpose	Daily Non-Auto Trips	Percentage of Total Non-Auto Trips
Home-based Work	12,242	48.0%
Home-based Shopping	2,118	8.3%
Home-based Social/Recreational	5,742	22.5%
Other Home-based	3,087	12.2%
Non Home-based	2,299	9.0%
TOTAL	25,488	100.0%

Total Vehicle OD Matrix

The non-auto PA matrices are subtracted from the input PA matrices to obtain the auto PA trip matrices. An all-day PA to OD procedure is performed on the auto PA matrices to obtain the auto OD matrix.

It is in this step that the person trips are converted to vehicle trips using auto occupancy rates for each trip purpose. Auto occupancy rates used in the Lincoln MPO model are presented in Table 20. Table also shows a comparison of the Lincoln MPO occupancy rates with that of 2001 NHTS rates. The NHTS rates for the West-North Central region were used as guidelines and the home-

based work was adjusted during the validation process to account for Lincoln auto occupancy data.

TABLE 20. VEHICLE OCCUPANCY RATES

Trip Purpose	Lincoln MPO Average Vehicle Occupancy (Persons)	West North Central*
Home-based Work	1.18	1.11
Home-based Shopping	1.84	1.84
Home-based Social/Recreational	1.81	1.81
Other Home-based	1.75	1.75
Non Home-based	1.70	1.70
All	1.65	1.65

*Source: National Household Travel Survey(2001), U.S. Department of Transportation, Bureau of Transportation Statistics

Table 21 presents the vehicular trips for each trip purpose. The NHTS data was used as a base and modified during calibration to reflect the unique travel characteristics in the Lincoln metropolitan area displayed by the traffic counts. The "Modal Split" button in the model interface will perform all the process detailed under this step.

TABLE 21. VEHICLE TRIPS BY PURPOSE

Trip Purpose	Daily Vehicle Trips - Lincoln MPO	Percentage of Trips - Lincoln MPO	Percentage of Trips -West North Central*
Home-based Work	179,026	19.7%	16.1%
Home-based Shopping	164,946	18.1%	22.7%
Home-based Social/Recreational	91,684	10.1%	9.8%
Other Home-based	206,283	22.7%	17.5%
Non Home-based	268,652	29.5%	33.9%
TOTAL	910,591	100.0%	100.0%

*Source: National Household Travel Survey(2001), U.S. Department of Transportation, Bureau of Transportation Statistics

External-External trip matrix is added to the vehicle OD matrix to create the Total Vehicle OD Matrix. The total number of vehicular trips for the 2004 model is 906,526 of which 27,177 are through trips.

TRIP ASSIGNMENT

Trip assignment first involves the calculation of the shortest path from each origin to all destinations (usually the minimum time path is used). Trips for each O-D pair are then assigned to the links in the minimum path and the trips are added up for each link. The assigned trip volume is then compared to the capacity of the link to see if it is congested. If a link is congested the travel time is adjusted to result in a longer travel time on that link. Changes in travel time means that the shortest path may change. Hence the whole process is repeated several times (iterated) until there is an equilibrium between travel demand and travel supply. Trips on congested links will be shifted to uncongested links until this equilibrium, condition occurs. Figure 15 shows the trip assignment process for the Lincoln MPO model.

TransCAD Stochastic User Equilibrium method is utilized for each assignment with a default number of 70 iterations per assignment. After each assignment, the output volumes for each link are exported to a new geographic file.

Several summary tables are created for each assignment run. They are –

- ***LOS mileage summary table based on V/C ratio*** – summarizes roadway mileage for each type of LOS based on V/C ratio. Table 22 lists the V/C ratio ranges used.
- ***LOS mileage summary table based on percent reduction in actual speed*** - summarizes the mileage for each type of LOS using the percent reduction in actual speed. Table 23 lists the percent reduction speed ranges used for each LOS type.
- ***Screenline results summary table*** – compares the model assigned volume to actual counts for links on each screenline.
- ***Functional class summary table for VMT, VHT, Average Speed*** – summarizes the VMT, VHT, and Average Speed values for each functional class type.
- ***Area type summary table for VMT, VHT, Average Speed*** - summarizes the VMT, VHT, and Average Speed values for each area type.
- ***Count Vs Flow (Assigned volumes) summary statistics for each functional class type*** – summarizes model statistics such as percent error (assigned volume vs actual counts), RMSE for each functional class type.
- ***Turn Movements Table*** – stores the turn movement volumes for intersections selected during model setup.

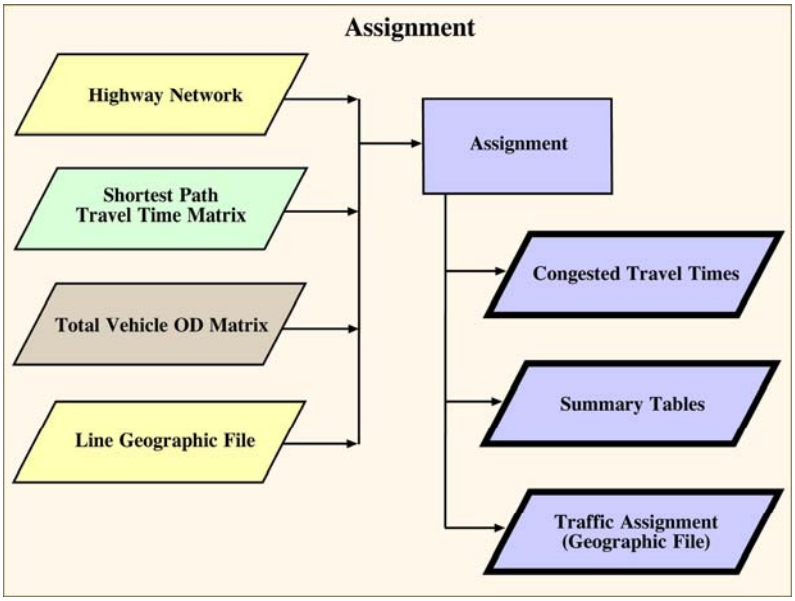
TABLE 22. LEVEL OF SERVICE - V/C RATIOS USED IN LINCOLN MPO MODEL

Level of Service	V/C Ratio
A	0-0.50
B	0.51-0.70
C	0.71-0.80
D	0.81-0.90
E	0.91-0.99
F	≤1

TABLE 23. LEVEL OF SERVICE – PERCENT REDUCTION IN SPEED USED IN LINCOLN MPO MODEL

Level of Service	Percent Reduction in Posted Speed
A	0
B	1-7
C	8-15
D	16-32
E	33-48
F	>48

FIGURE 15. TRIP ASSIGNMENT

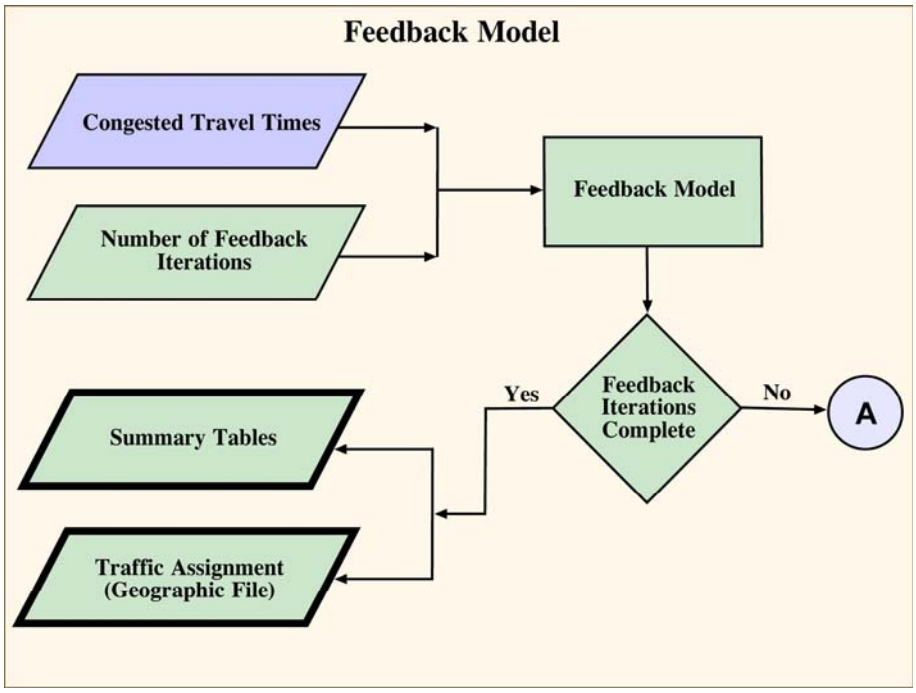


FEEDBACK MODEL

The purpose of a feedback loop implementation is to generate realistic congested travel times so that the gravity model accurately allocates trips to zones with more accuracy than by using free-flow travel times. The feedback loop step uses the assignment model to calculate updated congested travel times. These congested travel times are then "fed back" into the network and the highway skim travel time matrix is re-calculated. Since this would change the results of the gravity model and any subsequent model that is in the stream process, all models are re-run with this updated information. The feedback loop is repeated several times until either the output flow volumes between successive loop iterations are within a convergence criteria or the number of iterations exceeds a specified amount. Figure 16 outlines the process for the feedback model.

The Lincoln MPO model does not use the feedback model at this time for the base year validation. However, this option can be used in the future when congestion levels on the streets increases significantly.

FIGURE 16. FEEDBACK MODEL



MODEL CALIBRATION/VALIDATION

Calibration/Validation is an iterative process — upgrading or adjusting entered data, program coefficients or parameters, and assumptions on successive simulation runs, until the volumes and traffic patterns produced by the model approximate known traffic counts within acceptable limits. The primary reason behind validation is that simulated model data should not significantly differ from actual count data to cause inappropriate under- or over-design of roadway facilities. However, the percent difference between modeled volumes and actual counts may be large, but is only significant in relation to its functional classification and the magnitude of the volume itself. The following performance measures were reviewed:

- Percent assignment error
- Root Mean Square error
- Coefficient of Determination; RSquared (R^2)
- Screenline analysis

Percent Error of Traffic Assignment

The percent error of traffic assignment indicates the accuracy with which the transportation model replicates the actual traffic counts. Percent error is the difference between the assigned traffic volumes and the counted traffic volumes divided by the counted traffic volumes. Table 24 displays the percent error by functional classification for Lincoln MPO model.

TABLE 24. PERCENT ERROR BY FUNCTIONAL CLASSIFICATION

FUNCTIONAL CLASS	SUM OF COUNTS	SUM OF ASSIGN	NUMBER OF COUNTS	PERCENT ERROR	PERCENT ERROR TARGET*
Collector	267,981	214,851	51	-19.83%	25.0%
Interstate/freeway	352,200	349,309	21	-0.82%	7.0%
Major Arterial	1,291,935	1,327,761	58	2.77%	10.0%
Major Collector County	69,119	78,299	44	13.28%	25.0%
Minor Arterial	4,693,779	4,649,079	364	-0.95%	15.0%
Principal Arterial (Div)	927,313	962,444	76	3.79%	10.0%
Average Network Stats	7,602,327	7,581,743	614	-0.27%	5.0%

"Calibrating and adjustment of system planning models" December 1990, FHWA

Root Mean Square Error

Another measure of the model's ability to assign traffic volumes is the percent RMSE. The RMSE measures the deviation between the assigned traffic volumes and the counted traffic volumes and is given as:

$$\%\ \text{RMSE} = \frac{100 * \sqrt{\frac{\sum_j (Model_j - Count_j)^2}{(Number\ of\ Counts - 1)}}}{\left(\frac{\sum_j Count_j}{Number\ of\ Counts}\right)}$$

A large percent RMSE indicates a large deviation between the assigned and counted traffic volumes; whereas, a small percent RMSE indicates a small deviation between the assigned and counted traffic volumes. Usually, lower volume roads shows bigger percent RMSE and higher volume roads shows smaller percent RMSE. The percent RMSE by facility type is given in Table 25.

TABLE 25. PERCENT RMSE BY FUNCTIONAL CLASSIFICATION

FUNCTIONAL CLASS	PRMSE	PRMSE TARGET
Collector	43.40%	100.0%
Interstate/freeway	10.08%	15.0%
Major Arterial	13.94%	30.0%
Major Collector County	42.10%	100.0%
Major Collector State	n/a	100.0%
Minor Arterial	23.02%	45.0%
Minor Collector (Rural)	n/a	100.0%
Principal Arterial (Div)	14.75%	30.0%
Ramps	n/a	100.0%
Average Network Stats	21.46%	35.0%

Coefficient of Determination

Another tool to measure the overall model accuracy is the coefficient of determination or R^2 (see formula below). The R^2, or "goodness of fit" statistic shows how well the regression line represents the assignment data. The very desirable R^2 is 0.88 or higher. A value of 1.00 is perfect, but even if traffic counts were compared against themselves, the daily variation would

not allow for a regression coefficient of 1.00. The value of 0.90 achieved for the Lincoln MPO illustrates that the model validation is also good.

$$r^2 = \left(\frac{n\sum(x_i y_i) - (\sum x_i)(\sum y_i)}{\sqrt{\left[n\sum x_i^2 - \left(\sum x_i\right)^2\right]\left[n\sum y_i^2 - \left(\sum y_i\right)^2\right]}} \right)^2$$

where: x = counts
y = model volumes
n = number of counts

Screenline Analysis

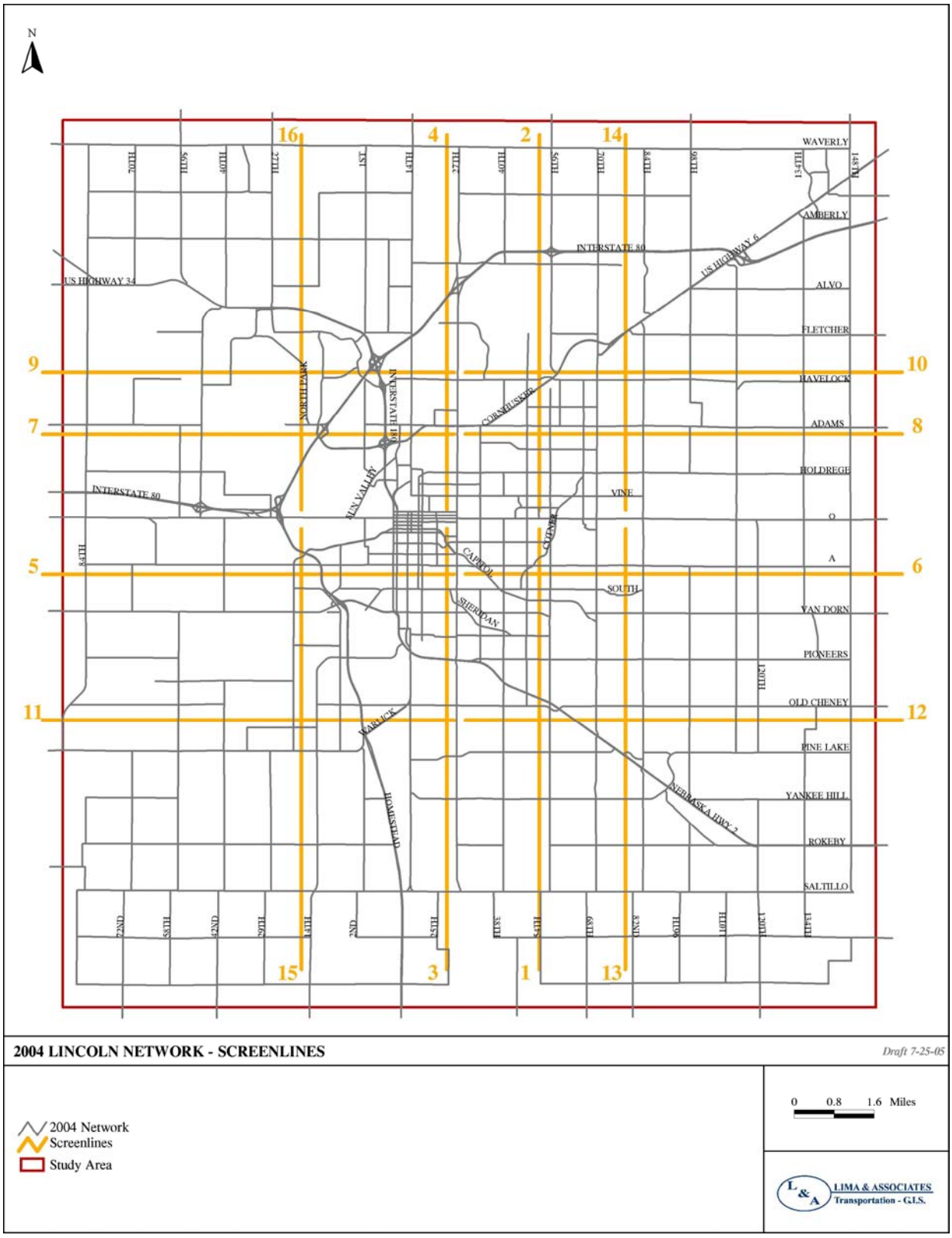
There are 16 screenlines in the Lincoln MPO model. Screenlines are imagery lines drawn across several sections of various roadways to assess the performance of the model by comparing the total model assigned volumes and total actual counts for those roadway sections. Figure 17 shows the location of screenlines used in the Lincoln MPO model. Table 26 shows the screenline analysis results.

TABLE 26. SCREENLINE ANALYSIS RESULTS

Screenline	Model Assigned Volume	Actual Count	Percent Difference
1	116,428	129,977	5.63
2	107,766	106,621	-1.06
3	163,562	163,594	0.02
4	157,019	156,926	-0.06
5	104,183	110,158	5.74
6	102,276	97,368	-4.80
7	56,510	53,778	-4.83
8	90,927	95,426	4.95
9	58,467	52,726	-9.82
10	50,477	48,014	-4.88
11	27,300	27,743	1.62
12	76,906	73,074	-4.98
13	65,494	72,476	10.66
14	54,253	53,876	-0.69
15	55,779	60,924	9.22
16	64,900	64,896	-0.01

Individual screenlines volume should have a comparison goal of plus or minus 10%.

FIGURE 17. SCREENLINE LOCATIONS FOR LINCOLN MPO MODEL



Vehicle Miles Traveled

The assigned 2004 daily traffic volumes were compared with the counted daily traffic volumes for individual links. The comparison indicated the following: 1) the computed vehicle miles traveled (VMT) in the study area are approximately 4,853,074 per day, 2) the estimated vehicle hours traveled (VHT) in the study area are approximately 119,311 per day. The VMT, and VHT do not include the centroid connectors or externals. The average trip length in the system using the system output data is anticipated to be approximately 5.4 miles in length. The VMT is in line with the projections made by the City of Lincoln in their 2004 assessment. Table 27 presents the VMT and VHT results by functional class produced by the Lincoln MPO model.

TABLE 27. 2004 VMT & VHT BY FUNCTIONAL CLASS

FUNCLASS	VMT	VHT
Collector	142,400	5,311
Interstate/freeway	770,642	12,109
Major Arterial	739,743	17,925
Major Collector County	113,192	2,084
Major Collector State	20,016	364
Minor Arterial	2,082,606	58,717
Minor Collector (rural)	9,454	191
Principal Arterial (Div)	860,728	19,560
Ramps	69,703	2,166
Others	44,590	884
TOTAL	4,853,074	119,311

Comparison of Results

The 1998 and the 2004 model were developed using different parameters, assumptions and characteristics. However, the comparison of certain variables and ratios independent of the model development process can be made. Table 28 displays the comparison's results.

TABLE 28. 1998 MODEL AND 2004 MODEL COMPARISON

Variable	1998	2004
Population	234,266	253,700
Dwelling Units (DU)	95,230	105,714
Vehicle Trips	844,220	906,526
Person Trips	n/a	1,478,358
Vehicle Trips/DU	8.87	8.58
Vehicle Trips/Person	3.60	3.57
Person Trips/ DU	14.36	13.98

APPENDIX A

E-E TRIPS DISTRIBUTION

TAZ	530	531	532	533	534	535	536	537	538	539	540	541	542	543	544	545	546	547	548	549	550	551	552	553	554	555	556	557	558	559	560	Total
530	0	0	0	0	0	0	14	51	0	0	0	0	0	13	0	0	0	0	44	0	0	0	0	0	0	0	0	0	14	0	0	135
531	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
532	0	0	0	0	0	0	6	14	0	0	6	0	0	12	0	0	0	0	15	0	0	0	0	0	0	0	0	0	0	0	0	53
533	0	0	0	0	0	0	0	531	0	0	0	0	0	117	0	0	0	0	0	0	0	0	0	0	0	0	322	0	60	0	0	1030
534	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
535	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
536	14	0	6	0	0	0	0	0	0	0	8	0	0	14	0	0	0	0	35	0	0	0	0	0	0	48	120	0	20	10	0	274
537	51	0	14	531	0	0	0	0	0	0	0	0	0	405	0	0	0	0	652	0	0	0	0	0	0	0	8107	0	110	0	0	9871
538	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
539	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
540	0	0	6	0	0	0	8	0	0	0	0	0	0	87	0	0	0	0	174	0	0	0	0	0	0	88	473	0	0	0	0	836
541	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
542	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
543	13	0	12	117	0	0	14	405	0	0	87	0	0	0	0	0	0	0	356	0	0	0	0	0	0	0	425	0	178	107	0	1713
544	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
545	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
546	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	151	122	0	32	0	0	305
547	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
548	44	0	15	0	0	0	35	652	0	0	174	0	0	356	0	0	0	0	0	0	0	0	0	0	0	0	337	0	185	100	0	1899
549	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
550	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
551	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
552	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
553	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
554	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
555	0	0	0	0	0	0	48	0	0	0	88	0	0	0	0	0	151	0	0	0	0	0	0	0	0	0	21	0	0	0	0	308
556	0	0	0	322	0	0	120	8107	0	0	473	0	0	425	0	0	122	0	337	0	0	0	0	0	0	21	0	0	0	0	0	9928
557	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
558	14	0	0	60	0	0	20	110	0	0	0	0	0	178	0	0	32	0	185	0	0	0	0	0	0	0	0	0	0	0	0	599
559	0	0	0	0	0	0	10	0	0	0	0	0	0	107	0	0	0	0	100	0	0	0	0	0	0	0	0	0	0	0	0	216
560	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	135	0	53	1030	0	0	274	9871	0	0	836	0	0	1713	0	0	305	0	1899	0	0	0	0	0	0	308	9928	0	599	216	0	

TURN PENALTIES TABLE

FROM_ID	TO_ID	PENALTY	STREET NAME
7244	7242		
5680	20220		
1397	20158		
18007	15526		
15333	15328		
15317	15328		
18203	15318		
18527	5582		
18527	20229		
15546	15539		
15539	15544		
10797	10800		
15546	15545		
15539	15545		
15543	15539		
10797	10801		
18198	10796		
18198	15900		
20436	19363		
8257	20436		
7924	8015		
1698	1765		
1698	1727		
15331	15335		
20933	20854	0.050	O ST
20854	1489	0.050	O ST
1489	1472	0.050	O ST
1472	1470	0.050	O ST
1470	1472	0.050	O ST
1472	1470	0.050	O ST
20854	20933	0.050	O ST
19001	19006	0.060	40TH
19006	9322	0.060	40TH
9322	19009	0.060	40TH
19009	19026	0.060	40TH
19026	9302	0.060	40TH
9302	19026	0.060	40TH
19026	19009	0.060	40TH
19009	9322	0.060	40TH
9322	19006	0.060	40TH
19006	19001	0.060	40TH
9123	19217	0.100	70TH
19217	9029	0.100	70TH
9029	19217	0.100	70TH
19217	9123	0.100	70TH

TURN PENALTIES TABLE (Continued)

FROM_ID	TO_ID	PENALTY	STREET NAME
19190	16888	0.200	84TH
16888	1311	0.200	84TH
1311	16888	0.200	84TH
16888	19190	0.200	84TH
20092	2906	0.100	33RD
2906	20092	0.100	33RD
10890	10867	0.500	I-180
10867	5008	0.500	I-180
4325	10742	0.500	I-180
10742	18499	0.500	I-180
1280	18618	0.500	98TH
18618	1280	0.300	98TH
18497	10767	0.500	I-180
18499	18500	0.500	I-180
1275	19686	0.300	112 TH
19686	1275	0.300	112 TH
1775	1705	0.300	R ST
1705	1775	0.300	R ST
1698	18559	0.060	O ST
18559	20232	0.090	O ST
20232	20889	0.060	O ST
20889	20232	0.060	O ST
20232	18559	0.090	O ST
18559	1698	0.060	O ST
6926	18521	0.001	Cotner
18521	9626	0.001	Cotner
5510	20370	0.300	Cotner
5402	1764	0.300	Cotner
1765	5510	0.300	Cotner
18577	18305	0.300	Normal
18305	18577	0.300	Normal
20140	3434	0.100	Vine ST
3434	19570	0.100	Vine ST
19570	3577	0.100	Vine ST
3577	19570	0.100	Vine ST
19570	3434	0.100	Vine ST
3434	20140	0.100	Vine ST
21239	8046	0.500	Sheridan
8046	21239	0.500	Sheridan
11680	19703	0.200	84 TH
19703	20882	0.200	84 TH
20882	19703	0.200	84 TH
19703	11680	0.200	84 TH
21376	5402	0.300	Cotner
3385	19345	0.300	R ST
19345	3385	0.300	R ST
20304	15175	0.300	40 TH
15175	20304	0.300	40 TH
1275	19660	3.000	112 TH
19660	1275	3.000	112 TH