Chapter 6

TRAVEL DEMAND MODEL

As a component of the Teller County Transportation Plan development, a computerized travel demand model was developed. The model was utilized for development of the Transportation Plan and will have future utility for examining transportation issues following development of the plan.

To take advantage of the County’s transition to Geographic Information System (GIS) infrastructure inventory and management, the TransCAD platform was selected for use in Teller County. As one of the few models developed to operate entirely in a GIS environment, this platform is ideally suited for the County and the needs of the transportation plan.

Development of a travel demand model can be fairly simplistic and straightforward, or very complex, depending on the anticipated use and required level of accuracy required. While more complex models can deliver more accurate results, the more detailed output requires significantly more detailed input and complex algorithms for analysis. The level of detail used was tailored to the anticipated application of model and use of results. The detail of the model development and output was also tempered by the reality of the available input data, since resources were not available to conduct detailed travel surveys or to develop detailed socio-economic data.

This document details development of the TransCAD travel demand model for Teller County. Developed to provide information to, and take advantage of the data available through the developing County GIS system, the model developed for this planning effort is flexible. The model procedures developed may be executed easily and, with continuous updates to input data, will continue to remain “current”. Should more detailed or accurate input data become available, model procedures can easily be modified to take advantage of the added level of detail. Should a comprehensive travel survey be conducted within Teller County, model calibration can be easily enhanced as well.

Each of the traditional four-step modeling processes (Trip Generation, Trip Distribution, Mode Split, and Assignment) is described in the following sections. Each section describes the data required, the methodology utilized, and summarizes the results. Separate sections provide suggestions for model enhancements and provide a “users guide” to operation of the model.

Model Development

The two main components of a travel demand model are the input data and the processes applied to the data to achieve desired results. This section documents and details the data and sources utilized to build the framework for the Teller County Travel Model (TCTM).

Teller County recently embarked on a process to manage the County infrastructure in a Geographic Information System (GIS) database. This system provides a geo-referenced “picture” of physical and spatial entities linked to a descriptive database. Since the County had developed extensive GIS coverage of roadways within the County, it was used as a starting point for
The development of the travel demand model network. The County’s GIS coverage was an ideal selection for use with travel demand modeling.

Teller County has conducted studies to identify and project socio-economic conditions throughout the County. Most recently a study divided the County into 27 “growth zones” and quantified data such as population and households within each growth zone. The study also projected future socio-economic conditions within each growth zone out to the year 2020. This database was utilized as a starting point to develop a detailed socio-economic database for use with the travel demand modeling procedures. The growth zones previously developed for Teller County are shown in Figure 11.

Teller County maintains thorough traffic count data for County roads. With data provided by Teller County staff, traffic counts (daily totals) were available for 346 separate County road segments. In addition to County facilities, traffic counts were obtained for state highways from the Colorado Department of Transportation (CDOT) web site databases. In total, traffic count data was available for 370 roadway segments.

**Land Use Data**

Socio-economic, or demographic, data is an important input to the travel demand modeling process. The need for travel is generated primarily by the demographic data. Necessary data varies depending on the modeling methods employed, but generally consists of estimates of population, households, retail and non-retail employment. Detailed data, such as average household income, the number of autos per household, etc. are desirable since they allow for more detailed model processes but are not required.

In addition to the level of detail with respect to the type of data available, level of detail for the spatial (geographic) distribution is the data is also important. Since travel models represent geographic areas that generate travel demand as nodes, a finer node structure (more nodes) can support a more refined network structure. The raw demographic data and projections provided by Teller County were based in a geographic structure that divided the County into 27 “growth areas”, or zones. Comparison of the demographic zones with the roadway network of collector or higher classified roads indicated that a more refined zone structure would be required.

The existing growth zones were utilized as a starting point, retaining their boundaries while developing a zone structure suitable for travel demand modeling purposes. Through subdividing these growth areas, a structure of 65 traffic analysis zones (TAZ) was created. Traffic zones were structured to represent distinct areas of development that were tied to the transportation system at one or two logical points. Major highways and roads, geographic features, political boundaries, and the roadway network were all considered during the process of developing the TAZ structure. The TAZ structure for the Teller County model is shown in Figure 12.
Figure 11 – Teller County Growth Zones

Teller County Growth Zones
Map Layers
- Roads
- County
- Growth Zones

Roadway Functional Class
- US/State Highways
- Principal Arterial Road
- Minor Arterial Road
- Collector Road
- Local Road
- Not County Maintained

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Figure 12 – Teller County Model Traffic Analysis Zone Structure

Teller County TAZ Map Layers

Roads
- County
- Growth Zones

Roadway Functional Class
- US/State Highways
- Principal Arterial Road
- Minor Arterial Road
- Collector Road
- Local Road
- Not County Maintained

Miles

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THK Associates, Inc. was retained by TranSystems Corporation to assist with the preparation of historical employment, population, and household data and to prepare their respective projections over the next twenty years. The purpose of this research is to provide estimates of growth by Traffic Analysis Zone (TAZ) in the Teller County area. The data were used in the traffic model to estimate future roadway/infrastructure needs in the County.

- Review of census data for Teller County and its three census tracts;
- Review of census data on a block level;
- Review of data supplied by the Teller County Planning Office, the Pikes Peak Area Council of Governments (PPACG), the State demographer, and previously compiled growth projections for employment, population, and households made by THK Associates, Inc. in 2000 utilized in master planning efforts for the Cripple Creek and Victor areas;
- Inspection of aerial photos and other road maps of Teller County;
- Physical inspection of the Teller County area to confirm and identify major concentrations of employment, population, and households;
- Research of any major announcements of expansion in the area by major employers, and;
- Analysis of growth trends by TAZ and projections of future growth by TAZ

**Baseline Data**

This research was complicated by the lack of reliable census data. Teller County has only three census tracts, while 65 different areas need to be researched for the traffic model. In addition, data on a block level has not been maintained in a manner that allows for a block-by-block analysis of data that would match, or could be compared to, individual Traffic Analysis Zones.

After review of the available data sources, THK was most comfortable with baseline data for the TAZs supplied by The Pikes Peak Area Council of Governments. This was the only data source that outlined employment, population, and household data by TAZ for 1990 and 2000.

**Analysis**

With the 1990 and 2000 baseline data (employment, population, and households) in place for the 65 TAZs, growth rates were then analyzed for each TAZ in terms of annual rate of growth and percentage share of historical growth. The rates of growth and share of growth were then applied to each TAZ to develop the projected increase in employment, population, and households over the next twenty years. This analysis was presented previously in the master plan prepared for the Victor/Cripple Creek area. These projections of growth were presented in numerous public hearings and reviewed by a number of private and public organizations.

The projected growth in Teller County was then distributed by TAZ on a percentage basis for “clustered” TAZs. For example, six of the TAZs that make up the Woodland Park area, three TAZs that make up the Victor/Cripple Creek area, etc. were analyzed as groups to distribute projected growth. The “clustered” areas were then distributed among the different specific TAZs.

Next, the annual rates of growth since 1990 for employment, population, and households were applied to each TAZ, providing a second projection for growth of each TAZ. The growth projections for each TAZ were then verified by a physical inspection of the Teller
County area, a review of aerial photos and current road maps of Teller County, and knowledge of where major employers, major residential subdivisions, etc., were located.

**Summary**

After a detailed review of the collected material, analysis of the data, evaluation of the results of different growth projections, and response to comments from various project team members, the projections of employment, population, and households for each TAZ were finalized. The results are presented in Appendix B.

It should be noted that the projections of employment, population, and household growth include employees in office buildings, mining operations, public buildings (libraries, schools, post offices, etc.) and persons that will reside in housing units that meet future housing needs. Each specific development project that could be developed over the next twenty years, was not identified. Also of note is the difference between a household and a housing unit. A household is a permanently occupied or primary residence. A housing unit is the physical structure, regardless of occupancy, or whether or not it is vacant, permanent, or seasonal. This is important when comparing other estimates of household or housing unit growth to the data presented in this technical report.

Perhaps even more important, for travel demand modeling purposes, is the number of occupied households, since vacant households do not produce or attract travel demands. To determine the number of occupied households, the census block group data were utilized. This data source contains both the total number of existing households, the number of existing occupied households, as well as future projections for the same data. For travel demand modeling purposes, the number of occupied households was estimated for each TAZ based on the census block group level data.

After population, household and total employment data were projected for each TAZ, a separate effort was launched to determine the amount of retail vs. non-retail employment. Teller County staff was consulted to determine the employment split for TAZs with over 150 total employment. Even after specific scrutiny, it was noted, with only a few exceptions, that 80% of employment in the County could be categorized as retail. The remainder was classified as non-retail. Except where more accurate data was available, the 80/20 split of total employment to retail/non-retail was utilized to characterize employment for modeling purposes.

**Model Network Development**

Following modification of the GIS roadway coverage to correct spatial and database errors, the coverage was modified to allow it to be used in the transportation planning process as well for the model network. Initial modifications consisted of examining the existing functional classification system and making modifications as appropriate (discussed in Chapter 5). Traffic count data were also coded to appropriate roadway links, and data fields were added to indicate surface type, surface condition, and roadway geometric ratings.

Initial modifications consisted of creating additional database attributes to enable identification of roadway characteristics important to the modeling process. Fields were added to enable coding of a “flag” to identify which roadway segments would be utilized as network links in the travel demand model. With few exceptions, all roadways with a functional classification of Collector or higher were initially coded as network links.
In addition to identifying which roadways would be used for the travel model network, roadway links were coded with the new variables described below:

- An area type numerical code to distinguish rural from urban roads
- A link type numerical code to identify functional class and area type, as well to distinguish between model roadways and zone centroid connectors
- Directional daily traffic counts
- A speed code to indicate average travel speeds
- A time field containing the link travel time using the link length and speed fields

After the GIS database was updated to include the new data fields which were added for modeling, the database was tested for connectivity and compatibility with the modeling process. Through this process unconnected links were discovered and corrected, and links without necessary data were updated. Lastly, a connection between the TAZ layer centroids and the travel model network was made. Using special links called centroid connectors, each TAZ was connected to the travel model network at one or more locations to represent how trips generated at each TAZ reach the roadway network. The roadway network used for travel demand modeling, as well as the zone connectors is shown in Figure 13.

For more detail on the model development, including trip generation and production, trip distribution, traffic assignment, and calibration, please refer to Technical Report 3 – Travel Demand Model. A copy of this report can be found in the Technical Notebook provided to the County as a part of this effort.
Figure 13 – Teller County Model Network Roads

Model Network Roads
Map Layers
Endpoints
Traffic Analysis Zones
Rocks

Traffic Analysis Zones
Zone Centroid
External Station

Network Link Types
Model Network
Centroid Connectors

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Future Travel Demand Modeling

With the procedures utilized for the calibrated base year model, modeling of future conditions can then be performed with a reasonable expectation of useful results. Modeling of future conditions utilizes projected land use and roadway characteristics with modeling procedures established for the calibrated base year condition.

For future conditions modeling in Teller County, the existing roadway network was used since no significant improvements to the roadway network are anticipated. Although improvements to roadway capacity may be made between now and the future modeling horizon (year 2020), no significant new roadway links are anticipated to be added to the network. Since roadway capacity is not utilized in the model assignment process, the existing roadway network is used for modeling of future conditions.

Future growth in land use throughout Teller County will change (increase) the resulting travel demand. In addition, growth in travel demands outside the modeling area (Teller County) will also impact traffic volume on County roads.

For growth in external traffic, traffic count history at external stations was examined to define a growth trend. The examination showed that a growth factor of about 1.5 can be expected for traffic on US24 (CDOT 20-year growth factor). This same growth factor was conservatively applied to other external stations as well for use with future modeling conditions.

Without any change in the trip generation rate, the future projections of households and employment were used in the Trip Generation process to produce future (year 2020) person trip productions and attractions for the 65 TAzs of the Teller County model.

Executing model procedures utilized for the calibrated base-year model, future growth is expected to be responsible for an average 72% increase in traffic volume on the County roadways and highways. Future conditions modeling showed an expected 104% increase in collector road traffic, a 97% increase in minor arterial traffic, and a 68% increase in traffic on principal arterial facilities.

Future Traffic Volume Projections

Reporting projected year 2020 traffic on County roadways involves more than just using the year 2020 assignment results. Although the base year model was calibrated to acceptable levels of accuracy on a collective basis, assignment errors on individual roadway links can vary significantly. To report future traffic projections, an adjustment procedure was employed that considers the errors preset with the base year model and adjusts the future year assignment accordingly to produce a more reliable estimate of future traffic projections. The adjustment procedure used was one recommended by the National Council for Highway Research Projects (NCHRP) Report #255. The procedure considers both the absolute difference and percentile difference between base year assignment and base year count at each location where the procedure is employed.

To produce traffic volume projections for expected year 2020 conditions, the procedure was performed for every location where there was a count of over 100 vehicles per day on a facility classified as a collector or above that was also part of the model network. A total of 104 roadway links met this criterion and were subject to the adjustment procedure. Of the 104 links where adjustments were performed, 88 links were deemed
to have produced reliable results. The remaining 16 links exhibited base year assignment errors of significant magnitude that adjustments were deemed unreliable and were not utilized. The adjustment process is documented in Technical Report 3. Resulting future traffic projections are shown on the map included in this report.
Users Guide & Procedures

As a part of this study, it was important to provide the County with a model that could be updated and used in the future. In order to assist staff, or any other group in the future, a detailed Users Guide and Procedures was developed. This detailed guide is found in Technical Report 3 – Travel Demand Model, a copy of which is contained in the Technical Notebook provided the County as a part of this effort.

Model Maintenance

One of the more difficult, time consuming, and hence costly aspects of travel demand models is maintenance of model input data. Communities like Teller County are constantly changing. Growth in terms of households, population and employment is accompanied with improvements to the transportation system. A model developed today may not be representative or useful in the near future as a result of these changes.

The use of a GIS-based model overcomes many of the data maintenance chores since the data used by the model is typically maintained as part of the on-going GIS system data maintenance. Maintenance of the GIS system data used for the model is discussed separately in the following sections for the roadway and land use data sets.

Roadway Network

The model network is only a portion of the total roadway inventory maintained by the GIS system in Teller County. Specific roadways used for travel demand modeling are indicated by a “1” in the NET field of the roadway network database. Since the model uses travel time to perform trip distribution and assignment, change to roadways that affect their travel time need to be noted, and the value in the “TIME” field updated accordingly (travel time over the link, in minutes). Other maintenance activities generally associated with the GIS roadway coverage (minor corrections to geographic location, changes to surface type, etc.) should not affect the use of the roadway coverage for modeling purposes.

Land Use Data

The land use data utilized by the travel demand model is probably the most rapidly changing element, with occupied households and retail & non-retail employment being the most important factors for modeling. Up to this point, the County GIS system has not tracked demographics. Previous work efforts to forecast growth throughout the County focused on the 27 “Growth Zones”. With development of the travel demand model, the 27 growth zones have been further subdivided into 65 traffic analysis zones. Maintenance of model input demographics must now take place at the TAZ level, or additional work will be required to update TAZ-level demographics for future modeling.

Depending on the data the County anticipates tracking for housing, population an employment, a more refined subdivision of land use may be employed by the County for GIS system purposes. Frequently, municipalities track parcel information with GIS systems. Tracking households and employment at this level of detail can fit very nicely with model data maintenance. If housing and employment data is tracked at the parcel level, developing TAZ level totals is only a matter of overlaying the TAZ area structure on the parcel structure and extracting data totals for each TAZ, a function easily accomplished by the ArcView GIS system used by Teller County.
**Suggested Enhancements**

The TransCAD travel demand model documented in this report was developed for the one-time use in support of the Transportation Plan development. The model will, however, have continued utility and can be utilized for analysis of other transportation issues in the future. Contained in this section are enhancements that are suggested for future implementation. These enhancements will make the model more accurate, give it greater flexibility for transportation system analysis, and make it easier to use.

**Batch Processing**

Batch processing is a method of executing specific portions of the model procedures without the need for repetitious input of file names, coefficients, etc. Under batch processing, for instance, the gamma coefficients for gravity model evaluation would not need to be input each and every time a distribution is run. TransCAD supports full customization of user add-ins to support batch processing. Under full batch processing it would be feasible to execute the entire model process with only five or six user inputs or commands. Even after implementation, the user could bypass batch processing to experiment with different model procedures or coefficients, if desired.

**Travel Survey Data**

Many of the factors, coefficients, and variables used with this Teller County model were selected based on national averages or based on traditional modeling in the Colorado Front Range. While these elements may not be accurate for Teller County, they were the best available information at the time this model was developed. Travel surveys conducted for Teller County would reveal details of trip making within the County that could be utilized to further refine the model and make it more accurate. For instance, surveys of travel behavior would enable to refine the trip distribution, more accurately model auto occupancies, and even refine estimates of I-E and E-E trips.

**Network Refinements**

Link capacity was not utilized as an input variable since this model used all-or-nothing assignment on a daily basis. While this seems to be sufficient for the model at this time, further growth and the resulting roadway congestion may suggest the use of capacity restrained assignment procedures. For these procedures to be implemented, information about roadway capacities needs to be developed as well as information about the portions of daily trips made during each peak period for each trip purpose. Armed with this information, a time-of-day model could be developed for each peak period to allow closer scrutiny of travel demands and system constraints.

**Land Use Data Refinements**

Accurate land use data is arguably the most important input to any travel demand model. Only with accurate and current land use information can the remainder of the model processes be expected to be accurate. Land use data forms the very foundation for all modeling elements that ensue. Collecting and maintaining accurate land use data can be tedious and expensive. The US Census Department can provide data to help. If requested, the US Census Department will develop census data for population and employment at the TAZ level, and can even develop journey-to-work data at the TAZ level. This data is useful not only as input to model functions, but also as a yard stick to refine model calibration.