Dirty, Detrimental, and Deadly

Central Ohio Diesel Hot Spots

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ENVIRONMENTAL
COUNCIL
KEEP WATCH, TAKE ACTION, MAKE CHANGE

Prepared by the Ohio Environmental Council
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The Ohio Environmental Council (OEC) has been behind the scenes and on the front lines of some of Ohio's most critical environmental battles. For 30 years, citizens across the state have counted on the Ohio Environmental Council to be their voice in the Statehouse—fighting to protect Ohio's environment and vanishing open space.

The mission of the Ohio Environmental Council is to inform, unite, and empower Ohio citizens to protect the environment and conserve natural resources. We rely on the support of foundations, community organizations and individuals to carry on our work. The Ohio Environmental Council is a 501(c)3 charitable organization that neither promotes nor opposes any candidate for public office.

With its over 2200 individual members, 115 Eco-Network Members and 90 community supporters, the OEC continues to unite Ohio's conservation and environmental community to *keep watch* of Ohio's air and water quality, *take action* to better environmental policies, and *make change* for a greener tomorrow.

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Executive Summary

This report, *Diesel Hot Spots–Dirty, Detrimental and Deadly,* was undertaken by the Ohio Environmental Council (OEC) to address the serious health threats and air quality non-attainment issues that relate to emissions from dirty diesel engines. The OEC compiled and analyzed traffic counts, diesel emissions, and census data to identify areas in central Ohio with elevated diesel emissions, referred to as "hot spots". The goal of this report is two-fold. First, we want to make people aware of this serious and deadly threat that is affecting the health of our families, agricultural crops, forests, waters, wildlife, and climate. Second, we hope that, with recognition of these dangers and the need to meet federal air quality standards, regulations and programs will be adopted both locally and at the state level by school districts, transit fleets, government supported operations, private industry, and legislators to utilize available technology and establish regulations to clean up Ohio's air.

Emissions from dirty diesels affect both public health and the environment. Diesel exhaust emissions have been linked to eye irritation, asthma attacks, respiratory and neurological ailments, lung cancer, and premature death. Diesel pollution is a major contributor to particulate pollution–about 30% for Ohio's urban areas. According to research conducted by Joel Schwartz of the Harvard School of Public Health, particulate matter pollution "kills about 70,000 Americans each year. That's more people than die from breast and prostate cancers combined. Air pollution is a huge public health problem."[1] Diesel emissions contribute significantly to the pending failure of National Ambient Air Quality Standards (NAAQS) for ozone and fine particulate matter by Columbus and all major Ohio cities. Finally, our crops, forests, waterways, wildlife, and cityscapes (skyline views) are also being adversely impacted by toxic diesel emissions.

There are solutions. For example, the combination of pollution control retrofits and use of ultralow sulfur diesel can reduce diesel particulate matter by over 90%. This technology is readily available and currently used by many bus and truck fleets. It is unmistakably cost effective to work at eliminating diesel exhaust emissions rather than dealing with the resulting health impacts and the consequences of failing to meet air quality standards. It is up to communities and local and state governments to take the necessary steps to require cleaner practices leading to healthier air and people and a healthier environment.

Columbus–Failing Air Quality Standards

The ambient air quality in Columbus is considered unhealthy according to the U.S. Environmental Protection Agency (EPA). The U.S. EPA updated the national air quality standards for ozone and particulate matter in 1997 after research showed health effects at concentrations below the then-established standard. Columbus and every major city in Ohio officially will be declared in non-compliance with these standards in 2004 and required to meet them by 2010. Monitoring by the U.S. EPA indicates that diesels contribute up to 30% of the fine particulates and half of the ozone-forming nitrogen oxide emissions in a Columbus-sized urban area.

Hot Spots

Hot spots are areas that experience levels of diesel exhaust emissions that pose health risks beyond those from normal background levels. In this report, we define hot spots as areas that are within one-quarter mile of a roadway with particulate matter (PM) emission levels of at least 675 grams per mile per day (g/mi/day). According to several recent studies, populations living in areas such as this are considered to have significantly elevated exposure to air toxics and be at an elevated risk for childhood cancer and leukemia, development of asthma, asthma hospitalizations, and premature death (see appendix A).

An estimated 294,896 people in central Ohio live in a diesel hot spot—20% of the area's total population. Approximately 68,431 of those living in central Ohio hot spots suffer from asthma.

The Dirty Dozen

The top twelve Columbus communities with the most people living in diesel hot spots are:

DIESEL HOT SPOTS–TABLE 1	
Municipality	Population living in a hot spot
Columbus	198,860
Newark	9,662
Lancaster	9,529
Delaware	7,699
Gahanna	5,865
Westerville	5,779
Marysville	2,767
Bexley	2,504
Hilliard	2,468
Heath	2,079
Grove City	2,063
Sunbury	1,738

The top twelve communities with the highest percentage of their population living in diesel hot spots are:

DIESEL HOT SPOTS–TABLE 2	
Municipality	Percent of population living in a hot spot
Sugar Grove	73.0%
Carroll	70.7%
Sunbury	66.1%
Hebron	51.1%
Plain City	46.7%
Gratiot	46.1%
South Bloomfield	36.5%
Delaware	30.5%
Urbancrest	28.0%
Columbus	28.0%
Lancaster	27.0%
Canal Winchester	26.0%

Additional areas with potentially significant levels of diesel emissions are train yards, airports, construction sites and loading docks. Due to insufficient availability of traffic counts in these areas, they were not included in our hot spot analysis but should be recognized as likely "hot spot" areas.

Where Do We Go From Here?

U.S. EPA has established rules for on-road diesels which will reduce emissions from newly manufactured diesel engines beginning in 2007. In April of 2003, U.S. EPA also proposed rules to include non-road diesel engines in the diesel cleanup process. The on-road and proposed non-road diesel rules will apply *only* to newly manufactured engines, starting in 2007. Because diesel engines have inherently long lifetimes and are commonly rebuilt rather than retired, pre-2007 engines will continue to pollute the air until the end of their life. Consequently, air quality benefits from cleaner diesels will not be fully realized for an estimated 30 years.

Recommendations

In order to reduce or eliminate diesel hot spots and meet federal air quality standards in central Ohio, it is imperative that existing diesels reduce their pollution. Initiative is needed both at the local and state level to make existing diesel cleanup a reality.

The OEC recommends the following local and state efforts to reduce Ohio's pollution burden from dirty diesels:

Local Efforts

- School and local transportation fleets should retrofit with pollution control technologies and use ultralow sulfur diesel fuel by utilizing federal retrofit assistance and grant programs.
- All fleets owned or contracted by local governments (garbage trucks, city services, government construction, etc.) should be required to use ultralow sulfur diesel fuel, to retrofit by installing pollution control technology, and to purchase new, cleaner diesel engines or cleaner alternative fuel engines when replacing fleets.
- Local governments should encourage the adjustment of contracts to require the use of ultralow sulfur diesel fuel and install pollution control devices now, without waiting for federal mandates to require such actions.
- Anti-idling ordinances should be passed to limit emissions from vehicles waiting to load and unload people or cargo.

State Efforts

- Ohio should establish a more comprehensive air quality monitoring program to address issues of passenger exposure to emissions and indoor air quality affected by diesel exhaust.
- State-level vehicle inspection and monitoring programs should be implemented to promote routine maintenance of vehicles.
- Ohio should develop a retrofit assistance program to provide financial assistance to school boards and local governments for cleaning up their fleets and purchasing alternative-fuel vehicles.
- Ohio should require existing vehicles to retrofit with pollution controls and use ultralow sulfur diesel fuel prior to 2007. This requirement should be part of Ohio's plan to meet federally established air quality standards.

ANALYSIS

Hot Spots

Hot spots are areas that chronically experience levels of diesel exhaust emissions that likely result in increased risks for health impacts including cancer, asthma hospitalizations, and premature death. This is a pilot analysis designed to identify central Ohio-area diesel hot spots based on distance from the roadway and estimated diesel emissions based on truck and bus traffic levels. There are other significant sources of diesel emissions that almost certainly qualify as hot spots, but are not included in the analysis due to lack of data. These include non-road sources such as locomotives and airport service equipment. Temporary sources of large diesel emissions, such as large highway construction projects, are not considered in this analysis. Finally, the analysis does not include “micro hot spots,” areas that may experience elevated diesel emissions in a small but intense area–such as school and transit buses, shipping docks, and large bus terminals.

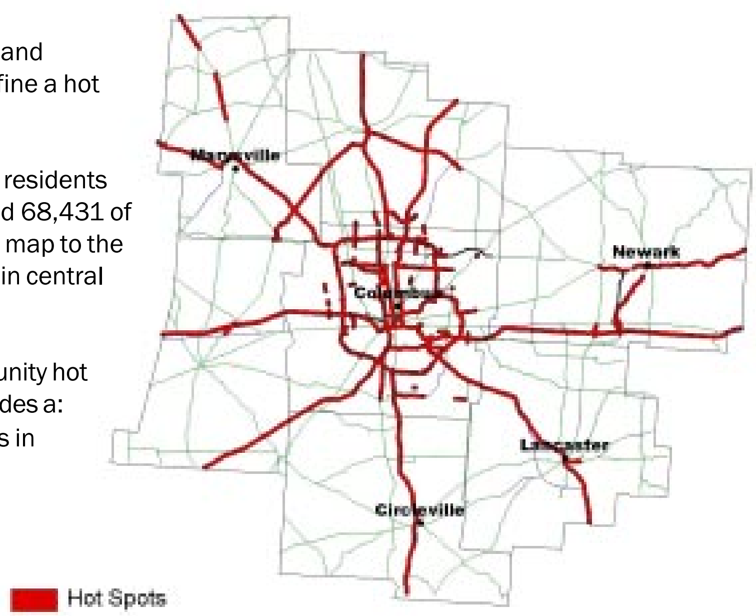
Source: Bruce Hill, Clean Air Task Force

For the purposes of this report, we define hot spots as areas that are within one-quarter mile of a roadway with PM emission levels of at least 675 g/mi/day (equivalent to the PM emissions from an average major urban arterial roadway). According to recent studies, populations living in these areas are considered to have significantly elevated exposure to air toxics and to be at greater risk for childhood cancer and leukemia, asthma development, and asthma hospitalizations. The following health studies were used to define a hot spot:

- A study in Denver identified that children living within 250 yards of urban roadways with heavy truck traffic were six times more likely to develop cancer and eight times more likely to develop leukemia.[2]
- A study in Erie County, New York identified that children living within 200 meters of roadways with heavy truck traffic had a significant increase in risk of asthma hospitalization.[3]
- A British study determined that living near major roads was associated with the risk of hospital admission for asthma in children.[4]
- A study in London identified that children living within 90 meters of a major roadway had a significant increase in risk for the development of asthma.[5]

For a more detailed list of health studies and explanation of how they were used to define a hot spot, please see Appendix A.

An estimated 294,896 central Ohio-area residents live within a diesel hot spot. An estimated 68,431 of these residents suffer from asthma. The map to the right identifies the hot spot communities in central Ohio.



For more complete information on community hot spot rankings see Appendix B, which includes a:

- listing of Columbus area communities in alphabetical order (Table 3).
- ranking by number of people living in hotspots (Table 4).
- ranking by number of people with

asthma living in hotspots (Table 5).
- ranking by percent of population living in hotspots (Table 6).

Diesel exhaust is a far-reaching problem. It is not simply a pollutant affecting outdoor environments. An astounding two-thirds of diesel particulate matter penetrates indoor environments.[6] This pollution problem is aggravated by the collection of diesel exhaust in urban canyons and streets, where it can penetrate adjacent buildings. A prime example is the idling of school buses outside of schools. Exhaust is able to accumulate and penetrate the school via the ventilation system, impacting children in their classrooms. Indoor air quality is largely unregulated with the exception of occupational chemicals, pesticides, and some tobacco smoke regulations.

Source: Bruce Hill, Clean Air Task Force

Measurements show that exhaust from idling trucks and buses not only affects those outside the vehicle, but also affects those inside when exhaust seeps into the vehicle through windows and doors, unsealed engine compartments, backdoors on school buses, leaking exhaust systems, and unfiltered air and heating vents.[7] Emission concentrations can be hazardous for an individual riding a bus or driving a truck. A study examining children's exposure to diesel exhaust on school buses in Connecticut determined children were exposed to ambient PM (PM_{10} and $PM_{2.5}$) concentrations as much as 5-15 times higher than background levels of fine PM.[8] Contrary to what some may believe, closing windows actually results in a higher level of diesel exhaust trapped inside the bus while opening windows facilitates rapid ventilation.

"Children's exposure to diesel exhaust on school buses is as much as 5-15 times higher than background levels."

Source: Environment and Human Health, Inc. (EHHI), Children's Exposure to Diesel Exhaust on School Buses

Furthermore, studies have shown that the most harmful diesel emissions are those released at ground level. A California study measuring concentrations of black carbon inside vehicles during transit found the following: 5 micrograms per cubic meter (ug/cu m) for vehicles following no other vehicles, 15 ug/cu m for vehicles following a diesel truck with high exhaust stack, 50 ug/cu m for vehicles following a diesel truck with a ground-level tailpipe, and 130 ug/cu m for vehicles traveling behind an urban transit bus making numerous stops.[9] A review by the International Center for Technology Assessment of 20 reports on internal vehicular air contamination determined that pollution levels inside vehicles were regularly significantly higher than levels along roadsides. The message is that commuters are exposed to some of the highest levels of diesel emissions simply by traveling the same roads as diesel vehicles.

Source: Union of Concerned Scientists, Clean Vehicles Campaign

Diesel Pollution: Components and Consequences

Introduction

Diesel engines are efficient and long-lived pieces of machinery. Their low maintenance and efficient generation of power and electricity has led to their desirable use in heavy duty buses, trucks, trains, marine vessels, and non-road equipment such as construction, agricultural, and airport equipment. Diesel engines utilize two-thirds the fuel and emit less carbon dioxide (CO_2) compared to similar ignition-based gasoline engines. Yet, these workhorses of industry have a downside. Exposure to diesel emissions has been linked to serious health effects including a compromised immune system, aggravated asthma and allergy symptoms, heart and lung disease, and cancer. Diesel emissions are the number one air toxics cancer risk in the United States.[10,11] The federal government regulates the standards for newly manufactured diesel engines, but it is the responsibility of the individual states to clean up existing diesel systems.

The diesel engines creating the most concern are heavy duty diesel engines (HDDE) with gross vehicle weight ratings over 8,500 pounds. These are the primary source of diesel emissions, contributing 95% of on-road diesel emissions and 85 to 90% of all diesel particulate matter.[12] On-road diesels include transport trucks as well as municipal and commercial buses. Non-road diesels include construction equipment (bulldozers and excavators), agricultural equipment (tractors), recreational vehicles, airport service equipment, locomotives, and marine vessels (river boats, barges and oceangoing vessels).

Diesel Exhaust–What's In It?

The health impacts of diesel emissions are of grave concern. Emissions from diesels have been cited as the leading air toxics cancer risk in the United States. Emissions contain hundreds of harmful constituents in both gaseous and solid form such as particulate matter (PM), nitrogen oxides (NOx), volatile organic compounds (VOCs), hydrocarbons (HC), and sulfur oxides (SOx). Air pollution from diesel exhaust contributes to health problems such as increased asthma attacks, aggravation of chronic bronchitis, painful breathing, decreased lung function, heart and lung disease, cancer, and premature death. Diesel exhaust includes 40 hazardous air pollutants defined under the Clean Air Act, with 15 being known or probable carcinogens such as benzene, formaldehyde, acetaldehyde, dioxins, and polycyclic aromatic hydrocarbons (PAHs). PAHs[13] are some of the most potent known carcinogens.[14] All of these elements make diesel exhaust a serious health concern for our communities.

A component of diesel emissions generating substantial alarm is particulate matter. Diesel exhaust contributes the largest source of particulate matter from motor vehicles. Coarse PM ($PM_{10-2.5}$) are particulates less than 10 micrometers but larger than 2.5 micrometers in size. Coarse PM sources include windblown dust, materials handling, and crushing operations. This type of matter can settle in the windpipe but is considered less harmful to people than fine PM. Fine PM, or $PM_{2.5}$, is particulate matter smaller than 2.5 micrometers (millionths of a meter). These particles are so small that several thousand could fit on the tip of a pin. Fine PM sources include fuel combustion, motor vehicles, industrial facilities, and forest fires. It can penetrate deeply into the lungs, collecting in tiny air sacs where oxygen enters the bloodstream.

Common Items and Their Respective Particle Sizes	
Tobacco Smoke	0.01 to 1 micron
Oil Smoke	0.03 to 1 micron
Typical Atmospheric Dust	0.001 to 30 microns
Mold Spores	10 to 30 microns
Human Hair	40 to 300 microns
Pollens	10 to 1000 microns
Beach Sand	100 to 2000 microns
Eye of a Needle	1,230 microns
Postage Stamp, 1 inch high	25,400 microns

Particulate matter does not act alone in adversely affecting the environment and health. Nitrogen oxides are another problem. A colorless and odorless gas, NOx contributes to smog (ground-level ozone) formation by reacting with hydrocarbons and sunlight. In 1999, the Midwest produced the second highest NOx emissions in the country–4.98 million tons–with highway vehicles, electrical utilities and off-highway vehicles being the top three contributors.[15] Nitrogen oxides combine with other atmospheric constituents to form fine particulate matter. One-quarter of all ozone and PM-forming nitrogen oxide emissions in the United States come from diesel emissions.[16]

Health Impacts

It is estimated that 70% of the total air toxics cancer risk is attributable to diesel exhaust.[17,18] The health impacts of diesel emissions have been heavily studied in recent decades. In May 2002, the U.S. EPA's *Health Assessment Document for Diesel Exhaust* stated that the hazards of diesel included "acute exposure-related symptoms, chronic-exposure related noncancer respiratory effects, and chronic carcinogenic effects" saying diesel is "likely" a human carcinogen.[19] Dozens of epidemiological studies have linked diesel exhaust to lung cancer as well as bladder cancer. An American Cancer Society study in 2002 equated the risk of breathing in particulate matter in our most polluted cities as comparable to the risk of secondhand smoke.[20] Pollutants inflame the lungs, damaging tissue and causing the formation of scar tissue which makes the lungs rigid and less efficient. Additionally, inflammation causes stress on the heart by reducing the amount of oxygen carried by the blood. Exposure to air pollution can thicken the blood, increasing the tendency for clotting, which damages arteries, and leading to a buildup of fatty deposits along vessel walls. Railroad workers with long-term exposure to emissions were shown to have serious and permanent impairment of the central nervous system.[21] Animal studies suggest it is likely that diesel emissions impact the immune system.[22,23] Diesel exhaust adversely affects fetuses and newborn children, resulting in birth defects, growth retardation and sudden infant death syndrome.[24,25,26,27,28] The U.S. EPA's *Health Assessment Document for Diesel Exhaust* also stated "other supporting evidence includes the demonstrated mutagenic and chromosomal effect of diesel exhaust and its organic constituents, and the suggestive evidence for bioavailability of the diesel particulate matter organics in humans and animals," further suggesting emissions are carcinogenic.[29]

"Air pollution kills about 70,000 Americans each year. That's more people than die from breast and prostate cancers combined. Air pollution is a huge public health problem."

Source: Joel Schwartz, Associate Professor of Public Health at the Harvard School of Public Health

Almost half of the nation's population is breathing unhealthy air. With over 70,000 premature deaths per year attributed to air pollution, air quality should certainly be a national concern. Sensitive populations include the elderly, those with pre-existing heart and/or lung disease, children, asthmatics, and occupationally exposed workers. Tens of thousands of elderly die prematurely every year from exposure to ambient levels of fine particulate matter.[30] People with heart and lung disease suffer aggravation of symptoms from exposure to air pollutants.

Source: American Lung Association

Children are extremely susceptible to potential health threats from exposure to diesel emissions because their respiratory systems are still developing. Nearly half of all asthma cases occur in children. They breathe 50% more air per pound of body weight than an adult.[31] Exposure to fine PM has been associated with increased frequency of childhood illness resulting in acute and chronic complications. Coughing, difficulty breathing, and other respiratory ailments may require limiting of activity and absences from school. Asthmatics are another group vulnerable to pollutants in our air. Deaths resulting from asthma have increased three times since two decades ago, with 14 Americans dying every day.[32] Breathing in particulate matter, along with other pollutants, leads to an

increase in the need for medical treatment. An average of $500 a year is spent on asthma-related health care per child afflicted.[33]

Numerous studies show Ohio needs to work on cleaning up air pollution. The American Lung Association's *State of the Air: 2003*, an annual report assessing "the toll that ozone air pollution places on our nation's ability to breathe," recently gave a failing grade to all ozone-monitoring counties in Ohio. A report commissioned by State and Territorial Air Pollution Program Administrators/Association of Local Air Pollution Control Officers (STAPPA/ALAPCO) estimated that if the U.S. EPA begins to regulate non-road mobile sources, Ohio would avoid 341 premature deaths and 7,229 asthma attacks per year. The state would see a monetary benefit of $2.7 billion annually, through the prevention of lost work days, hospitalizations, and other hrealth care costs, simply by regulating diesel emissions through improved technology and ultralow sulfur diesel fuels. A 1999 study by Abt Associates, a consulting firm for the U.S. EPA, estimated that 2,800 Ohioans were admitted to the hospital and 8,200 visited the emergency room due to smog levels in 1997, a relatively low smog season. A Natural Resources Defense Council study from 1996 estimated that nearly 4,000 Ohioans have their lives cut short each year due to the level of particulate air pollution in the state. These numbers are cause for concern and much needed change in Ohio's air quality policy.

> "Ohio would avoid 341 premature deaths and 7,229 asthma attacks a year, with a monetary benefit of $2.7 billion annually, if EPA regulated non-road mobile sources."
>
> *Source: STAPPA/ALAPCO report*

Columbus Air Quality–Failing the Standard

Every major metropolitan area in Ohio–including Columbus–will fail to meet the new standards for ozone and fine particulate matter. The Clean Air Act established in 1970 created the provisions for air quality standards and monitoring. The act requires the federal government to establish National Ambient Air Quality Standards (NAAQS) and requires states to develop state implementation plans (SIPs) to meet these standards. Failure to meet the NAAQS requirements results in an area being designated a non-attainment area. Areas designated non-attainment may lose federal highway dollars and be subject to a federally mandated implementation plan rather than a state established plan.

In 1997, U.S. EPA updated the exposure limits of ozone and particulate matter based on decades of research concluding that the standards were too lax. U.S. EPA data from 1999-2000 records show that 157 counties in the East are in non-attainment for $PM_{2.5}$. That equates to over 59 million people in the Eastern United States living with air quality levels that exceed U.S. EPA standards. Likewise, 1997-1999 data for meeting the 8-hour ozone standard showed that 305 counties, home to 94 million people in the East, were in non-attainment for ozone standards. Diesel vehicles contribute 72% of $PM_{2.5}$ and 42% of NOx emissions from all on-road mobile sources and 67% of $PM_{2.5}$ and 49% of NOx emissions for all non-road sources (see Appendix C). Consequently, it is vital that both on-road and non-road mobile sources be targeted to facilitate cleanup of air quality and to enable attainment to be reached.

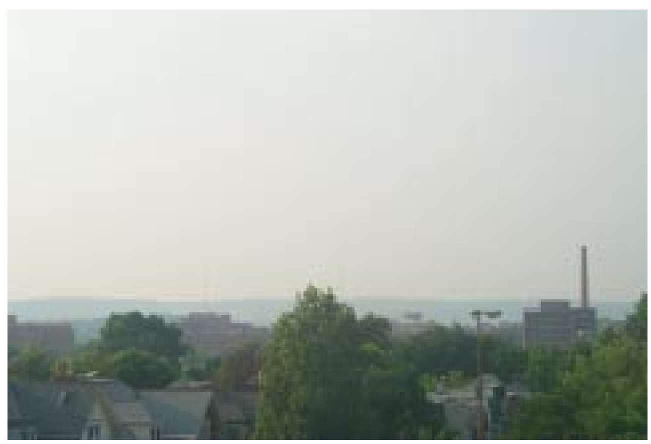
State implementation plans must be finalized by 2008 and designed to meet standards by 2010 (2015 at the latest). U.S. EPA studies have shown that some areas will need to significantly reduce the pollution from motor vehicles *in addition* to meeting all other aspects of Clean Air Act requirements in order to reach attainment levels. Ohio can begin today to reach towards attainment by regulating diesel emissions. This will require the implementation of programs to clean up existing diesels rather than waiting three decades for the effects of the on-road and potential off-road rules to be realized. (See Appendix D for a more comprehensive look at the Clean Air Act.)

Other Impacts

Ecosystem and agricultural

Air pollution is not simply a threat to the humans breathing the air, but also to the environment and the life it supports. Diesel smoke is composed of organic compounds and heavy metals that persist in the environment and food chain. The chemistry of soils and waters are being changed by pollution to the extent they cannot adequately sustain aquatic and terrestrial life. Nitrogen deposition from diesel NOx emissions contributes to eutrophication of waterways, resulting in harmful algae blooms and increased fish mortality. Soot soils buildings and affects cloud cover, contributing to atmospheric warming. Diesel emissions contribute to other environmental damage such as acid rain, crop and forest damage, and erosion on buildings and car paint. Emissions have also been linked to haze in our cities and global warming.

Cincinnati skies under ideal conditions (above) and on a hazy day (below). Source: Midwest Hazecam



Haze

Our cityscapes are being defiled by these pollutants. Together, particulate matter and NOx contribute to haze. Although individual particles cannot be seen, collectively they are viewed as soot, dust clouds and gray hazes. Useful tools for appreciating the effects of haze are Hazecam sites on the internet. The Midwest Hazecam site (www.mwhazecam.net/cincinnati.html) allows you to view current haze conditions in Cincinnati as well as other Midwestern cities and scenic areas. These sites show current cityscapes' haze conditions with a reference picture for a clear day. There is usually a rating for PM and ozone levels included with the picture. Visibility impairment from diesel engine pollutants has resulted in parts of the United States having lost 70% of the natural condition visibility range. Fine particles can travel great distances, with one-third of the haze in the Grand Canyon attributed to pollution from Southern California.[34] In 1977, Clean Air Act Amendments began to address the issue of haze in our national parks and wilderness areas. This shows that, more than 25 years ago, it was realized that air pollution is not restricted to our cities and areas of emissions discharge.

Climate Change

Particulate matter and nitrogen oxide emissions from diesels are major global warming agents. Reduction in these emissions will not just benefit public health and the environment, but will also create real reductions in significant greenhouse pollutants–in spite of the fact there is no national policy on climate change. Diesels are Ohio's largest source of black carbon emissions and second largest source of ozone-forming nitrogen oxides. By some estimates, black carbon has about 75% of the warming impact of CO_2 and ground-level ozone has about 50% of the warming impact of CO_2.[35] Black carbon and ozone have short residence times in the atmosphere (a few days to weeks, respectively) which means reductions would immediately provide a climate benefit as compared to carbon dioxide which has a very long residence time in the atmosphere (a few years to 100 years). Reducing these emissions can help bypass political opposition to action on climate change by practically demonstrating that reductions are achievable.

Technology

Modern emission control technologies and fuels could allow diesel engines to rival emissions from gasoline and natural gas engines, emitting one-quarter less CO_2 while achieving better fuel economy.[36] In addition, replacement of older diesel vehicles with less polluting and cost-effective alternative fuel vehicles (which utilize liquified natural gas, compressed natural gas, propane, biodiesel, or hybrid electric technology) will help reduce emissions and achieve better air quality. Current technology provides the ability to reduce emissions with PM and NOx control devices as well as the implementation of lower sulfur fuels.

Particulate matter reduction technology has been around for decades and is quite effective. One retrofit technology for PM is the catalyzed diesel particulate filter (DPF), also known as a trap. The catalysts are poisoned by large concentrations of sulfur, so for the practical use of a trap, the sulfur content in diesel fuel must be reduced to 15 parts per million (ppm), resulting in ultralow sulfur diesel fuel (ULSD). A combination of catalyzed DPF and ULSD can lead to a 90% reduction of PM emissions and a significant air toxics reduction benefit.[37] A 2002 Washington, D.C. Metro bus DPF retrofit study showed PM reduction of over 90%, CO reduction of 95%, and complete elimination of HC. Another emission control product for particulate matter reduction is a diesel oxidation catalyst (DOC). Less costly than DPFs, DOCs are easy to install; unfortunately, they are also less effective, reducing PM by only 20% to 50%. The Big Dig project in Boston has used DOCs for their voluntary retrofit program. They oxidize diesel pollutants by converting them to less harmful emissions such as water and carbon dioxide.

There are several solutions for reducing NOx concentrations in diesel exhaust that are commercially available today or likely to be so in the next two to three years. First, there is the NOx adsorber catalyst which removes NOx by chemically binding the pollutant to the surface of the catalyst. This control requires the use of ULSD. Testing on new cars and trucks has shown a 70% to 90% reduction in NOx emissions. A second control is diesel-water emulsion, a diesel and water fuel blend additive that reduces NOx by cooling combustion temperatures. It is commercially available and has been shown to reduce NOx by 16% to 41% and PM by 24% to 69%. Another NOx control is selective catalytic reduction (SCR) which reduces NOx by 75% to 90%, HC by 80%, and PM by 20%. It injects a chemical agent to convert oxides of nitrogen to gaseous nitrogen and water vapor. An additional option is exhaust gas recirculation (EGR) which returns exhaust gas to the engine, reducing NOx by 29% to 56%.[38] Installation of NOx retrofit controls on HDDE will help facilitate ozone attainment.

The reduction of sulfur content in diesel fuel will significantly lower harmful emissions from diesel exhaust. Some of the pollution control devices previously mentioned utilize catalysts that are poisioned by large concentrations of sulfur making the reduction of sulfur in diesel fuel from 500 ppm to 15 ppm vital to pollution reduction. Ultralow sulfur diesel fuel is currently available for distribution by BP in Ohio.

Clearly, the technology is available to substantially decrease diesel exhaust emissions for both on-road and

Source: City of San Francisco (left) and Manufacturers of Emissions Controls Association (right) non-road mobile sources. This technology should be applied to existing engines as well as newly manufactured diesel engines. A combination of PM and NOx pollution control technologies with ultralow sulfur diesel fuel will have the most significant impact on cleaning up diesel emissions.

New Federal Rules–a positive, but incomplete step

In 2002, the U.S. EPA updated its emission regulations for on-road diesel engines. Known as the HDE 2007 Rule, it will cut PM emissions from new on-road diesels by 90% beginning in the year 2007. The rule requires that new engines must incorporate up-to-date pollution control technologies. The sulfur content of highway diesel fuel will be reduced from 500 ppm to 15 ppm, the standard for ultralow sulfur diesel fuel, by 2006–a step that is necessary in order for pollution control devices to function properly. While these new regulations mean the diesel engines coming off production lines in 2007 will be the cleanest we have seen, they do not account for the existing diesel engines which will continue to pollute our skies for the next 20 to 30 years. The U.S. EPA estimates that the emission reduction benefits from the on-road rule will not be fully realized until 2036, when theoretically all the vehicles on the road will have the newer technology.

Non-road diesels have escaped the depth of the regulations that on-road diesels have been subjected to over the years. Consequently, the technology used in these engines is generally older and likely emits higher levels of pollution, making it all the more imperative to bring these archaic generators of emissions up to current on-road standards. In April 2003, U.S. EPA proposed rules for non-road diesels similar to the rules for on-road diesels. Implementation of the non-road diesel rule would reduce PM and NOx emissions by more than 95% and 90%, respectively, starting in 2010. Emission reductions would extend to hydrocarbons, carbon monoxide, sulfur oxides, and air toxics (air pollutants of concern for which a NAAQS does not exist). By 2030, U.S. EPA estimates the program will reduce annual NOx emissions by 827,000 tons and PM by 127,000 tons. Such a reduction will prevent an estimated 9,600 premature deaths, over 8,300 hospitalizations, and nearly a million lost workdays each year. U.S. EPA estimates the quantifiable benefits will be approximately $81 billion annually by 2030. This savings far outweighs the $1.5 billion annual cost of the necessary engine and fuel requirements.[39]

The shortfall of current and proposed regulations is that they can only apply to the production of new engines. The long life of diesel engines means the majority of those in existence today will be operating for another two to three decades, polluting our environment. The federal government is unlikely to extend regulations into this realm, so it is up to state governments to implement regulations for retrofit programs on existing engines. Retrofitting, in conjunction with reduced sulfur content in fuel, will further decrease the amount of detrimental emissions affecting the public and environment. As U.S. EPA suggested, many states will absolutely need to clean up emissions from diesel exhaust as well as fulfill the other requirements of the Clean Air Act in order to reach attainment for NAAQS. The fastest way for states to reach attainment is to clean up the emission problems within their authority, and it is within a state's power to implement regulations for meeting NAAQS.

Where Do We Go From Here?

According to the U.S. EPA's recently released *Toxic Release Inventory for 2001*, Ohio ranked number one in the nation for air discharges, releasing over 121 million pounds of toxic pollutants into the atmosphere.[40] Virtually every ozone monitor and all but two fine particulate monitors in Ohio show that most of the state will be in non-attainment for new NAAQS. As a highly industrial state with coal burning power plants, steel production, and gas and oil refineries, it is not surprising our emission levels are abundant. Diesels are the second largest source of fine particle (soot) and ozone (smog) forming emissions in Ohio, after power plants. This makes it all the more important to utilize current technology to reduce emissions and improve Ohio's air quality. Certainly the dubious honor of top state for air discharges is not one we wish to gloat about. Rather, a state-wide initiative to reduce emissions and clean the air through self-imposed regulations and deadlines would provide a more distinguishable honor.

The majority of Ohio's population is spread throughout six urban areas. Consequently, reducing emissions from sources in these areas will most effectively reduce mortality and facilitate attaining

NAAQS for fine particles. Action can be taken at the community, local, and state government levels.

Community and Local Government Solutions

Anti-idling ordinance sign at the Big Dig in Boston, Mass.
Source: www.bigdig.com

Locally, school and transit fleets should take up the challenge of implementing clean technology by utilizing ULSD fuel, installing retrofits and purchasing alternative fuel vehicles when replacing older buses in fleets. Accordingly, the cleanest buses should be used on the longest routes to limit widespread contamination from emissions and population exposure. Anti-idling regulations should be established and enforced to prevent excessive exhaust affecting people both in and outdoors. School buses should be required to shut down their engines while waiting at schools to load or unload student travelers. Such action would greatly benefit communities socially and economically by decreasing the health-related effects of air pollution and subsequent health care costs.

All fleets owned or contracted by local government (garbage trucks, city services, local government construction, etc.) should be required to use ULSD, install retrofit technology, and purchase new, cleaner diesel or alternative-fuel engines when replacing fleets. Local government should encourage the adjustment of contracts to require the use of ULSD and retrofits now, without waiting for federal mandates to require such actions. Construction contracts should be contingent upon the diesel engines involved utilizing emission reducing technologies and ULSD.

Local initiative is not uncommon and has been successful in many metropolitan areas. Ann Arbor, Michigan has used grants to facilitate the purchase of alternative fuel vehicles and is currently using a biodiesel fuel blend (a blend of plant or animal derived diesel with conventional diesel) for its 124 vehicles while considering a transition to ULSD.[41] The Ann Arbor Transportation Authority operates its bus fleet on ULSD. The University of Michigan runs its diesel powered equipment on ultralow sulfur biodiesel fuel and has retrofitted some of its buses, reducing emissions by over 85%. The University of Michigan also purchased ethanol-powered vehicles and electric trucks as part of its transportation department's movement to alternative-fuel vehicles. Automotive Fleet magazine's August 2001 issue rated the University of Michigan first among universities in its use of alternative fuels.[42]

Other transit authorities have also taken the initiative, even here in Ohio. The Greater Cleveland Regional Transit Authority (RTA) began utilizing alternative fuels in 1990. They currently have 166 buses running on compressed natural gas (CNG) with two garages fitted for CNG fueling.[43] A total of 225 new buses which run on ULSD fuel should arrive by mid-2003 which will allow RTA to retire older, polluting buses. The RTA could further reduce emissions by implementing the use of after-treatment technologies in their fleet. The Cleveland Municipal School District received a U.S. EPA grant to install particulate filters on its fleet. Delays in funding assistance for the purchase of ULSD postponed installation of the traps, but as of late July 2003, seven of the 23 buses had been retrofitted. Public officials should help facilitate these retrofit projects through assistance programs and incentives allowing our children to ride to school on cleaner, healthier buses.

Statewide Solutions

At the state level, programs focusing on maintainance, inspection and monitoring, and grant assistance should be developed. Ohio EPA has proposed an inspection and maintenance program for urban buses and should proceed with finalizing these rules and extending them to all diesels. Routine maintenance of vehicles will help ensure they are running properly and reduce unnecessary excess emissions from improperly tuned engines. A standard, mandatory testing of tailpipe emissions should also be required to further persuade companies to implement clean air technologies. Ohio should develop a retrofit assistance program which would provide financial assistance to school boards and local governments for cleaning up their fleets.

Legislatively, the state can have profound impacts on diesel cleanup and remove the tarnish of being a pollution forerunner by taking the initiative in reducing diesel emissions. First, as mentioned above, Ohio EPA should finalize rules for an inspection and monitoring program for all diesels. Second, the state should require an earlier transition to ULSD by fleets than that currently set by the U.S. EPA, which would result in an immediate reduction in emissions and aid the state in meeting attainment requirements. Third, state regulations should be adopted to include existing diesels in the retrofit process and establish a retrofit assistance program to foster this project. Fourth, the state should establish a more comprehensive air monitoring program to address the issues of passenger exposure to emissions and indoor air quality. Finally, state law should restrict idling of diesel engines for the safety of passengers, drivers and populations located near idling areas. A combination of these approaches will dramatically reduce the amount of NOx and PM entering our air.

CONCLUSION

Thirty years ago, the Clean Air Act provided the guidelines for evolving the United States into a country with healthier air, yet not all the regulations have been applied to make these goals a reality. Both newly manufactured and existing diesels should be required to utilize emission control technologies and ULSD to minimize pollution. Continued efforts to purchase alternative fuel vehicles should be encouraged and assisted by government grants. As the U.S. EPA has stated, the cost of implementing clean technology and regulations is largely outweighed by the cost of health complications from diesel emissions. Likewise, many states, including Ohio, will need to address diesel emissions as a direct approach to reaching attainment for NAAQS.

By 2030, U.S. EPA estimates implementation of the non-road diesel rule alone could prevent 11,000 premature deaths and 18,000 nonfatal heart attacks per year. The combined benefits of both the non-road and the on-road diesel rules are estimated at 19,300 avoided deaths per year in 2030. Imagine the benefits if all the dirty diesels on the road were cleaned up today. Children could actually ride buses to school without the threat of developing asthma from the poisonous exhaust. Our environment would reap the benefits as well with healthier crops, forests, waterways, and wildlife. Cityscapes would regain some of their natural visibility and reductions in harmful global warming agents would be beneficial across the board.

It is time for Ohio to rise to the challenge of reducing emissions from diesels by retrofitting existing fleets, using ULSD, and encouraging purchase of alternative-fuel vehicles, as well as establishing an inspection and monitoring program, anti-idling ordinances, and a retrofit assistance program. These are important steps which will help protect the health of our communities. People living along heavy diesel traffic routes, children riding their only mode of transportation to and from school, people sitting in their places of work and residence, individuals outside enjoying “fresh” air, and workers doing their job transporting people and goods deserve to be safe and happy without this often unseen health hazard taking years off their lives.

The health risks are real. The technology and know-how to clean up exists. The economic benefits are significant. The need for action is as stark as the exhaust belching from a diesel tailpipe. It is time for Ohioans to demand that we restore our air quality through comprehensive diesel cleanup programs. Maybe then, we can all breathe easier.

The analysis for determining the hot spot areas and affected population was based on traffic data, particulate matter emission estimates, and census data. The definition of a hot spot was based on recent studies identifying the risk associated with distance from and traffic intensity of roadways.

Defining a Hot Spot

A hot spot is meant to describe an area in which the risk of health impacts from exposure to HDDE emissions is likely to be significantly increased. We defined a hot spot as an area within one-quarter mile of a roadway with PM emission levels of at least 675 g/mi/day. The maximum one-quarter mile distance was chosen based on several recent studies indicating that within this distance there is an increased risk for cancer and leukemia in children (250 yards), development of asthma in children (90 meters), hospitalizations due to asthma for children (500 and 200 meters), and premature death (50 to 100 meters). The minimum 675 g/mi/day PM level was chosen based on our estimates of the PM level from a major urban arterial roadway with an annual average daily traffic level (AADT) of 20,000 or a congested urban area highway with an AADT of 32,000. There are three recent studies that identify traffic counts as a risk threshold for health impacts. With the two American studies, the Denver 2000 study identified a 20,000 AADT risk threshold for nearby busy roadways, and the Erie County, NY study identified a 4,000 vehicle miles traveled (VMT) threshold, equivalent to 32,000 AADT for state highways. Neither study identified the relative number of roadways that were urban arterials and highways. We assumed the Denver study was more likely to be urban arterial and the Erie County study was more likely to be highway. In both cases, the PM emission levels are similar.

Studies that were used in developing this definition include:

Truck Traffic Linked to Childhood Asthma Hospitalizations

A study in Erie County, New York (excluding the city of Buffalo) found that children living in neighborhoods with heavy truck traffic within 200 meters of their homes had increased risks of asthma hospitalization. The study examined hospital admissions for asthma among children ages 0 to 14 and residential proximity to roads with heavy traffic.

Lin, Munsie, Hwang, Fitzgerald, and Cayo. (2002). Childhood Asthma Hospitalization and Residential Exposure to State Route Traffic. Environmental Research*, Section A, Vol. 88, pp. 73-81.*

Children Living Near Busy Roads More Likely to Develop Cancer

A 2000 Denver study showed that children living within 250 yards of streets or highways with 20,000 vehicles per day are six times more likely to develop all types of cancer and eight times more likely to get leukemia. The study looked at associations between traffic density, power lines, and all childhood cancers from measurements obtained in 1979 and 1990. It found a weak association from power lines, but a strong association with highways. It suggested, without epidemiological evidence, that benzene pollution might be the cancer promoter causing the problem. However, the paper was published prior to a study by a the California Air Recources Board (CARB) identifying diesel emissions as a significant human carcinogen. An additional CARB study found HDDE emissions to be responsible for 70% of all ambient air toxics (from traffic and other sources) in the Los Angeles Basin.

Pearson et al. (2000). Distance-weighted traffic density in proximity to a home is a risk factor for leukemia and other childhood cancers. Journal of Air and Waste Management Association, *50:175-180.*

Air Pollution from Nearby Roads Linked to Shorter Life Spans for Residents

Dutch researchers looked at the effects of long-term exposure to traffic-related air pollutants on 5,000 adults. They found that people who lived near a main road were almost twice as likely to die from heart or lung disease and 1.4 times as likely to die from any cause compared with those who lived in less-trafficked areas. Researchers say these results are similar to those seen in previous United States studies on the effects of long-term exposure to traffic-related air pollution. The authors say traffic emissions contain many pollutants that might be responsible for the health risks, such as ultrafine particles, diesel soot, and nitrogen oxides, which have been linked to cardiovascular and respiratory problems.

Hoek, Brunekreef, Goldbohn, Fischer, van den Brandt. (2002). Association between mortality and indicators of traffic-related air pollution in the Netherlands: a cohort study. Lancet*, 360 (9341): 1203-9.*

Cancer Risk from Outdoor Air 1 in 750 near Urban Highway due to Truck Traffic

A 2002 study modeled the ambient level of air toxics near the convergence of three major highways near Los Angeles, California. The cancer risk was estimated based on the analysis of how diesel particulate emissions dispersed in the area. The peak risk, closest to the highway, was identified to be a 1,500 cancer risk per 1 million (1 in 750), with the risk lowered to 200 in 1 million (1 in 5000) 1 kilometer away from the peak. The air dispersion model also indicated that, while prevailing winds did contribute to higher risk zones in downwind areas, the risk from emission exposure included all directions emanating from the highway convergence.

Balentine, et. al (2003) Risk Assessment for Diesel Particulate Matter from Motor Vehicles Using the ISCST3 Model, Air and Waste Management Association Annual Meeting*, June 2003.*

Asthma More Common for Children Living Near Freeways

A study of nearly 10,000 children in England found that wheezing illnesses, including asthma, were more likely with increasing proximity of a child's home to main roads. The risk was greatest for children living within 90 meters of the road.

Venn et al. (2001). Living Near A Main Road and the Risk of Wheezing Illness in Children. American Journal of Respiratory and Critical Care Medicine*. Vol. 164, pp 2177-2180.*

Cancer Risk Higher Near Major Sources of Air Pollution, Including Highways

A 1997 English study found a cancer corridor within three miles of highways, airports, power plants, and other major polluters. The study examined children who died of leukemia or other cancers from 1953 to 1980, where they were born, and where they died. It found that the greatest danger lies a few hundred yards from the highway or pollution facility and decreases as you get away from the facility.

Knox and Gilman. (1997). Hazard proximities of childhood cancers in Great Britain from 1953-1980. Journal of Epidemiology and Community Health. *51: 151-159.*

Proximity of a Child's Residence to Major Roads Linked to Hospital Admissions for Asthma

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

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

People Who Live Near Freeways Exposed to 25 Times More Particle Pollution

Studies conducted in the vicinity of Interstates 405 and 710 in southern California found that the number of ultrafine particles in the air was approximately 25 times more concentrated near the freeways and that pollution levels gradually decrease back to normal (background) levels around 300 meters, or 984 feet, downwind from the freeway. The researchers note that motor vehicles are the most significant source of ultrafine particles, which have been linked to increases in mortality and morbidity. Recent research concludes that ultrafine particles are more toxic than larger particles with the same chemical composition. Moreover, the researchers found considerably higher concentrations of carbon monoxide pollution near the freeways.

Zhu, Hinds, Kim, Sioutas. Concentration and size distribution of ultrafine particles near a major highway. Journal of the Air and Waste Management Association. *September 2002.*
Zhu, Hinds, Kim, Shen, Sioutas. Study of ultrafine particles near a major highway with heavy-duty diesel traffic. Atmospheric Environment. *36(2002), 4323-4335.*

Estimating PM Emissions

Emissions from on-road HDDE were determined by combining traffic data with emission factors derived by the

U.S. EPA's mobile vehicle emissions model, Mobile6.[44]

Traffic data

Annual Average Daily Traffic data on state roads was obtained from the Ohio Department of Transportation (ODOT) and AADT local road data was obtained from the Mid-Ohio Regional Planning Commission (MORPC). The state road data was pre-selected for Federal Highway Administration (FHWA) vehicle class types 4 through 13 (trucks and buses). It was assumed that all these vehicles used diesel engines. The local road data included FHWA vehicle class types 1 through 13. In order to determine the portion of vehicles from local roads that fell in categories 4 through 13, an estimate of the distribution for vehicles had to be applied. We used a statistical distribution developed by ODOT that provided an estimated breakdown for every vehicle category for each type of roadway in Ohio.[45]

Emissions data

The analysis applied an emission factor to the AADT data from each roadway. The emission factor was weighted for the distribution of each FHWA vehicle class for that particular road type, based on the ODOT analysis mentioned above.

Road types were divided into three speed categories: uncongested freeway (FHWA class rural interstate) at 55 mph, congested freeways (FHWA classes urban interstate, urban other freeways, and expressways) at 35 mph, and local roads (all remaining FHWA classes) at 20 mph.

An emission factor for each vehicle road class type was developed by taking the HDDE emissions and correction factors from U.S. EPA's Mobile 6 model and applying them to the appropriate FHWA vehicle classification types.[46] The emission factors (EFs) were initially based on the U.S. EPA's emission standards for HDDEs (HDDE categories 2B, 3, 4, 5, 6, 7, 8a, 8b, School Buses, and Transit Buses[47]) and age of engine (1994 through 2003, 1991 through 1993, 1990 and older). The EFs were weighted by the distribution of vehicles by age and converted from g/bhp-hr to g/mi. Speed correction factors were based on CO speed correction factors.[48]

Asthma Estimates

Asthma estimates were based on American Lung Association's 1997 publication, *Estimated Prevalence and Incidence of Lung Disease by Lung Association Territory.* All seven counties experienced an asthma rate of 5.88% (adult and child rates combined). This was applied to U.S. census population numbers to obtain the study's specific asthma estimates. For example, 198,860 residents in Columbus live in a diesel hot spot. Multiplying that figure by .0588 produces 11,693, the estimated number of Columbus residents with asthma living in a diesel hot spot.

COLUMBUS AREA COMMUNITIES IN ALPHABETICAL ORDER–TABLE 3						
Municipality	County	Type	Hot Spot Population	Population	Percent of Population Living in a Hot Spot	Population in a Hot Spot with Asthma
Bexley	Franklin	city	2,504	13,203	19.0%	145
Buckeye Lake	Licking	village	216	3,049	7.1%	13
Canal Winchester	Franklin	village	1,140	4,478	25.5%	66
Carroll	Fairfield	village	345	488	70.7%	20
Circleville	Pickaway	city	1,637	13,485	12.1%	95
Columbus	Franklin	city	198,860	711,470	28.0%	11,534
Delaware	Delaware	city	7,699	25,243	30.5%	447
Dublin	Franklin	city	1,139	31,392	3.6%	66
Gahanna	Franklin	city	5,865	32,636	18.0%	340
Grandview Heights	Franklin	city	18	6,695	0.3%	1
Granville	Licking	village	282	3,167	8.9%	16
Gratiot	Licking	village	86	187	46.1%	5
Grove City	Franklin	city	2,063	27,075	7.6%	120
Groveport	Franklin	village	249	3,865	6.4%	14
Hanover	Licking	village	39	885	4.4%	2
Heath	Licking	city	2,079	8,527	24.4%	121
Hebron	Licking	village	1,039	2,034	51.1%	60
Hilliard	Franklin	city	2,468	24,230	10.2%	143
Kirkersville	Licking	village	27	520	5.3%	2
Lancaster	Fairfield	city	9,529	35,335	27.0%	553
Marysville	Union	city	2,767	15,942	17.4%	161
Minerva Park	Franklin	village	9	1,288	0.7%	1
New Albany	Franklin	village	84	3,711	2.3%	5
Newark	Licking	city	9,662	46,279	20.9%	560
Obetz	Franklin	village	512	3,977	12.9%	30
Plain City	Union	village	1,322	2,832	46.7%	77
Powell	Delaware	village	39	6,247	0.6%	2
Reynoldsburg	Fairfield	city	1,579	32,069	4.9%	92
South Bloomfield	Pickaway	village	431	1,179	36.5%	25
Sugar Grove	Fairfield	village	327	448	73.0%	19
Sunbury	Delaware	village	1,738	2,630	66.1%	101
Upper Arlington	Franklin	city	1,554	33,686	4.6%	90
Urbancrest	Franklin	village	243	868	28.0%	14
Valleyview	Franklin	village	25	601	4.2%	1
Westerville	Franklin	city	5,779	35,318	16.4%	335
Worthington	Franklin	city	1,382	14,125	9.8%	80

COLUMBUS AREA COMMUNITIES RANKED BY NUMBER OF PEOPLE LIVING IN HOT SPOTS–TABLE 4						
Municipality	County	Type	Hot Spot Population	Population	Percent of Population Living in a Hot Spot	Population in a Hot Spot with Asthma
Columbus	Franklin	city	198,860	711,470	28.0%	11,693
Newark	Licking	city	9,662	46,279	20.9%	568
Lancaster	Fairfield	city	9,529	35,335	27.0%	560
Delaware	Delaware	city	7,699	25,243	30.5%	453
Gahanna	Franklin	city	5,865	32,636	18.0%	345
Westerville	Franklin	city	5,779	35,318	16.4%	340
Marysville	Union	city	2,767	15,942	17.4%	163
Bexley	Franklin	city	2,504	13,203	19.0%	147
Hilliard	Franklin	city	2,468	24,230	10.2%	145
Heath	Licking	city	2,079	8,527	24.4%	122
Grove City	Franklin	city	2,063	27,075	7.6%	121
Sunbury	Delaware	village	1,738	2,630	66.1%	102
Circleville	Pickaway	city	1,637	13,485	12.1%	96
Reynoldsburg	Fairfield	city	1,579	32,069	4.9%	93
Upper Arlington	Franklin	city	1,554	33,686	4.6%	91
Worthington	Franklin	city	1,382	14,125	9.8%	81
Plain City	Union	village	1,322	2,832	46.7%	78
Canal Winchester	Franklin	village	1,140	4,478	25.5%	67
Dublin	Franklin	city	1,139	31,392	3.6%	67
Hebron	Licking	village	1,039	2,034	51.1%	61
Obetz	Franklin	village	512	3,977	12.9%	30
South Bloomfield	Pickaway	village	431	1,179	36.5%	25
Carroll	Fairfield	village	345	488	70.7%	20
Sugar Grove	Fairfield	village	327	448	73.0%	19
Granville	Licking	village	282	3,167	8.9%	17
Groveport	Franklin	village	249	3,865	6.4%	15
Urbancrest	Franklin	village	243	868	28.0%	14
Buckeye Lake	Licking	village	216	3,049	7.1%	13
Gratiot	Licking	village	86	187	46.1%	5
New Albany	Franklin	village	84	3,711	2.3%	5
Powell	Delaware	village	39	6,247	0.6%	2
Hanover	Licking	village	39	885	4.4%	2
Kirkersville	Licking	village	27	520	5.3%	2
Valleyview	Franklin	village	25	601	4.2%	1
Grandview Heights	Franklin	city	18	6,695	0.3%	1
Minerva Park	Franklin	village	9	1,288	0.7%	1

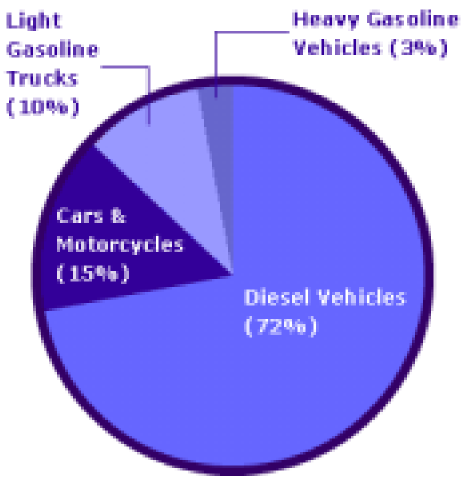
COLUMBUS AREA COMMUNITIES RANKED BY NUMBER OF PEOPLE WITH ASTHMA LIVING IN HOT SPOTS–TABLE 5						
Municipality	County	Type	Hot Spot Population	Population	Percent of Population Living in a Hot Spot	Population in a Hot Spot with Asthma
Columbus	Franklin	city	198,860	711,470	28.0%	11,534
Newark	Licking	city	9,662	46,279	20.9%	560
Lancaster	Fairfield	city	9,529	35,335	27.0%	553
Delaware	Delaware	city	7,699	25,243	30.5%	447
Gahanna	Franklin	city	5,865	32,636	18.0%	340
Westerville	Franklin	city	5,779	35,318	16.4%	335
Marysville	Union	city	2,767	15,942	17.4%	161
Bexley	Franklin	city	2,504	13,203	19.0%	145
Hilliard	Franklin	city	2,468	24,230	10.2%	143
Heath	Licking	city	2,079	8,527	24.4%	121
Grove City	Franklin	city	2,063	27,075	7.6%	120
Sunbury	Delaware	village	1,738	2,630	66.1%	101
Circleville	Pickaway	city	1,637	13,485	12.1%	95
Reynoldsburg	Fairfield	city	1,579	32,069	4.9%	92
Upper Arlington	Franklin	city	1,554	33,686	4.6%	90
Worthington	Franklin	city	1,382	14,125	9.8%	80
Plain City	Union	village	1,322	2,832	46.7%	77
Canal Winchester	Franklin	village	1,140	4,478	25.5%	66
Dublin	Franklin	city	1,139	31,392	3.6%	66
Hebron	Licking	village	1,039	2,034	51.1%	60
Obetz	Franklin	village	512	3,977	12.9%	30
South Bloomfield	Pickaway	village	431	1,179	36.5%	25
Carroll	Fairfield	village	345	488	70.7%	20
Sugar Grove	Fairfield	village	327	448	73.0%	19
Granville	Licking	village	282	3,167	8.9%	16
Groveport	Franklin	village	249	3,865	6.4%	14
Urbancrest	Franklin	village	243	868	28.0%	14
Buckeye Lake	Licking	village	216	3,049	7.1%	13
Gratiot	Licking	village	86	187	46.1%	5
New Albany	Franklin	village	84	3,711	2.3%	5
Powell	Delaware	village	39	6,247	0.6%	2
Hanover	Licking	village	39	885	4.4%	2
Kirkersville	Licking	village	27	520	5.3%	2
Valleyview	Franklin	village	25	601	4.2%	1
Grandview Heights	Franklin	city	18	6,695	0.3%	1
Minerva Park	Franklin	village	9	1,288	0.7%	1

COLUMBUS AREA COMMUNITIES RANKED BY PERCENT OF POPULATION LIVING IN HOT SPOTS—TABLE 6

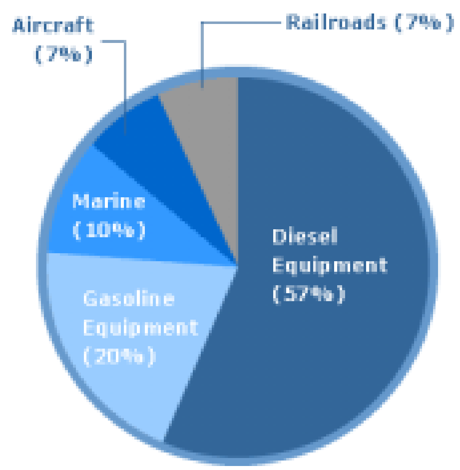
Municipality	County	Type	Hot Spot Population	Population	Percent of Population Living in a Hot Spot	Population in a Hot Spot with Asthma
Sugar Grove	Fairfield	village	327	448	73.0%	19
Carroll	Fairfield	village	345	488	70.7%	20
Sunbury	Delaware	village	1,738	2,630	66.1%	101
Hebron	Licking	village	1,039	2,034	51.1%	60
Plain City	Union	village	1,322	2,832	46.7%	77
Gratiot	Licking	village	86	187	46.1%	5
South Bloomfield	Pickaway	village	431	1,179	36.5%	25
Delaware	Delaware	city	7,699	25,243	30.5%	447
Urbancrest	Franklin	village	243	868	28.0%	14
Columbus	Franklin	city	198,860	711,470	28.0%	11,534
Lancaster	Fairfield	city	9,529	35,335	27.0%	553
Canal Winchester	Franklin	village	1,140	4,478	25.5%	66
Heath	Licking	city	2,079	8,527	24.4%	121
Newark	Licking	city	9,662	46,279	20.9%	560
Bexley	Franklin	city	2,504	13,203	19.0%	145
Gahanna	Franklin	city	5,865	32,636	18.0%	340
Marysville	Union	city	2,767	15,942	17.4%	161
Westerville	Franklin	city	5,779	35,318	16.4%	335
Obetz	Franklin	village	512	3,977	12.9%	30
Circleville	Pickaway	city	1,637	13,485	12.1%	95
Hilliard	Franklin	city	2,468	24,230	10.2%	143
Worthington	Franklin	city	1,382	14,125	9.8%	80
Granville	Licking	village	282	3,167	8.9%	16
Grove City	Franklin	city	2,063	27,075	7.6%	120
Buckeye Lake	Licking	village	216	3,049	7.1%	13
Groveport	Franklin	village	249	3,865	6.4%	14
Kirkersville	Licking	village	27	520	5.3%	2
Reynoldsburg	Fairfield	city	1,579	32,069	4.9%	92
Upper Arlington	Franklin	city	1,554	33,686	4.6%	90
Hanover	Licking	village	39	885	4.4%	2
Valleyview	Franklin	village	25	601	4.2%	1
Dublin	Franklin	city	1,139	31,392	3.6%	66
New Albany	Franklin	village	84	3,711	2.3%	5
Minerva Park	Franklin	village	9	1,288	0.7%	1
Powell	Delaware	village	39	6,247	0.6%	2
Grandview Heights	Franklin	city	18	6,695	0.3%	1

APPENDIX C: EPA DATA ON 1999 EMISSIONS

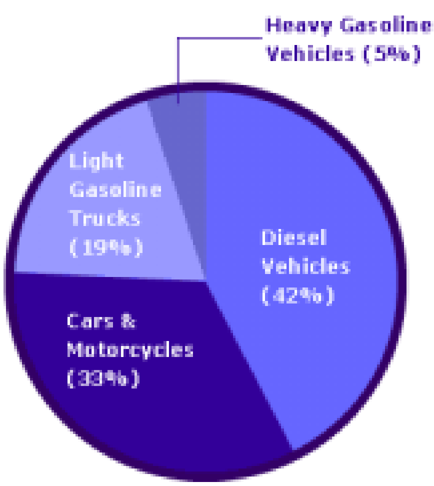
1999 National Emissions by Source:
Particulate Matter ($PM_{2.5}$)
On-road Mobile Sources



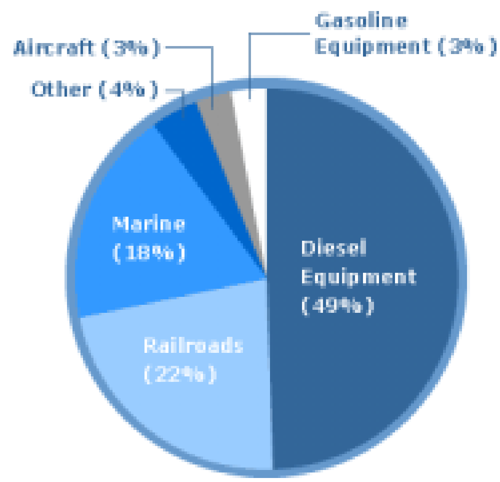
1999 National Emissions by Source:
Particulate Matter ($PM_{2.5}$)
Non-road Mobile Sources



1999 National Emissions by Source:
Nitrogen Oxides
On-road Mobile Sources



1999 National Emissions by Source:
Nitrogen Oxides
Non-road Mobile Sources



The Clean Air Act was officially established in 1970 with amendments over the years, the most significant occurring in 1990. The act started with requiring the federal government to establish National Ambient Air Quality Standards (NAAQS), states to develop implementation plans, and new sources to meet more stringent standards than existing sources, as well as setting emission limits for passenger cars. The NAAQS cover six pollutants, called criteria pollutants: carbon monoxide (CO), sulfur dioxide (SO_2), particulate matter (PM), ozone (O_3), lead (Pb) and nitrogen oxides (NOx). Over the subsequent two decades the act was amended and the deadlines for meeting attainment for NAAQS were repeatedly moved back. The 1990 Amendments extended the deadlines into the 21st century, established a new permit program for major stationary sources, created new programs dealing with acid rain and stratospheric ozone-depleting substances, tightened motor vehicles emission standards, and revised requirements for state implementation plans. Air quality laws also regulate hazardous air pollutants, 189 chemicals which cause serious health and environmental hazards. U.S. EPA must identify the primary sources of pollution and issue regulations such as the use of Maximum Achievable Control Technology (MACT) to reduce pollutants.

When U.S. EPA sets a standard or adopts a rule related to attaining NAAQS, they require the states to develop a state implementation plan (SIP). Primary enforcement lies with the state governments, which can create stronger regulations but may not have lower standards than the national guidelines. Basically, U.S. EPA is required to tell the states what goals they must meet, but cannot tell them how to achieve those goals. A SIP contains the regulations the state will use to clean up polluted areas in accordance with the Clean Air Act. Examples would be control measures for setting limits on emissions from stationary sources (factories), area sources (residential fireplaces), and motor vehicles. States identify the levels of control to be utilized in the facility-specific permits. The public must be allowed involvement through hearings and comment periods during the creation of a SIP. The SIP must then be approved by the U.S. EPA. If it is found unacceptable, the U.S. EPA can either take over the state's role of enforcing the Clean Air Act by creating a federal implementation plan (FIP) or withhold federal highway dollars from the state. In addition, U.S. EPA has the ability to veto permits issued by the state.

Ohio has some of the worst air quality in the country. Ozone and fine particulate monitors in Ohio show that most of the state will be in non-attainment for new NAAQS. U.S. EPA data suggests that diesel engines and power plants are the primary source of particulate matter in urban areas. The majority of Ohio's population is spread throughout six urban areas; reducing emissions from these areas will most effectively reduce mortality and facilitate attaining NAAQS for fine particles. Ohio EPA is currently determining which counties to list as non-attainment areas for ozone and finalizing the ozone plan for submission to the U.S. EPA. Thirty-three counties fail to meet federal limits for the revised ozone limit of 85 parts per billion averaged over eight hours. Ohio EPA has not yet drafted a list of counties failing to meet PM standards. SIPs must be adopted by 2008 with provisions to meet the standards by 2010. Failure to meet attainment will result in prohibition of new facilities releasing emissions unless the overall emissions for the area can be lowered through other means. Consequently, if a new or modified source is proposed for the non-attainment area Ohio EPA must demonstrate that the total emissions in the area will decrease (Lowest Achievable Emissions Rate or LAER). U.S. EPA studies have shown that some areas in Ohio will need to significantly reduce the pollution from motor vehicles in addition to meeting all the other aspects of Clean Air Act requirements in order to reach attainment levels. While Ohio may then be able to attain the ozone standard with current programs, it will fail in reaching attainment for PM. A real and immediate way for states to quickly push towards reaching attainment is to regulate for diesel emissions. This requires programs to clean up existing diesels instead of waiting three decades for the benefits of the on-road diesel rules, and potentially the proposed non-road diesel rules, to be realized.

Appendix E: Programs in Other Areas

Ann Arbor, MI The City of Ann Arbor is using B20, biodiesel from virgin vegetable oil blended at 20:80 with low sulfur diesel, on 124 vehicles. A member of the Clean Cities Program, grants have facilitated the purchase of four CNG buses, two bi-fuel propane vehicles and a heavy-duty CNG refuse hauler. Further, the city is considering implementing the use of ULSD.

The Ann Arbor Transportation Authority is currently using ULSD for its fleet.

University of Michigan operates its diesel engines with ultralow sulfur biodiesel fuel, has ethanol powered vehicles and electric trucks as part of its transportation department's movement to alternative fuel vehicles. Ranked #1 University for alternative fuel use by Automotive Fleet magazine.

Boston, MA Several hundred pieces of heavy-duty off-road diesel equipment are being used in construction of the Central Artery/Tunnel Project (Big Dig). The Massachusetts Turnpike Authority (MTA) in collaboration with the Massachusetts Department of Environmental Protection (DEP) and the Northeast States for Coordinated Air Use Management (NESCAUM) implemented a voluntary diesel retrofit program. The use of oxidation catalysts was so successful that what began as a voluntary program was shifted to a requirement for all vehicles used through the end of the dig.

Boston Massachusetts Bay Transit Authority has committed to using ULSD fuel prior to the federal requirement in 2006 and to the phased-in purchase of compressed natural gas buses with 358 in service by February 2004. Initiatives also include improving pollution controls on existing buses and working to relocate maintenance facilities from urban neighborhoods to industrial locations where feasible.

Cleveland, OH The Greater Cleveland Regional Transit Authority (RTA) began utilizing alternative fuels in 1990. They currently have 166 buses running on compressed natural gas, with two garages fitted for CNG fueling. RTA recently purchased 225 clean air buses, which can run on ultralow sulfur fuel, and is negotiating with BP to expand their use of ULSD.

The Cleveland Municipal School District received funding for a retrofit project from the U.S. EPA as part of the Cleveland Clean Air Century Campaign. The District had been awaiting a grant to offset the cost of purchasing the ULSD required to utilize the retrofit technology. At the time of printing, seven of the 23 buses in the fleet had been retrofitted.

New York, NY All New York City transit buses (part of the Metropolitan Transit Authority) have been retrofitted and are running on ULSD. New York State has $11 million dollars in funding for projects, with $6 million from the New York Power Authority and $5 million from bonds. The $6 million available for school bus retrofits has not been utilized for a variety of reasons, but advocacy efforts and meetings in the past few months may move the retrofit projects forward. The $5 million bond package originally was written for purchasing alternative-fuel vehicles. After realizing school districts found this too costly, the language was rewritten to include retrofits. Grants to be awarded this fall will cover 100% of the retrofit technology, but school districts will need to cover the increase in fuel costs.

Washington State Governor Gary Locke signed SB 6072 to provide up to $5 million annually to be used for school bus retrofits in Washington State. The bill uses an existing title transfer fee for vehicles to create a $5 million annual appropriation. At least 85% of the money must be spent on school bus retrofits and the remainder can be spent on other mobile source, air toxics and air quality programs. The bill was initiated by the Puget Sound Clean Air Agency which currently has commitments to retrofit over 2,000 diesel vehicles and a list of up to 8,000 retrofit candidates.

The City of Seattle has committed to retrofitting 500 vehicles. The Port of Seattle is fueling construction vehicles working on a new runway with ULSD. Cruise ships in Seattle Harbor are using ULSD while in port. The Washington State Ferry system is testing different fuel blends and types for emission reduction potential in marine fleets.

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46. Matching the EPA's weight-based classification system with the FHWA vehicle classification system was undertaken using an analysis from ODOT identifying average weight of FHWA vehicle classes and matching that to the HDDE emission factors identified by weight taken from EPA's (cite rport). Buses were self-identified in both classification systems.

47. The Transit bus emissions factor was used as a conservative default for FHWA class 4 (buses), because a distribution of school, transit and inter-city buses was not available, and the transit bus EF was the lowest EF in that category.

48. EPA has not yet developed a speed correction factor based on Mobile 6. The CO speed correction factor was used as a default, based on a study indicating that CO and PM emissions respond in similar ways to engine performance, *Paul Andrei, West Virginia University, 2001.*

GLOSSARY OF ACRONYMS

AADT	annual average daily traffic
CARB	California Air Resources Board
CNG	compressed natural gas
CO	carbon monoxide
CO_2	carbon dioxide
DEP	(Massachusetts) Department of Environmental Protection
DOC	diesel oxidation catalyst
DPF	diesel particulate filter
EF	emission factors
EGR	exhaust gas recirculation
EHHI	Environment and Human Health, Inc.
EPA	Environmental Protection Agency
FHWA	Federal Highway Administration
FIP	federal implementation plan
g/mi/day	grams per mile per day
HC	hydrocarbons
HDDE	heavy duty diesel engines
LAER	lowest achievable emissons rate
MACT	maximum achievable control technology
MORPC	Mid Ohio Regional Planning Commission
mph	miles per hour
MTA	Massachusetts Turnpike Authority
NAAQS	National Ambient Air Quality Standards
NESCAUM	Northeast States for Coordinated Air Use Management
NOx	nitrogen oxides
O_3	ozone
ODOT	Ohio Department of Transportation
OEC	Ohio Environmental Council
PAHs	polycyclic aromatic hydrocarbons
Pb	lead
PM	particulate matter
PM_{10}	coarse particulate matter
$PM_{2.5}$	fine particulate matter
ppm	parts per million
RTA	(The Greater Cleveland) Regional Transit Authority
SCR	selective catalytic reduction
SIP	state implementation plan
SO_2	sulfur dioxide
SOx	sulfur oxides
STAPPA/ALAPCO	State and Territorial Air Pollution Program Administrators/Association of Local Air Pollution Control Officers
ug/cu m	micrograms per cubic meter
ULSD	ultralow sulfur diesel
VMT	vehicle miles traveled
VOCs	volatile organic compounds

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