Exposition Metro Line Construction Authority

Exposition Corridor Transit Project Phase 2

Final Environmental Impact Report

Technical Background Report

FINAL

Patronage Forecasting Methodology Version 0.4

December 2009

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Exposition Metro Line Construction Authority

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Contents

Figures

Tables

INTRODUCTION

This document provides an overview of the interim version of the Los Angeles County Metropolitan Transportation Authority's (LACMTA) Transportation Analysis Model that was used in the patronage forecasting effort for Exposition Corridor Transit Project Phase 2 Alternatives Analysis (AA). The ridership forecasts are based on methods that are generally consistent with current Federal planning regulations, particularly those of the Federal Transit Administration (FTA) related to the transit New Starts program since Section 5309 New Starts funding was considered at the time of the study.

As described later in Section 2.0, the Metro Transportation Analysis Model is still under development to fully conform to the requirements of the FTA. In order to support on-going planning in the region, an "interim" version of this model was developed by Metro and was used to forecast ridership for the Expo Phase 2 as well as the Eastside project, Westside Corridor, and Crenshaw Corridor AA projects.

Section 2 briefly describes elements of the interim version of the Metro Transportation Analysis Model while Section 3.0 describes the calibration results.

PATRONAGE FORECASTING METHODOLOGY

The interim version of the Metro Transportation Analysis Model, like nearly all transit forecasting models, uses assumptions regarding regional socioeconomic and transportation network characteristics to develop estimates of the amount of travel (i.e., trips) occurring between different locations in the area, the market share of each transportation mode, and the routing of these trips over the highway and transit networks. The results of this process include trips by mode and by facility including usage of individual transit routes or stations (ridership). These procedures also develop estimates of travel time savings and other Transportation System User Benefits which are a key component of the Federal evaluation of potential transit projects.

This process is repeated for every combination of origin and destination location in the metropolitan area. In order to maintain a tractable modeling process, locations in the model are aggregated into a series of Traffic Analysis Zones (TAZs) which are the fundamental geographic unit of analysis for the entire process.

The model, itself, is a form of the conventional four-step model used for transportation analysis throughout the United States. Key steps of the model include:

- Trip generation. This step estimates the number of trips produced in and attracted to each zone based on zonal socioeconomic variables such as population, households, and employment. The trip generation step estimates the amount of travel beginning and ending in each production (home) and attraction (non-home) TAZ for Home-Based Work, Home-Based University, Home-Based Other, and Non-Home Based trips. Trip generation rates are based on procedures developed by the Southern California Association of Governments.
- Trip distribution. Computerized network representations of the highway system is used to estimate the time and cost associated with travel between each pair of zones and

these estimates are combined with trip generation results to develop a matrix (known as a "trip table") of travel between each production and each attraction zone in the region. Both the zone-to-zone travel times (known as "skims") and the trip tables are organized as very large matrices that have one row for each production zone and one column for each attraction zone. Each cell in these matrices contains an estimate of the time or number of trips beginning at a given production zone and ending at a given attraction zone. Each skim table or trip table contains over 9 million values representing each combination of production and attraction zone.

- Mode Choice. Following trip distribution, the skim matrices for each mode of travel (drive alone, HOV, and various transit options) are used to characterize the quality of each transportation option and to estimate the market share that each mode would attract. This step is known as "Mode Choice." In addition to generating trip tables for each mode of travel, this step generates estimates of the number of linked trips (i.e., from origin to destination, independent of transfers) attracted to each mode and an estimate of the aggregate time savings and other benefits that are associated with different transportation improvements.
- Assignment. Finally, network processing software is used to determine the best path or routing that each highway and transit trip will use to travel between the trip origin and destination. This step is known as "Assignment" and ridership results such as boardings by station or route are determined from the results of this element of the model.

The remainder of this section describes each aspect of the modeling approach in more detail.

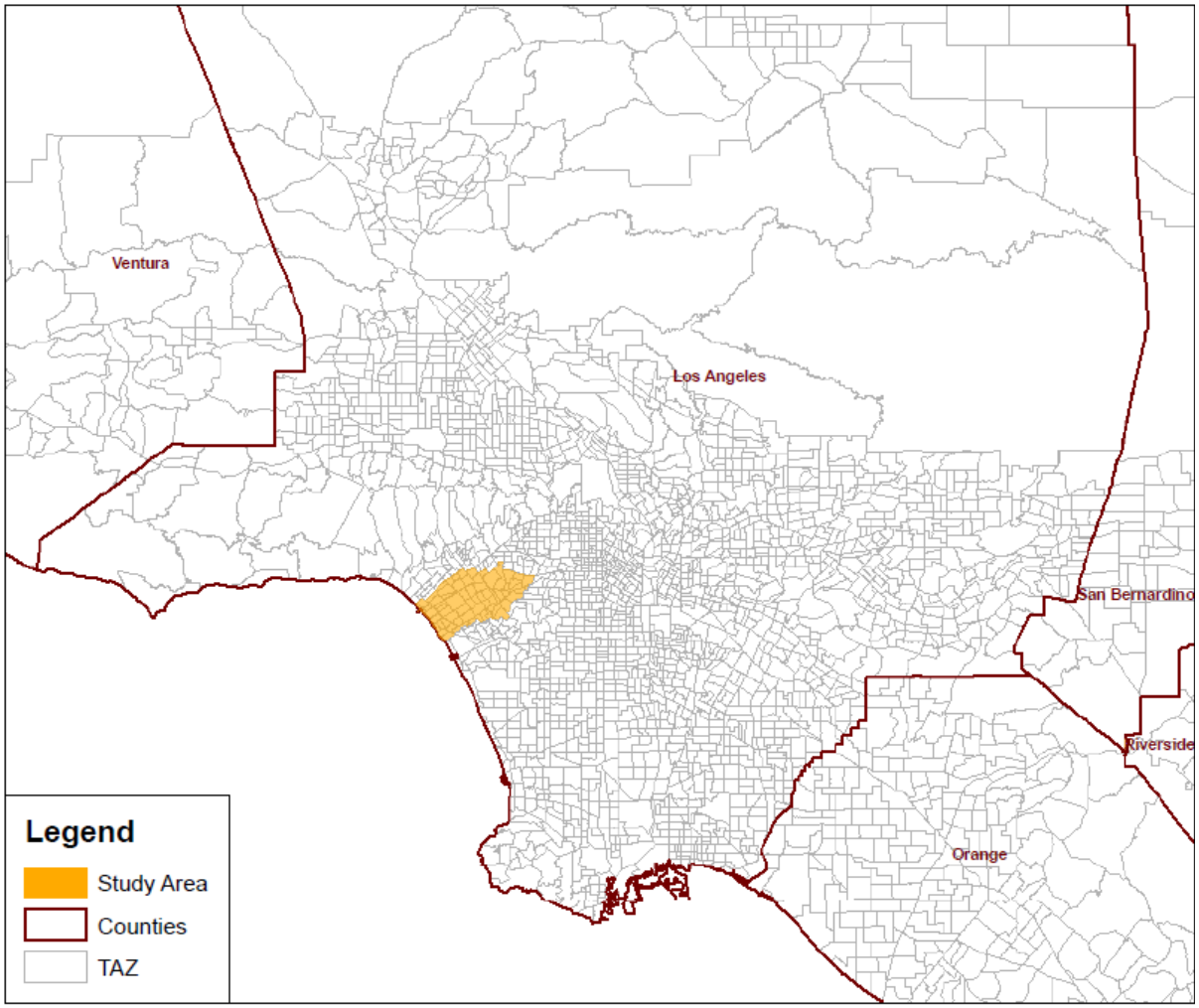
Traffic Analysis Zone System

The system of zones applied in the Metro Transportation Analysis Model is designed to support an understanding of all travel occurring to, from and within Los Angeles County. Within the model, all travel is represented beginning at the trip origin (e.g., home) and ending at the trip destination (e.g., workplace or shopping location). This approach requires a broad regional geographic system that encompasses the key travel sheds to, from, and within Los Angeles County including Ventura, Orange, San Bernardino, Riverside, and Imperial Counties. The zone system includes 3,017 zones and a depiction of the zone structure in Los Angeles County is shown in Figure 2-1.

Socioeconomic Data

Data on existing and projected socioeconomic characteristics are major inputs to the travel demand model. The socioeconomic data include population, employment, and household information and are aggregated by TAZ. Base year (2005/2006) data and forecast year (2030) projections were obtained from the Southern California Association of Governments (SCAG) using the April 2004 series of forecasts that cover the period ending in the Year 2030[1], consistent with Federal planning guidelines at the time of the study. These forecasts were developed for individual SCAG zones and converted to Metro Zones based on Census estimates of population by Census Block within each Metro TAZ.

[1] The April 2004 forecasts were superseded in April 2008 by a new forecast series ending in 2035. Given the fact that multiple planning studies were underway at that time, Metro has elected to retain the April 2004 forecast series and transition to the April 2008 at a later time.



Source: Metro

Figure 2-1 Metro Multimodal Model Zone System

Tables 2.1 and 2.2 show 2005 and 2030 population, employment, and households by income level summarized to the district level of detail. Table 2-3 shows the percent change from 2005 to 2030 for each demographic data set. Figure 2-2, on the following page, shows the districts definitions used in this study.

Areas of key interest to this project include the Central LA East, CBD, Westside South and all districts that are adjacent to Expo Phase 2 corridor (districts 15 to 24). Each of these areas shows population growth between 10 and 28 percent and employment growth between 13 to 38 percent.

North Los Angeles County and San Fernando Valley show higher growth rates than those projected in other highly developed portions of the Los Angeles County and Orange County. Riverside County is expected to lead the region in growth in population and employment (74 percent and 88 percent, respectively) while Ventura and San Bernardino are expected to see intermediate levels of both population and employment growth.

Table 2-1 2005 Socioeconomic Data

	District	Population	Workers	Retail Employment	Total Employment	Low-Income Households	Medium-Income Households	High-Income Households
1	Central LA - East	478,350	167,517	21,066	161,039	61,160	48,386	16,211
2	San Gabriel Valley	1,842,871	794,654	130,268	762,588	213,178	249,237	93,167
3	Gateway Cy	1,912,008	756,521	118,675	799,500	242,009	233,586	83,356
4	Southbay	1,452,035	600,019	100,060	645,322	215,024	195,179	68,272
5	Westside - South	61,612	27,837	11,042	44,380	13,222	10,963	3,614
6	SanFernV-6	90,554	45,216	7,068	47,299	9,722	16,268	6,527
7	SanFernV-7	1,419,207	651,435	111,343	593,755	207,706	202,829	72,264
8	ArroyoVerd	343,149	161,167	32,088	212,724	59,192	52,876	18,338
9	N LA County	637,951	270,025	43,769	200,782	69,961	93,553	36,112
10	Orange County	2,980,624	1,436,084	276,505	1,581,996	356,757	442,249	166,722
11	Riverside County	1,789,456	725,665	127,765	625,229	260,823	261,410	84,683
12	San Bernardino	1,860,154	746,562	145,354	687,109	231,741	261,006	91,262
13	Ventura County	796,642	377,647	61,438	358,598	86,906	123,727	48,446
14	Imperial County	-	-	-	-	-	-	-
15	LA CBD	114,452	43,126	25,170	302,064	28,579	9,289	2,084
16	Vermont	131,634	43,325	5,785	63,618	23,981	10,960	2,981
17	Crenshaw	70,110	25,338	4,059	16,953	15,069	9,384	2,866
18	La Cienega	28,188	10,620	1,701	7,209	4,994	3,563	1,136
19	Venice/Robertson	35,799	18,241	3,079	19,347	6,914	5,499	1,804
20	Venice/Sepulveda	120,925	65,460	12,699	71,503	28,632	21,345	6,819
21	Ocean/ColoradoBL	90,949	50,968	13,397	67,567	22,700	17,121	5,534
22	Central LA - South	224,282	76,149	8,303	53,307	32,640	23,420	7,644
23	Central LA - North	673,793	306,592	45,438	304,092	162,801	86,094	24,352
24	Westside - North	282,446	151,705	40,864	270,961	64,412	55,040	18,582
	Total	***17,437,191***	***7,551,873***	***1,346,936***	***7,896,942***	***2,418,123***	***2,432,984***	***862,776***

Source: SCAG, April 2004.

Table 2-2 2030 Socioeconomic Data

	District	Population	Workers	Retail Employment	Total Employment	Low-Income Households	Medium-Income Households	High-Income Households
1	Central LA - East	574,813	203,096	25,044	192,293	77,435	60,914	20,242
2	San Gabriel Valley	2,331,228	1,004,986	153,946	922,806	271,458	320,795	119,913
3	Gateway Cy	2,220,215	884,931	142,930	960,037	279,742	269,928	95,811
4	Southbay	1,674,917	696,192	128,002	788,678	253,075	226,077	78,368
5	Westside - South	72,425	31,983	20,375	61,166	16,249	13,498	4,434
6	SanFernV-6	125,764	61,520	8,722	58,503	13,580	22,901	9,204
7	SanFernV-7	1,582,476	738,180	132,684	723,501	248,290	241,450	85,577
8	ArroyoVerd	394,918	187,842	40,771	269,157	67,440	60,977	21,109
9	N LA County	1,191,665	489,822	63,860	292,691	124,202	175,036	68,188
10	Orange County	3,551,980	1,700,940	335,537	1,921,349	394,068	510,418	193,446
11	Riverside County	3,110,329	1,280,444	250,324	1,174,057	501,938	477,775	144,681
12	San Bernardino	2,686,003	1,097,759	248,035	1,175,932	377,916	389,339	123,701
13	Ventura County	989,697	469,957	83,381	465,449	107,576	160,918	63,605
14	Imperial County	-	-	-	-	-	-	-
15	LA CBD	133,729	50,987	32,680	340,171	37,289	12,453	2,811
16	Vermont	168,877	56,092	6,590	74,242	34,108	15,566	4,187
17	Crenshaw	89,675	32,797	4,505	20,619	21,014	13,054	3,941
18	La Cienega	36,053	13,736	1,905	8,887	6,921	4,925	1,554
19	Venice/Robertson	44,178	22,894	3,614	23,606	9,312	7,270	2,355
20	Venice/Sepulveda	136,719	75,356	14,284	85,455	35,147	26,157	8,299
21	Ocean/ColoradoBL	99,840	56,529	14,933	79,409	25,945	19,499	6,258
22	Central LA - South	251,106	86,231	9,785	67,102	39,345	27,835	8,993
23	Central LA - North	752,953	346,060	50,548	358,317	201,384	106,877	29,920
24	Westside - North	311,479	169,375	46,572	324,403	73,396	63,456	21,457
	Total	***22,531,039***	***9,757,709***	***1,819,027***	***10,387,830***	***3,216,830***	***3,227,118***	***1,118,054***

Source: SCAG, April 2004

Table 2-3 Socioeconomic Change 2005 to 2030

	District	Population	Workers	Retail Employment	Total Employment	Low-Income Households	Medium-Income Households	High-Income Households
1	Central LA - East	20%	21%	19%	19%	27%	26%	25%
2	San Gabriel Valley	26%	26%	18%	21%	27%	29%	29%
3	Gateway Cy	16%	17%	20%	20%	16%	16%	15%
4	Southbay	15%	16%	28%	22%	18%	16%	15%
5	Westside - South	18%	15%	85%	38%	23%	23%	23%
6	SanFernV-6	39%	36%	23%	24%	40%	41%	41%
7	SanFernV-7	12%	13%	19%	22%	20%	19%	18%
8	ArroyoVerd	15%	17%	27%	27%	14%	15%	15%
9	N LA County	87%	81%	46%	46%	78%	87%	89%
10	Orange County	19%	18%	21%	21%	10%	15%	16%
11	Riverside County	74%	76%	96%	88%	92%	83%	71%
12	San Bernardino	44%	47%	71%	71%	63%	49%	36%
13	Ventura County	24%	24%	36%	30%	24%	30%	31%
14	Imperial County	-	-	-	-	-	-	-
15	LA CBD	17%	18%	30%	13%	30%	34%	35%
16	Vermont	28%	29%	14%	17%	42%	42%	40%
17	Crenshaw	28%	29%	11%	22%	39%	39%	38%
18	La Cienega	28%	29%	12%	23%	39%	38%	37%
19	Venice/Robertson	23%	26%	17%	22%	35%	32%	31%
20	Venice/Sepulveda	13%	15%	12%	20%	23%	23%	22%
21	Ocean/ColoradoBL	10%	11%	11%	18%	14%	14%	13%
22	Central LA - South	12%	13%	18%	26%	21%	19%	18%
23	Central LA - North	12%	13%	11%	18%	24%	24%	23%
24	Westside - North	10%	12%	14%	20%	14%	15%	15%
	Total	***29%***	***29%***	***35%***	***32%***	***33%***	***33%***	***30%***

Source: SCAG, April 2004

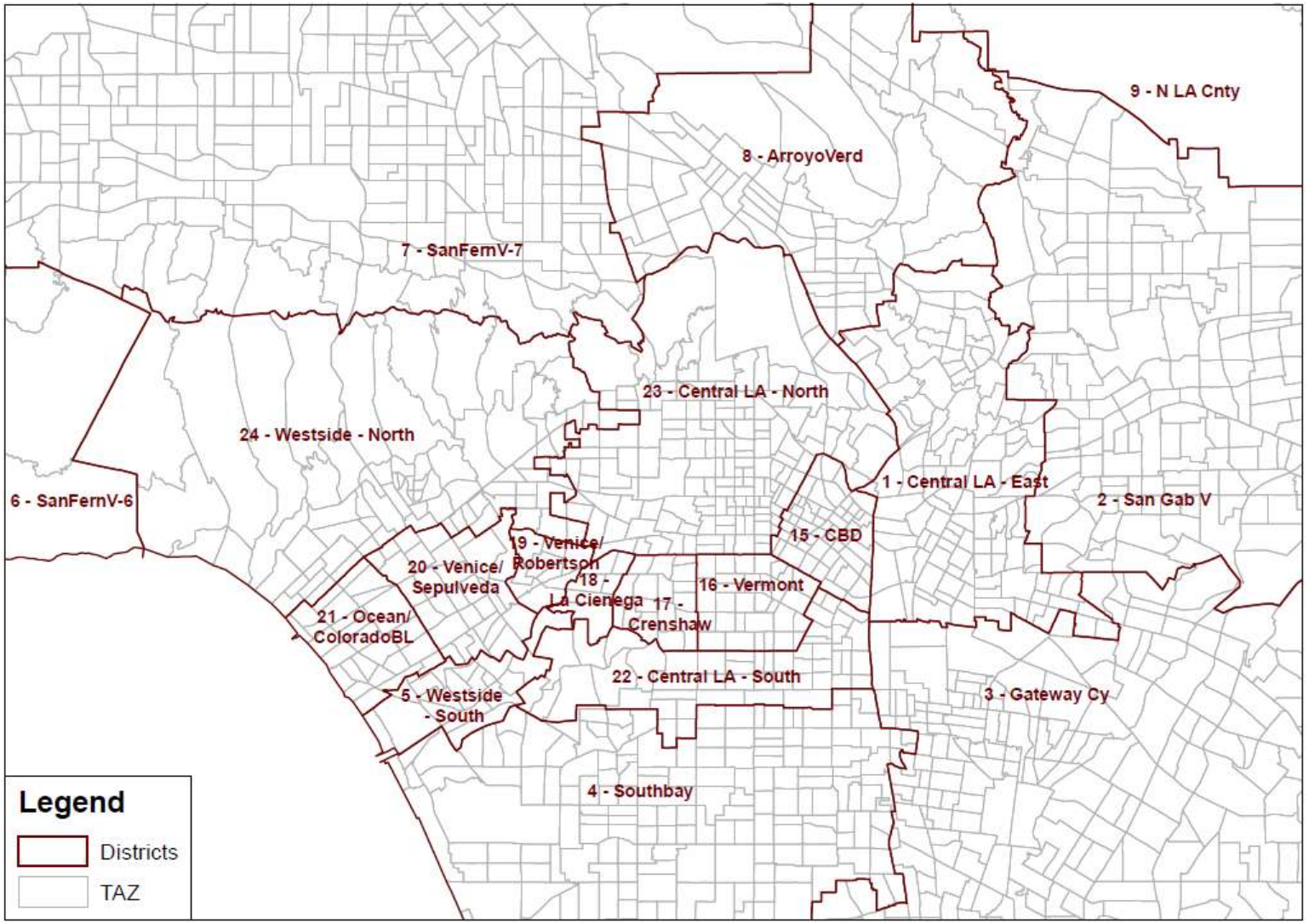


Figure 2-2 Travel Districts

Trip Generation and Distribution

Trip tables contain information on the number of trips produced in and attracted to each zone-to-zone interchange in the modeling area. These tables are structured as large matrices where each row represents a production zone (the home end of a trip) and each column represents an attraction zone (the non-home end of a trip). Each cell represents the number of trips traveling between a particular production zone and a particular attraction zone.

The Metro Transportation Analysis Model stratifies travel by the underlying purpose of the trip and time of travel. These stratifications include:

- Home-Based Work: Peak and Off-Peak (HBWPK, HBWOP)
- Home-Based Other: Peak and Off-Peak(HBOPK, HBOOP)
- Non-Home Based: Peak and Off-Peak (NHBPK, NHBOP)
- Home Based University: Peak and Off Peak (HBUPK, HBUOP)

Trip tables for the Metro Transportation Analysis Model were obtained from the model set developed by the Southern California Association of Governments (SCAG) for their 2004 Regional Transportation Plan and converted to the Metro zone system. This conversion is based on the relative number of trips produced in or attracted to each Metro zone as estimated using the SCAG trip generation model and Metro zone-based socioeconomic data described in Section 2.2.

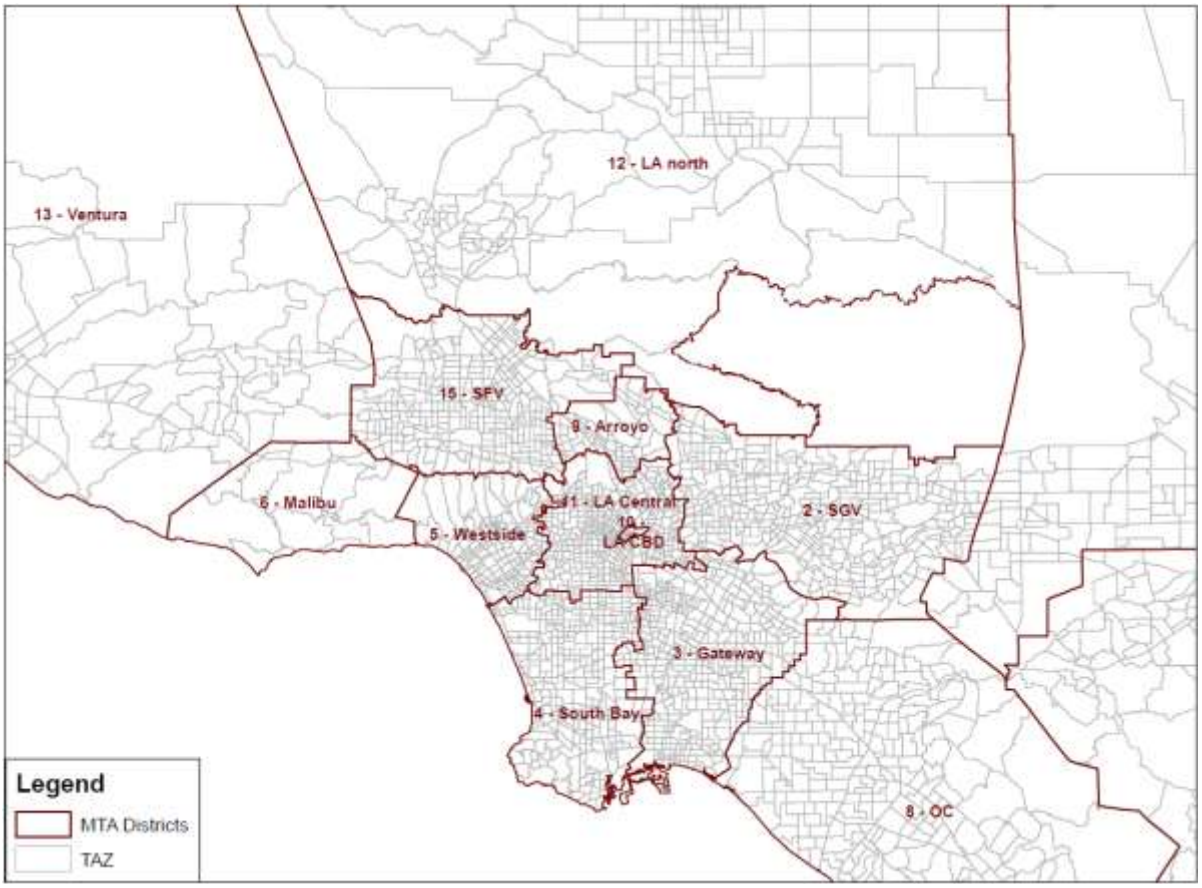
As part of the calibration of the Metro interim model, Home Based Work (HBW) and Home-Based University (HBU) trip tables were factored to provide a more realistic representation of travel by income group for key district-to-district movements. This adjustment was necessary so that the implied transit share by income group obtained by comparing target transit trips from on-board surveys divided by the person trips from the SCAG trip tables did not exceed realistic limits. Adjustment factors, which were derived by iteratively factoring the SCAG trip tables until the modeled transit trips were comparable to the target transit trips from the on-board survey, are shown in Table 2-4. The Metro districts on which the adjustment factors were based are shown in Figure 2-3. These factors range between 1.3 and 2.7 for selected low income trips traveling to and from the Central LA region of the model. Low income travel to Orange County was reduced by two-thirds while low income travel in the Westside was increased by 30 to 180 percent. The factoring process was also used to increase high income travel to the LA CBD for long distance commutes from the eastern suburbs.

A summary of the original, unadjusted SCAG and the final adjusted person trip tables for 2005 and 2030 are presented in Table 2-5. Both the original and adjusted trip tables show that regional travel between the present and 2030 is expected to grow by 31 percent with slightly lower than average growth occurring for Home-Based Work trips and slightly higher than average growth occurring for University travel. The factoring process does have the effect of increasing regionwide work travel by four percent (as compared to the unfactored tables). This change affects both the Year 2005 and 2030 so growth rate in trips is very similar to the original unadjusted trips. As noted above, these changes were required to assure that the transit mode share as measured by surveyed trip volumes represented realistic expectations of the proportions of travelers in different market segments using transit.

Table 2-4 Trip Table Adjustment Factors

Geographic Region		Low Income Trip Table Adjustments				High Income Trip Table Adjustments
		HBW Peak	HBW Off-Peak	HBU Peak	HBU Off-Peak	HBW Peak
To CBD						
Riverside-LA CBD	1-10					16.50
San Gabriel Valley-LA CBD	2-10					15.00
San Bernardino-LA CBD	7-10					15.00
To Central LA						
San Gabriel Valley-Central LA	2-11	2.58				
Gateway-Central LA	3-11	1.85				
South Bay-Central LA	4-11	1.99	2.31			
Central LA-Central LA	11-11	2.67	2.68	2.29	2.13	
From Central LA						
Central LA-San Gabriel Valley	11-2	1.57				
Central LA-Gateway	11-3	1.96	2.85			
Central LA-South Bay	11-4	1.63	2.51			
Central LA-Westside	11-5	1.97	1.39	1.71	1.49	
Central LA-Arroyo	11-9	1.63				
Central LA-LA CBD	11-10	1.31				
Central LA-Central LA	11-11	2.67	2.68	2.29	2.13	
Other						
Westside-Westside	5-5	2.76	1.87	1.32		
South Bay-Gateway	4-3	1.29				
South Bay-Westside	4-5	1.41				
South Bay-Orange Co.	4-8	0.33				
Gateway-Orange Co.	3-8	0.33				

Source: AECOM analysis of mode choice control files prepared by PB Americas
CBD: Central Business District



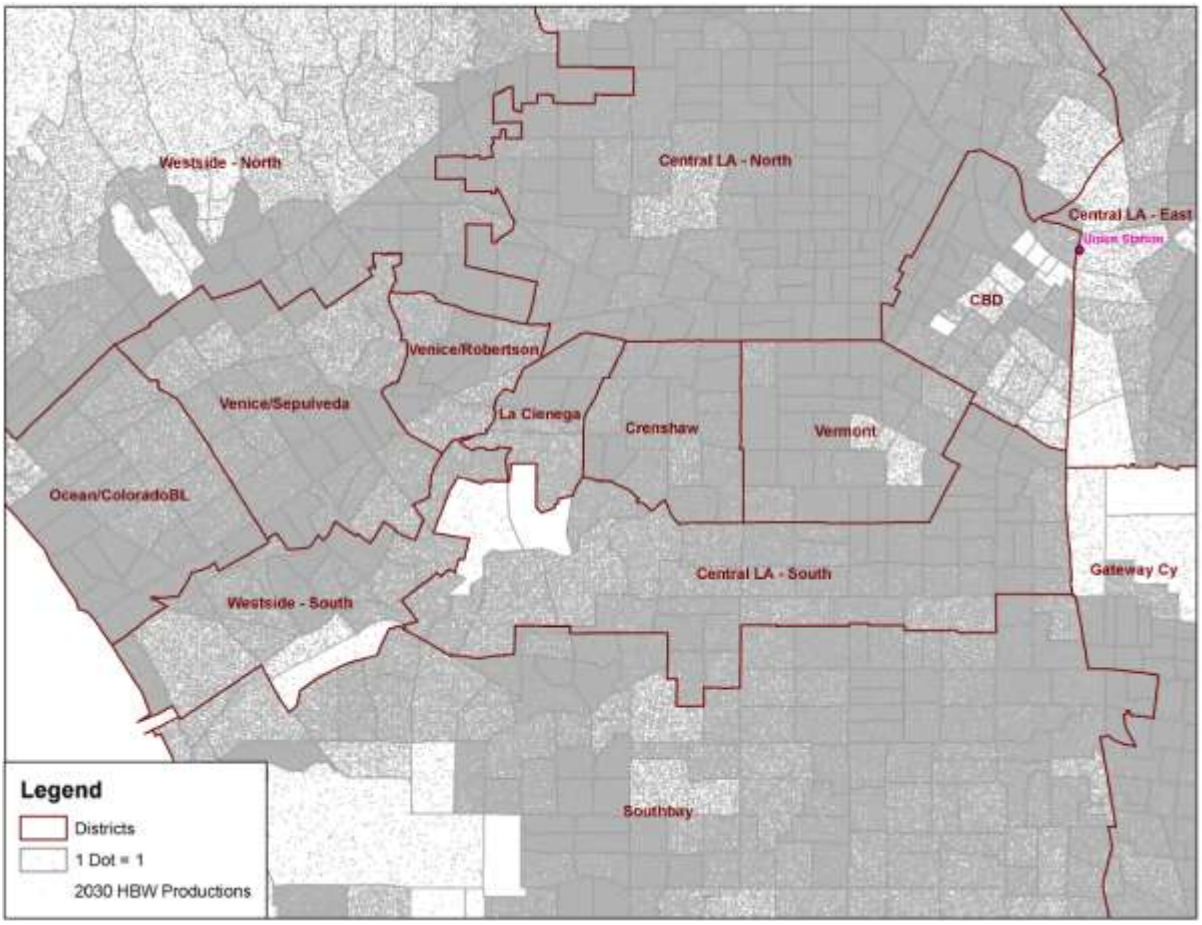
Source: PB Americas

Figure 2-3 LA Metro Districts

Table 2-5 2005 and 2030 Regional Person Trips by Purpose

Trip Purpose	Unadjusted Year 2005 Weekday Person Trips	Unadjusted Year 2030 Weekday Person Trips	Unadjusted 2005 to 2030 Growth	Adjusted Year 2005 Weekday Person Trips	Adjusted Year 2030 Weekday Person Trips	Adjusted 2005 to 2030 Growth
Home-Based Work	9,673,809	12,487,627	29%	10,092,642	12,938,421	28%
Home-Based University	1,776,672	2,423,548	36%	1,867,659	2,528,372	35%
Home-Based Other	28,644,692	37,582,892	31%	28,644,692	37,582,892	31%
Non-Home Based	18,892,198	24,808,822	31%	18,892,198	24,808,822	31%
Total	58,987,371	77,302,889	31%	59,497,191	77,858,507	31%

Figure 2-4 presents a depiction of the Year 2030 Home-Based Work trip productions in the Expo Phase 2 corridor and surrounding areas. As this figure shows, trip densities are approximately uniform in all the subcorridors except for regions that are already highly developed (LA CBD) or where there are universities or recreational areas.



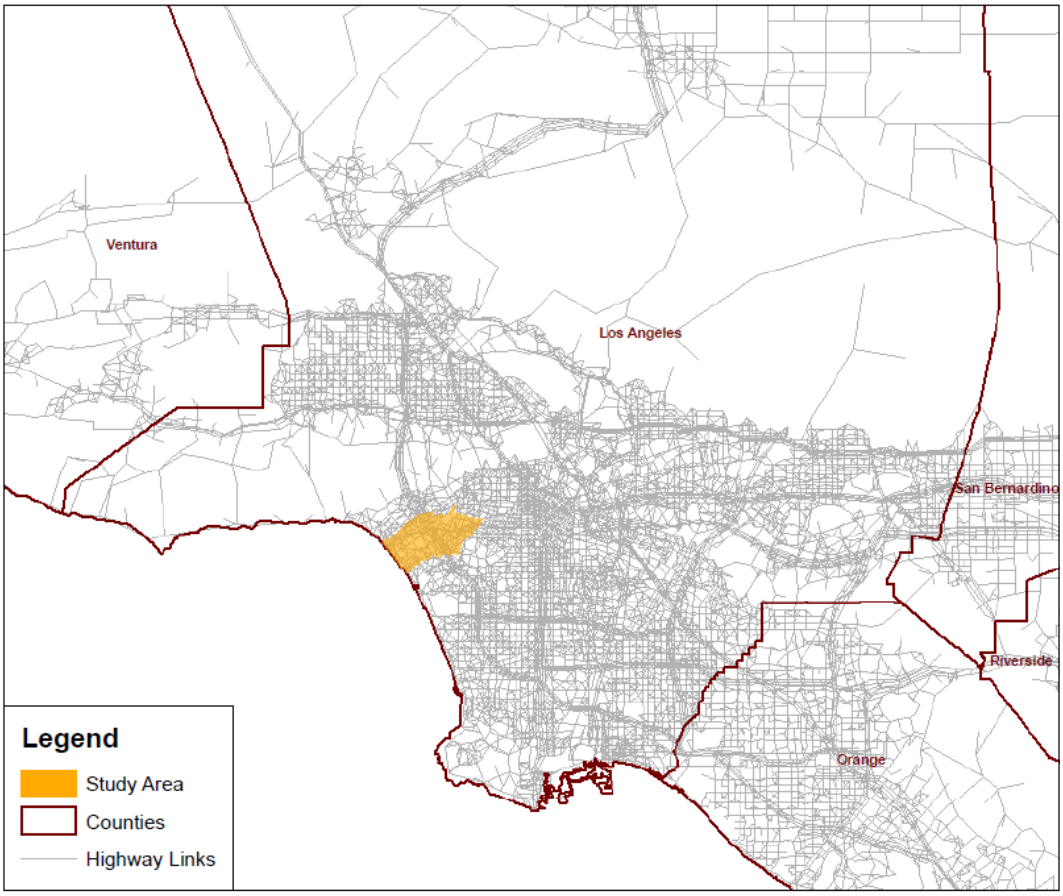
Source: AECOM analysis of HBW model trip tables

Figure 2-4 Distribution of Year 2030 Expo Corridor Home-Based Work Trip Productions

Highway Networks

Highway networks for 2005/2006 and 2030 are based on the SCAG highway networks developed for the 2004 Regional Transportation Plan. These networks are similar to the networks used by all agencies responsible for modeling in Southern California (SCAG, Metro, OCTA, SANBAG, RCTC, Caltrans). The only significant difference is that Metro uses a utility program to generate any missing connector links between each of the Metro zone centroids and the roadway network. The utility program takes the transit network as input and identifies the connector links required to make the transit network compatible with the highway network. The program is part of the transit network processing procedures discussed in the next section.

The network includes estimates of peak and off-peak link speeds which were obtained from Caltrans and local municipalities. These speeds are used as part of the network processing procedures described in Section 2.5.



Source: Metro

Figure 2-5 Year 2030 Highway Network

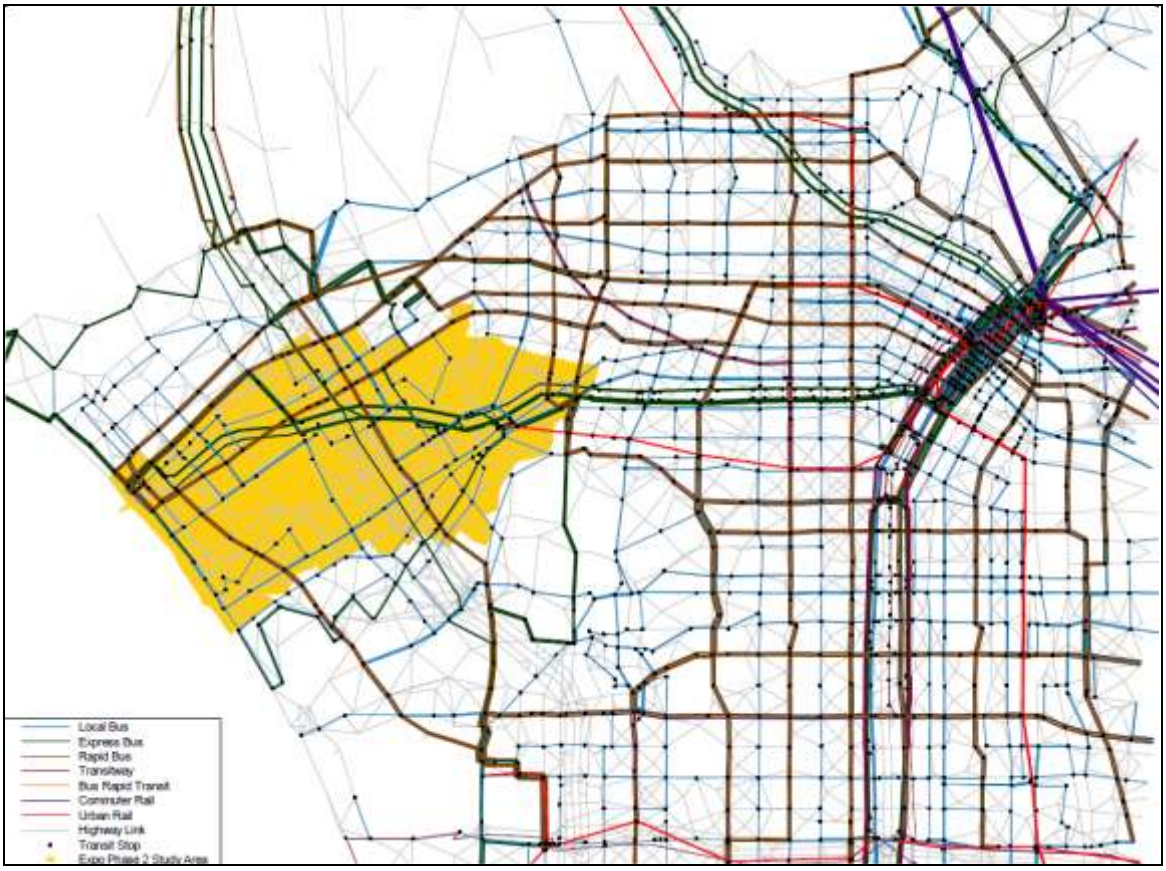
Transit Networks

Transit Networks for the year 2005/2006 and 2030 are maintained by Metro and represent all bus and rail public transit services operating in Los Angeles County and neighboring jurisdictions. Coded services include:

- Metrolink Commuter Rail
- Metro Rail
- Metro Bus operations including Local, Rapid, Express and Transitway services
- Municipal Bus operations

Transit services are divided into modes defined as follows:

1. Local Bus
2. Express Bus
3. Rapid Bus
4. Transitway
5. Bus Rapid Transit
6. Commuter Rail
7. Urban Rail



Source: Metro

Figure 2-6 Year 2030 No Build Transit Network

Table 2-6 shows the list of transit companies operating in the modeled area by each type of transit service.

Transit access was estimated using Metro's INET-2-TNET application. This application is a set of "awk" programming language scripts and UNIX shell utilities. Transit access from a zone to a bus stop or a rail station is a function of the straight line (Cartesian) distance between them. This distance is a parameter that can be controlled to get longer/shorter walk links. The resulting access links were adjusted by a circuity factor to adjust the impedances to account for difference between actual network distance and straight line distance between a zone and a transit stop.

Table 2-6 Transit Companies in the Metro Model

Mode	Companies	Service Type
10	Metrolink	Commuter Rail
11	MTA Local Bus	Local Bus
12	MTA Express Bus	Express Bus
13	MTA Rail (Red, Blue, Green, Gold)	Urban Rail
14	Commerce Municipal, Inglewood, Santa Fe Springs	Local Bus
15	Whittier, Azusa, Bellflower, Cerritos, Duarte, El Monte, Glendale, Monterey Park, W Hollywood, LA DOT, West Covina, Shuttle	Local Bus
16	Norwalk Transit, Long Beach Transit, Carson Circuit, Gardena Municipal, Santa Clarita	Local Bus
17	Torrance Transit, Santa Monica, Culver City Bus, MAX	Local Bus
18	Foothill Transit, Montebello Bus Lines, AVTA	Local Bus
19	South Coast Area Transit, Moorpark, Thousand Oaks, Simi Valley	Local Bus
20	OCTA, OMNITRANS, Riverside Transit Agency	Local Bus
21	Santa Monica, Gardena Municipal, Santa Clarita, Torrence Transit, AVTA, LADOT	Express Bus
22	MAX, Foothill Transit	Express Bus
23	Vista, Inland Empire Connection, OCTA, OMNITRANS, Simi Valley	Express Bus
24	MTA	Rapid Bus
25	MTA	Transitway Bus
26	Orange Rail	Urban Rail

Source: Metro

Travel Times

This section describes the procedures used to generate travel time matrices containing the zone-to-zone travel times for each mode of travel.

Peak Highway Travel Times

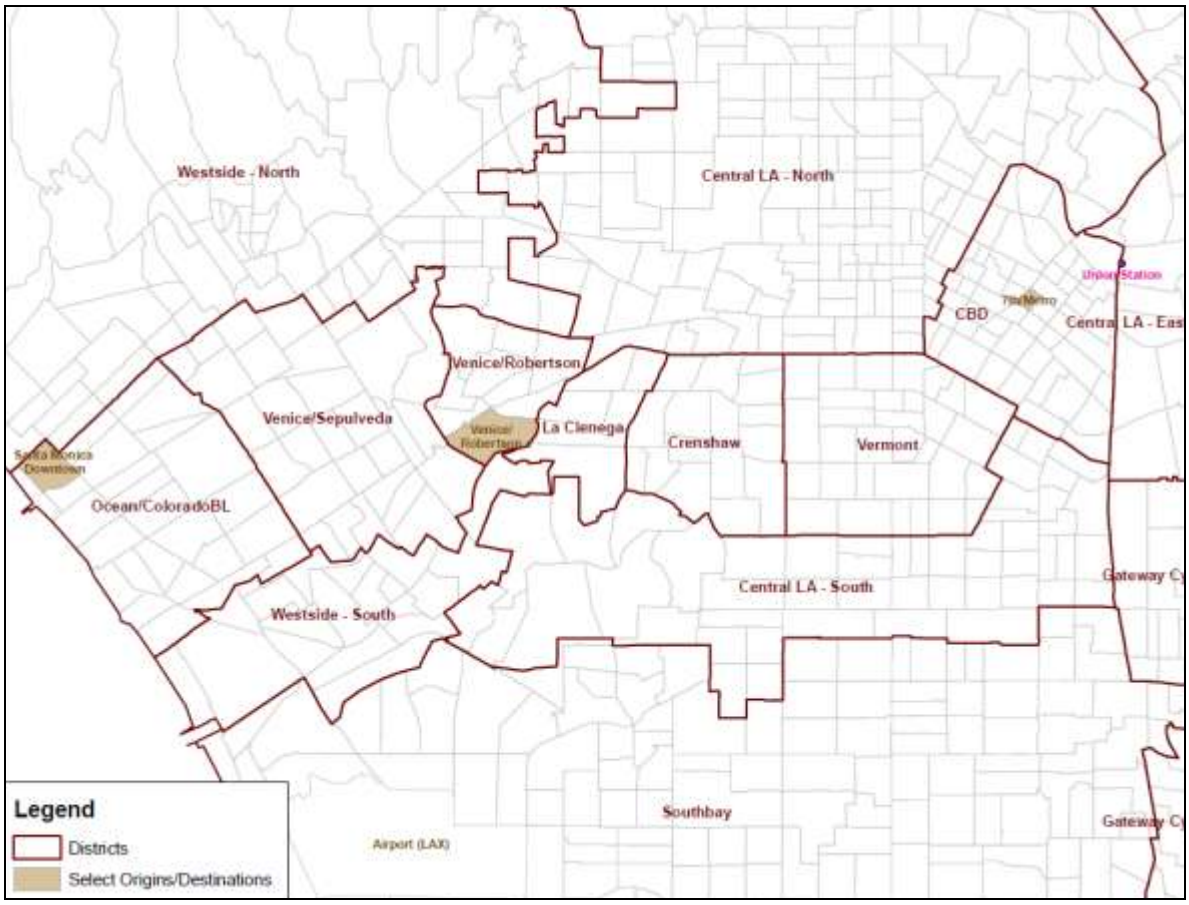
Peak travel times for SOV and HOV trips were determined by assigning an initial peak period vehicle trip table onto the highway network and using the resulting volumes to determine congested speeds on each link. A shortest path procedure is used to determine the fastest route between each origin and destination and the resulting travel times are recorded in a skim matrix. This process is performed three times—first for all network links except HOV-only, and second for all links including HOV-2 but not HOV-3 links, and third for all links. The first set of results is used to depict travel times for drive-alone trips. The second set represents travel times for HOV-2 users and the third for HOV-3 users.

Table 2-7 presents a comparison of the resulting estimates of peak highway travel times between selected points in the corridor - 7th/Metro, Venice/Robertson and Santa Monica Downtown (shown in Figure 2-7), for both 2005 and 2030. As this table shows, travel times to Santa Monica Downtown increase by approximately 30% between 2005 and 2030. Travel in eastbound direction does not show significant increases suggesting an existing congested corridor.

Table 2-7 Peak 2005 and 2030 Highway Travel Times for Selected Corridor Interchanges

From	To	2005 Highway Time	2030 Highway Time	Percentage Change
7th/Metro	Santa Monica Downtown	34	45	32%
Venice/Robertson	Santa Monica Downtown	17	22	29%
Santa Monica Downtown	7th/Metro	31	32	3%
Santa Monica Downtown	Venice/Robertson	15	16	6%

Source: AECOM analysis of Metro Model Highway Skims



Source: AECOM

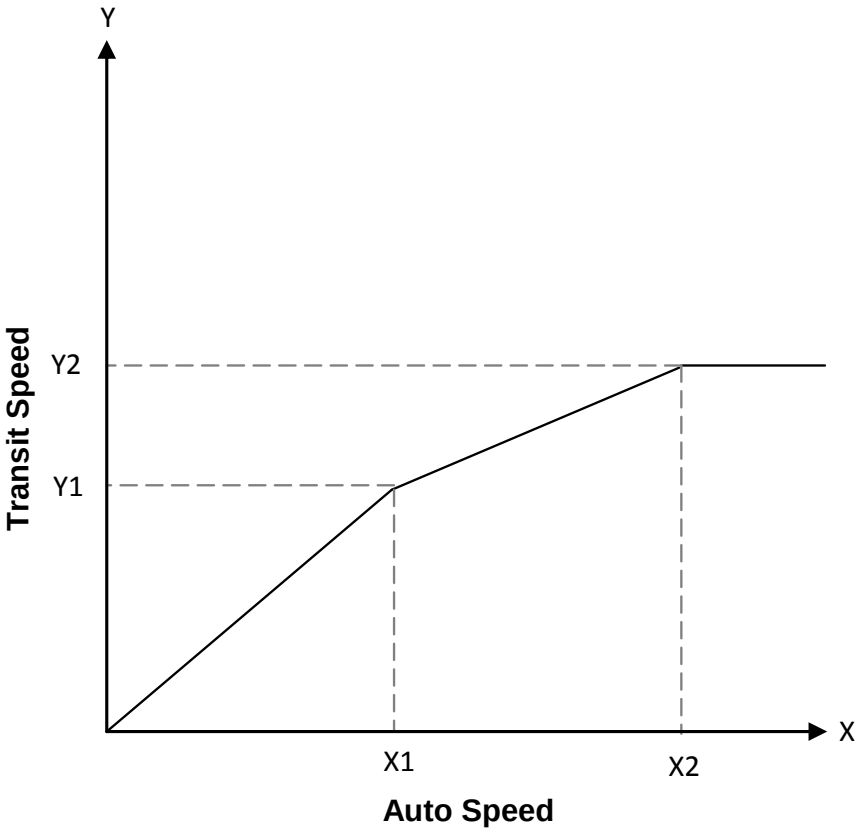
Figure 2-7 Corridor Sample Time Point Locations

Off-Peak Highway Travel Times

Off-peak highway travel times for each link are based on coded values of time developed by Caltrans and the municipalities. Zone to zone times are estimated using path-finding and skimming procedures similar to those used for the peak networks.

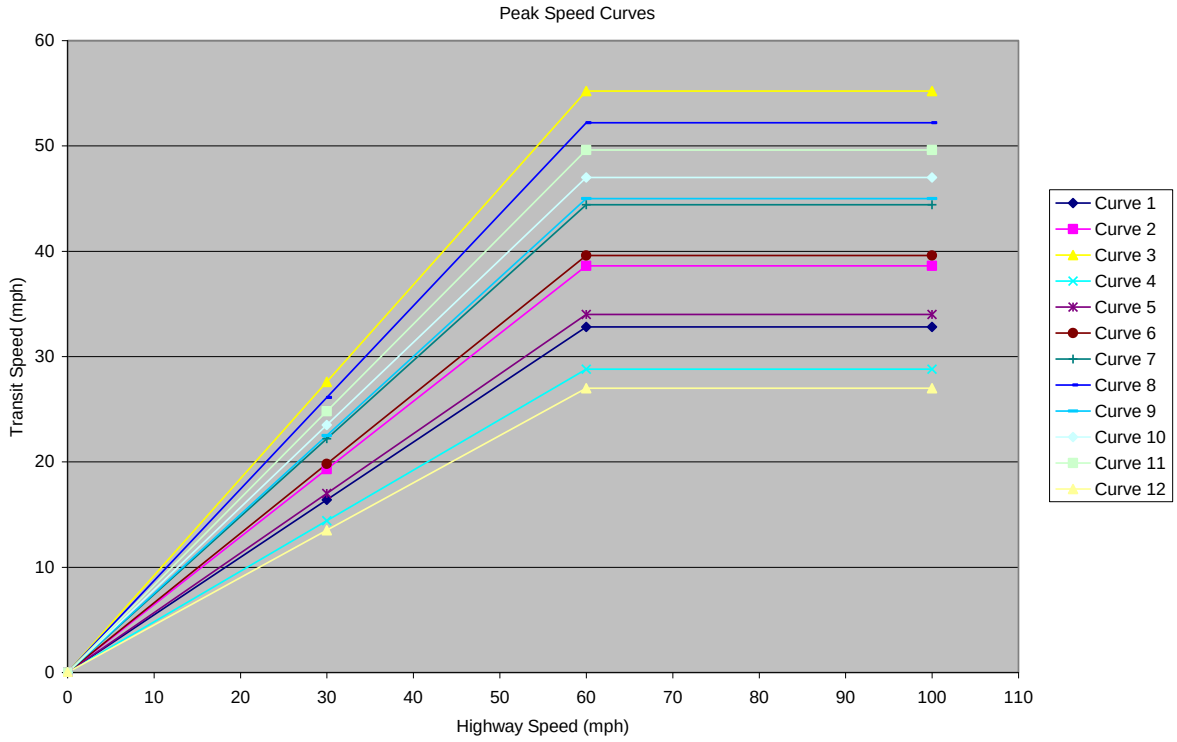
Transit Travel Times

Transit running times for fixed guideway modes (i.e., rail modes) are directly specified based scheduled or anticipated station-to-station travel times. Running times for bus services operating in mixed traffic are based on a simple function that relates transit travel times to the highway travel time on the corresponding link in the highway network as shown in Figure 2-8. As can be seen from Figure 2-8, transit speed is a linear function of highway speed until (X1, Y1) and (X2, Y2) and beyond that is constant. Figure 2-9 presents the specific relationship between highway speeds and bus transit speeds used in the Interim Metro Model.



Source: INET Documentation

Figure 2-8 Sample Highway/Transit Speed Function



Curve No.	Used By
1	Rapid Bus traveling in CBD on Expressways, Primary or Secondary Arterials
2	Rapid Bus traveling in Urban Areas on Expressways, Primary or Secondary Arterials
3	All buses (except Rapid) traveling in Suburban, Mountain or Rural Areas on Freeways
4	All buses (except Rapid) traveling in CBD on Expressways, Primary or Secondary Arterials Local bus traveling in Suburban and Mountain Areas on Expressways, Primary or Secondary Arterials
5	All buses (except Rapid) traveling in Urban Areas on Expressways, Primary or Secondary Arterials
6	All buses (except Rapid) traveling in Suburban and Mountain Areas on Expressways, Primary or Secondary Arterials
7	All buses (except Rapid) traveling in CBD or Urban Areas on HOV2 or Toll Lanes All buses (except Rapid) traveling on Ramps
8	All buses (except Rapid) traveling in CBD or Urban Areas on Freeways
9	Rapid Bus traveling in Suburban, Mountain or Rural Areas on Expressways, Primary or Secondary Arterials
10	All buses (except Rapid) traveling in Suburban, Mountain or Rural Areas on HOV2 or Toll Lanes All buses (except Rapid) traveling in CBD or Urban Areas on HOV3 Lanes All buses (except Rapid) traveling in Rural Areas on Expressways, Primary or Secondary Arterials
11	All buses (except Rapid) traveling in Suburban, Mountain or Rural Areas on HOV3 Lanes
12	Not used

Figure 2-9 LA Metro Highway/Transit Speed Functions

Mode Choice Overview

The heart of the ridership forecasting process is the mode choice model. This process is designed to subdivide the person trip tables from the trip distribution model into separate trip tables for each travel mode. The share attracted to each mode is based on the travel characteristics of competing highway and transit services, socio-economic characteristics of the production and attraction traffic analysis zones, and parameters that define the relative importance of each factor.

The proportion of trips selecting each mode is estimated using a logit function that relates the probability of selecting a mode to the relative utility of that mode compared to that of all other modes. The form of this function is as follows:

$$P_{g,i} = \frac{e^{[U_{g,i}(x_{g,i})]}}{\sum e^{[U_{g,m}(x_{g,m})]}}$$

where:

$P_{g,i}$ is the probability of a traveler from group g choosing mode i;

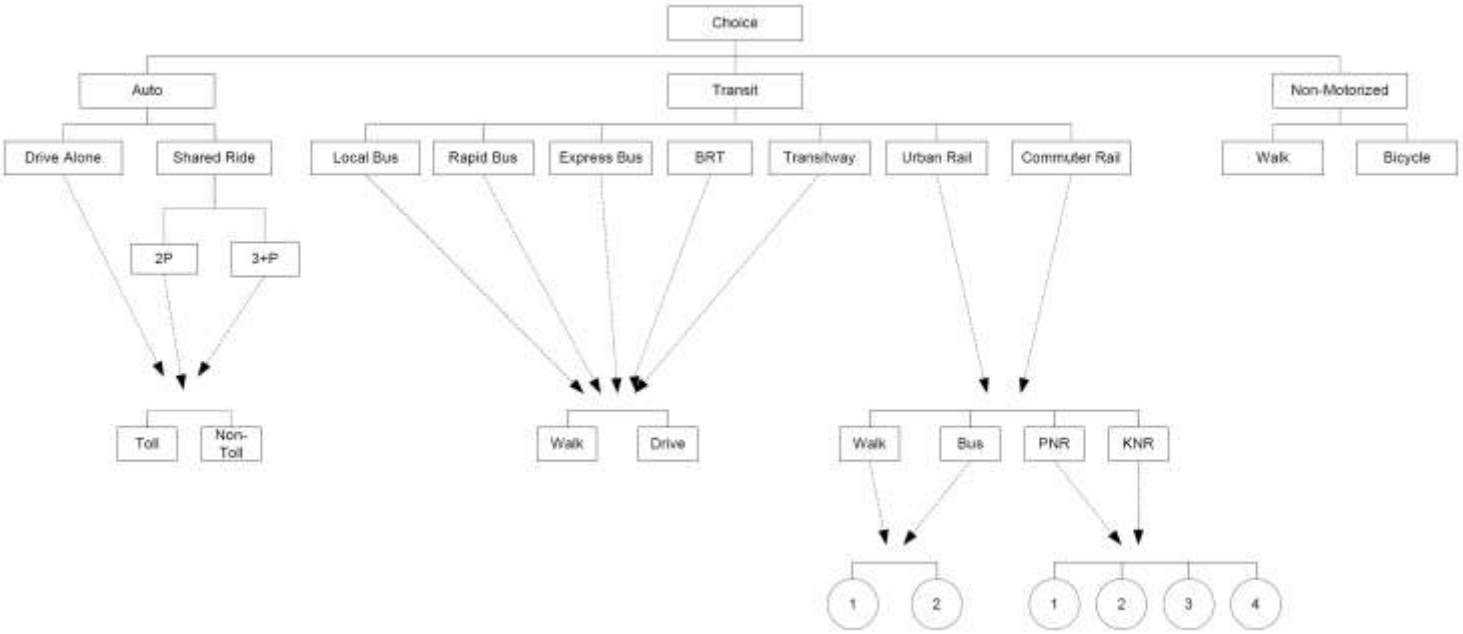
$x_{g,i}$ are the attributes of mode i that describe its attractiveness to group g; and

$U_{g,m}(x_{g,m})$ is the utility (or attractiveness) of mode m for travelers in group g.

The Metro Transportation Analysis Model is based on the nested logit form of this function which allows for sub-modal trade-offs to be more sensitive to service measures than higher level choices of the "main" modes. Separate models have been developed for each time period (peak and off-peak) and for each modeled purpose (described earlier). The choice set is depicted in Figure 2-10 and includes 19 different potential transit paths:

1. Walk to Local Bus
2. Drive to Local Bus
3. Walk to Express Bus
4. Drive to Express Bus
5. Walk to Commuter Rail
6. Bus to Commuter Rail
7. Park-and-Ride to Commuter Rail
8. Kiss-and-Ride to Commuter Rail
9. Walk to Urban Rail
10. Bus to Urban Rail
11. Park-and-Ride to Urban Rail
12. Kiss-and-Ride to Urban Rail
13. Walk to Transitway
14. Drive To Transitway
15. Walk To Rapid Bus
16. Drive to Rapid Bus
17. Walk to BRT
18. Drive to BRT
19. Drive to BRT & Urban Rail

In addition, each rail station and park-and-ride bus station is coded as a pseudo zone. The auto access path and impedance are generated by skimming the path from the origin zone to all pseudo zones.



Source: PB Americas
Note: Model produces separate trip tables for Drive to BRT and Drive to BRT and Urban Rail

Figure 2-10 Mode Choice Nesting Structure

The relative attractiveness (or "Utility") of each travel mode takes the following form:

$$U_{gm}(x_{gm}) = a_m + b_m LOS_m + c_{gm} SE_g + d_m TRIP$$

where:

LOSm is a variable set describing levels-of-service by mode m;

SEg is a variable set describing the socioeconomic characteristics of group g;

TRIP is a variable set describing the characteristics of the trip;

bm is vector of coefficients describing the importance of each LOSm variable;

cg,m is vector of coefficients describing the importance of each SEg characteristic of group g with respect to mode m

dm is vector of coefficients describing the importance of each TRIP characteristic of with respect to mode m, and

am is a constant specific to mode m.

Table 2-8 shows key coefficients and constants that define the utility function for the Metro mode choice model. The coefficients on in-vehicle time, waiting time, walking time, and cost are generally consistent with FTA guidance. Likewise, the constants for commuter rail, urban rail, and most bus modes generally conform to FTA expectations. The large negative constants for

Express bus and Transitway bus exceed FTA guidance in magnitude and have a sign that suggests that travelers strongly prefer local buses to Express services. This counter-intuitive outcome requires further investigation as part of the final model calibration.

Table 2-8 Mode Choice Model Coefficients and Constants

			VARIABLE DESCRIPTION						HBW		HBO		NHB	
		MCOEF												
	STATION	1	In-Vehicle	Time					-0.16650		-0.09756		-0.11964	
	CHOICE	2	Drive	Access	Time				-0.41292	2.48	-0.24195	2.48	-0.25842	2.16
		3	1st	Wait	Time				-0.35298	2.12	-0.21073	2.16	-0.25842	2.16
		4	Transfer	Wait	Time				-0.35798	2.15	-0.24195	2.48	-0.29073	2.43
		5	Number	of	Transfers				-1.44400	8.67	-0.84584	8.67	-1.03761	8.67
		6	Fare						-0.01401	$7.13	-0.03289	$1.78	-0.01845	$3.89
		7	Walk	Time					-0.25974	1.56	-0.21073	2.16	-0.25842	2.16
		8	Parking	Capacity					0.00023		0.00023		0.00023	
		9	Drive	Egress	Time				-0.41292		-0.24195		-0.25842	
		10	In-Vehicle	Time	(Commuter Rail Only)				-0.12488		-0.07317		-0.08973	
		LSUMSW	LogSum	Walk	Access				0.5015		0.5015		0.5015	
		LSUMSB	LogSum	Bus	Access				0.3381		0.3381		0.3381	
		LSUMSP	LogSum	P&R	Access				0.4376		0.4376		0.4376	
		LSUMSK	LogSum	K&R	Access				0.5029		0.5029		0.5029	
		VCOEF												
	GENERAL	1	In-Vehicle	Time					-0.02500		-0.01321		-0.0162	
	MODEL	2	1st	Wait		< 5.0 Minutes			-0.05300	2.12	-0.028534	2.16	-0.0350	2.16
		3	1st	Wait		> 5.0 Minutes			-0.02500	1.00	-0.01321	1.00	-0.0162	1.00
		4												
		5	Transfer	Wait					-0.05375	2.15	-0.03210	2.43	-0.0394	2.43
		6	Fare						-0.00253	$5.93	-0.00445	$1.78	-0.0025	$3.89
		7	General	Walk		< 1.0 Mile			-0.05300	2.12	-0.02853	2.16	-0.0350	2.16
		8	General	Walk		> 1.0 Mile			-0.06200	2.48	-0.03276	2.48	-0.0525	3.24
		9												
		10												
		MWALK1	Walk Mode	Time		< MWALKT			-0.05300	2.12	-0.02853	2.16	-0.0350	2.16
		MWALK2	Walk Mode	Time		> MWALKT			-0.07950	3.18	-0.04280	3.24	-0.0525	3.24
		MBIKE1	Bike Time	Time		< MWALKT			-0.05300	2.12	-0.02853	2.16	-0.0350	2.16
		MBIKE2	Bike Time	Time		> MWALKT			-0.07950	3.18	-0.04280	3.24	-0.0525	3.24
		MWALKT	Walk & Bike Threshold Distance						1.00000		1.00000		1.00000	
		LSUMA	Primary Mode	LogSum					0.7500		0.7500		0.7500	
		LSUMS	SubMode	LogSum					0.6000		0.6000		0.6000	
		LSUMT	Access Mode	LogSum					0.6000		0.6000		0.6000	

Mode Specific Constants (express as equivalent minutes of modal preference as compared to local bus)

Equivalent minutes	LACMTA MODEL							
	HBWPK	HBUPK	HBOPK	NHBPK	HBWOP	HBUOP	HBOOP	NHBOP
Commuter Rail Alternative Specific Constant	17.09	15.00	15.00	15.00	15.00	15.00	15.00	15.00
Urban Rail Alternative Specific Constant	11.61	10.31	12.53	10.27	9.10	9.25	11.70	5.38
Express Bus Alternative Specific Constant	(19.49)	(22.10)	(16.38)	(37.95)	5.52	(10.79)	4.76	(9.07)
Rapid Bus Alternative Specific Constant	4.93	5.00	5.00	5.00	5.00	5.00	5.00	26.00
BRT Alternative Specific Constant	13.43	13.00	13.00	13.00	13.00	13.00	13.00	13.00
Transitway Alternative Specific Constant	(21.77)	(15.12)	(28.64)	(32.37)	(38.43)	(20.07)	(65.59)	(21.32)
Los Angeles CBD Constant (all transit modes)	14.98				24.71			

Source: PB Americas

Highway Assignment

The output of the modal choice process includes work and non-work auto vehicle trips, which reflect the modal trade-offs among SOV, HOV, and various transit options. The vehicle trips are

maintained separately in the mode choice model between SOV and HOV categories, based on the occupancy policy specified for the HOV facilities included (i.e., 2+ occupancy or 3+ occupancy restrictions).

An equilibrium assignment process was applied that assigns three trip tables to appropriate paths and links. The TRANPLAN equilibrium assignment routine has the ability to load multiple highway modes coincidentally during the assignment process. During each iteration of the equilibrium assignment, the model performed SOV, HOV2 and HOV3+ loadings using an all-or-nothing assignment. The resulting link volumes (SOV, HOV2 and HOV3+) were added together before the equilibrium adjustments were performed. The assignment produced a "loaded" highway network that includes "constrained" times and speeds from the final assignment iteration as well as the initial input times and speeds. Times and speeds on both general-use and HOV facilities were included.

Transit Assignment

The resulting loads were reported by link and mode using the standard TRANPLAN "Load Transit Network" module. It should be noted that these assignments were produced in production-attraction format, as is normal for transit analyses, rather than the origin-destination format more commonly used in highway assignments.

MODEL VALIDATION

The performance of the transit model was validated by comparing transit boardings from the observed boarding data for the calibration year and by comparing district-to-district transit flows to data obtained from the regional on-board survey. The observed data included MTA bus on-board survey boardings from 2001, urban rail boardings from 2005 and Orange Line bus rapid service boardings from 2006. These results are presented in Table 3-1 and 3.2. The districts used in Table 3-2 are same as the ones shown earlier in Figure 2-3. Key findings are as follows:

- Metro bus boardings by service type and urban rail ridership by route appear to be reasonable.
- Urban rail ridership by line match observed values to within plus or minus 20 percent and overall urban rail ridership is matched to within 1 percent.
- BRT ridership is underestimated by 24 percent.

These model results suggest that the Interim Metro Transportation Analysis Model has a reasonable understanding of the overall demand for transit. Given the facts that the model includes significant adjustments to the underlying trip tables and the that some specific services such as the BRT and Transitway routes are not well-represented, development of the final model is still necessary. In the meantime, the Interim model should be sufficient to support on-going rail planning given the understanding that there is a band of uncertainty of at least 20 percent around each result. It should be noted that nationwide experience with forecasting models suggest that 20 percent uncertainty is not unusual, even for forecasts to support projects in more advanced stages of development.

Table 3-1 Transit Model Validation

Source: PB Americas

Metro Bus

MTA Service	Mode	Peak Boardings	Off-Peak Boardings	Daily Boardings
MTA_Local	11	727,413	402,882	1,130,295
Express	12	2,644	1,033	3,677
Rapid	24	96,157	61,357	157,514
T-Way	25	97,930	27,092	125,022
Total MTA Bus		**868,352**	**481,455**	**1,349,807**

Rapid bus Data Source: On-Board Survey Conducted by New Stats in December, 2006

Urban Rail Boardings by Line

Station to Station		Estimated		
	TRANPLAN	PEAK	Off-Peak	Daily
Rail Line	Line #	Boardings	Boardings	Boardings
801-1ST/PACIFIC-7TH/FLWR	1	25,766	17,907	43,673
801-WILLOW-7TH/FLOWER	2	17,073		17,073
802-WILS/WSTRN-UNION STA	3	22,192	9,233	31,425
802-CHANDLER/LANK-UNION	4	51,339	22,533	73,872
803-I105/I605-MARINE/CMP	5	18,929	6,973	25,902
Gold Line	6	14,316	5,141	19,457
Gold Line Express	26	36		36
Total		**149,651**	**61,787**	**211,438**

Metrolink Transfer		Estimated		
	TRANPLAN	PEAK	Off-Peak	Daily
Rail Line	Line #	Boardings	Boardings	Boardings
801-1ST/PACIFIC-7TH/FLWR	1	971	181	1,152
801-WILLOW-7TH/FLOWER	2	878		878
802-WILS/WSTRN-UNION STA	3	7,571	1,045	8,616
802-CHANDLER/LANK-UNION	4	8,751	1,293	10,044
803-I105/I605-MARINE/CMP	5	479	43	522
Gold Line	6	235	189	424
Gold Line Express	26			0
Total		**18,885**	**2,751**	**21,636**

Total		Estimated			Oct 05 MTA Observed	Change
	TRANPLAN	PEAK	Off-Peak	Daily	Daily	Over
Rail Line	Line #	Boardings	Boardings	Boardings	Boardings	MTA 05
Green Line		19,408	7,016	26,424	32,130	-17.8%
Blue Line		44,688	18,088	62,776	73,366	-14.4%
Red Line		89,853	34,104	123,957	112,371	10.3%
Gold Line		14,587	5,330	19,917	17,783	12.0%
Total		**168,536**	**64,538**	**233,074**	**235,650**	-1.1%

Total Urban Rail Trips
Urban Rail Transfer Rate

BRT Boarding

		Estimated			Survey Dec 06	Change
	TRANPLAN	PEAK	Off-Peak	Daily	Daily	Over
BRT Line	Line #	Boardings	Boardings	Boardings	Boardings	ObservedY06
Orange Line	M=26, L=1-2	**11,334**	**6,880**	**18,214**	**23,812**	**-23.5%**
				PK Observed	13,629	-16.8%
				OP Observed	10,185	-32.4%

Table 3-2 Year 2001/2005 HBW District-to-District Transit Trips

Report 7-1
Total Transit
Observed
Home-Based Work Peak

Production District	Attraction District 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
1 Riverside	12	129	376	82	75	0	11	2462	64	949	620	11	0	0	3	0	4794
2 SGV	20	15320	2881	1505	2371	48	118	152	2846	17009	17285	106	8	0	747	0	60415
3 Gateway	45	3178	12562	6237	2714	171	18	1177	551	4142	10747	800	1	0	1180	0	43523
4 South Bay	9	1788	7874	12631	6420	6	3	524	601	3117	11800	354	0	0	1939	0	47067
5 Westside	0	689	938	1920	15963	108	24	83	645	1312	5163	172	0	0	1203	0	28221
6 Malibu	0	209	0	13	70	0	0	3	0	49	132	0	0	0	111	0	587
7 SBD	4	971	423	190	374	0	64	530	227	3147	2476	0	0	0	69	0	8476
8 OC	148	173	476	623	257	23	23	617	248	2775	1835	38	11	0	176	0	7425
9 Arroyo	0	663	525	559	1132	0	5	145	1118	1342	2421	138	9	0	1259	0	9316
10 LA CBD	65	289	67	132	80	0	91	113	3	199	579	17	9	0	76	0	1719
11 LA central	71	8377	12689	12611	29767	336	175	1392	6398	12248	63064	913	6	0	7642	0	155687
12 LA north	0	152	84	360	276	0	0	39	761	1354	1319	1128	2	0	819	0	6295
13 Ventura	0	19	7	65	0	0	2	23	238	403	212	0	8	0	98	0	1075
14 Imperial	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15 SFV	0	798	1118	1072	3800	620	17	835	3170	2969	5665	262	53	0	23147	0	43524
16 Pseudo	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	374	32756	40019	37999	63299	1312	550	8096	16870	51014	123319	3940	107	0	38467	0	418122

Source: LACMTA Travel Demand Model

Report 7-2
Total Transit
Estimated
Home-Based Work Peak

Production District	Attraction District 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
1 Riverside	2401	207	109	42	57	0	279	1598	9	980	180	0	0	0	12	0	5873
2 SGV	27	15975	3291	1629	3339	19	752	1866	1284	18417	11812	50	47	0	1639	0	60145
3 Gateway	19	2497	17846	8281	3438	11	57	3798	558	3015	9921	18	15	0	970	0	50444
4 South Bay	2	1057	8148	18635	5947	19	25	1245	579	3171	13048	36	48	0	1178	0	53138
5 Westside	0	480	790	1878	15470	25	8	188	315	1009	3744	23	40	0	941	0	24914
6 Malibu	0	17	11	14	24	8	0	1	20	39	75	0	16	0	97	0	323
7 SBD	438	2771	358	180	484	1	7537	1394	147	4337	1256	3	2	0	160	0	19068
8 OC	66	641	2996	1529	579	0	46	42611	143	967	1732	1	0	0	163	0	51475
9 Arroyo	0	909	386	402	842	15	12	113	1880	968	2358	24	52	0	1783	0	9745
10 LA CBD	0	77	69	62	137	1	0	21	43	53	353	1	2	0	48	0	865
11 LA central	1	7363	11256	11185	30863	87	112	1512	5570	13610	66924	88	206	0	5290	0	154066
12 LA north	0	330	142	144	403	3	5	12	371	589	1047	1040	6	0	877	0	4969
13 Ventura	0	206	111	113	290	21	1	5	316	375	743	9	2419	0	1247	0	5855
14 Imperial	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15 SFV	0	1298	782	941	2649	193	13	123	4010	2246	5258	112	235	0	23303	0	41161
16 Pseudo	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	2955	33827	46295	45033	64522	402	8849	54487	15244	49776	118452	1405	3087	0	37708	0	482042

Source: LACMTA Travel Demand Model

Report 7-3
Total Transit
Estimated - Observed
Home-Based Work Peak

Production District	Attraction District 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
1 Riverside	2389	77	-267	-40	-19	0	268	-864	-55	31	-439	-11	0	0	9	0	1079
2 SGV	8	655	411	123	968	-30	634	1714	-1562	1408	-5473	-56	39	0	892	0	-269
3 Gateway	-27	-681	5284	2044	724	-159	39	2621	7	-1127	-826	-782	14	0	-210	0	6921
4 South Bay	-7	-730	274	6004	-473	12	22	721	-22	54	1247	-318	48	0	-760	0	6072
5 Westside	0	-209	-147	-42	-493	-82	-15	105	-330	-304	-1419	-149	40	0	-262	0	-3307
6 Malibu	0	-192	11	1	-45	8	0	-2	20	-11	-57	0	16	0	-14	0	-264
7 SBD	433	1800	-65	-10	110	1	7473	864	-80	1190	-1221	3	2	0	92	0	10592
8 OC	-82	468	2520	906	322	-23	23	41993	-105	-1808	-103	-38	-11	0	-13	0	44050
9 Arroyo	0	246	-139	-157	-289	15	8	-32	762	-374	-63	-115	42	0	524	0	429
10 LA CBD	-65	-212	1	-70	58	1	-90	-92	39	-146	-226	-17	-8	0	-27	0	-854
11 LA central	-69	-1014	-1433	-1426	1096	-249	-63	120	-828	1362	3861	-825	201	0	-2352	0	-1620
12 LA north	0	178	58	-217	127	3	5	-27	-391	-765	-272	-88	4	0	58	0	-1327
13 Ventura	0	187	104	49	290	21	-1	-18	78	-26	531	9	2411	0	1149	0	4780
14 Imperial	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15 SFV	0	500	-336	-130	-1151	-427	-4	-712	840	-723	-407	-150	182	0	156	0	-2363
16 Pseudo	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	2581	1071	6275	7035	1223	-910	8299	46391	-1626	-1238	-4867	-2536	2980	0	-759	0	63920

Source: LACMTA Travel Demand Model

Source: PB Americas