Development of a Model for Commercial Vehicle Trips

prepared for

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1. INTRODUCTION

1.1 Project Overview

The Metropolitan Washington Council of Governments (MWCOG) prepares travel forecasts for the metropolitan Washington region. For this purpose, MWCOG has developed a comprehensive travel forecasting model. This model estimates many different types of trips, including trips by the region's residents and non-residents, and by type of vehicle: private auto, public transportation, medium truck, and heavy truck, as well as by non-motorized travel modes (walk/bike).

However, there is one category of travel that is not specifically accounted for in the MWCOG travel model: *Commercial trips*. For the purposes of this analysis, these are defined as trips made for business or other non-personal purposes, using a light-duty vehicle (auto, light truck, SUV, etc.). Since the MWCOG model defines Heavy Trucks as 3+-axle vehicles and Medium Trucks as 2-axle/6-tire vehicles, Commercial vehicles can have only 2 axles and 4 tires. Most such vehicles are part of a fleet and they almost always display the vehicle owner's name or logo. If a vehicle bears no text or logo, but is carrying (or towing) equipment of an obviously commercial nature (painter's ladders, commercial lawnmowers, cement mixers, etc.) it is also considered a Commercial (COM) vehicle. Examples include delivery and courier vehicles (including postal vehicles), light trucks used in construction, tradesmen, craftsmen, equipment service personnel, telephone company trucks, shuttle vans, taxicabs, ambulances, police cars, government vehicles, and 4-tire vans used for paratransit and school transportation. Light-duty trucks pulling horse, equipment, or rental trailers would generally be excluded, unless the truck bears text or a logo, which would suggest it is engaged in commercial operation (as opposed to private use). Fire trucks, garbage trucks, transit buses, and school buses would most likely all be counted as Medium or Heavy Trucks. Simple observation of the traffic stream on any roadway will reveal the basic fact that Commercial trips represent a category of travel that is too large to ignore.

Planners are only now beginning to realize that business-related travel is very poorly identified in home-interview surveys. In fact, the extreme difficulty in identifying such trips and surveying their travel patterns has doubtless kept many planners from including these trips in the modelling process. These trips are inherently all but impossible to survey. Most of the drivers are tradesmen, couriers, and people who generally spend a lot of time in their vehicles. Because they make so many trips, their travel behavior tends to be overlooked by home interview surveys. Since the MWCOG model is validated to actual traffic counts, which include all vehicles, it is possible that COM trips are included indirectly. This most likely occurs through an adjustment that is applied to the surveyed trip rate for Non-Home-Based (NHB) trips. If so, then this suggests that some COM trips are misclassified as NHB. COM trips are quite different from NHB personal travel and are not subject to auto vs. transit mode choice considerations. This would result in the improper estimation of transit trips. Alternatively (or in addition), some COM trips might be misclassified as Medium Truck (MTK). If so, then the model could be overstating vehicle emissions, since medium-duty vehicles produce a higher level of emissions per mile than do light-duty vehicles. Thus, it is clear that there is value in identifying this category of trips separately.

The purpose of this project is to develop a model to estimate trips by Commercial vehicles, write the TP+ scripts to implement this model, and integrate those scripts into the existing MWCOG travel model chain.

1.2 General Approach

The consultant has concluded that creating a sample and surveying these people in any kind of statistically useful way would be infeasible, both technically and financially. The wide variety of vehicle types and the nature of COM travel makes direct collection of travel behavior data impossible. Instead, this model relies on a technique that "backs into" a model on the basis of counts. This process uses a starting generation and distribution model borrowed from another area, assigns the resulting trip table, and then uses the comparison of link-level counts and assigned volumes to adjust the starting model so as to provide a better fit. Since the counts are "driving" this model, it is very important that they be of high quality. The resulting model should at least match the count data.

Unfortunately, there is no way to count COM vehicles by machine (yet). The only way is to station people on the side of the road. Armed with the above definition (plus an appropriate, specific set of exceptions), it is relatively simple for a person to count vehicles by COM and non-COM categories. This is a good way to get the high-quality count data that is needed, but the labor-intensive nature of this process means that the number of counts that can be taken this way is very low. Also, 24-hour counts are probably infeasible due to logistical difficulties and high cost.

For other recent similar projects, the consultant has developed a procedure that leverages a relatively small number of counts to create a larger count database. This process uses a small number of manual counts to develop a "COM count model". This is a model of the percent Commercial traffic. The newly conducted counts are used to develop this model, which is then applied to a larger group of links. In projects in Baltimore, Ohio (several cities), and Atlanta, a COM count model was developed based on fewer than 200 counts (in each metropolitan area).

With a starting model and a synthesized count database, it is then possible to apply a matrix estimation procedure to adjust the starting trip table so that the resulting assignment more closely matches the counts. The difference between the initial and final trip tables can be used in two ways: 1) to better understand the nature of COM travel, thus leading to changes to the starting model , and 2) to develop a calibration adjustment table that can be used to enhance the accuracy of the model.

2. COMMERCIAL COUNT SYNTHESIS MODEL

2.1 Counts

MWCOG staff conducted counts of COM vehicles during May - July 2005. The original plan was to obtain counts at 177 locations, spread throughout the metropolitan Washington region. This sample size is based on an equation in Chapter 5 of the *Travel Survey Manual*, prepared by Cambridge Systematics, June 1996, for the TMIP project. The equation is:

$$N = CV^2 * z^2 / d^2$$

Where:
N = sample size
CV = coefficient of variation for the statistic of interest (mean/standard deviation)
z = z-statistic for the desired confidence level; for 95% confidence, z = 1.96
d = relative precision (error)

From the Baltimore and Ohio data, the CV for %COM is 0.33. For a relative precision of ±5% of the mean %COM with a confidence level of 95%, the calculated sample size is 168. A few more locations were subsequently added to the sampling plan, so as to be assured of producing enough usable data points.

A sampling program was developed to allocate these counts by facility type and by area type, based on link-miles and vehicle-miles travelled (VMT), as well as assuring geographic representation around the region (see Tables 2-1 and 2-2).

Table 2-1
Count of Sampled Locations by Area & Facility Type

	Facility Type			
Area Type	Fwy/Expw	Arterials	Collectors	Total
Urban (AT 1-3)	9	37	24	70
Suburban (AT 4-6)	11	30	24	65
Rural (AT 7)	6	19	17	42
Total	26	86	65	177

Source: MWCOG

Counts were conducted for six hours in the middle of the day. The article "Short-Period Counts with a Focus on Truck Traffic Estimation" in *ITE Journal*, November 2002, presented an excellent analysis of the number of hours that should be counted in order to provide a representative value for the daily percent trucks. Commercial traffic patterns are probably similar enough to trucks that the conclusions are transferable to this situation. That analysis found that the CV of the mean truck volume was lowest for a 12-

hour count, from 7 AM to 7 PM. The authors concluded that the minimum statistically acceptable count duration was 6 hours, specifically, from 10 AM to 4 PM. Thus, that period was used for this study. Due to various factors, only 148 of the 177 locations were actually counted. No adjustments were applied to the COM count data.

Further details on the count program are available in the MWCOG memorandum *Data Collection for the Commercial Vehicle Model*, 19 April 2007.

Table 2-2
Count of Sampled Locations by Jurisdiction & Facility Type

	Facility Type			
Jurisdiction	Fwy/Expw	Arterials	Collectors	Total
0/DC	1	12	3	16
1/Mtg	3	12	7	22
2/PG	7	10	14	31
3/Arl	1	3	0	4
4/Alx	1	1	0	2
5/FFx	3	16	13	32
6/Ldn	0	6	7	13
7/PW	2	5	13	20
9/Frd	2	3	1	6
10/How	2	3	1	6
11/AnnAr	2	3	1	6
12/Chs	0	3	2	5
14/Car	0	1	0	1
15/Cal	0	1	0	1
16/StM	0	1	1	2
17/KG	0	1	0	1
18/Fbrg	0	0	0	0
19/Staf	0	2	2	4
20/Spts	0	0	0	0
21/Fauq	2	3	0	5
22,23Cl,Jeff	0	0	0	0
Total	26	86	65	177

Source: MWCOG

2.2 Count Model

From the consultant's experience in other areas, it is not feasible to develop a COM model using only the actual count data. The proposed approach requires a broader base of count coverage. Thus, the consultant has chosen to leverage the actual data to develop a count synthesis model. This is a procedure to estimate "counts" on many more links than there is actual count data for.

The theory behind this approach is that it is possible to relate the percent of traffic that is Commercial to various characteristics of the roadway link. This was done successfully in recent similar models in Baltimore and Atlanta and for eight medium sized cities across Ohio. MWCOG staff have assembled a database containing the counts of Commercial and total vehicles at various locations distributed across the region. This database also contains some characteristics of the highway at each count location from the coded network: facility type, area type, number of lanes, and annual average weekday traffic volume (AAWDT).

The dependent variable in this model is %COM, the percent of total traffic that is commercial. The %COM resulting from MWCOG's 6-hour classification counts is assumed to be reasonably representative of the 24-hour %COM value. Table 2-3 shows a crosstab of the counted %COM by jurisdiction from the survey.

Table 2-3
%COM by Jurisdiction

Jurisdiction	%COM
DC	11.1%
MTG	7.1
PG	7.2
ARL	8.8
ALX	6.6
FFX	7.2
LDN	9.9
PW	7.6
FRD	9.5
HOW	5.8
AA	8.7
CHS	8.4
CAR	8.8
CAL	10.3
STM	7.4
KG	5.1
STA	8.5
FAU	6.4
Total	7.9

The overall share of 7.9% is very similar to the overall share from the Baltimore survey (7.7%), Atlanta survey (7.2%), and higher than that from the ODOT surveys (5.8%). DC has the highest share, which probably relates to the higher level of office employment there. In the outer jurisdictions, the slightly higher share is probably related to the higher level of construction (and/or perhaps the lower level of traffic) in those areas.

The first effort was to develop a simple look-up table, with %COM as a function of the link's facility type and area type, as shown in Table 2-4.

Table 2-4
%COM Look-Up Table

	Urban	Suburban	Rural	All
Freeway	7.1%	5.9%	6.5%	6.4%
Arterial	8.8	9.1	8.5	8.8
Local	7.6	8.8	10.9	8.7
All	8.2	7.3	8.5	7.9

This table says that there are not huge differences in %COM by link type. Arterials tend to have a slightly higher share and Freeways the lowest share, which seems logical. This is consistent with similar findings from Baltimore, Atlanta, and Ohio.

Applying this look-up table to the observed data points produces a model with the following statistics: %RMSE = 39.3%, r^2 = 0.135, total error = 0.0%. These are reasonable results.

The next effort was to develop a logit model. The logit function is well suited to this kind of model, since it estimates a percentage that must be between 0 and 100%. A logit model was estimated that related %COM to the number of lanes, jurisdiction, area type, and facility type. This model is as follows:

$\%COM = 1/(1+e^U)$

Where:
U = -0.1147 * lanes + 0.0000106 * AAWDT + FT/AT bias + jur bias

FT/AT bias = bias constant related to link facility type and area type
jur bias = bias constant related to jurisdiction

FT/AT bias	Urban	Suburban	Rural
Freeway	0.1064	0.0342	0.2800
Arterial	0.1456	-0.1024	-0.0743
Collector	0.2357	-0.1009	-0.2399

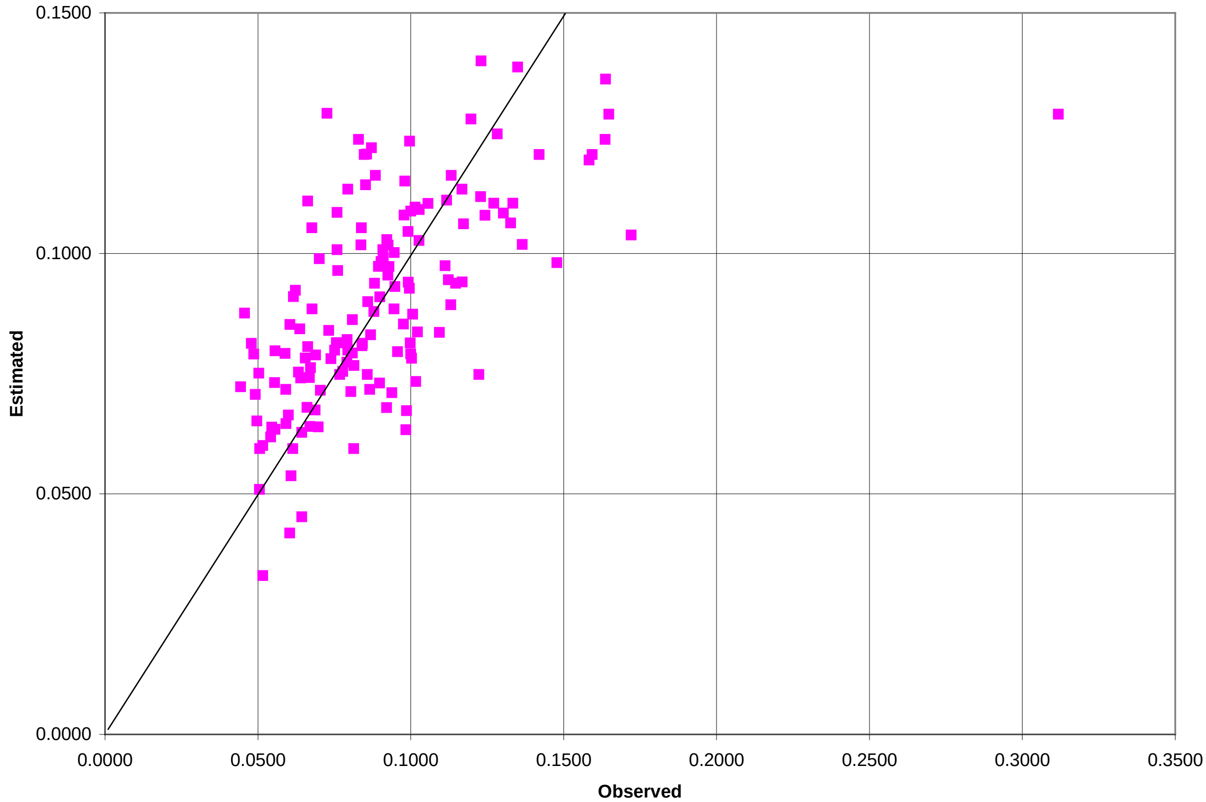
jur	bias coeff	
0	1.9292	dc
1	2.4239	mtg
2	2.3620	pg
3	2.1619	arl
4	2.3358	alx
5	2.5772	ffx
6	2.3314	ldn
7	2.2809	pw
8		
9	2.3636	frd
10	2.7131	how
11	2.5796	aa
12	2.4334	chs
13		
14	2.4544	car
15	2.4363	cal
16	2.7750	stm
17	3.1650	kg
18	2.5	fbrg
19	2.4732	sta
20	2.5	spt
21	2.5904	fau

The negative coefficent on the number of lanes means that the wider roads have higher %COM values. This appears logical – COM vehicles probably stay on the major arterials. This result is consistent with the other COM models.

In the above tables, it should be remembered that algebraically higher values of the bias coefficient mean a lower %COM share. No observations were available for Fredericksburg and Spotsylvania, so those bias coefficients were approximated from those of surrounding jurisdictions.

The logit model has the following statistics: %RMSE = 32.7%, $r^2 = 0.391$, total error = 0.1%, ρ^2 with respect to zero = 0.566, ρ^2 with respect to constants = 0.005. The model was estimated using the Excel Solver function, so more detailed statistics are not available. Figure 2-1 shows an estimated vs. observed scatterplot. The points generally fall near the desired 45° line, except for one noticeable outlier (Connecticut Ave NW, between K and L Streets – which should not be a big surprise).

Figure 2-1
Scatterplot – Initial Logit Model



The higher accuracy of the logit model compared to the look-up table outweighs its additional complexity and makes it the preferred approach. This model is easily applied to all links with a count, using a TP+ script. The product of %COM and AAWDT is the synthesized Commercial count. This produces as many Commercial count values as there are AAWDT values, which provides a database that is sufficient for model development.

Subsequent to the initial analysis, MWCOG staff provided additional detail on the area type variable. Instead of three groups (urban, suburban, rural), four groups would be used: CBD, urban, suburban, rural. Although there are only three observations in the CBD, the initial analysis (and common sense) suggests that it would be better to provide special treatment for the CBD in this model.

The initial two models (look-up table and logit function) were updated with this new information. The first additional model is a look-up table using the four area type groups, as shown in Table 2-5.

Table 2-5
Revised %COM Look-Up Table

	CBD	Urban	Suburban	Rural	All
Freeway		6.6%	6.1%	6.5%	6.4%
Arterial	16.3	7.9	9.1	8.5	8.8
Local		7.6	8.8	11.0	8.7
All	16.3	7.4	7.5	8.5	7.9

By distinguishing CBD from the rest of Urban, this table clearly shows that CBD links have a much higher %COM and that the other Urban links aren't extremely different from Suburban links. However, it should be remembered that there are only three observations in the CBD and they are all Arterials. The actual %COM values for these three CBD links is 9%, 16%, and 31%, so there is quite some variation in these observations.

The second additional model is another logit model, developed in the same way as the initial logit model, but using four area type groups instead of three. This model is as follows:

$\%COM = 1/(1+e^{U})$

Where:
U = -0.0334 * lanes + 0.0000059 * AAWDT + FT/AT bias + jur bias

FT/AT bias = bias constant related to link facility type and area type
jur bias = bias constant related to jurisdiction

FT/AT bias	CBD	Urban	Suburban	Rural
Freeway		1.5985	1.6508	1.7414
Arterial	0.9714	1.6780	1.4059	1.4467
Collector		1.7137	1.4227	1.2400

jur	bias coeff	
0	0.5117	dc
1	0.8591	mtg
2	0.7999	pg
3	0.5721	arl
4	0.7878	alx
5	1.0319	ffx
6	0.7485	ldn
7	0.7349	pw
9	0.8187	frd
10	1.1448	how
11	1.0103	aa
12	0.8726	chs
14	0.8931	car
15	0.8082	cal
16	1.2179	stm
17	1.5262	kg
18	0.9	fbrg
19	0.8707	sta
20	0.9	spt
21	0.9899	fau

As before, the bias coefficients for Fredericksburg and Spotsylvania are estimated, since there are no observations from these jurisdictions.

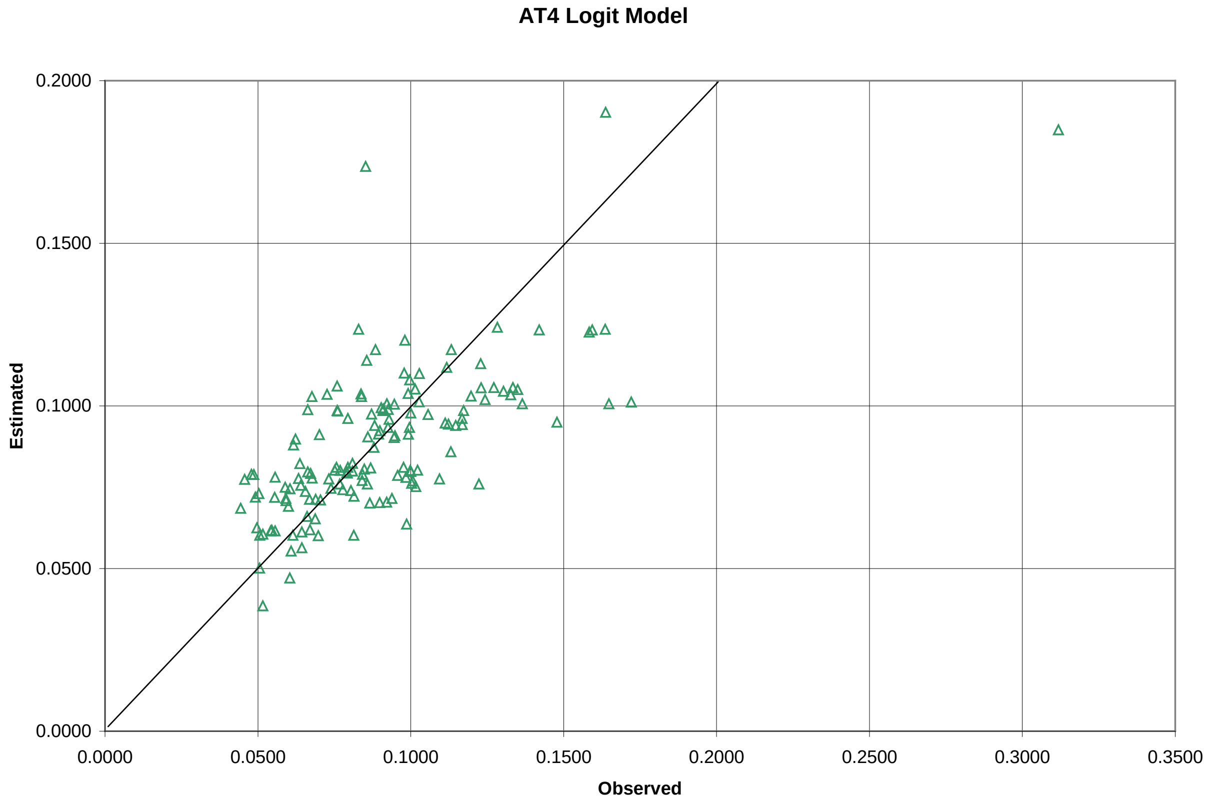
The revised logit model has the following statistics: %RMSE = 30.1%, r^2 = 0.490, total error = 0.0%, ρ^2 with respect to zero = 0.567, ρ^2 with respect to constants = 0.314. These are slightly better than the initial logit model and either of the look-up table models. Figure 2-2 shows the new estimated vs. observed scatterplot. Even with the addition of a CBD constant to the model, the Connecticut Ave NW location is still an outlier (observed %COM = 31%)!

The consultant also looked at a cross-tab of %COM, using the full set of seven area type codes. It did not distinguish much better than the grouping of four codes. As Table 2-6 shows, the final %RMSE is similar to that of the other %COM models prepared by the consultant. The revised logit model, using four area type groups, is the recommended model.

Table 2-6
%RMSE Comparison

Model	%RMSE
Baltimore	25.0%
Ohio	31.4
Atlanta	29.9
MWCOG	30.1

Figure 2-2
Scatterplot – Revised Logit Model



After the revised logit model was applied, the consultant reviewed the resulting synthesized COM counts and manually deleted those that appeared illogical or inconsistent.

3. MODEL DEVELOPMENT

3.1 Overview

There has not been much research into light-duty Commercial travel behavior. Even if there were, it is likely that the variables that truly influence such tripmaking are not among those that comprise the existing MWCOG zone-level data. So, the consultant decided to limit this analysis to those variables that are currently available and forecast-able.

COM models in other areas are relatively simple functions of employment by type and households, with straightforward F-factor curves for the gravity model and fixed factors for the time of day split. Simpler models are easier to develop and to understand and in this particular case, the available observed data does not support the development of a very sophisticated approach. That will have to await the development of technology (probably involving GIS-based vehicle tracking) that provides more information on COM travel patterns.

Thus, this approach relies on borrowing a relatively simple model from another urban area and adjusting it, based on count data, so as to make it more reflective of conditions in the Washington region.

This report documents the sequential process used to arrive at the recommended model. Four separate models were developed:

1) Standard model (trip generation, trip distribution, time of day)
2) Standard model with calibration adjustment
3) Revised standard model with calibration adjustment
4) Revised standard model with calibration adjustment, based on new assignment procedures

3.2 Model 1

Trip Generation

The trip end model for Model 1 is based on a similar model the consultant developed for the Lehigh Valley metropolitan area (Allentown-Bethlehem-Easton, PA), which is in turn based on data in the TMIP *Quick Response Freight Manual* (QRFM). The trip end equation is shown below:

$$\text{COM productions} = (0.214 * [\text{indemp} + \text{offemp}] + 0.260 * \text{retemp} + 0.076 * \text{HH}) * \text{ATFAC} \quad (1)$$

(attractions are set equal to productions, by zone)

Where:
indemp = industrial employment
offemp = office employment
retemp = retail employment
HH = households
ATFAC = area type adjustment factor:

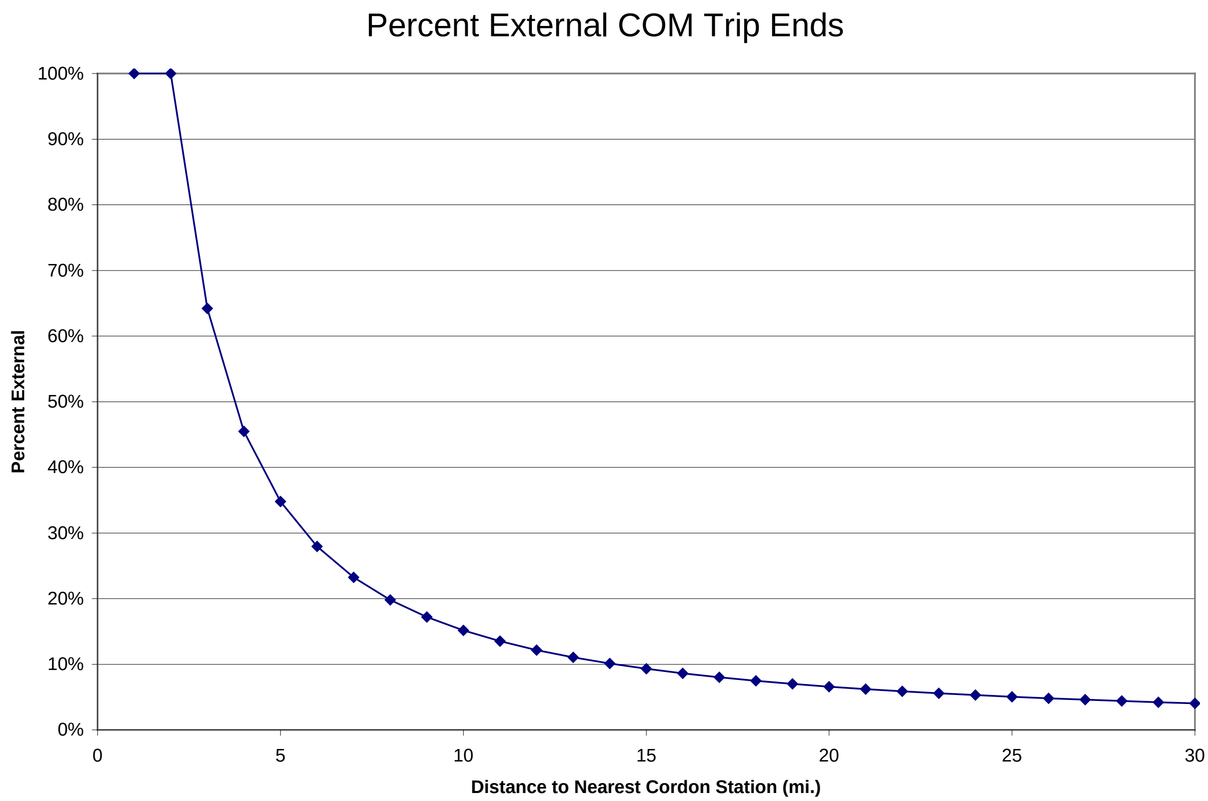
Area type	Factor
1 (CBD)	0.95
2	0.90
6	1.20
7 (rural)	1.15

Note: no factor is applied to area types 3-5.

The coefficients and area type factors were computed so as to achieve the lowest %RMSE at the link level, a total estimated/observed link volume very close to 1.0, and minimum difference in error by area type. The consultant also checked to be sure that the total number of estimated COM trips, compared to MWCOG's current total year 2000 vehicle trips, was approximately within the range of the same figures from other COM models.

This model estimates the total number of productions by zone (the number of attractions is defined as being equal to the number of productions). An external model estimates the proportion of those trip ends that are external, as a function of the zone's distance to the cordon, based on the relationship shown in Figure 3-1 (also adapted from the Lehigh Valley model). The percent of trip ends in a zone that are external (I/X or X/I) is inversely proportional to the distance from that zone to the nearest external cordon station, raised to the 1.2 power (the equation is: $extpct = 2.4 * extdist^{-1.2}$). In application, external trips are extracted and treated as a separate trip purpose, defined as productions at the internal zones and attractions at the external stations. The productions are normalized to match the attraction total.

Figure 3-1
External Share Model



External attractions by station are a basic input to the model. For 2000, the total COM trip ends at each external station were set to the synthesized count closest to that station, as shown in Table 3-1. The consultant then applied a look-up table to split these trip ends into external and through, based on facility type and relationships from other models (see Table 3-2).

Table 3-1
External Station Trip Ends

Station	Route	FTYPE	2-way COM vol	Input COM ext trip ends	COM X/X trip ends	Output COM ext trip ends (from Fratar)
2145	VA 3	3	198	198	0	196
2146	US 301 (S)	2	504	489	15	503
2147	US 17	3	368	368	0	364
2148	VA 2	2	548	532	16	545
2149	I-95 (VA)	1	3,918	3,448	470	3,959
2150	US 1 (VA)	2	876	850	26	872
2151	VA 208	3	356	356	0	352
2152	VA 612	4	430	430	0	426
2153	VA 3	4	1,664	1,664	0	1,650
2154	US 15/29	2	1,772	1,719	53	1,768
2155	US 211	4	1,352	1,352	0	1,344
2156	I-66	1	1,508	1,327	181	1,528
2157	VA 55	4	200	200	0	199
2158	US 340	3	486	486	0	483
2159	US 17/50	2	1,142	1,108	34	1,141
2160	VA 7	2	1,756	1,703	53	1,756
2161	WVA 51	3	486	486	0	484
2162	WVA 9	2	1,298	1,259	39	1,300
2163	WVA 45	2	800	776	24	801
2164	WVA 480	3	486	486	0	485
2165	US 40 Alt	2	944	916	28	948
2166	I-70 (W)	1	4,806	4,229	577	4,888
2167	US 40 (W)	3	384	384	0	384
2168	MD 77	3	198	198	0	198
2169	MD 550	3	198	198	0	198
2170	MD 140 (N)	2	944	916	28	948
2171	US 15	5	1,632	1,534	98	1,646
2172	MD 194	2	358	347	11	360
2173	MD 97	2	710	689	21	715
2174	MD 30 (N)	2	1,052	1,020	32	1,066
2175	MD 86	3	180	180	0	180
2176	MD 88	2	534	518	16	519
2177	MD 30 (E)	2	1,878	1,822	56	1,870
2178	MD 140 (E)	2	3,504	3,399	105	3,502
2179	MD 26	2	2,602	2,524	78	2,601
2180	I-70 (E)	1	3,420	3,010	410	3,384
2181	US 40 (E)	5	2,194	2,062	132	2,186
2182	I-95 (MD)	1	6,768	5,956	812	6,696
2183	I-195	2	1,666	1,616	50	1,678
2184	MD 295	1	3,798	3,342	456	3,758
2185	MD 648	2	1,246	1,209	37	1,246
2186	MD 170	2	946	918	28	921
2187	MD 3	5	1,440	1,354	86	1,457
2188	MD 2	2	3,406	3,304	102	3,406
2189	MD 10	1	6,376	5,611	765	6,307
2190	MD 710	2	1,396	1,354	42	1,358
2191	US 50 (MD)	1	3,710	3,265	445	3,783
total			76,438	71,112	5,326	76,359

Table 3-2
External Station X/X Share Look-Up Table

FTYPE	Percent External	
1	88%	Freeway
2	97%	Maj Art
3	100%	Min Art
4	100%	Collector
5	94%	Expressway

A target value for the X/X trip end total was established as 7.9% of the total MWCOG 2000 passenger car and truck trip ends (67,537), since 7.9% was the COM count's overall estimate of the percent COM vehicles. This produces a target of 5,335 X/X trip ends (= 2,667 trips). These X/X trip ends were used to Fratar the existing MWCOG year 2000 X/X daily auto trip tables, to create a COM X/X trip table. The final X/X table contains 2,620 daily vehicle trips (X/X trips = half of the X/X trip ends).

For 2000, this model produces 705,574 I/I trips, 71,112 external trips, and 2,620 X/X trips. This totals 779,306 and is 4.2% of the 18.6 million daily vehicle trips the MWCOG model produced in 2000. This percentage is lower than in other areas (Baltimore: 6.6%, Charlotte: 5.0%, Reading, PA: 9.0%).

Trip Distribution

Trip distribution will be performed using a standard gravity model. The principal component of gravity model calibration is the F factor curve, which translates travel time into the effective impedance separating each zone-zone pair. The consultant considered several sources of F factors, tested a few different formulas, and initially selected the QRFM single-unit truck F's for COM I/I trips and the current MWCOG external medium truck F's for COM external trips. These curves appeared logical and the resulting average trip lengths looked reasonable, in comparison to similar values from other models. Figure 3-2 shows the F factors. The equation for the I/I curve is:
$F = 1800 * e^{-0.1t}$.

The highway travel times are those calculated by the existing MWCOG Highway_Skims.s setup. The off-peak travel times on the SOV paths are used, including terminal times and intrazonal times as per the existing MWCOG setup. Intrazonal time is computed as half the time to the nearest neighboring internal zone.

Two separate gravity models are applied: one for I/I trips and one for external trips. In the gravity model setup file (TP+ program TRIPDIST), a maximum of 20 iterations of the gravity model are used, unless the %RMSE for both trip types is less than 10%. The resulting trip tables are <u>not</u> integerized and are output using single precision accuracy. In TP+, single precision format stores numbers with six digits to the right of the decimal point. Although single precision causes the file sizes to be much larger, its use is necessary because the TP+ default of two decimal places was causing too many trips to be lost to round-off error.

Table 3-3 shows the resulting estimated trip length frequency distributions and average trip lengths. There is no observed data to compare these to, but they seem reasonable.

Figure 3-2
COM F Factor Curves

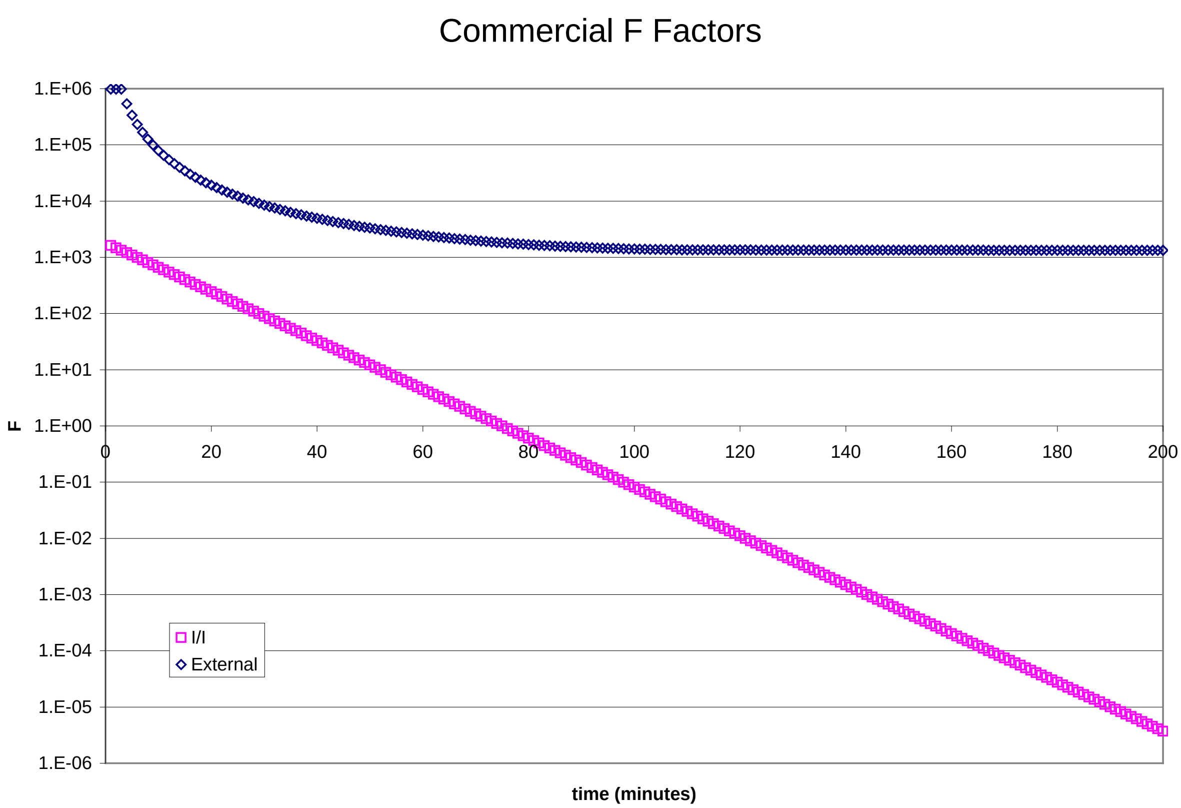


Table 3-3
Trip Length Frequency Distributions – Model 1

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FREQUENCY (Iteration=1) Est Commercial I/I Trips vs. Off-Peak Hwy Time BASEMW=3 VALUEMW=1
RANGE=0,90,2

      MW[3]         Obs         Total    Pct   äPct
---------------------------------------------------
          0       1,005        12,088   1.71   1.7 |======
          2       1,507        18,321   2.60   4.3 |=========
          4       5,633        21,120   2.99   7.3 |==========
          6      12,508        14,416   2.04   9.3 |=======
          8      22,006        23,293   3.30  12.6 |===========
         10      32,340        27,373   3.88  16.5 |=============
         12      44,842        38,014   5.39  21.9 |==================
         14      59,804        39,687   5.62  27.5 |===================
         16      74,625        52,049   7.38  34.9 |=========================
         18      90,266        57,173   8.10  43.0 |===========================
         20     103,174        51,684   7.33  50.3 |========================
         22     111,540        48,442   6.87  57.2 |=======================
         24     116,322        41,617   5.90  63.1 |====================
         26     121,067        36,839   5.22  68.3 |=================
         28     124,714        32,029   4.54  72.8 |===============
         30     127,019        27,751   3.93  76.8 |=============
         32     128,890        24,782   3.51  80.3 |============
         34     130,518        21,142   3.00  83.3 |==========
         36     132,905        18,717   2.65  85.9 |=========
         38     133,129        16,567   2.35  88.3 |========
         40     131,186        14,561   2.06  90.3 |=======
         42     127,202        11,734   1.66  92.0 |======
         44     125,980        10,005   1.42  93.4 |=====
         46     122,917         8,701   1.23  94.6 |====
         48     119,256         7,634   1.08  95.7 |====
         50     115,131         6,149   0.87  96.6 |===
         52     111,004         4,963   0.70  97.3 |==
         54     104,793         3,970   0.56  97.9 |==
         56      98,487         2,997   0.42  98.3 |=
         58      94,025         2,390   0.34  98.6 |=
         60      90,646         1,950   0.28  98.9 |=
         62      86,547         1,536   0.22  99.1 |=
         64      80,425         1,196   0.17  99.3 |=
         66      75,583           945   0.13  99.4 |
         68      70,775           751   0.11  99.5 |
         70      65,643           578   0.08  99.6 |
         72      61,663           519   0.07  99.7 |
         74      56,619           428   0.06  99.7 |
         76      52,977           325   0.05  99.8 |
         78      48,942           235   0.03  99.8 |
         80      44,692           185   0.03  99.9 |
         82      41,269           160   0.02  99.9 |
         84      36,944           122   0.02  99.9 |
         86      32,771           100   0.01  99.9 |
         88      29,102            78   0.01  99.9 |
        90+     196,076           263   0.04 100.0 |
---------------------------------------------------
                    ä         705,577
                    m           23.84
                    @J=I       52,249
```

FREQUENCY (Iteration=1) Est Commercial Ext Trips vs. Off-Peak Hwy Time BASEMW=3 VALUEMW=2 RANGE=0,90,2

MW[3]	Obs	Total	Pct	äPct	
2	2	351	0.49	0.4	|==
4	9	1,333	1.88	2.3	|=======
6	31	4,867	6.84	9.2	|===========================
8	36	3,051	4.29	13.5	|=================
10	39	2,795	3.93	17.4	|================
12	55	4,101	5.77	23.2	|=======================
14	65	4,013	5.64	28.8	|======================
16	92	3,362	4.73	33.5	|===================
18	121	2,593	3.65	37.2	|==============
20	141	2,411	3.39	40.6	|=============
22	196	2,359	3.32	43.9	|=============
24	229	1,851	2.60	46.5	|==========
26	328	1,652	2.32	48.8	|=========
28	404	1,380	1.94	50.7	|========
30	508	1,533	2.16	52.9	|=========
32	579	1,304	1.83	54.7	|=======
34	752	1,645	2.31	57.1	|=========
36	885	1,608	2.26	59.3	|=========
38	950	921	1.30	60.6	|=====
40	1,037	1,259	1.77	62.4	|=======
42	1,161	1,515	2.13	64.5	|========
44	1,268	1,304	1.83	66.3	|=======
46	1,322	1,442	2.03	68.4	|========
48	1,399	1,882	2.65	71.0	|==========
50	1,456	1,529	2.15	73.2	|========
52	1,494	1,437	2.02	75.2	|========
54	1,587	1,388	1.95	77.1	|========
56	1,599	1,454	2.04	79.2	|========
58	1,696	1,288	1.81	81.0	|=======
60	1,612	1,039	1.46	82.5	|======
62	1,676	877	1.23	83.7	|=====
64	1,672	1,023	1.44	85.1	|======
66	1,772	953	1.34	86.5	|=====
68	1,875	825	1.16	87.6	|=====
70	1,897	759	1.07	88.7	|====
72	2,008	755	1.06	89.8	|====
74	2,049	738	1.04	90.8	|====
76	2,327	911	1.28	92.1	|=====
78	2,525	774	1.09	93.2	|====
80	2,669	660	0.93	94.1	|====
82	2,957	505	0.71	94.8	|===
84	3,143	444	0.62	95.4	|==
86	2,919	435	0.61	96.0	|==
88	2,969	362	0.51	96.6	|==
90+	31,869	2,420	3.40	100.0	|=============
	ä	71,112			
	m	36.15			
	@J=I	--			

Time of Day

For the time of day fractions, the consultant looked at several different sources, as shown in Table 3-4. These figures are typically not derived from surveys, but are assumed and sometimes validated through limited count comparisons. However, since 24 hourly counts of COM vehicles are not available, the rigorous derivation of temporal COM fractions from the data was not possible. In some cases, there was not much difference between MTK and COM temporal distributions, but the data in Table 3-4 suggested that the PM share should be much higher than the current MWCOG MTK fraction. The consultant developed a new set of temporal fractions, based on professional judgment, and these are also shown in Table 3-4. The time of day setup also outputs trip tables using single-precision accuracy.

Table 3-4
Temporal Fractions

Model	AM	OP	PM	Notes
MWCOG MTK	19.5%	65.3%	15.2%	
MWCOG X/X TRK	23.0%	66.0%	11.0%	
Existing BMC COM	25.1%	45.5%	29.4%	4 hr AM, PM periods
ODOT COM	17.0%	46.6%	36.4%	
ARC COM	17.9%	58.4%	23.7%	4 hr AM, PM periods
Recommended (I/I + ext)	23.0%	50.0%	27.0%	

Assignment

For assignment, the existing MWCOG Highway_Assignment.s setup was adopted, with these changes:

- COM trips are assigned using the SOV link usage restrictions. It is assumed that COM vehicles cannot legally use any HOV lanes, but that they can use the truck-restricted roads (parkways).
- For purposes of initial testing, the COM trips are input on a separate trip table and these trips are subtracted from the SOV trip table, cell-by-cell, prior to loading. If this subtraction results in a negative number, such cells are re-set to zero. This was done in order to avoid double-counting. The COM link volume is output as a separate field on the output network.
- The network used for assignment is the year 2000 ZONEHWY.NET, with an additional field, COMCNT, added to hold the synthesized daily COM counts (3,591 one-way link records had synthesized counts).

The resulting assignment produced 162,648,647 total daily regional VMT in 2000 (the sum of the VehDist column from TP+'s assignment iteration report).

Table 3-5 shows the total estimated/observed ratio by facility and area type and Table 3-6 shows the %RMSE by facility and area type. The overall estimated/observed ratio is excellent, although there is still some slight overestimation in the urban areas and some underestimation in the more rural areas. Also, Freeways and Expressways are still being overestimated.

Table 3-5
Link Estimated/Observed Crosstab – Model 1

```
CROSSTAB ROW=FTYPE COL=AREATP COMP=comvol/COMCNT
```

	1	2	3	4	5	6	7	1 - 7
1 - 1	1.17	1.34	1.29	1.47	1.15	1.23	1.51	1.30
2 - 2	1.13	1.07	0.91	0.68	0.85	0.78	0.76	0.91
3 - 3	0.56	0.82	0.88	0.60	0.64	0.63	0.80	0.74
4 - 4	0.71	0.54	0.43	0.39	0.39	0.68	0.55	0.56
5 - 5	0.00	1.18	0.96	1.06	1.24	1.56	1.35	1.19
6 - 6	0.30	0.00	0.00	0.00	0.00	0.00	0.00	0.30
0 - 6	1.04	1.13	1.03	0.96	0.94	0.88	0.93	1.01

Table 3-6
Percent RMSE Crosstab – Model 1

```
CROSSTAB ROW=FTYPE COL=AREATP COMP=sqrt(_sqerr/_links)/(COMCNT/_links)
```

	1	2	3	4	5	6	7	1 - 7
1 - 1	0.53	0.60	0.48	0.85	0.41	0.50	0.73	0.58
2 - 2	0.63	0.48	0.43	0.48	0.61	0.48	0.52	0.53
3 - 3	0.64	0.59	0.66	0.76	0.86	0.67	0.72	0.74
4 - 4	0.59	0.82	0.85	0.99	0.97	0.94	0.75	0.90
5 - 5	0.00	0.48	0.34	0.31	0.57	1.02	0.35	0.58
6 - 6	0.94	0.00	0.00	0.00	0.00	0.00	0.00	0.94
0 - 6	0.67	0.71	0.63	0.95	0.61	0.68	0.83	0.73

Note: values are %RMSE as a fraction of 1.0, e.g., 0.73 = 73% RMSE

The %RMSE figures really are not too bad for an "unadjusted" model and are better than many such models in other areas. The error is fairly consistent by area type and is lower on the higher facility types, as one expects.

3.3 Model 2

Model 2 is similar to Model 1, except that the trip end equation is modified slightly and a calibration adjustment matrix is included. The calibration adjustment matrix is calculated as the difference between the computed year 2000 trip table and the trip table that results from application of a matrix estimation step (see Appendix A). The matrix estimation process modifies the initial trip table in such a way that the resulting assigned volumes more closely match the count data. The initial table is then subtracted from the modified table (for each O/D cell) and the difference is saved as a calibration adjustment matrix. This matrix is then added to the initially computed trip table, for all forecast scenarios.

The trip end equation for Model 2 is shown below:

COM productions = (0.256 * indemp + 0.154 * offemp + 0.452 * retemp + 0.132 * HH) * ATFAC (2)

(the ATFAC area type factors are the same as for Model 1)

This model estimates 859,429 I/I trips, 71,096 external trips, and 2,620 X/X trips. The external trips are normalized to the input values at the external stations, as in Model 1. The X/X table is the same as in Model 1. The F factors and trip distribution process are also the same as for Model 1.

For Model 2, the consultant applied the “Adaptable Assignment” technique to automatically adjust the starting trip table so as to better match the counts. This produces an “after” table. Comparing this “after” table to the “before” (starting) table, provides useful information to the calibration process. Specifically, comparison of the “before” and “after” trip ends and examination of the correlation of their difference with various socioeconomic data items available from the ZONE.ASC file, at the zone level, should disclose any bias of the model with respect to the socioeconomic data.

In theory, if the difference in trip ends has any reasonable correlation with, say, retail employment, then that would suggest that the starting model is biased with respect to that variable. This would mean that the starting model’s coefficient on that variable should be changed and the process re-applied. After 14 iterations of this kind of testing, the consultant arrived at the coefficients shown in Equation (2) and the correlations shown in Table 3-7. These correlations are truly negligible values, which indicates that the differences between the “before” and “after” trip ends are not related to any socioeconomic data items in the model. This is desirable.

Table 3-7
Final Trip End Correlations – Model 2

Zonal Variable	Correlation with Trip End Difference
hh	-0.033
hhpop	-0.027
gqpop	0.013
totpop	-0.026
totemp	0.021
indemp	-0.076
retemp	0.031
offemp	0.048
othemp	0.002

Compared to Equation (1) (Model 1), Equation (2) suggests that industrial and retail employment and households are more important, and office employment less important, in generating COM trips. One can interpret this to mean that the trip rate *per employee* is higher for non-office than for office jobs, which probably makes sense. Even though a great many COM trips are indeed associated with office employment (package deliveries, copier repairmen, etc.), the rate per employee is lower. This also helps correct a problem with Model 1, overestimating volumes in the CBD. Reducing the coefficient on office employment obviously helped that.

As noted above, Model 2 is applied in the same way as Model 1, up to the time of day step. In that step, the (daily) calibration adjustment matrix is added to the output of the trip distribution step. The calibration matrix (a.k.a. "delta table") is a set of cell values that adjust the basic model's cell values in a way that produces link volumes that more closely match the counts. These adjustments are related to the specific locations of counts and the assignment methodology, but are otherwise random-looking values. Table 3-8 shows the "before", "after", and delta tables, and the delta ratio, compressed to jurisdictions.

As Table 3-8 shows, the delta table adds 12% more trips to the "before" trip table. The resulting trip total, 1,046,525, is 5.6% of the 18.6 million daily vehicle trip total, which is actually closer to the total that the consultant expected.

The adaptable assignment process, like all such processes, tends to add more short trips than longer ones. This is because in the process of trying to influence the trips on a link, these algorithms find it more efficient to change the short trips than the longer ones. Also, shorter trips generally affect only a few counts, while longer trips affect several counts. On longer trips, the individual link errors tend to even each other out, which means that such trips don't need to be adjusted by very much. The resulting trip length frequency diagrams, shown in Table 3-9, bear this out. For I/I trips, the "after" trip length is about 15% less than the "before" and for External/XX trips it is about 18% less. This is not *too* bad – it is common to see trip length differences of 20-30% in such analyses. Since the starting average trip length is itself only an estimate, this is not a major concern.

Tables 3-10 and 3-11 show the assignment validation results for Model 2. These can be compared directly with Tables 3-5 and 3-6 from Model 1. The estimated/observed ratios are much better for Model 2, with no real bias by area type. Interestingly, even with 12% more trips, Model 2's overall estimated/observed ratio is the same as Model 1's: 1.01. Model 2's %RMSE numbers are far better than for Model 1. The overall %RMSE is down from 73% to 30%.

The resulting assignment produced 162,941,502 total daily regional VMT. Interestingly, this is about 300K *higher* than for Model 1, even though the COM trip lengths are shorter. The difference may be due to the way in which Model 2's COM trips affect the capacity restraint. It may also be an artifact associated with the MWCOG's use of the equilibrium volume averaging method of assignment, which has been shown to produce random-looking variations in link volumes, due to tiny changes in the equilibrium weights.

The delta matrix is a matrix file with two tables: I/I and External/XX. It is 2191 x 2191, in single precision, so it occupies 17 Mb of disk space. In the I/I table, the largest cell value is 7,681 and the smallest (algebraically) is -453. The average of the non-zero values is 0.046. Of 4.8 million total cells, about 800K have a positive value, about 3 million have a negative value, and the remaining million cells are zero. One of the principal disadvantages of using a delta matrix is that if the zone system changes, the cells in this matrix have to be renumbered as well. Fortunately, this is not too difficult.

Table 3-8
Calibration Adjustment Table – Model 2

Date: 12/27/2005
Time: 12:45

MWCOG Commercial Trip Model
Starting Model Trips

Destination District

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Total
	1 DC	62155	13635	19996	11410	5393	15102	514	902	162	1184	2689	749	52	183	42	7	9	100	31	39	1	6	4689	139050
	2 Mont Co	13520	68774	10138	2833	1039	10319	881	448	3549	4145	2171	108	777	38	2	0	4	29	9	33	18	125	5130	124090
	3 PG Co	19871	10415	36275	3128	2572	6299	162	417	129	4192	8637	2170	136	681	148	26	11	47	11	18	0	2	4710	100057
	4 Arlingtn	11441	2825	3112	6958	2855	9164	258	545	50	144	387	182	9	28	5	0	14	51	6	35	0	1	1138	39208
O	5 Alxndria	5484	1049	2459	2892	3627	7574	105	625	23	76	223	276	2	32	16	3	11	80	20	9	0	0	655	25241
r	6 Fairfax	15218	9997	6399	9171	7541	101220	9352	12531	277	392	625	641	33	79	23	5	162	919	201	847	57	62	4729	180481
i	7 Loudoun	499	863	151	248	94	9388	11907	1153	706	40	21	7	33	1	0	0	1	20	4	254	326	393	888	26997
g	8 PrWillam	943	410	465	555	635	12499	1160	23041	19	17	33	60	3	10	2	24	356	2111	469	1347	18	10	1825	46012
i	9 Fredrick	165	3529	122	53	22	306	705	23	14989	589	138	0	1163	0	0	0	0	1	0	7	66	593	3007	25478
n	10 Howard	1212	4092	4184	155	81	387	41	15	578	10532	5128	23	838	20	1	0	1	2	2	2	3	17	9650	36964
	11 AnnArndl	2652	2277	8572	374	224	621	24	35	137	5108	33259	198	229	579	22	2	0	7	1	2	1	2	18403	72729
D	12 Charles	801	114	2268	197	291	611	9	49	1	30	213	10077	1	433	784	318	6	16	9	1	1	0	616	16846
i	13 Carroll	47	783	138	7	2	36	31	1	1190	838	221	2	11722	1	0	0	0	1	0	1	0	28	4224	19273
s	14 Calvert	190	49	735	33	38	85	1	7	2	20	626	457	2	5780	1355	15	1	3	0	0	0	0	303	9702
t	15 St Marys	39	5	170	10	14	28	0	2	0	1	28	875	0	1433	10924	130	6	4	1	0	0	0	474	14144
r	16 King Geo	9	2	29	1	3	11	0	23	0	0	3	324	0	17	113	1598	82	126	82	4	0	0	541	2968
i	17 Frdckbrg	18	5	10	11	14	163	3	378	0	0	1	6	0	1	2	74	1656	1654	1241	68	0	0	1335	6640
c	18 Stafford	103	31	54	58	80	908	16	2133	0	2	4	12	0	2	6	114	1638	7228	1910	299	0	0	1714	16312
t	19 Spotsylv	23	6	12	14	18	199	5	467	0	1	0	6	0	2	2	80	1278	1889	4466	82	0	0	3767	12317
	20 Fauquier	33	34	12	24	13	863	251	1345	6	1	2	2	0	0	0	4	65	289	87	3311	38	15	1307	7702
	21 Clarke	3	16	0	1	1	52	312	22	66	3	0	0	3	0	0	0	0	0	0	42	777	385	496	2179
	22 Jeffrson	4	135	3	5	0	54	391	13	590	20	3	0	28	0	0	0	0	0	0	13	390	2975	1511	6135
	23 External	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2619	2619
	Total	134430	119046	95304	38138	24557	175889	26128	44175	22474	27335	54412	16175	15031	9320	13447	2400	5301	14577	8550	6414	1696	4614	73731	933144

Note: External trips are shown in P/A format. Productions defined at internal zones, attractions defined at external stations.

Date: 12/27/2005
Time: 12:45

MWCOG Commercial Trip Model
Adaptable Assignment Revised Trips

Destination District

Origin District	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Total
1 DC	145560	11274	19040	6560	2478	10390	603	551	70	622	1338	788	31	150	26	8	12	62	16	31	0	2	2556	202168
2 Mont Co	11490	98724	10440	1361	522	4121	541	190	2169	2248	1414	90	459	43	5	1	1	12	3	22	6	87	3162	137111
3 PG Co	18332	10256	73090	1567	1357	3636	134	230	68	2953	4967	4330	53	1283	253	39	4	35	10	4	1	2	3183	125787
4 Arlingtn	7714	1333	1692	15574	3209	11272	546	619	19	74	177	97	0	12	3	0	8	62	10	14	4	5	665	43109
5 Alxndria	2959	524	1313	3208	2848	5677	144	411	4	37	110	174	3	24	8	3	9	57	15	5	1	3	369	17906
6 Fairfax	11142	3934	3722	11653	5483	107732	11134	11336	164	218	364	381	8	52	18	11	144	835	173	648	61	64	3391	172668
7 Loudoun	547	559	126	538	153	9417	38307	1104	617	27	13	5	35	3	0	0	3	16	3	526	399	302	1061	53761
8 PrWillam	594	172	243	398	323	10537	1156	44959	20	6	18	30	4	3	2	18	297	2376	468	1512	30	11	1430	64607
9 Fredrick	73	2134	74	22	6	162	627	15	13611	1121	70	0	1221	2	0	0	0	1	0	7	54	454	4768	24422
10 Howard	598	2174	3170	67	39	213	26	14	1011	9244	2870	17	242	15	1	0	0	2	0	0	1	12	10707	30423
11 AnnArndl	1356	1397	5203	159	115	337	15	19	55	3329	28664	238	48	634	34	3	0	2	1	0	0	3	16556	58168
12 Charles	858	89	4230	113	184	376	6	29	0	25	236	12940	0	495	1026	170	2	9	12	0	0	1	575	21376
13 Carroll	25	463	60	3	1	16	27	2	1240	314	73	1	8255	0	0	0	0	0	0	0	2	27	8439	18948
14 Calvert	172	48	1251	16	23	51	0	5	0	13	649	503	0	7284	1358	6	1	0	1	0	0	0	342	11723
15 St Marys	40	2	279	5	11	17	0	2	0	1	36	997	0	1348	6343	14	2	2	5	0	0	0	399	9503
16 King Geo	10	0	43	1	2	7	0	23	0	0	3	176	0	7	15	496	184	321	189	8	0	0	875	2360
17 Frdckbrg	11	3	5	7	7	99	3	321	0	0	1	3	0	0	1	207	568	1200	1887	71	0	0	1577	5971
18 Stafford	62	13	28	39	38	645	15	2672	1	1	2	8	0	0	0	353	1252	6045	2339	955	0	0	1916	16384
19 Spotsylv	15	3	8	9	10	158	2	485	0	0	1	9	0	0	2	163	1406	2179	2451	118	1	0	4702	11722
20 Fauquier	23	16	6	17	9	641	505	1555	10	0	0	1	1	0	0	7	71	978	123	2688	60	14	2107	8832
21 Clarke	1	13	1	3	0	58	408	35	52	2	0	0	2	0	0	0	1	1	0	81	196	366	609	1829
22 Jeffrson	6	94	4	2	2	59	320	9	467	18	1	0	25	0	0	0	0	0	0	21	374	1948	1889	5239
23 External	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2508	2508
Total	201588	133225	124028	41322	16820	165621	54519	64586	19578	20253	41007	20788	10387	11355	9095	1499	3965	14195	7706	6711	1190	3301	73786	1046525

Note: External trips are shown in P/A format. Productions defined at internal zones, attractions defined at external stations.

Date: 12/27/2005
Time: 12:45

MWCOG Commercial Trip Model
Delta Trips

Destination District

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Total
	1 DC	86656	-2256	-967	-4852	-2916	-4752	85	-318	-83	-536	-1320	-13	-14	-67	-3	-2	-7	-35	-9	-7	0	0	-2076	66508
	2 Mont Co	-2001	35589	374	-1437	-532	-6179	-346	-257	-1355	-1913	-726	-21	-270	-3	0	0	-2	-16	-1	-30	-5	-44	-2054	18771
	3 PG Co	-1729	-1	37773	-1325	-1197	-2622	-33	-207	-2	-1093	-3569	2137	-37	400	104	-1	-2	-8	-1	-5	0	-2	-1561	27019
	4 Arlingtn	-3718	-1505	-1415	9649	351	2101	286	114	-28	-88	-206	-76	-2	-14	-3	0	0	0	-1	-3	1	0	-438	5005
O	5 Alxndria	-2517	-528	-1148	290	-352	-1936	41	-189	-10	-43	-112	-107	-1	-8	-5	0	-5	-23	-1	0	0	0	-288	-6942
r	6 Fairfax	-3985	-6007	-2676	2367	-2022	12371	1753	-1109	-151	-153	-277	-245	-16	-23	-6	-4	-28	-73	-23	-214	-4	-3	-1394	-1922
i	7 Loudoun	47	-246	-27	256	46	43	27537	-47	-97	-4	-5	-2	-2	0	0	0	-2	-1	0	274	70	-50	156	27946
g	8 PrWillam	-305	-246	-211	-162	-312	-1935	-40	24028	-8	-8	-14	-25	-1	-1	0	1	-52	222	-15	225	13	0	-395	20759
i	9 Fredrick	-82	-1399	-42	-31	-11	-147	-86	-5	3554	535	-61	0	57	0	0	0	0	-1	0	1	-15	-136	1757	3888
n	10 Howard	-617	-1922	-1015	-84	-46	-176	-10	-9	438	1218	-2253	-5	-599	-3	0	0	-1	0	0	-1	-1	-3	1059	-4030
	11 AnnArndl	-1273	-879	-3380	-194	-107	-280	-15	-17	-75	-1787	3027	40	-176	51	11	0	-2	-1	0	-1	0	-3	-1863	-6924
D	12 Charles	56	-11	1949	-69	-105	-232	0	-25	0	-1	16	5454	0	65	253	-155	-3	-7	0	0	0	0	-52	7133
i	13 Carroll	-18	-320	-74	-8	0	-21	-4	0	43	-518	-147	0	2267	0	0	0	0	0	0	0	-2	-2	4210	5406
s	14 Calvert	-19	-1	512	-10	-16	-33	0	0	0	-2	21	49	0	3440	4	-10	-1	0	0	0	0	0	27	3961
t	15 St Marys	2	0	108	0	-3	-8	0	0	0	0	7	115	0	-69	-1964	-106	-3	-4	0	0	0	0	-96	-2021
r	16 King Geo	0	0	13	0	0	-2	0	0	0	0	0	-151	0	-7	-98	-153	104	191	106	4	0	0	334	341
i	17 Frdckbrg	-5	-3	-5	-3	-7	-63	-2	-56	0	0	0	-3	0	0	-3	130	0	-450	644	5	0	0	240	419
c	18 Stafford	-32	-15	-26	-17	-42	-263	-2	529	0	-1	0	-8	-2	0	-3	238	-377	1291	417	657	0	0	202	2546
t	19 Spotsylv	-4	-4	-3	-2	-6	-44	-1	13	-1	0	0	-1	0	0	0	81	125	293	109	34	0	0	935	1524
	20 Fauquier	-3	-18	-4	-6	-3	-220	242	208	0	0	0	0	0	0	0	3	9	686	36	1089	23	1	798	2841
	21 Clarke	0	-2	0	0	0	4	97	12	-13	-1	0	0	0	0	0	0	0	0	0	42	0	-19	112	232
	22 Jeffrson	0	-37	-1	-1	0	1	-70	0	-125	-3	-3	0	-1	0	0	0	0	0	0	2	-7	0	378	133
	23 External	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-111	-111
	Total	70453	20189	29735	4361	-7280	-4393	29432	22665	2087	-4398	-5622	7138	1203	3761	-1713	22	-247	2064	1261	2072	73	-261	-120	172482

Note: External trips are shown in P/A format. Productions defined at internal zones, attractions defined at external stations.

Date: 12/27/2005
Time: 12:45

MWCOG Commercial Trip Model
Delta Trip Ratio

Destination District

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Total
	1 DC	2.34	.83	.95	.57	.46	.69	1.17	.61	.43	.53	.50	1.05	.60	.82	.62	1.14	1.33	.62	.52	.79	.00	.33	.55	1.45
	2 Mont Co	.85	1.44	1.03	.48	.50	.40	.61	.42	.61	.54	.65	.83	.59	1.13	2.50	.00	.25	.41	.33	.67	.33	.70	.62	1.10
	3 PG Co	.92	.98	2.01	.50	.53	.58	.83	.55	.53	.70	.58	2.00	.39	1.88	1.71	1.50	.36	.74	.91	.22	.00	1.00	.68	1.26
	4 Arlingtn	.67	.47	.54	2.24	1.12	1.23	2.12	1.14	.38	.51	.46	.53	.00	.43	.60	.00	.57	1.22	1.67	.40	.00	5.00	.58	1.10
O	5 Alxndria	.54	.50	.53	1.11	.79	.75	1.37	.66	.17	.49	.49	.63	1.50	.75	.50	1.00	.82	.71	.75	.56	.00	.00	.56	.71
r	6 Fairfax	.73	.39	.58	1.27	.73	1.06	1.19	.90	.59	.56	.58	.59	.24	.66	.78	2.20	.89	.91	.86	.77	1.07	1.03	.72	.96
i	7 Loudoun	1.10	.65	.83	2.17	1.63	1.00	3.22	.96	.87	.68	.62	.71	1.06	3.00	.00	.00	3.00	.80	.75	2.07	1.22	.77	1.19	1.99
g	8 PrWillam	.63	.42	.52	.72	.51	.84	1.00	1.95	1.05	.35	.55	.50	1.33	.30	1.00	.75	.83	1.13	1.00	1.12	1.67	1.10	.78	1.40
i	9 Fredrick	.44	.60	.61	.42	.27	.53	.89	.65	.91	1.90	.51	.00	1.05	.00	.00	.00	.00	1.00	.00	1.00	.82	.77	1.59	.96
n	10 Howard	.49	.53	.76	.43	.48	.55	.63	.93	1.75	.88	.56	.74	.29	.75	1.00	.00	.00	1.00	.00	.00	.33	.71	1.11	.82
	11 AnnArndl	.51	.61	.61	.43	.51	.54	.63	.54	.40	.65	.86	1.20	.21	1.09	1.55	1.50	.00	.29	1.00	.00	.00	1.50	.90	.80
D	12 Charles	1.07	.78	1.87	.57	.63	.62	.67	.59	.00	.83	1.11	1.28	.00	1.14	1.31	.53	.33	.56	1.33	.00	.00	.00	.93	1.27
i	13 Carroll	.53	.59	.43	.43	.50	.44	.87	2.00	1.04	.37	.33	.50	.70	.00	.00	.00	.00	.00	.00	.00	.00	.96	2.00	.98
s	14 Calvert	.91	.98	1.70	.48	.61	.60	.00	.71	.00	.65	1.04	1.10	.00	1.26	1.00	.40	1.00	.00	.00	.00	.00	.00	1.13	1.21
t	15 St Marys	1.03	.40	1.64	.50	.79	.61	.00	1.00	.00	1.00	1.29	1.14	.00	.94	.58	.11	.33	.50	5.00	.00	.00	.00	.84	.67
r	16 King Geo	1.11	.00	1.48	1.00	.67	.64	.00	1.00	.00	.00	1.00	.54	.00	.41	.13	.31	2.24	2.55	2.30	2.00	.00	.00	1.62	.80
i	17 Frdckbrg	.61	.60	.50	.64	.50	.61	1.00	.85	.00	.00	1.00	.50	.00	.00	.50	2.80	.34	.73	1.52	1.04	.00	.00	1.18	.90
c	18 Stafford	.60	.42	.52	.67	.48	.71	.94	1.25	.00	.50	.50	.67	.00	.00	.00	3.10	.76	.84	1.22	3.19	.00	.00	1.12	1.00
t	19 Spotsylv	.65	.50	.67	.64	.56	.79	.40	1.04	.00	.00	.00	1.50	.00	.00	1.00	2.04	1.10	1.15	.55	1.44	.00	.00	1.25	.95
	20 Fauquier	.70	.47	.50	.71	.69	.74	2.01	1.16	1.67	.00	.00	.50	.00	.00	.00	1.75	1.09	3.38	1.41	.81	1.58	.93	1.61	1.15
	21 Clarke	.33	.81	.00	3.00	.00	1.12	1.31	1.59	.79	.67	.00	.00	.67	.00	.00	.00	.00	.00	.00	1.93	.25	.95	1.23	.84
	22 Jeffrson	1.50	.70	1.33	.40	.00	1.09	.82	.69	.79	.90	.33	.00	.89	.00	.00	.00	.00	.00	.00	1.62	.96	.65	1.25	.85
	23 External	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.96	.96
	Total	1.50	1.12	1.30	1.08	.68	.94	2.09	1.46	.87	.74	.75	1.29	.69	1.22	.68	.62	.75	.97	.90	1.05	.70	.72	1.00	1.12

Note: External trips are shown in P/A format. Productions defined at internal zones, attractions defined at external stations.

Table 3-9
Trip Length Frequency Distributions – Model 2

```
FREQUENCY (Iteration=1) Revised COM I/I Trips vs. Off-Pk Highway Time BASEMW=9 VALUEMW=11
RANGE=0,90,3

       MW[9]         Obs         Total    Pct   äPct
----------------------------------------------------
           0       1,641        19,952   1.93    1.9 |====
           3       6,514        46,164   4.47    6.4 |========
           6      22,184        75,675   7.33   13.7 |==============
           9      44,811       104,699  10.15   23.8 |===================
          12      72,888       133,857  12.97   36.8 |========================
          15     106,709       150,222  14.56   51.4 |===========================
          18     140,687       127,043  12.31   63.7 |=======================
          21     164,803        90,482   8.77   72.5 |================
          24     177,221        63,749   6.18   78.6 |===========
          27     185,544        49,992   4.85   83.5 |=========
          30     191,362        37,495   3.63   87.1 |=======
          33     195,801        30,091   2.92   90.0 |=====
          36     200,035        23,873   2.31   92.3 |====
          39     197,961        19,097   1.85   94.2 |===
          42     190,782        14,822   1.44   95.6 |===
          45     185,973        11,956   1.16   96.8 |==
          48     177,499         9,407   0.91   97.7 |==
          51     168,525         6,989   0.68   98.4 |=
          54     155,164         4,771   0.46   98.8 |=
          57     143,071         3,307   0.32   99.2 |=
          60     134,925         2,386   0.23   99.4 |
          63     123,455         1,695   0.16   99.6 |
          66     111,932         1,159   0.11   99.7 |
          69     100,595           802   0.08   99.7 |
          72      90,831           645   0.06   99.8 |
          75      80,852           456   0.04   99.9 |
          78      71,841           299   0.03   99.9 |
          81      63,321           229   0.02   99.9 |
          84      53,917           157   0.02   99.9 |
          87      45,069           114   0.01   99.9 |
          90+    196,361           237   0.02  100.0 |
----------------------------------------------------
                    sum      1,031,821
                    mean         20.04
                    @J=I        59,120
```

FREQUENCY (Iteration=1) Revised COM EXT Trips vs. Off-Pk Highway Time BASEMW=9 VALUEMW=12
RANGE=0,90,3

MW[9]	Obs	Total	Pct	äPct	
3	11	3,086	4.18	4.1	|=========
6	50	8,900	12.06	16.2	|===========================
9	62	5,814	7.88	24.1	|==================
12	92	7,304	9.90	34.0	|======================
15	122	6,303	8.54	42.5	|===================
18	185	4,293	5.82	48.3	|=============
21	274	4,216	5.71	54.0	|=============
24	381	3,207	4.35	58.4	|==========
27	582	3,235	4.38	62.8	|==========
30	779	2,826	3.83	66.6	|=========
33	1,077	1,988	2.69	69.3	|======
36	1,363	2,121	2.87	72.2	|======
39	1,540	1,868	2.53	74.7	|======
42	1,814	1,495	2.03	76.7	|=====
45	1,958	1,934	2.62	79.3	|======
48	2,092	2,144	2.91	82.2	|=======
51	2,282	1,484	2.01	84.3	|=====
54	2,375	1,553	2.10	86.4	|=====
57	2,535	1,565	2.12	88.5	|=====
60	2,469	1,088	1.47	90.0	|===
63	2,536	970	1.31	91.3	|===
66	2,734	756	1.02	92.3	|==
69	2,847	708	0.96	93.2	|==
72	3,015	654	0.89	94.1	|==
75	3,399	584	0.79	94.9	|==
78	3,887	558	0.76	95.7	|==
81	4,304	433	0.59	96.3	|=
84	4,652	372	0.50	96.8	|=
87	4,438	325	0.44	97.2	|=
90+	32,120	2,022	2.74	100.0	|======
	sum	73,808			
	mean	29.77			
	@J=I	--			

Table 3-10
Link Estimated/Observed Crosstab – Model 2

CROSSTAB ROW=FTYPE COL=AREATP COMP=comvol/COMCNT

	1	2	3	4	5	6	7	17
1 - 1	0.98	1.00	1.01	1.03	1.02	1.01	1.19	1.02
2 - 2	1.04	1.06	1.03	0.94	0.98	1.00	1.02	1.02
3 - 3	0.84	1.09	1.13	0.92	0.99	0.98	0.95	1.02
4 - 4	1.02	0.82	0.79	0.64	0.60	1.14	0.96	0.91
5 - 5	0.00	1.04	0.93	0.86	1.01	1.04	1.40	0.98
6 - 6	0.67	0.00	0.00	0.00	0.00	0.00	0.00	0.67
0 - 6	1.01	1.03	1.01	0.94	0.99	1.02	1.05	1.01

Table 3-11
Percent RMSE Crosstab – Model 2

CROSSTAB ROW=FTYPE COL=AREATP COMP=sqrt(_sqerr/_links)/(COMCNT/_links)

	1	2	3	4	5	6	7	17
1 - 1	0.27	0.16	0.10	0.12	0.13	0.17	0.31	0.16
2 - 2	0.30	0.26	0.23	0.19	0.23	0.15	0.24	0.25
3 - 3	0.54	0.41	0.78	0.25	0.27	0.31	0.35	0.51
4 - 4	0.81	0.65	0.52	0.89	0.83	0.80	0.60	0.91
5 - 5	0.00	0.20	0.12	0.24	0.14	0.26	0.43	0.19
6 - 6	0.36	0.00	0.00	0.00	0.00	0.00	0.00	0.36
0 - 6	0.40	0.26	0.24	0.23	0.22	0.26	0.38	0.30

Note: values are %RMSE as a fraction of 1.0, e.g., 0.73 = 73% RMSE

3.4 Model 3

MWCOG staff reviewed Model 2 in December 2005 and suggested that Other Employment be included in the trip end equation. The consultant examined the Model 2 trip end model with respect to the correlation between the trip end delta and Other Employment. As noted above, if this correlation were much different from zero, this would indicate some bias in the model that could (should) be corrected by adding a coefficient on Other Employment. Unfortunately, this value (from the best Model 2 run) was 0.002, suggesting that no such bias existed.

The consultant then examined the correlations between the delta trip ends and the other variables. The correlations of the delta trip ends with HHs and Industrial Employment were negative, which suggests that the delta adjustment matrix "wants" those coefficients to be a little lower (i.e., where the delta adjustment was high, the HHs and Industrial Employment were low). Thus the values of those coefficients were reduced and a new coefficient on Other Employment was added. The value of the Other Employment coefficient was set such that the original Model 2 total of 859K I/I trips was maintained. This produces the model shown below:

COM productions = (0.205 * indemp + 0.154 * offemp + 0.452 * retemp + 0.075 * othemp + 0.119 * HH) * ATFAC (1)

(attractions = productions, by zone)

Where:
indemp = industrial employment
offemp = office employment
retemp = retail employment
othemp = other employment
HH = households
ATFAC = area type adjustment factor:

Area type	Factor
1 (CBD)	0.95
2	0.90
6	1.20
7 (rural)	1.15

Note: no factor is applied to area types 3-5.

This model produces 858,831 I/I trips, 71,101 external trips, and 2,620 X/X trips. This totals 932,552 and is 5.0% of the 18.6 million daily vehicle trips the MWCOG model produced in 2000.

No other aspect of Model 2 was changed, except that a new delta adjustment matrix was created.

The new correlations of the delta trip ends with the socioeconomic data are shown in Table 3-12.

Table 3-12
Final Trip End Correlations – Model 3

Zonal Variable	Correlation with Trip End Difference
hh	-0.025
hhpop	-0.017
gqpop	0.031
totpop	-0.015
totemp	0.012
indemp	-0.070
retemp	0.033
offemp	0.033
othemp	-0.003

Table 3-13 shows the "before", "after", and delta tables, and the delta ratio, compressed to counties. As Table 3-13 shows, the delta table adds 12% more trips to the "before" trip table. The resulting trip total, 1,046,413, is 5.6% of the 18.6 million daily vehicle trip total, which is actually closer to the expected value.

The new trip length frequency diagrams are shown in Table 3-14 and do not indicate much change from Model 2. Tables 3-15 and 3-16 show the assignment validation results for Model 3. These results are essentially the same as for Model 2.

Table 3-13
Delta Table – Model 3

Date: 1/ 8/2006
Time: 14:11

MWCOG Commercial Trip Model
Starting Model Trips

Destination District

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Total
	1 DC	66032	14428	20934	11916	5469	15164	533	911	175	1230	2729	769	41	178	34	14	13	100	18	38	2	5	4951	145684
	2 Mont Co	14332	69125	10536	2922	1049	10297	916	449	3612	4086	2174	114	776	35	4	3	7	30	8	31	14	124	5235	125879
	3 PG Co	20788	10786	38327	3222	2565	6197	150	451	142	4293	8750	2187	128	684	144	37	7	54	10	9	2	5	4943	103881
	4 Arlingtn	11959	2932	3205	7104	2823	8952	262	546	49	148	383	172	12	35	7	3	9	50	12	23	1	5	1162	39854
O	5 Alxndria	5550	1053	2468	2858	3503	7149	108	596	18	76	215	268	2	33	11	3	15	76	16	10	1	0	646	24675
r	6 Fairfax	15273	9997	6296	8957	7123	95692	9174	11868	309	367	590	619	36	73	26	9	150	861	183	814	48	53	4561	173079
i	7 Loudoun	521	883	159	246	97	9220	12085	1140	726	34	24	8	35	1	0	1	1	18	7	256	306	386	900	27054
g	8 PrWillam	947	433	455	556	616	11822	1143	22172	23	16	37	52	2	5	2	22	354	2030	440	1282	18	11	1770	44208
i	9 Fredrick	173	3598	131	53	20	308	718	25	15914	589	140	2	1178	0	0	0	1	0	0	4	65	599	3179	26697
n	10 Howard	1241	4028	4277	152	82	372	43	15	580	10351	5084	23	813	19	2	1	0	2	1	1	2	19	9603	36711
	11 AnnArndl	2685	2273	8708	379	215	594	21	40	139	5067	32436	186	224	548	24	0	0	7	0	0	2	4	18456	72008
D	12 Charles	804	112	2252	187	282	575	6	49	3	26	204	9658	0	418	754	306	7	11	6	2	0	0	598	16260
i	13 Carroll	45	764	140	8	4	33	28	3	1197	810	217	0	11497	1	0	0	0	0	0	1	3	28	4169	18948
s	14 Calvert	183	49	724	31	37	77	1	4	0	19	581	436	1	5483	1320	22	0	2	0	0	0	0	290	9260
t	15 St Marys	40	4	165	5	16	24	1	1	0	1	31	824	0	1377	11030	125	4	3	2	0	0	0	475	14128
r	16 King Geo	10	1	28	1	3	11	0	23	0	0	4	308	0	16	111	1530	76	116	76	4	0	0	511	2829
i	17 Frdckbrg	19	6	9	11	14	155	2	371	0	0	2	6	0	0	2	72	1640	1599	1189	65	0	0	1307	6469
c	18 Stafford	104	29	54	57	76	843	17	2042	1	1	6	12	0	0	5	107	1586	6815	1793	283	0	0	1631	15462
t	19 Spotsylv	22	7	11	11	18	185	4	445	0	1	1	8	0	1	1	73	1224	1771	4149	77	1	0	3534	11544
	20 Fauquier	34	33	13	24	12	818	248	1271	5	1	2	1	0	0	1	4	63	276	80	3179	33	14	1264	7376
	21 Clarke	2	15	1	1	1	48	302	20	65	2	1	0	3	0	0	0	0	0	0	38	724	362	471	2056
	22 Jeffrson	4	132	3	2	2	51	380	11	590	18	4	0	26	0	0	0	0	0	0	13	366	2814	1455	5871
	23 External	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2619	2619
	Total	140768	120688	98896	38703	24027	168587	26142	42453	23548	27136	53615	15653	14774	8907	13478	2332	5157	13821	7990	6130	1588	4429	73730	932552

Note: External trips are shown in P/A format. Productions defined at internal zones, attractions defined at external stations.

Date: 1/ 8/2006
Time: 14:11

MWCOG Commercial Trip Model
Adaptable Assignment Revised Trips

Destination District

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Total
	1 DC	146535	11319	19187	6883	2514	10444	632	573	75	633	1348	787	22	137	35	10	8	77	15	24	3	5	2697	203963
	2 Mont Co	11551	99159	10423	1324	518	4114	561	178	2179	2212	1398	80	452	38	8	0	2	11	6	20	13	95	3197	137539
	3 PG Co	18517	10265	73008	1564	1381	3570	131	236	74	2972	5045	4356	52	1297	265	41	4	43	4	6	0	3	3328	126162
	4 Arlingtn	7849	1299	1714	15479	3283	11264	568	644	20	75	169	106	4	6	7	3	10	61	11	16	5	2	706	43301
O	5 Alxndria	2959	508	1316	3227	2766	5733	149	417	8	45	102	168	0	24	10	1	8	60	15	7	0	0	379	17902
r	6 Fairfax	10983	3931	3672	11422	5431	106354	11108	11236	164	201	341	405	11	41	18	6	126	793	186	609	61	71	3362	170532
i	7 Loudoun	570	566	128	546	154	9425	38724	1121	626	34	16	5	26	0	1	0	1	20	3	511	386	295	1088	54246
g	8 PrWillam	599	179	246	408	325	10409	1173	44908	22	7	17	30	0	3	1	15	301	2315	449	1495	30	7	1428	64367
i	9 Fredrick	77	2151	74	24	7	157	638	18	13886	1107	68	0	1228	2	0	0	0	1	0	11	47	432	4886	24814
n	10 Howard	598	2152	3191	61	39	204	26	8	998	9190	2876	20	241	17	1	0	2	2	0	0	0	15	10744	30385
	11 AnnArndl	1351	1360	5291	158	109	319	15	15	55	3338	28611	230	48	635	36	4	1	2	1	1	0	1	16487	58068
D	12 Charles	848	84	4276	112	181	369	5	28	0	19	233	12794	1	488	1021	163	3	8	13	0	0	0	564	21210
i	13 Carroll	25	463	60	4	0	12	28	0	1244	310	72	1	8192	0	0	0	0	0	0	0	3	25	8460	18899
s	14 Calvert	165	42	1271	13	23	47	1	5	1	14	658	496	0	7267	1357	5	0	3	1	0	0	0	334	11703
t	15 St Marys	34	4	284	4	10	20	0	2	0	0	38	998	0	1345	6356	9	0	3	3	0	0	0	397	9507
r	16 King Geo	10	1	43	1	2	7	0	24	0	0	4	166	0	6	14	477	177	313	186	8	0	0	863	2302
i	17 Frdckbrg	11	3	4	7	7	96	2	320	0	1	0	3	0	0	1	195	554	1201	1895	75	0	0	1557	5932
c	18 Stafford	60	15	26	42	35	611	13	2622	0	1	1	9	0	0	2	346	1257	6048	2274	991	3	0	1870	16226
t	19 Spotsylv	17	1	8	10	10	148	3	467	0	0	0	6	0	0	5	159	1405	2122	2344	118	0	0	4513	11336
	20 Fauquier	24	16	8	17	10	621	501	1531	7	1	0	1	0	0	0	8	78	1007	123	2691	64	13	2010	8731
	21 Clarke	3	11	1	3	0	54	387	35	49	1	0	0	3	0	0	0	0	0	0	81	180	342	575	1725
	22 Jeffrson	7	92	5	4	0	57	324	13	442	17	2	0	22	0	0	0	0	1	0	17	353	1840	1849	5045
	23 External	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2518	2518
	Total	202793	133621	124236	41313	16805	164035	54989	64401	19850	20178	40999	20661	10302	11306	9138	1442	3937	14091	7529	6681	1148	3146	73812	1046413

Note: External trips are shown in P/A format. Productions defined at internal zones, attractions defined at external stations.

Date: 1/ 8/2006
Time: 14:11

MWCOG Commercial Trip Model
Delta Trips

Destination District

Origin District	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Total
1 DC	83982	-3054	-1750	-5035	-2962	-4733	90	-330	-87	-558	-1352	-32	-24	-65	-8	-2	-6	-20	-13	-5	0	-1	-2179	61856
2 Mont Co	-2738	35573	-29	-1580	-541	-6171	-358	-259	-1424	-1889	-746	-31	-264	-1	-1	0	-4	-18	-2	-27	-5	-36	-2121	17328
3 PG Co	-2459	-364	35773	-1420	-1190	-2588	-38	-198	-6	-1159	-3628	2138	-42	422	109	-2	-6	-14	-1	-10	0	-4	-1646	23667
4 Arlingtn	-4113	-1631	-1489	9470	463	2301	291	152	-37	-71	-208	-86	-7	-18	-4	0	0	3	0	-1	1	2	-421	4597
5 Alxndria	-2583	-548	-1147	335	-305	-1455	35	-152	-11	-38	-109	-96	-2	-8	-5	-3	-5	-14	-2	0	0	0	-267	-6380
6 Fairfax	-4159	-6057	-2618	2355	-1676	16346	1884	-551	-142	-149	-267	-225	-22	-20	-4	-2	-13	-50	-17	-191	-8	3	-1277	3140
7 Loudoun	43	-260	-27	257	46	232	27814	-19	-105	-8	-3	0	-3	0	0	0	0	0	0	274	67	-43	162	28427
8 PrWillam	-305	-240	-210	-152	-285	-1409	-4	24801	-6	-9	-19	-22	-1	-2	-1	0	-43	258	-11	260	13	4	-334	22283
9 Fredrick	-87	-1461	-44	-32	-15	-143	-94	-8	3316	518	-63	0	55	0	0	0	0	0	0	1	-16	-159	1703	3471
10 Howard	-645	-1878	-1083	-90	-39	-175	-9	-10	417	1332	-2201	-5	-572	-5	0	0	0	-1	0	-1	-1	-5	1143	-3828
11 AnnArndl	-1318	-908	-3427	-198	-105	-278	-9	-16	-73	-1736	3609	42	-176	83	11	0	0	0	-1	-1	0	-5	-1989	-6495
12 Charles	42	-13	2011	-64	-94	-201	-3	-20	0	-1	23	5661	0	75	270	-152	-3	-5	1	0	0	0	-48	7479
13 Carroll	-21	-305	-79	-5	-1	-23	-4	0	46	-494	-143	-1	2361	0	0	0	0	0	0	0	0	-3	4285	5613
14 Calvert	-22	-2	548	-11	-13	-28	0	-2	0	-1	66	61	0	3619	36	-10	0	0	-1	0	0	0	36	4276
15 St Marys	0	0	117	0	-3	-5	0	-1	0	0	8	164	0	-21	-1961	-99	-4	-3	0	0	0	0	-102	-1910
16 King Geo	0	0	14	0	0	-1	0	0	0	0	0	-148	0	-6	-96	-127	101	193	109	3	0	0	351	393
17 Frdckbrg	-6	-2	-5	-3	-7	-59	-1	-53	0	0	-1	-3	0	0	-1	123	0	-396	704	10	0	0	249	549
18 Stafford	-33	-15	-24	-18	-38	-231	-2	571	-1	0	-2	-6	0	0	-3	240	-316	1588	471	710	0	0	237	3128
19 Spotsylv	-4	-2	-6	-1	-5	-36	-1	19	0	0	0	-1	0	0	0	83	181	350	173	40	0	0	981	1771
20 Fauquier	-5	-15	-6	-5	-5	-196	244	259	0	0	0	0	0	0	0	3	16	732	41	1175	27	2	747	3014
21 Clarke	0	-2	0	0	0	5	85	13	-15	-1	0	0	0	0	0	0	0	1	0	44	0	-19	103	214
22 Jeffrson	-1	-31	-3	0	0	2	-53	0	-147	-2	-4	0	-2	0	0	0	0	0	0	2	-6	0	391	146
23 External	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-103	-103
Total	65568	18785	26516	3803	-6775	1154	29867	24196	1725	-4266	-5040	7410	1301	4053	-1658	52	-102	2604	1451	2283	72	-264	-99	172636

Note: External trips are shown in P/A format. Productions defined at internal zones, attractions defined at external stations.

Date: 1/ 8/2006
Time: 14:11

MWCOG Commercial Trip Model
Delta Trip Ratio

Destination District

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Total
	1 DC	2.22	.78	.92	.58	.46	.69	1.19	.63	.43	.51	.49	1.02	.54	.77	1.03	.71	.62	.77	.83	.63	1.50	1.00	.54	1.40
	2 Mont Co	.81	1.43	.99	.45	.49	.40	.61	.40	.60	.54	.64	.70	.58	1.09	2.00	.00	.29	.37	.75	.65	.93	.77	.61	1.09
	3 PG Co	.89	.95	1.90	.49	.54	.58	.87	.52	.52	.69	.58	1.99	.41	1.90	1.84	1.11	.57	.80	.40	.67	.00	.60	.67	1.21
	4 Arlingtn	.66	.44	.53	2.18	1.16	1.26	2.17	1.18	.41	.51	.44	.62	.33	.17	1.00	1.00	1.11	1.22	.92	.70	5.00	.40	.61	1.09
O	5 Alxndria	.53	.48	.53	1.13	.79	.80	1.38	.70	.44	.59	.47	.63	.00	.73	.91	.33	.53	.79	.94	.70	.00	.00	.59	.73
r	6 Fairfax	.72	.39	.58	1.28	.76	1.11	1.21	.95	.53	.55	.58	.65	.31	.56	.69	.67	.84	.92	1.02	.75	1.27	1.34	.74	.99
i	7 Loudoun	1.09	.64	.81	2.22	1.59	1.02	3.20	.98	.86	1.00	.67	.63	.74	.00	.00	.00	1.00	1.11	.43	2.00	1.26	.76	1.21	2.01
g	8 PrWillam	.63	.41	.54	.73	.53	.88	1.03	2.03	.96	.44	.46	.58	.00	.60	.50	.68	.85	1.14	1.02	1.17	1.67	.64	.81	1.46
i	9 Fredrick	.45	.60	.56	.45	.35	.51	.89	.72	.87	1.88	.49	.00	1.04	.00	.00	.00	.00	.00	.00	2.75	.72	.72	1.54	.93
n	10 Howard	.48	.53	.75	.40	.48	.55	.60	.53	1.72	.89	.57	.87	.30	.89	.50	.00	.00	1.00	.00	.00	.00	.79	1.12	.83
	11 AnnArndl	.50	.60	.61	.42	.51	.54	.71	.38	.40	.66	.88	1.24	.21	1.16	1.50	.00	.00	.29	.00	.00	.00	.25	.89	.81
D	12 Charles	1.05	.75	1.90	.60	.64	.64	.83	.57	.00	.73	1.14	1.32	.00	1.17	1.35	.53	.43	.73	2.17	.00	.00	.00	.94	1.30
i	13 Carroll	.56	.61	.43	.50	.00	.36	1.00	.00	1.04	.38	.33	.00	.71	.00	.00	.00	.00	.00	.00	.00	1.00	.89	2.03	1.00
s	14 Calvert	.90	.86	1.76	.42	.62	.61	1.00	1.25	.00	.74	1.13	1.14	.00	1.33	1.03	.23	.00	1.50	.00	.00	.00	.00	1.15	1.26
t	15 St Marys	.85	1.00	1.72	.80	.63	.83	.00	2.00	.00	.00	1.23	1.21	.00	.98	.58	.07	.00	1.00	1.50	.00	.00	.00	.84	.67
r	16 King Geo	1.00	1.00	1.54	1.00	.67	.64	.00	1.04	.00	.00	1.00	.54	.00	.38	.13	.31	2.33	2.70	2.45	2.00	.00	.00	1.69	.81
i	17 Frdckbrg	.58	.50	.44	.64	.50	.62	1.00	.86	.00	.00	.00	.50	.00	.00	.50	2.71	.34	.75	1.59	1.15	.00	.00	1.19	.92
c	18 Stafford	.58	.52	.48	.74	.46	.72	.76	1.28	.00	1.00	.17	.75	.00	.00	.40	3.23	.79	.89	1.27	3.50	.00	.00	1.15	1.05
t	19 Spotsylv	.77	.14	.73	.91	.56	.80	.75	1.05	.00	.00	.00	.75	.00	.00	5.00	2.18	1.15	1.20	.56	1.53	.00	.00	1.28	.98
	20 Fauquier	.71	.48	.62	.71	.83	.76	2.02	1.20	1.40	1.00	.00	1.00	.00	.00	.00	2.00	1.24	3.65	1.54	.85	1.94	.93	1.59	1.18
	21 Clarke	1.50	.73	1.00	3.00	.00	1.13	1.28	1.75	.75	.50	.00	.00	1.00	.00	.00	.00	.00	.00	.00	2.13	.25	.94	1.22	.84
	22 Jeffrson	1.75	.70	1.67	2.00	.00	1.12	.85	1.18	.75	.94	.50	.00	.85	.00	.00	.00	.00	.00	.00	1.31	.96	.65	1.27	.86
	23 External	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.96	.96
	Total	1.44	1.11	1.26	1.07	.70	.97	2.10	1.52	.84	.74	.76	1.32	.70	1.27	.68	.62	.76	1.02	.94	1.09	.72	.71	1.00	1.12

Note: External trips are shown in P/A format. Productions defined at internal zones, attractions defined at external stations.

Table 3-14
Trip Length Frequency Distributions – Model 3

```
FREQUENCY (Iteration=1) Revised COM I/I Trips vs. Off-Pk Highway Time BASEMW=9
VALUEMW=11 RANGE=0,90,3

       MW[9]         Obs         Total    Pct   äPct
----------------------------------------------------
           0       1,641        19,986   1.94    1.9 |====
           3       6,514        45,197   4.38    6.3 |========
           6      22,184        74,963   7.27   13.5 |=============
           9      44,811       103,852  10.07   23.6 |===================
          12      72,888       133,320  12.93   36.5 |========================
          15     106,709       150,127  14.56   51.1 |===========================
          18     140,687       127,442  12.36   63.5 |=======================
          21     164,803        91,097   8.83   72.3 |================
          24     177,221        64,568   6.26   78.5 |============
          27     185,544        50,367   4.88   83.4 |=========
          30     191,362        37,774   3.66   87.1 |=======
          33     195,801        30,319   2.94   90.0 |=====
          36     200,035        23,980   2.33   92.4 |====
          39     197,961        19,093   1.85   94.2 |===
          42     190,782        14,812   1.44   95.6 |===
          45     185,973        11,944   1.16   96.8 |==
          48     177,499         9,408   0.91   97.7 |==
          51     168,525         6,965   0.68   98.4 |=
          54     155,164         4,754   0.46   98.8 |=
          57     143,071         3,293   0.32   99.2 |=
          60     134,925         2,368   0.23   99.4 |
          63     123,455         1,679   0.16   99.6 |
          66     111,932         1,149   0.11   99.7 |
          69     100,595           795   0.08   99.7 |
          72      90,831           639   0.06   99.8 |
          75      80,852           453   0.04   99.9 |
          78      71,841           297   0.03   99.9 |
          81      63,321           226   0.02   99.9 |
          84      53,917           154   0.01   99.9 |
          87      45,069           113   0.01   99.9 |
          90+    196,361           233   0.02  100.0 |
----------------------------------------------------
                    sum      1,031,367
                    mean         20.08
                    @J=I        58,768
```

```
FREQUENCY (Iteration=1) Revised COM EXT Trips vs. Off-Pk Highway Time BASEMW=9
VALUEMW=12 RANGE=0,90,3

      MW[9]         Obs         Total    Pct   äPct
----------------------------------------------------
          3          11         3,059   4.14   4.1 |=========
          6          50         8,859  12.00  16.1 |===========================
          9          62         5,773   7.82  23.9 |==================
         12          92         7,240   9.81  33.7 |======================
         15         122         6,276   8.50  42.2 |===================
         18         185         4,277   5.79  48.0 |=============
         21         274         4,222   5.72  53.7 |=============
         24         381         3,221   4.36  58.1 |==========
         27         582         3,231   4.38  62.5 |==========
         30         780         2,890   3.92  66.4 |=========
         33       1,078         1,988   2.69  69.1 |======
         36       1,368         2,146   2.91  72.0 |=======
         39       1,551         1,899   2.57  74.6 |======
         42       1,829         1,529   2.07  76.6 |=====
         45       1,974         1,953   2.65  79.3 |======
         48       2,107         2,173   2.94  82.2 |=======
         51       2,293         1,506   2.04  84.3 |=====
         54       2,386         1,567   2.12  86.4 |=====
         57       2,542         1,562   2.12  88.5 |=====
         60       2,481         1,088   1.47  90.0 |===
         63       2,548           952   1.29  91.3 |===
         66       2,746           754   1.02  92.3 |==
         69       2,865           694   0.94  93.2 |==
         72       3,027           650   0.88  94.1 |==
         75       3,408           586   0.79  94.9 |==
         78       3,907           563   0.76  95.7 |==
         81       4,319           446   0.60  96.3 |=
         84       4,671           368   0.50  96.8 |=
         87       4,464           324   0.44  97.2 |=
         90+     32,311         2,025   2.74 100.0 |======
----------------------------------------------------
                   sum         73,820
                   mean         29.85
```

Table 3-15
Link Estimated/Observed Crosstab – Model 3

CROSSTAB ROW=FTYPE COL=AREATP COMP=comvol/COMCNT

	1	2	3	4	5	6	7	1 7
1 - 1	1.00	1.00	1.00	1.03	1.02	1.00	1.17	1.02
2 - 2	1.03	1.07	1.03	0.93	0.98	0.99	1.01	1.02
3 - 3	0.84	1.10	1.13	0.92	0.98	0.98	0.94	1.02
4 - 4	1.02	0.80	0.79	0.64	0.60	1.14	0.95	0.90
5 - 5	0.00	1.07	0.93	0.85	1.01	1.03	1.32	0.98
6 - 6	0.69	0.00	0.00	0.00	0.00	0.00	0.00	0.69
0 - 6	1.01	1.03	1.01	0.94	0.99	1.01	1.04	1.01

Table 3-16
Percent RMSE Crosstab – Model 3

CROSSTAB ROW=FTYPE COL=AREATP COMP=sqrt(_sqerr/_links)/(COMCNT/_links)

	1	2	3	4	5	6	7	1 7
1 - 1	0.27	0.16	0.10	0.12	0.13	0.17	0.30	0.16
2 - 2	0.29	0.27	0.23	0.19	0.23	0.15	0.23	0.25
3 - 3	0.55	0.43	0.77	0.25	0.27	0.31	0.36	0.51
4 - 4	0.75	0.66	0.52	0.89	0.84	0.81	0.59	0.88
5 - 5	0.00	0.18	0.13	0.25	0.14	0.26	0.33	0.19
6 - 6	0.34	0.00	0.00	0.00	0.00	0.00	0.00	0.34
0 - 6	0.39	0.27	0.24	0.23	0.22	0.26	0.37	0.30

Note: values are %RMSE as a fraction of 1.0, e.g., 0.73 = 73% RMSE

3.5 Model 4

MWCOG staff performed testing and review of Model 3 throughout 2006 and identified further changes that were warranted.

This review disclosed that the initial COM analysis showed more trip ends at some external stations than NHB trip ends in the original MWCOG model. This was judged to be illogical and MWCOG staff and the consultant agreed to address that by setting the COM external trip ends to 40% of the NHB trip ends at those stations.

Another change made by MWCOG staff was that the NHB trips in the main model were reduced by 22%. This was done under the assumption that some of the NHB trips in the original main model were in fact COM trips and this change was needed in order to avoid double-counting such trips.

Also, upon further review of the F factor curves, it appeared that the I/I curve would actually be more suitable for both I/I and external trips, so this change was made.

The final change was that MWCOG staff modified the main model's highway assignment procedure and switched to version 4.1.0 of TP+. Since the development of the COM model is dependent on the assignment procedure, it was judged necessary to revisit the COM calibration process with all of these changes in place. Thus, the consultant implemented all of these changes and re-applied the same calibration methodology as before.

Table 3-17 shows the new external (I/X + X/I) and X/X trip ends at each cordon station, for 2000 and 2030. The 2000 total cordon values were posted in the network.

The consultant reviewed the COM X/X trip table and removed some anomalies that were found. The new X/X table has about the same number of total trips as before: 2,659.

Table 3-17
COM External Trip Ends – Model 4

	2000		2030	
Station	External	X/X	External	X/X
2145	198	0	416	0
2146	479	25	1,006	53
2147	366	0	769	0
2148	548	0	1,151	0
2149	3,369	549	7,412	1,208
2150	876	0	1,927	0
2151	356	0	783	0
2152	152	0	334	0
2153	1,664	0	2,330	0
2154	1,682	88	3,532	185
2155	1,350	0	2,835	0
2156	1,297	211	2,724	443
2157	60	0	126	0
2158	484	0	1,016	0
2159	1,083	57	2,274	120
2160	1,666	88	3,499	185
2161	484	0	1,016	0
2162	1,231	65	2,585	137
2163	758	40	1,592	84
2164	484	0	1,016	0
2165	895	47	1,611	85
2166	4,131	673	7,436	1,211
2167	384	0	691	0
2168	192	0	346	0
2169	192	0	346	0
2170	895	47	1,611	85
2171	1,500	130	2,700	234
2172	358	0	573	0
2173	261	14	418	22
2174	336	18	538	29
2175	69	0	110	0
2176	169	0	270	0
2177	599	32	958	51
2178	3,325	175	5,320	280
2179	743	39	1,189	62
2180	2,939	479	4,702	766
2181	2,015	175	3,224	280
2182	5,819	947	8,147	1,326
2183	1,581	83	2,530	133
2184	3,266	532	7,185	1,170
2185	1,246	0	1,994	0
2186	944	0	1,510	0
2187	1,323	115	2,117	184
2188	3,234	170	4,528	238
2189	6,374	0	10,198	0
2190	1,394	0	2,230	0
2191	3,191	519	5,106	830
Totals	65,962	5,318	115,931	9,401

The consultant examined the Model 4 trip generation model with respect to the correlation between the trip end delta and each of the zonal socioeconomic variables. The major change that was evident from the new analysis was that the original coefficient on Industrial Employment was too high. This was reduced from 0.205 to 0.056. The other coefficients were adjusted upward slightly to make up the difference. In addition, the adjustment factor on area type 1 was increased from 0.95 to 1.05. The final starting model estimates about 906,000 I/I trips. The resulting equation is shown below:

$$\text{COM productions} = (0.056 * \text{indemp} + 0.168 * \text{offemp} + 0.494 * \text{retemp} + 0.082 * \text{othemp} + 0.130 * \text{HH}) * \text{ATFAC} \quad (1)$$

(attractions = productions, by zone)

Where:
indemp = industrial employment
offemp = office employment
retemp = retail employment
othemp = other employment
HH = households
ATFAC = area type adjustment factor:

Area type	Factor
1 (CBD)	1.05
2	0.90
6	1.20
7 (rural)	1.15

Note: no factor is applied to area types 3-5.

Because of the change in total trips, the external share model changed slightly, to the following:

$$\text{extpct} = 1.73 * \text{extdist}^{-1.2}$$

Where:
extpct = proportion of trip ends that are external
extdist = distance to nearest external station, miles

This model produces about 906,000 I/I trips, 66,000 external trips, and 3,000 X/X trips. This totals 975K and is 5.1% of the 19.0 million daily vehicle trips the MWCOG model produced in 2000.

No other aspect of Model 3 was changed, except that a new delta adjustment matrix was created. The new correlations of the delta trip ends with the socioeconomic data are shown in Table 3-18.

Table 3-18
Final Trip End Correlations – Model 4

Zonal Variable	Correlation with Trip End Difference
hh	-0.028
hhpop	-0.018
gqpop	0.025
totpop	-0.016
totemp	-0.106
indemp	-0.098
retemp	-0.054
offemp	-0.099
othemp	-0.037

Table 3-19 shows the “before”, “after”, and delta tables, and the delta ratio, compressed to counties. As this table shows, the delta table adds 6% more trips to the “before” trip table. The resulting trip total, 1,093,369, is 5.8% of the 19.0 million daily vehicle trip total, which is closer to the expected value. The 12% increase is below the increases usually seen with this approach.

The new trip length frequency diagrams for the “after” trips are shown in Table 3-20. Not much change is seen from Model 3. Tables 3-21 and 3-22 show the assignment validation results for Model 4. These results are a noticeable improvement over Model 3. The overall estimated/observed ratio is 1.01 and the %RMSE is improved from 30% to 23%. Table 3-23 shows a comparison of estimated and observed volumes by MWCOG screenline (note that only 17% of all links with counts are on a screenline). Twenty-nine of the 38 screenlines have an error of 10% or less.

Table 3-24 shows a comparison of the percent Commercial for a random sample of the 148 counted locations. This compares the actual counted %COM, the count synthesis model’s estimated %COM, and Model 4’s final estimated %COM. The percent Commercial is the only figure that can be compared in this manner.

The year 2000 total regional VMT is 142,717,937, which is 0.4% lower than the 143,263,536 reported by MWCOG from the Version_2.2P_Cvtest1\Static_I6_Assignment.

Based on discussions between MWCOG staff and the consultant, Model 4 was selected as the final model of Commercial trips.

Table 3-19
Delta Table – Model 4

Date: 4/19/2007
Time: 9: 9

MWCOG Commercial Trip Model
Starting Model Trips

Destination District

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Total
	1 DC	74961	15685	22065	13449	5881	16508	539	1018	181	1275	2835	841	41	183	30	16	19	91	32	38	1	7	5033	160729
	2 Mont Co	15575	72693	11101	3190	1095	11009	915	457	3756	4231	2264	119	808	42	5	1	8	32	13	44	13	143	5077	132591
	3 PG Co	21924	11390	39546	3431	2635	6396	160	460	132	4353	8990	2290	154	692	152	30	10	50	14	10	0	1	4708	107528
	4 Arlingtn	13492	3210	3424	7887	2992	9593	275	577	51	161	406	195	9	31	6	0	11	63	16	25	1	5	1184	43614
O	5 Alxndria	5984	1097	2513	3028	3535	7225	100	624	20	81	214	272	3	33	12	0	17	77	15	10	0	1	620	25481
r	6 Fairfax	16607	10673	6521	9602	7199	98789	9055	11909	314	372	614	640	34	76	27	8	151	856	201	860	50	52	4375	178985
i	7 Loudoun	548	898	159	260	99	9068	11809	1092	723	39	26	6	31	2	1	0	5	16	4	248	320	391	819	26564
g	8 PrWillam	1040	435	484	605	629	11860	1094	22630	22	18	31	55	3	7	1	19	392	2159	490	1261	24	10	1641	44910
i	9 Fredrick	187	3744	133	59	16	316	725	22	16708	630	150	1	1252	1	0	0	0	1	0	8	66	626	3050	27695
n	10 Howard	1280	4174	4346	163	82	387	39	17	624	10839	5317	25	903	15	1	0	0	1	0	2	1	22	8545	36783
	11 AnnArndl	2789	2364	8938	393	219	609	23	39	148	5308	34403	197	249	554	25	3	0	4	4	1	1	2	16633	72906
D	12 Charles	858	118	2348	201	286	586	6	49	1	25	211	9908	2	429	772	332	8	13	8	1	0	0	565	16727
i	13 Carroll	47	812	148	8	3	36	29	4	1270	893	238	1	11907	2	0	0	0	0	0	0	4	28	3717	19147
s	14 Calvert	192	49	735	33	37	77	2	7	1	18	585	444	0	5524	1334	18	1	1	0	1	0	0	269	9328
t	15 St Marys	42	6	172	8	17	25	0	3	0	2	24	835	0	1391	11242	132	7	2	0	0	0	0	447	14355
r	16 King Geo	10	2	33	2	3	9	0	25	0	0	2	333	0	18	120	1729	86	123	81	5	0	0	469	3050
i	17 Frdckbrg	23	5	11	12	16	165	2	421	0	1	0	6	0	1	3	81	1960	1783	1361	76	0	0	1278	7205
c	18 Stafford	112	29	57	65	75	839	16	2162	1	1	2	13	0	2	6	118	1767	7044	1923	307	0	0	1524	16063
t	19 Spotsylv	25	8	13	12	19	190	4	485	0	0	2	7	0	0	3	81	1400	1897	4709	85	0	0	3133	12073
	20 Fauquier	41	34	15	25	13	863	251	1262	5	2	0	3	1	0	0	6	74	299	91	3443	40	12	1160	7640
	21 Clarke	2	16	2	1	1	50	309	20	66	3	0	0	2	0	0	0	1	0	1	39	735	376	405	2029
	22 Jeffrson	6	141	5	1	2	54	397	9	624	21	5	0	26	0	0	0	0	1	0	14	379	3124	1322	6131
	23 External	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2659	2659
	Total	155745	127583	102769	42435	24854	174654	25750	43292	24647	28273	56319	16191	15425	9003	13740	2574	5917	14513	8963	6478	1635	4800	68633	974193

Note: External trips are shown in P/A format. Productions defined at internal zones, attractions defined at external stations.

Date: 4/19/2007
Time: 9: 9

MWCOG Commercial Trip Model
Adaptable Assignment Revised Trips

Destination District

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Total
	1 DC	150377	11691	17440	7102	2363	11143	368	556	81	560	1239	776	36	153	44	10	11	28	12	23	1	5	1191	205210
	2 Mont Co	11696	102610	10534	1269	460	3267	280	177	2006	2015	1324	94	628	41	4	1	1	9	2	16	3	100	1543	138080
	3 PG Co	18079	10378	77336	1916	1295	3624	83	254	81	2620	5658	3791	60	1134	264	38	8	14	10	2	0	1	1395	128041
	4 Arlingtn	7014	1206	2414	14771	2742	11207	183	478	17	114	215	130	6	15	9	1	7	14	8	18	0	1	332	40902
O	5 Alxndria	2074	441	1324	2844	4072	5253	60	433	4	66	107	161	2	22	4	1	4	32	8	6	0	1	162	17081
r	6 Fairfax	10730	3302	3916	11336	5089	121905	7481	8870	185	212	320	428	17	66	29	2	59	185	81	649	39	54	1427	176382
i	7 Loudoun	321	298	85	164	51	7200	27279	971	494	25	12	3	29	0	1	0	3	10	0	523	193	346	459	38467
g	8 PrWillam	700	169	298	488	374	8490	1041	55650	21	13	20	32	2	5	3	19	245	1526	369	1726	14	10	649	71864
i	9 Fredrick	77	1961	67	21	5	199	482	22	21162	831	66	0	1365	0	0	0	0	1	0	7	39	354	2671	29330
n	10 Howard	634	2028	2669	93	53	198	28	11	826	13755	3374	18	489	11	0	0	0	1	0	0	2	17	4452	28659
	11 AnnArndl	1282	1406	5754	166	104	322	8	19	42	3624	39174	237	50	421	40	3	1	2	0	0	1	1	8943	61600
D	12 Charles	879	93	3714	135	166	399	5	27	1	20	247	15517	0	438	955	126	1	7	5	0	0	0	261	22996
i	13 Carroll	30	621	51	4	1	18	29	1	1369	506	79	2	13873	1	0	0	0	0	0	0	3	25	2872	19485
s	14 Calvert	170	43	1095	22	23	56	1	2	0	4	415	439	0	7809	1331	7	0	0	0	0	0	0	91	11508
t	15 St Marys	47	7	276	8	9	18	0	3	0	1	40	941	0	1318	9470	12	1	2	1	1	0	0	126	12281
r	16 King Geo	11	0	37	1	2	4	0	17	0	1	4	138	0	5	11	1593	199	311	155	4	0	0	413	2906
i	17 Frdckbrg	10	2	6	4	4	47	3	256	0	0	0	4	0	1	0	177	1959	1536	1517	48	0	0	900	6474
c	18 Stafford	42	12	26	12	20	169	16	1543	1	1	1	10	0	1	2	347	1367	9088	2599	959	1	0	983	17200
t	19 Spotsylv	12	4	8	6	7	80	5	392	0	0	0	9	0	0	2	157	1527	3204	4501	100	0	0	2133	12147
	20 Fauquier	22	16	6	12	7	589	515	1777	5	1	2	1	1	0	0	6	53	971	102	4808	55	10	1026	9985
	21 Clarke	1	8	0	1	0	48	223	21	36	2	0	0	3	0	0	0	0	0	0	74	735	322	456	1930
	22 Jeffrson	4	92	0	2	1	58	320	11	364	16	1	0	25	0	0	0	0	0	0	17	337	3122	854	5224
	23 External	1178	1547	1390	334	165	1412	469	662	2671	4450	8947	260	2872	93	126	415	899	980	2132	1028	458	855	2274	35617
	Total	205390	137935	128446	40711	17013	175706	38879	72153	29366	28837	61245	22991	19458	11534	12295	2915	6345	17921	11502	10009	1881	5224	35613	1093369

Note: External trips are shown in P/A format. Productions defined at internal zones, attractions defined at external stations.

Date: 4/19/2007
Time: 9: 9

MWCOG Commercial Trip Model
Delta Trips

Destination District

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Total
	1 DC	75416	-3994	-4625	-6347	-3518	-5365	-171	-462	-100	-715	-1596	-65	-5	-30	14	-6	-8	-63	-20	-15	0	-2	-3842	44481
	2 Mont Co	-3879	29917	-567	-1921	-635	-7742	-635	-280	-1750	-2216	-940	-25	-180	-1	-1	0	-7	-23	-11	-28	-10	-43	-3534	5489
	3 PG Co	-3845	-1012	37790	-1515	-1340	-2772	-77	-206	-51	-1733	-3332	1501	-94	442	112	8	-2	-36	-4	-8	0	0	-3313	20513
	4 Arlingtn	-6478	-2004	-1010	6884	-250	1614	-92	-99	-34	-47	-191	-65	-3	-16	3	1	-4	-49	-8	-7	-1	-4	-852	-2712
O	5 Alxndria	-3910	-656	-1189	-184	537	-1972	-40	-191	-16	-15	-107	-111	-1	-11	-8	1	-13	-45	-7	-4	0	0	-458	-8400
r	6 Fairfax	-5877	-7371	-2605	1734	-2110	23116	-1574	-3039	-129	-160	-294	-212	-17	-10	2	-6	-92	-671	-120	-211	-11	2	-2948	-2603
i	7 Loudoun	-227	-600	-74	-96	-48	-1868	15470	-121	-229	-14	-14	-3	-2	-2	0	0	-2	-6	-4	275	-127	-45	-360	11903
g	8 PrWillam	-340	-266	-186	-117	-255	-3370	-53	33020	-1	-5	-11	-23	-1	-2	2	0	-147	-633	-121	465	-10	0	-992	26954
i	9 Fredrick	-110	-1783	-66	-38	-11	-117	-243	0	4454	201	-84	-1	113	-1	0	0	0	0	0	-1	-27	-272	-379	1635
n	10 Howard	-646	-2146	-1677	-70	-29	-189	-11	-6	202	2916	-1943	-7	-414	-4	-1	0	0	0	0	-2	1	-5	-4093	-8124
	11 AnnArndl	-1507	-958	-3184	-227	-115	-287	-15	-20	-106	-1684	4771	40	-199	-133	15	0	1	-2	-4	-1	0	-1	-7690	-11306
D	12 Charles	21	-25	1366	-66	-120	-187	-1	-22	0	-5	36	5609	-2	9	183	-206	-7	-6	-3	-1	0	0	-304	6269
i	13 Carroll	-17	-191	-97	-4	-2	-18	0	-3	99	-387	-159	1	1966	-1	0	0	0	0	0	0	-1	-3	-845	338
s	14 Calvert	-22	-6	360	-11	-14	-21	-1	-5	-1	-14	-170	-5	0	2285	-3	-11	-1	-1	0	-1	0	0	-178	2180
t	15 St Marys	5	1	104	0	-8	-7	0	0	0	-1	16	106	0	-73	-1772	-120	-6	0	1	1	0	0	-321	-2074
r	16 King Geo	1	-2	4	-1	-1	-5	0	-8	0	1	2	-195	0	-13	-109	-136	113	188	74	-1	0	0	-56	-144
i	17 Frdckbrg	-13	-3	-5	-8	-12	-118	1	-165	0	-1	0	-2	0	0	-3	96	-1	-247	156	-28	0	0	-378	-731
c	18 Stafford	-70	-17	-31	-53	-55	-670	0	-619	0	0	-1	-3	0	-1	-4	229	-400	2044	676	652	1	0	-541	1137
t	19 Spotsylv	-13	-4	-5	-6	-12	-110	1	-93	0	0	-2	2	0	0	-1	76	127	1307	-208	15	0	0	-1000	74
	20 Fauquier	-19	-18	-9	-13	-6	-274	264	515	0	-1	2	-2	0	0	0	0	-21	672	11	1365	15	-2	-134	2345
	21 Clarke	-1	-8	-2	0	-1	-2	-86	1	-30	-1	0	0	1	0	0	0	-1	0	-1	35	0	-54	51	-99
	22 Jeffrson	-2	-49	-5	1	-1	4	-77	2	-260	-5	-4	0	-1	0	0	0	0	-1	0	3	-42	-2	-468	-907
	23 External	1178	1547	1390	334	165	1412	469	662	2671	4450	8947	260	2872	93	126	415	899	980	2132	1028	458	855	-385	32958
	Total	49645	10352	25677	-1724	-7841	1052	13129	28861	4719	564	4926	6800	4033	2531	-1445	341	428	3408	2539	3531	246	424	-33020	119176

Note: External trips are shown in P/A format. Productions defined at internal zones, attractions defined at external stations.

Date: 4/19/2007
Time: 9: 9

MWCOG Commercial Trip Model
Delta Trip Ratio

Destination District

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Total
	1 DC	2.01	.75	.79	.53	.40	.68	.68	.55	.45	.44	.44	.92	.88	.84	1.47	.63	.58	.31	.38	.61	1.00	.71	.24	1.28
	2 Mont Co	.75	1.41	.95	.40	.42	.30	.31	.39	.53	.48	.58	.79	.78	.98	.80	1.00	.13	.28	.15	.36	.23	.70	.30	1.04
	3 PG Co	.82	.91	1.96	.56	.49	.57	.52	.55	.61	.60	.63	1.66	.39	1.64	1.74	1.27	.80	.28	.71	.20	.00	1.00	.30	1.19
	4 Arlingtn	.52	.38	.71	1.87	.92	1.17	.67	.83	.33	.71	.53	.67	.67	.48	1.50	.00	.64	.22	.50	.72	.00	.20	.28	.94
O	5 Alxndria	.35	.40	.53	.94	1.15	.73	.60	.69	.20	.81	.50	.59	.67	.67	.33	.00	.24	.42	.53	.60	.00	1.00	.26	.67
r	6 Fairfax	.65	.31	.60	1.18	.71	1.23	.83	.74	.59	.57	.52	.67	.50	.87	1.07	.25	.39	.22	.40	.75	.78	1.04	.33	.99
i	7 Loudoun	.59	.33	.53	.63	.52	.79	2.31	.89	.68	.64	.46	.50	.94	.00	1.00	.00	.60	.63	.00	2.11	.60	.88	.56	1.45
g	8 PrWillam	.67	.39	.62	.81	.59	.72	.95	2.46	.95	.72	.65	.58	.67	.71	3.00	1.00	.63	.71	.75	1.37	.58	1.00	.40	1.60
i	9 Fredrick	.41	.52	.50	.36	.31	.63	.66	1.00	1.27	1.32	.44	.00	1.09	.00	.00	.00	.00	1.00	.00	.88	.59	.57	.88	1.06
n	10 Howard	.50	.49	.61	.57	.65	.51	.72	.65	1.32	1.27	.63	.72	.54	.73	.00	.00	.00	1.00	.00	.00	2.00	.77	.52	.78
	11 AnnArndl	.46	.59	.64	.42	.47	.53	.35	.49	.28	.68	1.14	1.20	.20	.76	1.60	1.00	.00	.50	.00	.00	1.00	.50	.54	.84
D	12 Charles	1.02	.79	1.58	.67	.58	.68	.83	.55	1.00	.80	1.17	1.57	.00	1.02	1.24	.38	.13	.54	.63	.00	.00	.00	.46	1.37
i	13 Carroll	.64	.76	.34	.50	.33	.50	1.00	.25	1.08	.57	.33	2.00	1.17	.50	.00	.00	.00	.00	.00	.00	.75	.89	.77	1.02
s	14 Calvert	.89	.88	1.49	.67	.62	.73	.50	.29	.00	.22	.71	.99	.00	1.41	1.00	.39	.00	.00	.00	.00	.00	.00	.34	1.23
t	15 St Marys	1.12	1.17	1.60	1.00	.53	.72	.00	1.00	.00	.50	1.67	1.13	.00	.95	.84	.09	.14	1.00	.00	.00	.00	.00	.28	.86
r	16 King Geo	1.10	.00	1.12	.50	.67	.44	.00	.68	.00	.00	2.00	.41	.00	.28	.09	.92	2.31	2.53	1.91	.80	.00	.00	.88	.95
i	17 Frdckbrg	.43	.40	.55	.33	.25	.28	1.50	.61	.00	.00	.00	.67	.00	1.00	.00	2.19	1.00	.86	1.11	.63	.00	.00	.70	.90
c	18 Stafford	.38	.41	.46	.18	.27	.20	1.00	.71	1.00	1.00	.50	.77	.00	.50	.33	2.94	.77	1.29	1.35	3.12	.00	.00	.65	1.07
t	19 Spotsylv	.48	.50	.62	.50	.37	.42	1.25	.81	.00	.00	.00	1.29	.00	.00	.67	1.94	1.09	1.69	.96	1.18	.00	.00	.68	1.01
	20 Fauquier	.54	.47	.40	.48	.54	.68	2.05	1.41	1.00	.50	.00	.33	1.00	.00	.00	1.00	.72	3.25	1.12	1.40	1.38	.83	.88	1.31
	21 Clarke	.50	.50	.00	1.00	.00	.96	.72	1.05	.55	.67	.00	.00	1.50	.00	.00	.00	.00	.00	.00	1.90	1.00	.86	1.13	.95
	22 Jeffrson	.67	.65	.00	2.00	.50	1.07	.81	1.22	.58	.76	.20	.00	.96	.00	.00	.00	.00	.00	.00	1.21	.89	1.00	.65	.85
	23 External	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.86	13.39
	Total	1.32	1.08	1.25	.96	.68	1.01	1.51	1.67	1.19	1.02	1.09	1.42	1.26	1.28	.89	1.13	1.07	1.23	1.28	1.55	1.15	1.09	.52	1.12

Note: External trips are shown in P/A format. Productions defined at internal zones, attractions defined at external stations.

Table 3-20
Trip Length Frequency Distributions – Model 4

```
FREQUENCY (Iter=1) Revised COM I/I Trips vs. Off-Pk Highway Time
  BASEMW=9 VALUEMW=11 RANGE=0,90,3
  MW[9]                           Accum
>=  -  <   Obs       Sum     Pct  Pct
----------------------------------------------------------------
  0 -  3   1,644  21,975.89  2.1   2.1 |==
  3 -  6   6,517  48,402.33  4.7   6.9 |====
  6 -  9  22,191  82,753.42  8.1  14.9 |========
  9 - 12  44,835 121,754.91 11.9  26.8 |===========
 12 - 15  72,922 133,204.84 13.0  39.8 |=============
 15 - 18 106,754 142,477.40 13.9  53.7 |=============
 18 - 21 140,772 128,035.18 12.5  66.2 |============
 21 - 24 164,928  79,971.18  7.8  74.0 |=======
 24 - 27 177,401  59,377.38  5.8  79.8 |=====
 27 - 30 185,798  47,218.63  4.6  84.5 |====
 30 - 33 191,735  36,516.75  3.6  88.0 |===
 33 - 36 196,268  28,784.17  2.8  90.8 |==
 36 - 39 200,623  22,597.65  2.2  93.0 |==
 39 - 42 198,671  17,808.70  1.7  94.8 |=
 42 - 45 191,569  13,252.72  1.3  96.1 |=
 45 - 48 186,799  10,440.48  1.0  97.1 |=
 48 - 51 178,468   8,419.52  0.8  97.9 |
 51 - 54 169,534   6,274.28  0.6  98.5 |
 54 - 57 156,047   4,344.98  0.4  98.9 |
 57 - 60 143,929   3,042.40  0.3  99.2 |
 60 - 63 135,710   2,197.60  0.2  99.5 |
 63 - 66 124,228   1,579.01  0.2  99.6 |
 66 - 69 112,729   1,087.58  0.1  99.7 |
 69 - 72 101,401     769.99  0.1  99.8 |
 72 - 75  91,720     628.14  0.1  99.9 |
 75 - 78  81,672     451.29  0.0  99.9 |
 78 - 81  72,718     296.43  0.0  99.9 |
 81 - 84  64,246     226.89  0.0  99.9 |
 84 - 87  54,771     158.44  0.0 100.0 |
 87 - 90  45,829     117.94  0.0 100.0 |
 90+     199,177     251.77  0.0 100.0 |
---------------------------------------
Total Obs = 3,821,606
Total Sum = 1,024,417.89
Mean      = 19.43
@I=J      = 62,318.42
```

```
FREQUENCY (Iter=1) Revised COM EXT Trips vs. Off-Pk Highway Time
  BASEMW=9 VALUEMW=12 RANGE=0,90,3
  MW[9]                         Accum
>=  -  <   Obs     Sum    Pct  Pct
----------------------------------------------------------------
  3 -  6     11 2,615.52  3.8   3.8 |===
  6 -  9     48 8,898.51 12.9  16.7 |============
  9 - 12     60 8,578.38 12.4  29.1 |============
 12 - 15     92 5,945.20  8.6  37.8 |========
 15 - 18    122 6,026.57  8.7  46.5 |========
 18 - 21    185 4,425.80  6.4  52.9 |======
 21 - 24    273 3,824.48  5.5  58.5 |=====
 24 - 27    381 3,235.15  4.7  63.2 |====
 27 - 30    579 2,311.07  3.4  66.5 |===
 30 - 33    775 2,119.71  3.1  69.6 |===
 33 - 36  1,077 1,834.00  2.7  72.2 |==
 36 - 39  1,366 1,596.53  2.3  74.6 |==
 39 - 42  1,551 1,726.29  2.5  77.1 |==
 42 - 45  1,826 1,434.41  2.1  79.1 |==
 45 - 48  1,974 2,150.96  3.1  82.3 |===
 48 - 51  2,103 1,790.64  2.6  84.9 |==
 51 - 54  2,289 1,441.59  2.1  86.9 |==
 54 - 57  2,385 1,265.73  1.8  88.8 |=
 57 - 60  2,537 1,144.38  1.7  90.4 |=
 60 - 63  2,474   882.23  1.3  91.7 |=
 63 - 66  2,544   725.05  1.1  92.8 |=
 66 - 69  2,750   616.37  0.9  93.7 |
 69 - 72  2,863   601.96  0.9  94.5 |
 72 - 75  3,025   503.16  0.7  95.3 |
 75 - 78  3,403   439.21  0.6  95.9 |
 78 - 81  3,904   415.99  0.6  96.5 |
 81 - 84  4,308   300.75  0.4  96.9 |
 84 - 87  4,664   325.53  0.5  97.4 |
 87 - 90  4,452   228.19  0.3  97.7 |
 90+     32,264 1,552.31  2.3 100.0 |==
----------------------------------------
Total Obs = 86,285
Total Sum = 68,955.64
Mean      = 27.69
@I=J      = 0
```

Table 3-21
Link Estimated/Observed Crosstab – Model 4

CROSSTAB ROW=FTYPE COL=AREATP COMP=comvol/COMCNT

	1	2	3	4	5	6	7	1 7
1 - 1	0.95	1.01	1.00	1.03	1.03	1.03	1.13	1.01
2 - 2	1.04	1.02	1.02	0.96	0.99	0.97	1.00	1.01
3 - 3	0.93	1.02	1.04	0.95	1.00	1.01	0.94	1.00
4 - 4	0.87	0.92	0.91	0.92	0.82	1.03	1.06	0.94
5 - 5	0	1.09	0.96	0.93	1.05	1.04	1.27	1.01
0 - 6	0.99	1.02	1.01	0.98	1.01	1.00	1.03	1.01

Table 3-22
Percent RMSE Crosstab – Model 4

CROSSTAB ROW=FTYPE COL=AREATP COMP=sqrt(_sqerr/_links)/(COMCNT/_links)

	1	2	3	4	5	6	7	1 7
1 - 1	0.20	0.18	0.10	0.17	0.12	0.20	0.26	0.16
2 - 2	0.35	0.19	0.15	0.12	0.17	0.13	0.19	0.21
3 - 3	0.55	0.29	0.28	0.20	0.24	0.27	0.35	0.31
4 - 4	0.35	0.29	0.32	0.48	0.85	0.42	0.46	0.46
5 - 5	0	0.26	0.08	0.12	0.11	0.19	0.30	0.15
0 - 6	0.33	0.22	0.16	0.21	0.18	0.22	0.31	0.23

Note: values are %RMSE as a fraction of 1.0, e.g., 0.73 = 73% RMSE

Table 3-23
Screenline Comparison – Model 4

Screenline	Synthesized Count	Estimated Volume	Estimated/ Observed
1	31,904	37,675	1.18
2	49,550	57,552	1.16
3	37,150	40,060	1.08
4	62,628	61,595	0.98
5	49,146	54,687	1.11
6	83,770	85,944	1.03
7	53,293	57,270	1.07
8	70,122	70,164	1.00
9	32,482	38,876	1.20
10	25,706	25,097	0.98
11	17,400	16,499	0.95
12	13,316	14,564	1.09
13	17,564	17,729	1.01
14	14,514	14,572	1.00
15	19,417	19,441	1.00
16	9,066	8,446	0.93
17	22,574	23,845	1.06
18	21,494	22,211	1.03
19	31,310	35,557	1.14
20	73,892	76,695	1.04
22	57,910	58,546	1.01
23	7,262	6,920	0.95
24	18,661	19,809	1.06
25	5,248	5,809	1.11
26	15,924	17,498	1.10
27	23,452	25,390	1.08
28	9,028	9,421	1.04
31	7,010	6,991	1.00
32	2,592	2,950	1.14
33	9,248	14,171	1.53
34	4,878	4,949	1.01
35	45,006	46,766	1.04
36	1,902	2,060	1.08
37	2,864	3,223	1.13
38	15,586	16,167	1.04
total	962,869	1,019,149	1.06

Table 3-24
Sample Percent Commercial Comparison – Model 4

Count ID	Count Segment Name	Jurisdiction	Counted %COM	Synthesized Obs %COM	Model Est %COM
15	Crain Hwy	PG	10.1%	9.3%	9.4%
20	I-66	PW	6.6%	7.4%	5.8%
24	I95 northbound	HOW	5.2%	3.8%	4.9%
30	I-66	FAU	5.5%	6.2%	5.1%
32	Wootton Pkwy	MTG	5.9%	7.1%	7.6%
34	Middlebrook Rd	MTG	6.0%	7.4%	6.6%
40	Branch Ave	PG	7.0%	7.1%	8.6%
44	King St	ALX	7.3%	7.7%	4.7%
53	Wisconsin Ave NW	DC	13.5%	10.5%	4.8%
55	K St NE	DC	12.0%	10.3%	20.6%
58	7th St NW	DC	12.3%	10.5%	8.2%
63	Spencerville Rd	MTG	9.0%	9.2%	7.8%
64	Woodfield Rd	MTG	11.2%	9.4%	3.9%
69	Telegraph Rd	FFX	4.9%	6.1%	12.0%
73	Prince William Pky	PW	10.0%	10.8%	6.4%
81	Charles Town Pike	LDN	8.4%	10.4%	8.4%
87	Defense Hwy	AA	7.9%	8.0%	5.0%
92	John S Mosby Hwy	LDN	12.4%	10.2%	9.4%
93	John S Mosby Hwy	LDN	9.5%	10.0%	12.8%
96	Charles Town Pike	LDN	9.0%	9.9%	9.0%
105	LaPlata Rd	CHS	9.5%	9.1%	11.8%
115	Cherrywood La	PG	8.4%	7.7%	9.9%
130	Church Rd	LDN	6.7%	7.9%	27.0%
131	Connecticut Ave	DC	31.2%	18.5%	14.8%
133	14th St NW	DC	16.4%	19.0%	13.0%
146	Lee Chapel Rd	FFX	4.8%	7.9%	8.4%
153	Stuart Mill Rd	FFX	9.8%	8.1%	2.9%
154	Pleasant Valley Rd	FFX	10.2%	8.0%	8.4%
155	Linton Hall Rd	PW	13.0%	10.4%	11.8%
158	Waterloo Rd	HOW	5.6%	7.2%	3.3%
159	Burns Crossing Rd	AA	6.4%	8.2%	6.2%
162	Whites Ferry Rd	MTG	8.6%	11.4%	9.2%
164	New Hampshire Ave	MTG	9.8%	11.0%	5.9%
167	Saint Louis Rd	LDN	14.2%	12.3%	9.9%
169	Vint Hill Rd	PW	12.8%	12.4%	14.5%
171	High St/ Butchers Row	LDN	15.9%	12.3%	6.5%

4. FORECASTING

The consultant tested Model 4 by applying it to 2030 conditions, using the "CGV2_1D_50_Sept_05_Conformity2006" version of the MWCOG model and inputs dated 15 Dec 2005. For this run, the consultant reduced the estimated NHB trips by 22%. This run produced the following results:

- COM trips (before adding the delta): 1,323,100 I/I, 115,900 external, 4,700 X/X = 1,443,700 total (+48% from 2000). After adding the delta: 1,581,100 (+45% from 2000).
- COM average trip length (in minutes, before adding the delta): 25.5 I/I, 41.7 external (compared to 23.7 I/I, 35.6 external in 2000).
- Total assigned VMT: 225,522,489 (+58% over 2000).

Table 4-1 shows the 2030 COM trips and comparison to 2000. As might be expected, the largest percentage increases are in the areas that are not highly developed today and the lowest percentage increase is in DC. Fairfax Co. sees the largest absolute increase, followed by Prince George's Co. and Loudoun Co. In all jurisdictions, relatively short trips (that stay within the jurisdiction) grow faster than longer trips.

Table 4-1
2030 COM Trips

Date: 1/ 8/2007
Time: 9:46

MWCOG Commercial Trip Model
2030 Trips
With Calibration Adjustment

Destination District

Origin District	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Total
1 DC	172623	11096	22634	12059	4369	12005	340	918	101	366	781	640	9	107	16	1	6	82	9	33	0	1	2363	240559
2 Mont Co	10762	141722	14586	1725	631	4745	369	375	4733	2577	994	56	429	20	0	0	2	32	2	12	1	79	3197	187049
3 PG Co	23398	13859	107844	3009	3197	5529	102	566	124	4075	6831	5655	45	1239	227	31	9	77	8	10	0	2	3225	179062
4 Arlingtn	11947	1666	3360	22617	4761	14815	326	904	43	90	161	86	2	11	4	0	6	71	11	26	2	0	818	61727
5 Alxndria	4138	649	2903	4931	7891	7878	77	916	19	51	105	134	0	18	1	0	10	98	10	10	0	1	438	30278
6 Fairfax	11971	4968	5956	14778	7484	158333	17005	14433	200	137	181	308	5	59	3	0	39	614	67	868	35	29	2954	240427
7 Loudoun	326	369	108	231	89	16818	62333	3358	548	20	5	2	15	0	0	0	4	25	3	868	406	476	1519	87523
8 PrWillam	1078	400	607	923	776	14181	3461	75777	20	13	17	28	1	4	0	2	295	3038	341	3112	23	4	1719	105820
9 Fredrick	90	4771	115	45	13	208	564	15	35536	1218	56	0	1490	0	0	0	0	0	0	3	16	370	4198	48708
10 Howard	440	2606	4106	83	52	154	22	11	1223	22577	5446	13	640	3	0	0	0	1	0	0	1	15	7578	44971
11 AnnArndl	841	1013	6792	137	114	169	1	22	46	5819	52734	155	28	400	20	0	0	5	0	2	0	0	13231	81529
12 Charles	773	62	5683	101	175	286	3	29	1	17	164	25745	0	564	1134	224	0	7	4	0	0	0	609	35581
13 Carroll	8	408	42	1	0	4	13	1	1534	635	33	0	17123	0	0	0	0	0	0	0	1	10	3846	23659
14 Calvert	128	28	1255	14	26	44	0	5	0	4	413	602	0	12465	1310	2	1	1	0	1	0	0	219	16518
15 St Marys	24	2	253	1	2	6	0	1	0	0	23	1228	0	1354	16345	34	0	0	0	0	0	0	351	19624
16 King Geo	5	0	42	0	1	0	0	8	0	0	3	251	0	2	24	4550	235	339	156	1	0	0	810	6427
17 Frdckbrg	8	3	7	6	7	47	3	313	0	0	0	2	0	0	0	203	7145	3725	2825	74	0	0	2210	16578
18 Stafford	90	35	70	64	77	556	28	3120	1	1	3	7	0	1	0	365	3512	22383	4191	1253	0	0	2341	38098
19 Spotsylv	9	3	8	6	8	55	3	380	0	0	0	3	0	0	3	158	2883	4759	9924	114	0	0	4021	22337
20 Fauquier	31	17	12	24	11	837	852	3169	4	0	0	0	0	0	0	7	78	1242	112	10363	59	6	1951	18775
21 Clarke	0	1	1	0	0	43	444	24	16	1	0	0	0	0	0	0	0	0	0	80	990	479	585	2664
22 Jeffrson	1	74	1	0	1	36	464	9	369	14	0	0	11	0	0	0	0	0	0	11	504	7736	1703	10934
23 External	2286	3089	3122	795	425	2849	1473	1661	4067	7335	12825	590	3727	211	343	784	2141	2267	3902	1888	565	1652	4335	62332
Total	240977	186841	179507	61550	30110	239598	87883	106015	48585	44950	80775	35505	23525	16458	19430	6361	16366	38766	21565	18729	2603	10860	64221	1581180

Note: External trips are shown in O/D format.

Date: 1/ 8/2007
Time: 9:46

MWCOG Commercial Trip Model
2030 Minus 2000 Trips
With Calibration Adjustment

Destination District

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Total
	1 DC	22248	-594	5194	4957	2006	862	-28	362	20	-194	-458	-136	-27	-46	-28	-9	-5	54	-3	10	-1	-4	1152	35332
	2 Mont Co	-944	39124	4052	456	171	1478	89	198	2727	562	-330	-38	-199	-21	-4	-1	1	23	0	-4	-2	-21	1632	48949
	3 PG Co	5320	3484	30506	1093	1902	1905	19	312	43	1456	1170	1864	-15	105	-37	-7	1	63	-2	8	0	1	1803	50994
	4 Arlingtn	4934	456	945	7845	2019	3609	143	426	27	-29	-54	-46	0	-4	-1	-1	-1	57	3	8	2	-1	483	20820
O	5 Alxndria	2062	210	1581	2085	3821	2625	17	483	9	-11	-2	-27	-2	-3	-5	-1	6	66	2	4	0	0	274	13194
r	6 Fairfax	1232	1668	2043	3440	2396	36437	9524	5563	13	-64	-146	-133	-17	-7	-16	-2	-20	429	-14	219	-4	-25	1509	64025
i	7 Loudoun	4	73	20	63	39	9622	35055	2387	56	-10	-6	-1	-9	0	0	0	1	15	3	344	213	130	1052	49051
g	8 PrWillam	387	224	311	432	402	5695	2419	20123	-5	4	-7	-7	0	2	0	-17	50	1512	-28	1385	9	-6	1055	33940
i	9 Fredrick	9	2807	51	24	8	9	82	-7	14375	388	-10	0	125	0	0	0	0	-1	0	-4	-23	16	1486	19335
n	10 Howard	-193	575	1441	-10	-1	-44	-6	0	396	8823	2071	-5	154	-8	0	0	0	0	0	0	-1	-2	3053	16243
	11 AnnArndl	-439	-396	1040	-29	10	-153	-7	3	-1	2199	13556	-82	-18	-21	-20	-3	-1	3	0	2	-1	-1	4145	19786
D	12 Charles	-107	-30	1969	-34	9	-113	-2	2	-1	-3	-80	10226	-2	126	181	98	-1	0	-1	0	0	0	344	12581
i	13 Carroll	-26	-210	-11	-3	-1	-14	-16	0	166	129	-46	-2	3249	-1	0	0	0	0	0	0	-2	-15	930	4127
s	14 Calvert	-41	-17	161	-8	3	-12	-1	3	0	0	0	163	0	4655	-21	-5	1	1	0	1	0	0	126	5009
t	15 St Marys	-21	-4	-23	-7	-7	-12	0	-2	0	-1	-18	287	0	37	6874	22	-1	-2	-1	-1	0	0	221	7341
r	16 King Geo	-7	-1	3	-2	0	-4	0	-9	0	0	0	113	0	-3	13	2958	36	27	1	-3	0	0	392	3514
i	17 Frdckbrg	0	0	1	2	2	1	0	57	0	-1	0	-1	0	0	-1	26	5186	2189	1308	26	0	0	1295	10090
c	18 Stafford	51	22	45	50	61	383	15	1574	1	1	2	-1	0	0	-6	18	2145	13294	1592	294	-1	0	1340	20880
t	19 Spotsylv	-5	1	1	0	0	-27	2	-14	0	0	0	-3	0	-1	-1	0	1357	1555	5422	14	0	0	1855	10156
	20 Fauquier	5	6	4	11	2	248	338	1389	-3	-1	0	0	0	0	0	0	23	276	12	5554	4	-4	910	8774
	21 Clarke	-1	-5	0	0	0	-6	220	5	-21	0	-1	0	-2	0	0	0	0	-1	0	6	256	157	121	728
	22 Jeffrson	-3	-17	1	-4	1	-20	145	-2	4	-2	-2	0	-13	0	0	0	0	0	0	-8	168	4613	835	5696
	23 External	1127	1566	1753	469	263	1453	1015	1012	1441	2958	4021	333	897	121	217	378	1255	1304	1801	876	116	807	2063	27246
	Total	35592	48942	51088	20830	13106	63922	49023	33865	19247	16204	19660	12504	4121	4931	7145	3454	10033	20864	10095	8731	733	5645	28076	487811

Date: 1/ 8/2007
Time: 9:46

MWCOG Commercial Trip Model
2030/2000 Trips
With Calibration Adjustment

Destination District

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Total
	1 DC	1.15	.95	1.30	1.70	1.85	1.08	.92	1.65	1.25	.65	.63	.82	.25	.70	.36	.10	.55	2.93	.75	1.43	.00	.20	1.95	1.17
	2 Mont Co	.92	1.38	1.38	1.36	1.37	1.45	1.32	2.12	2.36	1.28	.75	.60	.68	.49	.00	.00	2.00	3.56	1.00	.75	.33	.79	2.04	1.35
	3 PG Co	1.29	1.34	1.39	1.57	2.47	1.53	1.23	2.23	1.53	1.56	1.21	1.49	.75	1.09	.86	.82	1.13	5.50	.80	5.00	.00	2.00	2.27	1.40
	4 Arlingtn	1.70	1.38	1.39	1.53	1.74	1.32	1.78	1.89	2.69	.76	.75	.65	1.00	.73	.80	.00	.86	5.07	1.38	1.44	.00	.00	2.44	1.51
O	5 Alxndria	1.99	1.48	2.20	1.73	1.94	1.50	1.28	2.12	1.90	.82	.98	.83	.00	.86	.17	.00	2.50	3.06	1.25	1.67	.00	1.00	2.67	1.77
r	6 Fairfax	1.11	1.51	1.52	1.30	1.47	1.30	2.27	1.63	1.07	.68	.55	.70	.23	.89	.16	.00	.66	3.32	.83	1.34	.90	.54	2.04	1.36
i	7 Loudoun	1.01	1.25	1.23	1.38	1.78	2.34	2.29	3.46	1.11	.67	.45	.67	.63	.00	.00	.00	1.33	2.50	.00	1.66	2.10	1.38	3.25	2.27
g	8 PrWillam	1.56	2.27	2.05	1.88	2.07	1.67	3.32	1.36	.80	1.44	.71	.80	1.00	2.00	.00	.11	1.20	1.99	.92	1.80	1.64	.40	2.59	1.47
i	9 Fredrick	1.11	2.43	1.80	2.14	2.60	1.05	1.17	.68	1.68	1.47	.85	.00	1.09	.00	.00	.00	.00	.00	.00	.43	.41	1.05	1.55	1.66
n	10 Howard	.70	1.28	1.54	.89	.98	.78	.79	1.00	1.48	1.64	1.61	.72	1.32	.27	.00	.00	.00	1.00	.00	.00	.50	.88	1.67	1.57
	11 AnnArndl	.66	.72	1.18	.83	1.10	.52	.13	1.16	.98	1.61	1.35	.65	.61	.95	.50	.00	.00	2.50	.00	.00	.00	.00	1.46	1.32
D	12 Charles	.88	.67	1.53	.75	1.05	.72	.60	1.07	.50	.85	.67	1.66	.00	1.29	1.19	1.78	.00	1.00	.80	.00	.00	.00	2.30	1.55
i	13 Carroll	.24	.66	.79	.25	.00	.22	.45	1.00	1.12	1.25	.42	.00	1.23	.00	.00	.00	.00	.00	.00	.00	.33	.40	1.32	1.21
s	14 Calvert	.76	.62	1.15	.64	1.13	.79	.00	2.50	.00	1.00	1.00	1.37	.00	1.60	.98	.29	.00	.00	.00	.00	.00	.00	2.35	1.44
t	15 St Marys	.53	.33	.92	.13	.22	.33	.00	.33	.00	.00	.56	1.30	.00	1.03	1.73	2.83	.00	.00	.00	.00	.00	.00	2.70	1.60
r	16 King Geo	.42	.00	1.08	.00	1.00	.00	.00	.47	.00	.00	1.00	1.82	.00	.40	2.18	2.86	1.18	1.09	1.01	.25	.00	.00	1.94	2.21
i	17 Frdckbrg	1.00	1.00	1.17	1.50	1.40	1.02	1.00	1.22	.00	.00	.00	.67	.00	.00	.00	1.15	3.65	2.43	1.86	1.54	.00	.00	2.42	2.56
c	18 Stafford	2.31	2.69	2.80	4.57	4.81	3.21	2.15	2.02	.00	.00	3.00	.88	.00	1.00	.00	1.05	2.57	2.46	1.61	1.31	.00	.00	2.34	2.21
t	19 Spotsylv	.64	1.50	1.14	1.00	1.00	.67	3.00	.96	.00	.00	.00	.50	.00	.00	.75	1.00	1.89	1.49	2.20	1.14	.00	.00	1.86	1.83
	20 Fauquier	1.19	1.55	1.50	1.85	1.22	1.42	1.66	1.78	.57	.00	.00	.00	.00	.00	.00	1.00	1.42	1.29	1.12	2.15	1.07	.60	1.87	1.88
	21 Clarke	.00	.17	1.00	.00	.00	.88	1.98	1.26	.43	1.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	1.08	1.35	1.49	1.26	1.38
	22 Jeffrson	.25	.81	.00	.00	.00	.64	1.45	.82	1.01	.88	.00	.00	.46	.00	.00	.00	.00	.00	.00	.58	1.50	2.48	1.96	2.09
	23 External	1.97	2.03	2.28	2.44	2.62	2.04	3.22	2.56	1.55	1.68	1.46	2.30	1.32	2.34	2.72	1.93	2.42	2.35	1.86	1.87	1.26	1.96	1.91	1.78
	Total	1.17	1.35	1.40	1.51	1.77	1.36	2.26	1.47	1.66	1.56	1.32	1.54	1.21	1.43	1.58	2.19	2.58	2.17	1.88	1.87	1.39	2.08	1.78	1.45

5. APPLICATION NOTES

The Commercial trip generation and distribution models are fairly straightforward processes that can easily be incorporated into the current MWCOG travel model setup. No new zone-level variables or travel time matrices are required.

For trip generation, the only required new file is a file of total COM daily vehicle trips at each cordon station, for the forecast year. The generation model reads the land use file (basic input) and the area type file (previously calculated elsewhere in the MWCOG model chain). For trip distribution, another set of F factors must be supplied. The calibration adjustment matrix must be input to the time of day step, which is where those adjustments are applied. In assignment, the COM trips should be loaded using the SOV paths. If it is desired to be able to identify the COM trips separately in the link volumes, they should be identified as a separate VOL field on the PATH statement. Otherwise, the COM trips can be summed with the SOV trips. Appendix B shows the stand-alone TP+ script file to apply the COM model to 2030 conditions.

APPENDIX A ADAPTABLE ASSIGNMENT

Adaptable assignment (AA) is the name given to the consultant's proprietary procedure to perform matrix estimation. Matrix estimation is generally defined as the process of creating a synthesized trip table based on traffic count data. The AA process requires a starting trip table of some kind and then implements a semi-automated process of adjusting this table, cell-by-cell, such that the resulting assignment of that trip table to the network produces estimated link volumes that are much closer to the count data than before. This process is documented in a paper, *Adaptable Assignment*, that was presented at the Sixth TRB Conference on the Application of Transportation Planning Methods, May 1997. The main features of the procedure are summarized below.

The AA process requires the following items to begin:

- a starting trip table (or starting model)
- a highway network with counts posted
- an assignment procedure

The process is applied through a DOS batch file that runs the following steps:

- applies the starting model to get the starting trip table
- performs a trip end summary for external + through trips and saves these to a file
- runs the AA procedure a certain number of times (see below); generally 10-20 iterations are sufficient, but this figure must be determined for each project by trial-and-error (in this case, it ended up being 15)
- Fratar the final trip table's external zones so that the external + through totals match the starting values (this step implements the assumption that the starting cordon trip totals by external station are "correct" and should not be modified)
- subtract the starting table from the final table to get the delta matrix

The "AA procedure" is contained in a TP+ setup, consisting of the following steps:

- apply time of day model to the daily COM trips, to split them by time period (AM, PM, OP)
- assign <u>all</u> vehicle trips to the network by time period using the current MWCOG assignment protocol; output COM volumes as separate values on each link
- merge the COM volumes from the loaded networks by period; compute daily assigned vs. count statistics for COM trips
- build paths through the network and then skim two fields: the (synthesized COM) count, and the assigned COM volume for links that have a count; this produces 2 zone-zone matrices, one with the sum of the counts along each O/D path and one with the sum of the assigned volumes (only on links with counts) on each O/D path
- adjust the starting daily trip table, cell-by-cell; use the above skims to determine a ratio for each O/D: total count divided by total assigned volume; multiply the starting matrix trips by that ratio, cell-by-cell; check the absolute change in trips for each O/D cell, if too large, cap it; output a new daily trip table

The first pass of the AA procedure uses the starting model's trip table. Each subsequent pass uses the trip table that is output from the previous pass. On each of the AA iterations, the %RMSE usually decreases. The external Fratar step at the end always increases the assignment error, but this is judged to be a reasonable trade-off that is necessary to match the counts at the cordon. The final output of this process is a new trip table.

It bears emphasis that the counts used in this process must be very "clean", because they are actually driving the development of the trip table. Even with a process to synthesize counts (as used in this case), there were some COM counts that looked inconsistent. The consultant examined the network carefully and removed such counts before proceeding.

There are several other commercially-available processes to do matrix estimation, such as Cube ME. The consultant believes that any such process could be substituted for the AA procedure in this analysis.

The consultant believes that in this case it is reasonable to use matrix estimation to calculate a calibration adjustment (delta) matrix. It bears emphasis that this model (indeed, <u>all</u> models) are relatively simplistic formulations, that cannot possibly account for all of the factors that influence the way actual travellers behave each day. Most travel researchers do not believe that we know enough about how individuals make personal travel decisions and it is reasonable to think that we know even less about how Commercial travel decisions are made. It should not be surprising that there would be a substantial random component to the decision process for Commercial travel. It makes sense to think of the calibration adjustment matrix as that random component. As long as that adjustment is small, relative to the total base of tripmaking, such adjustment should be acceptable.

Since the delta matrix is a count-based calibration adjustment, it does not change for forecasting. Some have argued that the delta matrix should change in the future, that it is in effect tied to the land use. This implies that the adjustments should be calculated as cell-by-cell *factors*: final trips/starting trips, instead of *differences* (final trips – starting trips). The consultant believes that the final delta matrix adjustments represent random changes relating to the topology of the network and count locations and are thus not related to land use. So, they should <u>not</u> be changed for future years and should be applied as additive differences.

APPENDIX B APPLICATION SCRIPT

```
maxzones = 2191
intzones = 2144
fext     = intzones + 1
pth = '\cog\CGV2_1D_50_Sept_05_Conformity2006\2030'

run pgm=tripgen

; com.s
; MWCOG Light Commercial Vehicle Model

  id = "Commercial Trip Generation

; Input Zonal Data and special generator factors
  zdati[1] = @pth@\inputs\zone.asc, z=1-4, hh=10-15, hhpop=16-23, gqpop=24-31,
    totpop=32-39, totemp=40-47, indemp=48-55, retemp=56-63,
    offemp=64-71, othemp=72-79, jur=80-81, area=82-92, incrat=93-95,
    extdist=96-98

; COM external and X/X trip ends (forecasted with FCASTXX.S)
  zdati[2] = comext.prn, z = #1, extte = #2

; Zonal area type
  zdati[3] = @pth@\atype.asc, z = #1, atype = #11

; Output P/A file: 1 = I/I, 2 = external
  pao = comte.dat form=8.0 list= z(5.0), p[1],a[1],p[2],a[2]  print=y

  zones = @maxzones@

; Look up area type factors
  lookup name=atcom, interpolate=n, fail=1.0,1.0,1.0,
    r = '1.05  1',
        '0.90  2',
        '1.20  6',
        '1.15  7'

; Apply equation to internal zones

  if (i <= @intzones@)

; AT-based adjustment factor.
    atfac = atcom(atype)

; Calculate commercial productions
; Incorporate adjustments from the delta trip end analysis
    cmp = (0.056 * indemp + 0.168 * offemp +
           0.494 * retemp + 0.082 * othemp + 0.130 * HH) * ATFAC
;  Apply external trip end share model.
;  External share is a declining function of the zone's distance to the
;   nearest cordon station (in miles).  This particular model is an
;   amalgam of the Berks Co, PA purpose-specific models, modified
;   to produce the correct number of external trips in 2000.
    extpct = 0.0
    if (extdist > 0) extpct = 1.73 * extdist^-1.2
    extpct = max(min(extpct,1.0),0)
    intpct = 1.0 - extpct

; Apply internal trip end shares; set A's equal to P's
    p[1] = cmp * intpct
    a[1] = p[1]
```

```
; Define all external trip ends as "Productions" at the internal
;  zones and "Attractions" at the external stations.  Calculate
;  these (initially) for internal zones as what's left over
;  after the above calculation.
    p[2] = cmp * extpct
  endif

; External trip ends.  These were calculated externally, in
;  COM Externals.xls  These are defined as
;  Attractions, at the external stations.
  if (i > @intzones@)
    p[1] = 0
    p[2] = 0
    a[1] = 0
    a[2] = extte
  endif

  phase = adjust

; Normalize external trips to the attractions (input at the external
;  stations).
    p[2] = p[2] * a[2][0]/p[2][0]

  endphase

endrun

;-------------------------------------------------------------------
run pgm=tripdist

  id = "Commercial Trip Distribution

; Skims
  mati = trkop.skm

; Trip ends
  zdati = comte.dat z=#1,p1=#2,a1=#3,p2=#4,a2=#5

; Output
  mato = com.trp, mo=1,2, name = COMII,COMEXT, dec=2*S

; Set maximum iterations, unless RMSE for all purposes is met.
  maxiters = 20, maxrmse = 10

; Set productions and attractions
  setpa p[1]=p1, a[1]=a1, p[2]=p2, a[2]=a2

; Get skims.
  mw[5] = mi.1.1

; Look up friction factors.
  lookup file=..\adaptc\new06.ffs, name=ff,
    lookup[1]=1, result=2,
    lookup[2]=1, result=2,
    interpolate=y,
    fail=1800,0,0

; Distribute trips on off-peak skim time.
  gravity purpose=1, los = mw[5], ffactors=ff
  gravity purpose=2, los = mw[5], ffactors=ff

; Trip end report
  report margins = 1,2
```

```
endrun
;---------------------------------------------------------------------
run pgm=matrix

  id = "Commercial TLFDs

;  Input files: trips, skims
  mati[1] = com.trp
  mati[2] = trkop.skm

; Get trips.
  mw[1] = mi.1.1       ; COM I/I
  mw[2] = mi.1.2       ; COM Ext

; Time.
  mw[3] = mi.2.1

; TLF
  frequency basemw=3, valuemw=1, range=0-90-2,
  title='Est Commercial I/I Trips vs. Off-Peak Hwy Time'
  frequency basemw=3, valuemw=2, range=0-90-2,
  title='Est Commercial Ext Trips vs. Off-Peak Hwy Time'

endrun
;---------------------------------------------------------------------
run pgm=matrix

  id = "Commercial time of day

  mati[1] = com.trp
  mati[2] = comxx.trp
  mati[3] = ..\adaptc2\delta.trp
  mato    = tmcom.trp, mo=5-7, name=AMCOM,PMCOM,OPCOM, dec = 3*S

; I/I trips are already balanced, so we can apply a single factor
;  to all trips.  Apply separate P/A and A/P factors to externals.
;  Assume externals are 70/30 inbound (X/I, or A/P) in the morning,
;  70/30 outbound (I/X, P/A) in the evening.  Off-peak is 50/50.
  mw[1] = mi.1.COMII
  mw[2] = mi.1.COMEXT           ; P/A (outbound)
  mw[3] = mi.1.COMEXT.t         ; A/P (inbound)

; Also add in the X/X's.
  mw[4] = mi.2.1

; Read and transpose the external delta
  mw[11] = mi.3.1
  mw[12] = mi.3.2
  mw[13] = mi.3.2.t

; Add in the deltas.  First, for I/I and Ext (I/X).
  if (i = 1-@intzones@)
    jloop
      mw[21] = max(mw[1] + mw[11],0)
      mw[22] = max(mw[2] + mw[12],0)
    endjloop
  endif

  if (i > @intzones@)
; Now for Ext transposed (X/I).
    mw[23] = max(mw[3] + mw[13],0), include = 1-@intzones@

; Now for X/X.
    mw[24] = max(mw[4] + mw[12],0), include = @fext@-@maxzones@
```

```
  endif

; Use proposed new COM TOD factors
  mw[5] = 0.23 * (mw[21] + mw[24] + 0.7 * mw[23] + 0.3 * mw[22])  ; AM
  mw[6] = 0.27 * (mw[21] + mw[24] + 0.3 * mw[23] + 0.7 * mw[22])  ; PM
  mw[7] = 0.50 * (mw[21] + mw[24] + 0.5 * mw[23] + 0.5 * mw[22])  ; OP

endrun

;------------------------------------------------------------------
INPNET   = pth + '\zonehwy.net'
in_tskm  = pth + '\inputs\toll.skm'   ; read in toll param file
VDF_File = '..\Version_2.2P\Static_I6_Assignment\Conical_VDF_V21D.txt'   ; Volume
Delay Functions file
Que_File = '..\Version_2.2P\Static_I6_Assignment\Qeueing_Time.TXT'       ; Queuing
Time  specification

LOOP Period=1,3;  Three assignment loops: 1/AM, 2/PM, 3/Off-Pk

IF     (Period==1)         ; AM Peak Period
    PRD    =  'AM'         ;
    PCTADT =   40  ; %_AMPF_%  AM Pk Ftr (% of traffic occurring in pk hr)

ELSEIF (Period==2)         ; PM Peak Period
    PRD    =  'PM'         ;
    PCTADT =   37  ; %_PMPF_%  PM Pk Ftr (% of traffic occurring in pk hr)

ELSE                       ;  Off-Peak Period
    PRD    =  'OP'         ;
    PCTADT =   12  ; %_OPPF_%  OP Pk Ftr (% of traffic occurring in pk hr)
ENDIF

CAPFAC=1/(PCTADT/100)      ; Capacity Factor = 1/(PCTADT/100)

RUN PGM=HWYLOAD
  NETI=@INPNET@               ; TP+ Network
  ;
  ;  The input trip table has 5 Vehicle Tables:
  ;     1 - 1-Occ Auto Drivers
  ;     2 - 2-Occ Auto Drivers
  ;     3 - 3+Occ Auto Drivers

  ;     4 - Trucks
  ;     5 - Airport Pass. Auto Driver Trips

   MATI[1] = i6@prd@LessNHB.VTT
   mati[2] = tmcom.trp

   NETO    = temp@prd@.lod

   ;=================================================================
   ;*****************************************************************
   ;**  LOS'E' Capacities and Freeflow Speeds Assumptions:          **
   ;*****************************************************************
   ;
   ;            areatp > 1    2    3    4    5    6    7   fac type
   ;                    ---  ---  ---  ---  ---  ---  ---     V
   SPDCAP CAPACITY[01]=3150 3150 3150 3150 3150 3150 3150  ; cen
   SPDCAP CAPACITY[11]=1500 1600 1800 1800 2000 2000 2100  ; fwy REVISED 7/20/03
   SPDCAP CAPACITY[21]= 800  800  960  960 1260 1260 1260  ; maj REVISED 6/19/03
   SPDCAP CAPACITY[31]= 500  600  700  840 1000 1000 1000  ; min REVISED 6/30/03
   SPDCAP CAPACITY[41]= 300  400  500  700  700  700  800  ; col
   SPDCAP CAPACITY[51]= 900 1000 1000 1200 1500 1500 1500  ; xwy
   SPDCAP CAPACITY[61]=1000 1000 1000 1000 2000 2000 2000  ; rmp
```

```
SPDCAP CAPACITY[71]=1600 1800 1800    ; JCPARK I-270 CAP 7/20/03 ICC CAP 11/18/03
SPDCAP CAPACITY[91]=2400 2100         ; JCPARK 7/24/03 I-495 CAP
;
;  initial speed values :
;
;            areatp > 1    2    3    4    5    6    7   fac type
;                    ---  ---  ---  ---  ---  ---  ----    V
SPDCAP    SPEED[01]= 15   15   20   25   30   30   35    ; cen
SPDCAP    SPEED[11]= 55   55   60   60   67   67   67    ; fwy
SPDCAP    SPEED[21]= 25   25   35   35   40   45   45    ; maj REVISED 6/18/03
SPDCAP    SPEED[31]= 20   20   30   30   35   40   40    ; min REVISED 6/18/03
SPDCAP    SPEED[41]= 15   15   20   20   25   30   30    ; col REVISED 6/18/03
SPDCAP    SPEED[51]= 45   45   50   50   50   55   55    ; xwy
SPDCAP    SPEED[61]= 20   20   30   30   35   40   50    ; rmp
SPDCAP    SPEED[71]= 55   60   50 ; JCPARK I-270 SPD 7/20/03 ICC SPD 10/30/03

;-----------------------------------------------------$
;    Read in Toll Parameters:                         $
;-----------------------------------------------------$
READ FILE = @in_tskm@


;-----------------------------------------------------$
;   Queuing Penalty Function (qtime = f(V/C))         $
;-----------------------------------------------------$
;   Time Penalty is a function of VC ratio
;
LOOKUP NAME=QTIME,
       lookup[1] = 1,result = 2,  ;Centroids   Queuing Time (MIN)
       lookup[2] = 1,result = 3,  ;Fwys        Queuing Time (MIN)
       lookup[3] = 1,result = 4,  ;MajArts     Queuing Time (MIN)
       lookup[4] = 1,result = 5,  ;MinArts     Queuing Time (MIN)
       lookup[5] = 1,result = 6,  ;Colls       Queuing Time (MIN)
       lookup[6] = 1,result = 7,  ;Expways     Queuing Time (MIN)
       lookup[7] = 1,result = 8,  ;Ramps       Queuing Time (MIN)
       FAIL=0,0,0, INTERPOLATE=T, file= @Que_File@
;
;-----------------------------------------------------$
;    VDF (Volume Delay Function) establishment:       $
;-----------------------------------------------------$
; Note:  curves updated 2/16/06 rjm/msm
;
LOOKUP NAME=VCRV,
       lookup[1] = 1,result = 2,  ;Centroids   old VCRV1
       lookup[2] = 1,result = 3,  ;Fwys        old VCRV2
       lookup[3] = 1,result = 4,  ;MajArts     old VCRV3
       lookup[4] = 1,result = 5,  ;MinArts     old VCRV4
       lookup[5] = 1,result = 6,  ;Colls       old VCRV5
       lookup[6] = 1,result = 7,  ;Expways     old VCRV6
       lookup[7] = 1,result = 8,  ;Ramps       old VCRV2
       FAIL=0.00,0.00,0.00, INTERPOLATE=T,file=@VDF_File@

FUNCTION {                                ; Congested Time (TC)specification:
  TC[1]= T0*VCRV(1,VC) + QTIME(1,VC)      ; TC(LINKCLASS) =
  TC[2]= T0*VCRV(2,VC) + QTIME(2,VC)      ;   Uncongested Time(T0) *
  TC[3]= T0*VCRV(3,VC) + QTIME(3,VC)      ;   Volume Delay Funtion(VDF)Value
  TC[4]= T0*VCRV(4,VC) + QTIME(4,VC)      ;   VDF function is based on VC
  TC[5]= T0*VCRV(5,VC) + QTIME(5,VC)      ; Note: the LINKCLASS is defined
  TC[6]= T0*VCRV(6,VC) + QTIME(6,VC)      ; during the LINKREAD phase below.
  TC[7]= T0*VCRV(7,VC) + QTIME(7,VC)      ; .
}

CAPFAC=@CAPFAC@  ;
;
```

```
   ;

  MAXITERS=20      ;

   GAP  = 0.0      ; ** To ensure Max iterations are fully executed **
   AAD  = 0.0      ; ** To ensure Max iterations are fully executed **
   RMSE = 0.0      ; ** To ensure Max iterations are fully executed **
   RAAD = 0.0      ; ** To ensure Max iterations are fully executed **


 PHASE=LINKREAD
       C     = CAPACITYFOR(LI.@PRD@LANE,LI.CAPCLASS) * @CAPFAC@
       SPEED = SPEEDFOR(LI.@PRD@LANE,LI.SPDCLASS)
       T0    = (LI.DISTANCE/SPEED)*60.0


    IF (ITERATION = 0)
      ; Define AM /OP link level tolls by vehicle type here:
         LW.SOV@PRD@TOLL = LI.@PRD@TOLL * @PRD@_TFAC(1,LI.TOLLGRP) ; SOV       TOLLS
in 1994 cents
         LW.HV2@PRD@TOLL = LI.@PRD@TOLL * @PRD@_TFAC(2,LI.TOLLGRP) ; HOV 2 occ TOLLS
in 1994 cents
         LW.HV3@PRD@TOLL = LI.@PRD@TOLL * @PRD@_TFAC(3,LI.TOLLGRP) ; HOV 3+occ TOLLS
in 1994 cents
         LW.TRK@PRD@TOLL = LI.@PRD@TOLL * @PRD@_TFAC(4,LI.TOLLGRP) ; Truck     TOLLS
in 1994 cents
         LW.APX@PRD@TOLL = LI.@PRD@TOLL * @PRD@_TFAC(5,LI.TOLLGRP) ; AP Pax    TOLLS
in 1994 cents

      ; Initial Iteration LINK IMPEDANCE (HIGHWAY TIME + Equiv.Toll/Time) by vehicle
type here:
          LW.SOV@PRD@IMP = T0    + (LW.SOV@PRD@TOLL/100.0)* SV@PRD@EQM ;SOV   IMP
          LW.HV2@PRD@IMP = T0    + (LW.HV2@PRD@TOLL/100.0)* H2@PRD@EQM ;HOV 2 IMP
          LW.HV3@PRD@IMP = T0    + (LW.HV3@PRD@TOLL/100.0)* H3@PRD@EQM ;HOV 3+IMP
          LW.TRK@PRD@IMP = T0    + (LW.TRK@PRD@TOLL/100.0)* TK@PRD@EQM ;Truck IMP
          LW.APX@PRD@IMP = T0    + (LW.APX@PRD@TOLL/100.0)* AP@PRD@EQM ;APAX  IMP

     ENDIF

     ;
     ;   The highway network is coded with limit codes from 1 to 9
     ;     Limit Code  Definition
     ;     --------  ----------------------
     ;        1      All vehicles accepted
     ;        2      Only HOV2 (or greater) vehicles accepted only
     ;        3      Only HOV3 vehicles accepted only
     ;        4      Med,Hvy Trks not accepted, all other traffic is accepted
     ;        5      Airport Passenger Veh. Trips
     ;        6-8    (Unused)
     ;        9      No vehicles are accepted at all
     ;
     IF     (LI.@PRD@LIMIT==1)
       ADDTOGROUP=1
     ELSEIF (LI.@PRD@LIMIT==2)
       ADDTOGROUP=2
     ELSEIF (LI.@PRD@LIMIT==3)
       ADDTOGROUP=3
     ELSEIF (LI.@PRD@LIMIT==4)
       ADDTOGROUP=4
     ELSEIF (LI.@PRD@LIMIT==5)
       ADDTOGROUP=5
     ELSEIF (LI.@PRD@LIMIT==6-8)
       ADDTOGROUP=6
     ELSEIF (LI.@PRD@LIMIT==9)
```

```
       ADDTOGROUP=7
     ENDIF

     IF (LI.FTYPE = 0)      ;  LinkClass related to TC[?] above
        LINKCLASS = 1       ;
     ELSEIF (LI.FTYPE = 1)  ;
        LINKCLASS= 2        ;
     ELSEIF (LI.FTYPE = 2)  ;
        LINKCLASS= 3        ;
     ELSEIF (LI.FTYPE = 3)  ;
        LINKCLASS= 4        ;
     ELSEIF (LI.FTYPE = 4)  ;
        LINKCLASS= 5        ;
     ELSEIF (LI.FTYPE = 5)  ;
        LINKCLASS= 6        ;
     ELSEIF (LI.FTYPE = 6)  ;
        LINKCLASS= 7        ;
     ENDIF

 ENDPHASE

 PHASE=ILOOP

    IF (I=1)
      LINKLOOP
        ; Initial Iteration LINK IMPEDANCE (HIGHWAY TIME + Equiv.Toll/Time) by vehicle
type here:
          LW.SOV@PRD@IMP = TIME    + (LW.SOV@PRD@TOLL/100.0)* SV@PRD@EQM ;SOV   IMP
          LW.HV2@PRD@IMP = TIME    + (LW.HV2@PRD@TOLL/100.0)* H2@PRD@EQM ;HOV 2 IMP
          LW.HV3@PRD@IMP = TIME    + (LW.HV3@PRD@TOLL/100.0)* H3@PRD@EQM ;HOV 3+IMP
          LW.TRK@PRD@IMP = TIME    + (LW.TRK@PRD@TOLL/100.0)* TK@PRD@EQM ;Truck IMP
          LW.APX@PRD@IMP = TIME    + (LW.APX@PRD@TOLL/100.0)* AP@PRD@EQM ;APAX  IMP

      ENDLINKLOOP

    ENDIF

 ; Assign COM with SOV -- assume the Truck prohibitions don't apply
 ;  to COM vehicles.

     PATH=LW.SOV@PRD@IMP,
       EXCLUDEGRP=2,3,5,6,7,   ; prohibitions for free SOV veh
       VOL[1]=MI.1.1, vol[6] = mi.2.@prd@com
     PATH=LW.HV2@PRD@IMP,
       EXCLUDEGRP=3,5,6,7,     ; prohibitions for HOV2 veh
       VOL[2]=MI.1.2
     PATH=LW.HV3@PRD@IMP,
       EXCLUDEGRP=5,6,7,       ; prohibitions for HOV3 veh
       VOL[3]=MI.1.3
     PATH=LW.TRK@PRD@IMP,
       EXCLUDEGRP=2,3,4,5,6,7, ; prohibitions for trucks
       VOL[4]=MI.1.4
     PATH=LW.APX@PRD@IMP,
       EXCLUDEGRP=6,7,         ; prohibitions for Airport pass.veh trips
       VOL[5]=MI.1.5

;

 ENDPHASE

 PHASE = ADJUST

 ENDPHASE
```

```
 ENDRUN

 ENDLOOP

;---------------------------------------------------------------------
RUN PGM=HWYNET
;
;   Summarize 24 hour VMT  of current AM, PM, & Off-Peak Assignments
;---------------------------------------------------------------------
;

  NETI[1]=tempAM.lod
  NETI[2]=tempPM.lod
  NETI[3]=tempOP.lod

   neto    = com24.lod, exclude=V_1,V1_1,V2_1,V3_1,V4_1,V5_1,V6_1,
    VDT_1,VHT_1,VT_1,V1T_1,V2T_1,V3T_1,V4T_1,V5T_1,V5T_1,V6T_1,TIME_1,
    CSPD_1,VC_1

  totvol = round(li.1.V_1 + li.2.V_1 + li.3.V_1)
  comvol = round(li.1.v6_1 + li.2.v6_1 + li.3.v6_1)
;
 ;
  VOLAM =  LI.1.V_1  VCAM = LI.1.VC_1  SPEEDAM = LI.1.CSPD_1   VHTAM = LI.1.VHT_1
  VOLPM =  LI.2.V_1  VCPM = LI.2.VC_1  SPEEDPM = LI.2.CSPD_1   VHTPM = LI.2.VHT_1
  VOLOP =  LI.3.V_1  VCOP = LI.3.VC_1  SPEEDOP = LI.3.CSPD_1   VHTOP = LI.3.VHT_1

; COMPUTE FINAL DAILY VOLUME  ON ALL LINKS
  VOL24 =  VOLAM + VOLOP + VOLPM  ; Total Daily Volume

; COMPUTE FINAL DAILY VMT ON ALL NON-CENTROID LINKS
IF (FTYPE = 0)
  VMT24 =  0
 ELSE
  VMT24 =  VOL24 * DISTANCE  ; Total Daily VMT
ENDIF

; Crosstab Total VMT by Jurisdiction and FTYPE
    CROSSTAB VAR=VMT24, FORM=12cs,
             ROW=JUR,    RANGE=0-23-1,,0-23,
             COL=FTYPE,  RANGE=0-6-1,0-6


ENDRUN

*del temp*.lod
```