Appendix G-14: Air Quality Benefits of an Aggressive Telecommute Strategy

Air Quality Benefits of an Aggressive Telecommute Strategy

March 16, 2007

Jeffrey Stehr, Charles Piety, Dale Allen, Patricia Castellanos*

Department of Atmospheric and Oceanic Science
*Department of Chemical and Biomolecular Engineering
University of Maryland
College Park, MD

1. **Why is this analysis important?**
   This analysis shows the impacts of implementing an aggressive telecommute program on high ozone days. The benefits would be substantial, and would extend throughout the non-attainment areas where the program was modeled.

2. **What questions are answered by this analysis?**
   - What would be the air quality impact of a targeted program to greatly reduce the number of vehicle miles traveled by commuters within the Baltimore, Washington, D.C., and Philadelphia non-attainment areas on high ozone days?
   - Could a telecommute program implemented on high ozone days improve air quality on Maryland's worst ozone days?

3. **What are the key take-away messages of this analysis?**
   An aggressive telecommute program would uniformly benefit Maryland air quality on high ozone days. The largest benefits occur at the most problematic monitoring locations in Washington, D.C. (Arlington County) and Philadelphia (Colliers Mills) non-attainment areas, but not in the Baltimore non-attainment area (Edgewood), although the Edgewood monitoring location does see substantial benefits.

4. **What conclusions are reached in this analysis with respect to Maryland's attainment demonstration?**
   Implementation of an aggressive telecommute strategy coupled with extraordinary compliance would substantially benefit Maryland's air quality and aid in the process of reaching attainment of the 8-hour ozone standard. If implemented successfully, ozone design values at all monitoring locations in Washington, D.C. and Baltimore would fall well below 85 ppbv. In Washington, D.C., the monitoring location with the highest future year design value (Arlington County, Virginia) would show the greatest improvement. In the Philadelphia non-attainment area, the Colliers Mill monitoring location would show the greatest improvement (3 ppbv), although that monitoring location would not be brought into modeled attainment.

Abstract

To simulate the effects of an aggressive telecommute program, the University of Maryland modeled the air quality change that would result if 40% of all light duty vehicles were taken off the road in the non-attainment areas of Baltimore, Philadelphia, and Washington, D.C. on 38 high ozone days in the summer of 2002. Changes in emissions were implemented as a flat 40% reduction in vehicle miles traveled in each county of the three non-attainment areas. The effects of implementing such a program were modeled using version 4.4 of the CMAQ model. The model results showed that across the three non-attainment areas tested, an aggressive telecommute program has the potential for considerable benefit to air quality, with fairly uniform benefits across all three areas. The highest monitoring locations in the Philadelphia and Washington, D.C. non-attainment areas would see the largest benefits from this program, suggesting that reductions in mobile emissions would have the greatest impact at the most troublesome monitoring locations on the worst ozone days. Benefits in all three non-attainment areas averaged a reduction in ozone of over 2 ppbv.

Introduction

Ozone levels are episodic, and high ozone concentrations are largely influenced by meteorology, so a forecast-driven program of emissions reductions makes a lot of sense. To this end, it has been suggested that telecommuting be strongly encouraged on high ozone days in the summer to take vehicles off of the roads and vehicle emissions out of the air. To simulate the effects of a very aggressive telecommute program, the University of Maryland performed a sensitivity test, assuming that 40% of all light duty vehicles were taken off the road in the non-attainment areas of Baltimore, Philadelphia, and Washington, D.C. on the 38 days in the summer of 2002 when 8-hour ozone was ≥ 85 ppbv (AQI of code orange or higher). Changes in emissions were implemented as a flat 40% reduction in vehicle miles traveled (VMT) in each county of the three non-attainment areas. No attempt was made to determine areas where workers were more or less likely to telecommute.

Air quality was modeled for the summer of 2002, using the 2009 base A1 emissions inventory as a starting point, and reducing the light duty vehicle VMT in that inventory only on high ozone days and only within the three non-attainment areas mentioned. The model started on May 22, and ran through the end of September, though benefits were only calculated from June 1 to September 30 to allow concentrations in the model time to reach realistic levels, also known as "spin up" time. Since the model starts initially with clean conditions, it must be run for a few days to allow pollution levels to build up to representative levels. In keeping with other base A1 modeling, CMAQ version 4.4 was used so that the same 2002 and 2009 base case values determined from other modeling runs could be used for comparisons. Relative reduction factors were calculated as per EPA guidance, using 2002 design values as a base.

Results

As might be expected for an aggressive local program targeted to the worst air pollution days in a region, the results indicated significant benefits at all monitoring locations throughout the region. As pointed out in Appendix G-8, CMAQ appears to be most sensitive to local emissions changes, and model performance is at its best in urban

and suburban areas. These are the same areas covered by this scenario, so the strong model response of lower ozone concentrations is not surprising. In all three areas, the average benefit across all monitoring locations exceeds 2 ppbv. Throughout the Baltimore non-attainment area, the improvements are substantial (Table 1), with an average benefit of 2.4 ppbv. The smallest benefit is a 1.3 ppbv drop at the Essex monitoring location, while the largest is a 3.3 ppbv benefit at the South Carroll monitoring location. In the Washington, D.C. non-attainment area, results are likewise rather striking (Table 2), with an average benefit of 2.6 ppbv, ranging from only 0.3 ppbv in Frederick County, Virginia to 3.5 ppbv in Chantilly, Virginia. To the north, in the Philadelphia non-attainment area (Table 3), the average benefit is 2.0 ppbv, ranging from 1.1 to 3 ppbv.

Table 1. CMAQ Results for Monitoring Locations in the Baltimore, Maryland Non-Attainment Area

Monitoring Location	EPA AQS Site Code	2002 Base Design Value (ppbv)	2009 OTB/OTW (ppbv)	Telecommute Scenario (ppbv)	Change due to Telecommuting (ppbv)
Davidsonville	240030014	98.0	83.4	80.5	-2.9
Fort Meade	240030019	97.0	83.1	80.1	-3.0
Padonia	240051007	88.7	77.1	74.6	-2.5
Essex	240053001	91.3	79.8	78.5	-1.3
South Carroll	240130001	88.7	75.0	71.8	-3.3
Edgewood	240251001	100.3	85.1	83.3	-1.8
Aldino	240259001	97	82.1	80.0	-2.0

Table 2. CMAQ Results for Monitoring Locations in the Washington, D.C. Non-Attainment Area

Monitoring Location	EPA AQS Site Code	2002 Base Design Value (ppbv)	2009-A1 OTB/OTW (ppbv)	Telecommute Scenario (ppbv)	Change due to Telecommuting (ppbv)
Takoma Park	110010025	88.7	78.5	75.8	-2.7
River Terrace	110010041	89.0	78.1	75.3	-2.8
McMillan Reservoir	110010043	92.7	81.4	78.4	-3.0
Southern MD (Hughesville)	240170010	93.0	74.9	72.6	-2.2
Frederick Apt	240210037	87.3	73.9	71.8	-2.2
Rockville	240313001	86.7	75.5	72.6	-2.9
Greenbelt	240330002	94.0	80.9	78.0	-2.9
Prince Georges Equestrian	240338003	94.0	81.0	78.3	-2.7

Arlington Co.	510130020	96.7	85.6	82.6	-3.0
Chantilly	510590005	87.0	74.9	71.4	-3.5
Mt. Vernon	510590018	96.7	84.8	81.9	-2.9
Lee Park	510590030	95.0	83.3	80.4	-2.9
Annandale	510591005	94.0	82.4	79.5	-2.9
McLean	510595001	88.0	77.7	74.8	-2.9
Frederick Co.	510690010	82.7	71.9	71.6	-0.3
Loudoun Co.	511071005	90.0	77.6	75.3	-2.2
Prince William	511530009	85.0	73.6	71.7	-1.9
Alexandria	515100009	90.0	78.9	76.2	-2.7

Table 3. CMAQ Results for Monitoring Locations in the Philadelphia Non-Attainment Area

Monitoring Location	EPA AQS Site Code	2002 Base Design Value (ppbv)	2009-A1 OTB/OTW (ppbv)	Telecommute Scenario (ppbv)	Change due to Telecommuting (ppbv)
Fair Hill	240150003	97.7	80.7	78.1	-2.6
Brandywine	100031010	92.7	81.7	79.2	-2.5
Bellefonte	100031013	90.3	78.4	76.0	-2.3
Killens Pond	100010002	88.3	77.8	76.4	-1.4
Lewes	100051003	87.0	77.5	76.4	-1.1
Lums Pond	100031007	94.5	79.3	76.9	-2.4
Seaford	100051002	90.0	75.1	73.7	-1.3
Colliers Mills	340290006	106.0	92.9	89.9	-3.0
Rider U	340210005	97.0	86.8	84.5	-2.3
Ancora Hospital	340071001	100.7	89.1	86.5	-2.6
Camden Lab	340070003	98.3	89.0	87.0	-2.0
Clarksboro	340155001	98.3	87.8	86.2	-1.6
Millville	340110007	95.7	81.7	79.3	-2.4
Nacote Creek	340010005	89.0	77.8	76.4	-1.3
Bristol	420170012	99.0	89.6	87.0	-2.6
West Chester	420290050	95.0	81.4	79.2	-2.2
New Garden	420290100	94.7	78.5	76.1	-2.4
Chester	420450002	91.7	81.5	79.6	-1.9
Norristown	420910013	92.3	81.9	80.1	-1.7
Southwest	421010136	83.0	74.7	73.2	-1.5
Frankford	421010004	71.3	64.9	63.4	-1.6
Northwest	421010014	90.7	82.0	80.5	-1.4
Northeast	421010024	96.7	88.0	85.7	-2.3

In some areas, the biggest benefits occurred at the monitoring locations that have the leading design values for the non-attainment area (e.g. the Colliers Mills monitoring

location in the Philadelphia non-attainment area). This was not uniformly the case, but all monitoring locations did see benefit. For example, the Edgewood monitoring location would be brought well into attainment by implementing this telecommute scenario, dropping 1.8 ppbv from a projected 2009 design value of 85.1 ppbv to 83.3 ppbv. For the Baltimore area, this is especially important, since Edgewood is the lone remaining Maryland monitoring location with a design value above 85 ppbv. Benefits in the Washington, D.C. area are likewise fortuitous, with the high monitoring location in Arlington County, Virginia dropping from a projected 2009 design value of 85.6 to 82.6.

Conclusions

Across the three non-attainment areas that are tested, an aggressive telecommute program has the potential for considerable benefit to air quality, with fairly uniform benefits across all three areas. The highest monitoring locations in the Philadelphia and Washington, D.C. non-attainment areas see the largest benefits from this program, suggesting that it is targeting the most troublesome monitoring locations on the worst ozone days.

Future Work

The simulation might be updated in the future when newer versions of the emissions inventories are available. The simulation might also benefit from a different chemical mechanism such as SAPRC99. As outlined in Appendix G-10, there are solid scientific reasons why CMAQ's CB4 chemistry does not entirely represent the chemistry of the atmosphere. As outlined in Appendix G-9, CMAQ underpredicts the changes in ozone due to changes in NO_x emissions, so a future model run might be expected to more accurately project the benefits of a telecommuting program.

Acronyms

AQI	Air Quality Index
CB4	Carbon Bond IV chemical mechanism
CMAQ	Community Multiscale Air Quality model
EPA	United States Environmental Protection Agency
NO_x	Reactive oxides of nitrogen, the sum of only NO and NO_2.
ppbv	Parts of ozone (or any other substance) per billion parts of air, by volume
SAPRC99	Statewide Air Pollution Research Center (1999) chemical mechanism
VMT	Vehicle Miles Traveled
OTB	All regulations on the books
OTW	All regulations on the way