What is a safe distance to live or work near high auto emission roads?

May 28, 2015 by Bill Adams

A nearby roadway may be putting your household's health at risk. The same is true of workplaces, schools, and other places where people spend significant time. This health risk is from the elevated auto emissions near high traffic roadways. It's a health risk separate and in addition to the regional air pollution from auto emissions.

We have come to draw a false sense of security from our collective sharing of regional air pollution and, perhaps, the belief that regulatory agencies protect us. However, research continues to show that air pollution, particularly from auto emissions, has profound effects on health. Moreover, such impacts are unequally distributed among local populations, largely based on nearness to major roadways.

Discussions about whether or not to build or expand roadways are dominated by the topics of traffic congestion relief, urban planning, and greenhouse gasses. The impact of roadways on Americans' health and morbidity is often lost in the discussions. 53,000 U.S. deaths annually are attributable to automobile emission air pollution. (Calazzo, et al., 2013) Many more are ill or incapacitated from auto emissions. Ninety percent of the cancer risk from air pollution in Southern California is attributable to auto emissions. (Hulsey, et al., 2004, par. 10) For comparison, there are 35,000 U.S. deaths a year from auto collisions (NHTSA, 2012), which is the top cause of death for U.S. males between the age of 15 and 24, and in the top ten causes of death of all Americans through the age of 54.

The impact on life and safety generally from road expansion receives little attention. However, auto emission pollution based on proximity to source, i.e. line-source pollution, is one of the most overlooked health threats in the U.S.

Current U.S. policies and regulations do little to protect susceptible populations, including children, from the dangers of nearness to auto-emission sources. Undoubtedly, the disproportionate lack of urgency concerning the health impacts of air pollution is attributable to its hidden and delayed impact. Although the health impacts of air pollution on general populations are certain, individual diagnoses of disease rarely identify air pollution as the cause. As a result, the health threat fails to take on the personal dimension of other health threats. The same was true with smoking for many decades. Additionally, awareness of line-source pollution is further hindered by confusion with regional / ambient air pollution, which typically manifests in more noticeable high ozone levels, i.e., smog.

Air pollution monitored by various agencies includes particulate matter (PM), ozone, nitrogen dioxide, carbon monoxide, sulfur dioxide, and lead. However, two of these cause the most concern due to their prevalence and health significance: 1) Ozone, which causes the brown smog commonly seen over cities and 2) Particulate matter (PM), also referred to as ultra-fine particulates (UFP). Unlike ozone, PM exposure is directly related to proximity to source – primarily areas near to or downwind from high traffic areas. Moreover, for health impacts, PM pollution may be the worst of the lot. Heart disease, lung function impairment, leukemia, asthma, and lung cancer, are some of the conditions that have been associated with PM exposure resulting from proximity to high traffic sources. (Hulsey, et al., 2004, par. 6; Fuller, et al., 2012, pp. 257 – 265) As stated in a 2002 study about exposure to highway PMs:

Throughout the past decade, epidemiological studies have reported a consistent relationship between increases in particulate matter (PM) exposure and contemporary increases in mortality and morbidity. (Zhu, et al., 2002)

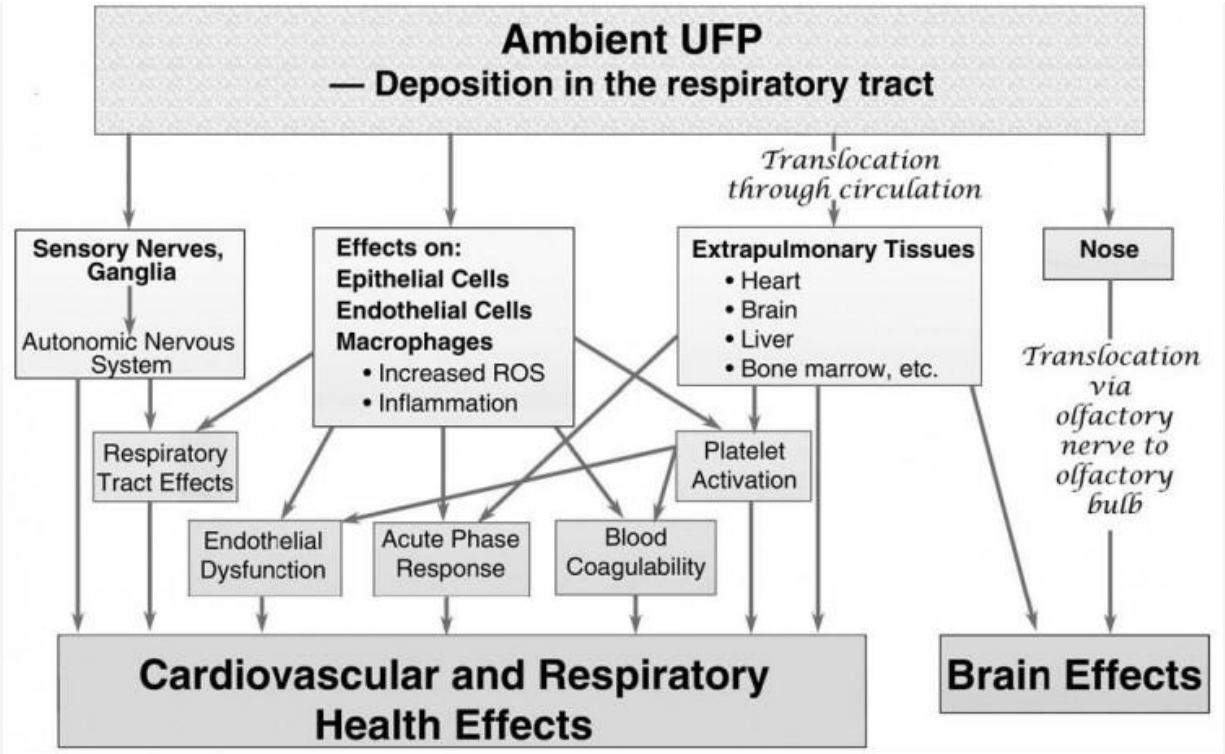


Figure 17. Hypothesized pathways via which inhalation of UFPs may lead to effects on cardiovascular and respiratory systems and on the brain. Reprinted with permission from the Health Effects Institute, Boston MA.

Children are especially vulnerable to auto-emission health impacts because, among other reasons, they breathe more air relative to their body weight than adults, are more physically active, and spend more times outdoors during times when pollutant levels are at their highest. (Hulsey, et al., 2004) Additionally, children have many more years ahead of them in which the cumulative damage caused by auto emissions can manifest itself in disease or disability. Women who live near areas of high automobile traffic during pregnancy have a 20 – 30% higher chance of having children with lung impairment. (Morales, et al., 2014) Auto emission PM exposure from nearness to high traffic during the the third trimester of pregnancy doubles the risk for autism. (Raz, et al., 2014).

11% of U.S. residents, over 30 million people, live within 100 meters of 4 lane or greater highways. (Brugge, et al., 2007; Howard, 2011) Adding in work places, schools, and commuting, it is reasonable to extrapolate that roughly 1/3 of people spend a substantial portion of their day exposed to unhealthy levels of auto emission PMs.

So how can you determine your own exposure level or that of your children? Below are some key distances and other factors:

Ground Zero:

Curbside and in-traffic air contains high levels of all pollutants associated with auto emissions – both PMs and gaseous substances like benzene and carbon monoxide. (Hulsey, et al., 2004, par. 7) PM exposure at intersections is as much as 29 times higher than other portions of the road. (Goel & Kumar, 2015) Cyclists, auto occupants with windows down or vents open, toll booth operators, and roadside residents and businesses receive up to 25 times the level of PM exposure. (Zhu, et al., 2002) Moreover, the air inside a car typically contains higher concentrations of these pollutants than the air outside of the car – as much as 4 times the benzene and 10 times the carbon monoxide. (ICTA, 2000) Keeping the windows closed and the ventilation set to recirculate can reduce in-car pollutants to 20% that of air outside the car. (L.A. Times, 2013)
High Toxicity Zone – 300 – 500 feet:

On average, PM concentration is significantly higher within 330 feet (100 meters) of major highways than it is further away. (Zhu, et al., 2002) The smallest PMs, with a peak concentration of 1.6 x 10(5)/cm3, are the most dangerous.
Smaller PMs carry toxic substances deeper into the lungs and body, and as a result, have more profound health effects. (Cal. EPA, Aug. 2014, p.29) They are concentrated in an area within 330 feet from highways. (Zhu, supra) Pregnant women who live within 500 feet of high traffic areas are prone to birth complications, including premature birth, low birth weight children, and children with medical problems. (Wilhelm & Ritz, 2003) A review of a broad range of studies has correlated early mortality — from a wide range of illnesses — with living within 330 feet of a high traffic roadway and related exposure to various auto emission substances. (Beelen, et al., 2008)

Figure 3.2.6-4: Sensitive Receptor Locations
(Springdale Street to Warner Avenue) May 2012, I-405 Improvement Project

Elevated Toxicity Zone – 1,000 – 1,500 feet:

PMs from auto emissions are elevated within 1,000 feet (300 meters) of a major highway. (Yifang, et al., 2002, pp. 1038-1039) A Denver study indicated that children living roughly within that distance were eight times as likely to develop leukemia and six times as vulnerable to all types of cancer. (Hulsey, et al., 2004,-par. 1) In another study, children under 5 years of age admitted to hospitals with asthma emergencies were significantly more likely to live within 500 meters (1,640 feet) of a major highway when traffic flow exceeded 24,000 vehicles per hour than those who lived further away or when traffic flow was less. (Edwards & Walters, 1994) Particle levels return to near normal beyond that distance.

Other Factors Influencing Air Pollution Levels Near Roadways:

Wind:

People living "downwind" of highways with 4 or more lanes (2 lanes in each direction) are exposed to higher levels of fine particulate matter. (Brugge, et al. 2007) However, this circumstance does not exempt one side of a highway from PM dangers. In many regions, wind direction changes not only depending on weather conditions, but also between day and night.

Sun, Rain & Humidity:

Areas receiving higher amounts of rain or humidity can experience reduced auto-emission pollution levels, especially ultra-fine particulate pollution. The clean air you sense after a rain storm really is cleaner. This fact is regularly demonstrated in high-pollution Bejing. (USA Today, Aug. 11, 2008) Atmospheric conditions alter the size, distribution, and composition of freshly-emitted PM through condensation, evaporation, and dilution during transport to downwind locations. (Brugge, et al., 2007) Thus, higher humidity levels can tamp down the distribution of PMs. (HEI Review Panel, 2013, p.24) Conversely, sun, heat, and lack of humidity generally favor greater distribution of PM. Additionally, ground level ozone concentration is unhealthiest on sunny and warm days.

Topography:

A temperature inversion in a valley – clean air poster from a Teacher's Guide to Clean Air by BC Transit, Nov. 2005 – republished permission Ministry of Environment, British Columbia Canada

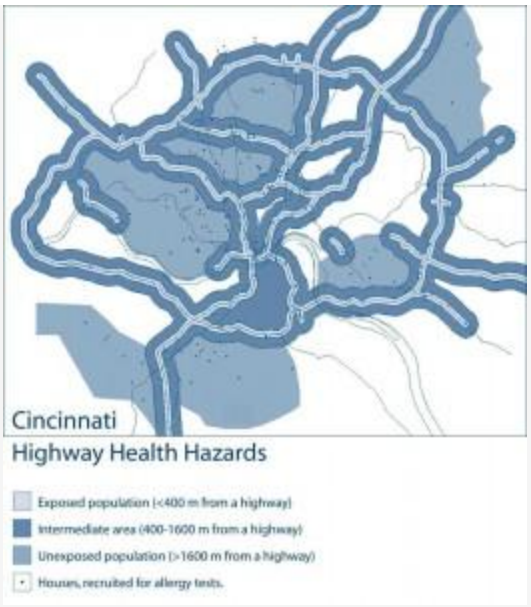
PM, as well as gaseous air pollutants, tend to concentrate in valleys due to containment by topographical features. (HEI Review, supra) Inversions, in which a layer of cold air is trapped underneath a layer of warm air, keep PM concentrated near ground level and aggravate the concentration of PM in valley and canyon floors. Ibid. Fog is often an indicator of an inversion.

Time:

The time of day can influence PM concentrations near highways – both in terms of traffic concentrations and in terms of weather. (HEI Review Panel, supra) Of course, highways experience much higher traffic concentrations at certain times of the day. However, such concentration has become less varied as employers stagger work shifts to alleviate commuting burdens and as continued highway expansion creates induced demand (tendency of freeway expansion to create more demand and congestion in the long run by facilitating sprawl). Additionally, the heating and cooling of day and night effect pollution concentrations at ground level.

Auto Emission Air Pollution as a Social Justice Issue:

The unavoidable conclusion from the research is that each time a major highway is built or expanded, some of the residents living nearby will pay with their health or lives. Nevertheless, compared to industrial uses that pose potential health risks, roadway construction projects remain relatively unregulated as a direct air pollution health risk. (Hulsey, et al., 2004) The same is true of the siting of residential, employment, senior, or educational uses near highways.



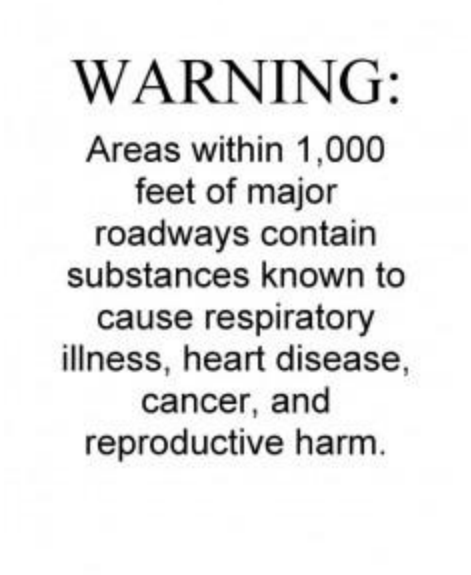
Cincinnati highway proximity health hazards. Republished permission LADCO

Low income and minority populations are disproportionately impacted by air pollution health risks. (Beleen, 2008) Suburban expansion creates a demand for road expansion through existing neighborhoods. Lower income neighborhoods and ethnic minority populations least often wield the political influence necessary to resist road expansion projects. Additionally, multifamily and affordable housing is more likely to be sited near high traffic areas than is more expensive detached housing. More recently, the construction of high density "transit oriented developments" (TODs), which are intended to reduce auto reliance and which often include affordable housing, are frequently sited near high traffic areas. There has been little acknowledgement in U.S. transportation policy of the social inequality and the ethical issues related to sacrificing the health of members of one community to facilitate the growth and commuting of another community.

Property condemned for a road expansion project results in monetary compensation to the owner based on fair market value. However, residents put at risk by the additional traffic emissions as a result of living adjacent to or near the road project cannot recover compensation or assistance to relocate.

Construction and expansion of roadways may involve some public disclosure of health impacts via environmental reporting documents but the reporting tends to assume that "no build" highway expansion options will simply result in ever increasing congestion. However, more than a half century of highway building has demonstrated that congestion relief from road expansion tends to be temporary, and that the long term impact is increased automobile use and traffic congestion. Such "induced demand" is increasingly recognized as the long term effect of expanding roadways to relieve current traffic congestion.

Increasingly, line-source proximity to auto emission pollution and the refinement and improved accuracy of roadway air pollution dispersion modeling is being used in legal and political challenges to highway expansion proposals. Given the stakes, its hard to justify the continued expansion of roadways in urban areas, the slowness of conversion to non-combustible fuel automobiles, or the proportionately small investment in public transit. If such decisions were based solely on health criteria proportionate to other identified public risks, highways might be quarantined as an acutely elevated health hazard to those who live or work near them. Of course, such action is impractical as it would result in vast tracts of existing homes, schools, and places of employment being abandoned.



It is clear that the public is still not fully aware of the difference between ambient air pollution effecting the general populace of a city and line-source air pollution impacting health based on nearness to highways. Perhaps, if the public was more aware of the direct and unequal health impacts of high-traffic roadways, transitioning from roadway expansion to transportation alternatives would receive more urgency. One proposal for an air quality district plan in California required that builders of homes, schools, or day care centers provide notice to their customers of toxic emissions, including those emanating from busy roads, within 1,000 feet. (Hulsey, 2004, p.13)

Without a better understanding of line-source proximity exposure by the general public, its hard to foresee substantial changes. It may take activism and information campaigns, such as posting warning notices in neighborhoods within the 1,000 foot zone, to catch the public's attention and educate it on this health issue.

Notes:

While this article cites a number of scientific articles, some "rounding" is used for the purpose of readability. In other words, this article attempts to organize and summarize current available data into a general conceptual framework for general public understanding rather than to provide new data.

References:

Caiazzo, F., Ashok, A., Waitz, I.A., Yim, S.H.L., Barrett, S.R.H. (2013) *Air pollution and early deaths in the United States. Part I: Quantifying the impact of major sectors in 2005*, Laboratory for Aviation and the Environment, Department of Aeronautics and Astronautics, Massachusetts Institute of Technology, August 2013.

Zhu, Y., Hinds, W.C., Seongheon Kim, S., and Sioutas, C. (2012) *Concentration and Size Distribution of Ultrafine Particles Near a Major Highway*, Journal of the Air & Waste Management Association, vol. 52

Fatality Analysis Reporting System (2012) fars.*NHTSA.dot.gov*

Morales, E., Garcia-Esteban, R., Asensio de la Cruz, O., Basterrechea, M., Lertxundi, A., Martinez Lopez de Dicastillo, M.D., Zabaleta, C., Sunyer, J. (2014) *Intrauterine and early postnatal exposure to outdoor air pollution and lung function at preschool age*. *Thorax*, 2014; See also, BMJ-British Medical Journal; See also *Exposure to traffic pollution during pregnancy can damage future child's lungs*. ScienceDaily, 20 October 2014.

Howard, E. (2011) *Every Breath You Take*, Tufts Now, November 2, 2011

Brugge, B., Durant, J.L., Rioux, C. (2007) *Near-highway pollutants in motor vehicle exhaust: A review of epidemiologic evidence of cardiac and pulmonary health risks*, Environmental Health, Autust 9, 2007, 6:23

Goel, A. and Kumar, P. (2015) *Characterisation of nanoparticle emissions and exposure at traffic intersections through fast–response mobile and sequential measurements Atmospheric Environment*, Vol. 107, April 2015, pp. 374–390

Hulsey, B., Hopkins, E., Olson, E., Burg, E., and Carlson, M. (2004) *Highway Health Hazards: How highways and roads cause health problems in our communities—and what you can do about it*, Sierra Club, 2004, 6

Draft Environmental Impact Report/ Environmental Consequences, and Environmental Impact Statement Avoidance, Minimization, And/Or Mitigation Measures, I-405 Improvement Project, May 2012 3.2.6-22

Fuller, C.H., Brugge, D. Williams, P., Mittleman, M., Durant, J.L., and Spenglera, J. D. (2012) *Estimation of ultrafine particle concentrations at near-highway residences using data from local and central monitors*, Atmospheric Environment, Volume 57, September 2012, Pages 257–265

Yifang, Z, Hinds, W.C., Seongheon, K., Shen, S., Sioutas, C. Concentration and size distribution of ultrafine particles near a major highway. Journal of the Air and Waste Management Association. September 2002, pp. 1038-1039.
Beelen,R., Hoek, G., A. van den Brandt, P., Goldbohm, R.A., Fischer, P., Schouten, L.J., Jerrett, M., Hughes, E., Armstrong, B., and Brunekreef, B., Long-Term Effects of Traffic-Related Air Pollution on Mortality in a Dutch Cohort (NLCS-AIR Study), Environmental Health Perspectives (vol. 116, no. 2, Feb. 2008)
Rain, rain: Beijing air pollution washes away, August 11, 2008 – USA Today
In-Car Air Pollution: The Hidden Threat to Automobile Drivers. International Center for Technology Assessment (ICTA). July 2000 , page 5.
Borboza, T., For cleaner air, set car vents to 'recirculate,' study says September 12, 2013, LA Times.
California Communities Environmental Health Screening Tool, Version 2.0 (Calenviroscreen 2.0) Guidance And Screening Tool, California Environmental Protection Agency (August 2014), p.29.
HEI Review Panel on Ultrafine Particles. 2013. Understanding the Health Effects of Ambient Ultrafine Particles. HEI Perspectives 3. Health Effects Institute, Boston, MA, p. 24
Wilhelm, M. and Ritz, B., Residential Proximity to Traffic and Adverse Birth Outcomes in Los Angeles County, Environmental Health Perspectives (vol. 111, No. 2, Feb. 2003)
Edwards, J.; S. Walters, et al., Hospital admissions for asthma in preschool children: relationship to major roads in Birmingham, United Kingdom. Archives of Environmental Health. (49(4): 223-7 1994)
San Diego Freeway (I-405) Supplemental Draft Environmental Impact Report / Environmental Impact Statement, Figure 3.2.6-4 Sensitive Receptor Locations, California Dept. of Transportation (2013) (freeway widening project)
Raz, R., Roberts, A.L., Lyall, K., Hart, J.E., Just, A.C., Laden, F., and Weisskopf, M.G., Autism Spectrum Disorder and Particulate Matter Air Pollution before, during, and after Pregnancy: A Nested Case–Control Analysis within the Nurses' Health Study II Cohort, Environmental Health Perspectives (2014)