More Sprawl, More Traffic, No Relief: An Analysis of Proposed Potomac River Crossings

Technical Report of research completed by:

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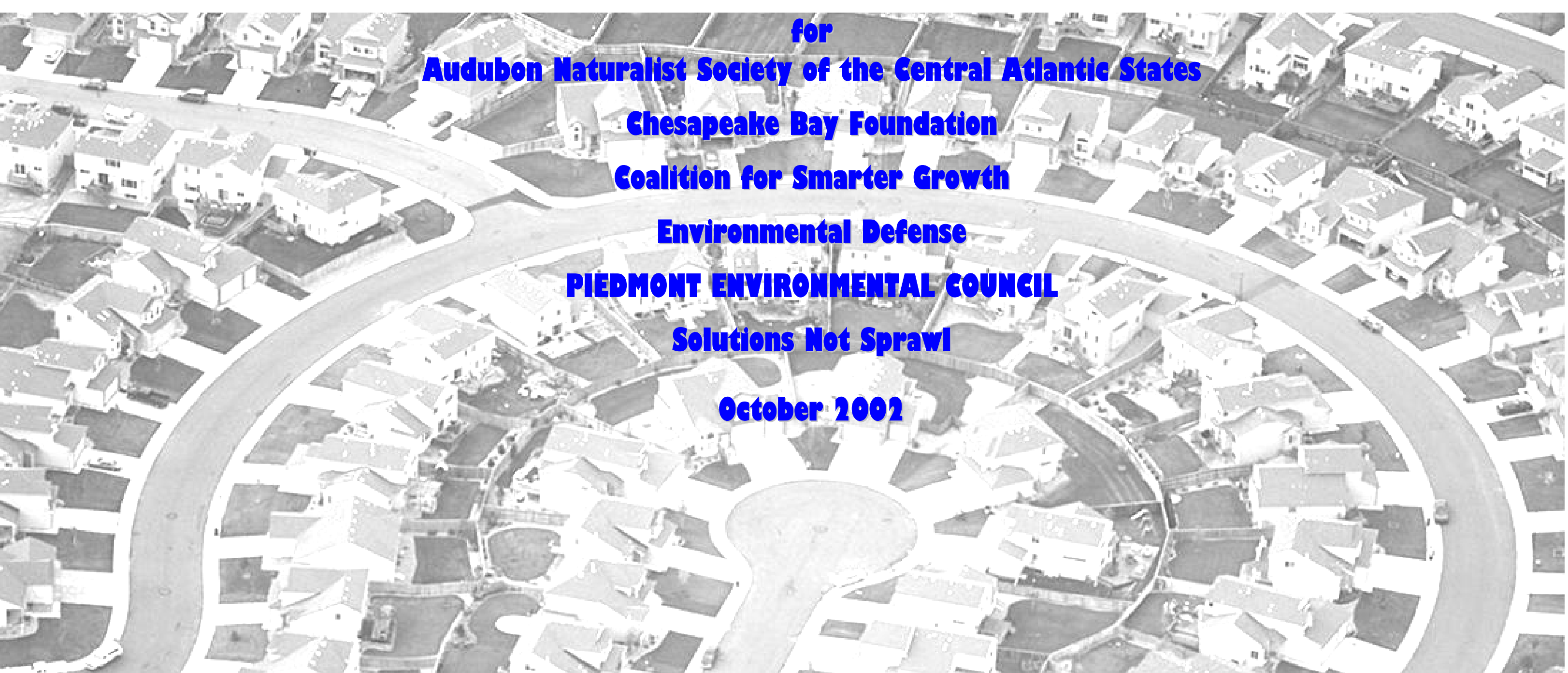

for

Audubon Naturalist Society of the Central Atlantic States

Chesapeake Bay Foundation

Coalition for Smarter Growth

Environmental Defense

PIEDMONT ENVIRONMENTAL COUNCIL

Solutions Not Sprawl

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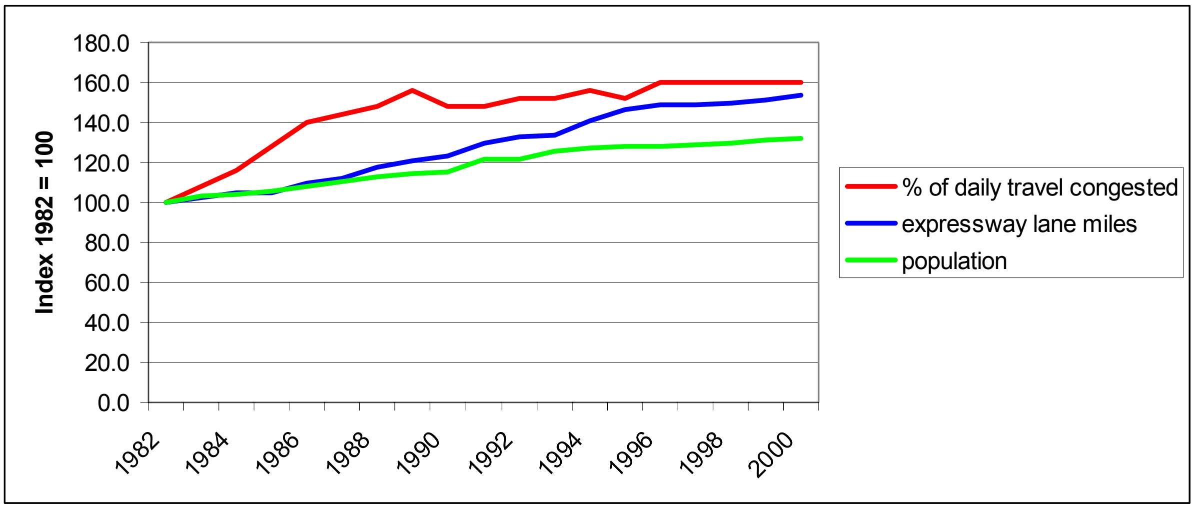
INTRODUCTION

The Washington region is considering several alternatives for a new expressway Potomac River crossings west of the beltway. Before investing in any of these projects, it is critical that citizens understand what has happened in past efforts to reduce traffic congestion through highway construction, and what will likely happen in the future. This report documents land use changes and traffic impacts that would result from different possible new Potomac River crossings west of the beltway. In each case, the new roadways will bring additional development, and additional traffic. The traffic benefits of any of these alternative highways will be small, and outweighed by the costs.

Despite billions of dollars of investments in suburban expressways, congestion has increased in every major metropolitan area in the U.S. over the past twenty years. In the Washington D.C. region, expressway capacity has increased much faster than population growth, without any success in alleviating traffic congestion.

Figure 1: Expressway Investments Have Failed to Reduce Congestion in the Region



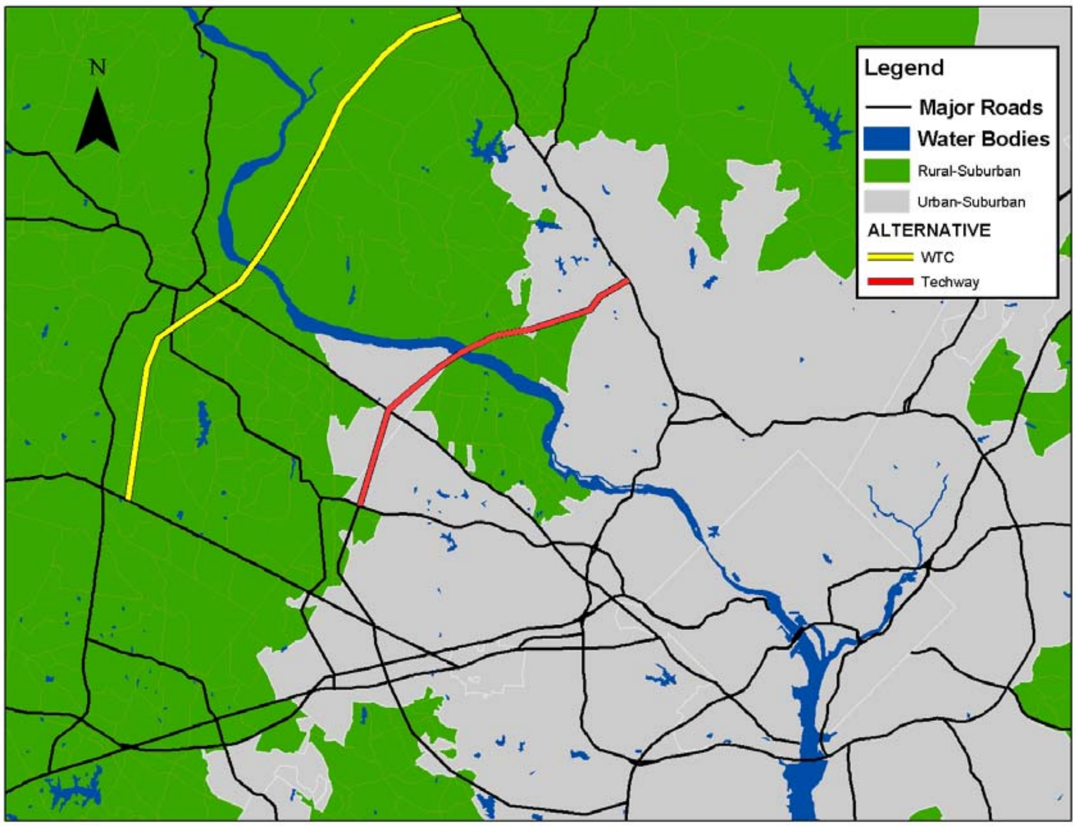
Texas Transportation Institute *Urban Mobility Study* data for the Washington D.C. region

New and widened suburban expressways have failed to live up to their promise. Sprawling development has followed the expressway projects, and expressways have filled with traffic much faster than planners assumed. Travel begins at homes and businesses. No trip begins or ends on an expressway, and the increased expressway traffic has spilled over onto intersecting roadways, creating many new bottlenecks. Expected traffic decreases on other roadways often have failed to occur at all.

The history of widening I-270 in Montgomery County, Maryland in the late 1980's demonstrates all these failings. Traffic conditions improved briefly. Then land development boomed in the corridor. "In the five years before construction began, officials endorsed 1,745 new homes in the area stretching from Rockville to Clarksburg. During the next five years, 13,642 won approval." (*Washington Post*, January 4, 1999) By 1997, I-270 was routinely overrunning its designed capacity, and peak-hour traffic volumes on some segments had surpassed levels forecasted for 2010.

This report analyzes traffic impacts that would result from different proposed expressway projects shown in Figure 2 below.

Figure 2: Proposed New Expressway/Potomac River Crossings



Different alignments have been proposed for the roadways. The WTC as modeled would cross the Potomac east of Leesburg. The Techway as modeled would cross the river near the Fairfax/Loudoun County line.

The following sections describe:

- how the regional travel demand model was used to forecast travel
- model enhancements for more accurate river crossing estimates,
- future land use forecasts, and
- resulting changes in traffic volumes and patterns.

TRAVEL DEMAND MODEL AND ENHANCEMENTS

The Metropolitan Washington Council of Governments (MWCOG) and its National Capital Region Transportation Planning Board (TPB), which serves as the region's Metropolitan Planning Organization (MPO) is developing a new version of its travel demand model. The Draft Version 2.0 model released to us on March 25, 2002 will be referred heretofore in this report as the "DCV2 model." The DCV2 model uses the TP+ transportation modeling software, and includes a number of changes that have been made to various modules which make up the traditional four-step travel demand modeling process as compared with previous versions of the TPB model.

The TPB intends to couple a slightly refined version of the DCV2 model, which was released in October 2002 as the "Version 2.1 model", with the EPA's new mobile source emissions factor model, MOBILE6. The joint travel demand and mobile source emission models will be used for future air quality conformity analyses of the D.C. region's Transportation Improvement Program (TIP) and the Constrained Long-Range Plan (CLRP) as well as for transportation project evaluations.

Our review of the DCV2 model has revealed deficiencies in assumptions and methods which have serious implications for air quality planning, the traffic projections for an additional Potomac River bridge, and other transportation project analyses.

Some of the key deficiencies in the DCV2 model include:

1. An extensive set of K-factors and time penalties is used during trip distribution
2. The number and length of vehicle trips estimated by the model is inconsistent with National Person Transportation Survey data
3. The distribution feedback mechanism is only applied to home-based work trips
4. The gravity model is not converging due to coding errors in the trip distribution TP+ script file

TIME PENALTIES AND K-FACTORS

A key part of modeling travel behavior is joining trip origins and trip destinations. This is accomplished in the trip distribution step of the travel demand model using a gravity model. The gravity model is named because it is analogous to the theory of gravitation. The attractiveness of a potential origin-destination pair is positively related to the number of trips at each end, and negatively related to travel time. "K-factors" and time penalties are sometimes used to adjust the relative attractiveness of possible origin-destination pairs.

The DCV2 model has more than 42 K-factors and 356 income-level time penalties in the trip distribution step for home-based work (HBW), home-based shopping (HBS), home-based other (HBO), and nonhome-based (NHB) trip purposes. In addition, there are also 114 K-factors for the medium and heavy truck trip purposes. Time penalties and K-factors ranging from 0.5 minutes to 15 minutes are used to restrict travel between certain zone pairs in the model. Available modeling tools can not always replicate observed travel behavior when psychological and/or historical elements are at work, which is often the case with natural barriers such as rivers. In these cases, K-factors are sometimes used to better match bridge volumes and/or model calibration. In the assignment step, the DCV2 model includes 14 bridge penalties of 5 minutes each on all of the Potomac River bridges. However, the time penalties and K-factors implemented in the TPB gravity model simply add time to inter-county trips and trips between Washington D.C. and the surrounding regions. Most disturbing is the use of time factors for intra-county trips, where there is no physical or socioeconomic reason that these factors should be necessary.

Although the use of K-factors may improve model results in the base year, it also forces future model scenarios to be similar to the base year, thereby limiting model sensitivity. Furthermore, they often address symptoms that really should be treated more systematically, by using more accurate methods to assure that trip rates, trip length distributions, and average auto occupancy values are all correct. The standard textbook on travel demand modeling is *Modeling Transport* by Ortúzar and Willumsen. Their guidance on K-factors is:

> *The best advice that can be given in respect of K-factors is: do not use them. If a study area has a small number of zone pairs (say, less than 5% of the total) with a special trip making association which is likely to remain in the future, then the use of a few K-factors might be justified, sparingly and cautiously. But the use of a model with a full set of Kfactors cannot be justified.*[1]

We believe that the best case for K-Factors in the Washington region can be made for State-to-State movements (considering D.C. as another "State"). In these cases, taxation can be different, affecting both work and shopping trips. Other trips can be linked to those trips.

We have removed all the income-level time penalties from the trip distribution step in the Enhanced Model, and replaced the TPB K-factors with a more limited set. For each of the six trip purposes, three "State" specific K-factors are applied during trip distribution. A K-factor value of 1800[2] is applied for all trips from the D.C. region to the D.C. region (TAZs 1-319). A K-factor value of 1400 is applied for all trips internal to the State of Maryland (TAZs 320-1229). The final K-factor is also equal to 1400 for trips internal to the Sate of Virginia (TAZs 1230-2144). K-factors are used in the gravity model to increase the attraction power of certain traffic analysis zones. As such, the K-factors we have specified make border-crossing trips less attractive than a trip that begins and ends in one of three regions defined above.

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[1] Ortúzar, Juan de Dios and Luis G. Willumsen. *Modeling Transport 3rd Edition,* p. 193. New York, NY: John Wiley and Sons, 2001.

[2] TP+ K-Factors are in implied thousandths; therefore 1800 is equal to a multiplier of 1.8.

NUMBER OF TRIPS AND TRIP LENGTHS

Even with more realistic K-factors, the model consistently over-predicted the number of Potomac River crossings. We began to suspect that the DCV2 model was not accurately predicting the number of trips and/or the trip lengths.

In order to understand this discrepancy with the DCV2 model, we compared the estimated number of vehicle miles of travel (VMT) against the vehicle miles of travel from corresponding base year traffic counts. The estimated VMT is calculated by multiplying the modeled link volume by the link distance. Traffic counts are not available for every link in the model. However, where count data is available, the count VMT is calculated by multiplying the count volume by the link distance. Table 1 below shows estimated 1994 daily VMT and corresponding count VMT according to the count range (a proxy for facility type).

Table 1: Daily 1994 VMT – Estimated versus Count

Count Range	Estimated VMT	Count VMT	% Difference
0 - 20,000	61,383,259	54,216,970	13%
20,000 - 40,000	29,351,014	29,494,240	0%
40,000 - 60,000	9,986,070	9,515,490	5%
60,000 - 80,000	4,923,946	5,196,100	-5%
80,000 - 100,000	8,728,344	9,421,070	-7%
100,000 – 120,000	8,823,471	9,866,850	-11%
120,000 – 140,000	208,882	290,920	-28%
Total	123,404,986	118,001,640	5%

As seen in Table 1, the DCV2 model assigns too many vehicles to the low class facilities which have count volumes under 20,000 vehicles per day. The estimated volume on these roadways is 13 percent too high. In addition, the model is under-assigning vehicles to the high class facilities which have count volumes greater than 100,000 vehicles per day. The estimated volumes on the two high class facility types are 11 percent and 28 percent low respectively when compared against the count VMT. The evidence in Table 1 suggests that the DCV2 model is estimating too many trips and that on average the trips are too short.

These suspicions were confirmed when we compared DCV2 model results against data extracted from the National Person Transportation Survey (NPTS) for the D.C. region. Table 2 shows the number of daily vehicle trips from the 1994 DCV2 model and 1995 NPTS.[1]

[1] The 1995 NPTS sample for the Washington region includes 798 households which are weighted by household size, race, ethnicity, and month of response. This sample size is sufficiently large to estimate regional totals as is done here. A larger sample size is necessary for subpopulation estimates. However, TPB is no longer using their household survey data directly. In the most recent model work, they arbitrarily increase the number of non-work trip productions by 50 percent over the survey results, which they say addresses "underreporting of short non-work trips" (*Version 2.1/TP+ Travel Model Calibration Report Draft,* October 4, 2002). The 1995 NPTS made a major effort to remove undercounting and is a good source to check this assumption.

Table 2: Daily 1994 DCV2 Model versus 1995 NPTS[1] Vehicle Trips

Trip Purpose	1994 DCV2 Model	NPTS	% Difference
HBW	2,981,260	2,197,943	36%
HBS	2,265,846	1,517,079	49%
HBO	6,012,558	4,049,528	48%
NHB	5,106,981	4,029,594	27%
Total	16,366,645	11,794,145	39%

When compared against the NPTS, the DCV2 model predicts 36%, 49%, 48%, and 27% too many trips for HBW, HBS, HBO, and NHB trips respectively. Therefore, the trip rates being applied during trip generation are too high and/or the auto occupancy factors being applied to the number of person trips prior to assignment are too low. Trip generation is accomplished via a FORTRAN program written by MWCOG staff. Because modifying this program and estimating new trip rates and auto occupancy factors is outside our scope of work, we factored the number of trips (by purpose) produced by the DCV2 model. Prior to the highway assignment step in the model chain, the HBW, HBS, HBO, and NHB trip purposes in the final vehicle trip table are factored to yield totals consistent with the NPTS data.

Having reduced the number of vehicle trips, we then needed to lengthen trips. Once again, we compared the DCV2 model results against data extracted from the NPTS for the D.C. region. Table 3 shows the average trip length (in miles) by trip purpose.

Table 3: Average Vehicle Trip Lengths - DCV2 versus NPTS

Trip Purpose	DCV2 Average Trip Length (miles)	NPTS Average Trip Length (miles)	% Difference
HBW	15.29	16.04	-5%
HBS	4.79	5.71	-16%
HBO	5.55	8.82	-37%
NHB	6.63	8.64	-23%

As suspected, vehicle trip lengths in the DCV2 model are too short, especially for non-work trips. We derived and implemented a new set of friction factors for each trip purpose that replicate the observed trip length distances extracted from the NPTS database. Table 4 shows the number of vehicle trips produced by the Enhanced Model as a result of the pre-assignment step trip purpose factoring. Table 5 shows the average vehicle trip lengths that result from the new set of friction factors we have applied in trip distribution. In both cases, the results from our Enhanced Model replicate the NPTS data. The percent differences in the number of trips are within 1 percent, and the trip lengths are within 5 percent.

[1] The NPTS region is not identical to the TPB region; therefore the NPTS numbers shown were developed by scaling the NPTS numbers with the population ratio between the two regions.

Table 4: Daily 1994 Vehicle Trips – Enhanced Model versus NPTS

Trip Purpose	Enhanced Model	NPTS	% Difference
HBW	2,173,041	2,197,943	-1.1%
HBS	1,529,584	1,517,079	0.8%
HBO	4,051,617	4,049,528	0.1%
NHB	3,998,996	4,029,594	-0.8%
Total	11,753,238	11,794,145	-0.3%

Table 5: Average Vehicle Trip Lengths – Enhanced Model versus NPTS

Trip Purpose	Enhanced Model Ave Trip Length (miles)	NPTS Ave Trip Length (miles)	% Difference
HBW	16.50	16.04	2.9%
HBS	5.63	5.71	-1.4%
HBO	9.16	8.82	3.9%
NHB	8.47	8.64	-2.0%

DISTRIBUTION FEEDBACK

The 1990 Clean Air Act Amendments (CAA) have placed new emphasis on the outputs of transportation forecasting procedures and their sensitivity to travel reduction or congestion reduction strategies. This in turn has focused more attention on "feedback" in the traditional four-step travel forecasting process to ensure that the methods properly account for congestion that does exist and its impact on travel and location decisions.

The U.S. Environmental Protection Agency's guidance on the preparation of emissions inventories (U.S. EPA, 1992) describes feedback as a necessary part of the travel forecasting process and in fact footnotes that the U.S. District Court of Northern California ruled that "where the model had the capability to incorporate feedback affects, the planning agency was obliged to project travel with those effects included." It also emphasized that:

> *EPA considers that the feedback effect between trip assignment and the trip origin/destination is the most important at this time, given the current state of modeling practice and the potential for model improvement that incorporating such effects may have. The link travel times used for trip distribution should be consistent with the results of the trip assignment step.*

To put it simply, distribution feedback is required by the 1990 CAA in the preparation of emissions inventories and air quality conformity determinations. The Code of Federal Regulations Title 40 Section 93.122 which describes the procedures for determining regional transportation-related emissions states:

> *Zone-to-zone travel impedances used to distribute trips between origin and destination pairs must be in reasonable agreement with the travel times that are*

estimated from final assigned traffic volumes. Where use of transit currently is anticipated to be a significant factor in satisfying transportation demand, these times should also be used for modeling mode splits.

The TPB DCV2 model does include distribution feedback. However, the feedback mechanism is only applied to home-based work trips. Specifically, AM congested times are used to distribute HBW trips while off-peak uncongested times are used to distribute HBS, HBO, and NHB trips. The underlying assumption by TPB staff is that congestion does not influence non-work trip making. More should be done to ensure that the zone-to-zone travel times used to distribute trips are in agreement with the travel times resulting from assignment.

In a publication by the Travel Model Improvement Program (TMIP) – a program sposored by the EPA and U.S. DOT – entitled *Incorporating Feedback in Travel Forecasting: Methods, Pitfalls, and Common Concerns* dated March 1996, the authors provide technical guidance on incorporating feedback in the traditional four-step model. Some of the findings published in the report are summarized below:

The implementation of the assignment-distribution feedback can produce different system-wide travel characteristics when there is congestion in the modeled networks. This result suggests that feedback may be essential to accurately forecast travel when congestion exists.

The mix of trips during the congested periods of the day should determine the trip purposes for which feedback should be investigated. Feedback should be implemented for the work-related trips at a minimum, and the other purposes should be examined for their percentage of peak travel.

Table 6 shows the number of 1995 NPTS vehicle trips by trip purpose and time period from the Enhanced Model. Table 7 shows the same data as percentages of the total number of trips in the period.

Table 6: 1995 NPTS Vehicle Trips by Purpose and Time of Day from Enhanced Model

Time Period	HBW	HBS	HBO	NHB	Total
AM Peak	744,709	103,197	609,176	361,035	1,818,177
PM Peak	705,992	392,283	987,148	1,051,491	3,136,914
Off-Peak	722,340	1,034,104	2,455,293	2,506,470	6,798,207

Table 7: Percent of Vehicle Trips by Purpose and Time of Day

Time Period	HBW	HBS	HBO	NHB	Total
AM Peak	41%	6%	34%	20%	100%
PM Peak	23%	13%	31%	34%	100%
Off-Peak	11%	15%	36%	38%	100%

In the AM Peak period, home-based work trips are the highest proportion of total vehicle trips, representing 41 percent, but represent less than half of all trips. In the PM Peak period home-based work trips are not even the highest fraction of total trips. In the PM Peak period, there are more home-based other and nonhome-based trips representing 31 percent and 34 percent of the total vehicle trips respectively. Although TPB may argue that only home-based work trips are influenced by congestion, the mix of trips during the peak periods determines the trip purposes for which feedback should be implemented. Therefore, in the Enhanced Model we distribute all trip types with the AM congested times, not just HBW trips, thereby allowing the feedback mechanism to function for the non-work trips as well.

GRAVITY MODEL CODING ERROR

Trip distribution is the process of estimating the number of trips that will travel between all zones in the network. Usually the process uses the number of trip ends in each zone as the starting point. These marginal totals are distributed to the rows and columns of a generated trip matrix. The most commonly used distribution process is the "gravity" model.

The gravity model equation ensures that the correct number of trips will be distributed for each production zone; the row (production zone) totals for each will always match the number of productions for the zone. However, there is no guarantee that the correct column totals (number of attractions) will be obtained for each attraction zone. The estimated column values usually do not match the desired number of attractions calculated for each zone during trip generation. This is corrected for by iterating the gravity model. After each iteration, the estimated column totals are compared to the desired attractions. Based upon the comparison, the process is repeated with an adjustment in the data. The iteration process is repeated until the results are deemed close enough, or that a maximum number of iterations have been performed. The module stops when one of two conditions is satisfied. These conditions are specified using two parameters in TP+, MAXITERS and MAXRMSE.

MAXITERS specifies that no more than a maximum specified number of iterations are to be performed. The default in TP+ is 3, and the maximum allowed is 99. The DCV2 model is only performing 3 iterations of the gravity model because of a coding error in the TP+ trip distribution script file “Trip_Distribution.s” In the DCV2 script, the maximum number of iterations is specified with the following code:

```
MAXITRS = 7          ; specify GM iterations to be 7 to be consistent with
                     ; prior MINUTP runs
```

The parameter call is missing the letter "E" in MAXITERS. As such, TP+ is not recognizing this parameter initialization and is doing the default number of gravity model iterations (3). It is unlikely the gravity model is converging with only three iterations. The Enhanced Model is using the maximum number for MAXITERS, 99.

The module also computes the root mean square error (RMSE) of the differences in estimated versus desired attractions. If the computed RMSE is less than MAXRMSE, the gravity model is terminated. The DCV2 model uses the default MAXRMSE setting which is 10. The minimum value accepted by TP+ is 0.0001. Considering the computation time necessary to run the DCV2 model, we have reset this parameter to 1 in order to produce better convergence of the gravity model. Setting the MAXITERS and MAXRMSE parameters as described above ensures that the gravity model will converge.

BASE YEAR VALIDATION

As the model will be used to evaluate different proposed Potomac River bridge alignments, an important objective in making these modifications to the DCV2 model was to improve the model's performance in estimating Potomac River crossings. Screenline 20 in the DCV2 model represents the Beltway and 'Inner' Potomac River crossings. The reported 1994 daily traffic count for screenline 20 is 892,000 vehicles. The reported volume estimated using the DCV2 TP+ model is 965,000 vehicles. Therefore, the DCV2 model overestimates the number of river crossings in 1994 by 8 percent. Our model reduces the number of 1994 daily river crossings to 936,561 vehicles per day. This volume is only 5 percent higher than the traffic counts.

Following our analysis of the Version 2.0 model, MWCOG released Version 2.1 and draft documentation dated October 4, 2002. In the *Draft Calibration Report*[1], Exhibit 8-3 shows that the estimated 1994 volume for screenline 20 has increased to 1,090,000 vehicles per day. Therefore, the Version 2.1 model overestimates the number of river crossings in 1994 by 22 percent, an increase of 14 percent against the Version 2.0 model. As such, the Enhanced Model performs better than both the Version 2.0 and 2.1 models in estimating Potomac River crossings.

In addition to improving the Potomac River crossings screenline, our modifications have also improved the overall performance of the model on the other screenlines analyzed by TPB. In the Enhanced Model, 20 of the 35 screenlines show improvement over the DCV2 model (i.e. the ratio of estimated to observed volume is closer to 1). The DCV2 model volume is 8 percent too high. The inner screenlines subtotal (yellow) is 2 percent too low in the Enhanced Model, while the DCV2 model is 9 percent too high. The outer screenlines subtotal (blue) also favors our model which is only 4 percent high instead of the DCV2 model which is 16 percent too high. Most importantly, the grand total of all the screenline volumes (orange) for the Enhanced Model is only 2 percent low. The DCV2 model volume is 10 percent too high when all screenline volumes are summed.

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[1] Metropolitan Washington Council of Governments. *Version 2.1/TP+ Travel Model Calibration Report Draft,* October 4, 2002.

Table 8: Screenline Analysis – DCV2 Model versus Enhanced Model

Screenline	DCV2 Volume	Enhanced Volume	Ground Count	Est/Obs DCV2	Est/Obs Enhanced
1	726,000	643,616	802,000	0.91	0.80
2	942,000	809,961	915,000	1.03	0.89
3	921,000	856,553	866,000	1.06	0.99
4	973,000	841,810	966,000	1.01	0.87
5	1,220,000	1,069,896	1,078,000	1.13	0.99
6	1,733,000	1,496,134	1,591,000	1.09	0.94
7	1,224,000	1,02,291	1,154,000	1.06	0.89
8	1,567,000	1,359,784	1,368,000	1.15	0.99
9	668,000	645,603	598,000	1.12	1.08
10	276,000	267,859	230,000	1.20	1.16
11	168,000	153,055	156,000	1.08	0.98
12	505,000	435,602	472,000	1.07	0.92
13	395,000	362,995	370,000	1.07	0.98
14	308,000	256,109	318,000	0.97	0.81
15	245,000	203,979	238,000	1.03	0.86
16	204,000	168,874	214,000	0.95	0.79
17	435,000	368,698	390,000	1.12	0.95
18	645,000	568,110	544,000	1.19	1.04
19	488,000	459,918	466,000	1.05	0.99
20	965,000	936,561	892,000	1.08	1.05
22	1,427,000	1,252,880	1,196,000	1.19	1.05
23	168,000	166,788	136,000	1.24	1.23
24	440,000	427,707	444,000	0.99	0.96
25	103,000	122,187	78,000	1.32	1.57
26	399,000	383,145	256,000	1.56	1.50
27	308,000	319,408	290,000	1.06	1.10
28	143,000	144,983	108,000	1.32	1.34
Inner Subtotal	17,596,000	15,743,506	16,136,000	1.09	0.98
31	139,000	149,559	58,000	2.40	2.58
32	90,000	84,335	54,000	1.67	1.56
33	281,000	250,549	226,000	1.24	1.11
34	113,000	108,616	94,000	1.20	1.16
35	819,000	703,532	782,000	1.05	0.90
36	66,000	58,437	28,000	2.36	2.09
37	27,000	26,524	24,000	1.13	1.11
38	136,000	123,077	174,000	0.78	0.71
Outer Subtotal	1,671,000	1,504,629	1,440,000	1.16	1.04
Grand Total	**19,267,000**	**17,248,135**	**17,576,000**	**1.10**	**0.98**

Table 9: Screenline Analysis – DCV2.1 Model versus Enhanced Model

Screenline	DCV2.1 Volume	Enhanced Volume	Ground Count	Est/Obs DCV2.1	Est/Obs Enhanced
1	817,000	643,616	802,000	1.02	0.80
2	1,120,000	809,961	915,000	1.22	0.89
3	965,000	856,553	866,000	1.11	0.99
4	1,133,000	841,810	966,000	1.17	0.87
5	1,202,000	1,069,896	1,078,000	1.12	0.99
6	1,749,000	1,496,134	1,591,000	1.10	0.94
7	1,245,000	1,02,291	1,154,000	1.08	0.89
8	1,606,000	1,359,784	1,368,000	1.17	0.99
9	679,000	645,603	598,000	1.14	1.08
10	252,000	267,859	230,000	1.10	1.16
11	163,000	153,055	156,000	1.04	0.98
12	548,000	435,602	472,000	1.16	0.92
13	420,000	362,995	370,000	1.14	0.98
14	327,000	256,109	318,000	1.03	0.81
15	286,000	203,979	238,000	1.20	0.86
16	255,000	168,874	214,000	1.19	0.79
17	437,000	368,698	390,000	1.12	0.95
18	627,000	568,110	544,000	1.15	1.04
19	485,000	459,918	466,000	1.04	0.99
20	1,090,000	936,561	892,000	1.22	1.05
22	1,461,000	1,252,880	1,196,000	1.22	1.05
23	176,000	166,788	136,000	1.29	1.23
24	447,000	427,707	444,000	1.01	0.96
25	101,000	122,187	78,000	1.29	1.57
26	382,000	383,145	256,000	1.49	1.50
27	298,000	319,408	290,000	1.03	1.10
28	109,000	144,983	108,000	1.01	1.34
Inner Subtotal	18,380,000	15,743,506	16,136,000	1.14	0.98
31	127,000	149,559	58,000	2.19	2.58
32	86,000	84,335	54,000	1.59	1.56
33	292,000	250,549	226,000	1.29	1.11
34	94,000	108,616	94,000	1.00	1.16
35	834,000	703,532	782,000	1.07	0.90
36	72,000	58,437	28,000	2.57	2.09
37	26,000	26,524	24,000	1.08	1.11
38	119,000	123,077	174,000	0.68	0.71
Outer Subtotal	1,650,000	1,504,629	1,440,000	1.15	1.04
Grand Total	**20,030,000**	**17,248,135**	**17,576,000**	**1.14**	**0.98**

LAND USE INPUTS TO TRAVEL DEMAND MODEL

The famous line "Build it and they will come" from *Field of Dreams* has often been used to describe increased development and traffic following construction of suburban roadways. Looking at a local area only, it is true – build it and they will come. New housing and commercial development follows the roadways, and traffic increases.

The story is more complex at the regional level. Researchers have found that constructing suburban roadways does not increase regional population and employment. Instead it shifts them from some areas to other areas. Economists Marlon G. Boarnet of University of California at Irvine and Andrew F. Haughwout of the Federal Reserve Bank of New York reviewed research in a paper published by the Brookings Institution.

> *In sum, the evidence suggests that highways influence land prices, population, and employment changes near the project, and that the land use effects are likely at the expense of losses elsewhere. . .*
>
> *The evidence discussed above, especially the census tract population and employment studies, suggests that highways can be conduits for decentralization, helping to channel urban growth in some places rather than others. Furthermore, the evidence on negative spillovers suggests that locations that gain due to highway access do so in part at the expense of other locations. Highway projects confer economic advantages on some places and the relative pattern of comparative advantage can be expected to, and appears to, influence the location of economic activity and growth within and across metropolitan areas. . .*
>
> *There are many reasons to conclude that highways are often paid with funds that come from outside of the area that will benefit from the project. The evidence summarized in Section III suggests that modern highway projects typically bring localized benefits, often for only a part of a metropolitan area or region. Further, the evidence implies that much of the economic impact of highways is to shift activity across the landscape, suggesting that some local benefits are, in part, at the expense of other places that might lose economic activity as a result of a highway project. . .*
>
> *Highways bring spatial externalities. Spatial externalities exist when the geographic pattern of activities affects households or firms in ways that are not fully mediated even by well functioning, otherwise competitive markets. As discussed above, suburban highway projects might weaken agglomeration benefits in central cities, isolate poor residents in ways that are socially undesirable, and possibly worsen air quality or (although the evidence here is weaker) traffic congestion problems.11 Because all of these are external to any one local jurisdiction, a policy of matching local benefits and local costs would still not incorporate the external costs of highway building. Even if local governments paid the full dollar value cost of local highway benefits, the external effects of highway construction described above could lead to, on net,*

> *a highway program that is too large from the broader perspective of an entire metropolitan area or region.*[1]

In the excerpt above, Boarnet and Haughwout include the phrase: "suburban highway projects might weaken agglomeration benefits in central cities." This point is collaborated by a study by A.C. Nelson and Mitchell Moody.[2] They studied 44 metropolitan areas in the U.S. with populations exceeding 700,000 people, but excluding New York City, Chicago and Los Angeles, because their large size makes them outliers in many ways. The study evaluated the sales of goods and services per capita as a key indicator of economic performance, and correlated this against the presence of 0, 1, or 2 circumferential beltways. The results were striking, correlating loss of per capita sales and services with the presence of beltways. This loss to the regional economy of a second beltway, as is proposed for the Washington region, is even stronger than the loss posed by a first beltway.

The research concludes that a metropolitan area's first beltway results in a loss in retail and service sales of $626 per capita in the metropolitan area, and that a second beltway results in an additional loss of $722 per capita.

Both studies contradict assertions by proponents of outer beltways and other suburban expressways that the projects will increase the number of jobs in a region. While the Nelson and Mitchell study does not address the question of whether outer beltways and other suburban expressways affect regional employment and regional population, a negative impact on sales most likely would translate into a negative impact on employment.

The history of the Washington region is consistent with the research discussed in the two studies. The total number of regional households in 2000 was 2 percent less than forecast prior to the I-270 widening project. When the I-270 widening project was planned, forecast housing and employment growth in the corridor was moderate, and growth in the region's core was expected to be much stronger.[3] The forecasts were completely wrong about the distribution of the households. Growth was much lower in the region's core than forecast, and much higher in western suburban areas, especially in the I-270 corridor.

Figure 3 compares the 2000 forecast made before the I-270 widening with actual 2000 numbers. The largest forecasting error was for Montgomery County in the I-270 corridor, where the actual number of households in 2000 exceeded the forecast by 27 percent. Widening I-270 was a primary cause.

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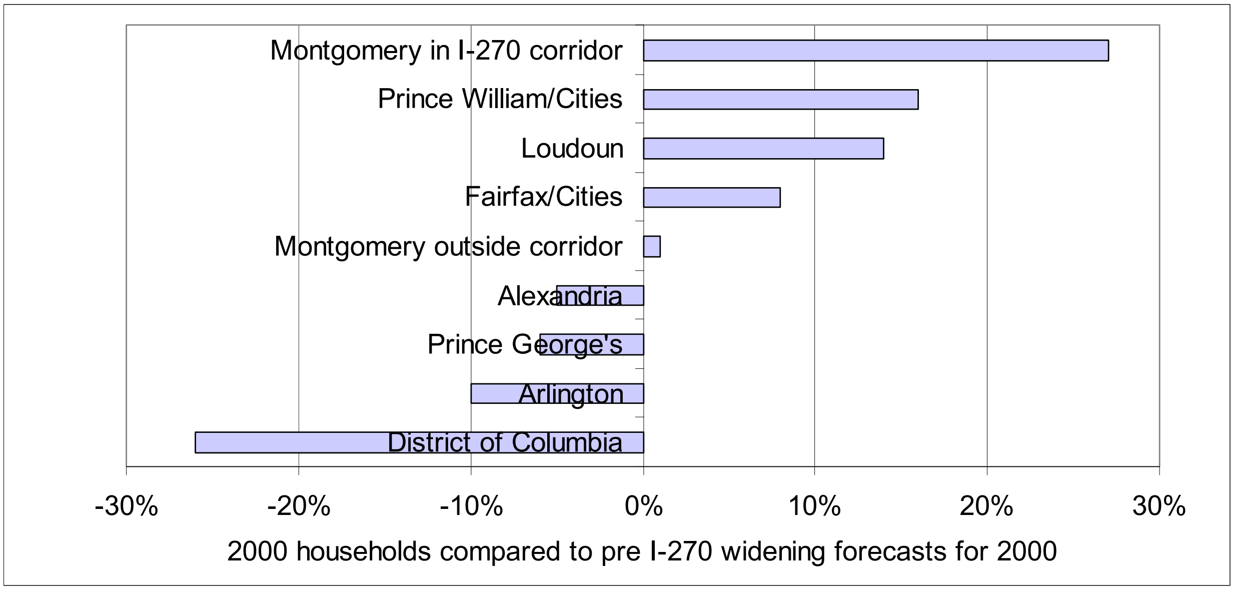
[1] Boarnet, Marlon G. and Andrew F. Haughwout. "Do Highways Matter? Evidence and Policy Implications of Highways' Influence on Metropolitan Development." The Brookings Institution Center on Urban and Metropolitan Policy, August 2000 (http://www.brookings.edu/dybdocroot/urban/boarnetexsum.htm).

[2] Nelson, A.C. and M. Moody. "Effect of Beltways on Metropolitan Economic Activity," *Journal of Urban Planning and Development*, December 2000.

[3] Data from National Capital Region Transportation Planning Board, Metropolitan Washington Council of Governments, "Comparison of 1984 Study Forecasts with Most Recent Data: I-270 Corridor, June 18, 2001.

Figure 3: Past Suburban Expressway Projects Shifted Households to Suburbs from Core



The other areas where growth exceeded the forecast are suburban Virginia areas where expressway capacity has also been greatly expanded. Recent projects in these areas include construction of the Dulles Greenway, and the Route 234 Bypass and widening I-66.

The suburban increases were balanced by declines and slower growth in the core of the region, including D.C., Arlington, Prince George's County, and Alexandria.

Underestimation of employment growth in the I-270 corridor was even more significant. Actual employment in the corridor in 2000 was 45 percent greater than the forecast.

Anita Kramer & Associates have modeled the demographic effects in 2025 that would result from a new Potomac River Bridge.[1] They find that all bridge alternatives will result in increases to growth in households and employment over the base COG 6.2 forecasts in Loudoun, Fairfax, Prince William, and Fauquier counties in Virginia, and in Montgomery and Frederick counties in Maryland.[2]

Tables 10 and 11, reproduced from the Kramer report, summarize the projected demographic changes to the study area counties resulting from the Potomac River Bridge alternatives.

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[1] Anita Kramer & Associates - Economic and Financial Consultants, Washington D.C. "Analysis: Impact on Land Use of a North Potomac River Crossing", 2002.

[2] Anita Kramer & Associates modeled three alternatives. The Techway alternative described in this report is labeled "High Techway" in the Kramer report. The "Low Techway" considered in the Kramer report includes the same alignment as the "High Techway" in Virginia but follows a different route in Maryland. Modeled household and employment shifts are lower than the High Techway scenario but higher than the WTC scenario.

Table 10: Increase in Households Due to Proposed North Potomac River Crossings

	Techway	Techway	WTC	WTC
County	New HH	% New HH	New HH	% New HH
Loudoun	14494	10%	6868	5%
Fairfax	18491	4%	6660	1%
Fauquier	2300	6%	1792	5%
Prince William	10067	6%	6032	4%
Montgomery	31222	8%	11238	3%
Frederick	8866	8%	9526	8%
Total	85441		42116	

Table 11: Increase in Employment Due to Proposed North Potomac River Crossings

	Techway	Techway	WTC	WTC
County	New Emp	% New Emp	New Emp	% New Emp
Loudoun	33224	14%	19957	9%
Fairfax	64186	8%	28279	4%
Fauquier	1856	6%	1559	5%
Prince William	14234	8%	9560	5%
Montgomery	121591	18%	46866	7%
Frederick	17137	11%	18569	11%
Total	252228		124789	

Based on the Boarnet and Haughwout research cited above and the experience of the region in the past two decades, these increases will be balanced by slower growth in other parts of the region. Total regional population and employment will be about the same for all of the scenarios, and are assumed to be exactly the same.[1] It also is assumed that the core areas with a smaller than expected share in the I-270 case will similarly lose share here – D.C., Arlington, Prince George's County, and Alexandria. As shown in Figure 4, these areas grow in both scenarios, but grow at a smaller rate than if a new expressways is constructed.

Similar shifts in employment were from the core areas to balance the increases in the suburbs also were assumed in the expressway scenarios.

In order to model the transportation impacts of the scenarios, the socioeconomic forecasts must be refined to the Transportation Analysis Zone (TAZ) level. The household changes for the Techway and WTC scenarios are shown in Figures 5 and 6.

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[1] Assuming exactly the same number of households and employment in both scenarios makes comparisons of the impacts straightforward. If, contrary to the research cited, constructing a new roadway were to increase regional population, the traffic impacts would be more severe than those described in this report.

Figure 4: Household Growth Shifts from the Core to the Suburbs

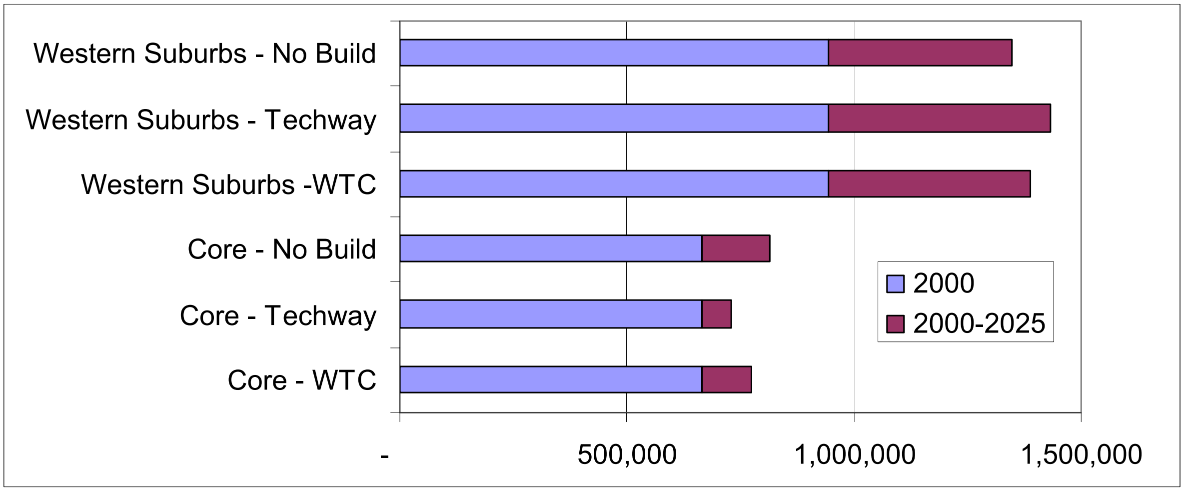


Figure 5: Household Shift: Techway from No Build

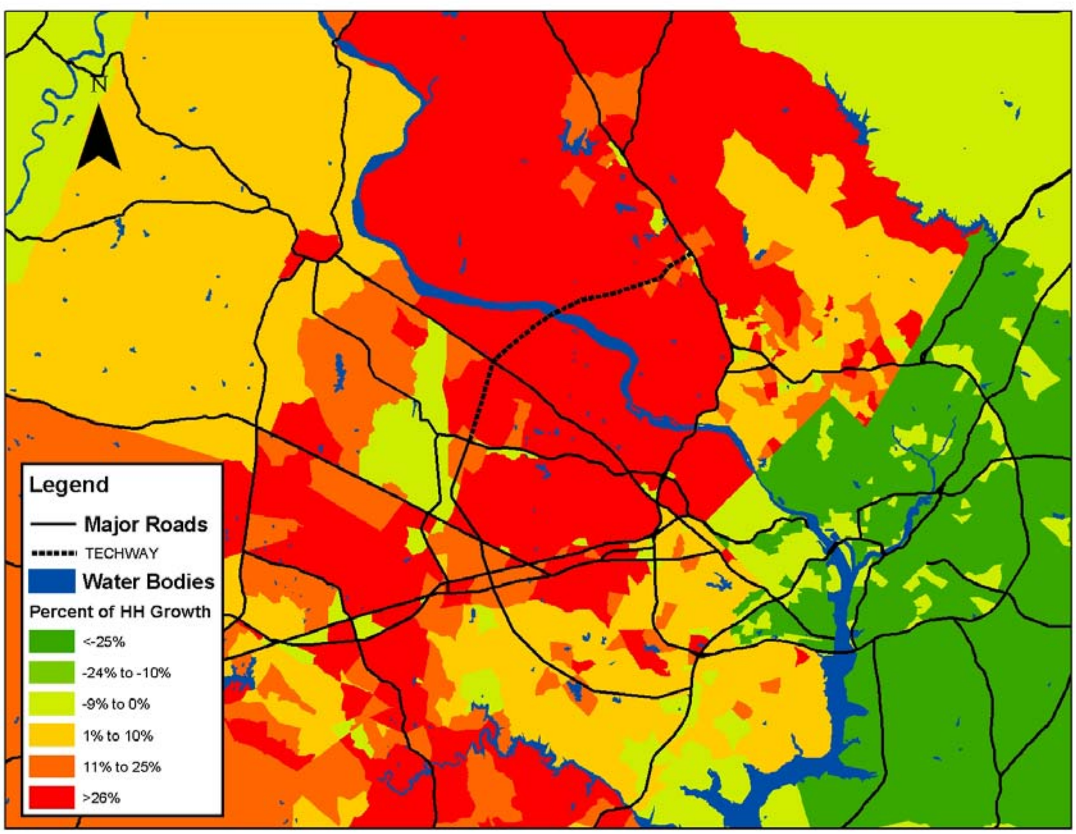
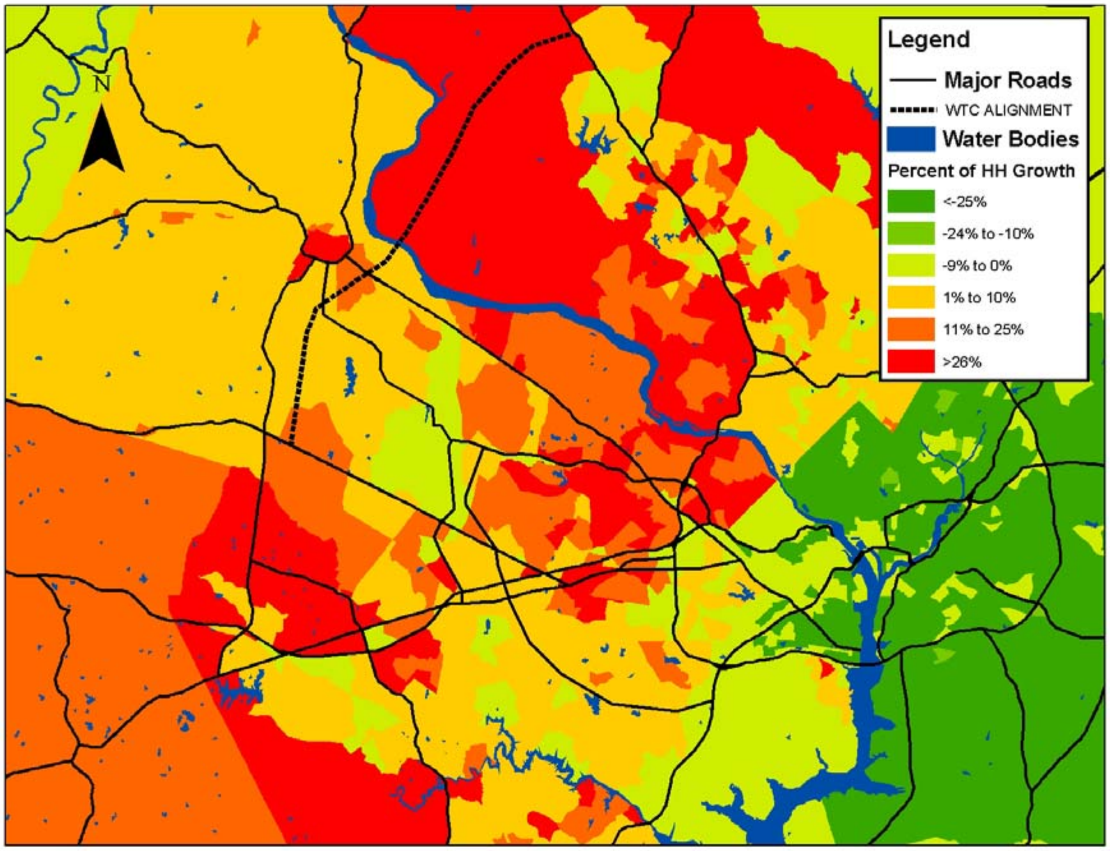


Figure 6: Household Shift: WTC from No Build



LAND USE SHIFTS CAUSE TRAVEL SHIFTS

Following the forecasted shift in land use to the suburbs from the core areas, there also is a shift in trip making to the suburbs. There are more suburb-to-suburb trips, and the average trip length increases because land uses are more dispersed in the suburbs. There is less opportunity for transit use and the transit trips decline. Traffic on some roadways declines; while traffic on other roadways increases.

The model shows that the new roadways would carry a lot of traffic. Depending on how many lanes were built, sections of the new expressways could be congested in 2025. It would be easy to conclude that traffic congestion would have been even worse without the new roadway, but in fact the opposite is true. When the land use shifts and travel shifts are considered, there will be more traffic congestion with the new roadway than without.

Either of these alignments - the Techway or the Western Transportation Corridor - would spur sprawl, traffic, and pollution growth, especially in the western portion of the region, while failing to relieve traffic problems on many existing roads. Construction of the proposed

Techway, for example, would cause the average traffic congestion[1] to rise by 10 percent in Montgomery County, 6 percent in Loudoun, 4 percent in Prince William, and 2 percent in Fairfax and Frederick counties, compared to the No Build scenario. The Western Transportation Corridor would have similar, but more modest growth shift and traffic impacts because the full build out of that corridor would occur later than for the Techway corridor. Thus, average county level traffic congestion would increase by 5 percent in Prince William, 4 percent in Montgomery, 3 percent in Frederick, and 1 percent in Fairfax, compare to the No Build scenario. Loudoun County's comprehensive plan helps limit sprawl effects of the WTC, producing a 4 percent drop in Loudoun County, compared to the No Build scenario. Under either alignment, inner suburban and urban jurisdictions would experience some reduction in traffic due to declining economic and travel activity caused by loss of job and housing growth.

No trip begins or ends on an expressway. With increases in households and employees that a new expressway will bring, almost all local roadways will also have traffic increases. Traffic growth will be greatest around new and existing interchanges. For example, in the Techway scenario traffic on Virginia Route 7 adjacent to a new interchange is 89 percent higher than in the No Build scenario. In the WTC scenario, traffic on Maryland Route 28 is 195 percent higher than the No Build scenario.

Figures 7 and 8 show the difference in traffic congestion by transportation analysis zone. Congestion is represented as the ratio between volume and capacity, where the capacity is higher with any of the proposed expressway scenarios.

The congestion maps tell the same story as the land use maps. Areas near the new expressways will see more development and more traffic. Any increase in capacity from the new expressways is more than offset by increased traffic. Congestion in the corridor is greater with the new expressways than without.

[1]The changes in congestion reported here are calculated as the change in the average daily volume to capacity ratio.

Figure 7: Volume-to-Capacity Ratio (Congestion) Shift: Techway from No Build

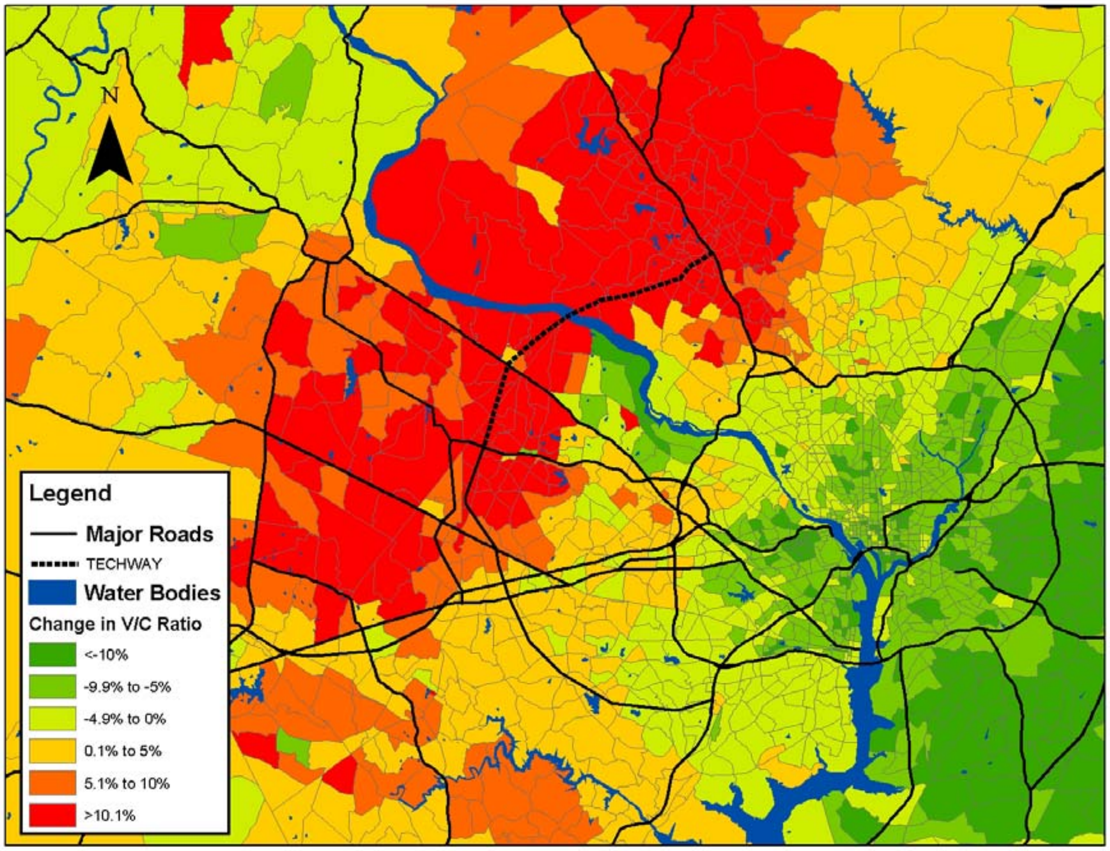
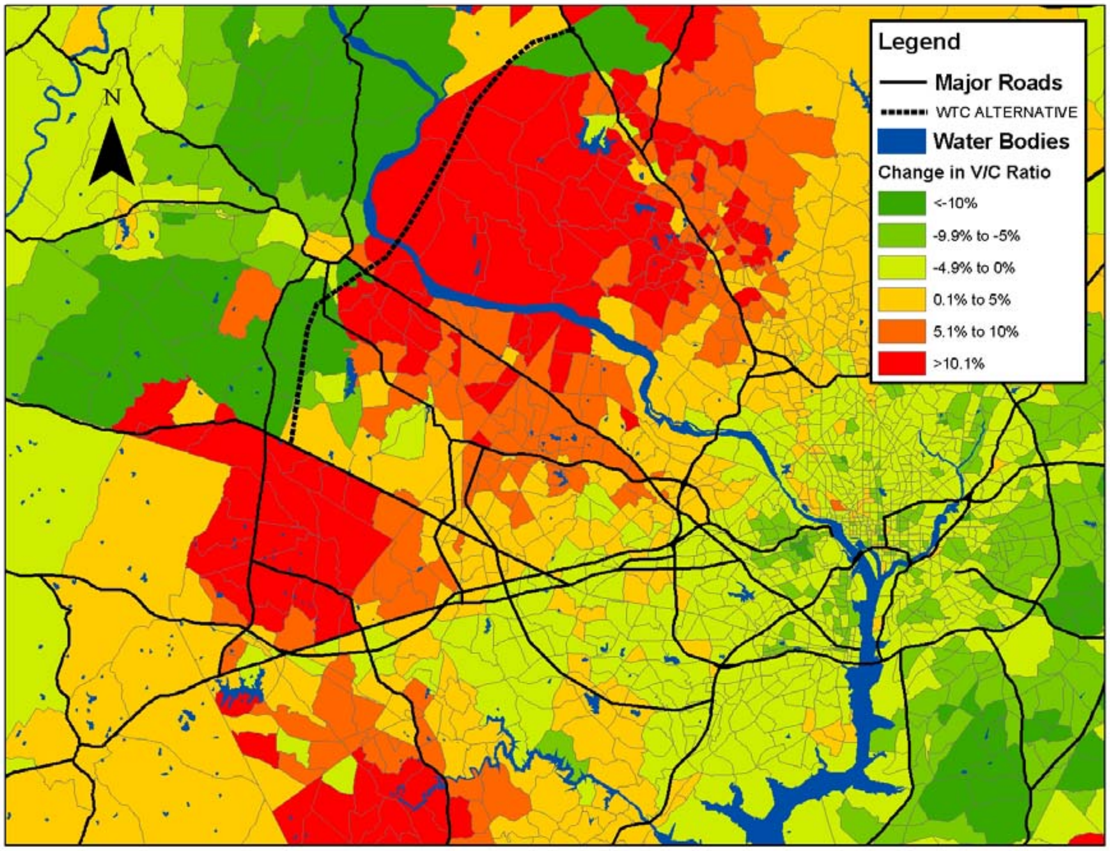
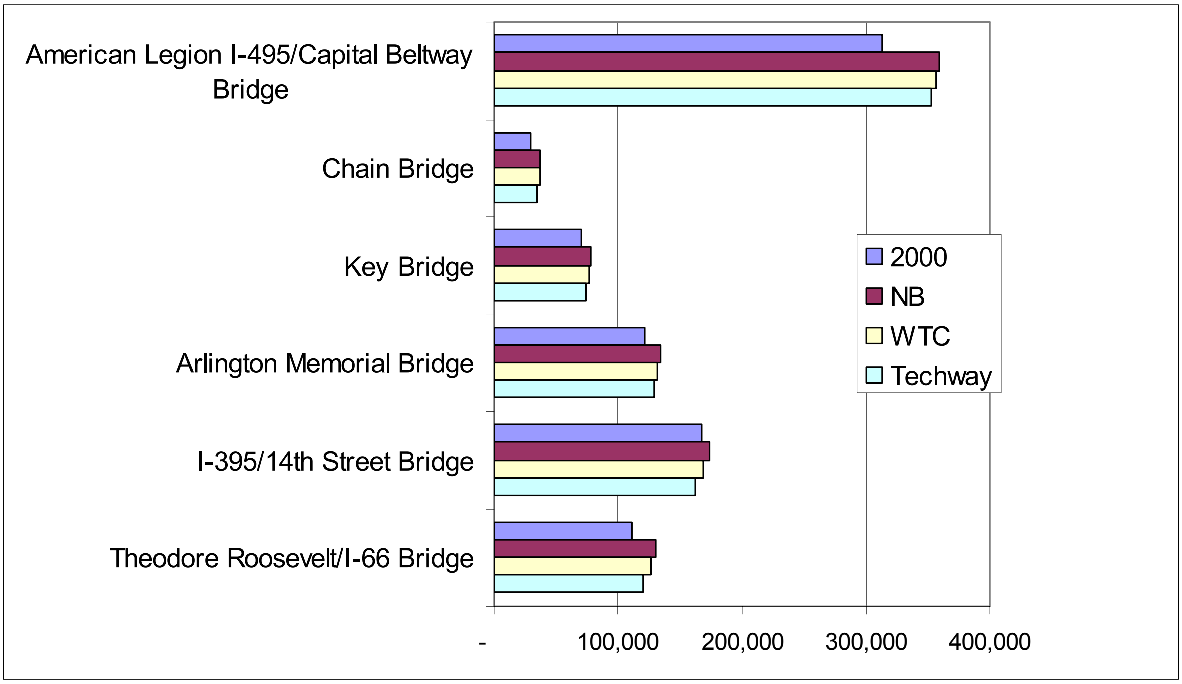


Figure 8: Volume-to-Capacity Ratio (Congestion) Shift: WTC from No Build



In general, traffic congestion will be greater in the vicinity of the new expressways. Exceptions generally are along parallel roads, including existing bridges, where traffic is diverted onto the new expressway. Figure 9 and Table 12 show the forecast 2025 daily traffic volume on the other bridges compared to 2000. (The Woodrow Wilson Bridge is scheduled for a major capacity expansion and large traffic increases are forecast.)

Figure 9: New Expressway across the Potomac Will Have Little Effect on Traffic on Other Bridges



The percent traffic reductions on existing bridges compared to the No Build scenario is shown below:

Even with New Expressway Bridge, Reductions from No Build Scenario Are Small

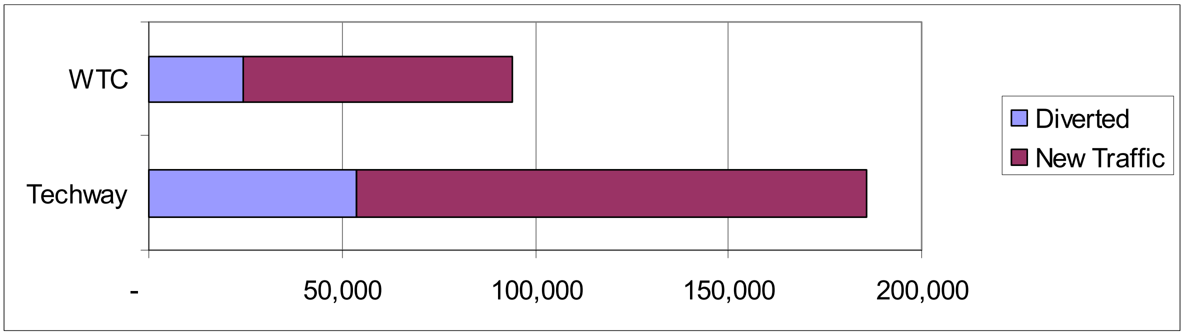
Table 12: Percent Change in forecast daily traffic volume

	WTC	Techway
American Legion I-495/Capital Beltway Bridge	-0.8%	-1.9%
Chain Bridge	-0.1%	-5.1%
Key Bridge	-1.2%	-5.4%
Arlington Memorial Bridge	-1.9%	-4.0%
I-395/14th Street Bridge	-2.8%	-6.6%
Theodore Roosevelt/I-66 Bridge	-2.7%	-7.6%

Thus, the Techway would reduce traffic on the American Legion Capital Beltway Bridge by less than 2 percent, providing no noticeable traffic relief to motorists who are now stuck in traffic. Reductions in traffic on other bridges would come about mostly due to reduced economic and travel activity in the core of the metropolitan region compared to the Techway no-build scenario."

A new bridge would carry almost four times as much traffic as the total reduction in traffic on the other bridges (Figure 10). Part of the increase is due to the land use shifts. In addition, providing an additional roadway across this natural barrier to travel induces new trips as well. Adding bridge capacity is inefficient because most of the capacity serves new traffic rather than reducing congestion. If the bridge is constructed with four lanes in each direction, only one of the four lanes will carry traffic that was served by the existing bridges, but the other three lanes will fill up with vehicles that did not previously cross the river. For every trip diverted off an existing Potomac River Bridge, three new river crossing vehicle trips are induced.

Figure 10: Most New Bridge Traffic Will Be New Traffic



This is a specific case of the well-documented phenomenon of induced travel demand. A synthesis of recent peer-reviewed research on induced traffic shows that for every 10% increase in lane miles of road capacity, we can expect a short term 3-6% increase in vehicle miles of travel and a long-term 8-10% increase in vehicle miles traveled. A recent analysis by the Metropolitan Washington Transportation Planning Board showed that by deferring 100 lane miles of highway expansion projects in 2002 - a 0.5% reduction in lane-miles of road capacity - Virginia saves $800 million in capital costs while cutting NOx emissions by more than 1%, or nearly 2 tons per day, and reducing vehicle miles of traffic by 0.6%.[1] This illustrates how the very expensive expansion of new highways typically produces a growth in air pollution emissions by spurring more traffic, rather than a reduction in emissions as often claimed by the road lobby. It illustrates how reducing expenditures on new roads is often the most cost-effective emission reduction strategy, because it avoids generating both costs and air pollution."

With any of the new expressways, there will more regional traffic as measured in vehicle miles of travel (VMT), and more air pollution than in the No Build scenario. Total regional vehicle miles of travel (VMT) increases in all of the scenarios, as shown in Table 13. The largest increase is for the Techway scenario (1.6 percent), with an increase of 1.3 percent in the WTC scenario. Total vehicle hours of travel (VHT) also increases for all the scenarios.

[1] Kirby, Ronald F., Director of Transportation Planning, Transportation Planning Board. "Emissions Estimates Associated with the 2002 CLRP and FY2003-08 TIP, and Potential Transportation Emissions Reductions Measures (TERMs). Memorandum to Transportation Planning Board, June 28, 2002.

Again, the largest increase is for the Techway scenario (1.3 percent), with an increase of 0.8 percent in the WTC scenario.

Table 13: 2025 System Measure of Effectiveness

Measure of Effectiveness	No Build	WTC	Techway
Daily VMT	187,513,523	190,035,810	190,422,713
Daily VHT	5,006,136	5,045,545	5,068,845
Daily Average Speed (m.p.h.)	37.5	37.7	37.6

A LOSE-LOSE RESULT

Often regional issues are described in "win-lose" terms; for example, the suburbs gain employment at the expense of the urban core. With outer beltways like the WTC or Techway, it is a "lose-lose" situation. The inner core loses population, jobs, and tax base. The suburbs lose open space and gain traffic congestion. Suburban dwellers drive much more than urban dwellers because destinations are farther away and they have fewer travel choices. Urban dwellers without cars face decreased access to employment opportunities, which shift to areas unserved by transit. With the shift in population and jobs to the suburbs, regional travel, regional congestion, regional air pollution and greenhouse gas emissions, and inequity of access to jobs and public facilities all increase.

CONCLUSIONS

Construction of a new expressway crossing the Potomac River will cause household and employment growth to shift to the western suburbs. This shift to more decentralized areas will cause increases in regional vehicle miles travel and air pollution. It will cause increased traffic congestion in the western suburbs compared to the No Build scenario. Traffic volumes on other bridges will be considerably higher than current levels, and only slightly below volumes in the No Build scenario.

Instead of continuing to pour good money after bad into a failed policy of attempting to build its way out of congestion, the region needs to look towards implementing real and permanent solutions. Some elements of a new transportation policy could include:

Automated Time-of-Day Tolls on Bridges – Highway capacity on bridges is very costly to provide, both in dollars and in its effects on the environment. Therefore, bridge capacity will always tend to be a scarce good, compared with more conventional roadway capacity. Our region could better manage this scare bridge capacity with far less congestion delay by making some or all of the lanes on these bridges toll facilities. Fully automated electronic toll collection, with off-peak discounts, and dedication of toll revenues to improved transit and incident management would improve both efficiency and equity of transportation in the region. The NY-NJ Hudson River bridges and tunnels offer automated time-of-day toll discounts that help finance transit and cut traffic congestion. Our region can do so too.

Locating Jobs and Housing Near the Existing Transit System – There is much discussion in the region concerning transit extensions in the suburbs. While some of these extensions may be worthwhile, often it is impossible to serve dispersed suburban land uses efficiently with transit. The Washington region already has many opportunities for development close to existing Metro rail stations. It will be much more effective concentrate housing and jobs near the stations than to expand the system. New initiatives are needed to promote creation of "invisible affordable housing" in the form of accessory units in existing neighborhoods close to jobs and transit.

Local Roadway Improvements in the Suburbs –Suburban areas suffer from traffic congestion primarily because of poorly planned, disconnected street systems. There are too few through streets for the level of development, and traffic is all forced to travel through the resulting bottlenecks. Adding lanes to those bottlenecks does not add a proportional increase in intersection capacity and is inefficient. Indeed, engineering research shows that highly interconnected slow traffic street grids can provide up to double the traffic capacity of sparce street grids that force traffic onto major arterials and freeways. Requiring more through streets in developing areas can make a huge difference in traffic flow, and also improves opportunities for walking and bicycling. Traffic calming and bicycle/pedestrian safety improvements need to be an integral part of such initiatives to protect and enhance neighborhood quality. Intersection improvements on existing roadways, including intelligent signal systems and modern roundabouts, can also help.[1]

Commuter Choice – Commuters are often subsidized with free parking. If they were offered a choice between the parking or its cash value or a transit pass, many would choose alternative modes. The Commuter Choice Maryland supports employers in eliminating these incentives to drive through tax credits and other assistance. This type of program should be extended to the rest of the region. It should be complemented with impact fees on employer-provided free parking that would be waived if employers offer paid transit benefits or cash-in-lieu-of-parking commuter assistance programs. If widely adopted, these initiatives could significantly reduce traffic during the morning and afternoon peak periods.

Smart Growth – The ideas described above are consistent with Maryland's Smart Growth initiatives. Maryland's policies include: investing in existing communities, providing alternatives to driving, improving traffic flow without adding lanes, improving pedestrian and bicycle options, and providing incentives for development around existing transit stations. Adoption of these concepts throughout the region would result in major progress towards reducing suburban congestion.

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[1] Kulash, Walter. 1990. Traditional Neighborhood Development: Will the Traffic Work? Orlando: Glatting Lopez Kercher Anglin., see also: http://sustainable.state.fl.us/fdi/fscc/news/world/tnd.htm