APPENDIX C

TRANSPORTATION MODELING AND ANALYSIS TOOLS

The WFRC / MAG Travel Demand Model ("the model") is an integrated land-use, transportation, and air quality model. The model estimates the travel patterns of people, based on the demographic characteristics, where they live and work as well as on the transportation facilities available to them. The model forecasts where and by what mode (e.g. single occupant autos, local bus, light rail, etc.) people are likely to travel and assigns these trips onto facilities that represent the best route for each particular trip. Travel model output is used to evaluate transportation corridors where the future travel demand is likely to exceed the capacity of the facilities in the corridor, to identify and assess projects that meet the travel demand, and to analyze the air quality impacts of the transportation system.

The model includes several advanced features that place it on the cutting edge of improved modeling methods required to meet the needs of SAFETEA-LU and the Clean Air Act Amendments of 1990. In addition, several features recommended by the Travel Model Improvement Program of the US Department of Transportation, the Federal Highway Administration (FHWA), the Federal Transit Administration (FTA) and the Environmental Protection Agency (EPA) are incorporated into the model. The WFRC uses the model to perform comprehensive regional transportation analyses, and to evaluate various transportation and traffic impacts. Some of the most useful model outputs include:

- Origin-Destination flows
- Directional link vehicle volumes
- Vehicular travel times and speeds
- Transit ridership numbers

Model Coverage

The models cover all of the developable area of Utah, Salt Lake, Davis and Weber counties. This excludes the canyons and the mountains to the east of the urbanized areas**.** In these cases the population in the areas that are outside of the travel model coverage is relatively small and is separated from the urban area by some distance. The upper or eastern portion of Weber County represents a significant percentage of the area, but its mountainous character and limited access make it unlikely that it will need to be incorporated into the modeled area in the near future.

There is significant commuting from both Summit County (Park City) and Tooele County from the perspective of the populations of each of these outlying counties. The population of Summit County was approximately 37,000 in 2009 and Tooele County was approximately 58,000. In both cases the population centers are separated by distances of more than 15 miles from the urban portions of Salt Lake County. At this time the commuting levels are of a magnitude that treating the flows as an external-internal flow, as the current models do, does not compromise the abilities of the urban models to a significant degree.

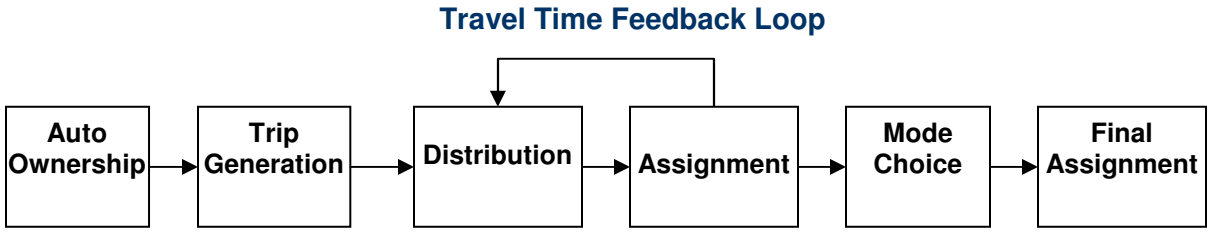
Model Structure

System-wide transportation planning models are typically based on a four-step modeling process: trip generation, trip distribution, mode split, and trip assignment. The WFRC / MAG model incorporates these steps and adds an auto ownership model that is sensitive to urban design variables.

The model has a feedback loop between trip distribution and traffic assignment, which is a process that ensures consistency between travel congestion and times that influence trip distribution patterns and are also an outcome of trip assignment. Travel time, or more generally speaking accessibility, is calculated based on outputs from the assignment model, but also is an important determinant of trip distribution and mode split. Therefore it is customary to iterate these three models in order to reach a convergent solution as shown in Figure C-1.

FIGURE C-1

CONCEPTUAL OVERVIEW OF THE WFRC / MAG MODEL



At the start of a full model run, the auto ownership model estimates household auto ownership levels and then the trip generation model uses land use data and auto ownership to calculate trip ends at the Traffic Analysis Zone (TAZ) level. These trip ends are then paired into origins and destinations in the distribution model. In the mode split model, a mode of travel is selected for each trip. Trips are assigned to the highway network in the assignment model. The travel time feedback loop in the model is accomplished prior to mode choice by converting person trips to vehicle trips based on observed data.

Model Components

Although considered a five-step process as stated above, the model is actually comprised of several steps and each step is programmed separately. These steps include, but are not limited to:

- **Land use allocation model** allocates future land use (i.e. housing and jobs) based on accessibility, availability of land (through physical constraints and zoning), and location of existing land uses. The land use model is typically run to suggest a land use forecast for the modeling system.

- **Auto ownership model** estimates the likelihood of each household in the region owning 0, 1, 2, 3+ cars. Auto ownership is a function of characteristics of the household and where the household is located. Auto ownership and availability is a strong predictor of trip making and mode choice behavior.

- **Trip generation model** calculates the number of person trips generated within each TAZ. The trip generation model parameters are developed from travel surveys collected in 1993 and 2001. The number of trips to and from a place is a function of the amount and types of land-use activity within the zone.

- **Trip distribution model** pairs the origins and destinations for each zone for each of the trip purposes. Trip generation estimates the number of trips to or from each TAZ, and the model completes the trip by describing which trip origins are linked with which trip destinations. The result of this is a person trip matrix for each trip type. Trip distribution links trip-ends of the

same type based primarily on the spatial separation of different land-uses and observed sensitivities to trip length. One output of trip distribution is the person trip table for home to work that can be compared to the "Journey-to-Work" data provided by the Bureau of the Census.

- **Highway / transit skim builder** finds the best available travel path via each of the travel modes modeled. Several modes are explicitly modeled, including auto, transit modes (local bus, bus rapid transit, light rail, commuter rail) and non-motorized modes. Skims are reasonable approximations of the travel time and cost between all pairs of TAZs, and skims are described for each travel mode. The path-finding algorithms are calibrated based on observed travel paths and observed relationships between volumes and congested speeds.

- **Mode split model** calculates which mode the person trips are likely to take based on availability and mode-specific parameters (e.g. time, cost, transit frequency). Mode split provides a breakdown of person trips by mode both for captive riders (people without automobiles) and for the total population. The mode split model is developed based on observed data on mode preferences and what those preferences imply about sensitivities to mode attributes.

- **Vehicle assignment** model locates the "best" routes between each origin / destination pair and assigns the vehicle trips to the highway network. Important outputs of this module include number of vehicles on each roadway segment by time period and turning movements at intersections. Several other pieces of data can be extracted, including operating speeds, travel times, Vehicle Miles Traveled (VMT), Vehicle Hours of Travel (VHT), and Volume to Capacity (v/c) on links and at intersections. In addition, one can configure the vehicle assignment to save all the vehicle trips that use a single link in either direction (select link analysis) or all the vehicle trips that originate or are destined for a zone (select zone analysis).

- **Transit assignment** uses the transit trip table output from mode split and assigns person trips using transit to the appropriate transit route. This provides a means of viewing transit ridership graphically and understanding the relative effectiveness of different segments of the transit network.

- **Model output** is summarized automatically by the model, including regional statistics (e.g. VMT, VHT, transit shares and trip lengths), corridor and segment performance statistics (e.g. delay, volume, and ridership), district and county-level trip flows, mobile source emissions model (MOBILE) 6 inputs, and calibration statistics.

Network Structure

For modeling purposes, the road network includes all facilities functionally designated as collector or above. There are approximately 27,000 road links in the network. Map C-1 shows a portion of the travel model highway network covering north Davis County.

TAZ Structure

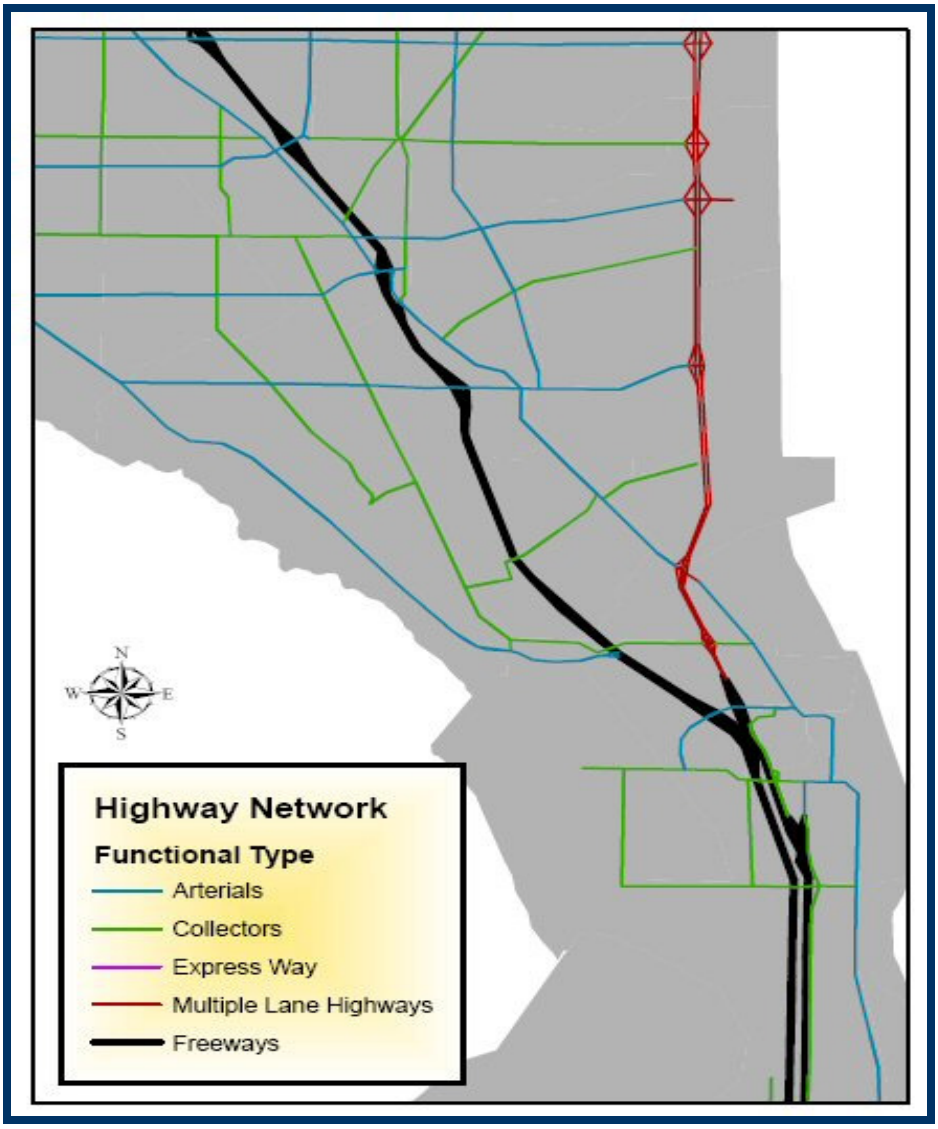
The WFRC / MAG model is a zonal-based forecasting tool, modeling travel between TAZs. Map C-2 shows an example of the TAZ structure of the model. TAZs are mutually exclusive (i.e. they don't overlap) and collectively exhaustive (they cover the entire model region). There are 2,230 internal TAZs and 24 external TAZs in the regional model. Land-use and socioeconomic data are summarized within this spatial framework and travel is estimated between the TAZs.

Model Calibration

The model is calibrated to reasonably represent 2007 “base year” travel conditions and patterns, a process in which model output is checked or "validated" against real-world data. Trip rates, transit ridership and highway volumes are examples of the type of model outputs that are validated. When the model results do not match the base-year values within an acceptable tolerance, parameters are adjusted until the model is acceptable. For future forecast years, the model output is reviewed for "reasonableness" to validate model results and to assess model sensitivities.

MAP C-1

TRAVEL MODEL HIGHWAY NETWORK



MAP C-2

MODEL GEOGRAPHY AND TAZ STRUCTURE