SECTION 3 Travel Demand Model

This chapter describes the development and validation of the transportation model used to evaluate existing travel conditions and forecast future travel demand for the City. This mathematical approach simulates existing traffic patterns and projects future travel demands, and as a result, is one of the most important tools used in the transportation planning process.

When transportation planning was in its infancy, *simple trend-line analysis* was performed to forecast traffic demands. However, such methods were based on the existing relationships between land uses and intensities of land use. If land development patterns changed over time (and most do), forecasts were seldom reliable.

Historical trend analysis also failed to account for the impact of construction of new transportation facilities or the improvement of existing facilities. To obtain reliable estimates of future travel patterns, both the travel simulation models and the projected land use data must be sensitive to the many quantitative and qualitative parameters influencing the generation and distribution of trips. These characteristics and patterns depend largely on the following factors:

- Socioeconomic conditions affecting trip production and attraction;
- The land-use pattern, including the location and intensity of use; and,
- The type, extent, and quality of transportation facilities.

With these factors as input to travel demand models, forecasts of future travel patterns are made and used to test the adequacy of any proposed transportation system improvements to serve projected traffic demands. The evaluation of alternatives by use of the transportation model was a primary factor in developing a responsive transportation plan for the Georgetown area.

For this study, the regional transportation model, maintained by CAMPO, was used as the basis for the Georgetown OTP model. Utilizing the CAMPO zone structure, zones were further subdivided to enable the model to be focused at a local level..

The relationship of the models and their inputs and outputs are illustrated in **Figure 3-1.**

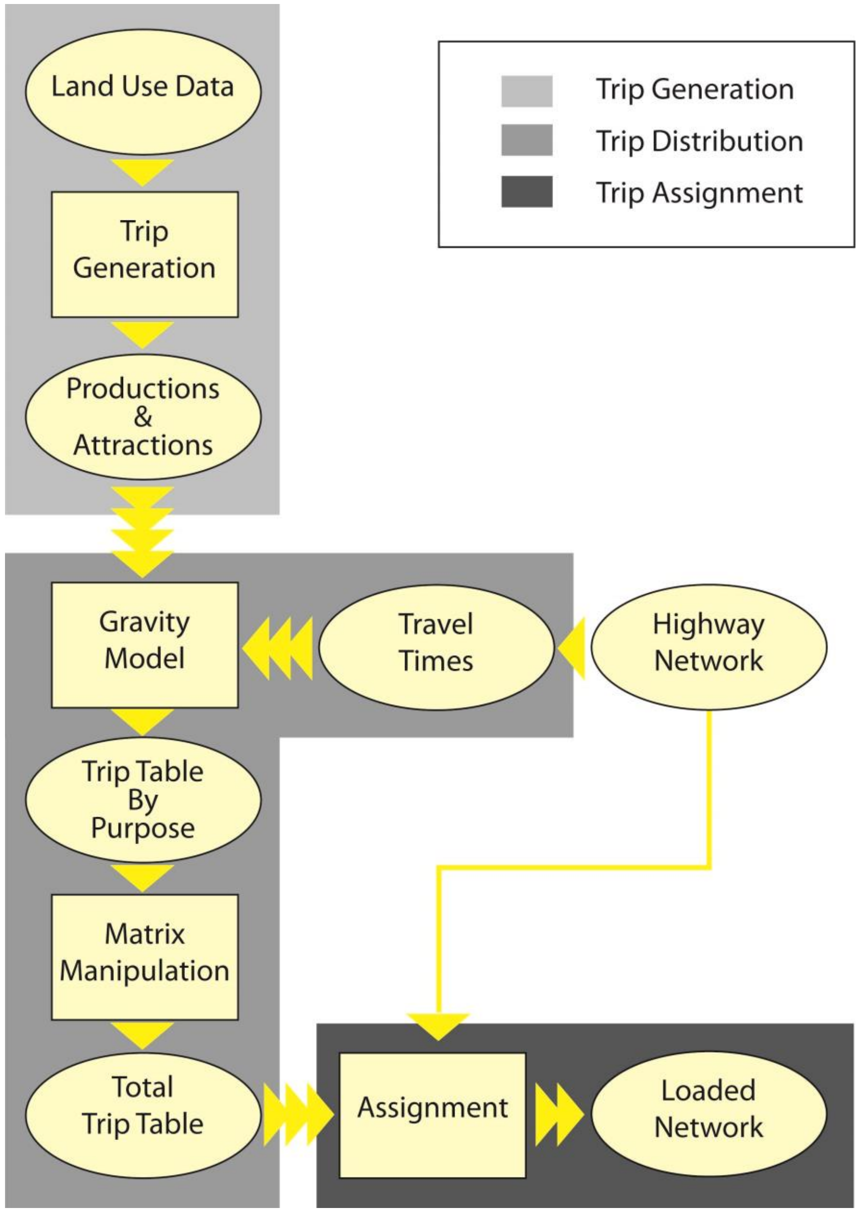

Figure 3-1: Regional Model and Georgetown Model Interaction

Demographic assumptions contained in the regional CAMPO model were further refined, and better allocated to reflect actual development as well as growth patterns within the Georgetown ETJ. City Staff worked with the Consultant Team to develop the most accurate demographic allocations for the model, which, in turn, will result in more accurate model trip predictions and roadway facility assignments. To further enhance the reliability of the model, potential route designations were evaluated to determine those roadways most commonly traveled.

3.1 Data Analysis and Forecasting

The TDM requires inputs such as regional socioeconomic and demographic data, roadway and land use characteristics, person and vehicle trip data, travel time and other impedance factors. A major portion of the data inputs came from the regional transportation model and network maintained by the CAMPO.

The CAMPO model and network contained population, household, and employment data for the CAMPO study area, which included the Georgetown region. To accommodate Georgetown needs, the consultant gathered demographic data from the City of Georgetown for Williamson County and maintained CAMPO's demographic data for the regional model and network. Next, the Traffic Analysis Zone (TAZ) structure was refined within Williamson County to include several new zones within the Georgetown study area; while the zones outside of Williamson County were aggregated to center the focus of the model analysis on the Georgetown study area. With the revised TAZ structure for the travel model, the population, household, and employment data was then assigned to the respective zones. A summary of the study area's demographic data is provided in **Table 3.1.**

Table 3.1: Summary of Demographics within Georgetown Study Area

Variable	2010	2030
Population (ETJ)	89,954	289,481
HH (Dwelling Units)	31,921	102,725
Employment	16,737	69,580

3.2 Traffic Analysis Zones

Traffic Analysis Zones (TAZs) define geographic areas (typically the size of census block groups), which are used to relate travel demand to socioeconomic characteristics. For each TAZ, population, dwelling units, total employment, retail employment, and school attendance were developed for the base year of 2010. The resulting traffic zone system is shown in **Figure 3-2**. There are a total of 60 internal zones (within the Georgetown study area) and 714 additional zones comprising of the entire CAMPO region. That totals 774 zones in the analysis area.

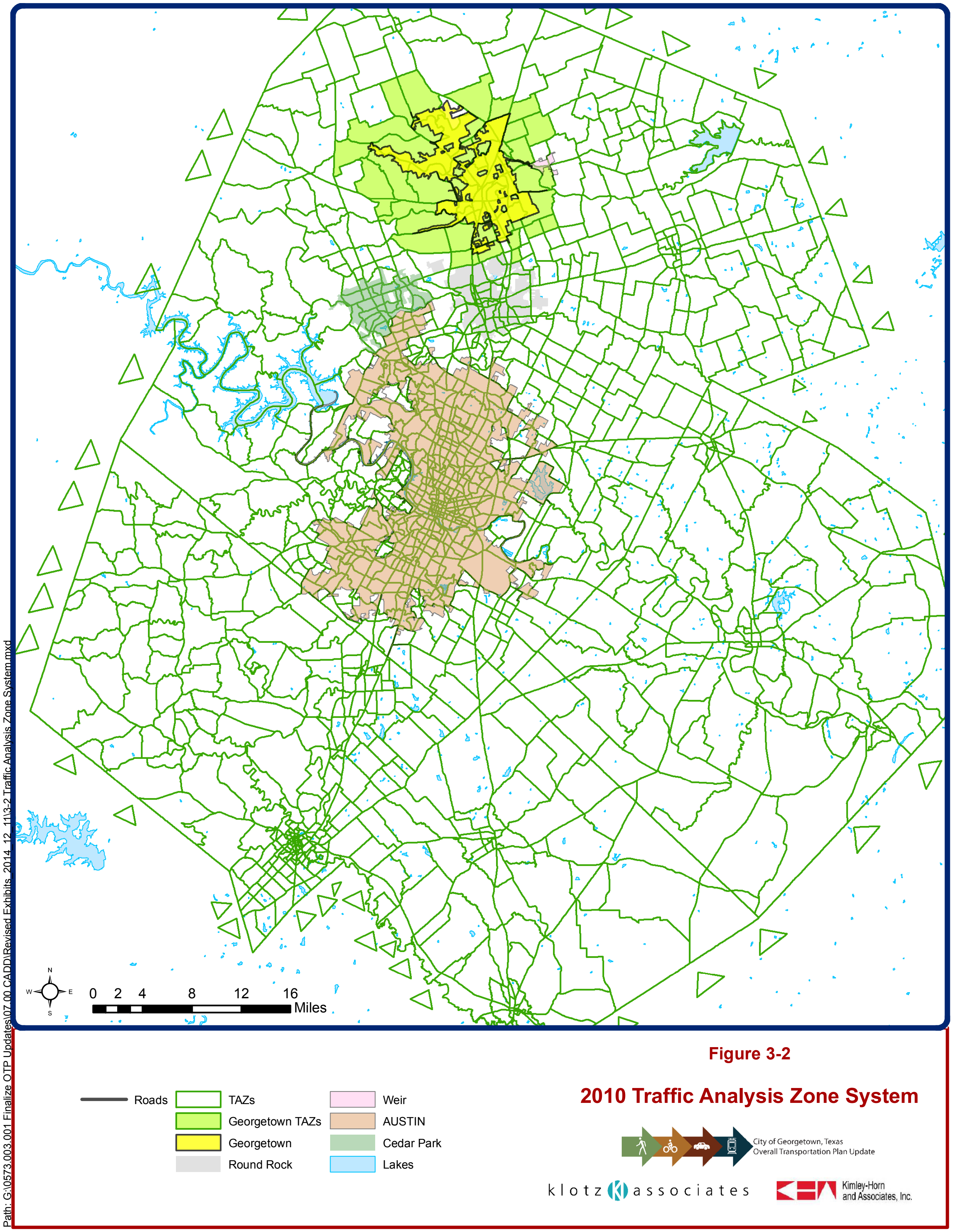
0 2 4 8 12 16
Miles
Roads
TAZs
Georgetown TAZs
Georgetown
Round Rock
Weir
AUSTIN
Cedar Park
Lakes
Figure 3-2
2010 Traffic Analysis Zone System
City of Georgetown, Texas
Overall Transportation Plan Update
klotz associates
Kimley-Horn and Associates, Inc.
Path: G:\0573.003.001 Finalize OTP Updates\07.00 CADD\Revised Exhibits_2014_12_11\3-2 Traffic Analysis Zone System.mxd

Figure 3-2

The next part of the Georgetown travel model development was the refinement of the CAMPO transportation network to provide more focus for the Georgetown study area. The CAMPO network contained all primary freeways, arterials, and some collector roadways for the Metropolitan Planning Organization (MPO) region. The network within the Georgetown study area was updated to include all freeways, major and minor arterials, collectors, and some regionally significant local roadways. The consultant then verified roadway lanes and posted speed limits within the Georgetown area. As a result, the Georgetown TDM provided a stronger focus for analyzing transportation conditions in their study area.

Ultimately, a travel model for the Georgetown study area was developed that contained an updated transportation network (ready for coding proposed transportation improvements) population, household and employment data based on CAMPO's and Georgetown's current and projected statistics. The consultant then conducted an initial travel model run, and utilized this run to verify that the model was replicating current year conditions (i.e. demographics, traffic volumes, and traffic speeds). The model did replicate current conditions within a particular confidence interval (described later in this chapter), and was validated to continue with forecasting future travel patterns.

3.3 Travel Demand Model Development Overview

The Georgetown TDM is comprised of a series of mathematical equations that simulate travel across the overall transportation network. This macroscopic process encompasses the four (4) primary steps taken to estimate travel demand from a given land use and transportation network as shown previously in **Figure 3-3**. A detailed description of this process can be found in the following section. In general, the four steps in this approach are as follows:

1. Trip generation is the estimation of the number of trip-ends for each zone within the model or the number of trip ends generated in (productions) and attracted to (attractions) each traffic analysis zone. Each trip on the regional highway system has both an origin and a destination. In this fashion, each trip is defined by two trip ends, one being a production and one being an attraction;

2. Trip distribution estimates the number of trips between each zone pair which is accomplished by a mathematical trip distribution (gravity) model. The gravity model is so named because its basic form follows the mathematical formula Isaac Newton developed to approximate the pull of gravity. In general terms, this model suggests that the frequency of trip interchange between zone pairs is directly related to the number of productions and attractions in each zone, and inversely related to the travel time between them;
3. Modal split provides the prediction of the number of trips made by each zone pair by different modes. Prior to the assignment process the combined 24-hour person-trip transit table is factored to produce 24-hour peak and off-peak person-trip tables and a peak 3-hour person-trip table; and
4. Traffic assignment evaluates the amount of travel (or number of trips) that is loaded onto the transportation network through path-building and is used to determine network performance. Transit Assignments may also be evaluated in this step and is used to evaluate a person's ability to walk between transit stops and trip origin/destinations. The resulting transit person-trip tables are then assigned to the appropriate off-peak or peak transit networks.

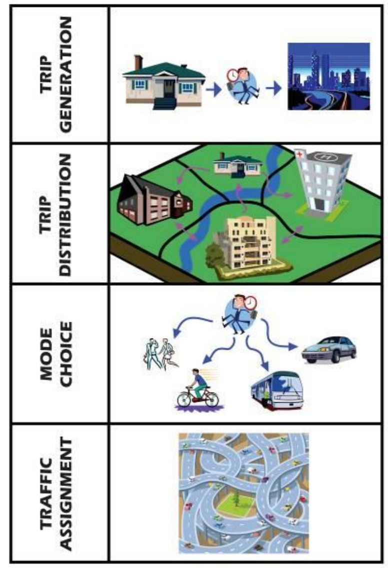

Figure 3-3: Transportation Modeling Process

3.4 Existing Roadway Network

The determination of zone-to-zone travel times, as utilized in the gravity model, and the assignment of traffic to a network of streets and highways, requires a simulation of the transportation network by describing roadway sections and intersections in numerical or digital terms. The City of Georgetown provided a digital city street network, which was integrated into the CAMPO network and provided the basis for the Georgetown network. Each intersection, referred to as a "node", is assigned a unique number and is connected to adjacent intersections. The section of street between nodes is referred to as a "link". Each link in a network system contains information regarding distance, speed, number of lanes, functional classification, and capacity characteristics. For each network link, posted speed limits and number of lanes was field verified. Traffic capacity for each link was calculated based on the number of lanes and functional classification.

In addition, traffic analysis zones were represented by "centroids", and the connection between TAZs and the road network are represented by special links called "centroid connectors." Total travel time between any pair of traffic zones consists of the sum of the travel times for all links traversed.

3.5 Existing Planning Data

Travel demand is greatly influenced by the pattern of development or land use in the study area. Changes in land use create new travel demand or modify existing patterns. A certain and measurable relationship exists between trip-making and land use and demographic data. Existing socioeconomic data, including population, number of dwelling units, total employment, retail employment, and school attendance, were used as input variables for the transportation model to estimate the number of trips produced by and attracted to the development within each traffic zone. Land uses, as they existed in each TAZ in the year 2000, is presented at the end of this chapter.

3.6 Trip Generation

Trip generation models estimate the number of trips that begin or end in a zone without identifying where the other ends of these trips are located, which is the function of the trip distribution model. Two types of trip generation models were developed: trip production models and trip attraction models. These models were stratified into three trip purposes: Homebased-Work, Homebased-Other, and Non-Homebased. For the two types of homebased trips, trip productions refer to the home end of the trip, and trip attractions refer to the non-home end of the trip. For non-homebased trips, trip productions and trip attractions refer to the origin and destination of the trip; respectively. Initial computer runs utilized multiple regression equations borrowed from travel demand models developed for other similar areas.

Socioeconomic data including population, dwelling units, total employment, retail employment, and school attendance were used as independent variables to compute production and attractions. However, modifications were made to the equations during the calibration process, described in more detail in a following section of this report.

3.7 Trip Distribution Models

Once the numbers of trips emanating from a zone were estimated by the trip production models, distribution models were developed to distribute them among the trip attractions in the other zones. A gravity model was used to distribute trips. This model employs two relationships, the first of which is indirect. The shorter the travel time to the destination zone, the greater the number of trips distributed to it from the origin zone. The second relationship is a direct one. The more attractions there are in a destination zone, the more trips distributed to it from the origin zone.

Relative distribution rates express the effect that spatial separation has on trip interchanges. These factors are measures of the impedance to inter-zonal travel due to the separation between zones. In effect, they measure the probability of trip making at each one-minute increment of travel time. In traditional travel demand models, traffic counts are collected at external stations to use in the calibration process. The traffic assignment values at the external stations in the Georgetown model used to calibrate the model are derived from the "super regional" model developed for the entire study area. A subarea analysis was conducted within TransCAD to identify which trips from the super-regional TDM were traveling to which TAZs in the Georgetown study area. This subarea analysis was used to generate the External-External (E-E), Internal-External (I-E), and External-Internal (E-I) splits in trips to and from the external stations.

3.8 Traffic Assignment

The traffic assignment model determines which route the trips take to get from the origin zone to the destination zone. Traffic assignments were made using an equilibrium capacity restraint technique. This technique consists of an iterative series of all-or nothing assignments where travel times are adjusted to reflect delays encountered due to congestion. As a result of these time adjustments, the loading of different iterations may be assigned to different paths. Each assignment load after the initial iteration is combined with the previous load to minimize the impedance of each trip until equilibrium is reached. In summary, equilibrium occurs when no trip can be made by an alternate path without increasing the total travel time of all trips on the network.

External travel consists of three types of trips, external-external, internal-external and external-internal. External-external trips are trips that pass through the entire study area without making a stop. External-internal and internal-external trips are those having one end of the trip inside of the study area and the other end outside of the study area. The trips that have one or more ends outside the study area are captured by traffic counts at the study area boundary. These trips are represented in the model at External Stations, which are simply locations where major highways enter or exit the study area.

Once all of the base models were developed, the models were validated using the following procedure:

1. Apply production and attraction models (including external-internal) to existing (2000) socioeconomic data to obtain zonal productions and attractions;
2. Distribute zonal productions and attractions with gravity model;
3. Add external-external trips to internal and external-internal trips resulting from gravity model distributions;
4. Assign total vehicle trips to base year (2000) network and compare model volumes to existing traffic counts;
5. Adjust trip production and attraction models if necessary;
6. Adjust external traffic models if necessary;
7. Adjust gravity model distribution rates if necessary;
8. Adjust highway network if necessary; and,
9. Repeat steps 1 through 8 until models are validated.

3.9 Additional Data Analysis and Forecasting

In order to produce greater detail from the base travel demand model, the team conducted additional post processing, using the 5D process. The 5D's – Density, Diversity, Design, and Distance/Destination – were developed from over 50 national case studies completed by MPOs, Council of Governments, and Federal agencies looking at the effects that these basic characteristics have on transit ridership. Specifically, a majority of these case studies are being aggregated in the NCHRP Report 08-61 "Travel Demand Forecasting: Parameters and Techniques." In the 5D mode choice each factor affects ridership according to elasticity factors. For instance the closer a person is to transit the more likely they are to ride transit. These factors are then used to determine travel times and used to estimate ridership. The process adds an additional detail to the person to vehicle trip conversion factor that exists within the Travel Demand Model. The process was developed as an additional layer to the person to vehicle trip conversion factor that exists within the Travel Demand Model since many of these elements are not accounted for in the current Travel Demand Model.

The TDM produces person trips for the entire region then distributes these trips amongst all travel modes (auto, transit, bicycle, and walk), based primarily on travel time and cost.

- *Distance/Destination*
  After each model run, predicted travel times were used to generate trip tables of constrained travel times (often called skims). These skims were used as input into a mode choice routine and compared with transit travel times. These travel times were used to evaluate the likelihood that individuals will select transit over a personal vehicle based on the total travel time of the trip. The distance factor also looks at the availability of alternative modes near the traveler's beginning or end point.

- *Density*
  Each demographic scenario contains household and employment density which plays a major role in the time it takes to get to a transit station. Less dense

developments often have fewer streets and larger lot sizes which translate to reduced access to transit.

- *Diversity*
  The diversity factor evaluates the balance of housing and jobs, in the vicinity of the traveler, as well as demographic inputs, such as the number of available vehicles per household, to determine if travelers are more or less likely to be transit-dependent.

- *Design*
  Developments that have a mix of uses (i.e., residential, employment, retail, etc.) within walking or biking distance from each other have the ability to reduce overall auto travel demand and often result in increased transit trips. Standard practice assumes that on average, a single household generates ten auto trips per day. Of those ten trips only two to four are home to work trips. In walkable, mixed use developments, some percentage of the remaining trips is satisfied by walking or biking – typically between 12 to 40 percent. The 5D process refines the mode choice development step by applying design characteristics (intensity/density, walkable/mixed use, etc.) to the outputs with factors based on national and localized data.

  The resulting person trip shift derived from the 5D process is then reintroduced into the Travel Demand Model as the "Transit Assignment". The Consultant team maintained consistent network coding procedures during the analysis Georgetown model.

3.10 Application of 5D Post Process

Figure 3-4 on the next page illustrates how the 5D process fits into the typical four step model process. Specifically the process begins by targeting the unassigned model-generated person trips. These trips have not yet been assigned to Walk, Transit, or Vehicle but are distributed by type. The process starts when the model selects areas that are within a walk, bicycle or drive shed (¼ mile, ½ mile, and 1 mile, respectively). The process then targets specific trip types in the model. For instance Home Based Work Trips tend to favor transit more than a Non Home Based Other trip type. Therefore the 5D process will assign/allocate/apportion [any of these] higher percentage of trips from the Home Base Work Trips to transit. The additional factor that 5D adds includes development. At this point in the process Traffic Analysis Zones are given increased transit capture rates based on Density, Diversity, Design, and Distance/Destinations.

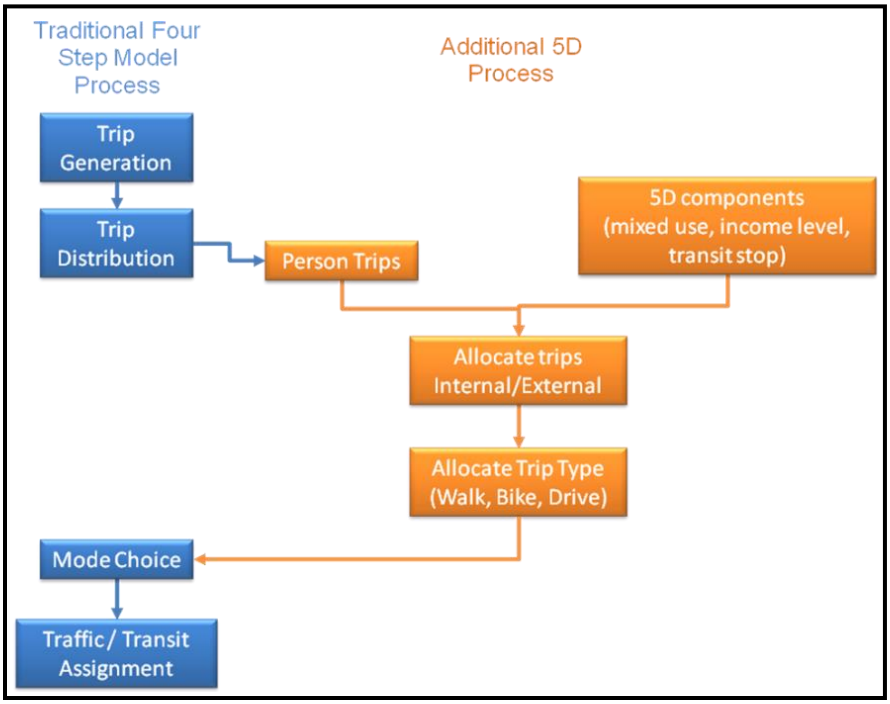

Figure 3-4: Application of 5D Post Process

3.11 Model Application and Refinement

Following the above procedure, the models were applied with existing transportation and planning data and compared to these counts. Comparisons of the first model application to existing counts indicated that the models were over estimating traffic on a total basis by only 13 percent. However, even though comparisons were good on a total basis, there were many individual comparisons that were unacceptable. Based on these results, it was obvious that some "fine tuning" of the models was required. These adjustments included some minor speed changes to various links on the network and trip generation modifications to account for special generators. Comparisons of observed and assigned traffic for the final model run are shown in **Table 3.2.** Overall, the estimated trips are within two percent of observed traffic.

The correlation coefficient, R2, is calculated from a linear regression analysis of assigned and observed volumes. An R2 value of 1.0 indicates a perfect correlation.

3.12 Summary and Conclusions

The comparison of estimated trips with observed traffic counts crossing various sections throughout the study area confirms that the model is in close agreement with actual Year 2010 conditions, and attests to the ability of the travel demand models to recreate Year 2010 travel patterns. Upon review of these results, it was concluded that the Georgetown models can be used to reliably forecast travel patterns.

Table 3.2: Comparison Of Observed Versus Assigned Traffic Volumes

Street Name	Link ID	AADT	Assigned Volumes
Westinghouse Rd	14,906	747	714
Parmer Lane/CR 178	14,068	2,435	2,004
US 79	9,106	2,941	2,441
CR 113	7,127	3,000	2,437
Brushy Creek Rd	6,443	4,012	3,646
Loop 332/FM 1889	6,528	4,229	2,421
CR 115/Sunrise Rd	7,124	4,398	3,592
FM 2243	7,008	4,531	3,690
Old Settler's Blvd	8,012	4,590	3,748
Brushy Creek Rd	6,882	4,640	7,120
SH 95	13,961	6,265	6,287
SH 29	18,373	6,500	5,334
SH 29	17,410	7,375	6,023
Lakeline Rd	6,789	7,422	6,637
McNeil Dr	7,167	8,530	17,813
Louis Henna Blvd	8,214	9,085	7,691
FM 973	6,264	9,626	9,974
Cypress Creek	6,790	10,108	10,593
FM 2768/Anderson Mill Rd	12,876	10,855	13,208
FM 2338	17,648	10,900	7,697
FM 734/Parmer Ln	10,137	11,759	9,646
Pflugerville Rd	8,197	12,156	25,684
FM 734/Parmer Ln	10,103	19,723	16,950
US 183	7,271	19,917	19,991
FM 1431	6,565	19,971	26,583
FM 1431	6,445	21,651	19,342
IH 35	8,578	24,350	24,638
McNeil Dr	10,084	33,831	34,005
US 79	7,762	35,422	29,159
FM 1325	11,986	50,734	41,266
IH 35 N	4,834	62,071	51,016
IH 35	3,712	107,890	94,081
IH 35	3,860	111,516	111,057
TOTAL		**2,037,749**	**2,000,724**
Differential Between AADT and Assigned		**37,025**	
Percent Differential		1.81 %	