**From:** Maria Ristow <ristows@comcast.net>
**Sent:** Friday, July 08, 2016 7:03 PM
**To:** Council; Planning; Laurel Prevetti; Joel Paulson
**Subject:** North 40 Phase One application comments

Mayor Spector, Vice Mayor Sayoc, and Council Members Jensen, Rennie and Leonardis,

I am sending you an article I have written for LGCA, in response to a flier opposing the North 40 Phase 1 application. While reasonable people may disagree over facts, this flier, distributed widely through Next Door, Facebook, email lists and in paper form, contains a large number of inaccuracies.

LGCA strives to ask questions, search out facts and look for solutions. This flier appears to embrace none of that.

Thank you for reading yet another email about the North 40 Phase One application.

## SOME INCONVENIENT TRUTHS

**A flier as published on FB, Next Door and distributed in emails. LGCA finds this document full of inaccuracies.**

Comments and corrections below in *italics*.

FINDINGS FOR DENIAL: THE PROPOSAL DOES NOT FULFILL THESE REQUIREMENTS, WHICH THE TOWN HAS MANDATED THROUGH ITS SPECIFIC PLAN

The proposed development is required to "look and feel like Los Gatos." P 1.1
The drawings for the Phase 1 proposal show boxy, massive, industrial style 3 -5 story buildings that have nothing in common with the look and feel of Los Gatos

*Whaaaaat????? There is NOTHING 5 stories in the Phase 1 proposal (I looked again). The housing is permitted to only be 25 feet high in some parts of the Lark District and up to 35 feet in parts of Lark District and elsewhere, up to 2-3 stories. The affordable senior housing is located on the Market Hall and parking structure (in the Transition, not Lark District), and it is ONE BUILDING in total, at 4 stories. If people don't like the architectural style, that can be discussed in A&S, but the "3-5 stories" is a ludicrous and incorrect statement.*

The Specific Plan says "Lower intensity residential and limited retail/office uses are envisioned…" for the Lark District (Lark/Los Gatos Blvd.) (pp.2-3) The developer has instead proposed highly intense development—including massive 6-, 7-, and 8-unit 3-story rowhome complexes and commercial/residential space up to 51 ft. high. (This is taller than the Albright buildings.)



EXHIBIT 35

*While everything proposed in the Lark district is a max of 25 feet tall along Lark and Los Gatos Boulevard and 35 feet tall toward the center, only the affordable senior housing located on top of the Market Hall and parking structure (in the Transition District) is permitted to go to 45 feet, and I believe the elevator shaft goes to 51 feet. For all who forgot, the Albright Buildings are SOLID RECTANGLES with two at 50 feet tall and two at 65 feet tall (exclusive of mechanical equipment). So how does one feature on one 45-foot tall building make the housing "taller than the Albright buildings" which also may be taller than their nominally stated heights????? Seriously, I'm blown away by the 72% of this Town that voted for the Albright buildings and now can't remember what they supported. The North 40 Phase One application is not as tall, or intense, or traffic-generating as Albright.*

The proposed development must "embrace hillside views, trees, and open space." P. 1.1
The intensity and height and layout of the buildings block hillside views and provides minimal open space.

*The Phase One application meets the 30% required open space requirement. How is this possibly MINIMAL? Compared to what? No Planned Development of even HALF the density of the North 40 has one-fourth the open space. At least one of the public open areas proposed on Phase 1 is as large as the Plaza downtown, plus there are several more slightly smaller spaces. For reference, Santana Row has 1-2% open space!*
*All solid buildings block hillside views. So do trees. Walk anywhere in town and look around. Unless you are on top of a mountain, something will block your view at some point. Clumping residential units together and stacking them provides MORE open space, and the present application has more open space than any other development in Los Gatos.*

*I attended the Planning Commission Special Meeting maybe two years ago where commissioners and members of the public were allowed to walk through much of the North 40. Ask anyone who was there-- through all the trees, one could NOT see the hillsides in the present state. We are certainly NOT going to deny trees for this, are we?*

Relocating some of the residential in the Lark District to the North would alleviate some of the loss of views as would reducing the height and create more open space.

*As to the distribution of housing among the districts, Phase 1 proposes 193 units in the Lark District, and 127 units in the Transition District, which leaves 44 to carry over to the Northern District. (270 units + bonus units = 364). When taken together with the location of the retail/garage/senior housing structure towards the north end of the Transition District, the Phase I proposal is consistent with the Specific Plan, which calls for a lower intensity of use (height, mass, traffic etc). Within the Lark District there would be a primary emphasis on residential, in the Transition District new development (residential and commercial), moving to greater intensity*

*commercial development in the Northern District. The reduced number of housing left for the Northern District is consistent with the Specific Plan requirement that commercial uses be located where they will have the least impact on residential uses. Others may disagree, but at least understand how the Specific Plan calls out the various types of uses and where it allows or encourages them.*

*Further, relocating some of the residential could then put more commercial in the Transition district. That brings more traffic. How does this reduce intensity??? Residential is the least intensive from a traffic point of view. How does height get reduced? Height restrictions are the tightest in the Lark District. And the housing Element has zoned the N40 for 13.5 acres at 20 dwelling units/acre, so this is the density the Town has set. Between the density the Town set and the max height limit of 35 feet (except for affordable or hotel), the cluster cottages (the only detached housing permitted in the Spec Plan) likely impossible to build, as the density would need to be increased further in other residences.*

The proposed development must "incorporate the site's unique agricultural characteristics." P. 1.1 All the walnut trees will be removed. The site will be planted with other trees, mostly deciduous, that will take years to grow.

*Please read the Phase 1 proposal for the trees. Drought tolerant plantings are required in most places, and the periphery and inner ares will have orchard trees. The application is proposing a variety of fruit trees, to reflect the agricultural roots of the valley. Fruit trees can be planted closer together than walnut trees and ground-covering natives like mustard and lavender can be planted beneath, but if the TC prefers walnuts, then that will be the tree. Walnuts need to be spaced further and undergrowth is not viable. But that is up to the Town and TC. If the fruit trees are planted, the fruit will be gleaned and sold at the Market Hall, plus be available to those in the senior affordable housing. This was covered at the CDAC hearing.*

*If you want to check anything, please see the EIR, Specific Plan, Housing Element, Phase One application, and the Q&A from the Study Session. Don't just believe what ANY one person publishes! (Including me. I can make mistakes.) I see no point in creating hysteria with half-truths and lies. I can accept that those armed with facts may still dislike the proposal, but it helps if we all start from the same point.*

*The Specific Plan, as Council Member Marcia Jensen pointed out at least once, was created to be a bit non-specific to give the Town Council room for discretion. Aspects of the Proposal can be discussed and reviewed. But starting from a point where the public is getting outright misinformation is not fruitful to this process.*

There is no amenity that "incorporates the site's unique agricultural characteristics." The developer claims the marketplace, A STORE, will fulfill this requirement.

*The entire application is set into a functioning agricultural setting, and there are proposed*

*community gardens for residents and demonstration gardens for commercial users. The orchard trees are not just there as eye candy.*

The Specific Plan states the development should "address the Town's unmet needs." P 1.1
Move-down housing for the Town's seniors and millennial housing is not provided.

*As mentioned by at least one Council member, who says seniors can't move into any of the proposed housing? And of course the affordable housing is for seniors.*

*Only 49 very low income senior apartments are provided. No other affordable housing will be built.*

*This is more affordable housing at the lowest level of affordability than has been built in Los Gatos. And certainly a 1200-sf townhouse will be more affordable than the 4000-and up-sf homes going up else where in this town. By zoning 13.5 acres of the North 40 at 20 units/per acre, the Town planned for affordable housing, and that is what we are required to do. Los Gatos does NOT build housing and can not mandate exactly how the affordability levels will be distributed. I learned a lot about this sitting on the Housing Element Advisory Board.*

The retail as proposed duplicates that provided elsewhere and competes with rather than complements the downtown commercial space. P2.2

*What does the Market Hall duplicate? Why can't there be a neighborhood restaurant? Do we expect to build all this housing and then force the residents into CARS for food and services?*

The proposed development doesn't "minimize or mitigate impacts on town infrastructure, schools, and other community services." P 1.1
Schools, street, and other services will be adversely affected

*Yet there is an unprecedented agreement with the developers and school district, above and beyond SB50 to address school impacts. The schools will get more than $6,000,000 with this agreement if the living units go into Phase 1 as requested by the school district. If you put more students in the Northern District, Los Gatos tax payers will likely pick up the cost of their education, and the other school districts will get the state funds. Sound like a Catch 22? It is!*

Mitigation measures are based on dated studies and do not sufficiently address adjacent pending and incomplete developments.

*The EIR (if you actually read it) covered all the recent and planned developments.*

The Specific Plan states the intent is "to provide a comprehensive framework in which development can occur in a planned, logical fashion rather than a piecemeal approach." P 1-1
Phase I includes only a portion of the 44 acres. The current application is just part of a piecemeal approach since no information is provided about Phase II.

*The entire point of a Specific Plan is to lay the ground rules so any number of applications can come in and comply. The assumption of a Specific Plan is that there are multiple owners and phases, so one set of guidelines is set for the entire property.*

OTHER ISSUES

The Specific Plan calls for residential development throughout the North 40, not just in this Phase. However, the developer includes all 320 units in the first 20 of the 44 acres. All these homes would be within the Los Gatos School District.

*The Los Gatos school district covers about 2/3 of the North 40.*

*The Specific Plan includes maximums for housing, height, and commercial space. The developer has chosen to use all of these maximums even though at least some lower buildings would be appropriate.*
*Most applications start at the max and ask for exceptions. This proposal complies.*

The proximity to Highway 17 is a potential health and safety issue for residential properties due to fumes and toxins from automobile pollution.

*The EIR addressed this and requires mitigations.*

**A final comment:**

**The flier starts with the assertion that as proposed, the development will destroy our Town's small-town character forever.**

*Really??? We KNOW more housing and 60k ft of commercial will DESTROY our small-town character? Seriously? There are people north of Blossom Hill Road BEGGING for something they can walk to, other than the burrito/coffee/burger trio that keep showing up at the strip malls. Possibly offering a Market Hall and another sit-down restaurant (as Viva is the only one in Town north of Blossom Hill) might actually allow more people a nice place to access by bike or foot. Talk to people on Oka or Highland Oaks. And those moving into the new residences in the North 40 will have something desirable nearby. How is planning a real neighborhood DESTROYING OUR Town's small-town character forever? Those who can't walk to downtown now, get in their cars and go to downtown Campbell, Santana Row, Valley Fair, Pruneyard, Westgate, Oakridge, or Saratoga now. How is getting more residents to leave their cars and stay in Los Gatos DESTROYING our town????*

Thank you,

--

***Maria Ristow***
***Los Gatos Community Alliance***

**From:** Carleen <carleen_schomberg@comcast.net>
**Sent:** Saturday, July 09, 2016 11:20 AM
**To:** Planning
**Subject:** North 40 and traffic congestion

To whom it may concern,
I am sure many others have already voiced their concerns regarding our serious traffic problems, but I needed to add my voice to the record. I drive down L.G. Blvd. almost every weekday afternoon to pick grandkids up from school. We already have a serious problem with congestion where, at times, I sit through two or three lights before I actually get across Samaritan Dr. It is also quite hazardous for people entering and exiting the businesses/homes on the same side of the street at RAMBLC pediatric. The addition of all that proposed traffic from homes and businesses is unimaginable. I don't know who did the traffic study, but it must have been done between 1 a.m. and 5 a.m. to be considered as feasible.
Please consider our already untenable situation with traffic passing through to and from Santa Cruz, the bad situation we already have, and the safety of bicyclists, pedestrians and cars entering and exiting the road. All that property should be able to handle is a very scaled down, low-height, low-density residential development. Even that would add more cars to an already bad situation. Let's not also have an eyesore in the process.
Thank you,
Carleen Schomberg

From: Jennifer Riano [mailto:jennifer.riano@gmail.com]
Sent: Saturday, July 09, 2016 1:55 PM
To: Joel Paulson
Subject: North 40

I'm strongly encouraging you to DENY North 40. I've enjoyed living in Los Gatos for the last 7 years and moved here for the TOWN feeling. Please vote to deny north 40.

Thank you.

Jennifer Riano
100 Escobar Ave.

**From:** hsupermike@gmail.com [mailto:hsupermike@gmail.com] **On Behalf Of** Michael Hsu
**Sent:** Saturday, July 09, 2016 5:26 PM
**To:** Joel Paulson; Planning; Sally Zarnowitz
**Subject:** Project North 40 concerns

Dear LG planning commission,

Thank you in advance for reading this letter.

My wife and I fell in love with Los Gatos years ago when we visited years ago. The city had such a charming, welcoming character, so different from all the other places in the bay area. You have mountains, beautiful trails, a wonderful downtown, great residents, and a town that's organized and laid out perfectly.

In fact, we loved it so much we knew we would buy a home and live in Los Gatos, and raise our children here. We got married 3 years ago, moved into Los Gatos 1 year ago, and now have a 6 month old son that was born at Good Sam.

We loved everything about Los Gatos. But when I found out about North 40 a few months ago, I couldn't believe it, but I was more curious.

When I realized the full scope of North 40, that's when I started worrying. A lot.

**- I worry about traffic and congestion**. You all know how bad the traffic is already. It's not just during the summer on weekends anymore. And it's not just downtown. It's getting worse and worse year round, all throughout the town. North 40 is going to make traffic 2x as bad, if not more.

**- I worry about LG becoming an undesirable place to live.** I've tried to convince numerous friends and relatives in the Bay Area to move to LG, but all of them worry about the traffic. I've also talked to a number of former residents that moved out as soon as their kids got old enough b/c they couldn't stand the traffic anymore. North 40 is only going to make this a much bigger issue.

**- I worry about my son and LG schools.** LG schools are already stretched near the limit. So what if North 40 gives the school district some money. Can our schools actually absorb all the projected new students over the next X years after North 40? Can the classrooms and teachers handle the increase? How much will the quality of education go down by? There's no way adding that many people can keep the bar as high as it is now, especially with the issues that already exist today.

**- I worry about LG losing it's charm.** We moved in because we love everything about the town. But the part of LG between the 85 and Lark Ave -- especially along Los Gatos Blvd -- is the part that is LEAST like the rest of LG. It has no character. If anything, North 40 should be an opportunity to turn this part of town to be MUCH MORE like the rest of LG.

Unfortunately, from the vision and planning, that is not going to happen. And North 40 will feel even further from LG, and will attract people that may not care as much for the LG we know and love.

I'm not against developing the North 40 area, and I think it could be done in a way that adds a lot to the town. Not the way it's planned now.

Michael

**From:** edrathmann@comcast.net [mailto:edrathmann@comcast.net]
**Sent:** Saturday, July 09, 2016 9:31 PM
**To:** North40 Comment
**Cc:** Joel Paulson
**Subject:** North 40 July 12 meeting

Planning Commission,

As the owner of Main Street Burgers and Willow Street, I am writing in opposition to the proposed North 40 development. Many things define our community, but probably the most important is our charming downtown. The Downtown cannot be replicated by any new development, but it can be harmed by one. The North 40 development before you, will do serious damage to the economic vitality of the downtown. The Los Gatos downtown is a fragile entity and it requires a critical mass of people to be vibrant: people walking the streets and shopping. The North 40 Specific Plan allows for 400,000 new square feet of retail (60,000 sf in this first proposal). That is not much below the 525,000 sf of retail at Santana Row. Our downtown has not more than 230,000 sf of ground floor retail. Combine the North 40 project with the damage already done to the Downtown from competition by the revitalized downtown Campbell and we have the potential for a serious drop in people visiting our downtown. What happens if 10 to 20% less people visit the Downtown? The North 40 will have beautiful walking streets, plenty of new restaurants with outdoor seating, national retail stores, and abundant parking conveniently off the Lark Ave exit of Highway 17. As one of the current council members wrote during the North 40 study session: "It is difficult to see what specific restaurant and retail providers would not impact our downtown."

This North 40 proposal stands in direct contradiction to the Town's North 40 Vision Statement. How is 400,000 sf of retail " seamlessly woven into the fabric of our community...complementing...other Los Gatos residential and business neighborhoods." And supposedly the North 40 will "... address the Town's ... commercial unmet needs." Does Los Gatos have 400,000 sf of "commercial unmet needs"? Does anyone really believe that?

Do we want the downtown to become like Saratoga's? The North 40 will do to our downtown what Valley Fair and Santana Row has done to Downtown San Jose: destroy it. Our Downtown is under attack from traffic congestion, lack of parking, and competition. The Planning Commission and Council should be working to promote our Downtown, not voting for a second one.

I strongly urge you to vote against this North 40 development proposal.

Ed Rathmann

**From:** Liana Palmer <lianapalm@aol.com>
**Sent:** Sunday, July 10, 2016 10:04 AM
**To:** Planning
**Subject:** North 40

Dear Planning Commission,

I am in favor of approving the plan that is before the commission for the North 40. Dense housing and multi level homes and flats are the way of today and the future. Los Gatos cannot remain in the 1950ies with regard to our community. Urban sprawl is the past. It is time to confront the housing problems we have in the bay area, and to do our share to participate in the solution. We need to comply with state and housing element requirements.

Traffic will be a problem, but we can't solve everything at the same time. We will have to suffer a bit before we will all get behind the funding of town road improvements. Increasing local tax may be a necessity that Los Gatos has long avoided. We can no longer feel entitled to so much abundance in our town with no participation.

Schools will be impacted for a time, but provisions are in place for the district to have space in the plan to continue to provide an excellent education to our children in the classroom. Although the allotted space will not have the expansive play and sports area that Fisher and Blossom Hill have, or the decreasing area that Van Meter, Daves, and Lexington have, limited space for education is a reality of the present and the future. Our children will continue to be educated in the classroom. Families and 3rd party children's organizations will have to learn new ways of providing extracurricular experiences, such as visits to our abundant city, county, and state parks. Parents and the community will need to provide exposure for our kids to nature, sports activities, and open space.

I appreciate the efforts by the Yukis, the developers, and especially the volunteer time and dedication of the Planning Commission for the years spent tackling, refining and respectfully considering the thoughts and input of the community. Now is the time for Los Gatos to break ground in the North 40, build, welcome new Los Gatons to town, and join the 21st century.

Liana Palmer
16345 Los Gatos

**From:** Liana Palmer <lianapalm@aol.com>
**Sent:** Sunday, July 10, 2016 10:20 AM
**To:** lianapalm@aol.com; Planning
**Subject:** Re: North 40

Date:
July 10, 2016

To:
Los Gatos Planning Commission

From:
Liana Palmer
16345 Los Gatos Blvd, #30
Los Gatos, CA 95032
lianapalm@aol

Dear Planning Commission,

I am in favor of approving the plan that is before the commission for the North 40. Dense housing and multi level homes and flats are the way of today and the future. Los Gatos cannot remain in the 1950ies with regard to our community. Urban sprawl is the past. It is time to confront the housing problems we have in the bay area, and to do our share to participate in the solution. We need to comply with state and housing element requirements.

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I can say we still live in the 50ies, because my family moved here in the mid-40ies, I was born and raised here, and it hasn't changed all that much. Yes, I remember the orchards, but they were bull-dozed within a span of about 10 years making room for the boom time of the 60ies when highly paid and mid-range paid Lockheed and IBM engineers streamed into the Manor, Surry Farms, Daves Ave, Kennedy Road, etc, things haven't changed that much in terms of housing growth. We reached about 30,000 people, then suddenly everyone wanted to keep "charm" of the "town" which meant anti-

growth, anti-diversity, anti-low to moderate income. We have had a good 40 years of "containment" attitude in Los Gatos. It's time to give it up.

I appreciate the efforts by the Yukis, the developers, and especially the volunteer time and dedication of the Planning Commission for the years spent tackling, refining and respectfully considering the thoughts and input of the community. Now is the time for Los Gatos to break ground in the North 40, build, welcome new Los Gatons to town, and join the 21st century.

Liana Palmer

**From:** dcwestcott@aol.com [mailto:dcwestcott@aol.com]
**Sent:** Sunday, July 10, 2016 11:47 AM
**To:** Joel Paulson; Planning; Sally Zarnowitz
**Subject:** North 40, Too Dense

Dear Planning Commission

I am disturbed by the density of the North 40 proposal. It seem way too dense for the character of Los Gatos. As a long time resident, I've come to know and love the small town atmosphere, and this "city in a city" is not good for the town. Just the density of cars in the Los Gatos/Lear area should be a warning sign. Its already congested and would become a traffic nightmare. And there is no way around that!

Please turn down this proposal. It is not good fit for Los Gatos!

David C. Westcott

**From:** mmpmitzi@comcast.net
**Sent:** Sunday, July 10, 2016 11:47 AM
**To:** Planning
**Cc:** Marico Sayoc; BSpector; Rob Rennie; Steven Leonardis; Marcia Jensen
**Subject:** North 40

Dear Planning Commission and Town Council,

Please don't allow the proposed massive development in the North 40. The town streets and schools can not handle such mass. A one story, more spread out development would be better for the town and all of us who live here. We have gridlock on our streets now. I avoid the downtown and the shops on Los Gatos Blvd. because it takes me so long to get through the traffic and because of the lack of parking. Please don't add more!!

This is our only chance to save our quaint little town!!!

Thank you,
Mary Patterson

**From:** Susan Cahn <susancahn@earthlink.net>
**Sent:** Sunday, July 10, 2016 12:29 PM
**To:** Planning
**Subject:** **********Upset neighbor - Very against the proposal for the new construction and building on 401-409 Alberto Way **********

To the planning commission,
It is pretty unbelievable the size and especially the height of the proposed structures of 401 – 409 Alberto way. In particular the building that is next to my our complex – 435 Alberto Way.- Las Casitas - The building is so tall that the units that are adjacent to the building will have no privacy – where people will be able to look into their backyards and bedrooms. We all bought our units expecting to the have the privacy and this is completely unfair. My understanding is that the proposed entrance to the parking is also next to our units at Las Casitas which is going to provide a constant source of noise and vibrations even after the project is finished which is unfair with the car traffic. It is also dangerous for pedestrians trying to cross and cars trying to drive. Please consider moving the parking entrance away from our units.
I also heard what sounded like construction noise coming from the project adjacent to our units before 8AM both days of the weekend, and my understanding is this is unacceptable for Los Gatos ordinances and rules.
This is completely unbelievable to me that a project of this magnitude could be acceptable on our street. Please imagine if you had to live next to this proposed structure.

We had a trial run of what it would be like with all of the traffic and trucks with the repayment of the streets this last week; it was awful and will be horrible for all of Los Gatos because of the location, the traffic, big trucks, and especially bad for the people on our street or that have to get into down town Los Gatos or go on the HW 17.

Thanks for your consideration. Please consideration adjusting the scale of the project. The heights of the buildings and the location of the parking garage. Of course, my ideal wish would be that you would please reconsider approving any of the construction on this project

Thanks for your time!

Susan Cahn
408 395 5366

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**From:** Susan Cahn [mailto:susancahn@earthlink.net]
**Sent:** Wednesday, June 08, 2016 1:13 PM
**To:** 'planning@losgatosca.gov'
**Subject:** **********Upset neighbor - Very against the proposal for the new construction and building on 401-409 Alberto Way **********

To the Planning Commission:

I am very upset and 100% against the building and construction proposed for 401- 409 Alberto Way. I don't believe I will be able to attend the meeting today so I wanted to email you my following grievances that I have towards this construction project. I cannot leave my dog alone because of her health issues, and I don't have sitter for her.

My parents and my family have been residents of Los Gatos since I was 5, and I have been a homeowner and resident at 435 Alberto Way, #12 since 1992. I went to Van Meter, Fisher JR High, and Los Gatos High School.

I am very upset because there will be constant and a tremendous increase in traffic which will require a lot of extra time to get to and from my house and to the freeway and anywhere in Los Gatos or anywhere in general. The traffic is already very bad and has increased over the years in Los Gatos. Sometimes, especially in the day or from~ 5PM through ~7PM, it takes 10 + minutes to travel to downtown LG or to my Vet, etc. in Los Gatos from my home when it should only take about 3 minutes. The construction will create traffic jams to get on to the freeway or to try to return to or leave our houses which will require more time waiting at the lights, etc. and which will affect all residents in Los Gatos. This will be very dangerous for the emergency vehicles such as ambulances and the fire department who help and serve residents with health concerns, especially the elderly residents that live in the Senior Condo complex on Alberto Way.

I am also extremely upset about the fact that there will be constant banging and noise that the construction will create. I work all day through the late evening and into the early morning every day until at least 430AM or 5AM at my house, and I need to be able sleep in the morning until about 11AM with constant banging from the construction, it will be extremely hard to sleep and will be very disturbing to me, my dog, and all of neighbors and their dogs, cats, and families (with lots of kids). I also need to be able to make important work calls from home since I work out of my home so the constant banging from the construction will make it hard to have any important work calls. The constant banging will be detriment to the my health and peace of mind; it will contribute to an inability to sleep, constant noise which will create a lot of anxiety for me and my neighbors, their families and their dogs and cats.

Sometimes I have migraines /headaches and /or repeated extreme neck pain sometimes for 3 days with some breathing issues (related to chemicals and smoke), and I am very concerned that about the added noise and stress from the construction projects will make my headaches and neck pain more prevalent and worse in intensity without the ability to rest when I need to or the banging may trigger additional episodes.

It will be very dangerous to try to cross the street on foot to walk my dog or to walk in general – trying to avoid the construction trucks (and extra traffic) that do not typically come to our street. We have a lot of children (many very young children) who are residents on Alberto Way and especially at 435 Alberto Way, and there are 100s of elderly and retired individuals who live on Alberto Way in the Senior Citizen condos that will be in danger walking on the sidewalk, the street, and crossing the streets or driving, and also many elderly residents on Alberto way individuals have to walk because they can no longer drive, and there are a lot of residents that walk (with or without their dogs), etc. We all will have a significant amount of potential danger that we would not have because of construction, the extra traffic and additional people travelling to our street.

I am also concerned about workmen coming to our quiet residential neighborhood for safety reasons; being a single lady, I don't want folks driving into our neighborhood who are not residents which definitely includes construction workers who are typically men. There is already a lot of crime on the street (a lot of car break-ins, and some property thefts) and the construction will bring in unwanted individuals, which could and will most likely lead to an increase in crime.

I believe this construction project will bring down our property values with the construction, traffic, noise pollution, etc. People will not be able to sell or rent out their units since no one will want to buy or rent near this huge proposed construction project. There is already limited street parking on Alberto Way so the extra vehicles on the street will make it very difficult for residents and their guests to enjoy the quality of life and conveniences that they have been enjoying related to enjoying a quiet and peaceful life, parking near their homes for convenience, being able to travel on a timely basis in their cars, walking without worrying about getting run over by construction trucks and the extra traffic associated with this project, etc.

Additional, you can't use mixed commercial / residential or commercial zoning properties for comparables for real estate or mortgage matters or transactions (part of the appraisals, etc.) with residential condos or townhouses /PUDs (our existing housing units on Alberto); therefore, a future newly finished condos at 401 - 409 (which I believe are included in this project) won't help anyone's residential property values as some people erroneously think it will.

There will also be nails and other sharp objects that could puncture our tires which could provide a safety hazard, unfair costs, and extra unexpected time inconveniences, which could lead to an emergency situation if we can't get to a medical or veterinary office or hospital, especially if residents only have 1 car per family or household or if they are the only one home. (I only have 1 car.) I have a dog who has a lot of health problems and older parents, and I need to be able to get to the Vet or possibly to help my parents (who also live in Los Gatos) ASAP at times.

I absolutely don't think it is fair to have such a horrible disturbance. The residents that live on Alberto Way should have the right and opportunity to rest and have a quiet peaceful home life and work life like the rest of the people do in Los Gatos.

Please call me if you have any questions.

**You have permission to read this email at the planning meeting tonight, but please don't read my name, my unit number or phone number out loud at the meeting. You can say which complex I live at in general - 435.**

Thanks for your time, understanding, and consideration. Please don't let Shane Arters, LP Acquisitions and /or any other parties related to the proposed construction project 401 – 409 Alberto way, proceed forward.

Thanks,

Susan Cahn
408 395 5366

On Jul 10, 2016, at 3:17 PM, Martha Wills <mtswills@gmail.com> wrote:

Dear Town Council members,

I strongly urge you to DENY the current application for the North 40 development on these grounds:

1) All of the Phase 1 housing is located in the Los Gatos Union School District. This plan will maximize profits for the developer but will likely contribute to overcrowding at Los Gatos elementary schools and Fisher Middle School.

2) A project of the size and scope proposed by the developer cannot but adversely affect traffic flow on Los Gatos Boulevard and the surrounding areas. The town is trying to deal with massive beach traffic on 17; adding this much commercial and residential development near 17 and Lark is a recipe for compounded traffic woes for residents.

3) The proposed development is required to "look and feel like Los Gatos," but drawings indicate large, boxy buildings that have little in common with the traditional look and feel of Los Gatos.

I urge you to listen carefully to voices of caution regarding this parcel of land. As I see it, only the developer is in a rush to put high-density houses and retail on that property. The rest of us will be forced to deal with the negative consequences as long as we live in Los Gatos.

Yours sincerely,

Martha Wills
229 Vista del Monte

**From:** Janise Burford [mailto:janiseburford@gmail.com]
**Sent:** Sunday, July 10, 2016 6:05 PM
**To:** Joel Paulson; Planning; Sally Zarnowitz; BSpector; Marico Sayoc; Rob Rennie; Steven Leonardis; Marcia Jensen
**Subject:** Proposed North 40 Development

To: The Planning Commssion
The Los Gatos TOWN Council

Re: Proposed North 40 Development

As a small business owner and a resident of Los Gatos 95033, I spend many hours frequenting the TOWN of Los Gatos for shopping, dining and the small TOWN atmosphere. I have been a resident for 9 years. I was born and raised in the Inland Empire of Southern California and moved to Los Gatos to escape the urban sprawl and overcrowding of So Cal. It breaks my heart to see the development proposal on the North 40!!!! I was born in 1951 and during my childhood Redlands, CA was similar to Los Gatos. Over the years I watched the deterioration of my once beautiful homeland as shopping malls and hordes of people moved in. All in the name of progress. That "progress" has left So Cal a wasteland. When I saw the LOOMING orange development tape on the North 40 I was reminded of the demise of So Cal. I had time to reflect because I was once again dead stopped - that area of Hwy 17 is extremely impacted already and traffic is nightmare. I can't imagine what will happen when more people move into the development. Let's not forget those same people will get hot in the summer and add to the NIGHTMARE traffic jams we currently see now doing the 17 crawl to the coast. Making a roundabout at the south end of town is a bandaid for what is to come if that development

proceeds. The entire TOWN will become gridlocked. Remember the 4th of July 2015?

The following development will violate the following from P.1.1:

* " look and feel like Los Gatos"- NOT SO CAL
* " embrace hillside views, trees and open space" - not wall to wall concrete as seen in So Cal
* "incorporate the site's unique agricultural characteristics"- How can the walnut trees remain if that monstrosity goes in?
* " minimize or mitigate impacts on town infrastructure, SCHOOLS, and other community services"- Schools are already overcrowded, streets are frequently jammed,

Please do not allow this development to ruin the charming town of Los Gatos.

Kindest Regards,

**Janise Burford**
**Amore Pet Sitting Services LLC**
**408.741.5408**

***"We can judge the heart of a man by his treatment of animals."*** *Immanual Kant*
***"Until one has loved an animal, a part of one's soul remains unawake."*** *Anatole France*

**www.amorepetsittingservices.com**

**From:** beccabergeron@gmail.com [mailto:beccabergeron@gmail.com]
**Sent:** Sunday, July 10, 2016 10:56 PM
**To:** Sally Zarnowitz; BSpector; Marico Sayoc; Rob Rennie; Steven Leonardis; Marcia Jensen
**Subject:** Experience with Grosvenor

Dear Planner and Town Council Members:

My name is Becky Bergeron; I am granddaughter to Pete Brutsche, a long time property owner on Bennett Way in Los Gatos. I am writing today to let all of you know how much I appreciated the care with which my Grandpa Pete was treated during the process of selling his home. As you can imagine, it was a momentous decision to sell! Throughout the entire transition our family was treated with respect and dignity. We are all especially grateful that Grandpa Pete was able to spend the rest of his days in his own home, passing away peacefully last February at the wonderful age of 100.

Sincerely,

Becky Bergeron

408/580-4646

**From:** Jeff Loughridge <lokrij@comcast.net>
**Sent:** Sunday, July 10, 2016 11:47 PM
**To:** Laurel Prevetti; Joel Paulson; Marni Moseley; Robert Schultz; Planning
**Cc:** BSpector; Marico Sayoc; Steven Leonardis; Rob Rennie; Marcia Jensen
**Subject:** DESK ITEM FOR N40 MEETING: Response to the "A CITY WITHIN A TOWN!" flyer

**7-10-2016**
**To: Planning Commission and Town Council**
**From: Jeff Loughridge**
**Re: Response to the "A CITY WITHIN A TOWN!" flyer**

I think that it is irresponsible to distribute a flyer which presents opinions without supporting facts. Before I make any decision, I'd need to have facts so that I might be able to use my intellect and come to my own conclusions.

The flyer that was presented here was filled with misleading information to try and get support for a particular conclusion. After reading this you may come to the same conclusion you had before, but you will have done so with a few more of the fact in the process. Hopefully this information will help to create a more informed group of residents who can help to sort out this complicated problem.

I have found that most facts are difficult to research and assemble, especially on a complicated project like the N40. Let's face it, the N40 deals with many complex issues that are dear to our hearts, as Los Gatos residents. But facts should be used to make any argument. Not tactics that convince people to follow blindly using only information that supports your argument while ignoring the real facts. Especially purposely leaving out facts that would support a different conclusion.

The Community Alliance has struggled, and continues to struggle, to present hard-to-research facts of many issues around town so that residents can make up their own minds.

Now if the reason that you don't want the N40 is just that you don't want it, I can appreciate that. That, by itself is an argument. But to publish misleading information to try to sway people to a particular way of thinking is just plain wrong. Unethical.

I've included some facts on this issue below in red to hopefully shed a bit of light on some of the erroneous conclusions and misinformation that this flyer presents.

Jeff Loughridge

-------START OF FLYER-------

FINDINGS FOR DENIAL:
**THE PROPOSAL DOES NOT FULFILL THESE REQUIREMENTS, WHICH THE TOWN HAS MANDATED THROUGH ITS SPECIFIC PLAN**

1. The proposed development is required to "look and feel like Los Gatos." P 1.1
   *RESPONSE:* **Los Gatos doesn't have any particular look or feel. It is made up of many looks and many feels from the downtown to the west side of town to the north and to the east. All different, as are the various office buildings spread across town. Some of these as well as some homes are downright ugly. That is still how Los Gatos looks and feels.**

   a. The drawings for the Phase 1 proposal show boxy, massive, industrial style 3 -5 story buildings that have nothing in common with the look and feel of Los Gatos
      *RESPONSE:* **There is NOTHING 5 stories in the Phase 1 proposal. The housing is permitted to only be 25**

feet high in some parts of the Lark District and up to 35 feet in parts of Lark District and elsewhere, up to 2-3 stories. The affordable senior housing is located on the Market Hall and parking structure (in the Transition, not Lark District), and it is ONE BUILDING in total, at 4 stories

2. The Specific Plan says "Lower intensity residential and limited retail/office uses are envisioned..." for the Lark District (Lark/Los Gatos Blvd.) (pp.2-3) The developer has instead proposed highly intense development—including massive 6-, 7-, and 8-unit 3-story rowhome complexes and commercial/residential space up to 51 ft. high. (This is taller than the Albright buildings.)
   *RESPONSE:* Calling 20 units per acres intense is misleading. 20 units per acre is the MINIMUM state requirement for affordable housing. Plus, the percentage of the overall site coverage over 45' = .0055% As an example, Santana Row is 75 units per acre.

3. The proposed development must "embrace hillside views, trees, and open space." P. 1.1
   a. The intensity and height and layout of the buildings block hillside views and provides minimal open space.
      *RESPONSE:* Definitely if you stand on the other side of a building you will be deprived of a hillside view. This is true of ANY building in town. As far as open space is concerned, the N40 proposal includes the following open spaces...
      *Community Park: 22,000 + sf Passive and active open space*
      Amenities include: Multiple outdoor dining areas w/ large communal table, café tables and chairs, outdoor grills, lounge seating, bocce court, firepits & fireplace, community gardens, orchards with benches and hammocks
      *Grand Paseo: 8,000 sf Passive open space*
      Amenities include: 1,000 sf mixed fescue lawn area, water fountain courtyard with seating, fire table courtyard, orchard and wide seat steps
      *Courtyard Plaza: 9,500 sf Passive/lightly active open space*
      Amenities include: flexible public gathering spaces, lounge seating, dining areas, movie wall, café tables/chairs, seat walls
      *2 Pocket Parks: 2,800 and 3,200 sf Active/Passive open space*
      Amenities include: mixed fescue lawn areas, benches, dog water stations, dog bag stations
      *Demonstration Gardens: 5,000 sf Active open space*
      Amenities include: Kitchen gardens, gardening and harvesting demonstration areas
      *These calculations do not include the orchard setbacks along Lark/Los Gatos Boulevard or A Street, or the pedestrian paseos throughout the project.*

   b. Relocating some of the residential in the Lark District to the North would alleviate some of the loss of views as would reducing the height and create more open space.
      *RESPONSE:* As to the distribution of housing among the districts, Phase 1 proposes 193 units in the Lark District, and 127 units in the Transition District, which leaves 44 to carry over to the Northern District. (270 units + bonus units = 364). When taken together with the location of the retail/garage/senior housing structure towards the north end of the Transition District, the Phase I proposal is consistent with the Specific Plan, which calls for a lower intensity of use (height, mass, traffic etc). Within the Lark District there would be a primary emphasis on residential, in the Transition District new development (residential and commercial), moving to greater intensity commercial development in the Northern District. The reduced number of housing left for the Northern District is consistent with the Specific Plan requirement that commercial uses be located where they will have the least impact on residential uses. Others may disagree, but at least understand how the Specific Plan calls out the various types of uses and where it allows or encourages them.

4. The proposed development must "incorporate the site's unique agricultural characteristics." P. 1.1
   a. All the walnut trees will be removed. The site will be planted with other trees, mostly deciduous, that will take years to grow.

*RESPONSE:* Walnut trees are a huge mess to maintain and even the Yukis don't suggest keeping them. The original crops was different anyway. Approx. 500 proposed new orchard trees
+ Approx. 1200-1300 additional trees are proposed in Phase 1
Total: 1700-1800 new trees in Phase 1
Note on the existing walnut trees: The existing walnut trees are nearing the end of their lifespan and are on the decline. New orchards of various fruiting trees will be planted to honor the agricultural history of the site
Please read the Phase 1 proposal for the trees. Drought tolerant plantings are required in most places, and the periphery and inner ares will have orchard trees. The application is proposing a variety of fruit trees, to reflect the agricultural roots of the valley. Fruit trees can be planted closer together than walnut trees and ground-covering natives like mustard and lavender can be planted beneath, but if the TC prefers walnuts, then that will be the tree. Walnuts need to be spaced further and undergrowth is not viable. But that is up to the Town and TC. If the fruit trees are planted, the fruit will be gleaned and sold at the Market Hall, plus be available to those in the senior affordable housing. This was covered at the CDAC hearing.

b. There is no amenity that "incorporates the site's unique agricultural characteristics." The developer claims the marketplace, A STORE, will fulfill this requirement.
*RESPONSE:* The entire application is set into a functioning agricultural setting, and there are proposed community gardens for residents and demonstration gardens for commercial users. The orchard trees are not just there as eye candy.

5. The Specific Plan states the development should "address the Town's unmet needs." P 1.1
   a. Move-down housing for the Town's seniors and millennial housing is not provided.
   *RESPONSE:* These were both eliminated by the Town Council ruling of a maximum of 35 feet.

   b. Only 49 very low income senior apartments are provided. No other affordable housing will be built.
   *RESPONSE:* That's 20% of the housing, same as our BMP regulations.
   What is proposed is affordable housing at the lowest level of affordability than has been built in Los Gatos. And certainly a 1200-sf townhouse will be more affordable than the 4000-and up-sf homes going up elsewhere in this town. By zoning 13.5 acres of the North 40 at 20 units/per acre, the Town planned for affordable housing, and that is what we are required to do by the state, whether we like it or not. Los Gatos does NOT build housing and is not allowed to mandate exactly how the affordability levels will be distributed. I learned a lot about this sitting on the Housing Element Advisory Board.

   c. The retail as proposed duplicates that provided elsewhere and competes with rather than complements the downtown commercial space. P2.2
   *RESPONSE:* So having another restaurant competes with those downtown? Where are the residents in the North supposed to dine? Campbell? Retail here competes more with Campbell and San Jose more than it does our downtown.
   What does the Market Hall duplicate? Why can't there be a neighborhood restaurant? Do we expect to build all this housing and then force the residents into CARS for food and services?

6. The proposed development doesn't "minimize or mitigate impacts on town infrastructure, schools, and other community services." P 1.1
   *RESPONSE:* Yet there is an unprecedented agreement with the developers and school district, above and beyond SB50 to address school impacts. The schools will get more than $6,000,000 with this agreement if the living units go into Phase 1 as requested by the school district. If you put more students in the Northern District, Los Gatos tax payers will likely pick up the cost of their education, and the other school districts will get the state funds.

   a. Schools, street, and other services will be adversely affected

b. Mitigation measures are based on dated studies and do not sufficiently address adjacent pending and incomplete developments.
*RESPONSE:* **No study can take into account the future, but this study took into account far more than what is being proposed. The EIR (if you actually read it) covered all the recent and planned developments.**

7. The Specific Plan states the intent is "to provide a comprehensive framework in which development can occur in a planned, logical fashion rather than a piecemeal approach." P 1-1.
*RESPONSE:* **The entire point of a Specific Plan is to lay the ground rules so any number of applications can come in and comply. The assumption of a Specific Plan is that there are multiple owners and phases, so one set of guidelines is set for the entire property.**

    a. Phase I includes only a portion of the 44 acres. The current application is just part of a piecemeal approach since no information is provided about Phase II.
    *RESPONSE:* **Without an approved Specific Plan, piecemeal development will continue as it has on that section of Los Gatos Blvd.**

**OTHER ISSUES**

1. The Specific Plan calls for residential development throughout the North 40, not just in this Phase. However, the developer includes all 320 units in the first 20 of the 44 acres. All these homes would be within the Los Gatos School District.
*RESPONSE:* **The Los Gatos school district covers about 2/3 of the North 40.**

2. The Specific Plan includes maximums for housing, height, and commercial space. The developer has chosen to use all of these maximums even though at least some lower buildings would be appropriate.
*RESPONSE:* **Most applications start at the max and ask for exceptions. This proposal complies. When the maximums were brought down to 35 feet by Council, yes the developers chose to go to that height for most of the development. Except those housing units and building fronting Lark or Los Gatos Blvd. Those were kept at 25 feet.**

3. The proximity to Highway 17 is a potential health and safety issue for residential properties due to fumes and toxins from automobile pollution.
*RESPONSE:* **The EIR addressed this and REQUIRES mitigations.**

## Planning Commission Meeting 7-12-16

**Dear Planning Commissioners,**

**I support the 270 housing units, 50 Senior affordable housing units and 66,000 square feet of commercial development.**

**What I am opposed to is locating the housing units in what Figure 15 of the N40 EIR delineates as an area that is considered a higher health risk area along the 17 Freeway.**

**Please review the research I have included regarding the Health Hazards of living near a highway.**

**According to the Sierra Club report, below is a list of health hazards if you live close to a freeway.**

- **Children Living Near Busy Roads More likely to Develop Leukemia, Cancer**
- **Road Traffic Contributes to the Origin of Childhood Leukemia**
- **Soot Particulate Matter Linked to Lung Cancer, Cardiopulmonary Mortality**
- **Truck Traffic Linked to Childhood Asthma Hospitalizations**
- **Pregnant Women Who Live Near High Traffic Areas More Likely to Have Premature and Low Birth Weight Babies**
- **Traffic Increased Cancer**
- **People Who Live Near Freeways Exposed to 25 Times More Soot Particulate Pollution**
- **Lung Function Reduced Among Children Living Near Truck Traffic**

- **Traffic-Related Air Pollution Associated with Respiratory Symptoms in Two-Year Old Children**
- **Asthma Symptoms Caused by Truck Exhaust**
- **Proximity of a Child's Residence to Major Roads Linked to Hospital Admissions for Asthma**
- **Exposure to Cancer-Causing Benzene Higher for Children Living Near High Traffic Areas**
- **Air Pollution from Busy Roads Linked to Shorter Life Spans for Nearby Residents**
- **Exposure to Nitrogen Dioxide (NO2) from Vehicles Exacerbates Asthma Attacks**
- **Five Times More Deaths Due to Air Pollution than Traffic Accidents**
- **Motor Vehicle Air Toxins Cause High Pollution Levels Inside Homes**

**I understand that other communities are doing this, but that does not make it right.**

**Putting Housing Units along the 17 Freeway within the designated area is IRRESPONSIBLE!**

**Children don't have a choice, but you do. Recommend to the Town Council that the Developer move the Housing Units farther away from the Freeway and put an office building in that area with fixed windows and filtered HVAC.**

**Thank you,**

**Anne Robinson**
**201 Charter Oaks Circle**
**Los Gatos, CA 95032**


***Legend***

Project Boundary

Cancer Risk Over 10 per Million

Fine Particulate Matter Concentrations over 0.3 Micrograms per Cubic Meter

Point of Greatest Effect

0 400 feet

Source: Illingworth and Rodkin, Inc. 2013, Google Earth 2011

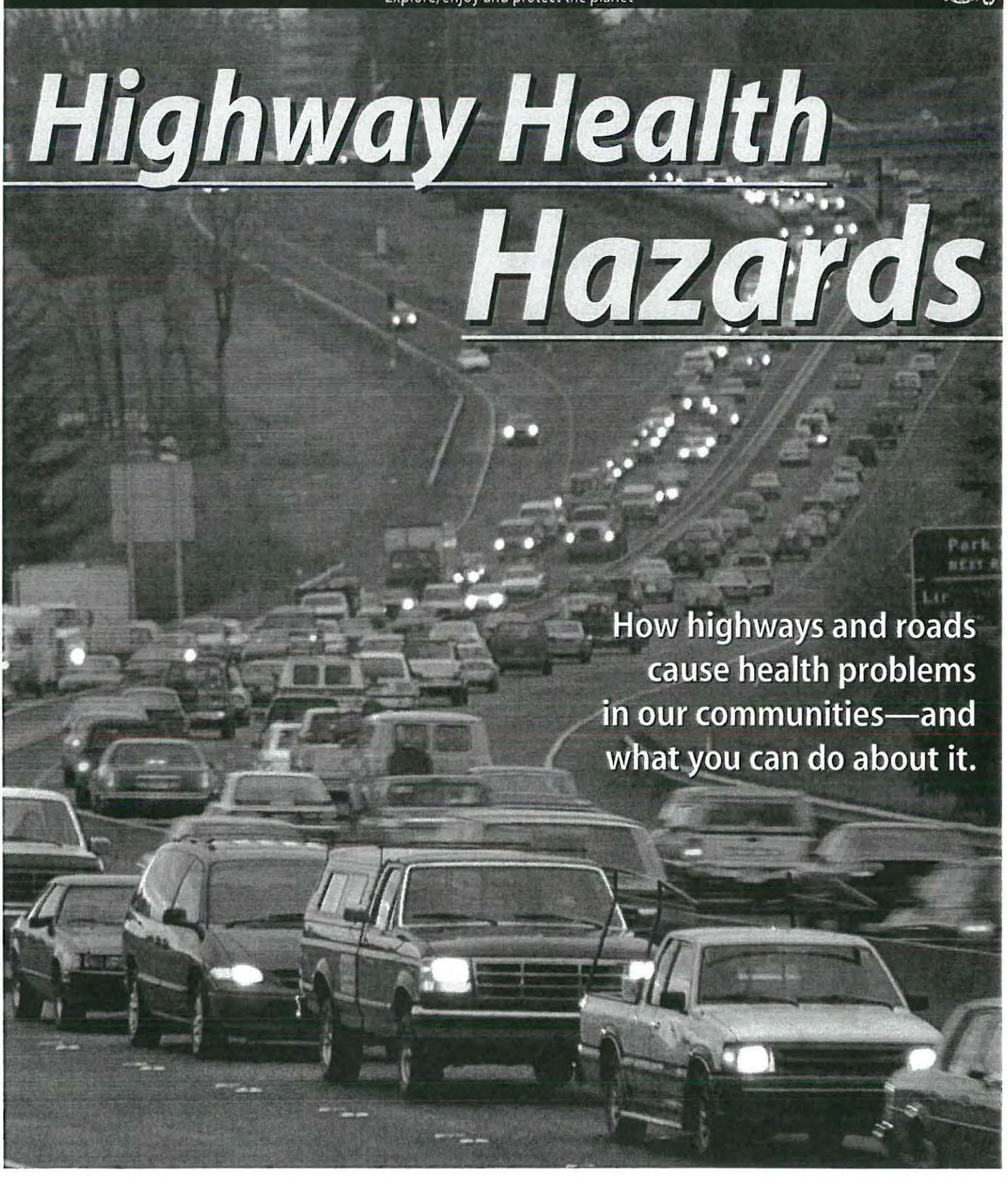
Figure 15

# Health Risks

North Forty Specific Plan EIR

SIERRA CLUB
FOUNDED 1892
Explore, enjoy and protect the planet

# Highway Health Hazards



How highways and roads cause health problems in our communities—and what you can do about it.

# Highway Health Hazards

## Acknowledgements

This report was made possible through the hard work of many Sierra Club staff and interns including:

**Research, Writing, and Editing**
Brett Hulsey, Ed Hopkins, Eric Olson, Erin Burg, and Michael Carlson.

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Brian Vanneman

**Cover Photography**
PhotoDisc

A special thanks to The Environmental Law and Policy Center for assisting with and compiling research. Much gratitude to Professor Howard Wachtel and Associate Professor Tim Buckley for their technical input.

This report is one of many reports the Sierra Club issues about sprawl. To read previous reports or for more information in our Challenge to Sprawl Campaign, please visit our web site at: *www.sierraclub.org/sprawl.*

This report has been funded by The Sierra Club Foundation.



# Executive Summary

"Traffic presents a unique public health threat due to the toxicity of its emissions and its extensive integration into our lives and communities. The stakes are high including excess cancers and children's asthma rates occurring at epidemic proportions. This threat can no longer be ignored; it must be clearly understood and addressed."

—ASSOCIATE PROFESSOR TIM BUCKLEY
BLOOMBERG SCHOOL OF PUBLIC HEALTH
JOHNS HOPKINS UNIVERSITY

A critical consequence of sprawling development and reliance on highways as a principal means of transportation is tailpipe pollution. Evidence is increasing that air pollution from vehicles increases a wide range of health risks. This report summarizes more than 24 peer-reviewed studies that document health hazards caused by pollution from cars, trucks, and other vehicles. It also describes current debates over major highway projects occurring in more than ten communities around the country.

## Key Findings from Scientific Studies:

- A Johns Hopkins study shows association between traffic and curbside concentrations of cancer causing pollutants.
- The Journal of the American Medical Association study links soot in diesel exhaust to lung cancer, cardiopulmonary disease and other causes of death.
- A Denver study shows children living near busy roads are six to eight times more likely to develop leukemia and other forms of cancer.
- A Journal of the American Medical Association study finds that increasing public transportation along with other traffic control measures during the 1996 Atlanta Olympics reduced acute asthma.
- The California South Coast Air Quality Management District did a Multiple Air Toxics Exposure Study-II, the most comprehensive study of urban toxic air pollution, showing that vehicle exhaust is the source of cancer-causing air pollutants in Southern California.

A significant body of scientific evidence is emerging that links pollution from motor vehicles to a range of human health problems including asthma, lung cancer and premature death.

Federal transportation policy has long focused on expanding the highway system as its principal goal. Approximately 80 percent of federal transportation funding is spent on highways. But by designing communities to reduce reliance on vehicles and giving people more transportation choices like trains and clean buses, we can diminish the health risks associated with highway pollution. Crucial public policy changes must include a more balanced transportation policy, greater emphasis on public transportation systems and other options such as walking and bicycling. In addition, we need to limit development near new roadways.

# Health Effects from Highway Pollution

"I don't think that they should build a school that lies along a freeway."

—BARRY WALLERSTEIN, EXECUTIVE OFFICER, SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT

Air pollution is a major risk to our health and safety and is the contributing cause of nearly 100,000 premature deaths each year,[1] more than twice the number of deaths from car crashes.[2] In 2002, almost half of all Americans - or 137 million people - lived in counties with unhealthy air laden with one or more criteria air pollutants, according to the American Lung Association.[3]

A major source of this air pollution is the exhaust from the tailpipes of trucks and cars. A variety of dangerous pollutants are released daily from the extensive networks of busy highways that border countless neighborhoods and businesses. These pollutants cause numerous adverse health effects including cancer, asthma, and heart attacks. In addition, asthma, which is exacerbated by pollution from trucks and cars, is the leading serious chronic illness among children and the number one reason children miss school.[4]

The main cancer-causing pollutants from trucks and cars are diesel particulate matter and Volatile Organic Compounds (VOCs) such as benzene, 1,3-butadiene, formaldehyde, and polycyclic aromatic hydrocarbons (PAHs).

In recent years the relationship between vehicle pollution and increased cancer risk has received considerable scientific attention. A Denver study shows that children who live within 250 yards of a road with 20,000 or more vehicles per day are eight times more likely to get leukemia and six times more likely to get other cancers. The authors of the study attribute most of this risk to the VOCs in motor vehicle exhaust.[5] As the graphic shows, roadways create a corridor of pollution for the drivers and residents nearby.

## Highway Air Pollution and Public Policy

### Bush Administration Transportation Policy: Fewer Transportation Choices and More Pollution

Just as public transportation ridership is reaching record numbers,[6] the Bush administration is proposing to diminish investment in diverse transportation choices in America within the Senate Bill 1071 that has yet to be approved by the legislature.[7] The administration is recommending greater incentives for highways than for cleaner public transportation projects. Under their plan communities would pay 50 percent of the cost for new public transportation projects. Completing only 20 percent of the new proposed road projects would put public transportation alternatives further out of their reach. In addition, the administration proposes spending less than one dollar on train transit projects for every four dollars spent on highways.

The administration's transportation plan fails to adequately fund the Congestion Mitigation and Air Quality Improvement (CMAQ) program that spurs transportation projects that improve a region's air quality. Demand for the CMAQ is expected to skyrocket, as the number of regions with unhealthy air

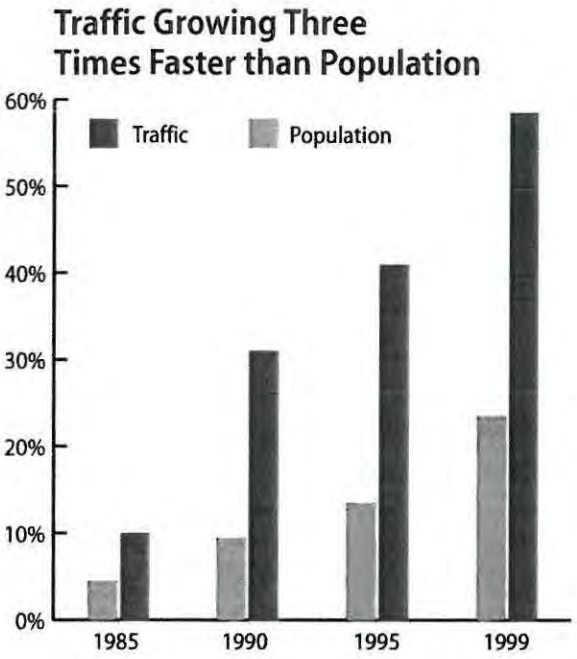



FIGURE 1

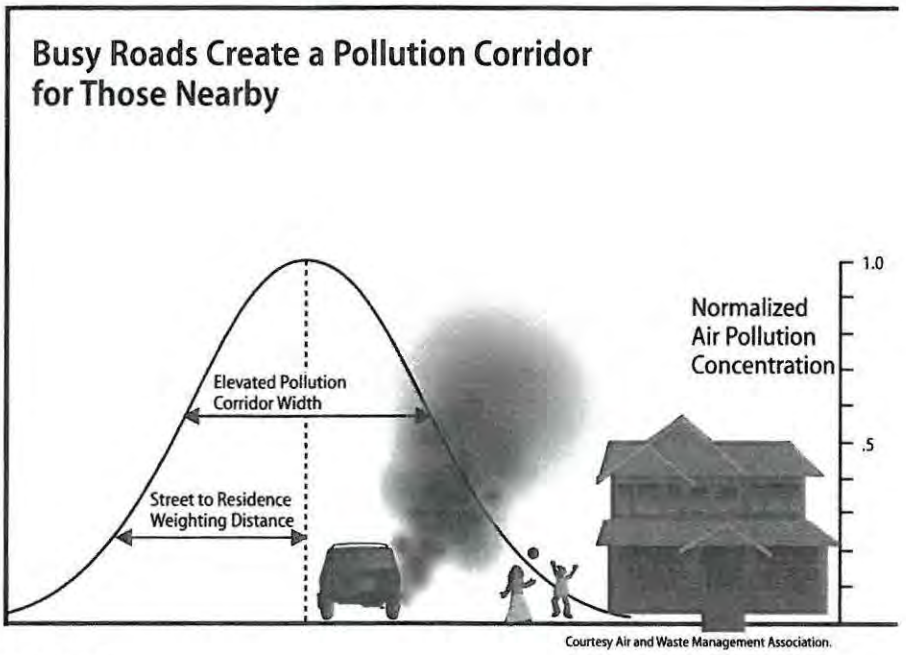



FIGURE 2

will more than double in the next few years, but funding for this critical program is to increase by less than 10 percent.

Other Bush administration proposals would make it more difficult to ensure that pollution from transportation does not violate air quality standards. The administration also wants to reduce the frequency of check-ups from three to five years. These check-ups ensure that transportation plans conform with local air quality needs. In addition, the administration proposes to ignore the long-term effects of new road construction on air quality. The administration suggests examining how road construction would affect air quality over a ten-year period instead of a twenty-year period, as is current practice. Long-term studies, like the current 20-year period, give us a better idea of the effects of road construction on air pollution.

## More Highways, More Sprawl, More Pollution

Poorly designed, sprawling development requires building more roads. Increasingly, new developments are scattered across the landscape with wide streets and driveways, cul-de-sacs, large parking lots, and single-use areas such as office parks or residential sub-divisions with few sidewalks and few connections to other developments.[8] By keeping the places we live independent of our workplace, the average length of our commute increased by over one-third (from 8.5 to 11.6 miles) between 1983 and 1995.[9] Increased sprawl forces people to drive further each year. As the graph shows, between 1985 and 1999, traffic in the U.S. (measured as vehicle miles traveled (VMT)) increased three times faster than population because of a lack of transportation choices and sprawl.[10]

One Atlanta study showed that new highway construction on suburban land is the leading contributor to sprawling development.[11] In another study, the Texas Transportation Institute (TTI) and Surface Transportation Policy Project (STPP) showed that a 10 percent increase in the size of a highway network is associated with a 5.3 percent increase in additional driving.[12] The study also illustrated that longer car trips, aside from generating more pollution, are also the leading cause of traffic congestion, which in turn leads to even greater air pollution.[13]

# Solutions: How We Can Reduce Health Risks from Vehicle Pollution

The Bush administration, along with state and local governments, should promote smart growth, reduce sprawl, and increase transportation choices. By revitalizing existing communities and designing new developments that have bus, bike, or train service to reduce the reliance on cars, travel will be easier for people.

Building better communities cuts traffic and reduces the distance that commuters have to travel.

## Increasing Transportation Choices Decreases Pollution

We can do better. Providing transportation choices such as trains, buses, sidewalks, biking paths, and ridesharing are key aspects of healthy communities where residents can have the option not to drive. Taking these steps would reduce traffic, minimize air pollution, and protect our health, our families, and our future. A 2001 study published in the Journal of American Medical Associates showed that providing more transportation choices and other traffic control measures during the Atlanta Olympic Games in 1996 reduced traffic 22 percent, air pollution by 28 percent, and asthma attacks by up to 44 percent in children.[14]

## Better Community Design Cuts Traffic

Efficient development brings houses, workplaces, and shopping areas closer together and reduces the distance of daily commuter travel. Mixed-use design allows integration of residential and commercial zones, making it possible to live near your place of work.[15] This efficient design can be accomplished through infill, transit-oriented development, zoning, and brownfields redevelopment. Transit-oriented development places new development within easy walking distance of a major transit center. Centering activities on a transit station and providing pedestrian-friendly walkways makes transit a convenient mode of transportation. It revitalizes neighborhoods and reduces traffic by up to 20 percent according to the Land Use Transportation Air Quality Connection (LUTRAQ) study from Portland, Oregon.[16]

PHOTO ALBERT MELCHER

Businesses, public space, and transportation co-exist on this downtown Denver street.

## Changes in Federal Transportation Policy Can Cut Pollution and Provide More Transportation Choices

• Federal and state transportation agencies should balance transportation investments between highways and alternative forms of transportation including public transit, bike paths, and sidewalks.

• They should also support a "fix it first" mentality, which uses resources to maintain existing roads before building new ones. This spends fewer tax dollars for new car-only transportation projects.

• In addition, the EPA and DOT should conduct health risk studies in its environmental review of new road projects with more than 150,000 vehicles per day and provide that information to the public as part of transportation decision-making processes.

## We Can Take Action in Our Communities for Clean Transportation

• We can carpool, bus, or take the train to work whenever possible to reduce traffic and pollution; encourage local governments to use clean-burning buses and hybrid cars for public transportation systems and government vehicles.

• Ask our local governments and workplaces to offer more public transportation incentives.

• Incentives might include "Commuter Choice Checks" that give workers a tax deduction for the money they spend using public transit to commute to work, tax credits for walking or biking, or a parking cash-out.

# Twenty-Four Scientific Studies Link Health Risks with Highway Pollution

"Our studies suggest that children who live near busy roads are more likely to get leukemia and other forms of cancer. It would be prudent to study such cancer risks near all busy roads where elevated VOC levels are likely."

—DR. HOWARD WACHTEL, UNIVERSITY OF COLORADO

The following peer-reviewed and published studies concluded that there is a link between traffic-related air pollution and health risks. The health risks include increased likelihood of asthma, cancer, premature and low-birth weight babies, and a generally higher risk of death. Where possible, we put the researcher's contact information.[17]

## 1. Children Living Near Busy Roads More Likely to Develop Leukemia, 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 with measurements obtained in 1979 and 1990. It found a weak association from power lines, but a strong association with highways. It suggested that Volatile Organic Compound pollution from traffic may be the cancer promoter causing the problem.

Pearson, Wachtel; Robert L. Pearson, and Kristie Ebie. (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.

Contact: Professor Howard Wachtel, Department of Electrical Engineering, University of Colorado. phone: (303) 492-7713, e-mail: *wachtel@colorado.edu.*

## 2. Road Traffic Contributes to the Origin of Childhood Leukemia

A 2004 Italian study found that Childhood Leukemia is partially caused by roadside emissions in the Province of Varese. The authors conducted a population-based, case-controlled study in the Province of Varese, northern Italy, which was covered by a population-based cancer registry. Their study found that the risk of childhood leukemia was almost four times higher for heavily exposed children compared to children whose homes were not exposed to road traffic emissions of benzene. Children either inhale Benzene as a gas or particulate matter which has absorbed benzene. Their model included traffic density divided into two groups–one greater and one less than 10,000 vehicles per day, distance, and weather conditions to estimate benzene concentration. The researcher's data suggests that motor vehicle traffic emissions are involved in the origin of childhood leukemia.

"Childhood Leukemia and Road Traffic: A population-based Case-Control study." Crosignani P ; Tittarelli A; Borgini A; Codazzi T; Rovelli A; Porro E; Contiero P; Bianchi N; Tagliabue G; Fissi R; Rossitto F; Berrino F. *International Journal of Cancer,* 2004 , V108, N4 (FEB 10), P 596-599 2004-02-10

## 3. Increasing Public Transportation and Cutting Traffic Reduces Asthma Attacks

This 2001 Journal of the American Medical Association study found that increasing public transportation along with other traffic control measures during the 1996 Atlanta Olympics reduced

acute asthma attacks by up to 44 percent in children, reduced ozone concentrations by 28 percent, and morning peak traffic by 22.5 percent. These data provide support for efforts to reduce air pollution and improve health via reductions in motor vehicle traffic.

Friedman, Michael; Kenneth Powell MD; Lori Hutwagner; Leroy Graham; Gerald Teague. Impact of Changes in Transportation and Commuting Behaviors During the 1996 Summer Olympic Games in Atlanta on Air Quality and Childhood Asthma, *Journal of the American Medical Association*, 2001;285:897-905.

Contact: Michael S. Friedman, National Center for Environmental Health, Center for Disease Control and Prevention, email: *mff7@cdc.gov.*

## 4. Soot Particulate Matter Linked to Lung Cancer, Cardiopulmonary Mortality

A recent study appearing in the Journal of the American Medical Association showed that day-to-day exposure to soot or fine particulate matter, a major component of tailpipe pollution increased the risk of various adverse health effects. More specifically the study shows that each 10 microgram/meter$^3$ elevation in fine particulate air pollution leads to an 8 percent increased risk of lung cancer deaths, a 6 percent increased risk of cardiopulmonary mortality (heart attacks) and 4 percent increased risk of death from general causes.

Pope, Clive Arden III; Richard P. Burnett, et al. Lung Cancer, Cardiopulmonary Mortality, and Long-term Exposure to Fine Particulate Air Pollution. *Journal of the American Medical Association*, March 6 2002— Vol. 287, No. 92.

Contact: Clive Arden Pope, Brigham Young University, phone: (801) 422-2157, e-mail: *cap3@email.byu.edu.*

## 5. 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 220 yards of their homes had increased risks of asthma hospitalization. The study examined hospital admission for asthma amongst children ages 0-14, and residential proximity to roads with heavy traffic.

Over the last 50 years we have torn down communities to build highways. We need to rebuild our future with clean transportation and better community design.

Lin, Shao; Jean Pierre Munsie; Syni-An Hwang; Edward Fitzgerald; and Michael R. Cayo; (2002). Childhood Asthma Hospitalization and Residential Exposure to State Route Traffic. Environmental Research, Section A, Vol. 88, pp. 73-81.

## 6. Pregnant Women Who Live Near High Traffic Areas More Likely to Have Premature and Low Birth Weight Babies

Researchers observed an approximately 10-20 percent increase in the risk of premature birth and low birth weight for infants born to women living near high traffic areas in Los Angeles County. In particular, the researchers found that for each one part-per-million increase in annual average carbon monoxide concentrations where the women lived, there was a 19 percent and 11 percent increase in risk for low-birth weight and premature births, respectively.

Wilhelm, Michelle and Beate Ritz. (2002). Residential Proximity to Traffic and Adverse Birth Outcomes in Los Angeles County, California, 1994-1996. *Environmental Health Perspectives.* doi: 10.1289/ehp.5688.

Contact: Beate Ritz, Department of Epidemiology, School of Public Health, UCLA, phone: (310) 206-7458, e-mail: *britz@ucla.edu.*

## 7. Traffic Increased Cancer-Causing Pollution Levels at Tollbooth

A 2003 study published in the Journal of Air &

You do not need to be a public health official to know that it is dangerous to breathe diesel exhaust.

Waste Management shows that there is a "significant association between vehicle traffic and curbside concentrations of the carcinogens benzene, 1,3-butadiene, and particle-bound polycyclic aromatic hydrocarbons (PAH)." The measurements, which were taken at the Baltimore Harbor Tunnel tollbooth, show that much of the daily pollutant variability was explained by traffic volume, class and meteorology. The study provides a model for estimating curbside pollution levels associated with traffic that may be relevant to exposures in the urban environment.

Sapkota, Amir and Buckley, Timothy J. The Mobile Source Effect on Curbside 1,3-Butadiene, Benzene, and Particle-Bound Polycyclic Aromatic Hydrocarbons Assessed at a Tollbooth. *Journal of Air & Waste Management*. 53:7400748.

Contact: Dr. Timothy J. Buckley, Department of Environmental Health Sciences, Johns Hopkins Bloomberg School of Public Health; phone: (410) 614-5750, e-mail: *tbuckley@jhsph.edu*.

## 8. Air Inside Cars Typically Contains More Dangerous Air Pollutants than Outside

The results of 23 separate scientific studies shows that in-car air pollution levels frequently reach concentrations that may threaten human health. The reports show that the air inside of cars typically contains more carbon monoxide, benzene, toluene, fine particulate matter, and nitrogen oxides than ambient air at nearby monitoring stations. These pollutants are particularly dangerous for children, the elderly, and people with asthma or other respiratory conditions.

Kimbrell, Andrew. In-Car Air Pollution: The Hidden Threat to Automobile Drivers. International Center for Technology Assessment. July 2000.

Contact: Andrew Kimbrell, phone: (202) 547-9359, email: *kimbrell@icta.org*

## 9. People Who Live Near Freeways Exposed to 25 Times More Soot Particulate Pollution

Studies conducted in the vicinity of Interstates 405 and 710 in Southern California found that the number of ultra-fine soot particles in the air was approximately 25 times more concentrated near the highways and that pollution levels gradually decrease back to normal (background) levels around 300 meters, or nearly 330 yards, downwind from the highway. The researchers note that motor vehicles are the most significant source of ultra-fine particles, which have been linked to increases in mortality and morbidity. Recent research concludes that ultra-fine soot 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 highways.

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

## 10. Motor Vehicle Pollution Dominate Cancer Risk

The most comprehensive study of urban toxic air pollution ever undertaken shows that motor vehicles and other mobile sources of air pollution are the predominant source of cancer-causing air pollutants in Southern California. Overall, the study showed that motor vehicles and other mobile sources accounted for about 90 percent of the cancer risk from toxic air pollution, most of which is from diesel soot (70 percent of the cancer risk). Industries and

other stationary sources accounted for the remaining 10 percent. The study showed that the highest risk is in urban areas where there is heavy traffic and high concentrations of population and industry.

South Coast Air Quality Management District. Multiple Air Toxics Exposure Study-II. March 2000.

Contact: Steve Barbosa, phone: (909) 396-2171, *sbarbosa@aqmd.gov.* or Barbara Weller, California Air Resources Board, phone: (916) 324-4816.

## 11. Lung Function Reduced Among Children Living Near Truck Traffic

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

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

## 12. Traffic-Related Air Pollution Associated with Respiratory Symptoms in Two Year Old Children

This cohort study in the Netherlands found that two year old children who are exposed to higher levels of traffic-related air pollution are more likely to have self-reported respiratory illnesses, including wheezing, ear/nose/throat infections, and reporting of physician-diagnosed asthma, flu or serious cold.

Brauer, Dr. Michael J. et al. (2002). Air Pollution from Traffic and the Development of Respiratory Infections and Asthmatic and Allergic Symptoms in Children. *American Journal of Respiratory and Critical Care Medicine.* Vol. 166 pp 1092-1098.

Contact: Dr Michael Brauer, School of Occupational and Environmental Hygiene, University of British Columbia, Vancouver, British Columbia, Canada. Phone: (604) 822-9585, e-mail: *brauer@interchange.ubc.ca.*

## 13. Asthma Symptoms Caused by Truck Exhaust

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


Many schools are located near busy roads in addition to having diesel buses idling nearby.

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

## 14. 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 five 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 (more than 24,000 vehicles/ 24 hrs) located along the nearest segment of main road.

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.

## 15. Exposure to Cancer-Causing Benzene Higher for Children Living Near High Traffic Areas

German researchers compared 48 children who lived in a central urban area with high traffic density


Despite strong opposition prior to its construction, Salt Lake City's TRAX system is running strong. It carries over 20,000 riders every day—many of whom commuted in cars before switching to rail.

with 72 children who lived in a small city with low traffic density. They found that the blood levels of benzene in children who lived in the high-traffic-density area were 71 percent higher than those of children who lived in the low-traffic-density area. Blood levels of toluene and carboxyhemoglobin (formed after breathing carbon monoxide) were also significantly elevated (56 percent and 33 percent higher, respectively) among children regularly exposed to vehicle pollution. Aplastic anemia, a serious condiion in which bone marrow stops producing blood cells, and leukemia were associated with excessive exposure to benzene.

Jermann E, H. Hajimiragha, A. Brockhaus, I Freier, U. Ewers, A. Roscovanu: Exposure of children to benzene and other motor vehicle emissions. Zentralblatt fur Hygiene und Umweltmedizin 189:50-61, 1989.

## 16. Air Pollution from Busy Roads Linked to Shorter Life Spans for Nearby 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 premature cause compared with those who lived in less-trafficked areas. The authors say traffic emissions contain many pollutants that might be responsible for the health risks, such as ultra-fine 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.

## 17. Asthma More Common for Children Living Near Highways

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

## 18. Exposure to Nitrogen Dioxide ($NO_2$) from Vehicles Exacerbates Asthma Attacks

Researchers at St. Mary's Hospital in Portsmouth, England determined that while 80 percent of asthma attacks are initially caused by viral infections, exposure to traffic pollution can increase symptoms as much as 200 percent. The team measured the exposure of 114 asthmatic children between ages eight-eleven from nonsmoking families over almost a whole year. They found a strong correlation between higher $NO_2$ pollution and the severity of an attack.

Chauhan, A.J., et al. Personal exposure to nitrogen dioxide (NO2) and the severity of virus-induced asthma in children. *Lancet.* Volume 361 Issue 9373 Page 1939.

## 19. A School's Proximity to Highways Associated with Asthma Prevalence

A study of 1,498 children in 13 schools in the Province of South Holland found a positive relationship between school proximity to highways and asthma occurrence. Truck traffic intensity and the concentration of pollutants measured in schools were found to be significantly associated with chronic respiratory symptoms.

Van Vliet, P., M. Knape, et al. (1997). Motor vehicle exhaust and chronic respiratory symptoms in children living near freeways. Environmental Research. 74(2): 122-32.

## 20. Five Times More Deaths Due to Air Pollution than Traffic Accidents

This study analyzed the affect of traffic-related air pollution and traffic accidents on life expectancy in the area of Baden-Wurttemberg, Germany. It estimated that almost five times more deaths in this region resulted from motor vehicle pollution than from traffic accidents.

Szagun and Seidel. (2000). Mortality due to road traffic in Baden-Aurttemberg. Gesundheitswesen. 62(4): 225-33.

## 21. 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 the years 1953-1980, where they were born and where they died. It found that the greatest danger lies a few hundred yards from a highway or polluting facility and decreases as you get further 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.

## 22. Diesel Exhaust Linked to Asthma

This study found that particulate matter from diesel trucks can act as an irritant in the airway causing asthma. The authors show that diesel exhaust can trigger asthma attacks in individuals with no pre-existing asthmatic history. When a natural allergen, such as pollen, was added to the situation, the reaction was even more dramatic.

Pandya, Robert, et al. "Diesel Exhaust and Asthma: Hypothesis and Molecular Mechanisms of Action." Environmental Health Perspectives Supplements Volume 110, Number 1, February 2002.

## 23. Low Levels of Air Pollution Cause Asthma Attacks

Exposure to miniscule amounts of ozone and soot particulate matter 2.5 μm or less (PM2.5) in air at levels above current U.S. Environmental Protection Agency (EPA) standards is a risk factor for respiratory symptoms in children with asthma.

Daily respiratory symptoms and medication use were examined prospectively for 271 children younger than 12 years with physician-diagnosed, active asthma residing in southern New England. Exposure to ambient concentrations of ozone and PM 2.5 from April 1 through September 30, 2001, was assessed using ozone (peak 1-hour and 8-hour) and 24-hour PM 2.5. Logistic regression analyses using generalized estimating equations were performed separately for maintenance medication users (n = 130) and nonusers (n = 141). Associations between pollutants (adjusted for temperature, controlling for same- and previous-day levels) and respiratory symptoms and use of rescue medication were evaluated.

Mean (SD) levels were 59 (19) ppb (one-hour

**Don't inhale!** In-car pollution contains more toxins than ambient air according to a California study.

**One happy commuter!**
Lea loves Disney's monorail, but wishes that she had more transportation choices sooner.

average) and 51 (16) ppb (8-hour average) for ozone and 13 (8) µg/m3 for PM2.5. In co-pollutant models, ozone level but not PM2.5 was significantly associated with respiratory symptoms and rescue medication use among children using maintenance medication; a 50-ppb increase in one-hour ozone was associated with increased likelihood of wheeze (by 35 percent) and chest tightness (by 47 percent). The highest levels of ozone (one-hour or eight-hour averages) were associated with increased shortness of breath and rescue medication use. No significant, exposure-dependent associations were observed for any outcome by any pollutant among children who did not use maintenance medication.

Asthmatic children using maintenance medication are particularly vulnerable to ozone, controlling for exposure to fine particles, at levels below EPA standards.

Gent, Janneane PhD; Elizabeth W. Triche, PhD; Theodore R. Holford, PhD; Kathleen Belanger, PhD; Michael B. Bracken, PhD; William S. Beckett, MD; Brian P. Leaderer, PhD, Association of Low-Level Ozone and Fine Particles With Respiratory Symptoms in Children With Asthma, *Journal of the American Medical Association.* 2003; 290:1859-1867.

*http://jama.amaassn.org/cgi/content/abstract/290/14/1859.*

## 24. Motor Vehicle Air Toxins Cause High Pollution Levels Inside Homes

An air pollution study was done as a part of the West Oakland Diesel Truck Emissions Reduction Initiative. Researchers measured diesel particulates near mobile and idling trucks at the West Oakland Port. An aethalometer was used to measure indoor toxins and a high level of diesel particulates was found. The people who lived in these homes were exposed indoors to five times the level of diesel particulates that people were exposed to outdoors in other areas of Oakland.

W. Buchan, M.D.and M. Chan Jackson; Container Truck Traffic Assessment and Potential Mitigation Measures for the West Oakland Diesel Truck Emission Reduction Initiative, from "Clearing the Air, Reducing Diesel Pollution in West Oakland," a Report to Pacific Institute, 654 13th Street, Preservation Park, Oakland, California 94612, by TIAX LLC, 1601 S. De Anza Blvd., Suite 100, Cupertino, California 95014, November, 2003

The following technical reports are online at: *http://www.pacinst.org/diesel/*

1. TIAX Diesel Truck Study (TIAX, 2003) 2. West Oakland Diesel Particulate Matter Emissions Inventory and Air Quality Monitoring Study (Pacific Institute (PI, 2003) 3. Summary of Studies (PI, 2003) 4. Data Gap Analysis (PI, 2003)

# Highway Health Hazard Stories

The following stories highlight transportation-related air pollution issues from around the country. As metropolitan areas continue to sprawl and traffic congestion worsens, communities are facing important long-term decisions about transportation. The Sierra Club believes that widening and building new highways is not only poor transportation policy but also threatens public health.

We realize that there are transportation challenges around the country, but we believe that reasonable, alternative solutions exist that expand transportation choices, reduce congestion, and help to clean our air.

We have included stories from California, Illinois, Nevada, New Hampshire, Ohio, Texas, Utah, Washington, D.C. and Wisconsin.

## California

**Challenge.** Existing air pollution laws in Southern California set the maximum emission limits for toxic pollution from individual facilities, but cumulative emissions of toxic pollutants are not regulated. Highways are an important contributor to the cumulative emissions of toxic air pollutants in a given area but are currently not regulated as individual facilities.

**Solution.** The South Coast Air Quality Management District is developing a plan that would entail new public notification requirements for schools and home builders and make the regional air pollution control agency more prominent in land use decisions. One proposal for the plan would require developers of new schools, hospitals, day care centers, and home builders to provide notice to their patrons of toxic emissions within 1,000 feet. The presence of any freeway, or potentially busy boulevard, within 1,000 feet could trigger the notice. "I don't think that they should build a school that lies along a freeway." said Barry Wallerstein, Executive Officer of the South Coast Air Quality Management District.[18]

Contact: Sam Atwood, South Coast Air Quality Management District, phone: 909-396-3687, email: satwood@aqmd.gov. or Tim Frank (510) 710-4563, email: *tim.frank@sierraclub.org.*

## Illinois

**Challenge.** The Illinois Department of Transportation is planning to expand the Eisenhower Expressway through Oak Park. The Illinois Tollway Authority has proposed building tollways; Route 53 into Lake County north of Chicago and I-355 in Will County south of Chicago. These highways and tollways will create hundreds of thousands of added truck and car trips near neighborhoods, schools, and parks. Families with small children could be put at risk, but are unaware of the health consequences of larger roadways near their homes.

Children design alternative transportation options. Why won't the Bush administration put more money into clean buses and trains?

**Solution.** The Illinois DOT and Tollway authority should examine the cancer, asthma, and other health impacts on local neighborhoods, schools and children and invest more in public transportation to reduce traffic and pollution risks.

Contact: Nancy Wagner, Environmental Law and Policy Center, phone: (312) 795-3726; Jack Darin, Sierra Club, (312) 251-1680, *jack.darin@sierraclub.org.*

## Nevada

**Challenge.** Public health and environmental advocates in Las Vegas support widening U.S. 95 from six to ten lanes. A Sierra Club supported independent study concluded that widening U.S. 95 would cause up to 1,400 more cancers per one million people over 70 years or more than 1000 times the EPA goal of one-in-a-million cancer risk. The Sierra Club is suing to stop the project, because the Bush Administration failed to consider health consequences and alternatives to highway construction as required by law.

**Solution.** When alternatives to the project are assessed it will quickly become evident that less polluting options exist, such as clean diesel buses and light rail. In order to avoid significant increases in cancer causing emissions from trucks and cars, more highway lanes should not be considered a reasonable option.

For more information see USA Today article by John Ritter titled "Lawsuit Pits Risks and Roads." USA Today, Friday, March 7, 2003 at *www.usatoday.com/news/nation/2003-03-06-vegas-highway-usat_x.htm.*

Contact: Tara Smith, Sierra Club, phone: (702) 732-7750, email: *tara.smith@sierraclub.org*

## New Hampshire

**Challenge.** The U.S. EPA Region 1's office has accused the state of New Hampshire of failing to prepare for the environmental impact of the rapid population boom that is expected to follow the widening of Interstate-93, the main commuter highway connecting the state to Boston, Massachusetts. This is one of the highways that the Bush administration has fast tracked for approval, which may not leave enough time to study the health implications of widening Interstate-93. New Hampshire plans to spend $18 million to ease the environmental impacts of the highway project, but that is far too little to address a likely population boom in more than 20 New Hampshire communities that would tax existing services and threaten open spaces, drinking water supplies, and wildlife.

**Solution.** Robert Varney, head of the EPA for New England, called for a total of $52 million to be allocated to environmental protections and threatened delays in the highway project if the environmental concerns weren't adequately addressed. The state is counting on federal highway dollars to cover 80 percent of the cost of the $350 million project, meaning the EPA has significant say in the highway's future. The EPA should focus on alternative transportation plans, such as clean buses and a rail system, which would protect public health and the environment. In addition, environmental leaders are looking for mitigation and technical assistance to protect towns bordering the highway and teach them how to protect themselves.

Contact: Catherine Corkery, Sierra Club, phone: (603) 224-8222, email: *catherine.corkery@sierraclub.org*

# Ohio

**Cincinnati Challenge.** In the fall of 2003, after a two-year long study of increasing gridlock on I-75 in SW Ohio, one of the nation's most congested interstate highway sections, a committee representing local regional governments and the Ohio Department of Transportation (ODOT) recommended building passenger train service from downtown Cincinnati to the northern suburbs along I-75.

However, the committee's recommendation also included a plan to widen the highway by one or two lanes, despite clear evidence from an independent consultant that high frequency passenger trains in this area are the "only solution to the congestion problem."

The study's own expert consultants predict that widening I-75 by one lane would result in a 30% increase in region-wide traffic by 2030, and at no time would widening by one lane improve traffic congestion levels above "failing" levels as measured by ODOT.

Furthermore, a cost-benefit study, conducted by HLB Decision Economics of Maryland and directed by a panel of economists and transportation experts from Cincinnati-area businesses, universities, and governments, found that "the benefits from highway expansion would be concentrated in the early years of the life cycle of the project and that these benefits erode over the years," whereas "the light rail train benefits grow over the years because commuters would divert to transit as congestion worsens in the corridor."

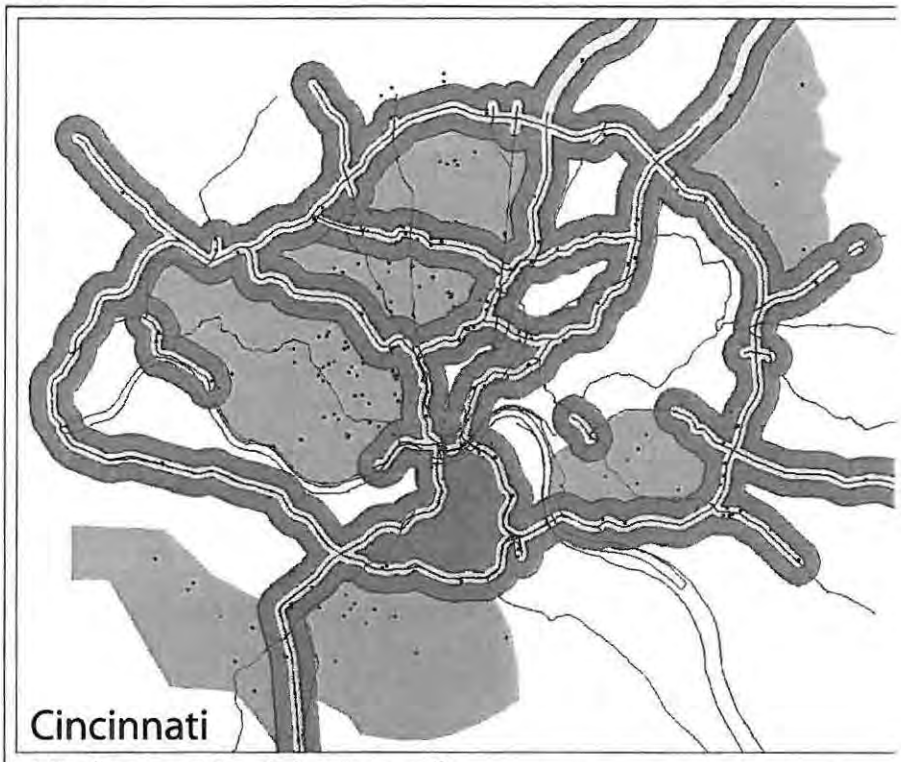
Analysis of the proposed train route projected more than $900 million in net benefits over the next 30 years, with an 8.5 percent rate of return on the investment. The economic benefits of train service include time savings, affordable mobility, and a decrease in air pollution, among other benefits.

**Solution.** Throughout the study local representatives from the public interest, land use, and academic communities advocated that the public health, environmental, and land use impacts of the each alternative solution be thoroughly examined. One of the most promising solutions raised by several members of the committee is to combine several smart growth land use planning in coordination with the passenger train service. Unfortunately, the committee refused to include these critical factors in the study.

Because Cincinnati has long struggled with poor air quality and the SW Ohio and Northern Kentucky area currently fails to meet federal smog and soot health standards, the proposed highway expansion is likely to have long-term, negative public health impacts.

The Sierra Club strongly supports the passenger train solution and calls for smarter land use practices to support it. We also continue to push for a full eval-

FIGURE 3




This map shows the extensive coverage of highways in the Cincinnati metropolitan area, and the areas of highest risk for cancer. New or expanded highways will only increase these cancer corridors and put more of the population at risk. Map courtesy LADCO.

uation of the impact on sprawl and air quality of the proposed highway project.

The Lake Michigan Air Directors are currently assessing the health impacts of highways in the Cincinnati area.

**Columbus Challenge.** According to a report released by the Ohio Environmental Council, more than a quarter million people in central Ohio live in a diesel hot spot, or an area with chronically elevated levels of toxic air pollutants from diesel engine exhaust. The people living in these areas are at greater risk of suffering from a variety of adverse health effects including asthma, cancer, and even premature death. The hot spots include corridors surrounding all of the Interstate Routes 70, 71, 270, and 670; the U.S. Routes 23, 33, and 36; and portions of State Routes 13, 16, 31, 37, 79, 104, 161, and 315.

**Solution.** The report recommends both local and state actions to rectify the problem. At the local level, all school and public transit buses should be retrofitted and switch to ultra-low sulfur diesel fuel. In addition, all vehicles owned or contracted by local governments (i.e. garbage trucks, construction equipment and other city services) should also be retrofitted and powered by cleaner fuel. At the state level, assistance programs should be developed to help localities fund their retrofitting and fuel switching agenda. The state can also mandate that all privately-owned vehicles must retrofit and use ultra-low diesel fuel to reduce pollution.

Contact: Glen Brand, Midwest Representative, Sierra Club, phone: (513) 861-4001, email: *glen.brand@sierraclub.org*. Kurt Walzer, Ohio Environmenal Council, phone: (614) 487-7506.

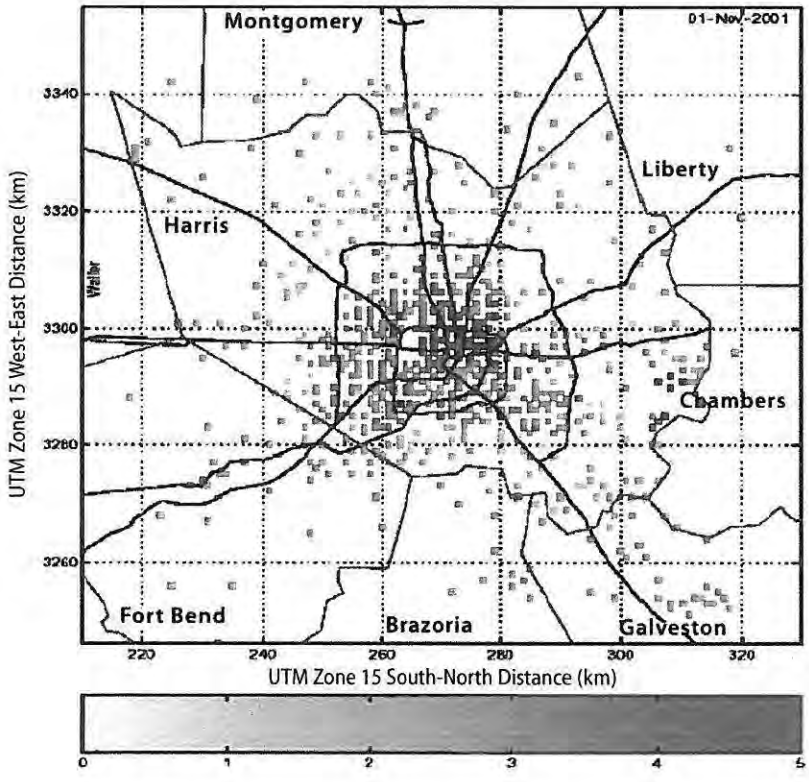



FIGURE 4

**Particulate Matter Concentrations, Houston Metro Area**

Annual Average Ambient Concentrations of Diesel PM in Houston, 1996, based on Dispersion Modeling Using Industrial Source Complex Short Term (ISCST3) model.

## Texas

**Challenge.** The Houston area has been at the center of much debate over major freeway expansions, most notably the Katy Freeway and the Grand Parkway. The Katy Freeway traverses the City of Houston, serving over 200,000 vehicles a day. Local transportation officials plan to enlarge the highway to more than 18 lanes, greatly increasing the number of vehicles traveling through some of the more densely populated areas of the city and surrounding areas.

The Grand Parkway is a proposed series of highway segments that would constitute the fourth "loop" around Houston. Built through or near many small towns, it is considered critical for major housing and commercial developments in the city's suburbs that would be built near the Grand Parkway path, soon after the highway's construction. Portions of Grand Parkway have recently been included in both the I-69 and Trans-Texas Corridor (T-TC) "NAFTA" trade route, which would drastically increase international truck traffic to the region. T-TC is designed to be a road-rail-utility corridor 1 mile wide.

**Solution.** The current highway expansion plans will hurt neighboring cities and towns but will do little in the long-term to alleviate congestion and urban

Air pollution obscuring downtown Salt Lake City is hard on eyes and harmful to children's lungs.

sprawl. Instead of continuing to build new lanes that will induce further sprawl and increase the number of cars on the roads, the Texas Department of Transportation (TXDOT) and Federal Highway Administration (FHWA) should focus on safer and more reasonable alternatives.

For the Katy Freeway, transit alternatives such as expanded rail system and more bus routes should be pursued. A coalition of residents affected by the Katy Freeway expansion project has called upon TXDOT to halt their old and ineffective plan, and adopt an alternative plan which will improve mobility without harming the health and livelihood of citizens. Their alternative plan for the freeway calls for a combination of depressing the road, adding rail and a dense planting of trees to protect schools and residential areas from dangerous fine particulates in freeway pollution.

For the Grand Parkway, resources should be allocated on a "fix it first" approach. Before constructing new freeways to serve a projected population that would not exist without this new road, resources should be focused to more needy projects. For example, a number of existing and poorly maintained highways should be fixed and improved to avoid flooding and relieve unnecessary congestion for existing towns and neighborhoods near portions of the proposed route.

Contact: Christine Sagstetter, Sierra Club, phone: (713) 725-9421.
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## Utah

**Challenge.** Utah's Salt Lake City metropolitan area runs along the base of the 10,000 ft. Wasatch Mountains. During winter months low lying, high-pressure inversions trap air pollution from automobiles directly at the level people breathe. This problem causes cases of childhood asthma and respiratory illnesses of the public. In January, 2004 Utah began another winter inversion, filling hospitals with respiratory victims. The state is asking people not to drive and prohibiting wood burning stoves and fireplaces.

Exacerbating the problem, Utah is undertaking three highway expansions. The State of Utah is preparing for another expansion of I-15 to the north, pushing through court the first phase of a new 125-mile bypass freeway ironically named the Legacy Highway, and beginning an Environmental Impact Statement process for a second phase of Legacy in western Salt Lake County re-named for political and legal reasons, the Mountain View Corridor. Each of these projects facilitates massive sprawling development and increases automobile dependency. Legacy Highway would also act as a trucking bypass route, which would significantly increase the pollution from trucks in the metropolitan area.

**Solution.** Utah should postpone new road building and change their priority to building a regional transit system first. This could be accomplished by expanding upon the very popular and

successful two existing light rail lines and adding commuter train and bus rapid transit construction to the mix. A regional transit system would encourage smarter development patterns that would reduce automobile use and protect public health from air pollution related illnesses.

Contact: Marc Heileson, Sierra Club. phone: (801) 467-9294 email: *marc.heileson@sierraclub.org*

## Washington D.C. Metro Area

**ICC Challenge.** In 2002, the Maryland Legislature passed a resolution urging that a five year old study concerning the Inter-County Connector (ICC) be restarted. The new Governor, Robert Ehrlich, favors re-starting the study and building the highway as quickly as possible. The Sierra Club has raised the health issue to the Legislature, to public officials, and to the public in various materials. Pro-highway advocates say the ICC will improve air quality and health by getting cars traveling at higher speeds, and thus emitting less pollution. However, data previously highlighted in this report would suggest otherwise.

**Solution.** Instead of adding a highway extremely close to communities throughout much of Maryland, the state should instead examine ways to implement realistic alternative forms of transportation. A train system is the option that holds the most promise.

**Wilson Bridge Challenge.** The fate of this project was formally decided in 1997. But since then the Sierra Club has urged Maryland and Virginia to choose train, rather than High Occupancy Vehicle lanes, for the bridge. The Sierra Club has stressed the air quality benefits from less traffic and more public transit.

**Solution.** Instead of expanding the bridge to hold more cars, the state should instead add a lane for commuter train. Many of the drivers who utilize the Wilson Bridge are commuters traveling to the fairly concentrated downtown of the District of Columbia. As a result, Metrorail would be an effective method for transporting many of these workers.

**Beltway Challenge.** Virginia Department of Transportation issued a DEIS in 2002 which proposed widening the Beltway from eight lanes to ten or twelve lanes. Sierra Club organized against the proposal with the message that widening the Beltway would worsen air quality and hurt public health. The Beltway already passes in close proximity to many communities surrounding the DC area. Further expansion would undoubtedly worsen air pollution and put more people at risk of cancer and other adverse health effects.

> "Considerable scientific evidence links higher rates of asthma and other respiratory problems with freeway proximity. Residents who live near freeways would clearly benefit from lower, not higher traffic volumes."
>
> —DR. SETH FOLDY, FORMER CITY OF MILWAUKEE HEALTH COMMISSIONER

**Solution.** The Beltway does not have a subway line that mirrors its path around the city. Before any lane expansion should even be considered, people should be given the option of traveling around the perimeter of the city on public transit and particularly on a new Metrorail line.

Contact: Chris Carney, Sierra Club Mid-Atlantic Office, phone: 703-312-0533, email: *chris.carney@sierraclub.org*

## Wisconsin

**S.E. Challenge.** Southeast Wisconsin road builders and developers proposed a massive highway expansion project for Hwy I-94 and Hwy 45. The impact of highway expansion will be the greatest in Milwaukee County, where numerous schools are within a mile of highways. Milwaukee County is also home to minorities and lower income residents in metropolitan Milwaukee. The plan is to increase the number of lanes of I-94 and Hwy-45 from six lanes to eight lanes of traffic. This plan would increase air pollution, encourage augmented traffic flow, and will put at risk Wisconsin residents' ability to breathe clean air.

**Solution.** Since highly traveled road corridors are becoming hazardous to our health, then one logical alternative would be to utilize transportation investments to slow the growth of vehicle miles traveled on our roadways. The best example of that is the transportation improvements in Portland, Oregon that considered land use and air quality issues during the planning process. Milwaukee is an area of non-compliance for ground-level ozone pollution, Portland is not.

**Madison Challenge.** The City of Madison and WI DOT are reconstructing East Washington Avenue to ease the flow of traffic, now at 55,000 vehicles per day. This route runs near East High School and several grade schools. Pollution monitors show high levels of soot or particulate pollution already. Wisconsin DOT is also expanding the Verona Road interchange located near many neighborhoods.

**Solution.** The DOT should assess the cancer and smog risks to these schools, and nearby neighborhoods, and consider alternatives like streetcars, commuter trains, and clean buses that can cut traffic and pollution risks.

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# Appendix
# Resources and Local Information

## Endnotes


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# Appendix
# Resources and Local Information

www.sierraclub.org/sprawl is a comprehensive website with information on cutting traffic and air pollution

Statistics on pedestrian safety, congestion, federal transportation spending, and household transportation expenditures can be found for each state and some smaller regions at:
*http://transact.iracorp.com/states/default.asp*

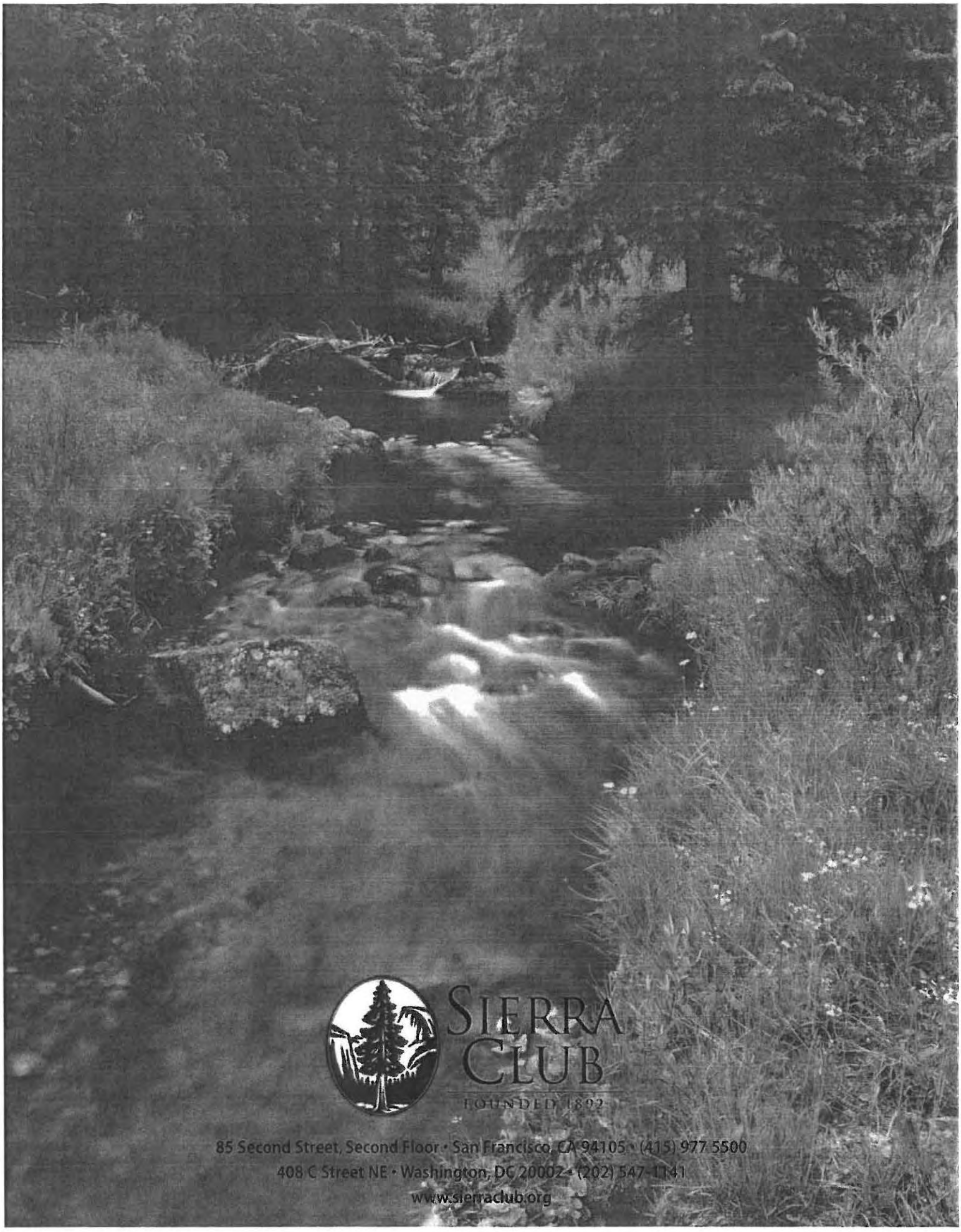
Maps of local cancer-causing pollution can be found at: *http://www.epa.gov/ttn/atw/nata/*

To find local traffic or VMT (Vehicle Miles Traveled), check your local Metropolitan Planning Organization (MPO) or find regional statistics on congestion, travel delay, fuel consumption and congestion cost at:
*http://mobility.tamu.edu/ums/mobility_data/*

Information on public transit spending, smog, and investment in transportation choices for our 50 largest cities can be found at: *www.sierraclub.org/sprawl/report01/charts.asp.*

Information on hazardous air pollution in your area can be found at the Environmental Defense website:
*http://www.scorecard.org/env-releases/hap/*

The "State of the Air" report, released by the American Lung Association can be found at: *http://lungaction.org/reports/stateoftheair2003.html*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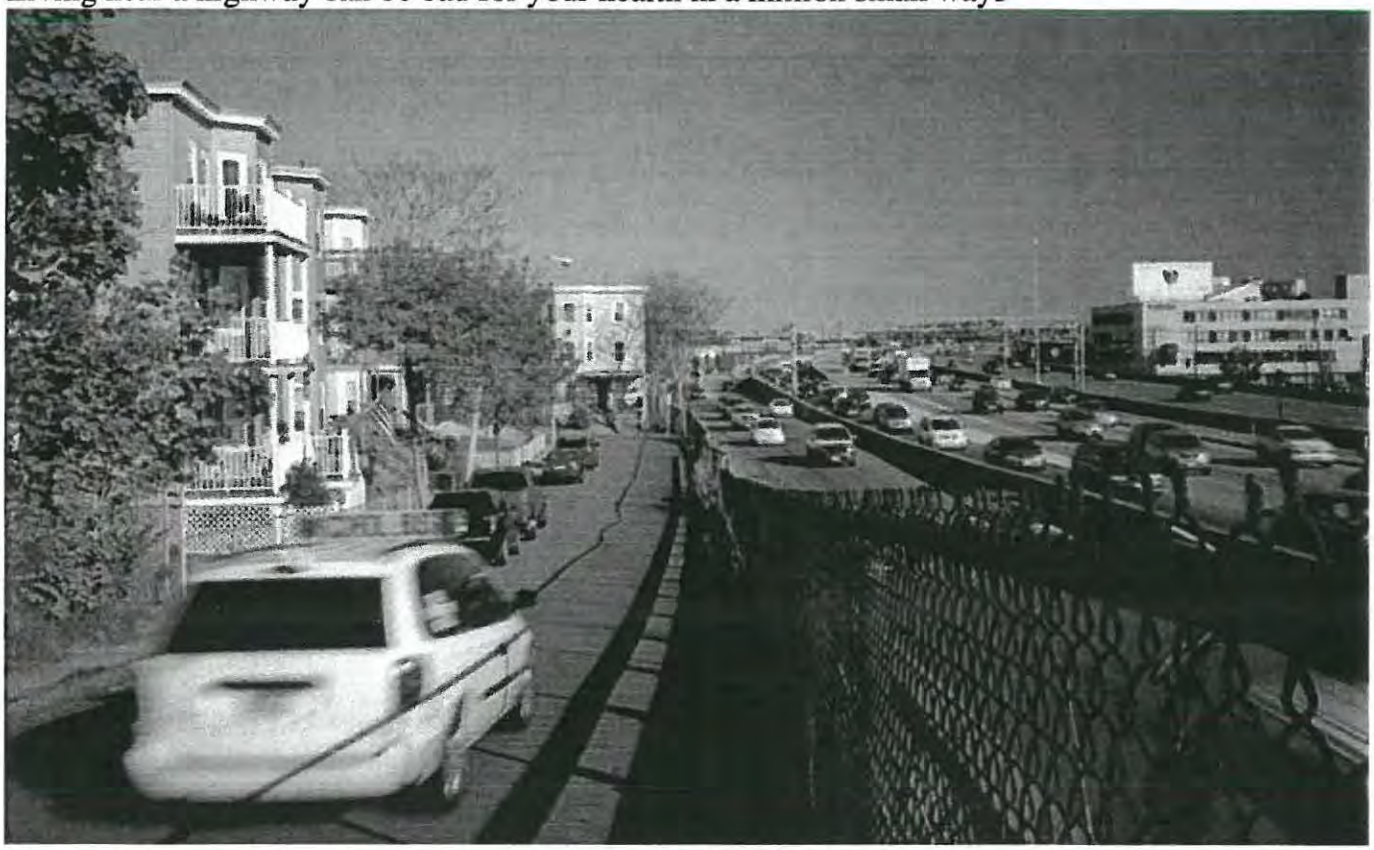
Living near a highway can be bad for your health in a million small ways



"When it comes to air pollution, the main thing that really affects people is particulates—not gases," says Doug Brugge, a professor of public health and community medicine at Tufts. Photo: John Soares

By David Levin
August 16, 2012

I'm sitting in gridlock in Boston's Chinatown neighborhood on a Thursday afternoon. It's a typical Boston rush hour—traffic isn't so much driving as oozing through town. Less than a block away, Interstate 93 is in even worse shape; a snarl of commuters is beginning a painful crawl home to the suburbs.

Thankfully, I'm not behind the wheel. I'm in the back of a 26-foot RV driven by Tufts environmental engineering student Jess Perkins, E12, and recent grad Dana Harada, A11. They are regulars in Chinatown. But unlike scores of frustrated commuters on I-93, they don't have a destination. They simply drive in circles. "It's like going on a road trip twice a week," says Perkins. Sometimes the two listen to country; mostly, they just talk.

With every lap through Chinatown, Perkins and Harada are hard at work, collecting air-quality data for a five-year interdisciplinary study based at Tufts called the Community Assessment of Freeway Exposure and

Health (CAFEH). The goal of the study, expected to wrap up a year from now, is to understand how vehicular pollution affects the health of people living close to a highway.

Over four years, the RV has racked up more than 15,000 miles circling the Boston-area communities of Chinatown, Dorchester, Somerville and Malden. Behind the driver's seat, where I'm sitting, a mobile laboratory measures airborne pollutants: gases, such as nitrogen oxide and carbon monoxide, and tiny solids called ultrafine particulate matter. Of the three, the ultrafine particulates are arguably the biggest threat to public health.

"When it comes to air pollution, the main thing that really affects people is particulates—not gases," says Doug Brugge, the study's principal investigator and a professor of public health and community medicine at Tufts.

"Most of the mortality, most of the economic impact [of fine and ultrafine particulates] are coming from cardiovascular disease. It's not primarily asthma or lung cancer," says Doug Brugge. Photo: John Soares

Because of their small size—some are just a few molecules across—tiny particulates are essentially minuscule bullets, delivering toxins deep into the body where larger particles can't reach. "The Environmental Protection Agency estimates that they cause 80,000 or 100,000 deaths a year in the United States, and maybe four million or more worldwide," Brugge says.

Tracking air pollution today is a far more subtle job than monitoring the haze of pollutants a few generations ago ever was. Before the U.S. government first allocated funding for air pollution research, in 1955, entire regions could be swallowed by smoke and smog. In 1948, residents of Donora, Pa., a mill town just south of Pittsburgh, woke to a dense cloud of particulate pollutants that had become trapped in the Monongahela River valley by stagnant weather. When the smog lifted five days later, 20 people were dead, and nearly half of the town's 14,000 residents had fallen sick.

It was one of the worst air pollution disasters in U.S. history, and its impact on public health was easy to see: "You didn't have to do statistical analysis. You could just see people come to the hospital and die," says

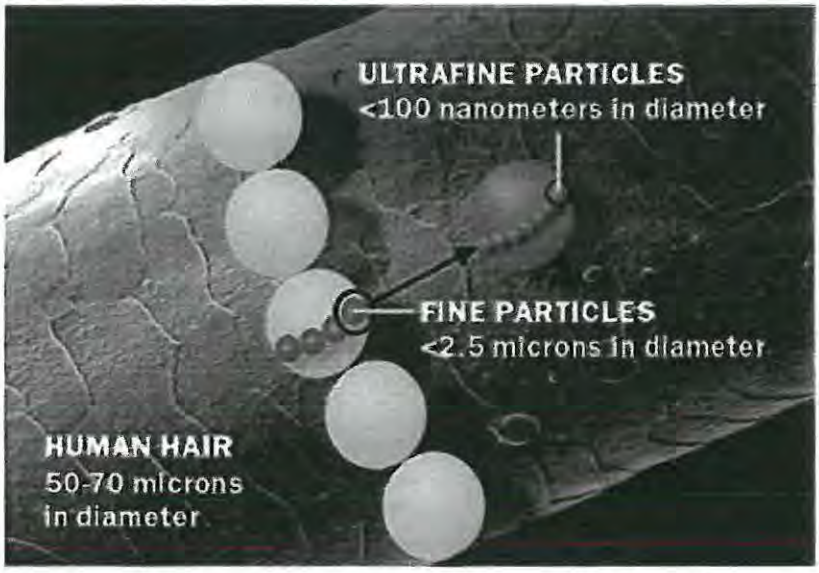
Brugge.

Although U.S. environmental regulations have gotten the big, visible clouds of particulates, such as the industrial sulfur dioxide emissions that contributed to the Donora crisis, under control, Brugge believes there's still plenty of cause for alarm.

Over the last 30 years, growing numbers of studies have shown that smaller particulates emitted by trucks and cars barreling down our nation's highways can promote heart disease and strokes. The EPA regulates these tinier hazards, to a point, but Brugge is concerned that the agency hasn't gone far enough to safeguard the health of roadside residents.

About 10 percent of the U.S. population—some 35 million people—live within 100 meters of a four-lane highway, according to the EPA. Brugge's hope is to clarify the implications of this fact by measuring the airborne particulates along the road while monitoring the health of people who live in the vicinity. It's a task requiring both patience and precision.

**Small, Smaller, Smallest**




Fine and ultrafine particles are much smaller than the width of a human hair, with ultrafines posing the greater potential risk to human health.

Particulates come in a few different flavors, each smaller than the next, and each with its own implications for public health. Coarse particulates (known as "PM10" in the public health world) measure about 10 microns across—roughly one-seventh the width of a human hair. They're mostly made up of dust from construction, vehicular tire and brake wear and the road surface itself. As particulates go, they're not as high on Brugge's hit list.

It's the really tiny stuff, he says, that poses the real danger: fine particulates (PM2.5)—particles smaller than 2.5 microns—and "ultrafines" (PM0.1), the smallest of the small, at 0.1 microns and below. These are created almost exclusively by combustion. As a car or truck engine runs, its exhaust gases condense into minuscule blobs within seconds of leaving the tailpipe. Some blobs are made up of unburned oil and gasoline; others form out of the countless chemical byproducts of burning fossil fuels.

When they're inhaled, it's not just the lungs that take a hit, Brugge says. It's mainly the heart that suffers. "Most of the mortality, most of the economic impact [of fine and ultrafine particulates] are coming from cardiovascular disease," he observes. "It's not primarily asthma or lung cancer."

Throughout the 1980s and early '90s, dozens of studies found links between fine particulate pollution and cardiovascular health. One of the largest and most influential of these, the Harvard Six Cities Study, followed

more than 8,000 participants in six towns across the Midwest and New England. Over 15 years, the initial phase of the study tracked each person's health and measured particulate levels in the air over their communities. Its findings, first released in 1993, showed that even a minuscule increase in fine particulates (just 10 micrograms per cubic meter of air), could cause up to an 18 percent bump in cardiovascular disease.

With research like this confirming the health impact of fine particulates, the EPA finally began to regulate them in 1997. Yet Brugge says there's reason to think that ultrafine particles, which the EPA does not regulate, are even more insidious than their larger counterparts.

Unlike fine particulates (PM2.5), which don't change much from day to day, ultrafines can fluctuate dramatically over the course of a morning or afternoon, depending on the weather and how many cars and trucks are on the road. Ultrafines are also confined to a relatively small area. While fine particulates disperse over an entire city, their tinier cousins stick close to major highways, often spiking dramatically within a few hundred meters of the source.

Short distances do matter. During one winter rush hour, as the Tufts mobile testing lab drove within 100 meters of Interstate 93, it tallied more than 120,000 ultrafine particles in every cubic centimeter of air. Moving a few blocks farther away, that number dropped dramatically—to less than 40,000 particles.

The reduction might be a result of new particles evaporating, condensing into larger particles, or—most likely—mixing with fresh air as they drift away from the road. But Brugge says one thing is clear: Because ultrafines are mostly concentrated near their source, people living and working immediately next to a highway will disproportionately suffer their effects.

**Matters of the Heart**

At first glance, the health impact of fine and ultrafine particulates seems counterintuitive. Breathing particles of any sort should cause problems in your lungs, not heart, right? But like most things in medicine, it's not so simple.

Fine and ultrafine particulates both cause cardiovascular disease in similar ways. Once they hit your lungs, your body immediately recognizes that something is amiss. "It essentially says, 'Oh, crap, something's wrong here,' and releases cytokines, molecules that control immune response," says David Weiss, M12, who works on the CAFEH study analyzing health surveys generated as part of the community outreach component of the research project. Those cytokines are used to summon help to the site of the infection, but also affect the activity of the immune system throughout the body.

Weiss likens the body's reaction to the terror-alert system that was put into place after 9/11. "You know, the one that was green, yellow, red," he says. "The higher levels of cytokines will take you from a level green to a level yellow." In other words, your whole body goes on high alert, causing elevated levels of inflammation.

Of course, not all inflammation is bad, says Doug Brugge. For example, if you cut your finger, within a day, you'll see some inflammation (redness) around the cut as your immune system mobilizes to kill any invading bacteria. "That is an example of a good inflammatory response, because it's localized," says Brugge. "It's responding to a real problem, and it's controlled. It has a beginning and an end."

"Larger particles can't cross the barrier from the lungs to the bloodstream," says David Weiss, M12, who has worked on analyzing neighborhood health surveys. "But the ultrafine particles can." Photo: John Soares

But constant exposure to fine and ultrafine particulate pollution can cause chronic inflammation. If that happens, white blood cells called macrophages, which are part of the body's natural defense mechanism, go into overdrive, seeking out bacteria or other foreign objects in the bloodstream. They start attacking whatever's there with extra gusto—including certain types of cholesterol that accumulate in the bloodstream. As macrophages gorge themselves on this fatty molecule, they (and their cholesterol contents) settle into the inner lining of blood vessels, where they slowly build up and create

artery-clogging plaques.

Weiss says that some of these deposits may happen anyway as the body ages, but inflammation caused by particulate pollution speeds the process, leading to premature heart attacks and strokes.

In this regard, fine and ultrafine particles have identical effects on the body. The big difference between them is their size. The smaller the particle, the more surface area it has per its mass. If that sounds confusing, think of it this way: When you're holding a bowling ball (or any other solid, for that matter) you're really only touching one thing—its outermost surface. But smash that bowling ball into tiny pieces, and you'll end up with dozens of surfaces you can touch. Each new shard increases the total amount of bowling ball material exposed, meaning the surface area of the bowling ball increases.

The same is true of particulate pollution—the smaller the particles of a pollutant, the more exposed surfaces they have collectively. That means they're more likely than larger particles to react with chemicals in the body that trigger an immune response.

Essentially, Weiss says, this gives the pollutants that make up ultrafine particles more bang for their buck. They're more potent than larger particles, so they may lead more quickly to heart disease. And, he adds, they may be small enough to get directly into the bloodstream, where they can do even more damage.

"Larger particles can't cross the barrier from the lungs to the bloodstream," says Weiss, "but the ultrafine particles can. So because of that, and partly because of their increased exposed surface area, there's more of an opportunity for them to have reactions that will cause inflammation." The only way to avoid this inflammation—short of somehow removing particles from the air around you—is to spend less time near major highways.

"For people who move away from the highway, it's like they quit smoking," says Wig Zamore, a longtime resident of Somerville with a master's degree in urban planning. Over the past decade, Zamore has worked with community groups on public health and clean-air issues, and is a member of the CAFEH steering committee, a group of academics and community members who help guide the study's research.

"Their risk pretty immediately starts to go down, and for the people who move closer to a highway, their risk immediately starts to go up over a matter of just a couple years," he says, citing a 2009 study by the University of British Columbia.

The problem is, of course, that many people living near highways don't have the financial means to move. According to Zamore, of the 35 million Americans who live by a major four-lane highway, roughly 18 percent are renters or live in low-income housing.

"For people who move away from the highway, it's like they quit smoking," says Wig Zamore, a CAFEH steering committee member. Photo: John Soares

**Community Action**

Tina Wang deals with new immigrants in Chinatown every day as a translator for the Chinese Progressive Association, a neighborhood advocacy group. Four years ago, she moved to the United States from China. She says that most of the community members she knows are aware that living near a major highway isn't great for their health, but they simply have nowhere else to go.

"[One man] told me, 'How can I leave? I don't have more money to move out. I [waited] more than five years to get this low-income apartment.' He knows there's pollution from the highway. He knows it's not good. But he asks me, 'What else can I do?' "

Wang is a member of CAFEH's field staff, a group of 23 people who live mostly in the study's target neighborhoods. To assess the health impacts of ultrafine particulates in those areas, CAFEH not only needs air samples; it needs biological data, too—so members of the field team go door-to-door, convincing neighbors to answer medical questionnaires, submit to blood pressure tests and give blood samples during weekly clinics held at a central location in each participating neighborhood.

Tina Wang is a member of CAFEH's field staff. Photo: John Soares

Over four years, the field team has canvassed Somerville, Dorchester, Chinatown and Malden—all areas where the CAFEH RV has collected air-quality data. So far, they've recruited 700 participants, 450 of whom have attended the CAFEH-run clinics.

"To our knowledge, our study is the only one that's both measuring ultrafines near the highway and looking at biological markers of people living in those areas," says Brugge. That's only part of what makes the study distinctive, he says. CAFEH's philosophy is to involve community members not just as sources of data, but also as colleagues in its research, as Tina Wang and Wig Zamore are.

Other researchers in the public health community are taking notice. "[CAFEH] is pretty unique in terms of its blend of hard-science approaches and attempts to both use community residents and keep the community informed throughout the project," says Jonathan Levy, a professor of environmental health at Boston University, who is on the thesis committees of two Ph.D. students working with CAFEH—Allison Patton from Tufts School of Engineering and Kevin Lane at the BU School of Public Health.

The benefits of collaboration are many. As Tina Wang sees it, even a task as simple as filling out a survey or giving blood can help embolden those involved. "[Chinatown residents] don't have high expectations for the government doing something for Chinatown. But if they can do a little bit for the community, [by participating in the study], they feel powerful."

**One City's Response**

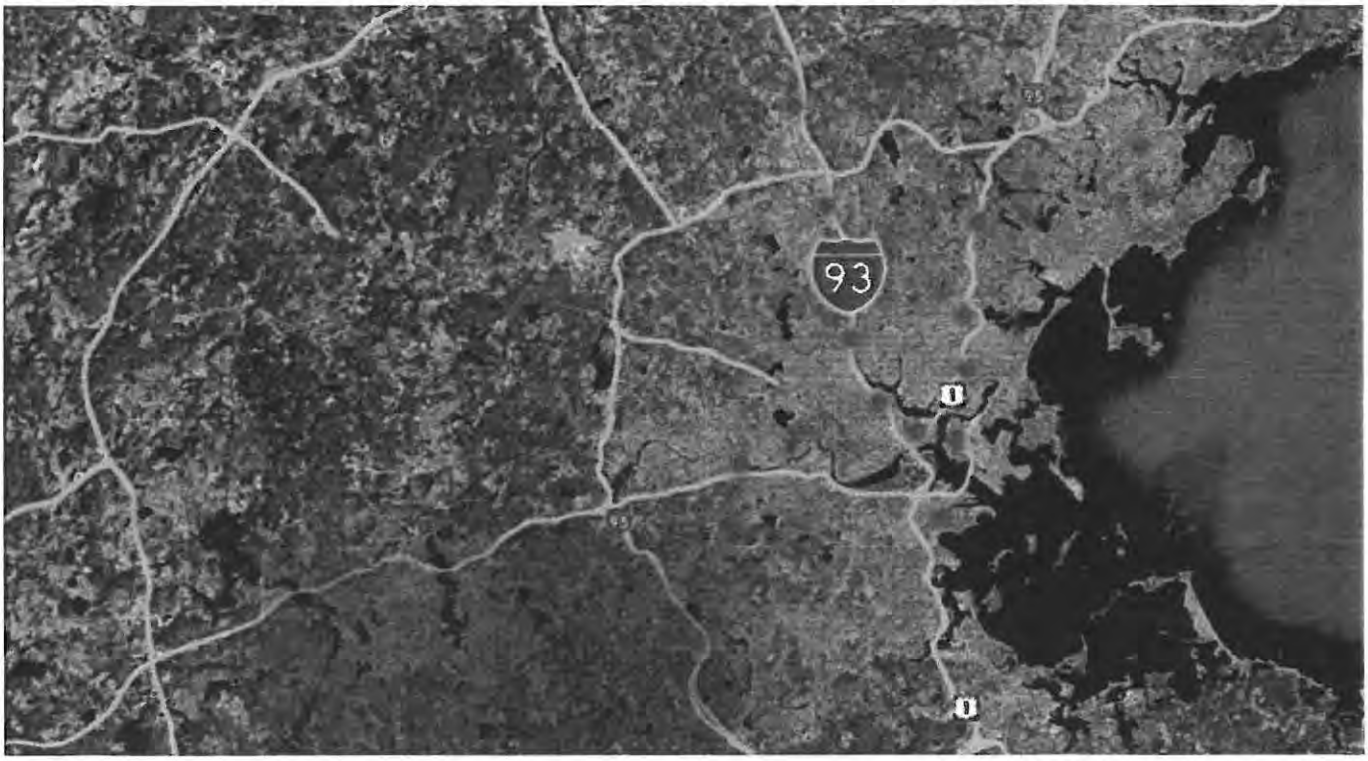
Some communities aren't simply waiting for the final results before they do something. Tucked into a bend in the Mystic River lies Somerville's Ten Hills neighborhood—a tiny, wedge-shaped slice of land covering 50 acres. The mayor of Somerville calls it home, as do two city aldermen. Driving through, it's easy to see why

there's an allure to the place. Its trim streets are lined with trees, and people wave to each other in the parks and running trails that flank the river. It's a gem of a neighborhood. But at 5 p.m. on a Tuesday, with almost no visible traffic nearby, you can hear the steady drone of car and truck engines.

Ten Hills is cut off from the rest of Somerville by two major highways. To the east, it's hemmed in by Route 28, which brings traffic across the Mystic River and into the neighboring city of Medford. To the south, it stops abruptly at Interstate 93.

Somerville Mayor Joseph Curtatone is incensed about the interstate. He was just seven years old when it opened in 1973, splitting the city in two. Nearly 40 years later, he still hears complaints about the highway from his neighbors. "It really changed the canvas of the city," he says. "Today, people sort of accept it in bewilderment, and say, 'How the hell did anyone ever make that decision? How did this happen?' [The highway] isn't really servicing neighborhoods; it's isolating them."

And, he adds, it has a distinct impact on the health of Somervillians. The city is the most densely populated in New England, and with some 75,000 people concentrated on just four square miles of land, more than 11 percent of residents live within 400 meters of a major highway, according to estimates drawn from recent census data.




Red dots show elevated mortality rates in towns aligned with major highways in the Boston area. Of 100 cities and towns in eastern Massachusetts, the highlighted communities hold some 75 percent of excess mortality, according to a recent survey.

Curtatone is hoping that the CAFEH study results, once published, will help guide city policy to mitigate the effects of pollutants from these roadways. Until then, his team at city hall is working with Brugge on finding interim solutions.

Emmanuel Owusu, Somerville's program manager for public housing, has already begun examining ways to

improve indoor air quality near the highway. He's focused his attention on the city's largest public housing project, the Mystic River Development, which sits right next to I-93. As is the case in the Ten Hills neighborhood, a front yard and a sidewalk are the only barriers separating the apartments from a highway traveled by an average 168,000 vehicles each day, according to the Massachusetts Department of Public Health.

With a grant from the U.S. Department of Housing and Urban Development (HUD), Owusu is working with Tufts environmental engineer John Durant and the community advocacy group STEP (Somerville Transportation Equity Partnership) to study the effectiveness of window filtration units installed in the Mystic River apartments. They're small, about the size of an average air conditioner, but Owusu says they're making a big difference in the overall indoor air quality.

"We've already seen a 35 percent reduction in particles in the rooms where we've run the filters," says Owusu. "HUD is watching the outcome of this study. If it's successful, it means indoor air filtration could go a long way to help the pollution issue we have at hand, not only in Somerville, but across the nation."

There may be other solutions. A study by the National Oceanic and Atmospheric Administration found that erecting tall sound barriers between highways and the people who live near them could contain most ultrafine particles inside highway boundaries. Another study from the University of California, Davis, experimented with trees as a natural barrier. Redwoods, researchers found, can remove up to 80 percent of ultrafines. But mitigation efforts such as these can go only so far.

Kevin Stone, a field team member for CAFEH, has lived in the Ten Hills neighborhood for 25 years. He says that many of his neighbors simply haven't heard about the potential health risks of living near a highway. "This one friend of mine lives at the top of the hill, right next to the highway. He's got all his windows wide open, and he's saying, 'Isn't this just a great view of Boston?'" Stone laments, shaking his head. "I'm saying to myself, 'You don't even realize what you're sucking in right off of I-93. You're getting really exposed to this stuff!'"

At the very least, Stone says, he'd like to see warning signs posted on the bike path that runs alongside the interstate. It's a small gesture, but it is something that would give residents an idea of what they might be breathing during rush hour.

Researchers with the CAFEH project are just beginning to sift through terabytes of air-pollution data from the RV and hundreds of blood samples from participants. They've released several preliminary papers this year, and are working toward presenting the study's main findings in summer 2013.

*This story first appeared in the Summer 2012 issue of* Tufts Medicine *magazine.*

*David Levin is a freelance science writer based in Boston.*

# Take a Deep Breath

**1943—First big smog event in Los Angeles**

In the middle of World War II, a dense brown fog descends on Los Angeles, stinging residents' eyes and noses. Some residents fear that the Japanese are waging chemical warfare, but the culprit turns out to be a combination of industrial smoke and auto exhaust.

**1948—Donora, Pa., smog**

On October 28, stagnant weather conditions trap thick smog over the mill town of Donora, Pa. When it lifts five days later, 20 people are dead and thousands are sickened. It remains one of the worst air pollution events in the United States.

**1952—"The Great Smog" of London**

Windless conditions drape London in a pea-soup smog. The pollution is so thick that it penetrates indoor areas, shutting down movie theaters. More than 4,000 people later die from the smog's effects, and 25,000 claim sickness benefits.

**1955—Air Pollution Control Act**

For the first time, the U.S. Congress passes legislation addressing air pollution as a national problem, pouring $5 million ($85 million in 2012 dollars) into federal air-quality research.

**1963—Clean Air Act of 1963**

Congress sets emission standards for stationary pollution sources such as power plants and steel mills and gives $96 million to state and local governments for air-quality research and control programs.

**1970—Clean Air Act of 1970**

In a major amendment to the 1963 legislation, Congress sets more demanding standards for emissions, including the first regulations for motor vehicles. The Environmental Protection Agency is created to enforce the new standards.

**1987—EPA regulates PM10**

In light of studies showing that PM10 (particles 10 microns across) can cause respiratory disease, the EPA singles them out for regulation. Before 1987, the agency regulated only "total suspended particulates"—a term for airborne particles of all sizes.

**1997—EPA regulates PM2.5**

In the early '90s, multiyear studies published by Harvard University and the American Cancer Society show clear links between fine particulates (PM2.5) and cardiovascular disease. As a result, the EPA begins to monitor and regulate PM2.5.

**2006—EPA tightens PM2.5 standards**

The EPA raises its 24-hour exposure standard for PM2.5, bringing the acceptable level down from 65 micrograms (per cubic meter of air) to 35 micrograms. CAFEH steering committee member Wig Zamore testifies before the EPA's Clean Air Scientific Advisory Committee to encourage the changes. Ultrafine

particulates (PM0.1) remain unregulated.

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# Residential Proximity to Major Highways — United States, 2010

## *Supplements*

**November 22, 2013 / 62(03);46-50**

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## Introduction

Traffic-related air pollution is a main contributor to unhealthy ambient air quality, particularly in urban areas with high traffic volume. Within urban areas, traffic is a major source of local variability in air pollution levels, with the highest concentrations and risk of exposure occurring near roads. Motor vehicle emissions represent a complex mixture of criteria air pollutants, including carbon monoxide (CO), nitrogen oxides (NOx), and particulate matter (PM), as well as hydrocarbons that react with NOx and sunlight to form ground-level ozone. Individually, each of these pollutants is a known or suspected cause of adverse health effects (*1*–*4*). Taking into consideration the entire body of evidence on primary traffic emissions, a recent review determined that there is sufficient evidence of a causal association between exposure to traffic-related air pollution and asthma exacerbation and suggestive evidence of a causal association for onset of childhood asthma, nonasthma respiratory symptoms, impaired lung function, all-cause mortality, cardiovascular mortality, and cardiovascular morbidity (*5*).

The mixture of traffic-related air pollutants can be difficult to measure and model. For this reason, many epidemiologic studies rely on measures of traffic (e.g., proximity to major roads, traffic density on nearest road, and cumulative traffic density within a buffer) as surrogates of exposure (*6–8*). These traffic measures typically account for both traffic volume (i.e., number of vehicles per day), which is a marker of the type and concentration of vehicle emissions, and distance, which addresses air pollution gradients near roads. Traffic emissions are highest at the point of release and typically diminish to near background levels within 150 to 300 meters of the roadway (*7,9,10*); however, the potential exposure zone around roads can vary considerably depending on the pollutant, traffic volume, ambient pollution concentrations, meteorologic conditions, topography, and land use (*5*). Traffic exposure metrics in the published literature have used a variety of different density and distance cut-points (*6*). Nevertheless, numerous epidemiologic studies have consistently demonstrated that living close to major roads or in areas of high traffic density is associated with adverse health effects, including asthma, chronic obstructive pulmonary disease, and other respiratory symptoms (*11–15*); cardiovascular disease risk and outcomes (*16–20*); adverse reproductive outcomes (*21,22*); and mortality (*23–25*). Some studies have observed a dose-response gradient such that living closer to major roads is associated with increased risk (*13,14,16–18*). In terms of traffic density, several studies have reported adverse health effects associated with residential proximity to roads with average daily traffic volume as low as 10,000 vehicles per day (*6,11,15–17*).

In the United States, it is widely accepted that economically disadvantaged and minority populations share a disproportionate burden of air pollution exposure and risk (*26,27*). A growing body of evidence demonstrates that minority populations and persons of lower socioeconomic status experience higher residential exposure to traffic and traffic-related air pollution than nonminorities and persons of higher socioeconomic status (*5,28–31*). Two recent studies have confirmed that these racial/ethnic and socioeconomic disparities also exist on a national scale (*32,33*).

This report is part of the second CDC Health Disparities and Inequalities Report (CHDIR). The 2011 CHDIR (*34*) was the first CDC report to assess disparities across a wide range of diseases, behavior risk factors, environmental exposures, social determinants, and health-care access. The topic presented in this report is based on criteria that are described in the 2013 CHDIR Introduction (*35*). This report provides descriptive data on residential proximity to major highways, a topic that was not discussed in the 2011 CHDIR. The purposes of this report are to discuss and raise awareness of the characteristics of persons exposed to traffic-related air pollution and to prompt actions to reduce disparities.

## Methods

To characterize the U.S. population living close to major highways, CDC examined data from several sources using Geographical Information Systems (GIS). Three data sources were used for this assessment: 1) the 2010 U.S. census (available at http://www.census.gov/2010census ), 2) 2006–2010 American Community Survey (ACS) 5-year estimates (available at http://www.census.gov/acs ), and 3) 2010 (Quarter 3) road network data from NAVTEQ, a commercial data source that provides comprehensive road information for the United States (available at http://www.navteq.com ). Seven sociodemographic variables were examined. Data on age, sex, and race/ethnicity were obtained from the 2010 census; data on nativity, language spoken at home, educational attainment,

and poverty status were obtained from the ACS.

The U.S. Census Bureau collects data on race and ethnicity (i.e., Hispanic origin) as two separate questions. For this analysis, persons of non-Hispanic ethnicity were classified as white, black, Asian/Pacific Islander, American Indian/Alaska Native, other race, and multiple races. Persons of Hispanic ethnicity, who might be of any race or combination of races, were grouped together as a single category. Educational attainment was defined as less than high school, high school graduate or equivalent, some college, or college graduate. For the variable nativity, "native born" includes U.S. citizens born abroad (one or both of whose parents were citizens at the time of birth) and anyone born in the United States or a U.S. territory; "foreign-born" denotes persons who were not U.S. citizens at birth. Poverty status was categorized by using the ratio of income to the federal poverty level (FPL), in which "poor" is <1.0 times FPL, "near poor" is 1.0–2.9 times FPL, and "nonpoor" is ≥3.0 times FPL.

Major highways were defined as interstates (Class 1) or as other freeways and expressways (Class 2) based on the Federal Highway Administration (FHWA) Functional Classification system. These road types represent the most heavily-trafficked, controlled-access highways in the United States. Although traffic volume is not factored directly into the Functional Classification system, FHWA statistics indicate that the majority of major highways have average daily traffic volumes exceeding 10,000 vehicles per day (i.e., 77% of rural interstates have >10,000 vehicles per day and >72% of urban interstates and other freeways and expressways have >30,000 vehicles per day) (*36*).

The census tract is the smallest geographic unit of analysis available for the variables of interest in the ACS data. ESRI ArcGIS v10 GIS software was used to create circular buffers of 150 meters around all major highways, and the proportion of each census tract included within the buffer area was calculated. This area proportion was then applied to the census tract-level data from the 2010 census and ACS to estimate the number of persons living within 150 meters of a major highway for the total population and by sociodemographic characteristics. Census tract count estimates were summed to obtain state and national estimates. The proportion of the population living within 150 meters of a major highway was calculated for each category of the seven sociodemographic variables, using category-specific denominators derived from the 2010 census and ACS. No sampling error is associated with the 100% population counts obtained from the 2010 census. Standard errors were not calculated for the estimated population counts derived from the ACS because of the complexity of the GIS analysis used to generate these data. Therefore, for this descriptive analysis, no statistical testing or calculation of 95% confidence intervals was conducted, and it was not possible to determine if the observed differences across population subgroups are statistically significant.

## Results

Approximately 11.3 million persons (or 3.7% of the 308.7 million U.S. population) live within 150 meters of a major highway. State-level estimates ranged from 1.8% in Maine to 5.6% in New York (Figure). Regional patterns, based on U.S. Census Bureau groupings, indicate that the estimated proportion of the population living within 150 meters of a major highway ranged from 3.1% in the Midwest and 3.3% in the South to 4.3% in the Northeast and 4.4% in the West. The proportion of the population living near a major highway did not differ by sex (Table). By age group, the estimated proportion of persons living close to a major highway varied from 3.4% among those aged 45–79 years to ≥4.0% among those aged 18–34 years.

The greatest disparities were observed for race/ethnicity, nativity, and language spoken at home; the populations with the highest estimated percentage living within 150 meters of a major highway included members of racial and ethnic minority communities, foreign-born persons, and persons who speak a language other than English at home (Table). The estimated percentage of the population living within 150 meters of a major highway ranged from a low of 2.6% for American Indians/Alaska Natives and 3.1% for non-Hispanic whites to a high of 5.0% for Hispanics and 5.4% for Asians/Pacific Islanders. Likewise, the estimated proportion of the population living near a major highway was 5.1% for foreign-born persons, 5.1% for persons who speak Spanish at home, and 4.9% for persons who speak another non-English language at home.

Disparities by educational attainment and poverty status were less pronounced (Table). The estimated percentage of the population living near a major highway varied from 3.4% for high school graduates to 4.1% for those with less than a high school diploma. A more consistent pattern was observed for poverty status; the estimated proportion of the population living near a major highway was 4.2% for those in the poor category, 3.7% for those in the near-poor category, and 3.5% for those in the nonpoor category.

## Discussion

Overall, approximately 4% of the total U.S. population lives within 150 meters of a major highway, suggesting increased exposure to traffic-related air pollution and elevated risk for adverse health outcomes. Estimates of residential proximity to major roads are influenced by the number and type of roads and the distance or buffer size used. In terms of quantifying the total U.S. population exposed to traffic-related air pollution, the estimate of 11.3 million people derived from this analysis should be considered conservative because only interstates, freeways, and expressways were included and a relatively small buffer distance of 150 meters was used. These conditions were selected to capture persons who are at the highest risk for exposure to traffic-related air pollution. In addition, this estimate is based on distance to a single road and does not account for cumulative exposure to traffic from multiple roads.

The percentage of the population exposed to traffic-related air pollution is expected to be larger in urban areas because of higher population density, more roads, and higher traffic volume. A case study of two North American cities (Los Angeles County and Toronto, Canada) estimated that 30%–45% of the population in these urban areas lives within 500 meters of a highway or 50–100 meters of a major road (5). Although this report does not address urban/rural differences directly, an additional state-level analysis of these data indicated that the percentage of the population living within 150 meters of a major highway was correlated positively ($R = 0.65$) with the percentage of the population living in urban areas. Additional studies are needed to understand potential sociodemographic disparities among populations living near major highways across levels of urbanization.

This analysis suggests that social and demographic disparities exist with respect to residential proximity to major highways. Larger disparities were observed for indicators of minority status (i.e., race/ethnicity, nativity, and language spoken at home) than for traditional indicators of socioeconomic status (i.e., poverty and educational attainment). Two other national studies have reported similar findings using alternative approaches. A study that examined the distribution of sociodemographic variables across various traffic exposure metrics assessed at the residential address found that race, ethnicity, poverty status, and education all were associated with one or more traffic

exposure metrics (*32*). Another study demonstrated that the correlation between traffic exposure metrics and sociodemographic variables across all U.S. census tracts was stronger for race and ethnicity than it was for poverty, income, and education and that the magnitude of the correlations varied spatially by region and state (*33*).

The environmental justice literature suggests that socially disadvantaged groups might experience a phenomenon known as "triple jeopardy" (*37*). First, poor and minority groups are known to suffer negative health effects from social and behavioral determinants of health (e.g., psychosocial stress, poor nutrition, and inadequate access to health care). Second, as suggested in this analysis, certain populations (e.g., members of minority communities, foreign-born persons, and persons who speak a non-English language at home) might be at higher risk for exposure to traffic-related air pollution as a result of residential proximity to major highways. Third, there is evidence suggesting a multiplicative interaction between the first two factors, such that socially disadvantaged groups experience disproportionately larger adverse health effects from exposure to air pollution (*37–39*).

## Limitations

The findings in this report are subject to at least three limitations. First, the area-proportion technique used assumes a homogeneous population density and population distribution by sociodemographic characteristics within each census tract, which might result in erroneous count estimates. The direction of the bias (overestimate or underestimate) could differ across population subgroups. For example, if socioeconomic disparities associated with residential proximity to major highways exist within census tracts, then the calculated percentages for minority subgroups might be underestimated and those for nonminority subgroups might be overestimated. Second, living within 150 meters of a major highway is only a surrogate for exposure to traffic-related air pollution. This study did not address the following factors that could affect exposure to traffic-related air pollution: number and type of vehicles traveling on major highways, cumulative effect of living near multiple roads, individual time-activity patterns (e.g., time spent at home vs. away, time spent inside vs. outside), meteorologic conditions, topography, and land-use patterns. Finally, it was not possible to perform testing to determine if the differences in the estimated percentages across population subgroups were statistically significant. However, the findings are consistent with other published research (*32,33*).

## Conclusion

Primary prevention strategies to reduce traffic emissions include improving access to alternative transportation options (e.g., transit, rideshare programs, walking, and cycling), financial incentives to reduce vehicle miles traveled and congestion, diesel retrofitting, and promoting the use of electric and low emission vehicles. In addition, secondary prevention strategies to reduce exposure to traffic emissions include mitigation techniques for existing homes and buildings (e.g., roadside barriers and improved ventilation systems) and land-use policies that limit new development close to heavily-trafficked roads. For example, a recent study of roadside barriers suggests that solid barriers (i.e., noise barriers) might be more effective at mitigating traffic-related air pollution than vegetative barriers (i.e., tree stands) (*41*). In California, public health law has been used to restrict siting of new schools near major highways and busy traffic corridors (California Education Code §7213.c.2.C). Implementation of these strategies can help reduce exposures to traffic-related air pollution and health risks associated with these exposures.

Focusing prevention and mitigation interventions in urban areas, where there is a higher concentration of traffic-related air pollution and a greater proportion of the population residing near major roads, and in areas with the most socially disadvantaged populations will likely result in larger health benefits (*37*). Future and ongoing efforts to address disparities in residential proximity to major highways and traffic-related air pollution exposures will require an interdisciplinary collaboration between transportation, urban planning, and public health specialists.

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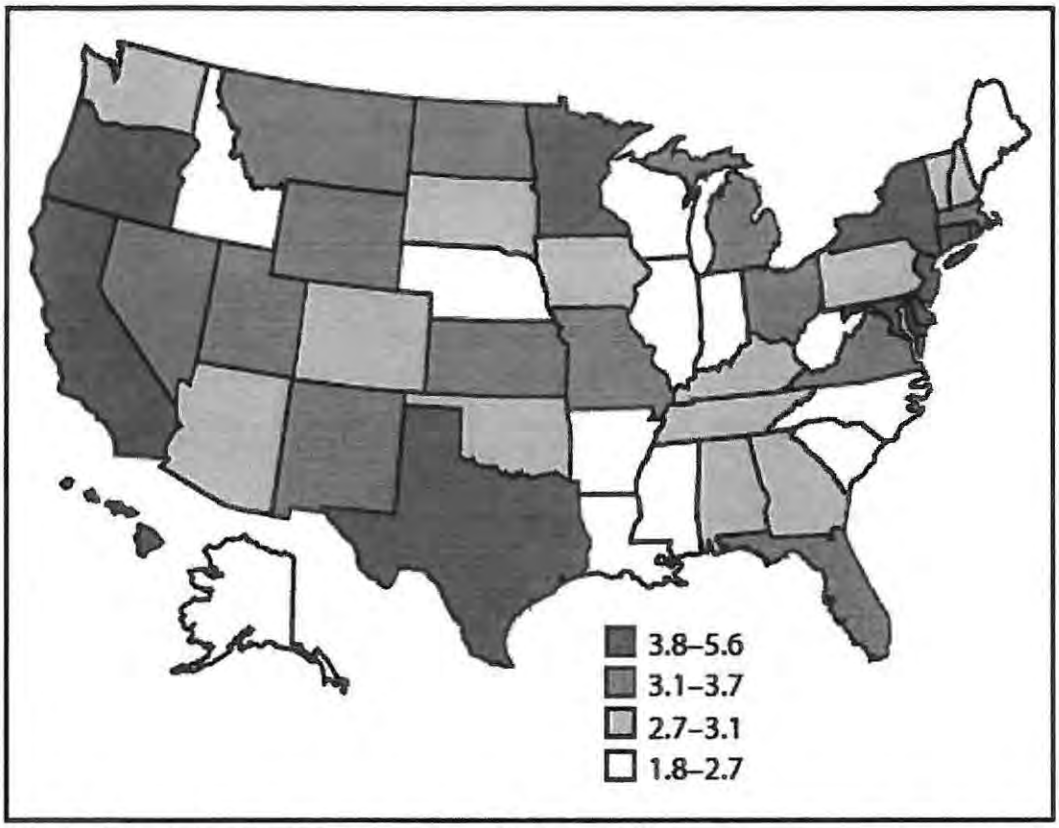
**FIGURE. Percentage* of population living within 150 meters of a major highway, by state — United States, 2010**




* Calculated by dividing the population within 150 meters of a major highway by the total population per state and multiplying by 100. The percentages are displayed using quartiles.

**Alternate Text:** The figure shows the percentage of the U.S. population living within 150 meters of a major highway, by state in 2010. The percentage was calculated by dividing the total population within 150 meters of a major highway by the total population per state and multiplying by 100. The percentages are displayed using quartiles.

**TABLE. Number and percentage of population living within 150 meters of a major highway, by selected characteristics — United States, 2010**

| Characteristic | No. | (%)* |
|---|---|---|

| | | |
|---|---|---|
| **Total†** | **11,337,933** | **(3.7)** |
| **Sex†** | | |
| Male | 5,547,223 | (3.7) |
| Female | 5,790,844 | (3.7) |
| **Age group (yrs)†** | | |
| 0–4 | 766,603 | (3.8) |
| 5–9 | 727,279 | (3.6) |
| 10–17 | 1,168,995 | (3.5) |
| 18–24 | 1,219,887 | (4.0) |
| 25–34 | 1,714,903 | (4.2) |
| 35–44 | 1,523,607 | (3.7) |
| 45–64 | 2,808,121 | (3.4) |
| 65–79 | 977,948 | (3.4) |
| ≥80 | 412,215 | (3.7) |
| **Race/Ethnicity†** | | |
| Non-Hispanic | | |
| White | 6,030,811 | (3.1) |
| Black | 1,676,225 | (4.4) |
| Asian/Pacific Islander | 800,723 | (5.4) |
| American Indian/Alaska Native | 59,378 | (2.6) |
| Other | 27,239 | (4.5) |
| Multiple race | 235,995 | (4.0) |
| Hispanic§ | 2,502,616 | (5.0) |
| **Nativity¶** | | |

| | | |
|---|---|---|
| Native born** | 9,172,481 | (3.5) |
| Foreign born†† | 1,966,763 | (5.1) |
| **Language spoken at home (≥5 yrs)¶** | | |
| English only | 7,513,304 | (3.3) |
| Spanish | 1,805,261 | (5.1) |
| Other | 1,059,572 | (4.9) |
| **Educational attainment (≥25 years)¶** | | |
| Less than high school | 1,225,735 | (4.1) |
| High school graduate or equivalent | 1,988,228 | (3.4) |
| Some college | 1,977,261 | (3.5) |
| College graduate | 2,092,232 | (3.8) |
| **Poverty status¶,§§** | | |
| Poor (<1.0 times FPL) | 1,733,031 | (4.2) |
| Near-poor (1.0–2.9 times FPL) | 3,882,694 | (3.7) |
| Nonpoor (≥3.0 times FPL) | 5,227,274 | (3.5) |

**Abbreviation:** FPL = federal poverty level.

* Denominator for overall population is 308,745,348. Percentages for all other rows were calculated by using category-specific denominators.

† **Source:** U.S. Census Bureau, 2010 census (available at http://www.census.gov/2010census ).

§ Persons of Hispanic ethnicity might be of any race or combination of races.

¶ **Source:** U.S. Census Bureau, 2006–2010 American Community Survey (available at http://www.census.gov/acs ).

** Includes U.S. citizens born abroad (one or both of whose parents were citizens at the time of birth) and anyone born in the United States or a U.S. territory.

†† Persons who were not U.S. citizens at birth.

§§ Additional information is available at http://aspe.hhs.gov/poverty/figures-fed-reg.cfm .

## Freeways are a Public Health Hazard

1. Studies show that the zone of increased pollution along a freeway corridor (compared to community wide concentrations) is approximately two miles wide.

2. People who live, work or travel within 165 feet downwind of a major freeway are exposed to the most dangerous part of air pollution, ultrafine particulate matter, at concentrations 25-30 times higher than the rest of the community.

3. For people who live near a freeway, the concentration of freeway generated pollution inside their homes is about 70% as high as outdoor air along the freeway corridor. For an average home, the indoor air exchanges completely with outdoor air every two hours. People living near a freeway are unquestionably breathing more pollution.

4. Wasatch Front air pollution is already a serious public health hazard. Our air pollution is sometimes the worst in the nation and typically we rank in the top ten worst cities in the country for acute spikes in air pollution. All of the health consequences of air pollution are found at even higher rates among people who live near freeways or other high traffic locations, including heart and lung diseases, strokes, shortened life spans, higher mortality rates, poor pregnancy outcomes, multiple types of cancer and even autism. Freeways are literally cancer and autism corridors.

**Thousands of studies confirm the health threat of freeway pollution. Below is a small samples of those studies.**

The rate of progression of hardening of the arteries, the cause of strokes, heart attacks and generalized aging, is double for those living within 100 meters of a freeway.

Künzli N, Jerrett M, Garcia-Esteban R, Basagaña X, Beckermann B, et al. (2010) Ambient Air Pollution and the Progression of Atherosclerosis in Adults. PLoS ONE 5(2): e9096. doi:10.1371/ journal.pone.0009096

Children who live within 500 meters of a major highway are not only more likely to develop asthma and other respiratory diseases, but their lung development may also be stunted permanently.

Gauderman WJ, et al. "Effect of exposure to traffic on lung development from 10 to 18 years of age: a cohort study," The Lancet, Volume 368, February 2007.

Living within 1,000 ft of a freeway doubles the risk of a child being born with autism.

Volk HE, Hertz-Picciotto I, Delwiche L, Lurmann F, McConnell R. Residential proximity to freeways and autism in the CHARGE study. Environ Health Perspect. 2011 Jun;119(6):873-7. doi:10.1289/ehp.1002835. Epub 2010 Dec 13.

Children growing up with more traffic pollution have significantly lower IQs and

impaired memory.

Suglia SF, et al. Association of Black Carbon with Cognition among Children in a Prospective Birth Cohort Study Am J Epidemiology 2008 167:280-286

Pregnant mothers exposed to more air pollution, give birth to children with lower intelligence, and behavioral and attention deficit disorders, even if the children breathe clean air themselves.

Frederica P. Perera, Deliang Tang, Shuang Wang, Julia Vishnevetsky, Bingzhi Zhang, Diurka Diaz, David Camann, Virginia Rauh. Prenatal Polycyclic Aromatic Hydrocarbon (PAH) Exposure and Child Behavior at age 6-7. Environmental Health Perspectives, 2012; DOI: 10.1289/ehp. 1104315

Edwards SC, Jedrychowski W, Butscher M, Camann D, Kieltyka A, Mroz E, et al. 2010. Prenatal Exposure to Airborne Polycyclic Aromatic Hydrocarbons and Children's Intelligence at Age 5 in a Prospective Cohort Study in Poland. Environ Health Perspect :-. doi:10.1289/ehp.0901070

Pregnant women who lived close to high-traffic roadways during pregnancy were more likely to give birth prematurely or have a low-weight baby, putting the child at risk for multiple, life long chronic diseases

Laurent O, Wu J, Li L, Chung J, Bartell S. Investigating the association between birth weight and complementary air pollution metrics: a cohort study. Environ Health. 2013 Feb 17;12(1):18. doi: 10.1186/1476-069X-12-18.

Wilhelm M, et al. Traffic-Related Air Toxics and Term Low Birth Weight in Los Angeles County, California. Environ Health Perspect. 2012 January; 120(1): 132–138. Published online 2011 August 11. doi: 10.1289/ehp.1103408

Living within 100 meters of a freeway increases the risk of childhood leukemia 370%, living within 300 meters increases the risk 100%.

Amigou A, et al. "Road traffic and childhood leukemia: The ESCALE study (SFCE) authors" Environ Health Pers 2010; DOI: 10.1289/ehp.1002429.

Pregnant mother breathing higher rates of air pollution give birth to children who have higher rates of several types of rare childhood cancers.

Prenatal air pollution associated higher rates of retinoblastomas, ALL, and germ cell tumors. http://www.aacr.org/home/public--media/aacr-in-the-news.aspx?d=3062

Women exposed to more traffic-related air pollution have higher rates of breast cancer and decreased survival if they get breast cancer. Background Wasatch Front levels correlate with an increase of about 125%, living near a freeway increases that much more.

Crouse DL, Goldberg MS, Ross NA, Chen H, Labrèche F 2010. Postmenopausal Breast Cancer Is Associated with Exposure to Traffic-Related Air Pollution in Montreal, Canada: A Case–Control Study. Environ Health Perspect 118:1578-1583. doi:10.1289/ehp.1002221

Chronic exposure to traffic air pollution increases the risk of lung cancer.

Raaschou-Nielsen O, Andersen Z, Hvidberg M, Jensen SS, Ketzel M, Sørensen M, Loft S, Overvad K, Tjønneland A. Lung Cancer Incidence and Long-Term Exposure to Air Pollution from Traffic. Environ Health Perspect. 2011 Jan 12. [Epub ahead of print]

## High traffic air pollution exposure more than doubles the rate of cervical and brain cancer, and increases the risk of prostate cancer and stomach cancer

Raaschou-Nielsen O, Andersen ZJ, Hvidberg M, Jensen SS, Ketzel M, Sørensen M, Hansen J, Loft S, Overvad K, Tjønneland A. Air pollution from traffic and cancer incidence: a Danish cohort study. Environ Health. 2011 Jul 19;10:67. doi: 10.1186/1476-069X-10-67.

Parent ME, Goldberg MS, Crouse DL, Ross NA, Chen H, Valois MF, Liautaud A.
Traffic-related air pollution and prostate cancer risk: a case-control study in Montreal, Canada. Occup Environ Med. 2013 Mar 26. [Epub ahead of print]

## People exposed to more traffic related air pollution have more DNA damage, a trigger for multiple chronic diseases including cancer.

Huang HB, Lai CH, Chen GW, Lin YY, Jaakkola JJ, Liou SH, Wang SL. Traffic-related air pollution and DNA damage: a longitudinal study in Taiwanese traffic conductors. PLoS One. 2012;7(5):e37412. doi: 10.1371/journal.pone.0037412. Epub 2012 May 21.

## Traffic related air pollution shortens telomeres (a critical part of chromosomes). Shortened telomeres are highly correlated with reduced life expectancy

McCracken J, Baccarelli A, Hoxha M, Dioni L, Melly S, Coull B, Suh H, Vokonas P, Schwartz J. Annual ambient black carbon associated with shorter telomeres in elderly men: Veterans Affairs Normative Aging Study. Environ Health Perspect. 2010 Nov;118(11):1564-70.

## Residential proximity to major roadways is associated with decreased kidney function.

Lue S, Wellenius G, Wilker E, Mostofsky E, Mittleman M. Residential proximity to major roadways and renal function. J Epidemiol Community Health Published Online First: 13 May 2013 doi:10.1136/jech-2012-202307

## Long term exposure to traffic-related air pollution is associated with insulin resistance in children and type II diabetes in adults

Thiering E, Cyrys J, Kratzsch J, Meisinger C, Hoffmann B, Berdel D, von Berg A, Koletzko S, Bauer CP, Heinrich J. Long-term exposure to traffic-related air pollution and insulin resistance in children: results from the GINIplus and LISAplus birth cohorts
Diabetologia, DOI 10.1007/s00125-013-2925-x

Chen H, Burnett RT, Kwong JC, Villeneuve PJ, Goldberg MS, Brook RD, van Donkelaar A, Jerrett M, Martin RV, Brook JR, Copes R. Risk of Incident Diabetes in Relation to Long-term Exposure to Fine Particulate Matter in Ontario, Canada. Environ Health Perspect (): .doi:10.1289/ehp.1205958

Liu C, Ying Z, Harkema J, Sun Q, Rajagopalan S. Epidemiological and Experimental Links between Air Pollution and Type 2 Diabetes. Toxicol Pathol. 2012 Oct 26. [Epub ahead of print]

Compiled by the Utah Physicians for a Healthy Environment

The ***Southern California Particle Center and Supersite*** (SCPCS) seeks to explore health and exposure issues related to mobile source pollution. With funding from the U.S. EPA and California Air Resources Board, investigators at the SCPCS work to better understand why airborne particulate matter emitted from cars and trucks causes adverse health outcomes. As part of our research, we have taken measurements on and near major freeways in Los Angeles in an effort to characterize the particles found there. These and other scientific studies have sparked media attention and community interest, generating many questions regarding where to buy property and whether health is affected by living in a particular location. It is impossible for us to answer individual questions about potential risks in specific locations. We can, however, offer some general guidance on what is currently known about exposure to pollution and the related health effects of living near busy roads and freeways.

Numerous studies have linked traffic-related air pollution with respiratory problems such as asthma and chronic bronchitis. Studies have found decreased lung function, increased hospital visits for people with respiratory diseases, increased absenteeism from work and school, and increased morbidity (illnesses) and mortality (deaths) associated with exposure to particulate matter. All of these effects were observed at levels common in many U.S. cities. (Pope)

New studies show that long-term exposure to particulate matter has also been linked to increased illness and death rates from cardiovascular (heart-related) disease, and that sudden increases in air pollution may even cause more heart-related illnesses and deaths than is seen from lung disease. (Pope; Johnson) Some particles in air pollution, given their tiny size, are able to pass through the cellular tissue in the lungs and enter the circulation system. Their presence in the lungs may also induce a series of events that ultimately affect the heart. (Utell)

Of growing concern to the general public is whether living near a freeway is detrimental to health. The closer people are to the source of traffic emissions, the higher their exposure is to many of the constituents of exhaust. Compelling evidence suggests that people living, working and going to school near roads with heavy traffic may have an increased risk of adverse health effects associated with exposure to mobile source pollution. These "traffic density" studies have observed development and increased aggravation of asthma (Montnémery), decreased lung function in children (Brunekreef), and low birth weight and premature births for mothers living near major roadways (Ritz).

Taking this research into consideration, it is easy to see why new homebuyers are concerned with how close property is to a busy road or freeway. Unfortunately scientists cannot say exactly how close is "too close" at this point. European studies have shown increased respiratory health problems in children who live or go to school within 100 meters (~330 feet) of a busy roadway, with the greatest risks appearing in the first 50 meters (~165 feet). Studies conducted by SCPCS investigators here in LA show that carbon monoxide and ultrafine particles – the smallest portion of particulate matter emissions and potentially the most toxic – are extremely high on or near the freeway, dropping to about half that concentration 50-90 meters (~165-295 feet) from the freeway. After about 300 meters (~990 feet) the concentration of particulate matter reaches the "ambient" level – the normal level in the air without the influence of any nearby sources. In 2003 the California state legislature enacted a law that new schools must be built at least 500 feet from very busy roadways.

Besides the actual distance from a roadway, there are a number of additional factors that influence exposure to mobile source pollution when at home:

- Weather - temperature, humidity, wind direction and speed all affect the concentration of pollution;
- Placement of the house - is it upwind or downwind of the major roadway? That is, does the wind blow pollutants from the cars and trucks toward the property?
- Construction/design of the house – older houses may have greater air exchange between indoors and outdoors with more outside air getting inside and therefore potentially increasing exposure to pollutants;
- Type of filtration system installed in the home - few homes have HEPA (High Efficiency Particulate Air) filters, but they have been shown to remove significant amounts of the particulate matter from the air.

There are also a number of personal factors to consider when determining what your personal exposure may be, such as:

- Will I be at home during peak traffic times?
- Will I spend much time outdoors during these times?
- Will I open my windows or will I use central heating and cooling?
- How much time do I spend on the freeway? [On-road studies are currently being conducted which may show that if you have a considerable commute, the exposure you receive during your time on the freeway may well overshadow your level of exposure at home.]

***Other resources for questions on particle measurements and possible health effects:***

South Coast Air Quality Management District
http://www.aqmd.gov/
*General phone number – (800) CUT-SMOG (800-288-7664)*

California Air Resources Board
http://www.arb.ca.gov/
*Community Health / Environmental Justice Section – (866) 397-5462*

Air Pollution and Respiratory Health, National Center for Environmental Health, CDC
http://www.cdc.gov/nceh/airpollution/default.htm

U.S. EPA – Air
http://www.epa.gov/ebtpages/air.html

**For more detailed information about the topics presented above, please reference the following citations.**

Green RS, Smorodinsky S, Kim JJ, McLaughlin R, Ostro B. (2004) Proximity of California Public Schools to Busy Roads. Environmental Health Perspectives, 112 (1): 61-66.

Pope CA III, Bates DV, Raizenne ME. (1995) Health Effects of Particulate Air Pollution: Time for Reassessment? Environmental Health Perspectives, 103 (5)

**Asthma** – acute exacerbation and possible onset
Delfino RJ. (2003) Epidemiologic Evidence for Asthma and Exposure to Air Toxics: Linkages between Occupational, Indoor, and Community Air Pollution Research. Environmental Health Perspectives, 110 (Sup 4): 573-589.

McConnell R, Berhane K, Gilliland FD, London SJ, Vora H, Avol E. (1999) Air Pollution and Bronchitic Symptoms in Southern California Children with Asthma. Environmental Health Perspectives 107(9):757-760

Montnémery P, Bengtsson P, Elliot A, Lindholm L-H, Nyberg P, Lofdahl C-G. (2000) Prevalence of obstructive lung diseases and respiratory symptoms in relation to living environment and socio-economic group. Respiratory Medicine, 95: 744-752

**Cardiovascular effects**
Dockery, DW. (2001) Epidemiologic Evidence of Cardiovascular Effects of Particulate Air Pollution. Environmental Health Perspectives, 109(Suppl 4): 483-486.

Johnson, RL. (2004) Relative Effects of Air Pollution on Lungs and Hearts. Circulation, 109:5-7.

Pope CA III, Burnett RT, Thurston GD, Thun MJ, Calle EE, Krewski D, Godleski JJ. (2004) Cardiovascular Mortality and Long-Term Exposure to Particulate Air Pollution. Circulation, 109:71-77.

Utell MJ, Frampton MW. (2000) Acute Health Effects of Ambient Air Pollution: the Ultrafine Particle Hypothesis. Journal of Aerosol Medicine, 13(4): 355-59.

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# Near-highway pollutants in motor vehicle exhaust: A review of epidemiologic evidence of cardiac and pulmonary health risks

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## Abstract

There is growing evidence of a distinct set of freshly-emitted air pollutants downwind from major highways, motorways, and freeways that include elevated levels of ultrafine particulates (UFP), black carbon (BC), oxides of nitrogen (NOx), and carbon monoxide (CO). People living or otherwise spending substantial time within about 200 m of highways are exposed to these pollutants more so than persons living at a greater distance, even compared to living on busy urban streets. Evidence of the health hazards of these pollutants arises from studies that assess proximity to highways, actual exposure to the pollutants, or both. Taken as a whole, the health studies show elevated risk for development of asthma and reduced lung function in children who live near major highways. Studies of particulate matter (PM) that show associations with cardiac and pulmonary mortality also appear to indicate increasing risk as smaller geographic areas are studied, suggesting localized sources that likely include major highways. Although less work has tested the association between lung cancer and highways, the existing studies suggest an association as well. While the evidence is substantial for a link between near-highway exposures and adverse health outcomes, considerable work remains to understand the exact nature and magnitude of the risks.

## Background

Approximately 11% of US households are located within 100 meters of 4-lane highways [estimated using: [1, 2]]. While it is clear that automobiles are significant sources of air pollution, the exposure of near-highway residents to pollutants in automobile exhaust has only recently begun to be characterized. There are two main reasons for this: (A) federal and state air monitoring programs are typically set up to measure pollutants at the regional, not local scale; and (B) regional monitoring stations typically do not measure all of the types of pollutants that are elevated next to highways. It is, therefore, critical to ask what is known about near-highway exposures and their possible health consequences.

Here we review studies describing measurement of near-highway air pollutants, and epidemiologic studies of cardiac and pulmonary outcomes as they relate to exposure to these pollutants and/or proximity to highways. Although some studies suggest that other health impacts are also important (e.g., birth outcomes), we feel that the case for these health effects are less well developed scientifically and do not have the same potential to drive public policy at this time. We did not seek to fully integrate the relevant cellular biology and toxicological literature, except for a few key references, because they are so vast by themselves.

We started with studies that we knew well and also searched the engineering and health literature on Medline. We were able to find some earlier epidemiologic studies based on citations in more recent articles. We include some studies that assessed motor vehicle-related pollutants at central site monitors (i.e., that did not measure highway proximity or traffic) because we feel that they add to the plausibility of the associations seen in other studies. The relative emphasis given to studies was based on our appraisal of the rigor of their methodology and the significance of their findings. We conclude with a summary and with recommendations for policy and further research.

### Motor vehicle pollution

It is well known that motor vehicle exhaust is a significant source of air pollution. The most widely reported pollutants in vehicular exhaust include carbon monoxide, nitrogen and sulfur oxides, unburned hydrocarbons (from fuel and crankcase oil), particulate matter, polycyclic aromatic hydrocarbons, and other organic compounds that derive from combustion [3, 4, 5]. While much attention has focused on the transport and transformation of these pollutants in ambient air – particularly in areas where both ambient pollutant concentrations and human exposures are elevated (e.g., congested city centers, tunnels, and urban canyons created by tall buildings), less attention has been given to measuring pollutants and exposures near heavily-trafficked highways. Several lines of evidence now suggest that steep gradients of certain pollutants exist next to heavily traveled highways and that living within these elevated pollution zones can have detrimental effects on human health.

It should be noted that many different types of highways have been studied, ranging from California "freeways" (defined as multi-lane, high-speed roadways with restricted access) to four-lane (two in each direction), variable-speed roadways with unrestricted access. There is considerable variation in the literature in defining highways and we choose to include studies in our review that used a broad range of definitions (see Table 1).

Table 1

Summary of near-highway pollution gradients

| Citation | Location | Highway traffic intensity[a] | Pollutants measured[b] | Observed Pollution Gradients |
|---|---|---|---|---|
| Shi et al. 1999 (6) | Birmingham, UK | 30,000 veh/d | UFP + FP (10-$10^4$ nm) | 2–100 m [c] |
| Zhu et al. 2002 (8) | Los Angeles; Freeway 710 | 12,180 veh/h | UFP, CO, BC | 17–300 m [c] |
| Zhu et al. 2002 (7) | Los Angeles; Freeway 405 | 13,900 veh/h | UFP, CO, BC | 30–300 m [c] |
| Hitchins et al. 2002 (11) | Brisbane (Austr.) | 2,130–3,400 veh/h | UFP + FP (15-2 × $10^4$ nm), $PM_{2.5}$ | 15–375 m [c] |
| Fischer et al. 2000 (13) | Amsterdam | <3,000–30,974 veh/d | $PM_{2.5}$, $PM_{10}$, PPAH, VOCs | NA |
| Roorda-Knape et al. 1998 (14) | Netherlands | 80,000–152,000 veh/d | $PM_{2.5}$, $PM_{10}$, BC, VOCs, $NO_2$ | 15–330 m [c] |
| Janssen et al. 2001 (15) | Netherlands | 40,000–170,000 veh/d | $PM_{2.5}$, VOCs, $NO_2$ | < 400 m [c] |
| Morawska et al. 1999 (12) | Brisbane (Austr.) | NA | UFP | 10–210 m [c] |

[a]As defined in article cited (veh/d = vehicles per day; veh/h = vehicles per hour).

[b]UFP = ultrafine particles; FP = fine particles; $PM_{2.5}$ = particles with aerodynamic diameter ≤ 2.5 um; $PM_{10}$ = particles with aerodynamic diameter ≤ 10 um; BC = black carbon; PPAH = particle-bound polycyclic aromatic hydrocarbons; VOCs = volatile organic compounds

[c]Pollutant measurements were made along a transect away from the highway

NA = not applicable; measurements were not made.

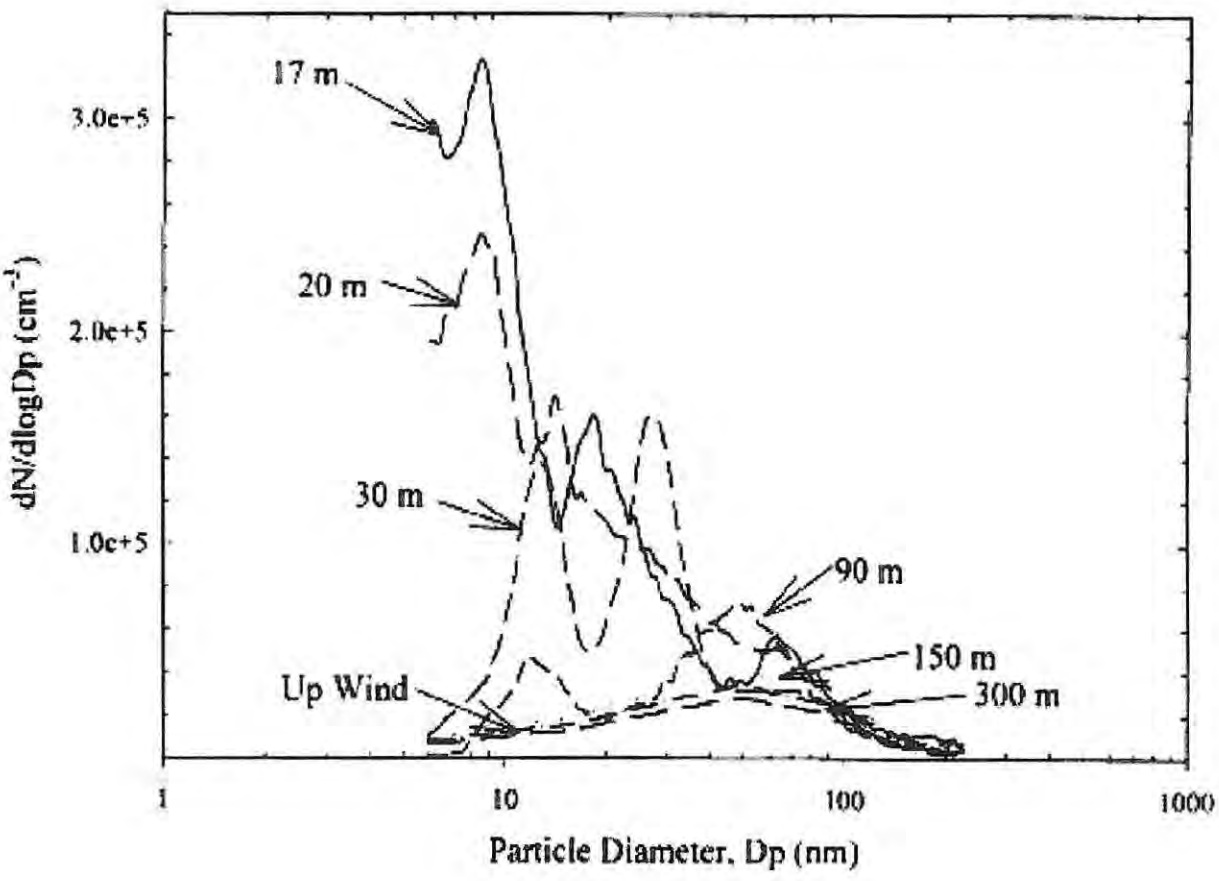
It should also be noted that there may be significant heterogeneity in the types and amounts of vehicles using highways. The typical vehicle fleet in the US is composed of

passenger cars, sports utility vehicles, motorcycles, pickup trucks, vans, buses, and small, medium, and large trucks. The composition and size of a fleet on a given highway may vary depending on the time of day, day of the week, and use restrictions for certain classes of vehicles. Fleets may also vary in the average age and state of repair of vehicles, the fractions of vehicles that burn diesel and gasoline, and the fraction of vehicles that have catalytic converters. These factors will influence the kinds and amounts of pollutants in tailpipe emissions. Similarly, driving conditions, fuel chemistry, and meteorology can also significantly impact emissions rates as well as the kinds and concentrations of pollutants present in the near-highway environment. These factors have rarely been taken into consideration in health outcome studies of near-highway exposure.

Based on our review of the literature, the pollutants that have most consistently been reported at elevated levels near highways include ultrafine particles (UFP), black carbon (BC), nitrogen oxides (NOx), and carbon monoxide (CO). In addition, $PM_{2.5}$, and $PM_{10}$ were measured in many of the epidemiologic studies we reviewed. UFP are defined as particles having an aerodynamic diameter in the range of 0.005 to 0.1 microns (um). UFP form by condensation of hot vapors in tailpipe emissions, and can grow in size by coagulation. $PM_{2.5}$ and $PM_{10}$ refer to particulate matter with aerodynamic diameters of 2.5 and 10 um, respectively. BC (or "soot carbon") is an impure form of elemental carbon that has a graphite-like structure. It is the major light-absorbing component of combustion aerosols. These various constituents can be measured in real time or near-real time using particle counters (UFP) and analyzers that measure light absorption (BC and CO), chemiluminescence (NOx), and weight ($PM_{2.5}$ and $PM_{10}$). Because UFP, $NO_x$, BC, and CO derive from a common source – vehicular emissions – they are typically highly inter-correlated.

## Air pollutant gradients near highways

Several recent studies have shown that sharp pollutant gradients exist near highways. Shi et al. [6] measured UFP number concentration and size distribution along a roadway-to-urban-background transect in Birmingham (UK), and found that particle number concentrations decreased nearly 5-fold within 30 m of a major roadway (>30,000 veh/d). Similar observations were made by Zhu et al. [7, 8] in Los Angeles. Zhu et al. measured wind speed and direction, traffic volume, UFP number concentration and size distribution as well as BC and CO along transects downwind of a highway that is dominated by gasoline vehicles (Freeway 405; 13,900 vehicles per hour; veh/h) and a highway that carries a high percentage of diesel vehicles (Freeway 710; 12,180 veh/h). Relative concentrations of CO, BC, and total particle number concentration decreased exponentially between 17 and 150 m downwind from the highways, while at 300 m UFP number concentrations were the same as at upwind sites. An increase in the relative concentrations of larger particles and concomitant decrease in smaller particles was also observed along the transects (see Figure 1). Similar observations were made by Zhang et al. [9] who demonstrated "road-to-ambient" evolution of particle number distributions near highways 405 and 710 in both winter and summer. Zhang et al. observed that between 30–90 m downwind of the highways, particles grew larger than 0.01 um due to condensation, while at distances >90 m, there was both continued particle growth (to >0.1 um) as well as particle shrinkage to <0.01 um due to evaporation. Because condensation, evaporation, and dilution alter size distribution and particle composition, freshly-emitted UFP near highways may differ in chemical composition from UFP that has undergone atmospheric transformation during transport to downwind locations [10].



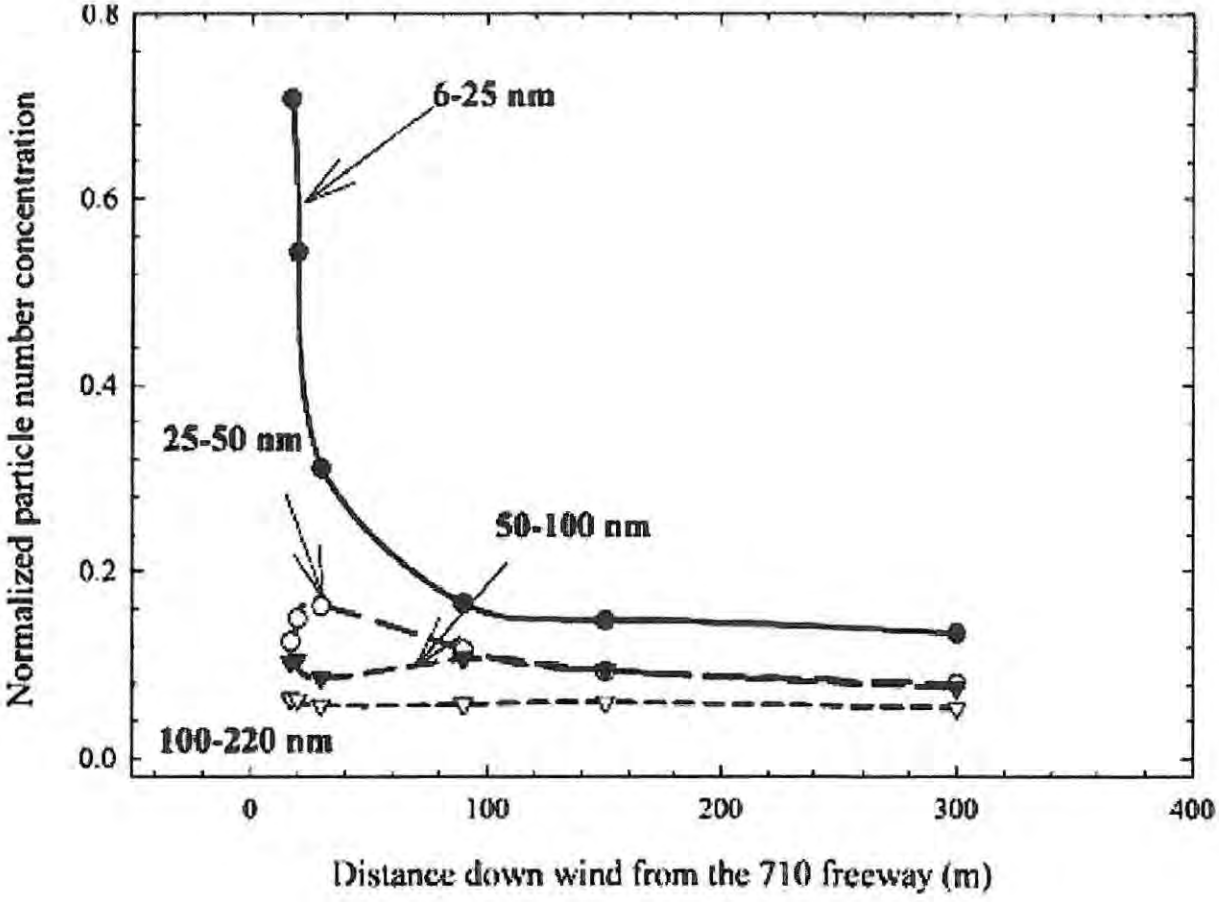



Figure 1

Ultrafine particle size distribution (top panel) and normalized particle number concentration for different size ranges (bottom panel) as a function of distance from a highway in Los Angeles. From Zhu et al. (8). Reprinted with permission from Elsevier.

Two studies in Brisbane (Australia) highlight the importance of wind speed and direction as well as contributions of pollutants from nearby roadways in tracking highway-generated pollutant gradients. Hitchins et al. [11] measured the mass concentrations of 0.1–10 um particles as well as total particle number concentration and size distribution for 0.015–0.7 um particles near highways (2,130–3,400 veh/h). Hitchens et al. observed that the distance from highways at which number and mass concentrations decreased by 50% varied from 100 to 375 m depending on the wind speed and direction. Morawska et al. [12] measured the changes in UFP number concentrations along horizontal and vertical transects near highways to distinguish highway and normal street traffic contributions. It was observed that UFP number concentrations were highest <15 m from highways, while 15–200 m from highways there was no significant difference in UFP number concentrations along either horizontal or vertical transects – presumably due to mixing of highway pollutants with emissions from traffic on nearby, local roadways.

In addition to UFP, other pollutants – such as $PM_{2.5}$, $PM_{10}$, $NO_2$ (nitrogen dioxide), VOCs (volatile organic compounds), and particle-bound polycyclic aromatic hydrocarbons (PPAH) – have been studied in relation to heavily-trafficked roadways. Fischer et al. [13] measured $PM_{2.5}$, $PM_{10}$, PPAH, and VOC concentrations outside and inside homes on streets with high and low traffic volumes in Amsterdam (<3,000–30,974 veh/d). In this study, PPAH and VOCs were measured using methods based on gas chromatography. Fischer et al. found that while $PM_{2.5}$ and $PM_{10}$ mass concentrations were not specific indicators of traffic-related air pollution, PPAH and VOC levels were ~2-fold higher both indoor and outdoor in high traffic areas compared to low traffic areas. Roorda-Knape et al [14] measured $PM_{2.5}$, $PM_{10}$, black smoke (which is similar to BC), $NO_2$, and benzene in residential areas <300 m from highways (80,000–152,000 veh/d) in the Netherlands. Black smoke was measured by a reflectance-based method using filtered particles; benzene was measured using a method based on gas chromatography. Roorda-Knape et al reported that outdoor concentrations of black smoke and $NO_2$ decreased with distance from highways, while $PM_{2.5}$, $PM_{10}$, and benzene concentrations did not change with distance. In addition, Roorda-Knape et al. found that indoor black smoke concentrations were correlated with truck traffic, and $NO_2$ was correlated with both traffic volume and distance from highways. Janssen et al. [15] studied $PM_{2.5}$, $PM_{10}$, benzene, and black smoke in 24 schools in the Netherlands and found that $PM_{2.5}$ and black smoke increased with truck traffic and decreased with distance from highways (40,000–170,000 veh/d).

In summary, the literature shows that UFP, BC, CO and NOx are elevated near highways (>30,000 veh/d), and that other pollutants including VOCs and PPAHs may also be elevated. Thus, people living within about 30 m of highways are likely to receive much higher exposure to traffic-related air pollutants compared to residents living >200 m (+/- 50 m) from highways.

## Cardiovascular health and traffic-related pollution

Results from clinical, epidemiological, and animal studies are converging to indicate that short-term and long-term exposures to traffic-related pollution, especially particulates, have adverse cardiovascular effects [16, 17, 18]. Most of these studies have focused on, and/or demonstrated the strongest associations between cardiovascular health outcomes and particulates by weight or number concentrations [19, 20, 21] though CO, $SO_2$, $NO_2$, and BC have also been examined. BC has been shown to be associated with decreases in heart rate variability (HRV) [22, 23] and black smoke and $NO_2$ shown to be associated with cardiopulmonary mortality [24].

Short-term exposure to fine particulate pollution exacerbates existing pulmonary and cardiovascular disease and long-term repeated exposures increases the risk of cardiovascular disease and death [25, 26].

Though not focused on near-highway pollution, two large prospective cohort studies, the Six-Cities Study [27] and the American Cancer Society (ACS) Study [28] provided the groundwork for later research on fine particulates and cardiovascular disease. Both of these studies found associations between increased levels of exposure to ambient PM and sulfate air pollution recorded at central city monitors and annual average mortality from cardiopulmonary disease, which at the time combined cardiovascular and pulmonary disease other than lung cancer. The Six-Cities Study examined $PM_{2.5}$ and $PM_{10/15}$. The ACS study examined $PM_{2.5}$. Relative risk ratios of mortality from cardiopulmonary disease comparing locations with the highest and lowest fine particle concentrations (which had differences of 24.5 and 18.6 ug/$m^3$ respectively) were 1.37 (1.11, 1.68) and 1.31 (1.17, 1.46) in the Six Cities and ACS studies, respectively. These analyses controlled for many confounders, including smoking and gas stoves but not other housing conditions or time spent at home. The studies were subject to intensive replication, validation, and reanalysis that confirmed the original findings. $PM_{2.5}$ generally declined following implementation of new US Environmental Protection Agency standards in 1997 [17, 29], yet since that time studies have shown elevated health risks due to long-term exposures to the 1997 PM threshold concentrations [29, 30].

Much of the epidemiological research has focused on assessing the early physiological responses to short-term fluctuations in air pollution in order to understand how these exposures may alter cardiovascular risk profiles and exacerbate cardiovascular disease [31]. Heart rate variability, a risk factor for future cardiovascular outcomes, is altered by traffic-related pollutants particularly in older people and people with heart disease [22, 23, 32]. With decreased heart rate variability as the adverse outcome, negative associations between HRV and particulates were strongest for the smallest size fraction studied [33] (PM0.3–1.0); [34] (PM0.02–1). In two studies that included other pollutants, black carbon, an indicator of traffic particles, also elicited a strong association with both time and frequency domain HRV variables; associations were also strong for PM2.5 for both time and frequency HRV variables in the Adar et al study [[23]; this and subsequent near highway studies are summarized in Table 2], however, PM2.5 was not associated with frequency domain variables in the Schwartz et al. study [22].

Table 2

Summary of near-highway health effects studies

| Citation | Location | Highway traffic intensity[a] | Pollutants measured[b] | Distance from highway | Health Outcomes | Statistical association[e] |
|---|---|---|---|---|---|---|
| Schwartz et al. 2005 (22) | Boston | NA | $PM_{2.5}$, BC, CO | NA | Heart rate variability | Decreases in measures of heart rate variability |
| Adar et al. 2007 (23) | St. Louis, Missouri | NA | $PM_{2.5}$, BC, UFP | On highway in busses | Heart rate variability | Decreases in measures of heart rate variability |
| Hoek et al. 2002 (24) | Netherlands | NA | BC, $NO_2$ | Continuous [d] | Cardio-pulmonary mortality, lung cancer | 1.41 OR for living near road |
| Tonne et al. 2007 (41) | Worchester, Mass. | NA | $PM_{2.5}$ | Continuous [d] | Acute myocardial infarction (AMI) | 5% increase in odds of AMI |
| Venn et al. 2001 (49) | Nottingham, UK | NA | NA | Continuous [d] | Wheezing in children | 1.08 OR for living w/in 150 m of road |
| Nicolai et al. 2003 (58) | Munich, Germany | >30,000 veh/d | Soot, benzene, $NO_2$ | Traffic counts within 50 m of house | Asthma, respiratory symptoms, allergy | 1.79 OR for asthma and high traffic volume |
| Gauderman et al. 2005 (65) | Southern California | | $NO_2$ | Continuous [d] | Asthma, respiratory symptoms | Increased asthma closer to freeways |
| McConnell et al. 2006 (57) | Southern California | NA | NA | Continuous [d] | Asthma | Large risk for children living w/in 75 m of road |
| Ryan, et al. 2007 (59) | Cincinnati, Ohio | > 1,000 trucks/d | PM2.5 | 400 m | Wheezing in children | NA |
| Kim et al. 2004 (60) | San Francisco | 90,000 – 210,000 veh/d | PM, BC, $NO_x$ | School sites | Childhood asthma | 1.07 OR for high levels of $NO_x$ |

| | | | | | | |
|---|---|---|---|---|---|---|
| Wjst et al. 1993 (68) | Munich, Germany | 7,000–125,000 veh/d | $NO_x$, CO | School sites | Asthma, bronchitis | Several statistical associations found |
| Brunekreef et al. 1997 (69) | Netherlands | 80,000 – 152,000 veh/d | $PM_{10}$, $NO_2$ | Continuous[d] | Lung function | Decreased FEV with proximity to high truck traffic |
| Janssen et al. 2003 (74) | Netherlands | 30,000–155,000 veh/d | $PM_{2.5}$, $NO_2$, benzene | < 400 m [c] | Lung function, respiratory symptoms | No association with lung function |
| Peters et al. 1999 (82) | Southern California | NA | $PM_{10}$, $NO_2$ | NA | Asthma, bronchitis, cough, wheeze | 1.54 OR of wheeze for boys with exposure to $NO_2$ |
| Brauer et al. 2007 (67) | Netherlands | Highways and streets | $PM_{2.5}$, $NO_2$, soot | Modeled exposure | Asthma, allergy, bronchitis, respiratory symptoms | Strongest association was with food allergies |
| Visser et al. 2004 (91) | Amsterdam | > 10,000 veh/d | NA | NA | Cancer | Multiple associations |
| Vineis et al. 2006 (87) | 10 Eurpoean countries | NA | $PM_{10}$, $NO_2$, $SO_2$ | NA | Cancer | 1.46 OR near heavy traffic, 1.30 OR for high exposure to $NO_2$ |
| Gauderman et al. 2007 (73) | Southern California | NA | $PM_{10}$, $NO_2$ | Continuous[d] | Lung Function | Decreased FEV for those living near freeway |

[a]As defined in article cited (veh/d = vehicles per day; veh/h = vehicles per hour).

[b]UFP = ultrafine particles; FP = fine particles; $PM_{2.5}$ = particles with aerodynamic diameter ≤ 2.5 um; $PM_{10}$ = particles with aerodynamic diameter ≤ 10 um; BC = black carbon; PPAH = particle-bound polycyclic aromatic hydrocarbons; VOCs = volatile organic compounds

[c]Pollutant measurements were made along a transect away from the highway

[d]Proximity of each participant to a major road was calculated using GIS software

[e]Statistical association between proximity to highway or exposure to traffic-generated pollutants and measured health outcomes

NA = not applicable; measurements were not made.

Several studies show that exposure to PM varies spatially within a city [35, 36, 37], and finer spatial analyses show higher risks to individuals living in close proximity to heavily trafficked roads [18, 37]. A 2007 paper from the Woman's' Health Initiative used data from 573 $PM_{2.5}$ monitors to follow over 65,000 women prospectively. They reported very high hazard ratios for cardiovascular events (1.76; 95% CI, 1.25 to 2.47) possibly due to the fine grain of exposure monitoring [18]. In contrast, studies that relied on central monitors [27, 28] or interpolations from central monitors to highways are prone to exposure misclassification because individuals living close to highways will have a higher exposure than the general area. A possible concern with this interpretation is that social gradients may also situate poorer neighborhoods with potentially more susceptible populations closer to highways [38, 39, 40].

At a finer grain, Hoek et al. [24] estimated home exposure to nitrogen dioxide ($NO_2$) and black smoke for about 5,000 participants in the Netherlands Cohort Study on Diet and Cancer. Modeled exposure took into consideration proximity to freeways and main roads (100 m and 50 m, respectively). Cardiopulmonary mortality was associated with both modeled levels of pollutants and living near a major road with associations less strong for background levels of both pollutants. A case-control study [41], found a 5% increase in acute myocardial infarction associated with living within 100 m of major roadways. A recent analysis of cohort data found that traffic density was a predictor of mortality more so than was ambient air pollution [42]. There is a need for studies that assess exposure at these scales, e.g., immediate vicinity of highways, to test whether cardiac risk increases still more at even smaller scales.

Although we cannot review it in full here, we note that evidence beyond the epidemiological literature support the contention that $PM_{2.5}$ and UFP (a sub-fraction of $PM_{2.5}$) have adverse cardiovascular effects [16, 17]. $PM_{2.5}$ appears to be a risk factor for cardiovascular disease via mechanisms that likely include pulmonary and systemic inflammation, accelerated atherosclerosis and altered cardiac autonomic function [17, 22, 43, 44, 45, 46]. Uptake of particles or particle constituents in the blood can affect the autonomic control of the heart and circulatory system. Black smoke, a large proportion of which is derived from mobile source emissions [30], has a high pulmonary deposition efficiency, and due to their surface area-to-volume ratios can carry relatively more adsorbed and condensed toxic air pollutants (e.g., PPAH) compared to larger particles [17, 47, 48]. Based on high particle numbers, high lung deposition efficiency and surface chemistry, UFP may provide a greater potential than $PM_{2.5}$ for inducing inflammation [10]. UFPs have high cytotoxic reactive oxygen species (ROS) activity, through which numerous inflammatory responses are induced, compared to other particles [10]. Chronically elevated UFP levels such as those to which residents living near heavily trafficked roadways are likely exposed can lead to long-term or repeated increases in systemic inflammation that promote arteriosclerosis [18, 29, 34, 37].

## Asthma and highway exposures

Evidence that near highway exposures present elevated risk is relatively well developed with respect to child asthma studies. These studies have evolved over time with the use of different methodologies. Studies that used larger geographic frames and/or overall traffic in the vicinity of the home or school [49, 50, 51, 52] or that used self-report of traffic intensity [53] found no association with asthma prevalence. Most recent child asthma studies have, instead, used increasingly narrow definitions of proximity to traffic, including air monitoring or modeling) and have focused on major highways instead of street traffic [54, 55, 56, 57, 58, 59]. All of these studies have found statistically significant associations between the prevalence of asthma or wheezing and living very close to high volume vehicle roadways. Confounders considered included housing conditions (pests, pets, gas stoves, water damage), exposure to tobacco smoke, various measures of socioeconomic status (SES), age, sex, and atopy, albeit self-reported and not all in a single study.

Multiple studies have found girls to be at greater risk than boys for asthma resulting from highway exposure [55, 57, 60]. A recent study also reports elevated risk only for children who moved next to the highway before they were 2 years of age, suggesting that early childhood exposure may be key [57]. The combined evidence suggests that living within 100 meters of major highways is a risk factor, although smaller distances may also result in graded increases in risk. The neglect of wind direction and the absence of air monitoring from some studies are notable missing factors. Additionally, recent concerns have been raised that geocoding (attaching a physical location to addresses) could introduce bias due to inaccuracy in locations [61].

Studies that rely on general area monitoring of ambient pollution and assess regional pollution on a scale orders of magnitude greater than the near-roadway gradients have also found associations between traffic generated pollution (CO and NOx) and prevalence of asthma [62] or hospital admission for asthma [63]. Lweguga-Mukasa et al. [64] monitored air up and down wind of a major motor vehicle bridge complex in Buffalo, NY and found that UFP were higher downwind, dropping off with distance. Their statistical models did not, however, support an association of UFP with asthma. A study in the San Francisco Bay Area measured $PM_{2.5}$, BC and $NO_X$ over several months next to schools and found both higher pollution levels downwind from highways and a linear association of BC with asthma in long-term residents [60].

Gauderman et al. [65] measured $NO_2$ next to homes of 208 children. They found an odds ratio (OR) of 1.83 (confidence interval (CI): 1.04–3.22) for outdoor $NO_2$ (probably a surrogate for total highway pollution) and lifetime diagnosis of asthma. They also found a similar association with distance from residence to freeway. Self-report was used to control for numerous confounders, including tobacco smoke, SES, gas stoves, mildew, water damage, cockroaches and pets which did not substantially affect the association. Gauderman's study suggests that ambient air monitoring at the residence substantially increases statistical power to detect association of asthma with highway exposures.

Modeling of elemental carbon attributable to traffic near roadways based on ambient air monitoring of $PM_{2.5}$ has recently emerged as a viable approach and a study using this method found an association with infant wheezing. The modeled values appear to be better predictors than proximity. Elevation of the residence relative to traffic was also an important factor in this study [66]. A 2007 paper reported on modeled $NO_2$, $PM_{2.5}$ and soot and the association of these values with asthma and various respiratory symptoms in the Netherlands [67]. While finding modest statistically significant associations for asthma and symptoms, it is somewhat surprising that they found stronger associations for development of sensitization to food allergens.

## Pediatric lung function and traffic-related air pollution

Studies of association of children's lung function with traffic pollutants have used a variety of measures of exposure, including: traffic density, distance to roadways, area (city) monitors, monitoring at the home or school and personal monitoring. Studies have assessed both chronic effects on lung development and acute effects and have been both cross-sectional and longitudinal. The wide range of approaches somewhat complicates evaluation of the literature.

Traffic density in school districts in Munich was associated with decreases in forced vital capacity (FVC), forced expiratory volume in 1 second ($FEV_1$), FEV1/FVC and other measures, although the 2-kilometer (km) areas, the use of sitting position for spirometry and problems with translation for non-German children were limitations [68]. Brunekreef et al. [69] used distance from major roadways, considered wind direction and measured black smoke and NO2 inside schools. They found the largest decrements in lung function in girls living within 300 m of the roadways.

A longitudinal study of children (average age at start = 10 years) in Southern California reported results at 4 [70] and 8 years [71]. Multiple air pollutants were measured at sites in 12 communities. Due to substantial attrition, only 42% of children enrolled at the start were available for the 8-year follow-up. Substantially lower growth in $FEV_1$ was associated with $PM_{10}$, $NO_2$, $PM_{2.5}$, acid vapor and elemental carbon at 4 and at 8 years. The analysis could not indicate whether the effects seen were reversible or not [72]. In 2007, it was reported from this same cohort that living within 500 m of a freeway was reported to be associated with reduced lung function [73].

A Dutch study [74] measured $PM_{2.5}$, $NO_2$, benzene and EC for one year at 24 schools located within 400 m of major roadways. While associations were seen between symptoms and truck traffic and measured pollutants, there was no significant association between any of the environmental measures and FVC < 85% or $FEV_1$ < 85%. Restricting the analysis to children living within 500 m of highways generally increased ORs.

Personal exposure monitoring of $NO_2$ as a surrogate for total traffic pollutants with 298 Korean college students found statistically significant associations with $FEV_1$, $FEV_1$/FVC, and forced expiratory volume between 25 and 75% ($FEV_{25-75}$), but not with FVC. The multivariate regression model presented suggests that $FEV_{25-75}$ was the outcome measure that most clearly showed an effect [75]. Cross-sectional studies of children in Korea [76] and France [77] also indicate that lung function is diminished in association with area pollutants that largely derive from traffic.

Time series studies suggest there are also acute effects. A study of 19 asthmatic children measured PM via personally carried monitors, at homes and at central site monitors. The study found deficits in $FEV_1$ that were associated with PM, although many sources besides traffic contributed to exposure. In addition, the results suggest that ability to see associations with health outcomes improves at finer scale of monitoring [78]. PM was associated with reduced $FEV_1$ and FVC in only the asthmatic subset of children in a Seattle study [79]. Studies have also seen associations between PM and self reported peak flow measurements [80, 81] and asthmatic symptoms [82].

## Cancer and near highway exposures

As noted above, both the Six-Cities Study [27] and the American Cancer Society (ACS) Study [28] found associations between PM and lung cancer. Follow-up studies using the ACS cohort [29, 37] and the Six-Studies cohort [83] that controlled for smoking and other risk factors also demonstrated significant associations between PM and lung cancer. The original studies were subject to intensive replication, validation, and re-analysis which confirmed the original findings [84].

The ASHMOG study [85] was designed to look specifically at lung cancer and air pollution among Seventh-day Adventists in California, taking advantage of their low smoking rates. Air pollution was interpolated to centroids of zip codes from ambient air monitoring stations. Highway proximity was not considered. The study found associations with ozone (its primary pollutant of consideration), PM10 and SO2. Notably, these are not the pollutants that would be expected to be substantially elevated immediately adjacent to highways.

A case control study of residents of Stockholm, Sweden modeled traffic-related NO2 levels at their homes over 30 years and found that the strongest association involved a 20 year latency period [86]. Another case control study drawn from the European Prospective Investigation on Cancer and Nutrition found statistically significantly elevated ORs for lung cancer with proximity to heavy traffic (>10,000 cars per day) as well as for $NO_2$ and $PM_{10}$ at nearby ambient monitoring stations [87]. Nafstad et al. [88] used modeled $NO_2$ and

$SO_2$ concentrations at the homes of over 16,000 men in Oslo to test associations with lung cancer incidence. The models included traffic and point sources. The study found small, but statistically significant associations between $NO_2$ and lung cancer. Problems that run through all these studies are weak measures of exposure to secondhand tobacco smoke, the use of main roads rather than highways as the exposure group and modeled rather than measured air pollutants.

A study of regional pollution in Japan and a case control study of more localized pollution in a town in Italy also found associations between $NO_2$ and lung cancer and PM and lung cancer [89, 90]. On the other hand, a study that calculated SIRs for specific cancers across lower and higher traffic intensity found little evidence of an association with a range of cancers [91].

The plausibility of near-highway pollution causing lung cancer is bolstered by the presence of known carcinogens in diesel PM. The US EPA has concluded after reviewing the literature that diesel exhaust is "likely to be carcinogenic to humans by inhalation" [92]. An interesting study of UFP and DNA damage adds credibility to an association with cancer [93]. This study had participants bicycle in traffic in Copenhagen and measured personal exposure to UFP and DNA oxidation and strand breaks in mononuclear blood cells. Bicycling in traffic increased UFP exposure and oxidative damage to DNA, thus demonstrating an association between DNA damage and UFP exposure *in vivo*.

### Policy and research recommendations

Based on the literature reviewed above it is plausible that gradients of pollutants next to highways carry elevated health risks that may be larger than the risks of general area ambient pollutants. While the evidence is considerable, it is not overwhelming and is weak in some areas. The strongest evidence comes from studies of development of asthma and reduction of lung function during childhood, while the studies of cardiac health risk require extrapolation from area studies of smaller and larger geographic scales and inference from toxicology laboratory investigations. The lung cancer studies, because they include pollutants such as $O_3$ that are not locally concentrated, are not particularly strong in terms of the case for near-highway risk. There is a need for lung cancer research that uses major highways rather than heavily trafficked roads as the environmental exposure.

While more studies of asthma and lung function in children are needed to confirm existing findings, especially studies that integrate exposure at school, home and during commuting, to refine our knowledge about the association, we would point to the greater need for studies of cardiac health and lung cancer and their association with near highway exposures as the primary research areas needing to be developed. Many of the studies of PM and cardiac or pulmonary health have focused on mortality. Near highway mortality studies may be possible, but would be lengthy if they were initiated as prospective cohorts. Other possibilities include retrospective case control studies of mortality, cross sectional studies or prospective studies that have end points short of mortality, such as biological markers of disease. For all health end points there is a need for studies that adequately address the possible confounding of SES with proximity to highways. There is good reason to think that property values decline near highways and that control for SES by, for example, income, may be inadequate.

Because of the incomplete development of the science regarding the health risks of near highway exposures and the high cost and implication of at least some possible changes in planning and development, policy decisions are complicated. The State of California has largely prohibited siting of schools within 500 feet of freeways (SB 352; approved by the governor October 2, 2003). Perhaps this is a viable model for other states or for national-level response. As it is the only such law of which we are aware, there may be other approaches that will be and should be tried. One limitation of the California approach is that it does nothing to address the population already exposed at schools currently cited near freeways and does not address residence near freeways.

## Conclusion

The most susceptible (and overlooked) population in the US subject to serious health effects from air pollution may be those who live very near major regional transportation route, especially highways. Policies that have been technology based and regional in orientation do not efficiently address the very large exposure and health gradients suffered by these populations. This is problematic because even regions that EPA has deemed to be in regional PM "attainment" still include very large numbers of near highway residents who currently are not protected. There is a need for more research, but also a need to begin to explore policy options that would protect the exposed population.

## Abbreviations

*UFP:*

ultra fine particles

*BC:*

black carbon

*$NO_2$:*

nitrogen dioxide

*NOx:*

oxides of nitrogen

*CO:*

carbon monoxide

*PM:*

particulate matter

*$PM_{2.5}$:*

particulate matter less than 2.5 um

*$PM_{10}$:*

particulate matter less than 10 um

*PPAH:*

particle bound polyaromatic hydrocarbons

*EC:*

elemental carbon

*VOC:*

volatile organic compounds

*$SO_2$:*

sulfur dioxide

*ACS:*

American Cancer Society

*SES:*

socioeconomic status

*EPA:*

Environmental Protection Agency

*OR:*

odds ratio

*$FEV_1$:*

forced expiratory volume in 1 second

*$FEV_1$/FVC:*

ratio of $FEV_1$ and forced vital capacity

*$FEV_{25-75}$:*

forced expiratory volume between 25 and 75

*FVC:*

forced vital capacity

*$ug/m^3$:*

micrograms per cubic meter of air

*m:*

meters

*um:*

micrometers

*veh/d:*

vehicles per day

*veh/h:*

vehicles per hour

# Declarations

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### Authors' original submitted files for images

Below are the links to the authors' original submitted files for images.
12940_2007_122_MOESM1_ESM.pdf Authors' original file for figure 1

### Competing interests

The author(s) declare that they have no competing interests.

### Authors' contributions

DB took the lead on the manuscript. He co-wrote the background and wrote the sections on asthma, lung function and cancer and the conclusions. JLD wrote the section on air pollutants near roadways and contributed substantially to the background. CR wrote the section on cardiovascular health. All authors participated in editing and refining the manuscript and all read it multiple times, including the final version.

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