MARICOPA ASSOCIATION of GOVERNMENTS

TOLL ROAD MODELING TECHNIQUES

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URS

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Table of Contents

Section 1 Introduction 1

Section 2 MPO Survey 2

2.1 Survey Results 3

Section 3 Toll Modeling Approaches, Data Needs, & Implementation Plan 17

3.1 Toll Modeling Approaches & Recommendations 17

3.2 Data Needs for Toll Modeling 19

3.3 Toll Modeling Implementation Plan 21

3.4 Summary 24

Appendix A Survey Results A-1

Appendix B Macro Advanced Highway Assignment with Toll Route Choices B-1

List of Tables

Table 1 – Surveyed Agencies 2
Table 2 – Toll Road / Managed Lanes in Surveyed MPO Regions 3
Table 3 – Financing Methods for Toll Facilities 4
Table 4 – Existing and Future Travel Demand Model 5
Table 5 – Existing Software Platform 5
Table 6 – Trip Distribution Model 6
Table 7 – Impedance Function in Trip Distribution 6
Table 8 – Mode Choice Model for Trip Table Development 7
Table 9 – Trip Purposes in the Mode Choice Model 7
Table 10 – Trip Tables Produced from the Mode Choice Model 8
Table 11 – Toll/Toll-Free in Mode Choice Model 9
Table 12 – Value-of-Times (VOTs) 10
Table 13 – Time of Day Trip Table in Traffic Assignment 11
Table 14 – Traffic Assignment Method 12
Table 15 – Toll Demand Estimation Method in Traffic Assignment 13
Table 16 – Shortest Path Variables in Traffic Assignment 14
Table 17 – Volume/Delay Function in the Traffic Assignment Process 15
Table 18 – Feedback Loops in the Model 16
Table 19 – Sample Toll Diversion Model Parameters 23

List of Figures

Figure 1 – Proposed MAG Toll Modeling Process 18
Figure 2 – Bluetooth Data Collection Concept 20
Figure 3 – Sample VDF Curves 22
Figure 4 – Sample Toll Diversion Curves 23

Section 1
Introduction

The Maricopa Association of Governments (MAG), under its on-call consulting service contract for transportation planning with URS, assigned a task order to assist MAG by recommending toll road modeling options within the regional model.

For the past several decades, the Greater Phoenix Metropolitan Area has been one of the fastest growing regions in the nation. The population has increased from just fewer than one million in 1970 to more than four million today. This rapid growth has created a major challenge for the transportation system. Since 1985, a half-cent sales tax in Maricopa County has been devoted to transportation improvements. MAG, as the designated Metropolitan Planning Organization, is responsible for the planning, prioritization, and allocation of these funds; currently referred to as Proposition 400 Funds. During the past 25 years, much of the planned freeway system has been constructed with high occupancy vehicle (HOV) lanes on most freeways and direct HOV ramp connectors through several system interchanges. Recently, due to the economic slowdown, some highway construction projects have been delayed, bus services have been cut, and planned expansions have been put on indefinite hold. This situation highlights the need to optimize the use of existing capacity and managed lanes.

With the passage of HB 2396 in 2009, the State Legislature authorized the use of Public-Private Partnerships (P3s), including the collection of tolls. This legislation opened the door for considerations of a different array of techniques to fund and manage the transportation system. Several states have implemented "managed lanes," which are lanes that are tolled for certain types of users for some portion of the day. Such a system in the MAG Region could provide increased system reliability for some users and could create additional revenue, which may be used for debt service by a P3 or State Agency.

The current MAG travel demand model lacks a robust toll modeling process, especially capable of analyzing tolled managed lane traffic. URS was assigned this task order to assist MAG with survey of toll modeling techniques and recommendation for toll modeling enhancements.

The scope of service for URS under this task order included four tasks:

Task 1 – Review Best Practices of Toll Modeling

Task 2 – Recommend a Toll Modeling Approach for MAG

Task 3 – Identify Data Needs for Toll Modeling

Task 4 – Develop an Implementation Plan

This report documents the work performed for these four tasks. Section 2 provides a description of URS' work on the review of existing toll modeling practices (Task 1) for the 17 MPOs/agencies in North America. Section 3 describes URS' work on Tasks 2, 3, and 4, which include a description of toll modeling options and recommendations, a description of the type of data needed for toll modeling development and calibration/validation, and a brief implementation plan to incorporate the recommended toll modeling approach into the existing four step MAG modeling process. The URS scope did not include the actual implementation of the recommended approach into the existing regional model.

Section 2

MPO Survey

This section summarizes Task 1 – review the best practice of toll modeling for URS' on-call consulting services for toll road modeling support for MAG. By reviewing peer toll road modeling practices, MAG will be able to identify the best practice, make improvements to the MAG regional model, and use the new practice in toll road traffic forecasting in support of the development of toll roads in the Phoenix Metro area.

To achieve this goal, URS conducted a survey of 17 MPOs in North America to obtain their current techniques in toll modeling. This survey builds on URS' previous work conducted in early 2010 for the Baltimore Metropolitan Council (BMC), where URS surveyed 11 MPOs around the nation to understand the toll modeling process used for toll road and managed lanes, including High Occupancy Travel (HOT) lanes.

The survey instrument design was coordinated with MAG Technical staff. Also the selection of MPOs and agencies to survey was decided jointly between URS and MAG. The majority of the 17 MPOs that were selected have either existing toll facilities in operation and/or toll facilities planned for the near future in their region. Table 1 includes the surveyed agencies.

Table 1 – Surveyed Agencies

No	MPO	MPO/Agency Name	State
1	Atlanta	Atlanta Regional Commission	GA
2	Austin	Capital Area Metropolitan Planning Organization	TX
3	Baltimore	Charles Barber Principal Transportation Planner	MD
4	Chicago	Chicago Metropolitan Agency for Planning	IL
5	Dallas	North Central Texas Council of Governments	TX
6	Denver	Denver Regional Council of Governments	CO
7	Houston	Houston-Galveston Area Council	TX
8	Los Angeles	Southern California Association of Governments	CA
9	Minneapolis	Metropolitan Council of the Twin Cities	MN
10	NJTPA	North Jersey Transportation Planning	NJ
11	Salt Lake City	Wasatch Front Regional Council	UT
12	San Antonio	San Antonio/Bexar County MPO	TX
13	San Diego	San Diego Association of Governments	CA
14	San Francisco	Metropolitan Transportation Commission	CA
15	Toronto	Ministry of Transportation, Ontario	ON, CN
16	VDOT	Virginia Department of Transportation	VA
17	Washington	National Capital Region Transportation Planning Board	DC

The survey instrument includes a total of 26 questions that covered the following topics:

1. Existence of Toll Facilities and Managed Lanes in the Region
2. Type of Funding Used/Planned for Tolled Facilities
3. Type of Model and Modeling Platform
4. Trip Distribution Process
5. Mode Choice Procedure
6. Toll Assignment Algorithm
7. Feedback Concept
8. General Questions

2.1 Survey Results

URS received responses from all 17 agencies, reviewed the results from this survey, and has presented both the responses and observations below. The completed survey instrument received from each MPO is provided in **Appendix A**.

As shown in Table 2, all of the 17 MPOs have either toll roads or managed lanes in operation in their region, except San Antonio who has planned toll roads and managed lanes. Seven metro areas have operating managed lanes including recently converted HOV lanes to HOT on the I-85 Corridor in the Atlanta area. The North Jersey region is the only region that does not have any plan to add toll road or managed lanes facilities. However, the area has many existing toll roads and even has reversible exclusive bus lanes (XBL) on I-495.

Table 2 – Toll Roads / Managed Lanes in Surveyed MPO Regions

			Toll Road in the Region?		ML in the Region?		Toll Road/ML Planned?	
No	**MPO**	**State**	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**
1	Atlanta	GA	√		√		√	
2	Austin	TX	√			√	√	
3	Baltimore	MD	√			√	√	
4	Chicago	IL	√			√	√	
5	Dallas	TX	√			√	√	
6	Denver	CO	√		√		√	
7	Houston	TX	√		√		√	
8	Los Angeles	CA	√			√	√	
9	Minneapolis	MN		√	√		√	
10	NJTPA	NJ	√			√		√
11	Salt Lake City	UT	√		√		√	
12	San Antonio	TX		√		√	√	
13	San Diego	CA	√		√		√	
14	San Francisco	CA		√	√		√	
15	Toronto	ON, CN	√			√	√	
16	VDOT	VA	√			√	√	
17	Washington	DC	√			√	√	

Table 3 shows the financing methods that each MPO used or is planning to use for the toll road or managed lane facilities. While most MPOs seek funding from federal or state governments, 9 out of 17 MPOs used or plan to use P3 or private funding in addition to government funding.

Table 3 – Financing Methods for Toll Facilities

No	MPO	State	Federal Government	State Government	Local/County/ District Government	PPP/ P3	Private Sector	Bond Financing
1	Atlanta	GA	√					
2	Austin	TX	√	√		√		√
3	Baltimore	MD						√
4	Chicago	IL	√	√		√		
5	Dallas	TX	√	√	√	√		√
6	Denver	CO						
7	Houston	TX	√	√				
8	Los Angeles	CA	√			√		√
9	Minneapolis	MN	√	√				
10	NJTPA	NJ		√				
11	Salt Lake City	UT	√	√			√	
12	San Antonio	TX	√	√				
13	San Diego	CA	√	√	√	√	√	√
14	San Francisco	CA	√	√	√			√
15	Toronto	ON,CA		√		√		
16	VDOT	VA				√		
17	Washington	DC				√		√

Table 4 and Table 5 shows the type of travel demand models and software platform that each MPOs is currently using, as well as their plans for the future. Six MPOs are in the process of or planning to migrate to an AB Model in the next few years.

Table 4 – Existing and Future Travel Demand Model

No	MPO	State	Existing Model			Future Model Plan		
			AB Model	4-Step Model	Other	Same Model	AB Model	Enhanced 4-Step Model
1	Atlanta	GA	√	√			√	
2	Austin	TX		√				
3	Baltimore	MD		√			√	
4	Chicago	IL		√			√	
5	Dallas	TX		√		√		
6	Denver	CO	√					
7	Houston	TX		√			√	
8	Los Angeles	CA		√			√	
9	Minneapolis	MN		√				√
10	NJTPA	NJ		√		√		
11	Salt Lake City	UT		√		√		
12	San Antonio	TX		√		√		
13	San Diego	CA		√			√	
14	San Francisco	CA	√	√		√		
15	Toronto	ON, CN		√				
16	VDOT	VA		√				√
17	Washington	DC		√				√

Note: AB model – Activity based / tour-based model

Table 5 – Existing Software Platform

No	MPO	State	TRANSCAD	CUBE/VOYAGER	EMME2/3	TP+
1	Atlanta	GA		√		√
2	Austin	TX	√			
3	Baltimore	MD		√		√
4	Chicago	IL			√	
5	Dallas	TX	√			
6	Denver	CO	√			
7	Houston	TX		√		
8	Los Angeles	CA	√			
9	Minneapolis	MN		√		√
10	NJTPA	NJ		√		
11	Salt Lake City	UT		√		
12	San Antonio	TX	√			
13	San Diego	CA	√			
14	San Francisco	CA		√		√
15	Toronto	ON, CN			√	
16	VDOT	VA		√		
17	Washington	DC				√

Table 6 and Table 7 list the trip distribution process that each MPO uses. The Gravity Model formulation is most common (the Atomistic Model, used in Texas, is similar to the Gravity Model), although MPOs moving to ABM have moved to the Destination Choice Model. As shown in Table 7 almost all agencies use Travel Time in their Impedance Function along with other variables. Toll Cost is used by 9 MPOs in the Trip Distribution Process.

Table 6 – Trip Distribution Model

No	MPO	State	Gravity Model	Atomistic Model	Synthetic Friction Factors Model	Destination Choice Model
1	Atlanta	GA	√			√
2	Austin	TX		√		
3	Baltimore	MD	√			
4	Chicago	IL				
5	Dallas	TX	√			
6	Denver	CO				√
7	Houston	TX		√		
8	Los Angeles	CA				√
9	Minneapolis	MN				√
10	NJTPA	NJ	√			
11	Salt Lake City	UT	√			√
12	San Antonio	TX		√		
13	San Diego	CA	√			
14	San Francisco	CA				√
15	Toronto	ON, CN	√			
16	VDOT	VA	√			
17	Washington	DC	√			

Table 7 – Impedance Function in Trip Distribution

No	MPO	State	Travel Time	Travel Cost	Toll Cost	Operating Cost
1	Atlanta	GA	√	√	√	√
2	Austin	TX	√			
3	Baltimore	MD	√		√	
4	Chicago	IL	√	√	√	√
5	Dallas	TX	√			
6	Denver	CO	√	√	√	√
7	Houston	TX	√			
8	Los Angeles	CA	LOGSUM			
9	Minneapolis	MN	√			
10	NJTPA	NJ	√	√		
11	Salt Lake City	UT	√	√	√	√
12	San Antonio	TX	√			
13	San Diego	CA	√	√	√	√
14	San Francisco	CA	√	√	√	√
15	Toronto	ON, CN	LOGSUM			
16	VDOT	VA	√	√		
17	Washington	DC	√		√	

Tables 8-11 list the Mode Choice Process that each MPO uses. Table 8 indicates that the Nested Logit Model is the most popular among MPOs. Table 11 reveals that 9 out of 17 MPOs divide trip tables into Toll and Toll-Free as part of the Mode Choice Process. However, it should be noted that some of these agencies split trip tables into Toll and Toll-Free as a part of the first step during the Traffic Assignment Routine.

Table 8 – Mode Choice Model for Trip Table Development

			Mode Choice		Highway Tolls Included?	
No	MPO	State	Multinomial Logit Model	Nested Logit Model	Yes	No
1	Atlanta	GA		√	√	
2	Austin	TX		√		√
3	Baltimore	MD		√	√	
4	Chicago	IL				√
5	Dallas	TX		√	√	
6	Denver	CO	√		√	
7	Houston	TX		√	√	
8	Los Angeles	CA		√	√	
9	Minneapolis	MN		√		√
10	NJTPA	NJ		√	√	
11	Salt Lake City	UT		√	√	
12	San Antonio	TX		√		√
13	San Diego	CA		√	√	
14	San Francisco	CA		√	√	
15	Toronto	ON, CN		√		
16	VDOT	VA	√			√
17	Washington	DC	√		√	

Table 9 – Trip Purposes in the Mode Choice Model

No	MPO	State	HB-Work	HB-Other	HB-School	HB-Shopping	HB-University	Non-HB-Work	Non-HB-Other
1	Atlanta	GA	√	√		√			
2	Austin	TX	√	√	√	√	√	√	√
3	Baltimore	MD	√	√	√	√		√	√
4	Chicago	IL	√	√				√	
5	Dallas	TX	√	√					√
6	Denver	CO							
7	Houston	TX	√	√	√	√	√	√	√
8	Los Angeles	CA	√	√	√	√	√	√	√
9	Minneapolis	MN	√	√	√	√	√	√	√
10	NJTPA	NJ	√	√		√		√	
11	Salt Lake City	UT	√	√			√	√	
12	San Antonio	TX	√	√	√	√	√		
13	San Diego	CA	√	√	√		√		√
14	San Francisco	CA							
15	Toronto	ON	√	√	√	√	√	√	√
16	VDOT	VA	√	√		√		√	√
17	Washington	DC	√	√		√			√

Table 10 – Trip Tables produced from the Mode Choice model

No	MPO	State	SOV	HOV 2	HOV 2+	HOV 3	HOV3+	Trucks	Local Bus	Express Bus	Rapid Bus	BRT	Commuter Rail	Light Rail	Walk	Bike
1	Atlanta	GA	√	√		√	√									
2	Austin	TX	√	√	√	√	√									
3	Baltimore	MD	√	√			√		√	√			√	√		
4	Chicago	IL	√		√											
5	Dallas	TX	√	√			√									
6	Denver	CO	√	√			√	√							√	√
7	Houston	TX	√	√		√	√									
8	Los Angeles	CA	√	√		√	√		√	√	√	√	√	√	√	√
9	Minneapolis	MN	√	√			√		√	√			√	√	√	√
10	NJTPA	NJ	√	√		√										
11	Salt Lake City	UT	√	√			√		√	√		√	√	√	√	√
12	San Antonio	TX	√		√		√									
13	San Diego	CA	√				√	√	√	√		√	√	√		
14	San Francisco	CA	√	√			√	√	√	√			√	√	√	√
15	Toronto	ON	√						√				√	√	√	√
16	VDOT	VA	√		√				√	√						
17	Washington	DC	√	√			√									

Table 11 – Toll/Toll-Free in Mode Choice Model

			Divided into Toll/Toll-Free modes?		For what modes are Trip Tables divided?					
No	**MPO**	**State**	**Yes**	**No**	**SOV**	**HOV 2**	**HOV 2+**	**HOV 3**	**HOV3+**	**Trucks**
1	Atlanta	GA	√		√	√		√	√	
2	Austin	TX	√		√	√	√	√	√	
3	Baltimore	MD	√		√	√			√	√
4	Chicago	IL		√						
5	Dallas	TX		√						
6	Denver	CO		√						
7	Houston	TX	√		√	√		√	√	
8	Los Angeles	CA	√		√	√			√	
9	Minneapolis	MN		√						
10	NJTPA	NJ		√						
11	Salt Lake City	UT	√		√	√			√	
12	San Antonio	TX		√						
13	San Diego	CA	√		√	√			√	√
14	San Francisco	CA	√		√	√			√	√
15	Toronto	ON		√						
16	VDOT	VA	√		√		√			
17	Washington	DC		√						

Table 12 shows how Value of Time (VOT) is modeled in each MPO's Travel Demand Model. Almost all MPOs include VOT. The use of VOT in Mode Choice and Traffic Assignment steps is more common than in Trip Distribution

Table 12 – Values-of-Times (VOTs)

			Are VOTs Included?		How are VOTs Estimated?			Which Steps Use VOTs?		
No	**MPO**	**State**	**Yes**	**No**	**By Mode**	**By Vehicle Type**	**By Purpose**	**Trip Distribution**	**Mode Choice**	**Traffic Assignment**
1	Atlanta	GA	√			√			√	√
2	Austin	TX	√		√	√				√
3	Baltimore	MD	√							√
4	Chicago	IL	√		√		√	√	√	
5	Dallas	TX	√			√			√	√
6	Denver	CO	√				√	√	√	√
7	Houston	TX		√						
8	Los Angeles	CA	√		√	√	√	√	√	√
9	Minneapolis	MN		√						
10	NJTPA	NJ	√		√			√	√	√
11	Salt Lake City	UT	√						√	√
12	San Antonio	TX	√			√				√
13	San Diego	CA	√				√		√	√
14	San Francisco	CA	√					√	√	
15	Toronto	ON	√		√					√
16	VDOT	VA	√		√	√	√	√		√
17	Washington	DC	√		√	√	√	√	√	√

Tables 13-18 discuss the Traffic Assignment Process and how toll elements are considered in this step. The majority of MPOs conduct Traffic Assignment by multiple time periods, four time period being the most common, as shown in Table 13. Table 14 acknowledges that User Equilibrium Generalized is the most common Traffic Assignment Method. As indicated in Table 15, the Toll Diversion Curves and Logit Based Toll Diversion Process are the most commonly used processes for agencies having the special process for toll road modeling. Seven agencies were revealed to have the ability to model congestion pricing or variable tolling in the regional model or as part of post processing. Only Atlanta and Los Angeles divide the trip table into smaller time periods, which is important for the congestion pricing/variable tolling algorithms, to improve toll road modeling.

As shown in Table 16, 9 out of 17 agencies use Toll Cost as an explicit variable during impedance calculation for the shortest path during traffic assignment. The customized Volume Delay Functions (VDF) for all roads are the most common form of VDFs used by MPOs (Table 17). However, only two MPOs (Chicago & Denver) indicated that they use special VDFs for toll road or managed lanes. As listed in Table 18, the majority of MPOs have feedback loops - from assignment back to trip distribution and mode choice being the most common.

Table 13 – Time of Day Trip Table in Traffic Assignment

No	MPO	State	AM Peak Period	AM Peak Hour	PM Peak Period	PM Peak Hour	Midday	Night Time	Off-Peak (Midday + Night Time)	Daily
1	Atlanta	GA	√		√		√			
2	Austin	TX	√							√
3	Baltimore	MD	√		√		√		√	
4	Chicago	IL	√		√		√		√	
5	Dallas	TX	√		√				√	
6	Denver	CO								√
7	Houston	TX	√		√		√	√		
8	Los Angeles	CA	√		√		√	√		
9	Minneapolis	MN	√		√		√	√	√	
10	NJTPA	NJ	√		√		√	√		
11	Salt Lake City	UT	√		√		√	√		
12	San Antonio	TX	√		√				√	√
13	San Diego	CA	√		√				√	
14	San Francisco	CA	√		√		√		√	
15	Toronto	ON	√		√					
16	VDOT	VA	√		√		√		√	
17	Washington	DC	√		√				√	

Table 14 – Traffic Assignment Method

No	MPO	State	User Equilibrium Generalized	Cost User Equilibrium	Customized GCUE	Diversion Curve/Logit Model	Stochastic User Equilibrium	Dynamic Traffic Assignment	Origin-Based	Path-Based
1	Atlanta	GA	√							
2	Austin	TX		√						
3	Baltimore	MD	√							
4	Chicago	IL								√
5	Dallas	TX								
6	Denver	CO	√							
7	Houston	TX	√							
8	Los Angeles	CA	√							
9	Minneapolis	MN	√							
10	NJTPA	NJ								
11	Salt Lake City	UT	√							
12	San Antonio	TX	√	√						
13	San Diego	CA	√							
14	San Francisco	CA	√							
15	Toronto	ON, CN	√							
16	VDOT	VA	√					√		
17	Washington	DC	√							

Table 15 – Toll Demand Estimation Method in Traffic Assignment

			Method Used to Estimate Toll Demand			Any Special Technique in Traffic Assignment for Toll?		Models Variable/Congestion pricing facilities?		If yes, are trip tables divided into smaller periods?	
No	MPO	State	Diversion Curve	Logit Model	Other	Yes	No	Yes	No	Yes	No
1	Atlanta	GA	√	√		√		√		√	
2	Austin	TX				√			√		
3	Baltimore	MD	√				√	√			
4	Chicago	IL				√			√		
5	Dallas	TX			√		√	√			√
6	Denver	CO				√			√		√
7	Houston	TX		√			√		√		√
8	Los Angeles	CA	√			√			√	√	
9	Minneapolis	MN	√			√		√			√
10	NJTPA	NJ	√				√		√		√
11	Salt Lake City	UT		√			√		√		√
12	San Antonio	TX			√	√			√		
13	San Diego	CA	√	√			√		√		√
14	San Francisco	CA		√			√	√			√
15	Toronto	ON		√			√		√		
16	VDOT	VA		√			√		√		√
17	Washington	DC				√		√			√

Table 16 – Shortest Path Variables in Traffic Assignment

			Variables Considered for shortest path			
No	**MPO**	**State**	**Travel Time**	**Toll Cost**	**Operating Cost**	**Value of Time**
1	Atlanta	GA	√			
2	Austin	TX	√			
3	Baltimore	MD	√			
4	Chicago	IL	√	√		
5	Dallas	TX	√	√	√	√
6	Denver	CO			√	√
7	Houston	TX	√			
8	Los Angeles	CA	√	√	√	√
9	Minneapolis	MN	√			
10	NJTPA	NJ	√			
11	Salt Lake City	UT	√	√	√	√
12	San Antonio	TX		√		
13	San Diego	CA	√	√	√	√
14	San Francisco	CA		√	√	√
15	Toronto	ON	√	√		√
16	VDOT	VA	√			√
17	Washington	DC	√	√		

Table 17 – Volume /Delay Function in the Traffic Assignment Process

No	MPO	State	BPR	Conical	Ackelik	Customized VDFs for all facilities	Customized VDFs for Toll/Managed Lane Facilities
1	Atlanta	GA		√			
2	Austin	TX	√				
3	Baltimore	MD				√	
4	Chicago	IL					√
5	Dallas	TX		√			√
6	Denver	CO				√	
7	Houston	TX	√				
8	Los Angeles	CA	√			√	
9	Minneapolis	MN		√			
10	NJTPA	NJ					
11	Salt Lake City	UT				√	
12	San Antonio	TX	√				
13	San Diego	CA				√	
14	San Francisco	CA				√	
15	Toronto	ON, CN		√			
16	VDOT	VA				√	
17	Washington	DC				√	

Table 18 – Feedback Loops in the Model

No	MPO	State	Traffic Assignment and Mode Choice	Traffic Assignment and Trip Distribution	Traffic Assignment and Trip Distribution and Mode Choice	Other
1	Atlanta	GA		√		
2	Austin	TX		√		
3	Baltimore	MD			√	
4	Chicago	IL			√	
5	Dallas	TX			√	
6	Denver	CO				√
7	Houston	TX				√
8	Los Angeles	CA			√	
9	Minneapolis	MN			√	
10	NJTPA	NJ		√		
11	Salt Lake City	UT			√	
12	San Antonio	TX	√			
13	San Diego	CA		√		
14	San Francisco	CA				√
15	Toronto	ON, CN	√			
16	VDOT	VA			√	
17	Washington	DC			√	

Many of MPOs (9 out of 17) are willing to share the scripts or programs where tolls are involved with certain agreements.

This survey of MPO provides MAG staff with an understanding of various Toll Road Modeling methods employed by many MPOs throughout North America. Some of these agencies are used by MAG staff to compare various modeling processes. URS used the information from this survey along with our experience in Toll Road Modeling to develop a set of recommendations for incorporating tolls into the existing MAG Model, which is presented in the next section.

Section 3

Toll Modeling Approaches, Data Needs & Implementation Plan

This section summarizes Tasks 2, 3 and 4, including recommendations for toll modeling approaches, data needs, and the implementation plan, which will allow MAG to identify/adapt the best practice available, make improvements to the MAG regional model, and use it in toll road traffic forecasting in support of the development of toll roads in the Phoenix Metro area.

In order to meet MAG's needs for a robust process for modeling toll facilities, URS has prepared a recommendation for a model improvement plan for a practical toll modeling process. This plan is comprised of the following three components:

a. Recommendations for Toll Modeling Approach
b. Data Needs and Modified Trip Table Preparation Step
c. Implementing the Advanced Highway Traffic Assignment with Toll Route Choices

A brief description of each of the above components, along with other suggestions on preparing and running the toll model, are provided below.

3.1 Toll Modeling Approaches & Recommendations

While there is no standard procedure for toll modeling, various approaches have been utilized in practice, ranging from advanced model structures to basic and quick tools such as Sketch Level Planning models. The following are several procedures used in toll road traffic forecasting.

Toll Based Mode Choice Models

In addition to the traditional Mode Choice, toll paths are added as a route choice in this model structure. By doing so, trips for each mode are divided into toll and toll-free choices. A traditional Drive Alone matrix is disaggregated into Drive Alone toll and Drive Alone toll-free. Similarly, trips are divided into HOV and Truck modes. The significant advantage of Mode Choice models over Assignment Based models is that a choice of toll route is included in two steps: Mode Choice and Assignment. This procedure allows the model to be sensitive to the socioeconomic choices of commuters. One concern with this approach is that the toll trips estimated by the mode choice model may not be actually assigned on the toll roads. Feedback loops could be employed to update average travel time from assignment for both toll and toll-free roads into the Mode Choice structure. Sensitivity to toll by Time of Day (TOD) can also be modeled provided sufficient data is available to develop such a model.

Assignment Based Procedures

There are multiple procedures for modeling tolls using the traffic assignment process. Some of them use fixed tolls while others use variable tolls adjusted based on the Level of Service (LOS) of the toll road. The following procedures are examples employed by several public and private agencies.

<u>Traditional Generalized Cost User Equilibrium (GCUE)</u>

The GCUE procedure compares cost impedance between toll and toll-free paths while choosing the shortest path. Three types of costs are considered for each path in the impedance equation: network travel time, distance, toll cost (if any) and operating cost. This procedure is widely used to forecast traffic on toll roads. The sum of these costs is compared for each path before assigning trips.

<u>Customized Generalized Cost User Equilibrium</u>

This procedure is a modification of the traditional GCUE process incorporating different procedures between assignment iterations. Customized GCUE can be, in general, categorized into two procedures:

- Diversion Curves: This is a heuristic approach where after each assignment iteration the traffic distribution between toll and toll-free highway links is estimated using a calibrated diversion curve. The diversion curve distributes the percentage of traffic assigned to the toll route based on

travel time savings and toll charge. The travel cost between two zones could be calculated using the traditional impedance costs (travel time + toll cost + operational cost) or a relationship between those costs (cost ratios).

- Logit Type Models: This is a more elaborate model than the Diversion Curves procedure and is a behavior based approach. Utility of both paths (toll and toll-free) are estimated and the probability of choosing either of the paths is estimated using the logit equations.

Both, Diversion Curves and Logit model equations, could be calibrated from Stated or Revealed Preference surveys for each tollway corridor by TOD or by vehicle type.

Sketch Level Planning Models

While the above mentioned procedures involve complete travel demand modeling processes, more basic and quick models are also used in analyzing toll roads. The Spreadsheet Model for Induced Travel Estimation-Managed Lanes (SMITE-ML) and the Sketch Planning for Road User Charge Evaluation (SPRUCE) are examples of quick models which were developed by the Federal Highway Administration to analyze managed lanes and toll road projects.

Recommended Toll Modeling Approach

Based on our toll road modeling experience and the MPO practice survey, URS proposed to incorporate a Logit Type Model as described above. This process, as illustrated in Figure 1, is basically a route choice model that would be built into the traffic assignment step. It would allow the model to partition the trips between the best tolled route and the best non-tolled route for a given origin-destination zonal pair in each iteration of the equilibrium highway assignment process. The toll choice model would be structured as a binary logit model for each of the three trip modes in the MAG model's highway assignment step – SOV, HOV and Trucks. This process could also be implemented by trip purpose instead of the trip modes. The probability of selecting a toll road would be based on a utility function that estimates the tradeoff between travel time savings and the associated toll costs and also considers other travelers characteristics such as income and electronic transponder ownership.

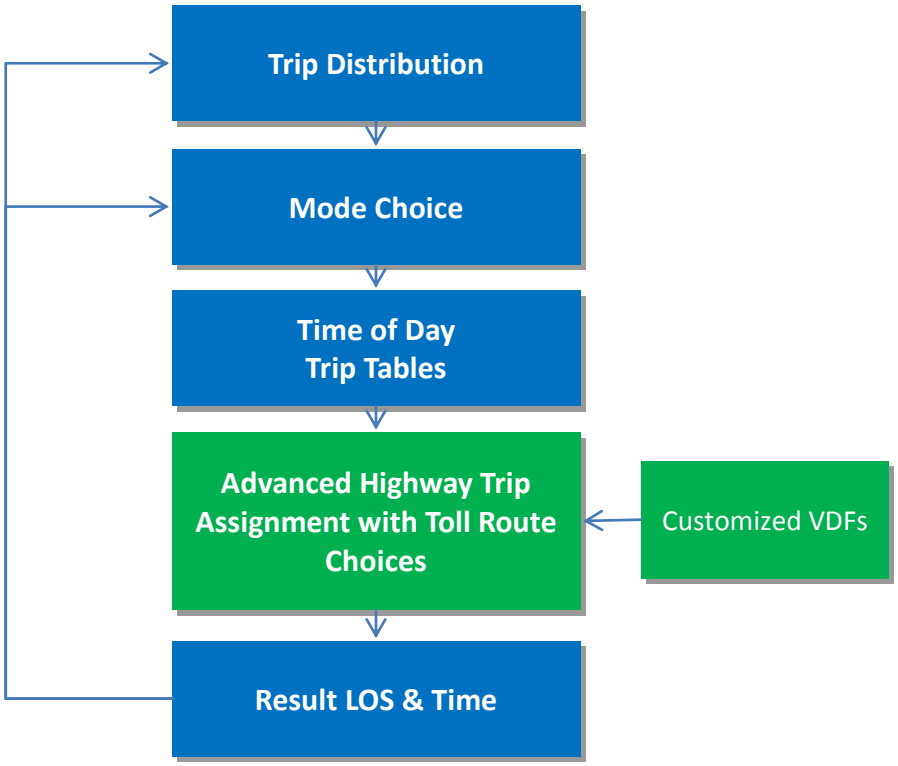

Figure 1: Proposed MAG Toll Modeling Process

3.2 Data Needs for Toll Modeling

In order to meet MAG's needs for a comprehensive toll modeling approach, URS proposed a two-tier data collection effort. The first tier includes data inquiries of the existing data and studies from various MPOs, toll agencies, and other toll project stakeholders. The second tier, which is the focus of this section, includes a comprehensive set of traffic surveys that MAG may utilize during the initial development or calibration/validation of the toll model.

Traffic Counts

A well-designed traffic counting program provides the MAG staff with the capability to understand actual traffic conditions and develop necessary traffic volume estimates to develop, calibrate and validate the toll models. Systematic collection of traffic counts in the region could consist of the following types:

- Continuous counts – stations that are counted hourly every day of the year.
- Coverage counts – stations that spread across the study area or on screenlines and are counted once every 1-3 years.
- Classification counts.
- Turning movement counts at key locations.

The traffic count program should capture the following characteristics of traffic demand on the roadways:

- Temporal distribution of traffic demand
    - Peak vs. off peak
    - Weekday vs. weekend
- Auto vs. truck by classification
- Existing toll road transactions versus local traffic

Traffic counting methods can be generally divided into intrusive and non-intrusive methods. Intrusive counting methods include counting systems that place sensors in or on the roadway, such as pneumatic tube counters, piezo-electric sensors, or inductive loops. The most common intrusive method is the portable pneumatic tube counter because of its ease of use and low cost. Non-intrusive methods include manual counts, infra-red, passive magnetic, and video image detection. A commonly used method for turning movement counts at intersection level is a hand-held traffic counting board.

Speed / Travel Time Data

A speed survey can be conducted at different time periods to collect free flow speed for a roadway segment during non-peak periods or to evaluate congestion speed and travel times during peak periods. Spot speed at a certain location can be collected using radar-based methods. These days, it is more common to use a floating car method with GPS units to evaluate travel time or average speed on a roadway segment. It is useful to model the time savings for travelers to use toll facilities versus general purpose lanes or local roads.

Speed surveys and/or travel time studies should be conducted on the specific corridor on parallel routes of proposed toll facilities, cross street routes, and frontage roads. The speed-delay runs could be performed in each direction for the peak and off-peak periods. This data would be collected via multiple trials and the conditions will be averaged to provide estimates of typical travel times through the corridor by time period. This data will be compared to the estimates of travel times provided by the toll model as part of the final model calibration.

O-D Survey

The Origin-Destination (O-D) survey is conducted to identify travel distribution patterns. Many methods can be deployed for the O-D survey such as household O-D surveys, roadside O-D surveys, license-plate surveys or passive Bluetooth technology.

The traditional method of roadside O-D surveys distributes mail-back cards to drivers at selected roadside locations. This method is difficult to implement for highways due to safety concerns and agency restrictions and often has low return rates.

A video-based license plate survey is common for an enclosed corridor such as a toll facility. For this technique, license plates are recorded by video cameras at multiple roadside stations that are synchronized. Traffic volume counts are usually conducted simultaneously in order to obtain a "capture rate" for the expansion of the sample/matched data to the population. The record of all license plates recorded from one station is compared to records from other stations within the study corridor. A match is noted if a license plate is seen at two stations within a certain time parameter, that is, upper and lower bounds of reasonable travel time between the two stations.

The cost of a video-based license plate survey varies significantly based on the actual scope. Just as a reference, the professional service fee for license plate survey of a 20-mile corridor with 40 video cameras could reach $300,000 including traffic counts, video recording, license matching and a final O-D matrix.

New technology, such as passive Bluetooth, is also becoming prevalent these days. Using this method, a set of Bluetooth sensors will be deployed along the roadside of a highway at key locations to capture the unique MAC ID's for activated Bluetooth devices in cars that are traveling along the corridor. Vehicles will be matched at different points along the corridor using the unique MAC ID and the timestamp for when the vehicle passed each Bluetooth sensor. This data will provide estimates of origin-destination patterns and travel speed estimates for vehicles in the corridor (Figure 2). The data from the Bluetooth sensors can be expanded using actual traffic counts to represent the full traveling population if accurate estimates of the Bluetooth penetration rates can be developed. This method has a very high matching rate and the cost depends on how many sensors will be needed. A recent project managed by URS included such a survey with 46 Bluetooth sensors for one week and processing speeds and O-D matrices into four time periods of a day had a budget of $100,000.

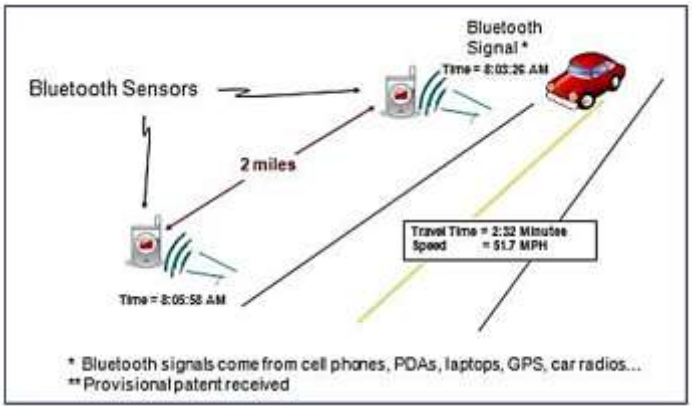

Figure 2: Bluetooth Data Collection Concept (source: Traffax Inc.)

Stated Preference Survey

The stated preference (SP) survey is designed to identify the travel patterns and preferences of passenger and commercial vehicle drivers who currently use or could reasonably use a specific, existing or proposed toll road corridor. The survey approach could employ computer-assisted, self-interview techniques, which are programmed for administration at field intercept sites on laptop computers as well as for use over the internet via email distribution to a targeted audience. Field intercept administration can take place at numerous locations throughout the study corridor. Travelers can be intercepted at shopping areas, public offices, and local institutions. Activity centers can be selected based on the likelihood of intercepting a large number of eligible travelers and a varied sample of the traveling population, including members of key segments such as work commuters and non-work travelers. The sample can be augmented by administering the survey online to employees of large area businesses, to users intercepted at intersections along the study corridor, and to participants of an earlier O-D study.

The SP survey results reveal drivers' likelihood to use the toll road as a function of trip purpose, travel time and toll cost. It will help to develop the regional toll route choice model (usually in the binary Logit form) permitting travelers to select between the best toll and non-toll routes. The ratio of the parameters of time and cost variables also implies the VOT of these travelers.

The SP survey cost varies significantly depending on the complexity of questions and the sample size. A typical phone-based SP survey by a professional company could cost between $75,000-$150,000.

3.3 Toll Modeling Implementation Plan

This section presents a possible implementation plan, if MAG elects to implement toll modeling approach as part of the highway assignment procedures. To incorporate the toll modeling approach in the MAG model, there are a few modeling components which would need to be modified. These include:

- Modified Trip Table Preparation
- Customized Volume Delay Function (VDF)
- Advanced Highway Assignment with Toll Route Choices

The detailed modifications are described below.

Modified Trip Table Preparation Step

In the current MAG model, the daily-level trip tables from the mode choice model are converted to time-of-day trip tables by mode which is the format used for the trip assignment step. The advanced highway traffic assignment with toll choices proposed by URS is applied by time-of-day and by trip purpose for SOV (or LOV), HOV, and trucks. The original MAG LOV trip table will be split into SOV and trucks. And the truck tables will include light, medium, and large trucks. The MAG model's trip purposes will be regrouped into three purposes: Home-Based-Work (HBW), Home-Based-Non-Work (HBNW) and Non-Home-Based (NHB). For the Home-based trips (HBW and HBNW), the trip tables are maintained in P->A format to utilize the income at the home end in the toll route choice evaluation. Other trip purposes need to be combined into the above three purposes. This is to implement the toll diversion process for all trip purposes and modes being assigned to the network while at the same simplifying loaded volumes fields in the standard setup of highway assignment. Usually X-X trips are reassigned to their respective modes; this would allow proper diversion based on value of time by trip purpose and by mode (such as auto and trucks).

Customized VDF Curve

The MAG model currently uses Bureau of Public Roads (BPR) volume-delay curves (VDF) with modified parameters for ten facility types and five area types, including

- *Freeways (1)*
- *Expressway (2)*
- *Collectors (3)*
- *Six Legged Arterials (4)*
- *Centroid Connectors (5)*
- *Major Arterials (6)*
- *Freeway Unmetered Ramps (7)*
- *Freeway Ramp Meters (8)*
- *Collector/Distributor (CD) Roads (9)*
- *Freeway High-Occupancy Vehicle (HOV) Lanes (0)*

Pending on a review of observed travel speeds within the MAG region, URS suggested a customized VDF curve for the principal arterials within Phoenix based on simulation studies for similar areas. A separate VDF curve would also be used for the proposed managed lanes for future year model runs. The managed lane capacity would be lowered (compared to general purpose lanes) to maintain a pre-determined LOS (i.e. minimum speed of 45 mph). These curves are incorporated into the advanced toll diversion assignment step. The sample of customized VDF curve for the managed lanes is shown in Figure 3 along with current VDF curves for other facility types.

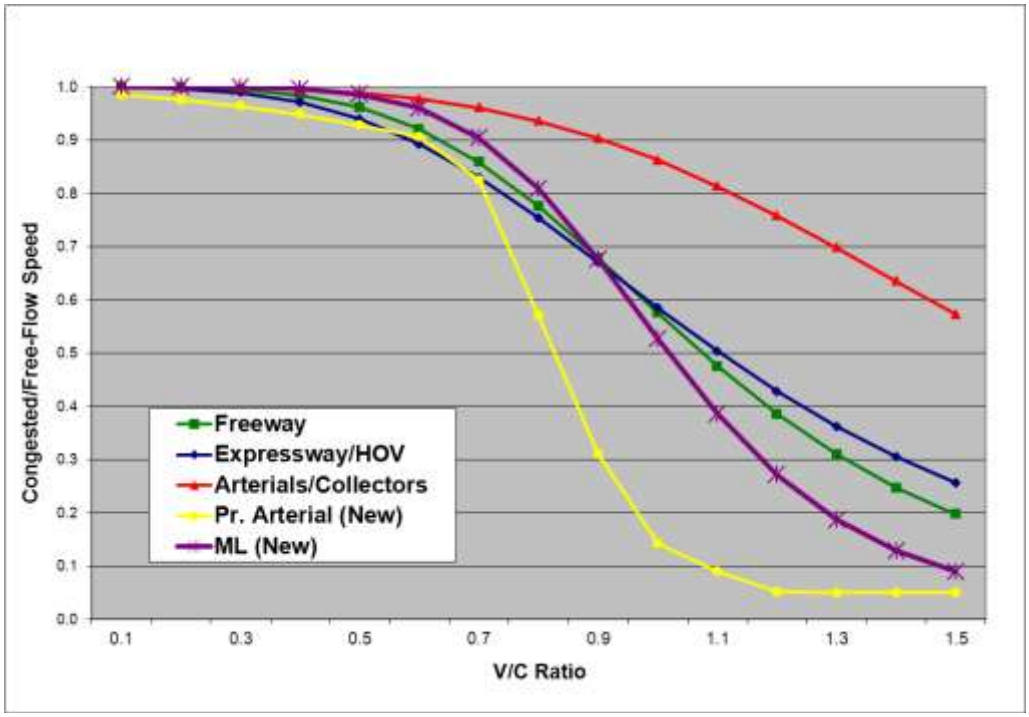

Figure 3: Sample VDF Curves

Advanced Highway Traffic Assignment with Toll Route Choices

The recommended toll model component is basically a route choice model that is built into the highway traffic assignment step that allows the model to partition the trips between the best tolled route and the best non-tolled route for a given origin-destination zonal pair in each iteration of the equilibrium highway assignment process. The MAG model's toll route choice process would be structured as a binary logit model for each of the five trip modes in the MAG model's highway assignment step – SOV, HOV, Light Trucks, Medium Trucks and Heavy Trucks and for each of the individual trip purposes for the modes (HBW, HBNW and NHB). The probability of selecting a toll road would be based on a utility function that estimates the tradeoff between travel time savings and the associated toll costs and also considers other travelers characteristics such as income. The model would be structured to enable market segmentation by payment type (ETC, cash/video-tolling). The advanced highway traffic assignment model with toll route choices includes the following logit equation:

$$Toll\ Share = 1/(1 + \exp(\alpha * \Delta T + \beta * Cost/\ln(Income) + c + ETC_bias))$$

where:

e	=	Base of natural logarithm (ln)
ΔT	=	time saving between toll road and non-toll road travel, in minutes
Cost	=	toll cost in dollars
Income	=	median zonal annual household income
α	=	time coefficient
β	=	cost coefficient
c	=	toll road bias constant
ETC_bias	=	bias towards selecting toll routes using ETC payment

In the logit equation, the relationship between the 'α' and 'β' coefficients creates an implied value of time, i.e. VOT ($/hour) = [α/{β/ln(Income)}]*60. These were determined to be in the range of $11 to $17 per hour for auto trips, assuming an average household income of $58,500 for the MAG region (based on the Census 2010). The value of time is typically within the range of 50 to 70 percent of the average wage rate. For trucks, a relatively higher value of time is used that would reflect the greater sensitivity related to the delivery of the commodities being transported and costs associated with driver' salaries.

The toll road bias constant 'c' accounts for unobserved effects associated with the preconceived reluctance on the part of travelers to utilize toll roads. In regions such as the MAG area where toll facilities are not present, the toll bias terms tend to be significant for initial period. However, as travelers recognize the benefits, in terms of time saving provided by the toll facilities, the bias will be decrease. The 'ETC bias' term applies when both cash and ETC systems are implemented. The reason to separate this constant term from the general bias constant is that the 'ETC_bias is likely to be removed in the first few years after the toll facilities are in place, when more and more people starts to use the ETC payment and realize the benefits of using toll road without stopping for the toll payments.

The logit-based route choice model described above has several parameters that are typically estimated based on stated or revealed preference surveys. The time and cost coefficients as well as the toll road and ETC bias constants initially can be borrowed from stated preference surveys in other regions and from URS' experience on other toll road studies. Over the time, these values would be further adjusted based on the calibration of the model using actual stated preference in MAG region and eventually revealed preferences of toll road users and toll transactions from the toll facilities in the MAG region. Sample values of toll model parameters are shown in Table 18. The parameters for SOV and HOV were assumed to be identical for the HBW, HBNW and NHB purposes. Figure 4 shows a sample of the percent toll diversion by purpose and mode based on these parameters.

Table 18: Sample Toll Diversion Model Parameters

Parameter	HBW	HBNW	NHB	LTK	MTK	HTK
Time Coefficient (Alpha)	0.2030	0.0950	0.1300	0.1070	0.1070	0.1070
Cost Coefficient (Beta)	8.0200	5.4015	5.9877	0.2378	0.1605	0.1070
Median Annual Household Income ($/yr)	$ 58,500	$ 58,500	$ 58,500			
Value of Time ($/hr)	**$ 16.67**	**$ 11.58**	**$ 14.30**	**$ 27.00**	**$ 40.00**	**$ 60.00**
Toll Bias Constant (c)	0.8120	0.8120	0.8120	0.8120	0.8120	0.8120
ETC Bias Constant (ETC_bias)	-0.2030	-0.2030	-0.2030	-0.2030	-0.2030	-0.2030

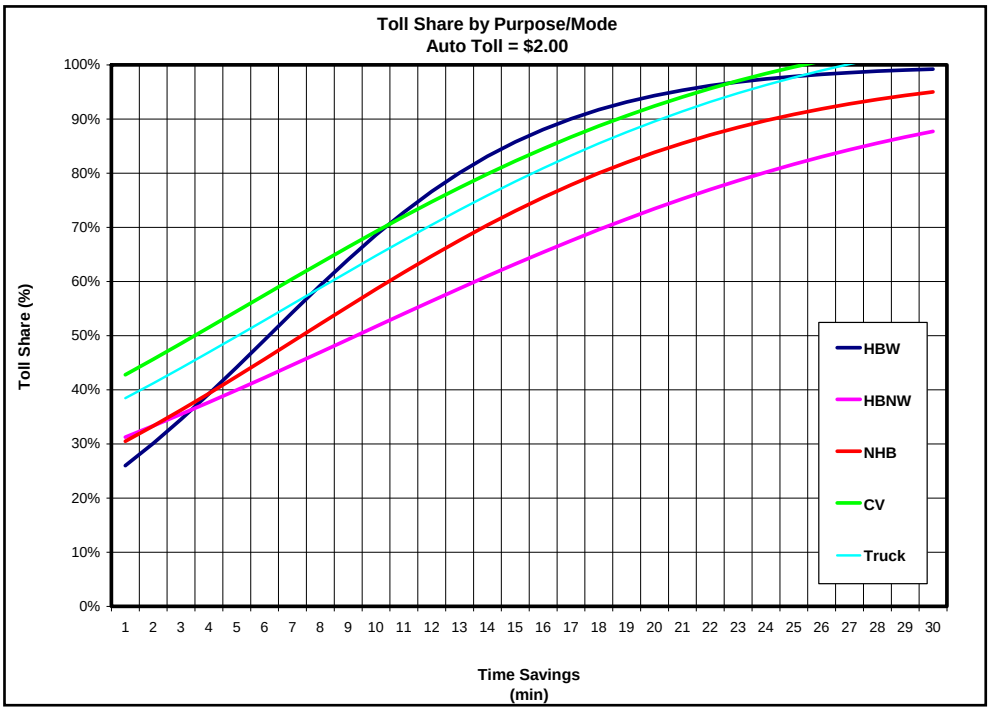

Figure 4: Sample Toll Diversion Curves

Besides the route choice logit model described above, other salient features of the new toll diversion process are as follows:

Transponder ownership:

Each trip mode was segmented into percentages of vehicles with and without transponders. Based on transaction data at the existing toll facilities, transponder ownership is expected to be around 70% in the early years of toll projects. In the absence of detailed data by geography, this value will be used systemwide across all purposes and modes. If such data becomes available at a later time, these percentages could be stored within matrices, allowing for further segmentation geographically, e.g., urbanized corridors with higher transponder usage. These percentages are established by the user and are anticipated to increase in future years. The transponder trips would be split between free and ETC paths whereas the non-transponder trips would be split between free and cash/video paths.

Video flag:

As mentioned earlier, an ETC 'bias' term is used in the toll probability calculation to denote the positive bias towards selecting a toll road with ETC payment compared to cash payment system. Since 'video' facilities would also provide similar operation in the sense that those would also not require vehicles to stop and make the toll payment (such as the case with cash facilities), the 'etcbias' term is also applied to video facilities. This will be implemented through the use of the 'vidflag' link variable, which would be skimmed during path-building and if the value of the skim is 0, the etcbias term would be applied.

Truck Multipliers:

A 'truck multiplier' is defined as the ratio of the average tolls paid by trucks to the average toll paid by autos on the existing toll facilities. Based on toll rates charged for different vehicle classes, a medium truck multiplier of 2.0 and heavy truck multiplier of 3.5 are typical; however this would be determined by the tolling policy decided by MAG or operating agency and vehicle composition of the corridor users.

Assigned modes:

The proposed MAG model assigns SOV, HOV, Light Trucks, Medium Trucks, and Heavy Trucks. As mentioned earlier, it is possible to combine some of these modes. Also, the HBW, HBNW and NHB trip purposes will be combined together by payment type for the SOV and HOV modes after trip table partitioning. The final modes assigned in the advanced toll diversion highway assignment are SOV, HOV, Light Trucks, Medium Trucks and Heavy Trucks. These are assigned separately by free, ETC and cash/video trips. The process should be flexible to allow for change in combination of trip purpose and mode combination in toll modeling.

Feedback:

The toll modeling process can be implemented in the MAG model chain's feedback process; i.e., 2 AM assignments are performed before the final assignment. The congested time and toll cost at the end of the highway assignment procedure would be fed back to the trip distribution step (via the composite time) as part of the feedback loop, in order to reflect the effect of the enhanced toll diversion process on the trip distribution and mode choice steps for the work-based trips.

3.4 SUMMARY

The information gathered by surveying 17 MPOs in North America along with various toll modeling techniques presented in this report provides a wealth of information for MAG staff to consider implementing new toll road modeling in the MAG Model. URS also presented our initial findings and recommendations at the Toll Road Modeling Workshop held at MAG Offices on October 24, 2011. The slides from this two part presentation were provided to MAG. This report also includes a brief descriptions of modifications required to existing modeling procedures along with a sample pseudo code provided in **Appendix B**.

URS

Appendix A – Survey Responses

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TOLL ROAD MODELING INTO MAG TRAVEL DEMAND MODEL

URS Corporation (URS) is retained by the Maricopa Association of Governments (MAG), the MPO in Phoenix, AZ to conduct research on existing practices adopted by MPOs for Toll Road Modeling, especially the Managed/HOT Lanes Modeling. We would appreciate your cooperattion in responding to the following questions. Thank you in advance for your participation. (Please click gray box to enter text or mark check boxes)

Survey Questionnaire

Name of the MPO/Agency: Atlanta Regional Commission
Name of the Respondent-Position/Title: Guy Rousseau Traffic Modeling
Phone: 404.463.3274 *Email:* grousseau@atlantaregional*Date:* 9/6/11

1. Are there any Toll roads in the MPO region?
   ☒Yes ☐ No
   If yes, please name them and their operating agencies:
   GA-400 (see www.georgiatolls.com)

2. Are there any Managed/HOT Lanes in the MPO region?
   ☒Yes ☐ No
   If yes, please name them and their operating agencies:
   to open soon, in a couple of weeks, a segment of I-85 HOV being converted to HOT, see
   http://www.georgiatolls.com/assets/docs/TestingAnnouncement_090611.pdf

3. Are there any planned Toll roads/HOT Lanes/Managed Lanes in the MPO region?
   ☒Yes ☐ No
   If yes, please name them and their operating agencies:
   One will open in September 2011 on I-85, an HOV to HOT conversion (www.georgiatolls.com will operate)

4. If answered yes for one of questions #1 through #3, what sources of financing were used or are planned for the toll facilities?
   ☒Federal Government (All Sources) ☐State Government
   ☐Local/County/District Government ☐Public-Private Partnership (PPP/P3)
   ☐Private Sector ☐Bond Financing
   Other:

5. What type of travel demand model does the MPO currently use for its forecast needs?
   ☒Activity/Tour Based Model ☒Four-Step Model
   Other: we have both and run / use both

6. What software platform does the MPO use for the above chosen model?
   ☐TransCAD ☒Cube/Voyager ☐EMME2/3
   ☒TP+ Other:

7. What type of model is used for the Trip Distribution process?
   ☒Gravity Model ☐Atomistic Model
   ☐Synthetic Friction Factors Method ☒Destination Choice Model
   Other: gravity model in 4-step model, destination choice in activity-based model

8. What variables are used in the impedance function of the Trip Distribution procedure?
   ☒Travel Time ☒Travel Cost
   ☒Toll Cost ☒Operating Cost
   Other: varies depending on model used, 4-steo model or ABM

9. What type of Mode Choice model is used to develop trip tables?
   - ☐ Multinomial Logit Model
   - ☒ Nested Logit Model
   - Other:

10. Are highway tolls included in the utility estimation of the Mode Choice model?
    - ☒ Yes
    - ☒ No

11. Are Value-of-Times (VOTs) included in the model?
    - ☒ Yes
    - ☐ No

    If answered yes for the Question #11, how are VOTs estimated?
    - ☐ By Mode
    - ☒ By Vehicle Type
    - ☐ By Purpose

    If answered yes for the Question #11, which steps uses VOTs in the model?
    - ☐ Trip Distribution
    - ☒ Mode Choice
    - ☒ Traffic Assignment

12. What types of trip purposes are included in the Mode Choice model? Please mention them:
    - ☒ Home-Based Work
    - ☒ Home-Based Other
    - ☐ Home-Based School
    - ☒ Home-Based Shopping
    - ☐ Home-Based University
    - ☐ Non-Home-Based Work
    - ☐ Non-Home-Based Other
    - Other:

13. What types of trip tables are produced from the Mode Choice model?
    - ☒ Single Occupancy Vehicles
    - ☒ High Occupancy Vehicles 2
    - ☐ High Occupancy Vehicles 2+
    - ☒ High Occupancy Vehicles 3
    - ☒ High Occupancy Vehicles 3+
    - ☐ Trucks (Light/Medium/Heavy)
    - ☐ Local Bus
    - ☐ Express Bus
    - ☐ Rapid Bus
    - ☐ Bus Rapid Transit (BRT)
    - ☐ Commuter Rail
    - ☐ Light Rail
    - ☐ Walk
    - ☐ Bike
    - Other: Transit

14. Are the trip tables from Mode Choice output divided into Toll and Toll-Free modes?
    - ☒ Yes
    - ☒ No

    If yes, for what modes are the Trip Tables divided into toll and toll-free?
    - ☒ Single Occupancy Vehicles
    - ☒ High Occupancy Vehicles 2
    - ☐ High Occupancy Vehicles 2+
    - ☒ High Occupancy Vehicles 3
    - ☒ High Occupancy Vehicles 3+
    - ☐ Trucks (Light/Medium/Heavy)
    - Other:

15. What time-of-day trip tables are developed for the Traffic Assignment process?
    - ☒ AM Peak Period
    - ☐ AM Peak Hour
    - ☒ PM Peak Period
    - ☐ PM Peak Hour
    - ☒ Midday
    - ☒ Night Time
    - ☐ Off-Peak (Midday + Night Time)
    - ☐ Daily
    - Other:

16. What type of Traffic Assignment process is used in the MPO model?
    - ☒ User Equilibrium Generalized
    - ☐ Cost User Equilibrium
    - ☐ Customized GCUE
    - ☐ Diversion Curve/Logit Model
    - ☐ Stochastic User Equilibrium
    - ☐ Dynamic Traffic Assignment
    - ☐ Origin-Based
    - ☐ Path-Based
    - Other:

17. What method do you use to estimate demand on the tolled facilities?
    - ☒ Diversion Curve
    - ☒ Logit Model
    - Other: diversion curves in 4-step model

    If answered Diversion Curve for the previous question, what data did you use for calibration?
    Please provide the name of data: local count data

18. Does the Traffic Assignment procedure involve any special technique for the modeling of Toll Roads/Managed Lanes?
☒Yes ☐No
If yes, please provide documentation of the procedure.
Toll diversion curves

19. Can the Traffic Assignment procedure model Variable/Congestion pricing facilities?
☒Yes ☐No
If yes, can the tolls on such facilities be changed between assignment iterations? Please provide documentation for such technique.
Via post processing, see already provided documentation

20. If answered yes for the previous question, are the time-of-day trip tables divided into smaller periods for Variable/Congestion pricing?
☒Yes ☒No
If yes, please provide the resolution of time periods: yes in ABM

21. Are you willing to share the scripts or programs where toll is involved?
☒Yes ☐No
If yes, please provide them: see attached

22. What variables are considered in choosing the shortest path during the Traffic Assignment procedure?
☒Travel Time Travel Cost ☐Toll Cost
☐Operating Cost ☐Value of Time (VOT)
Other:

23. What type of Volume/Delay Function curves are used in the Traffic Assignment process?
☐BPR ☒Conical ☐Ackelik
☐Customized VDFs for all facilities ☐Customized VDFs for Toll/Managed Lane facilities
Other:

24. Between what steps does the model apply feedback loops?
☐Traffic Assignment and Mode Choice ☒Traffic Assignment and Trip Distribution
☐Traffic Assignment and Trip Distribution and Mode Choice
Other:

25. Does the MPO intend to migrate to a new model structure in the near future?
☐Same Model ☒Activity Based Model ☐Modified Four-Step Model
Other:

26. If you want to provide additional information regarding questions above or other comments, please insert in this box.
additional details available and to be provided upon request

For any questions regarding the survey, please contact:

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Thank you for your cooperation.

TOLL ROAD MODELING INTO MAG TRAVEL DEMAND MODEL

URS Corporation (URS) is retained by the Maricopa Association of Governments (MAG), the MPO in Phoenix, AZ to conduct research on existing practices adopted by MPOs for Toll Road Modeling, especially the Managed/HOT Lanes Modeling. We would appreciate your cooperattion in responding to the following questions. Thank you in advance for your participation. (Please click gray box to enter text or mark check boxes)

Survey Questionnaire

Name of the MPO/Agency: Capital Area Metropolitan Planning Organization
Name of the Respondent-Position/Title: Daniel Yang, Ph.D., Program Manager
Phone: 512.974.6423 *Email:* daniel.yang@campotexas.or*Date:* 2-2-10

1. Are there any Toll roads in the MPO region?
   ☒Yes ☐ No
   If yes, please name them and their operating agencies:
   SH 130, 183A, SH 45 SE; by Central Texas Regional Mobility Authority (CTRMA) and TxDOT

2. Are there any Managed/HOT Lanes in the MPO region?
   ☐Yes ☒ No
   If yes, please name them and their operating agencies:

3. Are there any planned Toll roads/HOT Lanes/Managed Lanes in the MPO region?
   ☒Yes ☐ No
   If yes, please name them and their operating agencies:
   CTRMA and TxDOT potentially

4. If answered yes for one of questions #1 through #3, what sources of financing were used or are planned for the toll facilities?
   ☒Federal Government (All Sources) ☒State Government
   ☐Local/County/District Government ☒Public-Private Partnership (PPP/P3)
   ☐Private Sector ☒Bond Financing
   Other:

5. What type of travel demand model does the MPO currently use for its forecast needs?
   ☐Activity/Tour Based Model ☒Four-Step Model
   Other:

6. What software platform does the MPO use for the above chosen model?
   ☒TransCAD ☐Cube/Voyager ☐EMME2/3
   ☐TP+ Other:

7. What type of model is used for the Trip Distribution process?
   ☐Gravity Model ☒Atomistic Model
   ☐Synthetic Friction Factors Method ☐Destination Choice Model
   Other:

8. What variables are used in the impedance function of the Trip Distribution procedure?
   ☒Travel Time ☐Travel Cost
   ☐Toll Cost ☐Operating Cost
   Other:

9. What type of Mode Choice model is used to develop trip tables?
   ☐Multinomial Logit Model ☒Nested Logit Model

Other:

10. Are highway tolls included in the utility estimation of the Mode Choice model?
☐ Yes ☒ No

11. Are Value-of-Times (VOTs) included in the model?
☒ Yes ☐ No
If answered yes for the Question #11, how are VOTs estimated?
☒ By Mode ☒ By Vehicle Type ☐ By Purpose
If answered yes for the Question #11, which steps uses VOTs in the model?
☐ Trip Distribution ☐ Mode Choice ☒ Traffic Assignment

12. What types of trip purposes are included in the Mode Choice model? Please mention them:
☒ Home-Based Work ☒ Home-Based Other
☒ Home-Based School ☒ Home-Based Shopping
☒ Home-Based University ☒ Non-Home-Based Work
☒ Non-Home-Based Other
Other:

13. What types of trip tables are produced from the Mode Choice model?
☒ Single Occupancy Vehicles ☒ High Occupancy Vehicles 2
☒ High Occupancy Vehicles 2+ ☒ High Occupancy Vehicles 3
☒ High Occupancy Vehicles 3+ ☐ Trucks (Light/Medium/Heavy)
☐ Local Bus ☐ Express Bus
☐ Rapid Bus ☐ Bus Rapid Transit (BRT)
☐ Commuter Rail ☐ Light Rail
☐ Walk ☐ Bike
Other: Transit

14. Are the trip tables from Mode Choice output divided into Toll and Toll-Free modes?
☒ Yes ☐ No

If yes, for what modes are the Trip Tables divided into toll and toll-free?
☒ Single Occupancy Vehicles ☒ High Occupancy Vehicles 2
☒ High Occupancy Vehicles 2+ ☒ High Occupancy Vehicles 3
☒ High Occupancy Vehicles 3+ ☐ Trucks (Light/Medium/Heavy)
Other: Transit

15. What time-of-day trip tables are developed for the Traffic Assignment process?
☒ AM Peak Period ☐ AM Peak Hour
☐ PM Peak Period ☐ PM Peak Hour
☐ Midday ☐ Night Time
☐ Off-Peak (Midday + Night Time) ☒ Daily
Other:

16. What type of Traffic Assignment process is used in the MPO model?
☐ User Equilibrium Generalized ☒ Cost User Equilibrium
☐ Customized GCUE ☐ Diversion Curve/Logit Model
☐ Stochastic User Equilibrium ☐ Dynamic Traffic Assignment
☐ Origin-Based ☐ Path-Based
Other:

17. What method do you use to estimate demand on the tolled facilities?
☐ Diversion Curve ☐ Logit Model
Other:
If answered Diversion Curve for the previous question, what data did you use for calibration?
Please provide the name of data:

18. Does the Traffic Assignment procedure involve any special technique for the modeling of Toll Roads/Managed Lanes?
☒Yes ☐No
If yes, please provide documentation of the procedure.

19. Can the Traffic Assignment procedure model Variable/Congestion pricing facilities?
☐Yes ☒No
If yes, can the tolls on such facilities be changed between assignment iterations? Please provide documentation for such technique.

20. If answered yes for the previous question, are the time-of-day trip tables divided into smaller periods for Variable/Congestion pricing?
☐Yes ☐No
If yes, please provide the resolution of time periods:

21. Are you willing to share the scripts or programs where toll is involved?
☐Yes ☒No
If yes, please provide them:

22. What variables are considered in choosing the shortest path during the Traffic Assignment procedure?
☒Travel Time Travel Cost ☐Toll Cost
☐Operating Cost ☐Value of Time (VOT)
Other:

23. What type of Volume/Delay Function curves are used in the Traffic Assignment process?
☒BPR ☐Conical ☐Ackelik
☐Customized VDFs for all facilities ☐Customized VDFs for Toll/Managed Lane facilities
Other:

24. Between what steps does the model apply feedback loops?
☐Traffic Assignment and Mode Choice ☒Traffic Assignment and Trip Distribution
☐Traffic Assignment and Trip Distribution and Mode Choice
Other:

25. Does the MPO intend to migrate to a new model structure in the near future?
☐Same Model ☐Activity Based Model ☐Modified Four-Step Model
Other:

26. If you want to provide additional information regarding questions above or other comments, please insert in this box.

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TOLL ROAD MODELING INTO MAG TRAVEL DEMAND MODEL

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Survey Questionnaire

Name of the MPO/Agency: BRTB
Name of the Respondent-Position/Title: Charles Baber Principal Transportation Planner
Phone: 410-732-0500 *Email:* cbaber@baltometro.org*Date:* 9/12/11

1. Are there any Toll roads in the MPO region?
   ☒Yes ☐ No
   If yes, please name them and their operating agencies:
   Harbor Crossings I-95, I-895, I-695, Susquehanna River I-95 and Bay Bridge US 50/301 Maryland Transportation Authority

2. Are there any Managed/HOT Lanes in the MPO region?
   ☐Yes ☒ No
   If yes, please name them and their operating agencies:

3. Are there any planned Toll roads/HOT Lanes/Managed Lanes in the MPO region?
   ☒Yes ☐ No
   If yes, please name them and their operating agencies:
   I-95 from Baltimore Beltway to north of MD 43 Maryland Transportation Authority

4. If answered yes for one of questions #1 through #3, what sources of financing were used or are planned for the toll facilities?
   ☐Federal Government (All Sources) ☐State Government
   ☐Local/County/District Government ☐Public-Private Partnership (PPP/P3)
   ☐Private Sector ☒Bond Financing
   Other:

5. What type of travel demand model does the MPO currently use for its forecast needs?
   ☐Activity/Tour Based Model ☒Four-Step Model
   Other:

6. What software platform does the MPO use for the above chosen model?
   ☐TransCAD ☒Cube/Voyager ☐EMME2/3
   ☒TP+ Other:

7. What type of model is used for the Trip Distribution process?
   ☒Gravity Model ☐Atomistic Model
   ☐Synthetic Friction Factors Method ☐Destination Choice Model
   Other:

8. What variables are used in the impedance function of the Trip Distribution procedure?
   ☒Travel Time ☐Travel Cost
   ☒Toll Cost ☐Operating Cost
   Other: Transit Travel Time

9. What type of Mode Choice model is used to develop trip tables?
   ☐Multinomial Logit Model ☒Nested Logit Model

Other:

10. Are highway tolls included in the utility estimation of the Mode Choice model?
☒Yes ☐No

11. Are Value-of-Times (VOTs) included in the model?
☒Yes ☐ No
If answered yes for the Question #11, how are VOTs estimated?
☐By Mode ☐By Vehicle Type ☐By Purpose
If answered yes for the Question #11, which steps uses VOTs in the model?
☐Trip Distribution ☐Mode Choice ☒Traffic Assignment

12. What types of trip purposes are included in the Mode Choice model? Please mention them:
☒Home-Based Work ☒Home-Based Other
☒Home-Based School ☒Home-Based Shopping
☐Home-Based University ☒Non-Home-Based Work
☒Non-Home-Based Other
Other:

13. What types of trip tables are produced from the Mode Choice model?
☒Single Occupancy Vehicles ☒High Occupancy Vehicles 2
☐High Occupancy Vehicles 2+ ☐High Occupancy Vehicles 3
☒High Occupancy Vehicles 3+ ☐Trucks (Light/Medium/Heavy)
☒Local Bus ☒Express Bus
☐Rapid Bus ☐Bus Rapid Transit (BRT)
☒Commuter Rail ☒Light Rail
☐Walk ☐Bike
Other:

14. Are the trip tables from Mode Choice output divided into Toll and Toll-Free modes?
☒Yes ☐ No
If yes, for what modes are the Trip Tables divided into toll and toll-free?
☒Single Occupancy Vehicles ☒High Occupancy Vehicles 2
☐High Occupancy Vehicles 2+ ☐High Occupancy Vehicles 3
☒High Occupancy Vehicles 3+ ☒Trucks (Light/Medium/Heavy)
Other:

15. What time-of-day trip tables are developed for the Traffic Assignment process?
☒AM Peak Period ☐AM Peak Hour
☒PM Peak Period ☐PM Peak Hour
☒Midday ☐Night Time
☒Off-Peak (Midday + Night Time) ☐Daily
Other:

16. What type of Traffic Assignment process is used in the MPO model?
☒User Equilibrium Generalized ☐Cost User Equilibrium
☐Customized GCUE ☐Diversion Curve/Logit Model
☐Stochastic User Equilibrium ☐Dynamic Traffic Assignment
☐Origin-Based ☐Path-Based
Other:

17. What method do you use to estimate demand on the tolled facilities?
☒Diversion Curve ☐Logit Model
Other:
If answered Diversion Curve for the previous question, what data did you use for calibration?
Please provide the name of data:

18. Does the Traffic Assignment procedure involve any special technique for the modeling of Toll Roads/Managed Lanes?
☐Yes ☒No
If yes, please provide documentation of the procedure.

19. Can the Traffic Assignment procedure model Variable/Congestion pricing facilities?
☒Yes ☐No
If yes, can the tolls on such facilities be changed between assignment iterations? Please provide documentation for such technique.

20. If answered yes for the previous question, are the time-of-day trip tables divided into smaller periods for Variable/Congestion pricing?
☐Yes ☐No
If yes, please provide the resolution of time periods:

21. Are you willing to share the scripts or programs where toll is involved?
☒Yes ☐No
If yes, please provide them:

22. What variables are considered in choosing the shortest path during the Traffic Assignment procedure?
☒Travel Time Travel Cost ☐Toll Cost
☐Operating Cost ☐Value of Time (VOT)
Other:

23. What type of Volume/Delay Function curves are used in the Traffic Assignment process?
☐BPR ☐Conical ☐Ackelik
☒Customized VDFs for all facilities ☐Customized VDFs for Toll/Managed Lane facilities
Other:

24. Between what steps does the model apply feedback loops?
☐Traffic Assignment and Mode Choice ☐Traffic Assignment and Trip Distribution
☒Traffic Assignment and Trip Distribution and Mode Choice
Other:

25. Does the MPO intend to migrate to a new model structure in the near future?
☐Same Model ☒Activity Based Model ☐Modified Four-Step Model
Other:

26. If you want to provide additional information regarding questions above or other comments, please insert in this box.

For any questions regarding the survey, please contact:

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john_song@urscorp.com

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TOLL ROAD MODELING INTO MAG TRAVEL DEMAND MODEL

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Survey Questionnaire

Name of the MPO/Agency: Chicago Metropolitan Agency for Planning
Name of the Respondent-Position/Title: Kermit Wies, Deputy Executive Director
Phone: 312 386 8820 *Email:* kwies@cmap.illinois.gov*Date:* 9/6/2011

1. Are there any Toll roads in the MPO region?
   ☒Yes ☐ No
   If yes, please name them and their operating agencies:
   Illinois Tollway

2. Are there any Managed/HOT Lanes in the MPO region?
   ☐Yes ☒ No
   If yes, please name them and their operating agencies:

3. Are there any planned Toll roads/HOT Lanes/Managed Lanes in the MPO region?
   ☒Yes ☐ No
   If yes, please name them and their operating agencies:
   I-90 Jane Addams Tollway, Illinois Tollway
   Elgin-O'Hare West Bypass, Illinois Department of Transportation
   I-290 Eisenhower Expressway, Illinois Department of Transportation

4. If answered yes for one of questions #1 through #3, what sources of financing were used or are planned for the toll facilities?
   ☒Federal Government (All Sources) ☒State Government
   ☐Local/County/District Government ☒Public-Private Partnership (PPP/P3)
   ☐Private Sector ☐Bond Financing
   Other:

5. What type of travel demand model does the MPO currently use for its forecast needs?
   ☐Activity/Tour Based Model ☒Four-Step Model
   Other:

6. What software platform does the MPO use for the above chosen model?
   ☐TransCAD ☐Cube/Voyager ☒EMME2/3
   ☐TP+ Other:

7. What type of model is used for the Trip Distribution process?
   ☐Gravity Model ☐Atomistic Model
   ☐Synthetic Friction Factors Method ☐Destination Choice Model
   Other: Intervening Opportunities

8. What variables are used in the impedance function of the Trip Distribution procedure?
   ☒Travel Time ☒Travel Cost
   ☒Toll Cost ☒Operating Cost
   Other:

9. What type of Mode Choice model is used to develop trip tables?
   - ☐ Multinomial Logit Model
   - ☐ Nested Logit Model
   - Other: Binary Logit w/ Stochastic Enumeration

10. Are highway tolls included in the utility estimation of the Mode Choice model?
    - ☐ Yes
    - ☒ No

11. Are Value-of-Times (VOTs) included in the model?
    - ☒ Yes
    - ☐ No

    If answered yes for the Question #11, how are VOTs estimated?
    - ☒ By Mode
    - ☐ By Vehicle Type
    - ☒ By Purpose

    If answered yes for the Question #11, which steps uses VOTs in the model?
    - ☒ Trip Distribution
    - ☒ Mode Choice
    - ☐ Traffic Assignment

12. What types of trip purposes are included in the Mode Choice model? Please mention them:
    - ☒ Home-Based Work
    - ☒ Home-Based Other
    - ☐ Home-Based School
    - ☐ Home-Based Shopping
    - ☐ Home-Based University
    - ☒ Non-Home-Based Work
    - ☐ Non-Home-Based Other
    - Other:

13. What types of trip tables are produced from the Mode Choice model?
    - ☒ Single Occupancy Vehicles
    - ☐ High Occupancy Vehicles 2
    - ☒ High Occupancy Vehicles 2+
    - ☐ High Occupancy Vehicles 3
    - ☐ High Occupancy Vehicles 3+
    - ☐ Trucks (Light/Medium/Heavy)
    - ☐ Local Bus
    - ☐ Express Bus
    - ☐ Rapid Bus
    - ☐ Bus Rapid Transit (BRT)
    - ☐ Commuter Rail
    - ☐ Light Rail
    - ☐ Walk
    - ☐ Bike
    - Other: Generic Transit

14. Are the trip tables from Mode Choice output divided into Toll and Toll-Free modes?
    - ☐ Yes
    - ☒ No

    If yes, for what modes are the Trip Tables divided into toll and toll-free?
    - ☐ Single Occupancy Vehicles
    - ☐ High Occupancy Vehicles 2
    - ☐ High Occupancy Vehicles 2+
    - ☐ High Occupancy Vehicles 3
    - ☐ High Occupancy Vehicles 3+
    - ☐ Trucks (Light/Medium/Heavy)
    - Other:

15. What time-of-day trip tables are developed for the Traffic Assignment process?
    - ☒ AM Peak Period
    - ☐ AM Peak Hour
    - ☒ PM Peak Period
    - ☐ PM Peak Hour
    - ☒ Midday
    - ☐ Night Time
    - ☒ Off-Peak (Midday + Night Time)
    - ☐ Daily
    - Other:

16. What type of Traffic Assignment process is used in the MPO model?
    - ☐ User Equilibrium Generalized
    - ☐ Cost User Equilibrium
    - ☐ Customized GCUE
    - ☐ Diversion Curve/Logit Model
    - ☐ Stochastic User Equilibrium
    - ☐ Dynamic Traffic Assignment
    - ☐ Origin-Based
    - ☒ Path-Based
    - Other:

17. What method do you use to estimate demand on the tolled facilities?
    - ☐ Diversion Curve
    - ☐ Logit Model
    - Other:

    If answered Diversion Curve for the previous question, what data did you use for calibration?
    Please provide the name of data:

18. Does the Traffic Assignment procedure involve any special technique for the modeling of Toll Roads/Managed Lanes?
☒Yes ☐No
If yes, please provide documentation of the procedure.
http://www.cmap.illinois.gov/modeling

19. Can the Traffic Assignment procedure model Variable/Congestion pricing facilities?
☐Yes ☒No
If yes, can the tolls on such facilities be changed between assignment iterations? Please provide documentation for such technique.

20. If answered yes for the previous question, are the time-of-day trip tables divided into smaller periods for Variable/Congestion pricing?
☐Yes ☐No
If yes, please provide the resolution of time periods:

21. Are you willing to share the scripts or programs where toll is involved?
☐Yes ☒No
If yes, please provide them: http://www.cmap.illinois.gov/modeling

22. What variables are considered in choosing the shortest path during the Traffic Assignment procedure?
☒Travel Time Travel Cost ☒Toll Cost
☐Operating Cost ☐Value of Time (VOT)
Other:

23. What type of Volume/Delay Function curves are used in the Traffic Assignment process?
☐BPR ☐Conical ☐Ackelik
☐Customized VDFs for all facilities ☒Customized VDFs for Toll/Managed Lane facilities
Other:

24. Between what steps does the model apply feedback loops?
☐Traffic Assignment and Mode Choice ☐Traffic Assignment and Trip Distribution
☒Traffic Assignment and Trip Distribution and Mode Choice
Other:

25. Does the MPO intend to migrate to a new model structure in the near future?
☐Same Model ☒Activity Based Model ☐Modified Four-Step Model
Other:

26. If you want to provide additional information regarding questions above or other comments, please insert in this box.

For any questions regarding the survey, please contact:

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Survey Questionnaire

Name of the MPO/Agency: North Central Texas Council of Governments (NCTCOG)
Name of the Respondent-Position/Title: Behruz Paschai, Transportation System Modeling Manager
Phone: 817.704.2547 *Email:* bpaschai@nctcog.org*Date:* 9/20/2011

1. Are there any Toll roads in the MPO region?
   ☒Yes ☐ No
   If yes, please name them and their operating agencies:
   Dallas North Tollway (DNT), President George Bush Turnpike (PGBT), and Sam Rayburn Tollway (State Highway 121 Tollway) all operated by the North Texas Tollway Authority (NTTA).

2. Are there any Managed/HOT Lanes in the MPO region?
   ☐Yes ☒ No
   If yes, please name them and their operating agencies:

3. Are there any planned Toll roads/HOT Lanes/Managed Lanes in the MPO region?
   ☒Yes ☐ No
   If yes, please name them and their operating agencies:
   There are several facilities planned that will be constructed by NTTA or by other firms as part of a CDA agreement.

4. If answered yes for one of questions #1 through #3, what sources of financing were used or are planned for the toll facilities?
   ☒Federal Government (All Sources) ☒State Government
   ☒Local/County/District Government ☒Public-Private Partnership (PPP/P3)
   ☐Private Sector ☒Bond Financing
   Other:

5. What type of travel demand model does the MPO currently use for its forecast needs?
   ☐Activity/Tour Based Model ☒Four-Step Model
   Other:

6. What software platform does the MPO use for the above chosen model?
   ☒TransCAD ☐Cube/Voyager ☐EMME2/3
   ☐TP+ Other:

7. What type of model is used for the Trip Distribution process?
   ☒Gravity Model ☐Atomistic Model
   ☐Synthetic Friction Factors Method ☐Destination Choice Model
   Other:

8. What variables are used in the impedance function of the Trip Distribution procedure?
   ☒Travel Time ☐Travel Cost
   ☐Toll Cost ☐Operating Cost
   Other:

9. What type of Mode Choice model is used to develop trip tables?
   - ☐ Multinomial Logit Model
   - ☒ Nested Logit Model
   - Other:

10. Are highway tolls included in the utility estimation of the Mode Choice model?
    - ☒ Yes
    - ☐ No

11. Are Value-of-Times (VOTs) included in the model?
    - ☒ Yes
    - ☐ No

    If answered yes for the Question #11, how are VOTs estimated?
    - ☐ By Mode
    - ☒ By Vehicle Type
    - ☐ By Purpose

    If answered yes for the Question #11, which steps uses VOTs in the model?
    - ☐ Trip Distribution
    - ☒ Mode Choice
    - ☒ Traffic Assignment

12. What types of trip purposes are included in the Mode Choice model? Please mention them:
    - ☒ Home-Based Work
    - ☒ Home-Based Other
    - ☐ Home-Based School
    - ☐ Home-Based Shopping
    - ☐ Home-Based University
    - ☐ Non-Home-Based Work
    - ☒ Non-Home-Based Other
    - Other:

13. What types of trip tables are produced from the Mode Choice model?
    - ☒ Single Occupancy Vehicles
    - ☒ High Occupancy Vehicles 2
    - ☐ High Occupancy Vehicles 2+
    - ☐ High Occupancy Vehicles 3
    - ☒ High Occupancy Vehicles 3+
    - ☐ Trucks (Light/Medium/Heavy)
    - ☐ Local Bus
    - ☐ Express Bus
    - ☐ Rapid Bus
    - ☐ Bus Rapid Transit (BRT)
    - ☐ Commuter Rail
    - ☐ Light Rail
    - ☐ Walk
    - ☐ Bike
    - Other: Rail, Bus, Bus/Rail

14. Are the trip tables from Mode Choice output divided into Toll and Toll-Free modes?
    - ☐ Yes
    - ☒ No

    If yes, for what modes are the Trip Tables divided into toll and toll-free?
    - ☐ Single Occupancy Vehicles
    - ☐ High Occupancy Vehicles 2
    - ☐ High Occupancy Vehicles 2+
    - ☐ High Occupancy Vehicles 3
    - ☐ High Occupancy Vehicles 3+
    - ☐ Trucks (Light/Medium/Heavy)
    - Other: N/A

15. What time-of-day trip tables are developed for the Traffic Assignment process?
    - ☒ AM Peak Period
    - ☐ AM Peak Hour
    - ☒ PM Peak Period
    - ☐ PM Peak Hour
    - ☐ Midday
    - ☐ Night Time
    - ☒ Off-Peak (Midday + Night Time)
    - ☐ Daily
    - Other:

16. What type of Traffic Assignment process is used in the MPO model?
    - ☐ User Equilibrium Generalized
    - ☐ Cost User Equilibrium
    - ☐ Customized GCUE
    - ☐ Diversion Curve/Logit Model
    - ☐ Stochastic User Equilibrium
    - ☐ Dynamic Traffic Assignment
    - ☐ Origin-Based
    - ☐ Path-Based
    - Other: GCUE

17. What method do you use to estimate demand on the tolled facilities?
    - ☐ Diversion Curve
    - ☐ Logit Model
    - Other: GCUE

    If answered Diversion Curve for the previous question, what data did you use for calibration?
    Please provide the name of data: N/A

18. Does the Traffic Assignment procedure involve any special technique for the modeling of Toll Roads/Managed Lanes?
☐Yes ☒No
If yes, please provide documentation of the procedure.

19. Can the Traffic Assignment procedure model Variable/Congestion pricing facilities?
☒Yes ☐No
If yes, can the tolls on such facilities be changed between assignment iterations? Please provide documentation for such technique.
N/A

20. If answered yes for the previous question, are the time-of-day trip tables divided into smaller periods for Variable/Congestion pricing?
☐Yes ☒No
If yes, please provide the resolution of time periods:

21. Are you willing to share the scripts or programs where toll is involved?
☐Yes ☒No
If yes, please provide them: N/A

22. What variables are considered in choosing the shortest path during the Traffic Assignment procedure?
☒Travel Time Travel Cost ☒Toll Cost
☒Operating Cost ☒Value of Time (VOT)
Other:

23. What type of Volume/Delay Function curves are used in the Traffic Assignment process?
☐BPR ☒Conical ☐Ackelik
☒Customized VDFs for all facilities ☐Customized VDFs for Toll/Managed Lane facilities
Other:

24. Between what steps does the model apply feedback loops?
☐Traffic Assignment and Mode Choice ☒Traffic Assignment and Trip Distribution
☐Traffic Assignment and Trip Distribution and Mode Choice
Other:

25. Does the MPO intend to migrate to a new model structure in the near future?
☒Same Model ☐Activity Based Model ☐Modified Four-Step Model
Other:

26. If you want to provide additional information regarding questions above or other comments, please insert in this box.

For any questions regarding the survey, please contact:

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Thank you for your cooperation.

TOLL ROAD MODELING INTO MAG TRAVEL DEMAND MODEL

URS Corporation (URS) is retained by the Maricopa Association of Governments (MAG), the MPO in Phoenix, AZ to conduct research on existing practices adopted by MPOs for Toll Road Modeling, especially the Managed/HOT Lanes Modeling. We would appreciate your cooperattion in responding to the following questions. Thank you in advance for your participation. (Please click gray box to enter text or mark check boxes)

Survey Questionnaire

Name of the MPO/Agency: Denver Regional Council of Governments
Name of the Respondent-Position/Title: Regional Modeling Manager
Phone: 303-455-1000 *Email:* esabina@drcog.org *Date:* 11/7/11

1. Are there any Toll roads in the MPO region?
   ☒Yes ☐ No
   If yes, please name them and their operating agencies:
   Northwest Parkway (Northwest Parkway Authority), E-470 (E-470 Authority)

2. Are there any Managed/HOT Lanes in the MPO region?
   ☒Yes ☐ No
   If yes, please name them and their operating agencies:
   I-25 HOV Express Lanes

3. Are there any planned Toll roads/HOT Lanes/Managed Lanes in the MPO region?
   ☐Yes ☐ No
   If yes, please name them and their operating agencies:
   Extension of the I-25 HOV Express Lanes onto US-36, and several other possibilities (varous corridor studies are looking at pricing in one form or another)

4. If answered yes for one of questions #1 through #3, what sources of financing were used or are planned for the toll facilities?
   ☐Federal Government (All Sources) ☐State Government
   ☐Local/County/District Government ☐Public-Private Partnership (PPP/P3)
   ☐Private Sector ☐Bond Financing
   Other: I'm not an expert in this area, but I think that most of the above are under consideration.

5. What type of travel demand model does the MPO currently use for its forecast needs?
   ☒Activity/Tour Based Model ☐Four-Step Model
   Other:

6. What software platform does the MPO use for the above chosen model?
   ☒TransCAD ☐Cube/Voyager ☐EMME2/3
   ☐TP+ Other: Plus custom sw build to interface with TransCAD

7. What type of model is used for the Trip Distribution process?
   ☐Gravity Model ☐Atomistic Model
   ☐Synthetic Friction Factors Method ☒Destination Choice Model
   Other:

8. What variables are used in the impedance function of the Trip Distribution procedure?
   ☒Travel Time ☒Travel Cost
   ☒Toll Cost ☒Operating Cost
   Other: All the above, plus various characteristics of the people and zones (such as size variables showing jobs by type in the zone.)

9. What type of Mode Choice model is used to develop trip tables?
   ☒Multinomial Logit Model ☐Nested Logit Model
   Other:

10. Are highway tolls included in the utility estimation of the Mode Choice model?
   ☒Yes ☐No

11. Are Value-of-Times (VOTs) included in the model?
   ☒Yes ☐ No
   If answered yes for the Question #11, how are VOTs estimated?
   ☐By Mode ☐By Vehicle Type ☒By Purpose
   If answered yes for the Question #11, which steps uses VOTs in the model?
   ☒Trip Distribution ☒Mode Choice ☒Traffic Assignment

12. What types of trip purposes are included in the Mode Choice model? Please mention them:
   ☐Home-Based Work ☐Home-Based Other
   ☐Home-Based School ☐Home-Based Shopping
   ☐Home-Based University ☐Non-Home-Based Work
   ☐Non-Home-Based Other
   Other: Work, School, Escort, Other, and work-based sub-tour

13. What types of trip tables are produced from the Mode Choice model?
   ☒Single Occupancy Vehicles ☒High Occupancy Vehicles 2
   ☐High Occupancy Vehicles 2+ ☐High Occupancy Vehicles 3
   ☒High Occupancy Vehicles 3+ ☒Trucks (Light/Medium/Heavy)
   ☐Local Bus ☐Express Bus
   ☐Rapid Bus ☐Bus Rapid Transit (BRT)
   ☐Commuter Rail ☐Light Rail
   ☒Walk ☒Bike
   Other: Walk to transit, drive to transit

14. Are the trip tables from Mode Choice output divided into Toll and Toll-Free modes?
   ☐Yes ☒ No
   If yes, for what modes are the Trip Tables divided into toll and toll-free?
   ☐Single Occupancy Vehicles ☐High Occupancy Vehicles 2
   ☐High Occupancy Vehicles 2+ ☐High Occupancy Vehicles 3
   ☐High Occupancy Vehicles 3+ ☐Trucks (Light/Medium/Heavy)
   Other:

15. What time-of-day trip tables are developed for the Traffic Assignment process?
   ☐AM Peak Period ☐AM Peak Hour
   ☐PM Peak Period ☐PM Peak Hour
   ☐Midday ☐Night Time
   ☐Off-Peak (Midday + Night Time) ☐Daily
   Other: ten periods: three for AM period, three for PM period, two mid-day, and two evening/night.

16. What type of Traffic Assignment process is used in the MPO model?
   ☒User Equilibrium Generalized ☐Cost User Equilibrium
   ☐Customized GCUE ☐Diversion Curve/Logit Model
   ☐Stochastic User Equilibrium ☐Dynamic Traffic Assignment
   ☐Origin-Based ☐Path-Based
   Other: working on a DTA model too.

17. What method do you use to estimate demand on the tolled facilities?
   ☐Diversion Curve ☐Logit Model
   Other: we just let the path-minimization of the generalized cost say where the vehicles should go. we have found that this under-estimates toll facility use, and have been struggling to find a better way. at present we are working on a survey of

toll users, and at the same time a better design for toll modeling, most likely either putting toll/non-toll into a nest below auto modes in the mode choice model, or into a binary toll/non-toll model that will be run just before assignment.
If answered Diversion Curve for the previous question, what data did you use for calibration?
Please provide the name of data:

18. Does the Traffic Assignment procedure involve any special technique for the modeling of Toll Roads/Managed Lanes?
☒Yes ☐No
If yes, please provide documentation of the procedure.
at present, we tie cost/mile on freeways/tollways to V/C, with higher cost on high V/C, to simulate the desire of some groups to avoid congested freeways/tollways, but not to avoid uncongested freeways/tollways. we prefer to move to the method we describe above, though.

19. Can the Traffic Assignment procedure model Variable/Congestion pricing facilities?
☐Yes ☒No
If yes, can the tolls on such facilities be changed between assignment iterations? Please provide documentation for such technique.

20. If answered yes for the previous question, are the time-of-day trip tables divided into smaller periods for Variable/Congestion pricing?
☐Yes ☒No
If yes, please provide the resolution of time periods:

21. Are you willing to share the scripts or programs where toll is involved?
☒Yes ☐No
If yes, please provide them: but they are nothing special, that's for sure!

22. What variables are considered in choosing the shortest path during the Traffic Assignment procedure?
☐Travel Time Travel Cost ☐Toll Cost
☒Operating Cost ☒Value of Time (VOT)
Other:

23. What type of Volume/Delay Function curves are used in the Traffic Assignment process?
☐BPR ☐Conical ☐Ackelik
☒Customized VDFs for all facilities ☐Customized VDFs for Toll/Managed Lane facilities
Other:

24. Between what steps does the model apply feedback loops?
☐Traffic Assignment and Mode Choice ☐Traffic Assignment and Trip Distribution
☐Traffic Assignment and Trip Distribution and Mode Choice
Other: goes back to daily activity pattern (and possibly to primary workplace, school, and auto choice too. I can check if that is important to you.

25. Does the MPO intend to migrate to a new model structure in the near future?
☐Same Model ☐Activity Based Model ☐Modified Four-Step Model
Other: we have an ABM now, and are working on a DTA and advanced land use model.

26. If you want to provide additional information regarding questions above or other comments, please insert in this box.

For any questions regarding the survey, please contact:

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TOLL ROAD MODELING INTO MAG TRAVEL DEMAND MODEL

URS Corporation (URS) is retained by the Maricopa Association of Governments (MAG), the MPO in Phoenix, AZ to conduct research on existing practices adopted by MPOs for Toll Road Modeling, especially the Managed/HOT Lanes Modeling. We would appreciate your cooperattion in responding to the following questions. Thank you in advance for your participation. (Please click gray box to enter text or mark check boxes)

Survey Questionnaire

Name of the MPO/Agency: Houston-Galveston Area Council
Name of the Respondent-Position/Title: Shixin David Gao/Chief Transportation Planner
Phone: 713.499.6698 *Email:* shixin.gao@h-gac.com*Date:* 2/10/2010

1. Are there any Toll roads in the MPO region?
   ☒Yes ☐ No
   If yes, please name them and their operating agencies:
   Hardy Tollway, Beltway 8, Katy Tollway and Fort Bend Tollway. Harris County Toll Road Authority and Fort Bend County.

2. Are there any Managed/HOT Lanes in the MPO region?
   ☒Yes ☐ No
   If yes, please name them and their operating agencies:
   I-10 (Katy Freeway), Harris County Toll Road Authority.

3. Are there any planned Toll roads/HOT Lanes/Managed Lanes in the MPO region?
   ☒Yes ☐ No
   If yes, please name them and their operating agencies:
   All current HOV lanes are expected to be converted into HOT lanes in the Houston metro area, which include the HOV lane on US 59, US 290, I-45, Katy HOT lane, and SH 288.

4. If answered yes for one of questions #1 through #3, what sources of financing were used or are planned for the toll facilities?
   ☒Federal Government (All Sources) ☒State Government
   ☐Local/County/District Government ☐Public-Private Partnership (PPP/P3)
   ☐Private Sector ☐Bond Financing
   Other:

5. What type of travel demand model does the MPO currently use for its forecast needs?
   ☐Activity/Tour Based Model ☒Four-Step Model
   Other:

6. What software platform does the MPO use for the above chosen model?
   ☐TransCAD ☒Cube/Voyager ☐EMME2/3
   ☐TP+ Other:

7. What type of model is used for the Trip Distribution process?
   ☐Gravity Model ☒Atomistic Model
   ☐Synthetic Friction Factors Method ☐Destination Choice Model
   Other:

8. What variables are used in the impedance function of the Trip Distribution procedure?
   ☒Travel Time ☐Travel Cost
   ☐Toll Cost ☐Operating Cost
   Other:

9. What type of Mode Choice model is used to develop trip tables?
   - ☐ Multinomial Logit Model
   - ☒ Nested Logit Model
   - Other:

10. Are highway tolls included in the utility estimation of the Mode Choice model?
    - ☒ Yes
    - ☐ No

11. Are Value-of-Times (VOTs) included in the model?
    - ☐ Yes
    - ☒ No
    - If answered yes for the Question #11, how are VOTs estimated?
    - ☐ By Mode
    - ☐ By Vehicle Type
    - ☐ By Purpose
    - If answered yes for the Question #11, which steps uses VOTs in the model?
    - ☐ Trip Distribution
    - ☐ Mode Choice
    - ☐ Traffic Assignment

12. What types of trip purposes are included in the Mode Choice model? Please mention them:
    - ☒ Home-Based Work
    - ☒ Home-Based Other
    - ☒ Home-Based School
    - ☒ Home-Based Shopping
    - ☒ Home-Based University
    - ☒ Non-Home-Based Work
    - ☒ Non-Home-Based Other
    - Other:

13. What types of trip tables are produced from the Mode Choice model?
    - ☒ Single Occupancy Vehicles
    - ☒ High Occupancy Vehicles 2
    - ☐ High Occupancy Vehicles 2+
    - ☒ High Occupancy Vehicles 3
    - ☒ High Occupancy Vehicles 3+
    - ☐ Trucks (Light/Medium/Heavy)
    - ☐ Local Bus
    - ☐ Express Bus
    - ☐ Rapid Bus
    - ☐ Bus Rapid Transit (BRT)
    - ☐ Commuter Rail
    - ☐ Light Rail
    - ☐ Walk
    - ☐ Bike
    - Other: Transit

14. Are the trip tables from Mode Choice output divided into Toll and Toll-Free modes?
    - ☒ Yes
    - ☐ No
    - If yes, for what modes are the Trip Tables divided into toll and toll-free?
    - ☒ Single Occupancy Vehicles
    - ☒ High Occupancy Vehicles 2
    - ☐ High Occupancy Vehicles 2+
    - ☒ High Occupancy Vehicles 3
    - ☒ High Occupancy Vehicles 3+
    - ☐ Trucks (Light/Medium/Heavy)
    - Other:

15. What time-of-day trip tables are developed for the Traffic Assignment process?
    - ☒ AM Peak Period
    - ☐ AM Peak Hour
    - ☒ PM Peak Period
    - ☐ PM Peak Hour
    - ☒ Midday
    - ☒ Night Time
    - ☐ Off-Peak (Midday + Night Time)
    - ☒ Daily
    - Other:

16. What type of Traffic Assignment process is used in the MPO model?
    - ☒ User Equilibrium Generalized
    - ☐ Cost User Equilibrium
    - ☐ Customized GCUE
    - ☐ Diversion Curve/Logit Model
    - ☐ Stochastic User Equilibrium
    - ☐ Dynamic Traffic Assignment
    - ☐ Origin-Based
    - ☐ Path-Based
    - Other:

17. What method do you use to estimate demand on the tolled facilities?
    - ☐ Diversion Curve
    - ☒ Logit Model
    - Other:
    - If answered Diversion Curve for the previous question, what data did you use for calibration?
    - Please provide the name of data:

18. Does the Traffic Assignment procedure involve any special technique for the modeling of Toll Roads/Managed Lanes?
☐Yes ☒No
If yes, please provide documentation of the procedure.

19. Can the Traffic Assignment procedure model Variable/Congestion pricing facilities?
☐Yes ☒No
If yes, can the tolls on such facilities be changed between assignment iterations? Please provide documentation for such technique.

20. If answered yes for the previous question, are the time-of-day trip tables divided into smaller periods for Variable/Congestion pricing?
☐Yes ☒No
If yes, please provide the resolution of time periods:

21. Are you willing to share the scripts or programs where toll is involved?
☐Yes ☒No
If yes, please provide them:

22. What variables are considered in choosing the shortest path during the Traffic Assignment procedure?
☒Travel Time Travel Cost ☐Toll Cost
☐Operating Cost ☐Value of Time (VOT)
Other:

23. What type of Volume/Delay Function curves are used in the Traffic Assignment process?
☒BPR ☐Conical ☐Ackelik
☐Customized VDFs for all facilities ☐Customized VDFs for Toll/Managed Lane facilities
Other:

24. Between what steps does the model apply feedback loops?
☐Traffic Assignment and Mode Choice ☐Traffic Assignment and Trip Distribution
☐Traffic Assignment and Trip Distribution and Mode Choice
Other: So far, feedback loops have not been applied in our model.

25. Does the MPO intend to migrate to a new model structure in the near future?
☐Same Model ☒Activity Based Model ☐Modified Four-Step Model
Other: H-GAC is in the process of developing an ABM system, with the assistance from Cambridge Systemtics, Inc. Expected to have the ABM with in 1.5 years.

26. If you want to provide additional information regarding questions above or other comments, please insert in this box.

For any questions regarding the survey, please contact:

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Thank you for your cooperation.

TOLL ROAD MODELING INTO MAG TRAVEL DEMAND MODEL

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Survey Questionnaire

Name of the MPO/Agency: Southern California Association of Governments
Name of the Respondent-Position/Title: Guoxiong Huang / Chief Modeler
Phone: 213.236.1948 *Email:* huang@scag.ca.gov*Date:* 2/10/2010

1. Are there any Toll roads in the MPO region?
   ☒Yes ☐ No
   If yes, please name them and their operating agencies:
   SR-91 Express Lanes / OCTA; SR-73 / San Joaquin Hills Transportation Corridor Agency; SR-241 / The Foothill / Eastern Transportation Corridor Agency

2. Are there any Managed/HOT Lanes in the MPO region?
   ☐Yes ☒ No
   If yes, please name them and their operating agencies:

3. Are there any planned Toll roads/HOT Lanes/Managed Lanes in the MPO region?
   ☒Yes ☐ No
   If yes, please name them and their operating agencies:
   Metro pilot HOT project on I-10 and I-110

4. If answered yes for one of questions #1 through #3, what sources of financing were used or are planned for the toll facilities?
   ☒Federal Government (All Sources) ☐State Government
   ☐Local/County/District Government ☒Public-Private Partnership (PPP/P3)
   ☐Private Sector ☒Bond Financing
   Other:

5. What type of travel demand model does the MPO currently use for its forecast needs?
   ☐Activity/Tour Based Model ☒Four-Step Model
   Other:

6. What software platform does the MPO use for the above chosen model?
   ☒TransCAD ☐Cube/Voyager ☐EMME2/3
   ☐TP+ Other:

7. What type of model is used for the Trip Distribution process?
   ☐Gravity Model ☐Atomistic Model
   ☐Synthetic Friction Factors Method ☒Destination Choice Model
   Other:

8. What variables are used in the impedance function of the Trip Distribution procedure?
   ☐Travel Time ☐Travel Cost
   ☐Toll Cost ☐Operating Cost
   Other: Logsum

9. What type of Mode Choice model is used to develop trip tables?
   - ☐ Multinomial Logit Model
   - ☒ Nested Logit Model
   - Other:

10. Are highway tolls included in the utility estimation of the Mode Choice model?
    - ☒ Yes
    - ☐ No

11. Are Value-of-Times (VOTs) included in the model?
    - ☒ Yes
    - ☐ No

    If answered yes for the Question #11, how are VOTs estimated?
    - ☒ By Mode
    - ☒ By Vehicle Type
    - ☒ By Purpose

    If answered yes for the Question #11, which steps uses VOTs in the model?
    - ☒ Trip Distribution
    - ☒ Mode Choice
    - ☒ Traffic Assignment

12. What types of trip purposes are included in the Mode Choice model? Please mention them:
    - ☒ Home-Based Work
    - ☒ Home-Based Other
    - ☒ Home-Based School
    - ☒ Home-Based Shopping
    - ☒ Home-Based University
    - ☒ Non-Home-Based Work
    - ☒ Non-Home-Based Other
    - Other:

13. What types of trip tables are produced from the Mode Choice model?
    - ☒ Single Occupancy Vehicles
    - ☒ High Occupancy Vehicles 2
    - ☐ High Occupancy Vehicles 2+
    - ☐ High Occupancy Vehicles 3
    - ☒ High Occupancy Vehicles 3+
    - ☐ Trucks (Light/Medium/Heavy)
    - ☒ Local Bus
    - ☒ Express Bus
    - ☒ Rapid Bus
    - ☒ Bus Rapid Transit (BRT)
    - ☒ Commuter Rail
    - ☒ Light Rail
    - ☒ Walk
    - ☒ Bike
    - Other: Heavy Duty Truck trip tables are generated using an integrated HDT model

14. Are the trip tables from Mode Choice output divided into Toll and Toll-Free modes?
    - ☒ Yes
    - ☐ No

    If yes, for what modes are the Trip Tables divided into toll and toll-free?
    - ☒ Single Occupancy Vehicles
    - ☒ High Occupancy Vehicles 2
    - ☐ High Occupancy Vehicles 2+
    - ☐ High Occupancy Vehicles 3
    - ☒ High Occupancy Vehicles 3+
    - ☐ Trucks (Light/Medium/Heavy)
    - Other:

15. What time-of-day trip tables are developed for the Traffic Assignment process?
    - ☒ AM Peak Period
    - ☐ AM Peak Hour
    - ☒ PM Peak Period
    - ☐ PM Peak Hour
    - ☒ Midday
    - ☒ Night Time
    - ☐ Off-Peak (Midday + Night Time)
    - ☐ Daily
    - Other: Evening

16. What type of Traffic Assignment process is used in the MPO model?
    - ☒ User Equilibrium Generalized
    - ☐ Cost User Equilibrium
    - ☐ Customized GCUE
    - ☒ Diversion Curve/Logit Model
    - ☐ Stochastic User Equilibrium
    - ☐ Dynamic Traffic Assignment
    - ☐ Origin-Based
    - ☐ Path-Based
    - Other:

17. What method do you use to estimate demand on the tolled facilities?
    - ☒ Diversion Curve
    - ☐ Logit Model
    - Other:

    If answered Diversion Curve for the previous question, what data did you use for calibration?
    Please provide the name of data: SP Survey

18. Does the Traffic Assignment procedure involve any special technique for the modeling of Toll Roads/Managed Lanes?
☒Yes ☐No
If yes, please provide documentation of the procedure.

19. Can the Traffic Assignment procedure model Variable/Congestion pricing facilities?
☐Yes ☒No
If yes, can the tolls on such facilities be changed between assignment iterations? Please provide documentation for such technique.

20. If answered yes for the previous question, are the time-of-day trip tables divided into smaller periods for Variable/Congestion pricing?
☒Yes ☐No
If yes, please provide the resolution of time periods: 31 mostly 1/2 hour periods

21. Are you willing to share the scripts or programs where toll is involved?
☐Yes ☐No
If yes, please provide them: Not at this time

22. What variables are considered in choosing the shortest path during the Traffic Assignment procedure?
☒Travel Time Travel Cost ☒Toll Cost
☒Operating Cost ☒Value of Time (VOT)
Other:

23. What type of Volume/Delay Function curves are used in the Traffic Assignment process?
☒BPR ☐Conical ☐Ackelik
☒Customized VDFs for all facilities ☐Customized VDFs for Toll/Managed Lane facilities
Other:

24. Between what steps does the model apply feedback loops?
☐Traffic Assignment and Mode Choice ☐Traffic Assignment and Trip Distribution
☒Traffic Assignment and Trip Distribution and Mode Choice
Other:

25. Does the MPO intend to migrate to a new model structure in the near future?
☐Same Model ☒Activity Based Model ☐Modified Four-Step Model
Other:

26. If you want to provide additional information regarding questions above or other comments, please insert in this box.

For any questions regarding the survey, please contact:

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Thank you for your cooperation.

TOLL ROAD MODELING INTO MAG TRAVEL DEMAND MODEL

URS Corporation (URS) is retained by the Maricopa Association of Governments (MAG), the MPO in Phoenix, AZ to conduct research on existing practices adopted by MPOs for Toll Road Modeling, especially the Managed/HOT Lanes Modeling. We would appreciate your cooperattion in responding to the following questions. Thank you in advance for your participation. (Please click gray box to enter text or mark check boxes)

Survey Questionnaire

Name of the MPO/Agency: Metropolitan Council of the Twin Cities
Name of the Respondent-Position/Title: Mark Filipi, Manager, Technical Planning Support. Metropolitan Transportation Services
Phone: 651.602.1725 *Email:* mark.filipi@metc.state.mn*Date:* 2/4/2010

1. Are there any Toll roads in the MPO region?
   ☐ Yes ☒ No
   If yes, please name them and their operating agencies:

2. Are there any Managed/HOT Lanes in the MPO region?
   ☒ Yes ☐ No
   If yes, please name them and their operating agencies:
   I-394 MnPASS Lane and I-35W MnPASS Lane (opened in September, 2009) - both operated by Mn Dept. of Transportation

3. Are there any planned Toll roads/HOT Lanes/Managed Lanes in the MPO region?
   ☒ Yes ☐ No
   If yes, please name them and their operating agencies:
   Currently in planning phase - final selection to occur later this year

4. If answered yes for one of questions #1 through #3, what sources of financing were used or are planned for the toll facilities?
   ☒ Federal Government (All Sources) ☒ State Government
   ☐ Local/County/District Government ☐ Public-Private Partnership (PPP/P3)
   ☐ Private Sector ☐ Bond Financing
   Other:

5. What type of travel demand model does the MPO currently use for its forecast needs?
   ☐ Activity/Tour Based Model ☒ Four-Step Model
   Other:

6. What software platform does the MPO use for the above chosen model?
   ☐ TransCAD ☒ Cube/Voyager ☐ EMME2/3
   ☒ TP+ Other:

7. What type of model is used for the Trip Distribution process?
   ☐ Gravity Model ☐ Atomistic Model
   ☐ Synthetic Friction Factors Method ☒ Destination Choice Model
   Other: Destination Choice Model

8. What variables are used in the impedance function of the Trip Distribution procedure?
   ☒ Travel Time ☐ Travel Cost
   ☐ Toll Cost ☐ Operating Cost
   Other: Composite impedance of highway sov and hov travel times and transit travel times weighted by household vehicle availabilty

9. What type of Mode Choice model is used to develop trip tables?
   - ☐ Multinomial Logit Model
   - ☒ Nested Logit Model
   - Other:

10. Are highway tolls included in the utility estimation of the Mode Choice model?
    - ☐ Yes
    - ☒ No

11. Are Value-of-Times (VOTs) included in the model?
    - ☐ Yes
    - ☒ No
    - If answered yes for the Question #11, how are VOTs estimated?
    - ☐ By Mode
    - ☐ By Vehicle Type
    - ☐ By Purpose
    - If answered yes for the Question #11, which steps uses VOTs in the model?
    - ☐ Trip Distribution
    - ☐ Mode Choice
    - ☐ Traffic Assignment

12. What types of trip purposes are included in the Mode Choice model? Please mention them:
    - ☒ Home-Based Work
    - ☒ Home-Based Other
    - ☒ Home-Based School
    - ☒ Home-Based Shopping
    - ☒ Home-Based University
    - ☒ Non-Home-Based Work
    - ☒ Non-Home-Based Other
    - Other: Home-Based Work Related

13. What types of trip tables are produced from the Mode Choice model?
    - ☒ Single Occupancy Vehicles
    - ☒ High Occupancy Vehicles 2
    - ☐ High Occupancy Vehicles 2+
    - ☐ High Occupancy Vehicles 3
    - ☒ High Occupancy Vehicles 3+
    - ☐ Trucks (Light/Medium/Heavy)
    - ☒ Local Bus
    - ☒ Express Bus
    - ☐ Rapid Bus
    - ☐ Bus Rapid Transit (BRT)
    - ☒ Commuter Rail
    - ☒ Light Rail
    - ☒ Walk
    - ☒ Bike
    - Other: Transit

14. Are the trip tables from Mode Choice output divided into Toll and Toll-Free modes?
    - ☐ Yes
    - ☒ No
    - If yes, for what modes are the Trip Tables divided into toll and toll-free?
    - ☐ Single Occupancy Vehicles
    - ☐ High Occupancy Vehicles 2
    - ☐ High Occupancy Vehicles 2+
    - ☐ High Occupancy Vehicles 3
    - ☐ High Occupancy Vehicles 3+
    - ☐ Trucks (Light/Medium/Heavy)
    - Other:

15. What time-of-day trip tables are developed for the Traffic Assignment process?
    - ☒ AM Peak Period
    - ☐ AM Peak Hour
    - ☒ PM Peak Period
    - ☐ PM Peak Hour
    - ☒ Midday
    - ☒ Night Time
    - ☒ Off-Peak (Midday + Night Time)
    - ☐ Daily
    - Other: 24 time periods, but not all one hour in length

16. What type of Traffic Assignment process is used in the MPO model?
    - ☒ User Equilibrium Generalized
    - ☐ Cost User Equilibrium
    - ☐ Customized GCUE
    - ☐ Diversion Curve/Logit Model
    - ☐ Stochastic User Equilibrium
    - ☐ Dynamic Traffic Assignment
    - ☐ Origin-Based
    - ☐ Path-Based
    - Other:

17. What method do you use to estimate demand on the tolled facilities?
    - ☒ Diversion Curve
    - ☐ Logit Model
    - Other:
    - If answered Diversion Curve for the previous question, what data did you use for calibration?
    - Please provide the name of data: I-394 user survey data prepared by NuStats for MnDOT

18. Does the Traffic Assignment procedure involve any special technique for the modeling of Toll Roads/Managed Lanes?
☒Yes ☐No
If yes, please provide documentation of the procedure.
Diversion function based on time saved versus toll free applied to SOV trips in HOT lane corridors, allowing some SOVs to use HOT lane

19. Can the Traffic Assignment procedure model Variable/Congestion pricing facilities?
☒Yes ☐No
If yes, can the tolls on such facilities be changed between assignment iterations? Please provide documentation for such technique.
Toll level based on highest V/C ratio along tolled segment

20. If answered yes for the previous question, are the time-of-day trip tables divided into smaller periods for Variable/Congestion pricing?
☐Yes ☒No
If yes, please provide the resolution of time periods:

21. Are you willing to share the scripts or programs where toll is involved?
☒Yes ☐No
If yes, please provide them: RUN PGM=HWYLOAD

```
  ID TRIP ASSIGNMENT FOR 7:30 TO 8:30

  FILEI MATI[1] = ..\work\veh_nt_nhov.trp       ; Non-HOV trips to be assigned (non-toll)
      MATI[2] = ..\work\veh_nt_hov.trp        ; HOV trips to be assigned (non-toll)
      MATI[3] = ..\work\trk.trp               ; Truck Trips to be assigned (non-toll, non-HOV)
  FILEI NETI=    ..\nets\Network2030_1632.net          ; input network

  FILEO NETO= ..\work\load2030_8.net      ; output network
      MATO= chktoll_8.mat, MO=1-11, COMBINE=T

  PARAMETERS raad=0 gap = 0.000001 MAXITERS = 30 COMBINE=EQUI    ; maximum number of iterations

  FUNCTION TC[1] = T0 * (2+SQRT(16*(1-(V/C))^2 + 1.361) - 4*(1-(V/C)) - 1.167)
  FUNCTION TC[2] = T0 * (2+SQRT(16*(1-(V/C))^2 + 1.361) - 4*(1-(V/C)) - 1.167)
  FUNCTION TC[3] = T0 * (2+SQRT(16*(1-(V/C))^2 + 1.361) - 4*(1-(V/C)) - 1.167)
  FUNCTION TC[4] = T0 * (2+SQRT(16*(1-(V/C))^2 + 1.361) - 4*(1-(V/C)) - 1.167)
  FUNCTION TC[8] = T0 * (2+SQRT(16*(1-(V/C))^2 + 1.361) - 4*(1-(V/C)) - 1.167)
  FUNCTION TC[10]= T0 * (2+SQRT(16*(1-(V/C))^2 + 1.361) - 4*(1-(V/C)) - 1.167)
  FUNCTION TC[9] = T0
  FUNCTION TC[5] = T0 * (2+SQRT(16*(1-(V/C))^2 + 1.361) - 4*(1-(V/C)) - 1.167)
  FUNCTION TC[6] = T0 * (2+SQRT(25*(1-(V/C))^2 + 1.266) - 5*(1-(V/C)) - 1.125)
  FUNCTION TC[7] = T0 * (2+SQRT(36*(1-(V/C))^2 + 1.210) - 6*(1-(V/C)) - 1.100)
  FUNCTION TC[11] = T0 * (2+SQRT(16*(1-(V/C))^2 + 1.361) - 4*(1-(V/C)) - 1.167)
  FUNCTION TC[13] = T0 * (2+SQRT(16*(1-(V/C))^2 + 1.361) - 4*(1-(V/C)) - 1.167)
  FUNCTION TC[14] = T0 * (2+SQRT(16*(1-(V/C))^2 + 1.361) - 4*(1-(V/C)) - 1.167)
  FUNCTION TC[15] = T0 * (2+SQRT(16*(1-(V/C))^2 + 1.361) - 4*(1-(V/C)) - 1.167)
  FUNCTION TC[18] = T0 * (2+SQRT(16*(1-(V/C))^2 + 1.361) - 4*(1-(V/C)) - 1.167)

  FUNCTION V=VOL[1] + VOL[2] + VOL[3]

  LOOKUP NAME=TOLL,
      LOOKUP[1]=1, RESULT=2,
      INTERPOLATE=Y,
      FAIL=25,800,
      R = '0.00 25',              ; LOS-Toll table reported by MnDOT
        '0.35 50',
        '0.54 150',
```

```
        '0.77 250',
        '0.93 350',
        '1.00 600'

LOOKUP NAME=DIVERT,
     LOOKUP[1]=1, RESULT=2,
     INTERPOLATE=Y,
     FAIL = 5,100,
     R = ' 0.0  5.0',            ; VOT distribution as reported by NuStats
        ' 8.0 50.0',
        '10.0 60.0',
        '16.3 75.0',
        '20.0 81.7',
        '23.7 85.0',
        '31.4 90.5',
        '41.7 95.0',
        '51.8 96.0',
        '58.3 98.0',
        '66.7 98.8'

PHASE=LINKREAD
   IF(LI.ASGNGRP = 0) LINKCLASS = 10
   IF(LI.ASGNGRP > 0) LINKCLASS = LI.ASGNGRP
   T0 = LI.TIME
   C  = LI.AMCAP                        ; set capacity equal to a link field
   LW.HOVFACILITY = LI.HOVFACILITY
   IF(LINKCLASS==1-7,9,11,13,14,15) ADDTOGROUP=1
   if(LI.asgngrp<>9 & LI.AMCAP=0) ADDTOGROUP=3
   IF(LW.HOVFACILITY==99) ADDTOGROUP=2     ; I-35W HOV lanes
   IF(LW.HOVFACILITY==1-9) ADDTOGROUP=4     ; I-394 HOT lanes
   IF(LW.HOVFACILITY==5) ADDTOGROUP=5
   IF(LW.HOVFACILITY==6) ADDTOGROUP=6
   if(lw.hovfacility==1,7,9) addtogroup=7
   if(lw.hovfacility==8) addtogroup=8
   _toll1 = 25
   _toll2 = 25
   _toll3 = 25
   _toll4 = 25
ENDPHASE

PHASE=ILOOP                         ; main loop for module
  PATHLOAD PATH=TIME,               ; build SOV non-pay path based on time
        EXCLUDEGRP=2,3,4,          ; exclude sovs from hov and toll facilities
        MW[1]=PATHCOST

  PATHLOAD PATH=TIME,               ; build SOV pay path based on time
        EXCLUDEGRP=2,3,            ; exclude sovs from hov facilities
        MW[2]=PATHCOST,
        MW[3]=_toll1, SELECTGROUP=5,
        MW[4]=_toll2, SELECTGROUP=6,
        mw[13]=_toll3, selectgroup=7,
        mw[14]=_toll4, selectgroup=8

  MW[5] =  MW[3]+MW[4]+mw[13]+mw[14]              ; sum of segment tolls
  MW[6] =  MW[1]-MW[2]              ; non-pay time minus pay time

  JLOOP
   IF (I==J)
```

```
      MW[8] = 0
     ELSE
      IF (MW[6]>0)
       MW[7] = MW[5]/MW[6]              ; toll cost per minute saved
       MW[8] = 100 - DIVERT(1,MW[7])      ; percent willing to pay at this level
       MW[9] = MI.1.2 * MW[8] / 100      ; paying non-hov trips
       MW[10] = MI.1.2 - MW[9]          ; non-paying non-hov trips
       MW[11] = MW[9] * MW[5]           ; revenue for average toll calculations
      ELSE
       MW[7] = -1                   ; flag for 0 min saved
       MW[8] = 0                    ; no-one will pay if there is no savings
       MW[9] = 0                    ; so paying non-hov trips are 0
       MW[10] = MI.1.2                ; all non-hov trips are non-paying
       MW[11] = 0
      ENDIF
     ENDIF
    ENDJLOOP

    PATHLOAD PATH=TIME,                 ; build non-paying sov path based on time
          EXCLUDEGRP=2,3,4,          ; exclude non-paying sovs from hov/hot facilities
          VOL[1]=MW[10]+MI.3.2        ; load non-paying sov and input truck trips

    PATHLOAD PATH=TIME,                 ; build HOV path based on time, no restrictions
          EXCLUDEGRP=3,
          VOL[2]=MI.2.2             ; load HOV trips from input matrix

    PATHLOAD PATH=TIME,                 ; build paying sov path based on time
          EXCLUDEGRP=2,3,           ; exclude paying sovs from hov facilities
          VOL[3]=MW[9]              ; load paying sov trips

  ENDPHASE

  PHASE=ADJUST
     IF (LINKNO=1)
      _maxVC1 = 0
      _maxVC2 = 0
      _maxVC3 = 0
      _maxVC4 = 0
     ENDIF
     IF (LW.HOVFACILITY==5)
      IF ((V/C) > _maxVC1) _maxVC1 = (V/C)
     ELSEIF (LW.HOVFACILITY==6)
      IF ((V/C) > _maxVC2) _maxVC2 = (V/C)
     ELSEIF (LW.HOVFACILITY==1,7,9)
       IF ((V/C) > _maxVC3) _maxVC3 = (V/C)
     ELSEIF (LW.HOVFACILITY==8)
       IF ((V/C) > _maxVC4) _maxVC4 = (V/C)
     ENDIF
    _toll1 = TOLL(1,_maxVC1)
    _toll2 = TOLL(1,_maxVC2)
    _toll3 = toll(1,_maxvc3)
    _toll4 = toll(1,_maxvc4)
  ENDPHASE
;
;
```

22. What variables are considered in choosing the shortest path during the Traffic Assignment procedure?
    ☒ Travel Time Travel Cost ☐ Toll Cost
    ☐ Operating Cost ☐ Value of Time (VOT)
    Other:

23. What type of Volume/Delay Function curves are used in the Traffic Assignment process?
    ☐ BPR ☒ Conical ☐ Ackelik
    ☐ Customized VDFs for all facilities ☐ Customized VDFs for Toll/Managed Lane facilities
    Other:

24. Between what steps does the model apply feedback loops?
    ☐ Traffic Assignment and Mode Choice ☐ Traffic Assignment and Trip Distribution
    ☒ Traffic Assignment and Trip Distribution and Mode Choice
    Other:

25. Does the MPO intend to migrate to a new model structure in the near future?
    ☐ Same Model ☐ Activity Based Model ☒ Modified Four-Step Model
    Other:

26. If you want to provide additional information regarding questions above or other comments, please insert in this box.

For any questions regarding the survey, please contact:

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602-254-6300
vlivshits@azmag.gov

Thank you for your cooperation.

TOLL ROAD MODELING INTO MAG TRAVEL DEMAND MODEL

URS Corporation (URS) is retained by the Maricopa Association of Governments (MAG), the MPO in Phoenix, AZ to conduct research on existing practices adopted by MPOs for Toll Road Modeling, especially the Managed/HOT Lanes Modeling. We would appreciate your cooperattion in responding to the following questions. Thank you in advance for your participation. (Please click gray box to enter text or mark check boxes)

Survey Questionnaire

Name of the MPO/Agency: North Jersey Transportation Planning
Name of the Respondent-Position/Title: Bob Diogo, Principal Planner
Phone: 973.639.8409 *Email:* diogo@njtpa.org*Date:* 2/2/2010

1. Are there any Toll roads in the MPO region?
   ☒Yes ☐ No
   If yes, please name them and their operating agencies:
   NJ Turnpike and Garden State Parkway (Operated by the NJ Turnpike Authority)

2. Are there any Managed/HOT Lanes in the MPO region?
   ☐Yes ☒ No
   If yes, please name them and their operating agencies:
   There is an HOV lane on a stretch on the NJ Turnpike but not a HOT

3. Are there any planned Toll roads/HOT Lanes/Managed Lanes in the MPO region?
   ☐Yes ☒ No
   If yes, please name them and their operating agencies:

4. If answered yes for one of questions #1 through #3, what sources of financing were used or are planned for the toll facilities?
   ☐Federal Government (All Sources) ☒State Government
   ☐Local/County/District Government ☐Public-Private Partnership (PPP/P3)
   ☐Private Sector ☐Bond Financing
   Other:

5. What type of travel demand model does the MPO currently use for its forecast needs?
   ☐Activity/Tour Based Model ☒Four-Step Model
   Other:

6. What software platform does the MPO use for the above chosen model?
   ☐TransCAD ☒Cube/Voyager ☐EMME2/3
   ☐TP+ Other:

7. What type of model is used for the Trip Distribution process?
   ☒Gravity Model ☐Atomistic Model
   ☐Synthetic Friction Factors Method ☐Destination Choice Model
   Other:

8. What variables are used in the impedance function of the Trip Distribution procedure?
   ☒Travel Time ☐Travel Cost
   ☒Toll Cost ☐Operating Cost
   Other:

9. What type of Mode Choice model is used to develop trip tables?
   ☐Multinomial Logit Model ☒Nested Logit Model

Other:

10. Are highway tolls included in the utility estimation of the Mode Choice model?
☒Yes ☐No

11. Are Value-of-Times (VOTs) included in the model?
☒Yes ☐ No
If answered yes for the Question #11, how are VOTs estimated?
☒By Mode ☐By Vehicle Type ☐By Purpose
If answered yes for the Question #11, which steps uses VOTs in the model?
☐Trip Distribution ☒Mode Choice ☒Traffic Assignment

12. What types of trip purposes are included in the Mode Choice model? Please mention them:
☒Home-Based Work ☒Home-Based Other
☐Home-Based School ☒Home-Based Shopping
☐Home-Based University ☒Non-Home-Based Work
☐Non-Home-Based Other
Other: Home-Based Work Stratigic (Direct and Strategic split of HBW); Work-Based Other

13. What types of trip tables are produced from the Mode Choice model?
☒Single Occupancy Vehicles ☒High Occupancy Vehicles 2
☐High Occupancy Vehicles 2+ ☒High Occupancy Vehicles 3
☐High Occupancy Vehicles 3+ ☐Trucks (Light/Medium/Heavy)
☐Local Bus ☐Express Bus
☐Rapid Bus ☐Bus Rapid Transit (BRT)
☐Commuter Rail ☐Light Rail
☐Walk ☐Bike
Other: HOV 4+; Drive to Transit and Walk to Transit (for each type of transit such as bus, rail, light rail, etc.)

14. Are the trip tables from Mode Choice output divided into Toll and Toll-Free modes?
☐Yes ☒ No
If yes, for what modes are the Trip Tables divided into toll and toll-free?
☐Single Occupancy Vehicles ☐High Occupancy Vehicles 2
☐High Occupancy Vehicles 2+ ☐High Occupancy Vehicles 3
☐High Occupancy Vehicles 3+ ☐Trucks (Light/Medium/Heavy)
Other:

15. What time-of-day trip tables are developed for the Traffic Assignment process?
☒AM Peak Period ☐AM Peak Hour
☒PM Peak Period ☐PM Peak Hour
☒Midday ☒Night Time
☐Off-Peak (Midday + Night Time) ☐Daily
Other:

16. What type of Traffic Assignment process is used in the MPO model?
☐User Equilibrium Generalized ☐Cost User Equilibrium
☐Customized GCUE ☐Diversion Curve/Logit Model
☐Stochastic User Equilibrium ☐Dynamic Traffic Assignment
☐Origin-Based ☐Path-Based
Other: Iterative Capacity Restraint

17. What method do you use to estimate demand on the tolled facilities?
☒Diversion Curve ☐Logit Model
Other:
If answered Diversion Curve for the previous question, what data did you use for calibration?
Please provide the name of data: I believe just traffic volumes

18. Does the Traffic Assignment procedure involve any special technique for the modeling of Toll Roads/Managed Lanes?
☐Yes ☒No
If yes, please provide documentation of the procedure.

19. Can the Traffic Assignment procedure model Variable/Congestion pricing facilities?
☐Yes ☒No
If yes, can the tolls on such facilities be changed between assignment iterations? Please provide documentation for such technique.
There is the possibility to vary the tolls by time-of-day (e.g., AM peak with different toll value than Night) but not exactly congestion pricing.

20. If answered yes for the previous question, are the time-of-day trip tables divided into smaller periods for Variable/Congestion pricing?
☐Yes ☒No
If yes, please provide the resolution of time periods:

21. Are you willing to share the scripts or programs where toll is involved?
☐Yes ☒No
If yes, please provide them:

22. What variables are considered in choosing the shortest path during the Traffic Assignment procedure?
☒Travel Time Travel Cost ☐Toll Cost
☐Operating Cost ☐Value of Time (VOT)
Other:

23. What type of Volume/Delay Function curves are used in the Traffic Assignment process?
☐BPR ☐Conical ☐Ackelik
☐Customized VDFs for all facilities ☐Customized VDFs for Toll/Managed Lane facilities
Other: We used a hybrid function from our consultant

24. Between what steps does the model apply feedback loops?
☐Traffic Assignment and Mode Choice ☒Traffic Assignment and Trip Distribution
☐Traffic Assignment and Trip Distribution and Mode Choice
Other:

25. Does the MPO intend to migrate to a new model structure in the near future?
☒Same Model ☐Activity Based Model ☐Modified Four-Step Model
Other:

26. If you want to provide additional information regarding questions above or other comments, please insert in this box.

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Survey Questionnaire

Name of the MPO/Agency: Wasatch Front Regional Council
Name of the Respondent-Position/Title: Andy Li/ Land Use and Travel Model Development
Phone: 801-363-4230 *Email:* andyli@wfrc.org*Date:* 9/5/2011

1. Are there any Toll roads in the MPO region?
   ☒Yes ☒ No
   If yes, please name them and their operating agencies:
   Adam Avenue, Private

2. Are there any Managed/HOT Lanes in the MPO region?
   ☒Yes ☐ No
   If yes, please name them and their operating agencies:
   I-15 HOT Lanes, Utah Department of Transportation

3. Are there any planned Toll roads/HOT Lanes/Managed Lanes in the MPO region?
   ☒Yes ☐ No
   If yes, please name them and their operating agencies:
   Mountain View/SR-201/I-15 HOT lanes

4. If answered yes for one of questions #1 through #3, what sources of financing were used or are planned for the toll facilities?
   ☒Federal Government (All Sources) ☒State Government
   ☐Local/County/District Government ☐Public-Private Partnership (PPP/P3)
   ☒Private Sector ☐Bond Financing
   Other:

5. What type of travel demand model does the MPO currently use for its forecast needs?
   ☐Activity/Tour Based Model ☒Four-Step Model
   Other:

6. What software platform does the MPO use for the above chosen model?
   ☐TransCAD ☒Cube/Voyager ☐EMME2/3
   ☐TP+ Other:

7. What type of model is used for the Trip Distribution process?
   ☒Gravity Model ☐Atomistic Model
   ☐Synthetic Friction Factors Method ☒Destination Choice Model
   Other:

8. What variables are used in the impedance function of the Trip Distribution procedure?
   ☒Travel Time ☒Travel Cost
   ☒Toll Cost ☒Operating Cost
   Other:

9. What type of Mode Choice model is used to develop trip tables?
   ☐Multinomial Logit Model ☒Nested Logit Model

Other:

10. Are highway tolls included in the utility estimation of the Mode Choice model?
☒Yes ☐No

11. Are Value-of-Times (VOTs) included in the model?
☒Yes ☐ No
If answered yes for the Question #11, how are VOTs estimated?
☐By Mode ☐By Vehicle Type ☐By Purpose
If answered yes for the Question #11, which steps uses VOTs in the model?
☒Trip Distribution ☒Mode Choice ☒Traffic Assignment

12. What types of trip purposes are included in the Mode Choice model? Please mention them:
☒Home-Based Work ☒Home-Based Other
☐Home-Based School ☐Home-Based Shopping
☒Home-Based University ☒Non-Home-Based Work
☐Non-Home-Based Other
Other:

13. What types of trip tables are produced from the Mode Choice model?
☒Single Occupancy Vehicles ☒High Occupancy Vehicles 2
☐High Occupancy Vehicles 2+ ☐High Occupancy Vehicles 3
☒High Occupancy Vehicles 3+ ☐Trucks (Light/Medium/Heavy)
☒Local Bus ☒Express Bus
☐Rapid Bus ☒Bus Rapid Transit (BRT)
☒Commuter Rail ☒Light Rail
☒Walk ☒Bike
Other:

14. Are the trip tables from Mode Choice output divided into Toll and Toll-Free modes?
☒Yes ☐ No
If yes, for what modes are the Trip Tables divided into toll and toll-free?
☒Single Occupancy Vehicles ☒High Occupancy Vehicles 2
☐High Occupancy Vehicles 2+ ☐High Occupancy Vehicles 3
☒High Occupancy Vehicles 3+ ☐Trucks (Light/Medium/Heavy)
Other:

15. What time-of-day trip tables are developed for the Traffic Assignment process?
☒AM Peak Period ☐AM Peak Hour
☒PM Peak Period ☐PM Peak Hour
☒Midday ☒Night Time
☐Off-Peak (Midday + Night Time) ☐Daily
Other:

16. What type of Traffic Assignment process is used in the MPO model?
☒User Equilibrium Generalized ☐Cost User Equilibrium
☐Customized GCUE ☐Diversion Curve/Logit Model
☐Stochastic User Equilibrium ☐Dynamic Traffic Assignment
☐Origin-Based ☐Path-Based
Other:

17. What method do you use to estimate demand on the tolled facilities?
☐Diversion Curve ☒Logit Model
Other:
If answered Diversion Curve for the previous question, what data did you use for calibration?
Please provide the name of data:

18. Does the Traffic Assignment procedure involve any special technique for the modeling of Toll Roads/Managed Lanes?
☐Yes ☒No
If yes, please provide documentation of the procedure.

19. Can the Traffic Assignment procedure model Variable/Congestion pricing facilities?
☐Yes ☒No
If yes, can the tolls on such facilities be changed between assignment iterations? Please provide documentation for such technique.

20. If answered yes for the previous question, are the time-of-day trip tables divided into smaller periods for Variable/Congestion pricing?
☐Yes ☒No
If yes, please provide the resolution of time periods:

21. Are you willing to share the scripts or programs where toll is involved?
☒Yes ☐No
If yes, please provide them:

22. What variables are considered in choosing the shortest path during the Traffic Assignment procedure?
☒Travel Time Travel Cost ☒Toll Cost
☒Operating Cost ☒Value of Time (VOT)
Other:

23. What type of Volume/Delay Function curves are used in the Traffic Assignment process?
☐BPR ☐Conical ☐Ackelik
☒Customized VDFs for all facilities ☐Customized VDFs for Toll/Managed Lane facilities
Other:

24. Between what steps does the model apply feedback loops?
☐Traffic Assignment and Mode Choice ☐Traffic Assignment and Trip Distribution
☒Traffic Assignment and Trip Distribution and Mode Choice
Other:

25. Does the MPO intend to migrate to a new model structure in the near future?
☒Same Model ☐Activity Based Model ☐Modified Four-Step Model
Other:

26. If you want to provide additional information regarding questions above or other comments, please insert in this box. Please share with us the findings from this research.

For any questions regarding the survey, please contact:

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Thank you for your cooperation.

TOLL ROAD MODELING INTO MAG TRAVEL DEMAND MODEL

URS Corporation (URS) is retained by the Maricopa Association of Governments (MAG), the MPO in Phoenix, AZ to conduct research on existing practices adopted by MPOs for Toll Road Modeling, especially the Managed/HOT Lanes Modeling. We would appreciate your cooperattion in responding to the following questions. Thank you in advance for your participation. (Please click gray box to enter text or mark check boxes)

Survey Questionnaire

Name of the MPO/Agency: San Antonio/Bexar County MPO
Name of the Respondent-Position/Title: Zachary Graham Senior Travel Demand Modeler
Phone: 210.230.6907 *Email:* graham@sametroplan.org*Date:* 2/05/2010

1. Are there any Toll roads in the MPO region?
   ☐ Yes ☒ No
   If yes, please name them and their operating agencies:

2. Are there any Managed/HOT Lanes in the MPO region?
   ☐ Yes ☒ No
   If yes, please name them and their operating agencies:

3. Are there any planned Toll roads/HOT Lanes/Managed Lanes in the MPO region?
   ☒ Yes ☐ No
   If yes, please name them and their operating agencies:
   (1)US 281 North & (2)Loop 1604 North (3)IH35 Northeast (4)State Hwy 130 near Seguin. All of these planned toll roads are very controversial at this time except for SH 130. All planned toll roads would be operated by the Alamo Regional Mobility Authority except for SH 130, which would be operated by Texas Department of Transportation.

4. If answered yes for one of questions #1 through #3, what sources of financing were used or are planned for the toll facilities?
   ☒ Federal Government (All Sources) ☒ State Government
   ☐ Local/County/District Government ☐ Public-Private Partnership (PPP/P3)
   ☐ Private Sector ☐ Bond Financing
   Other:

5. What type of travel demand model does the MPO currently use for its forecast needs?
   ☐ Activity/Tour Based Model ☒ Four-Step Model
   Other:

6. What software platform does the MPO use for the above chosen model?
   ☒ TransCAD ☐ Cube/Voyager ☐ EMME2/3
   ☐ TP+ Other:

7. What type of model is used for the Trip Distribution process?
   ☐ Gravity Model ☒ Atomistic Model
   ☐ Synthetic Friction Factors Method ☐ Destination Choice Model
   Other:

8. What variables are used in the impedance function of the Trip Distribution procedure?
   ☒ Travel Time ☐ Travel Cost
   ☐ Toll Cost ☐ Operating Cost
   Other:

9. What type of Mode Choice model is used to develop trip tables?
   - ☐ Multinomial Logit Model
   - ☒ Nested Logit Model
   - Other:

10. Are highway tolls included in the utility estimation of the Mode Choice model?
    - ☐ Yes
    - ☒ No

11. Are Value-of-Times (VOTs) included in the model?
    - ☒ Yes
    - ☐ No

    If answered yes for the Question #11, how are VOTs estimated?
    - ☐ By Mode
    - ☒ By Vehicle Type
    - ☐ By Purpose

    If answered yes for the Question #11, which steps uses VOTs in the model?
    - ☐ Trip Distribution
    - ☐ Mode Choice
    - ☒ Traffic Assignment

12. What types of trip purposes are included in the Mode Choice model? Please mention them:
    - ☒ Home-Based Work
    - ☒ Home-Based Other
    - ☒ Home-Based School
    - ☒ Home-Based Shopping
    - ☒ Home-Based University
    - ☐ Non-Home-Based Work
    - ☐ Non-Home-Based Other
    - Other: Non-Work Airport, Commercial TRK, EXLO-Comm, EXLO-Non_Comm, NHB, NHB-Special

13. What types of trip tables are produced from the Mode Choice model?
    - ☒ Single Occupancy Vehicles
    - ☐ High Occupancy Vehicles 2
    - ☒ High Occupancy Vehicles 2+
    - ☐ High Occupancy Vehicles 3
    - ☒ High Occupancy Vehicles 3+
    - ☐ Trucks (Light/Medium/Heavy)
    - ☐ Local Bus
    - ☐ Express Bus
    - ☐ Rapid Bus
    - ☐ Bus Rapid Transit (BRT)
    - ☐ Commuter Rail
    - ☐ Light Rail
    - ☐ Walk
    - ☐ Bike
    - Other: Transit

14. Are the trip tables from Mode Choice output divided into Toll and Toll-Free modes?
    - ☐ Yes
    - ☒ No

    If yes, for what modes are the Trip Tables divided into toll and toll-free?
    - ☐ Single Occupancy Vehicles
    - ☐ High Occupancy Vehicles 2
    - ☐ High Occupancy Vehicles 2+
    - ☐ High Occupancy Vehicles 3
    - ☐ High Occupancy Vehicles 3+
    - ☐ Trucks (Light/Medium/Heavy)
    - Other:

15. What time-of-day trip tables are developed for the Traffic Assignment process?
    - ☒ AM Peak Period
    - ☐ AM Peak Hour
    - ☒ PM Peak Period
    - ☐ PM Peak Hour
    - ☐ Midday
    - ☐ Night Time
    - ☒ Off-Peak (Midday + Night Time)
    - ☒ Daily
    - Other: Combined Peak Hour

16. What type of Traffic Assignment process is used in the MPO model?
    - ☒ User Equilibrium Generalized
    - ☒ Cost User Equilibrium
    - ☐ Customized GCUE
    - ☐ Diversion Curve/Logit Model
    - ☐ Stochastic User Equilibrium
    - ☐ Dynamic Traffic Assignment
    - ☐ Origin-Based
    - ☐ Path-Based
    - Other:

17. What method do you use to estimate demand on the tolled facilities?
    - ☐ Diversion Curve
    - ☐ Logit Model
    - Other: Multi modal multi class UE assignment (TransCAD)

    If answered Diversion Curve for the previous question, what data did you use for calibration?
    Please provide the name of data:

18. Does the Traffic Assignment procedure involve any special technique for the modeling of Toll Roads/Managed Lanes?
☒Yes ☐No
If yes, please provide documentation of the procedure.
Use the multi class, multi mode UE assignment in TransCAD to simultaneously assign larger commercial trucks and vehicles to toll & non-toll lanes. This is done because the toll pricing and the assumed values of time are different for these two modes.

19. Can the Traffic Assignment procedure model Variable/Congestion pricing facilities?
☐Yes ☒No
If yes, can the tolls on such facilities be changed between assignment iterations? Please provide documentation for such technique.

20. If answered yes for the previous question, are the time-of-day trip tables divided into smaller periods for Variable/Congestion pricing?
☐Yes ☐No
If yes, please provide the resolution of time periods:

21. Are you willing to share the scripts or programs where toll is involved?
☐Yes ☒No
If yes, please provide them: This is still work in progress and is not yet calibrated to anything

22. What variables are considered in choosing the shortest path during the Traffic Assignment procedure?
☐Travel Time Travel Cost ☒Toll Cost
☐Operating Cost ☐Value of Time (VOT)
Other:

23. What type of Volume/Delay Function curves are used in the Traffic Assignment process?
☒BPR ☐Conical ☐Ackelik
☐Customized VDFs for all facilities ☐Customized VDFs for Toll/Managed Lane facilities
Other:

24. Between what steps does the model apply feedback loops?
☒Traffic Assignment and Mode Choice ☐Traffic Assignment and Trip Distribution
☐Traffic Assignment and Trip Distribution and Mode Choice
Other:

25. Does the MPO intend to migrate to a new model structure in the near future?
☒Same Model ☐Activity Based Model ☐Modified Four-Step Model
Other:

26. If you want to provide additional information regarding questions above or other comments, please insert in this box.

For any questions regarding the survey, please contact:

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Thank you for your cooperation.

TOLL ROAD MODELING INTO MAG TRAVEL DEMAND MODEL

URS Corporation (URS) is retained by the Maricopa Association of Governments (MAG), the MPO in Phoenix, AZ to conduct research on existing practices adopted by MPOs for Toll Road Modeling, especially the Managed/HOT Lanes Modeling. We would appreciate your cooperattion in responding to the following questions. Thank you in advance for your participation. (Please click gray box to enter text or mark check boxes)

Survey Questionnaire

Name of the MPO/Agency: San Diego Association of Governments
Name of the Respondent-Position/Title: Mike Calandra, Senior Transportation Modeler
Phone: 619.466.7729 *Email:* mca@sandag.org*Date:* 2/4/2010

1. Are there any Toll roads in the MPO region?
   ☒Yes ☐ No
   If yes, please name them and their operating agencies:
   SR-125 between SR-54 and SR-905 is operated by Southbay Expressway although SANDAG is currently negotiating to purchase the toll road.

2. Are there any Managed/HOT Lanes in the MPO region?
   ☒Yes ☐ No
   If yes, please name them and their operating agencies:
   SANDAG is currently operating the I-15 Managed Lanes, which are currently being expanded

3. Are there any planned Toll roads/HOT Lanes/Managed Lanes in the MPO region?
   ☒Yes ☐ No
   If yes, please name them and their operating agencies:
   Several Managed Lanes are proposed in the region including I-5 and I-805, and on SR-52, SR-54 and SR-78. SR-241 is a proposed toll road connecting San Onofre to Orange County

4. If answered yes for one of questions #1 through #3, what sources of financing were used or are planned for the toll facilities?
   ☒Federal Government (All Sources) ☒State Government
   ☒Local/County/District Government ☒Public-Private Partnership (PPP/P3)
   ☒Private Sector ☒Bond Financing
   Other:

5. What type of travel demand model does the MPO currently use for its forecast needs?
   ☐Activity/Tour Based Model ☒Four-Step Model
   Other:

6. What software platform does the MPO use for the above chosen model?
   ☒TransCAD ☐Cube/Voyager ☐EMME2/3
   ☐TP+ Other:

7. What type of model is used for the Trip Distribution process?
   ☒Gravity Model ☐Atomistic Model
   ☐Synthetic Friction Factors Method ☐Destination Choice Model
   Other:

8. What variables are used in the impedance function of the Trip Distribution procedure?
   ☒Travel Time ☒Travel Cost
   ☒Toll Cost ☒Operating Cost
   Other:

9. What type of Mode Choice model is used to develop trip tables?
   - ☐ Multinomial Logit Model
   - ☒ Nested Logit Model
   - Other:

10. Are highway tolls included in the utility estimation of the Mode Choice model?
    - ☒ Yes
    - ☐ No

11. Are Value-of-Times (VOTs) included in the model?
    - ☒ Yes
    - ☐ No

    If answered yes for the Question #11, how are VOTs estimated?
    - ☐ By Mode
    - ☐ By Vehicle Type
    - ☒ By Purpose

    If answered yes for the Question #11, which steps uses VOTs in the model?
    - ☐ Trip Distribution
    - ☒ Mode Choice
    - ☒ Traffic Assignment

12. What types of trip purposes are included in the Mode Choice model? Please mention them:
    - ☒ Home-Based Work
    - ☒ Home-Based Other
    - ☒ Home-Based School
    - ☐ Home-Based Shopping
    - ☒ Home-Based University
    - ☐ Non-Home-Based Work
    - ☒ Non-Home-Based Other
    - Other: plus "Serve Passenger"

13. What types of trip tables are produced from the Mode Choice model?
    - ☒ Single Occupancy Vehicles
    - ☐ High Occupancy Vehicles 2
    - ☐ High Occupancy Vehicles 2+
    - ☐ High Occupancy Vehicles 3
    - ☒ High Occupancy Vehicles 3+
    - ☒ Trucks (Light/Medium/Heavy)
    - ☒ Local Bus
    - ☒ Express Bus
    - ☐ Rapid Bus
    - ☒ Bus Rapid Transit (BRT)
    - ☒ Commuter Rail
    - ☒ Light Rail
    - ☐ Walk
    - ☐ Bike
    - Other:

14. Are the trip tables from Mode Choice output divided into Toll and Toll-Free modes?
    - ☒ Yes
    - ☐ No

    If yes, for what modes are the Trip Tables divided into toll and toll-free?
    - ☒ Single Occupancy Vehicles
    - ☒ High Occupancy Vehicles 2
    - ☐ High Occupancy Vehicles 2+
    - ☐ High Occupancy Vehicles 3
    - ☒ High Occupancy Vehicles 3+
    - ☒ Trucks (Light/Medium/Heavy)
    - Other:

15. What time-of-day trip tables are developed for the Traffic Assignment process?
    - ☒ AM Peak Period
    - ☐ AM Peak Hour
    - ☒ PM Peak Period
    - ☐ PM Peak Hour
    - ☐ Midday
    - ☐ Night Time
    - ☒ Off-Peak (Midday + Night Time)
    - ☐ Daily
    - Other:

16. What type of Traffic Assignment process is used in the MPO model?
    - ☒ User Equilibrium Generalized
    - ☐ Cost User Equilibrium
    - ☐ Customized GCUE
    - ☐ Diversion Curve/Logit Model
    - ☐ Stochastic User Equilibrium
    - ☐ Dynamic Traffic Assignment
    - ☐ Origin-Based
    - ☐ Path-Based
    - Other:

17. What method do you use to estimate demand on the tolled facilities?
    - ☒ Diversion Curve
    - ☒ Logit Model
    - Other: Logit for autos, Diversion for trucks

    If answered Diversion Curve for the previous question, what data did you use for calibration?
    Please provide the name of data: Observed Toll Transactions

18. Does the Traffic Assignment procedure involve any special technique for the modeling of Toll Roads/Managed Lanes?
☐Yes ☒No
If yes, please provide documentation of the procedure.

19. Can the Traffic Assignment procedure model Variable/Congestion pricing facilities?
☐Yes ☒No
If yes, can the tolls on such facilities be changed between assignment iterations? Please provide documentation for such technique.
No, the variable tolls can only vary between the three modeled time periods.

20. If answered yes for the previous question, are the time-of-day trip tables divided into smaller periods for Variable/Congestion pricing?
☐Yes ☒No
If yes, please provide the resolution of time periods:

21. Are you willing to share the scripts or programs where toll is involved?
☒Yes ☐No
If yes, please provide them: A non-disclosure aggreement will need to be signed first

22. What variables are considered in choosing the shortest path during the Traffic Assignment procedure?
☒Travel Time Travel Cost ☒Toll Cost
☒Operating Cost ☒Value of Time (VOT)
Other:

23. What type of Volume/Delay Function curves are used in the Traffic Assignment process?
☐BPR ☐Conical ☐Ackelik
☒Customized VDFs for all facilities ☐Customized VDFs for Toll/Managed Lane facilities
Other: Logit-based VDF (available in TransCAD)

24. Between what steps does the model apply feedback loops?
☐Traffic Assignment and Mode Choice ☒Traffic Assignment and Trip Distribution
☐Traffic Assignment and Trip Distribution and Mode Choice
Other:

25. Does the MPO intend to migrate to a new model structure in the near future?
☐Same Model ☒Activity Based Model ☐Modified Four-Step Model
Other:

26. If you want to provide additional information regarding questions above or other comments, please insert in this box.

For any questions regarding the survey, please contact:

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Thank you for your cooperation.

TOLL ROAD MODELING INTO MAG TRAVEL DEMAND MODEL

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Survey Questionnaire

Name of the MPO/Agency: Metropolitan Transportation Commission, Oakland, CA
Name of the Respondent-Position/Title: David Ory, Principal Planner/Analyst
Phone: 510.817.5755 *Email:* dory@mtc.ca.gov*Date:* 11/10/11

1. Are there any Toll roads in the MPO region?
   ☐ Yes ☒ No
   If yes, please name them and their operating agencies:
   (There are toll bridges, but not toll roads)

2. Are there any Managed/HOT Lanes in the MPO region?
   ☒ Yes ☐ No
   If yes, please name them and their operating agencies:
   I-680 Express Lanes, Alameda County Transportation Commission

3. Are there any planned Toll roads/HOT Lanes/Managed Lanes in the MPO region?
   ☒ Yes ☐ No
   If yes, please name them and their operating agencies:
   A fairly extensive network is planned; details are available here: http://www.mtc.ca.gov/planning/hov/

4. If answered yes for one of questions #1 through #3, what sources of financing were used or are planned for the toll facilities?
   ☒ Federal Government (All Sources) ☒ State Government
   ☒ Local/County/District Government ☐ Public-Private Partnership (PPP/P3)
   ☐ Private Sector ☒ Bond Financing
   Other: Please see http://www.mtc.ca.gov/planning/hov/ for more details

5. What type of travel demand model does the MPO currently use for its forecast needs?
   ☒ Activity/Tour Based Model ☐ Four-Step Model
   Other:

6. What software platform does the MPO use for the above chosen model?
   ☐ TransCAD ☒ Cube/Voyager ☐ EMME2/3
   ☒ TP+ Other:

7. What type of model is used for the Trip Distribution process?
   ☐ Gravity Model ☐ Atomistic Model
   ☐ Synthetic Friction Factors Method ☒ Destination Choice Model
   Other:

8. What variables are used in the impedance function of the Trip Distribution procedure?
   ☒ Travel Time ☒ Travel Cost
   ☒ Toll Cost ☒ Operating Cost
   Other: (Mode choice log sum is used, which includes each of these variables)

9. What type of Mode Choice model is used to develop trip tables?
   ☐ Multinomial Logit Model ☒ Nested Logit Model

Other:

10. Are highway tolls included in the utility estimation of the Mode Choice model?
☒Yes ☐No

11. Are Value-of-Times (VOTs) included in the model?
☒Yes ☐ No
If answered yes for the Question #11, how are VOTs estimated?
☐By Mode ☐By Vehicle Type ☐By Purpose
If answered yes for the Question #11, which steps uses VOTs in the model?
☒Trip Distribution ☒Mode Choice ☐Traffic Assignment

12. What types of trip purposes are included in the Mode Choice model? Please mention them:
☐Home-Based Work ☐Home-Based Other
☐Home-Based School ☐Home-Based Shopping
☐Home-Based University ☐Non-Home-Based Work
☐Non-Home-Based Other
Other: Activity-based model which operates on tours, not trips. Documentation is available here: http://mtcgis.mtc.ca.gov/foswiki/Main/Development

13. What types of trip tables are produced from the Mode Choice model?
☒Single Occupancy Vehicles ☒High Occupancy Vehicles 2
☐High Occupancy Vehicles 2+ ☐High Occupancy Vehicles 3
☒High Occupancy Vehicles 3+ ☒Trucks (Light/Medium/Heavy)
☒Local Bus ☒Express Bus
☐Rapid Bus ☐Bus Rapid Transit (BRT)
☒Commuter Rail ☒Light Rail
☒Walk ☒Bike
Other: Regional rail also included

14. Are the trip tables from Mode Choice output divided into Toll and Toll-Free modes?
☒Yes ☐ No
If yes, for what modes are the Trip Tables divided into toll and toll-free?
☒Single Occupancy Vehicles ☒High Occupancy Vehicles 2
☐High Occupancy Vehicles 2+ ☐High Occupancy Vehicles 3
☒High Occupancy Vehicles 3+ ☒Trucks (Light/Medium/Heavy)
Other:

15. What time-of-day trip tables are developed for the Traffic Assignment process?
☒AM Peak Period ☐AM Peak Hour
☒PM Peak Period ☐PM Peak Hour
☒Midday ☐Night Time
☒Off-Peak (Midday + Night Time) ☐Daily
Other: Five time periods, early AM, AM Peak, Midday, PM Peak, Evening

16. What type of Traffic Assignment process is used in the MPO model?
☒User Equilibrium Generalized ☐Cost User Equilibrium
☐Customized GCUE ☐Diversion Curve/Logit Model
☐Stochastic User Equilibrium ☐Dynamic Traffic Assignment
☐Origin-Based ☐Path-Based
Other:

17. What method do you use to estimate demand on the tolled facilities?
☐Diversion Curve ☒Logit Model
Other:
If answered Diversion Curve for the previous question, what data did you use for calibration?
Please provide the name of data:

18. Does the Traffic Assignment procedure involve any special technique for the modeling of Toll Roads/Managed Lanes?
☐Yes ☒No
If yes, please provide documentation of the procedure.
Toll-eligible vehicles are just another assignment class.

19. Can the Traffic Assignment procedure model Variable/Congestion pricing facilities?
☒Yes ☐No
If yes, can the tolls on such facilities be changed between assignment iterations? Please provide documentation for such technique.
The decision to pay the toll is done before assignment. We do not do this, but you could fairly easy vary the toll by the one hour periods in which travelers make time of day decisions. The assignment would still be doen by the five times of day.

20. If answered yes for the previous question, are the time-of-day trip tables divided into smaller periods for Variable/Congestion pricing?
☐Yes ☒No
If yes, please provide the resolution of time periods:

21. Are you willing to share the scripts or programs where toll is involved?
☒Yes ☐No
If yes, please provide them:

22. What variables are considered in choosing the shortest path during the Traffic Assignment procedure?
☐Travel Time Travel Cost ☒Toll Cost
☒Operating Cost ☒Value of Time (VOT)
Other: Value of time is considered in the mode choice procedure which dictates which paths are available.

23. What type of Volume/Delay Function curves are used in the Traffic Assignment process?
☐BPR ☐Conical ☐Ackelik
☒Customized VDFs for all facilities ☐Customized VDFs for Toll/Managed Lane facilities
Other: Modified BPR for freeways, Akcelik speed-flow for arterials

24. Between what steps does the model apply feedback loops?
☐Traffic Assignment and Mode Choice ☐Traffic Assignment and Trip Distribution
☐Traffic Assignment and Trip Distribution and Mode Choice
Other: The entire model stream

25. Does the MPO intend to migrate to a new model structure in the near future?
☒Same Model ☐Activity Based Model ☐Modified Four-Step Model
Other: Hope to integrate a land use model in the near future.

26. If you want to provide additional information regarding questions above or other comments, please insert in this box.

For any questions regarding the survey, please contact:

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Thank you for your cooperation.

TOLL ROAD MODELING INTO MAG TRAVEL DEMAND MODEL

URS Corporation (URS)is retained by the Maricopa Association of Governments (MAG), the MPO in Phoenix, AZto conduct research on existing practices adopted by MPOs for Toll Road Modeling, especially the Managed/HOT Lanes Modeling. We would appreciate your cooperattion in responding to the following questions. Thank you in advance for your participation. (Please click gray box to enter text or mark check boxes)

Survey Questionnaire

Name of the MPO/Agency: Ministry of Transportation, Ontario
Name of the Respondent-Position/Title:
Phone: *Email:* *Date:*

1. Are there any Toll roads in the MPO region?
   ☒Yes ☐ No
   If yes, please name them and their operating agencies:
   Highway 407, Private Concession

2. Are there any Managed/HOT Lanes in the MPO region?
   ☐Yes ☒ No
   If yes, please name them and their operating agencies:

3. Are there any planned Toll roads/HOT Lanes/Managed Lanes in the MPO region?
   ☒Yes ☐ No
   If yes, please name them and their operating agencies:
   Government has announced the Highway 407 Extension in the east, but no announcement on the operating agency.

4. If answered yes for one of questions #1 through #3, what sources of financing were used or are planned for the toll facilities?
   ☐Federal Government (All Sources) ☒State Government
   ☐Local/County/District Government ☒Public-Private Partnership (PPP/P3)
   ☐Private Sector ☐Bond Financing
   Other:

5. What type of travel demand model does the MPO currently use for its forecast needs?
   ☐Activity/Tour Based Model ☒Four-Step Model
   Other:

6. What software platform does the MPO use for the above chosen model?
   ☐TransCAD ☐Cube/Voyager ☒EMME2/3
   ☐TP+ Other:

7. What type of model is used for the Trip Distribution process?
   ☒Gravity Model ☐Atomistic Model
   ☐Synthetic Friction Factors Method ☐Destination Choice Model
   Other:

8. What variables are used in the impedance function of the Trip Distribution procedure?
   ☐Travel Time ☐Travel Cost
   ☐Toll Cost ☐Operating Cost
   Other:logsum from the mode choice model that inlcudes all of the above and other variables.

9. What type of Mode Choice model is used to develop trip tables?
   ☐Multinomial Logit Model ☒Nested Logit Model

Other:

10. Are highway tolls included in the utility estimation of the Mode Choice model?
☒Yes ☐No

11. Are Value-of-Times(VOTs) included in the model?
☒Yes ☐ No
If answered yes for the Question #11, how areVOTsestimated?
☒By Mode ☐By Vehicle Type ☐By Purpose
If answered yes for the Question #11, which steps usesVOTs in the model?
☐Trip Distribution ☐Mode Choice ☒Traffic Assignment

12. What types of trip purposes are included in the Mode Choice model? Please mention them:
☒Home-Based Work ☒Home-Based Other
☒Home-Based School ☒Home-Based Shopping
☒Home-Based University ☒Non-Home-Based Work
☒Non-Home-Based Other
Other:

13. What types of trip tables are produced from the Mode Choice model?
☒Single Occupancy Vehicles ☐High Occupancy Vehicles 2
☐High Occupancy Vehicles 2+ ☐High Occupancy Vehicles 3
☐High Occupancy Vehicles 3+ ☐Trucks (Light/Medium/Heavy)
☒Local Bus ☐Express Bus
☐Rapid Bus ☐Bus Rapid Transit (BRT)
☒Commuter Rail ☒Light Rail
☒Walk ☒Bike
Other:Note - Our mode definition inlcudes "Auto Drivers" and "Auto Ppassengers" as two different modes

14. Are the trip tables from Mode Choice output divided into Toll and Toll-Free modes?
☐Yes ☒ No
If yes, for what modes are the Trip Tables divided into toll and toll-free?
☐Single Occupancy Vehicles ☐High Occupancy Vehicles 2
☐High Occupancy Vehicles 2+ ☐High Occupancy Vehicles 3
☐High Occupancy Vehicles 3+ ☐Trucks (Light/Medium/Heavy)
Other:

15. What time-of-day trip tables are developed for the Traffic Assignment process?
☒AM Peak Period ☐AM Peak Hour
☒PM Peak Period ☐PM Peak Hour
☐Midday ☐Night Time
☐Off-Peak (Midday + Night Time) ☐Daily
Other:

16. What type of Traffic Assignment process is used in the MPO model?
☒User Equilibrium Generalized ☐Cost User Equilibrium
☐Customized GCUE ☐Diversion Curve/Logit Model
☐Stochastic User Equilibrium ☐Dynamic Traffic Assignment
☐Origin-Based ☐Path-Based
Other:

17. What method do you use to estimate demand on the tolled facilities?
☐Diversion Curve ☒Logit Model
Other:
If answered Diversion Curve for the previous question, what data did you use for calibration?
Please provide the name of data:

18. Does the Traffic Assignment procedure involve any special technique for the modeling of Toll Roads/Managed Lanes?
☐Yes ☒No
If yes, please provide documentation of the procedure.

19. Can the Traffic Assignment procedure model Variable/Congestion pricing facilities?
☐Yes ☒No
If yes, can the tolls on such facilities be changed between assignment iterations? Please provide documentation for such technique.

20. If answered yes for the previous question, are the time-of-day trip tables divided into smaller periods for Variable/Congestion pricing?
☐Yes ☐No
If yes, please provide the resolution of time periods:

21. Are you willing to share the scripts or programs where toll is involved?
☐Yes ☒No
If yes, please providethem:

22. What variables are considered in choosing the shortest path during the Traffic Assignment procedure?
☒Travel Time Travel Cost ☒Toll Cost
☐Operating Cost ☒Value of Time (VOT)
Other:

23. What type of Volume/Delay Function curves are used in the Traffic Assignment process?
☐BPR ☐Conical ☐Ackelik
☐Customized VDFs for all facilities ☐Customized VDFs for Toll/Managed Lane facilities
Other:Tangential (similar to Conical)

24. Between what steps does the model apply feedback loops?
☒Traffic Assignment and Mode Choice ☐Traffic Assignment and Trip Distribution
☐Traffic Assignment and Trip Distribution and Mode Choice
Other:

25. Does the MPO intend to migrate to a new model structure in the near future?
☐Same Model ☐Activity Based Model ☒Modified Four-Step Model
Other:

26. If you want to provide additional information regarding questions above or other comments, please insert in this box.

For any questions regarding the survey, please contact:

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Thank you for your cooperation.

TOLL ROAD MODELING INTO MAG TRAVEL DEMAND MODEL

URS Corporation (URS) is retained by the Maricopa Association of Governments (MAG), the MPO in Phoenix, AZ to conduct research on existing practices adopted by MPOs for Toll Road Modeling, especially the Managed/HOT Lanes Modeling. We would appreciate your cooperattion in responding to the following questions. Thank you in advance for your participation. (Please click gray box to enter text or mark check boxes)

Survey Questionnaire

Name of the MPO/Agency: VDOT
Name of the Respondent-Position/Title: Rick Tambellini
Phone: 804-786-7459 *Email:* rick.tambellini@vdot*Date:* 11/04/11

1. Are there any Toll roads in the MPO region?
   ☒Yes ☐ No
   If yes, please name them and their operating agencies:
   195 - RMA
   Powhite (76) - RMA
   Westover Hills Blvd (Rte 161) - RMA
   895 - TransUrban
   Chesapeak Expressway (168) - VDOT
   York River (17) - VDOT

2. Are there any Managed/HOT Lanes in the MPO region?
   ☐Yes ☒ No
   If yes, please name them and their operating agencies:

3. Are there any planned Toll roads/HOT Lanes/Managed Lanes in the MPO region?
   ☒Yes ☐ No
   If yes, please name them and their operating agencies:
   I-95,I-64,US 460, I-264, US-58

4. If answered yes for one of questions #1 through #3, what sources of financing were used or are planned for the toll facilities?
   ☐Federal Government (All Sources) ☐State Government
   ☐Local/County/District Government ☒Public-Private Partnership (PPP/P3)
   ☐Private Sector ☐Bond Financing
   Other:

5. What type of travel demand model does the MPO currently use for its forecast needs?
   ☐Activity/Tour Based Model ☒Four-Step Model
   Other:

6. What software platform does the MPO use for the above chosen model?
   ☐TransCAD ☒Cube/Voyager ☐EMME2/3
   ☐TP+ Other:

7. What type of model is used for the Trip Distribution process?
   ☒Gravity Model ☐Atomistic Model
   ☐Synthetic Friction Factors Method ☐Destination Choice Model
   Other:

8. What variables are used in the impedance function of the Trip Distribution procedure?
   - ☒ Travel Time
   - ☐ Travel Cost
   - ☒ Toll Cost
   - ☐ Operating Cost
   - Other:

9. What type of Mode Choice model is used to develop trip tables?
   - ☒ Multinomial Logit Model
   - ☐ Nested Logit Model
   - Other:

10. Are highway tolls included in the utility estimation of the Mode Choice model?
    - ☐ Yes
    - ☒ No

11. Are Value-of-Times (VOTs) included in the model?
    - ☒ Yes
    - ☐ No

    If answered yes for the Question #11, how are VOTs estimated?
    - ☒ By Mode
    - ☒ By Vehicle Type
    - ☒ By Purpose

    If answered yes for the Question #11, which steps uses VOTs in the model?
    - ☒ Trip Distribution
    - ☐ Mode Choice
    - ☒ Traffic Assignment

12. What types of trip purposes are included in the Mode Choice model? Please mention them:
    - ☒ Home-Based Work
    - ☒ Home-Based Other
    - ☐ Home-Based School
    - ☒ Home-Based Shopping
    - ☐ Home-Based University
    - ☒ Non-Home-Based Work
    - ☒ Non-Home-Based Other
    - Other:

13. What types of trip tables are produced from the Mode Choice model?
    - ☒ Single Occupancy Vehicles
    - ☐ High Occupancy Vehicles 2
    - ☒ High Occupancy Vehicles 2+
    - ☐ High Occupancy Vehicles 3
    - ☐ High Occupancy Vehicles 3+
    - ☐ Trucks (Light/Medium/Heavy)
    - ☒ Local Bus
    - ☒ Express Bus
    - ☐ Rapid Bus
    - ☐ Bus Rapid Transit (BRT)
    - ☐ Commuter Rail
    - ☐ Light Rail
    - ☐ Walk
    - ☐ Bike
    - Other:

14. Are the trip tables from Mode Choice output divided into Toll and Toll-Free modes?
    - ☒ Yes
    - ☐ No

    If yes, for what modes are the Trip Tables divided into toll and toll-free?
    - ☒ Single Occupancy Vehicles
    - ☐ High Occupancy Vehicles 2
    - ☒ High Occupancy Vehicles 2+
    - ☐ High Occupancy Vehicles 3
    - ☐ High Occupancy Vehicles 3+
    - ☐ Trucks (Light/Medium/Heavy)
    - Other:

15. What time-of-day trip tables are developed for the Traffic Assignment process?
    - ☒ AM Peak Period
    - ☐ AM Peak Hour
    - ☒ PM Peak Period
    - ☐ PM Peak Hour
    - ☒ Midday
    - ☐ Night Time
    - ☒ Off-Peak (Midday + Night Time)
    - ☐ Daily
    - Other:

16. What type of Traffic Assignment process is used in the MPO model?
    - ☒ User Equilibrium Generalized
    - ☐ Cost User Equilibrium
    - ☐ Customized GCUE
    - ☐ Diversion Curve/Logit Model
    - ☐ Stochastic User Equilibrium
    - ☒ Dynamic Traffic Assignment
    - ☐ Origin-Based
    - ☐ Path-Based
    - Other:

17. What method do you use to estimate demand on the tolled facilities?
☐ Diversion Curve ☒ Logit Model
Other:
If answered Diversion Curve for the previous question, what data did you use for calibration?
Please provide the name of data:

18. Does the Traffic Assignment procedure involve any special technique for the modeling of Toll Roads/Managed Lanes?
☐ Yes ☒ No
If yes, please provide documentation of the procedure.

19. Can the Traffic Assignment procedure model Variable/Congestion pricing facilities?
☐ Yes ☒ No
If yes, can the tolls on such facilities be changed between assignment iterations? Please provide documentation for such technique.

20. If answered yes for the previous question, are the time-of-day trip tables divided into smaller periods for Variable/Congestion pricing?
☐ Yes ☒ No
If yes, please provide the resolution of time periods:

21. Are you willing to share the scripts or programs where toll is involved?
☒ Yes ☐ No
If yes, please provide them:

22. What variables are considered in choosing the shortest path during the Traffic Assignment procedure?
☒ Travel Time Travel Cost ☐ Toll Cost
☐ Operating Cost ☒ Value of Time (VOT)
Other:

23. What type of Volume/Delay Function curves are used in the Traffic Assignment process?
☐ BPR ☐ Conical ☐ Ackelik
☒ Customized VDFs for all facilities ☐ Customized VDFs for Toll/Managed Lane facilities
Other:

24. Between what steps does the model apply feedback loops?
☐ Traffic Assignment and Mode Choice ☐ Traffic Assignment and Trip Distribution
☒ Traffic Assignment and Trip Distribution and Mode Choice
Other:

25. Does the MPO intend to migrate to a new model structure in the near future?
☐ Same Model ☐ Activity Based Model ☒ Modified Four-Step Model
Other:

26. If you want to provide additional information regarding questions above or other comments, please insert in this box.
This does not descibe all models in Virginia. This desribes the newest models (Richmond/ Tri-Cities, Hampton Roads, Fredericksburg) to be released in the next couple of months.

For any questions regarding the survey, please contact:

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TOLL ROAD MODELING INTO MAG TRAVEL DEMAND MODEL

URS Corporation (URS) is retained by the Maricopa Association of Governments (MAG), the MPO in Phoenix, AZ to conduct research on existing practices adopted by MPOs for Toll Road Modeling, especially the Managed/HOT Lanes Modeling. We would appreciate your cooperattion in responding to the following questions. Thank you in advance for your participation. (Please click gray box to enter text or mark check boxes)

Survey Questionnaire

Name of the MPO/Agency: National Capital Region Transportation Planning Board (NCRTPB)
Name of the Respondent-Position/Title: Ronald Milone-Principal Transporation Engineer
Phone: 202.962.3283 *Email:* rmilone@mwcog.org*Date:* 2/12/2010

1. Are there any Toll roads in the MPO region?
   ☒Yes ☐ No
   If yes, please name them and their operating agencies:
   There are two existing tolled facilities in the TPB member area: 1) Dulles Toll Road (VA 267) currently operated by Metropolitan Washington Airports Authority and 2) the Dulles Greenway which is privately owned and operated, but is regulated by the Virginia State Corporation Commission. Both facilities are located in Northern Virginia. Please note that the TPB's modeled area extends well beyond the TPB member area. The Governor Nice bridge (connecting King George's County in Virginia and Charles County in Maryland) is another existing tolled facility that is included in the TPB's highway network but is outside of the TPB member area.

2. Are there any Managed/HOT Lanes in the MPO region?
   ☐Yes ☒ No
   If yes, please name them and their operating agencies:

3. Are there any planned Toll roads/HOT Lanes/Managed Lanes in the MPO region?
   ☒Yes ☐ No
   If yes, please name them and their operating agencies:
   There are two planned HOT lane facilities in Northern Virginia and one planned managed lane facility in Maryland. The two HOT lane facilities are: 1) the Capital Beltway (I-495) currently under construction and 2) I-95/I-395 which is currently under study. Both facilities are being/would be constructed and operated by two private companies (Flour Virginia based in Arlington, VA and Transurban based in Melbourne, Australia) under an arrangement with the Virginia Department of Transportation (i.e., a public private partnership arrangement). The managed lane facility in Maryland is known as the Intercounty Connector (or ICC). The facility is planned to be opened in sections between 2010 and 2012. It is being funded via bonding (Garvee bonds).

4. If answered yes for one of questions #1 through #3, what sources of financing were used or are planned for the toll facilities?
   ☐Federal Government (All Sources) ☐State Government
   ☐Local/County/District Government ☒Public-Private Partnership (PPP/P3)
   ☐Private Sector ☒Bond Financing
   Other:

5. What type of travel demand model does the MPO currently use for its forecast needs?
   ☐Activity/Tour Based Model ☒Four-Step Model
   Other:

6. What software platform does the MPO use for the above chosen model?
   ☐TransCAD ☐Cube/Voyager ☐EMME2/3
   ☒TP+ Other:

7. What type of model is used for the Trip Distribution process?
   - ☒ Gravity Model
   - ☐ Atomistic Model
   - ☐ Synthetic Friction Factors Method
   - ☐ Destination Choice Model

   Other:

8. What variables are used in the impedance function of the Trip Distribution procedure?
   - ☒ Travel Time
   - ☐ Travel Cost
   - ☒ Toll Cost
   - ☐ Operating Cost

   Other: Clarification: The impedance measure used in the trip distribution model is a composite (highway and transit) time measure. Highway time in the composite function is developed as the sum of the 'over-the-network' time and the 'tolled-time equivalent', or the time value that is approximately equal to the monetary toll value on the minimum path, if a tolled facility is used. As our distribution model is income-stratified, the factors for converting monetary toll values into equivalent minutes are income level-based and time period based. Higher level incomes are less sensitive to toll charges (2-3 min. per dollar) while lower income levels are quite sensitive to toll charges (20-30 min. per dollar).

9. What type of Mode Choice model is used to develop trip tables?
   - ☒ Multinomial Logit Model
   - ☐ Nested Logit Model

   Other:

10. Are highway tolls included in the utility estimation of the Mode Choice model?
    - ☒ Yes
    - ☐ No

11. Are Value-of-Times (VOTs) included in the model?
    - ☒ Yes
    - ☐ No

    If answered yes for the Question #11, how are VOTs estimated?
    - ☒ By Mode
    - ☒ By Vehicle Type
    - ☒ By Purpose

    If answered yes for the Question #11, which steps uses VOTs in the model?
    - ☒ Trip Distribution
    - ☒ Mode Choice
    - ☒ Traffic Assignment

12. What types of trip purposes are included in the Mode Choice model? Please mention them:
    - ☒ Home-Based Work
    - ☒ Home-Based Other
    - ☐ Home-Based School
    - ☒ Home-Based Shopping
    - ☐ Home-Based University
    - ☐ Non-Home-Based Work
    - ☒ Non-Home-Based Other

    Other:

13. What types of trip tables are produced from the Mode Choice model?
    - ☒ Single Occupancy Vehicles
    - ☒ High Occupancy Vehicles 2
    - ☐ High Occupancy Vehicles 2+
    - ☐ High Occupancy Vehicles 3
    - ☒ High Occupancy Vehicles 3+
    - ☐ Trucks (Light/Medium/Heavy)
    - ☐ Local Bus
    - ☐ Express Bus
    - ☐ Rapid Bus
    - ☐ Bus Rapid Transit (BRT)
    - ☐ Commuter Rail
    - ☐ Light Rail
    - ☐ Walk
    - ☐ Bike

    Other: Transit

14. Are the trip tables from Mode Choice output divided into Toll and Toll-Free modes?
    - ☐ Yes
    - ☒ No

    If yes, for what modes are the Trip Tables divided into toll and toll-free?
    - ☐ Single Occupancy Vehicles
    - ☐ High Occupancy Vehicles 2
    - ☐ High Occupancy Vehicles 2+
    - ☐ High Occupancy Vehicles 3
    - ☐ High Occupancy Vehicles 3+
    - ☐ Trucks (Light/Medium/Heavy)

    Other:

15. What time-of-day trip tables are developed for the Traffic Assignment process?
    - ☒ AM Peak Period
    - ☐ AM Peak Hour
    - ☒ PM Peak Period
    - ☐ PM Peak Hour
    - ☐ Midday
    - ☐ Night Time
    - ☒ Off-Peak (Midday + Night Time)
    - ☐ Daily

    Other:

16. What type of Traffic Assignment process is used in the MPO model?
    - ☒ User Equilibrium Generalized
    - ☐ Cost User Equilibrium
    - ☐ Customized GCUE
    - ☐ Diversion Curve/Logit Model
    - ☐ Stochastic User Equilibrium
    - ☐ Dynamic Traffic Assignment
    - ☐ Origin-Based
    - ☐ Path-Based

    Other:

17. What method do you use to estimate demand on the tolled facilities?
    - ☐ Diversion Curve
    - ☐ Logit Model

    Other: The effect of tolls are considered in trip distribution, mode choice, and traffic assignment. Tolls are considered as an additional congested travel time "burden" in the development of highway skims (monetary toll values are converted to travel time equivalents). The use of a diversion curve in traffic assignment is insufficient for the Washington, D.C. region. The potential impact of HOT lane-induced mobility has implications for trip distribution, as well as mode choice and traffic assignment steps.

    There are three central modeling issues that we as an MPO have been dealing with in reflecting HOT lanes:
    1: Lack of data: There is no revealed preference data for us to calibrate any model which is always an issue. We have been applying a simple and explainable technique that appears to provide rational results within the context of a trip-based framework. The HOT lane facilties being planned (and also now under construction) are very problematic to study because the new facilities are very unique. I'm not aware of any HOT lanes being constructed on a beltway-type facility which will serve both long-distance trips together with "short-hop" trips. Furthermore several important operational policy questions are not yet known, for example, how transit will be treated, etc.
    2: Determining dynamic toll rate levels by time period: We are developing HOT lane toll rates on a trial-and -error basis, using iterative traffic assignments by time period. This appears to work well but is extremly time consuming and subject to human judgement. (Interestingly, network coding errors are very easy to identify during the course of toll-setting. An inordinately high toll on a given section is usually an indicator of some type of coding problem).
    3: Complexity of the policy to be reflected: In Virginia, HOV trips will be allowed to use a HOT facility free of charge, while SOV's will be charge. By law, HOV service levels will be held harmless by the new facility. Modeling this condition is a challenge. We have been proceeding by running the model twice, once where the HOT facility is initially modeled as an HOV facility (to develop HOV skims for the mode choice model), and then again where the HOT lanes are appropriately reflected as a tolled facility for SOVs. (The HOV skims developed initially are preserved in the mode choice model step during the second run of the model). Again, the processing time for this modeling approach is substantial.
    If answered Diversion Curve for the previous question, what data did you use for calibration?
    Please provide the name of data: N/A

18. Does the Traffic Assignment procedure involve any special technique for the modeling of Toll Roads/Managed Lanes?
    - ☒ Yes
    - ☐ No

    If yes, please provide documentation of the procedure.

19. Can the Traffic Assignment procedure model Variable/Congestion pricing facilities?
    - ☒ Yes
    - ☐ No

    If yes, can the tolls on such facilities be changed between assignment iterations? Please provide documentation for such technique.

20. If answered yes for the previous question, are the time-of-day trip tables divided into smaller periods for Variable/Congestion pricing?
    - ☐ Yes
    - ☒ No

    If yes, please provide the resolution of time periods:

21. Are you willing to share the scripts or programs where toll is involved?
☒Yes ☐No
If yes, please provide them: Scripts and model inputs are available upon formal request to Ronald Kirby, Director of Transportation Planning (rkirby@mwcog.org). We do not presently share the off-line 'toll-searching' process used to develop toll rate inputs, given that a great deal of manual review is necessary after its execution.

22. What variables are considered in choosing the shortest path during the Traffic Assignment procedure?
☒Travel Time Travel Cost ☒Toll Cost
☐Operating Cost ☐Value of Time (VOT)
Other:

23. What type of Volume/Delay Function curves are used in the Traffic Assignment process?
☐BPR ☐Conical ☐Ackelik
☒Customized VDFs for all facilities ☐Customized VDFs for Toll/Managed Lane facilities
Other:

24. Between what steps does the model apply feedback loops?
☐Traffic Assignment and Mode Choice ☐Traffic Assignment and Trip Distribution
☒Traffic Assignment and Trip Distribution and Mode Choice
Other:

25. Does the MPO intend to migrate to a new model structure in the near future?
☐Same Model ☐Activity Based Model ☒Modified Four-Step Model
Other:

26. If you want to provide additional information regarding questions above or other comments, please insert in this box.
TPB is in the process of upgrading it's existing travel demand modeling process (Version 2.2) with new household travel survey data (from 2007/08) and a more detailed TAZ system. The new model is know as the Version 2.3 travel demand model and we anticipate adopting it in November. The essential approach that Version 2.3 will use for modeling highway pricing is the same as that described above (at the present time).

For any questions regarding the survey, please contact:

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602-254-6300
vlivshits@azmag.gov

Thank you for your cooperation.

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URS

Appendix B – Macro Advanced Highway Assignment with Toll Route Choices

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Macro Advanced Highway Assignment with Toll Route Choices

Purpose

Performs advanced highway assignment with embedded toll route choices for the specified time period. It is a Stochastic User Equilibrium (SUE) assignment where the toll route choice is based on a logit model for choices between free and toll routes.

Methodology

The advanced highway trip assignment with toll route choice is the process in which zone-to-zone vehicle trips are assigned to paths on the links comprising the highway network, including paths involving tolls. The MAG model utilizes the SUE assignment procedure. In this process, the desired equilibrium state is such that where no traveler can improve his/her **perceived** travel cost by unilaterally changing routes. Route travel costs can also be generalized by summarizing the link toll cost and link travel time cost (which is obtained by converting travel time and/or travel distance into monetary cost). Iterations of capacity-restrained traffic assignments are repeated and averaged until a specified level of equilibrium is attained.

This macro performs highway assignment for the specified time period, averages link volumes with previous iteration volumes, re-computes travel times based on the averaged volumes, and exports those times to a binary file. The advanced trip assignment keeps the flexibility to consider trip purposes and vehicle classes including single occupied vehicle (SOV), high occupied vehicle (HOV), and trucks (heavy, medium , and light). The process also considers electronic transponder (ETC) toll users and cash/video toll users. ETC users usually get a discounted price. The toll charges can be hard-coded in the network or based on the toll link length. The later will be useful for dynamic toll scheme for the managed lanes.

This macro calculates averaged link volumes and computes travel times based on those volumes, for building travel skims for the next iteration. The following steps represent the process.

Step 1: Shortest paths between each O-D pair *r* and *s* are found based on free-flow travel times $t_a(0)$. If the shortest path between *r* and *s* falls on a toll path, then a shortest non-toll path is found between *r* and *s*. The total demand between *r* and *s*, q_{rs}, is split between the toll and non-toll shortest paths based on the following toll equation for the logit model. This yields flow vector, $\vec{x}^1$. Iteration counter *n* is set to 1.

$$P_{toll}^{rs} = \frac{1}{1 + e^{-\theta(VOT * T_{toll}^{rs} - T_{free}^{rs} + \tau^{rs} + c)}}$$

where T_k^{rs} is the total travel time of path k between r and s;

τ_k^{rs} is the total toll cost of path k between r and s;

VOT is the value of travel time; and

θ and c are parameters.

Step 2: Link times are updated using the volume delay function.

$$t_a^n = t_a(x_a^n)$$

Step 3: Auxiliary flow vector $\vec{y}^n$ is obtained by splitting the total flow between each O-D pair *r* and *s* based on the logit model above, by using the updated link times $\vec{t}^{\,n}$ from Step 2.

Step 4: The parameter λ_n (step size) is found, that solves $\min_{0 \le \lambda_n \le 1} z[x_a^n + \lambda_n(y_a^n - x_a^n)]$ as in equation.

Step 5: Link flows are updated.

$$x_a^{n+1} = x_a^n + \lambda_n(y_a^n - x_a^n),\ \forall a \in A$$

Step 6: Convergence is checked. If a convergence criterion is met, then the current flow vector $\vec{x}^{n+1}$ represents the equilibrium link flows. If convergence is not reached, then the iteration counter *n* is updated, $n = n + 1$ and Steps 1 through 6 are repeated.

Please note that Steps 2 through 6 are part of the standard equilibrium algorithm (e.g., Frank-Wolfe algorithm) embedded in the travel demand model packages such as TransCAD, CUBE/Voyager, and VISUM. Usually no additional script is required for these steps. Alternatively, the step size parameter can be replaced by using the method of successive averages (MSA).

For some software such as CUBE/Voyager, where the logit step can be directly scripted in the iterative equilibrium algorithm, the SUE approach is straightforward and easy to implement. However, in other cases such as TransCAD, the GISDK script cannot modify the route choice decision directly (by either calling the UE or SUE function). To compromise this situation, a practical, alternative solution is described in the Pseudo Code. In each iteration of the algorithm, the UE assignment will be called firstly and the travel cost will be scanned and fed into the logit split. The split toll and non toll trip tables will be then loaded to the network using another UE assignment. This is equivalent to a SUE approach, based on our prior project experiences.

Pseudo Code

1. Prepare trip tables for all modes (SOV, HOV, heavy trucks, medium trucks, and light trucks)
   1.1. Opens passenger car and truck OD matrices and read matrices for the specified time period
   1.2. Split passenger car and truck matrices for ETC ownership
   1.3. Specifies the appropriate output flow table based on the specified period
   1.4. Adds link layer and create exclusion sets for each vehicle class (e.g., SOV will not allow to use HOV lanes)
2. Initial TransCAD assignment run
   2.1. Sets general assignment parameters

2.2. Runs UE assignment for all links
2.3. Skim for shortest path for each OD pair
2.4. Run UE assignment excluding toll links
2.5. Skim for shortest path~~e~~ for each OD pair
2.6. For each OD pair with two different paths from the two skims (i.e., toll and non-toll paths), evaluate the toll route choice using the logit equation
2.7. Split the matrix for each mode with the toll route choice probability
2.8. Split the toll trip matrix with ETC and Cash/video payment

3. Continue TransCAD assignment runs
   3.1. Set assignment parameters
   3.2. Run UE assignment with the new trip tables
   3.3. Opens the output flow table from this iteration and the averaged flow table from previous iterations using the method of successive averages (MSA)
   3.4. Updates the network flows with the averaged volumes
   3.5. Check for convergence
   3.6. Recalculates link times based on averaged flows
   3.7. Skim for toll and non-toll paths
   3.8. Split the matrix for toll and non-toll trips with updated time
   3.9. Continue iteration
4. If converged, output the network volume and travel time; output the toll link volumes.

The following assignment settings are specified:

Opts.Input.Database	Highway DB	Highway database
Opts.Input.Network	Highway Net	Highway network file
Opts.Input.[OD Matrix Currency]	{Car OD Matrix}	Trip matrices to assign by time period
Opts.Input.[Exclusion Link Sets]	Excl_set	Exclusion set of links by time period
Opts.Field.[Vehicle Classes]	Classes	Vehicle Classes
Opts.Field.[Fixed Toll Fields]	Toll	Fixed link toll cost specified in highway database
Opts.Field.[VDF Fld Names]	VDF_flds	Volume delay function fields
Opts.Global.[Load Method]	UE	User Equilibrium Method
Opts.Global.Convergence	convg	Relative gap convergence
Opts.Global.Iterations	iters	maximum number of iterations
Opts.Global.[Number of Classes]	class_n	Number of Vehicle Classes
Opts.Global.[Class PCEs]	PCEs	Passenger car equivalents
Opts.Global.[Class VOIs]	VOIs	Value of Time by Vehicle Class
Opts.Global.[Cost Function File]	vdf_file	Volume delay functions file
Opts.Global.[VDF Defaults]	VDF_defaults	Array of values containing the VDF default values
Opts.Flag.[Do Share Report]	1	Report assignment results by vehicle classes
Opts.Output.[Flow Table]	flow_tb	output table

Inputs

Name	Description	Example
code	Assignment Type (24H,AM,PM,MD,NT)	AM
loop	Loop number	1
loop_n	Max number of loops	3
convg	Assignment convergence criteria	0.001
UE	User Equilibrium Method	5
load_all	Load all classes	1
period	Time period	AM
Highway DB	Highway network database	highway\highway.dbd
Highway Net	Highway network file	out\highway.net
MSA Highway Times	Link travel times averaged from feedback	out\HighwayLinkTime.bin
MSA AB Highway Times	Link travel times in AB direction averaged from feedback	out\HighwayLinkTimeAB.bin
MSA BA Highway Times	Link travel times in BA direction averaged from feedback	out\HighwayLinkTimeBA.bin
Car OD Matrix	Passenger car OD matrix for all periods	out\car_od.mtx
Truck OD Matrix	Truck OD matrix for all periods	out\truck_od.mtx

Outputs

Name	Description	Example
Highway DB	Updates highway network database	highway\highway.dbd
Highway Net	Updates highway network file	out\highway.net

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URS

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