DRAFT

Background Information on Housing Proximity to Freeways and Health Concerns

Many areas throughout California are seeking to increase urban density, support transit oriented development, and create vibrant communities that are less car dependent. As cities, counties, and regions promote these important smart growth[1] policies, many are also considering potential health impacts of housing developments that may edge closer to freeways[2] and other pollution sources. A variety of policies and guidelines have been developed to allow for dense smart growth without compromising public health; these are summarized below. A discussion of the severity of potential health impacts related to freeway proximity follows.

Summary of Policies to Reduce Health Impacts of Developments Near Freeways in California

Geographic Scope, Agency & Start Date	Threshold for Action	Process
A. Statewide Guidance		
1. California Air Resources Board, Air Quality and Land Use Handbook, 2005	500 feet from freeways and urban roads with >100,000 AADT or rural roads with >50,000 AADT.[3] *The policy also includes recommended distances for other pollution sources.*	CARB Recommends that land use planners throughout the state refer to this list for safe distances between sensitive sites like homes and pollutions sources like freeways.
B. Air District Guidance		
2. Bay Area Air Quality Management District 2010	1,000 feet of a permitted source, a highway, or a roadway with > 10,000 AADT. Significance thresholds: 0.3 µg/m^3 PM2.5; 10 additional cases of cancer/ million; > 1.0 non-cancer Hazard Index, Chronic or Acute.	CEQA requirements for screening housing sites relative to thresholds; Health Impact Assessment required if over thresholds and mitigation expected.
3. Sacramento AQMD 2008	500 feet of roads with 100,000 AADT, urban or 50,000 AADT, rural Threshold for further review: Increased individual cancer risk of 276/million.	Recommended protocol for CEQA assessment of housing: Site-specific Health Risk Assessment. Estimate cancer risk at distances up to 500 feet from source roadway. Report cancer risk publicly.
4. South Coast AQMD 2005	"close proximity" recommendations similar to CARB.	Recommend that projects consider mitigations.
C. Municipal Guidance and Laws		
5. San Francisco Ordinance, Department of Public Health 2008	492 feet of a road > 100,000 AADT; 328 feet of a road > 50,000 AADT; and 164 feet of a road > 10,000 AADT Risk threshold: 0.2 µg/m^3 average annual exposure from roadway vehicles within 492 feet of a sensitive receptor.	Article 38 requires PM2.5 modeling for proposed residential projects of 10 dwelling units or more. If PM2.5 levels exceed thresholds of significance, include HVAC system which removes 80% of PM2.5.
6. City of Oakland, Development Standards 2010	1000 feet of a source of diesel PM exceeding BAAQMD thresholds of significance.	If thresholds are exceeded, conduct a site-specific health risk analysis or apply seven standard mitigations to get planning approval.
7. National City (San Diego area) 2011	500 feet of a freeway.	Mitigations required for planning approval.
8. Los Angeles County Draft General Plan 2035	"Discourage" development within 500 feet of a freeway	"Encourage mitigation" for sites within 1500 feet of a freeway.
9. Los Angeles City "Green Zones" under consideration by the Council for Fall 2011.	Select neighborhoods designated by the city council. Currently under consideration are Pacoima, Boyle Heights, and Wilimington.	Unclear what provisions may be included for new residential developments.

[1] An approach to urban planning which promotes compact development patterns which include mixed-uses and a variety of active transportation and transit options. In California smart growth usually implies infill development and development near existing or new transit.
[2] In this discussion freeways refer to all busy roadways, the precise definition for which varies depending on the policy.
[3] AADT = Annual Average Daily Traffic Count, the number vehicles on a roadway as reported by CalTrans.

More Information on Land Use Proximity Guidelines and Policies

CEQA requires lead agencies to consider air quality among other impacts of land use projects.[4] Each air district sets CEQA Guidelines that dictate how air quality impact of projects should be assessed, including thresholds of significance for various pollutants and health impacts. Some air districts have issued such criteria along with decision-making methodologies for evaluating exposure and risk at new developments that do not necessarily emit significant amounts of air pollution (e.g. housing). Local municipalities have also issued their own policies for assessing risks and requiring mitigations during the CEQA review.

Under CEQA, lead agencies must consider air quality but they can still permit projects sited in areas where pollution and health risks exceed the thresholds of significance set by the local air district. Some municipalities impose their own restrictions on projects near roadways and follow a policy of exposure and risk assessment followed by mitigation. Many of the policies currently used in California for assessing residential exposure to and risk from air pollution as well as the thresholds of significance are described below.

A. Statewide Standards

1. California Air Resources Board Land Use Guidelines[5]

The California Air Resources Board recommends a 500 foot buffer between sensitive receptors and busy roadways, defined as a freeway, urban road with 100,000 AADT or rural road with 50,000 AADT. CARB has not set thresholds of significance. However, some municipalities and air districts use the California Ambient Air Quality Standards as reasonable thresholds of significance. The statewide ambient air quality 24 hour standard for PM is 35 $\mu g/m^3$ and the annual arithmetic mean standard is 12 $\mu g/m^3$.[6]

B. Air Districts

2. BAAQMD Risk and Hazard Threshold, CEQA Guidelines[7]

Summary: BAAQMD has issued risk and hazard thresholds for new sensitive land uses, such as residential developments. They provide a screening tool to help municipalities and lead agencies screen project sites and assess health risks from air pollution. The screening guidelines follow these steps:

A. Proximity of a site to roadways and stationary sources is determined using BAAQMD Google Earth maps.
B. Thresholds of significance are evaluated for PM2.5 concentrations and lifetime cancer risks using data tables for each major roadway and source provided by BAAQMD. Thresholds of significance are:
   1. Individual Impacts: 0.3 $\mu g/m^3$ PM2.5; 10 additional cases of cancer/million; >1.0 non-cancer Hazard Index, Chronic or Acute
   2. Cumulative Impacts: 0.8 $\mu g/m^3$ PM2.5; 100 cases of cancer/million; >10.0 chronic Hazard Index
C. Health Impact Analysis
D. Mitigate or seek alternative site

3. Sacramento Air Quality Management District (SMAQMD)[8]

Summary: SMAQMD has issued guidance to help project proponents evaluate health risks at a site. They provide risk tables for developers and lead agencies to calculate cancer risk for all sensitive land use projects (including new housing development) falling within a 500 foot buffer of major roadways. If the risks exceed a specified level, the air district recommends a site-specific health risk assessment.

A. Screen all projects within 500 feet of high traffic roads (100,000 AADT urban, 50,000 AADT rural).
B. Determine risk based on the location's upwind and downwind status from roadways.
C. If project cancer risks are below 276 cancer cases/million,[9] disclose information and proceed.
   If above this level, recommend a site-specific health risk assessment using CAL3QHCR.

---

[4] California Environmental Quality Act Guidelines, Appendix G. 2005. Available at: http://ceres.ca.gov/ceqa/guidelines/Appendix_G.html.
[5] *CARB Air Quality and Land Use Handbook: A Community Health Perspective.* California Environmental Protection Agency, California Air Resources Board. April 2005. Available at: http://www.arb.ca.gov/ch/landuse.htm.
[6] http://www.arb.ca.gov/research/aaqs/aaqs2.pdf
[7] *CEQA Guidelines Tools and Methodology.* Bay Area Air Quality Management District, May 3, 2011. Available at: http://www.baaqmd.gov/Divisions/Planning-and-Research/CEQA-GUIDELINES/Tools-and-Methodology.aspx.
[8] *Recommended Protocol for Evaluating the Location of Sensitive Land Uses Adjacent to Major Roadways.* Sacramento Metropolitan Air Quality Management District. March 2011. Available at: http://www.airquality.org/ceqa/SLUMajorRoadway/SLURecommendedProtoco2.4-Jan2011.pdf.
[9] Sacramento calculated the worst-case cancer risk from their highest-traffic road at fifty feet downwind as 919 cases/million people. Then they multiplied by 0.30 and got 276 cases/million as a reasonable evaluation criterion.

1. Evaluate risk for a modeled receptor at 50, 100, 200, 300, 400, and 500 feet.
2. Publicly disclose all results in the form of cancer risk.

D. The guidance proposes mitigations, or "exposure reduction measures," in no particular hierarchy:
- Distance
- Site Design
- Tiered Vegetation
- Passive Air Filtration

4. South Coast Air Quality Management District[10]

Summary: The South Coast Air Quality Management District's guidance for lead agencies (such as planning departments) provided recommended safe distances and a review of the evidence against roadway pollution, similar to the CARB guidance. "[The Guidance] provides suggested policies that local governments can use in their General Plans or through local planning to prevent or reduce potential air pollution impacts and protect public health." Information on mitigations is also included:
- Physical separation between the source and the sensitive site.
- Design features at the source to minimize air pollution emissions.
- Siting, permitting and zoning policies.
- Capping cumulative impacts of various pollution sources.
- Changing the land use designations in areas where there are significant cumulative impacts.

C. Municipalities

Cities and Counties may issue their own guidance for lead agencies to follow when assessing air quality concerns during the CEQA review. The municipality can also include in its general plan a requirement that air quality be considered in land use decisions. Some cities have published guidance on how they will determine when air quality is a concern and what is an appropriate mitigation.

5. San Francisco[11]

Summary: San Francisco Municipal Code Article 38 calls for considering and modeling air quality in newly constructed buildings with 10 or more dwelling units.[12] Developers must "screen sensitive use projects for proximity to traffic and calculate the concentration of PM 2.5 from traffic sources where traffic volumes suggest a potential hazard. If modeled levels of traffic-attributable PM 2.5 at a project site exceed an action level (currently set at 0.2 ug/m^3) developers are required to incorporate ventilation systems to remove 80% of PM2.5 from outdoor air."[13]

A. Buffer –
The Department of Public Health has created a "Potential Roadway Exposure Zone Map" which screens sites which may have high PM2.5 from local roadways.[14]
100,000 vehicles/day within 492 foot (150 meter) radius;
50,000 vehicles/day within 328 foot (100 meter) radius;

---

[10] *Guidance Document for Addressing Air Quality Issues in General Plans and Local Planning.* South Coast Air Quality Management District. May 6, 2005. Available at: http://www.aqmd.gov/prdas/aqguide/doc/aq_guidance.pdf.

[11] Bhatia, Rajiv and Thomas Rivard. *Land Use Guidance for Roadway Proximity Health Effects: Assessment and Mitigation of Air Pollution – Guidance for Land Use Planning and Environmental Review.* San Francisco Department of Public Health. May 6, 2008. Available at: http://www.sfphes.org/publications/Mitigating_Roadway_AQLU_Conflicts.pdf.

[12] "Article 38: Air Quality Assessment and Ventilation Requirements for Urban Infill Residential Developments." San Francisco Municipal Code. Available at: http://library.municode.com/HTML/14136/level1/ART38AIQUASVEREURINREDE.html#TOPTITLE.
This is in accordance with the San Francisco General Plan: **"POLICY 3.7 Exercise air quality modeling in building design for sensitive land uses such as residential developments that are located near the sources of pollution such as freeways and industries.** *Project review and approval in the City should consider air quality implications. Certain land uses such as some types of industrial uses and freeways generally emit air pollutants that could be hazardous to human health, particularly that of sensitive receptors such as children, elderly and people with respiratory diseases. When reviewing new housing projects or other land uses to be used by sensitive receptors, location of industrial sites or other sources of air pollution should be considered in the design of the building to orient the air intake of the building away from the sources of pollution. Conversely, future industrial and other air polluting development should consider the existence of sensitive receptors in the vicinity."*

[13] "Air Quality Analysis for Planning (Article 38)." San Francisco Department of Public Health website, accessed July 13, 2011. Available at: http://www.sfdph.org/dph/EH/Air/default.asp.

[14] "Article 38 Section 3803: Definitions." San Francisco Municipal Code. Available at: http://library.municode.com/HTML/14136/level1/ART38AIQUASVEREURINREDE.html#TOPTITLE.
The Potential Roadway Exposure Zone is publicly posted on the San Francisco Department of Public Health's website at: http://www.thehdmt.org/img/indicators/pdf/AirQualityRelatedToTraffic.pdf.

10,000 vehicles/day within 164 foot (50 meter) radius

B. Modeling –
Model PM2.5 concentrations using CAL3QHCR or equivalent methodology. Include modeled receptors in a grid on site, at minimum density of 6/acre. Receptors shall be on ground, middle, and rooftop levels as well as at all fresh air intakes and along the perimeter of the site closest to traffic.
For a fee of $1560 the SFDPH will conduct the air dispersion modeling.

C. Threshold Evaluation –
0.2 $\mu g/m^3$ PM2.5 average annual exposure from roadway vehicles within a 492 foot (150 meter) buffer of a sensitive receptor. PM2.5 is used as a proxy for all pollutants of concern.

D. Mitigation – Project shall include ventilation which is capable of removing at least 80% of ambient PM2.5 from habitable areas. The ventilation must be maintained, and project sponsors have to document maintenance for five years after installation.

6. City of Oakland[15]

Summary: The City of Oakland requires the planning department to examine new projects and apply all Standard Conditions of Approval in the CEQA review. SCA-94 calls for air pollution mitigation measures for any projects sited within 1000 feet of a roadway with emissions above the BAAQMD thresholds of significance.

A. Check for busy roadways within 1000 feet of a site.
B. Conduct a Health Risk Assessment; OR
C. Include seven standard mitigations:
   1. Redesign the site layout to locate sensitive receptors as far as possible from any freeways, major roadways, or other sources of air pollution (e.g., loading docks, parking lots).
   2. Do not locate sensitive receptors near distribution center's entry and exit points.
   3. Incorporate tiered plantings of trees (redwood, deodar cedar, live oak, and/or oleander) to the maximum extent feasible between the sources of pollution and the sensitive receptors.
   4. Install, operate and maintain in good working order a central heating and ventilation (HV) system or other air take system in the building, or in each individual residential unit, that meets or exceeds an efficiency standard of MERV 13. The HV system shall include the following features: Installation of a high efficiency filter and/or carbon filter to filter particulates and other chemical matter from entering the building. Either HEPA filters or ASHRAE 85% supply filters shall be used.
   5. Retain a qualified HV consultant or HERS rater during the design phase of the project to locate the HV system based on exposure modeling from the pollutant sources.
   6. Install indoor air quality monitoring units in buildings.
   7. Project applicant shall maintain, repair and/or replace HV system on an ongoing and as needed basis or shall prepare an operation and maintenance manual for the HV system and the filter. The manual shall include the operating instructions and the maintenance and replacement schedule. This manual shall be included in the CC&Rs for residential projects and distributed to the building maintenance staff. In addition, the applicant shall prepare a separate homeowners manual. The manual shall contain the operating instructions and the maintenance and replacement schedule for the HV system and the filters.

7. National City[16]

Summary: National City adopted a Health and Environmental Justice Element of its general plan which outlines the city's method for addressing air quality concerns. The plan sets a buffer of 500 feet from a freeway within which specified mitigations should be included.

Policy HEJ-2.3: "Avoid siting new sensitive land uses within 500 feet from the centerline of a freeway, unless such development contributes to smart growth, open space, or transit-oriented goals, in which case the development shall include feasible measures such as separation/setbacks, landscaping, barriers, ventilation systems, air filters/cleaners, and/or other effective measures to minimize potential impacts from air pollution."

[15] *Oakland Uniformly Applied Development Standards, Standard Conditions of Approval*. 2007-2014 Oakland Housing Element Draft Environmental Impact Report. City of Oakland.
[16] *General Plan Elements – Health and Environmental Justice Element.* National City. Adopted June 2011. Policy HEJ2.3. Available at: http://www.ci.national-city.ca.us/index.aspx?page=549, pages 3-234 and 3-235.

8. Los Angeles County[17]

Summary: The County's draft general plan acknowledges potential air quality concerns by discouraging development within 500 feet of a major roadway and encouraging mitigation in developments built within 1500 feet of a major roadway. The plan notes CARB's recommendation to put sensitive receptors (including residences) at least 500 feet from freeways. They also note that research from the Health Effects Institute shows exposure may occur as far as 1640 feet (500 meters) away from a freeway. Therefore, they are concerned about any sensitive receptors within 1500 feet. They include parks and recreation facilities in this list because people might be exposed when exercising.

9. Los Angeles City "Green Zones"

Summary: This is an effort to get some environmental justice neighborhoods in LA designated "Green Zones" by the city council (Pacoima, Boyle Heights, and Wilmington). A green zone designation would restrict new sources of pollution, compel increased inspection of existing sources of pollution, and provide economic development for overburdened communities. The green zone concept may be considered at the committee level in fall 2011.
The Green Zone does not restrict new residential development near sources of pollution. It tries to limit new sources and enforce restrictions on existing sources of pollution in these neighborhoods.

Additional Policies: California Schools

California requires that schools, be located 500 feet from freeways, urban roads with 100,000 AADT, and rural roads with 50,000 AADT. "The site shall not be adjacent to a road or freeways that any site-related traffic and sound level studies have determined will have safety problems or sound levels which adversely affect the educational program."[18] The Los Angeles Unified School District is more specific with their health and safety criteria to guide the siting of schools. They do not allow new schools within 500 feet of freeways and major transportation corridors (an "exclusion zone") and require special consideration of potential impacts within 1,500 feet of these busy roadways.

Epidemiologic Studies of Health Effects and Mobile Source Emissions Show That Particulate Pollution Has a Significant Impact on Health

Dozens of studies have shown greatly increased pollutant levels and health impacts in close proximity to freeways, prompting the California Air Resources Board (CARB) to recommend in 2005 that local governments "Avoid siting new sensitive land uses within 500 feet of a freeway, urban roads with 100,000 vehicles/day, or rural roads with 50,000 vehicles/day."[i] The rationale for that caution is summed up as follows: "In traffic-related studies, the additional non-cancer health risk attributable to proximity was seen within 1,000 feet and was strongest within 300 feet. California freeway studies show about a 70% drop off in particulate pollution levels at 500 feet."

Air Pollution is Significantly Elevated Near Roadways

One recent study in the LA basin measured elevated air pollutants far downwind, up to 6562 feet (2000 meters) and up to 1969 feet (600 meters) upwind of a major freeway.[ii] The study, along the I-10, documented high concentrations of ultra-fine particulates, polycyclic aromatic hydrocarbons and nitric oxide at distances of nearly 4000 feet (1,200 meters) and farther downwind, especially during pre-sunrise hours when winds were low, humidity was high and there was a surface temperature inversion. Numerous other studies show elevated pollutant concentrations within up to 1640 feet (500 meters) of freeways and busy roadways.

Correlation Between Asthma And Attending School Near A Major Roadway

In California, over two percent of public schools (K-12) are within 492 feet (150 meters) of high traffic roads and a disproportionately large percentage of students attending these schools are economically disadvantaged and nonwhite.[iii] A related study surveying over 1,000 elementary school students in Northern California found higher rates of asthma and bronchitis symptoms in children attending schools near busy roads and freeways.[iv] A study of thirteen southern California communities found children exposed to traffic-related pollution in school were more likely to develop asthma irrespective of residential exposure.[v] A study of almost 1500 children in Dutch schools

[17] *Los Angeles County Draft 2035 General Plan*. Los Angeles County. April 2011. Available at: http://planning.lacounty.gov/assets/upl/project/gp_2035_part2-chapter5.pdf, page 93.
[18] Title 5 California Code of Regulations, Division 1, Chapter 13, Subchapter 1, Article 2, Section 14010.

found a positive relationship between school proximity to freeways and asthma occurrence with truck traffic intensity and pollutant levels measured in schools significantly associated with chronic respiratory symptoms.[vi]

A recent nationwide study of almost 9,000 public schools asserts that children spend significant amount of time at school, making exposure to pollution at school an important consideration; the study found that approximately one third of students were likely to be at increased risk of acute and chronic respiratory disorders due to close proximity of their school to a freeway.[vii] Surveys among thousands of junior high school students in Jakarta also revealed a link between traffic levels and respiratory impacts including phlegm, persistent cough and asthma.[viii]

Correlation Between Respiratory Disease And Living Near A Major Roadway

Proximity of residences to heavy traffic levels has been associated with respiratory impacts such as cough, wheeze, persistent cough, asthma, and hospital admissions for asthma in many studies.[ix] After considering the large and growing body of literature on children's exposure to traffic emissions, the Health Effects Institute concluded that the evidence is "sufficient to infer a causal association for exacerbation of asthma."[x]

The California Children's Health Study, which began in 1992, found an 89 percent increase in the likelihood of being diagnosed with asthma for those children living close to freeways versus those living farther away.[xi] Another report from the Children's Health Study showed adverse health impacts of local traffic exposure on children independent of regional air quality, including decreased lung function that is unlikely to be regained and thus predisposes those individuals to cardiovascular illness later in life.[xii] A recent review of California Health Interview Survey (CHIS) data revealed a three-fold increase in asthma related hospital visits among children living in high traffic density areas.[xiii] A similar study based on CHIS data attributes a 92 percent increase in asthma symptoms among those living near the highest traffic densities, and suggests that impacts may be disproportionately worse among those in poverty due to heightened vulnerability.[xiv] Those in poverty may also be disproportionately exposed to pollution due to older and poorer quality housing stock. A study in Washington state found that older homes, smaller homes, and homes with fewer renovations were more likely to have a higher infiltration fraction of PM2.5.[xv]

Distance matters. 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, with the greatest risk being for children living within 295 feet (90 meters) of the road.[xvi] A study in rural New York found that children living in neighborhoods with heavy truck traffic within 656 feet (200 meters) of their homes had increased risks of asthma hospitalization.[xvii] A Dutch study of over 1,000 children found that asthma, wheeze, cough, and runny nose were significantly more common in children living within 328 feet (100 meters) of freeways; and that increasing density of truck traffic was associated with significantly higher asthma levels.[xviii] A different Dutch study found that traffic-related pollution was associated with increased respiratory infections and some measures of asthma and allergies among four year olds followed from birth.[xix]

Association Between Cancer And Living Near A Roadway

A comprehensive Southern California study of urban toxic air pollution shows that motor vehicles and other mobile sources of air pollution are the predominant source of cancer-causing air pollution, accounting for roughly 94% of the cancer risk from toxic air pollution, most of which is from diesel exhaust (84% of the cancer risk).[xx] The California Air Resources Board (CARB) estimates an increased cancer risk of 100 in one million within 295 feet (90 meters) downwind of freeways carrying 10,000 trucks per day.[xxi] A study in Denver showed that children living within 750 feet 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.[xxii] A Danish study of several thousand children concluded that a doubling of vehicle pollution increased the risk of lymphomas by 25 percent.[xxiii] An earlier English study found a cancer corridor within three miles of highways, airports, power plants, and other major polluters, showing greater risk of leukemia or other cancers within a few hundred yards from highways or other major pollution sources and decreasing risk with distance from these roadways and facilities.[xxiv]

Association Between Reproductive Impacts And Exposure To Motor Vehicle Pollutants

Pre- and post-natal impacts on infants born to mothers with heavy traffic exposure have also been well documented. A Los Angeles study found that pregnant women living near heavy traffic areas with high levels of carbon monoxide were more likely to experience adverse birth outcomes such as low birth weights and preterm births.[xxv] Another study found that pregnant women with high traffic exposure were three times as likely to have a child with certain heart defects as women breathing the cleanest air.[xxvi] A study of California children found an increased risk of autism among children who lived within 984 feet (300 meters) of a freeway during the third trimester and shortly after birth.[xxvii]

Association Between Proximity to Busy Roadways and Other Health Impacts

A wide body of research also confirms other adverse health outcomes related to close proximity to busy roadways. Dutch researchers evaluating long term exposure to traffic have found that people who lived near a main road were almost twice as likely to die from heart or lung disease and 1.4 times as likely to die from any cause compared with those who lived in less-trafficked areas.[xxviii] A Canadian study of 5,000 people showed that those living within 164 feet (50 meters) of a major road or within 328 feet (100 meters) of a highway had increased risks of mortality, with an "aging effect" (i.e. years of life lost) of roughly 2.5 years, which is similar to the "aging effect" of having chronic heart disease (3.1 year Rate of Advancement for mortality).[xxix]

Another Canadian study found that people residing within 492 feet (150 meters) of a highway or within 164 feet (50 meters) of a major road were more likely to die of coronary heart diseases. Furthermore, subjects who moved away from a road during the study period showed a decreased risk of death from coronary heart disease while those who moved closer to a road were more likely to die of coronary heart disease.[xxx] These findings are consistent with studies of PM2.5 exposure on heart rate variability. A study of elderly people in Missouri found heart rate variability decreased as PM2.5 exposure increased.[xxxi]

---

[i] California Air Resources Board. Air Quality and Land Use Handbook: A Community Health Perspective, April 2005. http://www.arb.ca.gov/ch/handbook.pdf

[ii] Hu, S. et.al. A wide area of air pollutant impact downwind of a freeway during pre-sunrise hours. *Atmospheric Environment* 2009; 43:2541-2549.

[iii] Green, R.S. et. al.. Proximity of California Public Schools to Busy Roads. *Environmental Health Perspectives* 2004; 112(1): 61-66.

[iv] Kim, J. et al. Traffic-related air pollution and respiratory health: East Bay Children's Respiratory Health Study. *American Journal of Respiratory and Critical Care Medicine* 2004;170: 520-526.

[v] McConnell, R. et al. Childhood Incident Asthma and Traffic-Related Air Pollution at Home and School. *Environmental Health Perspectives* 2010; 118(7): 1021-1026.

[vi] Speizer, F. E. and B. G. Ferris, Jr. Exposure to automobile exhaust. I. Prevalence of respiratory symptoms and disease. *Archives of Environmental Health* 1973;26(6):313-8.

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

[vii] Appatova, A.S., et al. Proximal exposure of public schools and students to major roadways: a nationwide US survey. *Journal of Environmental Planning and Management* 2008; 51(5): 631-646.

[viii] Duki, M.I.Z., Sudarmadi, S., Suzuki, S., Kawada, T., & Tri-Tugaswati, A. Effect of Air Pollution on Respiratory Health in Indonesia and its Economic Cost. *Arch Environmental Health* 2003; 58: 135–143.

[ix] Nicolai, T., Carr, D., Weiland, S.K., Duhme, H., Von Ehrenstein, O., Wagner, C., & Von Mutius. Urban traffic and pollutant exposure related to respiratory outcomes and atopy in a large sample of children. *Eur Respir J.* 2003;21: 956–963.

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

Duhme, H., S. K. Weiland, et al. The association between self-reported symptoms of asthma and allergic rhinitis and self-reported traffic density on street of residence in adolescents. *Epidemiology* 1996; 7(6): 578-582.

Edwards, J., S. Walters, et al. Hospital admissions for asthma in preschool children: relationship to major roads in Birmingham, United Kingdom. *Archives of Environmental Health* 1994; 49(4): 223-227.

[x] Health Effects Institute Panel on the Health Effects of Traffic-Related Air Pollution. Traffic-Related Air Pollution: A Critical Review of the Literature on Emissions, Exposure, and Health Effects. *Health Effects Institute Special Report 17,* January 2010.

[xi] Gauderman WJ et al. Childhood Asthma and Exposure to Traffic and Nitrogen Dioxide. *Epidemiology* 2005; 16:737-743.

This study was confirmed by a separate Southern CA study finding an 85% higher likelihood for an asthma diagnosis among children living with 246 feet (75 meters) of a major road.

McConnell R, Berhane K, Yao L, Jerrett M, Lurmann F, Gilliland F, et al. 2006. Traffic, susceptibility, and childhood. *Environ Health Perspect* 2006; 114(5):766-772.

[xii] Gauderman WJ et al. Effect of exposure to traffic on lung development from 10 to 18 years of age: a cohort study. *Lancet* 2007; 369(19561): 571-7.

[xiii] Wilhelm et. al. Environmental Public Health Tracking of Childhood Asthma Using California Health Interview Survey, Traffic, and Outdoor Air Pollution Data. *Environmental Health Perspectives* 2008;116(8):1254-1260.

[xiv] Meng et. al. Are Frequent Asthma Symptoms Among Low-Income Individuals Related to Heavy Traffic Near Homes, Vulnerabilities, or Both? AEP 2008; 18(5):343-350.

[xv] Hystad, P.U. et al. Modeling Residential Fine Particulate Matter Infiltration for Exposure Assessment. *Journal of Exposure Science and Environmental Epidemiology*2009; 19:570-579.

[xvi] Venn et al. Living Near A Main Road and the Risk of Wheezing Illness in Children. *American Journal of Respiratory and Critical Care Medicine* 2001; 164:2177-2180.

[xvii] Lin, Munsie, Hwang, Fitzgerald, and Cayo.. Childhood Asthma Hospitalization and Residential Exposure to State Route Traffic. *Environmental Research, Section A* 2002; 88:73-81.

Similarly, A San Diego study found increased medical visits in children living within 550 feet of heavy traffic.

English P., Neutra R., Scalf R. Sullivan M. Waller L. Zhu L. Examining Associations Between Childhood Asthma and Traffic Flow Using a Geographic Information System. *Environmental Health Perspectives* 1999; 107(9):761-767.

[xviii] van Vliet et al.. Motor exhaust and chronic respiratory symptoms in children living near freeways. *Environmental Research* 1997; 74:12-132. These findings are widely supported by other studies such as:

[xix] Brauer, M., et al.. Air pollution and development of asthma, allergy and infections in a birth cohort. *Eur Respir J* 2007; 29:879-888.

[xx] South Coast Air Quality Management District. Multiple Air Toxics Exposure Study-III. September 2008. Available online at http://www.aqmd.gov/prdas/matesIII/MATESIIIFinalReportSept2008.html.

[xxi] CARB, 2005.

[xxii] Pearson et al.. 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* 2000; 50:175-180.

[xxiii] Raaschou-Nielsen, O., Hertel, O., Thomsen, B.L., & Olsen, J.H. Air Pollution from traffic at the residence of children with cancer. *Am J Epidemiol* 2001; 153:433-443.

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

[xxv] Wilherm M. et al. Local variations in CO and particulate air pollution and adverse birth outcomes in Los Angeles County, California, USA. *Environ Health Perspect*. 2005; 113(9):212-21.

[xxvi] Ritz B, et al. Ambient air pollution and risk of birth defects in Southern California. *Am J Epidemiol*. 2002; 155:17-25.

[xxvii] Volk, H. Residential Proximity to Freeways and Autism in the CHARGE Study. *Environmental Health Perspectives* 2010. Available online December 16, 2010. doi: 10.1289/ehp.1002835 (available at http://dx.doi.org).

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

[xxix] Finkelstein et.al. Traffic Air Pollution and Mortality Rate Advancement Periods. *Am J Epidemiol* 2004; 160:173-177.

[xxx] Gan, W. Q. Changes in Residential Proximity to Road Traffic and the Risk of Death from Coronary Heart Disease. *Epidemiology* 2010; 21(5):642-649.

[xxxi] Adar, S., Gold, D., Coull, B., Schwartz, J., Stone, P., Suh, H. Focused exposures to airborne traffic particles and heart rate variability in the elderly. *Epidemiology* 2007; 18(1):95-103.