Health Effects Institute Annual Conference
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Key Policy Questions on Traffic and Health

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Key Messages

- Transportation decisions take place across multiple jurisdictions and geographic scales
- We need research to understand the health impacts of emissions from the future vehicle fleets (i.e., those meeting our standards, plus tire, brake, road dust, noise)
- Framing health based on only one issue can result in decisions with unintended consequences
  - Horizontal gradients around roadways aren't enough
  - Also important in epidemiologic exposure assessments

Quick notes

- Though I use NO_2 throughout this presentation as an example of a traffic-related air pollutant, I don't mean to suggest that it is sensitive or specific enough to represent other pollutants or traffic in general
- I will mostly be addressing air pollution, but don't take that as indicating noise isn't important. There are both human and animal studies suggesting that traffic-related noise exposures can affect things like insulin resistance.

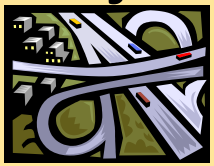
National Scale

Metropolitan Scale

Municipal Scale

Neighborhood and Individual Scale

Road/Project Scale



Road & ROW design (State DOT)

Siting, planting, building retrofit
(individuals, schools)
Site and building design (developers)

Land Use Planning and Regulation (State, local)

Transportation Planning (MPOs, State DOTs)

Environmental standards (EPA, CARB)
Transportation policy (Congress, US DOT)

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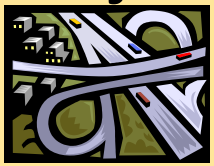
EPA regulatory programs

Road/Project Scale



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EPA Responsibilities: Vehicle and Fuel Standards

- The Clean Air Act requires EPA to set emission standards for mobile sources
  - Reflect the greatest degree of emission reduction achievable for pollutants that cause/contribute to air pollution reasonably anticipated to endanger public health or welfare (including criteria, toxic, and GHG pollutants)
  - Given cost and other factors
- Fuel standards are established if emission products:
  - Cause/contribute to air pollution reasonably anticipated to endanger public health or welfare, or
  - Impair performance of emission control device or systems

EPA Heavy-Duty Emission Standards and Near-Road Pollution

- For heavy-duty highway engines
  - Most recent emission regulations and fuel standards reduced PM mass emissions from 1970-2010 by ~99%
  - Standards also reduce NOx and toxics to a large degree
  - Science affecting the decisions
    - OTAQ first demonstrated feasibility of the standards in our own laboratory
    - Health studies on PM were used in support of the decisions
- Evidence of impacts on near-road exposures
  - Brown et al. (2015) found 40% reductions in black carbon (BC) along a Las Vegas freeway from 2008-2013, despite constant traffic volumes, similar to reductions predicted by EPA's MOVES model
  - Hudda et al. (2013) reported that heavy-duty diesel vehicle emissions on LA freeways have dropped, and due to the combination of emission standards and local policies, "*the assumption that freeways with the highest HDD fractions are significantly worse sources of total emissions may need reexamination in Los Angeles.*"

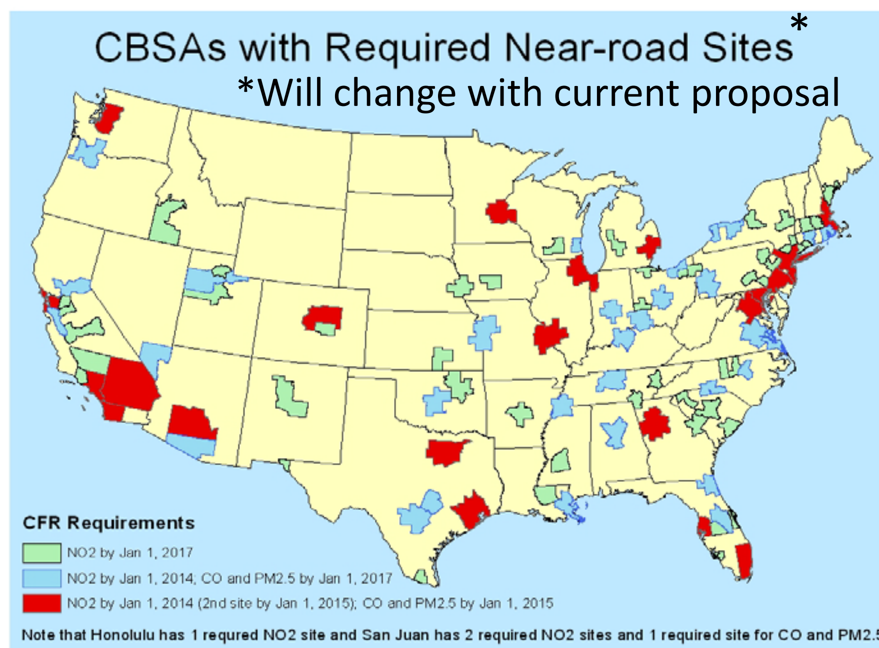
National Ambient Air Quality Standards

- NAAQS (40 CFR Part 50): primary and secondary standards set to protect human health and welfare
- Monitoring rules, now requiring near-road monitors (next slide)
- Implementation of the NAAQS also improves near-road air quality
  - State implementation plans (SIPs)
  - Conformity (general, transportation)

Near-Road Monitoring Network

- One near-road NO2, CO and PM2.5 monitor in each CBSA with >1 million population
- Second near-road NO2 monitor in each CBSA with >2.5 million population (or road segment with ≥250K AADT)
- Some sites will also voluntarily measure black carbon, particle number, and other metrics
- Anticipate this network will be a data source for new health studies

- Meta-data available through EPA's website at: www3.epa.gov/ttn/amtic/



Transportation Planning

Programs influence decision making at state/local levels, requiring air quality to be considered in public processes

- Transportation conformity affects MPOs and state DOTs
  - Required by the Clean Air Act
  - Ensures that transportation activities funded or approved by FHWA or FTA are consistent with air quality goals in nonattainment and maintenance areas
  - Applies to transportation plans, programs, and individual projects (some projects need “hot-spot” analyses using a dispersion model)
- Review of environmental impact statements (EIS) from other agencies for Federal funds or actions required under National Environmental Policy Act (NEPA)

Noise and Vegetation Barriers

- Research shows that roadside noise barriers and vegetation affect near-road air quality
- Additional research underway or planned that may enable use in regulatory applications
  - Design and implementation of roadside barriers that effectively reduce concentrations downwind
  - Developing algorithms for dispersion models to quantify the impacts of barriers and vegetation on near-road air quality
  - Intervention-type studies to evaluate effectiveness of implementing these strategies

National Scale

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EPA's mitigation efforts

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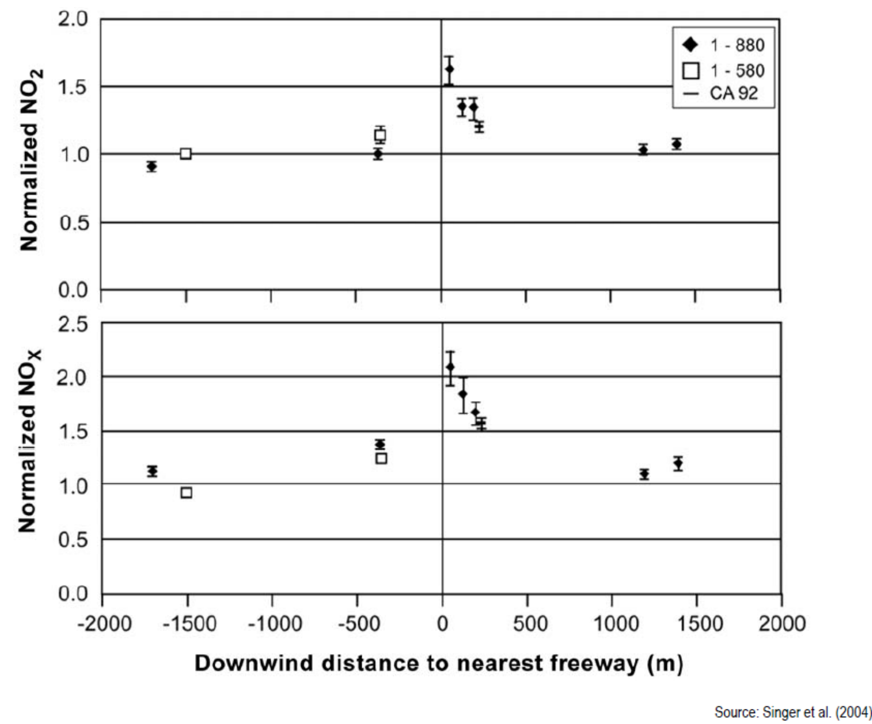
Framing Health is Important

- Near-road health concerns often focus on one component of overall exposure: horizontal gradients around roadways
- During the development of EPA's school siting guidelines, several organizations called for recommendations that no new schools be located within a "buffer" of several hundred meters around major roadways



igure 2.5-2. NO_2 and NO_X concentrations normalized to ambient values, plotted as a function of downwind distance from the freeway. Symbols indicate freeway closest to each monitor.

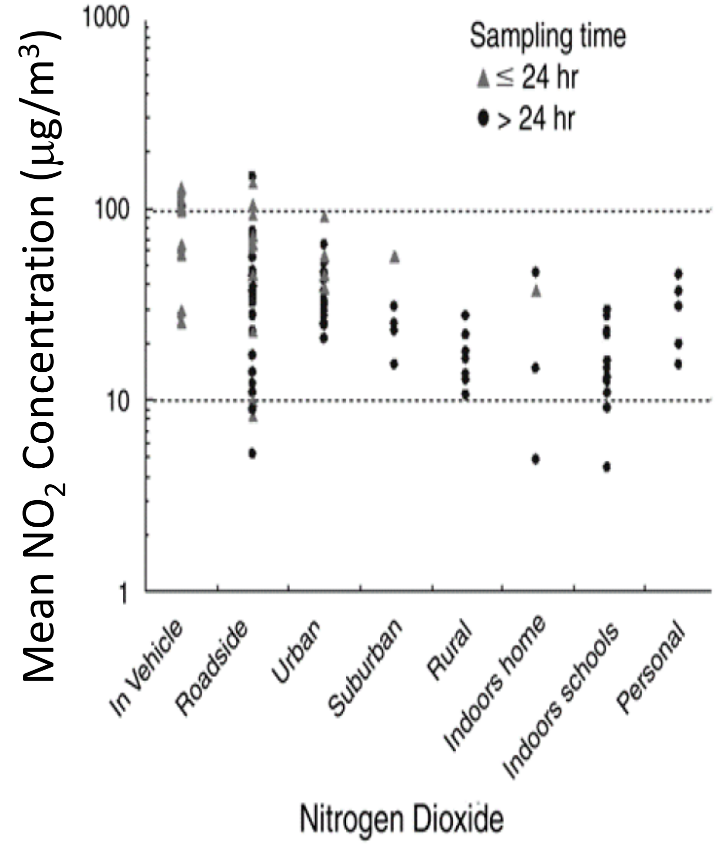
2008 ISA for Oxides of Nitrogen

Exposures During Commutes

- Increases daily average exposures compared to "home only" ambient concentrations (Shekarrizfard et al., 2016)
  - primary traffic-related pollutants
  - Affects statistical power of epidemiology studies?
- Exposures and time in traffic linked with health concerns in adults and children

  (e.g., Adar et al., 2007; Peters et al., 2004; Riediker et al., 2004; McConnell et al., 2010)
- Some evidence that low-SES populations have longer commutes in the U.S.

  (e.g., Karner and Benner, 2015)

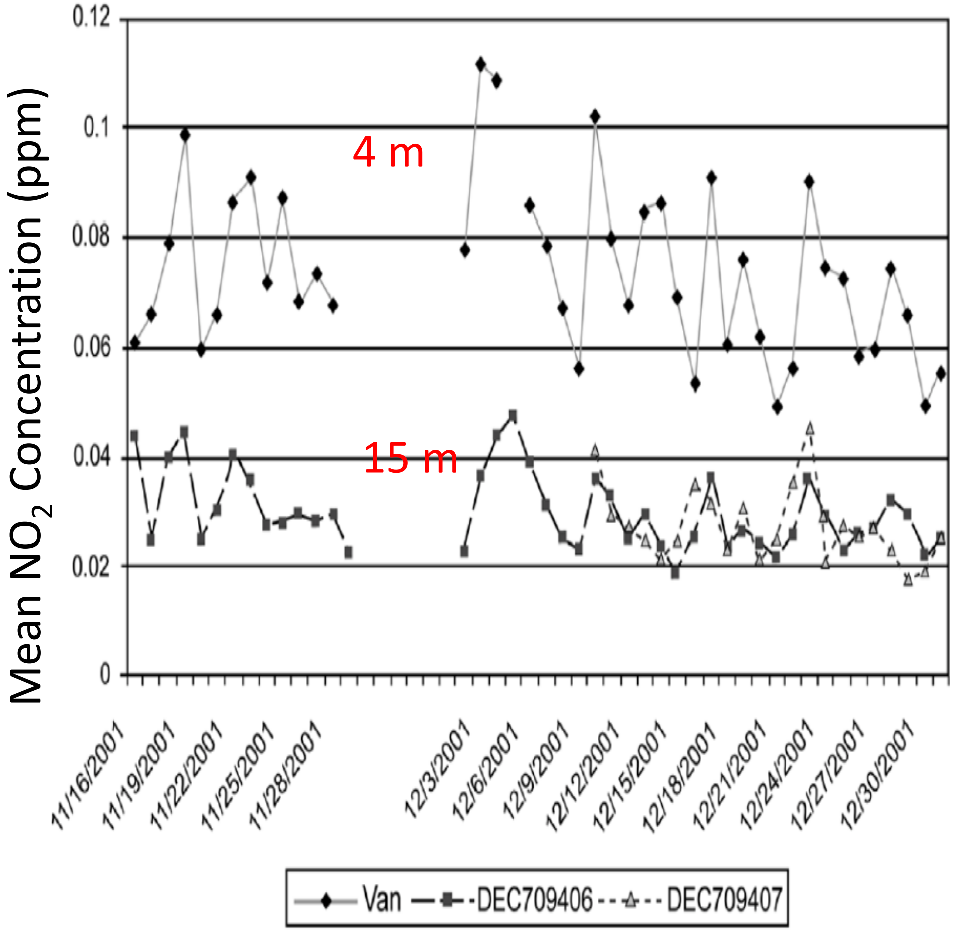


Source: EPA ISA for Oxides of Nitrogen (2016), citing HEI (2010) Report on Traffic and Health

References found in appendix

Vertical Gradients, Building Designs, and HVAC

- Vertical gradients, urban canyons, and population density all affect exposures, particularly in central cities
- Urban canyons reduce dispersion and increase concentrations
- Air conditioning appears to modify effects of ambient air quality on health
- All important to consider for exposure



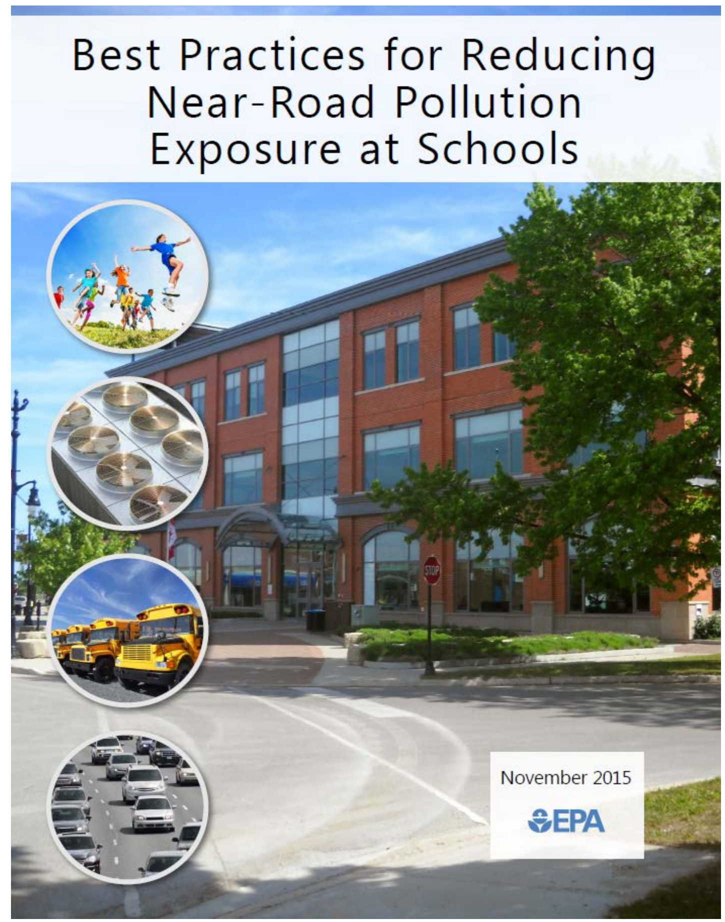
Source: ISA for Oxides of Nitrogen (2008), citing Restrepo et al. (2004) – NYC measurements

EPA School Siting Guidelines (2010)

- *"The complexity and multitude of factors affecting air pollutant concentrations near transportation sources … make it difficult to recommend a strict set of guidance for safe distances from these source types, particularly given the potential for unintended consequences. "*
  - Consider other locations *within* the same community at farther distances from the source; urban areas may be limited in appropriate locations
  - Moving schools farther away may increase exposure during longer bus/car commutes, increase traffic on local roads, reduce commute options such as walking/biking
- What options might be feasible for mitigating pollutant concentrations at the site?
  - 2010 guidelines include recommendations for new schools
  - In 2015, we released recommendations for existing schools

2015 Document for Reducing Exposures at Schools

- *Best Practices for Reducing Near-Road Pollution Exposure at Schools*
  - HVAC design and operation
  - Building and envelope design
  - Filtration
  - Site configuration
  - Noise barriers
  - Vegetation
- Potential for outreach to other decision-makers, such as planners in state and local government



Limits to EPA Authority for Emission Standards

- The Clean Air Act does not give EPA authority to establish emission standards for vehicle tires and brakes
  - However, tire and brake emissions are included in emissions inventories for applications such as transportation conformity and state implementation plans (SIPs)
- EPA also no longer works on noise control
  - Under legislation from 1972 and 1978, EPA once coordinated all federal noise control activities through its Office of Noise Abatement and Control.
  - In 1982, responsibility of noise control passed to state and local governments with EPA's noise office defunded
- FHWA maintains regulations and guidance over highway traffic and construction noise as well as models and measurement procedures

Research Priorities to Support Future Decisions

- Health benefits associated with reducing emissions of specific traffic-related sources (e.g., tailpipe, brake and tire dust) and pollutants (e.g., PM, NO2, benzene)
  - How will future vehicles affect air quality and health?
- Identification and quantification of health impacts of mitigation methods, some of which may also be effect modifiers in epidemiology. For example,
  - Air condition in time-series studies
  - Vertical gradients in cohort studies in large cities using a horizontal land use regression (LUR) model for exposure
- Contribution to different elements of daily exposure (in vehicle, indoor air) to health issues

State, Local, and Tribal Choices

National Scale

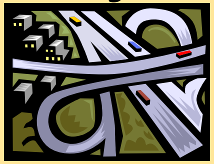
Metropolitan Scale

Municipal Scale

Neighborhood and Individual Scale

Road/Project Scale

S,L, and T Policies



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Decisions at the State/Local Level

- State and local governments oversee many other policies and programs, for example:
  - Zoning and land regulation
  - Transportation planning
  - Truck routes, loading zones, weight/size restrictions
  - Building codes
  - Education policy, including school siting and school choice
- Evidence that plans for large highway and transit projects frequently overestimate benefits and underestimate costs (e.g., Flyvbjerg, 2014)
  - Impacts on air quality and exposure?
  - Impacts on health?

Local Intervention Studies Could Support Better Decisions

- Studies focused on location-mobility tradeoffs could help understand impacts of decisions on exposure and health
- Small numbers of studies have examined local policies' impacts on air quality, exposure, or health.* For example, limited evidence suggests:
  - Air quality and health outcomes seem better when traffic bypasses populations
  - Studies on transit strikes suggest that transit improves region-wide air quality
  - Redesigning streets may affect microscale air quality
  - Short-term highway closures may improve region-wide air quality
  - Road widening may worsen air quality
  - Bike/walk routes away from high traffic roads/hours may reduce exposure
  - Studies have looked at congestion charging zones (CCZ), low-emission zones (LEZ), and reducing highway speed limits with varying results

**References found in appendix*

Conclusions

- Transportation decisions take place across multiple jurisdictions and geographic scales
- We need research to understand the health impacts of emissions from the future vehicle fleets (i.e., those meeting our standards, plus tire, brake, road dust, noise)
- Framing health based on only one issue can result in decisions with unintended consequences
  - Horizontal gradients around roadways aren't enough
  - Also important in epidemiologic exposure assessments

Appendix

Models

- EPA publishes rules and guidance documents for model uses in different applications
  - Attainment demonstration modeling for state implementation plans (SIPs)
  - Transportation conformity/hot spot assessments
  - Permit modeling
- Specific models are required under Clean Air Act for policy use
  - MOVES is EPA's model for onroad vehicles and nonroad equipment (CAA Sec. 130)
  - AERMOD is EPA's dispersion model used for predicting ambient air concentrations of primary pollutants near sources
  - CMAQ is EPA's chemistry-transport model (CTM) used for predicting air pollutants regionally or nationwide

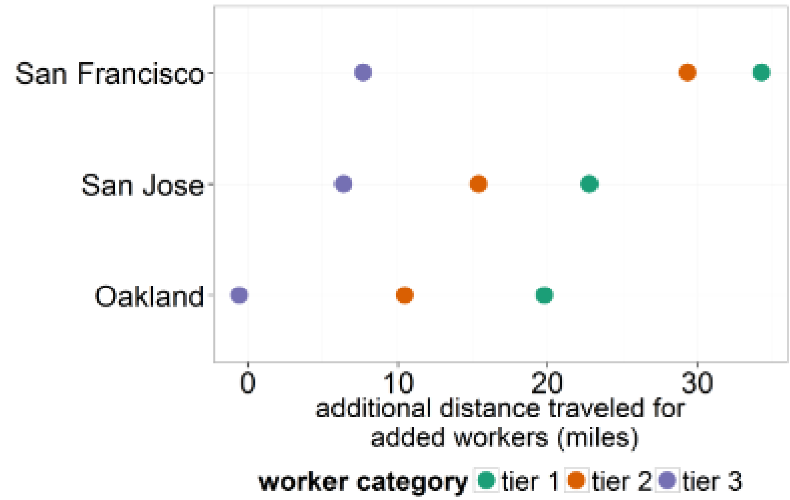
Summary Table from School Report

Strategy	Ventilation/ HVAC System Type	Benefits	Drawbacks	New/ Existing Schools
Staff education on ventilation best practices	All	Teachers are less likely to turn systems off; doors/ windows stay closed during peak pollution periods	Results are not guaranteed, depend on staff cooperation; effectiveness may decrease over time	Both
Air seal around windows, doors, HVAC ducts, etc.	All	Reduces infiltration of unfiltered air	Indoor pollutant concentrations may build over time, especially if ventilation is insufficient or indoor pollutant generation is high	Both
Air intake relocation if near roadway/source	Central HVAC systems; window units	Reduces particle and gaseous concentrations in incoming air	Cost; may require new system balancing	Both
Filtration	Mechanical ventilation systems	Reduces particle concentrations from both outdoor and indoor sources	Maintenance required; may require system upgrades or rebalancing	Both
Improved HVAC system design compatible with high-efficiency filtration	Central HVAC systems	Larger reductions in particle concentrations are possible	Cost; may require new system balancing	Both
Anti-idling/idle reduction policies	N/A	Reduces emissions of particles and gases	Cost	Both
Bus fleet upgrades	N/A	Reduces emissions of particles and gases	Cost	Both
Encourage active transportation	N/A	Reduces emissions of particles and gases	Walkers/bicyclists may be exposed to traffic-related pollution during trips	Both
Site design strategies	N/A	Reduces student exposure to particles and gases	Literature is limited; effectiveness is site-specific	New
Barriers along roadway	N/A	Reduce concentrations of particles and gases near schools	High cost; research regarding optimal design is limited	Both
Vegetation along roadway	N/A	Reduce concentrations of particles and gases near schools	Cost; maintenance requirements; research regarding optimal design is limited	Both

Evidence of Exposure Complexity

- Between 2008 and 2011, Northern California's cities added low-wage jobs, but affordable housing did not keep pace
- New low-income workers in core cities have higher commute distances
- Framing environmental health on near-road exposures alone could overlook this type of issue (and potentially increase overall exposure)

Commute Distance for NorCal Workers Added from 2008-2011



Additional commute distance for added workers

Karner and Benner, 2015

Tier 1 / 2 / 3 = Low / Medium / High Income

Local Intervention Studies Could Support Better Decisions

- Studies focused on location-mobility tradeoffs could help understand exposure and health impacts of land use and transportation policy decisions
- Small numbers of studies have examined local policy issues impacts on air quality, exposure, or health. For example:
  - Air quality and health impacts seem better when traffic bypasses populations
    - (Burr et al., 2004) (Cowie et al., 2012a, 2012b) (He et al., 2016)
  - Studies on transit strikes describes how transit improves region-wide air quality
    - (Ding et al., 2014) (Carvalho-Oliveira et al., 2005) (Bauernshuster et al., 2015)
  - Redesigning streets may affect microscale air quality
    - (Whitlow et al., 2011) (Shu et al., 2014) (Shu et al., 2016)
  - Short-term highway closures may improve region-wide air quality
    - (Quiros et al., 2013; Hong et al., 2015)
  - Road widening may worsen air quality
    - (Vedantham et al., 2012)(Brown et al., 2014)(Font et al., 2014)
  - Bike/walk routes away from high traffic roads/hours may reduce exposure
    - (Jarjour et al., 2013)(Cole-Hunter et al., 2013)(Bigazzi and Figliozzi, 2014)
  - Studies have looked at congestion charging zones (CCZ), low-emission zones (LEZ), and reducing highway speed limits with varying results
    - (Kelly et al., 2009) (Giles et al., 2011, Ellison et al., 2013) (Cesaroni et al., 2012) (Qadir et al., 2013) (Dijkema et al., 2008)(Keuken et al., 2010)(Jones et al., 2012)

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