V. EVALUATING OUR CURRENT TRANSPORTATION SYSTEM

The transportation system of the Baltimore region has developed and expanded in response to the needs of both its resident population and employment opportunities. Monitoring and evaluating the performance of the transportation system is important to the system fulfilling its role of supporting the region's society and economy.

The Baltimore region was included in an annual study of congestion in metropolitan areas conducted by the Texas Transportation Institute (TTI)[1]. The Baltimore region, using TTI's most recent available data (1999), is ranked 29th in traffic congestion among the nation's 68 largest urban environments. The TTI Congestion Index was calculated based on travel and incident delay, the duration of congested periods, and the amount of fuel wasted due to congestion. Table V-1 shows Baltimore's placement compared to the top 45 other metropolitan areas. The table also shows the amount of freeway and principal arterial vehicle miles of travel (VMT) occurring during the average day.

The TTI analysis examines roadway factors while a new report, *Easing the Burden*[2], by the Surface Transportation Policy Project (STPP) introduces the presence or absence of quality transit service. STPP analyzed data collected by TTI for its annual Urban Mobility Study and found that metro areas that added the most roads have had little success in easing congestion. But metro areas with good transit service rank significantly lower on a new index.

The Congestion Burden Index, developed by STPP, measures both the severity of traffic congestion and the degree to which commuters are exposed to it. The new index combines TTI's measure of rush-hour congestion with federal data showing the portion of commuters who are driving to work and are therefore exposed to congestion.

STPP reports that quality transit service makes a big difference in allowing more people to avoid driving to work. STPP's analysis shows that the places with the best transit service, as measured by the Transportation Choice Ratio, are also the places where the smallest portion the workforce drives to work. This shows that efforts to provide transit at the local level are delivering a direct payoff to commuters.

This analysis shows that the presence of transit service makes a significant difference in the number of residents who are subject to driving in congested conditions. In places with more transit service, a smaller portion of the population drives to work each day, lowering overall exposure to congested conditions.

In determining the effect of congestion on everyday quality of life, STPP took into account both an area's level of congestion and the degree to which people avoid it by getting around without getting in a car. STPP has calculated a Congestion Burden Index as a first attempt at quantifying the combined effect of congestion and the degree to which people are exposed to it. This index combines TTI's measure of rush-hour traffic, the Travel Rate Index, with figures available for the portion of commuters who are subject to that congestion because they drive to work. A high ranking on the Congestion Burden Index indicates that congestion places a higher burden on residents, both because congestion is worse and because fewer of them are escaping it.

[1] *2001 Urban Mobility Study*, Texas Transportation Institute, May 2001
[2] *Easing the Burden, A Companion Analysis of the TTI's Congestion Study*, Surface Transportation Policy Project, May 2001

Table V-1 Baltimore Region's Placement in TTI Traffic Congestion Ranking

Rank	Urbanized Area	Freeways		Principal Arterials		Roadway Congestion Index
		Daily VMT (000)	Daily VMT Lane/Mile	Daily VMT (000)	Daily VMT Lane/Mile	
1	Los Angeles, CA	123,200	23,335	73,525	6,755	1.58
2	San Francisco-Oakland, CA	45,710	19,575	14,930	7,145	1.39
3	Washington, DC-MD-VA	33,875	18,210	19,850	8,270	1.34
4	Chicago, IL-Northwestern, IN	48,550	18,250	41,660	7,375	1.31
5	Seattle-Everett, WA	24,130	18,560	9,390	6,155	1.30
6	Boston, MA	22,500	17,240	16,600	8,060	1.28
7	Atlanta, GA	40,630	17,780	16,025	7,170	1.27
8	San Diego, CA	31,775	17,850	10,600	5,625	1.25
9	San Bernardino-Riverside, CA	16,270	18,490	11,100	5,150	1.24
10	Portland-Vancouver, OR-WA	12,350	17,520	6,240	6,640	1.24
11	Miami-Hialeah, FL	12,920	17,225	17,450	6,710	1.23
12	Phoenix, AZ	16,995	17,705	18,160	5,975	1.21
13	Denver, CO	16,500	15,940	13,100	7,575	1.20
14	Detroit, MI	30,400	16,840	28,200	6,500	1.20
15	Minneapolis-St. Paul, MN	26,165	16,880	8,100	6,185	1.20
16	Sacramento, CA	11,490	16,895	7,795	6,525	1.20
17	San Jose, CA	18,635	16,490	8,355	6,990	1.19
18	Tacoma, WA	5,250	17,500	3,035	5,100	1.19
19	Las Vegas, NV	6,270	15,675	3,820	7,875	1.18
20	Ft. Lauderdale-Hwood-Pomp.Bch, FL	11,935	16,575	8,355	6,055	1.17
21	New York, NY-Northeastern, NJ	100,260	15,215	57,355	7,855	1.15
22	Charlotte, NC	7,000	15,555	3,490	6,980	1.14
23	Albuquerque, NM	3,875	16,850	4,820	5,385	1.13
24	Cincinnati, OH-KY	15,500	15,980	4,280	5,190	1.12
25	Indianapolis, IN	11,315	15,605	7,000	6,085	1.11
26	Houston, TX	37,725	15,400	16,545	5,950	1.10
27	Tampa, FL	6,000	13,795	7,600	7,345	1.10
28	Louisville, KY-IN	10,035	14,980	4,155	6,490	1.09
29	Baltimore, MD	21,755	14,800	9,070	6,345	1.07
30	Austin, TX	8,110	14,480	4,600	6,345	1.06
31	Philadelphia, PA-NJ	24,155	14,005	21,465	6,870	1.06
32	Honolulu, HI	5,715	14,290	1,900	7,310	1.06
33	Dallas, TX	30,900	14,645	15,740	5,960	1.05
34	Orlando, FL	8,725	12,375	11,600	7,555	1.05
35	Columbus, OH	11,700	14,355	3,975	6,735	1.05
36	Tucson, AZ	2,000	11,430	5,165	7,025	1.05
37	Milwaukee, WI	9,325	15,165	6,725	5,255	1.05
38	St. Louis, MO-IL	25,600	14,465	12,030	5,455	1.03
39	San Antonio, TX	15,420	14,345	4,790	5,295	1.02
40	Nashville, TN	10,245	13,570	4,260	6,925	1.01
41	Jacksonville, FL	9,355	13,365	7,100	6,455	1.00
42	Salt Lake City, UT	6,470	13,070	3,335	7,170	1.00
43	Fresno, CA	2,170	12,765	2,975	6,465	1.00
44	Cleveland, OH	17,320	13,745	6,375	5,640	0.99
45	New Orleans, LA	5,750	13,855	5,320	5,455	0.99

Baltimore ranked 29 on the Travel Burden Index while ranking 41 on the Congestion Burden Index, indicating that the presence of transit, along with ridesharing, walking and bicycling allows more people to avoid rush-hour traffic.

Performance Measures

Socio-economic data are the basic information needed to understand future implications of congestion, patterns of movement, growth changes, etc. These data are provided by transportation analysis zone (TAZ), which is a unit of geography specifically designed for transportation modeling and planning. Existing data are entered into a travel demand model to determine the extent of need for transportation network improvements. Basic socio-economic data are needed for the trip generation module of the travel demand model to develop person trips. Since the model must be validated against present day conditions, the year 1996 was chosen as a base year for which information is available. (Data for the year 2000 were not completely available for this calibration activity.) Trips are generated by four main trip purposes; Home-Based Work (HBW), Home-Based Non-work (HBNW), Work-Based Other (WBO) and Other-Based Other (OBO). For the average weekday in the Baltimore region, the following trips are realized by purpose: HBW trips account for 1,619,800; HBNW trips equal 3,697,900; WBO trips equal 684,600; and OBO trips account for 1,270,200.

These trips are distributed throughout the region and the output vehicle trip table from mode split is assigned to the 1996 highway network using a ten-increment capacity restraint all-or-nothing assignment process. Simulated volumes for the year 1996 are used to identify corridors of congestion, some of which show “below acceptable” driving conditions. Performance measures have been developed to analyze simulation characteristics to show travel demand results.

Performance measures were calculated using the 1996 analysis. Table V-2 displays performance measures for an A.M. peak and 24-hour period. The A.M. peak period, lasting from 6 A.M. to 10 A.M. each weekday, was chosen since this time period represents the highest volumes of travel recorded during any period of the average day. The measures include: VMT, transit ridership, vehicle and person hours of delay, associated costs with delay, trip length, average speed, and air quality emissions. The following are the major summary points:

- About 30 percent of daily VMT occurs during the A.M. peak period.
- Over 44 percent of A.M. peak period VMT occurs on freeways.
- Although only 56 percent of daily VMT occurs on freeways, freeways account for 85% of all VMT occurring under congested conditions.
- Freeways and arterials account for about 92% of all daily VMT and almost 98% of all daily congested VMT.
- Transit ridership was 206,200.
- The percentage of all trips made using transit was 2.8%.

Performance measures are utilized in various tables throughout this report (Tables V-2, VII-1, VIII-1, and VIII-2) and their definitions are described below.

The following describes each of the regional performance measures used in the 2001 BRTP analysis. Measures are for travel within the Baltimore region including: Baltimore City, and Anne Arundel, Baltimore, Carroll, Harford, and Howard counties. Measures were determined for the A.M. peak and for the 24-hour weekday. Measures for the A.M. peak only reflect travel occurring between 6 A.M. and 10 A.M. Measures for the weekday are the sum of travel occurring during the

Table V-2 Regional A.M. Peak and 24-Hour Measures: 1996

Indicator of Transportation Demand	A.M. Peak	24-Hour
Vehicle Miles of Travel (VMT)		
Freeways	10,534,000	35,456,000
Arterials	6,755,000	22,110,000
Collector and Local Roads	1,571,000	5,274,000
All Roads	18,860,000	62,840,000
Congested VMT (LOS E&F)		
Freeways	4,653,000	8,618,000
Arterials	749,000	1,253,000
Collector and Local Roads	125,000	245,000
All Roads	5,527,000	10,116,000
Percentage of Congested VMT (LOS E&F)		
Freeways	44.2%	19.3%
Arterials	11.1%	5.1%
Collector and Local Roads	8.0%	0.0%
All Roads	29.3%	12.8%
Total Transit Ridership	-	206,200
Travel Characteristics		
Average Vehicle Person Trip Length (in minutes)		
Work (HBW)	27.0	-
Non-Work (Non-HBW)	12.4	-
SOV	18.8	-
HOV	15.4	-
All Trips	18.0	-
Transit Mode Share	-	2.8%
Performance		
Vehicle Hours of Delay	54,600	91,400
Annual Cost of Person Hours of Delay (1996 $)	238,820,000	399,784,000
Congested Speed (mph)		
Freeways	43.2	-
Arterials	34.0	-
Collector and Local Roads	30.7	-
All Roads	38.2	-
Air Quality Conformity		
NOx (tons/day)	-	112.60
VOC (tons/day)	-	54.00

five time periods (6-10, 10-3, 3-7, 7-12, 12-6), thereby reflecting a 24-hour weekday.

1. Vehicle Miles of Travel (VMT) of a road segment is the product of its traffic volume and length. VMT for all roads is therefore the sum of the VMT for all road segments in the transportation network. Likewise, VMT for freeways is the sum of the VMT for all freeway segments in the transportation network. All VMT has been refined to reflect Highway Performance Monitoring System (HPMS) VMT estimates factored to represent an average summer weekday.

2. Congested VMT was defined as VMT at Level-of-Service (LOS) E&F. LOS is an "A" through "F" grading system that expresses the severity of congestion for a road segment based on its Volume/Capacity (V/C) ratio. LOS "A" and "F" describe the least and most congested conditions. The LOS ranges used in this analysis are from the 1994 *Highway Capacity Manual* (HCM) as identified in Table V-3 below:

Table V-3 Level of Service Ranges from the 1994 Highway Capacity Manual

Level of Service	1994 HCM LOS Ranges For Volume/Capacity Ratio	
	Freeway[1]	Highway[2]
A	0 to 0.304	0 to 0.30
B	0.304 to 0.487	0.30 to 0.50
C	0.487 to 0.715	0.50 to 0.70
D	0.715 to 0.876	0.70 to 0.84
E	0.876 to 1.0	0.84 to 1.0
F	1.0 +	1.0 +

1 Assumes a 70 mph free-flow speed and a 6 or 8 lane freeway.
2. Assumes a 50 mph free-flow speed.

3. Percentage of Congested VMT is the percentage of VMT that occurs at LOS E&F.

4. Total Transit Ridership is for all linked transit trips for bus and rail transit modes. Linked trips refer to a trip from the transit rider's residence to their workplace, including any stops or transfers along the way.

5. Transit Mode Share is the percentage of all motorized person trips that use transit.

6. Automobile Occupancy is the driver and number of passengers in an auto. Occupancy was calculated for work and non-work automobile trips.

7. Vehicle Hours of Delay is determined by summing the difference between the A.M. peak free-flow and congested travel times multiplied by the traffic volume for every link in the network.

8. Annual Cost of Person Hours of Delay was calculated by first dividing person hours of delay by the average vehicle occupancy factor to determine vehicle hours of delay. Next, the cost per vehicle hour of delay, $10.92 in 1990 dollars, was looked up in the National Highway Institute's *Estimating the Impacts of Urban Transportation Alternatives, Course No. 15257 Participant's Notebook*. The 1990 cost per vehicle hour of delay was converted into 1996 dollars using the Consumer Price Index for Transportation. The 1996 cost per vehicle hours of delay, $12.96, was then multiplied by the number of vehicle hours of delay to determine the daily cost of person hours of delay. Lastly, assuming 250 workdays per year, the annual cost of person hours of delay was calculated.

9. Average Vehicle Person Trip Length was determined for the A.M. peak work and non-work trips and for Single Occupant Vehicle (SOV) and High Occupancy Vehicle (HOV) trips. This was done by first summing the product of zone to zone travel times on the congested network and the number of vehicle trips. The sum was then divided by the number of person trips to get trip length in minutes.

10. Congested Speed for all roads was determined by weighting the congested speeds for each road type, e.g., freeway, arterial, by the VMT for that road type. Congested speeds for freeways, arterials, and collector and local roads were determined directly from the model output.

11. Air Quality Conformity refers to the daily number of tons of Nitrogen Oxides (NO_x) and Volatile Organic Compounds (VOC) produced by all vehicles in the Baltimore region as determined by the required Environmental Protection Agency (EPA) Mobile model.

Current System Deficiencies

Suburban growth outside of established communities and activity centers has caused an increase in the distribution of person trips among the new suburban activity centers. The lack of adequate facilities to meet this need causes increased congestion, longer trip lengths producing greater VMT, increases in emissions, and lost productivity in the workplace. With more of the region's residents and employees moving to dispersed locations, an increasing share of the region's person travel needs cannot be served effectively by any one conventional transportation improvement. The mainly radial design of the transit network and high-capacity roadway network is becoming unsuitable for serving the multi-directional travel that results from dispersed development patterns.

The most evident problem areas in the Baltimore region continue to be the major connectors linking the region's perimeter with Baltimore City. I-95, I-695, and MD 295 are the most heavily-traveled roadways in the region. High levels of congestion are exhibited on these roadways especially during the peak periods. To a lesser extent, US 29 and I-70 in Howard County, MD 2 in Anne Arundel County, and I-795 in Baltimore County, experience periods of high congestion at some period during the day. A map displaying these congested areas for some time period during the day is shown in Figure V-1. There is no practical means that would reduce the peak traffic on these roadways to levels that would allow free-flow speeds. Congestion will continue to be a factor in these corridors.

The Committed Transportation Network: 2001-2006

To serve as a foundation for development of the 2001 Baltimore Regional Transportation Plan (BRTP), a baseline network was created based on the following components; land use, socio-economic forecasts, and the projects committed for construction by 2006. The baseline consists of an existing and committed (E&C) network that included a combination of two key infrastructure groupings:

- The existing network of highway and transit infrastructure
- The collection of highway and transit projects with committed funding for implementation through year 2006

Figure V-1

and all figures/maps in this document are available on the BMC webpage, http://www.baltometro.org/mambo/content/view/399/322/.

Figure V-2

and all figures/maps in this document are available on the BMC webpage, http://www.baltometro.org/mambo/content/view/399/322/.

The existing and committed (E&C) highway network for the Baltimore region shows all existing roadways and new roads and additional lanes scheduled for construction by the year 2006. Figure V-2 displays the E&C, or programmed, improvements through 2006. (For a list of E&C improvements, see Appendix A.) It is considered baseline because it is the network that would be in place assuming no additional transportation facilities are funded after 2006.

The baseline network includes transit lines, freeways and expressways, major and minor arterials, and some local connector roads. Generally, local access roads are not represented. This network will serve as the baseline from which to analyze socio-economic forecasts and related travel demand trends.

To assess the impacts of proposed projects, simulated travel on alternative networks is compared with simulated travel on the E&C network. To prepare for this exercise, a 2025 trip table, comprised of 2025 socio-economic assumptions, is assigned to the E&C network to illustrate what regional system deficiencies would occur if no new improvements were constructed by the year 2025.

If socio-economic projections hold true and only the E&C network of infrastructure remains, future roadway congestion levels will be pronounced. The congestion effects of the 2025 E&C simulation are shown in Figure V-3. The figure shows that congestion will be pronounced on I-695, I-95, I-83, I-97, MD 295, US 29, I-70, MD 30, I-795 and MD 140. This comparison shows that congestion has encompassed a much larger area in comparison to the existing 1996 conditions. It appears that the growth in vehicular travel, spurred by population and employment growth, has overtaken the rate at which highway and transit construction would minimize the congestion problem.

Figure V-3

and all figures/maps in this document are available on the BMC webpage, http://www.baltometro.org/mambo/content/view/399/322/.