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Clean Air Through Transportation:

Challenges in Meeting National Air Quality Standards

A Joint Report from the United States Department of Transportation and Environmental Protection Agency

August 1993

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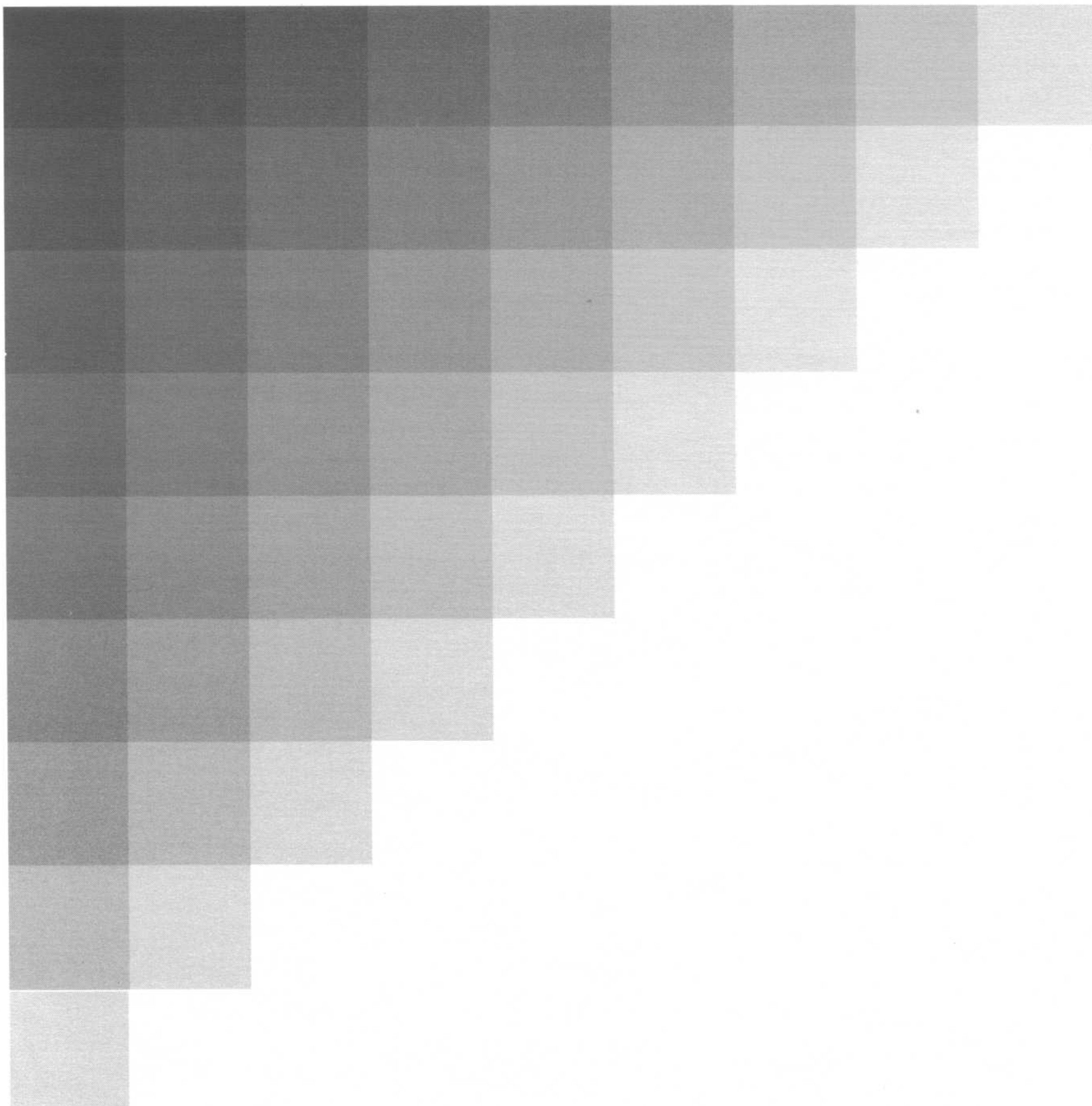
Clean Air Through Transportation:

Challenges in Meeting National Air Quality Standards



A Joint Report from the United States Department of Transportation and Environmental Protection Agency

Pursuant to
Section 108(f)(3) of the Clean Air Act

August 1993

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The Honorable Albert Gore, Jr.
President of the Senate
Washington, D.C. 20510

Dear Mr. President:

Enclosed is the Department of Transportation and Environmental Protection Agency joint report titled, "Clean Air Through Transportation: Challenges in Meeting National Air Quality Standards." The report, required by Section 108(f)(3) of the Clean Air Act, as amended in 1990, addresses the issues of motor vehicles and air quality. The report discusses the challenges faced in attempting to improve air quality through transportation programs. It also provides a status report on meeting the transportation provisions of the Clean Air Act Amendments of 1990 and the air quality provisions of the Intermodal Surface Transportation Efficiency Act.

A copy of this report has also been sent to the Speaker of the House of Representatives.

Sincerely,

Carol M. Browner
Administrator
Environmental Protection Agency

Federico Peña
Secretary
Department of Transportation

Enclosure

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The Honorable Thomas S. Foley
Speaker of the House of
Representatives
Washington, D.C. 20515

Dear Mr. Speaker:

Enclosed is the Department of Transportation and Environmental Protection Agency joint report titled, "Clean Air Through Transportation: Challenges in Meeting National Air Quality Standards." The report, required by Section 108(f)(3) of the Clean Air Act, as amended in 1990, addresses the issues of motor vehicles and air quality. This report discusses the challenges faced in attempting to improve air quality through transportation programs. It also provides a status report on meeting the transportation provisions of the Clean Air Act Amendments of 1990 and the air quality provisions of the Intermodal Surface Transportation Efficiency Act.

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Carol M. Browner
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Table of Contents

I. INTRODUCTION

A. Purpose and Scope of Report -The Provisions of Section 108(f)(3)

Section 108(f)(3) of the Clean Air Act (CAA) as amended in 1990 requires the Secretary of Transportation (DOT) and the Administrator of the Environmental Protection Agency (EPA) to submit to Congress by January 1, 1993, and every 3 years thereafter, a report that: "reviews and analyzes existing State and local air quality-related transportation programs...." The report is also required to evaluate the adequacy of funding and make recommendations regarding meeting the Act's requirements. (See Appendix A for the complete text of Section 108(f)(3)).

This report is the first in that series. It provides the Congress with: an identification of the challenges faced in attempting to improve air quality through transportation projects and programs (Chapter II), the status of implementing the new transportation provisions of CAA and air quality provisions of the Intermodal Surface Transportation Efficiency Act (ISTEA) (Chapter III), and conclusions (Chapter IV). This report generally covers the 2-year timeframe beginning with the promulgation of the 1990 CAA amendments, November 1990, through the end of fiscal year (FY) 1992.

In many ways, it is too early to address whether the legislated funding and approach will be successful in meeting the goals of CAA. Federal guidance and regulations continue to be developed, and most States and local areas around the country are just beginning to develop and implement transportation plans, projects, and programs to meet their CAA requirements. This report describes the challenges of meeting the requirements; future reports will be more comprehensive and address the relative success of meeting CAA goals through transportation programs.

B. Summary

Many areas that currently fail to meet the national ambient air quality standards, as well as the transportation and air quality agencies assisting them, face formidable challenges if they are to meet the CAA requirements. When they were enacted on November 15,1990, the 1990 CAA amendments set strict deadlines for these "nonattainment" areas to meet the standards depending on the severity of their air pollution problems for specific pollutants. The most important pollutants for this report are ozone, carbon monoxide (CO), and particulate matter of under 10 microns in size (PM-10) where mobile sources have a significant impact. The areas with the least serious problems must reach attainment this year (1993); the most severe area, the counties around and including Los Angeles, have until 2010.

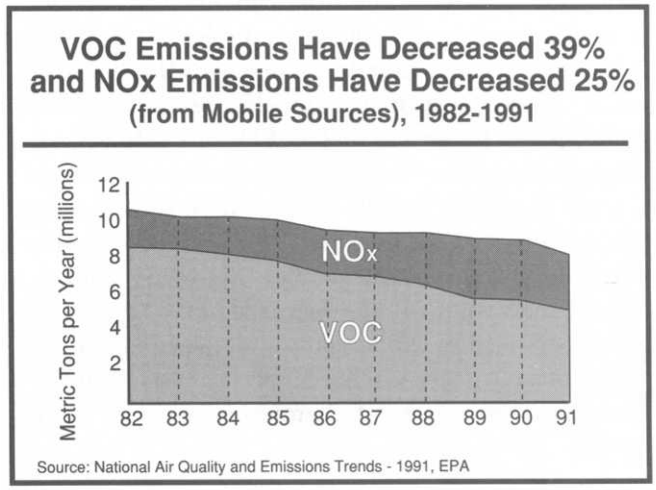


Figure 1

Nonattainment areas must reduce emissions that either directly cause or combine to form pollution from three primary sources: stationary, "area" (such as dry cleaning establishments), or mobile. A great deal of attention has been focused on mobile sources generally, and the role that transportation facilities (roads, transit, bike-, and pathways) play specifically, in part, because of the emphasis CAA places on transportation measures as a means to reduce emissions. Mobile source emissions can be significant; for urban areas they are variously estimated at 40 to 50 percent for hydrocarbons (HC), which combine with oxides of nitrogen (NOx) to form ozone, 50 percent for NOx, and 80 to 90 percent for CO, and they can be higher in some areas. Reliable estimates for PM-10 do not yet exist, but total PM-10 emissions are increasing.

As the effort to meet CAA requirements for transportation-related pollution was undertaken across the country, distinct challenges became evident, and to place these challenges in context, several points bear mention.

Technological improvements have reduced emissions from motor vehicles despite increases in vehicle travel.

Air quality, as measured in terms of CO, hydrocarbons and NOx emissions, has substantially improved over the last 10 years. Between 1982 and 1991, total emissions from all sources have decreased substantially (32 percent for CO, 13 percent for hydrocarbons, and 8 percent for NOx), almost entirely from motor vehicles. But the improvements have not been uniform from all sources. Stationary source emissions, for example, have actually increased for certain emissions over the last 10 years. By contrast, motor vehicle emissions generally declined between 1982 and 1991 due to improved automobile technology, despite continued increases in vehicle travel. According to EPA's report titled, "National Air Quality and Emissions Trends - 1991," CO from mobile sources (highway, transit, and off-road engines) has decreased by 40 percent; NOx decreased by 25 percent; and volatile organic hydrocarbons decreased by 39 percent (see Figures 1 and 2). Highway-related emissions showed even greater reductions.

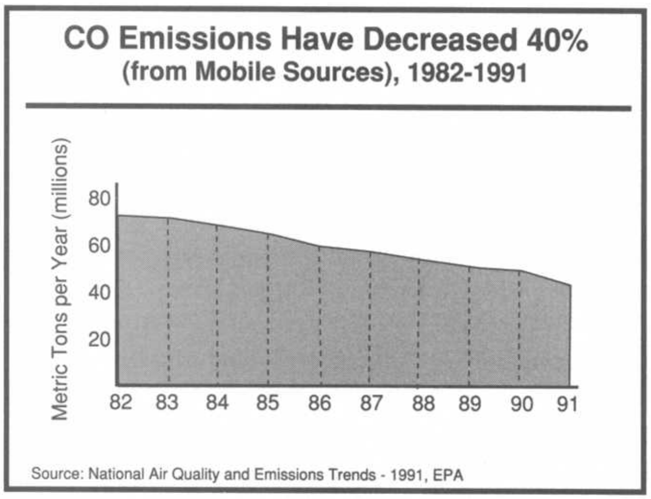


Figure 2

Automobile travel has increased substantially. For example, between 1983 and 1990, vehicle miles traveled (VMT) increased by 41 percent, continuing a century-long trend. A variety of trends contributed to this growth: increases in the number of workers, increases in vehicle ownership, longer average trip lengths, growth in suburb to suburb travel, and continued decreases in the cost of driving. The real cost of gasoline, for example, is now lower than it was in 1950. Efforts to reduce travel in single occupant vehicles (SOV) and VMT face tremendous challenges in light of these trends.

Reductions from all sources will need to be considered in developing a strategy to meet the national ambient air quality standards. In addition to stationary and motor vehicle sources, area sources can contribute a third or more to emissions in nonattainment areas. A specific type of area emissions, nonroad engines can contribute between 7 and 17 percent of an area's hydrocarbon, NOx, and CO emissions, and in the struggle to reduce all emissions, new standards may be established for this increasingly important source. Nonroad emissions come from a variety of sources ranging from agriculture and construction machinery to lawn mowers and garden equipment, and to recreational vehicles, including pleasure boats.

While further reductions will be necessary from all sources, the costs and benefits of specific air quality strategies must be carefully weighed to ensure that the most cost-effective strategies are selected from among all sources of emissions.

Federal funding available for transportation control measures (TCMs) has increased dramatically— but most TCMs produce small emission reductions.

The experience to date indicates that efforts to reduce emissions through traditional TCMs have not generated significant air quality benefits. (See Appendix E for a description of traditional TCMs as defined by Section 108(f)(1) of CAA). Previously the lack of funds at the local level to develop and implement competitive alternatives to automobile travel was seen as a major impediment to reducing mobile source emissions. This was addressed by ISTEA. Authorized at $155 billion, ISTEA represents a significant shift in the way transportation funds are used nationwide. It expands planning and research funds, establishes a new program, the Congestion Mitigation and Air Quality Improvement (CMAQ) Program, to improve air quality, and enhances the flexibility that State and local governments have in using other Federal funds. However, even with this funding increase, traditional measures are expected to have limited benefits.

Low densities and high travel demand in suburban areas, low automobile user costs, and an increasing number of trips generated by an eclectic American lifestyle lead to relatively low participation rates in alternative forms of travel to the automobile. While transit is a crucial component of the Washington, D.C., transportation network, for example, it carries only 13 percent of regional commuter trips. And as a percentage of total regional travel, transit's share is even lower. Making matters worse, the percentage of travelers using higher occupancy forms of travel (transit, ride sharing) has declined nationwide, and single-occupant automobile travel has increased since 1983. Across the country, the share of commuting trips made by driving alone increased from 64.4 percent of all trips in 1980 to 73.3 percent in 1990. Average vehicle occupancy decreased by 16 percent since 1977.

Recent modeling by MPOs shows that combinations of congestion reduction measures, including highway capacity expansion, and improvements to ridesharing programs, transit, and other TCMs, produce only 1- to 2-percent reductions in emissions without concomitant travel reduction efforts such as increased travel costs or restrictions and policies to increase land use density. Despite an $11 billion package of transportation initiatives in the San Francisco area, for example, emissions are expected to decline by less than 1 percent compared to simply maintaining current facilities and services.

More effective measures exist, including pricing and other incentives to stop driving alone, but these are politically unpopular and are uncharted territory in most urban areas. Other control measures that target emissions from every trip, such as inspection and maintenance programs, are likely to be more productive ways of making significant emission reductions. Measures that target the vehicles having disproportionately high emissions may also be effective.

The modeling tools and technical information available to States and metropolitan planning organizations (MPOs) are imperfect.

Within this overall framework, other challenges also face the transportation and air quality community that arise from the dramatic changes brought about by CAA and ISTEA. One challenge is caused by the complexity of analyzing the effects of atmospheric changes and geography on air quality and predicting the impacts of changes in human behavior on transportation and emission rates.

Both the transportation and air quality communities have collected data and developed sophisticated tools for analyzing such effects, generally aided by computer models. But models to determine transportation impacts on emissions have their shortcomings. Transportation models were not designed to develop emissions estimates, and both transportation and emissions models rely on approximations that only yield accurate predictions within certain parameters. Work is continuing in this area, but the lack of adequate data and models poses a significant analytical challenge.

Related to the need for better tools is the need for better technical information. States and local areas must meet several requirements that necessitate high quality transportation/air quality information. They report that better data are needed on trends in travel demand, emission levels from cars and trucks in their areas, the effectiveness of technological improvements to reduce tailpipe and other emissions, and relative contributions from stationary, area, and mobile source inventories. Most importantly, States and local areas need better information on what they can expect to achieve through TCMs. While Federal agencies have attempted to provide as much data as possible, better information can be developed only as better tools and more comprehensive data become available.

There has been a great need for guidance and direction, and Federal agencies have struggled to provide as much information as is available.

Another need that has been often expressed by State and local officials is for more, and more timely, guidance from Federal agencies. Enactment of two major pieces of legislation, CAA and ISTEA, in a relatively short period of time has challenged EPA's and DOT's abilities to develop timely transportation/air quality guidance, but has also fostered a close working relationship between the agencies. The need to realistically address the requirements of these Acts has caused a convergence of purpose and precipitated a greater understanding between them.

DOT and EPA have provided detailed guidance in many areas. Substantial effort has been made to package and disseminate relevant information, jointly sponsor national conferences and regional workshops, develop coordination mechanisms through the National Association of Regional Councils (NARC), and respond to individual State and local requests for information through site visits and telephone communications. Guidance and regulations have been published on VMT forecasting, transportation and air quality planning, State implementation plan development, motor vehicle inspection and maintenance, the CMAQ Program, TCMs, and conformity.

The conformity requirement bears special mention because it significantly changes the relationship between transportation and air quality agencies, and failure to meet it can bring transportation programs and projects, both highway and transit, to a halt. Under CAA, transportation plans and programs using Federal funds must "conform" to State plans to improve air quality, called State Implementation Plans, or SIPs. (See Section I.C.) If they fail to meet the conformity test, projects contained therein cannot advance, with some exceptions. EPA and DOT jointly published interim guidance on June 7, 1991, and EPA published a Notice of Proposed Rulemaking (NPRM) with DOT concurrence on January 11, 1993. The final rule is expected in the fall of 1993.

CAA and ISTEA have substantially increased the coordination requirements for transportation and air quality decisionmaking, entailing greater complexity and requiring more staff time.

ISTEA and CAA not only changed the goals of transportation planning and implementation, they also altered State and local responsibilities, and broadened the number of public agencies and private interest groups involved in the process. Local areas have been greatly empowered under ISTEA, and decisions over transportation priorities are now the joint responsibility of local MPOs and states.

With expanded responsibilities, many nonattainment areas discovered the need for more staff and better training. Almost 69 percent of recently surveyed MPOs in nonattainment areas cited the need for more staff to meet their obligations. Many had recently added staff. Approximately the same number said their personnel also required training in critical areas to develop effective transportation programs to improve air quality. The most important areas where training is needed were cited as: enhancement of technical skills, such as predicting the impacts of transportation programs (through computer modeling, etc.), and enhancement of policy development skills to manage interagency negotiations and consensus-building. Similarly, adequate staff and resources are concerns with other Federal, State, and local agencies involved in transportation and air quality.

With changing relationships and new partners in plan development, the need for productive coordination has been greatly multiplied. State transportation and air quality agencies must work together with MPOs to meet their air quality needs. Air quality agencies must successfully collaborate in the development of transportation priorities, just as transportation agencies must gain entree in the SIP development process. The traditional relationships that have separated these agencies must be reconstructed toward mutual understanding and cooperation. This pertains not only to State and local offices, but to Federal agencies as well.

Similarly, as more community, citizen action, and private interest groups have become involved in transportation plan development and the setting of environmental priorities, they have brought new points of view and new agendas, further changing the decisionmaking process. While such changes have greatly diversified the approach and added new perspective and information to the setting of transportation priorities, they have also increased the potential for confrontation. Legal actions have already been threatened or initiated against States as well as DOT. Managing the coordination process poses a considerable challenge and must be a high priority for agencies at all levels of government.

Finally, major budget shortfalls are common across the Nation. Many States, localities, and metropolitan areas must focus their attention and resources on many other real and pressing priorities, including crime, education, health care, homelessness, unemployment, and poverty.

C. Background - CAA and ISTEA

CAA and ISTEA provide complementary approaches to decrease transportation-related emissions. CAA sets air quality requirements and milestones, mandates further improvements to vehicles and fuels, requires greater integration of transportation and air quality planning procedures, and establishes penalties for failing to meet its requirements. The ISTEA provides funding and the flexibility to use it to improve air quality through development of a balanced transportation program.

CAA classifies nonattainment areas according to the severity of their air quality problems. For ozone, these classifications in order of increasing severity are: marginal, moderate, serious, severe 1, severe 2, and extreme. For CO, they are: low moderate (<12.7 ppm), high moderate (>12.7 ppm), and serious. For PM-10, they are: moderate and serious. As the classification increases, so do the number of CAA-required actions the areas must take (see Appendices B, C, and D) and the time intervals they have to meet the national ambient air quality standards (NAAQS). Depending on their classifications, some nonattainment areas will have to meet mobile source requirements relating to:

- inspection and maintenance programs,
- vapor recovery systems,
- clean fuel fleet programs,
- VMT limitations,
- employer trip reduction programs,
- reformulated gasoline, or
- oxygenated fuels.

All areas must determine and document the magnitude of the problem, set emission reduction targets, and specify the means by which these targets will be reached, including TCMs. TCMs are not generally mandated under CAA, but Employee Commute Option Programs—a TCM listed in Section 108(f)(1), are required in areas classified as severe and above for ozone and serious for CO. These elements must be included in the SIP. In addition, these areas must implement TCMs to offset any growth in emission due to growth in VMT or vehicle trips.

Under CAA, the SIP is the means by which a State monitors, controls, maintains, and enforces compliance with the NAAQS. The SIP is intended to set realistic numerical goals for each emissions sector and enforceable measures to attain them, with input from those responsible for development of emission reduction plans, as well as implementation of those plans.

Other plans and programs are also affected by CAA, specifically the metropolitan transportation plan and transportation improvement program (TIP). As noted above, CAA requires that the plans, programs, and projects contained in these transportation documents “conform” to the purpose of the SIP. The conformity requirement significantly changes the way transportation plans are developed in nonattainment areas. In essence, transportation plans and programs must ensure that the transportation sector contributes its planned share of emission reductions. If they fail to do so, either they must be modified or the SIP must be modified to offset the disparity in projected emissions, or they cannot advance. What this means is that if transportation plans and programs fail to meet the conformity requirements, they *must* be amended before they can be implemented. With some exceptions, this provision can hold up virtually the entire Federal highway and transit program until conformity is demonstrated.

Generally, if a nonattainment area fails to meet its deadline for attaining the standards, it is automatically bumped up into the next worse category. For example, all nonattainment areas designated as marginal for ozone must either meet CAA requirements for attainment by November of this year or they will be redesignated as moderate areas.

If a nonattainment area fails to meet the SIP submittal requirements, EPA must apply sanctions to DOT’s highway program or sanctions that require a 2:1 offset for new major stationary source emissions. Highway sanctions entail the withholding of Federal highway funds, except those targeted for exempted safety or environmentally beneficial projects, and can be applied for SIP deficiencies related not only to mobile sources but stationary sources as well. Under certain conditions, EPA may extend the boundaries within which highway sanctions are applied to include the entire State.

Two-to-one emissions offsets are applied to new stationary sources where each ton of emissions generated must be offset by a two-ton reduction through additional control measures on existing stationary sources. EPA must apply highway or offset sanctions after 18 months to areas for failure to submit a SIP or a portion of a SIP, disapproval of a SIP by EPA, failure to implement the provisions of an approved SIP, or failure to meet any other provisions required by CAA. Six months after the imposition of highway or offset sanctions, EPA must apply both if the requirements have not been met. EPA interprets the CAA to give it authority to apply sanctions earlier on a discretionary basis in order to ensure that CAA requirements are met.

As CAA prescribes the goals and procedures for achieving the standards in nonattainment areas, ISTEA provides funding for reducing transportation-related emissions. Previously, the lack of funds at the local level to develop and implement competitive alternatives to automobile travel and the dedication of most Federal fuel tax revenue to highways were seen as major impediments to reducing motor vehicle emissions. This was addressed by ISTEA through establishment of the CMAQ Program and by enhancing the flexibility that State and local governments have in using Federal funds.

Rather than narrowly categorized programs for highways, mass transit, and other forms of transportation, recipients can now use broadly flexible funds for a variety of transportation purposes. The largest program under ISTEA is the Surface Transportation Program (STP), authorized at $23.9 billion over a 6-year period. STP funds can be used at the discretion of State and local officials for many different types of transportation programs, including highways, transit, TCMs, and planning and research. Further, ISTEA allows for transfers from national highway system, bridge, and interstate maintenance programs to STP, greatly increasing the flexibility with which many Federal program funds are used.

Authorized at $6 billion over 6 years, the CMAQ Program directly funds transportation projects to improve air quality and provides nonattainment areas with necessary resources to reduce congestion and provide or improve alternative forms of travel, including transit, ridesharing, bicycling, and even walking. ISTEA precludes CMAQ funding for certain TCMs listed in CAA, specifically programs to reduce extreme cold start emissions and vehicle scrappage programs, despite emission reduction potential of such measures at least in the short run. About $340 million of an authorized $809 million was obligated in FY 1992, and well over half of this (58 percent) was used for transit. While the FY 1992 obligation rate for this program was low by DOT standards at 42 percent, it is appropriate that nonattainment areas carefully consider how best to spend these funds. Other typical projects under the Program included development of highway and road projects such as high-occupancy vehicle lanes, traffic signalization and incident management, and establishment of a statewide coordinator for bicycle and pedestrian transportation, ridesharing programs, and park-and-ride lots.

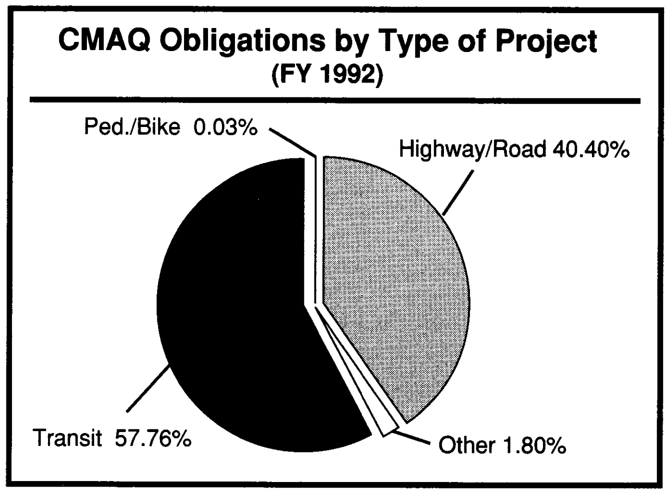


Figure 3

II. CHALLENGES IN TRANSPORTATION AND AIR QUALITY PROGRAMS

A. MPOs Face Significant Challenges in Meeting New CAA Requirements

ISTEA significantly increased the responsibility of MPOs in the development of transportation and air quality planning and programming. Their traditional transportation planning responsibilities have been increased to include expanded roles in program and project selection. Because of these added responsibilities, some have questioned the current ability of the MPOs to evaluate and implement transportation control measures and effectively advance these plans as part of the overall political process.

In an effort to identify MPO concerns, NARC, the American Association of State Highway and Transportation Officials (AASHTO), and the University of North Carolina-Charlotte (UNCC) conducted surveys of MPOs, and the Federal Highway Administration (FHWA) surveyed its field offices. These surveys were aimed at determining what issues are of most concern to MPOs, and to identify ways in which the Federal Government can assist MPOs in implementing the air quality requirements embodied in ISTEA and CAA. Results of the surveys were incorporated into a DOT effort, in coordination with EPA, to develop an action plan that could be used to assist MPOs in carrying out their new transportation and air quality planning responsibilities. What follows is a general compilation of specific issues that were identified as being areas of concern that are crucial to the MPOs' effective implementation of the transportation and air quality requirements embodied in the two acts.

1. Staffing and Training

Given the fundamental changes in the nature and responsibilities facing MPOs and States involved in the planning process, it is appropriate to consider whether their professional staffing and training are sufficient to carry out their expanded roles and responsibilities. Based on its 1992 survey, UNCC estimated that 18 percent of MPO staff in nonattainment areas were working on CAA issues, and that as many as 50 percent of staff in severe nonattainment areas were working on CAA issues. According to the NARC survey, nearly 70 percent of MPOs thought they needed greater staffing to carry out new responsibilities under both the ISTEA and CAA. It should be emphasized that staffing resources in these areas generally have been static or declining over the past several years due to a leveling off of Federal funds for transportation planning. Since MPO staff commitments are directed by annual planning work programs set in advance, new priorities in staffing and organization will take time to implement.

As might be expected, many MPOs think their staffs need substantial training to carry out the transportation planning and air quality mandates established in the ISTEA and CAA. Again, since most MPOs had few or no ongoing air quality planning responsibilities, developing strong technical and policy competence will take time. Nearly 80 percent of MPOs responding to AASHTO and NARC surveys said they could draw on staff and technical support from various State agencies in the short run.

In the near term, MPOs may be forced to shift staffing priorities towards their new ISTEA and CAA responsibilities at the expenses of some traditional functions. In addition, they are using available State technical support in lieu of in-house training for staff and full integration of air quality software into their transportation modeling capabilities. Although there is no requirement that MPOs perform all such tasks themselves, most appear to prefer having the required technical capabilities more immediately available from in-house expertise.

2. Data, Models, and Technical Information

The results of the FHWA field scan, as well as the NARC, AASHTO, and UNCC surveys, document a widely perceived need for better information and analytical tools for transportation controls measures. TCMs will be under consideration in most nonattainment areas. Nevertheless, the development of political or technical consensus and support for certain TCMs will be difficult because of their effects on travel alternatives and their cost, travel behavior, and the perceptions that various parties bring with them to the deliberative process. TCM selection and implementation will require a clear understanding of the air quality benefits that can be achieved, as well as an examination of other consequences. Hence, the need for better information and analytical tools for TCMs.

In the area of transportation planning models, there is an urgent need to raise the state-of-the-practice in many metropolitan areas, and a need to create a new generation of transportation models which can better reflect the dynamics of travel decision processes. There also is a wide disparity among MPOs relating to the timeliness of their travel demand data bases. There is a strong need to expand data collection to improve accuracy in VMT tracking, real-time output from the Highway Performance Monitoring System (HPMS), and estimates of mode split, vehicle occupancy, volume-to-capacity ratios, and commercial vehicle activity. With regard to air quality models, there seems to be a desire among MPOs to improve understanding of EPA's MOBILE5 emission model and EPA's regional air quality model, since their outputs are so critical to transportation system decision tradeoffs.

3. Institutional Coordination - State and Local Agencies

The MPO planning responsibilities within metropolitan regions are focused on development of TCMs, and making conformity determinations on TIPs and Transportation Plans. State DOTs and MPOs need to be involved in the development of SIPs and in monitoring local attainment of national standards. However, there is little consistency among the States in the coordination between transportation agencies (State DOTs, MPOs, transit agencies, or local governments) and the SIP-developing agency. Of particular concern is the lack of MPO or State DOT involvement in emission inventory and budget development in many States. Some MPOs even report that they are not involved in project and program development.

It is not entirely clear to what extent MPOs have been excluded from a process that is well underway and to what extent the process itself is not advancing as well as it should be. Since MPO and DOT commitments to TCMs in approved SIPs will eventually be required, and since consistency between the transportation plan and the SIP is necessary to meet CAA's requirements for enforceability and adequate measures for implementation (at the time of SIP approval), it is important that DOTs and MPOs be involved.

Another area of varied MPO responsibility is that of growth management and land use control. Traditionally, these functions have been the responsibility of local governments. And while there is a growing belief that land use and growth management can be important in the long run to achieving transportation system efficiency, mobility, and reducing mobile source emissions, there is also a growing belief that local governments acting individually do not achieve optimal regional results. Federal agencies must do everything possible to support and disseminate research and information in this area to appropriate State, regional, and local organizations.

4. Funding

The NARC survey found that nearly half of the MPOs thought they needed greater planning and research funds to fully implement their new air quality responsibilities. Nearly one-third responded that they have a backlog of transportation and air quality planning activities delayed due to insufficient funding. Traffic monitoring and data collection were cited as areas specifically needing significantly increased resources. In the case of TCM implementation, almost half of the MPOs believed increased funding would be needed to fully implement all TCMs planned.

Even though ISTEA substantially increased transportation funding levels and eliminated many of the restrictions on the use of Federal assistance, there remain many unmet transportation system needs. For instance, although STP and NHS funds may be used for planning activities, there are many unfunded construction and operations projects competing for these limited resources, including rehabilitation and reconstruction of aging transit and highway infrastructure, traffic signalization, congestion alleviation, and safety needs.

5. Public Awareness and Involvement

ISTEA mandates an opportunity for strong public input and review of transportation plans and programs. Further, the public, as well as State and local elected officials, need to understand the CAA requirements, the benefits of reduced emissions, and the effectiveness of various measures to achieve those benefits.

Even though ISTEA will result in substantially expanded public participation in State and MPO planning and programming processes, achievement of general public consensus will be difficult. In the case of air quality, the public will undoubtedly demand to know that increasing its transportation costs or reducing mobility will result in cleaner air. Also those who perceive themselves to be adversely affected by transportation infrastructure projects in any way will very likely raise air quality issues. The expanded public involvement can be expected to assist elected officials in understanding the nature of impacts associated with their decisions. It will also require a full knowledge of the implications of their proposed actions on the part of staff as well as decisionmakers.

B. Reducing Vehicle Emissions Through TCMs is Difficult

Despite the significant emission reductions that have been achieved, many areas of the United States have not attained the NAAQS for one or more specific pollutants. While nonattainment areas have gleaned emission reductions from technological controls of stationary and mobile sources, many of them must now consider additional strategies for emission reductions necessary to attain the NAAQS. TCMs are being considered as part of those strategies. TCMs must be part of a balanced transportation plan that meets both air quality and mobility objectives. However, based on preliminary indications, the traditional methods of altering transportation behavior by offering alternatives have not yet been shown to significantly reduce emissions.

TCMs are intended to decrease mobile source emissions by eliminating or reducing motor vehicle trips, cold start emissions, VMT, and highway congestion. And they are usually meant to affect individual behavior by inducing transportation mode shifts or shifting travel to off-peak times, which can result in a decrease in mobile source emissions.

Certain TCMs are listed in Section 108(f)(1) of CAA and, with two exceptions, identified as eligible strategies under the Surface Transportation and CMAQ Programs of ISTEA. The CAA list offers a sample of the traditional control measures available to State and local governments which includes improved public transit, development of bicycle and pedestrian facilities, trip reduction ordinances, vehicle access restrictions, and traffic flow improvements, among others. Of the Section 108(f)(1) TCMs, only the employer-based transportation management plans (employer trip reduction/employee commute options) are specifically required and then only in Severe and Extreme ozone- and Serious CO nonattainment areas.

Despite the emphasis placed on these TCMs, it will probably be necessary for many State and local governments to look beyond these TCMs in order to attain the ozone and CO NAAQS. In particular, TCMs that focus on providing more attractive alternatives to SOV travel are limited in effectiveness. (See also Chapter II.C.) Preliminary indications from around the country indicate that traditional TCMs will yield only a 1- to 2-percent reduction in mobile source emissions, far short of what some areas will need.

Historically, decreasing emissions from mobile sources mean that TCMs will incur emission reductions off a shrinking base, at least for HC and CO. More generally, the transportation sector's ability to contribute to regional emission reductions shrinks with its portion of total regional emissions. In many areas these trends will continue resulting in smaller and smaller TCM impacts on regional emissions. In other areas, continuing increases in travel could lead to an increasing share of total emissions by the transportation sector. Here, the types of TCMs employed will be critical—trip-based, VMT-based, work trips—and will determine the effectiveness of different kinds of emission reduction strategies.

Substantial changes in the level of TCM effectiveness will require all levels of government to look beyond traditional TCMs to economic/market-based TCMs, such as congestion pricing, increases in parking prices, emissions charges, etc., which show greater emission reduction potential. The introduction of economic/market-based TCMs into the transportation supply and demand decisionmaking process can and must be designed to improve mobility and air quality, and at the same time not detract from regional economic growth.

Regulatory TCMs included in Section 108(f)(1) and others which place restrictions on automobile travel show greater emission reduction potential than TCMs that increase the supply of transportation alternatives. But economic/market-based TCMs have some important advantages as emission reduction strategies over strictly regulatory TCMs. For example, economic/market-based TCMs can apply to all types of drivers and all kinds of trips—not just employment-related travel—as employer trip reduction programs are structured. In that work trips only constitute 26 percent of all trips, almost three times more trips are unaffected by TCMs targeting commuting trips.

While providing a disincentive to SOV travel, economic/market-based TCMs can alter travel behavior and, at the same time, maintain individual choice concerning travel mode. For necessary work- or other-related travel, absolute restrictions are not imposed, and those who would be burdened the most by abandoning their cars (e.g., people who rely on their cars for business) need not do so. Perhaps the greatest advantage of economic/market-based TCMs over traditional TCMs is that economic/market-based TCMs can enhance ridership on conventional travel alternatives—rail, bus, carpooling—and offer individuals and businesses the incentive to develop innovative options such as telecommuting and vanpools. Other advantages can include greater economic efficiency and reduced congestion.

VMT/emissions pricing is one method that uses economic/market-based incentives to bring about behavioral changes many traditional TCMs fail to achieve. A tax on VMT or emissions can theoretically provide a significant incentive to drive less and use cleaner vehicles. Congestion/road pricing is another way which uses market disincentives potentially providing benefits that traditional TCMs cannot. It can be argued, for example, that road/congestion pricing is more effective and fair when compared to indirect pricings such as fuel or registration fees because road pricing can be tailored to the location, level, and duration of traffic congestion or emission problems. In addition, the external and unaccounted costs of driving—pollution, congestion, accidents—which vary with driving conditions and have the highest impacts during congested periods on specific roadways, may be accounted for in some congestion/road pricing plans.

A pricing strategy need not, however, begin by charging for these externalities. Charging users the full cost of road construction and maintenance on local roads, for example, could constitute an efficacious incentive and produce revenues which might then be used to lower taxes or increase other services. A broad-based pricing mechanism such as this is likely to be more effective since it targets all trips and not just work trips.

Despite these advantages, economic/market-based mechanisms must be implemented carefully to ensure equity and to realize the air quality benefits. For example, raising the costs of SOV travel could have disproportionate impacts on the working poor. Where such impacts occur, mitigation measures such as tax rebates, transportation vouchers, or new cost-effective transportation alternatives can offset them and should be considered. (It should be noted, though, that many current transportation costs and benefits are also not distributed equally). Moving to a system which charges those who benefit is likely to improve the fairness of the transportation system by shifting costs to those who create them. In any case, a more efficient use of infrastructure would decrease transportation-related costs and externalities generally.

Other implementation issues are also important. Most pricing mechanisms need to be implemented uniformly throughout a nonattainment area or SOV travelers will be able to find and use alternate roads, parking, and other facilities to avoid the higher costs, causing problems in other areas. Finally, such mechanisms require strong political will to be implemented. Recent experience has shown that many consumers balk at the notion of higher fees and taxes without a clear understanding of the benefits. All levels of government will need to support an economic/market-based approach if it is to assist in reducing emissions, maintain mobility, and gain public acceptance.

While an individual TCM may only provide a small emissions reduction, a grouping of selected TCMs which includes economic/market-based TCMs could yield greater emissions reductions. Accordingly, complementary TCMs should be developed and evaluated as part of a coordinated strategy with particular attention on intermodal alternatives.

Although TCMs can assist in reducing emissions, the level of their effectiveness varies across the country because of geographic, meteorological, demographic, and economic differences. Therefore, neither DOT nor EPA can assign uniform effectiveness values to either individual TCMs or groups of TCMs. Furthermore, the state-of-practice and data on which to conduct analyses are inadequately developed in many areas to assess all TCMs which may be of interest.

While the ability to evaluate a TCM's effectiveness for reducing mobile source emissions is not an exact science, EPA has individually, and jointly with DOT, undertaken several projects aimed at increasing the accuracy and amount of information concerning TCMs. (See Chapter III.C.) In addition, EPA is currently preparing guidance on methodologies for estimating emissions and travel activity effects of TCMs. EPA has provided a grant to the University of Michigan to do research on human behavioral characteristics as they relate to transportation choices.

These projects, although beneficial, will probably not produce definitive information needed to accurately estimate the emissions reduction benefits directly attributable to TCMs in all cases. Additional research into the emission reduction potential of TCMs is warranted. The combination of market disincentives to SOV use coupled with attractive alternatives should be pursued, including their potential costs and benefits. Finally, every effort must be made to share relevant information among Federal, State, and local agencies and raise the state-of-practice in areas where it is needed.

C. By Themselves, Capital-Intensive Investments May Not Be the Best Way to Address Air Quality Concerns

An important question in developing transportation/air quality projects and programs is how to best use Federal and other funding. Some TCMs require large capital investments and a great deal of funds in new or expanded high occupancy vehicle (HOV) lanes, transit, or intermodal facilities. Others may be of relatively low capital intensity such as pricing and regulatory mechanisms or ridesharing. Of course, many TCMs will fall between these extremes, and different nonattainment areas will undoubtedly use the increased funding under ISTEA to finance a wide variety of projects to address their transportation and air quality needs. It will be important for each area to decide among the capital alternatives based on the relative costs and benefits, but there is little evidence that capital investments in new transportation facilities, particularly large investments, are the best way to improve air quality. In fact, available information and analysis suggest that capital investments when made without disincentives to SOV use have negligible impacts on air quality.

Information to judge the effectiveness of different transportation investments or control strategies in reducing emissions is limited. This is partly because the emissions consequences of transportation capital projects are difficult to evaluate systematically and virtually impossible to actually measure in isolation from other influences. Most analyses of the effectiveness of capital investments and TCMs are based on simulations using regional transportation and vehicle emissions models rather than on the measured impacts of actual projects or controls. These models usually have at least some structural or conceptual simplifications which leave room for doubt about the accuracy of their predictions.

Nevertheless, useful estimates of the potential effectiveness of new investment as an emissions-reducing strategy can be inferred. And the evidence suggests that capital investments in transportation facilities are not likely to produce significant emission reductions by themselves, although they may be more effective when undertaken in conjunction with pricing or regulatory mechanisms to reduce SOV travel.

1. Evidence from California

Because of the severity of the air quality problems in California, TCM effectiveness has been the subject of considerable analysis there. This section reports on four studies that show the relatively low emission benefits of capital-intensive TCMs. In one study done for the 1991 Clean Air Plan for the San Francisco Bay area, over 22 TCMs were evaluated. Of these, the market-based mechanisms (smog fees, congestion pricing, gas taxes, and increased parking charges) showed the greatest air quality, reducing mobile source emissions from about 4.5 to 7.6 percent. In comparison, the capital-intensive TCMs were much less effective. For example, an expansion of the regional rail system, including an extension of the Bay Area Rapid Transit (five stations) and the Tasman light rail (12 miles), would reduce HC and CO by only 0.86 percent each. Similarly, adding 300 miles of HOV lanes to the existing network would reduce HC and CO by only 0.64 and 0.62 percent, respectively.

Table 1 reports the results from two other analyses that attempt to predict the emission reductions from transportation controls and related programs. These estimates are drawn from a variety of sources with varying degrees of precision, tend to be optimistic, and need to be interpreted cautiously. Nevertheless, the table supports the idea that only small emission reductions will result from TCMs generally and further indicates that high-capital TCMs are not expected to be among the most effective in reducing emissions.

The statistics from Los Angeles are based on the Air Quality Management Plan (July 1991 update) developed by the South Coast Air Quality Management District (AQMD). It offers emission reduction goals that would be necessary to bring Los Angeles into compliance by the year 2010. The total cost of such measures is difficult to estimate, but the direct costs of the transportation investments needed to meet these goals is projected to be $5.16 billion per year until 2010. The emission reduction goals estimated by Los Angeles are considerably larger than the projections by San Diego. According to MPO personnel, whether they can achieve such targets remains to be seen.

The analysis done for San Diego was an effort sponsored by CALTRANS to determine the effectiveness of potential TCMs that could be implemented to meet the NAAQS. The TCM costs and the time needed to implement the selected TCMs were not provided in the analysis but would be considerable for many of them, especially those targeting land use management and transit expansions.

For both San Diego and Los Angeles, the most capital-intensive investments resulted in the smallest percentage decreases in emissions. For example, a 20-mile extension of San Diego's light rail line is expected to reduce HC and CO emissions (from mobile sources) by less than 0.4 percent and 0.6 percent, respectively. Similarly, construction of an extensive rail transit system in southern California is expected to reduce HC emissions by about 1 percent and CO emissions by 3 percent, even in conjunction with areawide adoption of measures to encourage its use.

Another study by the Metropolitan Transportation Commission, San Francisco's MPO, showed that an $11 billion investment in transportation initiatives will yield a 0.9 percent and 0.8 percent reduction in CO and HC emissions, respectively. San Francisco's investments were primarily composed of new transit lines, HOV lanes, and local arterial improvements. The analysis showed little difference between large mass transit and large highway projects.

The low projected emission reduction is unsurprising. San Francisco and many other nonattainment areas have massive transportation infrastructures already in place. Further investment, even $11 billion worth, only marginally changes the existing infrastructure and consequently has a marginal impact on emissions as well.

Control measures that generally have lower capital costs, such as increased prices for parking and vehicle use, and telecommuting, are anticipated to be somewhat more effective. Such measures will likely have variable costs associated with them, ranging from net benefits to very high compliance costs on firms or individuals. But, as suggested above, revenues generated by these mechanisms can be used to mitigate the impacts on particular groups. In any case, these measures do appear to offer potential for greater emissions reductions.

2. Interim Conformity Findings

Most nonattainment areas have now been through two rounds of transportation conformity determinations under CAA. Taken together, they indicate that transportation infrastructure programs alone will make little difference in changing regionwide mobile source emissions. Further, detail on what many areas included in their TIPs needs to be explored. And while much is known about the extensive programs in California, other areas may not have incorporated programs to influence land use, TDM measures, or other more stringent efforts in their TIPs. Further, their analyses may not fully examine the impact increasing congestion can have on travel behavior. Still, the programs put forth so far show that expanded infrastructure will yield less than a 2 percent emission reduction in most cases.

By contrast, most nonattainment areas anticipate that even without new capital investment, mobile source HC and CO emissions will decline by 4-5 percent each year and in some areas considerably more, according to an analysis of the first round conformity determinations. But it should be noted that realizing these estimated emission reductions will depend on future VMT increases and that such

Table 1
Emission Restriction Targets for Selected TCMs
(from Mobile Sources)

San Diego

TCM	Description	% Reduction HC	% Reduction CO
Transit Expansion	20-mile rail extension, double bus service	0.4	0.6
Ridesharing	Increase vehicle occupancy 25%	0.4	0.7
Flexible Work Schedule/ Telecommuting	15% participating in telecommuting 5% shift work hours	0.8	1.1
Land Use Impacts	10% reduction in overall home-work distance	1.4	2.0
Traffic Flow Improvements	Regionwide signal control	2.2	2.5
Parking Management	60% increase in costs	2.4	4.1

Los Angeles

TCM	Description	% Reduction HC	% Reduction CO
Transit Expansion	Add 300 miles to rail system, expand bus service by 50%	0.9	3.1
Traffic Flow Improvements	Signal control, truck restrictions	2.1	4.9
Flexible Work Schedule/ Telecommuting	Eliminate 3 million work trips 60% participation in flexible schedules	2.2	6.9
Land Use Impacts	25% reduction in overall home-work distance	4.1	11.8

Sources:
1. From Loudon and Dagang, "Predicting the Impact of Transportation Control Measures on Travel Behavior and Pollutant Emissions," JHK Associates, 1992.
2. South Coast Air Quality Management District, "Air Quality Management Plan," Appendix IV-G, 1989.

reductions are not expected for PM-10 emissions that are increasing. These reductions will come primarily from newer vehicles with additional emission control features and from reductions in gasoline volatility, a major contributing factor to evaporative emissions.

Under the Interim Conformity Determination procedures established by EPA and DOT, nonattainment areas are required to submit estimates of future year emissions levels under two sets of conditions: first, assuming that no additions to their regional transportation networks would be made (the "no-build" case); and second, assuming that all infrastructure projects and TDM programs included in their Regional Transportation Plans and/or TIPs were fully implemented (the "build" scenario). These estimates were required for both the milestone year (1995 or 1996) and for the horizon year, by which each area is expected to comply with the NAAQS. (See Appendices B, C, and D for a list of deadlines by nonattainment status.) Since it is unlikely that many TDM measures were included so soon after passage of the 1990 CAA amendments, the “build” versus “no-build” comparison predominantly serves to examine the impact of new transit and highway infrastructure.

The anticipated differences in emissions levels between the “build” and “no-build” scenarios are quite modest. Anticipated reductions in HC emissions by the milestone year were greater than 2 percent in only a few cases, and most nonattainment areas estimated a 0- to 1-percent decrease. Similar, though somewhat larger, decreases were estimated for CO emissions. Still, in only a very small number of areas were CO decreases expected to be more than 5 percent. By the horizon year, considerably more nonattainment areas expected emission reductions greater than 2 percent, but well over half expected that implementation of their current TIPs would reduce emissions by less than that. While current analytical techniques preclude greater precision, it is clear that the impact of the measures included in the determinations is small.

Among the tasks facing some MPOs and DOTs is the need to develop new and innovative approaches to reduce mobile sources and to insure that their modeling methods can predict the air quality impacts as well as possible.

3. Investments in New Rail Transit

Further evidence about the emissions reduction potential of one important category of capital intensive TCM is the construction of rail transit facilities. Rail transit is of particular interest due to its high visibility and high cost, and due to the availability of examples in several areas. Despite the significant investment in rail transit, ridership increases that would significantly affect emissions levels have not materialized. While rail projects in Washington, D.C., Atlanta, and Baltimore added significantly to transit ridership—67 percent, 18 percent, and 14 percent, respectively—increases in other locations were very modest or failed to occur. Such increases in ridership, however, are not reflective of concomitant emissions reductions since the proportion of regional travel carried by transit is typically very small. In the Washington, D.C., metropolitan area, for example, transit’s share of commuter trips is 13 percent, and Washington’s Council of Governments in its “1982 Regional Air Quality Plan” estimated that Metrorail’s impact on emissions from all trips combined was about a 1-percent reduction.

Analyses from the Boston metropolitan area also suggest the high cost of emission reductions from new rail services. One study examined the cost-effectiveness of various alternatives including an expansion of a subway line (one station) and rehabilitation of the commuter rail line (four stations). The analysis shows that these transit investments were not cost-effective means of reducing emissions, with HC reductions costing $100,000 per ton when all costs were assigned to HC reduction. Others were far more productive. Even the addition of 20,000 more park-and-ride spaces was somewhat more cost-effective, although this study did not consider the effects of policies over time.

Noninvestment transportation measures tend to be more cost-effective because they affect the whole fleet, and the rate at which the fleet pollutes. According to the Boston study, inspection and maintenance (I/M) programs, for example, affect the entire fleet and yield greater cost-effectiveness, between $1,400 and $5,300 per ton. I/M programs can even be more cost-effective. According to recent EPA estimates, I/M programs could be as cost-effective as $500 per ton. This wide variation in control costs is not unique to transportation-related emissions; stationary source control costs also cover a wide range, from net savings to costs of $20,000 per ton.

Further along the cost-effectiveness scale, reducing a travel subsidy can have net benefits. For example, over 95 percent of U.S. employees receive a tax-free parking subsidy at work. Offering them the cash value of that subsidy gives them a choice: continued subsidized parking or cash. Such an approach was examined by Shoup in 1992 and shown to help people save money (by carpooling or walking without forcing them to do so), decrease a subsidy, and decrease emissions.

One reason for the modest air quality effects attributed to new rail transit is that only part of the additional ridership of these systems is drawn from SOV users. Others are drawn from buses, carpools, and latent demand. In addition, many riders access rail stations by automobile, meaning that their trips still entail engine cold starts and subsequent cooling down. This generates the bulk of HC emissionsw—65 percent from a 10-mile trip—because of an automobile’s relative inefficiency and higher emission rates while warming up and higher gasoline evaporation rates when cooling down.

Table 2
Cost-Effectiveness of HC Emission Control Measures

Measure		$/ton
Investment	Rail Extension and Rehabilitation	> 100,000
	Park & Ride Spaces	> 50,000
Regulation	Inspection and Maintenance	1,400-5,300
Market Incentive	Cashing Out Parking Subsidies	Net Benefits

Sources: "The Mass Transit Air Quality Link," Antonioli, 1992; and "Cashing Out Employer-Paid Parking," Shoup, 1992.

Of course, this is not to say that existing rail services should be allowed to deteriorate or even that further investments should not be made as part of a comprehensive strategy or for other reasons. In Northeastern cities with long-established rail transit systems, there is little doubt these urbanized areas would suffer much worse congestion and air pollution if these rail systems ceased operating. In the greater New York metropolitan area, for example, there is virtually no alternative to a viable rail system. Subway ridership is over 3 million passengers per day, and this does not include patronage from two of the largest commuter rail systems in the country. No combination of automobile travel and other transportation alternatives could accommodate this level of demand for the foreseeable future. It should also be noted that new rail systems and extensions are justified on the basis of fulfilling a range of objectives besides air quality improvement: improved accessibility and travel time, reinforcement of desired land use patterns and densities, energy considerations, etc. When viewed in this broader context, the very modest air quality effects are seen as ancillary benefits of these systems, not the primary reason for implementing them.

Experience with bringing new rail systems on line over the past 20 years has shown that they cannot approach their carrying capacity unless accompanied by measures that would allow transit to compete more effectively with SOVs. The experience in Washington, D.C., over the past decade is a case in point. There, despite having a fairly built-out rapid transit system and land use controls that are generally supportive of transit use, the system was not able to increase its share of journey-to-work trips throughout the region. From 1980 to 1990, the Washington Metrorail system grew from 30 to 73 miles of line and opened an additional 30 stations. And the number of workers using rail transit grew from 69,000 to 143,000, a significant increase. However, the number of people driving alone to work in the Washington metropolitan area also increased dramatically from 980,000 to 1,394,000, and overall transit's mode share declined slightly. The situation in Washington with respect to personal travel trends is mirrored in other urban areas as well. To the extent that costly new rail projects are relied on as transportation control measures to improve air quality, it is clear that their effectiveness depends largely on a comprehensive, regionwide program that makes transit a more attractive option relative to single-occupant driving.

4. Supply of Alternatives versus Demand for SOV Travel

Even if capital investment in transportation is not the most effective emissions-reduction strategy taken alone, it may still represent an important complement to other measures. Capital investments in new HOV facilities, expanded transit service, or widespread facilities for exclusive use by bicyclists and pedestrians increase the supply and attractiveness of transportation alternatives to SOV travel.

For such TCMs to be effective at reducing emissions, however, large numbers of trips must be shifted from SOV to non-SOV travel alternatives, and experience has shown that increases in supply alone will not produce these shifts. In addition to increasing the supply of non-SOV options, the demand for SOV travel needs to be reduced. In many cases, high demand for SOV travel is a direct result of free parking and other distortions in the transportation marketplace, and successful demand management can reduce those distortions. Travelers act to minimize a combination of time and money costs, and thus eliminating subsidies has shown significant effects. The simple act of charging for, rather than giving away, parking has shown 20-45 percent decreases in SOV commuting rates for individual employers (Shoup 1992), although similar regional impacts have not yet been shown. This is even true in poorly transit-served areas of suburban Los Angeles.

TCMs that increase the cost of commercial parking, reduce or offer a cashing out of employer-provided parking, establish road and congestion pricing mechanisms or VMT restrictions can be effective means of reducing the demand for SOV travel. Such measures will impose variable costs which can be quite high. For understandable reasons, such measures are unpopular with those bearing the direct costs when they are.

Some people argue for simultaneously increasing the supply and attractiveness of alternatives through capital investments and creating disincentives to SOV travel as a way to create an integrated program that maximizes emission reductions. Such a program will not eliminate resistance to SOV disincentives but may reduce it because the program includes more visible and widely supported elements, such as capital investments in transit, ridesharing, bikeways, and other transportation alternatives and critical elements necessary to achieve emission reduction targets. Others argue that all too often the attractive and sometimes costly TCMs are offered without the tougher disincentives to SOV travel.

Resistance to SOV disincentives has varied but can be significant. In Washington, D.C., and many areas around the country, major political battles have been fought over the implementation of parking or roadway restrictions. In the Nation's capital, the opposition has come despite major investments in bus and rail transit and two major HOV corridors. A more encouraging example comes from Portland, Oregon, which over the past 20 years has removed a major freeway, canceled construction of another, imposed a parking moratorium, and passed transit-supportive zoning changes and bond initiatives, all with significant public support. Yet even the Oregon Legislature declined to take the next step to implement congestion pricing and vehicle emission fees, as recommended by a special State task force.

5. Long-Term Emissions Consequences of Capital Investment

While the short- to mid-term emissions impacts of transportation capital investments are modest, their longer-term effects may be more pronounced. Because of their durability, these investments continue to influence urban travel patterns over a prolonged period and in turn have an impact on the location of homes and businesses. Households and businesses base their location decisions in part on the accessibility and convenience provided by the regional transportation network. As transportation investments are made, certain locations are made more desirable which, as new businesses and residences relocate, increases utilization of the transportation facility. Of course other variables, such as building costs, crime, schools, and other amenities, also play a significant role in household and business location decisions. (See Chapter II.F for more information.)

Certain types of investments may decrease emissions over time. The benefits of this longer-term strategy, however, may not be realized in time to assist nonattainment areas meet the NAAQS according to the deadlines set out in CAA. The first deadlines occur this year and most areas are supposed to reach attainment before the year 2000. Even the Los Angeles area only has until 2010 to meet the standards. These are relatively short timeframes to effect such land use changes.

In summary, if large reductions in vehicle travel are sought, State and locally elected officials will need the political will to make tough decisions necessary to adopt and implement the kinds of TCMs, such as stringent and economically viable pricing mechanisms, that will reduce the attractiveness of SOVs in their region, yet preserve mobility. Previous emphasis has been on reducing commuter travel, and strategies that affect every trip—commuter and nonwork—will be necessary if significant emission reductions are to be realized.

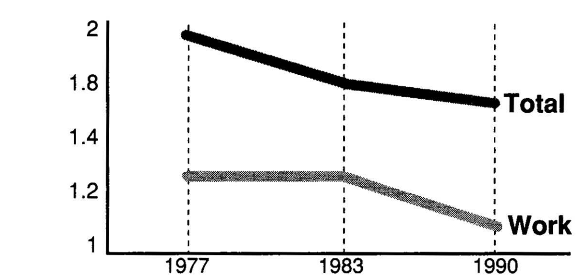
D. *Technological Improvements Have Reduced Vehicle Emissions Despite Increasing VMT*

The CAA provisions intended to reduce SOV travel and VMT pose tremendous challenges for transportation, air quality, and land use planners, particularly in light of the travel trends in the United States. Efforts to control VMT have mostly concentrated on eliminating work trips, but given the rising importance of other trip purposes, such efforts are destined to be marginally effective alone. Efforts to control total VMT require broad support to pass enabling State legislation, making them beyond the jurisdiction of the transportation and air quality communities. Other ways exist to reduce highway emissions, such as inspection and maintenance programs and other programs targeted at so-called "gross-emitters."

1. Transportation Trends

Vehicle travel is by far the predominant travel mode in the country. Of 250 million daily passenger trips, 94 percent are made in automobiles or trucks and only 2 percent by public transportation. Automobile travel as measured by VMT has increased markedly, far outpacing population growth and household formation in the recent past. Between 1983 and 1990, passenger VMT increased by 41 percent, compared to relatively slight increases in population and households (6 and 9 percent, respectively).

Average Vehicle Occupancy Has Declined
1977-1990



	1977	1983	1990
Total	**1.8**	**1.7**	**1.6**
Work Trip	**1.3**	**1.3**	**1.1**

Source: NTPS, 1990

Figure 4

The reasons for increased VMT are varied. The 1990 National Personal Transportation Survey identified several major national trends in travel patterns that offer a partial explanation. First, there has been a dramatic increase in the number of workers, particularly women, up 58 percent since 1969, which means an increase in commuter travel. Second is an increase in the number of jobs located in the suburbs where generally fewer travel alternatives are offered and distances are greater than suburb-to-city travel. Suburb-to-suburb travel is now the dominant commuting pattern in the United States. Third, vehicle ownership has increased significantly between 1969 and 1990. Nationwide, households with two or more vehicles increased from 31 percent to 58 percent. And finally, average automobile occupancy continued to decline to 1.5 in 1990, from 1.9 in 1977. Vehicle occupancy for work trips is even lower and dropped under 1.1 persons per vehicle in the last 10 years.

The cost of gasoline has also been a significant factor in VMT growth. Gasoline costs in real terms are now lower than they were in 1950. Fuel efficiency has also increased dramatically. Low fuel costs combined with high fuel efficiencies means that marginal per-mile driving costs are among the lowest they have ever been.

While more people are driving more cars for more miles, highway capacity has been practically constant since 1970. Depicted in Figure 5, highway road-miles have increased slightly, 4 percent, since 1970, although it should be noted that in urban areas capacity has increased more significantly. One consequence of this is clear—increasing congestion. Furthermore, many have become concerned that these trends mean worsened air quality.

These data suggest the continued dominance of personal vehicles for passenger travel. The large increases may slow as vehicle ownership approaches saturation and female participation in the work force levels off. Nevertheless, the multiple trends contributing to growth show how difficult it will be to reduce traffic congestion and the resulting air pollution. This difficulty is reinforced by the current land use patterns of dispersed residences and jobs, with the corresponding heavy reliance on automobiles and limited alternatives.

2. Control Mechanisms

Because of the above trends, increasing attention has been focused on ways of controlling VMT, with particular emphasis on controlling work trips.

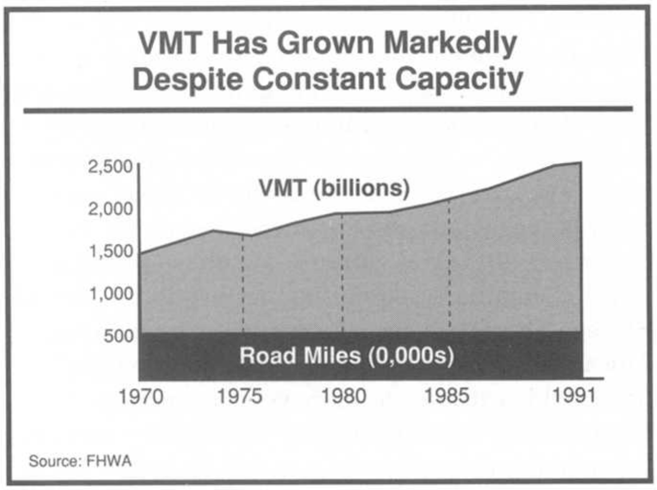


Figure 5

Work trips, however, have dropped to only 26 percent of all trips, down from 32 percent in 1969. Similar trends are demonstrated for purpose-specific VMT. So, if controlling VMT is a necessary and desirable way of reducing mobile source emissions, targeting work trips alone limits the overall effectiveness of the strategy.

As work trips decreased as a percentage of all trips, other trip purposes increased. The share of trips made on family or personal business increased from 14 percent to 24 percent, for example, between 1969 and 1990; shopping trips increased from 15 percent to 20 percent in the same period. Clearly if VMT is going to be effectively controlled, trips for every purpose, not just journey to work, need to be targeted.

Effecting changes in travel behavior can be accomplished by adjusting the comparative advantage each offers, particularly through the disincentives discussed above, i.e., regulatory or market-based initiatives. Unlike providing new infrastructure or better services, such initiatives often require enabling legislation at the State level. Winning the public support necessary for enactment has shown to be extremely difficult. Enabling legislation requires not only the consent but the active participation of elected officials. In this sense, such initiatives are substantially beyond the control of either air quality or transportation officials and the communities they represent, and a much broader base of support is necessary to implement them.

Another means to control mobile source emissions is to target those vehicles producing the greatest amount of emissions. Only 10 percent of all vehicles on the road produce between 50 to 60 percent of highway CO emissions. (Less dramatic impacts are demonstrated for other emissions: 10 percent of the vehicles produce 40-50 percent of HC emissions and 20-30 percent of NOx emissions. These considerations may not apply to PM-10 in a significant way). Since such gross emitters are the predominant source of highway emissions and not only increase the formation of CO hotspots but ambient pollution as well, reducing their impacts can effectively improve air quality without radically disrupting American economic and lifestyle choices.

3. Emissions Consequences and Control Strategy Implications

Even as VMT increased, mobile source emissions declined as stricter tailpipe measures were established and enforced. Since 1982, hydrocarbon, CO, and NOx all decreased by substantial margins; hydrocarbons are down 39 percent, CO decreased 40 percent and NOx declined 25 percent, according to the EPA report, "National Air Quality and Emissions Trends - 1991." Given the growth in VMT, however, the environmental and transportation communities are concerned that rising VMT may eventually overtake the emission improvements realized over the last 10 years.

Technology has improved the emission rates of new cars considerably. For example, 1990-model vehicles emit hydrocarbons and CO at only one-third the rate of 1975-model vehicles. In the near term, further emission reductions can be expected as older vehicles are retired and replaced with newer, cleaner ones. But even with these technological improvements, the total vehicle emissions could once again increase if VMT rises rapidly. Some esti-

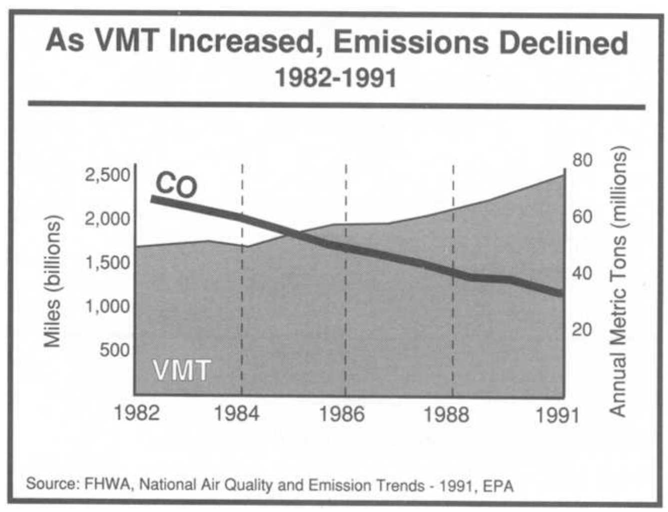


Figure 6

mates predict that mobile source emissions will again rise on or about the year 2005. Others suggest that VMT growth will subside and negative emissions impacts may be averted.

Whether and when emissions rise again with VMT (under uncontrolled conditions), and to what level, depends in part on what is done in the future to reduce the emissions per mile of travel. The 1990 Clean Air Act has resulted in the implementation of even stricter tailpipe and evaporative emission controls that will increasingly benefit all areas over the next two decades. Enhanced inspection and maintenance programs, now required in nonattainment areas designated serious and above for ozone (or high moderate and above for CO), use high technology emissions testing on an annual or biennial basis along with supplemental on-road emissions testing to ensure that vehicles meet the standards. If they do not, maintenance is required to bring them into compliance. EPA estimates that enhanced I/M programs can yield a 28-percent emission reduction. Areas not specifically required to adopt enhanced I/M can choose to do so for greater emissions reductions and to reduce the need to control VMT. Similarly, States and nonattainment areas variously must or may choose (depending on classification) to implement other technology-oriented measures such as reformulated gasoline, oxygenated gasoline, California vehicle standards, clean fuel fleets, or other measures.

Nevertheless, VMT reductions (uncontrolled) through control mechanisms described earlier may be part of the preferred long-term strategy. The overall emissions control strategy that is right for an area will depend on the overall emission reduction that is required, as well as on local preferences among all the control possibilities. To the extent that vehicle technology and fuel measures cause smaller per-mile emissions, they tend to shift the logical focus for additional emission reductions away from VMT and on to trips and nonvehicle sources. It should be noted that in many areas, congestion reduction and quality of life are also reasons to consider many VMT control strategies.

Except for fuel changes and inspection and maintenance programs, the technology measures' benefits will phase in gradually and will not provide much of a contribution to meeting the requirement to reduce VOC emissions by 15 percent by 1996. Because growth in emissions from rising VMT must also be offset in addition to the 15 percent reduction, the rate at which VMT will grow naturally is a crucial question to determine the importance of reductions from new efforts to limit VMT growth, fuel changes, enhanced I/M, and non-vehicle control measures. The affected States are considering their emission reduction targets and options at this time, with SIP revisions due on November 15, 1993.

E. Better Data and Models Are Needed

Several steps are required to analyze the emissions consequences of regional transportation plans or measures designed to control travel behavior. First, based on the existing development and land use patterns, a regional transportation modeling system is typically used to estimate a baseline volume and pattern of travel. Second, the resulting estimate of total travel broken down by vehicle type, time period, speed, or other important category is used in conjunction with a vehicle emissions model to predict regionwide emissions of different pollutants. Next, these same steps are repeated with the transportation plan or control measure in effect, and the predicted emissions are compared to the baseline estimates. (See Appendix F for a complete description of the transportation and emissions modeling processes.)

The regional transportation modeling system currently used to estimate travel volumes and patterns was designed 30 years ago. This system was originally intended to forecast the need for new highway facilities, and today has far greater demands placed on it with such CAA and ISTEA policy implications as air quality modeling. Though useful when applied in the traditional role of determining how many lanes are necessary to serve a particular region, these models are not sensitive to many of the inputs and parameters needed for their adaptation to air quality modeling. Short-term improvements to the current transportation model set have the potential of satisfying many of the gaps in the air quality model link. Other deficiencies, however, point to a need for more in-depth research into new procedures and algorithms.

The ability to translate a transportation plan to influence travel behavior into changes in inputs for the regional models is a critical step in this process. Each individual project in a transportation plan or

TIP can potentially alter the configuration or capacity of the regional transportation network. Any changes are reflected in the computerized representation of the network by altering the capacity or performance characteristics. The results of a number of such changes implemented together, such as would occur if all of the projects included in a regional transportation plan were constructed, are estimated by operating the system of regional transportation models with the reconfigured network substituted for the original network.

Translating many TCMs into corresponding changes in regionwide travel patterns and vehicle emissions is more challenging. The average travel and emissions impacts of capital-intensive TCMs, such as new transit facilities or HOV lanes, are usually evaluated in much the same way as individual elements of the regional transportation plan. However, expressing the effects of measures such as mandates for employers to encourage or require flexible work schedules or mandates for employer-based ridesharing promotion programs in a regional modeling system is considerably more difficult. Assessing the emissions consequences of these measures is likely to require more creative, detailed, and localized analysis, which in many cases can be conducted most effectively outside the framework of conventional regional transportation and vehicle emissions modeling.

Taken together, both transportation and emissions models must make various technical and behavioral assumptions. Such assumptions often fall short of accurately representing an extremely complex reality.

1. Uncertainty in Transportation, Emissions, and Concentration Models

Inaccurate estimates of regional vehicle emissions associated with urban travel can result from errors in either the detailed estimates of traffic volumes and speeds produced by transportation models, or the emissions rates for the fleet of vehicles operating in an urban area. The accuracy of these estimates is tied to the data inputs, mathematical structure, and solution procedures of commonly used regional transportation and vehicle emissions models.

There are three primary sources for inaccuracy in the execution of regional transportation models: limitations to the *inputs* on which these models rely, areas where the models need to be expanded, and shortcomings in the models themselves. As an example of the first, the forecasted distribution of regional population and employment is often an erroneous input because such information is dependent on fluctuating political compromises more than on technical expertise. Local officials who want forecasts to reflect positive growth and development within their jurisdictions sometimes assume successful implementation of land-use plans that later prove difficult to adopt or enforce. Aside from their unavoidably controversial nature, the future geographic distributions of human activity are likewise *inherently* difficult to predict at the level of detail demanded for input into regional transportation models. In practice, errors sometimes occur if adjustments are not made to improve accuracy. Forecasting can be improved by including additional transportation alternatives in the models. For example, incorporating variables for, and better estimates of, bike and pedestrian mode shares can provide more reliable results than is sometimes done.

Nevertheless, many of the errors which occur lie in the nature of adopting a process for a purpose other than for which it was originally intended. As an illustrative point—travel by time of day is not necessary for the traditional travel model to estimate regional demand, though it is a critical input for air quality modeling. The handling of time of day variables lies outside the basic structure of the regional transportation model.

Input errors also arise from the reliance of many regional model systems on incomplete or outdated databases. In particular, information on the volume, geographic pattern, and timing of tripmaking is often estimated from household surveys administered 20 or more years earlier. Though an attempt is sometimes made to update such data with limited surveys or public sources such as the U.S. Census, the availability of variables which explain travel behavior and changing trends may be insufficient.

One particularly significant gap between the regional transportation models and those used for air quality planning lies in the area of speed estimates. Though accurate speeds are a critical input for estimating emissions, the traditional travel model process was not intended as a source for such information. The accuracy of volume and speed estimates from a regional transportation model may become increasingly unreliable under congested conditions; this serves as an area of concern for many urban highway networks with prevalent congestion and high volumes in the peak hour. The limitation of unreliable speed estimates is also serious for areas with major arterial streets because congestion-related delays on these facilities stem from a complex interaction between directional traffic volumes and traffic signal phasing. The representation of such complexities is an application which goes beyond the design of the traditional travel model system.

Vehicle emissions models can err in basic emission rates for individual vehicles, as well as in the correction factors used to adjust these measured rates. Basic emission rates are measured for a simulated pattern of "typical" city driving, which does not accurately reflect the variety of road facilities, vehicle types and traffic flow conditions encountered in urban travel. Most important, the overall average speed (19.6 mph) of the test cycle may not reflect the actual mix of speeds on local roads and highways. It is excessive for local trips primarily on collector and arterial streets and underrepresents travel at freeway speeds which now constitutes much of urban travel, particularly off-peak.

Another source of error is that basic emission rates for specific vehicles, categorized by type, model year, and age, represent test measurements from a small sample of vehicles. This is particularly true for rate estimates for emissions due to fuel vapor. Yet emission rates among individual vehicles within any category vary widely even under laboratory conditions, so that a small sample may not produce a reliable estimate of emissions.[1] It may be possible to reduce this problem by using test results from State vehicle emissions inspection and maintenance programs, once they introduce more realistic, mass based test procedures and standardized reporting requirements take effect.

The correction factors used to adjust measured emissions rates may also be a source of error, particularly the adjustment factors intended to correct for speeds different from the 19.6 mph average in the Federal Test Procedure (FTP). MOBILE model speed correction factors are developed by interpolating between FTP-measured emission rates and those measured for other test driving cycles, each of which generates a different average speed. However, actual patterns of urban driving may differ from test cycles in other critical aspects, even with similar average speeds. Frequency and duration of high acceleration periods, for example, may be different from test cycles. EPA has a major effort underway to better characterize cycle aspects, which will be reflected in the emissions model in 2 years.

2. Improving Transportation, Emissions, and Concentration Models

In November 1994, nonattainment areas designated serious and above for ozone must submit SIP revisions that demonstrate their plans are sufficient to achieve attainment of the NAAQS by the CAA-mandated dates. That demonstration will be done in part through use of transportation, emission, and concentration models. But it is not certain that strategies developed with these models will ensure attainment. This goal of emission estimations beyond planning for mobility stretches the state of the art in transportation/air quality modeling to its limits.

Current regional transportation and air quality models are unlikely to perfectly reflect actual emissions impacts of transportation plans and programs. There is a need for broader application and greater responsiveness in the models which increases the practitioners' ability to analyze air quality impacts, as well as other aspects of transportation projects. To this end, efforts to improve the reliability of current models have been widely initiated.

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[1]The presence of extremely high-emitting vehicles in most model year cohorts suggests that small differences in their representation between the national test sample and any urban area's local fleet can cause the MOBILE model to misestimate the local emission rate for some vehicle type and age categories substantially (usually by underestimating the true rate, since the sample selection procedure tends to exclude high-emitting vehicles); see W.R. Pierson et al., "Comparison of the SCAQS Tunnel Study with Other On-Road Vehicle Emissions Data," 1495ff; and D.R. Lawson et al., "Emissions from In-Use Motor Vehicles in Los Angeles: A Pilot Study of Remote Sensing and the Inspection and Maintenance Program," *Journal of the Air and Waste Management Association*, Volume 40 (1990), pp. 1096ff. This source of potential error has recently become more important, as the number of vehicles tested to estimate the model's basic emission rates for used vehicles has declined, while the representation of these vehicles in the nationwide fleet has increased; see U.S. General Accounting Office, *Reliability of EPA's Mobile Source Emissions Model Could be Improved,* GAO/RCED-90-138, May 1990.

A priority initiative has been launched to improve the current regional travel forecasting models, and to better handle the land use/transportation relationship. Jointly funded by FHWA, FTA, and EPA, this initiative is significant; under FHWA's lead, the project is likely to encompass many years. Research has begun, and the final plan for the effort is currently being prepared. The overall effort includes an outreach program, improving existing procedures, researching new procedures, and a focus on data collection. Included will be research into the "supply side" of different modes, focusing on the access of both activities and different times of day. Revised network procedures, in response to changing forecasting needs, will include incremental loadings by time of day, embedded in a simulation procedure which will feedback network information to an "activity generation" step. This feedback process should increase the reliability of speeds and volumes under congested conditions. The overall model design must be flexible and sensitive to changes in needs of decision makers and to changes in air pollution control technology.

Vehicle emissions models can also be improved, and EPA conducts an ongoing program of research and testing that has led to continuing improvements in its MOBILE emissions model. A source of potential error in vehicle emissions models has been the inability of the test driving cycle to represent the variety and mix of vehicle operating conditions encountered in typical urban driving. Currently, EPA is working to correct this potential error through a large-scale research effort to determine actual in-use driving behavior and the emission impacts as compared to the FTP. To ensure that vehicles are being tested under circumstances which reflect the actual current driving conditions, EPA found potential concerns with the FTP's treatment of acceleration, speed, soak time, and cold start driving behavior during an earlier review.

EPA was unable to sufficiently address the aforementioned problems before the CAA deadline for correcting and producing a new FTP. Consequently, EPA is operating under a court-mandated schedule to complete the new FTP. Under the court-mandated schedule EPA must: produce a first draft of the FTP NPRM by October 1993, publish the NPRM by March 30, 1994, and promulgate the final rule by December 31, 1994.

F. Beyond Transportation - Land Use, Public Acceptance, and Fiscal Constraints Figure Prominently

The Clean Air Act and ISTEA set forth challenging goals which become even more challenging when taken together. ISTEA clearly sets forth a policy that transportation investments and strategies must meet social, environmental, and economic objectives while meeting the Nation's mobility goals. The Clean Air Act, as amended, is designed to attain and maintain the NAAQS. The combination of these Acts has changed the way transportation planning will be done in areas failing to meet the NAAQS.

The challenges to air quality and transportation planners in jointly meeting these objectives are numerous and complex. There are important factors which are part of the background in which transportation and air quality planners must operate, but which are beyond control of any single government entity. These factors include the importance of land use in influencing transportation demand and air quality, the lack of public understanding of benefits of clean air, and competing urban priorities under constrained fiscal conditions.

1. Land Use

We are becoming increasingly aware of the interrelationships of land use and transportation. Low density development often means that the preponderance of trips can only be made by the automobile. This limits travel for those who cannot drive or afford an automobile. Simliarly, higher density land use better supports public transit services.

> "The pattern of urban development dictates whether people can walk or cycle to work or whether they must travel dozens of miles; it also determines whether a new bus or rail line can attract enough riders. Despite this obvious link, city layouts often are too dispersed to foster efficient transportation." [Marcia D. Lowe, Worldwatch Institute, in Surface Transportation Policy Project Bulletin, October 1992.]

While transportation facilities influence growth patterns, there are many variables which combine to influence growth and land use. Land use is regulated by local governments, usually under authority granted by State governments. However, policies at all levels of government affect land use decisions and individual preferences to live or conduct business at a specific location. Economic factors such as demand for housing and office space are particularly important. Tax policies at all levels of government have an influence on land use. For example, income tax deductions for mortgage interest have provided a major incentive for purchase of single family homes. Local real estate taxes, especially differences in taxes among local jurisdictions, also have an influence on location decisions. The extent of land use regulation is often a factor in decisions by developers. Availability of water, sewer, and other infrastructure also influences development decisions.

ISTEA requires metropolitan and State transportation plans to reflect consideration of land use plans. This will be an important step. Better understanding of the relationships among land use patterns, travel patterns and air quality will be needed to respond to the challenge of reducing transportation's contributions to air quality. Cities such as Portland, Oregon, are studying what can be done to encourage land use patterns which support more efficient transportation. Changing land use poses significant political challenges and may not yield results within the CAA timeframes.

2. Public Acceptance

Transportation control measures seek to provide incentives to use more efficient, less polluting modes of transportation and/or disincentives to use of automobiles with single occupants. Local decision-makers in some areas have difficult choices to make in the near future as to transportation plans and transportation control measures in SIPs if they are to achieve significant emission reductions from TCMs.

The public needs to understand the overall emissions requirements of CAA, benefits of reduced emissions, and the ability of various strategies to achieve the benefits. Public acceptance of measures that impose higher costs or constraints on SOV travel will be important to the success of the transportation control measure and its effectiveness in reducing emissions.

A recent example in the Washington, D.C., area highlights how the failure to gain public support can lead to a measure's demise. On September 1, 1992, the Virginia Department of Transportation (VDOT) started operating new lanes on the Dulles Toll Road in the HOV mode, as agreed to by relevant transportation agencies. The toll road, built to handle 47,000 vehicles per day, was carrying 76,000 in 1992, with projected volumes to double by the year 2010 unless mitigation measures (HOV operation) were adopted. The operation limited the left lane to carpools of three or more persons. While the facility accommodated about 650 3-person carpools during its first weeks of operation, the closure of the lane to general traffic caused greater congestion on the other two lanes. This created a furor among SOV users, worsened by a lack of support from traffic reporters and a perception that the new lanes were underutilized. Neither environmental organizations nor local politicians rallied to support the HOV proposal. Bowing to overwhelming pressure from congressional representatives and motorists, Virginia's Commonwealth Transportation Board suspended the HOV restrictions on October 5, 1992.

To give HOV lanes and other control measures a greater chance of success and to avoid commitments to measures where they cannot succeed, the public must have an opportunity to participate in the transportation and air quality planning processes. ISTEA expands opportunities for public participation in State and MPO transportation planning.

3. Fiscal Constraints

At all levels of government, there is a paradox of increasing requirements for staff time, analysis, and other resources while at the same time fiscal constraints are increasing. For example, the analysis required to support determinations that transportation plans and programs conform to air quality plans will be extensive. For most areas, this will cost about $50,000 for the conformity determination alone. However, costs can be very significant, perhaps reaching hundreds of thousands of dollars, as in the case of Los Angeles. Further, the conformity analysis will have to be repeated each time revisions to a plan or program are proposed. Development of emissions inventories, budgets, and other elements of State implementation plans also require substantial expenditures by air quality agencies. At the same time, all levels of government are facing hard decisions about budget shortfalls. Other concerns not related to transportation and air quality are important and fighting for limited resources.

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III. STATUS OF PROGRAMS

A. Full Funding of ISTEA Would Help Meet Mobility and Air Quality Goals

1. Funding Levels for Title I Programs (Surface Transportation)

Expensive, capital-intensive projects may not be the best use of transportation funds for air quality, but current funding is still needed to improve alternatives to SOV travel and reduce emissions through effective programs like enhanced inspection and maintenance, among others. Funding levels are authorized in ISTEA, and yearly limits are placed on total expenditures by the Congress through the appropriations process. In 1993, appropriated amounts for Title I Programs (for Surface Transportation) were considerably less than the ISTEA-authorized levels, forcing the States with nonattainment areas to make hard choices regarding how to meet both their mobility and air quality goals despite overall increases in authorized funding levels.

ISTEA substantially increased funds for air quality purposes in two ways: by creating a dedicated source of funds in the $6 billion CMAQ Program and by providing the flexibility to use funds for transportation projects which may improve air quality. ISTEA's flexibility allows $23.9 billion in Surface Transportation Program funds to be used for transit and other transportation projects and programs that can have a positive impact on air quality. Furthermore, funds from other ISTEA programs can be transferred to STP and used for eligible purposes under that program. Fifty percent of NHS funds can be transferred to STP without Federal approval, and 100 percent can be transferred with DOT approval. Forty percent of Bridge funds and 20 percent of Interstate Maintenance funds can also be transferred to STP.

ISTEA also increased the quantity of funds available for planning purposes, needed to support both transportation and environmental programs. Metropolitan planning is funded by a legislated set-aside from NHS, STP, CMAQ, Interstate Maintenance, and Bridges. The percentage of planning funds doubled from 0.5 percent to 1.0 percent under ISTEA and the actual dollar amount more than doubled ($47 million in FY 1991 to $117 million in FY 1992) because of the higher authorization level. Highway Planning and Research (HPR) funds similarly increased from 1.5 percent to 2.0 percent. Finally, planning and research are eligible activities under both NHS and STP.

Table 3
Summary of Major ISTEA/Title I Programs

Surface Transportation Program	$23.9	billion
National Highway System	21.0	billion
Interstate Maintenance	17.0	billion
Bridges	16.1	billion
Interstate Construction	7.2	billion
CMAQ	6.0	billion
Interstate Substitution	1.0	billion

Source: FHWA

The ISTEA-authorized levels, however, have not been realized. In the appropriations for FY 1993, the obligation ceiling—the maximum amount of annual Federal aid funds the states are allowed to spend under all programs—was set significantly below the authorized amount. As Table 4 shows, an additional $2.9 billion could have been included in the obligation ceiling and spent on needed transportation and air quality projects.

Current funding is needed for transportation programs to improve air quality, but setting the obligation ceiling below authorized levels further constrains the already difficult choice that States must make to meet both their mobility and air quality needs. Priorities will differ from State to State, but by appropriating less than authorized levels, Congress makes those choices all the more difficult. And even though $967 million was apportioned to the States under the CMAQ Program in 1993, the States will not have the opportunity to make full use of the funds for air quality purposes if their obligation ceiling is reached by advancing other needed transportation projects.

2. Funding Levels for Title III Programs (Federal Transit Act)

In FY 1992, the total authorized funding level under Title III of ISTEA (which amends the Federal Transit Act) was $3.64 billion, including $2.29 billion

Table 4
Authorized vs. Appropriated Levels for Title I Programs - 1993

Authorized Funding Levels	$16.410	billion
Obligation Ceiling	13.519	billion
Difference	2.891	billion

Source: FHWA

for the formula grants program and $1.34 billion authorized for discretionary grants. The enacted budget for FY 1992 very nearly matched authorized funding levels for that year.

For FY 1993, the funding picture changed markedly. FTA's total authorization for FY 1993 increased significantly to $5.23 billion, including $3.2 billion for the formula grants program and $2.03 billion for discretionary grants. The FY 1993 enacted budget, however, provided only $1.7 billion for formula grants and $1.72 billion for discretionary grants.

The greatest shortfall in appropriations was in the formula grant program where $758.26 million was appropriated for capital grants under the Section 9 urban formula program as compared to a total of $1.02 billion for the previous fiscal year. This level of funding for the Section 9 capital program in FY 1993 detracted from the ability of transit agencies to advance needed capital improvement projects. Funding was insufficient to allow transit agencies to upgrade and expand service at a time when Clean Air Act requirements would encourage an expanded role for transit in nonattainment areas.

The disparity between authorized and appropriated funding levels is also evident for transit's metropolitan planning. MPOs rely heavily on FTA's Section 8 planning funds to conduct long- and short-range transportation planning which meets CAA requirements. In FY 1993, $70.67 million was authorized for metropolitan planning but only $38.25 million was appropriated.

The magnitude of this shortfall for metropolitan planning seriously undercut the ability of MPO's to acquire the technical capabilities that they need in order to satisfy the new CAA requirements. Unquestionably, CAA placed a significantly greater analytical burden on State DOTs and MPOs in demonstrating that their plans and programs conform to the objectives of the SIP.

3. The CMAQ Program

ISTEA created a $6 billion authorization for the CMAQ Program over 6 years. Approximately $1.8 billion has been apportioned among the States based on the severity of ozone pollution and the number of people affected. During FY 1992, $340 million was obligated under the CMAQ Program, more than 50 percent of which was assigned to transit capital projects and about 40 percent for highway purposes (including HOV lanes, traffic surveillance and incident management, and signalization and intersection improvements). (See Figure 7.) Other typical projects and programs included:

- *establishment of inspection and maintenance programs,*
- *projects to enhance pedestrian and bicycle transportation,*
- *ridesharing programs, and*
- *park-and-ride lots.*

As noted above, the CMAQ Program has clearly been the most utilized source of flexible funds under ISTEA to date, based on FY 1992 obligations. By contrast, the nationwide total of STP funds which States made available for transit use was only $24 million, or about 0.5 percent of the total STP funds available in FY 1992. Thus, at least during the first year of the current authorization, the STP program was generally used for traditional highway projects, while the CMAQ Program provided the great bulk of Title I funds that were put to transit use.

The CMAQ Program is tightly focused on the need to bring nonattainment areas into attainment, but each State receives a minimum apportionment of at

CMAQ Obligations by Type of Project
(FY 1992)

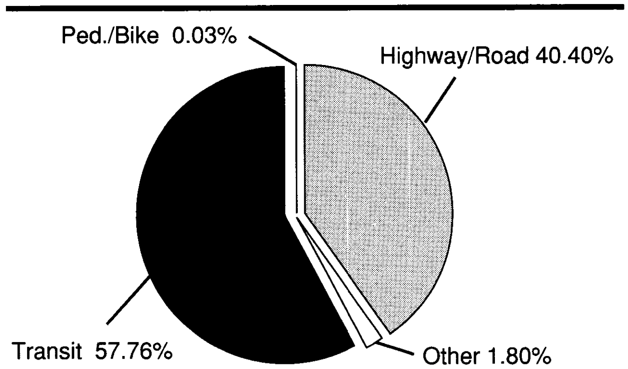

Figure 7

least 0.5 percent of each year's authorization. Twenty-six States, the District of Columbia, and Puerto Rico received the minimum apportionment specified by law (almost $9 million each so far). Thirteen of these have no ozone or carbon monoxide nonattainment areas and may, therefore, spend the funds on any project eligible under either the CMAQ or STP Program. Only 24 States receive more than the minimum apportionment because of their air quality problems. Due to the statutory apportionment formula, which gives added weight to the more seriously polluted nonattainment areas, these States received 86 percent of all the CMAQ Program funds distributed thus far.

The States have been slow to obligate their available funds. In FY 1992, approximately $340 million was obligated for programs and projects, representing a 42-percent obligation rate. The low obligation rate is due to the fact that the program breaks new ground, and initially nonattainment areas struggled with how to best use the funds. As States and MPOs become more familiar with the program generally—and specifically, DOT guidance on project eligibility—and the needed coordination is fostered between transportation and air quality agencies, the obligation rate is expected to increase. Furthermore, as TCMs are included in SIPs which are subsequently approved by EPA, the demand for CMAQ funds will increase, also raising the obligation rate.

B. Limited CAA Funds Exist for Air Quality Operations and Management

Four sections of CAA allow the EPA Administrator to provide funding to State and local governments, and other public and private groups and individuals:

- **Section 103** - provides grants for research and demonstrations relating to the causes, effects, and control of air pollution.
- **Section 105** - provides grants for general air pollution mitigation. For FY 1993, $94.1 million was allocated for Section 103, 105, and 106 programs.
- **Section 106** - provides for the development of interstate air quality agencies or commissions.
- **Section 175** - provides funds for developing a plan revision. Although authorized, no appropriations have been made under Section 175.

Two additional EPA programs are designed specifically to reduce mobile source emissions: The CAA Increments Program and Selected National Priorities program. The CAA Increments Program sets aside $9.0 million (FY 1993) for program development of I/M programs, Stage II regulations, planning studies, enhanced monitoring activities, and public outreach. The Selected National Priorities Program was allocated $1.8 million for emission reduction demonstration projects based on market and other initiatives.

C. Regulations and Guidance Implementing CAA and IS TEA Have Been Issued

1. CAA Regulations and Guidance

This summarizes the status of EPA and DOT efforts to implement the transportation-related CAA requirements. Regulations and guidance in several areas are covered below, including: transportation conformity, transportation control measures, VMT forecasting and tracking guidance, transportation and air quality planning guidelines, motor vehicle inspection and maintenance, mobile source modeling, clean fuel fleet programs, and other related provisions.

1.a. Transportation Conformity

CAA requires that the Federal Government shall not support or approve any activity which does not conform to an approved SIP. No metropolitan planning organization (MPO) shall approve any transportation plan, program, or project which does not conform to the applicable implementation plan. The assurance of conformity is an affirmative responsibility of DOT and the affected MPO.

They also require EPA to publish regulations, with the concurrence of DOT, which lay out the criteria and procedures for determining conformity of transportation plans, programs and projects that are developed, funded, or approved under Title 23 of the United States Code (USC) or the Federal Transit Act. Interim guidance was distributed on June 7, 1991. A notice of proposed rulemaking (NPRM) was published in the Federal Register on January 11, 1993. The final rule is expected to be promulgated by October 1993.

1.b. Transportation Control Measures

CAA requires EPA, in consultation with DOT, to publish guidance on updated information on 16 broadly defined TCMs. The Agency has produced a group of documents to satisfy the aforementioned CAA requirements, including the *Transportation Control Measure Information Documents* and the *Transportation Control Measure: State Implementation Plan Guidance.* The availability of these documents was announced on May 29, 1992. These documents are designed to assist State and local officials in planning and evaluating transportation control measures. Information is provided through discussions of implementation issues, variations of measures, degree of effectiveness, and institutional processes. More quantitative information is provided on current methods, strategies, and variables for making estimates on how transportation control measures affect the number of vehicle trips, vehicle miles traveled, and vehicle speed.

EPA is currently working on several documents to augment the guidance listed above, including information on the estimation of emission and travel activity effects of TCMs expected in 1993. Guidance on the reduction of work-related trips, titled the Employee Commute Options (ECO) program, were issued in January 1993. Three workshops were held in the spring of 1992 to provide additional guidance. In addition, EPA, DOT, and NARC are sponsoring additional TCM analysis and information dissemination for State and local governments.

1.c. VMT Forecasting and Tracking Guidance

CAA requires EPA to publish guidance, in consultation with DOT, on forecasting VMT. EPA published the *Section 187 VMT Forecasting and Tracking Guidance* on March 19, 1992. This guidance addresses how to forecast and track VMT in moderate and serious CO nonattainment areas with design values greater than 12.7 parts per million (ppm). The guidance States that estimates of actual annual VMT in areas subject to the Section 187 requirements should be obtained from the Highway Performance Monitoring System (HPMS), maintained by DOT. The HPMS VMT estimates will be used to track actual VMT.

1.d. Transportation and Air Quality Planning Guidelines

CAA mandates that EPA update and publish the 1978 guidelines on Transportation and Air Quality Planning, in consultation with DOT. EPA published the updated *1992 Transportation and Air Quality Planning Guidelines.* This document is designed to provide guidance to State and local government officials and to assist them in planning for transportation-related emissions reductions that will contribute to the attainment and maintenance of the NAAQS for ozone, CO, and PM-10. The notice of availability for the *Transportation and Air Quality Planning Guidelines* was published in the *Federal Register* on August 18, 1992.

1.e. Clean Fuel Fleet Programs

CAA requires the establishment of a program to require certain centrally fueled fleets to include some clean fuel vehicles in their new vehicle purchases. As defined in CAA:

'a clean alternative fuel' means any fuel (including methanol, ethanol, or other alcohols (including any mixture thereof containing 85 percent or more by volume of such alcohol with gasoline or other fuels), reformulated gasoline, diesel, natural gas, liquefied petroleum gas, and hydrogen) or power source (including electricity) used in a clean fuel vehicle that complies with the standards and requirements applicable to such vehicle under this title when using such fuel or power source.

Clean fuel vehicles will be required to meet stringent emissions standards.

The Clean Fuel Fleet Programs involve two rulemakings. The first establishes guidelines for a Clean Fuel Fleet credit program, regulations for governing transportation control measure exemptions for Clean Fuel Fleet Vehicles, and provisions affecting Federal Fleet Facilities. The second rulemaking will include regulations governing the conversion of conventional vehicles to meet the clean fuel standards for all vehicle/engine classes, heavy duty engine standards, and general provisions for State implementation of the Clean Fuel Fleet program.

EPA issued an NPRM for TCM exemptions to the Clean Fuel Fleet program on October 3, 1991, and a final rule on March 1, 1993. The rule specifies which clean fuel vehicles are exempt from transportation control measures, such as time-of-day and HOV lane restrictions. Work on the second rulemaking, concerning emission and conversion requirements, is underway but no forecast of a promulgation date has been released.

1.f. Mobile Source Emissions Modeling

Section 130 of CAA requires EPA to review and revise the emission factors used to estimate the emissions of CO, VOC, and NOx from mobile sources. EPA has produced a series of computer programs which incorporate emission factors known as the MOBILE series.

In response to CAA, EPA announced the release of MOBILE 4.1 on January 4, 1991, and an updated version MOBILE 5.0 on December 4, 1992. This updated model superseded all previous MOBILE series models. MOBILE5 will be used for all projection year ozone inventories, and for consistency, 1990 inventories in ozone areas will have to be reestimated with MOBILE5 also. It may also be used for projection-year CO inventories.

1.g. Motor Vehicle Inspection and Maintenance

Each State containing a moderate ozone nonattainment area, and under certain conditions a marginal area, as well as certain CO nonattainment areas, is required to submit a SIP revision, due immediately after enactment of the 1990 CAA amendments, that includes provisions necessary to provide for a basic vehicle inspection and maintenance program. Additionally, each State containing serious ozone nonattainment areas or high-moderate CO nonattainment areas, or areas of higher level classifications, is required to submit a SIP revision to provide for an enhanced vehicle inspection and maintenance program for urban areas of 200,000 or more within 2 years of the enactment of the 1990 amendments. States with metropolitan areas greater than 100,000 population in an Ozone Transport Region must also submit SIP revisions for this purpose.

CAA directs EPA to publish guidance for motor vehicle inspection and maintenance programs within 12 months of enactment. EPA's guidance on vehicle inspection and maintenance is required to include information on the frequency of inspections, the types of vehicles to be inspected, vehicle maintenance required by owners and operators, audits by the State, test methods and measures to include whether testing is centralized or decentralized, inspection methods and procedures, quality of inspection components covered, assurance that a vehicle under recall from a manufacturer has complied with that notice, and effective implementation and enforcement, including assurance that any vehicle retesting after a failure shall include proof of corrective action.

The language in CAA concerning the vehicle inspection and maintenance guidance is of a legally binding nature not often associated with guidance. After consultation with EPA's Office of General Counsel and after public hearing and comment, EPA concluded that it was required to pursue a rulemaking instead of the publication of guidance for enhanced I/M programs.

EPA promulgated a rule for both basic and enhanced vehicle inspection and maintenance on November 5, 1992.

1.h. New Bus Emission Standards

CAA contains several provisions relating to buses which include: a new particulate matter standard, a requirement for retrofitting of 1993 and earlier model year urban buses, and new requirements for an "in-use" urban bus test. In addition to and associated with the bus programs, a revised NOx standard for all 1998 and later year heavy-duty engines is also contained in CAA. EPA has responded to the aforementioned requirements by pursuing two separate rulemakings, a retrofit rule which was promulgated on April 22, 1993, and a rule containing 1994 requirements which was published in the *Federal Register* on March 24,1993.

1.i. Related Provisions - General Preamble

EPA published the General Preamble for Title I of CAA in the *Federal Register* on April 16,1992. This document provides guidance to States on how to prepare SIPs that comply with CAA provisions relating to the attainment of the NAAQS. It addresses State submittals under Title I due during the first 6 years after enactment.

2. ISTEA Regulations and Guidance

The following section provides the status of DOT regulations and guidance relating to air quality.

2.a. Procedures for Flexible Funding

FHWA and FTA released procedures which govern the use of STP and Interstate Substitution-Highways Program funds for transit projects, and the use of FTA Section 9 Program funds for highway projects in March 1992. This was followed in July 1992 by the publication of procedures for using CMAQ funds for transit programs and projects.

2.b. CMAQ Guidance

FHWA and FTA issued interim guidance on the CMAQ program in February 1992 and comprehensive guidance in October 1992. The guidance States that TCMs contained in the SIPs have the highest priority for CMAQ funding. In addition, the guidance clarifies what is eligible under CMAQ and emphasizes the need for cooperation among Federal, State, and local governments and agencies in deciding which projects to fund under the CMAQ program.

2.c. Metropolitan and Statewide Planning Regulations

FHWA and FTA issued interim guidance on ISTEA's new metropolitan planning requirements in April 1992. This guidance covers several issues related to CAA compliance such as the need for a coordinated approach on regional emissions analysis. Additionally, the guidance requires that projects covering the first 3 years of the TIP be prioritized. An NPRM for the metropolitan planning regulation was published on March 2, 1993, along with an NPRM for statewide planning. The comment period closed on May 3. A final rule is being developed and is expected to be issued in late summer 1993.

2.d. Management Systems Regulations

ISTEA requires DOT to issue regulations on the State of development and implementation of systems for managing: (1) pavement of Federal-aid highways, (2) bridges on and off Federal-aid highways, (3) highway safety, (4) traffic congestion, (5) public transportation facilities and equipment, and (6) intermodal facilities and systems. Three of the management systems (traffic congestion, public transportation, and intermodal) relate to air quality considerations. ISTEA requires that the results of these management systems be considered in making project selection decisions under Title 23 of the United States Code and the Federal Transit Act.

FHWA and FTA published an NPRM in the *Federal Register* on March 2, 1993. It requires States to implement the aforementioned management systems by FY 1995. The NPRM would require identification of areas where congestion occurs and its causes, evaluation of strategies to manage it, and recommended congestion reduction strategies. In the NPRM, priority is given to measures which both reduce SOV travel and improve the efficiency of the existing system. Issuance of a final rule is expected by late summer 1993.

The public transportation management system proposes a system of data collection on the age, condition, useful life, and replacement value of transit facilities and equipment as the basis for choosing the most cost-effective strategies for providing and maintaining transit assets. The proposal envisions an ongoing process of assessing the conditions of the assets of a transit system in order to identify the areas of greatest need.

The current proposal of the intermodal management system requires the identification of intermodal facilities and the use of efficiency measures to gauge the performance of facilities and the system as a whole. Data collection at both the project and system level would be necessary to evaluate what measures or actions will promote maximum connectivity and more efficient linkages across the air, water, and various land-based transportation systems.

2.e. Congestion Pricing Pilot Program

In May 1992, FHWA published a *Federal Register Notice* announcing a congestion pricing pilot program, administered by FHWA, and designed for the establishment, maintenance, and monitoring of congestion pricing projects. FHWA published a second *Federal Register Notice* on November 24, 1992, which formally solicited proposals and outlined evaluation and rating criteria. Competing proposals received by the close of the proposal period on January 25, 1993, are being evaluated and rated by

Table 5
A Summary of Current Guidance/Regulations and Other Documents Published in Fulfillment of ISTEA and CAA

Act	Subject	Date	FR Notice
CAA	Bus Emission Standards (Retrofit)	4/22/93	58 FR 21359
CAA	Bus Emission Standards (1994 Reqs.)	3/24/93	58 FR 15781
CAA	Employee Commute Options Guidance	3/12/93	58 FR 13596
ISTEA	Metropolitan Planning NPRM	3/2/93	58 FR 12064
ISTEA	Statewide Planning NPRM	3/2/93	58 FR 12084
ISTEA	Management Systems NPRM	3/2/93	58 FR 12096
CAA	TCM Exemptions to Clean Fuel Programs	3/1/93	58 FR 11888
CAA	Conformity NPRM	1/11/93	58 FR 3768
ISTEA	CMAQ Program Guidance (issued 10/16/92)	1/4/93	58 FR 128
ISTEA	Congestion Pricing Program	11/24/92	57 FR 55293
CAA	Inspection and Maintenance Rule	11/5/92	57 FR 52950
CAA	Sanction NPRM (Section 110(m))	9/28/92	57 FR 44534
CAA	1992 Transportation and Air Quality Guidelines	8/18/92	57 FR 37162
CAA	TCM Information Guidance	5/29/92	57 FR 22746
CAA	Title I/General Preamble	4/16/92	57 FR 13498
CAA	VMT Forecasting Guidance	3/19/92	57 FR 9549

an interagency review committee. A second solicitation could take place, should the initial period result in fewer than the five cooperative agreements permitted under ISTEA.

D. SIP Development, Revisions, and EPA Approvals Are Proceeding

This section describes the status of transportation-related SIP submittals under CAA. A SIP is a legally enforceable document submitted by the Governor or designee consisting of rules and regulations demonstrating attainment of the NAAQS by the dates set forth in the Act. States are required to submit SIP revisions at specified points between 1991 and 1994 to meet specific clean air requirements. EPA expects States to have submitted fully adopted, technically and administratively complete SIPs and SIP elements by the required due dates. In a limited number of circumstances, EPA may accept "committal SIPs" in lieu of a fully adopted SIP which consists of a commitment by the State to adopt specific enforceable measures within 1 year of the promulgation of EPA's conditional approval of the commitment.

If a State fails to make a SIP submittal by the due date, EPA must make a finding of failure to submit a SIP, or an element of a SIP. If a finding is made, it will start the 18-month clock for purposes of imposing one of two sanctions provided for in section 179(b) of CAA. This action also activates the 24-month period for Federal Implementation Plan (FIP) promulgation.

1. SIP Revisions for "Reasonably Available Control Technology" (RACT)

States were required to submit SIP revisions in May 1991 that demonstrate their plans to implement emission control technology on existing stationary sources that are acceptable to EPA. These revisions are noted in this report because of the potential for the imposition of highway sanctions (see below). EPA published its finding that 12 areas in 5 States had failed to adequately comply with the RACT SIP revisions in the *Federal Register* on October 22, 1991. EPA has a nondiscretionary duty to apply sanctions to any of the 12 areas which had not submitted complete and acceptable SIPs before April 22, 1993. State efforts are underway to correct deficiencies in SIP submittals even while administrative procedures are put in place to impose sanctions.

2. PM-10 SIP Revisions

The first of the mobile source SIP revisions was due on November 15, 1991, in which States were required to demonstrate how they will reach attainment for PM-10 by December 31, 1994. Sixty-seven areas were required to submit SIP revisions. Forty SIPs were submitted on time; 27 were not. During 1992, eight additional SIPs were submitted. Of the remaining 19 areas, 3 were incomplete and 16 were missing. Sanctions are required to be imposed on the 16 areas after June 15, 1993. Sanctions will be due in one area submitting an incomplete SIP in September 1993, and the last two in November 1993.

3. Ozone and CO SIP Submittals Required on November 15, 1992

CAA also required certain SIP submittals for ozone and CO nonattainment areas by November 15, 1992. Ozone and carbon monoxide SIPs that have met the November 15,1992, submittal deadline have undergone a review to determine the completeness of both the SIP elements and the entire SIP. Letters of failure to submit a SIP element or an entire SIP were sent from the EPA Regions to 33 States, the District of Columbia, and Puerto Rico on January 15, 1993.

In the aforementioned letters, EPA summarized the findings. In general terms, if a State failed to submit any plan elements, the letter identified the nonattainment areas for which the State did not make a submittal, identified the specific requirements that were not met, and made a finding of State failure to submit a required plan or plan element. The letters also explained the statutory consequences of failure to make a submittal, and the statutory consequences of EPA disapproval of any submittal. These letters start the 18-month sanctions clock and the 2-year FIP clock. The number of States receiving a letter for failure to submit a SIP is shown in Table 6. They have until July 15, 1994, before sanctions are due to be imposed.

Table 6
Number of States Failing to Meet 11/15/92 SIP Submittals

Required SIP Submittal	Finding of Failure to Submit
Emission Inventory	
- Ozone	4 States
- Carbon Monoxide	5 States
Basic I/M Program	7 States
Enchanced I/M Program	3 States
Stage II vapor recovery program	10 States
TCMs to offset growth in emissions	4 States
Employee Commute Options (ECO) program	8 States
Contingency Measures	6 States
Oxygenated Fuels	2 States

4. Future SIP Revisions

By November 15, 1993, States with moderate ozone nonattainment areas must submit SIP revisions that demonstrate emission reductions of at least 15 percent in the first 6 years for volatile organic compounds (VOC) and attainment demonstration SIPs. By November 15, 1994, serious, severe, and extreme ozone areas must submit SIP revisions that demonstrate VOC reductions that average 3 percent per year each consecutive 3-year period after the initial 6-year period and attainment demonstration SIPs.

5. Sanctions

Under Section 179(a) of CAA, EPA must impose sanctions on any State which fails to submit a SIP or a portion of a SIP. Under Section 179(a), EPA must impose sanctions 18 months after it makes a finding of a missing, incomplete, or inadequate SIP for the purpose of ensuring that the requirements of the Act are met. In unusual circumstances EPA may be able to impose sanctions earlier than at the end of the 18-month period under Section 110(m). EPA published a proposed rule in the *Federal Register* on September 28, 1992, explaining the criteria for sanction determinations. A final rule is expected in late 1993.

One of two sanctions is applied to States not meeting the relevant CAA requirements: sanctions on Federal highway funds or sanctions on new stationary source emissions ("2:1 offsets"). If highway sanctions are applied, no Federal highway funds, with some exceptions, may be obligated for projects in the area failing to meet SIP submission requirements. Nine categories, describing projects largely related to TCMs and safety, are exempt from sanctions. After 24 months following the SIP submittal deadline, EPA can impose highway sanctions statewide. If 2:1 offset sanctions are imposed, EPA requires a 2-ton emission reduction for each ton of emissions coming from new or modified stationary sources that increase emissions in the area. If the deficiency has not been corrected within 24 months, EPA must impose both sanctions.

As of March 1993, EPA had notified 37 States that they had failed to meet deadlines for submittal of various CAA requirements and are under threat of sanctions. Sanctions were due in five States as of April 22, 1993.

For EPA to impose sanctions, EPA must select whether the highway sanction or the general offset ratio sanction will be applied first. EPA has determined that this selection is a rule under the Administrative Procedures Act, which means EPA must propose and allow the public to comment on its selection. Sanctions will begin to apply in the affected areas when EPA completes this selection rulemaking.

E. Transportation Plans, TIPs, and Conformity Determinations Are Also Proceeding

Enactment of CAA and ISTEA significantly changed the way Transportation Plans and TIPs are developed in nonattainment areas. Where previously they were developed primarily to address a region's mobility needs, now these Plans and TIPs must also contribute to improvements in air quality in nonattainment areas.

This section describes the status of Plan and TIP development in nonattainment areas since enactment of CAA and ISTEA. This section also summarizes conformity determinations made on TIPs by MPOs and DOT.

1. Plan and TIP Development

Based on a survey of MPOs done under the auspices of NARC in September 1992, most nonattainment areas are in the process of developing transportation strategies to improve air quality. These strategies can include various projects and programs to reduce emissions, including transportation control measures. However, development and implementation of new strategies to improve air quality are still in their early stages, particularly in ozone areas. This is understandable because MPOs in nonattainment areas are not expected to update their Transportation Plans until later this year (October 1993), and further SIP revisions are not required until November 1993 and 1994. As such, not many MPOs have as yet incorporated these TCMs into their Plans, TIPs, or transportation elements of SIPs.

The overwhelming majority of MPOs in ozone nonattainment areas are currently developing new strategies (and TCMs where necessary) to address their air quality needs. Over 90 percent of the sampled MPOs in areas designated as moderate and above are developing transportation measures to improve their air quality. Even those MPOs in areas with less critical air quality problems are developing transportation/air quality plans. In areas designated as marginal, approximately 76 percent of the MPOs report that TCM development is underway, even though marginal areas are expected to reach attainment largely through fleet turnover.

Once transportation projects to improve air quality have been developed and determined to be appropriate from an effectiveness and financial standpoint, they are included in the SIP (in areas where TCMs are necessary) and specifically identified. CAA requires these TCMs to receive priority consideration and expeditious implementation. While MPOs are required to only include FHWA/FTA-funded or -approved projects in their Plans and TIPs, the status of all SIP transportation control measures is covered in the TIP submission because of the need to demonstrate expeditious implementation of TCMs in making conformity determinations on Plans and TIPs.

Despite the large proportion of nonattainment area MPOs seeking ways to effectively reduce emissions, so far only a small proportion report that they have incorporated any transportation measures developed as a part of this process into the Plan (25 percent) or TIP (37 percent). Some of the reasons for this relatively low percentage are that either SIPs have not been completed or EPA has not yet approved them; or SIPs may address air quality needs through strategies solely targeting stationary or area sources; or mobile source reductions may be achieved through technological means rather than transportation programs, and SIPs would not necessarily include specific TCMs that would be included in the Plans and TIPs. On the other hand, if emission reductions from transportation projects and programs are a part of their strategies, these efforts will most likely be included in Plans and TIPs.

2. Conformity Determinations

The conformity provisions of CAA will be the most challenging for transportation planners. Conformity provisions were first added to the Clean Air Act by Section 176(c) of the Act as amended in 1977. This section makes it the affirmative responsibility of the Federal agency supporting an action to ensure that its activities conform to an approved or promulgated air quality implementation plan. It also prohibits the MPO from approving any transportation plan, program, or project which does not conform to such a plan.

To ensure continuing conformity between transportation plans and programs and SIPs, CAA requires that conformity determinations be made no less frequently than every 3 years. The actual frequency rate will be established by the EPA conformity regulation. A conforming plan or program must be consistent with the area's emissions budget, not cause, create, or worsen violations, not obstruct attainment, and demonstrate timely TCM implementation.

At the project level, the following four conditions need to be demonstrated in order to make a conformity determination:

- The project must come from a conforming Plan and TIP;
- the design concept and scope of the project should not have changed significantly since the Plan and TIP were found to conform;
- the design concept and scope of the project must be sufficiently developed to determine emissions at the time of the conformity determination for the TIP; and
- in CO and PM-10 nonattainment areas, the project must not create or worsen hot spot violations.

CAA allows a case-by-case conformity determination for projects not coming from a Plan and TIP.

Most State agencies and MPOs in nonattainment areas have now been through two rounds of conformity determinations under CAA. Most of these agencies spent a considerable amount of staff resources and funds to complete the required analysis; and some are currently under a threat of litigation by environmental groups that see the conformity process as a means of forcing a change in the transportation decisionmaking process.

In most areas, the conformity requirement has made a major difference in the development and acceptance of Transportation Plans and TIPs. This has occurred in various ways, and can be best illustrated by the following examples.

- FHWA and FTA withheld acceptance of certain TIPs from the Great Lakes area for 4 months until the public had the opportunity to comment on them and the MPOs responded. Future improvements in MPO modeling and technical process was also a condition for TIP acceptance in these nonattainment areas.

- In several Midwest areas, only the "neutral" projects within the TIPs were found to be in conformity. Neutral projects are defined as those with minimal air quality impacts and can proceed without a conformity analysis. MPOs in these areas were required to improve their models used to make conformity determinations. In other areas in Ohio and Indiana, for example, MPOs themselves submitted TIPs composed only of neutral projects while they adjusted to the new analysis requirements.

- In the Southeast and Northwest parts of the country, highway projects were delayed until the TIP containing the conformity analysis was completed. In some cases, this meant that projects were withheld from the statewide TIP until a TIP conformity analysis was completed.

- One area in the Southwest reported that innovative projects contributing to improved air quality have been accelerated as a result of the conformity requirements.

Throughout the United States, MPOs report that they have had to drop or delay projects previously scheduled for implementation to meet the conformity requirements. The impact of this is that most plan and TIP amendments now consist of only neutral projects due to the constraints of this complex process.

Due to the working relationship that exists among DOT, the States, and MPOs, no nonconformity determinations have been made to date. In their analytical processes, the MPOs themselves alleviate most potential nonconformity situations prior to formal submission to Federal agencies. In addition, informal Federal review of Plan and TIP development typically avoids the inclusion of projects failing to meet the conformity test.

IV. CONCLUSIONS

CAA together with ISTEA calls for significant changes in the way we go about meeting transportation and air quality goals. CAA seeks to reduce vehicle emissions through a combination of cleaner vehicles, cleaner fuels, and transportation programs and projects to help achieve national air quality goals. Transportation control measures may play a role in many State air quality implementation plans. The requirements to determine conformity of transportation plans, programs and projects to State air quality plans dictate consideration of air quality concerns in transportation planning and project development.

The ISTEA complements the Clean Air Act by giving State and local transportation officials the flexibility to use Federal transportation funds in ways that will help develop a balanced, environmentally sound, intermodal transportation system. ISTEA increases the emphasis on multimodal considerations, land use decisions, and air quality problems in the transportation planning process and on public participation in transportation planning. New ISTEA programs, such as the Congestion Mitigation and Air Quality Improvement Program, were established to help fund transportation control measures and other projects intended to help meet standards in air quality nonattainment areas. Other programs such as the congestion pricing pilot program may also offer air quality benefits, although the details of implementing these projects remain to be worked out.

These two statutes together call for fundamental changes in the transportation and air quality planning processes. It is too early to judge the extent to which the intended process changes have occurred. Transportation agencies are just beginning to take advantage of the flexibility and new programs offered by ISTEA. New players in the transportation planning process are just beginning to become involved in many areas. Development of State air quality implementation plans will continue for ozone and other pollutants at least until late 1994.

Because we are still assessing how transportation and air quality agencies are responding to CAA and ISTEA, this report does not offer conclusions on how well new programs and requirements are working. Legislative recommendations are not offered at this time. But tremendous challenges remain to be met in responding to these new requirements, including the following:

- Mobile source emissions have decreased considerably since the early 1970s due to the improvements in automobile technology, but future long-term reductions are in doubt. Transportation trends show increasing VMT, while shared rides and transit are decreasing. VMT increases could counteract important progress made over the last 10 years in producing cleaner vehicles and retard attainment efforts.

- Traditional methods of altering transportation behavior such as construction of transit and high occupancy vehicle lanes have not been shown to substantially reduce pollution. Preliminary indications from several areas in the country show that traditional transportation control measures alone will only yield a 1- to 2-percent reduction in air pollutant emissions. Significant potential for further progress can also be made through technological improvements by reducing cold start, tailpipe, and evaporative emissions.

  Substantial changes in the level of TCM effectiveness will need to offer a comprehensive program of TCMs, including both the traditional TCMs and economic/marketing based TCMs such as congestion/road pricing, increases in parking prices, and emissions or VMT charges. Such a comprehensive program would need to combine transportation choices and measures to discourage trips in single-occupant vehicles.

- The complex requirements of CAA and ISTEA have increased the burdens on staffs of local transportation and air quality agencies, as well as Federal agencies, and increased the complexity of issues which need to be considered by decisionmakers.

- Transportation and air quality modeling tools need to be upgraded to be useful in meeting these increased requirements.

- Our knowledge of the interrelationships among land use, economics, demography, and transportation is still developing, but the reciprocal interaction of two factors seems to be a significant driving force. Land use densities and travel costs have decreased simultaneously across the country. Even as lower densities increased reliance on the auto, real decreases in the cost of driving and travel subsidies caused further density decreases. The resulting growth in travel produced increases in emissions (prior to the introduction of tailpipe standards). Because both economics and development patterns contributed to our current pollution levels, changes in both may be necessary for improvements in air quality. These will require a sustained effort over many years and will take meaningful land management policies at the local level.

Progress is being made in addressing these challenges, but substantial continued efforts are needed.

- DOT and EPA are working with groups like the National Association of Regional Councils and the Surface Transportation Policy Project to educate State and local agencies on the provisions of the acts through the NARC Clean Air Project and the STPP Livable Communities conferences. These organizations are also involved in helping to develop new coordination and public involvement processes in transportation and air quality planning. Continuation of these efforts will be important.
- DOT and EPA are working to develop and distribute guidance to assist areas in meeting the new requirements. Guidance has been issued, but some important regulations have not yet been finalized.

While future success depends on our response to the challenges facing us, significant progress has been made. EPA's Air Quality Trends Report for 1991 showed that 41 of the 97 nonattainment areas for ozone and 13 of the 42 areas for CO have met the standards for the last 3 years. Smog decreased by 8 percent, and CO levels are down 30 percent, although not all areas have demonstrated such improvements and some new nonattainment areas are appearing, especially for PM-10. Major reductions in vehicle emissions have been made, and further reductions continue as fleet turnover occurs and more stringent emissions standards come into effect. Implementation of basic and enhanced inspection and maintenance programs in many areas will substantially assist this effort and reduce the disproportionate impacts of gross emitters. Increasing use of reformulated fuels, oxygenated fuels, fuel with lower vapor pressure limits, and improvements in alternative fuels will further reduce vehicle emissions. All of these will make important contributions to attainment of national ambient air quality standards.

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CLEAN AIR ACT
SECTION 108(f)(3)

(3) The Secretary of Transportation and the [EPA] Administrator shall submit to Congress by January 1, 1993, and every 3 years thereafter a report that -

(A) reviews and analyzes existing State and local air quality-related transportation programs, including specifically any analyses of whether adequate funding is available to complete transportation projects identified in State implementation plans in the time required by applicable State implementation plans and any Federal efforts to promote those programs;

(B) evaluates the extent to which the Department of Transportation's existing air quality-related transportation programs and such Department's proposed budget will achieve the goals of and compliance with this Act; and

(C) recommends what, if any, changes to such existing programs and proposed budget as well as any statutory authority relating to air quality-related transportation programs that would improve the achievement of the goals of and compliance with the Clean Air Act.

(4) In each report to Congress after the first report required under paragraph (3), the Secretary of Transportation shall include a description of the actions taken to implement the changes recommended in the preceding report.

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SPECIFIC TRANSPORTATION-RELATED PROVISIONS OF THE CLEAN AIR ACT AS AMENDED IN 1990 FOR *OZONE* NONATTAINMENT AREA CLASSIFICATIONS

Marginal

- These areas exceed the ozone standard of .12 parts per million (ppm) by 15 percent or less (.121 ppm up to .138 ppm), and are required to attain the standard within 3 years of enactment (11/15/93).

- Emission inventories are due within 2 years of enactment. Revised emission inventories are required at the end of each 3-year period until attainment.

- These areas must correct existing or previously required inspection/maintenance (I/M) programs.

- These areas will be reclassified as moderate nonattainment areas if they fail to attain the standard by the deadline (plus up to two 1-year available extensions).

Moderate

- These areas exceed the standard by 15 percent to 33 percent (.138 ppm to .160 ppm), and are required to attain the standard in 6 years (11/15/96). Moderate areas must meet marginal area requirements.

- In addition to meeting marginal area requirements, moderate areas have to submit SIP revisions within 3 years of enactment demonstrating volatile organic compound (VOC) reductions, within 6 years of enactment of at least 15 percent from 1990 baseline emissions, while accounting for any growth in emissions after enactment. (Additional requirements for major NOx sources apply in certain areas).

- Contingency measures to be implemented if the area fails to make reasonable further progress or attain the NAAQS by the attainment date; these measures are to be included in the SIP and are to take effect without further action by the State or EPA.

- These areas must adopt basic I/M programs.

- These areas will be reclassified as serious nonattainment areas if they fail to attain the standard by the deadline (plus up to two 1-year available extensions).

Serious

- These areas exceed the standard by 33 percent to 50 percent (.160 ppm to .180 ppm), and are required to attain the standards in 9 years (11/15/99). Serious areas must meet moderate area requirements.

- In addition to meeting moderate area requirements, these areas have to submit SIP revisions within 4 years of enactment that demonstrate VOC reductions that average 3 percent per year each consecutive 3-year period beginning 6 years after enactment.

- These areas must submit SIP revisions within 42 months of enactment establishing clean-fuel vehicle programs, mandating that certain percentages of new fleet vehicles be clean fuel vehicles and use clean fuels within the nonattainment area, including measures to make the use of clean alternative fuels economical to clean-fuel vehicle owners.

- Beginning 6 years after enactment and each 3-year period thereafter, the State has to submit a demonstration as to whether vehicle emissions, congestion levels, vehicle miles traveled (VMT), and other relevant parameters are consistent with those used in the SIP; if not the State has 18 months to submit SIP revisions that include transportation control measures (TCMs) to reduce emissions to levels consistent with SIP levels.

- In addition to the contingency provisions required under Section 172(c)(9), the SIP shall provide for implementation of specific measures to be undertaken if the area fails to meet any applicable milestone.

- These areas must adopt enhanced I/M programs if the 1980 urban population exceeds 200,000.

- These areas will be reclassified as severe nonattainment areas if they fail to attain the standard by the deadline (plus up to two 1-year available extensions).

Severe

- These areas exceed the standard by 50 percent to 133 percent (.180 ppm - .280 ppm). Areas with design values from .180 - .189 ppm are required to attain the standards in 15 years (11/15/05). Areas with design values from .189 - .280 ppm are required to attain the standards in 17 years (11/15/2007). Severe areas must meet serious area requirements.

- In addition to meeting serious area requirements, these areas must submit SIP revisions within 2 years of enactment, which identify and adopt TCMs to offset growth in emissions from growth in trips or VMT.

- Within 2 years of enactment, SIP revisions are due that require employers of 100 or more to increase the average passenger occupancy per vehicle for work trips by not less than 25 percent above the average for all work trips in the area. The average vehicle occupancy for the nonattainment area needs to be established at the time of the SIP submittal. The affected employers have to submit compliance plans within 2 years of the SIP revision (within 4 years of enactment) demonstrating compliance not later than 4 years after the revision (within 6 years of enactment).

- Severe areas which fail to attain the standard by the deadline are subject to mandatory fees on stationary emission sources and the more stringent new source review requirements applicable to extreme areas.

Extreme

- The area exceeds the standard by more than 133 percent (.280 ppm and above), and has 20 years to attain (11/15/2010).

- Extreme areas must meet severe area requirements.

- In addition to meeting severe area requirements, each SIP revision may contain measures to reduce the use of high polluting vehicles or heavy-duty vehicles during heavy traffic hours.

- Extreme areas which fail to attain the standard by the deadline must submit a SIP revision within 9 months to implement a program of economic incentives and transportation controls.

TRANSPORTATION-RELATED PROVISIONS OF THE CLEAN AIR ACT AS AMENDED IN 1990 FOR *CARBON MONOXIDE (CO)* NONATTAINMENT AREA CLASSIFICATIONS

Moderate

- These areas exceed the 8-hour CO standard of 9 parts per million (ppm) by not more than 82 percent (9.1 ppm to 16.4 ppm), and are required to attain the standard by December 31, 1995.

- Emissions inventories are due within 2 years of enactment with revised inventories no later than September 30, 1995, and no later than the end of each 3-year period thereafter until attainment.

- States with CO nonattainment areas which have CO design values of 9.5 ppm and above based on 1988 and 1989 data, or for any 2-year period after 1989, must submit SIP revisions requiring any gasoline sold in the metropolitan statistical area (MSA) or consolidated metropolitan statistical area (CMSA) to contain not less than 2.7 percent oxygen by weight. This requirement must be in effect for not less than 4 months per year. Those areas with design values of 9.5 ppm or more on the date of enactment of CAA must provide for the requirement to take effect no later than November 1, 1992. Areas that reach the design value after enactment must provide for the requirements to take effect no later than November 1, of the third year after the 2-year period for which the design value is determined.

- For those areas with design values above 12.7 ppm, State Implementation Plan (SIP) revisions (due no later than 2 years of enactment) have to contain vehicle miles traveled (VMT) forecasts for each year until the attainment date, based on the Environmental Protection Agency's guidance; SIPs have to provide for annual updates of forecasts, and annual reports regarding the forecast accuracy. SIPs must include contingency provisions to be undertaken if actual or projected VMT exceed the prior forecast.

- These areas are required to correct existing or previously required inspection and maintenance (I/M) programs, with those areas with design values above 12.7 and a 1980 urban population greater than 200,000 being required to adopt enhanced I/M programs.

- These areas will be reclassified as serious nonattainment areas if they fail to attain the standard by the deadline (plus two 1-year available extensions).

Serious

- These areas exceed the 8-hour CO standard by 83 percent or more (16.5 ppm and higher), and are required to attain by December 31, 2000. Winnebago and Steubenville-Weirton may apply for waivers from mobile source controls, based on a determination, yet to be made, that mobile sources do not contribute significantly to CO levels.

- Serious areas have to meet the requirements for moderate areas with design values of 12.7 ppm or greater.

- In addition to meeting moderate area requirements, States with serious areas have to submit SIP revisions within 2 years of enactment that include transportation control measures to reduce CO emissions and offset emission increases from growth in VMT, employer trip reduction programs, and require the seasonal use of oxygenated fuel for the MSA or CMSA, whichever is larger. The oxygen content must be sufficient, in combination with other measures, to provide for attainment of the CO standard by the applicable attainment date. The oxygenated fuels requirement is to be in effect no later than October 1, 1993.

- Attainment demonstrations have to include annual emission reduction milestones; if the areas fail to meet the milestones, a SIP revision to implement economic incentives and a transportation control program is required.

While the relationship of the aforementioned SIP elements to transportation is not always well defined, several programs requiring SIP revisions clearly have an impact upon transportation. For example, the conformity provisions of CAA, which are part of a general movement towards considering social, economic, and environmental goals in planning the transportation system, require that transportation plans and programs ensure and support the SIP's goal of attaining the NAAQS. A more complete description of the conformity requirements and the other transportation-related programs of CAA are contained in Section II of this report.

TRANSPORTATION-RELATED PROVISIONS OF THE CLEAN AIR ACT AS AMENDED IN 1990 FOR *PM-10* NONATTAINMENT AREA CLASSIFICATION

Areas designated nonattainment for PM-10 and classified moderate, on November 15, 1990, are required by Section 189 of the amended act to submit a SIP no later than November 15, 1991. Among other requirements, this SIP must include the following two elements:

1) Either a demonstration that the plan will provide for attainment on or before December 31, 1994, or a demonstration that attainment by that date is impractical.

2) Provisions to assure that reasonably available control measures (RACM) for the control of PM-10 are implemented by December 10, 1993.

Areas designated nonattainment for PM-10 after November 1990 must submit a SIP within 18 months after being designated nonattainment. States with a moderate nonattainment area are required to submit a plan that includes, among other provisions, a demonstration of attainment, quantitative milestones, and provisions to guarantee that RACM are implemented. Specific requirements are set forth in subparts 1 and 4 of Title I of CAA.

Serious Areas

The Administrator of the EPA may classify as a serious PM-10 nonattainment area any moderate PM-10 nonattainment area that the Administrator determines cannot practicably attain the NAAQS for PM-10 by the attainment date or if the Administrator finds that the area has failed to attain the standard. Once reclassified as a Serious PM-10 nonattainment area, the State must reach attainment of the NAAQS for PM-10 as expeditiously as practicable but no later than the end of the 10th calendar year beginning after the area's redesignation as nonattainment. However, areas designated nonattainment for PM-10 under Section 107(d)(4) of the Clean Air Act must reach attainment of the NAAQS for PM-10 by December 2001.

If a Serious PM-10 nonattainment areas fails to attain the NAAQS for PM-10 by the prescribed attainment date, the State shall, after providing for both notice and an opportunity for public comment, submit within 12 months after the attainment date, a SIP revision which provides for attainment of the PM-10 NAAQS. From the date of the SIP submission until attainment, the SIP shall provide for an annual reduction in PM-10 or PM-10 precursor emissions of not less than 5 percent of the total amount of such emissions as reported in the most recent inventory prepared for the area.

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TRANSPORTATION CONTROL MEASURES FROM SECTION 108(f)(1) OF CAA

i programs for improved public transit;

ii restrictions of certain roads or lanes to, or construction of such roads or lanes for use by passenger buses or high occupancy vehicles;

iii employer-based transportation management plans, including incentives;

iv trip reduction ordinances;

v traffic flow improvement programs that achieve emission reductions;

vi fringe and transportation corridor parking facilities serving multiple occupancy vehicle programs or transit service;

vii programs to limit or restrict vehicle use in downtown areas or other areas of emission concentration particularly during periods of peak use;

viii programs for the provision of all forms of high occupancy, shared-ride services;

ix programs to limit portions of road surfaces or certain sections of the metropolitan area to the use of non-motorized vehicles or pedestrian use, both as to time and place;

x programs for secure bicycle storage facilities and other facilities, including bicycle lanes, for the convenience and protection of bicyclists, in both public and private areas;

xi programs to control extended idling of vehicles;

xii programs to reduce motor vehicle emissions consistent with Title II, which are caused by extreme cold start conditions;

xiii employer-sponsored programs to permit flexible work schedules;

xiv programs and ordinances to facilitate non-automobile travel, provision and utilization of mass transit, and to generally reduce the need for single-occupant vehicle travel, as part of transportation planning and development efforts of a locality, including programs and ordinances applicable to new shopping centers, special events, and other centers of vehicle activity;

xv programs for new construction and major reconstruction of paths, tracks, or areas solely for use by pedestrian or other non-motorized means of transportation when economically feasible and in the public interest; and

xvi programs to encourage the voluntary removal from use and the marketplace of pre-1980 model year light duty vehicles and pre-1980 light duty trucks.

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TRANSPORTATION AND EMISSIONS MODELING

Regional transportation models were originally developed for use in designing major capital investments in urban highway facilities to accommodate anticipated growth in automobile travel. The modeling process employs observed regularities in the patterns of household and business activity to make reliable inferences about the volume, location, means, and timing of travel within an urban area, and to simulate the performance of its transportation system in accommodating different volumes and patterns of travel.

Conducting an analysis of regional travel behavior and transportation system performance requires information describing the number and geographic distributions of households, businesses, and other activity locations, as well as the demographic and economic characteristics of households and individuals, and a detailed description of the spatial configuration and performance characteristics of the regional transportation network. A complete set of these inputs is required for each period to be analyzed; thus forecasts for each of these areas must be prepared for each future year under consideration. Analyzing regional travel behavior and transportation system performance also requires an integrated set of models and procedures for translating the spatial distributions and activity patterns of households and businesses into regional travel demands, and for analyzing the interaction of these demands with the capacity of the regional transportation system to accommodate them.

Regional travel demand analysis typically proceeds through a sequence of four modeling steps. In the first of these (termed trip generation), the number of trips originating in and destined for each geographic zone in the region is calculated. Separate calculations are generally performed for different travel purposes, such as commuting to work, shopping, or recreational travel.

The second step links the numbers of trip origins and destinations predicted for each zone into a specific geographic pattern of travel volumes or origin-to-destination flows. Such "trip distribution" models typically represent the flow of trips between zones as a function of total zone trips, and some measure of the "difficulty" in traveling between them, usually reflecting a combination of the time and cost entailed in doing so.

In the third modeling step, the interzonal travel flows for each trip purpose are split among travel modes (hence the term "mode split"), using information on the personal characteristics of travelers, as well as on the comparative costs and performance (speed, frequency, etc.) of the available modes, and is used to produce a total daily travel matrix by mode. Using external information, this can then be separated into tables for each time period of interest, most commonly separate morning and evening peak travel periods and a single off-peak period.

In the final modeling step, the trip flows between zone pairs made by each travel mode during one of these time periods are assigned (hence "traffic assignment") to routes or paths through a regional network of transportation facilities. The regional automobile network is composed of interconnected road and highway segments, while the transit network consists of individual routes and services, interconnected at passenger transfer points. Assignment procedures generally assume that travelers choose routes to minimize travel time. The traffic assignment process is usually conducted in stages, in an attempt to simulate the diversion of travelers to alternate routes in response to congestion on preferred routes.

One major complication in the four-step modeling process arises from the fact that earlier modeling stages—trip distribution and mode split—require as inputs the travel times between zone pairs that are the final outputs of the fourth modeling step, traffic assignment. A common response to this interdependence is to estimate provisional interzonal travel times for use in those earlier stages, and then to repeat those steps if the more definitive travel times calculated from the traffic assignment process differ significantly from provisional estimates. How many times to repeat this process is currently a matter of debate.

An important product of the regional transportation modeling process for developing vehicle emission estimates is an inventory of total travel by vehicle type for each time period included in the analysis. Most traffic assignment models produce estimates of the number of vehicle miles traveled (VMT) on facilities represented in the regional network (such as major arterial streets, highways, and limited-access expressways), together with estimates of the resulting average speed of travel on each type of facility. If information regarding the typical mixes of automobiles and trucks utilizing different types of facilities at different time periods within the day is available, or if parallel regional modeling processes are conducted for automobile and truck travel, separate estimates of VMT by type of vehicle and time period can also be developed for each facility type. This information can be used in conjunction with a vehicle emissions model to estimate total emissions generated by the calculated pattern of regional travel.

Vehicle emission models calculate the rates at which different pollutants are emitted per mile of travel by various types of vehicles. These emissions include exhaust gases generated by operation of their internal combustion engines, and evaporative losses from their fuel systems occurring during vehicle operation, refueling, and storage. Two vehicle emission models are currently in widespread use, the EPA's MOBILE model and the EMFAC model developed by the California Air Resources Board (CARB).

Vehicle emissions models consist of an extensive database of emissions of each pollutant per vehicle-mile of travel measured under controlled operating and environmental conditions, together with procedures for modifying these rates to reflect actual on-road operating conditions. Measured emission rates differ among types of vehicles (passenger automobiles, light and heavy-duty trucks, and motorcycles), as well as by model year and age, reflecting changes in new-vehicle emission standards and the increase in emission rates that typically occurs with accumulated mileage. The MOBILE model uses measured emission rates from a sample of vehicles run through the Federal Test Procedure (FTP).

Actual per-vehicle mile emission rates are calculated by adjusting these basic emission rates to reflect differences between the test and actual conditions. These differences include tampering with emissions control equipment, variation in driving patterns from those used to measure emissions rates, and air temperatures different from that (75 degrees) at which emissions testing is conducted. Applying the appropriate correction factors to the basic emission rate produces an estimate of its actual exhaust emissions rate in urban driving. Finally, evaporative hydrocarbon emissions from vehicles' fuel systems are added to these tailpipe emission rates to determine total emissions per mile of operation. The resulting total emission factors are supplemented with information on the age distribution and utilization of each type of vehicle to estimate the average emissions per mile of each pollutant generated by the total number of such vehicles operating in the urban area.

Total vehicle emissions are estimated by applying the per-mile vehicle rates (from emissions models) to estimates of VMT. Separate contributions to total vehicle emissions can be estimated for different time periods of the day, vehicle types, and transportation facilities.

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