# Testimony of Michael Replogle
## Transportation Director, Environmental Defense
## Before the Senate Environment and Public Works Committee, United States Senate
## July 30, 2002

Mr. Chairman and members of the Committee, I am Michael Replogle, and am pleased to testify today on behalf of Environmental Defense, a national organization with over 300,000 members nationwide, which I serve as Transportation Director. Our Living Cities program designs market-based solutions to promote clean air, water and land in major metropolitan areas nationwide. Today I also represent the Sierra Club, the nation's largest and oldest grassroots environmental organization, with over 700,000 members, and the Surface Transportation Policy Project, a nationwide network of organizations, including planners, community development organizations, and advocacy groups, devoted to improving the nation’s transportation system.

The motor vehicles are a key contributor to bad air quality in major American cities that kills tens of thousands each year and injures millions. Great progress with cleaner cars has been significantly offset by growth in driving. Over 160 million of us live in areas with poor air quality. Fourteen million with asthma gasp for air when ozone levels rise. Since 2000, the number of high ozone days is up a fifth. Those living near high volume roads face cancer risks of 1 in 500 from air toxics. Emissions from cars and trucks are increasingly linked to cancer, childhood asthma and other respiratory illnesses. And transportation greenhouse gas emissions – up 9 percent since 1990 - bring new threats to our health and environment.

U.S. DOT estimates the health effects of air pollution from motor vehicles costs us $40 to $65 billion, dwarfing the $27 billion in federal transportation spending, and this doesn’t consider the effects of air toxics. This is a hidden tax of over $600 a year on each U.S. household, and is disproportionately borne by our children, elders, and the infirm.

Responding to the failure of air pollution laws between 1970-90, Congress added Clean Air Act requirements that transportation plans and programs must contribute to timely attainment of healthful air quality and conform to State Implementation Plans (SIPs). This has improved accounting for air quality effects of transportation, spurred investments in clean fuels, vehicles, and maintenance, better transportation choices, and smart growth that cuts traffic and pollution.

But conformity has just gotten in gear, since many metro areas adopted attainment SIPs for ozone with the motor vehicle emission budgets needed for conformity only last year. Failure of transportation plans to comply with SIPs is why most areas failed to meet ozone standards in 1987. Many serious ozone areas again failed to attain by 1999 because vehicle emissions haven’t been cut to levels needed for attainment. What this means is that the Clean Air Act is only now beginning to uncover a truth that millions of Americans have been living with for decades: that the transportation sector is a major contributor to bad air quality *and* that there are cost-effective steps that can be taken to clean the air and increase mobility in areas of high pollution.

The Clean Air Act provides the regulatory framework for finding these solutions. In many ways it is a classic market mechanism. It helps set air quality targets and then gives metropolitan regions flexibility in how to meet those targets. Through this system, conformity is an engine of innovation, spurring cost-effective and market-based solutions to bad air quality.

While conformity is working, it faces challenges that could again cause the failure of SIP control strategies. In reauthorizing TEA-21, Congress should address these challenges and pursue opportunities promote better stewardship by transportation agencies:

**Improve transportation agency travel and emissions models, and bolster transportation data collection and evaluation.** Traffic and emission models are better than in 1990 but most undercount future traffic and emissions caused by road expansions and undercount the benefits of smart growth, pricing, information technologies, and improvements that aid pedestrians, bicyclists, and transit users. The Act should require that when developing air quality and transportation plans, planning agencies use the best modeling practices that have been demonstrated to most reliably predict future travel behavior and emissions. The Act should require EPA to track the development of such modeling tools and make the information available through a modeling clearinghouse. DOT should be required to review the modeling tools used to make conformity determinations and MPO audits. Together, EPA and DOT should have a clear responsibility for finding and fixing deficiencies in these critical accounting systems.

**Congress should reauthorize the Congestion Mitigation Air Quality Program at a much higher level.** This vital program helps cut traffic and pollution. Funding needs to be more than doubled to meet the needs of the larger population now recognized to be living in non-attainment areas. CMAQ funding should favor lasting traffic and pollution reductions and should be suballocated to metropolitan planning organizations, since states have failed to spend roughly one out of four CMAQ dollars – about $2.75 billion - provided by Congress in the past decade. Air agencies should be given access to and a greater voice in how CMAQ dollars are spent.

**Congress must ensure a high priority for funds to implement transit and economic incentive programs needed to attain air quality standards**. Barriers to planning currently unfunded facilities and services needed for air quality attainment should be lowered while ensuring local, state and federal support for such measures. Air quality standards will not be met and maintained in fast-growth metro areas without implementation of projects designed reduce use of single occupant vehicles. Nonattainment areas should have priority access to fund such projects with unprogrammed minimum guarantee funds and any funds proposed for flex between funding categories by the states.

Before 1990, some states cooked their books with big unfunded promises of transit expansion to offset pollution from new roads. Roads got built, the transit didn’t. Motor vehicle emissions soared, contributing to the failure of SIP control strategies in the ‘70s and 80s, and remains the major obstacle to developing successful SIP strategies now. Today, the difficulty finding local match funds for transit facilities and services, the lack of resources to fund highly effective incentive programs that provide alternatives for those who do not drive, poor accounting for transportation funds, lax federal oversight of transportation and air quality planning requirements, and abuse of TEA-21 financing undermines conformity and SIP control strategies. Virginia’s recent road funding crunch is illustrative of widespread underestimation of project costs that makes most transportation programs fiscally unreal. FHWA’s failure to lapse fund balances unspent by the states as required by TEA-21 exacerbates this growing fiscal mess.

**Congress should assure that the frequency of conformity analysis supports timely attainment of air quality goals.** Many of today’s surprises come from poor coordination. Making the deadlines farther apart would likely just make the surprises larger. Less frequent analysis could reduce the timely improvement of emissions estimates in SIPs, as conformity analysis often results in timely updates to modeling assumptions that improve accountability. Three or five year conformity determinations may be too far apart to detect and correct the rapid growth in VMT in fast-growing metropolitan areas that is causing those areas to fail to attain on time. Schedule coordination should come from better interagency coordination, not through relaxing the frequency of accounting system checks and balances. With wider gaps between reporting deadlines, opportunities for abuses and poor accounting grow larger. Uncertainty about true air quality impacts and benefits would increase.

**Congress should require EPA to give effect to the current obligations in CAA § § 182(c)(5) and (g) to track and report regional emissions every three years in nonattainment areas, and to ensure that remedial measures are implemented immediately when emission reduction targets are not met.** Legislation is needed to—

- Ensure states submit timely milestone compliance reports;
- Ensure that SIPs contain adopted contingency measures that are required to be implemented immediately after an area fails to meet its emission reduction milestone;
- Require contingency measures to achieve minimum emissions reductions equal to one year of further progress based on the annual reductions needed for attainment in the area;
- Assure EPA remedies its failure to adopt regulations to govern State submissions of milestone compliance reports.

**Congress should ensure that air quality planning continues to address the impact of future growth on compliance with public health standards, and reject proposals to end conformity analysis when the Act's 20 year maintenance planning period expires.** SIP control strategies will fail if areas don't consider the long-term impacts on land use and traffic caused by major transportation projects, like outer beltways. Twenty-year conformity requirements have spurred Charlotte and other areas to adopt new transit and smart growth plans or other measures to curb projected sprawl, traffic, and pollution growth.

**Congress should assure that areas in a conformity lapse can add conformity-exempt and emission-reducing transportation projects to non-conforming Transportation Improvement Programs and long-range transportation plans**, even if those projects were not previously contained in a conforming, fiscally-constrained TIPs or plans. To facilitate this result, EPA and DOT should be able to develop a joint list of transit and shared-ride facilities and services, and economic incentive programs that would presumptively qualify as TCMs that can be adopted into the regional transportation plan and TIP during a conformity lapse without separate approval by EPA as a SIP revision.

**Congress should enhance transportation project delivery and transportation environmental stewardship by better integrating planning and project reviews.** State and metropolitan areas should be required to develop integrated transportation, natural resource protection, and growth management plans, with performance reporting on public health, greenhouse gas emissions, the achievement of natural resource planning goals for air, water, and habitat protection, and the provision of equal access to jobs and public facilities. TIPs and plans should be required to demonstrate conformity to adopted greenhouse gas emissions budgets and adopted Total Daily Maximum Load clean water plan pollution budgets for watersheds.

**Congress should assure timely EPA action to regulate air toxics and assure that FHWA accounts for and avoids or mitigates the adverse health impacts suffered by communities exposed to hazardous air pollutants caused by expansion of major highways.**

**<u>Congress should</u> <u>support the creation of a Transportation Environmental Research Program</u>, with funding of at least $15 million a year and a board involving a range of stakeholders, as recently recommended by a National Academy of Sciences Committee.**

**<u>Congress should</u> <u>strengthen incentives for employers to pay for transit benefits and offer cash incentives in lieu of parking, promote other market-incentive transportation strategies such as road pricing and use-based car insurance, and encourage increased investment in rail, bus rapid transit, pedestrian, bicycle, and intermodal travel</u> <u>options</u>.** These can cut traffic and emissions 15 to 25 percent relative to trends over 20 years, and greatly improve the performance of the existing transportation system.

During the Atlanta Olympics, Georgia officials expanded their transit system with roughly 1000 buses, promoted travel alternatives, telecommuting, and travel incentives, and cut morning peak traffic levels by almost one-fourth while the region accommodated a million visitors over three weeks. This cut ozone 28 percent and cut hospital visits for asthma by 42 percent. We can replicate that success story across America.

Public support for transportation funding depends on transparency about how agencies spend money and better accountability. I close by presenting you with copies of letters from 16 diverse national health and environmental leaders asking Congress and the Administration to enhance accounting for the effects of transportation on health, air quality, and the environment. We look forward to working with you on reauthorization of TEA-21.

# Holding Transportation Accountable for Air Quality Performance

**Testimony of Michael Replogle**
**Transportation Director, Environmental Defense**
**Before the Senate Environment and Public Works Committee, United States Senate**
**July 30, 2002**

Mr. Chairman, I am Michael Replogle, Transportation Director of Environmental Defense. I am pleased to appear here this morning to present testimony on behalf of both Environmental Defense and the Surface Transportation Policy Project where I serve as Chairman of the Energy and Environment Task Force of the Alliance for a New Transportation Charter and a member of the STPP Steering Committee.

Environmental Defense, a leading, national, NY-based nonprofit organization, represents 300,000 members. Environmental Defense links science, economics, and law to create innovative, economically viable solutions to today's environmental problems. The Surface Transportation Policy Project or STPP is a nationwide network of hundreds of organizations, including planners, community development organizations, and advocacy groups, devoted to improving the nation's transportation system.

I am pleased to have this opportunity to discuss transportation and air quality, especially focusing on transportation conformity and the Congestion Mitigation and Air Quality Program and to offer our views on how the reauthorization of TEA-21 can enhance these programs.

I would like to highlight the following recommendations for Congressional action:

- Clean Air Act transportation conformity is working increasingly well to hold transportation plans accountable to air quality control strategies, but steps should be taken to assure better modeling of traffic and emissions and better compliance by the Department of Transportation and states to assure that transportation plans and programs are fiscally constrained. Poor accounting threatens underestimation of motor vehicle emissions and the failure of SIP control strategies to deliver on the promise of clean air for all Americans.
- Congress should assure that areas in a conformity lapse will be able to add new emission-reducing transportation projects to non-conforming short-term Transportation Improvement Programs (TIP) and long-range transportation plans, even if those projects were not previously contained in a conforming, fiscally-constrained TIP or plan.
- Congress should reject proposals to reduce the frequency of conformity analyses, which are now required at least once every 2 years for TIPs and once every 3 years for transportation plans. Such proposals threaten to introduce more surprises and conformity problems and to reduce the timely improvement of motor vehicle emissions estimates to protect the integrity of SIP control strategies. When transportation conformity is done more frequently, it results in timely updates to modeling assumptions that improve accountability.

- Congress should require all state and metropolitan areas to develop and periodically update, with public involvement, integrated transportation, natural resource protection, and growth management plans that consider at least one alternative scenario that considerably reduces traffic growth and enhances environmental performance through better system management. Agencies should annually report on the current and projected performance of their transportation system management, investment, and proposed programs and plans, accounting for cumulative and secondary impacts on growth patterns, public health, greenhouse gas emissions, the achievement of natural resource planning goals for air, water, and habitat protection, and the provision of equal access to jobs and public facilities for all residents, including those without cars, without undue time and cost burdens.
- The Congestion Mitigation Air Quality Program (CMAQ), which helps local communities and states reduce traffic and transportation pollution, should be reauthorized at a substantially higher level, recognizing the much larger population living in non-attainment areas and exposed to hazardous air pollutants. CMAQ funds should be targeted to innovative strategies that produce lasting traffic and pollution reduction, rather than to short-term one-time emission reduction strategies or traffic flow improvements,
- Congress should establish and fund a Transportation Accounting Standards Board to assure timely progress towards honest accounting for how transportation funds are spent, including oversight of innovative finance programs, to assure compliance with transportation planning fiscal constraint requirements, and assure the integrity and timely improvement of transportation agency environmental management systems, including travel and emissions analysis models, which should be required to demonstrate adequate sensitivity to induced traffic and land use effects of expanded road capacity.
- Congress should strengthen national transportation data collection, spatial data analysis, and evaluation, to support performance-based funding and decision-making.
- Congress should assure timely EPA action to regulate air toxics and assure that FHWA accounts for and avoids or mitigates the adverse health impacts of exposure of communities to hazardous air pollutants caused by expansion of major highways.
- Congress should strengthen incentives for employers to pay for transit benefits and offer cash incentives in lieu of parking, promote other market-incentive transportation strategies such as road pricing and use-based car insurance, and encourage increased investment in rail, bus rapid transit, pedestrian, bicycle, and intermodal travel options.

## I. Accounting for Transportation Air Pollution: A Hidden Tax Burden on Americans

While motor vehicles and expanded highways have offered many Americans unprecedented levels of mobility, the costs of that system on public health, the environment, and social equity have been poorly accounted for. Motor vehicles account for a major share of harmful air pollution emissions that cause shortness of breath, respiratory disease, cancer, death, structural deterioration, crop damage, and decreased visibility affecting cities, national parks, and rural areas, and global climate change, constituting a hidden tax on our health and well being. Since 1970, our nation has tried to reduce this pollution problem through the federal Clean Air Act. While we have made remarkable progress in reducing many kinds of pollution, growth in motor vehicle use has offset a large share of emission reductions gained through cleaner technologies, especially for nitrogen oxides (NOx) and particulate matter (PM).

Three decades after the 1970 Clean Air Act, more than 125 million Americans – including 70 percent of the people most vulnerable to air pollution – live in areas that exceed the National Ambient Air Quality Standards (NAAQS)[1], and this number may increase by as much or more than 40 million once EPA completes the new designations for the 8-hour ozone and fine particle NAAQS. Ozone causes asthma, lung damage, and illness in children, and increases the risk of stroke mortality. More than 14 million Americans with asthma – a record number – gasp for air when ozone levels rise and more than 5,000 Americans die each year from exposure to high ozone levels. The number of high ozone days increased 19 percent between 2000 and 2002 in U.S. counties with air quality monitors.

Particulate matter causes cancer, including childhood leukemia, as well as respiratory disease and death. New research in shows that people living proximate to high traffic volume highways breathe traffic-related air toxics that expose them to cancer risks at times greater than 1 in 500.[2]

The U.S. accounts for vastly disproportionate greenhouse emissions. Although Americans account for 5 percent of the world's population, we account for almost a third of greenhouse emissions worldwide. In 1996, mobile sources accounted for more than 30 percent of CO2, more than 40 percent of VOC, 50 percent of NOx and 80 percent of CO emitted in the U.S.[3] Between 1990 and 1999 U.S. greenhouse gas emissions from transportation rose almost 9 percent.

A U.S. DOT report, included in this testimony as Attachment 1, estimates the annual cost to the public in 2000 of the adverse health effects attributable to air pollution from motor vehicles at $40 billion to $65 billion, depending on the value ascribed to a human life.[4] A disproportionate share of these costs are imposed on the most vulnerable – those with respiratory diseases, children, and the elderly. So while taxpayers bore a cost of $27 billion in 2000 for direct federal transportation investments, all face far greater true costs. Moreover, this DOT cost accounting does not even consider the costs of health effects of air toxics or fine particles, which DOT now admits is the biggest air quality health issue to be dealt with; nor does it include the costs for agricultural losses, impaired visibility, damage to buildings, acid rain, impairment of various terrestrial and aquatic ecosystems from excess nitrogen, and other adverse impacts of air pollution. Nor does it include the costs of global climate change or traffic accidents. New research from the Centers for Disease Control associates rising obesity levels with declining physical activity and impaired mental health with reduced social interactions, both associated with car-dependent mobility and development patterns. These add further to the hidden burden of true transportation system costs on Americans.

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[1] Environmental Protection Agency, *Latest Findings on National Air Quality: 1999 Status and Trends*, Washington, DC, August 2000, page 5.

[2] South Coast Air Quality Management District, *Multiple Air Toxics Exposure Study-II,* March 2000, Los Angeles, CA.

[3] State and Territorial Air Pollution Program Administrators/Association of Local Air Pollution Control Officials, *Reducing Greenhouse Gases & Air Pollution: A Menu of Harmonized Options, Executive Summary*, Washington, DC, October 1999. page 5.

[4] U.S. Department of Transportation, Addendum to the 1997 Federal Highway Cost Allocation Study Final Report, May 2000, Washington, DC. Page 11. Available at: www.fhwa.dot.gov/policy/hcas/addendum.html.

The toll exacted by these adverse health and other impacts continue because 32 years after passage of the 1970 Clean Air Act (CAA) most non-attainment areas have still not attained the long-standing 1-hour ozone or PM National Ambient Air Quality Standards (NAAQS). Health research has shown that additional controls on 8-hour ozone and fine particulate matter (PM 2.5) are needed to protect public health, but EPA is moving only slowly to designate related non-attainment areas and timetables for states to adopt related pollution control strategies.

## II. Transportation Conformity: Accounting for Motor Vehicle Air Pollution in State Air Quality Control Plans

**Why Conformity?** The 1990, Clean Air Act amendments strengthened the transportation conformity provision to assure that transportation infrastructure spending and poor accounting for mobile source emissions would not continue to unwittingly undermine progress towards healthful air quality. Expansion of highways and resultant growth in traffic and pollution led to widespread, systematic underestimation of motor vehicle air pollution in state air pollution control plans between 1970 and 1990, causing those plans to fail.

Transportation conformity is a straightforward concept, at times made complex by overly lengthy transition rules designed to undermine its simple operation. Conformity requires the regional transportation system to contribute to timely attainment of healthful air quality and to be designed so that emissions from transportation sources in a non-attainment area are less than the levels established by the State's adopted plan for attaining healthful air quality.

The CAA requires that SIPs for achieving healthful air quality in polluted areas establish emission budgets for mobile sources (cars and trucks), stationary sources (powerplants and factories), and area sources (paints, agriculture), including control strategies limiting emissions from each. Trade-offs can be negotiated between control of various sources, encouraging exploration of the lowest cost means for timely attainment. The CAA and federal transportation laws passed since 1990, ISTEA and TEA-21, require short-term (1-6 year) fiscally-constrained funding programs – called Transportation Improvement Programs (TIPs) – and long-term (20-year) fiscally-constrained Regional Transportation Plans (RTPs) to conform to SIP emission budgets so that new transportation approval, acceptance, and funding decisions will not violate emission limits or delay timely air quality attainment.

By requiring TIPs and RTPs to be fiscally constrained, Congress sought to address a problem that had caused the failure of an ineffectual earlier, weaker version of CAA conformity: many states and regions demonstrated conformity relying on a hefty, expensive, fantasy wish list of emission-reducing projects that could not be built on the schedule identified in the transportation program. This false accounting for transportation projects contributed to the underestimation of motor vehicle emissions and the failure of SIP control strategies in the 1970s and 1980s.

Bad state and federal accounting for transportation funds, lax federal oversight of transportation and air quality planning requirements for fiscal constraint of TIPs and RTPs, and abuse of TEA-21 funding flexibility and innovative financing provisions undermine conformity and threaten to undermine SIP control strategies in the coming decade. Many state and local project sponsors grossly underestimate project costs so they can adopt fiscally unconstrained transportation plans and programs. Many states are increasing their reliance on federal dollars and reducing state commitments to fund transportation while running up large debts that sacrifice future fiscal capacity. This is further exacerbated by the recent failure of the Federal Highway Administration to lapse unspent fund obligations to the states as required by TEA-21. Environmental accountability is further undermined by under-forecasting of motor vehicle traffic and air pollution in SIPs, TIPs, and plans due to use of travel models that discount induced traffic. Together, these problems amount to another national accounting scandal affecting not just the

$217 billion, 6-year federal TEA-21 authorization, but hundreds of billions more in state and local transportation spending.

**Conformity Is Increasingly Successful: Better Accounting, Coordination, Support for Emission Reduction Strategies.** By fostering cooperation between transportation and air quality agencies over the past decade, conformity has improved accounting for transportation air pollution in State Implementation Plans (SIPs) for air quality attainment and it has increased consideration of air quality as a factor in transportation decision-making, as intended by Congress.

- Since 1990, transportation conformity has increasingly ensured that state and local air quality planners account for the growth in vehicle driving activity and other sources of vehicular emissions, helping assure progress on clean air goals in the past decade.

- Conformity has assured that transportation agencies coordinate with state and regional environmental agencies through interagency consultation procedures to evaluate the emissions impacts of major transportation investments before funding decisions are final. Where conformity lapses have occurred because of problems in coordination, they have been generally of only a few months duration and have led to improved local administration and governance to coordinate air quality, transportation, and growth management.

- Conformity has almost invisibly led to increased investments in cost-effective pollution-reducing transportation strategies that support more diverse travel choices, equitable access to jobs and public facilities, smarter growth, improved traffic safety, safer and more attractive opportunities for walking and bicycling. Conformity has expanded the base of political support for control strategies to reduce air pollution emissions through more stringent emission controls on vehicles, cleaner fuels, and more effective inspection and maintenance. Local and state transportation agencies and real estate development interests and the highway construction industry are motivated to support such strategies to avert transportation conformity constraints on highway construction funding.

- Conformity has fostered continuing improvement in transportation forecasting and emissions models used to appraise the implications of transportation and land use alternatives, providing a more sound basis for air quality and transportation plans.

- Conformity has enhanced the public's right-to-know about air quality and transportation impacts before decisions have been made.

**Full Implementation of Conformity Was Delayed in Many Regions Until 2000-2001.** These successes have come about even though transportation conformity has been until recently only partially implemented in many regions. Full implementation of the 1990 conformity amendment has always been dependent on the establishment of motor vehicle emissions budgets in attainment SIPs. Delays by the States in the development of air quality attainment plans for most of the nation's largest cities delayed the setting of emissions budgets to be met by metropolitan transportation systems, forcing reliance on earlier complex transition rules. The first motor vehicle budgets designed to attain the 1-hour ozone standard in most large cities were first submitted in 2000 in response to litigation enforcing Congress's deadlines for SIPs. EPA has approved most of these SIPs only in the past year. Additional revisions to many of these SIPs are anticipated in the coming year to reflect updated motor vehicle emissions estimates using EPA's Mobile 6 computer model.

These new mobile source emission budgets took effect in 2000 as interim budgets while EPA continued to review the adequacy of the overall attainment plans for the more polluted metropolitan areas. These budgets provide a standard against which to measure the emissions produced by regional transportation plans. Metropolitan areas have 18 months from the submission of the interim budgets to revise their transportation plans to meet the new emissions targets for motor vehicles in each air shed. Thus, many cities are adopting revisions to their transportation plans to meet the 1990 Act's conformity requirements only within the past year, after a decade of delay.

For most of the 1990s, conformity in most regions relied on a weak, widely criticized, and often gamed 'build/no-build' test established by EPA as an interim stop-gap measure while States were developing the attainment plans with emissions budgets that are required by the CAA. The result was a system that required extensive modeling and planning, some upgrade to analysis methods, but in most cases produced relatively little change in transportation plans or investments beyond a few new ridesharing and transit projects. But now that attainment motor vehicle emission budgets are finally in place in non-attainment areas, conformity is operating as intended: *holding TIPs and RTPs accountable to attainment SIP motor vehicle emission budgets.*

**Conformity Remains Critical to Clean Air Progress.** Conformity remains critical to clean air progress because motor vehicles account for roughly half of all ozone precursor emissions in most large metropolitan areas. But even in those areas where the motor vehicle pollution share is less, such as Houston, where heavy industry accounts for a much larger contribution of pollution, steps to curb motor vehicle pollution are critical to attaining healthful air quality.

New, cleaner motor vehicle technologies mandated under the CAA Tier II standards will do a lot to clean up motor vehicle pollution over the next 15 years. But at the same time, EPA's NOx SIP call will curb emissions from large stationary sources such as power plants, so that the share of total emissions of ozone precursors and PM from motor vehicles may actually grow, despite cleaner vehicle technologies. And meeting the 8-hour ozone and PM fine pollution standards will require far more substantial reductions in emissions. Routine compliance of fiscally constrained TIPs and RTPs with motor vehicle emissions budgets through a strong and continuous transportation conformity program is essential to the success of the Clean Air Act in delivering healthful air quality for all Americans.

The failure of transportation plans to comply with SIP budgets is the reason why most metropolitan areas failed to meet the ozone NAAQS in 1987. Many serious ozone non-attainment areas again failed to attain by 1999 (including Atlanta, Washington, DC, Baton Rouge, Dallas-Ft.Worth, Connecticut, Springfield) is that motor vehicle emissions have not been reduced to the levels required for attainment. If Congress were to weaken conformity by reducing its frequency or analysis time horizon, or if conformity analyses continue to be further undermined by weak enforcement and oversight of fiscal constraint, traffic analysis, and emissions accounting methods by US DOT, the Clean Air Act is at risk of failing once again in the coming decade to deliver long-promised clean air for millions of Americans.

## III. Growth in Motor Vehicle Use Threatens Air Quality Progress

Growth of motor vehicle use is one of the most stubborn obstacles to lasting progress in cutting $NO_x$, particulate matter, and cancer-causing air toxics from the transportation sector. National and state programs to control air pollution from transportation through cleaner vehicle and fuel technologies and inspection and maintenance have significantly reduced motor vehicle pollution rates. But because of steep increases in the number of vehicle miles, cuts in the amount of pollutant emitted per mile, particularly for $NO_x$ and small particulates (PM2.5), have been offset by growth in miles driven.

Growth in motor vehicle use stems from many factors. Large investments in highway system expansion, subsidies for driving and sprawl, and policies favoring increased car-dependence over the past half-century have contributed to growth in trip distances and the number of vehicle trips for most Americans. More than three-fourths of all job and housing growth since 1970 has been in suburban areas that have been designed to promote automobile access as the only convenient or available means of travel for most trips. From 1970 to 1998, vehicle miles traveled (VMT)—has increased by 136 percent, or more than three times the rate of population growth. Other indicators of driving activity – vehicle trips per person, average vehicle trip length, and number of motor vehicles per person - have also risen sharply. Traffic growth not only threatens air quality progress, but it adds to traffic congestion and travel times, greenhouse gas emissions, dependence on imported petroleum, and degradation of water quality and community livability.

**Inadequate Regional Transportation Models Threaten SIPs.** One of the major causes of the failure of ozone SIPs to produce attainment during the 1980s was the systematic failure of the transportation models to account for the very significant increase in motor vehicle emissions that resulted from induced travel demand caused by new highway construction. The best evidence from the Transportation Research Board (TRB) studies reported during the last 5 years indicates that about 25% of total VMT growth in metropolitan areas is attributable to induced demand. The failure to account for that magnitude of motor vehicle emissions increases in the 1980s would have caused virtually all ozone SIPs to fail. Indeed, almost all metropolitan areas failed to attain even when they implemented SIPs EPA thought were adequate for attainment. The need for Congress in 1990 to enact an entire new program for ozone control in America's urban areas can be attributed, in significant part, to the deficiencies in the transportation models that failed to account for VMT growth trends of the last two decades.

A large number of recent TRB peer-reviewed scientific studies, summarized in Attachment 4, show that increasing road capacity in an area by 10% will cause a growth of 8% (with ranges found to vary from 3-10% depending on context) in total area traffic. Yet most regional travel models used for conformity analysis - even after the improvements of the 1990s - fail to properly account for this fact.

The most serious consequence of large errors in these transportation and emission models is the failure to reduce motor vehicle emissions enough to meet the NAAQS. In the case of Particulate Matter (PM) insufficient emissions reductions means hundreds or thousands of people will die in a non-attainment area, and for ozone it means tens of thousands may require hospitalization, emergency care or other medical treatment for debilitating conditions if the models under-predict emissions. While such end effects of a flawed traffic and emissions model are not as easily dramatized as the use of a flawed engineering model for design of a building that later fails and collapses, killing those inside and around it, the net effect of bad traffic models are in fact injurious to far more people over a longer period of time.

When metropolitan areas first began to undertake transportation conformity analysis a decade ago, regional transportation planning and emission models were barely up to the task. Many of these analysis tools were estimated on old data, insensitive to induced traffic and land use changes caused by changes in transportation system capacity and user costs, and unable to represent walking, bicycling, public transportation, or travel choices other than driving. Typical traffic models used by metropolitan planning organizations (MPOs) in 1990 were simple highway engineering models ill suited for public policy or environmental analysis.

**Inadequate Federal Actions to Improve Travel and Emissions Models.** To address this problem, following passage of the 1990 CAA amendments, the 1991 ISTEA law provided a 1.5 percent set-aside from several federal transportation funding categories to support MPO planning, data collection, modeling, and related activities required to implement the conformity and transportation planning process. Congress also authorized the use of Congestion Mitigation Air Quality (CMAQ) funds and other federal transportation funds to support such activities. In 1993, US DOT and EPA established a Federal Travel Model Improvement Program (TMIP) to help foster needed changes to MPO traffic models and EPA invested in further improvements to its MOBILE emissions factor models. TMIP provides useful training to MPOs and documents and disseminates current best practices in transportation and land use modeling, but has invested the bulk of its resources since 1995 in a multi-million dollar program based at Los Alamos National Lab to develop TRANSIMS, a supercomputer-based traffic simulation model that will be available for somewhat more general use by agencies over the next several years. MPOs in non-attainment areas increased their spending to update their travel models and data collection throughout the 1990s in response to EPA conformity regulations that established minimum modeling standards, but few MPOs flexed STP or NHS funds to support an expanded data collection and planning effort to improve their travel and emissions modeling capabilities. EPA's conformity regulations were streamlined in 1995, reducing the specificity of modeling requirements. FHWA in the mid-1990s issued some weak, limited guidance on transportation modeling practices that failed to promote best practices and encouraged MPOs to be satisfied with adopting "standard practice" models instead. Interagency consultation established as part of transportation and air quality planning and every three-year MPO certification reviews have been the principal source of oversight of the adequacy and integrity of the transportation modeling process.

While most of these measures have been of value and have encouraged some improvement of MPO transportation modeling for conformity and SIP analysis, they have been grossly inadequate to effect timely MPO adoption of best practices.

As TRB Special Report 245 (1995) concluded: "The four-step process, as it is conventionally applied, will generally understate the amount of induced travel." And most MPOs persist in conventional standard-practice application of four-step process traffic models in 2002, falling well short of best practices, meaning that most MPOs seriously underestimate induced traffic and related air pollution emissions. Unless addressed, this poses a major continuing threat to the success of SIP control strategies, which are likely to be inadequate to produce healthful air quality.

The question that needs to be answered is: How can we make sure that the modeling tools are improved so that they can more reliably serve the purposes that the clean air objectives of the Clean Air Act demand? It seems unlikely that the public or the Congress will abandon the goal of making the air safe to breathe. Therefore, TRB, DOT, EPA, MPOs, and the transportation agencies need to invest the resources to refine the modeling tools to ensure that they become more effective at identifying the factors that most reliably predict vehicle use, and the strategies most likely to be effective in reducing VMT growth and motor vehicle emissions. And MPOs need to apply those tools to evaluate alternative TIP, RTP, and SIP control strategies that can reduce traffic growth and motor vehicle emissions, so these can be considered effectively in the interagency decision-making process.

EPA last year released guidance allowing emissions reduction credit for land use strategies. The effectiveness of those strategies is linked to the quality and effectiveness of transit facilities and services offered to people in corridors where land use is planned to minimize travel demand. However, most MPO travel models have limited capacity to represent the travel behavior effects of transit-oriented development, walkable neighborhoods, new intelligent transportation system technologies supporting Bus Rapid Transit and ridesharing, or changes in parking policies and commuter travel incentives. As a result, the environmental and energy benefits of these strategies are not reliably reflected in the outputs to the traffic models.

An excellent recent GAO report noted that "the federal requirement to demonstrate that transportation plans and programs conform to an emissions budget serve as the primary incentive to assessing the emissions impacts of different land uses. Furthermore, such estimates had some effect on transportation and land use decisions. For examples, almost half of planners who reported conducting such estimates revised their transportation plans as a result, and about a third reported that local land use plans were revised…In the future more of the transportation and air quality officials may need to consider land use as a means to control emissions and improve air quality if EPA implements, as planned, two more stringent air quality standards. These officials face several barriers to further considering different land uses and their emission impacts, however, including a lack of required technical tools."[5]

This GAO report notes that, "DOT and EPA efforts to improve travel-demand-forecasting models may help MPOs and communities determine the effects of transportation improvements on congestion and air quality. However…these efforts currently do not call for integrating land use or environmental components into the travel demand model…Without such integrated

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[5] U.S. General Accounting Office, *Environmental Protection: Federal Incentives Could Help Promote Land Use That Protects Air and Water Quality,* Washington, DC, October 2001, GAO-02-12. page 6.

models, communities cannot consider the likely effects that their transportation decisions will have on land use, future growth and development, and air quality."[6]

Most MPO travel models need updating and refinement. Recent independent audits of computer travel models in Washington, DC, and other regions have exposed serious flaws in official Metropolitan Planning Organization models that bias their findings strongly against transit investments and smart growth strategies and strongly in favor of expanded highway investments. Attachment 7, a recent critique of the Metropolitan Washington, DC travel models that found significant underestimation of motor vehicle emissions of both NOx and VOC, illustrates this problem, which, if uncorrected, puts SIP control strategies at risk of failing once again.

And much greater investment is needed in national travel, land use, employment, demographic, and environmental monitoring data to properly support environmental management systems integrated with better decision-support for transportation planning. But this is not an argument to weaken conformity or to stop holding regional planning agencies accountable for the air quality consequences of the investment choices they make, or local governments accountable for the land use choices they make. The public health costs, and the harm to the personal well-being of too many Americans are too important to consider weakening the process. The only reason why there is any debate at all about the reliability and accuracy of transportation models is because the law requires accountability and imposes consequences. There have been major refinements in the planning process and the modeling tools used in that process since 1990. MPOs and transportation agencies are no longer using the overly simplistic unidimensional travel models that were the foundation for the grossly inadequate SIPs on the 1980s. Those improvements are some of the best evidence that the law is not broken; it is working.

With the enactment of the 1990 Clean Air Act Amendments, for the first time the law required the transportation agencies to be directly accountable for emissions effects of their decisions. This has created the need for and the incentive to advance the modeling science. Some MPOs, such as Portland, Oregon, and Sacramento, California, have invested in data collection, analysis tools, and staff development, enabling them to demonstrate best practices in their applied analysis work. These best practices need to be more widely replicated. Portland's models are now being adapted to improve statewide models used by Oregon DOT and used to advance a transportation planning process that is integrated with environmental resource and growth management. Such integration is the key to improving project delivery and the environmental stewardship of transportation agencies. Best practice transportation models have multiple ways of reflecting induced demand and land use impacts of transportation policies and investments and lead to better emission estimates.

Other regional models still are far from the mark when it comes to accounting for induced demand, land use effects, and the potential benefits of smart growth transit oriented development, pedestrian and bicycle enhancements, and transportation pricing strategies. As a result they typically continue to underestimate future VMT and motor vehicle emissions. In turn, this error leads to insufficient emissions reductions in SIPs, and to motor vehicle emissions budgets in SIPs that understate expected future emissions. This poses a problem for the transportation agencies when future actual vehicle counts show that VMT and emissions exceed

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[6] U.S. GAO-02-12, op. cite, page 95.

the budget. The remedy to this problem is not to dispense with or make highly infrequent conformity determinations, as some in the transportation industry would wish. The appropriate remedy is to improve the models so that they honestly and routinely account for what are now generally well-characterized phenomena in the world of transportation planning.

Several actions are needed to bring about more timely improvement of regional travel models.

- MPOs and transportation agencies should be required to make available at no cost to interested stakeholders all travel and emission model assumptions, data, documentation, and software driver files to allow routine independent oversight by outside parties. Such access varies now between MPOs, with some retaining a much more closed culture that resists disclosure or puts up barriers such as charging thousands of dollars for the copying of a few CD ROMs of data.

- MPOs and transportation agencies should be required to test their models for their sensitivity to induced demand as illustrated in Attachment 4. Agencies should also evaluate model capacity to evaluate changes in travel costs and travel times by time-of-day, changes in pedestrian and bicycle friendliness, urban design factors, and other key elements, comparing model performance with best practice models and scientific findings. EPA and DOT should require independent evaluation of travel model and emissions model adequacy as part of conformity and planning certification reviews and approvals.

- Where models are noted to have shortcomings against best practices, MPOs should be required to identify through their Unified Planning Work Program a schedule and budget for addressing these shortcomings in a timely way over the course of each 3-year planning cycle for regional transportation plans and SIP updates.

- Congress should establish and fund a Transportation Accounting Standards Board. This new independent entity is needed to assure timely progress towards honest accounting for how transportation funds are spent, including oversight of innovative finance programs such as GARVEE and TIFIA bonds, to assure compliance with transportation planning fiscal constraint requirements, and to assure the integrity and timely improvement of transportation agency environmental management systems, including travel and emissions analysis models.

- America needs a new much stronger national transportation data center to replace the Bureau of Transportation Statistics. This center should help set a core set of uniform standards for travel survey data collection, transportation network coding, spatial data analysis, and evaluation, developing a new generation of scientifically valid methods for local, regional, and national travel behavior analysis to support performance-based funding and decision-making. Local innovation should be encouraged to augment this core set of measurement systems.

## IV. Transportation Conformity at Work in Atlanta

In most U.S. metropolitan areas, agencies have successfully managed their transportation plans and programs to stay within the limits of adopted air quality plans. When these have come into conflict, resulting in conformity lapses, these have been brief. Most have been resolved in a matter of several months or less after working out administrative problems or by adding new emission-reducing transportation projects to TIPs and RTPs to offset excess pollution.

In several instances, most notably in metropolitan Atlanta, conformity lapses have persisted longer, thanks to ongoing interagency conflict and resistance from transportation and sprawl development interests who would prefer to ignore adopted SIP emission budgets. Throughout the 1970s and 1980s Georgia DOT invested heavily in freeway expansions, spurring massive low-density car-dependent sprawl development. By the mid-1990s, Atlanta area residents drove 34 miles per day per person, more than in any other metro area in the world. This came at a high price in regional air quality. The 1979 ozone NAAQS has been exceeded each year in Atlanta since 1980, continues to be violated many days each year, and exceeds the national standard by 30% to 50%. In 1999, the year when Atlanta was required by the Clean Air Act to attain healthful air quality, the region had the highest number of unhealthy days in the decade, with 22 days above the 1-hour health standard for ozone air pollution.

In December 1998, Georgia Power and Southern Company completed a $3 million scientific study to identify the primary sources contributing to Atlanta's ozone problem. Scientific analysis showed that power plant emissions caused about 15 percent of the Atlanta area's ground-level ozone, while mobile sources - including off-road - accounted for 70 percent, and emissions from other sources accounted for 15 percent. Shortly after this study, the state finalized its first plan to reduce smog-causing emissions in metro Atlanta. This plan is resulting in investment of $850 million in new pollution control technologies on power plants by May 2003, reducing Georgia Power's contribution to ground-level ozone in the Atlanta area to 6 percent. In fact, power plant controls represent 86 percent of the reductions that will be achieved in the state plan. With these Georgia Power reductions, mobile sources, including on-and off-road, will be responsible for about 83 percent of the Atlanta area's ozone problem.[7]

Routine conformity analysis of the TIP and RTP has been vital to making progress on clean air in Atlanta. In 1996, the region's MPO submitted a SIP stating that the region would meet a motor vehicle emission budget of 214 tons per day (tpd) by 1999, when they were required to attain the ozone NAAQS. In 1998, the MPO wrote to EPA saying that its 1999 NOx emissions would actually be 238 tpd in 1999, reflecting the use of a refined travel model and updated growth forecasts. In 1999, the MPO found that real-time NOx emissions were 264 tpd. In 2001, the MPO admitted that it would not reach the 214 tpd motor vehicle NOx budget until 2005.

Conformity requirements led the Atlanta MPO to admit in September 1996 that its proposed new TIP would exceed the SIP emission budget submitted in June 1996. In response, the region deferred plans to add even more road expansion projects to the TIP and began to limit changes to its TIP to conformity-exempt projects. However, various proposals to adopt more stringent motor

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[7] *The Telegraph*, Jun. 15, 2002, Atlanta, GA.

vehicle inspection and maintenance programs, cleaner fuel standards, and expanded transit services and emission reduction strategies proposed by local agencies and the regional transit agency were blocked by Georgia officials, although together these local actions could have resolved the conformity lapse.

In late 1997, just prior to the expiration of the TIP, Georgia DOT, with FHWA concurrence and opposition from EPA, sought to exempt nearly a billion dollars in highway capacity expansion projects from transportation conformity so they could continue building these sprawl, traffic, and pollution inducing new roads through what many expected to be a lengthy conformity lapse.

After the conformity lapse began in January 1998, the MPO adopted several interim TIPs and RTPs. In response to a suit filed by Environmental Defense, the DC Court of Appeals found invalid in March 1999 certain EPA conformity regulations that had been the basis for ultimately exempting over $700 million in Atlanta area road projects from compliance with transportation conformity. As a result, the Atlanta region lost no federal funds, but did end up shifting over $300 million in spending during the conformity lapse from sprawl-inducing, pollution-boosting road projects to instead fund transit, sidewalks, bikepaths, HOV lanes, transit-oriented brownfields infill redevelopment, traffic signalization, intersection improvements, highway safety, bridge reconstruction, maintenance, and other conformity-exempt projects and Transportation Control Measures.

Atlanta’s conformity problems also prompted intense engagement of business, civic, and community leaders to address the failures of their governance structures to agree on strategies to clean the air, manage sprawl, and provide the region’s citizens with travel choices other than driving. It allowed Gov. Roy Barnes to get legislative approval in 1999 to create a potentially powerful Georgia Regional Transportation Authority (GRTA), with authority to fund transit expansions, review and approve transportation and development plans, and manage growth in non-attainment areas.

But soon after its creation, GRTA was pressed by Georgia officials to approve a new Atlanta RTP that would renew massive sprawl and pollution inducing road system expansions, while adding new transit and commuter rail investments. The new Atlanta RTP supports a lot of road investment and sprawl, including outer beltway development, in the early years of the plan and promises largely unfunded major transit investments farther in the future. As a result, the MPO’s own analysis shows that under the $35 billion Atlanta RTP, the share of regional employment reachable by those without cars will decline from 2000 to 2005 and not return to year 2000 levels until after 2015. This raises serious questions about compliance of the federal approval of this plan with Title VI of the Civil Rights Act, which requires consideration of disparate impacts of federal spending on protected minorities, and it bodes ill for the region’s ability to meet Clean Air Act requirements. Attachment 3 provides tables illustrating, with data from the Atlanta MPO, these troubling trends of declining access to job opportunities for people without cars, who are disproportionately minority populations and lower income residents.

Indeed, conformity of the new RTP was dependent on an EPA attainment date extension policy that the U.S. Court of Appeals for the D.C. Circuit recently invalidated in connection to a law suit challenging approval of a SIP for the Washington, DC metropolitan area, which similarly depended on this policy. It also relied on a SIP revision to increase the motor vehicle emission budget to allow *greater* pollution, although the region was experiencing record levels of health-harming ozone violations in the year it was by statute required to come into attainment.

FHWA, EPA, and environmental and civil rights groups all raised serious questions about the legal compliance of the new RTP with TEA-21 fiscal constraint requirements; local elected officials raised questions about who would pay for the new transit investments and the costs of expanded transit operations; the regional transit agency was simultaneously in a severe fiscal crisis that led to a general fare increase and substantial bus service cutbacks, harming low income minority transit-dependent riders.

In the past year, Georgia officials have sought to accelerate spending for their massive road program under this RTP through new “innovative financing” bond issues. How to pay for transit operations assumed in the RTP remains a critical and unresolved problem. Should it later be revealed that Georgia’s current transportation investments were imprudent from an air quality perspective, it will be too late to redirect this spending, and the fiscal capacity of the state to fund emission-reducing projects will be impaired.[8]

Adding to these concerns, an independent audit of the Atlanta MPO traffic model by a nationally-recognized modeling expert found that the MPO seriously underestimated motor vehicle emissions by misrepresenting travel speeds on freeways. A later speed study commissioned by GRTA affirmed these findings, but was suppressed by Georgia officials until after approval of the RTP and TIP conformity analysis that relied on the seriously flawed model. The mis-accounting for nearly 12 tpd NOx, which contributes to continuing health impairment of hundreds of thousands of people in the Atlanta area, was simply swept under the carpet by regional agencies, FHWA, and EPA. Attachment 2, “Emissions Effects of Atlanta Speed Study,” provides additional documentation.

Unfortunately, my two decades of experience as a transportation engineer and modeling expert, working with many regional travel forecasting models across America, allows me to state with confidence that the kinds of problems observed in the Atlanta model with poor estimation of speeds are widespread elsewhere. Until independent critiques of regional travel models become commonplace, the integrity of the traffic and emissions forecasting process in most non-attainment areas will remain suspect, casting doubt on the success of SIP control strategies to deliver healthful air to all Americans.

Following lengthy settlement negotiations that led to a tentative agreement in December 2000 for additional emission reductions, Georgia officials balked at making the agreement enforceable and withdrew from talks in January 2001, moving forward with new road projects in the TIP and RTP. This led environmental and civil rights groups to challenge approval of the Atlanta RTP

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[8] Unfortunately, a number of other states are following this approach, using GARVEE bonds and other leveraged finance methods to evade fiscal constraint requirements. New Mexico, for example, several years ago did an end run around opposition in the state legislature to a 140-mile road expansion project by issuing GARVEE bonds that obligate transportation receipts for the next generation to the project and adopted a repayment scheme that avoided any payments on the bonds for the first several years. As a result, a large share of the state’s transportation budget will be eaten up by debt repayment.

and SIP revisions in several suits. These legal actions are still in process. One of the key questions, now before the Court of Appeals in the 11th Circuit, is whether the TIP must demonstrate conformity to the EPA-approved 1999 SIP motor vehicle emission budget at the time the TIP is approved and while the funds in the TIP are being spent. Georgia Governor Barnes and FHWA convinced the District Court that the Atlanta FY 2001-2003 TIP does not need to demonstrate conformity until 2004, despite the CAA statutory requirement for Atlanta to attain healthful air quality by 1999. If this stands, it will represent an unfortunate weakening of the accountability of transportation programs to SIP emission budgets.

While Atlanta has made progress in its governance structures, planning, and emission control strategy development, thanks to conformity, these reforms continue to encounter resistance from interests in the state that seek continued sprawl and road system expansion regardless of the consequences for air quality. The price of this resistance is degraded health and a tarnished quality of life, and likely higher future pollution clean up costs to compensate for the irretrievable commitment of resources today to investments that will spur higher pollution for decades to come. Without conformity, there would be even less accountability.

## V. Recent Transportation Conformity Action in Washington, DC

Conformity has also been valuable in helping to win new emission reduction strategies in the metropolitan Washington, DC region and bringing about better accountability for transportation decisions. In July 2001, the MPO updated its modeling assumptions to reflect the growing use of sport utility vehicles (SUVs) and light trucks, which produce more pollution per mile driven than standard cars. As a result, they observed that that they could no longer add new road projects to their TIP and RTP and still conform with the NOx motor vehicle emission budget in their adopted SIP. Officials formed a task force to consider reopening the SIP to allow for more motor vehicle pollution by finding offsets from other emission sources or fixing the conformity problem by adopting added emission reduction measures. With adjustments for some refinements to their model estimates and for emission reducing measures already being implemented but not previously credited, the MPO found that the 8 tpd NOx excess emissions over budget was reduced to about 3 tpd.

Following further meetings and analysis, Maryland Governor Glendening proposed a $42 million package of transportation emission reduction strategies, including buying clean buses, improving pedestrian and bicycle access to transit, and supporting transit oriented development. The MPO is confident that this package, along with measures advanced by other jurisdictions, provides sufficient reductions to offset this emission budget shortfall and the region is moving to adopt them as part of a new TIP and RTP at the end of July 2002. If proposals to lengthen the duration of conformity findings to 5 years had been in effect, this $42 million package of emission reduction measures would not likely have been funded.

Because of dramatic underestimation of transportation project costs by Virginia DOT, the region recently cut back its proposed short-term road program for 2005 by 100 lane miles of new road capacity. The MPO estimated this would result in a 1.9 tpd reduction in NOx, along with a 0.6% reduction in daily VMT, a 1.3% increase in daily transit trips, a 0.1% decrease in VOC.

## VI. Cancer Risk Must Be Accounted For In Decision-Making

Compelling new scientific evidence suggests that people living in communities located near heavily traveled highway facilities are being exposed to concentrations of toxic and hazardous air pollutants emitted by motor vehicles that cause an extremely high and unacceptable risk of cancer including childhood leukemia, and other respiratory and cardiovascular disease.

Research by California's South Coast Air Quality Management District demonstrates that toxic pollutants emitted by motor vehicles account for an unacceptably high cancer risk in the range of approximately 1 in 1,000 exposed individuals to 1 in 650. See, *Multiple Air Toxics Exposure Study-II (MATES-II)*, March 2000. The study found that the total cancer risk in the Los Angeles Basin from toxic air pollutants measured at 8 monitoring sites ranges from 1,100 in 1 million (or 1 in 900) to 1,700 in 1 million (or 1 in 670), and that 90% of the total cancer risk is attributable to toxic air pollutants emitted by mobile sources. Most of the mobile source cancer risk is associated with exposure to the toxic pollutants benzene, 1,3 butadiene, formaldehyde and diesel particulate matter ("DPM"). In addition, concentrations of toxic pollutants estimated by a regional air quality model show that neighborhood exposures near heavily traveled highways is significantly higher than exposures monitored at the regional monitoring stations, producing a cancer risk as high as 1 in 130 (5800 in 1 million) in some receptor areas.

The estimates of increased cancer risk predicted in *MATES-II* are supported by recent epidemiology data. Evidence of the incidence of childhood leukemia in Denver during the late 1970s and early 80s, Pearson and colleagues (2000), shows an association between residential location within 750 feet of a major traffic corridor and an elevated incidence of childhood leukemia. These data suggest that exposure to higher than regional urban background concentrations of motor vehicle emissions is a significant risk factor for childhood leukemia. Other research provides evidence of increased incidence of other adverse health outcomes for residents of neighborhoods near heavily traveled highways. Brunekreef and colleagues (1997) show that adverse health outcomes including premature mortality and increased morbidity through increased respiratory and cardiovascular effects are associated with the increase in ambient fine particulate matter, e.g., particles less than 2.5 microns in diameter ("$PM_{2.5}$") from roadway sources.

Taken together, this evidence requires FHWA to prepare comprehensive risk assessments to determine the health risks for neighborhoods located near heavily traveled roadways that are proposed to be built or expanded in densely populated metropolitan areas, and that alternatives to the development of high cancer risk travel corridors be chosen as the preferred alternative or that mitigation be adopted to prevent the incremental health risk attributable to toxic air pollutants emitted from these projects.

Attachment 5, *A Preliminary Toxicological Review of Roadway Traffic Pollution*, provides additional information on the need for better monitoring and mitigation or remediation to reduce exposure of people to air toxics from roadway traffic. It finds that

> *Analysis of published data for traffic emission factors and the resulting exposure estimates demonstrates that uncontrolled expansion of roadways will significantly*

> *increase exposures to both fine particulate matter and air toxins by the population in the contiguous residential corridor. This is significant because several epidemiological studies have shown that levels of fine particulate matter typically found adjacent to heavily trafficked roadways are comparable to levels that can exacerbate both acute and chronic respiratory disease symptoms and cause premature death among sensitive populations. This finding applies to short-term exposures of a few hours to one or several days. With regard to air toxins, exposures experienced by roadway corridor residents are likely to equal and probably exceed the air toxins levels measured at monitoring sites located near heavily traveled highways and reported in the Multiple Air Toxics Emissions Study II Study. Risk estimates based on the levels reported in the Multiple Air Toxics Emissions Study II resulted in an unacceptably high cancer risk of approximately 1 in 1,000 to 1 in 650 that was attributed to diesel exhaust and other motor vehicle emissions. The relative impact on other roadway corridor populations could be commensurate with the increased exposures to motor vehicle pollution that would result from their proximity to the large numbers of additional vehicles traveling the expanded highway.*

The study notes that "Many current environmental assessments have not properly accounted for the differential impact that could be imposed on the nearby the population adjacent to expanded highways. This analysis of available data demonstrates that a detailed program of pollutant monitoring and modeling that are specific for the planned expansion should be undertaken to properly quantify the potential adverse health impacts associated with projects of this type."

Another study, *Review of Exposure to Toxic Air Pollutants From Mobile Sources and the Impact of Expansion of US 95 in Las Vegas, Nevada*, is included as Attachment 6. It relates the traffic increase caused by expansion of a major highway to the increased exposure of people in the corridor to traffic related air toxics. FHWA needs to assure that this kind of analysis will be routinely made a part of the review of major highway capacity expansion project approvals if these agencies are to fulfill their legal mandate to avoid adverse health impacts in decisions about project approvals.

Control of mobile toxics has not been adequately addressed by EPA and DOT. Conformity does not currently apply to air toxic pollutants. Although EPA has identified 21 air toxic pollutants emitted by mobile sources, it has not adopted an urban air toxics strategy as required by section 112(k) and 202(l) to reduce mobile source toxic emissions.

## VII. Prospects for Reducing Traffic Growth to Reduce Pollution and Harms from Traffic

While technology based emission control strategies have been vital to progress towards cleaner air, strategies that reduce VMT growth can make low cost contributions to timely attainment and maintenance of healthful air quality, offering substantial benefits beyond clean air. These strategies include smart growth that renews existing communities and incentives and investments that improve transit, walking, bicycling, ridesharing, and telecommuting. Together these can provide reductions of 15 to 25 percent in VMT, hours of vehicle travel, and emissions relative to trend-line automobile-dependent sprawl development forecast over the 20 year horizon of regional transportation plans.

Recent changes in the tax code, make it more attractive for employers to provide transit, vanpool, and cash-in-lieu-of-parking benefits for their employees, which if widely implemented could reduce motor vehicle commute trips by 26-30 percent. These and other innovative strategies - such as intelligent transportation systems, value pricing of roads and transit, usage-based car insurance, traffic calming for pedestrian and bicycle safety, smart growth and telework can expand equitable access to jobs and public facilities and reduce growth in traffic, congestion, and air pollution. Regions can cap and reduce per capita VMT in coming years with such strategies, producing diverse short and long term benefits.

Georgia officials illustrated their capacity to achieve short term reduction in traffic, pollution, and health hazards from traffic during the Atlanta Olympics. By expanding their transit system with roughly 1000 leased buses, promoting travel alternatives, telecommuting, and other travel incentives, they cut morning peak traffic levels by almost one-fourth during the Olympics while the region accommodated one million visitors over a three week period. This led to a 28 percent drop in ozone levels and a reduction by 42 percent in the number of people seeking hospital treatment for asthma.

Several state studies have illustrated rail's benefits for energy conservation, air pollution and global warming, For example, in California, a recent state study concluded that the state-supported intercity train network will prevent 265 million motor-vehicle-miles from being driven in 2002. While the resulting reduction in gasoline consumption is offset by increased diesel consumption by trains, the state projects a net saving of 7.3 million gallons of gasoline in 2002, helping to reduce both air pollutant emissions and the demand for imported oil (California Department of Transportation, *California State Rail Plan 2001-02 to 2010-11,* 2001, p. 6). A gasoline saving of this magnitude would reduce carbon dioxide emissions by about 140 million pounds, which is the equivalent of taking 12,000 cars off the road for a year. A study done for the Coalition of Northeast Governors in 1990 estimated that the introduction of high-speed rail service between Boston and New York would save 20 million gallons of jet fuel and 4.5 million gallons of gasoline per year. Although some pollution is generated from the electricity that powers the trains, the net effect of high-speed rail between Boston and New York would be to eliminate almost 2,700 tons of smog-forming pollutants each year.

Public transportation has been estimated to cut gasoline use by more than 1.5 billion gallons a year and to prevent the emission of 63,000 tons of hydrocarbons and 78,000 tons of nitrogen oxides. These numbers don't even consider the much greater indirect energy and environmental benefits of the efficient housing and work environments made possible only by the availability of rich transit networks in places like New York City, San Francisco, and Washington, DC. And vital new economic centers, such as San Jose, Denver, and Portland, Oregon, could not sustain and manage their growth without having invested heavily in transit.

When high quality transit services are consistently developed and sustained over the long-term, they transform community patterns of travel, commerce, and urban development, producing much larger pollution reductions. A recent study by the National Transit Cooperative Research Program of the National Academy of Sciences found that transit-supported compact developments yield 10-30% less overall community energy use and pollution compared to low density, car-dependent sprawled development, as well as lower total social and infrastructure costs. Many regional and sub regional studies using best practice analysis tools to compare alternative investment strategies and related policies, e.g., in Denver, Portland (OR), Sacramento, and Washington, DC, have found that transit supported strategies can accommodate equivalent amounts of new development with significantly less traffic and pollution while automobile-oriented strategies induce added traffic and pollution.

Indeed, by focusing growth around an expanded transit system, reducing expenditures on roads, and adopting an urban growth boundary and pedestrian-friendly urban design standards, Portland, Oregon has pursued a path different from most other U.S. metropolitan areas. Since the adoption of the 235,000-acre growth boundary in 1979, Portland has urbanized just 39,000 acres. At the same time the population inside the boundary has increased by more than a third. No new road capacity has been added to the downtown for nearly a quarter century although employment has nearly doubled in that time to 109,500. Transit carries the equivalent of two lanes of traffic on every major thoroughfare to downtown. Portland tore out a six-lane expressway to create a downtown river front park, traded in the money for two new freeways and invested in transit. Between 1990 and 1996, transit ridership grew 20 percent faster than the growth in vehicle miles traveled, 41 percent faster than the growth in transit service and nearly 150 percent faster than the growth in population. Portland's adopted regional plan envisions a 40% increase in population and just a 2% increase in land area by 2017. The experience of most cities with less consistently transit-focused policies has been that urban land consumed per person has skyrocketed, exacerbating car dependence. Seattle's experience is typical, with a 38% population increase accompanied by an 87% increase in urban land area between 1970 and 1990.

Portland has been a leader in adopting effective SIPs and Maintenance Plans that include high-performance Transportation Control Measures (TCMs). Portland expects to achieve a 5 percent cut in vehicle miles traveled by 2010 thanks to changes to its zoning and parking codes that reduce the over-supply of parking and encourage mixed-use development. It has previously adopted SIP TCMs that required local governments to modify local zoning to support transit oriented development, consistent with Federal Transit Full Funding Agreements that were predicated upon such zoning changes to assure a sound market for transit use.

Another region facing sprawl pressures that are being countered with better transit is Denver, which anticipates accommodating a million new residents in the coming 20 years. A recent survey by the Downtown Denver Partnership shows that before the new Southwest light rail line opened, one in four downtown commuters used transit; since the new line opened, one in three do. It is estimated that it would take 175 additional miles of highway in the Denver metro region to carry all the people who use transit today. Recent public transit investments have been very successful; both light rail and the bus and carpool lanes on north I-25 have exceeded projections for ridership. The 14-mile light rail system takes 525 bus trips off city streets each day. One light rail train can replace over 200 single occupant vehicles. More than 33,000 people ride the light rail daily- about 30% above the original ridership projections. New transit investments are not only alleviating traffic congestion and cutting pollution, they are revitalizing communities by serving as infrastructure for creating new town centers and livable, walkable communities. The once dead Englewood mall has been reborn in the past two years as a mixed-use city center with homes, offices, stores, cultural, and civic uses, thanks to Denver's Southwest light rail line that now serves it. And the growth attracted to this center otherwise would likely have taken a much more polluting, car-dependent form at the periphery of the metro area, but for Denver's transit-supportive policies.

**Strengthen Commuter Choice: Boost Employer Support for Transit.** Federal and state tax policies are a key factor driving increased dependence on motor vehicles. For the vast majority of working Americans, a free parking space at work has for decades been the sole commuter benefit offered by employers because that was until recently the only tax-free commute benefit worth speaking of. So if you drive alone to work you gain the benefit. If you take transit, carpool, walk, or bike, you lose the benefit and likely pay your own daily transit fare. With this kind of incentive, it's no surprise that on any given day nine out of ten American commuters drive to work and nine out of ten of the cars driven to work have one occupant. Yet the 85 million "free" or subsidized employer parking spaces actually cost American business more than $36 billion per year. By spurring more driving, these subsidies exacerbate traffic congestion and air pollution. A congressional study found that "free" parking of all kinds costs our society over $250 billion per year.

In 1998, Congress took steps to make tax policies more equal for all commuters, allowing employers to offer tax-free transit and vanpool benefits of up to $100 a month, with taxable cash-in-lieu-of-parking benefits allowable for the first time. Tax-free benefit limits for employer-provided parking were set at $175 per month – a practice which still leaves solo drivers at an advantage. Allowing employee-paid pre-tax transit benefits saves transit-using employees over $400 a year while saving employers a smaller amount on withholding. Having employers pay for transit is a bigger incentive for employees. Offering such a benefit to federal executive agency employees in the national capital region induced 11 percent of employees who used to drive to work to switch to transit, taking 12,500 cars off the region's crowded roads every workday. At firms in California and Minnesota offering a $2 a day incentive instead of free parking, one out of eight who used to drive are finding another way to get to work. Such benefits help employers attract and retain employees and provide the greatest help to low and moderate wage workers who spend the largest share of their incomes commuting and often ride transit, carpool, bike, or walk to work.

The cost of such employer provided transit benefit programs to employers is very small and can easily be fit within the scope of ordinary cost-of-living increases offered by most employers to their employees on a periodic basis. State tax credits can make this cost even smaller. For example, in Maryland, if an employer offers an employee a cost of living increase, for each $1 in after-tax cost to the employer, the employee typically receives $0.53 in after-tax income. If that same $1 in after-tax employer expense is instead devoted to an employer-paid qualified transit benefit of $60 a month, the typical Maryland employee who receives it ends up gaining $1.76 in after-tax benefits, thanks to the leveraging effect of federal and state tax provisions.

The savings for employees offered by the federal tax law changes are significant and make a high level of employer and employee participation in the next several years realistic across America. For example, an employee earning $50,000 per year who spends $780 annually on transit ($65/month) could realize a tax savings (at 42%) of $328 as a result of paying their transit cost using pre-tax dollars, exercising one of the new Commuter Choice options, while their employer would gain payroll tax savings (at 7.65%) of $60 per employee (Arthur Andersen).

Even if the cost to set up and administer the program equals 2% of the transit benefit, the employer will still enjoy payroll savings of $44. Employers are likely to face new costs to offer transit passes or added cash income in lieu of parking, but these can also translate into substantial cost savings of several types. It is much cheaper for an employer to boost non-taxable employee benefits than to offer added taxable income to retain or attract workers, which is an increasing issue in a tight labor market. If the employer is able to expand employment without adding more parking spaces or to otherwise avoid the cost of building, leasing, or maintaining parking spaces for workers, capital cost savings can amount to $5,000 to $20,000 per avoided space and operating costs can amount to $750 to $3,000 or more per year per avoided space. Such savings are often significant enough to more than pay for a cash in lieu of parking or transit pass benefit.

Commuter Choice programs have been shown to unite the diverse interests of environmentalists, business, labor and transit and highway advocates. Most realize that Commuter Choice is good for business and for communities. Commuter Choice is a voluntary incentive that boosts travel options and supports more efficient use of the roads and transit we already have. It can provide quick relief to traffic-strained communities and will expand market opportunities for new forms of access to suburban jobs. Low- and moderate-income workers benefit particularly, since commuting costs represent a larger relative burden on them, and they tend to be more reliant on ridesharing and transit. The Alliance for Clean Air and Transportation, a national group representing a diverse array of sectors, including the road builders, automobile industry, environmentalist and health groups, the American Association of State Highway and Transportation Officials, Highway User Federation, American Automobile Association, the National Association of Regional Councils, and the US DOT and EPA, in February 2000 adopted a consensus goal of making Commuter Choice benefit programs a standard part of the American worker benefit program over the next five years.

However, Commuter Choice will have an effect on air pollution only if people know about it and use it, and if the opportunities for cost savings offered by aggressive implementation of these incentives are made evident and available to developers, building owners and tenants, and commuters. Marketing alone has been shown to be inadequate to win widespread adoption of Commuter Choice incentives. There are many strategies that can be taken by states, regional bodies, and local municipalities to foster rapid and widespread adoption of Commuter Choice incentives so these might become available to the average commuter. Additional financial incentives and support by transportation agencies and other government bodies are essential to rapid adoption of Commuter Choice voluntary incentives and can be highly cost-effective in reducing congestion and pollution.

DOT and EPA are promoting Commuter Choice, but Congressional action is needed to further expand efforts to foster widespread adoption of these voluntary incentives. EPA estimates that if half of all U.S. employees were covered under these commuter benefits, traffic and air pollution could be cut by the equivalent of taking 15 million cars off the road every year, saving American workers about $12 billion in fuel costs. For every 10% of U.S. employees participating, commute VMT would be cut by 3.2%, or 20 billion miles, with emission reductions of 54,000 tons VOC, 480,000 tons CO, 33,600 tons NOx, and 2.36 million tons CO2. In *SIP Development Guidance: Using Emission Reductions from Commuter Choice Programs to Meet Clean Air Act Requirements*, EPA estimates reductions of 26-30% in commute vehicle trips for a full

Commuter Choice program. Los Angeles research shows that those who receive free parking at work drive 72 cars per 100 employees, while those who paid for parking at work drove 53 cars per 100 employees, or 26% less (D. Shoup, "An Opportunity to Reduce Minimum Parking Requirements," *Journal of the American Planning Association*, Winter 1995, pp. 14-28.).

Congress should take further steps to encourage employer support for such 'Commuter Choice' initiatives. Congress should support for the following bills that would do this:

- The Commuter Benefits Equity Act of 2001 (H.B.318) would provide equal tax-treatment for parking and transit benefits.

- The Bike Commuter Act (H.R. 1265) would allow employees who bike to work the same financial incentives as transit users.

- The Mass Transit Tax Credit Act of 2001 (H.R. 906) would provide a 25 percent tax credit to employers for the cost of providing transit benefits to their employees. This is modeled after measures adopted by several states – including Maryland, Minnesota, Oregon, Washington, Georgia, New Jersey – that have begun offering tax credits of up to 50 percent and up to $50 per employee per month for employer-paid non-driving commuter benefits.

TEA-3 should also require that local and state officials do more to consider integrating Commuter Choice into their transportation plan and program development. In all non-attainment areas, transportation programs should assure that potential air pollution reduction benefits from Commuter Choice will be realized in a timely manner. These would include provision of these benefits to state and local government employees, aggressive marketing of these benefits to employers and employees, inclusion of Commuter Choice programs in local planning, development review, and other decision-making procedures and favorable local and state tax treatment. Such new travel demand management activities and incentives should be given priority by including them in air quality SIPs as Transportation Control Measures.
This promotion should include marketing, technical and administrative assistance, new transit fare products, such as deep-discount bulk purchase transit and vanpool benefits for 100 percent of an employer's workforce in the region, and new financial incentives for employers and employees that are adjusted annually in an effort to meet stated performance targets. State Implementation Plans should include targets, timetables, and expanded funding commitments for (a) providing different segments of the labor force with Commuter Choice options of various types and (b) achieving increased levels of use of various Commuter Choice incentives by various portions of the labor force. These targets could be used as the basis for estimating SIP credits if accompanied by commitments to reasonably linked funding and policy commitments that could be anticipated to meet these targets.

**Financing Transit With Automated Road Pricing.** Another promising option for curbing traffic and emissions growth while enhancing mobility is automated time-of-day tolls and High Occupancy Toll (HOT) lanes, which allow solo drivers to pay to use High Occupancy Vehicle (HOV) lanes, while giving a free ride to buses, vans, and sometimes carpools. These can put to work unused capacity in HOV lanes and help pay for expanded transit services. A network of

HOT lanes on existing highways is likely to provide more effective congestion relief than building new roads. New outer beltway toll roads are likely to bring more sprawl and put more jobs out of reach for those without cars, hurting the poor and the environment. Why not instead give time-stressed travelers a way to buy relief from growing congestion delays in existing freeway corridors and finance better transit?

HOT lanes in existing road corridors can expand both travel choices and equity. HOT lane critics unfairly bash them as "Lexus Lanes," serving only the rich. Real-world HOT lanes look more like "Lumina Lanes," used by people of widely varying incomes who occasionally need to bypass traffic delays that disrupt their social, family, or work life. A working class mom who is facing a $1 a minute penalty for picking her kids up late at day care is happy to pay $4 to save 20 minutes by using the HOT lane on those several days a month when she needs it. The typical users in California spend less than $20 a month on HOT lane tolls, using them on days they are in a real rush. If HOT lane revenues fund new bus services, as on San Diego's I-15 HOT lane, everyone wins. Lower income transit users and carpoolers get access to otherwise inaccessible suburban jobs. Drivers benefit from reduced road congestion and better services and choices. If HOT lane revenues help pay for the road, those who drive most are paying more of their fair share, helping all taxpayers win. Road user fees don't nearly cover the full cost of building and operating America's roads, which remain subsidized by broader taxes. And with new accounting rules forcing fuller disclosure of deferred maintenance, transportation providers need new sources of revenue to maintain systems, expand choices, and cope with growing travel demand.

New non-stop electronic toll technology means motorists don't need to slow down to pay tolls. And HOT lane fees -- higher in rush hour and discounted at other times -- keep traffic flowing without wasting scarce road capacity like HOV lanes do. This makes it possible to contemplate future conversion of some existing general-purpose lanes to HOT lanes, particularly where new capacity is being added to existing roads. HOT lane experience indicates this strategy can garner popular support. On California's Route 91, diversion of traffic onto HOT lanes has reduced congestion on the entire road and increased the number of passengers per car to 1.6, compared to the average of 1.2. Similar incentives have been implemented or are being considered in Texas, Florida, Colorado, Georgia, New Jersey, New York, and other states.

The Port Authority of NY-NJ in March 2001 introduced time-of-day tolls on Hudson River bridges and tunnels and Staten Island bridges, giving discounts for electronic toll payers who avoid rush hours and charging a premium in the time of most concentrated demand, just like movie theaters and many other services. This helps reduce congestion by shifting the time of day of traffic. Toll revenues support better PATH transit and regional transportation infrastructure and services. The NJ Turnpike, NY Thruway Authority, and other tolling agencies have implemented time-of-day tolls to manage traffic.

Congress should encourage states and transportation facility operators to replace obsolete toll booths that cause congestion and pollution with new barrier-free customer-friendly tolling systems using toll transponders and image processing and billing systems. Congress should encourage state motor vehicle agencies to issue toll transponders with motor vehicle registrations to encourage their widespread availability in states where tolls are used. Congress should eliminate restrictions on tolling highways that were constructed with federal aid, which can now only be tolled under limited pilot projects authorized by TEA-21.

**Promote Smart Transit Fare Payment Systems for Productivity Gains.** New information technologies and smart management strategies are vital to making America's transit systems more efficient and attractive for users while controlling costs. There are many things that should be done in this regard, including improving fare collection systems and giving buses and trolleys greater priority in traffic. Enhancing priority for buses and trolleys in traffic can increase average transit travel speeds, schedule adherence, and the number of passenger seat-miles per hour that can be carried by existing transit vehicles. A key part of this strategy involves upgrading traffic signals to support greater priority in traffic for buses, so they can hold a green signal green for a few extra seconds, or advance a red signal to green to avoid an extra stop. The strategy can also include building or configuring bus queue jumper lanes at key traffic bottlenecks to speed bus traffic past congestion, creating dedicated bus lanes, and bus boarding stations. These are often combined to provide "Bus Rapid Transit", which can often provide many of the benefits of fixed guideway rail services quickly at a lower cost.

Across America, buses are slowed by passengers who must file through the vehicle's narrow front door to board and pay an exact cash fare. Encouraging near universal use of pre-paid transit fare instruments and other high efficiency transit payment options, as in Europe and Japan, enhances productivity of existing and new transit services by reducing delays related to fare payment at time of boarding. Instead of having people pay cash on boarding, require that passengers carry a prepaid transit pass, or other fare media that must be validated before or immediately after boarding a transit vehicle, and which at a premium cost could be purchased on board the vehicle. Greater use of daily, weekly, monthly, and annual transit passes helps accomplish this. Fare inspectors roaming transit systems and spot checking to verify that passengers are carrying a valid proof of fare payment or a pass, with large fines for fare evasion assure broad compliance. This enables boarding of buses through both front and rear doors, which boosts transit vehicle productivity.

**Provide Safe Routes to Schools and Transit by Foot and Bike.** Walking and biking are pollution free modes of transportation that millions of Americans enjoy where street and community design allows them to be done safely. And public transit is only as useful when people can get to and from its stops, which usually requires walking at one or both ends of the trip. A key part of the transit success story of recent years – with U.S. transit ridership growing faster than vehicle miles driven for the past 5 years - is attributable to TEA-21's increased support for investments in walking and bicycling. TEA-21 reauthorization should take further actions to assure a safe route to schools and transit stops across America, adapting successful strategies from the most bicycle and pedestrian friendly communities. This should include requiring transit agencies to develop least-cost transit access plans that consider and compare walk, bike, and automobile access opportunities to expand the market reach along all their transit lines. It should include accelerated funding to local governments to enable the build-out of the 20 year bike and pedestrian plans in the next 3 years, planning funds to engage in local area pedestrian and bicycle planning to identify key barriers and safety problems, and delay of some road projects to provide funds to retrofit sidewalks, bike paths, and traffic calming measures within a half-mile of all transit stops and schools. Such measures should be required as reasonably available control measures in all non-attainment areas.

About 40 percent of Americans own bicycles, and many of these people live one-quarter mile to two miles away from express transit stops. Few of these people now use transit to get to work, in part because of the lack of an inexpensive, convenient, safe, and fast transit access system suited to trips of this distance. In the Silicon Valley of California, 40% of those using bicycle lockers at rail stations leave bicycles in them overnight and use them to get from the station each morning to their nearby schools and employment, just as in the Netherlands.

Another means of reducing traffic is to implement neighborhood traffic calming to reduce motor vehicle speeds on many streets to improve safety for pedestrians, bicyclists, and motorists, and reduce emissions from car travel. Traffic calming has been shown by research to reduce idle times by 15%, gear changing by 12%, brake use by 14%, and gasoline use by 12%, injuries by 60%, fatilities by 53%, and air pollution by 10 to 50%. The majority of all urban and suburban streets and roads are already quite suitable for bicycling, with relatively low traffic speeds and low traffic volumes. However, such residential streets usually lead to bicycle-hostile major roads before reaching major activity centers and schools. Frequently, development of small missing links can make the difference between safe bicycle access and lack of access.

Experience shows that high levels of bicycle use only occur where the street system is bicycle-friendly. Where well-connected networks of bicycle friendly streets, bicycle paths, and bicycle lanes have been provided -- such as Davis, Palo Alto, and Santa Barbara, California, Madison, Wisconsin, and Gainesville, Florida -- bicycle mode shares of 10-25% are common. Where such networks are not available, only the hardiest of cyclists take to the roads for purposeful travel, leading to bicycle mode shares of 2% or less. (Michael Replogle, *Bicycle and Pedestrian Policies and Programs in Asia, Australia, and New Zealand*, U.S. Federal Highway Administration, Washington, DC 1993). Marketing, education, and promotion programs are also needed to encourage greater and safer use of bicycles for short utilitarian trips, including transit access, particularly in conjunction with initiatives that reduce the current barriers of theft, security, safety, and legitimacy which impede non-recreational bicycle use in America.

**Build Guarded Bike Parking at Major Transit Stops.** U.S. metro areas have invested in costly park-and-ride systems that have made transit increasingly dependent on the automobile. Other regions, especially in Europe but also in some U.S. communities, have been strengthening the potential for people to walk and bicycle to and from transit, boosting ridership at a far lower cost. In much of Europe, the fastest growing and often predominant access mode to suburban express transit services is the bicycle. Bike-and-ride services expand the potential market area of express public transportation at low cost without the very high air pollution emission and energy use rates per VMT, excessive space requirements, and high capital costs of automobile park-and-ride systems. While park-and-ride enables those living in lower density areas to travel from home-to-transit stop, bike-and-ride systems providing secure overnight bicycle parking can facilitate both access and egress to transit, enabling travelers to get from transit stops to nearby workplaces and schools which are otherwise unreachable by transit. Bicycle access can be invaluable in adapting transit to serve 21st century suburban development patterns.

In many U.S. communities, transit access planning looks only at automobile access. Yet many people don't use transit because they can't find affordable or available parking nearby when they want it. It costs $5,000-$20,000 to build a single additional parking space, and $750-3,000 a year to operate a park-and-ride space. Providing bike lockers, bike racks, and guarded bicycle parking at transit stops can free up car parking spaces for those who can't bike or who live too far to bike to transit, while offering a low cost healthy way for those 1/2 mile to 2 miles from the transit station or stop get to and from transit. Guarded bike parking at transit is a predominant part of transit access in European and Japanese suburbs, where it costs 1/10 to 1/100 as much as auto parking at transit to provide and operate. And secure overnight bike parking at transit allows people to get from transit to nearby schools and jobs that are beyond walking distance of the transit stop.

In 1996 the City of Long Beach implemented the nation's first attended bicycle parking facility, or "Bikestation." These facilities provide a range of clean transportation options--including secure, bicycle parking, bicycle repairs and accessory sales, changing and restrooms, and bicycle rentals. Bikestations have sinced opened in the communities of Palo Alto and Berkeley and are under development in San Francisco, Denver, Seattle, Santa Barbara, Los Angeles and Pittsburgh, Pennsylvania. (see www.bikestation.org)

**Congestion Mitigation Air Quality Funding: Vital For Clean Air.** All of the traffic reduction strategies discussed above are eligible for funding under the $8.1 billion 6-year Congestion Mitigation Air Quality Program (CMAQ) and under most other flexible TEA-21 programs. However, spending by state DOTs of CMAQ projects have gone disproportionately towards more traditional investments, such as buying conventional fuel transit vehicles and making conventional improvements to facilitate traffic flow. States have flexed little STP or NHS funding to the kinds of traffic reduction programs described above.

CMAQ was first established in the 1991 ISTEA law to assure that regions and states would have funds to help clean up pollution from transportation and to meet the conformity and planning requirements of the 1990 Clean Air Act. While funds could have been better spent in many cases on more innovative traffic reduction activities, the CMAQ program has proven its value and earned wide support.

Funding for CMAQ should be substantially expanded in TEA-21 reauthorization in recognition of the increased problem of air quality non-attainment. Traffic flow enhancement projects should have reduced eligibility for funding under CMAQ, as there are more than ample other sources of federal and state funds available for these types of projects. CMAQ should not be opened up to become a general operating assistance program for transit, but should focus on funding innovative air pollution reducing initiatives and a wide array of strategies and programs to reduce or managing travel demand, including incentives for smart growth; revision of local zoning, parking, and design codes; creation of accessory apartments near jobs and transit; freight and goods movement management strategy planning; traffic calming; and much better data collection and analysis to support and evaluate these initiatives before and after implementation.

State and local air quality agencies should be given authority to allocate CMAQ funds in consultation with transportation agencies to foster more cost-effective and innovative investments. More funding for public-private partnerships working to reduce traffic and pollution growth should be funded with CMAQ. Projects producing reductions in greenhouse gas emissions and air toxics should be recognized and funded. And CMAQ project approvals should be simplified to facilitate innovation and timely response, with a stronger emphasis on program evaluation to facilitate organizational learning. The obligation rate for CMAQ funds has been a major problem, with many state DOTs overspending other fund accounts and short-changing CMAQ eligible projects that could have delivered more timely progress on clean air. A significant portion of CMAQ funds should be sub-allocated to metropolitan areas and counties to assure a stronger local voice in project selection.

U.S. EPA has promulgated new health-standard based National Ambient Air Quality Standards (NAAQS) under the Clean Air Act in recognition that the old NAAQS were insufficiently protective of public health. The Supreme Court has upheld this new standard following an industry challenge, and new designations are now overdue. According to the latest available monitoring data from EPA, 123 million people live in the 333 counties violating the 8-hour ozone standard and 82 million live in 173 counties that violate the PM fine NAAQS. There is some overlap but it is reasonable to expect that the total population living in areas with unhealthy air will be approximately 150 to165 million. In 1999, nearly 54 million people live in areas that do not meet the 1-hour ozone standard. Currently only ozone non-attainment area population is recognized in TEA-21's CMAQ obligation formula.

It would be equitable to allocate CMAQ funds to help counties, cities, and states deal with fine particulates and air toxics in addition to ozone. Reauthorization apportionments should recognize the expanded scope of funding needs by proportionate expansion of CMAQ funding based on both population and the degree of pollution remediation needed. Otherwise existing non-attainment areas will suffer crippling cut-backs in funds for air pollution reduction programs even while being asked to take additional steps to further cut pollution to protect public health. An increase from the 54 million population in ozone non-attainment areas to 150 million in new non-attainment areas would imply far more than a doubling of funds is needed just to assure maintenance of effort in older non-attainment areas.

Some argue that CMAQ projects and TCMs are not cost-effective, but a recent TRB study concluded that it was not possible to undertake a credible scientific evaluation of the cost-effectiveness of the CMAQ program at the national level. Lack of data collection, deficiencies in regional travel analysis models, and the wide ranging nature and small scale of many CMAQ funded TCMs, which affect only a small segment of a large regional transportation system limits the ability of anyone to evaluate this program's cost-effectiveness.

The more answerable and important question to pose may be: What is the cost-effectiveness of overall regional transportation and growth plans vs. smart growth and transportation-choice-enhancing alternatives? This is a vital query that could be answered over the course of the next transportation reauthorization if Congress requires states and metropolitan areas to develop integrated transportation, environmental resource management, and growth management plans, with public involvement and consideration of alternatives.

## VIII. Accountability and Stewardship: Key to Clean Air and Sustainable Mobility

Public support for transportation funding will be sustained only if federal, state and local agencies improve transparency about how they spend money and can be held more accountable for the long-term effects of transportation projects, programs, and plans.

Some state DOTs are carrying through on the mandate of TEA-21 to integrate the Major Investment Study requirements into NEPA project reviews and the transportation planning process, despite the absence of DOT regulations, and by doing so are considering smart system management, pricing, partial build scenarios, and smart growth strategies as they consider major new investments. Some states are pursuing stewardship initiatives to change the culture of state DOTs and to foster closer planning and operational partnerships with state resource agencies and key stakeholders. Most states have improved interagency cooperation so that their transportation plans conform with their adopted air pollution control plans. To accomplish this, some regions, like Charlotte, NC, are adopting SIP TCM air pollution control strategies, such as new regional transit with supportive growth management to help offset future emission increases from highway transportation. Congress should encourage these best practices.

Other transportation agencies and road builders are trying to scapegoat environmental laws for their own administrative failures which are manifested in a lack of local consensus on proposed projects, insufficient state and local funding match dollars, and stalled reviews due to inadequate consideration of alternatives, inadequate mitigation and avoidance of adverse impacts, and efforts to end-run federal requirements. These interests want to expedite transportation project delivery by weakening Clean Air Act conformity requirements, setting deadlines for project reviews, diminishing consideration of alternatives and indirect impacts, limiting opportunities for stakeholders and resource agencies to influence decisions, and limiting judicial review. Congress should reject these proposals that would undermine core environmental protections, spur greater conflict, erode public support for transportation funding, and make it less likely that communities will consider and implement investments and policies that improve and support transit.

In reauthorizing TEA-21, Congress should require all state and metropolitan areas to develop and periodically update, with public involvement, integrated transportation, natural resource protection, and growth management plans that consider at least one alternative scenario that considerably reduces traffic growth and enhances environmental performance through better system management. Agencies should annually report on the current and projected performance of their transportation system management, investment, and proposed programs and plans, accounting for cumulative and secondary impacts on growth patterns, public health, greenhouse gas emissions, the achievement of natural resource planning goals for air, water, and habitat protection, and the provision of equal access to jobs and public facilities for all residents, including those without cars, without undue time and cost burdens.

The GAO recently noted, “Those MPOs in areas without air quality problems that anticipate rapid growth in the future might benefit the most from conducting emissions assessments and considering land use because their areas still have the opportunity to shape growth in ways that will also protect against future air quality degradation. However, because so few of them conduct assessments and are not required to do so, they may not realize these benefits."[9]

California's recently enacted AB 2140 law provides a model for this, (1) establishing a standardized set of basic transportation performance indicators related to safety, congestion, road repair needs and public transit that each region must begin to track; (2) establishing a standard method of financial reporting to help the public and local officials know what their money's being spent on; and (3) requiring an "alternative planning scenario" in the development of each region's 20 year transportation plan in order to provide a clear alternative to present growth patterns that could minimize future demand on transportation infrastructure while reducing congestion, protecting open space, and saving taxpayers money. Adopting a federal version of AB 2140 in TEA-3 would give the public and local elected officials expanded transportation investment choices including options to better support transit and manage both traffic and land development, supporting an environmentally-sound approach to expediting project delivery.

Proposals to weaken transportation conformity by having it apply less frequently to combined 5-year TIPs and RTPs threaten to put this accountability system into a deep freeze where it can be ignored except during periodic conformity crises that occur each time conformity analysis is performed. Rather than helping transportation agencies make accountability for air quality an ordinary part of doing business, less frequent conformity analysis requirements would allow much greater pressures to build in the system between analyses, causing more frequent failure of SIP control strategies and more frequent conformity lapse surprises. By demonstrating conformity of TIP amendments routinely, transportation agencies get early warning of problems with 'conformity lockdowns' that prevent new traffic and pollution inducing projects from being added to RTPs and TIPs until resolved. Most agencies are thus able to act in a timely manner to avoid conformity lapses, which more seriously limit them to advancing projects that already have funding agreements, exempt projects, and TCMs.

Proposals to weaken conformity by having it apply only to the first 10 years of the RTP or to the last horizon year in the SIP also threaten to cause a renewed widespread failure of SIP control strategies. This proposal would allow major projects, such as new outer beltways, to advance far into planning, development, and construction before accounting more fully for their profound long-term impacts on regional growth and traffic patterns, and related air pollution. Regional traffic models are already too insensitive to induced traffic and land use effects. This proposal would exacerbate this problem. Some state DOTs complain that they must make up for pollution growth from traffic in the out years of their 20 year transportation plans, without help from SIP control strategies after the attainment year. While SIPs are not required to adopt control strategies beyond the attainment year until the attainment year is reached and requirements for a 10 year maintenance plan are triggered, at least a half dozen states have adopted SIP control strategies that extend beyond or begin after the attainment year, to help transportation agencies deal with this problem.

For example, Denver was faced with a terrible PM problem in the 1980s. Agencies began taking action against wood burning. There was progress made during this period, but PM was still measuring 185 $\mu g/m^3$ compared to the NAAQS of 150 $\mu g/m^3$. Conformity made transportation

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[9] U.S.GAO-02-12, op. cite, page 45.

planning and air quality agencies look at other sources of PM. They started looking at street maintenance practices and implemented street sanding and sweeping strategies in the mid 1990s. Strategies have been implemented beyond what is legally required by the CAA. Within 2 years PM level dropped to 80 µg/$m^3$. Conformity really woke everyone up. Denver legally has enough measures in maintenance plan to meet health standards through 2015. Conformity provided additional incentive for developing light rail in Denver since it would help mitigate the PM problem. Conformity also led to the development of Metro Vision 2020 which recommends limiting growth to a 700 square mile area and is committed the region to transportation alternatives to support this goal. Denver also has a number of TDM strategies in their long range plan such as a RideArrangers program and a telework program. They do not take credit for TDM system management in the 2025 conformity finding, but they recognized the potential for reduction and retain them as a safety margin in meeting the emissions budget.

TCMs represent nearly 5 percent of total emission reductions in the San Joaquin region of California. The SJCOG Model projects that TCMs will deliver as much as 10 percent reduction in emissions by 2020. In San Joaquin County rideshare, vanpool, and commuter rail provide significant emissions reductions, with a large percentage of San Joaquin County residents facing long distance commutes into the San Francisco Bay Area.

Charlotte, North Carolina’s struggle with conformity in the out years of its RTP has helped it to recognize the importance of making careful land use and transit decision to avoid losing jobs and housing to areas outside the center city, and becoming overburdened by congestion, problems that other cities are currently facing. The 2025 Transit Land/Use plan for Charlotte-Mecklenburg proposes a rapid transit system to support the five major transportation and development corridors identified in the 1994 Centers and Corridors Plan as well as connections to key development hubs between these corridors. The plan includes proposals to:

- Concentrate jobs around stations
- Provide residential multi-family housing at stations
- Develop rail technology
- Establish Bus Rapid Transit

Capital costs, plus operation, maintenance and other expenditures will cost $1.085 billion over 25 years and quantifiable benefits such as travel time savings and vehicle operating cost savings total $72 million a year, generating a benefit cost ratio of 1.6. There are also numerous benefits of the plan that are not quantifiable such as improved access to jobs and revitalization of the core center. Funding for the plan will come from a combination of local, state, and federal funding. Mecklenburg County Voters approved a half cent local sales tax in 1998 to fund expansion of bus service and rapid transit improvements in major corridors. The requirement that the RTP conform 20 years into the future was a vital element in motivating this regional progress and action. Limiting conformity determinations to a 10-year time horizon might reduce the incentive for other regions to take the kind of leadership initiatives seen in Charlotte.

States and local governments have the opportunity to use their SIP process to establish caps on pollution from the transportation sector that will make conformity a meaningful performance objective for progress in attaining more healthful air quality by reducing traffic growth. If they choose, by law they may increase technology-based emission controls on transportation vehicles and fuels and non-transportation sources to allow extra room for growth in motor vehicle use while still meeting deadlines for timely attainment of healthful air quality. If states relax emission controls or allow increased emissions from power plants, new energy development, airport expansions, or other activities, states may need to further curb motor vehicle emissions to offset these other sources of pollution and protect public health.

Conformity will help assure progress towards timely attainment of newly revised National Ambient Air Quality Standards (NAAQS). Proposed and potential emission controls on diesel engines and fuels and off-road mobile emissions will create considerable new room for growth in motor vehicle use within conforming one-hour ozone transportation plans until new 8-hour ozone SIPs are put in place unless the on-road SIP motor vehicle emission budgets are reduced to assure more timely attainment of healthful air quality. Many transportation agencies will seek to use such near-term emission controls to make irretrievable commitments to sprawl-inducing outer beltways and other traffic and pollution generating investments in advance of the setting of new more stringent motor vehicle emission budgets that are part of attainment demonstrations to the new NAAQS. If this occurs, the public, utilities, and industry alike will face higher costs and greater delay to attain healthful air quality.

Congress should resist pressure from the road builders to weaken or rework conformity before it has had opportunity to operate under the framework of adopted emission budgets demonstrating attainment, which have only taken effect during the last year in most seriously polluted regions. Conformity is working. We need to strengthen its accountability to help reinforce the trend that is evident in some states for stronger environmental stewardship by transportation agencies.

The concerns I raise today are shared by hundreds of thousands of members of diverse environmental and public health groups, represented by the two letters, Attachments 9 and 10, enclosed for the record.

**Attachment 1:**

U.S. Department of Transportation
Federal Highway Administration

FHWA Home | Feedback

# Addendum to the
# 1997 Federal Highway
# Cost Allocation Study
# Final Report
U.S. Department of Transportation
Federal Highway Administration
May 2000

## Introduction

When the 1997 Federal Highway Cost Allocation Study (HCAS) was sent to Congress in August 1997, estimates of air pollution-related costs of highway use were not included. Research by the Environmental Protection Agency (EPA) on social costs associated with air pollution was being completed and the Department of Transportation wanted estimates of air pollution costs attributable to highway use by motor vehicles to reflect the new EPA research. This addendum to the 1997 Federal HCAS presents estimates of air pollution-related costs of highway use and summarizes how these costs relate to other costs analyzed in the 1997 Federal HCAS. In this addendum, as in the 1997 HCAS report, costs of air pollution, congestion, and other impacts of highway use not borne by transportation agencies represent social and economic costs incurred by affected individuals, not engineering costs to comply with standards or to mitigate adverse impacts as the term "costs" is often used in the environmental literature.

Two changes relevant for highway cost allocation have occurred since the 1997 Federal HCAS was submitted to Congress. First, proceeds of 4.3 cents per gallon of motor fuel tax that had been dedicated for deficit reduction by the Omnibus Budget Reconciliation Act of 1993 (P.L. 103-66) were directed to the Federal Highway Trust Fund beginning October 1, 1997 by the Taxpayer Relief Act of 1997 (P.L. 105-34). This not only increased total highway user revenues available for highway and related improvements, but it also changed the relative shares of Federal user fees paid by different vehicle classes. Ratios of user fee payments to highway cost responsibility for different vehicles (so-called equity ratios) were affected by this change.

The second change was passage of the Transportation Equity Act for the 21st Century (TEA-21) (P.L. 105-178). While this watershed legislation builds upon initiatives established in the Intermodal Surface Transportation Assistance Act of 1991 (ISTEA) (P.L. 102-240), it significantly increases overall surface transportation funding levels and has new initiatives to meet challenges of improving safety, enhancing the natural and human environment, and advancing America's economic growth and competitiveness. Changes in authorization levels for different program areas have affected the relative cost responsibility of different vehicle classes and ratios of user fee payments to cost responsibility for different vehicles. These changes are analyzed in this report.

For ease of comparison, this report is organized similarly to the Summary Report of the 1997 Federal HCAS. The analysis year continues to be 2000, and the same vehicle classes, vehicle miles of travel, and other vehicle characteristics are used. This not only facilitates comparison with the earlier report, but is essential if results are to be directly useful for the Department's

Comprehensive Truck Size and Weight (TS&W) Study which uses travel characteristics developed for the 1997 Federal HCAS in its base case.

# Summary of Findings

Total social costs of air pollution associated with motor vehicle use are estimated to range from $30 billion to $349 billion per year.(1) Most of those costs are associated with premature death and illness caused by particulate matter, including both direct particulate emissions and the secondary formation of particulates from other emissions. The wide range of air pollution cost estimates is indicative of the many uncertainties surrounding costs of motor-vehicle-related air pollution.

The 1997 HCAS discussed four main costs of highway use not borne directly by transportation agencies -- crash costs, air pollution, congestion, and noise. Based on mid-range estimates, crash costs are the largest of those costs, accounting for about 75 percent of total costs for those four impacts. Congestion costs represent the next highest cost (14%), followed by air pollution (9%) and finally noise (1%). Most crash and congestion costs are borne directly by motorists, but impacts of air pollution and noise are not directly tied to an individual's use of the highway.

As noted above, the Omnibus Budget Reconciliation Act of 1993 imposed a 4.3 cents per gallon tax on transportation fuels to be used for deficit reduction. Proceeds of this tax were not considered to be highway user fees - they were deposited in the General Fund rather than the Highway Trust Fund, and were not available to finance highway, transit, or other transportation improvements. Since proceeds of the 4.3 cents per gallon deficit reduction tax were not highway user fees, they were not included in the 1997 Federal Highway Cost Allocation Study.

The Taxpayer Relief Act of 1997 directed that proceeds of the 4.3 cents per gallon tax on highway motor fuels that had been dedicated for deficit reduction should be deposited in the Highway Trust Fund beginning October 1, 1997 and be available for transportation purposes. This made the 4.3 cents per gallon tax a highway user fee which should be included with other fuel tax revenues in highway cost allocation. The change affects the relative equity of the Federal highway user fee structure. The share of total Federal highway user revenues paid by heavy trucks declines, thereby reducing the share of highway cost responsibility that heavy trucks pay through user fees.

In the 1997 HCAS combination trucks were found, on average, to pay 90 percent of their Federal highway cost responsibility through user fees, but with changes in the fuel tax they now pay only 80 percent of their cost responsibility. The heaviest combinations, those over 80,000 pounds, pay only half of their cost responsibility.

Programmatic changes enacted in the recent TEA-21 are anticipated to have virtually no effect on user fee equity.

The Department plans to update the 1997 HCAS before the next surface transportation reauthorization. Potential options to improve overall user fee equity will be examined in greater depth in that study.

# Vehicle Travel Characteristics and Population by Different Vehicle Classes

Table 1 shows total 2000 vehicle miles of travel (VMT) by different groups of vehicles. Travel for single unit and combination truck classes is broken down by registered weight groups. Passenger vehicles account for about 93 percent of total VMT in the United States. Single unit trucks and combination trucks account for 3 and 4 percent of total travel, respectively. Over two-thirds of single unit truck travel is by vehicles registered below 25,000 pounds while among combination vehicles, 75 percent of travel is by vehicles registered between 75,000 and 80,000 pounds.

**Table 1. Total 2000 Travel and Number of Vehicles by Class and Registered Weights**

| **Vehicle Class/Registered Weight** | **Vehicle Miles of Travel (millions)** | | **Number of Vehicles** | |
|---|---|---|---|---|
| **Passenger Vehicles** | **Total** | **Percent** | **Total** | **Percent** |
| Autos | 1,818,461 | 67.5% | 167,697,897 | 70.0% |
| Pickups/Vans | 669,198 | 24.8% | 63,259,330 | 26.4% |
| Buses | 7,397 | 0.2% | 754,509 | 0.3% |
| Total | 2,495,056 | 92.6% | 231,711,736 | 96.7% |
| **Single Unit Trucks** | | | | |
| >25,000 pounds | 56,451 | 2.1% | 4,126,241 | 1.7% |
| 25,001 - 50,000 pounds | 18,631 | 0.7% | 1,352,441 | 0.6% |
| <50,000 pounds | 8,018 | 0.3% | 491,745 | 0.2% |
| Total | 83,100 | 3.1% | 5,970,431 | 2.5% |
| **Combination Trucks** | | | | |
| >50,000 pounds | 6,744 | 0.3% | 253,022 | 0.1% |
| 50,001 - 70,000 pounds | 16,685 | 0.4% | 225,347 | 0.1% |
| 70,001 - 75,000 pounds | 5,926 | 0.2% | 94,509 | 0.0% |
| 75,001 - 80,000 pounds | 86,176 | 3.2% | 1,295,973 | 0.5% |
| 80,001 - 100,000 pounds | 3,879 | 0.1% | 64,365 | 0.0% |
| <100,001 pounds | 2,279 | 0.1% | 37,788 | 0.0% |
| Total | 115,689 | 4.3% | 1,971,004 | 0.8% |

In Chapter II of the main 1997 HCAS report, VMT, operating weight, and registered weight distributions for 20 different vehicle classes were presented. Vehicle classes include automobiles, pickups and vans, buses, three types of single unit trucks, six types of single trailer combinations, three types of truck-trailer combinations, four types of twin-trailer combinations, and a triple trailer combination. Truck travel and operating weight distributions on each of 12 highway functional classes are also estimated for each vehicle configuration. Data needs of the Department's Comprehensive TS&W Study were important considerations in selecting configurations to be included in the 1997 Federal HCAS.

Figure 1 shows VMT for different vehicle classes in rural and urban areas. Almost two-thirds of total automobile travel is in urban areas, a much higher percentage than for other vehicle classes. Over half of the annual travel by pickups, vans, buses, and single unit trucks is in urban areas, but only 40 percent of combination truck travel is in urban areas.

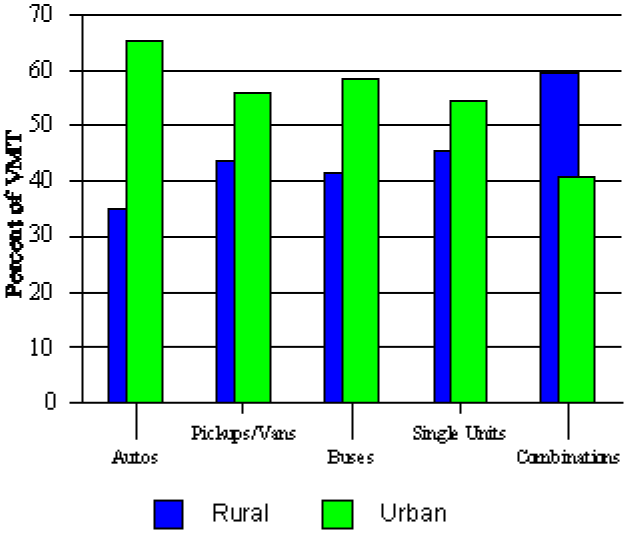

Figure 1. Distribution of VMT in Rural and Urban Areas

# Federal-aid Highway Program Costs

The distribution of Federal obligations by improvement type and highway functional class has a strong influence on the relative cost responsibility of different vehicle classes. Estimates of the 2000 distribution of Highway Trust Fund (HTF) obligations by improvement type in the 1997 HCAS were based on the actual distribution of obligations during the 1993 to 1995 base period. For analysis purposes total 2000 obligations were assumed to equal total revenues to the HTF in Calendar Year 2000 which were estimated to be $27,174 million including $3,380 million for the Mass Transit Account (MTA) of the HTF.

As noted above two laws passed since the 1997 HCAS have affected the level and distribution of Federal obligations for highway-related purposes. First, the Taxpayer Relief Act of 1997 transferred proceeds of 4.3 cents per gallon of Federal motor fuel taxes that had been dedicated for deficit reduction to the HTF, thereby increasing overall funds available for highway-related purposes. Second, TEA-21 reauthorized surface transportation programs for six years, raising most program levels with some changes in the distribution of funds among the various programs. TEA-21 also guarantees that highway and transit program funding will be aligned with actual and projected HTF receipts. The most recent estimate of calendar year 2000 HTF receipts, including proceeds of the 4.3 cents per gallon that previously had been dedicated for deficit reduction, is $33,233 million.

Table 2 compares the relative authorizations for major program areas under TEA-21 with those under ISTEA. In most cases the distribution of funds is quite similar. One notable exception is the elimination of a separate Interstate Construction program in TEA-21. All remaining work to complete the Interstate System was fully funded under prior legislation. Certain improvements to the Interstate System are eligible under the Interstate Maintenance program and Interstate System lane additions are eligible from National Highway System funds.

**Table 2. Comparison of TEA-21 and Major**

**ISTEA Program Authorizations**

| Program Area | TEA-21 | ISTEA |
|---|---|---|
| Interstate Maintenance | 13.8% | 13.8% |
| Interstate Construction | 0 | 5.9 |
| National Highway System | 16.5 | 17.1 |
| Bridge | 11.8 | 13.1 |
| Surface Transportation Program | 19.2 | 19.4 |
| Congestion Mitigation and Air Quality | 4.7 | 4.9 |
| Minimum Allocation | 13.7 | 9.3 |
| Other | 20.3 | 16.5 |
| Total | 100% | 100% |

Translating changes in authorization levels for different programs into changes in the distribution of obligations by improvement type and highway functional class is difficult. TEA-21, like ISTEA, provides States considerable flexibility to shift funds among program categories. In this analysis, the distribution of funds by improvement type for each program area in 2000 is assumed to be the same as the distribution for that program area in 1997.

Table 3 compares 2000 Federal obligations by improvement type estimated for the 1997 HCAS with revised estimates based on the TEA-21 program composition. Assuming that funds from each program area are spent in the same manner as they were in 1997, the TEA-21 program composition would be expected to have slightly more capacity expansion, and slightly less system preservation than was estimated for the 1997 HCAS based on the overall 1993-1995 distribution of obligations by improvement type.

**Table 3. 2000 Distribution of Federal Highway Program Costs**

**Estimated in 1997 HCAS and Under TEA-21 ($ Millions)**

| Category | Improvement Type | 1997 HCAS | | TEA-21 | |
|---|---|---|---|---|---|
| | | **Amount** | **Percent** | **Amount** | **Percent** |
| New Capacity | New Construction | $2,941 | 10.8% | $2,879 | 8.7% |
| | Reconstruction - Added Lanes | $937 | 3.4% | $2,864 | 8.6% |
| | Major Widening | $1,836 | 6.8% | $2,007 | 6.0% |
| | **Total** | $5,713 | 21.0% | $7,750 | 23.3% |
| System Preservation | 3R Preservation | $7,250 | 26.7% | $7,934 | 23.9% |
| | Minor Widening | $484 | 1.8% | $651 | 2.0% |
| | Bridge Replacement | $2,114 | 7.8% | $2,480 | 7.5% |
| | Major Bridge Rehabilitation | $1,198 | 4.4% | $1,110 | 3.3% |
| | Minor Bridge Rehabilitation | $445 | 1.6% | $643 | 1.9% |
| | **Total** | $11,490 | 42.3% | $12,819 | 38.6% |
| System Enhancement | Safety/TSM | $2,542 | 9.4% | $3,112 | 9.4% |
| | Environmentally-Related | $530 | 2.0% | $1,064 | 3.2% |

|  |  |  |  |  |  |
|---|---|---|---|---|---|
|  | Other Projects | $1,113 | 4.1% | $590 | 1.8% |
|  | **Total** | $4,184 | 15.4% | $4,766 | 14.3% |
| MTA |  | $3,380 | 12.4% | $4,597 | 13.8% |
| Other |  | $2,407 | 8.9% | $3,302 | 9.9% |
| **Total** |  | $27,175 | 100.0% | $33,233 | 100.0% |

Again, for analysis purposes, the distribution of obligations by highway functional class is assumed to be the same in 2000 as in the 1993-1995 base period. Two-thirds of Federal obligations are on urban highways and one-third on rural highways. In both urban and rural areas more Federal monies are obligated for improvements on higher order highway systems (Interstate and other principal arterial highways) than on lower order systems.

The distribution of program expenditures by highway type can significantly influence the relative cost responsibilities of different vehicle classes. The distribution of travel on different types of highways varies substantially by vehicle class, and other physical and operational characteristics of highways that can affect cost responsibility also vary by highway type.

# Allocation of 2000 Federal Highway Program Costs

In this analysis, procedures for allocating various highway improvement costs among vehicle classes are the same as used in the 1997 HCAS. Table 4 summarizes the cost responsibility of different vehicles for anticipated obligations under the TEA-21 program structure, assuming that funds for each program element under TEA-21 are obligated in the same way they were obligated under ISTEA.

| **Table 4. 2000 Federal Cost Responsibility by Vehicle Class Under TEA-21 Program Structure ($ Millions)** |  |  |  |
|---|---|---|---|
| Vehicle Class/ Registered Weight | **Total Program Costs** | **Cents per Mile** | **Shares of Total** |
| Autos | $14,501 | 0.80 | 43.6% |
| Pickups/Vans | $5,103 | 0.76 | 15.4% |
| Buses | $237 | 3.20 | 0.7% |
| All Passenger Vehicles | $19,841 | 0.80 | 59.7% |
| Single Unit Trucks |  |  |  |
| ≤25,000 pounds | $1,245 | 2.20 | 3.7% |
| 25,001 - 50,000 pounds | $1,049 | 5.46 | 3.2% |
| >50,000 pounds | $1,344 | 18.12 | 4.0% |
| All Single Units | $3,638 | 4.38 | 10.9% |
| Combination Trucks |  |  |  |
| ≤50,000 pounds | $231 | 3.43 | 0.7% |
| 50,001 - 70,000 pounds | $557 | 5.21 | 1.7% |
| 70,001 - 75,000 pounds | $452 | 7.62 | 1.4% |
| 75,001 - 80,000 pounds | $7,458 | 8.65 | 22.4% |
| 80,001 - 100,000 pounds | $594 | 15.32 | 1.8% |
| >100,001 pounds | $462 | 20.28 | 1.4% |
| All Combinations | $9,754 | 8.43 | 29.4% |
| All Trucks | $13,392 | 6.74 | 40.3% |
| All Revenues | $33,233 | 1.23 | 100.0% |

Figure 2 compares shares of cost responsibility under the TEA-21 program structure with cost responsibility estimated in the 1997 HCAS based upon the distribution of program costs during the 1994-1995 period. The small differences in program structure between TEA-21 and ISTEA are not large enough to substantially affect the relative cost responsibilities of different vehicle classes. Passenger vehicles have a slightly higher share of cost responsibility under TEA-21 while combinations have a slightly lower share.

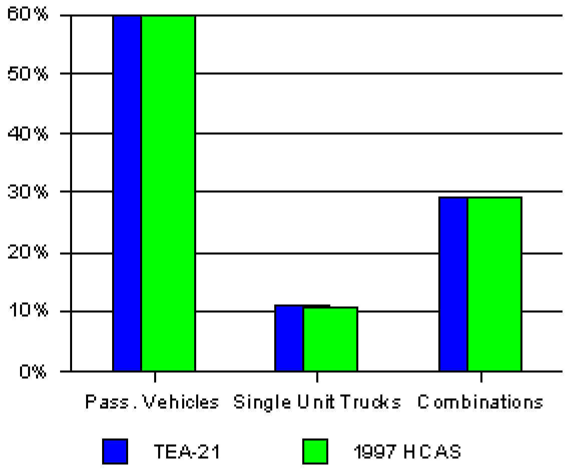

Figure 2. Shares of Highway Cost Responsibility Under TEA-21 Program Structure Compared to 1997 HCAS Shares

Source: FHWA Estimate

# Highway User Fee Payments

Highway user charges are fees upon owners and operators of motor vehicles for their use of public highways.

Historically, the primary purpose for imposing highway user fees at both the Federal and State levels has been to raise revenues to finance highway improvement programs. This direct relationship between highway user fees and highway program funding is highlighted by the fact that the Federal Government and many States deposit large parts of their highway user fees in dedicated highway or transportation trust funds rather than in the general fund. The linkage between highway user fees and highway program financing is central to HCASs which seek to determine whether fees paid by each vehicle class cover costs occasioned by those vehicles.

Current Federal highway user fees and rates are shown in Table 5. Federal highway user taxes include taxes on various highway fuels, an excise tax on the sale of heavy trucks, a tax on tires weighing over 40 pounds, and a heavy vehicle use tax (HVUT) on trucks with registered weights over 55,000 pounds. Each of these taxes has been in place for many years, although rates and the specific equipment that is taxed have changed from time to time.

Table 5. Current Federal Highway User Tax Rates

| Current Tax | Tax Rate Under Current Law |
|---|---|
| **Fuel** | |
| Gasoline | 18.3 cents per gallon [1] |
| Diesel | 24.3 cents per gallon [1] |

| | |
|---|---|
| Alternative Fuels | 0 - 18.3 cents per gallon [1] |
| **Vehicle Excise Tax** | |
| Heavy Trucks >33,000 pounds, trailers >26,000pounds GVW | 12 percent of retail sales for new vehicles (trucks, tractors, or trailers) |
| **Tire Tax** | |
| 41 to 70 pounds | 15 cents per pound over 40 pounds |
| 71 to 90 pounds | $4.50 plus 30 cents per pound over<br>70 pounds |
| Over 90 pounds | $10.50 plus 50 cents per pound over<br>90 pounds |
| **HVUT** | |
| Annual tax on vehicles<br>55,000 pounds gross weight or more | $100 plus $22 per 1,000 pounds over 55,000 with an annual cap of $550 |

[1] excludes 0.1 ¢ per gallon to Leaking Underground Storage Tank Fund

# Federal User Fee Payments by Vehicle Class

When the 1997 HCAS was conducted, 4.3 cents per gallon of Federal fuel tax was dedicated for deficit reduction and was not considered a highway user fee. Proceeds of the 4.3 cents per gallon are now deposited in the HTF to be used for purposes eligible under TEA-21, and are now considered highway user fees. This change affects the relative shares of highway user fees paid by different vehicle classes. Table 6 shows Federal highway user revenues (HURs) projected to be paid by different vehicle classes in 2000 under the current user fee structure. Passenger vehicles, which account for 93 percent of total highway travel, pay 68 percent of total Federal highway user fees. Combination trucks, on the other hand, pay 23 percent of total highway user fees even though they travel less than 5 percent of total mileage. Among the truck classes, user fees vary substantially by vehicle weight. Single unit trucks registered at 50,000 pounds or more pay 2.2 times as much per mile in Federal user fees as single unit trucks registered at 25,000 pounds or less. User fees paid by combination trucks do not vary as much with weight as for single unit trucks, but the variation is still substantial.

**Table 6. 2000 Federal User Fee Payments by Vehicle Class Under the Current Federal User Charge Structure ($ Millions)**

| Vehicle Class/ Registered Weight | **Total User Fee Payments** | **Cents per Mile** | **Shares of Total** |
|---|---|---|---|
| Autos | $14,819 | 0.81 | 44.6% |
| Pickups/Vans | $7,416 | 1.11 | 22.3% |
| Buses | $50 | 0.67 | 0.1% |
| All Passenger Vehicles | $22,285 | 0.89 | 67.1% |
| Single Unit Trucks | | | |
| <25,000 pounds | $1,853 | 3.28 | 5.6% |
| 25,001 - 50,000 pounds | $746 | 3.88 | 2.2% |
| >50,000 pounds | $543 | 7.32 | 1.6% |
| All Single Units | $3,142 | 3.78 | 9.5% |
| Combination Trucks | | | |
| <50,000 pounds | $332 | 4.92 | 1.0% |
| 50,001 - 70,000 pounds | $561 | 5.25 | 1.6% |

|  |  |  |  |
|---|---|---|---|
| 70,001 - 75,000 pounds | $402 | 6.78 | 1.2% |
| 75,001 - 80,000 pounds | $6,006 | 6.97 | 18.1% |
| 80,001 - 100,000 pounds | $300 | 7.74 | 0.9% |
| >100,001 pounds | $205 | 9.01 | 0.6% |
| All Combinations | $7,806 | 6.75 | 23.5% |
| All Trucks | $10,948 | 5.51 | 32.9% |
| All Revenues | $33,233 | 1.23 | 100.0% |

Figure 3 summarizes the average Federal user fees paid per mile of travel by different vehicle classes.

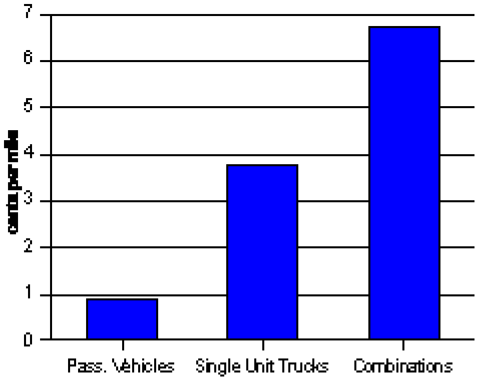

Figure 3.

Figure 4 compares shares of Federal highway user fees paid by passenger vehicles, single unit trucks, and combination trucks under the current user fee structure with shares estimated in the 1997 HCAS when proceeds of the 4.3 cents per gallon were dedicated for deficit reduction and not considered highway user fees. The share of Federal user fees estimated to be contributed by passenger vehicles in 2000 has increased by almost 4 percentage points while the share of total user fees paid by combination vehicles decreased by almost the same amount. This difference arises because combination vehicles also pay other Federal user charges that have not changed since 1997 except for a minor technical change in the taxation of tires on new vehicles. The higher fuel taxes thus have a relatively smaller effect on total user fees paid by combination vehicles than they have on total fees paid by passenger vehicles.

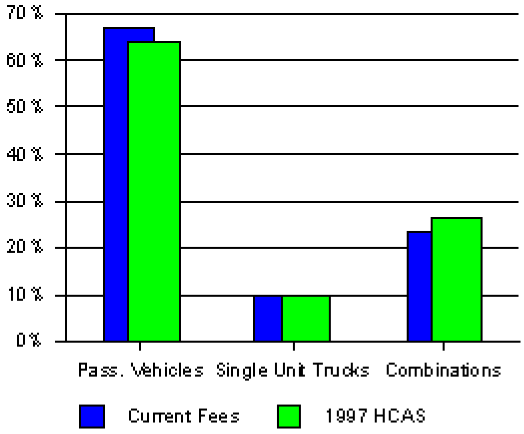

Figure 4. Shares of User fees for Different Vehicle Classes
Under Current and 1997 User Fee Structures

Source: FHWA Estimates

# 2000 Federal Highway User Fee Equity Ratios

The equity of highway user charges typically is measured in HCASs as the ratio of the shares of revenues contributed by each vehicle class to the shares of highway costs that vehicle class occasions. This ratio is often called a revenue/cost ratio or an "equity ratio." As discussed in the 1997 HCAS, highway agency costs are different from the economic costs associated with the operation of different vehicle classes. Analyses of economic costs occasioned by each vehicle class, which include environmental, safety, and delay costs imposed on others as well as pavement, bridge, and other infrastructure costs, are important in considering the economic efficiency of highway user fees. However, HCASs traditionally have focused primarily on the equity of highway user fees as measured by the extent to which each vehicle class pays the share of highway agency costs for which it is responsible. Agency costs considered in HCASs do not reflect what transportation agencies should spend in various areas, but are estimates of how obligations actually are being distributed. The Department's Surface Transportation Conditions and Performance report provides overall estimates of investment requirements to meet system performance and condition objectives, although it does not suggest how much of those costs should be borne by Federal, State, and local transportation agencies.

Table 7 shows estimated Federal equity ratios in 2000 under the current highway user charge structure and the TEA-21 program structure. Equity ratios estimated in the 1997 HCAS are shown for comparison. As a class, automobiles continue to pay about the same share of Federal highway user fees as their share of highway costs, and pickups and vans continue to pay substantially more than their share of highway costs. Differences in equity ratios between automobiles and other passenger vehicles are primarily attributable to the automobiles' better fuel economy (higher miles per gallon) which means they pay less fuel tax per mile of travel than pickups and vans.

**Table 7. Ratios of 2000 Federal User Charges to Allocated Costs by Vehicle Class**

| Vehicle Class/Registered Weight | 1997 HCAS Ratios | Updated Ratios |
|---|---|---|
| Autos | 1.0 | 1.0 |
| Pickups/Vans | 1.4 | 1.5 |
| Buses | 0.1 | 0.2 |
| Passenger Vehicles | 1.1 | 1.1 |
| Single Unit Trucks | | |
| ≤25,000 pounds | 1.5 | 1.5 |
| 25,001 - 50,000 pounds | 0.7 | 0.7 |
| > 50,001 pounds | 0.5 | 0.4 |
| Total Single Unit | 0.9 | 0.9 |
| Combination Trucks | | |
| ≤50,000 pounds | 1.6 | 1.4 |
| 50,001 - 70,000 pounds | 1.1 | 1.0 |
| 70,001 - 75,000 pounds | 1.0 | 0.9 |
| 75,001 - 80,000 pounds | 0.9 | 0.8 |
| 80,001 - 100,000 pounds | 0.6 | 0.5 |

| | | |
|---|---|---|
| >100,001 pounds | 0.5 | 0.4 |
| Total Combinations | 0.9 | 0.8 |
| Total All Vehicles | 1.0 | 1.0 |

User fee equity for single unit and combination trucks is highly dependent on the weight of the vehicles. As a class single units continue to pay about 90 percent of their Federal highway cost responsibility under the new user fee and TEA-21 program structure. In the 1997 HCAS combination trucks as a group were estimated to pay 90 percent of their highway cost responsibility in 2000, but under the new user fee and program structure, combinations will pay only about 80 percent of their cost responsibility. This reduction in the equity ratio for combination trucks primarily arises because combination trucks will pay a smaller share of Federal user fees under the new user fee structure than they did under the former fee structure while their share of cost responsibility remains virtually the same. For both single unit and combination trucks, there continue to be large differences in equity ratios for vehicles in different weight groups.

# Other Highway-Related Costs

The 1997 HCAS included extensive discussions of highway-related costs that are not borne by transportation agencies, but by motorists or society at large. These costs include environmental, safety, congestion, and other costs associated with highway use. While transportation agencies do not bear these costs directly, their concern about such costs is evidenced by a broad range of regulatory and programmatic initiatives to reduce crashes, emissions, and other consequences of highway use that create costs for society. Significant progress has been made in reducing many of these social costs of highway use, but substantial costs remain. As discussed in the 1997 HCAS, crashes, congestion, air pollution, and noise are generally acknowledged to be the most significant social costs that can be quantified.

As noted in the Introduction to this Addendum, the 1997 HCAS did not include estimates of air pollution costs. Work on a major EPA study on Benefits and Costs of the Clean Air Act was still underway which was relevant to estimates of air pollution costs associated with motor vehicle use. The Department postponed estimating highway-related air pollution costs until that work was completed and the same methods could be used for the Department's highway cost allocation study.

One point emphasized in the 1997 HCAS is the uncertainty surrounding estimates of most social costs of highway use. Differences between high and low cost estimates may vary by one or more orders of magnitude. Many factors contribute to this uncertainty including (1) the difficulty in isolating effects of highway-related factors from other factors that contribute to health and other social costs; (2) the site-specific nature of many social costs of highways; and (3) uncertainties in valuing costs of premature deaths attributable to highway crashes and motor vehicle emissions.

# Highway-Related Air Pollution Costs

Motor vehicles produce emissions that in sufficient pollutant concentrations can cause a variety of health and other impacts including shortness of breath, respiratory and other disease, death, structural deterioration, crop damage, and decreased visibility. Since 1970, the Federal Clean Air Act (CAA) and 1977 and 1990 Clean Air Act Amendments (CAAA) have provided a framework for nationwide efforts to reduce motor vehicle and other sources of air pollution. Important provisions of those laws include establishment of National Ambient Air Quality Standards for key pollutants, requirements that States develop implementation plans for attaining those standards, and limits on allowable motor vehicle tailpipe emissions. The ISTEA and TEA-21 complement the CAA by providing funding to implement balanced transportation programs that will reduce emissions.

In 1997, EPA developed a report, The Benefits and Costs of the Clean Air Act, 1970-1990. This report reflects EPA's findings and not necessarily those of other agencies in the Administration. Other agency's concerns included, among other things, the methods used to estimate the number of premature deaths and illnesses avoided due to the CAA, and the methods used to value non-health related benefits. Part of these concerns arise from the no-control baseline EPA uses to estimate reductions that have been achieved in emissions since passage of the CAA. Mindful of other agencies concerns, this Addendum uses EPA's estimates as an illustrative bounding case example of the impact of motor vehicle emissions.

Table 8, based on data in EPA's 1998 report, shows the estimated contribution of on-highway motor vehicles to total emissions for key air pollutants in 1990. The EPA estimates that in 1990 motor vehicles accounted for only 2 percent of total sulfur dioxide emissions and 11 percent of total suspended particulate emissions. Conversely, motor vehicles accounted for 70 percent of total carbon monoxide and 2/3 of lead emissions.

**Table 8. Major Highway-Related Air Pollutants**

| Pollutant | Percent of Total 1990 Emissions from Highway Motor Vehicles |
|---|---|
| Total Suspended Particulates | 11.1% |
| Sulfur Dioxide | 2.4% |
| Nitrous Oxides | 36.0% |
| Volatile Organic Compounds | 37.1% |
| Carbon Monoxide | 70.4% |
| Lead | 66.7% |

Despite the progress that has been made to date in reducing harmful motor vehicle emissions, air pollution remains a concern in many parts of the country. In its report, The Benefits and Costs of the Clean Air Act, 1970 - 1990, EPA estimates the economic benefits of air pollution reductions achieved under the CAA. Methods used by EPA in its 1998 study are the primary bases of air pollution cost estimates in this report. As noted in the Introduction, costs of air pollution estimated in this Addendum are social and economic costs of air pollution, not the engineering costs to comply with standards or to mitigate adverse impacts as the term "costs" is often used in the environmental literature.

Table 9 shows estimates of economic costs associated with highway-related air pollution based upon data and methods used by EPA in its study. Almost all costs are attributable to mortality, chronic bronchitis, and other respiratory and heart diseases caused by inhalation of particulate matter, but some costs also arise from ozone, sulfur dioxide, nitrogen dioxide, and carbon monoxide. Other effects of air pollution including infant mortality, changes in pulmonary function, lung inflammation, and reduced crop yields are known to arise from air pollution but are not included in these costs because researchers have not yet quantified those effects. Future research should allow a more complete accounting of air pollution costs arising from motor vehicles and other sources.

**Table 9. Estimated Economic Costs of Motor Vehicle-Related Air Pollution in 2000** [1]

| Pollutant | Impact | Costs of Rural Motor Vehicle Travel<br>$1990 (millions) | Costs of Urban Motor Vehicle Travel<br>$1990 (millions) | Costs of All Motor Vehicle Travel<br>$1990 (millions) |
|---|---|---|---|---|

| | | | | |
|---|---|---|---|---|
| Particulate Matter | Mortality[2] | 12,695 | 21,558 | 31,162 |
| Particulate Matter | Non-fatal Illness | 3,683 | 6,232 | 9,183 |
| Sulfur dioxide, nitrogen dioxide, carbon monoxide | Non-fatal Illness | 0 | 51 | 51 |
| Ozone | Non-fatal Illness | 28 | 16 | 47 [3] |
| Total | | 16,406 | 27,857 | 40,443 [4] |

[1] Costs for "criteria" pollutants only (does not include toxic pollutant costs). Excludes certain health-related costs and costs of reduced visibility, crop damage, and material damage not quantified by EPA.

[2] Mortality costs based on DOT's $2.7 million estimated cost of a premature death.

[3] Does not include ozone mortality costs, which are highly uncertain.

[4] Comparable estimate using EPA's value of life is $64,681.

Source: Abt Associates, 1998, pages 9-11.

Even costs quantified in Table 9 are highly uncertain due to data and methodological limitations and should be viewed as indicative only of the order of magnitude of costs. Chemical processes that transform emissions into ozone, particulate matter, and other pollutants are very complex, as is the transport of pollutants from their source to where they ultimately affect human health. Sources of some pollutant types are not well understood, nor are some aspects of the health impacts due to motor vehicle emissions. Scientific data on relationships between air pollution and premature death also are weak in many cases. This Addendum does not fully discuss these limitations and uncertainties. Technical reports by Systems Applications International(2) and Abt Associates,(3) from which air pollution cost estimates shown in Table 9 and subsequent tables are derived, discuss many of those factors and indicate areas where further research is needed. They also discuss the various empirical studies that have attempted to estimate economic costs for different pollutants and issues involved in extrapolating results of those case-specific studies to nationwide cost estimates.

There is considerable debate about valuing economic costs of premature deaths associated with air pollution. This debate is important because costs associated with premature deaths from particulate matter account for over three-quarters of total air pollution-related costs.

In policy and regulatory analyses, EPA uses a value of $4.8 million to represent the cost of a premature death. This value is the mean of estimates from 26 studies dating back to the mid 1970s that have attempted to place a value on the cost of premature deaths. Estimates from those studies range from $0.6 million to $13.5 million, reflecting the large uncertainties in trying to estimate the public's willingness to pay to avoid premature death.

The Department of Transportation has adopted a value of $2.7 million per premature death, based on a comprehensive 1991 study by the Urban Institute. While that study focused on the costs of premature deaths associated with highway crashes, it drew upon many of the same studies that EPA used, and the results apply to premature deaths attributable to factors other than highway crashes. Both DOT and EPA have devoted significant efforts in developing these cost estimates, and while their costs differ somewhat, they fall within a much broader range of costs that have been estimated by others.

The EPA's study, The Benefits and Costs of the Clean Air Act, notes that the Science Advisory Board charged with reviewing the study recommended comparing cost estimates based upon EPA's traditional value of life estimates with costs using an alternative approach for valuing costs of air pollution-related deaths. That approach explicitly considers the number of years by which lives may be shortened as a result of exposure to air pollution. Under this life-years lost approach, costs of premature death are estimated to be about 55 percent of EPA's value of $4.8 million per premature death. This translates into an average value of about $2.6 million per premature death, which coincidentally, is very close to the value DOT uses for the cost of premature deaths. The EPA has additional research underway in this area.y

Figure 5 compares total motor vehicle-related air pollution costs estimated using DOT's cost of premature death with costs estimated using EPA's value. As noted above, preliminary estimates using an alternative life-years lost approach would be slightly less than costs using the DOT cost estimates, but more work needs to be done to develop a consensus on the advisability and applicability of a life-years approach to valuing costs of premature death associated with air pollution and to refine those cost estimates. It is also important to note that data and methods used by EPA that were the basis for these cost estimates continue to be improved.

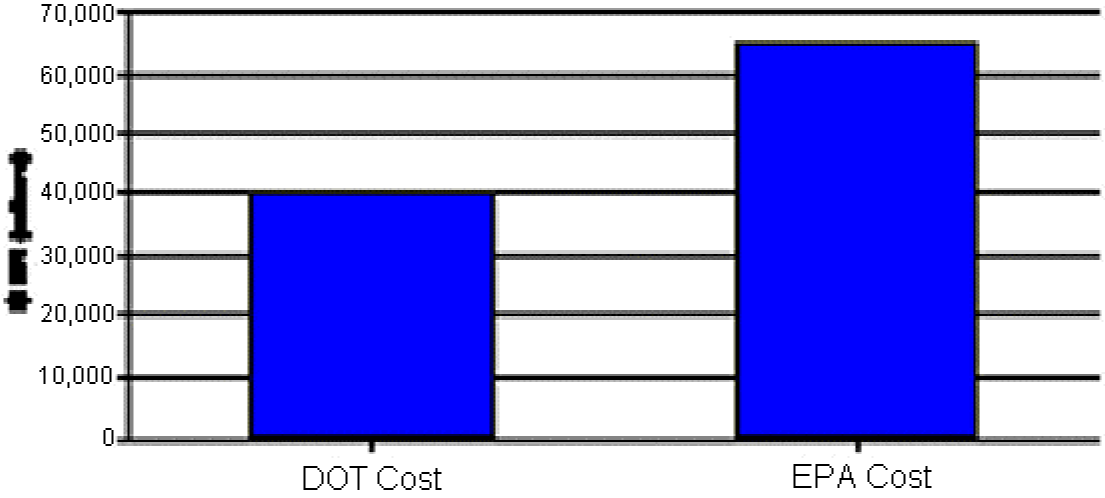

Figure 5. Comparison of Social Costs of Highway Related Air Pollution in 2000 Based on DOT and EPA Costs of Premature Death

Source: Abt Associates for EPA and FHWA.

Air pollution costs attributable to motor vehicles were estimated by comparing levels of air pollution when all sources of pollution were present with air pollution when motor vehicle emissions were eliminated. Costs attributable to rural motor vehicle travel were estimated by eliminating all urban motor vehicle travel, and urban costs were estimated by eliminating rural travel. These methods were necessary to eliminate interactions between emissions in rural and urban areas that would make it impossible to estimate whether there are significant differences in costs associated with travel in rural and urban areas.

About two-thirds of motor vehicle-related air pollution costs are attributable to urban travel and one-third to rural travel. As can be seen in Table 9, the sum of these costs for urban and rural travel individually is slightly greater than costs for all motor vehicle travel. This is explained by regional transport of both precursor emissions and air pollutants and the complex chemistry leading to the production of ozone and particulate matter.

Figure 6 shows overall average air pollution costs per mile of travel in rural and urban areas. Average costs for rural travel are about 1.5 cents per mile compared to 1.75 cents per mile for urban travel. Average costs for all motor vehicle travel are about 1.5 cents per mile. Costs for all travel are lower than would be expected based on costs for urban and rural travel alone because, as noted above, total costs for all motor vehicle travel are less than the sum of costs of rural and urban travel when those costs are estimated individually.

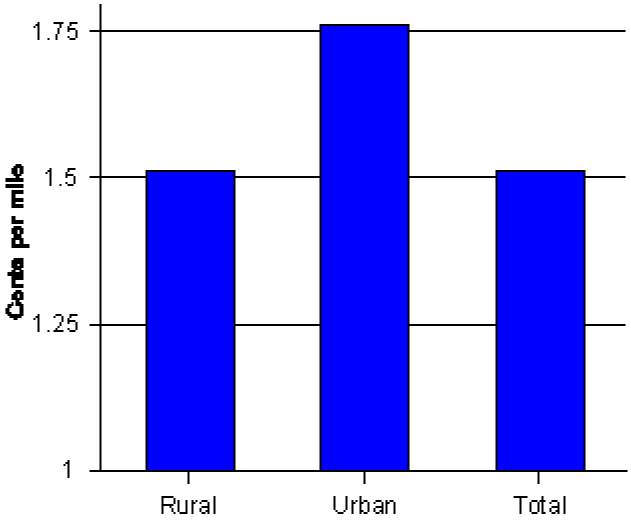

Figure 6. Average Air Pollution Costs per Mile in Rural and Urban Areas

Source: FHWA estimates based on SAI and Abt Associates data.

The average costs shown in Figure 6 mask large differences in highway-related air pollution costs in various parts of the country. They also do not reflect differences in costs associated with travel by different vehicle classes.

While the uncertainty of cost estimates was emphasized in technical reports submitted by consultants for this study, no explicit range of high, medium, and low estimates of motor vehicle-related air pollution costs was developed. A recent study of air pollution costs attributable to motor vehicles by Mark Delucchi and Donald McCubbin estimated that costs range from 0.9 to 14 cents per mile.(4) This is a wide range, but it is consistent with ranges estimated for other social costs of highway use.

A major source of variation in estimates of air pollution costs attributable to motor vehicles is whether or not road dust is included. The EPA does not classify road dust as a pollutant attributable to motor vehicles, but others have included road dust in cost estimates.

Table 10 shows high, medium, and low estimates of the costs of air pollution attributable to motor vehicle use along with the costs of crashes, congestion, and noise that were included in the 1997 HCAS. The mid-range air pollution cost estimate is taken from costs shown in Table 9. The EPA did not develop ranges of motor-vehicle-related air pollution costs; high and low cost estimates shown in Table 10 are taken from McCubbin and Delucchi's estimates of total social costs of motor vehicle use. None of the air pollution cost estimates include costs associated with road dust stirred up by the passage of motor vehicles.

**Table 10. 2000 High, Mid-Range, and Low Estimates for Social Costs of Motor Vehicle Use**

| ($ Millions) | | | |
|---|---|---|---|
| | **High** | **Mid-Range** | **Low** |
| Congestion | $181,635 | $61,761 | $16,352 |
| Crash Costs | $839,463 | $339,886 | $120,580 |
| Air Pollution | $349,100 | $40,443 | $30,300 |
| Noise | $11,446 | $4,336 | $1,214 |
| Total | $1,533,344 | $446,319 | $170,246 |

Crash costs represent the largest social cost of motor vehicle use shown in Table 10 across all cost ranges. The high estimate of air pollution costs ranks second among high cost estimates, but mid-range estimates of congestion costs are 50 percent higher than corresponding estimates of air pollution costs.

For each of the impact areas shown in Table 10 the mid-range estimate is closer to the low than to the high estimate. This is another reflection of uncertainties surrounding economic costs of highway use. The high cost estimates often include costs which some analysts do not believe should be attributed to highway use, costs that are difficult to quantify, or costs for which only limited evidence exists. Also, the high range costs generally include the highest values that have been estimated for key cost components from among the various studies that have been done whereas mid-range costs typically use values that approximately reflect mean values estimated in other studies. Mid-range cost estimates rely on the soundest evidence available to date for each impact area, but are subject to change over time as new research results become available.

Figure 7 compares highway agency costs with social costs of highway use. Social costs are broken into costs borne by highway users (congestion costs and most crash costs) and costs borne by non-users (air pollution, noise, and a small share of crash costs). While most social costs of highways included in Figure 7 are borne by highway users, the $90 billion borne by society in general is significant.

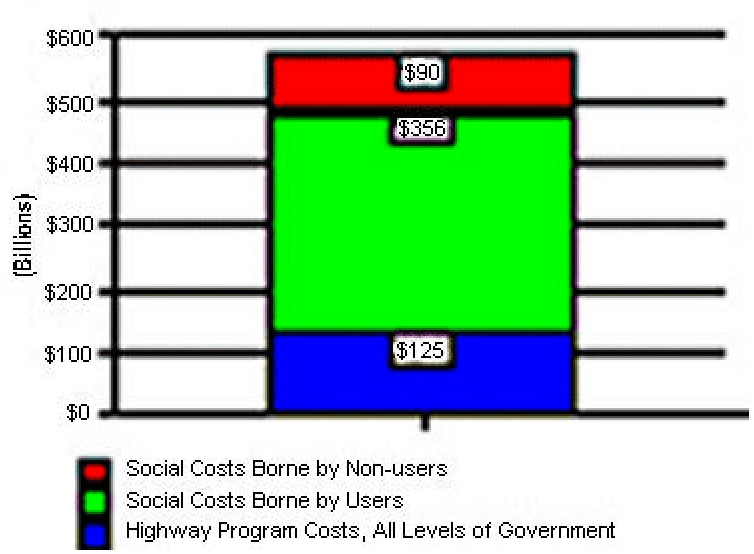

Figure 7. Total 2000 Highway Program Costs and Social Costs Borne by Users and Non-Users

Source: FHWA estimates.

# Air Pollution Costs Attributable to Different Vehicle Classes

Table 11 shows percentages of different types of emissions attributable to the vehicle classes included in EPA models. These vehicle classes do not correspond well with vehicle classes used by the Department for highway cost allocation and truck size and weight analyses. In particular, most of the trucks with three or more axles are all grouped in the EPA class of heavy duty diesel vehicles. Thus, it is difficult to directly use the EPA models to estimate air pollution costs attributable to the different highway cost allocation study vehicle classes.

**Table 11. Distribution of Various Emissions by Vehicle Class**

| | **LD Gas Vehicles** | **LD Gas Trucks 1** | **LD Gas Trucks 2** | **HD Gas Vehicles** | **LD Diesel Vehicles** | **LD Diesel Trucks** | **HD Diesel Vehicles** | **Motor-cycles** | **Total** |
|---|---|---|---|---|---|---|---|---|---|
| SOA | 51% | 15% | 10% | 5% | 0% | 0% | 17% | 1% | 99% |
| SOx | 45% | 15% | 8% | 3% | 0% | 0% | 29% | 0% | 100% |
| NOx | 42% | 29% | 0% | 4% | 0% | 0% | 25% | 0% | 100% |
| VOC | 60% | 30% | 0% | 5% | 0% | 0% | 5% | 0% | 100% |
| PM10 | 26% | 7% | 4% | 3% | 0% | 0% | 59% | 0% | 99% |
| PM, coarse | 47% | 12% | 7% | 4% | 0% | 0% | 29% | 0% | 99% |
| PM2.5 | 19% | 6% | 3% | 3% | 0% | 0% | 68% | 0% | 99% |
| Group 1 | 50% | 29% | 0% | 4% | 0% | 0% | 16% | 0% | 99% |
| Group 2 | 50% | 28% | 0% | 4% | 0% | 0% | 17% | 0% | 100% |
| Group 3 | 50% | 28% | 1% | 4% | 0% | 0% | 17% | 0% | 100% |

LD Gas Vehicle - gas-powered automobile

LD Gas Truck 1 - gas-powered trucks weighing 6,000 pounds or less (pickups, vans, etc.)

LD Gas Truck 2 - gas powered trucks weighing between 6,001 and 8,500 pounds

HD Gas Vehicles - gas powered trucks and buses weighing more than 8,500 pounds

LD Diesel Vehicle - Diesel-powered automobiles

LD Diesel Trucks - diesel-powered trucks weighing 8,500 pounds or less

HD Diesel Vehicles - diesel-powered vehicles weighing more than 8,500

SOA - secondary organic aerosols

SOx - sulfur dioxide

NOx - nitrogen oxide

VOC - Volatile organic compounds

PM10 - directly emitted particulate matter less than 10 microns

PM, coarse - directly emitted particulate matter between 10 and 2.5 microns

PM2.5 - directly emitted particulate matter less than 2.5 microns

Group 1 - VOC and NOX, the primary precursor emissions for ozone

Group 2 - Group 1 plus PM2.5, SOx, and SOA, precursors for both ozone and PM formation

| Group 3 - Group 2 plus ammonia, a precursor for both ozone and PM formation |
|---|

Except for $PM_{10}$ and $PM_{2.5}$, automobiles account for the largest share of various motor vehicle emissions. Because of the complex chemical processes by which emissions are transformed into particulate matter, ozone, and other secondary pollutants, and variations in the transport of pollutants in different regions of the country, relative emissions attributable to different vehicle classes cannot be directly translated into relative air pollution costs without detailed air quality modeling that was beyond the scope of this project. For instance, while heavy trucks account for a large share of particulate emissions, they account for a smaller share of costs because significant portions of particulate matter are formed through chemical reactions involving other compounds emitted predominantly by light trucks and passenger vehicles.

Four vehicle classes are responsible for 99 percent of all emissions: automobiles; pickups, vans, and sport utility vehicles; heavy duty gas vehicles; and heavy duty diesel vehicles. Other vehicle classes have much less VMT, and thus their total emissions are lower, although emissions per mile of travel would be comparable. The emissions modeling approach used in this study did not differentiate emissions more finely than the eight vehicle classes shown in Table 11. While the relative emissions shown in Table 11 do not directly correspond to the relative contribution to pollution and pollution-related costs for different vehicle classes, they do indicate the relative order of magnitude of the contribution by different vehicle classes. Further work is underway to improve estimates of emissions by different vehicle classes under a variety of operating conditions. This work should improve the ability to estimate the relative contribution to air pollution costs by different vehicle classes.

Table 12 uses the percentages from Table 11 to estimate total costs attributable to the four EPA vehicle classes that account for the majority of costs along with the average costs per mile of travel for each vehicle class. Costs are estimated by taking proportions of total precursor emissions for each vehicle class, based upon the Group 3 set of emissions shown in Table 11, and multiplying by total air pollution costs. Costs per mile are estimated by dividing total costs for each vehicle class by the VMT for that class. Passenger vehicles (automobiles, pickups and vans) account for about three-quarters of total estimated costs. Costs per mile for pickups and vans are closer to those of trucks than they are to costs per mile for automobiles because pickups and vans are not subject to the same tailpipe emissions standards as automobiles and because they get poorer fuel economy than automobiles.

**Table 12. Air Pollution Costs Attributable to Different Vehicle Classes**

| Vehicle Class | Total Estimated Cost ($1990 millions) | Cents Per Mile of Travel |
|---|---|---|
| Automobiles | $20,343 | 1.1 |
| Pickups, Vans | $11,324 | 2.6 |
| Gasoline Vehicles > 8,500 pounds | $1,699 | 3.0 |
| Diesel Vehicles > 8,500 pounds | $6,794 | 3.9 |
| Overall | $40,443 | 1.5 |

# Marginal Costs of Highway Use

Marginal costs of highway use reflect changes in total costs associated with an additional increment of travel. Marginal costs include incremental costs to the highway user (e.g., added vehicle operating cost and travel time), costs to public agencies (added use-related rehabilitation and maintenance costs), and external costs such as air pollution and congestion costs imposed on others. Many marginal costs vary by either location of travel or time-of-day. For instance, incremental pavement deterioration associated with an extra mile of travel by particular vehicle classes depends on the design and condition of the pavement upon which they travel, temperature, and other local characteristics. Congestion costs associated with an additional mile of travel on low-volume rural Interstate highways are negligible, but costs on urban Interstate highways may be high, particularly during peak periods when traffic volumes are greatest.

With the exception of their own travel time, vehicle operating costs, and perhaps risks of having a crash, highway users normally do not consider many of these marginal costs when deciding whether to make a trip. In general, economic efficiency would be enhanced if users had to pay those marginal costs they do not consider in trip-making decisions.

Since many marginal costs vary according to when or where a trip is made, charges based on average costs will not necessarily promote improved economic efficiency. To achieve the greatest degree of efficiency, fees reflecting the marginal costs of trips made in various locations at various times of the day should be charged. Then, only trips whose benefits equal or exceed the full cost of the trip would be made.

Table 13 shows estimates of marginal pavement, congestion, crash, air pollution, and noise costs in 2000 for selected vehicles operating under different conditions. Costs reflect typical or average conditions; in certain locations, costs could be expected to vary from values shown. The relative costs of pavement damage, congestion, crashes, air pollution, and noise for different vehicle classes operating in rural and urban areas are as important as the individual costs themselves.

**Table 13. 2000 Pavement, Congestion, Crash, Air Pollution, and Noise Costs for Illustrative Vehicles Under Specific Conditions**

| Vehicle Class/Highway Class | Cents per Mile | | | | | |
|---|---|---|---|---|---|---|
| | Pavement | Congestion | Crash | Air Pollution | Noise | Total |
| Autos/Rural Interstate | 0 | 0.78 | 0.98 | 1.14 | 0.01 | 2.91 |
| Autos/Urban Interstate | 0.1 | 7.70 | 1.19 | 1.33 | 0.09 | 10.41 |
| 40 kip 4-axle S.U. Truck/Rural Interstate | 1.0 | 2.45 | 0.47 | 3.85 | 0.09 | 7.86 |
| 40 kip 4-axle S.U. Truck/Urban Interstate | 3.1 | 24.48 | 0.86 | 4.49 | 1.50 | 34.43 |
| 60 kip 4-axle S.U. Truck/Rural Interstate | 5.6 | 3.27 | 0.47 | 3.85 | 0.11 | 13.3 |
| 60 kip 4-axle S.U. Truck/Urban Interstate | 18.1 | 32.64 | 0.86 | 4.49 | 1.68 | 57.77 |
| 60 kip 5-axle Comb/Rural Interstate | 3.3 | 1.88 | 0.88 | 3.85 | 0.17 | 10.08 |
| 60 kip 5-axle Comb/Urban Interstate | 10.5 | 18.39 | 1.15 | 4.49 | 2.75 | 37.28 |
| 80 kip 5-axle Comb/Rural Interstate | 12.7 | 2.23 | 0.88 | 3.85 | 0.19 | 19.85 |
| 80 kip 5-axle Comb/Urban Interstate | 40.9 | 20.06 | 1.15 | 4.49 | 3.04 | 69.64 |

NOTE: S.U. = Single Unit, Comb. = Combination; Air pollution costs are averages of costs of travel on all rural and urban highway classes, not just Interstate. Available data do not allow differences in air pollution costs for heavy truck classes to be distinguished.

Pavement costs represent the contribution of a mile of travel by different vehicles to pavement deterioration and the costs of repairing the damage. Congestion costs reflect the value of added travel time due to additional small increments of traffic. Crash costs include medical costs, property damage, lost productivity, pain and suffering, and other costs associated with highway crashes. Air pollution costs are measured in terms of the cost of premature death, illness, and other effects of various highway-related emissions. Noise costs reflect changes in the value of adjacent properties caused by motor vehicle-related noise.

Marginal air pollution costs are particularly difficult to estimate because they are influenced by other sources of pollution in an area, climatic and atmospheric conditions, the complex chemistry of secondary pollutant formation, and other factors that vary over time and location. Not only do emissions per mile of travel vary depending on local conditions, but more importantly, contributions of those emissions to changes in pollutant concentrations and to health and other air pollution-related costs vary widely.

Marginal air pollution costs were estimated for this study by first estimating differences in air pollution concentrations with and without highway traffic. Costs of the air pollution attributable to motor vehicle use were then estimated based on marginal costs of changes in pollutant concentrations estimated in other recent studies and used by EPA in its study, The Benefits and Costs of the Clean Air Act, 1970 - 1990. Finally, per-mile costs were estimated by dividing total costs by VMT. While strictly speaking these are average rather than marginal costs with respect to VMT, they are derived from estimates of the marginal costs of changes in air pollution concentrations. Furthermore changes in air pollution concentrations with and without motor vehicle emissions were less than 10 percent at most locations where changes were estimated. Since resource constraints did not allow direct estimation of marginal air pollution costs of motor vehicle use, the average cost estimates are used to approximate marginal costs.

Separate estimates were made of costs of rural and urban travel but those estimates do not show the large variations that occur in specific rural or urban locations. No separate estimates were made for travel on different highway functional classes. Costs for different vehicle classes are estimated simply on the basis of relative emissions. Considerable work remains to improve estimates of marginal air pollution costs by different vehicle classes.

While marginal pavement, safety, congestion, and noise costs more closely represent true marginal costs than do marginal air pollution costs, they all represent average or typical marginal costs estimated for a broad cross section of Interstate highways. Costs at specific locations could vary considerably from costs shown, especially for noise costs which, like air pollution costs, are subject to many external factors.

Variations in marginal costs among vehicles and locations are not uniform; they are highly dependent on the type of cost being considered. Pavement, congestion, air pollution, and noise costs are higher in urban areas than rural areas, but marginal crash costs are higher in rural areas, reflecting the higher fatality rates for travel in rural areas. Cost differences among vehicle classes also vary widely. The 80,000 pound 5-axle combination truck operating in urban areas, has marginal costs many times greater than those of autos operating in rural areas, but marginal costs for 60,000 pound combination trucks operating in rural areas are less than marginal costs of automobiles operating on congested urban Interstate highways.

Figure 8 shows high and low ranges of air pollution, noise, congestion, and crash cost estimates along with best estimates (middle range) of those costs based upon the best research in each area. The large uncertainty surrounding these estimates suggests that caution should be exercised in making decisions that could significantly influence either user costs or highway investment based upon these social costs.

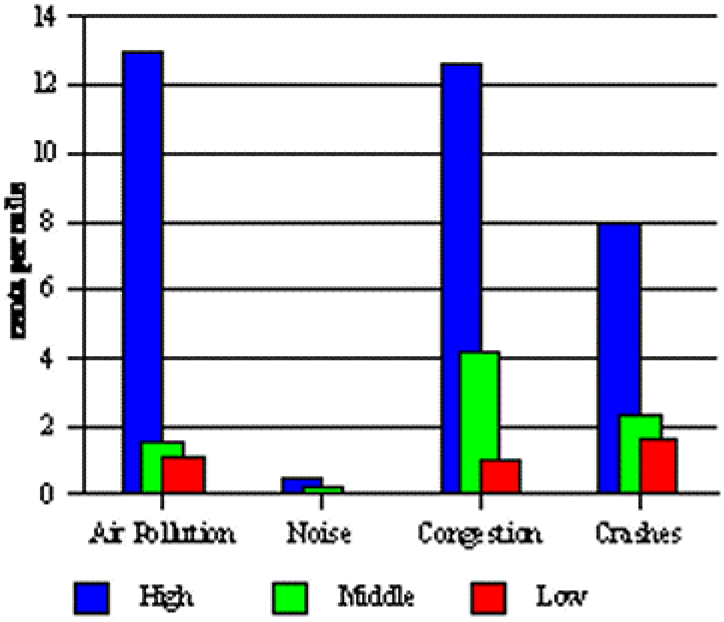

Figure 8. 2000 Estimated Ranges of Marginal Costs of Highway Travel

Highway marginal costs cannot directly be separated into Federal and non-Federal costs. Costs result from travel on all highways and to one extent or another affect all segments of society and all geographic areas. All units of government working together have joint responsibilities to take appropriate steps to reduce these costs. These steps may include mitigating costs through regulatory means, making investment decisions that contribute toward reducing highway marginal costs, or using pricing mechanisms to more nearly reflect marginal costs in the prices that motorists pay for highway transportation.

While highway marginal costs cannot be assigned to one level of government or another, there is an interest in how close current Federal user fees are to efficient fees. To compare cost allocations based on efficiency criteria with Federal user fee payments by different vehicles, marginal costs must be distributed among different levels of government. The 1982 Federal HCAS distributed marginal costs in proportion to the shares of total highway user revenues produced at each level of government on the grounds that this would leave the relative roles of each level of government for financing and charging for highways unchanged. The same approach is used in this study.

Table 14 compares the estimated Federal shares of marginal costs from Table 13 to Federal highway cost responsibility estimated in the equity analysis and to Federal user fees paid by different vehicle classes. Comparing Federal user fees with the Federal share of marginal costs reflects the efficiency of the user fee structure while comparing user fees to program cost responsibility is a measure of equity. Marginal costs and program costs are estimated by different methods for completely different purposes and cannot be added together.

**Table 14. 2000 Comparison of Assumed Federal Share of Marginal Highway Costs to Federal Agency Costs and Federal User Fees**

(cents per mile)

| Vehicle Class/Highway Class | Marginal Costs | Federal Program Costs | Federal User Fees |
|---|---|---|---|
| Autos/Rural Interstate | 0.9 | 0.4 | 0.8 |

| | | | |
|---|---|---|---|
| Autos/Urban Interstate | 3.1 | 1.8 | 0.8 |
| 40 kip 4-axle S.U. Truck/Rural Interstate | 2.4 | 2.1 | 12.4 |
| 40 kip 4-axle S.U. Truck/Urban Interstate | 10.3 | 4.6 | 12.4 |
| 60 kip 4-axle S.U. Truck/Rural Interstate | 4.0 | 8.6 | 14.0 |
| 60 kip 4-axle S.U. Truck/Urban Interstate | 17.3 | 15.3 | 14.0 |
| 60 kip 5-axle Comb*/Rural Interstate | 3.0 | 3.3 | 6.9 |
| 60 kip 5-axle Comb*/Urban Interstate | 11.2 | 8.1 | 6.9 |
| 80 kip 5-axle Comb*/Rural Interstate | 5.9 | 9.5 | 7.4 |
| 80 kip 5-axle Comb*/Urban Interstate | 20.9 | 21.2 | 7.4 |

Federal program costs are greater than the estimated Federal share of marginal costs for rural travel by heavy single unit trucks and combinations, but less than marginal costs for automobiles and light single unit trucks. Marginal costs of congestion, noise, and safety are relatively low in rural areas, and overall agency cost responsibility in rural areas exceeds marginal costs for all but the lightest vehicle classes. In urban areas the opposite is true. Not only are costs of congestion, air pollution, and noise higher in urban than rural areas, but marginal pavement costs also are higher, reflecting among other things the higher construction costs in urban areas and the delay incurred by users when pavements are being rehabilitated. Federal user fees per mile of travel exceed marginal costs of rural travel for all vehicle classes except automobiles. Marginal costs of urban travel exceed Federal user fees per mile for all vehicle classes except the light single unit truck.

There currently are no Federal, State, or local user fees imposed that directly reflect congestion, air pollution, noise, or other external costs of highway use. There is interest, however, among some State and local agencies in exploring the feasibility of variable or time-of-day pricing to help manage highway travel in certain corridors. For instance on State Route 91 in California, four additional lanes were constructed with private funds on which tolls are charged that vary by time of day. A project is underway in San Diego under the Value Pricing Pilot Program that has tolls which vary according to the level of congestion.

Fees on "gross emitters," the most polluting of vehicles that are responsible for large percentages of total pollutants, have been suggested as a way to charge the worst polluters for air pollution costs they impose, and general increases in fuel taxes have also been suggested to address air pollution costs. A gross emitter tax could directly reflect air pollution costs, but questions of equity and other implementation issues have prevented such a tax from being implemented to date. General fuel tax increases implemented at the local level would not be as sensitive to factors affecting air pollution as the gross emitter tax, but could reflect regional differences in air pollution costs.

While there are opportunities at the local level to develop user fees that could reflect congestion, air pollution, and other external costs, implementing charges that could reflect the locational and temporal variability or most such costs would be difficult.

# Summary and Conclusions

Since the 1997 HCAS was completed, several changes affecting conclusions about the equity and economic efficiency of Federal highway user fees have occurred. First and most importantly, proceeds of 4.3 cents per gallon of Federal fuel taxes have been shifted from the General Fund where they were dedicated to deficit reduction to the Highway Trust Fund where they may be used for highway-related purposes under the new TEA-21 legislation. Second, TEA-21 significantly increased total authorizations for highway, transit and related purposes and shifted the distribution of funding among different program areas. Third, additional information has been developed concerning air pollution-related costs of highway use which fills a large gap in estimates of social and marginal costs of highway travel.

From an equity perspective, the most significant change is an increased spread in ratios of user fee payments to highway cost responsibility between lighter vehicles and heavier vehicles. Table 7 showed that equity ratios for the heaviest single unit trucks and all the weight groups of combination trucks went down. Now only the very lightest combination trucks pay their share of Federal highway cost responsibility. The most common combination vehicles, those registered at weights between 75,000 and 80,000 pounds, now pay only 80 percent of their share of Federal highway costs and combinations registered between 80,000 and 100,000 pounds pay only half their share of Federal highway costs. Any future increase in Federal fuel taxes without corresponding increases in taxes on the heaviest trucks will further exacerbate the underpayment of Federal user fees by heavy trucks.

Changes in program composition and funding levels between ISTEA and TEA-21 did not have a large effect on the relative cost responsibility of different vehicle classes. Much larger changes in relative program funding levels would be required to substantially affect cost responsibility, and the flexibility for States to shift funds from one program to another would temper even large changes in program composition.

Economic costs of motor vehicle-related air pollution remain large, even though substantial progress has been made in abating emissions through a variety of initiatives. While average air pollution costs per mile of travel in rural areas are not much lower than average costs of urban travel - 1.5 cents per mile in rural areas compared to 1.75 cents per mile in urban areas - care must be exercised in interpreting these results because they mask real differences in air pollution-related costs of motor vehicle use in different areas. Air pollution costs of travel in very rural areas away from population centers would be lower than the average rural costs shown in this report, and likewise, costs of travel in urban areas with the highest ambient air pollution levels would be higher than average costs of urban travel shown in this report. Air pollution is one of the most difficult social costs of highway use to evaluate from a policy perspective because effects vary geographically and spill over to other areas in ways that vary from region to region. More research will be needed to further refine estimates of marginal air pollution costs in various locations.

The Department plans to update the 1997 HCAS before the next surface transportation reauthorization. Potential options to improve overall user fee equity will be examined in greater depth in that study and additional research to improve estimates of air pollution and other social costs of highway travel will be conducted.

## Footnotes

1. McCubbin, Donald and Delucchi, Mark, "The Annualized Social Cost of Motor-Vehicle Use in the U.S., 1990-91: Summary of Theory, Data, Methods, and Results." Institute of Transportation Studies, University of California, Davis. UCD-ITS-RR-96-3 (1), 1998, p.55.

2. Douglas, Sharon G., et. al., Air-Pollution-Related Social Costs of On-Highway Motor Vehicles, Part 1: Air Quality Modeling, Systems Applications International, June 1998.

3. Abt Associates, Air-Pollution-Related Social Costs of On-Highway Motor Vehicles, Part 2: Physical and Economic Valuation Modeling, June 1998.

4. McCubbin and Delucchi, 1997.

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SYSTEMS GROUP
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## ATTACHMENT 2: EMISSIONS EFFECTS OF ATLANTA SPEED STUDY

**Memorandum**

To: Southern Environmental Law Center
From: Brian Grady and Norm Marshall
Subject: Atlanta Non-Attainment Area Speed Study
Date: 20 July 2001

### INTRODUCTION

In February 2000, we were retained by the Southern Environmental Law Center (SELC) to review the 2001-2003 Transportation Improvement Program (TIP), the 2025 Regional Transportation Plan (RTP), and the Conformity Determination Report (CDR) prepared by the Atlanta Regional Commission (ARC). In our initial critique, we demonstrated that observed freeway speeds were much higher than the speeds in the ARC travel demand model using data from the Georgia Navigator Intelligent Transportation System (ITS). Furthermore, we demonstrated that the major discrepancy between observed and modeled freeway speeds resulted in a significant underestimation of mobile source nitrogen oxide (NOx) emissions.

In October 2000, the Georgia Regional Transportation Authority (GRTA) commissioned a speed study to examine and update the parameters used in developing peak and off-peak speeds in the ARC regional travel demand model. The final draft of the study conducted by Wilbur Smith Associates (WSA) was released in January 2001. The findings of the Atlanta Non-Attainment Area Speed Study substantiate and validate our earlier findings and conclusions. Specifically, that observed freeway speeds in the Atlanta non-attainment area are higher than the freeway speeds modeled in the ARC travel demand model, and produce much higher NOx emissions than calculated in the conformity process. After correcting for this error, the NOx emissions exceed the allowable amount by a wide margin.

## SPEED STUDY FINDINGS

The *Final Draft of the Atlanta Non-Attainment Area Speed Study* was prepared by Wilbur Smith Associates on behalf of the Georgia Regional Transportation Authority. After analyzing the speed data collected for the region's freeways, three trends were evident when comparing the observed speeds against the modeled ARC speeds. These findings are presented on page 35 of the speed study.

- With exception of the central business district (CBD) area, off peak observed weighted speeds are higher than the peak speeds and fairly constant across area types at close to 60 miles per hour (MPH).
- The observed peak-period speeds vary considerably without a discernable pattern: from 31.9 MPH during the AM peak to 57.7 MPH during the PM peak in the CBD area and from 36.7 MPH in the Suburban area during the PM peak to 57.0 MPH in the Exurban/Rural area during the PM peak.
- Observed speeds are consistently higher than modeled speeds (9 out of 12 averages are higher) and in some cases the difference is relatively large (5 averages are more than 10 MPH higher).

Table 10.2.1 on page 35 of the speed study contains the observed weighted average speeds and weighted ARC modeled speeds for freeways. The same data is presented here in Table 1.

***Table 1: Observed Weighted Average Freeway Speeds***

| Area Type | Period | Observed Weighted Avg. Speed (MPH) | Weighted ARC Modeled Speed (MPH) |
|---|---|---|---|
| CBD | AM Peak | 31.9 | 21.1 |
| | Off Peak | 40.0 | 22.8 |
| | PM Peak | 57.7 | 20.7 |
| Urban | AM Peak | 40.1 | 41.3 |
| | Off Peak | 59.8 | 50.2 |
| | PM Peak | 50.4 | 43.9 |
| Suburban | AM Peak | 54.4 | 47.2 |
| | Off Peak | 59.9 | 43.9 |
| | PM Peak | 36.7 | 37.7 |
| Exurban/Rural | AM Peak | 40.9 | 53.5 |
| | Off Peak | 58.8 | 45.1 |
| | PM Peak | 57.0 | 51.9 |

The authors of the speed study concluded the following about the Volume Delay Functions (VDF) and resulting model freeway speeds used in the ARC regional travel demand model:

> In conclusion, it appears that the existing shape of the existing ARC regional travel demand model VDF freeway curves is not supported by the observed speed data and additional samples are required at higher V/C ratios to better estimate the shape at the higher V/C ratios. Further with many observed speeds generally higher than what the VDF curve would estimate, it is likely that the overall freeway average speed is underestimated.

We are in complete agreement with this conclusion, as we drew the same conclusion about the ARC model freeway speeds after examining data collected by the Georgia Navigator ITS. Prior to the speed study, the most comprehensive speed data available in the region were those collected by the Georgia Navigator ITS. In particular, there are 14 Autoscope stations located on I-75 and I-85 that are judged by the Georgia Department of Transportation (GDOT) to be the most accurate in the system. These installations include advanced video equipment that measure speed within each travel lane continuously.

Data for one weekday per month were obtained from GDOT for the previous 13 months (January 1999 – January 2000), with data summarized for each of 24 hours by each lane. Average daily speeds were calculated from these summaries.[1] Figure 1 on the next page shows these speeds by location compared to final adjusted travel speeds for the 2000 ARC model.

The ARC dismissed our initial comments regarding the discrepancy between observed and modeled freeway speeds. ARC claimed we had relied on data from a sample that was not only small but also inaccurate. However, the data from the Georgia Navigator ITS and the findings in the speed study, which collected speed data for hundreds of roadway segments, tell the same story. The VDF freeway curves used in the ARC model yield speeds that are much lower than observed speeds.

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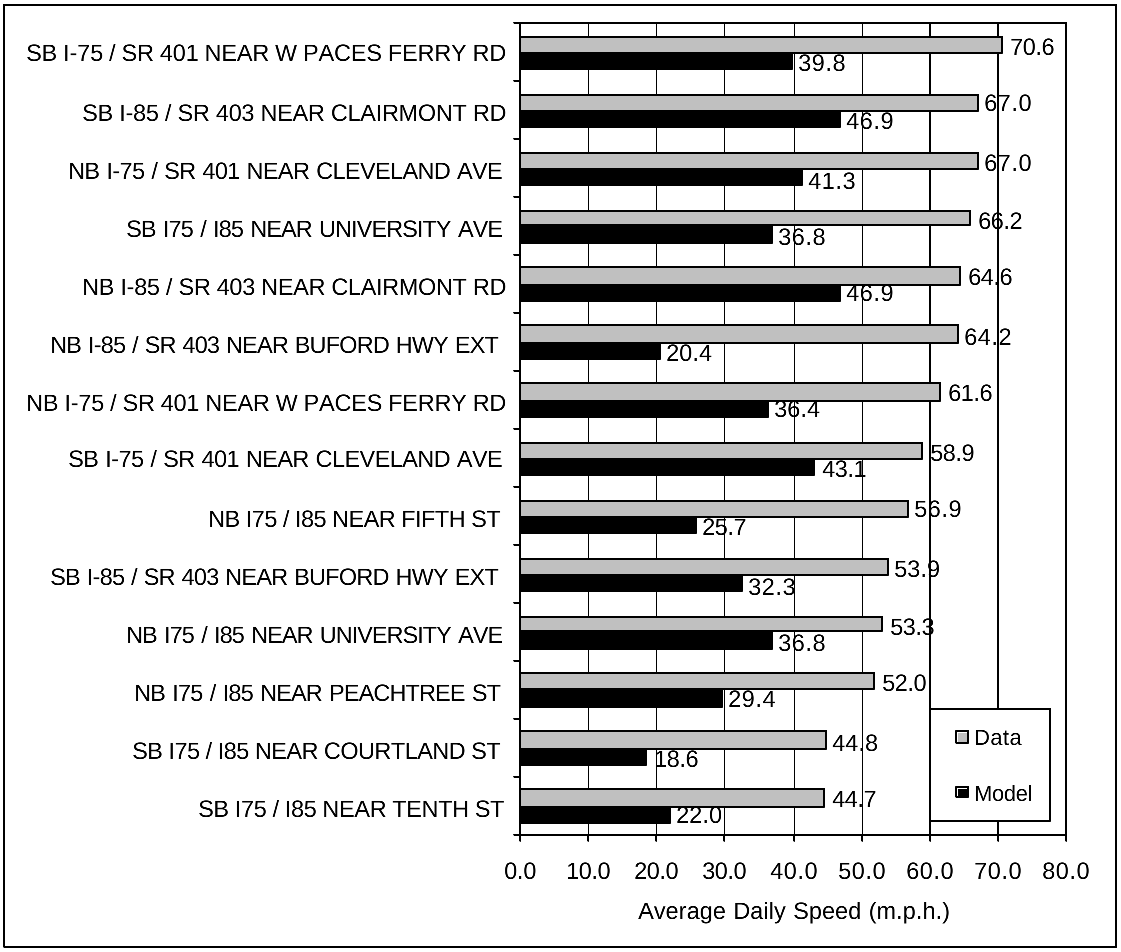
[1] Data were used from all days where 24 hours of data were available for a station. Averages were calculated by dividing vehicular miles by vehicle hours to avoid bias in the averages.

***Figure 1: ARC Model Speeds Compared with Georgia Navigator ITS Speed Data***



## IMPACT ON MOBILE SOURCE EMISSIONS

As a short-term improvement, the study recommends the development of a post-processor to predict speeds based on data in the study for use in the State Implementation Plan and Conformity Determination. This post-processor would estimate speeds based on enhanced VDF curves and volume output from the ARC regional travel demand model. The authors of the study recognize the importance of post-processing the ARC model speeds because the MOBILE5b emission factor model is extremely sensitive to speed inputs.

Despite recognizing the problem with ARC modeled freeway speeds, enhanced VDF curves were not generated by WSA to facilitate development of a post-processor. Citing insufficient data, new enhanced VDF curves were not developed. The speed study identifies a problem, but does not provide any practical means of fixing it. The study is therefore incomplete. This is particularly disturbing because the development of new VDF curves was an explicit part of GRTA's speed study project when the Request For Qualifications (RFQ) was issued.

The discrepancy between observed and modeled freeway speeds has a significant impact on mobile source nitrogen oxide emissions. This fact may partially explain why the authors don't suggest implementing many of the recommended improvements until 2006 and beyond. To quantify the emission impacts from underestimation of freeway speeds, we have calculated 2003 nitrogen oxide emissions from freeways using both sets of speeds presented in Table 1 of this memorandum (Table 10.2.1 in the speed study). Table 2 contains NOx emissions from freeways using the observed weighted average speeds by time period and area type. Table 3 contains NOx emissions from freeways using the weighted ARC modeled speeds by time period and area type.

*Table 2: NOx Emissions From Freeways Using Observed Weighted Average Speeds*

| Area | Time Period | 2003 ARC Vehicle Miles | Observed Weighted Avg. Speed (MPH) | 2003 MOBILE5b Emission Factor (grams/mile) | Total Emissions (grams) |
|---|---|---|---|---|---|
| CBD | AM | 230,407 | 31.9 | 1.595 | 367,498 |
|  | Off | 245,594 | 40.0 | 1.631 | 400,564 |
|  | PM | 782,192 | 57.7 | 2.236 | 1,748,982 |
| Urban | AM | 1,639,888 | 40.1 | 1.631 | 2,674,657 |
|  | Off | 1,851,089 | 59.8 | 2.363 | 4,374,122 |
|  | PM | 5,105,091 | 50.4 | 1.815 | 9,265,740 |
| Suburban | AM | 4,223,728 | 54.4 | 2.011 | 8,493,916 |
|  | Off | 4,813,253 | 59.9 | 2.363 | 11,373,717 |
|  | PM | 12,970,190 | 36.7 | 1.611 | 20,894,976 |
| Exurban/rural | AM | 3,436,841 | 40.9 | 1.639 | 5,632,983 |
|  | Off | 3,946,154 | 58.8 | 2.299 | 9,072,207 |
|  | PM | 10,424,177 | 57.0 | 2.177 | 22,693,433 |
|  |  |  |  | **Total Daily Emissions (tons/day)** | **106.9** |

***Table 3: NOx Emissions From Freeways Using Weighted ARC Modeled Speeds***

| Area | Time Period | 2003 ARC Vehicle Miles | Weighted ARC Modeled Speed (MPH) | 2003 MOBILE5b Emission Factor (grams/mile) | Total Emissions (grams) |
|---|---|---|---|---|---|
| CBD | AM | 230,407 | 21.1 | 1.630 | 375,563 |
| | Off | 245,594 | 22.8 | 1.616 | 396,880 |
| | PM | 782,192 | 20.7 | 1.630 | 1,274,973 |
| Urban | AM | 1,639,888 | 41.3 | 1.639 | 2,687,776 |
| | Off | 1,851,089 | 50.2 | 1.815 | 3,359,726 |
| | PM | 5,105,091 | 43.9 | 1.670 | 8,525,502 |
| Suburban | AM | 4,223,728 | 47.2 | 1.710 | 7,222,574 |
| | Off | 4,813,253 | 43.9 | 1.670 | 8,038,132 |
| | PM | 12,970,190 | 37.7 | 1.616 | 20,959,827 |
| Exurban/rural | AM | 3,436,841 | 53.5 | 2.011 | 6,911,487 |
| | Off | 3,946,154 | 45.1 | 1.682 | 6,637,430 |
| | PM | 10,424,177 | 51.9 | 1.909 | 19,899,754 |
| | | | | **Total Daily Emissions (tons/day)** | **95.1** |

Total daily NOx emissions from freeways are estimated as 106.9 tons/day when observed weighted average freeway speeds from the speed study are used in the emissions calculation. Total daily NOx emissions from freeways are only estimated as 95.1 tons/day when weighted ARC modeled freeway speeds are used in the emissions calculation. Therefore, by using incorrect freeway speeds which are less than actual observed speeds in the emissions analysis, NOx emissions are underestimated by 11.8 tons/day. This represents 11 percent of the total freeway emissions.

The speed study also presented speed data for Class I, Class II and Class III Arterials as well as Class I Collectors. Observed weighted average and weighted ARC modeled speeds by time period and area type for these facilities were also tabulated. We conducted an emissions analysis for each of these facilities using the observed and modeled speeds as was done previously for freeways. Table 4 contains the results of this emissions analysis. Despite some inconsistencies between observed and modeled speeds on these facilities, the impact on emissions is slight given the nature of the NOx emission curve. The NOx curve is relatively flat between 20 and 40 MPH, so speed variations in this speed range do not produce drastic changes in total emissions.

***Table 4: NOx Emissions Analysis for Class I,II, III Arterials and Class I Collectors***

| Facility Type | Daily NOx Emissions Using Observed Weighted Average Speeds (tons/day) | Daily NOx Emissions Using Weighted ARC Modeled Speeds (tons/day) | Difference [Observed – Modeled] (tons/day) |
|---|---|---|---|
| Class I Arterials | 21.32 | 21.82 | -0.51 |
| Class II Arterials | 20.44 | 20.51 | -0.07 |
| Class III Arterials | 29.45 | 29.43 | 0.02 |
| Class I Collectors | 26.92 | 27.74 | -0.83 |

## IMPACT ON CONFORMITY DETERMINTATION

The ARC does not satisfy the 2003 SIP NOx budget when the correct freeway speeds are used in the emissions analysis. The year 2003 SIP budget without off-model adjustments is 245.88 tons/day. In the CDR, the ARC estimated 2003 NOx emissions are reported as 241.60 tons/day. However, we have shown that emissions are underestimated by 11.8 tons/day because incorrect ARC model freeway speeds were used in the emissions analysis. The 2003 SIP budget is exceeded when this underestimation is considered. The conformity data is presented in Table 5 below.

***Table 5: ARC 2003 NOx Emissions***

| Year | SIP Budget (tons/day) | ARC Projection (tons/day) | New Projection [ARC + 11.80] (tons/day) | New Projection < Budget |
|---|---|---|---|---|
| 2003 | 245.88 | 241.60 | 253.40 | ***No*** |

The 2003 NOx emissions projection increases to 253.40 tons/day when the correct observed freeway speeds are used in the emissions analysis. This emission rate exceeds the 2003 NOx emissions budget established in the SIP by 7.52 tons/day.

## CONCLUSION

In February 2000, we were retained by the Southern Environmental Law Center (SELC) to review the 2001-2003 Transportation Improvement Program (TIP), the 2025 Regional Transportation Plan (RTP), and the Conformity Determination Report (CDR) prepared by the Atlanta Regional Commission (ARC). In our initial critique, we demonstrated that observed freeway speeds were much higher than the speeds in the ARC travel demand model using data from the Georgia Navigator Intelligent Transportation System (ITS). Furthermore, we demonstrated that the major discrepancy between observed and modeled freeway speeds resulted in a significant underestimation of mobile source nitrogen oxide emissions.

In October 2000, the Georgia Regional Transportation Authority (GRTA) commissioned a speed study to examine and update the parameters used in developing peak and off-peak speeds in the ARC regional travel demand model. The final draft of the study conducted by Wilbur Smith Associates (WSA) was released in January 2001. The findings of the Atlanta Non-Attainment Area Speed Study substantiate and validate our earlier findings and conclusions. Specifically, that observed freeway speeds in the Atlanta non-attainment area are higher than the freeway speeds modeled in the ARC travel demand model.

When the correct observed freeway speeds are used in the emissions analysis, 2003 NOx freeway emissions increase by 11.8 tons/day. This increase is significant because the 2003 SIP budget is exceeded when the additional freeway emissions are included in the emission projections. 2003 NOx emission projections increase to 253.40 tons/day, which exceeds the 245.88 tons/day budget established in the SIP. Accounting for the underestimation resulting from the use of incorrect freeway speeds, the ARC conformity determination is invalid.

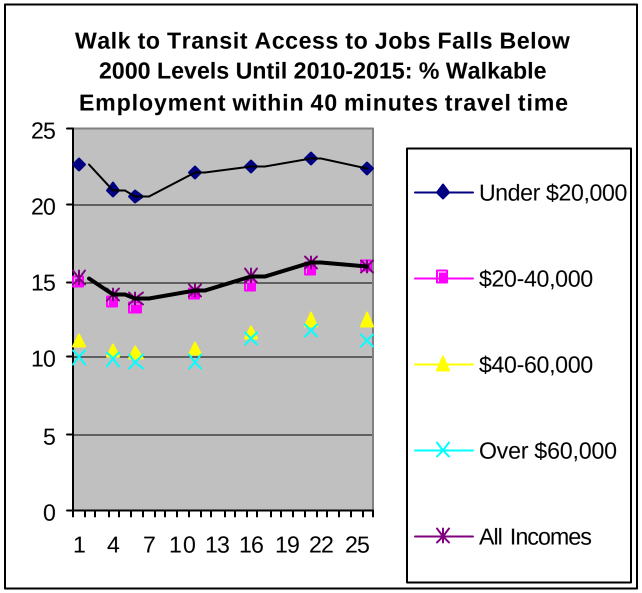
# Attachment 3: Relative Access to Jobs Declines Under Atlanta Transportation Improvement Program (TIP) Especially for People Without Cars

%walkable employment within 40 minutes - walk to transit

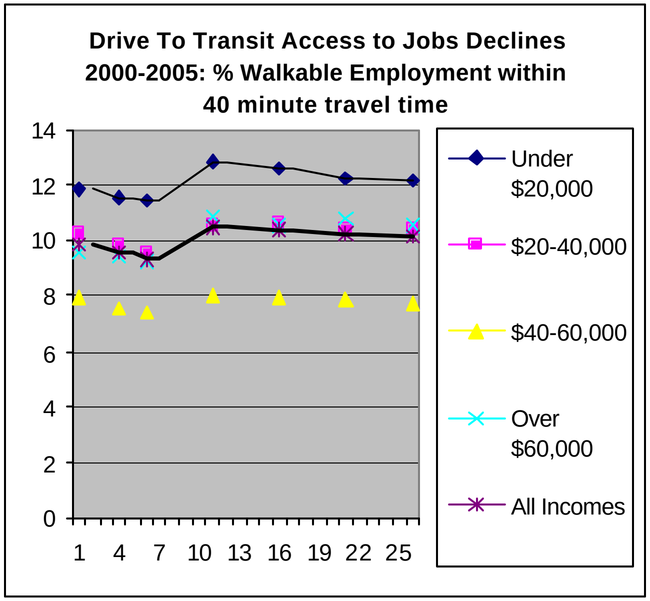
| **YEAR:** | **2000** | **2003** | **2005** | **2010** | **2015** | **2020** | **2025** |
|---|---|---|---|---|---|---|---|
| **Household Income** | | | | | | | |
| Under $20,000 | 22.6 | 20.97 | 20.66 | 22.07 | 22.55 | 23.07 | 22.37 |
| $20-40,000 | 15.03 | 13.54 | 13.15 | 14.08 | 14.71 | 15.86 | 15.9 |
| $40-60,000 | 11.1 | 10.48 | 10.31 | 10.63 | 11.61 | 12.53 | 12.46 |
| Over $60,000 | 10.04 | 9.87 | 9.79 | 9.76 | 11.27 | 11.79 | 11.17 |
| All Incomes | 15.28 | 14.18 | 13.93 | 14.46 | 15.37 | 16.2 | 15.88 |

%walkable employment within 40 minutes - drive to transit

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Under $20,000 | 11.85 | 11.59 | 11.44 | 12.83 | 12.63 | 12.26 | 12.13 |
| $20-40,000 | 10.26 | 9.84 | 9.59 | 10.53 | 10.61 | 10.43 | 10.42 |
| $40-60,000 | 7.96 | 7.57 | 7.39 | 8.04 | 7.98 | 7.88 | 7.75 |
| Over $60,000 | 9.54 | 9.42 | 9.26 | 10.83 | 10.55 | 10.79 | 10.55 |
| All Incomes | 9.87 | 9.57 | 9.37 | 10.5 | 10.4 | 10.28 | 10.17 |



**Walk to Transit Access to Jobs Falls Below 2000 Levels Until 2010-2015: % Walkable Employment within 40 minutes travel time**



**Drive To Transit Access to Jobs Declines 2000-2005: % Walkable Employment within 40 minute travel time**

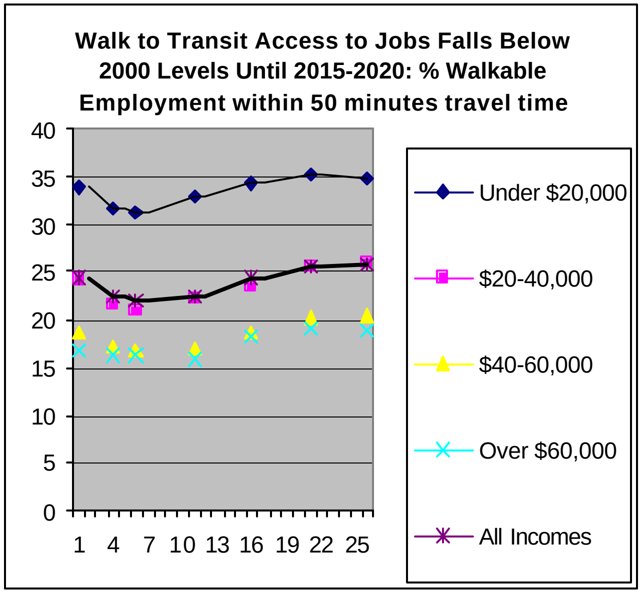
Source for all data: Atlanta Regional Commission, "Transportation Solutions for a New Century", Appendix V, Model Output, Table 3-21, March 2000

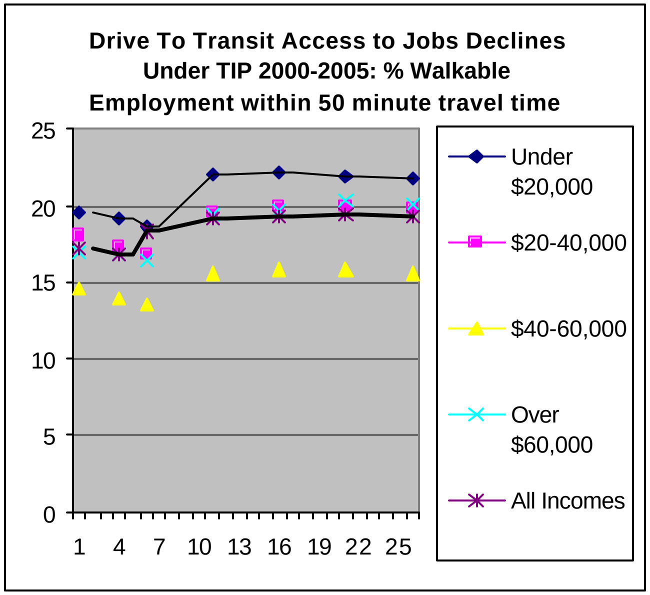
%walkable employment within 50 minutes - walk to transit

| **YEAR:** | **2000** | **2003** | **2005** | **2010** | **2015** | **2020** | **2025** |
|---|---|---|---|---|---|---|---|
| **Household Income** | | | | | | | |
| Under $20,000 | 33.78 | 31.72 | 31.17 | 32.88 | 34.39 | 35.11 | 34.82 |
| $20-40,000 | 24.2 | 21.64 | 20.96 | 22.3 | 23.53 | 25.39 | 25.92 |
| $40-60,000 | 18.6 | 17.09 | 16.74 | 16.97 | 18.65 | 20.29 | 20.4 |
| Over $60,000 | 16.75 | 16.34 | 16.19 | 15.84 | 18.19 | 19.19 | 18.99 |
| All Incomes | 24.3 | 22.35 | 21.91 | 22.47 | 24.4 | 25.57 | 25.71 |

%walkable employment within 50 minutes - drive to transit

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Under $20,000 | 19.53 | 19.07 | 18.58 | 22.04 | 22.08 | 21.9 | 21.73 |
| $20-40,000 | 17.98 | 17.39 | 16.78 | 19.49 | 19.89 | 19.91 | 19.86 |
| $40-60,000 | 14.65 | 13.97 | 13.53 | 15.62 | 15.83 | 15.83 | 15.52 |
| Over $60,000 | 16.98 | 16.75 | 16.46 | 19.35 | 19.67 | 20.39 | 20.07 |
| All Incomes | 17.27 | 16.78 | 18.24 | 19.08 | 19.33 | 19.45 | 19.24 |





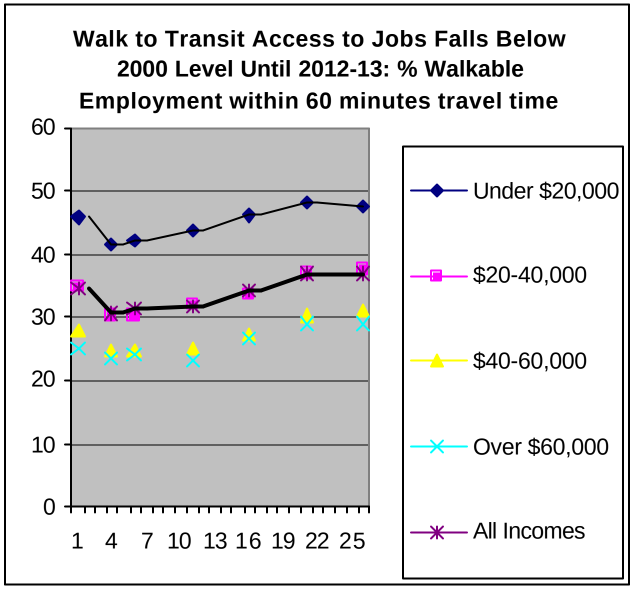
Source for all data: Atlanta Regional Commission, "Transportation Solutions for a New Century", Appendix V, Model Output, Table 3-21, March 2000

%walkable employment within 60 minutes - walk to transit

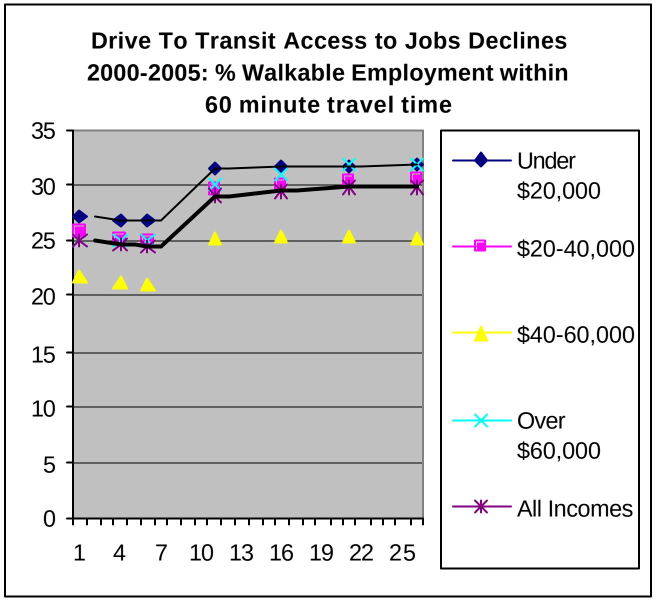
| **YEAR:** | **2000** | **2003** | **2005** | **2010** | **2015** | **2020** | **2025** |
|---|---|---|---|---|---|---|---|
| **Household Income** | | | | | | | |
| Under $20,000 | 45.88 | 41.56 | 42.08 | 43.89 | 46.12 | 48.11 | 47.57 |
| $20-40,000 | 35.09 | 30.35 | 30.48 | 31.97 | 33.74 | 37.04 | 37.61 |
| $40-60,000 | 27.98 | 24.61 | 24.87 | 24.9 | 27.42 | 30.44 | 31.07 |
| Over $60,000 | 24.97 | 23.57 | 24.02 | 23.21 | 26.79 | 29.02 | 29.11 |
| All Incomes | 34.66 | 30.8 | 31.16 | 31.59 | 34.15 | 36.86 | 37.05 |

%walkable employment within 60 minutes - drive to transit

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Under $20,000 | 27.15 | 26.83 | 26.69 | 31.62 | 31.82 | 31.84 | 31.99 |
| $20-40,000 | 25.84 | 25.34 | 25.02 | 29.57 | 30 | 30.35 | 30.55 |
| $40-60,000 | 21.86 | 21.23 | 21.08 | 25.3 | 25.38 | 25.5 | 25.28 |
| Over $60,000 | 25.15 | 24.99 | 25.05 | 30.04 | 31.02 | 32 | 31.9 |
| All Incomes | 24.99 | 24.58 | 24.42 | 29.09 | 29.5 | 29.86 | 29.88 |



**Walk to Transit Access to Jobs Falls Below 2000 Level Until 2012-13: % Walkable Employment within 60 minutes travel time**



**Drive To Transit Access to Jobs Declines 2000-2005: % Walkable Employment within 60 minute travel time**

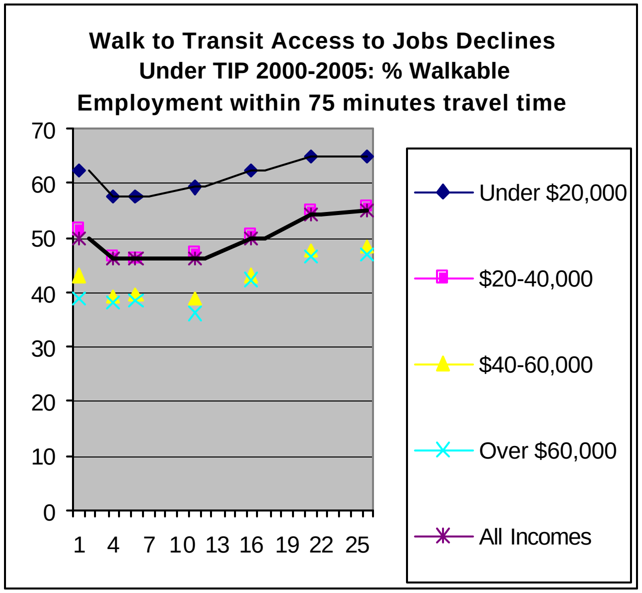
Source for all data: Atlanta Regional Commission, "Transportation Solutions for a New Century", Appendix V, Model Output, Table 3-21, March 2000

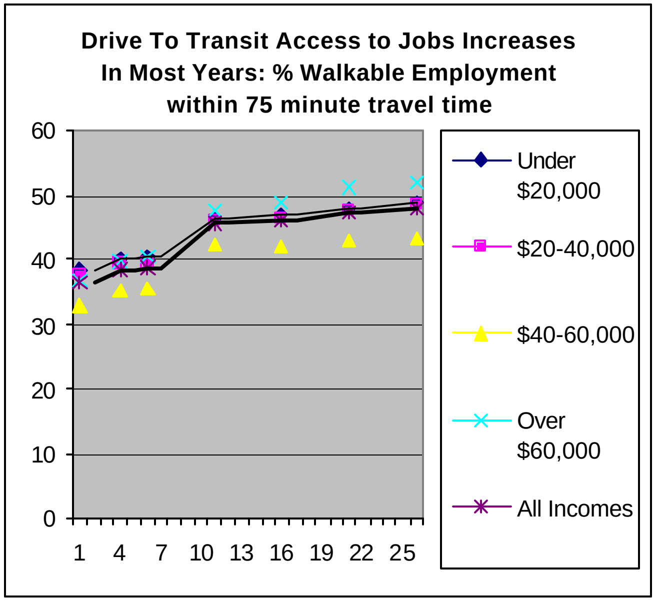
%walkable employment within 75 minutes - walk to transit

| **YEAR:** | **2000** | **2003** | **2005** | **2010** | **2015** | **2020** | **2025** |
|---|---|---|---|---|---|---|---|
| **Household Income** | | | | | | | |
| Under $20,000 | 62.17 | 57.86 | 57.72 | 59.17 | 62.22 | 65.12 | 64.93 |
| $20-40,000 | 51.38 | 46.48 | 46.21 | 47.39 | 50.35 | 54.97 | 55.75 |
| $40-60,000 | 43.08 | 39.33 | 39.45 | 38.77 | 43.03 | 47.88 | 48.6 |
| Over $60,000 | 38.85 | 37.97 | 38.35 | 36.29 | 42.12 | 46.48 | 46.99 |
| All Incomes | 50.18 | 46.31 | 46.32 | 46.1 | 50.12 | 54.34 | 54.81 |

%walkable employment within 75 minutes - drive to transit

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Under $20,000 | 38.46 | 39.86 | 40.21 | 46.34 | 46.74 | 47.92 | 48.87 |
| $20-40,000 | 37.58 | 39.22 | 39.32 | 45.83 | 46.2 | 47.53 | 48.46 |
| $40-60,000 | 32.88 | 35 | 35.44 | 42.34 | 42 | 42.94 | 43.24 |
| Over $60,000 | 36.72 | 39.61 | 40.48 | 47.59 | 48.75 | 51.04 | 51.77 |
| All Incomes | 36.42 | 38.42 | 38.83 | 45.48 | 45.87 | 47.29 | 48.02 |


**Walk to Transit Access to Jobs Declines Under TIP 2000-2005: % Walkable Employment within 75 minutes travel time**


**Drive To Transit Access to Jobs Increases In Most Years: % Walkable Employment within 75 minute travel time**

Source for all data: Atlanta Regional Commission, "Transportation Solutions for a New Century", Appendix V, Model Output, Table 3-21, March 2000

**Attachment 4:**

# Induced Demand and Regional Transportation Models:

## Summary of Recent Studies and Application to Evaluate a Regional Transportation Planning Model

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**Prepared for Environmental Defense**
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**Washington, DC**

**July 2002**

Transportation investments and policies have many impacts and these are often examined using regional transportation planning models. Among the key impacts is induced traffic, which can have a profound impact on air pollution, congestion, and transportation system performance. This paper summarizes recent studies of induced traffic and shows how induced traffic can be measured in a regional travel models to evaluate their adequacy to evaluate the likely future performance of regional transportation systems under different investment and policy scenarios.

DeCorla-Souza and Cohen define "induced demand" as an: "increase in daily vehicle miles of travel (VMT), with reference to a specific geographic context, resulting from expansion of highway capacity."[1] This definition includes both short-term effects and long-term effects. The short-term effects include more trips, longer trips, more auto trips, and auto trips with lower occupancies. The long-term effects follow land use changes caused by expanded roadway capacity.

Over the past several years, a series of national studies have been published quantifying the induced travel effect. The measure used in most studies is *elasticity*, a basic concept of economics. When the supply of a good or service increases, its price drops. When the price drops, consumption of the product increases. For the majority of Americans, the incremental cost of operating cars is low enough that the perceived cost is primarily travel time. An increase in lane miles of road capacity (supply) causes a near-term decrease in travel time (price), which in turn leads to an increase in vehicle miles traveled (consumption).

Elasticity is calculated as the ratio of the change in consumption divided by the change in supply. For example, if a 10 percent increase in vehicle miles traveled is caused by a 10 percent increase in lane miles, the elasticity is:

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[1]. DeCorla-Souza, P. and H. Cohen. Accounting for Induced Travel in Evaluation of Metropolitan Highway Expansion. TRB 77th Annual Meeting Preprint CD-ROM, TRB, National Research Council, Washington D.C., January 1998.

10 percent / 10 percent = 1.0.

Alternatively, if a 5 percent increase in vehicle miles traveled is caused by a 10 percent increase in lane miles, the elasticity is:

5 percent / 10 percent = 0.5.

Research findings from five studies presented at recent Transportation Research Board Annual Meetings are directly comparable and are summarized in Table 7.

Table 7: Long-Term Regional Elasticity of Vehicle Miles Traveled to Lane Miles

| Study | Long-term regional elasticity |
|---|---|
| Hansen [2] [3] | 0.9 |
| Noland [4] | 0.7 - 1.0 |
| Fulton et. al.[5] | 0.5 – 0.8 |
| Noland and Cowart [6] | 0.904 |
| Marshall [7] | 0.76 arterials, 0.85 highways |
| Average of five studies (highways) | 0.83 |

**Analysis of Regional Travel Model Sensitivity to Induced Traffic.** To illustrate how regional travel model performance in measuring induced traffic can be evaluated, we examine the model used in 2001 by the Baltimore Metropolitan Council and compare it to a similar regional sketch model developed in early 2002 for the Vision 2030 initiative in Baltimore.

To determine the sensitivity of the BMC model to induced travel demand effects, two separate model runs were performed using the BMC regional travel demand model. First, the model was run using the BMC 2025 land use scenario and the 1996 highway network. The model was then run again using the BMC 2025 land use scenario with the 2025 highway network. By using the same land use inputs, we can

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[2] Hansen, M. The Traffic Inducement Effect: Its Meaning and Measurement. In Transportation Research Circular Number 481 (Summary of Panel Session at 1997 Annual Meeting of the Transportation Research Board: *Highway Capacity Expansion and Induced Travel – Evidence and Implications*. TRB, National Research Council, Washington D.C., February 1998, pp. 7-15.

[3] Hansen, M. and Y. Huang. Road Supply in California. *Transportation Research A*, Vol. 31, No. 3, 1997, pp. 205-218.

[4] Noland, R. Relationships Between Highway Capacity and Induced Vehicle Travel. TRB 78th Annual Meeting Preprint CD-ROM, TRB, National Research Council, Washington D.C., January 1999.

[5] Fulton, Lewis M., Daniel J. Meszler, Robert B. Noland, and John V. Thomas. Statistical Analysis of Induced Travel Effects in the U.S. Mid-Atlantic Region. TRB 79th Annual Meeting Preprint CD-ROM, TRB, National Research Council, Washington D.C., January 2000.

[6] Noland, Robert B. William A. Cowart. Analysis of Metropolitan Highway Capacity and the Growth in Vehicle Miles of Travel. RB 79th Annual Meeting Preprint CD-ROM, TRB, National Research Council, Washington D.C., January 2000.

[7] Marshall, Norman L. Evidence of Induced Demand in the Texas Transportation Institute's Urban Roadway Congestion Study Data Set. TRB 79th Annual Meeting Preprint CD-ROM, TRB, National Research Council, Washington D.C., January 2000.

determine the effect of the transportation capacity improvements in the 2025 highway network. Table 8 contains the results of the two BMC model runs.

To determine the sensitivity of the sketch model to induced demand effects, two separate model runs were again performed this time using the sketch travel demand model. First, the model was run using the 2030 land use inputs developed for the Vision 2030 Highway scenario and the 1996 highway network. The model was then run again using the 2030 Highway land use scenario with the 2025 highway network. Table 9 contains the results of the two sketch model runs.

Table 8: Induced Demand Sensitivity of the BMC Model

| | Vehicle Miles of Travel (VMT) | Lane Miles (LM) |
|---|---|---|
| 2025 BMC land use with 1996 network | 19,323,453 | 8,514 |
| 2025 BMC land use with 2025 network | 19,469,459 | 9,283 |
| % Change | 0.76% | 9.03% |

| | |
|---|---|
| % Change VMT / % Change LM | 0.08 |

Table 9: Induced Demand Sensitivity of the Sketch Model

| | Vehicle Miles of Travel (VMT) | Lane Miles (LM) |
|---|---|---|
| 2030 Highway Scenario land use with 1996 network | 18,757,041 | 8,514 |
| 2030 Highway Scenario land use with 2025 network | 19,306,043 | 9,283 |
| % Change | 2.93% | 9.03% |

| | |
|---|---|
| % Change VMT / % Change LM | 0.32 |

The elasticity of vehicle miles of travel with respect to lane miles for the BMC model is only 0.08. The elasticity of vehicle miles of travel with respect to lane miles for the improved sketch model is 0.32. Although the sketch model does not capture induced demand to the same degree as the published research, the sketch model gives a much more realistic induced travel demand response than does the BMC travel demand model.

> This is important that induced demand is properly accounted within the Vision 2030 process, so that the benefits of new roadways are not overestimated. This is also critical in roadway planning, and in estimating air emissions.

For further information, see, Smart Mobility, Inc., *Baltimore Vision 2030: Sketch Travel Demand Model Adapted from the Baltimore Metropolitan Council Regional Travel Model,* Baltimore Regional Partnership, Baltimore, Maryland, April 2002.

**Attachment 5:**

# Preliminary
# Toxicological Review
# of
# Roadway Traffic Pollution

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# 1.0 EXECUTIVE SUMMARY

Roadway traffic generates a complex mixture of particles and gases. In particular, diesel exhaust continues to be a major focus of research and public health concern, both in the United States and internationally, due to the large amounts of ultrafine particulate matter and known carcinogens such as benzene, formaldehyde, 1,3 butadiene and polycyclic aromatic hydrocarbons including benzo(a)pyrene that are released. The constituents of roadway traffic emissions, either singularly or in combination, have demonstrated toxicological properties that are either known to cause or are suspected of causing a variety of health effects in individuals that are exposed to them.

From an acute exposure standpoint, diesel exhaust is a strong irritant and may cause a variety of inflammation related symptoms including respiratory irritation, asthma-like reactions, eye irritation, headaches and nausea. The primary chronic health concerns include nonmalignant respiratory and cardiovascular disease, exacerbation or initiation of allergic hypersensitivity and lung cancer.

An ever-growing body of research reported in the literature demonstrates excessive morbidity and mortality in populations that are in close proximity to heavily trafficked roadways. Our understanding of the magnitude of these adverse health impacts has increased as improved scientific methods for spatial and temporal resolution have refined the exposure estimates for roadway traffic emissions for nearby residents.

Analysis of published data for traffic emission factors and the resulting exposure estimates demonstrates that uncontrolled expansion of roadways will significantly increase exposures to both fine particulate matter and air toxins by the population in the contiguous residential corridor. This is significant because several epidemiological studies have shown that levels of fine particulate matter typically found adjacent to heavily trafficked roadways are comparable to levels that can exacerbate both acute and chronic respiratory disease symptoms and cause premature death among sensitive populations. This finding applies to short-term exposures of a few hours to one or several days. With regard to air toxins, exposures experienced by roadway corridor residents are likely to equal and probably exceed the air toxins levels measured at monitoring sites located near heavily traveled highways and reported in the Multiple Air

Toxics Emissions Study II Study. Risk estimates based on the levels reported in the Multiple Air Toxics Emissions Study II resulted in an unacceptably high cancer risk of approximately 1 in 1,000 to 1 in 650 that was attributed to diesel exhaust and other motor vehicle emissions. The relative impact on other roadway corridor populations could be commensurate with the increased exposures to motor vehicle pollution that would result from their proximity to the large numbers of additional vehicles traveling the expanded highway.

Many current environmental assessments have not properly accounted for the differential impact that could be imposed on the nearby the population adjacent to expanded highways. This analysis of available data demonstrates that a detailed program of pollutant monitoring and modeling that are specific for the planned expansion should be undertaken to properly quantify the potential adverse health impacts associated with projects of this type.

## 2.0 INTRODUCTION

Roadway traffic generates a complex mixture of particles and gases. The constituents, either singly or in combination, have demonstrated toxicological properties. Some compounds are known to cause a variety of health effects and others are suspected of causing a variety of health effects in individuals exposed to them. Table 2.1 presents a list of compounds commonly released from motor vehicles and their primary expected adverse health effects. Many of these compounds are related to diesel exhaust while others are also associated with gasoline powered vehicles.

**Table 2.1** Selected Components of Diesel Exhaust and Potential Health Impacts

| Compound | CAS Number | Carcin-ogen | Cancer Unit Risk Factor (per 1 ug/m$^3$) | Respiratory Effects | Neurological Effects | Sensitizing Agent |
|---|---|---|---|---|---|---|
| Acetaldehyde | 75-07-0 | Yes | 2.2E-06 | Yes | No | No |
| Acrolein | 107-02-8 | No | NA | Yes | No | No |
| Anthracene | 120-12-7 | No | NA | Yes | Yes | Yes |
| Benzaldehyde | 100-52-7 | No | NA | Yes | Yes | Yes |
| Benzene | 71-43-2 | Yes | 2.2 to<br>7.8 E-06 | Yes | Yes | No |
| Benzo(a)anthracene | 56-55-3 | No | NA | NA | NA | NA |
| Benzo(a)pyrene | 50-32-8 | Yes | 2.9E-5 (A) | No | No | No |
| Benzo(b)fluoranthene | 205-99-2 | Yes | 1.1E-4 (A) | NA | NA | NA |
| Benzo(g,h,i)perylene | 191-24-2 |  | NA | NA | NA | NA |
| Benzo(j)fluoranthene | 205-82-3 | Yes | 1.1E-4 (A) | NA | NA | NA |
| Benzo(k)fluoranthene | 207-08-9 | Yes | 1.1E-4 (A) | NA | NA | NA |
| 1,3-Butadiene | 106-99-0 | Yes | 2.8E-04 | Yes | Yes | No |
| Cadmium | 7440-43-9 | Yes | 1.8E-03 | Yes | No | No |
| Chrysene | 218-01-9 | Yes | 1.1E-5 (A) | Yes | No | No |
| Crotonaldehyde | 123-73-9 | No | NA | Yes | No | No |
| Diesel Particulate Matter | NA | Yes | 3.0E-4<br>(A,B) | Yes | No | No |
| Ethyl benzene | 100-41-4 | No | NA | NA | NA | NA |
| Fluoranthene | 206-44-0 | No | NA | NA | NA | NA |
| Formaldehyde | 50-00-0 | Yes | 1.3E-05 | Yes | No | Yes |
| Indeno(1,2,3-cd)pyrene | 193-39-5 | Yes | 1.1E-4 (A) | NA | NA | NA |
| Lead compounds | 7439-92-1 | Yes | 1.2E-5 (A) | No | Yes | No |
| Manganese compounds | 7439-96-5 | No | NA | Yes | Yes | No |
| Methyl tert-butyl ether | 1634-04-4 | No | NA | No | No | No |
| Naphthalene | 91-20-3 | No | NA | Yes | Yes | No |
| Nickel compounds | 7440-02-0 | Yes | 2.6E-4 (A) | Yes | Yes | Yes |
| 1-Nitropyrene | 5522-43-0 | Yes | 1.1E-4 (A) | NA | NA | NA |
| Nitrogen oxides (NOx) | 10102-44-0 | No | NA | Yes | No | No |
| Phenanthrene | 85-01-8 | No | NA | NA | NA | NA |
| Phenol | 108-95-2 | No | NA | Yes | Yes | No |
| Pyrene | 129-00-0 | No | NA | Yes | No | No |
| Toluene | 108-88-3 | No | NA | No | Yes | No |
| Xylenes (mixed) | 1330-20-7 | No | NA | No | Yes | No |

Note: All information, unless otherwise noted, is from U.S. Environmental Protection Agency. IRIS. Integrated Risk Information System. [Database, online.] Cincinnati, OH: EPA. Available from: http://www.epa.gov/iris.

NA: Not available

A: From toxic air contaminant document, Office of Environmental Health Hazard Assessment, California, as cited in Air Toxics Hot Spots Program Risk Assessment Guidelines, Part II Technical Support Document for Describing Available Cancer Potency Factors. April 1999.

B: Listed as "Reasonable Estimate" by California Air Resources Board (Range = 1.3E-4 to 1.5E-3 [(mg/m$^3$])

Evidence from Pearson and colleagues (2000) shows an association between an elevated incidence of childhood leukemia and children's exposure to higher than regional urban background concentrations of motor vehicle emissions. Brunekreef and colleagues (1997) show that adverse health outcomes, including premature mortality and increased morbidity from increased respiratory and cardiovascular effects, are associated with the increase in ambient fine particulate matter, e.g., particles less than 2.5 microns in diameter ($PM_{2.5}$) from roadway sources. The recent Multiple Air Toxics Emissions Study II (MATES II) performed by the South Coast Air Quality Management District for the Los Angeles air basin (SCAQMD 1999) also shows increases in cancer risk due to the presence of known carcinogens such as benzene, formaldehyde, 1,3 butadiene, benzo(a)pyrene and other chemical species found in diesel particulate matter. Furthermore, there is increasingly strong evidence that diesel exhaust may be a significant factor in initiating or exacerbating allergic hypersensitivity. Diesel exhaust is also a likely factor for increasing airway reactivity in those with asthma.

A number of uncertainties are involved in determining the magnitude of health hazards associated with pollutants generated by motor vehicles. However, sufficient information is available from both human studies and animal studies showing adverse health effects, including cancer, respiratory disease, and premature death among populations exposed to motor vehicle emissions at levels found in the urban atmosphere. The magnitude of these effects will be determined by several factors, including the frequency and duration of exposure, health status, interactions with other pollutants, and the differential impact on those individuals that have "hot spot" exposures or those found in heavily traveled freeway corridors. This evidence demonstrates that populations exposed to air pollutants from motor vehicles in excess of average regional urban concentrations are likely to experience a significantly elevated risk of adverse health effects, and that such risks are well above the levels of public health concern.

These factors argue for conduct of detailed, carefully considered analyses to ensure that an excessive exposure burden is not placed unjustly on a subset of the population.

## 3.0 CARCINOGENIC RISK

Roadway traffic generates many pollutants categorized as known or suspected human carcinogens or considered as potential carcinogens. Table 3.1 summarizes the current categorization of diesel exhaust as a carcinogen of by a variety of state, federal, and international organizations. These organizations are consistent in finding that experimental studies demonstrate that diesel exhaust is carcinogenic in rats and that the epidemiological data demonstrate that diesel exhaust, which is a mixture of many organic and inorganic compounds, is a potential or a probable human carcinogen. Table 3.2, developed from the MATES II Study (SCAQMD 1999), shows that diesel particulate is the overwhelming contributor to cancer risk in diesel exhaust.

**Table 3.1** Regulatory Positions on Cancer and Diesel Exhaust

| Agency | Animal Evidence | Human Evidence | Classification |
|---|---|---|---|
| NIOSH (1988) | Confirmatory | Limited | Potential carcinogen |
| IARC (1989) | Sufficient | Limited | Probable human carcinogen |
| WHO (1996) | Adequate | Inadequate | N/A |
| California EPA (1998) | Demonstrated carcinogenicity | Causal association reasonable and likely | Diesel PM designated toxic air contaminant |
| USEPA draft (1999) | Highly likely or likely | Highly likely or likely | Under review |
| NIEHS (2000) | Consistent tumor development | Reasonable | Reasonably anticipated to be a human carcinogen |

**Table 3.2** Unit Risk Factor (URF) Weighted Emissions from MATES II Draft Report

| Species | Emissions (lbs/day) | URF ($x10^{-6}$) | URF Weighted Emissions |
|---|---|---|---|
| Diesel emissions other than "diesel particulate" | | | |
| Benzene | 834 | 29 | 24,186 |
| 1,3-Butadiene | 79 | 170 | 13,430 |
| Formaldehyde | 6,136 | 6 | 36,816 |
| Acetaldehyde | 3,066 | 2.7 | 8,278 |
| Cadmium | 1.54 | 4,200 | 6,468 |
| Lead | 0.68 | 12 | 8 |
| Nickel | 0.36 | 260 | 94 |
| ***Total*** | | | ***89,280*** |
| "Diesel particulate" emissions | | | |
| **Diesel Particulate** | **22,890** | **300** | **6,867,000** |

The Diesel Exhaust Report by the Health Effects Institute (1995) reported that a 20% to 40% greater incidence in lung cancer was found in certain occupations, such as railroad workers and truck drivers, that involved repeated exposures to diesel exhaust. Of particular relevance is the study of exposure to diesel particulate in long haul and city truckers reported by Steenland et al. (1998) where an exposure-response relationship was found. The personal, eight-hour exposures of these truck drivers were found to be similar to the ambient exposures of the general population and the "highway background" exposure (Zaebst et al. 1991). The health implications of such exposures for the general population remain to be determined.

# 4.0 NON-CANCER HEALTH EFFECTS OF DIESEL EXHAUST

## 4.1 RESPIRATORY EFFECTS

Several epidemiological studies published in peer reviewed journals by researchers both in the U.S. and Europe point to significant respiratory and cardiovascular health effects with short-term exposure to airborne particulate air pollution.

Brunekreef and colleagues (1997, 1999) found reduced lung function and increased respiratory symptoms in children living near roadways and linked it to air pollutants from motor vehicle emissions, particularly diesel exhaust. The six communities they analyzed were near roadways that carried between 80,000 and 152,000 vehicles per day. The truck traffic density over a 24-hour period ranged from 8,000 to approximately 17,000. Their findings showed a greater association between decrements in lung function and truck traffic density than that with automobile traffic density. Furthermore, they found a strong association with exposure and symptoms in children who lived less than 300 meters from the roadways.

Measured concentrations of black smoke, which is used as an indicator of diesel exhaust particles, and nitrogen dioxide were strongly correlated with distance of the monitoring station from the roadway. They found that impaired lung function was closely associated with the concentration of black smoke and proximity to the highway.

Several epidemiological studies (Dockery et al. 1993; Pope et al. 1995; Zmirou et al. 1998; Pope and Dockery 1999) have shown that short-term exposures to urban air pollution can play a significant role in both acute and chronic respiratory and cardiovascular disease. These studies show that episodes of particulate air pollution are associated with increased hospital admissions for patients with underlying heart disease. These effects have been shown to be significant at concentrations of $PM_{2.5}$ that are likely to be routinely exceeded by emissions from motor vehicles within 300 meters of heavily-trafficked roadways.

Mar et al. (2000) found that elemental carbon was significantly associated with cardiovascular mortality in Phoenix, Arizona. They attributed the elemental carbon fraction primarily to diesel exhaust.

### 4.2 ALLERGENIC RESPONSES

Components of diesel exhaust can act synergistically with bioaerosols, such as pollen, to initiate and increase the incidence of allergic airway disease in individuals (Diaz-Sanches et al. 1997). Diesel exhaust components at levels typically found in urban background hotspots can also exacerbate the onset of symptoms in an allergic individual (Ishizaki et al. 1987; Miyamoto 1997; Braun-Fahrlander et al. 1999).

### 4.3 AMBIENT EXPOSURES

Various studies have attempted to provide estimates for the contribution to fine particle mass concentrations made by diesel exhaust. Although direct comparison is hampered due to differences in analytical techniques and averaging times used, there is an overwhelming consistency in the trends observed, which adds further impetus for including a more careful evaluation of environmental impacts on populations located in close proximity to heavily trafficked roadways.

Of particular concern is the impact so-called "hot spots" can have on exposure. Although ambient diesel concentrations in urban and suburban areas are generally reported to range from approximately 1 to 5 $\mu g/m^3$, "hotspots," such as heavily traveled roadways and bus stops with a high density of diesel vehicles, can have concentrations ranging from 11 to 46$\mu g/m^3$. Table 4.1 is adapted from EPA's Draft Report (1999).

**Table 4.1** Ambient Diesel PM Concentrations Reported from Chemical Mass Balance Modeling (Adapted from EPA 1999)

| Author | Location | Location/ Exposure Type | Total $PM_{2.5}$ (std dev), mg/m$^3$ | Diesel PM2.5 (std dev), mg/m$^3$ |
|---|---|---|---|---|
| Schauer et al. 1996, Southern California | West LA | Urban/Traffic | 24.5 (2.0) | 4.4 (0.6) |
| | Pasadena | Urban/Traffic | 28.2 (1.9) | 5.3 (0.7) |
| | Rubidoux | Suburban/Traffic | 42.1 (3.3) | 5.4 (0.5) |
| | Downtown LA | Urban/Traffic | 32.5 (2.8) | 11.6 (1.2) |
| Chow et al. 1991 | Phoenix, AZ area | Urban/Traffic | NA | 4-22$^a$ |
| California EPA 1998a | 15 Air basins | Rural-urban/Traffic | NA | 0.2-3.6$^a$ |
| Federal Highway Administration 1997 | Manhattan, NY | Urban/Bus Stop | 35.8-83.0 | 13.2-46.7$^a$ |
| NFRAQS 1998 | Welby, CO | Urban/Traffic | 16.7 | 1.7 |
| | Brighton, CO | Suburban/Traffic | 12.4 | 1.2 |

a PM$_{10}$
NA Not available

Other studies have shown that diesel PM in enclosed vehicles driving on Los Angeles roadways range from nearly 3 μg/m$^3$ to 36 μg/m$^3$ (California EPA 1998b). Samples collected near the Long Beach Freeway (California EPA 1998a) indicate that diesel contributions range from daily averages of nearly 1 μg/m$^3$ to 7.5 μg/m$^3$.

Brunekreef and colleagues (1997) found that adverse health effects were associated with diesel particulate levels near roadways in the Netherlands between 7 μg/m$^3$ and 21 μg/m$^3$ of diesel particulate matter (measured with black smoke). Such concentrations were measured at monitoring stations within 300 meters of roadways.

## 5.0 CONCLUSION

The wide range of particulate matter concentrations, a large fraction of which can attributed to diesel exhaust, obtained in the studies referred above indicate adverse health effects can reasonably be anticipated among populations exposed to motor vehicle emissions. However, site specific analysis would be required to appropriately assess and quantify the expected health impacts for any specific exposed population. "Hotspots" such as heavily traveled roadways, bus stops and train stations, have an extraordinary impact on localized exposures. Utilizing data from studies such as Brunekreef and colleagues (1997) and modeling studies evaluated as part of this review, it is likely that a significantly increased risk of experiencing the adverse impacts associated with motor vehicle emissions would extend 300 to 400 meters from the roadway for populations exposed in that area for a significant period of time. These populations would include persons residing, attending school and working in such areas, and persons traveling for extended periods in highway corridors.

In summary, both the epidemiological data and toxicological evidence reviewed indicate there would be a significantly increased risk of adverse health outcomes through increased carcinogenic risk and effects on the respiratory and cardiovascular systems among populations exposed to concentrations of motor vehicle emissions expected to be found in the vicinity of heavily traveled highways. The data support that under conditions typically reported in monitoring and modeling studies of motor vehicle emissions in the vicinity of heavily traveled highways, concentrations of diesel-related air pollutants alone are high enough to trigger unacceptable health risks. The risk of adverse health effects is further increased when concentrations of gasoline-related air pollutants are added.

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# ATTACHMENT 6: REVIEW OF EXPOSURE TO TOXIC AIR POLLUTANTS FROM MOBILE SOURCES AND THE IMPACT OF EXPANSION OF US 95 IN LAS VEGAS, NEVADA

## INTRODUCTION

An Environmental Impact Statement (EIS) has been prepared by the Nevada Department of Transportation for improvement and expansion of US-95 in Las Vegas. These improvements will include the widening of US 95 to 10 lanes from Rainbow to I-15 (5 miles) and widening to 6 lanes from Craig to Rainbow (5 miles) plus other traffic expansion measures. The result will be to increase average annual vehicle trips in the widened area and facilitate additional traffic flows on adjoining highways and arterials. As a result vehicle travel in the US 95 corridor near the I-15 interchange would be expected to increase from 200,000 average annual daily vehicle trips (AADT) in 2000 to 230,300 by 2020, and north of Summerlin the increase will be from 122,000 in 2000 to 212,500 in 2020[1]. The EIS provides a brief evaluation of the impact of additional traffic-generated carbon monoxide, but it does not deal with a wide range of other air pollutants emitted from motor vehicles. This omission includes the 21 air contaminants from motor vehicles that are classified by EPA as toxic or hazardous air pollutants[2]. These pollutants are listed in Table 1 below.

The importance of these hazardous pollutants to public health has increasingly been recognized in recent literature as the result of comprehensive emission and exposure studies[3], as well as by additional public health evidence reviewed by EPA as summarized in the Technical Support Document issued in support of the MSAT list published pursuant to § 201(l) of the Clean Air Act, and in a report prepared on the US 95 project by Dr. Jack McCarthy of Environmental Health and Engineering. Based on results in studies from major US cities, there is ample basis to conclude that the levels of exposure to air toxics from motor vehicles present a significant risk of adverse health effects in human populations. These adverse health risks should be thoroughly reviewed in a Supplemental EIS for the US 95 project. This conclusion is derived from the application of studies of other cities to the specific situation along US 95 in Las Vegas. An evaluation of the applicability of studies from Los Angeles and elsewhere follows.

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[1] Letter from Adiyana Sharag-Eldin, Principal Planner, Regional Transportation Commission (RTC), Las Vegas Nevada to Colin High, Resource Systems Group Inc., White River Junction VT, dated October 9, 2001 with reference to 2000 AADT and with repect to 2020 estimates a letter from Stan Andersen, RTC to Pat Galllagher, Sierra Club San Francisco dated August 22, 2000 and confirmed in the letter of Adiyana Sharag-Eldin to Colin High dated October 9, 2001 cited asbove.

[2] Control of Emissions of Hazardous Air Pollutants from Mobile Sources," published March 29, 2001. 66 FR 17,229

[3] California South Coast Air Quality Management District , Multiple Air Toxics Exposure Study (MATES II) November 1999.

**Table 1: List of toxic air emissions from motor vehicles**

| |
|---|
| Acetaldehyde |
| Acrolein |
| Arsenic compounds |
| Benzene |
| 1,3-Butadiene |
| Chromium |
| Dioxins/ Furans |
| Diesel Particulate Matter and Diesel Exhaust Organic Gases |
| Ethyl benzene |
| Formaldehyde |
| n-Hexane |
| Lead compounds |
| Manganese compounds |
| Mercury compounds |
| Methyl tert-butyl ether MTBE |
| Naphthalene |
| Nickel compounds |
| Polycyclic Organic Matter |
| Styrene |
| Toluene |
| Xylenes |

## ESTIMATION OF PRESENT AND FUTURE MOTOR VEHICLE AIR TOXIC LEVELS

The present exposure to air toxics from motor vehicles can be estimated for the Las Vegas area and for areas adjacent to major highways by extrapolation from the results of the Multiple Air Toxics Exposure Study (South Coast Air Quality Management District, 2000)(“MATES II”) [1]. The MATES II study showed that regional exposures to toxic air pollutants are high enough to cause a significant risk of cancer to exposed populations, that the risk is higher for populations exposed within 2 kilometers of major freeway corridors, and that mobile source emissions account for 90% of the cancer risk attributable to all sources of toxic air pollutants.

The MATES II study did not estimate other adverse health outcomes in addition to cancer risk. The toxic air pollutants emitted by mobile sources are also associated with other adverse health effects in addition to cancer, including respiratory, cardiovascular and allergenic effects. These effects should also be characterized in a Supplementary EIS for the project.

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[1] op cit

The MATES II study carried out by California's South Coast Air Quality Management District used an air dispersion model to estimate the regional concentration of air toxics emissions from motor vehicles and other sources in the Greater Los Angeles Basin. As part of the MATES II study, these air contaminants also were measured in the ambient air at 10 regional sites and 14 microscale sites in the Los Angeles Basin. Thirty one air toxics were considered, including the mobile source derived emissions considered most significant to human health, such as benzene, 1,3, butadiene, formaldehyde, acetaldehyde, polycyclic organic matter and diesel particulate matter (DPM). Most of these air toxics are carcinogens. The results of the MATES II study showed that the air quality model underestimated actual measured concentrations at most of the 10 regional monitoring sites, but showed consistently close correlations among predicted and measured values to validate the modeling results.

The emission rates for the regional fleet of vehicles in the MATES II study was derived from the State of California EMFAC model and from air toxics speciation provided by the California Air Resources Board (CARB). The air dispersion model used the inventory of mobile source and industrial air toxics emissions for the Los Angeles area. The model was regional in scale and it produced estimates of the average concentrations in two kilometer square areas throughout the region. The model was able to distinguish between ambient concentrations derived from mobile sources and other sources.

The conclusion of the study was that the aggregate cancer risk for all air toxics in the Los Angeles basin was 1,400 in a million (1 in 710). The range of risk is between 1,120 in a million (1 in 890) and 1,740 in a million (1 in 570). Of the total cancer risk 90% was contributed by emissions from all mobile sources and 50% by on-road vehicles[1]. Therefore the cancer risk attributable to on-road vehicles is approximately 700 in a million (1 in 1400). The MATES II study also concludes that the differences in risk levels between sites within the Los Angeles Basin is primarily related to mobile sources and concentrations are especially high in proximity to major highway corridors.

When the concentrations of the toxic air pollutants measured at the various monitoring sites are plotted on maps as given in the California MATES II study it becomes apparent that the highest concentrations of motor vehicle derived air toxics are concentrated along the major high traffic freeway corridors, such as US 101, I-10, I-405, I-110 and I-710 These highways AADT levels are between approximately 100,000 and 330,000 with AADT levels in the 200,000 range being most common in the central urban areas[2]. The AADT on impacted sections of US 95 in Las Vegas in 2000 was between 122,000 and 200.000 vehicles[3]. After widening, plus estimated growth in the corridor, the Regional Transportation Commission (RTC) projects that the AADT will range

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[1] MATES II, Executive Summary. and see the report by Dr. Jack McCarthy.

[2] State of California, Department of Transportation, Traffic Operations Division, 1998 Traffic Counts for Major Highways in Los Angeles County. http://svhqsgi4.dot.ca.gov/hq/traffops/saferesr/trafdata/1998all.htm

[3] Letter from Adiyana Sharag-Eldin, Principal Planner, Regional Transportation Commission, Las Vegas NV to Colin High Resource Systems Group Inc. White River Junction VT dated October 9, 2001.

from 212,500 to 230,300[1] an average increase of approximately 38%. AADT levels in Las Vegas at present and after the expansion will fall within the range of AADTs found in the Los Angeles Basin that was the subject of the MATES II study.

The percentage of diesel truck traffic of the total AADT on Las Vegas freeways, based on Nevada urban freeways data, is 7% and on urban interstate highways is 9%.[2] This is close but slightly higher than the percentage of trucks on the major freeways and interstates of Los Angeles, which is 6%[3].

Based on comparable AADTs, diesel truck percentages and toxics air emission rates from the highway vehicle fleet in the Las Vegas area, comparable ambient air concentrations for toxic air pollutants in the US 95 corridor are to be expected after discounting the contribution of non-road mobile source emissions. Estimates of regional motor vehicle related air toxics concentrations for the Las Vegas area are given in Table 2.

**Table 2: Estimated Air Toxics Exposure Concentrations from On-Road Motor Vehicle Derived Sources for the expanded section of US 95 in Las Vegas. Based on High Impact Highway Corridors in the MATES II Study[4]**

| **Pollutant** | **Ambient Concentration micrograms per cubic meter** |
|---|---|
| Benzene | 4.4 |
| 1,3 Butadiene | 1.7 |
| Diesel Particulate | 3.1 |

## ASSUMPTIONS AND RELIABILITY OF THE EXPOSURE ESTIMATES

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[1] Letter from Stan Andersen, RTC to Pat Galllagher, Sierra Club San Francisco dated August 22, 2000 and confirmed in the letter of Adiyana Sharag-Eldin to Colin High dated October 9, 2001 cited asbove.

[2] State of Nevada Department of Transportation , Traffic Reports http://www.nevadadot.com/reports_pubs/traffic_report/2000/pdfs/vcesal2000.pdf

[3] State of California, Department of Transportation, Traffic Operations Division, 1998 Traffic Counts for Major Highways in Los Angeles County. http://svhqsgi4.dot.ca.gov/hq/traffops/saferesr/trafdata/1998all.htm

[4] The ambient concentrations are estimated as 70% of highest modeled concentration shown in the MATES II study for benzene and 1,3 butadiene and 50% for diesel particulate to allow for the percentage of total exposure derived from on road vehicles sources compared with the total emissions of all sources given in the MATES II study. The percentages are based on emissions inventory data in the MATES II study in tables 4.2 and 4.3.

The exposure estimates discussed here are derived from the MATES II study in California. For a number of reasons, exposure estimates derived from the MATES II study will most likely underestimate maximum exposures in other locations. These include:

1) The MATES II study uses regional computer models and estimates exposures to air toxics at average levels within two kilometer squares, not at hot spot locations. Therefore, the estimates are not worst case nor do they represent the exposure levels for residences close to major highways. Exposure levels close to major highways will be higher, and depending on distance, wind direction and other factors, may be considerably higher. Modeling conducted by Resource Systems Group for several highway projects shows that exposures to both gaseous and particulate pollution emitted from highways is much greater close to the highway. The results of the modeling showed that air toxics concentrations derived from motor vehicles on the highway were approximately ten times higher at 40 meters from the highway than at 300 meters from the highway.

2) These estimates represent only a limited number of motor vehicle air toxics. The total exposure for all motor vehicle air toxics, and the total cancer risk, is greater.

3) The MATES II study is supported by monitoring data that shows the model tends to underestimate ambient exposure levels for air toxics by about 16%[1].

4) The MATES II study uses California motor vehicle air emission rates that in general, are lower for all vehicle types than the national emission rates that apply to the Las Vegas metropolitan area.

5) Diesel particulate, which is the largest single risk factor from motor vehicles, is measured and defined in slightly different ways in modeling and monitoring studies cited, and in the epidemiological literature used to assess the impact on public health. Although there are differences of opinion among experts in the field as to the most appropriate measure of diesel PM, it seems most probable that because of the way diesel particulate is defined in the MATES II study, the result is that total air toxics exposure is, if anything, underestimated rather than overestimated.

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[1] MATES II, Executive Summary, ES 5 and ES 6.

Overall the exposure estimates used in this report to estimate current cancer risk in the US 95 corridor are conservative, and likely underestimate actual exposures and the magnitude of the health hazard to nearby populations.

In the future there may be reductions in air toxics emissions rates as increasingly more stringent air emissions standards are applied to motor vehicles. However, the emissions reduction strategies for heavy-duty vehicles do not apply until 2007, are under judicial challenge, and are under review by the current Administration. If retained, they will not be implemented until late this decade and will not significantly reduce emissions from vehicles now on the road until those vehicles are replaced. Heavy-duty diesel trucks and buses may remain in use for 15 to 25 years with engine rebuilds.

In the short to intermediate term there will also be improved traffic flows on US 95 during peak hours that will increase average speeds and reduce the level of some non toxic air emissions. However, there is not any clear evidence that increased vehicle speeds during peak hours will significantly reduce overall emissions of air toxics.

## CONCLUSIONS

Based on the data provided by the RTC and discussed above the proposed expansion of US 95 is projected to increase to AADT levels 38% above 2000 levels. Because toxic air pollution is proportional to traffic levels we may expect a corresponding increase in air toxics levels in the areas close to the US 95 highway corridor. The US 95 expansion would increase traffic levels to volumes comparable to those in the Los Angeles Basin that were the subject of the MATES II study

This brief evaluation demonstrates that the proposed expansion of the highway will significantly increase the exposure of the public to air toxics in the neighborhoods along the US 95 corridor. The present and future levels of air toxics are probably at least comparable to levels in parts of Los Angeles adjacent to major freeways. These levels are associated with elevated cancer risk and other health problems as described in the separate report of Dr. Jack McCarthy. The present EIS ignores these significant public health risks. Because these emissions have a significant impact on the human environment, a Supplemental EIS is required to evaluate the health risks in the corridor and identify alternatives that can mitigate the health risk attributable to vehicle travel in the corridor.

# ■ A Critique of Transportation Planning Board Travel Demand and Air Emissions Models

**Revised: January 14, 2002**

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# Executive Summary

Metropolitan areas where air pollution levels seriously threaten public health are required by federal law to establish pollution control plans to limit emissions and then make sure that both short- and long-range transportation plans and decisions conform to those emission limits. If transportation plans are anticipated to exceed adopted pollution limits, state and local officials must adopt additional pollution controls or redirect their transportation spending away from projects that will increase pollution, traffic and sprawl. Computer models are a key foundation for this traffic and pollution analysis. They determine whether billions of dollars in transportation investments will lead to healthful air quality that protects public health, or whether these plans will degrade air quality and force higher pollution clean-up costs onto business and the public. These models also underlie critical state and local decisions about whether it makes sense to build new roads and bridges, to expand highways, and support new sprawl development, or to invest in better transit, sidewalks, and transit-oriented development.

The key body of state and local officials that carries out such activities in the national capital region is the Metropolitan Washington Council of Governments and its National Capital Region Transportation Planning Board (“TPB”), which serves as the region’s Metropolitan Planning Organization (“MPO”). Under Federal laws and regulations, MPOs are responsible for a set of regional planning activities including developing long-range transportation plans and demonstrating air quality conformity. Until recently, by margins that at times have been less than one percent, the TPB has claimed that its transportation plans and programs conform to adopted air quality plans. In mid-2001, TPB staff adjusted its emission estimates to recognize the much higher than previously assumed use of sport utility vehicles and light trucks in the region, revealing that the adopted transportation plan exceeds the adopted and legally binding regional motor vehicle air pollution limits. As a result the region cannot add new regionally significant highway projects to its transportation plan without offsetting the excess air pollution.

Our new, detailed review of the TPB traffic and emissions model has revealed additional deficiencies in assumptions and methods which have serious implications for air quality planning, the traffic projections for an additional Potomac River bridge, and other transportation project evaluations. Most notably:

- The computer model, and the way that its data have been manipulated, significantly overestimates future traffic growth and congestion, especially on major roads and bridges. This overestimation of future traffic demand can be falsely used to support the need for additional highway capacity, overestimating future congestion in no-build scenarios and overstating the benefits of constructing new roadway capacity.

- The model significantly underestimates expected air pollution from the region's cars and trucks especially for scenarios with increased roadway capacity. Correcting one key identified deficiency in the TPB model, for example, would result in an increase in the estimate of motor vehicle emissions of smog-producing volatile organic compounds by 12% compared with TPB’s estimate for 2005.

- The model fails to account properly for induced traffic that will be attracted to new roads and fails to reflect how people will shift travel in response to congestion. This biases the model against investment strategies favoring transit, walking, bicycling, and transit-oriented development.

- The model fails to account for the quality of conditions in neighborhoods for walking and bicycling, ignoring how these travel options affect transit use, car use, and trip-making and ignoring how support for these travel modes could help curb congestion and air pollution.

The TPB has been working on an improved model version for several years, but the version reviewed here is the one that has been used in developing the current long-range transportation plan and air quality conformity analysis, as well as in the preparation of many recent highway planning studies.

## Model Fails to Reflect Congested Travel Speeds

MPOs rely on computer models in these planning efforts. The models include separate but linked travel demand models and air quality models. Modeling activities are regulated by federal guidelines. TPB documentation states: “The feed back of congestion speeds resulting from the traffic assignment step is a federally mandated requirement for acceptable modeling practice.”

This requirement is not being adequately met by the TPB model. The documentation describes a congestion speed feedback step, but this step is too weak, and has little effect on the results. For non-work trips, there is no feedback at all. Without strong enough feedback, forecast traffic volumes in the model grow in an unrealistic unconstrained manner. This overestimation of future traffic demand can be falsely used to support the need for additional highway capacity.

## Irregularities in Calculations Lead to Underestimated Emissions

Air pollution is a function of vehicle miles of travel (VMT) and speed. The most serious air pollutant for transportation emissions in the Washington region is nitrogen oxide (NOx), a precursor of smog, which is harmful to public health. Vehicular emissions are high at low travel speeds, but it is less well known that NOx emissions increase at speeds greater than 40 m.p.h. Increasing speeds beyond this point increases NOx emissions. NOx emissions per mile at 65 m.p.h. are greater than at 2.5 m.p.h. The region cannot solve its NOx problem by building roads to increase travel speeds.

Several improper techniques are used to make the model results appear to maintain air quality conformity by lowering calculated NOx emissions. The TPB model invalidly shifts traffic from congested links to less congested travel periods on a link by link basis. This shift does not represent “peak spreading” because the shifts are done at a relatively high level of service, 30-35 m.p.h. for a large share of freeways, and because in some cases the afternoon peak hour is spread beyond midnight. This speed range of 30-35 m.p.h. is associated with minimum emissions per VMT for NOx, the region’s most critical pollutant. Calculated emissions for the most congested periods are reduced by shifting the traffic from one period to another while simultaneously lowering the travel speed to 30-35 m.p.h. for adjacent time periods.

Without these invalid assumptions about the speed characteristics of traffic on road links congested above a 1.6 V/C ratio for emissions analysis, calculated NOx emissions in 2005 would be 1.4 percent greater. This increase of 2.2 tons per day would cause the region to exceed the maximum allowed under the adopted state air quality control plans by 1.7 tons per day. In addition, calculated VOC emissions in 2005 would be 12.4 percent greater. This increase of 12.6 tons per day would also cause the region to exceed significantly the maximum allowed in the air quality control plans. Other deficiencies in the MWCOG modeling methods, such as the use of a sharply dampened travel time feedback for congested road links in the travel demand analysis process, contribute to additional underestimation of emissions. This makes it likely that unless steps are taken to correct the MWCOG models and their emission estimates, the Washington metropolitan area will find itself continuing to violate existing Clean Air Act air quality standards even after 2005, threatening public health.

## Conclusions

The weakness of the TPB model's treatment of congestion speed feedback on travel demand makes it one of the poorest of large metropolitan travel demand models in capturing the effects of induced travel demand resulting from new highway construction. With these problems, the TPB travel demand model overestimates travel demand in the future, and overestimates the benefits of proposed highway improvements.

These problems are especially acute in past studies of potential new Potomac River bridge crossings, all of which were based on this model or previous versions of the model. The American Legion Bridge on I-495 highlights these problems. This bridge is the closest existing Potomac River crossing to any of the proposed "Techway" routes. In 2025, the forecast traffic volume on the bridge is 77,000 vehicles per day higher (30 percent) assuming the same capacity as in 2001. The speed being fed back to the trip distribution model declines by 15 percent. If parameters recommended in the research literature were applied, the reduction in speed would be either by 60 percent (Speiss function) or 90 percent (BPR function). However, this great an increase would not occur. A proper model would produce an intermediate result – an increase in peak hour/peak direction travel due to growth in population and employment, but much less of an increase than assumed in the TPB model. The TPB model includes only very weak feedback for work trips and no feedback at all for no-work trips. Therefore, it does not accurately model shifts in destination, mode, and travel time in response to increased congestion.

As the TPB model can not properly forecast reductions in VMT as a result of congestion, it can not properly forecast increases in VMT that will result from increases in roadway capacity. In the context of Potomac River crossings, future traffic volumes on the existing bridges, including the American Legion Bridge, are surely overestimated in scenarios with no new bridges.

Any forecast travel time savings with a new bridge would be at least partially offset by increased congestion caused by induced travel, including congestion at roadways leading to and from any new bridges. The TPB model overstates the benefits of new roadway capacity, and underestimates the costs, including the effects of increased traffic in other areas.

The TPB and the Metropolitan Washington Air Quality Committee (MWAQC) have recently appointed a task force to recommend strategies to reduce air pollution to compensate for the excess emissions from increased use of sport utility vehicles and light trucks in the region. There are a number of strategies that could be used to solve this emission budget shortfall within the transportation planning process, for example by delaying some traffic-inducing road projects to accelerate funding of new bus and railcar purchases, promoting employer-paid commuter transit benefits, and investing in bicycle and pedestrian access to schools and transit stops.

The TPB has recommended that about half of this emission budget shortfall be eliminated – on paper - simply by adjusting what it believes to be faulty model assumptions about the composition of traffic on local roads and accessing park-and-ride lots in the region. Any modification of the TPB models to refine the analysis of traffic and its emissions should also correct the deficiencies noted in this report. Failure to do so would raise serious questions about compliance of the region’s planning process with the Clean Air Act regulations guiding modeling and use of the latest and best planning assumptions.

# Deficiencies in TPB Model and Application

## Overview

The Metropolitan Washington Council of Governments National Capital Region Transportation Planning Board (“TPB”) is the region’s Metropolitan Planning Organization (“MPO”). Under Federal laws and regulations, MPOs are responsible for a set of regional planning activities including developing long-range transportation plans and demonstrating air quality conformity.

MPOs rely on computer models in these planning efforts. The models include separate but linked travel demand models and air quality models.

## Travel Demand Modeling

The TPB travel demand model is a “four-step” model similar to those in use in other regions in the United States. The four steps are:

1) Trip Generation – Origins and destinations are calculated for each transportation analysis zone (TAZ), for each trip type, for each time period. A single origin or destination is called a “trip end.”
2) Trip Distribution – The trip ends calculated in step 1 are connected to form complete trips. These are “person trips” and include both auto and transit trips.
3) Mode Choice – The person trips are divided among transit trips, auto drive alone trips, and auto shared ride trips. (The TPB model does not model nonmotorized trips.)
4) Assignment – The auto trips are assigned to each link of the highway network.

The purpose of the travel demand model is to approximate human behavior. While the four steps are presented individually and usually are calculated sequentially, they must always be thought of as parts of a complex process. People make their decisions simultaneously, i.e. they decide where they are going, and how they are going to get there at the same time.

Consider a potential traveler who anticipates severe congestion in traveling to a specific destination at a particular time. This information is only available to the travel demand model after assignment (the fourth step). However, this expectation of congestion certainly affects where the trip is destined (trip distribution), how the trip will be made (mode choice), and possibly whether the trip will be made at all (trip generation).

The TPB travel demand model attempts to address this problem by introducing feedback between the four steps. The model documentation shows that congested model output from the assignment step feeds back to influence trip distribution and mode choice decisions.

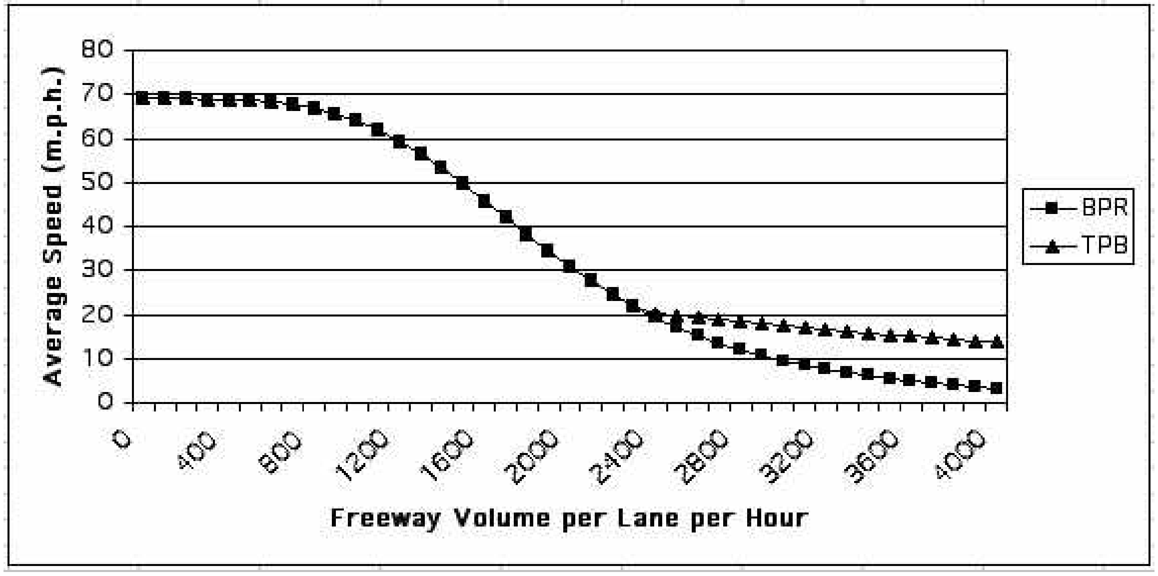
This is acceptable in principle, but there are two major problems with the implementation. First, only work trips are affected at all. This represents a fairly small and decreasing share of all trips. Second, the feedback process for work trips is weakened to the point that it has little effect.

The assignment step of the travel demand model calculates a travel speed for each one-way link in the network. This speed is calculated as a function of the model volume, the link capacity, and the link free-flow speed.

For example, most freeway links are coded in the TPB model with capacities of 1182 vehicles per lane per hour and 60 m.p.h. speed. More information must be given for these values to be fully understood. The capacity number is for "level of service C", where level of service (LOS) is a scale running from "A" to "F", with A indicating free flow traffic, and F representing severe congestion. Therefore, 1182 does not represent the ultimate capacity, but rather a volume at a fairly good level of service. Similarly, the speed represents conditions at level-of-service C. At free-flow conditions, the speed is assumed to be 15 percent higher or 69 m.p.h. (This typical example is for Ring 8 freeways).

The model speed is calculated using a relationship published by the Bureau of Public Roads many years ago (before there was a Federal Highway Administration), and is generally known as the "BPR curve." Figure 1 below illustrates the forecast model speed as a function of vehicles per lane per hour, using the freeway case as described above.

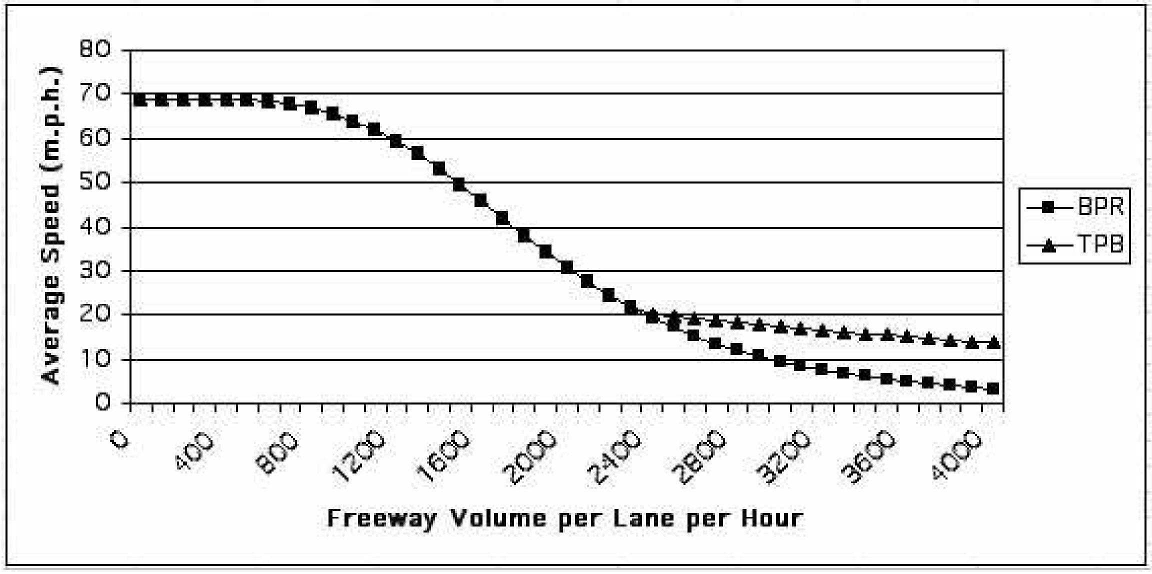
**Figure 1: BPR Volume-to-Delay Function for Freeways Using TPB Assumptions**



As shown in Figure 1, the BPR function calculates high average speeds at small volumes, up to 69 m.p.h., and decreasing speeds at lower volumes, 22 m.p.h. at 2400 vehicles per lane per hour. The value of 2400 vehicles represents the upper end of accepted values for ultimate capacity.

As shown in Figure 2, the TPB model modifies the BPR function for volumes exceeding two times level-of-service C. The result is higher calculated speeds for volumes far in excess of ultimate capacity than if the standard BPR curve were applied.

**Figure 2: Comparison of BPR and TPB Volume-to-Delay Functions**



There is a corresponding assumption made in the air emissions analysis process. In this case, the delay curve is not damped but actually clipped at 1.6 times LOS C capacity.

There are two major impacts of these assumptions, which are discussed in more detail in later sections:

1) The feedback from travel delay is weakened significantly.
2) Calculated air emissions are minimized.

There are five other related problems in the TPB modeling process.

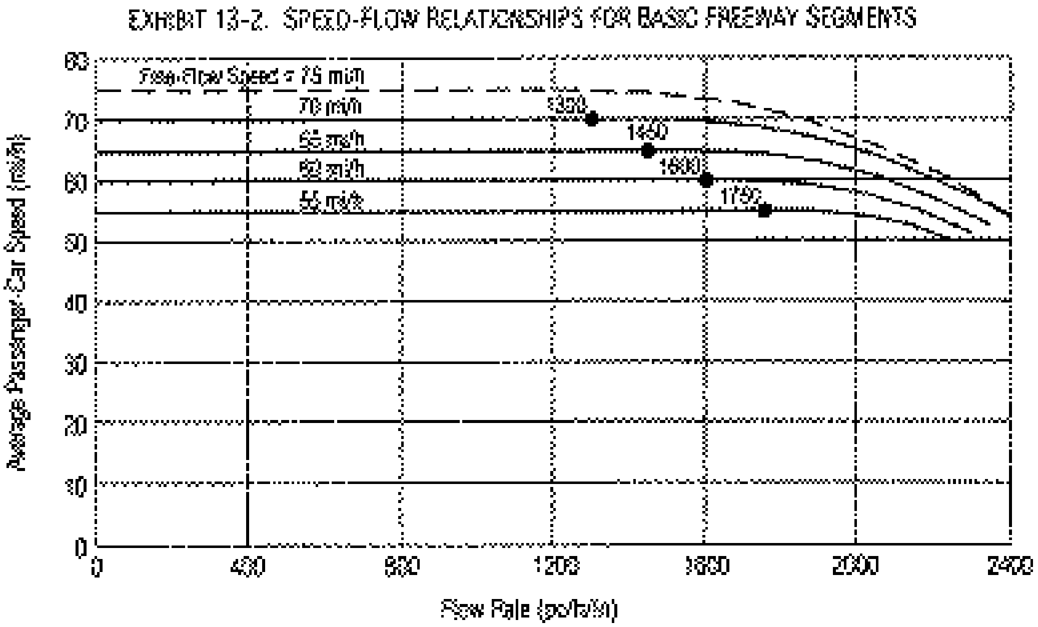
First, use of LOS C capacity, also called design capacity, is no longer considered to be the best practice. In work done for the U.S. Department of Transportation and published in 1991, Alan J. Horowitz outlines the reasons for using LOS E/F capacity, or “ultimate capacity.”

- Ultimate capacity has a consistent meaning across all facility types, while design capacity does not. For example, it is a relatively simple matter to relate the capacity of an intersection to the capacity of the street approaching that intersection.
- Ultimate capacity is always easier to compute than design capacity. Finding the design capacity of a signalized intersection is especially difficult.
- Ultimate capacity can be more easily related to traffic counts than design capacity, which would also require estimates of density, percent time delay, reserve capacity or stopped delay .
- Ultimate capacity is the maximum volume that should be assigned to a link by the forecasting model. Design capacity does not give such firm guidance during calibration and forecasting. (Horowitz, Alan J. Delay-Volume Relations for Travel Forecasting: Based on the 1985 Highway Capacity Manual, 1991, http://tmip.fhwa.dot.gov/clearinghouse/dos/general/dvrt/ch4.stm)

Second, the implicit assumption in the TPB model concerning the ultimate capacity for freeways is wrong. By limiting traffic volume to 1.6 times the LOS C capacity in the air emissions estimation process (or 1981 vehicles per lane per hour), the TPB model, in effect, sets this as the ultimate capacity. As shown in Figure 3 below taken from the

*Highway Capacity Manual* (Transportation Research Board, 2000), level of service for freeway links is defined for volumes as high as 2,400 vehicles per hour per lane.

## Figure 3: Speed-Flow Relationships for Freeways



Source: *Highway Capacity Manual*. Washington DC: Transportation Research Board, 2000.

The *Highway Capacity Model* also identifies freeway segments in the Washington DC area among their lists of the highest observed traffic volumes. These include I-66 in Fairfax carrying 2,650 vehicles per lane per hour for a 4-lane freeway, and I-495 in Montgomery County carrying 2,498 vehicles per lane per hour on a 6-lane section (Exhibit 8-19, p. 8-19).[1]

Third, the TPB model operates as a daily model. Most other larger U.S. regions now have travel demand models that divide the day into several time periods. This provides the basis for more accurate travel forecasts and air emissions estimates. As will be discussed below, the time-of-day post processing done in the air emissions calculations cannot overcome the weaknesses inherent in a daily travel model.

Fourth, the TPB model uses a discredited incremental assignment technique instead of the almost universally applied equilibrium method. Again, we will describe the correct practice first, and then discuss why the TPB practice is unacceptable.

Travel times over the roads of the network increase in relation to traffic flows. Therefore, trips shift from more congested routes to less congested routes until all routes are equally congested, as measured by a weighted sum of travel time and vehicle operating cost from

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[1] Conditions at these high volumes represent unstable flow. If traffic flow breaks down for any reason, and traffic is slowed, it is impossible to sustain these high traffic volumes at lower speeds, and it can take significant time for the higher speeds to be regained.

origin to destination. A good assignment model seeks to assign each vehicle to the "shortest route", the route with the least generalized travel cost. In a complex urban system, more than one route may offer the least generalized cost. The assignment has achieved equilibrium conditions when no vehicle can reduce its cost by switching routes. This is defined as a "user optimal" condition.

Equilibrium assignment algorithms in use at most large MPOs reassign traffic in a series of iterations until this equilibrium condition is approached. After each iteration, the travel times between transportation analysis zones are recalculated and refined.

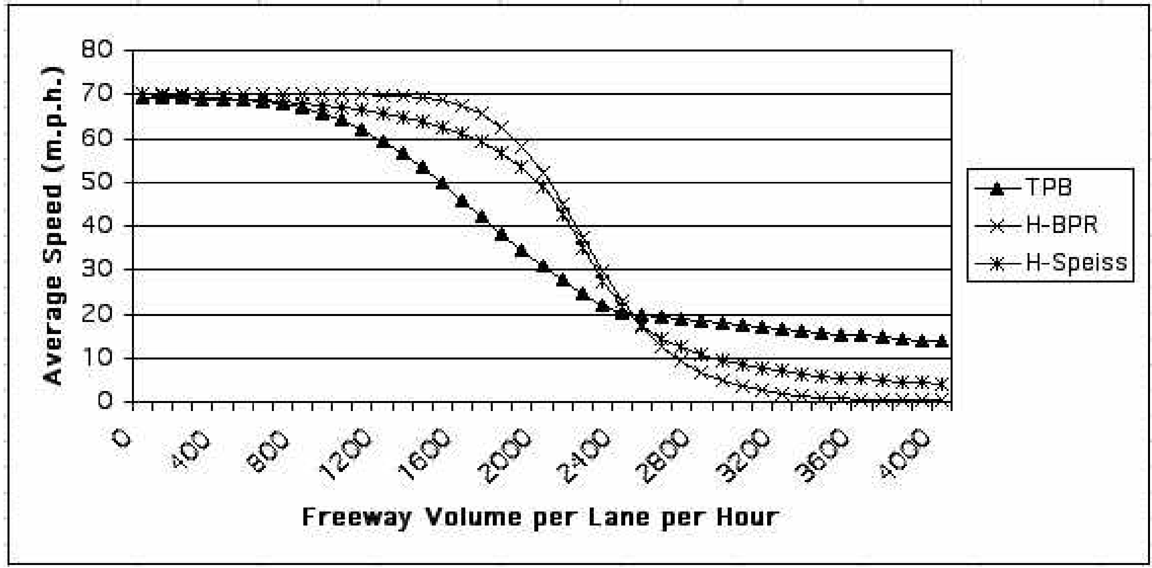
In contrast, the TPB model uses an incremental assignment process that very poorly matches the desired equilibrium condition. Four increments of traffic are assigned, each representing 25 percent of the total traffic volume. At the beginning of each increment, travel times are recalculated. Therefore, the travel times for the first increment are based on 0 percent of the traffic, the times for the second increment are based on 25 percent of the traffic, and the times for the third increment are based on 50 percent of the traffic. The travel times calculated for the fourth and final increment of traffic loading are based on the results of the previous increment, and therefore include only 75 percent of the traffic.

This is critical because traffic will generally operate very smoothly at 75 percent of the peak period traffic volumes, yet break down completely at 100 percent. This is another way in which the TPB model short circuits an important feedback between congestion and traffic volume.

The MINUTP travel demand modeling software used by TPB includes an equilibrium assignment option. However, if incremental assignment techniques are unavoidable, the standard BPR coefficients should be replaced with coefficients that cause reductions in modeled speed equivalent to 100 percent of traffic when only 75 percent of the model traffic is loaded. In this way, at least the fourth and final increment will reflect appropriate levels of congestion, even if the first three do not. In the current TPB implementation, none of the assignment increments reflect proper levels of congestion.

Fifth, the old BPR coefficients do not calculate speeds that are consistent with more modern research. The primary focus of the 1991 Horowitz report quoted earlier was to develop improved coefficients. Figure 4 below shows the TPB function (in this example, for Ring 8 freeways) as compared with two alternatives that better fit observed speeds.

**Figure 4: Comparison of TPB Volume-to-Delay Function to Best Practice (Horowitz Prepared for U.S. D.O.T. 1991)**



We have calculated the two Horowitz recommended functions assuming a free flow speed of 70 m.p.h. and a capacity of 2200 vehicles per lane per hour.

The curve labeled “H-BPR” is of the BPR functional form, but with more updated coefficients. The curve labeled “H-Speiss” fits observed data even better. It is notable how very different these volume-delay relationships are as compared to the one built into the TPB model. The TPB model underestimates speeds in the very prevalent range of 1400 – 2200 vehicles per lane per hour, and then overestimates speeds at the highest volumes. At the point where ultimate capacity is approached and exceeded, and the congestion feedback should be strongest, the TPB model provides only very weak feedback.

This discussion has focused on freeways because of their importance in travel demand modeling and emissions modeling. However, the problems described are not limited to freeways, but are present for all types of roadway links.

## *Air Emissions Modeling*

This section of the report critiques the Air Quality Conformity Determination of the 2000 Constrained Long Range Plan and the FY2001-2006 Transportation Improvement Plan for the Washington Metropolitan Region, dated October 18, 2000, conducted by the Metropolitan Washington Council of Governments (MWCOG), the Metropolitan Planning Organization (MPO) for the Washington, D.C. urban area.

Serious technical deficiencies are present in the Conformity Analysis documentation. The MWCOG has failed to use commonly accepted practices, and instead has used practices that are not consistent with EPA requirements. These technical deficiencies seriously undermine the credibility of the emissions estimates reported in the conformity determination report.

Four major errors and inconsistencies in the MWCOG conformity analysis have been identified.

1. The vehicle miles of travel (VMT) mix used in the MOBILE5b emissions modeling conducted by the MWCOG is inconsistent with EPA default values (values used unless there is more accurate local information), as well as national

trends being observed in cities around the country. While TPB is now addressing this problem in its proposed conformity analysis released on December 19, 2001 for public comment, it is not a new problem. There has been a major problem even without the increase in SUV purchases.

2. MWCOG only generated emission factors for 13 different speeds despite the fact that link speeds in the model vary from less than 2.5 mph to more than 65 mph. This is not only unnecessary because MOBILE5b can calculate emission factors for all speeds between 2.5 and 65 mph, but is also inaccurate.
3. MWCOG also uses a clipped BPR equation to calculate congested speeds for use in the emissions analysis. In the clipped BPR equation, the Volume to Capacity (V/C) ratio is restricted to values less than or equal to 1.6 which maintains unrealistically high speeds during congested time periods and reduces speeds during uncongested time periods. Use of a restricted BPR equation and subsequent MWCOG implementation results in a relatively large number of links having speeds in the middle range of the pollutant emissions curves, where emission factors are minimized.
4. Excess traffic volume is shifted between time periods to accommodate the V/C ratio restriction. Excess volume remaining after the tenth and final time period represents 1,370,000 vehicle miles of travel in the 2025 emissions analyses. Since this volume cannot be moved into another time period, more than 1,500 links in the 2025 network are still over capacity at midnight. This result is totally unreasonable. In addition, the V/C ratio used to calculate congested speeds on these links is inconsistent with the actual volume in the tenth time period.

## MOBILE5b Emissions Modeling Assumptions

### *VMT Distribution by Vehicle Type - VMT Mix*

The vehicle miles of travel (VMT) distribution by vehicle type, also known as the VMT mix, is a very important user input into the Environmental Protection Agency’s MOBILE5b vehicle emissions model. The VMT mix specifies the fraction of total highway VMT that is accumulated by each of the eight vehicle types. The eight vehicle types in the MOBILE are listed below:

LDGV = light-duty gasoline vehicles
LDGT1 = light-duty gasoline trucks, I
LDGT2 = light-duty gasoline trucks, II
HDGV = heavy-duty gasoline trucks
LDDV = light-duty diesel vehicles
LDDT = light-duty diesel trucks
HDDV = heavy-duty diesel vehicles
MC = motorcycles

The VMT mix used in the MOBILE5b emissions modeling conducted by MWCOG for the adopted conformity analysis of the 2000 Constrained Long Range Transportation Plan is inconsistent with EPA default values as well as national trends being observed in cities around the country. The default VMT mix in MOBILE5b is based on national averages and changes over time (calendar years). There are three main trends driving the shifts in VMT. The first is a shift in sales from light duty passenger cars to light duty trucks. The next two have to do with the dieselization of trucks in general. Light duty diesel trucks are increasing in sales over time as compared to light duty gasoline trucks. The same trend can be seen even more noticeably, with heavy duty diesel trucks replacing heavy duty gasoline trucks. The VMT mix used by MWCOG did not reflect these documented national trends. MWCOG has redefined the VMT mix using new local data for the 2001 Constrained Long Range Plan (CLRP) update for the 2002-07 Transportation Improvement Program. It would be of value to compare this new data with the EPA default values and national trends.

Table 1 shows the urban and rural VMT mix used by MWCOG for the 2000 CLRP update and the 2005 MOBILE5b national default values.

### Table 1: MWCOG and MOBILE5b Default VMT Mix

| MOBILE5b | LDGV | LDGT1 | LDGT2 | HDGV | LDDV | LDDT | HDDV | MC |
|---|---|---|---|---|---|---|---|---|
| MWCOG Urban | 0.820 | 0.091 | 0.014 | 0.016 | 0.014 | 0.000 | 0.029 | 0.016 |
| MWCOG Rural | 0.750 | 0.150 | 0.013 | 0.021 | 0.012 | 0.000 | 0.038 | 0.016 |
| 2005 EPA Default | 0.600 | 0.197 | 0.087 | 0.031 | 0.002 | 0.002 | 0.075 | 0.006 |

MWCOG VMT from light-duty gasoline vehicles (LDGVs) is 37 percent and 25 percent higher than the EPA default for urban and rural areas respectively. In addition, the VMT from light duty gasoline trucks (LDGTs) I and II is 63 percent and 43 percent lower than the EPA default for urban and rural areas respectively. Only 10.5 percent of the urban MWCOG VMT is from LDGTs, while the national default is 28.4 percent. Finally, the VMT fraction for light-duty diesel trucks is zero in both urban and rural areas. These are very peculiar assumptions for VMT mix. No documentation about the MWCOG VMT mix assumptions for the 2000 CLRP have been provided beyond the fractions themselves, so it is difficult to comment further about the basis for these assumptions.

Not only were the fractions used by MWCOG for the 2000 CLRP inconsistent with the EPA defaults, but they are likewise inconsistent with the emission modeling being conducted by other urban areas around the county. Table 2 shows VMT mix assumptions being employed in other cities in the United States.

### Table 2: VMT Mix Assumptions from Other U.S. Cities

| MOBILE5b | LDGV | LDGT1 | LDGT2 | HDGV | LDDV | LDDT | HDDV | MC |
|---|---|---|---|---|---|---|---|---|
| MWCOG Urban | 0.820 | 0.091 | 0.014 | 0.016 | 0.014 | 0.000 | 0.029 | 0.016 |
| Atlanta, GA | 0.655 | 0.160 | 0.082 | 0.028 | 0.009 | 0.002 | 0.062 | 0.002 |
| Houston, TX | 0.699 | 0.171 | 0.076 | 0.018 | 0.002 | 0.001 | 0.031 | 0.002 |
| Las Vegas, NV | 0.545 | 0.387 | 0.025 | 0.002 | 0.003 | 0.003 | 0.006 | 0.029 |
| New Haven, CT | 0.624 | 0.193 | 0.089 | 0.033 | 0.002 | 0.001 | 0.057 | 0.001 |
| Tempe, AZ (EPA default) | 0.600 | 0.197 | 0.087 | 0.031 | 0.002 | 0.002 | 0.075 | 0.006 |
| Salt Lake City, UT (EPA default) | 0.600 | 0.197 | 0.087 | 0.031 | 0.002 | 0.002 | 0.075 | 0.006 |

In comparing the MWCOG 2000 CLRP VMT fractions against the data from other urban areas, two things are immediately evident. The MWCOG fraction of VMT from light-duty gasoline vehicles is much higher, while the fraction of VMT from light-duty gasoline trucks is much lower. Not only is this modeling assumption inconsistent with national trends, it is completely contrary to what is actually happening in the Washington metropolitan area.

A July 8, 2001 article in *The Washington Post* entitled “SUVs Drive Area to Pollution Violations” reported on the growing number of sport utility vehicles (SUVs) on the city’s highways:

> “Ronald Kirby, a transportation specialist for the Metropolitan Washington Council of Governments, said his staff concluded what it first suspected last month: The number of SUVs had risen far more rapidly than predicted, increasing the amount of pollution sent into the air.
>
> “Five years ago, SUVs were thought to represent about 15 percent of personal vehicles on area roads, Kirby said. Now the figure is pegged at 25 percent. With SUVs accounting for half of new purchases, he said, the larger vehicles are bound to become an even greater percentage of the mix.”

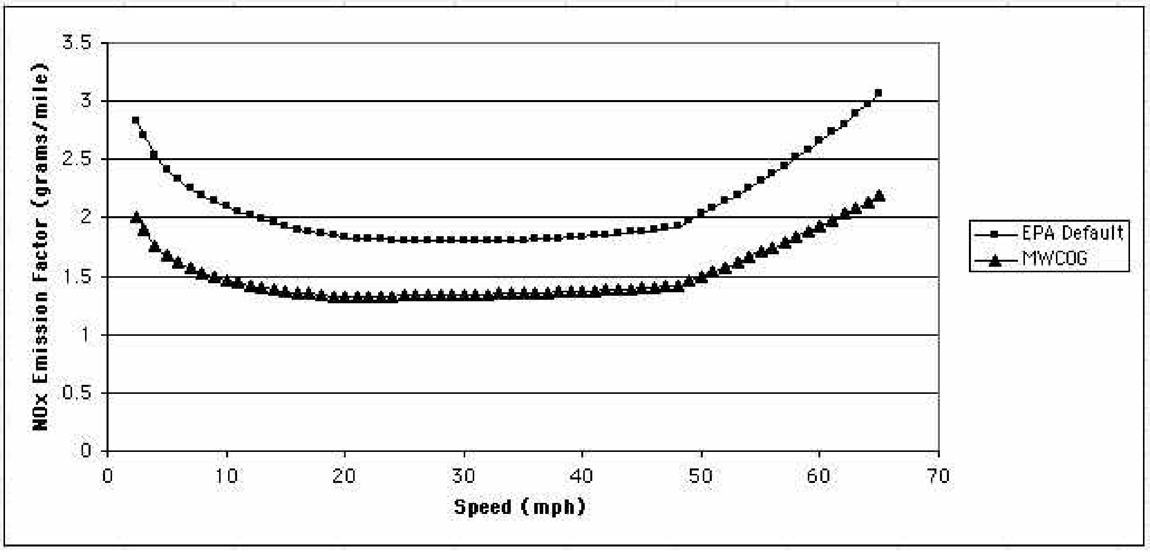
If one in four vehicles on the road in metropolitan Washington is indeed a SUV, and 50 percent of new purchases are SUVs, the VMT mix used by the MWCOG in their MOBILE emissions modeling is completely wrong. Light-duty gasoline trucks I, (LDGT1) are trucks less than 6,000 pounds. LGDT2 are trucks between 6,000 and 8,500 pounds. Therefore, VMT from SUVs should be accounted for in one of these two vehicle types. Despite the report that 25 percent of all personal vehicles in the metropolitan

Washington area are SUVs, the MWCOG had assumed that only 10.5 percent of the total VMT was from light-duty gasoline trucks in their MOBILE emissions modeling.

The VMT mix input has a dramatic effect on the nitrogen oxide (NOx) emission factors produced by MOBILE5b. Increasing the fraction of VMT from trucks significantly increases the total regional NOx emissions.

To demonstrate the impact of different VMT mix assumptions, we ran MOBILE5b using the EPA 2005 defaults and the urban VMT mix used by MWCOG for the 2000 CLRP. All other MOBILE5b inputs were held constant. Figure 5 is an emissions profile for 2005 nitrogen oxide emission factors using the EPA default and MWCOG VMT mix.

**Figure 5: NOx Emission Profile using Default and MWCOG VMT Mix**



The NOx emission factors based on the default VMT mix are significantly higher than the 2000 CLRP MWCOG emission factors. On average, the percent difference between the default and MWCOG emission factors is 27 percent. Therefore, using the default VMT mix would produce total emissions 27 percent higher than those calculated originally by MWCOG. MWCOG has acknowledged that NOx emissions were significantly underestimated in the 2000 CLRP by using an invalid VMT mix, with too much VMT from light-duty gasoline vehicles and not enough VMT from light-duty gasoline trucks.

If the emissions had been estimated using EPA defaults, the motor vehicle emission budget (MVEB) for the MWCOG metropolitan statistical area (MSA) would be exceeded by almost 43 tons per day. In the 2005 horizon year, the margin between calculated emissions and the MVEB is only 0.8 tons per day. MWCOG has developed new VMT mix fractions that it says reflect actual conditions in the Washington area and this resulted in significantly higher emissions estimates for the 2001 CLRP update conformity analysis. A closer examination of how these new VMT mix fraction assumptions vary from the EPA defaults is warranted.

### *Modeled Average Speeds*

Emission factors vary considerably with the average speed assumed. The values input for average speed in MOBILE5 have a significant impact on the resulting emission factors for exhaust and running loss emissions. MOBILE5 will calculate emission factors for average speeds of 2.5 to 65.0 mph, in increments of 0.1 mph. It is important to note here that the emission factors produced by the MOBILE5 model are not a linear function of average speed. See Figure 5 for a NOx emission profile.

MWCOG ran the MOBILE5 model for 13 different speeds at 5 mph increments (5, 10, 15, and so on up to 65). MWCOG performs a link-based emissions calculation. Specifically, an emission factor corresponding to the speed on a link in the network is multiplied by the VMT on that particular link. The emissions on all links in the network are then summed to produce the total regional emissions. MWCOG only generated emission factors for 13 different speeds despite the fact that link speeds in the model vary from less than 2.5 mph to more than 65 mph. In performing the emissions calculation, the 5 mph emission factor generated by the MOBILE model was used for all links with congested speeds between 2.5 and 7.5 mph. The 10 mph emission factor was used for speeds between 7.5 and 12.5 mph and so on. This is not only unnecessary because MOBILE5b can calculate emission factors for all speeds between 2.5 and 65 mph, but is also inaccurate. The following sample calculations will illustrate how emissions are underestimated by the MWCOG methodology.

The sample network below consists of 5 links with congested speeds of 53, 54, 55, 56, and 57 mph. The MWCOG methodology would use the 55 mph emission factor for each link despite the variance in link speed and the fact that each speed has a distinct emission factor. The results of the sample calculation following the MWCOG methodology are presented in Table 3.

## Table 3: Sample Emissions Calculation Using MWCOG Methodology

| Link | Speed | 55 mph NOX Emission Factor (grams/mile) | VMT | Total Emissions |
|---|---|---|---|---|
| 1 | 53 | 2.321 | 50 | 116.05 |
| 2 | 54 | 2.321 | 75 | 174.08 |
| 3 | 55 | 2.321 | 150 | 348.15 |
| 4 | 56 | 2.321 | 175 | 406.18 |
| 5 | 57 | 2.321 | 325 | 754.33 |
| | | **TOTAL** | 775 | 1798.78 |

Now we will repeat the analysis by correctly applying unique MOBILE5b emission factors for each distinct link speed. The results of the sample calculation following the correct methodology are presented in Table 4.

## Table 4: Sample Emissions Calculation Using Correct Methodology

| Link | Speed | NOX Emission Factor (grams/mile) | VMT | Total Emissions |
|---|---|---|---|---|
| 1 | 53 | 2.201 | 50 | 110.05 |
| 2 | 54 | 2.260 | 75 | 169.50 |
| 3 | 55 | 2.321 | 150 | 348.15 |
| 4 | 56 | 2.384 | 175 | 417.20 |
| 5 | 57 | 2.448 | 325 | 795.60 |
| | | **TOTAL** | 775 | 1840.50 |

The MWCOG methodology produces total NOx emissions of 1798.78 grams. However, correctly applying unique emission factors for each link yields total emissions equal to 1840.50 grams. Therefore, the MWCOG methodology has underestimated total emissions in this sample calculation by 2.3 percent. Given the narrow margin by which MWCOG reportedly meets the 2005 MVEB for NOx (by less than 1 ton per day) this potential underestimation is very significant. The emissions reported in the MWCOG Air Quality Conformity Determination dated October 18, 2000 are at the very least incorrect and may have been underestimated by their calculation methodology. MWCOG should repeat their emissions analysis by generating unique emission factors for speeds between 2.5 and 65 mph instead of only running the MOBILE model for 13 different speeds at 5 mph increments. This same methodological problem leads to some underestimation of emissions in the revised MWCOG conformity analysis for the 2001 CLRP.

### Restrained Speed Equation

MWCOG post-processes model free-flow speed in order to calculate congested (restrained) speeds for use in the emissions analysis. MWCOG uses the following adapted Bureau of Public Roads (BPR) equation to calculate congested speeds by time period:

$$Sr = (Sc * 1.15) / ( 1 + 0.15 * (V/C)^4)$$

Where:

Sr = Restrained speed

Sc = LOS "C" Speed

V/C = Volume to capacity ratio

In post-processing, this equation is subjected to an additional constraint. The V/C ratio is not allowed to exceed 1.6. If the V/C ratio exceeds 1.6, the excess volume is displaced into the following time period. There are ten time periods in total.

Under heavily congested conditions, the BPR equation is reduced to the following by restricting the V/C ratio to a maximum of 1.6:

$$Sr = 0.58 * Sc$$

Therefore, regardless of link volume, the free-flow speed can only be reduced by 42 percent during congested conditions. In the MWCOG travel demand model, typical freeway speeds at LOS C are 60 mph (these speeds vary somewhat depending on the road's location, which is coded by 'ring codes' which radiate out from the Central Business District of the District of Columbia). Due to the V/C constraint implemented by MWCOG, the lowest possible congested freeway speed for Ring 8 is 35 mph (60 * 0.58 = 35). Figure 6 shows the full set of restrained freeway speed equations used by MWCOG for all rings. The conformity report indicates, "The results of this process were validated with observed speed data conducted in the District of Columbia and Beltway data." However, no other documentation has been provided which validates the use of this V/C restrained BPR equation. This aspect of the MWCOG post-processing has implications in the emissions analysis because the NOx emission curve is relatively flat between 30 and 40 mph (See Figure 5). However, the emissions curve increases as speeds fall below 30 mph. If congested speeds were allowed to continue falling below the levels at which the MWCOG model freezes them (e.g., 35 mph in ring 8, 33 mph in ring 7, 30 mph in ring 5, etc.), which they likely do in reality during peak hours, the NOx emissions from freeways would increase. This is particularly significant in this area where about 40 percent of total 2005 VMT is from freeways.

## Figure 6: Restrained Freeway Speed Equation Used by MWCOG

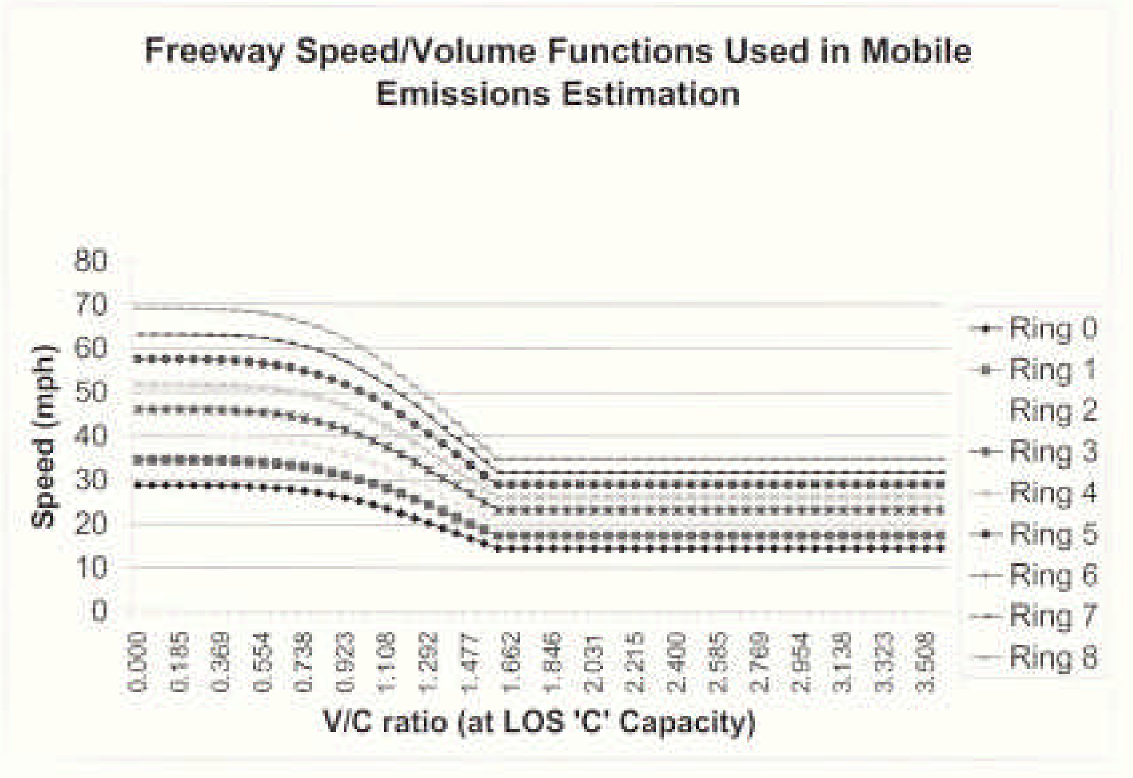
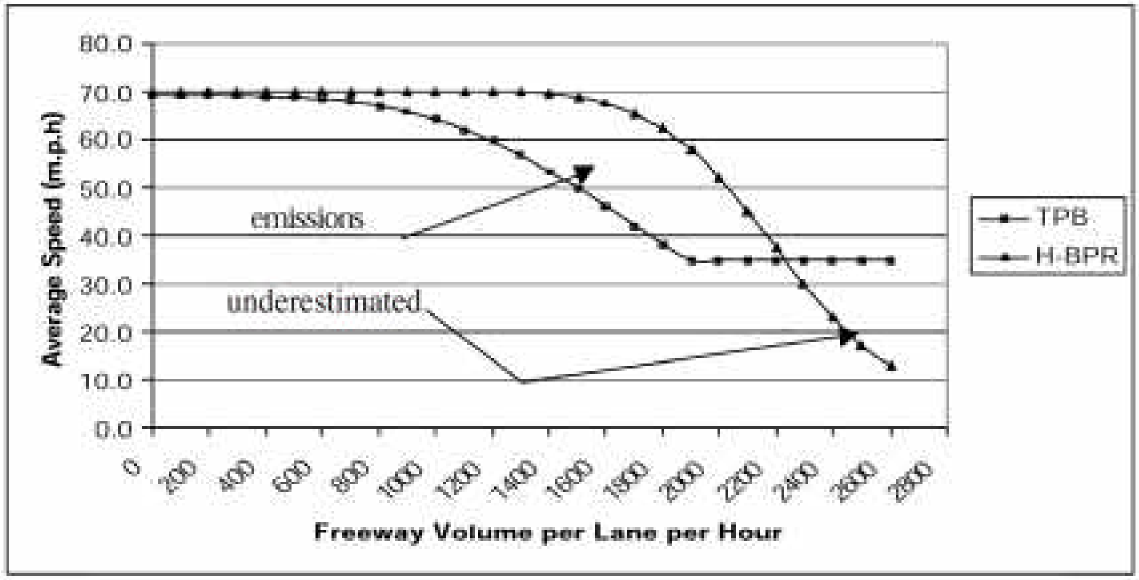


Figure 7 shows a typical volume-delay function used by TPB to translate hourly traffic volumes into traffic speeds to estimate emissions (in this case for Ring 8) as well as the Horowitz BPR volume-delay function presented earlier in this report. During the most prevalent highway conditions (1000 to 2000 vehicles per lane per hour), the TPB curve yields freeway speeds slower than the Horowitz BPR curve. Due to the nature of the NOx emissions curve, the total NOx emissions resulting from the TPB volume delay function will be less than the emissions calculated from speeds based on the Horowitz formulation. During congested conditions (greater than 2200 vehicles per lane per hour) the TPB curve yields speeds greater than the Horowitz BPR curve. Congested speeds are limited to a minimum of 35 mph because of the V/C constraint. NOx emissions are also underestimated in this region because NOx emission factors increase below 30 mph. The TPB volume-delay curve implemented with a V/C constraint minimizes NOx emissions both by relying on low speeds during uncongested periods and then by assuming a minimum speed of 35 mph during times of heavy congestion.

## Figure 7: NOx Emissions Underestimated



### *Hourly Traffic Shifting*

Excess traffic volumes during congested time periods are moved into less congested time periods in order to restrict the V/C ratio to values less than 1.6. Therefore, less congested periods such as 9:00 to 10:00 AM become more congested as excess volume from the morning peak hours are moved into this shoulder period. Speeds which would have been relatively high are reduced by the additional excess volume from the previous time periods. This strategy maintains speed in times of heavy congestion (AM and PM peak hours) while reducing speed in times of little congestion (midday and evening hours). The restricted BPR equation and MWCOG implementation push speeds to the middle of the emissions curve by moving volume out of congested periods into uncongested periods. Due to the parabolic shape of the emissions curves (Figure 5), this effectively minimizes total regional emissions.

We reproduced the emissions analysis conducted by MWCOG in a series of spreadsheets to quantify the impact of the V/C ratio constraint. First, we implemented the MWCOG methodology which restricts the V/C ratio to 1.6. Then, total emissions were recalculated without the V/C restriction. Use of the V/C constraint underestimates 2005 total regional NOx emissions by 1.4 percent, and total regional VOC emissions by 12.4 percent. The V/C constraint effectively minimizes emissions by pushing speeds towards the middle of the pollutant curves, allowing the 2005 motor vehicle emissions budget to be met by a very narrow margin. Therefore, it is not surprising that total emissions for 2005 exceed the MVEB when the V/C constraint is removed from the MWCOG emissions analysis.

### *Effect of V/C Constraint on Hourly Traffic Distributions*

Traffic distributions for ten discrete time periods of the day were used to process the 24-hour model link volumes and speeds from the MWCOG travel demand model. Hourly capacities and converted hourly volumes were then used in the restrained BPR formula to calculate speeds for use in the emissions analysis. However, if the V/C ratio exceeded 1.6, the excess volume was displaced into the following time period. For example, if there was too much volume on a particular link in the 3:00 to 4:00 PM time period to satisfy the V/C restriction, the excess volume was moved into the next time period, 4:00 to 5:00 PM. This shift does not represent “peak spreading” because the shifts are done at a relatively high level of service (e.g., 35 mph for ring 8 freeways) and because in some cases the afternoon peak hour is spread beyond midnight. Moving excess volume into the following time period can continue in this fashion until the last time period is reached (7:00 PM to 12:00 AM). What happens to excess volume that remains after the tenth and final time period?

This was obviously a concern for the programmer of the SAS code in the file “HRLKc101.sas” provided to us by MWCOG. After the section of code that performs the V/C check and moves excess volume when necessary, the following comment was included in the SAS file.

```
*   NOTE: FOR NOW, EVEN IF PERIOD 10 VOLUME EXCEEDS MAX VOLUME ;

*   PERIOD 10 VOLUME WILL NOT BE RESET AS IN PREVIOUS TIME PRDS;

*   (WHERE THE HELL IS IT SUPPOSED TO GO, ANYWAY?)

*   BUT VC IS SET TO 1.6

*   PER10VOL=MAX10VOL;
```

We performed the same V/C constraint and time period analysis in Excel, and found that the excess volume remaining after the tenth time period for 2005 represents 448,765 vehicle miles of travel. Some of the links with excess volume remaining after the tenth time period in 2005 have been identified in the network. The model link, roadway description, and VMT are presented in Table 5.

## Table 5: Sample of Links with Excess Volume Remaining After Final Time Period

| ANODE | BNODE | VMT | Link Description |
|---|---|---|---|
| 12008 | 12009 | 3,532 | I-66 (Custis Memorial Highway) between Route 120 and Route 29 (Lee Highway) - WB |
| 12034 | 12048 | 3,052 | I-66 (Custis Memorial Highway) between Route 120 and Route 29 (Lee Highway) - EB |
| 13671 | 13692 | 3,075 | Route 32 between Route 26 and I-70 - NB |
| 12030 | 12031 | 2,558 | I-66 (Custis Memorial Highway) between Route 29 (Lee Highway) and Route 237 |
| 13692 | 13671 | 3,424 | Route 32 between Route 26 and I-70 - SB |
| 13501 | 13517 | 4,166 | Route 32 north of Route 26 - NB |
| 13517 | 13501 | 4,424 | Route 32 north of Route 26 - SB |
| 6195 | 12204 | 2,203 | I-95 just south of interchange with Capital Beltway (I-495) and north of Route 644 |
| 10774 | 6195 | 2,457 | I-95 just south of interchange with Capital Beltway (I-495) - NB |
| 12203 | 10683 | 2,679 | I-95 just south of interchange with Capital Beltway (I-495) - SB |
| 13795 | 13918 | 2,156 | Route 32 between Route 1 and I-295 (Capital Beltway) |
| 13993 | 13914 | 4,154 | Route 198 between I-295 (Baltimore Washington Parkway) and Route 32 - EB |
| 13914 | 13993 | 4,533 | Route 198 between I-295 (Baltimore Washington Parkway) and Route 32 - WB |
| 9903 | 8729 | 2,372 | I-395 just west of Case Memorial Bridge and east of Potomac River |
| 13399 | 13207 | 12,146 | Opossumtown Pike north of I-15 (Frederick Freeway) - NB |
| 13207 | 13399 | 12,842 | Opossumtown Pike north of I-15 (Frederick Freeway) - SB |
| 13367 | 13438 | 4,111 | Route 351 south of interchange with I-15/I-340 - SB |
| 13438 | 13367 | 4,568 | Route 351 south of interchange with I-15/I-340 - NB |

Congestion is more severe in future analysis years 2015, 2020, and 2025. As congestion increases and the V/C restriction is maintained, more and more excess volume will remain after the tenth time period. We once again performed the same V/C constraint and time period analysis in Excel, and found that the excess volume remaining after the tenth time period for 2025 increases to 1,372,311 vehicle miles of travel. This volume cannot be moved into another time period since the tenth and final time period represents 7:00PM to 12:00AM. Therefore, the volume is maintained within the tenth time period and as a result, there are more than 1,500 links in the 2025 network that are considered over capacity at midnight. This result is completely unreasonable. In essence, the amount of daily traffic assigned to certain links in the model does not fit within a 24-hour period.

In the nine periods prior to the 7:00PM to 12:00AM time period, the time period volume is tested against the V/C constraint. If the time period volume is less than the maximum allowable volume, the V/C ratio is calculated according to the link volume. If the time period volume exceeds the maximum allowable volume, the excess volume is displaced into the next time period and the V/C ratio is set equal to 1.6. However, if the tenth time period volume exceeds the maximum allowable volume it cannot be displaced into another time period. Despite this limitation, the V/C ratio is still set to 1.6 when the tenth time period volume exceeds the allowed maximum. This V/C ratio is then used to calculate congested speed for input into the MOBILE emissions model. Therefore, in 2025 there are more than 1,500 links that have calculated congested speeds based on a V/C ratio equal to 1.6, which is inconsistent with the actual tenth time period volume that exceeds the allowed maximum. The net result is that the MWCOG model produces forecasts of hourly volumes that underestimate traffic volumes especially on high-traffic flow congested links during peak hours while overestimating traffic volumes on those same links during non-peak hours. In both cases this likely leads to underestimation of motor vehicle NOx and VOC emissions.

## Implications of Model Deficiencies on Travel Forecasts

It is clear that land development and traffic growth follows highway construction. The Interstate highway system was originally conceived and funded as a civil defense measure, as a means to evacuate cities in case of nuclear war. Instead, Interstate and other highway interchanges have become the centers of development in cities throughout the United States. When highway capacity is increased, generally it has quickly filled with increased traffic flow.

DeCorla-Souza and Cohen define this “induced demand” as an: “increase in daily vehicle miles of travel (VMT), with reference to a specific geographic context, resulting from expansion of highway capacity.”[i] This definition includes both short-term effects and long-term effects. The short-term effects include more trips, longer trips, more auto trips, and auto trips with lower occupancies. The long-term effects follow land used changes caused by expanded roadway capacity.

Induced demand effects are well known both to planners and lay people, but until recently they were not quantified. Now there is a rapidly-growing research literature quantifying the effects of induced demand. The Annual Meeting of the Transportation Research Board, held in January in Washington D.C., is the premiere transportation conference in the United States, and papers presented at these meetings are approved through a peer review process. In the 1997, 1999, and 2000 meetings, seven papers have been presented that quantify induced demand.

The measure used in most studies is *elasticity*, a basic concept of economics. When the supply of a good or service increases, its price drops. When the price drops, consumption of the product increases. For the majority of Americans, the incremental cost of operating cars is low enough that the perceived cost is primarily travel time. An increase in lane miles of road capacity (supply) causes a near-term decrease in travel time (price), which in turn leads to an increase in vehicle miles traveled (consumption).

Elasticity is calculated as the ratio of the change in consumption divided by the change in supply. For example, if a 10 percent increase in vehicle miles traveled is caused by a 10 percent increase in lane miles, the elasticity is:

10 percent / 10 percent = 1.0.

Alternatively, if a 5 percent increase in vehicle miles traveled is caused by a 10 percent increase in lane miles, the elasticity is:

5 percent / 10 percent = 0.5.

Research findings from five of the studies presented at the Transportation Research Board Annual Meetings are directly comparable and are summarized in Table 6.

### Table 6: Long-Term Regional Elasticity of Vehicle Miles Traveled to Lane Miles

| Study | Long-term regional elasticity |
|---|---|
| Hansen [ii] [iii] | 0.9 |
| Noland [iv] | 0.7 - 1.0 |
| Fulton et. al.[v] | 0.5 – 0.8 |
| Noland and Cowart[vi] | 0.904 |
| Marshall[vii] | 0.76 arterials, 0.85 highways |
| Average of five studies (highways) | 0.83 |

The other two studies use different measures but results are consistent with the five studies summarized in Table 6. One of the studies (Chu) focuses on the response of VMT to congestion. It states: “... an expansion of 1 percent to an existing capacity of 1,000 lane miles, for example, congestion would reduce by one-eleventh of a percent on freeways.”[viii] Chu defines “congestion” as vehicle miles traveled divided by lane miles. Therefore, vehicle miles traveled must increase by 10/11 percent in Chu’s example. This implies an elasticity of vehicle miles traveled to freeway capacity of 0.91.

In the final study, Barr found elasticities of vehicle miles traveled to travel time of -0.3 to -0.5.[ix] The negative sign means that the change in travel is in the opposite direction from the change in travel time. For example, if travel time decreased by 10 percent, VMT would increase by 3-5 percent. Although the absolute values of 0.3 – 0.5 are lower than the 0.5 – 1.0 values presented in the other studies, they are not inconsistent. In most cases, added capacity is on highways and relatively high-speed arterials. The new capacity has higher average speeds than the old capacity, and the percentage change in travel time generally is greater than the percentage change in lane miles. Therefore, the calculated elasticity values will have the reverse relationship: elasticity to travel time will appear smaller than the elasticity to lane miles.

For highways, the average from the five most comparable studies is an elasticity of 0.83. This implies that adding a new lane of capacity adds, on average, traffic equal to 83 percent of what is currently on the adjacent lane of traffic. Some of this traffic will be on the widened, and less congested, road and some will be on extensions of the widened link or intersecting roads that have not been widened and are now more congested roads.

## The Induced Travel Demand Debate

The statistical case presented above is rather abstract, and it is easy to get confused by how these numbers are the same as or different that other numbers that have been published. For example, Kevin Heanue made a presentation at the 1997 TRB Annual Meeting where he concluded that only 6.0 - 22.1 percent of the VMT growth in the Milwaukee metropolitan area between 1960 and 1990 was attributable to induced demand.[x] Heanue attributed the rest of VMT growth to increased population, households, labor force participation, income, auto availability, and licensed drivers, as well as increases in single home ownership, lower development densities, and low real costs of gasoline.

While Heanue's conclusions may appear to contradict the induced demand literature, there is really no conflict at all. Heanue does not calculate an elasticity of induced travel demand himself. Rather, he simply assumes a range of 0.3 – 1.0 taken from studies available at that time. The 22 percent number is not a much smaller number than an elasticity of 1.0; it is another way of expressing an elasticity of 1.0 in the context of Milwaukee between 1960 and 1990.

Heanue did not claim that induced travel growth was insignificant in this 1997 report, only that it was less important in Milwaukee than the great socioeconomic changes during that period. Nevertheless, Milwaukee was a poor choice for the case study, as it constructed much less road capacity per capita during this period than most American urban areas. While Milwaukee demonstrates that VMT increased during that historic period without much roadway construction, it can not really address the question of what happened with significant roadway construction.

The rapid socioeconomic changes between 1960 and 2000 have resulted in a great increase in labor force participation among women, almost universal auto availability, and much smaller households. While these have been important engines for VMT growth during this historical period, they have run their course and will be much less important over the coming decades.

The study recently done for TPB on induced travel demand[xi] concludes that it is unimportant, without contradicting any of the evidence of induced travel demand. This study focuses on the I-270 corridor, where the study acknowledges that traffic growth has been much more rapid following construction than anticipated. The study shows that population and employment growth has also been much more rapid than anticipated, and attributes the traffic growth to this rather than the capacity expansion.

But, this is a pure case of induced traffic. The study states: "Other induced travel may result from longer-term location decisions by households, employers and other facilities." The study shows that the earlier forecasts greatly underestimated population and employment in the suburban areas in the I-270 corridor, and greatly overestimated population and employment in the more urbanized areas in and around Washington D.C. In effect, jobs and housing shifted to the I-270 corridor and away from Washington D.C. and the inner suburbs including Prince George's County. As VMT per capita is much higher in the I-270 corridor than in the central Washington D.C. area, this land use shift has resulted in a large increase in regional VMT.

Furthermore, in the data presented in the study for TPB, the land use effects do not account for all of the growth in VMT. While 2000 population for the corridor area was 23 percent greater than assumed in studies, the daily traffic volumes in 1999 in the three most traveled sections of I-270 were 40-51 percent higher than the 2000 forecasts. This is also strong evidence of the non-land-use induced travel effects at work.

## Incorporating Induced Demand for More Realistic Modeling

In order to develop realistic future transportation scenario results, the metropolitan transportation planning process must incorporate induced demand into modeling activities. This is critical in: 1) the development of long-range transportation plans, 2) analyzing motor vehicle emissions, 3) project planning, and 4) providing a reliable assessment of the costs and benefits of alternative regional and corridor-level investment strategies.

All of these processes are predicated on a region having and applying a sophisticated and valid regional travel demand model. However, induced demand generally is not fully treated in regional models. In a review of how well regional models capture induced demand, DeCorla-Souza and Cohen conclude that elements of induced demand that can be modeled within the four-step process include:

- increased trip distance (distribution),
- increased LOV share (mode choice), and
- shift to improved facilities (assignment).[1]

The extent to which these aspects are modeled in practice depends on the model implementation.

They suggest induced demand elements generally not modeled in four-step process include:

- land use effects, and
- trips per unit of development (trip generation).

Land use effects are of two types. Micro-scale land use effects related to pedestrian and other non-auto accessibility are closely related to trip generation effects. These effects include the number of trips made by type and time of day, and the mode used. Macro-scale land use effects are the allocation of new residences and employment throughout the region, based in part on the relative accessibility of different land.

Micro-scale land use effects have been neglected in travel demand models because computing and data requirements required large transportation analysis zones (TAZs) which were poorly suited for microscale analysis. Advanced modeling procedures that include smaller transportation analysis zones (TAZs) or do away with TAZs altogether make capturing these effects in travel demand models feasible. In addition, advances in Geographical Information Systems (GIS) and the synthetic population methods developed as part of TRANSIMS are making socioeconomic data available at the point or small grid cell level. These trends are paralleled by much research focused on understanding and quantifying these microscale effects. Therefore, we anticipate that micro-scale land use effects (which are already captured partially in some MPO models) will become a standard feature of travel demand modeling.

Macro-scale effects of different land use allocations with different transportation scenarios can be captured with land use allocation models. A number of regions have used land use allocation models in special studies in order to evaluate alternative futures. For example, the Chicago region has evaluated alternative highway/transit and airport land use scenarios as part of its long-range planning process. The

Burlington Vermont and New Hampshire Seacoast regions routinely run land use allocation models as in both long-term planning and major project planning. However, many regions with land use allocation models develop only a single land use scenario, and therefore ignore these effects.

The Second Oregon Symposium on Integrating Land Use and Transport Models held this July disseminated information on the latest research and application to a large number of enthusiastic attendees. Oregon is out ahead of the pack as usual, with a statewide model under development and planned for completion in 2001. However, we expect others to catch up. The important observation is that tools to account for land use allocation are now available to planners and should become a standard feature of travel demand modeling for application to both long-term planning and analyzing major projects.

Another important area (not mentioned by DeCorla-Souza and Cohen) which is generally not modeled is travel by time of day. An important behavioral response to congestion is to shift travel into less congested times. These shifts have public benefits because they allow the transportation system to be more fully utilized.

In general, regional travel demand models treat the proportion of travel within different periods as fixed. As regions have become more congested, the peak periods modeled have grown from a single hour to two-hour or three-hour periods, based on historical observations. However, future peak proportions are considered to be the same as the past, regardless as to whether the future will be more or less capacity constrained than the past. This overestimates the benefits of adding roadway capacity on peak hour delay. Advanced models are addressing this deficiency by assigning trips dynamically by time of day. This capability is present especially in the new generation of activity-based models.

In reviewing recent long-range transportation plans and conformity analyses for Chicago, Atlanta, Houston, and Phoenix, along with this current review of the TPB model, we conclude that none of the long-range plans considers induced demand completely. Nevertheless, the TPB model performs the worst. The table below summarizes which components of induced demand are included in these four regional travel demand models. While many of the elements needed to evaluate induced demand are found in the models, more analysis is needed to determine how well the models analyze induced demand effects.

## Table 7: Elements of Induced Demand Included in Travel Demand Models for Selected Large U.S. Metropolitan Areas

| | Chicago | Atlanta | Houston | Phoenix | Portland | Washington D.C. |
|---|---|---|---|---|---|---|
| Macro-scale land use | Partially, base and build scenarios | No, only one scenario | No, only one scenario | Conflicting documentation as to how land use allocation model was applied | No, only one scenario | No, only one scenario |
| Micro-scale land use and trip | Partially | Partially | Partially | Partially | Yes | No |

| | | | | | | |
|---|---|---|---|---|---|---|
| generation | | | | | | |
| Trip distribution | No, intervening opportunities model insensitive to capacity | Yes | Yes | Yes | Yes | Insensitive |
| Mode choice | Yes | Yes | Yes | Yes | Yes | Insensitive |
| Time of Day | No | No | No | No | Yes | No |
| Assignment | Yes | Yes | Yes | Yes | Yes | Insensitive |

The flip side of induced travel demand is reduced travel demand. If planned roadway capacity increases are insufficient to maintain congestion at current levels, travel demand should decrease. Components of the reduction would include changes in destination, mode, time of travel. Over the longer term, residential and business location choices would be affected by accessibility including the effects of congestion. As demonstrated in the table above, the TPB model is least able to account for this reduced travel demand of any of the models reviewed.

With these problems, the current TPB travel demand model will overestimate travel demand in the future, overestimate the benefits of proposed highway improvements, and will miscalculate both current and future air emissions.

## Effects of These Deficiencies on Past Analyses of Potential Potomac Bridge Crossings

As shown in Table 7 above, the TPB model includes almost none of the travel demand features that would support modeling induced travel demand. Therefore, it is not surprising that the model does not realistically represent induced travel demand.

There is one area that TPB identifies as critical and then fails to follow through on its promise. TPB documentation describes the importance of model feedback:

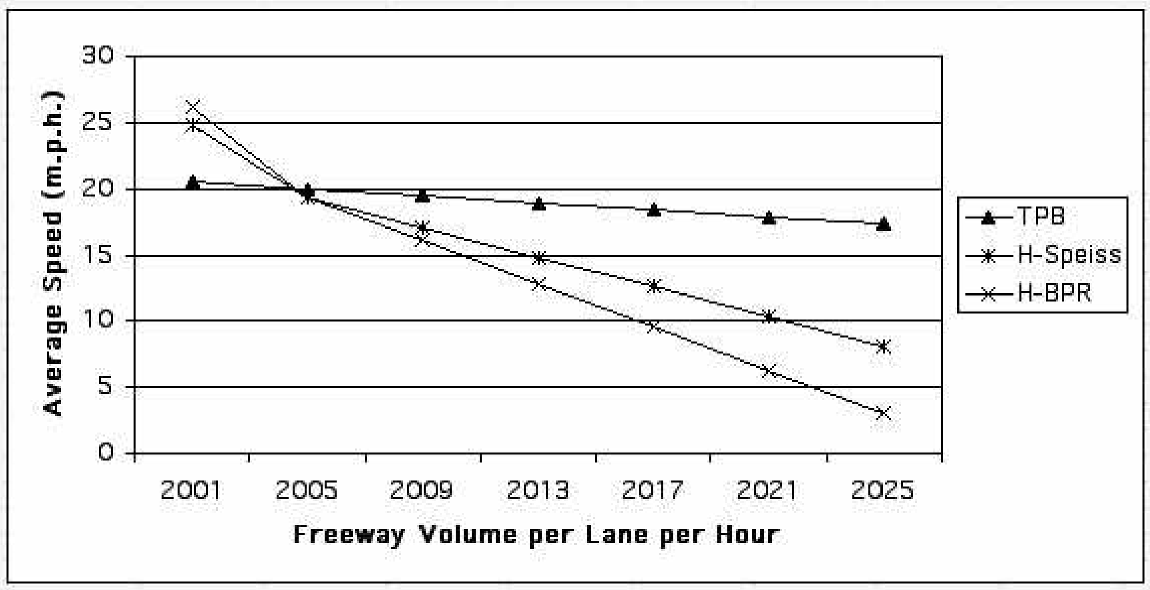
> Another key distinguishing feature of the Version 1 model linkage of traffic assignment-based speeds to the HBW trip distribution model. The feeding back of congestion speeds resulting from the traffic assignment step is a federally mandated requirement for acceptable modeling practice, and allows for greater consistency of congested highway speed assumptions used throughout the modeling process. (Transportation Planning Board: *FY-98 Models Development Program for COG/TPB Travel Models*, June 30, 1998)

The TPB model has such weak feedback that it does not meet the intent of the requirement. Consider the case of the American Legion Bridge on I-495. This bridge is the closest existing Potomac River crossing to any of the proposed “Techway” routes. Figure 8 illustrates the bridge speeds calculated by the TPB model for the period 2001-2025. In 2025, the forecast traffic volume on the bridge is 77,000 vehicles per day higher (30 percent) assuming the same capacity as in 2001. The speed being fed back to the trip distribution model declines by 15 percent. If the Horowitz recommended parameters described above were applied, the reduction in speed would be either 60 percent (Speiss function) or 90 percent (BPR function). These more realistic feedback functions would better reflect the real world response of travelers to changing traffic conditions. Motorists would find that work travel across the bridge would be increasingly less attractive as traffic volumes increase, and would reduce such trip making as people chose instead to use transit or carpool, to travel at different times of day, chose different destinations, or decided to telecommute.

An increase of 30 percent in traffic volume would be accompanied by a reduction in speed of 70 - 90 percent. However, this great an increase in traffic would not occur. A proper model would produce an intermediate result – an increase in peak hour/peak direction travel due to growth in population and employment, but much less of an increase than assumed in the TPB model. The TPB model lacks adequate feedback which causes shifts in destination, mode, and travel time in response to increased congestion.

This problem is not limited to the American Legion Bridge. It affects almost half of total regional VMT in 2001 and 2005 (46.7 percent and 49.5 percent, respectively) increasing to 63.9 percent of regional VMT in 2025. The impact of not including realistic feedback from congested travel speeds is substantial.

**Figure 8: American Legion Bridge – TPB Assumed Speed vs. Properly Modeled Speed**



Note: H-Speiss and H-BPR are two formulations recommended by Horowitz in 1991 in work done for the U.S. Department of Transportation. This work is described in greater detail in an earlier section of this report.

Most trips are non-work trips, and the TPB model does not even attempt feedback for non-work trips. The rationale appears to be that these are made during off-peak times, when there is little if any congestion. This rationale is contradictory to the other assumptions of TPB – that excess traffic from the peak traffic periods will spill over to the following periods, creating long periods of what they call “forced flow.” As the majority of trips even in the peak hours are non work, this lack of considering feedback for these trips as well is unacceptable.

As the TPB model can not properly forecast reductions in VMT as a result of congestion, it can not properly forecast increases in VMT that will result from increases in roadway capacity. In the context of Potomac River crossings, future traffic volumes on the existing bridges, including the American Legion Bridge, are surely overestimated in scenarios with no new bridges.

Time savings with a new bridge would be at least partially offset by increased congestion caused by induced travel, including congestion at roadways leading to and from any new bridges. The TPB model overstates the benefits of new roadway capacity, and underestimates the costs, including the effects of increased traffic in other areas.

## Methods That Address These Deficiencies

### *Short-Term*

In the short term, the TPB model should be upgraded to the state of the practice. While the Version 2 model that TPB is developing will address some of these, other areas for action are likely to remain outstanding. Critically needed improvements include:

1) using equilibrium assignment.
2) substituting ultimate capacity values for the current LOS C capacity values.

3) substituting realistic speed-delay functions for the outmoded BPR function. TPB's preliminary Version 2 model does not currently address this issue.

4) modeling multiple times of day, with time-of-day of travel sensitive to changes in travel times and costs between origins and destinations and changes in the heterogenity and mix of local land uses. TPB's preliminary Version 2 model does not currently address these factors.

5) making the model sensitive to changes in pedestrian/bicycle friendliness that are independent of job or household density and the location of an area in the region. TPB's preliminary Version 2 model does not currently address these factors, which include the average size of street blocks, availability and continuity of sidewalks, difficulty of crossing streets, implementation of traffic calming measures and pedestrian- and bicycle-friendly intersection and street designs, urban design standards such as maximum building setback requirements, restriction of 'blank wall' developments, and provision of bus shelters and bicycle parking facilities.

### *Intermediate Term*

Implementation of these short-term improvements would completely change the model results. Therefore, it is difficult to anticipate what further improvements may be warranted. Over the intermediate term, a thorough investigation should be made as to how well the upgraded model accounts for land use/transportation interactions and the other components of induced travel demand. These types of improvements could be advanced as needed to address any deficiencies found.

## Conclusions

The Metropolitan Washington Council of Governments National Capital Region Transportation Planning Board ("TPB") is the region's Metropolitan Planning Organization ("MPO"). Under Federal laws and regulations, MPOs are responsible for a set of regional planning activities including developing long-range transportation plans and demonstrating air quality conformity.

MPOs rely on computer models in these planning efforts. The models include separate but linked travel demand models and air quality models. Modeling activities are regulated by federally guidelines. TPB documentation states: "The feed back of congestion speeds resulting from the traffic assignment step is a federally mandated requirement for acceptable modeling practice."

This requirement is not being adequately met by the TPB model. While going through the motions of a feedback step, this step is extremely weak for work trips. For non-work trips, there is no feedback at all. Forecast traffic volumes in the model grow in an unrealistic unconstrained manner. This overestimation of future traffic demand can be falsely used to support the need for additional highway capacity.

In general, modeling such high traffic volumes with such high levels of congestion would present problems to TPB in demonstrating air quality conformity in future years. Air pollution is a function of vehicle miles of travel (VMT) and speed. Emission rates for all pollutants governed by federal standards are higher for low travel speeds associated with congestion.

However, TPB avoids the air conformity problem by invalidly shifting the traffic into less congested travel periods on a link by link basis, and maintaining unrealistic assumptions about travel speeds during congested periods. For freeways in the middle and outer part of the region, for example, TPB assumes that the minimum congested speed is 30-35 m.p.h., which is a range of speed with the minimum emissions for NOx, the region's most critical pollutant. By shifting the traffic from one period to another, calculated emissions for the most congested periods are reduced while simultaneously reducing travel speeds, and therefore calculated emissions, for adjacent time periods to 30-35 m.p.h. in the middle and outer rings of the region.

Without these invalid assumptions, calculated NOx emissions in 2005 would be 1.4 percent greater. This increase of 2.2 tons per day would cause the region to exceed the maximum allowed by 1.7 tons per day. In addition, calculated VOC emissions in 2005 would be 12.4 percent greater. This increase of 12.6 tons per day would cause the region to exceed the maximum allowed by 11.9 tons per day.

The TPB model is one of the poorest of large metropolitan travel demand models in capturing the effects of induced travel demand. With these problems, the TPB travel demand model overestimates travel demand in the future, overestimates the benefits of proposed highway improvements, and miscalculates air emissions.

These problems are especially acute in past studies of potential new Potomac River bridge crossings, all of which were based on this model or previous versions of the model. The American Legion Bridge on I-495 highlights these problems. This bridge is the closest existing Potomac River crossing to any of the proposed "Techway" routes. Despite a modeled increase in traffic volume of 30 percent or 77,000 vehicles per day, the TPB modeled speed declines by only 15 percent. This small decrease in speed effects only work trips. There is no effect on non-work trips at all.

Recommended speed delay functions indicate that this increase of 30 percent in traffic volume would be accompanied by a reduction in speed of 70 - 90 percent. However, this great an increase would not occur. A proper model would produce an intermediate result – an increase in peak hour/peak direction travel due to growth in population and employment, but much less of an increase than assumed in the TPB model. The TPB model lacks the realistic feedback which causes shifts in destination, mode, and travel time in response to increased congestion.

As the TPB model can not properly forecast reductions in VMT as a result of congestion, it can not properly forecast increases in VMT that will result from increases in roadway capacity. In the context of Potomac River crossings, future traffic volumes on the existing bridges, including the American Legion Bridge, are surely overestimated in scenarios with no new bridges.

Any forecast travel time savings with a new bridge would be at least partially offset by increased congestion caused by induced travel, including congestion at roadways leading to and from any new bridges. The TPB model overstates the benefits of new roadway capacity, and underestimates the costs, including the effects of increased traffic in other areas.

The TPB and the Metropolitan Washington Air Quality Committee (MWAQC) have recently appointed a task force to recommend strategies to reduce air pollution to compensate for the excess emissions from increased use of sport utility vehicles and light trucks in the region. There are a number of strategies that could be used to solve this emission budget shortfall within the transportation planning process, for example by delaying some traffic-inducing road projects to accelerate funding of new bus and railcar purchases, promoting employer-paid commuter transit benefits, and investing in bicycle and pedestrian access to schools and transit stops.

The TPB has recommended that about half of this emission budget shortfall be eliminated – on paper - simply by adjusting what it believes to be faulty model assumptions about the composition of traffic on local roads and accessing park-and-ride lots in the region. Any modification of the TPB models to refine the analysis of traffic and its emissions should also correct the deficiencies noted in this report. Failure to do so would raise serious questions about compliance of the region's planning process with the Clean Air Act regulations guiding modeling and use of the latest and best planning assumptions.

* * *

*This report is a revision of an earlier edition released on December 10, 2001. It refines and clarifies several figures presented in the earlier report on the basis of information obtained in a meeting between Transportation Planning Board staff, consultants, and report sponsors on January 10, 2002. The report's findings and conclusions remain unaltered by these refinements. Opinions expressed in this report do not reflect the position of the Metropolitan Washington TPB or its staff.*

# SMART MOBILITY, INC.

# NORMAN L. MARSHALL, PRESIDENT

## *Education*

B.S. Mathematics, Worcester Polytechnic Institute, 1977

M.S. Engineering Sciences, Dartmouth College, 1982

## *EXPERIENCE*

Mr. Marshall helped found Smart Mobility, Inc. in 2001 and is its President. Prior to this, he was employed for 14 years at Resource Systems Group, Inc. where he developed a national practice in travel demand modeling and related transportation planning work.

## *RESPONSIBILITIES AND RELEVANT PROJECTS*

### Developing Regional Transportation Models

Mr. Marshall led teams that developed regional transportation models for five Metropolitan Planning Commissions (MPOs) and also one statewide model. State-of-the-art features include integrated land use allocation models, advanced mode choice models, linked air emission models, and geographic information systems (GIS) interfaces. Mr. Marshall also has made significant enhancements to models in other regions.

*Route 53 and I-355 Alternatives Studies*—with assistance from University of Illinois at Chicago staff, developed advanced transportation modeling capability of the Chicago. The model includes simultaneous selection of destination, mode, route, and time of day, and is being used to test alternative highway, transit, land use, and TDM scenarios.

*Georgia Intercity Rail Plan*—developed statewide travel demand model for the Georgia Department of Transportation including auto, air, bus and rail modes. Work included estimating travel demand and mode split models, and building the Departments ARC/INFO database for a model running with a GIS user interface.

*Chittenden County ISTEA Planning*—developed a land use allocation model and a set of performance measures for Chittenden County (Burlington) Vermont for use in transportation planning studies.

*Syracuse Intermodal Model*—developed custom trip generation, trip distribution, and mode split models for the Syracuse, New York metropolitan area .

*Trip Generation Characteristics of Multi-Use Developments*—estimated internal vehicle trips, internal pedestrian trips, and trip-making characteristics of residents at large multi-use developments in Fort Lauderdale, Florida.

*Pease Area Transportation and Air Quality Planning*—developed an integrated land use allocation, transportation, and air quality model for a three-county New Hampshire and Maine seacoast region

*PACTS Travel Demand Model Upgrade*—enhanced the Portland Maine regional model. Estimated person-based trip generation and distribution, and a mode split model including drive alone, shared ride, bus, and walk/bike modes.

*Improved Transportation Models For the Future*—assisted Sandia National Laboratories in developing a prototype model of the future linking ARC/INFO to the EMME/2 Albuquerque model and adding a land use allocation model and auto ownership model including alternative vehicle types.

## Applying Regional Transportation Models

Mr. Marshall has applied regional transportation models developed by his own team and by others in highway and transit planning projects at the project, corridor, and regional levels.

*Metropolis 2020*—part of team evaluating comprehensive land use/transportation scenarios for the Chicago Region in project sponsored by the Commercial Club of Chicago, the organization that sponsored the Burnham *Plan of Chicago* in 1909.

*State Routes 5 & 92 Scoping Phase*—evaluated TSM, TDM, transit and highway widening alternatives for the New York State Department of Transportation using local and national data, and a linkage between a regional network model and a detailed subarea CORSIM model.

*Conformity Analyses* – Applied models for three New Hampshire MPOs in calculating air emissions in the conformity process.

*Twin Cities Area and Corridor Studies*—improved regional demand model to better match observed traffic volumes, particularly in suburban growth areas. Applied enhanced model in a series of subarea and corridor studies.

*Keene/Swanzey Environmental Impact Transportation Model*—used system planning model to evaluate different sets of major roadway improvements including a proposed bypass and TDM alternatives for the New Hampshire Department of Transportation.

*South Burlington City Center, South Burlington Vermont*—analyzed the traffic impacts of a large, high-density mixed-use development with associated highway improvements using the Chittenden County Travel Forecasting Model.

*Ohio 3-C Corridor Rail Estimation*—re-calibrated a previously-developed demand model and produced ridership and revenue estimates for a proposed Cleveland-Columbus-Cincinnati high-speed rail service.

## Reviewing Regional Transportation Models

Mr. Marshall draws on his experience in developing and applying regional transportation models to review the work of others. Recent projects include:

*Washington, DC region* – Reviewing modeling of Potomac River bridge crossings.

*Tempe, Arizona* – Reviewing conformity analyses and long-term transportation plan for a municipality in the Phoenix region.

*Atlanta, Georgia* – Critiqued conformity analyses and long-term transportation plan for an environmental coalition.

*Daniel Island (Charleston, South Carolina)* – Reviewed Draft Environmental Impact Statement for large proposed Port expansion (the “Global Gateway”) for an environmental coalition.

*Houston, Texas*– Analyzed conformity analyses and long-term transportation plan for an environmental coalition.

## *Recent Publications and presentations*

“Evidence of Induced Travel” with Bill Cowart, presented in association with the Ninth Session of the Commission on Sustainable Development, United Nations, New York City, April 2001.

“Induced Demand at the Metropolitan Level – Regulatory Disputes in Conformity Determinations and Environmental Impact Statement Approvals”, Transportation Research Forum, Annapolis November 2000.

“Evidence of Induced Demand in the Texas Transportation Institute’s Urban Roadway Congestion Study Data Set”, *Transportation Research Board Annual Meeting*, Washington D. C: January 2000.

“Subarea Modeling with a Regional Model and CORSIM” with K. Kaliski, presented at *Seventh National Transportation Research Board Conference on the Application of Transportation (Transportation Research Board),* Boston, May 1999.

“New Distribution and Mode Choice Models for Chicago” with K. Ballard, *Transportation Research Board Annual Meeting*, Washington D. C: January 1998.

“Land Use Allocation Modeling in Uni-Centric and Multi-Centric Regions” with S. Lawe, *Transportation Research Board Annual Meeting,* Washington, D. C: January 1996.

"Multimodal Statewide Travel Demand Modeling Within a GIS" with S. Lawe, *Transportation Research Board Annual Meeting*, Washington, D. C: January 1996.

"Forecasting Land Use Changes for Transportation Alternatives" with S. Lawe, *Fifth National Conference on the Application of Transportation Planning Methods (Transportation Research Board)*, Seattle, WA, April 1995.

## ***Memberships/Affiliations***

Associate Member, Institute of Transportation Engineers (ITE)

Individual Affiliate, Transportation Research Board

Board Member, Vital Communities (NH/VT)

## REFERENCES

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[ix] Lawrence C. Barr. Testing for the Significance of Induced Highway Travel Demand in Metropolitan Areas. TRB 79th Annual Meeting Preprint CD-ROM, TRB, National Research Council, Washington D.C., January 2000.

[x] Heanue, K. Highway Capacity and Induced Travel: Issues, Evidence and Implications. *Highway Capacity Expansion and Induced Travel – Evidence and Implications*. TRB, National Research Council, Washington D.C., February 1998, pp. 33-45.

[xi] Induced Travel: Definition, Forecasting Process, and A Case Study in the Metropolitan Washington Region. A Briefing Paper for the National Capital Region Transportation Planning Board
Metropolitan Washington Council of Governments, September 19, 2001

**Attachment 8:**

AMERICAN PUBLIC HEALTH ASSOCIATION * ASTHMA AND ALLERGY FOUNDATION OF AMERICA * CHILDREN'S ENVIRONMENTAL HEALTH NETWORK * CHILDREN'S NATIONAL MEDICAL CENTER * ENVIRONMENTAL DEFENSE * GRACE PUBLIC FUND * PHYSICIANS FOR SOCIAL RESPONSIBILITY

July 26, 2002

The Honorable Norman Y. Mineta
Secretary, U.S. Department of Transportation
400 7th Street SW
Room 10200
Washington, DC 20590

Dear Secretary Mineta:

We represent a diverse array of groups dedicated to supporting and improving public health. We are writing to request that the Administration's proposal for reauthorization of the Transportation Equity Act for the 21st Century (TEA-21) contain measures that protect that public's health from unintended consequences of transportation initiatives.

A transportation system that encourages or supports increased use of personal automobiles can impair human health by a variety of means, including:

- Increased injuries and deaths from motor vehicle crashes (including pedestrians and bicyclists);
- Increased respiratory illness, infant mortality and other health damage connected with exposure to air pollutants;
- Impaired water quality related to runoff from paved land; and
- Decreased physical activity, contributing to the nation's epidemic of obesity and diabetes

We therefore call on the Administration to take the following steps in their reauthorization proposal:

- Require new road projects to meet the same criteria and local funding match as required for new transit projects.
- Require health impact statements for all new transportation plans and major projects. These statements must address the potential impact of the proposed plan on public health, including fitness, community cancer risk, health effects related to air quality, and transportation-related injuries and fatalities, as well as consideration of disparate impacts on minorities.
- Oppose environmental streamlining, which threatens to promote failed policies of trying to build our way out of congestion. Instead, we should require integrated state, regional, and local transportation, natural resource, and growth plans.

- Defend requirements that all updates to 20-year transportation plans and short-term programs conform with Clean Air Act State Implementation Plans.

- Expand and strengthen the Congestion Mitigation Air Quality Program (CMAQ), which provides $1.3 billion a year for non-highway widening projects that reduce pollution in non-attainment areas. Seek funding growth proportionate to the population of all newly designated non-attainment areas.
- Boost tax incentives for employers to offer employees tax-free transit benefits.

Changes in how we manage and operate transportation can save money and lives, cut congestion, and improve environmental quality. But to achieve this we need better planning, better accountability for the effects of decisions, and fuller consideration of alternatives to building more and bigger highways. We strongly urge you to move this country in the direction of transportation systems that benefit, rather than harm, the health and well-being of our residents and communities. We look forward to working closely with you in this effort.

Sincerely,

Donald Hoppert
American Public Health Association

Daniel Swartz
Children's Environmental Health Network

John Balbus, MD, M.P.H.
Environmental Defense

Robert K. Musil, Ph.D, M.P.H.
Physicians for Social Responsibility

Jaqui Vok
Asthma and Allergy Foundation of America

Benjamin Gitterman, MD
Children's National Medical Center

Alice Slater
GRACE Public Fund

Cc: Mary Peters
Adminstrator, FHWA

Emil Frankel,
Assistant Secretary for Policy, US DOT

**Attachment 9:**

AMERICAN RIVERS * ENVIRONMENTAL DEFENSE* FRIENDS OF THE EARTH * IZAAK WALTON LEAGUE * NATIONAL ENVIRONMENTAL TRUST * NATURAL RESOURCES DEFENSE COUNCIL * PHYSICIANS FOR SOCIAL RESPONSIBILITY * RAILS TO TRAILS * SCENIC AMERICA * TRUST FOR PUBLIC LANDS * UNION OF CONCERNED SCIENTISTS

July 26, 2002

The Honorable James M. Jeffords
Chairman, Senate Environment and Public Works Committee
410 Dirksen Senate Office Building
Washington, DC 20510

RE: Streamlining and TEA-21 Reauthorization

Dear Senator Jeffords:

Reauthorization of the Transportation Equity Act for the 21st Century (TEA-21) is a key opportunity to promote transportation environmental stewardship, renewing the promise of the ISTEA reforms. We urge the Administration to pursue such opportunities and resist "environmental streamlining" proposals for highways, aviation, pipelines, and energy which threaten to impair core environmental laws such as the National Environmental Policy Act (NEPA) and clean air, clean water, parks, and historic resources protection statutes.

Some states have begun to embrace environmental stewardship, forge partnerships with resource agencies and stakeholders, and use TEA-21's flexibility to support smart growth, resource protection, system management and incentives, and expanded travel choices as a core part of transportation plans and programs. Other states continue to pursue a failed strategy of trying to build their way out of congestion. Some scapegoat environmental laws for their own administrative failures, manifested in a lack of consensus on proposed projects; insufficient local matching funds; and projects delayed by inadequate consideration of alternatives, inadequate mitigation, avoidance of adverse impacts, and efforts to end-run federal requirements.

This has led to 'environmental streamlining' proposals with arbitrary review deadlines, time limits on judicial review of transportation decisions, limitations on the determination of purpose and need for transportation projects and lead agency designations, circumscribed public involvement, mandatory concurrent processing of reviews and permits, and the elimination rather than integration of the Major Investment Study requirements of ISTEA into NEPA and the planning process. We urge you to oppose such anti-environmental measures threatening core environmental laws that assure the public's right-to-know about the effects of decisions before actions are taken.

We urge your support for efforts to expedite transportation project delivery by improving integration of project reviews with a planning process designed to minimize adverse impacts;

strengthen accountability; and consider opportunities for improved transportation system management and stewardship. Such approaches can produce timely consensus to build good projects that protect public health, curbing delays and conflict that arise when agencies advance harmful projects without broad public support.

Transportation planning which considers communities and protected resources such as public parks, wildlife habitat and historic sites will produce better projects less likely to incur opposition and delay. Taking protected resources into account at the beginning, and planning accordingly will both protect resources and facilitate project approvals.

TEA-3 should require coordination of transportation, environmental, resource and land use plans with effective public involvement and more funding for resource agencies for their early and continuous engagement. Transportation data and analysis must be improved for sound evaluation of secondary, induced and cumulative impacts and the effects of smart growth and transportation management alternatives on air quality, equity, and other goals. Many delays arise when agencies have failed to effectively consider impacts on specific populations or neighborhoods, or the effects of transportation infrastructure projects on land use, travel behavior and public health.

Better classification of transportation projects for environmental review could cut delays. Some major highway widening projects evade environmental analysis while small, no-impact projects sometimes endure needless processing delays. The more rigorous New Starts review procedures applied to new transit projects should be equally applied to new highways. All federally funded projects should be planned and designed under the principles of context-sensitive highway design. Improved inter-city rail service and congestion pricing strategies should be considered as alternatives to new airport capacity.

Health impact assessments should be made part of all transportation plans. We urge you to oppose weakening of transportation conformity, which assures transportation plans do not cause a failure of state air pollution control strategies. Public health would be threatened if plans and programs could be amended without considering air quality implications or if conformity applied only to short-term programs, rather than to both 20-year transportation plans and short-term programs. Conformity is spurring investments in transportation strategies and technologies that reduce air pollution and better interagency cooperation. A few areas like Atlanta have faced short-term limits on their flexibility to build new roads because their transportation plans conflicted with their air quality plans, motivating timely action for interagency cooperation. The $1.3 billion a year CMAQ program, which funds clean air programs, should be expanded by at least 50%, proportionate to the number of people living in new non-attainment areas.

Finally, TEA-3 should also require regional transportation plans and programs to contribute to timely attainment of clean water goals, and require stormwater management strategies for all new transportation facilities in watersheds not meeting standards, and application of best retrofit technologies for any highway undergoing significant reconstruction.

We would welcome the opportunity to meet with you during September to discuss these critical environmental issues with you. Felicia Lopez, Green Group Coordinator, will be in touch with your office in the near future to identify a convenient meeting time for you.

Sincerely,

Keith Laughlin
President, Rails to Trails

Will Rogers
President, The Trust for Public Lands

Howard Ris
President, Union of Concerned Scientists

Meg Maguire
President, Scenic America

Fred Krupp
Executive Director, Environmental Defense

Rebecca R. Wodder
President, American Rivers

Philip E. Clapp
President, National Environmental Trust

John H. Adams
President, Natural Resources Defense Council

Brent Blackwelder
President, Friends of the Earth

Rober K, Musil
Executive Director, Physicians for Social Responsibility

Paul Hansen
Executive Director, Izaak Walton League

Cc: The Honorable Bob Smith