

Regional Travel Demand Model

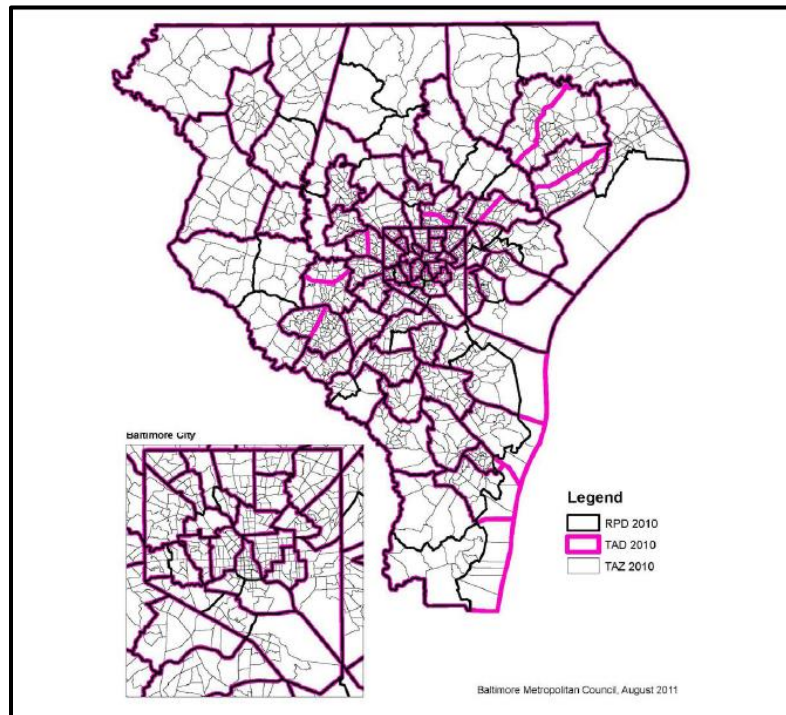
The Howard County Regional Travel Demand Model was developed using the Baltimore Metropolitan Council (BMC) version 4 regional Cube model. As part of the Census Bureau's 2010/2011 TAZ/TAD Delineation Program, BMC in cooperation with its member jurisdictions – Baltimore City and Anne Arundel, Baltimore, Carroll, Harford, and Howard counties – and the Maryland Department of Transportation (MDOT) developed a new TAZ structure in the travel demand modeling process to connect the Census' demographic and economic data to BMC's Travel Demand Model.

The TAZ/TAD Delineation Process resulted in:

- **1,387 Transportation Analysis Zones (TAZ)** – a net increase of 236 TAZs from the 2000 TAZ structure (various additions and mergers across the region).
- **93 Regional Planning Districts (RPD)** – one less than the 2000 RPD structure (the two Aberdeen Proving Grounds RPDs were consolidated).
- **72 Transportation Analysis Districts (TAD)** – created using the RPDs and Census tracts as a basis (consolidation of similar and adjacent RPDs less than 20,000 residents and splits of RPDs above 60,000 residents).

Presented in Figure 2, is the zonal configuration.

Figure 2, BMC Version 4 TAZ structure



General Validation Approach

The general approach to model validation of the Howard County travel demand model was one that was focused on improving highway assignments for the key corridors being studied as part of this project and as a part of future county planning efforts. The current model was developed from the BMC version 4 model, and modules such as Trip Generation, Distribution, and Mode-Choice all performed reasonably well for this project. Zone-splitting was considered as a strategy for improving network loadings, but was to be used on an as-needed basis. The BMC Tp+ script was revised to accommodate an additional 200 zones for the Howard County model. The core of the validation effort included evaluating each corridor individually in order to verify critical link attributes for accuracy. These attributes included number of lanes, facility type, roadway type, etc., in addition to other more qualitative features such as roadway geometry. Addition of collector roadways, repositioning of centroids, and adding additional centroid connectors were additional techniques used in validation. Also, certain original roadway links were eliminated from the analysis if they were considered redundant for the effort. These techniques have improved vehicular loadings such that the simulated volumes become a better match with the existing counts.

Prior to the corridor validation, several screenline validations were conducted to ensure the regional flows through the county and Columbia Town Center (CTC) were consistent with existing base year 2008 counts. The BMC model is simulating traffic flows between Baltimore and Washington within 2% of observed traffic counts at the screenline level. This flow is particularly important to model accurately given the magnitude of the flows between Baltimore and Washington and Howard County's location between both cities. However, initial model results indicated that US 1 was simulating at over 20% of observed counts, which is outside of the accepted FHWA threshold. In addition, the BMC model was validated using the screenline locations from the CTC to ensure consistency with the CTC validation. This initial validation indicated that the BMC model was not adequately replicating travel behavior in the CTC area, and that additional model adjustments were required. A detailed review of the Howard County network indicated that the BMC model was validating adequately at the regional level; however, the model was significantly under-estimating trips in the CTC area. The cause of this was determined to be an inadequate number of short trips being assigned between the Oakland Mills area to the east of US 29 and CTC. These short trips could be for any number of Home Based Shopping (HBS) and Home Based Other (HBO) trip purposes such as restaurants, movies, entertainment, pharmacy trips, etc. In lieu of spitting zones, which would have improved the validation, but not within the FHWA thresholds, the study team developed a fratar table, used to factor the trip table in the Oakland Mills/CTC area. The fratar procedure was implemented in the existing BMC model TP+ script, and this procedure significantly improved the validation results at the CTC screenlines. To improve the validation on US 1 and more accurately reflect the land use pattern in the Elkridge and Laurel areas, the functional class for US 1 was lowered from functional class 3 to functional class 4 and this improved the validation on US 1.

Each of the corridors analyzed used the existing year 2010/2011 counts. While the model validation year is 2008, given the recent recession, traffic counts have been stable or declining between the years 2007-2011; therefore, counts from this timeframe would be appropriate for model validation purposes. The base year conditions for validation represent the year 2008, with the socioeconomic inputs for the validation year also representing 2008 conditions.

Validation statistics that used include volume-to-count ratio, root mean squared error (RMSE), and Percent Deviation. All of these statistics and the validation goals were consistent with the current FHWA guidelines. The guidelines for volume-to-count ratios are as follows:

- Freeways/Expressways $\pm 7\%$

- Principal Arterials ±10%
- Minor Arterials ±15%
- Collector Roadways ±25%

The subsequent pages provide a summary for the regional flows, CTC area, and each corridor that discusses the validation approach, challenges encountered, and final validation results. The results are presented in a “before validation” and “after validation” context in order to simplify the results of the validation techniques used. The charts are also color-coded such that segments that exceed the threshold appear with a **RED BACKGROUND**, while segments that are below the threshold are shown with a **GREEN BACKGROUND**. Segments that are within the validation goals are shown with a **YELLOW BACKGROUND**. The results of the final run also include the overall RMSE for the corridor.

Regional Flows

As mentioned previously, the regional flows between Baltimore and Washington are a key validation goal in the model development effort. The existing BMC model was adequately simulating travel on I-95 and US 29, the US 1 corridor was over simulating by as much as 46%. MD 295 was under simulating by 17%; however this facility has historically under simulated in the BMC model due to the unique characteristics of this parkway facility.

Table 1

BMC Version 4 Regional Validation

Howard County Model Regional Flows			
North			
Facility	Count	Simulation	% Difference
MD 295	103487	86235	-17%
US 1	32110	46768	46%
I 95	186781	195069	4%
US 29	59000	60584	3%
Total	381378	388656	2%
South			
Facility	Count	Simulation	% Difference
MD 295	81313	82348	1%
US 1	33062	37367	13%
I 95	204178	199455	-2%
Total	318553	319170	0%
East			
Facility	Count	Simulation	% Difference
MD 100	89530	88232	-1%
MD 175	28038	26083	-7%
MD 32	69565	58858	-15%
Total	187133	173173	-7%
West			
Facility	Count	Simulation	% Difference
MD 100	73000	61577	-16%
MD 175	49900	24922	-50%
MD 32	90650	82061	-9%
Total	213550	168560	-21%

The east screenline indicates that MD 32 is under simulating by 15% in the BMC model. This under simulation was addressed by Anne Arundel County in their past SAM 2 model development efforts by splitting zones and improving the loadings in the Fort Meade area; however that is outside of the scope of this current study. The BMC model significantly under simulated the MD 175 corridor leading into the CTC area. The fratar procedure improved the under simulation so that the counts on MD 175 were a much better match to model results. Adjusting the functional class on US 1 improved the validation within FHWA thresholds, and model adjustments improved the screenline validations for the east and west locations.

Table 2

Howard County Model Regional Validation

Howard County Model Regional Flows			
North			
Facility	Count	Simulation	% Difference
MD 295	103487	87564	-15%
US 1	32110	33122	3%
I 95	186781	197006	5%
US 29	59000	63437	8%
Total	381378	381129	0%
South			
Facility	Count	Simulation	% Difference
MD 295	81313	84172	4%
US 1	33062	31034	-6%
I 95	204178	201178	-1%
Total	318553	316384	-1%
East			
Facility	Count	Simulation	% Difference
MD 100	89530	92052	3%
MD 175	28038	26819	-4%
MD 32	69565	62079	-11%
Total	187133	180950	-3%
West			
Facility	Count	Simulation	% Difference
MD 100	73000	75977	4%
MD 175	49900	45936	-8%
MD 32	90650	82942	-9%
Total	213550	204855	-4%

Columbia Town Center

The Columbia Town Center is the focal point of the county and its plans for urban development. As such proper validation of the base year is critical. The previous CTC subarea model was used as a goal for the Howard County Model validation. The BMC model results indicated that this area was significantly under simulating. The CTC zone structure and highway network were implemented and this improved the results somewhat, however, further adjustments were required. The following table illustrates the BMC model validation for the CTC links with the green cells indicating acceptable model performance, yellow indicating adequate model performance (slightly over FHWA thresholds), and the red cells indicating links that are well outside of the FHWA thresholds. The table also illustrates the CTC control, which is the sum of the trips entering the Town Center from Broken Land Parkway (south) and Governor Warfield Parkway (north). The control locations show that the BMC model was simulating approximately half of the trips entering/exiting the Town Center.

Table 3
BMC Model CTC Validation

Count Location	Screenline	Observed	Simulated	Difference	FHWA Threshold	Screenline Difference
US 29 north of MD 108	1	111,175	99555	-10%	7%	
Centennial Lane north of MD 108	1	13,100	9017	-31%	15%	-11%
Homewood north of MD 108	1	8,800	6240	-29%	25%	
MD 32 west of MD 108	1	27,500	27,777	1%	10%	
Harpers Farm Road (CO 744) south of MD 108	2	13,000	6982	-46%	15%	-18%
Ten Mills Road (CO 886) south of MD 108	2	3,700	6366	72%	25%	
Columbia Road south of MD 108	2	10,350	8740	-16%	15%	
MD 32 east of US 29	3	90,650	82061	-9%	7%	
MD 175 east of US 29	3	49,900	24922	-50%	10%	-16%
MD 108 east of US 29	3	24,100	35805	49%	15%	
Broken Land Pkwy east of US 29	3	36,600	26168	-29%	10%	
MD 175 west of US 29	4	50,900	26881	-47%	10%	-51%
Broken Land Pkwy west of US 29	4	45,000	20112	-55%	10%	
Little Patuxent Pkwy north of Governor Warfield Pkwy	5	52,650	26683	-49%	10%	
Little Patuxent Pkwy south of Governor Warfield Parkway	5	21,250	998	-95%	15%	-10%
S. Entrance Road south of Little Patuxent Pkwy	5	4,350	10872	150%	25%	
Little Patuxent Pkwy (CO 794) west of Governor Warfield Pkwy	5	25,600	12750	-50%	15%	
Twin Rivers Road west of Governor Warfield Pkwy	5	15,100	9857	-35%	15%	
Ten Oaks Road west of MD 108	6	10,750	9,087	-15%	25%	15%
US 29 south of MD 32	6	59,000	71265	21%	10%	
Columbia Town Center Control		97,650	46,795	-52%		

As mentioned previously, a fratar procedure was implemented in Tp+ to adjust the trip tables in the CTC area prior to assignment, and this procedure significantly improved the model validation.

Table 4
Howard County Model CTC Validation

Count Location	Screenline	Observed	Simulated	Difference	FHWA Threshold	Screenline Difference
US 29 north of MD 108	1	111,175	105707	-5%	7%	
Centennial Lane north of MD 108	1	13,100	10226	-22%	15%	-6%
Homewood north of MD 108	1	8,800	7442	-15%	25%	
MD 32 west of MD 108	1	27,500	26,827	-2%	10%	
Harpers Farm Road (CO 744) south of MD 108	2	13,000	11491	-12%	15%	-14%
Ten Mills Road (CO 886) south of MD 108	2	3,700	3409	-8%	25%	
Columbia Road south of MD 108	2	10,350	8472	-18%	15%	
MD 32 east of US 29	3	90,650	82942	-9%	7%	
MD 175 east of US 29	3	49,900	45936	-8%	10%	-2%
MD 108 east of US 29	3	24,100	28371	18%	15%	
Broken Land Pkwy east of US 29	3	36,600	40472	11%	10%	
MD 175 west of US 29	4	50,900	58221	14%	10%	5%
Broken Land Pkwy west of US 29	4	45,000	42582	-5%	10%	
Little Patuxent Pkwy north of Governor Warfield Pkwy	5	52,650	60934	16%	10%	
Little Patuxent Pkwy south of Governor Warfield Parkway	5	21,250	15718	-26%	15%	-10%
S. Entrance Road south of Little Patuxent Pkwy	5	4,350	3684	-15%	25%	
Little Patuxent Pkwy (CO 794) west of Governor Warfield Pkwy	5	25,600	17931	-30%	15%	
Twin Rivers Road west of Governor Warfield Pkwy	5	15,100	12270	-19%	15%	
Ten Oaks Road west of MD 108	6	10,750	11,457	7%	25%	7%
US 29 south of MD 32	6	59,000	63437	8%	10%	
Columbia Town Center Control		97,650	103,516	6%		

Broken Land Parkway

Broken Land Parkway is a short but key corridor connecting MD 32 to Columbia Town Center. The initial model runs indicated that this corridor was over simulating between MD 32 and Snowden River Parkway and significantly under simulating for the rest of the corridor.

Graph 1

Broken Land Parkway BMC Validation

	MD 32	Snowden River Pkwy	US 29	Patuxent Pkwy		
2011 AADT		39,641	36,600	45,000	15,942	
Difference		26.17%	-28.50%	-55.31%	-24.47%	Broken Land Parkway
Simulated Volume		50016	26168	20112	12041	

While the fratar procedure did not fix the over simulation between MD 32 and Snowden River Parkway, it significantly improved the validation for the links leading to the Town Center. The links leading up to the mall are below and slightly above the FHWA threshold of 10%. It should be noted that the link north of Patuxent Parkway is used primarily for loading purposes, and therefore no further adjustments were made to the corridor.

Graph 2

Broken Land Parkway Howard County Model Validation

	MD 32	Snowden River Pkwy	US 29	Patuxent Pkwy		
2011 AADT		39,641	36,600	45,000	15,942	
Difference		27.08%	10.58%	-5.37%	44.89%	Broken Land Parkway
Simulated Volume		50375	40472	42582	23098	

I-95

The I-95 corridor is the primary freeway facility between Baltimore and Washington and carries as many as 200,000 ADT, illustrating its importance in the region. The BMC model validated acceptably for all links in the county. The adjustments to US 1 shifted some additional demand to the I-95 corridor; however, all links still simulated below the FHWA threshold of 7%.

Graph 3

I-95 BMC Validation

	MD 100	MD 175	Patuxent Parkway MD 32	MD 216	
2011 AADT	193,062	195,334	188,862	187,692	186,972
Difference	3.31%	5.13%	-0.74%	0.97%	4.33%
Simulated Volume	199455	205360	187457	189510	195069

Graph 4

I-95 Howard County Model Validation

	MD 100	MD 175	Patuxent Parkway MD 32	MD 216	
2011 AADT	193,062	195,334	188,862	187,692	186,972
Difference	4.20%	6.44%	1.34%	2.99%	5.37%
Simulated Volume	201178	207918	191400	193307	197006

US 1 Corridor

This corridor extends from the Baltimore Beltway (I-695) to the Capital Beltway (I-495) and serves a parallel route to I-95. The BMC model has historically over simulated the US 1 corridor between the two beltways, and the current version of the BMC model over simulates by as much as 60% in the county.

Graph 5

US 1 BMC Validation

	MD 100	Patuxent Parkway MD 32	
2011 AADT	35,641	33,371	35661
Difference	15.58%	47.25%	59.76%
Simulated Volume	41195	49140	56973

The functional class for US 1 was reduced from primary arterial to minor arterial to reflect the speeds and land use in the Laurel and Elkridge areas. This adjustment between the two beltways significantly improved the base year validation for this corridor, with all links below the FHWA threshold of 10%.

Graph 6

US 1 Howard County Model Validation

	MD 100	Patuxent Parkway MD 32	
2011 AADT	35,641	33,371	35661
Difference	5.26%	9.97%	9.39%
Simulated Volume	37515	36698	39009

MD 216 Corridor

The MD 216 corridor extends from downtown Laurel to the Scaggsville area of the County. The corridor is generally parallel to the Gorman Road study area and MD 198.

Graph 7

MD 216 BMC Validation

	US 29	I 95	
2011 AADT	18,041	21,731	25,121
Difference	-44.27%	8.32%	-0.52%
Simulated Volume	10055	23538	24990

Initial model runs indicated that the MD 216 corridor was simulating below the FHWA threshold of 15% with the exception of the link west of US 29. Moving centroids along the corridor closer to MD 216 improved the loadings in this area.

Graph 8

MD 216 Howard County Model Validation

	US 29	I 95	
2011 AADT	18,041	21,731	25,121
Difference	-15.00%	12.71%	15.42%
Simulated Volume	15334	24493	28995

The link east of MD 216 slightly over simulates above the FHWA threshold; however, as the value of 15.42% barely exceeds the threshold of 15%, no further model adjustments were made.

MD 32 Corridor

The MD 32 corridor extends from the Anne Arundel County Line to I-70 in western Howard County. This corridor is a major east-west route through the County and provides access to much of the future growth in the County.

Graph 9

MD 32 BMC Validation

	Clarksville Pike	Columbia Pike	I -95	Washington Blvd	
2011 AADT	26,921	55,191	91,011	79,191	68,291
Difference	3.18%	0.10%	-8.62%	-31.30%	-27.06%
Simulated Volume	27777	55248	83163	54406	49814

However, from a modeling perspective, this corridor was one of the most problematic regarding validation. The initial evaluation showed some segments of the corridor under-simulating by almost 25,000 ADT, which for that segment was 31% of the 2010 count volume. Similar to I-95 and US 29, this corridor functions very much like an interstate facility given the design, speeds, and limited access. Therefore, the entire corridor was re-coded as such.

Although there were slight improvements as a result of these refinements, the links approaching Fort Meade/NSA were still under simulating. To further improve the validation for these links would require modifying the Fort Meade/NSA TAZ structure to replicate the zone structure used in the Anne Arundel County SAM2 model. This adjustment included splitting zones and adjusting the loadings on the base and significantly improved the model validation for the SAM2 model. While this is outside of the current scope of the Howard County model development, the county may explore this option to improve the model performance in the future.

Table 10

MD 32 Howard County Model Validation

	Clarksville Pike	Columbia Pike	I-95	Washington Blvd	
2011 AADT	26,921	55,191	91,011	79,191	68,291
Difference	-0.35%	3.47%	-10.09%	-26.51%	-21.71%
Simulated Volume	26827	57107	81830	58199	53466

When developing the traffic forecasts with this improved model, NCHRP 255 screenline techniques will be used to remedy the remaining inaccuracies for the model in this corridor.

MD 175 Corridor

The MD 175 corridor runs from the Columbia Town Center area to MD 3 in Anne Arundel County. This is a limited-access expressway in some sections west of I-95 and at grade for the remaining portions. MD 175 is a key corridor in the county serving the Jessup State Prison, Fort Meade, and NSA in addition to the Town Center. The initial BMC model runs indicated that this corridor was significantly under simulating in the Town Center area.

Table 11

MD 175 BMC Validation

	Columbia Pike	Snowden River Pkwy	I-95	Washington Blvd		
2011 AADT	50,990	49,990	69,060	47,280	17,590	
Difference	-47.28%	-50.15%	-8.56%	28.88%	1.92%	MD 175
Simulated Volume	26881	24922	63146	60933	17928	

The fratar procedure led to a slight over simulation on the link approaching the Town Center, but improved the validation percentage by 30%. The fratar process led to overall improved validation for the MD 175 corridor particularly near the Town Center, which is the focal point of the BRT study.

Graph 12

MD 175 Howard County Model Validation

	Columbia Pike	Snowden River Pkwy	I-95	Washington Blvd		
2011 AADT	50,990	49,990	69,060	47,280	17,590	
Difference	17.14%	-8.11%	-12.97%	4.08%	1.43%	MD 175
Simulated Volume	59732	45936	60100	49210	17841	

MD 100 Corridor

The MD 100 corridor extends from US 29 to the Anne Arundel County line and east to MD 2 and Pasadena. The corridor is a limited access facility throughout the county, meaning that it would not be sensitive to network changes such as centroid adjustments.

This initial BMC model run indicated that the corridor was simulating reasonably well with half of the links below the FHWA threshold, with the other links under simulating by 15-19%.

Graph 13

MD 100 BMC Validation

	Snowden River Pkwy	I-95	Washington Blvd		
2011 AADT	73,000	90,361	96,881	89,891	
Difference	-15.65%	-3.92%	-18.64%	-5.94%	MD 100
Simulated Volume	61577	86819	78827	84554	

The fratar procedure added some additional trips to the MD 100 corridor, and overall the corridor validation was improved with half of the links simulating below the FHWA threshold as in the initial BMC model run, but with the other links simulating just outside of the FHWA thresholds.

Graph 14

MD 100 Howard County Model Validation

	Snowden River Pkwy	I-95	Washington Blvd		
2011 AADT	73,000	90,361	96,881	89,891	
Difference	4.08%	9.98%	-9.15%	-1.16%	MD 100
Simulated Volume	75977	99383	88016	88850	

MD 108 Corridor

The MD 108 corridor is located north of the Columbia Town Center. It is two lanes for the majority of its length with some small 4 lane sections. The BMC model was simulating this corridor acceptably with all links below the FHWA threshold of 15%.

Graph 15

MD 108 BMC Validation

			Snowden River Pkwy	US 29	Patuxent Pkwy	
2011 AADT				24,080	27,890	15,942
Difference				12.18%	-14.31%	11.70%
Simulated Volume				27012	23898	17808

The fratar procedure added additional trips to the study area network in the CTC area and as such led to the slight over simulation of the link west of US 29. As the remaining links remained below the FHWA threshold, the study team decided that no further adjustment were required for validation purposes.

Graph 16

MD 108 Howard County Model Validation

			Snowden River Pkwy	US 29	Patuxent Pkwy	
2011 AADT				24,080	27,890	15,942
Difference				17.82%	-9.84%	14.75%
Simulated Volume				28371	25145	18294

US 29 Corridor

The US 29 corridor runs north-south from I-70 to the Capital Beltway (I-495). It is a prime candidate for the implementation of BRT service, as it connects densely developed portions of Montgomery County to the south with Columbia Town Center, it is a prime candidate for the implementation of BRT service. US 29 is a limited access facility that also serves a parallel route to I-95 through the county, particularly south of the Town Center.

The initial BMC model results indicated that US 29 was validating within the FHWA thresholds. The fratar procedure led to poorer simulation on the US 29 corridor in the CTC area, with several of the links simulating outside of the FHWA threshold. However, a more detailed review of the results indicated that the percentages do not exceed 10%, which means the corridor is simulating reasonably well. Some of the over simulation on US 29 also results from over simulation on I-70 which feeds US 29. A penalty

could be added to I-70 in the western portion of the county to reduce the number of trips entering the county from the west, though this would have to be accounted for in the forecasting process.

Graph 18

US 29 BMC Validation

	MD 100	MD 175	Patuxent Parkway MD 32	MD 216		
2011 AADT	145,361	105,421	80,061	69,550	57,661	
Difference	-2.47%	-4.04%	3.86%	2.47%	5.07%	US 29
Simulated Volume	141777	101164	83153	71265	60584	

Graph 19

US 29 Howard County Model Validation

	MD 100	MD 175	Patuxent Parkway MD 32	MD 216		
2011 AADT	145,361	105,421	80,061	69,550	57,661	
Difference	7.33%	0.96%	9.99%	-7.30%	10.02%	US 29
Simulated Volume	156016	106430	88058	64476	63437	

Summary of Results

The BMC Version 4 regional model validated reasonably well at the regional level; however under simulation of the CTC area led to the under simulation of regional flow in the east-west direction in the county.

The fratar procedure considerably improved the validation for the CTC area and led to the improvements in validation for a number of the key study corridors in the county. Providing reasonable, intuitive refinements to the highway network achieved further network validation. The only notable tradeoff in introducing the additional trips to the network, was the US 29 corridor which did not simulate as well after the procedure.

Overall, the model replicates travel behavior in the CTC area more accurately that in turn improves the countywide model validation.

The MD 32 corridor is the only key corridor in the study area that is still simulating well outside of the FHWA thresholds. As referenced previously, it is recommended that the county explore replicating the zone structure used in the SAM2 model for the Fort Meade/NSA area in the future. In the meantime, when developing the traffic forecasts with this improved model, NCHRP 255 screenline techniques will be used to remedy the remaining inaccuracies for the model in this corridor