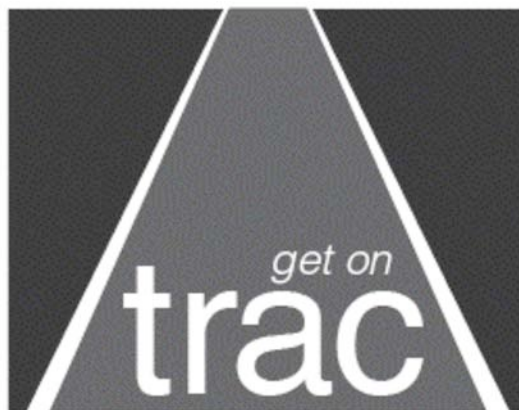


**A Comparison of the Number of Travelers Riding MARC
and Driving I-95 and MD-295
*between the Hours of 5 and 9 a.m.***

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Summary

MARC matters! MARC service removes a significant number of vehicles from congested I-95 and MD-295. A comparison of the number of people driving south in the I-95/MD-295 corridor during rush hour to the number of people riding the MARC train reveals that MARC carries 10% to 13% of the people south across MD-100 between 5:00 a.m. and 9:00 a.m. and north across MD-100 between 4:00 p.m. and 7:00 p.m. Between 6:00 a.m. and 7:00 a.m. and between 5:00 p.m. and 6:00 p.m., up to 21% of travelers are on the train. If MARC service were terminated, traffic loads and travel times on those roads would increase significantly. Conversely, if MARC ridership were increased by 50% to 100%, peak vehicle loads and travel times would fall. These numbers actually under report the train share because the highway numbers include inter-state and freight traffic while the train numbers exclude AMTRAK passengers.

Between 5:00 and 9:00 a.m. the southbound trains average 91% to 95% of sitting capacity, and during the peak 6:00 to 8:00 time operate well above 100% of capacity such that conductors have expressed to the author concerns for passenger safety because of overcrowding. These numbers, based on one sample in 2002 and two in the fall of 2005, have remained remarkably consistent. The MARC train carries a significant fraction of the southbound commuter traffic and would likely carry more if its capacity were increased. When high quality transit that meets people's needs is provided, it will be used. These findings, which highlight the importance of MARC, imply that the reason more people do not ride the train is a lack of capacity rather than a lack of demand.

The quickest and least expensive way for MARC to contribute to Maryland's goal of doubling transit ridership and the only way to significantly increase MARC's fare box recovery is to fill the counter flow empty seats. That is to increase the commuters bound for Baltimore. If good MARC service with good connections can capture 10% of the Washington bound traffic, then good MARC service with good connections to major employment centers in Baltimore City coupled with good advertising should be able to attract more than 5% of the I-95 traffic northbound from the Columbia region and southbound from the White Marsh area. These one to two thousand potential riders going to Baltimore would fill otherwise empty seats, provide 2,000 to 4,000 additional rides per day (a 6% to 12% increase), boost MARC revenue by \$1.5 to \$3 million a year, and reduce highway congestion inbound to Baltimore. However, providing the required connections will require significant MTA operating changes in Baltimore, such as improved connections, and increased morning northbound service to community stations such as St. Denis.

Table 1. Number of trains at Dorsey, Savage, BWI, and Odenton stations in 2002, fraction of corridor traffic on the MARC, and the percent of occupied seats on the train.

Time a.m.	Number Trains @ Dorsey/ Savage	Number Trains @ BWI/ Odenton	MARC Share		Max. Penn Line Seat Occupancy
			Dorsey / BWI	Savage / Odenton	
5:00-6:00	2 / 1	2 / 1	11.8%	7.9%	81%
6:00-7:00	1 / 2	2 / 3	9.0%	19.4%	107%
7:00-8:00	2 / 2	3 / 2	12.2%	13.1%	112%
8:00-9:00	1 / 1	2 / 3	5.8%	11.2%	75%
Total	6	9	9.4%	13.4%	95%

Research Results

This study compared the number of people southbound on I-95 and MD-295 south of MD-100 with the number of people on the MARC Camden and Penn Lines at Dorsey/BWI and Savage/Odenton. Table 1 shows the morning rush hour fraction of the corridor traffic carried by the MARC train.

While Dorsey and BWI each had two trains between 5:00 and 6:00 a.m., one of them did not reach the next station until after 6:00. Therefore, Dorsey and BWI have a larger traveler share before 6:00 than Savage and Odenton. Also, one train arrived at BWI before 8:00 but arrived at Odenton after 8:00 increasing BWI's 7:00-8:00 share over its 8:00-9:00 share.

About the same time the 2002 data was gathered, I received a copy of the Penn Line dispatch sheet, showing which coaches were in each train set. From this I estimated the seat occupancy for each morning train. The hourly averages are shown in the right most column of Table 1. Between 6:00 and 8:00 a.m., the trains operated at 107% to 112% of capacity, which means that up to 11% of the passengers were standing despite the fact that these trains are not designed for standing passengers: there are no hand holds, and the standing times are much longer than would be expected on, say, the D.C. Metrorail system, about 30 minutes from Odenton to Union Station. It is well known that large numbers of commuters endure crowded standing room conditions on the ride home. These results show that MARC carries a significant fraction of the morning rush traffic south toward Washington D.C. and the reason the fraction is not higher is because of capacity limits, not because of demand limits.

To see how things might have changed over time and to provide statistical validity to the original study, I obtained data for 12 October and 9 November 2005. Unfortunately the automatic traffic counter on MD-295 just south of MD-100 was removed during the construction of the Arundel Mills exit. Therefore, there is no way to really know how the vehicle usage of the Parkway has changed. In the first study, the Parkway vehicle counts ranged from 45% to 65% of the I-95 vehicle counts. The second study presumed the Parkway vehicle counts were 55% of the I-95 counts. The results, shown in Table 2, are very similar to the initial study results.

There was no dispatch sheet for the second study. Therefore on Saturday 7 January 2006, I identified the cars in each Penn Line train set and matched them to trains during the following week to compute train occupancy, shown in the right most column of Table 2. While minor services changes have reduced peak overcrowding, the similarity of the results to Table 1 gives statistical validity to the results.

Table 2. Number of trains at Dorsey, Savage, BWI, and Odenton stations in 2005, fraction of corridor traffic on the MARC, and average train seat occupancy.

Time a.m.	Number Trains @ Dorsey/ Savage	Number Trains @ BWI/ Odenton	MARC Share		Max. Penn Line Seat Occupancy
			Dorsey & BWI 12 Oct. / 9 Nov.	Savage & Odenton 12 Oct. / 9 Nov.	
5:00-6:00	1 / 0	2 / 1	12.0% / 12.0%	7.5% / 7.1%	75% / 70%
6:00-7:00	2 / 2	3 / 4	12.1% / 12.0%	21.5% / 21.1%	98% / 103%
7:00-8:00	1 / 2	3 / 2	11.9% / 12.2%	13.4% / 13.6%	106% / 106%
8:00-9:00	1 / 1	1 / 2	3.7% / 3.5%	9.4% / 9.0%	73% / 71%
Total	5	9	9.9% / 9.9%	13.8% / 13.6%	91% / 92%

The second data set included MARC passenger counts for the entire day. The results for the evening rush hour are similar to the morning. Between 4:00 p.m. and 7:00 p.m. on 9 November 2005, MARC carried 14% of the northbound traffic based on the passengers arriving at Odenton / Savage and 9.8% based on the Dorsey / BWI arrival counts. During the peak 5:00 to 6:00 p.m. hour, 21.4% were on the trains arriving at Savage / Odenton and 14.1% on the Dorsey / BWI trains. The 12 October 2005 data shows a lower fraction because the delayed train 432 carried only half its normal load and train 534 was not counted due to overcrowding.

The data reported above compares highway and train usage crossing a specific point. It is open to questions about what points should be used for the comparison, what timeframe should be used, etc. There is a completely different way to look at the question. A daily total of 307,000 vehicles drove past MD-100 on I-95 and MD-295 in the 2002 data. The total daily MARC Penn and Camden line ridership in August 2002 was 18,600 people, about 6% of the highway numbers. Twice the total number of riders measured in my data is 17,270, consistent with the reported 18,600 average daily MARC riders in Aug. 2002. Considering that midday MARC ridership falls to insignificant numbers while the mid-day highway numbers are about half the peak values, the 6% train share is significant and consistent with the rush hour numbers.

The I-95 Master Plan released by the Maryland Transportation Authority on 15 April 2005 states that “Currently, commuter rail (MARC) averages 400 riders per peak period” (page 33) The data gathered here show nearly 500 passengers departing Edgewood and over 700 departing Martin’s Airport.

The number of passengers and seat occupancy rates for each of the southbound morning trains at Martin’s Airport are shown in Table 3. Notice that there are only four trains, about once per hour and generally one quarter to one third of the seats are occupied. North of Baltimore none of the exits from I-95 are identified with a MARC sign. The fact that MARC has as many passengers as it does is remarkable. In the sample here, only 11% of the passengers detrained at Baltimore Penn Station; most of the rest were probably going to Washington.

The author was unable to obtain hourly vehicle counts for I-95 near MD-43. The I-95 Master Plan indicates that at MD-43 peak southbound traffic is nearly 9,000 vehicles per hour, slightly higher than the peak counts just south of MD-100. Using the same 0.3 ratio of peak hour to total 5:00 to 9:00 a.m. counts, total southbound a.m. traffic volume is about 30,000 vehicles or about 33,000 people. Therefore, MARC carries about 2% of the traffic volume south from Martin’s Airport.

Table 3. Number of southbound morning MARC passengers at Martin's Airport.

Time a.m.	Seats per train	12 Oct 2005		9 Nov 2005		Average
		Passengers	Percent Filled	Passengers	Percent Filled	Percent Filled
5:20	1040	196	19%	224	22%	20%
6:15	756	280	37%	283	37%	37%
7:00	910	175	19%	175	19%	19%
9:20	741	41	5.5%	44	5.9%	5.7%
Totals		692		726		

Author's Comments

The high train occupancy near MD-100 suggests that the MARC train fraction would be higher if the system capacity were increased. There are three limits to capacity increases: seats, slots, and spaces. The riders would love to have more seats (longer trains) so they all get seats. Unfortunately there is no space to store more rail cars. It is not possible to run more rush hour trains because the tracks are congested and there are no free slots for more trains and no free equipment. Finally there are no more parking spaces for additional autos. Significant capacity increases would require considerable capital investment in all three areas.

The administration expresses lots of concern for fare box recovery. The only way to significantly increase MARC revenue without increasing its operating costs is to attract commuters to the empty seats northbound in the morning or the empty seats arriving in Baltimore from Perryville. Filling these seats would increase the fare box recovery, increase the number of people invested in the MARC system, and is the lowest cost way for MARC to contribute to Maryland's goal of doubling transit ridership. Morning Penn Line trains return to Baltimore with less than 10% seat occupancy. Similarly, Perryville trains arrive in Baltimore with 20% to 40% seat occupancy. While there were nearly 29,000 vehicles southbound between 5:00 a.m. and 9:00 a.m. crossing MD-100, there were also over 19,000 vehicles (nearly 21,000 people) northbound. The Baltimore Metropolitan Council's 2003 Baltimore Central Business District (CBD) Trip Characteristics Task Report 04-2 dated November 2003 shows that over 10,000 vehicles (more than 12,000 people) drove into the Baltimore central business district between 7:00 a.m. and 9:00 a.m. on I-395 and Russell Street. (Note the two fewer hours than used throughout this report.) If good train service to good connections in Washington D.C. can capture more than 10% of southbound passengers, it is reasonable to conclude that good train service to good connections at Camden and Penn Stations, coupled with good advertising, could capture a significant fraction, perhaps 5%, going north on I-95/MD-295 (1,045 passengers) or 5% of those entering Baltimore on I-395 and Russell street (also about 1,000 potential MARC passengers). These passengers would be filling otherwise empty seats, provide 2,000 additional passenger trips per day and, assuming on average \$125 monthly tickets, boost MARC revenue by \$1.5 million annually, reduce congestion on Russell, Howard, and Conway Streets, and reduce the need for additional parking in downtown Baltimore.

When construction of Maryland route 43 is finished from the White Marsh area to Martin's Airport, it is reasonable to assume that there will be additional people wanting to take advantage of the train

either into Baltimore or to Washington. Again, if there were good service to good connections in Baltimore, a significant fraction, perhaps 5%, of the I-95 traffic in the White Marsh area might divert to the train adding about 1,000 new MARC riders. Those going to Baltimore, the BWI region, or Fort Mead would again be filling otherwise empty seats, which they would then release for additional passengers bound for Washington. These riders would also add 2,000 additional passenger trips per day, boost MARC revenue by another \$1.5 million annually, and reduce congestion south of the beltway. Capturing these riders will likely increase MARC ridership and revenue by 10% to 20% without incurring significantly greater operating costs.

Significantly increasing the number of Baltimore bound commuters will require changes to MTA operating procedures. Morning northbound trains would need to make more stops, not fewer. Baltimore region community stations would need more service, not closure. Light Rail operations would need to be changed to provide good connections with the MARC schedule, not a shuttle that requires a double transfer and average 14 minutes from MARC arrival at Penn Station to Light Rail departure from Mt. Royal. Bus schedules would need to be changed to minimize connection time. Bus schedules might need some flexibility to accommodate delayed trains. With a comprehensive plan, MTA should be able to fill otherwise empty seats with relatively little operating cost increase, significantly raise the MARC fare box recovery, and increase MARC ridership. After increasing the ridership using the methods described, the capital investments (track work and rolling stock) required to increase southbound capacity can be justified.

This study has a companion study comparing the ridership on the Baltimore Metro Subway at Owings Mills with traffic on I-795 and Central Light Rail ridership with traffic on I-83.

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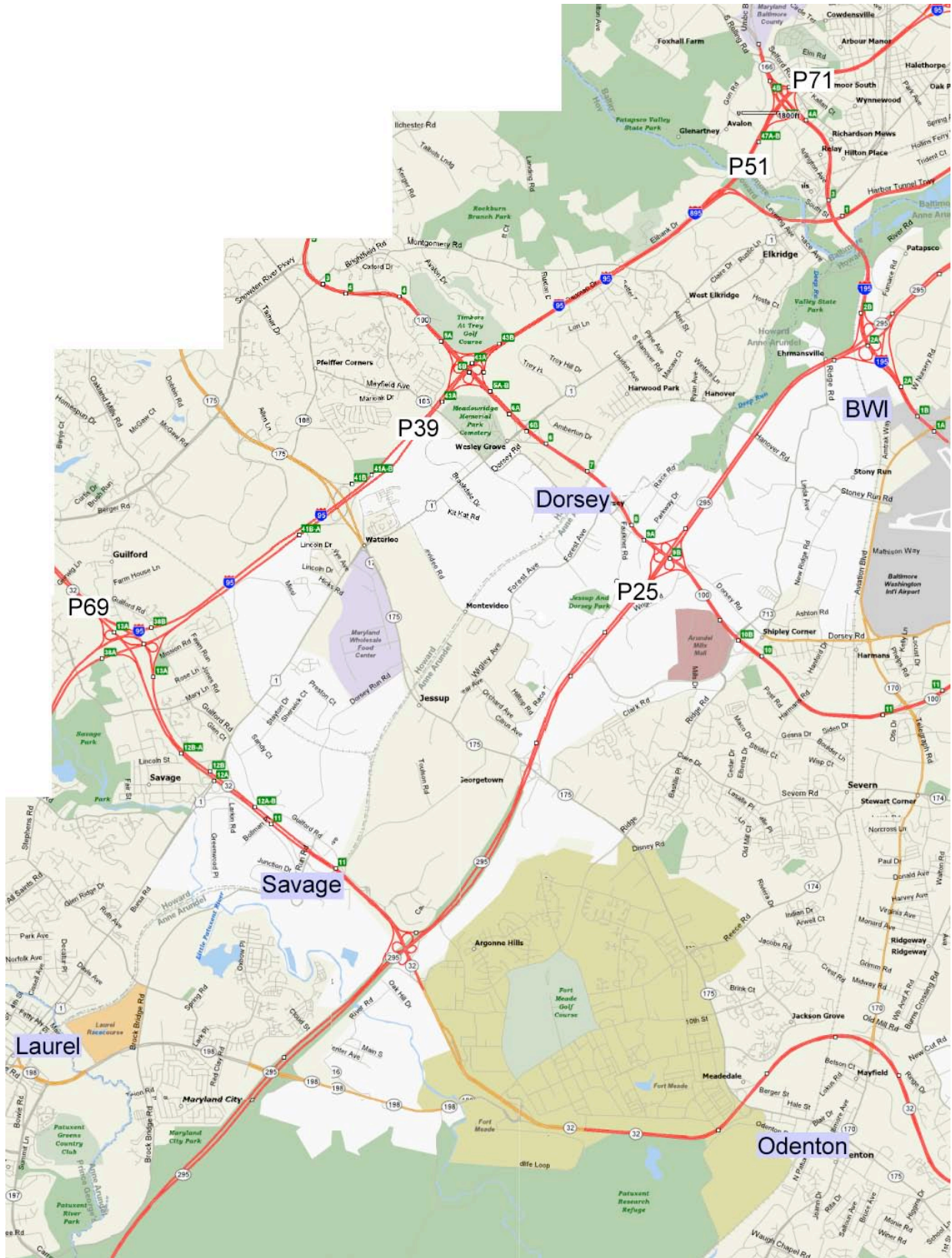


Figure 1. Map showing station and Automatic Traffic Counter (ATC) locations. P0039 and P0025 were used for the 2002 data. Only P0039 was available for the 2005 samples.

Table 3. Raw vehicle and passenger counts in 2002 by hour. The train and highway data were collected on different days.

Time a.m.	I 95 @P0039	MD 295 @P0025	Camden Passengers		Penn Passengers	
	Vehicles	Vehicles	Dorsey	Savage	BWI	Odenton
5:00-6:00	3,951	2,534	109	89	843	521
6:00-7:00	6,676	4,188	130	392	1,045	2477
7:00-8:00	8,267	4,120	393	615	1,501	1435
8:00-9:00	7,706	3,522	66	117	697	1447
Total	26,600	14,364	698	1,213	4,086	5,880

Table 4. Raw vehicle and passenger counts in 12 October and 9 November 2005 by hour. The train and highway data were collected on the same day. MD-295 data estimated.

Time a.m.	12 October 2005						9 November 2005					
	I 95 @P0039	MD295 Estimated	Camden Passengers		Penn Passengers		I 95 @P0039	MD295 Estimated	Camden Passengers		Penn Passengers	
	Vehicles	Vehicles	Dorsey	Savage	BWI	Odenton	Vehicles	Vehicles	Dorsey	Savage	BWI	Odenton
5:00	4,580	2,519	171	100	896	530	4,863	2,675	172	120	961	511
6:00	7,512	4,132	288	436	1,479	3,062	7,920	4,356	274	406	1,560	3,198
7:00	8,474	4,661	216	595	1,741	1,635	8,339	4,586	219	602	1,754	1,635
8:00	7,762	4,269	113	167	402	1,201	7,847	4,316	98	154	395	1,162
Total	28,328	15,581	788	1,298	4,518	6,428	28,969	15,933	763	1,282	4,670	6,506

Semi-raw Data

There are those who will doubt the results given above. For them, this section describes how the data were collected, processed, and a summary of the raw results is included. The vehicle counts were from Automatic Traffic Counter (ATC) on I-95 just south of MD-100 (P0039) and on MD-295 also just south of MD-100 (P0025). There are other ATCs on I-95 and they have been identified in Figure 1. It seemed to the author that these were the best locations. As stated above, P0025 was removed during the construction of the Arundel Mill exit from MD-295. Therefore, the author assumed the parkway traffic volume was 55% of the I-95 traffic. Vehicle counts were converted to passengers by multiplying by 1.1 people per vehicle. Traffic data is available on the web at <http://www.marylandroads.com/keepingcurrent/trafficstudy.asp>.

The 2002 MARC data indicated the number of people on the train departing each station. The 2005 data included estimates of the number of people getting on and off each train at each station from which the number on the train is computed. The train counts were grouped into one-hour blocks based on the scheduled arrival time at each station. As stated above, there were several trains that crossed hour boundaries between the stations of interest.

Savage and Odenton stations have the largest number of morning boardings on the Camden and Penn lines respectively. For best comparison between the highway and train data, it would be ideal to have traffic counts near MD-32. The author is not aware of traffic counters there.

In 2002, the number of seats on the train was calculated from the dispatch sheet that indicated which cars were in each train set. The number of seats was computed assuming 118 seats on the 7700 series single level cars and 130 seats on the new 7800 series bi-level cars. For the second study, the train sets were identified visually. The same seat capacities of the railcars were used.

Assumptions

- 1) The data is correct, meaningful, and correctly entered.

Several conductors have expressed high confidence in the passenger counts. There have been hints that the on board numbers may be more reliable than the station boarding and de-training numbers. The on board numbers were the ones used.

The highway numbers are collected electronically. Although the counters are not ideal, they provide a general idea of the vehicle flow. As noted above, the vehicle counts at this ATC were unclassified and included trucks and through traffic while the train data excluded the 4 to 5 AMTRAK trains.

- 2) Vehicle counts were converted to passengers by assuming 1.1 people per vehicle.

The 2000 US Census gives a rush hour vehicle occupancy rate of 1.08 per vehicle in the Baltimore Region. The Baltimore Metropolitan Council (BMC) has conducted numerous studies of rush hour vehicle occupancy. Their "2003 Baltimore Central Business District (CBD) Trip Characteristics" found 1.18 people per passenger vehicle entering the Baltimore CBD over the entire rush hour. Their "2004 Employment/Activity Center Vehicle Occupancy and Classification Study" found vehicle occupancy of 1.25 in Bel Air, 1.21 at BWI, 1.12 in the White Marsh business region, and 1.05 in Woodlawn. Using 1.08 increases the Dorsey/BWI fraction to above 10%. Using 1.2 reduces the Savage/Odenton fraction to 12.5%

- 3) The first study assumed that the single data sample was typical and train and highway data collected on different days could be compared.

The new data reinforces the validity of these assumptions.

- 4) The comparisons assume that the highway and rail numbers were measured at equivalent locations.

Because the sample points were not co-located, train numbers north and south of the highway measuring points were used. Also the total day numbers support the rush hour data.

- 5) The studies assumed that the relevant roads are limited to I-95 and MD-295.

One could argue that US-1 (there are no counters on US-1), US-29 and, perhaps, I-97 should be included in the corridor. More than 90% of the train riders and a large fraction of the I-95 and MD-295 traffic are going to Washington D.C. I assume that a large fraction of the US-1 and US-29 traffic is of shorter duration. Most vehicles on I-97 are headed to Annapolis, although some, including my coworkers, use I-97 / US-50 to reach New Carrollton or Washington D.C.