Preliminary Analysis of Potential Transportation-related Greenhouse Gas Reduction Strategies for the Washington, DC Region

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National Capital Region Transportation Planning Board

Acknowledgements

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EXECUTIVE SUMMARY

In April 2007 the COG Board of Directors created a regional climate change initiative as part of the Metropolitan Washington Council of Governments' 50th anniversary celebration. The Climate Change Steering Committee was established which released the National Capital Region Climate Change Report in November 2008. The current BAU projections of growth in population, housing and employment show that the total emissions from transportation will increase by 38 percent by 2030 in the region. As the transportation sector contributes 30 percent of total emissions, CCSC recommends reducing GHG emissions from transportation sector by increasing fuel efficiency, reducing the carbon content of fuel, reducing vehicle miles traveled (VMT) and increasing the travel efficiency, etc. The ability of the transportation sector to reduce emissions will have a large bearing on the region's ability to meet its greenhouse gas emission reduction goals.

In a parallel effort, TPB staff has been working on the What Would it Take? (WWIT) scenario study, directed by TPB's Scenario Study Task Force, which aims to determine what mix of strategies in the fuel efficiency, alternative fuel and alternative vehicle technology, and travel efficiency categories, can get the region to meet its greenhouse gas reductions targets in the transportation sector. The staff of the National Capital Region Transportation Planning Board (TPB) was tasked with analyzing the recommendations for greenhouse gas reduction measures as proposed in the National Capital Region Climate Change Report. In addition to the recommended measures from the National Capital Region Climate Change Report, the WWIT scenario also incorporates existing, proposed, and potential regional strategies from other sources. This technical memorandum contains the results of an initial analysis of potential greenhouse gas reductions strategies for the transportation sector.

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LIST OF REFERENCES

1) Air Quality Conformity Determination for the 2009 CLRP and FY 2010-2015 TIP , Adopted by the National Capital Region Transportation Planning Board on July 15, 2009
2) Heavy Duty CAFE Spread Sheet for Estimating Emissions Impacts, Dan Meszler, Dated 2/21/2009
3) TERM Section-Appendix A and B of Call for Projects 2009 CLRP & FY 2010-2015 TIP, Appendix B TERM Reporting – TERM Tracking Sheet. Available at: http://www.mwcog.org/transportation/activities/quality/terms.asp
4) Barth and Boriboonsomsin, "Real-world CO_2 Impacts of Traffic Congestion," Paper for the 87th Meeting of the Transportation Research Board, January 2008
5) Analysis of Potential Transportation Emissions Reductions Measures (TERMs) Under Consideration for the 2009 CLRP & FY2010-15 TIP. Available at: http://www.mwcog.org/uploads/committee-documents/Y15bW1ZW20090728103436.pdf
6) McKinsey & Company and The Conference Board. Reducing U.S. Greenhouse Gas Emissions: How Much at What Cost? U.S. Greenhouse Gas Abatement Mapping Initiative, Executive Report. December 2007. Available at: http://www.mckinsey.com/clientservice/ ccsi/pdf/US_ghg_final_report.pdf.
7) National Capital Region, Climate Change Report, Prepared by the Climate Change Steering Committee for the Metropolitan Washington Council of Governments Board of Directors Adopted November 12, 2008. Available at: http://www.mwcog.org/uploads/pub-documents/zldXXg20081203113034.pdf

Introduction

This technical report summarizes the results of the initial analysis of potential greenhouse gas (GHG) reduction strategies for the transportation sector as applied in the Washington, DC region. The report includes analysis of measures in three categories: (1) fuel efficiency, (2) alternative fuels and alternative vehicle technologies, and (3) travel efficiency. There are several sources for these potential measures including:

1. Transportation Emissions Reduction Measures (TERMs) from the TERM Tracking Sheet (i.e. additional implementations);
2. "Potential TERMs" from the *Analysis of Potential Transportation Emissions Reductions Measures (TERMs) Under Consideration for the Conformity of the 2009 CLRP and FY 2010-2015 TIP*;
3. the recommended travel efficiency and VMT reduction measures for the transportation sector from the COG Climate Change Report;
4. and new proposals and recent regional initiatives.

This document contains a summary of the results for the measures that have been analyzed to date and included in the first phase of the What Would it Take? (WWIT) Scenario Analysis. The purpose of this report is not to make recommendations, nor does it claim to be an exhaustive list of potential greenhouse reduction strategies. The aim of this analysis is to provide planners and policy makers with an initial analysis of strategies with what staff believes to be reasonable, and possibly ambitious, input assumptions. The analysis for the majority of the strategies can be scaled up or down according to greater or lesser levels of implementation. The detailed analysis of the individual measure is included in Appendix A. This analysis is a first step in what will be an on-going process for working towards meeting the region's GHG reduction goals.

Baseline

The first step in reducing the region's contribution to CO_2 and other greenhouse gas levels is to develop a greenhouse gas inventory. This provides a basis for developing an action plan and setting goals and targets for future reductions, helps to identify the largest sources of greenhouse gases, enables tracking of trends over time, and documents the impacts of actions taken to reduce emissions. Baseline inventories were developed during the course of this study to capture the most current regional plan and federal programs; inventories were prepared for 2005, 2010, 2020 and 2030.

The first step in developing the CO_2 inventory was to establish "business as usual." For the Washington, D.C. region, business as usual (BAU) means that there would be no major changes to the forecast of travel management programs or vehicle fleet. The baseline uses the modeling output for the 2009 CLRP and 2010-2015 TIP (*Reference 1*) which contain vehicle fleet forecasts based on 2008 vehicle fleet data and round 7.2 land use data. The BAU CO_2 emissions inventory was developed using Mobile 6.2. A detailed description of the Mobile 6.2 inventory development can be found in Appendix B.

The second step was to determine the reductions in CO_2 emissions that would result from the improvement in vehicle fleet fuel economy as a result of federal CAFE requirement. Mobile 6.2

does not have the capability of modeling this increased CAFE requirement; therefore, the reductions are calculated using a spreadsheet tool developed by a consultant who had previously done similar work for Maryland's Department of the Environment *(Reference 2)*. Initially, the CAFE reductions were based on achieving 35 mpg by 2020 as specified in the 2007 Energy Independence and Security Act (EISA); however, staff worked with the consultant to update calculations to reflect the proposed joint rulemaking between DOT and EPA which would improve the CAFE to 35.5 mpg by 2016. The spreadsheet was also updated to use fuel efficiency forecasts based on the 2008 vehicle registration data that had been prepared after the original spreadsheet was developed.

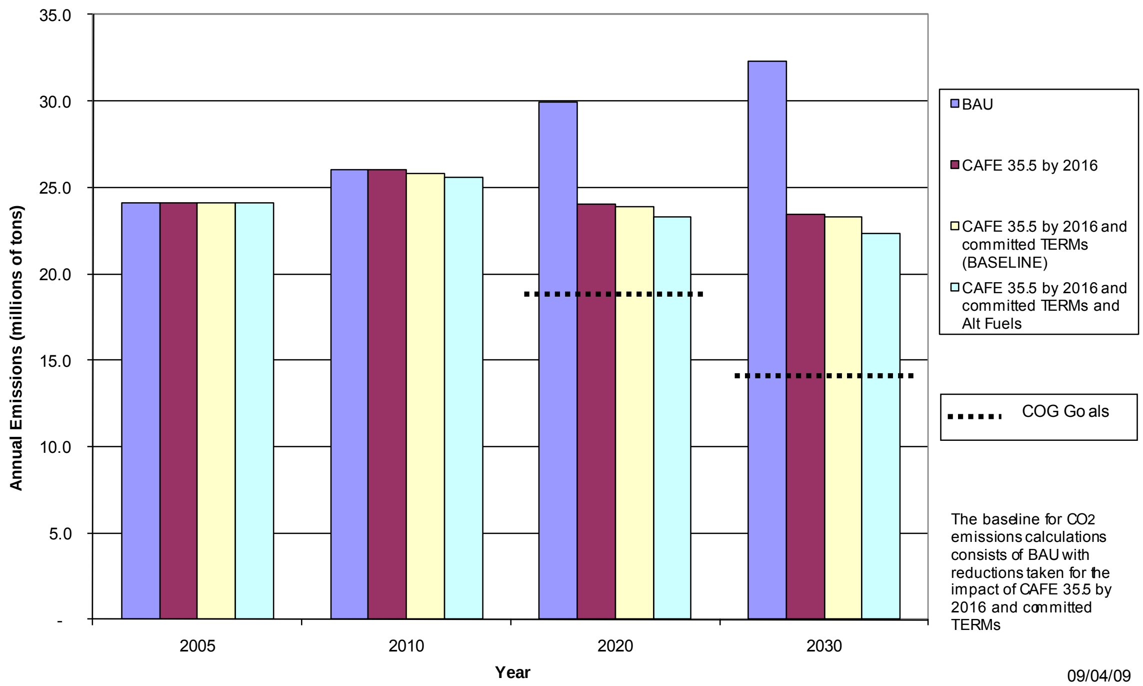
The third step was to estimate the CO_2 reductions from the regionally committed TERMs as listed in the TERM Tracking Sheet (*Reference 3*). These TERMs were put into place after the last travel demand model calibration and thus are not reflected in the model and must be accounted for separately.

Table 1 shows the results of each of the three steps for calculating the "Final Baseline" as well as the COG goals for 2020 and 2030 and the required reductions to meet those annual goals. Chart 1 illustrates the baseline inventories.

Table 1: Baseline CO2 Emissions Calculations for 8-hour Ozone Non-Attainment Area (annual tons)

	2005	2010	2020	2030
Total Network Emissions (BAU)	24,094,546	26,053,949	29,914,925	32,281,166
Reductions due to CAFE 35.5 by 2016			(5,862,615)	(8,837,569)
Net emissions after CAFE 35.5 by 2016			24,052,309	23,750,664
Previously Committed TERMs		(258,697)	(138,065)	(120,268)
Final Baseline		**25,795,252**	**23,914,244**	**23,630,396**
COG Goal			**19,275,637**	**14,456,728**
Required Reductions			**4,638,607**	**9,173,669**

Chart 1: Annual CO_2 Emissions based on the 2009 CLRP & 2010-2015 TIP



Emissions Rates

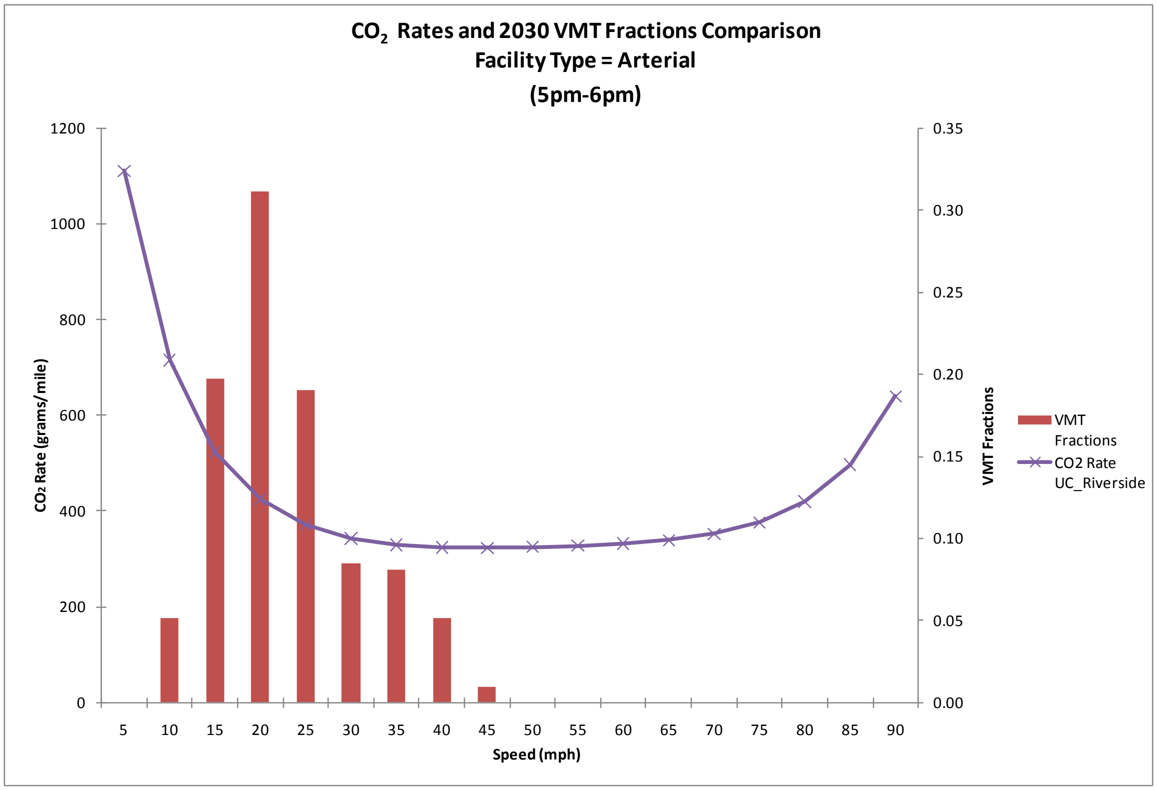
The emissions rates for commuter (light-duty only) vehicle measures were established by using the rates generated by Mobile 6.2 and reduced by the impacts due to CAFE 35.5 by 2016. Table 2 shows the light-duty CO_2 emissions rates.

Table 2: Mobile 6.2 and CAFE 35.5 LDV Emissions Rates

	Mobile 6.2 (g/mi)	Mobile 6.2 reduced by CAFE 35.5 (g/mi)
2010	461.70	461.70
2020	474.11	358.78
2030	474.18	312.53

There are limitations to developing a CO_2 inventory using Mobile 6 beyond the inability to model CAFE. Mobile 6 produces only one emissions rate for CO_2 for all speeds even though CO_2 emissions are very sensitive to speed, especially at low speeds. The MOVES model will take speed into account when performing CO_2 calculations. In the meanwhile, for speed-based measures such as traffic signal optimization or anti-idling, a CO_2 by speed curve developed at the University of California, Riverside (*Reference 4*) is being used to estimate speed sensitive measures. Chart 2 shows a CO_2 emissions by speed curve as developed by UC Riverside with a bar chart illustrating 2030 VMT by speed range for the Washington, DC area as forecasted by the regional travel demand model.

Chart 2



Emissions Assessment of New Potential Control Strategies

In order to estimate emissions reductions from strategies not already analyzed for criteria pollutants, staff used sketch planning methods and existing programs as a model whenever possible.

Cost-effectiveness Assessment of Potential Control Strategies

For the most part, the costs for the project were considered to be only the cost for the government or program administrator such as capital or operating costs. The user costs (or cost savings) were not factored in. The cost-effectiveness for each of the strategies was calculated for year 2020 in current year dollars, except for the examples from the TERM Tracking Sheet which have cost-effectiveness for 2010. The methodology for calculating cost-effectiveness can be found on page A-19 of the "Potential TERMs" document (*Reference 5*)

In examining the cost-effectiveness, it should be noted that most of the strategies are not under the 50 $/ton of CO_2 that is considered a threshold for cost-effectiveness (*Reference 6*). However, it is important to note that the Washington, DC region has implemented many of these programs and many other programs for benefits such as criteria pollutant reduction, congestion reduction, neighborhood livability, etc. Many of these programs have benefits that extend far beyond CO_2 reduction and those benefits should be kept in mind.

Sources for Potential Control Strategies

As stated in the introduction, the potential strategies that were analyzed came from four primary sources.

1. TERM Tracking Sheet

Transportation Emission Reduction Measures (TERMs) are strategies or actions that the TPB can employ to offset increases in nitrogen oxide (NOx) and volatile organic compound (VOC) emissions from mobile sources. The TERM Tracking Sheet is the document which is used by the region to document all the emissions reduction projects to which the region has committed (*Reference 3*).

All TERMs are intended to reduce either the number of vehicle trips (VT), vehicle miles traveled (VMT), or both. No new VT/VMT analysis was completed for these measures. Using the existing VMT reduction calculations, the CO_2 emission rate was applied to determine the CO_2 reductions from these already existing programs and projects. The baseline includes the CO_2 reductions from all of the TERMs from the Tracking Sheet; however, since the list of TERMs is lengthy, the CO_2 emissions reductions for individual projects are only shown for a representative selection of TERMs as an example of how existing programs are also contributing to greenhouse gas reductions.

2. *Analysis of Potential Transportation Emissions Reductions Measures (TERMs) Under Consideration for the Conformity of the 2009 CLRP and FY 2010-2015 TIP*

This document contains the analysis of potential transportation emissions reduction measures (TERMs) for the 2009 Constrained Long range Plan (CLRP) and FY 2010-2015 Transportation Improvement Program (TIP). The Transportation Planning Board (TPB) has been adopting TERMs since FY1995 as a method for reducing ozone precursor emissions NOx and VOC. The Travel Management Subcommittee provides technical oversight of the TERMs analysis process and makes recommendations to the TPB Technical Committee. The Technical Committee then makes recommendations or endorsements of TERMs to the TPB for adoption.

Similar to the TERM Tracking Sheet, no new VT/VMT analysis was completed for these measures. The CO_2 emissions rate was applied to the VMT reductions to determine the greenhouse gas reductions from the potential TERMs. These reductions are shown in this report.

3. National Capital Region Climate Change Report

With the rapid growth in population, housing, employment, and energy use in Washington metropolitan region, the Metropolitan Washington Council of Government (COG) forecasts that the total green house gas emissions in the region will increase by 33 percent by 2030 and 43 percent by 2050 based on current "business as usual"(BAU) projections. The National Capital Region Climate Change Report (*Reference 7*) states that the resulting changes in the climate will have significant effects on the region's natural and built environments, all sectors of its economy, and its residents and families, communities, and workplaces.

The report contains fourteen recommendations for the transportation sector under the categories of Increase Fuel Efficiency and use of Clean Vehicles, Reduce Vehicle Miles Traveled (VMT) and Increase Travel Efficiency. Each of the recommendations has multiple examples of measures. The recommendations are fairly general leaving staff to make assumptions in order to complete a detailed analysis. Some of the strategies were either too general or policy-related for staff to complete an analysis. The majority of these strategies have been presented to the Travel Management Subcommittee and/or the TPB Technical Committee. Appendix C has the full list of transportation-related measures from the Climate Change Report and the analysis strategy employed.

4. **Recent, Proposed, and Potential Regional Initiatives**

This fourth source of potential reduction strategies reflects anything that is not covered by the first three sources. This list includes strategies such as TPB's recent TIGER Grant proposal submissions, TPB's Value Pricing study, eco-driving, and federal forecasts such as the Alternative Energy Outlook.

Results

Table 3 shows a summary of the potential GHG reductions measures analyzed to date. The measures are divided into the three aforementioned categories (fuel efficiency, alternative fuel and vehicle technology, and travel efficiency) and include analysis of select regionally committed TERMs from the TERM Tracking Sheet, "Potential Terms," transportation-related recommendations from the Climate Change Report and other initiatives. Chart 3 illustrates the relative cost-effectiveness of the measures.

Appendix A contains detailed analysis of the individual strategies from the Climate Change Report and other initiatives. Due to length, the individual measures from the TERM Tracking Sheet and the Potential TERM list are not included, but can be found at http://www.mwcog.org/transportation/activities/quality/terms.asp and http://www.mwcog.org/uploads/committee-documents/Y15bW1ZW20090728103436.pdf, respectively.

Table 3: Potential GHG Reduction Measures

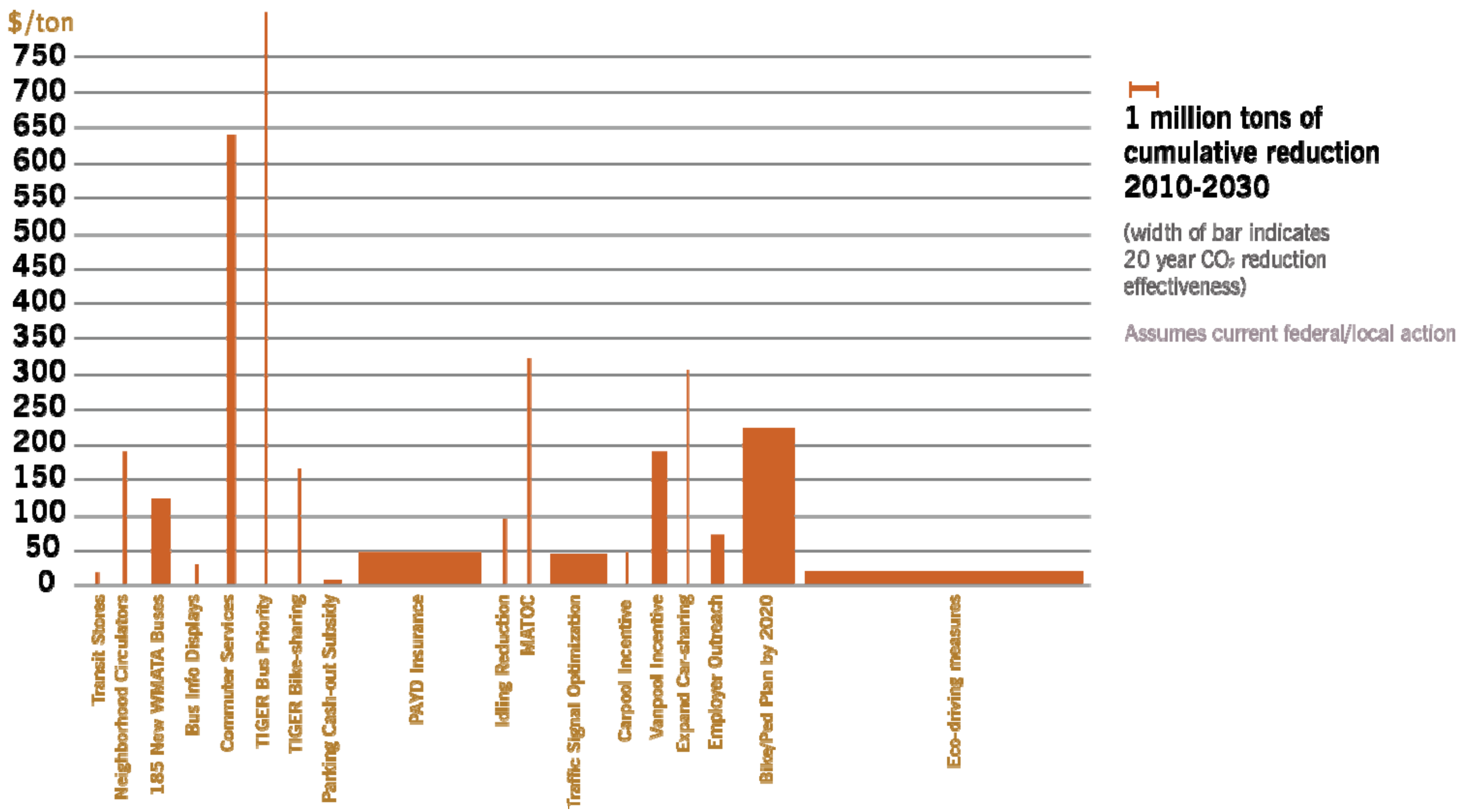
Emissions Reductions from Baseline and Cost-effectiveness

Measure	CO_2 Reductions in 2010 (annual tons)	CO_2 Reductions in 2020 (annual tons)	CO_2 Reductions in 2030 (annual tons)	Cost-effectiveness in 2020* ($'s/ton CO_2)
Fuel Efficiency				
A.1.ii Evaluate options for extending CAFE requirements past 2020				
Extend existing 35.5 mpg by 2016 to achieve CAFE 45 by 2030	-	120,842	2,455,355	n/a
Extend existing 35.5 mpg by 2016 to achieve CAFE 55 by 2030	-	361,846	4,156,467	n/a
Cash for Clunkers	46,321	-	-	$200-$500
Local Tax Incentive for Hybrid Vehicle Purchase	-	42,913	-	$643
A.1.ii Evaluate options for extending CAFE to cover heavy trucks				
Improve HDV fuel efficiency by 10%	-	598,963	667,515	n/a
Improve HDV fuel efficiency by 20%	-	866,955	1,149,928	n/a
Improve HDV fuel efficiency by 30%		1,105,170	1,568,020	n/a
Improve HDV fuel efficiency by 100%	-	1,143,189	3,010,685	n/a
Alternative Fuels and Alternative Vehicle Technologies				
“Reference Case” based on current energy legislation (source: AEO 2009)	190,000	810,000	980,000	n/a
“High Price Case” based on scenario with $200/barrel oil (source: AEO 2009)	470,000	1,540,000	1,840,000	n/a
Travel Efficiency				
Part 1 - Examples Regionally Committed TERMs from the TERM Tracking Sheet (full TERM Tracking Sheet can be found at http://www.mwcog.org/transportation/activities/quality/terms.asp)				
Access Improvements to Transit/ HOV				
Car sharing at Metro stations	542			
500 parking space at transit stations	1,782	1,385	1,206	
Bicycle / Pedestrian projects				
# 74 500 Bicycle Racks in DC	162	126	110	
Neighborhood sidewalk improvements in MD	155	120	105	
Transit Service improvements				
Circulator Bus in DC	5,415	4,208	3,666	
PRTC express bus service	229	178	155	
Rideshare Assistance Programs and Commuter Connections				
MV-123 Employer Outreach	6,431	4,998	4,353	
MD Commuter Tax Credit	33,279	25,860	22,527	
Guaranteed Ride Home	28,937			
Park & Ride Lots (Transit and HOV)				
Northern Virginia District Wide P& R lots	6,491	5,044	4,394	
Telecommute Programs				
MV-92 Expanded Telework Program	36,939	28,705	25,005	
Traffic Improvements/TSM				
Traffic Signal Optimization Program	112,228	93,227	85,446	$43
Engine Technology/Alternative Fuel Programs				
Hybrid Electric Buses in Montgomery County	1,297			
100 Hybrid Electric light duty vehicles	153			
Part 2 - Potential TERMs (from SIP/Conformity Assessment) (Full Potential TERM document can be found at http://www.mwcog.org/uploads/committee-documents/Y15bW1ZW20090728103436.pdf)				
M-07A Voluntary Employer Parking Cash-Out Subsidy	32,859	25,535	22,243	$8
M-47c Employer Outreach for Private Sector Employers (expanded)	2,609	2,028	1,766	$419
M-93 Improve Pedestrian Facilities Near Rail Stations	2,816	2,188	1,906	$2,181
M-110 10 Transit Stores in Maryland	8,269	6,426	5,597	$23
M-113 6 Kiosks in Maryland	38	30	26	$499,166
M-123 Employer Outreach for Public Sector Employers	21,536	16,735	14,578	$49

M-133 Metrorail Feeder Bus Service	770	598	521	$568
M-134 Implement Neighborhood Circulator Buses (10)	5,916	4,598	4,005	$245
M-135 Construction of 1000 Parking Spaces at Metrorail Stations	2,631	2,044	1,781	$652
M-143 Real Time Bus Schedule Information	2,430	1,888	1,645	$1,209
M-146 Purchase 185 WMATA buses (ridership growth)	37,214	28,918	25,191	$158
M-148 WMATA Bus Information Displays with Maps (2000 cases)	4,358	3,387	2,950	$37
M-150 Enhanced Commuter Services- (HOV Facilities)	6,580	5,113	4,454	$521
M-151 Enhanced Commuter Services-US 1 (Reverse Commute)	3,778	2,936	2,557	$857
M-152 Enhanced Commuter Services- (Rail Relief)	9,298	7,226	6,294	$1,113
M-155 Expand Carsharing Program	572	444	387	$394
M-156 Free bus-to-rail/ rail-to-bus transfers (Similar to NYC pricing structure)	10,058	7,816	6,808	$4,710
M-158 Free Bus Service Off-Peak (10:00 AM to 2:00 PM Mid-Day and Weekends)	8,449	6,565	5,719	$3,324
M-144 Parking Impact Fees	240,274	186,714	162,645	$2,121
Part 3 -Transportation-related measures from COG Climate Change Report (http://www.mwcog.org/uploads/pub-documents/zldXXg20081203113034.pdf)				
B.1.ii Financial incentives to reduce VMT				
Pay-As-You-Drive Insurance	51,105	264,999	258,112	$45
B.3.i Incremental Expansion of Transit Capacity				
Dulles Rail Project as example	-	44,884	45,063	tbd
B.4.i Expand Commuter Connections Program				
Carpool Incentive	3,684	2,857	2,488	$130
Vanpool Incentive (Scenario 1 - $15/van/day)	-	14,553	25,354	$301
Vanpool Incentive (Scenario 2 - $25/van/day)	-	31,766	55,342	$187
B.4.ii Enhance Access to Transit and Alternative Modes	-			
Telework expansion		13,560	8,826	tbd
B.4.iii Bicycle and Pedestrian Plan				
Completion of 2030 TPB Bike/Ped Plan by 2020	-	121,050	105,446	$219
Completion of 2030 TPB Bike/Ped Plan by 2030	-	60,525	105,446	tbd
B.4.v Address need for bicycle facilities				
Construct nine new bike stations	557	433	377	$2,500
C.2 Implement MATOC Program				
MATOC analysis from CMAQ application	5,270	6,071	6,540	$322
C.3 Enforce existing idling regulations				
Idling Reduction (low estimate)	2,909	5,363	8,109	$172
Idling Reduction (high estimate)	7,069	13,035	19,707	$70
Part 4 - Recent, Proposed, and Potential New Initiatives				
TIGER Grant Application - Regional bike sharing program	-	2,573	5,946	tbd
K St. Busway (Center Median)	-	2,522	2,522	tbd
K St. Busway (Curb SIde)	-	14,642	14,642	tbd
TIGER Grant Application - Smart Hubs	-	1,881	1,772	tbd
TIGER Grant Application - Bus prioritization	-	5,115	5,119	tbd
TPB Value Pricing Study	-	757,600	107,210	n/a
CLRP Aspirations Scenario (Land-use only)	-	43,339	102,537	n/a
Traffic Signal Optimization Program	112,228	93,227	85,446	$43
Eco-Driving	-	530,739	889,034	$22

* Cost-effectiveness is in 2009 dollars, CE for Potential TERMs is calculated for 2010

Chart 3: Cost-effectiveness



Appendix A: Detailed Analysis of Potential Reduction Strategies

Part 1: Fuel Efficiency

Part 2: Alternative Fuels and Alternative Vehicle Technology

Part 3: Travel Efficiency

Part 1: Fuel Efficiency

Extend CAFE Requirements past 2020

Expand CAFE Requirements to Heavy Duty Vehicles

Financial Incentive for “Clean” Vehicle Purchase

Analysis of Impact of Car Allowance Rebate System (CARS) Program

Climate Change Measure – Heavy Duty Vehicle Fuel Economy Improvement

Description

This measure assumes a federal program will be implemented to improve the fuel economy all heavy duty (HD) vehicles (Mobile 6.2 categories) by 10%, 20%, 30%, and 100% from current standards by 2020.

Analysis Approach

- Use a spread sheet program developed by Dan Meszler a consultant for TPB. The program uses baseline fuel economy for HD vehicles from the Mobile 6.2 model, fleet age, and vehicle miles of travel to estimate fuel consumption and CO_2 from heavy duty vehicles operating in the region. Using the new fuel economy, market penetration of new vehicles, and vehicle miles of travel, estimates of fuel consumption under the new HD fuel economy standards are estimated and the associated CO_2 emissions. Using the baseline and the reduced emissions, the spread sheet estimates the percent reduction in CO_2 emissions due to the new HD fuel economy standards. The percentage reductions are available for every year until 2050.

Assumptions

- Current HD fuel economy based on Mobile 6.2 standards
- Introduction of new fuel efficient heavy duty vehicles to the fleet based on Mobile 6.2 defaults.
- Vehicle miles of travel based on the regional travel demand model estimates for heavy duty vehicles.
- Percentage of gasoline and diesel vehicle fleet based on 2008 vehicle registration data obtained from the VIN decoder analysis.
- The first year of improvement in fuel economy for HD vehicles will occur in 2016 and reach full improvement by 2020. See table 1 for the fuel economy standards that is assumed.

Impact

Travel

No travel impacts as the VMT is assumed to be the same

Emissions

Chart 1 shows the impact of the various HDV mpg improvement assumptions on the region's CO_2 emissions

Cost

No cost to state or local governments since it is assumed to be a federal mandate

Cost Effectiveness

Not applicable

Table 1

	GASOLINE									DIESEL									
	Class 2B	Class 3	Class 4	Class 5	Class 6	Class 7	Class 8A	Class 8B	Bus	Class 2B	Class 3	Class 4	Class 5	Class 6	Class 7	Class 8A	Class 8B	City-Bus	Sch-Bus
MY	mpg	mpg	mpg	mpg	mpg	mpg	mpg	mpg	mpg	mpg	mpg	mpg	mpg	mpg	mpg	mpg	mpg	mpg	mpg
2011	10.23	9.48	9.44	8.09	8.22	7.52	7.14	6.83	6.51	13.09	11.78	10.30	9.98	8.80	7.61	6.66	6.36	4.40	6.24
2012	10.23	9.48	9.44	8.09	8.22	7.52	7.14	6.83	6.51	13.09	11.78	10.30	9.98	8.80	7.61	6.66	6.36	4.40	6.24
2013	10.23	9.48	9.44	8.09	8.22	7.52	7.14	6.83	6.51	13.09	11.78	10.30	9.98	8.80	7.61	6.66	6.36	4.40	6.24
2014	10.23	9.48	9.44	8.09	8.22	7.52	7.14	6.83	6.51	13.09	11.78	10.30	9.98	8.80	7.61	6.66	6.36	4.40	6.24
2015	10.23	9.48	9.44	8.09	8.22	7.52	7.14	6.83	6.51	13.09	11.78	10.30	9.98	8.80	7.61	6.66	6.36	4.40	6.24
2016	12.28	11.38	11.33	9.71	9.87	9.03	8.57	8.19	7.82	15.71	14.13	12.36	11.97	10.56	9.13	7.99	7.64	5.28	7.49
2017	14.32	13.28	13.22	11.33	11.51	10.53	10.00	9.56	9.12	18.33	16.49	14.42	13.97	12.32	10.65	9.32	8.91	6.17	8.74
2018	16.37	15.17	15.11	12.94	13.15	12.04	11.43	10.92	10.42	20.94	18.84	16.48	15.97	14.08	12.17	10.65	10.18	7.05	9.99
2019	18.42	17.07	17.00	14.56	14.80	13.54	12.85	12.29	11.73	23.56	21.20	18.54	17.96	15.83	13.69	11.98	11.45	7.93	11.24
2020	20.46	18.97	18.89	16.18	16.44	15.05	14.28	13.66	13.03	26.18	23.55	20.60	19.96	17.59	15.21	13.31	12.73	8.81	12.48
2021	20.46	18.97	18.89	16.18	16.44	15.05	14.28	13.66	13.03	26.18	23.55	20.60	19.96	17.59	15.21	13.31	12.73	8.81	12.48
2022	20.46	18.97	18.89	16.18	16.44	15.05	14.28	13.66	13.03	26.18	23.55	20.60	19.96	17.59	15.21	13.31	12.73	8.81	12.48
2023	20.46	18.97	18.89	16.18	16.44	15.05	14.28	13.66	13.03	26.18	23.55	20.60	19.96	17.59	15.21	13.31	12.73	8.81	12.48
2024	20.46	18.97	18.89	16.18	16.44	15.05	14.28	13.66	13.03	26.18	23.55	20.60	19.96	17.59	15.21	13.31	12.73	8.81	12.48
2025	20.46	18.97	18.89	16.18	16.44	15.05	14.28	13.66	13.03	26.18	23.55	20.60	19.96	17.59	15.21	13.31	12.73	8.81	12.48
2026	20.46	18.97	18.89	16.18	16.44	15.05	14.28	13.66	13.03	26.18	23.55	20.60	19.96	17.59	15.21	13.31	12.73	8.81	12.48
2027	20.46	18.97	18.89	16.18	16.44	15.05	14.28	13.66	13.03	26.18	23.55	20.60	19.96	17.59	15.21	13.31	12.73	8.81	12.48
2028	20.46	18.97	18.89	16.18	16.44	15.05	14.28	13.66	13.03	26.18	23.55	20.60	19.96	17.59	15.21	13.31	12.73	8.81	12.48
2029	20.46	18.97	18.89	16.18	16.44	15.05	14.28	13.66	13.03	26.18	23.55	20.60	19.96	17.59	15.21	13.31	12.73	8.81	12.48
2030	20.46	18.97	18.89	16.18	16.44	15.05	14.28	13.66	13.03	26.18	23.55	20.60	19.96	17.59	15.21	13.31	12.73	8.81	12.48

Climate Change Measure A.1.iii – Assess benefits from tax incentives for the purchase of hybrid vehicles.

Description

The assumptions for this measure are based personal property tax incentive that Arlington County has given for owners of qualifying clean-fuel vehicles to support Arlington County's Fresh AIRE – Arlington Initiative to Reduce Emissions – campaign.

Analysis Approach

Use sketch planning analysis to calculate emissions reductions which result from the construction of bike stations based on an estimate for daily trip reduction provided by DDOT. It is assumed that benefits begin in 2010.

Assumptions

Half of hybrid vehicle purchases were made because of the availability of the tax credit. Approximately 1.9% of LDV in Arlington are "clean-fuel;" thus, as a result of the tax incentive, 1% of LDV vehicles in Arlington were purchased because of the tax incentive. To apply regionally, 1% of LDV vehicles can be assumed to be hybrids if a similar tax incentive is applied regionally. This would equate to 32,301 vehicles

The hybrid vehicle has a fuel economy rating 10 mpg higher than the vehicle that would have been purchased. Vehicles go from an average of 25 mpg to 35 mpg. Thus, 32,301 vehicles are improving their fuel efficiency by 10 mpg.

The property tax credit in Arlington works out to approximately $800/year. For this analysis, since MD and DC do not have personal property tax credit, it is assumed that purchasers will receive $800 tax credit per year for four years ($3200 total)

The average vehicle travels 12,000 miles/year

Impact

Travel

There is no impact to travel.

Emissions

The annual CO_2 emissions reductions are estimated to be 42,913.5 tons/year due to a fuel savings of 4.4 million gallons of gasoline/year.

Cost

The program would cost $25.8 million assuming that 32,301 vehicles are receiving the tax credit each year. Additionally, there would be a $1.7 million loss in gasoline tax revenue each year due to the increased fuel economy.

Cost Effectiveness

Cost-effectiveness: 643 $/ton

Climate Change Measure A.1.iii Cash for Clunkers

Description

The statistics from the federal Car Allowance Rebate System (CARS) have been published on the CARS website (www.CARS.gov). Nationally, 677,081 vehicles were traded-in as part of this program. The national average fuel economy for a trade-in was 15.8 mpg and the national average fuel economy for a new vehicle purchase was 24.9 mpg which is an overall increase of 9.2 mpg, or a 58% improvement. These statistics are based on a summary report published on October 23, 2009. The GHG benefits resulting from the CARS program and the cost-effectiveness of the program should be considered carefully. Until the 2011 VIN data for the Washington, DC area is collected and analyzed, it is difficult to assess the long term impact, if any, of the CARS program. A September 2009 study from the University of Michigan (The Effect of the 'Cash for Clunkers' Program on the Overall Fuel Economy of Purchased New Vehicles) asserts that based on the cost of gasoline and the unemployment rate, the average fuel economy of the new vehicles purchased was 0.6 mpg higher in July 2009 and 0.7 mpg higher in August 2009 than it would have been without the financial inventive from the CARS program.

Analysis Approach

Sales data were provided for each purchase and included the address of the auto dealer and the fuel economy rating of both the trade-in vehicle and the new vehicle purchase. The assumption is that vehicles purchased in the Washington, DC region will be operated in the region. The purchases were filtered by zip code to determine the purchases made in the 8-hour ozone area which is used for GHG analysis. If any part of a zip code was within an analysis county, it was included.

Assumptions

There were a total of 17,012 vehicle trade-ins/purchases in the area as part of the CARS program. Of those, there were 16,876 records with both the trade-in and new purchase fuel economy rating listed. In the Washington, DC region, the average fuel economy for a trade-in was 16.0 mpg and average fuel economy for a new vehicle purchase was 25.8 mpg which is an overall increase of 9.8 mpg, or a 61% improvement. The average annual VMT per vehicle was 12,609 miles.

Impact

Travel

It is assumed that there will be no change to VT or VMT.

Emissions

The CO_2 savings for each record was calculated based on the average vehicle miles driven per year (calculated from the odometer reading and model year of the trade-in). The sum of the CO_2 savings for all of the trade-ins was 46,321 annual tons.

Cost

The cost for the CARS program in the Washington DC area was $70.9 million. Overall, $2.85 billion were spent on incentives. According to The Washington Post (January 6, 2010), the final tally of the administrative cost will be somewhere between $77 and $100 million for DOT to administer the program.

Cost-Effectiveness

The New York Times ("High Carbon Cost for 'Clunkers' Program," August 14, 2009) cites the opinions of two experts, Michael Wara of Stanford University and Christopher R. Knittel of the University of California, Davis, on their estimates of cost-effectiveness of the CARS program. Their estimates range from $200 to $500 dollars per ton largely based on number of miles the clunker would have otherwise been driven before it was replaced.

Part 2: Alternative Fuels and Alternative Vehicle Technology

Alternative Fuel 2030 Forecast

High Energy Price Scenario ($7/gallon gas)

Alternative Fuel 2030 Forecast

Description:

The Energy Information Administration (EIA) at the US Department of Energy publishes a yearly annual energy outlook with 2030 projections of energy use across a variety of sectors, including transportation. These projections are based on current national policy and assumptions regarding fuel production potential and market penetration. For transportation, staff analyzed EIA data to produce specific projections by regional VMT for a variety of alternative fuel uses, such as biodiesel, ethanol, and electric-gasoline hybrids.

Summary of Impacts:

Total CO_2 reduction 2010-2030: 13.21 MT

Total CO_2 reduction 2010: 0.19 MT

Total CO_2 reduction 2020: 0.81 MT

Total CO_2 reduction 2030: 0.98 MT

Assumptions:

- Used DOE 2009 Annual Energy Outlook, Reference Case, Transportation Demand Sector supplemental table #60, "Light-Duty Vehicle Miles Traveled by Technology Type"
- Use 2009 CLRP VMT totals
- Used current fuel mix of 99% gasoline and 1% diesel, based on DOE AEO national average for 2009
- Assumed LDV percentage of emissions to be 80.4% in 2010, 75.8% in 2020, and 72.9% in 2030
- Assumed lifecycle ("well-to-wheels") emissions rates (grams/mile) for 13 different fuel/vehicle types:

Fuel/vehicle type:	**Grams/mile**
Gasoline Internal Combustion Engine (ICE) (assumed reformulated gasoline)	552
Turbo Direct Ignition (TDI) Diesel ICE	442
TDI Diesel ICE with B20 (20% Biodiesel)	398
Corn Ethanol	451
Cellulosic Ethanol	154
Compressed Natural Gas (CNG)	436
Liquefied Petroleum Gas (LPG)	420
Electric Vehicle (EV)	447
Plug-in Gasoline Hybrid (PHEV)	382
Electric-diesel hybrid	373
Electric-gasoline hybrid (HEV)	449
Fuel cell hydrogen	256

- All emissions rates, with exceptions noted below, were taken from: GM Study: Well-to-Wheels Analysis of Advanced Fuel/Vehicle Systems — A North American Study of Energy Use, Greenhouse Gas Emissions, and Criteria Pollutant Emissions (May 2005, 1.4 MB pdf)
- Biodiesel emissions rates were estimated using EPA information, from: http://www.epa.gov/smartway/growandgo/documents/factsheet-biodiesel.htm
- LPG and EV emissions rates were estimated using U.S. DOE information, from: http://www.afdc.energy.gov/afdc/vehicles/emissions.html
- PHEV emissions rates were estimated using ACEEE information, from: http://aceee.org/pubs/t061.pdf?CFID=3485285&CFTOKEN=27924418
- Fuel cell hydrogen emissions rates assume the most popular hydrogen production method: gaseous hydrogen produced from natural gas via steam methane reforming in a centralized plant.
- Corn and cellulosic ethanol amounts were estimated using a percentage of the total national ethanol consumption for each taken from the AEO 2009 report.
- Credit from reductions from PHEV, EV and HEV are not included in this analysis and are assumed to be included in reductions taken from new CAFE standards

Emissions Analysis:

The national level DOE forecast provides forecast VMT per fuel/vehicle type for each year out to 2030. This VMT data was converted into a percentage of total national VMT per fuel/vehicle type and then applied to the regional VMT for the Washington region MSA to determine an approximation of a regional-level forecast.

For each fuel/vehicle type:

VMT * (CO_2 grams/mile)* (1 ton/907185 grams) = daily CO_2 tons

The total tons for each fuel/vehicle type were added together and compared against the emissions assumed using the current fuel mix and the lifecycle rates for gasoline and diesel. The percentage difference was used as the percent reduction off of the baseline.

This percent was multiplied by the light duty percentage to come up with a final reduction factor.

Fuel/Vehicle Type	**CO_2 MT**		
	2010	**2020**	**2030**
(RFG) Gasoline ICE Vehicles	28.88	29.48	29.86
TDI Diesel ICE	0.41	0.56	1.26
TDI Diesel ICE (assuming B20)	0.00	0.26	0.58
Ethanol-Flex Fuel ICE (E85) (Corn)	0.85	2.07	1.84
Ethanol-Flex Fuel ICE (E85) (Cellulosic)	0.00	0.32	0.44
Compressed Natural Gas ICE	0.01	0.01	0.01

Compressed Natural Gas Bi-fuel	0.01	0.01	0.01
Liquefied Petroleum Gases Bi-fuel	0.01	0.00	0.00
Electric Vehicle*	0.00	0.00	0.00
Plug-in Gasoline Hybrid*	0.00	0.12	0.35
Electric-Diesel Hybrid (compared to diesel)	0.00	0.01	0.01
Electric-Gasoline Hybrid*	0.18	1.08	3.07
Fuel Cell Hydrogen	0.00	0.00	0.01
TOTAL	**30.162**	**32.721**	**34.018**
Baseline Assumption (based on current fleet mix using life-cycle emissions)	30.448	34.259	36.1 04
% Reduction	0.94%	4.49%	5.78%
LDV percentage of fleet	80.38%	75.83%	72.89%
% Reduction, FINAL	0.76%	3.40%	4.21%
Absolute reduction, off of CAFÉ 35.5 by 2016	0.19	0.81	0.98

*included in CAFE, reductions not included here

High Energy Prices ($7/gallon gas)

Description:

The Energy Information Administration (EIA) at the US Department of Energy publishes a yearly annual energy outlook with 2030 projections of energy use across a variety of sectors, including transportation. Included in these projections are additional scenarios, including a high price scenario which assumes $200/barrel of oil, which roughly translates into $7/gallon gas. These projections provide national level VMT projections for different types of light duty vehicles, including both conventional and alternative fuel/hybrid vehicles. Staff analyzed EIA data to produce specific projections for alternative fuel use by regional VMT. DOE estimates increased alternative fuel use from their baseline forecast and decreased national VMT by 6%.

Summary of Impacts:

Total CO_2 reduction 2010-2030: 27.13 MT

Total CO_2 reduction 2010: 0.47 MT

Total CO_2 reduction 2020: 1.54 MT

Total CO_2 reduction 2030: 1.84 MT

Assumptions:

- Used DOE 2009 Annual Energy Outlook, High Price Case, Transportation Demand Sector supplemental table #60, "Light-Duty Vehicle Miles Traveled by Technology Type"
- Use 2009 CLRP VMT totals
- Used current fuel mix of 99% gasoline and 1% diesel, based on DOE AEO national average for 2009
- Assumed LDV percentage of emissions to be 80.4% in 2010, 75.8% in 2020, and 72.9% in 2030
- Assumed lifecycle ("well-to-wheels") emissions rates (grams/mile) for 13 different fuel/vehicle types:

Fuel/vehicle type:	Grams/mile
Gasoline Internal Combustion Engine (ICE) (assumed reformulated gasoline)	552
Turbo Direct Ignition (TDI) Diesel ICE	442
TDI Diesel ICE with B20 (20% Biodiesel)	398
Corn Ethanol	451
Cellulosic Ethanol	154
Compressed Natural Gas (CNG)	436
Liquefied Petroleum Gas (LPG)	420
Electric Vehicle (EV)	447
Plug-in Gasoline Hybrid (PHEV)	382

Electric-diesel hybrid	373
Electric-gasoline hybrid (HEV)	449
Fuel cell hydrogen	256

- All emissions rates, with exceptions noted below, were taken from: GM Study: Well-to-Wheels Analysis of Advanced Fuel/Vehicle Systems — A North American Study of Energy Use, Greenhouse Gas Emissions, and Criteria Pollutant Emissions (May 2005, 1.4 MB pdf)
- Biodiesel emissions rates were estimated using EPA information, from: http://www.epa.gov/smartway/growandgo/documents/factsheet-biodiesel.htm
- LPG and EV emissions rates were estimated using U.S. DOE information, from: http://www.afdc.energy.gov/afdc/vehicles/emissions.html
- PHEV emissions rates were estimated using ACEEE information, from: http://aceee.org/pubs/t061.pdf?CFID=3485285&CFTOKEN=27924418
- Fuel cell hydrogen emissions rates assume the most popular hydrogen production method: gaseous hydrogen produced from natural gas via steam methane reforming in a centralized plant.
- Corn and cellulosic ethanol amounts were estimated using a percentage of the total national ethanol consumption for each taken from the AEO 2009 report.
- Credit from reductions from PHEV, EV and HEV are not included in this analysis and are assumed to be included in reductions taken from new CAFE standards

Emissions Analysis:

The national level DOE forecast provides forecast VMT per fuel/vehicle type for each year out to 2030. This VMT data was converted into a percentage of total national VMT per fuel/vehicle type and then applied to the regional VMT for the Washington region MSA to determine an approximation of a regional-level forecast. The regional VMT was adjusted to reflect the high price case VMT reduction of 6%, which was determined by comparing total VMT from the high price case to the reference case (which was used for the baseline alternative fuel forecast)

For each fuel/vehicle type:

VMT * (CO_2 grams/mile)* (1 ton/907185 grams) = daily CO_2 tons

The total tons for each fuel/vehicle type were added together and compared against the emissions assumed using the original regional VMT and the current fuel mix with lifecycle rates for gasoline and diesel. The percentage difference was used as the percent reduction off of the baseline.

This percent was multiplied by the light duty percentage to come up with a final reduction factor.

Fuel/Vehicle Type	**CO_2 MT**		
	2010	**2020**	**2030**
(RFG) Gasoline ICE Vehicles	28.48	28.01	25.83

TDI Diesel ICE	0.41	0.56	1.22
TDI Diesel ICE (assuming B20)	0.00	0.26	0.56
Ethanol-Flex Fuel ICE (E85) (Corn)	0.84	2.12	3.21
Ethanol-Flex Fuel ICE (E85) (Cellulosic)	0.00	0.33	0.50
Compressed Natural Gas ICE	0.00	0.01	0.01
Compressed Natural Gas Bi-fuel	0.01	0.01	0.02
Liquefied Petroleum Gases Bi-fuel	0.01	0.00	0.00
Electric Vehicle*	0.00	0.00	0.00
Plug-in Gasoline Hybrid*	0.00	0.04	0.12
Electric-Diesel Hybrid (compared to diesel)	0.00	0.01	0.01
Electric-Gasoline Hybrid*	0.02	0.34	0.76
Fuel Cell Hydrogen	0.00	0.00	0.00
TOTAL	**29.752**	**31.310**	**31.354**
Baseline Assumption (based on current fleet mix using life-cycle emissions)	30.448	34.259	36.104
% Reduction	2.28%	8.61%	13.1 6%
LDV percentage of fleet	80.38%	75.83%	72.8 9%
% Reduction, FINAL	1.84%	6.53%	9.59%
Absolute reduction, off of CAFÉ 35.5 by 2016	0.4737	1.5375	1.83 77

*included in CAFE, reductions not included here

Part 3: Travel Efficiency

1. The measures from the TERM Tracking Sheet can be found at http://www.mwcog.org/transportation/activities/quality/terms.asp
2. The measures from the *Analysis of Potential Transportation Emissions Reductions Measures (TERMs) Under Consideration for the Conformity of the 2009 CLRP and FY 2010-2015 TIP* can be found at http://www.mwcog.org/uploads/committee-documents/bF5bXltX20090615092634.pdf
3. Recommend Transportation-related Measures from the COG Climate Change Report
    a. Pay-as-you-drive Auto Insurance
    b. Incremental increase in transit
    c. Carpool Incentive
    d. Vanpool Incentive
    e. Expanded Telecommuting
    f. Fully fund regional bicycle/pedestrian plan
    g. Build additional bike stations
    h. Implement MATOC
    i. Enforce existing idling regulations
4. Recent, Proposed, and Potential Regional Initiatives
    a. TIGER Bike-sharing
    b. K St. Busway (to be completed)
    c. TIGER Smart Hubs
    d. TIGER Bus Prioritization
    e. TPB Value Pricing Study
    f. Traffic Signal Optimization Program
    g. Eco-driving

Climate Change Measure B.1.ii – Provide Pay-as-you-drive Auto Insurance

Description

This is an analysis of the potential impact of the "Pay-as-you-drive Auto Insurance (PAYD)". It provides the motorists the option of purchasing auto insurance per mile rather than in a lump sum. The program is assumed to begin in January 2010.

The current lump-sum pricing of auto insurance is inefficient and inequitable. Drivers who are similar in other respects—age, gender, location, driving safety record—pay nearly the same premiums if they drive five thousand or fifty thousand miles a year. Just as an all-you-can-eat restaurant encourages more eating, all-you-can-drive insurance pricing encourages more driving. That means more accidents, congestion, carbon emissions, local pollution, and dependence on oil. This pricing system is inequitable because low-mileage drivers subsidize insurance costs for high-mileage drivers, and low-income people drive fewer miles on average.

Eligibility

Light Duty Vehicles: Cars, Vans, Pickup Trucks and SUVs.

Heavy Duty Vehicles are not eligible because their premiums may already closely reflect mileage.

Analysis Approach

Use sketch planning analysis to calculate greenhouse gas emission reductions which result from the program implementation by estimating the emissions with and without the pay-as-you-drive insurance option. (This analysis is based on the information from the report "Pay-As-You-Drive Auto Insurance: A Simple Way to Reduce Driving-Related Harms and Increase Equity", The Brookings Institution). Pilot program is in North Central Texas. This study monitored the response of three thousand customers.

Assumptions

- This analysis considers all the vehicles in metropolitan Washington region.
- PAYD is available for light duty vehicles (cars, vans, pickup trucks, SUVs).
- Per-mile insurance premium and Per-mile Fuel cost are constant as of the year 2007.
- The driving reduction for the total light duty vehicles in the region is 7.8 % (weighted among DC, MD, VA) when all the light duty vehicle owners switch to PAYD.
- Beginning 2010, 5% of the eligible light duty vehicle owners will switch to PAYD each year and 30% of all eligible owners will switch within 6 years.
- Cost of PAYD is $20 per newly involved vehicle and $10 per existing vehicle per year. There could be additional cost involved such as marketing the program.
- CO_2 estimates are based on CAFÉ 35.5 by 2016 (2009 CLRP).
- Number of vehicles is based on 2008 vehicle registration data and the growth rate is 1.94%. (Based on the historical growth rate used in the region.)
- The cost effectiveness calculation does not take into consideration the fuel savings

Impact

Travel

The VMT reductions for all the light duty vehicles are estimated to be 100,414,209 miles in the first year (2010) of the program. The cumulative VMT reductions between 2010 and 2030 are estimated to be 12,606,250,825 miles.

Emissions

The CO_2 emissions reductions for all the light duty vehicles are estimated to be 51,105 tons in the first year (2010) of the program. The cumulative CO_2 emissions reductions between 2010 and 2030 are estimated to be 5,020,759 tons.

Cost

The cost is estimated to be $ 3,355,509 in the first year (2010) of the program and the cumulative cost is estimated to be $ 235,329,887 between 2010 and 2030.

Cost Effectiveness

The cost effectiveness for the first year of the program is estimated to be $66 per ton of CO_2 in 2010 and the cost effectiveness for the last year of the program is estimated to be $55 per ton of CO_2 in 2030.

Climate Measure B.3.i: Incremental Increase in Transit

Description:

This analysis was done for the Dulles rail project as an indicator for the order of magnitude for a major Metrorail expansion.

Summary of Impacts:

Daily VT reduction (2015): 24,114

Daily VMT reduction (2015): 289,367

Total CO_2 tons reduction (2010-2030): 762,264

Assumptions:

- Projected new metrorail ridership attributable to the Dulles Rail extension was taken from the Summary of Effects (Table 2.4-2) in the Final Environmental Impact Statement for the Dulles Corridor Rapid Transit Project for the Wiehle Ave Extension opening year (2014) and for the full project in 2025.
- Project completion dates were assumed based on current CLRP data: 2014 for the Wiehle Avenue Extension and 2015 for the full Locally Preferred Alternative
- 70% of new transit trips were assumed to come from low occupancy vehicles (LOV)
- 10% of new transit trips were assumed to come from previous carpools
- Auto occupancy for LOV is assumed to be 1.28
- Auto occupancy for carpools is assumed to be 3.05
- Average trip length is assumed to be 12 miles
- Metrorail annual ridership growth (for 2025-2030) is assumed to be 1.5%, which is based on WMATA baseline forecast: http://www.wmata.com/about_metro/board_of_directors/board_docs/042408_RailCapacitypresentation.pdf

Emissions Analysis:

First, prior mode person trips were calculated, starting in 2014:

LOV prior trips = New trips * 70%

Carpool prior trips = New trips * 10%

Then VT reduction was calculated:

(LOV prior trips/1.28) + (Carpool prior trips/3.05)

VMT reduction was calculated:

VT reduction * 12

CO_2 reduction was calculated:

Daily VMT Reduced *(420.53 grams/mile) * (1 ton/907185 grams)

	2014	2020	2025	2030
New Trips (avg weekday)	29100	44700	47800	5152 0
Prior Mode Person Trips				
LOV 2037	0	31290	33460	36064
Carpool 2910		4470	4780	5152
Vehicle Trips Reduced				
LOV 1591	4	24445	26141	28175
Carpool 954		1466	1567	1689
Total 1686	8	25911	27708	29864
Emissions				
VMT reduced	202418	310931	332494	358368
CO2 emissions reduced (tons/year)	34249	44884	44903	45063

Climate Change Measure B.4.i – Carpool Incentive

Description

The assumptions for this measure are based on the National Capital Region Transportation Planning Board Commuter Connections Program's Carpool Incentive Program Demonstration Project Study which was released on January 27, 2009. A three month pilot project is schedules to begin in November 2009.

Analysis Approach

- Use sketch planning analysis to calculate emissions reductions which result from the shift from SOV to carpool. It is assumed that benefits begin in 2010.

Assumptions

- Based on commuter information from the Commuter Connections 2004 State of the Commute, the average commute in the metropolitan Washington region is approximately 15.5 miles (each way)
- The goal of this Carpool Incentive Program is to increase carpooling in select corridors in the Washington, DC region. Participants will receive $1 for each work trip taken by carpool (up to $2/day/person). Participants must be switching from SOV.
- In the report, the VT/VMT reductions were calculated per hour. This measure assumes benefits for two hours in the AM peak and two hours in the PM peak period.

Impact

Travel

VT Reduction/Hour (all corridors) =	466
VMT Reduction/Hour (all corridors) =	7,223
Daily VT Reduction (all corridors) =	1,864
Daily VMT Reduction (all corridors) =	28,892

VT/year reduced = 7,223,106

VMT/year reduced = 7,223,106

Emissions

The annual CO2 emissions reductions are estimated to be 3,676, 2,857 and 2,488 tons in 2010, 2020 and 2030, respectively. The cumulative CO_2 emissions reductions are estimated to be 35,930 tons after year 2020 and 62,471 tons after year 2030.

Cost

According to the *Carpool Incentive Program Demonstration Project Study*, the cost of a six month pilot program is $186,182.88.

Cost Effectiveness

Annual cost for the carpool incentive program is $372,365.76

Annual tons of CO_2 reduction in 2020 – 2,857

Cost-effectiveness in 2020: 130.33 $/ton

Climate Change Measure B.4.i – Provide Vanpool Incentive Program

Description

This is an analysis of the potential impact of vanpool incentives in Commuter Connections Program. It provides the commuters who drive alone and choose to switch to vanpooling a financial incentive. The program is assumed to begin in January 2010.

Analysis Approach

- Use sketch planning analysis to calculate emissions reductions which result from the program implementation by estimating emissions with and without providing incentives for vanpooling. This analysis is based on the EPA's Commuter Model V2.0 and three scenarios of vanpool financial incentives are analyzed ($15/vehicle/day, $20/vehicle/day, $25/vehicle/day).

Assumptions

- This analysis considers all the employment in metropolitan Washington region. The employment data is from the land use file of our model.
- Work-trip mode shares are based on mode choice output of 2008 CLRP and 2007/2008 TPB Household Travel Survey.
- The average trip length of vanpool is assumed to be 30 miles/day.
- Based on 2008 MWCOG Vanpool Driver Survey, there are 683 vanpools in the region and the average vanpool occupancy is 9 people.
- The length of peak period is 3 hours and the percent of work trips in peak periods is 40%.
- CO2 estimates are based on CAFÉ 35.5 by 2016 (2009 CLRP).

Impact

Travel

- Scenario 1: $15/vehicle/day
  The VMT reductions are estimated to be 36,797,500 miles in the year 2020 and 73,595,000 miles in 2030.

- Scenario 2: $20/vehicle/day
  The VMT reductions are estimated to be 56,033,315 miles in the year 2020 and 112,066,630 miles in 2030.

- Scenario 3: $25/vehicle/day
  The VMT reductions are estimated to be 80,320,739 miles in the year 2020 and 160,641,477 miles in 2030.

Emissions

- Scenario 1: $15/vehicle/day

The CO_2 emissions reductions are estimated to be 14,553 tons in the year 2020 and 25,354 tons in 2030.

- Scenario 2: $20/vehicle/day
  The CO_2 emissions reductions are estimated to be 22,160 tons in the year 2020 and 38,608 tons in 2030.

- Scenario 3: $25/vehicle/day
  The CO_2 emissions reductions are estimated to be 31,766 tons in the year 2020 and 55,342 tons in 2030.

Cost

- Scenario 1: $15/vehicle/day
  The cost is estimated to be $3,061,250 after the first year (2010) of the program. The cumulative cost is estimated to be $40,892,500 after year 2020 and 91,848,750 after the year 2030.

- Scenario 2: $20/vehicle/day
  The cost is estimated to be $3,061,250 after the first year (2010) of the program. The cumulative cost is estimated to be $44,672,500 after year 2020 and 106,286,250 after the year 2030.

- Scenario 3: $25/vehicle/day
  The cost is estimated to be $3,061,250 after the first year (2010) of the program. The cumulative cost is estimated to be $49,438,750 after year 2020 and 124,488,750 after the year 2030.

Cost Effectiveness

- Scenario 1: $15/vehicle/day
  The cost effectiveness for the first year of the program is estimated to be $301 per ton of CO_2 in 2020 and $224 per ton of CO_2 in 2030.

- Scenario 2: $20/vehicle/day
  The cost effectiveness for the first year of the program is estimated to be $228 per ton of CO_2 in 2020 and $183 per ton of CO_2 in 2030.

- Scenario 3: $25/vehicle/day
  The cost effectiveness for the first year of the program is estimated to be $187 per ton of CO_2 in 2020 and $159 per ton of CO_2 in 2030.

Climate Change Measure B.4.ii - Expanded Telecommuting

Description:

This measure assumes that all potential telecommuters begin telecommuting at least 1 day a week within 5 years from 2010. Potential commuters are based on those stating in the 2007 State of the Commute report that they do not currently telecommute, but are willing and able.

Summary of Impacts:

Daily VT reduction (2011): 59,197

Daily VMT reduction (2011): 917,546

CO_2 tons reduction (2010-2030): 819,429

Assumptions:

- Employment totals are from the COG Cooperative Forecast Round 7.2 for the TPB planning area
- Telecommuting figures were estimated using findings from the 2007 State of the Commute Survey
  - 18% currently telecommute
  - 24% job responsibilities allow and are interested in telecommuting
  - 6% job responsibilities allow but not interested in telecommuting
  - 52% job responsibilities would not allow telecommuting
- 97.5% of telecommuters are home-based (meaning they telecommute from home)
- 2.5% of telecommuters are non-home-based (meaning they telecommute from somewhere that is not home or the office)
- Vehicle trip reduction (VTR) factor for home-based teleworkers is 0.45 daily trips reduced per teleworker, reflecting the part-time (1.5 days per week average) telework frequency.
- VTR factor for non-home-based teleworkers is 0.31 because a majority of these workers are assumed to drive alone to outside locations.
- Telecommuting increases each year for 5 years until the potential telecommuters are converted and then increases with the rate of job growth until 2030
- Average trip length in assumed to be 15.5
- 260 work days are assumed for the year

Emissions Analysis:

The conversion of all potential telecommuters was estimated to occur over 5 years by increasing the current telecommuting each year so that 42% of all employees are telecommuting by 2016. These new telecommuters are split into home-based and non-home-based telecommuters. The benefit of these new telecommuters is calculated as follows:

Daily VT Reduced = (New home-based telecommuters * 0.45) + (New non-home-based telecommuters * 0.31)

Daily VMT Reduced = Daily VT Reduced * 15.5

Daily CO_2 Reduced (2010) = Daily VMT Reduced * 461.7 grams/mile) * (1 ton/907185 grams)

	2011	**2020**	**2030**
Employment	2835915	3228535	3586718
Current Telecommuters	530316	603736	670716
Potential New Telecommuters	680620	774848	860812
Added Telecommuters	132579	19054	14237
Total Telecommuters	655007	1373821	1526237
home-based telecommuters	129265	18578	13881
non-home-based telecommuters	3314	476	356
Daily Vehicle Trips Reduced	59197	8508	6357
Daily tons CO2 reduced	456.6	52.2	33.9
Annual tons CO2 reduced	118706.5	13559.7	8825.7

Climate Change Measure B.4.iii – Bicycle and Pedestrian Programs – Fully fund regional bicycle/pedestrian plan

Description

In July 2006, TPB approved the *Bicycle and Pedestrian Plan for the National Capital Region* which identifies the capital improvements, studies, actions, and strategies that the region proposes to carry out by 2030 for major bicycle and pedestrian facilities. The plan costs an estimated $530 million and consists of approximately 350 bicycle and pedestrian projects, which includes 680 new miles of new paths and bike lanes. There are two scenarios analyzed for this measures – accelerated completion of the plan by 2020 (Scenario 1) and completion of the plan by 2030 (Scenario 2).

Analysis Approach

- Use sketch planning analysis to calculate emissions reductions which result from the accelerated construction of the TPB's *Bicycle and Pedestrian Plan for the National Capital Region*. The analysis is based on the methodology used for TERM 102 (Revised) Priority Bicycle Project.

Assumptions

- Construction begins immediately and the same number of bicycle lane miles is added each year through year 2020 in Scenario 1 and 2030 in Scenario 2.
- Single-occupancy vehicle (SOV) trips make up 63% of trips in the region and that mode share is applied to the trip reductions.
- The average trip length is 3 miles.
- The lifespan of the facilities is 20 years (based on the assumptions in the *Transportation Emissions Reduction Measures (TERMs) Analysis Instructions* (http://www.mwcog.org/uploads/committee-documents/bl5dX1Zb20080922185249.pdf)

Impact

<u>Travel</u>

Scenario 1: Accelerated Completion by 2020

# new cyclists/day per mile of bicycle lane/trail constructed (Ref: TERM 102 (Revised) Priority Bicycle Project =	180
# new cyclists/day due to the full construction of the bicycle/pedestrian plan =	221,845
Motorized trips reduced each day (2/person) =	443,689

% SOV in region =	63%
SOV trips reduced each day =	279,524
average trip length (mi) =	3
VMT reduced each day in 2020 =	838,573
VMT reduced annually in 2020 =	306,078,965

Scenario 2: Completion by 2030

# new cyclists/day per mile of bicycle lane/trail constructed (Ref: TERM 102 (Revised) Priority Bicycle Project =	180
# new cyclists/day due to the full construction of the bicycle/pedestrian plan =	221,845
Motorized trips reduced each day (2/person) =	443,689
% SOV in region =	63%
SOV trips reduced each day =	279,524
average trip length (mi) =	3
VMT reduced each day in 2030 =	838,573
VMT reduced annually in 2030 =	306,078,965

<u>Emissions</u>

Scenario 1:

The annual CO2 emissions reductions are estimated to be 121,050 and 105,446 tons in 2020 and 2030, respectively. The cumulative CO2 emissions reductions are estimated to be 723,072 tons after year 2020 and 1,847,751 tons after year 2030.

Scenario 2:

The annual CO2 emissions reductions are estimated to be 60,525 and 105,446 tons in 2020 and 2030, respectively. The cumulative CO2 emissions reductions are estimated to be 361,536 tons after year 2020 and 1,226,725 tons after year 2030.

Cost

The plan costs an estimated $530 million.

Cost Effectiveness

Scenario 1:

The total cost for the plan is $530,000,000

Annualized over 20 years - $26.5 million/year

Annual tons of CO_2 reduction in 2020 - 121,050

Cost-effectiveness in 2020: 219 $/ton

Climate Change Measure B.4.v – Bicycle and Pedestrian Programs - Address need for on-road bicycle accommodations and facilities - Build additional bicycle stations similar to the one at Union Station

Description

For this measure, it is assumed that nine additional bicycle stations (similar to the one opening at Union Station in summer 2009) will be constructed in the region in areas such as Bethesda, Silver Spring, Arlington and Alexandria.

Analysis Approach

- Use sketch planning analysis to calculate emissions reductions which result from the construction of bike stations based on an estimate for daily trip reduction provided by DDOT. It is assumed that benefits begin in 2010.

Assumptions

- Each bicycle station will reduce 150 one-way (75 round-trip) vehicle trips
- Each trip is two miles one-way (four miles round-trip)
- Number of effective days to convert daily trips to annual- 300 days

Impact

Travel

number of bicycle stations in region =	10
VT (one-way) reduced / bicycle station =	150
length of trip (one-way) mi =	2
VT reduced / bicycle station =	300
VMT reduced / bicycle station =	300
VT/day reduced =	3,000
VMT/day reduced =	3,000
VT/year reduced =	900,000
VMT/year reduced =	1,095,000

<u>Emissions</u>

The annual CO_2 emissions reductions are estimated to be 557, 433 and 377 tons in 2010, 2020 and 2030, respectively. The cumulative CO_2 emissions reductions are estimated to be 5,447 tons after year 2020 and 9470 tons after year 2030.

Cost

The bicycle station at Union Station ended up costing approximately $4 million in part because of the constrained location and the desire to design a structure that would complement Union Station. Assuming that other bike stations would not have these constraints and could be built the cost could be much less (approximately $2 million). It is assumed that any operating costs would be covered by user fees. Therefore, the cost for all ten bike stations would be $22 million

Cost Effectiveness

The total cost for the bike stations is $22,000,000

Annualized over 20 years - $1.1 million/year

Annual tons of CO2 reduction in 2020 - 433

Cost-effectiveness in 2020: 2500 $/ton

Climate Change Measure C.3. – Enforce Existing Idling Regulations

Description

This is an analysis of the potential impact of enforcing the existing idling regulations. The harmful impact of idling has long been recognized. Many states have state-wide anti-idling laws and several counties and cities have their own anti-idling rules. A significant amount of CO_2 emissions can be reduced by enforcing these regulations.

Idling Regulations in Metropolitan Washington Region(July 2008 ATRI)

District of Columbia:

Maximum Idling Time: 3 minutes (5 minutes in less than 32°F)

Exemptions: Power takeoff

Fines: $500, double for each subsequent violation

Maryland:

Maximum Idling Time: 5 minutes

Exemptions: Traffic conditions or mechanical difficulties

Heating, cooling or auxiliary equipment

Confirm to manufacture's specifications

Accomplish intended use

Fines: Not< $500

Virginia:

Maximum Idling Time: 10 minutes for diesel vehicles and 3 minutes for all other vehicles in commercial or residential urban areas

Exemptions: Auxiliary power

Fines: Not >$25,000:

Analysis Approach

Use sketch planning analysis to calculate greenhouse gas emission reductions which result from the program implementation by estimating the fuel savings per vehicle per minute. (This analysis is based on the information of North Carolina Department of Environment and Natural Resources (Division of Air Quality) and Natural Resources Canada, see attachment for details).

Assumptions

- This analysis only considers light-duty gasoline vehicles in metropolitan Washington region. (cars, vans, pickup trucks, SUVs)
- The average engine size of the light-duty vehicle in our region is assumed to be 3 liters.
- Number of light-duty gasoline vehicles (LDGV) is based on 2008 vehicle registration data.
- 82% of LDGV are on the road every day.
- CO_2 estimates are based on 8,788 grams CO_2/gallon of gasoline.
- The average idling reduction is assumed to be 1 minute per vehicle.
- The vehicle registration forecast is based on the old growth rate.
- 20% of the light-duty gasoline vehicles on road will be involved in 2010, 40% will be involved in 2020 and 60% will be involved in 2030.

Impact

Travel

No travel impacts as the VMT is assumed to be the same

Emissions

Natural Resource Canada Version:

The CO_2 emissions reductions for all the light duty gasoline vehicles are estimated to be 7,069 tons in the year 2010, 13,035 tons in 2020 and 19,707 tons in 2030.

North Carolina DOE Version:

The CO_2 emissions reductions for all the light duty gasoline vehicles are estimated to be 2,909 tons in the year 2010, 5,363 tons in 2020 and 8,109 tons in 2030.

Cost

The cost is estimated to be $500,000 annually from the first year (2010) of the program.

Cost Effectiveness

Natural Resource Canada Version:

The cost effectiveness of the program is estimated to be \$70 per ton of CO_2 in 2010, \$38 per ton of CO_2 in 2020 and \$25 per ton of CO_2 in 2030.

North Carolina DOE Version:

The cost effectiveness of the program is estimated to be \$172 per ton of CO_2 in 2010, \$93 per ton of CO_2 in 2020 and \$62 per ton of CO_2 in 2030.

TIGER Bike-sharing

Description:

This is the bike-sharing package from the 2009 TPB TIGER grant application, which includes 3,250 bicycles and 325 bicycle stations in the District of Columbia, Arlington County, City of Alexandria, City of Fairfax, College Park, Hyattsville, Bethesda, Silver Spring, and National Harbor. The system will work similar to a car-sharing system, such as ZipCar, where members pay a fee and have access to any available bike throughout the regional system. The program builds off of the success of the District's pilot bike-sharing program of 500 bikes.

Summary of Impacts:

Daily VT reduction (2012): 5,040

Daily VMT reduction (2012): 8,164

Total CO_2 tons reduction (2010-2030): 66,229

Assumptions:

- The number of bikes will increase 5% a year under the assumption that the program will be expanded to eventually achieve ideal saturation (roughly 200 residents per bike).
- This bike-sharing system will be similar in size to the Montreal, Barcelona, and Lyon bike-sharing systems. The greatest data is available for the much larger Paris bike-sharing system. Therefore, a combination of experiences from these global models was used to generate system assumptions, such as revenue generation, mode shifts, and ridership.
  - 8% of bike riders shifted from SOV
  - 3% of riders shifted from taxi to bike
  - 8% of bike riders as new transit riders
  - 10% of new transit trips shifted from SOV
- Each bike will be used by 7 people per day, but this increases 5% a year as the system expands.
- Each person will make 2 trips (1 roundtrip)
- The average bike trip length is 1.5 miles, according the COG Household Travel Survey (HHTS) 2007/2008. This is used as the average trip length for all trips assumed to have been replaced with a bike trip.

Emissions Analysis:

Because this measure assumes provision of an entirely new system, all riders are "new riders" and thus represent increased bicycle ridership. VT and VMT reduction was calculated by applying the mode shift percentages outlined above to the total bike-sharing system ridership and using the average trip length above.

2010 calculations are shown below, which was done for every year assuming ridership and capital annual increases outline in the assumptions.

Total daily ridership (2010) = 45,500

VT reduced (2010) = (Total ridership * 8% switching from SOV) + (Total ridership * 3% switching from taxi) + (Total ridership*8% bike riders as new transit riders*10% new transit trips switching from SOV)

VMT reduced = VT reduced * 1.5 miles average trip length

CO_2 reduced (2010) = VMT reduced *(461.7 grams/mile) * (1 ton/907185 grams)

Full documentation of a cost-benefit analysis done for this measure is available here:
http://www.mwcog.org/transportation/tiger

	2012	**2020**	**2030**
Bicycle-sharing trips, per day	45500	99321	263528
Bicycle miles traveled (BMT)/day	68250	148981	395291
Auto/Taxi VT/day reduced	4664	10180	27012
Auto VMT/day reduced	6996	15271	40517
Transit ridership increase, trips/day	3758	8204	21767
Auto VT/day reduced	376	820	2,177
Auto VMT/day reduced	1,169	2,551	6,770
Total VT/day reduced	5,040	11,001	29,188
Total VMT/day reduced	8,164	17,822	47,287
Mode shift			
Trips shifted from auto	3,526	7,697	20,423
Trips shifted from taxi	1,138	2,483	6,588
CO_2, Tons of pollutants per day	3.97	7.05	16.29

TIGER Smart Hubs

Description:

This is the technology component from the 2009 TPB TIGER grant application, which includes 20 "smart hubs" at intermodal transfer points, such as metro stations that are also home to a bike-sharing station, car-sharing, and bus stops. At these hubs, users will be able to see which modes are available near them by using free wireless internet to access a regional website of transportation information. Additionally, high-tech "smart displays" with information such as real-time bus arrivals and expanded wayfinding will be placed at each hub. The hubs will have strong branding and signage to increase visibility and legibility of the region's many transportation options.

Summary of Impacts:

Daily VT reduction (2012): 3,595

Daily VMT reduction (2012): 11,180

Daily CO_2 reduction: 37,472

Assumptions:

- Assumed a 3% transit ridership increase in the first year due to real-time information systems and integrated mobility plan with more extensive, interactive improvements
  - Based on literature review done by Georgia Tech including:
    Schweiger, Carol. "Real-Time Bus Arrival Information Systems" TCRP Synthesis 48. 2003
- Total transit trips were assumed from the 2007 CLRP, regional travel demand model output
- Ridership increases past the first year of operation are assumed to be normal according to the regional travel demand model output
- Assumed 10% of new transit trips shifted from SOV
- Average transit trip length for a local WMATA route is assumed to be 3 miles according to WMATA staff

Emissions Analysis:

A 3% increase in transit trips was applied for the first year (2012). For subsequent years the normal ridership increases were assumed to occur on top of the increased base ridership.

VT reduction per day was calculated:

New transit trips * 10% switching from SOV to transit

VMT reduction per day was calculated:

VT reduction * 3 miles average trip length

CO_2 reduced (2012) = VMT reduced *(441.1 grams/mile) * (1 ton/907185 grams)

	2012	2020	2030
Total current transit trips	1198283	1396874	1510369
Total transit trips, with 3% increase in first year	1234231	1438780	1555680
Total VT/day reduced	3,595	4,191	4,531
Total VMT/day reduced	11,180	13,033	14,092
CO2, Tons of pollutants per day	5.4362	5.1543	4.8547

TIGER Bus Priority

Description:

This is the bus priority package from the 2009 TPB TIGER grant application, which consists of a network of fourteen connected bus priority corridors in Maryland, Virginia and the District of Columbia, running on both arterials and managed lanes (high occupancy vehicle, HOV) on freeways, as well as two bridge and arterial connections. In addition to transitways and improvements to express bus services, this includes runningway improvements along nine corridors inWMATA's Priority Corridor Network. Runningway improvements include bus/HOV lanes, queue jump lanes, and transit signal priority. This project also includes service-related improvements, such as real-time bus information and provision of high quality bus stops.

Summary of Impacts:

Daily VT reduction (2012): 4,877

Daily VMT reduction (2012): 47,874

Total CO_2 tons reduction (2010-2030): 100,533

Assumptions:

- 287 bus routes will be impacted
- The daily ridership on the bus routes is approximately 260,000 (based on operator ridership statistics)
- Total travel time elasticity was assumed to be 0.5
- Average trip length was assumed to be:
  - 3.1 for local WMATA routes
  - 10 for express WMATA routes
  - 2 for local inner jurisdiction routes
  - 13 for express inner jurisdiction routes
  - 32 for express outer jurisdiction routes
- The % of passengers receiving travel time benefits is 50% for local routes and 95% for express routes
- The % of new riders switching from SOV is 10% for local WMATA routes, 35% for local inner jurisdiction routes, and 90% for all express routes.
- The standard deviation wait time is assumed to be 2 minutes less across all routes, from 5 minutes to 3.
- Annual ridership increases are assumed based on operator input

Emissions Analysis:

The analysis is broken out into five different bus transit modes, each with different operating characteristics including average fares and average trip lengths, described above. The bus routes in each mode are then assigned a number of travel time savings in minutes based on the project components with

which they interact, including real-time bus arrival displays, queue jump lanes, transit signal priority, and dedicated lanes.
Ridership increases were then estimated by assuming a -0.50 travel time elasticity, meaning that for each percent decrease in travel time, the ridership would increase by ½-percent. When applied to the travel time savings across all nearly 300 bus routes, a total of 19,395 new riders was calculated, approximately 5000 of which switch from private auto. This figure is projected out to 2030 to grow at the appropriate ridership growth rates outlined in the assumptions above.

2010 calculations are shown below, which was done for every year assuming ridership and capital annual increases outline in the assumptions.

VT reduced = Total new ridership * % switching from SOV (varies according to bus mode)

VMT reduced = VT reduced * average trip length (varies according to bus mode)

CO2 reduced (2010) = VMT reduced *(461.7 grams/mile) * (1 ton/907185 grams)

Full documentation of a cost-benefit analysis done for this measure is available here:
http://www.mwcog.org/transportation/tiger

For Bus Modes Combined:	**2012**	**2020**	**2030**
VT reduced	1268058	1395029	1571767
VMT reduced	12447358	13693715	15428596
CO2 tons reduced	5813.212	5115.373	5119.141

TPB Value Pricing Study, with transit

Description:

This analysis was done of the 2007 TPB Value Pricing Study, specifically of "Scenario CPT", which included pricing new lanes on all major freeways, pricing existing lanes within DC, and pricing existing lanes on the region's parkways. This also includes enhancement of existing bus transit on these managed lanes.

Summary of Impacts:

Annual CO_2 tons reduction (2030): 1,489,914

Assumptions:

- CO2 reductions were assumed to predominantly come from congestion reductions and speed improvements since VMT reductions were minor under the CPT scenario in comparison to the 2006 CLRP baseline
- Regional Travel Demand Model outputs were used for AM peak period speeds and volumes for each link
- Calculations of CO2 emissions rates were completed using the equation relating speed to CO2 emissions based on research out of the University of California Riverside. The following equation is a function of speed, where X = speed:
  CO_2 grams/mile = $e^{(7.61353534994965 - 0.138565457462594X)} + (0.003915102063854X^2) - (0.000049451361017X^3) + (0.000000238630156X^4)$
- The Value Pricing Study was only modeled for year 2030, so the analysis is only completed for that year.

Emissions Analysis:

For both the Value Pricing Scenarios and the 2006 CLRP:

The above equation was applied to the AM peak period speed for each link in the modeled network for both the Value Pricing Scenarios and the 2006 CLRP for comparison to obtain the specific CO_2 emissions rate for that link.

Grams of CO_2 per trip were calculated:

CO_2 emissions rate * Link Distance

Grams of CO_2 for all trips were calculated:

CO_2 emissions per trip * Link Volume

Total CO_2 emissions for all trips were added for all links.

National Capital Region Transportation Planning Board

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Memorandum

Date: April 27, 2010

To: Travel Management Subcommittee

From: Anant Choudhary
Transportation Engineer

Subject: Update on revised estimate for VOC, NOx & CO_2 emissions benefits from the TERM 'Signal Optimization'

This memorandum provides an update on the revised VOC, NOx & CO_2 emissions reduction estimate for the adopted TERM 'Signal Optimization' using the most current data on the optimized signals in the region.

The TERM 'Signal Optimization' was adopted in July 2002 and its accrued emissions benefits (VOC & NOx) are shown in the TERM Tracking Sheet included in the past conformity documents. The 2002-05 emissions benefits were estimated using the 2002 data on optimized signals. A goal of optimizing 2000 signals was considered in the year 2002 analysis. In the subsequent years the emissions benefits were factored by using the emissions ratios obtained from the traffic stream emissions rates and the resulting emissions were reported in the TERM Tracking Sheet.

The Status Report on the Signal Optimization presented to the March 18, 2009 TPB committee (Agenda Item-12), reports that there are about 5400 signalized intersections in the region, and about 3000 signals have been optimized under the program. This indicates that compared to 2002 data on optimized signals, there is an increase in the number of optimized signals in the region by about 1000 signals. (Table-1) This necessitates a revision to the past emissions benefits to reflect the benefits available from the increased number of optimized signals in the region using the most current data. Also the earlier analysis was carried out using the 2002 emissions factors which also need to be revised using the 2010 emissions factors.

The prior analysis used results from the two corridor studies prepared: (1) by the District of Columbia Department of Transportation for the 16th Street corridor from Eastern Avenue, NW to P Street NW, and (2) by Maryland State Highway Administration for MD 650 (New Hampshire Avenue) from MD 212 to Peabody Street in the District. Delay reductions and operating speed improvements were obtained from the Synchro model and were field verified. Then, emissions benefits were estimated using emissions factor differential for the before and after average speeds from the Mobile6.2 model and VMT information. In the analysis AM speed improved from 8.3 to 14 mph and PM speed improved from 13.5 to 18 mph. It was assumed that the speed improvements throughout the region will be similar.

At the April 21, 2009 Travel Management Subcommittee, DTP staff recommended a revision to the methodology used in the previous analysis, as the previous analysis was based on studies carried out for the two corridors as noted above, and since we now have average speed information on a number of corridors from the annual travel time survey which can be used in the revised analysis.

The data from the annual travel time survey includes average speed, number of signals, distances and this is supported by the traffic volume data from the state DOT reports. For the VOC & NOx emissions estimation the arterial traffic stream emissions rates were used and for CO_2 benefits emission factors developed by UC Davis were used. Staff has assumed that average speed will improve by 5 mph (as indicated by Synchro model) after signal are optimized in the corridors. Using the volume, distance and emissions rates differential for 5 mph, staff estimated emissions benefits for all the corridors in the arterial travel time study. Then the estimated benefit per signal is obtained by dividing the total benefits by the number of signals along the corridors. The regional benefit is then obtained by multiplying the number of signal optimized.

The attachment shows the analysis and revised estimate for the VOC, NOx & CO_2 using the latest data on number of signals optimized in the region and using the traffic stream emissions factors for arterial.

The VOC, NOx & CO_2 emissions benefits using the revised method and 2009 data are as below.

2010 Revised Benefits

(It is assumed that the benefits from the signal optimization will deteriorate 50% over time)

NOx emissions benefit for 3000 signals	**0.6427**	**tons/day**
VOC emissions benefit for 3000 signals	**0.7561**	**tons/day**
CO_2 emissions benefit for 3000 signals	**772**	**tons/day**

Table 1. 2006 – 2008 Regional Signal Optimization Reported Results
All figures are approximate.

Total Signalized Intersections	Total Signals Optimized or Checked/Adjusted				Signals Not Analyzed or Checked 2006 to 2008		Signals for which No Report Received	
	Signals Optimized 2006 to 2008 (by Computer Analysis Methods)		Signals Checked and If Necessary Adjusted 2006 to 2008 (by Methods Other than Computer Analysis)					
	Number	Percentage	Number	Percentage	Number	Percentage	Number	Percentage
5,400	3,000	56%	1,300	24%	1,000	18%	100	2%
	4,300 – 80%							

Source: Agenda Information Item-12, March 18, 2009 TPB meeting

Signal Optimization TERM
Revised Analysis

	2010			2020			2030		
	VOC	NOx	CO2	VOC	NOx	CO2	VOC	NOx	CO2
Emissions Benefits tons/day (DC, MD, VA for 1119 signals)	0.5641	0.4794	575.78	0.3277	0.1592	575.78	0.3115	0.1213	575.78
Emissions Benefits per signals	0.0005	0.0004	0.5145	0.00029	0.00014	0.5145	0.00028	0.00011	0.5145
2010 Benefits for 3000 signals (50% deterioration is assumed)	0.7561	0.6427	772	0.4393	0.2134	772	0.4176	0.1625	772
Annual Benefit (250 days) t/yr for 3000 signals	189.03	160.67	192,955	109.83	53.35	192,955	104.39	40.64	192,955

Following assumptions are made in the above analysis
All the signals from the routes segments surveyed in the Arterial Travel Times Studies have been optimized (50% deterioration is assumed)
An average of 5 mph speed improvement would be gained from signal optimization
About 75% of traffic is through traffic

Signal Optimization TERM - Revised Analysis
(Arterial Travel Time Survey Corridors)

State	Year	Route	Average Speed (Both direction)	Speed Increase Post Optimization	Length	Facility type	# of signals	Traffic volume (average) (Factored for 75% through traffic)	2010 VOC Emissions Benefits	2010 NOx Emissions Benefits	2010 CO2 Emissions Benefits	2020 VOC Emissions Benefits	2020 NOx Emissions Benefits	2030 VOC Emissions Benefits	2030 NOx Emissions Benefits
MD	2006	MD 117	24.9	29.9	6.8	II/SU	15	9619	0.0022	0.0024	2.02	0.0013	0.0008	0.0012	0.0006
MD	2006	MD 197	31.05	36.1	14.7	II/SU	22	14494	0.0047	0.0013	2.73	0.0028	0.0006	0.0027	0.0006
MD	2006	MD 198	28.65	33.7	5.0	II/SU	6	23993	0.0031	0.0020	2.11	0.0018	0.0008	0.0017	0.0006
MD	2006	MD 355 -1	18.1	23.1	8.7	II/SU	36	26484	0.0152	0.0172	17.33	0.0088	0.0055	0.0084	0.0040
MD	2006	MD 355-2	14.75	19.8	6.6	II/SU	32	34018	0.0216	0.0228	24.59	0.0129	0.0073	0.0123	0.0053
VA	2006	VA 123 - 1	20.05	25.1	5.9	II/SU	13	22875	0.0069	0.0084	7.92	0.0040	0.0027	0.0037	0.0020
VA	2006	VA 123 - 2	16.95	22.0	7.6	II/SU	28	26250	0.0148	0.0164	17.00	0.0087	0.0052	0.0083	0.0038
VA	2006	VA 123 - 3	31.95	37.0	14.2	II/SU	23	21750	0.0062	-0.0001	3.33	0.0036	0.0002	0.0036	0.0003
VA	2006	US 15	37.9	42.9	12.5	III/SU	5	26625	0.0041	-0.0091	0.86	0.0026	-0.0026	0.0025	-0.0016
VA	2006	US 50 - 1	25.55	30.6	13	II/IM	20	39000	0.0157	0.0159	13.71	0.0093	0.0054	0.0089	0.0041
VA	2006	US 50 - 2	17.9	22.9	10	I/SU & II/IM	32	50250	0.0331	0.0375	37.80	0.0192	0.0119	0.0182	0.0088
DC	2006	Wisconsin	13.1	18.1	4.1	IV/U	40	19388	0.0092	0.0098	11.24	0.0054	0.0032	0.0051	0.0024
DC	2006	Pennsylvania Ave	8	13.0	1.1	IV/U	14	14700	0.0044	0.0031	4.51	0.0024	0.0010	0.0023	0.0008
DC	2006	Independence Ave	8	13.0	0.6	IV/U	18	15150	0.0025	0.0018	2.53	0.0014	0.0006	0.0013	0.0004
	2006	I Street Nw	5.6	10.6		IV/U	9	11475	0.0000	0.0000	0.00	0.0000	0.0000	0.0000	0.0000
DC	2006	H St. NW	7.9	12.9	0.7	IV/U	8	12300	0.0023	0.0017	2.40	0.0013	0.0006	0.0012	0.0004
DC	2006	15th St. NW	8	13.0	0.8	IV/U	5	11700	0.0025	0.0018	2.61	0.0014	0.0006	0.0013	0.0005
DC	2006	17th St. NW	9.1	14.1	0.7	IV/U	5	12975	0.0019	0.0017	2.20	0.0011	0.0006	0.0010	0.0004
DC	2006	16th St	17.85	22.9	6.3	IV/U	44	25200	0.0104	0.0118	11.89	0.0060	0.0037	0.0057	0.0028
DC	2006	L St	5.8	10.8	1.1	IV/U	14	10013	0.0050	0.0026	4.12	0.0027	0.0009	0.0026	0.0007
					120		**389**		**0.1658**	**0.1489**	**170.90**	**0.0967**	**0.0488**	**0.0920**	**0.0369**

	2007	Route													
MD	2007	MD Route 4	35.2	40.2	11.5	I/SU	15	34500	0.0059	-0.0070	2.36	0.0035	-0.0020	0.0034	-0.0013
MD	2007	MD Route 144	21.2	26.2	2.2	II/SU	9	0	0.0000	0.0000	0.00	0.0000	0.0000	0.0000	0.0000
MD	2007	MD Route 450	26.3	31.3	12.8	II/SU	37	14610	0.0058	0.0059	5.06	0.0034	0.0020	0.0033	0.0015
MD	2007	MD Route 586	21.7	26.7	5.4	II/SU	9	32712	0.0075	0.0089	8.06	0.0043	0.0028	0.0041	0.0021
VA	2007	VA 7 - Segment 1	13.7	18.7	11	I/SU	10	32250	0.0373	0.0394	44.12	0.0221	0.0127	0.0211	0.0095
VA	2007	VA 7 - Segment 2	22.6	27.6	3.3	II/SU or I/SU	15	20175	0.0026	0.0030	2.67	0.0015	0.0010	0.0014	0.0007
VA	2007	VA 7 - Segment 3	29.4	34.4	11	I/SU	15	49125	0.0141	0.0092	9.51	0.0082	0.0034	0.0077	0.0028
VA	2007	VA Route 28	30.8	35.8	17.1	I/SU	17	65250	0.0245	0.0070	14.30	0.0145	0.0032	0.0139	0.0030
VA	2007	VA Route 120	18.9	23.9	8.1	II/SU	30	13125	0.0061	0.0072	7.06	0.0035	0.0023	0.0033	0.0017
VA	2007	VA 234 - Segment 1	24.6	29.6	33	II/SU	12	24000	0.0263	0.0292	24.50	0.0156	0.0098	0.0149	0.0073
VA	2007	VA 234 - Segment 2	39.1	44.1	10.3	II/SU	17	24000	0.0031	-0.0076	0.42	0.0018	-0.0021	0.0018	-0.0013
DC	2007	Canal/M St	16.9	21.9	3.7	IV/U	12	19988	0.0055	0.0061	6.30	0.0032	0.0019	0.0031	0.0014
DC	2007	Georgia Ave - Segment 1	14.9	19.9	3.3	IV/U	23	19763	0.0063	0.0066	7.14	0.0037	0.0021	0.0036	0.0015
DC	2007	Georgia Ave/7th St	9.9	14.9	3.4	IV/U	39	12188	0.0070	0.0074	8.73	0.0040	0.0025	0.0038	0.0019
DC	2007	Louisiana/Constitution Ave	12.1	17.1	2.4	IV/U	21	7838	0.0024	0.0026	3.03	0.0014	0.0008	0.0013	0.0006
DC	2007	Pennsylvania/Branch Ave	11.2	16.2	3.7	III/IM	23	30563	0.0167	0.0176	20.82	0.0095	0.0058	0.0090	0.0043
					142		**304**		**0.1711**	**0.1355**	**164.09**	**0.1005**	**0.0463**	**0.0956**	**0.0359**

State	Year	Route	Average Speed (Both direction)	Speed Increase Post Optimization	Length	Facility type	# of signals	Traffic volume (average) (Factored for 75% through traffic)	2010 VOC Emissions Benefits	2010 NOx Emissions Benefits	2010 CO2 Emissions Benefits	2020 VOC Emissions Benefits	2020 NOx Emissions Benefits	2030 VOC Emissions Benefits	2030 NOx Emissions Benefits
		Route													
VA	2008	FFX Co. Pkwy - 1	22.1	27.1	8.7	I/SU	10	36000	0.0132	0.0157	14.23	0.0076	0.0050	0.0073	0.0038
VA	2008	FFX Co. Pkwy - 2	39.6	44.6	12.5	I/SU	8	36000	0.0053	-0.0151	0.42	0.0031	-0.0041	0.0030	-0.0025
VA	2008	US 29 - Seg 1	15.1	20.1	7.9	II/IM	30	16125	0.0123	0.0129	13.95	0.0073	0.0041	0.0070	0.0030
VA	2008	US 29 - Seg 2	13.6	18.6	7.5	II/SU	27	22125	0.0174	0.0183	20.50	0.0103	0.0059	0.0098	0.0044
VA	2008	US 29 - Seg 3	22.0	27.0	6.6	I/SU	13	26250	0.0074	0.0087	7.92	0.0043	0.0028	0.0040	0.0021
VA	2008	US 1 - Seg 2	18.8	23.8	11.7	II/IM	27	28500	0.0192	0.0227	22.14	0.0111	0.0072	0.0105	0.0052
VA	2008	US 1 - Seg 1	22.8	27.8	8.3	II/IM	38	36375	0.0119	0.0138	12.18	0.0068	0.0045	0.0065	0.0033
MD	2008	MD 97 (Georgia Av.) - Seg	20.1	25.1	5.4	I/SU or II/SU	16	45818	0.0126	0.0153	14.43	0.0072	0.0049	0.0068	0.0036
MD	2008	MD 97 (Georgia Av.) - Seg ´	13.9	18.9	4.3	II/SU	18	32825	0.0147	0.0156	17.41	0.0087	0.0050	0.0083	0.0037
MD	2008	MD 5	35.1	40.1	12.0	I/SU	17	14405	0.0026	-0.0030	1.03	0.0015	-0.0009	0.0015	-0.0006
MD	2008	MD 28	31.0	36.0	6.5	II/SU	13	26458	0.0038	0.0011	2.20	0.0022	0.0005	0.0021	0.0005
MD	2008	MD 193 (University Blvd)	21.2	26.2	4.3	II/SU	17	21740	0.0044	0.0052	4.87	0.0025	0.0017	0.0024	0.0013
MD	2008	Randolph Road	21.3	26.3	9.3	II/SU	28	0	0.0000	0.0000	0.00	0.0000	0.0000	0.0000	0.0000
DC	2008	14th St.	9.4	14.4	1.0	IV/U	12	27750	0.0062	0.0053	6.99	0.0034	0.0018	0.0033	0.0013
DC	2008	Conn. Ave.	14.8	19.8	4.0	IV/U & III/U	33	18188	0.0070	0.0074	7.97	0.0042	0.0024	0.0040	0.0017
DC	2008	K St./NY Ave.	8.2	13.2	4.6	IV/U & III/U	35	52125	0.0648	0.0464	66.84	0.0358	0.0155	0.0338	0.0118
DC	2008	Military Rd.	14.9	19.9	2.6	IV/U	13	14475	0.0037	0.0039	4.17	0.0022	0.0012	0.0021	0.0009
DC	2008	Penn. Ave.	9.8	14.8	0.9	IV/U	13	16763	0.0026	0.0027	3.18	0.0015	0.0009	0.0014	0.0007
DC	2008	**16th St**	14.8	19.8	6.3	IV/U	44	25200	0.0152	0.0161	17.30	0.0091	0.0051	0.0087	0.0037
DC	2008	**L St**	7.9	12.9	1.1	IV/U	14	10013	0.0030	0.0021	3.07	0.0016	0.0007	0.0016	0.0005
					125		**426**		**0.2271**	**0.1950**	**240.79**	**0.1306**	**0.0641**	**0.1239**	**0.0485**
				Total length	**388**	miles	**1119**	**Total**	**0.5641**	**0.4794**	**575.78**	**0.3277**	**0.16**	**0.3115**	**0.12**

Eco-driving

Description

Eco-driving covers a wide array of behavior changes where drivers consciously adapt their driving habits to improve their overall fuel economy and maintain their vehicles for optimal performance. Techniques can include accelerating and decelerating smoothly, keeping tires properly inflated, anticipating traffic flow, and reducing idling time. The website www.ecodrivingusa.com has an extensive list of measures.

Analysis Approach

Use sketch planning analysis to calculate emissions reductions which result from more efficient driving. The main assumption used in this measure is that eco-driving can improve LDV fuel economy by 10%. This is based on the results of an experiment done in Denver. For seven months, 400 drivers had accelerometers installed in their vehicles that would record actions, such as slamming on the brakes or excessive idling, that decrease the fuel efficiency by 20%. By being able to review their accelerometer reports on a website, participants were able to improve their gas mileage by 10%. (Los Angeles Times, February 2, 2009).

While onboard monitoring is likely the most effective way of changing driver behavior, most vehicles do not have a monitoring device, although some manufacturers are making a point to advertise those that do. It is possible that customer demand will encourage such monitors to become standard. In the meantime, other methods of educating drivers are available to local governments and a potential regional strategy is outlined in the cost section.

Assumptions

- Drivers who apply eco-driving techniques will see a 10% improvement in their fuel economy, based on the results of the Denver, CO experiment
- The public information and public awareness campaign begins in 2010. Emissions reductions begin in 2011 as the drivers become informed and begin to change their habits. For the first five years (2011-2015), 3% of drivers adopt eco-driving habits each year. For the next five years (2016-2020), an additional 2.5% of drivers each year begin eco-driving. After 2020, 2% of additional drivers each year through 2030 will begin eco-driving. Based on these assumptions, by the end of 2030, 47.5% of LDV drivers will be practicing eco-driving techniques.

- This measure focuses only on LDV. HDV eco-driving is assumed as part of the HDV fuel efficiency improvement measure.

Impact

Travel

It is assumed that there will be no change to VT or VMT.

Emissions

	LDV Emissions (tons CO2)	Reductions from Eco-Driving (tons CO2)
2010	20,942,367	-
2020	19,299,584	530,739
2030	18,716,503	889,034

Cost

The cost for an eco-driving program would depend on the strategies employed. For this measure, to achieve the 10% reduction per driver, the following package of measures is assumed: a mass market public education and public out-reach campaign ($15,000,000 years 1-3, $10,000,000 years 4-10, $5,000,000 years 11-20), an addition to the drivers' education curriculum ($1,000,000/year), driver training for public fleet drivers ($500,000 years 1-3, $300,000 years 4-20), and a one-time incentive for private fleet operators ($1,000,000 year 1). There is also assumed to be a $200,000/year administrative cost.

Cost –effectiveness

The cost-effectiveness for the first year of emissions reductions (2011) is $265/ton CO2. The cost-effectiveness for years 2020 and 2030 are $22/ton CO2 and $8/ton CO2, respectively.

Note: *The upfront cost is high to increase awareness and the benefits are realized at a later time.*

Appendix B: Mobile Source Greenhouse Gas (GHG) Emissions for the Metropolitan Washington Region: 2005, 2010, 2020, and 2030

ITEM # 3A

MEMORANDUM

November 23, 2009

To: Mike Clifford

From: Eulalie Gower-Lucas
Daivamani Sivasailam

Subject: Mobile Source Greenhouse Gas (GHG) Emissions for the Metropolitan Washington Region: 2005, 2010, 2020 and 2030

Introduction

This memo transmits draft mobile source emissions results for CO_2 and documents input assumptions and technical methods used in the preparation of these emission estimates. This memo also serves to document the impact of the latest Corporate Average Fuel Economy CAFE standards on these emissions estimates. Inventories were developed in response to one of the work items listed in the FY 2010 Unified Planning Work Program, Item 3 B Mobile Emissions Analysis.

Current work activities and results presented in this memo update the original inventories which were documented in a technical memo dated March 6, 2009 to the TPB Technical Committee. This current analysis applies all latest planning assumptions for some inputs, for example 2008 vehicle registration data. The geography used for the analysis is the 8-hour ozone non-attainment area illustrated in the attached Map 1.

Emissions Calculation

Network Development

A network for 2005 was created for this analysis and networks for 2010, 2020, and 2030 from the air quality analysis of the 2009 Constrained Long Range Plan (CLRP) and the FY2010-2015 Transportation Improvement Plan (TIP) were used in this analysis. A detailed list of projects and documentation of this process are contained in the report *Air Quality Conformity Determination of the 2009 Constrained Long Range Plan and the FY 2010-2015Transportation Improvement Program for the Washington Region*, dated July 15, 2009.

Travel Demand

The travel demand component for this work was based upon execution of the COG/TPB's Version 2.2D travel forecasting process; see *COG/TPB's Version 2.2 Specification, Validation, and User's Guide: TPB, March 1, 2008.* Inputs to the process include Round 7.2 Cooperative Forecast land activity assumptions, and CLRP and TIP network inputs contained in the conformity report mentioned in the previous paragraph. Table 1 summarizes for baseline (2005) as well as forecast years by jurisdiction.

Emissions Factors

CO_2 emission factors were prepared using EPA's Mobile model version 6.2; these rates were also used in the initial set of CO_2 results and do not include CAFE standards. COG/DTP staff estimated reductions associated with the latest CAFE standards and this is addressed in the CAFE section. Table 2 shows regional average rates for CO_2 for selected all analysis based on individual jurisdiction specific rates.

Mobile Source Emissions-Mobile6.2 Results

CO_2, emissions were calculated using software developed by COG/TPB'S consultant, E.H. Pechan (EHP) using an approach consistent with COG/TPB's emission calculation procedures: **Emission Factor * Travel Component.** Unlike COG's post-processor which was previously used for calculating CO_2 emissions EHP's software is designed to calculate total GHG emissions for both network and off-network components of the trip cycle. Emissions are shown in Table 3, by year and trip cycle. A summary of inputs used in this analysis are shown below the results.

Total GHG emissions which will include N_2O and CH_4 are available but are not included in this memorandum. Since these two emissions are obtained by factoring the CO_2 emissions this step will be the last step in the analysis at every stage.

Corporate Average Fuel Economy (CAFE) Impacts

Since the EPA Mobile 6.2 model does not consider the impact of the latest CAFE standards of 35.5 mpg by 2016, staff embarked on an off-line analysis to incorporate the impacts in the baseline estimation of CO_2 emissions. The spread sheet program used for this off-line analysis was developed by a consultant (Dan Meszler). The program uses baseline CAFE, fleet age, and vehicle miles of travel to estimate fuel consumption and CO_2 in the region. Using the new CAFE, market penetration of new vehicles, and VMT estimates, the new fuel consumption and associated CO_2 emissions are estimated. The difference between the baseline and the new 35.5 mpg CAFE is then applied to the CO_2 emissions from the network described above to estimate the new baseline CO_2 emissions.

Exhibit 1 shows the output page from the off-line analysis program developed by our consultant. The new fuel efficient vehicles will be introduced beginning in model year 2012. The calculations of the baseline, control and reduced emissions shown in exhibit 1 are all in millions of metric tons. Since the regional CO_2 emissions estimates are in short tons, we use the final column which shows the emissions reduction in percentages. With the new CAFE program we would achieve a reduction of 25.8% by 2020 and 34.1% by 2030.

Exhibit 2 illustrates the estimation of the reduction in short tons by 2020 and 2030. Since the new standards affect only light duty vehicles, we apply the 25.8% reduction to light duty portion of the emissions. Row A shows the emissions broken up by the various components namely network, local, transit, school bus and auto access to transit stations. Row B shows the percentage reduction from exhibit 1. Row C shows the percentage of emissions from light duty vehicles for the various components shown on Row A. Row D shows the reductions by the various components, and the final row shows the net emissions for 2020 and 2030.

Since the new CAFE standards are the law, the CO_2 rates from the MOBILE model were adjusted to reflect the CAFE standards for use in off-line emissions estimates of implemented TERMs, Potential TERMs and control strategies from the COG Climate Change Report are shown in Exhibit 3.

Results and Next Steps

Exhibit 4 illustrates the impact of the new CAFE standards in graphical form. By 2020 and 2030 the new fuel economy program results in a reduction of 24% and 34% of CO_2 emissions respectively. The following steps will illustrate how the region will march towards meeting the COG GHG emissions goal.

- Estimate the CO_2 benefits of implemented TERMs in the region and subtract them from the new baseline emissions.
- Compare the above number with the COG Goal and estimate the additional reduction needed to meet the goals.
- Estimate CO_2 benefits for Potential TERMs, measures in the Climate Change Report and any new regional measures.
- Estimate "What It Would Take" to meet the goals.
- Apply GHG factors to estimate total GHG.

Following
Map 1
Tables 1 - 3
Exhibits 1- 4

Map 1

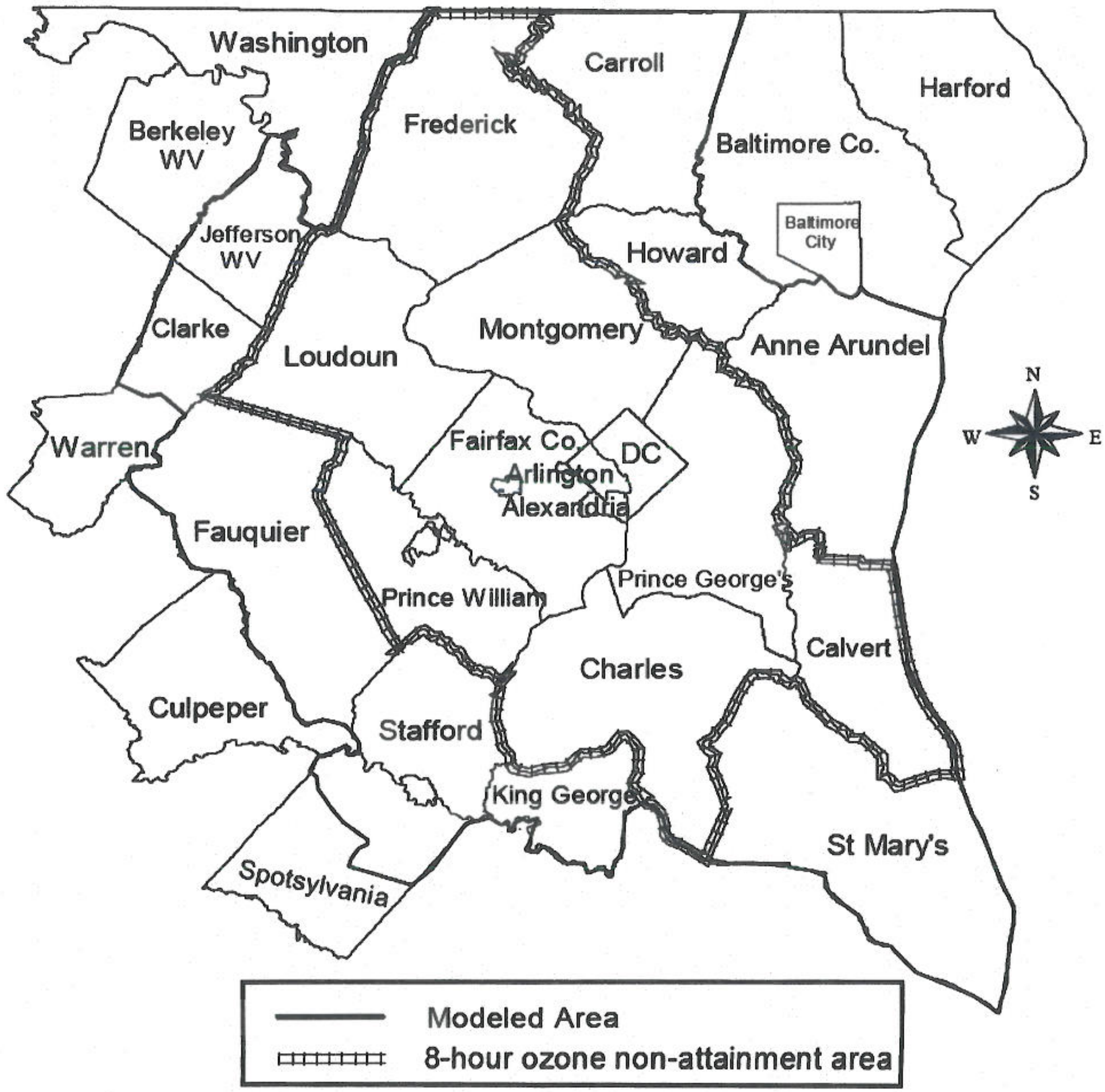
Washington
Carroll
Harford
Frederick
Berkeley WV
Baltimore Co.
Baltimore City
Jefferson WV
Howard
Montgomery
Clarke
Loudoun
Anne Arundel
N
W
E
S
Warren
Fairfax Co.
DC
Arlington
Alexandria
Fauquier
Prince George's
Prince William
Calvert
Charles
Culpeper
Stafford
King George
St Mary's
Spotsylvania
Modeled Area
8-hour ozone non-attainment area

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Table 1

Annual Vehicle Miles of Travel (000,000's)

2009 CLRP and the FY 2010-2015 TIP

Jur	2005	2010	2020	2030
DC	3657	3704	3797	3883
Mtg	7854	8009	8741	9298
PG	7974	8379	9093	9610
Cal	591	635	736	779
Chs	1049	1110	1299	1460
Frd	3373	3668	4157	4608
Arl	1749	1762	1836	1859
Ffx	9721	10209	11551	12150
Ldn	2049	2383	3119	3624
PW	3175	3594	4210	4795
Sta	1288	1452	1838	2110
Alx	827	902	979	1005
Total	43306	45805	51355	55182

Table 2

Regional Average Rates for CO_2

(Grams per Vehicle Mile)

Does not include CAFE Standards

	2005	2010	2020	2030
Major Road Network	512	526	542	546
Local Roads	461	474	487	490
School Bus	1,637	1642	1,646	1,647
Transit Bus	2,373	2348	2,334	2,334

Table 3
MOBILE6.2 Emissions in Annual Tons

8-Hour Non-Attainment Area	2005	2010	2020	2030
Major Roads	21,898,100	23,680,381	27,233,592	29,436,515
Local Roads	1,711,442	1,852,746	2,123,439	2,278,660
School Buses	152,025	157,141	157,564	157,564
Transit Buses	247,489	259,702	258,062	258,062
Auto Access	85,490	103,979	142,268	149,590
Total	24,094,546	26,053,949	29,914,925	32,280,391

Notes on Inputs:

Mobile Source Inventory
2009 CLRP and the FY2010-2015 TIP **Ver 2.2 Travel Demand Model** **Round 7.2 Cooperative Forecast** **2008 Vehicle Registration** **"Pechan Software" Emissions Estimation**

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Exhibit 1 CAFE IMPACTS 35.5 MPG By 2016

Light Duty Cars and Trucks Combined

Year	Baseline LDV/T CO2-eq MMtons	Control LDV/T CO2-eq MMtons	Reduced LDV/T CO2-eq MMtons	Pct Chg LDV/T CO2-eq
2010	22.34	22.34	0.00	0.0%
2011	22.57	22.38	0.19	-0.8%
2012	22.80	22.21	0.59	-2.6%
2013	23.03	21.90	1.13	-4.9%
2014	23.27	21.48	1.78	-7.7%
2015	23.50	21.01	2.49	-10.6%
2016	23.74	20.38	3.35	-14.1%
2017	23.97	19.74	4.24	-17.7%
2018	24.21	19.19	5.03	-20.8%
2019	24.46	18.71	5.74	-23.5%
2020	24.70	18.34	6.36	-25.8%
2021	24.94	18.05	6.90	-27.7%
2022	25.19	17.83	7.36	-29.2%
2023	25.44	17.69	7.75	-30.5%
2024	25.70	17.62	8.08	-31.5%
2025	25.95	17.59	8.36	-32.2%
2026	26.21	17.61	8.60	-32.8%
2027	26.47	17.66	8.81	-33.3%
2028	26.73	17.74	8.99	-33.6%
2029	27.00	17.84	9.16	-33.9%
2030	27.27	17.96	9.31	-34.1%

Note: The program begins in Model Year 2012
MM tons = Millions of Metric Tons

Exhibit 2

2009 CLRP CO_2 Emissions with reductions from CAFE 35.5 by 2016 Standards Effective with MY 2012

Based on Dan Meszler's spreadsheet February 21, 2009 with adjustments made for CAFE 35.5 by 2016 proposal and 2009 CLRP

A.

2020	Network	Local	Transit	School	Auto Access	Total
Baseline Emissions	27,233,592	2,123,439	258,062	157,564	142,268	29,914,925

Percent Reductions in 2020

B. +24.3%

C.

Percent of Vehicles affected

Network	Local	Transit	School	Auto Access	
80.6%	95.1%	0%	0%	100%	

D= A*B*C

Reductions by Travel Component

Network	Local	Transit	School	Auto Access	Total
5,337,015.12	490,992.88	-	-	34,607.72	5,862,615.72

A-D

Net Emissions for 2020

Network	Local	Transit	School	Auto Access	Total
21,896,577	1,632,446	258,062	157,564	107,660	24,052,309

Percent Reductions in 2030

A.

2030	Network	Local	Transit	School	Auto Access	Total
Baseline Emissions	29,436,515	2,278,660	258,062	157,564	149,590	32,280,391

B. +34.1%

C.

Percent of Vehicles affected

Network	Local	Transit	School	Auto Access	
80.2%	95.0%	0%	0%	100%	

D= A*B*C

Reductions by Travel Component

Network	Local	Transit	School	Auto Access	Total
8,048,536.69	738,036.81	-	-	50,995.66	8,837,569.15

A-D

Net Emissions for 2030

Network	Local	Transit	School	Auto Access	Total
21,387,978	1,540,623	258,062	157,564	98,594	23,442,822

Exhibit 3

Rates for Analyzing Off-Line TERMs And Measures in the COG Climate Change Report

	2009 CLRP
	35.5 mpg by 2016
2020	24.33%
2030	34.09%

2010

	Commuter TERMS (LDV only)	Traffic Stream (all veh.) (35 mph)
CAFE 35.5 by 2016 (2009 CLRP)	461.70	526.03

2020

	Commuter TERMS (LDV only)	Traffic Stream (all veh.) (35 mph)
CAFE 35.5 by 2016 (2009 CLRP)	358.78	436.97

2030

	Commuter TERMS (LDV only)	Traffic Stream (all veh.) (35 mph)
CAFE 35.5 by 2016 (2009 CLRP)	312.53	400.50

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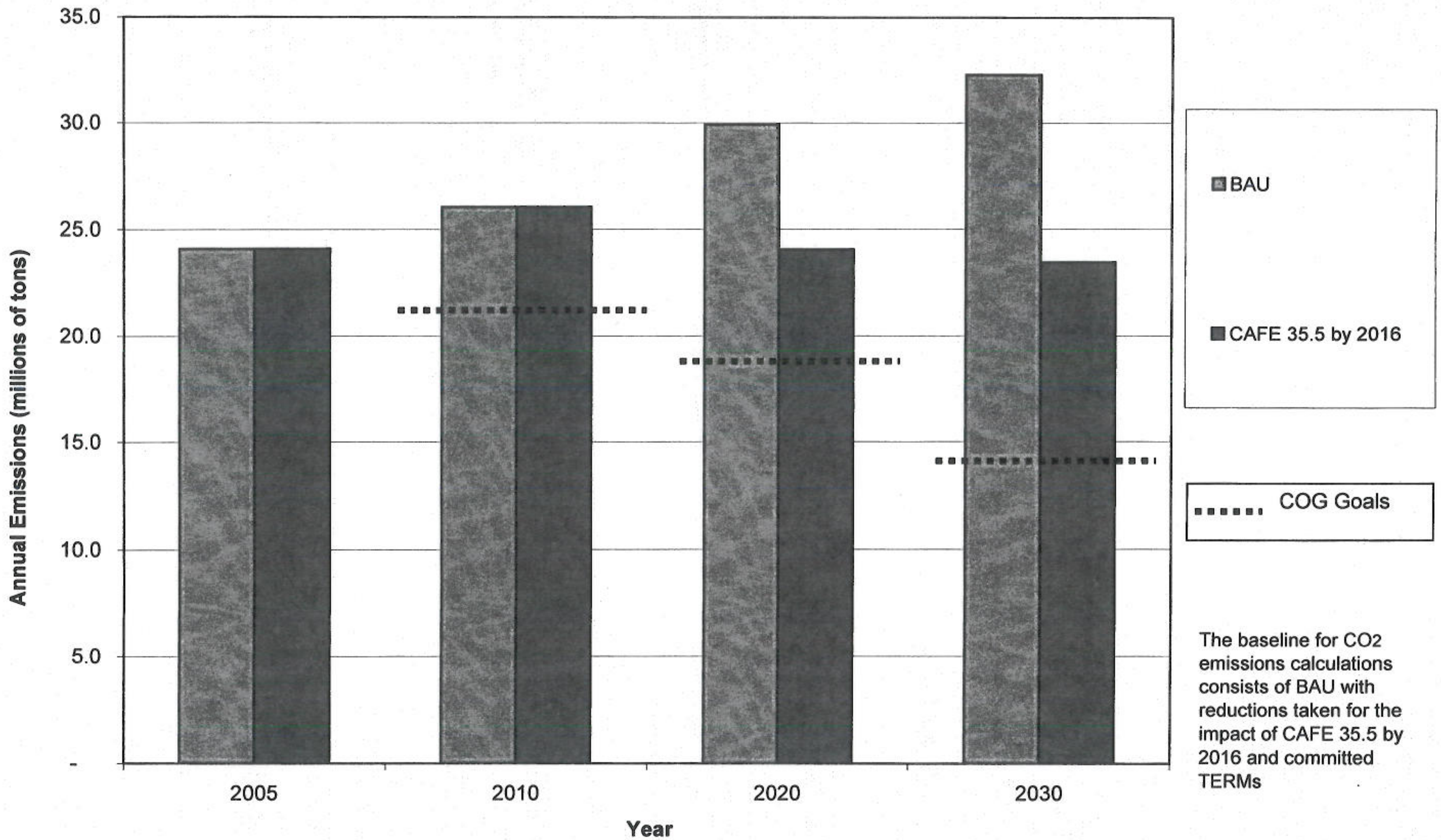
Exhibit 4

DRAFT 11/22/09

Annual CO_2 Emissions based on the 2009 CLRP & 2010-2015 TIP



Appendix C: Analysis Approach for Recommended Measures in the *National Capital Region Climate Change Report*

Analysis Approach for Recommended Measures in the "National Capital Region Climate Change Report"

Recommendations for Reducing GHG from Transportation and Land Use
Local and Regional Strategies for Government and Business

	Type of Analysis[1]		
A. Increase Fuel Efficiency and Use of Clean Fuel Vehicles	**TERM**	**Scenario**	**Policy**
1. Promote Clean Fuel Vehicles (cars, trucks, buses)			
i. Promote/accelerate adoption of efficient clean-fuel vehicles, including hybrids (cars, trucks, and buses).			X
ii. Evaluate options for promoting CA LEV-II, extending CAFE requirements past 2020 and to cover heavy trucks, and facilitating adoption of high-mileage vehicles through incentives and tax policies	X		
iii. Assess the benefits from a "Cash-for-Clunkers" program and rebates or tax incentives for the purchase of hybrid vehicles	X		
2. Adopt regional green fleet policy			
i. Establish a regional green fleet policy with measurable goals and timetables. Target public and private fleets, transit, taxicabs, rental cars, and refuse haulers. Evaluate the benefits of specific "green fleet" conversion percentages	X		
3. Promote use of clean fuels		X	
B. Reduce Vehicle Miles Traveled (VMT)			
1. Adopt VMT reduction goals			
i. Collaborate with the TPB to develop VMT reduction goals for 2012 and 2020 and associated options for meeting the goals			X
ii. Evaluate the potential greenhouse gas emission reduction benefits and costs of using financial incentives (e.g., pay as you travel insurance, tolling, or congestion pricing) to reduce VMT		X	
iii. Identify the percentage of auto trips under 3, 2, 1, and ½ miles; develop a strategy to shift half of these trips to bike, pedestrian, or transit modes; and evaluate the benefits of such a shift			X
2. Expand transit use (incentives, exclusive transit lanes)			
i. Examine options to promote the increased use of existing transit capacity		X	X
ii. Evaluate funding requirements for transit incentives and an expanded metrocheck program			X
3. Invest/Expand transit infrastructure			
i. With the Washington Metropolitan Area Transit Authority, MARC, VRE, and the local transit operators, evaluate the greenhouse gas reduction benefits of specific incremental expansion of transit capacity and commuter rail service		X	
ii. Evaluate the greenhouse gas reduction benefits of expanding existing and establishing new exclusive bus transit routes, lanes, on-ramps, corridors, and intercity high-speed rail		X	

4. Expand commuter options (car sharing, bicycle/pedestrian, financial incentives)			
i. Building on the accomplishments of Commuter Connections, develop specific targets for shifting modes from single-occupancy vehicles to transit, walking, and bicycling for commuting and noncommuting trips.	X		
ii. Expand existing and fund new programs to enhance access to transit and alternative modes, commuter connections, guaranteed ride home, telework programs, bike/pedestrian access, and park/ride lots	X		
iii. Fully fund the construction of bicycle/pedestrian paths in the region, as outlined in the regional bicycle/pedestrian plan.	X		
iv. Provide incentives to developments that speed improvements in bicycle/pedestrian access, including improvements in sidewalks, curb ramps, crosswalks, and lighting	X		
v. Address the need for on-road bicycle accommodations and facilities	X		
vi. Promote regional implementation of SmartBike program similar to the Zipcar concept	X		
5. Promote transit-oriented development/Concentrate future growth in Regional Activity Centers			
i. Evaluate the benefits from achieving a range of possible goals (up to 95 percent) for directing new residential and commercial growth to designated regional activity centers, including growth around transit as well mixed-use, higher-density development		X	
ii. Encourage local governments to evaluate opportunities to provide incentives (including zoning changes) to encourage mixed-use development, including workforce housing at transit stations and hubs to reduce sprawl and VMT		X	
iii. Encourage localities to revisit current land-use plans, in light of current shifts in the real estate market, coupled with high energy costs		X	
iv Establish TOD as the region's preferred growth strategy			X
6. Examine parking policies to reduce VMT			
i. Examine parking policies and their relation to VMT, and implement new parking policies to reduce VMT			X
ii. Strengthen financial and other incentives (e.g., tax rebates, higher parking costs, and transit benefits) to encourage residents to drive less			X
iii. Advocate for federal income tax benefits for transit use that equal or exceed the benefits for employer provided/subsidized parking			X
C. Travel Efficiency			
1. Adopt best practices for traffic engineering improvements and road management to reduce VMT and congestion. Identify locations of significant recurrent congestion, and prioritize investments to reduce	X		
2. Implement the Metropolitan Area Transportation Operations Coordination Program to improve coordination among transportation agencies for data sharing and incident management	X		
3. Enforce existing idling regulations	X		

4. Aviation			
D. Land Use			
1. Tree canopy preservation - prepare plan to meet "increase regional canopy"			
2. Evaluate LEED-ND standards for new development			
3. Carefully plan the location and design of new, infill, and redevelopment projects			
i. Promote regional policies that support walkable communities and affordable housing near transit, and that protect green infrastructure.		X	
4. Integrate GHG analyses into comprehensive planning, new capital projects			
i. Quantify projected greenhouse gas emissions from major new transportation and other new capital projects			X
ii. Identify best practices enabling local governments to include greenhouse gas reduction and energy efficiency/conservation as elements in their local comprehensive planning			X
iii. In cooperation with COG's Planning Directors Technical Advisory Committee and local government environmental and energy planners, convene a working group to devise a consistent, standard methodology for evaluating the greenhouse gas emissions from proposed individual development projects		X	
iv. Encourage new commercial construction to include a "travel management plan."		X	
E. Regional Metropolitan Planning Process			
1. Develop regional metropolitan planning process for GHGs			
i. Collaborate with the TPB to evaluate how a regional process modeled after the current regional metropolitan planning process for transportation and air quality planning might be adapted to address greenhouse gas emissions			X
2. Make greenhouse gas reduction a stated goal of regional transportation planning activities, including the newly launched multi-stakeholder Greater Washington 2050 initiative, poised to generate additional growth scenarios, and quality growth scenarios.			X
3. Consult with other regions around the country to broadly evaluate options for regional approaches to greenhouse gas reductions that include cap and trade and other approaches that might be relevant to our region (e.g., California SB 375), or that might be under consideration in upcoming national climate, energy or transportation legislation			X

[1] TERM - Sketch planning analysis methods employed in previous SIP and air quality conformity analysis
Scenario - TPB's Scenario Task Force work activities
Policy - TPB policy/goal, rather than a technical assessment