

WORKSHOP ON TRAFFIC, HEALTH, AND INFRASTRUCTURE PLANNING  
FEBRUARY 1–3, 2004  
BACKGROUND INFORMATION SUMMARY DOCUMENT

**TRANSPORTATION – AIR QUALITY PLANNING AND POLICY ISSUES**

**INTRODUCTION**

The need to protect the public from the serious adverse health effects of motor vehicle emissions has been recognized as an important public health goal since the 1960s. Evidence of adverse health effects associated with vehicle emissions of carbon monoxide, benzene, ozone and lead was the primary driving force behind the enactment of the Air Quality Act of 1967, the Clean Air Act of 1970 (CAA), and the air pollutant control provisions of the 1970 amendments to the Federal-Aid Highway Act (Highway Act). The environmental impacts of highways were also cited as a major factor behind the enactment in 1970 of the National Environmental Policy Act (NEPA). The failure of these early statutes to fully protect the public from these adverse health effects prompted the 1977 and 1990 Amendments to the Clean Air Act. Together, these statutes provide the framework for all federal efforts, and most State programs, to protect the public from the health effects of vehicle emissions. In a 2000 report to Congress, the Federal Highway Administration (FHWA) estimated the annual health cost of air pollution from transportation sources in the U.S. is over \$40 billion (U.S. Department of Transportation [U.S. DOT], 2000). These estimates did not include health costs for fine particles or toxic air pollutants emitted by motor vehicles, and were based on a substantially lower value per life lost than is used by the U.S. Environmental Protection Agency (EPA).

The control of motor vehicle emissions falls under two general approaches:

- 1) Reducing emissions at the source by limitations on emissions from vehicles that are based upon the application of emission control technologies; the modification of engine design and the combustion characteristics of traditional fuels to reduce pollutant formation; and/or the conversion of gasoline and diesel-fueled vehicles to less-polluting or non-polluting energy sources; and
- 2) Reducing aggregate emissions in any locale or region by reducing total vehicle travel through the implementation of transportation control and/or land use strategies that encourage personal travel by multiple occupant vehicle modes, walking or bicycling rather than single occupant vehicles; reducing trip lengths by bringing origins and destinations into closer proximity; consolidate freight shipments onto larger platforms (e.g., truck to rail or barge) and encouraging freight transport by less emitting modes of shipment; and reducing travel demand.

The public health consequences of motor vehicle emissions can also be mitigated by reducing exposure to motor vehicle emissions through planning strategies that separate populations from “hot spot” areas where emissions are highly concentrated, such as the isolation of truck and bus depots from residential neighborhoods, the relocation of rail switch yards to unpopulated areas, the creation of open space buffer zones along major freeway rights-of-way and near large airports.

## **LIMITING AGGREGATE EMISSIONS IN METROPOLITAN AREAS AND LOCAL HOT SPOTS**

Strategies to reduce vehicle emissions by means other than reducing direct emissions from vehicles have been adopted by the States as part of their State Implementation Plans (SIPs), which are required under the CAA for states with air pollution levels that exceed the National Ambient Air Quality Standards (NAAQS). One such strategy is the development of public transportation alternatives to single occupant vehicle travel as part of metropolitan transportation systems. The CAA “conformity” provision (section 176(c)) now requires that planned development of future additions to metropolitan transportation systems contribute to the emissions reductions needed for attainment of the NAAQS. NEPA has played a limited role in reducing emissions by requiring consideration of less polluting alternatives in the development of major highways, but this obligation has been limited to a consideration of alternatives that can be implemented at the scale of the corridor to be served by an individual highway. Strategies that are effective only at the regional or metropolitan level, such as economic incentives, land use, or freight route relocation, have generally been excluded from NEPA analyses of highways.

The requirement of section 109(h) of the Highway Act that alternatives to highways be assessed to determine the costs of measures that would “eliminate or minimize” the adverse effects of highway pollution, and then compared with the mobility benefits of the highway to determine the “best overall public interest,” has not been implemented by U.S. DOT. Unrelated to federal law, local governments have undertaken programs to enhance local bus service, to provide free or heavily subsidized transit services to certain classes of users or in heavily trafficked zones, to expand rights-of-way reserved for bicycles, to convert transit vehicles to cleaner-burning alternative fuels, to adopt land use plans that focus new development in corridors served by regional transit facilities, to relocate rail switch yards, and to create buffer zones near highways and airports.

The 1990 Amendments also added new authority in section 202(l) for EPA to regulate emissions of toxic pollutants emitted by motor vehicles that are associated with significant adverse health effects. In a 2001 rulemaking, EPA identified 21 of these pollutants as “mobile source air toxics” (MSATs), including six “priority” MSATs (benzene, 1,3 butadiene, formaldehyde, acetaldehyde, diesel organic gases and diesel particulate matter (DPM)) (U.S. EPA, 2001). EPA decided not to regulate emissions of these pollutants based on the finding that no feasible technological means are available to achieve additional emissions reductions beyond the reductions expected from compliance with current emissions limitations for NAAQS pollutants. EPA’s MSAT rule could require the retrofit of existing diesel vehicles with available particulate matter (PM) traps to achieve significant reductions in diesel PM and other MSATs without waiting for fleet replacement, but EPA denied requests from nine states to exercise this authority.

### ***Conformity and Transportation Project Air Quality Impacts***

EPA currently requires that “hot spot” analyses to assess the impact of vehicle emissions on air quality near a transportation facility only be performed for carbon monoxide and PM<sub>10</sub>. In its 2003 draft rule to implement the PM<sub>2.5</sub> NAAQS, EPA originally proposed to exempt transportation projects (e.g., major freeway expansions, new interchanges, diesel truck/bus depots or terminals) from any “hot spot” analysis for both PM<sub>2.5</sub> and PM<sub>10</sub> emissions (U.S. EPA, 2003). In response to strong objections from many States and public interest organizations, EPA published a revised proposal in December 2004 containing options for regulation as well as the original no-action proposal (U.S. EPA, 2004). If the rule were finalized as originally proposed, transportation projects that result in increases in PM levels sufficient to cause violations of either PM NAAQS would not be identified in most cases. Where NAAQS violations were predicted, the conformity requirement that mitigation measures sufficient to prevent NAAQS violations be adopted prior to project approval would not apply. A final decision on the PM NAAQS hot spot issue was not issued at the time this document was developed (early 2006).

### ***Regional versus Local Scale Monitoring Data***

Air quality for regulatory purposes is typically monitored in a relatively coarse geographical grid. For example, the monitoring of PM with an aerodynamic diameter of 10 microns or less (PM<sub>10</sub>), is done in an area of Chicago with a density of 1 monitor every 38 square miles, and in the six states USEPA Region V, roughly 1 monitor covering every 1,000 square miles, respectively (Koerber, Michael, 2004; Lake Michigan Air Directors Consortium and Midwest Regional Planning Organization, 2004).

Research conducted in many areas of the world in the last several years to detect and measure the health effects of PM inhalation from traffic emissions has made use of technologies and approaches that did not exist when the original PM monitoring network was created in the 1970's. Geo-coded data and new computing power made geographic information systems useful and affordable; changes in technology miniaturized "personal" air quality monitors; expansion of state and metropolitan traffic monitoring networks and new disclosure requirements yielded small area traffic volumes; and new modeling techniques enabled the disaggregation of vehicle and fuel types to yield more rigorous emissions identification. This work has resulted in a grid geometry and topology that is much finer-grained than the official monitoring network. Differentiating health effects in the range of 50 to 400 meters from the exposure source (e.g. highway) would theoretically require a monitoring density of approximately 1,000 monitors per square mile, which would be cost prohibitive to implement. For example, the present density in Region V is one monitor per 1,000 square miles. If this analogy holds true, then monitoring density would need to increase by a factor of 6 (i.e., one million times) to give valid results across the entire monitoring region.

The lack of locally representative monitoring data (see below) can lead to uninformed policy making. Regulatory authorities that govern strategies for reducing emissions from traffic rely on conformity at the regional level. Regional transportation improvement plans must conform to SIPs, which in turn, stipulate that growth in emissions from traffic in non-attainment areas must be offset by transportation control measures, which are specified by function in Section 110 of the Clean Air Act Amendments of 1990. Conformity has been determined on the basis of models that use emissions budgets derived from regionally scaled monitoring. The modeling of interactions between land use, transportation and air quality at the metropolitan level does not adequately inform the policy decisions related to traffic emissions impacts at the local level.

## **TRAFFIC EXPOSURE ESTIMATION STRATEGIES**

In order to estimate the relative importance of factors affecting emissions from transportation systems, the following methodology was outlined at the Workshop:

$$P = \frac{P}{F} \times \frac{F}{VMT} \times \frac{VMT}{V} \times \frac{V}{Pop}, \text{ where}$$

- P is pollution
- F is amount of fuel
- VMT is amount of travel in vehicle miles
- V is number of vehicles and
- Pop is population

Most efforts to date to reduce mobile source pollution have focused on tailpipe emissions through improvements in engine and emission control technologies and fuels, but not on changing the transportation systems and travel demand. To the extent that our regulatory policy focus is on relative air

quality improvements rather than absolute levels of air pollution, and since the observed increase in travel is offsetting much of the gains in relative efficiency from cleaner fuels and cleaner technology, exposure to motor vehicle-related air pollutants is increasing and health is likely declining (Salvucci, 2004).

Location efficiency research is another approach to assessing traffic levels. This approach utilizes the attributes of place (households per residential acre, households per total acre, income per capita, persons per household, zonal transit density, block size as a surrogate for pedestrian/bike friendliness) as independent variables, and attributes of travel demand (vehicles per household and vehicle-miles-traveled (VMT) per household-year) as the dependent variables in a multiple regression equation—all subject to the identity

$$\frac{VMT}{HH} = \frac{Veh}{HH} \times \frac{VMT}{Veh}, \text{ where}$$

HH is households

Veh is vehicles

The shape of the curves relating the travel demand variables to net residential density is an inverse-J; in the statistical models for Vehicles/HH and VMT/Vehicle, density is raised to a negative power, so doubling density causes a fixed decrease in Vehicles or VMT.

The findings of one analysis of the relationship between population density and motor vehicle traffic levels show that doubling of density within metropolitan regions of very different geographies always leads to a 20-40 percent long term reduction in annual vehicle miles traveled per household. By contrast, decentralization has the opposite effect. Increasing land consumption leads to increased travel demand; each one percent increase in land consumption in metropolitan Chicago from 1970-1990 was associated with 1.25 percent increase in VMT. Nationally, from 1982 to 1997, land consumption increased at 4.5 times the growth in population (Fulton et al., 2001).

## **EXPOSURE REDUCTION STRATEGIES**

Using traffic density as an exposure surrogate, a minimum of 10,000 vehicles of average daily traffic serves as a trigger level for health concerns related to high density traffic, and there is more concern for corridors dominated by truck and diesel traffic than traffic corridors in general. Other congestion areas that do not necessarily meet the traffic density criteria include areas near schools, bus depots, loading docks, industrial parks, malls, and shopping strips.

There are several strategies that might reduce exposure and urban planning policies and incentive tools that might achieve risk reduction if not outright health improvement. These include traffic reduction, preventing particles and dust, and focus on “hot spots.”

### ***Traffic Reduction***

Strategies for achieving attainment under the framework of the Clean Air Act Amendments generally include cleaner cars, cleaner fuels, and reductions in VMT (Roth et al., 1993). The increasing trend in vehicle numbers and use represents a countering force to these measures. Vehicle ownership and use have increased 2.1 and 2.7 times population increase, respectively.<sup>1</sup> While growth in passenger traffic flattened

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<sup>1</sup> Calculations from FHWA time series data, Tables MV-1 and VM-1, <http://www.fhwa.dot.gov/policy/ohpi/hss/hsspdocs.htm> and census data. Total vehicle registrations increased from 190.3 million in 1992 to

out from 1998 to 2002, growth in goods movement skyrocketed, with implications for emissions, air quality and public health. Traffic increase is occurring mostly on roads that have no room for expansion, and that in most cases were originally planned for horse-powered and pedestrian travel.

Ramping up incentives for non-motorized travel is feasible and should be scaled up. Reducing minimum parking requirements, installation of adequate signalization and signage for pedestrian safety, increase in “safe routes to school” and even “safe routes to everywhere” strategies should be actively encouraged. The use of electric power to substitute for diesel engine idling is another option under consideration. Innovative approaches to mass transportation include region-wide efforts to develop performance-based standards for transit-oriented development, and approaches to rapid deployment of car-sharing services.

Much of the increased risk from increased traffic comes from goods movement. While the trend in long distance goods movement is toward intermodal movements with tremendous energy benefits, this is not an “emissions-free” scenario. As manufacturing moves offshore, product movements are increasingly through coastal ports and airports. These movements can be depicted as a multiplier of emissions that otherwise would be solely locally generated. Efforts to explore shifting pickup and delivery to off peak hours should be encouraged, particularly where this involves a public port or airport. The emissions implications of continued decentralization of manufacturing needs to be better understood. Higher emission vehicles could be reserved for longer distance travel and lower emission strategies reserved for local pickup and delivery. Mass transportation agencies have experimented with offering package service on rapid transit.

The relationship between decentralization and traffic pollution risk reduction is not fully understood. It is not clear that newer communities at low densities can be planned with setbacks and other geometric features that would successfully segregate human activity from traffic-related emissions.

### ***Particle and Dust Prevention***

Much of the strategies of the CAA and of the Intermodal Surface Transportation Efficiency Act and Transportation Equity Act for the 21<sup>st</sup> Century statutes are of a mitigating nature: policy requires growth in travel over 1990 baselines to be offset at a rate of 1:1 or greater (Bernstein, 1993). There are two problems with this strategy. The first is its *post facto* nature; the second is the non-recognition of the health effects of 1990 levels (Salvucci, 2004; Yuhnke, 2004).

While priority should be given to deployment of best available emissions technology, much of the motor vehicle PM pollution problem is derived from the dissipative nature of brake linings, tires, and road paving materials. The more durable these materials can be made, the longer they will last and the less likely they are to increase exposures of concern. Tires, for example, are a composite material that to achieve their target specifications of lasting 50,000 miles or more must have enough carbon added to make them the equivalent of elastic diamonds. As they wear, ultrafine carbon black is released. Road paving releases particles and a variety of VOCs. Premature paving increases the flow of these materials. The US Bureau of Mines estimated that about fifty percent or 2.5 billion metric tons of materials flowing through the US economy are of a dissipative nature. The greatest part of the increase is due to construction and maintenance of the built environment and other dissipative or residual wastes (Rogich, et

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229.6 million in 2002,  $39.5/190.3=2.1$  percent per year. VMT increased from  $2.25 \times 10^{12}$  in 1992 to  $2.86 \times 10^{12}$  in 2002 or 2.7 percent per year. 1992 population was 253.6 million and 2002 was 280.5 million; mean rate of change was 1 percent per year. Components of change of annual VMT analyzed by the Surface Transportation Policy Project at [http://www.transact.org/library/decoder/Transit\\_VMTDecoder.pdf](http://www.transact.org/library/decoder/Transit_VMTDecoder.pdf)

al., 1994; Wernick & Ausubel, 1995).<sup>2</sup> About two-thirds of the non-energy material inputs are for construction. The so-called “fugitive” emissions from construction and maintenance of and erosion from the built environment, which probably at this point in history constitutes the bulk of such materials ever extracted, deserves more attention from the public health community.

### ***Fleet Vehicle Management***

To the extent that localized emissions inventories show publicly owned vehicles to be a significant part of the problem, maintenance, retrofit and replacement of these vehicles should be addressed. The target population includes garbage and sanitation trucks, mass transit buses, and school buses. These fleets have been very slow to convert to low emissions and a case could be made for public leadership and for expanded public finance. In the case of school buses, not only are children who use these services at risk, but also bus drivers and neighbors of the school facilities. In a sense, publicly owned vehicles are treated as mobile source or non-point source emissions, when in reality much of the risk occurs in very identifiable “hot spots.”

## **CONCLUSIONS**

The Clean Air Act’s regulatory paradigm focuses on “progress” in terms of relative air quality, or how much better air quality is compared to potential pollution levels absent implementation of control measures, as the key milestones in the long-term process of attaining healthful air quality (i.e. NAAQS). However, air pollution health effects research is demonstrating adverse effects at lower and lower levels of pollution, further extending the health targets, and for pollutants such as PM and ozone no threshold level for adverse effects has yet been identified.

The implementation of relatively stringent motor vehicle emissions standards for light-duty vehicles initiated for the 2004 model year, and the pending requirement for substantial reductions in heavy-duty motor vehicle emissions beginning in 2007, are likely to achieve significant reductions in metropolitan area level population exposure to criteria and many air toxics pollutants. In addition to vehicle tailpipe controls, traffic movement and VMT reduction strategies will also need to be increasingly employed to reduce mobile source emissions in order to meet the national ambient air quality standards of the Clean Air Act. However, these strategies alone are not likely to be sufficient to fully address the health impacts of exposure to vehicle emissions for those populations that are in close proximity to high density roadways.

Significant additional reductions in motor vehicle emissions from new vehicles beyond those already adopted are not likely unless manufacturers convert to new engine types (e.g., hybrids), or new fuels (e.g., hydrogen, electric). However, even optimistic projections for the adoption of these new power systems suggest that they are not likely to achieve significant emissions reductions within the next 10 to 20 years. Further emissions reductions will require emphasis on strategies designed to retrofit existing heavy-duty vehicles with improved pollution control equipment, reduce vehicle use, and separate at-risk populations from the sources of emissions.

The increasing environmental and health concerns regarding urban sprawl and the movement toward urban in-fill and mixed use land use planning suggests the potential for an increase in the numbers of populations that will be working and residing in close proximity to high density roadways. The challenge for urban development and transportation system planners, and their environmental protection and public

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<sup>2</sup> This simple balance sheet does not include 130 billion metric tons of water for consumptive use, or the production of 10 billion metric tons of extractive wastes nor the even larger amount of carbon dioxide produced from anthropogenic emissions.

health counterparts, will be to meld sensible urban and transportation system planning with adequate public health protection for these populations.

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