The Travel Model Improvement Program

Summary Report

Arizona Department of Transportation (ADOT)

Travel Modeling Peer Review

Phoenix, Arizona

November 18, 2011

Helping Agencies Improve Their Planning Analysis Techniques

TMIP

Travel Model Improvement Program

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1. Introduction

1.1 Disclaimer

The views expressed in this document do not represent the opinions of FHWA and do not constitute an endorsement, recommendation or specification by FHWA. The document is based solely on the discussions that took place during the peer review sessions and supporting technical documentation provided by the Arizona Department of Transportation (ADOT).

1.2 Acknowledgements

The FHWA wishes to acknowledge and thank the peer review panel members for volunteering their time to participate in the peer review of the Arizona Statewide Travel Demand Model (AZTDM) and for sharing their valuable experience.

The Peer Review Panel Members were:

- Chad Baker, Chief of Statewide Modeling, California Department of Transportation
- Jim Benson, Senior Research Engineer, Texas Transportation Institute
- Fred Ducca, Director of Transportation Policy Research Group, University of Maryland
- Karen Faussett, Statewide Model Specialist, Michigan Department of Transportation
- Greg Giaimo, Manager of Travel Demand Modeling, Ohio Department of Transportation

Brief biographies for each of the peer review panel members are presented in Appendix C.

1.3 Report Purpose

This report summarizes the results of a peer review of the AZTDM. The peer review was supported by the Travel Model Improvement Program (TMIP), which is sponsored by FHWA. The peer review of a travel model can serve multiple purposes, including identification of model deficiencies, recommendations for model enhancements, and guidance on model applications. Given the increasing complexities of travel demand forecasting practice and the growing demands by decision-makers for information about policy alternatives, it is essential that travel forecasting practitioners have the opportunity to share experiences and insights. The TMIP-supported peer review provides a forum for this knowledge exchange.

1.4 Report Organization

This report is organized into the following sections:

- *Overview of the AZTDM modeled region and ADOT's roles and responsibilities for travel demand forecasting* – this section gives an introduction to the demographics, land use and transportation characteristics of the region, ADOT's planning responsibilities, and their goals for the peer review.
- *Overview of modeling at ADOT*– this section provides a brief historical context of travel modeling at ADOT, including past and current model versions and ADOT's current model improvement program.
- *Discussion of the AZTDM* – this section provides a summary of the topics posed by ADOT during the peer review for which ADOT sought specific insight and guidance from the peer review panel.

- *Peer review panel response* – this section provides the peer review panel's comments and recommendations to ADOT.

In addition, the report includes four appendices:

- *Appendix A* – list of peer review participants
- *Appendix B* – peer review meeting agenda
- *Appendix C* – biographies for each of the peer review panel members
- *Appendix D* – summary of the current AZTDM

2. ADOT Overview

2.1 Regional Characteristics

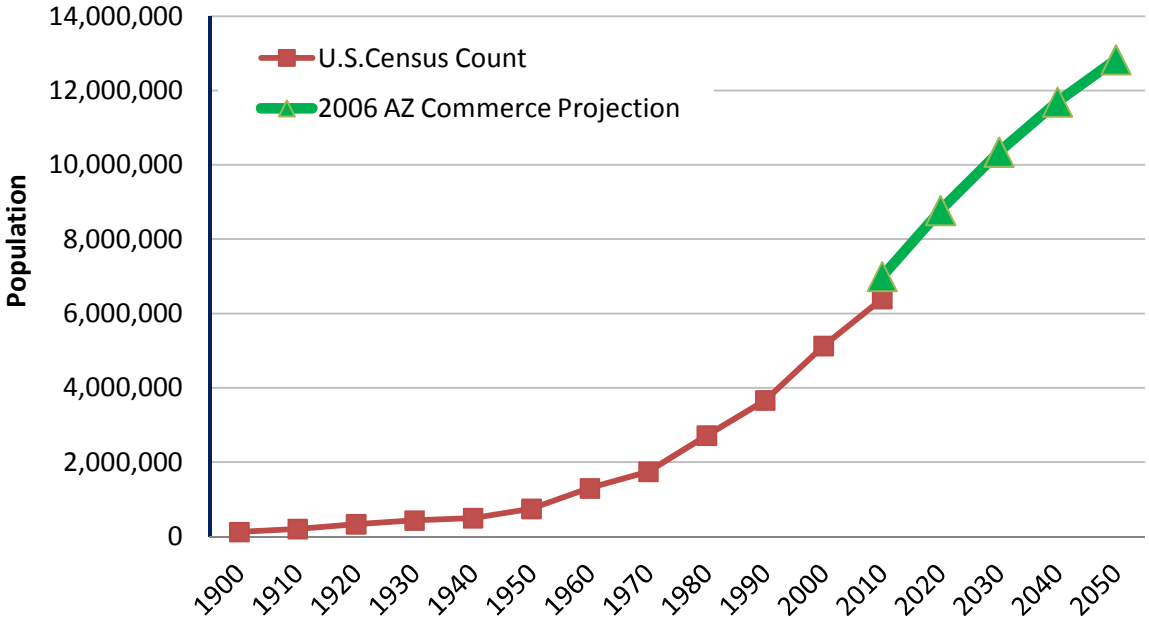
This section gives a brief description of the key characteristics of the AZTDM model space provided by ADOT for this peer review.

Socioeconomics

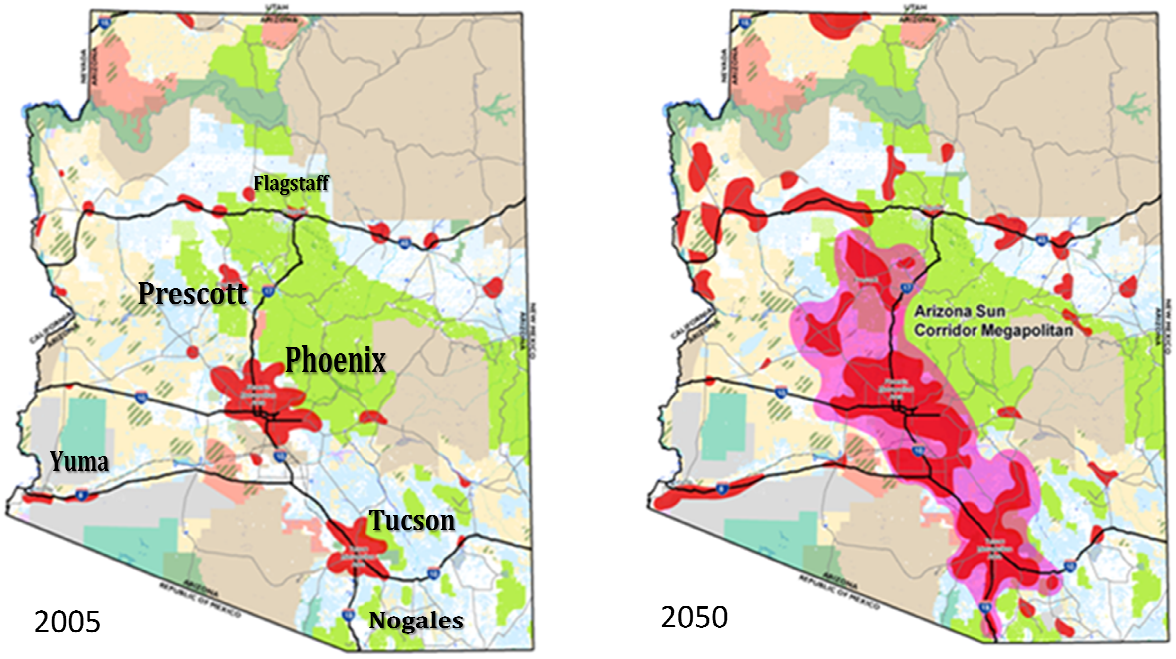
Socioeconomic growth within the state of Arizona is the primary driver of travel demand. The population in Arizona is expected to nearly double in the next 40 years, from just over 6 million in 2010 to over 12 million in 2050. The future population follows the historical trend where each decade since 1970 has seen substantial growth.

Growth has been due primarily to natural birth and to immigration. Factors such as climate, geographic location and a strong job market have also fostered the growth. The climate factor has also attracted a significant seasonal senior population. This “snowbird” population travels to Arizona during the winter months then leaves in the spring. Despite the perception of a large senior population, Arizona has a young population with an average age below the national average.

Most of the state’s population resides in the urban areas, a trend which is expected to continue in the future. Water rights have been secured to support the forecasted growth in the urban areas (rural areas have limited water rights to support growth). With growth occurring in the urbanized areas, it is expected that the metro areas will link up creating a “megapolitan” area containing approximately 85% of the state’s population. Much of the transportation infrastructure for this megapolitan area has yet to be built.



Source: ADOT Peer Review Presentation



Source: Maricopa Association of Governments

Transportation Infrastructure

Arizona hosts five key interstate corridors which serve as the backbone transportation system for intrastate and interstate travel. I-40, I-8 and I-10 make up the primary east-west corridors. I-40 connects California and New Mexico through the north-central portion of the state and passes through Flagstaff. I-8 and I-10 pass through the southern part of the state connecting California to New Mexico through Yuma, Phoenix and Tucson. I-17 and I-19 form the primary north-south corridors in Arizona. I-17 begins at I-40 in Flagstaff passing through Phoenix and Tucson. I-19 completes the final north-south leg connecting Tucson with Mexico. The stretch of the I-10/I-17 corridor through Phoenix and Tucson is considered one of the most important portions of the interstate system in Arizona having and expecting to have the highest volumes in the state.

Transportation corridors in the northern part of the state are limited by geographic features, such as the Grand Canyon, national and state parks, and tribal lands.

2.2 Agency Responsibilities

ADOT manages the modeling program for the statewide model. The AZTDM is expected to have a role in the following transportation planning studies and projects:

- Statewide Long Range Transportation Plan (LRTP)
- Support to MPOs & COGs including interregional trips
- Corridor and sub-area analyses
- Air quality & emissions analyses for nonattainment and maintenance areas
  - CO: Phoenix & Tucson
  - 8-Hour Ozone: Phoenix

  - PM10: 10 areas, 1 proposed
  - PM2.5: Pinal County
  - SO2: 6 areas
- Freight and goods movement studies
- Toll and HOV studies
- Public-private partnership projects
- Facility design and operations support
- I-10 Phoenix to California border multimodal corridor profile study
- Support Arizona state rail plan
  - High speed rail to California and to Las Vegas
  - Intercity Rail from northern Arizona to Mexico
  - Commuter rail between Phoenix and Tucson

2.3 Agency's Goals for Peer Review

ADOT's overall goal and motivation for seeking a TMIP peer review is to have the peer review panel members assist ADOT staff in identifying the best practices in statewide travel modeling to enhance the methods employed in the AZTDM and to improve its utility for planning analyses at state, regional, and municipal levels. To that end, the peer reviewers spent a day responding to specific questions from ADOT and its planning partners.

ADOT would like the TMIP peer review to particularly focus on the transition from a 3-step, highway-oriented travel demand model to a 4-step travel demand model that includes a mode choice component. Additionally, guidance was sought on supporting data collection activities and on methodologies for truck and freight modeling. ADOT prepared a list of specific topics for which they sought the panel's comments and recommendations. The list of topics is presented in section 4 and of this report. The panel's response on these topics is presented in section 5.

ADOT, along with its partner agencies, will critically assess the feedback from the peers when prioritizing its model development plan. While the advice of the peers is invaluable, there are many factors to work through when considering a model improvement strategy, and therefore the recommendations of the peers should be regarded as recommendations for ADOT and its partners.

3. Development of the Arizona Travel Demand Model (AZTDM)

3.1 History of Travel Modeling at ADOT

ADOT has a long history of travel modeling in the Arizona. In 1985 ADOT developed the travel demand models for Maricopa Association of Governments (MAG) and Pima Association of Governments (PAG) MPO's. Responsibility for these models was transferred to the MPO's in 1991. More recently, with the development of the 1st generation statewide model ADOT has once again jumped into the model development world. In 2008, ADOT along with MAG and PAG formed a model advisory committee to foster coordination and development across travel models and across jurisdictions.

3.2 AZTDM Version 1 (AZTDM1)

The first generation Arizona Statewide Travel Demand Model (AZTDM1) was developed in 2009 as a three-step trip based model. AZTDM1 had a coarse network and zone structure (zone structure based on Census tracts) and used rates borrowed from Indiana and the Quick Response Freight Manual (QRFM).

The model provided estimates of general statewide performance of alternative system improvement strategies. It was used during the visioning activities of the Building a Quality Arizona Framework Study. Due to the aggregate structure of the first generation model, AZTDM1 was determined to have limited suitability for both transportation planning and to answering many of the policy questions anticipated in current statewide transportation system planning and development activities.

3.3 Current Model (AZTDM2)

ADOT is currently using the second generation of the statewide model, AZTDM2. Development of AZTDM2 was initiated in March 2010 and completed in May 2011. Development focused on increasing the input data detail and on implementing improved personal and freight travel demand model components.

Zonal detail increased approximately six-fold from the first generation model, primarily in the urban areas where AZTDM2 uses a one-to-one correspondence with the zone structure from the MPO models and in emerging areas outside MPO boundaries. The highway network also had enhanced detail, including a direct import of the MPO networks in the urban areas. AZTDM2 included an extended external zone system (and corresponding highway network) covering North America allowing the model to capture important long distance person and truck travel as well as the visitor market to Arizona.

The AZTDM2's personal travel demand model component was calibrated using the 2009 National Household Travel Survey (NHTS) data as the primary source of travel behavior information. The calibration/validation database consisted of approximately 7,000 household samples, which includes an additional 4,286 samples purchased by MAG and 2,285 by PAG.

The freight and goods movement component of AZTDM2 was based on available data from sources such as the FHWA Freight Analysis Framework (FAF3) and the Bureau of Transportation Statistics (BTS) databases.

3.4 ADOT Model Improvement Plan (AZTDM3 and AZTDM4)

In July 2010, ADOT initiated the development of the third generation model, AZTDM3. The initial focus of this work will be on transitioning from a 3-step to a 4-step model. This will involve incorporating a person-mode choice model component and using an abstraction of local transit services. Non-local services (i.e., fixed-guideway and other line haul transit services) will still be explicitly coded. AZTDM3 will be capable of providing estimates of transit use for major system and service improvements for multimodal planning studies.

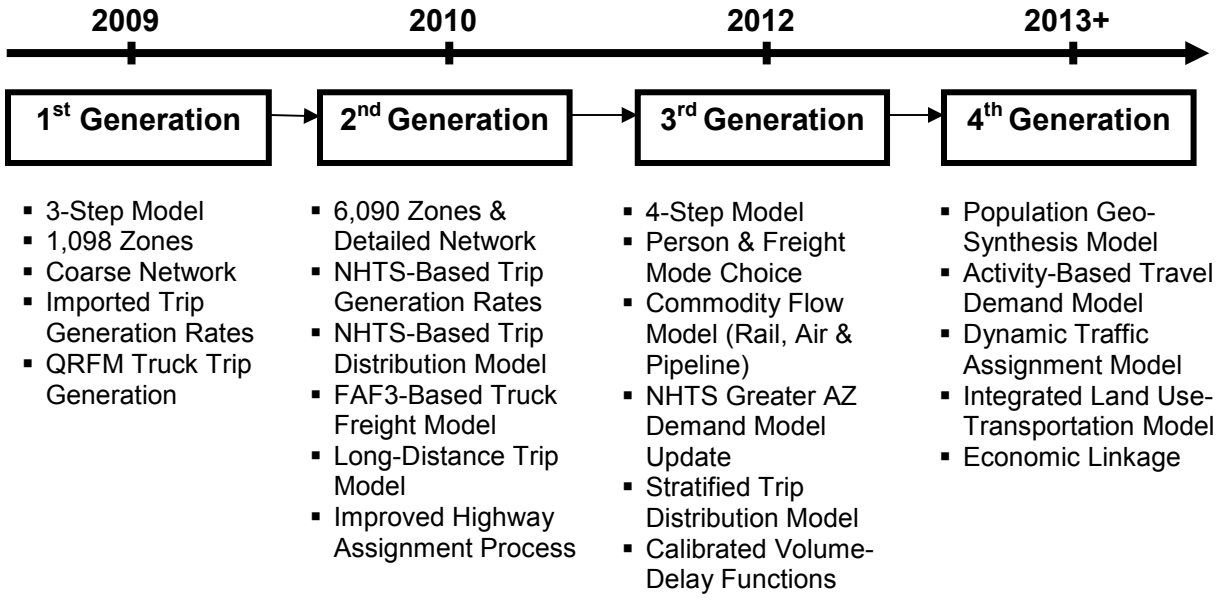
ADOT has recently acquired the Global Insight Transearch database which will provide commodity flow data at the TAZ-level for Arizona. This will enable further refinements to the existing truck freight modeling components and the potential addition of a rail freight component to the model. ADOT also plans to conduct in the near future a cordon count and classification study with a view towards possibly collecting origin-destination information for vehicles entering, leaving, and passing through Arizona.

Other model improvements ADOT plans to include in AZTDM3 are a stratified trip distribution model and feedback interactions with other model components (vehicle availability, trip generation, trip distribution and network assignment).

Beyond the current model development phase, ADOT is planning further refinements to the statewide model. These include: a population synthesis model, an activity-based model, a dynamic traffic assignment model, an integrated land use/transportation model and an economic model. These model improvements are considered to be part of the fourth generation model, or AZTDM4.

The historical context of ADOT's statewide travel model and the future development plans are summarized in the following chart.

AZTDM Development Phasing



Source: ADOT Peer Review Presentation

4. Topics of Interest to ADOT

During the peer review ADOT staff and a consultant team presented an overview of the current Arizona statewide model, AZTDM2, and of the development plans and specifications for AZTDM3. (An overview of AZTDM2 taken from the model documentation provided by ADOT is found in Appendix D.) While discussion occurred around aspects of both AZTDM2 and AZTDM3, ADOT requested the panel to provide in this review insight and guidance related to specific topics of interest for AZTDM3 and AZTDM4 development. These topics helped frame the panel discussion and the panel made recommendations specific to these items. Specifically, ADOT wanted the peer panel to comment on:

- Developing a mode choice component that utilizes a simplified, abstract representation of local transit services but fully accounts for other transit services such as fixed guide-way, park & ride and bus rapid transit
- Identifying additional data needs for model improvement, including a statewide cordon count and classification survey and a rural household travel survey to supplement the urban-oriented 2009 National Household Travel Survey
- Improving the existing truck freight model component through the use of recently acquired commodity flow data and adding a freight rail component
- Creating a hybrid version of the statewide model that can be focused and applied in metropolitan and sub-regional areas
- Incorporating advanced modeling techniques at the statewide level such as dynamic traffic assignment, activity-based, land-use and economic modeling

4.1 Local Transit Network Abstraction in Mode Choice Model

One proposed application for the statewide model is to test interregional transit corridors, such as might be served by a commuter rail system. These transit corridors are between MPO areas and not fully represented by the MPO models. The MPO models do represent other transit modes, such as local bus, express bus and light rail, and which will also be represented in the statewide model.

At a statewide level, the coding of the various transit components could be a large undertaking. For example, the combined transit systems in the statewide model contain 214 unique routes (337 directional routes) in the base year. Coding this many routes, along with their supporting link structure and park-and-ride access, can be significant, especially when considering future scenarios.

To simplify the bus network coding, AZTDM3 proposes to employ a method where the local bus networks are approximated or abstracted to compute in and out of vehicle travel times and measures of accessibility by bus to access rail and intercity bus services. This method is similar to the method applied in the California statewide travel model. The abstraction method will be applied to the local bus mode only. Rail and intercity bus will still be explicitly coded in the transit network.

Local bus travel times will be based on land use and highway network variables as opposed to a local transit network. Travel times will include sensitivities to time of day and geographic accessibility to transit (catchment area) information. The abstraction model uses:

- Transfer areas: the areas within which a person can travel
- Service areas: the areas within which transit service is provided

- Level of Service: a single number representing the quantity of local bus service
- Fare: a composite value, indicating the typical fare paid by a customer

ADOT proposes to code local bus transit networks simultaneously with the local bus abstraction method in order to validate the abstraction method. The base year local bus network will be available to run on projects as needed, or the model could use the abstracted local bus network. The abstraction method of the local bus network will be the primary method used in future long range planning.

4.2 Data Needs: Statewide Cordon Count Data and Rural Household Travel Survey

Statewide Cordon Count Data

ADOT anticipates conducting a statewide cordon survey in spring 2012. The cordon survey is designed to capture the external and through trip movements into and out of Arizona. The survey includes counts, vehicle classification, trip purpose, trip frequency and the origins and destinations of trips.

ADOT proposes to do a license plate capture survey followed by a mail-out questionnaire. The questionnaire would be used to collect the trip origin-destination, trip purpose and the frequency of the trip. ADOT is also exploring use of other technology, such as bluetooth tracking, for routing and delay data.

ADOT was interested in the panel's experience related to conducting cordon surveys, such as improving response rates, example questionnaires, and working with neighboring states. As of yet, Arizona has not pushed to do an intercept survey and it was uncertain if intercept surveys have been allowed. ADOT was also researching the use of different technologies, such as GPS or cellular.

Rural Household Travel Survey

The AZTDM2's personal travel demand model was calibrated using the 2009 National Household Travel Survey (NHTS) data as the primary source of travel behavior information. The NHTS survey data were primarily focused in the urban areas. Of the 7,157 total household surveys collected, only 89 were collected outside the MAG/PAG MPO regions.

ADOT would like to conduct a household survey for the rural areas of the state to better understand rural trip making patterns. The survey would replicate the NHTS as close as possible. ADOT is considering a sample size of around 1,000 households. ADOT requested the panel's reaction to this proposal.

4.3 Commodity-based Freight Model

The current AZTDM2 forecasts short haul and long haul truck volumes based on FHWA's Freight Analysis Framework version 3 (FAF3). ADOT would like to use a commodity-based framework using the Global Insight Transearch database that would allow ADOT to consider goods movements between different modes, such as truck and heavy rail. The model would be applied for planning and policy testing along the existing freight infrastructure as well as to test potential new freight corridors, such as the I-11 CANMEX corridor.

ADOT has purchased the Global Insight Transearch database that has commodity flows in Arizona at a TAZ level and throughout the country at a more aggregate geographic level. ADOT plans to compare the truck trips and volumes from the commodity-based freight model against

the trips from the FAF3-based model before deciding on which is the better approach to use and would like the panel to provide comment on the proposed freight model method.

4.4 Hybrid Statewide-Local Model Application

ADOT would like to create a hybrid version of the statewide model that could be applied to metro areas or sub-regions of the statewide model. The hybrid model would use a more refined zone structure, highway network and socioeconomic database than currently exist in the statewide model. The hybrid model would allow for more easy sub-area extraction from the statewide model which could be used for more localized or focused planning.

Central Arizona Association of Governments (CAAG) would like to see ADOT use the statewide model or hybrid statewide model in the development of their long range transportation plan. Pinal County in the CAAG area is expected to see a four-fold increase in population by 2055 and Pinal County was the only county in Arizona that exceeded its growth projection in the 2010 Census. CAAG is looking to ADOT to help model the future growth in the development, which ADOT is hoping to do in the spring of 2012.

ADOT would like to get from the panel insights on best approaches to sub-area model extractions and subsequent sub-area model usage.

4.5 Incorporating Advanced Modeling Techniques

ADOT is considering applying several advanced modeling techniques as part of the statewide model improvement program. These include dynamic traffic assignment, activity-based modeling, integrated transportation and land-use modeling and economic modeling. ADOT cited several examples of advanced model research projects through FHWA and Transportation Research Board (TRB). ADOT is requesting the peer review panel's guidance on the viability and best practice of implementing advanced modeling techniques at the statewide level.

5. Panel Discussion and Recommendations

The following text summarizes a point-by-point response to the topics of interest posed by ADOT at the commencement of the peer review. The comments and recommendations are provided in order of the questions posed by ADOT and the summary of this discussion follows the panel's final presentation to ADOT. After the topics of interest portion of this section, a summary is included containing the comments and recommendations of the peer panel on the other modeling topics discussed at the review.

5.1 Local Transit Network Abstraction in Mode Choice Model

The panel commented that the use of an abstraction method to estimate local transit in a statewide model was acceptable practice since the model would be used to test regional transit demand and not estimating local ridership or local transit route choice. Employing a transit abstraction method would reduce network coding at a statewide scale. The panel recommended pursuing applying the local bus abstraction method in the Arizona statewide travel models.

The panel also concurred with the practice of only using similar transit service types in an abstraction set when doing transit abstraction. Transit services with different characteristics, such as local bus vs. express bus, should not be combined in the same abstraction. The panel recommended following a pre-established structure when developing the local transit abstraction methods.

In applying the abstraction process, the panel suggested the consideration of variables, such as employment density as a factor for out of vehicle time. For reference, the California statewide travel model uses employment density as a parameter in the out of vehicle time function as well as population, HOV3 distance and transit LOS. The panel also commented that there may be a need for the representation of other services, such as dial-a-ride, which may be part of the local system.

5.2 Data Needs: Statewide Cordon Count Data and Rural Household Travel Survey

Statewide Cordon Count Data

Much of the discussion centered on the merits of an intercept cordon survey vs. an approach that uses license plate capture and a mail in survey. The panel found that using a license plate survey with a follow up questionnaire did not have high response rates and the method was typically seen by the public as intrusive resulting in bad publicity. Also, the panel raised concern that in a license plate survey semi trucks with trailers would have the license plate obscured. This could prevent a mail in survey to be sent to the right address if trucks were to be included in the response survey.

The panel had better experiences using an intercept survey to collect cordon data. Michigan DOT notifies the public safety department to make them aware that the DOT is performing an intercept survey but does not ask to have police present while performing the survey. This is done to reinforce the idea that participation in the survey is voluntary. It was believed that having a police presence would cause drivers to think the study was mandatory. Ohio DOT also works with the public safety department in performing an intercept survey. The panel also commented that an effectively structured survey can minimize respondent burden. For instance, Ohio DOT has been able to survey respondents in under a minute, on average. The panel also shared advice on administering paper-based vs. electronic survey collection methods indicating

that the paper-based works just fine and may be preferred. The panel also suggested that intercept surveys can more easily be obtained at international border crossings.

The panel recommended that if ADOT is allowed to stop vehicles then they do so. For low volume roadways, ADOT could stop traffic in the lane. For interstate or higher volume facilities, ADOT may want to consider only stopping a sample at a designated area such as a rest stop. If ADOT is not allowed to stop vehicles, then the panel recommended conducting a license plate survey. However, when conducting either an intercept or a license plate survey, the panel strongly recommended that ADOT not conduct a mail-in follow-up survey due to the panel's previous experience resulting in inconsistent data and bad public relations. The panel also recommended ADOT review potential new technologies, such as cell phone or bluetooth, as these may provide an alternate method to collect key data if vehicles cannot be stopped.

The panel also suggested that the timing of when a cordon survey is administered will be important to minimize seasonal bias, as the model represents an average weekday condition. The panel also suggested that combining various data collection methods could correct for this and other biases and validate average trip lengths as necessary.

Rural Household Travel Survey

The panel concurred that there was a need to obtain better household data in the rural areas of the state as well as better data for long distance trips. The panel recommended that ADOT collect this data but acknowledged that it would most likely not be available for the current model development deadline of March.

The panel also recommended stratifying the sampling plan by geography, such as by county, as well as by hard to reach groups, such as minorities or long distance trips. The panel suggested that ADOT could conduct a preliminary sample design study as a low cost way of getting a sense of the number of samples needed.

The panel also recommended ADOT look for opportunities to partner with local MPO's to share in their data collection efforts. Partnering with the MPO's would provide for more efficient data collection and greater consistency between data sources.

5.3 Commodity-based Freight Model

The panel commented that commodity-based mode choice modeling for freight can be difficult. Typically it is driven by a need, such as for distribution through major rail yards or for looking at economic viability of different modes. The panel recommended that ADOT begin by defining the questions they would like to answer with a freight model, such as:

- Is the freight question just about how trucks affect highways?
- Does ADOT need to understand freight movements, such as for a potential rail mode option?
- How sensitive to different policies does the model need to be?

The panel recommended scaling the complexity of the truck mode choice model to meet the need based on the questions being asked of the model. For instance, would the mode choice model be built to simply answer questions about truck volumes on highway or is the need to answer economic questions? If the need is to simply answer questions about trucks on the highway system, the panel suggested ADOT may want to consider implementing simpler mode choice freight model, such as a rule-based mode choice freight model, or a simplified network with GIS tagged rail/non-rail access links. Economic answers could require a more complex

solution. The key is to understand the type of questions that need to be answered by the truck model.

The panel also commented that ADOT should be able to take advantage of the Transearch commodity database purchased regardless of the complexities chosen for the development of the freight mode choice model. The panel also cautioned that in the past there has been an issue with the TAZ level disaggregation of the Transearch data. The panel acknowledged that the issue may have been corrected in more recent releases of the data but recommended a check of the data to ensure usability at that scale.

5.4 Hybrid Statewide-Local Model Application

The panel thought building a hybrid statewide-local model was a good idea and strongly recommended that ADOT pursue this development. Most of the panel members have similar functionality in the statewide models they use or maintain. The panel concurred with ADOT's recommended approach of maintaining data at a more disaggregate level. The panel also recommended ADOT look at creating a "window out" tool that could be used to perform the sub-area extraction from the statewide model.

The panel recommended that ADOT develop sub-area models that could be used for project-level forecasts. The panel's experience has shown that it is best to plan ahead with design-level results in mind as this is often the reason these sub-area models are run. The panel also suggested considering a combination of a sub-area travel demand model and a micro-simulation model in the solutions for these areas.

5.5 Incorporating Advanced Modeling Techniques

The panel expressed their accommodations to ADOT for the progress made by ADOT staff in establishing ADOT's modeling program and the development made to date on the current statewide model. The panel encouraged ADOT to continue to build from this good place and acknowledged that ADOT is definitely within the state of the practice in statewide modeling. The panel did want to caution against being on the bleeding edge of model development unless there was a specific need. They recommended that ADOT tie the development of advanced modeling techniques to specific needs moving forward.

Of the advanced modeling specifically mentioned by ADOT in the peer review, the panel made the following recommendations:

The panel recommended ADOT consider ties to both state and national economic models when looking at linkages between the statewide and economic models. Ohio, Maryland, Michigan and California statewide models have an economic component. The panel commented that ADOT would need to decide if the economic models tied to the front or back end of the statewide model and if/how the Transearch commodity flows would be used by the economic models.

The panel commented that true dynamic traffic assignment (DTA) implementation, which is to drill down to operational level fidelity, is only appropriate for subarea studies and is not computationally feasible for statewide model application. However, aspects of DTA may be useful for dealing with long trip lengths spanning model periods. A statewide DTA application would require development of a simplified approach that extracts the salient portions, such as time of day. The University of Maryland is experimenting with a low fidelity DTA which does not have signal controls but would have network performance by time of day. The panel recommended that ADOT consider why advanced models are needed, and then develop them according to available resources and ease of application.

The panel recommended looking into dynamic traffic assignment (DTA) due to the long distances in state travel. However, the panel commented that ADOT needed to specify the functions that would be performed by a dynamic traffic assignment and to be clear on the functional specifications. The panel also recommended ADOT consider collecting more detailed highway network data, such as signal locations and timing plans, in anticipation of implementing a dynamic traffic assignment.

The panel felt they needed more information in order to answer the activity based modeling (ABM) question. The panel wanted to better understand the need to move to an ABM platform. The panel wondered if there was something missing from the current models that a tour model would address. For instance, was the need to get a better assignment or was the need to better understand items such as transit, hot lanes or peak spreading. The panel felt these issues needed to be addressed first. The panel recommended that ADOT consider an open architecture to implement any ABM platform if ADOT decides to use an ABM. The panel also commented that an activity based approach would most like also entail an investment in resources and acceptance of longer runtime until technology caught up.

5.6 Discussion of Other Modeling Topics

Along with the topics of interest presented, ADOT invited the peer panel to comment on the current model and the proposed model development plans. The comments made by the peer panel are summarized below by topic.

Markets

The panel commented that non-resident travel did not seem to be fully addressed in the statewide model. The panel recommended an assessment of the relative importance of including non-resident, visitor or tourist trips in the model.

Trip Generation

The panel commented that home-based school (HBS) and home-based university (HBU) trip purposes were unusual for a statewide model, though there are instances where this is the case such as the California statewide model which has “school” as a trip/tour purpose.

Long Distance Person Travel

It was proposed that the long distance personal travel in AZTDM3 will be based in part on county-to-county flows and employment (FHWA traveler analysis framework method). The panel suggested that county to county flows from the latest Census may not be available in time to meet the AZTDM3 development schedule deadline.

Freight Model

The panel liked that the AZTDM2 borrowed MAG’s short distance freight model and recommended ADOT use MAG’s freight data to complement the FAF3 data in recalibrating their freight models. The panel also commented that a rule of thumb threshold for long distance trucks is about 250 miles.

Time of Day

The AZTDM3 transit model will include peak, off-peak and a separate overnight period when limited service is provided. The panel suggested ensuring that the model is reconciled between the highway peak periods, the peak periods when transit operators provide service, and the peak periods when people actually use the transit system.

A decision has not been yet made as whether AZTDM3 will use the midpoint of the travel time for a trip or a trips-in-motion method for defining the trip's period (AZTDM2 uses trips in motion). The panel acknowledged that this is an important issue and commented that using midpoint may not be as useful given the long duration expected in statewide model trips. The panel further commented that a trips-in-motion method seems to make sense if dynamic traffic assignment is being considered. The panel wondered if trips could be parsed so that they appear in multiple time periods.

The panel also commented on the proposed peak spreading model in AZTDM3. The peak spreading model is expected to be a multinomial logit model that breaks up the peak periods into 30 minute intervals. The model would use a variety of household, person and trip variables that are specific to each period. The panel questioned if local data existed to measure the shift due to congestion and commented that ADOT may need to look for outside data sources to support this model. The panel also commented that ADOT consider employing a measure of congestion, such as congested travel time, as an explanatory variable. There was some discussion regarding the use of speed versus time as the explanatory variable. Though there was no consensus reached, the panel did recommend using time as the measure.

Mode Choice Model

AZTDM3 will use mode choice logsums in distribution. There was much discussion on whether mode choice should come before or after distribution and how that might be implemented. The question was asked if the mode choice model was applied at the daily level or if it was planned to split the trip tables into periods before mode choice.

The panel offered several suggestions as to the implementation order of the time of day, mode choice and distribution models. The panel commented that applying time of day factors before distribution or mode choice would be needed as skims are performed by period. The panel also suggested that time of day factoring could be split into two parts, one up front in the model for micro-level assessments and the second at the back end similar to the adjustments made in dynamic traffic assignment or activity based models. Alternatively, the panel suggested beginning the modeling process with preloaded congested networks to reduce the number of iterations.

The panel was in favor of having mode choice come after distribution; however, acknowledged that the decision would ultimately depend on what the estimation results say about the chosen hierarchy. Decisions more sensitive to travel conditions should be later on in lower nests of the model. Mode is often more sensitive than destination, but not always. Poor estimation results can indicate an incorrect ordering of model steps. Estimation results may also vary by socio-economic category.

Socioeconomic Forecasts

The panel commented that the review did not include much discussion of the socioeconomic forecasts being used by the statewide model. The panel suggested the need to pay attention to the socioeconomic forecasts to ensure a certain comfort level as it pertained to reasonableness of the data and the process by which the forecasts were derived.

Source Data

ADOT plans to use the recent release of the American Community Survey (ACS) in AZTDM3 model development. The panel commented that the 3 year data may have missing data due to sample size suppression and recommended using both the 3 year and 5 year ACS data sources.

Appendix A: List of Peer Review Panel Participants

Peer Review Panel Members:

Chad Baker	California DOT
Jim Benson	Texas Transportation Institute
Fred Ducca	University of Maryland
Karen Faussett	Michigan DOT
Greg Giaimo	Ohio DOT

Local Agency and Partner Agency Staff:

Floyd Roehrich, Jr.	Arizona DOT
Mark Hodges	Arizona DOT
Keith Killough	Arizona DOT
Deng Bang Lee	Arizona DOT
Baloka Belezamo	Arizona DOT
Tracy Clark	Arizona DOT
Beverly Chenausky	Arizona DOT
Georgi Ann Jasenovec	FHWA – Arizona Division
Minyan Ruan	Pima Association of Governments
Aichong Sun	Pima Association of Governments

Consultant Staff:

Rob Bostrom	Wilbur Smith Associates
Krishnan Viswanathan	Wilbur Smith Associates
Liza Amar	Wilbur Smith Associates
Vijay Mahal	HDR, Inc.
Michael Gorton	HDR, Inc.
Brent Cain	HDR, Inc.
Greg Erhardt	Parsons Brinckerhoff
Sean Messner	URS Corporation
Ruth Gutierrez	CivTech

Supporting Staff to Peer Review Panel Members:

Sarah Sun	FHWA
Chad Worthen	Resource Systems Group, Inc

Appendix B: Peer Review Panel Meeting Agenda

Peer Review of the ADOT Statewide Travel Demand Model

November 18, 2011

8AM – 5PM

ADOT Board Room
206 South 17th Avenue
Phoenix, AZ 85007

8:00 – 8:30	Meet at ADOT; Continental Breakfast
8:30 – 8:45	Welcome and Introductions
8:45 – 10:00	Arizona Travel Demand Modeling Overview
10:00 – 10:15	Morning Break
10:15 – 12:00	Existing Travel Forecasting Techniques
12:00 – 1:00	Lunch
1:00 – 2:45	Proposed Travel Forecasting Improvements
2:45 – 3:00	Afternoon Break
3:00 – 4:00	Peer Review Panel Internal Discussion
4:00 – 5:00	Preliminary Findings / Recommendations from Panel

Appendix C: Peer Review Panel Biographies

Chad Baker (California Department of Transportation)

Chad Baker has been the Statewide Model Branch Chief for Caltrans since 2009. In this capacity, he is responsible for all aspects of the model including quality control, operation, scenario development, post-processing and reporting. In his role as Branch Chief, he provides technical reviews and reports for various planning efforts such as travel surveys, regional demand modeling, freight modeling and passenger rail modeling. Prior to his current engagement, he has worked for the Department performing design, project study, programming and macro and microsimulation work.

Prior to working for Caltrans, Mr. Baker worked for a private engineering firm doing design, construction and open channel flow simulation work. Mr. Baker graduated from the University of California at Davis with both a Bachelors and a Masters degree in Civil Engineering. Mr. Baker is an active participant with the Transportation Research Board as the Chair for NCFRP Project 38, Improving Freight System Performance in Metropolitan Areas, as well as other panels and is a member of the technical expert panel for SHRP2 Project C10B.

Jim Benson (Texas Transportation Institute)

Dr. Benson has more than 40 years experience in transportation planning and engineering. During his 35+ years with TTI, his research has focused in the areas of transportation planning and travel forecasting. He has served as Principal Investigator or Study Director for numerous projects in these areas. During the past 10 years, Dr. Benson's research and development efforts have focused primarily on the provision of technical support and assistance in the area of travel demand model development, travel demand model applications and travel model software support. Through his work with the Transportation Planning and Programming Division of the Texas Department of Transportation (TxDOT), he has been directly or indirectly involved with the model development efforts for most of the metropolitan areas in Texas. He played a major role in TxDOT's migration to the TransCAD software platform for travel demand modeling. Through his work with the Houston-Galveston Area Council (H-GAC), he has provided management and technical guidance in the development of the travel demand models for the region for over 25 years.

Dr. Benson has served on various panels and committees including: the Peer Review Panel for the Development of the Oahu MPO Travel Demand Models and the Texas Statewide Analysis Model Review Panel.

Fred Ducca (University of Maryland)

Dr. Fred Ducca directs the Transportation Policy Research Group of the National Center for Smart Growth (NCSG) at the University of Maryland. As director he supervises the development of the Maryland Statewide Transportation Model (MSTM), a cutting edge tool which analyzes traffic throughout the state of Maryland. The MSTM closely links with the Baltimore and Washington MPO models, allowing the MSTM to respond to changes in land use patterns resulting from activities in individual urban areas. In addition, Dr. Ducca leads the Maryland Scenarios Project, funded by the Maryland Department of Transportation. This project examines long range transportation and land use scenarios in the state of Maryland and surrounding areas. While with the Federal Highway Administration, Dr. Ducca managed the Travel Model Improvement Program (TMIP). The TMIP focused on improving both the state-of-the-art and state of the practice in travel forecasting. TMIP activities ranged from the development of advanced forecasting to integrate activity based forecasts with network simulations, to

improvements to current forecasting methods. TMIP also provided training on travel forecasting, conferences and seminars on travel modeling issues, and an email list for modelers to provide technical support to each other.

Dr. Ducca managed the Urban Land Institute's Suburban Mobility Program, a cooperative effort between the private sector and the public sector, local governments, to reduce traffic congestion. The program examined a range of congestion reduction options including allowing higher density, pedestrian friendly site design, transportation impact fees, changes to parking policy and the imposition of carpooling requirements. While in graduate school Dr. Ducca worked on the DRAM and EMPAL population and employment location models. He then integrated DRAM and EMPAL with traffic analysis procedures to create an integrated package of land use and transportation models, allowing for analyses of the interactive effects of travel and urban development.

Karen Faussett (Michigan DOT)

Karen Faussett is the Statewide Model Specialist at the Michigan Department of Transportation (MDOT). She is responsible for the update and maintenance of the Michigan statewide travel demand model and leads the statewide model team.

Karen was also project manager for MDOT's 2004-2005 and 2009 statewide household travel surveys. Before moving to statewide modeling, Karen spent several years developing small urban models at MDOT. Prior to MDOT, Karen worked at the Southeast Michigan Council of Governments (SEMCOG). Karen has a Bachelor of Science in Urban Planning from Michigan State University and a Master's Certificate in Project Management from the George Washington University.

Greg Giaimo (Ohio DOT)

Greg Giaimo graduated from the Ohio State University with BSCE (1989) and MS (1991) degrees. He has worked for ODOT as a travel modeler for almost two decades and is a registered professional engineer in Ohio. Besides day to day project and corridor analysis, he is in charge of new model development, data collection and development of technical methods related to the planning process. In this roll he develops methods for producing project level forecasts from models and other inputs and creates those forecasts for complex projects in the northwest quadrant of the state.

Mr. Giaimo estimates/calibrates new travel demand models or manages consultant contracts to do so for the statewide model and seventeen Ohio MPO models and has actively guided Ohio's adoption of advanced modeling techniques focusing on activity micro-simulation, freight, land use and integration of traffic operations models. He develops data collection protocols and implements new technologies for household surveys, intercept surveys and travel time data collection programs and oversees staff and consultants collecting the data. He has also developed various other related planning processes including the statewide congestion management system, bypass project analysis process, transportation review advisory council scoring factors, planning level Highway Capacity Manual program and toll revenue forecasting process.

Appendix D: Overview of AZTDM2

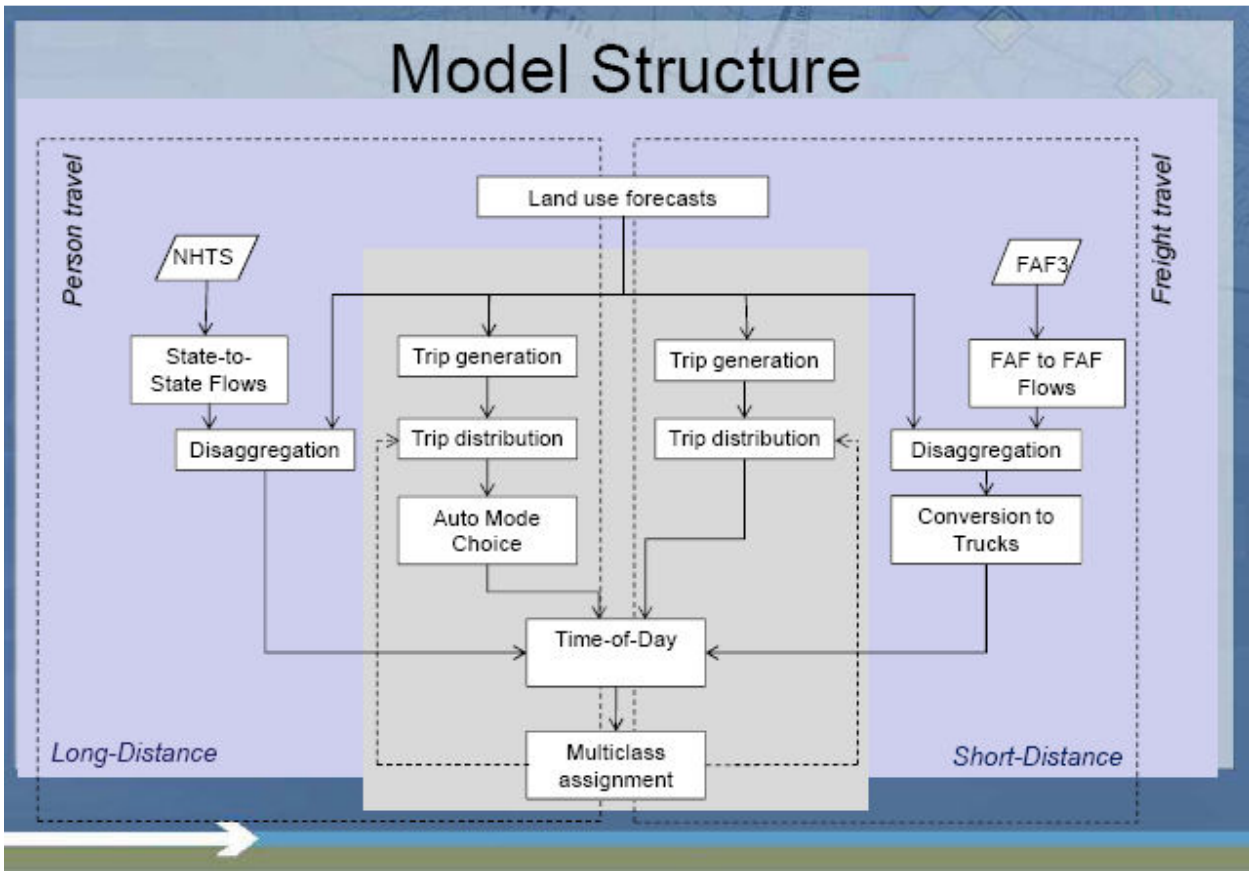
The following text summarizes the current version of the Arizona Statewide Travel Demand Model (AZTDM2) at the time of the review, along with data sources used in the development of the model.

In AZTDM2, the travel market is divided by person trips and truck trips. Each is also sub-grouped by distance. For person travel, 50 miles is the threshold of short trip versus long trip. Truck travel is sub-grouped based on the judgment if the truck trip crosses FAF3 zone boundaries.

- Short Distance Person Travel (<=50miles)
- Long Distance Person Travel (>50 miles)
- Short Distance Truck Travel (within FAF3 zone)
- Long Distance Truck Travel (crossing FAF3 boundaries)

Model Components

The AZTDM2 model structure includes separate components for passenger travel and truck trips as shown in the following flow chart:



Source: ADOT Peer Review Presentation

AZTDM2 has five primary model components as described in the current model documentation:

- Setup/Trip generation
- Skimming
- Person Travel
- Truck/Long Distance Travel
- Assignment

Setup/Trip Generation

In this stage, trip generation is conducted for short distance person trip only. Truck and long distance person trips are processed separately in other stages of the model.

Trip generation rates for short distance person trip were generated based on the 2009 National Household Travel Survey (NHTS). For each county, rates were calculated for five trip purposes:

- Home based work (HBW)
- Home based university (HBU)
- Home based school (HBS)
- Home based other (HBO)
- Non home based (NHB)

Person trip generation rates are stratified by the area type. Area type definitions were calculated based on an accessibility measure. Area types used by AZTDM2 are:

- Central Business District (CBD)
- Urban
- Suburban
- Rural
- Small Town Central Business District

Skimming

AZTDM2 creates toll/non-toll skims using a generalized cost that is based on travel time, toll and distance for the following four vehicle classes:

- drive alone
- shared ride 2
- shared ride 3+
- truck

Person Travel

In this stage, AZTDM2 performs trip distribution for short distance person travel using a destination choice logit model. After distribution, transit trips are factored off by purpose and area type. A multinomial logit model is then used to predict auto occupancy. Shares were derived from NHTS and then smoothed to ensure logical relationship among modes.

Truck & Long Distance Person Travel

In this stage, the model separately processes short & long distance truck travel and long distance person travel. Short distance truck model is a three-step model without mode choice. Its trip generation is segmented by twelve land use categories:

- Employer (start and end point of any truck trip)
- Retail
- Construction
- Farming
- Mining
- Households
- Governments
- Warehousing
- Transportation
- Office
- Industrial/Manufacturing

A gravity model is applied to distribute short distance truck trips. Friction factors between zone pairs are calculated dynamically based on congested travel time.

Long distance person trips are mainly processed by a Java script, which reads and expands the 2002 NHTS long distance data to a state-to-state trip table then disaggregated to TAZ using household data, employment and a weighting scheme. A 10% sample of ticked air travelers by BTS was also used. After missing NHTS records are synthesized and the NHTS data are expanded, trips are disaggregated to the AZTDM zones based on population and employment. The model also uses state parks as a special attraction.

Long distance truck trips are also processed by a Java program but uses FAF3 data to create FAF-district to FAF-district commodity flow matrix, which are then disaggregated to TAZ based on employment. Long distance commodity flows are converted to truck trips using payload factors for single-unit and multi-unit trucks. An empty truck rate is used to factor the truck trips for returning empty trucks. Capacity and volume/delay function curve parameters were obtained from MAG. Passenger car equivalent vales were obtained from the Highway Capacity Manual.

Assignment

Highway assignment in AZTDM2 combines the long and short passenger and truck trip tables and assigns them onto the network by four time periods:

- AM Peak (6AM - 9 AM)
- Mid Day (9 AM - 3 PM)
- PM Peak (3 AM - 6 PM)
- Night (6 PM - 6 AM)

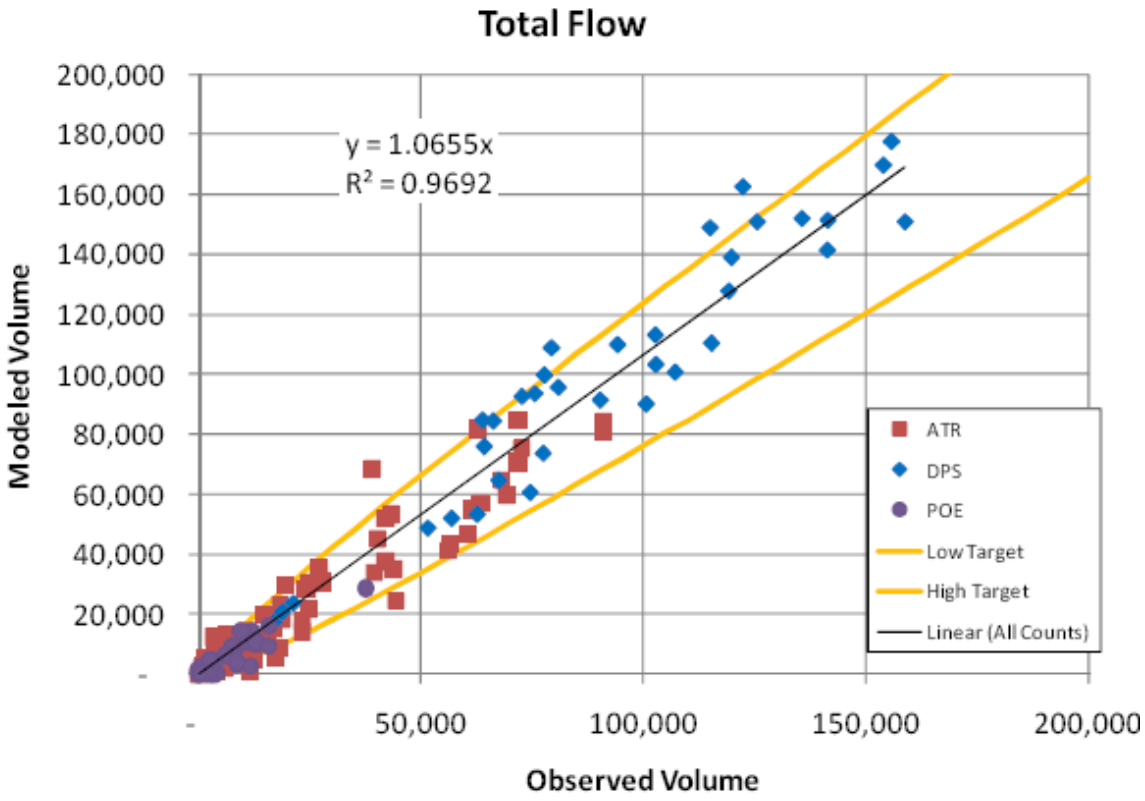
The model performs a feedback loop from trip generation to assignment. In first feedback loop iteration, long distance trips (person and truck) are loaded onto network using an all-or-nothing assignment. Then the short distance persons and trucks are loaded to the network with a user

equilibrium traffic assignment. Congested travel times are calculated using a BPR-type volume-delay function. Only the AM and MD travel times are fed back. Convergence is reached when the percent RMSE for the AM and the MD periods are both less than 1%. On the final model iteration, the model assigns PM and NT trips to highway network.

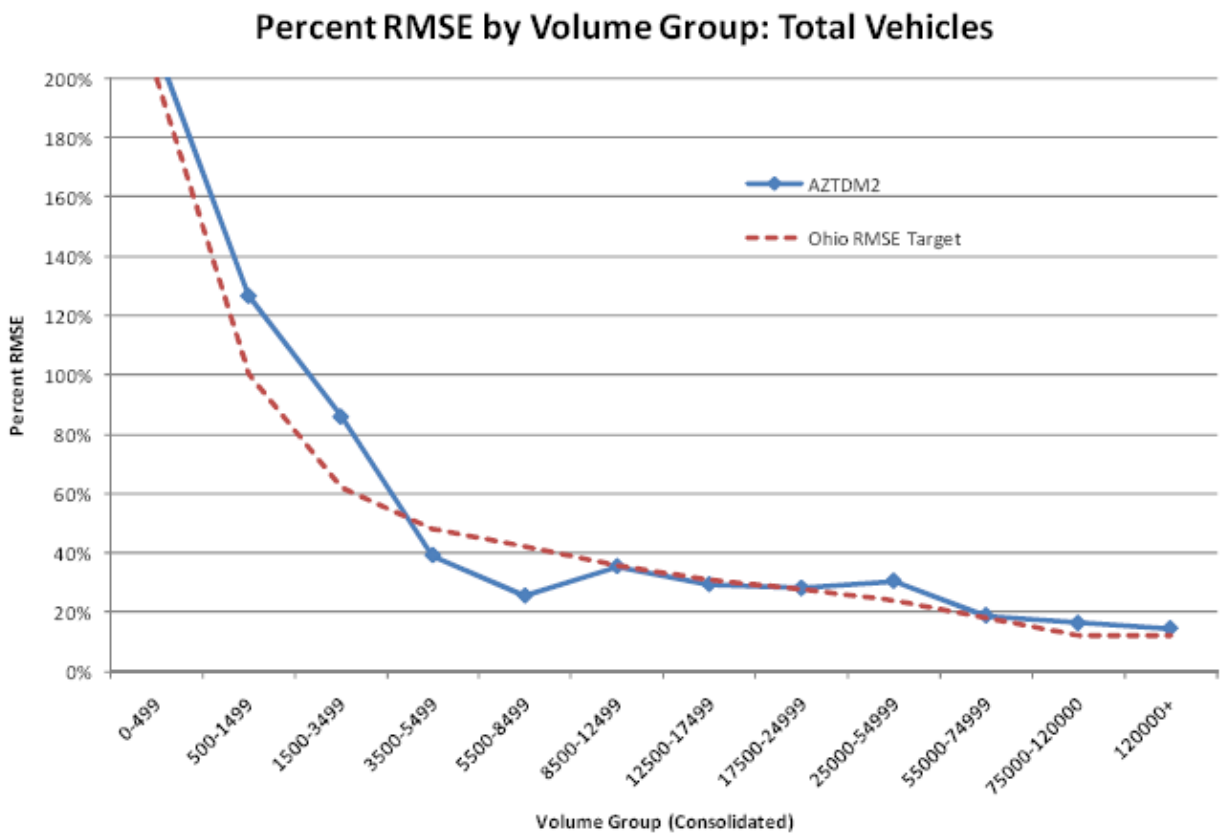
Model Validation

Model calibration focused on the state highway system. Traffic counts were used to validate AZTDM2.

Aggregate volume to count comparisons showed that the R-Square for the total flow was approximately 0.97, and the percent RMSE of total flow was 30%.



Source: ADOT Peer Review Presentation

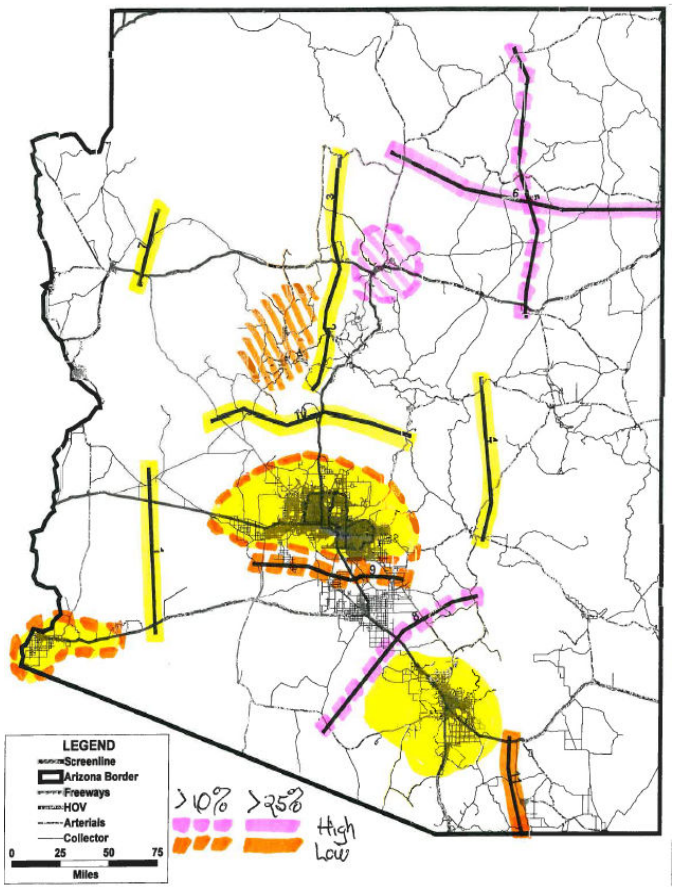


Source: ADOT Peer Review Presentation

Screenline validations were also performed. The percent error of volume on 9 of 10 screenlines was within 16%. Variances on the one screenline outlier in northeast AZ were associated with tribal reservations and parks. State line crossing screenlines had the total volume percent error within15% at each border crossing.

Screenline Totals on Links with ATR Counts								
Description	SCREENLINE	Number of Counts	ATR	Model	Difference	% Difference	Maximum Desirable Deviation	Within Target?
I-8 & I-10 West	1	6	35,862	34,189	-1,673	-5%	38%	YES
I-40 Mid	2	4	24,728	25,568	840	3%	46%	YES
I-40 East	3	4	21,400	23,722	2,322	11%	46%	YES
I-10 East	4	3	36,875	24,293	-12,582	-34%	38%	YES
MAG-Flagstaff	5	3	42,382	40,791	-1,591	-4%	36%	YES
MAG-CAAG	6	6	123,717	107,901	-15,816	-13%	22%	YES
CAAG-PAG	7	3	52,233	59,854	7,621	15%	32%	YES
I-40 West	8	3	14,986	16,036	1,050	7%	55%	YES
Northeast	9	3	8,676	14,416	5,740	66%	61%	NO
I-10 East--North Split	41	4	9,354	9,569	215	2%	61%	YES
Total of Screenlines		39	370,213	356,339	-13,874	-4%	17%	YES
MAG Cordon	MAG	14	209,524	183,067	-26,457	-13%	17%	YES
PAG Cordon	PAG	10	92,462	97,563	5,101	6%	25%	YES
Yuma Cordon	YUMA	4	28,711	22,731	-5,980	-21%	43%	YES
Flagstaff Cordon	FMPO	8	54,766	66,941	12,175	22%	32%	YES
Total of Cordons		36	385,463	370,302	-15,161	-4%	17%	YES

Source: ADOT Peer Review Presentation



Source: ADOT Peer Review Presentation

Data Source Summary

The following are the various sources for model development, calibration and validation used in the AZTDM2 model (source: ADOT Peer Review Presentation):

- Transportation Analysis Zone & Transportation Network attribute data from MAG, PAG, FMPO, YMPO, CYMPO
- U.S. Decennial Census & Census Transportation Planning Package
- Quarterly Census of Employment & Wages (QCEW)
- 2009 National Household Travel Survey (NHTS)
    - Including Add-Ons purchased by MAG & PAG
- Traffic Counts
    - Automated traffic recorders (ATRs)
        - 143 locations, largely inter-city
        - Break-out by vehicle type
        - Continuous monitoring, highly reliable
    - Department of Public Safety (DPS) counts
        - 35 locations on Phoenix area freeways
        - Total volumes from speed monitoring system
    - ADOT Port-of-Entry (POE) estimates
        - 41 state line crossings
        - Auto versus truck classifications
    - Bureau of Transportation Statistics (BTS) border crossing data
        - 8 border crossings
        - Auto versus truck classifications
    - Highway performance monitoring system (HPMS)
        - All HPMS links
        - Used for broad area comparisons, rather than individual link comparison
- FHWA Freight Analysis Framework (FAF3)
- IHS Global Insight Transearch

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