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Air Toxics Benefits from Vehicle Inspection and Maintenance Programs in Select U. S. Cities

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ACRONYM LIST

CO..carbon monoxide
DEP.. Department of Environmental Protection
EPA..U.S. Environmental Protection Agency
HAP ....hazardous air pollutant
I/M .... inspection and maintenance
lb/day ....pound per day
mg/mi .... milligrams per mile
MOBILE...EPA's mobile source emission factor model
MOBTOX 5b ....EPA's mobile source emission factor model for air toxics
MSAT ....Mobile Source Air Toxics
NAAQS..National Ambient Air Quality Standards
NO_x .... nitrogen oxides
OTAQ ....Office of Transportation and Air Quality
PM ....particulate matter
PPM ....parts per million
RCI...roadway congestion index
SIP .... state implementation plan
tpy ....tons per year
TTI... Texas Transportation Institute
VMT ....vehicle miles traveled
VOC... volatile organic compound
g/mi...gram per mile

AIR TOXICS BENEFITS FROM VEHICLE I/M PROGRAMS IN SELECT U. S. CITIES

EXECUTIVE SUMMARY

The use of motor vehicles is so prevalent throughout the U.S. that nearly every person is exposed to vehicle emissions at some level. Automobiles and light duty trucks are responsible for a large percentage of emissions of several types of pollution. For areas with unhealthy air, the Clean Air Act requires motor vehicle emission inspection and maintenance (I/M) programs to help reduce excess vehicle emissions. I/M programs achieve this by assessing whether a vehicle's emission control systems are working correctly. As vehicles age, their emissions are expected to increase – even for well-maintained vehicles with properly functioning emission control systems. Further, the percentage of vehicles that emit pollutants in excess of these higher levels increases with vehicle age. An effective I/M program can identify those vehicles that emit high levels of pollution, allowing them to be repaired.

While most I/M programs were originally designed to reduce ozone and carbon monoxide, they also reduce other harmful pollutants. This report examines the effect of I/M programs on one class of harmful pollutants, air toxics, which includes a wide range of dangerous chemicals. EPA estimates that nationwide, on-road mobile sources are the largest source of toxic air pollution emissions and that roughly 40 percent of air toxics emitted in urban areas are from motor vehicles.

Despite their emission reduction benefits, there is ongoing debate over the merits of retaining I/M programs. To some, these programs are little more than a consumer nuisance, especially for owners of newer vehicles, which are typically very clean. To others, I/M programs are necessary as a periodic "health" checks for cars and light trucks that help with early identification of high-emitting vehicles. This report presents the results of an assessment of the air toxic impacts that I/M programs have in 14 major U.S. cities.

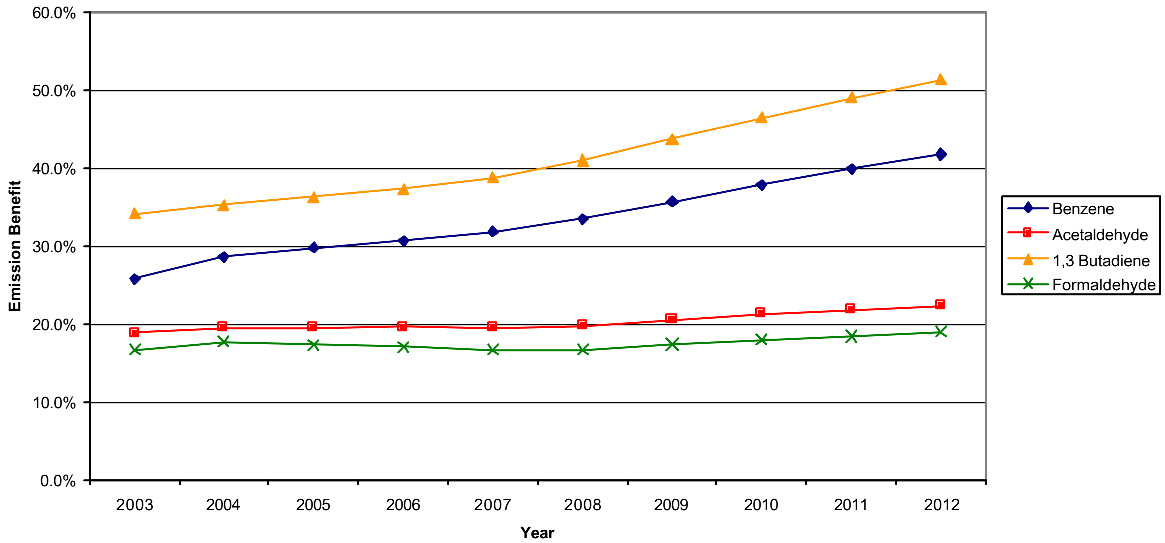
Using an EPA model, the assessment examines four of the most important air toxics emitted by vehicles: acetaldehyde; benzene; 1,3-butadiene; and formaldehyde. If I/M programs were to be discontinued in the 14 cities selected for this report, increases in vehicle emissions of these air toxics are projected to occur. Results for the first full year of possible discontinuation (2003) are shown in Table ES-1.

Table ES - 1

Toxic Compound	*Projected Increase in 2003 without I/M*
Acetaldehyde	**404 Tons**
Benzene	**2,939 Tons**
1,3-Butadiene	**509 Tons**
Formaldehyde	**931 Tons**

To put these toxic emission increases into perspective, consider that EPA defines an industrial facility to be a "major source" of air toxics if it has the potential to emit 10 tons per year of any single hazardous air pollutant (i.e., air toxic) or 25 tons per year of any combination of such pollutants. Therefore, the projected benzene emission increase from the removal of I/M in the target cities would correspond to the benzene equivalent of 293 new major stationary sources. These increased emissions can also be expressed in terms of new vehicles. Assuming that the average vehicle drives 12,500 miles per year, the projected benzene increase also corresponds to the benzene pollution produced by an additional 65 million new vehicles.

Figure ES - 1



The analysis also shows that the relative benefit of I/M programs to reducing these air toxics increases as a percentage over time, through 2012 (see Figure ES – 1). For benzene (a known human carcinogen) and 1,3-butadiene (recommended by EPA for reclassification from "probable" to "known" human carcinogen), the relative benefit of I/M programs is projected to increase over the next 10 years.

This analysis demonstrates the importance of I/M programs in protecting public health. Since several air toxics are known or probable carcinogens, reducing air toxics may reduce the potential risk for cancer.

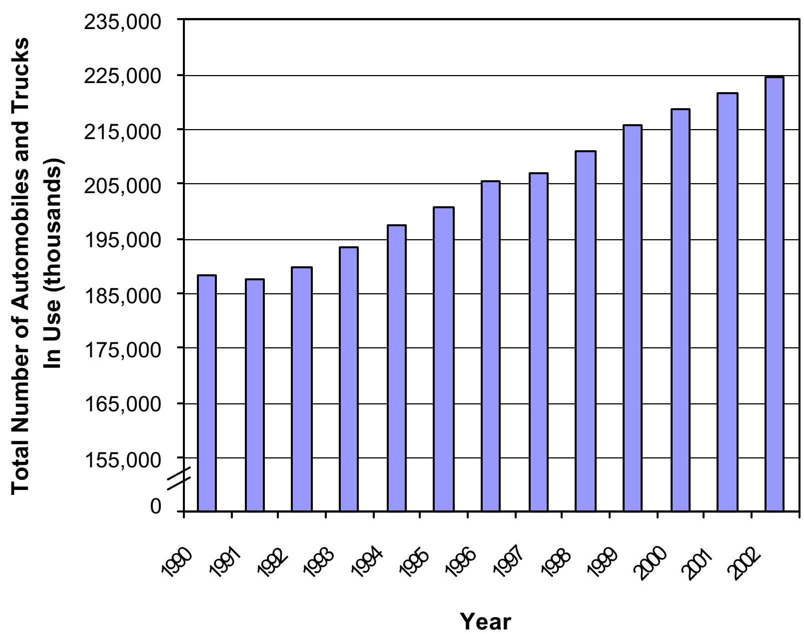
This report demonstrates the importance of the role that I/M programs play currently in reducing air toxics, in addition to the meaningful reductions in ozone and carbon monoxide that I/M programs also achieve. With this in mind, I/M programs should be retained in their existing areas and should be expanding to deliver their air toxics and other benefits in other areas – particularly in cities. EPA and other regulatory and policy makers should recognize I/M programs as an important component of a comprehensive plan for reducing air toxics from motor vehicles.

1 INTRODUCTION

The use of motor vehicles is so prevalent throughout the U.S. that nearly every person is exposed to vehicle tailpipe emissions at some level. Over the last ten years, the U.S. Department of Energy estimates that automobile and truck use has increased more than 12 percent. Current trends indicate that both the number of vehicles on the road and how much they are being driven, or vehicle-miles-traveled (VMT), will continue to increase.[1] Figure 1 and Figure 2 illustrate these trends from 1990 through 2002.[2]

Taken together, the vehicles operating on our nation's roadways represent the single largest source of air pollution in the country.

Figure 1: Vehicles In-Use Trend, 1990 – 2002



Taken together, the vehicles operating on our nation's roadways represent the single largest source of air pollution in the country.[3] While vehicle engines and fuels have become substantially cleaner over the past 30 years, poor vehicle maintenance can overwhelm these improvements, allowing vehicles to pollute in much greater amounts. In recognition of this, the 1990 Clean Air Act required areas with elevated levels of ozone or carbon monoxide (CO) to implement enhanced vehicle emission inspection and maintenance (I/M) programs. In addition to reducing emissions of the primary ingredients of ozone, nitrogen oxides (NO_x) and hydrocarbons, as

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[1] "Transportation Energy Data Book, Edition 21," U.S. Department of Energy, September 2001.

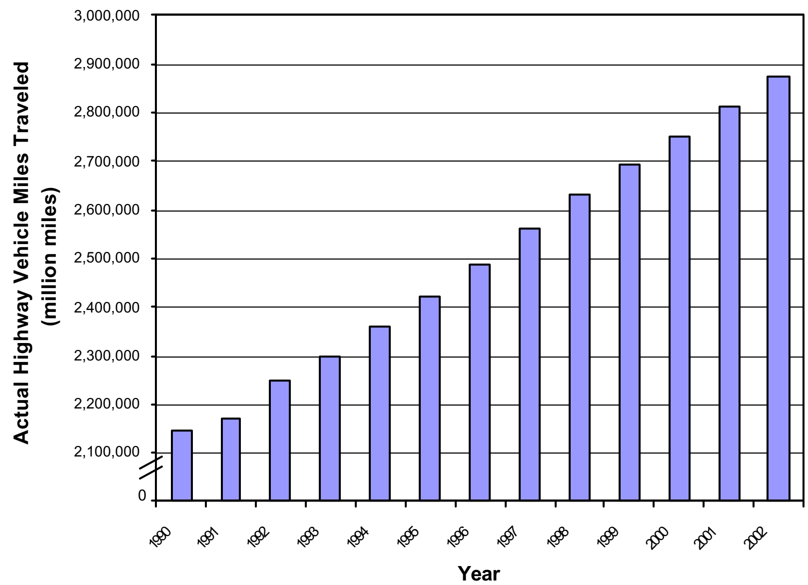
[2] *Ibid*, with estimates of 2000 through 2002 based on extrapolation of 1990 through 1999 data.

[3] "National Air Quality and Emissions Trends Report, 1999," EPA Document No.: EPA 454/R-01-004, March 2001.

While vehicle engines and fuels have become substantially cleaner over the past 30 years, poor vehicle maintenance can overwhelm these improvements, allowing vehicles to pollute in much greater amounts.

well as emissions of carbon monoxide, I/M programs also reduce levels of other harmful compounds: air toxics.[4]

Figure 2: VMT Trend, 1990 – 2002



The U.S. Environmental Protection Agency (EPA) classifies 188 compounds that cause adverse health effects as air toxics. Some potential effects of air toxics are cancer, birth defects, developmental delays, and reduced immunity. The primary criterion for identifying and controlling air toxics has historically been the degree to which they are carcinogenic (cancer-causing). Benzene is found in vehicle emissions and is a known human carcinogen. Formaldehyde, acetaldehyde, and 1,3-butadiene, also found in vehicle exhaust are classified as probable human carcinogens. Reducing air toxics may reduce the potential risk for cancer. Recently, the profound impact of toxics on health has drawn increasing scientific and regulatory attention.

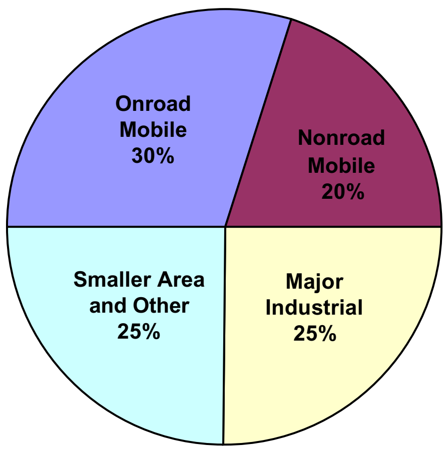
Motor vehicles emit air toxics and other pollutants in two ways: through the evaporation of fuel, and via the vehicle's exhaust. Certain volatile air toxics, such as benzene, are present both in fuel and in exhaust (as some fuel passes through unburned), and are thus emitted by both of the above processes. Other air toxics, such as acetaldehyde, 1,3-butadiene, and formaldehyde are produced during combustion and are, as a result, present only in the exhaust.

[4] Hydrocarbon compounds are organic compounds consisting exclusively of the elements carbon and hydrogen, and are a subset of the larger group of volatile organic compounds (VOCs).

Nationwide, on-road mobile sources are the largest contributing source to toxic air pollutant emissions.[5] Figure 3 shows an estimate of the contributing source categories, with approximately 50% of the national total attributable to both on- and non-road mobile sources.[6] Of particular concern is the concentration of motor vehicles – and their emissions – in urban areas. Roughly 40 percent of key air toxics emitted in urban areas come from motor vehicles.[7] The high number of vehicles in urban areas leads to potentially increased exposure to vehicle pollution among those who live and work in urban areas.

Roughly 40 percent of key air toxics emitted in urban areas come from motor vehicles.

Figure 3: Toxic Air Pollutant Emissions by Source Category



Under the Clean Air Act, EPA is required to regulate the 188 compounds that are classified as air toxics. Because air toxics cause special concern in urban areas, EPA developed its Urban Air Toxics Strategy to focus on reducing the human health threats of air toxics in urban areas. Of the 188 air toxics, EPA identified 33 toxics that are of particular concern because they pose an increased threat in urban areas (see Table 1). With regard to these 33 urban air toxics, EPA identified the goals of its strategy as: a 75 percent reduction in the risk of cancer associated with air toxics from industrial sources; a substantial reduction in non-cancer health risks associated with small commercial and industrial sources; and addressing and preventing disproportionate impacts of air toxics hazards on sensitive

[5] "National Air Quality and Emissions Trends Report, 1999," EPA Document No.: EPA 454/R-01-004, March 2001; and "Technical Support Document: Control of Emissions of Hazardous Air Pollutants from Motor Vehicles and Motor Vehicle Fuels," EPA Document No.: EPA-420-R-00-023, December 2000.

[6] *Ibid*.

[7] "Technical Support Document: Control of Emissions of Hazardous Air Pollutants from Motor Vehicles and Motor Vehicle Fuels," EPA Document No.: EPA-420-R-00-023, December 2000.

Because air toxics cause special concern in urban areas, EPA developed its Urban Air Toxics Strategy to focus on reducing the human health threats of air toxics in urban areas.

populations in urban areas including children, the elderly, minority, and low-income communities.

Table 1: List of 33 Urban Air Toxics

Acetaldehyde	Acrolein	Acrylonitrile
Arsenic compounds	Benzene	Beryllium compounds
1,3-butadiene	Cadmium compounds	Carbon tetrachloride
Chloroform	Chromium compounds	Coke oven emissions
Dioxin	1,2-dibromoethane	Propylene dichloride
1,3-dichloropropene	Ethylene dichloride	Ethylene oxide
Formaldehyde	Hexachlorobenzene	Hydrazine
Lead compounds	Manganese compounds	Mercury compounds
Methylene chloride	Nickel compounds	Perchloroethylene
Polychlorinated biphenyls (PCBs)	Polycyclic organic matter	Quinoline
1,1,2,2-tetrachloroethane	Trichloroethylene	Vinyl chloride

Despite the fact that 40 percent of urban air toxics come from mobile sources, in EPA's final rule on Mobile Source Air Toxics (MSAT), the agency did not establish unique MSAT limits for vehicles and concluded that its "Tier 2 and heavy-duty 2007 standards are the most stringent controls feasible at this time [December, 2000] to reduce MSAT emissions from highway vehicles and engines."[8] As part of its MSAT rule, EPA also established a Technical Analysis Plan and committed to revisiting the need for additional mobile source controls for air toxics no later than July 1, 2004.

In the last decade, many states have adopted enhanced I/M programs as required under the Clean Air Act to further assist in reducing emissions of motor vehicles (see Figure 4). Before new motor vehicles can be sold to the public, they must be certified by EPA as meeting required emission levels for NO_x, CO, volatile organic compounds (VOC), and particulate matter (PM).[9] I/M programs are important because they help ensure that emission levels do not increase beyond specified limits over the life of the vehicle. In addition to helping control emissions of NO_x, CO, and VOC from motor vehicles, an important benefit of an I/M program is the control of air toxics emissions.

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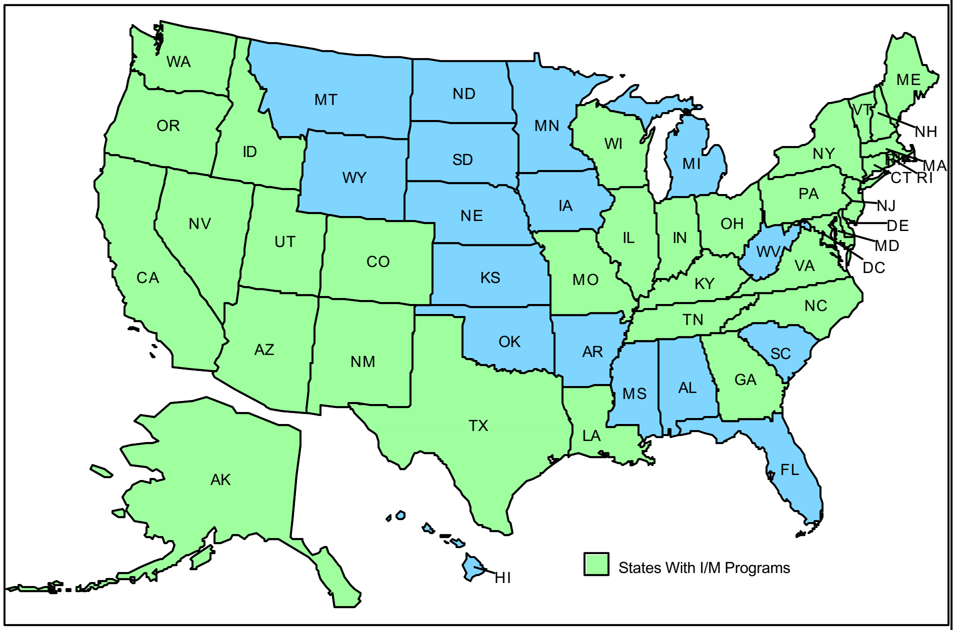
[8] EPA Press Release: "New Toxics Emission Standards Set for Gasoline" (December 21, 2000)

[9] Depending upon the classification of vehicle, VOC emissions of interest are total hydrocarbons, non-methane hydrocarbons, or non-methane organic gases. More information on the federal emission standards is available from EPA's Office of Transportation Air Quality (OTAQ) publication EPA 420-B-00-001.

Figure 4: States with I/M Programs



…an important benefit of an I/M program is the control of air toxics emissions.

Over the years, many I/M programs have been challenged at one time or another. Opponents have challenged these programs as ineffective and burdensome to consumers, and as being particularly unnecessary for newer vehicles whose emission levels are relatively low. On the other hand, proponents of I/M programs have argued they provide necessary periodic "health" checks for vehicles and are critical to the early identification of vehicles with emission problems. The purpose of this report is to document a frequently overlooked benefit of I/M programs: the significant reduction of emissions of air toxics (in addition to other pollutants) that are present in vehicle exhaust.

The purpose of this report is to document a frequently overlooked benefit of I/M programs: the significant reduction of emissions of air toxics that are present in vehicle exhaust.

This analysis focuses on the benefits of enhanced I/M programs, which represent the most sophisticated "tailpipe" I/M test available to states. Although recent air toxics information has highlighted diesel emissions concerns, the purpose of this analysis is to demonstrate the often-overlooked air toxics benefits of enhanced I/M programs – programs which are not applied to diesel vehicles.[10] This report assesses emissions benefits for the four most prevalent motor vehicle air toxics in 14 major American cities. The two scenarios that are assessed are: maintaining the current enhanced I/M program, and suspending the enhanced I/M program.

[10] Diesel vehicles are sometimes subjected to smoke or opacity tests. However, the dynamometer-based tailpipe-testing systems used in enhanced I/M programs are not applied to diesel-fueled vehicles.

In 1990, the U.S. Congress amended the Clean Air Act in part to significantly reduce emissions from light-duty motor vehicles.

2 BACKGROUND

2.1 The Clean Air Act – Vehicle Regulatory Programs

The Clean Air Act is designed to protect public health and the environment. Among the revisions to the 1990 Clean Air Act Amendments are changes to its provisions for attaining the National Ambient Air Quality Standards (NAAQS) for criteria pollutants, as well as for controlling emissions of air toxics.[11] In 1990, the U.S. Congress amended the Clean Air Act in part to significantly reduce emissions from light-duty motor vehicles. The development and manufacture of cleaner engines and cleaner fuels represent two important strategies embodied in the Amendments. The third strategy is a program designed to ensure that vehicles are properly tested and maintained to limit their emissions throughout their useful lives.[12] This third strategy is commonly referred to as an I/M program.

I/M programs are used to assess whether a vehicle's emission control systems are operating correctly. New vehicles sold in the U.S. today must meet specific emission certification standards. However, if after sale, the vehicles do not function properly, their emissions may be much higher than originally designed. By implementing an I/M program that requires periodic checks of the integrity of a vehicle's emissions and evaporative control systems, the benefit of advanced emission controls can be maintained as a vehicle ages. This is especially important because, even though the capability of the emission control system is expected to deteriorate over time, the percentage of vehicles that pollute at much greater amounts than they should increases with the vehicle's age. More recent information collected by EPA indicates that newer vehicles do not deteriorate as quickly as previously thought, though collective emissions from newer cars remain significant.[13, 14]

Both criteria and toxic air pollutants pose adverse health effects. Criteria pollutants represent a group of six common air pollutants ambient air limits are established to reduce adverse impacts on the public. A separate group of 188 air pollutants are classified under the 1990 Clean Air Act as toxic

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[11] Criteria air pollutants are carbon monoxide, nitrogen dioxide, sulfur dioxide, ozone, particulate matter, and lead.

[12] 40 CFR Part 51

[13] "Analysis of the Impacts of Control Programs on Motor Vehicle Toxics Emissions and Exposure in Urban Areas and Nationwide," EPA document number EPA420-R-99-029, November 1999.

[14] The revised deterioration rate information has been incorporated into this analysis.

because they are known or suspected to cause serious health problems, which may include cancer or birth defects.[15]

Federal ambient air standards do not exist for these 188 air toxics. Rather than try to determine safe levels of exposure for these compounds, EPA instead limits their levels by requiring controls on specific sources of the compounds.[16] Provisions to limit certain vehicle-related air toxics exist in Section 202(l) of the Clean Air Act. In recent years, EPA has combined these initiatives under the Urban Air Toxics Strategy. This program is intended to complement existing national efforts by focusing on further reductions in air toxics emissions in urban areas from both mobile and stationary sources.

Federal ambient air standards do not exist for these 188 air toxics.

2.2 State and Local Air Quality Planning

EPA requires that each state develop a State Implementation Plan (SIP), which includes a variety of emission control measures designed to attain and maintain the NAAQS. For many areas, I/M programs are one of these measures. At the state level, I/M programs are evaluated to determine the benefit they will provide to the state. Once an I/M program is implemented, the state can use the emission reductions associated with it to demonstrate progress towards attainment of the NAAQS.

I/M programs also have a significant impact in the development of metropolitan transportation plans, which must conform to the requirements of the SIP. Transportation improvement plans are smaller pieces of the transportation plan and in metropolitan areas are prepared by the local metropolitan planning organization. While transportation plans are required by the U.S. Department of Transportation, they must also comply within the larger framework of the SIP. In preparing transportation plans, determining the emissions impact from motor vehicle emissions is an important factor in evaluating the benefits of the plan.

To estimate the impact of mobile sources on air quality, EPA has developed a standardized computer software program (the MOBILE model) to provide an estimate of NO_x, CO, and hydrocarbon emissions. This program also allows for the estimate of benefits associated with different varieties of I/M programs. The MOBILE model has undergone a series of upgrades since its introduction, with the most recent version (MOBILE6) introduced in January 2002. EPA allows states up to two years to switch from using the previous version in determining the transportation aspects of a SIP, as a result, most areas continue to use the previous version, MOBILE5b. The MOBILE model generates emission factors for NO_x, CO, and hydrocarbons on a gram per mile (g/mi) basis that, when combined with estimates of total VMT, produces an estimate of the total amount of each pollutant released to the local atmosphere from mobile sources.

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[15] A full list of the 188 hazardous air pollutants is available at http://www.epa.gov/ttn/atw/188polls.html

[16] The toxic air pollutant provisions of Title I are found in Section 112.

2.3 Inspection and Maintenance Programs

The Clean Air Act requires I/M programs for most areas that are in violation of the ozone or CO standards. EPA classifies areas which are violating these standards into categories based on their level of ozone or carbon monoxide.[17] Any area violating CO standard or classified as moderate, serious, severe, or extreme nonattainment for ozone must have I/M programs. Additionally, some areas must adopt the more stringent level of I/M monitoring, called enhanced I/M. Those areas include the following: all areas classified as serious, severe, or extreme nonattainment for ozone; or any nonattainment area for carbon monoxide which had 1) CO levels greater than 12.7 parts per million, and 2) a 1980 population in the urbanized area of more than 200,000 or more. In addition, nonattainment areas in the ozone transport region that had a population of 100,000 or more in 1991 are required to use the enhanced I/M program.[18]

Emission test procedures have evolved over time from a simple idle test to the sophisticated transient tests now employed in enhanced I/M programs. An idle test is performed by inserting a probe into the vehicle exhaust pipe and capturing a snapshot of emissions from the vehicle as the engine idles. An enhanced test involves driving the vehicle on a dynamometer over a range of conditions that may include idle, acceleration, and cruising conditions. The dynamometer is a treadmill-like device used so that the wheels can rotate to simulate various types of driving while the vehicle is stationary. Appendix A provides background information on enhanced I/M tests.

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[17] Currently, ozone nonattainment areas are classified under one of five categories based on their level of exceedence of the 1-hour standard. The categories are: marginal, moderate, serious, severe, and extreme. Carbon monoxide nonattainment areas have two levels: moderate and serious. For more details on how those are classified, see the Clean Air Act, Title 1, Part D, Subpart 2, Sections 181 and 186

[18] The Ozone Transport Region includes all or parts of these states: Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, northern Virginia and the District of Columbia. The Clean Air Act, Title 1, Part D, Subpart 2, Section 184.

2.4 *Toxic Pollutants Considered*

Air toxic emissions from gasoline-fueled motor vehicles are closely related to the levels of VOC emissions. Some toxic pollutants are emitted as products of fuel combustion, while others are present in fuel, and as a result are emitted by evaporation and as byproducts of incomplete combustion. As part of the Urban Air Toxics Strategy, EPA has identified 33 air toxics that pose the greatest threat to public health. Under Section 202(l) of the 1990 Clean Air Act, EPA has also developed a list of 21 mobile source air toxics, 13 of which are included on EPA's list of 33 urban air toxics; seven of the remaining eight are on the list of 188 hazardous air pollutants. The only mobile source air toxic not included on either of the list of 33 or the list of 188 is diesel exhaust, which EPA defines as consisting of diesel particulate matter and diesel exhaust organic gases. Table 2 provides a list of the 21 mobile source air toxics identified by EPA.[19] This report considers four of those 33 air toxic pollutants that exist in the greatest quantity in motor vehicle emissions. Sections 2.4.1 through 2.4.4 provide a short background on each of the four air toxics considered in this analysis.[20]

As part of the Urban Air Toxics Strategy, EPA has developed a list of 33 air toxics that pose the greatest threat to public health.

Table 2: List of 21 Mobile Source Air Toxics

Acetaldehyde	Diesel Exhaust	Methyl Tertiary Butyl Ether (MTBE)
Acrolein	Ethylbenzene	Naphthalene
Arsenic Compounds	Formaldehyde	Nickel Compounds
Benzene	n-Hexane	Polycyclic Organic Matter
1,3-Butadiene	Lead Compounds	Styrene
Chromium Compounds	Manganese Compounds	Toluene
Dioxin/Furans	Mercury Compounds	Xylene

EPA has also developed a list of 21 mobile source air toxics, 13 of which are included on EPA's list of 33 urban air toxics; seven of the remaining eight are on the list of 188 hazardous air pollutants.

[19] "Technical Support Document: Control of Emissions of Hazardous Air Pollutants from Motor Vehicles and Motor Vehicle Fuels," EPA420-R-00-023, December 2000.

[20] Information on cancer potency and general health effects is taken primarily from: (1) "Air Toxics Hot Spots Program Risk Assessment Guidelines, Part II, Technical Support Document for Describing Available Cancer Potency Factors," California Environmental Protection Agency, Office of Environmental Health Hazard Assessment, Air Toxicology and Epidemiology Section, April 1999; and (2): "Technical Support Document: Control of Emissions of Hazardous Air Pollutants from Motor Vehicles and Motor Vehicle Fuels," EPA420-R-00-023, December 2000.

EPA classifies acetaldehyde and formaldehyde as probable human carcinogens.

2.4.1 Acetaldehyde

Acetaldehyde is formed as a byproduct of incomplete combustion of fuel as well as through a secondary process in which other motor vehicle pollutants undergo chemical reactions in the atmosphere. Short-term exposure at low to moderate levels of acetaldehyde results in irritation of the eyes, skin and respiratory tract. Currently, there is no information about adverse human reproductive effects or effects on fetal and childhood development, but data from animal studies suggest that it is a potential developmental toxin. Although there is insufficient information on carcinogenic effects in humans, EPA has classified acetaldehyde as a probable human carcinogen based on evidence of tumors in animals.

EPA classifies benzene as a known human carcinogen.

2.4.2 Benzene

Benzene is an ingredient in fuel that is released to the atmosphere either through evaporation or as a byproduct of incomplete combustion. The short-term exposure effects at low to moderate levels are drowsiness, dizziness, headache and unconsciousness as well as eye, skin and respiratory tract irritation. Long-term exposure effects include blood and immune system disorders. Additionally, women exposed to high benzene levels have exhibited adverse reproductive effects with reports of changes in human chromosome number and structure. Based on indisputable evidence of cancer in humans, EPA classifies benzene as a known human carcinogen.

EPA proposes reclassifying 1,3-butadiene as a known human carcinogen.

2.4.3 1,3-Butadiene

1,3-Butadiene is a byproduct of incomplete combustion of fuel. Short-term exposure by inhalation results in irritation of eyes, nasal passages, throat, and lungs, as well as blurred vision, fatigue, headache and vertigo. Currently, there is no information about adverse human reproductive effects or effects on fetal and childhood development, but data from animal studies show that it is a potential developmental toxin. EPA has classified 1,3-butadiene as a probable human carcinogen based on a growing body of evidence of carcinogenic effects in humans and evidence of tumors in animals. Currently, EPA proposes reclassifying 1,3-butadiene as a known human carcinogen.

2.4.4 Formaldehyde

Formaldehyde, like acetaldehyde, is formed as a byproduct of incomplete combustion of fuel as well as through a secondary process in which other motor vehicle pollutants undergo chemical reactions in the atmosphere. Both short- and long-term effects on humans from exposure to formaldehyde are irritation of eyes, nose, and throat, with irritation of the respiratory tract at higher exposures. Little information is available about developmental effects on humans, but animal studies do not indicate it to be a developmental toxin. Limited human studies indicate a potential relationship between formaldehyde exposure and cancer, and, as such, EPA has classified formaldehyde as a probable human carcinogen.

3 ANALYSIS METHODOLOGY

Mobile source emission models allow for the projection of emissions from vehicles with and without I/M programs.

A three-step process was used to assess the impact of I/M programs on the emissions of key toxic compounds in urban areas. The first step is to identify the cities of interest. Then, emission factors from motor vehicles for each of the key toxic compounds are determined. Finally, the emission factor is applied to the VMT profile in each of the target cities, assuming the continuation of each city's I/M program, and assuming its removal. The difference resulting from this last calculation – emissions with and without I/M – reveals the projected reduction in emissions attributable to the I/M program in the target city.

3.1 Identification of Target Cities

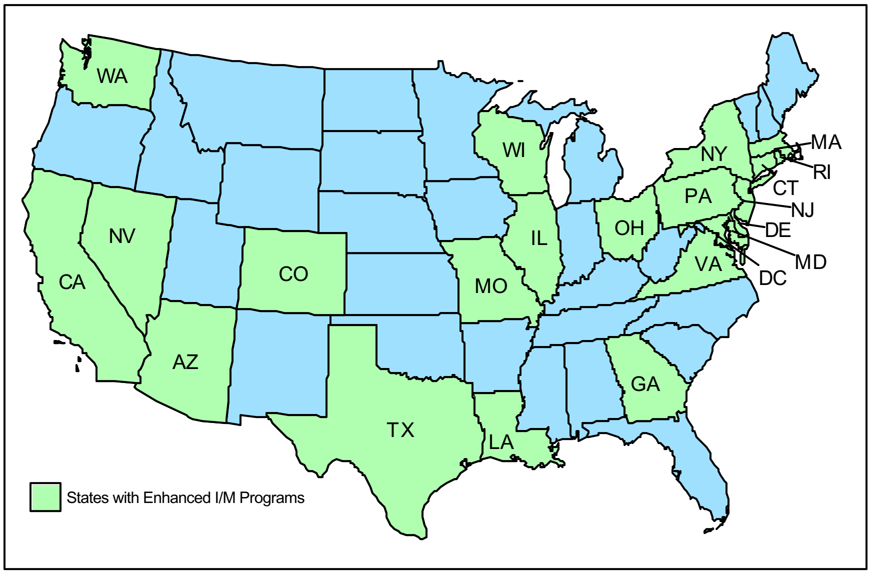
The primary objective in selecting target cities is to consider cities with enhanced I/M programs, while providing some variability in terms of regional fuel use and ambient conditions. A secondary consideration is the level of traffic congestion in the city.

3.1.1 Identifying Target Cities – Step 1: Enhanced I/M for Ozone

There are currently 21 states that have implemented an enhanced I/M program in at least a portion of the state, see Figure 5. Of these, this analysis considered cities in which I/M programs have been implemented for demonstrating compliance with the *ozone* NAAQS rather than the standard for carbon monoxide. Because air toxics are a subset of VOC emissions (a key precursor to ozone), an I/M program which effectively reduces emissions of VOCs also reduces air toxics. Of the cities with I/M programs that target ozone attainment, the analysis focuses on cities that have implemented an *enhanced* I/M program because these programs offer larger emission reductions benefits than basic programs. Finally, the cities selected for this analysis are not located in California. This is due to the fact that California has developed a unique model (EMFAC) for predicting motor vehicle emissions factors. In developing mobile source emission factors, the other 49 states use EPA's MOBILE5b model, on which MOBTOX5b is based. Since correlating the results of the two different emission factor prediction models is complex, California cities were omitted from this analysis.

Vehicle travel speed is a primary factor in calculating emissions because emission rates generally increase as speed decreases.

Figure 5: States with Enhanced I/M Programs



3.1.2 Identifying Target Cities – Step 2: Vehicle Congestion

Vehicle travel speed is a primary factor in calculating emissions because emission rates generally increase as speed decreases. VMT is also influential as the direct multiplier for the emission factor. To simplify the process of capturing VMT and speed data for the many cities in the U.S. that have enhanced I/M programs, a roadway congestion factor was used instead. Congestion is a reflection of relatively high levels of VMT for a given roadway capacity; it results in slow travel speeds. For congestion data, *The 1999 Annual Mobility Report* produced by the Texas Transportation Institute (TTI) was used as a resource. This report provides data on the travel characteristics of 68 urban areas throughout the U.S. The primary piece of information taken from this report is the Roadway Congestion Index, which is "a traffic density indicator (vehicles per road space) that indirectly measures traffic congestion."[21] An RCI cutoff of 1.0 was chosen when considering the list of potential cities in order to limit the cities to those that experience significant congestion during morning and evening peak travel hours. An RCI of 1.0 or greater indicates that congestion occurs for two hours or more during both the morning and evening peak travel hours.

The list of cities identified in 3.1.1 was ordered from highest to lowest based on the roadway congestion index. The higher the roadway congestion index, the more congestion, and therefore lower average travel speeds. Each of the cities chosen for this analysis has a high roadway congestion index, which indicates that traffic volume at peak periods is greater than roadway capacity as compared to other cities.

[21] Schrank, David, and Tim Lomax, "The 1999 Annual Mobility Report – Information for Urban America."

Table 3 presents a list of the 14 cities that were chosen for this analysis ordered by their congestion index. A map is provided in Figure 6 showing the cities selected.

Table 3: Cities Included in this Air Toxics Analysis

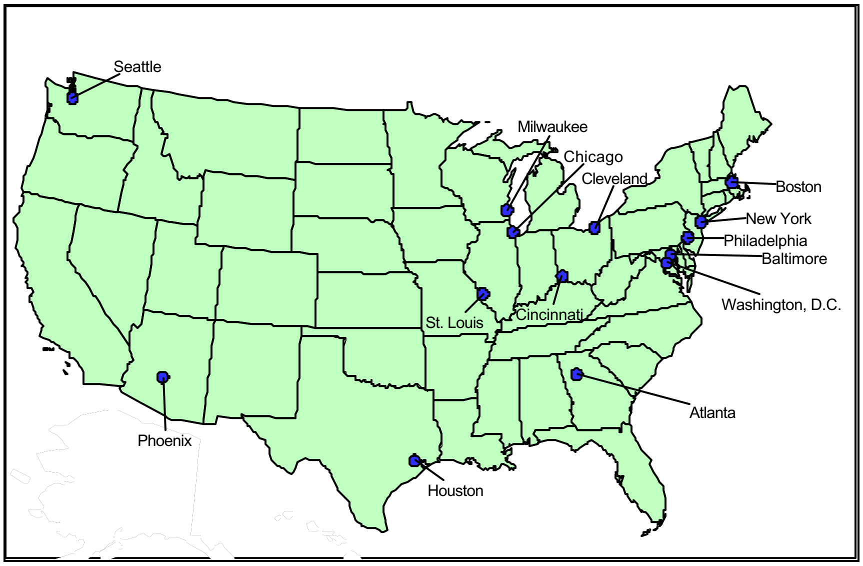
City/Region	Roadway Congestion Index [1]	RCI Rank [1]
Washington, D.C.	1.33	2
Chicago, IL	1.28	4
Seattle-Everett, WA	1.26	5
Boston, MA	1.24	7
Atlanta, GA	1.23	8
Phoenix, AZ	1.13	14
New York City, NY	1.11	17
Cincinnati, OH	1.08	18
Houston, TX	1.07	22
Philadelphia, PA	1.05	26
Baltimore, MD	1.05	26
St. Louis, MO	1.03	35
Cleveland, OH	1.01	37
Milwaukee, WI	1.01	37

1 – Source: Ranking reflects that shown *in The 1999 Annual Mobility Report – Information for Urban America*, The Texas Transportation Institute.

The emission factor for each toxic compound varies for each type of vehicle…[and]… with average vehicle speed.

Multiplying the emission factors …with VMT data at each speed yields the amount of toxic air pollutants emitted for each scenario.

Figure 6: Target Cities



3.2 Emission Factor Determination

Toxic air pollutant emission factors were estimated for each of the target cities for calendar years 2003 through 2012.[22] Emission factors were developed using MOBTOX5b, EPA's mobile source toxic emission factor model. The emission factor for each toxic compound varies for each type of vehicle; therefore, the unique composition of vehicles in each city results in different average emission factors per city for each type of air toxic considered. Further, the emission factor for each compound varies with average vehicle speed. Therefore, the average emission factor per compound, per city, is actually represented as a curve to reflect its different values at speeds ranging from 1 mph up to 65 mph. Emission factors were generated for each of two scenarios for each city, representing: (1) the continuation of the current I/M program through 2012, and (2) discontinuation of the I/M program beginning in 2003.

3.3 Calculating Emissions

The emission rate for each compound is expressed as milligrams emitted per mile (mg/mi) of vehicle travel. Therefore, VMT and speed data were needed for each of the cities. For each city, individual state and local environmental and transportation planning agencies were contacted for VMT and speed data. Multiplying the emission factors from the MOBTOX model with VMT data at each speed yields the amount of toxic air pollutants emitted for each scenario. A yearly comparison of the two scenarios for each pollutant shows the impact on toxic air emissions associated with removing an I/M program.

[22] Appendices B and C provide information about the assumptions used for this analysis.

4 ANALYSIS RESULTS

The results of this analysis consistently show that the effect of discontinuing the existing I/M program in each of the target cities would result in increased levels of air toxic emissions from vehicles. Table 4 provides a summary of baseline emission estimates for each of the four toxic air pollutants for calendar year 2003 along with the estimated increase in emissions that would occur if the I/M programs in all 14 cities were discontinued. Calendar year 2003 is shown for illustrative purposes because it is the first full year in which the I/M programs could be discontinued.

…discontinuing existing I/M programs in these target cities would result in increased levels of air toxic emissions from vehicles.

Table 4: Projected Impact of I/M on 2003 Toxic Air Pollutant Emissions

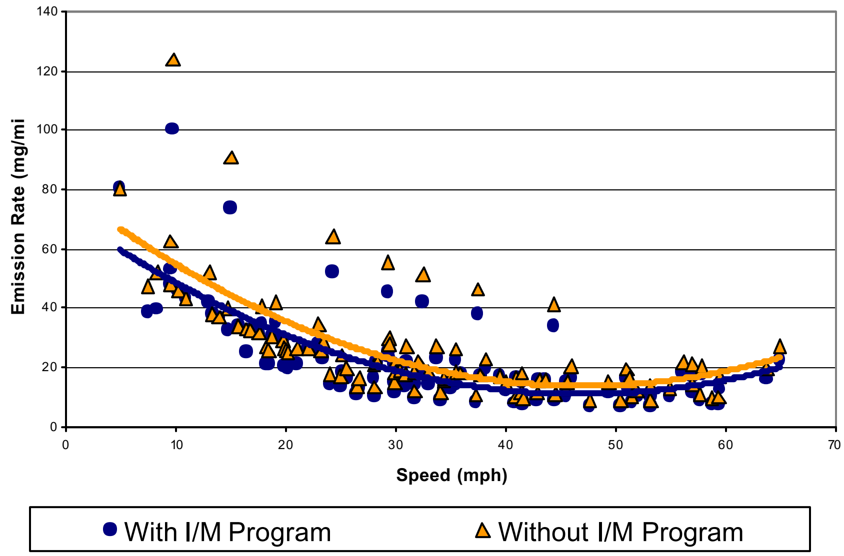
	Emissions by Pollutant for 2003 (lb/day)			
	Acetaldehyde	Benzene	1,3-Butadiene	Formaldehyde
Emissions with I/M	**11,740**	**62,593**	**8,181**	**30,535**
Emissions Increase without I/M	**2,211**	**16,107**	**2,791**	**5,103**
Percent Increase	**18.8%**	**25.7%**	**34.1%**	**16.7%**

Figure 7 shows the general benzene emission factor trend between the 'with' (blue line) and 'without' (orange line) I/M cases. As the figure shows, the emission factor is lower when the vehicle is operating at mid-range speeds between approximately 30 and 60 mph. At slower speeds, the emission factor rises substantially, with values that are four to five times higher than the emission factors at mid-range speeds. The figure also shows that:

- vehicles emit more toxics at slower speeds, such as those that would occur in congested areas;
- the presence of an I/M program reduces the emission factor at all speeds; and
- the benefit of the I/M program (the distance between the two lines) is largest at slower speeds – twice as high at five mph as compared to 45 mph.

…the benefit of the I/M program…is largest at slower speeds – twice as high at five mph as compared to 45 mph.

Figure 7: Benzene Emission Factor Trend, with and without I/M.



This trend is consistent for the other three air toxics evaluated in this analysis.

Figures 8 through 11 present the projected impact on emissions of the target air toxics of removing the I/M programs for all 14 cities combined for the period of 2003 to 2012. The top layer on the chart represents the total emission increase attributable to the discontinuation of I/M programs.

The downward emission trend can generally be attributed to turnover of the vehicle fleet despite expected annual increases in VMT. Over time, the addition of new vehicles and the removal of older ones results in a cleaner fleet since newer vehicles are required to meet more stringent emission limitations both at the time of manufacture and as they age.[23] As this shift occurs, though overall emissions are declining, the relative size of reductions achieved through I/M programs increases as a percentage of total emissions, creating a greater percentage benefit.

Results for each city are presented in Appendix D.

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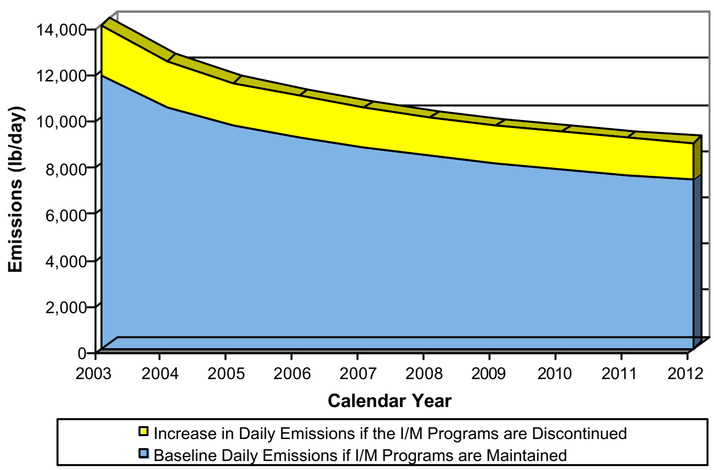
[23] The Tier 2 program which takes affect in 2004 sets new emission standards for new motor vehicles and for the first time applies the same emission standard to light duty trucks (e.g., SUVs) and cars. More information on EPA's Tier 2 program is available at http://www.epa.gov/otaq/tr2home.htm.

4.1 Acetaldehyde

Figure 8 presents the trend in acetaldehyde emissions over time. Looking at calendar year 2003, acetaldehyde emissions are estimated to increase by 2,211 lb/day, or 18.8 percent, if I/M programs are discontinued. This amounts to an annual emissions increase of 404 tons per year (tpy) in 2003. Although the total emissions of acetaldehyde declines over time, the relative benefit of I/M increases. By 2007, the I/M benefit increases to 19.6 percent, which correlates to an annual increase of 310 tons. By 2012, discontinuation of I/M would result in a 22.3 percent increase in acetaldehyde emissions.

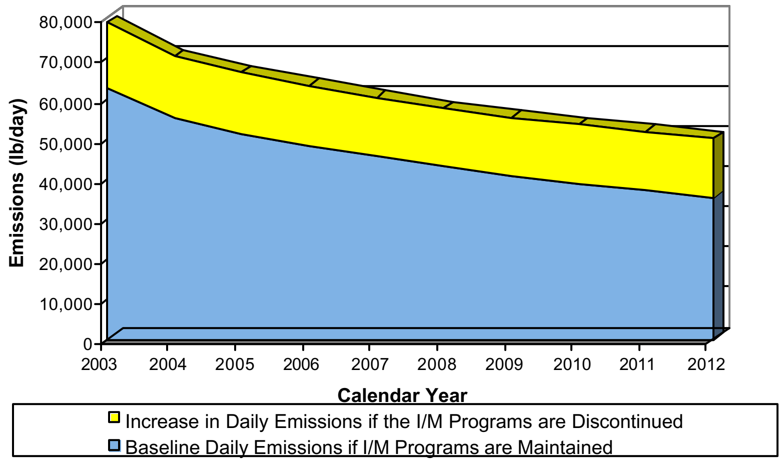
Figure 8: Acetaldehyde Emission Trend - Daily Basis



4.2 Benzene

Figure 9 presents the trend in benzene emissions over time. In 2003, benzene emissions are projected to increase by 8.05 lb/day, or 25.7 percent, if I/M programs are discontinued. This amounts to an annual emissions increase of 2,939 tons in 2003. By the midpoint of our analysis, 2007, the estimated increase grows to 31.8 percent, which correlates to an increase of 2,647 tpy. By 2012, enhanced I/M programs prevent a 41.8 percent increase in benzene emissions.

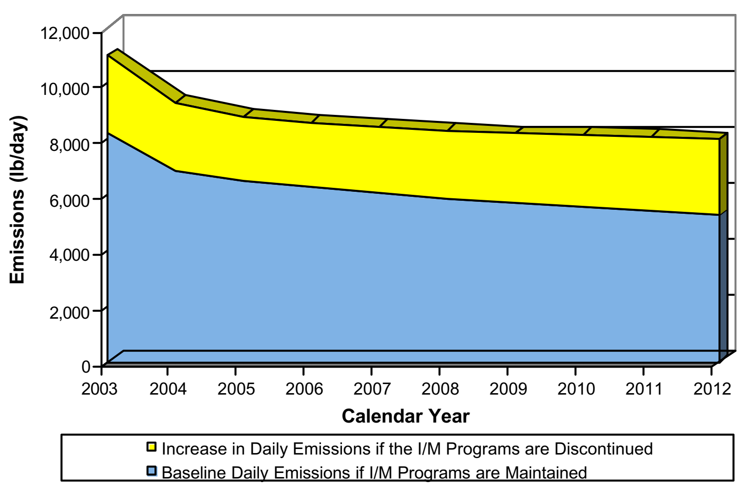
Figure 9: Benzene Emission Trend – Daily Basis



4.3 1,3-Butadiene

Figure 10 shows the trend in 1,3-butadiene emissions. For 2003, 1,3-butadiene emissions are estimated to increase by 2,791 lb/day, or 34.1 percent, if I/M programs are discontinued. This amounts to an annual emissions increase of 509 tons in 2003. By 2007, the increase is projected to grow to 38.8 percent, which correlates to an increase of 430 tpy. In 2012, the analysis predicts that 1,3 butadiene emissions would increase by 51.4 percent without I/M.

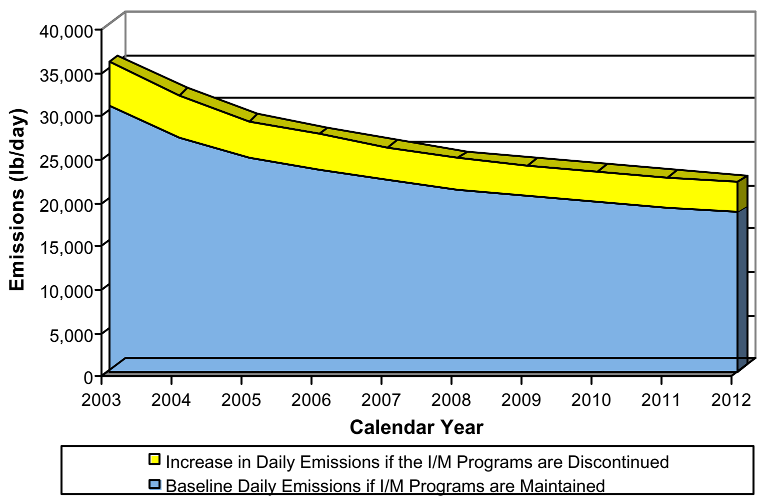
Figure 10: 1,3-Butadiene Emission Trend – Daily Basis



4.4 Formaldehyde

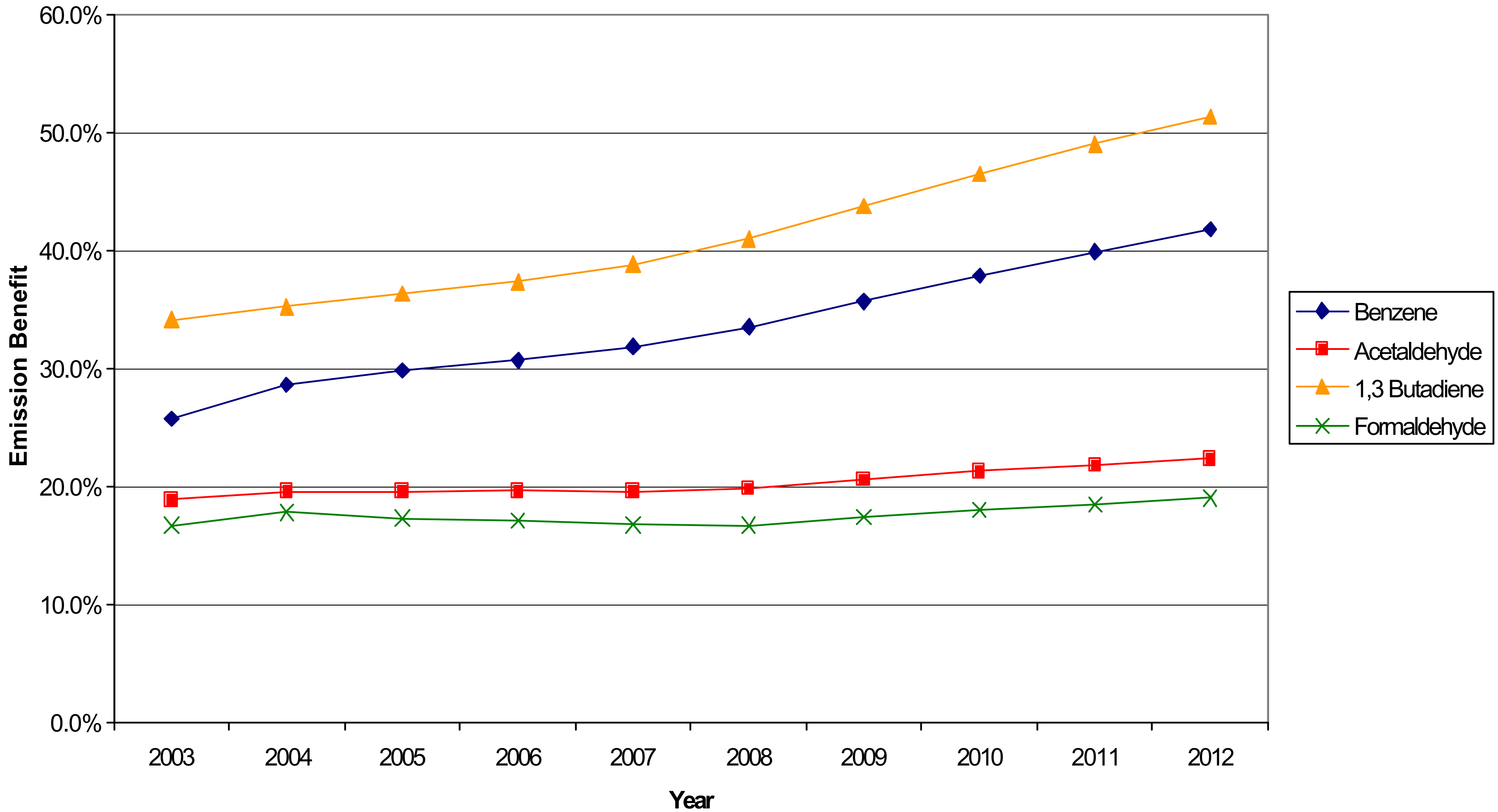
Figure 11 shows the trend in formaldehyde emissions. In 2003, formaldehyde emissions are estimated to increase by 5,103 lb/day, or 16.7 percent, if I/M programs are discontinued. This amounts to an annual emissions increase of 931 tons in 2003. By 2007 the I/M benefit is also 16.7 percent, which equals to an annual increase of 677 tons. In 2012, formaldehyde emissions would increase by 19 percent if I/M programs were discontinued.

Figure 11: Formaldehyde Emission Trend – Daily Basis



Finally, Figure 12 shows the percent benefit in emission reductions that accrues over time for each of the target compounds. Despite the overall emission reductions achieved over time due to vehicle fleet turnover – total emissions are reduced as older, dirtier vehicles are taken off the road – reductions delivered by I/M programs remain relatively steady. This results in a relative benefit from I/M programs that, in most cases, increases over time.

Figure 12: Percentage of Air Toxics Removed by I/M Programs



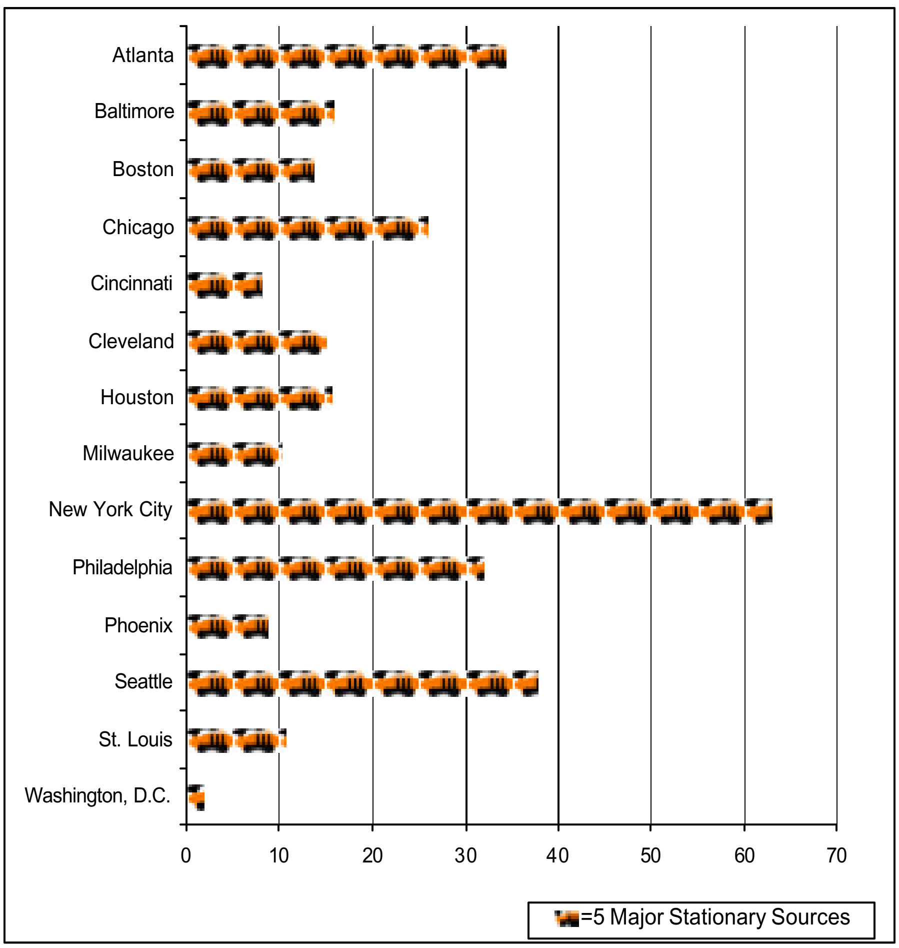
In the 14 cities evaluated, the total amount of benzene emissions avoided in 2003 due to the I/M programs represents the benzene equivalent of more than 293 major industrial sources or more than 65 million new cars.

4.5 Magnitude of Toxic Air Pollutant Emissions

In an effort to put these emission reductions into context, it is useful to consider the meaning of these emission increases in terms of other emission sources.

Other sources – most notably, stationary sources, such as factories and power plants – produce air toxics. The Clean Air Act defines a major stationary source of air toxics as one with the potential to emit 10 tons per year of any one toxic air pollutant, or 25 tpy of any combination of toxic air pollutants. By comparison, the total of 2,939 tons of benzene that are not emitted in 2003 due to the I/M programs in the 14 cities represents the benzene equivalent of more than 293 additional major stationary sources of benzene. The impact of this increase for each of the cities in the analysis is shown in Figure 13.

Figure 13: Benzene Emissions Avoided Through I/M Programs – Major Stationary Source Equivalent

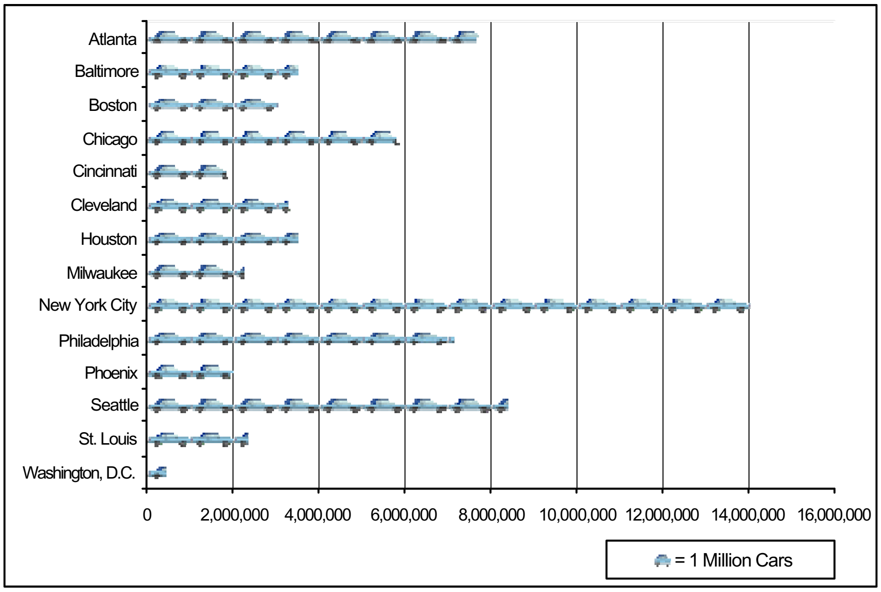


In addition to controlling these four toxic air pollutants, a significant amount of the remaining 29 urban air toxics identified by EPA are also controlled by I/M programs.

…if all areas with I/M programs nationwide are considered, the benefits realized by the I/M programs are far greater than the levels identified through this analysis.

These avoided emissions can also be expressed in terms of new vehicles. Assuming an average of 12,500 miles traveled per year per vehicle and an average benzene emission rate of 3.26 milligrams per mile, removing these I/M programs equals adding the air toxics produced by 65 million additional new vehicles, as shown in Figure 14.[24]

Figure 14: Benzene Emissions Avoided Through I/M Programs - Mobile Source Equivalent



In addition to controlling these four toxic air pollutants, a significant amount of the remaining 29 urban air toxics identified by EPA are also controlled by I/M programs. Also, if all areas with I/M programs nationwide are considered, the benefits realized by the I/M programs are far greater than the levels identified through this analysis.

[24] The MOBTOX model yields 3.26 mg/mi as the VMT-weighted average emission factor for benzene for new light-duty gasoline vehicles for the 14 cities included in this study.

5 CONCLUSIONS

Vehicles are responsible for a large portion of air pollution throughout the U.S., and their use is projected to grow each year for the next decade. Efforts to control their emissions by limiting emissions from their engines and in their fuels are only part of the solution. Without adequate safeguards on vehicle maintenance as vehicles age, their emissions can grow enormously. I/M programs provide a practical solution to address this concern.

The importance of I/M programs is multi-fold, reflecting the varied environmental impacts of vehicle exhaust. Not only do I/M programs reduce emissions of ozone-forming compounds, they also reduce emission levels of a variety of air toxics. Because air toxics have adverse public health impacts, the presence of I/M programs has a direct public health benefit – reducing cancer and noncancer risks to the population, especially in urban areas. EPA estimates that roughly 40 percent of air toxics emitted in urban areas come from motor vehicles.[25] Nationwide, on-road mobile sources are the largest contributing source to toxic air pollutant emissions.[26]

…the relative benefit of the I/M program increases over time – delivering larger percentage benefits in future years.

This report presents the results of an assessment of the air toxic impacts that I/M programs have in 14 U.S. cities. Using EPA models, the assessment examines four of the most important air toxics emitted by vehicles: acetaldehyde; benzene; 1,3-butadiene; and formaldehyde. The results show that if I/M programs were discontinued in the 14 cities selected for this report, then substantial increases in toxic vehicle emissions are projected to occur. While there is a general downward trend in the amount of air toxic emissions from motor vehicles over time, the decline can be attributed to older vehicles being retired from use. Nevertheless, the relative benefit of the I/M program increases over time – delivering larger percentage benefits in future years.

As an example, the magnitude of the benzene emission increase in the first year of the projection (2003) equates to an additional 293 additional "major" industrial sources of benzene, or an additional 65 million additional new cars in the 14 cities included in the analysis.

EPA's Urban Air Toxics strategy includes a goal to "…address and prevent disproportionate impacts of air toxics hazards on sensitive populations in urban areas including children, the elderly, minority, and

[25] "Air Toxics Emissions, EPA's Strategy for Reducing Health Risks in Urban Areas," EPA Document No.: EPA/453-F-99-002, July 1999.

[26] "National Air Quality and Emissions Trends Report, 1999," EPA Document No.: EPA 454/R-01-004, March 2001; and "Technical Support Document: Control of Emissions of Hazardous Air Pollutants from Motor Vehicles and Motor Vehicle Fuels," EPA Document No.: EPA-420-R-00-023, December 2000.

low-income communities." On the other hand, in its final rule on Mobile Source Air Toxics, EPA saw no need to establish unique MSAT controls and concluded that its "Tier 2 and heavy-duty 2007 standards are the most stringent controls feasible at this time [December, 2000] to reduce MSAT emissions from highway vehicles and engines."[27] Having acknowledged the need, in its Urban Air Toxics strategy, to protect sensitive populations in urban areas from disproportionate impacts of air toxics hazards, the need for EPA to focus on reductions from mobile sources is obvious. As part of its MSAT rule, EPA also established a Technical Analysis Plan and asserted that it will revisit the need for additional mobile source controls for air toxics no later than July 1, 2004. However, without meaningful requirements to-date in the MSAT rule for reducing toxics from mobile sources, protection of sensitive populations will be inadequate. Failure to identify meaningful air toxic reduction requirements in this process will elevate the importance of I/M programs to an even more critical level.

EPA should acknowledge the importance of the role that I/M programs play currently in reducing air toxics, in addition to the meaningful reductions in NO_x, VOCs and CO that I/M programs also achieve. With this in mind, I/M programs should be retained in their existing areas and should be expanding to deliver their air toxics and other benefits in other areas – particularly urban areas – as well. EPA and other regulatory and policy makers should recognize I/M programs as an important component of a comprehensive plan for reducing air toxics from motor vehicles.

[27] EPA420-R-00-023, December 2000.

APPENDICES

APPENDIX A: VEHICLE INSPECTION AND MAINTENANCE PROGRAMS

The Clean Air Act requires enhanced I/M programs in areas classified as nonattainment for either ozone or carbon monoxide nonattainment depending on population and nonattainment level.

EPA has developed nonattainment classification system to identify areas of the country where air quality exceeds the health-based national ambient air quality standards (NAAQS) (see Table A-1). Enhanced I/M is required in any area that has a 1980 urbanized area population of 200,000 or greater and that is classified as serious or worse for ozone, or a carbon monoxide classification of moderate or serious. Also, metropolitan statistical areas that are in the ozone transport region with a 1990 population of 100,000 or more are required to have enhanced I/M. The ozone transport region includes Connecticut, Delaware, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, northern Virginia and the District of Columbia.

Table A-1: Nonattainment Classification for Ozone and Carbon Monoxide

Criteria Pollutant Nonattainment

Designations:

Nonattainment: any area that does not meet (or that contributes to ambient air quality in a nearby area that does not meet) the national primary or secondary ambient air quality standard for the pollutant

Attainment: any area (other than an area identified in clause (I)) that meets the national primary or secondary ambient air quality standard for the pollutant

Unclassifiable: any area that cannot be classified on the basis of available information as meeting or not meeting the national primary or secondary ambient air quality standard for that pollutant

Ozone Classifications:

Extreme:	Area has a design value of 0.280 ppm and above
Severe 17:	Area has a design value of 0.190 up to 0.280 ppm and has 17 years to reach attainment
Severe 15:	Area has a design value of 0.180 up to 0.190 ppm and has 15 years to reach attainment
Serious:	Area has a design value of 0.160 up to 0.180 ppm
Moderate:	Area has a design value of 0.138 up to 0.160 ppm
Marginal:	Area has a design value of 0.121 up to 0.138 ppm

An area designated as an ozone nonattainment area as of the date of enactment of the Clean Air Act Amendments of 1990 has not violated the national primary ambient air quality standard for ozone for the 36-month period commencing on January 1, 1987, and ending on December 31, 1989. (Clean Air Act Section 185A)

Incomplete (or No) Data: An area designated as an ozone nonattainment area as of the date of enactment of the Clean Air Act Amendments of 1990 and did not have sufficient data to determine if it is or is not meeting the ozone standard.

Carbon Monoxide Classifications:

Serious:	Area has a design value of 16.5 ppm and above
Moderate:	Area has a design value of 9.1 up to 16.5 ppm

Not Classified: An area designated as a carbon monoxide nonattainment area as of the date of enactment of the Clean Air Act Amendments of 1990 and did not have sufficient data to determine if it is or is not meeting the carbon monoxide standard

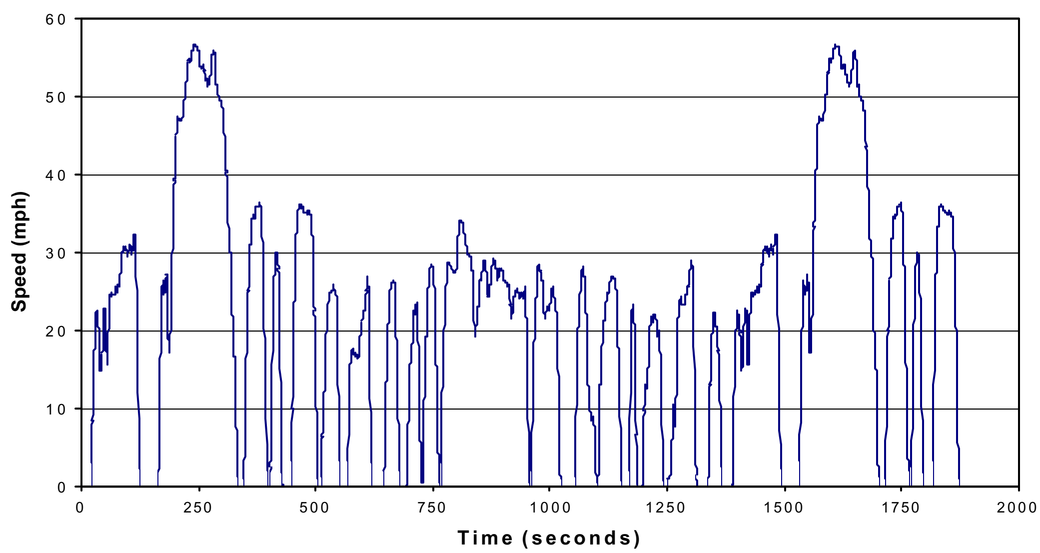
An enhanced I/M program consists of a dynamometer based inspection where the vehicle is put on a set of rollers that allows the vehicle to be run at various speeds. During the test, the vehicle is driven over a prescribed test cycle and exhaust gas is collected, analyzed, and compared against standards for that vehicle's model type and year. Several different kinds of enhanced I/M tests are being used by states and include the IM240 and other similar state-developed tests.

EPA's Federal Test Procedure (FTP), by EPA to certify light-duty vehicles for initial sale. The FTP driving cycle is designed to simulate typical urban driving patterns with the intent of measuring emissions that are generated during actual driving. Beginning with model year 2000 (with full phase-in by 2002), EPA will also use the supplemental FTP (SFTP) for vehicle certification at the time of manufacture. The SFTP cycle has been added to account more realistically for aggressive driving behavior, high acceleration rates and operation of an air conditioner, each of which has the effect of increasing vehicle emissions.

The IM240 test is significantly shorter in duration than the FTP, and is used in state I/M programs. The IM240 test is intended to provide a realistic assessment of a vehicle's emissions without subjecting the vehicle to the more time-consuming FTP or SFTP tests. Some state I/M programs use alternative state-specific driving cycles. Each of the tests used by the states are significantly shorter than the FTP test; as shown in Figures A-1 through A-3, the duration of FTP drive cycle is over 30 hours, while the SFTP is 10 minutes; the IM240 test duration is 4 minutes. In addition, the complexity of the speed profile is significantly reduced in the IM250 test as compared to the FTP and SFTP. This provides the states with a way to measure emissions from each vehicle with greater convenience than would be possible if the FTP or SFTP tests were used.

Figures A-1 through A-3 provide speed vs. time plots of the FTP, SFTP, and IM240 test cycles.

Figure A-1: Federal Test Procedure Emissions Test Cycle



Some states choose to use an alternative test, call the accelerated simulation measure (ASM). The ASM test measures emissions during steady-state driving conditions; it does not reflect the emissions generated during acceleration, which are captured during the IM240 test. The ASM test cycles are generally referred to as either ASM2525 or ASM5015. The name of each describes how the test is run. For example, the ASM2525 test involves operating the vehicle on the dynamometer under steady-state conditions at 25 miles per hour (mph). The dynamometer then applies a load to the vehicle requiring 25% of the power necessary to accelerate the vehicle at a rate of 3.3 mph/second at 25 mph. The rate of 3.3 mph/second corresponds to the maximum acceleration rate encountered during the FTP. The ASM5015 test involves operating the vehicle at 15 mph, and applying 50% power to the vehicle. The ASM test more accurately simulates real world driving conditions than idle tests. Another designation given to ASM tests is the ASM-2, which indicates that the test is performed in both testing modes, (ASM2525 and ASM5015).

Figure A-2: Supplemental FTP Emissions Test Cycles

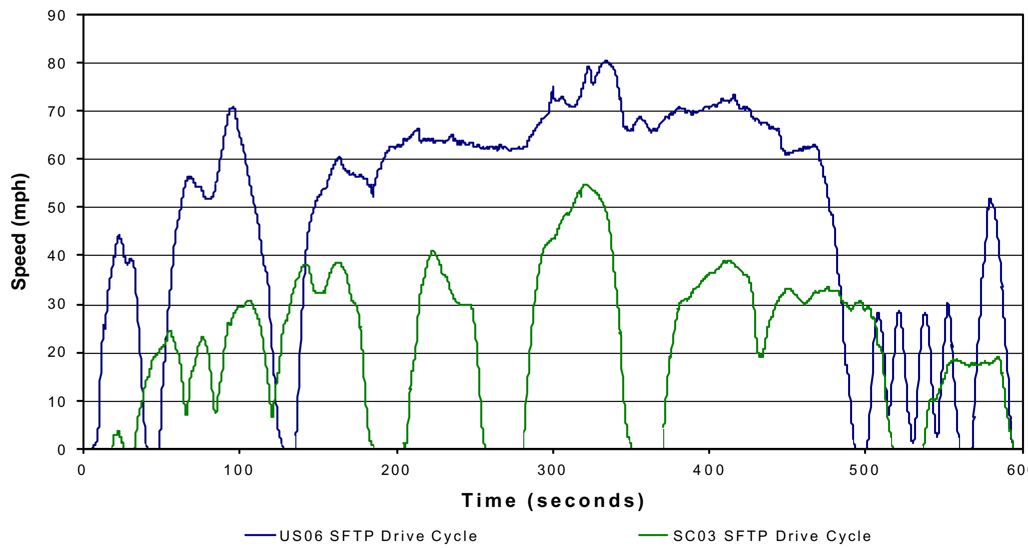
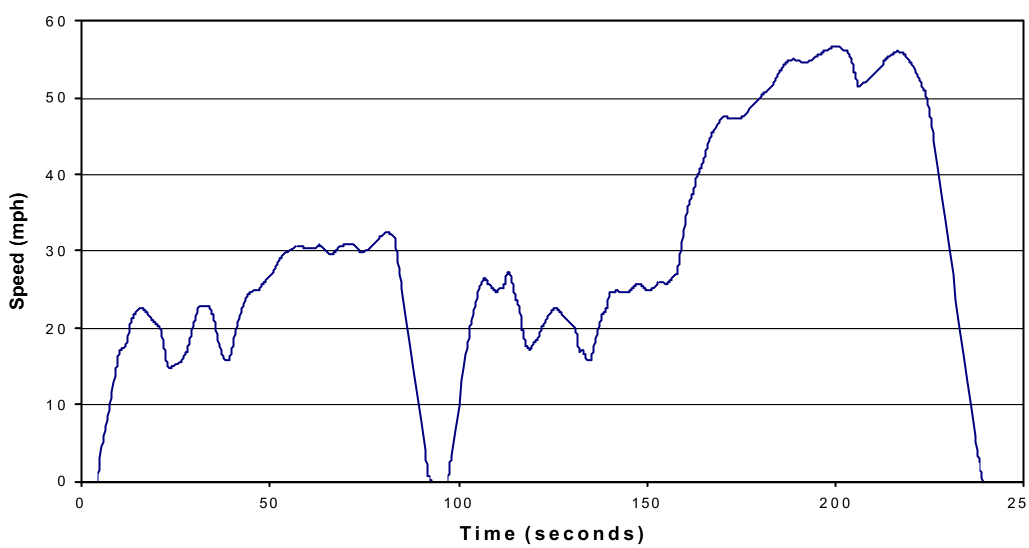


Figure A-3: IM240 Emissions Test Drive Cycle

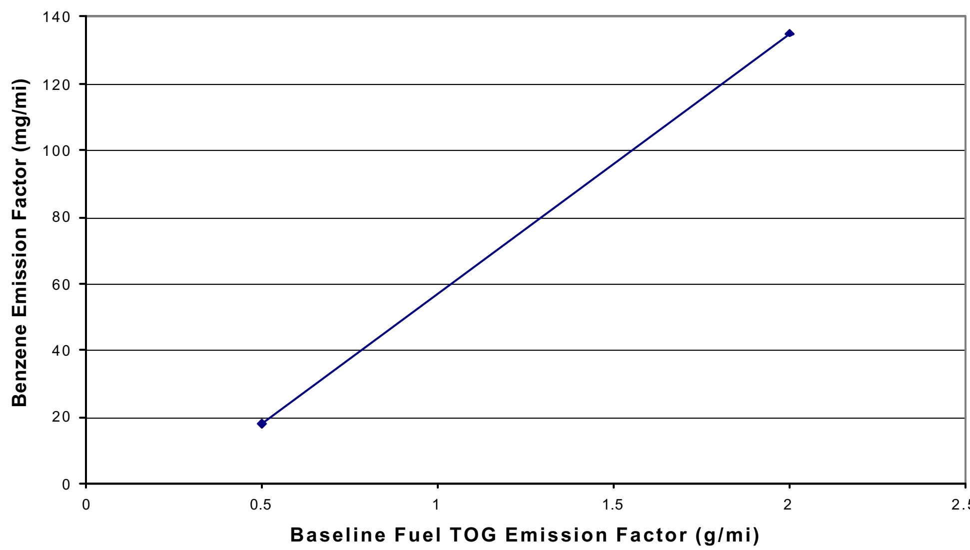


APPENDIX B: MOBTOX MODELING METHODOLOGY

Background

The MOBTOX5b model is designed around EPA's existing mobile source emission estimation model (MOBILE). Essentially, the MOBTOX5b model uses the methodology from the prior version of the MOBILE model (MOBILE5b). [1] However, it also incorporates many available elements of the newest generation model (MOBILE6), including offcycle impacts, and the impacts of sulfur reductions on low emission vehicles. The MOBTOX5b model generates speed-specific total organic gas (TOG) emission factors for each vehicle class and model year. A toxic fraction is applied to the TOG emission factor to produce a toxic emission factor. Toxic fractions represent the percentage of the toxic compound of interest contained in the TOG emission factor. The toxic fractions have been developed as toxic-TOG curves that plot the toxic emission rate of a target fuel against the base fuel TOG emission rate for each of the four pollutants. The model then applies the TOG emission rate to the toxic-TOG curve to determine the appropriate toxic emission rate. Each curve in the model is a function of vehicle type, fuel type, and emission control technology. An example toxic-TOG curve is shown in Figure B-1.

Figure B-1: Hypothetical Toxic-TOG Curve for Benzene



Since the MOBTOX5b model is designed around the MOBILE model, the modeling input parameters are very similar. Input files were developed for each city based on the MOBILE5b model inputs provided by a local agency. In some cases this was a state agency such as the Wisconsin Department of Natural Resources Bureau of Air Management, while in others, information was collected from more local entities such as the Ohio-Kentucky-Indiana Regional Council of Governments in Cincinnati.

[1] The MOBTOX5b model was developed by Radian International Corporation/Eastern Research Group (Radian) as a subcontractor to Sierra Research, Inc. under Work Assignment WA#1-06 of EPA Contract No. 68-C7-0051. That project was designed to evaluate a nationwide inventory for five toxic air pollutants from motor vehicle exhaust. The results of WA#1-06 including a discussion of the MOBTOX5b model is presented in the EPA report entitled "Analysis of the Impacts of Control Programs on Motor Vehicle Toxics Emissions and Exposure in Urban Areas and Nationwide," EPA document number EPA420-R-99-029, November, 1999.

In early 2002, EPA released a draft version of MOBILE6.2, which includes toxics for state and selected stakeholder review. EPA is on track to release an official version of the model that incorporates benzene, formaldehyde, acetaldehyde, 1,3-butadiene, MTBE, and acrolein by mid-2002. MOBILE6.2 differs from MOBTOX5b in that is has added acrolein and the ability to estimate other toxic emission factors based on user supplied information. Based on information provided by EPA, MOBILE6.2 predicts somewhat higher emission factors in base years, with convergence between 2015 and 2020. This introduces a limitation of this analysis in that it may be underpredicting toxic emission factors.

Modeling Assumptions

A series of assumptions were necessary to predict the toxic emission factors for mobile sources. These assumptions were incorporated into the MOBTOX5b model based on information available from both state environmental protection agencies and local metropolitan planning organizations. The MOBILE5b input files used to prepare each state's SIP were the primary source for such information. When possible, more specific assumptions taken from EPA documentation related to the MOBTOX5b model were used in place of the state-specific or MOBILE5b default values. These assumptions are specific to the vehicle fleet mix, the mileage and registration distributions, and base emission rates (BERs). In undertaking this analysis, it was necessary to decide between state-specific or EPA default data. When state-specific mileage accumulation rates and registration distributions were available, they were used in place of EPA's default values. For the vehicle mix and BERs, the revised EPA data were used as explained further below.

Although different assumptions were made regarding which data source to use for vehicle mix and registration distributions, EPA default values for both have been updated to account for more recent information on the fleet make-up. Specifically, the vehicle mix was revised to account for the large increase in light-duty truck sales (such as minivans and sport-utility vehicles) observed in recent years. Table B-1 provides a listing of the different classes of vehicles used in MOBTOX5b,

Table B-1: Vehicle Classification Abbreviations

Abbreviation	Definition
LDGV	Light-Duty Gasoline Vehicles
LDGT1	Light-Duty Gasoline Trucks with a Gross Vehicle Weight under 6,000 lb
LDGT2	Light-Duty Gasoline Trucks with a Gross Vehicle Weight over 6,000 lb
HDGV	Heavy-Duty Gasoline Vehicles
LDDV	Light-Duty Diesel Vehicles
LDDT	Light-Duty Diesel Trucks
HDDV	Heavy-Duty Diesel Vehicles
MC	Motorcycles

Table B-2 compares the EPA vehicle mix used in this analysis to the mixes used in the MOBILE5b SIP input files for each city. The registration distributions were modified to account for vehicles staying in the fleet for a longer period of time. In addition, mileage accumulation rates used for some cities are those used by EPA for the specific city in their nationwide toxic emission analysis.[2]

Table B-2: Comparison of Vehicle Mixes

	Vehicle Type							
	LDGV	**LDGT1**	**LDGT2**	**HDGV**	**LDDV**	**LDDT**	**HDDV**	**MC**
EPA [1]	.395	.383	.127	.023	.000	.002	.065	.005
Atlanta [2]	.600	.197	.087	.031	.002	.002	.075	.006
Baltimore [2]	.600	.197	.087	.031	.002	.002	.075	.006
Boston [2]	.600	.197	.087	.031	.002	.002	.075	.006
Chicago	.6124	.184	.079	.018	.008	.002	.085	.010
Cincinnati [3]	.848	.025	.025	.031	.002	.002	.061	.005
Cleveland [3]	.950	.013	.012	.002	.001	.001	.020	.001
Houston [2]	.600	.197	.087	.031	.002	.002	.075	.006
Milwaukee [4]	.581	.270	.093	.017	.004	.001	.033	.001
New York City [5]	.600	.197	.087	.031	.002	.002	.075	.006
Philadelphia [3]	.627	.210	.093	.017	.002	.003	.043	.006
Phoenix [2]	.600	.197	.087	.031	.002	.002	.075	.006
Seattle [2]	.600	.197	.087	.031	.002	.002	.075	.006
St. Louis [2]	.600	.197	.087	.031	.002	.002	.075	.006
Washington DC	.820	.091	.014	.016	.014	.000	.029	.016

1 – Updated vehicle mix provided with MOBTOX. Since the development of MOBTOX, EPA has found that there is a greater contribution of heavy-duty engines to overall VMT which is reflected in the recent 2007 heavy-duty rule.

2 – MOBILE5b default used in SIP planning; 2005 default shown.

3 – Vehicle mix varies by roadway type, normalized median of all provided is shown.

4 – Vehicle mix for non-freeway shown; freeway mix differs slightly in favor of HDGV and HDDV.

5 – Vehicle mix not provided, MOBILE5b default for 2005 shown.

The BERs are updated from the default MOBILE5b values based on more recent test data collected by EPA. The revised BERs account for lower deterioration rates than currently estimated by the MOBILE5b model, and takes into account a national low-emission vehicle (NLEV) program implemented in 2001.[3] With respect to BERs, one limitation of the MOBTOX5b model is that it does not distinguish the level of effectiveness of different I/M programs in controlling exhaust hydrocarbons, of which the air toxics are a subset. There are four sets of BERs used in the modeling; each defined by whether there is an I/M program in place and whether the city is within the ozone transport region (OTR). The BERs are broken down as (1) I/M / OTR, (2) I/M / Non-OTR (3) Non I/M / OTR and (4) Non I/M / Non-OTR. Table B-3 provides a summary of the sources for each of the mileage accumulation rates, registration distribution, and vehicle mix data inputs used in the modeling.

[2] "Analysis of the Impacts of Control Programs on Motor Vehicle Toxics Emissions and Exposure in Urban Areas and Nationwide," EPA420-R-99-029, November 1999.

[3] Mileage accumulation rates and a more complete discussion of the BERs are provided in the EPA document entitled "Analysis of the Impacts of Control Programs on Motor Vehicle Toxics Emissions and Exposure in Urban Areas and Nationwide," EPA420-R-99-029, November 1999.

Table B-3: Summary of Modeling Assumption Sources by City

City	Mileage Accumulation	Registration Distribution	Vehicle Mix
Atlanta	EPA	EA	EPA
Baltimore	EPA	Baltimore	EPA
Boston	EPA	Boston	EPA
Chicago	EPA	Chicago	EPA
Cincinnati	EPA	EPA	EPA
Cleveland	EPA	Cleveland	EPA
Houston	EPA	EPA	EPA
Milwaukee	EPA	Milwaukee	EPA
New York	New York	New York	EPA
Philadelphia	EPA	Philadelphia	EPA
Phoenix	EPA	Phoenix	EPA
Seattle	EPA	Seattle	EPA
St. Louis	EPA	St. Louis	EPA
Washington, DC	EPA	Washington, DC	EPA

Developing MOBTOX5b input files for a wide range of localized temperatures is a complex task, yet some seasonal variation is warranted for this analysis. In order to provide this temperature variation, MOBTOX5b input files were developed for generic summer and winter cases. The main differences between such input files are the minimum and maximum daily and ambient temperatures, though fuel parameters can change, as well.

Roadway VMT and speed data were collected from each state for areas impacted by the enhanced I/M program. Table B-4 provides a list of the area covered in the analysis for each city. Because data for only one year were usually provided, VMT estimates for the other years were obtained using either a supplied growth rate or an assumed rate of 1.5 percent per year. This latter growth rate assumption is based on recommendations from representatives of different state agencies that provided VMT data. Based on the growth rate, an estimate of VMT across the calendar years for each roadway/speed classification was developed. VMT and speed data are integral parts of the overall analysis because changes in either variable produce a direct effect on the calculation of total emissions.

Table B-4: List of Counties Included in Analysis for Each City

City	Included Counties
Atlanta, GA	Cherokee, Clayton, Cobb, Coweta, DeKalb, Douglas, Fayette, Forsyth, Fulton, Gwinnett, Henry, Paulding, Rockdale
Baltimore, MD	Annes Arundel, Baltimore, Baltimore City, Calwert, Carroll, Cecil, Charles, Frederick, Harford, Howard, Montgomery, Prince Georges, Queen Anne's, Washington
Boston, MA	Barnstable, Bristol, Dukes, Essex, Middlesex, Nantucket, Norfolk, Plymouth, Suffolk, Worcester
Chicago, IL	Cook, DuPage, Kane[1], Kendall[1], Lake, McHenry[1], Will[1]
Cincinnati, OH	Butler, Clermont, Hamilton, Warren
Cleveland, OH	Cuyahoga, Geauya, Lake, Lorain, Medina, Portage, Summit
Houston, TX	Harris
Milwaukee, WI	Kenosha, Milwaukee, Ozaukee, Racine, Washington, Waukesha
New York City, NY	Bronx, Kings, Nassau, New York, Queens, Richmond, Rockland, Suffolk, Westchester
Philadelphia, PA	Bucks, Chester, Delaware, Montgomery, Philadelphia
Phoenix, AZ	Phoenix Urbanized Area of Maricopa County
Seattle, WA	King, Kitsap, Pierce, Snohomish
St. Louis, MO	Jefferson, St. Charles, St. Louis, St. Louis City
Washington, D.C.	District of Columbia

1 – Only a portion of these counties are subject to the I/M program

To predict toxic pollutant emission factors, the MOBTOX5b model input file requires three distinct changes from the MOBILE5b input file. These inputs are used to identify other data files, which contain evaporative fractions, exhaust emissions fractions, and offcycle factors, and were provided with the MOBTOX5b model documentation. Each of these is used by MOBTOX5b to associate a toxic pollutant emission factor with the TOG result from MOBILE5b for each of the respective types of emissions. A core assumption of MOBTOX5B used for estimating air toxic emission factors is that there is no phase-out of Methyl Tertiary Butyl Ether (MTBE). If MTBE were phased out, the general composition of gasoline would change, and, therefore, the emission factors estimated by MOBTOX5b would be slightly different.

In the EPA analysis, four discrete years were evaluated (1990, 1996, 2007, and 2020), whereas in this analysis, each year from 2003 through 2012 was considered. The MOBTOX5b model only came with evaporative fraction, exhaust emission fraction and offcycle factor data files for each of the four discrete years. To evaluate other years, one of the existing data files was assigned to that particular analysis year. For this analysis, calendar year 2007 files were used for each analysis year. This year was chosen as it represented roughly the midpoint of our analysis span. Also, based on the available data files, there was no clear trend that established one file as more conservative, and therefore, the decision was made to continue using the 2007 files. Since the development of MOBTOX5b, two cities have reformulated gasoline (RFG) programs that are different from those used in developing city-specific evaporative fraction, exhaust emission fraction and offcycle factor data files. St. Louis has since opted into the Federal RFG program and now utilizes reformulated gasoline. Phoenix has opted out of the Federal program for purposes of adopting a more stringent state RFG program.

In choosing specific files for evaporative fractions, exhaust emissions fractions, and offcycle factors for the different modeling runs, a judgment was necessary where a file did not exist for a specific city. The judgement made was based primarily on the proximity of the city in question to others for which these files have been prepared. For example, files are not available for Boston, and the closest city for which they are available is New York. Since both cities are relatively close geographically, and are in the OTR, the New York files were used for the Boston analysis. Table B-5 provides a summary of the assumptions used for each of the BER, evaporative fractions, exhaust emissions fractions, and offcycle factors by city.

Table B-5: Summary of Files Used in MOBTOX5b Model Runs

		MOBTOX5b Data Files [1]			
City	**Analysis Years [2]**	**BER [3]**	**Tox-TOG.EVP [4]**	**Tox-TOG.EXH [4]**	**Offcycle [3]**
Atlanta	2003	NTR_**_b.BER	AT07*b.EVP	AT07*B_b.EXH	NTR**07b.OFF
	2004 – 2012	NTR_**_c.BER	AT07*3.EVP	AT07*3_t.EXH	NTR**07c.OFF
Baltimore	2003	OTR_**_b.BER	PA07*b.EVP	PA07*B_b.EXH	OTR**07b.OFF
	2004 – 2012	OTR_**_c.BER	PA07*3.EVP	PA07*3_t.EXH	OTR**07c.OFF
Boston	2003	OTR_**_b.BER	NY07*b.EVP	NY07*B_b.EXH	OTR**07b.OFF
	2004 – 2012	OTR_**_c.BER	NY07*3.EVP	NY07*3_t.EXH	OTR**07c.OFF
Chicago	2003	NTR_**_b.BER	CH07*b.EVP	CH07*B_b.EXH	NTR**07b.OFF
	2004 – 2012	NTR_**_c.BER	CH07*3.EVP	CH07*3_t.EXH	NTR**07c.OFF
Cincinnati	2003	NTR_**_b.BER	ON07*b.EVP	ON07*B_b.EXH	NTR**07b.OFF
	2004 – 2012	NTR_**_c.BER	ON07*3.EVP	ON07*3_t.EXH	NTR**07c.OFF
Cleveland	2003	NTR_**_b.BER	ON07*b.EVP	ON07*B_b.EXH	NTR**07b.OFF
	2004 – 2012	NTR_**_c.BER	ON07*3.EVP	ON07*3_t.EXH	NTR**07c.OFF
Houston	2003	NTR_**_b.BER	HS07*b.EVP	HS07*B_b.EXH	NTR**07b.OFF
	2004 – 2012	NTR_**_c.BER	HS07*3.EVP	HS07*3_t.EXH	NTR**07c.OFF
Milwaukee	2003	NTR_**_b.BER	MI07*b.EVP	MI07*B_b.EXH	NTR**07b.OFF
	2004 – 2012	NTR_**_c.BER	MI07*3.EVP	MI07*3_t.EXH	NTR**07c.OFF
New York	2003	OTR_**_b.BER	NY07*b.EVP	NY07*B_b.EXH	OTR**07b.OFF
	2004 – 2012	OTR_**_c.BER	NY07*3.EVP	NY07*3_t.EXH	OTR**07c.OFF
Philadelphia	2003	OTR_**_b.BER	PA07*b.EVP	PA07*B_b.EXH	OTR**07b.OFF
	2004 – 2012	OTR_**_c.BER	PA07*3.EVP	PA07*3_t.EXH	OTR**07c.OFF
Phoenix	2003	NTR_**_b.BER	PX07*b.EVP	PX07*B_b.EXH	NTR**07b.OFF
	2004 – 2012	NTR_**_c.BER	PX07*3.EVP	PX07*3_t.EXH	NTR**07c.OFF
Seattle	2003	NTR_**_b.BER	SP07*b.EVP	SP07*B_b.EXH	NTR**07b.OFF
	2004 – 2012	NTR_**_c.BER	SP07*3.EVP	SP07*3_t.EXH	NTR**07c.OFF
St. Louis	2003	NTR_**_b.BER	SL07*b.EVP	SL07*B_b.EXH	NTR**07b.OFF
	2004 – 2012	NTR_**_c.BER	SL07*3.EVP	SL07*3_t.EXH	NTR**07c.OFF
Washington DC	2003	OTR_**_b.BER	PA07*b.EVP	PA07*B_b.EXH	OTR**07b.OFF
	2004 – 2012	OTR_**_c.BER	PA07*3.EVP	PA07*3_t.EXH	OTR**07c.OFF

1 – More information can be found regarding MOBTOX5b input requirements in the EPA report entitled "Analysis of the Impacts of Control Programs on Motor Vehicle Toxics Emissions and Exposure in Urban Areas and Nationwide," EPA document number EPA420-R-99-029, November 1999.

2 – Separate model runs were performed to account for inclusion of Tier 2 emission standards taking affect in 2004.

3 – In place of **, either IM or NO is used to indicate whether an I/M program is in place.

4 – In place of *, either S or W is used to indicate whether the season is summer or winter.

APPENDIX C: AVERAGE ANNUAL VEHICLE MILES TRAVELED BY SPEED

Average Annual Vehicle Miles Traveled by Speed

Atlanta

Speed (mph) [a]	2003 [a]	2004 [b]	2005 [b]	2006 [b]	2007 [b]	2008 [b]	2009 [b]	2010 [b]	2011 [b]	2012 [b]
13.0	7,901,901,425	8,020,429,946	8,140,736,396	8,262,847,442	8,386,790,153	8,512,592,005	8,640,280,886	8,769,885,099	8,901,433,375	9,034,954,876
23.0	10,002,637,755	10,152,677,321	10,304,967,481	10,459,541,993	10,616,435,123	10,775,681,650	10,937,316,875	11,101,376,628	11,267,897,277	11,436,915,737
31.0	9,257,616,545	9,396,480,793	9,537,428,005	9,680,489,425	9,825,696,767	9,973,082,218	10,122,678,451	10,274,518,628	10,428,636,407	10,585,065,954
46.0	18,848,581,020	19,131,309,735	19,418,279,381	19,709,553,572	20,005,196,876	20,305,274,829	20,609,853,951	20,919,001,760	21,232,786,787	21,551,278,589
57.0	2,168,562,820	2,201,091,262	2,234,107,631	2,267,619,246	2,301,633,534	2,336,158,037	2,371,200,408	2,406,768,414	2,442,869,940	2,479,512,989
Total:	*48,179,299,565*	*48,901,989,058*	*49,635,518,894*	*50,380,051,678*	*51,135,752,453*	*51,902,788,740*	*52,681,330,571*	*53,471,550,529*	*54,273,623,787*	*55,087,728,144*

a - provided by GA DEP
b - assume growth rate of 1.5%/yr from 2003

Baltimore

Speed (mph) [a]	2003 [b]	2004 [b]	2005 [b]	2006 [b]	2007 [b]	2008 [b]	2009 [b]	2010 [b]	2011 [b]	2012 [b]
24.0	5,652,958,243	5,737,752,617	5,823,818,906	5,911,176,190	5,999,843,832	6,089,841,490	6,181,189,112	6,273,906,949	6,368,015,553	6,463,535,786
25.0	3,331,526,051	3,381,498,941	3,432,221,425	3,483,704,747	3,535,960,318	3,588,999,723	3,642,834,719	3,697,477,239	3,752,939,398	3,809,233,489
26.7	2,736,039,998	2,777,080,598	2,818,736,807	2,861,017,860	2,903,933,127	2,947,492,124	2,991,704,506	3,036,580,074	3,082,128,775	3,128,360,707
29.9	8,038,767,532	8,159,349,045	8,281,739,281	8,405,965,370	8,532,054,851	8,660,035,674	8,789,936,209	8,921,785,252	9,055,612,031	9,191,446,211
41.4	2,070,720,287	2,101,781,092	2,133,307,808	2,165,307,425	2,197,787,036	2,230,753,842	2,264,215,150	2,298,178,377	2,332,651,053	2,367,640,818
42.9	2,635,365,696	2,674,896,182	2,715,019,624	2,755,744,919	2,797,081,093	2,839,037,309	2,881,622,869	2,924,847,212	2,968,719,920	3,013,250,719
44.5	2,735,133,870	2,776,160,878	2,817,803,291	2,860,070,341	2,902,971,396	2,946,515,967	2,990,713,706	3,035,574,412	3,081,108,028	3,127,324,648
51.5	15,742,756,876	15,978,898,229	16,218,581,703	16,461,860,428	16,708,788,335	16,959,420,160	17,213,811,462	17,472,018,634	17,734,098,914	18,000,110,397
57.7	3,547,847,928	3,601,065,646	3,655,081,631	3,709,907,856	3,765,556,473	3,822,039,821	3,879,370,418	3,937,560,974	3,996,624,389	4,056,573,755
Total:	*46,491,116,482*	*47,188,483,229*	*47,896,310,477*	*48,614,755,135*	*49,343,976,462*	*50,084,136,109*	*50,835,398,150*	*51,597,929,122*	*52,371,898,059*	*53,157,476,530*

a - provided by MDE's Mobile Sources Control Program
b - assume growth rate of 1.5%/yr from 1999

Boston

Speed (mph) [a]	2003 [b]	2004 [b]	2005 [b]	2006 [b]	2007 [b]	2008 [b]	2009 [b]	2010 [b]	2011 [b]	2012 [b]
26.5	627,971,665	637,391,240	646,952,109	656,656,390	666,506,236	676,503,830	686,651,387	696,951,158	707,405,425	718,016,507
28.1	5,676,925,837	5,762,079,724	5,848,510,920	5,936,238,584	6,025,282,163	6,115,661,395	6,207,396,316	6,300,507,261	6,395,014,870	6,490,940,093
31.7	2,528,544,762	2,566,472,933	2,604,970,027	2,644,044,577	2,683,705,246	2,723,960,825	2,764,820,237	2,806,292,541	2,848,386,929	2,891,112,733
34.1	141,400,159	143,521,161	145,673,979	147,859,089	150,076,975	152,328,129	154,613,051	156,932,247	159,286,231	161,675,524
37.3	6,884,831,853	6,988,104,331	7,092,925,896	7,199,319,784	7,307,309,581	7,416,919,225	7,528,173,013	7,641,095,608	7,755,712,042	7,872,047,723
40.9	1,006,459,214	1,021,556,102	1,036,879,444	1,052,432,636	1,068,219,125	1,084,242,412	1,100,506,048	1,117,013,639	1,133,768,843	1,150,775,376
41.6	9,559,812,944	9,703,210,138	9,848,758,290	9,996,489,664	10,146,437,009	10,298,633,564	10,453,113,068	10,609,909,764	10,769,058,410	10,930,594,286
47.7	810,435,980	822,592,520	834,931,407	847,455,379	860,167,209	873,069,717	886,165,763	899,458,250	912,950,123	926,644,375
50.5	1,223,789,322	1,242,146,161	1,260,778,354	1,279,690,029	1,298,885,380	1,318,368,660	1,338,144,190	1,358,216,353	1,378,589,598	1,399,268,442
53.2	3,677,566,328	3,732,729,823	3,788,720,770	3,845,551,582	3,903,234,855	3,961,783,378	4,021,210,129	4,081,528,281	4,142,751,205	4,204,892,473
58.8	12,144,530,371	12,326,698,327	12,511,598,802	12,699,272,784	12,889,761,875	13,083,108,304	13,279,354,928	13,478,545,252	13,680,723,431	13,885,934,282
59.4	1,469,012,063	1,491,047,244	1,513,412,953	1,536,114,147	1,559,155,859	1,582,543,197	1,606,281,345	1,630,375,565	1,654,831,199	1,679,653,667
Total:	*45,751,280,497*	*46,437,549,705*	*47,134,112,950*	*47,841,124,645*	*48,558,741,514*	*49,287,122,637*	*50,026,429,477*	*50,776,825,919*	*51,538,478,307*	*52,311,555,482*

a - provided by MA DEP
b - assume growth rate of 1.5%/yr from 1999 per MADEP

Chicago

Speed (mph) [a]	2003 [b]	2004 [b]	2005 [b]	2006 [b]	2007 [b]	2008 [b]	2009 [b]	2010 [b]	2011 [b]	2012 [b]
20.0	6,934,223,223	7,107,578,804	7,285,268,274	7,467,399,980	7,654,084,980	7,845,437,104	8,041,573,032	8,242,612,358	8,448,677,667	8,659,894,608
30.0	7,501,169,119	7,688,698,347	7,880,915,806	8,077,938,701	8,279,887,168	8,486,884,347	8,699,056,456	8,916,532,867	9,139,446,189	9,367,932,344
35.0	12,633,258,849	12,949,090,320	13,272,817,578	13,604,638,017	13,944,753,968	14,293,372,817	14,650,707,138	15,016,974,816	15,392,399,186	15,777,209,166
40.0	17,232,940,988	17,663,764,513	18,105,358,626	18,557,992,591	19,021,942,406	19,497,490,966	19,984,928,240	20,484,551,446	20,996,665,233	21,521,581,863
55.0	17,639,666,235	18,080,657,891	18,532,674,339	18,995,991,197	19,470,890,977	19,957,663,251	20,456,604,833	20,968,019,953	21,492,220,452	22,029,525,964
Total:	*61,941,258,414*	*63,489,789,875*	*65,077,034,621*	*66,703,960,487*	*68,371,559,499*	*70,080,848,487*	*71,832,869,699*	*73,628,691,441*	*75,469,408,727*	*77,356,143,945*

a - provided by IEPA
b - assume growth rate of 2.5%/yr from 1999 per IEPA

Cincinnati

Speed (mph) [a]	2003 [b]	2004 [b]	2005 [b]	2006 [b]	2007 [b]	2008 [b]	2009 [b]	2010 [b]	2011 [b]	2012 [b]
19.1	993,167,157	1,008,064,665	1,023,185,634	1,038,533,419	1,054,111,420	1,069,923,092	1,085,971,938	1,102,261,517	1,118,795,440	1,135,577,371
29.4	2,107,768,980	2,139,385,515	2,171,476,298	2,204,048,442	2,237,109,169	2,270,665,806	2,304,725,793	2,339,296,680	2,374,386,131	2,410,001,922
33.7	3,985,573,014	4,045,356,609	4,106,036,958	4,167,627,513	4,230,141,925	4,293,594,054	4,357,997,965	4,423,367,934	4,489,718,453	4,557,064,230
35.5	292,850,855	297,243,618	301,702,272	306,227,806	310,821,223	315,483,542	320,215,795	325,019,032	329,894,317	334,842,732
56.2	564,769,502	573,241,045	581,839,661	590,567,255	599,425,764	608,417,151	617,543,408	626,806,559	636,208,658	645,751,787
66.2	4,406,046,208	4,472,136,902	4,539,218,955	4,607,307,239	4,676,416,848	4,746,563,101	4,817,761,547	4,890,027,970	4,963,378,390	5,037,829,066
Total:	*12,350,175,717*	*12,535,428,353*	*12,723,459,778*	*12,914,311,675*	*13,108,026,350*	*13,304,646,745*	*13,504,216,446*	*13,706,779,693*	*13,912,381,388*	*14,121,067,109*

a - provided by the Ohio-Kentucky -Indiana Regional Council of Governments
b - assume growth rate of 1.5%/yr from 2002 VMT projections

Cleveland

Speed (mph) [a]	2003 [b]	2004 [b]	2005 [b]	2006 [a]	2007 [b]	2008 [b]	2009 [b]	2010 [b]	2011 [b]	2012 [b]
9.5	2,681,931,445	2,722,160,416	2,762,992,823	2,804,437,715	2,846,504,281	2,889,201,845	2,932,539,873	2,976,527,971	3,021,175,890	3,066,493,529
17.8	2,654,496,365	2,694,313,810	2,734,728,517	2,775,749,445	2,817,385,687	2,859,646,472	2,902,541,169	2,946,079,287	2,990,270,476	3,035,124,533
29.4	6,760,560,765	6,861,969,177	6,964,898,714	7,069,372,195	7,175,412,778	7,283,043,970	7,392,289,629	7,503,173,974	7,615,721,583	7,729,957,407
38.2	3,573,212,719	3,626,810,910	3,681,213,074	3,736,431,270	3,792,477,739	3,849,364,905	3,907,105,379	3,965,711,959	4,025,197,639	4,085,575,603
51.0	1,726,154,799	1,752,047,121	1,778,327,828	1,805,002,745	1,832,077,786	1,859,558,953	1,887,452,337	1,915,764,122	1,944,500,584	1,973,668,093
57.9	5,452,693,726	5,534,484,132	5,617,501,394	5,701,763,915	5,787,290,374	5,874,099,729	5,962,211,225	6,051,644,394	6,142,419,060	6,234,555,345
Total:	*22,849,049,819*	*23,191,785,566*	*23,539,662,350*	*23,892,757,285*	*24,251,148,644*	*24,614,915,874*	*24,984,139,612*	*25,358,901,706*	*25,739,285,232*	*26,125,374,510*

a - provided by NOACA and Akron Metropolitan Planning Board
b - assume growth rate of 1.5%/yr from 2006

Houston

Speed (mph) [a]	2003 [b]	2004 [b]	2005 [b]	2006 [b]	2007 [a]	2008 [b]	2009 [b]	2010 [b]	2011 [b]	2012 [b]
21.0	3,215,889,310	3,257,027,398	3,298,691,730	3,340,889,038	3,372,758,775	3,415,903,558	3,459,600,256	3,503,855,927	3,548,677,723	3,594,072,885
28.0	8,374,717,958	8,461,019,756	8,548,210,897	8,636,300,546	8,706,873,155	8,796,597,825	8,887,247,111	8,978,830,542	9,071,357,744	9,164,838,442
33.0	5,017,247,535	5,026,633,440	5,036,218,465	5,046,009,832	5,052,021,575	5,062,103,649	5,072,410,031	5,082,948,870	5,093,728,616	5,104,758,033
57.0	16,109,419,209	16,459,743,384	16,817,685,898	17,183,412,425	17,401,550,565	17,779,974,130	18,166,627,099	18,561,688,433	18,965,340,986	19,377,771,586
Total:	*32,717,274,012*	*33,204,423,978*	*33,700,806,991*	*34,206,611,841*	*34,533,204,070*	*35,054,579,163*	*35,585,884,497*	*36,127,323,772*	*36,679,105,069*	*37,241,440,946*

a - provided by HGAC
b - assume a growth rate based on the rate of grow th between 2000 & 2007

Milwaukee

Speed (mph) [a]	2003 [b]	2004 [b]	2005 [b]	2006 [b]	2007 [b]	2008 [b]	2009 [b]	2010 [b]	2011 [b]	2012 [b]
14.7	1,513,158,087	1,535,855,458	1,558,893,290	1,582,276,690	1,606,010,840	1,630,101,003	1,654,552,518	1,679,370,805	1,704,561,368	1,730,129,788
23.4	1,900,055,133	1,928,555,959	1,957,484,299	1,986,846,563	2,016,649,262	2,046,899,001	2,077,602,486	2,108,766,523	2,140,398,021	2,172,503,991
32.1	2,621,842,684	2,661,170,324	2,701,087,879	2,741,604,197	2,782,728,260	2,824,469,184	2,866,836,222	2,909,838,765	2,953,486,346	2,997,788,641
41.5	3,603,155,752	3,657,203,088	3,712,061,135	3,767,742,052	3,824,258,183	3,881,622,055	3,939,846,386	3,998,944,082	4,058,928,243	4,119,812,167
51.3	2,158,271,391	2,190,645,462	2,223,505,144	2,256,857,721	2,290,710,587	2,325,071,246	2,359,947,315	2,395,346,524	2,431,276,722	2,467,745,873
63.8	4,478,759,337	4,545,940,727	4,614,129,838	4,683,341,785	4,753,591,912	4,824,895,791	4,897,269,227	4,970,728,266	5,045,289,190	5,120,968,528
Total:	*16,275,242,383*	*16,519,371,019*	*16,767,161,584*	*17,018,669,008*	*17,273,949,043*	*17,533,058,279*	*17,796,054,153*	*18,062,994,966*	*18,333,939,890*	*18,608,948,988*

a - provided by Wisconsin DNR
b - assume growth rate of 1.5%/yr from 2002

New York City

Speed (mph) [a]	2003 [b]	2004 [b]	2005 [b]	2006 [b]	2007 [b]	2008 [b]	2009 [b]	2010 [b]	2011 [b]	2012 [b]
4.9	561,417,543	569,838,806	578,386,388	587,062,184	595,868,117	604,806,139	613,878,231	623,086,404	632,432,700	641,919,191
9.5	2,995,515,624	3,040,448,358	3,086,055,083	3,132,345,910	3,179,331,098	3,227,021,065	3,275,426,381	3,324,557,777	3,374,426,143	3,425,042,535
10.2	4,875,474,583	4,948,606,701	5,022,835,802	5,098,178,339	5,174,651,014	5,252,270,779	5,331,054,841	5,411,020,664	5,492,185,974	5,574,568,763
10.9	2,333,462,427	2,368,464,363	2,403,991,329	2,440,051,199	2,476,651,967	2,513,801,746	2,551,508,772	2,589,781,404	2,628,628,125	2,668,057,547
13.3	1,250,878,497	1,269,641,675	1,288,686,300	1,308,016,594	1,327,636,843	1,347,551,396	1,367,764,667	1,388,281,137	1,409,105,354	1,430,241,934
13.9	3,475,144,239	3,527,271,402	3,580,180,473	3,633,883,180	3,688,391,428	3,743,717,299	3,799,873,059	3,856,871,155	3,914,724,222	3,973,445,085
15.7	7,812,323,005	7,929,507,850	8,048,450,468	8,169,177,225	8,291,714,883	8,416,090,606	8,542,331,965	8,670,466,945	8,800,523,949	8,932,531,808
16.8	3,577,489,977	3,631,152,327	3,685,619,612	3,740,903,906	3,797,017,464	3,853,972,726	3,911,782,317	3,970,459,052	4,030,015,938	4,090,466,177
17.6	2,432,811,769	2,469,303,945	2,506,343,504	2,543,938,657	2,582,097,737	2,620,829,203	2,660,141,641	2,700,043,766	2,740,544,422	2,781,652,588
18.7	1,528,373,566	1,551,299,170	1,574,568,657	1,598,187,187	1,622,159,995	1,646,492,395	1,671,189,781	1,696,257,627	1,721,701,492	1,747,527,014
19.8	1,031,195,416	1,046,663,347	1,062,363,297	1,078,298,747	1,094,473,228	1,110,890,326	1,127,553,681	1,144,466,986	1,161,633,991	1,179,058,501
22.1	5,341,821,143	5,421,948,461	5,503,277,688	5,585,826,853	5,669,614,256	5,754,658,469	5,840,978,346	5,928,593,022	6,017,521,917	6,107,784,746
23.2	4,390,712,167	4,456,572,850	4,523,421,442	4,591,272,764	4,660,141,855	4,730,043,983	4,800,994,643	4,873,009,563	4,946,104,706	5,020,296,277
28.3	1,064,167,998	1,080,130,518	1,096,332,476	1,112,777,463	1,129,469,125	1,146,411,162	1,163,607,329	1,181,061,439	1,198,777,361	1,216,759,021
29.8	310,471,544	315,128,618	319,855,547	324,653,380	329,523,181	334,466,028	339,483,019	344,575,264	349,743,893	354,990,052
35.9	1,744,209,463	1,770,372,605	1,796,928,194	1,823,882,117	1,851,240,349	1,879,008,954	1,907,194,088	1,935,801,999	1,964,839,029	1,994,311,615
37.7	7,000,814,448	7,105,826,665	7,212,414,065	7,320,600,276	7,430,409,280	7,541,865,419	7,654,993,401	7,769,818,302	7,886,365,576	8,004,661,060
39.5	2,327,897,450	2,362,815,912	2,398,258,150	2,434,232,023	2,470,745,503	2,507,806,685	2,545,423,786	2,583,605,143	2,622,359,220	2,661,694,608
41.0	2,216,552,291	2,249,800,575	2,283,547,584	2,317,800,797	2,352,567,809	2,387,856,326	2,423,674,171	2,460,029,284	2,496,929,723	2,534,383,669
43.1	4,325,617,865	4,390,502,133	4,456,359,665	4,523,205,060	4,591,053,136	4,659,918,933	4,729,817,717	4,800,764,983	4,872,776,458	4,945,868,105
43.6	4,242,966,510	4,306,611,007	4,371,210,172	4,436,778,325	4,503,330,000	4,570,879,950	4,639,443,149	4,709,034,796	4,779,670,318	4,851,365,373
45.6	4,570,571,414	4,639,129,985	4,708,716,935	4,779,347,689	4,851,037,904	4,923,803,473	4,997,660,525	5,072,625,433	5,148,714,814	5,225,945,536
Total:	*69,409,888,938*	*70,451,037,272*	*71,507,802,831*	*72,580,419,874*	*73,669,126,172*	*74,774,163,064*	*75,895,775,510*	*77,034,212,143*	*78,189,725,325*	*79,362,571,205*

a - provided by NYS DEC
b - assume growth rate of 1.5%/yr from 2000

Philadelphia

Speed (mph) [a]	2003 [b]	2004 [b]	2005 [b]	2006 [b]	2007 [a]	2008 [b]	2009 [b]	2010 [b]	2011 [b]	2012 [b]
8.3	5,008,528,074	5,070,633,822	5,133,509,681	5,197,165,202	5,261,610,050	5,326,854,015	5,392,907,004	5,459,779,051	5,527,480,311	5,596,021,067
16.4	5,790,007,952	5,861,804,050	5,934,490,420	6,008,078,102	6,082,578,270	6,158,002,241	6,234,361,468	6,311,667,551	6,389,932,228	6,469,167,388
25.1	7,914,825,704	8,012,969,543	8,112,330,365	8,212,923,262	8,314,763,510	8,417,866,578	8,522,248,123	8,627,924,000	8,734,910,257	8,843,223,145
35.5	1,112,673,542	1,126,470,694	1,140,438,931	1,154,580,373	1,168,897,170	1,183,391,495	1,198,065,549	1,212,921,562	1,227,961,790	1,243,188,516
49.4	5,405,731,159	5,472,762,225	5,540,624,477	5,609,328,220	5,678,883,890	5,749,302,050	5,820,593,396	5,892,768,754	5,965,839,086	6,039,815,491
59.5	5,028,742,690	5,091,099,100	5,154,228,728	5,218,141,165	5,282,846,115	5,348,353,407	5,414,672,989	5,481,814,934	5,549,789,439	5,618,606,828
Total:	*30,260,509,120*	*30,635,739,433*	*31,015,622,602*	*31,400,216,323*	*31,789,579,005*	*32,183,769,785*	*32,582,848,530*	*32,986,875,852*	*33,395,913,112*	*33,810,022,435*

a - provided by PADEP
b - assume growth rate of 1.24%/yr per PADEP from 2007

Phoenix

Speed (mph) [a]	2003 [b]	2004 [b]	2005 [b]	2006 [b]	2007 [b]	2008 [b]	2009 [b]	2010 [b]	2011 [b]	2012 [b]
19.9	1,870,462,030	1,898,518,961	1,926,996,745	1,955,901,696	1,985,240,222	2,015,018,825	2,045,244,107	2,075,922,769	2,107,061,610	2,138,667,535
30.4	10,971,318,558	11,135,888,337	11,302,926,662	11,472,470,562	11,644,557,620	11,819,225,985	11,996,514,374	12,176,462,090	12,359,109,021	12,544,495,657
31.7	2,031,280,056	2,061,749,257	2,092,675,496	2,124,065,628	2,155,926,613	2,188,265,512	2,221,089,495	2,254,405,837	2,288,221,925	2,322,545,254
53.2	5,351,510,982	5,431,783,646	5,513,260,401	5,595,959,307	5,679,898,697	5,765,097,177	5,851,573,635	5,939,347,239	6,028,437,448	6,118,864,010
Total:	*20,224,571,626*	*20,527,940,201*	*20,835,859,304*	*21,148,397,193*	*21,465,623,151*	*21,787,607,499*	*22,114,421,611*	*22,446,137,935*	*22,782,830,004*	*23,124,572,454*

a - provided by Maricopa County Environmental Services Department
b - assume growth rate of 1.5%/yr from 1996 per MCESD

Seattle

Speed (mph) [a]	2003 [b]	2004 [b]	2005 [b]	2006 [b]	2007 [b]	2008 [b]	2009 [b]	2010 [b]	2011 [b]	2012 [b]
9.7	4,272,229,410	4,336,312,851	4,401,357,544	4,467,377,907	4,534,388,575	4,602,404,404	4,671,440,470	4,741,512,077	4,812,634,758	4,884,824,280
15.0	813,668,853	825,873,886	838,261,994	850,835,924	863,598,463	876,552,440	889,700,726	903,046,237	916,591,931	930,340,810
24.3	154,189,051	156,501,886	158,849,415	161,232,156	163,650,638	166,105,398	168,596,979	171,125,933	173,692,822	176,298,215
29.3	2,637,380,404	2,676,941,110	2,717,095,227	2,757,851,655	2,799,219,430	2,841,207,721	2,883,825,837	2,927,083,225	2,970,989,473	3,015,554,315
32.5	8,375,136,751	8,500,763,802	8,628,275,259	8,757,699,388	8,889,064,879	9,022,400,852	9,157,736,865	9,295,102,918	9,434,529,461	9,576,047,403
37.5	589,756,861	598,603,214	607,582,262	616,695,996	625,946,436	635,335,632	644,865,667	654,538,652	664,356,732	674,322,083
44.4	11,593,441,935	11,767,343,564	11,943,853,718	12,123,011,523	12,304,856,696	12,489,429,547	12,676,770,990	12,866,922,555	13,059,926,393	13,255,825,289
Total:	*28,435,803,264*	*28,862,340,313*	*29,295,275,418*	*29,734,704,549*	*30,180,725,117*	*30,633,435,994*	*31,092,937,534*	*31,559,331,597*	*32,032,721,571*	*32,513,212,394*

a - provided by Washington Department of Ecology
b - assume growth rate of 1.5%/yr from 1999 per WADOE

St. Louis

Speed (mph) [a]	2003 [b]	2004 [a]	2005 [b]	2006 [b]	2007 [b]	2008 [b]	2009 [b]	2010 [b]	2011 [b]	2012 [b]
7.4	114,730,468	116,451,425	118,198,196	119,971,169	121,770,737	123,597,298	125,451,257	127,333,026	129,243,022	131,181,667
18.4	3,443,598,074	3,495,252,045	3,547,680,826	3,600,896,038	3,654,909,479	3,709,733,121	3,765,379,118	3,821,859,804	3,879,187,701	3,937,375,517
25.5	5,761,281,547	5,847,700,770	5,935,416,282	6,024,447,526	6,114,814,239	6,206,536,452	6,299,634,499	6,394,129,017	6,490,040,952	6,587,391,566
34.4	3,975,709,818	4,035,345,465	4,095,875,647	4,157,313,782	4,219,673,488	4,282,968,591	4,347,213,120	4,412,421,316	4,478,607,636	4,545,786,751
45.5	5,100,125,581	5,176,627,465	5,254,276,877	5,333,091,030	5,413,087,396	5,494,283,707	5,576,697,962	5,660,348,432	5,745,253,658	5,831,432,463
51.9	2,729,201,374	2,770,139,395	2,811,691,486	2,853,866,858	2,896,674,861	2,940,124,984	2,984,226,859	3,028,990,262	3,074,425,116	3,120,541,492
Total:	*21,124,646,862*	*21,441,516,565*	*21,763,139,314*	*22,089,586,403*	*22,420,930,199*	*22,757,244,152*	*23,098,602,815*	*23,445,081,857*	*23,796,758,085*	*24,153,709,456*

a - provided by MODNR
b - assume growth rate of 1.5%/yr per from 2004

Washington, DC

Speed (mph) [a]	2003 [b]	2004 [b]	2005 [b]	2006 [b]	2007 [b]	2008 [b]	2009 [b]	2010 [b]	2011 [b]	2012 [b]
18.2	281,355,133	285,575,460	289,859,091	294,206,978	298,620,083	303,099,384	307,645,875	312,260,563	316,944,471	321,698,638
20.2	1,883,332,080	1,911,582,061	1,940,255,792	1,969,359,629	1,998,900,023	2,028,883,524	2,059,316,777	2,090,206,528	2,121,559,626	2,153,383,021
30.9	49,302,324	50,041,859	50,792,487	51,554,374	52,327,690	53,112,605	53,909,294	54,717,933	55,538,702	56,371,783
34.4	942,779,095	956,920,782	971,274,593	985,843,712	1,000,631,368	1,015,640,838	1,030,875,451	1,046,338,583	1,062,033,661	1,077,964,166
Total:	*3,156,768,632*	*3,204,120,161*	*3,252,181,963*	*3,300,964,693*	*3,350,479,163*	*3,400,736,351*	*3,451,747,396*	*3,503,523,607*	*3,556,076,461*	*3,609,417,608*

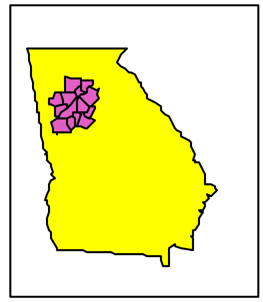
a - provided by Metropolitan Washington Council of Governments
c - assume growth rate of 1.5%/yr from 2001 per MWCOG

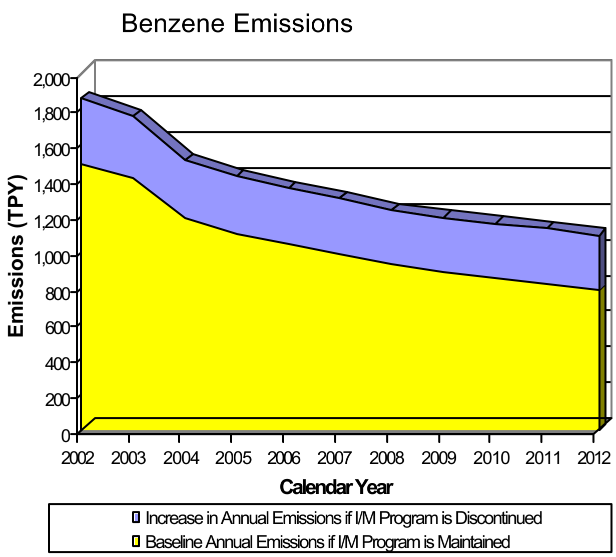
APPENDIX D: CITY-SPECIFIC RESULTS

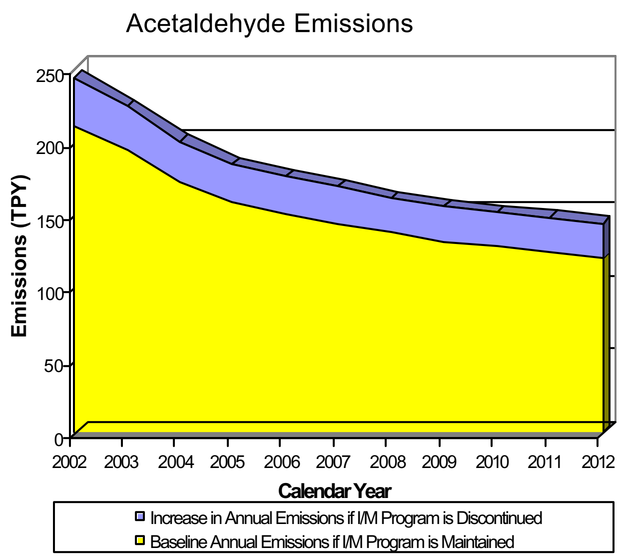
ATLANTA

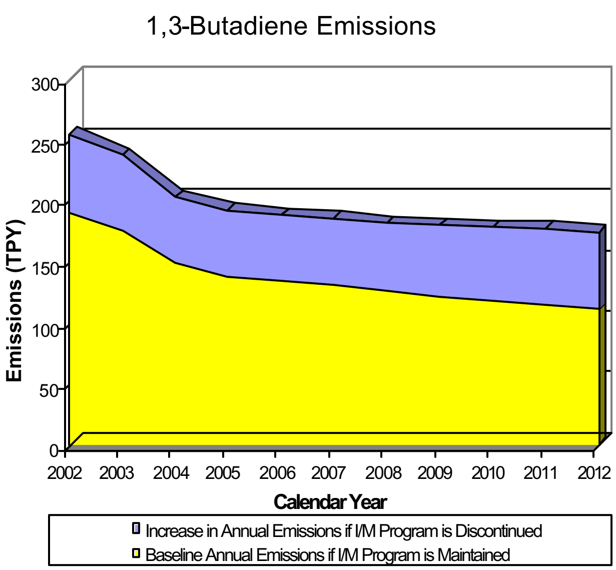
Georgia □

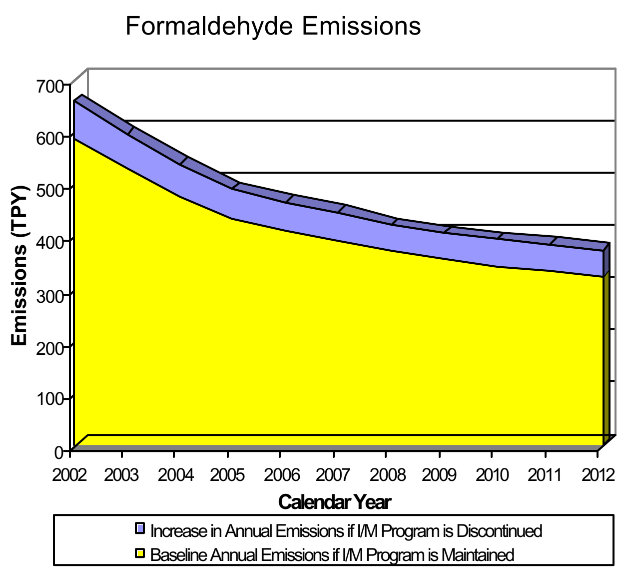
Emissions from motor vehicles contain pollutants that cause smog and acid rain as well as those classified by EPA as air toxics. According to EPA data, vehicles operating on Atlanta's highways represent the single greatest source of air toxics in the Atlanta area. The four air toxics emitted from automobiles in the greatest quantity are acetaldehyde, benzene, 1,3-butadiene, and formaldehyde. Benzene is classified as a known human carcinogen, and the other three toxics are classified as probable human carcinogens. This analysis examined the impact that Atlanta's I/M program has on emissions of these air toxics from motor vehicles.





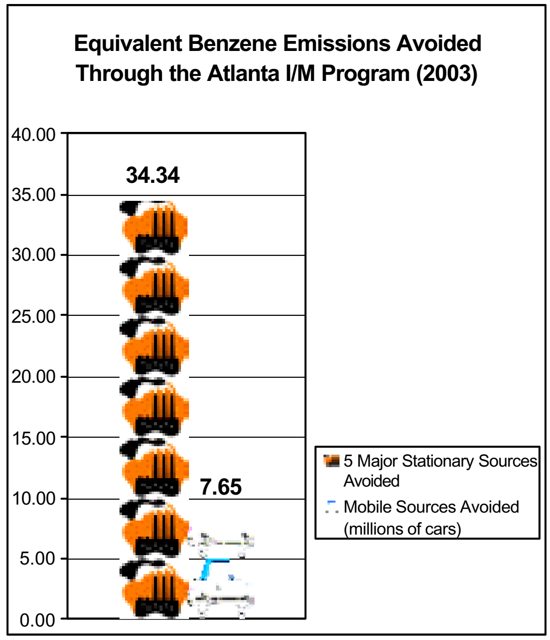






I/M Program Description: Atlanta's I/M program has a biennial 2-speed idle test for cars older than 5 years, and an ASM test for newer models. The test includes visual checks of the catalyst and gas cap, and pressure and gas cap evaporative checks. Counties included in Atlanta's I/M program are Cherokee, Clayton, Cobb, Coweta, DeKalb, Douglas, Fayette, Forsyth, Fulton, Gwinnett, Henry, Paulding, and Rockdale.

Results: In Atlanta in 2003, the I/M program is projected to reduce 30.4 tons of acetaldehyde (15.7 percent fewer emissions than with no I/M program), 343 tons of benzene (24.4 percent), 61.4 tons of 1,3-butadiene (34.9 percent), and 64.2 tons of formaldehyde (12.1 percent). In 2012, the emissions reductions as a percent of total potential emissions rise to 19.5 percent for acetaldehyde, 39.1 percent for benzene, 56.7 percent for 1,3-butadiene, and 15.7 percent for formaldehyde.

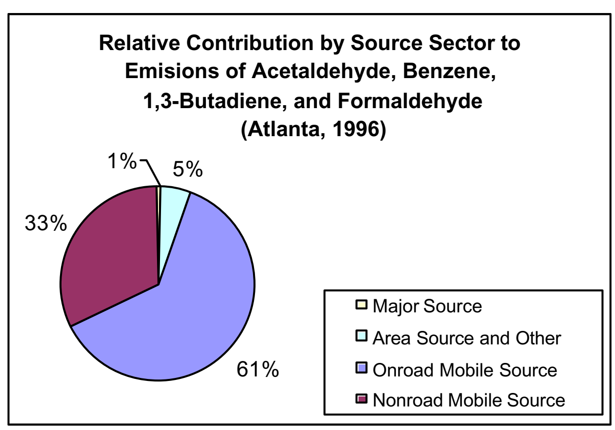


Emissions Context: The Clean Air Act defines a major stationary source of air toxics as one with the potential to emit 10 tons per year of any one toxic air pollutant, or 25 tpy of any combination of toxic air pollutants. Therefore, the total of 343.4 tons of benzene that are not emitted in the Atlanta area in 2003 due to the I/M programs represents the benzene equivalent of more than 34 new stationary sources of benzene.

These avoided emissions can also be expressed in terms of new vehicles. Assuming an average of 12,500 miles traveled per year per vehicle and an average benzene emission rate for new vehicles of 3.26 milligrams per mile, the benzene emissions avoided by the I/M program in the Atlanta area represents the benzene equivalent of more than 7.6 million new vehicles.

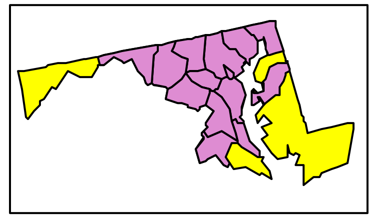
The chart below shows EPA's determination of the 1996 emissions from outdoor sources in the Atlanta I/M Area of the four air toxics included in the analysis. Onroad mobile sources – cars and trucks – emit 61 percent of these toxic pollutants. These air toxics are probable causes of cancer and some are linked to reproductive effects.

Conclusions: The Atlanta area's I/M program is a valuable tool for the improvement of air quality. It delivers meaningful reductions both of air toxics and criteria pollutants that harm both the environment and human health, especially in urban areas. Discontinuing this program would lead to significant increases in releases of these pollutants and would result in the addition of thousands of tons of pollution to the air that the people of Atlanta breathe.

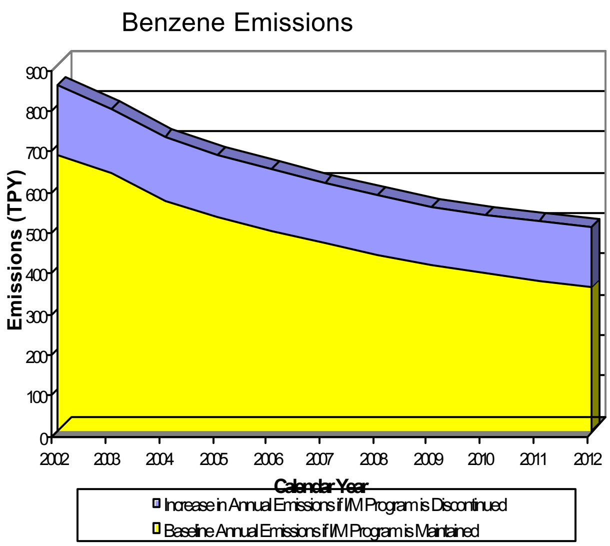


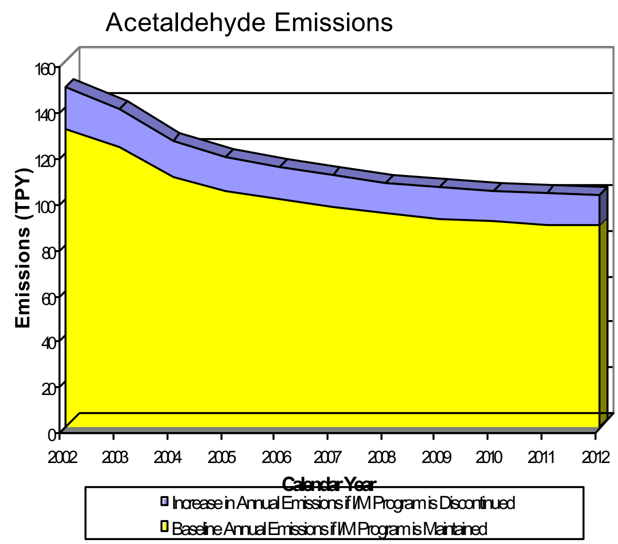
BALTIMORE

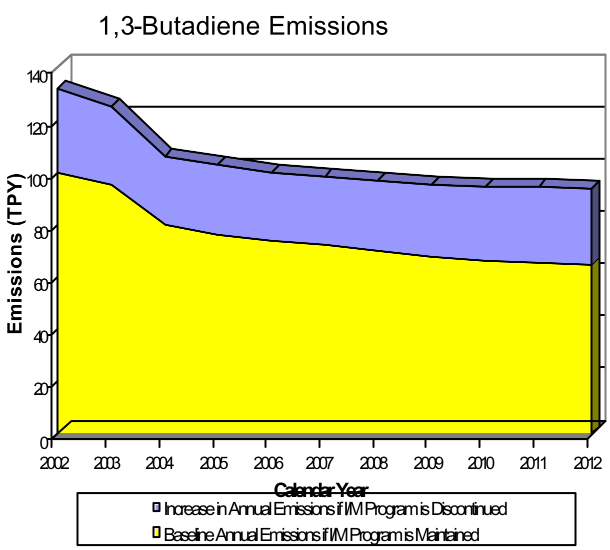
Maryland

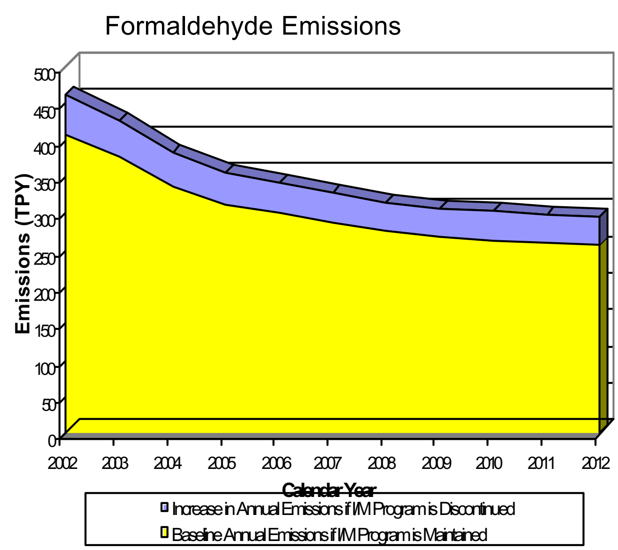


Emissions from motor vehicles contain pollutants that cause smog and acid rain as well as those classified by EPA as air toxics. According to EPA data, vehicles operating on Baltimore's highways represent the single greatest source of air toxics in the Baltimore area. The four air toxics emitted from automobiles in the greatest quantity are acetaldehyde, benzene, 1,3-butadiene, and formaldehyde. Benzene is classified as a known human carcinogen, and the other three toxics are classified as probable human carcinogens. This analysis examined the impact that Baltimore's I/M program has on emissions of these air toxics from motor vehicles.



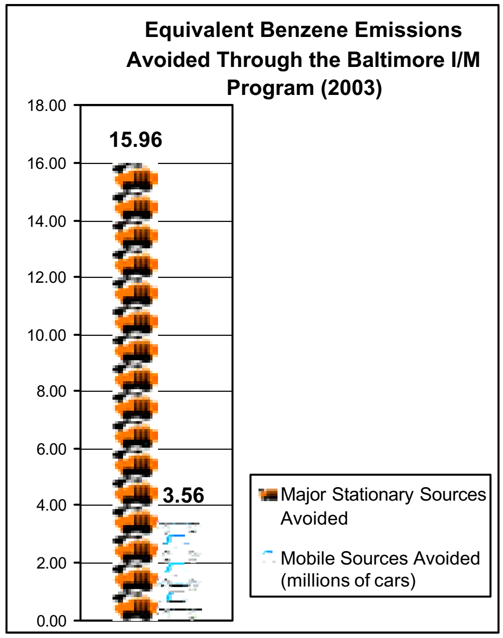






I/M Program Description: Baltimore has a biennial IM240 test for 1984 and newer models and an idle test 1977-83 models. The test includes visual checks of the catalyst and gas cap, and pressure, purge, and gas cap evaporative checks. Stage II vapor recovery is included. Baltimore is in the OTC region. The counties included in Baltimore's I/M program are Anne Arundel, Baltimore, Baltimore City, Calvert, Carroll, Cecil, Charles, Frederick, Harford, Howard, Montgomery, Prince George's, Queen Anne's, and Washington

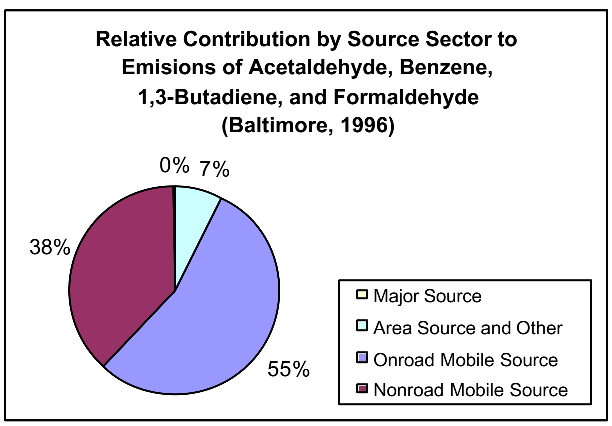
Results: In Baltimore in 2003, the I/M program is projected to reduce 16.9 tons of acetaldehyde (25.3 percent fewer emissions than with no I/M program), 159.6 tons of benzene (13.8 percent), 30.0 tons of 1,3-butadiene (31.6 percent), and 50.0 tons of formaldehyde (13.2 percent). In 2012, emissions reductions achieved through I/M as a percent of total potential emissions rise to 15.4 percent for acetaldehyde, 40.8 percent for benzene, 45.0 percent for 1,3-butadiene, and 15.2 percent for formaldehyde.



Emissions Context: The Clean Air Act defines a major stationary source of air toxics as one with the potential to emit 10 tons per year of any one toxic air pollutant, or 25 tpy of any combination of toxic air pollutants. Therefore, the total of 159.6 tons of benzene that are not emitted in the Baltimore area in 2003 due to the I/M programs represents the benzene equivalent of almost 16 new stationary sources of benzene.

These avoided emissions can also be expressed in terms of new vehicles. Assuming an average of 12,500 miles traveled per year per vehicle and an average benzene emission rate for new vehicles of 3.26 milligrams per mile, the benzene emissions avoided by the I/M program in the Baltimore area represents the benzene equivalent of more than 3.5 million new vehicles.

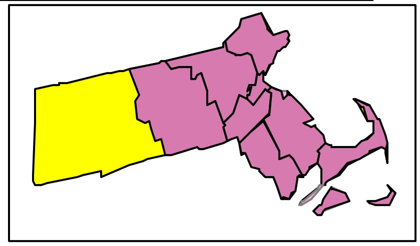
The chart to the right shows EPA's determination of the 1996 emissions from outdoor sources in the Baltimore I/M Area of the four air toxics included in the analysis. Onroad mobile sources – cars and trucks – emit 55 percent of these toxic pollutants. These air toxics are known or probable causes of cancer and some are linked to reproductive effects



Conclusions: The Baltimore area's I/M program is a valuable tool for the improvement of air quality. It delivers meaningful reductions both of air toxics and criteria pollutants that harm both the environment and human health, especially in urban areas. Discontinuing this program would lead to significant increases in releases of these pollutants and would result in the addition of thousands of tons of pollution to the air that the people of Baltimore breathe.

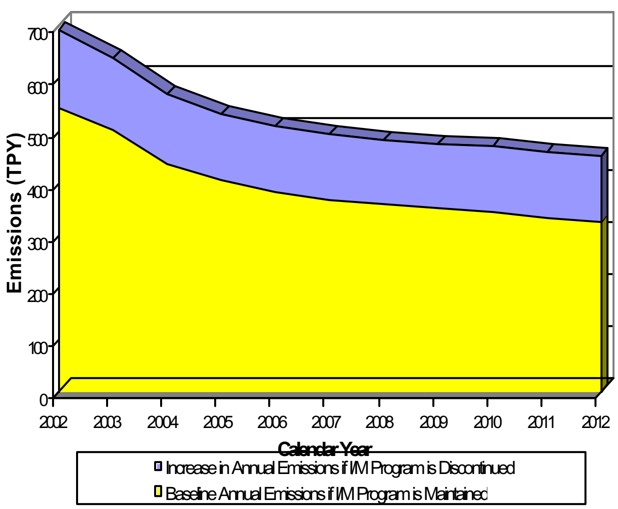
BOSTON

Massachusetts

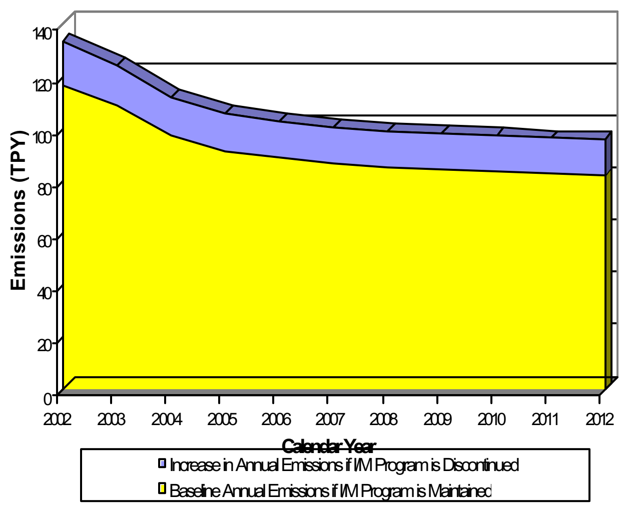


Emissions from motor vehicles contain pollutants that cause smog and acid rain as well as those classified by EPA as air toxics. According to EPA data, vehicles operating on Boston's highways represent the single greatest source of air toxics in the Boston area. The four air toxics emitted from automobiles in the greatest quantity are acetaldehyde, benzene, 1,3-butadiene, and formaldehyde. Benzene is classified as a known human carcinogen, and the other three toxics are classified as probable human carcinogens. This analysis examined the impact that Boston's I/M program has on emissions of these air toxics from motor vehicles.

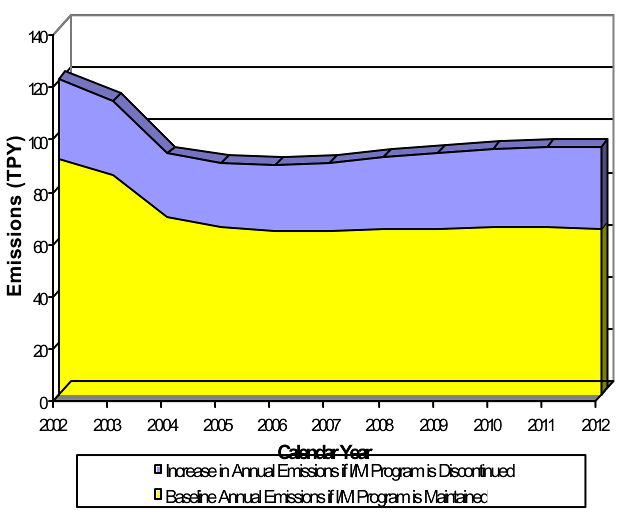
Benzene Emissions



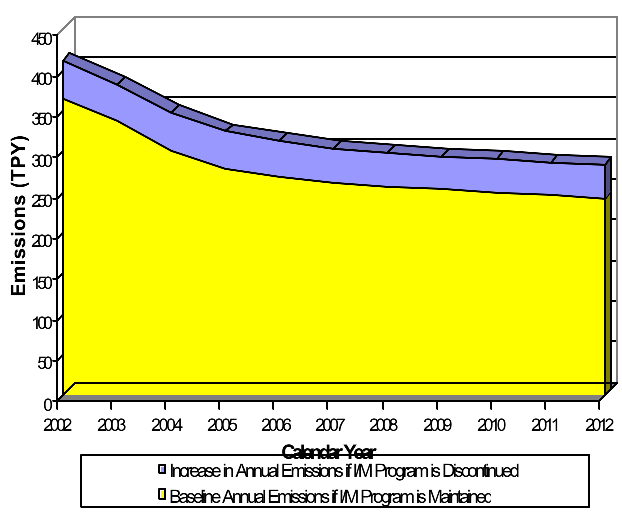
Acetaldehyde Emissions



1,3-Butadiene Emissions

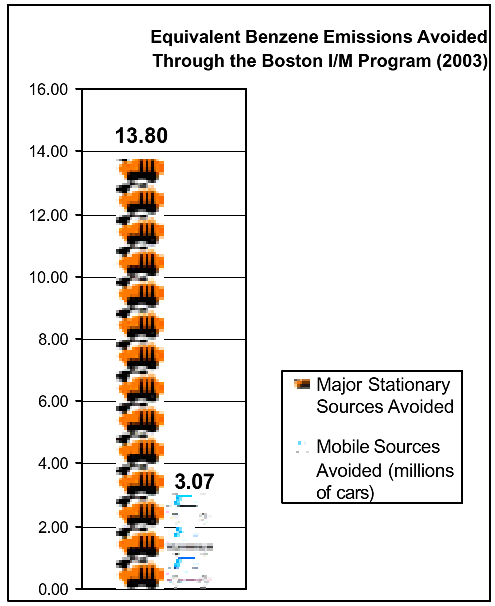


Formaldehyde Emissions



I/M Program: Massachusetts has a biennial MA31 dynamometer test for 1981 and newer models. The test includes visual anti-tampering checks of the catalyst and fuel inlet, and pressure and purge evaporative checks. Stage II vapor recovery is included. Boston is in the OTC region. Counties included in the Boston I/M program are Barnstable, Bristol, Dukes, Essex, Middlesex, Nantucket, Norfolk, Plymouth, Suffolk, and Worcester.

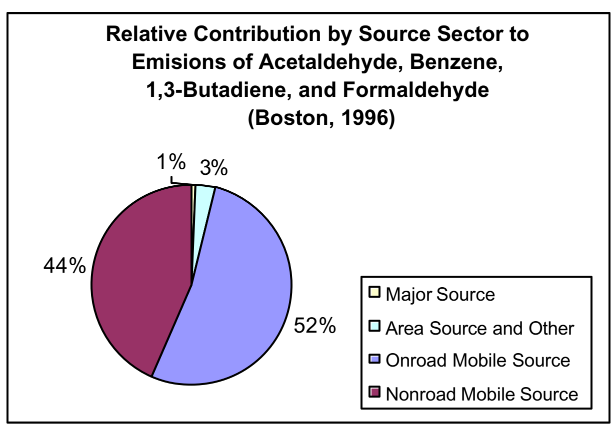
Results: In Boston in 2003, the I/M program is projected to reduce 15.7 tons of acetaldehyde (14.4 percent fewer emissions than with no I/M program), 138 tons of benzene (27.5 percent), 28.8 tons of 1,3-butadiene (34.3 percent), and 44 tons of formaldehyde (13.0 percent). In 2012, emissions benefits rise to 16.9 percent for acetaldehyde, 38.9 percent for benzene, 49.1 percent for 1,3-butadiene, and 16.7 percent for formaldehyde.



Emissions Context: The Clean Air Act defines a major stationary source of air toxics as one with the potential to emit 10 tons per year of any one toxic air pollutant, or 25 tpy of any combination of toxic air pollutants. Therefore, the total of 138 tons of benzene that are not emitted in the Boston area in 2003 due to the I/M programs represents the benzene equivalent of more than 13 new stationary sources of benzene.

These avoided emissions can also be expressed in terms of new vehicles. Assuming an average of 12,500 miles traveled per year per vehicle and an average benzene emission rate for new vehicles of 3.26 milligrams per mile, the benzene emissions avoided by the I/M program in the Boston area represents the benzene equivalent of more than 3 million new vehicles.

The chart below demonstrates the 1996 emissions from outdoor sources of the four air toxics included in the analysis for the Boston I/M area. Onroad mobile sources – cars and trucks – emit 52 percent of these toxic pollutants. These air toxics are known or probable causes of cancer and some are linked to reproductive effects.

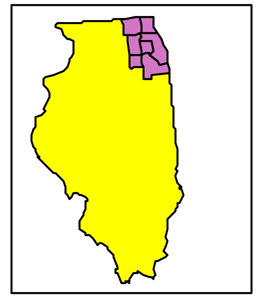


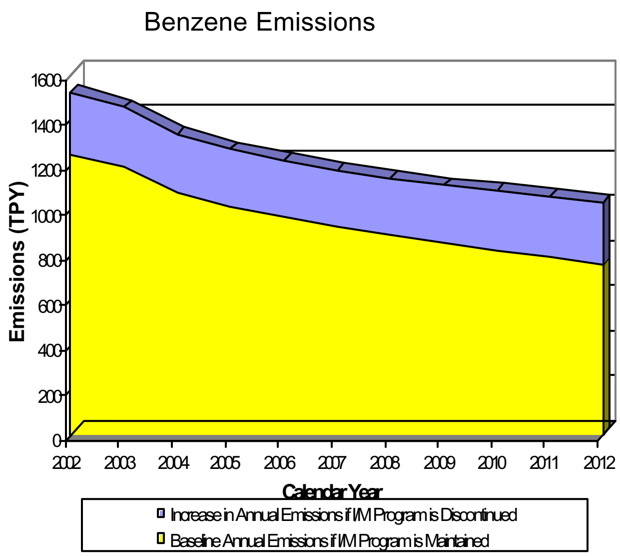
Conclusions: The Boston area's I/M program is a valuable tool for the improvement of air quality. It delivers meaningful reductions both of air toxics and criteria pollutants that harm both the environment and human health, especially in urban areas. Discontinuing this program would lead to significant increases in releases of these pollutants and would result in the addition of thousands of tons of pollution to the air that the people of Boston breathe.

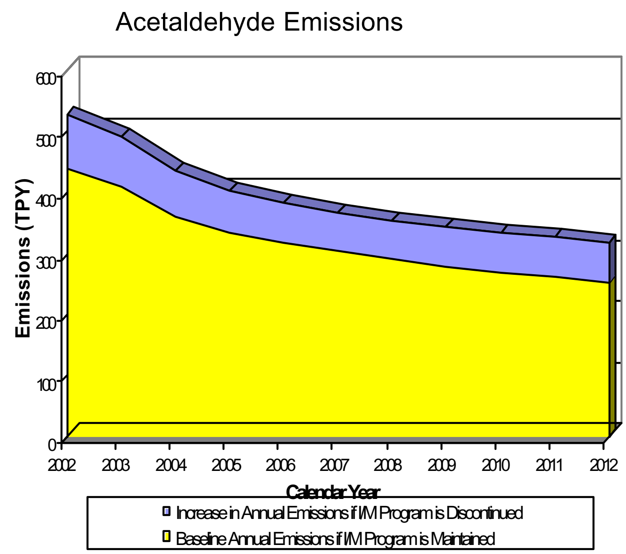
CHICAGO

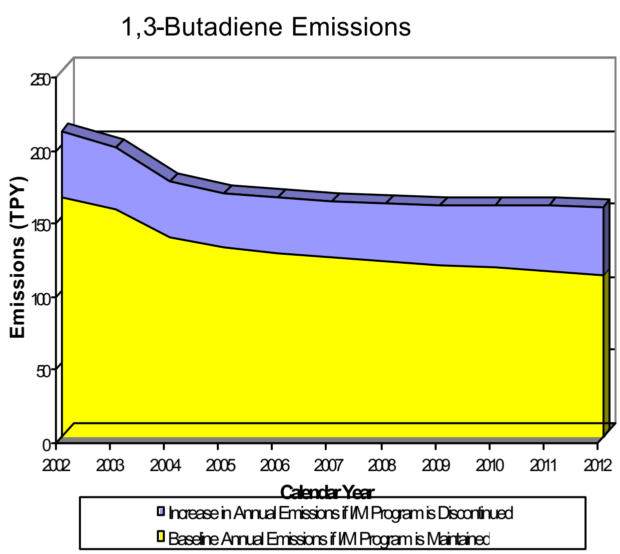
Illinois

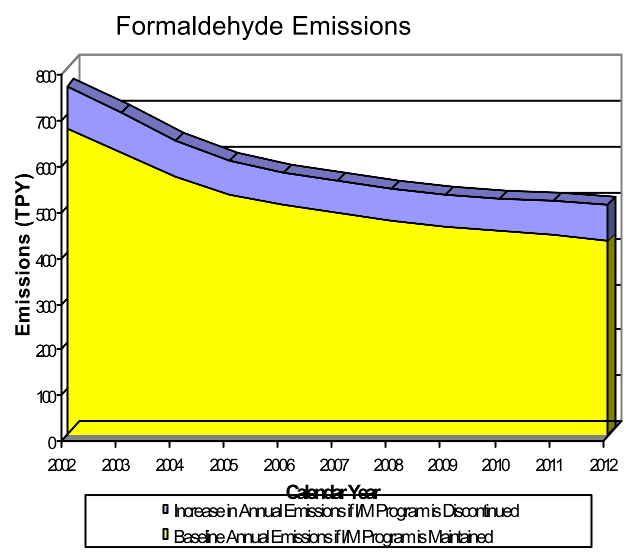
Emissions from motor vehicles contain pollutants that cause smog and acid rain as well as those classified by EPA as air toxics. According to EPA data, vehicles operating on Chicago's highways represent the single greatest source of air toxics in the Chicago area. The four air toxics emitted from automobiles in the greatest quantity are acetaldehyde, benzene, 1,3-butadiene, and formaldehyde. Benzene is classified as a known human carcinogen, and the other three toxics are classified as probable human carcinogens. This analysis examined the impact that Chicago's I/M program has on emissions of these air toxics from motor vehicles.



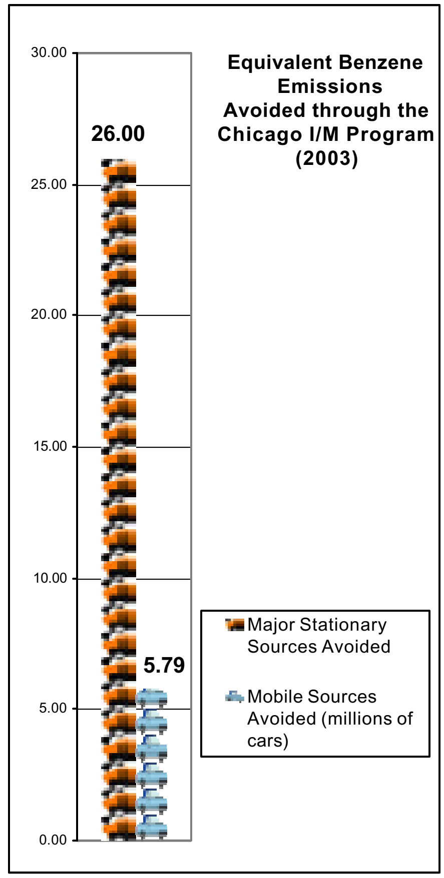








I/M Program: Chicago has an annual ASM test for cars older than twenty years and a biennial test for newer models. The test includes a pressure evaporative check. Counties included in the Chicago I/M program are Cook, DuPage, Kane, Kendall, Lake, McHenry, and Will.[1]

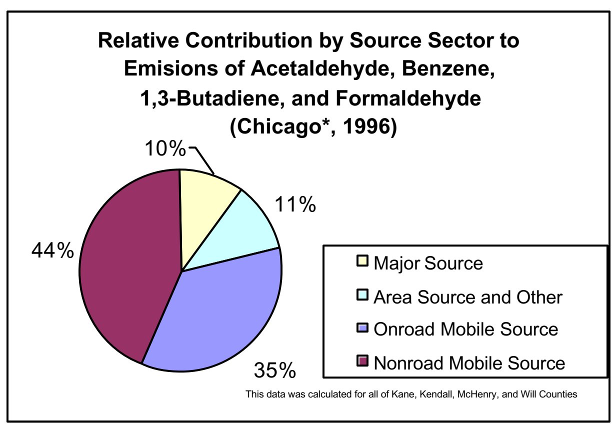


Results: In 2003, the Chicago I/M program is projected to reduce 493.0 tons of acetaldehyde (19.9 percent fewer emissions than with no I/M program), 1451.3 tons of benzene (21.8 percent), 197.8 tons of 1,3-butadiene (27.1 percent), and 705.0 tons of formaldehyde (13.8 percent). In 2012, emissions benefits rise to 26.0 percent for acetaldehyde, 35.9 percent for benzene, 41.9 percent for 1,3-butadiene, and 17.9 percent for formaldehyde.

Emissions Context: The Clean Air Act defines a major stationary source of air toxics as one with the potential to emit 10 tons per year of any one toxic air pollutant, or 25 tpy of any combination of toxic air pollutants. Therefore, the total of 260 tons of benzene that are not emitted in the Chicago area in 2003 due to the I/M programs represents the benzene equivalent of almost 26 new stationary sources of benzene.

These avoided emissions can also be expressed in terms of new vehicles. Assuming an average of 12,500 miles traveled per year per vehicle and an average benzene emission rate for new vehicles of 3.26 milligrams per mile, the benzene emissions avoided by the I/M program in the Chicago area represents the benzene equivalent of almost 5.8 million new vehicles.

The chart to the right demonstrates the 1996 emissions from outdoor sources of the four air toxics included in the analysis for the Chicago I/M area. Onroad mobile sources – cars and trucks – emit 35% of these toxic pollutants. These air toxics are known or probable causes of cancer and some are linked to reproductive effects.



Conclusions: The Chicago area's I/M program is a valuable tool for the improvement of air quality. It delivers meaningful reductions both of air toxics and criteria pollutants that harm both the environment and human health, especially in urban areas. Discontinuing this program would lead to significant increases in releases of these pollutants and would result in the addition of thousands of tons of pollution to the air that the people of Chicago breathe.

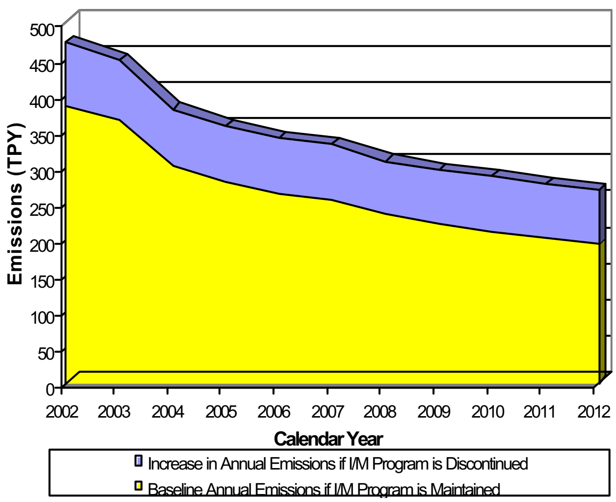
[1] Kane, Dendall, McHenry, and Will counties are only partially subject to the I/M program

CINCINNATI

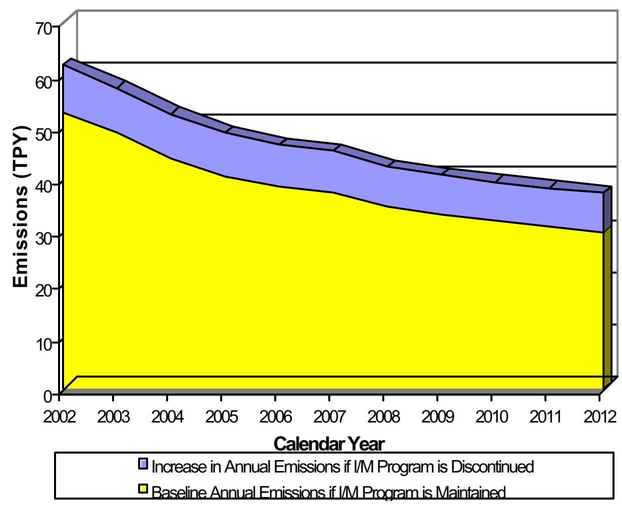
Ohio

Emissions from motor vehicles contain pollutants that cause smog and acid rain as well as those classified by EPA as air toxics. According to EPA data, vehicles operating on Cincinnati's highways represent the single greatest source of air toxics in the Cincinnati area. The four air toxics emitted from automobiles in the greatest quantity are acetaldehyde, benzene, 1,3-butadiene, and formaldehyde. Benzene is classified as a known human carcinogen, and the other three toxics are classified as probable human carcinogens. This analysis examined the impact that Cincinnati's I/M program has on emissions of these air toxics from motor vehicles.

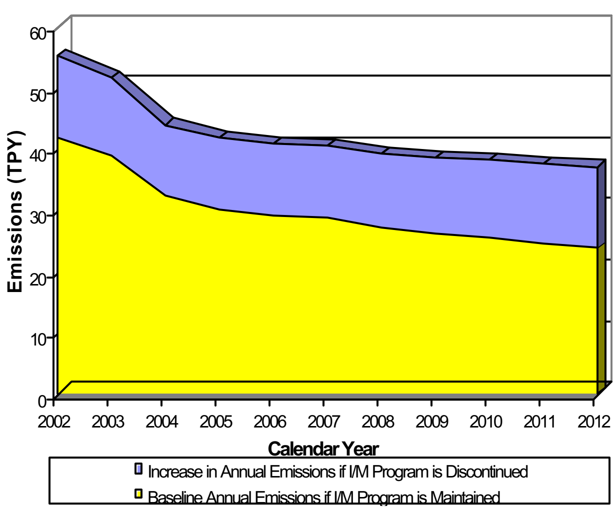
Benzene Emissions



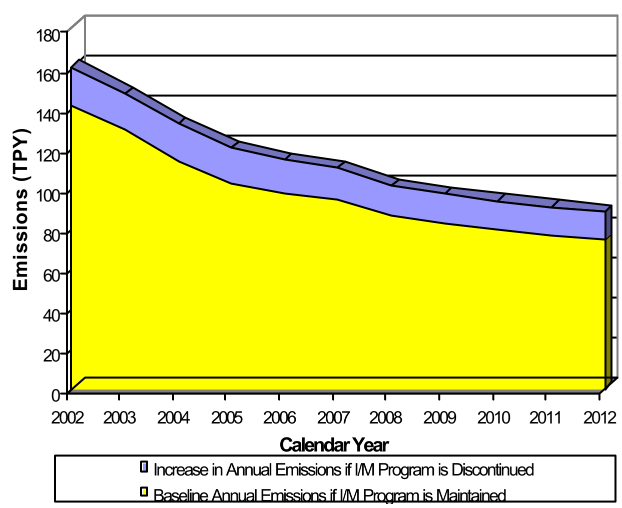
Acetaldehyde Emissions



1,3-Butadiene Emissions



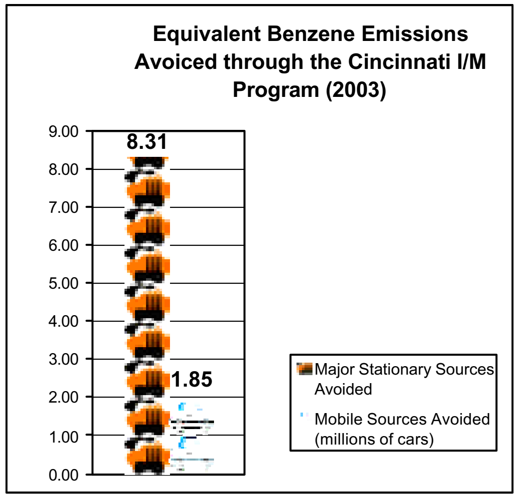
Formaldehyde Emissions



I/M Program: Ohio has a biennial ASM2525 test for 1981 and newer models and an idle test for older models. The test includes visual anti-tampering checks of the catalyst and pressure and purge evaporative checks. Stage II vapor recovery is included. Counties included in the Cincinnati I/M program are Butler, Clermont, Hamilton, and Warren.

Results: In 2003, the Cincinnati I/M program is projected to reduce 8.4 tons of acetaldehyde (17.1 percent fewer emissions than with no I/M program), 83 tons of benzene (22.9 percent), 12.8 tons of 1,3-butadiene (33.0 percent), and 17.9 tons of formaldehyde (13.8 percent). In 2012, emissions benefits rise to 24.5 percent for acetaldehyde, 39.1 percent for benzene, 56.0 percent for 1,3-butadiene, and 19.2 percent for formaldehyde.

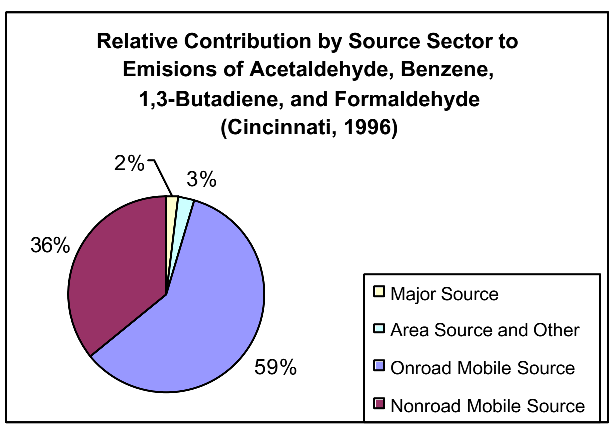
Emissions Context: The Clean Air Act defines a major stationary source of air toxics as one with the potential to emit 10 tons per year of any one toxic air pollutant, or 25 tpy of any combination of toxic air pollutants. Therefore, the total of 83.1 tons of benzene that are not emitted in the Cincinnati area in 2003 due to the I/M programs represents the benzene equivalent of more than eight new stationary sources of benzene.



These avoided emissions can also be expressed in terms of new vehicles. Assuming an average of 12,500 miles traveled per year per vehicle and an average benzene emission rate for new vehicles of 3.26 milligrams per mile, the benzene emissions avoided by the I/M program in the Cincinnati area represents the benzene equivalent of more than 1.8 million new vehicles.

The chart below demonstrates the 1996 emissions from outdoor sources of the four air toxics included in the analysis for the Cincinnati I/M area. Onroad mobile sources – cars and trucks – emit 59% of these toxic pollutants. These air toxics are known or probable causes of cancer and some are linked to reproductive effects.

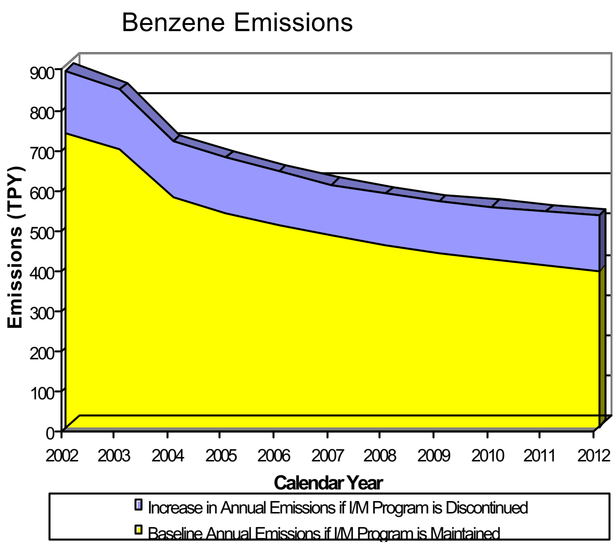
Conclusions: The Cincinnati area's I/M program is a valuable tool for the improvement of air quality. It delivers meaningful reductions both of air toxics and criteria pollutants that harm both the environment and human health, especially in urban areas. Discontinuing this program would lead to significant increases in releases of these pollutants and would result in the addition of thousands of tons of pollution to the air that the people of Cincinnati breathe.

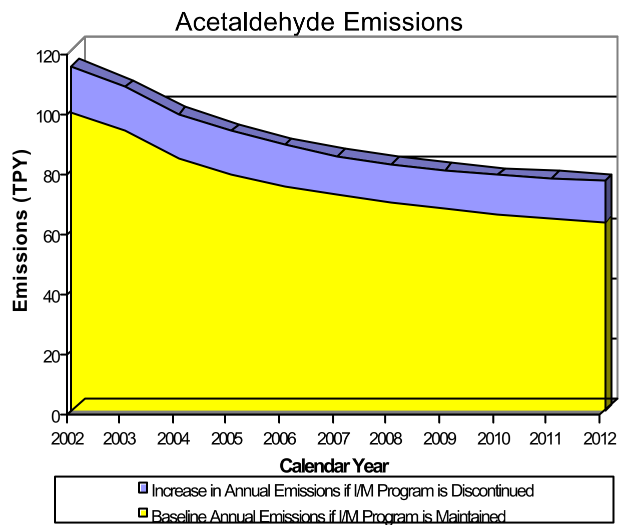


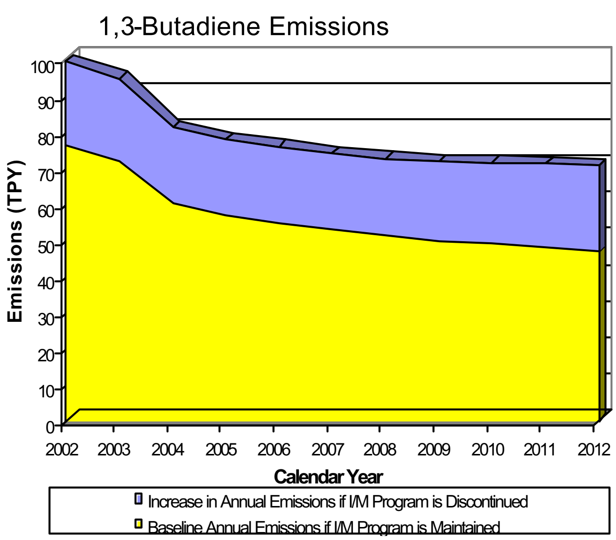
CLEVELAND

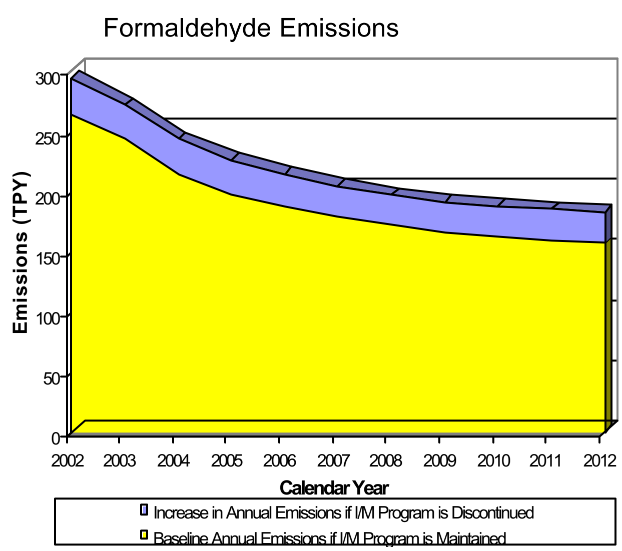
Ohio

Emissions from motor vehicles contain pollutants that cause smog and acid rain as well as those classified by EPA as air toxics. According to EPA data, vehicles operating on Cleveland's highways represent the single greatest source of air toxics in the Cleveland area. The four air toxics emitted from automobiles in the greatest quantity are acetaldehyde, benzene, 1,3-butadiene, and formaldehyde. Benzene is classified as a known human carcinogen, and the other three toxics are classified as probable human carcinogens. This analysis examined the impact that Cleveland's I/M program has on emissions of these air toxics from motor vehicles.





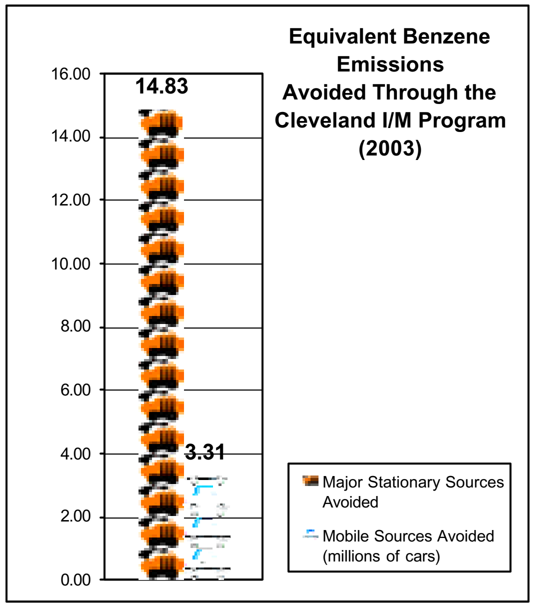




I/M Program: Ohio has a biennial ASM2525 test for 1981 and newer models and an idle test for older models. The test includes visual anti-tampering checks of the catalyst and pressure and purge evaporative checks. Stage II vapor recovery is included. The counties included in the Cleveland I/M program are Cuyahoga, Geauya, Lake, Lorain, Medina, Portage, and Summit.

Results: In 2003, the I/M program is projected to reduce 148 tons of benzene (21.4, 14.5 tons of acetaldehyde15.6, 22.8 tons of 1,3-butadiene31.7, and 28.3 tons of formaldehyde11.6. In 2012, emissions benefits rise to 21.4 percent for acetaldehyde, 34.9 percent for benzene, 50.9 percent for 1,3-butadiene, and 16.6 percent for formaldehyde.

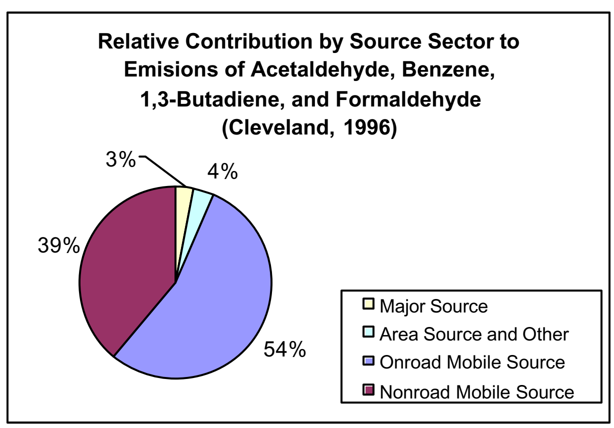
Emissions Context: The Clean Air Act defines a major stationary source of air toxics as one with the potential to emit 10 tons per year of any one toxic air pollutant, or 25 tpy of any combination of toxic air pollutants. Therefore, the total of 148.33 tons of benzene that are not emitted in the Cleveland area in 2003 due to the I/M programs represents the benzene equivalent of almost 15 new stationary sources of benzene.



These avoided emissions can also be expressed in terms of new vehicles. Assuming an average of 12,500 miles traveled per year per vehicle and an average benzene emission rate for new vehicles of 3.26 milligrams per mile, the benzene emissions avoided by the I/M program in the Cleveland area represents the benzene equivalent of more than 3.3 million new vehicles.

The chart below demonstrates the 1996 emissions from outdoor sources of the four air toxics included in the analysis for the Cleveland I/M area. Onroad mobile sources – cars and trucks – emit 54% of these toxic pollutants. These air toxics are known or probable causes of cancer and some are linked to reproductive effects.

Conclusions: The Cleveland area's I/M program is a valuable tool for the improvement of air quality. It delivers meaningful reductions both of air toxics and criteria pollutants that harm both the environment and human health, especially in urban areas. Discontinuing this program would lead to significant increases in releases of these pollutants and would result in the addition of thousands of tons of pollution to the air that the people of Cleveland breathe.

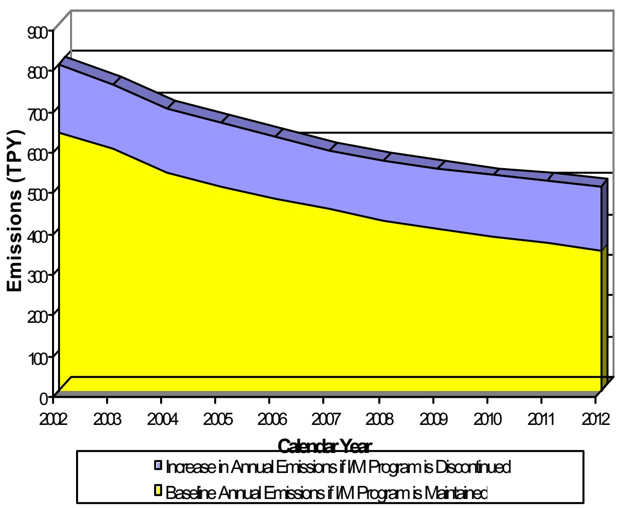


HOUSTON

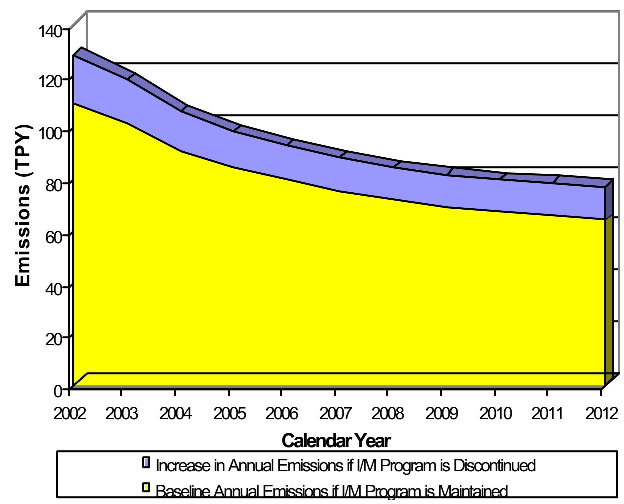
Texas

Emissions from motor vehic les contain pollutants that cause smog and acid rain as well as those classified by EPA as air toxics. According to EPA data, vehicles operating on Houston's highways represent the single greatest source of air toxics in the Houston area. The four air toxics emitted from automobiles in the greatest quantity are acetaldehyde, benzene, 1,3-butadiene, and formaldehyde. Benzene is classified as a known human carcinogen, and the other three toxics are classified as probable human carcinogens. This analysis examined the impact that Houston's I/M program has on emissions of these air toxics from motor vehicles.

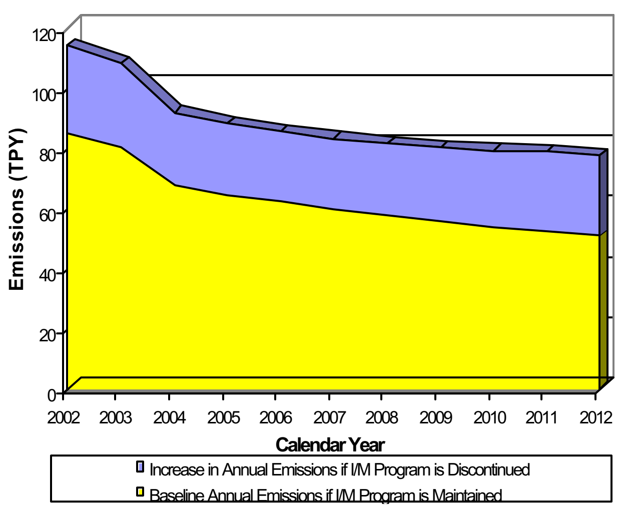
Benzene Emissions



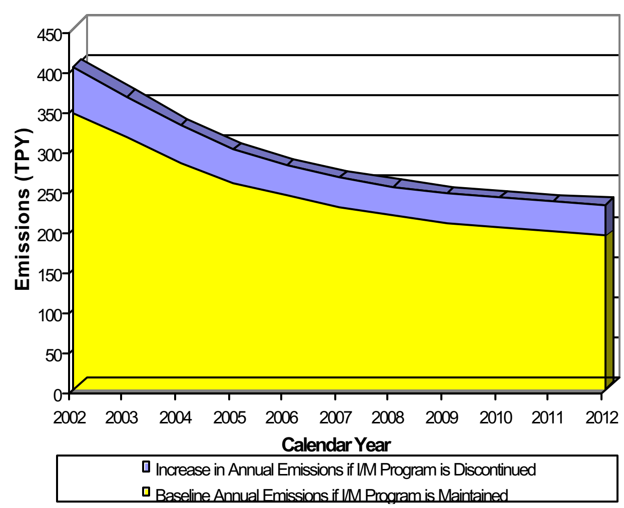
Acetaldehyde Emissions



1,3-Butadiene Emissions



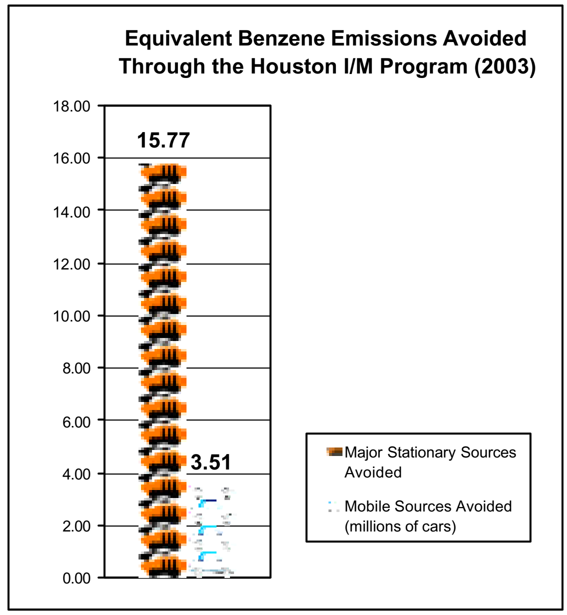
Formaldehyde Emissions



I/M Program: Houston has an annual ASM test. The test includes visual checks of the catalyst, air pump, EGR, PCV and evaporative system, and pressure, and gas cap checks. Harris county is regulated under the Houston I/M program.

Results: In 2003, Houston's I/M program is projected to reduce 16.7 tons of acetaldehyde (16.5 percent fewer emissions than with no I/M program), 145 tons of benzene (26.4 percent), 27.7 tons of 1,3-butadiene (34.5 percent), and 50.0 tons of formaldehyde (15.9 percent). In 2012, emissions benefits rise to 19.5 percent for acetaldehyde, 45.4 percent for benzene, 52.0 percent for 1,3-butadiene, and 19.8 percent for formaldehyde.

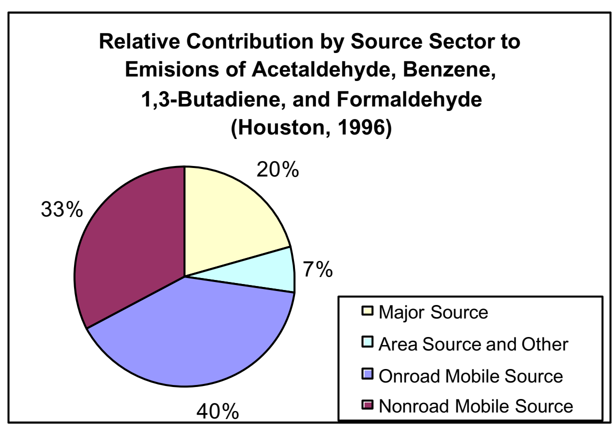
Emissions Context: The Clean Air Act defines a major stationary source of air toxics as one with the potential to emit 10 tons per year of any one toxic air pollutant, or 25 tpy of any combination of toxic air pollutants. Therefore, the total of 157.69 tons of benzene that are not emitted in the Houston area in 2003 due to the I/M programs represents the benzene equivalent of almost 16 new stationary sources of benzene.



These avoided emissions can also be expressed in terms of new vehicles. Assuming an average of 12,500 miles traveled per year per vehicle and an average benzene emission rate for new vehicles of 3.26 milligrams per mile, the benzene emissions avoided by the I/M program in the Houston area represents the benzene equivalent of more than 3.5 million new vehicles.

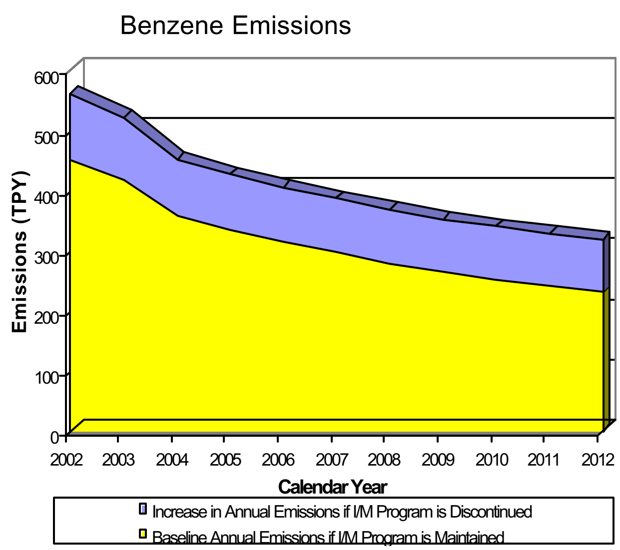
The chart below demonstrates the 1996 emissions from outdoor sources of the four air toxics included in the analysis for the Houston I/M area. Onroad mobile sources – cars and trucks – emit 59% of these toxic pollutants. These air toxics are known or probable causes of cancer and some are linked to reproductive effects.

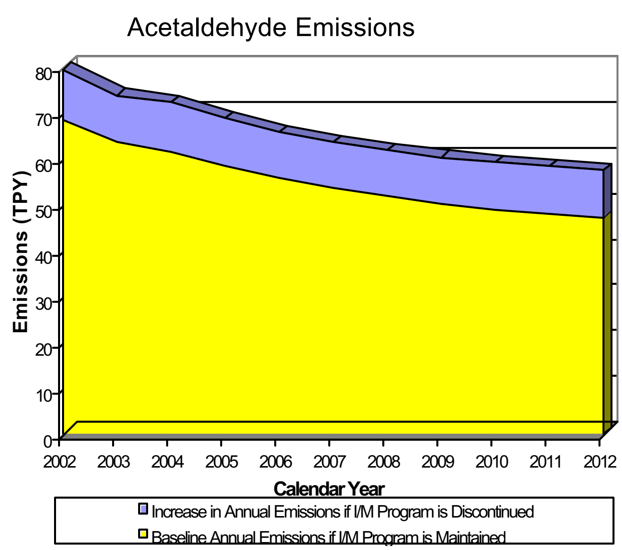
Conclusions: The Houston area's I/M program is a valuable tool for the improvement of air quality. It delivers meaningful reductions both of air toxics and criteria pollutants that harm both the environment and human health, especially in urban areas. Discontinuing this program would lead to significant increases in releases of these pollutants and would result in the addition of thousands of tons of pollution to the air that the people of Houston breathe.

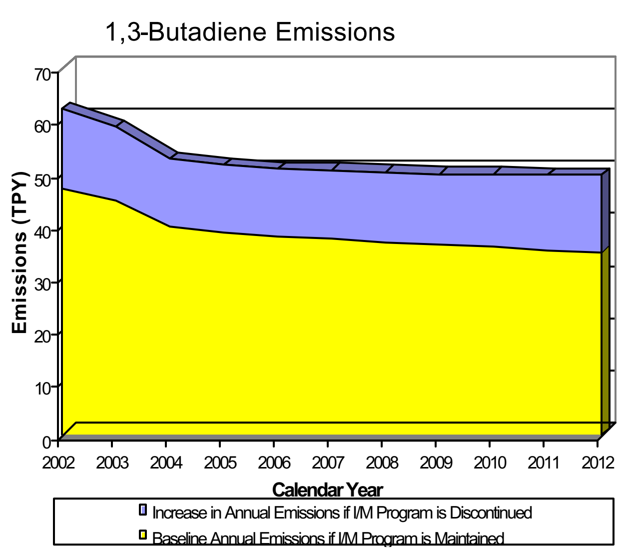


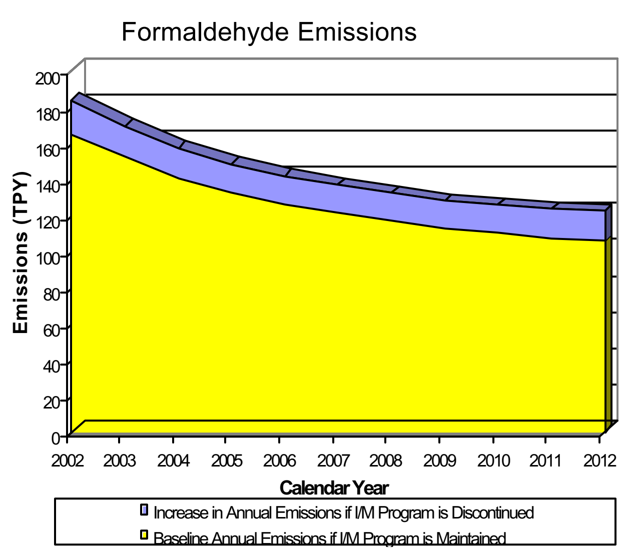
MILWAUKEE **Wisconsin**

Emissions from motor vehicles contain pollutants that cause smog and acid rain as well as those classified by EPA as air toxics. According to EPA data, vehicles operating on Milwaukee's highways represent the single greatest source of air toxics in the Milwaukee area. The four air toxics emitted from automobiles in the greatest quantity are acetaldehyde, benzene, 1,3-butadiene, and formaldehyde. Benzene is classified as a known human carcinogen, and the other three toxics are classified as probable human carcinogens. This analysis examined the impact that Milwaukee's I/M program has on emissions of these air toxics from motor vehicles.





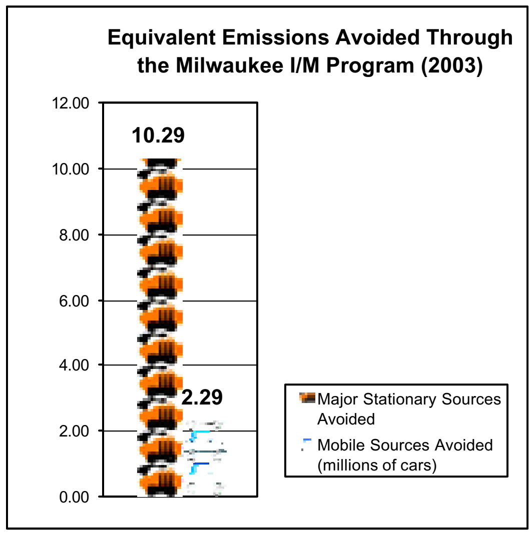




I/M Program: Milwaukee has a biennial IM240 test for 1968 and newer models. The test includes visual checks of the catalyst, air pump, EGR, PCV, and fuel inlet, and a gas cap evaporative check. The counties included in the Milwaukee I/M program are Kenosha, Milwaukee, Ozaukee, Racine, Washington, and Waukesha.

Results: In 2003, the Milwaukee I/M program is projected to reduce 103 tons of 10 tons of acetaldehyde (16.0 percent fewer emissions than in the absence of and I/M program), benzene (24.6 percent), 14 tons of 1,3-butadiene (31.8 percent), and 17 tons of formaldehyde (11.3 percent). In 2012, emissions benefits rise to 21.7 percent for acetaldehyde, 37.8 percent for benzene, 41.7 percent for 1,3-butadiene, and 15.6 percent for formaldehyde.

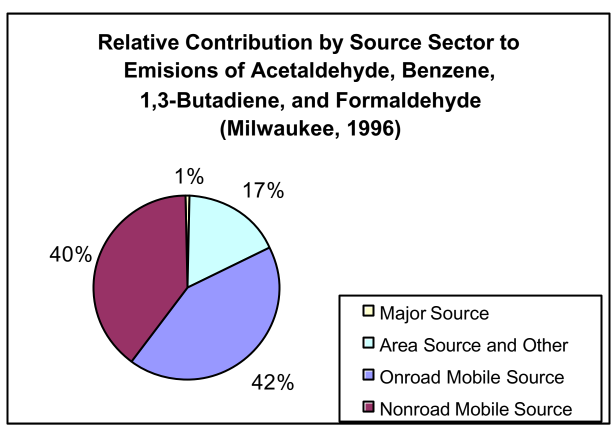
Emissions Context: The Clean Air Act defines a major stationary source of air toxics as one with the potential to emit 10 tons per year of any one toxic air pollutant, or 25 tpy of any combination of toxic air pollutants. Therefore, the total of 102.89 tons of benzene that are not emitted in the Milwaukee area in 2003 due to the I/M programs represents the benzene equivalent of more than 10 new stationary sources of benzene.



These avoided emissions can also be expressed in terms of new vehicles. Assuming an average of 12,500 miles traveled per year per vehicle and an average benzene emission rate for new vehicles of 3.26 milligrams per mile, the benzene emissions avoided by the I/M program in the Milwaukee area represents the benzene equivalent of more than 2.2 million new vehicles.

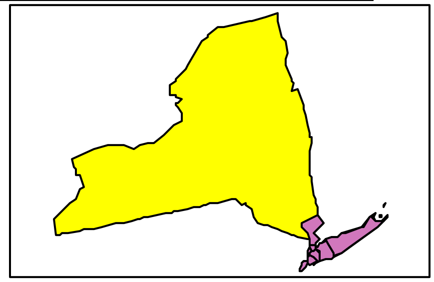
The chart below demonstrates the 1996 emissions from outdoor sources of the four air toxics included in the analysis for the Milwaukee I/M area. Onroad mobile sources – cars and trucks – emit 42 percent of these toxic pollutants. These air toxics are known or probable causes of cancer and some are linked to reproductive effects.

Conclusions: The Milwaukee area's I/M program is a valuable tool for the improvement of air quality. It delivers meaningful reductions both of air toxics and criteria pollutants that harm both the environment and human health, especially in urban areas. Discontinuing this program would lead to significant increases in releases of these pollutants and would result in the addition of thousands of tons of pollution to the air that the people of Milwaukee breathe.

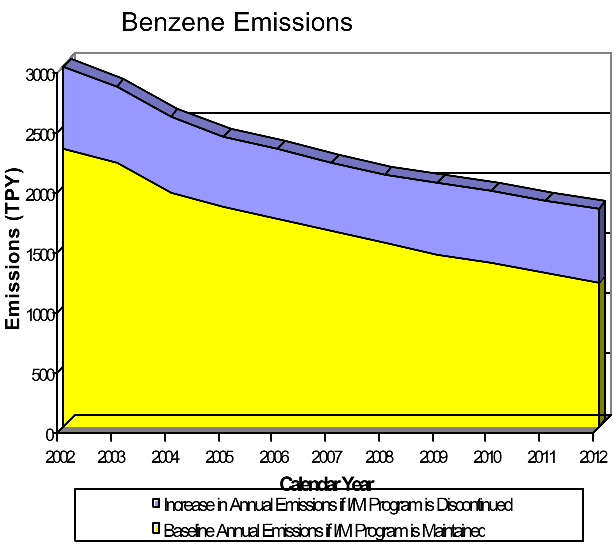


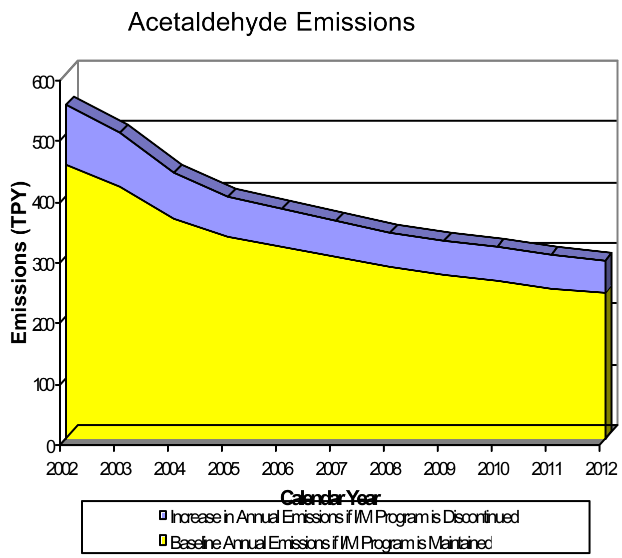
NEW YORK CITY

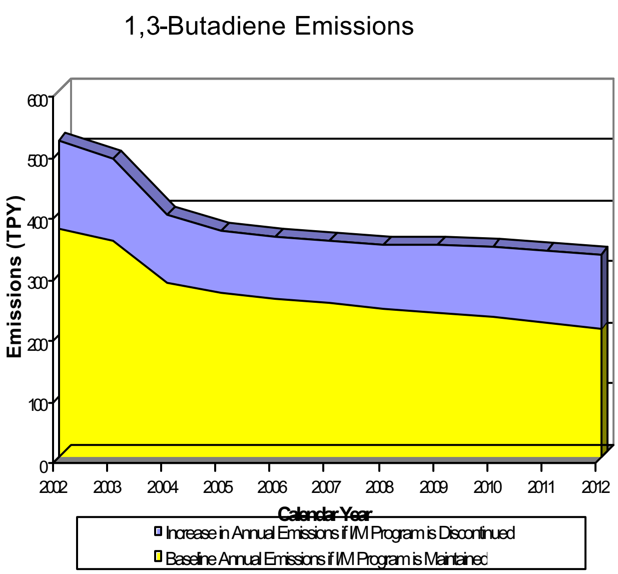
New York

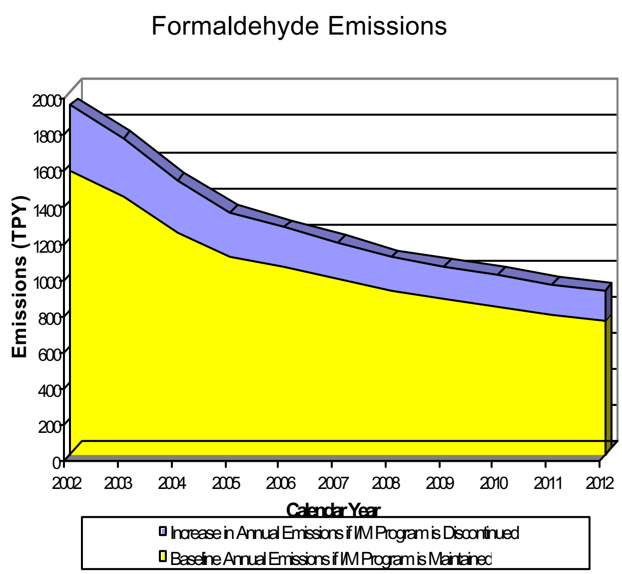


Emissions from motor vehicles contain pollutants that cause smog and acid rain as well as those classified by EPA as air toxics. According to EPA data, vehicles operating on New York's highways represent the single greatest source of air toxics in the New York area. The four air toxics emitted from automobiles in the greatest quantity are acetaldehyde, benzene, 1,3-butadiene, and formaldehyde. Benzene is classified as a known human carcinogen, and the other three toxics are classified as probable human carcinogens. This analysis examined the impact that New York's I/M program has on emissions of these air toxics from motor vehicles.



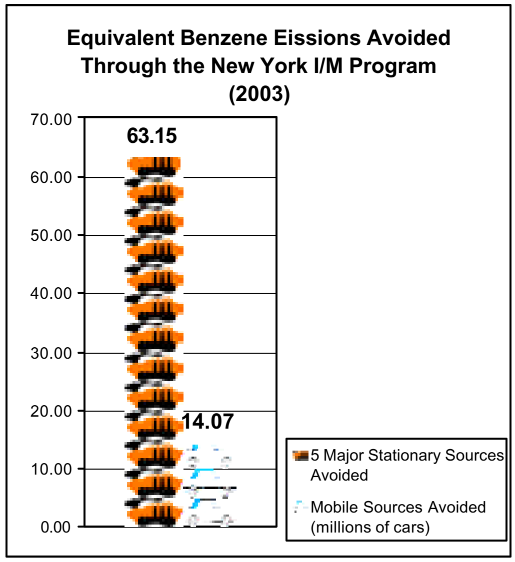






I/M Program: New York has an annual NYTEST (a modified dynamometer test) for 1981 and newer models and an idle test for older models. The test includes visual anti-tampering checks of the catalyst, fuel inlet, air pump, EGR, PCV, and gas cap and pressure and purge evaporative checks. Stage II vapor recovery is included. The counties included in the New York I/M program are Bronx, Kings, Nassau, New York, Queens, Richmond, Rockland, Suffolk, and Westchester.

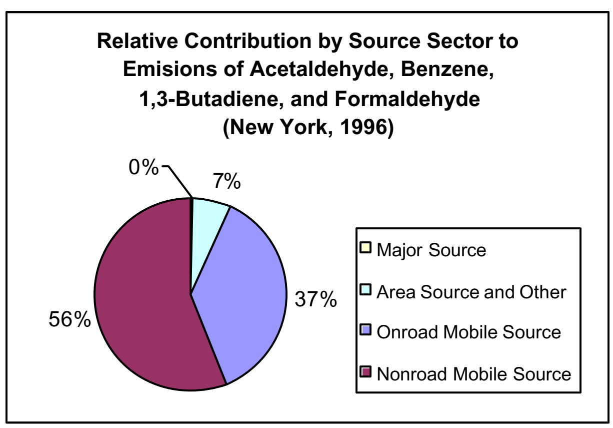
Results: In 2003, the New York I/M program is projected to reduce 86.5 tons of acetaldehyde (20.7 percent fewer emissions than in the absence of an I/M program), 631.5 tons of benzene (28.8 percent), 133.7 tons of 1,3-butadiene (37.6 percent), and 316.3 tons of formaldehyde (22.1 percent). In 2012, emissions benefits rise to 22.5 percent for acetaldehyde, 50.5 percent for benzene, 56.9 percent for 1,3-butadiene, and 22.9 percent for formaldehyde.



Emissions Context: The Clean Air Act defines a major stationary source of air toxics as one with the potential to emit 10 tons per year of any one toxic air pollutant, or 25 tpy of any combination of toxic air pollutants. Therefore, the total of 631.5 tons of benzene that are not emitted in the New York area in 2003 due to the I/M programs represents the benzene equivalent of more than 63.15 new stationary sources of benzene.

These avoided emissions can also be expressed in terms of new vehicles. Assuming an average of 12,500 miles traveled per year per vehicle and an average benzene emission rate for new vehicles of 3.26 milligrams per mile, the benzene emissions avoided by the I/M program in the New York area represents the benzene equivalent of more than 14 million new vehicles.

The chart below demonstrates the 1996 emissions from outdoor sources of the four air toxics included in the analysis for the New York I/M area. Onroad mobile sources – cars and trucks – emit 37% of these toxic pollutants. These air toxics are known or probable causes of cancer and some are linked to reproductive effects.

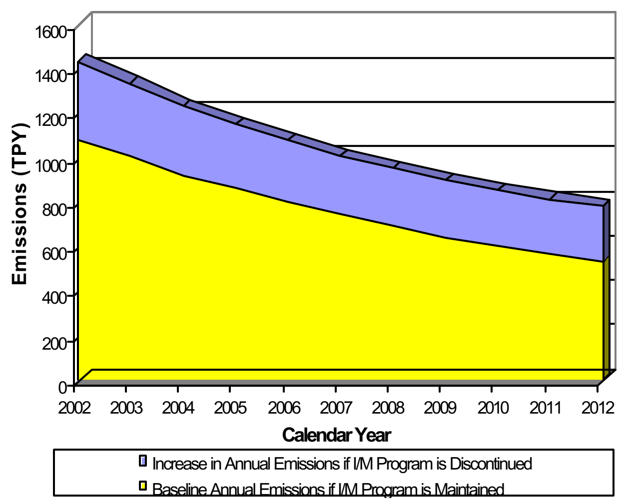


Conclusions: The New York area's I/M program is a valuable tool for the improvement of air quality. It delivers meaningful reductions both of air toxics and criteria pollutants that harm both the environment and human health, especially in urban areas. Discontinuing this program would lead to significant increases in releases of these pollutants and would result in the addition of thousands of tons of pollution to the air that the people of New York breathe.

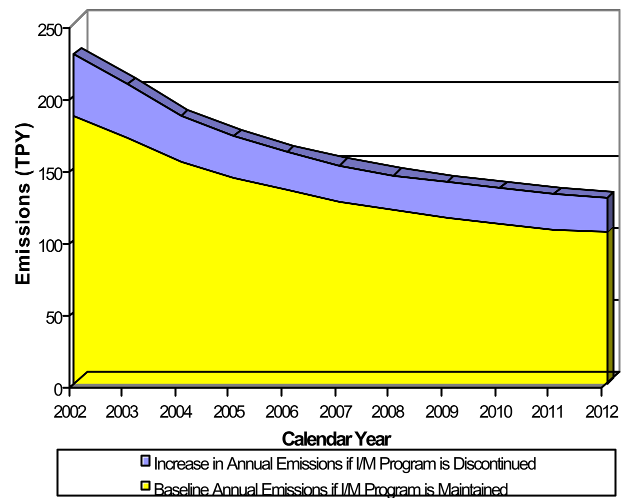
PHILADELPHIA Pennsylvania

Emissions from motor vehicles contain pollutants that cause smog and acid rain as well as those classified by EPA as air toxics. According to EPA data, vehicles operating on Philadelphia's highways represent the single greatest source of air toxics in the Philadelphia area. The four air toxics emitted from automobiles in the greatest quantity are acetaldehyde, benzene, 1,3-butadiene, and formaldehyde. Benzene is classified as a known human carcinogen, and the other three toxics are classified as probable human carcinogens. This analysis examined the impact that Philadelphia's I/M program has on emissions of these air toxics from motor vehicles.

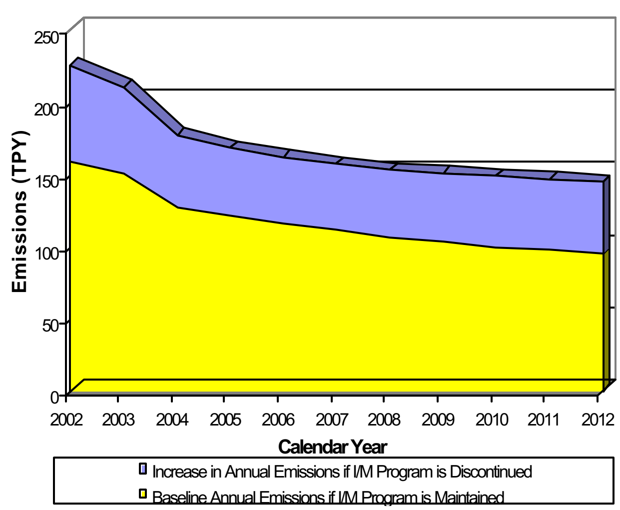
Benzene Emissions



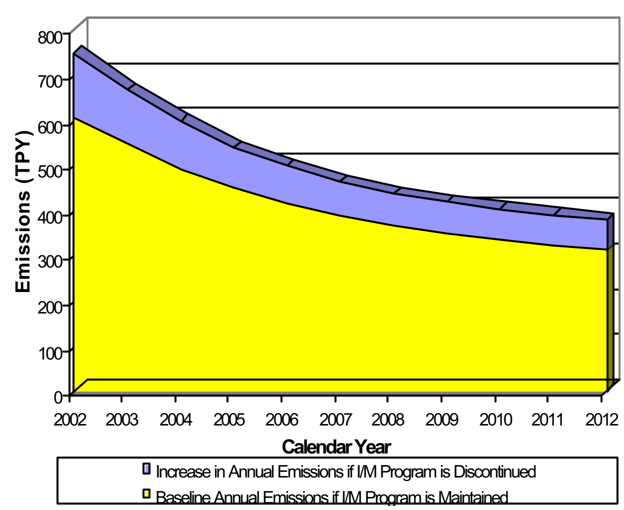
Acetaldehyde Emissions



1,3-Butadiene Emissions



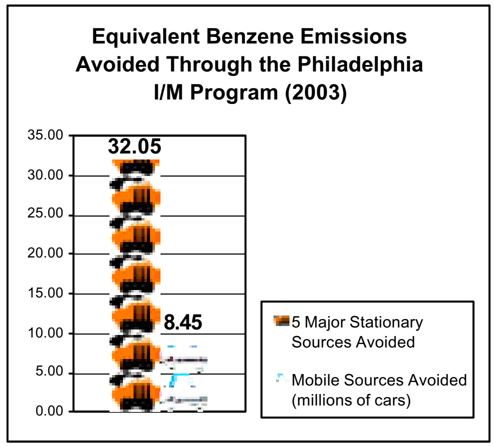
Formaldehyde Emissions



I/M Program: Philadelphia has an annual ASM1 test for 1981 and newer models, with an idle test for 1975-80 models). The test includes visual anti-tampering checks of the catalyst, fuel inlet, EGR, and PCV, and pressure and purge evaporative checks. Stage II vapor recovery is included. Counties included in the Philadelphia I/M program are Bucks, Chester, Delaware, Montgomery, and Philadelphia.

Results: In 2003, the Philadelphia I/M program is projected to reduce 37 tons of acetaldehyde (21.4 percent fewer emissions than in the absence of an I/M program), 320 tons of benzene (31.6 percent), 60 tons of 1,3-butadiene (39.8 percent), and 118 tons of formaldehyde (21.5 percent). In 2012, emissions benefits rise to 22.9 percent for acetaldehyde, 45.9 percent for benzene, 52.7 percent for 1,3-butadiene, and 21.8 percent for formaldehyde.

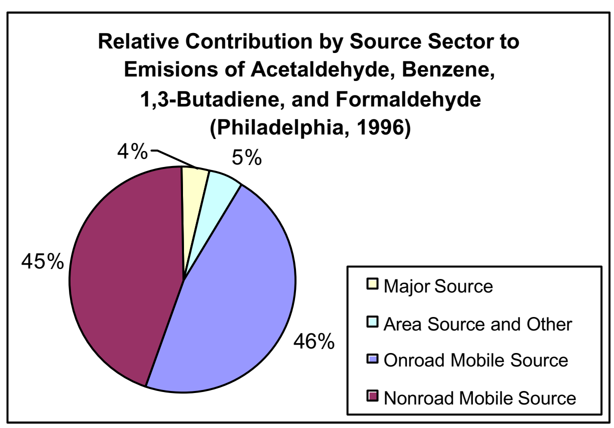
Emissions Context: The Clean Air Act defines a major stationary source of air toxics as one with the potential to emit 10 tons per year of any one toxic air pollutant, or 25 tpy of any combination of toxic air pollutants. Therefore, the total of 320.49 tons of benzene that are not emitted in the Philadelphia area in 2003 due to the I/M programs represents the benzene equivalent of more than 32 new stationary sources of benzene.



These avoided emissions can also be expressed in terms of new vehicles. Assuming an average of 12,500 miles traveled per year per vehicle and an average benzene emission rate for new vehicles of 3.26 milligrams per mile, the benzene emissions avoided by the I/M program in the Philadelphia area represents the benzene equivalent of more than 7.1 million new vehicles.

The chart below demonstrates the 1996 emissions from outdoor sources of the four air toxics included in the analysis for the Philadelphia I/M area. Onroad mobile sources – cars and trucks – emit 46 percent of these toxic pollutants. These air toxics are known or probable causes of cancer and some are linked to reproductive effects.

Conclusions: The Philadelphia area's I/M program is a valuable tool for the improvement of air quality. It delivers meaningful reductions both of air toxics and criteria pollutants that harm both the environment and human health, especially in urban areas. Discontinuing this program would lead to significant increases in releases of these pollutants and would result in the addition of thousands of tons of pollution to the air that the people of Philadelphia breathe.

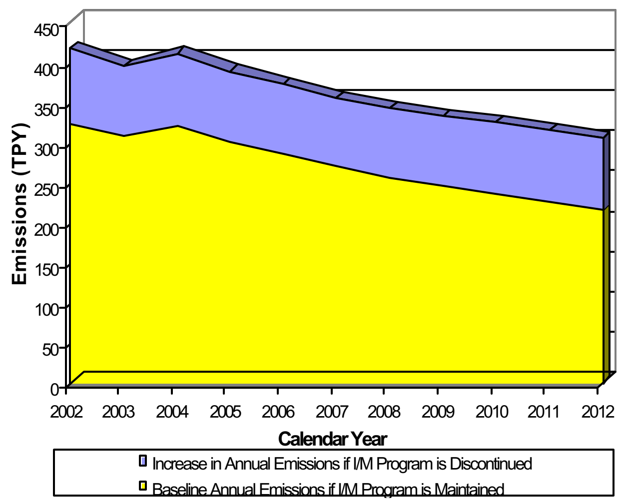


PHOENIX

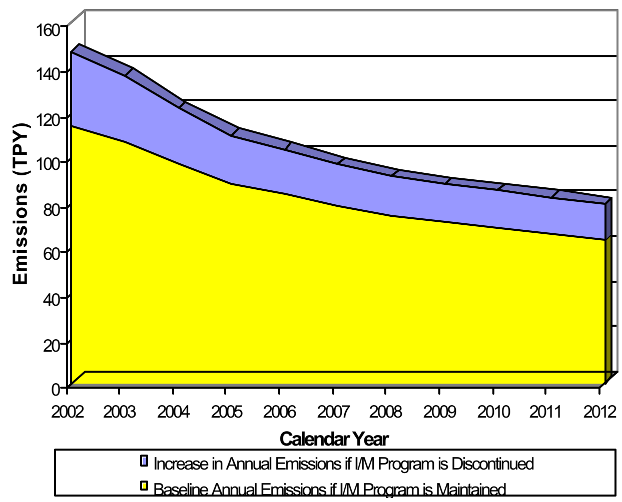
Arizona

Emissions from motor vehicles contain pollutants that cause smog and acid rain as well as those classified by EPA as air toxics. According to EPA data, vehicles operating on Phoenix's highways represent the single greatest source of air toxics in the Phoenix area. The four air toxics emitted from automobiles in the greatest quantity are acetaldehyde, benzene, 1,3-butadiene, and formaldehyde. Benzene is classified as a known human carcinogen, and the other three toxics are classified as probable human carcinogens. This analysis examined the impact that Phoenix's I/M program has on emissions of these air toxics from motor vehicles.

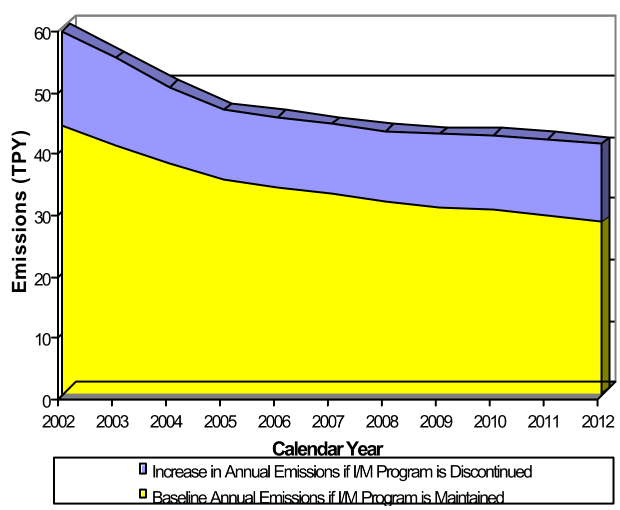
Benzene Emissions



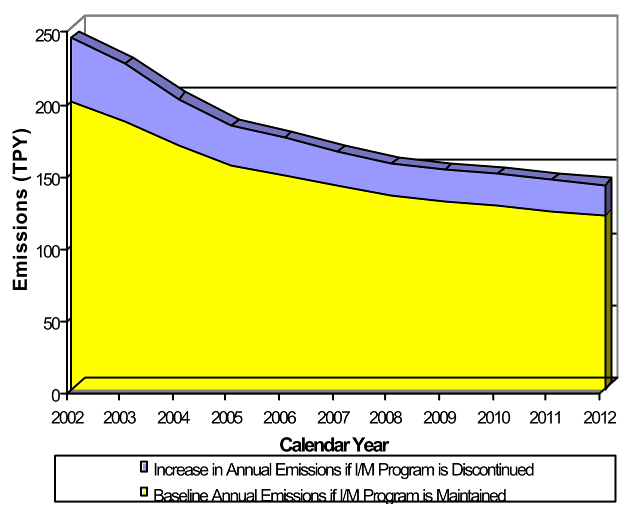
Acetaldehyde Emissions



1,3-Butadiene Emissions



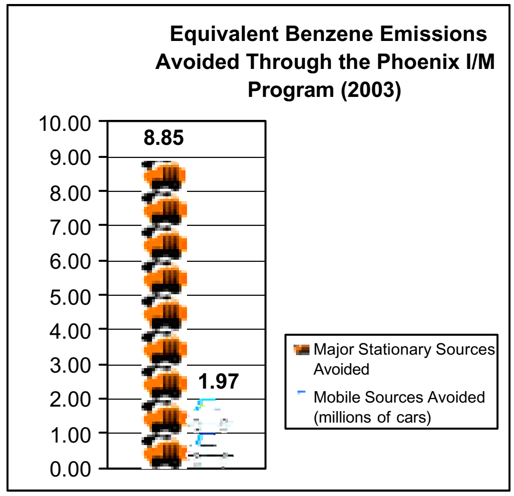
Formaldehyde Emissions



I/M Program: Phoenix has a biennial IM240 test for 1981 and newer models and an annual idle test for older models. The test includes visual anti-tampering checks of the catalyst, fuel inlet, air pump, EGR, PCV, and gas cap and pressure and purge evaporative checks. Stage II vapor recovery is included. The urbanized portion of Maricopa County is included in the Phoenix I/M program.

Results: In 2003, the Phoenix I/M program is projected to reduce 30 tons of acetaldehyde (27.8 percent fewer emissions than in the absence of an I/M program), 89 tons of benzene (28.9 percent), 14 tons of 1,3-butadiene (34.9 percent), and 40 tons of formaldehyde (21.8 percent). In 2012, emissions benefits are 25.3 percent for acetaldehyde, 41.1 percent for benzene, 45.0 percent for 1,3-butadiene, and 17.4 percent for formaldehyde.

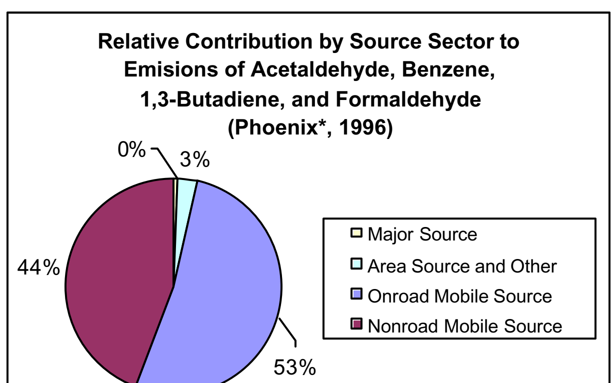
Emissions Context: The Clean Air Act defines a major stationary source of air toxics as one with the potential to emit 10 tons per year of any one toxic air pollutant, or 25 tpy of any combination of toxic air pollutants. Therefore, the total of 88.53 tons of benzene that are not emitted in the Phoenix area in 2003 due to the I/M programs represents the benzene equivalent of almost 9 new stationary sources of benzene.



These avoided emissions can also be expressed in terms of new vehicles. Assuming an average of 12,500 miles traveled per year per vehicle and an average benzene emission rate for new vehicles of 3.26 milligrams per mile, the benzene emissions avoided by the I/M program in the Phoenix area represents the benzene equivalent of almost two million new vehicles.

The chart below demonstrates the 1996 emissions from outdoor sources of the four air toxics included in the analysis in Maricopa County. Onroad mobile sources – cars and trucks – emit 53 percent of these toxic pollutants. These air toxics are known or probable causes of cancer and some are linked to reproductive effects.

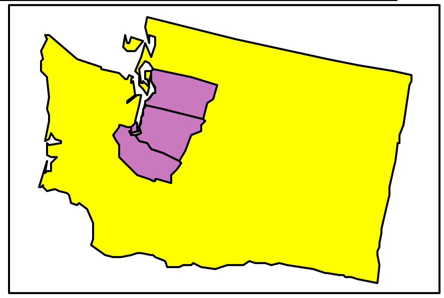
Conclusions: The Phoenix area's I/M program is a valuable tool for the improvement of air quality. It delivers meaningful reductions both of air toxics and criteria pollutants that harm both the environment and human health, especially in urban areas. Discontinuing this program would lead to significant increases in releases of these pollutants and would result in the addition of thousands of tons of pollution to the air that the people of Phoenix breathe.



*This data was calculated for all of Maricopa County

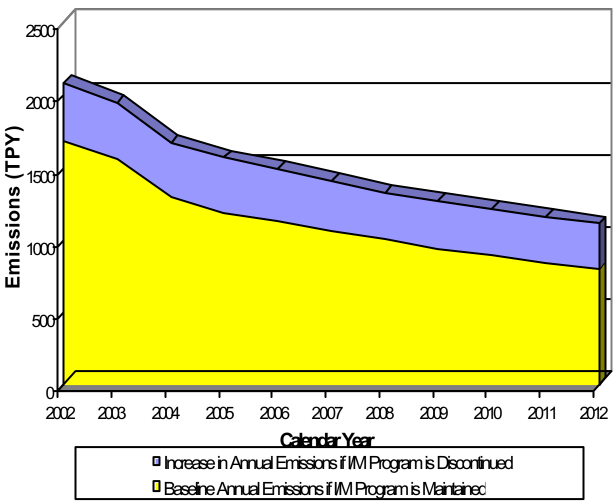
SEATTLE

Washington

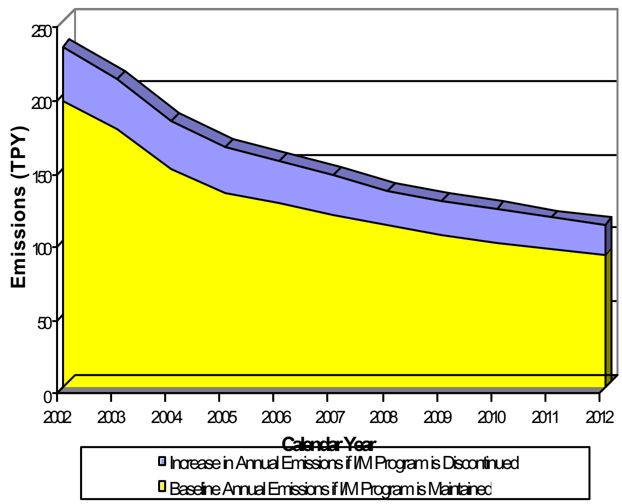


Emissions from motor vehicles contain pollutants that cause smog and acid rain as well as those classified by EPA as air toxics. According to EPA data, vehicles operating on Seattle's highways represent the single greatest source of air toxics in the Seattle area. The four air toxics emitted from automobiles in the greatest quantity are acetaldehyde, benzene, 1,3-butadiene, and formaldehyde. Benzene is classified as a known human carcinogen, and the other three toxics are classified as probable human carcinogens. This analysis examined the impact that Seattle's I/M program has on emissions of these air toxics from motor vehicles.

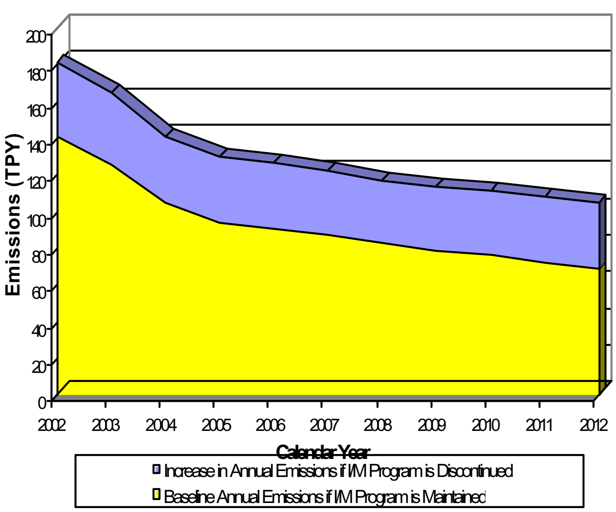
Benzene Emissions



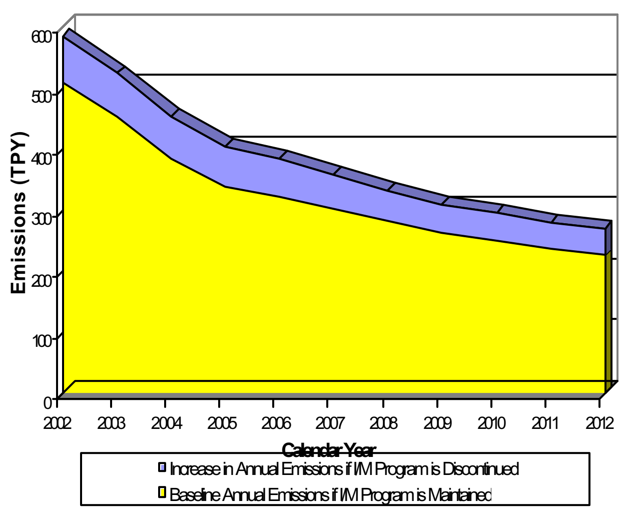
Acetaldehyde Emissions



1,3-Butadiene Emissions



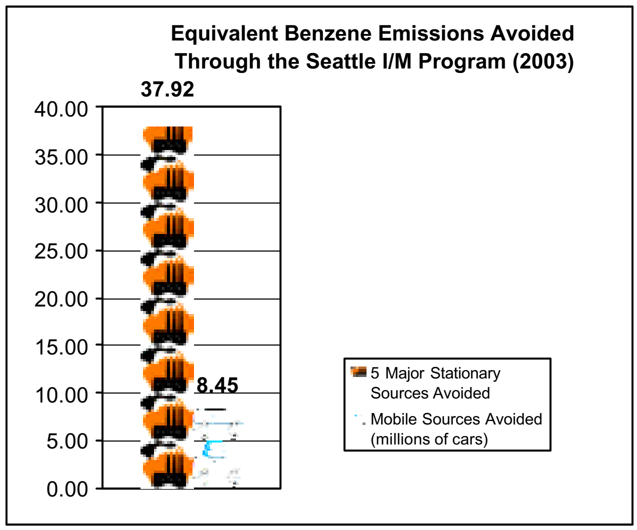
Formaldehyde Emissions



I/M Program: Seattle has a biennial ASM test for models 5 to 24 years old, with an idle test done through 2001. The test includes gas cap evaporative checks. Stage II vapor recovery is included. The counties included in the Seattle I/M program are King, Kitsap, Pierce, and Snohomish.

Results: In 2003, the Seattle I/M program is projected to reduce 16 tons of acetaldehyde (18.9 percent fewer emissions than in the absence of an I/M program), 178 tons of benzene (24.2 percent), 18 tons of 1,3-butadiene (30.4 percent), and 33 tons of formaldehyde (15.6 percent). In 2012, emissions benefits rise to 23.4 percent for acetaldehyde, 38.2 percent for benzene, 51.5 percent for 1,3-butadiene, and 19.5 percent for formaldehyde.

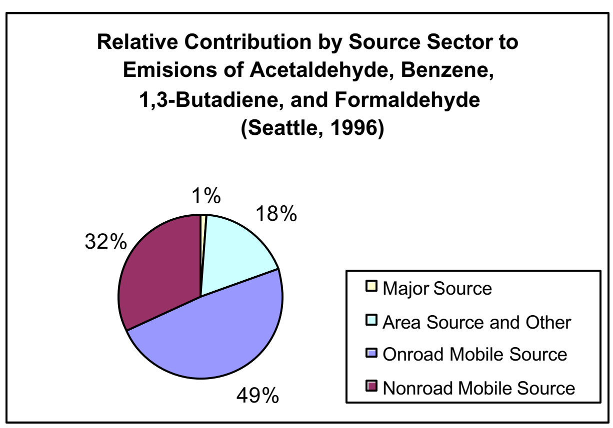
Emissions Context: The Clean Air Act defines a major stationary source of air toxics as one with the potential to emit 10 tons per year of any one toxic air pollutant, or 25 tpy of any combination of toxic air pollutants. Therefore, the total of 379.25 tons of benzene that are not emitted in the Seattle area in 2003 due to the I/M programs represents the benzene equivalent of almost 38 new stationary sources of benzene.



These avoided emissions can also be expressed in terms of new vehicles. Assuming an average of 12,500 miles traveled per year per vehicle and an average benzene emission rate for new vehicles of 3.26 milligrams per mile, the benzene emissions avoided by the I/M program in the Seattle area represents the benzene equivalent of more than 8.5 million new vehicles.

The chart below demonstrates the 1996 emissions from outdoor sources of the four air toxics included in the analysis for the Seattle I/M area. Onroad mobile sources – cars and trucks – emit 49 percent of these toxic pollutants. These air toxics are known or probable causes of cancer and some are linked to reproductive effects.

Conclusions: The Seattle area's I/M program is a valuable tool for the improvement of air quality. It delivers meaningful reductions both of air toxics and criteria pollutants that harm both the environment and human health, especially in urban areas. Discontinuing this program would lead to significant increases in releases of these pollutants and would result in the addition of thousands of tons of pollution to the air that the people of Seattle breathe.

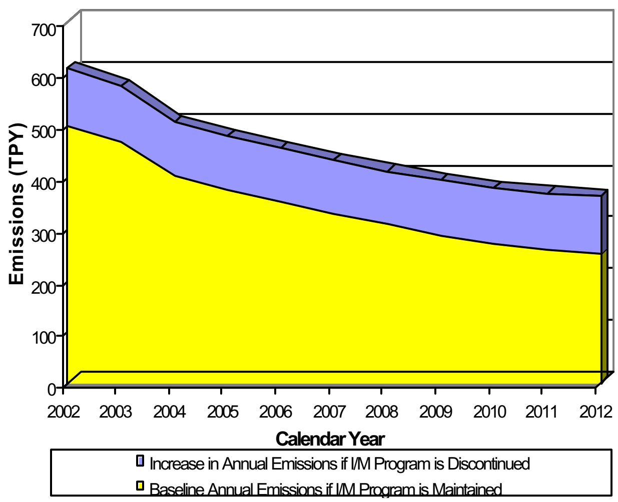


ST. LOUIS

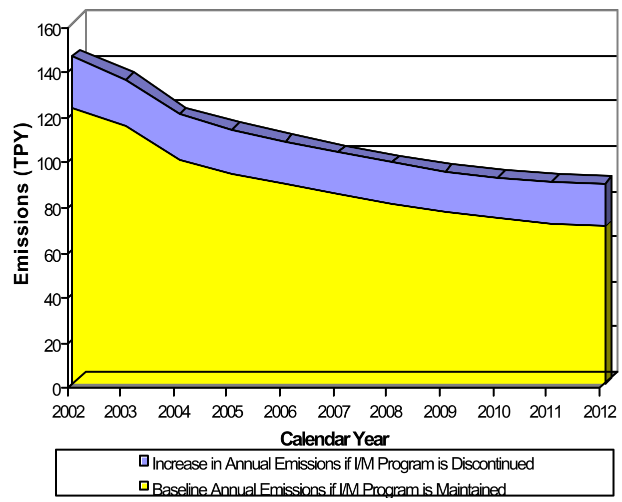
Missouri

Emissions from motor vehicles contain pollutants that cause smog and acid rain as well as those classified by EPA as air toxics. According to EPA data, vehicles operating on St. Louis's highways represent the single greatest source of air toxics in the St. Louis area. The four air toxics emitted from automobiles in the greatest quantity are acetaldehyde, benzene, 1,3-butadiene, and formaldehyde. Benzene is classified as a known human carcinogen, and the other three toxics are classified as probable human carcinogens. This analysis examined the impact that St. Louis's I/M program has on emissions of these air toxics from motor vehicles.

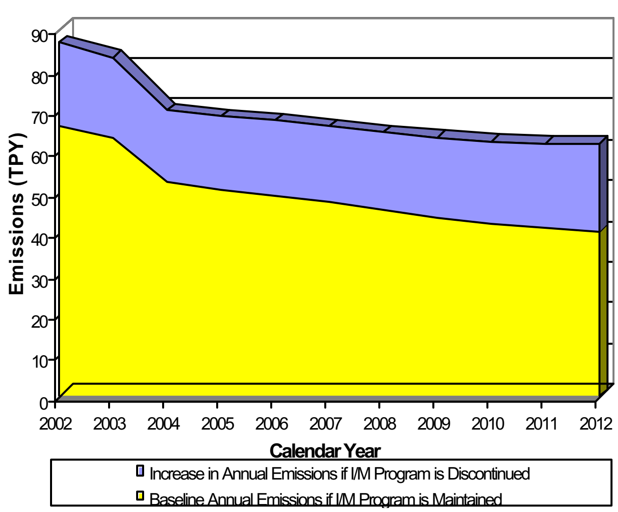
Benzene Emissions



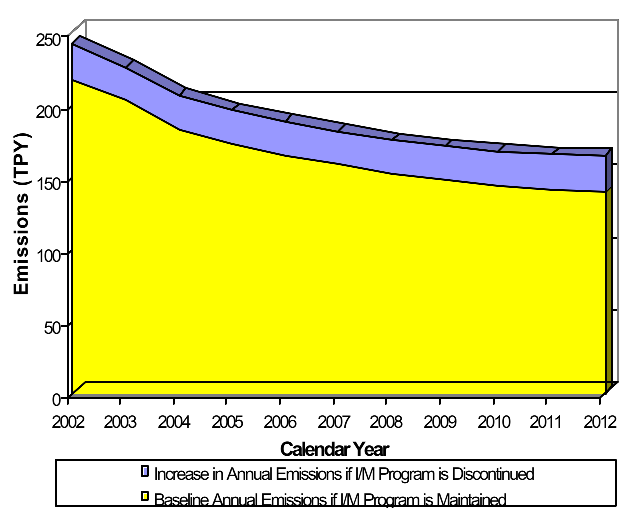
Acetaldehyde Emissions



1,3-Butadiene Emissions



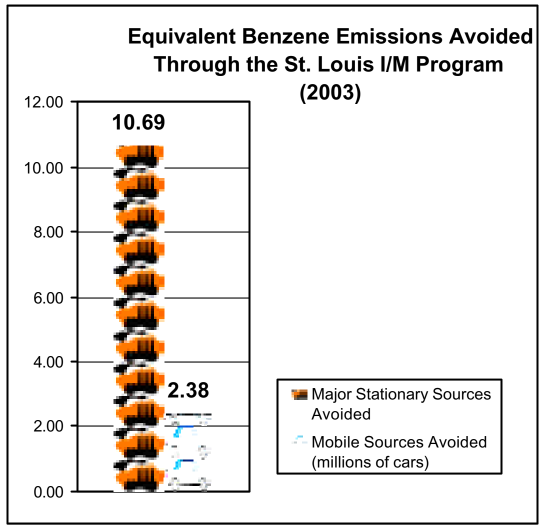
Formaldehyde Emissions



I/M Program: St. Louis has a biennial IM240 test for 1981 and newer models, with an idle test for older models. The test includes visual anti-tampering checks of the catalyst, air pump, EGR, PCV, and fuel inlet, and pressure, purge and gas cap evaporative checks. Stage II vapor recovery is included. The counties included in the St. Louis I/M program are Jefferson, St. Charles, St. Louis, and St. Louis City.

Results: In 2003, the St. Louis I/M program is projected to reduce 21 tons of acetaldehyde (18.4 percent fewer emissions than in the absence of an I/M program), 107 tons of benzene (22.9 percent), 20 tons of 1,3-butadiene (31.1 percent), and 23 tons of formaldehyde (11.3 percent). In 2012, emissions benefits rise to 27.2 percent for acetaldehyde, 45.2 percent for benzene, 53.6 percent for 1,3-butadiene, and 18.7 percent for formaldehyde.

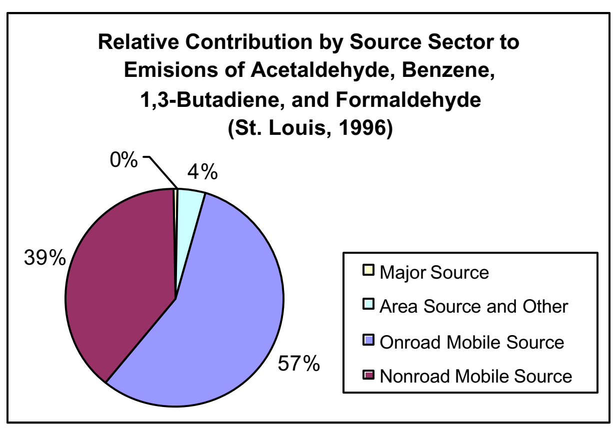
Emissions Context: The Clean Air Act defines a major stationary source of air toxics as one with the potential to emit 10 tons per year of any one toxic air pollutant, or 25 tpy of any combination of toxic air pollutants. Therefore, the total of 106.88 tons of benzene that are not emitted in the St. Louis area in 2003 due to the I/M programs represents the benzene equivalent of almost 11 new stationary sources of benzene.



These avoided emissions can also be expressed in terms of new vehicles. Assuming an average of 12,500 miles traveled per year per vehicle and an average benzene emission rate for new vehicles of 3.26 milligrams per mile, the benzene emissions avoided by the I/M program in the St. Louis area represents the benzene equivalent of more than 2.3 million new vehicles.

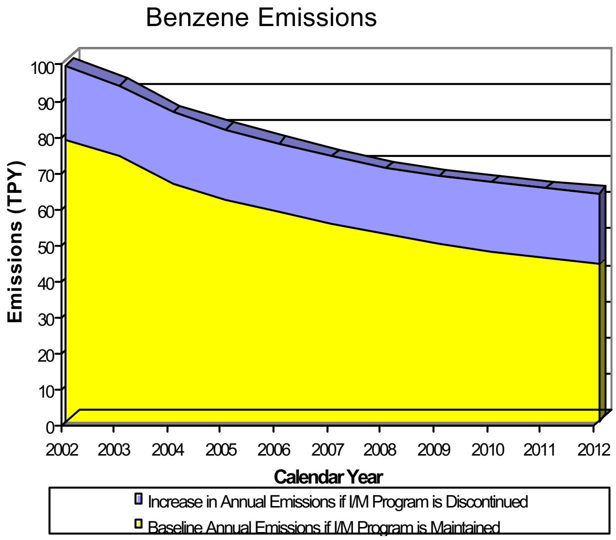
The chart below demonstrates the 1996 emissions from outdoor sources of the four air toxics included in the analysis for the St Louis I/M area. Onroad mobile sources – cars and trucks – emit 57 percent of these toxic pollutants. These air toxics are known or probable causes of cancer and some are linked to reproductive effects.

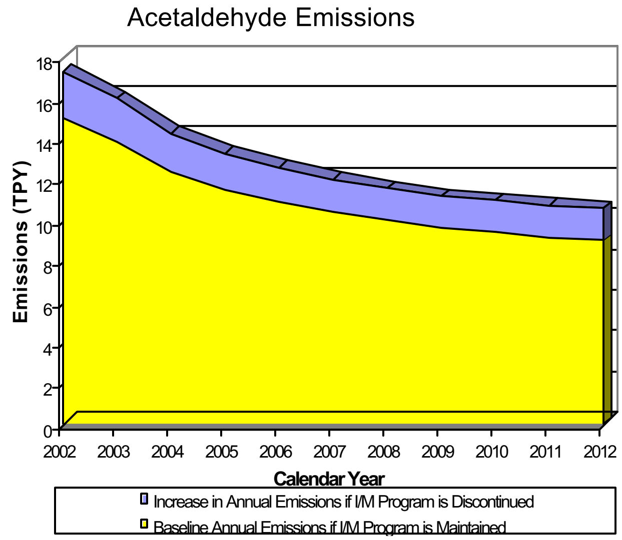
Conclusions: The St. Louis area's I/M program is a valuable tool for the improvement of air quality. It delivers meaningful reductions both of air toxics and criteria pollutants that harm both the environment and human health, especially in urban areas. Discontinuing this program would lead to significant increases in releases of these pollutants and would result in the addition of thousands of tons of pollution to the air that the people of St. Louis breathe.

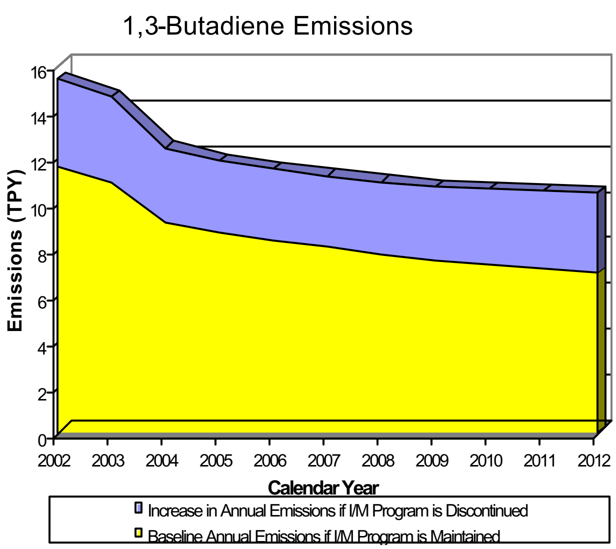


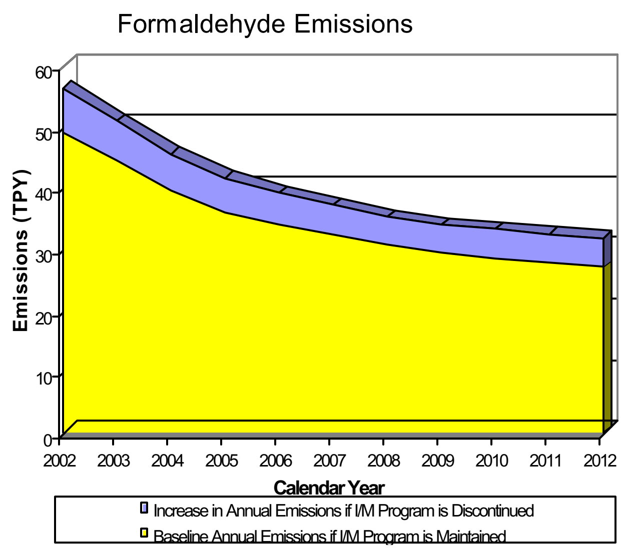
WASHINGTON District of Columbia

Emissions from motor vehicles contain pollutants that cause smog and acid rain as well as those classified by EPA as air toxics. According to EPA data, vehicles operating on Washington D.C.'s highways represent the single greatest source of air toxics in the Washington D.C. area. The four air toxics emitted from automobiles in the greatest quantity are acetaldehyde, benzene, 1,3-butadiene, and formaldehyde. Benzene is classified as a known human carcinogen, and the other three toxics are classified as probable human carcinogens. This analysis examined the impact that Washington D.C.'s I/M program has on emissions of these air toxics from motor vehicles.





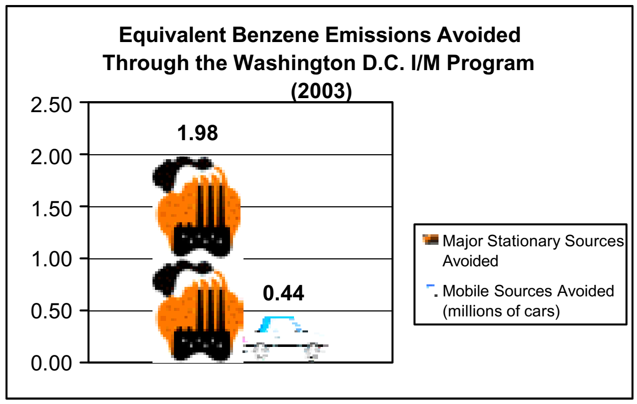




I/M Program: Washington, DC has a biennial IM240 test for 1984 and newer models, with an idle test for older models. The test includes visual anti-tampering checks of the catalyst and fuel inlet, and pressure, purge, and gas cap evaporative checks. Stage II vapor recovery is included. DC is in the OTC region.

Results: In 2003, the Washington, D.C I/M program is projected to reduce 2 tons of acetaldehyde (15.3 percent fewer emissions than in the absence of an I/M program), 20 tons of benzene (27 percent), 3.7 tons of 1,3-butadiene (33.9 percent), and 6.5 tons of formaldehyde (14.5 percent). In 2012, emissions benefits rise to 17.6 percent for acetaldehyde, 45.5 percent for benzene, 49.9 percent for 1,3-butadiene, and 17.6 percent for formaldehyde.

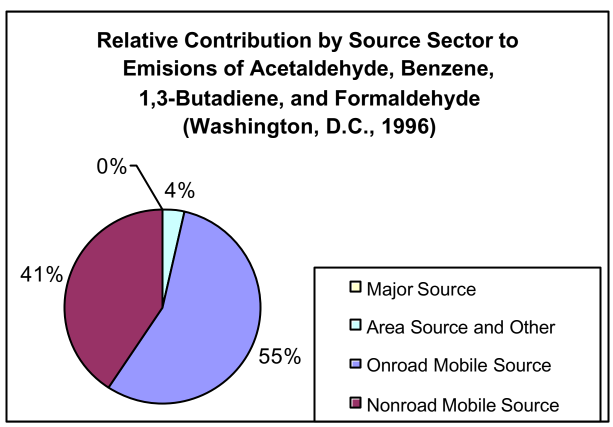
Emissions Context: The Clean Air Act defines a major stationary source of air toxics as one with the potential to emit 10 tons per year of any one toxic air pollutant, or 25 tpy of any combination of toxic air pollutants. Therefore, the total of 19.78 tons of benzene that are not emitted in the Washington, D.C area in 2003 due to the I/M programs represents the benzene equivalent of almost two new stationary sources of benzene.



These avoided emissions can also be expressed in terms of new vehicles. Assuming an average of 12,500 miles traveled per year per vehicle and an average benzene emission rate for new vehicles of 3.26 milligrams per mile, the benzene emissions avoided by the I/M program in the Washington, D.C area represents the benzene equivalent of 440,767 new vehicles.

The chart below demonstrates the 1996 emissions from outdoor sources of the four air toxics included in the analysis for the Washington, D.C. I/M area. Onroad mobile sources – cars and trucks – emit 55 percent of these toxic pollutants. These air toxics are known or probable causes of cancer and some are linked to reproductive effects.

Conclusions: The Washington D.C. area's I/M program is a valuable tool for the improvement of air quality. It delivers meaningful reductions both of air toxics and criteria pollutants that harm both the environment and human health, especially in urban areas. Discontinuing this program would lead to significant increases in releases of these pollutants and would result in the addition of thousands of tons of pollution to the air that the people of D.C. breathe.



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10/02