Revisions to Kern COG MIP travel demand model July 2013

by

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for

Kern Council of Governments

Prepared under the supervision of a licensed civil engineer.

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Cumulative summary of revisions to the KernCOG MIP travel demand model

DKS Associates

July 2013

Executive Summary

The KernCOG MIP travel demand model, versions of July and November 2013 as received by KernCOG from Fehr and Peers, applies an advanced four-step travel demand model system of trip generation, distribution, mode choice, and traffic assignment, with nearly all stages recognizing household demographics, auto availability, modes including explicit auto occupancy, transit by walk and drive access, walk and bike, pricing, congestion by time of day, plus explicit modeling of truck travel. Best-practice and advanced features accomplishing this include cross-classified trip generation, an auto availability model, multi-modal logsum composite measures of travel impedance used in trip distribution and auto availability models, auto-availability user-classes in trip distribution and mode choice, and iteration of most of the model system with feedback of peak and off-peak travel times due to congestion. The model applications, and their numerous inputs, outputs, and off-model analyses, were provided in an organized, coherent framework.

DKS Associates applied, examined, and modified this model beginning in late 2012, with the initial task to improve its base year validation on the gateways. Serious problems became evident in the trip distribution, first evidenced by the modeled gateway traffic volumes not corresponding to inputs. A large share of traffic produced at each gateway was distributed to the same gateway – when there should be none. Troubleshooting of this problem also revealed that many travel movements' trip distributions were insensitive to travel times and costs, due to truncation of their effective friction factors for short and long trips. Many of the gravity model's friction factor parameters (applicable to the non-truncated ranges) were set to unrealistic values vastly different from those of other calibrated models. The tabular input of friction factors, while a common practice successfully applied in numerous other models, did not work properly with the composite impedances and with the large size of Kern County and distances of travel beyond gateways. DKS rewrote parts of the trip distribution application to overcome those numerical computation problems to ensure the gravity model conforms to its standard mathematical formulation and good practice, distributes no intra-gateway trips (or any gateway-to-gateway trips other than the exogenous through trip input), and uses reasonable friction factors comparable to calibrated models of other areas.

Correction of the KernCOG MIP model's trip distribution was the most significant change by DKS affecting the model's sensitivity and response to changes in travel time and choices, land use growth and location. DKS made numerous other changes to this model's application code and parameters. Some of these changes were needed to recalibrate due to the trip distribution changes. Many were

made to address a variety of other calibration considerations, including the California Statewide Travel Survey of 2000, traffic counts, observed transit boardings, and travel characteristics and parameters known or derived from other regions in California or the US.

The following sections of this report describe in more detail the corrections to the KernCOG MIP model's trip distribution. Following are the other significant changes DKS made to this model, including their reasons and sources.

Corrected the trip distribution. The trip distribution model applies an advanced methodology similar to standard gravity models, except that it uses a "logsum" composite measure of all travel modes, rather than just one (usually auto time), as the measure of spatial separation in the gravity model. Although the application implemented this concept in a reasonably correct manner, it suffered some unanticipated numerical computational problems:

- A logsum-offset parameter was not set adequately to prevent destination logsums from falling below zero. This is an adjustable "key" parameter intended to be set by trial-and-error. As a result, trip distribution between some blocks of neighboring zones acted as if they are mutually equidistant.
- The friction factors for many trip purposes are much steeper than commonly seen in calibrated models. Home-Shop, School, Home-Other, and Other-Other fall by almost 2 orders of magnitude per minute, to zero at a 5 or 6 minute trip length. These are due to the exponential function's parameters of −5 for Other-Other and −4 for these other trip purposes. The SJV MIP documentation shows −0.15 for Other-Other and −0.07 for these others. Before I received this document, I checked NCHRP reports 365 and 716 to rough-estimate parameters ranging from −0.18 to −0.4. It is unclear whether these excessive parameters were coded as placeholders, or were adjusted this high intending to compensate for the computational problems.
- The distances on most of the gateways are intentionally long, to include travel beyond the gateway points to actual destinations. However, some appear even longer: 117 miles on I-5 south, 70 miles on SR 14 south, and over 100 miles on each of the west state highway gateways.
- The friction-factor lookup table couldn't handle the full range of friction factors, due to both the excessive beta parameters, and the wide range of trip lengths – especially to and from gateways, but also within Kern County. Some groups of neighboring zones acted as if mutually equidistant, while between more distant zone pairs, friction factors fell to a minimum, after which they acted flat, insensitive to further travel time.
- The first symptom noticed indicating these problems was that a large share of gateway trips input to the model actually failed to load on to the model gateways: many were distributed from a gateway to itself – despite provisions in the model attempting to suppress such improper travel.

The model's "calibration" in this state was illusory, even if summary statistics such as regional VMT were fitted. These trip distribution problems distorted and thwarted the MIP model's response and sensitivity to almost all inputs involving geographic proximity (including geographic placement of growth) and level of service (highway and transit travel times), which determine trip distribution.

DKS reworked the trip distribution computations with these changes:

- To solve the problem of friction factors falling below the range of the lookup table (even after applying reasonable parameters), and to eliminate the need for any logsum-offset parameter, the friction factor itself is computed directly from the exponential of the logsum. The friction factor lookup table is now referenced as a dummy placeholder, being a mechanical requirement of the distribution program, but it is entirely unused.
- New friction factors parameters were coded (in the Standard Parameters export), which are based on several calibrated models and common references. Table 1 lists the sensitivity parameter for each trip purpose. Figures 1 through 7 compare the given and revised frication factor functions to those from calibrated models of other areas.

Alternative solutions might have involved adjusting the logsum offset enough to avoid short-end truncation, and adding field width and digits to the friction factor lookup. However, the solution here chosen is more robust:

- This solution completely eliminates intrazonal distribution of gateways, not just suppresses them to small values.
- No logsum offset parameter needs to be presumed, so there is no risk that a parameter sufficient for one model is insufficient for another.
- All orders of magnitude of the friction factors are accommodated without any range limits, or field-width or other input precision complications.

Additional revisions to the trip distribution model include:

- External distance on gateway links was reduced to more realistic values – in many cases, to half of the originally coded distances.
- Changes to the calculation of intrazonal travel times in zones had been considered, but not applied in the model versions delivered in April 2013, for lack of clear basis or compelling indication.

Table 1
Friction Factor Parameters

Trip Purpose	Beta, in formula exp(beta * composite time)	
	As given	Revised
HB-Work	-0.1	-0.1
HB-Shop	-4	-0.3
HB-School K-12	-4	-0.4
HB-College	-0.9	-0.25
HB-Other	-4	-0.14
Work-Other	-0.2	-0.15
Other-Other	-5	-0.18

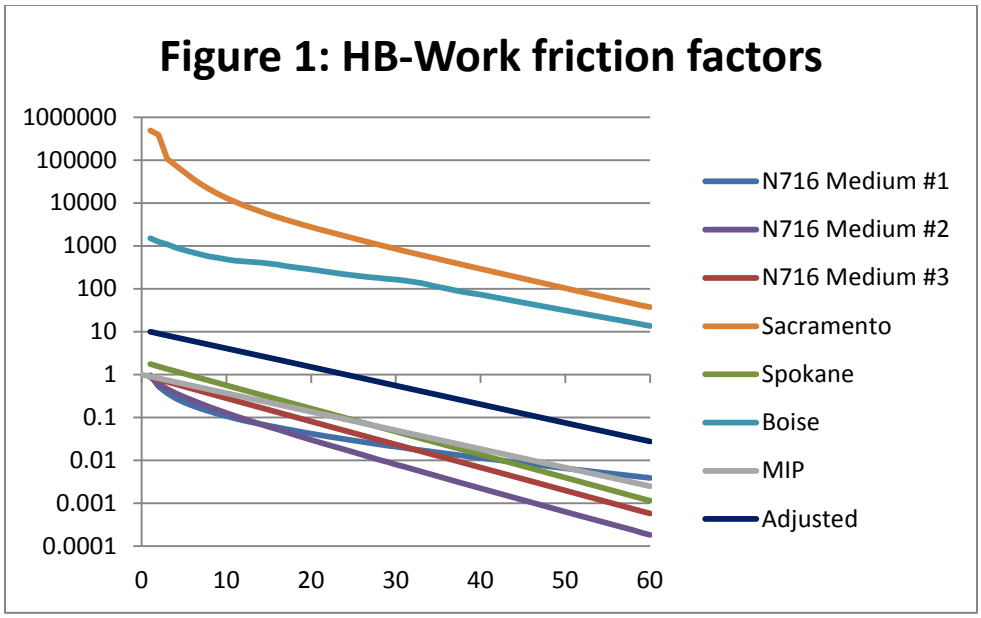
Figure 1: HB-Work friction factors
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100000
10000
1000
100
10
1
0.1
0.01
0.001
0.0001
0
10
20
30
40
50
60
N716 Medium #1
N716 Medium #2
N716 Medium #3
Sacramento
Spokane
Boise
MIP
Adjusted

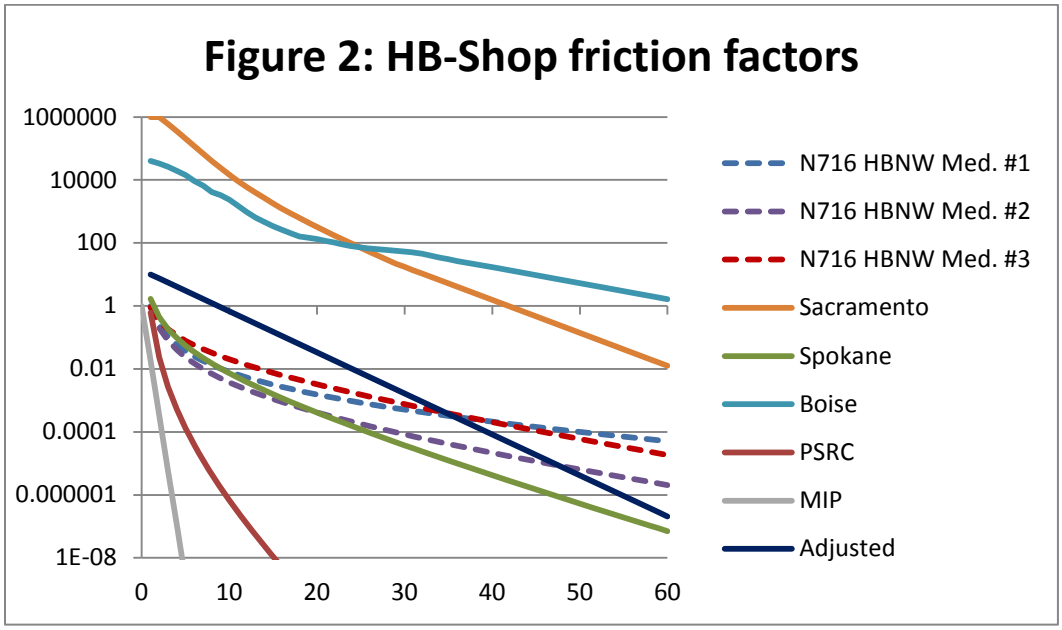
Figure 2: HB-Shop friction factors
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10000
100
1
0.01
0.0001
0.000001
1E-08
0
10
20
30
40
50
60
N716 HBNW Med. #1
N716 HBNW Med. #2
N716 HBNW Med. #3
Sacramento
Spokane
Boise
PSRC
MIP
Adjusted

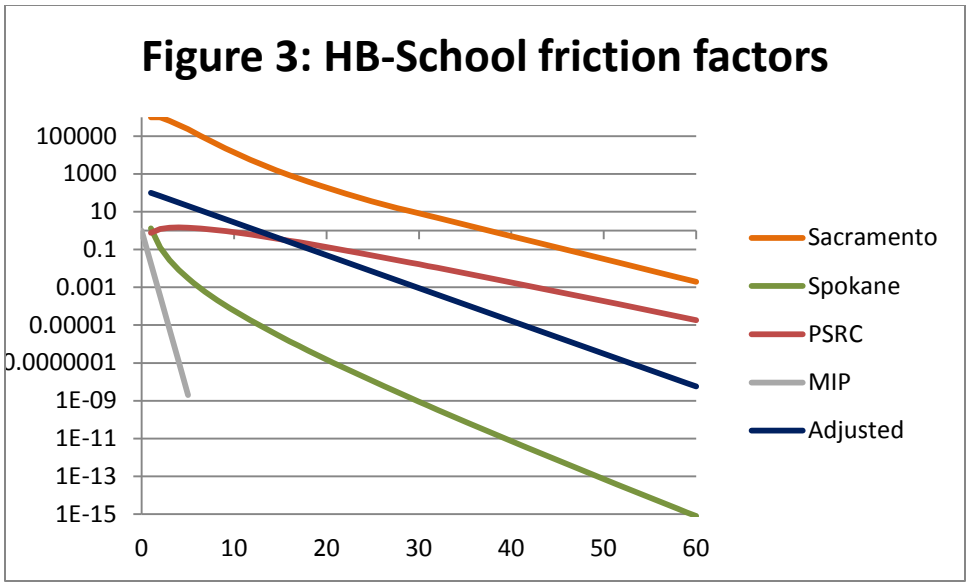
Figure 3: HB-School friction factors
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1000
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0.001
0.00001
0.0000001
1E-09
1E-11
1E-13
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30
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50
60
Sacramento
Spokane
PSRC
MIP
Adjusted

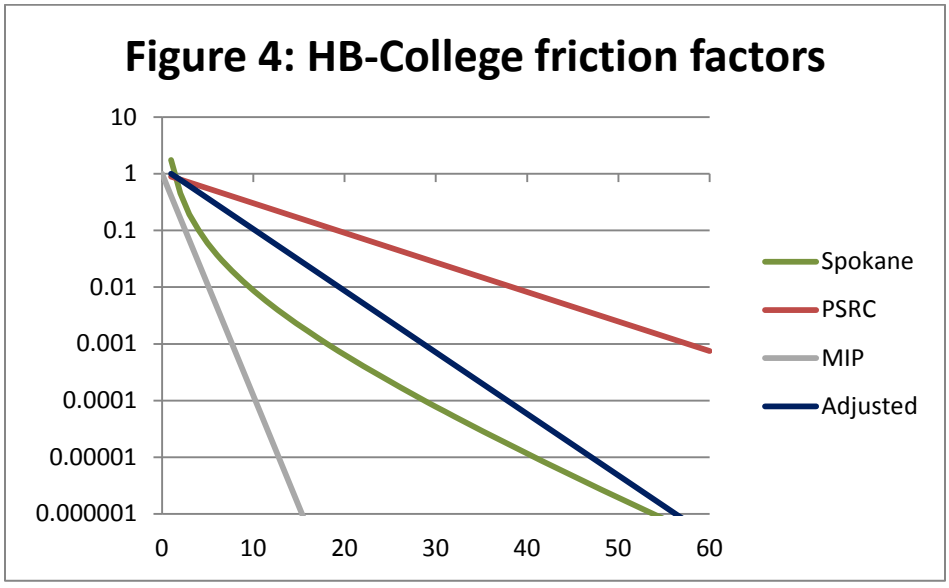
Figure 4: HB-College friction factors
10
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0.1
0.01
0.001
0.0001
0.00001
0.000001
0
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60
Spokane
PSRC
MIP
Adjusted

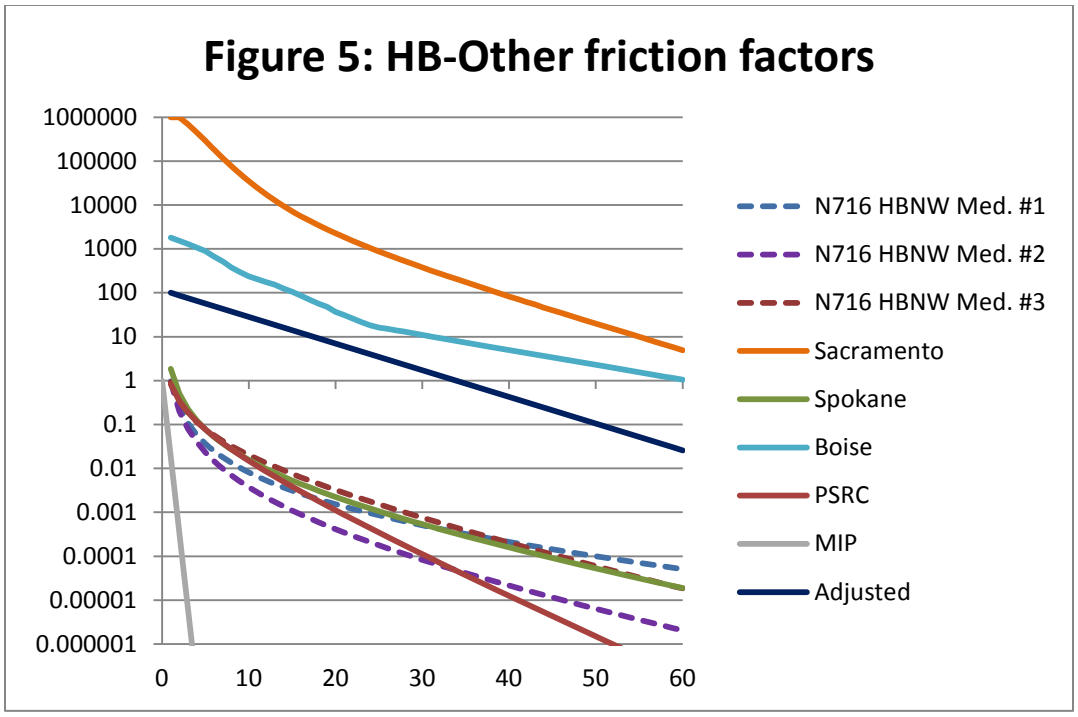
Figure 5: HB-Other friction factors
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100000
10000
1000
100
10
1
0.1
0.01
0.001
0.0001
0.00001
0.000001
0
10
20
30
40
50
60
N716 HBNW Med. #1
N716 HBNW Med. #2
N716 HBNW Med. #3
Sacramento
Spokane
Boise
PSRC
MIP
Adjusted

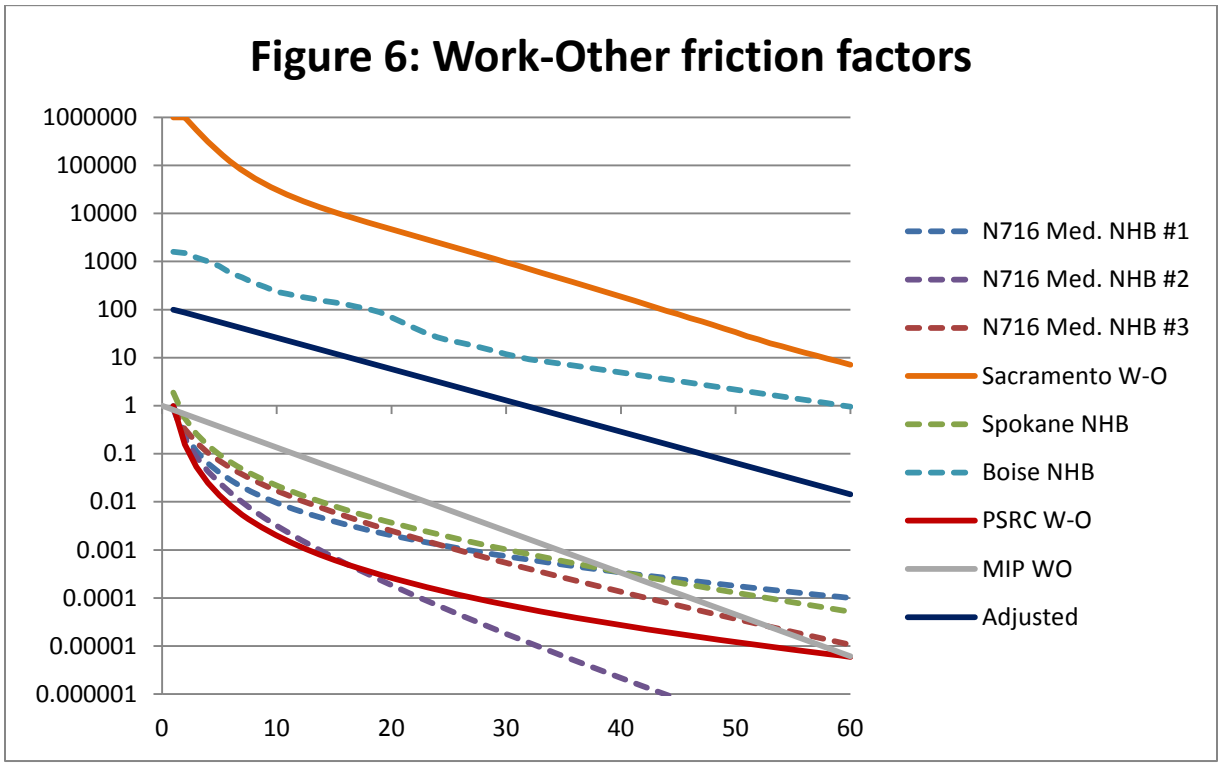
Figure 6: Work-Other friction factors
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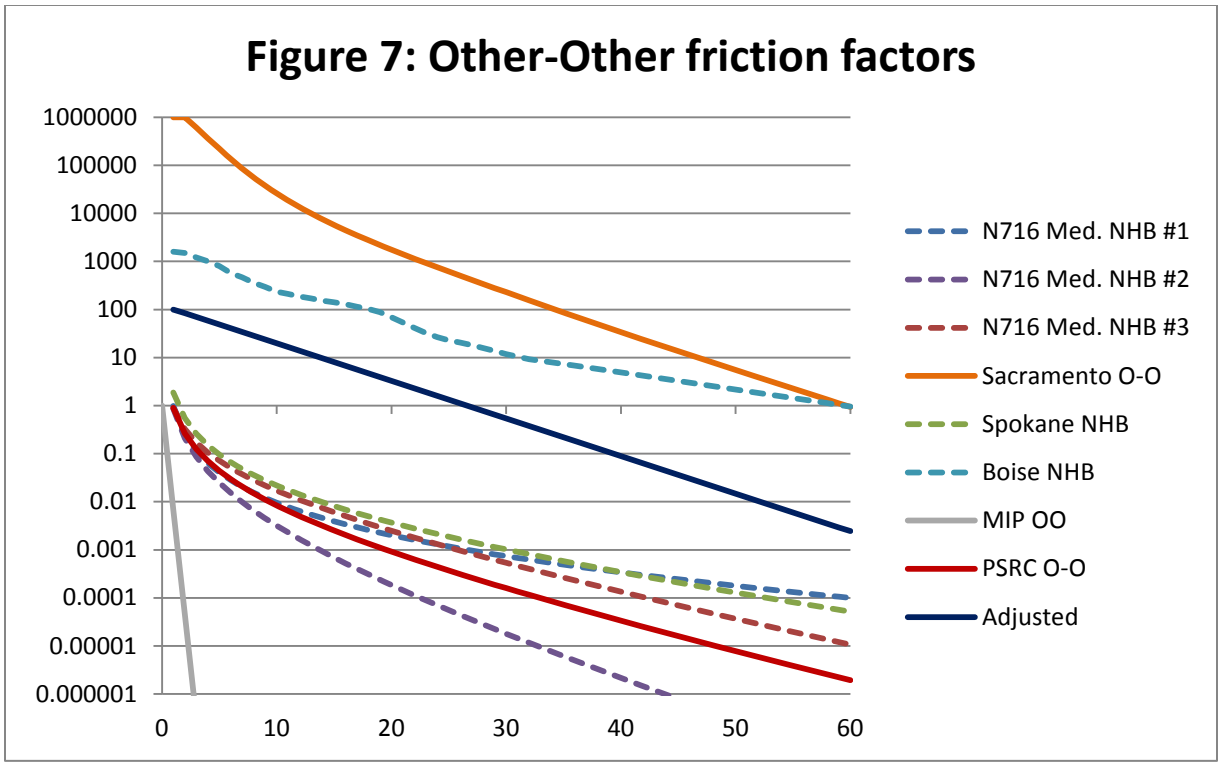
100000
10000
1000
100
10
1
0.1
0.01
0.001
0.0001
0.00001
0.000001
0
10
20
30
40
50
60
N716 Med. NHB #1
N716 Med. NHB #2
N716 Med. NHB #3
Sacramento W-O
Spokane NHB
Boise NHB
PSRC W-O
MIP WO
Adjusted



Revised gateway inputs, from a review of traffic counts, and forecasts in coordination with neighboring counties. A completely new California Statewide Travel Demand Model for 2008 was used to determine the components of gateway volumes – through, and internal-external (and external-internal), by trip purpose, including truck.

To estimate future-year gateway inputs, DKS did not have the older version of the California Statewide Model, nor had an understanding of the original MIP methodology based on that model's growth rate estimates. Instead, KernCOG provided future gateway volume estimates from neighboring counties, DKS compiled and applied these to grow the estimates from the 2008 version of the statewide model, and KernCOG approved of those compiled gateway forecast volumes.

Auto ownership was calibrated to shares summarized from the 2000 California Statewide Household Travel Survey for Kern County. The auto ownership model uses accessibility for the zero-auto household user class, a by-product of the logsum-based trip distribution model. A divisor converting between units and direction of utility and composite time (minutes) had been missing in the auto ownership model calculations, causing inappropriate amount and direction of sensitivity; this was corrected in the calculation scripts. The alternative-specific constants were adjusted to reasonably match observed auto-ownership shares. Table 2 compares the countywide shares of auto availability in the model to the Statewide Survey and to US Census results from the American Community Survey.

Table 2
Auto ownership model – comparison of shares

	Vehicles available				
	0	1	2	3	4+
Case (Kern County)	Percent of households with vehicles available				
2008 MIP model, 7/6/12 original	7.4%	28.5%	40.1%	19.4%	4.5%
Model, 2/2/13 interim	6.4%	30.7%	38.2%	17.3%	7.5%
Model, 3/7/13 revised	**7.9%**	**31.9%**	**37.8%**	**15.6%**	**6.9%**
2000-2001 California Statewide Household Travel Survey - Weekday Travel Report (June 2003).	8.8%	33.9%	37.0%	20.3%	
US Census ACS 2006-2010	7.4%	30.9%	37.7%	16.6%	7.3%

Mode choice was calibrated to mode shares in the 2000 California Statewide Household Travel Survey for Kern County (for where its sample size of nearly 500 households was adequate) or Kern plus six other San Joaquin Valley counties (for statistics needing the larger sample size). Before recalibration, transit shares near 5 percent of all trips were obtained in the base year – much higher than even Sacramento. Furthermore, the model produced more drive-access to transit trips than walk-access, especially for non-work. (In areas such as Sacramento with well-developed transit park-and-ride opportunities, transit trips by auto access are primarily commuters, and are a minority of all transit trips.) After calibration, transit carries around 1 percent of all trips. (Kern County's drive-access share remains unknown, so it was set very low for all except Home-Based Work trips.) The calibration for transit shares was further adjusted downwards to get closer to observed ridership on the GET system.

Mode choice "alternative-specific constants" were adjusted to reduce the model's transit mode shares so as to bring its transit boardings down closer to observed totals. Table 3 compares total transit boardings of previous and current models to observed ridership. The model's ratio of boardings per linked trip of 1.65 seems reasonable but on the high side of typical values. For comparison, the Sacramento region averages 1.44 according to a 2005 on-board survey (SACOG, Sacramento Regional Demand Model Version 2007 model reference report). Local on-board surveys should be reviewed to estimate the actual boardings-per-trip ratio. If this ratio significantly differs from observation, areas to investigate include the model's transit path choice parameters, transit trip purpose distribution, transit trip length distribution, the coding of major transfer locations or facilities, and the lines near them.

Table 3
Transit ridership comparison, modeled and observed

	Total, directional, per day	
Case	Linked Trips	Boardings
Observed (GET 2008 NTD)	(n/a)	23,131
Original Model (7/6/2013)	49,056	(n/a)
Interim Model (2/2/2013)	20,328	32,879
Revised Model (3/7/2013)	16,183	26,734

Table 4 compares the revised model's mode shares by trip purpose to a summary from the California Statewide Household Travel Survey of 2000. The model's transit share had to be reduced below the survey's levels to bring its boardings closer to observed levels.

Table 4

CSHTS2000-01 re-summarized by DKS 2/2013 to distinguish HS,HK,HC,HO

7 valley counties, weekday weighted (5152 households, avg weight ~= 300)

Trip Purpose	Auto Drive	Auto Pass'r	Avg Veh Occup'y	Transit	Bicycle	Walk
Home-Work	84.4%	12.9%	1.15	0.5%	0.6%	1.6%
Home-Shop	59.2%	31.2%	1.53	1.0%	0.9%	7.7%
Home-School K-12	8.8%	57.9%	7.59	1.5%	2.8%	29.0%
Home-College	72.6%	13.6%	1.19	2.5%	3.2%	8.2%
Home-Other	47.1%	45.9%	1.97	1.5%	0.7%	4.8%
Work-Other	88.7%	9.3%	1.10	0.4%	0.0%	1.6%
Other-Other	50.4%	43.8%	1.87	2.6%	0.3%	2.9%
All trips	**57.3%**	**33.8%**	**1.59**	**1.3%**	**0.9%**	**6.8%**

Kern County only (CSHTS2000-01, 574 households)

Trip Purpose	Auto Drive	Auto Pass'r	Avg Veh Occup'y	Transit	Bicycle	Walk
Home-Work	86.5%	12.0%	1.14	0.2%	0.8%	0.5%
Home-Shop	66.0%	23.4%	1.35	2.3%	0.0%	8.3%
Home-School K-12	7.2%	55.1%	8.63	2.1%	1.6%	33.9%
Home-College	92.3%	3.4%	1.04	0.0%	4.3%	0.0%
Home-Other	50.0%	44.2%	1.88	3.1%	0.1%	2.7%
Work-Other	91.2%	7.9%	1.09	0.0%	0.0%	0.9%
Other-Other	55.8%	36.5%	1.65	3.5%	0.0%	4.3%
All trips	**60.9%**	**30.5%**	**1.50**	**1.9%**	**0.5%**	**6.2%**

Model 3/7/2013 (All Kern County internal trips)

Trip Purpose	Drive Alone	Share-Ride 2 persons	Share-Ride 3+ persons	Avg Veh Occup'y	Transit Walk-Access	Transit Drive-Access	Bicycle	Walk
Home-Work	79.7%	9.7%	7.8%	1.12	0.41%	0.041%	0.7%	1.7%
Home-Shop	50.6%	26.7%	12.9%	1.33	0.45%	0.008%	1.0%	8.4%
Home-School K-12	1.5%	9.2%	52.4%	2.87	0.70%	0.000%	3.3%	33.0%
Home-College	79.1%	8.3%	0.8%	1.06	0.99%	0.017%	3.2%	7.6%
Home-Other	25.0%	31.6%	36.6%	1.80	0.72%	0.004%	0.8%	5.2%
Work-Other	82.3%	12.6%	2.7%	1.09	0.24%	0.057%	0.0%	2.1%
Other-Other	34.4%	36.3%	24.6%	1.59	1.16%	0.005%	0.3%	3.2%
All trips	41.7%	24.7%	24.9%	1.48	0.71%	0.014%	0.9%	7.0%

Truck models were activated, that had previously been discarded and overridden with a truck trip matrix taken from a multi-county tabulation. A consequence is that the gateway truck volumes given as inputs are actually propagated through the full model system, and (approximately) realized by the model results.

November 2012 revisions to the model by Fehr and Peers (especially for transit assignment) were reconciled and merged into the DKS corrective revisions. DKS also corrected a mislabeling of the line-boarding summaries from those transit assignments.

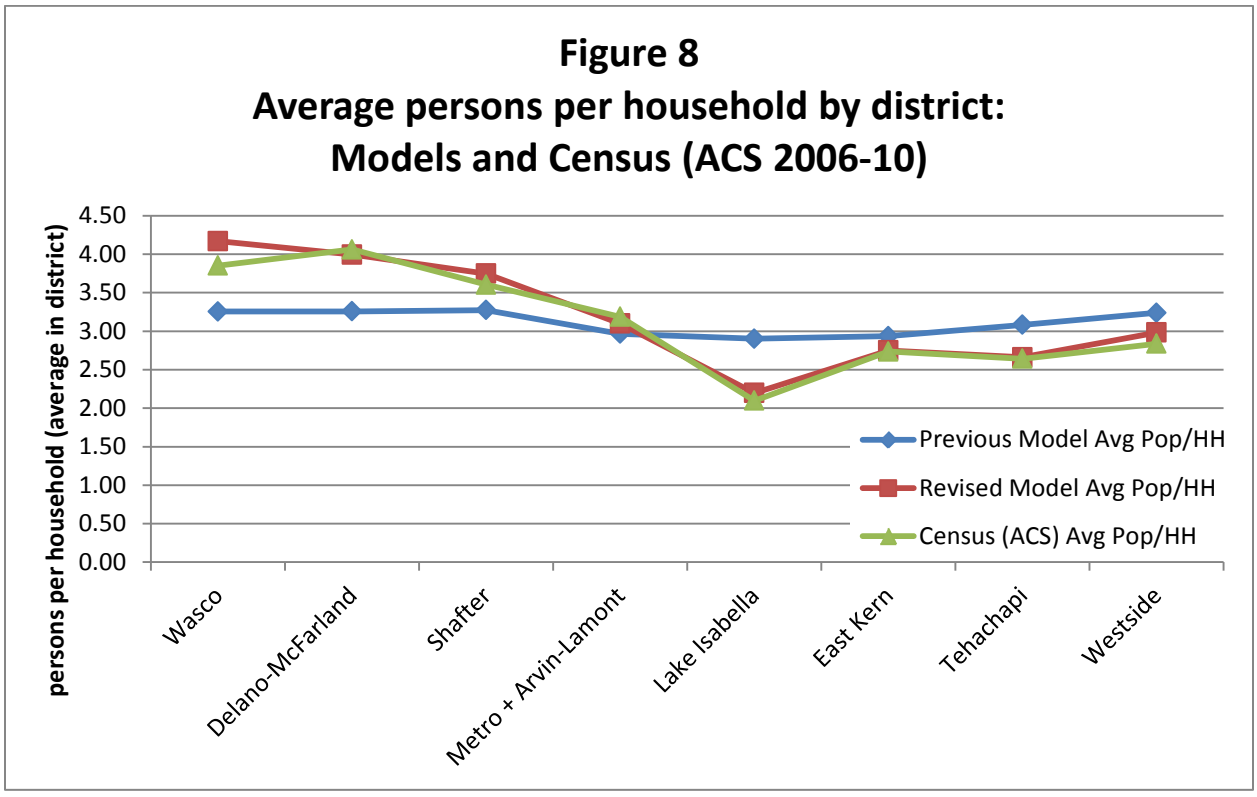
Socioeconomic data inputs

The KernCOG MIP model calculates an estimate of population in each TAZ, from occupied housing units in six housing-unit categories. The formulas for this population estimation are revised. The previous estimation used population per household factors keyed to dwelling unit type and PUMA. Countywide, this computed population totaled 765,900 in 2008, somewhat low compared to estimates near 819,000 (State of California, Department of Finance, *California County Population Estimates and Components of Change by Year, July 1, 2000-2010*, Sacramento, California, December 2011, and US Census Bureau *Intercensal Estimates of the Resident Population for Counties: April 1, 2000 to July 1, 2010*). The model's estimates were disproportionately low in Delano and other central valley areas having high population per household. The model's estimated population determines school trip productions, so these low estimates account for some of the imbalance between school trip productions and attractions in these areas.

The revised calculation replaces the given factors with formulas referencing the household size distributions also given in the socioeconomic data, which are keyed to dwelling unit type and Census block groups. For eight districts of Kern County (combined from its 12 CCDs), Table 5 compares numbers of persons estimated by the previous and revised models with the 2006-2010 American Community Survey (ACS) estimates from the US Census Bureau. Almost all revised estimated populations are closer to the ACS. Figure 8 compares the average persons per household. (The 5-year ACS countywide average is a little below the DOF and Census estimates for 2008, but were used for their geographic and demographic detail.)

Table 5
Comparison of 2008 model household data and calculated populations to American Community Survey (ACS) summary

CCD (grouped)	2008 Model data Households	Calculated Population			2006-10 ACS SDF	
		Previous model	Revised model		Households	Population
Wasco	6,077	19,776	25,338		6,106	23,518
Delano-McFarland	13,644	44,440	54,516		13,488	54,786
Shafter	6,109	19,999	22,895		5,170	18,635
Metro + Arvin-Lamont	171,555	508,757	531,611		168,215	536,198
Lake Isabella	7,602	22,059	16,708		7,476	15,675
East Kern	28,115	82,504	77,299		27,205	74,443
Tehachapi	11,445	35,277	30,451		11,143	29,433
Westside	9,632	31,195	28,732		9,254	26,254
Total Kern County	254,179	764,007	787,550		248,057	778,942



Employment data review

As summarized in the spreadsheet "2008 MIP detailed employment comparisons to other sources.xlsx" e-mailed on 3/5/2013, there are significant differences in 2008 employment between the given model

data, and other sources such as the California EDD and the federal BLS and LEHD-OnTheMap. In response to a previous version of that summary, KernCOG provided revisions to eight TAZs, focused on improving Home-Shop and Home-Other production-attraction balance in outlying areas, while deferring comprehensive employment checking until a subsequent more-thorough calibration. Table 6 lists the employment data changes in these TAZs.

Table 6

Employment revisions from KernCOG

Employment	TAZ 1864		TAZ 1883		TAZ 1902		TAZ 1934	
Category	Previous	Revised	Previous	Revised	Previous	Revised	Previous	Revised
AGRICULTUR	10	2	17	2	32	8	113	4
MINING	10	2	8	2	32	8	34	4
UTILITIES	0	0	5	5	6	6	0	0
CONSTRUCTN	0	0	0	0	0	0	3	3
MANUFACTUR	10	6	8	4	13	8	106	53
WHOLESALE	10	6	8	4	13	8	7	2
RETAIL	36	106	33	101	65	162	0	197
WAREHOUSE	10	6	7	4	13	10	0	0
INFORMATN	10	6	8	4	16	12	7	7
FINAN_INSR	10	6	8	4	16	12	7	7
REALESTATE	10	6	8	4	16	12	14	14
SVC_PROF	20	10	25	12	39	26	14	14
SVC_MNGMNT	0	0	0	0	0	0	3	3
SVC_ADMIN	10	6	0	0	0	0	0	0
EDUCATION	0	0	0	0	0	0	17	17
HEALTH	8	8	5	5	6	6	24	24
ENT_REC	6	6	0	0	0	0	0	0
ACCOMODTNS	0	0	0	0	0	0	0	0
FOOD	20	12	17	10	32	25	0	0
SVC_OTHER	20	12	8	4	23	19	3	3
PUBLIC	0	0	0	0	0	0	0	0
Total	200	200	165	165	322	322	352	352

Employment	TAZ 2130		TAZ 1687		TAZ 1663		TAZ 1670	
Category	Previous	Revised	Previous	Revised	Previous	Revised	Previous	Revised
AGRICULTUR	100	20	8	0	42	0	66	0
MINING	0	0	8	0	24	0	22	2
UTILITIES	0	0	0	0	0	0	0	0
CONSTRUCTN	0	0	3	0	21	21	0	0
MANUFACTUR	200	50	0	0	68	68	75	75
WHOLESALE	0	0	5	5	3	3	4	4
RETAIL	0	132	72	72	3	14	4	90
WAREHOUSE	100	50	0	0	3	3	4	4
INFORMATN	0	0	13	0	0	11	44	44
FINAN_INSR	0	0	13	0	0	11	48	48
REALESTATE	0	0	13	143	0	0	4	4
SVC_PROF	0	50	27	5	0	11	66	66
SVC_MNGMNT	0	0	5	5	0	0	13	13
SVC_ADMIN	0	0	3	3	9	20	0	0
EDUCATION	0	98	13	13	0	0	44	44
HEALTH	0	0	13	0	0	0	70	70
ENT_REC	0	0	3	0	3	3	0	0
ACCOMODTNS	100	50	13	0	104	104	0	0
FOOD	0	0	27	10	0	0	0	0
SVC_OTHER	0	50	27	10	33	44	0	0
PUBLIC	0	0	0	0	0	0	0	0
Total	500	500	266	266	313	313	464	464

Looking for data problems in the SR 58 corridor that might contribute to its high modeled volumes, the 860 employees in zone 2123 in Keene (west of Tehachapi) appears high judging from aerial views. The 239 employees in OnTheMap data (as distributed therein by sector) replaced the employment in this zone, as compared in Table 7. Applying this revision to the model, SR 58's modeled volume reduced east of Keene, but unfortunately not to the west between there and Bakersfield.

Table 7
Additional employment revisions

Employment Category	TAZ 2123	
	Previous	Revised
AGRICULTUR	172	1
MINING	0	0
UTILITIES	0	0
CONSTRUCTN	172	0
MANUFACTUR	172	19
WHOLESALE	0	2
RETAIL	0	2
WAREHOUSE	172	0
INFORMATN	0	32
FINAN_INSR	0	0
REALESTATE	0	24
SVC_PROF	0	3
SVC_MNGMNT	0	0
SVC_ADMIN	0	4
EDUCATION	0	23
HEALTH	0	0
ENT_REC	0	0
ACCOMODTNS	172	32
FOOD	0	0
SVC_OTHER	0	93
PUBLIC	0	4
Total	860	239

To further address the SR 58 corridor, a special generator is added to represent the state prison in Tehachapi (part of TAZ 2121), in place of the higher-generating Public employment reference in the socioeconomic detail. The TAZ appears to cover nearby areas too, so its other employment and residential data are left intact. As shown in Table 8, this change reduced the model's overestimation of traffic on Route 202 (West Valley Road) serving the prison and nearby areas.

Table 8
Data and traffic for Tehachapi Men's Prison and vicinity

	2008 Caltrans Traffic Count	2/2/13 2008 model	Revised 2008 model
Traffic volumes			
SR 202 E of Cummings Valley Rd	9,250	13,327	10,213
2008 data for TAZ 2121			
Employment			
Public		1,287	0
All other		552	552
Residential units		1	1
Special generator person-trips		0	3,423

Tables 9 and 10 compare employment totals in given and edited versions to two comparison sources:

(1) OnTheMap, an on-line US Census publication of its Longitudinal Employer-Household Dynamics (LEHD) program. Employment is synthesized (for confidentiality) in 20 NAICS categories by detailed geography. The 2010 synthesis is chosen because large errors were identified in 2008 and adjacent years, including a location with nearly 11,000 manufacturing employees in Tehachapi, and missing employment from three state prisons. These errors appear to be corrected in the 2010 synthesis.
(2) US Bureau of Labor Statistics, official estimates in detailed categories available by county. Both 2008 and 2010 are shown to serve as a comparability bridge between the 2008 model and 2010 OnTheMap data.

In Table 9, the new employment data edits increased retail employment in the north and east county, but the portion of the model's retail employment in these areas is still low compared to OnTheMap. The model's services employment is proportionately low in the east county compared to OnTheMap. In Table 10, the model's countywide employment in agriculture, manufacturing, retail, education, health, and other services differ most significantly from both OnTheMap and BLS. (Of those two countywide comparison sources, the BLS statistics are probably more reliable.) The model's total employment agrees reasonably well with the BLS for 2008, most of the difference likely due to the BLS's exclusion of uniformed military personnel.

Table 9
Kern County employment comparisons by district

	July 2012 given version of 2008 MIP					Percent of county by sector		
District (CCD group)	Retail	Services (incl. health)	Military bases	Other non-retail	Total employees	Retail	Services (incl. health)	Other non-retail
Bakersfield, Shafter, Arvin, Lamont	13,646	50,654	0	135,067	199,367	88%	85%	68%
Delano, McFarland, Wasco	853	3,531	0	30,452	34,836	6%	6%	15%
Tehachapi, Lake Isabella, East Kern	678	4,432	21,665	21,729	48,504	4%	7%	11%
Westside	250	1,179	0	12,413	13,842	2%	2%	6%
Total	15,427	59,796	21,665	199,661	296,549	100%	100%	100%

	3/7/13 edited version of 2008 MIP					Percent of countywide sector		
District (CCD group)	Retail	Services (incl. health)	Military bases	Other non-retail	Total employees	Retail	Services (incl. health)	Other non-retail
Bakersfield, Shafter, Arvin, Lamont	13,646	50,654	0	135,067	199,367	85%	85%	68%
Delano, McFarland, Wasco	1,050	3,531	0	30,255	34,836	7%	6%	15%
Tehachapi, Lake Isabella, East Kern	1,144	4,295	21,665	20,779	47,883	7%	7%	10%
Westside	250	1,179	0	12,413	13,842	2%	2%	6%
Total	16,090	59,659	21,665	198,514	295,928	100%	100%	100%

	2010 OnTheMap					Percent of countywide sector		
District (CCD group)	Retail	Services (incl. health)	Military bases	Other non-retail	Total employees	Retail	Services (incl. health)	Other non-retail
Bakersfield, Shafter, Arvin, Lamont	15,093	40,103	0	113,349	168,545	78%	81%	72%
Delano, McFarland, Wasco	1,726	3,159	0	24,163	29,048	9%	6%	15%
Tehachapi, Lake Isabella, East Kern	2,006	5,501	2,731	13,362	23,600	10%	11%	9%
Westside	487	878	0	5,997	7,362	3%	2%	4%
Total	19,312	49,641	2,731	156,871	228,555	100%	100%	100%

Table 10
Kern County employment comparisons by sector

	Model data		Comparison data			
NAICS sector	MIP 2008 given 7/6/12	MIP 2008 edited 3/7/13	OnTheMap 2010	BLS 2008	BLS 2010	CA EDD 2008
AGRICUL	35,336	36,327	29,412	48,250	44,258	49,600
MINING	12,462	12,465	8,704	10,707	9,528	10,700
UTILITIES	3,478	3,478	2,008	2,083	2,130	(comb'd w/WAREH)
CONSTRUC	9,324	9,444	11,770	16,303	12,197	16,500
MANUFAC	47,941	47,972	13,286	13,449	12,877	13,700
WHOLES	6,828	6,933	8,112	8,782	7,818	7,700
RETAIL	15,427	16,088	19,161	27,851	26,141	27,400
WAREH	16,674	16,983	6,063	9,364	8,135	9,600
INFORMAT	4,235	4,221	2,661	3,056	2,696	3,000
FIN_INSR	5,950	5,936	4,360	5,572	5,130	5,500
REALEST	3,383	3,501	2,706	3,276	3,076	3,300
SVC_PROF	13,583	13,586	10,544	10,845	10,987	10,500
SVC_MNGMNT	3,606	3,606	3,530	2,503	3,043	2,400
SVC_ADMIN	12,861	12,868	10,159	12,165	10,865	12,200
EDUC	10,449	10,547	27,063	27,243	26,570	29,600
HEALTH	14,980	14,967	23,975	25,748	26,585	23,600
ENT_REC	4,986	4,983	2,521	3,248	2,978	2,500
ACCOM (1)	16,241	16,178	14,442	1,948	1,730	19,100
FOOD (1)	4,264	4,225		17,117	16,479	
SVC_OTHER	19,325	19,353	8,622	9,508	9,148	7,000
PUBLIC (2)	32,888	32,888	19,381	24,709	25,219	33,900
Unclassified				822	370	
Total employment	294,222	296,549	228,480	284,549	267,960	287,800

Notes: (1) Accomodations and Food are a single combined category in OnTheMap, and differ significantly in proportion between the BLS reports and the model data. (2) Includes Edwards AFB and NAWS China Lake, even where overridden with special generators. MIP data classify all employees at these as "Public", but OnTheMap employment at these locations is distributed among many sectors (and are much fewer).

Model parameter revisions – Cross-classified trip productions

Anomalous fluctuations occur in the cross-classified household trip production rates (HW, HS, and HO) as given. Table 11 shows these rates as given in the 7/6/2012 MIP. An example of these anomalies appears in the first five rows, for different income levels among 1-person households in single-family units. For work productions (HW_P), the rate grows as would be expected in relation to whether and how much the person works, until leveling, but then falling slightly among income classes 3, 4, and 5. Even more irregularity shows in home-based other (HO_P), in this case falling from income class 1 to 3, but irregular at higher income levels. Much more severe irregularity shows in the last five rows, with 5-person mobile homes.

Table 11
Person-trip production rates per household for the trip purposes specified by cross-classification, Home-based work (HW_P), home-based shop (HS_P), and home-based other (HO_P)

		Single-family unit			Multi-family unit			Mobile homes, RV, etc.		
HHSize5	Income5	HW_P	HS_P	HO_P	HW_P	HS_P	HO_P	HW_P	HS_P	HO_P
1	1	0.18	0.37	0.88	0.15	0.37	0.72	0.35	0.49	0.49
1	2	0.46	0.45	0.75	0.67	0.40	0.65	0.43	0.32	0.44
1	3	0.79	0.55	0.53	0.88	0.60	1.05	1.21	0.36	0.39
1	4	0.81	0.56	0.69	1.20	0.40	0.28	1.01	0.19	0.37
1	5	0.73	0.40	0.57	1.30	0.09	0.59	1.39	0.39	0.40
2	1	0.64	0.93	1.06	0.47	0.11	0.87	0.51	0.36	0.52
2	2	0.87	0.80	1.24	1.12	0.55	1.07	0.45	0.63	0.78
2	3	1.01	1.08	1.31	1.03	0.35	1.29	1.20	0.66	0.66
2	4	1.60	1.20	1.37	2.11	0.91	0.78	1.78	1.13	0.21
2	5	1.66	1.05	1.43	1.01	0.65	1.39	1.43	2.17	1.73
3	1	0.59	0.78	1.39	0.38	0.98	3.00	1.03	1.80	2.59
3	2	1.05	0.75	2.37	1.11	0.81	2.09	0.83	0.25	0.70
3	3	1.93	1.03	1.57	1.27	0.99	2.62	1.61	1.11	0.75
3	4	2.10	1.05	2.20	2.19	0.28	1.59	2.24	1.49	1.70
3	5	2.59	0.98	1.57	0.68	1.80	1.73	0.90	0.90	5.18
4	1	1.23	1.18	3.64	1.22	0.23	1.46	0.97	0.74	1.32
4	2	1.26	0.92	3.35	1.49	0.45	2.88	0.41	0.31	1.85
4	3	1.95	0.96	3.23	1.45	0.95	1.97	1.86	1.24	1.30
4	4	2.02	0.90	3.84	1.47	0.50	1.12	1.80	2.70	2.59
4	5	2.44	1.24	2.99	2.25	0.59	0.65	1.94	1.49	2.64
5	1	0.95	0.92	2.00	0.73	1.35	3.11	1.52	0.35	4.84
5	2	1.48	1.12	4.03	1.72	1.82	2.16	1.26	0.64	3.07
5	3	2.15	0.92	4.14	2.18	1.74	4.67	2.33	0.44	7.19
5	4	1.89	1.37	5.16	1.12	0.94	1.67	0.90	0.40	3.46
5	5	2.29	1.29	5.11	0.83	0.70	1.24	1.80	0.43	7.78

Irregular trip production rates such as these tend to emerge from household travel surveys when split into a large number of separate categories – 75 in this case. It's not likely that 5-person mobile homes in income class 3 generally produce over twice the home-based work trips, and home-based other trips, as 5-person mobile homes in income class 4; it's just that the particular sampled ones did, on their particular survey days. Variation like this is expected from small numbers of samples, and should not be taken as proof of a general relationship. Applying these rates in the model leads to the dubious conclusion that a TAZ with a numerous 5-person, income-class 3 mobile homes generates twice as many trips per unit as a nearby TAZ with a many 5-person, income-class 4 mobile homes.

Small-sample statistics such as these should be interpreted carefully, with appropriate statistical significance tests. Time and budget did not permit formal analysis, so reasonable judgments were made for this model update. (It is practical and prudent to defer such analysis until new statewide survey data are available later in 2013.)

For the present effort, instead of rebuilding the household cross-classified trip rates over again directly from the 2000 survey, the model's given production rates were adjusted from those in the 2/2/13 version, which are directly proportional to those in Table 11. First, the cross-classified rates were simplified into a persons x income table by weighted averages (weighted by 2008 model households) across all dwelling types (single-family, multi-family, mobile-home). Second, where anomalous fluctuations remained, adjacent cells with the fluctuations were grouped, and a new weighted-average rate was computed and applied to all cells in each group.

Despite dropping the housing-unit type distinction in the trip rates, single-family houses continue to generate more trips than multi-family units because (1) they tend to house more persons than the other types, (2) the socioeconomic detail calculations continue to distribute to them a greater share of larger and higher-income households, and (3) the revised rates shown in Table 12 exhibit clearer relationship between persons, income, and trip generation.

Table 12
Revised person-trip production rates for home-based work (HW_P), home-based shop (HS_P), and home-based other (HO_P) trip purposes

HHSize5	Income5	HW_P	HS_P	HO_P
1	1	0.22	0.44	0.99
1	2	0.56	0.47	0.90
1	3	0.93	0.55	0.87
1	4	0.98	0.55	0.77
1	5	0.98	0.55	0.75
2	1	0.62	0.66	1.19
2	2	0.94	0.80	1.48
2	3	1.14	1.01	1.62
2	4	1.80	1.27	1.64
2	5	1.80	1.27	1.90
3	1	0.61	0.93	2.84
3	2	1.15	0.93	2.84
3	3	1.97	1.13	2.44
3	4	2.33	1.13	2.44
3	5	2.78	1.13	2.44
4	1	1.33	0.90	3.59
4	2	1.36	0.90	4.02
4	3	2.08	1.18	4.02
4	4	2.17	1.18	4.30
4	5	2.66	1.18	4.30
5	1	1.03	1.12	3.45
5	2	1.65	1.25	4.77
5	3	2.18	1.25	5.69
5	4	2.18	1.47	6.52
5	5	2.48	1.47	6.73

Since the home-based other attraction rates by households were all close to 0.18 times their respective category's home-based productions (totaled among these three trip purposes), these were updated to the same factor of the revised production rates. Other-Other productions and attractions were each close to 0.12 times home-based productions, so they are updated likewise in this proportion. (In the 7/6/2012 version, these ratios were close to 0.215 and 0.125 respectively.)

Trip Generation – Non-residential

In the Other-Other trip purpose, countywide productions were about 9% higher than attractions, and most employment categories had significantly different production rates to their attraction rates. Conventionally, Non Home-Based productions are set equal to attractions. The MIP model's

distinguishing of Work-Other trips introduces a logical production-attraction orientation between workplaces as productions and places visited during work as attractions (including lunch, retail, and services). But the differences in Other-Other production and attraction rates are not clear. Balance was achieved, while preserving each land use's total trip rate, by changing each land use's Other-Other production and attraction rates to the average of their former two rates.

The trip generation rates of Accommodations and Food employment categories were significantly different (10.3 vs. 41.5), with Food contributing the second-largest portion of Home-Based Shop trips (after retail). Concerns about the geographic distribution of detailed-sector employment, and the particular sensitivity of the model to this one category, led to changing the trip generation of Food and Accommodations to the equal rates – in effect, merging the two categories as far as the model is concerned. (The new total rate is 23.3 for both.)

All Work-Other trip generation was increased by a factor of approximately 2.6, to compare closer to other models having this trip purpose. Minor adjustments by consistent factors were made to other trip purposes to improve regional balance and calibration.

Table 13 shows the resulting trip generation rates by employment in the applicable trip purposes. (Truck trip rates were not changed, except for the equalizing of Accommodations and Food.)

Table 13
Revised person-trip generation rates for employment

Employment Type	Productions		Attractions				
	Work-Other	Other-Other	Home-Work	Home-Shop	Home-Other	Work-Other	Other-Other
AGRICULTUR	0.69	0.50	0.73	0.11	0.35	0.10	0.50
MINING	0.16	0.51	0.80	0.00	0.53	0.11	0.51
UTILITIES	0.86	0.35	1.02	0.00	0.13	0.11	0.35
CONSTRUCTN	0.69	0.35	1.00	0.10	0.05	0.10	0.35
MANUFACTUR	0.80	0.34	1.07	0.12	0.05	0.12	0.34
WHOLESALE	0.41	1.47	1.45	1.80	0.23	0.44	1.47
RETAIL	0.65	2.63	0.78	6.24	4.61	1.20	2.63
WAREHOUSE	0.89	0.73	1.13	0.17	0.54	0.16	0.73
INFORMATN	0.88	0.73	0.75	0.00	1.37	0.29	0.73
FINAN_INSR	1.26	0.75	0.78	0.00	1.43	0.31	0.75
REALESTATE	1.14	0.78	0.78	0.00	1.44	0.31	0.78
SVC_PROF	1.20	0.68	0.73	0.00	1.33	0.29	0.68
SVC_MNGMNT	0.58	0.68	0.69	0.00	1.26	0.27	0.68
SVC_ADMIN	0.91	0.80	0.81	0.00	1.49	0.32	0.80
EDUCATION	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HEALTH	0.71	1.87	1.25	0.52	1.65	0.49	1.87
ENT_REC	0.48	3.34	0.71	2.30	3.52	1.96	3.34
ACCOMODTNS	0.45	4.96	1.12	3.28	5.93	2.31	4.96
FOOD	0.45	4.96	1.12	3.28	5.93	2.31	4.96
SVC_OTHER	0.65	1.71	0.38	1.07	3.39	1.54	1.71
PUBLIC	0.82	2.60	1.26	0.71	3.13	1.74	2.60

Edwards Air Force Base warranted particular attention in calibration.

The Transportation Engineering Agency of the Military Surface Deployment and Distribution Command counted traffic on the three main gates of Edwards Air Force Base in 2006. Total daily traffic volumes are summarized in Table 14.

The south gate is a model gateway to Los Angeles County. The south gate count is that gateway's target traffic volume.

Table 14
Traffic volumes on the Edwards Air Force Base gates

Gate	Street	Daily traffic count
West	Rosamond Blvd	8,097
North	Rosamond Blvd	5,026
South	120th Street East	3,998
Total		17,121

Source: *ECF Safety Evaluations: Traffic Volumes*, Military Surface Deployment and Distribution Command Transportation Engineering Agency

The 2008 MIP model, ran as given, yielded a total of 40,453 vehicles per day on these roads, much higher than counted. TAZ 2156, covering the base, had 16,144 employees and 625 residential units, plus 34,232 special-generator person trips coded in the input data. Removing the special generator record did not reduce the modeled traffic adequately, but removing the employment and residential units instead results in a much closer approximation. A further adjustment attempting make its trip distribution more realistic is to reduce the intrazonal travel time in this zone by inserting an empty unused zone close to zone 2156, to shorten the time and distance to the nearest neighbor. Additionally, the base speed on the inner base links was reduced from 50 to 25 mph.

Another logical change to the network was attempted: in some test runs, the south gateway was connected directly to zone 2156, so that this gateway's trips could only distribute to that zone, and not pass through into the rest of the county. Even though the composite time between the gateway and all other zones was practically prohibitive, some of the gateway's trips "bled" to the other zones in trip distribution, but then they could not be assigned. Without this restriction, the portion distributing through the base to other zones does not excessively load the north or west gates, and no trips are lost from assignment.

Network edits to Edwards AFB:

- Add zone 2449 to Edwards AFB near 2156, also connecting it to 10262. 2449 is a dummy zone created to give 2156 a shorter intrazonal time.
- Also in Edwards AFB, slowed down the two highway links at node 10262 to 25 mph.

Highway network spot edits elsewhere

- Shorten the gateway-link distance override in field DIST_ADJ.
- Split link 11477-14277, picking middle node 15685 (which sits right under the link).
- Also, enable link 83-11477 in 2008 as well as all other years. It is a gateway with trips.
- Enable link 11401-12567 in both directions in all years including 2008. This is left turns at SR 58/SR 223.
- Add zone connector 1754-12175. In aerials, it appears that much of the activity in this zone has access to Lerdo Highway.
- Add zone 2449 to Edwards AFB near 2156, also connecting it to 10262. 2449 is a dummy zone created to give 2156 a shorter intrazonal time.
- Also in Edwards AFB, slow down the two highway links at node 10262 to 25 mph.

- Add access in 2008 and other years as needed to zones 165, 171, 1193.
- Slow down Twisselman - Kecks roads (in Lost Hills area) to 40 mph.
- There are three groups of coincident links, one among the three nodes 14265, 14443, 15736, one among the nodes 13840, 13841, 15737, and the other among 10868, 11610, 15740. My working master network deleted the "split" members of the first two of these groups. However, you should get practically the same results if you choose to keep the "split" pairs and delete the long links overlaying them, since the speed and capacity attributes are the same. I just discovered the third group.

Review and amendments to calibration tools included:

- Averaging of traffic counts at duplicate locations
- Adding numerous daily traffic counts, especially on state highways, from Caltrans sources and the KernCOG online traffic counts
- Adding screenlines throughout Kern County for evaluation of aggregated traffic flows between model and counts
- New comparisons of modeled to observed transit boardings (replacing the previous incorrect factoring of the model's linked transit trips)
- Comparison and adjustment of mode shares by the model's full set of trip purposes and modes. The previous summaries by three purposes and

Further adjustments are still recommended.

- A new California Statewide Household Travel Survey is expected to be available later in 2013. Its anticipated larger sample size for Kern County, plus methodological advances in data collection, offer an updated and improved basis of calibration for all demand-model components including trip generation, auto ownership, trip distribution, mode choice, and time-of-day.
- Countywide review of employment data is warranted, due to remaining production-attraction imbalances in some parts of Kern County, lingering difficulties calibrating Route 58's traffic volumes between Bakersfield and Tehachapi, and differences between the base-year model employment inputs, compared to estimates by the federal Bureau of Labor Statistics and the Census Bureau's Longitudinal Employer-Household Dynamics (LEHD).

Gateway targets and results

Table 15 compiles daily traffic counts and estimates for c.2008 on all the gateway roads at the boundary of Kern County. Sources include Caltrans, Tulare and San Luis Obispo Counties, the Southern California Association of Governments (SCAG), and the aforementioned gate counts of Edwards Air Force Base. Volumes for 2008 from the new November 2012 release of the California Statewide Travel Demand Model (CSTDM) are also shown for comparison. Except where noted, all are annual-average (AADT). The final columns, "KCOG-Reviewed 2008 AADT Estimate," are chosen as the representative estimates from the available data. These targets are used in the preparation of the gateway trip generation (IX and XI trips), and through trips (XX).

In Table 16, the estimated AADT is converted to midweek estimated traffic, by proportion to available 3-day and comparable 7-day counts from Caltrans. (The MIP model, like most, focuses on mid-week travel.) These are the targets for the revised MIP model, for preparation of the model input data. Table 16 compares the MIP model runs to the estimated actual traffic, for a run of the 7/6/2012 version as originally provided to DKS, and the standing revised DKS version of 3/7/2013. The original model's gateway volumes deviate significantly from counts and current estimates, although it may have used higher targets for some gateways such as I-5 north (where some counts and estimates are considerably higher than those chosen for this revision). For the revised model, total modeled traffic on the gateways is 2.6% below target, and truck traffic is 10% low overall. Each gateway, except for two of the lowest-volume ones, has total modeled traffic within 10 percent of target.

Table 15

Compilation of c.2008 Traffic volume counts and estimates for Kern County gateway roads

		Compilation of Counts and Estimates													
		Caltrans published 2008		Edwards AFB 2006 gate counts	Caltrans FY11ker_summary* (compare AADT, midweek)		10/2012 spreadsh'ts fr. adjac't counties			Forecasts in 2006 model documentation		CSTDM09 2008 weekday (11/2012 release)		**KCOG-Reviewed 2008 AADT Estimate**	
Kern MIP Gateway	Location	All	Trucks		2009 7-day	2009 3-day	TCAG 2007	SCAG RTP12	SLO RTM v1.2	2006	2010	All	Trucks	Total	Truck
61	SR 33 (N)	1,350	108		1,795	2,184				2,300	2,300	196	63	4,000	400
62	Baker (Barker)									400	400			60	10
63	King Rd									170	170			700	60
64	I-5 (N)	27,000	8,608		41,594	36,735				38,880	45,386	54,540	10,800	27,000	8,600
65	Corcoran/Dairy									490	490	1,010	534	350	145
66	Wildwood						214			60	60			200	15
67	SR 43	2,900	812		6,805	7,035	2,969			2,203	2,206	1,118	273	2,800	800
68	Melcher						994			770	770			900	70
69	SR 99	43,500	10,015		38,995	37,402	43,711			46,649	47,514	43,734	8,771	50,000	11,500
82	Girard St/N Kramer St						3,176								
70	Browning/Driver									3,450	3,450	1,288	204	3,000	60
83	Rd 160 (Veneto/Bowman)						685								
85	Road 192						2,397								
71	Famoso-Porterville						3,942			3,350	3,350	5,985	1,742	5,800	1,450
72	SR 65	8,500	2,250		6,161	5,966	8,473			7,800	7,800	4,928	1,713	8,200	2,170
73	Jack Ranch						699			420	420	685	223	500	160
74	Sierra Way									2,550	2,550	0		2,540	250
29	SR 395 (N)	5,700	684		2,782	2,578				6,340	6,661	1,994	376	5,700	684
30	SR 178	2,300	184		21,424	22,942				2,300	2,300	2,910	523	2,300	184
75	Searles Sta. Cutoff									260	260			130	20
31	US 395 (S)	4,200	608		4,087	3,677		3,508		4,211	4,226	1,708	527	4,200	825
76	Randsburg Cutoff									110	110	298	172	100	20
32	SR 58 (E)	13,500	6,169		13,542	12,797		9,701		18,151	24,086	2,801	1,374	13,500	6,169
77	20 Mule Team Rd in Boron									1,000	1,000	667	180	1,800	485
81	Lancaster Bl (120thE)			3,998				4,987				2,452	452	4,000	740
33	Sierra Hwy							3,137		985	1,578	93	10	4,800	300
34	SR 14	34,000	2,312		29,231	29,372		35,539		32,635	36,815	33,782	3,354	31,000	2,100
35	60th St West							1,120							
36	90th St West							1,355		2,221	2,316	1,609	210	1,100	80
78	170th St West									130	130	670	195	290	20
37	I-5 (S)	67,000	17,581		71,735	62,638		51,890		71,308	77,053	79,940	18,472	67,000	17,581
38	Lockwood Valley Rd							783		2,050	2,050	727	537	1,300	300
39	SR 33 (S)	4,000	1,000		3,896	3,646			4,186	3,743	4,568	651	386	3,600	1,000
79	Soda Lake									30	30			60	6
40	SR 58 (W)	340	72		310	274			502	301	348	140	65	350	70
80	Bitterwater Valley Rd								19	60	60			50	5
41	SR 46	7,700	1,663		6,626	5,893			7,944	7,595	7,718	1,147	258	7,700	1,663

* Nearest representative location available was chosen, not necessarily at the gateway. Purpose: to get ratio of AADT to mid-week (T-W-Th), not necessarily to establish gateway traffic volume.

Table 16

Comparison of 2008 MIP model daily traffic to estimated counts for Kern County gateway roads

Kern MIP Gateway	Location	KCOG-Reviewed 2008 AADT Estimates		DKS MIP Basis *Italic = weekday estim., from AADT*		MIP Model Runs		
						070612 MIP	DKS-revised MIP, 030713 run	
		Total	Truck	All	Trucks	All Veh	All	Trucks
61	SR 33 (N)	4,000	400	4,000	400	992	3,728	268
62	Baker (Barker)	60	10	60	10	49	59	7
63	King Rd	700	60	700	60	176	691	40
64	I-5 (N)	27,000	8,600	*23,846*	8,600	37,785	23,474	8,460
65	Corcoran/Dairy	350	145	350	145	457	325	108
66	Wildwood	200	15	200	15	201	203	11
67	SR 43	2,800	800	*2,895*	800	3,540	2,652	582
68	Melcher	900	70	900	70	896	839	51
69	SR 99	50,000	11,500	*47,957*	11,500	27,397	46,248	9,792
82	Girard St/N Kramer St			3,176	60	0	3,128	36
70	Browning/Driver	3,000	60	3,000	60	1,315	2,893	36
83	Rd 160 (Veneto/Bowman)			685	12		673	7
85	Road 192			2,397	50	0	2,380	30
71	Famoso-Porterville	5,800	1,450	5,800	1,450	1,732	5,484	1,123
72	SR 65	8,200	2,170	*7,940*	2,170	5,449	7,596	1,911
73	Jack Ranch	500	160	500	160	127	459	138
74	Sierra Way	2,540	250	2,540	250	1,365	2,581	215
29	SR 395 (N)	5,700	684	*5,282*	684	2,195	4,910	678
30	SR 178	2,300	184	*2,463*	184	1,494	2,319	109
75	Searles Sta. Cutoff	130	20	130	20	479	124	12
31	US 395 (S)	4,200	825	*3,779*	825	1,373	3,582	751
76	Randsburg Cutoff	100	20	100	20	62	83	15
32	SR 58 (E)	13,500	6,169	*12,757*	6,169	10,431	11,825	5,908
77	20 Mule Team Rd in Boron	1,800	485	1,800	485	22	1,557	372
81	Lancaster Bl (120thE)	4,000	740	4,000	740	3,015	3,951	579
33	Sierra Hwy	4,800	300	4,800	300	572	4,680	192
34	SR 14	31,000	2,100	*31,150*	2,100	1,990	31,850	1,446
35	60th St West			1,120	80	0	1,110	62
36	90th St West	1,100	80	1,100	80	506	1,080	62
78	170th St West	290	20	290	20	249	299	17
37	I-5 (S)	67,000	17,581	*58,503*	17,581	49,162	57,529	16,627
38	Lockwood Valley Rd	1,300	300	1,300	300	28	1,192	275
39	SR 33 (S)	3,600	1,000	*3,369*	1,000	278	3,217	793
79	Soda Lake	60	6	60	6	177	63	5
40	SR 58 (W)	350	70	*309*	70	43	300	61
80	Bitterwater Valley Rd	50	5	50	5	40	53	4
41	SR 46	7,700	1,663	*6,848*	1,663	3,054	6,696	1,551

Revisions to KernCOG MIP travel demand model – July 2013 – DKS Associates

Kern COG Travel Demand Model

Appendix B (partial)

Validation Details – Static Validation

Revised July 2013

DKS Associates

This is an appendix to the documentation for the Kern County travel demand model, accompanying the cumulative revisions by DKS Associates made through March 7, 2013 as documented July 2013. Numerical validation results are from this KernCOG MIP model as revised by DKS Associates.

Note: In the version of this appendix delivered July 17, 2013, DKS Associates does not represent the check-boxes (symbols for "met", "partially met", and "not met"), not having their standards of satisfaction.

TABLE B-1:
DAILY PERSON TRIP GENERATION RATES – KERN

Land Use	Kern
Residential	
RU 1	9.09
RU 3	6.79
RU 9	6.63
Non-Residential	
Agriculture	3.30
Mining	3.01
Utilities	3.22
Construction	3.03
Manufacturing	3.08
Wholesale	7.64
Retail	18.98
Warehouse	4.70
Information	5.00
Financial and Insurance	5.54
Real Estate	5.48
Professional Services	5.16
Management Services	4.42
Administrative Services	5.38
Education	0.00 (generation is by student enrollment, below)
Health	8.62
Entertainment and Recreation	15.90

Accommodations	23.26
Food	23.26
Other Service	10.69
Public	13.12
Student Enrollment	
Elementary	1.62
High School	2.14
College	2.95

Notes:

TABLE B-2-A:
DAILY PRODUCTIONS AND ATTRACTIONS AT GATEWAYS - KERN

Purpose	Productions	Attractions
Home-Work	49,660	30,960
Home-Shop	5,110	4,460
Home-K12	2,100	1,050
Home-College	1,320	3,680
Home-Other	20,760	14,330
Work-Other	8,360	6,790
Other-Other	3,630	3,900
Highway Commercial	1,040	1,040
Trucks-Small	1,290	1,530
Trucks-Medium	3,230	3,600
Trucks-Heavy	6,540	8,120

Notes:

TABLE B-2-B:
SPECIAL GENERATOR DAILY PRODUCTIONS AND ATTRACTIONS - KERN

Purpose	Productions	Attractions
Home-Work	0	11,670
Home-Shop	0	1,460
Home-K12	0	0
Home-College	0	0
Home-Other	0	4,250
Work-Other	5,570	670
Other-Other	3,490	4,740
Highway Commercial	0	0
Trucks-Small	1,270	1,270
Trucks-Medium	1,090	1,090
Trucks-Heavy	540	540

Notes:

STATIC VALIDATION (SEE VALIDATION SPREADSHEETS FOR DETAIL)

TABLE B-3:
SUMMARY OF MODEL PERFORMANCE – STATIC VALIDATION - KERN

Validation Topic	Kern
Land Use	●
Trip Generation	●
Trip Distribution	
Mode Choice	
Traffic Assignment	◑
Transit Assignment	●

Notes:
● = Met / Not Required
◑ = Partially Met
○ = Not Met

TABLE B-4:
SUMMARY OF MODEL PERFORMANCE – STATIC VALIDATION – LAND USE - KERN

Validation Topic	Kern
Residential	
Household Population	●
Total Households	●
Employment	
Retail	●
Non-Retail	●
Total	●

Notes:
● = Met / Not Required

◑ = Partially Met
○ = Not Met

TABLE B-5:
SUMMARY OF MODEL PERFORMANCE – STATIC VALIDATION – LAND USE – DETAILED - KERN

Validation Statistic	Evaluation Criterion	Reference*	Model	Difference	Percent Difference
Household Population	+/- 3%	775,558	787,550	+11,992	+1.5%
Total Households	+/- 3%	248,741	253,554	+4,813	+1.9%
Employment					
Retail		48,900	48,271	-629	-1.3%
Non-Retail		238,700	230,256	-8,444	-3.5%
Total		287,600	278,527	-9,073	-3.2%

*Population and household data are 2008 values from California Department of Finance's Table "E-8 Historical Population and Housing Estimates for Cities, Counties and the State, 2000-2010 " Employment data are 2008 values from California Economic Development Department's Data Library: http://www.labormarketinfo.edd.ca.gov/?PAGEID=94. "Retail" category includes EDD's Retail Trade and Leisure & Hospitality categories.

TABLE B-6:
SUMMARY OF MODEL PERFORMANCE – STATIC VALIDATION – TRIP GENERATION - KERN

Validation Topic	Kern
Trip Balancing by Purpose	
HBW	●
HBS	●
HBO	●
NHB	●
Total	●

TABLE B-6:
SUMMARY OF MODEL PERFORMANCE – STATIC VALIDATION – TRIP GENERATION - KERN

Validation Topic	Kern
Percentage of Trips by Purpose After Balancing	
HBW	●
HBO	●
NHB	●
Person Trips Per HH	
Vehicle Availability	●

Notes:
● = Met / Not Required
◑ = Partially Met
○ = Not Met

TABLE B-7:
SUMMARY OF MODEL PERFORMANCE – STATIC VALIDATION – TRIP GENERATION – PA BALANCE - KERN

Trip Purpose	Evaluation Criterion	Productions	Attractions	P/A Ratio	Difference	Percent Difference
HBW	+/- 10%	427,102	420,521	1.02	-6,581	-1.5%
HBS	+/- 10%	256,003	250,623	1.02	-5,380	-2.1%
HBO (incl. School)	+/- 10%	992,569	967,560	1.03	-25,009	-2.5%
NHB	+/- 10%	738,889	711,535	1.04	-27,354	-3.7%

Notes:

TABLE B-8
SUMMARY OF MODEL PERFORMANCE – STATIC VALIDATION – TRIP GENERATION – TRIP PURPOSE SPLIT - KERN

Purpose	Total (All Modes)	
	CHTS	Model
HBW	19.0%	17.3%
HBO	50.6%	52.6%
NHB	30.4%	30.0%
Total (All Purposes)	100.0%	100.0%

Notes: 2000-2001 California Statewide Household Travel Survey. Includes only internal-to-internal, weekday person trips for all modes, weighted by weekday, trip-level weights ("WDWGT"). Driver trips are adjusted by a factor of 1.647 to correct for underreporting. Transit excludes school bus trips.

TABLE B-9:
SUMMARY OF MODEL PERFORMANCE – STATIC VALIDATION – TRIP GENERATION –WEEKDAY PERSON TRIPS PER HOUSEHOLD - KERN

CHTS	Model
7.1	8.8

Notes: 2000-2001 California Statewide Household Travel Survey. Includes only internal-to-internal, weekday person trips for all modes, made by households within the county, weighted by weekday, household-level weights ("HHWDWGT"). Driver trips are adjusted by a factor of 1.647 to correct for underreporting.

TABLE B-10:
SUMMARY OF MODEL PERFORMANCE – STATIC VALIDATION – TRIP GENERATION –VEHICLE AVAILABILITY - KERN

	Vehicle Availability			
	0	**1**	**2**	**3+**
CHTS	8.8%	33.9%	37.0%	20.3%
ACS 2006-2010	7.4%	30.9%	37.7%	23.9%
Model	7.9%	31.9%	37.8%	22.4%

Notes: 2000-2001 California Statewide Household Travel Survey - Weekday Travel Report (June 2003); US Census American Community Survey 5-year sample 2006-2010.

TABLE B-11-A:
SUMMARY OF MODEL PERFORMANCE – STATIC VALIDATION – TRIP DISTRIBUTION – KERN

Validation Topic	Kern
All Modes	
Internal-Internal	◑
Internal-External	◑
External-Internal	◑
Passenger Auto Trips Only	
Internal-Internal	◑
Internal-External	
External-Internal	
Vehicle Miles Traveled	●
Average Travel Time	
HBW	
HBO	

NHB

Notes:
- = Met / Not Required
- = Partially Met
- = Not Met

TABLE B-11-B:
SUMMARY OF MODEL PERFORMANCE – STATIC VALIDATION – TRAFFIC ASSIGNMENT – VMT - KERN

Evaluation Criterion	HPMS	Model	Deviation
+/- 5%	22,217,235	21,612,502	-2.7%

TABLE B-12:
SUMMARY OF MODEL PERFORMANCE – STATIC VALIDATION – TRIP DISTRIBUTION – BY PURPOSE (ALL MODES) - KERN

Trip Purpose						
	HBW		HBO		NHB	
Trip Type	CHTS	Model	CHTS	Model	CHTS	Model
II	81.3%	81%	92%	96%	87%	97%
IX	8.7%	7%	4%	2%	7%	2%
XI	8.1%	12%	4%	2%	7%	2%

Notes: 2000-2001 California Statewide Household Travel Survey. All modes, weekday trips only. External-to-external (XX) trips are excluded; reported values are percentages of the total of all non- external-to-external weekday trips. Trips are weighted by weekday, trip-level weights ("WDWGT"). Driver trips are adjusted by a factor of 1.647 to correct for underreporting.

TABLE B-13:
SUMMARY OF MODEL PERFORMANCE – STATIC VALIDATION – TRIP DISTRIBUTION – BY PURPOSE (DRIVING TRIPS ONLY) - KERN

Trip Purpose						
	HBW		HBO		NHB	
Trip Type	CHTS	Model	CHTS	Model	CHTS	Model
II	83.8%	80.5%	91.5%	95.2%	86.1%	97%
IX	8.3%	7.5%	3.9%	2.2%	7.6%	2%
XI	8.0%	12.0%	4.6%	2.7%	6.3%	2%

Notes: 2000-2001 California Statewide Household Travel Survey. Weekday, driving trips only. External-to-external (XX) trips are excluded; reported values are percentages of the total of all non- external-to-external weekday driving trips. Trips are weighted by weekday, trip-level weights ("WDWGT"). Driver trips are adjusted by a factor of 1.647 to correct for underreporting.

TABLE B-14:
SUMMARY OF MODEL PERFORMANCE – STATIC VALIDATION – TRIP DISTRIBUTION – AVERAGE TRAVEL TIME (IN MINUTES) BY TRIP PURPOSE - KERN

Trip Purpose					
HBW		HBO		NHB	
CHTS	Model	CHTS	Model	CHTS	Model
20.2	16.7	15.1	14.8	15.5	11.5

Notes: 2000-2001 California Statewide Household Travel Survey. Includes only internal-to-internal, weekday person trips for all modes, weighted by weekday, trip-level weights ("WDWGT"). Driver trips are adjusted by a factor of 1.647 to correct for underreporting.

TABLE B-15:
SUMMARY OF MODEL PERFORMANCE – STATIC VALIDATION – MODE CHOICE - KERN

Validation Topic	Kern
Drive Alone	●
Shared Ride 2	●
Shared Ride 3+	●
Transit	
Walk	
Bike	

Notes:
● = Met / Not Required
◑ = Partially Met
○ = Not Met

TABLE B-16:
SUMMARY OF MODEL PERFORMANCE – STATIC VALIDATION – MODE CHOICE - KERN

Mode	CHTS (Fehr & Peers summary)	CHTS (7 Central Valley Counties, DKS summary)	CHTS (Kern County, DKS summary)	Model
Drive Alone	43.6%	(n/a)	(n/a)	41.7%
Shared Ride 2	28.4%	(n/a)	(n/a)	24.7%
Shared Ride 3+	22.4%	(n/a)	(n/a)	24.9%
Transit	1.0%	1.3%	1.9%	0.7%
Walk	4.3%	6.8%	6.2%	7.0%
Bike	0.3%	0.9%	0.5%	0.9%
Total	100%	100%	100%	100%

Notes: 2000-2001 California Statewide Household Travel Survey. Includes only internal-to-internal, weekday person trips for all modes, weighted by weekday, trip-level weights ("WDWGT"). In Fehr & Peers summary, Driver trips are adjusted by a factor of 1.647 to correct for underreporting. Transit excludes school bus trips.

TABLE B-17:
SUMMARY OF MODEL PERFORMANCE – STATIC VALIDATION – TRAFFIC ASSIGNMENT - KERN

Validation Topic	Kern
All Vehicles	
Daily	◑
AM Period	◑
Midday Period	○
PM Period	◑
Nighttime Period	○
AM 1 Hour	◑
PM 1 Hour	◑
Trucks	
By Time	○
By Class	○

Notes:
● = Met / Not Required
◑ = Partially Met
○ = Not Met

INSERT PDF PRINTOUT FROM HIGHWAY VALIDATION SPREADSHEET

TABLE B-18:
SUMMARY OF MODEL PERFORMANCE – STATIC VALIDATION – TRANSIT ASSIGNMENT - KERN

Validation Topic	Kern
System Ridership	●

Notes:
● = Met / Not Required
◑ = Partially Met
○ = Not Met

TABLE B-19:
SUMMARY OF MODEL PERFORMANCE – STATIC VALIDATION – TRANSIT ASSIGNMENT – DETAILED - KERN

Validation Statistic	Evaluation Criterion	Observed Ridership	Model Ridership	Percentage
Difference between actual ridership to model results for entire system	+/- 20%	23,131	26,734	16%

Notes:

San Joaquin Valley Model Improvement Project (San Joaquin Valley MIP)
Two-Way Volume Model Validation Results
Kern County Model

7/17/13 1:50 PM

DAILY Assignment		
Model/Count Ratio =	0.92	
Percent Within Caltrans Maximum Deviation =	66%	> 75%
Percent Root Mean Square Error =	45%	< 40%
Correlation Coefficient =	95%	> 0.88
%of Screenlines Within Caltrans Standard Dev. =	100%	100%
Externals M/C Ratio =	0.97	
Externals % RMSE =	9%	
Total Count	542	
Link Within Deviation	359	
Link Outside Deviation	183	
	Remaining	Total Needed
	48	407

Model/Count by ADT Volume Groups	
Link Volume	M/C
> 50,000	0.99
25,000 - 49,999	0.86
10,000 - 24,999	0.86
5,000 - 9,999	0.97
2,500 - 4,999	1.05
1,000 - 2,499	1.19
< 1,000	N/A

RMSE by ADT Volume Groups		
Link Volume	%RMSE	FHWA
> 50,000	12%	< 21%
25,000 - 49,999	26%	< 22%
10,000 - 24,999	38%	< 25%
5,000 - 9,999	80%	< 29%
2,500 - 4,999	83%	< 36%
1,000 - 2,499	107%	< 47%
< 1,000	N/A	< 60%

ADT Model/Count by Functional Class	
Link Volume	M/C
Freeway	1.04
Expressway	0.92
Arterial	0.91
Collector	0.83
Connector: Dist <=0.25	0.86
Connector: Dist >0.25	0.96

AM Peak Period (6 - 9 AM)		
Model/Count Ratio =	0.85	
Percent Within Caltrans Maximum Deviation =	72%	> 75%
Percent Root Mean Square Error =	46%	< 40%
Correlation Coefficient =	90%	> 0.88
%of Screenlines Within Caltrans Standard Dev. =	75%	100%
Total Count	166	
Link Within Deviation	120	
Link Outside Deviation	46	
	Remaining	Total Needed
	5	125

MD Peak Period (10 AM - 2 PM)		
Model/Count Ratio =	0.83	
Percent Within Caltrans Maximum Deviation =	59%	> 75%
Percent Root Mean Square Error =	47%	< 40%
Correlation Coefficient =	89%	> 0.88
%of Screenlines Within Caltrans Standard Dev. =	63%	100%
Total Count	322	
Link Within Deviation	189	
Link Outside Deviation	133	
	Remaining	Total Needed
	53	242

AM Peak Hour (7- 8 AM)		
Model/Count Ratio =	0.70	
Percent Within Caltrans Maximum Deviation =	61%	> 75%
Percent Root Mean Square Error =	48%	< 40%
Correlation Coefficient =	69%	> 0.88
%of Screenlines Within Caltrans Standard Dev. =	73%	100%
Total Count	122	
Link Within Deviation	75	
Link Outside Deviation	47	
	Remaining	Total Needed
	17	92

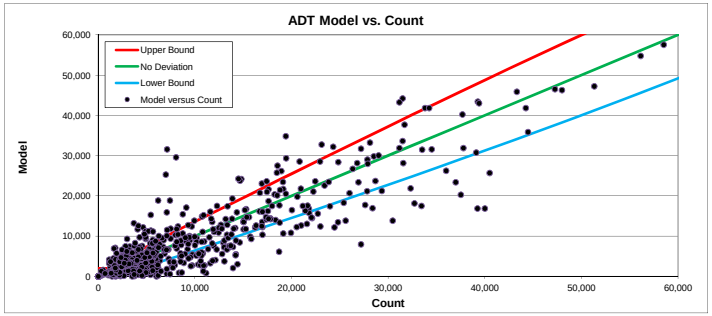
Freeway Traffic vs. Local Traffic	Model/Count	
Time Period Analyzed	Freeway	Streets
DAILY Assignment	1.02	0.91
AM Peak Period (6 - 9 AM)	1.79	0.82
MD Peak Period (10 AM - 2 PM)	1.21	0.82
PM Peak Period (3 - 7 PM)	1.19	0.84
Off Peak Period (8 PM - 5 AM)	0.59	0.96
AM Peak Hour (7- 8 AM)	1.44	0.67
PM Peak Hour (5 - 6 PM)	1.63	0.89

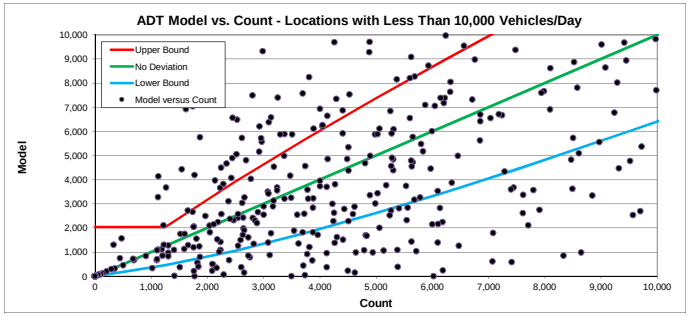
PM Peak Period (3 - 7 PM)		
Model/Count Ratio =	0.84	
Percent Within Caltrans Maximum Deviation =	73%	> 75%
Percent Root Mean Square Error =	41%	< 40%
Correlation Coefficient =	91%	> 0.88
%of Screenlines Within Caltrans Standard Dev. =	81%	100%
Total Count	291	
Link Within Deviation	213	
Link Outside Deviation	78	
	Remaining	Total Needed
	5	218

Off Peak Period (8 PM - 5 AM)		
Model/Count Ratio =	0.95	
Percent Within Caltrans Maximum Deviation =	56%	> 75%
Percent Root Mean Square Error =	54%	< 40%
Correlation Coefficient =	86%	> 0.88
%of Screenlines Within Caltrans Standard Dev. =	69%	100%
Total Count	268	
Link Within Deviation	149	
Link Outside Deviation	119	
	Remaining	Total Needed
	52	201

PM Peak Hour (5 - 6 PM)		
Model/Count Ratio =	0.91	
Percent Within Caltrans Maximum Deviation =	74%	> 75%
Percent Root Mean Square Error =	36%	< 40%
Correlation Coefficient =	79%	> 0.88
%of Screenlines Within Caltrans Standard Dev. =	53%	100%
Total Count	196	
Link Within Deviation	146	
Link Outside Deviation	50	
	Remaining	Total Needed
	1	147

Distribution of Class by Time of Day					
Count	AM	MD	PM	EV	Total
Passenger	11%	37%	23%	28%	100%
Medium	27%	32%	23%	18%	100%
Heavy	19%	31%	23%	27%	100%
Model	AM	MD	PM	EV	Total
Passenger	11%	33%	23%	33%	100%
Medium	12%	62%	17%	9%	100%
Heavy	12%	60%	18%	9%	100%





Distribution of Time of Day by Class				
Count	AM	MD	PM	EV
Passenger	99%	100%	100%	100%
Medium	0%	0%	0%	0%
Heavy	0%	0%	0%	0%
Total	100%	100%	100%	100%
Model	AM	MD	PM	EV
Passenger	90%	84%	93%	97%
Medium	7%	12%	5%	2%
Heavy	2%	4%	2%	1%
Total	100%	100%	100%	100%

Notes:	
Gravity Model Iterations =	
Number of Interations per Assignment =	
Number of Interations per Assignment =	
Time to Run =	