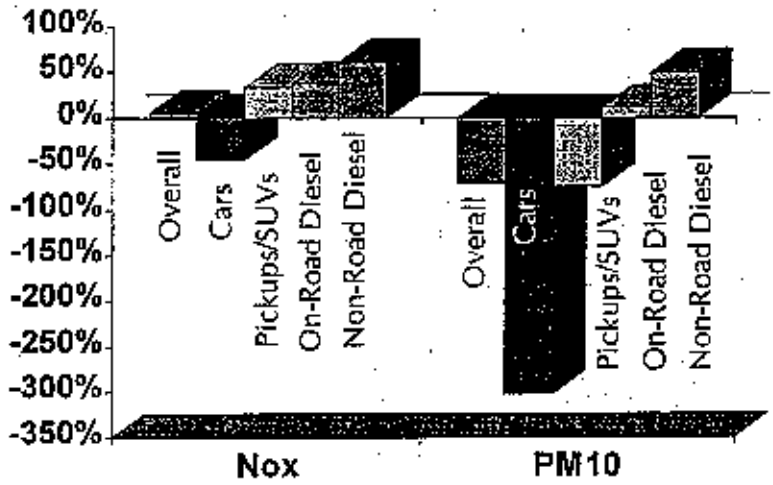
EXHIBIT EE

Introduction

Pollution from diesel engines is one of the most critical air pollution problems in the United States, especially in urban areas. It can be argued that diesel pollution is also one of the most under addressed environmental and public health problems in the United States. Diesel engines power on-road sources (buses and trucks), non-road sources (construction and agricultural equipment), and other important transportation sources, such as rail and marine vessels.

While diesel engines are more fuel efficient than gasoline-powered vehicles, diesel exhaust is more toxic and poses a greater health threat than gasoline exhaust. In addition, the most polluting diesel sources are often concentrated in urban areas—public transit, construction equipment, delivery trucks—thereby posing a human health risk to millions of urban residents. Diesel pollution causes a wide range of health effects, from severe respiratory ailments like asthma and emphysema, to cancer and premature death.

Comparison of Emissions from Mobile Sources
1970-1998 for NOx and PM10[2]



While cars have gotten cleaner since Congress passed the Clean Air Act in 1970, similar attention has not been paid to reducing emissions from diesel engines. In fact, diesel buses and trucks emitted 11% more toxic particulates and 37% more smog-forming nitrogen oxides (NOx) in 1997 than they did in 1970. Non-road diesel sources emitted 61% more NOx and 49% more particulates in 1997 than in 1970.[1]

Over the past ten years, citizen groups throughout the country have launched local campaigns to raise public awareness about the health effects of diesel exhaust and to push transit authorities to invest in cleaner fuel sources. It is only through these campaigns that alternatives to diesel-powered engines are being pursued since federal regulatory efforts have focused on cleaning up the diesel engine but not replacing it. Given the availability of alternative technology and government funding, cities throughout the U.S. have the option of investing in clean alternatives to diesel.

The purpose of the Diesel Sourcebook is to help citizen groups launch local campaigns to clean up diesel sources in their cities and neighborhoods to be a "how-to" manual, providing citizen activists the information they need

to make a compelling case to dump dirty diesel. The four main sections include:

- Why cities should invest in diesel alteratives; including human health impacts, available technolgies and alternatives to diesel;
- Potential funding sources;
- How to launch a campaign, written by the Natural Resources Defense Council (NRDC) based on their successful campaign experience;
- A collection of case studies on other local campaigns.

The focus of the Diesel Sourcebook is to equip activists to tackle discreet diesel fleets in their communities rather than diesel sources in general. And while the suggestions found in this Sourcebook are geared toward launching diesel bus campaigns, the tools provided can be used to target other diesel fleets, trucks or diesel sources. Choosing your target is the first step in a campaign, and we hope that this Sourcebook will lead you to taking that first step!

1. U.S. EPA Office of Air Quality Planning and Research, *National Air Pollutant Emissions Trends, 1970-1998*, March 2000, Appendix A.
2. Ibid.

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Pocket:
- Fact Sheets on Diesel
- Government Funding Contacts
- California School Bus Case Study
- Fast Facts on Clean Air

The Problem with Dirty Diesel

Whether it is on our highways, in our cities, at our construction sites, or at our schools, diesel engines are everywhere. Heralded for its fuel economy and power, the diesel engine powers most of the nation's buses, trucks, trains, ships, and off-road machinery.[1] There is a lot more to know about diesel though, and most of it far less inspiring.

History of the Diesel Engine

Invented in 1892 by Rudolf Diesel, the compression ignition engine achieves combustion by injecting diesel fuel into a chamber of highly compressed air. The heat of the compressed air is sufficient to ignite the diesel fuel, in turn generating the engine's power. Rudolf conceived the diesel engine seeing a need for a machine that was easily adaptable in size and cost, that utilized locally available fuels, and that was more fuel-efficient than the steam engine.[2]

The patent and sales rights to the diesel engine for the United States and Canada were purchaesd by Adolphus Busch in 1898, who then formed the American Diesel Engine Company (orginally Diesel Motor Company of America).[3] That same year, the company built the first successfull diesel engine in the world. It originally was intended for use by stationary power plants, marine engines and railway locomotives.[4] Soon it would be powering automotive vehicles, including large trucks and buses, worldwide.

While diesel-powered vehicles represent only 2% of all vehicles in the United States today, diesel vehicles account for nearly half of all nitrogen oxides (NOx) and more than two-thirds of all particulates (PM) from US transportation.[5]In the end, any praise the compression ignition engine might get for its fuel economy is far outweighed by the damaging impact of the engines exhaust.

The Problem

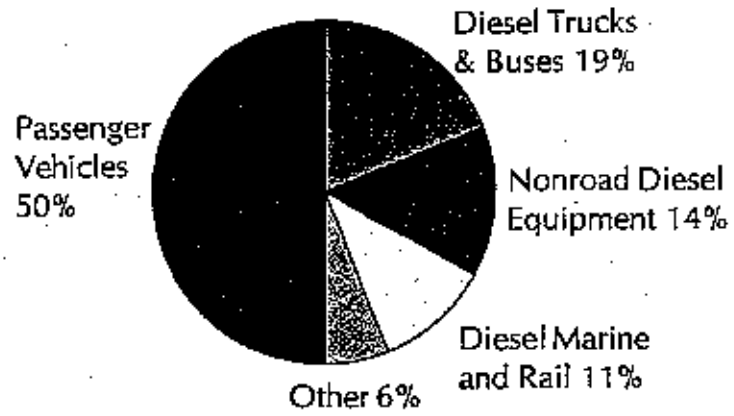
Diesel exhaust is perhaps the most under-addressed public health threat in America today. Nearly all of the 6 million heavy-duty trucks, tractors and buses registered in the U.S today burn diesel fuel. Diesel exhaust is a mixture containing over 450 different components, including nitrogen oxide (NOx), sulfur oxide (SOx), and fine particles coated with organic substances. Although the emissions comprise a small fraction of the national emissions inventory for PM10, diesel engines are a major component of PM inventories in urban areas where population concetrations are the highest.[6] In many cities, up to 60% of fine particle pollution is attributable to diesel exhaust.[7] Scientific studies completed by U.S. Environmenal Protection Agency (EPA) and the state of California have prompted California to upgrade the listing of diesel to a toxic air contaminant and probable human carcinogen. The EPA recently proposed listing diesel exhasust as a mobile source air toxic under section 202(l) in the Clean Air Act.

In many cities, up to 60% of fine particle pollution is attributable to diesel exhaust.[7]

Rudolf Diesel

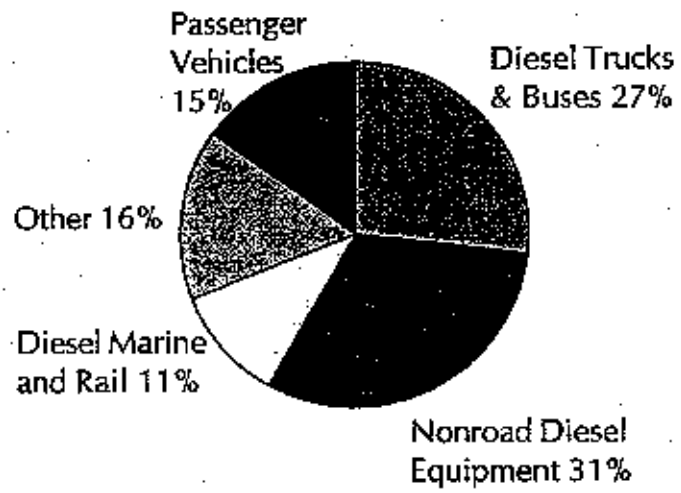
Common Sources of Diesel Pollution

Transportation Sources of Nitrogen Oxide Emissions



Transportation = 49% US Total NOx Emissions

Transportation Sources of Particulate Emissions



Transportation = 2% US Total PM10 Emissions

Source: U.S. EPA Office of Air Quality Planning and Research, *National Air Pollutant Emissions Trends*, 1970-1997, March 2000, Appendix A.

The main sources of diesel pollution are commuter and transit buses and heavy-duty trucks. Other significant sources fall into the non-road category – pollution sources that are not intended for road and highway travel. These sources include construction, logging, garden equipment, agricultural equipment (tractors, combines, sprayers), and recreational equipment (snow mobiles, jet skis). Finally, a small but significant group of diesel sources includes marine and aeronautical equipment (sail boats, motor boats, airplanes, baggage equipment), rail trains, and light commercial equipment.

Gaseous Emissions

One of the severe down-sides of the diesel engine is that it creates an environment where nitrogen from the ambient air can be readily fused with oxygen molecules, resulting in the formation of nitrogen oxides (NOx).[8] NOx, a regulated air pollutant, includes nitrous oxide (NO) and nitrogen dioxide (NO2). NO is a colorless and odorless gas; NO2 is a very toxic red-brown gas with an unpleasant irritating odor. Both are highly active in the creation of smog and acid rain.

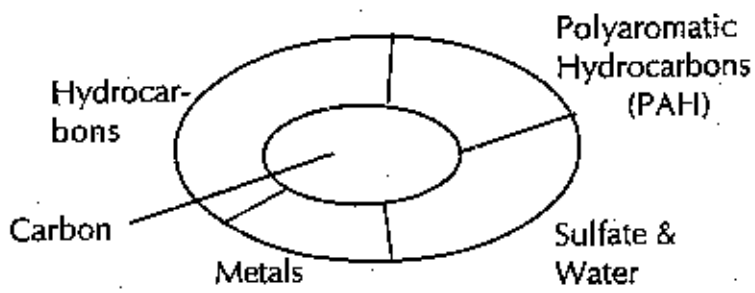
Sulfur oxides(SOx) are one of the major precursors to acid rain.[9] Sulfur dioxide (SO2) originates from the sulfur in diesel fuel and is a colorless gas with a characteristic, irritating odor. Sulfur dioxide can be oxidized to sulfur trioxide (SO3) a precursor acid aerosol responsible for sulfate fine particulate emissions.

Particulate Emissions

Diesel engines also emit high particulate emissions, due to incomplete combustion of the fuel, its high sulfur content, and poor refinement.

Diesel particulates consist of small carbon particles coated with several compounds which are formed during the engine combustion process. These particulates are extremely small (less than 2.5 microns) and complex and, unlike regular airborne dust particles, can carry known and possible cancer-

Anatomy of a Diesel Particle



source: Manufacturers of Emission Control Association

While diesel-powered vehicles represent only 2% of all vehicles in the U.S. today, diesel vehicles account for nearly half of all nitrogen oxides (NOx) and more than two-thirds of all particulates (PM) from US transportation.[5]

Over 40 chemicals in diesel exhaust are considered toxic air contaminants by the State of California.

causing substances directly into the lungs. Diesel particulates are also of concern because they are typically emitted directly into the "breathing zone" where the urban population works and recreates, unlike th emissions from

Toxic Air Contaminants In Diesel Exhaust

Over 40 chemicals in diesel exhaust are considered toxic air contaminants by the State of California.

Substances in Diesel Exhaust Listed by Cal EPA as Toxic Air Contaminants[10]

acetaldehyde*	ethyl benzene*
acrolein*	inorganic lead
aniline*	manganese compounds
antimony compounds	mercury compounds
arsenic	methanol*
benzene*	methyl ethyl ketone*
beryllium compounds	naphthalene*
biphenyl*	nickel
bis [2-ethylhexyl]phthalate*	4-nitrobiphenyl*
1,3-butadiene*	phenol*
cadmium	phosphorus*
chlorine*	polycyclic organic matter, including polycyclic aromatic hydrocarbons (PAHs) and their derivatives
chlorobenzene*	propionaldehyde*
chromium compounds	selenium compounds
cobalt compounds	styrene*
creosol isomers*	toluene*
cyanide compunds	xylene isomers and mixtures*
dibutylphthalate*	o-xylenes*
diesel exhaust particulate	m-xylenes*
dioxins and dibenzofurans*	p-xylenes*

** Listed by US EPA as Hazardous Air Pollutants Under Section 112 of the Clean Air Act Amendments of 1990.*

Note: California Health and Safety Code section 39655 defines a "toxic air contaminant" as "an air pollutant which may cause or contribute to an increase in mortality or in serious illness, or which may pose a present or potential hazard to human health."

The Solution

In 2000, EPA proposed to reduce emissions from heavy duty engines (HDEs) by up to 95% and remove 97% of the sulfur in diesel fuel, beginning in 2007. This is a critical time to highlight options for reducing diesel exhaust. By cleaning up existing diesel fleets and developing cleaner fuels and engines and raising public awareness about the health risks of diesel emissions through the development of localized diesel campaigns, efforts to reduce diesel pollution across the country will succeed.

1. Union of Concerned Scientists, *The Hidden Costs of Transportation*, URL <www.ucsusa.org.html>.
2. URL <www.invent.org/book/book-text/31.html>.
3. URL <www.exporail.org/publications/464/100Diesel_fra.html>.
4. Ibid.
5. U.S. EPA Office of Air Quality Planning and Research, *National Air Pollutant Emissions Trends, 1900-1996*, December 1997, Appendix A.
6. Natural Resources Defense Council and Clean Air Network comments submitted to the public docket (A-99-06) on Advanced Notice of Proposed Rulemaking on Sulfur Levels in Diesel Fuel, July 12, 1999.
7. Ibid.
8. Jason Mark, Union of Concerned Scientists, telephone communication, April 20, 1999.
9. DieselNet Technology Guide, Gaseous Emissions, URL <www.DieselNet.com>.
10. California Air Resources Board, URL <www.arb.ca.gov/toxics/dieseltac/de-fnds.htm>.

Diesel's Damaging Effects on Human Health & Ecosystems

Exhaust from diesel tailpipes can have significant detrimental effects on human health and the environment. Diesel exhaust contributes to particulate matter (PM), ground-level ozone precursors (nitrogen oxides), and toxics. These emissions can cause irritation of the pulmonary system, contribute to chronic respiratory morbidity and mortality and are suspected of causing cancer. They can also severely impact and alter the health of ecosystems.

Fine particles, when inhaled deeply into the lungs, damage respiratory and cardiovascular systems and can lead to premature death.

Particulates

Particulate matter from diesel exhaust is a mixture of chemically and physically diverse substances categorized by the particle size; fine particles are those less than 2.5 micrometers in diameter and coarse particles are those between 2.5 and 10 micrometers in diameter. These particles, when inhaled deeply into the lungs, damage respiratory and cardiovascular systems and can lead to premature death.

As small particles are inhaled, they can embed in lung tissue, and either accumulate or absorb into the bloodstream. As particles build up in the lung tissue they create an obstruction that slows the diffusion of oxygen into the bloodstream, thereby putting strain on the heart. This strain can increase the risk of heart disease leading to premature death, especially among the elderly and those susceptible to cardiovascular disease. In an analysis of over 239 US cities, fine particulates were estimated to be responsible for over 60,000 premature deaths due to heart and lung disease each year.[1] Residents of the nation's most particulate-polluted cities face a 1-2 year shortened life span than residents of the nation's cleanest cities.[2]

In addition to cardiovascular disease, particulate matter has been linked to cancer, Sudden Infant Death Syndrome (SIDS) and increased hospital admissions for chronic bronchitis, chronic obstructive pulmonary disease (COPD), pneumonia, coughing and difficult or painful breathing.[3] Many of these ailments suppress the immune system, making individuals more susceptible to the harmful effects of diesel exhaust. Exposure to diesel exhaust may even contribute to asthma - a respiratory diesease affecting more than 14.6 million Americans and has increased 75 percent nation-wide between 1980 and 1994.[4,5,6]

Fine particulates contribute to haze, impairing visibility in many of our national parks and wilderness areas. The fine particles either scatter light, creating a hazy sky or in some cases absorb light, creating a brownish hue. Fine particles can remain suspended in the air for long periods of time and travel long distances. For example, diesel exhaust from a truck in Southern California can contribute to haze in the Grand Canyon National Park, 500

miles away. In many parts of the U.S., visual range has been reduced 70% from natural conditions due to haze.[7]

Ecosystem effects of particulate matter include terminating photosynthesis, the plants' process of turning sunlight into energy for food and growth.[8] This occurs by particulate matter absorbing sunlight, hindering a plant or seedling's ability to produce enough energy to grow.

Nitrogen Oxides & Ground-Level Ozone

Nitrogen oxides (NOx) are a major contributor to the formation of ground level-ozone (or smog). Exposure causes a range a human pulmonary and respiratory effects, including chest pain, coughing, and shortness of breath. NOx and ozone have been linked to increased susceptibility to respiratory infection, increased airway resistance in asthmatics, inflammation of lung tissue and up to 15-20% decreased lung function in some healthy adults.[9]

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Short-term exposures to NO2 have resulted in a wide range of respiratory problems in school children, including cough, runny nose and sore throat.[10] Researchers at the Harvard School of Public Health have linked short-term exposure to high ground-level ozone levels to over 15,000 hospital admissions and 50,000 emergency room visits for respiratory conditions in 13 U.S. cities.[11]

There is some evidence that long-term exposure to low levels of ozone can cause chronic health effects. Repeated inflammation of lung tissue may result in permanent damage to lung tissue causing especially elderly individuals to suffer a reduced quality of life.[12]

Ozone and NOx effects on ecosystems can be just as damaging. Nitrogen oxides, when deposited on soil or in water, can dramatically alter the chemical composition of an ecosystem. Nitrogen deposition increases the growth of algae, reducing the amount of light needed for other aquatic plants to grow. Algal blooms can also reduce the level of dissolved oxygen in a waterbody, adversely affecting fish and shellfish populations.

Ozone interferes with plants' ability to produce and store food. This can lead to significant crop loss for the agricultural and forest industry. The effects of ozone on ecosystems can build up over many years, causing numerous problems for an entire forest system, reducing yield in tree seedlings and non-commercial forests.[13] Other effects include ecosystem and vegetation damage in National Parks; damage to urban grass, flowers and shrubs; increased susceptibility of plants to pests; and damage to man-made materials, such as buildings.

Toxics

As discussed earlier, diesel exhaust is a particle containing a mixture of chemicals and compounds. There are more than 40 toxic substances found in diesel exhaust, many of which are known or probable carcinogens, including arsenic, benzene, formaldehyde, nickel and polycyclic aromatic

hydrocarbons (see the table on page 9). Human exposure to these pollutants at sufficient concentrations and duration can result in poisoning and rapid onset of sickness, such as nausea and dizziness. Other less measurable effects include immunological, neurological, reproductive, and respiratory problems, as well as effects on fetal and child development.

Due to the high number of toxic substances found in diesel particles, the California Air Resources Board, the World Health Organization, the National Institute of Occupational Safety and Health, and the International Agency for Research on Cancer have determined these particles to be known or probable human carcinogen.[14, 15] California EPA estimates that 450 out of every million Californians are at risk of developing cancer due to diesel exhaust exposure.[16] In the U.S., diesel particle pollution is estimated to be responsible for 125,000 cancers.[17]

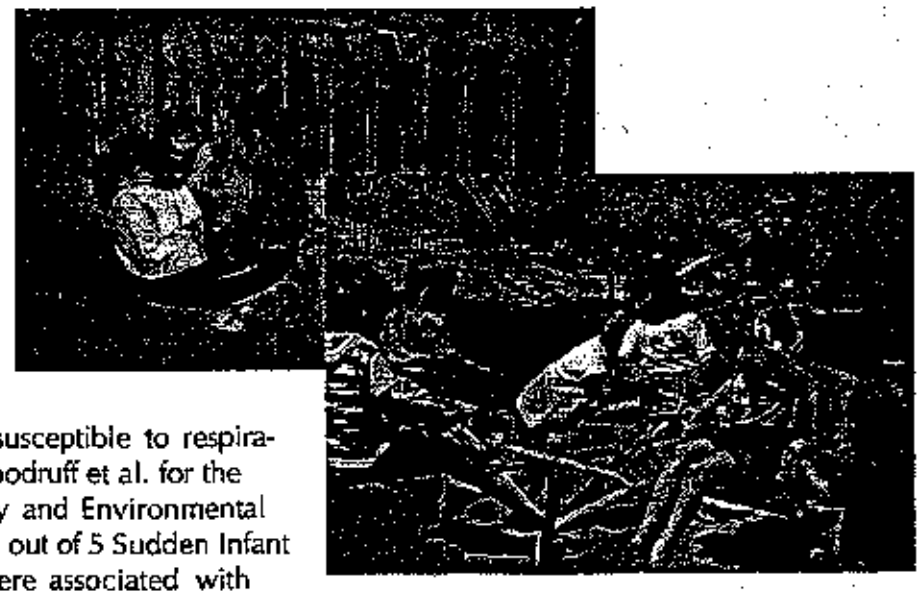
The toxics found in diesel exhaust can have negative effects on natural and man-made ecosystems and structures. When diesel particles fall onto the surface of a leaf, the toxins within these particles can cause corrosion, weakening the plant and making it susceptible to disease. Toxics in diesel particulates can also interfere with a plant's metabolism. These particles also erode buildings, monuments and historical statues.[18]

Who is Most At Risk

Every person is affected by diesel exhaust, but some are more sensitive to the negative health effects of these dangerous fumes. This group includes children, the elderly, people who have respiratory or cardiopulmonary disease, people who regularly exercise in diesel-polluted areas, and people who work or live near diesel exhaust sources.

Infants and Children

At rest, an infant's metabolic rate and air intake is about twice that of an adult. This greatly increases exposure of growing babies to the dangers of air pollution. In fact, various forms of lung disease and breathing problems constitute the number one killer of babies under the age of one year, accounting for 29.5% of infant deaths in 1997.[19] In high pollution areas, babies are 45% more susceptible to respiratory ailments. A 1997 study by Woodruff et al. for the Physicians for Social Responsibility and Environmental Working Group found that nearly 1 out of 5 Sudden Infant Death Syndrome (SIDS) deaths were associated with high levels of particulate pollution (PM10) in 12 major metropolitan areas.[20] The study found that babies have a 12% greater chance of SIDS for every 10 microgram increase of PM10 in the air.[21]



Children represent the largest section of the population susceptible to the effects of air pollution. Babies have a 12% greater chance of SIDS for every 10 microgram increase of PM10 in the air.[21]

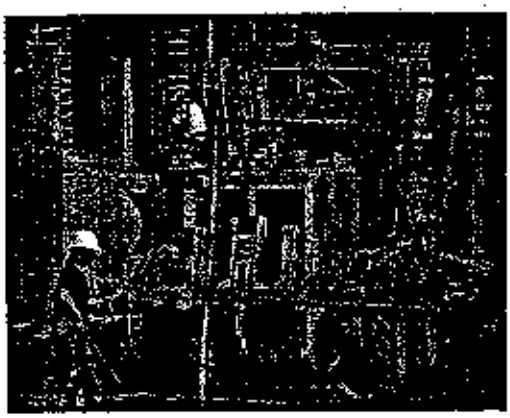
The relationship etween particle exposure and death is about three times greater in the elderly.[26]

Children represent the largest section of the population susceptible to the effects of air pollution. Compared with adults, children spend more time outdoors, particularly at midday and during the afternoons when air quality is poorest. Children engage in more vigorous physical activity, resulting in higher average breathing rates. Due to these factors, they receive greater relative doses of pollutants in the air. Children also have narrower airways and their lungs are still developing. Irritation caused by air pollutants that would produce only a slight response in an adult can result in potentially significant obstruction in the airways of a young child.[22] Several studies have demonstrated that children living near major roadways have poorer lung function than children living in cleaner areas. The same studies showed that lung function was correlated with elevated levels of diesel exhaust measured in schools.[23]

Elderly

Americans are living longer, but as they age their body begins to degenerate. This puts older adults at greater risk when inhaling dangerous diesel fumes. Their ability to clear inhaled particles decreases and their immune system declines over time.[24] The elderly are also more likely to have underlying respiratory or cardiopulmonary illnesses that can worsen when exposed to diesel exhaust.

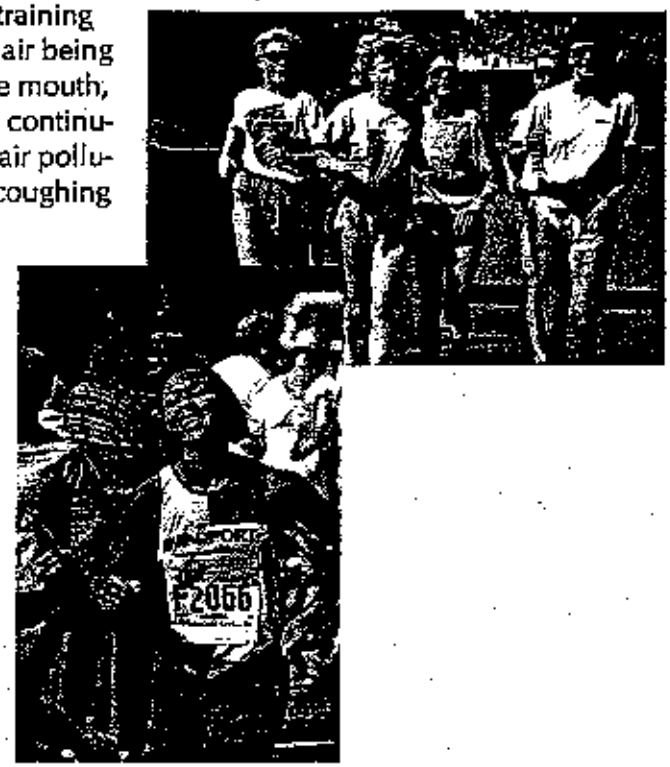
Recent studies found that the elderly and those with pre-existing heart and lung disease are at greatest risk of premature mortality due to particulate air pollution. Because cardio-pulmonary disease is more common in older people, and cardiovascular and pulmonary function declines with age, the elderly are likely to have heightened sensitivity to particle exposure. Several important studies have shown that those over 65 years of age are at greater risk of requiring emergency room service on days with higher particulate pollution.[25] In addition, the relationship between particle exposure and death is about three times greater in the elderly.[26] To the extent that the elderly and chronically ill are slower to remove particles from deep lung tissue, they are likely at greater risk from diesel exhaust exposure because slow particle removal from the lungs appears to increase the risk of tumor development.[27]



Outdoor Workers and Athletes

The majority of outdoor work is active and strenuous, requiring more exertion and energy and resulting in deeper, heavier breathing. Individuals who work outdoors are usually found in areas that pose a high risk for diesel exhaust exposure, such as construction sites, landscaping or roadways. Due to the nature of their jobs, they are more likely to increase their risk of respiratory ailments. Workers that use diesel-fueled non-road equipment, such as tractors and haulers are most directly exposed to diesel exhaust. Numerous studies have shown a link between teamsters and railway workers to increases in lung cancer.[28]

Those who exercise outdoors face similar problems. During exercise the intake of oxygen increases, further increasing the inhalation of outdoor pollutants, such as diesel exhaust. A runner is more vulnerable to the exhaust of a passing truck or bus because she or he is straining the cardiopulmonary system. Exposure is increased due to air being drawn more deeply into the lungs and primarily through the mouth, bypassing the nose, which is a better air filter. People who continually work or exercise outdoors can become accustomed to air pollution over time and have fewer obvious symptoms, such as coughing and wheezing, but their lungs are still being negatively affected.[29]



Environmental Justice Communities

Numerous studies have found that minority communities, also known as environmental justice communities, experience greater exposure to substandard outdoor air quality. Environmental justice communities are areas with high concentrations of racial or ethnic minorities or low-income families that are often disproportionately exposed to a variety of environmental burdens and hazards, including diesel exhaust. Minorities live in greater concentrations both in areas with above-average numbers of air polluting sources and in non-attainment areas.[30] For instance, 52 percent of all whites live in counties with high ozone concentrations, compared to 62 percent of Blacks and 71 percent of Hispanics.[31]

Children in environmental justice communities are losing the fight against asthma - one of the most prevalent respiratory illnesses aggravated by fine particles found in diesel exhaust. Black children are nearly twice as likely to have asthma as white children.[32] Moreover, black children aged 5 to 14 years were four times more likely than whites to die from asthma.[33] Children of Hispanic mothers have an asthma rate of 2-½ times higher than whites and more than one and a half times higher than blacks.[34]

1. NRDC, *Breathtaking: Premature Mortality Due to Particulate Air Pollution In 239 American Cities*, May 1996, p. 1.
2. Ibid.
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19. National Center for Health Statistics: Report of Final Mortality Statistics, 1997, American Lung Association URL <www.lungusa.org/pub/idd.htm>.
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EXHIBIT FF

1: *Ann Allergy Asthma Immunol* 1999 Mar;82(3):233-48; quiz 248-52 Related Articles, Books, LinkOut

Changing prevalence of allergic rhinitis and asthma.

Sly RM

Section of Allergy and Immunology, Children's National Medical Center, Washington, DC 20010-2970, USA.

OBJECTIVE: This review will enable the reader to discuss prevalence, risk factors, and prognosis of allergic rhinitis and asthma. DATA SOURCES: MEDLINE (PubMed) search using the terms allergic rhinitis, asthma, prevalence, risk factors. STUDY SELECTION: Human studies published in the English language since 1978, especially studies of relatively large populations in the United States, Great Britain, Australia, and New Zealand, with cross referencing to earlier relevant studies. RESULTS: Current prevalence of allergic rhinitis at 16 years of age in cohorts of British children born in 1958 and 1970 increased from 12% in the earlier cohort to 23% and in the later cohort. Local surveys of allergic rhinitis at approximately 18 years of age in the United States in 1962 to 1965 disclosed prevalence of 15% to 28%, while the national survey of 1976 to 1980 disclosed a prevalence of 26%. Thus, it is uncertain whether prevalence of allergic rhinitis has changed in the United States based on these limited data. Data from several sources indicate worldwide increases in prevalence of asthma. Annual Health Interview surveys indicate increases in prevalence of asthma in the United States from 3.1% in 1980 to 5.4% in 1994, but prevalence among impoverished inner city children has been much higher. Combined prevalence of diagnosed and undiagnosed asthma among inner city children has been 26% and 27% at 9 to 12 years of age in Detroit and San Diego. Positive family history and allergy are important risk factors for allergic rhinitis and asthma. Prognosis is guarded; allergic rhinitis resolves in only 10% to 20% of children within 10 years, and at least 25% of young adults who have had asthma during early childhood are symptomatic as adults. CONCLUSION: Increases in prevalence remain unexplained, but avoidance of recognized allergens should reduce the prevalence of allergic rhinitis and asthma.

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EXHIBIT GG

Impact of Changes in Transportation and Commuting Behaviors During the 1996 Summer Olympic Games in Atlanta on Air Quality and Childhood Asthma

Michael S. Friedman, MD; Kenneth E. Powell, MD, MPH; Lori Hutwagner, MS; LeRoy M. Graham, MD; W. Gerald Teague, MD

Context Vehicle exhaust is a major source of ozone and other air pollutants. Although high ground-level ozone pollution is associated with transient increases in asthma morbidity, the impact of citywide transportation changes on air quality and childhood asthma has not been studied. The alternative transportation strategy implemented during the 1996 Summer Olympic Games in Atlanta, Ga, provided such an opportunity.

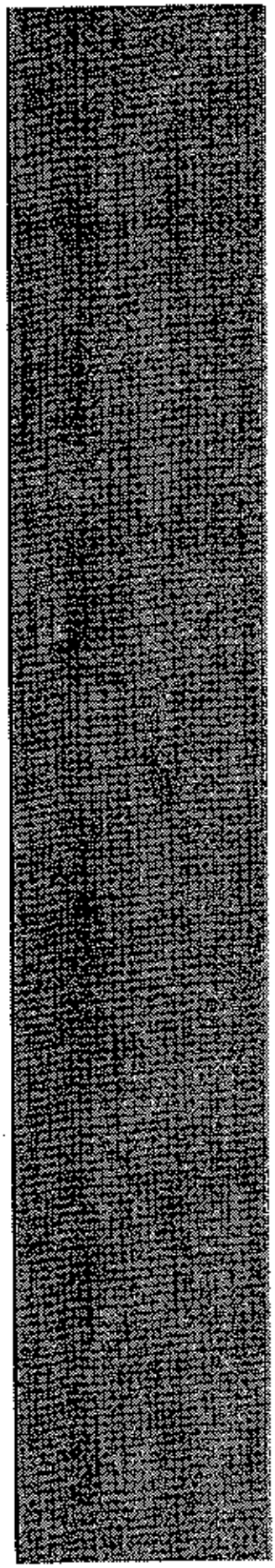
Objective To describe traffic changes in Atlanta, Ga, during the 1996 Summer Olympic Games and concomitant changes in air quality and childhood asthma events.

Design Ecological study comparing the 17 days of the Olympic Games (July 19–August 4, 1996) to a baseline period consisting of the 4 weeks before and 4 weeks after the Olympic Games.

Setting and Subjects Children aged 1 to 16 years who resided in the 5 central counties of metropolitan Atlanta and whose data were captured in 1 of 4 databases.

Main Outcome Measures Citywide acute care visits and hospitalizations for asthma (asthma events) and nonasthma events, concentrations of major air pollutants, meteorological variables, and traffic counts.

Results During the Olympic Games, the number of asthma acute care events decreased 41.6% (4.23 vs 2.47 daily events) in the Georgia Medicaid claims file, 44.1% (1.36 vs 0.76 daily events) in a health maintenance organization database, 11.1% (4.77 vs 4.24 daily events) in 2 pediatric emergency departments, and 19.1% (2.04 vs 1.65 daily hospitalizations) in the Georgia Hospital Discharge Database. The number of nonasthma acute care events in the 4 databases changed −3.1%, +1.3%, -2.1%, and +1.0%, respectively. In multivariate regression analysis, only the reduction in asthma events recorded in the Medicaid database was significant (relative risk, 0.48; 95% confidence interval, 0.44-0.86). Peak daily ozone concentrations decreased 27.9%, from 81.3 ppb during the baseline period to 58.6 ppb during the Olympic Games ($P<.001$). Peak weekday morning traffic counts dropped 22.5% ($P<.001$). Traffic counts were significantly correlated with that day's peak ozone concentration (average $r = 0.36$ for all 4 roads examined). Meteorological conditions during the Olympic Games did not differ substantially from the baseline period.



Conclusions Efforts to reduce downtown traffic congestion in Atlanta during the Olympic Games resulted in decreased traffic density, especially during the critical morning period. This was associated with a prolonged reduction in ozone pollution and significantly lower rates of childhood asthma events. These data provide support for efforts to reduce air pollution and improve health via reductions in motor vehicle traffic.

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Dr Powell participated in the study concept and design, acquisition of data, analysis and interpretation of data, drafting and critical revision of the manuscript, and provided supervision.

Ms Hutwagner participated in the analysis and interpretation of data, drafting and critical revision of the manuscript, and provided statistical expertise.

Dr Graham participated in the study concept and design, acquisition of data, critical revision of the manuscript, and provided administrative, technical, or material support.

Dr Teague participated in the study concept and design, acquisition of data, critical revision of the manuscript, and provided administrative, technical, or material support.

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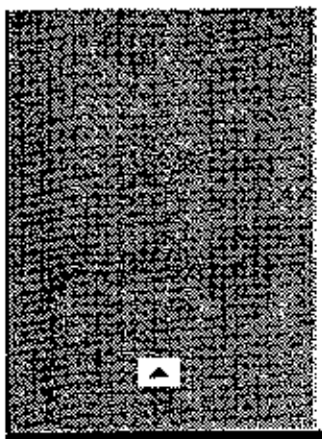

Georgia Department of Medical Assistance, Dale Shulman at the Georgia Department of Revenue, Chris Porter at Cambridge Systematics, the Georgia Department of Transportation, the Atlanta Allergy and Asthma Clinic, Metro Atlanta Rapid Transit Authority, and Darren Palmer at the US Environmental Protection Agency.

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Conclusions Efforts to reduce downtown traffic congestion in Atlanta during the Olympic Games resulted in decreased traffic density, especially during the critical morning period. This was associated with a prolonged reduction in ozone pollution and significantly lower rates of childhood asthma events. These data provide support for efforts to reduce air pollution and improve health via reductions in motor vehicle traffic.

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DESPITE ADVANCES IN ASTHMA therapy, asthma remains a substantial public health problem. In the United States, asthma is a leading cause of childhood morbidity, with an estimated prevalence of 6.9% in children and youth younger than 18 years.[1] Numerous studies have documented a rise in the morbidity, mortality, and prevalence of asthma in different populations.[2-8] The cause or causes of this trend remain controversial.[9-11]

Experimental, laboratory, and epidemiologic studies in the last several years have linked high concentrations of known air pollutants to respiratory health problems, most notably exacerbations of asthma.[12-25] However, opportunities to study the health effects of anthropogenic improvements in air quality are rare. One study found a decrease in particulate pollution and respiratory hospital admissions associated with the closure of an industrial factory in that community.[24] To our knowledge, no study has examined the impact of improved ozone pollution for an extended period of time on asthma exacerbations or other markers of asthma morbidity. Also, the extent to which moderate concentrations of ozone (ie, daily peak of 50-100 ppb) during various exposure lengths affects asthma morbidity remains controversial.[12-16]

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We used the EPA's standard method of measuring the 4 major primary pollutants.[35] Data on PM_{10} were collected at the 1 site capable of continuous 24-hour monitoring and expressed as the cumulative total for each 24-hour period. The mean 8-hour running daily peak carbon monoxide level, the 24-hour daily mean sulfur dioxide level, and the 1-hour daily peak nitrogen dioxide level were collected at 1, 2, and 3 monitoring sites, respectively. The daily levels obtained at the 2 sulfur and 3 nitrogen dioxide sites were then averaged. Allergen exposure was determined by total daytime mold counts (the predominant summertime allergen in Atlanta) collected weekdays during the study period at the Atlanta Allergy and Asthma Clinic.

Meteorological Data

We obtained hourly data for 5 weather-related variables (temperature, wind speed, relative humidity, barometric pressure, and solar radiation) from a state-run weather monitoring site located east of downtown Atlanta. These 5 variables have a direct or indirect impact on the rate of ozone formation and clearance in the lower atmosphere and, to a lesser extent, can affect levels of the primary pollutants.[12] For each day and for each variable, we calculated the mean of the 12 readings from 6 AM to 6 PM.

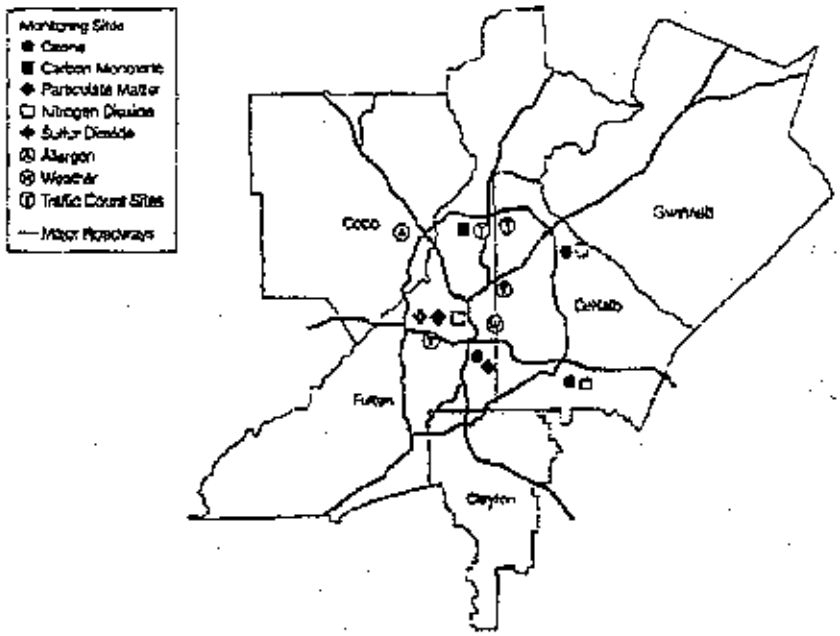
Traffic Counts

We obtained hourly traffic data collected by the Georgia Department of Transportation from the 4 functioning sites (2 highways and 2 local roads) located within Atlanta's perimeter interstate highway. Total 24-hour and 1-hour morning peak bidirectional traffic counts were available for analysis for 92% of the study weekdays and 85% of the study weekend days.

Public Transportation Data

We examined the total number of passenger trips per day on Atlanta's public buses and rail lines during the study period. The Metro Atlanta Rapid Transit Authority provided data for average weekday and weekend daily ridership totals for the pre- and post-Olympic Games periods. For the Olympic period, totals for each of the 17 days were available for analysis.[27]

Figure 1. Functioning Traffic Count and Air Quality Monitoring Sites in Atlanta, Ga, During the 1996 Summer Olympic Games



Borders indicate the 5 central counties of metropolitan Atlanta included in the study.

Statewide Gasoline Sales

We collected and compared total gallons of gasoline purchased in the state of Georgia in June, July, and August 1991-1997. The Georgia State Department of Revenue routinely calculates these gallon totals based on receipts of the state fuel tax. The month of purchase was determined by the month in which the fuel distributors delivered the gasoline to individual filling stations.

Statistical Analysis

We analyzed all collected data to determine the percentage change in mean values during the Olympic period compared with the 1996 summertime baseline period. One-way analysis of variance *t* testing was used to determine if the daily air pollutant, meteorological, and traffic count values differed significantly between the 2 study periods. Significance was defined as $P \leq .05$.

Further analysis of the asthma event data was performed using a time-series Poisson regression model. Univariate and adjusted relative risk (RR) (with 95% confidence intervals [CIs]) of asthma acute care events during the Olympic period compared with the baseline period was calculated for each of the 4 sources of data. The univariate analysis was based on the fraction of total acute care events with a primary diagnosis of asthma. The multivariate time-series Poisson model was fitted using generalized estimating equations to address possible serial (auto) correlation in the number of asthma events.[36] Models were implemented using the GENMOD procedure in SAS with AR(1) (SAS Institute Inc, Cary, NC) to account for correlation in asthma events on a given day with the previous day's events. The Durbin-Watson statistic was 1.96-2.01, which indicates minimal residual serial correlation. This model was adjusted for day of the week (weekday vs weekend) and minimum temperature (lagged 1 day to improve the fit of the model). Total mold counts were only

trol for minimum temperature and day of the week did not alter these findings. The data from Atlanta's Medicaid database remained statistically significant (adjusted RR, 0.48; 95% CI, 0.44-0.86).

FIGURE 2 shows the daily time series of each of the 5 measured pollutants and mold counts during the Olympic and baseline periods. The 1-hour peak ozone concentration in Atlanta decreased 27.9% from an average daily peak of 81.3 ppb during the baseline period to 58.6 ppb during the Olympic Games ($P<.001$). The daily ozone concentrations at the 3 monitoring sites in Atlanta were highly correlated ($r=0.91$-0.97). Combined ozone data for the 1997 and 1998 summer seasons did not show a similar decrease—the average peak ozone concentration was 77.2 ppb during July 19–August 4 and 78.8 ppb during the remainder of the study dates.

Ozone concentrations at Georgia sites outside of Atlanta decreased 11.1% in Augusta (58.8 ppb vs 66.2 ppb; $P=.11$), 17.5% in Fannin County (50.5 ppb vs 61.2 ppb; $P=.003$), and 18.3% in Columbus (52.2 ppb vs 64.1 ppb; $P=.01$) during the Olympic Games. These ozone reductions were, respectively, 60%, 37%, and 34% less than the ozone reductions experienced in Atlanta during the same period with similar weather conditions. After controlling for the 4 weather variables, serial correlation, and day of the week in a time-series regression model, the reduction in Atlanta's ozone concentrations during the Olympic Games was 13% ($P=.06$). Comparatively, the reduction in ozone was calculated at 2% in Augusta ($P=.71$), 7% in Fannin County ($P=.12$), and 6% in Columbus ($P=.30$).

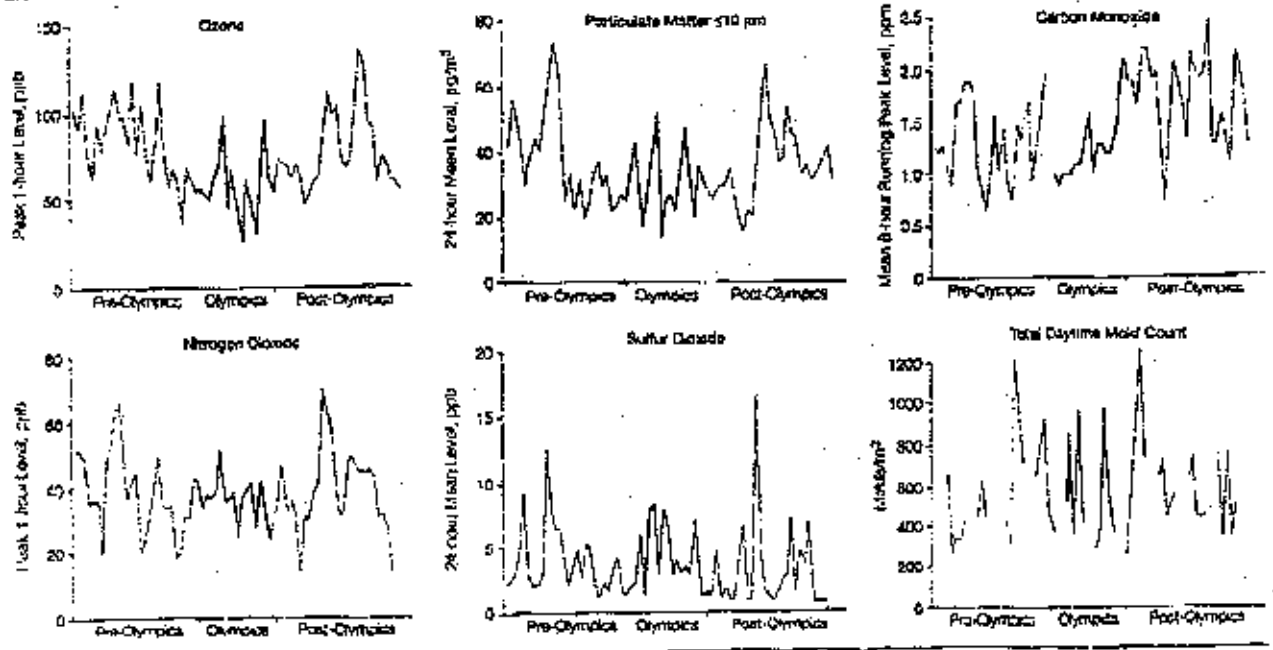
During the Olympic period, Atlanta additionally experienced significant reductions in daily carbon monoxide levels (1.26 vs 1.54 ppm, 18.5% decrease; $P=.02$) and PM_{10} concentrations (30.8 vs 36.7 μg/m³, 16.1% decrease; $P=.01$). Nitrogen dioxide levels decreased 6.8% (36.5 vs 39.2 ppb; $P=.49$), whereas sulfur dioxide levels increased 22.1% (4.29 vs. 3.52 ppb; $P=.65$). FIGURE 3 summarizes these findings relative to the EPA National Ambient Air Quality Standards for each of these pollutants.[35] Data for the baseline period are divided into pre- and post-Olympic time periods

Table 2. Univariate and Adjusted Relative Risk of Acute Asthma Events During the 1996 Summer Olympic Games Compared With the 1996 Summertime Baseline Period*

Data Source	Univariate RR† (95% CI)	*P* Value	Adjusted RR‡ (95% Confidence Interval)	*P* Value
Georgia Medicaid claims file	0.61 (0.44-0.85)	.003	0.48 (0.44-0.86)	.005
Health maintenance organization	0.56 (0.31-1.02)	.06	0.58 (0.32-1.06)	.10
Pediatric emergency departments	0.91 (0.65-1.42)	.48	0.93 (0.71-1.22)	.69
Georgia Hospital Discharge Database	0.81 (0.54-1.23)	.34	0.71 (0.46-1.11)	.22

*RR indicates relative risk; CI, confidence interval. For definition of baseline period, see "Study Design" subsection of "Methods" section.
†Relative risk based on Poisson model (fraction of total acute care events with a primary diagnosis of asthma).
‡Time-series regression analysis was adjusted for day of week (weekday vs weekend) and minimum daily temperature (lagged 1 day to minimize serial correlation).

Figure 2. Daily Time Series of Individual Air Pollutant Levels and Mold Counts During the 1996 Summer Olympic Games and Baseline Period



Broken line indicates incomplete data (eg, mold counts were available weekdays only).

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tween days with high ozone levels and increased rates of asthma exacerbations.[12-15,20-23] Our results support these previous findings and also indicate that extended reductions in ozone and PM_{10} concentrations at levels considerably below the EPA's National Ambient Air Quality Standards can reduce asthma morbidity in children. Furthermore, our findings suggest that by decreasing automobile emissions through citywide changes in transportation and commuting practices, a substantial number of asthma exacerbations requiring medical attention can be prevented.

We found variation in the relative change in asthma acute care events during the Olympic Games among the 4 sources of medical data. All showed a decrease in asthma events, ranging from 11% to 44%. Only the data from the Georgia Medicaid claims file reached statistical significance, which may be related to the low power of this short-term intervention. Based on a power of 80% and the number of events in each database, the percent reduction in asthma events needed to detect a significant difference between the baseline and Olympic periods was 37% for the Georgia Medicaid claims file, 58% for the health maintenance organization database, 33% for the pediatric emergency room database, and 51% for the Georgia Hospital Discharge database (without adjustment for serial correlation). Other possible explanations include differences between the study population in the 4 data sources in asthma severity, medication use,[38] exposure to other allergens, particularly those that could synergistically worsen the untoward effects of ozone and other air pollutants,[39,40] extent of indoor ozone exposure,[41] and of outdoor exposure.

The observed reductions in asthma events require us to address the following potentially confounding situation: did enough Atlanta children leave the city during the Olympics to significantly reduce the number of children with asthma who would seek medical attention for an acute asthma exacerbation? If true, this could account, in whole or in part, for the reduction in asthma events observed. However, for all 4 data sources, use of nonasthma-related urgent and emergency medical services by Atlanta children changed minimally. This suggests that neither the size of the study population nor use of emergency medical services by this population changed significantly during the Olympic games.

Of the factors potentially affecting asthma morbidity that we could readily assess, air quality remains the likely cause for the decline in asthma acute care events. Our analysis demonstrated a large and significant decrease in ozone concentrations, and to a lesser extent, PM_{10}, and carbon monoxide concentrations. Of all the pollutants, Atlanta's ozone concentrations in the summer most frequently violate the National Ambient Air Quality Standards.[42] These standards attempt to set a maximum pollution level, which, if exceeded, may be hazardous to the general public's health. The standards are based, in part, on the available information regarding the health effects of the 5 major air pollutants. However, pollution levels below these standards may be harmful to certain, high-risk populations (such as individuals with asthma and the elderly). Therefore, the 28% drop in ozone concentrations during the Olympic Games represented a substantial decrease in a potential health hazard.

Our study design and findings make it difficult to determine to what degree the observed reductions in ozone, PM_{10}, carbon monoxide, and nitrogen dioxide pollution individually contributed to the observed changes in health. As controlled studies of human exposure to multiple pollutants have demonstrated,[12,13,43] the effects of reduced levels of ozone and these primary pollutants likely were additive. This is supported by the finding that both ozone and PM_{10} levels were similarly correlated with asthma events. The fact that ozone and PM_{10} levels were highly correlated with each other (r=0.58-0.69) additionally limits our ability to determine which pollutant(s) accounted for the reduction in asthma events. This correlation between ozone and PM_{10} levels should have been expected, given that the environmental changes occurring during the study period (ie, decreased automobile emissions and

Table 4. Comparison of the Relative Risk of Asthma Events per 50-ppb Incremental Change in Ozone and 10-μg/m³ Incremental Change in PM_{10} Levels Based on a Same-Day, 2-Day, and 3-Day Cumulative Exposure Measure*

	Relative Risk (95% Confidence Interval)					
	Ozone			PM_{10}		
Data Source	Same Day	2 Day	3 Day	Same Day	2 Day	3 Day
Georgia Medicaid claims file	1.1 (0.83-1.47)	1.4 (1.05-1.93)†	1.4 (1.01-1.94)†	0.9 (0.57-1.49)	1.1 (0.62-1.78)	1.4 (0.80-2.48)
Health maintenance organization	1.4 (0.88-2.14)	1.2 (0.68-1.96)	1.2 (0.69-2.11)	2.1 (0.92-4.61)	1.8 (0.72-4.40)	1.8 (0.68-4.81)
Pediatric emergency department	1.2 (0.99-1.56)	1.4 (1.04-1.79)†	1.4 (1.03-1.86)†	1.2 (0.81-1.69)	1.3 (0.81-2.06)	1.5 (0.91-2.47)
Georgia Hospital Discharge Database	0.9 (0.64-1.34)	1.0 (0.62-1.51)	1.0 (0.61-1.58)	0.7 (0.34-1.45)	0.6 (0.29-1.45)	0.8 (0.33-1.83)

*PM_{10} indicates particulate matter of 10 μm or smaller; same day, single-day measure of exposure (day of asthma event only); 2 day, 2-day measure of exposure (day of asthma event plus the preceding day); and 3 day, 3-day measure of exposure (day of asthma event plus the preceding 2 days). Relative risk based on Poisson time-series regression analysis was adjusted for day of the week (weekday vs weekend) and minimum daily temperature (lagged 1 day to minimize serial correlation).
†P<.05.

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with a significant, albeit temporary, decrease in the burden of asthma among Atlanta's children.

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Author Contributions: Dr Friedman was the study coordinator and principal investigator, and participated in the study concept and design, acquisition of data, analysis and interpretation of data, drafting and critical revision of the manuscript, and provided administrative, technical, or material support.

Dr Powell participated in the study concept and design, acquisition of data, analysis and interpretation of data, drafting and critical revision of the manuscript, and provided supervision.

Ms Hutwagner participated in the analysis and interpretation of data, drafting and critical revision of the manuscript, and provided statistical expertise.

Dr Graham participated in the study concept and design, acquisition of data, critical revision of the manuscript, and provided administrative, technical, or material support.

Dr Teague participated in the study concept and design, acquisition of data, critical revision of the manuscript, and provided administrative, technical, or material support.

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EXHIBIT HH

Cancer Risk from Diesel Particulate:

National and Metropolitan Area Estimates for the United States

Prepared by the

State and Territorial Air Pollution Program Administrators

and the

Association of Local Air Pollution Control Officials

March 15, 2000

Cancer Risk from Diesel Particulate: National and Metropolitan Area Estimates for the United States

Prepared by the State and Territorial Air Pollution Program Administrators and the Association of Local Air Pollution Control Officials

March 15, 2000

Executive Summary

Diesel engines are significant contributors to air pollution. Moreover, the adverse health impacts of diesel pollution are dire, posing a serious threat to public health nationwide, and especially in urban areas. The hazardous mixture that comprises diesel exhaust contains hundreds of different chemical compounds that wreck havoc on our air quality in a variety of ways, playing a role in ozone formation, particulate matter, regional haze, acid rain and global warming. But perhaps the greatest threat posed by diesels comes from their toxic emissions. Diesel exhaust contains over 40 chemicals that are listed by EPA and California as toxic air contaminants, known human carcinogens, probable human carcinogens, reproductive toxicants or endocrine disrupters. In 1998, California declared particulate emissions from diesel-fueled engines a toxic air contaminant, based on data that supported links between diesel exposure and cancer. Dozens of other studies, including EPA's own draft health assessment document for diesel emissions, have also demonstrated a link between diesel exhaust and cancer.

Last fall, the South Coast Air Quality Management District (SCAQMD) in Los Angeles, California released a draft final report, the *Multiple Air Toxics Exposure Study in the South Coast Air Basin* (MATES-II), which included an analysis of the cancer risk in the region from exposure to diesel particulate. Based on this analysis – which estimated diesel particulate levels by using elemental carbon as a surrogate and applied a cancer potency factor determined by the state of California – SCAQMD concluded not only that mobile sources were responsible for approximately 90 percent of the cancer risk in the area, but that 70 percent of the total cancer risk was attributable to diesel particulate.

Alarmed by these findings, the State and Territorial Air Pollution Program Administrators (STAPPA) and the Association of Local Air Pollution Control Officials (ALAPCO) sought to extend the evaluation of cancer risk from diesel particulate to other cities across the country and to estimate how many cancers nationwide are the result of exposure to diesel particulate. STAPPA and ALAPCO's findings are no less frightening: the filthy soot spewed by diesel engines is responsible for a shocking 125,000 cancers in the United States. This is not only cause for tremendous concern, but reason for swift and certain federal action.

The U.S. Environmental Protection Agency (EPA) is currently preparing a proposal, for release this spring, for more stringent emission standards for onroad heavy-duty diesel vehicles and substantial cuts in levels of sulfur in diesel fuel used in onroad

applications. In addition, the agency is contemplating its course of action for emission and fuel quality standards for nonroad heavy-duty diesel engines, such as construction and agricultural equipment. The magnitude of the cancer threat from diesel particulate seals the overwhelmingly compelling case for aggressive and timely action by EPA for onroad and nonroad diesel engines and their fuels. To this end, STAPPA and ALAPCO strongly urge that EPA:

- Set more stringent nitrogen oxide (NO_x) and particulate matter (PM) emission standards for onroad heavy-duty engines – NO_x standards no less stringent than 0.2 grams per brake-horsepower hour (g/bhp-hr) and PM standards no less stringent than 0.01 g/bhp-hr, based on the most advanced technologies possible. Both of these standards should apply to 100 percent of the fleet in the 2007 model year;

- Set more stringent emission standards for nonroad heavy-duty diesel engines, equivalent to those for onroad heavy-duty diesels and in the same timeframe;

- Sharply reduce sulfur in diesel fuel used in onroad and nonroad diesel engines to ultra-low levels, to take effect in mid-2006, with an interim nationwide sulfur cap of no higher than 30 ppm, to take effect by 2004; and

- Ensure that all heavy-duty diesel engines – onroad and nonroad – operate as cleanly in-use as they are supposed to.

The fact is that tens of thousands of cancers, not to mention a host of other public health and environmental hazards, can be avoided if EPA implements these recommendations. Because states and localities have limited authority under the Clean Air Act to tackle this perilous source of air pollution, it is entirely up to EPA to exercise federal leadership to address this critical national issue.

About STAPPA and ALAPCO

STAPPA and ALAPCO are the national associations of state and local air quality control officers in the states and territories and over 165 metropolitan areas across the country. The members of STAPPA and ALAPCO have primary responsibility for implementing our nation's air pollution control laws and regulations. Both associations serve to encourage the interchange of information and experience among air pollution control officials; enhance communication and cooperation among federal, state and local regulatory agencies; and promote air pollution control activities. STAPPA and ALAPCO have joint headquarters in Washington, DC.

For further information, contact STAPPA and ALAPCO at 444 North Capitol Street, NW, Suite 307, Washington, DC 20001; telephone: (202) 624-7864; e-mail: 4clnair@sso.org; or website: www.4cleanair.org.

Cancer Risk from Diesel Particulate

National Totals

	Estimated Cancers
Metropolitan Areas	119,570
Non-metropolitan Areas	5,540
United States Total	**125,110**

Cancer Risk from Diesel Particulate: Estimates for 50 Largest Metropolitan Areas

Metropolitan Area	Cancers
Atlanta	1,930
Austin	570
Boston	2,900
Buffalo	595
Charlotte	710
Chicago	4,535
Cincinnati	1,005
Cleveland	1,500
Columbus	755
Dallas/Fort Worth	2,470
Denver	1,220
Detroit	2,810
Grand Rapids	535
Greensboro/Winston-Salem	600
Hartford	590
Houston	2,270
Indianapolis	780
Jacksonville, FL	540
Kansas City	895
Las Vegas	680
Los Angeles	16,250
Louisville	515
Memphis	565
Miami/Fort Lauderdale	1,880
Milwaukee	845
Minneapolis	1,460
Nashville	595
New Orleans	675
New York	10,360
Norfolk	795
Oklahoma City	535
Orlando	775
Philadelphia	3,085
Phoenix	1,510
Pittsburgh	1,210
Portland, OR	1,105
Providence	580
Raleigh	555
Richmond	495
Rochester	555
Sacramento	870
Salt Lake City	655
San Antonio	790
San Diego	1,430
San Francisco	3,510
Seattle	1,765
St. Louis	1,320
Tampa	1,160
Washington/Baltimore	3,750
West Palm Beach	530

Methodology for Estimating Cancer Risk from Diesel Particulate[1]

Estimating Diesel Particulate Concentrations

There is no method for measuring diesel particulate directly. However, diesel particulate concentrations can be estimated using concentrations of elemental carbon, as per research conducted by H.A. Gray[2] and used by the California Air Resources Board.[3] Therefore, elemental carbon can serve as a surrogate for diesel particulate. According to the research mentioned above, approximately 67 percent of the final elemental carbon mass in the atmosphere in Los Angeles came from diesel engine emissions. Of all diesel exhaust particles emitted, elemental carbon averaged approximately 64 percent of the total. Therefore, elemental carbon concentrations are multiplied by 1.04 (1.04 is derived from dividing 67 percent by 64 percent) to arrive at the diesel particulate concentrations.

Estimating Cancer Risk

The California Environmental Protection Agency (CalEPA) recommends using a cancer risk level for diesel particulate of 300 in a million per microgram per cubic meter (ug/m^3) of diesel particulate (3.0×10^{-4} per ug/m^3). This represents the risk of developing cancer over a 70-year lifetime. In deriving this figure, CalEPA considered evidence suggesting that diesel risks are from 150 in a million to 1,500 in a million per ug/m^3. The choice of 300 in a million per ug/m^3 represents a conservative estimate.

To arrive at cancer risk estimates using information about concentrations of elemental carbon, the following formula is used:

Elemental carbon concentration x 1.04 = diesel particulate concentration.

Diesel particulate concentration x 3.0×10^{-4} (or 3/10000) per ug/m^3 = cancer risk estimate.

Development of National and Metropolitan Area Estimates

To develop cancer estimates for the entire country, it is necessary to estimate levels of elemental carbon. The average level of elemental carbon in the Los Angeles, CA area is 3.3 ug/m^3. Based on monitoring data for levels of elemental carbon in several areas around the country, it was assumed that the levels of elemental carbon in metropolitan areas in the United States are one-half of the Los Angeles area average (1.65 ug/m^3) and levels in non-metropolitan areas are one-tenth of the Los Angeles average (.33 ug/m^3).

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[1] Based upon methodology used in the South Coast Air Quality Management District's Multiple Air Toxics Exposure Study (MATES-II) Draft Report, November 5, 1999.

[2] Gray, H.A. 1986. Control of Atmospheric Fine Primary Carbon Particle Concentrations. EQL Report No. 23, Environmental Quality Laboratory, California Institute of Technology, Pasadena, CA.

[3] ARB. 1998 Proposed Identification of Diesel Exhaust as a Toxic Air Contaminant. Part A, Exposure Assessment. California Environmental Protection Agency, Air Resources Board.

The population of the United States[4] is divided into residents of metropolitan areas[5] (80 percent of the population) and residents of non-metropolitan areas (20 percent). The metropolitan population total (~216.5 million) was multiplied by the appropriate formula (1.65 ug/m^3 x 1.04 x $3x10^{-4}$ per ug/m^3) and then the result was adjusted upward to account for the higher levels of diesel particulate in the Los Angeles CMSA. These calculations resulted in the estimated cancer risks for metropolitan-area residents. The non-metropolitan population total (~53.8 million) was multiplied by the appropriate formula (.33 ug/m^3 x 1.04 x $3x10^{-4}$ per ug/m^3) to arrive at the estimated cancer risks for non-metropolitan-area residents.

To estimate the cancer risk for each of the individual metropolitan areas, the population of each location was multiplied by the formula for metropolitan areas (1.65 ug/m^3 x 1.04 x $3x10^{-4}$ per ug/m^3).

[4] Population figures throughout this study are based on U.S. Census Bureau estimates.

[5] "Metropolitan Areas" include Consolidated Metropolitan Statistical Areas and Metropolitan Statistical Areas.

February 28, 2000

The Honorable Carol M. Browner
Administrator
U.S. Environmental Protection Agency

Dear Administrator Browner:

We would like to thank you once again for your courageous leadership to improve air quality and promote better health for all Americans. We particularly appreciate your ongoing efforts to reduce pollution from mobile sources. Your historic Tier 2/gasoline sulfur standards will bring health benefits for generations to come. And we are confident your strategy to clean up big diesel trucks and diesel fuel will yield additional vital public health improvements.

We want to bring to your attention another important public health issue related to mobile source air pollution – the need for additional reductions in toxic air pollutants.

As you are aware, EPA is under court order to promulgate a final rule by the end of this year under Section 202 (l) of the Clean Air Act. An agency proposal is expected sometime this spring. The law directs EPA to determine the risk to public health posed by benzene, formaldehyde and other pollutants, and to set technology-based vehicle and/or fuel standards.

A recent workshop sponsored by the Health Effects Institute pointed out the need for decisive EPA action. At that meeting, state and local government representatives noted that: 1) EPA's Cumulative Exposure Project (CEP) indicated dangerously high levels of air toxics throughout much of the nation; 2) Recent monitoring not only has confirmed the basic validity of the CEP modeling but also has found actual levels of air toxics are even higher than modeled levels in some instances; 3) Mobile sources comprise a very large percentage of the air toxics inventory; 4) State and local governments have limited regulatory authority to deal with this problem. This underscores the need for federal leadership; 5) Although EPA's reformulated gasoline (RFG), Tier 2 and other programs will lead to continuing reductions in air toxics, there is evidence that EPA's forecasted improvements in ambient air toxics levels may be overstated; and 6) Many large sources of air toxics, such as non-road diesel equipment, remain largely unregulated.

Of particular concern to us are the shortcomings in EPA's risk assessment that likely underestimate the true public health risk associated with mobile source emissions. For example, EPA's risk assessment does not account for emissions from the non-road sector, and limits its analysis to emissions from on-highway vehicles. Second, the risk assessment does not account for disproportionate risks for people with above average

EXHIBIT II

Testimony before the U.S. EPA's Science Advisory Board's
Clean Air Scientific Advisory Committee Diesel Review Panel
concerning the draft Health Assessment Document for Diesel Exhaust
October 12-13, 2000
on behalf of

[groups listed here]

Thank you for the opportunity to share the comments today concerning the U.S. EPA's draft Health Assessment Document for Diesel Exhaust. My name is Jayne Mardock and I am the National Director of the Clean Air Network. The Network is an alliance of environmental, health and citizen groups across the country that are working to make the air cleaner and safer to breathe. I am here today to represent the views of ____ national and state organizations that could not be here today to testify.

Dirty diesel exhaust is arguably one the most recognizable air pollution problems in the minds of the public. In fact, nine out of ten registered voters believe that diesel trucks should be required to use the best available pollution control equipment.[1] Over the past thirty years, nitrogen oxide (NOx) emissions from cars decreased 42% and coarse particulate matter (PM10) decreased 302%. Over the same period, on-road diesel NOx and PM10 emissions increased 37% and 11% respectively. Non-road diesel emissions grew even more, with a 61% increase in NOx and 49% increase in PM10.[2] Obviously, more can and should be done to clean up diesel sources, both on-road and non-road, and this deliberation on the Health Assessment for Diesel Exhaust will be a step in the right direction to further regulate toxic diesel exhaust.

I would like to offer several points for your consideration today:

*** We call on the Clean Air Scientific Advisory Committee to reach closure on draft Diesel Health Assessment at this meeting.**

The July 2000 draft follows three earlier drafts published in 1994, 1998 and 1999. Analysis of the health impacts of diesel began years before then. It is clear that diesel is harmful to human health, and the debate over the years to determine exactly how harmful it is has delayed significant actions to clean up diesel.

The State of California's Air Resources Board has listed diesel exhaust as a toxic air contaminant. In addition, the World Health Organization, the National Institute of Occupational Safety and Health and the International Agency for Research on Cancer have all determined that diesel exhaust is a known or probable human carcinogen.[3] The science is clear, finding a link between diesel exhaust and cancer, cardiovascular and pulmonary disease, and premature death.

*** While we are disappointed that the draft has been weakened, we still support closure so that EPA can begin regulating diesel exhaust in a meaningful way.**

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[1] Poll conducted for the Clean Air Trust in June 1999 by Lake, Snell, Perry and Associates.
[2] U.S. EPA Office of Air Quality Planning and Research, *National Air Pollutant Trends, 1970-1998*, March 2000, Appendix A.
[3] Natural Resources Defense Council, *Exhausted by Diesel: How America's Dependence on Diesel Threatens Our Health*, Second Printing, May 1998, p. v.

We share the views of the American Lung Association, and oppose changes in this draft that downgrade the toxicity of diesel exhaust from highly likely human carcinogen to likely carcinogen and fail to quantify the cancer risk relative to other pollutants. However, we believe that the CASAC must close the book on diesel exhaust in order to move forward.

Millions of Americans are exposed to high levels of diesel exhaust every day. The California Air Resources Board estimates that between 7000 to 143,000 Californians will develop cancer in their lifetimes simply from breathing diesel soot at levels found all across the state.[4] Even at the low end of the range, this is unacceptable. Occupational health studies of railroad, dock, trucking, and bus garage workers exposed to high levels of diesel exhaust over many years have consistently demonstrated a 20-50% increase in the risk of lung cancer or mortality.[5] In addition, children, the elderly, and people with heart and lung diseases are more vulnerable to diesel exhaust. Given the number of people at risk and the magnitude of the health impacts, it is time to come to closure.

*** Once the CASAC signs off on the draft, we call on EPA to finalize the Diesel Health Assessment as quickly as possible so it can begin to address toxic diesel problems.**

EPA staff should be commended for persevering to add diesel exhaust to the list of toxins in our air. Given the serious health effects of diesel, it is crucial that we close the book on this debate and get down the to business of cleaning up toxic emissions of diesel on-road and non-road engines. The lack of closure on the Diesel Health Assessment has been used as an impediment for swift and sure action in the Mobile Source Air Toxics and the Urban Air Toxics Strategy. As EPA continues to develop these programs over the years, the final determination of diesel exhaust's toxicity will make it possible to pursue more aggressive programs to make the air cleaner and safer to breathe.

In conclusion, we call on the Clean Air Scientific Advisory Committee to close the debate on the relative threat of diesel exhaust. Dirty diesels pose a danger to the health of millions of Americans. It is time to turn our attention to addressing this problem, and closure on the Diesel Health Assessment is a necessary first step in meaningful reductions of toxic exposure from diesel exhaust.

On behalf of the following groups, I thank you for this opportunity to raise this important issue.

(listed alphabetically by state)

Name
Organization
City, State

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[4] Chris Bowman, "Air Board Blames Diesel Soot for High Risk of Lung Cancer," Sacramento Bee, May 10, 1997. NEED TO FIND ORIGINAL CARB DOCUMENT TO CITE.

[5] Health Effects Institute, "A Critical Analysis of Emissions, Exposure and Health Effects," Cambridge, MA, April 1995.

EXHIBIT JJ

SIERRA CLUB
FOUNDED 1892
MIDWEST OFFICE

March 1, 2001

TO: Public Health, Sprawl, Transportation, and Environmental Justice Activists

FR: Brett Hulsey, Sierra Club Senior Midwest Representative

RE: Possible Human Health, Sprawl, and Clean Air campaigns related to new highways and how they cause cancer, asthma, and other serious health problems for people living near them.

Attached is a factsheet and some studies on the dangerous health effects of living near highways for your information. A new Denver study shows that children living near busy roads and highways are at much greater risk from cancer, asthma and other air pollutants.

This has important implications for people living near roads and highways, especially those of low income that often live near highways. It follows up the work we did on the Clean Air Act, "Cancer, Chemicals, and You" report, and many Clean Air enforcement actions.

Our goal is to provide clean air and water for every American, and to do that we need to clean up cars and trucks, give people more transportation choices like trains and clean buses, and design our communities smarter to reduce air pollution and traffic.

A recent Atlanta study shows that new highways are the number one cause of sprawl. EPA says that cars, trucks, and buses are the number one source of hazardous and greenhouse air pollution.

The Sierra Club has used this new information to increase travel choices and stop new highways. You may find it useful in your local efforts.

Please give me a call if you have any comments or questions at 608-257-4994.

Thank you.

File: sprawl/airpoll memo

SIERRA CLUB

Air Pollution and Sprawl

A major threat to our health and our families

Dirty Air is one of top concerns to our families. Air pollution causes 60,000 premature deaths each year, according to a 1995 Harvard study, killing more than murders and car deaths combined. Asthma is the number one reason kids miss school, according to the American Lung Association.

Although the air in many cities is getting cleaner, new studies show that air pollution from roads and highways create a corridor of cancer, asthma, and other health problems.

The Sierra Club promotes clean air and responsible growth to make our communities cleaner, our streets safer, and our neighborhoods nicer places to live. We want to protect our environment, for our families and for our future. For our communities sake, we must regulate air polluters and rein in sprawl.

Recent studies show that sprawl hurts us all with more traffic, air pollution, and road building . There are simple things we can do to clean the air-- make our trucks, buses, cars, and construction equipment run cleaner, give people more travel choices, and slow highway building.

Recent studies show that 60% of cancer cases are caused by environmental sources, such as smoking and pollution. A study by state and local air pollution professionals showed that diesel engine pollution caused 125,000 cases of cancer.

According to the EPA, trucks, buses and cars are the largest cancer pollution source, responsible for about 10 pounds of cancer-causing and hazardous air pollution per person per year. In the Los Angeles basin, diesel pollution accounts for almost three-fourths or 71% of cancer risk, according to the local air management district.

Sprawl and traffic create more air pollution because as development spreads out, forcing you to drive more and further. Most Americans are driving three times more than in 1965 because of sprawl. A California study showed that in-car air is the most polluted. Most cities's air is 200-900 times too polluted for safe levels, according to the EPA. In short, more cars and sprawl will cause more air pollution and, in turn, cause more people to get sick and die.

Highways and roads create a cancer corridor for children. A new study from the Denver metro area shows that children living near streets or highways with just 20,000 vehicles per day are six times more likely to develop childhood leukemia.

A 1997 study in the Journal of Epidemiology and Community Health showed a cancer corridor within 3 miles of highways, airports and other major polluters.

The U.S. Department of Transportation wants to spend $200 billion more on new highways without considering this risk. There is no guarantee that the DOT proposal will reduce traffic gridlock, but it is guaranteed to increase air pollution. Bigger highways will put more polluting trucks on our streets, increase sprawl, and threaten more people with air pollution.

We should move forward with commuter and high speed train systems. Transportation studies show that trains are the most cost-effective way to reduce

air pollution, congestion and offer people more choice. Auto companies should also make cleaner, more efficient trucks and cars to reduce air pollution, especially the huge sport utility vehicles and diesel trucks.

Vehicle pollution is also the number one cause of greenhouse air pollution. Cleaner cars and trucks will reduce cancer pollutants and also limit global warming causing pollutants.

Equally troubling is that air pollution costs us all with higher medical and insurance bills. A National Institute for Medicine study credited pollution as a significant contributor to the $1 trillion in medical bills each year. A study in The Lancet found that air pollution caused one of every sixteen deaths in three European countries.

Better transportation planning and air pollution regulation has to start at the state level. Thanks to a Sierra Club clean air lawsuit, Georgia recently enacted a smart growth bill to reduce sprawl and air pollution.

Responsible growth encourages more efficient development in existing communities and leads to less traffic, greater travel choices, and less air pollution. One Oregon study showed that Smart Growth policies that give people more travel choices can cut car trips by 20-40%.

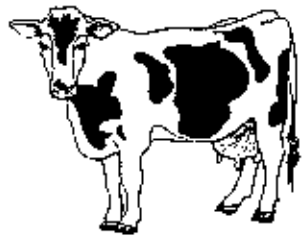
A Sierra Club study shows that efficient development strategies can reduce cancer-causing auto pollution by more than 70%. These strategies include better neighborhood planning, more efficient land use, substantive protection for parks and farmland, and providing commuters with alternative travel choices, i.e. commuter trains.

When we slow sprawl, we also clean up the air. Clean air falls just behind clean water and crime as the third most important factor people consider when deciding where to live, according to Money Magazine.

Running from cities will not escape pollution. A California study found that commuters in their own cars breathed the most polluted air, having sucked in pollution from other vehicles..

"What we each do is of ultimate importance," says farmer Wendell Berry. To make our air cleaner, our streets safer, our neighborhoods nicer, and promote responsible growth, you can:

1. Live near where you work to cut air pollution, gridlock, and sprawl. Look for a home in an existing neighborhood. Carpool, drive a clean car, bike, walk, take the train or clean bus whenever possible.



2. Support Responsible Growth Initiatives to buy and protect open spaces, focus government resources where most people live, provide more travel choices, and promote better land use planning.

3. Support EPA's efforts to enforce clean air laws and limit car and truck pollution by increasing efficiency standards and making clean diesels available nationwide, putting cleaner trucks and buses on the road by 2007, and supporting clean, high tech vehicles.

4. Ask the federal and state DOTs to install cancer pollution monitors at schools and neighborhoods near roads, and restrict new development within three miles of major polluted roadways.

5. Ask federal and state DOTs to direct at least half of highway dollars to existing communities to improve road safety, promote cleaner transportation choices such as trains, and provide property tax relief.

For more information, check the website www.sierraclub.org/sprawl or call 608-257-4994.

Sources: EPA, Journal of Air and Waste Management, American Lung Association, JAMA, Southern Cal. Air Quality Management District, NRDC, STAPPA, The Lancet, CA Air Resources Board.

File:highways/airpollfct 1/01

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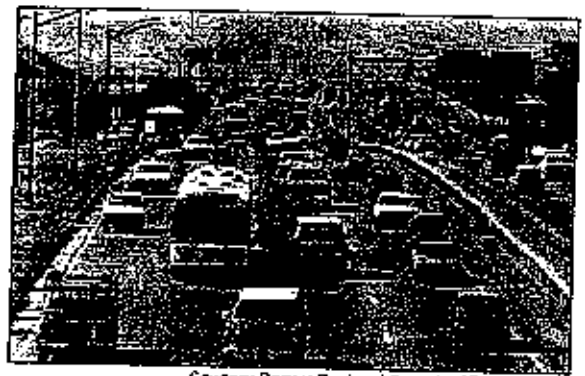
Mean streets: heavy traffic, leukemia linked

Saturday, March 4, 2000
By Lucy Chubb

Children who live near heavily traveled roads and highways are at greater risk of developing cancer, including leukemia, according to a study conducted in Denver, Colorado.

"What we are seeing is that children who live near high-traffic streets have an increased risk for childhood cancer," said co-author Robert Pearson, an adjunct professor of urban planning at the University of Colorado. He also works for Radian International, a Denver-based engineering firm.



Courtesy Denver Regional Council of Governments

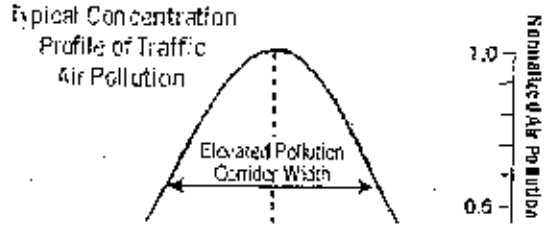
Heavily traveled roads are linked to a higher incidence of cancer in children, according to a new study in Denver, Colorado.

The researchers conclude that children living near transportation corridors carrying 20,000 or more vehicles per day are about six times as likely to contract cancer, including leukemia. The children are exposed to emissions through breathing and exposure to soil containing emissions.

The report is a corollary to a study in 1988 that attempted to link cancer in Denver children to high-capacity power lines.

The researchers involved in the 1988 study discovered an unexpected paradox that prevented them from making a clear connection between power lines and cancer. They took two different measurements of magnetic fields: a direct measurement using magnetometers and an indirect measurement using an apparatus known as a wire code.

They anticipated that both measurements would indicate a similar increased risk of cancer. The indirect confirmed their expectations but the direct method did not..



This inconsistency, dubbed the "wire code paradox," led Pearson and his team to look for other cancer causes in children. "We started looking for something else that might explain the data," he said.

Let us know what you th
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TECHNICAL PAPER

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Distance-Weighted Traffic Density in Proximity to a Home Is a Risk Factor for Leukemia and Other Childhood Cancers

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ABSTRACT

Occupational exposure to elevated concentrations of benzene is a known cause of leukemia in adults. Concentrations of benzene from motor vehicle exhaust could be elevated along highly trafficked streets. Several studies have reported significant associations between proximity to highly trafficked streets and the occurrence of childhood cancers and childhood leukemia. These associations may be due to chronic exposure to benzene or other carcinogenic components of vehicle exhaust from these nearby streets or to some other factor (e.g., noise, increased light exposure, or some unaccounted-for socioeconomic variable). We used data for homes studied in an earlier childhood cancer study conducted in Denver, CO, in the 1980s. No air pollution measurements were made in the original study. We identified the highest trafficked street near each study home and obtained the traffic density in 1979 and 1990. Traffic density was weighted for the distance from the street to the home using 3 different widths of Gaussian curves to approximate the decay of the emissions into the surrounding neighborhoods. The associations between the 750-ft-wide distance-weighted traffic density metrics and all childhood cancers and childhood leukemia are strongest in the highest traffic density category (≥ 20,000 vehicles per day [VPD]). The odds ratio is 5.90 (95% confidence interval [CI] 1.69–20.56) for all cancers and 8.28 (95% CI 2.09–32.80) for leukemia. The results are suggestive of an association between proximal high traffic streets with traffic counts ≥ 20,000 VPD and childhood cancer, including leukemia.

IMPLICATIONS

Motor vehicles are a significant source of air pollution emissions, including benzene, which may be carcinogenic. This study presents further evidence that children who live near heavily traveled streets or highways may be at elevated risk of developing cancer, including leukemia. Children living near such streets could be exposed via inhalation or exposure to soil where emissions deposit. Alternative hypotheses for these results could involve noise, increased light exposure, or some socioeconomic variable. Future studies with actual exposure measurements are needed.

INTRODUCTION

Many occupational studies have linked chronic exposure to high levels of benzene to the occurrence of leukemia in adults.[1-5] The association has been mainly with acute myeloid leukemia (AML).[1,2] Although AML is rare in children, this raises the possibility that leukemia and other cancers in children could also be associated with chronic exposure to elevated levels of benzene, a major constituent of volatile organic compounds (VOCs) from motor vehicles.[6,7] It has been estimated that over 80% of the total benzene emissions in the United States originate from motor vehicles.[8] Benzene has also been found in tobacco smoke.[9] Elevated levels of motor vehicle exhaust are likely to be localized (from a few hundred up to one thousand feet) near heavily traveled roadways,[10-12] which could produce localized high levels of VOCs containing benzene[13,14] that could also deposit in soil, but no measurements are available. Although traffic-related ambient air concentrations of benzene are well below occupational exposure levels normally considered leukemogenic,[15] the U.S. Environmental Protection Agency (EPA) believes chronic exposures may pose a risk for leukemia or cancer in general.[13] The causal agents for the most common childhood leukemia, acute lymphocytic leukemia (ALL), are largely unknown, although several studies suggest an association with some measure of traffic density.[15-17] Traffic density may act as a surrogate exposure indicator for elevated levels of VOCs containing benzene.

Courtesy Air and Waste Management Assoc.

This general profile of airborne exhaust pollution from vehicle traffic shows concentrations in still conditions.

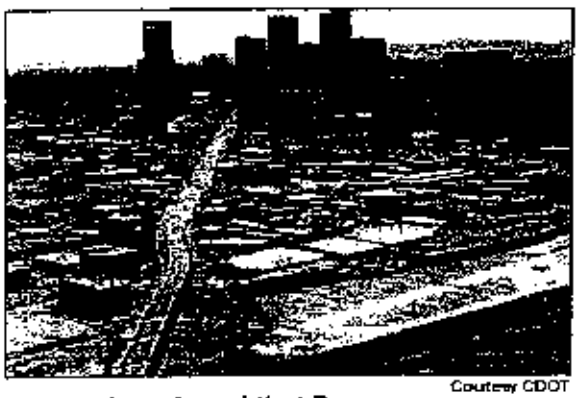
Pearson and his colleagues discovered that areas with high-capacity power lines often coincided with areas of high traffic density.

Motor vehicles are a significant source of polluting emissions, including benzene and other organic compounds, said Pearson. Exposure to high concentrations of benzene is a known cause of leukemia in adults.

Scientific analysis has never shown electromagnetic fields, or EMFs, to be initiators of cancer, said Howard Wachtel, an electrical engineering professor at the University of Colorado at Boulder who was involved in both studies. However, EMFs are believed to advance cancer because of their ability to alter DNA.

"It's possible that benzene and other organic compounds from vehicle exhaust may initiate cancer in children while EMFs may act to promote such cancers," said Wachtel.

Pearson, Wachtel and their colleagues found that children living near high-traffic corridors and high-capacity power lines showed a greater risk of cancer than children living only in high-traffic areas.



Courtesy CDOT

Researchers found that Denver-area children living near high-traffic corridors and high-capacity power lines showed a greater risk of cancer than children living only in high-traffic areas. .

The researchers studied data from the same 579 homes used in the 1988 study. They compared traffic density statistics from 1979 and 1990 supplied by the Colorado Transportation Department. They then measured cancer rates according to the proximity of homes to busy roadways.

There are several other possibilities that may contribute to the high rates of cancer in these homes, said Pearson. These include stress brought on by sound and light pollution, socio-economic status, lifestyle and diet.

However, the idea that vehicle emissions are to blame has "biological plausibility," he said.

"We need to design some well thought-out follow-up studies, since there is still a lot we don't understand about the associations involving cancer, high-density traffic and EMFs," Wachtel said.

The study was published in the February 2000 issue of the Air and Waste Management Association journal. Kristie Ebi of the Electric Power Research Institute in Palo Alto, California, also participated in the research, which was funded by EPRI.

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the homes of the case and control children. We obtained 1979 traffic density data from the Colorado Department of Transportation and 1990 traffic count data for Denver area streets and highways from the Denver Regional Council of Governments. These years were chosen because they were the two years closest in time to the period of exposure of the cases studied by Savitz et al.[19] when coordinated traffic counts were made across the Denver metropolitan area. If a street did not have a traffic count, we assigned the average of the traffic counts for all streets with the same traffic-carrying capacity code from a geographic information system (GIS) digital map[20] of all of the streets and highways in the Denver metropolitan area. Streets with low traffic-carrying capacity codes without traffic measurements (narrow residential and cul-de-sac streets) were assigned a default traffic count of 100 VPD.

We compared the traffic density measurements for these two years for all streets near the study homes and noted the similarities and trends between the years. Although the 1979 traffic density data were collected closer in time to the other data collected in the Savitz et al. study,[19] we preferred to use the 1990 traffic density data because traffic counts for more streets were available. We compared the 1990 traffic density with the traffic density for 1979 (Figure 1) for those homes that had measured traffic density on the nearby highest trafficked street for both years (n = 110). Traffic density increased on average 22% from 1979 to 1990 and is highly correlated between these years. The R^2 is 0.93. The straight line in Figure 1 is the least-squares linear regression. Therefore, we used the 1990 traffic data because there is a high correlation for traffic counts between these years with a fairly uniform trend of increasing traffic. A high-traffic street in 1979 also would be a high-traffic street in 1990 with about the same rank ordering by traffic count, because few streets fall far from the least-squares regression line in Figure 1.

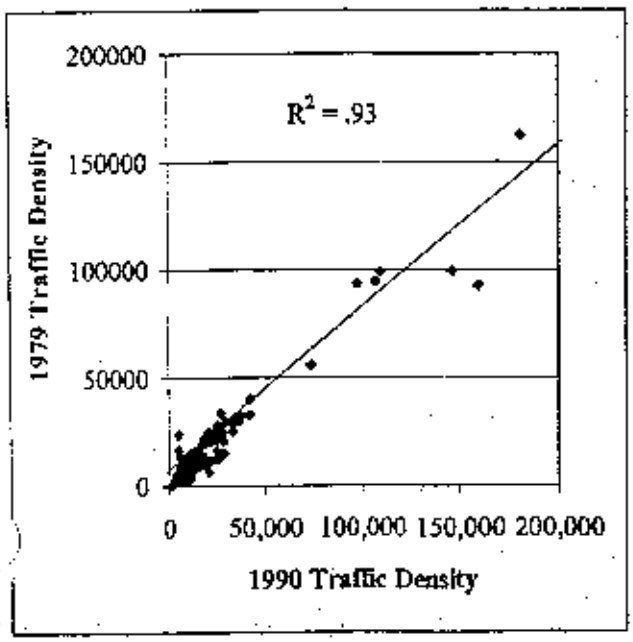

Figure 1. A comparison of traffic density measurements in VPD for 1979 and 1990 for 110 study homes in the Savitz and Feingold study.[16]

Each of the study homes was geocoded for location from its street address. Using GIS methods, we identified the highest trafficked street within 1500 ft in any direction from each home and calculated the perpendicular distance from the center line of the street to the center of the home.

The concentration profile of airborne exhaust pollution from motor vehicles traveling on a street could approximate a Gaussian (normal) distribution[11,12,21,22] similar to that shown in Figure 2. This idealized profile may vary due to many factors such as prevailing winds, turbulence generated by passing vehicles, and the dispersion blocking effect of nearby buildings and hillsides.[23,24] To bracket the spatial action that these and other factors may have on air pollution concentration profiles, 3 different widths (250, 500, and 750 ft) of Gaussian curves were used to distance-weight the traffic counts. The width of each Gaussian curve was determined at one-half of its maximum height (Figure 2). Distance-weighted traffic density was computed by multiplying the traffic counts in VPD for the highest trafficked street by the values derived from each of the 3 weighting curves at the street to home distance. For instance, a street with a traffic count of 10,000 VPD located at the distance from the home shown on the left in Figure 2 would have a distance-weighted traffic density of 2500 VPD at the home.

Odds ratios (OR) and 95% confidence intervals (CI) were computed between childhood cancer and childhood leukemia and the different distance-weighted traffic density metrics using standard statistical programs for stratified analysis.[25]

RESULTS

Savitz and Feingold[16] evaluated the association between childhood cancer and traffic counts up to ≥10,000 VPD for 328 case and 262 control homes, using the traffic counts on the street of address of each home. The associations for all childhood cancers and leukemias reached statistical significance in the highest category despite small numbers. Using their street of address data, we recomputed odds ratios for traffic counts up to ≥20,000 VPD (Table 1). The associations were not statistically significant or consistently elevated, except in the highest category, where the odds ratios abruptly increased. The associations were not precise because of the small number of controls, particularly in the higher-VPD categories.

We determined 3 distance-weighted traffic density metrics for the highest trafficked street proximate to the home for 579 of the 590 homes analyzed by Savitz and

Savitz and Feingold[14] reported that traffic density is associated with all childhood cancers and with childhood leukemia in Denver, CO. In their study, traffic density was defined as the traffic count on the street of address of the home, usually located in front of the home. They reported an odds ratio for children living on streets with traffic densities of ≥10,000 vehicles per day (VPD) of 3.1 (95% confidence interval [CI] 1.2–8.0) for total childhood cancers and 4.7 (95% CI 1.6–13.5) for childhood leukemias. These results suggest that children living on streets with traffic counts of more than 10,000 VPD are 3–5 times more likely to contract cancer than are children who live on streets with fewer than 500 VPD.

More recently, Feychting et al.[17] retrospectively modeled concentrations of nitrogen dioxide (NO_2) from motor vehicle exhaust in Sweden. They reported that at NO_2 levels >80 μg/m³ outside a child's home, the total childhood cancer odds ratio was 3.8 (95% CI 1.2–12.1). The NO_2 concentrations were estimated using mobile source air pollution models from the Swedish Environmental Protection Agency as the 99th percentile of the 1-hr averages for one year.

Knox and Gilman[18] examined spatial clustering patterns among 22,458 children who died from leukemia or other cancers in England, Scotland, or Wales from 1953 to 1980. They found excess childhood leukemias in proximity to motorways and industrial plants likely to be sources of airborne toxic substances such as VOCs. The largest excesses of cancer associated with traffic were found 1 km or less from motorways. Knox and Gilman concluded, "Childhood cancers are geographically associated with two main types of industrial atmospheric effluent, namely: (1) petroleum-derived volatiles and (2) kiln and furnace smoke and gases, and effluent from internal combustion engines" (p. 151).

This study is an extension of the work by Savitz and Feingold.[16] We developed an exposure metric based on the highest trafficked street surrounding the house, not simply the street of address (usually located in front of the house), and took into account the decay of air pollution concentration with distance from the street. These improvements are intended to reduce exposure misclassification for traffic air pollution. The results are presented to allow for a direct comparison of the results of this improved traffic density exposure metric with the results reported by Savitz and Feingold.[16]

Parents of case and control children were interviewed in the original study to obtain data about their child's past exposure to agents and activities potentially associated with cancer, including parents' cigarette smoking and the use of pesticides in and around the home. In order for a factor to be a confounder, it must be associated with both the disease and exposure of interest. Savitz et al. evaluated many factors as potential confounders, including the child's age, gender, year of disease diagnosis, and residential stability. Savitz et al. also controlled for family electricity consumption, parents' ages, parents' occupations, parents' education levels, per capita income, traffic density, and family cancer history. Also evaluated as confounders were the child's prenatal exposure to tobacco smoke and alcohol, birth order, birth weight, medications, illnesses, and X-rays.

Savitz et al. found evidence of an elevated cancer risk associated with young maternal age, lower father's education, lower per capita income, maternal smoking during pregnancy, and traffic density, all of which were taken into account as potential confounders of the association between cancer and proximity to power lines. The odds ratios for these factors were not large, and taking them into account did not change the point estimates, indicating that they were not confounders. Subsequent analyses (Savitz and Feingold[16]) supported the suggestion that there are few, if any, confounding factors in these data.

EXPERIMENTAL METHODS

We employed the case-control childhood cancer epidemiologic data used by Savitz and Feingold.[16] The data are from a study conducted by Savitz et al.[19] of the association between magnetic fields from electric power lines and childhood cancer in the Denver metropolitan area. Details of the methods used to identify cases and controls have been provided elsewhere.[19] In summary, eligible cases were children from 0 to 14 years of age who were diagnosed with cancer from 1976 to 1983 and who lived in the greater Denver metropolitan area. The 320 eligible cases consisted of 97 leukemias (including 78 ALL), 59 brain cancers, 30 lymphomas, 32 soft tissue cancers, and 102 other forms of cancer. Data on these children were obtained from the Colorado Central Cancer Registry; 259 controls were selected by random digit dialing with individual matching on gender, age ±3 years, and telephone exchange area.

The Colorado Central Cancer Registry of the Colorado Department of Health was the principal source of cases, with complete coverage of the study area from 1979 to 1982. To complete case ascertainment for 1976–1978 and 1983, records were reviewed of area hospitals that provided diagnosis and treatment for childhood malignancies. Over 95% of the cases were microscopically confirmed, with an additional 3% confirmed by direct visualization or radiography. Diagnostic accuracy was also assured through review by pediatric oncologists.[19]

Savitz et al. found elevated traffic density to be associated with childhood cancer, but no assessment of pollution exposure was made in their study. To follow up this observation, we used other publicly available data that could act as markers for air pollution exposure for

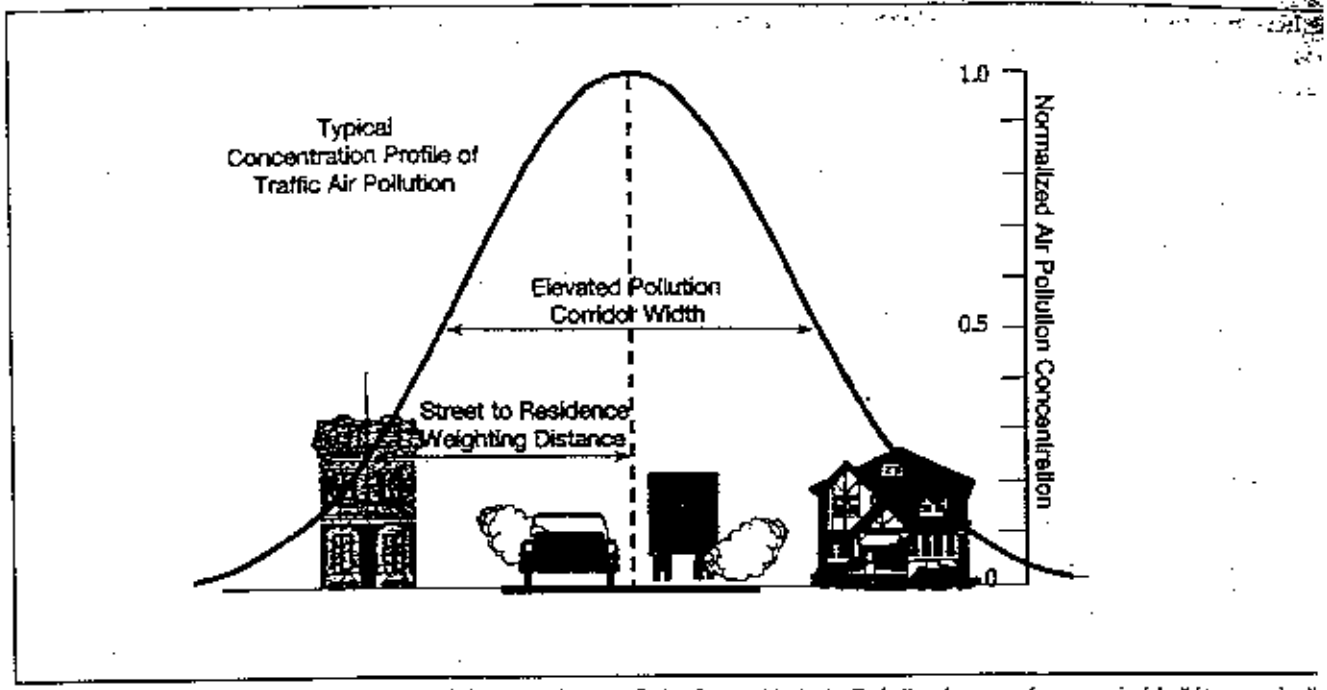

Figure 2. Generalized profile of concentration of airborne exhaust pollution from vehicular traffic in the absence of a crosswind. In this example, t distance-weighting value for the home on the left will be 0.25. If the traffic density on the street is 10,000 VPD, then the distance-weighted traf density at the home on the left would be 2500 VPD.

Table 1. Odds ratios between traffic density on the street of address and all childhood cancers and childhood leukemias using data reported by Savitz and Feingold.[14] This extends the earlier analysis to traffic strata above 10,000 VPD.

Distance-Weighted Traffic Density (VPD)	Controls	All Cancers			Leukemias		
	N	N	OR	95% CI	N	OR	95% CI
<500	238	280	1.0	Reference	81	1.0	Reference
500–4999	10	19	1.62	0.74–3.54	4	1.18	0.36–3.85
5000–9999	9	11	1.04	0.42–2.55	5	1.63	0.53–5.01
10,000–14,999	3	6	1.70	0.42–6.87	1	0.96	0.10–6.87
15,000–19,999	0*	4	-	-	2	-	-
≥20,000	2	8	3.40	0.72–16.17	5	7.35	1.40–38.60

*Odds ratios cannot be computed due to lack of controls in this category. N = number of children in each category, OR = odds ratio, and 95% CI = 95% confidence interval.

Table 2. Odds ratios between 750-ft distance-weighted traffic density and all childhood cancers and childhood leukemias.

Distance-Weighted Traffic Density (VPD)	Controls	All Cancers			Leukemias		
	N	N	OR	95% CI	N	OR	95% CI
<500	118	121	1.0	Reference	38	1.0	Reference
500–4999	86	101	1.15	0.78–1.68	26	0.94	0.53–1.66
5000–9999	32	55	1.68	1.02–2.80	21	2.04	1.05–3.95
10,000–14,999	14	18	1.26	0.60–2.66	2	0.48	0.10–2.21
15,000–19,999	6	7	1.15	0.37–3.51	2	1.04	0.20–5.34
≥20,000	3	18	5.90	1.69–20.56	8	8.26	2.09–32.80

Feingold[16] (11 of the 590 homes did not have complete). Table 2 shows the associations between all childhood cancers and childhood leukemias and the 750-ft distance-weighted traffic density metric. Note the shift of homes to the higher traffic density strata in Table 2 compared to Table 1 when taking the highest trafficked street into account. The association between traffic density and all cancers and leukemia only becomes elevated and significant in the ≥20,000 VPD category. The results for the 500-ft-width weighting curve are similar with odds ratios for ≥20,000 VPD of 9.45 (95% CI 1.19–74.79) for all cancers and 12.18 (95% CI 1.33–111.8) for leukemia. Both of these odds ratios are statistically significant. For the 250-ft distance-weighted traffic density metric, there were no controls with 15,000 or more VPD, so odds ratios could not be computed.

If the children are grouped by exposure to greater than 500 VPD (750-ft distance-weighted) versus less than 500 VPD, the odds ratios become 1.70 (95% CI 1.01–2.86) for all cancers and 2.08 (95% CI 1.06–4.07) for leukemia. Even though these risks are small, they are statistically significant.

CONCLUSION AND DISCUSSION

This study has several limitations. As in most studies of ldhood cancer, the number of cases and controls in ne high-exposure category is small, due to the relative rarity of childhood cancer. These small numbers affect the precision of the observed associations. The confidence limits are wide because of the small number of cases and controls, but some of the point estimates are still statistically significant. To make the group of children as large as possible, Savitz et al.[15] made their diagnosis period fairly wide (1976–1983). The cumulative pre-diagnosis exposure period for these children may have stretched for more than 10 years, but most of the children were less than 10 years old when diagnosed.

Savitz et al. did not directly measure traffic density for each child. Citywide coordinated traffic counts are only made in the Denver area about every 10 years. Retrospective estimates of exposure for the pre-diagnosis time period for each child could be extrapolated from these periodic traffic counts, assuming the child had lived in one residence for the whole period. However, data collected by Savitz et al. on the residential mobility showed that many children had moved. Therefore, we did not attempt to retrospectively estimate the traffic exposure during the pre-diagnosis exposure period for ach child. To do so would require knowledge of each child's residential history during the relevant (and unknown) etiologic period.

The results suggest that distance-weighted traffic density is a risk factor for all childhood cancers and for childhood leukemias. This is consistent with the earlier findings of Savitz and Feingold,[16] Feychting et al.,[17] and Knox and Gilman.[18] Elevated risks are found for ≥20,000 VPD for the 500- and 750-ft metrics. There are cases but no controls with ≥20,000 VPD for the 250-ft metric, so odds ratios cannot be computed. There is no evidence of elevated risk for distance-weighted traffic densities less than 20,000 VPD. At ≥20,000 VPD, the risks of childhood cancers and leukemia increase with decreasing distance-weighting from the street, although the numbers are small and the confidence intervals overlap. These results are suggestive of a threshold effect for highly exposed children when distance-weighted traffic density near a home rises well above the average value for the area.

This apparent threshold effect is to be expected where high densities of VPD increase the concentration of vehicle exhaust far above the ambient background in the surrounding neighborhoods. The gradient of traffic air pollution may be very steep (Figure 2) and diminish very rapidly with distance from the street. Thus, only those children who live very near high-traffic streets (within 750 ft) will have an exposure that is far above "ambient background" for the community. Noise, increased light exposure, or some socioeconomic factor may also help explain these results.

For distance-weighted traffic densities ≥20,000 VPD, the associations we observe are stronger than those reported by Savitz and Feingold.[16] This may be due to possible misclassifications of exposure in the Savitz and Feingold study, which only analyzed traffic density on the street of address in front of a home. This would not account for high exposure coming from a busy street either behind or beside the home. Feychting et al. used a retrospective estimate of mobile source NO_2 concentration as their metric.[17] The metrics used in our analyses are simpler to construct than estimating NO_2 concentrations and are also strongly associated with cancer. The confidence limits are wide because of the small number of cases and controls, but some of the point estimates are still statistically significant.

Together, these results are suggestive but do not constitute conclusive evidence of an association between living near a high-traffic street and increased incidence of childhood cancer, particularly leukemia. Further studies specifically designed to test this and other hypotheses are needed. Measurements of ambient or personal exposure to various pollutants are also needed.

This study used distance-weighted traffic density as an exposure surrogate for mobile source air pollution. This metric can be improved. Concentrations of motor vehicle VOCs containing carcinogens such as benzene can be retrospectively estimated for each home using mobile source models. The models could be used to estimate emissions from passing vehicles and the ambient concentrations

resulting after dispersion into the neighborhood. Finally, measurements are highly desirable. If benzene and other emissions in motor vehicle exhaust are associated with childhood cancer, then estimates of these concentrations should be more strongly associated with childhood cancer than is distance-weighted traffic density.

ACKNOWLEDGMENTS

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Air Pollution Is Often Worse Inside Automobiles Than in the Air Outside

Car Drivers and Passengers Are Exposed to High Levels of Carcinogens and Particles Linked to Premature Death

Washington, D.C. – Tens of thousands of Americans will take to the roads this Labor Day weekend, exposing themselves and their families to levels of air pollution inside of their cars that may be up to 10 times higher than in the air outside. A new report by the International Center for Technology Assessment (CTA), *In-Car Air Pollution: The Hidden Threat to Automobile Drivers*, surveys 23 separate scientific studies conducted over the last two decades and reveals that in-car air pollution frequently reaches concentrations that threaten human health. The Executive Summary as well as the entire report are available online at www.icta.org/projects/trans/index.htm.

Most people realize that there are risks associated with traveling by automobile—drunk drivers, road rage, and speeding tickets come to mind. Most likely, the greatest concern of drivers stuck in traffic is that they won't reach their destinations on time. Few people, however, are concerned about the health effects of the air quality inside of their cars. If their thoughts turn to the subject at all, they are more likely to consider air pollution an "outdoor" problem.

However, CTA found that dangerous exhaust pollutants easily penetrate the interior of automobile cabins–even if the windows are up and outside ventilation systems are set to low. In fact, aerodynamic effects tend to concentrate high levels of pollutants in roadway traffic lanes, so that motorists typically drive through an invisible tunnel of toxic gases, aerosols, and particles.

The air pollution accumulating inside automobiles consists almost exclusively of exhaust from gasoline and diesel engines. This toxic soup of microscopic pollutants includes benzene (a known carcinogen), carbon monoxide (which interferes with the blood's ability to transport oxygen), fine particulate matter (which studies have associated with increased death rates), and a host of other hazardous chemicals. In-car benzene levels may be four times higher than in the roadside air; carbon monoxide concentrations may be more than 10 times higher than outside of the car.

"Most people feel relatively safe from the health dangers of air pollution while they are inside their automobiles," said CTA Executive Director Andrew Kimbrell. "Unfortunately, they are misguided. Most drivers are unaware that they are breathing in up to ten times more air pollution than if they were walking along the side of the road."

Mark Briscoe, CTA Project Coordinator and author of the report, commented, "High in-car levels of benzene and other carcinogens show the need for strong federal regulations limiting auto emissions of so-called hazardous air pollutants. Similarly, the fact that some of the highest in-car pollution levels accumulate in cars sharing the road with diesel trucks shows the importance of EPA issuing a strong heavy-duty vehicle and diesel rule later this year."

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DIRTY DIESEL CLEAN-UP CAMPAIGN

AMERICAN LUNG ASSOCIATION. of Metropolitan Chicago

A SUMMARY OF RECENT STUDIES ON THE HEALTH EFFECTS OF DIESEL TRUCK EXHAUST

Asthma symptoms linked to truck exhaust.

A study was conducted in Munster, Germany to determine the relationship between truck traffic and asthma symptoms. In total, 3,703 German students, between the ages of 12-15 years, completed a written and video questionnaire in 1994-1995. Positive associations between both wheezing and allergic rhinitis and truck traffic were found during a 12 month period. Potentially confounding variables, including indicators of socio-economic status, smoking, etc., did not alter the associations substantially.

Duhme, H., S. K. Weiland, et al. (1996). "The association between self-reported symptoms of asthma and allergic rhinitis and self-reported traffic density on street of residence in adolescents." Epidemiology 7(6): 578-82.

Proximity of a child's residence to major roads is linked to hospital admissions for asthma.

A study in Birmingham, United Kingdom, determined that living near major roads was associated with the risk of hospital admission for asthma in children younger than 5 yrs of age. The area of residence and traffic flow patterns were compared for children admitted to the hospital for asthma, children admitted for nonrespiratory reasons, and a random sample of children from the community. Children admitted with an asthma diagnosis were significantly more likely to live in an area with high traffic flow (> 24,000 vehicles/ 24 hrs) located along the nearest segment of main road than were children admitted for nonrespiratory reasons or children form the community.

Edwards, J., S. Walters, et al. (1994). "Hospital admissions for asthma in preschool children: relationship to major roads in Birmingham, United Kingdom." Archives of Environmental Health 49(4): 223-7.

When You Can't Breathe, Nothing Else Matters

Fo[illegible]d in 1906, the American Lung Association of Metropolitan Chicago serves Chicago and Cook County with education, research and advocacy programs.

A school's proximity to freeways is linked to asthma prevalence.

A study of 1498 children in 13 schools in the Province of South Holland found a positive relationship between school proximity to freeways and asthma occurrence. Truck traffic intensity and the concentration of emissions measured in schools were found to be significantly associated with chronic respiratory symptoms.

> Speizer, F. E. and B. G. Ferris. Jr. (1973). "Exposure to automobile exhaust. I. Prevalence of respiratory symptoms and disease." Archives of Environmental Health 26(6): 313-8.
> van Vliet. P., M. Knape, et al. (1997). "Motor vehicle exhaust and chronic respiratory symptoms in children living near freeways." Environmental Research 74(2): 122-32.

Lung function reduction among children associated with living near truck traffic

A European study determined that exposure to traffic-related air pollution, "in particular diesel exhaust particles," may lead to reduced lung function in children living near major motorways.

> Brunekreef B; Janssen NA; de Hartog J; Harssema H; Knape M; van Vliet P. (1997). "Air pollution from truck traffic and lung function in children living near motorways." Epidemiology, 8(3):298-303.

Air polluted by diesel exhaust can trap pollen in the air, thus triggering asthma attacks.

This study found that grass pollen allergens can become more concentrated in air polluted by fine particles, like those present in diesel exhaust, by binding to the particles. The study concludes that this may be one reason why air pollution exacerbate allergies and asthma.

> Knox RB, Suphioglu C, Taylor P, Desai R, Watson HC,Peng JL, Bursill LA. (1997) Clinical & Experimental Allergy 27(3):246-51, 1997 Mar.

Exposure to diesel exhaust greatest near roads, particularly urban streets

Studies indicate that diesel emissions exposure is greatest near busy streets, bus and truck terminals, parking areas, and highways. In areas were there is less opportunity for particulate dispersion, such as urban streets, exposure can be even greater.

> Volkswagon AG. 1989. Unregulated Motor Vehicle Exhaust Gas Components [a corporate document]. Volkswagen AG, Auburn Hills, MI.

Diesel fumes could carry cancer risk.

In preliminary findings, the EPA found that exposure to diesel exhaust, even at low levels, is likely to pose a risk of lung cancer and other respiratory risk. The EPA stated that the risk of cancer from diesel exhaust, even at concentrations too low to cause other respiratory problems, could be 1 in 100, or even greater.

"Diesel Fumes Could Carry Cancer Risk, EPA Reports Low-Level Exposure Linked to Ailments" *Washington Post*, April 10, 1998: A11.

Freeway pollution is linked to increased asthma

A study of 1,068 Dutch children found that asthma, wheeze, cough, and runny nose were significantly more common in children living within 100 meters of freeways. Increasing density of truck traffic was also associated with significantly higher asthma levels – particularly in girls.

Patricia van Vliet, et al. Motor exhaust and chronic respiratory symptoms in children living near freeways. Environmental Research 1997;74:12-132.

EXHIBIT KK

Foreword

This report by the International Center for Technology Assessment (CTA) represents the fourth in a series of studies designed to assess the environmental and social impacts of transportation technology. These reports are meant to aid policymakers and the public in their ongoing deliberations concerning the future course of transportation in the United States.

This particular report contains an in-depth analysis of the concentrations of auto pollution that collect inside automobiles and affect the health of drivers and passengers. This report found that pollution levels inside cars are often much higher than those detected in the ambient air, at the roadside, and in other commonly used vehicles.

CTA gratefully acknowledges the contributions of many individuals, organizations, and government entities which assisted in the production of this report. In particular, CTA would like to thank John A. Harris, Henry Griggs (Communications Consortium), Bob Rose (Breakthrough Technologies Institute), Angie Farleigh (U.S. PIRG), Jayne Mardock (Clean Air Network), Ann Mesnikoff (Sierra Club), and Kristy Paulsen (Your Next Car Campaign). CTA offers special thanks to The Changing Horizons Charitable Trust for funding this project.

CTA was formed in 1994 to assist the general public and policymakers in better understanding how technology affects society. CTA is devoted to fully exploring the economic, ethical, social, environmental, and political impacts of technology or technological systems. Using this holistic form of analysis, CTA provides the public with independent, timely, and comprehensive information about the potential impacts of technology. CTA is also committed to initiating appropriate legal, grassroots, public education, and legislative responses relevant to its assessment findings.

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Executive Summary

Americans spend more time than ever before inside of cars. We drive to work, we drive to the supermarket, we drive to the family vacation spot. If we are going somewhere, chances are good that we are driving. People in this country traveled more than 2.8 trillion miles by automobile in 1995, up half a trillion miles from five years earlier and nearly double the number of miles driven in 1965. Not only are people driving more miles, traffic and other roadway delays mean that it often takes more time to go a shorter distance. The average amount of time spent commuting to and from work has increased steadily since the 1980s, with a growing number of people now facing a daily drive time of thirty minutes or more each way.

Most people realize that there are risks associated with traveling by automobile—drunk drivers, road rage, and speeding tickets come to mind. The greatest concern of drivers stuck in traffic is most likely that they won't get to their destinations on time. Few people, however, are concerned about the health effects of the air quality inside of their cars. If their thoughts turn to the subject at all, they are more likely to consider air pollution an "outdoor" problem.

This unprecedented survey of international studies shows that air pollution may be even more severe inside of cars than out. The results of 23 separate scientific studies conducted during the 1980s and 1990s reveal that in-car air pollution levels frequently reach concentrations that may threaten human health. The reports show that the air inside of cars typically contains more carbon monoxide, benzene, toluene, fine particulate matter, and nitrogen oxides than ambient air at nearby monitoring stations used to calculate government air-quality statistics. In-car pollution is often even worse than pollution in the air at the side of the road.

The air pollution accumulating in the interior of automobiles consists almost exclusively of gasoline and diesel exhaust. This toxic soup of gases, aerosols, and microscopic particles includes benzene (a known carcinogen), carbon monoxide (which interferes with the blood's ability to transport oxygen), particulate matter (which studies have associated with increased death rates), and a host of other hazardous chemicals.

Public health officials frequently issue warnings reported in local weather broadcasts when concentrations of auto pollutants exceed healthful levels in the ambient air. The air quality inside of cars is typically much worse. In-car benzene concentrations sometimes exceed concentrations in the roadside air by up to four fold. Carbon monoxide concentrations may be more than 10 times higher inside of cars than at the side of the road.

Elevated in-car pollution concentrations particularly endanger children, the elderly, and people with asthma and other respiratory conditions. While it receives little attention, in-car air pollution may pose one of the greatest modern threats to human health.

Recommendations

While individuals can take some actions to reduce in-car pollution levels—driving less, ensuring that their vehicles are properly maintained, and using public transportation whenever possible—the main burden falls on the shoulders of policymakers.

Initiatives to address this problem should include the following:

1). Federal, state and local governments must provide greater funding for public transportation projects, especially in cities plagued by high levels of traffic congestion. Tax incentives for individuals and employers should promote the use of public transportation, while tax breaks that encourage people to drive, including parking incentives, should be phased out.

2). The EPA must fix a major failing of its recent Tier 2 rule by requiring automakers to develop and sell zero-emissions alternatives to gasoline- and diesel-powered vehicles.

3). The California Air Resources Board must preserve its zero-emissions-vehicle mandate, which comes up for review later this year. This provides the greatest incentive for automakers to actively develop and sell nonpolluting cars that do not contribute to in-car pollution problems.

4). Until EPA addresses the issue of alternative vehicles, states should opt to implement California LEV 2 emissions rules, including the ZEV mandate, rather than the federal Tier 2.

5). The EPA's final heavy duty vehicles/diesel rule, due out later this year, must include steep reductions of PM and NOX emissions outlined in the agency's proposed rule. The final rule must require 100% of diesel fuel to contain low sulfur levels (less than 10 ppm) by 2007. The agency must not give in to industry demands for a lengthened timeline or a phase-in of the low-sulfur fuel.

6). EPA must end its history of repeated delays and issue a tough mobile source toxics rule that will significantly reduce new cars' emissions of benzene, toluene, 1,3 butadiene, xylenes, ethylbenzene, and other VOCs. This rule should include federal incentives for the development of zero-emission vehicles.

SECTION ONE

INTRODUCTION

Automakers have come a long way in recent years in terms of improving the interior comfort and safety of the cars they sell. Nearly all new models come equipped with stereo systems, dual airbags, tilt steering wheels, and power locks and windows. For a few dollars more a customer can get heated leather seats, dual-zone climate control, a hands-free cellular phone, a CD changer, and power seats with memory to store several position settings. Some minivan models even come with built-in televisions and VCRs to entertain passengers on lengthy trips.

All of this innovation has given drivers and passengers a heightened sense of comfort and well being inside their automobiles, even if the conditions outside happen to be oppressively hazy, hot, and humid. Driving on a code-red smog day with their windows sealed tight and their air conditioners set to high, some drivers may feel a tinge of remorse or guilt for their contribution to the air quality problems outside of their cars, but it is likely that few are seriously concerned about their own health or the health of their families as long as they are inside.

However, numerous studies conducted over the past two decades indicate that any sense of disconnection from the air pollution conditions outside is completely unwarranted. The truth is, the quality of air inside cars is often much worse than that of nearby ambient air samples or even the air at the side of the road. Hazardous pollutants, including carbon monoxide, volatile organic compounds, nitrogen oxides, and particulate matter, accumulate inside cars driving in moderate to heavy traffic. Aerodynamic effects of the moving vehicles, combined with the tendency of auto exhaust pollutants to dissipate quickly after emission, concentrates these chemicals and particles in the midst of the traffic flow in the roadway. In effect, cars on busy roadways drive through an invisible tunnel of concentrated pollutants. The exterior shells and ventilation systems of cars do little to divert these pollutants or filter them from the air entering the car's interior, and thus afford little protection to the people driving through this toxic tunnel.

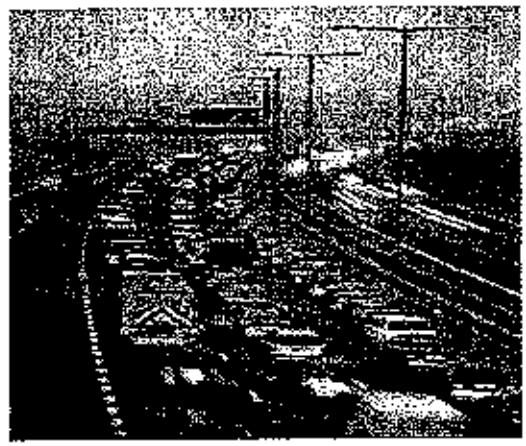
These higher concentrations of pollutants commonly detected inside automobiles boost the overall exposure of drivers and passengers to a number of very dangerous chemicals, including benzene, carbon monoxide, particulate matter, and toluene. Medical researchers have linked many of these substances to serious health problems, including respiratory irritation, cancer, and premature death. Many of these dangerous chemicals' effects on human health depend on a person's cumulative exposure, so each time a driver or passenger is subjected a high concentration of the pollutant is meaningful.

This report analyzes the results of 23 separate studies published between 1982 and 1998 that measured the concentrations of particulate matter, volatile organic compounds, carbon monoxide, nitrogen oxides, and/or ozone inside of automobiles. Many of the studies also looked at pollutant concentrations in ambient air samples, in the traffic stream immediately outside of test vehicles, at the roadside, in transit buses, on light rail cars, and in

subways. Several also specifically investigated the exposure of bicyclists and/or pedestrians to auto pollutants. Of the 23 studies, 14 included carbon monoxide measures, 11 considered various volatile organic compounds (benzene, toluene, xylenes, formaldehyde, etc.), five included particulate matter, four included nitrogen oxides, and two included ozone.

The results are consistent. All of the pollutants common to auto exhaust also appear in the air within automobiles. For all except carbon monoxide and the largest particulate matter, concentrations are typically higher inside cars in heavy traffic than other places—the roadside, nearby fixed measurement sites, and inside transit buses, trains, and subways—where we might also expect the presence of auto pollutants.

The purpose of this report is to educate the public and policymakers. There are actions that individuals can take to protect themselves from elevated in-car pollution levels. First and foremost, avoid driving whenever possible. When you are able, take public transportation, walk, or ride a bicycle. Second, avoid driving during heavy traffic periods. The studies considered by this report show that in-car pollution levels are highest when vehicles are traveling on congested roads or passing through busy intersections. Third, if you must drive, whenever possible avoid following high-polluting vehicles, such as diesel trucks and buses, older model cars and sport utility vehicles, and out-of-tune vehicles with visible exhaust. The studies indicate that much of the pollution inside vehicle cabins likely consists of the exhaust from other vehicles in the immediate vicinity.



Scientific studies beginning in the 1970s have shown that the pollutants in automobile and diesel exhaust readily make their way into cars' passenger compartments. Often, the pollutant levels inside cars far exceed those in the ambient air or at the roadside.

Real progress towards solving the in-car pollution problem, however, can only come through changes in existing public policies that encourage people to drive internal-combustion automobiles, exacerbate traffic congestion problems, and allow numerous high-polluting vehicles to remain on the roads. Public officials need to realize that the American addiction to polluting cars and trucks poses a national health crisis that must be aggressively confronted and requires decisive and innovative leadership. The conclusion of this report outlines several policy initiatives that would begin to address the problem.

SECTION TWO

PARTICULATE MATTER

Particulate matter (PM) pollution consists of solids and liquid droplets of up to 10 micrometers in diameter suspended in the air. Large, dark PM may include smoke and soot from incomplete combustion, though PM may also include dust. These "coarse" particles along with smaller ones are known as PM10. So-called "fine" PM measures less than 2.5 micrometers in diameter and can include particles so small that they may only be seen using an electron microscope. These are known as PM2.5. Even the largest PM particles are very small—the width of a human hair averages about 70 micrometers. Diesel vehicles are a major source of both coarse and fine PM pollution.

Health Effects of PM Exposure

People have realized for centuries that smoke and soot have adverse effects on human health. In 1307, King Edward I of England prohibited the burning of sea coal in London and several other towns because, according to his royal proclamation, "the air there [was] polluted over a wide area, to the considerable annoyance of the ... prelates, magnates, citizens and others dwelling there, and to the detriment of their bodily health." The original law imposed heavy fines on those who fouled the air with excessive amounts of PM; during the reign of Edward II, which began later that same year, violators of this early clean air standard became subject to physical torture or even execution.[1]

Particulate matter is arguably the most dangerous component of automobile exhaust. Particles are small enough to infiltrate nasal, sinus, and bronchial passages where they can accumulate and calcify. Fine PM can penetrate the deepest portions of the lungs and the very smallest particles can be absorbed into the bloodstream. In the nose, throat, and lungs, particulates act as extreme irritants. Exposure to even low levels of PM can cause nasal congestion, sinusitis, throat irritation, coughing, wheezing, shortness of breath, and chest discomfort. Medical studies have associated exposure to elevated PM10 levels with the aggravation of existing respiratory conditions, including asthma, and more serious medical problems.

Several studies have linked exposure to elevated PM2.5 levels to increased hospital admissions. One of the largest looked at people insured by Kaiser Permanente in Southern California. For every 10 micrograms/meter^3 (μ/m^3) increase in PM exposure, hospital admissions rose by 7% for patients with respiratory disease, 3.5% for patients with acute respiratory illnesses, and 3% for patients with cardiovascular disease. A similar study by the California Environmental Protection Agency associated every 10 μ/m^3 increase in PM exposure levels to a 2.5% increase in emergency room visits and a 1% increase in mortality for people with pneumonia.[2]

The so-called "Six Cities Study" by the Harvard

Heavy-duty diesel trucks are a prime culprit when it comes to elevated in-car PM levels. Several studies found that cars registered the highest in-car PM-levels when following these vehicles.

School of Public Health found that test subjects exposed to higher PM concentrations were 26% more likely to die prematurely than subjects exposed to lower concentrations.[3] A study published in 1995 by C. Arden Pope, et al., of Brigham Young University found that test subjects exposed to higher levels of PM were 17% more likely to die prematurely than those exposed to lower levels. Both of these studies accounted for the subjects' other individual risk factors and evaluated the effects of PM exposure independently.[4] All told, tens of thousands of Americans die prematurely due to PM exposure each year.[5]

Other research into the effects of long-term PM exposure is relatively sparse. Preliminary results indicate a possible link between fine PM and cancer. Several studies have demonstrated that known carcinogens, including several commonly found in automobile exhaust (see the section on VOCs, below), may latch onto fine particles that are breathed into and accumulate in the deepest recesses of the human respiratory system.

PM Exposure Studies

Europe, which proportionally has a higher concentration of diesel vehicles on the road than the United States, has provided the staging ground for most of the studies on the exposure of drivers, bicyclists, and pedestrians to PM pollution.

In 1995, researchers Joop H. van Wijnen, et al., in the Netherlands found levels of PM10 inside vehicles on busy streets in Amsterdam ranging from 90 to 194 μ/m^3 in tests conducted during May. In tests conducted on congested highways with stop-and-go traffic, in-car PM10 levels ranged from 120 to 139 μ/m^3. Concentrations during tests on a rural route ranged from 71 to 166 μ/m^3. In-car levels of PM10 were much lower in tests con-

PM2.5 Levels Measured in the 1998 CARB Study

Type of Road	Mean In-Car Car 1	Mean In-Car Car 2	Maximum In-Car Car 1	Maximum In-Car Car 2	Ambient Air	Roadside Mean	Roadside Max.
Los Angeles							
Arterial, Non-rush hour	67.7	56.4	86.0	71.7	63.5	nd	nd
Arterial, Rush hour	41.0	32.9	53.1	45.1	48.0	52.9	102.8
Freeway, Non-rush hour	54.7	44.9	59.0	47.0	33.3	nd	nd
Freeway, Rush hour	45.4	32.1	56.0	38.9	32.1	44.7	76.0
Freeway, Carpool lane	46.9	43.3	54.6	47.5	58.1	69.7	78.1
Sacramento							
Arterial, Rush hour	9.6	9.7	10.3	16.4	10.8	5.8	18.7
Freeway, Non-rush hour	14.4	12.4	16.6	14.2	10.3	9.6	19.9
Freeway, Rush hour	14.7	6.6	21.8	16.2	5.7	5.9	18.2
Rural	6.1	2.0	6.1	2.0	nd	3.1	4.2

Note: nd = no data available.
Source: California Air Resources Board.

ducted during January, ranging from 17 to 62 μ/m³ in the city, 14 to 48 μ/m³ on a busy highway, and 16 to 38 μ/m³ on a rural route. The researchers said that higher winds and rainy weather caused the lower in-car PM10 levels measured in January.[6]

A year later, researchers from Middlesex University reported the exposure of London bicyclists to vehicle-generated PM and compared this to the PM exposure were different in the Underground and at street level. The vast majority of the particles that comprised the PM in the subway measured greater than 1 micrometer in diameter, while the concentrations encountered by the cyclists were mostly in the 0.2 to 0.4 micrometer range. Therefore, the subway riders were exposed to a greater volume of PM, but the cyclists riding in good weather were exposed to a greater number of total

—"The [automobile] passenger compartment air quality can be described as 'unhealthful'"

Researchers T.J. Ptak and S.L. Fallon

exposure of commuters who ride the London Underground. For this study, the scientists measured exposure to PM of less than 5 micrometers in diameter, a proven danger to human health and a prime ingredient of diesel exhaust. Again, the results showed that weather conditions had a great bearing on test subjects' PM exposure. Cyclists studied during dry weather on days without wind showed exposure to PM5 of 88.54 μ/m³. However, data sets collected while the cyclists were riding the same routes in rainy or windy conditions showed exposure levels ranging from 14 to 16.49 μ/m³. Riders of the Underground, however, were exposed to staggeringly high PM5 levels of 708.6 μ/m³. Further analysis showed that the types of particles and to the types of particles most likely to cause serious negative health effects. Over 90% of the particles breathed by cyclists were likely components of diesel exhaust. The PM measured on the Underground more likely consisted of dust.[7]

A 1994 study that looked at the exposure of U.S. automobile drivers to PM similarly found that more than 90% of the particles found inside vehicle passenger compartments measured less than 1 micrometer in diameter. Overall, T.J. Ptak and Stephen L. Fallon measured average in-car PM concentrations of 105 μ/m³ during highway driving conditions, and concluded that "the passenger compartment air quality can be described as 'unhealthful.'" The highest exposure to PM, predict-

Studies indicate that overall exposure to PM may be lower inside cars than outside, but concentrations of the most dangerous fine particles in the in-car air often exceed those at the roadside.

ably, occurred in test cars traveling on gravel roads with their windows down. The second highest exposure occurred during city driving, where the in-car PM level was measured to be 133 μ/m^3. Filtering devices did little to help. Cars' air conditioning systems can remove between 40% and 75% of the largest PM, but remove only 2% to 15% of the dangerous particles less than 1 micrometer in diameter. A commercial interior air filter can reduce the concentration of large particles by up to 90%, but again has little effect on the concentration of the smallest particles—reducing them by as little as 5%.[8]

In a 1998 California Air Resources Boards study, PM was the only pollutant that appeared at significantly lower concentrations inside of cars than outside. However, PM measuring greater than 2.5 micrometers in diameter accounted for the vast majority of this reduction. In air samples from fixed monitoring sites along the test routes, fine particulates account for from 37.4% to 64% of the PM. In roadside air samples, fine particulates made up from 56.9% to 64.4% of PM. Inside the test vehicles, however, fine particles were between 76.8% and 97.2% of all PM. This indicates, as in the earlier studies, that the cars' ventilation and air conditioning systems filter out some of the largest particles, but do little to protect passengers from the much more dangerous fine particles.

The CARB study found high levels of PM pollution inside of cars under a variety of driving conditions. On Sacramento routes, in-car PM10 concentrations ranged from 16.5 to 30.3 μ/m^3, while PM2.5 (which is a subset of the PM10 figure) ranged from 6.1 to 17.0 μ/m^3. In Los Angeles, in-car levels were even higher, ranging from 45.6 to 89.1 μ/m^3 for PM10 and from 41.0 to 83.0 μ/m^3 for PM2.5.[9] (See chart, p. 11.)

SECTION THREE

VOLATILE ORGANIC COMPOUNDS

Volatile organic compounds (VOCs), also known as aromatic hydrocarbons, comprise a class of pollutants released during the combustion or evaporation of solvents, paints, glues, and fossil fuels. The exhaust of gasoline and diesel automobiles contains significant concentrations of about two dozen VOCs, the most important of which are benzene, 1,3-butadiene, m&p-xylenes (typically measured together), o-xylene, ethylbenzene, toluene, and formaldehyde.

These chemicals have the potential to do serious harm to the environment and human health. VOCs serve as ingredients in the chemical reactions that form ground-level ozone, better known as smog. The EPA has designated many VOCs, including those typically found in auto pollution, as air toxics or hazardous air pollutants (HAPs), which are known or suspected to cause serious health hazards. Both benzene and 1,3-butadiene are known carcinogens, and other VOCs, including formaldehyde, are suspected carcinogens.

Cancer Agents

It is difficult to directly link exposure to in-car VOCs to any individual cancer case. However, the carcinogenic effects of VOCs are associated with individuals' cumulative exposures. With people spending increasing amounts of time driving or riding in automobiles, elevated in-car levels of carcinogenic VOCs contribute a growing portion of many individuals' cumulative exposure.

The U.S. EPA classifies benzene as a "'known' human carcinogen by all routes of exposure," and multiple studies have linked inhaled benzene to the development of leukemia. Additional studies suggest that benzene exposure may induce changes in chromosomes, blood cells, and bone marrow cells, though these results are not regarded as conclusive. Most of the studies on benzene carcinogenicity have looked at the occupational exposure of adults. The leukemia risk of children exposed to benzene is likely much higher than that of adults, even at lower levels of exposure.[1] Because of its status as a known carcinogen, the World Health Organization has set the acceptable human exposure level for benzene at zero.

EPA classifies both 1,3-butadiene and formaldehyde as "probable human carcinogens." Animal and human studies, while not conclusive, have shown that exposure to 1,3-butadiene, including exposure by inhalation, may be responsible for respiratory, bladder, stomach, lymphatic, and blood-related cancers. According to the EPA, "limited human studies have reported an association between formaldehyde exposure and lung and nasopharyngeal cancer. Animal inhalation studies have reported an increased incidence of nasal squamous cell cancer."[2] One animal study suggests that ethybenzene exposure may be associated with the formation of tumors. However, this study was extremely limited and the few studies involving humans have shown no elevated cancer risks. EPA says that with currently available information, ethylbenzene is "not classifiable as to human car-

cinogenicity."[3] Other VOCs may also promote the growth of cancerous cells in humans, but conclusive medical research is lacking.

Non-Cancer Health Effects

Low-level exposure to the majority of VOC air pollutants, including benzene, 1,3-butadiene, ethylbenzene, formaldehyde, and xylenes, can irritate the eyes, nose, throat, and lungs. Short-term exposure to benzene may result in drowsiness, dizziness, or headaches. Toluene acts on the central nervous system and can cause short-term fatigue, sleepiness, headaches, and nausea.

Both animal and human studies have associated the long-term exposure to benzene via inhalation with blood disorders, including aplastic anemia, excessive bleeding, and the loss of antibodies and white blood cells. This final disorder can disrupt the immune system and make the individuals chronically exposed to benzene more susceptible to infections including influenza and the common cold. Women exposed to elevated benzene concentrations for long periods of time have exhibited menstrual disorders and atrophied ovaries. Limited studies suggest that benzene exposure can reduce fertility in women. Pregnant animals exposed to elevated benzene levels have produced offspring with low birth weights and damaged bone marrow. Fetuses of animals exposed to benzene have exhibited delayed bone formation.[4]

Long-term exposure to 1,3-butadiene air pollution may cause certain types of heart disease, according to at least one epidemiological study. Animal studies have also shown that inhaled 1,3-butadiene may hinder functioning of the respiratory and cardiovascular systems as well as the liver. Additional animal studies reveal that mothers exposed to elevated 1,3-butadiene levels are more likely to produce offspring with low body weights and skeletal deformities. Animals that have inhaled the pollutant in long-term studies have exhibited atrophied ovaries and testicles.[5]

Long-term exposure to inhaled toluene can irritate the upper respiratory tract and result in chronic sore throats, nausea, skin conditions, dizziness, headaches, and sleep disorders. The children of mothers exposed to high levels of toluene during pregnancy may exhibit attention deficit and central nervous system disorders. A link between lower-level exposure and these problems is less certain. Some studies have shown that pregnant women exposed to toluene have an increased vulnerability for spontaneous abortions, but these studies are not conclusive.[6]

Animal and human studies have also shown that long-term effects of the inhalation of ethylbenzene, formaldehyde, and xylenes may include problems with reproduction and fetal development. Additionally, ethylbenzene exposure may adversely affect the blood, liver, and kidneys, while chronic exposure to xylenes may result in chest pain, reduced heart and lung function, and increased heart palpitation.[7]

—The Wolrd Health Organization set the acceptable human exposure level for benzene at zero

VOC Exposure Studies

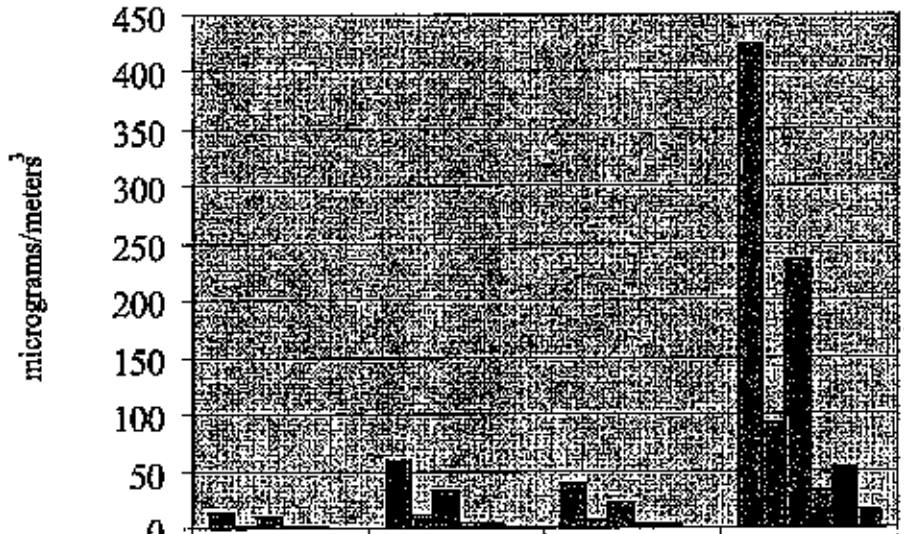
The first studies to measure the levels of VOCs within automobile passenger compartments took place in the late 1980s and early 1990s. These evaluations of cars on predominantly urban roads in Los Angeles, Raleigh, Boston, and New York/New Jersey found average concentrations of benzene ranging from 13.6 to 50.4 $\mu g/m^3$. Toluene concentrations ranged from 33.3 to 158.0 $\mu g/m^3$, ethylbenzene from 5.8 to 11.6 $\mu g/m^3$, m&p-xylene from 20.9 to 154.0 $\mu g/m^3$, o-xylene from 7.3 to 16.0 $\mu g/m^3$, and formaldehyde from 0.2 to 13.7 $\mu g/m^3$. The high concentrations in these ranges come out of one of the two Los Angeles studies for all of the pollutants, except ethylbenzene and o-xylene, which the Los Angeles studies did not consider. The low concentrations in the ranges given come from the Raleigh and Boston studies for all of the

pollutants except formaldehyde, which was measured at the lowest average concentration in the New York/New Jersey study. The research completed in Raleigh also reported average concentrations inside cars during highway driving: 9.9 µg/m³ for benzene, 34.5 µg/m³ for toluene, 6.7 µg/m³ for ethylbenzene, 23.1 µg/m³ for m&p-xylene, and 8.6 µg/m³ for o-xylene. During suburban driving, the New York/New Jersey study found average concentrations of 13.4 µg/m³ for benzene, 51.2 µg/m³ for toluene, 10.1 µg/m³ for ethylbenzene, 29.2 µg/m³ for m&p-xylene, 12.5 µg/m³ for o-xylene, and 0.4 µg/m³ for formaldehyde. In both of these studies, in every case except that of formaldehyde, the in-car concentrations were significantly higher during urban driving than during suburban or highway driving.[8]

The New York/New Jersey study also showed that improperly maintained vehicles may have significantly higher in-car VOC concentrations than well-maintained vehicles. A car in the test with a malfunctioning carburetor, under some driving conditions, registered more than 12 times the benzene, 5 times the toluene, 44 times the ethylbenzene, 23 times the m&p-xylene, and 40 times the o-xylene found in a properly maintained car on the same suburban test route.[9]

A Harvard School of Public Health study published in 1991 compared in-car VOC concentrations to those measured just outside the automobile passenger compartment, at the roadside, and at nearby fixed-site monitoring stations away from

In-Car and Fixed-Site VOC Concentrations in Raleigh



	Benzene	Toluene	M&p-xylene	Total of 24 VOCs
City In-car	13.8	59.1	39.5	424.1
City Fixed site	2.4	12.1	7	91.3
Interstate In-car	9.5	32.4	22.3	233.5
Interstate Fixed site	1.6	4.5	3	31.5
Rural In-car	1.5	5.2	3.7	53.2
Rural Fixed site	0.7	1.8	0.8	14.8

Source: Chang-Chuan Chan, et al., Environmental Science and Technology, 1991.

the roadway. The project also looked at in-car VOC concentrations at different times of day and on different types of roadways. (See graphic, p. 15.)

For benzene, 1,3-butadiene, toluene, m&p-xylene, o-xylene, and most of the 19 other VOCs measured, concentrations in the automobile passenger compartment were roughly the same as concentrations in the traffic stream immediately outside of the car. This was the case whether the vehicles were driven with the windows up or down and with the ventilation systems on or off. In-car concentrations were slightly lower when cars were driven with their air conditioners on.

The average in-car benzene concentration (11.6 $\mu g/m^3$) was 6.1 times higher than the average in the ambient air at fix-site measuring stations and 1.7 times higher than at the side of the road. The maximum in-car concentration of benzene, 42.8 $\mu g/m^3$, was nearly five times higher than the maximum at roadside. The in-car 1,3-butadiene average concentration (3.3 $\mu g/m^3$) was 2.8 times higher than both the fixed-site measurement and the roadside average. Again the in-car maximum concentration (17.2 $\mu g/m^3$) was significantly higher (14.3 times higher) than the roadside maximum.[10]

In 1990, Lars Lofgren, et al., of the Chalmers University of Technology in Goteborg, Sweden, conducted one of the first European studies to measure the levels of VOCs inside automobile passenger compartments. The researchers found total VOC concentrations inside cars during commuter trips in heavy traffic ranging from 200 to 400 $\mu g/m^3$. The researchers did not consider levels of VOCs at the roadside or in the ambient air, but did determine that in-car total VOC levels were 6 to 11 times higher than levels measured inside commuter trains making the same trips.

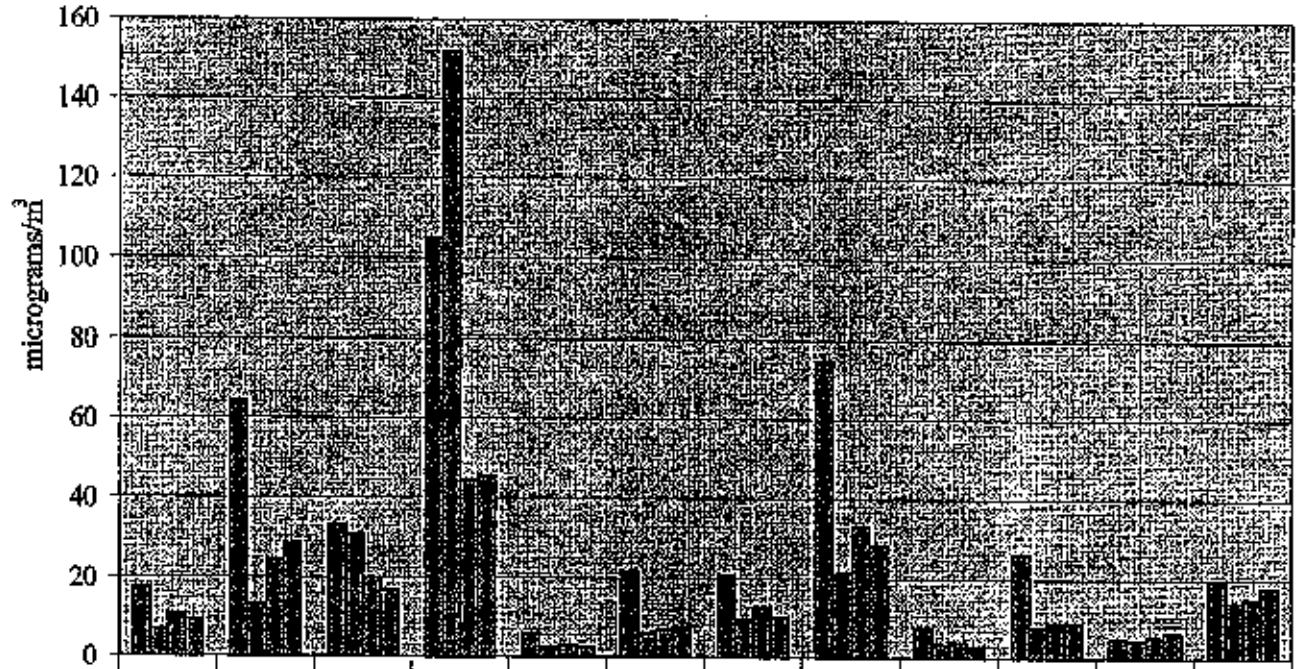
Benzene levels inside automobiles averaged 57.1 $\mu g/m^3$, nearly nine times higher than the average concentration of 6.6 $\mu g/m^3$ measured inside the commuter trains. The study found similar ratios for toluene (99.9 $\mu g/m^3$ in-car, 8.1 times higher than in-train), ethylbenzene (17.9 $\mu g/m^3$ in-car, 8 times higher than in-train), m&p-xylene (58.9 $\mu g/m^3$ in-car, 7.9 times higher than in-train), and o-xylene (23.0 $\mu g/m^3$ in-car, 7.9 times higher than in-train).[11] Lofgren and his colleagues reported that in-car concentrations for all of the VOCs reached their peak during commuter trips marked by heavy traffic or frequent stops at traffic lights behind other vehicles.

A second study published in 1991 by researchers from the Harvard School of Public Health compared the exposure to six different VOCs of automobile, subway, bicycle, and pedestrian commuters. (See graphic, p. 17.) The average concentrations of benzene, toluene, ethylbenzene, m&p-xylene, and o-xylene were higher inside automobiles than inside subway cars or in the air breathed by pedestrian or bicycle commuters. Formaldehyde concentrations were slightly higher for pedestrians and bicycle riders than for drivers and subway riders. For benzene, the average concentrations were: 17.0 $\mu g/m^3$ inside the cars (with a maximum concentration of 64 $\mu g/m^3$), 6.9 $\mu g/m^3$ in subway trains (13.5 $\mu g/m^3$ maximum), 10.6 $\mu g/m^3$ for pedestrians (24.2 $\mu g/m^3$ maximum), and 9.2 $\mu g/m^3$ for bicyclists (28.0 $\mu g/m^3$ maximum). For toluene, ethylbenzene, m&p-xylene, and o-xylene, concentrations inside cars ranged from 1.1 to 2.3 times higher than in subway cars, from 1.6 to 1.9 times higher than in the air breathed by pedestrians, and from 2.0 to 2.4 times higher than in the air breathed by bicyclists.

—Harvard researchers found that the daily commute accounted for 21% of car drivers' total benzene exposure

This study looked beyond the concentrations of the pollutants in different commuting environments by considering both the levels of VOC exposure and the average length of time that commuters were exposed. Thus, automobile drivers, with an average commute of 76 minutes, would have to be exposed to significantly higher concentrations of VOCs than subway commuters, who

Boston Commuters' Exposure to VOCs



	Benzene		Toluene		Ethybenzene		M&p-xylene		O-xylene		Formaldehyde	
	mean	max.	mean	max.	mean	max.	mean	max.	mean	max.	mean	max.
Car	17	64	33.1	105.1	5.8	21.6	20.9	74.6	7.3	26.1	5.1	19.7
Subway	6.9	13.2	30.8	151.7	2.5	5.8	9.8	21.6	3.6	7.8	4.5	14.1
Pedestrian	10.6	24.2	19.8	44.3	3	6.8	12.6	32.9	4.1	8.9	5.5	15.1
Bicyclist	9.2	28	16.3	45.1	2.4	7.1	10	28.3	3	8.9	6.3	18

Source: *Chang-Chuan Chan, et al.*, Journal of Air & Waste Management, *1991.*

Concentrations of benzene, a known carcinogen, reach levels inside automobiles nearly two-and-a-half times higher than in the air breathed by bicyclists, according to a Raleigh, NC, study.

took an average of 87 minutes getting to and from work, to have a higher total exposure. For benzene, ethylbenzene, m&p-xylene, and o-xylene, this was indeed the case—the total exposure of automobile commuters exceeded that of subway commuters despite the car drivers' shorter commutes. For toluene and formaldehyde, however, the longer commuting time pushed the exposure of subway riders slightly above that for auto commuters. In all cases, the total VOC exposures for bicyclists, with an average commute of 54 minutes, and pedestrians, with an average commute of 47 minutes, fell well below those of automobile and subway commuters.

The Harvard study also measured typical VOC levels in the commuters' homes and offices. Using these data, the researchers determined that the daily commute accounted for approximately 21% of automobile drivers' benzene exposure each day, with the commute contributing from 13% to 20% of the drivers exposure to the other four VOCs measured in the study. Thus, the drivers were breathing in more than one-fifth of the total amount of benzene they inhaled over the course of an entire day during the one hour and fifteen minutes they spent in their cars. For train commuters, the trip to and from work accounted for 10% of their daily benzene exposure and 11% to 13% of other VOC exposure.[12]

Three European studies published during 1995 and 1996 also compared the exposure to VOCs of people using different types of transportation. In the first, Joop H. van Wijnen, et al., measured the exposure of automobile drivers and bicyclists in and around Amsterdam to VOCs and other pollutants on different types of roadways and at different times of the year. The study also incorporated the exposure of pedestrians walking along an inner-city route during the summer. In-car exposures to benzene, toluene, and xylenes (these research-

ers did not differentiate between the different xylenes) were consistently higher than the exposures of bicyclists and pedestrians. Drivers along inner-city routes were exposed to average benzene concentrations ranging from 43 to 74 $\mu g/m^3$, which were 1.9 to 4.1 times higher than the concentrations in the air breathed by the bicyclists. Drivers' exposure to toluene was 2.2 to 3.9 times greater than that of bicyclists, while their exposure to xylenes was 2.0 to 3.8 times greater.

Analysis of exposure along rural routes was complicated by the fact that the average concentration of benzene and xylenes in the air breathed by bicyclists fell below the study's minimum detection level of 8 $\mu g/m^3$. In-car average concentrations of benzene and xylenes during tests conducted in May were 25 $\mu g/m^3$ and 50 $\mu g/m^3$, respectively. For toluene, in-car concentrations were 2.7 times higher than those in the air breathed by bicyclists during tests conducted in January and 6.5 times higher during the May tests.

Van Wijen, et al., note that while the in-car concentrations of benzene, toluene, and xylenes is much higher than in the air breathed by bicyclists, the actual exposure of bicyclists to these pollutants may approach that of automobile drivers during trips of like duration. The reason for this is that a bicyclist inhales more than 2 times the volume of air inhaled by a car driver over the same period of time.[13]

In the second European study of VOC exposure, researchers considered personal-automobile, bus, subway, and pedestrian commuters in Paris. The average concentrations of VOCs inside cars on routes in central Paris were 46 $\mu g/m^3$ for benzene and 260 $\mu g/m^3$ for toluene. These were significantly higher than concentrations breathed by other commuters. These concentrations ranged from 12 to 25 $\mu g/m^3$ for benzene and 80 to 110 $\mu g/m^3$ for toluene.

Researchers also compared in-car pollutant levels of a gasoline-powered car and an electric vehicle, which emitted no VOCs. The two vehicles driving the same commuter route in and around Paris registered relatively similar average in-car concentrations of benzene, toluene, and four other VOCs, leading the researchers to conclude that the vast majority of in-car VOCs come from the exhaust of nearby cars on the road. Using data from this and other studies, the researchers also determined that the commute of non-smoking drivers with no inordinate occupational exposure to VOCs accounts for 20-30% of the individuals' total daily exposure to benzene.[14]

The final European study looked at the exposure of Swedish subway and bus riders to VOCs. The cumulative concentration of all VOCs averaged 217.3 $\mu g/m^3$ on local buses, 151.7 $\mu g/m^3$ on commuter buses, and 93 $\mu g/m^3$ on commuter trains. On comparable commuter routes, in-bus pollutant concentrations averaged between 11.7 and 27.0 $\mu g/m^3$ for benzene, while in-train concentrations were from 1.8 to 3.1 times lower. For all VOCs combined, in-train concentrations were 2.0 to 3.5 times lower than in-bus concentrations.[15]

Research by the Kyungpook National University, Taegu, South Korea, compared personal exposure to five VOCs (benzene, toluene, ethylbenzene, m&p-xylene, and o-xylene) during personal-automobile and bus commutes along three different suburban-urban routes in that Asian city. Average in-car concentrations of each of the pollutants were higher than average in-bus concentrations on every route. The total average concentration of the five VOCs measured during urban commutes was 191.4 $\mu g/m^3$ inside the automobiles and 142.8 $\mu g/m^3$ inside the buses. The concentration of benzene inside the cars was more than 50% greater than the concentration inside the buses. Concentrations of the other measured VOCs were from 25% to 37% higher inside the cars than inside the buses. Comparatively, results from tests on suburban commutes were similar, though, as we might expect, in-car and in-bus concentrations of all the VOCs were slightly lower.[16]

The 1998 California Air Resources Board study measured 13 different VOCs inside a pair of cars on a variety of roads in Los Angeles and Sacramento, immediately outside of the cars in the traffic stream, and at the roadside. (See charts, p. 20-21.) In almost every instance, concentrations of benzene, 1,3-butadiene, m&p-xylenes, o-xylene,

Benzene Levels Measured in the 1998 CARB Study

Type of Road	Mean In-Car Car 1	Mean In-Car Car 2	Maximum In-Car Car 1	Maximum In-Car Car 2	Ambient Air	Roadside Mean	Roadside Max.
Los Angeles							
Arterial, Non-rush hour	16.7	13.9	19.0	14.7	6.6	nd	nd
Arterial, Rush hour	14.5	12.5	20.7	14.9	2.8	5.2	8.5
Freeway, Non-rush hour	14.4	12.5	15.1	12.8	3.9	nd	nd
Freeway, Rush hour	14.4	15.5	21.9	20.2	4.0	11.8	19.5
Freeway, Carpool lane	12.7	17.4	14.8	18.6	3.0	11.2	12.5
Sacramento							
Arterial, Rush hour	12.1	11.2	15.2	13.9	2.9	5.0	5.9
Freeway, Non-rush hour	6.5	7.2	7.4	7.6	0.9	1.0	1.4
Freeway, Rush hour	10.3	13.9	13.9	15.9	1.4	2.6	5.3
Rural	3.1	2.0	3.1	2.0	nd	1.0	1.1

Note: nd = no data available.
Source: California Air Resources Board.

ethylbenzene, toluene, and formaldehyde inside the test cars exceeded those measured immediately at the roadside and in the ambient air measured at remote fixed sites.[17] The in-car concentrations of all the VOCs generally were very similar to those measured in the traffic stream immediately outside of the vehicles.

In the Sacramento tests, the highest average in-car concentrations of all the VOCs occurred during rush hour on arterial and freeway routes. Average in-car benzene concentrations on these runs ranged from 10.3 to 13.9 µg/m³, while roadside measurements during these tests revealed average concentrations of 2.6 to 5.0 µg/m³. While the in-car and roadside benzene concentrations were lower on rural roads and freeways during non-rush hour, in-car concentrations still measured 2 to 7 times greater than the roadside concentrations. For toluene, average in-car concentrations ranged from 3.2 µg/m³ in one of the test cars on a rural route to 35.4 µg/m³ on an arterial road during rush hour. Roadside measures were 2.2µg/m³ on the rural route and 12.3 µg/m³ along side the artery. Average m&p-xylene concentrations ranged from 1.8 µg/m³ inside one of the test cars on a rural road to 31.0 µg/m³ inside a test vehicle on an artery during rush hour. The average roadside measures were 1.2 µg/m³ and 8.9 µg/m³, respectively.

Toluene Levels Measured in the 1998 CARB Study

Type of Road	Mean In-Car Car 1	Mean In-Car Car 2	Maximum In-Car Car 1	Maximum In-Car Car 2	Ambient Air	Roadside Mean	Roadside Max.
Los Angeles							
Arterial, Non-rush hour	44.4	32.8	53.9	38.2	23.2	nd	nd
Arterial, Rush hour	37.0	30.1	49.6	34.0	9.6	16.4	27.4
Freeway, Non-rush hour	38.8	33.0	42.3	37.5	39.9	nd	nd
Freeway, Rush hour	34.0	31.2	52.4	39.7	19.0	43.9	70.5
Freeway, Carpool lane	31.5	50.8	36.1	57.6	10.3	26.4	28.8
Sacramento							
Arterial, Rush hour	35.4	24.4	45.9	27.7	8.2	12.3	14.8
Freeway, Non-rush hour	13.1	15.3	17.0	15.7	5.8	6.2	9.3
Freeway, Rush hour	32.0	24.1	38.4	35.8	4.6	7.3	10.6
Rural	7.4	3.2	7.4	3.2	nd	2.2	2.2

Note: nd = no data available.
Source: California Air Resources Board.

M&P-XYLENE LEVELS MEASURED IN THE 1998 CARB STUDY

Type of Road	Mean In-Car		Maximum In-Car		Ambient	Roadside	
	Car 1	Car 2	Car 1	Car 2	Air	Mean	Max.
Los Angeles							
Arterial, Non-rush hour	35.5	23.7	43.6	27.3	9.4	nd	nd
Arterial, Rush hour	28.8	22.4	40.6	24.9	5.3	9.9	14.8
Freeway, Non-rush hour	26.9	27.7	21.5	23.4	5.7	nd	nd
Freeway, Rush hour	28.2	23.4	45.5	28.9	7.4	20.2	36.9
Freeway, Carpool lane	23.6	31.0	28.9	31.0	5.2	18.3	20.6
Sacramento							
Arterial, Rush hour	31.0	19.8	38.2	22.1	5.0	8.9	10.9
Freeway, Non-rush hour	12.6	11.0	12.7	11.0	1.8	2.6	3.5
Freeway, Rush hour	24.7	21.2	30.1	26.7	2.7	4.9	8.0
Rural	5.3	1.8	5.3	1.8	nd	1.2	1.3

Note: nd = no data available.
Source: California Air Resources Board.

Average in-car and roadside concentrations of all VOCs tended to be higher in Los Angeles than in Sacramento. For benzene, average in-car levels ranged from 12.5 µg/m³ for a vehicle on an arterial road during rush hour and for another on a freeway during non-rush hour (the Los Angeles tests did not include a rural route) to 17.4 µg/m³ for a vehicle in the carpool lane of a freeway during rush hour. Roadside concentrations averaged from 5.2 to 11.8 µg/m³. Despite the fact that one of the test vehicles on Los Angeles arterial roads during rush hour posted the lowest average benzene concentration in the Los Angeles tests, this vehicle's in-car concentration was still nearly two-and-a-half times higher than the average roadside concentration. The other vehicle on the same arterial non-rush hour route recorded an average in-car concentration nearly three times higher than the roadside average.

For toluene, average in-car concentrations ranged from 30.1 to 50.8 µg/m³, with a peak measurement of 57.6 µg/m³. Average ethylbenzene concentrations ranged from 5.7 to 9.7 µg/m³, and were up to 2.8 times higher than those measured at the roadside. M&p-xylene in-car concentrations averaged between 21.5 and 35.5 µg/m³ (up to 2.9 times roadside concentrations), while average o-xylene in-car concentrations were between 7.8 and 12.9 µg/m³ (1.1 to 2.7 times higher than at roadside). Average in-car formaldehyde concentrations ranged from 7.2 to 19.7 µg/m³.

SECTION FOUR

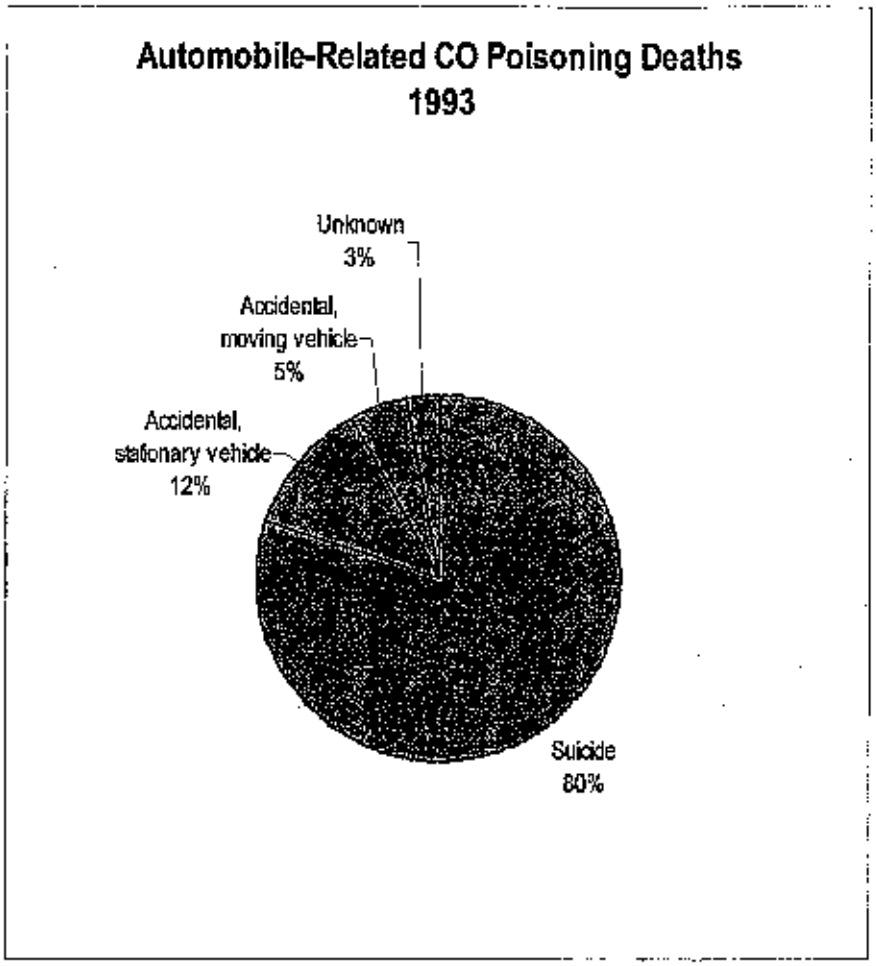
CARBON MONOXIDE

Carbon monoxide (CO), a very simple molecule consisting of a single carbon atom and a single oxygen atom, primarily enters the air we breathe as a gaseous byproduct of the incomplete combustion of hydrocarbon fuels, such as gasoline and diesel. A newer model, properly maintained car emits about 420 pounds of CO each year, while a newer model, properly maintained SUV emits about 547 pounds over the same period. Older vehicles and those with malfunctioning emissions-control systems can create much more CO.[1] A cold engine, whether or not it is properly maintained, emits significantly more CO than a warm one. Therefore, CO emissions and concentrations in urban and roadside air are often much higher during the winter months than in the summer. Nationwide, the exhaust from cars and trucks accounts for about 60% of the CO released into the air. In major urban areas, motor vehicles are responsible for up to 95% of CO emissions. CO disperses quickly in the air, so moderate and high levels of the gas are usually detected only in areas with significant motor vehicle traffic or within enclosed spaces where it may accumulate.[2]

CO is highly toxic and potentially deadly to humans and other animals. Each year, more than 10,000 people in the United States seek medical attention or are incapacitated for at least one day due to CO poisoning. Incidents in which people commit suicide by intentionally exposing themselves to CO in car exhaust have received significant coverage in the media and popular culture and number about 1,500 cases each year; it is less well known that an additional 1,500 people die from unintentional automobile-related CO poisoning annually. (See graphic, p. 24.) A study by the National Highway Traffic Safety Administration found that in 1993 nearly one-third of the accidental CO poisonings that resulted in fatalities and were caused by automobile exhaust involved drivers or passengers in moving vehicles.[3] Between 1977 and 1988, more than 1,100 people in the United States died due to accidental exposure to CO while they were driving or riding in moving vehicles.[4]

Health Effects of CO Exposure

Acute CO poisoning occurs when inhaled CO combines with hemoglobin in the bloodstream, thereby preventing the hemoglobin from supplying oxygen to the brain, heart, and other bodily organs and tissues. Low levels of CO, relative to levels of oxygen, in inhaled air can prove highly toxic because CO binds with hemoglobin some 200 to 230 times more readily than oxygen and, on top of that, CO can alter hemoglobin so that it is no longer able to deliver oxygen to organs and tissues. CO has no color, no smell, and no taste. Moderate exposure may produce flu-like symptoms--headaches, dizziness, and weakness–in healthy people. Therefore, many people who suffer non-fatal CO poisoning probably remain unaware that they have been exposed to the gas. It is likely that the majority of cases of acute poisoning



Source: Morbidity and Mortality Weekly Report, 1996.

go untreated and unreported, and the actual number of poisonings certainly exceeds the 10,000 cited above.[5]

Concentrations of CO inside properly maintained cars rarely exceed federal or international standards. However, acute poisoning of vehicle drivers and passengers may constitute less of a concern than the potential effects of chronic exposure. The health ramifications of long-term exposure to elevated CO levels are not fully understood. Preliminary studies indicate that regular exposure to even moderately elevated CO levels may carry some health consequences, especially among the elderly, people with cardiovascular diseases or lung dysfunction, and infants and unborn children. Meanwhile, numerous scientific studies have demonstrated that the driver and passengers in a motor vehicle potentially breathe in much higher levels of CO than people breathing normal, ambient air or even than people breathing air at the side of the road while the car is passing by.

In-Car CO Exposure Levels

At least 15 studies conducted during the 1980s and 1990s measured and examined the concentrations of CO inside vehicle passenger compartments, and a number of these studies compared in-car CO levels to those measured at the roadside, at remote fixed-site monitoring stations, or inside public buses, subway cars, or trains. The research shows that CO concentrations inside cars consistently measure higher than those at the roadside or inside other types of vehicles typically used for commuter transportation.

Researchers first discovered in 1978 that one of the strongest causal factors of elevated CO levels in passenger cars is other vehicles on the road; this conclusion grew out of research demonstrat-

ing that cars on cross-country trips following directly behind high-polluting vehicles, such as older cars lacking emissions-control systems, registered significantly elevated CO levels in their passenger compartments.[6] Since then, researchers have measured the interior CO concentrations of automobiles driving in numerous cities around the world and have considered such variables as road type, traffic conditions, vehicle speed, time of day, and

searchers measured average in-car CO concentrations ranging from 9.1 to 22.3 ppm. These compare to an average ambient air CO level, calculated from measurements at fixed stations near the commuter routes, of between 2.2 and 2.3 ppm. Typically the in-car levels were about seven times higher than those at the remote sites. CO levels for cars on one of the designated commuter routes in this study tended to be much higher inside cars

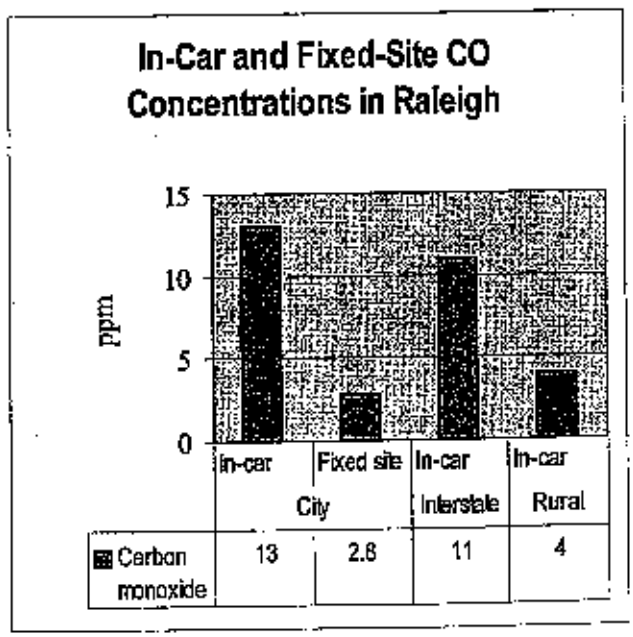
—Typical in-car CO levels were seven times higher than those at a nearby outdoor site in Washington, DC

"comfort state" (i.e., windows up or down, vents open or closed, etc.).

In 1982, William B. Petersen of the U.S. Environmental Protection Agency and Rodney Allen of Comp-Aid, Inc., measured CO concentrations inside cars on commuter routes in Los Angeles and compared them with levels just outside the vehicles and at remote monitoring stations nearby the commuter routes. They found that CO levels inside the test vehicles were nearly identical to those immediately outside the vehicles and were an average of nearly four times higher than levels recorded at remote monitoring stations. CO concentrations within vehicles traveling along these Los Angeles commuter routes where highest when the vehicles experienced heavy, stop-and-go traffic conditions. Under these conditions, peak CO levels frequently exceeded 40 ppm and sometimes exceeded 60 ppm. However, the in-car concentrations for these commuter routes never exceeded an hourly average of 35 ppm. Petersen and Rodney found that average CO concentrations in cars with their windows up were about the same as those with their windows down. Similarly, opening or closing the cars' vents had no significant effect on in-car CO concentrations.[7]

Peter G. Flachsbart, et al., reported even greater elevation of in-car CO levels compared to levels at remote measuring centers for Washington, D.C.-area commuters in 1987. During 213 automobile trips along routes through the metro Maryland, Virginia, and District of Columbia area, the re-

during evening commutes, even though ambient CO levels were slightly lower in the evening. This is because this route ended the morning commute and began the afternoon commute in an indoor parking facility. CO concentrations inside the garage averaged 20.9 ppm in the morning and 94.0 ppm in the evening. As previously mentioned, a cold engine produces more CO than a warm one. Multiple vehicle cold starts in the garage each evening when many commuters began their trips home at about the same time caused this extreme CO buildup in the parking structure. Interestingly,



Source: Chang-Chuan Chan, Environmental Science and Technology, 1991.

CO Levels Measured in the 1998 CARB Study

Type of Road	Mean In-Car Car 1	Mean In-Car Car 2	Maximum In-Car Car 1	Maximum In-Car Car 2	Ambient Air	Roadside Mean	Roadside Max.
Los Angeles							
Arterial, Non-rush hour	4.2	4.6	31.0	13.0	0.8	nd	nd
Arterial, Rush hour	4.2	4.4	48.0	11.0	0.0	0.6	7.0
Freeway, Non-rush hour	4.4	4.5	39.0	20.0	1.3	nd	nd
Freeway, Rush hour	5.1	5.4	67.0	22.0	0.5	3.1	11.0
Freeway, Carpool lane	3.5	4.9	12.0	22.0	0.0	3.6	10.0
Sacramento							
Arterial, Rush hour	2.3	3.0	16.0	14.0	0.0	0.4	8.0
Freeway, Non-rush hour	1.4	3.5	19.0	15.0	0.0	0.0	1.0
Freeway, Rush hour	2.1	3.1	17.0	52.0	0.0	0.3	4.0
Rural	0.7	0.4	22.0	6.0	nd	0.0	1.0

Note: nd = no data available.
Source: California Air Resources Board.

the vehicles on this particular test run showed extremely elevated in-car CO levels during the entire first leg of their homeward commute, indicating that residual CO from the high parking garage levels remained in the cars for a significant part of their commute home. Flachsbart, et al., also found a correlation between the speed of a test car on the commuter route and its average level of in-car CO. Increasing the vehicle speed from 10 to 60 mph decreased the average CO exposure by 35%.[8]

In 1991, researchers from the Department of Environmental Health, Harvard School of Public Health, compared in-car, out-of-car, and remote fixed-site CO measurements for a variety of urban, interstate, and rural routes in and around Raleigh, North Carolina. (See graphic, p. 25.) Overall, in-car CO concentrations ranged from 1 to 32 ppm, with an average of 11.3 ppm. This compares to levels of between 6 and 22 ppm with and average of 11.7 ppm on the immediate exterior of the car. Measurements at a nearby fixed site ranged from 1.7 to 5.5 ppm, with an average of 2.9 ppm. Thus, the average in-car CO level equaled nearly 97% of the car exterior average and was 3.9 times the average for the ambient air. This study found that in-car CO levels on urban streets and interstate highways were not significantly different, with median concentrations of 13 and 11 ppm, respectively. The median concentration of CO inside vehicles on rural roads, however, was substantially lower at 4 ppm. The researchers concluded that this fact is due to differing traffic densities, CO dispersion patterns, and air turbulence patterns.[9]

The California Air Resources Board, working with scientists from the Research Triangle Institute in North Carolina, conducted the most recent and most thorough project assessing CO concentrations inside automobiles. (See chart, this page.) This study measured the concentration of pollutants inside cars on various types of roads in and near Sacramento and Los Angeles. The CARB study included vehicles traveling under several different driving conditions and compared in-car pollutant levels to levels just outside the test cars and to levels at the side of the road. This differs from the previously cited studies, which reported CO concentrations from fixed-site monitoring stations that were near test routes, but not necessarily at the roadside.

Sacramento tests measured in-car CO concentrations on arterial roads during rush hour, on freeways during rush hour and non-rush hour, and on rural roads. Average levels in the main test car ranged from 0.7 ppm on the rural runs to 2.1 ppm on the arterial rush hour runs. The roadside CO concentration averaged 0 ppm for the non-rush hour freeway runs and the rural runs, 0.3 ppm for the freeway rush hour runs, and 0.4 ppm for the arterial road rush hour runs.

In Los Angeles, CARB ran tests on arterial

roads at rush hour and non-rush hour; freeways at rush hour and non-rush hour; and in car pool lanes of freeways at rush hour. Average in-car CO levels ranged from 3.5 ppm in the freeway carpool lanes to 5.1 ppm in regular freeway lanes during rush hour. The average peak CO concentration in the lead test car during the freeway rush hour runs was 34.0 ppm, compared to 26.5 ppm for freeway non-rush hour runs, and 9.0 ppm for freeway carpool lane runs. Researchers analyzed videotapes of driving conditions during the various runs to determine the causes of peak CO levels. Nearly all of the peak concentrations occurred when the test vehicle followed directly behind a heavily polluting vehicle in dense traffic. The highest peak CO concentrations occurred when the test vehicle was following an out-of-tune delivery truck and an older-model sedan.[10]

Several international studies have also measured and evaluated the exposure of automobile drivers and passengers to CO. A 1995 study of pollutant levels inside cars driving typical commuter routes in and around Paris reported average in-car CO levels of 12 ppm in central Paris, 10 ppm along a route from Paris to a western suburb, and 9 ppm along a route from Paris to an eastern suburb. This study also compared in-car CO concentrations on similar routes taken during the summer and the winter. In central Paris, CO concentrations averaged 15.3 ppm in the winter and 9.7 ppm in the summer. The seasonal difference in CO concentrations was less pronounced in cars traveling suburban routes. The Paris study found that CO concentrations at pedestrian sidewalks in central Paris were approximately three times lower than in the cars on the streets there.[11]

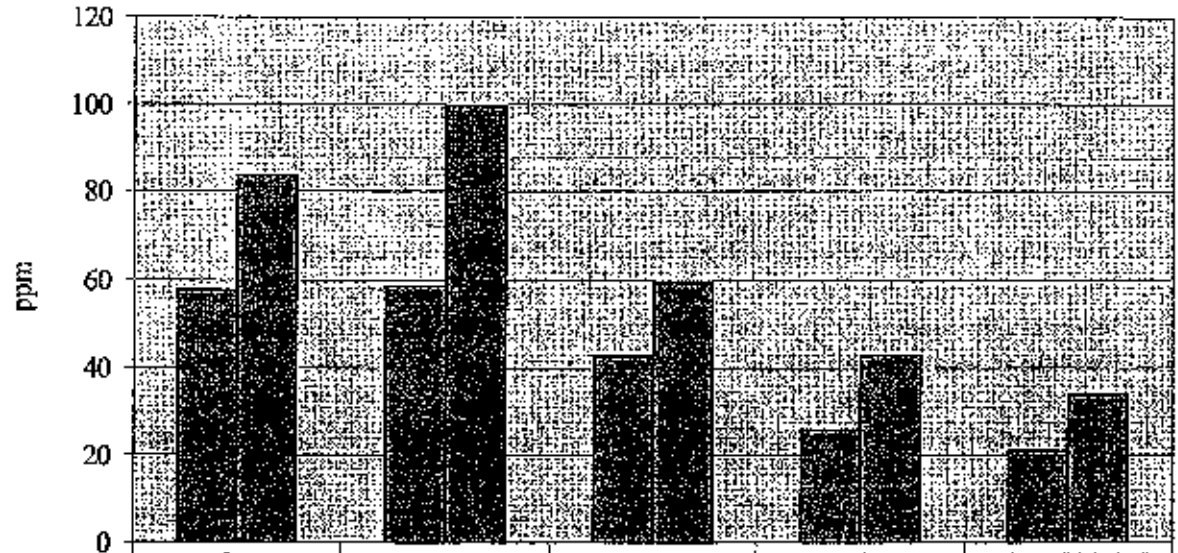
A 1997 study by researchers at the University of Nottingham found that drivers in that city in England were exposed to average CO levels of between 3 and 22 ppm. High concentrations typically resulted when the test car followed behind a particularly dirty lead vehicle and when the test car passed through extremely busy intersections. The study found only a very small correlation between meteorological effects, such as wind speed and direction, and in-car CO concentrations. Interestingly, the researchers reported that the speed of the test vehicle had no association with interior CO levels, independent of other traffic conditions. This suggests that other studies reporting a link between vehicle speed and in-car CO concentrations merely reflected the fact that cars tend to move more slowly in congested traffic where interior CO concentrations are likely to be high.[12]

Mexico City presents an interesting site for testing of in-car CO concentrations, because the city is notorious for its automobile-generated air pollution in general and its high ambient CO measures in particular. Readings at five fixed-site monitors around Mexico City in 1991 yielded average CO concentrations of between 7.2 and 11.3 ppm. Researchers Adrian A. Fernandez-Bremauntz and Michael R. Ashmore reported in 1995 that drivers and passengers in cars driving typical Mexico City commuter routes endured an average CO exposure of 56.1 ppm, more than five times ambient levels. The elevation of in-car CO levels was particularly pronounced during evening commutes, with in-car CO levels averaging six times those of ambient levels. During morning commutes, CO levels within cars were about 3.5 times the ambient levels.

Researchers explained that the high in-car CO measures in Mexico City are based on several factors. First, the city is located in a valley that acts as a sink to trap high levels of ambient CO. Second, Mexico has been slower than the United States to enact automobile emissions regulations. Finally, now that tighter emissions regulations for new cars are in place, these do not apply to many older cars

—The highest in-car CO concentrations in the CARB study occurred when the test vehicle followed an out-of-tune delivery truck and an older-model sedan

CO Concentrations Inside Vehicles in Mexico City



	Car	Minivan	Trolley	Transit Bus	Subway/Light Rail
Median	57.5	58.6	42.7	25.6	20.6
Maximum	83.7	99.7	59.4	42.4	33.5

Source: *Adrian A. Fernandez-Bremauntz, et al.*, Atmospheric Environment, 1995.

on the road in Mexico. Studies indicate that the average age of a car on the road in Mexico City is 11 years, and a high percentage of these older vehicles are not properly maintained.[13]

A 1992 study measured the interior and exterior CO concentrations for cars on commuter routes in Riyadh, Saudi Arabia, and considered traffic volume, vehicle speed, the period of the day, and wind velocity. Interestingly, this study also made measurements inside of cars whose occupants were smoking cigarettes. The average CO exposure of nonsmoking commuters ranged from 30 to 40 ppm during rush hour periods, which amounted to 84% of levels measured immediately outside of the vehicles. Traffic volume had the greatest influence on test cars' interior CO levels. Test cars on a road serving 5,000 vehicles per hour exhibited CO concentrations 71% higher than those on the same road serving 1,000 vehicles per hour. Average interior CO concentrations during non-peak traffic times ranged from 10 to 25 ppm. Vehicle speed also had an effect. A vehicle traveling 55 kilometers per hour had an interior CO concentration 36% lower than one traveling just 14 kilometers per hour. Again, however, this may be due to the fact that the slower vehicle was operating in heavier traffic. Predictably, smoking by automobile passengers had a noticeable effect on in-car CO concentrations. These levels often exceeded 100 ppm.[14]

Other Commuters' Exposure to CO

Several of the studies cited above compared the average CO exposure of automobile drivers and passengers to those of other commuters, including pedestrians, cyclists, and bus, train, and subway riders. The 1987 Washington, D.C., study found that average CO levels experienced by public bus riders were about half of those of automobile commuters, ranging from 4 to 8 ppm. Average CO levels inside subway cars were even lower—ranging from 2 to 5 ppm. Researchers found that the average CO exposure for bus riders was 2 to 6 ppm

higher than levels of CO in the ambient air. Some subway commuters actually breathed air with CO levels lower than in the ambient air.[15] The Mexico City studies revealed similar trends. (See graphic, p. 28.) The median CO concentration inside public buses was 30.2 ppm, compared to 25.6 ppm inside public trolleys, and 20.6 ppm on subway and light rail cars. These figures compare to a median concentration of 57.5 ppm in Mexico City cars. Average in-bus concentrations ranged from 2.5 to 4 times the ambient CO concentrations, while trolley concentrations were 2.5 to 3.5 times ambient concentrations and subway concentrations ranged from 1.7 to 2.5 times those of the ambient air.[16]

A 1995 research project conducted in and around Amsterdam used personal air sampling equipment to measure the exposure of pedestrians, bicyclists, and drivers on various types of roads to CO and other pollutants. Along an inner city route, the personal exposure to CO of automobile drivers averaged 4.23 ppm as measured by the personal air sampling devices (in-vehicle CO monitoring equipment reported somewhat higher concentrations). Bicyclists' personal exposure levels were much lower, averaging 1.65 ppm. Exposure levels of pedestrians in a much smaller study sample averaged 2.15 ppm. Along a rural route, CO exposure was very low for both drivers and cyclists.[17]

SECTION FIVE

NITROGEN OXIDES

Nitrogen dioxide (NO_2) is the best known of the nitrogen oxides (NO_x) and has been listed by the U.S. EPA as a criteria air pollutant under the Clean Air Act. NO_x contributes to the formation of ground-level ozone and acid rain. Chemical reactions involving NO_x in auto exhaust can lead to the creation of acidic particulate matter (see the section on PM above).

Health Effects of NO_x Exposure

Direct exposure to NO_x can irritate the eyes, nose, throat, and lungs, and can exacerbate respiratory diseases, including asthma and influenza. NO_x exposure can also reduce the capacity of the lungs to resist infectious viruses and bacteria, which could lead to increased incidence of colds, influenza, and pneumonia. Studies have associated exposure to concentrations of less than 30 parts per billion (ppb) with hyperactivity of airway muscles, and exposures as low as 15 ppb can cause nasal irritation and a cough. Research has correlated exposure to higher concentrations, around 80 ppb, with increased incidence of respiratory infections and sore throats. Children regularly exposed to NO_x levels of around 80 ppb may be more likely come down with colds and miss days of school.[1]

NO_x Exposure Studies

Chang-Chuan Chan, et al., of the Harvard School of Public Health measured in-car nitrogen dioxide (NO_2) on urban roads and interstate highways of between 8.0 and 196.0 ppb, with an average concentration of 87.3 ppb. Unfortunately, this study did not compare the in-car NO_2 levels with roadside or ambient air levels. The researchers concluded that in-car NO_2 levels were similar for vehicles on urban roads and on interstate highways.[2]

A more useful study for comparative purposes is one by Joop H. van Wijnen, et al., which examined the exposure of bicyclists, car drivers, and pedestrians in Amsterdam to NO_2 and other pollutants. Researchers found in-car NO_2 concentrations, measured via personal air sampling devices, ranging from less than 31 ppb on a rural route up to 144.5 ppb on a route that included a tunnel. On the rural route, the concentration of NO_2 in the air breathed by bicyclists averaged 47 ppb. On inner-city testing routes, average in-car NO_2 concentrations ranged from less than 31 ppb up to 90.8 ppb. Bicyclists on inner-city routes were exposed to

—The average NO_x exposure of a person driving a car was 370 ppb, compared to 130 ppb for a person bicycling on a city street

average NO_2 concentrations ranging from 49.6 ppb to 81.4 ppb. Pedestrians were exposed to an average NO_2 concentration of 55.3 ppb. The researchers found that the exposure of drivers to NO_2 was only slightly higher than that of bicyclers.[3]

An earlier study of pedestrians and bus commuters in Hong Kong found that on-bus NO_2 concentrations averaged about 76 ppb, compared to average roadside concentrations of 50 ppb. Average in-bus concentrations of NO, which makes up about 90% of automobile NO_x emissions, were more than 3 times higher than average roadside concentrations. The researchers determined that the air quality on city buses violated Hong Kong's Air Quality Objective for NO_2 during at least 10% of the measurements, while roadside NO_2 levels exceeded the Objective in less than 2% of the measurements.[4]

Finally, a 1989 report by the Transport and Road Research Laboratory in Berkshire, England, is interesting because it considers exposure to not just NO_2 but all forms of NO_x. This study reported that the average exposure of a person driving a car amounted to 370 ppb, compared to 130 ppb for a person bicycling on a city street.[5]

A study conducted in Hong Kong found that NO_2 concentrations inside transit buses exceeded those in the air breathed by pedestrians by 50%.

SECTION SIX

OZONE

Ozone is a molecule consisting of three bound oxygen atoms. Existing in the stratosphere, ozone protects us and other life forms on Earth from the destructive ultraviolet rays of the sun. Ground-level ozone, a byproduct of the internal combustion engine, constitutes the prime ingredient of urban smog and is highly harmful to human health. Cars and trucks do not directly emit ozone. Rather, VOCs and NO_x in auto exhaust react with sunlight to create the pollutant. Because sunlight and heat play a crucial role in the formation of ozone, smog levels are typically highest during the summer months.

Health Effects of Ozone Exposure

Ozone is highly caustic and prolonged exposure to elevated levels can damage lung tissues, exacerbate existing respiratory diseases, and decrease lung function. Short-term exposure can result in choking, coughing, burning eyes, and nasal and respiratory irritation. Repeated ozone exposures can diminish the body's ability to fight off respiratory infections and may be linked to scarring of lung tissues. Several studies have linked elevated ozone exposure to increases in visits to hospital emergency rooms by people with respiratory complaints. In fact, meta-analysis of a variety of studies indicates that hospitalizations for asthma, pneumonia, and chronic obstructive pulmonary disease increase by 6% to10% for every 50 ppb increase in peak ozone exposure.

Different people may have very different reactions to the same level of ozone exposure. For example, 10% to 20% of individuals may experience a 12% decline in lung function following one to two hours of exposure to 120 parts per billion (ppb) ozone. A few individuals may experience a 38% decline in lung function following six and a half hours of exposure to 80 ppb ozone. Children, the elderly, and people with existing respiratory diseases, such as asthma, tend to be most adversely effected by ozone.[1] Studies have also found a possible link between increased death rates and exposure to elevated ozone levels, especially among individuals over the age of 65.[2]

In-Car Ozone Exposure Studies

Despite the profound health implications of ozone, the concentration of ozone inside vehicles has not been well studied. From limited research, it appears that ozone is one of the few automobile exhaust-related pollutants for which concentrations tend to be lower inside vehicles than in the ambient air. There are several reasons for this. First, as noted above, automobiles do not directly emit ozone, but the pollutant is formed during a chemical reaction involving sunlight and other components of auto exhaust. Because the majority of in-car air pollutants consist of the exhaust of nearby vehicles, it is likely that the exhaust enters the automobile passenger cabin before significant amounts of ozone are formed. Second, ozone tends to quickly react with NO, the primary component of NO_x, which is likely to be present in high con-

centrations in air surrounding a busy roadway. Third, ozone tends to decay within the auto passenger compartment. Nonetheless, in-car ozone concentrations may still reach significant levels and further tests would seem to be in order.

In 1991, Chang-Chuan Chan et al. of the Harvard School of Public Health reported that the average ozone concentration inside test vehicles driving commuter routes near Raleigh, North Carolina, was 15.4 ppb, with a maximum concentration of 86.0 ppb. The highest in-car ozone concentrations occurred during afternoon driving. Ambient air measurements taken at a fixed site near the commuter route averaged 52.8 ppb with a maximum of 123.0 ppb. Unfortunately, the researchers did not measure ozone concentrations in the roadway or at the roadside.[3]

In 1995, Ted R. Johnson of International Technology Corp. conducted a study which determined the ratio of ozone detected inside test vehicles on roads in and around Cincinnati, Ohio, to that detected outside. Unfortunately, Johnson does not report the actual ozone concentrations but only that concentrations inside the test vehicles were approximately one-third of those outside.[4]

SECTION SEVEN

CONCLUSION

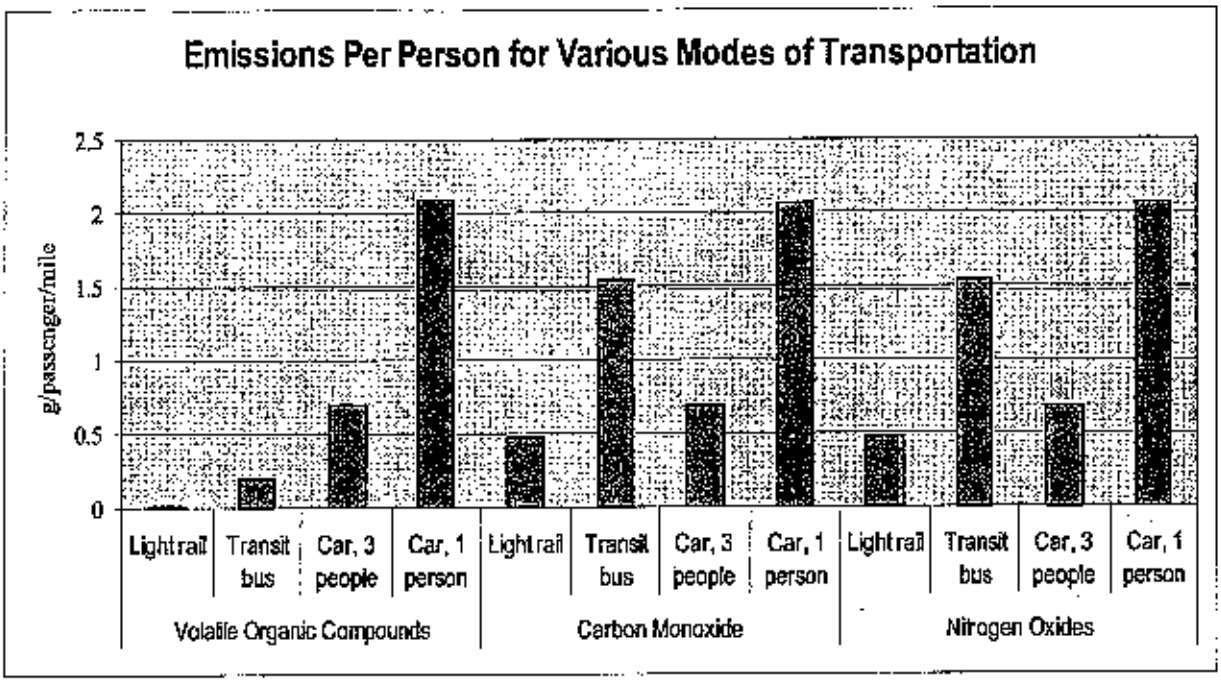
Studies conducted over the past two decades conclusively demonstrate that the shell of an automobile does little to protect the passengers inside from the dangerous air pollutants, including respiratory irritants, neurological agents, and carcinogens, commonly found in the exhaust of gasoline and diesel vehicles. In fact, the levels of exposure to most auto pollutants, including potentially deadly particulate matter, volatile organic compounds, and carbon monoxide, are generally much higher for automobile drivers and passengers than at nearby ambient air monitoring stations or even at the side of the road.

Similarly, drivers' exposures to these pollutants significantly exceed the significant exposures endured by bicyclists, pedestrians, and public transit riders. The amount of time Americans spend in their cars is increasing—not only are they driving more miles, but they are taking longer to get where they want to go. Several of the in-car pollution studies also considered pollution exposure in other environments and found that a person who commutes to and from work in a car each day may amass nearly a quarter of his or her total daily exposure to VOCs, PM, and other pollutants during those few hours he or she spends in the car.

Increased exposure to the pollutants in auto exhaust can produce serious health problems. Benzene is a known carcinogen, while several other VOCs and some forms of very fine PM are likely cancer agents. Nearly all of the pollutants covered by this report can irritate the eyes, nose, and respiratory systems of people exposed to them. They also may hinder the development of fetuses and infants. Studies indicate that CO, VOCs, NO_x, and PM can suppress the immune system, making people more vulnerable to colds, influenza, and other respiratory infections. Breathing elevated concentrations of PM in the air has been conclusively linked to increased hospital admissions and mortality. Studies also indicate that children, who breathe a proportionally greater volume of air based on body weight than adults, and people with pre-existing respiratory conditions, including asthma, face even greater risks than the general public from exposure to elevated levels of auto exhaust.

Policy Recommendations

There is no easy way to reduce the levels of in-car auto pollution exposure. Federal regulations require a significant minimal airflow from the outside of the car to the interior, even when the vents are closed. In the California Air Resources Board in-car pollution study, the lowest air exchange rate for a vehicle sitting still with the vents set to low was 1.8 air changes per hour (ach). An air change amounts to the complete exchange of the air inside the vehicle with air from the outside. The air exchange rate increases with vehicle speed; that is, the faster a vehicle is moving, the faster the air from the outside is vented inside, even if the vents are closed. At 55 miles per hour with the vents set



Source: APTA, Mass Transit—The Clean Air Alternative, 1991.

on low, the air exchange rates in the CARB study ranged from 13.5 to 39.0 ach. Thus, a complete air change occurred once every 1 ½ to 4 ½ minutes. Predictably, the rates were even higher with the vents open.

Standard filters do not significantly clean the air entering a car's passenger cabin. A number of the in-car pollution studies measured the concentrations of pollutants in the traffic stream just outside of the test cars and found that the in-car levels were nearly identical. VOCs, CO, and NO_x are microscopic gases and aerosols, able to easily pass through any filter that permits the exchange of air. One exception is coarse particulate matter, some of which automobile ventilation systems are able to filter out. However, filters can do little to stop the smallest of the fine particles, the ones most injurious to human health.

The studies show for all of the significant auto exhaust pollutants that elevated in-car levels are most closely associated with: 1). Congested traffic conditions, and 2). The proximity of high polluting vehicles, such as older-model cars, light trucks, diesel trucks and buses, and out-of-tune vehicles.

Get People Out of Their Cars

One step towards mitigating the problem of in-car air pollutants would be reducing the amount of congestion on highways and urban and arterial roads. Road construction is not the answer. Several studies indicate that building new roads or widening existing roads does little to alleviate congestion—more roads or bigger roads just bring more cars.[1] Americans now drive more miles each year than ever in the past. Since 1960, the total number of miles driven per year has tripled, while the number of miles traveled on local transit systems has only slightly increased. People use automobiles for more than 86% of local trips and nearly 80% of long-distance trips.[2] It is crucial to break this addiction to the automobile, and one solution is public transportation. On a per-passenger basis, a single-person automobile emits 209 times more VOCs than a transit train and 10.5 times more than a transit bus. Similar figures apply for other air pollutants. (See graphic, this page.) Aside from the reduced emissions associated with public transportation, an increase in ridership of trains and buses would reduce traffic congestion and alleviate one of the factors responsible for high in-car pollution levels. There is also an added bonus.

According to the in-car pollution studies, passengers on transit buses and trains are typically exposed to much lower levels of O_3, NO_x, VOCs, and fine PM than automobile drivers and passengers.

Federal, state, and local governments must do more to promote the use of public transit. Government spending on road construction and maintenance currently dwarfs spending on public transportation. Additionally, federal tax incentives permit employers to write off up to $155 per month per employee for parking reimbursement. Until 1998, businesses could not deduct compensation for employees' public transportation expenses. Now, a transit deduction does exist, but it amounts to less than half of the parking allowance—$60 per employee per month.[3] Similar disparities exist in state and local tax statutes. This is no small matter—government parking subsidies may total between $108.7 and $199.3 billion dollars per year.[4] This inequity provides an incentive for commuters to choose their automobiles over public transportation options.

Federal, state, and local governments need to increase appropriations for public transit projects, especially in areas such as Los Angeles, Washington, DC, San Francisco-Oakland, Miami, Chicago, and Detroit, where road congestion and traffic delays are epidemic. They also should remove tax incentives that encourage people to drive to work and replace them with greater incentives for employers who promote public transportation and employees who choose to leave their cars at home.

Put Cleaner Cars on the Road

The second policy response to the in-car pollution problem should involve government support for vehicle technologies that do not choke the other cars on the road with toxic fumes. Researchers realized during the first studies of in-car pollutants that the very highest interior pollution concentrations often occurred when a test vehicle followed a high-polluting vehicle, such as an improperly maintained car or a diesel truck. The second arm of a policy response to the problem of in-car pollution should encourage the replacement of these high-polluting vehicles with more benign alternatives.

EPA has made great strides toward cleaning up new cars with its Tier 2 rule published late last year. The Tier 2 regulations will eventually result in new cars that are up to 75% cleaner than those being produced today. New sport utility vehicles and other light trucks will be up to 95% cleaner, once the final phase of the rule takes effect. The Tier 2 regulations are also important because they will ensure that the cleaner cars will have low-sulfur gasoline, which they need to function properly. One failing of the Tier 2 rule, however, is that it does nothing to promote the development and marketing of zero-emission cars and trucks, such as electric vehicles now in production and fuel-cell vehicles now in development.

Fortunately, the federal regulations allow the states to choose between Tier 2 and the California emissions standards, which include a zero-emissions-vehicle mandate. The California ZEV mandate requires automakers doing business in the state to ensure that 10% of their sales are ZEVs by 2003. The ZEV mandate comes up for review every two years with the next review scheduled for September 2000. It is crucial that the California Air Resources Board stave off pressure from the automakers and maintain a strong ZEV mandate. Not only would this help relieve the problem of elevated in-car pollution levels, but it would also help alleviate ambient air smog problems and reduce automobiles' production of carbon dioxide and other greenhouse gases that contribute to global warming.

Currently, several states in the Northeast, including Massachusetts and New York, have decided to adopt the California standards, including the ZEV mandate, using the federal Tier 2 standard as a backstop. Other states, such as New Jersey and Pennsylvania should do the same. Implementing the California ZEV mandate in these large new-car markets would create a significant incentive for automakers to develop and sell zero-emissions vehicles. This would allow all the drivers on the road to breathe a little easier. While the in-car pollution studies found that drivers of electric

vehicle experienced nearly the same in-car pollution levels as drivers of traditional cars, this is because the EVs were operating in traffic filled with polluting vehicles. If a higher percentage of the cars in the traffic stream produced zero emissions, in-car air quality for all vehicles would surely improve.

Diesel vehicles emit a large portion of the dangerous roadway exhaust that often poisons the passenger compartments of other vehicles on the road. The in-car pollution studies indicate that levels of PM can be up to eight times higher within a car following a diesel truck or bus than the air at roadside. Separate studies have linked exposure to elevated levels of PM to increased hospitalization and premature death, and possibly to cancer. EPA is now in the process of finalizing a rule that will clean up PM emissions from new diesel vehicles by 90% in 2007. However, the agency is under strong pressure from engine manufacturers and fuel companies to weaken the final rule. One of the most contentious issues involves the sulfur content of diesel fuel. For cleaner diesel technologies to work, clean fuel must be available. It is critical that EPA maintain a strong diesel rule that requires 100% of diesel fuel to be low-sulfur (less than 10 ppm) prior to 2007. Also, EPA should alter the final rule to encourage the development of even lower polluting alternatives, include zero-emission technologies.

Finally, according to a timetable set by the 1990 revision of the Clean Air Act, the EPA is due to propose regulations concerning cars' emissions of mobile source air toxics, which include many of the VOCs mentioned in this report. The EPA published a study on the toxics' health effects and emissions trends in 1993, but has not yet taken regulatory action. EPA delays led to a lawsuit which set a September 1999 deadline for the promulgation of a proposed rule. However, the Agency obtained an extension from the court and still has not acted. The EPA must end the delays and issue a strong mobile source toxics rule to limit the highly hazardous automobile and diesel truck emissions of benzene, toluene, 1,3 butadiene, xylenes, and other mobile source toxics.

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EXHIBIT LL

FY 2000
TRANSPORTATION PLANNING CERTIFICATION

SUMMARY REPORT

DETROIT, MICHIGAN
TRANSPORTATION PLANNING PROCESS

Prepared by
Federal Highway Administration
Federal Transit Administration

June 14-15, 2000

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Executive Summary

On June 14-15, 2000, the Federal Highway Administration (FHWA) and the Federal Transit Administration (FTA) conducted the third certification review of the transportation planning process in the seven county southeast Michigan area. FHWA and FTA are required to jointly evaluate the planning process for each urbanized area over 200,000 in population at least every three years and determine if the process meets the Federal planning requirements. The first certification for the southeast Michigan metropolitan area was conducted in 1994. The second certification was conducted in July 1997.

The transportation planning process is making good progress in implementing national initiatives in the areas of job access and reverse commute, and development of a regional Intelligent Transportation System architecture. The process has responded to FHWA's state initiatives in timely updates of the Regional Transportation Plan (RTP), revenue forecasts for the RTP, and development of a TIP management process. SEMCOG, and its planning partners, are recognized as national leaders in incorporating safety considerations in the development of transportation plans and programs.

The Federal review found that the transportation planning process being conducted in the southeast Michigan area continues to make progress in implementing the planning framework adopted in 1997.

Implementation of a Congestion Management System and opportunity for public comment on air quality analyses were identified as areas where additional work is needed to fully meet Federal planning expectations. The MPO staff is also working on process improvements in the areas of public involvement and the consideration of the Environmental Justice effects of transportation plan and program decisions.

The review team received a significant amount of public comment on the transportation planning process in southeast Michigan. The public made specific suggestions on improving the transportation planning process or products of the process. MDOT, SEMCOG and the transit operators should seriously consider how they will respond to the suggestions made by their citizens.

Through the certification process, we also provide comments and recommendations on how the planning process or the products of the planning process could be improved. The review team identified opportunities for strengthened regional leadership in transit and land use planning and the development of technical tools for establishing regional priorities. This report highlights areas of good performance and contains recommendations for continuing quality improvements that should be implemented in a timely manner.

I. Introduction and Background Information

The FHWA and FTA are required to jointly review and evaluate the transportation planning process in all Transportation Management Areas (TMA)--urbanized areas over 200,000 population--on a 3-year cycle to determine if the process meets the Federal planning requirements. The resulting certification is a prerequisite to the approval of Federal funding for transportation projects in such areas. The certification review also provides an opportunity the Federal agencies to provide assistance on new programs and to enhance the ability of the process to provide decision makers with the knowledge they need to make well-informed capital and operating investment decisions. The first review for the southeast Michigan area was conducted in 1994 and the second in 1997. A summary of progress in addressing the findings from the second review is provided in Appendix F.

This was the third certification review in the southeast Michigan metropolitan area and consisted of a formal site visit and one public meeting. The site visit was conducted on June 14-15, 2000, and the public meeting was held on the evening of August 16, 2000. The public meeting was originally scheduled for the evening of June 13, 2000, but was delayed because of an electrical outage in downtown Detroit. Participants in this review included representatives of FHWA, FTA, the Michigan Department of Transportation (MDOT), the Ann Arbor Transportation Authority (AATA), the Ann Arbor/Ypsilanti Urban Area Transportation Study (UATS), the St. Clair County Transportation Study (SCCOTS), the Suburban Mobility Authority for Regional Transportation (SMART), and the Southeast Michigan Council of Governments (SEMCOG). A list of participants is included in Appendix B. A desk audit of current documents and correspondence was completed prior to the site visit. In addition to the formal review, routine oversight mechanisms provide a major source of information upon which to base the certification findings.

The certification review covers the transportation planning process conducted cooperatively by the Metropolitan Planning Organization (MPO), MDOT, and the public transit operators. SEMCOG is the designated MPO for the seven county southeast Michigan area, MDOT is the responsible state agency and DDOT, SMART, AATA, Blue Water Area Transportation Authority (BWATA), Lake Erie Transportation Commission (LETC), and Livingston Essential Transportation Services (LETS) are the responsible transit agencies. Current membership of the SEMCOG is primarily elected and appointed officials. The study area includes all of Livingston, Macomb, Monroe, Oakland, St. Clair, Washtenaw, and Wayne Counties. SEMCOG is the largest MPO in Michigan, with a 1990 study area population of 4,590,468. The population is expected to grow to 5,429,000 by 2025. SEMCOG includes two of the five TMAs in Michigan (Detroit and Ann Arbor), the Michigan portion of the Toledo, Ohio TMA, and the Port Huron urbanized area. Separate but coordinated sub-studies are conducted in Washtenaw County for the Ann Arbor/Ypsilanti urbanized area and in St. Clair County for the Port Huron urbanized area.

The items selected for on site review included:

- Status of recommendations from previous certification review
- Status of implementing the adopted planning process

- The transportation plan update/amendment process
- Process integration among the planning partners
- The process for developing a financial plan
- Relationship of TIP projects to the transportation plan
- Consideration of Environmental Justice/Public Involvement Plan
- Access to jobs
- Status of implementation of a CMS
- ITS consistency with national architecture

The report and appendices provide additional background information, key findings, commendations, corrective actions, and recommendations related to these items.

II. Job Access and Reverse Commute

Background

The review team provided an overview of the FTA program called Job Access and Reverse Commute (JA/RC). The objective of this program is to enhance the ability of welfare recipients and low-income individuals to get to jobs and related activities. In 1999 there were over 300 applicants with 60 to 70 selected to receive grants. For 2000 there is $75M available but it is expected that much of it will be "earmarked" by congress.

Findings

SEMCOG applied for second round JA/RC funding. They also applied for and received funding from MDOT, the U.S. Department of Labor, and the Family Independence Agency (FIA) for transportation to work programs for low-income persons. SEMCOG managed a regional consortium that developed the *Area-wide Job Access/Reverse Commute Plan for Southeast Michigan*. The plan recognizes the importance of using the existing transit systems and augmenting them with taxi and subscription van services when necessary. The consortium includes brokering of transportation services as well as a program for emergency rides and rides accommodating childcare. The plan also supports programs for individual car ownership and car/van pooling.

SEMCOG conducted a needs assessment that included interagency data collection; mapping of residential areas with concentrations of welfare recipients, major employment centers, licensed child care providers, and existing bus routes; and a spatial analysis of the mismatch between residences and existing jobs, services, and transit routes.

SEMCOG formed a task force along with the City of Detroit's Employment and Training Department and representatives of job placement agencies, the Wayne County FIA, transit providers, MDOT, and Child Care Coordinating Council. The task force has developed strategies for making transportation a resource, not a barrier, while seeking to understand the special transportation needs

of the region's various ethnic groups.

AATA has not applied for a JA/RC grant because Washtenaw County has an unemployment rate of less than 1%, which means that they could not meet the basic grant requirements. AATA has a guaranteed ride home program using shared ride taxi service when AATA is not operating. AATA indicated that there is a weakness in the job access program in Michigan because a lot of the transit service is provided on a county basis and it is hard to bridge services across county lines.

BWATA has not applied for JA/RC funds and is not currently in a position to apply. They are working with social service agencies to develop grant application materials in the near future.

Commendation

(1) SEMCOG is commended for taking a pro-active leadership role in the establishment of programs and services that connect people to jobs. SEMCOG, MDOT, and the transit agencies should continue their current activities to identify the location of welfare recipients and low-income individuals in the urbanized area and develop transportation programs to meet their needs.

III. Public Involvement Plan/Environmental Justice

Background

The team briefly reviewed (1) Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations," dated February 11, 1994, and (2) the U.S. Department of Transportation Environmental Justice Order published in the Federal Register on April 15, 1997. The consideration of environmental justice is not a new requirement. Federal agencies are taking opportunities, such as certification reviews, to remind recipients of Federal funds to seek early and continuing involvement of low income populations and minority populations in the development of transportation plans and programs. State, regional, and local agencies are required to assure meaningful community representation through effective public participation strategies. Although there is no standard formula for how environmental justice issues should be identified or addressed, agencies should consider the composition of the study area and how the benefits and burdens of transportation investments are distributed.

Findings

At the time of the office visit, SEMCOG was in the process of reviewing its public involvement processes. A special task force representing a wide range of population groups, including minority and low-income representatives was established to review SEMCOG's overall public involvement process. This Public Involvement Transportation Task Force has identified issues and concerns that need to be addressed. Among other things, the task force recommended that a citizen's guide to regional transportation planning be developed and that the public involvement plan be updated to

reflect current needs and practices. Results of the task force efforts were presented to the Transportation Advisory Council and Executive Committee in September 2000.

The SEMCOG Transportation Advisory Council is composed of local government officials, transportation technicians, special interest representatives as well as minorities and low-income representatives. This committee reviews the long range plan and project list and submits its recommendations to the Executive Committee. The TAC, Executive Committee, and General Assembly are open to the public and provide opportunities for public involvement.

SEMCOG had an extensive public outreach effort in the development of the 2025 Regional Transportation Plan (RTP) as documented in *Public Involvement in Regional Transportation Planning*. SEMCOG developed a three-phase public involvement plan, establishment of an oversight committee, educating and collaborating with the public, and post adoption publicizing of the plan. SEMCOG took specific actions to reach out to minority and low-income populations, including placing paid advertisement in various news publications reaching African-American, Hispanic, Asian-American, Native American and low-income residents and focusing efforts to meet with and present information to these various groups.

The oversight committee provided guidelines for plan development, reviewed technical information and offered guidance to ensure that plan priorities were truly representative of regional needs. SEMCOG identified venues for public input during the development of the transportation plan, many with multiple meetings. They had also made 32 presentations of the draft plan at the time of the certification review with additional presentations scheduled. SEMCOG will continue to make presentations on the 2025 RTP following its adoption as well as having a wide distribution of the plan document.

As part of the 2025 RTP process, SEMCOG staff identified all traffic analysis zones that have higher than the regional average percent population of low-income, African-American, Hispanic, Asian-American and Native American persons. The locations of projects were overlaid on maps of the protected populations and analyzed to ensure that project implementation would not negatively affect low-income populations or minority populations. There appeared to be a lack of projects in the City of Detroit. Staff investigation revealed that much of the funding for projects in Detroit was for projects that cannot be plotted on maps (e.g., safety and resurfacing projects). Staff also analyzed accessibility to jobs as an indicator of impacts on low-income populations and minority populations. From all of the analyses SEMCOG staff concluded, "that no disproportionately high and adverse effects on minority populations and low-income populations were anticipated as a result of implementation of the 2025 RTP."

Commendation

(2) We commend SEMCOG for implementing the recommendation from the Public Involvement Transportation Task Force on receiving public comment at public meetings. Instead of receiving comments only at the beginning of meetings, public comments are now solicited after each agenda item. Further we urge SEMCOG to complete development of a citizen's guide to regional transportation planning and the other task force recommendations.

Recommendation

(1) We recommend that MDOT, SEMCOG and the transit operators consult with the low income and minority populations in the development of a process for assessing the transportation needs in the region and in developing assessment techniques.

IV. Intelligent Transportation System (ITS) Architecture and Consistency Policy

Background

Section 5206 of TEA-21 requires federally funded ITS projects to conform to the national architecture and standards. Promoting and implementing ITS technologies in the largest metropolitan areas of the country, including the SEMCOG area, is a national priority. The review team heard a presentation from the SEMCOG staff regarding their activities in developing a Regional ITS consistency policy.

Findings

MDOT, SEMCOG and the transit operators recognize the importance of ITS to better manage and optimize the use of the infrastructure already in place in the metropolitan area. They understand the importance of ITS in resolving many of the congestion problems in the metropolitan area. SEMCOG has been a leader in promoting ITS in the metropolitan area through hosting seminars and workshops and participation on regional and national ITS committees. SEMCOG has been chosen by the Southeast Michigan ITS Task Force to be the champion in developing the regional ITS architecture. Federal regulations addressing this requirement are anticipated in the near future.

The AATA is currently in the third phase of providing real time information to customers at transit stations. Use of technologies such as an automated vehicle locator system allows AATA to dynamically display bus arrival times at their transit stations.

The Michigan Intelligent Transportation Systems Center (MITS) has expanded their coverage of monitoring the operation of the freeway system in the area. They are in the process of developing a five-year plan. They have about $40M worth of equipment on the ground and a $4M/year

replacement schedule for the next 10 years. General Motors Corporation has donated additional vehicles for the courtesy patrol so that coverage can be expanded. MITS is trying to get the courtesy patrol to be run from MITS so that all operations are run from one location.

Commendation

(3) We commend the SEMCOG staff for its leadership role in the ITS area and urge continued efforts to engage the stakeholders and facilitate the cooperative development of a regional ITS architecture.

V. Status of Implementation of a Congestion Management System

Background

The Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991 mandated the development of six management systems. Even though the National Highway System Designation Act of 1995 generally made the management systems optional, it did not change the requirement for development of Congestion Management Systems in urbanized areas over 200,000 population. The planning regulations in 23 CFR 450.320(c) and (d) state *"(c) In TMAs, the planning process must include the development of a CMS that provides for effective management of new and existing transportation facilities through the use of travel demand reduction and operational management strategies and meets the requirements of 23 CFR part 500. (d) The effectiveness of the management systems in enhancing transportation investment decisions and improving the overall efficiency of the metropolitan area's transportation systems and facilities shall be evaluated periodically, preferably as part of the metropolitan planning process."*

Findings

MDOT assumed the role of lead agency in the development of the management systems for all areas of the State. Following the passage of the National Highway System Designation Act, MDOT decided to continue the development of management systems but the pace of the development slowed. During the 1994 certification review, it was indicated that the CMS would be operational in the SEMCOG region prior to October 1, 1995. During the 1997 certification review, staff indicated that implementation of the State developed CMS was expected within the year. SEMCOG has the MDOT developed CMS which includes only State trunklines at this time. SEMCOG staff is developing methods for inputting local data into the State developed CMS

SEMCOG is in the process of developing a CMS, which they expect to have completed by the end of the year. SEMCOG is developing extensive tools for dealing with recurrent congestion including both travel forecasting and micro-simulation models. They are involved in numerous corridor studies to determine ways of addressing traffic congestion in the corridors. The SEMCOG staff promotes alternative commute options and integration of ITS strategies to help resolve congestion problems.

SEMCOG staff is collecting data on non-recurrent congestion from sources such as the Michigan State Police and the Freeway Courtesy Patrol. In the future SEMCOG plans to define additional performance measures, move to a new modeling platform which is more GIS compatible, incorporate the Regional ITS Architecture, develop a transit mode choice model, and enhance the relationship with other management systems.

Corrective Action

(1) As a TMA, the southeast Michigan urbanized areas must have a CMS that meets the requirements of 23 CFR 500.109. Work is well underway to develop a CMS for the southeast Michigan area, however, this effort has not been completed. The CMS for the southeast Michigan area must be operational by July 1, 2001.

Recommendation

(2) We recommend that the CMS, when completed, become one of the principal tools used to identify capacity deficiencies in the transportation plan development process and the primary mechanism to evaluate alternative solutions to those identified deficiencies.

VI. Process Integration Among Planning Partners

The 1991 ISTEA significantly enhanced the role of the planning process in establishing area wide transportation priorities. Across the country, the participants in the planning process reexamined the way they interacted to cooperatively produce plans and programs that were: financially constrained, offered increased opportunities for public involvement, conformed with air quality standards, preserved the existing system, and enhanced operations. These features were continued with the passage of TEA-21 in 1998.

Background

The cooperative aspects of the process in Michigan were put to the test in 1995. To the credit of those involved, a major effort to redesign the urbanized area transportation planning process produced a cooperative planning framework. This was an excellent undertaking and illustrated a strong commitment to the planning process in Michigan. A major goal of that effort, as mutually identified by MDOT and MPOs, was to create a single integrated cooperative planning process consistent with the Federal transportation planning regulations. A Memorandum of Understanding (MOU), referencing the newly adopted process, was signed by SEMCOG, UATS, SCCOTS and MDOT as a starting point for the planning partners to negotiate the details of how the how the parties would cooperate in carrying out each step. Overall, the collective effort of those involved has strengthened the partnership. A memo dated March 10, 1999, from SEMCOG to MDOT describes the agreement and time lines for implementing the planning process incrementally as new products are produced (see Appendix G).

Findings

The review team found that progress is being made in implementing the adopted planning process and in integrating procedures as evidenced by the mutual development of: a schedule for implementation; a process for preparing and managing the TIP; a revenue forecasting process for the Regional Transportation Plan; and the public involvement re-assessment effort. Additional opportunities for implementing other steps of the adopted process were also evident.

The review team found evidence of consultation and coordination among MDOT, SEMCOG, the county road commissions, other highway implementing agencies, and the transit operators through such things as participation on committees, requesting input on area transportation needs and sharing information. The review team found that the plan and TIP are assembled from components developed separately by the implementing agencies and then brought to the MPO committees for endorsement. Achieving cooperation requires working together, in an agreed upon way, throughout the planning process, not just comparing proposals prior to adoption. Federal regulations (23 CFR 450.104) define cooperation as *". . . parties involved in carrying out the planning, programming and management systems processes work together to achieve a common goal or objective."* See Appendix C for complete definitions.

Continued implementation of the adopted process provides the best approach for achieving the desired process integration and enhanced cooperation. The adopted process calls for cooperation at each step and agreement on how the parties will work together. As noted above, some new procedures are in place. Defining the methods to cooperatively achieve the remaining steps will give the partners a greater sense of collective ownership of decisions when establishing regional transportation priorities. In its most basic form, the overall success of the transportation planning process is linked to its ability to cooperatively produce a plan and a program that reflects regional priorities.

Commendation

(4) We commend MDOT and SEMCOG for developing a schedule for implementing the adopted planning process.

Recommendation

(3) We recommend that MDOT, SEMCOG, and the transit operators give continued attention to enhancing the cooperative procedures for carrying out the steps of the adopted planning process.

VII. Financial Plan

ISTEA called for the State and transit operators to provide the MPOs with estimates of revenues for use in developing plans and programs. TEA-21 modified that by saying that the State, transit operators, and MPOs should work together to develop estimates of revenues to be available for developing plans and programs.

2025 RTP Financial Plan--Background

SEMCOG staff began development of the 2025 RTP financial forecasts by reviewing the methodology and revenue projections that were developed for the 2020 RTP. The funding formulas and historic data on State gas tax distributions to local jurisdictions were used to forecast non-Federal user fee revenues, taking into account the recent increase in the State motor fuel tax. SEMCOG also analyzed non-user fee generated revenues that are used by local jurisdictions for transportation purposes. They found no trends but used averages to forecast future revenues.

The Federal funding from the second year of TEA-21 was used as a base for a straight-line projection of Federal revenues. SEMCOG and MDOT worked together to determine the split, on a statewide basis, between the amount of Federal revenues available to MDOT and the amount available to local governments.

MDOT and SEMCOG staff examined past spending practices and determined the percentage of expenditures that occur in the SEMCOG area and used that percentage to split the revenues between SEMCOG and the rest of the State. MDOT indicated that this is a model they intend to use for the other MPOs that are in the process of updating their transportation plans.

SEMCOG also worked with the transit operators in the development of mutually agreeable revenue forecasts for use in developing the transit portion of the transportation plan.

Findings

The review team found that use of a single revenue forecasting methodology for State, Federal and local revenues complies with the recommendation made in the previous certification review. The cooperative development of revenue estimates is one of the steps in the adopted planning process. The approach used in the financial plan covers funding from known and available revenue sources. There are no new or speculative funding sources identified in the financial plan.

Based on the revenue forecasts and historic expenditure patterns, funding targets were established for the Federal Aid Committee (FAC) for Livingston, Macomb, Monroe, Oakland and Wayne counties, and the City of Detroit, the Ann Arbor-Ypsilanti Urban Area Transportation Study, and the St. Clair County Transportation Study. The FACs, AAYUATS, SCOTTS, and MDOT develop lists of proposed improvements for their geographic areas within the expected funding targets.

Corridor studies are identified in the 2025 RTP and funding is reserved in the financial plan to

implement a limited number of the results of the studies. They are shown as studies only, not as assumed solutions, thus no funding is specified for particular corridors. For project development activities to proceed beyond the environmental feasibility phase, commonly referred to as early preliminary engineering (EPE), the results of the studies will need to be added to the transportation plan and the financial plan will need to show that full funding is available for the project.

Commendation

(5) We commend MDOT and SEMCOG for developing a cooperative revenue forecasting methodology for use in preparing the 2025 Regional Transportation Plan and urge MDOT and SEMCOG to share the cooperative revenue forecasting methodology with other Michigan MPOs.

TIP Financial Plan--Background

TEA-21 requires the State, MPO, and Transit operators to cooperatively develop a revenue estimate as a starting point for establishing TIP priorities.

SEMCOG and MDOT worked together to develop revenue estimates for the local jurisdiction projects portion of the TIP. Under Michigan law, "PUBLIC ACT 308 of 1998" requires that *"Twenty-three to 27% of the DOT-FHWA highway research, planning, and construction federal funds appropriated to this state from the Federal government for road and bridge construction will be allocated to programs administered by local jurisdictions."* Based on this State law and historic amounts provided to urbanized areas, SEMCOG staff allocated an amount of Federal funding for each county and the City of Detroit to be used on local jurisdiction roads.

Concurrent with this, staff of MDOT allocated the remaining amount of Federal funds for use through out the state on the State trunkline system by a work type template, which was developed in response to the Department's performance objectives. In order to achieve the future system condition identified by the template for preservation work, MDOT Regions received an allocation of funding in proportion to their needs. Revenues for improve and expand projects are allocated project by project on a statewide basis.

Findings

The review team found elements of a cooperative process in the development of revenue estimates for the local jurisdiction portion of the FY 2000 - 2002 TIP. The review team found that the revenue estimate for MDOT projects in the FY 2000 - 2002 TIP was provided by MDOT as a sum of the proposed expenditures taken from the MDOT 5-Year Road & Bridge Program.

Recommendation

(4) We recommend that MDOT, SEMCOG and the transit operators continue the cooperative development of revenue estimates for local jurisdiction projects and expand the cooperative process to include revenues that are expected to be available for MDOT projects.

VIII. Regional Transportation Plan

Background--Highways

The 2025 Regional Transportation Plan for Southeast Michigan (2025 RTP) was adopted on June 22, 2000, one week after the certification review, as an update to the 2020 Regional Transportation Plan. The 2025 RTP effort was guided by the 2025 RTP Committee comprised of staff of SEMCOG, UATS, SCCOTS, MDOT, FHWA, regional transit providers, county road commissions, and other local transportation agencies. Additionally, monthly progress updates and items needing formal action were provided to the Transportation Advisory Council. It was originally anticipated that the 2025 RTP would be a quick review and extension of the 2020 RTP forecasts. As the 2025 RTP Committee began work, however, the extent of the revisions and additions to the 2020 RTP increased the level of effort from that originally planned.

The SEMCOG staff identified three phases in the plan development: early plan development; draft plan evaluation; and plan approval. Early plan development included review of goals and objectives from the 2020 RTP; regional financial analysis; demographic changes; determination of needs to resolve capacity, pavement, bridge, safety, and transit deficiencies; and development of a draft plan and project list. The draft plan evaluation phase included analyses of financial constraint, air quality conformity, environmental justice, Federal planning factors, and regional goals and objectives. The plan approval phase included formal endorsement of the plan by the Transportation Advisory Council, approval by the Executive Committee, and adoption by General Assembly (which occurred on June 22, 2000).

SEMCOG held an outreach effort they called "Transportation 2000 and Beyond -- A Visioning Process" on September 29, 1999. One-hundred and fifty-five (155) people participated in the process through twenty-two small groups organized around specific topics within the areas of highways, public transit, freight and non-motorized. The problem most often identified by the groups was that there is not sufficient funding available to address all of the transportation problems in the region. More than 200 transportation issues and 150 potential solutions were identified through the visioning process. While the visioning process had input to the 2025 RTP, it is expected to have a greater impact on the next plan update, the 2030 RTP.

The adopted plan identifies a limited number of major improvements. The plan also identifies corridor studies currently underway along major routes or planned in the region. The financial plan assumes an investment level for implementing the results of the studies but does not indicate which ones. Additionally, it is planned that a freeway needs study will be started this fall to take a more comprehensive look at the freeway needs in the area. The 2025 RTP shows about 80% of available funding being spent on system preservation type activities and 20% being spent on capital needs

including safety, bridge, and capacity projects.

Findings

Past certification reviews have recommended that SEMCOG take a stronger leadership role in prioritizing deficiencies and suggesting solutions to the implementing agencies. Progress has been made in that direction by supplying the implementing agencies with lists of capacity, safety, bridge, and pavement deficiencies along with ranges of appropriate solutions based on the severity of the deficiencies. Implementing agencies that propose projects inconsistent with the regionally identified deficiencies or with the range of appropriate solutions are required to justify the proposed projects.

The plan accumulates projects developed by the implementing agencies. The use of funding targets, combined with a process where the FACs and MDOT choose projects for inclusion in the plan independently, creates a situation where there is no assurance that regional priorities are being addressed. The review team had difficulty identifying a regional vision for the transportation plan or that there was an analysis of tradeoffs among highway projects or between modes. It was difficult to find evidence that deficiencies had been prioritized on a regional basis or that improvements listed in the plan are addressing the highest regional priority needs.

Air quality conformity analysis on the RTP began in January 2000, with a meeting of the Interagency Work Group (IAWG) to review the proposed projects to determine those that are subject to the conformity requirements. Since that work group meeting, six additional non-exempt projects were added to the plan. The IAWG reviewed the projects and agreed that they were subject to the air quality conformity requirements. The review team found no evidence that the results of the second conformity analysis were taken to the public for review and comment.

Background--Transit

Provision of transit service for the Detroit metropolitan area has been an issue for a number of years. The existing transit providers are the Detroit Department of Transportation (DDOT), Suburban Mobility Authority for Regional Transportation (SMART), Ann Arbor Transportation Authority (AATA), Blue Water Area Transportation Commission (BWATC), Lake Erie Transportation Commission (LETC), Livingston Essential Transportation Services (LETS), and the Detroit Transportation Corporation, which operates the People Mover. Each of the transit agencies operates independently and serves specific geographic areas with little overlap or coordination of services. Recently there have been more efforts to coordinate schedules between DDOT and SMART to allow easier transfers between the two systems. The primary issue has been and remains whether there is a regional vision for the provision of transit service. A letter from FHWA to SEMCOG dated October 28, 1999, highlighted the importance of having "a region wide transportation vision and plan that considers all transportation modes and supports sustainable metropolitan community development and social goals." A copy of the letter can be found in Appendix H.

The 2025 RTP discusses a number of past or currently active transit corridor studies including the Woodward Avenue Corridor Transit Alternative Study; the Downtown Detroit to Detroit Metro

Airport Rail Study; the Detroit-Chicago High-Speed Rail Passenger Corridor Study; and the Lansing to Detroit Rail Study. However, there does not appear to be a source of funding to operate the system that would result from any of the studies. There is also discussion of two regional transit visioning studies, the *TransitChoice* vision developed by the Metropolitan Affairs Coalition in consultation with the Detroit Regional Chamber and the more recent *SpeedLink* Collaborative which includes the Metropolitan Affairs Coalition, Detroit Regional Chamber, Detroit Renaissance, and Greater Downtown Partnership. Neither of the above two studies have been included as a project in the transportation plan but the area is continuing to explore options for transit. SEMCOG held a transit visioning session on August 10, 2000, to continue the public dialog on the future of transit in the area.

The transit projects in the 2025 RTP continue the existing services and do not envision any significant change in the way transit service is provided. All projected Federal revenues are being used to upgrade facilities and replace buses.

Findings

MDOT, SEMCOG, and the transit operators do not have operational mode choice or transit network assignment models for the region. Without such tools, the ability to quantify choices; evaluate benefits and costs; and analyze tradeoffs among transit alternatives and between transit and highway projects is extremely limited. If transit visions such as *TransitChoice* or *SpeedLink* are to be seriously considered, the decision makers should have the benefit of the information that these tools can provide.

Plan Amendments--Background

Transportation plans are not static documents, conditions change and amendments are sometimes needed between scheduled updates. Unforeseen land development or unexpected special funding could prompt the need to reevaluate plan priorities and to consider an amendment. The decision making tools used to develop the plan and establish priorities are appropriate for use in the amendment process.

Findings

Since adoption in June 1997, the 2020 RTP was amended 3 times, adding a total of 17 projects. In most cases the plan was amended for projects that were ready to be constructed, but were not listed in the plan. The review team found that the 2020 RTP did not identify improvements to the major highway system beyond the first 5-years of the plan. As projects on these systems became ready, they were proposed for addition to the RTP. In each case the SEMCOG staff completed an analysis to demonstrate that the RTP remained in financial constraint and in air quality conformity.

The review team had difficulty finding evidence that available regional planning tools were used to evaluate the proposed amendments in the context of the adopted plan. The review team found that incrementally proposed additions, coupled with the absence of system level technical analyses, made

it difficult for decision makers to know if the proposed additions truly constituted the next set of regional priorities.

Commendation

(6) We commend MDOT, SEMCOG and the transit operators for consistently meeting the 3-year cycle for regional transportation plan updates.

Recommendations

(5) We recommend that MDOT, SEMCOG, and the transit operators develop and refine regional travel demand forecasting tools for both highway and transit modes, including methods for evaluating and establishing regional system wide priorities linked to area wide goals and objectives.

(6) We recommend that MDOT, SEMCOG, and the transit operators use these tools to develop a regional vision for transportation and a RTP that identifies cost feasible improvement priorities for both highways and transit over the 20-year plan horizon.

(7) We recommend that SEMCOG take a stronger role to encourage and assist in coordinating transportation services between DDOT, SMART and DCT.

(8) We recommend that all plan amendments and additions be subject to the same analyses recommended for the development of the RTP.

IX. Transportation Improvement Program

Background

SEMCOG staff described the procedures used in developing the local component of the Transportation Improvement Program (TIP). A revenue estimate and list of RTP projects is provided to the Federal Aid Committees (FAC) for Livingston, Macomb, Monroe, Oakland and Wayne counties, and the City of Detroit. The Ann Arbor-Ypsilanti Urban Area Transportation Study, and the St. Clair County Transportation Study each develop TIPs for their areas that are inputs to the SEMCOG TIP. Each FAC and transportation study is responsible for developing a prioritized list of projects within the revenue estimate for their area. SEMCOG staff, MDOT and the transit agencies sit on all the committees.

In conjunction with this discussion, MDOT staff described their Road Quality Forecasting System (RQFS). RQFS is a good technical process used to evaluate the condition of the trunkline system on a statewide basis. RQFS rates the roadway condition based on statewide goals set by MDOT for the freeway and non-freeway systems. Funds are allocated to MDOT Regions in proportion to their "needs" as defined by the system performance goals. The Regions then develop their repair, surface

and base program to meet the performance goals using RQFS and a pavement management system to choose the best mix of fixes. Project lists developed by the MDOT Regions are given to the MPO for review and inclusion in the TIP. MDOT staff indicated these lists are given to the MPO at least six months prior to TIP adoption in order to fit them into the program.

State trunkline "Improve" (adding lanes) and "Expand" (new roads) projects are developed and controlled at the MDOT central office in Lansing. The investment levels for these project priorities are set on a statewide basis within the State's investment strategies. As Improve/Expand projects are ready to be advanced, information is provided to the respective MPO for inclusion in the plan and TIP.

Each transit operator develops proposed transit projects separately within the amount of their expected FTA and state grants.

SEMCOG staff reviews the project listings from a regional perspective. The compiled lists of proposed projects (state and local, highway and transit) are then reviewed by the TIP Development Committee and recommended to the Transportation Advisory Council (TAC). The TAC reviews the TIP and recommends it to the Executive Committee for approval.

SEMCOG has developed "Transportation Improvement Program Development Policies" which describe policies for the development and modification of the TIP. The policies clearly indicate when the TIP must be amended and when it can be administratively changed. SEMCOG staff has authority to make administrative changes that it then reports back to the TIP Development Committee at the next meeting.

The TIP development policies include a schedule for processing amendments so that all project sponsors know when proposed changes must be submitted in order to get them amended into the TIP. The TIP policy document indicates the reviews that the projects undergo once they are submitted to SEMCOG. One of the reviews assesses consistency with the Regional Transportation Plan. If a project is not consistent with the plan, the TIP development policy document clarifies that the plan must be amended if the project is to advance.

The FY 2000-2002 TIP has been amended on the quarterly amendment schedule. The amendments have added hundreds of projects and hundreds of millions of dollars to the program. Sources of many amendments include the programs that are controlled on a statewide competitive basis that do not meet that TIP development schedule, such as the transportation enhancement and safety programs. The CMAQ program is also a source of many amendments. Outside of the off schedule programs, many amendments come from MDOT.

Findings

The review team found that good technical tools exist for implementing agencies to independently identify priorities within their jurisdictions. The effort by SEMCOG to identify RTP priorities for the implementing agencies at the beginning of the TIP development cycle is also commendable. In

addition, SEMCOG's TIP development policy is an excellent tool for managing the TIP and its amendments.

The review team found a regional approach at the start of the TIP development process and at the point of adoption by the MPO committee structure. In between, opportunities for a more regional approach were evident. Working with separate allocations of revenue the implementing agencies operate independently in establishing priorities for improvements within their jurisdictions. The final TIP then, accumulates the proposed improvements without a mechanism to determine if regional priorities (highway and transit) are being addressed.

Overall, the review team found that the TIP development and amendment process included opportunities for public review and for air quality conformity analyses. A gap was identified, however, in the TIP amendment process where the air quality conformity analysis often did not undergo a public review as required by the air quality conformity regulations and the State Implementation Plan for transportation conformity. The review team also identified instances where the conformity information was not available to the TAC at the time they are asked to take action on a TIP amendment.

The review team found that many TIP amendments were the result of statewide competitive programs such as the transportation enhancements and safety programs being out of sync with the TIP cycle. The next largest group of amendments were to MDOT projects, resulting from changes to their five-year program. In addition to getting programs on the same cycle, the review team found that the need for amendments could be reduced by more extensive use of groupings for projects that don't warrant individual inclusion.

Corrective Action

(2) The results of air quality conformity analyses for future TIPs and TIP amendments must be made available to the public for review and comment as required by *The Michigan Transportation Conformity Air Quality State Implementation Plan (SIP) Revision.*

Recommendations

(9) We recommend that MDOT, SEMCOG, and the transit operators move toward a TIP development process that more fully considers regional priorities for highway and transit improvements at every step, not just at the beginning and at the point of final approval.

(10) We recommend that MDOT, SEMCOG, and the transit operators develop time lines for the special programs consistent with the TIP cycle and consider grouping techniques to cover projects that don't warrant individual inclusion.

X. Public Comments

Background

A public input session was held on Wednesday, August 16, 2000, from 6:00 p.m. to 9:00 p.m. at the Cobo Center in downtown Detroit. The meeting was originally scheduled for Tuesday, June 14, 2000, but was delayed because of an electrical power outage. SEMCOG's mailing list was used to send out notices of the original and rescheduled meetings.

The public meeting is used to help the FHWA and FTA evaluate the effectiveness of the transportation planning process and its public involvement process. FHWA and FTA want to hear from the public about their experiences in interacting with the transportation planning process in the MPO area.

Forty people attended the meeting representing a wide spectrum of interests in the Detroit metropolitan area. Fourteen people gave oral testimony to the review team. Twenty-four non-duplicative written comments were submitted in response to the notice for the postponed meeting as well as the meeting held on August 16. Some of the comments were submitted more than once (e.g., mailed and faxed). Most of the people giving the oral testimony also presented a written copy of their comments. A court reporter was used to record the meeting. The public comments are on file at the Michigan Division Office of the Federal Highway Administration and are summarized in Appendix A

Findings

The notice of the public meeting reached a wide spectrum of the population in the planning area. The public comments demonstrated a strong interest in the planning process and underscored the public's desire for opportunities to have input to the plan development process. Many of the issues and concerns raised by the public are addressed by the review team's findings and recommendations.

XI. Summary and Certification Finding

The FHWA and FTA are required to jointly review and evaluate the transportation planning process in urbanized areas over 200,000 population on a 3-year cycle to determine if the process meets the Federal planning requirements. The resulting certification is a prerequisite to the approval of Federal funding for transportation projects in such areas. The certification review is also an opportunity to provide assistance on new programs and to enhance the ability of the process to provide decision makers with the knowledge they need to make well-informed capital and operating investment decisions.

This review assessed the status of the findings from the previous review and explored new items including: ITS Architecture, Environmental Justice, Job Access, Process Integration, and Financial Plans. The public also provided input to the review.

Overall the planning process conducted by MDOT, SEMCOG and the transit operators is addressing transportation issues facing the southeast Michigan area and the review team found a number of noteworthy examples of good practice. Good technical tools were being used to make decisions on individual projects and staff of SEMCOG has developed good TIP development and amendment policies. MDOT's pavement management system and a 5-year preservation program are also noteworthy. MDOT and SEMCOG have agreed on methods for developing revenue estimates for use in the RTP. MDOT, SEMCOG and the transit operators have a good start on the identification of low-income populations and minority populations and have made a good initial effort to evaluate the impact of the transportation plan on these populations.

The second certification, in 1997, identified opportunities for increased cooperation in preparing the RTP and TIP. Since that time the planning partners have made significant progress, developing a new framework for cooperative transportation planning and signing MOUs. Commitment to the adopted process is evidenced by MDOT and SEMCOG agreeing on a time schedule and steps to implement the adopted planning process.

While there was evidence of coordination and consultation in developing the 2025 RTP and the FY 2000 – 2002 TIP, the review team had difficulty identifying a cooperative process as required by the Federal planning regulations. The review team found that the RTP and TIP were assembled from components developed separately by MDOT, SEMCOG's Federal Aid Committees, and the transit operators.

Opportunities for increased regional leadership were identified for the development of technical tools to identify and prioritize needs, analyze alternatives, evaluate tradeoffs, and create a shared vision for the transportation plan for southeast Michigan.

The review identified two technical areas where the planning regulations were not being fully implemented. The area lacks an operational Congestion Management System as required in all TMAs. The required public comment period for air quality conformity analyses was also not being provided.

A full summary of the commendations, corrective actions and recommendations is provided in Appendix E.

Certification Finding

The transportation planning process for the Southeast Michigan area conducted by MDOT, SEMCOG, and the transit operators is certified subject to the corrective actions and recommendations contained in this report. The conditional certification does not restrict the advancement of projects, provided reasonable progress is made in addressing the findings of this review. From a Federal perspective, attention to these corrective actions is a high priority. The recommendations offer suggestions on items that would enhance the Southeast Michigan process and we urge a thoughtful consideration of these items. FHWA and FTA stand ready to assist MDOT, SEMCOG, and the transit operators in addressing the corrective actions and recommendations.

Appendix A

Summary of Public Comments

Citizen Input/Environmental Justice

A high priority issue identified by the public, was concern over their ability to influence the transportation decision-making process. Concern was expressed about the meeting time of the Transportation Advisory Council, the place on the agenda for public comment, their perception that by the time they see a proposed project it is already too late to influence it, and the need to have more end users of the transportation system on the Council. A commenter also questioned SEMCOG's sincerity in obtaining public input. Some felt that public comment was not welcome and that SEMCOG needed to do a better job of reaching out to the community.

Concern was expressed that the Environmental Justice evaluation of the 2025 Transportation Plan was flawed and confusing. It was felt that an evaluation of auto accessibility to jobs by protected populations is misleading when many households within the protected population groups do not have cars. The use of traffic analysis zones in the presentation of the results adds to the confusion since traffic analysis zones are a technical concept not understood by the public.

Transportation Plan

There were a number of comments related to the 2025 Regional Transportation plan and the process of developing the plan. Some comments questioned how realistic the long-range plan is since they felt that there was no serious consideration of transit or bicycling. There was concern that the plan was developed highway segment by highway segment without an overall system evaluation and that when a plan is developed in that manner there can be no serious consideration of the ability of transit to solve transportation corridor deficiencies. A comment suggested that the plan should include a cycling master plan and that cycling is not taken seriously as a transportation mode.

Related concerns were that planning for continued dependence on the automobile is "wrong." The plan should promote equity in funding among modes and; we should not expand a highway system that we cannot maintain.

Concern was expressed that the plan is a plan for sprawl and that if you plan for sprawl, it will happen. The projection of population and land use in a "business as usual" approach was accepted as fact rather than one way that the region might develop. The concern seems to be that there was no evaluation of alternative development scenarios.

The opinion was offered that the plan should protect and enhance the environment but fails to do so and that there should be an analysis of the emerging air quality issues of the 8-hour ozone standard and PM 2.5. It was felt by the commenters that the issues should be evaluated even though there is not a requirement to do so.

Transit Service

There were a number of comments about the existing transit service in Detroit. Most of the concern was directed at the service provided by the Detroit Department of Transportation (DDOT). Comments indicated that the service is becoming increasingly unreliable; the buses are dirty and not properly maintained; DDOT continues to cut service and; DDOT does not respond to suggestions or complaints.

The suggestion was made that SEMCOG should act as a transit ombudsman or an inspector general. In this role they would have authority to investigate complaints, call witnesses, and condition the receipt of Federal transit funding on the proper maintenance of buses. A related suggestion was that there should be a transit "Quality Management System" to assure that buses are properly maintained.

Federal Actions

There were a few comments suggesting that the USDOT mandate that SEMCOG take specific actions as a condition of continued Federal certification of the planning process. One was that we mandate that SEMCOG demonstrate clear support for public transportation by proposing timelines and budgets for implementation of an accessible and affordable public transportation system. A related suggestion was that we mandate that SEMCOG require communities to fund transit.

Another request was that we mandate that SEMCOG amend their bylaws to implement the concept of one person, one vote within the committee structure as well as in the voting process.

Other Comments

There were two comments supporting the planning process conducted by MDOT, SEMCOG, and the transit operators. They were from stakeholders indicating that they receive good service from the SEMCOG staff.

There was a letter from the taxi industry expressing concern that they are a major supplier of transportation services but have no opportunity for input in the planning process.

Appendix B

List of Participants

Federal Review Team:

Jim Cramer	Cindy Durrenberger	FHWA
Ashby Johnson	Mary McDonough Bragg	FHWA
Alicia Nolan		FHWA
Victor Austin		FTA Region V

Michigan Department of Transportation:

Denise Jackson	Renee Farnum
Gary Endres (6/15)	Steve Redmond (6/14)
Brad Funkhouse, University Region (6/14)	Jim Shultz, MITS (6/14)

Southeast Michigan Counil of Governments:

Paul Tait	Carmine Palombo
Kathleen Lomako	Jerry Rowe
Lore Watt Corradino	Stephanie Davenport
Sue Setler	

Ann Arbor Ypsilanti Urban Area Transportation Study

Robert Tetens	Terri Balckmore

St. Clair County Transportation Study

Grant Baumann

Ann Arbor Transportation Authority:

Chris White (6/14)

Suburban Mobility for Regional Transportation

Dan Dirks (6/14)	Jay Gardner

Others

Peggy Johnson, Eastern Michigan Environmental Action Council
Karen Kendrick Hands, Transportation Riders United

Appendix C

Definitions

23 CFR 450.104 Definitions:

- *Consultation* means that one party confers with another identified party and, prior to taking action(s), considers that party's views.

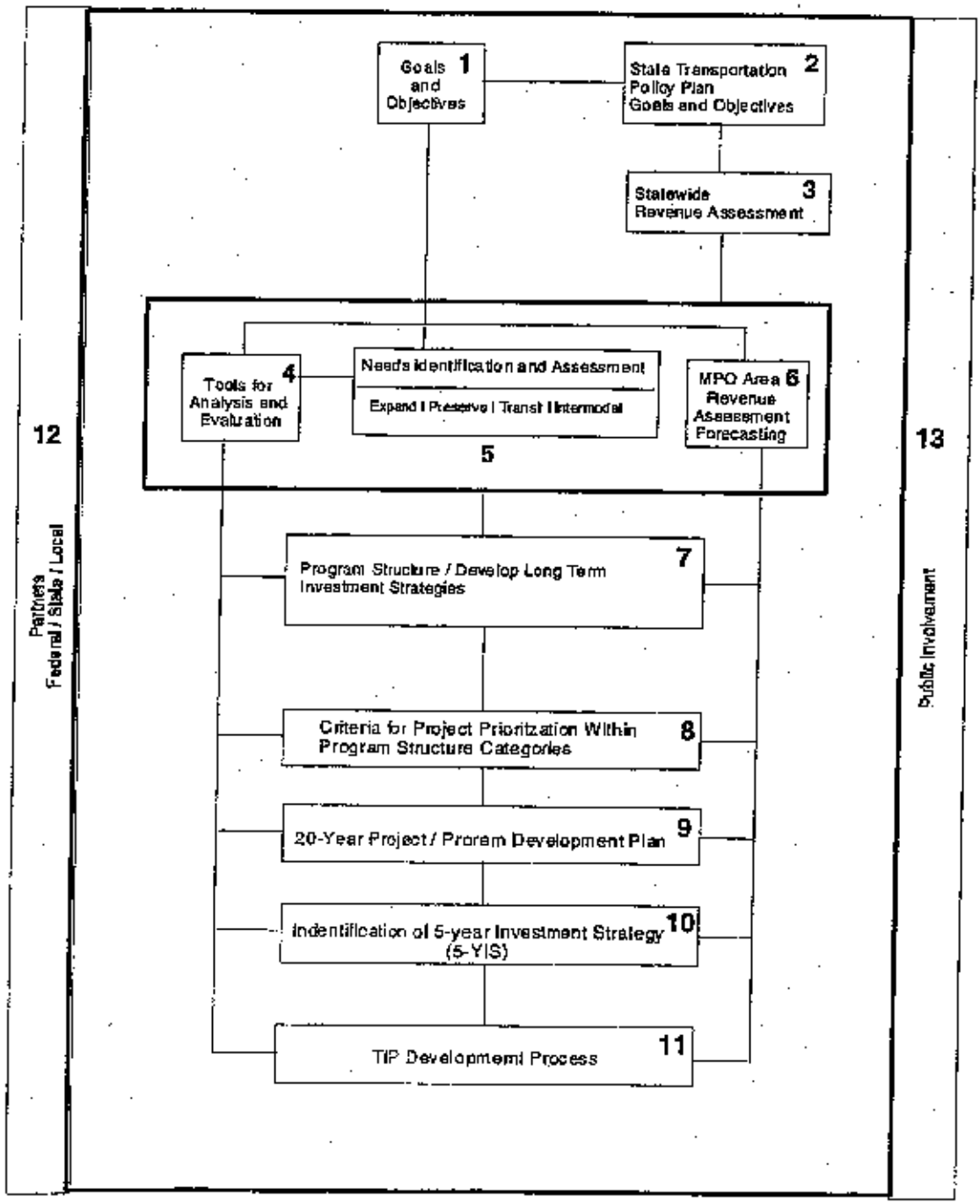
- *Cooperation* means that the parties involved in carrying out the planning, programming and management systems processes work together to achieve a common goal or objective.

- *Coordination* means the comparison of the transportation plans, programs, and schedules of one agency with related plans, programs and schedules of other agencies or entities with legal standing, and adjustment of plans, programs and schedules to achieve general consistency

Appendix D

New Process Framework

Transportation Plan Development Process



Appendix E

Summary of Commendations, Corrective Actions and Recommendations

Commendations

(1) SEMCOG is commended for taking a pro-active leadership role in the establishment of programs and services that connect people to jobs. SEMCOG, MDOT, and the transit agencies should continue their current activities to identify the location of welfare recipients and low-income individuals in the urbanized area and develop transportation programs to meet their needs.

(2) We commend SEMCOG for implementing the recommendation from the public involvement in transportation task force to change the place on the agenda for receipt of public input on each agenda item, and urge them to complete the development of a citizen's guide to regional transportation planning and the other task force recommendations.

(3) We commend the SEMCOG staff for its leadership role in the ITS area and urge continued efforts to engage the stakeholders and facilitate the cooperative development of a regional ITS architecture.

(4) We commend MDOT and SEMCOG for developing a schedule for implementing the adopted planning process.

(5) We commend MDOT and SEMCOG for developing a cooperative revenue forecasting methodology for use in preparing the 2025 Regional Transportation Plan and urge MDOT and SEMCOG to share the cooperative revenue forecasting methodology with other Michigan MPOs.

(6) We commend MDOT, SEMCOG and the transit operators for consistently meeting the three-year cycle for regional transportation plan updates.

Corrective Actions

(1) As a TMA, the southeast Michigan urbanized areas must have a CMS that meets the requirements of 23 CFR 500.109. Work is well underway to develop a CMS for the southeast Michigan area, however, this effort has not been completed. The CMS for the southeast Michigan area must be operational by July 1, 2001.

(2) The results of air quality conformity analyses for future TIPs and TIP amendments must be made available to the public for review and comment as required by *The Michigan Transportation Conformity Air Quality State Implementation Plan (SIP) Revision.*

Recommendations

(1) We recommend that MDOT, SEMCOG and the transit operators consult with the low income and minority populations in the development of a process for assessing the transportation needs in the region and in developing assessment techniques.

(2) We recommend that the CMS, when completed, become one of the principal tools used to identify capacity deficiencies in the transportation plan development process and the primary mechanism to evaluate alternative solutions to those identified deficiencies.

(3) We recommend that MDOT and SEMCOG give continued attention to enhancing the cooperative procedures for carrying out the steps of the adopted planning process.

(4) We recommend that MDOT, SEMCOG and the transit operators continue the cooperative development of revenue estimates for local jurisdiction projects and expand the cooperative process to include revenues that are expected to be available for MDOT projects.

(5) We recommend that MDOT, SEMCOG, and the transit operators develop and refine regional travel demand forecasting tools for both highway and transit modes, including methods for evaluating and establishing regional system wide priorities linked to area wide goals and objectives.

(6) We recommend that MDOT, SEMCOG, and the transit operators use these tools to develop a regional vision for transportation and a RTP that identifies cost feasible improvement priorities for both highways and transit over the 20-year plan horizon.

(7) We recommend that SEMCOG take a stronger role to encourage and assist in coordinating transportation services between DDOT, SMART and DCT.

(8) We recommend that all plan amendments and additions be subject to the same analyses recommended for the development of the RTP.

(9) We recommend that MDOT, SEMCOG, and the transit operators move toward a TIP development process that more fully considers regional priorities for highway and transit improvements at every step, not just at the beginning and at the point of final approval.

(10) We recommend that MDOT, SEMCOG, and the transit operators develop time lines for the special programs consistent with the TIP cycle and consider grouping techniques to cover projects that don't warrant individual inclusion.

Status of Previous (1997) Certification Recommendations

One objective for each certification review is assessing how well the planning partners in the area have addressed recommendations from the previous certification review. This section identifies the recommendations from the previous certification and addresses their status.

Recommendation 1: It is recommended that the MPO clearly identify which of the corridors listed in the 2020 Regional Transportation Plan as Major Investment Study candidates, are place holders, or which are studies.

Status: While the requirement for stand alone Major Investment Studies was removed by TEA-21, the concept of differentiation between studies of potential solutions and project development activities within the transportation plan is still valid. In the plan scheduled for adoption in June, 2000, about 30 studies are shown. There is no assumption that study will result in a project. As studies are completed, the results of the studies will need to be amended into the transportation plan. This recommendation is being met.

Recommendation 2: It is recommended that the SEMCOG aggressively market their variety of excellent products and services available to the public

Status: SEMCOG has been more aggressively marking their products with the media. They have over 200 news media contacts and they are trying to get out to those they have not traditionally reached out to. They have 121 documents they are marketing. SEMCOG is creating higher visibility both within Michigan and Nationally. This recommendation is being met.

Recommendation 3: It is recommended that SEMCOG work with those who prepare environmental documents to develop a mechanism to include information from the systems planning effort in environmental documents.

Status: SEMCOG is more actively involved in project development activities including studies and the environmental process. They assist in he public involvement process and provide traffic and air quality data. This recommendation is being met.

Recommendation 4: MDOT should continue to dedicate all resources necessary to fully implement the Congestion Management System for all Transportation Management Areas.

Status: This recommendation was a specific topic in the review and is discussed in the body of the report.

Recommendation 5: The staff of SEMCOG and MDOT should develop a single methodology for forecasting revenue for the area in accordance with the requirements of 23 CFR 450.322(b)(11).

Status: This recommendation was a specific topic in the review and is discussed in the body of the report.

Recommendation 6: SEMCOG and MDOT need to jointly develop a schedule outlining steps toward full implementation of the planning process and proceed accordingly.

Status: SEMCOG has signed new MOUs with MDOT, AAYUATS, SCCOTS, BWATA and is working on MOUs with DDOT and SMART. A March 10, 1999, MEMO from SEMCOG to MDOT outlines the general time frame and sequence for implementing the revised planning process in southeast Michigan. This recommendation is being met.

Recommendation 7: It is recommended that MDOT and SEMCOG formalize and commit to writing an agreement on how to manage both State and local projects in the TIP.

Status: SEMCOG is in the process of modifying their TIP management policies to more clearly articulate when amendments to the TIP are required and what authority the staff has to administratively modify the program. MDOT has provided additional funding for a position at SEMCOG to manage the TIP for the seven county area reasonable progress is being made in implementing this recommendation.

Appendix G

Memo dated March 10, 1999 from SEMCOG to MDOT

SEMCOG

MEMO

Southeast Michigan Council of Governments
660 Plaza Drive, Suite 1900
Detroit, MI 48226
(313) 961-4266
Fax (313) 961-4869
http://www.semcog.org/

March 10, 1999

TO: Susan Mortel

FROM: Carmine Palombo

SUBJECT: Planning Process Implementation

SEMCOG and MDOT have established a good track record as partners to deliver transportation improvement services to the residents of Southeast Michigan. At the staff level, this relationship remains strong and in many areas is getting stronger. We are adopting innovative approaches to ensure that projects are *developed* planned and implemented in a timely manner. Some of these efforts include our joint administration of the Eastern Border Crossing and the Ambassador Bridge project.

In addition to our regular planning coordination activities, we are now meeting with:

1. Dave Schade and his staff to develop a strategy to cooperatively collect traffic data in our region.

2. Dave Kiter and his staff to develop a strategy to cooperatively articulate transit and intermodal activities for the next work program.

3. Terry Gotts to initiate the review and coordination of the 2025 RTP and State sub-area plans.

This memo documents our mutually agreed approach for implementing the revised planning process. It focuses on our commitment to support a planning process that allows for wise transportation investments in Southeast Michigan within the umbrella of TEA-21. We desire to implement the revised planning process in a timely fashion, identifying interim activities to be undertaken between now and the full implementation date.

SEMCOG and MDOT agree to the following principles:

1. Overall

   - SEMCOG and MDOT are committed to maintaining a planning process that moves from mandates to relevancy, respond to the needs of the region and the goals and objectives of the Regional Transportation Plan (RTP)

   - Our planning process and project implementation should be customer-focused, allowing the customer to derive the maximum benefit from transportation investments in Southeast Michigan.

   - The planning process is designed and implemented to support decision making *while acknowledging that the planning process is more than a project by project decision tool.*

   - The planning process should strengthen the strong partnership between SEMCOG and MDOT.

2. New Planning Process

   - It is the intent of SEMCOG and MDOT to fully implement the revised planning process.

   - While it is our intent to fully implement the revised planning process, we recognize that this will take considerable amount of time and effort to accomplish and cannot be completed over night.

   - Annually report to the region on the planning process and project/plan accomplishments.

The purpose of the revised planning process is to improve communication and trust between stakeholders/partners in transportation, specially, between the MPOs, 3C agencies and MDOT. Following the completion of the planning process SEMCOG established a working committee made up of SEMCOG, MDOT, FHWA , UATS and SCCOTS to explore ways of fully implementing the revised process and to establish a time frame for implementation.

One of the challenges facing us is the fact that while we explored and established time frames for implementation, we *have* had to continue to recognize that projects are still being developed and let for construction. These projects are needed to meet the needs of the residents of Southeast Michigan. We also acknowledged that the agencies involved have different needs determined by the demands of their score keepers.

The working group agreed on these benchmarks/dates for process implementation; Phase I - October 1998, Phase II - October 1999 and Phase III - December 2000.

Phase 1, ending October 1998
Within the short duration, we made two significant improvements—MDOT presented their strategic approach to transportation investments and the resultant project list to SEMCOG and UATS committees and the implementation of a preliminary statewide revenue estimates, provided by MDOT to MPOs. These presentations have opened up new avenues for communication between SEMCOG, MDOT, UATS and SCCOTS. The local operators were equally involved in these discussions. We desire to strengthen and build upon these accomplishments in subsequent phases.

Phase II, ending October 1999
We agreed to significantly implement the new planning process including the following steps:

1. For the completion of the 2000 TIP:

Status	
Completed	• SEMCOG will provide state and local capacity and safety deficient locations and suggested improvements as contained in the 2020 plan to all agencies.
Completed	• SEMCOG will provide a region-wide revenue estimate based on the statewide revenue estimate received from MDOT to local units of governments.
Completed	• SEMCOG will send the deficiencies, 2020 RTP projects and revenue estimates to all operating agencies, including MDOT by January 1999.

Status

Enhancement in TIP, but only 2 years. CMAQ will be added by December, but will be 3 years. Safety needs to be added.

- MDOT will synchronize the timing of the following programs with regular STP *program* to allow for effective overall review of the 2000 TIP projects. These programs are CMAQ, Safety and Enhancement projects that currently have different timings for project selection (see Figure 1).

  Additional changes will be identified in future years as this process continues to mature.

We acknowledge that until complete technical tools are developed for each project or program type, e.g. pavement, the regional planning process as defined by the planning definition committee and agreed upon by SEMCOG and MDOT will continue to be implemented in parts or phases. **We keep in view the overall objective — to effectively and efficiently deliver transportation improvements to the residents of Southeast Michigan.**

Continuing

2. During this phase, we will focus attention to the development of these tools. SEMCOG and MDOT made a strategic decision 15 years ago to have SEMCOG perform all modeling activities for the region excluding Washtenaw and St. Clair Counties. This practice has served the region well. Recently significant investments have been made to strengthen the capabilities of the region's travel demand *modeling* tools. These improvements include new household and transit on-board surveys, external station survey and the ongoing commercial vehicle survey. Efforts are underway to nest the subarea models within the regional model. As a result of these improvements, every capacity improvement, no matter who is engaged to do the study uses the same data source and models for capacity analyses. We will continue to improve the travel demand model.

Status

3. The most challenging area is the pavement management system (PMS). Our current work program calls for the establishment of a regional PMS task force made of operating agencies in the region, including MDOT to:

Completed

- Review current PMS practices in the region, including the review of all or selected PMS approaches and software being used by operating agencies (including MDOT PMS) in Southeast Michigan.

In progress

- Recommend a preferred approach and software(s) to evaluate pavement conditions in Southeast Michigan.

Not started yet

- Develop RFP, if necessary, to implement task force recommendations. It is anticipated that this effort may lead to a unified or single PMS for the region.

In progress

4. Review of all existing/updated plans for roadway improvements in the region, including the freeway reconstruction plan and any other local significant transportation plan(s) not included in the 2020 RTP. *The results of such studies will be added to the Plan upon completion of the study, the identification of a preferred alternative and an identification of a likely funding source to implement the improvement.*

These activities move us closer to full implementation of the revised planning process, they encourage review of known deficiencies, projects contained in the plan and improved revenue estimates as the beginning point for selecting projects for 2020 TIP.

Status

Bridges and transit in progress	5.	We are proud to note that we are constantly mentioned as a model for including and integrating safety as part of the regional planning process. On October 20 and 21, 1998 we received staff from Iowa DOT and reviewed with them our work in safety. They hope to implement parts or all of our process in Iowa. FHWA Lansing and Michigan Office of Highway Safety Planning (OHSP) after spending one day with us are now proposing to fund a traffic engineer's position at another MPO in the state as part of the 402 funding. Also, we made a presentation at the FHWA meeting in Chicago on October 26-28, 1998 on our work in safety. It is our intention to further improve our safety tool within this phase. Work on other program areas such as bridges and transit are equally progressing.

Phase III: Year 2000 and beyond

As we complete the next regional RTP we anticipate that we will more fully implement the revised planning process. The development/refinement of the RTP provides an excellent opportunity to integrate the various processes and techniques *within an overall cooperative process.*

We have developed a tentative schedule for developing the 2025 and 2030, including the focus of each plan. (See Figure 2).

The 2020 RTP was approved by SEMCOG's GA in June 1997. With the passage of TEA-21 and the retention of a three-year RTP development circle, we have developed Figure 2 to assist us in focusing our planning activities. We have about 14 months to complete the 2026 RTP. As shown in Figure 2, we plan to focus our activities for the 2025 RTP on system integration and management while selectively reviewing the travel demand model results and making adjustments as necessary. This emphasis moves us towards attaining the 2020 RTP goals; promote a safe and secure transportation system, provide accessibility and mobility for all people and goods, invest strategically in transportation infrastructure to enhance the vitality of the community and promote and enhance the environment. Specifically the 2025 RTP will include a sharper focus on:

Status

Will be included	• Managing non-recurring congestion; including the integration of the incident management activities, such as the Freeway Courtesy Patrol and ITS. We will integrate analysis and implementation of these activities to address traffic congestion. It has been estimated that non-recurring congestion count for more than 45 percent of all freeway traffic congestion.
Will be included	• Reviewing 2020 RTP and results.
Will be included	• Inclusion of more roads in our safety analysis
Will be included	• Introduction of the initial results of our PMS efforts, if available.
Will be included	• Designation of special corridors for corridor-level analysis and evaluation, including freeways. Capacity deficient corridors will be grouped by severity, possible solutions will be included/refined from the 2020 RTP. For others, more detailed analysis will be recommended.
Will be included	• Defining and integrating various transit activities including our welfare-to-work initiatives.
Will be included	• Fully integrating/developing a five-year investment strategy that provides more details on our five-year investment focus for the regional transportation system.
Will be included	• Further integration of our modal activities —airports, freight and non-motorized transportation.

In short, 2025 RTP emphasis will be to improve the operating efficiencies of our transportation system and to selectively target capacity improvements consistent with adopted RTP goals.

Status

In progress	The RTP is the framework and document that guides transportation investments in Southeast Michigan. As in the past, it will highlight significant issues affecting the region and the region's opportunities and challenges, including preferred projects, policies and procedures to be used to address transportation issues in Southeast Michigan. In some instances and wherever possible it will specify the nature of transportation improvements selected and the criteria used to address specific issues. In other instances, it will guide procedures and criteria to be used for evaluating and prioritizing projects to be implemented in Southeast Michigan.

It is anticipated that several "white papers" will be completed as part of RTP development and released to guide project development. For instance, the activities and strategies to manage non-recurring congestion and ITS operations could be released and used by operating agencies before the final adoption of the 2025 RTP. The "white papers" will be integrated into the RTP.

The RTP to be completed in 2003 will take advantage of 2000 census and completely review the result of previous plans, develop new goals and objectives and models, if needed, as part of plan development.

The successful implementation of the planning process which clearly delineates the value of planning, (stressing a performance-based approach) allows us to fully benefit from the provisions of TEA-21 and maximize transportation investments in Southeast Michigan.

Response to FHWA Short-Term Concerns

- Missing steps/data (e.g., complete emission and financial data were not completed before presenting the projects to TAC).
- Lack of 20-year MDOT plan that is integrated with the 2020 Regional Transportation Plan (RTP)
- Project-to-project orientation
- Coordinated vs. cooperative planning efforts.

Status

Process revised to incorporate process used in developing 2000-2002 TIP.

Missing steps/data

As I indicated at the meeting, we completed the air quality and financial analyses of the proposed amendment in enough time to allow for adequate public review of the amendments including the supporting financial and air quality data. We do, however, note the FHWA comment and concern that we must complete these analyses prior to forwarding projects to TAC for action in the future.

The public and any other interested party still had about 30 days to review the project before the approval of the amendments at the October 28th SEMCOG General Assembly (GA).

Working with MDOT to increase number of projects.

Lack of 20-year MDOT Plan

This concern was discussed at length during the meeting. FHWA's concern centered more on the role of the MPOdeveloping a RTP that integrates both state and local priorities. Also at issue is the content of the 2020 RTP. FHWA desires that the RTP be as specific as possible to enable a useful analysis of air quality impacts.

While we agree that the RTP should be specific as possible, we don't believe that detailing all projects for the complete 20-year period is practical or appropriate. For one, we don't know the solutions of many of the major corridors that are deficient until we complete detailed study of the corridors. Some of these studies demand significant resource — time and money. We prefer and advocate for a corridor approach" to be used in identifying solutions for significant corridors or roadways. We agree with the observation that the MDOT Freeway Study should be an integral part of the RTP (see the new RTP development process for our thoughts on this issue).

Status

Project-to-project orientation

We believe that the new planning process will move us further towards system-wide planning. Part of the challenge we faced this year was the timing of TEA-21 and the need to obligate money as quickly as possible. MDOT has initiated a five-year investment plan development process. This effort if embedded within the new planning process will significantly enhance our ability to become more strategic and invest efficiently in transportation infrastructure in Southeast Michigan.

Continue to work with MDOT to coordinate varous public input opportunities through MPO process.

Coordinated versus Cooperative Process

I believe the intent of this comment or observation is that all key partners in the systems planning, project prioritization and project development need to work together from the beginning using the MPO as the forum. We still have some distance to travel to reach this goal. However, we made significant strides this year. MDOT regions (University and Metro) for the first in recent history provided their tentative projects to SEMCOG including making presentations at various SEMCOG committees and UATS.

While we have accomplished a lot together, much remains to be done. This framework can proactively define and implement a planning process that supports good transportation investment decision making by cooperatively working together and leveraging our resources.

U.S. Department
of Transportation

**Federal Highway
Administration**

Region 5
Michigan Division

315 West Allegan Street, Room 207
Lansing, Michigan 48933

October 28, 1999

Mr. Paul Tait, Executive Director
Southeast Michigan Council of Governments
660 Plaza Drive, Suite 1900
Detroit, MI 48226

Dear Mr. Tait:

Comprehensive, Region Wide, Transportation Vision and Plan
for the Greater Detroit Area

Public input on the I-94 Rehabilitation Project, the I-375 East Riverfront Access (ERFA) Improvement Feasibility Study, and the I-75 Freeway Study has brought into sharp focus the question of the role for transit in relieving congestion and serving mobility needs of area residents. A full response has been impeded by the lack of a comprehensive regional transit plan. We understand that a number of meetings have recently taken place between MDOT, SEMCOG, City of Detroit, DDOT, SMART, and the Detroit Transportation Corporation to coordinate transit activities, both current and future, with the I-375 study.

We strongly applaud your efforts to bring the parties together and encourage a continuing comprehensive effect. As you know, transit alternatives for abating congestion do not stop at the project limits; a region wide systems approach is needed. The same can be said with equal certainty for the other modes and the transportation network as a whole; a systems wide approach is needed to create a region wide transportation vision and plan that will guide individual project decisions for all modes.

Implementing agencies and policy level decision makers need to be developing projects that are consistent with the regional transportation vision and plan priorities considering all

modes of transportation. The recently expressed public concerns regarding mass transit in the Greater Detroit Area are an indication of the questions that future transportation projects in the SEMCOG area will have to be able to answer. Each transportation project needs to be a building block in an integrated, multi-modal transportation vision and plan for highways, transit, intermodal connectors, parking, and pedestrian. If the public is unable to clearly see how each project fits into the vision and plan, it is likely that project will bog down in the development process. If implementing agencies and policy level decision makers (in both the public and private sector) are unable to see how a project fits into the regional vision and plan, they should delay their decision or move their investment to another location.

I strongly encourage a continuing, cooperative, and comprehensive transportation planning process that results in a region wide transportation vision and plan that considers all transportation modes and supports sustainable metropolitan community development and social goals. The white paper prepared by your staff a year ago addressed these issues and presented an inspirational view of changes to the approach for transportation planning that should address these concerns. We look forward to helping SEMCOG implement such change. The leadership role provided by SEMCOG in regional transportation planning will be a major asset in developing an integrated, multi-modal regional transportation vision and plan that facilitates the efficient, economic movement of people and goods.

The challenge is there in front of us. Where we go from here, in large part, is up to you and the leadership of the SEMCOG organization. FHWA=s goal is to increase user satisfaction with the transportation system as a whole (mobility, productivity, and safety) and to aid implementing agencies and policy level decision makers by enhancing the information and data available to them for making well informed choices. We will take a supportive role and will gladly assist SEMCOG in your pro-active efforts to develop a comprehensive regional transportation vision and plan. I look forward to the opportunity to explore these opportunities with you and to develop a plan for action. Please contact me at 517-377-1844 at your earliest convenience so we can begin a discussion on how to proceed.

Sincerely,

/s/ James J. Steele

James J. Steele
Division Administrator