



# **I-710 EXPANSION COMMENTS**

**COMMUNITY • HEALTH • JUSTICE**

**SEPTEMBER 28, 2012**



September 28, 2012

Ronald Kosinski  
Caltrans District 7, Division of Environmental Planning  
100 South Main Street, MS 164  
Los Angeles, CA 90012

**Re: I-710 Expansion Comments**

Dear Mr. Kosinski:

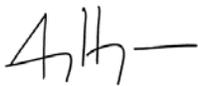
On behalf of the Coalition for Environmental Health and Justice and the undersigned organizations, we submit these comments on the I-710 corridor expansion project. This package of comments, including significant technical and legal input, critiques the environmental documentation for this expansion project and suggests how to improve it. Of particular importance, Attachment A includes our Coalition's detailed description of "Community Alternative 7," which outperforms the current proposals in 5A, 6A, 6B, and 6C on environmental, economic, and community-impacts grounds.

"Community Alternative 7" includes four dedicated zero emissions truck lanes, but **no** additional general purpose lanes. We believe that in order to propel the region into a more sustainable future, more effort should go toward enhancing transit (public transit plans, bike and pedestrian infrastructure) than toward creating yet more infrastructure for single-passenger automobiles in the smog capitol of the United States. Also, we propose many community improvements in this region because these neighborhoods suffer the brunt of the harmful impacts from freight movement to and from the Ports of Los Angeles and Long Beach and the railyards in Commerce and Vernon. These improvements include enhancements to the LA River and mitigation for air and noise pollution, among other measures that are imperative for a project of this magnitude.

It is important that the environmental review documents for this project clearly and comprehensively inform decision makers and the public about the impacts of the proposed project. The environmental documents we reviewed do not live up to this standard of allowing truly informed decision-making. We look forward to working with the agencies to help improve the environmental review and redefine the project in a way that is better for the environment, our economy, and most importantly the surrounding communities.

Please do not hesitate to contact Angelo Logan at (323)263-2113 or [alogan@eycej.org](mailto:alogan@eycej.org) if you would like to set up a meeting to discuss this matter more fully.

Sincerely,



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East Yard Communities for Environmental Justice

Adriano Martinez  
Natural Resources Defense Council

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Coalition for a Safe Environment

Malcom Carson  
Legal Aid Foundation of Los Angeles

Lewis MacAdams  
Friends of the Los Angeles River

Enclosures: Attachment A (Community Alternative 7 for Construction and Operation)  
Attachment B (Technical/Legal Comments on Draft EIR/EIS)  
Attachment C (Review of Transportation and Air Quality Analysis)  
Attachment D (Bicycle/Pedestrian Comments on CA 7.6)  
Attachment E (Review of Noise and Vibration Section of Draft EIR/EIS)  
Attachment F (Comments on DRAFT EIR/EIS, Water Quality and Stormwater  
Runoff and the Water Quality and Stormwater Runoff Study Final Report)  
Attachment G (Analysis of GHG Emissions)  
Attachment H (Demographic Comparison of I-710 Freeway Neighborhoods)  
Attachment I (Analysis of the Alternatives Selection Process for the I-710)  
Attachment J (Miscellaneous Documents for Review)

CC: Project Committee  
Jared Blumenfeld, EPA Region 9  
James Goldstein, CARB  
Barry Wallerstein, SCAQMD  
Hasan Ikhata, SCAG

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- C. Sustainable Systems Research, LLC: “Review of Transportation and Air Quality Analysis in the I-710 Draft Environmental Impact Report,” Technical Memorandum
- D. Livable Communities, Inc.: “CA 7.6: Comprehensive Pedestrian and Bicycle Element,” Technical Analysis
- E. The Acoustics and Vibration Group: “Results of Review of the Noise and Vibration Sections of the I-710 Corridor Project Draft Environmental Impact Report/Environmental Impact Statement and Evaluation of Proposed Mitigation Measures,” Letter Report
- F. Richard Horner: “Comments Regarding the I-710 Corridor Project EIR/EIS, Chapter 3.9, Water Quality and Stormwater Runoff and the Water Quality and Stormwater Runoff Study Final Report, Interstate 710 Corridor Project Between Ocean Boulevard and the State Route 60 Interchange,” Comment Letter
- G. Greg Gould: “Analysis of Greenhouse Gas Emission Estimates for the Interstate 710 Corridor Project,” Technical Memorandum
- H. U.S.C. Program for Environmental and Regional Equity (PERE), “Demographic Comparison of Neighborhoods Near the 710 Freeway to Los Angeles County, California and the United States (2010) and Maps,” Technical Analysis
- I. Greg Gould: “Analysis of the Alternatives Selection Process for the Interstate 710 Corridor Project,” Technical Memorandum
- J. Miscellaneous Documents for Review
  - 1. California Department of Transportation: “Complete Intersections: A Guide to Reconstructing Intersections and Interchanges for Bicycles and Pedestrians,” 2010
  - 2. Long Beach River Plan, Design Concept
  - 3. Community Livability Plan for the I-710 Corridor Neighborhoods
  - 4. I-710 Corridor Project Draft EIR/EIS, Preliminary Peer Review Findings, City of Commerce (August 21, 2012)
  - 5. Dr. Robert L. Russell: “Performance Evaluation of Air Filtration Devices, Final Report”
  - 6. South Coast Air Quality Management District: “Pilot Study of High Performance Air Filtration for Classrooms Applications, Final Report”
  - 7. Highway Safety Research Center: “How to Develop a Pedestrian Safety Action Plan,” March 2009

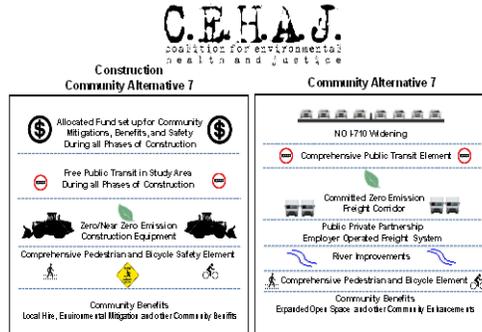


# **ATTACHMENT A**



# I-710 Corridor Project

## Community Alternative 7



### CA7 Community Alternative Proposal

First and foremost, the Interstate 710 (I-710) Corridor is a community of residents. For decades, this area has been identified as an Environmental Justice community because it is comprised of vulnerable populations, including a majority people of color. With the rise of freight movement over the last several decades in Southern California, these communities have been exposed to high levels of toxins due to the industrial landscape and geography related to the Goods Movement industry and the I-710 freeway. While we acknowledge that the I-710 freeway is a vital transportation artery, linking the Ports of Los Angeles and Long Beach (POLA and POLB) to Southern California and the nation’s logistic and Goods Movement system, we refuse to allow transportation planners to barrel through our neighborhoods in a manner that does not protect the communities that shoulder most of the burden of the Goods Movement system and receive so few of its benefits.

Since we are critical of the alternatives analyzed and presented for this expansion project, CEHAJ has developed a revised and superior alternative through community input and significant technical analysis. We developed this alternative with two main concerns in mind:

- Protecting community health in an already overburdened part of the Los Angeles metro region; and
- Proposing an alternative that performs better environmentally than existing alternatives, while achieving traffic safety, enhancing goods movement, and reducing congestion.

This analysis and input from organizations and community members within the I-710 Corridor culminated in the development of “Community Alternative 7,” which CEHAJ hereby presents to the I-710 Freeway Expansion Project Team and both the Executive and Finance Committees as an alternative that must be considered in the review of alternatives for this expansion project.

Community Alternative 7 includes seven components:

- 1) **No I-710 Widening (No Additional General Purpose Lanes);**
- 2) **Comprehensive Public Transit Element;**
- 3) **Mandatory Zero-Emission Freight Corridor;**
- 4) **Public Private Partnership – Operator of the “Freight Corridor System;”**
- 5) **River Improvements;**
- 6) **Comprehensive Pedestrian and Bicycle Element; and**
- 7) **Community Benefits.**

#### **CA7.1 No Widening of GENERAL PURPOSE LANES**

Community Alternative 7 will maintain the current configuration of the existing I-710 Corridor. Nonetheless, there would be other improvements that increase capacity to the I-710 mainline. Community Alternative 7 calls for maximizing on-dock rail and creating a comprehensive Transit Element that would accommodate both commuter and freight traffic demands assumed in studies.

**City of Commerce** specific: The design element of Community Alternative 7 consists of a modified option at the Washington Blvd. intersection. The modification preserves residential properties and minimizes industrial property acquisitions. Between Washington Blvd. and the I-5 freeway, the I-710 freeway will not have residential impacts, as Community Alternative 7 will maintain the I-710 in its current configuration.

**Long Beach** specific: The design element of Community Alternative 7 for the I-710 freeway at the Anaheim intersection will not have impacts on the Multi-Service Center, as Community Alternative 7 will maintain the freeway’s current foot print.

**City of Bell** specific: Community Alternative 7 will not interfere with Shelter Partnerships’ facility or Bell Shelters operated by the Salvation Army.

This section focuses on the I-710 general purpose lanes, corridor traffic and transit system. The general purpose lanes will, in effect, maintain their existing footprint and physical capacity. This Alternative will address the projected growth and traffic volumes by increasing the effectiveness of the corridor through a combination of traffic management, intelligent transportation systems (ITS), parking management (TSM), and increased transit services.<sup>1</sup> The strategies for this analysis assume that there is a 68% increase in transit service. This Alternative will require the transportation agencies in the I-710 Corridor to incorporate a funded comprehensive public transit strategy, which is discussed in detail in the Transportation & Air Quality Technical Report located at Attachment C. Specific focus should be paid to bus lines with high ridership (e.g. Metro Local 51 and 18).

The freeway itself will not be widened and will maintain eight general purpose lanes from Ocean Blvd. to the SR-60. This Alternative will modernize the design and

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<sup>1</sup> CEHAJ notes that the combination of using the highest projections of container throughput at the POLA and POLB possible in addition to the inflated population growth numbers likely resulted in capacity needed being overstated.

reconfigure local arterial/freeway interchanges to enhance safety but will not result in removing any of the currently existing residential or industrial structures.

To remedy the purported additional capacity needs, Community Alternative 7 proposes the following:

### ITS/TDM/TSM

Adaptive ramp metering should be deployed at at least 13 sites along I-710, providing an eight percent capacity improvement, and ITS Corridor Management will be implemented on I-710, I-110, and I-605, providing an additional capacity improvement of six percent.

Peak period parking restrictions on key arterials will provide additional capacity increases over a No-Build Alternative of 700 passenger car equivalents per hour per lane. Additional ITS implementation on major arterials will provide an additional effective capacity increase of more than 23 percent over a No-Build Alternative. (These changes will also allow for additional bus capacity on arterials. The positive effect of that change is not included in the capacity increases noted above.)

Additional ITS implementation on all other arterials crossings, will provide an additional effective capacity increase of six percent over a No-Build Alternative.

### Goods Movement Strategies

The projected growth in cargo and freight traffic will be accommodated by use of a separated four-lane, zero emissions-technology freight corridor (see Section CA7.3). The freight corridor would be located on an elevated structure with lanes in each direction between Ocean Boulevard and the intermodal railyards in the cities of Vernon and Commerce.

### Transit

The projected growth in commuter traffic and population growth will be accommodated by an aggressive, but achievable public transportation improvement strategy that enhances rail and bus usage in the I-710 corridor (see Section CA7.2). Implementing this strategy will mean transporting residents and reducing travel demand by at least:

- Adding bus shuttles to transit centers;
- Expanding Metro Blue Line and Green Line service;
- Adequately expanding local, express, and Metro Rapid Bus services; and
- Enhancing community bus service (e.g. local circulators in Long Beach, Commerce, and Paramount).

### **CA7.2 Comprehensive Public Transit Element**

Community Alternative 7 includes an aggressive strategy to improve public transportation via rail and bus in the I-710 corridor. It is well established that the population in the project area are users of public transit. The project area includes some of the most heavily utilized rail and bus lines in the entire Los Angeles metro area.

This part of the Alternative calls for substantial investments in public transit in the project area with a focus on local and express bus lines.

With the passage of AB 32 and SB 375, among other policy changes, California's metropolitan regions must focus on more efficient means to transport residents and

reduce travel demand. Part of the rationale provided by Caltrans for the major expansion of the I-710 is to accommodate future growth in automobile traffic. Expanding road capacity, however, does little to increase the efficiency of the transportation system in a way that is sustainable or will reduce travel demand. The Draft EIR/EIS assumes only the maximization of the Blue Line and increasing bus service. The failure to consider building additional light rail capacity or expanding bus routes and service is a critical flaw in the Draft EIR/EIS. The implementation of a corridor-wide, comprehensive capacity enhancement for public transportation would complement AB 32 and SB 375, as it would reduce global warming emissions and emissions of conventional air pollutants regionally. (See, e.g., CA7.1 for proposed transit enhancements.)

### **CA7.3 Committed Zero Emission Freight Corridor**

Community Alternative 7 includes a separated Zero Emission (mandatory) Freight Corridor. The Alternative calls for an enforceable commitment to use zero-emission technologies immediately upon project completion. The Zero Emission Freight Corridor would be located on an elevated structure with two lanes in each direction between Ocean Boulevard and the intermodal railyards in the cities of Vernon and Commerce.

#### Public Private Partnership

This Zero Emission Freight Corridor system would be operated by a qualified private firm contracted and overseen by CALTRANS using a Request for Qualifications (RFQ) process followed by a Request for Proposals (RFP) and final award.

#### Zero Emission Freight System

The Alternative restricts the use of the freight corridor to zero-emission freight movement systems rather than conventionally powered trucks. One such zero-emission technology consists of trucks powered by electric motors in lieu of internal combustion engines; these would produce zero tailpipe emissions while traveling on the freight corridor. The specific type of electric motor is not defined, but feasible options include linear induction motors, linear synchronous motors or more prevalent in-vehicle conventional brushless DC motors. The power systems for these electric propulsion trucks could include, but are not limited to, road-connected wayside power (e.g., overhead catenary electric power distribution system), as well as a variety of possible hybrid power sources with dual-mode operation (with a Zero-Emission Vehicle mode) such as Range Extender Electric Vehicle (with a Fuel Cell or Turbine along with a ZEV operations mode), a fully Electric Vehicle (with rechargeable batteries or power), or alternative fuel hybrids (e.g., zero-NOx dedicated fuel engines, such as Compressed Natural Gas, Renewable Natural Gas, Hydrogen [H<sub>2</sub>] Internal Combustion Engine) coupled with a range extender battery power Electric Vehicle mode (turbine power battery charging). These hybrid variations would be powered by their electric motors while traveling along the freight corridor and use their hybrid engines for both motive power and to recharge their batteries when not traveling for the freight corridor. For purposes of the I-710 Corridor Project DEIR/EIS, the zero-emission electric trucks are assumed to receive electric power while traveling along the freight corridor via an overhead catenary electric power distribution system (road-connected power). This proposed power distribution system is similar systems used to power electric trolley buses (e.g., in San Francisco) and requires traction power substations sited along the freight corridor to distribute electricity from the regional electrical power grid to the catenary system.

Energy consumption is based upon the maximum number of vehicles expected on the freight corridor at any one time. As such, a minimum of 26 electrical substations, providing 25-kilovolt (kV) output, are required. The stations are spaced approximately 4,000 feet apart and are located within the proposed rights-of-way for Alternatives 6A/B/C. Each substation requires approximately 25,000 square feet. Southern California Edison (SCE) has confirmed that current and planned local electrical distribution systems and power supplies are sufficient to accommodate the Alternative's energy demand.

### Design

The freight corridor will be located on an elevated structure with lanes in each direction between Ocean Boulevard and the City of Commerce. The freight corridor should not have residential or industrial right away impacts. For the most part, the freight corridor will run adjacent to the existing freeway facility, using railroad and utility rights of way. In some cases the freight corridor may need to use double-decked elevated structures. Dedicated entry and exit points to and from the freight corridor within the project limits are described below:

- Harbor Scenic Dr. (Southern Terminus)
- Pico Ave.
- I-710/I-405 Interchange
- I-710/SR-91 Interchange
- I-710/Interstate 105 (I-105) Interchange
- Atlantic Blvd./Bandini Blvd./Washington Blvd.
- Sheila St. (Northern Terminus)

The freight corridor will not have an entry or exit point at Anaheim Street in Long Beach.

### **CA7.4 Public-Private Partnership (PPP)-Operator of the “Freight Corridor System”**

A successful mandatory Zero Emission Freight Corridor requires an operator of the system to hold to the standards and requirements mandated. The alternative to a PPP is expecting thousands of individuals and/or companies to acquire zero emission trucks without support, which is terribly difficult, precluding efficient transition to new zero-emission trucks. The PPP approach for operating a mandatory Zero Emission Freight Corridor could be an **Operation & Maintenance Contract (O & M)**, which would retain a private operator under contract to operate the publicly-owned freight corridor for a specified term. CALTRANS would finance and construct the freight corridor facility. Ownership of the freight corridor would remain with CALTRANS. The other option would be a **Design-Build-Finance-Operate (DBFO)**, which would allow a private firm to design, finance and construct the freight corridor facility under a long-term lease, and then operate it during the term of the lease.

### **CA7.5 River Improvements**

Community Alternative 7 includes restoration of the natural river functions, including recreational trails, restored wetlands, continuous fish migration corridors, and native landscaping. This Alternative does—and any I-710 project should—remove barriers to neighborhood access to the river by providing improved walk and bike trail networks. The LA region is classified as a park-deprived area, and any efforts to change the I-710

should be used to address this critical issue. Polluted run-off should be treated via multi-benefit green treatment trains. To the extent that any I-710 project increases impermeable surfaces, it must mitigate negative hydrological impacts by removing impermeable surfaces elsewhere. Community Alternative 7 ensures the conditions at the limited facilities available for South LA residents are improved. Finally, the LA River should not be used as a right of way to house power infrastructure. All of the above applies to the entire river system, including the main stem of the LA River itself, and its 710-adjacent tributaries: Compton Creek and the Rio Hondo.

#### **CA7.6 Comprehensive Pedestrian and Bicycle Element**

Community Alternative 7 includes adequate and safe bicycling and pedestrian infrastructure for the residents in the corridor. These low cost improvements are vital to provide a full range of transportation options to residents and increase our energy independence while mitigating harmful emissions. Community Alternative 7 includes the connection and enhancement of the growing bike path networks along Compton Creek, Rio Hondo, and the Los Angeles River--better connecting them with each other, and with residential, employment, and retail destinations. Special attention is paid to connecting bikeways to Metro transit stations, and to bike-friendly destinations. All road alterations in conjunction with freeway on/off-ramps will implement best practices to ensure that roadways are safe for pedestrians and cyclists. These practices may include the implementation of innovative colored bike lanes to alert drivers to the presence of bicyclists.

The I-710 Corridor contains many residential communities, along with the commercial establishments, schools, and recreational facilities that residents need to access on a regular basis. Many residents of these communities walk or cycle daily on the local streets because they cannot afford an automobile, are disabled, and/or are too young or old to drive. In addition, the I-710 corridor has physically separated communities on either side of the freeway. In some cases, such as in Long Beach and South Gate, neighborhoods within the same city are detached from each other.

Community Alternative 7 recommends infrastructure and network improvements to better accommodate and encourage travel by bicycle and on foot, and connect communities divided by the freeway.

#### **Shifting Priorities in the I-710 Corridor**

Contrary to common perception in the Southern California region, the I-710 Corridor is not just an industrial district and conduit for commuter vehicles. The corridor has long been home to residential neighborhoods and thriving business districts. In fact, new schools are being built in these communities to accommodate the growing number of youth. Many of these young people do not have access to a personal automobile, so they rely on relatives or others to drive them to their schools. Concerns over increased traffic around schools in the corridor could be mitigated if safe and connected bicycle and pedestrian routes were provided.



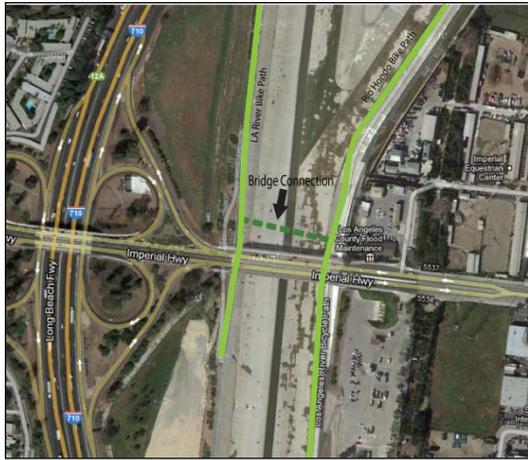
*The newly completed South Region High School #9 in South Gate has an open enrollment policy, so that residents of surrounding cities are eligible to attend.*

Long Beach, South Gate, and the County of Los Angeles have adopted bicycle master plans; Lynwood and Carson are currently in the process of developing plans as well. The Los Angeles County Metropolitan Transportation Authority (Metro) has studied existing conditions and potential improvements for pedestrian and bicyclist access to Blue Line rail stations. In addition, numerous organized bicycle rides and the popular open streets event CicLAvia demonstrate the latent demand for better cycling and walking environments in Los Angeles County. Caltrans should recognize this demand and abide by its own Complete Streets policies by incorporating high-quality pedestrian and bicycle infrastructure into its plans for enhancing the I-710 Corridor.

#### Improving the Walking and Cycling Environment Along the I-710 Corridor

In light of the shifting priorities in the I-710 Corridor's communities towards more sustainable transportation options and healthier, more livable neighborhoods, Community Alternative 7 calls on Caltrans and Metro to include high quality, safe pedestrian and bicycle infrastructure as part of any improvement project along the corridor. A highly connected pedestrian and bicycle network must be a part of this improvement process, so that all of the communities along the corridor will be better connected – physically, economically, and socially. To achieve these goals, we recommend that Caltrans and Metro make the below improvements.

- First and foremost, Caltrans should support through planning and implementation grants all communities in the corridor study area in drafting and adopting pedestrian and bicycle master plans that reflect local conditions and priorities, and that facilitate regional connectivity. Cities can follow the examples of Long Beach and South Gate, among others. By having comprehensive pedestrian and bicycle plans in place, cities in the corridor will clearly articulate their transportation vision, and they can also apply for grant aid to fund infrastructure improvements and educational campaigns.
- The Los Angeles River shared-use path should serve as the spine of an enhanced regional pedestrian and bicycle network. Therefore, Caltrans and Metro should extend the path or create a viable on-street connection to Downtown Los Angeles. In addition, the LA River path should be connected to both the Compton Creek and Rio Hondo paths via pedestrian- and bicycle-only bridges over the river.

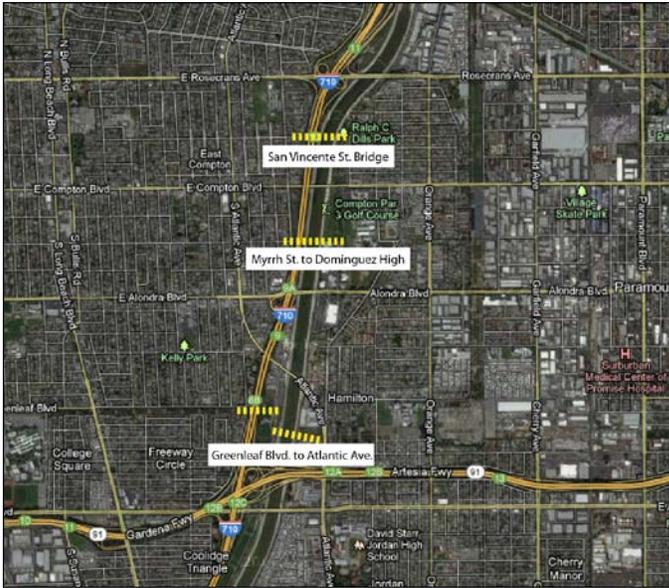


*An improved connection between the LA River and Rio Hondo bicycle paths*

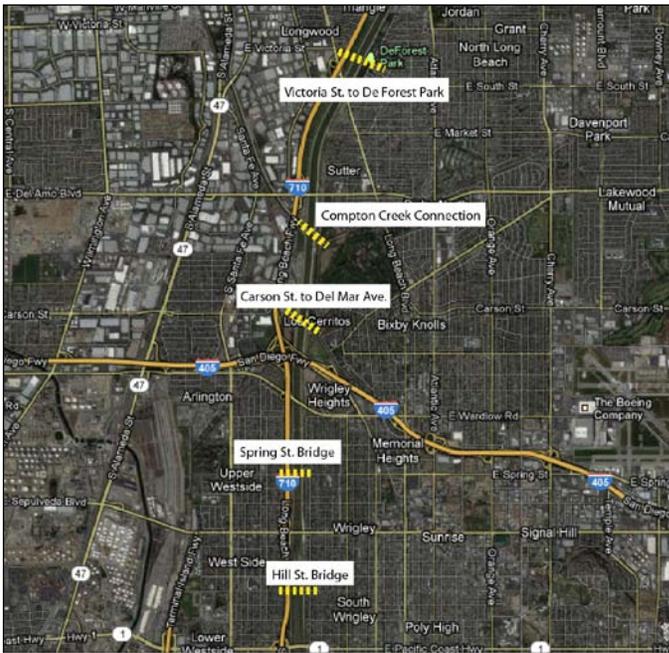


*Proposed connection between the LA River and Compton Creek bicycle paths*

- Connect the communities on either side of the I-710 with a series of pedestrian- and bicycle-only bridges or lids every  $\frac{1}{4}$  to  $\frac{1}{2}$  mile, especially where there is a particularly long gap between existing street crossings. The City of Long Beach is proactively requesting separated Class 1 facilities traversing the I-710 corridor for pedestrians and bicyclists at or very near to five priority crossing locations: Anaheim Street; between Pacific Coast Highway and Willow Street near Hill Street; between Willow Street and Wardlow Street near Spring Street; Long Beach Boulevard; and Artesia Boulevard. Other communities along the corridor can follow Long Beach's model and prioritize locations for pedestrian and bicycle bridges that will serve neighborhoods on both sides of the freeway.

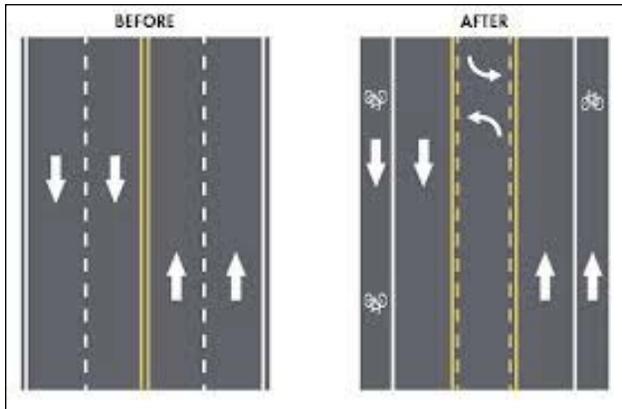


*Potential bike/ped bridges in Compton and Paramount*



*Potential bike/ped bridges in Long Beach*

- Implement Complete Street treatments, including “road diets,” on principal arterial and collector streets throughout the corridor study area, prioritizing those that currently cross the I-710 freeway and the Los Angeles River. Promote this strategy to area businesses and residents as both an enhancement to “Main Street” commercial districts and as a safety improvement for all road users.



*Typical road diet configuration*

- Where road-alterations occur in conjunction with freeway on-/off-ramps, implement best design practices to ensure that roadways are safe for pedestrians and cyclists. For instance, crosswalks should be placed in a location that offers pedestrians and drivers the optimum visibility of each other. Another effective technique is to paint a colored bicycle lane in the conflict zone to alert drivers to the presence of cyclists.
- Establish a dense network of bicycle-friendly neighborhood routes, also known as “bike boulevards,” that provide safe and pleasant cycling routes through residential areas. These bike boulevards use inexpensive treatments, such as traffic circles and turned-out stop signs, to slow automobile traffic and create a continuous flow condition for cyclists. As a side benefit, bike boulevards also enhance the pedestrian experience. The existing grid street network in the corridor’s communities facilitates the creation of this network.
- Utilize existing underused railroad and utility rights-of-way to construct separated pedestrian/bicycle paths. Several of these rights-of-way run for long distances parallel to major streets, offering the opportunity to greatly increase bicycle and pedestrian mobility.



*Union Pacific right-of-way parallel to Firestone Blvd.*



*Bike/Ped paths can safely coexist alongside rail*



*Underutilized right-of-way in  
Paramount*



*Pedestrian path within utility  
right-of-way, City of Stanton*

- Stripe bicycle lanes and install sufficient bicycle parking racks at industrial and commercial facilities. Despite common perceptions to the contrary, many workers in the corridor's industrial areas cycle to their jobs. The exceptionally heavy truck traffic in these areas necessitates dedicated space for cyclists on the roadways.
- Provide safe and effective walking and cycling connections to passenger rail stations – Metro and Metrolink – and to bus stops. Particularly popular access routes for pedestrians should be well lit, as should the transit stations and stops themselves.

### **CA7.7 Community Benefits and Enhancements**

Community Alternative 7 Community Benefits and Enhancements are necessary to mitigate impacts along the I-710 corridor as a result of the 710 Corridor Project during all phases of planning and construction. The following are a list of community design improvements that should be included as the I-710 Corridor project moves forward.

#### Neighborhood Services, Facilities and Amenities

Improvements to neighborhood should be responsive to any expressed community vision and avoid the demolition of public community facilities such as libraries, community centers, homeless shelters, schools, cultural centers, childcare centers, after school programs and other existing community assets.

#### Existing Parks

Include maintenance and upgrades at existing corridor parks as well as additional sports and recreation facilities and programs.

#### Linking the LA River and Parks, Greenbelts and Connections

Community Alternative 7 proposes an enhanced system of park networks along the LA River that will create greenbelts and open space connections, and improve access between the Los Angeles River and surrounding neighborhoods.

### Healthier Schools

Children attending the schools located along the I-710 Corridor Project will be impacted by the design and emissions of the project. To protect the health of the children, school improvements and mitigations should include: pedestrian and streetscape improvements to facilitate students' safe routes to school, using green and energy efficient building materials and systems in campus construction, planting trees along school parameters to mitigate noise and air pollution.

### Air Filtration

Air filtration systems should be placed in homes, schools, and public facilities within 500 meters of the highway and major arterials impacted by this Project.

### Trees and Streetscapes

Greening shared and public spaces in the project area is essential to creating community wellbeing. Caltrans should include tree planting and streetscape enhancement within the 710 Corridor Project study area and protect the existing trees in the area. New trees can also be planted along the sidewalks, medians and parkways, in order to promote desirability for walking. Other uses include using landscape improvements to mitigate noise, emissions and other nuisances from the I-710 Corridor Project and constructing green streets improvements to manage storm water.

### Neighborhood Services, Facilities and Amenities

Improvements to neighborhoods should be responsive to any expressed community vision and include constructing or avoiding the demolition of public community facilities such as libraries, community centers, homeless shelters, cultural centers, and childcare and after school programs.

### Pedestrian and Bicycle Improvements

Active modes of transportation must be enhanced and supported as part of the I-710 project. To promote and support walkability, community residents must feel that they can safely access and share the existing sidewalks and streets with cars. Caltrans can support pedestrian and bicycle improvements by making improvements and repairs to existing trails and sidewalks, enhancing pedestrian lighting and signalization, and making intersections and crossings safe with ADA improvements to facilitate access for the disabled. Bicycle improvements include construction of new Class I, II and III bicycle routes, repair of existing bike paths, and additional signage along existing routes. Additionally, planned bicycle and pedestrian routes should be assessed for safety and connect to other transit modes in order to encourage the use of public transit.

### Pedestrian Bridges

Pedestrian bridges serve as connectors and provide access to pedestrians. Pedestrian bridges should link community members to community and neighborhood amenities such as elementary schools. The design of the pedestrian bridges, such as the lighting, paint, access and sidewalk upgrades, greening, fencing upgrades, and potentially public art, should include the involvement of community feedback.

//

### Traffic and Parking

Truck parking is a problem in the neighborhoods along the corridor. Traffic and parking specifications need to include traffic signal upgrades, traffic control measures and traffic calming specifications. The project design should also address on and off street parking problems.

### Public Art

Incorporate more public art into existing park facilities, into neighborhoods and gateways, and into corridor transportation facilities.

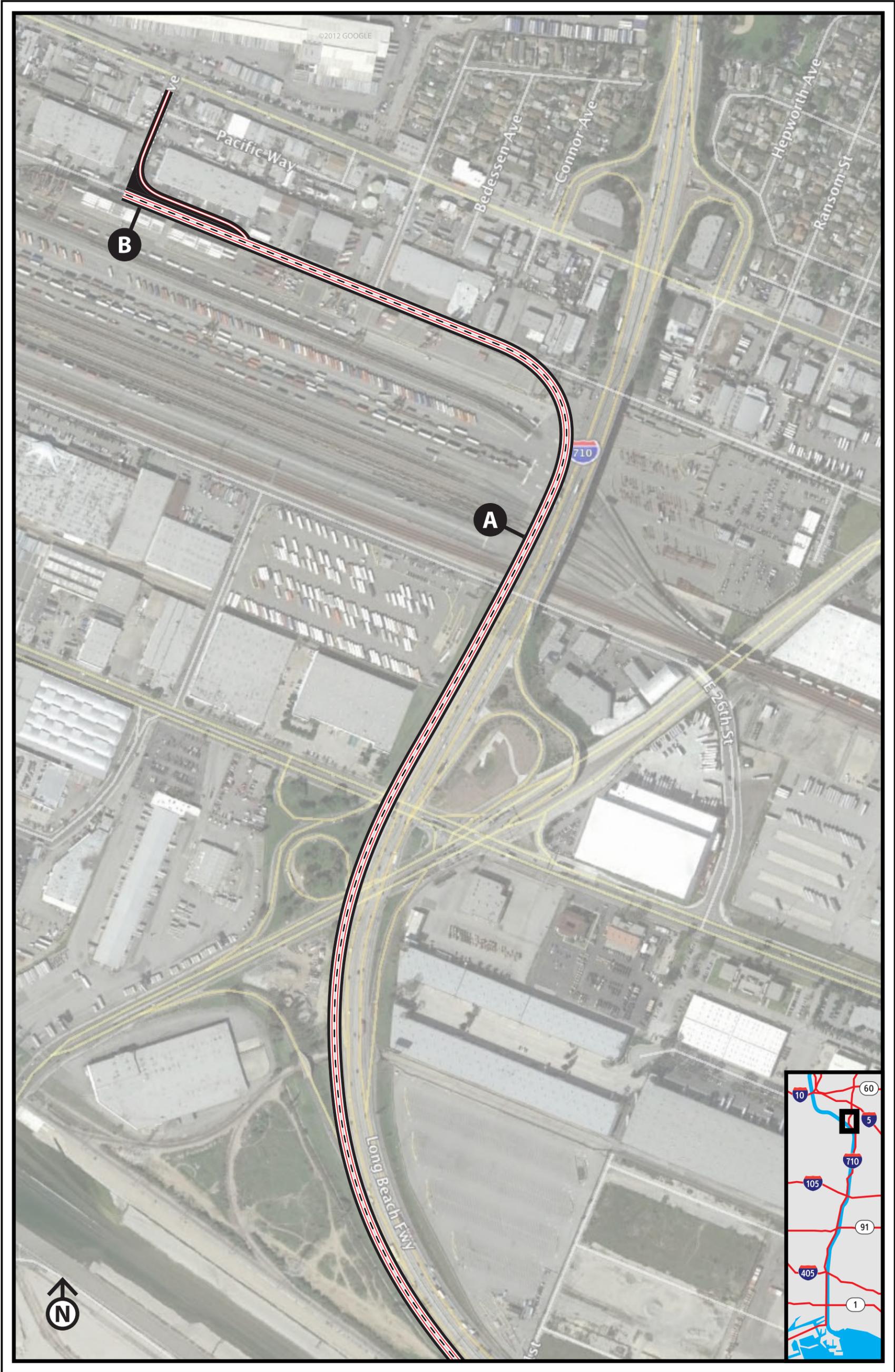


# **APPENDIX 1**



# *I-710 Corridor Project*

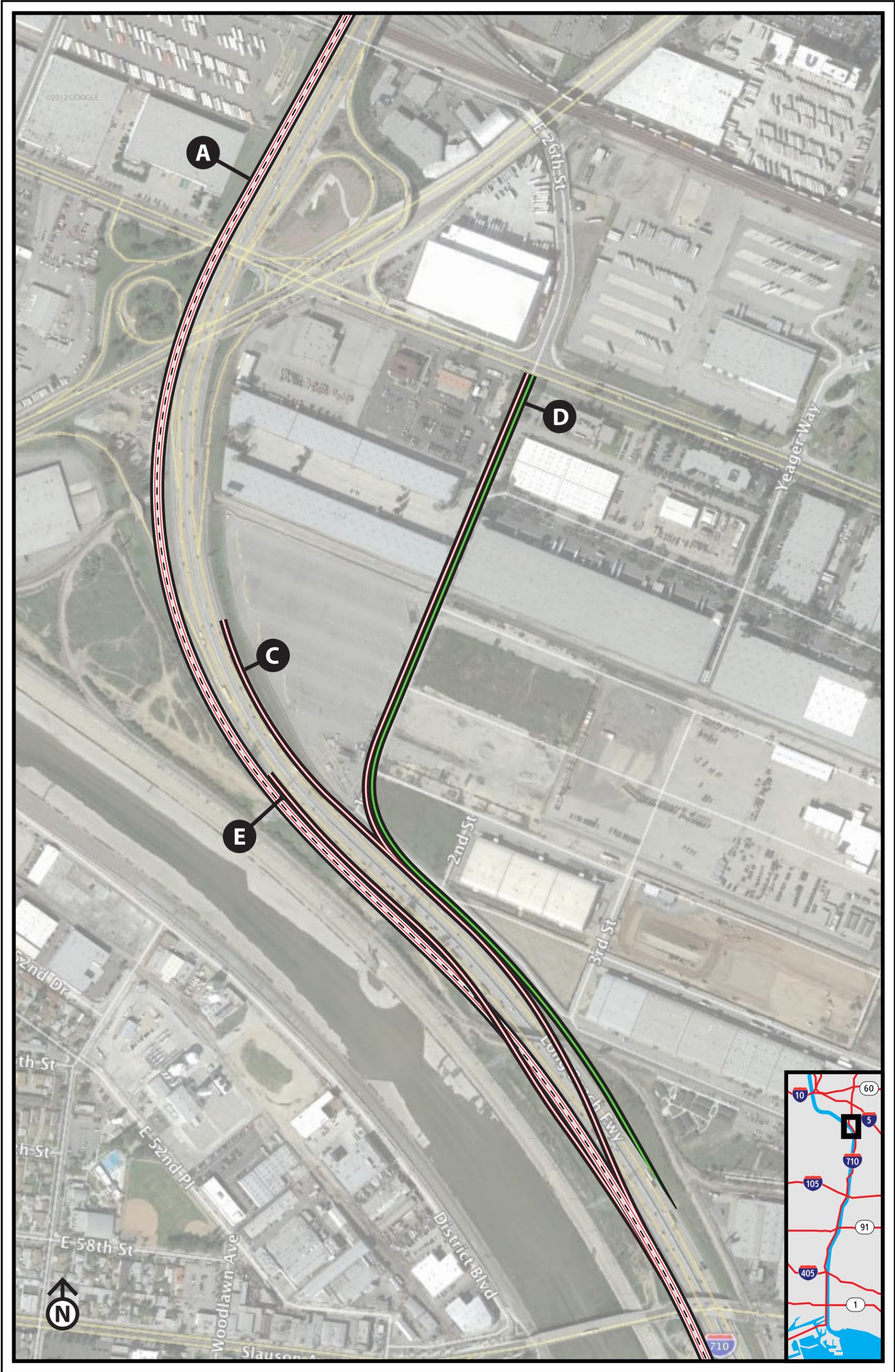
## **Community Alternative 7**



 Mandatory Zero-Emission Freight Corridor

0' 200' 400'  
 Scale: 1" = 400'

*I-710 Corridor Project* • **Community Alternative 7**



 Mandatory Zero-Emission Freight Corridor

 General Purpose Ramp

0' 200' 400'  
 Scale: 1" = 400'

**I-710 Corridor Project • Community Alternative 7**

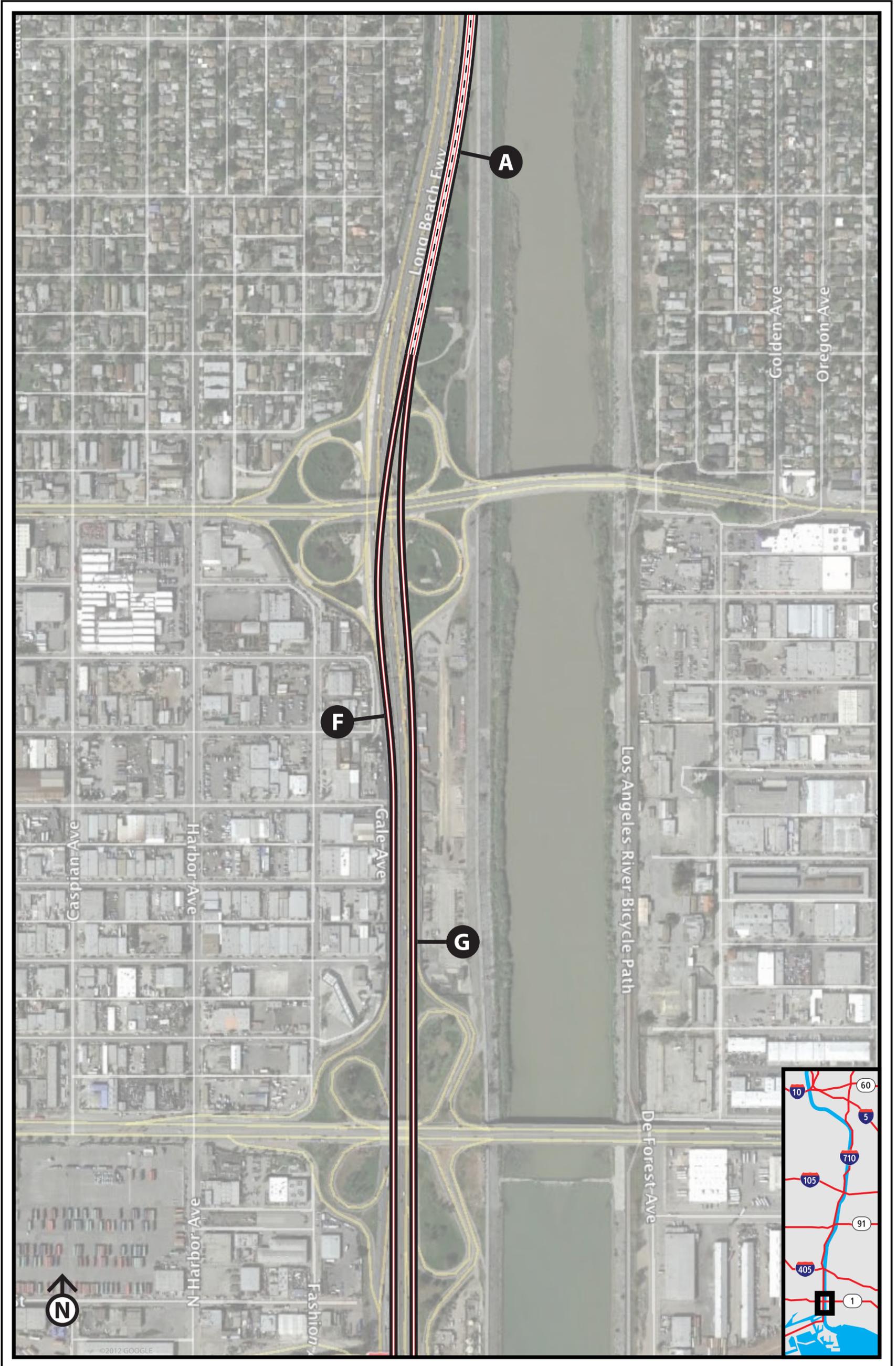


 Mandatory Zero-Emission Freight Corridor

Appendix 1 – Sheet 3 of 4

 Scale: 1" = 400'

**I-710 Corridor Project • Community Alternative 7**



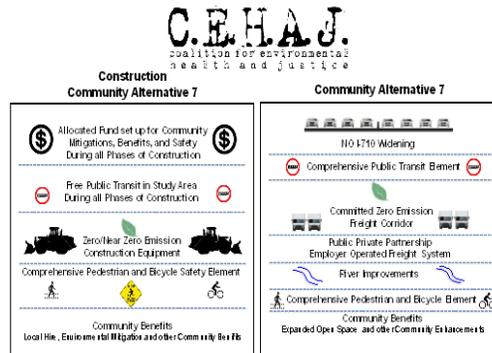
 Mandatory Zero-Emission Freight Corridor

0' 200' 400'  
 Scale: 1" = 400'



# I-710 Corridor Project

## Construction Community Alternative 7



### CCA7 Construction Community Alternative 7 Description

First and foremost, the Interstate 710 (I-710) Corridor is a community of residents. For decades, this area has been identified as an Environmental Justice community because it is comprised of vulnerable populations, including a majority people of color. With the rise of freight movement over the last several decades in Southern California, these communities have been exposed to high levels of toxins due to the industrial landscape and geography related to the Goods Movement industry and the I-710 freeway. While we acknowledge that the I-710 freeway is a vital transportation artery, linking the Ports of Los Angeles and Long Beach (POLA and POLB) to Southern California and the nation's logistic and Goods Movement system, it is also a major source of toxic exposure due the high use of diesel trucks servicing the Ports, rail yards and warehousing businesses. Along with the impacts mentioned above, the cumulative impacts from construction equipment, pollution emissions (noise, air etc.) and impacts from traffic delays, detours and safety issues are addressed here.

The Construction Community Alternative 7 details the elements and components developed to ensure community benefits and protections during all phases of construction.

The Construction Community Alternative 7 is as follows:

- 1) Allocated funds for mitigation, safety and outreach
- 2) Free Public Transit Program
- 3) Zero-Emission/Near Zero-Emission Construction Equipment
- 4) Comprehensive Pedestrian and Bicycle Safety Element
- 5) Community Benefits

### **CCA7.1 Mitigation Funding, Safety and Outreach**

Construction of the 710 Corridor Project will have serious air quality and related public health and safety impacts on surrounding communities. These impacts must be fully mitigated. CALTRANS must allocate sufficient funds to support all mitigation, safety and outreach programs during construction. CALTRANS must commit to an annual budget for fulfilling this program up to the completion of the project.

### **CCA7.2 Free Public Transit program**

During the construction phase of Community Alternative 7, Caltrans, by way of Metro, should provide free rides on the Metro Blue Line, and make additional Metro Bus Lines free when the I-710 will be closed for demolition and construction work. Metro will select bus lines for free fares that operate on major I-710 Corridor arterials in areas most affected by the closure. Free rides on the selected bus lines are intended to help mitigate congestion during the construction of the project. Regular fares will apply for all other bus and rail lines during the closure periods. Metro will also add buses and rail cars to enhance service on the bus and rail lines serving the area affected by the I-710 closure.

- Blue line will operate larger trains with 10-minute frequencies throughout the construction period.
- On the Metro Blue Line, all trains will operate with two cars. In addition to regular weekend 15-minute daytime and 20-minute night service, additional trains and capacity will be added to provide overall 10-minute service throughout the day.
- Blue Line will operate extended hours all days of the week.
- Express buses will be added to the study area from and to transit centers throughout the corridor.

Metro will closely monitor traffic congestion on all routes in the I-710 construction area and will make needed adjustments to bus service based on the current traffic conditions. Transit patrons should, however, anticipate longer trip times to reach their destinations and plan accordingly.

The Interstate 710 Freeway will be frequently closed throughout the construction project period. Therefore, the Metro Board of Directors should authorize the fare-free operation of the Blue Line subway and select busways that operate on major I-710 corridor streets during the construction period, to give inconvenienced motorists an option to driving between the Ports of Los Angeles and Long Beach and destination throughout the corridor. Metro should further determine what other Metro services should operate fare-free during the construction period. Even if motorists utilize park-ride lots in surrounding areas of the 710 corridor to access the Blue Line, they will still be charged a fare when they transfer from the Blue Line to local bus service.

Metro should extend fare-free operation during the I-710 construction period to those Metro local and Rapid bus lines which connect to the Blue Line and in major routes along the 710 corridor.

### **CCA7.3 Zero/Near Zero Emission Construction Equipment**

All construction equipment, engines and vehicles must meet the cleanest standards available. Air quality and related public health impacts from construction of a project of this magnitude are very serious and must be fully mitigated. The Port of Los Angeles or LA Metro clean construction policies should be implemented throughout the duration of this project for all off-road construction equipment, trucks and diesel generators. All other best practices from these model policies must also be implemented, such as special consideration and notification for nearby sensitive sites like schools.

#### Equipment Requirement

Construction equipment—on-road and off-road—used in its construction activities must be green and less polluting. In addition:

1. Idling should be restricted to a maximum of 5 minutes
2. Construction equipment shall meet the following specifications
  - a. Utilize a US EPA Tier 4 off-road engine; or
  - b. Utilize a US EPA Tier 3 off-road engine outfitted with a Level 3 diesel emissions control strategy, as defined by California Air Resources Board (CARB) (e.g. a diesel particulate filter),
3. All trucks full and empty or hauling material shall be fully covered to avoid release of dust particles
4. On road-equipment shall meet current EPA on road standards

#### Generators

Generators shall utilize grid-based electric power where feasible. If the power grid is not accessible, on-site generators must meet a 0.01-gram brake-horsepower-hour standard for PM or be equipped with BACT for PM emissions reductions.

The following Best Management Practices shall be implemented to the maximum extent feasible in addition to the requirements above.

- Maintain equipment according to manufacturers' specifications;
- Minimize all unnecessary idling of construction equipment and on-road heavy-duty trucks;
- Maintain a buffer zone that is a minimum of 1,000 feet between truck traffic and sensitive receptors;
- Work with local jurisdictions to improve traffic flow by signal synchronization;
- Configure construction parking to minimize traffic interference;
- Enforce truck parking restrictions, where applicable;

- Prepare haul routes that conform to local requirements to minimize traversing through congested streets or near sensitive receptor areas;
- Provide dedicated turn lanes for movement of construction trucks and equipment, on- and off-site;
- Schedule construction activities that affect traffic flow on the arterial system to off-peak hours; and
- Limit traffic speeds on all unpaved roads to 15 mph or less.

#### Independent Third Party Monitor

Compliance with requirements of this section should be monitored by an Independent Third Party Monitor.<sup>1</sup>

#### **CCA7.4 Comprehensive Pedestrian and Bicycle Safety Element**

During construction, pedestrian and bicycle safety must be elevated to a top priority. CALTRANS must develop a plan to secure safe walking conditions to prevent pedestrian and bicycle injuries. There are several objectives that CALTRANS should address to improve pedestrian safety and mobility in and around construction zones, including: reducing the speed of vehicles, reducing pedestrian risks at street crossing locations, providing sidewalks and walkways separate from motor vehicle traffic at all construction zones, and improving awareness of and visibility between vehicles and pedestrians. CALTRANS must consult with local governments to conform with pedestrian and bicycle safety plan, safe routes to schools and local concerns.

#### **CCA7.5 Community Benefits**

Construction of the project will cause disruption of local traffic patterns and access to residences and businesses, increased traffic congestion, and increased noise, vibration, dust and air pollution. During the construction of the project there will be negative impact to parks and recreation facilities and limits

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<sup>1</sup> The Independent Third Party Monitor would report to CALTRANS and the CCOG and public. Reports should include, but not be limited to, construction-related equipment, and summary of any reports of violations. Any member of the public may register a complaint with an Independent Third Party Monitor, alleging any entity's noncompliance with requirements of this Agreement, and the Independent Third Party Monitor shall investigate all complaints and determine where there has been a violation. Records or summaries of complaints to the Independent Third Party Monitor, and actions and determinations of it, shall be made available to the public upon request. CALTRANS shall require entities subject to requirements of this Agreement to provide records to the Independent Third Party Monitor sufficient for the Independent Third Party Monitor to determine compliance with requirements of this agreement. CALTRANS shall not select as an Independent Third Party Monitor any person or entity that has a contractual relationship with CALTRANS, Metro or GCCOG. This program should include policies consistent with the enforcement, reporting and definitions within LA Metro's policy.

on pedestrian and bicycle access points to regional and local trails and bikeways (including the Los Angeles River Trail). Construction of the project will, thus clearly affect local environmental justice populations. Due to these impacts on the corridor communities, the following mitigation measures are necessary at minimum for the project to move forward.

#### Residential and School Noise Mitigation

*Funding of Noise Mitigation Program:* CALTRANS shall fund its Noise Mitigation Program at least at \$10 million per year.

*Acceleration of Noise Mitigation Programs:* Within eight months of the effective date of the first freeway agreement, CALTRANS will provide a written schedule and work program to achieve completion of a soundproofing program before construction and will take all reasonable steps to timely implement that schedule and work program.

*Acceleration of Noise Mitigation of Schools:* CALTRANS shall accelerate the program of soundproofing schools within eight months of the effective date of the first freeway agreement; CALTRANS shall conduct a needs assessment for this program. CALTRANS shall provide annual reports on the progress of the program.

*Near Freeway Soundproofing:* Before construction, CALTRANS shall commence a distance soundproofing program, under which, if any residence on a particular city-block falls within the applicable noise contour for that block, then each residence on that block will be eligible for noise mitigation as described in this Section. Soundproofing under this program shall reduce interior noise at participating residences to an interior level of 30 decibels or less, within habitable rooms.

#### Residential and School Air Pollution Mitigation

*Funding of Air Pollution Mitigation Program:* CALTRANS shall fund its Air Pollution Mitigation Program at least at \$10 million per year.

*Acceleration of Air Pollution Mitigation Programs:* Within eight months of the effective date of the first freeway agreement, Caltrans will provide a written schedule and work program to achieve completion of an Indoor Air Filtration program before construction and will take all reasonable steps to timely implement that schedule and work program.

*Acceleration of Air Pollution Mitigation of Schools:* CALTRANS shall accelerate the program of Air Filtration of school facilities within eight months of the effective date of the first freeway agreement, CALTRANS will ensure soundproofing under this program reduces interior noise in classrooms to an interior level of 35 decibels or less. CALTRANS shall provide annual reports on the progress of the program.

*Near Freeway Air Filtration:* Before construction, Caltrans shall commence a distance Air Filtration program, under which, if any residence is within 500 meters from the highway or major arterials altered by this project.

#### Outreach, Communication and Compliance

*Community Outreach and Response Program:* CALTRANS shall fund its Community Outreach and Response Program at least at \$200,000 a year for the life of the projects construction. Community Outreach and Response is a informational, complaint and compliance program which targets the residents of the project study area. The program provides notification to local residents about potential public health risks and nuisances in the corridor as a result of the construction of the project. The Community Outreach and Response Program consultants will act as a liaison between CALTRANS and the community through collaboration to address needs, resource and information related to the projects impacts to the community. The consultants will cooperate and communicate with multiple agencies to ensure community needs are met.

#### Job training, workforce development and targeted hire

*Job Training Program:* CALTRANS shall provide \$3 million per year for the life of the project construction, to fund job trainings, and for Pre-apprenticeship Programs. Any funds unspent in a particular year shall be rolled over to the subsequent year. At the conclusion of the last year of the project any unused funds shall revert to the job training fund of related to the project job training program.

*Work Experience Programs:* CALTRANS shall be responsible for the fulfillment of Work Experience Programs, which provide work experience jobs and pay applicable wages. CALTRANS shall, to the extent permissible by law, specifically target opportunities for placement in these work experience programs to Project Impact Area and or Targeted Worker.

*Eligibility:* Enrollment opportunities in all-job training programs funded primarily by funds distributed under this Section shall be predominantly made available to:

- Low-Income Individuals living in the Study Area for at least one year;
- Special Needs Individuals;
- Low-Income Individuals residing in the Study Area or,
- Targeted Worker

*Content of Job Training:* Job training programs funded by funds distributed under this Section shall include job readiness programs, skills development, career ladder programs, incumbent worker training, and other, similar programs.

*Targeted Workers:* Targeting hiring measures are national in scope and will utilize Targeted Workers to meet the hiring goals. Targeted Workers means an individual whose primary place of residence is within an Economically Disadvantaged Area or an Extremely Economically Disadvantaged Area in the United States, or a Disadvantaged Worker.

CALTRANS shall ensure that the following targeted hiring requirements are met for the project, as follows:

- A minimum of 40% of all hours of Project Work shall be performed by Targeted Workers, with priority given to residents of Extremely Economically Disadvantaged Areas. For any hour of Project for which CALTRANS seeks to meet these requirements, CALTRANS must first refer residents of Extremely Economically Disadvantaged Areas. After CALTRANS has exhausted the available pool of residents of Extremely Economically Disadvantaged areas, they may refer any Targeted Workers.
- A minimum of 10% of all hours of Project Work shall be performed by Disadvantaged Workers.
- A minimum of 20% of total work hours on each project will be performed by apprentices. Targeted Workers will perform 50% of all apprenticeship hours worked on a Project.

#### Health Study

*Health Study:* Caltrans shall fund a study to measure and investigate upper respiratory system and freeway related health impacts from the 710 due to the projects construction. CALTRANS shall develop a scope of work and objectives for the Health Study. The resulting scope of work and objectives for the Health Study shall be incorporated into the RFP for selection of a contractor to perform the Health Study. Within one year of the effective date of the first freeway agreement, CALTRANS shall proceed with the Health Study.

*Review of Protocols and Interim Reporting:* CALTRANS shall require that the contractor selected to conduct the Health Study submit proposed protocols to CALTRANS. Within 30 days of receipt of the proposed protocols, CALTRANS shall provide them to the public. CALTRANS shall report semiannually to the public.

*Reports:* CALTRANS shall require the selected contractor to provide written annual progress reports to CALTRANS. CALTRANS shall promptly forward these reports to the Gateway Cities COG. Within 15 days of completion of the Health Study, CALTRANS shall provide the Health Study to the GC COG and make it available to the public.

#### Minority business enterprise, women business enterprise and small business utilization and retention program

CALTRANS shall coordinate with relevant business advocacy and assistance organizations to initiate a program to increase participation in the planning, construction, operation and maintenance of the project by Study Area small businesses and minority-owned business enterprises and women-owned business enterprises (MBE/WBE). A goal of this program will be the utilization of MBE/WBE as CALTRANS Contractors in these areas, by CALTRANS in

planning, design, financing, construction and all other projects of the construction of the Project. This program shall include:

- Targeted outreach within the project to small businesses, Project Study Area disadvantaged businesses, and relevant business organizations in pre-bid conferences;
- Inclusion of small businesses, Project Study Area disadvantaged businesses, and relevant business organizations in pre-bid conferences;
- “Meet the General Contractor” meetings for small businesses and disadvantaged businesses;
- Unbundling of construction projects into bid sizes that will allow small businesses level competition, without restricting the project timelines;
- Assistance with access to bonding, insurance, procurement and other types of capacity-related assistance where necessary.

CALTRANS will ensure that there is no discrimination against small businesses and disadvantaged businesses in selection of businesses to operate, locate a franchise, or provide services On-Site.

CALTRANS, in coordination with relevant small business assistance/finance organizations, shall assist to identify and/or develop a low-interest working capital revolving loan program to assist small businesses and disadvantaged businesses seeking to perform work related to the project.

#### Miscellaneous

*Implementation Meetings:* To facilitate implementation of this Agreement, address concerns, and ensure an ongoing dialogue between CALTRANS and interested parties shall have regular Implementation Meetings. During the first twelve months after the effective date of this Agreement, implementation meetings shall be held on a monthly basis. After that time period, implementation meetings shall be held every other month. CALTRANS shall ensure that at least one deputy executive director and one other management-level CALTRANS staff member attend each implementation meeting. At implementation meetings either the interested parties or CALTRANS may raise any issue regarding implementation of this Agreement for discussion. These meetings shall provide an opportunity for the interested parties to voice concerns about CALTRANS activities related to this Agreement.

# **ATTACHMENT B**



*Via U.S. Mail and Email*

September 28, 2012

Ronald Kosinski  
Caltrans District 7, Division of Environmental Planning  
100 South Main Street, MS 164  
Los Angeles, CA 90012  
ron\_kosinski@dot.ca.gov

**RE: LEGAL/TECHNICAL COMMENTS ON I-710 EXPANSION PROJECT**

Dear Mr. Kosinski:

On behalf of the Coalition for Environmental Health and Justice (“CEHAJ”) and its individual members, we write to provide comments on the I-710 Draft Environmental Impact Report/Environmental Impact Statement and Section 4(f) Evaluation (“DEIR/S”). We appreciate the opportunity to provide comments on the DEIR/S. Given the inevitable regional and acute local impacts of the proposed project, it is especially important that the DEIR/S contain the necessary analysis to enable both the decision makers and the public to understand the significant environmental repercussions of the Project and prescribe mitigation measures to address significant impacts. Unfortunately, the current DEIR/S fails to include this necessary analysis as identified in this comment letter and the technical reports commissioned by various CEHAJ members. In addition to providing significant critiques of the DEIR/S below, CEHAJ proposes a solution, Community Alternative 7, which can allow growth to occur, while protecting the community.

After our careful review, we have concluded that the DEIR/S fails in many respects to comply with the requirements of the California Environmental Quality Act (“CEQA”) and the National Environmental Policy Act (“NEPA”). As a result of the DEIR/S’s inadequacies, there can be no meaningful public review of the Project. CEQA and NEPA accordingly require the California Department of Transportation (“Caltrans”) to prepare and circulate a revised DEIR/S which will permit a complete understanding of the environmental issues at stake.

**I. Overview of Project.**

As one of the largest transportation infrastructure projects in the nation, this Project seeks to add six additional lanes to an eight-lane highway in a dense urban area. In an attempt to expand to accommodate freight expansion in the region, the project imposes far ranging impacts on a population that is primarily working class communities of color. Along the way, the project will impact and eliminate parks in a park-deprived area of Los Angeles, impact vital services for homeless populations and seniors with disabilities, and impose far ranging impacts from noise, air pollution, and water pollution.

Through an extensive stakeholder process, commenters have proposed an alternative which could resolve these impacts.

## **II. Alternative 7—Community Preferred Alternative.**

Both State and Federal law make it clear that a robust alternatives analysis is the “heart” of the EIS or EIR.<sup>1</sup> As a result, a strong alternatives analysis is a crucial component for compliance with CEQA/NEPA. Indeed, NEPA mandates that alternatives must be explored in depth and with the same level of detail as the proposed action.<sup>2</sup> This DEIR/S, however, screened out alternatives that would meet the project objective before giving them the deep and detailed analysis required by law. Specifically, the DEIR/S dismisses many alternatives to the addition of general purpose lanes and expanding single-passenger automobile use. Chapter IV of the DEIR/S articulates the purported basis for rejecting alternatives that do not expand the general purpose lanes as proposed in Alternative 5A, 6A, 6B, and 6C.

CEHAJ has prepared a robust technical document describing a build alternative—Community Alternative 7—that meets all of the proposed project objectives and dramatically reduces negative impacts on the project corridor’s residents and businesses. A complete description of the Community Alternative 7 is set out in Attachment A to this letter. In addition East Yard Communities for Environmental Justice (“EYCEJ”) and the Natural Resources Defense Council (“NRDC”) commissioned a technical report of transportation and air quality for the I-710 Draft Environmental Impact Report, which is Attachment C.<sup>3</sup> Finally, EYCEJ commissioned a technical report on potential pedestrian and bicycle enhancements that would enhance mobility and safety in the project area, which is Attachment D.<sup>4</sup> We incorporate each of these Attachments by reference as if set out in full in these comments.

Here, CEHAJ provides only a brief overview of the seven components of Community Alternative 7 and explains how each serves to meet the project’s objectives of: (1) Improving air quality and public health; (2) Improving traffic safety; (3) Modernizing freeway design; (4) Accommodating Projected Traffic Volumes; and (5) Addressing increased traffic volumes

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<sup>1</sup> 40 C.F.R. § 1502.14; *see also Monroe County Conservation Council, Inc. v. Volpe*, 472 F.2d 693, 697-98 (2d. Cir. 1972), (“The requirement for a thorough study and a detailed description of alternatives...is the linchpin of the entire impact statement.”); Cal. Pub. Res. Code § 21002; 14 Cal. Code Regs. § 15126.6 (hereinafter “CEQA Guidelines”).

<sup>2</sup> *See* 40 C.F.R. § 1502.14 (a) and (b); *see also* Forty Most Asked Questions Concerning CEQ’s National Environmental Policy Act Regulations, 46 Fed. Reg. 18026 (Mar. 23, 1981), (“The degree of analysis devoted to each alternative in the EIS is to be substantially similar to that devoted to the “proposed action.””).

<sup>3</sup> *See* Sustainable Systems Research, LLC, Technical Memorandum: Review of Transportation and Air Quality Analysis in the I-710 Draft Environmental Impact Report Traffic and Air Quality Report, (hereinafter “Traffic & Air Quality Report,” or “TAQR”), attached as Attachment C.

<sup>4</sup> *See* Memo from Livable Communities, Inc., to East Yard Communities for Environmental Justice, attached as Attachment D.

resulting from projected growth in population, employment, and economic activities related to goods movement.<sup>5</sup> Community Alternative 7 calls for the following:

- 1) No Widening of I-710 (No Additional General Purpose Lanes);
- 2) A Comprehensive Public Transit Element;
- 3) Adding a Mandatory Zero-Emission Freight Corridor;
- 4) Establishing a Public Private Partnership to operate a “Freight Corridor System”;
- 5) Incorporating River Improvements into the project;
- 6) Completing a Comprehensive Pedestrian and Bicycle Element; and
- 7) Ensuring Community Benefits.

### *Improving Air Quality and Public Health*

Community Alternative 7 improves air quality and public health by, most importantly, proposing a **mandatory** zero emission freight corridor. While this entails the addition of 4 dedicated truck lanes, these truck lanes would not contribute to further pollution, and would help reduce pollution (and improve air quality) as existing diesel trucks are replaced by zero-emission freight transport. In addition, other elements of Community Alternative 7 would improve air quality by ensuring access to cleaner modes of transportation like walking, bicycling, and public transit rather than encouraging single-passenger automobile use. Finally, this Alternative promotes enhancing active transportation, safety, green space, and other proposals that would further enhance public health.

### *Improving Traffic Safety*

Community Alternative 7 advances traffic safety by offering dedicated truck lanes thereby separating truck traffic from automobile traffic. In addition, Community Alternative 7 allows for the safety enhancements that are needed along the corridor. Also, unlike the alternatives explored in the DEIR/S, Community Alternative 7 takes a more holistic view of traffic safety to include safety for bicyclists and pedestrians, resulting in, for example, Community Alternative 7’s incorporation of bridges to enable safe passage across the freeway.

### *Modernize Freeway Design*

Community Alternative 7 also modernizes the freeway design in many respects. Notably, it provides a separate corridor for freight transport, thereby modernizing the goods movement system. Many additional modernization components are incorporated in Community Alternative 7’s design in Attachment A.

### *Accommodate Projected Traffic Volumes*

Community Alternative 7 also accommodates projected traffic volumes by adding 4 additional truck lanes to the I-710. In addition, Community Alternative 7 proposes other improvements, like on-dock rail enhancements that will accommodate even more cargo volume.

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<sup>5</sup> DEIR/S, at 1-38 -39.

Despite inclusion of these elements in Community Alternative 7's design, CEHAJ notes its complete skepticism of the DEIR/S's projections of cargo increase to 43 million twenty foot equivalent units ("TEUs"), which is approximately 148% more containers than any port in the world accommodated in 2010.<sup>6</sup> Also, 43 million TEUs is more cargo than North America's top 16 ports **combined** accommodated in 2011.<sup>7</sup> Despite these staggering assumptions about freight growth through the Ports, Community Alternative 7 allows for substantial growth to be accommodated through additional truck lane capacity.

*Address increased traffic volumes resulting from projected growth in population, employment, and economic activities related to goods movement*

This objective is tied to goods movement, which Community Alternative 7 accommodates by proposing four (4) additional zero emission truck lanes are built. Moreover, growth in employment and population will be accommodated by the combination of increased transit and additional capacity allowed from trucks moving from general purpose lanes to new truck lanes.

Community Alternative 7 provides a feasible way forward that allows the freight industry to have the dramatic expansion it desires, while also incorporating technological and common-sense elements to address serious community health and environmental concerns.

### **III. The Proposed Project Will Have an Indelible Impact On Communities and the Region in General.**

Despite other components, this project is being proposed primarily to address significant issues associated with freight transport along the I-710. Of particular importance to CEHAJ, are issues of public health related to the freight movement industry. Most of the equipment used to transport freight, including trucks, trains, ships, and cranes, are powered by diesel engines. These engines emit fine particulate matter (particles that are 2.5 microns or less in diameter or "PM2.5"), nitrogen oxides (NOx), and volatile organic compounds (VOCs) along with many other toxic chemicals. Most of the PM emitted by diesel engines consists of tiny particles, called ultrafines, that are less than 0.1 micron in diameter.

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<sup>6</sup> American Association of Port Authorities, 2010 World Port Rankings, *available at* <http://www.aapa-ports.org/industry/content.cfm?itemnumber=900&navitemnumber=551#Statistics> (noting that Port of Shanghai accommodated 29,069,000 TEUs in 2010).

<sup>7</sup> Those ports and there associated volumes are: Los Angeles (7,940,511), Long Beach (6,061,091), New York/New Jersey (5,503,485), Savannah (2,944,678), Metro Port Vancouver (2,507,032), Oakland (2,342,504), Seattle (2,033,535), Hampton Roads (1,918,029), Houston (1,866,450), Manzanillo (1,762,508), Tacoma (1,485,617), San Juan (1,484,595), Charleston (1,381,352), Montreal (1,362,975), Lazaro Cardenas (953,497), and Honolulu (938,821). American Association of Port Authorities, North America Port Container Traffic Ranking 2011, *available at* <http://www.aapa-ports.org/industry/content.cfm?itemnumber=900&navitemnumber=551#Statistics>

**Health effects of particulate matter:** Numerous studies have documented a wide range of adverse health impacts from exposure to PM, including increased rates of respiratory illness and asthma, cardiovascular disease, heart attacks, strokes, emergency room visits, and premature death.<sup>8</sup> Near-roadway exposure to particulate matter has also been linked to birth defects, low birth weights, and premature births.<sup>9</sup> Emerging studies have shown a potential connection between exposure to fine PM and diabetes, as well as cognitive decline and other serious impacts to the brain.<sup>10</sup>

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<sup>8</sup> Kuenzli, N., M. Jerrett, W.J. Mack, B. Beckerman, L. LaBree, F. Gilliland, D. Thomas, and H.N. Hodis. "Ambient Air Pollution and Atherosclerosis in Los Angeles," *Environmental Health Perspective* 113 (February 2005):201-6.

Miller, K.A., D.S. Siscovick, L. Sheppard, K. Shepherd, J.H. Sullivan, G.L. Anderson, and J.D. Kaufman. "Long-term Exposure to Air Pollution and Incidence of Cardiovascular Events in Women," *New England Journal of Medicine* 1:356 (February 2007):447-58.

Hoffman, B., S. Moebus, S. Mohlenkamp, A. Stang, N. Lehman, D. Dragano, A. Schmermund, M. Memmesheimer, K. Mann, R. Erbel, and K.-H. Jockel. "Residential Exposure to Traffic Is Associated With Coronary Atherosclerosis," *Circulation*, published online July 16, 2007, DOI:10.1161 / CIRCULATIONAHA.107693622.

Pope, C.A., J.B. Muhlestein, H.T. May, D.G. Renlund, J.L. Anderson, and B.D. Horne. "Ischemic Heart Disease Events Triggered by Short-term Exposure to Fine Particulate Air Pollution," *Circulation* 114 (December 5):20062443-8.

Schwartz, J., D. Slater, T.V. Larson, W.E. Person, and J.Q. Koenig. "Particulate Air Pollution and Hospital Emergency Room Visits for Asthma in Seattle," *American Review of Respiratory Disease* 147 (April 1993):826-31.

Jerrett, M., R.T. Burnett, R. Ma, C.A. Pope, D. Krewski, K.B. Newbold, G. Thurston, Y. Shi, N. Finkelstein, E.E. Calle, and M.J. Thun. "Spatial Analysis of Air Pollution and Mortality in Los Angeles," *Epidemiology* 16 (November 2005):727-36.

Mustafic, H., et al. "Main Air Pollutants and Myocardial Infarction: A Systematic Review and Meta-analysis," *JAMA*, February 15, 2012.

Wellenius, G.A., et al. "Ambient Air Pollution and the Risk of Acute Ischemic Stroke," *Archives of Internal Medicine*, Vol. 172, No. 3, February 13, 2012.

<sup>9</sup> Ritz, B., M. Wilhelm, and Y. Zhao. "Air Pollution and Infant Death in Southern California, 1989–2000," *Pediatrics* 118 (August 2000):493-502.

Ritz, B., and M. Wilhelm. "Residential Proximity to Traffic and Adverse Birth Outcomes in Los Angeles County, California, 1994–1996," *Environmental Health Perspectives* 111 (February 2003):207-16.

Wilhelm, M., and B. Ritz. "Local Variations in CO and Particulate Air Pollution and Adverse Birth Outcomes in Los Angeles County, California, USA," *Environmental Health Perspectives* 113 (September 2005):1212-21.

<sup>10</sup> 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, at <http://dx.doi.org>.

Anderson, Z.J., et al. "Diabetes Incidence and Long-Term Exposure to Air Pollution: A Cohort Study," *Diabetes Care*, November 10, 2011; 10.2337/dc11-1155. <http://care.diabetesjournals.org/content/early/2011/11/03/dc11-1155.abstract>.

**Health effects of nitrogen oxides:** NO<sub>x</sub> can have a toxic effect on the airways, leading to inflammation, asthmatic reactions, and worsening of allergies and asthma symptoms.<sup>11</sup> In addition, NO<sub>x</sub> reacts with VOCs in sunlight to form ozone—also known as smog. This layer of brown haze contributes to decreased lung function and increased respiratory symptoms, asthma, emergency room visits, hospital admissions, and premature deaths.<sup>12</sup> Ozone can also cause irreversible changes in lung structure, eventually leading to chronic respiratory illnesses, such as emphysema and chronic bronchitis.<sup>13</sup>

**Health effects of diesel exhaust:** The soot in diesel exhaust—diesel PM—is especially toxic, not only because of the very small size of the soot particles (*see above*), but also because these particles contain roughly 40 different toxic air contaminants, 15 of which are recognized carcinogens.<sup>14</sup> In fact, diesel PM itself has been identified as a carcinogen (cancer-causing agent) by the World Health Organization as well as the State of California,<sup>15</sup> which lists it as a

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Calderón-Garcidueñas, L., et al. “Neuroinflammation, Hyperphosphorylated Tau, Diffuse Amyloid Plaques, and Down-Regulation of the Cellular Prion Protein in Air Pollution Exposed Children and Young Adults,” *Journal of Alzheimer’s Disease*, Vol. 28, No. 1, 2012. Available at: <http://iospress.metapress.com/content/vux3g01201610607/?p=2437bdf11554408d8cc9060c28d77f1c&pi=82>.

Weuve, J., et al. “Exposure to Particulate Air Pollution and Cognitive Decline in Older Women,” *Archives of Internal Medicine*, Vol. 172, No. 3, February 13, 2012.

<sup>11</sup> Davies, R.J., C. Rusznak, M.A. Calderon, J.H. Wang, M.M. Abdelaziz, and J.L. Devalia. “Allergen-Irritant Interaction and the Role of Corticosteroids,” *Allergy* 52, (Suppl. 38) (1997):59–65.

Davies, R.J., C. Rusznak, and J.L. Devalia. “Why Is Allergy Increasing?—Environmental Factors,” *Clinical & Experimental Allergy* 28, (Suppl. 6) (1998):8–14.

<sup>12</sup> U.S. Environmental Protection Agency. *Provisional Assessment of Recent Studies on Health and Ecological Effects of Ozone Exposure*, Washington, D.C., EPA/600/R-09/101, 2009.

<sup>13</sup> Hodgkin, J.E., D.E. Abbey, G.L. Euler, and A.R. Magie. “COPD Prevalence in Nonsmokers in High and Low Photochemical Air Pollution Areas,” *Chest* 86 (1984):830-838.

Abbey, D.E., F. Petersen, P.K. Mills, and W.L. Beeson. “Long-term Ambient Concentrations of Total Suspended Particulates, Ozone, and Sulfur Dioxide and Respiratory Symptoms in a Nonsmoking Population,” *Archives of Environmental Health* 48 (1993):33–46.

<sup>14</sup> Diesel exhaust contains the following toxic constituents: acetaldehyde, acrolein, aniline, antimony compounds, arsenic, benzene, beryllium compounds, biphenyl, bis[2-ethylhexyl]phthalate, 1,3-butadiene, cadmium, chlorine, chlorobenzene, chromium compounds, cobalt compounds, cresol isomers, cyanide compounds, dioxins and dibenzofurans, dibutylphthalate, ethyl benzene, formaldehyde, hexane, inorganic lead, manganese compounds, mercury compounds, methanol, methyl ethyl ketone, naphthalene, nickel, 4-nitrobiphenyl, phenol, phosphorus, POM including PAHs and their derivatives, propionaldehyde, selenium compounds, styrene, toluene, xylenes.

[www.oehha.ca.gov/public\\_info/facts/dieselfacts.html](http://www.oehha.ca.gov/public_info/facts/dieselfacts.html);

[www.oehha.ca.gov/air/toxic\\_contaminants/html/Diesel%20Exhaust.htm](http://www.oehha.ca.gov/air/toxic_contaminants/html/Diesel%20Exhaust.htm).

<sup>15</sup> [www.oehha.ca.gov/prop65/prop65\\_list/files/P65single021712.pdf](http://www.oehha.ca.gov/prop65/prop65_list/files/P65single021712.pdf);

[http://press.iarc.fr/pr213\\_E.pdf](http://press.iarc.fr/pr213_E.pdf).

“Toxic Air Contaminant.” Dozens of studies have shown a high risk of lung cancer for those in occupations with high diesel exposures, including rail workers, truck drivers, and miners. Recent studies of miners indicate that the most heavily exposed workers have a risk of lung cancer approaching that of heavy smokers; studies also show that elevated risks of lung cancer apply not only to workers but to the general population in areas with high levels of diesel PM (e.g., near freeways and busy freight corridors).<sup>16</sup> Moreover, diesel pollution is estimated to contribute to more than half of the 9,200 premature deaths attributable to outdoor air pollution in California.<sup>17</sup>

People who live or go to school near ports, rail yards, distribution centers, freight roadways and other diesel “hot spots” face disproportionate exposure to diesel exhaust and associated health impacts, including increased risks of asthma and other respiratory effects, cancer, adverse birth outcomes, adverse impacts to the brain (including potentially higher risk of autism), heart disease, and premature death.<sup>18</sup>

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<sup>16</sup> Silverman, D.T., et al. “The Diesel Exhaust in Miners Study: A Nested Case-Control Study of Lung Cancer and Diesel Exhaust,” *Journal of the National Cancer Institute*, Vol. 104, No. 11, June 6, 2012,

[www.oxfordjournals.org/our\\_journals/jnci/press\\_releases/silvermandjs034.pdf](http://www.oxfordjournals.org/our_journals/jnci/press_releases/silvermandjs034.pdf).

<sup>17</sup> Personal communication, Alvaro Alvarado, California Air Resources Board, March 2012.

<sup>18</sup> 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.

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

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.

Appatova, A.S., et al. “Proximal Exposure of Public Schools and Students to Major Roadways: A Nationwide U.S. Survey,” *Journal of Environmental Planning and Management* 2008; 51(5):631-646.

Nicolai, T., D. Carr, S.K. Weiland, H. Duhme, O. Von Ehrenstein, C. Wagner, and E. von Mutius. “Urban Traffic and Pollutant Exposure Related to Respiratory Outcomes and Atopy in a Large Sample of Children,” *European Respiratory Journal* 2003;21:956–963.

Brunekreef, B.; N.A. Janssen, J. de Hartog, H. Harssema, M. Knape, and P. van Vliet. “Air Pollution From Truck Traffic and Lung Function in Children Living Near Motorways,” *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.

Gauderman W.J., et al. “Childhood Asthma and Exposure to Traffic and Nitrogen Dioxide,” *Epidemiology* 2005; 16:737-743.

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.

Residents along the I-710 will undoubtedly face additional impacts as a result of the construction and operation of this project. Throughout the public process for this Project, several health studies have been submitted that should be evaluated in improving the DEIR/S.

Moreover, in addition to the huge impacts on residents and workers closest to the sources of emissions, freight operations pose a particularly acute threat to regional air quality. The South Coast Air Basin (“SCAB”), where the project area is located, consistently ranks near the top of the lists for the nation’s most polluted air. Freight transport, including the operations at the Ports, greatly contributes to the persistent failure of the SCAB to meet clean air standards established by EPA. In fact, the South Coast Air Quality Management District has determined that freight movement poses a seriously risk to attainment of air quality standards.

The ports of Los Angeles and Long Beach are the largest in the nation in terms of container throughput, and collectively are the *single largest fixed sources of air pollution* in Southern California. Emissions from port-related sources, such as marine vessels, locomotives, trucks,

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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.

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.

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.

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.

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

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.

van Vliet et al.. Motor exhaust and chronic respiratory symptoms in children living near freeways. *Environmental Research* 1997; 74:12-132.

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.

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.

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

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.

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

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.

harbor craft and cargo handling equipment, adversely affect air quality in the local port area as well as regionally. Without substantial control of emissions from port-related sources, it will not be possible for this region to attain federal ambient air quality standards for ozone or PM2.5. Port sources also contribute to cancer risks.<sup>19</sup>

As the major truck artery to the Ports of Los Angeles and Long Beach, this project must be done in a manner that does not interfere with attainment of federal and state air quality air standards, in addition to localized health threats.

#### **IV. The DEIR/S's Project Description is Inadequate.**

The DEIR/S's Project Description fails to address numerous Project features. These omissions skew the DEIR/S's analysis of impacts and, thereby, undercut the validity of the entire document under CEQA and NEPA. Without a complete and accurate project description, an agency and the public cannot be assured that all of a project's environmental impacts have been revealed and mitigated. "An accurate, stable and finite project description is the *sine qua non* of an informative and legally sufficient EIR."<sup>20</sup> A complete project description is indispensable because "[a] curtailed or distorted project description may stultify the objectives of the reporting process."<sup>21</sup>

Notably, the DEIR/S's discussion of the need for the Project is circular. On the one hand, Caltrans contends that it cannot accommodate projected growth without expansion.<sup>22</sup> On the other hand, long-term forecasts didn't take into account capacity limitations of infrastructure.<sup>23</sup> In sum, Caltrans relies on forecasts that assume new infrastructure but then justifies the new infrastructure to accommodate the forecasted growth. Caltrans cannot have it both ways. The revised DEIR/S should include demand forecasts under existing conditions to provide a true picture of forecasted growth under the No Build Alternative.

The Project Need section also uses inflated numbers to promote the need for this project. In particular, the DEIR/S states:

Population in the Gateway Cities Subregion is expected to grow from 2,124,000 in 2008 to 2,364,000 in 2035, an increase of approximately 11 percent. Employment in this Subregion is expected to grow from 756,000 in 2008 to 818,000 in 2035, an increase of approximately 8 percent.<sup>24</sup>

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<sup>19</sup> SCAQMD, Revised Draft 2012 Air Quality Management Plan, at IV-A-37, available at <http://www.aqmd.gov/aqmp/2012aqmp/RevisedDraft/appIV-A.pdf> (emphasis added).

<sup>20</sup> *County of Inyo v. City of Los Angeles*, 71 Cal. App. 3d 185, 192-93 (1977).

<sup>21</sup> *Id.* at 199; see also *San Joaquin Raptor/Wildlife Center v. Stanislaus County*, 27 Cal.App.4th 713, 730 (1994), ("An accurate project description is necessary for an intelligent evaluation of the potential environmental effects of a proposed activity.")

<sup>22</sup> DEIR/S, at 1-8, 1-9, and 1-10.

<sup>23</sup> *Id.*

<sup>24</sup> DEIR/S, at 1-8.

As articulated in the critique of the traffic section below, these estimates are inflated, which taints the project need. A revised articulation of growth based on the projections from the 2012 Regional Transportation Plan (“RTP”) needs to be used, which showed dramatically lower growth than projected in the 2008 RTP.

Finally, the Project Description is also deficient because it fails to articulate the entire project. Specifically, it is our understanding that several interchanges and arterials will be modified from this project, yet they are not listed in the Project Description.<sup>25</sup>

**V. The DEIR/S Provides Inadequate Analysis of and Mitigation For the Project’s Traffic Impacts.**

Overall, the traffic analysis has myriad flaws that preclude effective and informed decision-making. The Traffic & Air Quality Report details many of these flaws, and the critiques from that report are incorporated in their entirety by reference. Overall, the traffic analysis is presented in a deceptive manner that is internally inconsistent and inflates growth estimates. This results in a skewed view of the benefits and impacts from the various alternatives.

**a. The Overstated Population Estimates Used in Modeling Inflate Project Benefits.**

The DEIR/S concludes that:

Regional population is forecast to grow by 27 percent and Study Area population is forecast to grow by 11 percent from 2008 to 2035. Employment will follow a similar pattern, with regional growth of 27 percent and Study Area employment growth of 7 percent. Growth will be lower in the Study Area than in the SCAG region because the Study Area is almost completely developed. New growth will be limited to smaller, infill-type developments. Table 1.2-3 summarizes forecasted population and employment growth from the 2008 RTP [Regional Transportation Plan] for the entire SCAG region and for the Study Area. The 2008 RTP growth forecast was the basis for the regional traffic modeling that was performed for the I-710 Corridor Project. Compared to the 2008 RTP growth forecast, the 2012 RTP growth forecast for population and employment by 2035 is about 9 percent lower (i.e., the 2012 RTP projects a population of 22.1 million people and 9.4 million jobs in the SCAG region by 2035).<sup>26</sup>

Continued use of the inflated 2008 RTP numbers is confirmed by the Travel Demand Modeling Methodology report.<sup>27</sup> As the Traffic & Air Quality report determined:

[t]he assumptions underlying the forecasts of travel demand are directly based on assumptions about future growth in population and goods movement. Any errors in these

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<sup>25</sup> DEIR/S, at 1-7.

<sup>26</sup> DEIR/S, at 1-15.

<sup>27</sup> Traffic & Air Quality Report, at 8.

estimates will propagate through the modeling process and result in errors in traffic volumes by vehicle class on every major link, interchange, and some arterials and intersections in the study area.<sup>28</sup>

Given the availability of more accurate 2012 predictions, more recent growth estimates should have been used in the DEIR/S. Notably, these inflated estimates will impact the analysis of traffic, noise, air quality, and other impacts analyzed in the DEIR/S. And perhaps, most importantly, “use of a higher estimate assures that the performance of the no-build alternative will be poor relative to alternatives that embody capacity expansion and the alternative with the greatest capacity expansion will perform best.”<sup>29</sup> These assumptions are particularly relevant to the justification for the general purpose lanes, which are purportedly provided to accommodate this future growth.

**b. The DEIR/S’s Failure to Include Analysis of Burlington Northern Santa Fe’s Southern California International Gateway Project and Union Pacific’s Intermodal Container Facility Expansion Violates CEQA and NEPA.**

The land use projections for the DEIR/S fail to assume expansion of two near-dock facilities that are currently undergoing environmental review.<sup>30</sup> Instead, the DEIR/S assumes there will be fictional facilities built “somewhere in the Inland Empire or further northeast.”<sup>31</sup> Neither the DEIR/S nor the supporting studies provide a reasoned basis for this assumption. By assuming facilities built further along the I-710, this inflates the amount of trucks projected to travel along the I-710. This also taints the traffic analysis, in addition to impacting the analysis of air quality, noise, and other impacts. In fact, the Draft EIR for the Southern California International Gateway Project was just released, which claims “it is estimated that the project will reduce over 1.3 million truck trips per year between the SCIG project site and the BNSF Hobart/Commerce Yard. This is due to the fact that the trips will occur to SCIG rather than to Hobart/Commerce Yard, thus eliminating the trips on I-710.”<sup>32</sup> Like with the inflated cargo growth projections assumed, the actual placement of freight magnets will play an important role in assessing the need for this project and what alternative is superior. Because the DEIR/S takes a fanciful and unrealistic view of where the intermodal capacity will be located, it must be amended to more adequately inform decision-makers.

**c. The Safety and Level of Service Analysis are Incomplete.**

Commenters agree that safety is an important consideration for this project. But, data cannot be presented in a misleading way. The Traffic & Air Quality Report identifies several

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<sup>28</sup> Traffic & Air Quality Report, at 9

<sup>29</sup> Traffic & Air Quality Report, at 9.

<sup>30</sup> Traffic & Air Quality Report, at 11.

<sup>31</sup> Traffic & Air Quality Report, at 11 (quoting Travel Demand Modeling Technical Memorandum).

<sup>32</sup> Port of Los Angeles, Southern California International Gateway Recirculated Draft EIR, at 3.10-26, available at [http://www.portoflosangeles.org/EIR/SCIG/DEIR/deir\\_scig.asp](http://www.portoflosangeles.org/EIR/SCIG/DEIR/deir_scig.asp).

misleading elements to how safety is measured in the DEIR/S.<sup>33</sup> The safety benefits of any facility modifications must be presented in an unbiased and representative manner to help inform reasoned decision-making.

Likewise, the presentation of Level of Service in the Final EIR is similarly misleading. As the Traffic & Air Quality Analysis points out, the DEIR/S cuts corners in presenting Level of Service (“LOS”) estimates.<sup>34</sup> This should be rectified in a re-circulated DEIR/S

**d. The DEIR/S Failed To Adequately Address Unique and Substantial Pedestrian Bicyclist Issues In the Project Area.**

Federal regulations require that “[t]he safe accommodation of pedestrians and bicyclists should be given full consideration during the development of Federal-aid highway projects, and during construction of such projects.”<sup>35</sup> The regulations also require that “[w]here current or anticipated pedestrian and/or bicycle traffic presents a potential conflict with motor vehicle traffic, every effort shall be made to minimize the detrimental effects on all highway users who share the facility.”<sup>36</sup> Caltrans flouts this duty by dismissively including little in its DEIR/S on this issue.<sup>37</sup> Luckily, EYCEJ commissioned the Bike & Pedestrian Report, enclosed as Attachment D.

Notably, Caltrans includes no analysis of traffic safety related to bicycle and pedestrian accidents in the DEIR/S.<sup>38</sup> By focusing so intently on Ports-related vehicles and automobiles, it has ignored a vital component of circulation in the project area. Moreover, the DEIR/S fails to disclose how many of the modifications that are part of this project will actually make it less safe for cyclists and pedestrians.<sup>39</sup> For example, the project proposes Single Point Urban Interchanges (“SPUIs”), which are dangerous for bicyclists because they create large intersections that don’t provide enough time in one cycle for the majority bicyclists to clear the intersection.<sup>40</sup> It is not proper to simply assert without substantiation that the project will improve conditions for bicyclists and pedestrians.

The Bicycle & Pedestrian Report includes a large array of mitigation that must be considered and adopted with this project.<sup>41</sup> Also, in the Compendium of Attachment J, there are several resources on bicycle and pedestrian infrastructure that should be reviewed in improving this Project.<sup>42</sup> Without these mitigation measures and transportation improvements, the DEIR/S violates federal and state laws.

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<sup>33</sup> Traffic & Air Quality Report, at 41.

<sup>34</sup> Traffic & Air Quality Report, at 42-43.

<sup>35</sup> 23 C.F.R. § 652.5.

<sup>36</sup> *Id.*

<sup>37</sup> DEIR/S, *supra* at note 10, at 3.5-86.

<sup>38</sup> Bike & Pedestrian Report, at 3

<sup>39</sup> Bike & Pedestrian Report, at 4.

<sup>40</sup> Bike & Pedestrian Report, at 4.

<sup>41</sup> Bike & Pedestrian Report, at 4-11.

<sup>42</sup> *See* Compendium of Comments in Attachment J.

## **VI. The Air Quality Analysis and Associated Mitigation Measures Are Inadequate Under CEQA, NEPA and the Clean Air Act.**

### **a. The DEIR/S Fails to Denote its True Impacts on Air Quality**

The DEIR/S fails as an informational document because it provides an overly rosy picture of how this Project fits into the region's ability to comply with federal and state clean air standards. The DEIR/S goes so far as to mislead the public and decision makers about its role in compliance with the Air Quality Management Plan ("AQMP") and State Implementation Plan (SIP). In particular, the DEIR/S states that "Implementation of the SIP will bring the region into conformance with the applicable air quality standards."<sup>43</sup> As described below, the DEIR fails to demonstrate this for federal air quality standards.

As it pertains to California Ambient Air Quality Standards ("CAAQS"), this assertion is incorrect. The resolution accompanying the 2007 AQMP, which the DEIR/S denotes as the applicable attainment plan, articulates that "the South Coast Air Quality Management District is unable to specify an attainment date for state ambient air quality standards for 8-hour ozone, PM2.5, and PM10."<sup>44</sup> Thus, the DEIR/S' assertion about the SIP leading to attainment for the CAAQS is wrong. Further, the DEIR/S contains no analysis of how this Project fits into attainment of federal and state air quality standards. Under CEQA, this is a failure to articulate a potential incompatibility with state CAAQS for ozone, PM2.5 and PM10. Moreover, this failure amounts to a violation of NEPA because an agency must disclose when a project "threatens a violation of Federal, *State*, or local law or requirements imposed for the protection of the environment."<sup>45</sup>

Another fatal flaw of the DEIR/S is that the air quality analysis does not even mention the huge "black box" that the region currently proffers to demonstrate attainment of ozone standards. *See* 42 U.S.C. § 7511A (e)(5). The following chart was presented by the Executive Officer of the South Coast Air Quality Management District at a recent workshop on SIP compliance.<sup>46</sup>

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<sup>43</sup> DEIR/S, at 4-15.

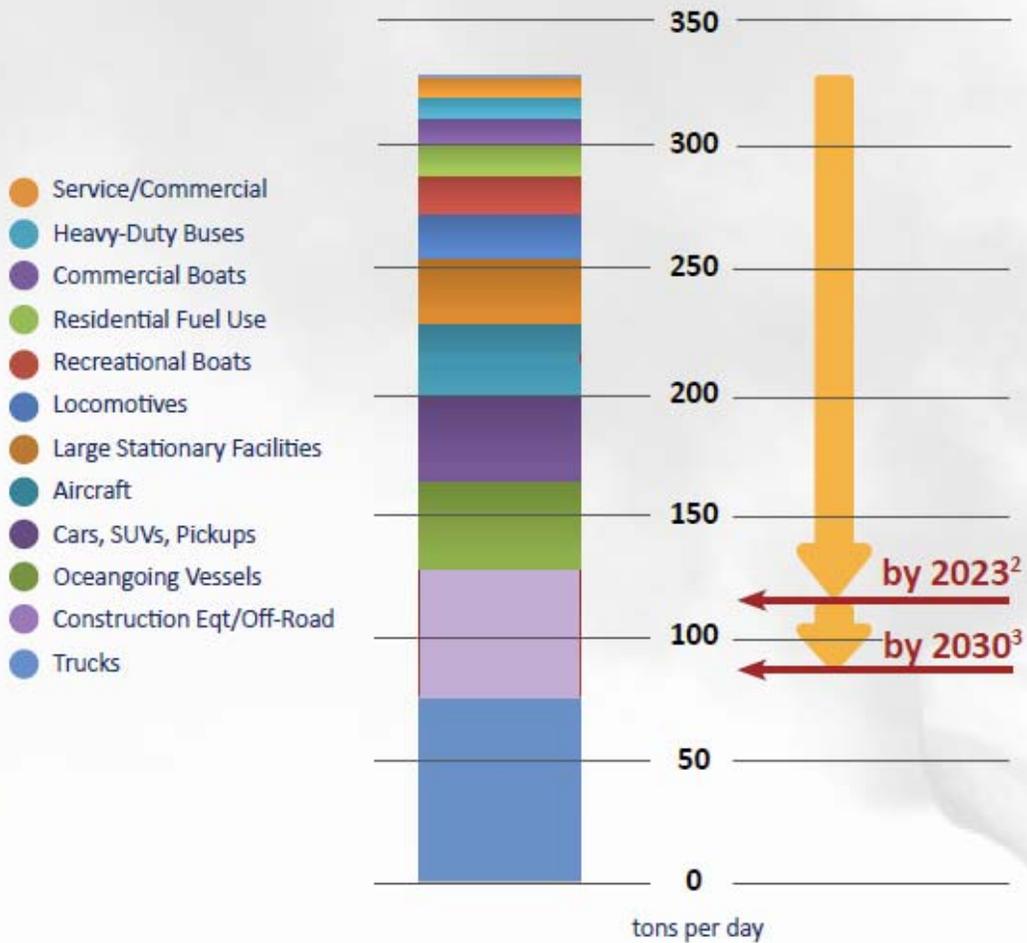
<sup>44</sup> South Coast Air Quality Management District, Attachment A Resolution No. 07-9, (June 1, 2007) available at [http://www.aqmd.gov/aqmp/07aqmp/aqmp/Complete\\_Document.pdf](http://www.aqmd.gov/aqmp/07aqmp/aqmp/Complete_Document.pdf).

<sup>45</sup> 40 C.F.R. § 1508.27(b)(10)(emphasis added).

<sup>46</sup> *See* Dr. Barry Wallerstein, Executive Officer, South Coast Air Quality Management District, Blue Sky Panel Presentation, available at <http://www.aqmd.gov/aqmp/2012aqmp/symposium/Panell1-Barry.pdf>.

## Nitrogen Oxides Emissions in 2023 with Adopted Standards<sup>1</sup>

## Additional Needed Emission Reductions



As is evident from this chart, the path to attainment is difficult, and freight related sources must play a role in meeting clean air standards. For example, this Project includes some of the source categories included in the above chart: “Trucks,” “Construction Equipment/Off-Road Equipment,” and “Cars, SUVs, Pickups.” The DEIR/S must disclose what alternatives help close the “black box” because they include measures that go above and beyond what is included to meet the NO<sub>x</sub> targets in 2023 articulated in the chart above. The DEIR/S needs to include an honest assessment of how different alternatives include mandatory requirements for zero and near zero emissions technologies. Without this analysis, the DEIR/S cannot claim that the Project does not conflict with the implementation of the AQMP.

It also bears mentioning that the DEIR/S also fails to address attainment of the 1-hour O<sub>3</sub> NAAQS and CAAQS. Notably, the 2007 AQMP concludes that “by 2010, this plan shows that the Basin will still exceed the federal 1-hour ozone standard by more than 30 percent despite the implementation of the 2007 AQMP control measures.”<sup>47</sup> The document further elaborates that the “2007 AQMP is designed to address the federal 8-hour ozone and PM<sub>2.5</sub> air quality standards, to satisfy the planning requirements of the federal Clean Air Act.”<sup>48</sup> This failure to address the state and federal 1-hour ozone standard is a serious deficiency.

Overall, the failure to actually show compliance with all NAAQS and CAAQS proves to be problematic given the key role this highway plays in regional emissions.<sup>49</sup>

#### **b. The DEIR/S Fails To Provide a Reasoned Air Quality & Conformity Analysis.**

The Traffic & Air Quality Report includes significant discussion about the flaws of the conformity analysis that is included in the DEIR/S and associated documents.<sup>50</sup> It concludes that the DEIR/S “lacks sufficient explanation of the actual logic used to conduct the analysis.”<sup>51</sup> Most importantly, Caltrans should have conducted a quantitative PM assessment for conformity purposes and for compliance with NEPA.

In particular, the conformity analysis has the following flaws:

- It provides an unclear justification for the selected background concentrations.<sup>52</sup> The use of the lowest value measured at the North Long Beach station is not supported. Moreover, using the value at the North Long Beach station for the *entire* highway segment is inappropriate. Finally, the DEIR/S does not explain why the Compton monitor was excluded from the analysis.
- Even if the qualitative analysis is appropriate,<sup>53</sup> the DEIR/S fails to justify the worst year analyzed.<sup>54</sup> The DEIR/S and reports fail to explain why 2035 is considered the year of peak emissions. As explained in the Traffic & Air Quality Report, “[b]ecause background concentrations and fleet emissions factors are typically expected to decline over time, while traffic volumes are

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<sup>47</sup> 2007 AQMP, *supra* note 7, at ES-4.

<sup>48</sup> *Id.* at 1-15.

<sup>49</sup> See Traffic & Air Quality Report, at 24-27.

<sup>50</sup> Traffic & Air Quality Report, at 17-28.

<sup>51</sup> Traffic & Air Quality Report, at 17.

<sup>52</sup> Traffic & Air Quality Report, at 17.

<sup>53</sup> While there is currently a grace period in place for use of EPA’s quantitative assessment, a quantitative assessment should have been completed for this project.

<sup>54</sup> EPA and FHWA, *Transportation Conformity Guidance for Qualitative Hot-Spot Analyses in PM<sub>2.5</sub> and PM<sub>10</sub> Nonattainment and Maintenance Areas*, at 16, (March 2006) available at <http://www.epa.gov/otaq/stateresources/transconf/policy/420b06902.pdf>.

expected to increase over time, 2035 does not necessarily represent the peak emissions year.<sup>55</sup>

- The modifications to EMFAC are not clear for the analysis.<sup>56</sup>
- The DEIR/S includes improper analysis of dust re-entrainment. Notably, without adequate justification, the DEIR/S uses a new methodology that even the lead agency does not acknowledge is proper.<sup>57</sup> As the Traffic & Air Quality Report, states, this dramatically underestimates the PM emissions from this project.<sup>58</sup>
- The analysis substantiating the assessment of lack of violations is similarly confusing, improper and misleading.<sup>59</sup>
- The conformity rule requires that “[t]he demonstrations required by § 93.116 . . . must be based on quantitative analysis using the applicable air quality models, data bases, and other requirements specified in 40 C.F.R. part 51, Appendix W (Guideline on Air Quality Models).” 40 C.F.R. § 93.123(a). Although EPA has deferred the use of dispersion models required for quantitative analysis by § 93.123(b)(1), it has not deferred the obligation to comply with those portions of Appendix W that specifically describe the procedures agencies must follow when determining source impacts using monitoring rather than dispersion modeling. In this case, where there will likely be hot spots resulting from conglomerating diesel truck traffic on one road, the measurement of baseline concentrations must be developed in compliance with the requirements in Appendix W ¶ 10.2.2.<sup>60</sup>

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<sup>55</sup> Traffic & Air Quality Report, at 18.

<sup>56</sup> Traffic & Air Quality Report, at 19.

<sup>57</sup> Traffic & Air Quality Report, at 19-20 (quoting Caltrans website in concluding that for projects, agencies should use EPA’s protocol).

<sup>58</sup> Traffic & Air Quality Report, at 20.

<sup>59</sup> Traffic & Air Quality Report, at 22.

<sup>60</sup> Section 10.2.2 reads:

10.2.2 Use of Measured Data in Lieu of Model Estimates

a. Modeling is the preferred method for determining emission limitations for both new and existing sources. When a preferred model is available, model results alone (including background) are sufficient. Monitoring will normally not be accepted as the sole basis for emission limitation. In some instances when the modeling technique available is only a screening technique, the addition of air quality data to the analysis may lend credence to model results.

b. There are circumstances where there is no applicable model, and measured data may need to be used. However, only in the case of a NAAQS assessment for an existing source should monitoring data alone be a basis for emission limits. In addition, the following items (i–vi) should be considered prior to the acceptance of the measured data:

Monitoring data was used from the North Long Beach monitor, a monitor not sited in accordance with any of the criteria in Appendix W. This is especially troublesome because Appendix W ensures that monitors sites are “designed to locate points of maximum concentration.” Id. ¶ 10.2.2.b.ii. The North Long Beach monitor is located too far from any major highway—.05 mile north of I-405 and 1 mile east of I-405/I710 junction—to be useful in characterizing background air quality at the receptor locations identified for the Schuyler Heim hot spot analyses and does not represent a point of “maximum concentration” pursuant to Appendix W. Moreover, other monitors in the project area present higher levels, which are points of higher concentrations, which demonstrates that the North Long Beach monitor is not the monitor of maximum concentration.

- The DEIR/S fails to show conformity based on § 176(c)(1)(B)(iii). The data does not provide evidence that violations of air quality standards will not continue.

The Traffic & Air Quality Analysis includes a more complete critique of the conformity analysis, and the DEIR/S must be rectified to address these serious flaws.

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- i. Does a monitoring network exist for the pollutants and averaging times of concern?
  - ii. Has the monitoring network been designed to locate points of maximum concentration?
  - iii. Do the monitoring network and the data reduction and storage procedures meet EPA monitoring and quality assurance requirements?
  - iv. Do the data set and the analysis allow impact of the most important individual sources to be identified if more than one source or emission point is involved?
  - v. Is at least one full year of valid ambient data available?
  - vi. Can it be demonstrated through the comparison of monitored data with model results that available models are not applicable?
- c. The number of monitors required is a function of the problem being considered. The source configuration, terrain configuration, and meteorological variations all have an impact on number and placement of monitors. Decisions can only be made on a case-by case basis. Guidance is available for establishing criteria for demonstrating that a model is not applicable?
- d. Sources should obtain approval from the appropriate reviewing authority (paragraph 3.0(b)) for the monitoring network prior to the start of monitoring. A monitoring protocol agreed to by all concerned parties is highly desirable. The design of the network, the number, type and location of the monitors, the sampling period, averaging time as well as the need for meteorological monitoring or the use of mobile sampling or plume tracking techniques, should all be specified in the protocol and agreed upon prior to startup of the network.

**c. Assumptions About Warehousing Location Result in Underestimation of Emissions.**

As articulated in the Traffic & Air Quality Report, “the DEIR/[S] analysis assumes that the same warehouses that are currently operating at capacity will accommodate a 150% increase in port throughput by 2035.”<sup>61</sup> Obviously understanding the economic and practical absurdity of this assumption, the DEIR/S engages in a sensitivity analysis assuming additional warehousing capacity in Southern Kern and in Victorville and leaves the trips to local warehouses in the project area at 2008 rates.<sup>62</sup> Even though largely illegible, the map of the results, indicates that there will be a 50% more port trucks on the I-605, 300% more port trucks on the I-210, and 2000% more port trucks on the I-15.<sup>63</sup> Despite these dramatic increases, the DEIR/S does not include any analysis of the impacts of these changes on air quality in the region and congestion on these road links. Notably, the approach used in the DEIR/S likely underestimates truck VMT because a trip from the Ports of Los Angeles to Long Beach to Victorville is 100 miles one way, as opposed to the much shorter trip within the project area (e.g. 18 miles or less).<sup>64</sup> Once again, these artificial assumptions that are provided with little analysis tend to undermine the disclosure of total emissions.

**d. The DEIR/S Ignores Several Feasible Measures That Would Mitigate the Project’s Air Quality Impacts.**

*Air Filtration*

Installation of air filtration systems is now commonplace around projects designed to accommodate freight. Despite this, the DEIR/S does not call for this mitigation measure. For example, both the TraPac expansion project at the Port of Los Angeles and the Middle Harbor Redevelopment project at the Port of Long Beach included air filtration as a mitigation measure. Even prior Caltrans projects have included air filtration. Both of these projects were substantially cheaper, and these projects determined that \$5 million and \$6 million dollars were feasible as mitigation for air filtration systems. In the context of this much larger and more expensive project, Caltrans should fund air filtration for houses, public facilities and schools within 500 meters of the highway and major arterials. Also, special attention should be paid towards facilities like Bell Shelters and the Multi Service Center in Long Beach, which houses sensitive populations who will be impacted greatly by this project. Additional information about the effectiveness of filtration system are included in Attachment J.

*Construction Mitigation*

The construction of cargo facilities, whether port terminals, roadways, rail yards, or warehouses, can have environmental and health impacts comparable to or even greater than those of the operation of the completed project. However, many steps can be taken to minimize air

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<sup>61</sup> Traffic & Air Quality Report, at 11.

<sup>62</sup> Traffic & Air Quality Report, at 11.

<sup>63</sup> Traffic & Air Quality Report, at 12.

<sup>64</sup> Traffic & Air Quality Report, at 13.

quality, public health, and climate impacts of these construction projects. In addition to the following measures, special precautions should be taken at construction sites within 1,000 feet of a sensitive site (such as schools, daycare centers, playgrounds, and hospitals. These sites should be notified of the project, in writing, at least 30 days before construction begins.<sup>65</sup>

#### Clean Construction Equipment and Work Trucks

Virtually any construction equipment can be retrofitted with diesel particulate filters and other exhaust controls. In some cases, older engines can be swapped out for cleaner, newer models. Much cleaner construction equipment, meeting U.S. EPA Tier 4 standards comparable to those governing modern on-road trucks, is becoming available. Where Tier 4 equipment is not available, the cleanest engines should be used and the best available control technology (BACT)<sup>66</sup> for emissions reductions of PM should be added, or alternative fuels should be used.<sup>67</sup> On-road trucks used at construction sites, such as dump trucks, should meet current emissions standards or be equipped with diesel particulate filters. Any trucks hauling materials such as debris or fill should be fully covered while operating off-site (i.e., in transit to or from the site).

#### Generators

Diesel generators can be a very significant source of pollution at construction sites. Where access to the power grid is possible, this should be established instead of using stationary or mobile power generators. Where access to the power grid is limited, on-site generators should meet a standard of 0.01 gram per brake-horsepower-hour for PM, or be equipped with best available control technology for reduction of PM emissions.

#### Recommendations to Limit Global Warming Pollution from Construction

Construction sites can be major contributors to global warming pollution. To save fuel and limit greenhouse gas emissions, all nonessential idling of equipment and vehicles onsite should be strictly limited. Where possible, use of the lowest-carbon fuels available (such as biodiesel or other alternative fuels) should be substituted for traditional diesel fuel. In San Francisco, for example, most city departments, including public works, are required to use biodiesel blends of 20 percent or more in their construction equipment.<sup>68</sup> In addition to using the power grid instead

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<sup>65</sup> Sensitive sites are defined and described in the CARB Air Quality and Land Use Planning Guidelines, 2005; <http://www.arb.ca.gov/ch/landuse.htm>.

Notification should include the name of the project, location, extent (acreage, number of pieces of equipment operating and duration), any special considerations (such as contaminated waste removal or other hazards), and contact information for a community liaison who can answer any questions.

<sup>66</sup> Here BACT refers to the “most effective verified diesel emission control strategy” (VDECS), which is a device, system, or strategy that is verified pursuant to Division 3, Chapter 14 of Title 13 of the California Code of Regulations to achieve the highest level of pollution control for an off-road vehicle.

<sup>67</sup> This could include natural gas or biodiesel (derived from vegetable oils or animal fats, meeting the requirements of ASTM D 6751). However, biodiesel must be proven to be sourced from sustainable feedstocks including waste grease, fats or oil, and, under certain circumstances, farmed oils that can be proven to be sustainable.

<sup>68</sup> [http://www.sfenvironment.org/our\\_policies/overview.html?ssi=11](http://www.sfenvironment.org/our_policies/overview.html?ssi=11)

of diesel generators where possible, other equipment including cranes and forklifts should be electrified to the extent possible.

In addition, Caltrans should abide by the recommendations on construction in Attachment A.

## VII. The DEIR/S's Greenhouse Gas Analysis is Flawed

One of the main purposes of the proposed I-710 Corridor project is to facilitate freight transport in the LA Region.<sup>69</sup> The project will have GHG emissions from its construction and operation, especially in facilitating more cargo growth. In 2010, the Council on Environmental Quality (“CEQ”) released a draft guidance document directing agencies to analyze GHG emissions under NEPA.<sup>70</sup> This draft guidance advises federal agencies “to consider, in scoping their NEPA analyses, whether analysis of the direct and indirect GHG emissions from their proposed actions may provide meaningful information to decision makers and the public.”<sup>71</sup> The Guidance and case law require the GHG section to quantify the emissions and analyze the effects of GHG emissions on climate change, including the cumulative impacts.<sup>72</sup>

The CEQ Draft NEPA GHG Guidance cites the scoping process as an important step in the GHG analysis—the point at which agencies decide how they will analyze the GHG emissions resulting from the project.<sup>73</sup> Here, however, Caltrans failed to estimate or analyze the GHG emissions for the initial sets of alternatives in either the Major Corridor Study (“MCS”) or the DEIR/S. Despite the fact that the proposed project is a massive transportation project, reducing GHG emissions was not a priority or concern. Communities for a Better Environment (“CBE”)

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<http://www.baybiodiesel.com/>

<sup>69</sup> DEIR/S, at 1-28-1-38.

<sup>70</sup> Counsel on Environmental Quality, Draft NEPA Guidance on Consideration of the Effects of Climate Change and Greenhouse Gases (Feb. 18, 2010) (hereinafter, CEQ, Draft NEPA GHG Guidance), available at <http://www.whitehouse.gov/sites/default/files/microsites/ceq/20100218-nepa-consideration-effects-ghg-draft-guidance.pdf>. California law also requires GHG analysis in environmental review documents: “Because there are more requirements set forth in California legislation and executive orders regarding climate change, the issue is addressed in detail in the CEQA chapter” of the DEIR/S. *See* Assembly Bill 1493 (2002) (requiring California Air Resources Board (“CARB”) to develop and implement regulations to reduce automobile and light truck GHG emissions); Executive Order S-3-05 (June 1, 2005) (goal to reduce GHG emissions to 1) 2000 levels by 2012, 2) 1990 levels by 2020, and 3) 80 percent below 1990 levels by 2050); AB 32, the Global Warming Solutions Act of 2006 (setting same reductions goals at EO S-3-05); Executive Order S-01-07 (setting low carbon fuel standards for California); and Senate Bill 97 (2007), (requiring Governor’s Office of Planning and Research to develop recommended amendments to State CEQA guidelines addressing GHG emissions). Caltrans and FHWA note however, that it may be used to inform the NEPA decision DEIR/S, *supra* at note 10, at 3.13-59.

<sup>71</sup> CEQ, Draft NEPA GHG Guidance, at 1.

<sup>72</sup> *Id.* at 4-8; *Center for Biological Diversity v. National Highway Traffic Safety Administration*, 538 F.3d 1172 (9<sup>th</sup> Cir. 2008).

<sup>73</sup> CEQ, Draft NEPA GHG Guidance, at 6.

commissioned an expert to examine the GHG analyses in the DEIR/S (attached as Attachment G). The report finds that the failure to consider GHG impacts during the early stages of environmental review foreclosed any possibility of including a potential alternative that could reduce GHG emissions.<sup>74</sup> According to a report on the GHG analysis in the DEIR/S process, “[t]his is a major limitation because the MCS considered the largest selection of initial alternatives (12 alternatives) and was the only analysis to consider a large investment in new transit infrastructure that may have reduced GHG emissions (a new heavy rail system).”<sup>75</sup>

The analysis in the DEIR/S is similarly lacking, though it does attempt to quantify the emissions. The DEIR/S estimates both construction-related GHG emissions and operation-related GHG emissions. The estimates for construction-related emissions range from 177,500 tons to 245,900 tons, “fairly small amounts of CO<sub>2</sub> considering that they are spread over 8 years and that the estimated year 2008 baseline emissions from vehicles traveling on the 710 freeway are 63.4 million metric tons of CO<sub>2</sub> per year.”<sup>76</sup> One reason why these estimates are so small is that they only consider emissions from construction equipment, but fail to take into account the “lifecycle” of GHGs: “large quantities of CO<sub>2</sub> emissions are also attributable to the materials used in construction such as steel, concrete, and asphalt.”<sup>77</sup>

This failure to include a lifecycle analysis of GHG emissions masks the potentially monumental impacts of a massive infrastructure project, designed precisely to facilitate ever-increasing amounts of freight transport to and from the Ports, on climate change. For example, “it is unclear if the GHG inventories include GHG emissions produced by power plants that supply electric power to the electric trucks.”<sup>78</sup> Caltrans argues it cannot estimate the project’s impacts on climate change, because climate change is a global problem and “there is no regulatory framework in place that would allow for a ready assessment of what any modeled increase in CO<sub>2</sub> emissions would mean for climate change. . . .”<sup>79</sup> The Ninth Circuit disagrees: “the fact that ‘climate change is largely a global phenomenon that includes actions that are outside of [the agency’s] control. . . does not release the agency from the duty of assessing the effects of *its* actions on global warming within the context of other actions that also effect global warming. . . .’ [T]he impact of greenhouse gas emissions on climate change is precisely the kind

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<sup>74</sup> Gregory Gould, Analysis of Greenhouse Gas Emission Estimates for the Interstate 710 Corridor Project, Technical Report (September 4, 2012) (hereinafter, Gould, Analysis of GHG Estimates), attached as Attachment G.

<sup>75</sup> *Id.*

<sup>76</sup> *Id.*; DEIR/S, at 4-74, Table 4.3-1.

<sup>77</sup> Gould, Analysis of GHG Estimates.

<sup>78</sup> *Id.* Gould’s report notes that “[w]hile the CEQA section of the draft EIR/EIS states that the estimates do include these emissions, the referenced technical study and its appendix do not mention including these emissions. . . . Additionally, the GHG estimates for each alternative in the CEQA section of the draft EIR/EIS do not correspond to the GHG estimates in the referenced technical study.”

<sup>79</sup> DEIR/S, at 4-83.

of impacts analysis that NEPA requires agencies to conduct.”<sup>80</sup> Indeed, a lifecycle analysis of GHG emissions and their effects on climate change is crucial for this type of project:

Unlike most harmful air pollutants where the impacts depend on where and when emissions occur, the impacts of GHG emissions are global and it does not matter if the emissions were produced at a distance cement plant or by the fuel burning in a construction vehicle working on site. For example, a recent study of the lifecycle GHG emissions from different modes of goods movement indicates that road infrastructure can account for almost 10% of the CO<sub>2</sub> emissions attributable to trucking assuming a flat, 4-lane, asphalt freeway. [citation omitted.] Adding elevated structures such as those proposed for the 710 freeway would likely result in greater CO<sub>2</sub> emissions.<sup>81</sup>

Overall, Caltrans’ failure to utilize a lifecycle analysis of the project’s GHG emissions rather than a narrow focus on emissions from construction equipment and vehicle miles traveled, and its failure to evaluate the project’s substantial potential impacts on climate change, given its objective to facilitate freight movement, render the DEIR/S’s GHG analysis wholly inadequate.

### **VIII. The DEIR/S Includes a Flawed Analysis of Land Use Impacts.**

In the Land Use section of the DEIR/S, Caltrans provides a whirl-wind tour of the land use within the project area by 1) describing the general land use environment for each of the jurisdictions impacted by the proposed project; 2) reviewing land use plans for each impacted jurisdiction including the Coastal Zone Plan, the Port of Los Angeles Master Plan, and the City of Long Beach’s Community Livability Plan for consistency with the build and no-build alternatives; and 3) describing mitigation for identified inconsistencies or impacts. Review of this section, however, reveals that the analysis provided by Caltrans is inadequate; even when inconsistencies or impacts are identified, the document does not provide any meaningful mitigation to address those issues.

To comply with CEQA guidelines, the DEIR/S must analyze and discuss inconsistencies between the proposed project and applicable general plans and regional plans as of the time that the Notice of Preparation (“NOP”) was prepared.<sup>82</sup> Caltrans has failed to do so, instead presenting its purported analysis of the “environmental consequences” of the build alternatives as “*generally consistent*”<sup>83</sup> with the land use plans along the I-710 corridor and failing to discuss its own admission that:

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<sup>80</sup> *Center for Biological Diversity v. National Highway Traffic Safety Administration*, 538 F.3d 1172, 1217 (9th Cir. 2008) (requiring the National Highway Traffic Safety Administration to monetize the benefits of GHG emissions from setting fuel economy standards and requiring the agency to analyze the project’s cumulative impacts on climate change).

<sup>81</sup> Gould, Analysis of GHG Estimates (citations omitted).

<sup>82</sup> CEQA Guidelines, §§ 15125(d) and (e).

<sup>83</sup> Emphasis added.

While adoption of any one of the build alternatives would require SCAG, the County of Los Angeles, and several other regional and local agencies to amend their plans to reflect modifications to the I-710 mainline, interchanges, arterial highways, and arterial intersections, as well as the elimination of any land uses that may need to be acquired for the project, the proposed build alternatives are generally consistent with these plans.<sup>84</sup>

Caltrans also failed to analyze the fact that

Caltrans will need to amend its existing freeway agreements with cities where the build alternatives would add or remove connections to I-710 or I-405.<sup>85</sup>

CEQA does not require a discussion of the *consistencies* of the build alternatives with the land use plans, but it requires a discussion of the *inconsistencies*.<sup>86</sup> Once inconsistencies have been identified, Caltrans must discuss the impacts of those inconsistencies and what can be done to reduce or avoid those impacts. Here, Caltrans asserts that the build alternatives are “generally” consistent and does not discuss either the inconsistencies or the impact of those inconsistencies on the environment. So, for example, Caltrans indicates that the build alternatives will impact between 1,352 and 1,657 acres of land “currently in other uses,”—that is non-transportation uses—but does not discuss the impacts of changing those land uses or, indeed, whether local jurisdictions would be willing to make such changes.<sup>87</sup>

Caltrans must disclose, analyze and avoid or mitigate what the land use inconsistencies mean for local jurisdictions and the people who live there. Are there impacts on the local housing, noise, traffic circulation, or other activities? If so, what are they? For example, the City of Commerce is very clear that it will oppose a project that “does not first consider the potential impacts of such facilities on the local community in which the facility will be located.” Yet, despite the fact that Commerce has some 280 entries in the Appendix L Parcel Acquisition table, Caltrans fails to discuss how the land use changes in the build alternatives are inconsistent with the land use plan. Asserting “general” consistency without a focused look at local inconsistencies does not meet state and federal requirements for this DEIR/S.

Second, it is unclear that the build alternatives *are* actually consistent. The County of Los Angeles Draft General Plan’s Sustainable Communities Strategy (“SCS”) calls for working to “increase the efficiency of the existing transportation system.” Many of the build alternatives, however, call for a major expansion of the I-710 freeway—that is to say, that alternatives call for a *significant expansion* of the existing transportation system. While Caltrans asserts all the build alternatives are consistent with the County’s SCS, it seems that, in fact, the two are opposed to one another.

In addition, where Caltrans has acknowledged inconsistencies, it has failed to discuss their impacts. For example, Caltrans notes that the build alternatives will be inconsistent with

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<sup>84</sup> DEIR/S, at 3.1-46.

<sup>85</sup> *Id.*

<sup>86</sup> See, e.g., *Pfeiffer v. City of Sunnyvale City Council*, 200 Cal. App. 4th 1552, 1565 (2011).

<sup>87</sup> DEIR/S, at 3.1-11.

the SCAG RTP goal of HOV gap closures or rideshare programs and with the General Plan of CLB and SCAG's RCP goal of providing new housing or education. Indeed, the build alternatives would eliminate housing from the region and also impact local jurisdictions goals for providing housing within their communities. Caltrans must better disclose and analyze inconsistencies with general plans in the build corridor.

Finally, Caltrans fails to provide any meaningful avoidance or mitigation efforts for impacts of the build alternatives on land use. In section 3.1.22, Caltrans notes that "the build alternatives would result in permanent land use impacts." For mitigation Caltrans refers the reader to Measure LU-1, which is serving double-duty for mitigating both these impacts and the impacts of inconsistency of the build alternatives with General Plans throughout the project area.

Upon review of Measure LU-1, the reader finds the only mitigation being offered is:

[Caltrans] shall request that the affected Cities and the County amend their respective General Plans to reflect the final alignment, interchange locations, and modification of land use designations for properties that would be acquired for the project.<sup>88</sup>

This proposed Caltrans request is not a mitigation measure in that it does nothing to avoid or reduce the impacts of the changes to the land use that will occur along the build route. So, for example, this Measure does nothing to avoid or mitigate the impact of the between 26 and 41 acres of land that will have its current zoning changed from residential to transportation to accommodate the project. Measure LU-1 is inadequate as mitigation for both the permanent impacts to land use and for the issues related to the inconsistency with general plans. As such, the DEIR/S is inadequate as a matter of law.

### **IX. DEIR/S Severely Understates the Project's Noise Impacts and Fails to Mitigate These Impacts.**

The California Legislature has declared in CEQA that "it is the policy of the state" to "[t]ake all action necessary to provide the people of this state with . . . freedom from excessive noise."<sup>89</sup> Research on noise from transportation—especially heavy-duty trucks—shows significant health impacts. For instance, noise above 60 decibels ("db") has been shown to have psychological impacts, such as worsening children's mental health, concentration, and classroom behavior in children at school.<sup>90</sup> (For reference, "a diesel truck 50 feet away going 50 miles per

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<sup>88</sup> DEIR/S, at 3.1-53.

<sup>89</sup> Pub. Res. Code § 21001(b).

<sup>90</sup> Matsuoka, M., Hricko, Al, Gottlieb, R., and De Lara, J., *Global Trade Impacts: Addressing the Health, Social and Environmental Consequences of Moving International Freight through Our Communities*, Occidental College and University of Southern California (Los Angeles, 2011) (hereinafter "*Global Trade Impacts*"), citing World Health Organization, Guidelines for Community Noise, Chapter 3, Adverse Health Effects of Noise (1999), available at: <http://www.who.int/docstore/peh/noise/Comnoise3.htm>; van Kempen, E.E., van Kamp, I., Stellato, R.K., et al., "Children's Annoyance Reactions to Aircraft and Road Traffic Noise," *J. Acoust. Soc. Am.* (2009) 125(2): 895-904; U.S. Department of Transportation, Federal Railroad

hour, may register between 80 and 90 decibels.”).<sup>91</sup> Other studies show that chronic noise exposure, including near roadway exposure, contribute to a worsening of heart disease and higher rates of stroke, after accounting for the risks association with air pollution.<sup>92</sup> Traffic noise can also disturb sleep.<sup>93</sup>

The DEIR/S’s analysis and proposed mitigation measures for noise impacts are wholly inadequate. EYCEJ, NRDC, and CBE retained an acoustic and vibration expert to review the Noise and Vibration sections of the DEIR/S, including underlying technical reports (hereinafter “Noise Report”). Some of that report is summarized below; the entire report is attached as Attachment E, and is incorporated in its entirety by reference. Some of the flaws identified include: the DEIR/S establishes standards and criteria that are substantially above the current recommended noise criteria, especially for sensitive receptors, such as schools; the threshold of significance of 12 dBA is much too high; the methodology contained serious omissions that skewed results and failed to provide information required by CEQA and NEPA; and, the DEIR/S proposes only minimal measures to lessen the severity of noise and vibration impacts and absolutely no measures to avoid them. For all of these reasons, the DEIR/S’s noise analysis does not meet the requirements of NEPA or CEQA.

**a. The DEIR/S Establishes Standards and Criteria that are Substantially Above the Currently Recommended and Required Criteria.**

The area of the proposed project travels through Los Angeles County, yet the DEIR/S ignores its noise criteria, which are stricter than the levels set forth in the DEIR/S. For example, the County sets an exterior maximum noise level at 45 dB for the *exterior* of a noise-sensitive area and residences at night.<sup>94</sup> Ignoring these requirements, the DEIR/S lists 57 dBA as the required level for “lands on which serenity and quiet are of extraordinary significance. . . .”<sup>95</sup> Similarly, the interior criteria for schools (also places of worship, hospitals, libraries, and day care centers) provided in the DEIR/S is given as 52 dBA.<sup>96</sup> As stated in the Noise Report,

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Administration, *The General Health Effects of Transportation Noise* (2002), Document # DTS-34-RR297-LR2 FRS/RDV-03/01; Lercher, P., “Ambient Neighbourhood Noise and Children’s Mental Health,” *Occup. Environ. Med.* (2002) 59(6): 380-6; Evans, G.W., “Child Development and the Physical Environment,” *Annual Review of Psychology* (2006) 57: 423-51.

<sup>91</sup> *Global Trade Impacts*, 19.

<sup>92</sup> *Global Trade Impacts*, 18, citing Babisch, W., “Transportation Noise and Cardiovascular Risk: Updated Review and Synthesis of Epidemiological Studies Indicate that the Evidence Has Increased,” *Noise & Health* (Jan. 2006), Vol. 8, Iss. 30, 1-29; Sorensen, M., Hvidberg, M., Andersen, Z. J., et al., “Road Traffic Noise and Stroke: A Prospective Cohort Study,” *Eur. Heart J.* (Jan. 25, 2011).

<sup>93</sup> *Global Trade Impacts*, 19, citing World Health Organization, *Guidelines for Community Noise*, Chapter 3, *Adverse Health Effects of Noise* (1999), available at: <http://www.who.int/docstore/peh/noise/Comnoise3.htm>.

<sup>94</sup> Los Angeles County Code § 12.08.390(A).

<sup>95</sup> DEIR/S, at 3.14-2 (Table 3.14-1).

<sup>96</sup> *Id.* See also Steve Pettyjohn, Results of Review of the Noise and Vibration Sections of the I-710 Corridor Project Draft Environmental Impact Report/Environmental Impacts Statement and

This is a value without any foundation for its use except that it is employed repeatedly and contradicts of the City of Long Beach [], the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) [], the Collaborative for High Performance Schools (CHPS) [], and an American National Standard Institute (ANSI) standard [] that is part of the Americans with Disabilities Act.<sup>97</sup>

The City of Long Beach Municipal Code sets a limit of 45 dBA in classrooms. The other programs require levels ranging from 35 dBA to 45 dBA as the absolute maximum level.<sup>98</sup> The reasons for these requirements are clear.

A level of 52 dB(A) would limit or prevent learning and cause the teacher to use a raised voice for extended periods, leading to vocal problems as has been documented in several studies. Dr. V. O. Knudsen in his 1950 book on acoustic design [] stated, “*The school was established to promote learning, which is acquired largely by word of mouth and listening. Therefore, acoustics is one of the most important physical properties that determine how well the school building can serve its primary function. Thus, the exclusion of noise and the reduction of reverberation are indispensable in adapting classrooms to the function of oral instruction.*”<sup>99</sup>

Caltrans must reevaluate its noise analysis using the appropriate local requirements and recommended criteria.

#### **b. The 12 dBA Threshold of Significance is Unacceptably High**

The DEIR/S uses 12 dBA as the threshold of significance.<sup>100</sup> Requiring such a large increase before considering mitigation measures is unrealistic and unreasonable. For context, a 12 dBA increase would be equivalent to increasing from a 5,000 average vehicles per day on a street to increase to almost 80,000 vehicles of the same speeds and mix per day.<sup>101</sup> Thus, for the proposed project,

The 2011 traffic volumes [] range from 57,000 vehicles per day to 230,000. These volumes would have to increase to a range of 903,400 to 3,217,300 vehicles per day. The road is not capable to [*sic*] carrying these volumes so the sound increase could not be significant due to the change in the volume alone. A test of significance that can not be reached is not a realistic standard and renders the process of evaluating noise [*sic*] impacts a charade without meaning.

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Evaluation of Proposed Mitigation Measures, at 1, 2 (Sept. 27, 2012) (hereinafter “Noise Report”), attached as Attachment E.

<sup>97</sup> Noise Report, at 3.

<sup>98</sup> *Id.*

<sup>99</sup> *Id.*

<sup>100</sup> DEIR/S, at 3.14-3.

<sup>101</sup> Noise Report, at 2.

A level of significance of 3 dBA would be more appropriate.<sup>102</sup> “A doubling of the volume is required to achieve a 3 dB(A) increase in the peak hourly average sound level. A change in the average speed or the percentage of heavy trucks could increase sound levels faster.”<sup>103</sup>

**c. The Methodology, Analysis, and Information on Noise Impacts in the DEIR/S are Inadequate**

Caltrans omitted several analytical measures and criteria that are crucial to adequately evaluate the noise impacts from the proposed project. For instance, “the tonal content is one of the important factors” in the perception, propagation, and transmission of sound, yet “[t]onal or sound frequency data was not provided for existing conditions at either measurement locations or modeling stations as is required by the State and the EPA in preparation of sound impact statements.”<sup>104</sup> The tonal and frequency data is particularly important because heavy trucks “generate more low frequency sound than automobiles and light trucks. This low frequency sound more easily passes from the exterior to the interior of buildings such as schools, creating more sound disturbances within noise sensitive buildings.”<sup>105</sup>

Similarly, “[n]either all input data nor even examples of the data used in the prediction of sound levels at the modeling locations or to calibrate short term sound measures was provided,” making it “impossible to corroborate the results independently.”<sup>106</sup> For instance, the DEIR/S fails to provide in the traffic noise study important modeling inputs such as “traffic volumes, traffic mix, topography, amount of the road that is ‘visible’, shielding, elevation of source and elevation of the receiver,” “sound level variations with time” for several of the long-term measurement sites, and the traffic assumptions that went into the predictions based on short-term measurements.<sup>107</sup>

Indeed, in addition to omitting tonal and frequency data, and other important inputs for accurate modeling and predictions, the DEIR/S only uses peak hourly  $L_{eq}$  sound levels, rather than the day-night average  $L_{dn}$  (or sometimes CNEL, which generally closely tracks the  $L_{dn}$ ) measurements almost always used by local jurisdictions in their noise standards and regulations. The  $L_{eq}$  measurement does not include a night-time “penalty” of 10 dBA as does the  $L_{dn}$  measurement. Moreover, including a separate measurement—the sound exposure level—to

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<sup>102</sup> For comparison, the City of L.A.’s CEQA thresholds are that a “project would normally have a significant impact on noise levels from project operations if the project causes the ambient noise level measured at the property line of affected uses to increase by 3 dBA in CNEL to or within the ‘normally unacceptable’ or ‘clearly unacceptable’ category [e.g., above 70 dBA at the exterior property line for a school], or any 5 dBA or greater noise increase.” LA CEQA Thresholds Guide (2006), at I 2-3, available at [www.ci.la.ca.us/ead/programs/Thresholds/I-Noise.pdf](http://www.ci.la.ca.us/ead/programs/Thresholds/I-Noise.pdf).

<sup>103</sup> Noise Report, at 2.

<sup>104</sup> *Id.*

<sup>105</sup> *Id.* at 1.

<sup>106</sup> *Id.* at 3-4.

<sup>107</sup> *Id.* at 3, 4, 5.

measure particularly loud events would also appropriate and useful.<sup>108</sup> Loud “startle” events could disrupt learning in schools or play in parks.

There are also several instances where the DEIR/S fails to accurately identify monitoring and modeling positions or provides what appears to be the wrong address.<sup>109</sup> Further, “[t]he background sound level measurement positions were sufficiently close to the project road to have been influenced by traffic on this road when sound drops only 3 dB(A) per doubling of distance.”<sup>110</sup> These omissions or mistakes skewed the results of the background sound level. For example, in order to correctly calibrate the model to determine how quickly the sound dissipates, tests should be conducted next to the freeway (as most of them were) and, say, four rows of houses in from the freeway. This is particularly important, because the elevated truck lanes proposed in Alternatives 6A/B/C could distribute truck noise over farther distances.<sup>111</sup>

The DEIR/S also failed to take into account peak and/or worst-case sound levels, including during the hours of use for places such as schools and parks. The heavy use of the “peak hourly Leq sound level poses many questions, particularly for schools and parks because the impact can not be determined by sound measured outside the time these facilities are used.”<sup>112</sup> Monitoring should also be done over periods longer than 1-hour increments to account for events, such as weather patterns like temperature inversions, which can increase sound by 10 dBA because they keep the sound waves closer to the ground.<sup>113</sup> Even for the long-term measurement sites, “[o]ther sound metrics, which could be used to understand how the sound varied with time, are not provided at all.”<sup>114</sup> What is more, “of the 24 sites where 24-hour measurements were done, 12 of the sites, 50 percent, had maximums outside the 8:00 a.m. to 5:00 p.m. period.”<sup>115</sup> The DEIR/S must give measurements during the periods of use, especially for places such as schools and parks and other sensitive daytime receptors, however; otherwise, the DEIR/S analysis is useless. Additionally, the DEIR/S fails to explain why so many worse-case / peak noise times occurred during these very early morning hours.<sup>116</sup> Is it because of increased truck volumes? Differences in average speed? High noise levels at very early times can disrupt sleep, so it is important to understand and mitigate these impacts.

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<sup>108</sup> *Id.* at 2, 3. This was required in *Berkeley Keep Jets Over the Bay Committee v. Bd. of Port Commissioners* (2001) 91 Cal.App.4th 1344, 1372.

<sup>109</sup> *Id.* at 3, 4.

<sup>110</sup> *Id.* at 4.

<sup>111</sup> *Id.* Note that the DEIR/S also fails to include any mention of the fact that sound radiates from the concrete structures elevating the truck lanes in Alternatives 6A/B/C.

<sup>112</sup> *Id.*

<sup>113</sup> Conversation between Maya Golden-Krasner and Steve Pettyjohn, September 28, 2012.

<sup>114</sup> Noise Report, at 4.

<sup>115</sup> *Id.*

<sup>116</sup> *Id.* at 5. Similarly, the DIER/S fails to explain why its correction value, or “K factor,” is so large, 3.9 dBA. This is important because a large “K factor” could result in over-predicting sound or misjudging the source of sound when modeling. The “K factor” should be closer to 1.5 dBA. *Id.* at 4.

Overall, poor methodology, missing data, and inadequate analysis render it exceedingly difficult, if not impossible, for even an expert to corroborate or independently verify the noise findings in the DEIR/S, and for the public to evaluate the impacts of the project.

**d. Noise Mitigation for the I-710 Corridor Project is Inadequate.**

Given the unreasonably high noise criteria and threshold of significance used by Caltrans, along with significant data omissions in monitoring and modeling, the mitigation measures proposed by the DEIR/S are wholly insufficient. The EIR/EIS cites five potential noise abatement measures identified in the Traffic Noise Analysis Protocol – constructing noise barriers, acquiring property to serve as a buffer, using traffic management measures to regulate the vehicles and speeds, providing acoustic insulation to public-use or nonprofit structures, and altering the horizontal or vertical alignment of the project to avoid the acoustic impact.<sup>117</sup> Due to the configuration and location of the project, Caltrans argues only soundwalls and acoustic insulation are considered feasible. Affected areas were categorized by type of land use, and mitigation measures considered by category. In some impacted residential areas, the presence of an existing noise barrier precluded the possibility of a higher barrier achieving the minimum noise attenuation. In other areas, a variety of possible soundwalls were considered.<sup>118</sup> In both residential and commercial areas, a number of such walls were found acoustically feasible, although many were found to be unreasonable.<sup>119</sup> Several of the required soundwalls conflict with the requirements for available stopping sight distance, and as a result may need to be shortened or removed.<sup>120</sup> Finally, nowhere does the DEIR/S say that the soundwalls will have noise absorptive material necessary to contain the noise. Thus, even the one mitigation measure Caltrans offers is severely and overly limited.

Caltrans admits acoustic insulation is feasible,<sup>121</sup> yet does not propose it as a mitigation measure. It should. The sound level at several schools is unacceptable, including at Boystown of California School, Marco Santonio Firebaugh High School, and Humphreys Avenue Elementary School (predicted to have levels of 54 to 56 dBA in the classrooms, far above the 35 to 45 dBA recommended limits), yet Caltrans found that new or increased soundwalls would be “unreasonable” due to the fact that they allegedly would not decrease the sound levels at least 7 dBA, itself an “unreasonable” threshold. Incredibly, Caltrans found that the “playing field near the freeway is generally not considered an area of frequent human use that would benefit from a lower noise level.”<sup>122</sup> In fact, children frequently use these playing fields, and the DEIR/S provides no basis for its blanket statement.

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<sup>117</sup> DEIR/S, at 3.14-14.

<sup>118</sup> *Id.*

<sup>119</sup> *Id.* at 3.14-20; Table 3.14-3. A sound barrier is “unreasonable” “if the estimated sound barrier construction cost exceeds the total reasonable allowance or was not predicted to provide at least seven dBA of noise reduction at one more benefited receiver.” *Id.* at 3.14-29. Requiring at least 7 dBA of noise reduction is actually what is “unreasonable,” however, given that a significance threshold of 3 dBA would be more appropriate and more in line with local standards.

<sup>120</sup> *Id.* at 3.14-30.

<sup>121</sup> *Id.* at 3.14-14.

<sup>122</sup> *Id.* at 3.14-18.

Aside from not providing more soundwalls, the DEIR/S does not consider whether acoustic insulation, though feasible, would be “reasonable” for these schools. The DEIR/S must explain this omission. Moreover, there are other mitigation measures for schools that the DEIR/S failed to consider, such as altering the school façade, which “provides better results than using sound barriers only or in combination with the sound walls,” and interior sound reduction.<sup>123</sup> Further, as asserted in the Noise Report,

[t]he predicted sound level at Julia Russ Asmus Park is 83 dB(A) during the noisiest hour. This renders the park almost unuseable [*sic*] for safety reasons because screams could not be hear[d] above the din from I-710. Sound levels are barely tolerable at present. Mitigation measures must be implemented to provide a minimum 14 dB(A) of reduction during operating hours. Monitoring must be completed if the project proceeds to ensure that the predicted sound reduction is realized.<sup>124</sup>

Overall, the Noise analysis in the DEIR/S fails to fulfill its role in providing a meaningful analysis and mitigation of noise impacts. It omits crucial data that would allow the agencies and the public to adequately analyze the noise impacts of the project. It relies on unreasonable criteria and thresholds of significance (and “reasonableness” for mitigation measures). Finally, it fails to include necessary mitigation measures.<sup>125</sup> As a result, the Noise analysis is inadequate under CEQA and NEPA.

## **XII. The EIR Fails to Provide an Accurate Picture of the Project’s Growth-Inducing Effects.**

An EIR must discuss the ways a project could directly or indirectly facilitate or remove obstacles to population growth or new development in the surrounding environment.<sup>126</sup> A proposed project is considered either directly or indirectly growth-inducing if it: (1) fosters economic or population growth or additional housing; (2) removes obstacles to growth; (3) taxes community services or facilities to such an extent that new services or facilities would be necessary; or, (4) encourages or facilitates other activities that cause significant environmental

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<sup>123</sup> Noise Report, at 4, 5, 6.

<sup>124</sup> *Id.* at 5.

<sup>125</sup> It is interesting to compare the mitigation measure proposed by Caltrans to those proposed in another recent freeway widening project: The 520 Freeway in Seattle, based on the recommendation of a SR 520 Noise Expert Review Panel and in response to community input puts forth several mitigation measures to alleviate increased noise, including landscaped lids, soundwalls, “noise-absorptive material on the traffic barriers and around the lid portals and expansion joints,” a higher profile for the project to reduce noise levels throughout the area, reduced speeds in some areas, and quieter concrete pavement. SR 520, I-5 to Medina: Bridge Replacement and HOV Project, available at:

<http://www.wsdot.wa.gov/Projects/SR520Bridge/EIS.htm>, Final EIS Executive Summary, 17.

<sup>126</sup> Pub. Res. Code § 21100(b)(5); *City of Antioch v. City Council of Pittsburg* (1986) 187 Cal. App. 3d 1325, 1337.

effects.<sup>127</sup> An environmental impact report must discuss how a proposed project, if implemented, could induce growth.<sup>128</sup> While the growth-inducing impacts of a project need not be labeled as adverse, the secondary impacts of growth (e.g., loss of open space/habitat/agricultural lands, air quality, transportation, etc.) may be significant and adverse. In such cases, the secondary impacts of growth inducement must be disclosed as significant secondary or indirect impacts of the project.

The appropriate components for an adequate analysis include: (1) estimating the amount, location and time frame of growth that may occur as a result of the project (e.g., additional housing, infrastructure, and mixed use developments); (2) applying impact assessment methodology to determine the significance of secondary or indirect impacts as a result of growth inducement; and (3) identifying mitigation measures or alternatives to address significant secondary or indirect impacts. The DEIR/S's growth-inducing impacts analysis fails to contain these essential components. Notably, there is a failure to assess the potential of this project to assess the changes to choices related to locations of residences, schools and workplace locations.<sup>129</sup> By only examining land use patterns related to warehousing, the DEIR/S fails to examine an important aspect of the environmental impacts from this Project. This is especially problematic given recent California legislation like SB 375, which seeks to promote more efficient land use patterns to reduce GHG emissions. The approach in the DEIR/S likely underestimated VMT increases associated with the various build alternatives by assuming fixed land use patterns.<sup>130</sup> This must be cured in subsequent versions of the DEIR/S.

### **XIII. The DEIR/S Does Not Adequately Address Water Quality Impacts From This Project.**

The DEIR/S's analysis of water quality impacts from construction and ongoing operation of the expanded I-710 corridor is inadequate and incomplete. As part of the review of this document, NRDC retained Dr. Richard Horner, an expert in water quality, to produce an expert analysis of the DEIR/S, Chapter 3.9, Water Quality and Stormwater Runoff ("Stormwater Chapter") and the Water Quality and Stormwater Runoff Study Final Report, Interstate 710 Corridor Project Between Ocean Boulevard and the State Route 60 Interchange, 07-LA-710-PM 5.4/24.6 EA: 249900 WBS 165.10.35 ("Stormwater Report"). Commenters hereafter refer to this report as the "Horner Expert Letter" and incorporate the entire content of this letter and its attachments into these comments by reference.<sup>131</sup>

Notably, the Horner Expert Letter found that "the Stormwater Documents are inadequate as a basis for both long-term and construction-phase stormwater management in the I-710 corridor."<sup>132</sup> The Horner Expert Letter further determined that "[i]n both the long-term and construction phases, the Stormwater Documents are flawed because their coverage of the

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<sup>127</sup> CEQA Guidelines, § 15126.2(d).

<sup>128</sup> *Id.* at § 15126(d).

<sup>129</sup> Traffic & Air Quality Report, at 13.

<sup>130</sup> Traffic & Air Quality Report, at 13.

<sup>131</sup> Horner Expert Letter attached as Attachment F.

<sup>132</sup> Horner Expert Letter, at 1 (Attachment F).

prospective stormwater management actions is so general, and lacking in site-specific context, as to be nearly meaningless.”<sup>133</sup> The report also concludes that the DEIR/S makes unsubstantiated claims about benefits to water quality based on studies that did not anticipate the dramatic expansion of infrastructure sought through this project.<sup>134</sup> This type of cursory analysis that fails to provide any precise location, specific data, or detail inhibits informed decision-making and comment by the public. Caltrans must provide significantly more information in order to make this section comply with and serve the purposes of CEQA and NEPA.

More specifically, the analysis fails to:

- Address how a major construction project and expanded freeway will be able to meet the Los Angeles River Watershed’s TMDLs for trash<sup>135</sup> and bacteria.<sup>136</sup> The DEIR/S must explain in detail how they will prevent further deterioration of these water resources, particularly in light of prospective restoration of the LA River.
- Provide specific estimates of runoff and pollutant load increases under each alternative, as well as projections of potential erosion, transport to receiving waters, pH and turbidity effects, and impacts on aquatic life. Beyond acknowledging that there will be increases, the analysis provides no indication of the levels and potential consequences;<sup>137</sup>
- Account for impacts from the construction phase itself, which may well be significant; at present the analysis focuses almost exclusively on ongoing operational impacts;<sup>138</sup>
- Classify the Alternatives into Risk Levels 1, 2, and 3, per Caltrans’ Construction General Permit.<sup>139</sup> These classifications, based on project sediment risk and receiving waters risk, are an important signal of the level of environmental harm posed by each alternative and should be included in the analysis.

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<sup>133</sup> *Id.*

<sup>134</sup> *Id.*

<sup>135</sup> Attachment A to Resolution No. 07-012 August 9, 2007. Amendment to the Water Quality Control Plan – Los Angeles Region to incorporate the TMDL for Trash in the Los Angeles River Watershed. Adopted by the California Regional Water Quality Control Board, Los Angeles Region on August 9, 2007

<sup>136</sup> Attachment A to Resolution No. R10-007. Amendment to the Water Quality Control Plan - Los Angeles Region to incorporate the Los Angeles River Watershed Bacteria TMDL. Proposed for adoption by the California Regional Water Quality Control Board, Los Angeles Region on July, 9, 2010.

<sup>137</sup> *Id.*

<sup>138</sup> *Id.* at 3.9-14 (stating that “[t]he long-term surface runoff operational effects on water quality stemming from construction of [the alternatives] considers only the continuous impact on contaminant runoff throughout the life of the new facility.”)

<sup>139</sup> Caltrans, Project Risk Level Determination Guidance (April 2012). California Department of Transportation, Division of Design Office of Storm Water Management.

- Properly compare the No Build Alternative to the various build options.<sup>140</sup> The analysis is particularly misleading on this point. As the Horner Expert Letter notes:

Not only is use of the stormwater corridor studies inappropriate as a basis for the massive highway expansion under consideration, but the Stormwater Documents misuse the results. The Stormwater Report is disingenuous in claiming, “The introduction of treatment BMPs as part of the build alternatives would represent an improvement when compared to the No-Build condition as there currently are no Caltrans-maintained BMPs treating freeway runoff.” The proposed expansion does not have to take place to get this benefit; the court order requires that Caltrans provide it when any significant new work occurs in the corridor.”<sup>141</sup>

- Provide an explanation of how 256,721 ft<sup>3</sup> of additional water quality volume under the smaller expansion and 798,499 ft<sup>3</sup> of additional water quality volume under the larger expansion will be mitigated, given this is above and beyond the Capacity articulated in the Corridor Studies.<sup>142</sup>

**a. The DEIR/S Needs To Adopt And Evaluate All Feasible Mitigation.**

*Construction Mitigation*

Notably, Attachment 1 to the Horner Expert Letter contains the following recommendations that must be evaluated and implemented to mitigate the impacts from the construction phases of this project:

1. As the top priority, emphasize construction management practices as follows:
  - Maintain existing vegetation cover, if it exists, as long as possible.
  - Perform ground-disturbing work in the season with smaller risk of erosion, and work off disturbed ground in the higher risk season.
  - Limit ground disturbance to the amount that can be effectively controlled in the event of rain.
  - Use natural depressions and plan excavation to drain runoff internally and isolate areas of potential sediment and other pollutant generation from draining off the site, so long as safe in large storms.
  - Schedule and coordinate rough grading, finish grading, and final site stabilization to be completed in the shortest possible time overall and with the shortest possible lag between these work activities.

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<sup>140</sup> Water Quality and Stormwater Runoff Study Final Report, Interstate 710 Corridor Project Between Ocean Boulevard and the State Route 60 Interchange, 07-LA-710-PM 5.4/24.6 EA: 249900 WBS 165.10.35 (“Stormwater Report”), 4-6.

<sup>141</sup> Horner Expert Letter, at 4.

<sup>142</sup> Horner Expert Letter, at 4.

2. Stabilize with cover appropriate to site conditions, season, and future work plans. For example:
  - Rapidly stabilize disturbed areas that could drain off the site, and that will not be worked again, with permanent vegetation supplemented with highly effective temporary erosion controls until achievement of at least 90 percent vegetative soil cover.
  - Rapidly stabilize disturbed areas that could drain off the site, and that will not be worked again for more than three days, with highly effective temporary erosion controls.
  - If at least 0.1 inch of rain is predicted with a probability of 40 percent or more, before rain falls stabilize or isolate disturbed areas that could drain off the site, and that are being actively worked or will be within three days, with measures that will prevent or minimize transport of sediment off the property.
3. As backup for cases where all of the above measures are used to the maximum extent possible but sediments still could be released from the site, consider the need for sediment collection systems including, but not limited to, conventional settling ponds and advanced sediment collection devices such as polymer-assisted sedimentation and advanced sand filtration.
4. Specify emergency stabilization and/or runoff collection (e.g., using temporary depressions) procedures for areas of active work when rain is forecast.
5. If runoff can enter storm drains, use a perimeter control strategy as backup where some soil exposure will still occur, even with the best possible erosion control (above measures) or when there is discharge to a sensitive water body.
6. Specify flow control SCMs to prevent or minimize to the extent possible:
  - Flow of relatively clean off-site water over bare soil or potentially contaminated areas;
  - Flow of relatively clean intercepted groundwater over bare soil or potentially contaminated areas;
  - High velocities of flow over relatively steep and/or long slopes, in excess of what erosion control coverings can withstand; and
  - Erosion of channels by concentrated flows, by using channel lining, velocity control, or both.
7. Specify stabilization of construction entrance and exit areas, provision of a nearby tire and chassis wash for dirty vehicles leaving the site with a wash water sediment trap, and a sweeping plan.
8. Specify construction road stabilization.

9. Specify wind erosion control.
10. Prevent contact between rainfall or runoff and potentially polluting construction materials, processes, wastes, and vehicle and equipment fluids by such measures as enclosures, covers, and containments, as well as berming to direct runoff.<sup>143</sup>

### *Operational Mitigation*

The Horner Expert Letter also articulates measures that should be used to mitigate water quality impacts during the operation of this facility. Like EPA,<sup>144</sup> Commenters recommend using Low Impact Development (“LID”). As the Horner Expert Report describes:

LID is a system of practices aimed at avoiding or minimizing runoff above pre-development quantities and reducing pollutants in any remnant excess runoff before its discharge. These methods concentrate on exploiting the capabilities of vegetation and soil to mimic pre-development site hydrology and effectuate pollutant capture mechanisms (e.g., solids filtration, exchange of toxic metal ions in runoff with innocuous metal ions like calcium in soils). The techniques reduce pollutant mass loadings by decreasing both their concentrations in runoff and the quantity of water transporting these contaminants.<sup>145</sup> Hallmarks of LID practices are amending soils with organic compost and selecting appropriate vegetation, preferably in several canopy layers, to increase water storage, infiltration, and evapotranspiration and improve pollutant removal mechanisms. Conventional practices such as selected in the 2009 studies utilize whatever soils are present and a simple vegetation palette (e.g., grasses) and generally fail to achieve as much volume reduction or water quality improvement.<sup>146</sup>

The Horner Expert Letter also provides ample examples of mitigation measures that must be evaluated and used for this project.<sup>147</sup> Commenters also note that many of the practices to address stormwater through LID could be combined to help alleviate the severe lack of park space in the region and address the park space that will be dramatically impacted as a result of this project. For example, LID practices are perfectly acceptable in public rights of ways, parks, and other public spaces to help improve the aesthetics and advance recreational opportunities for communities in the project area.

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<sup>143</sup> Horner Expert Letter, Attachment 1 (Attachment F).

<sup>144</sup> See Letter from Connell Dunning, U.S. Environmental Protection Agency, Region IX, to Ronald Kosinski, California Department of Transportation, District 7, Los Angeles, CA, (March 9, 2012).

<sup>145</sup> Loading (mass/unit time) = Concentration (mass/unit volume) x Flow rate (volume/unit time)

<sup>146</sup> Horner Expert Letter, at 5-6.

<sup>147</sup> Horner Expert Letter, at 6-7.

## **b. The Lead Agencies Have a History of Water Quality Violations.**

Metro and Caltrans District 7 (which includes Los Angeles and Ventura Counties) must assure the public that they will take all necessary steps to minimize and mitigate environmental harm resulting from construction and operation of the expanded I-710. Over the last five years, both agencies have been cited for a variety of water quality violations stemming from road construction projects under their management similar to the I-710 Corridor Project.

For example, from 2010-2012 Metro's 405 Pass Widening Project incurred several water quality violations, including eight Category 1 and 2 effluent violations for excessive loading of selenium, lead, copper, arsenic, and total suspended solids.<sup>148</sup>

From 2007-10 Caltrans District 7 incurred 51 deficient reporting violations, and 14 effluent violations including nitrogen, silver, chloride, TDS, sulfate and biological oxygen demand for the I-10 Pavement Rehabilitation Project alone.<sup>149</sup> Over the last five years, several other CalTrans District 7 construction projects have produced violations of other effluent limitations.

Courts allow a review of prior shortcomings in analyzing the adequacy of mitigation measures. The Supreme Court has stated that “[b]ecause an EIR cannot be meaningfully considered in a vacuum devoid of reality, a project proponent’s prior environmental record is properly a subject of close consideration in determining the sufficiency of the proponent’s promises in an EIR.”<sup>150</sup>

In order to fulfill CEQA’s twin purposes of informed decision-making and public accountability, the lead agencies must expand their skeletal analysis of the I-710 expansion’s water quality impacts, in addition to implementing real mitigation measures to address the significant threat to water quality imposed by this project. Moreover, without real data, modeling and analysis, public officials and concerned citizens cannot make a meaningful judgment of the four alternatives and whether any of them have acceptable environmental impacts.

## **XIV. The Environmental Justice Analysis Fails to Disclose and Analyze the True Impacts on the Project on the Surrounding Low-Income Communities of Color.**

Federal and state laws require agencies to consider environmental justice and to prohibit discrimination in their decisionmaking processes. Title VI of the Civil Rights Act of 1964 and related statutes require that there be no discrimination in Federally assisted programs on the basis of race, color, national origin, age, sex, or disability (religion is a protected category under the

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<sup>148</sup> See *State Water Resources Control Board Public Reports* at <http://www.waterboards.ca.gov/ciwqs/publicreports.shtml>.

<sup>149</sup> *Id.*

<sup>150</sup> *Laurel Heights Improvement Assoc. of San Francisco v. Regents of the University of California*, 47 Cal.3d 376, 420 (Cal. 1988).

Fair Housing Act of 1968). Federal Executive Order (EO) 12898 (1994) requires Federal agencies, including the United States Department of Transportation (DOT) and FHWA, to make environmental justice part of their mission and to develop environmental justice strategies. The Presidential Memorandum accompanying the Executive Order specifically singles out NEPA, and states that “[e]ach Federal agency must provide opportunities for effective community participation in the NEPA process, including identifying potential effects and mitigation measures in consultation with affected communities and improving the accessibility of public meetings, crucial documents, and notices.”<sup>151</sup> On August 4, 2011, the Secretary of Transportation, along with heads of other Federal agencies, signed a Memorandum of Understanding on Environmental Justice and Executive Order 12898 (EJ MOU) confirming the continued importance of identifying and addressing EJ considerations in agency programs, policies, and activities as required by E.O. 12898. DOT’s 1997 internal EJ Order (updated in May 2012), establishes procedures and guidance for the Department to implement E.O. 12898. “Compliance with this DOT Order is a key element in the environmental justice strategy adopted by DOT to implement the Executive Order, and can be achieved within the framework of existing laws.”<sup>152</sup> FHWA policy calls for the prevention of disproportionately high and adverse human health or environmental effects on minority and low-income populations, and calls for the collection of related data to identify any risk of discrimination in the implementation of the NEPA, among other Federal statutes.<sup>153</sup>

The State of California has defined “environmental justice” as: “the fair treatment of people of all races, cultures, and incomes with respect to the development, adoption, implementation, and enforcement of environmental laws, regulations, and policies.”<sup>154</sup> Additionally, California has enacted Government Code 11135(a), which states:

No person in the State of California shall, on the basis of race, national origin, ethnic group identification, religion, age, sex, sexual orientation, color, genetic information, or disability, be unlawfully denied full and equal access to the benefits of, or be unlawfully subjected to discrimination under, any program or activity that is conducted, operated, or administered by the state or by any state agency, is funded directly by the state, or receives any financial assistance from the state.

CEQA regulations define impacts or effects to be analyzed as including “ecological (such as the effects on natural resources and on the components, structures, and functioning of affected ecosystems), aesthetic, historic, cultural, economic, social, or health, whether direct, indirect, or cumulative.”<sup>155</sup>

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<sup>151</sup> Memorandum from President Clinton, March 1994, available at: [http://www.epa.gov/fedfac/documents/executive\\_order\\_12898.htm](http://www.epa.gov/fedfac/documents/executive_order_12898.htm).

<sup>152</sup> DOT EJ Order 5610.2(a), May 2012, p. 4, available at [http://www.fhwa.dot.gov/environment/environmental\\_justice/ej\\_at\\_dot/order\\_56102a/](http://www.fhwa.dot.gov/environment/environmental_justice/ej_at_dot/order_56102a/).

<sup>153</sup> FHWA Order 6640.23A, June 14, 2012, available at <http://www.fhwa.dot.gov/legsregs/directives/orders/664023a.htm>.

<sup>154</sup> Cal. Government Code § 65040.12(e).

<sup>155</sup> 40 C.F.R. § 1508.8(b).

**a. Expanding the 710 Freeway Perpetuates Environmental and Transportation Injustice.**

The DEIR/S is clear that the communities surrounding the 710 expansion are predominantly Latino and disproportionately low-income compared to the rest of the region.<sup>156</sup> The 710 DEIR/S states that one of the main goals of the project is to foster economic development to increase the capacity of the freeway in order accommodate projected growth in population and growth in freight movement to and from the Ports of Los Angeles and Long Beach.<sup>157</sup> While the proposed project may or may not provide a hoped-for economic benefit for the region, this project perpetuates a national trend that began in the 1950s (the I-710 was originally constructed during the 1950s - 1970s)—siting highways in minority and low-income communities, displacing or dividing entire communities.<sup>158</sup> The overburdened, underserved communities in Southeast Los Angeles must bear the brunt of the harmful impacts from a project ostensibly intended to benefit the entire region by moving ever-increasing amounts of freight in and out of the Ports of Los Angeles and Long Beach (further sources of pollution in this area); yet, they receive no reciprocal benefits in return for housing this gigantic infrastructure expansion.

Caltrans asserts that locals will, in fact, benefit from this project, too—in “improved mobility” and “corridor time savings,” which “[r]esidents of the Study Area will experience . . . to a greater extent than residents of the reference population area (Los Angeles County) due to their proximity to the facility.”<sup>159</sup> This simplistic analysis masks the true costs and benefits of the project. Reports show that Latinos rely significantly more on public transportation than do whites to commute to work.<sup>160</sup> Latinos and foreign-born residents also carpool at much higher

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<sup>156</sup> DEIR/S at Table 3.3-2, Table 3.3-15.

<sup>157</sup> DEIR/S, at §§ 12.1.2, 12.1.4-12.1.5

<sup>158</sup> Sanchez, Thomas W., Rich Stolz, Jacinta S. Ma, *Moving to Equity: Addressing Inequitable Effects of Transportation Policies on Minorities*. Cambridge, MA: The Civil Rights Project at Harvard University (2003), 3 (hereinafter, “*Moving to Equity*”).

<sup>159</sup> DEIR/S, at 3.3-23, 3.3-44.

<sup>160</sup> A 2003 report noted that, nationwide, while only 7 percent of white households own no cars, 17 percent of Latino households own no cars. As a corollary, while 3 percent of whites rely on public transportation to get to work, 9 percent of Latinos do. *Moving to Equity*, p. 9. Similarly, a 2009 study by the U.S. Census Bureau found that 8.1 percent of Latinos rely on public transit to get to work, while only 3.2 percent of whites do. U.S. Census Bureau, *Commuting in the United States: 2009*, American Community Survey Reports (Sept. 2011), Supplemental Appendix A: Means of Transportation by Selected Characteristics: 2009 (hereinafter, “*Commuting in the United States*”). This percentage with respect to Latinos is likely higher in areas of high poverty rates, like most of the cities along the I-710 corridor. The DEIR/S notes that the percentage of the population in the Study Area considered transit-dependent based solely on age (under 19 and over 65) ranges from 9.7 to 34.8 percent. DEIR/S, 3.3-5 – 6. According to USC researchers, 7.4% of workers over 16 who live within 500 feet of the freeway have no access to cars, as opposed to 4.8% of workers over 16 in Los Angeles County as a whole. The percentage slowly decreases the farther people live from the freeway, until at 2,000 feet and farther the percentage of workers who do not have access to cars matches the percentage of

rates than do whites and native-born residents.<sup>161</sup> Indeed, the DEIR/S never addresses this disparity, nor does it propose actual mitigation measures, such as enforceable comprehensive public transportation and pedestrian / bicycle plans, or even carpool lanes, that might actually truly benefit local communities. Further, as these comments point out elsewhere, even if expanding the freeway improves traffic in the short run, it likely will not improve traffic for long, due to induced demand.<sup>162</sup>

Rather, expanding the 710 freeway repeats and perpetuates the same discriminatory practice that expanding and siting freeways has done for decades: displace families and businesses, and further divide existing communities and disintegrating local networks.<sup>163</sup> When the 710 Freeways was originally completed, and “the last East Los Angeles freeway was slated for widening in 1972, the area easily surpassed other Los Angeles communities in containing the highest percentage of freeways.”<sup>164</sup> Indeed,

[t]he disparity between how much East Los Angeles land and other community property is devoted to freeways is alarming. For example, within the City of Los Angeles, freeways account for about 4 percent of total land surface of streets and highways. Overall, freeways utilize some 19 percent of Eastside property. In unincorporated East Los Angeles, 32 percent of the land use is covered with streets and freeways. In Boyle Heights, over 50 percent of the area is utilized for freeways and industrial zoning.<sup>165</sup>

Nowhere—not even in the environmental justice analysis—does the DEIR/S for a project that proposes to exacerbate these disparities mention them.

The DEIR/S does admit that the project will displace from 416 to 945 residences, from 203 to 459 businesses or other “nonresidential” property, and an apartment complex for senior citizens with developmental disabilities.<sup>166</sup> Most of the relocations will occur in Compton and

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workers in LA County. U.S.C. Program for Environmental and Regional Equity (PERE), Demographic comparison of neighborhoods near the 710 Freeway to Los Angeles County, California and the United States (2010) and Maps, attached as Attachment H.

<sup>161</sup> U.S. Census Bureau, *Commuting in the United States*, 5.

<sup>162</sup> Traffic & Air Quality Report, at 13.

<sup>163</sup> See e.g., Estrada, Gilbert, “If You Build it, They Will Move: The Los Angeles Freeway System and the Displacement of Mexican East Los Angeles, 1944-1952,” *Southern California Quarterly* (Fall 2005) 87(3): 287-315.

<sup>164</sup> *Id.* at 306.

<sup>165</sup> *Id.*

<sup>166</sup> DEIR/S at 3.3-22, 3.3-28 (Table 3.3-9), Table 3.3-10, Table 3.3-11. By contrast, the I-405 widening project, which passes through an area with income levels higher than Los Angeles County and City and percentages of minority populations lower in the project area than in the City of Los Angeles—in fact, the median income is twice the median income for either the County or the City—only displaces a handful of residences and businesses, with minimal impacts to tax revenues. I-405 Sepulveda Pass Project Draft EIR/S, available at: [http://www.dot.ca.gov/dist07/resources/envdocs/docs/I405\\_SepulvedaPass\\_IR\\_EIS.pdf](http://www.dot.ca.gov/dist07/resources/envdocs/docs/I405_SepulvedaPass_IR_EIS.pdf), at 69,

Commerce, the two cities that already have the highest unemployment rates (20.6 and 22.7 percent, respectively).<sup>167</sup> According to a 2003 report by the Civil Rights Project at Harvard,

When housing is taken away for freeway projects in minority and low-income communities or becomes unaffordable, the displaced individuals have fewer options for seeking alternative housing and may end up living farther away from their jobs and social networks. This will be especially burdensome if their transportation options are limited. An individual's residential location is crucial and encompasses not only issues of affordability, but also access to public schools, police and fire protection, and public transportation.<sup>168</sup>

The DIER/EIS confirms these findings and notes the psychological harms caused by displacement:

Residents have disclosed symptoms of stress, loss, grief, and poorer mental health following housing displacement and relocation. Certain groups, including children, the elderly, the intellectually disabled, and marginalized groups [such as low-income communities and minorities], can be particularly vulnerable to the health effects of housing displacement.<sup>169</sup>

The freeway has already damaged the social cohesion of the neighborhoods along the 710 corridor, and widening the freeway and displacing residents only further shatters them.

In addition to the psychological impacts of displacing people from their homes, the displacement of businesses decreases tax revenue in these low-income areas—areas that are most in need of this revenue. The DEIR/S estimates sales tax revenue losses from \$350,732 to \$999,044 per year for 10 cities along the I-710 corridor, and between \$973,838 and \$2,842,352 in lost property tax revenue among these cities.<sup>170</sup> In addition, the Study Area (average 15.7 percent, excluding Vernon, with 11 cities above 15 percent) already suffers from unemployment rates that are higher than Los Angeles County (12.6 percent) and the State (12.1 percent).<sup>171</sup> The

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Table 3.3-1, 73, 81, Table 3.3-4. Some alternatives appear also to acquire a Salvation Army shelter (Bell Shelter) and other facilities on the Salvation Army's land, though to what extent is unclear. *See e.g.*, DEIR/S, at Appendix L, Figure 2.4-2, No. 28. *See also*, comments submitted on the I-710 Corridor Project by Public Counsel and the Salvation Army. Bell Shelter houses 60 beds for homeless adults.

<sup>167</sup> DEIR/S, at Table 3.3-7, Table 3.3-10.

<sup>168</sup> *Moving to Equity*, 19.

<sup>169</sup> DEIR/S, at 3.3-24. For a personal story of residents—two children—displaced by the construction of the Golden State Freeway, see Estrada, 300: “‘It’s kind of sad. We lost all our friends and had to move into an area which was gang infested,’ according to Joe; he rarely played outside again. It was equally disturbing for Hortensia who ‘really missed [her] cousins and aunts’ after her family was displaced by the freeway. When the freeway was built, it ended their church attachments, their family homes and their childhood experiences in Boyle Heights.”

<sup>170</sup> DEIR/S, at 3.3-32 – 38.

<sup>171</sup> DEIR/S, at Table 3.3-7.

DEIR/S estimates between 440 and 1,349 employee “relocations” due to the acquisition of businesses.<sup>172</sup> Whether or not these employees will, in fact, reclaim their jobs or find new ones is unclear. The DEIR/S fails to acknowledge the scale of these impacts. The City of Commerce, for instance, already has a depression-level unemployment rate (22.7 percent), and a preliminary finding by the City of Commerce’s technical consultants shows a projected further loss as a result of the project of 7.8-8.9 percent of the jobs in Commerce and a loss of 2.4-4 percent of sales tax-generated city revenue, aside from hundreds of thousands of dollars in lost property tax revenue and significant displacements.<sup>173</sup> The small, overburdened cities that line the 710 corridor simply cannot and should not have to withstand such an enormous assault to their economies.

The DEIR/S claims that “all I-710 Corridor cities would experience a beneficial impact temporarily from direct jobs (jobs generated during construction) and permanently from indirect job growth (jobs generated as a result of the operation of the project) associated with the build alternatives.”<sup>174</sup> Construction jobs are temporary, however, and there is no data to support these blanket assertions, let alone any plan for how to relocate displaced businesses within the same communities. Further, though communities of color are often the ones who suffer the impacts of freeway projects in their neighborhoods, “they do not usually reap the benefits of lucrative contracts or high-paying jobs in construction industry. . . . [T]oo many of these jobs are filled by workers living in other neighborhoods.”<sup>175</sup> Indeed, people of color and women are either underrepresented in the construction industry or hold the lowest paying jobs. In fact, “Latino construction workers are likely to be among the lowest-paid workers. . . . [R]ecent data from the Bureau of Labor Statistics reveal that the median weekly earning of Latinos is lower than that of all other racial groups.”<sup>176</sup>

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<sup>172</sup> DEIR/S, at 3.3-32. The Preliminary Peer Review Findings by the technical consultants for the City of Commerce found that a projected loss of 446-510 jobs in the City of Commerce (which has an unemployment rate of 22.7 percent) represents 7.8-8.9 percent of jobs currently in the city. I-710 Corridor Project Draft EIR / EIS, Preliminary Peer Review Findings, City of Commerce (August 21, 2012) (hereinafter, “City of Commerce, Preliminary Findings”), attached in Attachment J.

<sup>173</sup> DEIR/S, at Table 3.3-7; City of Commerce, Preliminary Findings, Attachment J.

<sup>174</sup> DEIR/S, at 3.3-42-43; see also, Community Impact Assessment, Table 5.1-C, which shows estimated jobs created from construction, both directly and indirectly (through the “additional employment and business activity that would be generated in the regional economy by the initial construction expenditure for the project”), 5.1-11. Calculations to support these estimates are not provided, however; the DEIR/S simply states: “[p]otential direct and indirect job creation for each city was estimated according to that city’s share of 2035 employment in all I-710 Corridor cities, as indicated in the SCAG growth forecast for the 2012 Regional Transportation Plan,” 6-16.

<sup>175</sup> *Moving to Equity*, at 26

<sup>176</sup> *Moving to Equity*, at 28, citing U.S. Bureau of Labor Statistics (2003). Usual Weekly earnings of Wage and Salary Workers, Table 2: Median Usual Weekly Earnings of Full-Time Wage and Salary Workers by Age, Race Hispanic or Latino ethnicity, and sex, first quarter 2003 averages, not seasonally adjusted. Retrieved May 2003 from <http://www.bls.gov/news.release/wkyeng.t02.htm>.

The Alameda Corridor project in South Los Angeles, which also runs through low-income communities of color, required that “30 percent of all hours” worked on one portion of the project go to local hires, and “funded a pre-apprenticeship program, which provided stipends for 650 local residents.”<sup>177</sup> Similarly, although it will not fully remedy the disparity in construction work between Latinos and other groups, at the very least Caltrans should agree to hire local residents for the portions of the project that are not federally funded (such as those parts funded by Measure R).

The Civil Rights Project report notes that widening freeways and displacement affects access to public schools. Already, many students must cross the freeway to get from their homes to their schools.<sup>178</sup> School budget cuts means that children increasingly reliant on public transportation or walking, rather than school buses, to attend school.<sup>179</sup> According to one study, “65 schools are located within one mile of the I-710 Freeway,” and the DEIR/S notes at least 60 within ½ of a mile from the 710 Freeway mainline and interchange improvements.<sup>180</sup> Further, “[d]isparities in the number of pedestrian deaths are exacerbated because higher percentages of people of color than of whites do not own a car and must rely on walking as a primary mode of transportation.”<sup>181</sup> According to the Civil Rights Project, “one study of pedestrian injuries found that children who are pedestrians are at increased risk for serious traumatic brain injury and lifelong disability if they live in poverty, face a large traffic volume and traffic moving at high speeds, and lack space to play other than sidewalks and streets.”<sup>182</sup>

The DEIR/S acknowledges the positive health impacts of walking and biking, especially on childhood obesity, yet offers no mitigation plan beyond a blanket assertion that the project will result in new curbs, gutters, striping, replacing old sidewalks and crosswalks (of which not many exist to begin with) with new ADA compliant ones, and shoulders.<sup>183</sup> At the same time, as noted elsewhere in these comments, the 710 Corridor Project will seriously impact several parks in this already park-poor area of Los Angeles. These parks include basketball hoops, baseball fields, children’s play structures, and picnic areas, all of which allow children to get exercise and

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<sup>177</sup> *Moving to Equity*, at 27.

<sup>178</sup> For example, Bell Gardens Elementary School sits up against the 710 Freeway, and Bell Gardens Intermediate School is about one block east of the freeway. Students who attend these schools cross the 710 Freeway (often on foot or bicycle) at Clara Street, Florence Avenue, or Gage Avenue. This is just one example of many schools (over 60) within one-mile of the freeway.

<sup>179</sup> *Moving to Equity*, at 23.

<sup>180</sup> Matsuoka, M., Hricko, A., Gottlieb, R., and De Lara, J. *Global Trade Impacts: Addressing the Health, Social and Environmental Consequences of Moving International Freight Through Our Communities*. Occidental College and University of Southern California (Los Angeles, 2011) (hereinafter, “*Global Trade Impacts*”), 20, citing Designation of schools along I-710 Freeway in Thomas Brothers Guide of Los Angeles, Research by Andrea Hricko, 2009; DEIR/S, at 3.3-12 – 13, Table 3.3-5.

<sup>181</sup> *Moving to Equity*, at 25

<sup>182</sup> *Moving to Equity*, at 26, citing Rivara, F. P., “Pediatric Injury Control in 1999: Where do we go from here?” *Pediatrics* (1999), 103(4), 883-888.

<sup>183</sup> DEIR/S, at 3.3-21, 3.3-26.

families to spend time together outside. Before proceeding with this project, Caltrans must create a complete pedestrian and bike plan, including safer ways for children to walk and bike to schools, for the corridor communities in order to actually achieve project goals of improving traffic and air quality and to provide benefits to residents harmed by the project. Anything less further perpetuates environmental injustice in these communities.

**b. The DEIR/S Requires More Analysis of Existing Local Conditions in Order to More Fully Understand and Explain the Air Pollution Impacts to the Surrounding Overburdened Communities**

While the DEIR/S does note that the populations immediately adjacent to the project are disproportionately poor and Latino, it fails to take into account the fact that “low-income and minority communities are more vulnerable to pollution impacts than other communities.”<sup>184</sup> The DEIR/S should thus identify stressors that could aggravate the project’s harms within these communities in order to adequately analyze the environmental effects of the project on the surrounding communities.<sup>185</sup>

Rates of diseases—including asthma and cancer—are also higher among overburdened populations, such as low-income and minority populations, living near freeways.<sup>186</sup> Children, pregnant women, and the elderly within these populations are particularly susceptible to reduced lung function and aggravation of asthma and other chronic pulmonary disorders from living, working, or going to school near freeways.<sup>187</sup> A study based on California Health Interview

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<sup>184</sup> United States Environmental Protection Agency, Comments on the Administrative Draft Environmental Impacts Statement (ADEIS) for the Interstate 710 Corridor Project from Ocean Boulevard in the City of Long Beach to State Route 60 in Los Angeles County, California (addressed to Ronald Kosinski, March 9, 2012) (hereinafter, “EPA Comments on ADEIS”), 10, citing Symposium on the Science of Disproportionate Environmental Health Impacts, March 17-19, 2010, see the fourteen scientific reviews commissioned by EPA and published in the American Journal of Public Health at: <http://www.epa.gov/compliance/ej/multimedia/albums/epa/disproportionate-impacts-symposium.html>.

<sup>185</sup> In its Comments on the Administrative DEIS, EPA notes that children—although not a subpopulation generally considered in environmental justice analyses—are particularly vulnerable to near-roadway exposures. EPA argues that Caltrans should clearly identify sensitive receptors—especially children (schools and daycare centers) and the elderly (senior centers)—within 500 feet of the freeway, noting that California law restricts the construction of schools within 500 feet of a freeway because children are at higher risk of near-roadway pollution impacts than adults. EPA Comments on ADEIS, 10.

<sup>186</sup> *Global Trade Impacts*, 16, citing McCreanor, J., Cullinan, P., Nieuwenhuijsen, M. J. et al., “Respiratory effects of Exposure to Diesel Traffic in Persons with Asthma,” *New England J. Med.* (2007) 357(23): 2348-58.

<sup>187</sup> *Moving to Equity*, 25, citing (fn 153, 154). See also *Global Trade Impacts*, 16, 17, citing Gauderman W. J., Vora H. McConnel R., et al., “Effect of Exposure to Traffic on Lung Development from 10 to 18 years of Age: A Cohort Study,” *Lancet*, (2007) 369: 571-577; McConnel, R., Berhane K., Yao, L., et al., “Traffic, Susceptibility, and Childhood Asthma,”

Survey (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.*<sup>188</sup> *Those in poverty may also be disproportionately exposed to pollution due to older and poorer quality housing. 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 PM 2.5.*<sup>189</sup>

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).<sup>190</sup> Studies have also shown that exposure to near-roadway pollution, such as diesel, increases the risk of lung and breast cancers, reduced sperm production and endocrine disruption, cardiovascular disease, cognitive impairment, diabetes, and heart and lung disease-related death.<sup>191</sup> According to a recent report, “an analysis

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*Environ. Health Perspect.* (May 2006), 114(5): 766-72; McConnell, R., Islam, T., Shankardass, K., Jerrett, et al., “Childhood Incident Asthma and Traffic-Related Air Pollution at Home and School,” *Environ. Health Perspect.* (Jul 2010), 118(7): 1021-6; Gauderman, W. J., Avol, E., Lurmann, F., et al., “Childhood Asthma and Exposure to Traffic and Nitrogen Dioxide,” *Epidemiology* (2005), 16: 737-43.

<sup>188</sup> 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.

<sup>189</sup> 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.

<sup>190</sup> South Coast Air Quality Management District. Multiple Air Toxics Exposure Study-III. September 2008, available at

<http://www.aqmd.gov/prdas/matesIII/MATESIIIFinalReportSept2008.html>.

<sup>191</sup> *Global Trade Impacts*, 17-18, citing Crouse, D.L., et al., “Postmenopausal Breast Cancer is Associated with Exposure to Traffic-Related Air Pollution in Montreal Canada: A Case-Control Study,” *Environ. Health Perspect.* (2010) 118(11); Kunzli, N., et al., “Ambient Air Pollution and the Progression of Atherosclerosis in Adults,” *PLoS One* (Feb 8, 2010) 5(2): e9096; Ranft, U., et al., “Long-term Exposure to Traffic-Related Particulate Matter Impairs Cognitive Function in the Elderly,” *Environ. Res.* (2009) 109(8): 1004-11; Kramer, U., et al., “Traffic-Related Air Pollution and Incident Type 2 Diabetes: Results from the SALIA Cohort Study,” *Environ. Health Perspect.* (2010) 118(9): 1273-9; Hoek, G., et al., “Association Between Mortality and Indicators of Traffic-Related Air Pollution in the Netherlands: A Cohort Study,” *Lancet* (2002) 360: 1203-1209; Andersen, Z. J., et al., “Chronic Obstructive Pulmonary Disease and Long-Term Exposure to Traffic-Related Air Pollution: A Cohort Study,” *Am. J. Respir. Crit. Care Med.* (Feb 15, 2011) 183(4): 455-61. See also, *Global Trade Impacts*, 22, Table: Selected Health, Worker & Community Impacts—Freight Transportation. See also, Gauderman W. J., Vora H. McConnel R., et al., “Effect of Exposure to Traffic on Lung Development from 10 to 18 years of Age: A Cohort Study,” *Lancet*, (2007) 369: 571-577; Brugge D., Durant J. L., Rioux C., “Near-Highway Pollutants in Motor Vehicle Exhaust: A Review of Epidemiologic Evidence of Cardiac and Pulmonary Health Risks, *Environ. Health* (2007) 6: 23, available at:

<http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1971259/>; Kim J. J., Huen K., Adams S., et al.,

of cancer by census tracts in Los Angeles County found elevated rates of throat, mouth and tongue cancers and certain types of lung cancer in close proximity to [the] truck-congested I-710 freeway in Los Angeles County. . . .”<sup>192</sup>

One issue the DEIR/S fails to take into account is the differences in exposures and risks on children in particular from freeway pollution. At least 60 schools sit within 1/2 mile of the 710 Freeway, many of which are within 500 feet or sit directly up against the freeway. A survey of 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.<sup>193</sup> 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.<sup>194</sup> Studies have shown that truck traffic intensity and pollutant levels measured in schools are significantly associated with chronic respiratory symptoms.<sup>195</sup>

In this case, several elementary schools—including Bell Gardens and Humphreys Avenue—currently abut the Freeway, and the proposed project does little to mitigate impacts to the schools. The mitigation measures Caltrans proposes—namely, soundwalls—are little more than what the State offered schools seventy years ago when building the East LA interchange. Then, the Division of Highways took over a portion of Soto Street Elementary School for the Santa Ana Freeway and “without exercising sufficient mechanisms to abate subsequent overcrowding, excessive noise, or environmental health implications resulting from the high amounts of vehicular emissions the freeway would bring about to the children attending the freeway-adjacent school.”<sup>196</sup> In 2003, the California Air Resources Board studied air quality impacts on children’s health in Boyle Heights. Monitoring showed that levels of PM10, which is found in diesel soot, at Soto Street Elementary School “exceeds state PM10 standards twenty-eight out of thirty-seven days, or 75 percent of the time. Schools slightly farther from the East Los Angeles Interchange are only moderately cleaner, exceeding state PM10 standards ten out of thirty-four days, or 31 percent of the time, and ten out of thirty-two days, or 29 percent of the time, at the East Los Angeles Science Center.”<sup>197</sup>

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“Residential Traffic and Children’s Respiratory Health,” *Environ. Health Perspect.* (2008) 116: 1274-1279.

<sup>192</sup> *Global Trade Impacts*, 18, citing Mack, T., *Cancers in the Urban Environment*, 1<sup>st</sup> ed. Oxford, UK: Elsevier Academic Press: 2004.

<sup>193</sup> 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.

<sup>194</sup> McConnell, R. et al., “Childhood Incident Asthma and Traffic-Related Air Pollution at Home and School,” *Environmental Health Perspectives* (2010) 118(7): 1021-1026.

<sup>195</sup> 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. et al., “Motor Vehicle Exhaust and Chronic Respiratory Symptoms in Children Living Near Freeways,” *Environmental Research* (1997) 74(2): 122-32.

<sup>196</sup> Estrada, at 296.

<sup>197</sup> Estrada, at 308.

Living near freeways also damages children's health in ways differentiated from adults. A 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.<sup>198</sup> A study in Denver 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 contract leukemia.<sup>199</sup> A Danish study of several thousand children concluded that a doubling of vehicle pollution increased the risk of lymphomas by 25 percent.<sup>200</sup> 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 of cancer with distance from these roadways and facilities.<sup>201</sup>

Living near freeways also increases the risk of low-birth weight babies, miscarriages and other pregnancy complications.<sup>202</sup> 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.<sup>203</sup> 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.<sup>204</sup> A study of California children found an increased risk of autism among children who lived within 300 meters of a freeway during the third trimester and shortly after birth.<sup>205</sup> As result of all of these correlations between freeway exposure and diseases in children, in its Comments on the Administrative DEIR/S, EPA notes that Executive Order 13405 on Children's Health and Safety directs federal agencies to identify and assess environmental health and safety risks that may disproportionately affect children, and

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<sup>198</sup> Gauderman, W.J., et al., "Effect of Exposure to Traffic on Lung Development from 10 to 18 Years of Age: a Cohort Study," *Lancet* (2007) 369(9561): 571-7.

<sup>199</sup> 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.

<sup>200</sup> Raaschou-Nielsen, O., et al., "Air Pollution from traffic at the residence of children with cancer," *Am J Epidemiology* (2001) 153:433-443.

<sup>201</sup> Knox and Gilman, "Hazard proximities of childhood cancers in Great Britain from 1953-1980," *Journal of Epidemiology and Community Health* (1997) 51:151-159.

<sup>202</sup> *Global Trade Impacts*, 17, citing Wu, J., et al., "Association Between Local Traffic-Generated Air Pollution and Preeclampsia and Preterm Delivery in the South Coast Air Basin of California," *Environ. Health Perspect.* (2009) 117(11); Legro, R.S., et al., "Effect of Air Quality on Assisted Human Reproduction," *Human Reproduction* (2010) 25(5): 1317-1324.

<sup>203</sup> Wilhelm, 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): 1212-21.

<sup>204</sup> Ritz B. et al., "Ambient air pollution and risk of birth defects in Southern California," *Am J Epidemiology* (2002) 155:17-25.

<sup>205</sup> Volk, H., "Residential Proximity to Freeways and Autism in the CHARGE Study," *Environmental Health Perspectives* (2010) doi: 10.1289/ehp.1002835, available at <http://dx.doi.org>.

to ensure their programs address these risks.<sup>206</sup>

The current DEIR/S does not discuss any of this information in its discussion of the project's impacts on neighboring communities. Yet, as EPA states, "disadvantaged, underserved, and overburdened communities are likely to come to the table with pre-existing deficits of both a physical and social nature that make the effects of environmental pollution more, and in some cases, unacceptably, burdensome. Thus, certain subpopulations may be more likely to be adversely affected by a given stressor than the general population."<sup>207</sup> These vulnerabilities or susceptibilities can include: "inequities in levels of harmful environmental exposures, deficient services or benefits, and differentials in the ability to withstand or mitigate harms, because of the complex interplay of factors in communities with a history of social and economic disadvantage, inadequate services, and environmental hazards."<sup>208</sup> In addition, EPA also recognizes "chronic psychosocial stress, in response to emerging evidence of the potential contributions of social context and psychosocial hazards to differential environmental health outcomes," as a factor contributing to increased risk of harm from environmental exposures.<sup>209</sup> Added to these stressors, as EPA noted in a 2010 response on air quality and environmental justice, "minority, low income, and indigenous populations have borne a disproportionate share of the cumulative air toxics health impacts from goods movement."<sup>210</sup>

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<sup>206</sup> EPA recommends assessing the project's impact to children's environmental health by incorporating child-specific exposure factors using EPA's Child Specific Exposure Factors Handbooks, 2008. EPA Comments on ADEIS, 13-15.)

<sup>207</sup> EPA Comments on ADEIS, 10, citing *EPA's Framework for Cumulative Risk*, available at <http://www.epa.gov/raf/publications/framework-cra.htm>; Sacks, Jason D. et al. "Particulate Matter-Induced Health Effects: Who Is Susceptible?" *Environmental Health Perspectives* (2010) 119(4).

<sup>208</sup> Onyemaechi C. Nweke, Devon Payne-Sturges, Lisa Garcia, Charles Lee, Hal Zenick, Peter Grevatt, Sanders William H.III, Heather Case, and Irene Dankwa-Mullan, "Symposium on Integrating the Science of Environmental Justice into Decision-Making at the Environmental Protection Agency: An Overview," *American Journal of Public Health* (December 2011) Vol. 101, No. S1, pp. S19-S26, available at <http://ajph.aphapublications.org/doi/full/10.2105/AJPH.2011.300368>, citing Office of Environmental Justice. *Factors for Identifying and Assessing Disproportionate Environmental Health Impacts*. Washington, DC: Environmental Protection Agency; 2007.

<sup>209</sup> Onyemaechi C. Nweke, Devon Payne-Sturges, Lisa Garcia, Charles Lee, Hal Zenick, Peter Grevatt, Sanders William H.III, Heather Case, and Irene Dankwa-Mullan, "Symposium on Integrating the Science of Environmental Justice into Decision-Making at the Environmental Protection Agency: An Overview," *American Journal of Public Health* (December 2011) Vol. 101, No. S1, pp. S19-S26, available at <http://ajph.aphapublications.org/doi/full/10.2105/AJPH.2011.300368>.

<sup>210</sup> EPA, Response to the National Environmental Justice Advisory Council Report: Reducing Air Emissions Associated with Goods Movement: Working Toward Environmental Justice (2010) (hereinafter EPA, Response to NEJAC Report), 13, available at <http://www.epa.gov/compliance/ej/resources/publications/nejac/epa-resp-nejacgoods-movement-2009.pdf>.

The DEIR/S fails to include any of these studies or data in its analysis, and fails to analyze how the clear demographic data showing that the surrounding communities are overburdened, low-income, and minority affects the communities' risks for adverse impacts from the project. In order to adequately analyze the impacts and risks on communities living near the proposed expansion, therefore, the DEIR/S must first clearly identify the vulnerabilities and susceptibilities of the surrounding communities.<sup>211</sup> Given the likelihood that these communities also already suffer from high rates of pulmonary and cardiac diseases, cancers, pregnancy complications, adverse cognitive effects, diabetes, and other diseases with risks associated with living, working, or going to school near freeways, the DEIR/S must also identify the existing rates and severity of these diseases—especially those that disproportionately affect low-income and minority populations—among children and the general population living at the very least within one quarter of a mile of the proposed project.

Once Caltrans has clearly identified these risk factors and disease rates and severity, it must then fully analyze the impacts of the project on these communities, given both the vulnerabilities and susceptibilities of the surrounding communities and known impacts of roadway pollution on the health of those nearby. Researchers have identified several methodologies for undertaking this analysis.<sup>212</sup> Because Caltrans has failed to describe existing conditions among the surrounding community, it has not and cannot meaningfully describe impacts and mitigation measures it can take to remediate these impacts. For example, because Caltrans failed to identify existing asthma rates and severity among a population known to have high rates of asthma, it has not and cannot identify the impacts from construction and operation of the proposed project on asthma rates and severity.<sup>213</sup>

In fact, as noted elsewhere in these comments, the DEIR/S fails to quantitatively analyze localized impacts of PM and mobile source air toxics (MSATs), despite a high likelihood that the project will result in PM hotspot exceedances and elevated cancer risks along the freeway.<sup>214</sup> In

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<sup>211</sup> See Council on Environmental Quality, Environmental Justice Guidance Under the National Environmental Protection Act (Dec. 10, 1997) (hereinafter, CEQA EJ Guidance under NEPA), 9, available at <http://ceq.hss.doe.gov/nepa/regs/ej/justice.pdf>, which directs agencies to “recognize the interrelated cultural, social, occupational, historical, or economic factors that may amplify the natural and physical environmental effects of the proposed agency action.”

<sup>212</sup> See e.g., Joel Schwartz, David Bellinger, and Thomas Glass, “Expanding the Scope of Environmental Risk Assessment to Better Include Differential Vulnerability and Susceptibility,” *American Journal of Public Health* (December 2011) Vol. 101, No. S1, pp. S88-S93; Joel Schwartz, David Bellinger, and Thomas Glass, “Exploring Potential Sources of Differential Vulnerability and Susceptibility in Risk From Environmental Hazards to Expand the Scope of Risk Assessment,” *American Journal of Public Health* (December 2011) Vol. 101, No. S1, pp. S94-S101; Joel Schwartz, David Bellinger, and Thomas Glass, “Expanding the Scope of Risk Assessment: Methods of Studying Differential Vulnerability and Susceptibility,” *American Journal of Public Health* (December 2011) Vol. 101, No. S1, pp. S102-S109.

<sup>213</sup> EPA proposes that Caltrans also quantify the costs associated with impacts on asthma rates. EPA Comments on ADEIS, 15.

<sup>214</sup> Traffic & Air Quality Report, at 17.

order to provide a meaningful environmental justice analysis the DEIR/S must provide a quantitative assessment of PM2.5-related morbidity and mortality and a quantitative analysis of MSAT-associated risk, both according to race/ethnicity, income, age, and other vulnerability factors, such as those listed above.<sup>215</sup>

Construction-related impacts also harm local communities. Air pollution, noise pollution, and traffic changes caused by construction, for instance, can harm the communities living near the proposed project. The DEIR/S must identify any potential disproportionate impacts on communities living near the proposed project, analyzed by race/ethnicity, income, age, and other vulnerability factors. In addition, construction-related impacts can also cause acute harm to sensitive receptors. Poor air quality can cause and aggravate illness, while noise and traffic congestion can harm school learning and ability to work, along with the ability to travel to school, work, and other important places. EPA recommends that Caltrans include much more information on construction impacts, including how and where the project will be phased in over time, and quantified estimates of “construction-related changes in ambient concentration, MSAT risks, and PM2.5 mortality and morbidity,” added to the operation impacts while construction occurs.<sup>216</sup> Noise levels must also be included in this quantitative analysis. In its environmental justice analysis, Caltrans must analyze construction and operational impacts according the vulnerability and sensitivity factors described above.

Finally, the analysis of cumulative impacts on local, low-income communities and minority communities is non-existent. The DEIR/S lists approximately thirty projects that are going to be built along with the proposed project, all of which are related to freight transport, and most of which will bring more diesel, particulate, and toxic pollution to the communities along the 710 corridor. These include, among others: China Shipping Terminal, APL Terminal, Yang Ming Terminal, SR-47 project, SCIG and ICTF intermodal railyard projects, Middle Harbor project, Pier S project, and the Gerald Desmond Bridge replacement. THE DEIR/S admits “there would be some disproportionate adverse impacts related to air quality and noise very near the I-170.”<sup>217</sup> Similarly, it admits that the construction of many of these projects will overlap and would “temporarily affect environmental justice populations. . . . [via] disruption of local traffic patterns and access to residences and businesses, increased traffic congestions, and increased noise, vibration and dust.”<sup>218</sup> The only “mitigation” proposed for these harms include Caltrans’ unsupported assertion that construction and operation of the projects would provide jobs, which “would benefit local economies that include minority and low-income populations,” and that mitigation measures, such as discounted tolling for “low-income drayage drivers” if a tolling alternative is selected, and other unspecified “mitigation measures in other sections of the Draft EIR/EIS” will reduce impacts, “with the exception of those who are located very near I-710 and experience noise and air quality impacts that cannot be fully mitigated and/or abated.”<sup>219</sup> In other words, only the most disadvantaged who cannot afford to move farther from the freeway and must endure its impacts everyday already will be further (disproportionately)

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<sup>215</sup> EPA Comments on ADEIS, at 11, 15-16.

<sup>216</sup> EPA Comments on ADEIS, at 7-8.

<sup>217</sup> DEIR/S, at 3.25-44.

<sup>218</sup> DEIR/S, at 3.25-44 – 45.

<sup>219</sup> DEIR/S, at 3.25-45, emphasis added; 3.3-53.

harmful by all of these projects. What is more, the DEIR/S ignores the fact that communities surrounding the 710 corridor are *already* overburdened with other industrial sources of pollution, such as the Ports of LA and Long Beach, large refineries, scrap yards, chrome platers, lead smelters, and other facilities. These cumulative impacts of all of these pollution sources with the 710 project must be identified and analyzed as described above.<sup>220</sup>

**c. For Any Impacts Identified, the DEIR/S Must Identify Specific Mitigation Measures**

In part because the analysis of existing local conditions is so inadequate, Caltrans cannot propose mitigation measures to address the clear impacts this project will have on local communities. For example, as with cumulative construction impacts, Caltrans admits that “construction activities will temporarily affect environmental justice populations,” but again offers to mitigate these impacts only with unsupported assertions that construction will provide local jobs and a yet-to-be-drafted Traffic Management Plan (TMP).<sup>221</sup> Other measures proposed to mitigate construction impacts are so broad as to be meaningless. For example, for construction noise mitigation, the DEIR/S proposes site restrictions and “shielding with barriers,” and “[e]ducating contractors and their employees to be sensitive to noise impact problems. . . .”<sup>222</sup> Where will the site restrictions and shielding occur? How will the community know whether the “education” is adequate? In its comments on the ADEIS, EPA suggested some specific mitigation measures, including ensuring that construction staging areas are not near sensitive receptors, and the “utilization of green construction equipment. . . .”<sup>223</sup> This example is only one of many that provide platitudes and general policy goals instead of real mitigation measures.

Rather, as EPA suggests, Caltrans should identify and include “mitigations supported by the community” to “further protect the community from disproportionate and adverse impacts of the project.”<sup>224</sup> These measures should be “developed through open, collaborative processes that include the public and affected citizens.”<sup>225</sup> CEHAJ has put forth a “community preferred”

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<sup>220</sup> See Council on Environmental Quality, Environmental Justice Guidance Under the National Environmental Protection Act (Dec. 10, 1997) (hereinafter, “CEQA EJ Guidance under NEPA”), 9, available at <http://ceq.hss.doe.gov/nepa/reg/ej/justice.pdf>, which directs agencies to “consider relevant public health data and industry data concerning the potential for multiple or cumulative exposure to human health or environmental hazards in the affected population and historical patterns of exposure to environmental hazards, to the extent such information is reasonably available. For example, data may suggest there are disproportionately high and adverse human health or environmental effects on a minority population, low-income population, or Indian tribe from the agency action. Agencies should consider these multiple, or cumulative effects, even if certain effects are not within the control or subject to the discretion of the agency proposing the action.”

<sup>221</sup> DEIR/S, at 3.24-28.

<sup>222</sup> DEIR/S, at 3.24-49-50.

<sup>223</sup> EPA Comments on ADEIS, at 16.

<sup>224</sup> EPA Comments on ADEIS, at 10.

<sup>225</sup> EPA Comments on ADEIS, at 11.

alternative that includes both project alternatives and mitigation measures for both construction and operation of the project.<sup>226</sup> These include, among other measures, free public transit in the study area during all phases of construction, zero/near zero emission construction equipment, river improvements, community benefits, such as local hire for the non-federally-funded portion of the project, and the development of comprehensive public transit and pedestrian and bicycle elements. Additionally, both CEHAJ and EPA recommend an ongoing mitigation fund and grant program similar to the ones set up by the Port of Long Beach (Mitigation Grant Program) and the Port of Los Angeles in response to the new TRAPAC terminal construction (a new non-profit, the Harbor Community Benefits Foundation).<sup>227</sup> As EPA suggests, a program such as this could:

- Fund proactive measures to improve air quality in neighboring homes, schools, and other sensitive receptors;
- Provide public education programs about environmental health impacts to better enable residents to make informed decisions about their health and community; and
- Engage in proactive measures to train and hire local residents for construction or operation of the project to improve their economic status and access to health care.<sup>228</sup>

Additionally, Caltrans must look to other guidelines and studies to incorporate mitigation measures. EPA suggests that to “the extent that the separately completed HIA can inform mitigation measures, Caltrans should adopt and implement all feasible measures.”<sup>229</sup> Similarly, guidelines such as those suggested in CARB’s *Air Quality and Land Use Handbook: A Community Health Perspective* and EPA’s Draft Schools Environmental Health Guidelines should help inform the creation of more specific mitigation measures.<sup>230</sup>

It is interesting to contrast some of the mitigation measures proposed for two other freeways currently undergoing expansions, both of which travel through wealthier, less diverse communities—the I-405 Freeway in west Los Angeles, and the SR-520 Freeway in Seattle.<sup>231</sup>

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<sup>226</sup> Community Alternative 7, Attachment A.

<sup>227</sup> EPA Comments on ADEIS, at 12.

<sup>228</sup> EPA Comments on ADEIS, at 13.

<sup>229</sup> EPA Comments on ADEIS, at 12.

<sup>230</sup> CARB, *Air Quality and Land Use Handbook: A Community Health Perspective*, available at <http://www.arb.ca.gov/ch/landuse.htm>; EPA, Draft State School Environmental Guidelines, available at <http://www.epa.gov/schools/ehguidelines/index.html>.

<sup>231</sup> I-405 Sepulveda Pass Project Draft EIR/S, available at, [http://www.dot.ca.gov/dist07/resources/envdocs/docs/I405\\_SepulvedaPass\\_IR\\_EIS.pdf](http://www.dot.ca.gov/dist07/resources/envdocs/docs/I405_SepulvedaPass_IR_EIS.pdf), at 69, Table 3.3-1, and 72, Table 3.3-3; According to the US Census Bureau (2010 census), the areas housing the 520 widening project are predominantly high income and white. For instance, Medina, WA has a population of 2,969, of which 2,478 identify as themselves as white, and Clyde Hill next door has a population of 2,984 of which 2,517 identify themselves as white. <http://www.census.gov/popfinder/?fl=53:5313365:5344725>. Based on 2009 data, the median household income for Medina / Clyde Hill was \$170,605 / \$193,599, and per capita income was \$92,410 / \$85,193 (compared to Washington State at \$56,548 and \$28,847, respectively).

During construction of the I-405, for instance, Caltrans promises to “[c]oordinate with representatives of the homeowner associations and community organizations to avoid construction activities in the immediate vicinity during major events.”<sup>232</sup> To address cumulative impacts, Caltrans would “[e]stablish a Construction Traffic Committee which would consist of a representative(s) from each planned project, to develop a construction plan that would minimize cumulative community impacts.”<sup>233</sup> In contrast to the I-405 project, the I-710 corridor project contains no comprehensive coordination strategies like those for the I-405 project, to address the construction and cumulative impacts of the 710 expansion.

Similarly, the 520 Freeway in Seattle, based on the recommendation of a SR 520 Noise Expert Review Panel and in response to community input puts forth several mitigation measures to alleviate increased noise that Caltrans has so rapidly dismissed, including landscaped lids, soundwalls, “noise-absorptive material on the traffic barriers and around the lid portals and expansion joints,” a higher profile for the project to reduce noise levels throughout the area, reduced speeds in some areas, and quieter concrete pavement.<sup>234</sup> The landscaped lids would serve not only to reduce noise, but also would “reconnect neighborhoods, enhance movement of pedestrians and cyclists, restore and create views, and provide access to existing and new transit stops.”<sup>235</sup> Additionally, the SR 520 project includes a brand new 14-foot-wide bicycle/pedestrian path to connect to existing paths and public transit.<sup>236</sup> Unlike the multiple noise mitigation measures implemented for the SR-520 project, Caltrans proposes only soundwalls for the I-710, and even then finds some soundwalls too expensive, thus “unreasonable” in several places.<sup>237</sup> Unlike the 520 project as well, Caltrans does not even analyze lids to reconnect communities, enhance movement of pedestrians and cyclists (many of whom are children walking or cycling to

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<http://www.city-data.com/income/income-Medina-Washington.html>; <http://www.city-data.com/income/income-Clyde-Hill-Washington.html>. In 2010, the larger surrounding city, Bellevue, had a population of 122,363, of whom 59.2% identified as white, non Hispanic, with a median household income of \$81,912. <http://quickfacts.census.gov/qfd/states/53/5305210.html>. (The other large area through which the freeway widening project runs is part of Seattle, a large portion of which is the University of Washington, so it is more difficult to find precise census data on that area.) Compare these numbers to the 710 communities, which are over 90 percent Latino, and the per capita income of people who live within 2,000 feet of the 710 Project is \$13,039. U.S.C. Program for Environmental and Regional Equity (PERE), Demographic comparison of neighborhoods near the 710 Freeway to Los Angeles County, California and the United States (2010) and Maps, Attachment H.

<sup>232</sup> I-405 Sepulveda Pass Project Draft EIR/S, *available at*

[http://www.dot.ca.gov/dist07/resources/envdocs/docs/I405\\_SepulvedaPass\\_IR\\_EIS.pdf](http://www.dot.ca.gov/dist07/resources/envdocs/docs/I405_SepulvedaPass_IR_EIS.pdf), at 16.

<sup>233</sup> I-405 Sepulveda Pass Project Draft EIR/S, *available at*

[http://www.dot.ca.gov/dist07/resources/envdocs/docs/I405\\_SepulvedaPass\\_IR\\_EIS.pdf](http://www.dot.ca.gov/dist07/resources/envdocs/docs/I405_SepulvedaPass_IR_EIS.pdf), at 17.

<sup>234</sup> SR 520, I-5 to Medina: Bridge Replacement and HOV Project, *available at*

<http://www.wsdot.wa.gov/Projects/SR520Bridge/EIS.htm>, Final EIS Executive Summary, 17.

<sup>235</sup> SR 520, I-5 to Medina: Bridge Replacement and HOV Project, *available at*

<http://www.wsdot.wa.gov/Projects/SR520Bridge/EIS.htm>, Final EIS Executive Summary, 15.

<sup>236</sup> SR 520, I-5 to Medina: Bridge Replacement and HOV Project, *available at*

<http://www.wsdot.wa.gov/Projects/SR520Bridge/EIS.htm>, Final EIS Executive Summary, 15.

<sup>237</sup> DEIR/S, at Table 3.14-3.

school on the other side of the freeway), or provide access to existing or new transit stops. Indeed, the DEIR/S for the I-710 expansion fails to include any real plan for enhancing public transit or pedestrian/bicycle movement. The communities surrounding the 710 bear the brunt of the harms from this massive project, but receive few benefits in return.

**a. Caltrans' and the Federal Highway Administration's Analysis Contradicts Federal Environmental Justice Orders**

As noted above, in May 2012, the Department of Transportation (DOT) updated its 1997 internal EJ Order, which establishes procedures and guidance for the Department and its Operating Administrations to implement E.O. 12898 (DOT EJ Order).<sup>238</sup> “Compliance with this DOT Order is a key element in the environmental justice strategy adopted by DOT to implement the Executive Order. . . .”<sup>239</sup> The DOT EJ Order includes a mandate to administer statutes so as to “identify and avoid discrimination and avoid disproportionately high and adverse effects on minority populations and low-income populations by,” among other methods:

proposing measures to avoid, minimize and/or mitigate disproportionately high and adverse environmental and public health effects and interrelated social and economic effects, and *providing offsetting benefits and opportunities to enhance communities, neighborhoods, and individuals affected by DOT programs, policies, and activities*, where permitted by law and consistent with the Executive Order, [and]

*Considering alternatives to proposed programs, policies, and activities, where such alternatives would result in avoiding and/or minimizing disproportionately high and adverse human health or environmental impacts*, consistent with the Executive Order.<sup>240</sup>

It further requires that all activities that “will have a disproportionately high and adverse effect on minority populations or low-income populations will only be carried out if further mitigation measures or alternatives that would avoid or reduce the disproportionately high and adverse effect are not practicable.”<sup>241</sup> Significantly, in “determining whether a mitigation measure or alternative is ‘practicable,’ the social, economic (including costs) and environmental effects of avoiding or mitigating the adverse effects will be taken into account.”<sup>242</sup> Indeed, the order reiterates the need to take social costs into account by requiring that if a project disproportionately harms a

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<sup>238</sup> See

[http://www.fhwa.dot.gov/environment/environmental\\_justice/ej\\_at\\_dot/dot\\_ej\\_strategy/index.cfm](http://www.fhwa.dot.gov/environment/environmental_justice/ej_at_dot/dot_ej_strategy/index.cfm).

<sup>239</sup> Department of Transportation Updated Environmental Justice Order 5610.2(a) (May 2012), (hereinafter DOT EJ Order), available at:

[http://www.fhwa.dot.gov/environment/environmental\\_justice/ej\\_at\\_dot/order\\_56102a/](http://www.fhwa.dot.gov/environment/environmental_justice/ej_at_dot/order_56102a/).

<sup>240</sup> DOT EJ Order (emphasis added).

<sup>241</sup> DOT EJ Order.

<sup>242</sup> DOT EJ Order.

group protected under Title VI of the Civil Rights Act, that project can *only* be carried out if there is

- (1) a substantial need for the program, policy, or activity exists, based on the overall public interest; *and*
- (2) alternatives that would have less adverse effects on protected populations (and that still satisfy the need identified in subparagraph d(1) above), either
  - (a) would have other adverse social, economic, environmental or human health impacts that are severe; or
  - (b) Would involve increased costs of extraordinary magnitude.<sup>243</sup>

Thus, DOT's guidelines require Caltrans to carefully examine mitigation measures and alternatives that alleviate disproportionate impacts, and if it chooses a path that harms protected groups, to demonstrate that alternatives with less impacts would involved increased costs of *extraordinary magnitude*.<sup>244</sup>

Caltrans failed to undertake this analysis. In fact, a review commissioned by CBE of the process Caltrans undertook to develop and then eliminate project alternatives shows that Caltrans never gave much serious thought to alternatives that would have provided "offsetting benefits and opportunities to enhance communities." The report concluded:

The [Major Corridor Study] focused almost exclusively on highway options with the exception of a single transit option. The transit option was not well developed and little effort seemed to go into creating a competitive design. For example, why not consider a subway which would have avoided ROW [right of way] impacts which turned out to be a very important concern for the community? And why not consider alterative [*sic*] alignments that could spur additional economic growth and maximize ridership? Finally, why were differing levels of transit not considered such as new light rail lines or bus rapid transit? These seem to be failures caused in part by not engaging with the community early enough and in a meaningful way which would have identified air quality and ROW impacts as two very important concerns that were initially overlooked. A well thought out transit plan may have addressed these concerns. Additionally, these failures represent a lack of creativity. The alternatives propose traditional solutions based on familiar designs, an approach that ensures continuing the status quo of trying to accommodate all highway traffic rather than trying to manage demand or provide alternatives. The EIR/EIS alternatives were similarly uncreative and focused on highway solutions.

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<sup>243</sup> DOT EJ Order (emphasis added).

<sup>244</sup> See also US Department of Transportation, Federal Highway Administration, Guidance on Environmental Justice Under NEPA (December 16, 2011), available at: [http://environment.fhwa.dot.gov/projdev/guidance\\_ej\\_nepa.asp](http://environment.fhwa.dot.gov/projdev/guidance_ej_nepa.asp), requiring these evaluations to made in the NEPA document.

The selection of robust metrics for judging the initial set of alternatives was problematic in both studies. Mobility metrics were focused almost exclusively on measuring mobility for highway users. The mobility of transit users, alternative goods movement systems, pedestrians, and cyclists were not considered. The MCS initial screening analysis also failed to include a metric that considered air quality which was one of the projects stated needs. To a lesser extent there were also problems with the way data were presented and discussed. In some cases where metrics indicated that preferred alternatives (those that would ultimately be carried forward) performed poorly the data were described or displayed in a way to make them seem insignificant. This occurred by selectively displaying metrics as either raw numbers or as the relative change. It is impossible to know if this was intentional, but it does bias the analysis.<sup>245</sup>

Given the lack of attention to the needs of the surrounding communities, and the laser-like focus on moving freight trucks to and from the Ports, Caltrans failed to abide by DOT's clear order; Caltrans could not have and did not consider any real community benefits, mitigation measures, or alternatives that would avoid this project's clear disproportionate impacts on the surrounding overburdened communities.

**b. Failure to Translate the 710 DEIR/S Into Spanish Until Over Two Weeks After the DEIR/S was Released in English, and Failure to Include and “Official” Spanish Translation Perpetuates Environmental Injustice and Violates CEQA and NEPA**

As the DEIR/S admits, the I-710 corridor is comprised overwhelmingly of Latino populations. These communities are either bilingual or monolingual Spanish speaking communities. Community members requested that the DEIR/S be released in Spanish. The Project Committee agreed to recommend that at the very least, the Executive Summary would be released in Spanish. Caltrans never released any portion of the DEIR/S in Spanish. Caltrans released the DEIR/S on or about July 1, 2012, but only in English. CEHAJ sent Caltrans emails requesting the Spanish translation. The Gateway Council of Governments released the Spanish (and other languages) translation only of the Executive Summary on or about July 17, 2012, as a “courtesy” to those speaking other languages. The disclaimer in the Notice of the Translated Executive Summary states: “[t]he translations have not been reviewed by the authors of the studies nor the Gateway Council of Governments and therefore we cannot vouch for their accuracy. Due to the nature of translated documents, we recommend consulting the official document as referred to in the Notice of Public Hearings and Availability of Environmental Impact Report/Statement posted on the Caltrans web site for further information and for making comments.”<sup>246</sup> Unfortunately, the Caltrans website does not include the Spanish translation of the Executive Summary, presumably because as the disclaimer further notes: “[t]his translation

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<sup>245</sup> Gould, Gregory, “Analysis of the Alternatives Selection Process for the Interstate 710 Corridor Project,” Technical Memorandum (August 30, 2012), at 15, attached as Attachment I.

<sup>246</sup> Gateway Cities Council of Governments, Notice and Translated Executive Summary (Spanish), available at [http://www.metro.net/projects\\_studies/I710/images/eir-eis/0.0\\_710\\_Exec\\_Sum\\_Notice\\_sp.pdf](http://www.metro.net/projects_studies/I710/images/eir-eis/0.0_710_Exec_Sum_Notice_sp.pdf).

of this document has been provided for information only and is not an official part of the “I-710 Corridor Project Draft Environmental Impact Report/Draft Environmental Impact Study.”<sup>247</sup> In order to ensure that the local community understands the breadth of the expansion project, and to allow the meaningfully participate in review of the draft EIR, Caltrans should have released the DEIR/S along with a full, official Spanish translation on the same date, and made that available along with the English version on its website. Failure to do so perpetuates environmental injustice and violates CEQA and NEPA.

The Environmental Impact Report (EIR) under CEQA is the document that provides the public information about the possible environmental impacts of a proposed project. CEQA Guidelines section § 15004, subd. (c) states that “EIRs... should be prepared as early as feasible in the planning process to enable environmental considerations to influence project program and design and yet late enough to provide meaningful information for environmental assessment.”<sup>248</sup> CEQA requires public review of the draft EIR; therefore, the “lead agencies should furnish copies of draft EIRs to public library systems serving the area involved. Copies should also be in the offices of the Lead Agency.”<sup>249</sup> CEQA requirements and policy goals that the public be able to meaningfully participate in the CEQA process affirm the necessity of translating environmental review documents for the community surrounding the project. In order to allow Spanish-speaking communities the same right as English-speaking communities to comment on the project, Caltrans should have translated and released a Spanish version of the DEIR/S on the same day it released the English version, and made this official version available on its website for comment along with the English version.

NEPA includes an additional incentive to agencies to translate documents into the dominant language of the community housing the project. Under Presidential Executive Order 12898, “Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations,” each federal agency is required to make achieving environmental justice part of its mission.<sup>250</sup> The Presidential Memorandum accompanying the Executive Order specifically singles out NEPA, stated that “[e]ach Federal agency must provide opportunities for effective community participation in the NEPA process, including identifying potential effects and mitigation measures in consultation with affected communities and improving the accessibility of public meetings, crucial documents, and notices.”<sup>251</sup>

Notably, the Council on Environmental Quality’s Environmental Justice Guidance Under the National Environmental Quality Act, interpreting the Executive Order, stresses the importance of public participation throughout the NEPA process, specifically singling out the

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<sup>247</sup> *Id.* Interestingly, Caltrans does provide translations of studies for the 710 North Extension Project (Tunnel). See e.g., <http://www.dot.ca.gov/dist07/710study/>. It is unclear why Caltrans provided translations for one project and not the other.

<sup>248</sup> CEQA Guidelines § 15004(b).

<sup>249</sup> CEQA Guidelines § 15087(g).

<sup>250</sup> Executive Order 12898, Federal actions to address environmental justice in minority populations and low-income populations, 59 Fed. Reg. 7629 (February 16, 1994).

<sup>251</sup> Memorandum from President Clinton, March 1994, available at: [http://www.epa.gov/fedfac/documents/executive\\_order\\_12898.htm](http://www.epa.gov/fedfac/documents/executive_order_12898.htm).

necessity of translating NEPA documents if the community affected by the project speaks a language other than English:

[p]articipation of low-income populations, minority populations, or tribal populations may require adaptive or innovative approaches to overcome linguistic, institutional, cultural, economic, historical, or other potential barriers to effective participation in the decision-making processes of Federal agencies under customary NEPA procedures.<sup>252</sup>

Additionally, the Council on Environmental Quality's Environmental Justice Guidance Under the NEPA, interpreting the Executive Order, suggests appropriate methods to ensure public participation for non-English speaking members of the public, including:

- Translation of major documents (or summaries thereof), provision of translators at meetings, or other efforts as appropriate to ensure that limited-English Speakers potentially affected by a proposed action have an understanding of the proposed action and its potential impacts;
- Provision of opportunities for limited-English speaking members of the affected public to provide comments throughout the NEPA process.<sup>253</sup>

Therefore, both the policy goals behind NEPA (as with CEQA) and the Executive Order explicitly support the translation of EIS documents for community members that are non-English speaking. Under both laws—CEQA and NEPA—Caltrans was required to translate the 710 DEIR/S into Spanish and release it on the same day it released the English version, so that the surrounding community members who had a primary language of Spanish had the same amount of time to comment as English speakers. This would have allowed these Spanish speakers to fully and meaningfully participate in the environmental decisionmaking process.

### **c. Conclusion**

Caltrans knows that the 710 travels through predominantly low-income neighborhoods of color. Aside from offering the appearance (but not the reality) of providing opportunities for meaningful public participation in the development of the project, however, Caltrans has minimized its duty to properly analyze the environmental justice impacts of the project under CEQA and NEPA, including in the areas of community cohesion, noise, air quality, and health risk. It has failed to provide alternatives and mitigation measures that would benefit the surrounding overburdened communities, as required by the US Department of Transportation, and it has failed to adequately state why it so readily dismissed feasible alternatives and mitigation measures that would have benefited these communities. Caltrans has dismissed the concerns and needs of the low-income communities of color that must bear the burden of housing this massive infrastructure, freight transport project. Caltrans' actions constitute

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<sup>252</sup> Council on Environmental Quality, Environmental Justice Guidance Under the National Environmental Protection Act (Dec. 10. 1997) (hereinafter, "CEQA EJ Guidance under NEPA"), 13, available at <http://ceq.hss.doe.gov/nepa/regs/ej/justice.pdf>.

<sup>253</sup> CEQ EJ Guidance Under NEPA, 13.

deliberate indifference to the rights of the largely Latino, poor neighbors of the project and violates Government Code section 11135, and Title VI of the Civil Rights Act.

### **XV. The DEIR/S Improperly Segments the I-710 Corridor Project From the Larger 710-Freight Network Under CEQA and NEPA.**

Segmentation of proposed projects is highly disfavored by both CEQA and NEPA. As a result, agencies are required to discuss the “whole of an action” or “connected actions” in a single EIR/S.<sup>254</sup> The purpose of this requirement is “to prevent an agency from dividing a project into multiple ‘actions,’ each of which individually has an insignificant environmental impact, but which collectively has a substantial impact.”<sup>255</sup> Courts use the same set of factors to analyze segmentation of a highway project under both CEQA and NEPA: 1) whether the highway section is “as long as practicable to permit consideration of environmental matters on a broad scope, meaning the section falls between ‘logical termini’ (major crossroads, population centers, major traffic generators, or similar highway elements)”; 2) whether the segment in question has “independent utility”; 3) whether the length selected assures adequate opportunity for consideration of alternatives required by the act; and 4) whether the highway segment under consideration seems to fulfill important state and local needs.<sup>256</sup> Segmentation is proper only if all of these factors are met.<sup>257</sup>

California and Ninth Circuit Courts have found segmentation of a highway project to be proper under a limited set of circumstances. Only when the segment in question runs through logical termini (either population centers or other completed interstates), is not dependent on any pending proposals for major actions regarding related projects, provides opportunity for and actually does discuss alternatives and their impacts in the EIR/S, *and* actually fulfills a state and local need, such as reducing traffic congestion or increasing transportation safety, may an agency properly segment a highway section from related or connected projects.<sup>258</sup> In the Ninth Circuit, the most important factor is whether the segment has substantial independent utility, such that

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<sup>254</sup> Pub. Res. Code § 21100; CEQA Guidelines, § 15378 (a), (c); 40 C.F.R. § 1508.25.

<sup>255</sup> *Wetlands Action Network v. U.S. Army Corps. of Eng’rs*, 222 F.3d 1105, 1118 (9th Cir. 2000). *See also Rio Vista Farm Bureau Center v. County of Solano*, 5 Cal.App.4th 351, 370 (1992) (quoting *Bozung v. Local Agency Formation Commission of Ventura County*, 13 Cal.3d 263, 283-284 (1975)) (precludes “chopping a large project into many little ones—each with a minimal potential impact on the environment—which cumulatively may have disastrous consequences.”).

<sup>256</sup> *Daly v. Volpe*, 514 F.2d 1106, 1110 (9th Cir. 1975); *see also Del Mar Terrace Conservancy, Inc. v. City Council*, 10 Cal.App.4th 712 (1992) (disapproved on other grounds by *Western State Petro v. Superior Court*, 9 Cal.4th 559 (1995)) (because “CEQA was modeled on [NEPA], California Courts have consistently treated judicial and administrative interpretation of the latter enactment as persuasive authority in interpreting CEQA”).

<sup>257</sup> *Lange v. Brinegar*, 615 F.2d 812, 815 (9th Cir. 1980).

<sup>258</sup> *See Adler v. Lewis*, 675 F.2d 1085 (9th Cir. 1982); *Daly v. Volpe*, 514 F.2d 1106 (9th Cir. 1975); *Del Mar Terrace Conservancy, Inc. v. City Council*, 10 Cal.App.4th 712 (1992); *Lange v. Brinegar*, 625 F.2d 812 (9th Cir. 1980); *Thomas v. Peterson*, 753 F.2d 754, 759-760 (9th Cir. 1985).

the agency might “reasonably consider constructing only the segment in question.”<sup>259</sup> Applying these factors, the Ninth Circuit has upheld such projects as a roadway that creates a by-pass for a town plagued by extreme congestion, and an interstate highway connecting two other existing highways for more efficient and safer means of transportation.<sup>260</sup>

The I-710 Corridor Project segment is quite different from these cases, however. Instead of a highway project that serves as roadway by-pass or connector highway between two already-built interstates, for instance, the I-710 Corridor Project is part of a larger freight-network that includes the extension of the I-710 North, from Alhambra to the 210 freeway in Pasadena (“I-710 Extension”), and a projected 60 Freeway freight corridor (“East-West Freight Corridor”) (consisting of truck-only lanes along the 60 Freeway, currently a northern interchange of the I-170 Freeway).<sup>261</sup>

The I-710 Extension project has been ongoing since the late 1950s, when Caltrans first started purchasing homes to make way for the extension, and has been a contemplated part of the I-710 since its inception.<sup>262</sup> Since 1959, California has intended to create one freeway (then called LRN 167) to extend from the Ports to what is now the I-210 in Pasadena.<sup>263</sup> Although the project has been delayed due to legal battles and community opposition, Caltrans is currently researching tunneling alternatives and is in the process of completing an EIR/S.<sup>264</sup> Like *Indian Lookout Alliance v. Volpe*, 484 F.2d 11, 20 (8th Cir. 1973), which held that the highway segment in question did not have independent utility because there was a “commitment to further

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<sup>259</sup> *Thomas v. Peterson*, 753 F.2d at 760.

<sup>260</sup> *Daly*, 514 F.Supp at 1111; *Lange*, 625 F.2d at 814-816.

<sup>261</sup> See Southern California Association of Governments (“SCAG”), East-West Freight Corridor: Presentation to Plans and Programs Technical Advisory Committee (September 13, 2011), available at: [http://www.scag.ca.gov/pptac/pdfs/agendas/091311/pptac091311\\_5.3EastWestCorridorUpdate.pdf](http://www.scag.ca.gov/pptac/pdfs/agendas/091311/pptac091311_5.3EastWestCorridorUpdate.pdf); SCAG, Proposed East-West Freight Corridor, fact sheet (updated January 17, 2012), available at <http://rtpscs.scag.ca.gov/Documents/factsheets/EastWestCorridor.pdf>.

<sup>262</sup> See e.g., California Department of Transportation (Caltrans), 710 North Gap Closure, Scoping Summary Report, Volume II (September 1, 2011), Appendix C, 710 Historical Log of Events (1930-2010), available at: [http://www.dot.ca.gov/dist07/resources/envdocs/docs/SSR\\_volume\\_II\\_revised.pdf](http://www.dot.ca.gov/dist07/resources/envdocs/docs/SSR_volume_II_revised.pdf); City of South Pasadena, South Pasadena’s Historic Opposition to a Surface Extension, <http://www.ci.south-pasadena.ca.us/transportation/710.html>.

<sup>263</sup> California Department of Transportation (Caltrans), 710 North Gap Closure, Scoping Summary Report, Volume II (September 1, 2011), Appendix C, 710 Historical Log of Events (1930-2010), available at: [http://www.dot.ca.gov/dist07/resources/envdocs/docs/SSR\\_volume\\_II\\_revised.pdf](http://www.dot.ca.gov/dist07/resources/envdocs/docs/SSR_volume_II_revised.pdf); City of South Pasadena, South Pasadena’s Historic Opposition to a Surface Extension, <http://www.ci.south-pasadena.ca.us/transportation/710.html>. See also <http://www.cahighways.org/161-168.html#LR167>.

<sup>264</sup> Caltrans, 710 North Gap Closure Project, Scoping Summary Report, Volume I (September 30, 2011), available at: [http://www.dot.ca.gov/dist07/resources/envdocs/docs/710gap\\_SSR\\_Sept-2011\\_v1.pdf](http://www.dot.ca.gov/dist07/resources/envdocs/docs/710gap_SSR_Sept-2011_v1.pdf).

extension appearing on the record,” the I-710 Extension shows Caltrans’ commitment to further extend the freeway. In *Indian Lookout Alliance*, the southern terminus of the I-80 segment in question connected to a section of the freeway that was in the project stage and had received approval.<sup>265</sup> The court held that this other section was evidence that the segment in question did not have independent utility, but instead was reliant on the other section’s completion.<sup>266</sup> Similarly, here, both segments are part of the substantial commitment to extend the freeway overall and are therefore dependent on each other.

Additionally, the I-710 Corridor Project is unlike the highway segment in another Ninth Circuit case, *Del Mar Terrace*, 10 Cal.App.4th at 734, which reduced traffic without any other widening projects or connectors, because the I-710 expansion necessarily relies on the completion of other proposed projects (I-710 Extension and the East-West Corridor, among others) in order to reduce traffic and avoid a bottleneck. All of these projects are part of a proposed freight network designed to accommodate projected growth from the Ports of Los Angeles and Long Beach (“Ports”).<sup>267</sup> As one court has stated,

In some situations the relationship of several roads or parts of road may be so interrelated that no one road or part of a road can function as an efficient carrier of motor vehicles except in conjunction with the others. In such a case, it is possible that it would be necessary to have an EIS which would have as its subject all of the roads or parts of roads which could only function efficiently as a unit. In such an unusual situation, the several roads would not constitute a system of highways but would be treated essentially as a single highway for the purpose of the EIS.<sup>268</sup>

Such is the case here. Unlike in *Lange*, 625 F.2d 812, a Ninth Circuit case in which the highway segment proposed to connect two built freeways and relieve congestion as a result, the I-710 Expansion alone cannot relieve congestion from the growing Ports of Los Angeles and Long Beach without the simultaneous construction of the I-710 Extension, the East-West Freight Corridor, the Gerald Desmond Bridge replacement, and other projects. Without these other projects, a bottleneck will form at the intersection of the I-710, I-5, and 60 freeways. The I-710 Expansion is, therefore, more like the highway project in *Dickman v. City of Santa Fe*, 724 F.Supp. 1341, 1346 (D.N.M. 1989), which the court held did not have independent utility because the highway segment would create an “unworkable bottleneck” if improvements outside that section were not made. Similarly, here, although the project may initially reduce traffic, because more cars and trucks will eventually use the freeway as a result of the freeway’s expansion, the ultimate result could be increased traffic and worsened congestion where the expansion project ends.

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<sup>265</sup> *Indian Lookout Alliance v. Volpe*, 484 F.2d at 19.

<sup>266</sup> *Id.* at 20.

<sup>267</sup> See DEIR/S, at 1-29 – 38. The DEIR/S also notes that the Gerald Desmond Bridge (near the Ports), which is directly connected to the I-710 Freeway, is planned for replacement (with a wider bridge), and the I-5 freeway will be widened to accommodate 710 traffic. Further, the reconstruction of the I-605 and I-710 interchanges is tentatively scheduled to begin by 2019. DEIR/S, at 1-35.

<sup>268</sup> *Movement Against Destruction v. Volpe*, 361 F.Supp. 1360, 1385 (D. Md. 1973).

Because the Corridor Project has been contemplated as part of a larger freight network for decades, and cannot fulfill its purpose without other action by Caltrans, it cannot be analyzed without, at the very least, examining the impacts of the I-710 Extension and the East-West Freight Corridor projects as well. As such, the Corridor Project, I-710 Extension, and 60 Freeway Project, along with any other proposed or foreseeable related freight network projects should be discussed in a single EIR/S so as not to dilute the effects or ignore potential region-wide freight transport alternatives that could achieve the mission of accommodating increased trade coming through the Ports in a more holistic, less harmful way.

## **XVI. The DEIR/S's Analysis of the Project's Impacts on Parks is Inadequate.**

The DEIR/S identifies 65 parks and recreation facilities within half a mile of the proposed construction.<sup>269</sup> The DEIR/S provides only minimal assessment of the impacts from this Project to these areas. Similarly, the Draft Section 4(f) Evaluation ("4(f) Evaluation") fails to consider potentially severe impacts to enjoyment and use of parks located directly along the proposed construction. As a result of this bald analysis, these documents fail to (1) adequately analyze the impacts to these facilities, (2) identify alternatives which would limit these impacts to parks, and (3) identify sufficient measures to minimize and mitigate the impacts. This limited analysis fails to meet the requirements of NEPA, CEQA and Section 4(f) of the Department of Transportation Act ("Section 4(f)").

NEPA requires an EIS to carefully assess the impacts of a proposed project and to explore "all reasonable alternatives."<sup>270</sup> CEQA requires that all environmental impacts of a project be analyzed, and that no project be approved "if there are feasible alternatives or feasible mitigation measures available which would substantially lessen the significant environmental effects of such projects."<sup>271</sup> Similarly, under Section 4(f) of the Department of Transportation Act, an agency overseeing a transportation project may not approve any project requiring the use of a significant public park, recreation area, wildlife and waterfowl refuge, or historic site, unless it determines that:

- (1) there is no prudent and feasible alternative to using the property, and
- (2) the project includes all possible planning to minimize harm to the property.<sup>272</sup>

Section 4(f) applies to both physical taking and "constructive use" of parkland.<sup>273</sup> "Constructive use of park land occurs when a road significantly and adversely affects park land even though the road does not physically use the park."<sup>274</sup>

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<sup>269</sup> DEIR/S, 3.1-54 - 1-59, tbl. 3.1-3.

<sup>270</sup> 40 C.F.R. § 1502.14.

<sup>271</sup> Cal. Pub. Res. Code § 21002.

<sup>272</sup> 23 U.S.C. § 138(a); 49 U.S.C. § 303(c).

<sup>273</sup> 23 C.F.R. § 774.17.

<sup>274</sup> *Sierra Club v. Dep't of Trans.*, 948 F.2d 568, 573 (9th Cir. 1991); *see also Laguna Greenbelt, Inc. v. U.S. Dept. of Transp.*, 42 F.3d 517, 533 (9th Cir. 1994).

While numerous parks located along the I-710 Corridor will be subjected to increased noise and visual impacts as a result of the proposed construction, few of these impacts are addressed in the DEIR/S. Relying on the DEIR/S, the 4(f) Evaluation determines that the proposed project will result in no constructive uses of parkland.<sup>275</sup> This treatment and conclusion ignores the serious disruptions to use and enjoyment, both temporary and permanent, which the project will present to many of these parks.

As examples, both Coolidge Park and Julia Russ Asmus Park will be seriously impacted by both the construction activity and highway infrastructure placement and use under the proposed alternatives, yet the DEIS/DEIR and 4(f) Evaluation fail to properly address the impacts to either. Coolidge Park is located directly beside the I-710 Freeway in the City of Long Beach. The park facilitates a wide variety of uses, housing a lighted baseball field, tennis and basketball courts, a playground, and a community center. A large portion of the park consists of a grassy picnic and recreation area, which is shaded by large trees and which offers a peaceful natural environment not found in the surrounding neighborhood. Julia Russ Asmus Park is a small community park located in the City of Bell Gardens, beside the I-710. It contains a basketball hoop, grill, sheltered seating area, and children's play structures, and is easily accessible from Bell Gardens Elementary School.

The DEIR/S's discussion of the impacts to Coolidge Park focuses entirely on the baseball field, which, viewed from the west, comprises Key View 15. The DEIR/S concludes that Alternatives 6A/6B/6C will lower the visual quality of this Key View, due to the impacts of the proposed freight corridor and a planned expansion ramp.<sup>276</sup> However, the DEIR/S fails to discuss the impacts of the project to the other areas of the park, although these areas will likely suffer the most severe impacts. Notably, the DEIR/S entirely fails to address the visual and noise impacts to the park's picnic area. In fact, the DEIR/S uses the scarcity of other parkland in the area to dismiss the impacts of the proposed project to Coolidge Park, noting that because the park is "within an existing urban environment," the visual impacts to the park are not expected to reduce use.<sup>277</sup>

The DEIR/S provides even less analysis for Julia Russ Asmus Park, failing to seriously address any impacts to the park. Given the park's extreme proximity to the planned freeway expansion, it is likely to suffer significant adverse impacts as a result of the construction and expansion. The DEIR/S notes under "Permanent Direct and Indirect Impacts" only that the plan's *Noise Study Report* has found that sound barriers would be feasible and could reduce noise impacts to the park.<sup>278</sup> This oblique discussion of impacts parallels that provided for nearly half the parks and recreation facilities for which the DEIR/S notes any impact.

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<sup>275</sup> 4(f) Evaluation at A-5.

<sup>276</sup> DEIR/S, *Visual Impact Assessment*, at 104-06.

<sup>277</sup> DEIR/S at 3.1-72.

<sup>278</sup> DEIR/S at 3.1-68, tbl. 3.1-5; see DEIS/DEIR *Noise Study Report* at 43 (noting that a sound barrier "has been considered").

The DEIR/S's analysis does not meet the requirements of CEQA. CEQA requires an EIR is supposed to provide "detailed information" on the environmental effects of a proposed project.<sup>279</sup> The minimal information which the DEIR/S presents for the impacts to these parks, and the total lack of information on impacts to others, does not provide suitable information to support reasoned decision making or to inform members of the public of the anticipated effects of the project.

In the Section 4(f) Evaluation, Caltrans claims to have conducted "detailed review" of these parks and other Section 4(f) properties within the vicinity of the project.<sup>280</sup> However, noticeably absent from the Section 4(f) evaluation and the DEIR/S are the fruits of this purported "detailed review." Through this purported analysis, Caltrans determined that only three parks would be physically used by the project. However, the 4(f) Evaluation presents no evidence of any meaningful consideration of constructive use of parkland. For example, for the more than 100 parks, schools, and other properties that are subject to Section 4(f) within half a mile from the proposed development—including Coolidge and Julia Russ Asmus Parks—Caltrans apparently based its no-use finding on the properties' lack of physical overlap with the project's easements and rights-of-way.<sup>281</sup> While this method of analysis could reveal physical uses, it would not indicate constructive uses, which can occur in the absence of physical occupation. The 4(f) Evaluation also claims to have considered constructive uses to parks by reviewing the DEIR/S's impacts analysis.<sup>282</sup> However, the DEIR/S has itself not properly assessed these impacts, and cannot serve as a reasonable guide to determining constructive uses.

This approach does not meet the requirements of Section 4(f). The regulations implementing this statute specifically identify as constructive use a situation in which "[t]he projected noise level increase attributable to the project substantially interferes with . . . [e]njoyment of an urban park where serenity and quiet are significant attributes."<sup>283</sup> Thus, particularly for parks like Coolidge Park, which offer restful natural settings within urban areas, the impacts of this project may be both significant and adverse, and may substantially interfere with enjoyment. Section 4(f) requires Caltrans to actually analyze these effects, not simply make bald claims it conducted this analysis. It certainly is not enough to simply list the parks surrounding the project under a blanket conclusion of no use—Caltrans must actually consider the impacts to these areas.<sup>284</sup>

Section 4(f) sets a national policy that "special effort should be made to preserve the natural beauty of . . . public park and recreation lands . . ."<sup>285</sup> Until Caltrans undertakes sincere

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<sup>279</sup> Cal. Pub. Res. Code § 21061.

<sup>280</sup> 4(f) Evaluation at 3-2, A-1.

<sup>281</sup> 4(f) Evaluation at A-5.

<sup>282</sup> *Id.*

<sup>283</sup> 23 C.F.R. § 774.15.

<sup>284</sup> See *City of S. Pasadena v. Slater*, 56 F. Supp. 2d 1106, 1122-23 (C.D. Cal. 1999) (granting preliminary injunction against proposed expansion of 710 Freeway, where plaintiffs claimed Section 4(f) evaluation "merely repeat[ed] the same conclusion about each property without having conducted a thorough review").

<sup>285</sup> 23 U.S.C. § 138(a); 49 U.S.C. § 303(a).

inquiry into the constructive uses to these parks, it has not made the “special effort” required by Section 4(f).<sup>286</sup>

Further, unless the impacts to these parks are properly analyzed, Caltrans cannot meaningfully consider the range of alternatives, or conduct the necessary planning to minimize the harms to parkland. Section 4(f) only permits use of a park when there is no prudent and feasible alternative to using the park, and the project includes all possible planning to minimize the harm to the park.<sup>287</sup> Under Section 4(f), an alternative is “feasible” merely if it can be built “as a matter of sound engineering judgment.”<sup>288</sup> An alternative is “prudent” so long as it does not unreasonably compromise the project’s stated purpose and need, and does not produce certain “unacceptable,” “severe,” “extraordinary,” “unique,” or “unusual” impacts.<sup>289</sup> Thus, under Section 4(f), an agency approving a transportation project which uses parkland must consider all viable alternatives, even those not fully meeting the identified “needs” of the project:

The mere fact that a “need” for a highway has been “established” does not prove that not to build the highway would be “imprudent” . . . . To the contrary, it must be shown that the implications of not building the highway pose an “unusual situation,” are “truly unusual factors,” or represent cost or community disruption reaching “extraordinary magnitudes.”<sup>290</sup>

Whatever alternative is ultimately selected must include “all possible planning” to minimize the project’s harm to used parkland.<sup>291</sup> “All possible planning” means all reasonable measures to minimize or mitigate harm, including design modifications or goals, provision of comparable replacement land, and monetary compensation.<sup>292</sup>

Similarly, CEQA prohibits approval of any project when feasible alternatives or mitigation measures would substantially lessen the environmental impacts of the project.<sup>293</sup> “Feasible” means “capable of being accomplished in a successful manner within a reasonable period of time, taking into account economic, environmental, legal, social, and technological factors.”<sup>294</sup>

Under both CEQA and NEPA, Caltrans and Metro should consider an alternative plan which includes a zero emission freight corridor, but does not increase the number of general purpose lanes. This alternative is both “prudent” under Section 4(f) and “feasible” under Section 4(f) and CEQA, and could reduce the use and harm to parkland. While this alternative might not prevent all uses of parkland, it would allow increased freight transport efficiency and reduce

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<sup>286</sup> *Id.*

<sup>287</sup> *Id.*

<sup>288</sup> *Id.*; *Citizens to Pres. Overton Park, Inc. v. Volpe*, 401 U.S. 402, 411 (1971).

<sup>289</sup> 23 C.F.R. § 774.17.

<sup>290</sup> *Stop H-3 Ass’n v. Dole*, 740 F.2d 1442, 1455 (9th Cir. 1984), *quoting Overton Park*, 401 U.S. at 411-13.

<sup>291</sup> 23 U.S.C. § 138(a); 49 U.S.C. § 303(c).

<sup>292</sup> 23 C.F.R. § 774.17.

<sup>293</sup> Cal. Pub. Res. Code § 21002.

<sup>294</sup> CEQA Guidelines, § 15364.

traffic impacts while limiting the impact to nearby parks. For example, the reduced footprint of this alternative could potentially allow a freight corridor to be constructed without requiring the total acquisition of Parque Dos Rios. Under Section 4(f), even when all feasible and prudent alternatives require use of parkland, an agency must select the alternative which causes the least overall harm to the affected parks.<sup>295</sup> Because the alternative of a zero-emissions freight corridor with additional general purpose lanes is both prudent and feasible, it warrants consideration independently under Section 4(f), as a viable alternative to those already considered in the DEIR/S.

Finally, until all constructive uses and impacts have been analyzed, the measures necessary to minimize and mitigate the harms to used parkland cannot be determined. The DEIR/S has identified several steps Caltrans will take to minimize the permanent harms to those Section 4(f) properties which will be physically used under the proposed alternatives.<sup>296</sup> However, these steps are not sufficient to address the impacts to parkland, because they do not consider all the impacts of the proposed project. Moreover, these commitments are vague and lack accountability.

In determining how best to minimize the impact to parkland, and in developing mitigation strategies, Caltrans and Metro must consider all uses which will result from the project under all feasible alternatives. These uses include both physical and constructive use, including temporary uses due to construction, and any other noise, aesthetic or other impacts which may affect the enjoyment and use of parkland. Once Caltrans and Metro have determined the scope of these impacts, they should implement all available measures to minimize and mitigate the harms of the project. These measures should include installation of the sound barriers already found to be feasible, consideration of additional safeguards to limit noise and aesthetic interference with parks (including measures to limit construction impacts), and the LID practices described in Section XIII of these Comments. Further, one of the most effective measures to mitigate the harms to existing parks, which we hope Caltrans and Metro will seriously consider, will be the establishment of additional parks to serve the communities affected by the project.

Caltrans and Metro must address these serious deficiencies in their recirculated DEIR/S.

## **XVII. The Health Impact Assessment—Including Its Findings and Recommendations—Must be Included in the DEIR/S.**

The I-710 HIA shows that the health and well being of communities lying nearby the I-710 will be disproportionately impacted by the Project, and identifies many impacts, mitigations and alternatives that are not adequately analyzed in the DEIR/S for the Project. The I-710 HIA, totaling over 450 pages with appendices, extensively critiques the conclusions and findings in the DEIR/S. These include impacts in areas such as: mobility, noise, traffic, air quality, jobs and economic development, and access to neighborhood resources. That is what the HIA specifically was designed to assess, and its findings and recommendations cannot be ignored. *Despite this,*

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<sup>295</sup> 23 C.F.R. § 774.3(c).

<sup>296</sup> DEIR/S, at 3.1-75 - 1-83.

*Caltrans' DEIR/S document unlawfully fails to formally include or incorporate the I-710 HIA, and in fact barely references the I-710 HIA at all. This makes the DEIR/S analysis a sham.*

The findings of the I-710 HIA must be included in the DEIR/S. A successful HIA requires decisionmakers' openness and responsiveness to new information, and we are very concerned that Caltrans has not demonstrated these characteristics. We are concerned that Caltrans first made up its mind that the I-710 should be expanded and that this would, if anything, impact health favorably – and no new data or knowledge from the HIA will change its view. This hostility to the I-710 HIA continues in the DEIR/S. This is *not* how the DEIR/S process is intended to function, and constitutes a violation of governing law, and the principles of transparency and well-informed public policy.

**a. NEPA and CEQA Require that the DEIR/S Take the Findings and Recommendations of the Health Impact Assessment into Account.**

The DEIR/S must thoroughly analyze the analysis, findings and recommendations contained within the *I-710 Corridor Project Health Impact Assessment*.

A Health Impact Assessment is formally defined as a combination of procedures, methods and tools that systematically judges the potential, and sometimes unintended effects, of a proposed project, plan or policy on the health of a population and the distribution of those effects within the population. The HIA identifies appropriate actions to manage those effects.

The HIA is a practical tool that can provide a structured process to determine a policy or project's impact on health, bringing both immediate and long-term health benefits, and ensuring that policy and project dollars are used efficiently to provide the greatest benefit. A typical HIA includes five steps:

1. Screening - Determines the need and value of a HIA;
2. Scoping - Determines which health impacts to evaluate, the methods for analysis, and the workplan for completing the assessment;
3. Assessment and Recommendations - Provides:
  - a. a profile of existing health conditions;
  - b. evaluation of potential health impacts;
  - c. strategies to manage identified adverse health impacts;
4. Reporting - Includes development of the HIA report and communication of findings and recommendations; and
5. Monitoring - Tracks impacts on decision-making processes and the decision as well as impacts of the decision on health determinants.<sup>297</sup>

To provide input into the I-710 HIA, the Gateway Cities COG and Metro developed a framework with four committees comprised of stakeholders from public health, planning, and other county and local agencies, the ports and goods movement industry, and impacted residents and environmental justice advocates. With input from these committees, the HIA Scope was

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<sup>297</sup> See [www.humanimpact.org](http://www.humanimpact.org).

developed. The Scope prioritized research questions regarding impacts on health through changes in air quality, noise, mobility, traffic safety, jobs and economic development, and neighborhood resources. Thereafter, the HIA was prepared, and based on its collective study, analysis and findings, the HIA makes nearly 100 recommendations that would mitigate negative health impacts and maximize positive impacts of the Project.

The HIA, totaling over 450 pages with appendices, extensively critiques the conclusions and findings in the DEIR/S. These include impacts in areas such as: mobility, noise, traffic, air quality, jobs and economic development, and access to neighborhood resources. *Despite this, Caltrans' DEIR/S shockingly fails to formally include or incorporate the HIA.*

**i. NEPA requires that the DEIR/S Consider the Evidence and Findings of the HIA.**

NEPA requires that an EIS include an analysis of a proposed project's human health impacts, and prohibits the agency from delegating analysis to a separate agency outside of the NEPA process. Policy documents on environmental justice from FHWA and DOT support this conclusion. FHWA must include all required public health analysis in the I-710 Corridor Project EIS itself and may not delegate analysis of health impacts to others.

NEPA expressly recognizes the interdependence of environmental quality and human health. NEPA states that the Congressional intent embodied in the statute is to “assure for all Americans safe, *healthful*, productive, and aesthetically and culturally pleasing surroundings.”<sup>298</sup> Among NEPA's fundamental purposes is to “promote efforts which will prevent or eliminate damage to the environment and biosphere and stimulate *the health and welfare of man*.”<sup>299</sup> NEPA is intended to “attain the widest range of beneficial uses of the environment without degradation, risk to *health or safety*, or other undesirable and unintended consequences.”<sup>300</sup> NEPA is intended to apply to all federal actions “affecting the quality of the human environment.”<sup>301</sup>

CEQ's NEPA regulations also support the inclusion of a health impact analysis. In determining whether an effect may be significant (and therefore require analysis in an EIS) the lead agency must consider “the degree to which the effects on the *human environment* are likely to be highly controversial.”<sup>302</sup> The CEQ regulations specifically define health as one of the effects that must be considered in an EIS or an EA. In defining “effects,” the regulations state, “[e]ffects' includes ecological, aesthetic, historic, cultural, economic, social, or *health*, whether

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<sup>298</sup> 42 USC § 4331 (emphasis added).

<sup>299</sup> *Id.* (emphasis added).

<sup>300</sup> *Id.* (emphasis added).

<sup>301</sup> 42 USC § 4332(c).

<sup>302</sup> 40 CFR § 1508.27(b)4 (emphasis added).

direct, indirect, or cumulative.”<sup>303</sup> The regulations instruct agencies to consider “the degree to which the proposed action affects **public health or safety**” in determining significance.<sup>304</sup>

Both the EPA and CEQ have promulgated NEPA guidance documents that require analysis of human health impacts. Both documents rely on the statutory provisions of NEPA set forth above, and upon two Presidential Executive Orders. Executive Order 12898 instructs each Federal agency to “make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse **human health** or environmental effects of its programs, policies, and activities on minority populations and low-income populations in the United States.”<sup>305</sup> Executive Order 13045 states that each Federal agency must “make it a high priority to identify and assess **environmental health risks and safety risks** that may disproportionately affect children; and . . . shall ensure that its policies, programs, activities, and standards address disproportionate risks to children that result from environmental health risks or safety risks.”<sup>306</sup>

EPA’s *Final Guidance For Incorporating Environmental Justice Concerns in EPA’s NEPA Compliance Analyses* (April 1998) (“EPA NEPA Guidance”) relies on the Presidential Memorandum that accompanied Executive Order 12898, which called for specific actions directed at NEPA-related activities, including:

1. Each federal agency must analyze environmental effects, **including human health, economic, and social effects, of federal actions**, including effects on minority communities and low-income communities, when such analysis is required by NEPA.
2. In reviewing other agencies’ proposed actions under Section 309 of the Clean Air Act, EPA must ensure that the agencies have fully analyzed

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<sup>303</sup> 40 C.F.R. § 1508.8 (emphasis added).

<sup>304</sup> 40 C.F.R. § 1508.27. The term “human environment” expressed the intent of Congress for NEPA to promote public policy attentive to the interrelated needs of human well-being and environmental integrity. Senator Henry Jackson (1969), the key author of NEPA, expressed this clearly:

When we speak of the environment, basically, we are talking about the relationship between man and these physical and biological and social forces that impact upon him. A public policy for the environment basically is not a public policy for those things out there. It is a policy for people.

Bhatia & Wernham, “Integrating Human Health into Environmental Impact Assessment: An Unrealized Opportunity for Environmental Health and Justice,” 116 (8) *Environmental Health Perspectives* 991 (August 2008).

<sup>305</sup> Federal Actions To Address Environmental Justice in Minority Populations and Low-Income Populations, 59 FR 7629 (emphasis added).

<sup>306</sup> Protection of Children From Environmental Health Risks and Safety Risks, 62 FR 19885 (emphasis added).

environmental effects on minority communities and low-income communities, *including human health, social, and economic effects*.<sup>307</sup>

EPA has jurisdiction to review and comment on NEPA documents pursuant to Section 309 of the federal Clean Air Act.<sup>308</sup> The EPA NEPA Guidance states that in conducting its review under NEPA, EPA must analyze human health impacts. The Guidance document states:

In conducting § 309 reviews, EPA is further directed by the Presidential Memorandum that accompanied Executive Order 12898 to ensure that agencies fully analyze environmental effects of their proposed actions on minority and low-income communities, *including human health, social, and economic effects*. As a result of both § 309 and the Presidential Memorandum, EPA is able to assist other federal agencies in evaluating proposed actions that are subject to NEPA by identifying possible environmental justice concerns that may result from such actions and by offering alternative solutions and mitigation measures for unavoidable impacts.<sup>309</sup>

The EPA NEPA Guidance expressly requires the analysis of “Human Health and Risk Factors.”<sup>310</sup> Section 3.2.6 of the document states that federal agencies must “identify, predict and describe reasonably foreseeable beneficial as well as adverse changes to existing conditions that may result from implementing either the proposed action . . . . *In preparing an EIS or EA, ecological and human health risk assessments are conducted to identify and evaluate potential environmental and human health impacts that may be imposed.*”<sup>311</sup>

The EPA NEPA Guidance acknowledges that human health analysis may be complicated, but nevertheless requires analysis. The document states “[e]valuation of human health and risk factors relevant to environmental justice concerns may prove to be complicated when detailed technical analyses of risk factors and interaction of toxic chemicals are undertaken.”<sup>312</sup> The document recommends consideration of at least the following factors in analyzing human health impacts of a proposed project under NEPA:

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<sup>307</sup> EPA NEPA Guidance, p. 9.

<sup>308</sup> Specifically, § 309 mandates that EPA “review and comment in writing on the environmental impact of any matter relating to duties and responsibilities granted pursuant to this chapter or other provisions of the authority of the Administrator, contained in any (1) legislation proposed by any federal department or agency, (2) newly authorized federal projects for construction and any major federal agency action (other than a project for construction) to which Section 4332(2)(C) of this title applies [subject to Section 102(2)(C) of NEPA], and (3) proposed regulations published by any department or agency of the Federal government. Such written comment shall be made public at the conclusion of any such review.” 42 U.S.C. § 7609(a).

<sup>309</sup> EPA NEPA Guidance, p. 12 (emphasis added).

<sup>310</sup> *Id.* at 28.

<sup>311</sup> *Id.* at 43 (emphasis added).

<sup>312</sup> *Id.* at 28.

- Emissions: Number of point and nonpoint sources of emissions including permitted and non-permitted releases.
- Toxics: Presence of or exposure to highly toxic pollutants.
- Exposures: Multiple exposure sources and/or paths for the same pollutant.
- Pollutants: Exposure to multiple pollutants.
- Pesticides: Exposure to pesticides by workers and the misuse of pesticides.
- Locations: Exposure through multiple locations (e.g., workplace, home, school, ambient).
- Concentrations: Exposure to emissions from concentrated locations of the same type of industry or industries.
- Health Data: Health data for population in question (e.g., abnormal levels of cancers, asthma, emphysema, birth defects, low birth weight, infant and childhood mortality blood-lead levels asbestosis). This data could indicate historical hazards and health risks which, in concert with the effects of the proposed action could cumulatively or indirectly raise environmental justice issues.
- Research Gaps: Research gaps (e.g., subsistence consumption, demographics dietary effects, synergistic effects of chemicals).
- Data Collection: Data collection/analysis reliability and validity.<sup>313</sup>

Finally, Section 5.2 of the *EPA NEPA Guidance* expressly requires “Ecological and Human Health Risk Assessments,” including “two related, but separate, processes,” risk assessment and risk management:

Risk assessment characterizes the likelihood for a chemical or substance to cause adverse health effects to humans and can provide a means for assessing the possible impacts on a population, if exposure occurs. Risk assessment provides an estimate of the probability that human exposure to a chemical agent will result in an adverse health effect to the exposed individual, or an estimate of the incidence of the effect upon an exposed population. Risk management is the process whereby it is decided what actions are appropriate, given an estimate of potential risks and due consideration to other relevant factors. Information developed in the risk assessment process is used to guide decision makers in determining the appropriate action to take within the risk management process.<sup>314</sup>

CEQ has promulgated its own guidance document entitled *Environmental Justice Guidance Under the National Environmental Policy Act* (1997) (“CEQ NEPA Guidance”). The CEQ NEPA Guidance expressly requires federal agencies to include in their NEPA documents analysis of “the environmental effects, **including human health**, economic and social effects, of Federal actions.”<sup>315</sup> The CEQ NEPA Guidance states that NEPA review must analyze

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<sup>313</sup> *Id.* at 28.

<sup>314</sup> *Id.* at 63.

<sup>315</sup> CEQ NEPA Guidance, p. 1 (emphasis added).

“environmental effects on minority populations, low-income populations, or Indian tribes, including human health, social, and economic effects.”<sup>316</sup>

In conducting the human health analysis in a NEPA document, the CEQ NEPA Guidelines state that agencies should consider:

relevant public health data and industry data concerning the potential for multiple or cumulative exposure to human health or environmental hazards in the affected population and historical patterns of exposure to environmental hazards, to the extent such information is reasonably available. For example, data may suggest there are disproportionately high and adverse human health or environmental effects on a minority population, low-income population, or Indian tribe from the agency action. Agencies should consider these multiple, or cumulative effects, even if certain effects are not within the control or subject to the discretion of the agency proposing the action.<sup>317</sup>

When a disproportionately high and adverse human health or environmental effect on a low-income population, minority population, or Indian tribe has been identified, agencies should analyze how environmental and health effects are distributed within the affected community.<sup>318</sup>

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<sup>316</sup> *Id.* at 4, citing Memorandum from the President to the Heads of Departments and Agencies. Comprehensive Presidential Documents No. 279. (Feb. 11, 1994). So too, in December 2001, the FHWA Western Resource Center in San Francisco released Interim Guidance Addressing Environmental Justice in Environmental Assessment/Environmental Impact Statements that requires FHWA to identify coordination, access to information and participation, identify adverse effects, identify disproportionately high and adverse effects and contains an environmental documents checklist.

<sup>317</sup> *Id.* at 9.

<sup>318</sup> *Id.* at 14. This analysis is also consistent with the Federal DOT “Order To Address Environmental Justice in Minority Populations and Low-Income Populations,” dated April 15, 1997, and the FHWA policy entitled “Actions To Address Environmental Justice In Minority Populations And Low-Income Populations,” dated December 2, 1998.

The DOT Environmental Justice Order provides that “[p]lanning and programming activities that have the potential to have a disproportionately high and adverse effect on human health or the environment shall include explicit consideration of the effects on minority populations and low-income populations. Procedures shall be established or expanded, as necessary, to provide meaningful opportunities for public involvement by members of minority populations and low-income populations during the planning and development of programs, policies, and activities (including the identification of potential effects, alternatives, and mitigation measures).”

Among other things, the FHWA’s Environmental Justice Policy requires that it “administer its governing statutes so as to identify and avoid discrimination and disproportionately high and adverse effects on minority populations and low-income populations by: (1) identifying and evaluating environmental, public health, and interrelated social and economic effects of FHWA programs, policies, and activities; and (2) proposing measures to avoid, minimize, and/or

ii. CEQA Requires that the DEIR/S Consider the Evidence and Findings of the HIA

CEQA requires that an agency analyze the potential environmental impacts of its proposed actions in an EIR.<sup>319</sup> The EIR is the very heart of CEQA.<sup>320</sup> “The ‘foremost principle’ in interpreting CEQA is that the Legislature intended the act to be read so as to afford the fullest possible protection to the environment within the reasonable scope of the statutory language.”<sup>321</sup>

CEQA has two primary purposes. First, CEQA is designed to inform decision makers and the public about the potential significant environmental effects of a project.<sup>322</sup> “Its purpose is to inform the public and its responsible officials of the environmental consequences of their decisions before they are made. Thus, the EIR ‘protects not only the environment but also informed self-government.’”<sup>323</sup> The EIR has been described as “an environmental ‘alarm bell’ whose purpose it is to alert the public and its responsible officials to environmental changes before they have reached ecological points of no return.”<sup>324</sup>

Second, CEQA requires public agencies to avoid or reduce environmental damage when “feasible” by requiring implementation of “environmentally superior” alternatives and all feasible mitigation measures.<sup>325</sup> The EIR serves to provide agencies and the public with information about the environmental impacts of a proposed project and to “identify ways that environmental damage can be avoided or significantly reduced.”<sup>326</sup> If the project will have a significant effect on the environment, the agency may approve the project only if it finds that it

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mitigate disproportionately high and adverse environmental and public health effects and interrelated social and economic effects, and providing offsetting benefits and opportunities to enhance communities, neighborhoods, and individuals affected by FHWA programs, policies, and activities, where permitted by law and consistent with EO 12898; and (3) considering alternatives to proposed programs, policies, and activities, where such alternatives would result in avoiding and/or minimizing disproportionately high and adverse human health or environmental impacts, consistent with EO 12898; and (4) providing public involvement opportunities and considering the results thereof, including providing meaningful access to public information concerning the human health or environmental impacts and soliciting input from affected minority and low-income populations in considering alternatives during the planning and development of alternatives and decisions.

<sup>319</sup> See, e.g., Pub. Res. Code § 21100; *Communities For A Better Env't v. S. Coast Air Quality Mgmt. Dist.*, 48 Cal. 4th 310 (2010).

<sup>320</sup> *Dunn-Edwards Corp. v. Bay Area Air Quality Mgmt. Dist.*, 9 Cal. App. 4th 644, 652 (1992).

<sup>321</sup> *Communities for a Better Env't v. California Res. Agency*, 103 Cal. App. 4th 98, 109 (2002).

<sup>322</sup> CEQA Guidelines, § 15002(a)(1).

<sup>323</sup> *Citizens of Goleta Valley v. Board of Supervisors*, 52 Cal. 3d 553, 564 (1990).

<sup>324</sup> *Berkeley Keep Jets Over the Bay v. Bd. of Port Comm'rs.*, 91 Cal. App. 4th 1344, 1354 (2001) (“*Berkeley Jets*”); *County of Inyo v. Yorty*, 32 Cal.App.3d 795, 810 (1973).

<sup>325</sup> CEQA Guidelines § 15002(a)(2) and (3); see also *Berkeley Jets*, 91 Cal. App. 4th 1344, 1354; *Citizens of Goleta Valley v. Board of Supervisors*, 52 Cal.3d 553, 564 (1990).

<sup>326</sup> CEQA Guidelines, §15002(a)(2).

has “eliminated or substantially lessened all significant effects on the environment where feasible” and that any unavoidable significant effects on the environment are “acceptable due to overriding concerns.”<sup>327</sup>

While the courts review an EIR using an “abuse of discretion” standard, “the reviewing court is not to ‘uncritically rely on every study or analysis presented by a project proponent in support of its position.’ A ‘clearly inadequate or unsupported study is entitled to no judicial deference.’”<sup>328</sup> As the court stated in *Berkeley Jets*, 91 Cal. App. 4th at 1355:

A prejudicial abuse of discretion occurs ‘if the failure to include relevant information precludes informed decisionmaking and informed public participation, thereby thwarting the statutory goals of the EIR process.’<sup>329</sup>

The preparation and circulation of an EIR is more than a set of technical hurdles for agencies and developers to overcome. The EIR’s function is to ensure that government officials who decide to build or approve a project do so with a full understanding of the environmental consequences and, equally important, that the public is assured those consequences have been taken into account. For the EIR to serve these goals it must present information so that the foreseeable impacts of pursuing the project can be understood and weighed, and the public must be given an adequate opportunity to comment on that presentation before the decision to go forward is made.<sup>330</sup>

The first words of CEQA display that the Legislature intended the law to safeguard human health and safety. Section 21000 of CEQA, entitled, “Legislative Intent,” states that the fundamental purpose of CEQA is “to provide a high-quality environment that at all times is *healthful* and pleasing to the sense and intellect of man.”<sup>331</sup> CEQA continues:

it is the intent of the Legislature that the government of the state take immediate steps to identify any critical thresholds for the *health and safety of the people of the state* and take all coordinated actions necessary to prevent such threshold being reached.<sup>332</sup>

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<sup>327</sup> Pub. Res. Code § 21081; CEQA Guidelines, § 15092(b)(2)(A) & (B).

<sup>328</sup> *Berkeley Jets*, 91 Cal. App. 4th 1344, 1355 (emphasis added), quoting *Laurel Heights Improvement Assn. v. Regents of University of California*, 47 Cal. 3d 376, 391 409, n. 12 (1988).

<sup>329</sup> *San Joaquin Raptor/Wildlife Rescue Center v. County of Stanislaus*, 27 Cal. App. 4th 713, 722 (1994); *Galante Vineyards v. Monterey Peninsula Water Management Dist.*, 60 Cal. App. 4th 1109, 1117 (1997); *County of Amador v. El Dorado County Water Agency*, 76 Cal. App. 4th 931, 946 (1999).

<sup>330</sup> *Communities for a Better Environment v. Richmond (Chevron)*, 184 Cal. App. 4th 70 80 (2010) (“*CBE v. Richmond*”), quoting *Vineyard Area Citizens for Responsible Growth, Inc. v. City of Rancho Cordova*, 40 Cal.4th 412, 449-450 (2007).

<sup>331</sup> Pub. Res. Code § 21000(b) (emphasis added).

<sup>332</sup> Pub. Res. Code § 21000(d) (emphasis added).

The CEQA Guidelines define “Significant Environmental Impacts” to include “**health and safety problems** caused” by the project.<sup>333</sup> The CEQA Guidelines require a **mandatory** finding of significance if a project will have impacts on human health. The Guidelines state:

a lead agency shall find that a project may have a significant effect on the environment and thereby require an EIR to be prepared for the project where . . . the environmental effects of a project will cause **substantial adverse effects on human beings, either directly or indirectly**.<sup>334</sup>

CEQA case law has uniformly interpreted the above provisions of law to require that an EIR include an analysis of human health impacts of a proposed project. An agency abuses its discretion and fails to proceed in a manner required by law if it refuses to analyze human health impacts of a proposed project in an EIR despite being presented with substantial evidence that such impacts may occur.<sup>335</sup>

In *Bakersfield Citizens*, the court held that it was necessary in EIRs for two proposed WalMart projects to “correlate adverse air quality impacts to resulting adverse health impacts.”<sup>336</sup> The WalMart EIRs admitted that both projects would result in significant unmitigated air pollution impacts. However, the EIRs contained no analysis of the human health implications of that increased air pollution. The court held:

Guidelines section 15126.2, subdivision (a) requires an EIR to discuss, inter alia, “health and safety problems caused by the physical changes” that the proposed project will precipitate. Both of the EIRs concluded that the projects would have significant and unavoidable adverse impacts on air quality. It is well known that air pollution adversely affects human respiratory health. (See, e.g., Bustillo, Smog Harms Children's Lungs for Life, Study Finds, L.A. Times (Sept. 9, 2004).) Emergency rooms crowded with wheezing sufferers are sad but common sights in the San Joaquin Valley and elsewhere. . . . Yet, neither EIR acknowledges the health consequences that necessarily result from the identified adverse air quality impacts. Buried in the description of some of the various substances that make up the soup known as “air pollution” are brief references to respiratory illnesses. However, there is no acknowledgement or analysis of the well-known connection between reduction in air quality and increases in specific respiratory conditions and illnesses. After reading the EIR's, the public would have no idea of the health consequences that result when more pollutants are added to a nonattainment

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<sup>333</sup> CEQA Guidelines, § 15126.2(a) (emphasis added).

<sup>334</sup> CEQA Guidelines, § 15065(d) (emphasis added). *See also* CEQA Guidelines, App. G. Section XVIII (c) (“mandatory finding of significance” required if “the project [will] have environmental effects which will cause substantial **adverse effects on human beings, either directly or indirectly**” (emphasis added)).

<sup>335</sup> *Bakersfield Citizens for Local Control v. City of Bakersfield*, 124 Cal.App.4th 1184, 1219-20 (2004) (“*Bakersfield Citizens*”).

<sup>336</sup> *Id.* at 1219-20.

basin. On remand, *the health impacts resulting from the adverse air quality impacts must be identified and analyzed in the new EIR's.*<sup>337</sup>

Similarly, in *Berkeley Jets*, the court held that the “public health impact” of an airport expansion had to be analyzed in the EIR despite the absence of an accepted scientific methodology. The court held that the Port failed to assess the health effect of toxic air contaminants from mobile sources on persons who live in close proximity to the Airport.<sup>338</sup>

Numerous other cases have required that EIRs include an analysis of health impacts created by proposed projects. For example, the California Supreme Court recently held that an EIR was required for a refinery project due in part to “adverse health effects, especially aggravation of respiratory disease.”<sup>339</sup>

In *County Sanitation Dist. No. 2 v. County of Kern* (2005) 127 Cal.App.4th 1544, 1564-1565, the court held that an EIR was required due to potential human health effects of sewage sludge. The court held that, “additional scientific work is needed to reduce persistent uncertainty about the potential for adverse human health effects from exposure to biosolids [sludge].”<sup>340</sup>

In *Los Angeles Unified School District v. City of Los Angeles* (1997), 58 Cal. App. 4th 1019, the court held that an EIR was required to analyze the human health impacts of increased noise caused by a proposed project.<sup>341</sup> In *City of Long Beach v. Los Angeles Unified School Dist.* (2009) 176 Cal. App. 4th 889, 906, the court held that an EIR was adequate because it evaluated project-related and cumulative health impacts, included a reasoned analysis in support of its conclusions, and appropriately relied on mitigation measures to reduce project impacts.<sup>342</sup>

**b. The DEIR/S Fails to Address Significant Findings and Recommendations in the I-710 Health Impact Assessment.**

Despite the aforementioned legal requirements, the DEIR / DEIS fails to address important findings within the I-710 HIA.

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<sup>337</sup> *Id.* at 1219-20 (emphasis added); *see also Woodward Park Homeowners Assn., Inc. v. City of Fresno*, 150 Cal.App.4th 683, 731-732 (2007) (“air pollution discussion is inadequate for another reason. . . there is no disclosure and analysis whatsoever of the correlation of ‘the identified adverse air quality impacts to resultant adverse health effects’”).

<sup>338</sup> *Berkeley Jets*, 91 Cal. App. 4th at 1367-1368.

<sup>339</sup> *Communities for a Better Environment v. South Coast Air Quality Management Dist.*, 48 Cal. 4th 310, 317 (2010).

<sup>340</sup> *County Sanitation Dist. No. 2 v. County of Kern*, 127 Cal.App.4th 1544, 1565 (2005).

<sup>341</sup> *See also Gray v. Madera*, 167 Cal. App. 4th 1099 (2008) (EIR required to analyze noise impacts of rock quarry).

<sup>342</sup> *See also Sec. Env'tl. Sys. v. S. Coast Air Quality Management Dist.*, 229 Cal. App. 3d 110 (1991) (EIR required due to human health impacts caused by waste-burning incinerator).

As set forth at length below, the I-710 HIA concludes that the “alternatives under consideration for the Project are likely to lead to mixed health impacts.” The HIA extensively critiques the conclusions and findings in the DEIR/ DEIS and finds, *inter alia*, that:

1. Negative health impacts related to noise will diminish the project’s objective of improving public health and traffic safety.
2. Project impacts on traffic safety are unclear; some improvements (e.g., separating trucks) would increase traffic safety, but overall increase in volume and speed under some alternatives could decrease safety.
3. Based on changes in access to neighborhood resources, the health of some populations (i.e. those living further from the freeway) would be expected to improve, while other populations (i.e. those living closest to the freeway) would be expected to experience negative health impacts.
4. Impacts from changes in mobility were not found to be health beneficial, and, as such, the proposed alternatives miss important opportunities to improve public health.

Yet, the DEIR/S essentially ignores these findings from the I-710 HIA, instead concluding that health-related impacts of the Project are mitigated by mitigation measures adopted into the Project. A successful HIA requires decisionmakers’ openness and responsiveness to new information, and we are very concerned that Caltrans has not demonstrated these characteristics. We are concerned that Caltrans first made up its mind that the I-710 should be expanded and that this would, if anything, impact health favorably – and no new data or knowledge will change its view. If anything, Caltrans demonstrated hostility for the I-710 HIA process and its conclusions. This hostility is being carried forth into the DEIR/S process. This is *not* how NEPA and CEQA are intended to function.

Many of the conclusions and analysis in the DEIR/S therefore are unsupported by substantial evidence, and violate NEPA and CEQA.<sup>343</sup>

These are the Project impacts that the HIA specifically was designed to assess, and its recommendations should not be ignored. We therefore respectfully urge Caltrans to include the I-710 HIA in the DEIR/S. The DEIR/S must be revised and recirculated to take into consideration the findings and recommendations of the I-710 HIA described herein.

**i. The DEIR/ DEIS Fails To Address HIA Findings And Recommendations Concerning Mobility Impacts.**

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<sup>343</sup> See, e.g., *Bakersfield Citizens*, 124 Cal.App.4th at 1219-20 (agency abuses its discretion and fails to proceed in a manner required by law if it refuses to analyze impacts of a proposed project despite being presented with substantial evidence that such impacts may occur).

The HIA concludes that the I-710 Corridor Project's impacts to mobility in affected communities within the Study Area would *not* benefit public health. Moreover, the HIA concludes that the Project misses a critical opportunity to improve public health through the implementation of effective transportation policy.<sup>344</sup>

The DEIR/S fails to come to terms with these conclusions and does not analyze increases in vehicle usage, and subsequent decreases in usage of public and active transit (walking and biking) that would be spurred by the dramatic increases in freeway capacity proposed by the Project. Moreover, the DEIR/S assumes that public and active transit ridership would remain the same, regardless of pending budget cuts, as well as deteriorating pedestrian and bicycling conditions caused by Project design, increases in vehicle speeds and reduced congestion. Finally, the DEIR/S fails to address recommendations made by the HIA to mitigate health impacts that the Project may have on mobility within affected communities.

### 1. Mode Share

The DEIR/S analysis fails to take into account the increases in vehicle usage that would be spurred by the increase in capacity offered by the Project build alternative. The DEIR/S concludes that there will be an increase of Vehicle Miles Traveled under all build alternatives, but project reduction in Vehicle Hours Traveled and Vehicle Hours Delayed due to decreases in congestion.<sup>345</sup> Moreover, the DEIR/S analysis assumes that public transit and active transit (walking and biking) ridership will largely remain the same in spite of the proposed expansion of freeway capacity.<sup>346</sup>

The HIA takes issue with the DEIR/S' traffic analysis stating that highway capacity improvements ultimately result in increased congestion and travel times, as the Project will compel individuals to shift from other forms of transit to private vehicles. The HIA states that:

[M]ode share is likely to be dependent on traffic speeds and volumes, which differ between project alternatives. The Downs-Thomson effect (Downs 1962[122]; Thomson 1977[440]; Abram and Hunt 2001[2]) is the hypothesis that highway capacity improvements may ultimately increase overall congestion and travel times. An immediate effect of capacity expansion is a shift from transit to private vehicle use by some travelers. Downs-Thomson states this reduction in transit ridership leads to raises in transit fares or service reduction, resulting in further decreased patronage due to increased inconvenience of transit. Simulation modeling of the Downs-Thomson effect showed that long-term reductions in transit ridership can be induced by increases in highway capacity without any change in transit fares. Modeling in the EIR/EIS has not taken this effect into account.<sup>347</sup>

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<sup>344</sup> HIA Addendum, at 1.

<sup>345</sup> DEIR/S, at 3.5-85.

<sup>346</sup> HIA, at 1-7.

<sup>347</sup> HIA, at 6-35.

## 2. Level of Service Analysis

The DEIR/S fails to address concerns raised by the HIA that the traditional Level of Service (“LOS”) analysis that it utilizes to analyze traffic congestion is flawed. The HIA notes that LOS analysis fails to take into account impacts on health as it does not consider “traffic injuries, air pollution, CO2 emissions, noise, . . . physical activity[,] . . . [and] modal shift.”

## 3. Active Transit

The DEIR/S and HIA disagree upon whether usage of active transit (walking and biking) will decrease as a result of the I-710 Corridor Project. The DEIR/S concluded that since bicycle and pedestrian facilities will be maintained or improved as a result of the Project, the number of people traveling via active transit would not change substantially.<sup>348</sup>

The HIA, on the other hand, finds that, absent significant improvements in the pedestrian and bicycle transportation network, which the HIA finds inadequate at present (HIA at 6-24), the Project build alternatives would ultimately reduce active transit use. In particular the Project’s design would increase vehicle speeds and truck volumes, discouraging active transit and “offset[ing] any positive increases in walking and biking as a result of infrastructure improvement[s].”<sup>349</sup>

## 4. Public Transit Use

The HIA also finds that the DEIR/S modeling assumptions that public transit ridership would increase are unrealistic as they do not take into account the impact of budget cuts currently being implemented on public transit.<sup>350</sup>

## 5. The DEIR/S Ignores the HIA Mobility Recommendations

The DEIR/S fails to take into account recommendations made by the HIA concerning vehicle travel, public transportation, walkability, and bikeability.

The HIA recommends policies to reduce automobile and truck usage, reduce and enforce speed limits on targeted roadways, and enforce truck route regulations. In particular, the HIA recommends that the Project increase use of low emission rail technologies to transport freight, increase public transportation use, and adopt land use policies to encourage higher density and mixed use development.

The HIA also recommends improved public transit policies, in addition to the improvements already proposed by the project, as described in the 2012 RTP and 2011 Gateway Cities Sustainable Communities Strategy. In particular, public transit strategies should include

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<sup>348</sup> DEIR/S, at 3.5-86.

<sup>349</sup> HIA at 7-37.

<sup>350</sup> HIA at 6-35.

the use of dedicated bus lanes on targeted arterials and take into consideration an equity analysis examining where transit is most utilized and serves those who most need public transit options.

Finally, the HIA proposes implementing improved pedestrian and biking infrastructure as described in the 2012 RTP and 2011 Gateway Cities Sustainable Communities Strategy for the purposes of creating pedestrian-friendly links between residential areas, transit-oriented neighborhoods / facilities, select commercial and mixed use communities, and the LA River as well as the Rio Honda Channel.

The DEIR/S must be revised and recirculated to take into consideration the findings and recommendations of the I-710 HIA concerning these mobility impacts.

## **ii. The DEIR/S Fails To Address HIA Findings And Recommendations Concerning Noise Impacts**

While the DEIR/S attempts to mitigate the noise impact of the Project by selectively imposing sound walls in areas where noise models indicate that the noise generated would exceed healthful thresholds, the HIA makes clear that sound walls are simply insufficient to curtail the noise impact on an area where baseline conditions already exceed federal thresholds.<sup>351</sup>

The HIA finds that “negative health impacts related to noise will diminish the project’s objective of improving public health . . . .” Moreover, the noise thresholds adopted by the DEIR/S are insufficiently protective compared to international and California state standards. The DEIR/S also fails to consider the noise impact of non-freeway traffic generated by the Project. Finally, the DEIR/S disregards recommendations made by the HIA to address noise concerns.

### **1. The DEIR/S Disregards World Health Organization Noise Guidelines**

The DEIR/S fails to address findings in the HIA that the noise abatement criteria utilized by the DEIR/S insufficiently protect neighborhoods that are most likely to be effected by the project.

The DEIR/S relies upon the FHWA’s Highway Traffic Noise Abatement Criteria, codified at 23 C.F.R. Part 772, in determining where the I-710 Corridor Project will implement noise mitigation measures such as sound walls.<sup>352</sup>

However, the HIA points out that the noise thresholds relied upon by the DEIR/S differ significantly from thresholds set by the World Health Organization (“WHO”) and the County of Los Angeles.<sup>353</sup> The thresholds utilized by the DEIR/S are set at nearly twice the levels of those

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<sup>351</sup> HIA at 8-7 to 8-8.

<sup>352</sup> DEIR/S at 3.14-1.

<sup>353</sup> HIA at 8-4.

set by the WHO. Moreover, the noise thresholds are even higher than those set by the Los Angeles County Code.<sup>354</sup>

## 2. Non-Freeway-Related Noise Impacts

The DEIR/S does not mitigate non-freeway-related noise impacts on arterials and local roads as a result of the increased volume of traffic, particularly trucks, that will be generated by the increased volume of truck and auto traffic that will be generated by the Project. The HIA notes that the Project will have negative health impacts on noise on surrounding communities because of unmitigated noise impacts generated on arterial and local roads as well as by other goods movement facilities (warehouses, transloading facilities, etc.) that are likely to proliferate due to the Project.<sup>355</sup>

The HIA notes that existing land use patterns in the I-710 corridor leave the affected communities particularly vulnerable to noise generated by trucks and other goods movement infrastructure. The HIA states that:

Land use patterns in the study area lead to noise pollution in many residential neighborhoods (e.g., even the eight background noise measurement sites have relatively high noise levels). Major arterials with high traffic, and specifically truck, volumes and with high numbers of truck destinations divide the region. Residential neighborhoods are located between these arterials. Often, one row of commercial use along an arterial is the barrier between the first houses in a residential neighborhood and the noise of the arterial. If the commercial use is noise producing and if trucks stray onto residential streets, there is *little or no noise barrier at all*; a single truck passing on a street at intermediate speeds typically results in 80 to 90 dBA of noise. As a result, *many residents are exposed to noise levels from these sources*.<sup>356</sup>

The HIA finds that despite the mitigation measures proposed in the DEIR/S, the estimated noise under all alternatives (especially the build alternatives), is still likely to generate negative health impacts in the affected communities, including increases in sleep disturbance, cardiovascular disease, cognitive impairment, academic achievement in children, and hearing impairment.<sup>357</sup>

## 3. The DEIR/S Fails to Adequately Analyze the HIA Recommendations on Noise Impacts

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<sup>354</sup> *Id.* at 8-5.

<sup>355</sup> HIA 8-26.

<sup>356</sup> HIA at 8-11 to 8-12 (emphasis added).

<sup>357</sup> HIA at 8-27 to 8-29.

The DEIR/S neglects a number of recommendations made in the HIA concerning goods movement, transportation, land use planning, noise mitigation through design, noise-related regulations, and post build out monitoring and mitigation.<sup>358</sup>

The HIA recommends a number of goods movement, transportation and land use planning measures that are not addressed within the DEIR/S. The HIA recommends adopting alternative goods movement strategies, such as low emissions on-dock rail technology, implementing local land use planning measures to move goods movement infrastructure closer to the freeway and moving sensitive uses, such as schools and residences, away from the freeway, utilizing local conditional use permit processes to impose voluntary noise restrictions and require noise mitigation technology, and expanding pedestrian and bicycling networks into low noise areas.<sup>359</sup>

Furthermore, the HIA proposes noise mitigation design measures, such as the utilization of low-noise road surfaces, low-noise freeway design, variable tolling to reduce peak noise periods, and funding acoustical insulation for private residences.<sup>360</sup>

The HIA also recommends funding, enforcing and strengthening noise-related regulations, particularly on enforcement of idling regulations, truck routes and speed limits.<sup>361</sup>

Finally, the HIA recommends the development of a complete noise monitoring plan with contingency mitigation measures if the Project ultimately still generates noise above healthy thresholds.<sup>362</sup>

The DEIR/S must be revised and recirculated to take into consideration the findings and recommendations of the I-710 HIA concerning these noise impacts.

### **iii. The DEIR/S Fails To Address HIA Findings And Recommendations Concerning Air Quality Impacts**

The DEIR/S and HIA both conclude that health will likely increase, in terms of air quality impacts, regardless of the alternative adopted for the project due to improvements in technology.

However, the DEIR/S still fails to address HIA findings that the emission projections adopted by DEIR/S are unrealistic. Moreover, the DEIR/S fails to include emissions that would be generated by the increased volume of traffic served by the project on neighboring arterial and local roads. Finally, the DEIR/S fails to adequately model Particulate Matter mortality as well as consider recommendations made in the HIA.

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<sup>358</sup> *Id.*

<sup>359</sup> *Id.*

<sup>360</sup> *Id.*

<sup>361</sup> *Id.*

<sup>362</sup> *Id.*

## 1. Emission Projections

The DEIR/S concludes that under all alternatives, including no build, emissions of criteria air pollutants will decline. The HIA questions these projections, noting that the projected reductions in air pollutants, which the DEIR/S primarily attributes to improvements in technology, may not materialize, and then even if the reductions do occur emissions may still fail to meet 2035 targets. As the HIA notes:

[T]hese decreases should be considered cautiously. Conclusions from these estimates and models are based on the assumptions that improved car and truck technology will lead to cleaner engines and less air pollution from vehicular traffic. Gains in air quality will not be realized unless vehicle fleets do in fact turn over and the cleaner engines are used by 2035.

....

While a reduction can be seen in many of the pollutants given the alternatives, these reductions may not reach levels such that they provide significantly cleaner and healthier air for communities in the I-710 corridor. Standards are not set purely on health findings (e.g., costs are almost always considered), and health impacts often occur even below the standard.<sup>363</sup>

## 2. Non-Freeway Emissions

DEIR/S emission projections fail to take into account non-highway-related air pollutant emissions that would be generated by the increased volume of automobile and truck traffic generated by the Project. The HIA notes that “[n]on-highway-related air pollutants contribute to area level concentrations of air pollutants. Locations near major arterials and truck destinations (such as warehouses) are likely to have increased levels of truck emissions as the volume of trucks on or at these facilities increases.” Moreover, residential receptors and other sensitive receptors, such as schools, often lie nearby major arterials that would be affected by the increase in non-highway-related air pollutant emissions.<sup>364</sup>

## 3. Particulate Matter Mortality

The DEIR/S concludes that Particulate Matter mortality will likely go down under all alternatives. The conclusions are drawn from a qualitative assessment based upon comparative analysis of total I-710 PM<sub>2.5</sub> emissions.<sup>365</sup>

The HIA questions the findings, noting that the emission estimates in the DEIR/S fail to include non-exhaust sources of PM<sub>2.5</sub>. Moreover, the HIA relies upon modeling rather than

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<sup>363</sup> HIA at 7-45.

<sup>364</sup> HIA at 7-27.

<sup>365</sup> DEIR/S 3.13-54.

qualitative assessment to project PM<sub>2.5</sub> mortality, as a bevy of factors, including freeway design, number of people living within 500 feet of the freeway, etc, factor into mortality projections.

#### 4. The DEIR/S Fails to Adequately Analyze the HIA Recommendations on Air Quality Impacts

The HIA recommends a number of measures that are neglected by the DEIR/S, including recommendations concerning research and analysis, goods movement, transportation, land use planning, air pollution emission reductions, exposure mitigation, and air quality regulations.<sup>366</sup>

The HIA recommends that additional research and analysis be integrated into the DEIR/S. In particular, the HIA recommends that the DEIR/S confirm HIA findings with final data from traffic modeling, provide a complete analysis of the health effects of Particulate Matter based upon air quality modeling, ensure that any air quality models utilized take into account recent studies related to the distribution of air pollution in the presence of sound walls, and fund a study to understand the most effective way to accelerate the adoption of zero emission technologies for trucks.<sup>367</sup>

The HIA also recommends a number of technology development, land use, and goods movement policies that ought to be adopted as mitigation measures into the DEIR/S. In particular the HIA recommends implementing policies to accelerate the use of zero emissions trucks and develop alternative goods transport, such as low emission rail technology. In addition, the HIA recommends that the DEIR/S commit to expanding pedestrian and bicycle networks in affected communities, adopt land use planning measures to move sensitive uses, such as residences and schools, away from the freeway and move goods movement infrastructure towards it, and develop a complete inventory of goods movement facilities. Finally, the HIA also recommends strategies presented in the *I-710 / Major Corridor Study: Major Opportunity / Strategy Recommendations and Conditions* which include implementing findings in the Air Quality Action Plan.<sup>368</sup>

The HIA recommends air pollution emission reduction and exposure mitigation measures not reviewed within the DEIR/S. Those recommendations include aggressively applying truck emission reduction strategies and providing business and fiscal incentives for the operation of clean trucks.

The HIA also recommends strengthening and increasing funding for air quality-related regulations. In particular, the HIA recommends increasing funding for mitigation programs for air quality impacts, enforcement of clean or zero emission truck requirements, and strengthening enforcement on truck routes.

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<sup>366</sup> HIA 7-53–55.

<sup>367</sup> *Id.*

<sup>368</sup> *Id.*

Finally, the HIA recommends post build out monitoring and mitigation. The HIA recommends the development of an air quality monitoring plan, with contingency mitigation measures if pollution levels generated as a result of the Project rise above healthy levels.

The DEIR/S must be revised and recirculated to take into consideration the findings and recommendations of the I-710 HIA concerning these air quality impacts.

**iv. The DEIR/S Fails To Address HIA Findings And Recommendations Concerning Traffic Safety Impacts.**

The HIA concludes that the traffic safety impacts of the I-710 Corridor Project are unclear, as while the improvements in the build alternatives may increase traffic safety to a certain extent, increases in volume and speed caused by decreases in congestion under the build alternatives will decrease safety as well.<sup>369</sup>

The DEIR/S must be revised and recirculated to take into consideration these findings in the HIA. In particular, the HIA raises concerns concerning collisions between trucks / vehicles – pedestrians / bikes caused by the increased volume of traffic and speed under the build alternatives. In addition, the DEIR/S disregards recommendations made in the HIA on these same topics.

**1. Collisions**

The DEIR/S and HIA differ as to the impact the Project may have on the number of traffic collisions. The DEIR/S concludes that collisions of all types should decrease under the build alternatives due to reductions in congestion, modernized design, and improvements.<sup>370</sup>

To the contrary, the HIA projects that the increased traffic volumes spurred by the Project will result in an increase in truck collisions, regardless of but particularly under the build alternatives that do not separate freight traffic from regular automobiles. The HIA finds that truck collisions are likely to increase under all alternatives due to the faster pavement deterioration and an increased number of trucks that will utilize the I-710 and surrounding arterial roads.<sup>371</sup>

Moreover, the HIA concludes that Vehicle–Pedestrian / Bicycle collisions will decline under some but not all of the build alternatives, not because of improvements / maintenance made by the Project, but because the Project under Alternatives 6A/B/C will result in increased auto use and reduced pedestrian and bicycle activity.

**2. The DEIR/S Fails to Adequately Analyze the HIA Recommendations on Traffic Safety Impacts**

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<sup>369</sup> HIA Addendum at 1.

<sup>370</sup> DEIR/S at 3.5-86 to 3.5-87.

<sup>371</sup> HIA at 9-38 to 9-40.

The DEIR/S disregards, without substantial evidence or adequate analysis, a number of recommendations made by the HIA on traffic issues. In particular, the HIA recommends that the DEIR/S consider additional traffic safety analysis, vehicle polices, as well as pedestrian and bicycle improvements.<sup>372</sup>

The DEIR/S ignores recommendations in the HIA that additional traffic safety analysis be conducted. In particular, the HIA recommends that a traffic safety analysis be done taking into consideration changes in traffic volume and speed caused by the Project. Moreover, the HIA recommends that additional traffic modeling on connecting arterial roads be conducted in order to ascertain the impact that the Project will have on surrounding local neighborhoods.<sup>373</sup>

The HIA also recommends a number of vehicular safety measures, including strict enforcement of truck routes to keep trucks out of residential neighborhoods to reduce the chances of truck-pedestrian / bicyclist collisions.

Finally, the HIA recommends implementing improvements for pedestrian and bicycle safety including improved pedestrian and bike crossings for I-710 on-ramps, expansion of pedestrian and bicycle networks, and pedestrian improvements at intersections.

The DEIR/S must be revised and recirculated to take into consideration the findings and recommendations of the I-710 HIA concerning these traffic impacts.

**v. The DEIR/S Fails To Address HIA Findings And Recommendations Concerning Jobs & Economic Development Impacts**

The DEIR/S and HIA both conclude that health will likely increase as a result of the influx of new jobs generated by the I-710 Corridor Project.<sup>374</sup> However, the HIA raises concerns as to whether the Project will generate jobs that pay a living wage, and questions the cost-benefit analysis employed by the DEIR/S and the geographic distribution of jobs that will be generated by the Project. Finally, the DEIR/S fails to consider recommendations raised by the HIA on these topics. The DEIR/S must be revised and recirculated to take into consideration the findings and recommendations of the I-710 HIA concerning these jobs and economic development impacts.

**1. Living Wage**

The DEIR/S fails to account for analysis in the HIA distinguishing job creation in general as opposed to creating jobs with a living wage. The DEIR/S touts the Project as a means to accommodate projected growth in economic activities related to goods movement,<sup>375</sup> and the

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<sup>372</sup> HIA at 9-43 to 9-44.

<sup>373</sup> *Id.*

<sup>374</sup> HIA Addendum at 1.

<sup>375</sup> DEIR/S at 3.25-39.

importance of higher-paying jobs in terms of improvements in health outcomes, local economic activity, higher property values, decreased blight, crime, stress, and improved mental health.<sup>376</sup>

Yet, the HIA states that the goods movement industry does not create jobs that pay a living wage, noting that:

Only one of the seven job categories with the highest projected job openings in goods movement — have hourly wages greater than the living wage required for any type of family with a child. The goods movement industry employs many temporary workers—in positions such as warehouse workers and truck drivers—that are paid poverty-level wages (Matsuoka et al. 2011[308]). In addition, goods movement jobs typically have longer hours, more hazardous working environments, and provide fewer job-related benefits.<sup>377</sup>

## **2. Cost-Benefit Analysis**

The DEIR/S relies upon flawed cost-benefit analysis in terms of analyzing both the direct and indirect impacts that the Project may have on the local economy of the affected communities. In particular the DEIR/S touts the number of temporary construction jobs that the Project would create, stating “all I-710 Corridor cities would experience a beneficial impact temporarily from direct jobs (jobs generated during construction) and permanently from indirect job growth (jobs generated as a result of the operation of the project) . . . these additional jobs would be far more numerous than the jobs that might be lost . . . .”<sup>378</sup>

The HIA criticizes the traditional cost-benefit analysis utilized by the DEIR/S, finding that the analysis fails to take into account the possible regional business impacts that may occur as a result of the Project. In particular, the HIA shows that it is unclear whether the Project would have a beneficial or detrimental impact on the affected communities. The HIA notes that the Project could lead to economic growth as decreased congestion and travel times could lower the cost of business inputs and attract businesses and improve commercial land value. However, the decreased congestion caused by the Project could also allow goods movement infrastructure, such as warehouses, to relocate further away from the ports towards areas with cheaper land, drawing business away from the affected communities and harming the local economy.<sup>379</sup>

## **3. The DEIR/S Fails to Adequately Analyze the HIA Recommendations on Jobs and Economic Development Impacts**

The DEIR/S fails to address recommendations made by the HIA to ensure access to neighborhood resources. In particular, the DEIR/S fails to address recommendations made by

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<sup>376</sup> DEIR/S at 3.3-27.

<sup>377</sup> DEIR/S at 10-9.

<sup>378</sup> DEIR / DEIS at 3.3-42 to 3.3-43.

<sup>379</sup> HIA at 10-22 to 10-23.

the HIA to conduct additional economic analysis and adopt policies directed towards job creation for local residents and green jobs.<sup>380</sup>

The DEIR/S disregards the HIA's recommendation that it include additional economic analysis.<sup>381</sup> The HIA recommends that the DEIR/S conduct economic research and modeling to determine how the Project would impact local and regional job growth and business costs, including detailed information concerning how the Project would impact the geographic distribution of available jobs and overall income. Moreover, the HIA recommends that a cost-benefit analysis be conducted on the Project that includes externalities such as changes in healthcare-related costs and the impacts that the Project may have on business sectors unrelated to goods movement. Finally, the HIA calls for a study tracking the proportion of local jobs in the affected communities that are filled by local residents.

The HIA also calls for additional policies geared towards local job creation, such as the creation of incentives to encourage businesses to locate in the I-710 Corridor and funding for educational programs that prepare the local population for living wage jobs.

Finally, the HIA suggests that policies should be adopted to encourage training and creation of green jobs in the I-710 Corridor.

The DEIR/S fails to adequately analyze any of this. It must therefore be revised and recirculated to take into consideration the findings and recommendations of the I-710 HIA concerning these jobs and economic development impacts.

**vi. The DEIR/S Fails To Address HIA Findings And Recommendations Concerning Negative Impacts to Access to Neighborhood Resources.**

The HIA concludes that the health of populations living further from the freeway would improve while others living closer would be expected to experience negative health impacts based upon access to neighborhood resources. In particular, the HIA raises concerns about the effect of the Project on populations without access to a car, social cohesion, and property values. Despite this, the DEIR/S disregards HIA recommendations to mitigate the disproportionate impact on populations residing nearby the Freeway.

The DEIR/S therefore must be revised and recirculated to take into consideration the findings and recommendations of the I-710 HIA concerning these negative impacts to access to neighborhood resources.

**1. Different Health Outcomes**

The DEIR/S and HIA come to significantly different conclusions concerning the overall health impact that the I-710 project would have on neighboring communities in terms of access to neighborhood resources.

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<sup>380</sup> HIA at 10-22 to 10-23.

<sup>381</sup> HIA at 10-22.

The DEIR/S projects an overall increase in health in terms of access to neighborhood resources since there would be no adverse impact on access to parks and other neighborhood resources for pedestrians and bicyclist as well as a reduction in traffic congestion.

To the contrary, the HIA finds that overall health outcomes will improve or worsen for different populations, depending on where they live and whether they have access to a vehicle.<sup>382</sup> In particular, the HIA states that “health outcomes associated with access to neighborhood resources, social cohesion, and neighborhood wealth would be expected to improve for some (e.g., those living further away from the freeway who have access to a car and whose travel times are likely to decrease) and worsen for others (e.g., those that live close to the freeway or rely on active transport).”<sup>383</sup>

## **2. Impact on Those Without Access to a Car**

The DEIR/S appears to advance conflicting opinions of whether the I-710 Corridor project would improve or worsen pedestrian and bicycling access in the affected neighborhoods.

The DEIR/S claims that the I-710 Corridor project would improve pedestrian and bike travel facilities by replacing old sidewalks and repaving roads.<sup>384</sup> However, it also concedes that certain project design elements will decrease pedestrian and bicycle access, stating that “[i]n many cases, existing interchanges will be replaced with Single Point Urban Interchanges . . . these interchanges are thought to pose a greater safety challenge to bicyclists and pedestrians . . .”

The HIA concludes that the I-710 Corridor Project will decrease pedestrian and bicycle access, particularly impacting people who do not have access to a car--roughly 8–10% of the impacted population. In particular, the HIA concludes that the I-710 Corridor Project will make it more difficult for people without cars to access needed goods and services through walking and biking, having a “disproportionately adverse impact on those without access to cars, such as seniors who no longer drive, those who cannot afford a car, and those who are not eligible to get a driver’s license.”

The DEIR/S disregards recommendations in the Urban Design and Aesthetics Toolbox Report (Gruen Associates, Urban Design and Aesthetics Report (2011)), which recommends that the DEIR/S specifically explore the design and construction of a number of alternative pedestrian and bicycle crossing designs.<sup>385</sup>

## **3. Social Cohesion**

The DEIR/S and HIA differ upon the impact that the I-710 Corridor Project will have on the social cohesion of surrounding communities.

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<sup>382</sup> HIA, at 11-44.

<sup>383</sup> *Id.*

<sup>384</sup> DEIR/S Executive Summary at 38.

<sup>385</sup> DEIR/S Executive Summary at 31–33

The DEIR/S concludes that “with the exception of a few locations where access to the highway system would be changed and relocations would occur, the community character and cohesion of most communities would remain intact . . . .”<sup>386</sup>

Whereas the DEIR/S chooses to focus exclusively upon the displacement and relocation of a limited number of facilities, the HIA adopts a much more expansive approach towards analyzing the social cohesion of the affected communities. In particular, the HIA focuses upon a pattern of disinvestment in the communities surrounding the I-710, where individuals and families who acquire resources opt to move away, decreasing the strength of existing social networks and weakening social cohesion. The HIA concludes that expanding the I-710 Freeway would likely only further decrease pride in the community and further reinforce patterns of disinvestment.

The DEIR/S opts to completely ignore these findings, focusing merely upon how the Project will mitigate physical displacement and relocation, rather than its actual impact upon the affected communities.

#### **4. Property Values**

The DEIR/S fails to address findings made by the HIA concerning the impact that the Project will have on property values in the surrounding communities.

The HIA states that the Project will decrease property values for those who live close to the nearby Freeway while increasing the property value for residences further away but still able to conveniently access it.<sup>387</sup> This will have a significant impact on those who reside within the affected communities as it will decrease the potential for wealth generation for some residents while increasing wealth generation for others.

#### **5. The DEIR/S Fails to Adequately Analyze the HIA Recommendations on Neighborhood Access Impacts**

The DEIR/S fails to address recommendations made by the HIA to ensure access to neighborhood resources. In particular, the DEIR/S fails to address recommendations made by the HIA to implement transportation infrastructure improvements in local neighborhoods (especially to walking and biking infrastructure), offset negative impacts to access by funding additional improvements to existing neighborhood resources, adopt policies to increase and maintain mixed income housing, fund and implement recommendations made in the Urban Design and Aesthetics Toolbox Report (Gruen Associates, Urban Design and Aesthetics Report (2011)), and increase direct government investment in community infrastructure and services.

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<sup>386</sup> DEIR/S Executive Summary at 15–16.

<sup>387</sup> HIA, at 11-43.

The DEIR/S therefore must be revised and recirculated to take into consideration the findings and recommendations of the I-710 HIA concerning these negative impacts to access to neighborhood resources.

### c. Conclusion

The DEIR/S must be revised and recirculated to take into consideration the findings and recommendations of the I-710 Corridor Project Health Impact Assessment. We therefore respectfully urge Caltrans to include the I-710 HIA in the DEIR/S.

### **XVIII. The DEIR/S Fails To Comply with Section 109(h) of the Federal-Aid Highway Act by Failing to Make a Legally Adequate Determination that the Project is in the Best Overall Public Interest.**

Section 109(h) of the Federal-Aid Highway Act requires for all new highway projects eligible for federal funding,<sup>388</sup> a three-step evaluation of adverse impacts and mitigation measures to ensure that “final decisions on the project are made in the best overall public interest.”<sup>389</sup> The first step is to determine the “possible adverse economic, social and environmental effects relating to any proposed project.”<sup>390</sup> The second step is to determine “the costs of eliminating or minimizing such adverse effects,” including “air pollution” and “disruption of desirable community and regional growth.”<sup>391</sup> The third step is to evaluate “the costs of eliminating or minimizing such adverse effects” against “the need for fast, safe and efficient transportation” to determine whether the project is “in the best overall public interest.”<sup>392</sup> Section 109(h), therefore, imposes a substantive duty on Defendants to determine whether the selected alternative is in the “best overall public interest” based on consideration of the relevant factors defined by the statute.<sup>393</sup> The facts involved in this cost and benefit determination must be disclosed,<sup>394</sup> and properly documented in the EIS.<sup>395</sup> The ROD “shall identify and discuss all [relevant] factors . . . which were balanced by the agency in making its decision and state how those considerations entered into its decision.”<sup>396</sup> Here, there has been a failure to satisfy the demands of reasoned decision-making because the DEIR/S has not considered relevant factors defined by § 109(h) and its implementing regulations, and they have not explained the basis for their determination that the proposed project is in the “best overall public interest.”

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<sup>388</sup> 23 C.F.R. § 771.107(b).

<sup>389</sup> 23 U.S.C. § 109(h).

<sup>390</sup> *Id.*

<sup>391</sup> *Id.*

<sup>392</sup> *Id.*

<sup>393</sup> *See Sierra Club v. U.S. Dep’t of Transp.*, 310 F. Supp. 2d 1168, 1204 (D. Nev. 2004) (describing requirements imposed by § 109(h)).

<sup>394</sup> 40 C.F.R. § 1502.23.

<sup>395</sup> 23 C.F.R. § 771.105(a) (requiring that “compliance with all applicable environmental requirements be reflected in the environmental document required by this regulation”).

<sup>396</sup> 40 C.F.R. § 1505.2(b); *State Farm*, 463 U.S. at 43.

It is also relevant to note that simple compliance with NEPA, CEQA and the Clean Air Act does not satisfy the requirements of compliance with section 109(h). NEPA is the “basic national charter for protection of the environment.”<sup>397</sup> NEPA is a procedural statute,<sup>398</sup> designed to ensure that the significant impacts of major federal actions are adequately considered and evaluated by federal agencies.<sup>399</sup> The plain language of § 109(h) of the Federal-Aid Highway Act and its regulations impose a number of substantive duties that go well beyond NEPA.<sup>400</sup> Section 109(h) imposes a substantive duty on federal agencies to ensure that projects selected are in the “best overall public interest.”<sup>401</sup> FHWA regulations implementing § 109(h) also impose obligations that go beyond NEPA, requiring that “[m]easures necessary to mitigate adverse impacts be incorporated into the action.”<sup>402</sup>

Even if § 109(h) and its regulations were somehow ambiguous, a suggestion that they impose no duties beyond those required by NEPA runs contrary to another “cardinal rule of statutory construction that, to the extent possible, a legislative enactment is to be so read as to give operation to all of its parts.”<sup>403</sup> It is contrary to this important canon to suggest that Congress would intend by enacting two separate laws using different language and applying different relevant factors, where one applies solely to highway projects and the other to all major federal actions, for each to impose the exact same duties. This interpretation also violates the well-settled rule that “Congress is presumed to legislate consistently with existing law.”<sup>404</sup> NEPA, enacted in January 1970, generally governs all environmental reviews, while § 109(h), enacted twelve months later, imposes a public interest determination and requires federal transportation agencies to consider additional factors, including the cost of mitigation, not found in NEPA. Section 109(h), as a more specific statutory provision, adds to the general provisions in NEPA. *Dekoladenu v. Gonzales*, 459 F.3d 500, 505 (4th Cir. 2006). Accordingly, the specific, substantive public interest determination required of the Secretary by § 109(h) cannot be satisfied by mere compliance with the general procedural requirements of NEPA.

The implementing rules bars federal approval of a highway project unless documents show—that the development of the project has taken into consideration the need for fast, safe, and efficient transportation together with highway costs, traffic benefits and public services . . . and other economic, social and environmental effects . . . includ[ing]: (A) Identification of the adverse effects, (B) Appropriate measures to eliminate or minimize the adverse effects, (C) The

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<sup>397</sup> 40 C.F.R. § 1500.1(a).

<sup>398</sup> *Vt. Yankee Nuclear Power Corp. v. Natural Res. Def. Council, Inc.*, 435 U.S. 519, 558 (“NEPA does set forth significant substantive goals for the Nation, but its mandate to the agencies is essentially procedural.”); *Hughes River Watershed Conservancy v. Glickman*, 81 F.3d 437, 443 (4th Cir. 1996),

<sup>399</sup> 40 C.F.R. § 1502.1.

<sup>400</sup> *Ayes v. Dep’t of Veterans Aff.*, 473 F.3d 104, 108 (4th Cir. 2006) (“In interpreting a statute, a court should always turn first to one, cardinal canon [of construction] before all others: the plain meaning rule.”) (internal quotation omitted).

<sup>401</sup> 23 U.S.C. § 109(h); 23 C.F.R. § 771.105(b).

<sup>402</sup> 23 C.F.R. § 771.105(d).

<sup>403</sup> *Am. Fed’n of Gov’t Employees v. FLRA*, 944 F.2d 922, 932 (D.C. Cir. 1991).

<sup>404</sup> *United States v. Tomlinson*, 67 F.3d 508, 513 n.9 (4th Cir. 1995).

estimated costs (expressed in either monetary, numerical or qualitative terms) of the measures considered.<sup>405</sup> Notably absent is an analysis of all the adverse effects are impacts to water quality, noise, air pollution, homeless service provisions (e.g. Shelter Partnership’s facility in the City of Bell, the Multi-service Center, and The Salvation Army’s Bell Shelters), loss of parklands, among the many impacts. Since the DEIR/S fails to provide the analysis required under this federal law, it does not comply with § 109(h).

**XIX. A Revised Draft EIR Must Be Prepared and Re-circulated.**

Because of the inadequacies discussed above, the DEIR/S cannot form the basis of a final EIR/EIS. CEQA requires preparation and recirculation of a supplemental draft “[w]hen significant new information is added to an environmental impact report” after public review and comment on the earlier draft EIR.<sup>406</sup> The opportunity for meaningful public review of significant new information is essential “to test, assess, and evaluate the data and make an informed judgment as to the validity of the conclusions to be drawn therefrom.”<sup>407</sup> An agency cannot simply release a draft report “that hedges on important environmental issues while deferring a more detailed analysis to the final [EIR] that is insulated from public review.”<sup>408</sup>

In order to cure the panoply of DEIR/S defects identified in this letter, Caltrans must obtain substantial new information to adequately assess the proposed Project’s environmental impacts, and to identify effective mitigation and alternatives capable of alleviating the Project’s significant impacts. This new information will clearly necessitate recirculation. CEQA requires that the public have a meaningful opportunity to review and comment upon this significant new information in the form of a recirculated draft supplemental EIR.

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<sup>405</sup> 23 C.F.R. Part 790; 39 Fed.Reg. 41,804 (Dec. 2, 1974).

<sup>406</sup> Pub. Resources Code § 21092.1.

<sup>407</sup> *Sutter Sensible Planning, Inc. v. Sutter County Board of Supervisors*, 122 Cal. App. 3d 813, 822 (1981); *City of San Jose v. Great Oaks Water Co.*, 192 Cal. App. 3d 1005, 1017 (1987).

<sup>408</sup> *Mountain Lion Coalition v. California Fish and Game Comm’n*, 214 Cal.App.3d 1043, 1052 (1989).

We appreciate your consideration of our comments. Please feel free to contact us if you have any questions.

Sincerely,



Adriano L. Martinez  
Staff Attorney  
Natural Resources Defense Council



Maya Golden-Krasner  
Attorney  
Communities for a Better Environment



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# **ATTACHMENT C**



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September 26, 2012

Angelo Logan  
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East Yard Communities for Environmental Justice  
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Adriano Martinez  
Staff Attorney, Environmental Justice, Urban Program  
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Dear Mr. Logan and Mr. Martinez,

As requested, we have reviewed the findings related to air quality, traffic, and travel demand modeling presented in the I-710 Draft Environmental Impact Report. We have also examined the process by which transit-focused alternatives were evaluated in the DEIR; the findings from this review suggest that the process is constrained such that transit-focused alternatives will not perform well relative to highway alternatives. Attached please find: 1) curriculum vitae for the SSR personnel involved in the review, and 2) a draft memorandum summarizing the review of technical issues in the I-710 DEIR.

Please contact me if you have any questions.

Sincerely,

Dr. Debbie Niemeier  
Principal  
Sustainable Systems Research, LLC

Enclosures:

Curriculum Vitae for Debbie Niemeier, Alex Karner, Dana Rowan, Melody Eldridge  
Technical Memorandum: Review of Transportation and Air Quality Analysis in the I-710  
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City of Davis, *GHG Inventory*, 2010

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Editor-in-Chief, Transportation Research, Part A, 2007-Present

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**SELECTED PUBLICATIONS**

---

Heres Del Valle, D., Niemeier, D. (2011). CO<sub>2</sub> emissions: Are land-use changes enough for California to reduce VMT? Specification of a two-part model with instrumental variables. *Transportation Research, Part B*, 45(1):150-161.

Niemeier, D., Bai, S., Handy, S. (2011). The impact of residential growth patterns on vehicle travel and pollutant emissions. *Journal of Transport and Land Use*, 4(3):65-80.

Lee, A., Niemeier, D. (2011). Environmental justice and transportation, *A Dictionary of Transport Analysis*. Button and Nijkamp (eds), Pergamon.

Gao, O., Niemeier, D. (2011). Mobile emissions, *A Dictionary of Transport Analysis*. Button and Nijkamp (eds), Pergamon.

Rowan, D. Karner, A., Niemeier, D. (2010). Miles per gallon illusions and CAFE distortions: When even the transport experts have trouble. *Transportation Research Record*, 2191:8-15.

Karner, A., Eisinger, D., Niemeier, D. (2010). Near roadway air quality: Synthesizing the findings from real-world data. *Environmental Science and Technology*, 44(10):5334-5344.

Torres, R., Nelson, V., Momsen, J., Niemeier, D. (2010). Experiment or transition? Revisiting food distribution in Cuban agromercados from the "special period". *Journal of Latin American Geography*, 9:1-12.

- Timoshek, A., Eisinger, D., Bai, S., Niemeier, D. (2010) Mobile source air toxic emissions: Sensitivity to traffic volume, fleet composition, and average speed. *Transportation Research Record*, 2158:77-85.
- Hixson, M., Mahmud A., Hu, J., Bai, S., Niemeier, D., Handy, S., Gao, S., Lund, J., Sullivan, D., Kleeman, M. (2009). Influence of development policies and clean technology adoption on future air pollution exposure. *Atmospheric Environment*, 37(36):5047-5068.
- Silvis, J., Niemeier, D. (2009). Social networks and dwelling characteristics that influence ridesharing behavior of seniors. *Transportation Research Record*, 2118:47-54.
- Rowan, D., Niemeier, D. (2009). From kiosks to megastores: The evolving carbon market. *California Agriculture*, 63(2):96-103.
- Gould, G., Niemeier, D. (2009). Review of regional locomotive emission modeling and the constraints posed by activity data. *Transportation Research Record*, 2117:24-32.
- Chen, H., Bai, S., Eisinger, D., Niemeier, D., Claggett, M. (2009), Predicting near-road PM<sub>2.5</sub> concentrations: Comparative assessment of CALINE4, CAL3QHC, and AERMOD. *Transportation Research Record*, 2123:26-37.
- Karner, A., Eisinger, D., Bai, S., Niemeier, D. (2009) Mitigating diesel truck impacts in environmental justice communities. *Transportation Research Record*, 2125:1-8.
- Van Houtte, J., Niemeier, D. (2008). A critical review of the effectiveness of I/M programs for monitoring PM emissions from heavy duty vehicles. *Environmental Science and Technology*, 42(21):7856-7865.
- Niemeier, D., Gould, G., Karner, A., Hixson, M., Bachmann, B., Okma, C., Lang, Z., Heres Del Valle, D. (2008). Rethinking downstream regulation: California's opportunity to engage households in reducing greenhouse gases. *Energy Policy*, 38:3436-3447.
- Gao, H., Niemeier, D. (2008). Using functional data analysis of diurnal ozone and NO<sub>x</sub> cycles to inform transportation emissions control. *Transportation Research, Part D*, 13(4):221-238.
- Lin, J., C. Chen, Niemeier, D. (2008). An Analysis on Long-Term Emission Benefits of a Government Vehicle Fleet Replacement Plan in Northern Illinois, *Transportation*, 35(2):1572-9435.
- Kear, T., Eisenger, D, Niemeier, D., Brady, M. (2008). US vehicle emissions: Creating a common currency to avoid model comparison problems. *Transportation Research, Part D*, 13(3):168-176.
- Hendren, P., Niemeier, D. (2008) Identifying Peer States for Transportation System and Policy Analysis. *Transportation*, 35:445-465.
- Niemeier, D., Mannering, F. (2007) Bridging research and practice: A synthesis of best practices in travel demand modeling. *Special Issue (eds), Transportation Research, Part A*, 41:365-366.
- Bai, S., Nie, Y., Niemeier, D. (2007). The impact of speed post-processing methods on regional mobile emissions estimation. *Transportation Research, Part D*, 12: 307-324.
- Yura, E., Kear, T., Niemeier, D. (2007). Using CALINE dispersion to assess vehicular PM<sub>2.5</sub> emissions. *Atmospheric Environment*, 41(38): p. 8747-8757.
- Choo, S., Shafizadeh, K., Niemeier, D. (2007). The development of a prescreening model to identify failed and gross polluting vehicles. *Transportation Research, Part D*, 12: 208-218.
- Eisinger, D., Niemeier, D., Stoeckenius, T., Kear, T., Brady, M., Pollack, A., Long, J. (2006). Collecting driving data to support mobile source emissions estimation. *Journal of Transportation Engineering*, 132(11):845-854.
- Hendren, P., Niemeier, D. (2006). Evaluating the effectiveness of state department of transportation investment decisions: linking performance measures to resource allocation. *Journal of Infrastructure Systems*, 12(4): 216-229.

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## PUBLICATIONS

---

Rowan, D., Eldridge, M., Niemeier, D., (Submitted to *Energy Policy*, March 2012). Incorporating regional growth into forecasts of greenhouse gas emissions from project-level residential and commercial development.

Rowan, D., Karner, A., Niemeier, D. (2010). Miles per gallon illusions and Corporate Average Fuel Economy distortions: When even the transport experts have trouble. *Transportation Research Record*, 2191:8-15.

Sze, J., Gambirazzio, G., Karner, A., Rowan, D., London, J., Niemeier, D. (2009). Best in show? Climate and environmental justice policy in California. *Environmental Justice*, 2(4):179-184.

Niemeier, D., Rowan, D. (2009). From kiosks to megastores: The evolving carbon market. *California Agriculture*, 63(2): 96-103.

Madani, K., Rowan, D., Lund, J. (2007). The next step in central valley flood management: Connecting costs and benefits. Proceedings of the University Council on Water Resources Annual Conference, Boise, ID. July 24-26, 2007.

## PRESENTATIONS

---

Rowan, D., Karner, A. (2011). Moving toward equity: The ongoing struggle for environmental justice in California. Session co-organizer and moderator. Interdisciplinary Graduate and Professional Symposium, UC Davis, Davis, CA. April 23, 2011.

Rowan, D., Niemeier, D. (2011). Greenhouse gas emissions inventories of proposed residential and commercial developments: Dealing with growth. Poster presentation at the Transportation Research Board's 90th Annual Meeting. Washington, DC, January 23-27, 2011.

- Karner, A., Rowan, D., London, J., Sze, J., Niemeier, D. (2009). Environmental justice, gender, and conflict in California climate policy. Poster presentation at the 4th International Conference on Women's Issues in Transportation. Irvine, CA, Oct. 27 – 30, 2009.
- Rowan, D., Kirk, C., Girn, V., Stasio, K., Stillwater, T., Vassilian, C., Gunda, S., Hsieh, T. (2009). Campus energy solutions: Innovations and results from a collaborative program. Poster presentation at the International Energy Program Evaluation Conference. Portland, OR., August 12-14, 2009.
- Niemeier, D., Silvis, J., Rowan, D. (2007). Private Funding of High Profile Climate Change Skeptics: A Dense Network. Presented the Energy Crossroads Conference, the Roosevelt Institute. Stanford, CA, March 1-2, 2007.
- Newell, C., Aziz, C., Farhat, S., McDade, J., Rowan, D., Adamson, D., Hughes, J. (2003). Low Volume Pulsed Hydrogen Biosparging in an Experimental Controlled Release System. Presented at the Battelle Seventh International In Situ and On-Site Bioremediation Symposium. Orlando, FL. June 2-5, 2003.

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**PUBLICATIONS**

---

Karner, A., "The region or the state? California transportation planning, 1967-1977." Revise and resubmit from the *Journal of Transport History*.

Karner, A., Urrutia, A., Niemeier, D. (2012). US public transit fantasies: Performance and economic stimulus. *International Journal of Transport Economics*, 34(1):39-55.

Karner, A., Eisinger, D., Niemeier, D. (2010). Near-roadway air quality: Synthesizing the findings from real-world data. *Environmental Science and Technology*, 44(14):5334-5344.

Rowan, D., Karner, A., Niemeier, D. (2010). Miles per gallon illusions and Corporate Average Fuel Economy distortions: When even the transport experts have trouble. *Transportation Research Record*, 2191:8-15.

Gould, G., Karner, A. (2009). Modeling bicycle facility operation: A cellular automaton approach. *Transportation Research Record*, 2140:157-164.

Karner, A., Eisinger, D., Bai, S., Niemeier, D. (2009). Mitigating diesel truck impacts in environmental justice communities. *Transportation Research Record*, 2125:1-8.

Sze, J., Gambirazzio, G., Karner, A., Rowan, D., London, J., Niemeier, D. (2009). Best in show? Climate and environmental justice policy in California. *Environmental Justice*, 2(4):179-184.

Niemeier, D., Gould, G., Karner, A., Hixson, M., Bachmann, B., Okma, C., Lang, Z., Heres Del Valle, D. (2008). Rethinking downstream regulation: California's opportunity to engage households in reducing greenhouse gases. *Energy Policy*, 38:3436-3447.

## PRESENTATIONS

---

- Karner, A., Niemeier, D. A review of civil rights guidance and equity analysis methods for regional transportation plans. Submitted for presentation at the 92nd Annual Meeting of the Transportation Research Board. Washington, DC, January 13-17, 2013.
- Karner, A., Niemeier, D. Innovations in the equity analysis of regional transportation plans. Submitted for presentation at the 92nd Annual Meeting of the Transportation Research Board. Washington, DC. January 13-17, 2013.
- Karner, A., (2012). Innovations in regional transportation equity analysis. Paper accepted for presentation at the International Conference on Inequality and Sustainability. Medford, MA, November 9-10, 2012.
- Karner, A., (2012). Transportation equity analysis for activity-based travel demand models. Poster presentation at the University of California Transportation Center Student Conference. Davis, CA, April 20, 2012.
- Karner, A., (2012). Evaluating public participation in California's Global Warming Solutions Act. Paper presented at the 2nd Annual Dimensions of Political Ecology Conference. Lexington, KY, April 13-15, 2012.
- Karner, A., Niemeier, D. (2012). The region or the state? California transportation planning, 1967-1977. Transportation History, Session 303. Paper presented at the 91st Annual Meeting of the Transportation Research Board. Washington, DC, January 22-26, 2012.
- Rowan, D., Karner, A. (2011). Moving toward equity: The ongoing struggle for environmental justice in California. Session co-organizer and moderator. Interdisciplinary Graduate and Professional Symposium, UC Davis, Davis, CA. April 23, 2011.
- Karner, A., Niemeier, D. (2011). Translating policy to practice: An interdisciplinary investigation of transportation planning. Paper presented at the 13th Transportation Research Board National Planning Applications Conference. Reno, NV, May 8-12, 2011.
- Karner, A., Niemeier, D., (2011). Transportation spending under the American Recovery and Reinvestment Act in California. Taxation and Finance, Session 561. Paper presented at the 90th Annual Meeting of the Transportation Research Board. Washington, DC, January 23-27, 2011.
- Karner, A., Eisinger, D., Niemeier, D. (2010). Near-road air quality: Findings from real world data. Paper presented at the Coordinating Research Council Mobile Source Air Toxics Workshop. Sacramento, CA. November 30-December 2, 2010.
- Karner, A., Eisinger, D., Niemeier, D. (2010). Near-road air quality: Findings from real world data. Paper presented at the Air & Waste Management Association Symposium on Air Quality Measurement Methods and Technology. Los Angeles, CA, November 2-4, 2010.

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**LICENSE**

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E.I.T., October, 2010.

**PUBLICATIONS**

---

Rowan, D., Eldridge, M., Niemeier, D., (Submitted to *Energy Policy*, March 2012). Incorporating regional growth into forecasts of greenhouse gas emissions from project-level residential and commercial development.

# Technical Memorandum: Review of Transportation and Air Quality Analysis in the I-710 Draft Environmental Impact Report

SEPTEMBER 26, 2012

## FINAL

PREPARED FOR:  
EAST YARD COMMUNITIES FOR ENVIRONMENTAL JUSTICE  
&  
NATURAL RESOURCES DEFENSE COUNCIL

PREPARED BY:  
SUSTAINABLE SYSTEMS RESEARCH, LLC

## DISCLAIMER

The views expressed in this review are those of the authors. They do not represent the opinions of the East Yard Communities for Environmental Justice, the Natural Resources Defense Council, the University of California Davis, or any other organization with which the authors or recipients are affiliated. Due to time constraints and the number of technical documents supporting the DEIR, the technical review focuses on the DEIR itself, the Air Quality and Health Risk Assessments, the Travel Modeling Methodology, the Railroad Goods Movement Study, the Intersection Traffic Impact Analysis Report, the Traffic Operations Analysis Report, and relevant sections and appendices of related documents. It is possible that some of the questions raised in this review are answered in documentation that we were unable to review in the time available, or that additional questions would be raised if additional documentation had been readily available.

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## I. INTRODUCTION

During the summer of 2012, Sustainable Systems Research, LLC was commissioned by the Natural Resources Defense Council and the East Yard Communities for Environmental Justice to review the travel demand modeling, air quality, health, and traffic assessments in the I-710 Draft Environmental Impact Report (DEIR) and to evaluate the design components of the alternative proposed by the Coalition for Environmental Health and Justice (CEHAJ).

The I-710 Corridor Project is intended to improve the movement of people and goods along the I-710 Corridor for the 18 miles stretch between Ocean Boulevard near the Port of Long Beach and SR-60 in East Los Angeles. The project objectives include improving air quality, traffic, and safety along the corridor, as well as accommodating projected port, population, and job growth in the area. The project has been proposed by the State of California Department of Transportation (Caltrans) in cooperation with the Los Angeles County Metropolitan Transportation Authority, the Gateway Cities Council of Governments, the Southern California Association of Governments, the Ports of Los Angeles and Long Beach, and the Interstate 5 Joint Powers Authority.

Five alternatives and several design options are evaluated in the Draft Environmental Impact Report (DEIR). Each alternative builds on the previous one and includes the programs and design strategies presented in the Alternative before it, with additions as noted:

**Alternative 1:** The no-build alternative (includes approved and planned projects).

**Alternative 5A:** I-710 widening, geometric and arterial improvements, TSM/TDM, Transit, &ITS.

**Alternative 6A:** Dedicated freight corridor from Ocean Blvd to UP and BNSF railyards in the City of Commerce.

Option 1: Three ramp intersections at Washington Blvd.

Option 2: Two ramp intersections at Washington Blvd.

**Alternative 6B:** Freight corridor has only zero emissions trucks with automated guidance.

Option 1&2 apply.

Option 3: Has freight corridor ramps in place of Washington Blvd access to I-710.

ZEE Design Option: Extends the zero-emission technology to SR-60.

**Alternative 6C:** Freight corridor has a toll.

Option 1&2 and the ZEE Design Option apply.

Additionally, CEHAJ has proposed an alternative:

**Alternative 7:** Community benefits (local hiring, enhanced open space, community enhancements), comprehensive bicycle/pedestrian element, river improvements, comprehensive transit element, a committed zero emission freight corridor, and a public-private partnership employer operated freight system. This alternative does not add lanes to the I-710 mainline.

This memorandum is an evaluation of the travel modeling, air quality, and traffic analyses presented in the DEIR. We note that the DEIR does not indicate which alternative is preferred, so our analysis assesses the outcomes of all build alternatives (5A, 6A, 6B, 6C, and ZEE design variations). Following our assessment of the DEIR alternatives analysis, we evaluate the design components of CEHAJ's proposed alternative (Alternative 7) in light of the transit alternative evaluation that was undertaken as part of the DEIR alternatives evaluation process.

## I. TRAVEL DEMAND MODELING

Projected growth in goods moved through the port and population as well as expected future freight and passenger travel mode shares undergird nearly all of the EIR analyses. It is our opinion that the analytical methods employed in the DEIR lean toward assumptions that will inflate the performance of the project alternatives relative to no-build. No sensitivity tests were conducted for several key parameters so the magnitude of these assumptions on the project alternatives is unknown.

There are five major issues that are related to the travel modeling and forecasts presented in the report. These include uncertainty associated with the freight growth estimates, use of outdated population growth estimates, alternative definition, post-processing, sensitivity analysis, and induced demand.

### FREIGHT GROWTH ESTIMATES

The information underpinning all port truck trip data presented in the Draft EIR is the expected containerized cargo throughput for the San Pedro Bay Ports, i.e. the number of containers that are expected to be transported within the region. Growth in goods movement from the ports, commissioned by the San Pedro Bay Ports (SPBP) [1] (referred to here as the Tioga estimates), are used to develop each of the DEIR alternatives [2]. It is well established that long-term forecasts of growth are generally subject to substantial uncertainty. In the I-710 analysis, the port growth estimates are based on data going back only to 1995, so it is likely that growth projections 25 years out are highly uncertain. To illustrate this, consider Tioga's July, 2009 estimates of 2030 volumes compared to their estimates completed in December, 2007 (i.e. less than two years prior). Tioga adjusted the 2030 volumes downward from 65 million twenty foot equivalent units (TEUs) to 35 million, a drop of 47%. The 2010 estimates fell 39%, and actual 2008 values were 22% lower than expected. Put another way, the projected port growth from 2008 to 2035 went from 364% in the 2007 estimate to just 150% in the 2009 estimate. Tioga's analysis does not expand on the relationship between growth in goods movement at the SPBP and factors such as federal spending, fuel prices, productivity growth, and unemployment, among others [1, pp. 8-13]. Thus, the basis and uncertainty associated with this estimate are unknown, but likely to be very high.

The DEIR freight growth estimate describes several scenarios that result in 2035 container volumes ranging between 28.5 and 43 million TEUs. The boundaries of these scenarios are labeled "low cargo demand" and "high cargo demand," respectively, and the likelihood of realizing either forecast is not discussed [3, p. 3.2-19]. Citing Tioga, the DEIR uses the high cargo demand value of 43 million TEUs for the 2035 container volume for analysis purposes, which results in higher truck traffic volumes even when assuming more rail expansion in the high growth case.<sup>1</sup>

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<sup>1</sup> The DEIR argues that truck volumes in the low growth case would only be 11% lower than for high growth, but this determination rests entirely on their assumptions about the expansion of on-dock rail in both cases. No economic analysis is cited that justifies this assumption, so it is possible that increased on-dock capacity could accompany low cargo growth (DEIR p. 3.2-20).

Non-port heavy duty traffic is forecasted separately from port truck traffic using the Heavy-Duty Truck (HDT) model from the SCAG 2008 RTP. A portion of this model is devoted to interregional truck trips, which are based on commodity flow data. Commodity flow data are based on a 1996 forecast contained in the Caltrans Intermodal Transportation Management System (ITMS) database that was updated using the FHWA Freight Analysis Framework (FAF) data set [4, pp. 10-11]. This update was done in preparation for the 2008 RTP, and thus the most recent (FAF3) data for 2007 or 2010 was not available. We therefore assume that FAF2 data for the year 2002 were used to update the 1996 commodity flow numbers. Since 2002 was well in advance of the economic downturn that occurred in the latter part of the decade, the commodity flow data used in the model, modified as described in the report, may not accurately represent actual commodity flows for the base year or forecast year (2035). Over-estimation of the commodity flows would cause the non-port truck traffic to be similarly overestimated by the regional model, increasing the attractiveness of the build alternatives for congestion mitigation. As with port throughput, the inherent uncertainties present in long term projections make predicting commodity flow difficult, especially as far out as 2035.

Since long-term forecasts are by their nature highly uncertain, and given the high costs of the build alternatives, a more conservative approach would be to evaluate the design effects of differing growth assumptions on projected project outcomes. If lower growth is realized, smaller scale expansion (with lower capital expenditures) would likely appear more favorable. By using the maximum projected growth in the alternatives analysis, two outcomes are assured: first, the performance of the no-build scenario will be poor relative to any alternatives that embody substantial capacity expansion, and second, the alternative with the greatest capacity expansion will perform best.

## **POPULATION GROWTH ESTIMATES**

The DEIR states that

Regional population is forecast to grow by 27 percent and Study Area population is forecast to grow by 11 percent from 2008 to 2035. Employment will follow a similar pattern, with regional growth of 27 percent and Study Area employment growth of 7 percent. Growth will be lower in the Study Area than in the SCAG region because the Study Area is almost completely developed. New growth will be limited to smaller, infill-type developments. Table 1.2-3 summarizes forecasted population and employment growth from the 2008 RTP for the entire SCAG region and for the Study Area. *The 2008 RTP growth forecast was the basis for the regional traffic modeling that was performed for the I-710 Corridor Project. Compared to the 2008 RTP growth forecast, the 2012 RTP growth forecast for population and employment by 2035 is about 9 percent lower (i.e., the 2012 RTP projects a population of 22.1 million people and 9.4 million jobs in the SCAG region by 2035).* (DEIR page 1-15, emphasis added)

Page 31 of the Travel Demand Modeling Methodology report [4] states that the 2008 RTP population values are used in the travel demand model.

As indicated in the DEIR, the population and job growth estimates have been recently revised downward. The DEIR indicates that population and employment forecasts will be about 9% lower,

which means that growth in population and employment are about 32% lower, which will result in substantially lower travel demand estimates. Overestimated population and job growth would be expected to particularly affect estimates of travel demand on freeways and arterials. As with the freight growth estimates, the use of a higher estimate assures that the performance of the no-build alternative will be poor relative to alternatives that embody capacity expansion and that the alternative with the greatest capacity expansion will perform best. As with freight growth estimates, overestimated population growth estimates underlie the entire analysis, and so affect traffic, safety, health, and air quality projections.

The assumptions underlying the forecasts of travel demand are directly based on assumptions about future growth in population and goods movement. Any errors in these estimates will propagate through the modeling process and result in errors in traffic volumes by vehicle class on every major link, interchange, and some arterials and intersections in the study area [4]. Thus, the assumptions for growth are also likely to affect the conclusions reached throughout the document, for example, related to traffic, safety, health, and air quality.

### **ALTERNATIVES DEFINITION**

The no-build alternative includes committed transportation projects from the 2008 regional transportation plan and regional transportation improvement program.<sup>2</sup> Committed projects are those with funding definitely or reasonably expected to be available. In addition to capacity expansion, Alternative 5A and 6A/B also include arterial improvements, transportation systems management/travel demand management, public transit, and other intelligent transportation system (ITS) technologies. The latter improvements are generally less capital intensive than capacity expansion relative to the benefits they provide. In the Alternative Screening Analysis, Alternatives 2 and 4 include TDM/TSM/Transit/ITS without and with arterial improvements, respectively – these alternatives fared well in terms of most of the preliminary metrics evaluated in the screening analysis and their estimated costs are dramatically lower--\$200 million and \$700 million rather than \$2.6 to 5.3 billion for the selected alternatives (see Appendix B of the Alternatives Screening Analysis for its assessment of all alternatives). The elimination of Alternative 2 is described in more detail in this report in the section evaluating the alternative proposed by CEHAJ.

The process of eliminating lower cost, feasible alternatives prior to fully conducting the detailed DEIR analysis unnecessarily bounds the analysis of overall benefits and costs of both low- and high- cost alternatives in the DEIR. The current selection of alternatives for analysis in the DEIR suggests a preference for high-cost highway expansion projects. In light of the decision to use the higher growth assumptions, it raises the question: How would lower cost alternatives (e.g., alternatives 2 and 4) fare in managing increased freight traffic, particularly under lower projections? Similarly, if an alternative were considered that allocated additional funds for the construction of

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<sup>2</sup> Neither of the near-dock intermodal transfer facilities are assumed constructed. The DEIR states that this is because they are both currently in the Environmental Impact Review process.

new transit infrastructure, would the benefits compete with those predicted for the high cost highway expansion project alternatives?

## **POST-PROCESSING**

The report mentions that post-processing techniques are common when a regional model is applied at the corridor level. According to the Travel Demand Modeling Methodology report, “the traffic volumes produced by the model [were adjusted] to match ground counts as closely as possible” [4, p. 40, 82]. Essentially, traffic was added or subtracted from mainline links to ensure conservation of flow between the I-710 mainline and the on/off ramps. As stated in the report, “what remains on the mainline after an interchange has to equal what was on the mainline before the interchange plus what got on at the interchange and minus what got off” [4, p. 82]. Once these adjustments were made, the difference between raw modeled volumes for 2035 and 2008 were added to the adjusted 2008 volumes.

In other words, where the model is unable to accurately represent base conditions, the modeled base conditions are adjusted rather than adjusting the underlying modeled relationships that predict travel behavior. This step is undertaken in an effort to scale the estimated regional volumes down to those actually observed at an interchange or intersection in order to produce an accurate level of service evaluation. This might be the best approach if the modeled volumes are within the established acceptable errors<sup>3</sup> both upstream and downstream from the interchange/intersection being evaluated. But for those locations where this is not true, the approach obscures those instances where the base volume estimates exceed targets set for acceptable error for screenline arterials, and this appears to happen at a fairly large number of locations.

In general, the travel forecasting process is premised on the concept that relationships between trips and demographics in the base year hold over time. If the forecasted trips are outside the range of acceptable error, this error will propagate throughout the analysis, and will usually be much worse in future years. Manually revising model estimated volumes does not alter the relationships that are used to estimate forecasted volumes; these relationships will still produce the underlying errors in future volumes.

For the build alternatives, auto trips in the study area were reduced by 2.8% to account for transit improvements based on quantitative results from the Multimodal Review Technical Memorandum [5]. Additionally, mainline I-710 and major (>4 lanes) arterial capacity was increased by 6% to account for the implementation of intelligent transportation systems (ITS) including integrated corridor traffic management, and capacity was increased by an additional 17% for some parallel arterials in the study area to account for parking restrictions. The Multimodal Review states that “Studies indicate that when used in combination, capacity was increased 6% on the freeway, 23% on arterial street diversion routes, and 6% on arterial streets overall, relative to a baseline condition”

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<sup>3</sup> See Table 5, p. 25. Screenline arterials had a target of 35% root mean squared error (RMSE), but calculations showed error exceeding 40% in some cases [4].

[5, p. 51]. The studies used to justify the previous statement are not specified in the Multimodal Review. It is not clear whether the increases are just arbitrary amounts or have some empirical basis to underpin them. Adding arbitrary levels of additional capacity through low-cost (largely difficult to measure) strategies will tend to improve the performance of the build alternatives relative to no-build without appreciably increasing project costs.

The post-processing methods [5, pp. 41-42] also produced some negative volumes after post-processing mainline I-710 links and ramps, and post-processing of arterial intersection volumes did not allow volumes to decrease even if the model showed that outcome from the base year to the forecast year. Specifically, “If the model produced a negative growth, then it was assumed that the specific turning movements would grow by 5 percent in year 2035” [4, p. 42]. The net effect of these changes is unknown, but they speak to the uncertainty inherent in transportation modeling and the counterintuitive adjustments to modeling results that had to be made as a result.

### **SENSITIVITY ANALYSIS**

The analysis makes a number of assumptions regarding the treatment of future intermodal container facilities and warehousing facilities that may be appropriate for engineering analysis, but their linkages to current economics are unclear. With respect to intermodal facilities, the travel demand modeling report notes that “there will be insufficient capacity at the existing off-dock intermodal terminals to handle the forecast growth in cargo, especially when domestic intermodal demand is taken into account” [4, p. 15]. To address this capacity shortfall, two near-dock facilities have been proposed. The BNSF is pursuing construction of the Southern California International Gateway (SCIG) and UP is planning to expand its Intermodal Container Transfer Facility (ICTF). The DEIR does not include either of the facilities in its land use projections. It states that this is because both are currently under environmental review. Instead, fictional intermodal facilities constructed “somewhere in the Inland Empire or further northeast” are included to absorb this growth in intermodal demand [4, p. 15-16]. The economic rationale for locating these facilities in this manner is not discussed. Also, if future conditions see the approval and construction of the SCIG and ICTF, how would study area volumes be affected?

Existing warehousing capacity for local truck trips is also constrained [4, p. 17]. Despite this constraint, the DEIR analysis does not project any change in local truck trip patterns between 2004 and 2035. In other words, the DEIR analysis assumes that the same warehouses that are currently operating at capacity will accommodate a 150% increase in port throughput by 2035. To examine the effect of this assumption, the travel demand modeling report conducts a “sensitivity analysis” that varies the location of warehouses in 2035 [4, p. 70-75]. The sensitivity analysis assumes that additional warehouses are available in Southern Kern County and in Victorville and caps trips to warehouses within the I-710 study area at 2008 levels with additional growth directed to those new trip ends. This approach results in increased port-related traffic outside of the study area as trucks move to comparably more distant locations.

Unfortunately, the summary of the results is largely illegible [4, p. 74, Figure 30]; the results are presented in terms of increases in port trucks on freeways approaching Southern Kern County and Victorville only for the AM peak period. Both absolute and percentage increases are presented in the low fidelity figure. The decision to present only results for the AM peak is likely to underestimate the total impact since truck volumes peak in mid-day [4, pp. 72-73]. A more robust analysis would include all periods of travel. A higher fidelity version of the figure was provided by Metro (Figure 1), but it does not contain the same volume summaries as Figure 30 from the Travel Demand Modeling Methodology report. The salient results are still interpretable from the low fidelity graphic – substantial increases in port-related truck volumes on I-605 (50% more port trucks), I-210 (300% more port trucks), and I-15 (2000% more port trucks) are expected. The analysis does not provide information to assess how realistic the potential for increasing warehouse capacity in the I-710 study zone. Nor does it discuss potential impacts on air quality and congestion outside of the study zone.



Figure 1: Higher fidelity version of Figure 30 from the Travel Demand Modeling Methodology Report.

The DEIR assumes that all origin-destination pairs remain constant over time (i.e., origins and destination remain proportionally the same as exhibited in 2004). In other words, all DEIR analyses of the build alternatives assume that all port-related truck origin-destination pairs remain local to the

I-710 study zone in 2035 even though the *existing* warehouses are operating at capacity. Since the trip from the SPBP to Victorville is 100 miles one way, this assumption will tend to massively underestimate truck VMT and therefore impacts on regional emissions and congestion on surrounding facilities. A more accurate approach might assume some growth in the immediate I-710 warehousing capacity but would also shift some origin-destination pairs to the northwest and northeast, consistent with the sensitivity analysis results. Constraints on warehousing capacity may also tend to shift port-related traffic to other North American ports, reducing the total goods movement growth estimates. This possibility is not addressed.

## **INDUCED DEMAND**

In general, projects that add route capacity (e.g. additional lanes miles, or new roads) result in long term increases in VMT that fill the capacity [6]. These VMT increases can be largely explained by increases in household travel and commercial travel, and to a lesser degree by population increases and diversion from other roads [6]. Thus, massive expansion of the capacity of I-710 will reduce travel times between origin and destination pairs using that facility, potentially 1) shifting trips from other facilities in the region and 2) inducing entirely new trips or changes in long term choices like residential, school, warehouse, and workplace locations. The result is that congestion, air quality, and health benefits gained from capacity expansion may erode over time as additional travel fills the new capacity. The DEIR notes that the model predicts the first effect, and it accounts for growth in port activity related to the second effect in all alternatives (including, perhaps perversely, the no build alternative), but we note that accurately accounting for the second effect across alternatives would require that the changes in travel be assessed using an integrated modeling framework that allows land uses to change in response to capacity increases. However, aside from warehousing, land use assumptions are not explicitly discussed anywhere in the report.

To the extent that fixed land use assumptions were relied upon, as is typical with agency practice, VMT increases associated with the build alternatives are likely underestimated because induced demand would be ignored. However, because the DEIR models expanded port activities, its analysis of alternatives will at least partially avoid this pitfall (although as discussed elsewhere it may lead to overestimates of demand in the “no build” scenario, making the relative benefits of the build alternatives stronger). To the extent that the DEIR fails to account for induced demand that may occur in excess of the modeled port expansion, it will inflate the performance of the build alternatives relative to no-build in terms of energy use, traffic, and air quality.

## II. AIR QUALITY

In this section we review the DEIR with respect to regional and project level air quality requirements. This portion of our review draws primarily from information presented in Section 3.13 of the DEIR [3] and from the AQHRA [7]. Since estimates of travel demand feed directly into estimates of air quality effects, any biases or errors discussed in the previous section would propagate to the air quality analysis described in the DEIR. Additionally, we find that there are a number of unanswered questions related to regional conformity, PM hotspot analysis, CEQA evaluation, dust re-entrainment assumptions, the interpretation of incremental emissions estimates, the emissions factors adjustments, and the use of various types of updated guidance.

### REGIONAL CONFORMITY

The PM conformity analysis in the DEIR is qualitative. According to the 2006 PM<sub>2.5</sub> and PM<sub>10</sub> qualitative hotspot guidance:

For a project-level conformity determination, the design concept and scope of the project must be consistent with that included in the conforming transportation plan and transportation improvement program (TIP). Any significant change in a project's design concept or scope will require a reevaluation of regional emissions (i.e., a new plan/TIP conformity determination) and a new project-level conformity determination and hot-spot analysis. [8, p. 14]

The DEIR states that the 2008 RTP was consistent with Alternative 6B and that the project scope is the same scope that was modeled in the 2012 RTP. The DEIR also states that the project scope reflected in the 2012 RTP is consistent with Alternatives 6B and 6C. In both cases the project description modeled in the RTP is described as having a user fee,<sup>4</sup> so it seems more likely that Alternative 6C was closest to what was modeled rather than Alternative 6B. Overall it is unclear which alternatives have been represented in the RTP, and thus for which Alternatives the DEIR has demonstrated regional conformity (Table 1).

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<sup>4</sup> On page 3.13-15 of the DEIR [3], it states that

The project is in the 2008 RTP, which was found to conform by the FHWA/FTA on June 5, 2008 (Project ID: iC0401; Description: I-710 Corridor user-fee backed capacity enhancement – widen to five mixed flow plus two dedicated lanes for clean technology trucks [each direction], and interchange improvements). The design concept and scope of Alternative 6B is consistent with the project description in the 2008 RTP. This same concept and design scope is also included in the Draft 2012 RTP.

And that

The list of financially constrained projects in the 2012 RTP/SCS also includes the full I-710 Corridor Project (Project ID No. ICO401) and is described as follows: I-710 Corridor User-Fee Backed Capacity Enhancement – Widen to five mixed flow + two dedicated lanes for clean technology trucks (each direction) and interchange improvements, from Ocean Blvd. in Long Beach to the intermodal railroad yards in Commerce/Vernon. This description is consistent with the description of Alternatives 6B and 6C provided in Chapter 2 of this Draft Environmental Impact Report/Environmental Impact Statement (EIR/EIS).

**Table 1: RTP Consistency with DEIR Alternatives (based on information in the DEIR)**

	<b>Alt 5A</b>	<b>Alt 6A</b>	<b>Alt 6B</b>	<b>Alt 6C</b>
<b>Consistent with RTP?</b>	No	No	Unlikely: RTP project scope includes user fee	Likely: RTP project scope includes user fee

## **PROJECT LEVEL ANALYSIS**

Two project level hotspot analyses are conducted: CO and PM. Both analyses find that the project will not compromise attainment. However, the empirical justification for these findings is unclear. Specifically, for the CO analysis, it is unclear how worst case traffic conditions have been defined. For the PM hotspot analysis (which is qualitative), it is unclear why a quantitative analysis was not conducted given the level of future diesel traffic expected to use the facility as well as the fact that the grace period for the PM quantitative analysis concludes in December 2012.<sup>5</sup> A quantitative analysis would provide a more accurate basis for determining the air quality effects of the project. In addition, the health risk assessment suggests that a quantitative analysis is clearly merited and that the likelihood of a PM hotspot exceedance is high. Finally, it is our opinion that a quantitative analysis could have been done, especially in light of the analysis used in the health risk assessment.

### *CO ANALYSIS*

In the CO hotspot analysis, the DEIR states that Alternative 6B is the only alternative that is analyzed because traffic conditions had higher cumulative delays during the period evaluated (afternoon) in 6B than the other alternatives (See page 3.13-16 of the DEIR [3] and Appendix H of the AQHRA [7]). Although we would not expect a CO exceedance, we draw attention to the selection of worst-case traffic conditions used in the CO evaluation. It is not clear that Alternative 6B has the worst traffic conditions for all intersections evaluated. There are also a number of intersections in which 6B does not represent the worst delays or highest traffic volumes. As shown in Figure 2, Alternative 6B has longer afternoon cumulative delays<sup>6</sup> than Alternatives 1, 5A, and 6A for four of the 10 intersections analyzed (38, 23, 148, and 140), while 5A and 6A have the longest delays for four and two intersections, respectively.<sup>7</sup>

Cumulative delays are not presented for Alternative 6C because traffic conditions in Alternative 6C are “similar or slightly better traffic conditions than under Alternative B” page 29 of Appendix H of the AQHRA [7]. However, according to the Intersection Traffic Impact Analysis Report,

...a portion of port trucks utilizing the FC under Alternative 6B are diverting away from the FC and back onto the I-710 GP lanes under Alternative 6C due to the toll collection, and the increase in truck

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<sup>5</sup> EPA has promulgated guidance on the quantitative analysis of PM hotspots; there is a grace period that ends December, 2012 [9].

<sup>6</sup> Cumulative delay is calculated as the product of per-vehicle delays and total traffic volume.

<sup>7</sup> This discussion is based on the assumption that three unusually large values in Table 3 of Appendix H of the AQHRA are typos. If they are not typos, then the cumulative delays are the worst for 5A, 6A, and 6B in 2, 3, and 5 of the 10 intersections respectively.

traffic on the I-710 GP lanes in turn pushes some of the auto traffic from the I-710 onto the local arterials, similar to Alternatives 1 and 5A. [10, p. 5-120]<sup>8</sup>

This suggests that there may be sufficient revision to traffic patterns that further evaluation is warranted. While cumulative delays are not provided in the AQHRA analysis (i.e., the data shown in Figure 2), Alternative 6C has greater per vehicle delays than 6B for four out of the ten intersections modeled (estimated from Attachment 2 of Appendix H of the AQHRA [7]).

Additionally, the choice of evaluating only 10 intersections requires clarification. Although the intersection selection seems consistent with 1992 guidance provided by EPA [11], the most recent guidance provided by Caltrans (in 1997) indicates that all LOS D, E, or F intersections should be evaluated although some screening out of LOS D intersections may be possible [12].

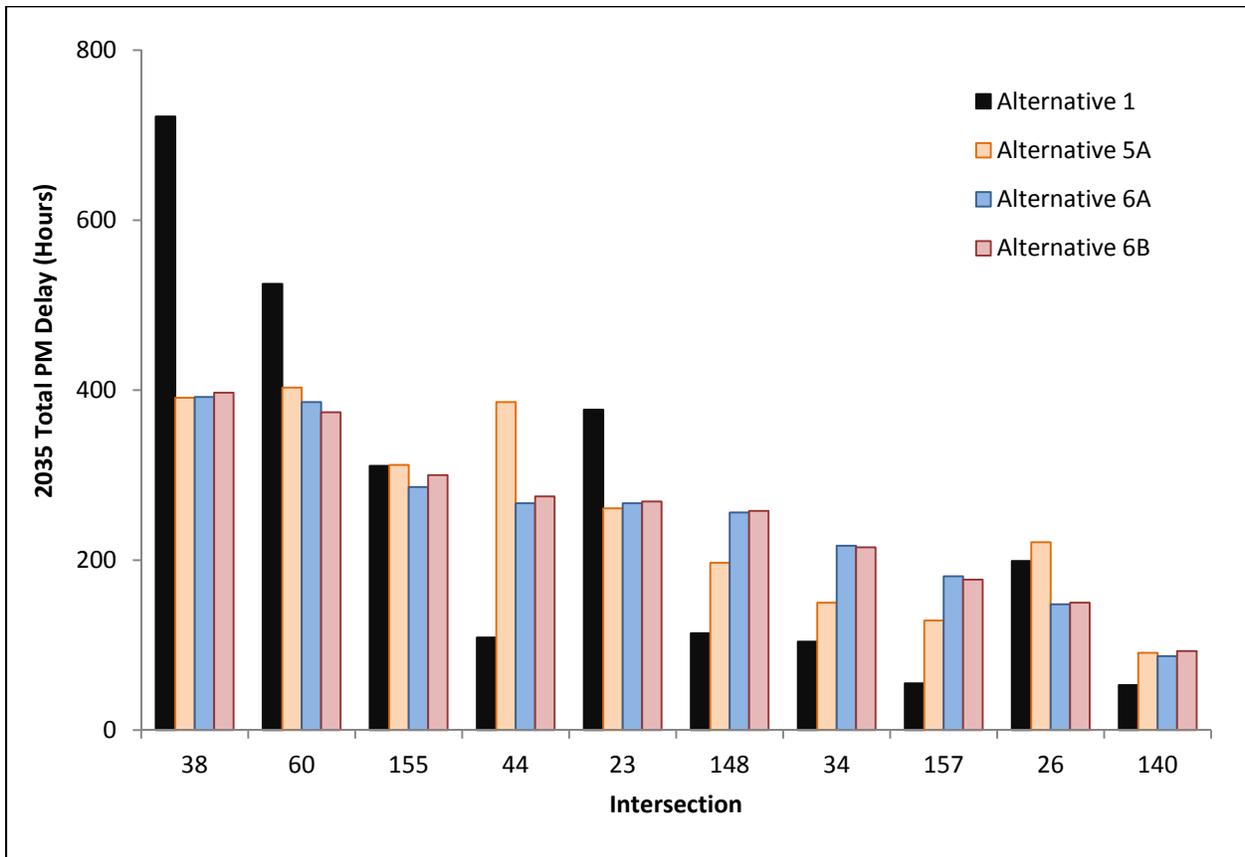


Figure 2: Delay at Intersections Included in CO Hotspot Analysis<sup>9</sup>

<sup>8</sup> This effect is discussed in more detail in the tolling section of the Discussion of CEHAJ’s Proposed Alternative section of this report.

<sup>9</sup> Compiled from AQHRA [7] Appendix H, pp. 10-12. Data shown assume that the three unusually large values are typos, and use the first three digits provided for those values as follows: Alternative 6A at intersection 60: 3869 ->386, Alternative 6B at intersection 155: 3007->300, Alternative 5A at intersection 26: 2211->221. Cumulative delays for Alternative 6C were not provided in the AQHRA.

## *PM ANALYSIS*

The general approach to conducting a qualitative PM hotspot analysis does not actually produce location specific PM pollution estimates. Although other methods can be acceptable, in general, the PM hotspot qualitative analysis relies on one of two primary means of demonstrating that the project will not have an adverse air quality effect: 1) comparison to an existing facility or project, or 2) utilizing air quality data from studies that have already been performed to demonstrate project-level effects at nearby locations [8]. In the former approach, among the key considerations that determine comparability are similar or higher ADT volumes, similar background volumes, and similar meteorological conditions.<sup>10</sup> In the latter approach, use of existing air quality data depends on a robust interagency consultation process to ensure that the approach and air quality data used in the analysis are sufficient. In general, it is expected that any existing air quality data would be in proximity to the project and that a discernible downward trend in current PM sources could be documented.

The analysis in the DEIR uses a qualitative approach; however the DEIR lacks sufficient explanation of the actual logic used to conduct the analysis. The DEIR approach relies on the use of monitoring data and an inter-year alternatives comparison that is very difficult to follow. Briefly, the analysis finds that PM project-level emissions will not violate Federal air quality standards because:

- PM<sub>2.5</sub> and PM<sub>10</sub> concentrations at monitors near the project location are not expected to exceed various Federal standards in 2014 and 2015,
- Federal standards for PM<sub>10</sub> were only exceeded in 2007, and
- Alternatives 5A and 6A will increase PM<sub>2.5</sub> and PM<sub>10</sub> emissions compared to Alternative 1 (the no build alternative), 6C would have little or no effect on PM<sub>2.5</sub> and PM<sub>10</sub> emissions relative to Alternative 1, while 6B, 6B with the ZEE design option, and 6C with the ZEE design option would reduce and 6C will result in a lower PM<sub>2.5</sub> and PM<sub>10</sub> emissions than the no build Alternative 1 in 2035.

There are a number of aspects to the DEIR analysis that cannot be verified or understood on the basis of the available documentation:

### 1. Unclear justification for the selected background concentration:

The PM<sub>2.5</sub> 24-hour and annual background concentrations that were selected for analysis reflect the minimum possible concentration that could have been selected. The DEIR analysis is based on the minimum possible range of projected 24-hour values<sup>11</sup> from the

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<sup>10</sup> See <http://www.dot.ca.gov/ser/vol1/sec3/physical/ch11air/chap11.htm> as referenced from [http://www.dot.ca.gov/hq/env/air/main\\_sections/analysistools.htm](http://www.dot.ca.gov/hq/env/air/main_sections/analysistools.htm)

<sup>11</sup> The predicted 24-hour PM<sub>2.5</sub> concentration selected is 31.2 µg/m<sup>3</sup>, the minimum of a range of predicted values for the Long Beach Station (31.2 – 41.9 µg/m<sup>3</sup>) (page 3.13-20 of the DEIR, with the range obtained from Table V-2-16 in Appendix V of the Air Quality Management Plan). The DEIR explains that the use of this minimum is acceptable because the measured concentrations in 2010 for North Long Beach, Long Beach PCH, and Los Angeles stations ranged

monitor with the lowest projected 24-hour and annual background concentrations of nearby monitors.<sup>12</sup> Had background concentrations other than the minimum been selected, the projected 24-hour background concentrations would have been above Federal standards. If either of the two nearby monitors had instead been used, the 24-hour background concentrations would have exceeded Federal standards and the annual concentrations would have been higher although just below Federal standards. The DEIR should also demonstrate that the selected monitor(s) shows a discernible downward trend in measured pollutant concentrations since existing concentrations are not significantly below Federal standards.

## 2. Methods used to estimate project-level emissions are inadequately documented:

### 2.a. Justification of ‘worst’ year analyzed.

EPA guidance for qualitative hotspot analysis suggests that the evaluation year should be set at peak emissions (in terms of both project effects and background concentrations).<sup>13</sup> The DEIR uses a future year of 2035 (for both emissions factors and traffic conditions). The 2035 analysis year represents a year of convenience since it coincides with the RTP horizon. However there is no discussion of when construction will be completed in the DEIR, although the AQHRA indicates that construction may be completed by 2029.<sup>14</sup> Because background concentrations and fleet emissions factors are typically expected to decline over time, while traffic volumes are expected to increase over time, 2035 does not necessarily represent the peak emissions year. The DEIR should clearly document the rationale for the year used in the analysis.

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from 31.7 to 35.1  $\mu\text{g}/\text{m}^3$ . This information is not sufficient to justify the selection of the minimum modeled value. It would be more conservative and likely more appropriate to use the maximum projected value, as the source document table provides just one summary value - the maximum predicted value. If the DEIR had used either the average (35.9  $\mu\text{g}/\text{m}^3$ ) or maximum (41.9  $\mu\text{g}/\text{m}^3$ ) predicted concentrations of 24-hour  $\text{PM}_{2.5}$  would be above the Federal standard of 35  $\mu\text{g}/\text{m}^3$ .

<sup>12</sup> The EIR Air Quality chapter begins by identifying North Long Beach, Los Angeles, and Lynwood as the nearest monitors in section 3.13.2, only to shift to North Long Beach, Long Beach PCH, and Los Angeles in section 3.13.3. It is unclear why the Long Beach 24-hr  $\text{PM}_{2.5}$  predicted concentration was selected from the Air Quality Management Plan, as projections from Los Angeles and Compton (previously measured at Lynwood) are available from the same source document, with projected 24-hr  $\text{PM}_{2.5}$  concentrations ranging from 46.1 – 55.1  $\mu\text{g}/\text{m}^3$  and 37.5 – 56.6  $\mu\text{g}/\text{m}^3$  respectively in 2015. Choosing the minimum, average, or maximum of either these values would result in a prediction that exceeds the 35  $\mu\text{g}/\text{m}^3$  Federal standard. Similarly, to describe expected attainment of  $\text{PM}_{2.5}$  annual concentration levels, the DEIR selects predicted values for Long Beach in 2014, yielding a predicted annual  $\text{PM}_{2.5}$  level of 12.7  $\mu\text{g}/\text{m}^3$ . Although both Compton and Los Angeles are predicted to be below Federal standards of 15  $\mu\text{g}/\text{m}^3$ , they are much closer to the standard (14.5 and 14.9  $\mu\text{g}/\text{m}^3$  respectively) and neither is mentioned in the DEIR.

<sup>13</sup> According to EPA/FHWA qualitative hotspot analysis guidance, “to ensure that conformity requirements are being satisfied, areas should examine the year(s) within the transportation plan or regional emissions analysis, as appropriate, during which peak emissions from the project are expected, and a new violation or worsening of an existing violation would most likely occur due to the cumulative impacts of the project and background concentrations in the project area” [8, p. 16].

<sup>14</sup> Based on footnote 6 of Page 28 of the AQHRA [7].

2.b. Modification to emissions factors unclear.

As described in the Appendix C (page C-9) of the AQHRA [7], the PM estimates in the DEIR rely on modified emissions factors. Specifically, the EMFAC2007 emissions factors have been modified to capture the ARB “Regulation to Control Emissions from In-Use On-Road Diesel-Fueled Heavy-Duty Drayage Trucks,” the “Clean Trucks Program” and the ARB “Truck and Bus Regulation”, all of which will reduce emissions from heavy-duty trucks. By accounting for improved emissions factors for heavy duty trucks, the modeled emissions from heavy duty trucks will be reduced across all alternatives. The effect will be larger for alternatives with higher heavy duty vehicles shares<sup>15</sup> or for alternatives with higher levels of heavy duty vehicle congestion. When comparing between build alternatives and the no build alternative in 2035 (as in the NEPA analysis), the effect of this change is likely smaller than when comparing between alternatives in 2035 and 2008 baseline (as in the CEQA analysis). While these modifications are generally logical, in the adjustment for the Truck and Bus regulation, the control factor approach may overestimate the reduction in emissions under the rule if the drive cycle average speed used to demonstrate regulatory compliance of vehicles is faster than actual or estimated average travel speeds in the project area. This is because the control factor used to adjust emissions is calculated as the targeted regulatory emissions factor divided by the fleet average emissions factor from EMFAC (averaged over all speeds). Because the control factor approach adjusts the fleet emissions that are modeled over the full range of traveled speeds using one control factor value (based on the regulatory emissions value rather than by a speed-specific control factor) the adjustment may be inaccurate to the extent that actual speeds differ from the speeds that result from the drive cycle used to test vehicles for the regulation.

2.c. Dust re-entrainment methodology is unclear.

The DEIR describes two different methods for evaluating dust re-entrainment: 1) the EPA’s January 2011 AP-42 method and 2) a method prepared by ARB that was used by SCAQMD for their 2012 AQMP (which is very similar to the SCAQMD method used for the 2007 AQMP). The DEIR states that the more recent ARB method:

(1) uses lower silt loadings in Los Angeles County for nonfreeway roadways, (2) uses a 15 percent  $PM_{2.5}/PM_{10}$  ratio rather than the 25 percent ratio in AP-42, and (3) changes in future entrained road dust emissions (for all road types) are proportional to increases in centerline miles, not vehicle miles traveled. (DEIR Page 3.13-18)

This is in contrast to the EPA method, which estimates re-entrained dust as a function of VMT, and so predicts higher levels of re-entrained dust for the project alternatives than for

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<sup>15</sup> From Tables 17 and 18 in Travel Demand Modeling Report [4], it seems that 5A has slightly fewer trucks on arterials, slightly more on freeways, but the net change in truck traffic may be a wash. The same is true for Alternatives 6A and 6B, although the changes on the freeways and arterials are larger.

the lower VMT no-build alternative. We note that 1) the use of the ARB method is not clearly explained or justified, and 2) both methods appear to be used in the analysis.

- Explanation and justification of the use of the ARB method: The DEIR states that the ARB method was used by the SCAQMD to prepare their 2012 AQMP. The reference provided is a link to a four-slide powerpoint presentation,<sup>16</sup> which has brief mentions of changes in methodology used in the 2012 AQMP. No other documentation could be found. Further confusing matters, the four-slide powerpoint presentation refers to the ARB method with the date and name of the EPA method: “ARB methodology (Jan. 2011 AP-42 update for PM10)”.

ARB provided us with “MISCELLANEOUS PROCESS METHODOLOGY 7.9 Entrained Paved Road Travel, Paved Road Dust”, which was revised and updated in July 2012. Without additional information, it’s not clear whether it is appropriate to use this method to analyze this project. The document describes county-level dust re-entrainment estimation methods for use in the state emissions inventory. Instructions on the Caltrans website, which (in line with the posted links to previous ARB dust re-entrainment methods) instructs readers to: “use EPA’s latest AP-42 procedure unless otherwise instructed through interagency consultation.”<sup>17</sup>

It is also not clear whether using the “ARB” method would affect the dust re-entrainment estimates as represented in the DEIR. Briefly, in the ARB method, current emission factors are estimated as a function of VMT (in the particle size multiplier), average vehicle weight, road surface area (in the silt loading factor), and share of rain days. *Growth* in emissions is assumed to be tied only to centerline miles, not VMT or road surface area. In the DEIR, calculations that use the ARB/SCAQMD method represent all PM<sub>2.5</sub> and PM<sub>10</sub> dust re-entrainment estimates for all alternatives as identical to the 2008 EPA estimates, that is, for all build alternatives the estimates remain stable from 2008 through 2035 regardless of the characteristics of the alternative.<sup>18</sup> It is unclear if the dust re-entrainment methods would yield different results if applied in 2008. It is also unclear whether each alternative has an identical number of centerline miles, given the slight differences in access proposed. Finally, the use of centerline roadway miles for projecting future emissions is complicated when much of the roadway is elevated. It might be assumed that the new elevated roadway should be counted as additional centerline

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<sup>16</sup> Page 3.13-18 and 3.13-40 of the DEIR provide the following link in reference to the SCAQMD method: [http://www.aqmd.gov/gb\\_comit/stmpradvgrp/2012AQMP/meetings/2011/dec15/PavedRoadDust.pdf](http://www.aqmd.gov/gb_comit/stmpradvgrp/2012AQMP/meetings/2011/dec15/PavedRoadDust.pdf)

<sup>17</sup> <http://www.dot.ca.gov/hq/env/air/pages/qualpm.htm>, accessed on 9/12/2012.

<sup>18</sup> Page 3.13-26 of the DEIR presents I-710 Freeway PM<sub>2.5</sub> emissions and the text states that “the entrained paved road emissions for the 2035 Alternatives (including Alternative 1) would be equal to the 2008 emissions, as calculated using EPA’s January 2011 AP-42 method with local silt loadings.” It is unclear why the 2008 values would be unchanged in light of the three changes adopted in the ARB method. It is also unclear that centerline miles would not change between alternatives given different configurations of intersections and freeway entrances and exits.

lane miles. The DEIR should justify the definition of centerline miles when an elevated structure is in use.

- The PM dust re-entrainment method being applied varies in different parts of the analysis. The hotspot analysis relies on the ARB method, as noted on Pages 3.13-18 and 3.13-26 of the DEIR, and as shown in Table 3.13-14 and 3.13-15. However, the EPA method was used in the hotspot analysis in the earlier AQHRA (see Appendix C of the AQHRA). Regional emissions impacts used to estimate incremental concentration impacts and health risk use the EPA method, as discussed on Pages 3.13-40 and 3.13-49 and shown in Tables 3.13-22 through 3.13-28 and in maps shown in Appendix R.

Clear justification of the method being used is important, as the EPA method yields higher PM estimates which, in turn, affect the relative benefits attributed to alternatives and how they perform relative to SCAQMD CEQA thresholds.

Figure 3 illustrates how the assumption that dust re-entrainment increases with VMT (EPA method) compares to the assumption that dust re-entrainment varies with centerline lane miles (ARB method) for each alternative's estimated emissions relative to 2008 emissions. The values shown are the percent change from 2008 emissions values for total, exhaust, and entrained PM<sub>2.5</sub> and PM<sub>10</sub>, for the South Coast Air Basin (SCAB), Area Of Interest (AOI), and I-710 Freeway study areas (with and without travel model post-processing). The values used to generate the plots are the unrounded values contained in the supplementary information provided to NRDC by Environ.<sup>19</sup> As shown in Figure 3, the ARB/SCAQMD results in total PM<sub>2.5</sub> and PM<sub>10</sub> emissions estimates that are below 2008 levels for the SCAB, AOI, and I-710 Freeway. In contrast, the EPA method predicted PM<sub>10</sub> emissions are greater than 2008 levels for all alternatives across all study areas, and PM<sub>2.5</sub> emissions are greater for Alternative 6A than 2008 levels in the I-710 study area.

The dust re-entrainment methodology affects SCAQMD mass emissions threshold exceedances for PM<sub>2.5</sub> (55 lbs/day) and PM<sub>10</sub> (150 lbs/day). Using the unrounded values provided to NRDC by Environ, we compared these thresholds to the change in emissions for each alternative over the 2008 baseline. Using the ARB/SCAQMD method, all total PM emissions are reduced from the 2008 baseline for all study areas, so the thresholds are not exceeded for any alternative for any of the study areas. However using the EPA method, all alternatives (including the no-build) exceed the PM<sub>10</sub> threshold at the SCAB, AOI, and I-710 (raw model) study areas, and all build alternatives (5A, 6A, 6B, 6B ZEE, 6C, 6C ZEE) exceed the PM<sub>10</sub> threshold in the I-710 study area with model

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<sup>19</sup> Data presented in Figure 3 and Table 2 are compiled from the files "CAP Mass Emissions\_ZEE SCAG.xls" and "CAP Mass Emissions\_ZEE PP Traffic.xls". These spreadsheets provided data that appeared to be estimated using the EPA method. Based on the description in the text of the ARB/SCAQMD methods and estimates shown in Tables 3.13-14 and 3.13-15 in the DEIR, we assumed that re-entrained dust values for all alternatives equaled the 2008 values estimated with the EPA method. We interpreted I-710 vs I-710 post-processed and Alternative 6A/B/C (Option 1 rather than 2) based on comparisons with values shown in with Table 3.13-22 in the DEIR.

post-processing. Alternative 6A also exceeds the PM<sub>2.5</sub> threshold for the I-710 (raw and post-processed) study area.

In addition to the 2008 comparisons, comparisons between alternatives are also greatly affected by the dust re-entrainment method. Table 2 provides the percent change<sup>20</sup> from 2008 levels for all alternatives for total PM<sub>10</sub> and PM<sub>2.5</sub> in each study area. Values shaded in yellow have the same percent change as the no-build alternative (alternative 1). Green values have a lower percent change (and so lower emissions) than the no-build alternative, and red values have a higher percent change (and so higher emissions) than the no-build alternative. With the EPA method, Alternatives 5A, 6A, 6B, 6B ZEE, 6C, and 6C ZEE fare worse relative to Alternative 1 than when they are compared using the ARB/SCAQMD method. Using the EPA method, the only improvements over Alternative 1 are for PM<sub>2.5</sub> under Alternatives 6B, 6B ZEE, 6C, and 6C ZEE in the SCAB and AOI areas. However, using the ARB/SCAQMD method, Alternatives 6B, 6B ZEE, 6C and 6C ZEE fare better than Alternative 1 for both PM<sub>10</sub> and PM<sub>2.5</sub> in the I-710 area (using raw and postprocessed data, with the exception of 6C which used raw data and fares worse), in the AOI, and also for PM<sub>10</sub> in the SCAB.

### 3. Assessment of likelihood of violation is not sufficient:

#### 3.a. Effect of emissions increases.

The analysis does not investigate whether the increase in emissions under Alternatives 5A and 6A will lead to exceedances. Even Alternatives 6B and 6C (and ZEE options of each) may have local emissions increases within the project area. Given recent exceedances for both PM<sub>2.5</sub><sup>21</sup> and PM<sub>10</sub><sup>22</sup> at monitors near the project site and projected background levels that are relatively close to standards,<sup>23</sup> it is unclear that changes in local PM<sub>2.5</sub> and PM<sub>10</sub> emissions will not increase the likelihood of a violation as a result of the project.<sup>24</sup>

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<sup>20</sup> Values shown are rounded to the nearest percent.

<sup>21</sup> According to 2005 – 2010 data shown in Table 3.13-5 of the DEIR, PM<sub>2.5</sub> 24 hour Federal standards were exceeded at the Los Angeles and North Long Beach stations from 2005 – 2009 and at the Long Beach PCH station from 2005 – 2008. PM<sub>2.5</sub> annual Federal standards were exceeded at the Los Angeles station from 2005 – 2009 and at the Long Beach PCH and North Long Beach stations from 2005 – 2006. Exceedances for Lynwood and Compton stations can be estimated for 2005 – 2007 and 2010 respectively, by estimating 3 year averages from data available at <http://www.arb.ca.gov/adam/>. Lynwood exceeded Federal standards for both 24-hour and annual concentrations in 2005 – 2007 (all years available), while Compton did not exceed Federal standards in 2010 (the first year available).

<sup>22</sup> According to 2005 – 2010 data shown in Table 3.13-6 of the DEIR, PM<sub>10</sub> concentrations at North Long Beach station exceeded the National 24-hour standard in 2009, while Long Beach PCH and Los Angeles did not have any exceedances from 2005 – 2010. PM<sub>10</sub> data are not available for Lynwood or Compton stations.

<sup>23</sup> In the DEIR, PM<sub>2.5</sub> 24-hour and annual concentrations are estimated to be 31.2 µg/m<sup>3</sup> in 2015 and 12.7 µg/m<sup>3</sup> in 2014 respectively. The PM<sub>2.5</sub> projections are particularly close to standards of 35 and 15 µg/m<sup>3</sup> respectively, especially in light of the issues with justifying the choice of background levels assumed (discussed above). The PM<sub>10</sub> 24-hour concentration is assumed to be 77 µg/m<sup>3</sup> by 2015, about half of the standard of 150 µg/m<sup>3</sup>.

<sup>24</sup> EPA's guidance on the quantitative analysis of PM hotspots describes that the entire project must be included in the determination, but that this can be demonstrated by focusing "the PM hot-spot analysis only on the locations of highest air quality concentrations" [13, p. 20].



**Figure 3: 2035 PM emissions estimated using EPA and ARB dust re-entrainment methods for the SCAB, AOI, and I-710 Study Areas (with and without post-processing).** Values are presented as percent difference from 2008 emissions. Values above 0% indicate higher emissions in 2035 than in 2008.

**Table 2: Total PM emissions estimated using EPA and ARB dust-reentrainment methods.** Values shown are percent of estimated 2008 emissions. Yellow values have the same percent change as Alternative 1 (No-build). Green values have a lower percent change (and therefore lower emissions) than Alternative 1. Red values have a higher percent change (and therefore higher emissions) than Alternative 1.

	EPA 2035 projection							ARB/SCAQMD 2035 projection						
	1	5A	6A	6B	6B ZEE	6C	6C ZEE	1	5A	6A	6B	6B ZEE	6C	6C ZEE
<b>SCAB</b>														
PM <sub>10</sub> (Total)	15%	15%	15%	15%	15%	15%	15%	-6%	-6%	-6%	-6%	-6%	-6%	-6%
PM <sub>2.5</sub> (Total)	-3%	-3%	-3%	-4%	-4%	-4%	-4%	-15%	-15%	-15%	-16%	-16%	-16%	-16%
<b>AOI</b>														
PM <sub>10</sub> (Total)	5%	5%	6%	5%	5%	5%	5%	-9%	-9%	-9%	-10%	-10%	-10%	-10%
PM <sub>2.5</sub> (Total)	-12%	-12%	-11%	-13%	-13%	-13%	-13%	-20%	-20%	-20%	-21%	-21%	-21%	-21%
<b>I-710</b>														
PM <sub>10</sub> (Total)	12%	31%	68%	54%	53%	49%	48%	-16%	-10%	-1%	-18%	-19%	-15%	-16%
PM <sub>2.5</sub> (Total)	-18%	-4%	24%	0%	-2%	-1%	-2%	-32%	-24%	-10%	-36%	-38%	-32%	-34%
<b>I-710 Post-processed</b>														
PM <sub>10</sub> (Total)	5%	19%	48%	34%	33%	29%	28%	-20%	-15%	-8%	-23%	-25%	-21%	-22%
PM <sub>2.5</sub> (Total)	-26%	-16%	5%	-16%	-18%	-17%	-19%	-38%	-32%	-21%	-43%	-46%	-41%	-43%

### 3.b. Comparison to state standards.

Projected concentrations are compared to Federal standards only; attainment of state standards is not demonstrated. The current hotspot analysis hinges on a projected annual concentration of PM<sub>2.5</sub> in 2014 of 12.7 µg/m<sup>3</sup>, which is below the Federal standard of 15 µg/m<sup>3</sup> but not below the state standard of 12 µg/m<sup>3</sup>. The projected 24-hour concentration of PM<sub>10</sub> is 77 µg/m<sup>3</sup> in 2015, which is below the Federal standard of 150 µg/m<sup>3</sup> but above the state standard of 50 µg/m<sup>3</sup>. The state standard for annual PM<sub>10</sub> (20 µg/m<sup>3</sup>) is not discussed.

Since the key PM hotspot qualitative findings were (at best) confusing, we performed rough calculations to estimate potential concentrations of PM concentrations. We used the 2035 incremental concentrations from the health risk assessment modeling. These estimates use the EPA dust re-entrainment method, which as discussed above, yields greater emissions than the ARB/SCAQMD method. With respect to the provided incremental concentrations, the DEIR indicates that these concentrations reflect only freeway traffic (omitting arterial pollutant concentrations) and were estimated at receptors along the I-710 freeway. The DEIR states that this simplification is conservative since arterials will have reduced emissions; however, we note that in cases where intersection conditions worsen (of which there are several), this would not be the case. In addition, other roadways do have elevated emissions relative to 2008 and alternative 1 (as shown in the DEIR in Appendix R, Figures 4.8 – 4.11). Nonetheless, the incremental concentrations

provide an indication of the magnitude of potential effects of the project in close proximity to the I-710 freeway. The results suggest that, at the minimum, a quantitative hotspot analysis should be conducted.

Table 3 provides a summary of the incremental impacts of the freeway mainline in 2035 for Alternative 1 (the no build) relative to 2008 concentrations, as well as in 2035 for alternatives 5A, 6A, 6B, 6B ZEE, 6C, and 6C ZEE relative to Alternative 1. These values are calculated from incremental concentrations for all alternatives relative to 2008 concentrations provided in Tables 3.13-24 to 3.13-28 of the DEIR and in information provided to NRDC by Environ<sup>25</sup> (for the ZEE design values). For alternatives 5A, 6A, 6B, 6B ZEE, 6C, and 6C ZEE the incremental concentrations of all pollutants are greater than for Alternative 1. As an initial approximation, we can add the DEIR’s annual background concentration to the annual incremental concentrations shown, and the state standards for annual PM<sub>10</sub> concentrations (the only standard with available data) would be exceeded for all build alternatives. There is no Federal standard for annual PM<sub>10</sub>, and it is not possible to compare the 24-hour PM<sub>10</sub> values to the standards using an annual background level; however it would be of interest to know the projected hourly concentration in 2035 for each alternative in order to compare to the Federal and State standards. For Alternatives 6A, 6B, and 6B ZEE, the incremental concentrations alone exceed the state ambient standards for 24-hour PM<sub>10</sub> (without accounting for background levels). As with PM<sub>10</sub>, the 24-hour PM<sub>2.5</sub> incremental concentrations cannot be compared to standards using an annual background level, however the projected background level is close to the Federal standard and the incremental concentrations are substantial; it would be useful to see a projected 24-hour PM<sub>2.5</sub> concentration to compare to the standards. The DEIR does not provide annual PM<sub>2.5</sub> incremental concentrations, so those cannot be compared to standards.

**Table 3: Incremental Concentration Impacts from the I-710 Freeway (calculated from Tables 3.13-24 through 3.13-28 in the DEIR).** 6B and 6C ZEE design incremental concentrations are the same as for Alternatives 6B or 6C. PM<sub>2.5</sub> annual values were not provided. All values are concentrations are in µg/m<sup>3</sup>

<b>Pollutant</b>	<b>Alt 1 compare to 2008</b>	<b>Alt 5A compare to Alt 1</b>	<b>Alt 6A compare to Alt 1</b>	<b>Alt 6B &amp; 6B ZEE compare to Alt 1</b>	<b>Alt 6C &amp; 6C ZEE compare to Alt 1</b>	<b>Annual background level in 2014 or 2015 (from DEIR)</b>	<b>Federal / State Standard</b>
<b>PM<sub>10</sub> 24-hr</b>	19.6	40.9	59.1	54.8	44.6	77	150 / 50
<b>PM<sub>10</sub> annual</b>	13.9	21.7	30.5	28.6	21.0	NA	NA / 20
<b>PM<sub>2.5</sub> 24-hr</b>	0.036 <sup>26</sup>	15.4	20.9	15.3	13.1	31.2	35 / NA
<b>PM<sub>2.5</sub> annual</b>	-	-	-	-	-	12.7	15 / 12

<sup>25</sup> Incremental concentrations for ZEE designs are obtained from the spreadsheet entitled “AQ Impact Summary.xls”. Incremental concentrations are identical for 6B and 6B ZEE and for 6C and 6C ZEE.

<sup>26</sup> This value is several orders of magnitude lower than other values so may be a typo, though it is consistent with the AQHRA Table 4.7a and 5.3b [7].

The incremental impacts relative to 2008 shown in the DEIR also exceed the SCAQMD CEQA Thresholds by an order of magnitude (Tables 3.13-24 to 3.13-28). The footnote in the data tables states that:

Impacts above the SCAQMD's threshold levels are in areas close (300 meters or less) to the mainline and/or freight corridor. Maximum impacts occur within 50 meters. (DEIR page 3.13-43 to 3.13-47)

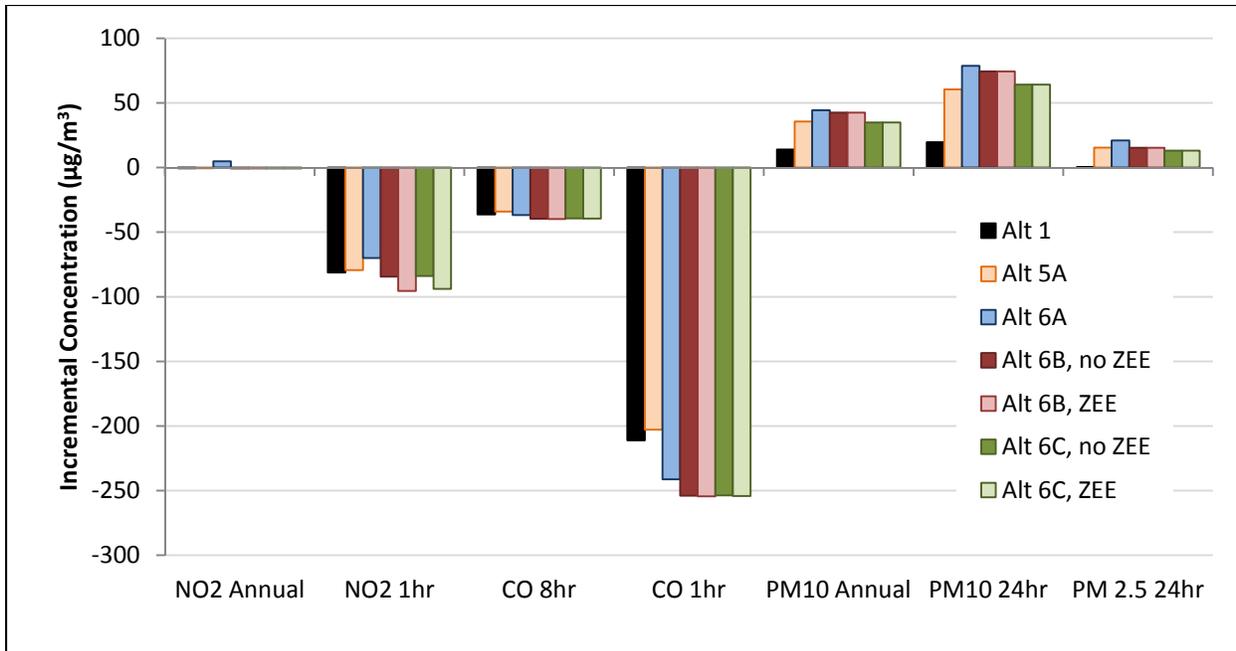
This footnote is important because there are numerous residential areas within 300 meters (984 feet) of the I-710 freeway. It is worthwhile to examine the localized effects along the highway more closely. In fact, the DEIR states that:

When differences between the build alternatives and Alternative 1 are considered, areas that would be more adversely impacted (i.e., could have a higher cancer risk under the build alternative) have higher concentrations of minority, low-income, young, and disabled populations than in the reference population of Los Angeles County. The most pronounced differences are seen in the north end of the I-710 Corridor, between the northern terminus of the freight corridor and State Route 60 (SR-60), where impacts are based on analysis results that reflect the assumption that trucks not on the freight corridor do not have zero-emission technologies under Alternatives 6A/B/C. Under the ZEE Design Option of Alternatives 6A/B/C, the impacts would be eliminated as the segment between the northern terminus of the freight corridor, and SR-60 would experience the same emission reductions as in the areas traversed by the zero-emission freight corridor. [Page 3.3-42 of the DEIR]

It is not clear from this text if the worst *disproportionate* impacts are the north stretch, or if the worst air quality impacts are on the north stretch – it seems likely that the latter is indicated. The DEIR does not address what seem to be the potential environmental justice impacts resulting from Alternative 5A, as implied in this text. Given that Alternative 6A does not include zero emissions vehicles or a ZEE design option, it is likely that there is a typo in the quote above and that Alternative 6A also has the potential to cause disproportionate impacts to minority and low-income communities.

To better understand the degree to which air quality impacts are eliminated by the ZEE design options, we can examine the incremental concentrations and maps of incremental concentrations. From the DEIR, it appears that the incremental concentrations do not change:

There would be no significant change in incremental emissions for the I-710 freeway between the ZEE Design Option and the original analysis for both Alternatives 6B and 6C, although emissions decrease 10% to 88% on the I-710 mainline north of the northern terminus of the freight corridor compared to the Original Analysis. (DEIR Page 3.13-50)



**Figure 4: Incremental concentrations for each alternative.** Values are relative to 2008 emissions.

This statement is consistent with supporting information provided to NRDC by Environ,<sup>27</sup> which shows nearly identical estimated incremental concentrations of PM with and without the ZEE design option for Alternatives 6B and 6C, and only slight variations in NO<sub>2</sub> incremental concentrations with the ZEE design option (Figure 4).

The maps in Appendix R provide an indication of the spatial extent of elevated concentrations modeled. Figures 7 – 24 indicate that in the northern section of the I-710 project there are modest reductions in exhaust and total PM concentrations in the ZEE case. However, looking at just exhaust emissions (which use the ARB dust re-entrainment method), there are still adverse effects in residential areas for Alternatives 6B with ZEE and 6C with ZEE (for annual PM<sub>10</sub>, Figures 17 and 18). Additionally, total PM emissions (using the EPA dust re-entrainment method) remain elevated along the highway for the ZEE options. These maps do not reflect the location of low-income and minority populations, so the distribution of these effects on those populations is unknown.

In addition, while the ZEE design option reduces emissions in the northern section of the project area, it is unlikely that it reduces emissions further south. This may explain the fact that most incremental emissions are unchanged with the ZEE design option, as discussed above. Looking at Figures 4.29, 4.30, 4.33, and 4.34 in Appendix R, it appears that Alternatives 6B and 6C (presumably shown without the ZEE design option) result in elevated annual and 24-hour PM<sub>10</sub>

<sup>27</sup> Values are obtained from a file entitled “AQ Impact Summary.xls”. “Option 1” estimates were used based on matches to DEIR values displayed in Tables 3.13-27 and 3.13-28.

exhaust emissions in a small number of residential areas to the south of the maps shown in Figure 7 – 24. Maps of total PM emissions in Appendix R (which use the EPA dust re-entrainment method) show elevated concentrations of pollutants along the freeway for all alternatives.

In terms of MSATs and cancer risks, the DEIR states that

As with criteria air pollutants, the greatest air toxic emission impacts occur along I-710. This occurs as the increased VMT (all alternatives) and increased capacity (build alternatives) increase emissions along I-710, although improved mobility and less traffic on local roadways can decrease emissions in the larger AOI and SCAB study areas... Table 3.13-29 compares maximum relative health impacts between each of the project alternatives and the 2008 base year. All project alternatives compared to 2008 show decreases in cancer risk (including 6A for residential areas) and hazard indices far below the SCAQMD's significance thresholds. Cancer risk and hazard indices decrease throughout the study areas for all project alternatives except for Alternative 6A in nonresidential areas in close proximity to I-710 (mainline and/or freight corridor). *All build alternatives have increases in cancer risk in certain locations along I-710 compared to Alternative 1.* Figures 4.44 through 4.48 in Appendix R (February 2012) show that Alternative 5A and Alternative 6A have large areas with greater cancer risk (compared to Alternative 1), including very large increases right along I-710 (mainline and/or freight corridor). [Page 3.13-50, emphasis added]

Maps 4.44 – 4.48 are not included in Appendix R document posted at the Caltrans website<sup>28</sup> but from the text above it seems that cancer risks are elevated along the highways for all build alternatives relative to the baseline alternative.

In light of the environmental justice concerns along this corridor (identified in the DEIR), it would be useful to understand the concentrations arising from other roads affected by the project, especially those that have elevated emissions relative to Alternative 1, in addition to just emissions from the I-710. It would also be informative to provide a more detailed assessment of air quality impacts to low-income and minority populations.

## **RELATIVE MERITS OF ALTERNATIVES**

Improving air quality is a stated purpose for the I-710 project. It is, therefore, especially relevant to compare the merits of the alternatives with respect to all pollutants and health outcomes. In many tables in Section 3.13 of the DEIR, the rounding of values to two significant figures and changes of less than 1% in several of the tables makes comparisons between alternatives difficult. While rounding prevents reporting differences that may be due to modeling error, for changes at larger scales where emissions unrelated to the project overwhelm the differences due to the project, rounding values inhibits comparisons between alternatives. Additionally, it is difficult to compare the large number of values provided in tabular form and text throughout the analysis.

To summarize the overall outcomes and relative merits of each alternative in terms of air quality and health, we provide graphical comparisons of 2035 outcomes of each alternative in terms of mass emissions for all emissions and in each study area (Figures 5a, 5b, and 6), incremental

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28 [http://www.dot.ca.gov/dist07/resources/envdocs/docs/710corridor/docs/Appendices/Appendix%20R%20-%20AQ\\_HRA%20Maps/Appendix%20R%20AQ\\_HRAMaps.pdf](http://www.dot.ca.gov/dist07/resources/envdocs/docs/710corridor/docs/Appendices/Appendix%20R%20-%20AQ_HRA%20Maps/Appendix%20R%20AQ_HRAMaps.pdf)

concentrations for all pollutants (Figure 4 above), and health risks (Figure 7). We also highlight values that exceed federal and state standards and SCAQMD thresholds (Table 4 and Figure 7). The values shown in these tables and figures are compiled from unrounded data provided to NRDC by Environ<sup>29</sup> except where otherwise noted. To avoid emphasizing differences which are small relative to totals and which may be due to modeling error, we present these data graphically as percent of 2008 values where possible, and as a change from 2008 values where no 2008 values are provided. Because the figures shown are based on unrounded values, it is possible to observe differences between alternatives that may not be clearly conveyed in summary tables in the DEIR. Where it is necessary to compare exact values (e.g. to compare to thresholds) we present unrounded values but caution that the modeling estimates are likely not accurate down to all digits. This section overlaps with information provided in the DEIR. It is intended to provide a distilled summary focused on comparisons between alternatives and exceedances of standards.

### *MASS EMISSIONS*

Mass emissions for MSATs shown in Figure 5a and 5b for the three study areas (with the I-710 Freeway area shown with and without travel model post-processing) indicate that emissions under all alternatives are substantially lower than 2008 levels. Data shown were provided to NRDC by Environ.<sup>30</sup> When comparing between alternatives, emissions change little at the SCAB and AOI scale relative to 2008 levels, with the largest differences occurring for DPM at the AOI scale. At the I-710 Freeway study area scale DPM varies the most, with Alternatives 5A and 6A resulting in more emissions than the no-build alternative and Alternatives 6B, 6B ZEE, 6C, and 6C ZEE resulting in lower emissions. TOG CAT EXH, Benzene, Acetaldehyde, Formaldehyde, 1,3-Butadiene, and Acrolein (2-propenal) are all emitted at slightly lower rates under Alternative 1.

Mass emissions for NO<sub>x</sub>, CO, PM<sub>10</sub>, PM<sub>2.5</sub>, ROG, and SO<sub>2</sub> are shown in Figure 6a and 6b. Data shown were provided to NRDC by Environ.<sup>31</sup> When comparing between alternatives, emissions change little at the SCAB and AOI scale relative to 2008 levels. At the I-710 Freeway study area scale, Alternatives 6B, 6B ZEE, 6C, and 6C ZEE reduce NO<sub>x</sub>, ROG, and SO<sub>2</sub> emissions the most, while Alternatives 5A and 6A result in greater emissions than Alternative 1 for those gases. For CO, PM<sub>10</sub>, and PM<sub>2.5</sub>, Alternative 1 (the no build) results in the lowest emissions. Note that the PM estimates shown use the EPA dust re-entrainment method; for comparisons using the ARB/SCAQMD method see Figure 3 above.

Emissions changes from 2008 for each alternative can also be compared to SCAQMD Mass Emission Thresholds (Table 4). Data shown were provided to NRDC by Environ.<sup>32</sup> Comparisons using the raw data provided indicate that for the SCAB and AOI study areas, changes from 2008 exceed the SCAQMD mass emission thresholds for PM<sub>10</sub> and SO<sub>2</sub> for all alternatives, including the

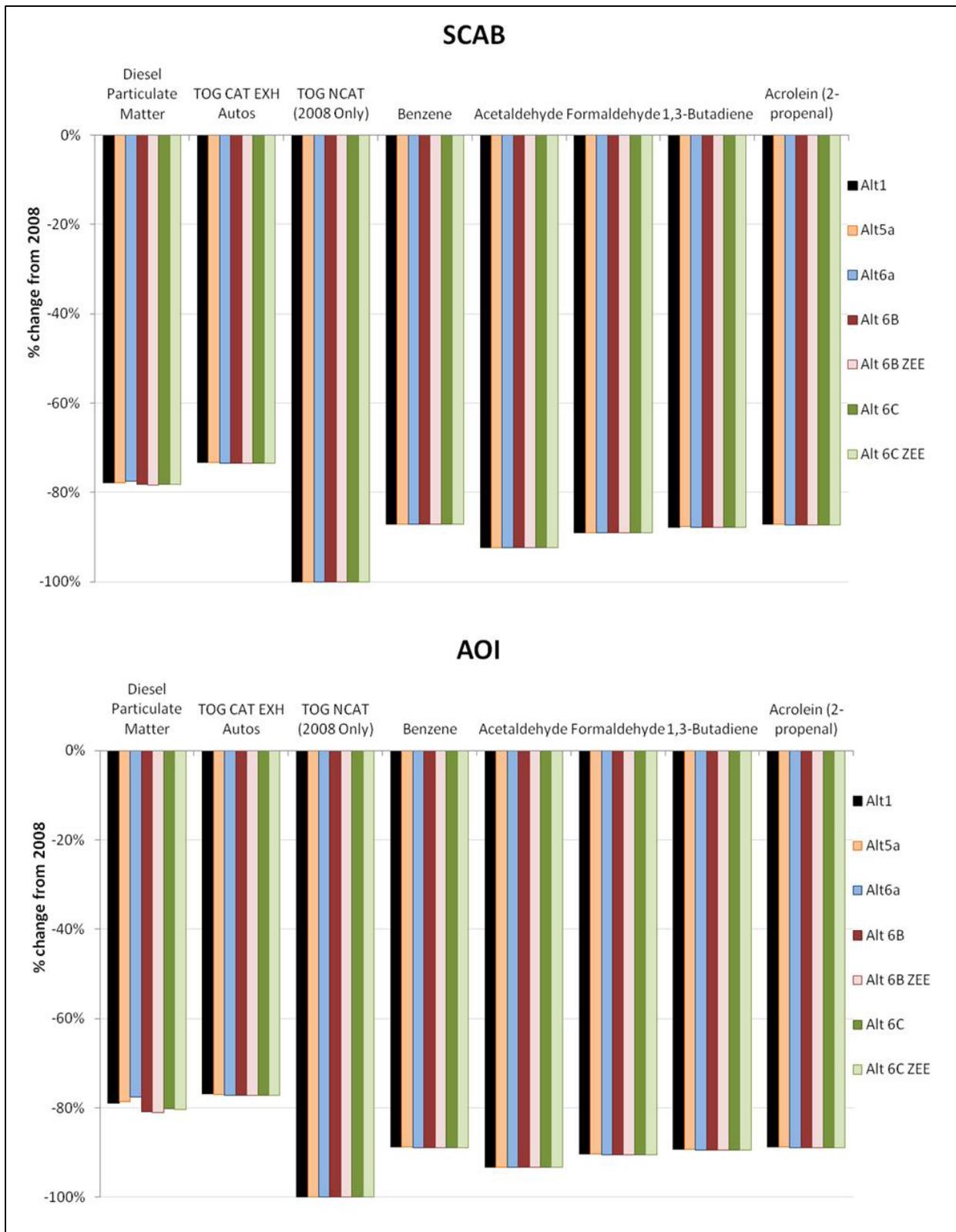
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<sup>29</sup> Data are compiled from “CAP Mass Emissions\_ZEE SCAG.xls” and “CAP Mass Emissions\_ZEE PP Traffic.xls” except where otherwise noted.

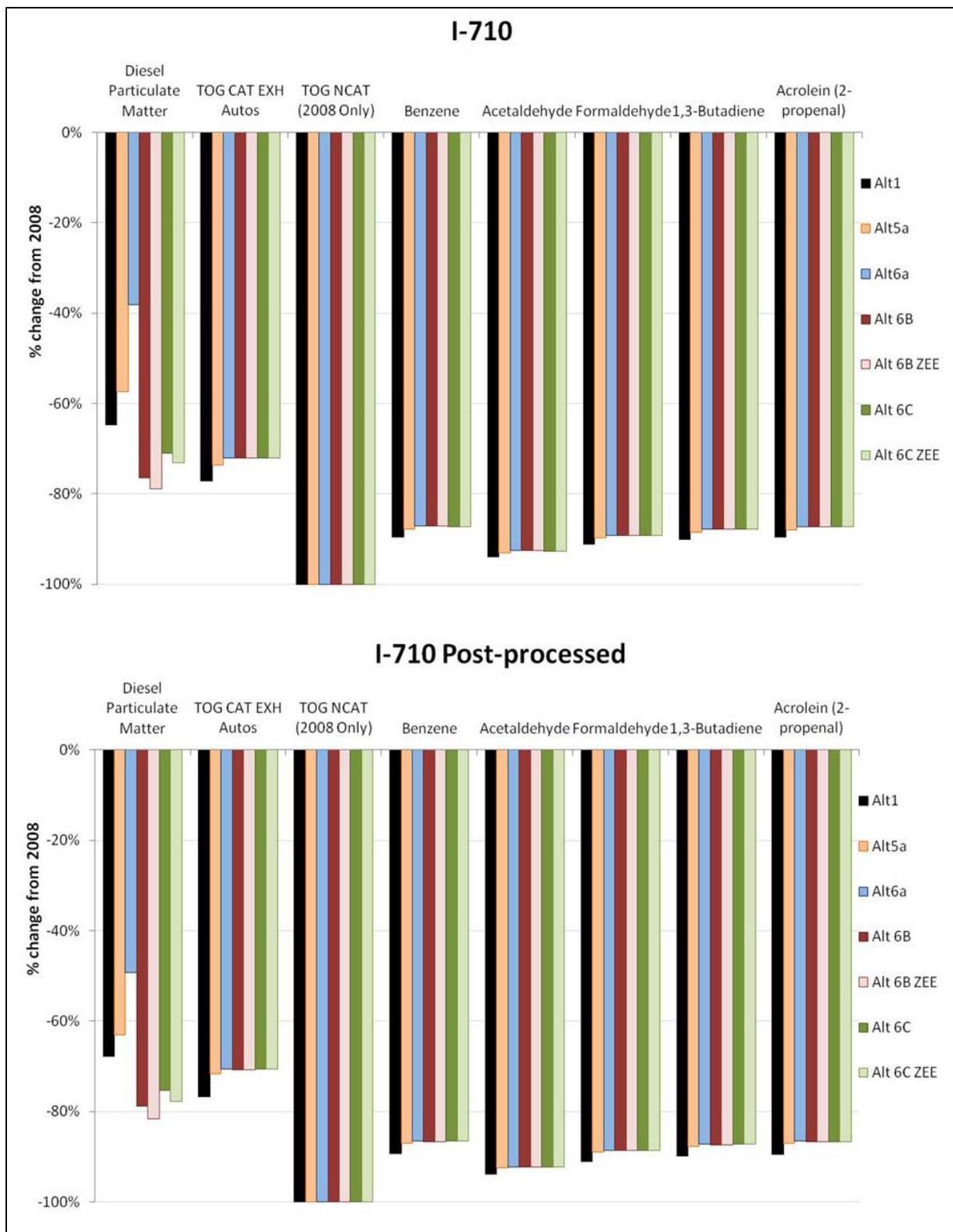
<sup>30</sup> Data are obtained from the spreadsheet entitled “MSAT Mass Emissions\_ZEE SCAG.xls”

<sup>31</sup> Data are obtained from the spreadsheet entitled “MSAT Mass Emissions\_ZEE SCAG.xls”

<sup>32</sup> Data are obtained from the spreadsheet entitled “MSAT Mass Emissions\_ZEE SCAG.xls”



**Figure 5a: 2035 MSAT mass emissions for the SCAB and AOI.** Emissions are shown as the percent change from 2008. Negative values indicate lower emissions in 2035 than in 2008.



**Figure 5b. 2035 MSAT mass emissions for the I-710 study area using raw and post-processed emissions.** Emissions are shown as the percent change from 2008. Negative values indicate lower emissions in 2035 than in 2008.

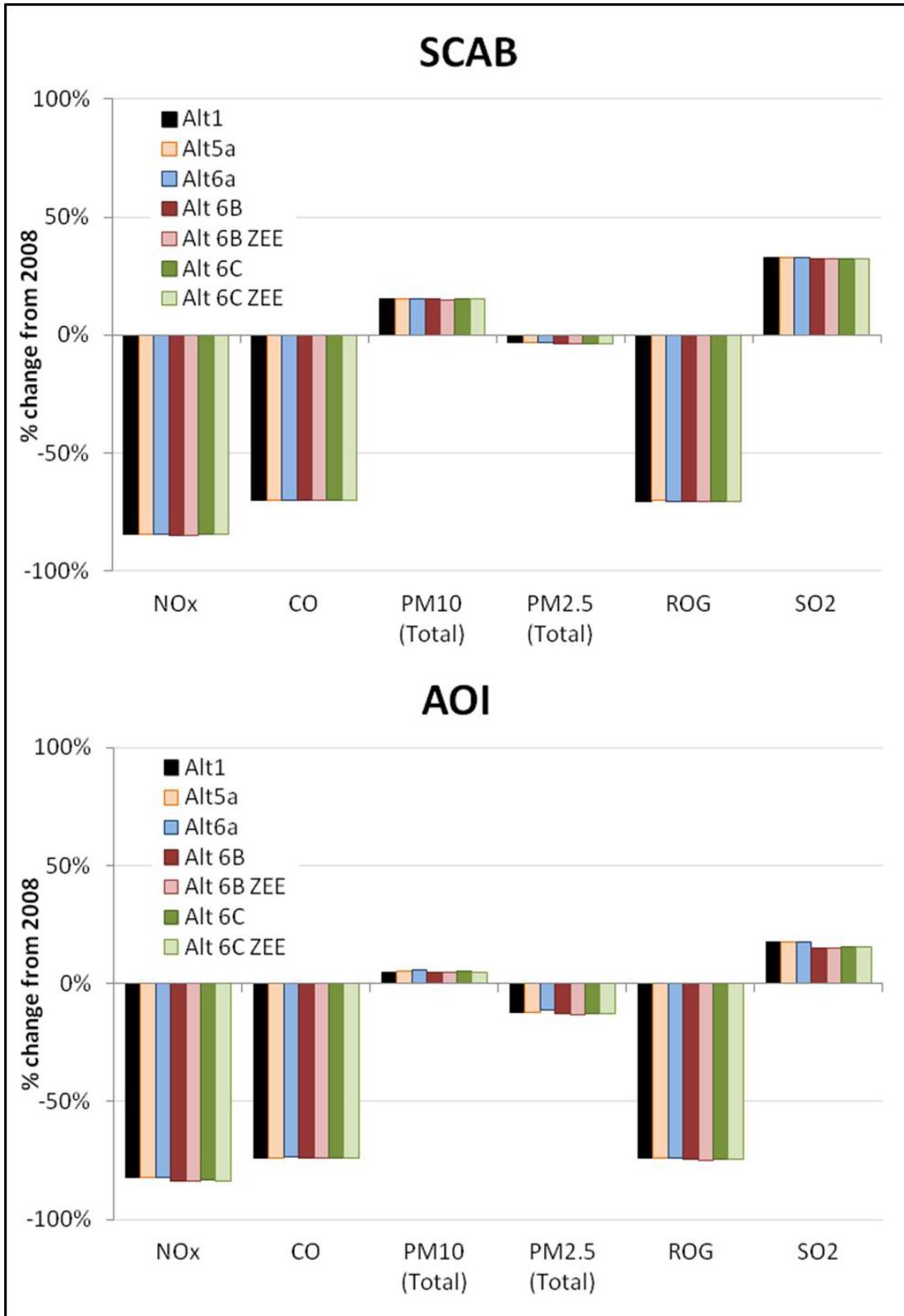


Figure 6a: 2035 NO<sub>x</sub>, CO, PM, ROG, and SO<sub>2</sub> mass emissions for the SCAB and AOI. Emissions are shown as the percent change from 2008. Negative values indicate lower emissions in 2035 than in 2008.

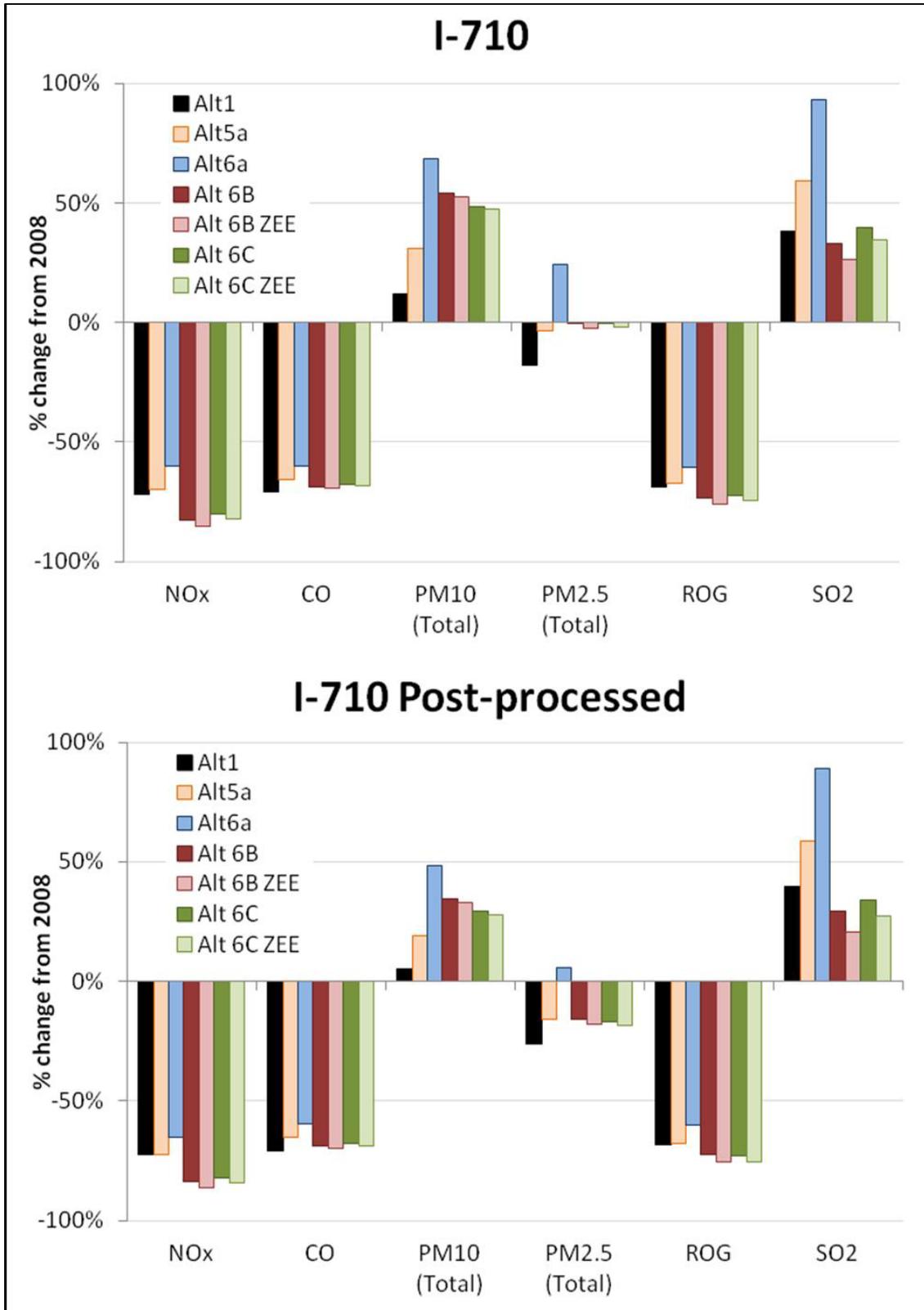


Figure 6b: 2035 NO<sub>x</sub>, CO, PM, ROG, and SO<sub>2</sub> mass emissions for the I-710 study area (using raw and post-processed data). Emissions are shown as the percent change from 2008. Negative values indicate lower emissions in 2035 than in 2008.

**Table 4: 2035 CO, PM, ROG, and SO<sub>2</sub> mass emissions in lbs/day.** Emissions are shown as the difference from 2008 emissions. Shaded values exceed SCAQMD Mass Emission Thresholds.

	Alt 1	Alt 5A	Alt 6A	Alt 6B	Alt 6B ZEE	Alt 6C	Alt 6C ZEE	SCAQMD Mass Emission Threshold
<b>SCAB</b>								
NO <sub>x</sub>	(872,165)	(872,384)	(872,521)	(876,763)	(877,227)	(875,802)	(876,183)	55
CO	(2,004,776)	(2,004,602)	(2,005,118)	(2,007,541)	(2,007,766)	(2,006,899)	(2,007,079)	550
PM <sub>10</sub> (Total)	23,405	23,402	23,578	23,272	23,248	23,290	23,270	150
PM <sub>2.5</sub> (Total)	(2,282)	(2,271)	(2,237)	(2,485)	(2,502)	(2,442)	(2,457)	55
ROG	(165,064)	(164,927)	(165,435)	(165,741)	(165,794)	(165,654)	(165,697)	150
SO <sub>2</sub>	1,276	1,275	1,269	1,245	1,242	1,251	1,249	55
<b>AOI</b>								
NO <sub>x</sub>	(195,862)	(195,919)	(195,717)	(199,893)	(200,357)	(199,062)	(199,442)	55
CO	(507,668)	(507,634)	(507,236)	(509,573)	(509,798)	(509,082)	(509,262)	550
PM <sub>10</sub> (Total)	1,795	1,896	2,129	1,817	1,793	1,844	1,824	150
PM <sub>2.5</sub> (Total)	(1,967)	(1,936)	(1,851)	(2,099)	(2,116)	(2,057)	(2,071)	55
ROG	(43,372)	(43,413)	(43,592)	(43,897)	(43,950)	(43,837)	(43,880)	150
SO <sub>2</sub>	165	164	165	141	138	146	144	55
<b>I-710</b>								
NO <sub>x</sub>	(12,938)	(12,636)	(10,890)	(14,964)	(15,428)	(14,448)	(14,829)	55
CO	(18,654)	(17,274)	(15,730)	(18,008)	(18,233)	(17,719)	(17,900)	550
PM <sub>10</sub> (Total)	227	583	1,294	1,019	995	919	899	150
PM <sub>2.5</sub> (Total)	(170)	(36)	230	(4)	(22)	(6)	(21)	55
ROG	(1,516)	(1,487)	(1,330)	(1,623)	(1,676)	(1,598)	(1,641)	150
SO <sub>2</sub>	15	23	36	13	10	15	13	55
<b>I-710 Post-Processed</b>								
NO <sub>x</sub>	(17,560)	(17,488)	(15,741)	(20,214)	(20,892)	(19,826)	(20,387)	55
CO	(18,794)	(17,359)	(15,781)	(18,245)	(18,565)	(18,002)	(18,264)	550
PM <sub>10</sub> (Total)	124	443	1,128	807	771	683	653	150
PM <sub>2.5</sub> (Total)	(318)	(191)	66	(192)	(219)	(201)	(224)	55
ROG	(1,701)	(1,679)	(1,492)	(1,803)	(1,875)	(1,813)	(1,870)	150
SO <sub>2</sub>	17	24	37	12	8	14	11	55

no-build alternative (Alternative 1). In the I-710 Freeway study area, PM<sub>10</sub> exceeds SCAQMD thresholds for all build alternatives (using raw and post-processed model data) and for Alternative 1 using raw data only. PM<sub>2.5</sub> is exceeded for Alternative 6A in the I-710 Freeway study area using raw and post-processed data.

#### *INCREMENTAL CONCENTRATIONS*

Incremental concentrations for CO, PM, ROG, and SO<sub>2</sub> are shown in Table 3 and Figure 4 above. The values in Table 3 are relative to Alternative 1 (the no-build alternative), and the values shown in Figure 4 reflect the difference between 2035 concentrations for each alternative and 2008 concentrations. As discussed for Table 3, as an initial approximation, we can add the DEIR's projected background concentration to the annual incremental concentrations relative to Alternative

1, and for all build alternatives the state standards for annual  $PM_{10}$  concentrations would be exceeded. For Alternatives 6A, 6B, and 6B ZEE, the incremental concentrations alone exceed the state ambient standards for 24-hour  $PM_{10}$  (without accounting for background levels). For 24-hour  $PM_{10}$ , incremental concentrations cannot be compared to standards using an annual background level, however the projected background level is close to the Federal standard and the incremental concentrations are substantial. As shown in Figure 4, Alternatives 6B, 6B ZEE, 6C, and 6C ZEE result in the lowest incremental concentrations of CO and 1-hr  $NO_2$ . Alternative 1 results in the lowest emissions of PM. For all alternatives the annual and 24-hour  $PM_{10}$  incremental concentrations exceed SCAQMD thresholds of  $1 \mu\text{g}/\text{m}^3$  and  $2.5 \mu\text{g}/\text{m}^3$  respectively.  $PM_{2.5}$  24-hour incremental concentrations exceed SCAQMD threshold of  $2.5 \mu\text{g}/\text{m}^3$  for all built alternatives, but not for the no-build alternative. For Alternative 6A the annual  $NO_2$  CAAQS level of  $56 \mu\text{g}/\text{m}^3$  is exceeded when the incremental concentration of  $4.8 \mu\text{g}/\text{m}^3$  is added to the background concentration of  $57.6 \mu\text{g}/\text{m}^3$  (for meteorological zone 3, based on the Lynwood monitor). Note that these values rely on the EPA dust re-entrainment method. Note that these values are estimated from emissions from the I-710 freeway only and do not include emissions from arterials or other roads in the region.

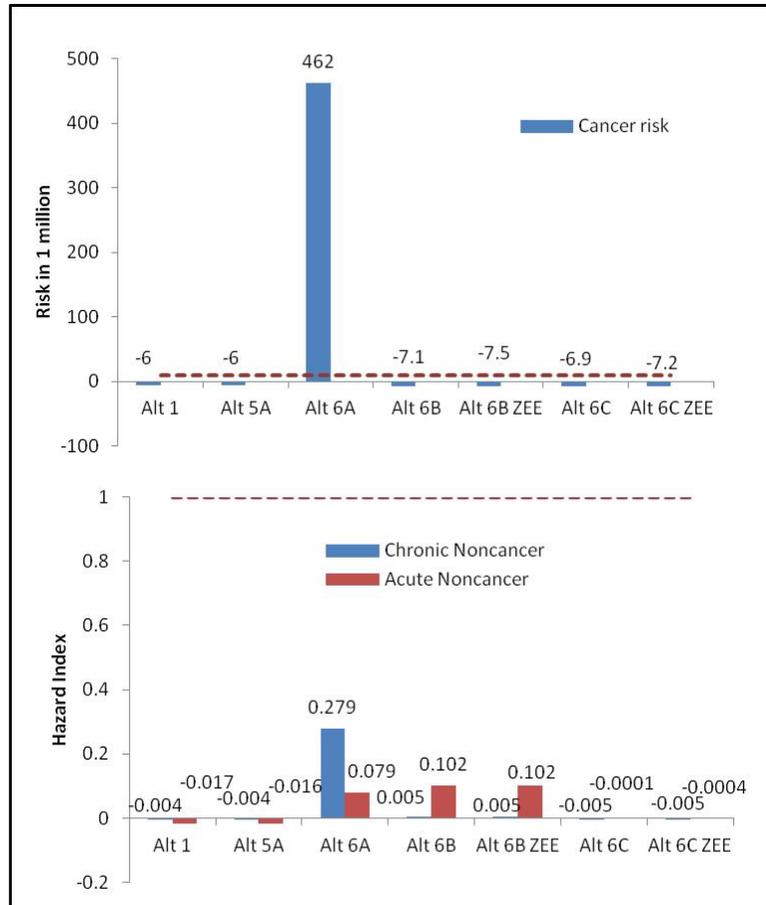
#### *HEALTH RISKS*

Health risks relative to 2008 levels are shown for each of the Alternatives in Figure 7. The values used to create these graphs are from Tables 4.10a – 4.10e in the AQHRA [7]. Alternative 6A exhibits the greatest cancer risk and chronic noncancer risk. Alternatives 6B and 6B ZEE show the greatest acute noncancer risk. SCAQMD thresholds are shown with a dotted line. Cancer risks exceed the SCAQMD threshold of 1 in 1 million for Alternative 6A, and chronic noncancer and acute noncancer risks do not exceed the SCAQMD threshold of 10 for any alternative.

#### **CEQA ANALYSIS**

The CEQA analysis (section 4.0 of the DEIR) provides assessments of impacts that are supported by brief text descriptions and references to other sections of the DEIR. In our review we were unable to trace the justification of some conclusions presented in the CEQA analysis back to the referenced sections, while in other sections the justification referred to was not sufficiently explained. Additional elaboration is provided below.

CEQA guidelines require a determination of significance in response to each of five air quality questions discussed below [14]. In each case, “the significance criteria established by the applicable air quality management or air pollution control district may be relied upon to make the following determinations.” (Page 43 of [14]. The CEQA analysis also includes an assessment of greenhouse gas emissions.



**Figure 7: Health risks associated with MSATs from I-710 Traffic. Risks shown are relative to 2008 risks. Dotted lines represent SCAQMD thresholds.**

*CEQA question III.a: Would the project conflict with or obstruct implementation of the applicable air quality plan?*

The DEIR concludes that these impacts are less than significant (Section 4.2.2.2.a) because the project has a less than significant impact if it conforms with the SCAQMD AQMP/SIP by 1) being included in the RTP and 2) demonstrating through detailed project-level analysis “that the project will not result in an exceedance of local standards for carbon monoxide (CO) and particulates” (page 4-14 of the DEIR).

In terms of point 1, the DEIR CEQA analysis states that the project is consistent with the AQMP, the 2012 RTP/SCS, and the 2011 FTIP as described in DEIR Section 3.13. However, as discussed above, it is not clear from Section 3.13 that all alternatives considered were included in the regional conformity modeling used to support these plans.

In answer to point 2, the DEIR states that:

The results for the No Project (no build) alternative and the Proposed Project (build alternatives) scenarios in the horizon year are compared to the AQMP’s air quality projections. Results indicate

that the proposed project will not significantly contribute to or cause deterioration of existing air quality (DEIR page 4-14).

As discussed in reference to Table 3, which shows that a rough estimate of concentrations obtained by adding modeled incremental concentrations to background concentrations would exceed state and SCAQMD standards, it is not clear that state standards and SCAQMD CEQA thresholds will not be exceeded for any alternative. While notes throughout the DEIR state that the SCAQMD thresholds are informational only (e.g. in Tables 3.13-24 – 3.13-38), several notes in the AQHRA indicate that Caltrans intended to use them as part of the significance determination (e.g. in the AQHRA on pages 36 and 38, 61, 62), and it is unclear why these would not apply as ‘local standards’ under CEQA. The CEQA section of the DEIR should be specific and traceable. It should clearly which criteria are required under CEQA so that it is clear which standards they do not exceed.

*CEQA question III.b: Would the project violate any air quality standard or contribute substantially to an existing or projected air quality violation?*

The DEIR concludes that these impacts are less than significant (Section 4.2.2.2.b). The DEIR states that,

For purposes of determining significance under CEQA, the project would result in a potentially significant impact if it resulted in the exceedance of Federal or State Air Quality standards.

Regional consistency with applicable State and Federal air quality standards is discussed in Section 3.13 and in the response to Checklist Question III-a above. Implementation of the SIP will bring the region into conformance with the applicable air quality standards. The analysis in Section 3.13 indicates that implementation of any of the build alternatives would not create a violation of applicable air quality standards.

The project is included in the recently adopted 2012 RTP/SCS. The analyses in the Air Quality/Health Risk Assessment (AQ/HRA), as summarized in Section 3.13, demonstrate that the project will not cause additional local exceedances for CO and particulates. The project will not result in the violation of any air quality standard or contribute substantially to an existing or projected air quality violation; therefore, impacts are less than significant. (page 4-15 of the CEQA analysis)

However, the DEIR also states that CAAQS is exceeded for NO<sub>2</sub> at one receptor for Alternative 6A (page 3.13-48). Additionally, as discussed in the Incremental Concentrations section above, it is not clear that PM concentrations will not exceed state for all alternatives and federal alternatives for all build alternatives.

*CEQA question III.c: Would the project result in a cumulatively considerable net increase of any criteria pollutant for which the project region is non-attainment under an applicable federal or state ambient air quality standard (including releasing emissions which exceed quantitative thresholds for ozone precursors)?*

The DEIR concludes that these impacts are less than significant (Section 4.2.2.2.c) because

For purposes of determining significance under CEQA, the project would result in a potentially significant impact if, at the time of the analysis, the region was in nonattainment under applicable Federal or state ambient air quality standards and the project contributed to such a designation.

As discussed in the PM Analysis section above, the discussion of attainment is not sufficiently explained.

*CEQA question III.d: Would the project expose sensitive receptors to substantial pollutant concentrations?*

The DEIR determines that this is an unavoidable significant impact based on increases in MSAT concentrations. The DEIR states that

The MSAT analysis provided in Section 3.13 indicates there would be similar or lower MSAT emissions in the Study Area under the build alternatives relative to the Alternative 1 in 2035...

While the MSAT analysis showed that there would be an overall reduction of MSAT emissions in the South Coast Air Basin (SCAB) and the I-710 area of interest (AOI), the build alternatives would result in near-roadway incremental emissions concentrations in a few areas very near I-710. Therefore, the project's long-term impacts are potentially significant and unavoidable at these near-roadway locations.

These localized increases in emissions are the result of increased total traffic volumes on the facility. Further mitigation of these emissions is not feasible, since Caltrans does not control the emission characteristics of vehicles using the freeway. (DEIR page 4-40).

Although Caltrans does not control the emissions characteristics of vehicles using the freeway, this project directly influences changes in the capacity of the freeway, which leads to increased total traffic. For additional discussion related to this point, see the induced demand section of the Travel Demand Modeling section of this report and the general purpose lanes section of the Evaluation of the CEHAJ Alternative section of this report.

*CEQA question III.e: Would the project create objectionable odors affecting a substantial number of people?*

The DEIR concludes that these impacts are less than significant (Section 4.2.2.2.e).

*Greenhouse gas emissions*

Section 4.3 of the CEQA analysis discusses climate change effects of the project. Although page 4-78 of the DEIR states that emissions from electricity used to power zero emission trucks are included in the estimate, there is no documentation of that calculation in the AQHRA Appendix F or the AQHRA Addendum, nor is it discernible from additional technical information provided to NRDC by Environ. If emissions from electricity use by zero emission trucks were not included in the estimate, GHG emissions are underestimated. The DEIR text cites CCAR GRP V3.0 (2008)

guidance (page 4-77), which has guidance for estimating GHGs from electricity. Using data from the DEIR's energy chapter<sup>33</sup> and CCAR guidance,<sup>34</sup> we estimate that these emissions are approximately 73,000 tonnes CO<sub>2</sub>e/yr for alternative 6B and 63,000 tonnes CO<sub>2</sub>e/yr for alternative 6C, increasing the total GHG estimates by 0.4% and 0.3% for alternatives 6B and 6C respectively. Note that these percentages are shares of all GHGs produced by vehicles modeled in the SCAB area, which is large relative to the project itself. These estimates can also be compared to the difference between no-build emissions and emissions from Alternatives 6B and 6C, eroding 15 and 16% of estimated reductions over the no-build (Alternative 1) level respectively (estimated from Table 4.3-3b in the DEIR). The ZEE design option is not analyzed here because the DEIR does not provide energy use for it, stating only that “the ZEE Design Option would result in a very minor increase in electricity consumption due to its extension of the overhead catenary system an additional two miles.” (Page 3.15-8 of DEIR).

### USE OF UPDATED GUIDANCE

The regulatory guidance for evaluating air quality changed over the course of the I-710 analysis timeframe. In some cases the DEIR analysis uses the latest recommended guidance, and in others it does not. In some cases the updated guidance would make the build alternatives fare better in comparison to the no-build, in others they would not perform as well. Below we list the various versions of guidance mentioned in the DEIR, their date, whether they were used or not, and what the expected outcome of using or not using them is (if known).

- ARB/SCAQMD dust re-entrained method (Dec 15, 2011 or July 2012?) – used in the hotspot analysis, reduces PM estimates relative to the EPA method. Not currently posted.
- EPA dust re-entrainment method AP-42 (January 2011) – used in the health risk assessment, increases PM estimates relative to the ARB/SCAQMD method. Available at <http://www.epa.gov/ttn/chief/ap42/ch13/index.html>.
- MSATs guidance: referred to on page 3.13-30 of the DEIR (Sept 2009) – used, outcome of using this guidance was not evaluated.
- MSATs speciation factors: referred to on page 3.13-31 of the DEIR (Sept 2010) - not used – outcome of using this guidance was not evaluated.
- Quantitative hotspot analysis requirement (Dec 2010, effective Dec 2012) – not used, using the new rule would likely result in a quantitative hotspot analysis. Available at <http://www.epa.gov/otaq/stateresources/transconf/policy/420b10040.pdf>

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<sup>33</sup> Table 3.15-7 of the DEIR provides annual electricity use for Alternatives 6B and 6C in 2035: 183 and 157 Million kWh respectively, which equal 183,000 and 157,000 MWh.

<sup>34</sup> CCAR GRP V3.0 (2008) provides optional guidance for estimating indirect emissions from electric vehicle use (page 40). Table C.2 gives the CO<sub>2</sub> factor used: 878.71 lbs CO<sub>2</sub>/MWh in WECC California (CAMX). Table C.3 gives the factors for CH<sub>4</sub> and NO<sub>2</sub>: 0.0067 and 0.0037 lbs/MWh respectively. Using GWPs from Table C.1: (1, 21, 310 for CO<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>O respectively), we calculate the GHG emissions intensity of electricity use in California according to CCAR 2008 as  $1*878.71+21*0.0067+310*0.0037= 879.999$  lbs CO<sub>2</sub>e/MWh, or 0.399 tonnes CO<sub>2</sub>e/MWh.

- Port growth assumption (2009) - used, reduces traffic volumes in all alternatives, reducing the traffic and air quality merits of build alternatives when compared to no-build alternative and improving the traffic and air quality merits of all alternatives relative to 2008.
- Population growth assumption (2012) – not used, reduces population and job estimates for the region. Not using this updated growth estimate results in greater modeled travel demand, increasing the relative traffic reducing benefits of all Alternatives over the No-build Alternative.

### III. TRAFFIC AND TRANSPORTATION

The project alternatives have largely been designed and evaluated on the basis of safety and traffic-related parameters. However, we believe the analysis of traffic accident data is incomplete and that there are some misrepresentations in the presentation of the level of service (LOS) data. This is of particular concern for the low-cost alternatives that were eliminated because they failed to address safety or traffic concerns. Project alternatives should be clearly linked to defined safety and traffic issues and should also be clearly and consistently evaluated against these same factors.

#### SAFETY ANALYSIS

The accident data presented in the DEIR is incomplete. For the purposes of the DEIR analysis, the I-710 is divided into segments; two of the four Northbound segments and one of the four Southbound segments exhibit higher than average accident rates [3]. The four segments are unequal in length and range from 2.7 to 6.9 miles. It is possible that both the way in which the segments have been created and the rates of accidents in the low segments together combine to create a facility with average traffic rates. In other words, while the DEIR discussion of the number of segments above and below the state average is of the type normally found in DEIRs, the statements do not support the claim that the I-710 is less safe than average.

Additional information as to how roadway segments were generated (and the consistency of these delineations with standard guidance) should be identified. We computed a rough approximation of the facility-level average accident rates (both Northbound and Southbound) using the information provided in Tables 4-10 and 4-12 of the Traffic Operations Report. These new accident rates are calculated to be 1.053 accidents/million vehicle miles for the Northbound lanes and 1.02 for the Southbound lanes, both of which are less than the expected corridor-long average of 1.068 that can be found using the provided state average data. Thus, while some sections of the freeway may indeed experience more accidents than the state average, as a whole I-710 is in line with what could be expected from similar facilities statewide.

It should also be noted that the accident rates are compared to “average accident rates for similar highway facilities throughout the State” [15, p. 4-21]. There is no information as to which other freeways the rates are compared to. The phrase “similar highway facilities” could be used to describe the volume of traffic on the freeway, the heavy-duty truck flows, the v/c ratios, etc. We find it unlikely that there are many freeways with both the volume and mode splits exhibited by I-710, and therefore the comparison criteria should be clearly identified. As the DEIR states, “a unique factor affecting the capacity of the I-710 Corridor is the large numbers of heavy-duty trucks that use the I-710 Corridor to travel between POLB, POLA, and the rail freight intermodal yards located near I-5, and to warehousing and distribution”[3, p. 2].

Additionally, there appears to be an inconsistency between the DEIR (page 3.5-7) and the tables found in the I-710 Corridor Project Traffic Operations Analysis Report. The DEIR states that “of the 54 southbound Study Area ramp locations, two have higher accident rates than the State

average” (DEIR page 3.5-7). This is inconsistent, however, with the referenced tables which indicate that the total number of SB ramps with higher accident rates than the state is 20 [15, p. 4-26 – 4-28].

### USE OF LEVEL-OF-SERVICE (LOS) METRICS

There are several instances throughout the DEIR where LOS calculations, which are used to indicate the level of traffic congestion, are not comprehensively presented. For example, though it may seem that there is a large increase in the number of LOS E or F segments from 2008 to 2035 under the no build scenario, the difference is partially attributable to the different number of freeway segments counted in each year. That is, in 2008 there are several N/A values for the basic and weaving lane types, and in 2035 these data are provided. Thus, the difference in the number of freeway segments operating at LOS E/F in 2035 (page 3.5-17) is not as large as presented. In Table 3.5-1 (for Northbound lanes), there are 13 N/As for 2008 (and none for 2035 no build), 11 of which are for segments that are LOS E or F in 2035. In Table 3.5-3 (for Southbound lanes), there are 15 N/A segments in 2008 (and none for 2035 no build), all of which are LOS E or F in 2035. There are also instances where the no build improves for portions of the day, yet is still counted in the LOS E or F (Examples from Table 3.5-3 I-710 Southbound Basic and Weaving Segments Existing and No Build Alternative Levels of Service can be found in Table 5). The LOS attributes for each alternative and segment should be clearly and consistently reported along with any missing data or explanations as to why LOS was calculated in one year or another.

**Table 5: Examples of Segments for which Information is Not Available for 2008 but is for 2035 Alternative 1, or where Conditions Worsen in Some Time Periods but Improve in Others.** Data from Table 3.5-3 [3].

Location Description	Freeway Type	Existing (2008)			No Build (2035)		
		AM	PM	Midday	AM	PM	Midday
Wright Off/Imperial EB Off	Basic	N/A	N/A	N/A	F	F	F
Rosecrans WB On/Rosecrans EB On	Basic	N/A	N/A	N/A	E	D	D
Imperial WB On/Imperial EB Off	Weave	C	C	C	F	C	A

Counting intersections LOS’s as presented indicates that there is an estimated 108% increase in the number of LOS E or F segments from 2008 to 2035 under the No Build scenario. If, however, we compare only those segments for which there are data for both 2008 and 2035, then the percent increase in the number of segments is roughly half that described in the DEIR, 43% for the Southbound lanes and 61% for the Northbound lanes, as can be seen in Table 6.

**Table 6: Revised Number of Alternative 1 LOS E or F Segements when segments with no data for the year 2008 base case are excluded.** Data from Tables 3.5-1, 3.5-3 in [3]

Direction	2008		No Build (2035)	
	Combined Basic and Weaving Segments with LOS E or F	N/A (with LOS E or F in 2035)	Combined Basic and Weaving Segments With LOS E or F	LOS E or F Segments excluding 2008 N/A Segments
Northbound	23	11	48	37
Southbound	23	15	48	33

In the case of the Interstate 405 Mainline Segments on page 3.5-21, the LOS values are provided for I-405 LOS in the area of the I-710 interchange. The DEIR states that there are no merge/diverge sections that operate at LOS E or F SB in 2008, and NB and SB in 2035. However, none of the merge/diverge sections are calculated for SB in either year, and only one is calculated for NB (per Table 3.5-5). The one calculated NB merge/diverge section actually improves under the no build alternative. It is unclear how the conclusion that none of the merge/diverge sections are operating at LOS E or F is reached when the data are not available.

It is also unclear how conclusions were drawn with respect to the 2035 build and no-build scenarios. To begin, the DEIR states that “it is expected that under Alternative 5A conditions, future traffic operations along I-710 for both northbound and southbound directions will improve when compared to the traffic operations under existing and 2035 No Build conditions” [3, p. 3.5-56] Yet a merge of Alternative 1 and Alternative 5A Summary LOS tables [15, Tables 7-3, 7-6] found in Table 7 below shows that while it is true that Alternative 5A generally reduces the percent of LOS E or F segments during the morning peak hour, for other time periods this is not necessarily the case. When broken down into lane types over the three peak periods, the percent of LOS E or F segments for Alternative 5A is equal to or higher than those for Alternative 1 in half of all cases. Again, there are some differences in the number of segments analyzed for each alternative, though in this case the provided clarification that “LOS and/or density information are not shown for major merge areas, single-lane addition/drop, and merge/diverge operations within a weaving segment” [3, Table 3.5-10] explains at least some of the discrepancies. Combining all lane types and all peak periods, Alternative 5A does indeed perform slightly better than Alternative 1 with 57.6% of all calculated segments at LOS E or F compared with 59.6% of all segments for Alternative 1. Given the differences in the number of segments and the uncertainties associated with predicting future traffic, a simplistic LOS analysis such as this one is limited in its ability to provide a comprehensive picture of traffic conditions.

**Table 7: Side-by-Side Comparison of the Percent of Freeway Segments Expected to be LOS E or F in 2035 for Alternatives 1 and 5A. Data from Tables 7-3, 7-6 in [15]**

Scenario		Alt 1		Alt. 5A		
Lane Type	Time	Total Analyzed	% LOS E or F	Total Analyzed	% LOS E or F	
Northbound	Basic	AM Peak Hour	46	41%	42	7%
		PM Peak Hour	46	59%	42	83%
		MD Peak Hour	46	78%	42	69%
	Merge/ Diverge	AM Peak Hour	27	48%	23	4%
		PM Peak Hour	27	56%	23	74%
		MD Peak Hour	27	67%	23	65%
	Weave	AM Peak Hour	14	50%	7	29%
		PM Peak Hour	14	50%	7	86%
		MD Peak Hour	14	64%	7	100%
Southbound	Basic	AM Peak Hour	46	72%	48	63%
		PM Peak Hour	46	50%	48	56%
		MD Peak Hour	46	63%	48	71%
	Merge/ Diverge	AM Peak Hour	34	68%	30	60%
		PM Peak Hour	34	47%	30	50%
		MD Peak Hour	34	56%	30	67%
	Weave	AM Peak Hour	15	73%	10	60%
		PM Peak Hour	15	60%	10	60%
		MD Peak Hour	15	73%	10	70%

## PROJECT IMPACT ON STUDY AREA TRAFFIC

The project impacts on the surrounding arterial streets and intersections are also expressed using the overall number of segments with a LOS E or F calculated value for all Alternatives. The DEIR simply says the following with respect to arterials:

“With the No Build conditions under Alternative 1, 74 of the Study Area roadway segments are forecast to operate at LOS E or F. Under Alternative 5A, 72 roadway segments would operate at LOS E or F. Under Alternatives 6A/B/C, 57 roadway segments would operate at LOS E or F. As a result, all of the I-710 Corridor Project build alternatives would improve roadway operations within the Study Area. These improvements result in part from not as much I-710 traffic diverting onto local arterials under the I-710 Corridor Project build alternatives as compared to Alternative 1.” [3, p. 3.5-79]

This does not provide a very comprehensive look at how the project Alternatives will impact the I-710 Study Area community. The cited report, the *Intersection Traffic Impact Analysis Report*, does not provide either V/C or LOS values for any of the segments in tables, supplying instead only expected daily volumes (in tables) and color-coded volume-to-capacity ratio maps (in figures). Therefore, the transition between the *Intersection Traffic Impact Analysis Report* calculations and the LOS values found in the EIR is difficult to follow. In several places it is indicated that parking restrictions during peak periods (7:00 a.m.–9:00 a.m. and 4:00 p.m.–7:00 p.m.) will be implemented on four arterial roadways shown below for Alternatives 5A and 6A/B/C [3, p. 3.5-79]:

- Atlantic Blvd., between Pacific Coast Hwy. and State Route 60 (SR-60)
- Cherry Ave./Garfield Ave., between Pacific Coast Hwy. and SR-60
- Eastern Ave., between Cherry Ave. and Atlantic Blvd.
- Long Beach Blvd., between San Antonio Dr. and Firestone Blvd.

While the Intersection Traffic Impact Analysis Report does not specify the capacity changes on these segments that would result from these parking restrictions, Section 2.4.1.9 of the DEIR [3, p. 2-53] states that the measures would “increase traffic capacity by one lane in each direction” on each of the segments. The Intersection Traffic Impact Analysis Report should not only provide detailed information about predicted volumes, but also provide discussion on how capacities vary between the alternatives. This will facilitate an “apples to apples” comparison.

A comparison of Figure 5-6 Roadway Segment Volume-to-Capacity Ratio (PM Peak Hour) – Alternative 1 and Figure 6-1 Roadway Segment Volume-to-Capacity Ratio (PM Peak Hour) – Alternative 5A in the Intersection Traffic Impact Analysis Report shows that while fifteen segments improve in their volume-to-capacity ratios, seven segments worsen. (This does not reflect the difference of 2 segments reported in the EIR and mentioned above, which may be either a figure inaccuracy or an adding error.)

For example, the impact of all of the build alternatives on Anaheim Street is especially noteworthy (Table 8). In the case of Alternatives 5A, 6B, and 6C, one segment, Alameda Street to Santa Fe, goes from a less than 0.9 volume-to-capacity ratio to a greater than 0.9 but less than 1.0 ratio, and another, I-710 to Atlantic, goes from a from a less than 0.9 volume-to-capacity ratio to a greater than 1.0 (exceeding capacity) ratio. For Alternative 6C, the Alameda Street to Santa Fe segment of Anaheim Street has a worse that 1.0 volume-to-capacity ratio. [10, Figures 5-6, 6-1, 6-6, 6-11, 6-16] In all of these alternatives, four of the five Anaheim Street segments are near to or exceeding capacity, while in Alternative 1 only two of the five segments are considered to be in critical condition. Especially noteworthy is the percent increase in 2035 volumes for the segment between I-710 and Atlantic Ave. Alternative 5A , for example, has a 32% increase in auto traffic over Alternative 1, while the number of non-port trucks is expected to be 25% higher.

**Table 8: Expected 2035 Daily Volumes and Volume to Capacity Ratios for Anaheim Street. From Tables 5-2 and 6-2 and Figures 5-6 and 6-1 in ref. [10]**

2035 Daily Volume	W. of Alameda St.			Alameda St. to Santa Fe			Sante Fe Blvd. to I-710			I-710 to Atlantic Ave.			Atlantic Ave. to Cherry		
	Alt. 1	Alt. 5A	% Incr.	Alt. 1	Alt. 5A	% Incr.	Alt. 1	Alt. 5A	% Incr.	Alt. 1	Alt. 5A	% Incr.	Alt. 1	Alt. 5A	% Incr.
Auto	28,000	26,800	-4%	33,400	41,600	25%	34,100	40,900	20%	27,300	35,900	32%	22,400	22,100	-1%
Port Truck	2,800	2,900	4%	7,300	7,800	7%	9,800	9,400	-4%	2,100	1,800	-14%	1,300	1,200	-8%
Non Port	1,100	1,100	0%	2,000	2,400	20%	2,100	2,400	14%	1,200	1,500	25%	1,000	1,000	0%
V/C Ratio	≥ 1.0	≥ 1.0	--	< 0.9	≥ 0.9, < 1.0	--	≥ 1.0	≥ 1.0	--	< 0.9	≥ 1.0	--	< 0.9	< 0.9	--

With respect to study area intersection LOS calculations, the results seem to be more exhaustively presented than those for the arterial LOS calculations, though the Intersection Traffic Impact Analysis Report implies that data were not gathered for all of the intersections that were intended to be included in the study:

45 of the aforementioned study intersections were initially identified to be included in the I-5 Corridor Study currently underway by Caltrans. Therefore, these intersections were removed from the list of study intersections to be analyzed by the I-710 Corridor Project EIR/EIS with the intent that the LOS results for these intersections from the I-5 Corridor Study would be presented within the I-710 reports for reference purposes. However, it was determined that only eighteen of these intersections (see Table 2-3) have ultimately been analyzed by the I-5 Corridor Study and included for reference purposes within the I-710 reports. [10, p. 2-4]

This means that 27 potentially significant intersections within the study area have not had data gathered or analysis conducted and as a result they were not included in the DEIR.

## **PUBLIC HEALTH CONSIDERATIONS AND THE CONGESTION/MOBILITY PUBLIC HEALTH STATEMENT**

The DEIR asserts in its public health statement that “increased access to transit is associated with increased biking and walking as modes of transportation. Increases in congestion and corresponding decreases in bicycle or pedestrian safety are associated with decreased biking and walking. Increases in walking and biking are positively associated with improvements in health, including decreased obesity, chronic disease, and stress (P. Simon et al. 2009)” [3, p. 3.5-86]. Logically, if driving travel times are longer, then increases in alternate mode ridership (biking, walking, transit, and combinations thereof) may occur under some conditions.

In the same section, the DEIR reports that “the VHT and the VHD are forecast to be less with the build alternatives than under Alternative 1. The slight reduction in VHT and VHD that would be experienced by residents in the Study Area would have nominal benefits to public health considerations related to congestion and mobility” [3, p. 3.5-86]. Table 3.5-32 indicates that while Alternative 5A decreases VHT within the study area by 9,300 hours, VMT is expected to increase by 280,400 [3, p. 3.5-85]. Many of the congestion improvements occur on I-710, where reduced congestion does not have the same pedestrian and biking-related public health improvements as detailed in Section 3.5.3.2. Some accident reductions might be estimated due to decreased congestion and improved interchanges, but the fact that “total vehicle volumes for all vehicle classifications along the I-710 freeway are higher in Alternative 5A when compared to Alternative 1” [15, p. 6-9] still means an increase in the number of drivers on the road.

## IV. EVALUATION OF ALTERNATIVE REVIEW PROCESS AND CEHAJ'S PROPOSED ALTERNATIVE 7

To understand how alternatives, such as that being proposed by CEHAJ,<sup>35</sup> which contains a comprehensive public transit element and does not include highway expansion or tolling of the freight corridor, might fare in the current evaluation process, we undertook seven strands of analysis, which also serve to organize this section:

- In the first part, we explore the outcome of adding general purpose lanes to the I-710 corridor, which are included in the build alternatives of the DEIR but not in Alternative 7.
- In the second part, we evaluate the potential outcomes of the tolling requirement for the freight corridor, as included in Alternative 6C. Tolling is not included in the zero emission freight corridor proposed in Alternative 7. In this section we also explore a potential improvement in the zero-emission vehicle requirement currently included in Alternatives 6B and 6C.

In the third through final sections, we turn our attention to alternative selection and the transit element of the alternatives:

- The third section describes the methods used during the environmental review to evaluate project alternatives in the Major Corridor Study [16] and the Alternatives Screening Analysis [17]. Because the standalone transit alternative (Alternative 2) was eliminated in the screening process, that alternative was not analyzed or compared in the DEIR/DEIS.
- The fourth section outlines how Alternative 2 specifically was considered during the alternatives analysis process. This process is at least partially described over several documents. From these documents, it is clear that confusion about how Alternative 2 was defined may have affected how it was evaluated.
- In the fifth part, we review the screening process used specifically for Alternative 2 and show that the prior analyses were predisposed to favor highway expansion because of modeling and analysis limitations.
- The sixth part presents the results of a preliminary public transit market analysis in the I-710 corridor study area using data provided by Metro and public data from the National Transit Database. Our analysis shows that there is a robust transit market in the area, supporting conclusions hypothesized in earlier sections regarding inconsistencies in the transit ridership projections.
- In the final section, approximate cost estimates are presented. These illustrations demonstrate that the transit alternative may actually perform better relative to highway expansion alternatives.

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35 The Coalition for Environmental Health and Justice (CEHAJ) has proposed a project alternative for consideration as part of the I-710 expansion project. The salient characteristics of this alternative from a transportation and land use perspective no additional general purpose lanes; a comprehensive public transit element; zero emissions freight lanes, and a comprehensive non-motorized plan. The alternative also contains specific recommendations for the construction phase of the project as well as additional recommendations for specific project elements that do not bear directly on the transportation analysis including improvements to the Los Angeles River and community benefits arrangements including local hires for construction.

On the basis of our analysis, we find that the evaluation of alternatives in the DEIR is, at best, confusing and more likely incomplete. And further, that the process was pre-disposed toward highway capacity expansion alternatives. Without a more technically sound framework for analyzing alternatives, the performance of non-highway capacity alternatives will be biased. Although we have used the EYCEJ alternative to highlight weaknesses of the alternatives analysis process, we believe our conclusion holds regardless of the particular transit improvements that are proposed.

## **OUTCOMES OF ADDING GENERAL PURPOSE LANES**

Historically transportation planning has focused on mobility, or the movement of people, with automobiles the obvious choice during the latter 20<sup>th</sup> century. In many areas of the US this has resulted in the construction of increasingly larger roadways, cementing the auto-oriented nature of urban environments. In the long-run, however, this added capacity has been found to induce demand for roads; that is, projects that add route capacity (e.g. additional lanes miles, or new roads) result in long term increases in VMT that fill the capacity [6]. In addition to increasing overall VMT, this cycle results in lowered air quality and cities that are unsuitable for transit and bicycle/pedestrian travel.

As a result, the focus of modern transportation planning has shifted toward accessibility, which focuses on people's ability to get to desired destinations. Accessibility can be achieved through many non-capacity strategies, including changes in land use planning and improvements in transit and bike/pedestrian infrastructure. California's Senate Bill 375 embodies this shift, requiring regions to achieve automobile greenhouse gas reduction targets via integrated land use and transportation plans. In the context of modern planning in California, adding new capacity would seem most appropriate as a 'last resort' approach to planning, to be relied upon when more sustainable strategies have been exhausted. The alternatives presented in the I-710 DEIR are narrow in scope, with a surprisingly dated focus on highway expansion.

The I-710 freeway project is motivated by air quality, traffic, and safety needs in addition to accommodating population, job, and port growth. Port growth projections point to a need to move more freight, reflected in the DEIR alternatives as the addition of truck-only lanes. Population and job growth point to a need for improved accessibility, reflected in the DEIR as additional transit and general purpose lanes. However, the population and job estimates used in the DEIR modeling are out of date and overestimated (as noted on page 1-15 of the DEIR and discussed in more detail in the travel model section of this report). Additionally, the addition of truck lanes is projected to reduce the number of trucks in the I-710 mainline, freeing up 'general purpose' capacity. The addition of transit has a similar effect, removing vehicles from 'general purpose' space.

Given SB 375 goals, the known problem of regional air quality, the known long-term VMT outcomes of adding capacity, the outdated and overestimated population and job growth estimates used in the I-710 analysis, and the additional general purpose roadway capacity that is projected to result from truck lane additions and transit improvements, we would expect the justification for

additional general purpose lanes to be airtight. The analysis presented in the DEIR presents a confusing and often internally conflicting portrait of the effect of adding (or not adding) general purpose lanes. Because the alternatives evaluated in the Draft EIR build upon each other in a vehicle centric way, it is impossible to unravel how specific components of any given alternative contribute to its overall effectiveness. That is, it is impossible to determine from the DEIR analysis whether the addition of general purpose lanes is needed if truck lanes are also added, since in Alternatives 6A, 6B, and 6C truck lanes are only considered in conjunction with general purpose lanes. The Major Corridor Study also does not present information about truck-only lanes without general purpose lanes.

The Alternative Screening Analysis (ASA) [17] provides some indication of the outcome of general purpose lanes (but not in comparison to the addition of truck lanes). Alternative 4 (which includes arterials/I-710 congestion relief, enhanced goods movement by rail, and TSM/TDM, ITS, Transit) can be compared to Alternative 5A (which includes all components of Alternative 4, plus additional I-710 general purpose lanes yielding a total of 10 lanes). In term of traffic, Figures 3 and 5 in the ASA indicate that traffic in I-710 general purpose lanes improves for Alternative 5A relative to Alternative 4 (as measured by v/c ratio and travel time respectively), although arterial traffic is unchanged (Figure 4). However it is noteworthy that adding truck only lanes (Alternative 6) also improves *general purpose* traffic on I-710, likely reflecting the freed capacity due to shifting trucks off of the mainline. In terms of air quality, Alternatives 5A and 6 have higher diesel particular matter (DPM) emissions and lower NO<sub>x</sub> emissions than Alternative 4 (see Figure 7 in the Alternative Screening Analysis), where particulate matter is one of the primary concerns in the area. Energy use is also lower for Alternative 4 than for 5A or 6 (Figure 8). Furthermore, traffic safety (as measured by percent of heavy duty trucks) is unaffected by the addition of general purpose lanes (Figure 9), although more design deficiencies are addressed in Alternative 5 when compared to Alternative 4.

In summary, it seems that adding general purpose lanes in addition to transit improves traffic, increases DPM, decreases NO<sub>x</sub>, and may have some safety benefit. However, for the purposes of the proposed alternatives, it is of interest to understand whether adding general purpose lanes in addition to truck lanes bring benefits that justify the cost of the added lanes. Without an assessment of an alternative that includes truck lanes and transit but not general purpose lanes, the answer is unknown.

### **TOLL EFFECTS: COMPARING ALTERNATIVE 6C (TOLL) TO ALTERNATIVE 6B (NO TOLL)**

Alternative 6A includes TSM/TDM, ITS, transit improvements, arterial improvements, general purpose lanes, and elevated truck lanes. Alternative 6B includes all components of 6A, with the added policy that the truck lanes are restricted to zero emission vehicles with automated guidance systems. Alternative 6C includes all aspects of Alternative 6B and additionally places tolls on the truck lanes. The tolling system implemented in Alternative 6C would rely on electric transponders

to collect the toll, with no cash payment options. All users would have to be previously registered with the system. The system would necessitate “overhead sign bridges and transponder readers like the SR-91 toll lanes currently operating in Orange County,” and provide the ability to charge higher tolls during peak travel times [3, p. 2-24]. The Zero Emission Extension (ZEE) design option for Alternatives 6B and 6C would extend zero emission technology to SR-60. As explained on page 11 of the Draft EIR, tolling could also occur under Alternative 6A, with standard trucks allowed on the freight corridor instead of only zero emissions vehicles, however, “tolling has only been evaluated for Alternative 6B, as this alternative provides for higher freight corridor capacity than Alternative 6A due to the automated guidance feature”[3, p. 11]

It is critical to point out that tolling affects the demand for the use of the truck lanes, which in turn affects traffic and air quality throughout the study area. In this section we review the existence of similar facilities and then discuss the implementation of the I-710 tolled freight corridor, its effects on demand for the corridor, traffic, and air quality. We then discuss the effects of the zero-emissions vehicle requirement.

#### *EXISTING TOLLING AND FREIGHT-ONLY ROAD FACILITIES*

The Draft EIR notes that “tolling is not widespread in the U.S., and tolling of a dedicated freight facility is essentially untried” [3, p. 3.3-50]. At least one other region has discussed freight tolling; the Seattle Variable Tolling Study completed in 2009 encourages freight access to travel lanes and pricing to create reliable travel times [18].

With respect to truck-only lanes, a truck-only freight highway was proposed in 1996 from near Winnipeg to Duluth, Minnesota, however, it was never constructed [19]. New Jersey unveiled plans in 1998 to build the “Portway” project, which are dedicated truck linkages to the Port Newark/Port Elizabeth complex, among other freight-intensive locations [19]. Three of the subprojects associated with Portway have already been completed [20]. California currently has two sets of truck-only lanes: one on southbound I-5 in Kern County at the State Route 99 junction and the other on both northbound and southbound I-5 in Los Angeles County at the State Route 14 split [21]. In both of these projects, trucks are required to use the specialized lanes; this contrasts with the proposed I-710 freight corridor lanes where use is optional. The proposed I-710 lanes are more similar to carpool lanes, where certain types of vehicles can choose to travel the lanes but are not required to do so, than they are to existing freight-only roads.

There are several Southern California regional examples of dynamically priced toll lanes for passenger vehicles, such as the SR-91 lanes cited in the DEIR. The State Route 91 Express lanes are a ten-mile stretch of four lanes (two in each direction) that are dynamically priced to control congestion, with the highest prices during the peak periods.[22] The connecting Eastern Toll Road (ETR) is an entirely separate road on which trucks are allowed, albeit at higher rates than for passenger (2 axle) vehicles [23]. Again, prices are adjusted so that the highest rates correspond with the highest demand. In both cases the extra capacity not only relieved congestion but also induced demand, as evidenced by the fact that “the opening of the 91X lanes in 1995 and of the ETR in 1998 were both accompanied by significant jumps in peak period traffic”. By the end of 1998, three years

after the express lanes opened, total midweek average daily traffic (for both the free lanes and the toll lanes) had increased by 36,160 vehicles per day while the average express lane midweek daily traffic was 31,400 [22]. The addition of the express lanes corresponds with a growth of 4,760 vehicles per day (13%) on the free (non-tolled) lanes.

San Diego's High Occupancy Toll (HOT) lanes on Interstate 15 represent another example of express toll lanes in the Southern California Region. The system consists of two reversible eight mile lanes with access only at the endpoints which change direction with the peak hour. The variable toll can change up to every six minutes to ensure that the lanes do not become congested [24]. A system with such variability may not lend itself well to the I-710 freight corridor because the corridor possesses a large number of access and egress points and extensive signage and driver education may be required for drivers to understand and predict what the tolls will be for their route.

### *I-710 TOLL IMPLEMENTATION*

Tolling of the I-710 freight corridor will affect the demand for the use of the truck lanes, which in turn affects traffic and air quality throughout the study area. Below we describe the potential effects of tolling on demand for tolled truck lanes. We then discuss the effect of these effects on traffic and air quality. We close with a cautionary note about the zero-emission vehicle requirement.

#### *Demand for Tolled Truck Lanes*

According to the Draft EIR, trucks would choose to pay the toll in order to gain the "travel time savings and trip time reliability offered by the freight corridor as compared to the adjacent general purpose lanes or alternative routes"[3, p. 2-25]. A study of the SR-91 express lanes also found that "travelers who choose to pay tolls consistently overestimate their time savings". The second and third ranked main reasons drivers cited as reasons to pay the toll were easier driving and perceived safety [22]. The choice to pay the toll, therefore, is linked to driver preference and may change over time with driver experience and with varying circumstances, both on and off the road. Below we explore two factors that may affect demand for tolled truck lanes in the I-710 corridor: trip distance and time savings and truck driver behavior. We also explore the effects of tolls on truck drivers.

Tolling is generally more effective for longer trips than for shorter trips; longer travel distances are associated with greater trip times that can accumulate larger delays. However, an earlier feasibility study for the I-710 freeway found that "the average trip length on the I-710 is relatively short, and thus significant travel time savings cannot be generated with truck lanes for many of the trips that would use the truck lanes"[19]. Also, trucks tend to travel during off-peak hours [19], when congestion is not as bad and potential time savings would not be as significant. Consider also that the expansion of the general purpose lanes on I-710 would relieve congestion somewhat, and might reduce the incentive for trucks to use the tolled freight corridor. For segments of the I-710 mainline that are less congested, trucks may choose to exit the freight corridor and re-enter further along in the trip to avoid paying higher tolls. The same feasibility study cited above also noted that, "with good traveler information, as would be the case with the addition of the ITS deployments included

in the TSM alternative, it is possible that this type of “on-off” behavior might be encouraged.”[19] This ability and the inclination to move on and off the freight corridor may have impacts on both the expected usage rates and vehicle safety.

Tolls are paid by truck drivers and/or truck companies when the vehicles pass through the tolling facilities, though the costs can be passed on to the cargo owners. According to the Draft EIR, “transportation contracts often specify that cargo owners must pay such fees” but goes on to state that “there is little precedent for understanding who would likely bear the cost of a toll if it were imposed on the I-710 freight corridor” [3, p. 3.3-50]. Truck drivers or their employers may choose to pay a toll at a different rate than personal vehicles due to differing financial constraints and values of time. Additionally, two 2006 studies cited in the DEIR indicate that drivers earnings for owner-operator truck drivers fall below the median income for Los Angeles County according to the 2000 Census, so driver behavior may be more financially constrained than the average driver in the region. While some of the drivers are employees of licensed motor carriers, others are individual truck owners. who would be impacted to a greater extent “since employee drivers presumably will have toll costs reimbursed by their employer” [3, p. 3.3-50]. The Draft EIR concluded that “given the very low net earnings of owner-operator port drayage drivers as a group, it is unlikely that they would be able to absorb the cost of freight corridor tolls. However, in the complex port drayage market, there is no coordinating authority to ensure that tolls would always be passed on to the shipper” (DEIR page 3.3-50). In response, the EIR included Mitigation Measure C-3, which states the following: “Should a tolling alternative (Alternative 6C) be selected as the preferred alternative, Caltrans shall encourage the tolling authority to implement a tolling system where tolls would either be paid directly by the benefitted cargo owner or provide for discounted tolls or rebates to qualifying low-income drayage drivers.” [3, p. 3.3-51]

While the DEIR analysis seems to account for some drivers choosing not to use the tolled freight corridor (as noted in the traffic discussion below), it is unclear from the DEIR whether a sufficiently robust analysis considering all of these known aspects to demand have been considered.

We note that the characteristics of truck drivers not only affect driver tolling behavior; they also affect the distributional impacts of the tolls. Truck drivers generally have a lower income than others in the region, and will be more impacted by the toll. In addition, a study conducted by the California State University, Long Beach “found that the port truck drivers surveyed were over 90 percent Latino (Hispanic)” [3, p. 3.3-50], indicating that the tolls may disproportionately affect Latinos. These effects will be exacerbated for employee drivers, as noted above. Drivers that don’t pay the toll will still experience lost time to the extent that traveling in I-710 general purpose lanes or using other routes is slower.

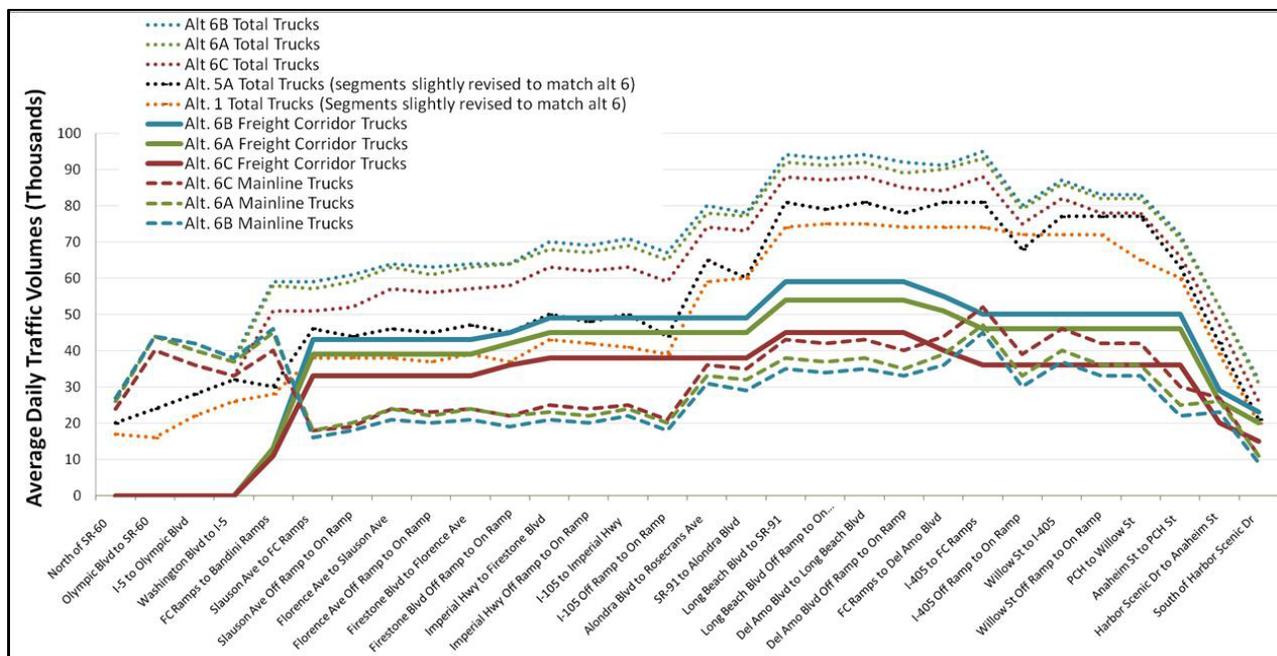
### *Effects on Traffic*

The following discussion explores the effects of tolling on the use of the entire freight corridor as well as the mainline freeway and arterial streets under Alternative 6C.

Alternative 6B and, therefore also Alternative 6C, assumes “that all trucks using the FC [freight corridor] will have an automated control system that will steer, brake, and accelerate the trucks under computer control while traveling”. The DEIR proposes that trucks will then be able to travel in groups of six to eight safely, increasing the freight corridor capacity from 2,350 passenger car equivalents per lane per hour (as in the case of Alternative 6A, which does not have this technology) to 3,000 passenger car equivalents per lane per hour [15, p. 6-7]. It is from this higher capacity baseline that DEIR estimates about the impact of dynamic pricing for Alternative 6C are made. However as discussed in the section about zero-emissions requirements below, automated control system technology may not be in widespread use by 2035.

According to the Draft EIR, the freight corridor is expected to operate “below capacity” for Alternative 6C, and the implementation of tolls is expected to “divert a portion of the truck traffic to the I-710 Mainline, other freeways, and local arterials, leaving the majority of the freight corridor segments underutilized during analyzed peak hours”[3, p. 3.5-57]. With respect to the mainline freeway lanes, “Alternative 6B has the highest FC capacity and thus the lowest truck traffic on general purpose lanes south of Washington Boulevard. Although Alternative 6C has the same FC capacity as Alternative 6B, the FC toll imposition results in the highest truck traffic [of the Alternative 6 Scenarios] on the I- 710 general purpose lanes south of Washington Boulevard.” [15, p. 6-9] Alternative 6C still has lower expected mainline truck ADT values than those for Alternative 1 (No Build) and Alternative 5 (Build – No Freight Corridor), as can be seen in Tables 6-1 through 6-5 of the Traffic Operations Report [15, p. 6-10,14], and summarized in Figure 1.

As can be seen in Figure 8, Alternative 6C has the lowest number of total trucks (on both the Freight Corridor and General Purpose lanes) of the three Freight Corridor alternatives, and, in most segments, the highest mainline average daily truck traffic. While the truck traffic shift to the arterial streets is “minimal, with the exception of Alameda Street between Anaheim Street and I-405, where an increase of approximately 500 daily port truck trips” for Alternative 6C, there are increases in auto traffic on the adjacent arterials. The Intersection Traffic Impact Analysis Report proposes that “a portion of port trucks utilizing the FC under Alternative 6B are diverting away from the FC and back onto the I-710 GP lanes under Alternative 6C due to the toll collection, and the increase in truck traffic on the I-710 GP lanes in turn pushes some of the auto traffic from the I-710 onto the local arterials, similar to Alternatives 1 and 5A”[10, p. 5-120].



**Figure 8: Projected 2035 Freight Corridor, Mainline I-710, and Total Truck Average Daily Traffic for the Five Alternatives for segments along the freeway.** The label order shown corresponds to traffic levels in the graph. Note that Alternative 6B has the highest FC truck use and the lowest mainline truck use of the freight corridor options while still maintaining the highest rate of total trucks of all the alternatives. On the other hand, Alternative 6C has the lowest FC truck use and the highest mainline use along with the lowest number of total trucks of the three freight corridor alternatives. Also note that there are no mainline and freight corridor categorical splits for Alternatives 1 and 5A; the total number of trucks and the number of mainline trucks are equivalent. In some cases, Alternative 1 and 5A do not have the same segments as for the FC Alternatives, so the Alt. 1 Total Trucks and Alt. 5A Total Trucks lines provided above are for the corresponding segments for each scenario that would be in the vicinity of the labeled segments on the graph.

It is unclear whether this is consistent with the DEIR, which states that [3, p. 3.3-50]:

InfraConsult (2011) conducted an analysis of the potential for truck tolls on the I-710 freight corridor to divert truck traffic onto local arterial streets. In the vicinity of I-710, most of these arterials serve areas with high percentages of minority and low-income residents. According to a summary of this analysis, tolling the freight corridor would reduce truck traffic on the parallel arterials compared with a no-toll freight corridor. This result indicates that there would be no disproportionate adverse impact to I-710 Corridor communities from diversion of trucks due to tolling on the freight corridor.

Overall, however, the Draft EIR does find that the implementation of a toll on the Freight Corridor decreases the number of vehicles that use it, and that these trucks in turn find alternative routes within the I-710 Corridor.

### *Effects on Air Quality*

As trucks shift out of the zero emission corridors under the toll, the DEIR assumes that they operate using conventional technology as they travel in general purpose lanes or on arterials. This affects air quality. Referring to the summary figures and tables from the air quality section of this memo, we

can compare the expected air quality impacts of Alternative 6C (with tolling) to 6B (without tolling) in 2035.

In the I-710 near-roadway study area (which includes travel on roads near the I-710 freeway), Alternative 6C may emit slightly more or less total PM<sub>10</sub> and PM<sub>2.5</sub> than 6B depending on the analysis method used; slightly more DPM, NO<sub>x</sub>, CO and SO<sub>2</sub>; possibly slightly more ROG; and similar levels of non-DPM MSATs (Figure 3, Figure 5b, and Figure 6b).

Incremental concentrations and health risks were only assessed for emissions from the I-710 freeway itself (excluding arterials and other nearby roads). In terms of the incremental concentrations resulting from only I-710 emissions, Alternative 6C results in nearly identical NO<sub>2</sub>, CO, and PM when compared with Alternative 6B (Figure 4). In terms of overall health risk resulting from these incremental emissions from only the I-710 freeway, Alternative 6C has slightly lower chronic and acute noncancer health risks and identical cancer risks (Figure 7). Note that without a detailed analysis of incremental concentrations that may occur along arterials and other roads in the study area, it is not possible to fully understand what the localized air quality and health effects of tolling will be.

For the Area of Interest (AOI) assessed in the DEIR (which includes roads in an area larger than the I-710 study area but smaller than the South Coast Air Basin), Alternative 6C results in slightly higher emissions of PM<sub>10</sub> using one method and nearly identical PM<sub>10</sub> emissions using another method (Figure 3) and nearly identical MSAT, NO<sub>x</sub>, CO, SO<sub>2</sub>, and ROG emissions (Figure 5a and Figure 6a). However because the AOI is a larger area the effects of the project may be masked so it may not be a robust indicator of changes in localized emissions that may result from tolling.

Last, in terms of the air quality effects on the South Coast Air Basin, Alternative 6C does not appreciably differ from Alternative 6B in terms of emissions of all pollutants (Figure 3, Figure 5a, and Figure 6a). This is not surprising given the large area of analysis, which includes many emissions unrelated to the project that mask differences.

#### *EFFECT OF REQUIRING ZERO EMISSION TRUCKS ON THE FREIGHT CORRIDOR*

Truck lanes in both Alternatives 6B and 6C will be restricted to zero emission trucks that use automated control technology. Just as tolls can deter some drivers from using the freight corridor, a restriction on the vehicle type can also act as a deterrent if the vehicle type is not widely used. In this section, we evaluate the DEIR's assumptions about the use of automated control technology and zero emissions trucks. We then discuss the implications of these assumptions and how air quality and traffic will differ if they are not realized.

#### *Will trucks have automated control technology?*

The increased capacity of the zero-emissions freight corridor over the standard freight corridor of Alternative 6A is attributed to the assumed implementation of automated control technology. According to the CALTSART report, vehicle guidance systems have their own set of challenges

associated with implementation, including complexity, driver resistance, and liability challenges, and are generally considered to be farther from commercial application than the zero emissions vehicles themselves [25]. Due to the long timeframe associated with a 2035 prediction date, such problems may be resolved; however, the challenges should be noted in case the technology is determined to be unsuitable for the freight corridor. The lack of an automated system would significantly reduce the capacity, and therefore the average daily traffic, for the freight corridor in Alternatives 6B and 6C, pushing more trucks back onto the freeway general purpose lanes or alternate arterial routes.

*Will trucks have zero emissions technology?*

The trucks travelling on the zero emissions freight corridor for both Alternatives 6B and 6C “are assumed to receive electric power while traveling along the FC via an overhead catenary electric power distribution system (road-connected power)” [15, p. 6-7]. However, the DEIR states that there are many different technologies that may satisfy the zero emissions requirement in the future. A CALSTART report funded by the Los Angeles County Metropolitan Transit Authority and the South Coast Air Quality Management District found that “a Zero Emissions truck to serve the I-710 freight corridor (in Alternatives 6B or 6C) is fully technically feasible and can be based on vehicle architectures and designs already in prototype status” [25]. However, the report also noted that “there are serious questions raised by manufacturers and suppliers about whether a market exists for the kinds of vehicles they could produce to meet this expressed need in the San Pedro Port region”. The time it takes to convert prototypes into commercially viable products varies from product to product, though it can be shortened with increased funding or consumer demand. If zero emissions truck technology is promoted or required in other regions, then this demand could help to speed up the development timeframe. Current California diesel regulations indicate that by January 1, 2023, nearly all trucks will need to have 2010 model year engines or equivalent [26]. Even with mandated upgrades, fleet turnover takes a considerable amount of time.

In Alternative 6B it is predicted that at least 59,000 trucks have zero emissions technology in 2035; there are more if it is assumed that not all trucks that are capable of taking the Freight Corridor use it. For Alternative 6C this number is 45,000 trucks, over 50% of the trucks on I-710 (both tolled and free lanes) at that point [15, Tables 6-4, 6-5]. This assumes that at least some of the lower-income truck drivers discussed previously would have paid to update their trucks, perhaps considerably if the zero-emissions technology cost more than the typical truck of the time, and then at a later date they would have been unwilling to pay the toll for a freight corridor where they have essentially already “bought into” the system.

Although the DEIR and several technical documents describe the technology used by zero emission vehicles, it is difficult to fully understand what is being assumed about zero emission truck demand and how a zero-emission requirement will affect demand for the freight corridor. The Travel Demand Modeling Report does not indicate what is assumed about which trucks are zero emission capable, however it does indicate that “usage of the freight corridor is influenced by two factors: 1)

the relative travel times and 2) access to local origins and destinations” [4, p. 57]. In its analysis of zero emissions trucks, the AQHRA assumes that all trucks using the freight corridor operate in zero emission mode on the freight corridor, and when zero-emission capable trucks leave the zero emissions corridor they switch to conventional technologies [7]. The AQHRA does not describe the assumptions about which trucks are zero-emission capable, although in its analysis of ZEE design options, the AQHRA Addendum states that it assumes that the ZEE design option only affects the share of trucks along that corridor that are zero emission vehicles, but not the number of vehicles using truck only lanes [27, pp. 3-4]. In the AQHRA Addendum, the estimate of the share of zero emission vehicles is based on the number of port and non-port trucks predicted to travel the corridor in the travel demand model. All port trucks are assumed to be capable of producing zero emissions because “a future element of the Ports’ Clean Trucks Program will restrict port access to only zero emission trucks” [27, p. 4]. However, details of this Port requirement are not provided and it is unclear that there will be a specific requirement in place in 2035.<sup>36</sup> Furthermore, 20 percent of non-port trucks are assumed to be zero emissions capable based on an analysis of “their trip origins/destinations and associated distribution among the I-5, SR-60, and I-10 interchanges with I-710”. It is unclear why the trip origin and destination analysis led to an estimate of twenty percent zero emissions capable non-port trucks. Additionally, the total number of zero emissions trucks using the corridor was constrained to the capacity of the freight corridor, consistent with the AQHRA assumption (above) that trucks use zero emission technologies if and only if they operate on the zero-emission restricted freight corridor.

Thus, it seems as though the DEIR analysis assumes that trucks use the freight corridor if using the freight corridor provides shorter travel times for their trip; and then following that, any trucks that would use the freight corridor are assumed to be zero emissions vehicles. In other words, it seems that zero emissions trucks are assumed to be so prevalent in 2035 that the trucks that would use an unrestricted freight corridor would be just as likely to use it if there was a restriction to zero emission automated control trucks. While the presence of a zero-emission freight corridor may provide some incentive for obtaining a zero-emissions truck, it has not been shown that this incentive, alone or in combination with other factors, will be sufficient to assure the modeled use of the zero emission freight corridor in 2035. Although it is conceivable that increasingly stringent regulations will force the majority of the trucks to zero emissions technology by 2035, this has also not been demonstrated in the DEIR.

*How does the use of these technologies affect traffic and air quality?*

Using the assumption of widespread zero-emission automated control trucks in 2035, Tables 6-3 through 6-5 of the Traffic Operations Analysis Report indicate that the expected average daily traffic (ADT) on the freight corridor is higher for Alternative 6B than for 6A [15, p. 6-12,14] (see

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<sup>36</sup> The Port of Los Angeles description of the Ports’ Clean Trucks Program does not indicate that zero emissions trucks will be a requirement ([www.portoflosangeles.org/ctp/idx\\_ctp.asp](http://www.portoflosangeles.org/ctp/idx_ctp.asp)), and a 2011 press release indicates only that “The Port is continuing in its technology advancement efforts by pursuing and investing in zero emission technologies....with a commitment to continue evaluating and potentially funding other zero emission technologies.”

Figure 8 above). This seems to be due to the higher capacity expected with Alternative 6B, which is a result of the automated control technology. Of the three freight corridor alternatives, the expected ADT is lowest for Alternative 6C due to the toll implementation.

However, if zero-emissions vehicles with automated control technology are not in widespread use in 2035, the rate at which drivers use the freight corridor in Alternatives 6B and 6C would be reduced, thereby eroding air quality gains over the other build alternatives. Overestimated availability of zero emission automated trucks would mean that the use of the freight corridor is overestimated, and use of the mainline and arterials is likely underestimated. Air pollution impacts and traffic on the mainline would then also likely be underestimated, while safety improvements would likely be overestimated. In an extreme situation, if the freight corridor is severely underused, the outcomes will be similar to Alternative 5A (although the costs will be much greater). A severely underused freight corridor might also result in political pressure to allow conventional vehicles to use the corridor, which if allowed would result in the impacts outlined in Alternative 6A (if no toll is implemented). As discussed in the air quality section of this memo, Alternatives 5A and 6A both have worse air quality impacts than Alternatives 6B and 6C.

Thus, to achieve outcomes associated with a zero-emission freight corridor, it would be prudent to thoroughly explore the expected use of zero-emission automated control trucks along the I-710 corridor in 2035, and if they will not be in widespread use by 2035. A stated commitment to specific programs or policy measures will also be needed to insure their widespread use.

## **TRANSIT CONSIDERATIONS FOR ALTERNATIVE 7**

### *OVERVIEW OF PREVIOUS ALTERNATIVES ANALYSIS FOR THE I-710 PROJECT*

Twelve different I-710 project alternatives were first described in detail in the February, 2002 Major Corridor Study. The performance of each alternative was assessed by making unspecified adjustments to the SCAG travel demand model's traffic volume projections for 2025 baseline conditions. Conceptually, each alternative is expected to have a different effect on travel patterns. For example, transit might be expected to influence travel patterns differently from increased roadway capacity. The magnitude of the travel pattern changes will be intricately linked to the major features of the alternative. The SCAG travel model was not used to individually evaluate each alternative; rather, "sketch planning tools," which were not described, were used to adjust future year travel based on the properties of the alternative [16, p. 4-19]. These adjustments, and the adjustment process, are not clearly spelled out. The methods used to modify the 2025 model volumes should be made transparent.

After volumes were adjusted, each alternative was evaluated across the categories of mobility, safety, environment, cost, and constructability. Based on the results of this evaluation, the I-710 technical advisory committee recommended a reduced set of five alternatives: three build alternatives, a no-build alternative, and a transportation systems management/travel demand management (TSM/TDM) alternative [16, Section 5].

Community response to the reduced set of alternatives was strongly negative [16, pp. 5-68 – 5-69]. Specific issues were raised regarding right-of-way acquisition, potential environmental, health, and environmental justice impacts, and shortcomings with the public engagement effort. Subsequently, the Metro board and the I-710 Oversight Policy Committee called for an updated public engagement process; the outcome was an alternative referred to as the “Hybrid Design Concept” that sought to meet the project objectives of increasing capacity while reducing or eliminating right-of-way impacts [16, p. 6-4]. The extent to which the hybrid design addressed the other community concerns is unclear; only its right of way impacts and financial costs were studied [16, p. 6-15 – 6-29]. The hybrid design concept consisted of 10 mixed flow lanes, interchange improvements, and four separated heavy truck lanes. In January, 2005, the Metro Board adopted the I-710 Locally Preferred Strategy (LPS) based on the hybrid design concept and additionally including the TSM/TDM improvements, improvements to arterials within the I-710 corridor and the construction of truck inspection facilities [16, p. 9-1].

The LPS was then one (Alternative 6) of a set of six different strategies evaluated as part of the Alternatives Screening Analysis (Table 9). The no build and TSM/TDM alternatives were also carried forward from the Major Corridor Study. The set of six alternatives were screened to reduce the number requiring full analysis. This process is described in the Alternatives Screening Analysis report, released in May, 2009.<sup>37</sup> A companion document, the Baseline Alternatives Analysis Report, defined each studied alternative in detail. Based on the findings of the Alternatives Screening Analysis report, Alternatives 2 through 4 were eliminated from further consideration [3, p. 2-72]. Alternative 1, 5A, and three variations on Alternative 6 labeled A through C were carried forward for analysis and presented within the DEIR. Although Alternative 2 was not carried forward, its components were included as part of Alternative 5A and 6A/B/C [3, p. 2-74]. Finally, although Alternative 2 was screened out during the Alternatives Screening Analysis, the justification for its elimination is further discussed in the DEIR.

**Table 9: Alternatives assessed in the Alternatives Screening Analysis.**

<b>Alternative</b>	<b>Description</b>
<b>1</b>	No build
<b>2</b>	TSM/TDM/Transit/ITS
<b>3</b>	Goods movement enhancement by rail or alternative technology
<b>4</b>	Arterial highway and I-710 congestion relief improvements
<b>5A</b>	Ten General Purpose Lanes
<b>5B</b>	Eight general purpose lanes + 2 high occupancy vehicle lanes
<b>6</b>	Alternative 5 plus four separated freight lanes

<sup>37</sup> The screening analysis is described in three documents. See refs. [17, 28, 29]

### *SUMMARY OF PROPOSED TRANSIT SERVICE IMPROVEMENTS IN ALTERNATIVE 2*

The specific attributes of Alternative 2 are never clearly elucidated, despite being included in two different reports, each of which purports to define its components. Although the reports present conflicting information, Alternative 2 appears to be largely focused on increasing existing transit service frequency within the study area, while generally not adding new transit capacity. Table 10 summarizes the transit alternatives analyzed during the environmental review process and is used to guide the following discussion.

The first document, the Multimodal Review, dated March 4, 2009, offers what appears to be the first detailed description of Alternative 2's transit improvements. In defining Alternative 2, the report states that it will include both a "25% transit service level increase within the study area" and that planned operational improvements for bus "include a 20% increase in service levels" [5, pp. 27, 37].

The Multimodal Review also illustrates a number of ways that service could be increased in addition to the 20-25% improvements proposed as part of Alternative 2 [5, pp. 38-39]. For example, Table 3.2 in the Multimodal Review lists unfunded bus transit improvements that, if implemented, would result in a 27% ridership increase by that mode. The report states that "these proposed improvements are not included in the No Build and TSM/TDM Alternatives" (i.e., in Alternative 2) [5, p. 38]. It also describes achieving the same ridership increase by reducing peak period headways to result in an average bus service frequency increase of 68%. The text states that the headway increases are included "for illustrative purposes" [5, p. 38]. Therefore, it appears that these more substantial bus service level increases were never actually included as part of Alternative 2.

This would be acceptable given the report's purpose, which was to evaluate the potential reduction in auto trips from transit improvements, if the methods used to demonstrate this were rigorous. In the next section, we show that the methods used are not sufficiently justified.

The second report, the Baseline Alternatives Analysis report, dated May 6, 2009, summarized all six alternatives analyzed in the Alternatives Screening Analysis [29]. As stated in the Baseline Alternatives Analysis report, Alternative 2 included all of the transit improvements summarized in Table 11. These improvements include a 68% increase in local bus service that appeared to have been used in the Multimodal Review merely as an illustration of other projects that might increase transit demand. Confusingly, the Baseline Alternatives Analysis Report also refers to the Multimodal Review for a "detailed description of Alternative 2" [29, p. 17] It is quite possible that the conflicting exposition of Alternative 2 contained in the Multimodal Review (discussing both 20-25% and 70% increases) was so confusing that later authors misinterpreted projects and operational improvements that had been included merely as illustrations to actually be a part of that Alternative.

**Table 10: History and fate of transit alternatives in the I-710 corridor study.**

Document	Name and description of transit elements	Outcome
<p><b>Major Corridor Study, February, 2002</b></p>	<p>In the initial set of alternatives, the transit alternative is labeled “Alternative 2 - TSM/TDM Alternative.”</p> <p>In the final set of alternatives, the transit alternative is labeled “Alternative B – TSM/TDM Alternative.” This alternative includes “transportation improvements such as added bus service for local communities” and additional feeder shuttles for light rail.<sup>a</sup></p>	<p>All components of Alternative B are included in the locally preferred strategy.</p> <p>Alternative B was also carried forward as a standalone alternative, consistent with regional and federal planning regulations.</p>
<p><b>Multimodal Review, December, 2008</b></p>	<p>In this report, the transit alternative is labeled “Alternative 2: TSM/TDM and Transit.” This alternative includes a 20% (or 25%) increase in study area transit service (not distinguished by mode), additional light rail shuttles, and additional high speed bus service between Los Angeles and Orange Counties.<sup>b</sup></p> <p>The Multimodal Review also contains an illustrative rudimentary analysis of the potential for additional service improvements to induce a 27% ridership increase but does not include those improvements as part of Alternative 2.</p>	<p>Informational only.</p>
<p><b>Alternatives Screening Analysis/Baseline Alternatives Analysis Report, May, 2009</b></p>	<p>In this report, “Alternative 2” appears to have been expanded and now includes “TSM/TDM/Transit/ITS.”</p> <p>The Baseline Alternatives Analysis Report references the Multimodal Review to define the components of Alternative 2.</p> <p>However, the Baseline Alternatives Analysis report also now appears to include – <b>as part of Alternative 2</b> - all of the headway increases that were explored in the Multimodal Review to illustrate how bus ridership could be further increased by 27% as well as all projects listed in Table 11.</p> <p>This would lead to a claim in subsequent references and modeling that a nearly 70% service increase had been modeled, yet it may be that only 20% (or 25%) had been modeled in the ASA/BAA.</p>	<p>Alternative 2 is included as a component of all build alternatives but is not carried forward as a standalone alternative. In other words, all of the features of Alternative 2 have now been included in all build alternatives going forward.</p> <p>This outcome would suggest that the build alternatives that were evaluated in subsequent reports included at most a modeled 20-25% service increase.</p>

**Table 10, continued.**

<b>DEIR/DEIS, June, 2012</b>	In this report, the elements of “Alternative 2: TSM/TDM/Transit/ITS,” are defined by reference to the Alternatives Screening Analysis report.	Alternative 2 is described but not evaluated. The Alternatives Screening Analysis report is referenced as justification for eliminating Alternative 2 from consideration. The elements of Alternative 2 are included as part of all of the build alternatives but may include either 20-25% or 70% transit service increases.
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<sup>a</sup>[16, pp. S-16 – S-17, 45]

<sup>b</sup>[5, p.27]

**Table 11: Proposed transit projects described as part of Alternative 2 in the Baseline Alternatives Analysis Report but likely absent from those modeled in the Multimodal Review.** Quoted verbatim from ref. [29, p. 18].

<b>Project</b>	<b>Description</b>
<b>Blue line light rail transit</b>	Approximately a 16% increase in peak period service (service frequency): reduce peak headways from 6 minutes to 5 minutes and off-peak headways from 15 minutes to 10 minutes
<b>Green line light rail transit</b>	Approximately a 16% increase in peak period service (service frequency)
<b>Metrolink</b>	Increase services, upgrade the Commerce Station to 100 percent of 91 Line Service (current service ~75 percent), new connection between the Green Line Norwalk station and the Metrolink Norwalk Station, expansion of existing Metrolink service (Riverside Line and Orange County/91 Lines)
<b>Express bus service</b>	Expansion of existing high speed bus service on freeways (e.g., I-605)
	Increase in corridor Metro Rapid service frequency by about 33 percent, reduce headways by 50 percent (from 10 minutes to 5 minutes) on all Metro Rapid routes in the study area
<b>Local bus service</b>	Increase corridor local bus service (service frequency) by about 68 percent: for bus routes in the study area (both Metro and Long Beach Transit) reduce headways greater than 20 minutes by 50 percent and headways less than 20 minutes to 10 minutes
	Expansion of existing community bus service (e.g. local circulators Montebello Transit, Compton Renaissance Transit System, East Los Angeles Shuttle)

There are a number of points that arise from our review:

- Alternative 2, as defined in the Multimodal Review, provides for a 20-25% service increase. Alternative 2, as defined in the Alternatives Screening Analysis report, appears to be defined as having a 68% service increase. Where was this increase actually modeled?
- If Alternative 2 as defined in the Alternatives Screening Analysis report was incorrectly specified and then used in subsequent analyses, the result would tend to decrease the apparent performance of the transit alternative in the screening analysis relative to all of the other alternatives.
- In turn, this would seem to cast doubt on conclusions regarding Alternative 2 stated in the DEIR such as “At best, Alternative 2 would provide a 6 to 7 percent improvement in traffic congestion levels on I-710, in terms of improved v/c ratios, and an approximately 5 percent improvement in NO<sub>x</sub> emissions” [3, p. 2-74]. We would have expected that if transit service equivalent to the illustrative examples included in the Multimodal Review had actually been included in the modeling Alternative 2, it would have performed better than it did in the Alternatives Screening Analysis. Instead, it appears that 20% (or 25%) improvements in service may have been modeled, but increases of 68% were stated.

The text and the analysis should be consistent, and transparent. If a 20-25% transit service alternative was actually modeled, then the text should be edited to reflect this. If a 68% transit service increase was actually modeled, subsequent analyses should not refer to the Multimodal Review for a description of Alternative 2. The DEIR currently implies that greater transit service has been modeled than may have been modeled. This would also increase the gap between the performance of Alternative 2 (which may assume 20-25% service improvements) and its potential costs (which may assume 70% service changes).

#### *SHORTCOMINGS WITH TRANSIT ANALYSIS APPROACHES*

The way in which alternatives were evaluated throughout the environmental review process over several documents may have not adequately reflected the transit market and the potential mode shifts that would occur with increased transit service. Of particular importance from a transit modeling perspective is the consideration of land use in the modeling tool. Changing land use policies rather than increasing transportation supply can also be an effective strategy for increasing transit ridership. Increasing retail and work destinations in the study corridor, increasing housing density in the walk-shed served by high quality transit routes within the study corridor, and ensuring that a mix of housing types are available can all contribute to reduced automobile ownership and increased transit ridership within the project-shed. Table 12 summarizes our understanding of the modeling approaches used for the major assessment documents and their likely treatment of land use change.

**Table 12: Methods used to assess alternatives in the I-710 corridor study and likely treatment of land use.**

<b>Document</b>	<b>Description</b>
<b>Major Corridor Study, February, 2002</b>	Initial 12 alternatives assessed by adjusting traffic volumes predicted for a single 2025 baseline scenario developed using the SCAG regional model. Final 5 alternatives assessed using individual model runs for each. Land use assumptions are not discussed, but in principle transit-supportive land uses could have been included to model Alternative B.
<b>Multimodal Review, December, 2008</b>	Ridership estimates are calculated using a single elasticity of transit ridership in response to transit service improvements. Land use changes to support transit were not considered.
<b>Alternatives Screening Analysis/Baseline Alternatives Analysis Report, May, 2009</b>	A screenline traffic forecasting tool was developed based on volumes predicted for the no build alternative and Alternative 6. At most two land use scenarios were used, neither of which was likely to support transit.
<b>DEIR/DEIS, June, 2012</b>	Analysis of Alternative 2 based on the Alternatives Screening Analysis.

As demonstrated in Table 12, modeling of land uses capable of supporting transit were only possible in the Major Corridor Study. All alternatives analyses conducted after 2002 used sketch planning tools that did not consider land uses that would support transit ridership. The Major Corridor Study states that “travel demand forecasts were developed for all five alternatives to show how traffic would change in response to the proposed alternatives”[16, p. 5-28]. Land use inputs for the travel demand model are not discussed.

The ridership estimates developed for illustrative transit service increases presented in the Multimodal Review were based on generic elasticities developed using mostly North American data in an incomplete TRB document authored over a decade ago.<sup>38</sup> This method is not likely to reflect current conditions in the I-710 Corridor Study Area. The authors of the TRB report point out that the average elasticity is most applicable when headways are reduced from initially very long times (30 minutes to one hour) and where the users are middle- to upper-income. In cases where transit service is already very frequent and lower-income residents are the primary users (as in the I-710 corridor), the elasticity is less applicable, and fare changes are more likely to elicit changes in ridership.

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<sup>38</sup> Elasticities relate a change in the quantity of a good provided to the amount of that good consumed. The Multimodal Review uses an elasticity of transit ridership with respect to service of +0.5 and were generated from ref. [30]. This means that for every 1% increase in transit service frequency, ridership is expected to increase by 0.5%. The TRB report used for these estimates is labeled as “Interim” and lists many sections as “In preparation.”

The Alternatives Screening Methodology report describes a “screenline traffic forecasting tool” that was developed to calculate traffic volumes at various points along the study corridor. The estimated volumes were then used to calculate performance indicators for each alternative. According to the Alternatives Screening Methodology report,

The screenline traffic forecasting tool develops traffic volumes for three time periods (AM Peak, Midday, and PM Peak) by “pivoting” off the facility traffic volumes produced by running the SCAG 2008 RTP model for two alternatives: future No Build and Alternative 6 (Hybrid LPS). [28, p. 15]

Without additional information about what exactly “pivoting off” entails,<sup>39</sup> it is impossible to gauge the robustness of this approach. Nonetheless, it seems very unlikely that the traffic volumes resulting from an alternative largely oriented toward increasing transit capacity (Alternative 2) would be well-represented by pivoting off of traffic volumes based on the no build alternative and Alternative 6. Since only two scenarios were modeled using the pivoting technique, at most two land use scenarios were considered and neither was likely to contain land uses supporting high transit mode share.

This discussion implies that Alternative 2 may have been prematurely screened out without robust consideration using realistic future volume estimates. The treatment of land use, especially as related to the modeling and assessment of Alternative 2 must be transparently stated and its effects on performance results acknowledged.

#### *CHARACTERIZATION OF TRANSIT IN THE STUDY AREA*

We acquired data from Metro on transit ridership by stop and by line for an average weekday in July, 2012 and total ridership for that month. Geographic data on Metro’s transit routes were available from Metro’s developer website.<sup>40</sup> Traffic analysis zone (TAZ) definitions were taken from SCAG.<sup>41</sup> Data from Long Beach Transit were requested but not received in time for inclusion. The I-710 corridor study area as described in the DEIR/DEIS (p. 1) was sketched into a geographic information system and overlaid with TAZ and transit data. Existing transit service in the area is characterized in the following tables: Metro local (Table 13), Metro rapid (Table 14), and Metro light rail (Table 15). Headways listed in those tables are approximate, and derived from posted schedules on Metro’s website. They generally report the smallest headway during the period from 6 am – 9 am.

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<sup>39</sup> Pivoting using elasticities from mode choice models is possible. However, it is unknown what the technique involved in this analysis.

<sup>40</sup> <http://developer.metro.net/introduction/gis-data/download-gis-data/>

<sup>41</sup> <http://www.scag.ca.gov/mappingGIS.htm>

**Table 13: Characteristics of Metro local bus routes within the I-710 study area.**

<b>Route</b>	<b>Peak headway (min)</b>	<b>Total daily ridership (July, 2012)</b>
18	< 10	23,654
51	< 10	27,509
53	< 10	13,408
55	< 10	8,501
60	< 10	20,093
62	15	5,056
66	< 10	18,394
84	15	8,559
102	60	2,274
105	10	12,496
108	11	16,513
110	25	9,050
111	< 10	18,202
115	< 10	16,105
117	20	9,087
120	40	4,090
125	20	5,382
127	60	794
128	45	1,308
130	25	3,797
202	60	249
205	30	4,426
232	10	7,448
246	30	2,637
251	15	9,011
252	15	2,181
254	60	771
256	60	1,752
258	45	1,847
260	< 10	12,320
265	45	1,683
266	40	5,394
<b>All Metro local</b>		6,186 (median) 8,186 (mean)

**Table 14: Characteristics of Metro Rapid routes within the I-710 study area.**

<b>Route</b>	<b>Peak headway (min)</b>	<b>Total daily ridership (July, 2012)</b>
<b>460</b>	20	4,862
<b>705</b>	< 10	7,347
<b>720</b>	< 10	42,240
<b>751</b>	15	4,923
<b>760</b>	< 10	5,816
<b>762</b>	20	4,222
<b>All metro rapid</b>		6,804 (median) 9,474 (mean)

**Table 15: Characteristics of light rail within the I-710 study area.**

<b>Line</b>	<b>Peak headway (min)</b>	<b>Total daily ridership (August, 2012)</b>
<b>Blue</b>	< 10	89,155 <sup>a</sup>
<b>Green</b>	< 10	47,214 <sup>a</sup>
<b>All light rail</b>		47,214 (median) 60,687 (mean)

<sup>a</sup>Light rail ridership figures from Metro’s website: <http://www.metro.net/news/ridership-statistics/>

As evidenced by the tables, the market for transit in the corridor is strong. Mean daily ridership on all Metro local routes in the study area of 8,562 exceeds the mean ridership on all Metro local routes. There are also Metro local routes with very high ridership including the 18, 51, 60, 66, 108, 111, and 115 with over 15,000 boardings daily. The three Metro local routes with the highest ridership in the study area exceed ridership on Metro’s newest light rail expansion, the Expo line. As of August, 2012 that line had 19,776 average weekday boardings.<sup>42</sup>

The mean daily ridership in all Metro rapid routes in the study area of 11,568 exceeds the mean ridership on all Metro rapid routes, mostly due to very high ridership on the 720. Additionally, the Blue line is the most patronized light rail line operated by Metro. It is clear that demand for transit varies throughout the study area. Two approaches are possible to model increase transit services, one of which takes advantage of this variation and the other does not. They are:

1. An area-wide service increase; for example, a 20% increase in the frequency of all local bus service within the study area, and
2. Targeted frequency increases to those lines and routes most likely to increase ridership.

<sup>42</sup> <http://www.metro.net/news/ridership-statistics/>

The approach taken to designing Alternative 2 throughout each of its iterations (Table 10) typically employed the first approach, including an area-wide service increase. The second approach, however, would be more likely to cost-effectively increase transit mode share in a transit-focused alternative than increasing service on all study area routes. This is because the second approach would take advantage of the study area variation in transit demand to only those lines expected to generate increases in ridership at the lowest cost.

*COST ESTIMATES FOR ALTERNATIVE 7*

The Alternative Screening Analysis provides total capital cost estimates as the cost of each alternative above those associated with the no build alternative [17, Appendix B]. These are summarized in Table 16. In addition to capital costs, transit services generate revenue from fares and require operating subsidies from local, state, or federal sources. Both highway and transit facilities must be maintained. To supplement the capital cost information already available, this section develops approximate operating and maintenance cost estimates for the transit and highway alternatives proposed in the Alternatives Screening Analysis. The estimates presented in this section are rough and would need to be refined based on detailed data if they were to form a basis for decision-making. At present they are only illustrative in nature and should be considered order of magnitude-type estimates.

**Table 16: Capital cost estimates for the alternative scenarios studied in the Alternatives Screening Analysis.** Note that the definition of the alternatives is generally cumulative. Alternative 2 contains all elements of the no-build alternative. Alternative 4 contains all elements of Alternative 2 and no-build. Alternative 5 A and B contain all elements of Alternative 2, 4, and no-build. Alternative 6 contains all elements of Alternatives 1, 2, 4, and 5A. See discussion in ref. [17, pp. 5-6].

<b>Alternative</b>	<b>Description</b>	<b>Total capital cost (Million \$)</b>
<b>2</b>	TSM/TDM/Transit/ITS	200
<b>3</b>	Goods movement enhancement by rail or alternative technology	4,100 – 11,500
<b>4</b>	Arterial highway and I-710 congestion relief improvements	700
<b>5A</b>	Ten general purpose lanes	3,600
<b>5B</b>	Eight general purpose lanes plus two HOV lanes	3,600
<b>6</b>	Alternative 5 plus addition of four separated freight lanes	6,900

Transit operating and maintenance costs were approximated using data from the National Transit Database on vehicle revenue-hours, fare revenue, and total operating expenditures at Metro and Long Beach Transit.<sup>43</sup> Ridership data for all Metro bus routes were provided by that agency. No data were available for Long Beach Transit ridership. Figure 9 shows trends in operating subsidies

<sup>43</sup> Operating expenditures include vehicle operations, vehicle maintenance, non-vehicle maintenance, and general administration. Using Time Series 2.2 available here: <http://www.ntdprogram.gov/ntdprogram/pubs/HistoricalData/TS2.2TimeSeriesSysWideOpexpSvc.xls>

(calculated as operating expenditures minus fares) per vehicle revenue-hours in constant 2010 dollars. The average value over the plotted period for both transit agencies is \$86.10/vehicle revenue-hour. Since increasing transit service frequency will increase the number of transit vehicles on the road in the hopes of increasing ridership, vehicle revenue-hours are an appropriate unit for estimating the cost of transit service frequency increases.

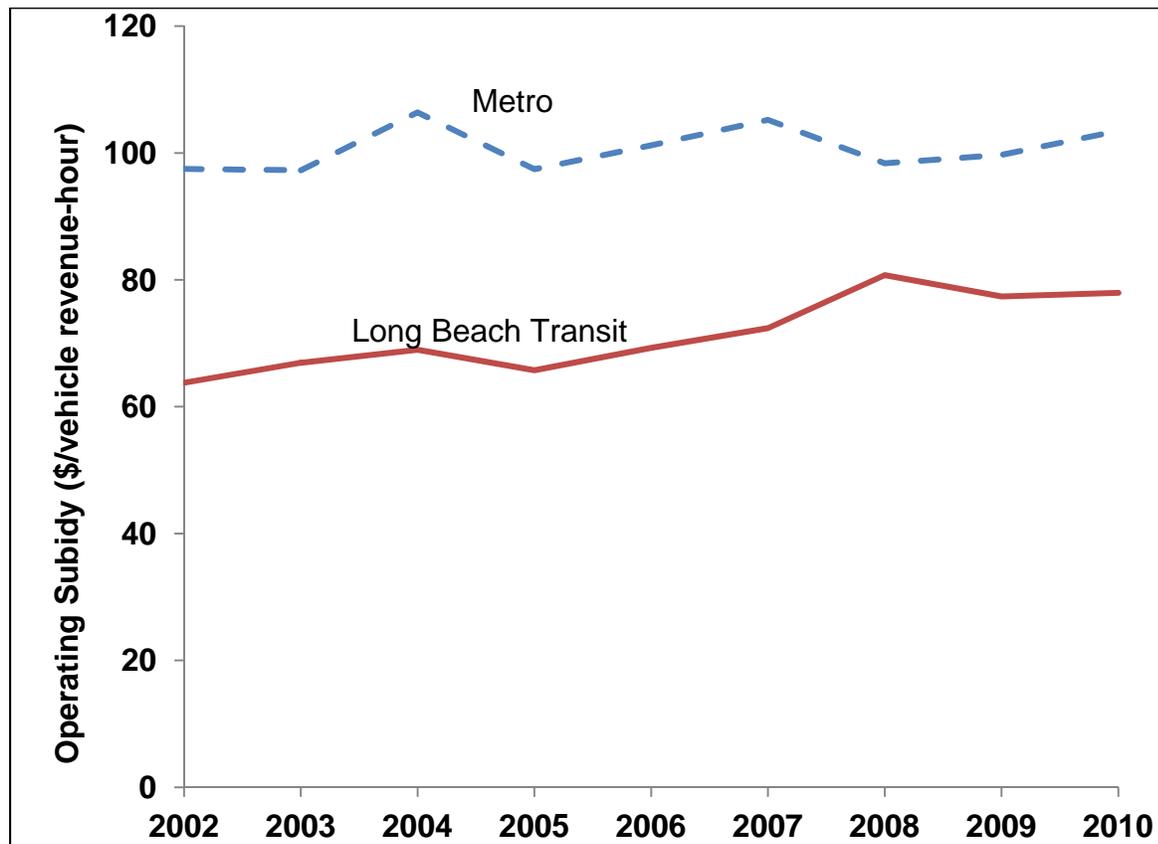


Figure 9: Operating subsidy (2010 \$) per vehicle revenue-hour for Metro and Long Beach transit, all modes, all routes, 2002-2010.

As described above, the Multimodal Review states that the transit service frequency improvements included as part of Alternative 2 result in either a 20% or 25% increase in transit service.<sup>44</sup> Assuming this figure applies only to bus operations,<sup>45</sup> cost estimates can be conservatively generated by assuming two hours travel time on all local bus routes in the study area. This is twice the travel time of the Blue Line from Downtown Los Angeles to Long Beach in the peak period and the approximate time taken by Metro local route 60 to traverse the study area from north to south during the AM peak. Using two hours should provide a conservative estimate of the time spent by the average route within the study area since not all routes traverse the entire north-south distance.

<sup>44</sup> The Multimodal Review contains both values [5, p. 27, 37].

<sup>45</sup> Because the modes to which service increases were not specified in the Multimodal Review.

We will assume 1.5 hours travel time for all Metro rapid routes since these buses have higher average speeds due to signal prioritization and fewer stops than Metro local routes. There are 30 local bus routes operated by Metro (Table 13), 16 operated by Long Beach transit, and 6 Metro Rapid routes that serve the study area (Table 14).

Assuming 20 minute headways, we can estimate the number of vehicles required to serve all local routes in the study area as  $120 \text{ minutes}/20 \text{ minutes/vehicle} * 2 \text{ directions} * 46 \text{ routes} = 552 \text{ vehicles}$ . Reducing headways by 25% to 15 minutes requires  $120 \text{ minutes}/15 \text{ minutes/vehicle} * 2 \text{ directions} * 46 \text{ routes} = 736 \text{ vehicles}$ . We assume that these 184 additional vehicles are in service 8 hours per day, 260 days per year. This service increase therefore results in an additional  $184 \text{ vehicles} * 8 \text{ hours/day} * 260 \text{ days/year} = 383,000 \text{ vehicle revenue-hours}$ .

The number of vehicles required to serve all Metro rapid routes in the study area with 10 minute headways is  $90 \text{ minutes}/10 \text{ minutes/vehicle} * 2 \text{ directions} * 6 \text{ routes} = 108 \text{ vehicles}$ . Reducing these headways by 25% to 7.5 minutes requires  $90 \text{ minutes}/7.5 \text{ minutes/vehicle} * 2 * 6 \text{ routes} = 144 \text{ vehicles}$ . Assume that these 36 additional vehicles are in service 8 hours per day, 260 days per year. The service increase therefore results in an additional  $36 \text{ vehicles} * 8 \text{ hours/day} * 260 \text{ days/year} = 74,800 \text{ vehicle revenue-hours}$ .

Four smaller transit operators also provide service in the study area. These are Montebello Transit (8 routes), Compton Renaissance Transit System (5 routes), the East Los Angeles Shuttle operated by the Los Angeles County Department of Public Works (3 routes), and the City of Commerce (5 routes).<sup>46</sup> In general, these routes are shorter in length than the Metro routes in the area, have longer headways, and operate during fewer service hours. As a first order approximation based on a review of their posted schedule information, we assume all of these routes spend 45 minutes on a one way trip through the study area, have peak period headways of 30 minutes, and similar cost figures as Metro and Long Beach Transit.

The number of vehicles required to serve all four smaller operators with 30 minute headways is  $45 \text{ minutes}/30 \text{ minutes/vehicle} * 2 \text{ directions} * 20 \text{ routes} = 60 \text{ vehicles}$ . Reducing these headways by 25% to 23 minutes requires  $45 \text{ minutes}/23 \text{ minutes/vehicle} * 2 \text{ directions} * 20 \text{ routes} = 78 \text{ vehicles}$ . Assume that these additional 18 vehicles are in service 6 hours per day, 260 days per year. Total additional vehicle revenue-hours resulting from this service increase are  $18 \text{ vehicles} * 6 \text{ hours/day} * 260 \text{ days/year} = 28,000$ .

The total operating and maintenance costs for the Alternative 2 service increases is therefore  $383,000 + 74,800 + 28,000 = 485,000 \text{ vehicle revenue-hours}$  at a cost of  $485,000 * 86.10 = \$41.8 \text{ million per year}$ . Note that Metro's total vehicle revenue-hours and total operating expenditures in

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<sup>46</sup> Information on service is available from each provider's website: <http://ca-commerce.civicplus.com/DocumentCenter/Home/View/548>, [http://www.transitunlimited.org/Compton\\_Renaissance\\_Transit](http://www.transitunlimited.org/Compton_Renaissance_Transit), <http://www.cityofmontebello.com/civica/filebank/blobload.asp?BlobID=2545>, <http://ladpw.org/pdd/elasw/en/>.

2010 were 8.5 million and \$1.2 billion, respectively. Assuming a discount rate of 4%, the present value of these service improvements in perpetuity is \$1.05 billion, bringing the estimate for Alternative 2 to \$1.25 billion. Since the build alternatives all contain the transit improvements by reference, their costs should also include this increment of operating costs.

Figures on the extent of California's interstate system and the associated maintenance costs were gleaned from the Federal Highway Administration's highway statistics publication.<sup>47</sup> In 2008, California contained 5,869 lane-miles of Interstate freeway and expended \$101,703,000 on maintenance of that system. These figures result in an average cost per lane-mile for maintenance of Interstate freeways of \$17,000. The I-710 project extends 18 miles and Alternative 6 would add four general purpose lanes to the existing six and four truck only lanes. Conservatively assuming similar maintenance costs for the truck only lanes, the average annual maintenance costs for the I-710 expansion in addition to the no-build scenario would be \$2.4 million. Assuming that this cost is incurred each year and using a discount rate of 4%<sup>48</sup> the present value of maintenance for the project in perpetuity would be \$60 million. Highway maintenance costs are smaller than the present value cost of the highway alternatives.

The results of a more comprehensive cost analysis than that undertaken for earlier alternatives analyses indicate that even considering transit operations and maintenance, the standalone transit alternative is less expensive than all highway build alternatives. Adding the four separated freight lanes as requested in the design of Alternative 7 would potentially increase the project cost by \$4.6 billion (\$6.9 billion<sup>49</sup> – \$3.6 billion<sup>50</sup> + \$1.25 billion<sup>51</sup> + \$0.06 billion<sup>52</sup>). All of the DEIR build alternatives should also include an additional \$1.25 billion + \$0.06 billion in operating and maintenance costs because only capital costs were estimated in the Alternatives Screening Analysis. Although Alternative 7 outperforms Alternative 6 on cost, its effects on other project performance measures will be unknown until it is modeled with land use assumptions consistent with increased transit investment. Also to reiterate, these cost estimates should only be considered accurate to their order of magnitude. More detailed analyses should be conducted to present total capital and operating costs in the DEIR and when evaluating project alternatives.

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<sup>47</sup> FHWA's 2008 Highway Statistics publication is available online at <http://www.fhwa.dot.gov/policyinformation/statistics/2008/>. This was the most recent year for which detailed maintenance expenditures were available. Table SF-12 contains data on state outlays for maintenance. Table HM-60 contains data on the extent of the system.

<sup>48</sup> Consistent with Caltrans practice. See ref. [31, p. 19].

<sup>49</sup> Alternative 6 capital cost, which adds freight-only lanes to Alternative 5 (see Table 16).

<sup>50</sup> Alternative 5 capital cost, which includes all components of Alternative 6 except freight-only lanes (see Table 16).

<sup>51</sup> Transit operations and maintenance costs.

<sup>52</sup> Highway maintenance costs.

## REFERENCES

1. The Tioga Group Inc. and IHS Global Insight, *San Pedro Bay Container Forecast Update*. 2009, The Port of Long Beach and the Port of Los Angeles.
2. URS and Cambridge Systematics, *Final Technical Memorandum - I-710 Railroad Goods Movement Study WBS Task ID: 160.10.50*,. 2009, Los Angeles County Metropolitan Transportation Authority.
3. State of California Department of Transportation and Los Angeles County Metropolitan Transportation Authority, *Draft Environmental Impact Report/Environmental Impact Statement and Section 4(f) Evaluation: Volume 1*. 2012: Los Angeles, CA.
4. URS and Cambridge Systematics, *Final Technical Memorandum - I-710 Corridor Project EIR/EIS Travel Demand Modeling Methodology WBS Task ID: 165.10.08*. 2010, Los Angeles County Metropolitan Transportation Authority.
5. URS, *Technical Memorandum - Multimodal Review WBS Task ID: 165.10.05-010*. 2009, Los Angeles County Metropolitan Transportation Authority.
6. Duranton, G. and M.A. Turner, *The Fundamental Law of Road Congestion: Evidence from US Cities*. American Economic Review, 2011. **101**(6): 2616-52.
7. ENVIRON, *Air Quality and Health Risk Assessments Technical Study for the I-710 Corridor Environmental Impact Report / Environmental Impact Statement*. 2012, Prepared for URS Corporation.
8. US EPA and FHWA, *Transportation Conformity Guidance for Qualitative Hot-Spot Analyses in PM<sub>2.5</sub> and PM<sub>10</sub> Nonattainment and Maintenance Areas, Epa420-B-06-902*, U.S. Environmental Protection Agency & Federal Highway Administration, Editor. 2006.
9. Caltrans. *Particulate Matter Hot Spot Analysis*. 2012; Available from: <http://www.dot.ca.gov/hq/env/air/pages/qualpm.htm>.
10. URS, *Intersection Traffic Impact Analysis Report WBS ID: 160.10.35-040*. 2012, Los Angeles County Metropolitan Transportation Authority.
11. US EPA, *Guideline for Modeling Carbon Monoxide from Roadway Intersections*, Office of Air Quality Planning and Standards, Editor. 1992: Research Triangle Park, NC.
12. Garza, V.J., P. Graney, and D. Sperling, *Transportation Project-Level Carbon Monoxide Protocol Revised December, 1997*, Revisions by Debbie Niemeier, et al., Editors. 1997, Prepared for Environmental Program California Department of Transportation: Institute of Transportation Studies, UC Davis
13. US EPA, *Transportation Conformity Guidance for Quantitative Hot-Spot Analyses in PM<sub>2.5</sub> and PM<sub>10</sub> Nonattainment and Maintenance Areas*. 2010.
14. Natural Resources Agency, *Ceqa Guidelines Amendments, December 30, 2009*, Amended: 15064, 15064.7, 15065, 15086, 15093, 15125, 15126.2, 15126.4, 15130, 15150, 15183 Appendix F, Appendix G, Added: 15064.4, 15183.5, 15364.5. 2009.
15. URS, *I-710 Corridor Project Traffic Operations Analysis Report WBS ID: 160.10.35*. 2012, Los Angeles County Metropolitan Transportation Authority.
16. Metro. *I-710 Major Corridor Study*. 2002; Available from: <http://www.metro.net/projects/i-710-corridor-project/feasibility-assessment/>.
17. URS, *Final Technical Memorandum – Alternatives Screening Analysis WBS ID: 165.05.15*. 2009, Prepared for LA County Metropolitan Transportation Authority: Santa Ana, CA.
18. Booz Allen Hamilton, *Seattle Variable Tolling Study*. 2009, City of Seattle Department of Transportation.

19. Fischer, M.J., D.N. Ahanotu, and J.M. Waliszewski, *Planning Truck-Only Lanes: Emerging Lessons from the Southern California Experience*, Transportation Research Board 2003 Annual Meeting. 2003.
20. State of New Jersey Department of Transportation. *Portway Projects*. 2012 9/11/2012]; Available from: <http://www.state.nj.us/transportation/freight/portway/projects.shtm>.
21. State of California Department of Transportation. *Truck-Only Lanes*. 2008; Available from: <http://www.dot.ca.gov/hq/traffops/trucks/ops-guide/truck-lanes.htm>
22. Sullivan, E., *Continuation Study to Evaluate the Impacts of the Sr 91 Value-Priced Express Lanes - Final Report*. 2000.
23. Transportation Corridor Agencies. *The Toll Roads Fasttrak Trip Calculator*. 2012 9/11/2012]; Available from: <https://www.thetollroads.com/>.
24. Golob, J.M. and T.F. Golob, *Studying Road Pricing Policy with Panel Data Analysis: The San Diego I-15 Hot Lanes*. 2000.
25. CALSTART, *Technologies, Challenges & Opportunities I-710 Zero-Emission Freight Corridor Vehicle Systems*. 2012.
26. California Air Resources Board, *Amendments to the Regulation to Reduce Emissions of Diesel Particulate Matter, Oxides of Nitrogen and Other Criteria Pollutants, from in-Use Heavy-Duty Diesel-Fueled Vehicles*, Section 2025. 2011.
27. URS, *Air Quality and Health Risk Assessments Technical Study for the I-710 Corridor Environmental Impact Report / Environmental Impact Statement: Addendum 1 Air Quality and Health Risk Technical Study for the Zero Emission Extension Design Option*. 2012: Santa Ana, CA.
28. URS, *Technical Memorandum - Alternatives Screening Methodology WBS ID: 165.05.15*. 2008, Los Angeles County Metropolitan Transportation Authority: Santa Ana, CA.
29. URS, *I-710 Corridor Project EIR/EIS Baseline Alternatives Analysis Report WBS ID: 160.06.05*. 2009, Los Angeles County Metropolitan Transportation Authority.
30. Pratt, R.H., Texas Transportation Institute, Cambridge Systematics, Parsons Brinckerhoff Quade & Douglas, SG Associates, and McCollow Management Consulting, *Traveler Response to Transportation System Changes Interim Handbook*. 2000, Transit Cooperative Research Program.
31. Caltrans, *Life-Cycle Cost Analysis Procedures Manual*. 2007, State of California, Department of Transportation, Pavement Standards Team & Division of Design.



# **ATTACHMENT D**



Livable Communities Inc.

To: East Yard Communities for Environmental Justice

From: Charles Gandy, Livable Communities Inc.  
Ryan Johnson

Date: September 27, 2012

Re: Comments on the draft EIR for the I-710 Corridor Project –  
Community Alternative 7.6: Comprehensive Pedestrian and Bicycle Element

East Yard Communities for Environmental Justice (EYCEJ) has retained Livable Communities Inc. to analyze the draft EIR for the I-710 Corridor Project and recommend alternatives that provide pedestrians and bicyclists with safe, efficient, and pleasant travel conditions. A summary of the analysis and recommendations follows.

Livable Communities, Inc.  
38 Orange Avenue, Long Beach, CA 90802  
562 298-7681 Gandy.Charles@gmail.com



## CA 7.6: Comprehensive Pedestrian and Bicycle Element

### Introduction

The I-710 corridor contains several residential communities, along with the commercial establishments, schools, and recreation facilities that these residents need to access on a regular basis. Currently, the built environment in the I-710 corridor makes walking or cycling a very unattractive, and even dangerous, option. However, many residents of these communities *do* walk or cycle daily on the local streets because they cannot afford an automobile, are disabled, and/or are either too young or too old to drive. In addition, the I-710 corridor has physically separated communities on either side of the freeway. In some cases, such as in Long Beach and South Gate, neighborhoods within the same city are detached from each other.

CA7 includes adequate and safe bicycling and pedestrian infrastructure for the residents of the I-710 corridor. These are low-cost improvements that are vital to providing a full range of transportation options to residents, while also increasing our energy independence and mitigating harmful mobile-source emissions. The remainder of this chapter discusses the shift in the corridor's communities towards sustainable transportation, highlights some of the flawed assumptions in the current I-710 Corridor Project draft EIR, then recommends infrastructure and network improvements to better accommodate and encourage travel by bicycle and on foot.

### Shifting Priorities in the I-710 Corridor

Contrary to common perception in the Southern California region, the I-710 corridor is not just an industrial district and conduit for commuter vehicles. The corridor has long contained residential neighborhoods and thriving business districts. In fact, new schools are being built in these communities to accommodate the growing number of youth. Many of these young people do not have access to a personal automobile, so they rely on relatives or others to drive them to their schools. Concerns over increased traffic around schools in the corridor could be mitigated if safe and connected bicycle and pedestrian routes were provided.



*Children going to and from school*



*The newly completed South Region High School #9 in South Gate has an open enrollment policy, so residents of surrounding cities are eligible to attend.*

The Los Angeles County Department of Public Health has also found that rates of obesity and diabetes are particularly high in the I-710 corridor study area, due in part to the sedentary lifestyle engendered by a reliance on automobiles for mobility, and the Department has made significant investments to combat these health epidemics. Fortunately, several communities along the corridor recognize the pressing need to provide residents with options for an active lifestyle. Long Beach, South Gate, and the County of Los Angeles have adopted bicycle master plans; Lynwood and Carson are currently in the process of doing so. In addition, the Los Angeles County Metropolitan Transportation Authority (Metro) has studied existing conditions and potential improvements for pedestrian and bicyclist access to Blue Line rail stations.

Numerous organized bicycle rides and the popular open streets event CicLAvia demonstrate the latent demand for better cycling and walking environments in Los Angeles County. Caltrans should recognize this demand and abide by its own Complete Streets policies by incorporating high-quality pedestrian and bicycle infrastructure into its plans for enhancing the I-710 corridor.

#### Flaws in the current Caltrans/Metro proposal

The current draft EIR assumes that the status quo conditions for walking and bicycling in the corridor study area are sufficient, and the report states that “travel by walking and bicycling will not substantially change as a result of the implementation of the build alternatives.” In fact, the draft EIR claims that walking and bicycling will actually *improve* in the affected communities simply because old sidewalks will be replaced and new pavement will be laid down on arterial bridges over the I-710 and the Los Angeles River. New street and sidewalk surfacing, however, are merely bandages, as far more significant improvements in dedicated infrastructure and network connectivity are needed to make walking and cycling safe and attractive alternatives to driving. In addition, the draft EIR lacks a thorough analysis of existing data on crashes involving pedestrians and cyclists.

Many of the proposed traffic flow improvements in the draft EIR will likely degrade already poor walking and cycling conditions in the I-710 corridor.

- Project includes "mitigations" at 60-70 surface street intersections several miles in either direction from the freeway that would greatly diminish the walking and biking environment throughout the Gateway Cities.
- Project would construct a parallel truckway in close proximity to the L.A. River and bicycle path, all but eliminating the current open space buffer. Particulate matter from tires and brakes will damage the lungs of path users, on one of the only quality active transportation corridors in the project vicinity. The draft EIR fails to address the near-roadway pollution effects of moving the I-710 freeway closer to the bicycle path.<sup>1</sup>
- The Single Point Urban Interchanges (SPUIs) proposed for the corridor project are dangerous for bicyclists as they create super-sized intersections that don't leave enough time in the signal cycle for most bicyclists to clear the intersection.

### Improving the Walking and Cycling Environment along the I-710 Corridor

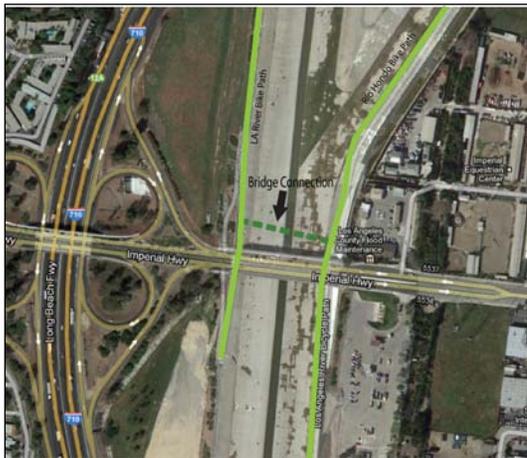
In light of the shifting priorities in the I-710 corridor's communities towards more sustainable transportation options and for healthier, more livable neighborhoods, CA7 calls on Caltrans and Metro to include high quality, safe pedestrian and bicycle infrastructure as part of any improvement project along the corridor. A highly connected pedestrian and bicycle network must be a part of this improvement process, so that all of the communities along the corridor will be better connected – physically, economically, and socially. To achieve these goals, we recommend that Caltrans and Metro make the below improvements.

- First and foremost, all communities in the corridor study area must draft and adopt pedestrian and bicycle master plans that reflect local conditions and priorities, and that facilitate regional connectivity. In particular, the Gateway Cities Council of Governments should move quickly to create a cohesive bicycle and pedestrian master plan for all of its member jurisdictions. Cities can follow the examples of Long Beach and South Gate, among others. By having comprehensive pedestrian and bicycle plans in place, cities in the corridor will clearly articulate their transportation vision, and they can also apply for grant aid to fund infrastructure improvements and educational campaigns.

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<sup>1</sup> Karner A., Eisinger D., Niemeier D. (2010). "Near-Roadway Air Quality: Synthesizing the Findings from Real-World Data." *Environmental Science and Technology* 44(14):5334-5344.

- The Los Angeles River shared-use path should serve as the spine of an enhanced regional pedestrian and bicycle network. Therefore, Caltrans and Metro should extend the path or create a viable on-street connection to Downtown Los Angeles. In addition, the L.A. River path should be better connected to both the Compton Creek and Rio Hondo bicycle paths via pedestrian- and bicycle-only bridges over the river. Finally, visibility screens and sound walls should be added to any portion of the I-710 project – including the proposed elevated truck-only lanes – that infringes upon the current open space buffer between the L.A. River bicycle path and the I-710 freeway.

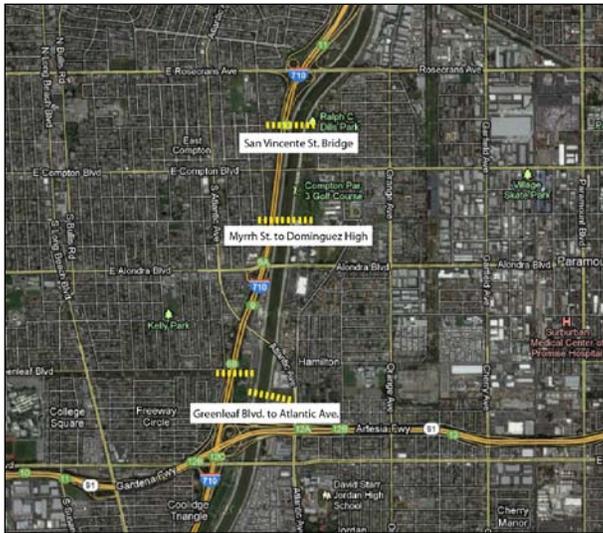


*An improved connection between the LA River and Rio Hondo bicycle paths*

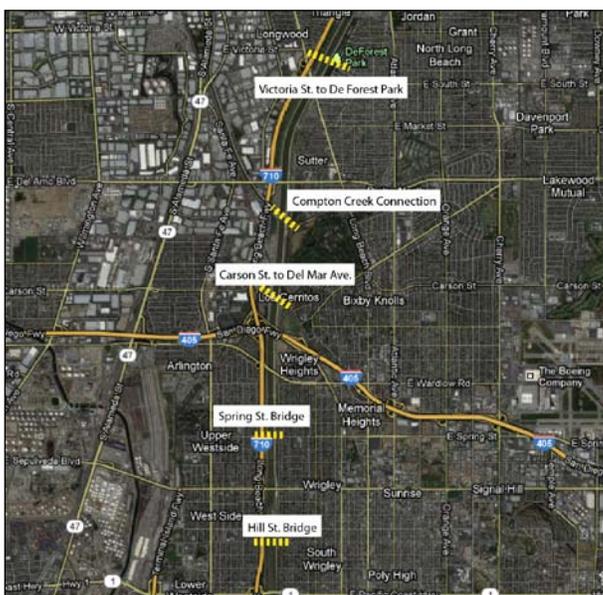


*Proposed connection between the LA River and Compton Creek bicycle paths*

- Connect the communities on either side of the I-710 corridor with a series of pedestrian- and bicycle-only bridges at least every one-half mile, especially where there is a particularly long gap between existing street crossings. The City of Long Beach is proactively requesting separated Class 1 facilities traversing the I-710 corridor for pedestrians and bicyclists at or very near to five priority crossing locations: Anaheim Street; between Pacific Coast Highway and Willow Street near Hill Street; between Willow Street and Wardlow Street near Spring Street; Long Beach Boulevard; and Artesia Boulevard. A bicycle and pedestrian connection should also be constructed to connect the separated path on the proposed Gerald Desmond Bridge to neighborhoods on the east side of the I-710 corridor in Long Beach. Other communities along the corridor can follow Long Beach’s model and prioritize locations for pedestrian and bicycle bridges that will serve neighborhoods on both sides of the corridor.



*Potential bike/ped bridges in Compton and Paramount*

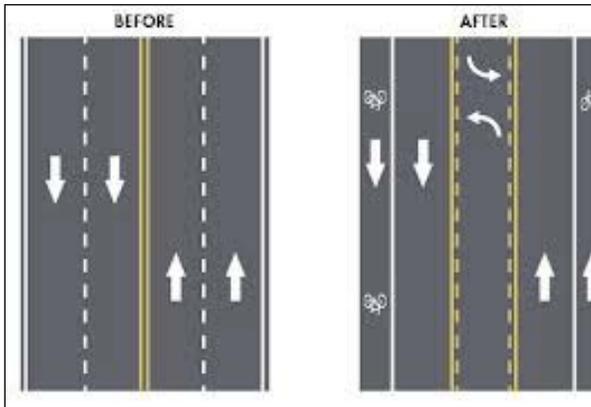


*Potential bike/ped bridges in Long Beach*

- Implement Complete Street treatments – which may include “road diets,” separated bicycle lanes, and wider sidewalks – on principal arterial and collector streets where appropriate, as determined by reliable travel demand modeling and a thorough community process. In particular, prioritize streets that cross the I-710 freeway and the Los Angeles River. Promote this strategy to area businesses and residents as both an enhancement to “Main Street” commercial districts and as a safety improvement for all road users.



*Tweedy Blvd. in South Gate might benefit from a road diet.*



*Typical road diet configuration*

- Where road-alterations occur in conjunction with freeway on-/off-ramps, implement best design practices to ensure that roadways are safe for pedestrians and cyclists. For instance, crosswalks should be placed in a location that offers pedestrians and drivers the optimum visibility of each other. Another effective technique is to paint a colored bicycle lane in the conflict zone to alert drivers to the presence of cyclists. If SPUIs are chosen in the design process, the project team should incorporate a bicycle detection system in the ground to trigger a lag in the signal phase that allows a bicycle to complete cross the intersection. Refuge areas should also be included in the design of these intersections to provide safe waiting spaces for pedestrians and cyclists who could not cross the intersection during a signal cycle.



*Example of a colored bike lane at an intersection conflict point*

- Establish a dense network of bicycle-friendly neighborhood routes, also known as “bike boulevards,” that provide safe and pleasant cycling routes through residential areas. These bike boulevards use inexpensive treatments, such as traffic circles and turned-out stop signs, to slow automobile traffic and create a continuous flow condition for cyclists. As a side effect, bike boulevards also enhance the pedestrian experience. The existing grid street network in the corridor’s communities facilitates the creation of this network.



*This residential street in Paramount encourages speeding traffic*



*The Vista Street Bike Blvd. in Long Beach presents a safe and pleasant alternative*

- Utilize existing underused railroad and utility rights-of-way to construct separated pedestrian/bicycle paths. Several of these rights-of-way run for long distances parallel to major streets, offering the opportunity to greatly increase bicycle and pedestrian mobility. Caltrans and Metro could use their clout to initiate discussions with the railways and utilities.



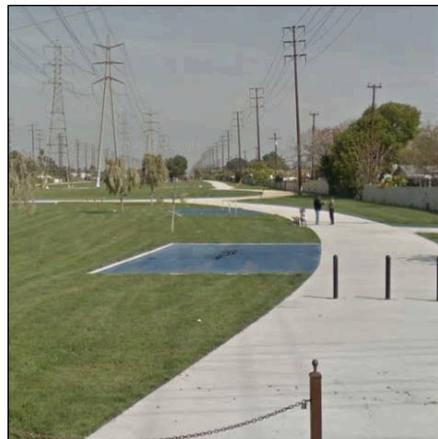
*Union Pacific right-of-way parallel to Firestone Blvd.*



*Bike/Ped paths can safely coexist alongside rail*

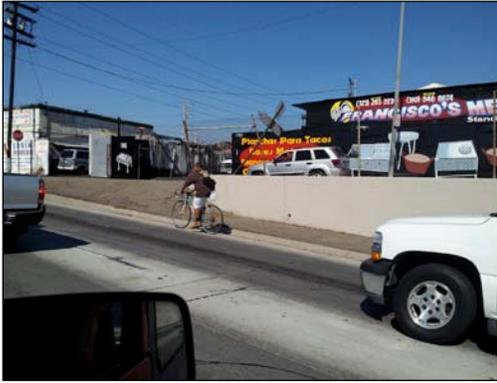


*Underutilized right-of-way in Paramount*



*Pedestrian path within utility right-of-way, City of Stanton*

- Stripe bicycle lanes and install sufficient bicycle parking racks at industrial and commercial facilities. Despite common perceptions to the contrary, many workers in the corridor’s industrial areas cycle to their jobs. The exceptionally heavy truck traffic in these areas necessitates dedicated space for cyclists on the roadways.



*A cyclist traveling through Vernon’s industrial landscape*



*Plentiful bike parking at the UPS facility in Vernon*

- Provide safe and effective walking and cycling connections to passenger rail stations – Metro and Metrolink – and to bus stops. Particularly popular access routes for pedestrians should be well lit, as should the transit stations and stops themselves.



*Bikes on transit: a common sight in Los Angeles County*

## Conclusion

The I-710 Corridor Project's draft environmental impact report claims that the project will improve mobility in the region. Certainly, more vehicles will be able to gain access to the I-710 freeway, but substantial transportation research has shown that widened highways become equally, if not more, congested shortly after completion<sup>2</sup>. In fact, the I-710 Corridor Project, as proposed, may actually *degrade* the mobility of the many residents and visitors who either choose to or must rely on modes other than automobiles to meet their transportation needs. The build alternatives in the draft EIR contradict the corridor communities' growing desire for cleaner, safer, more humane transportation options. Thus, Community Alternative 7 demands that a comprehensive pedestrian and bicycle element be part of any planned improvements in the I-710 Corridor Project Study Area.

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<sup>2</sup> Downs, A. (2004). "Why Traffic Congestion is Here to Stay... and Will Get Worse," *Access*, 25:19-25.



## About Charlie Gandy

Charlie Gandy is a nationally recognized expert in community design, trail planning and design, and bicycle and pedestrian advocacy. He is a popular consultant, speaker and lecturer on the leading edge of both the active living and livability conversations.

As the Mobility Coordinator for Long Beach California's Bike Long Beach program Gandy played a lead role in the award winning "sharrow" experiment, the 3rd and Broadway national "protected bike lane" pilot program, and collaborated on the nation's first Bicycle Friendly Business Districts.

Delighted to be a part of the remarkable culture shift embracing both bicycling and walking and its significant rewards, Gandy currently serves on the board of the California Bicycle Coalition, and in 2011 was chosen as Host Chair for the Pro Walk/Pro Bike Conference in Long Beach in September of 2012.

Gandy founded and served as the first Executive Director of the Texas Bicycle Coalition (now Bike Texas) from 1990 to 1994. Moving into national advocacy, Gandy was Director of Advocacy Programs for the Bicycle Federation of America from 1994 to 1998. At the Bicycle Federation he organized and launched citizen based advocacy groups for walking and cycling in thirty states and metropolitan areas, and coached and trained advocates in all fifty states. Gandy developed and launched the "Walkable Community Workshops," which have traveled to more than 1,200 communities nationwide. He is also a certified Safe Routes to School Instructor.

Since beginning his private consulting practice Livable Communities Inc. in 1998, Gandy has been in demand with government agencies, community organizations, design firms, and the media across the U.S. for his expertise in livability leadership and design solutions. Just a few of his clients include the Federal Highway Administration, New York City Metropolitan Transportation Council, Alta Transportation Consultants, AARP and the National Center for Bicycling and Walking. He has recently been featured in the Los Angeles Times, the Sacramento Bee, Sign On Sand Diego, Bicycling Magazine, Streetsfilms.org and TEDxSoCal *Thrive*.

Gandy graduated from the University of Texas at Austin in 1980 with a B.A. Degree in Political Science. In his early twenties served in the Texas House of Representatives as one of the youngest members ever elected. He has traveled extensively around the world, enjoys trail running, cycling, and his quest to climb all of the "14'ers" throughout Colorado and California. He now lives in Long Beach California. Find out more at [www.charliegandy.com](http://www.charliegandy.com).

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## **EDUCATION**

Master of Urban and Regional Planning (*Focus: Sustainable Transportation*)      *University of California, Los Angeles*  
*Member: UCLA Bicycle Coalition, Bruins for Transit*      *June 2012*

Bachelor of Arts in Political Science and Sociology, *summa cum laude*      *University of Mississippi, Oxford*  
Cumulative GPA: 4.0; Phi Beta Kappa      *May 2008*

## **EXPERIENCE**

### **CICLAVIA**

*Intern/Volunteer*      *Los Angeles, CA*  
*August 2010 – Present*

Surveyed over 300 participants at the October 2011 event as part of my UCLA Master's capstone project  
Helped plan and coordinate efforts for Los Angeles' inaugural CicLAvia, which attracted over 80,000 participants  
Canvassed businesses and residents along the 7.5-mile route to articulate the benefits and gain community support

### **BIKE LONG BEACH**

*Intern*      *Long Beach, CA*  
*March 2011 – April 2012*

Helped implement Long Beach's Bicycle Friendly Business District program  
Helped recruit over 145 local businesses to participate in the Bike Saturdays incentive program for cyclists

### **CENTRE FOR EXCELLENCE IN URBAN TRANSPORT, CEPT UNIVERSITY**

*Intern*      *Ahmedabad, Gujarat, India*  
*July 2011 – August 2011*

Conducted a pedestrian access audit for a proposed metro station and recommended improvements

### **URBAN LAND INSTITUTE-LOS ANGELES**

*Intern*      *Los Angeles, CA*  
*August 2010 – April 2011*

Organized for and supported staff at various meetings and conferences, including FutureBuild LA  
Provided administrative assistance, such as editing press releases and reports

### **LEWIS CENTER FOR REGIONAL POLICY STUDIES, UCLA**

*Research Assistant*      *Los Angeles, CA*  
*August 2010 – October 2010*

Conducted research on urban growth management scholarship and policies

### **PROGRESSIVE STRATEGY PARTNERS**

*Project Assistant/Office Manager*      *Los Angeles, CA*  
*July 2008 – July 2010*

Solicited and processed contributions for a successful multi-million dollar U.S. Senate campaign  
Did community outreach and coalition building for statewide ballot initiative campaigns  
Recruited and oversaw numerous volunteers and interns, many of whom were eventually hired as staff

## **VOLUNTEER WORK**

Pro Walk/Pro Bike, Long Beach – *Volunteer Coordinator*      *September 2012*

Pacoima Bicycle Count      *January 2011*

Metro Blue Line Bike & Walk Audit – Long Beach      *December 2009*

## **CONFERENCES/EVENTS**

Velo-City Global – Vancouver, BC      *June 2012*

Peds Count! – *Volunteer*      *May 2012*

Complete Streets for Los Angeles & California – *Volunteer*      *February 2011 & March 2012*

**SKILLS:** ArcGIS; CUBE; SPSS; Excel; PowerPoint; Analytical Writing; Spanish language (intermediate proficiency)

**AFFILIATIONS:** Southern California Planning Congress (Board Member), Transportation Research Board, Urban Land Institute, American Planning Association

# **ATTACHMENT E**





# The Acoustics & Vibration Group, Inc.

5700 Broadway Sacramento, CA 95820-1852

916-457-1444 FAX: 916-457-1475

Consultants in Acoustics, Vibration, Noise Control & Audio Visual Design

September 27, 2012

Angelo Logan  
East Yard Communities for Environmental Justice  
2317 Atlantic Boulevard  
City of Commerce, CA 90040

**SUBJECT:** Results of Review of the Noise and Vibration Sections of the I-710 Corridor Project Draft Environmental Impact Report/Environmental Impact Statement and Evaluation of Proposed Mitigation Measures

Dear Mr. Logan,

This letter report documents the results of an evaluation of the noise and vibration sections of the I-710 Corridor Project EIR/EIS [1]\* and the traffic noise study report [2] done as a basis of the EIR/EIS. The purported purpose of the project is to improve air quality and traffic safety, provide a modern design for I-710, address projected traffic volumes and address projected growth related to goods movement. The important part of this purpose is its relation to the movement of goods which is accomplished using primarily heavy trucks. These heavy trucks produce far more sound per unit than automobiles and light trucks and generate more low frequency sound than automobiles and light trucks. This low frequency sound more easily passes from the exterior to the interior of buildings such as schools, creating more sound disturbances within noise sensitive buildings. This transportation project is under the main jurisdiction of Los Angeles County, but the highway passes through and impacts several incorporated cities along its length. The noise and vibration section of the EIR/EIS document incorporates the results and is based on the traffic noise study. These two documents were reviewed for relevance to the subject project and for accuracy and completeness. Other documents reviewed include the existing [3] and Draft County of Los Angeles Noise Element [4] of the General Plan, the County Code [5], noise elements and noise ordinances of other local jurisdictions (e.g., [6,7]). The purpose of this review is to ensure that sound sources were properly addressed, evaluated and mitigated to be sure that noise sensitive receptors do not suffer as a result of the project's construction and operation.

Based on this review and evaluation, the noise and vibration sections of the I-710 Corridor Project Draft EIR/EIS and the Traffic Noise Study Report are inadequate and incomplete. In summary, these documents are incomplete and inadequate because:

1. The Draft EIR/EIS states that it is compliance with the requirements of the California Environmental Quality Act, CEQA, guidelines [8], however, local General Plan noise standards have not been considered. These local standards apply lower acceptable backyard sound levels in residential areas and much lower thresholds of significance. Comparisons with these standards are not given as required, making the Draft EIR/EIS incomplete.
2. Using Federal Guidelines and CalTrans standards, a significant increase is given as 12 dB(A) for the highest hourly average,  $L_{eq}$ , sound level at the receiver location. To get a 12

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\* - Number in brackets refers to references listed at the end of this letter report.



dB(A) would require a 5,000 average daily traffic volume on a street to increase to 79,240 or almost 80,000 vehicles per day assuming the vehicle speeds and mix of vehicle types remained the same. A road designed to carry 5,000 vehicles per day would not be capable of carrying 80,000. To believe that a noise-sensitive receptor would not raise strong objections over such a projected change in the volume for a variety of reasons including noise is ludicrous. Thus, it is unrealistic to have as a basis for deciding if an impact is significant, a minimum 12 dB(A) increase due to the project. For the current project, the 2011 traffic volumes [9] range from 57,000 vehicles per day to 230,000. These volumes would have to increase to a range of 903,400 to 3,217,300 vehicles per day. The road is not capable to carrying these volumes so the sound increase could not be significant due to the change in the volume alone. A test of significance that can not be reached is not a realistic standard and renders the process of evaluating noise impacts a charade without meaning.

3. Impacts can also be significant if they reach the US Department of Transportation, USDOT, limit for the highest hourly  $L_{eq}$  sound level of 67 dB(A). This standard is not consistent with the local standards that are based on the day-night average,  $L_{dn}$ , sound level as recommended by the US Environmental Protection Agency [10]. Often, the daytime (7:00 a.m. to 10:00 p.m.) hourly  $L_{eq}$  sound level will be very close to the  $L_{dn}$  sound level. The  $L_{dn}$  sound level standards of most of the jurisdictions along the project corridor have a goal of 60 dB(A) for the  $L_{dn}$  sound level with an upper limit of 65 dB(A) for the  $L_{dn}$  sound level when the available and reasonable mitigation measures can not be used to meet the goal. No one but the USDOT and CalTrans use the peak hourly  $L_{eq}$  level for evaluating transportation noise impacts. Thus, the Draft EIR/EIS uses a second tier to judge significance that is more lenient than local limits and this is not in compliance with CEQA requirements.
4. Sound at a noise-sensitive receiver due to road transportation can increase only because of an increase in volume, higher average speeds, a greater percentage of heavy trucks or some combination of these, assuming the sound reduction between the road and the receiver does not change. A doubling of the volume is required to achieve a 3 dB(A) increase in the peak hourly average sound level. A change in the average speed or the percentage of heavy trucks could increase sound levels faster. However, either condition would change the tonal content of the road transportation sources. The Draft EIR/EIS states that the tonal content is one of the important factors in the perception of sound by the receiver, the propagation of sound over barriers to the receiver and the transmission of sound into building. Tonal or sound frequency data was not provided for existing conditions at either measurement locations or modeling stations as is required by the State and the EPA in the preparation of sound impact statements. The Draft EIR/EIS is inadequate without this information.
5. CalTrans sets sound limits based on seven activity categories. Only the first five categories have worse case hourly  $L_{eq}$  sound levels limits and four of the limits are for exterior and one is for interior spaces. Two of the four exterior limits are the same, resulting in limits of 57, 67 and 72 dB(A). The lowest limit is for activity areas requiring extraordinary serenity and quiet, but examples are not given. Areas exist along the project site that are designated for peace and quiet but they also have the designation of a "park." This appears to be another goal that can never be met, which means that it has no meaning and is unattainable. This results in a biased evaluation of the impacts of the project.
6. The interior worse case hourly  $L_{eq}$  sound level for schools is set for 52 dB(A). This is a value without any foundation for its use except that it is employed repeatedly and contra-



dicts the requirements of the City of Long Beach [7], the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) [11,12,13], the Collaborative for High Performance Schools (CHPS) [14], and an American National Standard Institute (ANSI) standard [15] that is part of the Americans with Disability Act (ADA). The City of Long Beach Municipal Code sets a limit of 45 dB(A) in classrooms. The CHPS program has a prerequisite that the background sound level from all sources shall not exceed 45 dB(A). This value must be met to meet the minimum standard. An additional point is received if the background sound is not greater than 40 dB(A) and 3 points if the sound meets 35 dB(A). ASHRAE set a limit for background sound level of 37 dB(A) at least back to 1991, changing that to 35 dB(A) in 2011. ANSI 12.60, an acoustic design requirement for schools sets a limit for background sound levels due to all sources of 35 dB(A) based numerous referenced studies on the impact of high sound levels on learning, particularly for kindergarten through 6<sup>th</sup> grade. A level of 52 dB(A) would limit or prevent learning and cause the teacher to use a raised voice for extended periods, leading to vocal problems as has been documented in several studies. Dr. V.O Knudsen in his 1950 book on acoustic design [16] stated, *“The school was established to promote learning, which is acquired largely by word of mouth and listening. Therefore, acoustics is one of the most important physical properties that determine how well the school building can serve its primary function. Thus, the exclusion of noise and the reduction of reverberation are indispensable in adapting classrooms to the function of oral instruction.”* The CalTrans classroom sound limit fails this test of providing acceptable conditions for oral instruction and does not comply with the mainstream standards. Therefore, the analysis done on this project to assess the noise impacts is incorrect and inadequate.

7. The use of only the peak hourly Leq sound level poses many questions, particularly for schools and parks because the impact can not be determined by sound measured outside the time these facilities are used. This may not be adequate as shown by the Berkeley Keeps Jets Over Bay Committee [17]. In this case, the Court stated that relying on standard sound level criteria such as the  $L_{dn}$  sound level may not be adequate to define the noise impacts to a neighborhood. The Court required the use of the Single-Event Level or Sound Exposure level,  $L_{SEL}$ , as another method of evaluating the source. For this project, heavy trucks are considered a major source. Their individual impact could be greater than shown by the hourly average. The introduction of raised truck lanes will make this more significant because the sound will spread farther with less ground affects, resulting in a greater dominance. Both the tonal content and the individual events could adversely impact people using parks and the classrooms. Local jurisdictions commonly use the  $L_{dn}$  sound level in their General Plans. The  $L_{dn}$  sound level was not provided, preventing the comparison of the results with local standards as required by CEQA. The evaluation of noise impacts is incomplete and inaccurate without this information.
8. Figures 3.14-1 and 3.14-2 incorrectly identify sound monitoring and modeling positions, making it very difficult to analyze the results and to independently confirm the results as required by CEQA. This makes the Draft EIR/EIS incorrect and inadequate.
9. Predicting sound levels using either TNM 2.5 or FHA-RD-77-108 requires a knowledge of the traffic volumes, traffic mix, topography, amount of the road that is “visible”, shielding, elevation of source and elevation of the receiver. Neither all input data nor even examples of the data used in the prediction of sound levels at the modeling locations or to calibrate the short term sound measurements was provided. This makes it impossible to corroborate the



results independently. This is particularly important for the Alternative 6A/B/C results because the truck lanes are to be elevated, changing dramatically the elevation of the source relative to the receiver. Sound would be expected to propagate over much greater distances. Because of the tonal content of internal combustion engines, the impact could be much greater. Without this information, independent evaluation of the results is not possible. This does not meet the requirements of CEQA and makes the report inadequate.

10. Average,  $L_{eq}$ , sound level variations with time are presented only for a selected few 4 of 24, long term measurement sites. Other sound metrics, which could be used to understand how the sound varied with the time, are not provided at all. This means that the maximum hourly  $L_{eq}$  sound level can not be corroborated. Beyond that, for many of the sites that are important such as Julia Russ Asmus Park, the worse-case hourly  $L_{eq}$  sound level occurs during hours that the park is not open for general use. The sound levels during the hours of use are most important along with the tonal content of the sound during these hours. The sound levels during hours when the park is open are not available for schools, parks and other non-residential uses where this information is critical. Of the 24 sites where 24-hour measurements were done, 12 of the sites, 50 percent, had maximums outside the 8:00 a.m. to 5:00 p.m. period. Only one of these was between 5:00 p.m. and midnight, and 7 of 12 were between 5:00 a.m. and 7:00 a.m. The Draft EIR/EIS is incomplete without this information.
11. Several problems exist with the background sound level measurements made to learn what the sound level would be without the influence of I-710 traffic. The city is not given where the measurement was made. With significant work, this can be discovered, except that one of the positions, B7, was a long ways outside the project area or the address is wrong. This makes it impossible to provide an independent opinion on the adequacy of the measurements and the test position. Another issue is that the noise prediction model was not used to assess whether the sound measured at these points could be predicted based traffic counts, mixes and speeds made for Interstate 710. Thus, a blanket statement that the sound measured at these positions actually represents the background sound that would be measured if I-710 did not exist. The background sound level measurement positions were sufficiently close to the project road to have been influenced by traffic on this road when sound drops only 3 dB(A) per doubling of distance.
12. The CalTrans 1998 Technical Noise Supplement (TeNS) [18] and the 2009 versions [19] require a calibration of the field sound measurements using field traffic volumes, mixes, speed to predict the sound at the receiver position. This is good practice, but can be fraught with error if not done carefully and correctly. High correction values, "K factor", can suggest another problem because the model is supposed to be correct to  $\pm 1.5$  dB(A). For example, at receiver position NB-1a, Cesar Chavez School, the K-factor is 3.9 dB(A). That is, the measured sound level was 3.9 dB(A) greater than the predicted level at the site. Information regarding what was used to predict the sound at this site. However, the volume used in the model would have to be increased 2.5 times to reach agreement. This large a discrepancy in the modeling has to be understood because applying this factor to future conditions could result in over predicting the sound or misjudging the source of the sound. This is particularly important at this site because the predicted interior sound level is 51 dB(A), which is greater than the 45 dB(A) allowed by the City of Long Beach. For some cases such as schools, altering the school facade provides better results than using sound barriers only or in combination with the sound walls. This has not been considered and results in inaccurate



results. Large K-factors that can not be explained also make the results unreliable and inaccurate, especially when the field sound levels are greater than the predicted values.

13. Long duration measurements were made only 24 positions. At the 125 short duration sites and the 72 modeled sites, the worse-case hour sound levels were predicted based on information that is not provided in the Draft EIR/EIS [1] or the Traffic Noise Study [2]. That is, it is not clear whether they used a “nearby” 24-hour measurement, they used traffic percentages from this road or some other road. This is a very important factor in the noise impact analysis. Because the 24-hour counts showed so many worse-case hours during early morning hours, this has a significant impact on sleep. However, an explanation for the highest hourly  $L_{eq}$  sound level occurring at these hours is not explained. The highest  $L_{eq}$  sound level should correspond to the highest volumes, but in this case it could be due to differences in average speed or percentage of heavy trucks. The reports provide no explanation so an independent evaluation is not possible. This makes the Draft EIR/EIS and the Traffic Noise Study incomplete and inaccurate.
14. The Traffic Noise Study contains information about the vehicle counts, assumed to be just 10-minute counts and not normalized to 1-hour. The vehicle mixes should be representative of a typical day or the sound data will not be accurate. For short duration measurement site NB-7, the heavy truck percentage was 24.5 while the 2010 CalTrans truck traffic count [20] shows 12.1 percent heavy trucks for the whole day. Obviously, the daily percentage can differ from short duration counts, but the difference must be reasonable considering the time of day. At SB-6 along the same stretch of road, 25.1 percent of the vehicles were heavy trucks during sound tests done 2-hours before the NB-7 sound measurements. The peak sound hour at SB-3, the 24-hour measurement site closest to SB-6, occurred between 8:51 and 9:51 a.m. At SB-27, the maximum hourly  $L_{eq}$  sound level happened between 6:39 and 7:39 a.m., but 13.2 percent of the traffic was heavy trucks at SB-28 and SB-29 during tests started about 1:30 p.m. This is again twice the 6.2 percent heavy trucks for the whole day given in the 2010 CalTrans truck traffic publication. However, the peak hour occurred many hours earlier. An explanation of the influence of heavy truck traffic on the worse-case hourly  $L_{eq}$  sound level is needed to understand the results and to ensure that the assumptions used gave reliable results.
15. For the Boystown of California School and Marco Antonio Firebaugh School, sound levels due to Alternative 6A will approach or exceed the exterior limit and the interior limit used by CHPS. Mitigation measures are listed as not warranted because of insufficient sound reduction. However, interior sound reduction is possible at the school and must be required to ensure no adverse impacts on learning. This is particularly true because the elevated heavy trucks produce lower frequency sound that is transmitted through exterior wall assemblies more easily.
16. The predicted sound level at Julia Russ Asmus Park is 83 dB(A) during the noisiest hour. This renders the park almost unuseable for safety reasons because screams could not be heard above the din from I-710. Sound levels are barely tolerable at present. Mitigation measures must be implemented to provide a minimum 14 dB(A) of reduction during operating hours. Monitoring must be completed if the project proceeds to ensure that the predicted sound reduction is realized.



17. Humphreys Avenue Elementary School is predicted to have sound levels of 54 to 56 dB(A) in the classroom. This is far above the 35 to 45 dB(A) limit used by mainstream acoustical stands. Sound mitigation is not proposed because sound walls will not provide sufficient sound reduction. Doing nothing will render this school useless for learning purposes as children will not be able to hear instructions. As noted by Dr. Knudsen, hearing the instructions and the explanations is the foundation of all learning [16]. Sound reduction at the building facade is required to reduce interior sound levels to the minimum 45 dB(A) and preferably to less than 40 dB(A).

The reasons given above are sufficient to render the Draft EIR/EIS and the Traffic Noise Study inadequate and incomplete. The items addressed here must be taken into consideration in any revisions of the noise sections of the EIR/EIS for the I-710 Corridor Project. The reasons for the project are good, but those living along the corridor should not have to suffer significant consequences for the benefit gained by those not living along the corridor.

Please call if you have any questions or comments regarding the issues raised or the conclusions reached. Let me know if you need additional information.

Sincerely,

A handwritten signature in blue ink that reads 'Steve Pettyjohn'.

Steve Pettyjohn, Principal

Certified: Institute of Noise Control Engineers-1981

## REFERENCES

1. Anon., *I-710 Corridor Project Draft Environmental Impact Report/ Environmental Impact Statement and Section 4(f) Evaluation: Volume 1* by State of California Department of Transportation and the Los Angeles County Metropolitan Transportation Authority, District 07-LA-710-PM 4.9/24.9, EA 249900, June 2012.
2. A.J. Parmar, "Traffic Noise Study Report: I-710 Corridor Project from Ocean Boulevard in Long Beach to Route 60 in East Los Angeles in Los Angeles County, California", by Office of Environmental Engineering and Corridor Studies, District 7, Los Angeles, Project 07-LA-710-PM 4.9/24.9 EA 249900 (0700000443), January 31, 2012.
3. Anon., "Noise Element" from the *Los Angeles County General Plan*, adopted 1975, *General Plan* chapters adopted 1965 through 2008.
4. Anon., "Noise Element" from the *Revised Draft May 2012 Text Only Versions, Los Angeles County General Plan 2035*, by Los Angeles County Department of Regional Planning, May 2012.
5. Anon., "Part 3 — Community Noise Criteria, Section 12.08", from Los Angeles County, California, Code of Ordinances, 1978.
6. Anon., *City of Commerce 2020 General Plan*, adopted January 2008.



7. Anon., "Chapter 8.80 Noise" from Title 8 - health and Safety from *Long Beach, California, Municipal Code*, with changes through January 2012.
8. Title 14. California Code of Regulations, Chapter 3. Guidelines for Implementation of the California Environmental Quality Act, Article 9. Contents of Environmental Impact Reports, Sections 15120 to 15132.
9. Anon., <http://www.dot.ca.gov/hq/traffops/saferestr/trafdata/index.htm>, *Annual Average Daily Traffic*, CalTrans Traffic Operations Resource Division, Copyright 2011, State of California.
10. Anon., *Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety*, U.S. Environmental Protection Agency, Office of Noise Abatement and Control, March 1974.
11. Anon., "Chapter 42: Sound and Vibration Control", from *1991 ASHRAE Handbook: Heating, Ventilating and Air-Conditioning Applications*, American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., Atlanta, Georgia, 1991.
12. Anon., "Chapter 47: Sound and Vibration Control", from *2007 ASHRAE Handbook: Heating, Ventilating and Air-Conditioning Applications*, Inch-Pound Edition, American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., Atlanta, Georgia, 2007, Handbook Edition.
13. Anon., "Chapter 48: Sound and Vibration Control", from *2011 ASHRAE Handbook: Heating, Ventilating and Air-Conditioning Applications*, Inch-Pound Edition, American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., Atlanta, Georgia, 2011, Handbook Edition.
14. Anon., *Best Practices Manual: Volume III, Criteria*, from High Performance School, Best Practices Manual, 2009©, 2009 CHPS, Inc.
15. American National Standard, *Acoustical Performance Criteria, Design Requirements, and Guidelines for Schools*, ANSI S12.60-2002, Acoustical Society of America, Melville, NY.
16. V.O. Knudsen & C.M. Harris, *Acoustical Designing in Architecture*, Copyright 1950, recopy righted 1978, The Acoustical Society of America.
17. *Berkeley Keep Jets over the Bay Committee v. Board of Port Commissioners*, 91 California Appeals Court 4<sup>th</sup> 1344, 1372-1383, 2001.
18. R. Hendricks, *Technical Noise Supplement: A Technical Supplement to the Traffic Noise Analysis Protocol*, California Department of Transportation; Environmental Program; Environmental Engineering-Noise, Air Quality, and Hazardous Waste Management Office; October, 1998.
19. Anon., *Technical Noise Supplement: Redlined, A Technical Supplement to the Traffic Noise Analysis Protocol*, California Department of Transportation; Environmental Program; Environmental Engineering-Noise, Air Quality, and Hazardous Waste Management Office; November, 2009.
20. Anon., <http://www.dot.ca.gov/hq/traffops/saferestr/trafdata/index.htm>, *2010 Annual Average Daily Truck Traffic*, CalTrans Traffic Operations Resource Division, Copyright 2011, State of California.





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Consultants in Acoustics, Vibration, Noise Control & Audio Visual Design

## **STEVE PETTYJOHN**

### **Principal**

Steve is an engineering professional responsible for overseeing services provided by The Acoustics & Vibration Group, Inc. (TAVGI). He is especially proficient at setting realistic goals, explaining what the purpose is of these goals and how sound and vibration influences a project. He has extensive experience in designing facilities for optimum sound quality, measuring sound and vibration, analyzing data and completing noise and vibration impact statements. Steve analyzes heating, ventilating, air-conditioning systems for sound characteristics and vibration isolation; does sound level surveys to document employee noise exposures; and designs sound reinforcement systems and sound paging systems. He executes vibration measurements for industrial, commercial and public utility projects and specifies mechanical equipment systems to meet acoustic and vibration criteria. In addition he serves as an expert witness in cases involving acoustic and vibration issues.

Steve formed TAVGI in Sacramento in 1986 after completing seven years of acoustic and vibration research for Cummins Engine Company, a major international manufacturer headquartered in Indiana, and five years with acoustic and vibration consulting firms in Atlanta, Georgia. During these years he has completed over 2000 projects encompassing a wide scope of work. Clients include manufacturing and industrial firms, retail businesses and commercial firms, architects, engineering and mechanical companies, governments and governmental agencies, developers, lawyers, contractors, churches, hospitals, schools and private individuals.

### *Qualifications*

- Certified (#81010) by the Institute of Noise Control Engineers, 1981
- Certified (#9403-004B) by the Vibration Institute as Vibration Specialist III, 1994
- Professional Engineer in Acoustics (#19639PE) in Oregon
- M. S. from School of Mechanical Engineering's multi-disciplinary acoustics program, Georgia Institute of Technology, 1979
  - Included courses in acoustics and vibration from the Departments of Architecture, City Planning, Psychology, Physics, Electrical Engineering, Geophysical Science, Aerospace Engineering, Solid Mechanics and Mechanical Engineering
- Certified as an Engineer-In-Training from the state of Georgia, 1976
- B. S. in Mechanical Engineering, Oregon State University, 1972
  - Completed special projects on engine vibration and chain saw sound

### *Professional Memberships*

- Institute of Noise Control Engineers (INCE)
- Acoustical Society of America (ASA)
- American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE)
- American Society of Mechanical Engineers (ASME)
- The Vibration Institute



**PROJECTS ON WHICH STEVE PETTYJOHN SERVED AS AN EXPERT WITNESS**

- William D. Kopper, Attorney at Law, Davis, CA, 2012. Reviewed subsequent mitigated negative declaration for revised operations of Mesa Beverage Distribution Center in Solano County. Review is complete; court action is being considered and will depend on outcome of planned field tests on property of Beverly Schenck. In progress.
- William D. Kopper Attorney at Law, Davis, CA, 2012. Reviewed and commented on acoustic sections of the second addendum to the environmental impact report for proposed Red Bluff Wal-Mart Supercenter.
- Wittier & Parkin, LLP, Santa Cruz, CA, 2011-2012. Reviewed and commented on noise impact studies completed as part of the permit process to allow wedding receptions at Redwood Ridge Estates in Santa Clara County.
- Soluri Meserve, Sacramento, CA, 2011-2012. Reviewed and commented on noise and vibration sections of the mitigated negative declaration for the West Coast Recycling Group Metal Recycling Facility in West Sacramento. Resulting from the review, a full environmental impact report was required; reviewed and commented on the acoustic sections of the draft EIR.
- Lippe Gaffney Wagner LLP, Sacramento, CA, 2010-2011. Reviewed and commented regarding the noise and vibration sections of the mitigated negative declaration done to modify use permit 858-02(A) to permit increased yearly material removed from Enz Mine in San Benito County. Outcome unknown.
- Park Townsend Homeowners v. Park Townsend LLC, et al., 2010-2011; Green & Hall, Attorneys at Law, Roseville. Did sound tests, inspected site, reviewed sites, met with both teams. Settled in arbitration.
- Garret v. K. Hovnanian, Isla Del Lago, 2010-2011; Wagner Kirkman Blaine Klomparens & Youmans LLP, Attorneys at Law, Mather. Did sound tests, reviewed defense's expert materials, met with defense lawyers. Settled out of court.
- State of California/CalTrans v. Scheiber, et al., 2008-2010; Desmond, Nolan, Livaich & Cunningham, Attorneys at Law, Sacramento. Did sound tests and predicted road transportation sound impacts. Gave deposition in January 2010. Settled out of court.
- State of California/CalTrans v. Magenheimer, et al., 2008-2009; Ashby Law Firm, Yuba City, CA, & Desmond, Nolan, Livaich & Cunningham, Attorneys at Law, Sacramento. Did sound tests and predicted road transportation sound impacts. Settled out of court.
- Yosemite Terrace Apartment Investors, L.P., v. Chico Land Design Properties Corporation; et al., 2002 - 2009; Law Offices of David J. Murray, Chico. Did STC/IIC Tests, recommended modifications to wall and floor/ceiling assemblies, tested changes. Testified in arbitration hearings.



- Citizens for a Healthy Community, et al., v. City of Red Bluff, et al.; 2005-2009; William D. Kopper, Attorney at Law, Davis, Ca. Reviewed noise impact studies, measured sound and commenting on findings.
- Citizens for a Healthy Rural Environment, et al. v. County of Lassen, et al., Lise & Larry Wosick, et al.; 2002-2008, Kenyon/Yeates, LLP, Sacramento, CA; Reviewed reports, measured sound and commented results. Prepared declaration. Testified in court.
- Morton, et al., v. Orangevale Recreating & Park District, et al., 2002-2007; Neasham & Kramer, LLP, Attorneys at Lay, Gold Point, Patricia Kramer; make sound measurement of park activities and provide report; Gave deposition, awaiting trial date.
- Villagio Condominium Home Owners Association v. Westmark Homes, Las Vegas; Hired by Westmark Homes to do STC/IIC test ands provide report; Gave deposition.
- M.P. Allen v. Dreyer Babich Buccola & Callaham, 2005-2009; Anwyl, Scoffield & Stepp, LLP, attorneys at Law, Sacramento, James Anwyl & DBBC; Made sound and vibration measurements of HVAC system, floor/ceiling vibration, footfall noise and speech privacy and provided reports and recommendations; Gave deposition and testified at arbitration hearing.
- Ann Chargin, Richard Hackett, Carolyn Hackett, et al., v. Stockton Port District, 2004-2005; Montague & Viglione, Attorneys at Law, Sacramento, Dennis L. Viglione; Gathered data and provided reports; Deposition given and testified in court.
- Del Webb California Corp. v. Neil's Controlled Blasting, et al., 2004, Trainor - Robertson, Attorneys at Law, Sacramento, Todd Schaffer, Esq; Deposition given; Testified at arbitration hearing.
- Albert Warmerdam v. Steven & Kathleen Nelson, 2002-2004; Bakerink & McCusker, Attorneys at law, Tracy, Brinton R. McCusker, Esq.; Data taken & reports prepared; Deposition given; Testified in court.
- Jenkins v. Clemens, 2002; Williams Jordan & Brodersen, Attys at Law, LLP, Visalia, Mr Ralph Jordan. Deposition given; out of court settlement.
- Tom & Mary Morgan v. Honey Lake Motocross Park, 2002; Remy, Thomas & Moose, LLP, Sacramento, Ms. Mary Handel. Sound tests, review noise studies, and make several declarations as part of an EIR law suit.
- James Simons, et al. v. Larry A. Scruggs, et al., 2002; Law Offices of Joseph L. Spiva, Fairfield, Mr. Joe Spiva. Took sound data and provided testimony in court.
- Mario Flores v. Keith Hayes, 2001; O'Laughlin & Stein, Sacramento, Mr. Douglas Stein. Data collected. Testimony presented in arbitration hearing then in court.
- Bobby T's Sports Bar & Restaurant v. (Unknown), 2000; Joseph L. Russell, Atty at Law, Sacramento, Mr. Joseph Russell. Testimony presented in arbitration hearing.



- Kenneth & Mary Lou Cayocca v. Sacramento Area Flood Control Agency, 1999; Montague & Viglione, Attorneys at Law, Sacramento, Dennis L. Viglione; Gathered data and provided reports; Case settled out of court.
- Earl Miller v. Eagle Marine Services, Ltd., 1998; Mullen & Filippi, Attys at Law, San Francisco, Ms. Laura Bruyneel.
- Ballard et al., v. Union Pacific Railroad Company, 1998; Damrell Nelson Schrimp Pallios & Lardine, Modesto, Mr. James Lewis.
- Kipp v. Union Pacific Railroad Company; 1996; UPRR Law Department, Los Angeles, Ms. Priscilla Contreras.
- Farias v. Metrolink; 1995; Haight, Brown & Bonesteel, Los Angeles, Mr. Michael McMahon.
- J. T. Metz v. Union Pacific Railroad Company; 1995; UPRR Law Department, Los Angeles, Mr. Scott Baugh. Deposition given; out of court settlement.
- Remy Stewart, a minor, etc., and Joyce A. Stewart v. Southern Pacific Transportation Company; 1995; Southern Pacific Transportation Company, Sacramento, Mr. Richard J. Mitchell. Deposition given.
- Henry Phillips v. Maersk Stevedoring Company and Signal Administration Inc.; 1994; Finnegan, Marks & Hampton, Ms. Katherine Theofel. Testimony not required; out of court settlement.
- Clifton Crayton v. Maersk Stevedoring Company; 1994; Parish Law Offices, Mr. Bill Parish. Testimony not required; summary judgement.
- Al Vial v. William Crowder; 1994; Matthews, Fuqua & Puritz, Mr. Morey Fuqua and Mr. Stephen Riley. Testimony presented; pretrial settlement.
- Dzenountian v. Rosenberg Family Fund, et al; 1994; Kinder, Wuerfel & Cholakian, Mr. Julian Pardini. Testimony presented in arbitration hearing; out of court settlement.
- Thomas & Ingrid Ritz v. County of Tuolumne, Glenn Smith, Individually and dba Springfield Flying Service; 1994. Data taken and report prepared; Testimony not required; out of court settlement.
- Cheryl Dong and Max Francis v. Winncrest Homes II; 1994; Ms. Cheryl A. Dong. Testimony presented both in Small Claims Court and in Superior Court regarding wall STC issues.
- Edward Mackay, et al v. Gary Lingle, et al; 1994; Wagner Kirkman & Blaine, Mr. Douglas Kirkman. Deposition given.



- Cory, Zikes and Gladden v. County of Sacramento; 1993; Desmond-Miller-Desmond, Mr. Gary Livaich, Attorney for Zikes. Testimony presented.
- Brown v. Union Pacific Railroad Company; 1993; Union Pacific Railroad Company, Mr. James C. E. Barclay. Testimony presented.
- Porter Communication v. Corner Tavern; 1992; Mr. Don Porter and Ms. Rita Rispoli, Nevada City. Testimony presented in court hearing.
- (Unknown) v. State of California; 1989; State of California, Office of the Attorney General, Mr. Steve Egan. Data collected. Testimony presented in court.
- John Breen v. Regional Transit; 1989; Risk Management. Deposition given.
- Vacaville State Hospital/Prison v. Inmate; 1988; Mr. Hayes Gable, Attorney for the Inmate. Data collected. Testimony not required.



# **ATTACHMENT F**



**RICHARD R. HORNER, PH.D.**

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September 18, 2012

Adriano Martinez  
Natural Resources Defense Council  
1314 Second St.  
Santa Monica, CA 90401

Dear Mr. Martinez:

As you requested on behalf of Natural Resources Defense Council (NRDC), I wish to submit the following comments regarding the I-710 Corridor Project EIR/EIS, Chapter 3.9, Water Quality and Stormwater Runoff (“Stormwater Chapter”) and the Water Quality and Stormwater Runoff Study Final Report, Interstate 710 Corridor Project Between Ocean Boulevard and the State Route 60 Interchange, 07-LA-710-PM 5.4/24.6 EA: 249900 WBS 165.10.35 (“Stormwater Report”). Since these two documents cover much of the same ground, I refer to them collectively as “the Stormwater Documents”.

In formulating my comments I applied the experience of my 35 years of work in the stormwater management field and 11 additional years of engineering practice. During this period I have performed research, taught, and offered consulting services on all aspects of the subject, including investigating the sources of pollutants and other causes of aquatic ecological damage, impacts on organisms in waters receiving urban stormwater drainage, and the full range of methods of avoiding or reducing these impacts. Attachment 1 to this letter presents a more complete description of my background and experience. My full *curriculum vitae* are available upon request.

### **Summary of Comments**

In summary, in my opinion the Stormwater Documents are inadequate as a basis for both long-term and construction-phase stormwater management in the I-710 corridor. While the permanent stormwater management practices installed in the reconstruction of the highway will determine its effect on the environment for many years, potential impacts of the shorter-term construction phase are also important because of the intense exposure to contaminants at that time, particularly on such a large and relatively extended project.

In both the long-term and construction phases, the Stormwater Documents are flawed because their coverage of the prospective stormwater management actions is so general, and lacking in site-specific context, as to be nearly meaningless. Extending from this shortcoming, their prescriptions for construction and permanent stormwater best management practices (“BMPs”) are rudimentary and give no confidence that they will adequately address the water quality

problems of the waters receiving I-710 stormwater runoff and prevent the creation of additional problems. The documents make unwarranted assertions regarding ostensible improvement in water quality resulting from the first significant installation of stormwater management practices in the corridor without any technical analysis whatsoever of conditions before versus after great expansion of the highway and its traffic level. They improperly rely on prior studies conducted under different premises than now anticipated for the corridor. The BMPs identified in those studies and put forth as the core of the permanent stormwater management program for the proposed project will not begin to cover runoff treatment for approximately 20 miles of a corridor of 10-14 lanes. Prescriptions for construction-phase BMPs are nothing more than a scattered list, without any site context at all, and ignore a whole host of the most effective practices.

The remainder of this letter elaborates on these points.

### **Overall Excessive Generality**

The Stormwater Documents represent a common failure in project environmental documents (e.g., Environmental Impact Reviews/Statements, “EIRs/EISs”) in making very general statements that could apply to any similar project (e.g., an urban freeway anywhere). They shrink from any quantitative, or even qualitative, assessment of the site-specific conditions before and after the proposed project (see further discussion of this criticism below regarding both permanent and construction-phase stormwater management). This omission allows the documents to avoid confronting problems that may exist and could be made worse by the prospective action(s), and what should be done to avoid such an outcome. Then, they duly drop the names of the common practices intended to mitigate the environmental impacts they have not, in fact, assessed. They say these practices will be used, although not where, when, or how; with no commitment whatsoever; and with no estimation of their effect. They tend to ignore the recently introduced, state-of-the-art and often more cost-effective practices. Finally, they make unsubstantiated claims regarding the expected type and level of impacts, often without any meaningful analysis as a foundation. The I-710 Stormwater Documents are exemplary additions to this sad literature.

I realize that the I-710 corridor project will go through more stages of development before ground is broken. During this period, it is likely that the generality reflected in the Stormwater Documents will decrease, and site-specific considerations will rise. Still, these environmental documents are being offered to regulatory agencies for decision-making, and to citizens to decide if this is how they want their tax money spent and environment treated. These documents should be much, much more informative. They also set a tone for future actions by the project developers. Allowing corner-cutting at this point will likely stimulate a tendency for continuing laxity as project development moves forward. In such a climate I expect that the only outcome will be lip service to environmental protection. Therefore, I believe that the proponents of this project should be held to the highest standards of analysis and commitment to best practices, the outlines of which I suggest in this letter.

## **Permanent Highway Operational Phase**

### The Overly General and Inappropriate Basis for Permanent BMPs

The Stormwater Documents approach the management strategy to be applied on the finished highway in the overly general fashion pertaining throughout. They note that operational BMPs include design development, treatment, and maintenance BMPs. For design development and maintenance BMPs they include only very short lists of the types of BMPs expected to be used, with no exposition of where, to what extent, and with what expected effect. For treatment BMPs they note only that, currently, there are several permanent BMPs installed along the 710 corridor and that additional BMPs have been planned based on the results of two Corridor Stormwater Management Studies completed in 2009. As shown in the following discussion, these studies are not an adequate basis for stormwater management in the presently anticipated I-710 corridor; and their results were misused by the Stormwater Document authors.

### Critique of Stormwater Document Reliance on 2009 Corridor Stormwater Management Studies

The two 2009 corridor studies were performed under a court order pursuant to United States District Court, Central District of California, Case No. 93-6073-ER (JRX), *Natural Resources Defense Council and Santa Monica Baykeeper, Plaintiffs, v. California Department of Transportation, Defendant*. I was appointed by the court under the original permanent injunction as the monitor of the injunctive provisions, including the corridor studies, on behalf of the plaintiffs. Hence, I am familiar with the two studies referred to in the Stormwater Documents. They belong to a set of such studies covering all California Department of Transportation (“Caltrans”) highways in District 7 (Los Angeles and Ventura Counties).

The fundamental target of the corridor studies is to reduce the volume of stormwater runoff produced by impervious surfaces in Caltrans’ rights-of-way and discharged to receiving waters without treatment by 20 percent compared to that so discharged when the court issued the permanent injunction (December 1994). Volumes are estimated by multiplying impervious areas times the 0.75-inch water quality treatment design storm prevailing in the Los Angeles area, with the necessary unit conversion factors. The calculation of treatment credit is adjusted based on the efficiencies of selected BMPs in reducing pollutants of concern. For example, if a BMP can treat 1000 ft<sup>3</sup> of runoff and decrease copper by 60 percent, the volume credit is 600 ft<sup>3</sup>. The criterion is applied watershed by watershed (e.g., Los Angeles River, San Gabriel River). Meeting it requires treating 20 percent of the runoff volume produced in 1994 plus all of the volume generated by new impervious surfaces, or equivalent. At this point in time, Caltrans has completed almost all corridor studies for limited-access freeways (but not for other highways) and will soon make an initial estimate of how identified BMPs will meet the various watershed targets after they are installed.

The two corridor studies completed for the I-710 corridor would treat runoff from 178 acres of pavement. With treatment efficiencies applied, the credit would be 414,104 ft<sup>3</sup>. According to the Stormwater Report, there are 687 acres of existing impervious surface located within the I-

710 Corridor Project footprint. Applying the corridor studies procedure for calculating water quality volume, the existing highway would produce 1,870,358 ft<sup>3</sup> in the design rainfall event. Treating 20 percent of that quantity, as anticipated by the court order, would require BMP capacity of 374,072 ft<sup>3</sup>, allowing an excess of 40,032 ft<sup>3</sup> to serve highway expansion. Per the court order, all expansion runoff must be treated or any shortfall compensated by treatment in another corridor in the same watershed.

The Stormwater Report states that reconstruction of the highway would add 109 to 308 impervious acres, depending on the alternative selected. The ultimate impervious area would then total 796 to 995 acres. Again according to the corridor studies calculation procedure, the smaller expansion would add 296,753 ft<sup>3</sup> of water quality volume, and the larger one would add 838,531 ft<sup>3</sup>, both far in excess of reserve capacity (40,032 ft<sup>3</sup>) identified in the corridor studies. Thus, under the smaller expansion, there is 256,721 ft<sup>3</sup> of additional water quality volume under the smaller expansion footprint and 798,499 ft<sup>3</sup> of additional water quality volume under the larger expansion. These studies clearly did not anticipate the level of expansion now put forward. Thus, they do not apply at all to the alternatives analyzed in the Stormwater Documents. These documents can only be brought to a condition of adequacy through an analysis of the actual proposed highway modifications and specification of BMPs sufficient to provide thorough management for the stormwater that will be produced.

#### Inadequacy of Proposed Treatment

Not only is use of the stormwater corridor studies inappropriate as a basis for the massive highway expansion under consideration, but the Stormwater Documents misuse the results. The Stormwater Report is disingenuous in claiming, “The introduction of treatment BMPs as part of the build alternatives would represent an improvement when compared to the No-Build condition as there currently are no Caltrans-maintained BMPs treating freeway runoff.”<sup>1</sup> The proposed expansion does not have to take place to get this benefit; the court order requires that Caltrans provide it when any significant new work occurs in the corridor.

Not only is the statement disingenuous, but it is certainly wrong for the larger expansion alternative, and may also be for the smaller one, depending on its traffic levels and composition. At present 1,870,358 ft<sup>3</sup> of runoff is discharged in the design storm without treatment, except by the few BMPs already installed. With the larger expansion and addition of those BMPs listed for the corridor in Caltrans’ 2012 annual report required by the court order, 2,294,785 ft<sup>3</sup> would discharge with no treatment<sup>2</sup>, an increase of 23 percent in untreated stormwater into already highly impaired waters.<sup>3</sup> While the smaller road expansion with the same BMPs would discharge less untreated runoff than now, higher traffic, especially more large truck volume, could still result in more pollutant discharge than now occurs. Any shortfall in treating 20 percent of the existing water quality volume plus all of the volume due to expansion would, under the court order, require compensation on other Caltrans corridors in the watersheds through which the I-710 corridor extends. If one of these expansion projects goes forward with

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<sup>1</sup> Stormwater Report, page 4-6

<sup>2</sup> 1,870,358 ft<sup>3</sup> existing + 838,531 ft<sup>3</sup> new - 414,104 ft<sup>3</sup> sent to treatment = 2,294,785 ft<sup>3</sup>

<sup>3</sup> See Stormwater Chapter section 3.9.2.3 and Stormwater Report section 2.4.

only the BMPs identified by the 2009 studies, the shortfall could be large and difficult or impossible to compensate. Failing to do so would violate the court order.

The list of BMPs presented in the Stormwater Documents does not agree with Caltrans' working list as given in the agency's 2012 annual report required under the court order. The documents cite fewer BMPs with a different composition among biofiltration swales and strips, sand filters, extended-detention basins, and infiltration basins and trenches. I do not have the information necessary to resolve the difference, but I have conservatively assumed the larger number listed in Caltrans' annual report for my assessment above, which showed that using only the BMPs identified in 2009 would certainly worsen water quality with the larger highway expansion and may also do so with the smaller enlargement.

The authors of the Stormwater Documents performed no analysis at all before making the specious claim of improvement, ignoring an ample body of work providing a foundation for such analysis. More than 25 years ago research by Caltrans<sup>1</sup> itself, as well as myself with colleagues<sup>2</sup> and others<sup>3</sup>, determined that pollutant mass loadings in highway runoff accumulating over a number of storms are a function of traffic volume, specifically the number of vehicles traveling during storms. This research devised means of estimating loadings. Other research, again by Caltrans<sup>4</sup> along with many others, established the effectiveness of BMPs in reducing pollutant loadings. Together these results supply a basis for making quantitative estimates of pollutant releases under different scenarios of highway configuration, traffic, and stormwater management.

A further criticism of using the three-year old list of BMPs is that it includes no practices in the category of low impact development ("LID"). LID is a system of practices aimed at avoiding or minimizing runoff above pre-development quantities and reducing pollutants in any remnant excess runoff before its discharge. These methods concentrate on exploiting the capabilities of vegetation and soil to mimic pre-development site hydrology and effectuate pollutant capture mechanisms (e.g., solids filtration, exchange of toxic metal ions in runoff with innocuous metal ions like calcium in soils). The techniques reduce pollutant mass loadings by decreasing both their concentrations in runoff and the quantity of water transporting these contaminants.<sup>5</sup> Hallmarks of LID practices are amending soils with organic compost and selecting appropriate vegetation, preferably in several canopy layers, to increase water storage, infiltration, and evapotranspiration and improve pollutant removal mechanisms. Conventional practices such as selected in the 2009 studies utilize whatever soils are present and a simple vegetation palette

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<sup>1</sup> Kerri, K.D., J.A. Racine, and R.B. Howell. 1985. Forecasting Pollutant Loads from Highway Runoff. Pres. 64<sup>th</sup> Annual Meeting, Transportation Research Board, Washington, D.C.

<sup>2</sup> Horner, R.R. and B.W. Mar. 1982. Guide for Water Quality Impact Assessment of Highway Operations and Maintenance, WA-RD-39.14. Washington State Department of Transportation, Olympia, WA.  
Chui, T.W., B.W. Mar, and R.R. Horner. 1982. Pollutant Loading Model for Highway Runoff. *J. Environ. Eng. Div. ASCE* 108(EE6):1193-1210.

<sup>3</sup> Driscoll, E.D., P.E. Shelley, and E.W. Strecker. 1990. Pollutant Loadings and Impacts from Highway Stormwater Runoff, Vol. I-IV, FHWA-RD-88-007. Federal Highway Administration, McLean, VA.

<sup>4</sup> California Department of Transportation. 2004. BMP Retrofit Pilot Program Final Report, CTSW-RT-01-050. California Department of Transportation, Sacramento, CA.

<sup>5</sup> Loading (mass/unit time) = Concentration (mass/unit volume) x Flow rate (volume/unit time)

(e.g., grasses) and generally fail to achieve as much volume reduction or water quality improvement.

The U.S. Environmental Protection Agency noted this same deficiency in a comment letter on the I-710 corridor project, stating:<sup>1</sup>

EPA recommends that specific Low Impact Development (LID) design measures be identified and described in the DEIS, with reference to location for implementation as well as a description of impacts avoided and/or reduced through incorporating such measures. Expand upon the discussion to insure that stormwater runoff will be managed to insure no adverse impacts to water quality will result from the project.

Guidance exists for applying LID in highways settings (Low Impact Development Center, Inc. 2006a, b)<sup>2</sup>. The Washington State Department of Transportation<sup>3</sup>, among others, has added LID practices to its stormwater management strategies. LID practices are numerous and expanding with the application of existing configurations in new ways. Practices especially suitable for highways follow.<sup>4</sup>

- Runoff conveyance practices—maintaining natural drainage patterns (e.g., depressions, natural swales) as much as possible, and designing drainage paths to increase the time before runoff leaves the site by:
  - Emphasizing sheet instead of concentrated flow
  - Eliminating curb-and-gutter systems in favor of natural drainage systems
  - Roughening land surfaces
  - Creating long flow paths over landscaped areas
  - When flow must be concentrated, using vegetated channels with flow controls (e.g., check dams)

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<sup>1</sup> Letter from Connell Dunning, U.S. Environmental Protection Agency, Region IX, San Francisco, CA to Ronald Kosinski, California Department of Transportation, District 7, Los Angeles, CA; March 9, 2012

<sup>2</sup> Low Impact Development Center, Inc., GeoSyntec Consultants, University of Florida, and Oregon State University. 2006a. Evaluation of Best Management Practices for Highway Runoff Control, Low Impact Development Design Manual for Highway Runoff Control (LID Design Manual). Prepared for National Cooperative Highway Research Program, Transportation Research Board, National Research Council, Washington, DC.

Low Impact Development Center, Inc., GeoSyntec Consultants, University of Florida, and Oregon State University. 2006b. Evaluation of Best Management Practices for Highway Runoff Control, User's Guide for BMP/LID Selection (Guidelines Manual). Prepared for National Cooperative Highway Research Program, Transportation Research Board, National Research Council, Washington, DC.

<sup>3</sup> Washington State Department of Transportation. 2011. Highway Runoff Manual. Washington State Department of Transportation, Olympia, WA.

<sup>4</sup> After:

U.S. Environmental Protection Agency (USEPA). 2007. Reducing Stormwater Costs through Low Impact Development (LID) Strategies and Practices. USEPA, Nonpoint Source Control Branch, Washington, DC.  
National Research Council (NRC). 2009. *Urban Stormwater Management in the United States*. The National Academies Press, Washington, DC.

- Practices for temporary runoff storage followed by infiltration and/or evapotranspiration<sup>1</sup>—use of soil pore space and vegetative tissue to increase the opportunity for runoff to percolate to groundwater or vaporize to the atmosphere:
  - Bioretention cell (rain garden)
  - Vegetated swale (channel flow)
  - Vegetated filter strip (sheet flow)
  - Infiltration basin
  - Infiltration trench
  - Permeable pavement

### Needed for Stormwater Document Adequacy

The Stormwater Documents must present a detailed, quantitative water quality analysis based on the specific circumstances of the alternatives under consideration for the I-710 corridor. The analysis must assess the corridor's present and prospective future role in water quality impairment in the water bodies to which it drains (Dominguez Channel/Los Angeles Harbor, Los Angeles River and its Compton Creek and Rio Hondo tributaries, and San Gabriel River). It must employ the available analytical tools to produce estimates of water pollutant discharges with implementation of each alternative in comparison to the current status. The assessment must then determine how much stormwater treatment is needed to meet total maximum daily load (TMDL) and other water quality objectives in the receiving water bodies. It is essential to specify tentative BMPs to meet the requirement, emphasizing LID practices to the extent possible and supplementing them as needed with conventional techniques. The analysis must convincingly demonstrate that the reconstructed corridor's stormwater discharges will not worsen water quality and will supply its required share of load reduction to meet the regulatory objectives.

The Stormwater Documents must commit to extending the analysis as project development proceeds and to finalizing it with a highly detailed examination of the potential for discharge pollutants from the operating highway to receiving waters without sufficient BMPs. They must further commit to refining the BMP selections accordingly and to finalizing the permanent stormwater management strategy. It is essential for them to affirm that the ultimate project documents will provide full specifications on BMP composition and placement, the design and maintenance standards that will be applied, and a demonstration of their projected effectiveness relative to requirements for meeting water quality objectives.

### **Construction Phase**

#### Definition of the Problem

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<sup>1</sup> Some of these practices are also conventional stormwater BMPs but are LID practices when LID landscaping methods are employed as necessary to maximize storage, infiltration, and evapotranspiration. These landscaping methods include amending soils with organic compost unless they are highly infiltrative and planting several vegetation canopy layers (e.g., herbaceous growth, shrubs, and trees).

Construction of even a large project like the I-710 corridor is limited in length compared to its subsequent operation. Yet, performed poorly, the construction phase can be disproportionately damaging to the environment. Expanding I-710 from 6 or 8 lanes now to 10 or 14 lanes will require disturbing a large area of soil (1,613-1,803 acres depending on the alternative selected, according to the Stormwater Documents). Both measurements and estimates using a mathematical model indicate 30 to more than 1000 times as much soil loss after compared to before clearing land.<sup>1</sup> Therefore, one year of exposure with no erosion controls can release into the environment as much sediment loading as occurred over decades or even centuries before the piece of land was exposed. Increased sediment transport into water bodies has numerous ecological consequences, including:

- Covering and seeping into coarse bed materials where fish spawn and eggs develop; in filling the pore spaces, sediments restrict the flow of water carrying dissolved oxygen, resulting in asphyxiation of the young;
- Covering the surfaces serving as habitat for fish food sources (e.g., insects, algae);
- Filling deeper areas, tending to produce a more homogeneous bed and less habitat diversity;
- Reducing visibility, making it harder for fish to find food and avoid predators;
- Reducing light penetration to underwater plants and algae;
- Abrading the soft tissues of fish, especially gills; and
- Transporting other pollutants present in the soil or picked up in transport.

Soils generally contain nutrients such as phosphorus and nitrogen that fertilize plants and algae. These nutrients are transported along with eroded soil. When they enter natural water bodies and raise the amounts of these substances present in the water, they can stimulate increased growths of algae and aquatic plants, a process known as eutrophication. In these circumstances the forms of algae tend to change from single-celled organisms to filamentous forms, which are less desirable for several reasons. They are generally an inferior food source for wildlife; clog water intakes, conveyances, and boat motors; and foul beaches when they wash up on them. When the increased masses of algae die, bacteria decomposing them exert a large demand on the oxygen dissolved in the water and reduce the amount available for fish. It is not unusual for a eutrophic water body to have little or no oxygen in the colder waters at the bottom and reduced oxygen even near the surface. Expanding rooted plant growths take space otherwise available for both wildlife habitat and human recreation.

Soils can be contaminated with pollutants left over from past activities or applied in connection with construction. These contaminants also move with sediments into water bodies. Past operations and waste disposal can leave metals, petroleum, industrial and commercial chemicals, etc., many of which are toxic to aquatic life. It is very likely that this situation occurs in the highly urban and industrial area of the I-710 corridor. Pesticides are commonly used to eradicate unwanted organisms but can also harm aquatic life when they flow into water with eroded soil.

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<sup>1</sup> Novotny, V. and G. Chesters. 1981. *Handbook of Nonpoint Pollution: Sources and Management*. Van Nostrand Reinhold Company, New York, NY.

Fertilizers are applied in landscaping and can add greatly to the eutrophication potential presented by nutrients native in the soil.

#### Failures of the Stormwater Documents

The Stormwater Documents recognize none of these issues and do not begin to step into any consideration of where and to what extent they might manifest in the I-710 construction. The questions are manifold. For example, where are there relatively erosive soils? Where are there relatively steep slopes vulnerable to erosion? What legacy pollutants could travel with eroded soils and from what areas? How are erosion-susceptible and previously contaminated areas positioned with respect to water bodies? Could water running onto the construction site from elsewhere add to the burden of managing runoff generated on-site? Could groundwater intercepted in excavation add to that burden? Giving no consideration to these site-specific issues further signifies the overly general nature of the Stormwater Documents.

With no basis in site analysis, the Stormwater Documents give only the most basic and meager prescriptions for BMPs. The Stormwater Report is the more complete of the two documents in this respect; but it has just seven bullet points naming, but not further detailing, a “laundry list” of BMPs (tire wash, vehicle and equipment servicing controls, containments [although not coverings] for contaminated materials, spill containment, prohibition of lead-based paints, and the most general statement about monitoring). It goes on to discuss briefly additional mitigation of sediments when working in water but totally ignores how the massive disturbed soil areas will be managed. A large suite of controls is available to prevent or minimize erosion, sediment movement, and transport of other construction-generated pollutants. When used properly, they can avoid or greatly reduce the occurrence of the problems described above. Unfortunately, the Stormwater Documents do not meaningfully evaluate their application in the I-710 corridor or express a definite commitment to their actual use.

#### Needed for Stormwater Document Adequacy

The Stormwater Documents must take seriously the questions raised in the first paragraph of the preceding section of this letter. They must report on a least a preliminary site analysis that locates and assesses the extent of the challenges to managing stormwater properly during construction. They must further commit to extending this analysis as project development proceeds and to finalizing it with a highly detailed examination, across the entire work site, of the potential for release of sediments and other pollutants to receiving waters without sufficient BMPs.

The documents must proceed after the upgraded site analysis to consider the full range of available construction stormwater management BMPs. A committee convened by the National Academy of Sciences to evaluate the nation’s stormwater program, of which I was a member, noted the common shortcomings in protecting the aquatic environment during construction and diagnosed the problem, at least in part, as a failure to recognize the most effective practices and apply them first if appropriate to the construction site’s circumstances (National Research

Council, [NRC] 2009)<sup>1</sup>. To address this problem the committee outlined a recommended approach that puts the numerous types of practices in a hierarchy (Attachment 2). The first priorities are practices that avoid erosion, followed by those that do not entirely prevent it but limit it greatly. Sediment trapping practices are a lower priority, because they are not nearly as effective as the erosion prevention and limiting options, although they still should be considered as backups where risk of damaging sediment release still exists.

The Stormwater Documents, as they stand now, completely ignore the practices in the first two levels of the hierarchy (construction management and disturbed soil stabilization), as well as many others in the list. To be acceptable they must assess the need for and utility of all practices in Attachment 2; select, to the extent possible, those in the upper levels of the hierarchy; specify, at least generally, their applicability throughout the large construction site; and state a commitment to use those determined to be applicable. They must further commit to detailing the BMP selections as project development proceeds and to finalizing it with full specifications on placement throughout the work site and standards of installation, inspection, and maintenance.

I would be pleased to discuss my comment with you and invite you contact me if you wish to do so.

Sincerely,



Richard R. Horner, Ph.D.

Attachments:

1. Richard R. Horner, Ph.D., Background and Experience
2. Recommended Construction Site Stormwater Control Measures

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<sup>1</sup> National Research Council (NRC). 2009. *Urban Stormwater Management in the United States*. The National Academies Press, Washington, DC.

# **ATTACHMENT 1**



# ATTACHMENT 1

**RICHARD R. HORNER, PH.D.**

## BACKGROUND AND EXPERIENCE

I have 35 years of experience in the urban stormwater management field and 11 additional years of engineering practice. During this period I have performed research, taught, and offered consulting services on all aspects of the subject, including investigating the sources of pollutants and other causes of aquatic ecological damage, impacts on organisms in waters receiving urban stormwater drainage, and the full range of methods of avoiding or reducing these impacts.

I received a Ph.D. in Civil and Environmental Engineering from the University of Washington in 1978, following two Mechanical Engineering degrees from the University of Pennsylvania. Although my degrees are all in engineering, I have had substantial course work and practical experience in aquatic biology and chemistry. For 12 years beginning in 1981, I was a full-time research professor in the University of Washington's Department of Civil and Environmental Engineering. From 1993 until 2011, I served half time in that position and had adjunct appointments in two additional departments (Landscape Architecture and the College of the Environment's Center for Urban Horticulture). I spent the remainder of my time in private consulting through a sole proprietorship. My appointment became emeritus in late 2011, but I continue university research and teaching at a reduced level while maintaining my consulting practice.

I have conducted numerous research investigations and consulting projects involving all aspects of stormwater management. Serving as a principal or co-principal investigator on more than 40 research studies, my work has produced three books, approximately 30 papers in the peer-reviewed literature, and over 20 reviewed papers in conference proceedings. I have also authored or co-authored more than 80 scientific or technical reports. In addition to graduate and undergraduate teaching, I have taught many continuing education short courses to professionals in practice. My consulting clients include federal, state, and local government agencies; citizens' environmental groups; and private firms that work for these entities, primarily on the West Coast of the United States and Canada but in some instances elsewhere in the nation.

Over an 18-year period I spent a major share of my time as the principal investigator on two extended research projects concerning the ecological responses of freshwater resources to urban conditions and the urbanization process. I led an interdisciplinary team for 11 years in studying the effects of human activities on freshwater wetlands of the Puget Sound lowlands. This work led to a comprehensive set of management guidelines to reduce negative effects and a published book detailing the study and its results. The second effort, extending 10 years, involved an analogous investigation of human effects on Puget Sound's salmon spawning and rearing streams. These two research programs had broad sponsorship, including the U.S. Environmental Protection Agency, the Washington Department of Ecology, and a number of local governments.

I have helped to develop stormwater management programs in Washington State, California, and British Columbia and studied such programs around the nation. I was one of four principal participants in a U.S. Environmental Protection Agency-sponsored assessment of 32 state, regional, and local programs spread among 14 states in arid, semi-arid, and humid areas of the West and Southwest, as well as the Midwest, Northeast, and Southeast. This evaluation led to the 1997 publication of “Institutional Aspects of Urban Runoff Management: A Guide for Program Development and Implementation” (subtitled “A Comprehensive Review of the Institutional Framework of Successful Urban Runoff Management Programs”).

My background includes 18 years of work in California, where I have been a federal court-appointed overseer of stormwater program development and implementation at the city and county level and for two Caltrans districts. I was directly involved in the process of developing the 13 volumes of Los Angeles County’s Stormwater Program Implementation Manual, working under the terms of a settlement agreement in federal court as the plaintiffs’ technical representative. My role was to provide quality-control review of multiple drafts of each volume and contribute to bringing the program and all of its elements to an adequate level. I have also evaluated the stormwater programs in San Diego, Orange, Riverside, San Bernardino, Ventura, Santa Barbara, San Luis Obispo, and Monterey Counties, as well as a regional program for the San Francisco Bay Area. My clients in these cases include Natural Resources Defense Council, Santa Monica Baykeeper, Orange County Coastkeeper, Ventura Coastkeeper, Santa Barbara Channelkeeper, Russian Riverkeeper, and San Diego Coastkeeper. At the recommendation of the latter organization, I have been a consultant on stormwater issues to the City of San Diego, the San Diego Unified Port District, and the San Diego County Regional Airport Authority.

For the last six years I have been a member of Salmon-Safe’s assessment team. Salmon-Safe is an organization based in Portland, Oregon that certifies academic and professional campuses and other developed lands for maintaining practices supportive of salmon protection and recovery. We have assessed numerous parcels in Oregon and Washington and extended certification to those whose practices met our criteria or conditions imposed to achieve certification.

I was a member of the National Academy of Sciences-National Research Council (NAS-NRC) committee on Reducing Stormwater Discharge Contributions to Water Pollution. NAS-NRC committees bring together experts to address broad national issues and give unbiased advice to the federal government. The present panel was the first ever to be appointed on the subject of stormwater. Its broad goals were to understand better the links between stormwater discharges and impacts on water resources, to assess the state of the science of stormwater management, and to apply the findings to make policy recommendations to the U.S. Environmental Protection Agency relative to municipal, industrial, and construction stormwater permitting. The committee issued its final report in October 2008.

# **ATTACHMENT 2**



## ATTACHMENT 2

### Recommended Construction Site Stormwater Control Measures<sup>1</sup>

1. As the top priority, emphasize construction management practices as follows:
  - Maintain existing vegetation cover, if it exists, as long as possible.
  - Perform ground-disturbing work in the season with smaller risk of erosion, and work off disturbed ground in the higher risk season.
  - Limit ground disturbance to the amount that can be effectively controlled in the event of rain.
  - Use natural depressions and plan excavation to drain runoff internally and isolate areas of potential sediment and other pollutant generation from draining off the site, so long as safe in large storms.
  - Schedule and coordinate rough grading, finish grading, and final site stabilization to be completed in the shortest possible time overall and with the shortest possible lag between these work activities.
2. Stabilize with cover appropriate to site conditions, season, and future work plans. For example:
  - Rapidly stabilize disturbed areas that could drain off the site, and that will not be worked again, with permanent vegetation supplemented with highly effective temporary erosion controls until achievement of at least 90 percent vegetative soil cover.
  - Rapidly stabilize disturbed areas that could drain off the site, and that will not be worked again for more than three days, with highly effective temporary erosion controls.
  - If at least 0.1 inch of rain is predicted with a probability of 40 percent or more, before rain falls stabilize or isolate disturbed areas that could drain off the site, and that are being actively worked or will be within three days, with measures that will prevent or minimize transport of sediment off the property.
3. As backup for cases where all of the above measures are used to the maximum extent possible but sediments still could be released from the site, consider the need for sediment collection systems including, but not limited to, conventional settling ponds and advanced sediment collection devices such as polymer-assisted sedimentation and advanced sand filtration.
4. Specify emergency stabilization and/or runoff collection (e.g., using temporary depressions) procedures for areas of active work when rain is forecast.
5. If runoff can enter storm drains, use a perimeter control strategy as backup where some soil exposure will still occur, even with the best possible erosion control (above measures) or when there is discharge to a sensitive water body.
6. Specify flow control SCMs to prevent or minimize to the extent possible:
  - Flow of relatively clean off-site water over bare soil or potentially contaminated areas;
  - Flow of relatively clean intercepted groundwater over bare soil or potentially contaminated areas;
  - High velocities of flow over relatively steep and/or long slopes, in excess of what erosion control coverings can withstand; and
  - Erosion of channels by concentrated flows, by using channel lining, velocity control, or both.
7. Specify stabilization of construction entrance and exit areas, provision of a nearby tire and chassis wash for dirty vehicles leaving the site with a wash water sediment trap, and a sweeping plan.
8. Specify construction road stabilization.
9. Specify wind erosion control.
10. Prevent contact between rainfall or runoff and potentially polluting construction materials, processes, wastes, and vehicle and equipment fluids by such measures as enclosures, covers, and containments, as well as berming to direct runoff.

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<sup>1</sup> After National Research Council (NRC). 2009. *Urban Stormwater Management in the United States*. The National Academies Press, Washington, DC.



# **ATTACHMENT G**



# **ANALYSIS OF GREENHOUSE GAS EMISSION ESTIMATES FOR THE INTERSTATE 710 CORRIDOR PROJECT**

## **Technical Memorandum**

September 4, 2012

Prepared for  
Communities for a Better Environment  
6325 Pacific Blvd, Suite 300  
Huntington Park, CA 90255

Prepared by  
Dr. Gregory Gould, PhD  
Assistant Professor  
Department of Civil Engineering  
University of New Mexico  
Albuquerque, NM 87131

## **DISCLAIMER**

The analysis and findings presented in this memo are based on the author's review of select public records available on or before August 1<sup>st</sup>, 2012 related to the 710 corridor DEIR/EIS. Time constraints prohibited the review of all available documentation, technical appendixes, and related studies. The most focus was placed to the main study reports with less emphasis on technical appendices and references to earlier and secondary reports (i.e., those completed for other projects or purposes). The documents reviewed are referenced throughout the memo and it is possible that review of additional documents could have led to different conclusions. The contents of this memo and views concerning the 710 corridor project are solely those of the author and do not imply any endorsement by the University of New Mexico, the Department of Civil Engineering, or Communities for a Better Environment.

## INTRODUCTION

This memo analyzes the greenhouse gas (GHG) emission inventories completed for the 710 corridor project draft EIR/EIS. This analysis was commissioned by Communities for a Better Environment as an independent review of the process and methods used in the GHG analysis. The analysis considers information described in the main body of the draft I-710 Corridor Project EIR/EIS (the Air Quality and CEQA chapters)<sup>1</sup>, the Major Corridor Study (MCS)<sup>2</sup>, and two related technical studies completed for the project: Air Quality and Health Risk Assessments Technical Studies<sup>3</sup>, and the Energy Report<sup>4</sup>. This review focuses on the analytical methods used and the assessment processes (which items were considered and which were not). Given the time constraints of this study, an in-depth review of the data that were relied on was not possible. Additionally, estimating new GHG inventories for alternatives that were not considered are outside the scope of this review.

### The Assessment Process

The MCS (see the Analysis of the Alternatives Selection Process for the Interstate 710 Corridor Project technical memo for a brief description) did not evaluate GHG emissions for any of the alternatives. This is a major limitation because the MCS considered the largest selection of initial alternatives (12 alternatives) and was the only analysis to consider a large investment in new transit infrastructure that may have reduced GHG emissions (a new heavy rail system). The draft EIR/EIS and supporting documentation did consider GHG emissions for the final set of alternatives but not for the initial set of alternatives. Again, this represents a major limitation because the initial set of alternatives considered an alternative fixed guideway system that would have used electric power rather than fossil fuels, potentially reducing GHG. This alternative was screened out. Had GHG emission been considered the project may have been more appealing.

Whether a particular transit or non-highway goods movement alternative would reduce GHG emissions depends on several factors. The ability of the alternative mode to attract and replace a significant amount of current (or projected future) car and truck trips is the most important consideration. Assuming there is a market for the alternative mode, and at least some of that market is composed of former highway users, the GHG emissions of the alternative mode need to be considered. Most alternative transportation modes considered for reducing GHG emissions are electric powered. Estimating the GHG emissions of an electric vehicle can be more complicated than that of a traditional gasoline or diesel fueled vehicle. While the vehicle does not produce any GHG emissions, its power source likely does. Calculating the GHG emission from electric vehicles therefore requires estimating the GHG intensity of the power source which depends on the fuel source (coal, gas, wind, etc.) and the efficiency of the distribution network. In most cases there are no truly zero emission alternatives except for walking and cycling.

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<sup>1</sup> Draft EIR/EIS available from Caltrans: <http://www.dot.ca.gov/dist07/resources/envdocs/docs/710corridor/>

<sup>2</sup> Major Corridor Study available from Metro: <http://www.metro.net/projects/i-710-corridor-project/feasibility-assessment/>

<sup>3</sup> Air Quality and Health Risk Assessments Technical Studies available from Metro: Air Quality and Health Risk Assessments Technical Studies

<sup>4</sup> Energy Report available from Caltrans:

[http://www.dot.ca.gov/dist07/resources/envdocs/docs/710corridor/docs/tech\\_studies/i710\\_eireis\\_TechStudies\\_Vol1.zip](http://www.dot.ca.gov/dist07/resources/envdocs/docs/710corridor/docs/tech_studies/i710_eireis_TechStudies_Vol1.zip)

## The Assessment Methodology

A GHG inventory was estimated for each of the 4 final alternatives in the draft EIR/EIS. The GHG inventory considered both construction emissions (construction equipment) and operating emissions (vehicle energy use). The GHG emissions were also compared to present day (year 2008) GHG emission for CEQA purposes.

There were no construction emissions for alternatives 1 and 2 since they involve little or no construction. Build alternatives 5 and 6(a,b,c) would produce 177,500 and 245,900 metric tons of carbon dioxide (CO<sub>2</sub>), respectively. These are fairly small amounts of CO<sub>2</sub> considering that they are spread over 8 years and that the estimated year 2008 baseline emissions from vehicles traveling on the 710 freeway are 63.4 million metric tons of CO<sub>2</sub> per year.

This analysis is only a limited accounting of construction CO<sub>2</sub> emissions because is only emissions from the construction equipment used to build each project were considered. However, large quantities of CO<sub>2</sub> emissions are also attributable to the materials used in construction such as steel, concrete, and asphalt. While contributions from construction materials are not usually considered in environmental review documents like this, recent scientific literature has pointed out the importance of considering these impacts (i.e., life cycle GHG emissions). Unlike most harmful air pollutants where the impacts depend on where and when emissions occur, the impacts of GHG emissions are global and it does not matter if the emissions were produced at a distance cement plant or by the fuel burning in a construction vehicle working on site. For example, a recent study of the lifecycle GHG emissions from different modes of goods movement indicates that road infrastructure can account for almost 10% of the CO<sub>2</sub> emissions attributable to trucking assuming a flat, 4-lane, asphalt freeway<sup>5</sup>. Adding elevated structures such as those proposed for the 710 freeway would likely result in greater CO<sub>2</sub> emissions.

Operational emissions accounted for the bulk of GHG emissions which included CO<sub>2</sub>, N<sub>2</sub>O, and CH<sub>4</sub> emissions. The emission inventory used estimates of vehicle miles traveled (VMT), speed, and the vehicle fleet composition from a travel demand model created for the 710 corridor project. These data were used with California Air Resources Board's EMFAC2007 emission factor model to estimate the average fuel economy of each vehicle class, g/mi N<sub>2</sub>O, and g/mi CH<sub>4</sub> emission factors. Total fuel consumption was then estimated with the VMT and fuel economy data. Total CO<sub>2</sub> emissions were estimated by multiplying the fuel consumption total by CO<sub>2</sub> emission factors from California Climate Action Registry. The N<sub>2</sub>O and CH<sub>4</sub> emission factors and VMT estimates for each vehicle class were used to calculate the total N<sub>2</sub>O and CH<sub>4</sub> emissions. The CO<sub>2</sub>, N<sub>2</sub>O and CH<sub>4</sub> emission totals were then combined into a single CO<sub>2</sub> equivalent GHG metric (CO<sub>2</sub>e). These calculation methods are fairly standard and no flaws were evident.

A potential limitation of the operational GHG emission inventory is that it is unclear if the GHG inventories include GHG emissions produced by power plants that supply electric power to the electric trucks. While the CEQA section of the draft EIR/EIS states that the estimates do include these emissions, the referenced technical study<sup>6</sup> and its appendix<sup>7</sup> do not mention including these emissions. If these emissions were

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<sup>5</sup> Figure 2 in Facanha, C. and A. Horvath. (2007). *Evaluation of Life-Cycle Air Emissions Factors of Freight Transportation*. Environmental Science and Technology, Vol 41 (20), pp. 7138-7144.

<sup>6</sup> Ari Quality and Health Risk Assessments Technical Study:  
[http://www.metro.net/projects\\_studies/I710/images/tech\\_study/AQ\\_HRA\\_ENVIRON\\_Final\\_020312.pdf](http://www.metro.net/projects_studies/I710/images/tech_study/AQ_HRA_ENVIRON_Final_020312.pdf)

included, this reviewer could not find any documentation of the methods used. Additionally, the GHG estimates for each alternative in the CEQA section of the draft EIR/EIS do not correspond to the GHG estimates in the referenced technical study.

The future year (year 2035) operational GHG emission estimates were found to be very similar for all alternatives. This occurs because the main variable that varies between each of the alternatives that could affect GHG emissions is VMT (assuming that GHG emissions from electric trucks are not included). Since each alternative has about the same VMT they also have about the same GHG emission estimates. Had alternatives that considered transit, alternative goods movement technologies, or anything that would significantly change VMT been considered the GHG emission estimates would have shown greater variation.

### Summary

The GHG emission analysis had two limitations. GHG emissions were not estimated for the initial set of alternatives in either the MCS or 710 Corridor EIR/EIS. The potential of an alternative to reduce GHG was not part of the initial decision making process. GHG emissions were considered once a reduced set of alternatives were selected; however, since each alternative had similar VMT projections and used similar technology there was little variation in GHG emissions. The second limitation is that the GHG emission from power sources used for electric modes may not have been considered. A third, and more minor, limitation was that construction GHG emission estimates did not consider the GHG emissions from the highway building materials. These emissions are not normally considered in environmental review documents for public projects but would provide a more accurate basis for comparing GHG emissions between alternatives. Other than these omissions, there were no apparent flaws in the methods and models used to estimate the GHG emissions that would result from the project.

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<sup>7</sup> Ari Quality and Health Risk Assessments Technical Study Appendices:  
[http://www.metro.net/projects\\_studies/I710/images/tech\\_study/AQ\\_HRA-Appendices.pdf](http://www.metro.net/projects_studies/I710/images/tech_study/AQ_HRA-Appendices.pdf)



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## EDUCATION

PhD

**University of California, Davis**

Civil and Environmental Engineering: concentration in Transportation, 2010

Dissertation title: A Spatially Detailed Locomotive Emission Model and Goods Movement Data Constraints on Public Policy and Planning.

Committee: Debbie Neimeier, Ph.D. (advisor), Susan Handy, Ph.D., and Jay Lund, Ph.D.

MS

**University of Maine, Orono**

Resource Economics and Policy: concentration in Environmental Economics and Policy, 2006

Thesis title: A spatial analysis of passenger vehicle attributes, environmental impact and policy.

Advisor: Jonathan Rubin, Ph.D.

BS

**University of Maine, Orono**

Chemical Engineering, 2003

## RESEARCH EXPERIENCE

**University of New Mexico, Albuquerque, NM**

(8/2012 – current)

*Assistant Professor, Department of Civil Engineering*

- Sustainable transportation systems
- Mobile source emission modeling
- Goods movement modeling

**Natural Resources Defense Council, Santa Monica, CA** (7/2010 – 7/2012)

*Transportation and Air Quality Science Fellow*

- Created a spatially detailed, national GIS-based model that quantifies and maps disparities in income and racial composition of people living near high volume roads. This research is important for quantifying potential health risks from exposure to air pollutants, identifying environmental justice concerns, and siting a more robust air quality monitoring network.
- Researching disparities in particulate matter exposure from highway vehicle emissions in Los Angeles, CA using the region's travel demand model, emission factor modeling, and fine grained air dispersion modeling. The research will identify how different regional transportation plans affect local air quality hot spots, identify environmental justice concerns, and provide more accurate emission exposure data for epidemiology research.
- Created a multimodal freight model for the Chicago region to study regional transportation, air quality, and economic effects from proposed measures to prevent the spread of Asian Carp from the Mississippi River system to the Great Lakes.
- Research how regional transportation planning agencies use travel demand and land-use models, and the limitations of those models, for developing more sustainable transportation plans that reduce VMT and improve air quality.

- Provide technical modeling assistance to environmental justice organizations, environmental non-profit organizations, and community groups. Help these groups develop advocacy that is supported by objective scientific research.
- Mentor a Ph.D. student science intern and project assistants.

**University of California**, Davis, CA (9/2006 – 7/2010)

*Research Assistant*, Department of Civil & Environmental Engineering

- Created a new GIS-based locomotive emission model for the California Air Resources Board.
- Created and administered a household energy use survey to investigate technical and behavioral methods of energy conservation.
- Researched the role and limitation of goods movement data and models in California's Trade Corridor's Improvement Fund program, which disbursed \$3 billion for goods movement infrastructure projects including private freight rail infrastructure.
- Created a cellular automaton-based traffic simulation model for bicycle traffic and validated it with field data .
- Mentored undergraduate research assistants.

**Pew Center on Global Climate Change**, Washington, D.C. (12/2008 –

*Consultant*

8/2009)

- Co-authored a report on greenhouse gas emissions from domestic and international aviation and marine transportation.
- My primary contribution was researching and writing the marine transportation sections, quantifying the potential to reduce GHG emissions from domestic and international shipping through technology and operations and identifying policies to achieve those reductions.

**University of Maine**, Orono, ME (9/2004 – 8/2006)

*Research Assistant*, Department of Resource Economics & Policy and the Margaret Chase Smith Policy Center

- Created a GIS-based model to identify spatial patterns in vehicle ownership. The model was used to evaluate the equity of fuel economy and gas tax policies by comparing how consumer costs and benefits vary across communities.
- Assisted in researching and modeling tradable passenger vehicle fuel economy permit systems.
- Co-authored a report for the Maine Department of Transportation on alternative transportation funding options.

**OTHER WORK EXPERIENCE**

**National Semiconductor**, South Portland, ME (3/2004-8/04, 5/2001-8/01, 5/2000-9/00)  
*Process Engineer*, Cooperative work experience

**Fairchild Semiconductor**, South Portland, ME (5/2002 – 1/2003)  
*Process Engineer*, Cooperative work experience

**COMMUNITY SERVICE**

**The Ride for Roswell**, Buffalo, NY (4/2011 – 6/2011)

- Assessed the capacity of a course for a large organized bicycle ride for a non-profit foundation using my previous experience in bicycle traffic modeling. Advised the organizers on a plan to collect data that could help ensure an enjoyable and safe event in the future.

**PEER REVIEWED PUBLICATIONS**

**Gould, G.** and D. Niemeier (2011). Assignment of Emissions Using a New Locomotive Emissions Model. *Environmental Science and Technology*. 45(13): 5846-5852.

**Gould, G.** and A. Karner (2009). Modeling Bicycle Facility Operation: a Cellular Automaton Approach. *Transportation Research Record: Journal of the Transportation Research Board*. 2140: 157-164.

McCollum, D., **G. Gould**, and D. Greene (2009). Greenhouse Gas Emissions from Aviation and Marine Transportation: Mitigation Potential and Policies. Report prepared for the Pew Center on Global Climate Change, Washington D.C.

**Gould, G.** and D. Niemeier (2009). Review of Regional Locomotive Emission Modeling and the Constraints Posed by Activity Data. *Transportation Research Record: Journal of the Transportation Research Board*. 2117: 24-32.

Niemeier, D., **G. Gould**, A. Karner, M. Hixson, B. Bachmann, C. Okma, Z. Lang and D. Heres Del Valle (2008). Rethinking downstream regulation: California's opportunity to engage households in reducing greenhouse gases. *Energy Policy*, 36(9)

## OTHER PUBLICATIONS

**Gould, G.** Physical Separation of the Chicago Area Waterway System: The Economic and Environmental Impact of Barge Traffic Disruption. *NRDC Working Paper*.

**Gould, G.** and D. Niemeier. (2010). Report on the Development of a GIS Enabled Locomotive Emission Model for California. Research report prepared for the California Air Resources Board, Sacramento, CA.

**Gould, G.** and A. Karner. (2009). Modeling Bicycle Facility Operation: a Cellular Automaton Approach. Institute of Transportation Studies, University of California, Davis, Research Report UCD-ITS-RR-09-10.

C. Noblet, **G. Gould**, J. Rubin, D. Innis, and C. Morris (2006). Sustainable Transportation Funding for Maine's Future. Report prepared for the Maine Department of Transportation, Augusta, ME.

## PRESENTATIONS

**Gould, G.** (October 25, 2011). *Income, Race, and the Odds of Living Along Busy Roadways: Using Census Data to Consider Equity and Environmental Justice in Regional Transportation Planning*. Presented at the Transportation Research Board Using Census Data for Transportation conference, Beckman Center of the National Academies, Irvine, CA.

**Gould, G.** (May 7, 2010). *A Spatially Detailed Locomotive Emission Model and Goods Movement Data Constraints on Public Policy and Planning*. Presented at the Institute of Transportation Studies, University of California, Davis, CA.

**Gould, G.** and D. Niemeier (January 12, 2010). *A Geographically Detailed Locomotive Emission Model*. Poster presented at the Transportation Research Board 89th Annual Meeting, Washington, D.C.

**Gould, G.** (October 9, 2009). *Considering Goods Movement: Air Quality and Climate Change Issues in Planning and Policy*. Invited seminar at the School of Economics, University of Maine, Orono, ME.

**Gould, G.** and A. Karner (January 14, 2009). *Modeling Bicycle Facility Operation: a Cellular Automaton Approach*. Presented at the Transportation Research Board 88th Annual Meeting, Washington, D.C.

**Gould, G.** and D. Niemeier (January 12, 2009). *Review of Regional Locomotive Emission Modeling and the Constraints Posed by Activity Data*. Presented at the Transportation Research Board 88th Annual Meeting, Washington, D.C.

**Gould, G.**, D. Niemeier, and A.V. Goodchild (March 17, 2008). *A Cart Before the Horse: Disaggregate Locomotive Models and Data Constraints*. Poster presented at the Transportation Research Board Data for Goods Movement Impact on Air Quality Conference, Irvine, CA.

**Gould, G.** (March 17, 2006). *A spatial analysis of passenger vehicle attributes, environmental impact and policy*. Presented at Laval-UMaine Student Research Conference, Department of Agricultural Economics, Laval University, Quebec, Canada.

**Gould, G.** (December 6, 2005). *A spatial analysis of passenger vehicle attributes, environmental impact and policy*. Seminar talk at the Cambridge Center for Climate Change Research, University of Cambridge, Cambridge, UK.

**JOURNAL  
REFEREE**

Environmental Science and Technology  
Journal of Zhejiang University Science C  
Physics Letters A  
Transportation Research Part A: Policy and Practice  
Transportation Research Record, Journal of the Transportation Research Board

**AFFILIATIONS**

American Association for the Advancement of Science  
American Chemical Society  
American Economic Association  
Association of Environmental and Resource Economists  
Transportation Research Board

# **ATTACHMENT H**





To: Angelo Logan; I-710 Corridor Project Committee

From: Justin Scoggins; Program for Environmental and Regional Equity

RE: Socioeconomic characteristics of residents near the I-710 Corridor

Date: September 27, 2012

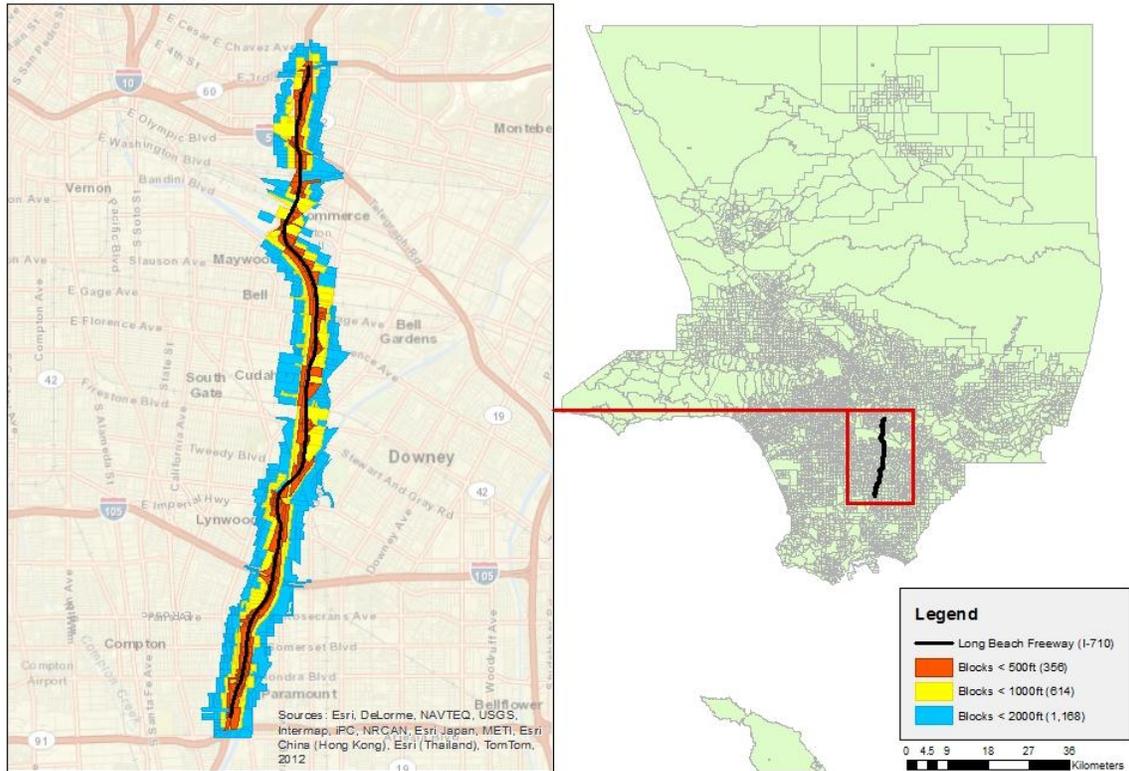
We have completed our analysis of the requested socioeconomic characteristics of residents living near the I-710 Corridor. The results are included below, and have been provided to you in other formats. We find that residents living with various distance bands of the I-710 Corridor (within 500ft, 1,000ft, and 2,000ft, respectively) are far more likely to residents of color (that is, not non-Hispanic white) when compared the general population of Los Angeles County, California, or the U.S. This disparity is driven by the Latino share of the population, which is about 92 percent within each of the distance bands – nearly double the share for Los Angeles County and more than five time the share for the U.S. overall. We also find higher poverty rates, lower per capita income, and (to a lesser extent) greater lack of access to vehicles for workers ages 16 and older who reside within the aforementioned distance bands of the I-710 Corridor.

Demographic comparison of neighborhoods near the 710 Freeway to Los Angeles County, California and the United States (2010)

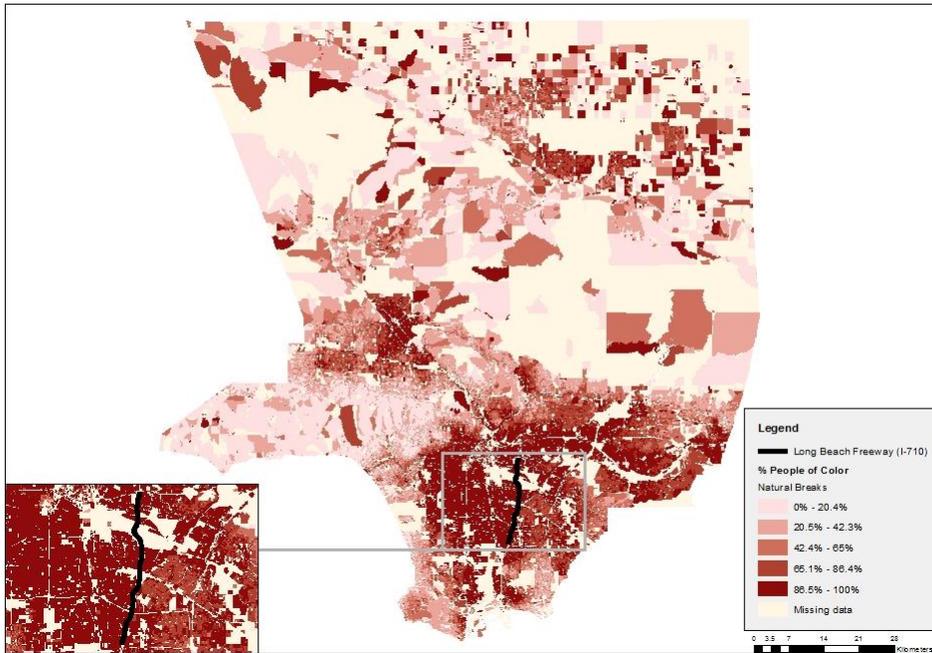
	Neighborhoods by Distance from 710 Freeway			Los Angeles County	California	United States
	<500 ft	<1,000 ft	<2,000 ft			
<b>Total population</b>	9,650	25,898	81,065	9,818,605	37,253,956	308,745,538
<b>Race/ethnicity</b>						
non-Hispanic white	3%	3%	3%	28%	40%	64%
non-Hispanic Black	3%	4%	4%	8%	6%	12%
Hispanic	92%	92%	92%	48%	38%	16%
non-Hispanic Asian or Pacific Islander	1%	1%	1%	14%	13%	5%
non-Hispanic all other	1%	1%	1%	2%	3%	3%
<b>Age composition</b>						
Under 5 years	9%	9%	9%	7%	7%	7%
5 to 17 years	24%	24%	25%	18%	18%	17%
18 to 64 years	59%	60%	60%	65%	64%	63%
Over 64 years	7%	7%	6%	11%	11%	13%
<b>Income, poverty and car access (2010 5-Year ACS)</b>						
Poverty rate	21%	19%	21%	16%	14%	14%
Per capita income (\$2010)	\$13,494	\$13,269	\$13,039	\$27,344	\$29,188	\$27,334
No vehicles available (share of workers ages 16+)	7.4%	5.4%	4.8%	4.8%	3.5%	4.3%

Source: Program for Environmental and Regional Equity (PERE) Analysis of data from the 2010 Census (SF1) and the 2010 5-Year American Community Survey (ACS).  
 Notes: Data for neighborhoods by distance from the 710 Freeway are based on census blocks for which the Internal Point (based on Internal Point Latitude and Internal Point Longitude) fell within the indicated distances of the 710 Freeway (see map). Data on income, poverty, and access to vehicles is not available at the census block level, and was estimated for neighborhoods by distance from the 710 Freeway by taking weighted averages of these measures across all census block groups (in the case of income and poverty) and census tracts (in the case of vehicles available) with any block-level population falling inside the various distance bands, using available block level population information to appropriately down-weight block groups and tracts for which the block-level population did not fall entirely within the distance bands.

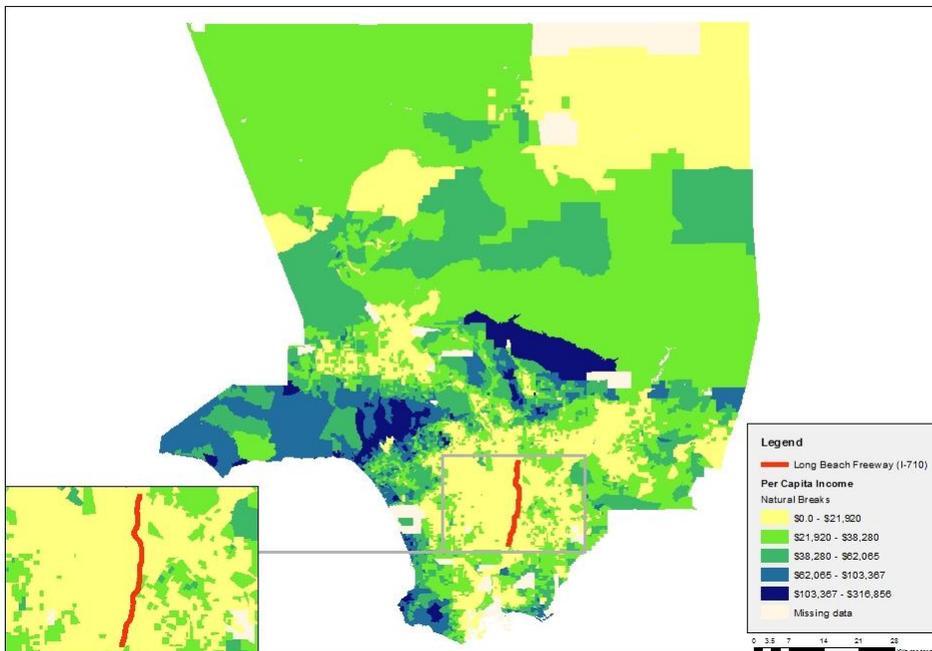
Census Blocks within 500, 1000 and 2000 Feet of the Long Beach Freeway



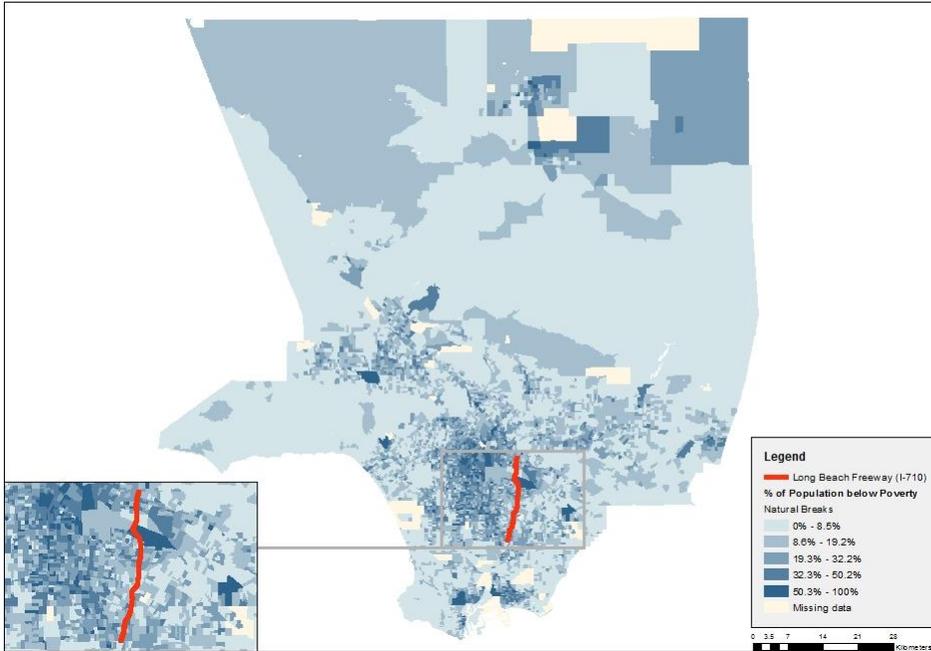
Percentage of People of Color by Census Block, Los Angeles County, Census 2010



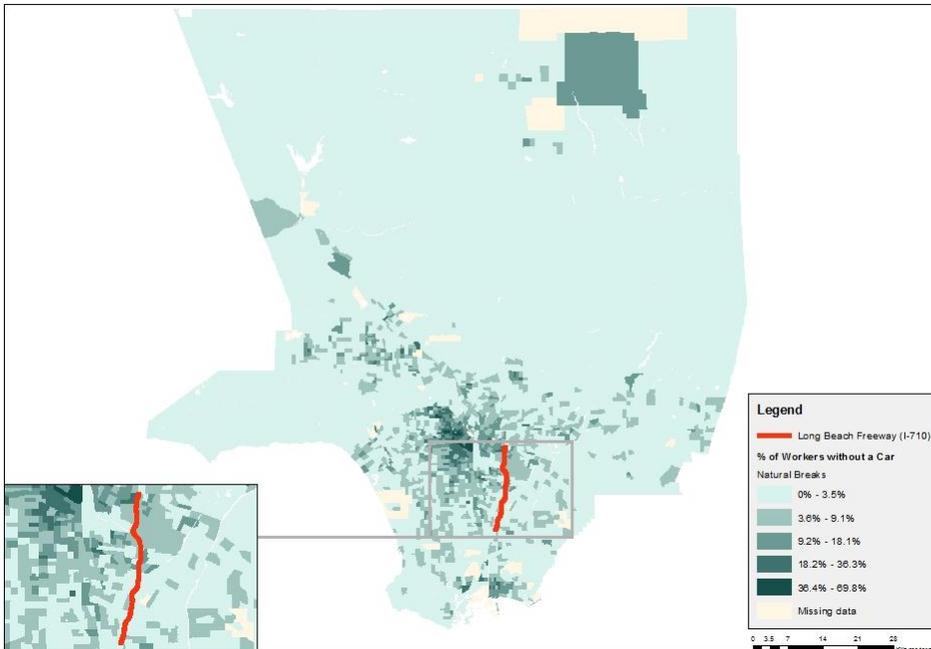
Per Capita Income by Census Block Group, Los Angeles County, ACS 2006-2010



Percentage of the Population below Poverty by Census Block Group, Los Angeles County, ACS 2006-2010



Percentage of Workers without Cars by Census Tract, Los Angeles County, ACS 2006-2010



# CURRICULUM VITAE

## Justin Scoggins

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Cell: (415) 314-5482

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### Education

1998-2002: BA, Economics, University of California, Santa Cruz  
2001-2003: MS, Applied Economics and Finance, University of California, Santa Cruz

### Job Skills

#### *Computer knowledge:*

- Proficiency in SAS, SPSS, STATA, SpaceStat, GEODA, ArcView GIS, ArcMap, MS Excel, MS Powerpoint, Adobe Illustrator and Adobe In-Design
- Significant econometric and spatial econometric knowledge and experience
- Extensive experience working with large datasets and spatial, geo-coded Datasets
- Substantial GIS experience and knowledge
- Good verbal/written communication skills including technical documentation
- Excellent Internet research skills

### Experience

#### *Data Manager*

*University of Southern California*

#### **2011 to present**

- Manage and maintain large datasets, and guide on quantitative analyses conducted by Data Analysts on a variety of projects of the Program for Environmental and Regional Equity (PERE) and the Center for the Study of Immigrant Integration (CSII).
- Assist director in developing research objectives
- Identify data sources and develop research methodologies
- Development methodology for quantitative analyses
- Contribute to the writing of research reports and documentation
- Preparation and delivery of presentations to various audiences
- Assist with the preparation of grant reports and proposals

#### *Data Analyst*

*University of Southern California*

#### **2008 to 2010**

- Data analytic and GIS support for the Program for Environmental and Regional Equity (PERE), and Center for the Study of Immigrant Integration (CSII)

- Development methodology for quantitative analyses
- Contribute to the writing of research reports and documentation
- Preparation and delivery of presentations to various audiences
- Assist with the preparation of grant reports and proposals

*Data analysis consultant  
Cabrillo Community College*

**2007**

- Provided preparation and analysis of publicly available community college data and census data for all community colleges in the US to develop a roll-out strategy for the Digital Bridge Academy program. Produced a Powerpoint presentation including maps, graphs and charts describing the strategy. Completed documentation of the methods used and data sources.

*Assistant Specialist, Research Series  
University of California, Santa Cruz*

**2004 to 2007**

- Processing and analysis of the data on air pollution (e.g. 1999 National Air Toxics Assessment (NATA) and the 2003 Toxic Release Inventory (TRI))
- Preparation and delivery of presentations to on our environmental justice and other research
- Developed a methodology for various quantitative analyses.
- Supervised two undergraduate students in working on some of the above research Projects

*Junior Specialist, Research Series  
University of California, Santa Cruz*

**2003**

- As primary researcher, completed programming of and documentation for a small area income forecasting module created for the Southern California Association of Governments (SCAG) that predicts median household income, income distributions and several other income measures at the Census tract level, and lead instructional sessions with SCAG staff on how to use it.

*Graduate Student Researcher  
University of California, Santa Cruz*

**2002**

- Assisted with regression analysis for research projects in the areas of labor market intermediaries and small area income forecasting.

## **Publications**

## **Journal articles**

Sadd, J., Pastor, M., Morello-Frosch, R., Scoggins, J., Jesdale, B. (2010). Playing It Safe: Assessing Cumulative Impact and Social Vulnerability through an Environmental Justice Screening Method in the South Coast Air Basin, California. *International Journal of Environmental Research and Public Health*, 2011, vol. 8, issue 5, pp. 1441-1459.

Pastor, M., Lester, B., Scoggins, J. (2009). Why Regions? Why Now? Who Cares?. *Journal of Urban Affairs*. Vol. 31 (No. 3)

Pastor, M., Scoggins, J. (2008). "'Space . . . The Final Frontier': Autocorrelation and Small Area Income Forecasting Models". *Journal of Planning Education and Research*.. Vol. 27, pp. 431-443.

### **Research reports**

Pastor, M., De Lara, J., Sadd, J., Scoggins, J. (2011). All Together Now? African Americans, Immigrants and the Future of California. USC Center for the Study of Immigrant Integration.

Pastor, M., Scoggins, J. Immigrant Labor and the American Recovery: A Brief Memo. USC's Center for the Study of Immigrant Integration.

Pastor, M., Scoggins, J., Tran, J. (2010). A State Resilient: Immigrant Integration and California's Future. Center for the Study of Immigrant Integration.

Pastor, M., Morello-Frosch, R., Sadd, J., Scoggins, J. (2010). Minding the Climate Gap: What's at Stake if California's Climate Law is Done Right and Right Away. USC Program for Environmental and Regional Equity.

Pastor, M., Scoggins, J., Tran, J., Ortiz, R. (2010). The Economic Benefits of Immigrant Authorization in California. USC's Center for the Study of Immigrant Integration.

Pastor, M., Ash, M., Boyce, J., Chang, G., Tran, J., Scoggins, J. (2009). Justice in the Air: Tracking Toxic Pollution from America's Industries and Companies to Our States, Cities, and Neighborhoods. Political Economy Research Institute / Program for Environmental and Regional Equity.

Pastor, M., Morello-Frosch, R., Sadd, J., Scoggins, J. (2009). Emitting on the Dock of the Bay: Air Toxics and Environmental Inequality in the San Francisco Metropolitan Area.

Pastor, M., Scoggins, J. (2004). Income Forecasting at the Small Area Level for Southern California: Issues, Methods, and Projections: Final Report to the Southern California Association of Governments. CJTC, UC Santa Cruz.

### **Book chapters**

Pastor, M., Morello-Frosch, R., Sadd, J., Scoggins, J. (2010). Risky Business: Cap-and-Trade, Public Health, and Environmental Justice.



# **ATTACHMENT I**



# **ANALYSIS OF THE ALTERNATIVES SELECTION PROCESS FOR THE INTERSTATE 710 CORRIDOR PROJECT**

## **Technical Memorandum**

August 30, 2012

Prepared for  
Communities for a Better Environment  
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Albuquerque, NM 87131

## **DISCLAIMER**

The analysis and findings presented in this memo are based on the author's review of select public records available on or before August 1<sup>st</sup>, 2012 related to the 710 corridor DEIR/EIS. Time constraints prohibited the review of all available documentation, technical appendixes, and related studies. The most focus was placed to the main study reports with less emphasis on technical appendices and references to earlier and secondary reports (i.e., those completed for other projects or purposes). The documents reviewed are referenced throughout the memo and it is possible that review of additional documents could have led to different conclusions. The contents of this memo and views concerning the 710 corridor project are solely those of the author and do not imply any endorsement by the University of New Mexico, the Department of Civil Engineering, or Communities for a Better Environment.

## INTRODUCTION

This analysis was commissioned by Communities for a Better Environment (CBE) to generate a better understand of how alternatives were developed and ultimately selected for Metro's (the Los Angeles County Transportation Agency) Interstate 710 corridor project. CBE's concerns included how alternatives to highway capacity expansion were considered and, in particular, how well the process evaluated ideas proposed by CBE's members and affiliates who live in the 710 corridor. CBE's concerns are addressed by reviewing each step of the alternatives selection process: the statement of purpose and needs, the creation of alternatives, and the development of evaluation metrics. At each step in the process analytical flaws, limitations, or important assumptions are noted and discussed. This review did not consider in detail the many models and data used throughout this process but focused on the analytical process. The models and data used are also very important considerations but were outside the scope of this study. This review also does not evaluate how well an alternative developed by CBE's members and affiliates would perform against the 710 corridor project's purposes and needs. This review does identify potential missteps throughout the process that may have limited the attractiveness of certain elements in CBE's alternative; for example, the feasibility of moving more goods by an alternative and non-polluting mode, improving conditions for pedestrians and cyclists, and a larger increases in transit service.

This analysis is based on a partial review of public documents related to the 710 corridor study. Under the time constraints of this study it was impossible to review every related technical study, appendix, or referenced report. The study does review the main body of the 710 draft EIR/EIS<sup>1</sup>, Major Corridor Study (MCS)<sup>2</sup>, and selected appendices and technical reports that focus on how alternatives were created and evaluated. Analysis of additional documents may have revealed additional methods and data used in the creation and selection of alternatives that would change the conclusions of this analysis. Additionally, the public documentation may not include a full account of how the alternatives were considered at public and private meetings. Nevertheless, it is the responsibility of the project sponsors to fully document how the alternatives were created and ultimately selected, and this review assumes that the publicly available documentation fully documents the process.

This analysis identifies various flaws, limitations, and assumptions which may have affected the creation and selection of particular alternatives. While it is the author's view that addressing these concerns would result in a more robust process that would have identified additional alternatives for consideration it is unclear if this would have ultimately resulted in the selection of a different or superior final set of alternatives. It is beyond the scope of this analysis to develop new alternatives, though several ideas are suggested, or re-evaluate existing alternatives with a more robust set of metrics.

### Overview of the Alternatives Process

While traffic congestion, air quality, and safety along the 710 corridor have been a concern for a long time, and many studies have considered the problems and potential solutions, this analysis begins with the most recent effort to understand the corridor's problems and identify a solution. This effort begins with the MCS which began in 2001 as a collaborative effort between Metro, Caltrans, Gateway Cities Council of

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<sup>1</sup> The Draft EIR/EIS is available from Caltrans on their website:  
<http://www.dot.ca.gov/dist07/resources/envdocs/docs/710corridor/>

<sup>2</sup> The Major Corridor Study is available from Metro on their website: <http://www.metro.net/projects/i-710-corridor-project/feasibility-assessment/>

Governments, and the Southern California Association of Governments (SCAG). The study also included an oversight committee that included many of the political leaders from communities along the corridor. The analysis begins with the MCS because the Locally Preferred Scenario (LPS) identified in that study was subsequently considered in the draft EIR/EIS and selected as one of several preferred alternatives.

Both the MCS and the 710 corridor EIR/EIS follow a fairly standard process for selecting a preferred alternative. The first step involves stated the project's purposes and needs. In other words, what are the problems that the project aims to fix? The next step involves creating a diverse set of alternatives that could each fix the problems that were identified. Finally, the initial set of alternatives is evaluated by a series of metrics. The metrics measures how well each alterative addresses the problems that were identified. The metrics are reviewed and a reduced set of alternatives are selected based on their relative scores. The reduced set of alternatives is then measured again, but in more detail, and a final preferred alternative is selected. The next two sections describe this process in more detail for the MCS and the 710 corridor EIR/EIS.

## **MAJOR CORRIDOR STUDY**

The MCS began by stating the purpose and needs for a potential 710 corridor project. These are summarized here:

- Reduce recurrent traffic congestion
- Reduce non-recurrent traffic congestion
- Reduce traffic accidents on I-710
- Better accommodate goods movement by trucks
- Remove freeway design deficiencies
- Improve air quality/public health; in particular reduce exposure to diesel particular matter
- Improve aesthetics
- Reduce noise
- Improve transit for current users and to attract more users that currently drive

Stating the purpose and needs for a particular project is an important consideration in the alternatives creation and selection process because each alternative will be evaluated and ultimately selected or rejected based on how well it meets these criteria. The MCS has identified a comprehensive list of purposes and needs that address major problems with the current freeway design and operation. The purpose and needs also identify problems caused by the 710 freeway that affect communities in the corridor.

A particular limitation in the list of purposes and needs is the goal to better accommodate goods movement by trucks. This language seems to restrict the set of possible solutions to highway projects rather than the development of alternatives that consider moving goods through the corridor by alternative means such as freight rail or other fixed guideway technologies. The list of purposes and needs also does not mention the problems faced by pedestrians and cyclists in the 710 corridor which are important to CBE's constituents and other corridor residents.

The MCS developed 12 alternatives that could potentially meet the projects purpose and needs. The list was designed to cover a wide range of options rather than small variations of a particular concept. The alternatives are summarized in Table 1 below.

**Table 1** List of the major differences between Major Corridor Study initial alternatives

Alt.	Transit	Arterial Capacity	710 Capacity	Other
2	increase bus service			ramp metering
3	increase bus service	add 2 lanes (10 streets)		
4	increase bus service	add 2 lanes on truck routes		add collector-distributor roads + truck inspection facility
5	increase bus service		add 2 HOV lanes	
6	increase bus service		add 2 lanes	add collector-distributor roads + new interchange
7	increase bus service	add 2 lanes on truck routes	add truck by-pass lanes	add direct truck ramps
8	increase bus service		add 2-4 lanes + auxiliary lanes	new interchange
9	increase bus service		adds 4-6 truck only lanes	
10	increase bus service	add 2 lanes (4 streets)	add 4 car only lanes	new connectors for trucks + new near dock rail yards + truck staging areas
11	increase bus service		add 4 HOV lanes	
12	increase bus service + new high speed rail			

The alternatives represent a wide range of construction intensity but not a wide range of alternatives. That is, the alternatives encompass projects with a wide range of cost and complexity but most of the alternatives only represent incremental changes in highway capacity. They are conceptually very similar. The main difference between alternatives 5 – 11 are just the number of lanes added to the 710 freeway and which vehicles may use those lanes. Only a single TDM/TSM alternative and a single transit alternative are considered. There is no low, medium, and high TDM/TSM or transit alternatives as there are with the highway capacity alternatives. For example, bus rapid transit (BRT) and light rail could have been considered as low and medium transit alternatives, respectively, in addition to the high speed rail alternative? There is also little creativity exercised in exploring alternatives to increasing highway capacity. In addition to not considering a diverse set of transit modes, the high speed rail alternative assumes that a new high speed rail line would simply parallel the 710 freeway at or above grade. The optimum alignment for maximizing ridership and minimizing costs may lie somewhere else and perhaps would be underground to minimize right of way (ROW) impacts. Given that ROW impacts are one of the community’s largest concerns it is unclear why a subway alternative was not considered. It should be noted that Metro is building new subway line on the West Side (i.e., the red line extension). No bike or pedestrian concerns were addressed, but that conforms with the absence of these concerns in the stated purpose and needs.

### Screening Analysis

A screening analysis was performed to narrow down the 12 alternatives to a reduced set of 3 build alternatives plus the TDM/TSM and no build alternatives. The reduced set of alternatives would then be analyzed more closely. The screening analysis used currently available data and other studies to assess how well each alternative would meet the project’s purpose and needs. The main piece of information used in this

analysis was SCAG's regional travel demand model output which provides estimates of traffic volume and speeds for two categories of vehicles, light & medium duty and heavy duty, for most roadways in the greater Los Angeles area. The model was run by SCAG for their 2008 regional transportation plan and predicted 2025 traffic conditions. The screening analysis used the 2025 traffic volume and speed estimates as the baseline conditions and then estimated how each alternative would affect these. The screening analysis scored each alternative with several metrics in each of 5 general categories: mobility, safety, environment, cost, and constructability.

Mobility was measured by 4 metrics: volume to capacity ratio (v/c ratio), travel time, delay, and percentage of vehicles or persons shifted from the 710 general purpose lanes. The v/c ratio, travel time, and delay are all good measures of mobility. Each metric describes the freedom or ease that a person or vehicle can move through the transportation system. A limitation of these metrics is that they only measure the mobility of vehicles using the arterial street network and 710 freeway. These metrics do not consider the mobility of transit users (bus or rail), pedestrians, cyclists, or alternative goods movement systems. For example, while the high speed rail alternative reduces the v/c ratio, travel time, and delay for drivers on the highway network by shifting some trips to the transit system, it also reduces travel time and delay for transit users. The benefits for transit users are not considered. By not counting the benefits to non-highway users, the mobility analysis is biased in favor of highway projects. This represents a flaw in the analysis since one of the stated purpose and needs was improving transit. While improving conditions for cyclists and pedestrians was not a stated purpose or need, the mobility measures do not account for improvements or impacts to their mobility either. The last metric, the percentage of vehicles or persons shifted from the general purpose lanes is not a measure of mobility. It simply indicates if more or less vehicles (or persons) are traveling in general purpose lanes but that does not correspond to one's ability to move throughout the transportation system. For example, adding several general purpose lanes may improve mobility but would not shift vehicles from the general purpose lanes.

Safety was measured by two metrics: the number of accidents and a qualitative safety score based on highway geometric design. The number of accidents is estimated as a function of the v/c ratio and the number of trips but does not consider the 710 freeway's specific design deficiencies or the proposed solutions. This limitation is the rationale for the qualitative metric. These metrics have several limitations. The number of accidents is a poor metric of a roadway's relative safety. A better metric would be the accident rate. That is the number of accidents relative to some volume of traffic. The accident rate provides a way to compare the relative safety of competing alternatives that have different traffic volumes. It would also be informative to compare the accident rate on the 710 freeway to accident rates on other freeways to provide some sense of scale. The qualitative assessment is of limited use without an explanation of evidence linking certain design features with fewer accidents. For example, is there evidence that separating trucks and passenger vehicles results in a lower accident rate? If so, that evidence should be cited. The final issues concerning the safety metrics is that they only consider the safety of drivers. The safety of transit riders, pedestrians, and cyclists are not considered in any of these metrics. The safety of pedestrians and cyclists is particularly important since many of the proposals consider widening the arterial street network to increase speeds.

The main environmental metric considered was land required for ROW. ROW impacts were assessed by estimating the area of different land uses that would be consumed by each alternative. This ROW metric is of limited use because it does not provide information on the actual number of structures or residences that may be impacted. The area of land impacted would be more relevant in areas where sensitive ecosystems or

agricultural land would be consumed. Other environmental metrics included qualitative assessments of visual aesthetics, noise, environmental justice, and community cohesion. It is unclear from the body of the report how these qualitative assessments were made. However, the main problem with the environmental metrics is not in how they were measured, but in several notable exclusions: air quality, water quality, and the natural environment. It is difficult to understand how air quality impacts could be ignored when the project is being built in several air quality non-attainment areas, is being built in Los Angeles where air quality has been a major concern for several decades, and when one of the stated purpose and needs for the project is to address poor air quality caused by highway vehicles. Rough estimates of air quality impacts could be made using the data collected to estimate the mobility metrics. Water quality should also be a major concern for two reasons. Many alternatives will add large areas of non-pervious surfaces which will increase storm water runoff and many alternatives will be built in, on top of, or near the Los Angeles River. Finally, though all the alternatives will pass through a heavily urbanized area, impacts to the natural environment including endangered species should also have been considered.

The cost of each alternative was considered by two metrics: the per-mile capital cost and the overall capital cost. The total capital cost is an important consideration in the financial viability of a particular alternative given that funding is always limited. However, assuming that there is enough funding to cover more than just the least expensive alternative, it becomes important to consider each alternative's total costs, mainly operating and maintenance costs. For example, while building a new rail system is very expensive, so is operating that system. And while building new highway capacity may be less capital intensive than rail, it may require higher maintenance costs. Capital cost alone is a poor metric for cost comparisons. The total project cost (capital, operating, and maintenance), now and in the future, should be the basis for comparing each alternative's costs to their benefits. The per-mile capital cost is not a useful metric as it is just a more limited version of the total capital cost metric. A second concern involves how the project sponsors propose to fund improvement in transit service since this will involve funding operating costs in perpetuity unlike the highway alternatives that are characterized as one time capital costs.

Constructability was the last metric considered. It is unclear how this metric relates to the project's purpose and needs or is otherwise useful in decision making. It would be useful to know if certain alternatives could not be built or would be very risky and dangerous. However, the alternatives do not appear to include any novel designs, radically new technologies, or unprecedented physical barriers that must be traversed. Many of the alternatives are logistically complex and are large construction projects but are otherwise typical infrastructure projects. Differences in the complexity of building each alternative should have been accounted for in the capital cost estimates. Non-constructible options should not have been considered in the initial set of alternatives.

### **Selection of Reduced Set of Alternatives**

Five alternatives were carried forward: the no build and TDM/TSM alternatives which are required, and three alternatives that expand the capacity of the 710 freeway and the arterial street network. The capacity expanding alternatives include alternative 6 (add two general purpose lanes, now called alternative C), alternative 9 (add 4 to 6 tuck lanes, now called alternative E), and a combination of alternatives 8 and 11 (add 2-4 general purpose lanes and 2-4 HOV lanes, now called alternative D). The selected alternatives are those that seem to maximize mobility for highway users. These alternatives do not appear to address air quality concerns or significantly improve transit which were two of the stated purposes and needs for the project.

The reduced set of alternatives was analyzed more carefully than the initial set. For example, rather than relying on travel demand modeling results prepared for SCAG's regional transportation plan, new modeling results were obtained for each of the alternatives. Similar to the initial screening analysis several metrics were developed to assess how well each alternative meets the project's purpose and needs and they were organized into 4 categories: mobility, ROW, environmental, and cost.

Mobility was assessed for the 710 freeway and for the 710 corridor as a whole. The freeway metrics were v/c ratio, average speed, utilization of new lanes, and truck diversion from the general purpose lanes. The v/c ratio and average speed are both good metrics of mobility for users of the 710 freeway. Utilization of new lanes does not directly measure mobility. If vehicles were not making use of additional lanes the v/c ratio and average speed metrics would indicate the poor performance of this situation. Therefore, the utilization metric is duplicative. The diversion of trucks from the general purpose lanes is more related to safety than mobility as the v/c ratios and travel time metrics already capture congestion caused by high volumes of truck traffic. Therefore, the truck diversion metric is also duplicative except as an indicator of potential safety benefits.

Corridor wide mobility was assessed with a different set of metrics: vehicle mile traveled (VMT), travel time, number of accidents, and travel time reliability. These are good metrics of vehicle mobility, though the number of accidents is more accurately described as indicator of safety rather than mobility. As discussed previously, these metrics do not measure mobility benefits or impacts to transit users, cyclists, pedestrians, or goods movement by some alternative means. There are other limitations as well. The metrics are often presented in absolute terms making it difficult to determine if the differences between each of the alternatives is significant. For example, Figure 5.2-7 (p. 5-14 in the MCS) shows the difference in VMT between each alternative and the baseline alternative. The figure indicates that alternatives C, D, and E would increase VMT and therefore reduce mobility. However, the accompanying text notes that the increase in study area VMT displayed in the chart represents less than a 1% increase in the corridors total VMT. That is, each of the alternatives does not significantly impact the corridor's VMT. The percentage difference in VMT from the baseline condition is useful for comparing the relative benefits of each alternative while the absolute change in VMT from the baseline is relatively meaningless. Travel time savings and hours of delay are also presented in terms of the absolute change from the baseline; however, unlike VMT there is no discussion of the percentage change in the text. Therefore it is difficult to understand if these metrics indicate any significant difference between the competing alternatives. Furthermore, the asymmetry of information; noting that the increase in VMT was insignificant by considering the percentage change but only discussing the absolute change in the other metrics, seems to bias the assessment towards the higher build alternatives by discounting the increase in VMT while emphasizing the improvements in travel time and delay.

In this phase of the analysis ROW impacts were considered separately from other environmental issues. The same basic approach of considering the area of different types of land required for ROW was used. The remaining environmental analysis considered a more complete set of environmental metrics including air quality, water quality, hazardous materials, cultural resources, the biological resources (endangered species), and agricultural lands in addition to the previously considered metrics. This is a large improvement over the very limited set of metrics considered in the initial screening analysis. The environmental analysis also included two metrics that seemingly have little to do with the environmental impacts of the project: traffic and circulation (i.e., mobility) and seismic hazards. The most significant additions to the analysis were the consideration of air quality and water quality. The air quality analysis modeled the dispersion of diesel particulate matter along the 710 freeway and also calculated regional inventories of other criteria air

pollutants. The methodology appeared to be adequate for this level of analysis. In general the results find only small changes in the amount of air pollution along the 710, with most alternatives having fewer emissions than the baseline. At the corridor level, there were larger changes in air pollutant emissions though these were still relatively small (< 2% change from the baseline) with reactive organic gases, carbon monoxide, and nitrogen oxides all increasing for the higher build scenarios while particulate matter decreased. The water resources analysis identifies and discusses various impacts that each alternative would have on water quality, water supply, and flood protection and appears to be adequate for this level of analysis.

The cost of each alternative was estimated with more detail than in the screening analysis; however, the cost estimates still only consider capital costs. The same concerns regarding capital costs that were discussed previously apply here as well.

### **The Locally Preferred Strategy**

Public comments on the reduced set of alternatives were very critical, particularly with respect to ROW and air quality. As a result the study team was directed by Metro to consider non-standard designs, reconsider the role of freight rail for reducing truck traffic, and avoid ROW impacts. This resulted in the development of a “hybrid strategy” which basically replaces the HOV lanes in alternative D (combination of the high HOV and general purpose alternatives) with truck lanes and eliminates the improvements to the arterial street network. The ROW and capital costs of the hybrid strategy were studied again, but there was no additional analysis of mobility or environmental impacts. The omission of further environmental analysis is surprising since air quality and health impacts were one of the main concerns with the reduced set of alternatives. There also appeared to be little or no additional analysis of the feasibility of moving more goods by freight rail. Despite these omissions, the hybrid strategy was adopted as the Locally Preferred Strategy and was carried forward as the basis for a full environment study.

## **THE I-710 CORRIDOR DRAFT EIR/EIS**

The draft EIR/EIS follows a similar series of steps in creating and choosing alternatives as the MCS; however, in most cases much more detail was involved and many technical studies were created. The 710 corridor draft EIR/EIS is also somewhat unique in that a preferred alternative was not selected, rather a reduced set of alternatives was proposed for additional public commenting.

### **Purpose and Need**

Like the MCS, the draft EIR/EIS begins by stating the purpose and need for the proposed project. The stated purpose and need for the project are to address poor air quality (specifically, ozone and particulate matter), reduce congestion (now and future), improve safety, and update roadway geometric design to reflect modern design standards. These objects are in some ways broader than those considered in the MCS because the EIR/EIS does not explicitly state that the goal is to improve goods movement by truck or improve public transit. The EIR/EIS broadly defines its mobility goals as accommodating growth and addressing increased traffic volumes. This definition allows for a wide range of potential solutions to highway congestion which are not limited to a specific mode or strategy. The EIR/EIS purpose and needs are also in some ways more limited than the MCS because improving aesthetics and reducing noise are not listed as specific project objectives, though these concerns along with many others are discussed in the draft EIR/EIS.

## Initial Set of Alternatives

The initial set of 6 alternatives included the baseline, do nothing, alternative and 5 build alternatives. The alternatives are for the most part cumulative, meaning that each higher number alternative includes all the elements of the lower numbered alternatives with the exception of alternative 3. Alternative 6 is based on the Locally Preferred Strategy identified in the MCS and represents the largest and most complex alternative. The EIR/EIS considers three versions of alternative 6: (6a) two additional general purpose lanes and 4 new truck lanes, (6b) which adds the requirement that the truck lanes are only used by “zero-emission” trucks and (6c) which adds a further requirement that the truck lanes are tolled. Alternatives 2, 4, and 5 represent less costly and complex alternatives. Alternative 2 (TDM/TSM) includes ramp metering, commute period parking restrictions on arterials, a moderate increase in light rail service frequency, a large increase in bus service frequency, and expansion of intelligent transportation systems (traffic monitoring and controls). Alternative 4 addresses congested intersections and interchanges throughout the study area with arterial capacity expansion and new intersection designs. Alternative 5A adds 4 additional general purpose lanes to the 710 freeway while 5B would add 4 additional HOV lanes. Each of these alternatives are very similar to the alternatives considered in the MCS, with the exception of Alternative 2 which makes more substantial transit improvements than the version presented in the MCS. Alternative 3 introduces a completely new alternative that considers moving goods by some alternative means (i.e., fixed guideway or electric trucks). Alternative 3 is not included as a part of any of the other alternatives.

The diversity of alternatives considered in the EIR/EIS is similar to the MCS. There are multiple levels and versions of highway projects, but only a single transit improvement alternative and a single non-highway goods movement alternative. Unlike the MCS, no alternative considers a major expansion of the transit system; only improvements to existing services are considered. While technical studies prepared for the EIR/EIS do investigate several alternative goods movement options<sup>3</sup> only one was included in the initial set of alternatives. Similarly a study that considered the potential for transit, pedestrian and bike infrastructure improvements resulted in only a single alternative<sup>4</sup>.

The Multimodal Review considered alternatives that could reduce the number of vehicle trips on the 710 freeway. The report begins by noting that a large percentage increase in transit ridership would result in only a small percentage reduction in vehicle use because most trips are currently vehicle trips. The study continues by reviewing the potential ridership benefits of increasing service frequency on the blue and green light rail lines, metro bus lines, metrolink commuter rail, and local bus services. The conclusion is that modest gains in ridership can be made: 20% increase in rail ridership, 8% increase in express bus ridership, and a 27% increase in local bus ridership. These gains in transit ridership are projected to replace 25,200 daily peak period vehicle trips. It is unclear what the baseline peak period number of trips is but 25,200 would be a significant reduction, though not enough to eliminate congestion on the 710 freeway. This study is problematic in that it only considered increasing the frequency of existing transit services. No new transit modes or alignments were considered which could have included new metro rapid bus lines, bus rapid transit, new light rail lines, or new subway lines. Considering that the authors of the study acknowledged that a very large increase in transit ridership would be required it is hard to understand why larger and more complex transit projects on a scale similar to alternatives 5 or 6 were not considered. The result is somewhat like

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<sup>3</sup> Multimodal Review, WBS Task ID 165.10.05-010, March 4, 2009; I-710 EIR/EIS Initial Feasibility Analysis, WBS Task ID 165.10.09, December 24, 2008; Alternative Goods Movement Technology Analysis Initial Feasibility Study Report, WBS ID 160.10.60, January 6, 2009.

<sup>4</sup> Multimodal Review, WBS Task ID 165.10.05-010, March 4, 2009

comparing apples to oranges: the mobility benefits of a marginal increase in transit service are compared to several multi-billion dollar highway infrastructure projects. An additional issue concerns how the project sponsors expect to fund the increase in transit service which will require covering operating expenses in perpetuity while the highway projects represent one time capital expenditures.

The Multimodal Review also considers improving conditions for cyclists and pedestrian. While the study notes that there are many things that could be done to significantly increase pedestrian and cyclist mode share, it concludes that any increase would not replace trips on the 710 freeway. The main reason for this is that pedestrian and cycling trips are relatively short while trips on the 710 are longer. This finding seems reasonable. However, because pedestrian and cyclist improvements can not reduce congestion on the 710 they are not considered any further even though it was shown that they could reduce the number of vehicle trips on local streets and arterials.

Finally, the Multimodal Review considers HOV and HOT lanes (HOT lanes are HOV lanes where single drivers can pay a toll to use the lane). The analysis finds that HOV and HOT lanes can more than replace a single general purpose lane. Even so, HOT lanes are not considered in the initial set of alternatives.

The Initial Feasibility Analysis considered the market potential for an alternative to moving goods by truck over the 710. The analysis begins by projecting the demand for goods movement on the 710 freeway. Demand projections were based on estimates of growth in the number of containers handled by the Ports of Los Angeles and Long Beach. Three port growth scenarios are considered: a high growth scenario where the BNSF and UP railroads are successful in expanding near-dock rail yard capacity, a high growth scenario where BNSF and UP are unsuccessful in expanding near-dock rail yard capacity, and a low growth scenario where BNSF and UP do not consider additional near-dock rail yard capacity and the port do not expand on-dock rail facilities. In each scenario, the analysis assumes that 40% of all containers moving to or from the port will travel by rail, 10% will initially move by truck to a warehouse and then by rail (referred to as transload shipments), and the remaining 50% will move by truck. The market potential for an alternative fixed guideway technology was considered to be the rail demand that BNSF and UP would not have capacity to move in each growth scenario. For the high port growth scenario with expanded near-dock rail capacity there would be no unmet demand and therefore no market for an alternative fixed guideway technology. However, under the high growth scenario where the railroads are unable to expand near dock railyards there would be market potential to move up to 2.9 million TEU (2 TEU = 1 container) by an alternative fixed guideway. Under the low growth scenario there would be an even larger market potential for an alternative fixed guideway (4.4 million TEU) because the port would still grow, but no new rail capacity would be added on or near dock.

The alternative fixed guideway analysis is deeply flawed. The three port growth scenarios are not exhaustive and they are illogical. For example, if the ports experience lower growth than expected it is likely that on-dock rail and off dock rail yard capacity would already have been expanded. In fact, several of these projects are currently under environmental review<sup>5</sup>. If the ports experience growth that exceeds near dock rail yard capacity it is likely that the railroads would try to add additional capacity. In the event that the railroads are not able to expand their rail yard capacity to meet future demand due to community concerns it is unclear

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<sup>5</sup> For example, SCIG near-dock rail yard EIR/EIS: [http://www.portoflosangeles.org/EIR/SCIG/DEIR/deir\\_scig.asp](http://www.portoflosangeles.org/EIR/SCIG/DEIR/deir_scig.asp); ICTF expansion plans: [http://www.ictf-jpa.org/modernization\\_project.php](http://www.ictf-jpa.org/modernization_project.php)

how a completely new fixed guideway system would fare any better. A new fixed guideway system would still require new on or near dock terminals as well as new ROW for the guideway.

A more robust analysis would consider how a new fixed guideway, be it electrified freight rail or a newer technology, would compete with conventional freight rail and the trucking industry. Assuming that an alternative fixed guideway would simply accommodate excess rail demand is a very conservative and likely flawed assumption. The analysis could have considered various alignments and terminal locations that provide something that existing freight rail or trucks cannot, either faster delivery or better access. Furthermore, the assumption that 40% of port containers will move by freight rail appears to be based on an assumption from a 1998 port study<sup>6</sup>. It is unclear what portion of containers move by rail at present and it is unlikely that the ratio of containers moved by truck and rail will remain constant in the future.

Removing design deficiencies is an important aspect of the proposed project. Removing deficiencies will help reduce congestion and increase safety; however, removing design deficiencies is only considered in alternatives which add new lanes to the 710 freeway. While it would be easier to fix many design deficiencies while building new lanes, there is no reason to exclude these elements from scenarios that focus on solutions other than highway capacity. For example, the screening analysis discussed below rejects the goods movement alternative because it does not provide enough mobility benefits and it does not address design deficiencies. The goods movement alternative scores well in most other areas. An additional alternative that combined the goods movement alternative with an option to fix 710 design deficiencies may have ranked high enough to gain further consideration. If certain criteria must be met for an alternative to advance, such as removing design deficiencies or avoiding ROW impacts, each alternative should be designed to address these issues to some extent. Narrowly defining alternatives in a way where they will have no chance of meeting important projects goals detracts from the consideration of potentially more feasible options.

### Initial Screening Analysis

Like the MCS, a screening analysis was performed to identify a reduced set of alternatives that would be studied in more detail. The screening analysis considered how each alternative met the project's purpose and needs by considering several metrics in 7 different categories including: mobility, air quality, energy consumption, traffic safety, ROW impacts, environmental impacts, and capital cost.

Mobility metrics included the 710 freeway general purpose lane v/c ratios, arterial street v/c ratios, average corridor v/c ratios, and 710 freeway travel time. Similar to the MCS, these metrics only evaluate the mobility of drivers but do not measure the mobility of transit users, cyclists, pedestrians, or goods moved by freight rail or other non-highway means. Furthermore, the v/c ratios for the 710 freeway are limited to the general purpose lanes. They do not consider v/c ratios for users of HOV or truck lanes. These limitations bias the mobility analysis in favor of alternatives that add more general purpose lanes to 710 freeway.

Air quality metrics included diesel particulate matter (DPM) and nitrogen oxides (NO<sub>x</sub>) emission inventories for the study area freeways (710, 110, and 605). Corridor level inventories were not estimated. The inventories were estimated using the California Air Resources Board's mobile source emission model (EMFAC) and estimates of traffic volumes and speeds at several locations along the 710 freeway. A limitation of this approach is that only highway vehicle emissions are considered. Emissions from transit, freight rail, or other

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<sup>6</sup> San Pedro Bay Ports Long-Term Cargo Forecast, Mercer Management Consulting, Inc., October 1998.

non-highway alternatives are not considered. For example, alternative 2 will increase the frequency of bus service which will increase air pollutant emissions from buses. While most transit buses in the area are powered by natural gas and do not create DPM emissions, they do create NO<sub>x</sub> and other harmful air pollutant emissions. Additionally, even all electric modes cause air pollutant emissions if their source of power is generated by a gas or coal fired plant. If the power source is located in Los Angeles, then electric modes could also contribute to local air quality problems. At the screening level it may be appropriate to ignore these indirect affects, but direct emissions from non-highway modes should probably be considered.

A second concern with the air quality metrics is the presentation of the data. The amounts of air pollutant emissions are presented in the main text of the document in absolute terms (pounds per day) with no baseline for comparison (see Figure 1 below). How does the 600 lb/day reduction in NO<sub>x</sub> in alterative 6 compare to the 50 lb/day increase in DPM? Or the 300 lb/day decrease in NO<sub>x</sub> in alterative 4? The plotting of these data on the same chart also hides the increase in DPM emissions while emphasizing the decrease in NO<sub>x</sub> emissions. The text that accompanies this figure describes the increase in DPM emissions for alternatives 5 and 6 as “slight” (p. 15) while describing the reduction in NO<sub>x</sub> emissions for alternatives 5 and 6 as “appreciable” (p. 17). However, if the percentage change in emissions from the baseline is plotted (see Figure 2 below) it is clear that change in DPM emissions is significant. The increase in DPM emissions for alternatives 5 and 6 are large while the decreases in NO<sub>x</sub> emissions are modest.

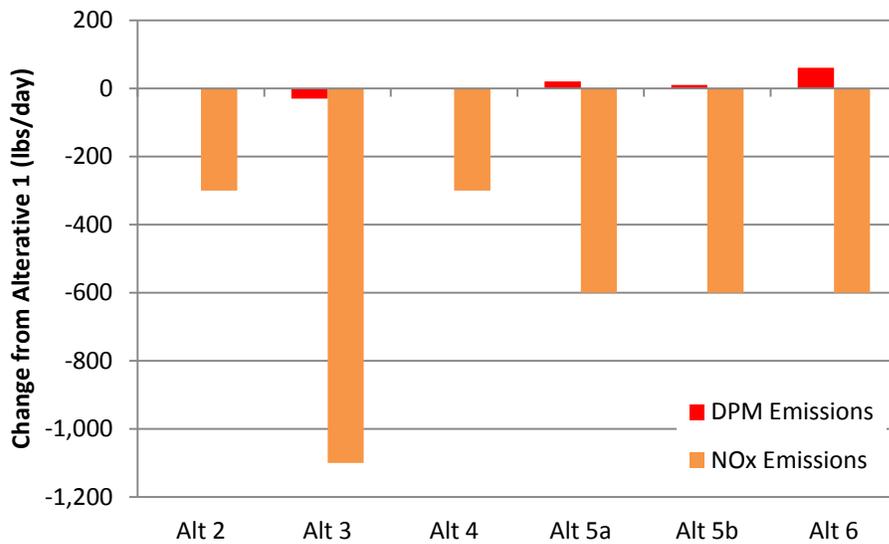


Figure 1 Plot shown in the Alternatives Screening Analysis (Figure7, p. 16)

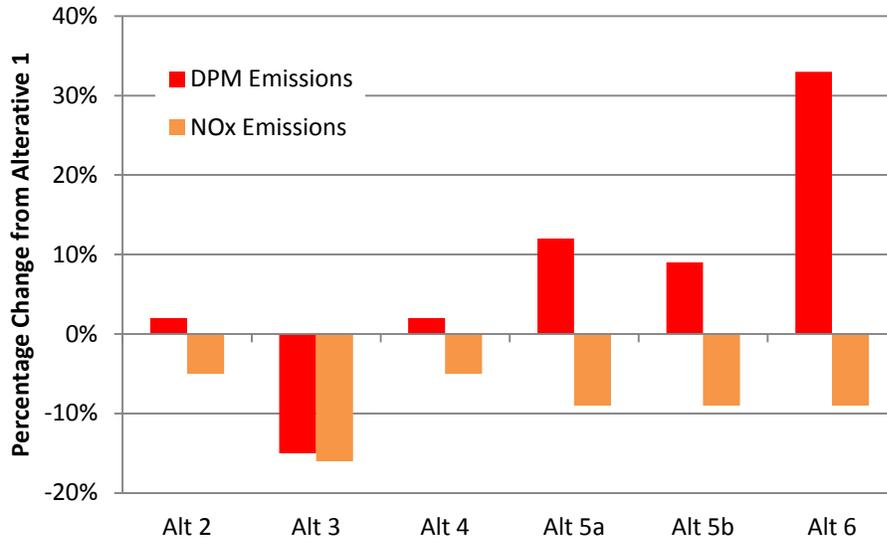


Figure 2 Plot of Relative Change in Emissions (created from data in the appendix B of the Alternatives Screening Analysis)

Energy consumption was measured as the amount of fuel used by vehicles traveling on study area freeway. It is unclear why this metric was chosen because energy use was not a stated purpose or need in the EIR/EIS. Regardless, this metric is a poor measure of each alternative’s energy consumption since it does not consider energy used by non-highway vehicles such as public transit and alternative goods movement technologies.

Safety was evaluated with two metrics: the percentage of trucks in 710 freeway general purpose lanes and the number of design deficiencies. These metrics are moderately satisfactory for measuring safety. While separating cars and trucks is viewed favorably by the public and may reduce the number of accidents, there is no evidence to support the claim that the mix of cars and trucks “...is one of the leading causes of traffic accidents on I-710” (p. 19, Alternatives Screening Analysis). Without a discussion of how various ratios of cars and trucks affect safety it is difficult to compare the relative safety of alternatives with differing levels of truck traffic. Removing design deficiencies should be a good indicator of improved safety. However not all design deficiencies are equal and so the total number of deficiencies removed is not a strong indicator of safety. A ranked list of the most dangerous design deficiencies and a table indicating how each alternative addresses those could be more useful. Additionally, similar to the MCS the safety metrics do not consider the safety of non-highway users including cyclists, pedestrians, and transit riders.

The ROW analysis is more comprehensive than that conducted in the MCS. Rather than estimating the area of ROW required by land use, the number of properties and structures that would be displaced is estimated. This is a much more meaningful and informative method for discussing ROW impacts in an urbanized area. The area of land required would be relatively more important when considering sensitive ecosystems or habitat and agricultural resources.

The environmental analysis considers three metrics: length of waterways intersected by ROW and the number of section 4(f) properties (government owned open space) intersected by ROW. These metrics do not measure the total environmental impact of the alternatives which include the air quality and energy consumption metrics, but do provide additional information about other environmental impacts. The analysis also considered environmental justice by considering the air quality impacts and ROW impacts within a

1,500ft radius of the project in low income and minority communities. However, the results of the environmental justice analysis are not shown. Instead, it is explained that little difference was seen and this method was inadequate for determining environmental justice concerns. It is unclear why the data were not shown or why a better metric was not used.

Finally, as with the MCS, the EIR/EIS considered the capital cost of each alternative but not the ongoing maintenance and operating costs.

### **Selecting a Reduced Set of Alternatives**

Four alternatives were selected to be carried forward including the no build alternative, alternative 5a (2 -4 new general purpose lanes) and alternative 6a and 6b (2-4 new general purpose lanes plus 4 new truck lanes or zero emission truck lanes). These alternatives were carried forward because they scored higher in more metrics than any of the other alternatives. After these alternatives were selected a third version of alternative 6 was added, 6c, which adds tolling to the truck lanes.

## **DISCUSSION ON CREATION AND SELECTION OF TRANSPORTATION ALTERNATIVES**

There are three important processes that affect the selection of a preferred alternative: the definition of the project's purpose and needs, the public outreach and creative design process where a set of initial alternatives is developed, and the choice of metrics that are used to judge how well each alternative meets the project's stated purpose and needs. The modeling methods and data used to calculate each metric is also important but is beyond the scope of this analysis. However, even the best models and data cannot help you choose a good alternative from several poor options.

In general the MCS and the EIR/EIS stated a comprehensive list of needs and clearly defined the purpose of the project they were considering. Each study varied slightly in this respect with the MCS considering a narrow scope focused on solutions to truck mobility while the EIR/EIS considered a broader definition focused on improving mobility in general. The statement of purpose and needs does not appear to have limited the options considered in the EIR/EIS though it may have limited the goods movement options considered in the MCS.

A weakness noticed in each study was a failure in the public outreach and creative design process when developing a list of initial alternatives. The MCS focused almost exclusively on highway options with the exception of a single transit option. The transit option was not well developed and little effort seemed to go into creating a competitive design. For example, why not consider a subway which would have avoided ROW impacts which turned out to be a very important concern for the community? And why not consider alternative alignments that could spur additional economic growth and maximize ridership? Finally, why were differing levels of transit not considered such as new light rail lines or bus rapid transit? These seem to be failures caused in part by not engaging with the community early enough and in a meaningful way which would have identified air quality and ROW impacts as two very important concerns that were initially overlooked. A well thought out transit plan may have addressed these concerns. Additionally, these failures represent a lack of creativity. The alternatives propose traditional solutions based on familiar designs, an approach that ensures continuing the status quo of trying to accommodate all highway traffic rather than trying to manage demand or provide alternatives. The EIR/EIS alternatives were similarly uncreative and focused on highway solutions.

The selection of robust metrics for judging the initial set of alternatives was problematic in both studies. Mobility metrics were focused almost exclusively on measuring mobility for highway users. The mobility of transit users, alternative goods movement systems, pedestrians, and cyclists were not considered. The MCS initial screening analysis also failed to include a metric that considered air quality which was one of the projects stated needs. To a lesser extent there were also problems with the way data were presented and discussed. In some cases where metrics indicated that preferred alternatives (those that would ultimately be carried forward) performed poorly the data were described or displayed in a way to make them seem insignificant. This occurred by selectively displaying metrics as either raw numbers or as the relative change. It is impossible to know if this was intentional, but it does bias the analysis.

While the concerns discussed in this memo are important they should be considered in context. The problems noted here are found in many EIR/EIS documents and highlight several unresolved questions in how alternatives should be created and considered for large and complex projects. In an ideal world we would consider every possible alternative to a given problem; however, we do not have that luxury of time. In practice an initial set of alternatives must be selected before any analysis takes place. The alternatives are chosen based on community input and the expert opinion of the analysts, engineers, and planners. This raises the question of how experts choose the initial set of alternatives. Does experience with a certain type of project, such as adding highway capacity, bias decisions in favor of what is well known and where the costs and benefits are relatively certain? The same issues may also affect the alternatives considered by the community; though in this case their experience may be displeasure with existing conditions and a desire for something different.

A second issue is, at what point in the alternatives analysis are different analytical methods appropriate. It makes sense that the initial set of alternatives should be “screened” in a less rigorous way than the reduced set of alternatives because creating the models and data to for more in-depth analysis can be very time consuming and expensive. However there is some balance that must be maintained that prevents potentially superior alternatives from being screened out early on when a more rigorous analysis at a later stage would find them to be the best. A comprehensive set of screening metrics can help. For example, the MCS screening analysis did not consider air quality and had a weak measure of ROW impacts. Metrics should also be selected that are sensitive to the question under consideration. For example, the environmental justice metric in the EIR/EIS failed to distinguish between any of the alternatives. A more sensitive and meaningful metric is needed. Similarly, the metrics need to be unbiased. The mobility metrics in the MCS and EIR/EIS strongly favor highway solutions because most of them only measure the benefits to highway users.

Finally, it should be noted that had each of the concerns raised in this memo been corrected a better alternative may not have been selected. There would, however, be more confidence in the chosen alternative. It is also possible that more analysis and discussion occurred than is evident from the reports that were reviewed here. Analysis of additional data may have revealed that some of the issues raised in this memo were in fact considered. This study is limited to the contents of the main reports and studies prepared for the 710 corridor project as referenced though out this memo.

# **ATTACHMENT J**



# Complete Intersections:

A Guide to Reconstructing Intersections  
and Interchanges for Bicyclists and Pedestrians

California Department of Transportation

2010



# Complete Intersections

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## A GUIDE TO RECONSTRUCTING INTERSECTIONS AND INTERCHANGES FOR BICYCLISTS AND PEDESTRIANS

The California Department of Transportation (Caltrans) is pleased to present *Complete Intersections: A Guide to Reconstructing Intersections and Interchanges for Bicyclists and Pedestrians* (Complete Intersections Guide). This one-of-a-kind guide provides direction on implementing an important aspect of Caltrans' Complete Streets policy. For the first time, a comprehensive and easy-to-follow guide identifies actions that will improve safety and mobility for bicyclists and pedestrians at intersections and interchanges. The Complete Intersections Guide can help California, and perhaps the nation, continue to make progress in developing a sustainable transportation system for all users.



The Complete Intersections Guide provides tools and techniques to improve bicycle and pedestrian transportation using basic guiding principles for common intersection types. The focus is on intersections and interchanges where transportation safety and mobility issues can be most challenging. By creating Complete Streets with complete intersections, Caltrans can increase the number of bicycle, pedestrian, and transit trips, helping California meet its goals for reducing greenhouse gas emissions. The Complete Intersections Guide also will serve as a model for other states.

I commend Caltrans staff, project partners, and consultants that participated in developing the Complete Intersections Guide.

A handwritten signature in black ink that reads "Cindy McKim".

CINDY McKIM  
Director



# Disclaimer

This reference guide (Guide) does not constitute a standard, specification, or regulation. It is not intended to replace the existing California Department of Transportation (Caltrans) mandatory or advisory standards, nor the exercise of engineering judgment by licensed professionals. The Guide is compiled of information and concepts from various agencies and organizations faced with similar transportation issues. Caltrans acknowledges the existence of other practices and provides this Guide for those responsible for making professional engineering or other design decisions.



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# 1. INTRODUCTION

Intersections and interchanges are major points of conflict for road users and are the frequent site of injuries and fatalities. In California, nearly 20 percent of pedestrian fatalities, and nearly a quarter of bicyclist fatalities occur at intersections.

Intersections also have a significant impact on the mobility of pedestrians and bicyclists. The speed and ease with which they can move through an intersection is affected by the signal timing scheme, the number and configuration of lanes, width of the traveled way, presence of a median or refuge islands, traffic calming configurations, roadsides, landscaping features, traffic volumes, and other factors.



Image: [www.pedbikeimages.org/](http://www.pedbikeimages.org/)Dan Burden.

Improving both safety and mobility at intersections for pedestrians and bicyclists presents a significant technical challenge for planners, engineers and other highway designers due to the complexity of the road environment and the number of tradeoffs to consider. This Guide is intended to help meet that challenge by presenting common issues faced by pedestrians and bicyclists at intersections and interchanges and best practices for addressing them through design and operational changes.

## 1.1. Policy Context

The material in this Guide supports several Caltrans and State of California (California) plans and policies requiring improvement in conditions for pedestrians and bicyclists. Recent examples include:

- **The California Strategic Highway Safety Plan** identifies 16 top priority areas (“Challenge Areas”) for improving road safety in California. This Guide will help address three priority areas: intersections (Challenge Area 7), pedestrians (Challenge Area 8), and bicyclists (Challenge Area 13).
- **Assembly Bill 1358 “The Complete Streets Act”**, passed in California in 2008, codified a statewide policy that streets be designed to accommodate all road users. It requires a circulation element with city and county general plans to provide safe travel for motorists, pedestrians, bicyclists, children, seniors, transit patrons, and individuals with disabilities.
- **Effective October 2008**, Caltrans Deputy Directive 64-R1, codified Caltrans’ intention to integrate motorized, transit, pedestrian and bicycle travel by creating complete



streets that provide safe travel for all road users, beginning early in system planning and continuing through project delivery and maintenance and operations.

- **The California Blueprint for Bicycling and Walking** was prepared by Caltrans for the 2002 California State Legislature. The blueprint laid out ambitious goals for improving bicycling and walking, including a 50 percent increase in bicycling and walking trips by 2010; a 50 percent decrease in pedestrian and bicycle fatality rates by 2010; and increased funding for **pedestrian and bicycle programs**.
- **Climate Change Legislation.** Assembly Bill 32, the Global Warming Solutions Act of 2006, and Senate Bill 375, the Sustainable Communities and Climate Protection Act of 2008, set up a process for California to meet its aggressive greenhouse gas reduction goals. The legislation includes goals to reduce greenhouse gases from transportation and land use strategies that support greater levels of walking, bicycling, and transit use.
- **Caltrans Highway Design Manual Update.** Caltrans is in the process of updating the Highway Design Manual (HDM) to include more detail on complete streets concepts, bicycle and pedestrian crossings, pedestrian issues, and related topics.
- **United States Department of Transportation (U.S. DOT) Policy Statement on Bicycle and Pedestrian Accommodation.** Signed on March 11, 2010, this statement announces the U.S. DOT's support for the integration of pedestrian and bicyclist needs in federally funded road projects. The policy states that bicyclists and pedestrians should be considered throughout the planning process and should not be adversely affected by other transportation projects.

In addition to these specific policy changes, Caltrans and other agencies throughout California are embracing a multimodal approach to transportation planning, engineering, and design, which this Guide supports.

## **1.2. Who Is This Guide For?**

This Guide is intended primarily for Caltrans planners, engineers, and other highway designers working as generalists or specialists in advising, engineering or designing for safe travel for all highway users at intersections and interchanges. It may also be useful to local government planners, engineers, and other highway designers; transit planners involved in the siting of transit stops and stations; site planners involved in designing or modifying intersections around new developments; local government pedestrian and bicycle planners; and those whose work may influence or be directly involved in designing or modifying intersections. Finally, the background information on educational and enforcement strategies for addressing pedestrian and bicyclist safety could be useful to practitioners in other areas, such as law enforcement, public health, or advocacy.



## 1.3. Terminology

This guide uses the following terminology based on the California Vehicle Code (CVC) definitions for bicyclist, pedestrian, driver, and vehicle:

- **Vehicle:** A “vehicle” is a device by which any person or property may be propelled, moved, or drawn upon a highway, excepting a device moved exclusively by human power or used exclusively upon stationary rails or tracks (CVC Division 1 § 670).
- **Motor vehicle:** A “motor vehicle” is a vehicle that is self-propelled. (b) “Motor vehicle” does not include a self-propelled wheelchair, motorized tricycle, or motorized quadricycle, if operated by a person who, by reason of physical disability, is otherwise unable to move about as a pedestrian (CVC Division 1 § 415).
- **Bicycle:** A bicycle is a device upon which any person may ride, propelled exclusively by human power through a belt, chain, or gears, and having one or more wheels (CVC Division 1 § 231).
- **Driver:** A “driver” is a person who drives or is in actual physical control of a vehicle (CVC Division 1 § 305).

Note that this includes bicyclists; however, for clarity, this Guide uses the term “motorist” to refer to someone operating a motor vehicle and the term “bicyclist” to refer to someone operating a bicycle (CVC Division 1 § 415)

- **Pedestrian:** (a) A “pedestrian” is a person who is afoot or who is using any of the following: (1) A means of conveyance propelled by human power other than a bicycle; (2) An electric personal assistive mobility device; (b) “Pedestrian” includes a person who is operating a self-propelled wheelchair, motorized tricycle, or motorized quadricycle and, by reason of physical disability, is otherwise unable to move about as a pedestrian, as specified in subdivision (a) (CVC Division 1 § 467).

## 1.4. Organization

This Guide is organized by intersection type. Eight major intersection types are included, along with a background sections:

- Section 2: All Intersections – General Guidance
- Section 3: Four-Leg Intersections
- Section 4: Three-Leg Intersections
- Section 5: Multi-leg, Offset and Skewed Intersections
- Section 6: Special Cases
- Section 7: Intersections with Transit
- Section 8: Roundabouts
- Section 9: Interchanges



- Section 10: Treatments on the Horizon
- Section 11: Background Information covering pedestrian and bicyclists' collision data, crash types, and other topics.

Each chapter includes:

- An introduction to the intersection type
- Discussion and illustration of typical issues facing pedestrians and bicyclists
- Discussion and illustration of treatments to be used in providing safe and convenient travel for pedestrians and bicyclists at each intersection subtype. In many cases, multiple types of treatments are provided, ranging from signing and striping to complete intersection redesign.

Treatments are cross-referenced with a list of guiding principles presented in Section 2.0: All Intersections Overview.

Individual treatments in this Guide are not described in detail. There are a large number of resources available that cover the details of specific treatments. Selections of these are listed in Appendix B.

## **1.5. How Should This Guide Be Used?**

Users can approach this Guide as follows:

- First review the general guiding principles contained in Section 2.0: *All Intersections Overview*.
- Then select the intersection type or types that best relates to the planning, design or engineering challenge you are facing. Review the issues and best practices contained within the section and consider how they could be applied in your situation.
- For additional context and information, review the background information in Section 11. Also, be sure to consult local bicycle and pedestrian experts, whether they are transportation professionals or advocates.

Not all treatments included in this Guide will be suitable for all intersections, and not all possible treatments are listed for each intersection type. Users should apply the principles in this Guide along with obtaining or ensuring the use of engineering judgment when making design decisions.

Additionally, users should keep in mind that although this Guide focuses on pedestrians and bicyclists, intersection design should be holistic and consider the needs of all users including bicyclists, pedestrians, transit vehicles, commercial vehicles, passenger vehicles, and should take into consideration the special needs of the disabled, elderly, and young children.



## 1.6. When Should This Guide Be Used?

This Guide can be used to inform minor signage and striping changes to intersections and interchanges and major geometric changes and designs for new intersections. For major projects, the needs of pedestrians and bicyclists should be addressed as early as possible in the planning and project development process, starting in the **planning stage**, when the project goals and objectives are determined and a rough concept for the project is developed. This Guide can be used to develop project concepts that address the safety and mobility needs of pedestrians and bicyclists.

The planning stage is followed by development of the project **purpose and need statement** that describes why the project is being undertaken. The purpose and need statement should be succinct, project-specific, and describe the primary reason for undertaking the project. An example of a project's purpose statement for an intersection improvement might be: to improve the operation and safety of the intersection for all users.

Whether or not pedestrian and bicyclist safety and mobility are the primary reasons the project is undertaken, the transportation needs of these users should be considered. Potential transportation deficiencies must be identified and addressed to properly scope the project, justify design decisions, and ensure the final project meets expectations. These deficiencies and project-driven requirements would not always be included in the purpose and need statement, but should be identified early and documented as additional criteria to evaluate and select the preferred alternative. Appropriate performance requirements should be included in the project initiation document and project report. Addressing pedestrian and bicyclist needs early in the planning process helps avoid expensive and time-consuming design changes later on.



**Complete Intersections:**  
*A Guide to Reconstructing Intersections  
and Interchanges for Bicyclists and Pedestrians*





## 2. ALL INTERSECTIONS OVERVIEW

Many of the issues affecting pedestrians and bicyclists can occur at any type of intersection. For example, at all intersections it is important for motorists, pedestrians and bicyclists to be able to see one another approaching, and to not have their stopping or corner sight distance blocked by parked vehicles, trees, transit vehicles, or other obstructions. The guiding principles listed below are meant to summarize some of these common considerations. These principles should be used to guide the development of pedestrian and bicycle accommodations in the project scoping, planning and design phases.

### 2.1. Guiding Principles

#### **“Observe”**

Watch how the intersection is being used. How are bicyclists, pedestrians, transit users, and motorists currently navigating the intersection? Where are they crossing? People will not detour very far to cross a highway. Will people actually use the proposed design change? Rather than restrict desired movements, intersection designs should encourage legal movements, per the California Vehicle Code.



*Does the crosswalk placement meet the needs of this pedestrian?*

#### **“Pedestrians and Bicyclists Will Be There”**

Expect pedestrians and bicyclists to travel anywhere it is legal. Whether or not you meet the transportation needs of pedestrians and bicyclists, they will use a facility, regardless of perceived safety concerns. It is better to meet basic pedestrian and bicyclist mobility and safety needs rather than assuming they will not use the facility.



*Was this road designed  
with pedestrians in mind?*

### **“Maintain and Improve”**

When improving an intersection, do not remove existing non-motorized facilities, or reduce safety or mobility for pedestrians or bicyclists. Instead, improve existing facilities for pedestrian and bicyclists. Consult the local pedestrian and bicycle coordinator and local and regional pedestrian, bicycle or transit plans to identify additional improvements the community would like incorporated into the intersection project.



*Keeping facilities well  
maintained and improving  
them during maintenance or  
road construction provides a  
benefit to pedestrians and  
bicyclists. This image shows  
construction of a bulb-out.*

Image: Dan Burden, [www.pedbikeimages.org](http://www.pedbikeimages.org)

### **“Tee It Up”**

Bring intersections to a 90-degree angle; this forces motorists to make slower turns at intersections.



*The high-speed ramp has been  
replaced with a 90-degree  
intersection.*

### **“One Decision at a Time”**

Design intersections so motorists, pedestrians, and bicyclists only need to make one decision at a time.



*Median refuges allow pedestrians to consider one direction of traffic at a time.*

### ***“Slow it Down”***

Where appropriate, use treatments that reduce the speed of motorized vehicles at intersections while maintaining operational efficiency, since there is a documented relationship between vehicle speeds and pedestrian and bicyclist crash severity.<sup>1</sup>



*Road diets can improve pedestrian and bicycle access while reducing motor vehicle crashes.*

### ***“Shorten Crossings”***

Reducing crossing distance reduces the time it takes for pedestrians and bicyclists to cross and results in less exposure to crashes. However, avoid increasing safety for one mode while decreasing it for another. For example, while curb extensions help pedestrians, if they extend past parked vehicles they can reduce the useable width of the shoulder, bike lane or shared lane, increasing the risk that bicyclists may strike the curb extension.

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<sup>1</sup> About 5 percent of pedestrians are likely to be killed when struck at 20 miles per hours (MPH), about 40 percent when struck at 30 mph; about 80 percent when struck at 40 mph, and nearly all are likely to be killed when struck at 50 mph or above. Source: Preusser Research Group, 1999. *Literature Review on Vehicle Travel Speeds and Pedestrian Injuries*. National Highway Traffic Safety Administration.



*Curb extensions shorten crossings and make pedestrians more visible to motorists.*

### ***“Improve Visibility”***

Always ensure maximum visibility of pedestrians and bicyclists through providing ample sight distance at crosswalks, lighting weaving, merging and crossing areas, and installing appropriate pedestrian and bicyclist markings, signage, and signals.



*Good design makes motorists more aware that bicyclists or pedestrians are expected, thus increasing visibility.*

### ***“Clarify the Right-of-Way”***

Use design treatments to clarify to pedestrians, bicyclists, and motorists who has the right-of-way.



*Bike lanes striped to the left of a right-turn only lane reduce the risk of a weaving-related collision.*



### ***“Keep it Direct”***

Design pedestrian and bicycle paths to be as direct as possible. Avoid restricting crossings or forcing bicyclists or pedestrians to use a detour instead of providing a direct route through an intersection. When comparing the directness of alternative routes, planners, engineers, and other highway designers should consider not only distance, but also time and the physical effort that must be expended by pedestrians and bicyclists.



*Restricting crossing movements increases the distance a pedestrian must travel to cross a road.*

### ***“Light at Night”***

Install lighting at pedestrian and bicycle crossings, weaving and merging areas, and along shared use paths.



Image: Dan Burden, [www.pedbikeimages.org](http://www.pedbikeimages.org).

*Lighting increases safety and security for pedestrians and bicyclists.*

### ***“Access for All”***

Design facilities so that pedestrians and bicyclists of all abilities, ages, and skills can navigate with ease.



Image: Jan Moser, [www.pedbikeimages.org](http://www.pedbikeimages.org).

*Pedestrian facilities must be reconstructed to meet or exceed ADA requirements.*



Table 1.1 identifies potential design treatments for intersections that support the guiding design principles introduced above. Dollar signs indicate the relative cost of the treatment, from the least expensive (\$) to the most expensive (\$\$\$). Actual costs will vary on case-by-case basis.

**Table 1.1 General Design Treatments for Intersections**

Design Principle	Treatments	Cost	User
Observe	Place sidewalks, marked crosswalks, and shared use path crossings where people are already walking and crossing.	\$	Both
	Redesign the intersection to make the desired bicycling or walking movement safer, more comfortable, and more convenient.	\$\$-\$\$\$	Both
Pedestrians and Bicyclists Will Be There	Construct or reconstruct intersections with sidewalks on both sides.	\$\$-\$\$\$	Pedestrians
	Allow or create adequate width for on-street bicycle lanes or wide curb lanes where appropriate.	\$\$-\$\$\$	Bicyclists
	Establish a limit line detection zone at traffic-actuated signals that will detect bicyclists and enable them to actuate the signal (per Caltrans Traffic Operations Policy Directive 09-06).	\$\$	Bicyclists
	Redesign the intersection to make the desired bicycling or walking movement safer, more comfortable, and more convenient.	\$\$-\$\$\$	Both
	Time signals to allow adequate time for pedestrians to cross in one signal phase and bicyclists to travel through the intersection before the opposing traffic receives a green light <sup>2</sup> .	\$	Both
	Avoid prohibiting pedestrian crossing on any leg of an intersection.	\$	Pedestrians
	Coordinate with transit providers to provide adequate widths for transit stops.	\$	Both
	Provide accessible pedestrian countdown signals at signalized intersections.	\$	Pedestrians

<sup>2</sup> Proposed Amendment to the National Manual for Uniform Traffic Control Devices (MUTCD) recommends 3.5 feet (ft) per second maximum, and the California MUTCD (CA MUTCD) recommends 2.8 seconds where pedestrians with disabilities or elderly will be regularly using the crosswalk. Caltrans Traffic Operations Policy Directive 09-06 provides minimum bicycle timing requirements for signals.



Design Principle	Treatments	Cost	User
Maintain and Improve	When widening an intersection, extend bike lanes to the intersection and stripe bike lanes to the left of right-turn only lanes.	\$\$	Bicyclists
	When reconstructing an intersection, widen sidewalks and provide sidewalks on both sides of the road.	\$\$	Pedestrians
	Regularly maintain on-street and off-street bicycle facilities, including sweeping the bike lane, shoulder or right-most traffic lane, trimming vegetation, and clearing snow from bicycle facilities during the winter.	\$\$	Bicyclists
	Regularly maintain pedestrian facilities, including trimming vegetation at pedestrian crossings, and inspecting and maintaining curb ramps.	\$\$	Pedestrians
	When reconstructing an intersection, install Americans with Disabilities Act-compliant (ADA) curb ramps at all corners with sidewalks.	\$\$	Pedestrians
	When repaving, pave out to existing edge of pavement to maintain the shoulder surface and prevent longitudinal lips in shoulder or between traffic lanes.	\$\$	Bicyclist
	Crosswalk markings should not be allowed to fade. Use high-visibility styles such as the “ladder” when installing or replacing crosswalk markings.	\$	Pedestrians
Tee It Up	Design or reconstruct intersections and interchanges so that roads and ramps meet at a 90-degree angle.	\$\$\$	Both
	Use stripe crosswalks so they cross traffic lanes at a 90-degree angle, unless this placement does not follow the pedestrian’s natural path.	\$	Pedestrians
One Decision at a Time	Provide appropriate weaving distance for bicyclists and motorists in advance of a right-turn only lane.	\$\$-\$\$\$	Bicyclists
	Separate the decision to yield to a pedestrian or bicyclist from the decision to merge into traffic by restricting right turns on red or controlling free right-turn only lanes with STOP control or signalization, if warranted.	\$\$-\$\$\$	Both
	Design weaving movements so the path of travel for the through bicyclist is maintained in a straight line and motorists preparing for a turn must weave across the bicyclist line of travel and yield to the bicyclist.	\$	Bicyclists



Design Principle	Treatments	Cost	User
Slow it Down	Design or reconstruct intersections to allow <u>maximum</u> motor vehicle turning movement speeds of 20 mph through reducing turning radii and bringing intersections close to a 90-degree angle.	\$\$-\$\$\$	Both
	Use proven speed management techniques, such as construction of roundabouts, median islands, or in-road way warning lights to slow motorized traffic.	\$\$-\$\$\$	Both
	Use enforcement measures such as speed-feedback signs in advance of intersections, to slow motorized traffic.	\$\$-\$\$	Both
Shorten Crossings	Reduce turning radii for motorists	\$\$	Both
	Construct curb extensions, raised pedestrian refuge islands, raised medians, or raised channelizing islands	\$\$-\$\$\$	Pedestrians
	Reconstruct skewed intersections to meet at a 90-degree angle.	\$\$\$	Both
	Reconstruct road to provide narrower motor vehicle lanes and wider pedestrian and bicycle facilities.	\$\$\$	Both
Improve visibility	Provide ample sight distance in advance of crossings.	\$\$-\$\$\$	Both
	Reconstruct intersections to meet at a 90-degree angle.	\$\$\$	Both
	Paint stop lines or advance yield lines in advance of crosswalks or intersections.	\$	Pedestrians
	Restrict parking at least 20 feet in advance of crossings, will reduce bicycle conflicts with car doors opening unexpectedly.	\$	Both
	Regularly trim vegetation at crossings.	\$\$	Pedestrians
Clarify the Right-of-Way	Use signing and striping to remind motorists to expect and yield to pedestrians and bicyclists.	\$	Both
	For all approaches with bike lanes, stripe bike lanes to the left of right-turn only lanes, and if significant left turn bicycle movements are expected, stripe bike lanes to the right of left-turn only traffic lanes.	\$	Bicyclists
Keep it Direct	Do not restrict crossings on any leg of an intersection unless there is strong justification.	\$	Pedestrians
	Reconstruct skewed intersections to meet at a 90-degree angle.	\$\$\$	Both
	Design crossings so pedestrians can cross in one signal phase.	\$\$-\$\$\$	Pedestrians
	Provide well-designed grade separation, if a feasibility study suggests that pedestrians and bicyclists will use the grade-separated facility.	\$\$\$	Both



Design Principle	Treatments	Cost	User
Light at Night	Provide ample lighting at crosswalks.	\$\$-\$\$\$	Both
	Install flashing beacons or in-pavement flashers at marked crosswalks and shared use path crossings.	\$\$	Both
Access for All	Construct ADA-compliant curb ramps at all corners with sidewalks unless a particular crossing is prohibited. If a crossing is prohibited, all pedestrians, regardless of disability, must erect a barrier to prevent crossings.	\$	Pedestrians
	Reconstruct existing non-compliant median refuges to be ADA-compliant.	\$\$-\$\$	Pedestrians
	Construct ADA-compliant median refuges if pedestrians cannot cross in one cycle.	\$\$	Pedestrians
	Construct ADA-compliant sidewalks on both sides of the road.	\$\$-\$\$\$	Pedestrians
	Construct accessible pedestrian countdown signals at signalized intersections.	\$\$-\$\$	Pedestrians
	Provide transit stops that meet ADA standards.	\$\$	Pedestrians
	Reconstruct skewed intersections to meet at a 90-degree angle so pedestrians with visual impairments can more easily navigate the intersection.	\$\$\$	Pedestrians

## 2.2. Safety Effectiveness of General Design Treatments

Treatments listed in Table 1.1 vary in their effectiveness in reducing injuries and fatalities among pedestrians and bicyclists. In general, the most effective treatments are those that reduce vehicle speeds or those that reduce the pedestrian or bicyclist’s exposure to vehicle traffic. Any reduction in vehicle speed benefits pedestrian and bicyclist safety, since there is a direct link between impact speeds and the likelihood of fatality.<sup>3</sup> Methods to reduce pedestrian and bicyclist exposure to vehicles improve safety by lessening the time that the user is in the likely path of a motor vehicle. These methods include the construction of physically separated facilities such as sidewalks, raised medians, refuge islands, and off-road paths and trails, or reductions in crossing distances through roadway narrowing. The safety effectiveness of all these measures has been established in the research literature, although there are still some safety issues associated with paths at intersections. Improved lighting has also been proven very effective in reducing nighttime collisions. Section 11.4 lists relevant references and provides additional detail.

<sup>3</sup> Preusser Research Group, 1999. *Literature Review on Vehicle Travel Speeds and Pedestrian Injuries*. National Highway Traffic Safety Administration.



## 2.3. Other General Considerations

Experts contributing to the intersection design process must take into account the characteristics of all road users, including the following considerations:

- **Pedestrian volumes and abilities.** Pedestrian volumes, age ranges (age affects depth perception, vision, judgment, hearing, walking speed and start-up time), and physical abilities affect crossing treatments and intersection operations.
- **Bicyclist volumes and abilities.** Bicyclist volumes and skill levels affect the type of bicycle facility or general roadway design provided.
- **Bicycle characteristics.** The acceleration and stopping speed of a bicycle, turning radius, length of bicycle (and trailer), and width of a bicycle affect the design of a bicycle facility.
- **Vehicle and motorist characteristics.** Size and maneuverability of motor vehicles affect corner radii and roadway widths. Motorist's perceptive ability and reaction time varies by age and skill level. Commercial vehicles and transit vehicles generally require larger corner radii and lane widths than smaller motor vehicles, which can cause longer pedestrian crossing distances and promote higher vehicular turning speeds.
- **Land use context.** Includes street parking, presence of transit, intersection siting, as well as factors that impact bicyclist and pedestrian volumes, such as development density.

### 2.3.1. A Note about Reaction Time

Intersection design should consider that motorist reaction time increases when unexpected information or events are encountered and when many decisions must be made simultaneously. Reaction time is measurably higher when motorists must process unexpected information. The AASHTO Green Book cites a study that showed motorist reaction times to be 35 percent higher when processing unexpected events and states that, "...for a simple, unexpected decision and action, some drivers may take as long as 2.7 seconds to respond. A complex decision with several alternatives may take several seconds longer than a simple decision."<sup>4</sup>

Intersections should be designed so that motorists learn to expect pedestrians and bicyclists. As stated by AASHTO, these "reinforced expectancies help drivers respond rapidly and correctly."<sup>5</sup> Pedestrian and bicyclist warning signage, flashing beacons,

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<sup>4</sup> Page 50, *Geometric Design of Highways and Streets*, American Association of State Highway and Transportation Officials, 2004. Also see Exhibit 2-26 Median Driver Reaction Time to Expected and Unexpected Information on page 51.

<sup>5</sup> *Ibid*, Page 53.



crosswalks, and other signage and striping should be used to indicate to motorists that they should expect to see and yield to pedestrians and bicyclists.

Formal information from traffic control devices should be reinforced by informal sources of information such as lane widths, landscaping, street furniture, and other road design features. Intersections should be designed to allow motorists, bicyclists, and pedestrians to perceive and react to one piece of information at a time. Intersections should separate the different driving, bicycling, and walking tasks, promoting the orderly behavior of each travel mode.



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## 3. FOUR-LEG INTERSECTIONS

Four-leg intersections are the most common intersection type and are very familiar to motorists, pedestrians, and bicyclists. Many issues that pedestrians and bicyclists face at four-leg intersections also apply to the other intersection types discussed in this guide. Similarly, many treatments for four-leg intersections can also be applied to the other intersection types.

This guide describes issues and treatments at two types of four-leg intersections:

- Signalized intersections, including fixed or pre-timed signals, and traffic-actuated signals
- Two-way STOP controlled intersections

Four-way STOP controlled intersections are not discussed, but many of the treatments described in Table 3.2 can improve these intersections for pedestrians and bicyclists.

### 3.1. Signalized Four-Leg Intersections

Issues for pedestrian and bicyclists at intersections of two major roads are primarily related to long crossing distances, turning conflicts, high speeds, bicycle detection, sufficient crossing signal time, roadway width, and number of travel lanes. These can all be exacerbated when the pavement is widened to provide turn lanes. A right-turn only lane may allow high turning speeds and, particularly if the turning traffic is YIELD controlled rather than STOP controlled or signalized, may reduce the likelihood that motorists will yield to pedestrians crossing the turn lane. On the other hand, right-turn only lanes, in conjunction with bicycle lanes striped to the left, can be beneficial to bicyclists by reducing the potential for a right hook type collision, in which a motorist turns right across the path of a bicyclist moving straight through the intersection.<sup>6</sup>

When the intersection of a minor road and a major road is controlled by fully actuated or semi-actuated signals, special consideration should be given to pedestrians and bicyclists who will be crossing the major road. If pedestrians have to wait an unreasonably long time for a WALK signal, they will likely cross against a red light. If bicyclists cannot actuate the signal, it is likely that they will cross or turn against a red light rather than wait for a motor vehicle to actuate the signal.

Signal operations can also negatively affect pedestrians and bicyclists. If a green phase of a signal is too short, bicyclists may not be able to finish traveling through the intersection before the opposing traffic is released. Six percent of urban bicycle-motor vehicle

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<sup>6</sup>“Section 11.3. Pedestrian and Bicyclist Collision Types at Intersections” illustrates the different types of common pedestrian and bicyclist collisions, including the right hook.



collisions are related to these users not being able to finish crossing an intersection before the opposing traffic is released.<sup>7</sup> Similarly, if the pedestrian phase is too short, pedestrians, particularly pedestrians with disabilities, children and the elderly, may not be able to finish crossing an intersection before the opposing traffic is released. Currently, signal timing for pedestrian crossings in California is based on a crossing time of 4 feet per second. The 2009 National MUTCD is proposing a reduction to 2.8 feet under certain conditions. If extending the green phase or allowing a longer walk phase significantly increases motorist delay, the signal can be configured to use pedestrian and bicycle detection or actuation devices to provide longer bicycle or pedestrian phases only when these users are present.

### 3.1.1. Common Issues

Common issues associated with signalized intersections include:

- A. **Long crossing distances**, due to multiple through lanes, turn-only lanes, and large corner radii.
- B. **Obstructions in the crosswalk** from medians or median noses
- C. Wide turning radii encourage **fast turns** and increase crossing distances.
- D. **Inadequate refuge area** if the crossing cannot be made in one walk cycle.
- E. **Restricted pedestrian crossing movements** such as closed crosswalks.
- F. The intersection may be designed to force **through-moving bicyclists to weave across multiple right-turn only lanes** to continue straight.<sup>8</sup> This problem is worsened when one of the lanes is for optional through or right-turning movements.
- G. Motor vehicles may encroach on crosswalk, **limiting visibility**.
- H. **Bicyclists may not be able to actuate** traffic-actuated signal.

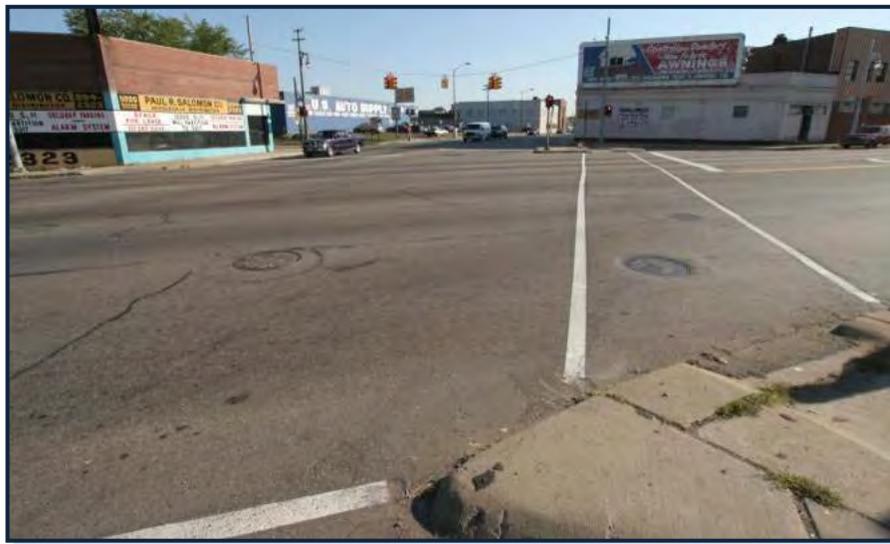
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<sup>7</sup> From NCHRP Report 500 series, Volume 18: A Guide for Reducing Collisions Involving Bicycles; Pg. V-11: It has been estimated that bicycle clearance-time crashes, where a motor vehicle hits a bicyclist who has entered a signalized intersection lawfully but has been unable to clear the intersection before the signal changes, constitute approximately 6 percent of urban bicycle/motor vehicle crashes (Wachtel et al., 1995). Wachtel, A., Forester, J., and Pelz, D. "Signal Clearance Timing for Bicyclists." ITE Journal. 65(3): 38-45, March 1995.

<sup>8</sup> CA MUTCD Section 9C.04 provides guidance for striping bicycle lanes at intersections. If right turns are permitted, and there is no right-turn only lane, bicycle lanes may be dropped or dashed for the last 100 to 200 feet. If right turns are not permitted, "the solid bike lane stripe should extend to the edge of the intersection." For some special cases ("extremely long" right-turn only lanes, double right turn lanes) "all striping should be dropped to permit judgment by the bicyclists to prevail." At ramp interchanges, "the bike lane stripe should be dropped 100 feet prior to the ramp intersection to allow for adequate weaving distance." Additionally, "an optional through-right turn lane next to a right-turn only lane should not be used where there is a through bicycle lane. If a capacity analysis indicates the need for an optional through-right turn lane, the bicycle lane should be discontinued at the intersection approach."



- I. **Pedestrian clearance time may not be long enough** to permit slower pedestrians to clear the intersection.
- J. Intersection clearance interval may not be long enough for bicyclists to clear the intersection.<sup>9</sup> This may become problematic in the case of large intersections. One potentially helpful technology now under development is bicycle-specific passive actuation.
- K. If pedestrian and motor vehicle volumes are high, there may be significant **conflicts between pedestrians and turning motor vehicles**. A significant number of pedestrian injuries and fatalities are associated with permissive left turns.
- L. **Loop detectors are placed at location where crosswalk would ideally be striped**, requiring the crosswalk to be striped at a less-than-optimal location (not shown);
- M. Signal poles, pull boxes, cabinet boxes, light standards, and other related electrical equipment obstructs the pedestrian path and blocks the view of pedestrians.<sup>10</sup>



*Long crossing distance can be especially challenging for bicyclists and pedestrians.*

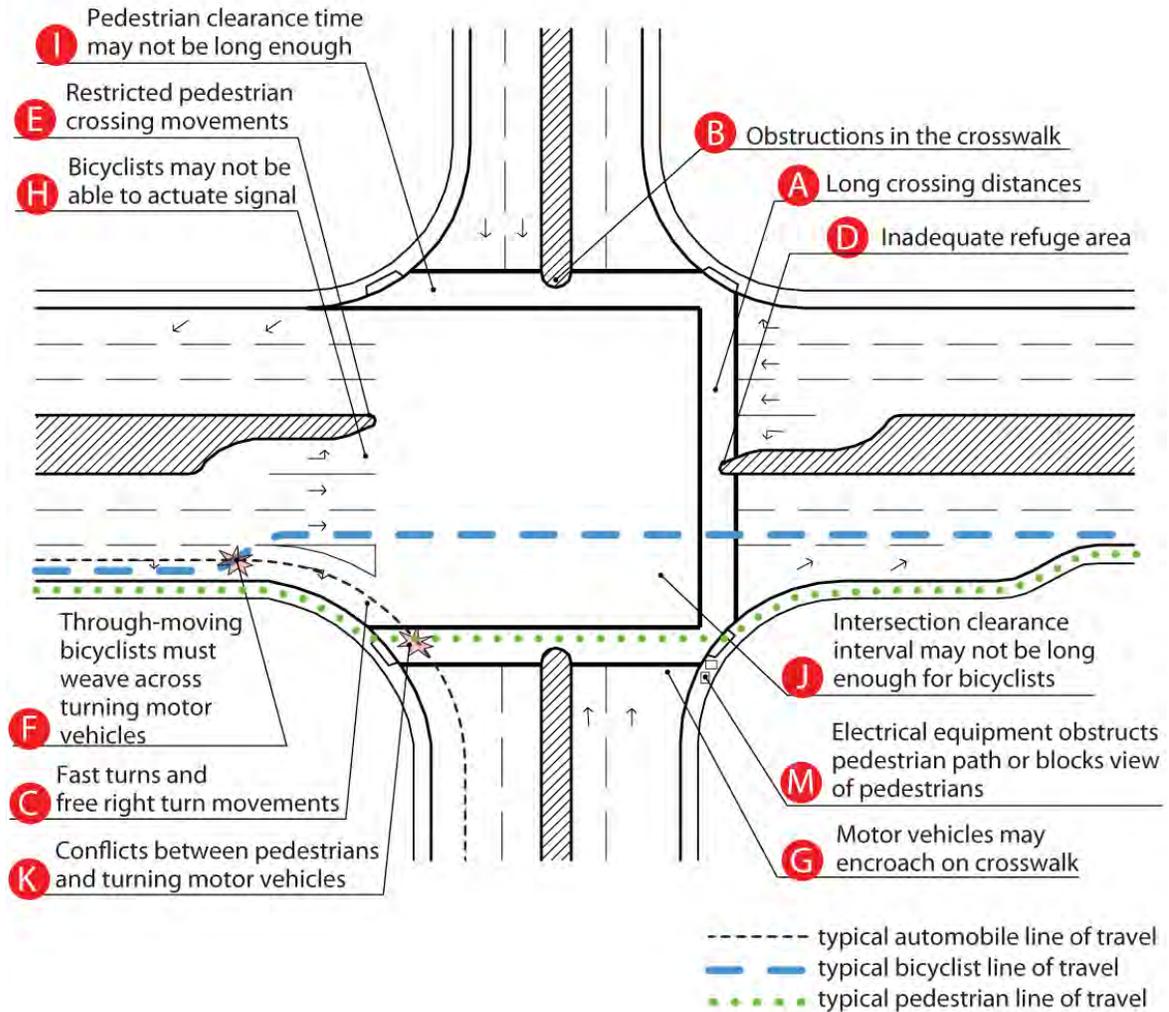
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<sup>9</sup> See Traffic Operations Policy Directive 09-06 for detail.

<sup>10</sup> Electrical equipment makes up more than half of the obstructions at intersections. Locations of pedestrian push buttons and crosswalk markings depend heavily on the placement of signal poles and loop detectors. Electrical plans should be developed precisely, and at scale, to allow reviewers to identify potential ADA and visibility issues and to proactively solve these issues.



**Figure 3.1 Issues Associated with Signalized Intersections**



### 3.1.2. Treatments

Treatments for signalized intersections focus on slowing motor vehicle speeds, reducing crossing distances, improving driver yielding, and ensuring that the signal actuation and timing can meet the needs of pedestrians and bicyclists. Specific treatments are described in Table 3.1.



**Table 3.1 Treatments for Signalized Intersections**

Treatment	Design Principles	Figure No.
<i>Signage and Striping</i>		
Stripes limit lines in advance of the crosswalk.	Clarify the Right-of-Way, Improve Visibility	3.2, 3.3
Stripe bicycle lane to the left of right-turn only lane, install “Right Turn Must Yield to Bicycles” sign and bicycle warning signs.	One Decision at a Time, Clarify the Right-of-Way	3.3
Stripe bicycle lane to the right of left-turn only lane.	Clarify the Right of Way, Pedestrians and Bicyclists There	3.3
Consider striping high-visibility crosswalks across all legs.	Improve Visibility, Clarify the Right-of-Way	Not shown
At signalized intersections, prohibit parking for two parking stall lengths (48 feet) on the near side of the intersection and one parking stall length (24 feet) at the far side of the intersection (CA MUTCD 3B.18).	Improve Visibility	Not shown
<i>Infrastructure</i>		
Reduce corner radii. If large vehicle turning movements is a concern, a solution may be to extend a mountable small-radius apron beyond the existing large-radius corner curbing (excluding crosswalks and curb ramps). The pedestrian waiting area would be behind the existing curbing.	Slow it Down, Shorten Crossings	3.2
Construct raised channelizing islands for right turns.	Slow it Down, Shorten Crossings, Improve Visibility, Clarify the Right-of-Way	3.2
Reconstruct median noses so they do not obstruct the crosswalk and provide a pedestrian refuge area.	Access for All	3.2
Install countdown signals.	Access for All	Not shown
Install Accessible Pedestrian Signals.	Access for All	Not shown
Construct right-turn lane as compound curve that meets intersecting street at close to 90-degree angle.	Slow it Down, Clarify the Right-of-Way	3.2
Design right-turn only lanes so that turning motorists must weave across through-moving bicyclists rather than vice-versa.	Clarify the Right of Way	3.3
Place loop detectors back from intersection to allow crosswalk to be marked at optimal location.	Improve Visibility	Not shown



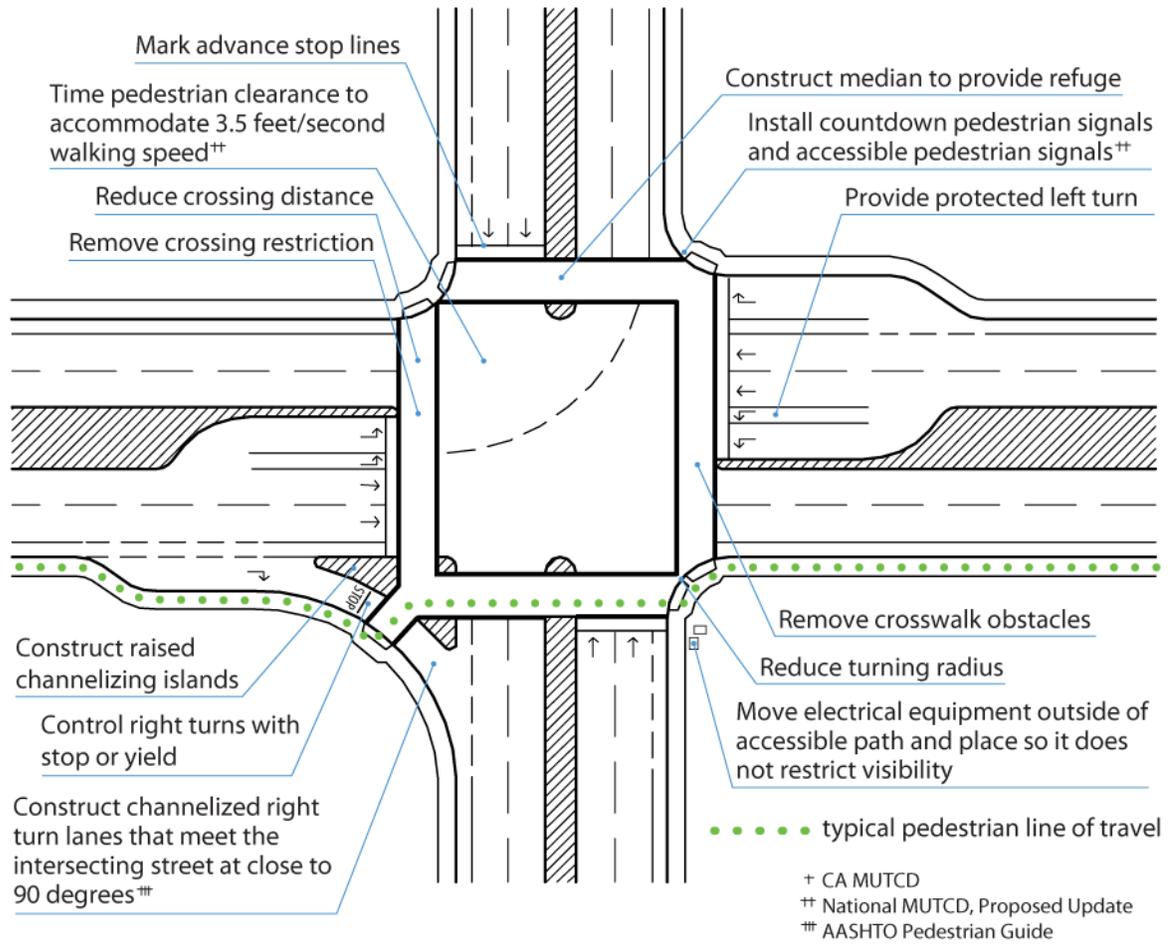
Treatment	Design Principles	Figure No.
Place electrical equipment to avoid impeding pedestrian travel, visibility, or installation of ADA accessible push button.	Access for All, Improve Visibility	3.2
<b>Operations</b>		
Control channelized right-turns with STOP or YIELD signs.	Slow it Down, Clarify the Right-of-Way	3.2
Where there are significant conflicts between pedestrians and right turning motor vehicles provide a leading pedestrian interval.	Clarify the Right of Way, Improve Visibility	Not Shown
Where there are significant conflicts between left turning vehicles and pedestrians, provide protected left turn.	Clarify the Right of Way	Not Shown
Install bicycle detection as indicated in Traffic Operations Directive 09-06.	Pedestrians and Bicyclists Will Be There	3.3
Time signal phase to 3.5 feet/second maximum (National MUTCD 2009) or 2.8 feet/second where older or disabled pedestrians routinely use the crosswalk (CA MUTCD 4E.10) Alternatively, push buttons to provide additional crossing time only on request may be installed.	Pedestrians and Bicyclists Will Be There, Access for All	3.2
Remove restrictions on pedestrian crossing.	Keep it Direct, Shorten Crossings	3.2

Two illustrations of treatments are shown:

- Figure 3.2 illustrates treatments for pedestrians
- Figure 3.3 illustrates treatments for bicyclists

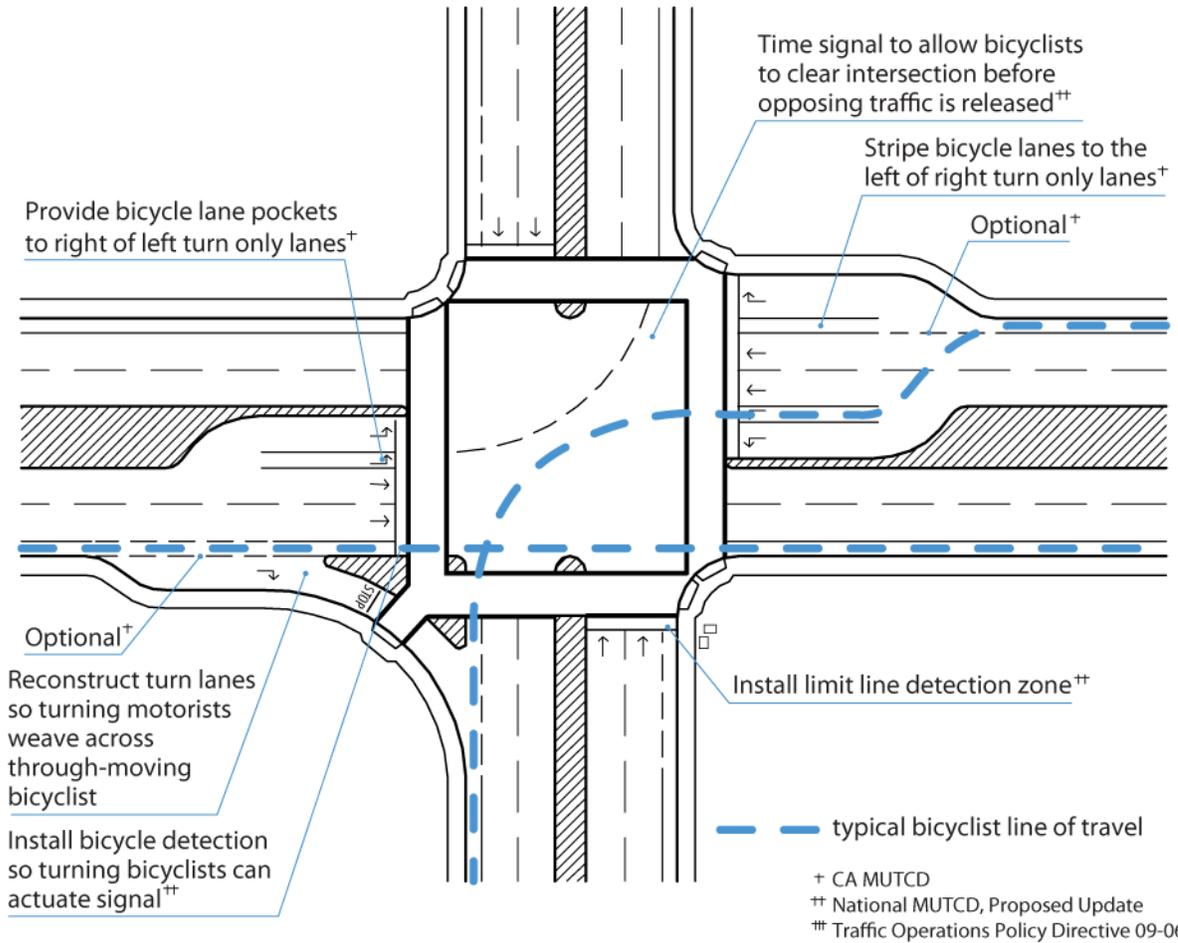


**Figure 3.2 Common Intersection Treatments for Pedestrians**





**Figure 3.3 Common Intersection Treatments for Bicyclists**





### ***Determining the Appropriate Design Vehicle***

The Caltrans HDM indicates that design of California highways should consider the needs of large vehicles to ensure they have space to maneuver. The HDM recommends using the Surface Transportation Assistance Act (STAA) design vehicle (figure 404.5A or B, 50- or 60-foot radius) in the design of all projects on the National Network or Terminal Access truck routes and the California Legal Design Vehicle (404.5D or E, 50- or 60-foot radius) in the design of all interchanges and intersections of California Legal routes and California kingpin to rear axle advisory routes (Section 404.2). Depending on the mix of motor vehicles on a roadway, this may lead to overbuilding streets for large, but infrequent vehicles to the detriment of the safety of more frequent roadway users. Large turning radii and wide travel lanes can negatively impact pedestrians and bicyclists by increasing crossing distances, increasing motor vehicle speeds, and reducing the visibility of nonmotorized users to motorists.

However, the HDM provides some flexibility, and indicates that “[i]n some cases, factors such as cost, right of way, environmental issues, local agency desires, and the type of community being served may limit the use of the STAA design vehicle template” (Section 404.3 (b)).

Rather than design every intersection with a California Legal route to 50- or 60-foot turning radii, planners, engineers, and other highway designers may consider the type of roadway that is intersecting with the California Legal route. Since STAA design vehicles are not expected to use local roads that are not California Legal routes, intersections with these roads do not always need to use the 50-foot or 60-foot radius.

This guidebook recommends that project planners, engineers, and other highway designers consider the following when determining turning radii:

- Consider the relative mix of vehicles on a roadway and the volumes of non-motorized users when selecting a design vehicle, and use the minimum appropriate turning radius.
- For intersections of California Legal routes and local roads, communicate with the local jurisdiction to determine the preferred turning radii. Where STAA design vehicles are used, a smaller design vehicle than the California Legal Design Vehicle should be considered.

The following are examples of guidance from other states on selecting a design vehicle:

- The Florida Department of Transportation (DOT) "Greenbook" requires that the design vehicle be at least 5 percent of the traffic volume.
- The Oregon DOT HDM allows lane widths of less than 12 ft where the 4-axle truck Average Daily Traffic is less than 250.
- Vermont DOT State Design Standards document provides a table showing acceptable lane and shoulder widths relative to design speed and traffic volume.



### **Speed Management Treatments**

Reducing motor vehicle speeds can improve safety for pedestrians and bicyclists. Reducing legal speed limits is not usually an appropriate means of accomplishing this goal, since speed limits are set by engineering surveys that reflect most drivers desired speeds given conditions. If speed limits are set artificially low, drivers may not comply.

There are several engineering techniques available to accomplish the goal of reduced speeds. The table below provides a list of proven speed management treatments applicable to the Caltrans roadway system, along with speed reductions observed in relevant studies.

<b>Engineering Countermeasures for Speed Management</b>	
<b>Countermeasure</b>	<b>Reduction in 85th percentile speed</b>
Roundabout <i>In urban and suburban environments where posted speed is 45 mph or less</i>	<b>25% to 42%</b>
Lateral Shift <i>Travel Lane shift</i>	<b>8% to 25%</b>
Center Island <i>Narrows travel lanes</i>	<b>12%</b>
Converging Chevron Marking Pattern <sup>a</sup> <i>Transverse pavement marking</i>	<b>11% to 24%</b>
In-Roadway Warning Lights <i>At pedestrian crossings</i>	<b>5% to 7%</b>
Speed Activated Feedback Signs <i>Dynamic display speed warnings</i>	<b>7% to 19%</b>
Gateway Treatment <i>Combined use of signs, landscaping, etc.</i>	<b>5% to 7%</b>

<sup>a</sup> Experimental treatment.

Source: FHWA, *Engineering Countermeasures for Reducing Speeds: A Desktop Reference of Potential Effectiveness*, May 2009. A full list along with studies cited can be found at [http://safety.fhwa.dot.gov/speedmgt/ref\\_mats/eng\\_count/](http://safety.fhwa.dot.gov/speedmgt/ref_mats/eng_count/).



### ***Bicycle Detection at Traffic-Actuated Signals***

Traffic Operations Policy Directive 09-06, issued August 27, 2009, modified CA MUTCD 4D.105 to require bicyclists to be detected at all traffic-actuated signals on public and private roads and driveways. The Policy Directive includes the following:

- Defines a 6 foot by 6 foot Limit Line Detection Zone in which a Reference Bicycle-Rider must be detected.
- Provides guidelines for when non-compliant limit line detectors must be replaced.
- Defines bicycle start-up and travel times that should be used to time signal phases to accommodate bicyclists.

The Policy Directive is still being revised, so readers should refer to the most recent version of the directive for specifics.

## **3.2. Four-Leg Intersections: Two-Way STOP Controlled**

The intersection of a minor road with a major road can be challenging for bicyclists and pedestrians. Most issues are related to difficulties with crossing the major road and potential conflicts between bicyclists, pedestrians, and turning vehicles.



If the major road is not controlled, pedestrians and bicyclists may experience a long delay before there is a large enough gap in traffic to allow them to cross the major road. The major road may not be adequately and appropriately designed to cue motorists to look for or expect pedestrians and bicyclists crossing at the minor road.

Medians in the major road can provide a refuge for crossing pedestrians and bicyclists, but only if they are designed to do so. If the median holds a left-turn only lane, it does not provide a refuge area, and may exacerbate a multiple threat situation since vehicles stopped waiting to turn left will block approaching motorists' view of the crosswalk.

### **3.2.1. Common Issues**

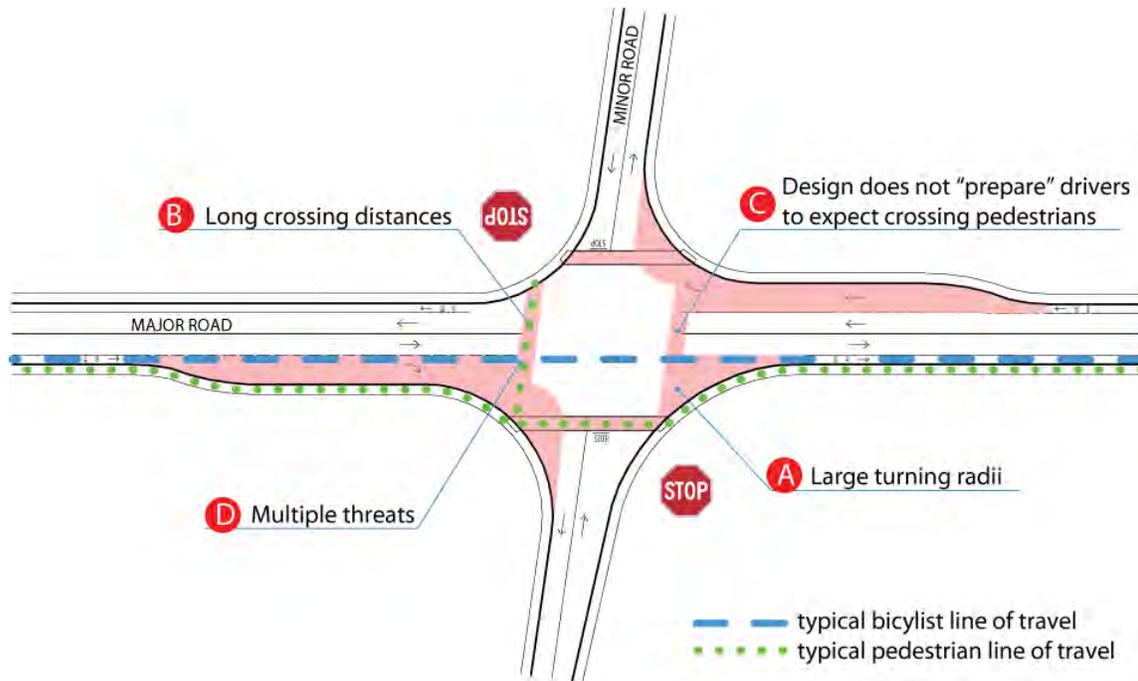
Common issues seen at two-way STOP-controlled, four-leg intersections are illustrated in Figure 3.4. They include:

- A. **Large turning radii** and right-turn only lanes allow motorists to take the corner at high speeds and increase pedestrian crossing distance. This design also decreases opportunities to cross when traffic is heavy.



- B. **Long crossing distances**, particularly in conjunction with high motor vehicle volumes and speeds make it difficult to cross the major road at an uncontrolled crossing.
- C. **Intersection is not adequately and appropriately designed so that drivers expect pedestrians to cross major road.**
- D. **Multiple threat** issues when crossing multilane roads (see Section 11.3 for discussion of multiple threat collisions).

**Figure 3.4 Issues Associated with Two-Way STOP Controlled, Four-Leg Intersections**



### 3.2.2. Treatments

Table 3.2 lists treatments to improve the comfort and safety of pedestrians and bicyclists at two-way STOP controlled intersections.

Three figures illustrating treatments are shown:

- Figure 3.5 shows less-expensive treatments to an intersection reducing curb radii and signage and striping improvements.
- Figure 3.6 shows more expensive treatments to an intersection: constructing raised islands to provide a refuge area for pedestrians and to shorten crossing distances.
- Figure 3.7 shows a treatment for a crossing of a multilane road that includes pedestrian actuated flashing beacons and refuge medians.



**Table 3.2 Treatments for Two-Way STOP Controlled Intersections**

Treatment	Design Principles	Figure No.
<i>Signage and Striping</i>		
Stripe high-visibility crosswalks	Pedestrians and Bicyclists Will Be There, Improve Visibility	3.5, 3.6, 3.7
Stripe yield lines and “Yield here to pedestrians” signs (per National MUTCD Proposed Update).	Pedestrians and Bicyclists Will Be There, Clarify the Right-of-Way	3.5, 3.6, 3.7
Stripe advanced stop lines.	One Decision at a Time, Improve Visibility, Clarify the Right-of-Way	3.5, 3.7
Restrict parking for at least one car length from each side (CA MUTCD 3B.18).	Improve Visibility	Not shown
If the uncontrolled crosswalk is a school crosswalk, install pedestrian actuated flashing beacon, as warranted (CA MUTCD 4K.103).	Clarify the Right-of-Way Light at Night	Not shown
Install in-road lights on the uncontrolled, marked crosswalks, as warranted (CA MUTCD 4L.02).	Clarify the Right-of-Way Light at Night	3.7
<i>Infrastructure</i>		
Construct raised pedestrian refuge if pedestrians cannot cross in one cycle, or if otherwise appropriate.	One Decision at a Time, Improve Visibility, Shorten Crossings	3.7

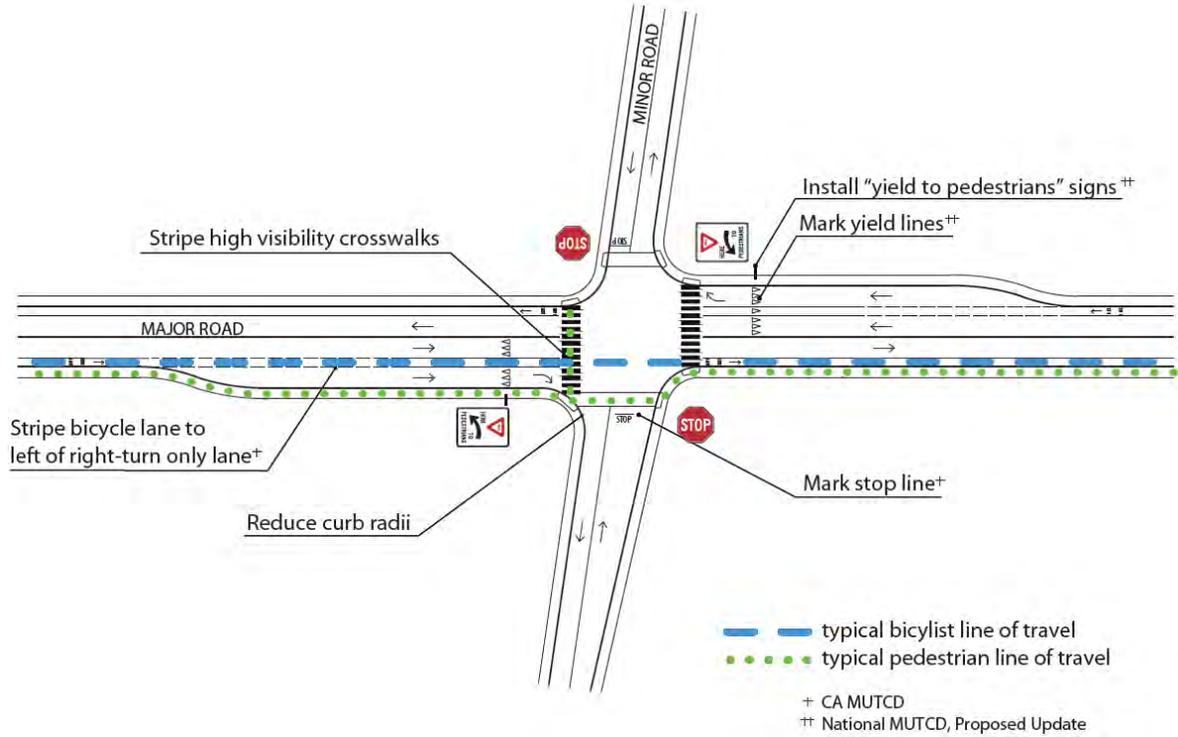


Image: [www.pedbikeimages.org](http://www.pedbikeimages.org) / Dan Burden

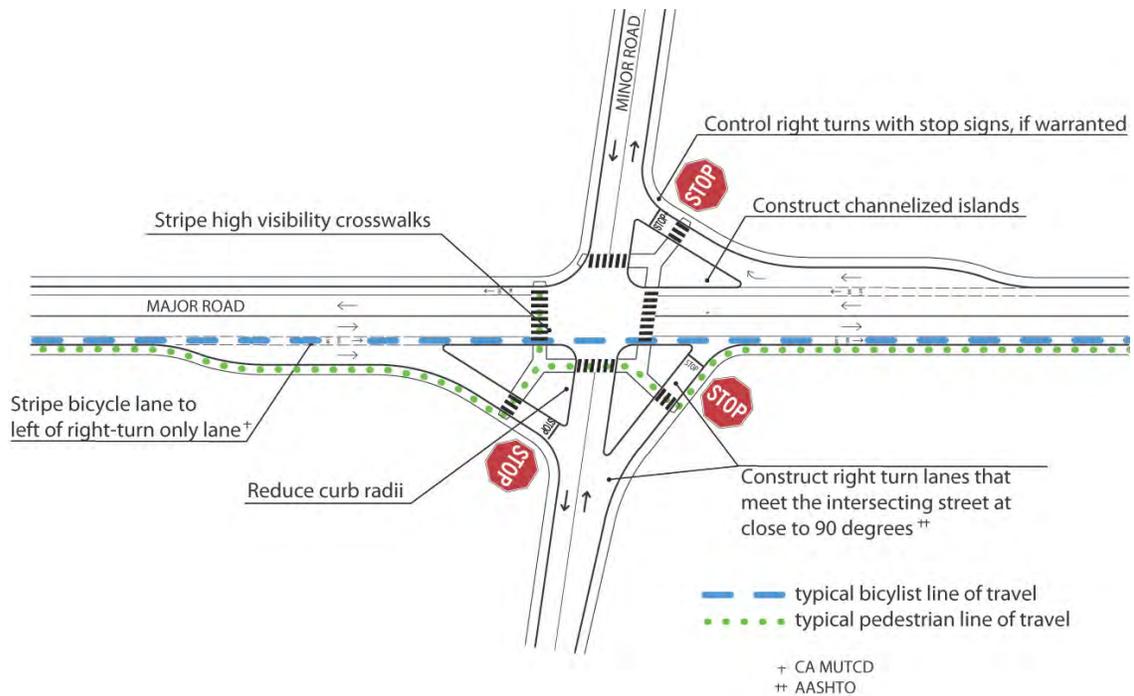
*Crosswalks at uncontrolled locations on high volume arterials should be paired with enhancements such as a raised median or pedestrian-actuated beacon.*



**Figure 3.5 Less Expensive Treatments: Reducing Turn Radii and Signage and Striping**

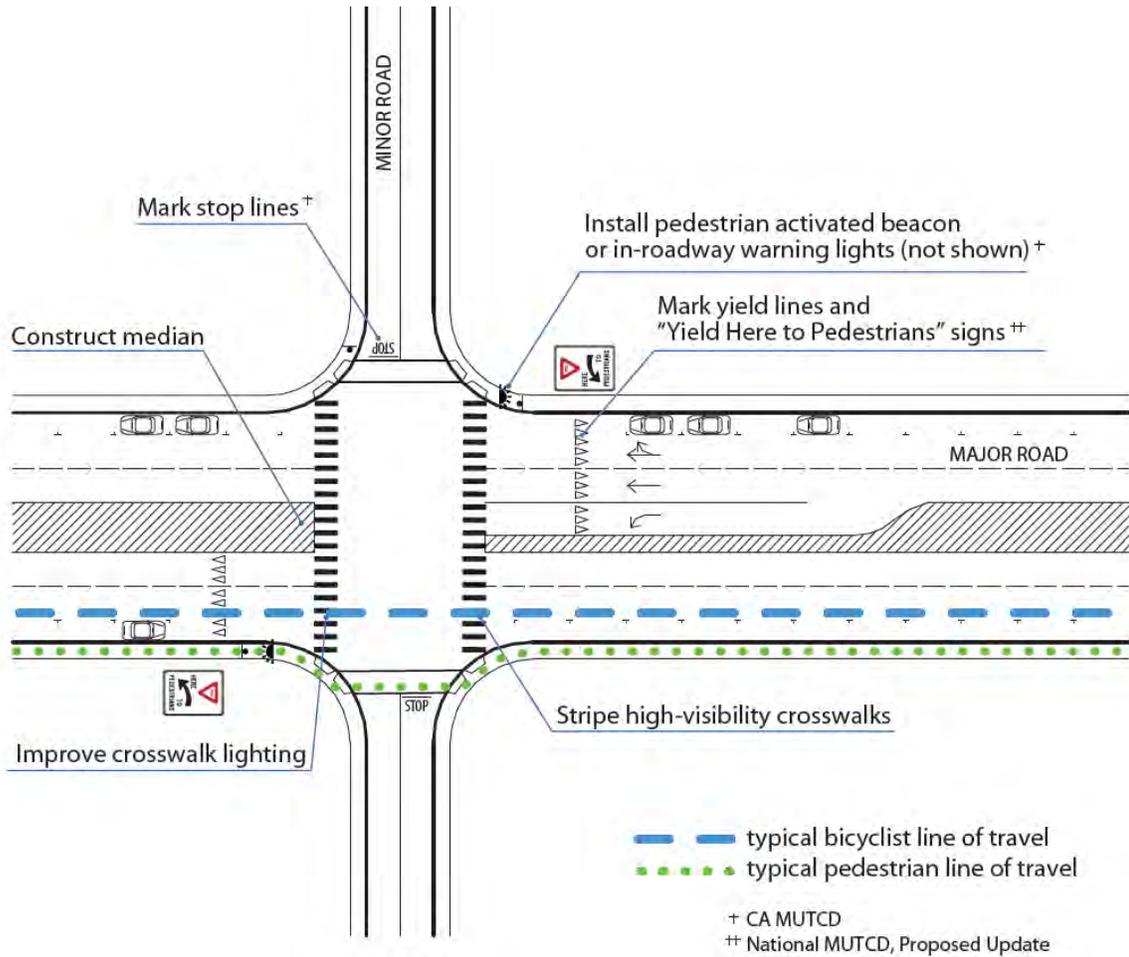


**Figure 3.6 More Expensive Treatments: Constructing Raised Islands**





**Figure 3.7 Flashing Beacons and Medians**





### ***Marked Versus Unmarked Crosswalks at Uncontrolled Locations***

Crosswalk lines should not be used indiscriminately. An engineering study should be performed before they are installed at uncontrolled locations. A comprehensive study on the safety effects of marked crosswalks at uncontrolled locations was published by FHWA in 2001. The study compares the number of vehicle pedestrian crashes at matched pairs of marked and unmarked crosswalks at the same intersection.

Several key points from the study are important to the design of crosswalks:

1. Volumes of pedestrian crossings were three to four times higher at marked crosswalks than at equivalent unmarked crosswalks.
2. When adjusted for pedestrian volumes, there were no statistically significant differences in number of pedestrian-vehicle crashes at marked and unmarked crosswalks on the following types of roadways:
  - Two-lane roadways
  - Multilane roadways with Average Daily Traffic (ADT) less than 12,000
  - Multilane roadways with a raised median (pedestrian refuge) and ADT less than 15,000
3. Conversely, providing a marked crosswalk with no additional treatment (e.g. medians, flashing beacons, curb extensions, signage) at the following types of roadways was shown to increase the rate of pedestrian-vehicle crashes:
  - Roadways with speed limits of 40 mph or greater
  - Roadways with four or more lanes, no raised median, and an ADT of greater than 12,000
  - Roadways with four or more lanes, with a raised median, and an ADT greater than 15,000

Source: Zegeer et al. *Safety Effects of Marked vs. Unmarked Crosswalks at Uncontrolled Locations*. Highway Safety Research Center, University of North Carolina, Chapel Hill, North Carolina, 2001. (FHWA-RD-01-075). The complete study and a table of recommended treatments by location type can be accessed from <http://www.walkinginfo.org/library/details.cfm?id=54>.



## 4. THREE-LEG AND OFFSET INTERSECTIONS

Three-leg and offset intersections present similar issues as four-leg intersections but have unique issues related to sightlines at one end of the crosswalk and conflicts between turning motor vehicles and pedestrians and bicyclists.

### 4.1. Ninety-Degree T

#### 4.1.1. Common Issues

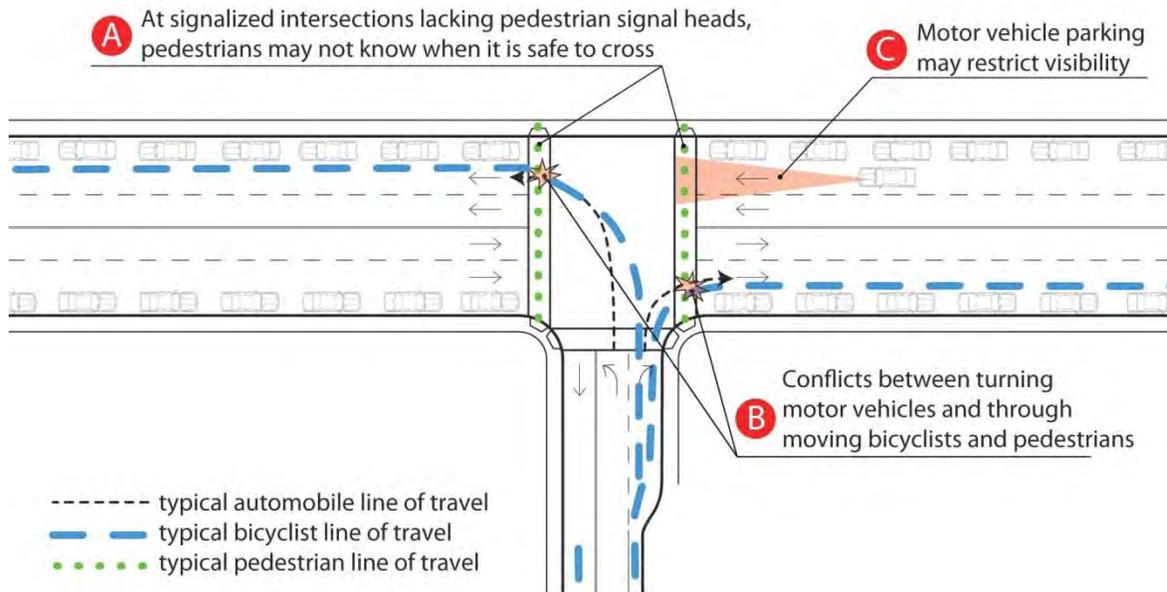
Pedestrian and bicycle issues related to T-intersections stem from the fact that a T-intersection is a three-way intersection for motorists, but a four-way intersection for pedestrians or bicyclists. Conflicts occur between turning vehicles and crossing pedestrians and bicyclists. This is problematic at STOP or YIELD controlled T's, but especially problematic at signal-controlled intersections.

Issues unique to T-Intersection are illustrated in Figure 4.1 and include:

- A. Signalized intersections, if vehicular signal indications are not visible to pedestrians, **pedestrians waiting to cross the major road against traffic may not know when it is legal** to do so
- B. **Turning vehicles conflict** with through-moving pedestrians and bicyclists
- C. Motor vehicle **parking may restrict visibility or obstruct the end of the crosswalk** that lands on a straight section of sidewalk



**Figure 4.1 Common Issues at Signalized T-Intersections**



### 4.1.2. Treatments

T-intersection treatments should focus on reducing conflicts between through-moving pedestrians and turning motor vehicles, indicating to pedestrians when they may legally cross the street, and improving visibility at the non-corner end of the crosswalk. All the standard treatments identified in four-leg intersections apply to T-intersections.

Figure 4.2 illustrates treatments for signalized T-intersections.

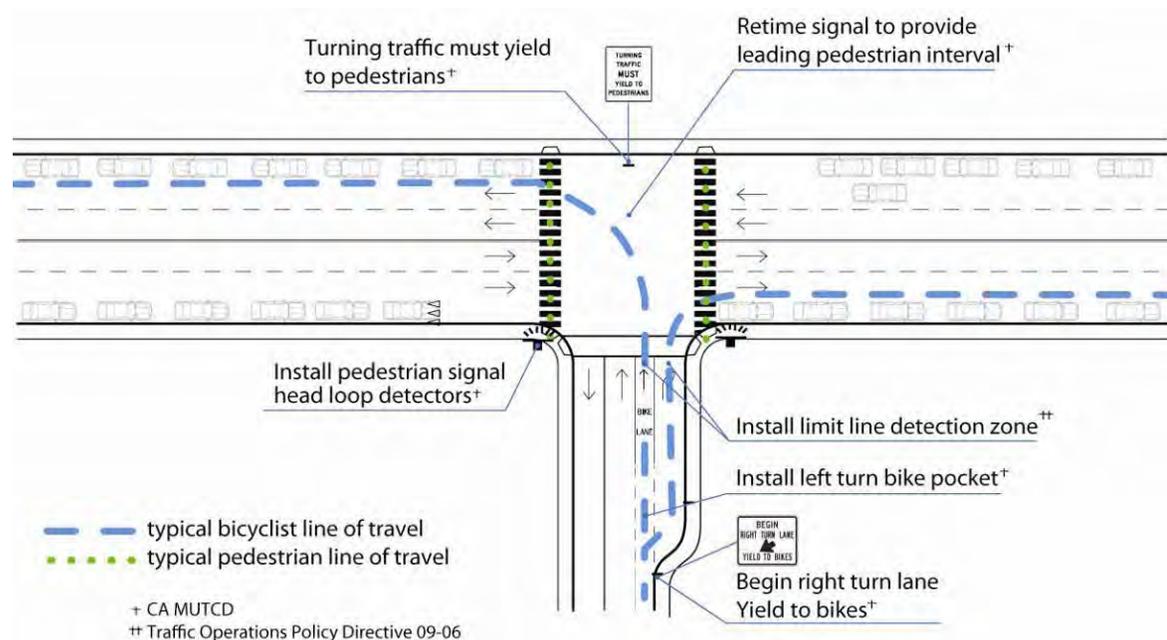
Figure 4.3 illustrates treatments for T-intersections where the major road is uncontrolled.



**Table 4.1 Treatments for T-Intersections**

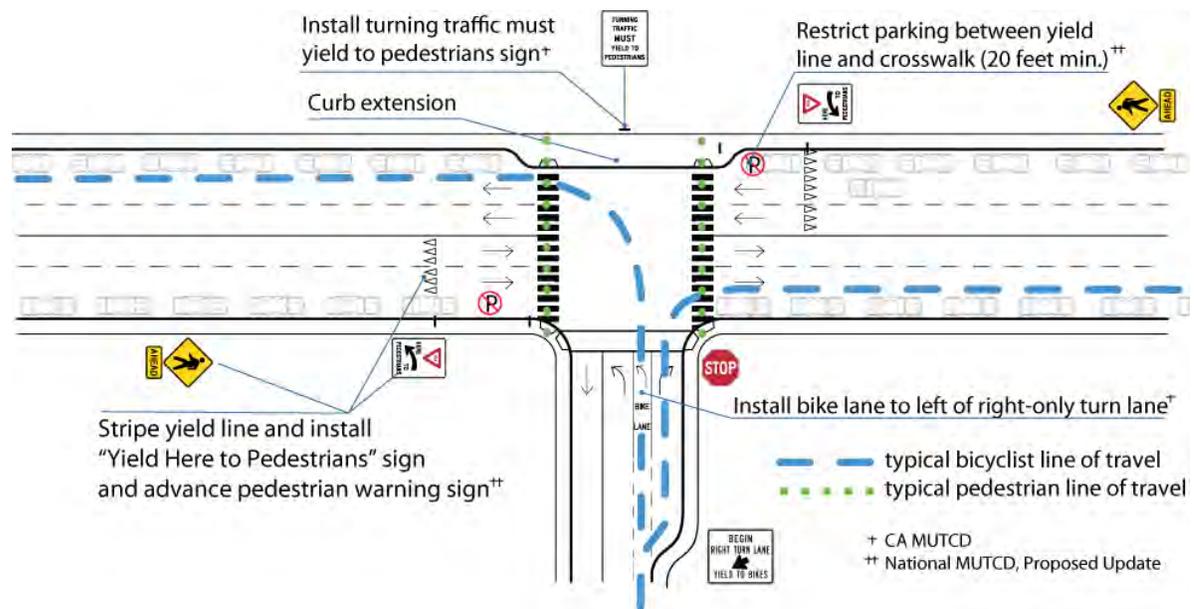
Treatment	Design Principles	Figure No.
<i>Signage and Striping</i>		
Stripe high-visibility crosswalks across the main road.	Improve Visibility	4.2,4.3
Install pedestrian warning and yield signage at the uncontrolled crosswalk.	Improve Visibility	4.2
Stripe yield lines and “Yield Here to Pedestrian (R1-5a)” signs in advance of the crosswalk.	Clarify the Right-of-Way	4.2
Restrict parking between yield line and crosswalk (20 feet minimum).	Improve Visibility	4.2
<i>Infrastructure</i>		
Construct curb extension at non-corner crosswalk end.	Shorten Crossings, Improve Visibility	4.3
<i>Operations</i>		
Configure signal to provide a leading pedestrian interval to reduce conflicts between crossing pedestrians and turning motorists.	Pedestrians and Bicyclists Will Be There	4.3
Install pedestrian signal head for pedestrians and bicyclists waiting to cross main road opposite minor road. Bicyclists crossing as pedestrians should dismount and walk their bike.	Pedestrians and Bicyclists Will Be There	4.3

**Figure 4.2 Signage and Operations Treatments for Signalized T-Intersections**





**Figure 4.3 Signage Treatments for T-Intersections Where Major Road is Uncontrolled**



## 4.2. Offset

### 4.2.1. Common Issues

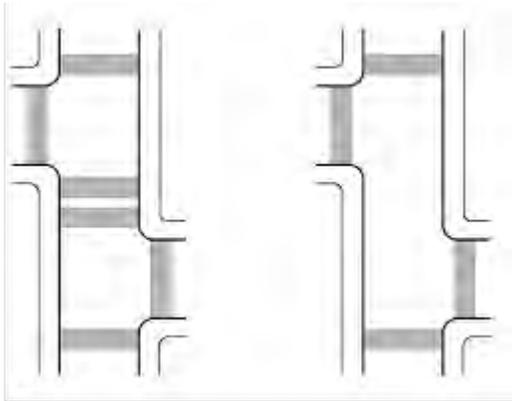
Offset intersections can be thought of as two closely spaced T-intersections, and have the same issues as T-intersections. A few issues, however, are unique to offset intersections:

- Conflicts between **turning motorists and through-moving bicyclists**.
- If crosswalks are not marked, **pedestrians may be uncertain which of the many legal crosswalks they should use**.
- For left-right offset intersections, **bicyclists crossing the main road are exposed to motor vehicles while waiting to turn left**.
- Bicyclists and drivers responding to gaps in traffic **may fail to notice crossing pedestrians**.
- Bicyclists continuing on the minor (offset) road must **cross opposing traffic streams all at once**; at right-left offset intersections, in particular there may be no logical refuge area.
- At signalized offset intersections, **bicycle clearance time may be insufficient** [not shown].

Figures 4.5 and 4.6 illustrate these issues at left-right and right-left offset intersections.



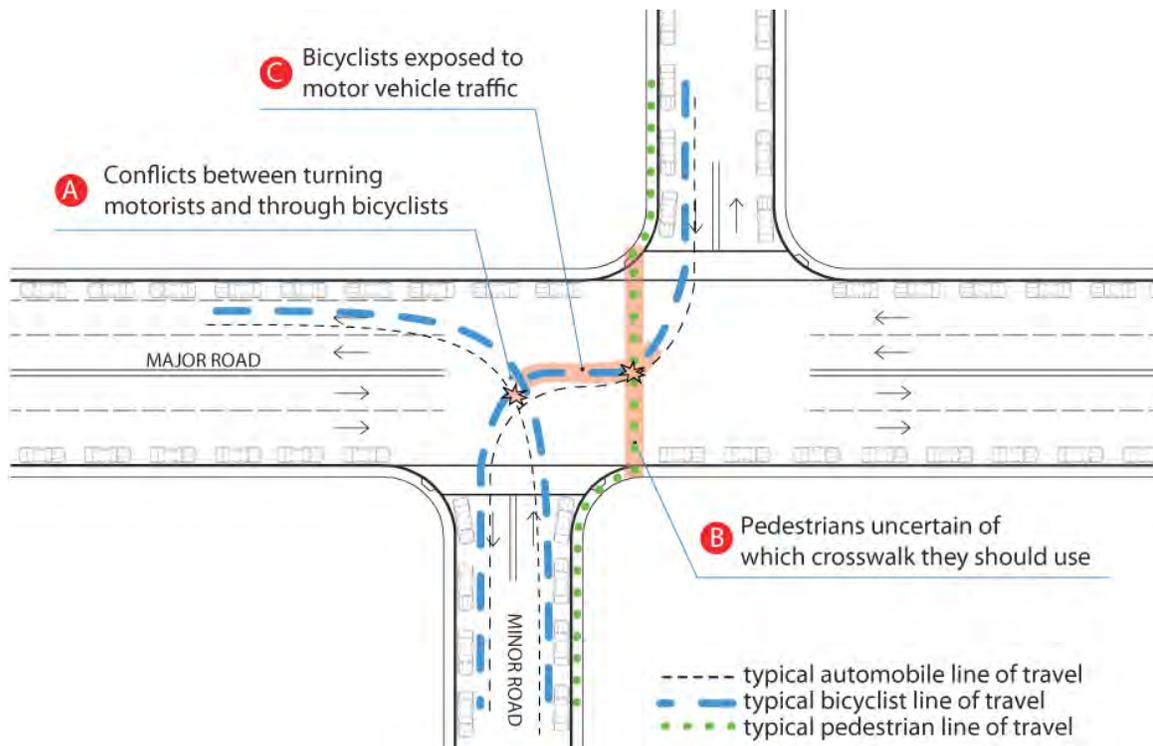
**Figure 4.4 Legal Crossings at Offset Intersections**



Source: Portland Pedestrian Master Plan.

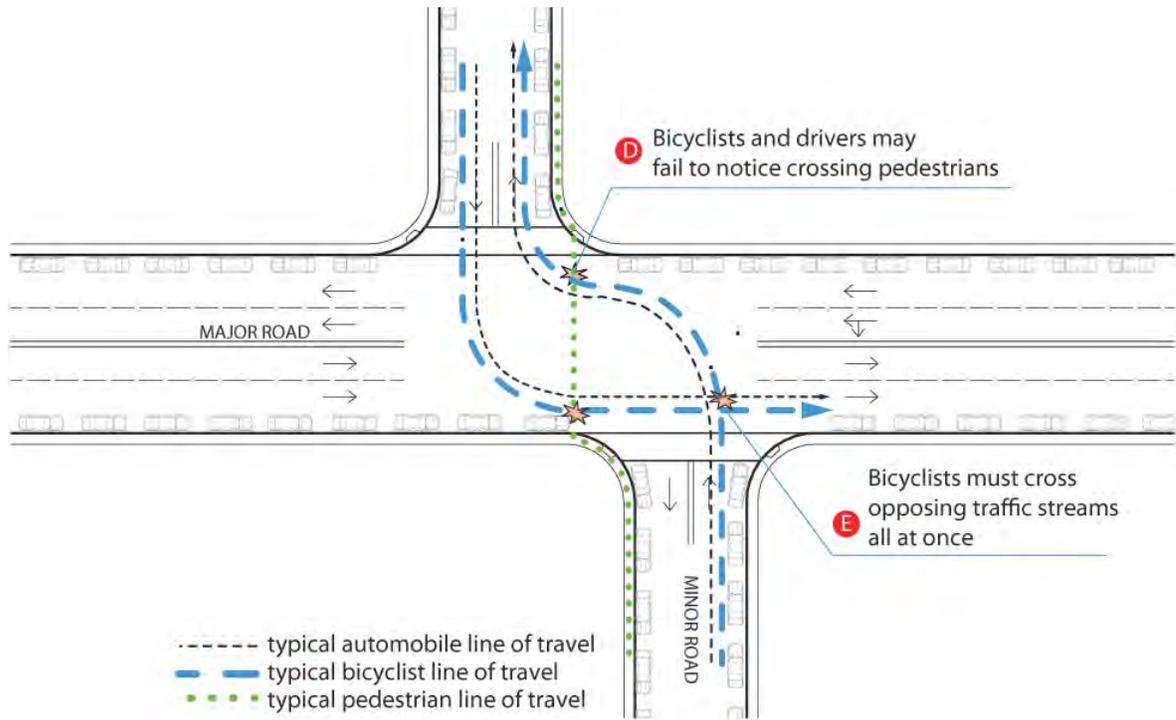
The left hand diagram shown above illustrates all the legal crosswalks in a typical offset intersection. A more practical and effective striping application is shown at right.

**Figure 4.5 Pedestrian and Bicycle Issues at a Left-Right Offset Intersection**





**Figure 4.6 Pedestrian and Bicycle Issues at Right-Left Offset Intersections**



### 4.2.2. Treatments

All the standard treatments for four-leg and T-intersections apply to offset intersections. At offset intersections, pedestrian safety and convenience can be improved by selectively removing some legal crosswalks and enhancing others.

Treatments to improve bicyclist travel through offset intersections should focus on making it easier for through-moving bicyclists to cross both directions of traffic on the major road, clarifying who has the right-of-way at the intersection, and improving the yielding behavior of turning motorists. These improvements may include signage indicating who must yield the right-of-way, striping, such as left-turn only lanes with bicycle pockets, and physical treatments such as median refuges. Several examples of innovative treatments for bicyclists at offset intersections exist, but these are not yet incorporated into the California HDM or the CA MUTCD. These include striping bicycle-only center turn lane or restricting motorist through movements at the intersection but allowing bicyclist movements (See Figure 4.8.).



*Example of bike only left-turn lane.*

Treatments specific to offset intersections are listed in Table 4.2.



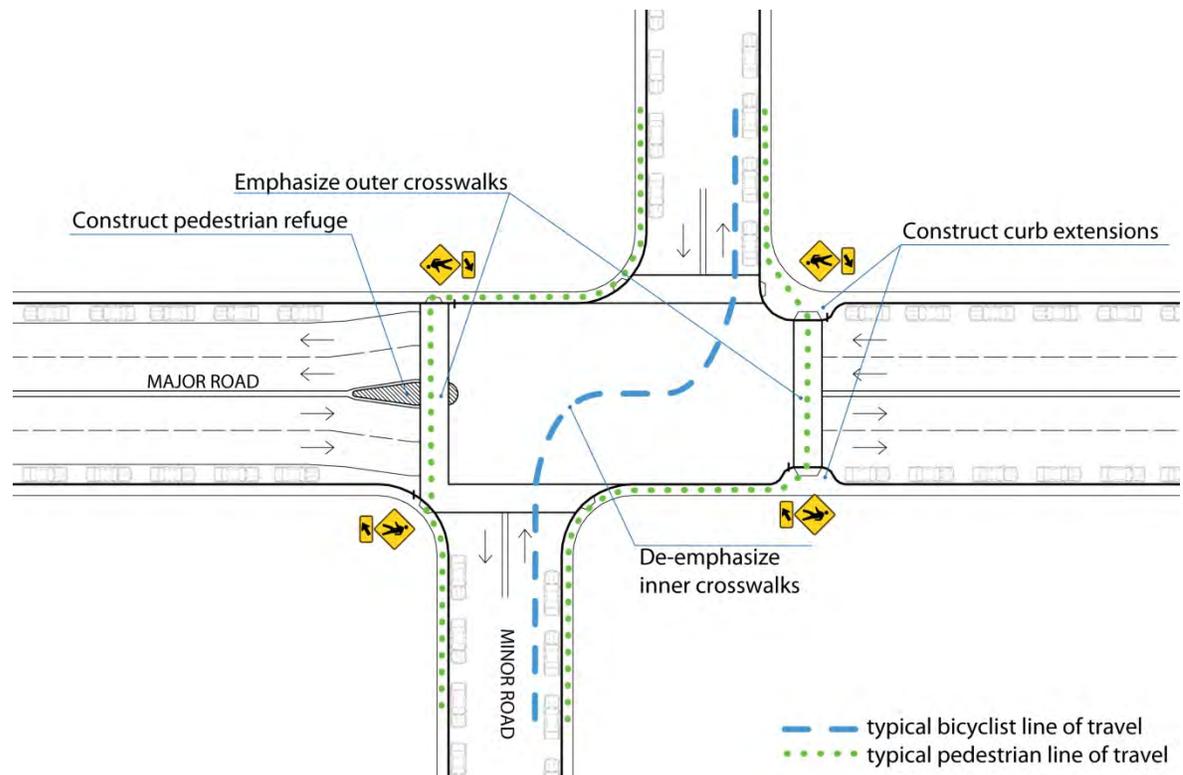
Figure 4.7 illustrates ways in which pedestrians can be better accommodated at offset intersections.

Figure 4.8 illustrates striping treatments that can be used to accommodate bicyclists at offset intersections.

**Table 4.2 Treatments for Offset Intersections**

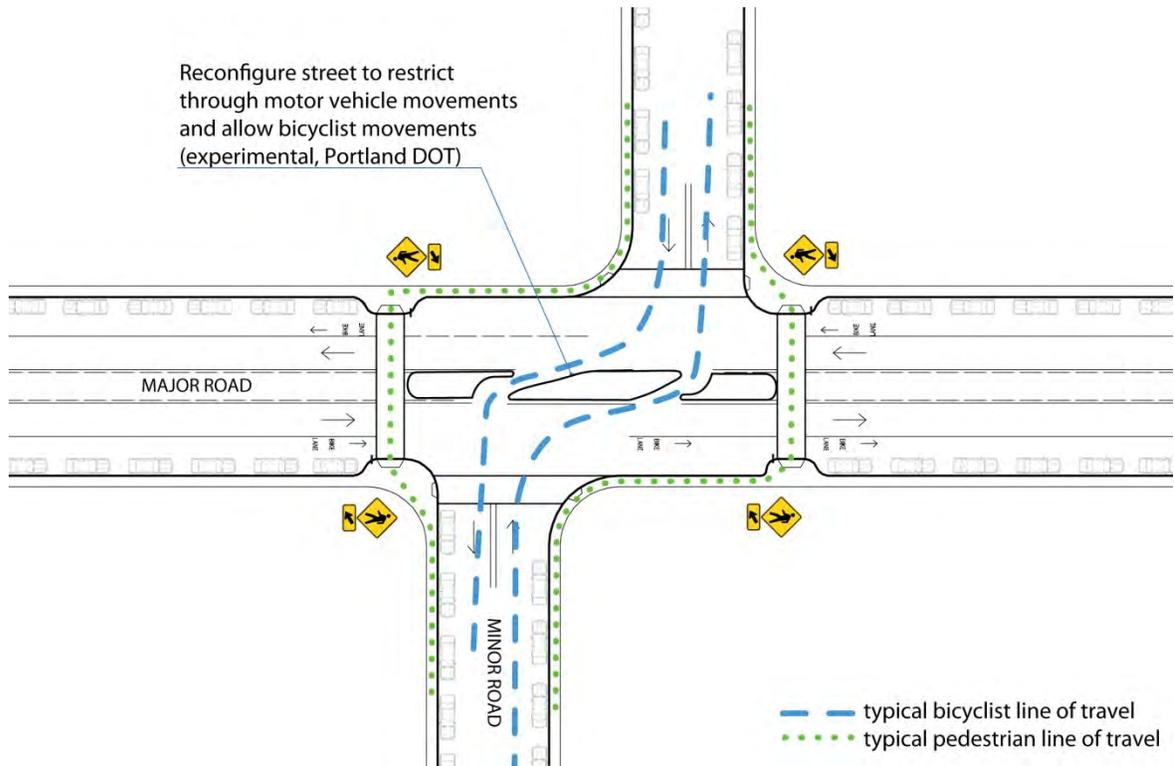
Treatment	Design Principles	Figure No.
<i>Signage and Striping</i>		
Enhance outer crosswalks while removing inner crosswalks. (Install “Pedestrians Use Marked Crosswalk” sign).	Clarify Right-of-Way	4.7,4.8
<i>Infrastructure</i>		
Provide refuge for turning bicyclists, through striping or construction of a refuge island.	Shorten Crossings, Clarify Right-of-Way	4.8
Construct curb extensions for pedestrians.	Shorten Crossings	4.7, 4.8
<i>Operations</i>		
Provide leading pedestrian interval or pedestrian-only phase at signalized offset intersections.		Not shown

**Figure 4.7 Selective Crosswalk Enhancement at Offset Intersections**





**Figure 4.8 Experimental Bicycle Treatments at Offset Intersections**





## 5. SKEWED AND MULTI-LEG INTERSECTIONS

Issues experienced by pedestrians and bicyclists at standard intersections are made more complicated at skewed and multi-leg intersections. These intersections increase crossing distances, may pose navigation difficulties for pedestrians with visual impairments, and can reduce the visibility of pedestrians and bicyclists to motorists.

For pedestrians, the key concerns at these types of intersections are related to crosswalk placement. When determining where to place crosswalks at skewed or multi-leg intersections, designers should observe the natural pedestrian path and place crosswalks at a location as close to the pedestrians' natural path as possible while maximizing visibility, driver and pedestrian expectation and minimizing crossing distances.

The AASHTO Guide for *"The Planning, Design, and Operation of Pedestrian Facilities"* notes that placement of crosswalks at skewed intersections generally falls between placing the crosswalk as a continuation of the sidewalk and at a right angle to the road.

**Table 5.1 Crosswalk Placement at Skewed Intersections**

Crosswalk Location	Advantages	Disadvantages
As a continuation of the sidewalk.	In line with the approach sidewalk; continues walking path; shortest overall distance.	Reduces visibility for pedestrians crossing some intersection legs where they travel on a path facing partly away from traffic approaching from the right; exposes pedestrians to traffic for a longer period.
At a right angle to road.	Shortest crossing distance; pedestrians have good visibility of approaching motorists.	Longer overall walking distance; may be counterintuitive; places crosswalk away from intersection where motorists may not expect pedestrians.

Note: Adapted from AASHTO Guide for The Planning, Design, and Operation of Pedestrian Facilities.

Skewed and multi-leg intersections present similar issues for bicyclists as they do for motorists. At these intersections, some bicyclist turning movements and crossing distances are increased. Where legs intersect at a non-perpendicular (skewed) angle, motorists, and bicyclists must turn their heads significantly to see across an entire sight triangle.<sup>11</sup>

<sup>11</sup> AASHTO Geometric Design of Highways and Streets, 2004.



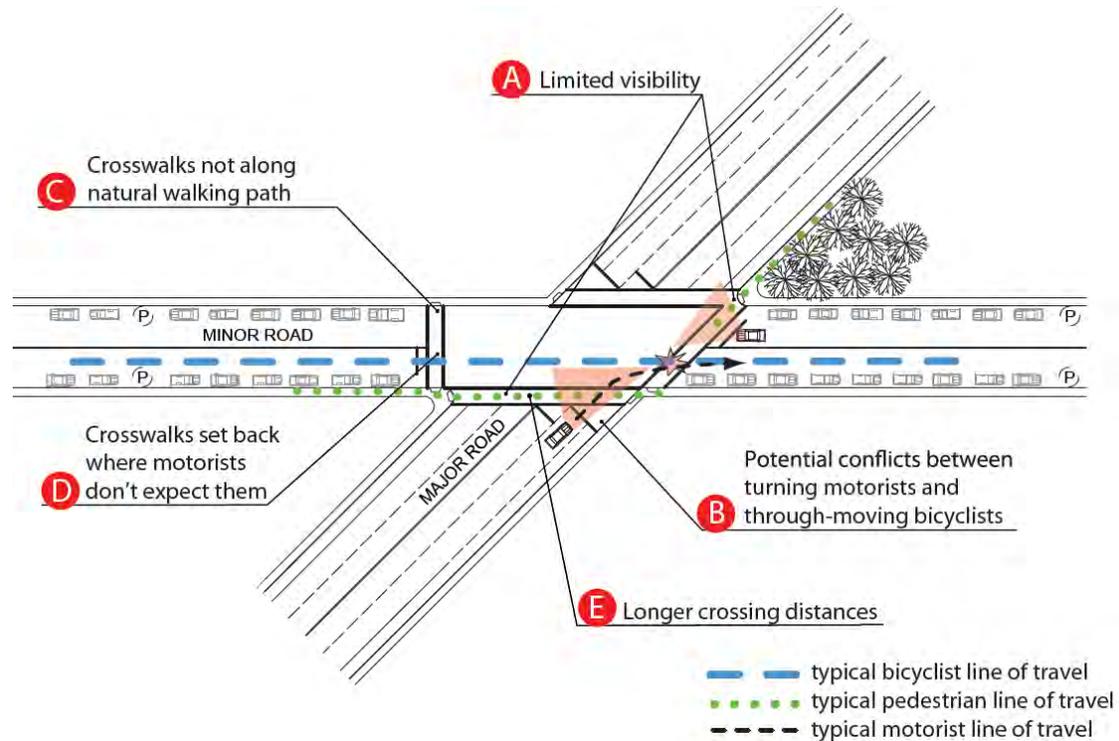
## 5.1. Skewed Intersections

### 5.1.1. Common Issues

Skewed intersections occur when two roads meet at a non-perpendicular angle. Common issues seen at skewed intersections are illustrated in Figure 5.1. They include:

- A. **Pedestrians and bicyclists approaching from a skew angle may be less visible to motorists.**
- B. **Turning motorists do not need to slow down for some movements, thus exacerbating conflicts between turning motorists and through moving bicyclists.**
- C. **Crosswalks may not be situated along the natural walking path.**
- D. **Crosswalks may be set back from the intersection, where motorists and bicyclists do not expect them.**
- E. **Longer crossing distances.**
- F. In skewed intersections, **poor pavement quality** may be an issue. Due to the skew, bicycle wheels can catch in grooves or along uneven pavement joints, increasing the possibility of a crash (not shown).

**Figure 5.1 Issues Associated with Skewed Intersections**





## 5.1.2. Treatments

Planners, engineers, and other highway designers can accommodate pedestrians and bicyclists at skewed intersections by reducing crossing distances, clarifying appropriate bicyclist movements, and improving visibility of pedestrians and bicyclists. Specific treatments are described in Table 5.2 and may be applied in addition to the basic treatments for all four-leg intersections listed in and Table 3.2.

Two illustrations are shown:

- Figure 5.2 illustrates less expensive treatments: modified crosswalk placement, improvements to visibility, construction of refuge islands, curb extensions and signage and striping; and
- Figure 5.3 illustrates a more expensive treatment: reconstructing the intersection to 90-degree angle.

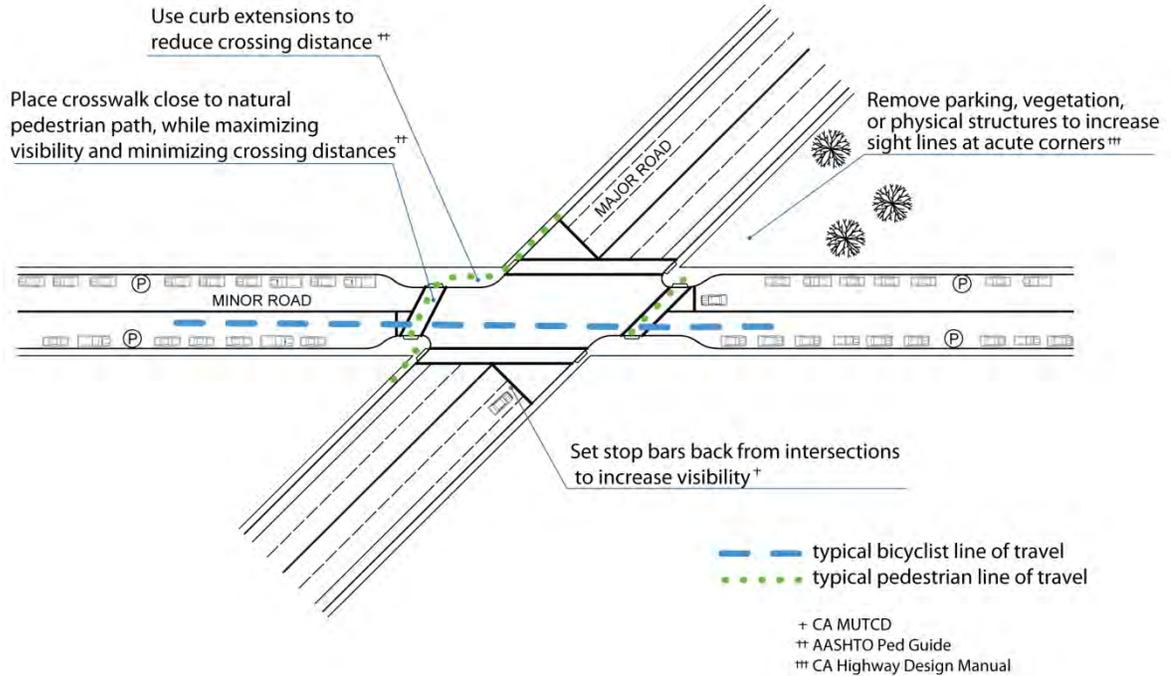
**Table 5.2 Treatments for Skewed Intersections**

Treatment	Design Principles	Figure No.
<b>Signage and Striping</b>		
Place crosswalks as close to the pedestrians' natural path as possible.	Improve Visibility, Tee It Up, Shorten Crossings	5.2
Set stop lines back from intersection to allow through moving bicyclists to wait in advance of right-turning motorists.	One Decision/Lane At a Time, Improve Visibility	5.2
Stripe right-turn only lane and bicycle lane to left of turn lane.	Clarify Right-of-Way, Improve Visibility	Not shown
<b>Infrastructure</b>		
Reconstruct intersection so that legs intersect at close to a 90- degree angle, or reconstruct intersection as a single-lane roundabout. See Section 8.0 in this document for issues and treatments associated with roundabouts.	Tee it Up	Not shown
Remove vegetation or physical structures to increase sight lines at acute corners.	Improve Visibility	5.2
Provide refuge islands or curb extensions to reduce crossing distance <sup>a</sup> .	Shorten Crossings	Not shown
Maintain pavement quality through intersection to minimize pavement lips that run less than 45 degrees to the bicyclist line of travel.	Maintain and Improve	Not shown
<b>Operations</b>		
If signalized, time pedestrian phase and green phase to take into account longer crossing distances for pedestrians and bicyclists, respectively.	Pedestrians and Bicyclists Will Be There	Not shown
Consider bicycle signal to give bicyclists a lead so that they may have enough time to clear the weaving area before the motorists are given the green.	Clarify the Right of Way	Not shown

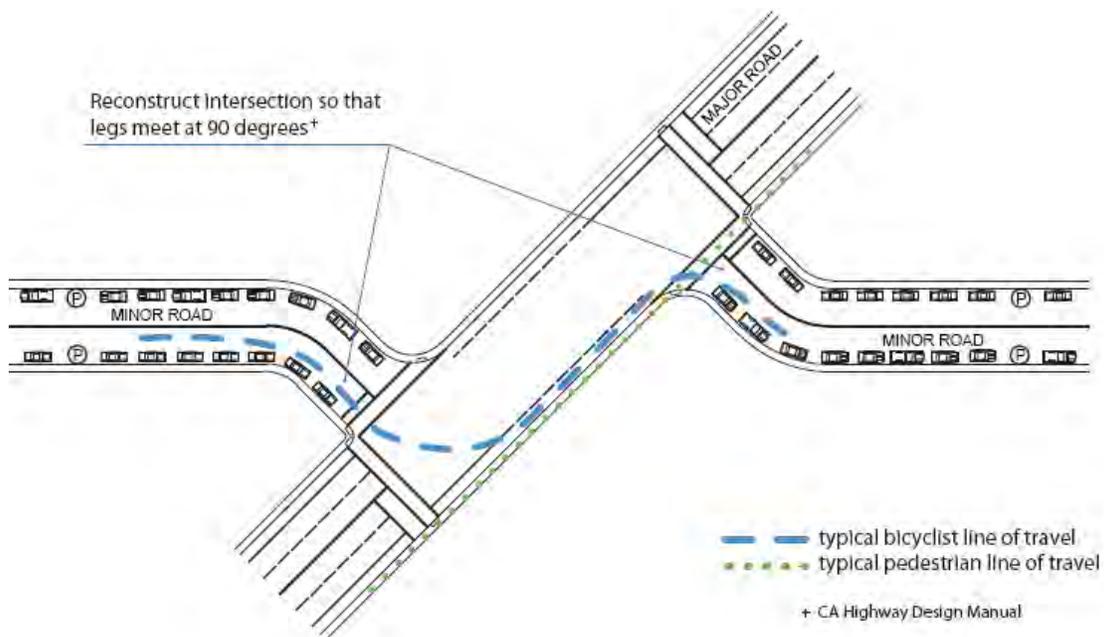
<sup>a</sup> See AASHTO *Geometric Design of Highways and Streets*, page 677 for an illustration of increased sight triangles at skewed intersections.



**Figure 5.2 Signage, Striping and Minor Construction Treatments for Skewed Intersections**



**Figure 5.3 Reconstruction of Skewed Intersections to a 90-Degree Angle**





## 5.2. Multi-leg Intersections

### 5.2.1. Common Issues

Multi-leg intersections are those with five or more intersection legs. *AASHTO Geometric Design of Highways and Streets* states, “multi-leg intersections should be avoided wherever practical” (page 571).

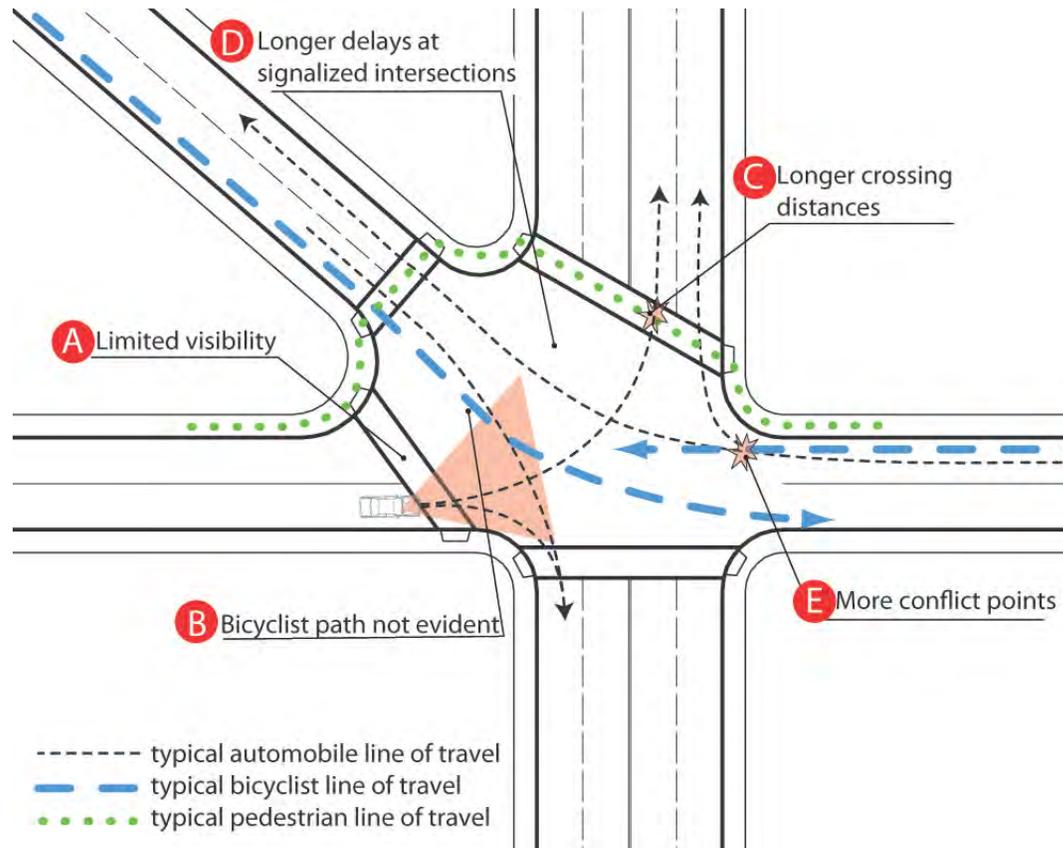
More than other types of intersections, issues for pedestrians and bicyclists at multi-leg intersections are difficult to generalize and tied to unique characteristics of the intersection. In general, issues associated with multi-leg intersections are similar to those at skewed intersections.

Common issues seen at multi-leg intersections are illustrated in Figure 5.4. They include:

- A. **Pedestrians and bicyclists approaching from an acute angle may not be visible to motorists.**
- B. **The bicyclists' path is not evident.**
- C. **Longer crossing distances.**
- D. **Longer delays for pedestrians and bicyclists at signalized multi-leg intersections.**
- E. **More conflict points** between pedestrians, bicyclists, and turning motorists.



**Figure 5.4 Issues Associated with Multi-leg Intersections**



### 5.2.2. Treatments

Aside from applying the treatments listed for skewed intersections in this document, the most effective way a designer can improve a multi-leg intersection for pedestrians and bicyclists is to reconstruct the intersection to provide two or more four-leg intersections, or to reconstruct the intersection as a roundabout with circulating speeds of 12 to 22 mph. Roundabouts are covered in Section 8. If reconstructing an intersection is not possible, designers should refer to treatments provided in this document for skewed intersections (Section 4) and four-leg intersections (Section 2).

Two illustrations of treatments are shown:

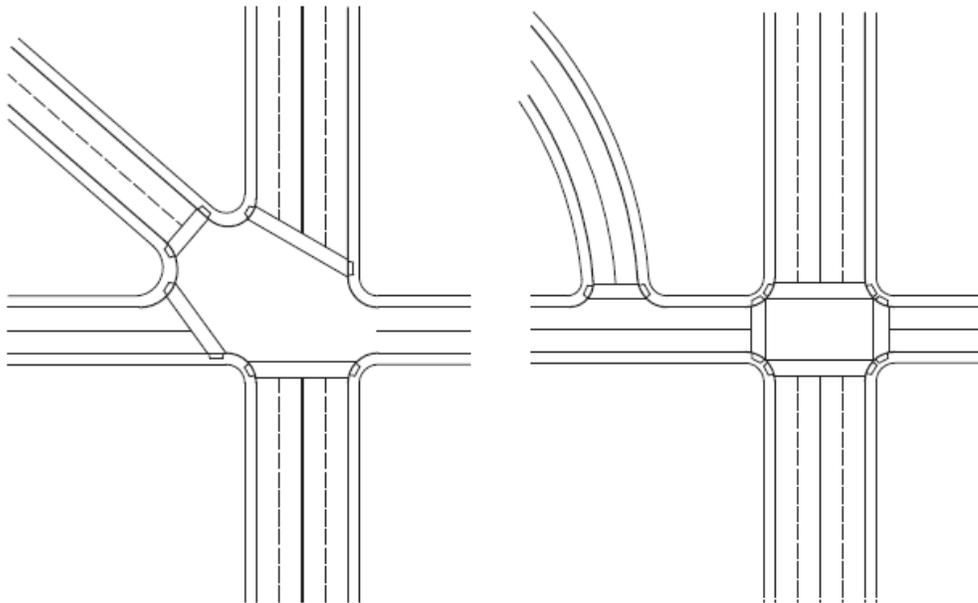
- Figure 5.5 illustrates a reconstruction of a five-leg intersection; and
- Figure 5.6 illustrates a reconstruction of a six-leg intersection.



**Table 5.3 Treatments for 5-Leg Intersections**

Treatment	Design Principles	Figure No.
<i>Infrastructure</i>		
Reconstruct intersection into two or more separate intersection. The design concept will depend largely on available right-of-way and the major traffic movements.	Tee it Up	5.5,5.6
Reconstruct intersection as roundabout with circulating speeds of 12 to 22 mph.	Clarify the Right-of-Way	Not shown

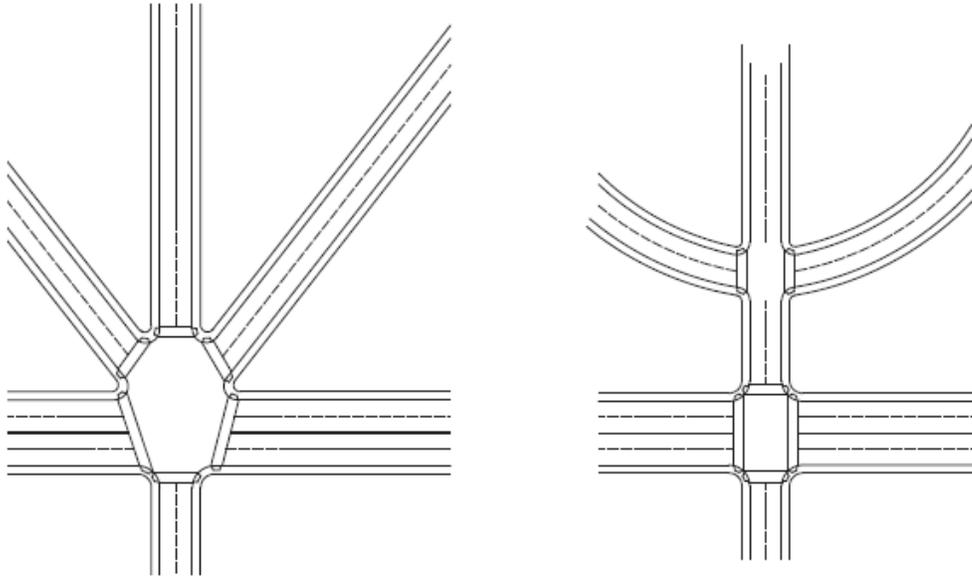
**Figure 5.5 Reconstruction of a Five-Leg Intersection**



Note: Adapted from Caltrans HDM.



**Figure 5.6 Reconstruction of a Six-Leg Intersection**



Note: Adapted from Caltrans HDM.

## 5.3. Y-Intersections

### 5.3.1. Common Issues

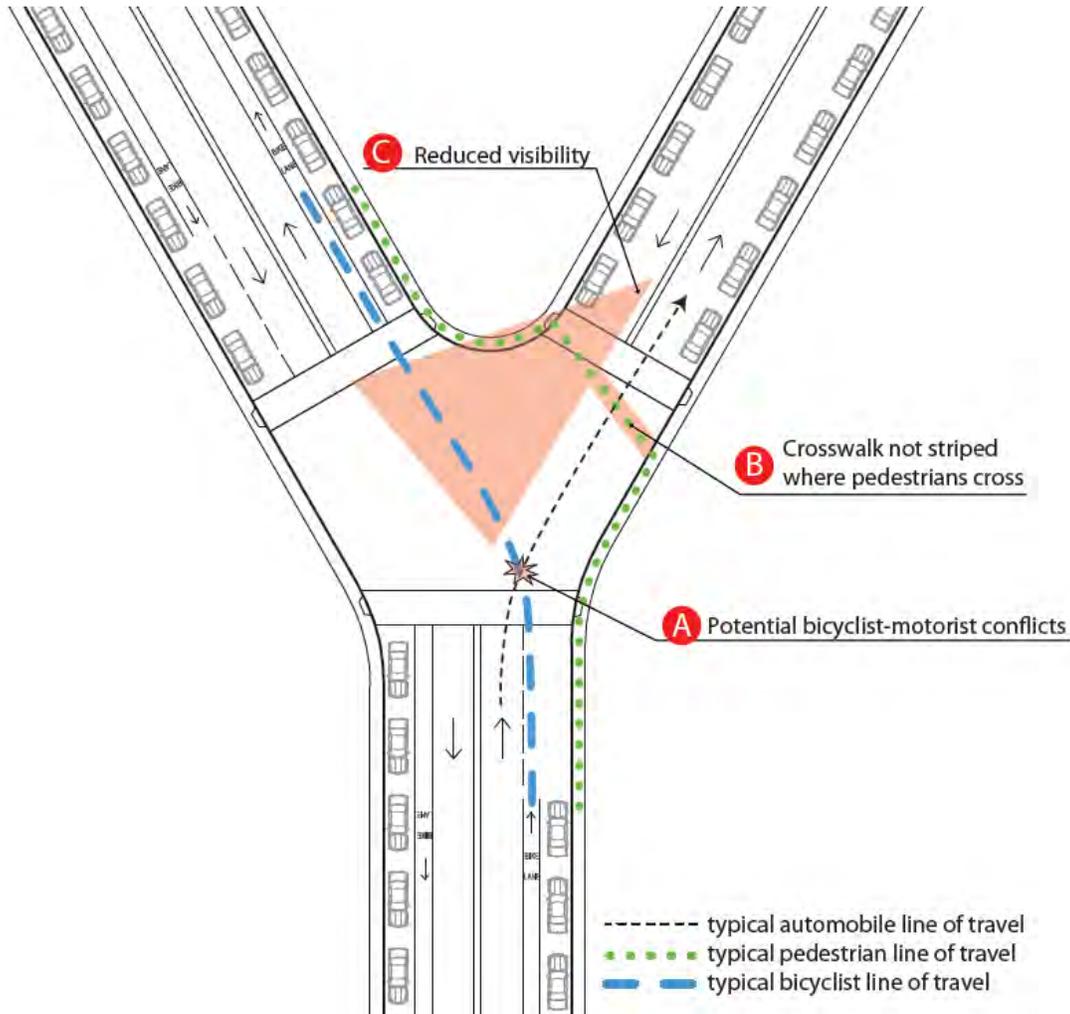
Y-intersections are skewed T-intersections. In addition to the challenges associated with T-intersections and skewed intersections, Y-intersections present special challenges to bicyclists who are approaching the Y.

Common issues seen at Y-intersections are illustrated in Figure 5.7. They include:

- A. Bicyclist and motor vehicle movements are not clear, **increasing the potential for conflicts** between through moving bicyclists and turning motorists.
- B. **Crosswalk may not be striped where pedestrians naturally want to cross.**
- C. **Visibility may be reduced** at the acute approach.



**Figure 5.7 Common Issues Associated with Y-Intersections**



### 5.3.2. Treatments

To improve a Y-intersection for pedestrians and bicyclists, designers may reconstruct the intersection so that the legs meet as close as possible to a 90-degree angle. If reconstruction is not possible, designers should use treatments that improve visibility of pedestrians and bicyclists, clarify the appropriate bicyclist path, reduce crossing distances, or increase the time available for crossing.

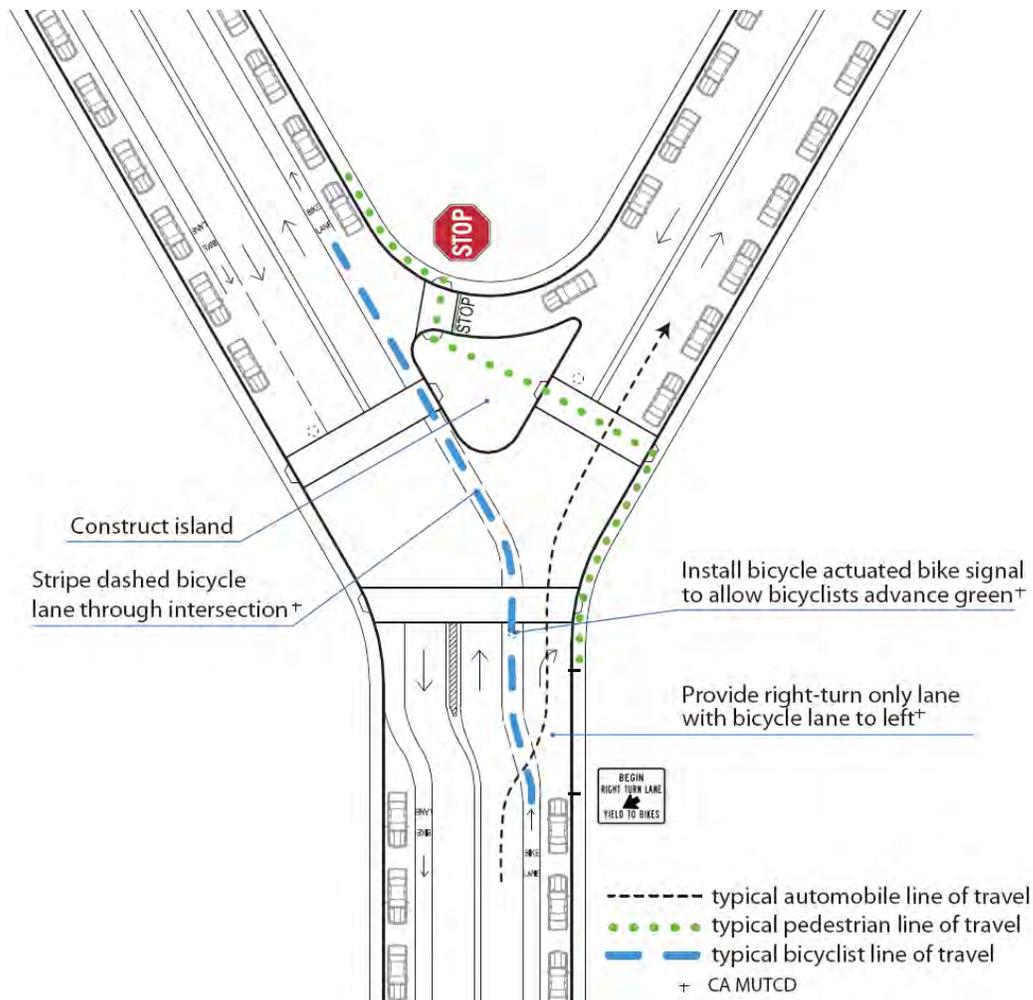
Figure 5.8 illustrates a treatment of a Y-intersection that relies on signage, striping, and infrastructure improvements. Table 5.4 lists treatments for Y-intersections.



**Table 5.4 Treatments for Y-Intersections**

Treatment	Design Principles	Figure No.
<i>Signage, Striping, and Operations</i>		
Stripe dashed bicycle lane through intersection to clarify bicyclist path.	Clarify Right-of-Way	5.8
Provide bicycle lane to the left of a right-turn only lane to separate through bicyclists and turning motorists.	Clarify Right-of-Way, One at a Time	5.8
Install bicycle-actuated signal to allow bicyclists advance green.	One decision at a time	5.8
<i>Infrastructure</i>		
Construct island to shorten crossing distance for pedestrians.	Shorten Crossings	5.8

**Figure 5.8 Signage, Striping, and Infrastructure Treatments for Y-Intersections**





## 6. SPECIAL CASES

### 6.1. Midblock Crossing

#### 6.1.1. Common Issues

Midblock crossings are important tools for improving pedestrian mobility, and if designed properly, can improve pedestrian ease and safety. The *CA MUTCD* states that midblock marked crosswalks “should be provided at appropriate points of pedestrian concentration, such as at loading islands, midblock pedestrian crossings, or where pedestrians could not otherwise recognize the proper place to cross.”<sup>12</sup> At the same time, the *MUTCD* acknowledges that midblock crossings are “generally unexpected by the motorist”, indicating the importance of alerting the motorist when a midblock crossing is present.

Common issues related to midblock are illustrated in Figure 6.1 and listed below:

- A. **Motorists and bicyclists do not expect crossings at midblock locations** and may not yield;
- B. **Multiple-threat situations**, in which a motorist yielding to a pedestrian may block the view of the pedestrian from another motorist or a bicyclist; and
- C. **Parked motor vehicles may block crosswalk or obstruct motorist or bicyclist sightlines.**

On high-speed or high-volume roads with four or more lanes, installing crosswalks alone, without other improvements, can increase the rate of pedestrian-vehicle crashes.<sup>13</sup>

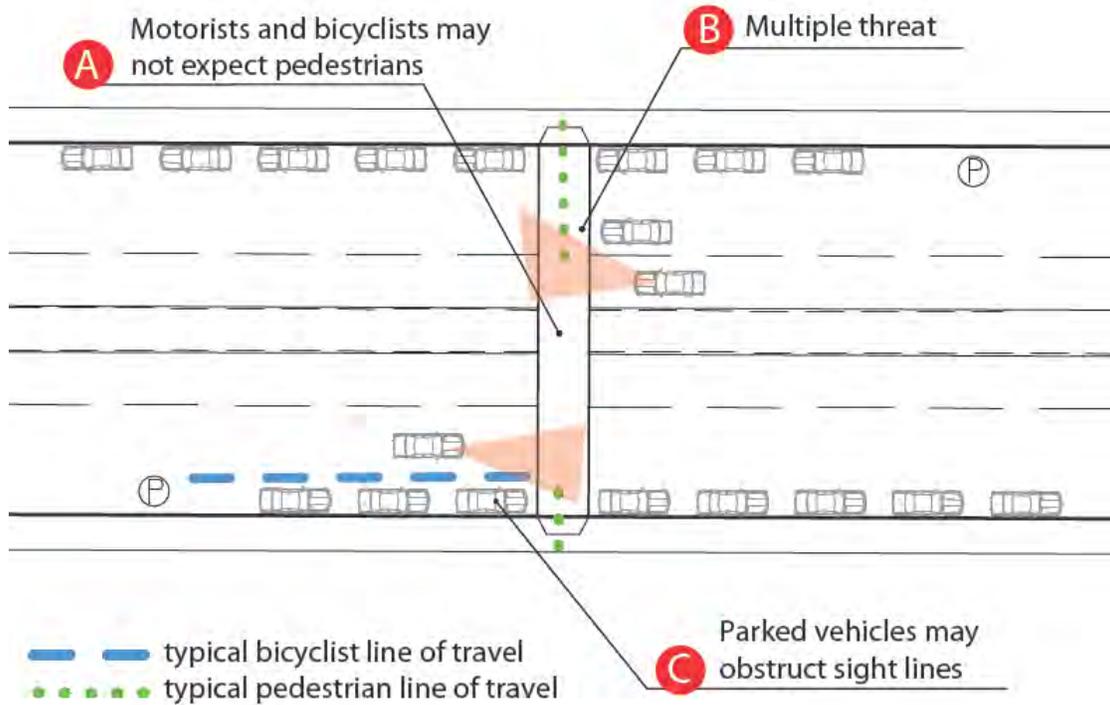
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<sup>12</sup>CA MUTCD Section 3B.17.

<sup>13</sup>Zeeger, Charles, et al. University of North Carolina Highway Safety Research Center. *Safety Effects of Marked versus Unmarked Crosswalks at Uncontrolled Locations: Final Report and Recommended Guidelines*. Sponsored by Office of Safety Research and Development, Federal Highway Administration, August 2005.



**Figure 6.1 Common Issues at Midblock Crossings**



On high speed (40 mph) or high volume (12,000 ADT) roadways, installing crosswalks alone without other improvements can increase the rate of pedestrian-vehicle crashes. (Zeeger, 2005)

### 6.1.2. Treatments

Table 6.1 lists treatments for improving crossings at uncontrolled midblock locations. Figure 6.2 illustrates the treatments.



**Table 6.1 Treatments for Midblock Crosswalks**

Treatment	Design Principles	Figure No.
<i>Signage and Striping</i>		
Install pedestrian warning signage.	Improve Visibility	6.2
Install yield lines and “Yield Here to Pedestrians” Signage.	Clarify Right-of-Way, Slow it Down	6.2
Prohibit parking adjacent to crosswalk.	Improve Visibility	6.2
<i>Infrastructure</i>		
Construct raised pedestrian refuge or raised medians if appropriate.	Shorten Crossings, One Decision at a Time	6.2
Construct curb extensions while ensuring they do not extend into the bicyclists’ path; use reflective materials on curbs to ensure visibility to bicyclists and motorists.	Shorten Crossings, Improve Visibility	6.2
Install lighting at crossing for pedestrian visibility, and to allow bicyclists to see curb extensions at night.	Improve Visibility	6.2
Construct speed table.	Slow It Down	Not shown
<i>Operations</i>		
Install pedestrian actuated beacon or in-pavement flashing lights as warranted.	Slow It Down, Clarify Right-of-Way	Not shown

As explained in the sidebar on page 26, crosswalks without additional treatments are not recommended on:

- Roads with speeds limits of 40 mph or greater.
- Roads with four or more lanes, no raised median, and an ADT of greater than 12,000.
- Roads with four or more lanes, with a raised median, and an ADT greater than 15,000.



### ***Pedestrian-Actuated Beacons***

The CA MUTCD recognizes overhead flashing pedestrian beacons and in-pavement flashing lights. Section 4K.03 of the CA MUTCD governs warning beacons and Section 4K.103 permits flashing beacons at school crosswalks. Beacons are typically used to supplement advance warning signals or at midblock crosswalks. Section 4L governs in-roadway lights, including in-roadway warning lights at crosswalks (4L.02). Section 4C.05 describes pedestrian volume warrant requirements for a pedestrian-actuated signal. Section 4C.06 describes warrants for a signal on a route to school.

There are other experimental pedestrian beacons that have higher yielding rates than the standard flashing beacon. These include:

- Rectangular-Shaped Rapid Flash light emitting diode (LED) Beacons, which have an 80 to 90 percent compliance rate in the field<sup>a</sup>; and
- High-Intensity Actuated Crosswalk (HAWK) beacons, which have a driver yielding rate of 97 percent and in one case were shown to reduce pedestrian-motor vehicle crashes by 58 percent.<sup>b</sup> The HAWK was approved by the Signal Technical Committee in January 2006 and is included in the 2009 National MUTCD.
- The TOUCAN, an experimental wider crossing, incorporates a bicycle signal that allows pedestrians and bicyclists to cross together. One portion of the crosswalk is marked for pedestrians and another is marked for bicyclists so that they can cross at the same time.

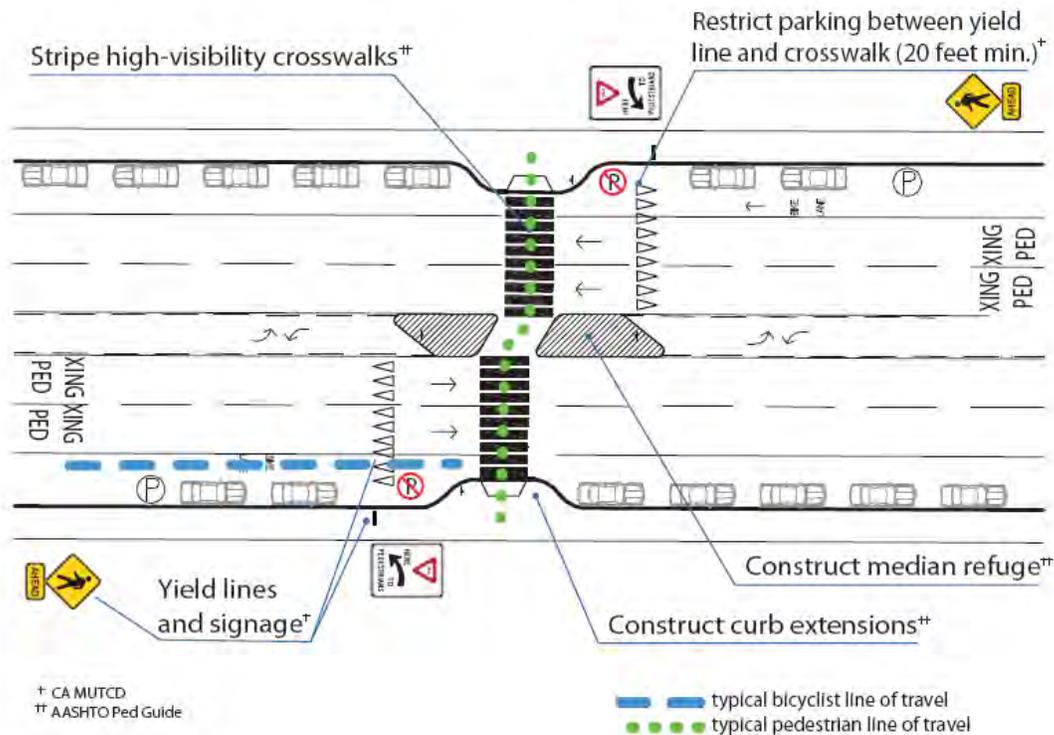
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<sup>a</sup> Van Houton, Ron and J.E. Louis Malenfant, "An Analysis of the Efficacy of Rectangular-shaped Rapid-Flash LED Beacons to Increase Yielding to Pedestrians Using Crosswalks on Multilane Roadways in the City of St. Petersburg, FL.", Center for Education in Research and Safety, Documentation provided as part of MUTCD's Interim Approval for Optional Use of Rectangular Rapid Flashing Beacons (IA-11), July 16, 2008. [mutcd.fhwa.dot.gov/resources/interim\\_approval/ia11/stpetersburgpt/index.htm](http://mutcd.fhwa.dot.gov/resources/interim_approval/ia11/stpetersburgpt/index.htm).

<sup>b</sup> Fitzpatrick, Kay, et. Al. "Improving Pedestrian Safety at Unsignalized Crossings," TCRP Report 112, NCHRP Report 562. Published by: Transportation Research Board, 2006.



**Figure 6.2 Treatments for Unsignalized Midblock Pedestrian Crossings**



## 6.2. Shared Use Path Intersections with Roads

### 6.2.1. Common Issues

Shared use paths can intersect with roads at midblock locations or road intersections.<sup>14</sup> This section addresses both types of crossings.

Common issues at intersections of shared use paths and roads are illustrated in Figure 6.3. They include:

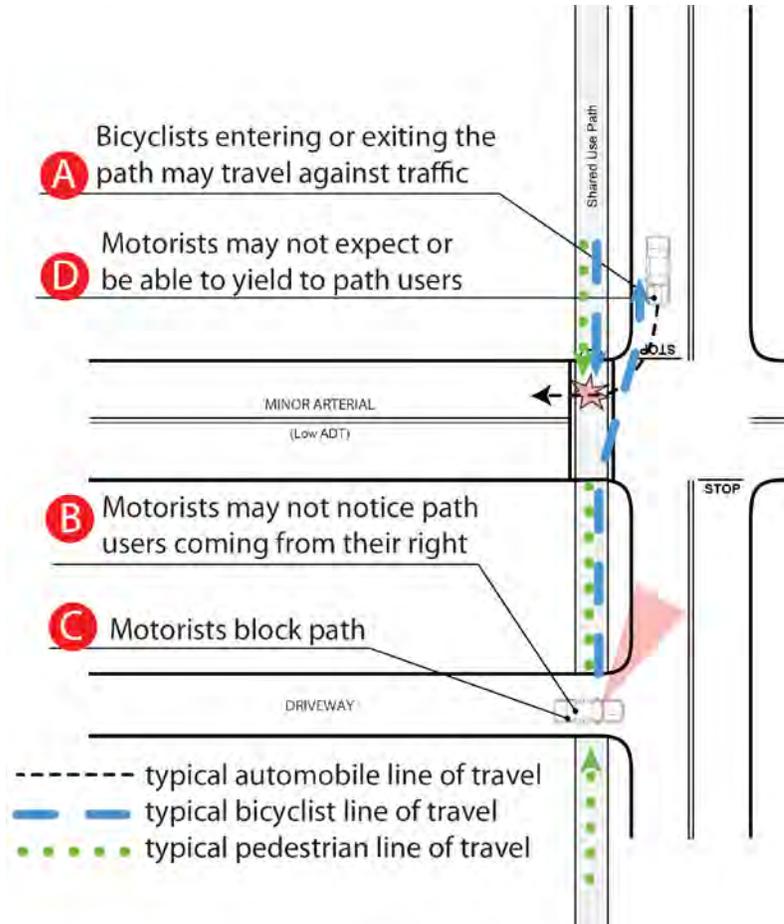
- A. Bicyclists entering or exiting the path may travel against motor vehicle traffic;
- B. Motorists crossing the shared use path at driveways and intersections may not notice path users coming from their right;
- C. Stopped motor vehicle traffic or vehicles exiting side streets or driveways may block the path; and

<sup>14</sup>Both the HDM and the AASHTO Guide for the Development of Bicycle Facilities generally recommend against the development of multi-use paths directly adjacent to roadways, or sidepaths.



D. Motorists may not be able to yield to fast-moving bicyclists at the intersection.

**Figure 6.3 Common Issues at Intersections of Side-paths and Roads**



### 6.2.2. Treatments

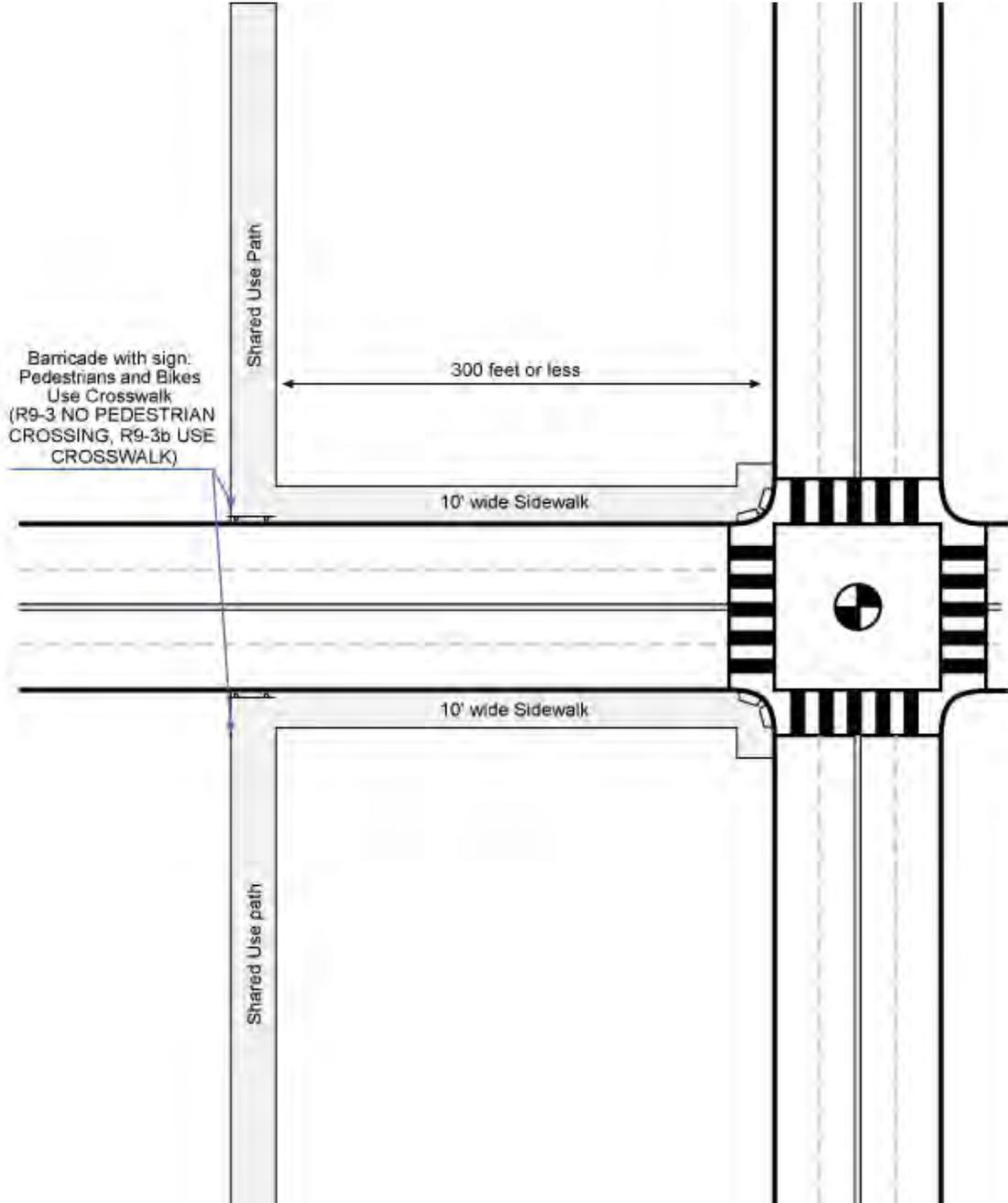
Pedestrian and bicycle pathway designers and traffic engineers generally have four options for designing multi-use pathway crossings. These include:

- **Option 1** - Reroute to the nearest at-grade controlled intersection crossing, shown in Figure 6.4;
- **Option 2** - Create a new at-grade midblock crossing with traffic controls where the pathway intersects with the road as shown in Figure 6.5;
- **Option 3** - Create a new unprotected midblock crossing where the pathway intersects the road, as shown in Figure 6.6; and
- **Option 4** - Create a grade-separated undercrossing or overcrossing of the road where the pathway intersects the road (not shown).

Table 6.2 summarizes the treatments applicable at side-path intersections.

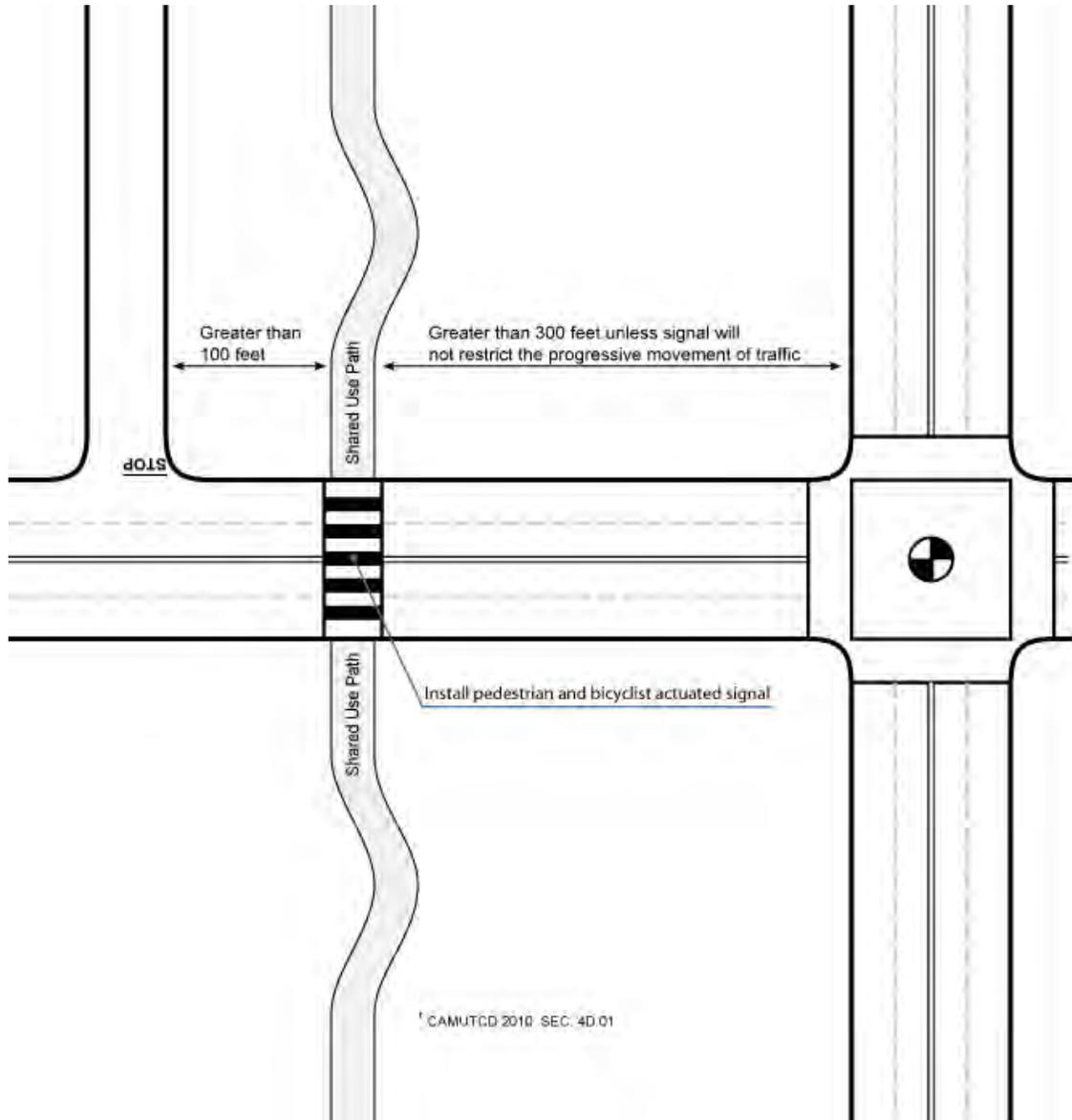


**Figure 6.4 Option 1 for Shared-Use Path Road Crossing: *Reroute***



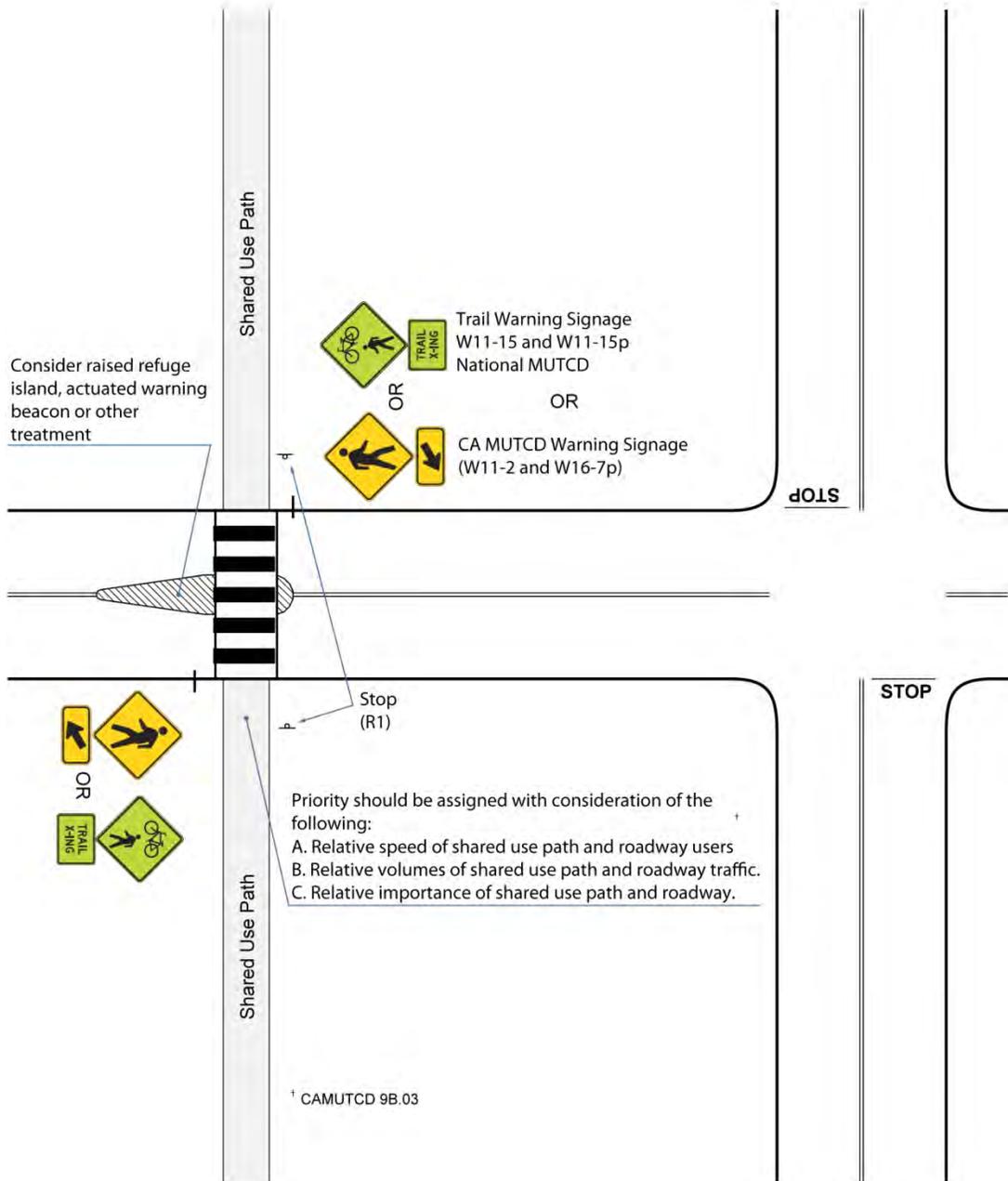


**Figure 6.5 Option 2 for Shared-Use Path Road Crossing: New Signal**





**Figure 6.6 Option 3 for Shared-Use Path: *Uncontrolled Midblock Crossing***





**Table 6.2 Treatments for Intersections of Paths and Roads**

Treatment	Design Principles	Figure No.
<i>Signage and Striping</i>		
Install STOP sign on intersecting road in advance of path intersection.	Clarify Right-of-Way	Not shown
Install STOP signs on path.	Clarify Right-of-Way	Not shown
Stripe high-visibility crosswalks.	Improve Visibility	6.4,6.5,6.6
Install warning signage on intersecting road.	Improve Visibility	6.6
<i>Infrastructure</i>		
Construct pedestrian refuge if warranted.	One Decision at a Time, Shorten Crossings	6.6
Slow trail users in advance of crossing using horizontal curves on the path.	Slow It Down	6.5
<i>Operations</i>		
Install pedestrian actuated beacon, including experimental HAWK and TOUCAN beacons.	Clarify Right-of-Way	6.6
Install signal, possibly including bicycle signal.	Pedestrians and Bicyclists Will Be There	6.5



## 7. INTERSECTIONS WITH TRANSIT

This section provides guidance on how to design intersections with transit to ensure they accommodate pedestrians and bicyclists. Transit vehicles should be considered at all intersections and interchange types, even if they lack a transit stop. Transit vehicles may still pass through the intersection, or do so in the future.

### 7.1. Bus Stops at Intersections

Several aspects of bus stop design affect pedestrians and bicyclists, including the decision to use nearside or far side bus stops; whether buses use a pullout or stop in the travel lane; location of the bus lane; and location of bus stops in the median or on the side of the road.

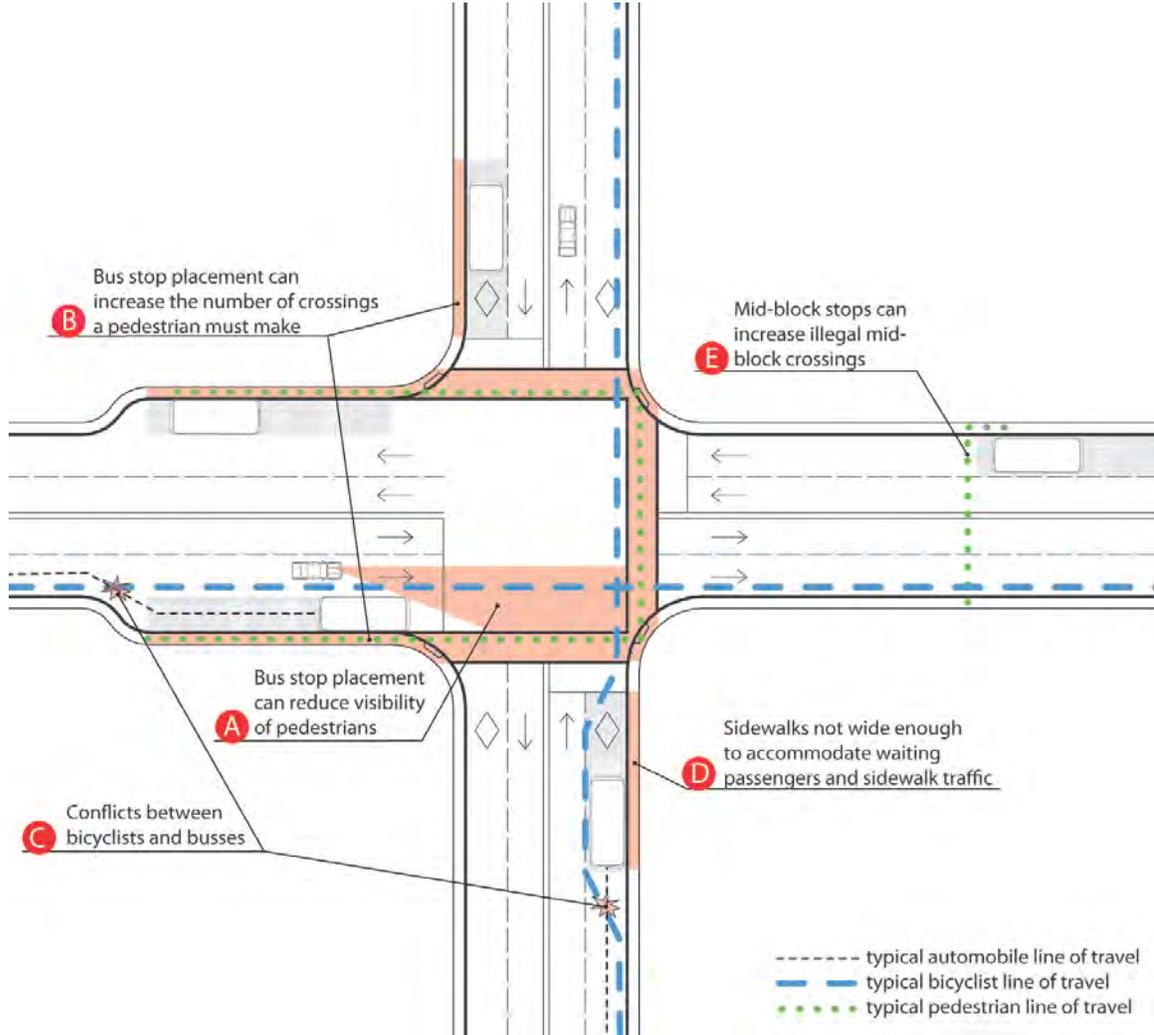
#### 7.1.1. Common Issues

Common issues for pedestrians and bicyclists at intersections with bus stops are listed below, and illustrated in Figure 7.1:

- A. **Bus stop placement can reduce visibility** for crossing pedestrians.
- B. Bus stop placement at transfer points can **increase the number of crossings** a pedestrian must make to transfer, particularly if some crossings are prohibited.
- C. **Conflicts likely between bicyclists and buses** at right-side bus stops.
- D. **Sidewalks are not wide enough** to accommodate waiting passengers and sidewalk traffic.
- E. **Increased potential for illegal midblock crossings** when bus stops are located midblock.
- F. **Asphalt pavement at bus stops tends to ripple and crack over time.** (Not shown).



**Figure 7.1 Issues at Intersections with Bus Stops**





## 7.1.2. Treatments

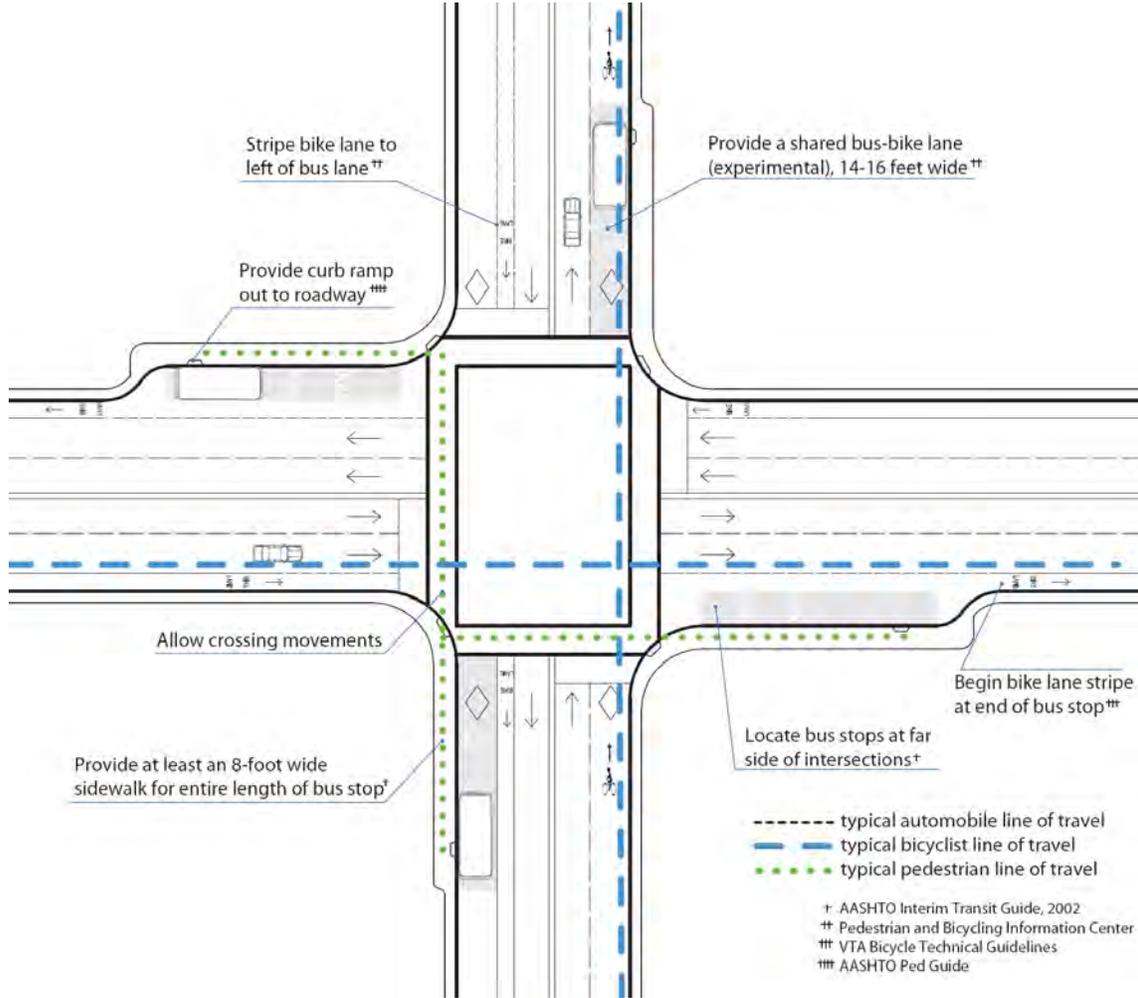
**Table 7.1 Treatments for Intersections with Bus Transit**

Treatment	Design Principles	Figure No.
<i>Infrastructure</i>		
Locate bus stops near intersections to discourage midblock crossings.	Keep It Direct	7.2
Provide an 8-foot-by-5-foot pedestrian landing pad (ADAAG 10.2.1).	Access for All	Not shown
Provide a continuous 8-foot-wide sidewalk for length of bus stop (minimum width).	Access for All	7.2
Provide a curb ramp out to road to allow waiting passengers to board a bus if it cannot pull up to sidewalk due to illegally parked vehicles or other obstructions.	Access for all	7.2
Provide bus shelters.	Pedestrians and Bicyclists Will Be There	Not shown
Provide an area to allow bicyclists to load and unload bicycles from front-mounted bike racks.	Pedestrians and Bicyclists Will Be There	Not shown
Locate bus stops farside to improve bus operations and visibility at intersections.	Improve Visibility	7.2
Provide a shared bus-bike lane (experimental) <sup>15</sup> .	Clarify Right-of-Way	7.2
Stripe bike lane to left of bus lane.	Clarify Right-of-Way	7.2
Provided dedicated bus lane in center median.	Clarify Right-of-Way	7.3
Provide Portland cement concrete (PCC) pavement at all bus stops to reduce rippling and cracking.	Maintain and Improve	Not shown

<sup>15</sup>From the Pedestrian and Bicycling Information Center, bicyclinginfo.org: “A growing number of communities are using shared bus and bike lanes to give preferential treatment to both bikes and public transport. Examples currently include Tucson, AZ; Madison, WI; Toronto, Ontario; Vancouver, BC; and Philadelphia, PA. Often the lanes are also able to be used by taxis and right-turning vehicles. Because buses and bikes will pass each other in these lanes, lane width is an important issue. The city of Madison likes to use 16 foot lanes to allow a clear three feet of separation between the bicyclist and a passing bus, but if either bus or bike traffic is light and space is limited, the width of a shared lane might be 14 ft or even less.”

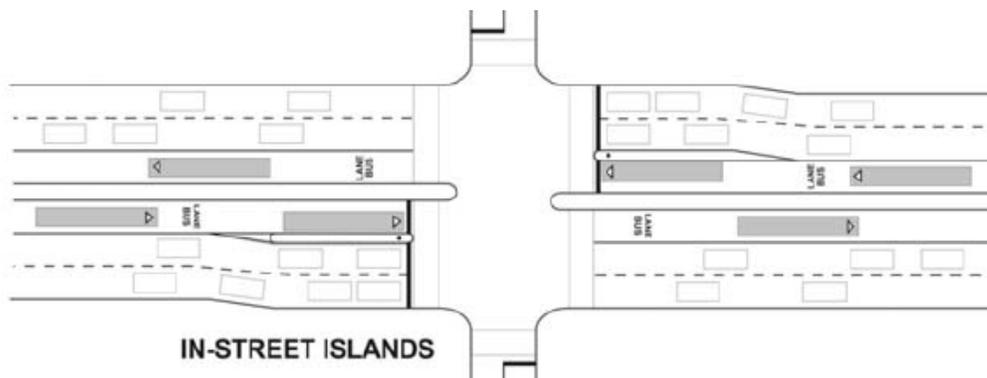


**Figure 7.2 Treatments for Intersections with Bus Stops**



Intersections with bus rapid transit and light rail may require special consideration as they frequently require placement of the transit stop in the median. Figure 7.3 illustrates alternative intersection configurations developed by AASHTO.

**Figure 7.3 Treatment for Median Bus/BRT/Light Rail Stops**





Source: AASHTO Interim Geometric Design Guide for Transit Facilities on Highways and Streets, 2001.



Image: [www.pedbikeimages.org](http://www.pedbikeimages.org) / Dan Burden.

*A wide landing pad and bus shelter can provide additional comfort to pedestrians and transit users.*

## 7.2. Railroad Crossings

### 7.2.1. Common Issues

Where bicycle or pedestrian facilities cross railroads at grade, the primary issues relate to trespassing and safety concerns. There is greater difficulty of crossing the tracks if the crossing is not perpendicular. People using wheelchairs can have difficulty crossing railroad tracks if the gap between railroad tracks and flange way<sup>16</sup> is wide, or if there is a significant vertical change between the sidewalk and the tracks.

Common issues at these intersections include:

- Pedestrians and bicyclists in wheelchairs may catch wheel in flange way gap if crossing is less than 45 degrees.
- Limited sight lines and visibility may not allow pedestrians and bicyclists to see approaching trains.

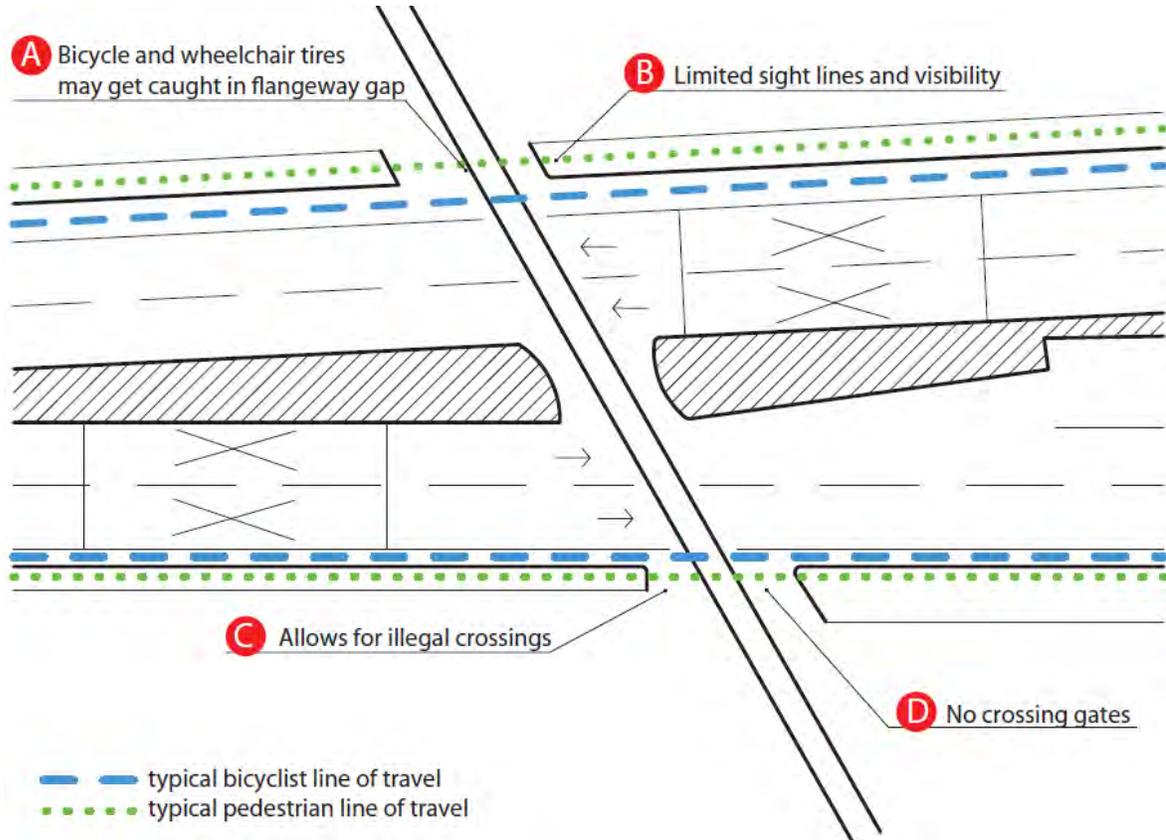
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<sup>16</sup>A flangeway is an opening, parallel to a rail; made through platforms, pavements, track structures, etc., to permit passage of wheel flanges.



- Pedestrians may cross tracks illegally or trespass.
- Crossing gates for pedestrians or bicyclists may not be provided.

**Figure 7.4 Railroad Crossing Issues**



### 7.2.2. Treatments

Pedestrians and bicyclists can be accommodated at at-grade railroad crossings by modifying the intersection to provide for a close to 90-degree crossing, and providing structures such as fences and mast arms to discourage trespassing.

Treatments for railroad intersections are listed in Table 7.2 and illustrated in Figure 7.5 Railroad Crossing Treatments. Additional information and suggestions can be found in the Public Utilities Commission’s 2008 Guide "Pedestrian Rail Crossings in California."<sup>17</sup>

**Table 7.2 Treatments for Railroad Crossings**

Treatment	Design Principles	Figure No.
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<sup>17</sup> The guide can be found here: <http://docs.cpuc.ca.gov/PUBLISHED/GRAPHICS/83568.PDF>.

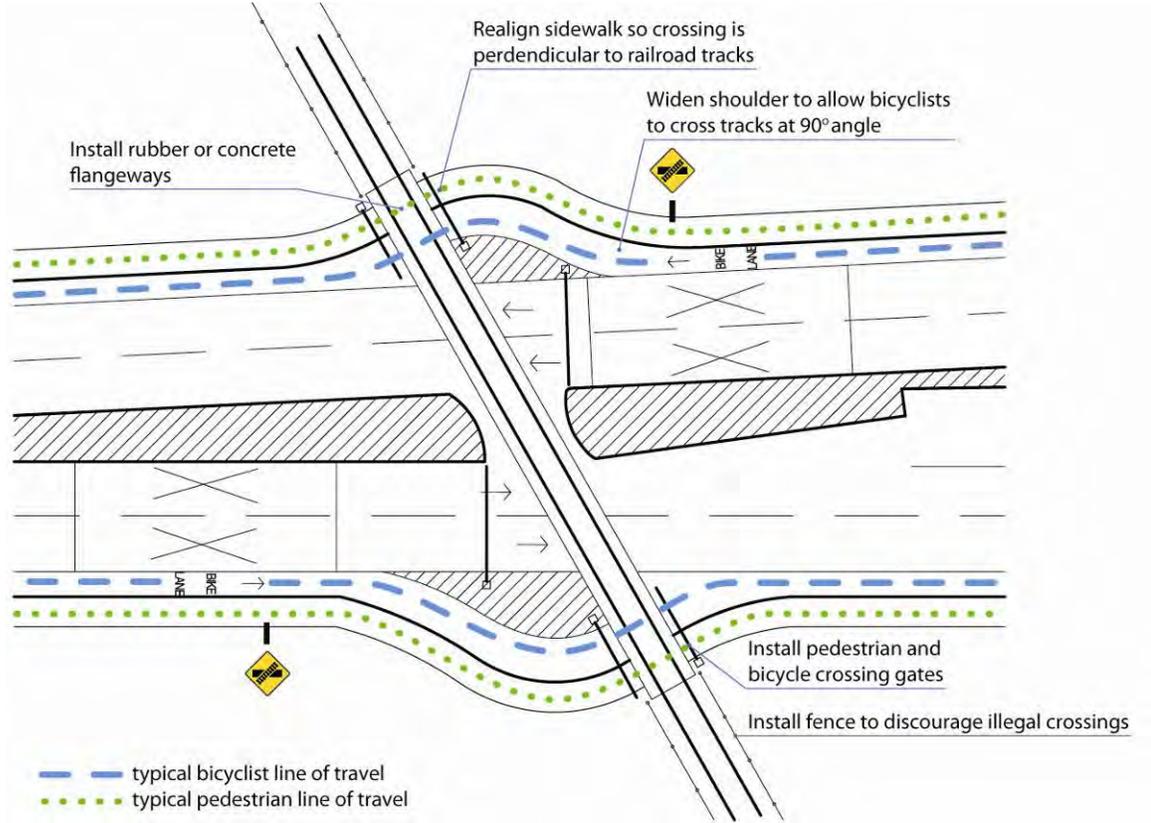


<i>Signage and Striping</i>		
Install signage in advance of crossing to warn bicyclists.	Improve Visibility	Not shown
<i>Infrastructure</i>		
Construct widened paved shoulder or separate path to allow bicyclists to turn to cross railroad tracks at close to a 90-degree angle.	Tee it Up	7.5
Construct sidewalks so they cross railroad tracks at close to a 90-degree angle.	Tee It Up	7.5
Provide flange way so that crossing is level and flush with the top of the rail at the outer edge. Between the rails, flange way gaps should not exceed 2.5 inches (passenger only) to 3 inches (freight). <sup>18</sup>		Not shown
Install detectible warnings in advance of crossing.		Not shown
Construct pedestrian-only crossing gates.		7.5
Install fencing along tracks to discourage trespassing or illegal crossing.		7.5
Remove abandoned railroad tracks.		Not shown

<sup>18</sup> Revised Draft Guidelines for Public Rights of Way, Access Board, November 23, 2005.  
<http://www.access-board.gov/PROWAC/draft.htm>.



**Figure 7.5 Railroad Crossing Treatments**





## 8. ROUNDABOUTS

The modern roundabout is a circular intersection with three primary characteristics: (1) motorists and bicyclists must yield on entry (2) the intersection has a central island that deflects traffic and forces it to slow down, (3) approaches have splitter islands that separate entering and exiting traffic. Although roundabouts should not be installed unless a need has been established, they should be considered at locations where signalization is warranted; where they could effectively address safety issues; or where new roads create new intersections.

Numerous studies have shown that single-lane roundabouts have the potential to increase both motor vehicle capacity and motor vehicle and pedestrian safety.<sup>19</sup> The conversion of a unsignalized intersection to a single-lane roundabout is frequently indicated as a pedestrian safety countermeasure.

Research suggests multilane roundabouts may not have the same safety benefits, and may actually increase bicyclist collisions.<sup>20</sup> Chapter 5 of the U.S. DOT FHWA publication, “Roundabouts: An Informational Guide,” states that adding an additional lane to a one-lane roundabout is likely to increase overall injury crashes by 25 percent.<sup>21</sup>

### 8.1. Common Issues

Pedestrians and bicyclists experience the following issues when navigating roundabout intersections:

- A. **All pedestrian crosswalks are uncontrolled.**
- B. At multilane roundabouts, pedestrians and bicyclists using the crosswalk are at risk for **multiple-threat** scenarios.
- C. **Bicyclists must control the lane** to avoid conflicts with circulating motorists.

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<sup>19</sup>For example, the Federal Highway Administration’s *Toolbox of Countermeasures and Their Potential Effectiveness for Pedestrian Crashes (2008)* indicates that converting an unsignalized intersection to a roundabout can reduce fatal crashes by as much as 27 percent and injury crashes by 12 percent.

<sup>20</sup>Multilane roundabouts have been observed to have more bicyclist collisions when compared to comparable single-lane roundabouts, as a result of a greater difference in speeds between modes (Furtado, 2004). Several studies (including Furtado, Brude & Larsson (2000), Harkey & Carter (2006), Shen (2000), and U.S. DOT FHWA (2000)) have found that multilane roundabouts are perceived as more dangerous, and often result in more collisions for all users when compared to single-lane roundabouts. This leads to a consensus that multilane roundabouts can significantly increase bicyclist safety risk. Brude and Larsson (2000) found that in Sweden, bicycle collisions were six times more frequent on multilane roundabouts compared to single-lane roundabouts.

<sup>21</sup>Federal Highway Administration, 2000. *Roundabouts: An Informational Guide*. <http://www.tfhrc.gov/safety/00068.htm>.



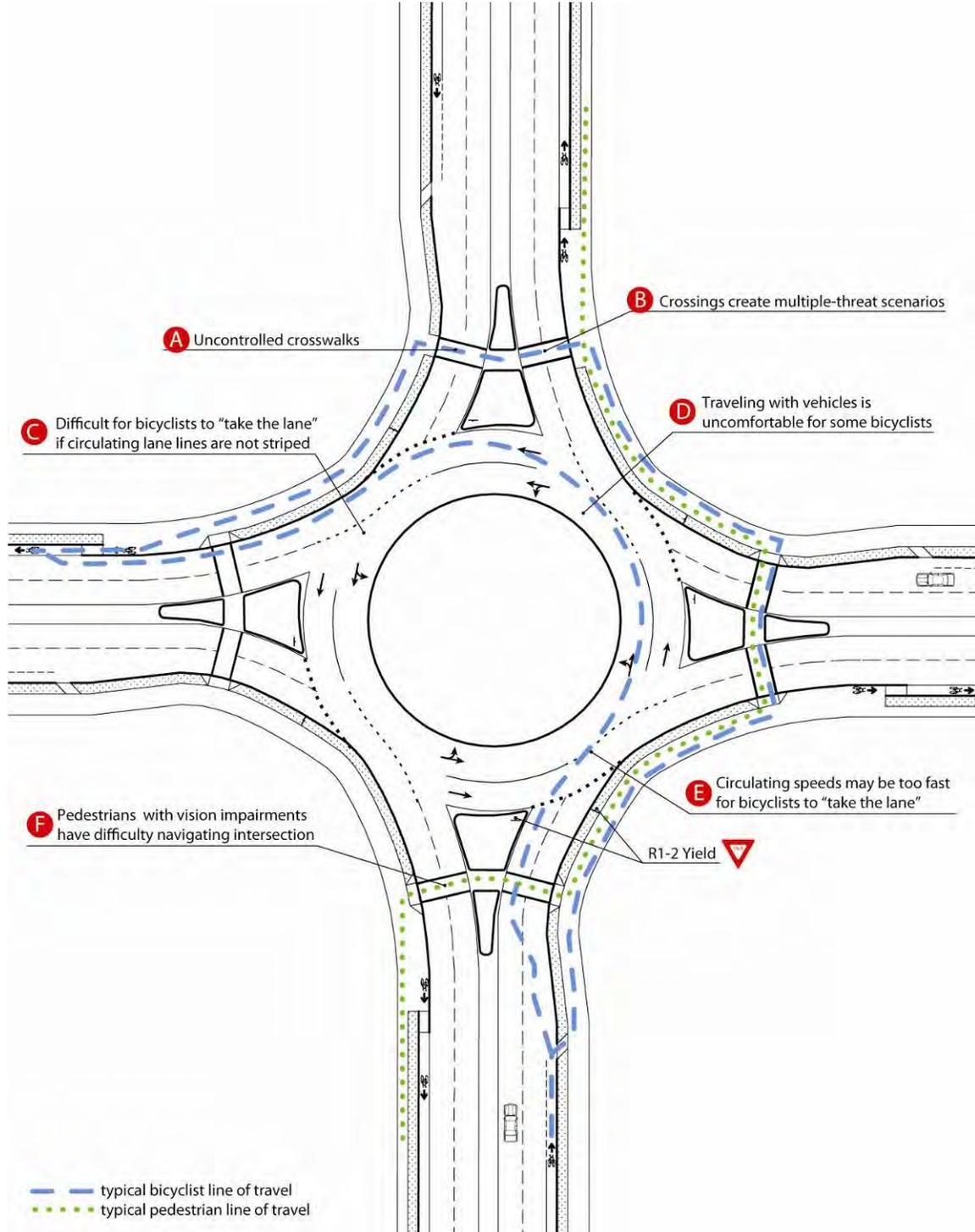
- D. **Bicyclists may not be comfortable traveling through the roundabout** on the road with motor vehicles.<sup>22</sup>
- E. At larger roundabouts, **circulating speeds may be too high for bicyclists to control the lane comfortably.**
- F. **Pedestrians with visual impairments may have difficulty navigating roundabouts,** particularly multilane roundabouts.
- G. Care must be taken to design turns so that large vehicles do not off-track onto sidewalks [not shown].

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<sup>22</sup>U.C. Berkeley Traffic Safety Center, Identifying Factors that Determine Bicyclist and Pedestrian-Involved Collision Rates and Bicyclist and Pedestrian Demand at Multilane Roundabouts Draft Summary of Research and Recommendations, Task Order 6222. Prepared for Caltrans. Prepared by Lindsay Arnold et al. September 30, 2009.



**Figure 8.1 Common Issues at Roundabouts**





## 8.2. Treatments

Design of roundabouts is addressed in Caltrans Design Information Bulletin 80-01 and in the Federal Highway Administration's *Roundabouts: An Informational Guide FHWA-RD-00-067*. A forthcoming study sponsored by Caltrans Department of Innovation and Research and prepared by U.C. Berkeley's Traffic Safety Center and Alta Planning + Design discusses treatments for pedestrians and bicyclists at multilane roundabouts. Design recommendations from that document are reproduced below:

- Design roundabouts to accommodate on-street bicyclists by **reducing the speed differential between circulating motorists and bicyclists**. The recommended maximum circulating design speed is 25 mph.<sup>23</sup>
- **Design approaches and exits to the lowest speeds possible**, in order to reduce the severity of potential collisions with pedestrians.
- Design roundabout approaches, circulating lanes and exits to **encourage bicyclists navigating the roundabout in the circulating roadway to control the lane**. This approach reduces the chances of a bicyclist being cut off by a "right hook".
- Utilize the most effective tools possible to maximize yielding rate of motorists to pedestrians and bicyclists at crosswalks.
- **Provide separated facilities for bicyclists** who prefer not to navigate the roundabout on the roadway.
- Clearly **indicate to motorists and bicyclists the correct way to circulate** through the roundabout through appropriately designed signage, pavement markings, and geometric design elements.
- **Clearly indicate to motorists, bicyclists, and pedestrians the right-of-way rules** at multilane roundabouts through appropriately designed signage, pavement markings, and geometric design elements.

Specific treatments for roundabouts are listed in and illustrated in Figure 8.2 and Figure 8.3.

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<sup>23</sup>A 2004 FHWA study that collected field data in 21 locations around the United States measured the 85<sup>th</sup> percentile speed of bicyclists at 14 mph. <http://www.tfhr.gov/safety/pubs/04103/index.htm>.



**Table 8.1 Treatments for Roundabouts**

Treatment	Design Principles	Figure No.
<i>Signage and Striping</i>		
Stripe ladder style crosswalks at all crosswalks.	Improve Visibility	8.2, 8.3
Install “Yield Here to Pedestrian” signs in advance of crosswalks.	Clarify Right-of-Way	8.2, 8.3
Install Pedestrian Warning signs at crosswalks (on both sides of crosswalk at multilane approaches).	Improve Visibility	8.2, 8.3
Install experimental “Bikes May Use Full Lane” signs after ramp up to path (see below) (Proposed Amendment to National MUTCD).	Clarify Right-of-Way	Not shown
On multi-lane roundabouts, delineate circulating lanes with spiral striping so that weaving does not occur in the roundabout (Proposed Amendment to National MUTCD).	Clarify Right-of-Way	8.2, 8.3
Stripe “fishhook” guidance arrows on pavement on approach to intersection to assist motorists with lane placement.	One Decision at a Time	Not shown
<i>Infrastructure</i>		
Construct the smallest diameter roundabout necessary, with the minimum number of lanes (single lane preferred).	Slow It Down	Not shown
Construct roundabouts with maximum circulating speed of 25 mph.	Slow It Down	8.2
Construct speed tables at crosswalks.	Slow It Down	8.2
Slow motorists in advance of roundabout using reverse curves, rumble strips, speed feedback signs, or other physical or enforcement strategies.	Slow It Down	Not shown
Construct splitter islands at all approaches	Shorten Crossings	8.2, 8.3
Construct separate bike path, with ramps connecting bike path and approaches.	Clarify Right-of-Way, Pedestrians and Bicyclists Will Be There	8.2, 8.3
<i>Operations</i>		
Consider pedestrian signals at the roundabout if the elderly or people with disabilities and particularly people with visual impairments regularly walk through the intersection.	Access for All	Not shown



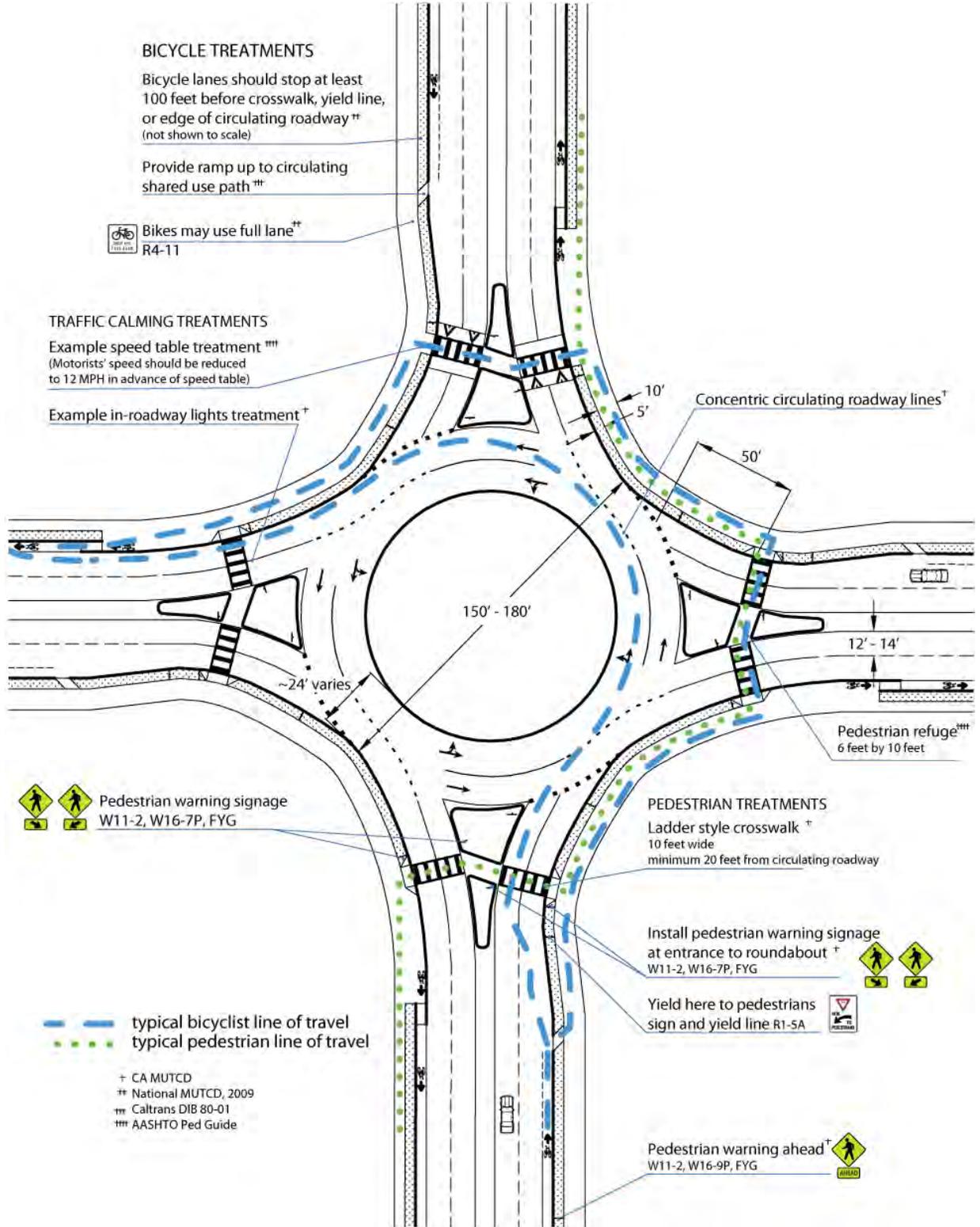
### ***Signalizing Roundabouts***

Roundabouts typically include multiple uncontrolled crossings which can be challenging for pedestrians, especially those with visual impairments or other disabilities. In an effort to develop safer roundabout crossing facilities, the Transportation Research Board is investigating various technologies which will be published in NCHRP report 3-78A "Crossing Solutions at Roundabouts and Channelized Turn Lanes for Pedestrians with Vision Disabilities." This research involves field studies with visually impaired participants and is expected to be completed in March 2010. Additional information on this study can be found at the Transportation Research Board website.

Pedestrian hybrid beacons show promise for improving roundabout operations for pedestrians and bicyclists in general and specifically for pedestrians with disabilities. These beacons allow pedestrians to actuate overhead signals, which will first flash yellow, then steady yellow, then steady red. The signal is dark when it is not activated. Pedestrian hybrid beacons and rapid rectangular flashing beacons are not part of the current California MUTCD and thus must be treated as experimental traffic control devices. Pedestrian hybrid beacons are currently being tested at a high-volume three-lane roundabout in Oakland County, Michigan.

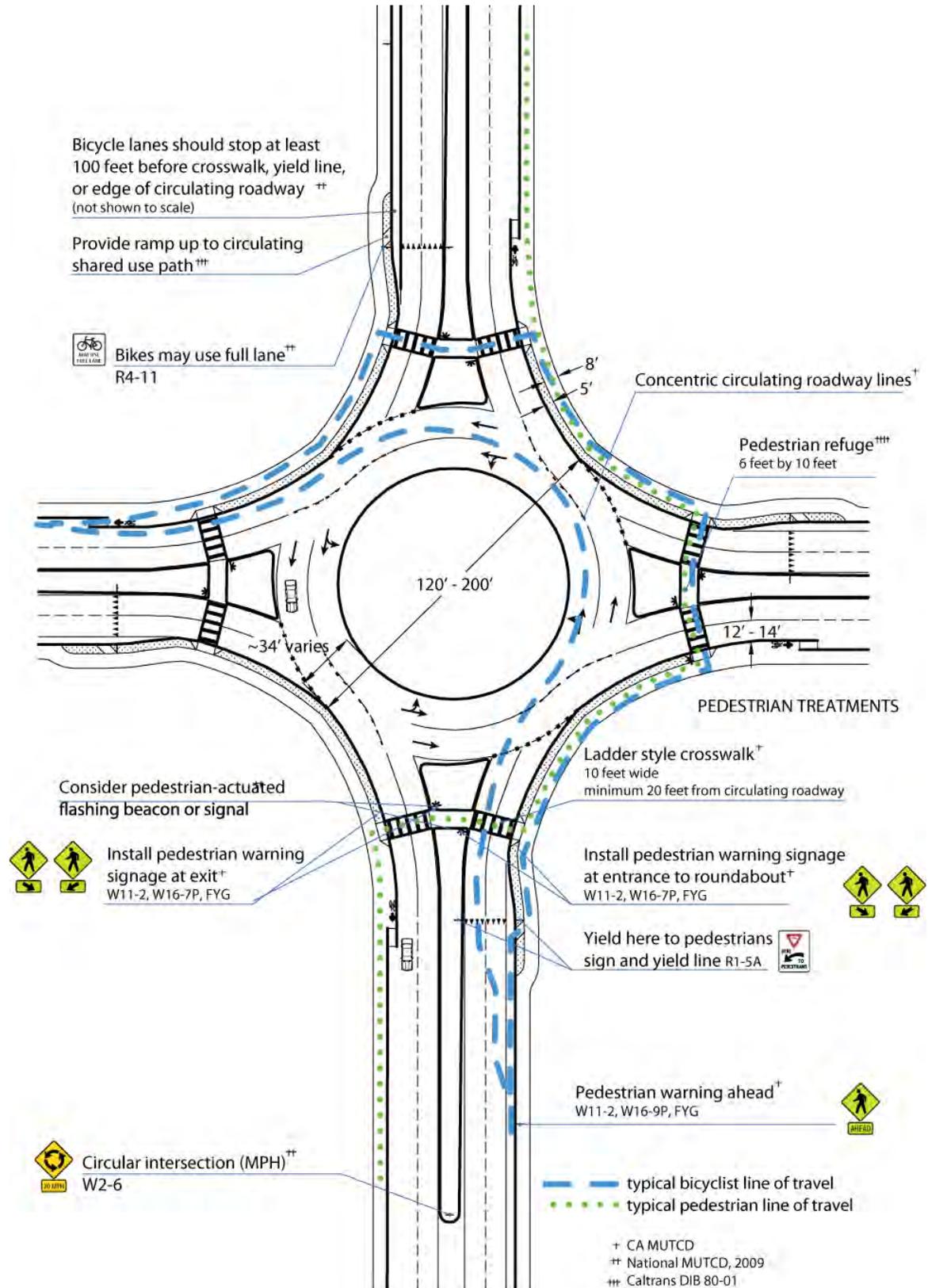


**Figure 8.2 Treatments for Urban Multilane Roundabouts**





**Figure 8.3 Treatments for Rural Multilane Roundabouts**



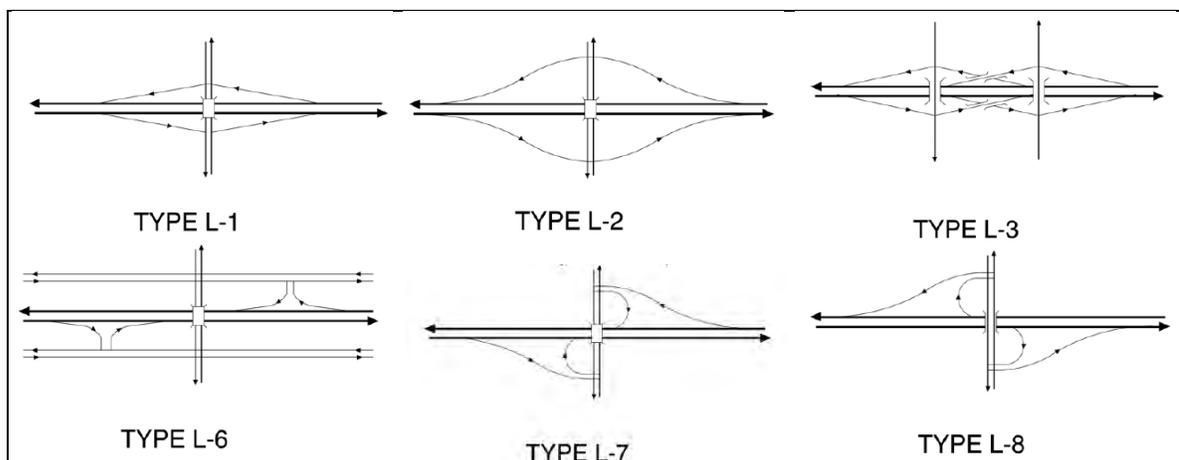


## 9. INTERCHANGES

Interchanges often provide the only pedestrian and bicycle access across a freeway, but are not always designed to provide comfortable or safe pedestrian and bicycle access. The best interchange configurations for pedestrians and bicyclists are those where the ramp intersects the crossroad at a 90-degree angle and where the intersection is controlled by a stop or signal. These characteristics cause motorists to slow down before turning, increasing the likelihood that they will see and yield to non-motorists. If an impact occurs, severity is lessened because of slower vehicular speeds.

The Caltrans HDM classifies interchanges into 13 different types. As illustrated in Figure 9.1, six of these types have ramp intersection designs that generally meet the crossroad at 90-degrees and are STOP-controlled or signalized. These interchanges generally incorporate diamond-type ramps or J-loop ramps.

**Figure 9.1 Interchange Types That Accommodate Pedestrians and Bicyclists**



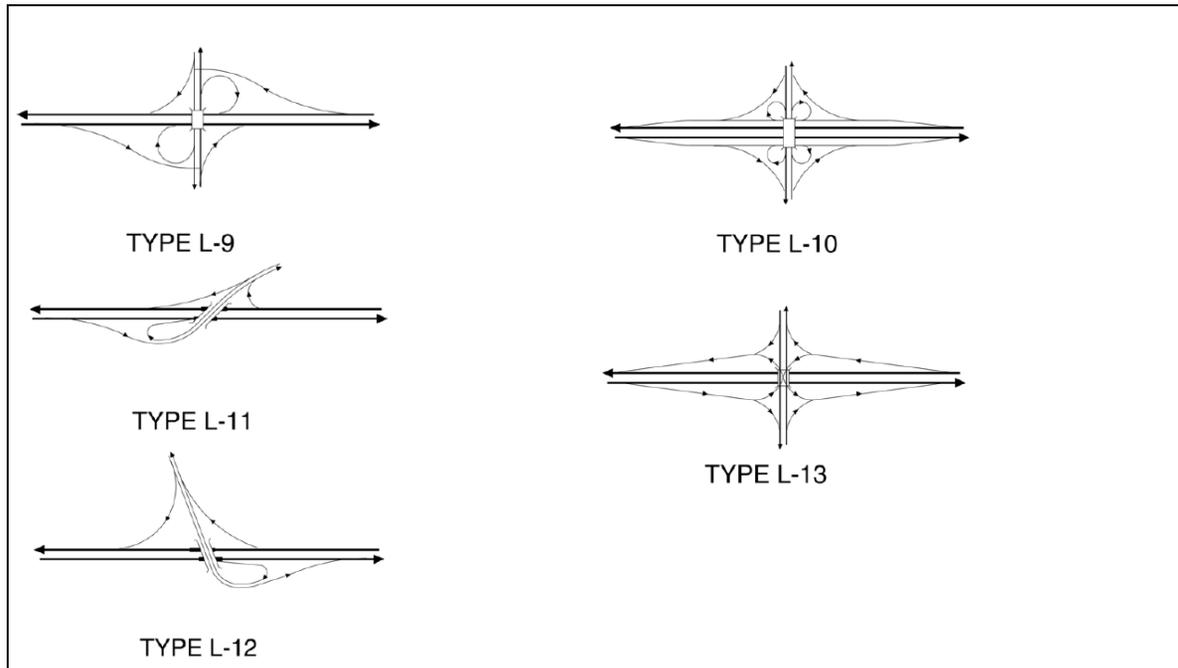
Source: Figure 502.2 Caltrans HDM.

The remaining interchange types do not easily accommodate pedestrians and bicyclists (Figure 9.2). These interchanges include high-speed free-flow ramps or complicated and large intersections. High-speed on- and off-ramps designed to encourage high-speed, free-flow turning movements are the major barrier to providing adequate pedestrian and bicycle access through interchanges. Even skilled and fit bicyclists find crossing such ramps difficult. Less skilled bicyclists, elderly or very young pedestrians and pedestrians with disabilities may face particular difficulty when navigating these types of interchanges.

Pedestrians and bicyclists may face greater crossing difficulty when a crossroad is widened, and design speeds are increased through the interchange. Often, designs allow and encourage motorists to accelerate to highway speeds while still on the crossroad, reducing the driver's ability to recognize and respond to pedestrians and bicyclists.



**Figure 9.2 Interchange Types That Do Not Easily Accommodate Pedestrians and Bicyclists**



Source: Figure 502.2 Caltrans HDM.

Techniques for addressing issues at high-speed free-flow ramps are discussed below. Additional issues specific to single point interchanges and trumpet interchanges are also discussed.

Ramps that intersect the crossroad at a five-leg intersection, as in Type L-5, have all the issues associated with multi-leg and skewed intersections, and are addressed in Section 5– Skewed and Multi-leg Intersections.

## 9.1. Free-Flow Ramps

When crossing free-flow ramps, pedestrians and bicyclists face challenges related to unyielding motorists, high motor vehicle speeds, limited visibility, and the absence of bicycle or pedestrian facilities. Bicyclists additionally face challenges related to unclear path of travel.

If motor vehicle traffic volumes are high, multi-lane on-ramps are used to accommodate motorists. Though multi-lane ramps can prevent upstream motor vehicle queuing (unless a ramp meter is present), they pose significant challenges for pedestrians and bicyclists, and further exacerbate the problems these users face at free-flow ramps.

### 9.1.1. Common Issues

Common issues associated with free-flow on- and off-ramps are:



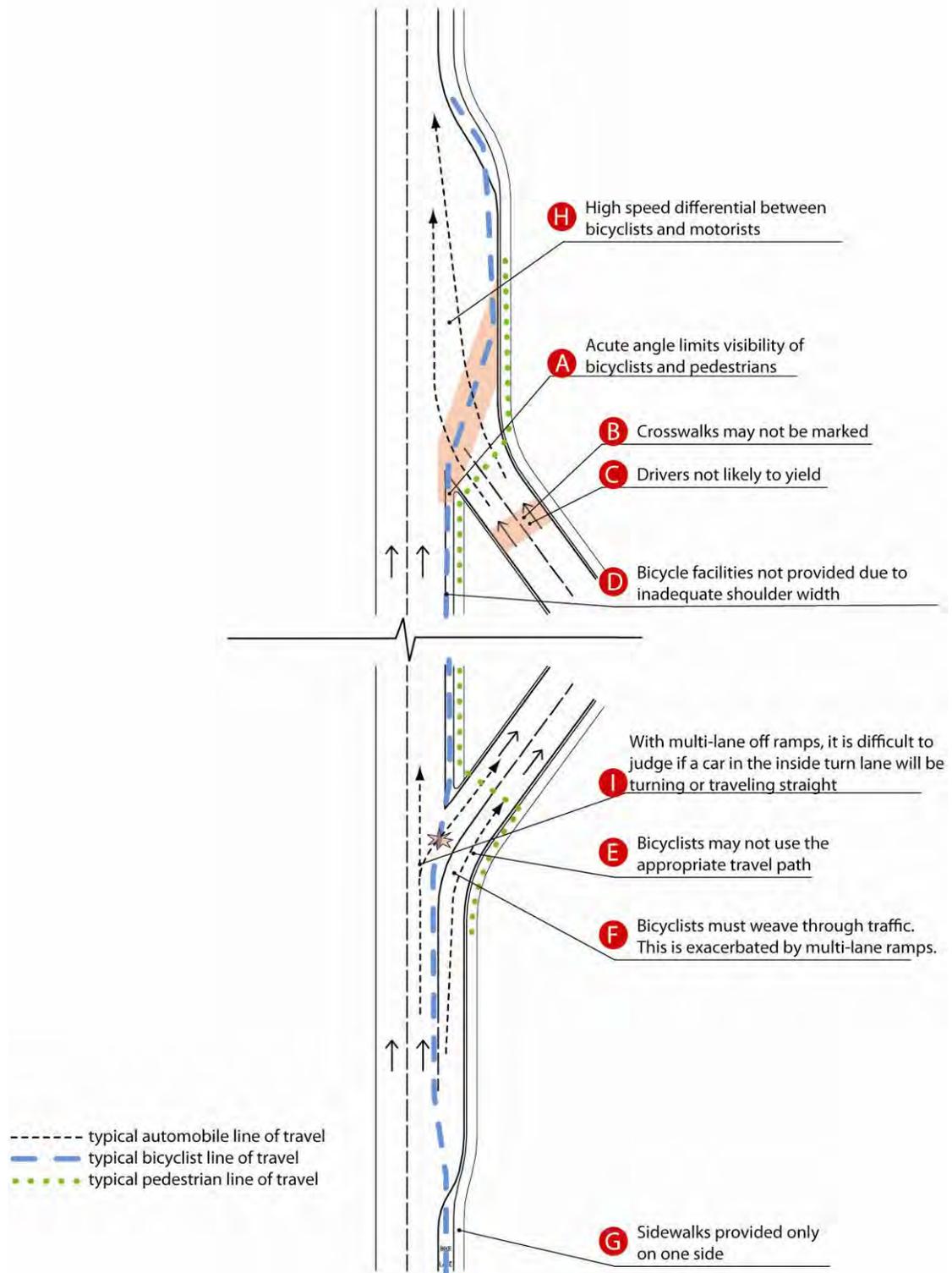
- A. Acute intersecting **angle limits visibility** of pedestrians and bicyclists;
- B. **Crosswalks are not marked** across ramps.
- C. Ramp traffic is not controlled, and **motorists traveling at high speed are not likely to yield** to bicyclists or pedestrians;
- D. If the outside lane or shoulder is not wide enough, **bicycle facilities are often not provided** through an interchange;
- E. **Bicyclists may not use the best travel path** when navigating through the intersection;
- F. **Bicyclists must weave** through free-flow turning traffic traveling at a much higher speed. This is exacerbated with multi-lane ramps; and
- G. **Sidewalks are sometimes not provided or only provided on one side** of a crossroad.

Common issues associated with multilane free-flow on- and off-ramps:

- H. **Motor vehicles travel at high speeds, resulting in a large speed differential with pedestrians and bicyclists;** and
- I. With multi-lane ramps and lanes with dual destinations, it is **difficult for pedestrians and bicyclists to judge when a vehicle in the inside lane will be turning or traveling straight.**



**Figure 9.3 Issues Associated with Free-Flow On- and Off-Ramps**





### 9.1.2. Treatments

Treatments for pedestrian and bicyclist concerns at on- and off-ramps range from striping and signage to make motorists more aware of and more likely to yield to pedestrians and bicyclists; reconstructing the intersection to eliminate all free-flow turning movements; and reconfiguring intersections so that on and off ramps meet the crossroad at or near 90-degrees. Even with signage and striping improvements, free-flow ramps present significant challenges for pedestrians and bicyclists; reconfiguring the intersection is the preferred treatment. This is easiest to achieve when the intersection is still in the planning phase; once constructed, interchanges are very costly to reconfigure.

The ITE Pedestrian and Bike Council recommends the following when designing interchanges:

- Encourage slower vehicle speeds until past on-ramp;
- Locate the crosswalk to maximize pedestrian visibility and before the location where vehicles begin to accelerate;
- Use short crosswalks;
- Where bicyclists travel between moving vehicles for more than 200 feet, install a painted or raised buffer; and
- Where bicyclists weave across a vehicle lane allow flexibility to transition when/where safe.<sup>24</sup>

Table 9.1 lists a range of treatments to help alleviate some of the challenges listed above.

Figure 9.4 illustrates a preferred intersection design for ramps: 90-degree signalized or stop-controlled intersections.

Figure 9.5 illustrates signage and striping treatments that help address some issues at single-lane free-flow ramps.

Figure 9.6 illustrates geometric changes that can make multiple-lane ramps easier for bicyclists to navigate.

Figure 9.7 illustrates the use of signage, striping, and medians to make it easier for bicyclists and pedestrians to navigate across multiple-lane on-ramps.

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<sup>24</sup> Adapted from: ITE Pedestrian and Bike Council, 2010, “Accommodating Bicyclists and Pedestrians at Interchanges Summary of Draft Recommendations,” *Transportation Research Board Annual Conference*, Washington D.C.



**Table 9.1 Basic Treatments to Accommodate Pedestrians and Bicyclists at Interchanges**

Treatment	Design Principles	Figure No.
<i>Signage and Striping</i>		
Stripe high-visibility crosswalks at all intersections.	Improve Visibility	9.4, 9.5, 9.6, 9.7
Provide bicycle facilities on all crossroads leading up to the interchange, and appropriate facilities through the interchange. Consider experimental treatments such as colored bike lanes. Drop bicycle lanes as appropriate to indicate where weaving movements may occur.	Pedestrians and Bicyclists Will Be There, Improve Visibility, Clarify the Right-of-Way	9.4, 9.5, 9.6
Stripe on- and off-ramps so that through-moving bicyclists do not need to weave across turning motorists, but instead can travel straight.	Clarify the Right of Way	9.4, 9.5, 9.6
Where bicyclists travel between moving vehicles for more than 200 feet, install a painted or raised buffer.	Clarify the Right of Way	9.7
Provide bicycle lanes to the left of dedicated right-turn lanes.	Clarify the Right-of-Way	9.4, 9.5, 9.6
Install pedestrian warning signage, yield lines, and pedestrian-actuated beacons at all uncontrolled crossings.	Pedestrians and Bicyclists Will Be There, Clarify the Right-of-Way, Improve Visibility	9.5
<i>Infrastructure</i>		
Provide sidewalks on both sides of crossroad.	Pedestrians and Bicyclists Will Be There	Not Shown
Reconstruct ramps to intersect crossroad at 90-degree angle with as low a radius as possible. Bring under stop or signal control if warranted.	Tee It Up, Slow it Down, Shorten Crossings, Improve Visibility, Clarify the Right-of-Way	9.4, 9.6
Construct single, rather than dual, right-turn only lanes.	One Decision at a Time	9.4, 9.5
If a dual right-turn only lane is required, channelize it and split into two separate movements. If a triple right-turn only lane is required, add the third turning lane to the left of the channelization, maintaining a single channelized right turn lane.	One Decision at a Time	9.6



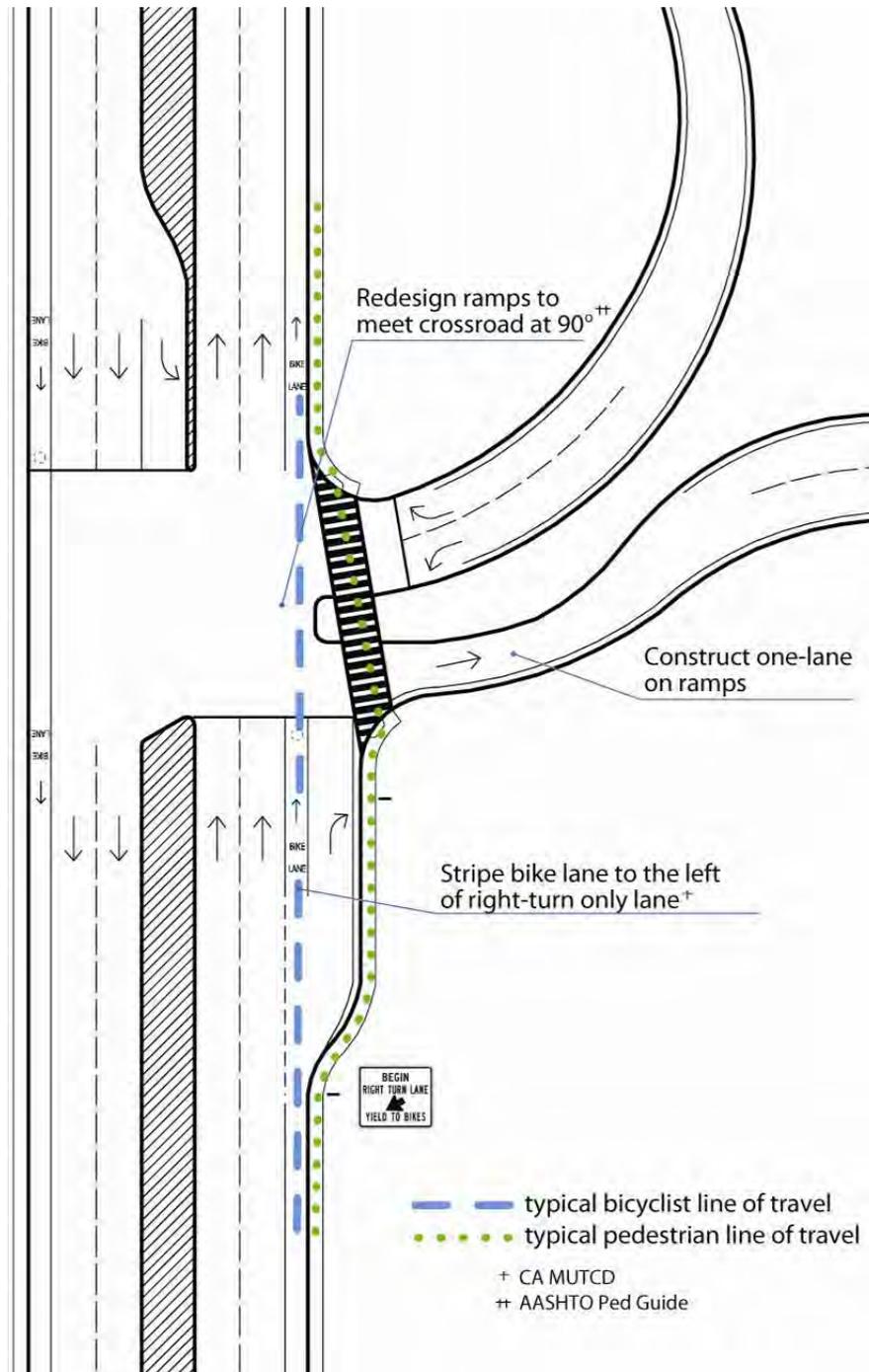
<i>Operations</i>		
Design speed of local road to the minimum required by Caltrans (35 mph). <sup>25</sup> If speeds on the approaches are more than 35 mph, consider seeking a design exception.	Slow it Down	Not shown
For ramp crossings, consider adding pedestrian signals coordinated with adjacent traffic signals.	Clarify the Right of Way, Slow it Down	Not shown

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<sup>25</sup> Caltrans HDM, Section 101.1 “Design Speed.”

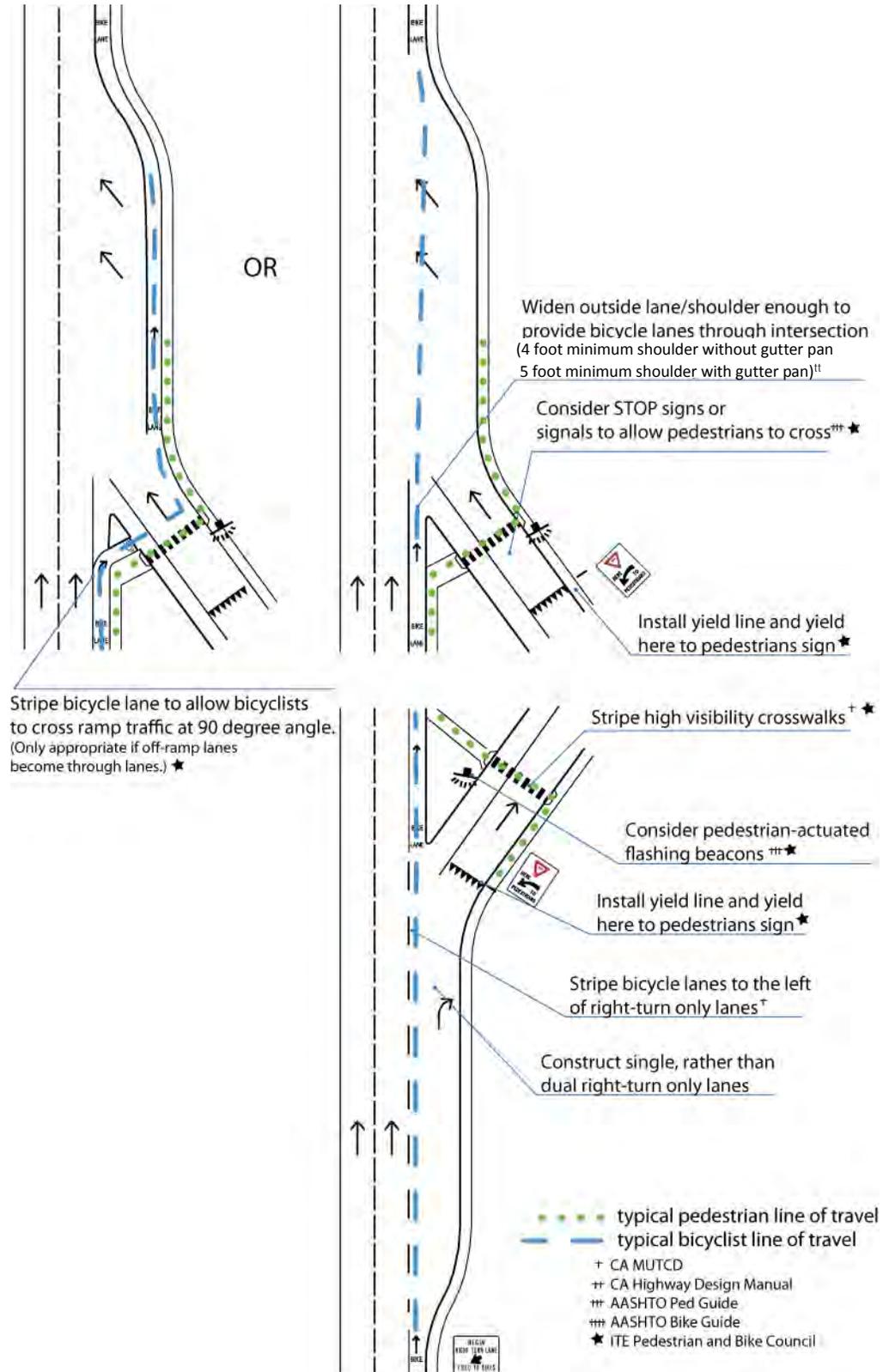


**Figure 9.4 Preferred Treatment for Free-Flow Ramp Intersections**



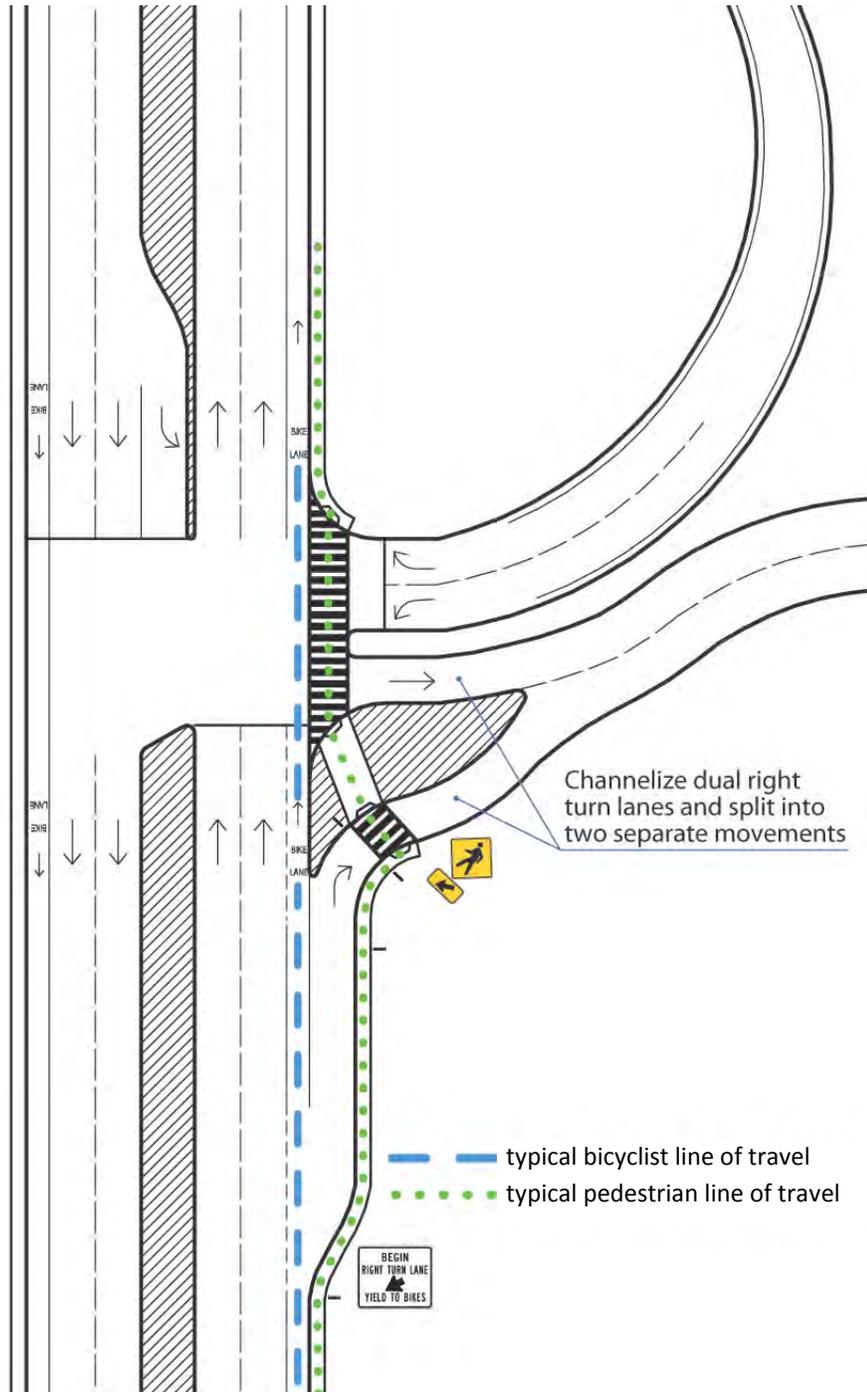


**Figure 9.5 Signage and Striping Treatments for Free-Flow Ramp Intersections**





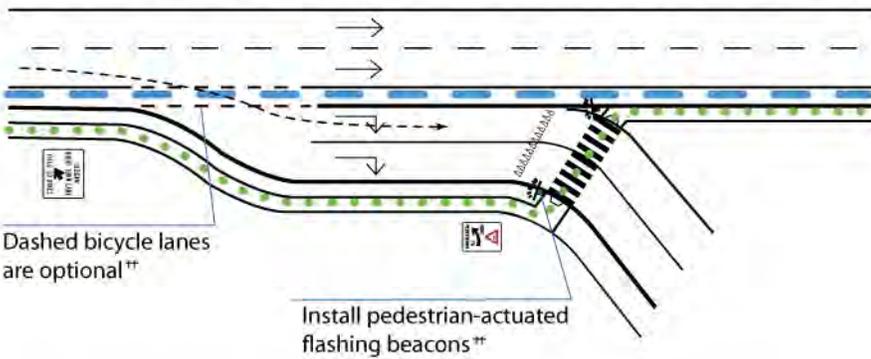
**Figure 9.6 Double-Lane Free-Flow On-Ramp Treatment:  
Channelize Turn Movements**



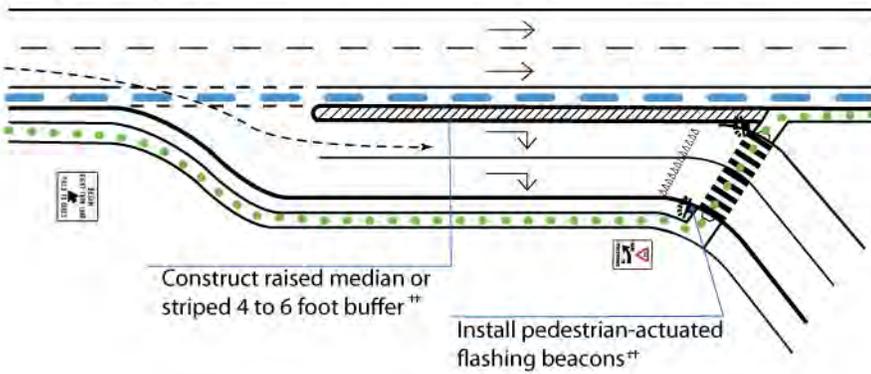


### Figure 9.7 Treatments for Dual-Lane On-Ramps

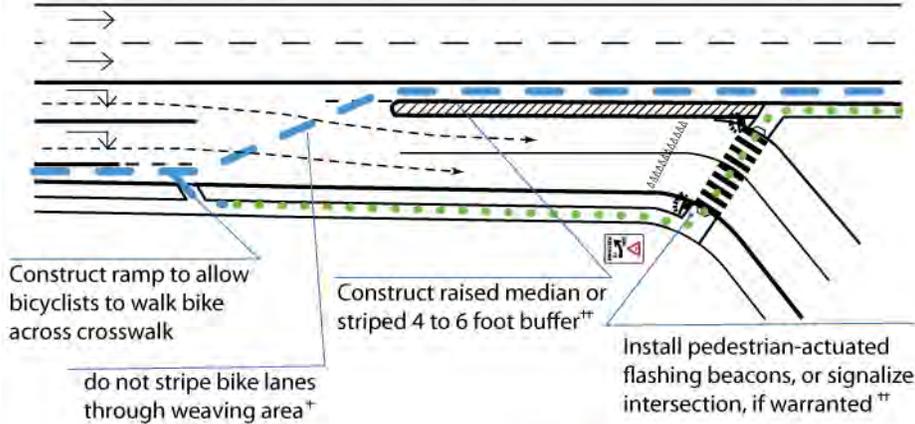
Short Dual Right Turn On-Ramp (right turn lanes less than or equal to 200 feet)\*\*



Long Dual Right Turn On-Ramp (right turn lanes greater than 200 feet)\*\*



Long Dual Trap Right Turn Lane (right turn lanes greater than 200 feet)\*\*



- typical automobile line of travel
- typical bicyclist line of travel
- typical pedestrian line of travel

Figures adapted from ITE Pedestrian and Bike Council.

† CA MUTCD  
\*\* ITE Pedestrian and Bike Council



## 9.2. Single Point Interchange

A Single Point Interchange (SPI) combines two diamond ramp intersections into a single at-grade intersection. Most SPI's operate with a three-phase signal, and due to the size of the intersection, long clearance intervals are required for all movements. These intersections can be efficient at moving high volumes of traffic, particularly left turns. However, the signal timing and intersection configuration required to provide the efficient movement of motor vehicles adversely affect pedestrians and bicyclists. Compact SPI's can be configured to mitigate some of the bicyclist issues. In its June 2001 Design Memorandum, "Single Point Interchange Design, Planning, and Operations Guidelines", Caltrans requires that "If an SPI alternative other than a Compact SPI is chosen, a separate bicycle facility shall be constructed in conjunction with the SPI." Note that even if a separate facility is provided, the SPI should still meet bicyclist signal timing guidance provided in Traffic Operations Policy Directive 09-06.

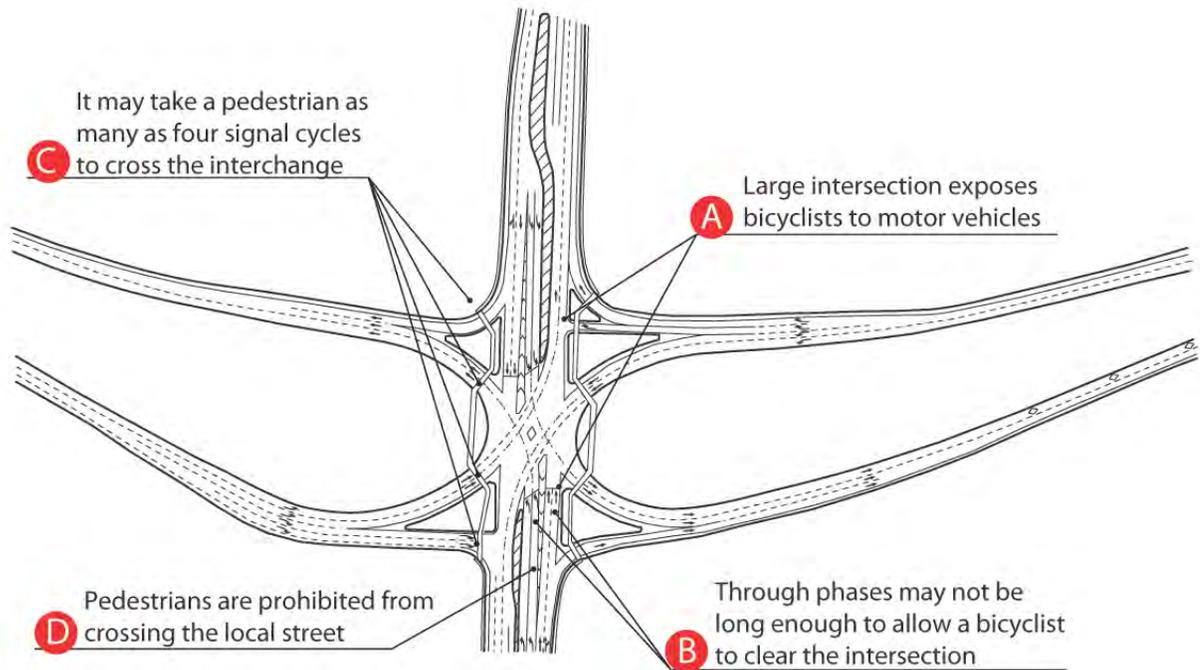
### 9.2.1. Common Issues

Many of the issues faced by pedestrians and bicyclists at free-flow ramp intersections apply at single point intersections. The following issues specific to SPIs also apply:

- A. The **large size of SPI intersections** exposes bicyclists to motor vehicles for a longer time than other interchange types.
- B. Typical through **green phases are not long enough to allow a bicyclist to clear the intersection.**
- C. Pedestrians can only cross a portion of the interchange in a single signal cycle. **It may take a pedestrian as many as four signal cycles to cross the interchange.**
- D. **Pedestrians are prohibited from crossing the local street** at an SPI.



**Figure 9.8 Common Pedestrian and bicycle Issues at Single Point Interchanges**





## 9.2.2. Treatments

**Table 9.2 Treatments for Single Point Interchanges**

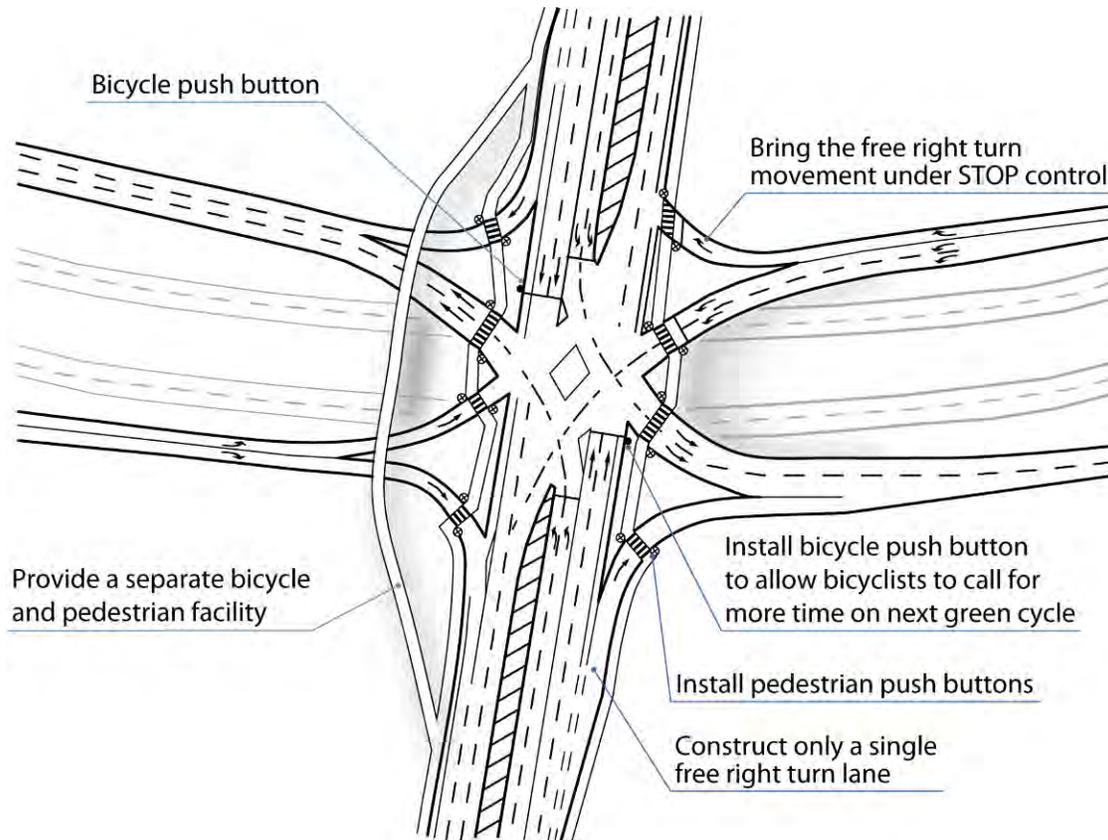
Treatment	Design Principles	Figure No.
<i>Signage and Striping</i>		
Stripe high-visibility crosswalks at all intersections.	Improve Visibility	9.9
<i>Infrastructure</i>		
Select a different interchange type if “moderate to heavy bicycle use is expected” <sup>a</sup> or if bicycle signal timing guidance in TOPD 09-06 cannot be met.	Maintain and Improve	Not Shown
Construct a compact SPI if separate bicycle facilities will not be provided. <sup>a</sup>	Maintain and Improve	9.9
Construct only a single free right turn lane, rather than a dual free right turn lane, to reduce weaving conflicts between bicyclists and turning motorists and reduce pedestrian crossing distance and multiple threat. <sup>a</sup>	Clarify the Right of Way, One Decision at a Time	9.9
Provide a separate undercrossing or overcrossing in the immediate vicinity of the interchange. “If it is anticipated that in the future the right turn move at a Compact SPI will be signalized, a separate bicycle facility should be incorporated into the current project.” <sup>a</sup>	Pedestrians and Bicyclists Will Be There, Maintain and Improve	9.9
<i>Operations</i>		
Install bicycle push button to allow bicyclists to call for more time on next green cycle and/or a detection system that detects bicyclists and automatically adjusts signal timing to allow the bicyclist enough time to clear the intersection per TOPD 09-06.	Pedestrians and Bicyclists Will Be There	9.9
Install pedestrian push buttons.	Pedestrians and Bicyclists Will Be There	9.9
Bring the free right turn movement under STOP, YIELD, or signal control.	Clarify the Right of Way, Slow It Down	9.9

<sup>a</sup> Caltrans Design Memo, “Single Point Interchange Design, Planning, and Operations Guidelines.” June 2001.

Note: Some items adapted from VTA Bicycle Technical Guide, December 2007.



**Figure 9.9** Treatments for Pedestrians and bicyclists at Single Point Interchanges



## 9.3. Trumpet Interchanges

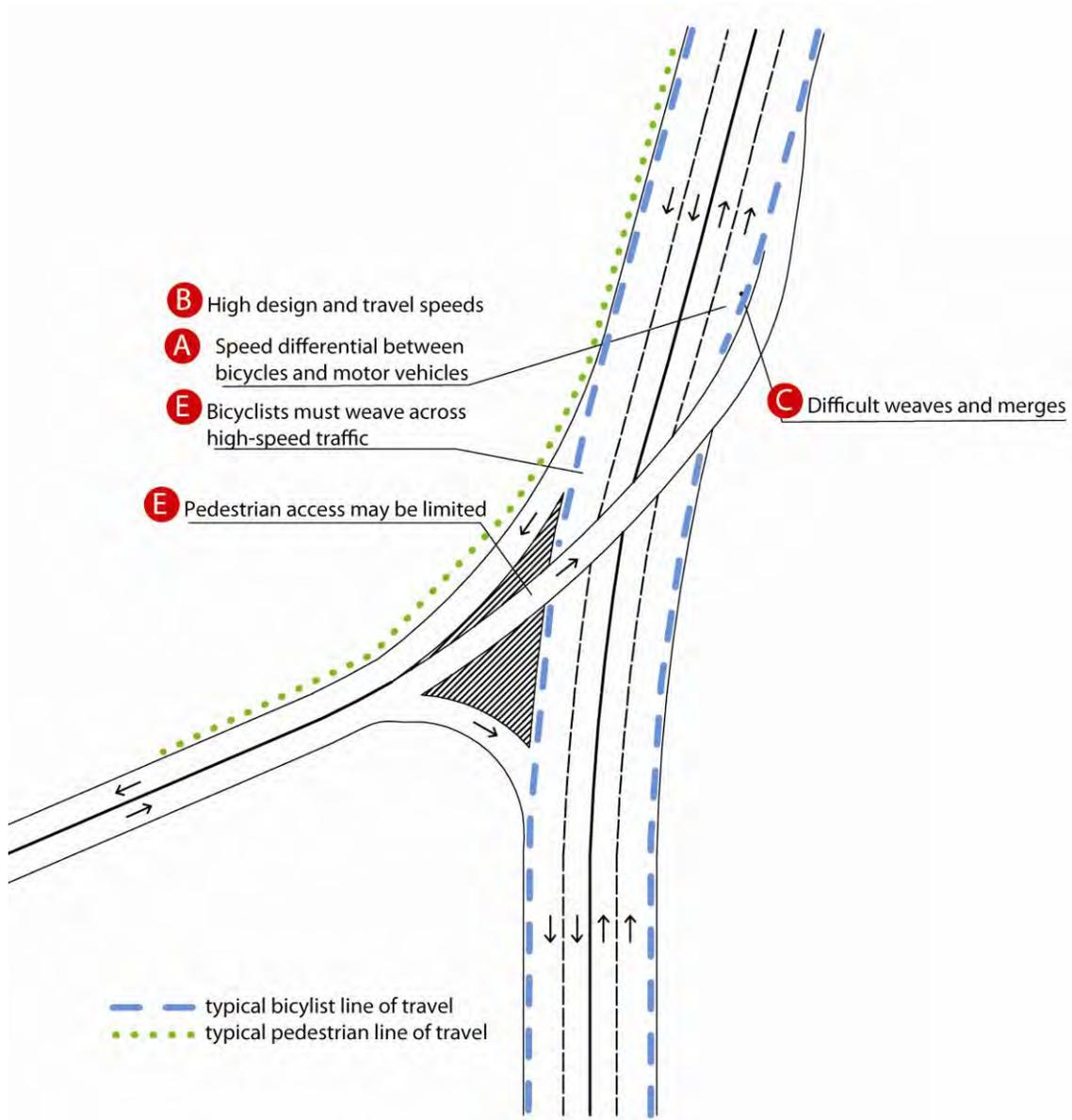
### 9.3.1. Common Issues

Trumpet interchanges are grade-separated three-leg intersections. Many of the issues faced by pedestrians and bicyclists at free-flow ramp intersections apply at trumpet interchanges. Trumpet interchanges pose the following additional safety issues for pedestrians and bicyclists:

- A. Grade of overpass exacerbates **speed differential between bicyclists and motor vehicles**.
- B. Trumpet interchanges generally have a **high design speed and travel speed**.
- C. Bicyclists are required to make difficult **weaves and merges** to traverse the intersection.
- D. Bicyclists are placed in lanes that are difficult to navigate or **forced to merge across high-speed traffic**.
- E. **Pedestrian access may be limited**.



**Figure 9.10 Common Issues with Trumpet Interchanges**





### 9.3.2. Treatments

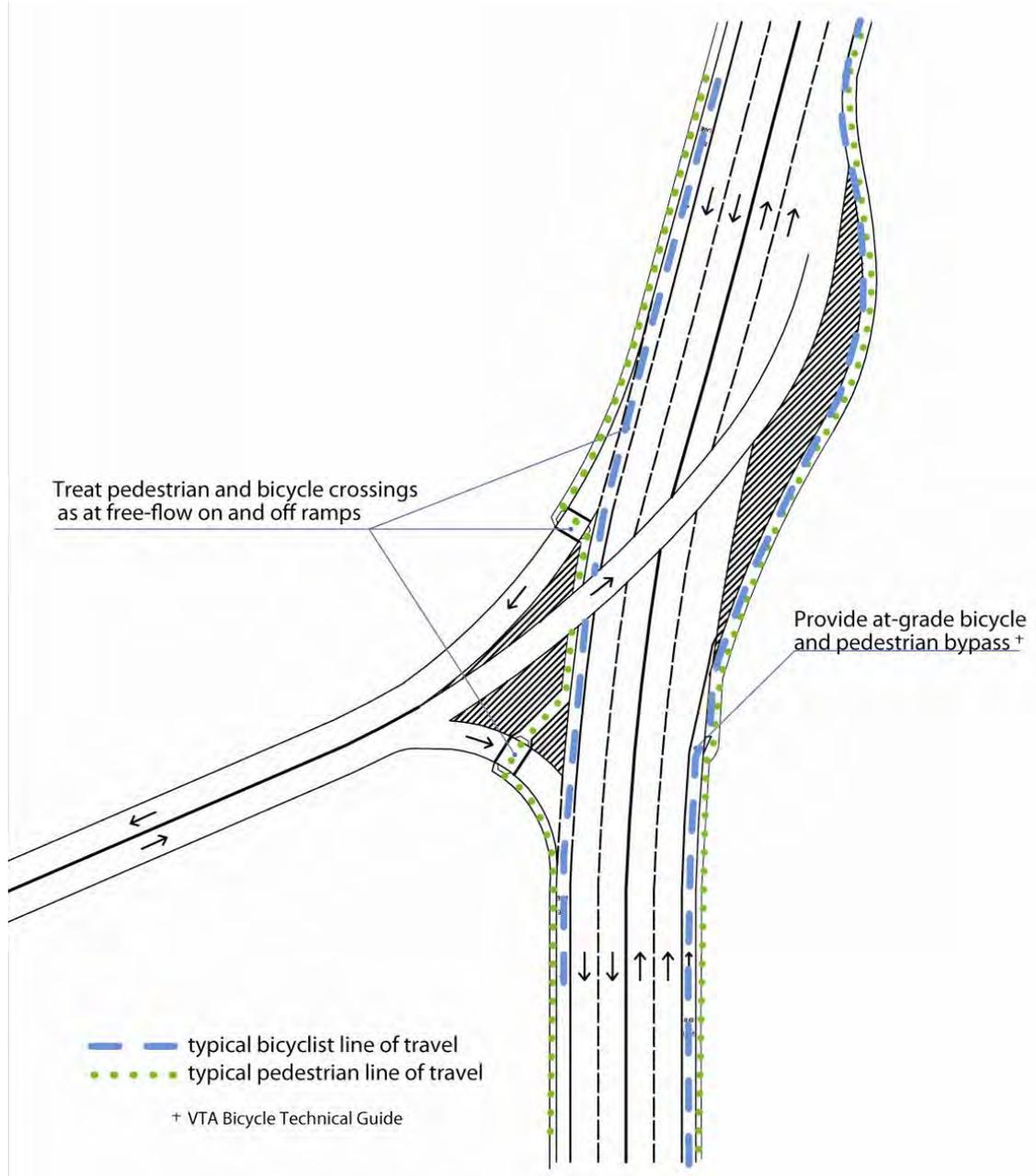
**Table 9.3 Treatments for Trumpet Interchanges**

Treatment	Design Principles	Figure No.
<i>Signage and Striping</i>		
8 foot wide shoulders or bike lanes throughout	Pedestrians and Bicyclists Will Be There	Not Shown
<i>Infrastructure</i>		
Maximum grades of 5 percent	Access for All	Not Shown
Provide at-grade bicycle bypass	Maintain and Improve, Pedestrians and Bicyclists Will Be There	9.11
<i>Operations</i>		
Design for a maximum speed of 35 mph	Slow It Down	Not Shown

Note: Adapted from VTA Bicycle Technical Guide, December 2007.



**Figure 9.11 Trumpet Interchange Treatment**



Note: Recommendations from *VTA Bicycle Technical Guide*, December 2007.



## **9.4. Diverging Diamond Interchanges**

The diverging diamond interchange is an unusual design and, as such, presents possible unknown challenges to the safe accommodation of pedestrians and bicyclists. In design, it will be important to first obtain the latest data and research on non-motorized safety through and across this type of interchange, and then to thoroughly incorporate the design principles of this Guide.





# 10. TREATMENTS ON THE HORIZON

Treatments suggested in this Guide reflect current California standards for striping and signage from the 2006 CA MUTCD. The CA MUTCD is based on the 2003 MUTCD with certain amendments, along with policies on traffic control devices issued by the California Department of Transportation. The National MUTCD was updated in 2009 and incorporates several modifications to pedestrian and bicycle related signage and new traffic control devices, some of which are being experimented with in California. The 2009 MUTCD is not effective in California until Caltrans and CTCDC review it and incorporate the changes into CA MUTCD through formal efforts. Although devices included in the 2009 MUTCD are not yet standard in California, they may be included in a revised version of the CA MUTCD and are discussed here as potential future treatments. California has two years to review the National MUTCD and adopt a new CA MUTCD.

## 10.1.2009 MUTCD

Several changes in the 2009 MUTCD update are significant for pedestrians and bicyclists at intersections, all shown in Table 10.1:

- **Bicyclist push button signs.** This sign supplements bicyclist push buttons at intersections.
- **Bicycle “May Use Full Lane” sign.** This sign is intended for roads where bicyclists may need to use the full travel lane due to lack of bicycle lanes, shoulders, or where travel lanes are too narrow for bicyclists and motor vehicles to operate side by side.
- **Bicycle Route Guide Signage.** These signs direct bicyclists to destinations and may include the distance to destinations.
- **Pedestrian Hybrid Beacon.** Also known as, the High-Intensity Activated Crosswalk (HAWK) signal, the Pedestrian Hybrid Beacon assists pedestrians crossing streets at unsignalized marked crosswalks. Pedestrians actuate the signal when crossing, causing it to begin flashing yellow and then solid yellow, advising motorists to prepare to stop. A steady red phase occurs during the pedestrian walk interval. After the red call, an alternating flashing red signal indicates that motorists may proceed when safe after coming to a full stop. When not activated, the signal is blank. The 2009 MUTCD has specific guidelines for installing Pedestrian Hybrid Beacons including the volume of pedestrian crossings and road speeds and volumes.
- **Countdown Signals.** Countdown Signals: The 2009 MUTCD states that countdown signals are now required on all pedestrian signal heads where the pedestrian change interval is more than 7 seconds (previously not required). Also, the signals now shall



not be used during the red clearance interval of a concurrent vehicular phase (previously yellow).

- **Slower Walking Speed.** The 2009 MUTCD states that pedestrian clearance time should be based on a walking speed of 3.5 feet per second (reduced from 4.0 feet per second in previous versions). At intersections where extended pedestrian time is provided, a walking speed of 4.0 feet per second may be used to evaluate crossing time.
- **Additional Crossing Time Sign.** In both the 2010 CA MUTCD and the 2009 MUTCD, pedestrians may be provided with extended crossing time by pressing an extended pushbutton. The 2009 MUTCD requires that these pushbuttons shall be identified by a PUSH BUTTON FOR 2 SECONDS FOR EXTRA CROSSING TIME (R10-32P) plaque.
- **Pedestrian Lead Interval.** At intersections with high pedestrian volumes and high conflicting turning vehicle volumes, a brief leading pedestrian interval, during which an advance WALKING PERSON (symbolizing WALK) indication is displayed for the crosswalk while red indications continue to be displayed to parallel through and/or turning traffic, may be used to reduce conflicts between pedestrians and turning vehicles. If a leading pedestrian interval is used it should be at least 3 seconds in duration and should allow pedestrians to cross at least one lane of traffic before turning traffic is released.

**Unsignalized Pedestrian Crossing Sign.** Overhead pedestrian crossing signs (R1-9 or R1-9a) for unsignalized intersections were added to the 2009 MUTCD. They are intended to remind motorists of laws regarding right-of-way at an unsignalized pedestrian crosswalk. The legend STATE LAW must be displayed at the top of the sign. The sign must be placed at the crosswalk, not in advance of it.

- **Trail Crossing Sign.** This new trail crossing sign (W11-15) displays both a pedestrian and bicycle symbol. An optional TRAIL XING plaque may accompany this sign.
- **Shared Lane Marking.** The 2009 MUTCD includes the Shared Lane Marking originally adopted in California. This marking is intended to assist bicyclists with lateral positioning in lanes with parallel parking or in lanes too narrow to share side-by-side. One key difference from the CA MUTCD is that the 2009 MUTCD does not require the Shared Lane Marking to be used on roads with on-street parallel parking.



**Figure 10.1 New Signs and Signals in the 2009 National MUTCD**

**Bicyclist push button signs**



R10-4

Existing Sign



R10-24

New Sign



R10-25

Existing Sign



R10-26

New Sign

**Bicyclist May Use Full Lane Sign**



R4-11

**Bicycle Route Guide Signs**



D1-1b



D1-1c



D1-2b



D1-2c



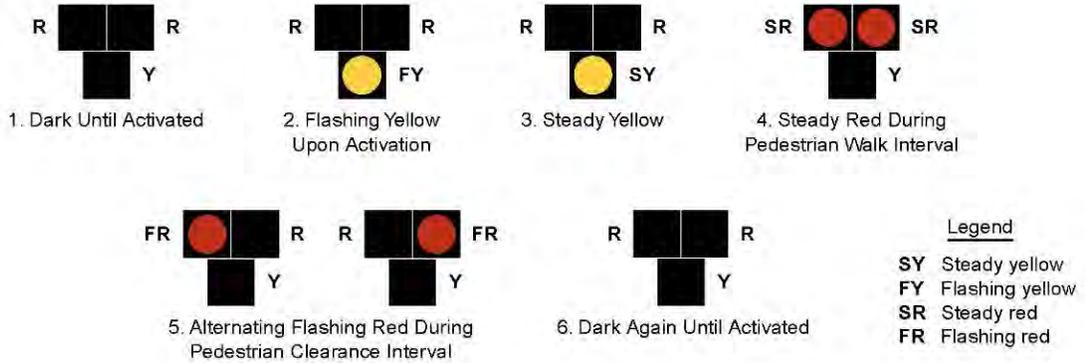
D1-3b



D1-3c



## Pedestrian Hybrid Beacon

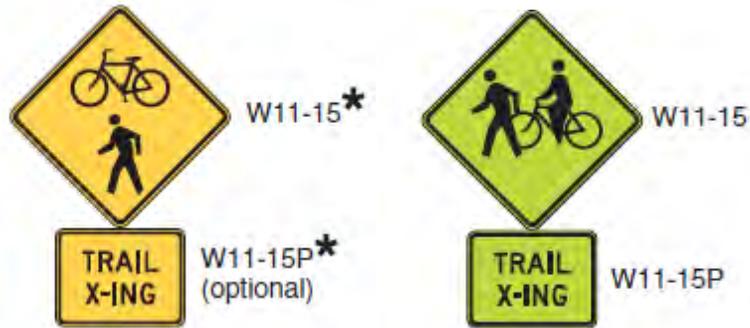


## Unsignalized Pedestrian Crossing Signs



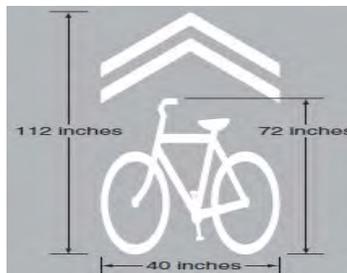
R1-9

## Trail Crossing Sign



\* Fluorescent yellow green may be used

## Shared Lane Marking





## 10.2. Interim Approved Device: Rectangular Rapid Flashing Beacons

FHWA has issued an Interim Approval for the optional use of Rectangular Rapid Flashing Beacons (RRFB) as warning beacons. Interim Approval allows interim use of a new traffic control device not specifically described in the MUTCD by written request to FHWA. RRFB do not meet current MUTCD standards because of their rectangular shape and flashing rate. RRFB devices supplement pedestrian and school crossing signs, using rectangular-shaped high-intensity LED-based indications that flash rapidly in a wigwag “flickering” flash pattern. They are mounted immediately between the crossing sign and the sign’s supplemental arrow plaque.



*Rectangular Rapid Flashing Beacons are installed between the crossing sign and the supplemental arrow.  
Source: FHWA.*

Based on data from experimental studies, FHWA considers the RRFB to be highly successful for uncontrolled crosswalk locations. FHWA believes that the RRFB offers significant potential safety and cost benefits; because it achieves very high rates of compliance at a very low relative cost in comparison to other more restrictive devices that provide comparable results, such as full midblock signalization. The components of RRFB are not proprietary and can be assembled by any jurisdiction with off-the-shelf hardware.

## 10.3. California Experiments

There are several bicycle traffic control device experiments underway in California.

The City of San Francisco has received FHWA approval for experimentation of colored bicycle lanes. This experiment will involve evaluation of green solid and dashed asphalt pavement for bike lanes at several locations.

Caltrans District 5 is experimenting with a “Bikes in Lane” sign as shown in Figure 10.2. This sign is for bikeways where there is limited space for both bicycles and vehicles and as a result, the two users must share a travel lane.



*The City of Long Beach is experimenting with shared lane marking augmented with a green colored strip.  
Source: Long Beach Department of Health.*

The City of Long Beach is conducting an FHWA-approved experiment evaluating shared lane markings augmented with a strip of green paint to further delineate the appropriate positioning of bicyclists in the travel lane. Long Beach is also requesting approval to experiment with separated/protected bikeways along two one-way streets.



**Figure 10.2 Experimental “Bikes in Lane” Sign**





# 11. BACKGROUND

This section provides background information on issues to be considered when designing and retrofitting intersections and interchanges for pedestrians and bicyclists, including:

- **Pedestrian and bicyclist injury and fatality data** – provides an overview of the numbers of pedestrian and bicyclist injuries and fatalities occurring at intersections in California;
- **Characteristics of bicycle- and pedestrian-friendly environments** – describes the land use and environmental characteristics that encourage travel by foot and bicycle;
- **Typical collision types at intersections** – describes the most common types of collisions involving pedestrians and bicyclists at intersections;
- **Safety benefits of treatments** – summarizes research on the relative safety benefits of design treatments for pedestrians and bicyclists;
- **Using a 4E approach to safety** – describes educational and enforcement strategies to address non-motorized user safety at intersections.

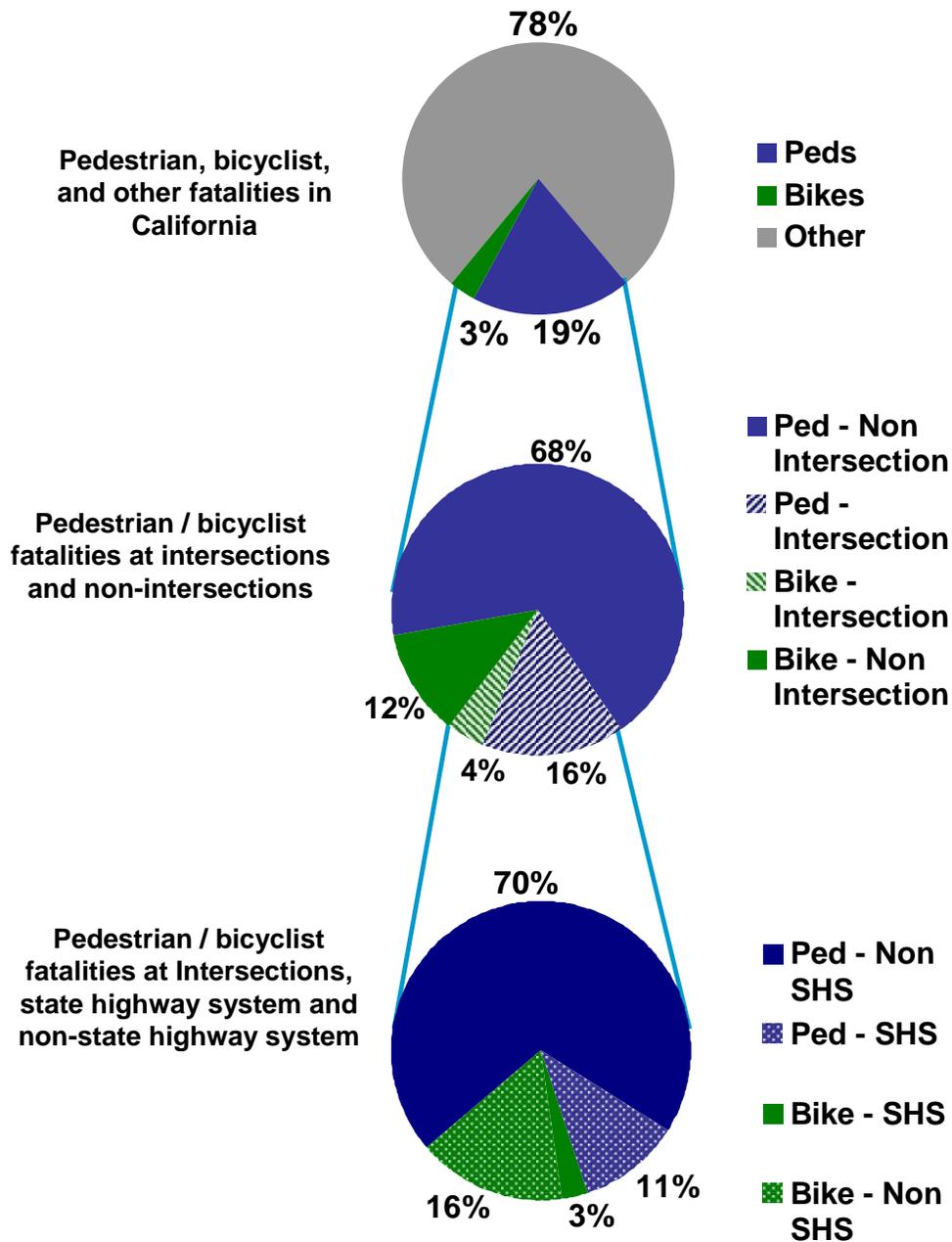
## 11.1. Pedestrian and bicycle Injuries and Fatalities in California

The following is a brief overview of the characteristics of police-reported pedestrian and bicyclist injuries and fatalities in California:

- Pedestrians and bicyclists accounted for 22 percent of all traffic fatalities between 2003 and 2007 in California.
- Twenty percent of pedestrian and bicyclist fatalities occurred at or near intersections.



**Figure 11.1 Pedestrian and Bicycle Fatalities in California**



Source: SWITRS, 2003-2007.

Injury data for pedestrians and bicyclists is less reliable due to underreporting. Comparisons of emergency room and hospital discharge records and reported police collisions in California show that pedestrian and bicyclist injuries are significantly



under-reported to the police, (43 percent of bicyclist-motor vehicle injuries are not reported, and 45 percent of pedestrian-motor vehicle injuries are not reported).<sup>26</sup> Consequently, SWITRS data significantly underestimates the total number of pedestrians and bicyclists involved in crashes.

Available data shows that 39 and 33 percent of pedestrian and bicyclist injuries, respectively, occurred at intersections between 2003 and 2007. Of all pedestrian and bicyclist injuries occurring at intersections, 9 and 7 percent, respectively, occurred on the State Highway System.<sup>27</sup>

Additional analysis of SWITRS fatality data, 2003-2007, indicates that:

- Twenty-eight percent of pedestrian and 21 percent of bicyclist fatalities at intersections involved alcohol usage by one or more individuals involved in the collision;
- Ninety-two percent of pedestrian and 82 percent of bicyclist fatalities at intersections occurred in incorporated areas; the remainder occurred in unincorporated areas; and
- Sixty-six percent of pedestrian and 76 percent of bicyclist fatalities occurring at intersections involved a properly functioning control device. Most of the remaining fatalities occurred at intersections indicated as having no control device.<sup>28</sup>
- Information on pedestrian injury and fatality rates is difficult to obtain given the lack of reliable, consistent information on pedestrian and bicycle volumes in California. When it becomes available, the 2008 California National Household Travel Survey Add-On data will provide the most up-to-date and comprehensive information on statewide rates of bicycling and walking.

## **11.2. Characteristics of Bicyclist- and Pedestrian-Friendly Environments**

While users of this Guide may not be able to directly influence land use decisions, they should be aware of the impact the land use context may have on the mobility and safety of pedestrians and bicyclists at intersections, and the characteristics that make certain environments more attractive to pedestrians and bicyclists than others.

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<sup>26</sup> Jane C. Stutts and William W. Hunter. *Injuries to Pedestrians and Bicyclists: An Analysis Based on Hospital Emergency Department Data*. Table 59. Percentage of cases reported by participating hospital emergency departments identified in California crash files. Sponsored by: Office of Safety Research, Development, and Technology, FHWA, Washington D.C. FHWA-RD 99-078. June 1997.

<sup>27</sup> All data are cumulative, 2003-2007, from SWITRS.

<sup>28</sup> Police officers may mark “no control” on the crash form when the intersection is stop controlled.



Major characteristics of bicyclist- and pedestrian-friendly environments include:

- **Closely spaced destinations.** Pedestrian and bicycle travel is not convenient unless destinations are close together. The distances between destinations can be shortened by building at higher densities, mixing land uses, and by creating direct routes to destinations.
- **Direct routes.** Direct routes facilitate pedestrian and bicycle travel and help shorten the distances between destinations. Routes can be made more direct by providing adequate roadway crossing opportunities; reducing crossing distances; providing an interconnected street network (as opposed to suburban-style disconnected street network), and by limiting the need for pedestrians and bicyclists to cross major obstacles, such as large parking lots, to get to their destination. Additionally, off-road paths and bicycle-pedestrian bridges can overcome barriers to pedestrian and bicycle mobility.
- **Slow-moving vehicles.** Fast-moving vehicle traffic reduces the comfort of pedestrians and bicyclists, and increases the risk of surveying if a collision occurs. Many of the treatments in this Guide can help reduce vehicle traveling and turning speeds, therefore increasing the safety and comfort of pedestrians and bicyclists. Figure 11.2–Fatal Injury Rates by Vehicle Speed by Pedestrian Age illustrates the rapid increase in the likelihood of pedestrian death that occurs as vehicle speeds increase, and shows how older pedestrians are particularly vulnerable.
- **Other pedestrians and bicyclists.** Pedestrian and bicycle-friendly environments can be identified simply by looking for areas where many pedestrians and bicyclists are present. There is evidence that more pedestrians and bicyclists may actually make the environment safer, a phenomenon known as “safety in numbers”. The reason for this has not been fully defined, but may be due to changes in driver behavior.<sup>29</sup>

### ***Context-Sensitive Solutions***

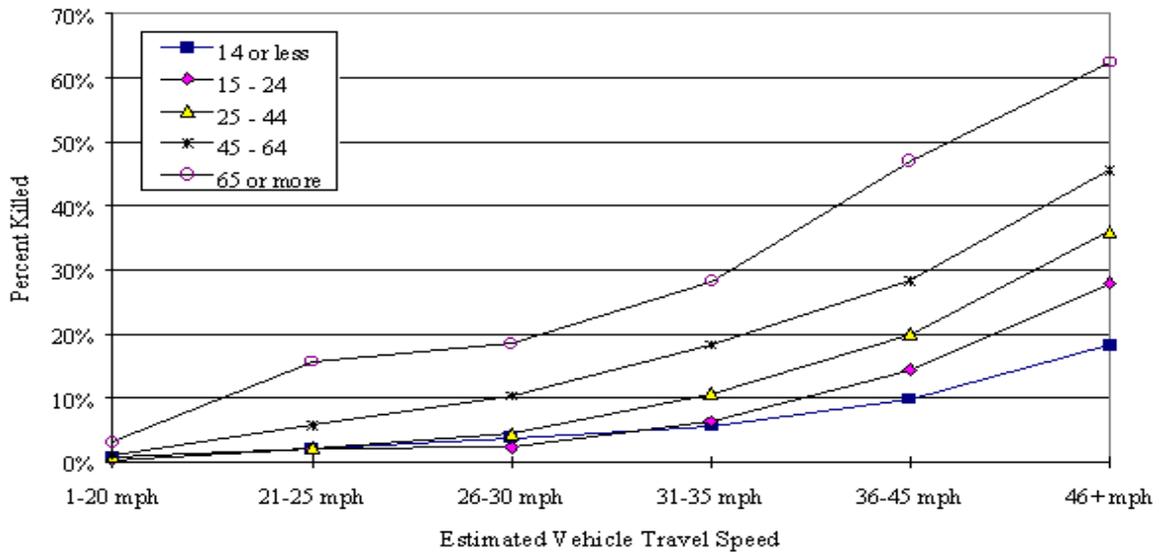
When designing intersections it is critical to consider the needs of the transportation system from the viewpoint of all users. Caltrans has adopted policy on “Context-Sensitive Solutions” to ensure the protection and enhancement of the environment and quality of life while meeting multimodal transportation needs. Context-sensitive solutions use innovative and inclusive approaches to integrate and balance community, aesthetic, historic, and environmental values with transportation safety, maintenance, and performance goals through a multidisciplinary approach. Utilizing context-sensitive solutions during the design process will promote the creation of intersections where it is safe, convenient, and comfortable to walk and bicycle.

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<sup>29</sup>See Jacobsen, P, 2003. More Walkers and Bicyclists, Safer Walking and Bicycling. Injury Prevention 9:205-209.



**Figure 11.2 Fatal Injury Rates by Vehicle Speed by Pedestrian Age**



Source: Preusser Research Group, 1999. *Literature Review on Vehicle Travel Speeds and Pedestrian Injuries*. National Highway Traffic Safety Administration. Data are from Florida, 1993-1996; pedestrians in single vehicle crashes.

### 11.3. Pedestrian and Bicyclist Collision Types at Intersections

To understand how to address pedestrian and bicyclist safety at intersections, it is helpful to be familiar with common collision types. The crash type describes the pre-crash actions of the pedestrian or bicyclist and motor vehicle involved in the collision. Each crash type may be linked to various problems and causes. It is critical to understand the predominant crash types to identify appropriate safety treatments.

Common pedestrian-vehicle crash types at intersections include:<sup>30</sup>

- A. **Intersection dash.** The pedestrian is struck while running through an intersection and/or the pedestrian was obstructed from view until right before impact;
- B. **Trapped.** The pedestrian began crossing a signalized intersection on a green phase or WALK interval and becomes trapped in the roadway when the signal changes;
- C. **Through vehicle.** The pedestrian is struck at an unsignalized intersection, when either the pedestrian or motorist fails to yield, or the pedestrian is struck at a signalized intersection by a vehicle traveling straight ahead (not shown);

<sup>30</sup>Pedestrian Safety Guide and Countermeasure Selection System (PEDSAFE). [http://www.walkinginfo.org/pedsafe/pedsafe\\_ca\\_crashtypes.cfm](http://www.walkinginfo.org/pedsafe/pedsafe_ca_crashtypes.cfm).

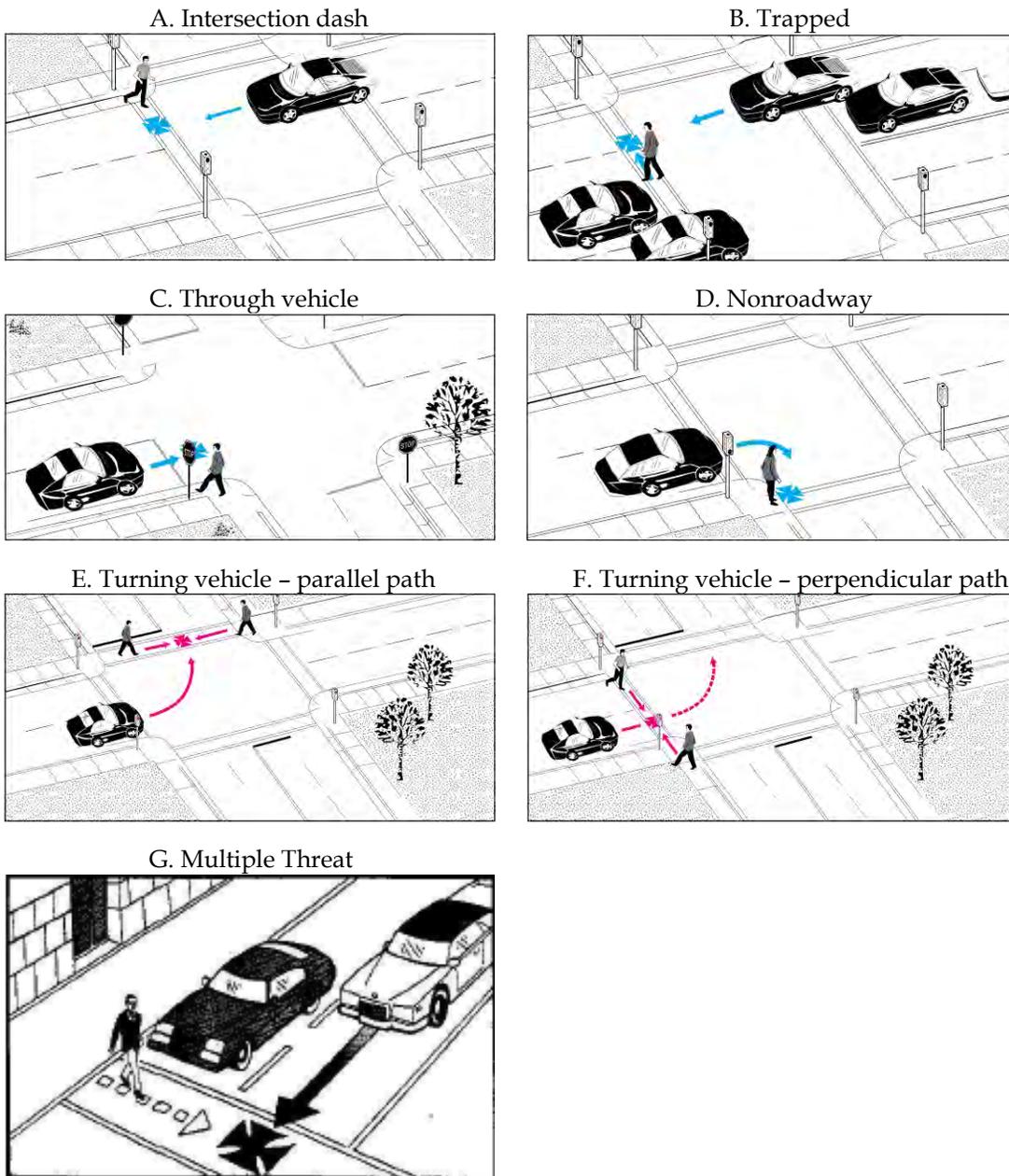


- D. Nonroadway.** The pedestrian is waiting to cross the intersection near the roadway edge or on a sidewalk and struck by a vehicle;
- E. Turning vehicle - parallel path.** The pedestrian is crossing the intersection and is struck by a vehicle turning left or right and traveling in the same direction as the pedestrian;
- F. Turning vehicle - perpendicular path.** The pedestrian is crossing the intersection and is struck by a vehicle turning left or right and traveling in a direction perpendicular to the pedestrian; and
- G. Multiple Threats.** The pedestrian crosses in front of a stopped vehicle in a one lane of a multi-lane road, and is subsequently struck by a vehicle in an adjacent lane.

These types are illustrated in Figure 11.3 - Pedestrian Crash Types at Intersections. Suggested treatments to address these crash types are listed in Appendix A. There are other collision types not listed here. A complete typology of crash types can be found on [www.walkinginfo.org](http://www.walkinginfo.org).



**Figure 11.3 Pedestrian Crash Types at Intersections**



Source: Adapted from [http://www.walkinginfo.org/facts/pbcat/ped\\_images.cfm](http://www.walkinginfo.org/facts/pbcat/ped_images.cfm). The image of multiple threat crashes is from Safety Effects of Marked Versus Unmarked Crosswalks at Uncontrolled Locations Final Report and Recommended Guidelines, FHWA-RD-04-100, 2005.



Common bicyclist-vehicle crash types at intersections include:<sup>31</sup>

- A. **Motorist fails to yield.** The bicyclist was struck by a motorist traveling in a perpendicular path that failed to properly stop or yield at a stop sign, yield sign, or traffic signal. In many of these crashes, the bicyclist is riding the wrong way against traffic.
- B. **Bicyclist fails to yield.** The bicyclist entered an intersection without stopping or yielding, or was caught during the intersection by a signal change and is struck by a motorist traveling through the intersection.
- C. **Motorist turns left into path of bicyclist - opposite direction.** The bicyclist is struck by an oncoming motorist turning left or by a motorist traveling in opposite direction making a left turn.
- D. **Motorist turns left into path of bicyclist - same direction.** The bicyclist is struck by a motorist traveling in the same direction making a left turn.
- E. **Motorist turns right into path of bicyclist - same direction.** The motorist turned right into the path of a bicyclist traveling in the same direction.
- F. **Motorist turns right into path of bicyclist - opposite direction.** The motorist turned right into the path of a bicyclist traveling in the opposite direction or a motorist turned right and struck an oncoming bicyclist riding against traffic.
- G. **Bicyclist turns left into path of motorist.** The bicyclist attempted to make a left turn into the path of an oncoming motorist or a bicyclist merged into the path of a motorist traveling in the same direction to make a left turn.
- H. **Bicyclist turns right into path of motorist.** A bicyclist was riding in the wrong direction of traffic and turned right into an oncoming motorist or a motorist traveling in the same direction.

These collision types are illustrated in Figure 11.4. There are other collision types not listed here, such as those involving bicyclists riding out into traffic from driveways or bike path intersections. A complete typology of crash types can be found on [www.bicyclinginfo.org](http://www.bicyclinginfo.org).

The appropriate treatment will depend on the prevalent crash type and the prevailing conditions at the intersection. Appendix A provides a summary table of potential safety treatments for each crash type discussed. Many common crashes involve improper pedestrian, bicyclist, or motorist behavior, and infrastructure and operations treatments should be selected to encourage legal and safe behavior. In addition, safety education and enforcement measures, which are not discussed in this Guide, can be used to provide benefits.

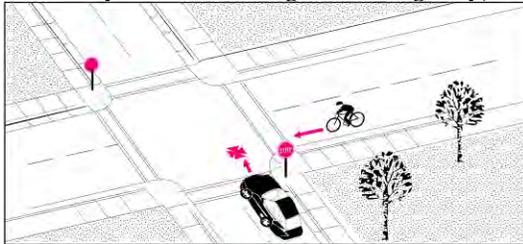
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<sup>31</sup>Bicycle Countermeasure Selection System (BIKESAFE). <[http://www.bicyclinginfo.org/bikesafe/crash\\_analysis-types.cfm](http://www.bicyclinginfo.org/bikesafe/crash_analysis-types.cfm)>

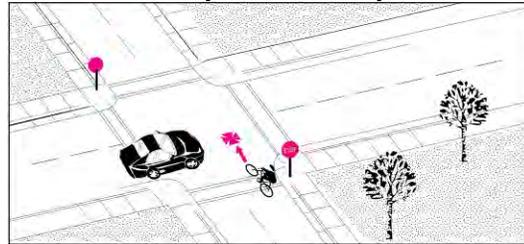


## Figure 11.4 Bicycle Crash Types at Intersections

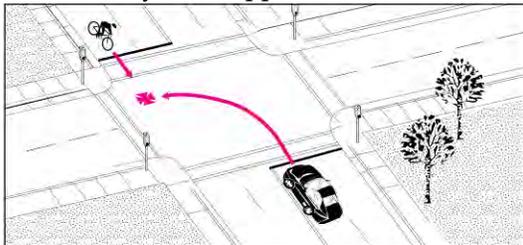
A. Motorist failed to yield (in many crashes, the bicyclist was riding the wrong way)



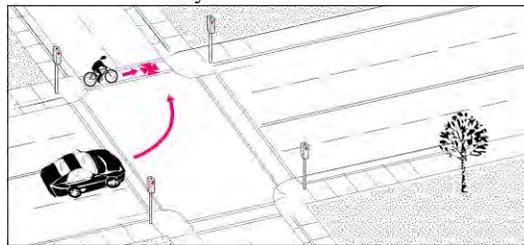
B. Bicyclist failed to yield



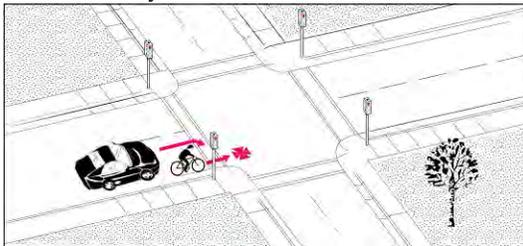
C. Motorist turned left into path of bicyclist – opposite direction



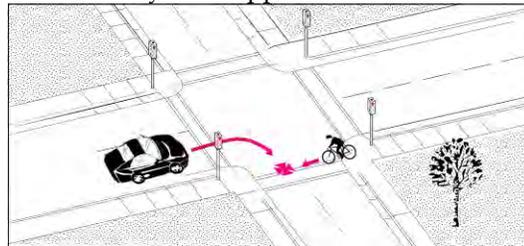
D. Motorist turned left into path of bicyclist – same direction



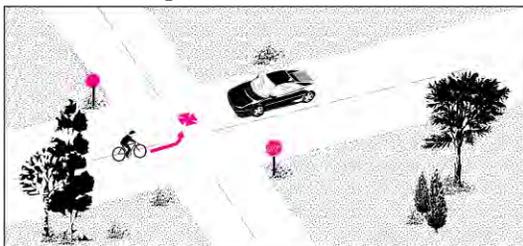
E. Motorist turned right into path of bicyclist – same direction



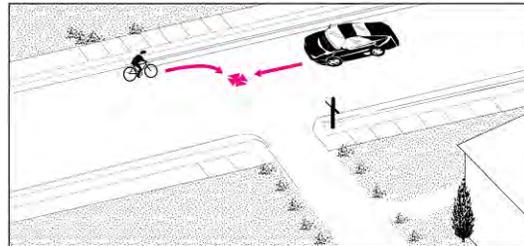
F. Motorist turned right into path of bicyclist - opposite direction



G. Bicyclist turned left into path of motorist



H. Bicyclist turned right into path of motorist



Source: Adapted from [http://www.walkinginfo.org/facts/pbcats/bike\\_images.cfm](http://www.walkinginfo.org/facts/pbcats/bike_images.cfm).

## 11.4. Effectiveness of Pedestrian and Bicyclist Safety Countermeasures

In many cases, there may be more than one treatment option identified to address a particular crash type. Treatments will vary in cost, and may have varying degrees of effectiveness in reducing pedestrian or bicyclist collisions. For some countermeasures,



Crash Reduction Factors (CRFs) are available. CRFs indicate the percentage crash reduction expected after implementing a safety treatment, and are developed from before and after studies. The most up-to-date source of pedestrian and bicyclist crash reduction factors is the FHWA's Clearinghouse of Crash Modification Factors. The site provides CRFs for a wide range of countermeasures including a quality rating (one to five stars) and a reference. CRFs based on simplistic before-and-after studies that do not account for changes in pedestrian, bicyclist, and vehicle exposure should be avoided or used with caution. Additionally, while CRFs and previous case studies can provide an indication of the expected effectiveness of a countermeasure, the actual effectiveness may vary from site to site. It remains necessary to apply engineering judgment and to assess specific site conditions, which may impact the effectiveness of a countermeasure.

The NCHRP Report 500 Volume 10: A Guide for Reducing Collisions Involving Pedestrians<sup>32</sup> and Volume 18: A Guide for Reducing Collisions Involving Bicycles<sup>33</sup> provide several strategies for reducing collisions involving pedestrians and are classified as proven, tried, or experimental based on the quality of research demonstrating their effectiveness.

PEDSAFE<sup>34</sup> and BIKESAFE<sup>35</sup> are additional tools to assist in identifying and assessing the effectiveness of various treatments. Both of these tools include several countermeasures for improving the safety of pedestrians and bicyclists at intersections and include case studies documenting the effectiveness of the countermeasures.

## 11.5. Using a “4-E” Approach

A “4-E” approach to safety looks beyond the road and incorporates a multidisciplinary approach by considering human behavior, vehicle engineering, road engineering, and the availability of medical care. The 4-E's of safety include engineering, education, enforcement, and emergency response.

While this Guide focuses on engineering countermeasures, there are some educational and enforcement countermeasures that are appropriate for implementation at or near intersections, such as:

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<sup>32</sup>Zegeer, C.V. et al. 2004. *NCHRP Report 500 Volume 10: A Guide for Reducing Collisions Involving Pedestrians*. Washington, D.C.: Transportation Research Board. [http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp\\_rpt\\_500v10.pdf](http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_500v10.pdf).

<sup>33</sup>Raborn, C. et al. 2008. *NCHRP Report 500 Volume 18: A Guide for Reducing Collisions Involving Bicycles*. Washington, D.C.: Transportation Research Board. [http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp\\_rpt\\_500v18.pdf](http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_500v18.pdf).

<sup>34</sup>Harkey, D.L. and C.V. Zegeer. 2004. *PEDSAFE: Pedestrian Safety Guide and Countermeasure Selection System*. Report No. FHWA-SA-04-003. Federal Highway Administration. Washington, D.C. <http://www.walkinginfo.org/pedsafe>.

<sup>35</sup>Hunter, W.W. et al. 2006. *BIKESAFE: Bicycle Countermeasure Selection System*. Report No. FHWA-SA-05-006. Federal Highway Administration. Washington, D.C. <http://www.bicyclinginfo.org/bikesafe/index.cfm>.



- **School pedestrian and bicyclist training.** Children in schools near problematic or high-volume intersections can be trained in safe intersection crossing techniques. One study showed that training children at elementary schools in safe walking techniques has an estimated effect of a 12 percent reduction in child pedestrian injuries.<sup>36</sup> Such a program should be implemented on an ongoing basis otherwise, its effects will be limited.
- **Automated enforcement.** Automated enforcement utilizes technology to capture violations made by motorists, such as red light-running and speeding. Studies in Canada, Australia and Europe have shown that the implementation of speed cameras, on average, have resulted in a 20 to 40 percent reduction in crashes.<sup>37</sup> Another study showed that red light cameras can result in a 16 percent reduction in all injury crashes, a 24 percent reduction in right-angle crashes, and no significant increase in rear-end crashes.<sup>38</sup>
- **Pedestrian or bicyclist safety zones.** Pedestrian or bicyclist safety zones combine targeted enforcement, education, and engineering efforts in geographic areas with a high incidence of pedestrian or bicyclist collisions. One program in Phoenix, Arizona, identified zones with high incidence of collisions involving older pedestrians. Countermeasures appropriate for older pedestrians were implemented in the zones, including signal retiming, communications and outreach for both drivers and pedestrians living near the crash zones, and enhanced enforcement. The program resulted in a significant reduction in crashes and injuries to older pedestrians in the target areas.<sup>39</sup>

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<sup>36</sup>Blomberg, R.D., Preusser, D.F., Hale, A., Leaf, W.A. (1983). Experimental Field Test of Proposed Pedestrian Safety Messages, Vol. 2: Child Messages. Washington, D.C.: Federal Highway Administration.

<sup>37</sup>Pilkington, P. and Kinra, S. (2005). Effectiveness of Speed Cameras in Preventing Road Traffic Collisions and Related Casualties: Systematic Review. *British Medical Journal* 330(7487), 331-334.

<sup>38</sup>Aeron-Thomas, A.S. and Hess, S. (2005). *Red Light Cameras for the Prevention of Road Traffic Crashes (Review)*. *The Cochrane Database of Systematic Reviews*, 2, Art. No. CD003862.pub2. Hoboken, N.J.: John Wiley & Sons Ltd.

<sup>39</sup> Source: Blomberg, R. D., & Cleven, A. M. (1998). Development, Implementation, and Evaluation of a Pedestrian Safety Zone for Elderly Pedestrians. Publication No. DOT HS 808 692. Washington, DC: National Highway Traffic Safety Administration.





# Appendix A. Treatments by Collision Type

**Table A.1 Pedestrian Countermeasures by Crash Type**

Countermeasure	Crash Type					
	Intersection Dart	Trapped	Through Vehicle at Unsignalized Intersection	Through Vehicle at Signalized Intersection	Non Roadway	Turning Vehicle
Sidewalks/ Walkways & Curb Ramps			◆	◆	◆	◆
Install or Upgrade Signals	◆	◆	◆	◆		◆
Refuge Islands & Raised Medians	◆	◆	◆	◆		◆
Crosswalk Enhancements	◆	◆	◆	◆		◆
Lighting/ Crosswalk Illumination	◆	◆	◆	◆	◆	◆
Improve sight distance	◆		◆	◆		◆
Revise Curb Radii			◆		◆	◆
Turning Restrictions						◆
Install or Improve Signing	◆		◆			◆
Traffic Calming	◆		◆	◆	◆	◆

Source: NCHRP Report 500 Volume 10: A Guide for Reducing Collisions Involving Pedestrians and Pedestrian Safety Guide and Countermeasure Selection System: PEDSAFE. [http://www.walkinginfo.org/pedsafe/pedsafe\\_ca\\_crashtypes.cfm](http://www.walkinginfo.org/pedsafe/pedsafe_ca_crashtypes.cfm).



**Table A.2 Bicyclist Countermeasure by Crash Type**

Countermeasure	Crash Type							
	Motorist failed to yield signalized intersection	Motorist failed to yield unsignalized intersection	Bicyclist failed to yield signalized intersection	Bicyclist failed to yield unsignalized intersection	Motorist turned left into path of bicyclist	Motorist turned right into path of bicyclist	Bicyclist turned left into path of motorist	Bicyclist turned right into path of motorist
Revise Curb Radii	◆	◆			◆	◆		
Add or Widen Bike Lanes					◆	◆		◆
Refuge Islands					◆		◆	
Install or Upgrade Signal		◆	◆	◆	◆		◆	
Lighting Improvements	◆	◆	◆	◆	◆	◆		
Install or Improve Signing	◆	◆	◆	◆	◆	◆		
Intersection Markings	◆	◆	◆	◆	◆	◆	◆	◆
Improve Sight Distance	◆	◆	◆	◆	◆		◆	
Use minimum lane width	◆	◆	◆	◆		◆	◆	◆
Turning Restrictions	◆				◆	◆		
Traffic Calming	◆	◆	◆	◆	◆	◆	◆	◆

Source: Bicycle Countermeasure Selection System: BIKESAFE. [http://www.bicyclinginfo.org/bikesafe/crash\\_analysis-types.cfm](http://www.bicyclinginfo.org/bikesafe/crash_analysis-types.cfm).



## Appendix B. Related Resources

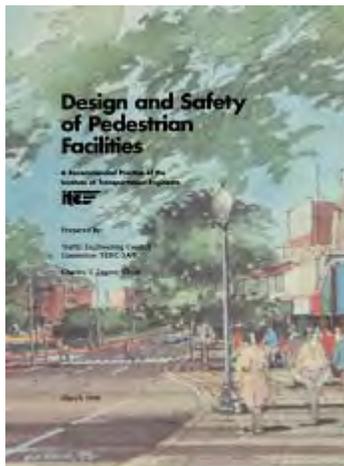
This section presents brief descriptions of key resources in the area of pedestrian and bicycle accommodation at intersections and related topics.



Zegeer, Charles V., et al., 2002, *Pedestrian Facilities User Guide - Providing Safety and Mobility*, for the Federal Highway Administration, U.S. Department of Transportation, Publication No. FHWA-RD-01-102, March 2002.

The Guide provides useful information regarding walkable environments, pedestrian crashes and their countermeasures, and engineering improvements for pedestrians. Includes cost estimates for several improvement options. Available on-line:

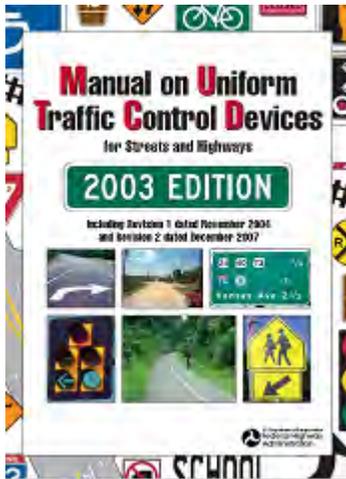
[http://drusilla.hsrc.unc.edu/cms/downloads/PedFacility\\_UserGuide2002.pdf](http://drusilla.hsrc.unc.edu/cms/downloads/PedFacility_UserGuide2002.pdf)



Zegeer, Charles V., et al., 1998, *Design and Safety of Pedestrian Facilities*, Institute of Transportation Engineers, March 1998.

This report describes recommended practices and discusses guidelines for the design and safety of pedestrian facilities. Available on-line:

[http://safety.fhwa.dot.gov/ped\\_bike/docs/designsafety.pdf](http://safety.fhwa.dot.gov/ped_bike/docs/designsafety.pdf)



MUTCD, 2003, *Manual on Uniform Traffic Control Devices for Streets and Highways 2003 Edition*, Federal Highway Administration, U.S. Department of Transportation.

This is comprehensive guide on signalization, signage, and other traffic control tools. Contains FHWA approved guidelines and warrants for different traffic control elements. Available on-line:

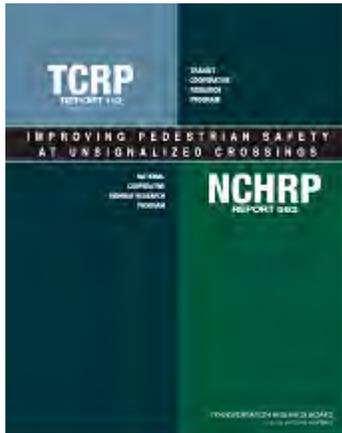
<http://mutcd.fhwa.dot.gov/pdfs/2003/pdf-index.htm>



FHWA, 2006, *Federal Highway Administration University Course on Bicycle and Pedestrian Transportation*, Report No. FHWA-HRT-05-085, Federal Highway Administration, U.S. Department of Transportation.

This report is a detailed 24-lesson course in planning and designing for non-motorized transportation. Key lessons include 3: “Pedestrian and Bicyclist Safety”, 11: “Pedestrian Design at Intersections”, and 21: “Bicycle and Pedestrian Accommodation in Work Zones”. Available on-line:

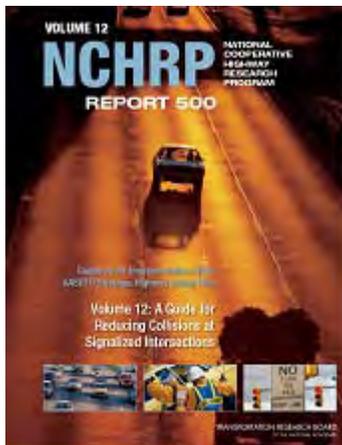
<http://www.tfhr.gov/safety/pedbike/pubs/05085/>



Fitzpatrick, K., et al., 2006, *Improving Pedestrian Safety at Unsignalized Crossings*, Transit Cooperative Research Program (TCRP) Report 112/National Cooperative Highway Research Program (NCHRP) Report 562, Transportation Research Board, U.S. Department of Transportation.

This report is a detailed guide on methods for improving pedestrian safety, including pavement markings, signage, beacons, warning lights, and signal warrant reviews and revisions. Based on surveys and field studies. Available on-line:

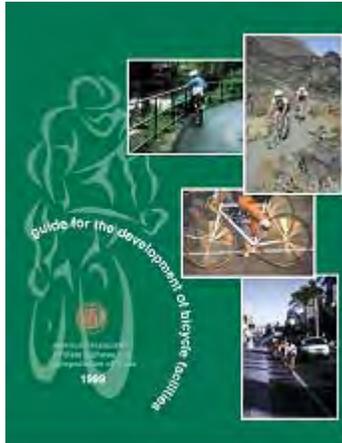
[http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp\\_rpt\\_562.pdf](http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_562.pdf)



Antonucci, N. D., et al., 2004, *Volume 12: A Guide for Reducing Collisions at Signalized Intersections*, Guidance for Implementation of the American Association of State Highway and Transportation Officials (AASHTO) Strategic Highway Safety Plan, NCHRP Report 500, Transportation Research Board, U.S. Department of Transportation.

This report describes types of strategies for reducing intersection collisions, including vehicle-pedestrian collisions. Includes relative implementation timeframes and cost estimates. Available on-line:

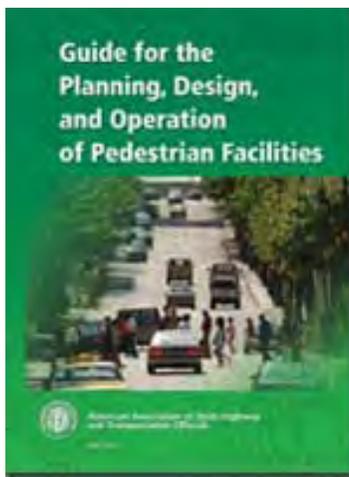
[http://onlinepubs.trb.org/Onlinepubs/nchrp/nchrp\\_rpt\\_500v12.pdf](http://onlinepubs.trb.org/Onlinepubs/nchrp/nchrp_rpt_500v12.pdf)



AASHTO, 1999, *Guide for the Development of Bicycle Facilities*, American Association of State Highway and Transportation Officials.

This guide contains suggested guidelines for bicycle facilities, including lane widths, turning lanes, intersections, shared use paths, pavement, lighting, and maintenance. Available on-line:

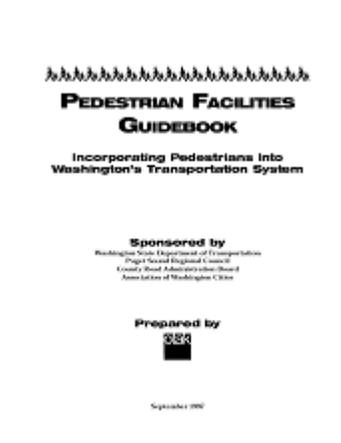
[http://www.sccrtc.org/bikes/AASHTO\\_1999\\_BikeBook.pdf](http://www.sccrtc.org/bikes/AASHTO_1999_BikeBook.pdf). The document is under revision with a new version expected in 2010.



AASHTO, 2004. *Guide for the Planning, Design, and Operation of Pedestrian Facilities*, American Association of State Highway and Transportation Officials.

This guide contains suggested guidelines and procedures for planning, designing, and operating pedestrian facilities, including pedestrian characteristics, planning strategies, sidewalk design, intersection design, midblock crossings, pedestrian signals, pedestrian signage, and maintenance of facilities.

<https://bookstore.transportation.org/home.aspx>



OTAK, 1997, *Pedestrian Facilities Guide*, prepared for Washington State Department of Transportation, September 1997.

This is a comprehensive guidebook to pedestrian facility design, including sidewalks, grades, curb ramps, traffic calming and control, and grade-separated crossings. Features helpful illustrations. Available on-line:

<http://www.wsdot.wa.gov/publications/manuals/fulltext/M0000/PedFacGB.pdf>



McMillan, B., et al., 1999, *Designing Sidewalks and Trails for Access Part I of II: Review of Existing Guidelines and Practices*, Federal Highway Administration, U.S. Department of Transportation.

This report presents a compilation of existing guidelines and recommendations for developing sidewalks and trails. Quantitative measurements of sidewalk and trail characteristics that affect accessibility are included as well. Available on-line:

<http://www.fhwa.dot.gov/environment/sidewalks/>



McMillan, B., et al., 2001, *Designing Sidewalks and Trails for Access Part II of II: Best Practices Design Guide*, Federal Highway Administration, U.S. Department of Transportation.

This guide outlines a comprehensive approach to creating accessible sidewalk networks, including planning, design, and maintenance. Includes chapters on pedestrian crossings, traffic calming, and construction site safety. Available on-line:

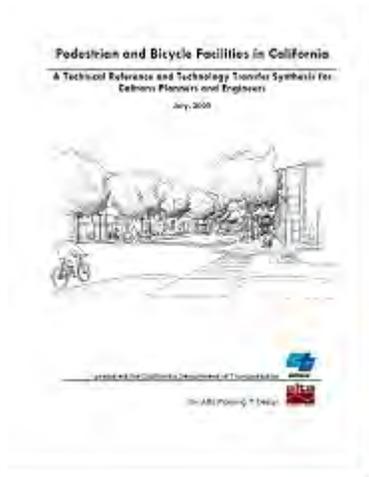
<http://www.fhwa.dot.gov/environment/sidewalk2/pdf.htm>

[No Image Available]

Revised Draft Guidelines for Accessible Public Rights of Way, 2005, United States Access Board.

The Draft PROWAG provides guidelines for providing pedestrian access to sidewalks and streets, crosswalks, curb ramps, street furnishings, pedestrian signals, parking, and other components of public rights-of-way.

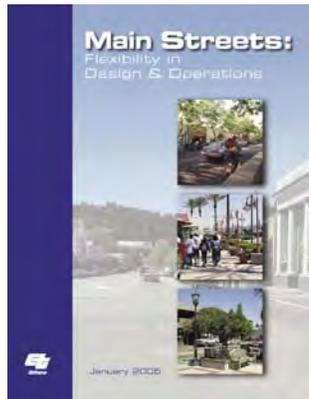
<http://www.access-board.gov/prowac/draft.htm>



California Department of Transportation, 2005, *Pedestrian and Bicycle Facilities in California: A Technical Reference and Technology Transfer Synthesis for Caltrans Planners and Engineers*.

This synthesis includes an exhaustive inventory of standard and innovative engineering and design treatments to benefit non-motorized users as well as background information on pedestrian and bicycle policy and funding sources.

[http://www.dot.ca.gov/hq/traffops/survey/pedestrian/TR\\_MAY0405.pdf](http://www.dot.ca.gov/hq/traffops/survey/pedestrian/TR_MAY0405.pdf)



California Department of Transportation, 2005 *Main Streets: Flexibility in Design and Operations*.

This report identifies Context Sensitive Solutions and Livable Community concepts that can assist communities and Caltrans in balancing community values with transportation concerns for safe and efficient operations for travelers, pedestrians, bicyclists, transit users, and highway workers.

<http://www.dot.ca.gov/hq/oppd/context/main-streets-flexibility-in-design.pdf>



# DESIGN CONCEPT



Gateways ■ Pathways ■ Connections ■ Destinations

# DESIGN CONCEPT

THIS DOCUMENT IS INTENDED TO ENVISION possibilities for an integrated open space and recreation network in the westside of Long Beach, connecting city to river. Based upon the issues and opportunities from the previous sections, this portion of the document will propose appropriate strategies to accomplish this vision. First will be a connectivity concept for the westside of Long Beach, integrating an existing transit system with proposed wayfinding devices to enhance the city image and connect the Los Angeles River greenway and associated parks to the cultural heritage of adjoining neighborhoods. Appropriate urban habitats will be re-created, and the urban forest will provide ecological and social benefits to the city. These natural and cultural resources are woven by the design team, into the westside of Long Beach connectivity concept and are expressed as gateways to mark entry in the RiverLink system, as pathways through the RiverLink system, as connections to transit and other pathways, and as destinations along the Los Angeles River.

The effort to connect city to river is most ambitious. There are myriad possibilities to conceptually connect these entities. The design team examined four preliminary conceptual strategies, described below as neighborhood patch, transit loop, river-centric, and eco-basin. Each presented creative opportunities for connecting city to river. Because of the complex nature of the all of the urban elements and systems in such a city as Long Beach, it was important to work out how to integrate the various parts in order to create a coherent system of river reconnection. The comparison and evaluation of each preliminary concept aided in the process of determining the final RiverLink concept.

The following criteria were established from the project goals and objectives to guide the design team in selecting the concept or combination of concepts, which would best relate to the issues of the westside of Long Beach:

- Create and enhance connections from the city to the river
- Enhance outdoor recreational opportunities
- Promote the adaptive reuse of existing sites and infrastructure
- Create and enhance connections between neighborhoods
- Encourage pedestrian and human-powered means of transportation
- Enhance the urban forest along streets and within sites
- Create connections between people and the natural and physical environments

## PRELIMINARY CONCEPTS

### Neighborhood Patch

The first concept considered, the neighborhood patch, linked the individual districts of the westside of Long Beach by enhancing the local street connections between adjacent neighborhoods. Because residents describe Long Beach as a “city of neighborhoods,” emphasis of the individual neighborhoods was a priority of the RiverLink project. Thus, movement to the river greenway is segmented, going from one neighborhood to another, taking advantage of local shopping nodes and neighborhood parks along the way.

### Transit Loop

The second concept considered, the transit loop, took full advantage of the existing mass transit network in Long Beach, encouraging a systematic movement through the westside of Long Beach. Emphasized transit nodes would allow people to board a bus or train from most major streets and follow that system directly to the river greenway.

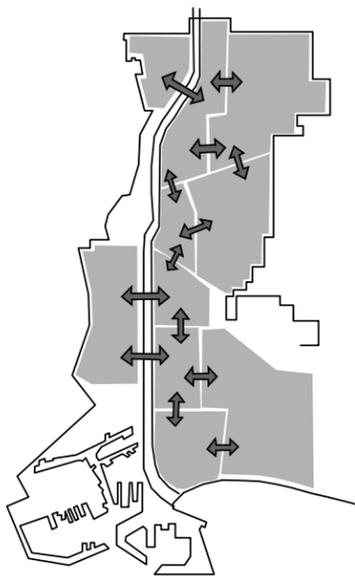
### River-Centric

The third concept, river-centric, emphasized the Los Angeles River as a major spine of movement in the westside of Long Beach. Pedestrian and bicycle travel would converge on access points along the river then move north or south within the system.

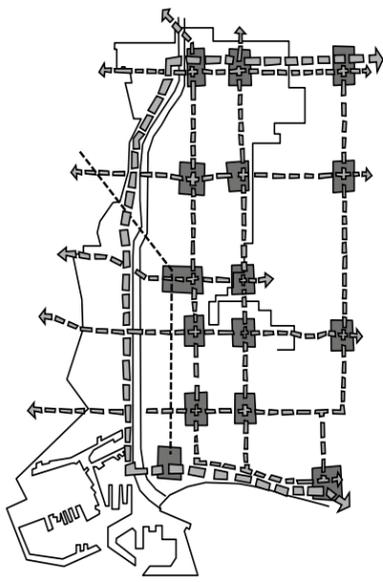
### Eco-Basins

The eco-basins concept focused on the natural river valley as the area of opportunity. Movement into the system begins on the watershed ridgelines and follows the flow of water towards the Los Angeles River.

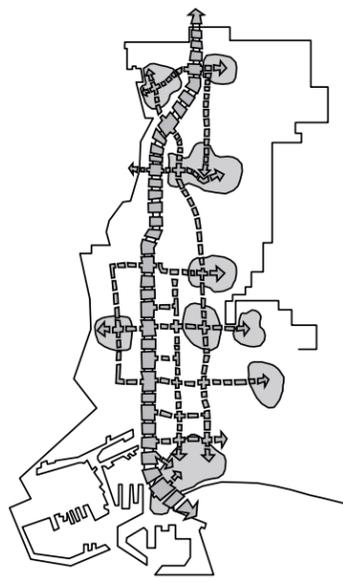
The four connectivity concepts overlaid with greater emphasis placed on the river-centric concept and the eco-basins concept related best to the project vision and goals, suggesting that features from each be combined into a composite concept. This combination of a concept lead to the development for the RiverLink concept.



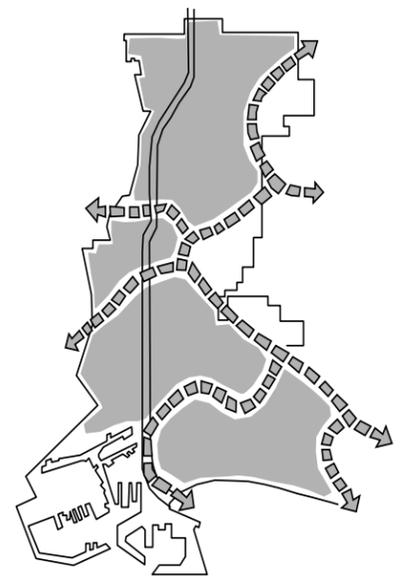
Neighborhood Patch



Transit Loop

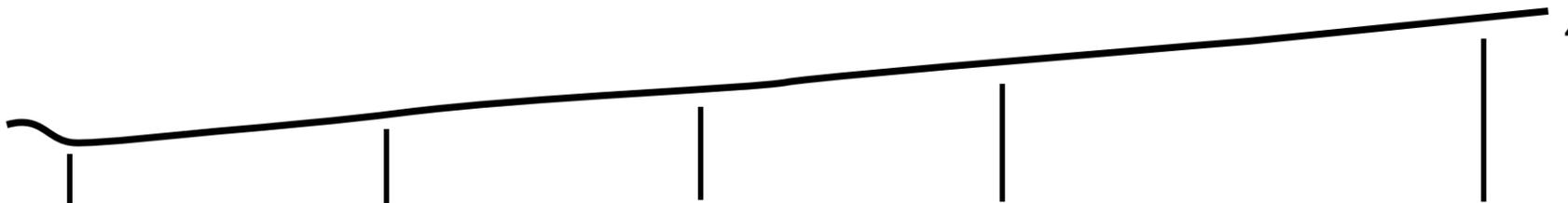


River-Centric



Eco-basin

Preliminary Concepts



**Destination**

**Pathway**

**Connection**

**Pathway**

**Gateway**

Major open space attractions of the system

Directs movement through the system

Exists where transit networks intersect

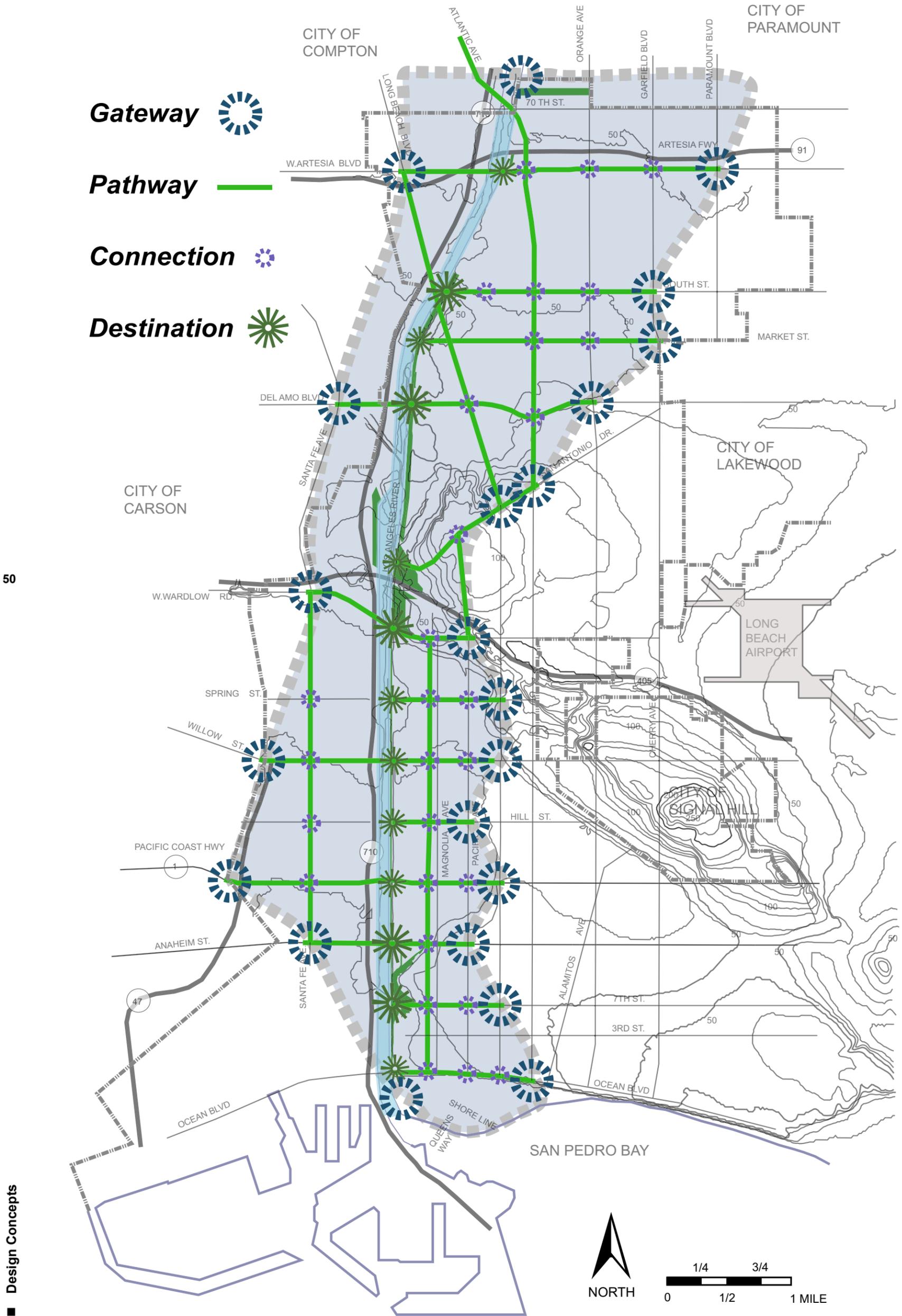
Directs movement through the system

Announces entry into the system and marks watershed boundaries

RiverLink System Diagram "Kit of Parts"

# WESTSIDE OF LONG BEACH RIVERLINK SYSTEM

SOURCE: BASE MATERIALS PROVIDED BY CITY OF LONG BEACH, CA



# RIVERLINK CONCEPT

**THE RIVERLINK CONCEPT DESIGNATES** A system of *gateways*, *pathways*, *connections*, and *destinations* directing visitors through the westside of Long Beach and to the Los Angeles River greenway. As with the eco-basin concept, the RiverLink system is defined by watershed ridgelines that reveal the hydrologic importance of the river. The river is the central feature of this concept and a major travel spine, augmented by a web of interconnected roads and pathways to assist movement throughout the rest of the westside of Long Beach.

As part of RiverLink's interwoven system of gateways, pathways, connections and destinations, the gateways announce entry into the RiverLink System and are located along the watershed ridgelines where they intersect with major streets. There are also gateways at the north and south ends of the Long Beach reach of the Los Angeles River. The RiverLink gateways are of major significance because they denote the entry into the Riverlink system and guide movement from the neighborhoods to designated routes that access the Los Angeles River greenway. The gateways into the greenway designate where the river connects to Long Beach, to adjacent cities in the north, and to San Pedro Bay Estuary in the south.

Pathways are the streets and routes that direct people and vehicles throughout the westside of Long Beach to the river greenway. The pathway designation begins along the street at the gateway and continues along the street to a connection or to the river destination, and then ultimately to a gateway on the other bank of the river. A unifying theme will distinguish pathways from other local streets as major river access routes. Along with connections, the RiverLink pathways assist and enhance the connectivity from the neighborhoods to destinations such as downtown Long Beach and the Los Angeles River, by providing safe, universally accessible routes.

Connections exist along the pathways at the intersections where, at minimum, two transit networks meet, either pedestrian, bicycle, and/or vehicular, and particularly at mass transit stops or stations. This allows easy access to the RiverLink system from the rest of the city and surrounding areas.

Destinations are the places of interest within the RiverLink system. The system will focus on the destinations of parks and open spaces along the river, which create the terminating points of pathways. Destinations are the major attraction of the system and can evolve as potential additional open space becomes available and as the needs of Long Beach change. Furthermore, they will add to the city's goal of eight acres of park

and open space for every 1,000 residents. Destinations are also microcosms of the entire system, with each having its own individual system of gateways, pathways, connections and destinations within its boundaries. This entire system relates to a modular 'kit of parts', assembled piece by piece to connect city to river and move people across the westside of Long Beach. Each individual part can function alone, which will allow the system to function even if some parts are not implemented or as additional properties are acquired.

## Built Environment of the RiverLink System

These guidelines will be used to design amenities based on scale:

- Emulate architectural and cultural styles for buildings and structures
- Use architectural and cultural elements for benches, lighting, and water fountains
- Use architectural and cultural motifs on signage and displays, etc.

## Color Selection

- Derive color from materials and tastes of the period architecture
- Use natural colors found within the foliage and structure of the native historic vegetation
- Make colors slightly darker than landscape precedents, as they will fade in the intense sunlight (dark colors also look lighter in bright sun) (USDA, 2001)
- Use light to moderate earth tones such as browns, dark greens gray-greens, light grays, olive, sage, tans, terra cotta, and ochre
- Avoid reflective colors (USDA, 2001)
- Use color as an accent in decorative elements such as clay tiles, mosaics, and in door and window frames (USDA, 2001)

## Materials

- Use materials that are solar-and wind-exposure resistant
- Select materials that require minimal maintenance and are vandal resistant
- Use stone bases for structural columns and similar elements (USDA, 2001)
- Use stained wood siding rather than painted wood (USDA, 2001)
- Select materials with natural colors or fin-

ishes that require no painting or staining

- Use steel, brushed aluminum, or other durable alloy materials to reduce maintenance and as alternative to wood on exposed structural elements
- Use materials to repel and disperse heat
- Use decomposed granite to match surrounding earth tones for pathways (USDA, 2001)
- Use stone pavers or concrete pathways for higher foot traffic areas
- Avoid reflective materials that create glare (USDA, 2001)
- Use locally produced material whether possible (USDA, 2001)

#### Plant Selection and Landform Design

- Consider wildlife habitat and forage potential when selecting vegetation
- Emulate historic patterns and groupings
- Plant trees to favor the west side of structures for shading
- Landscape with native and adapted plants to reduce resource and maintenance inputs.
- Grade landforms to direct water runoff to landscaping

#### Siting and Structure Placement

- Place at nodes that correspond to the urban grid
- Place at areas of historical or cultural significance
- Place appropriate to use and cadence of streetscapes and transportation system
- Choose sites based on shading possibilities
- Avoid riparian areas for structure placement—direct people to the water with trails while protecting such zones from foot traffic
- Buffer parking from buildings to keep buildings cool (USDA, 2001)
- Orient amenities and structures to provide shelter from the sun and wind
- Site structures to minimize western solar gain

#### Structural Elements

- Derive from vernacular architecture details and/or the color or structure of historic natural vegetation

- Use traditional courtyards to provide shade (USDA, 2001)

- Keep facility structures more horizontal than vertical (USDA, 2001)

- Use hipped and double pitched roofs on facilities structures (USDA, 2001)

- Recycle existing site buildings and materials whenever practical and safe

- Include larger overhangs for shade

- Include verandas and porches for shade

- Locate design details at focal points and at interpretive signage

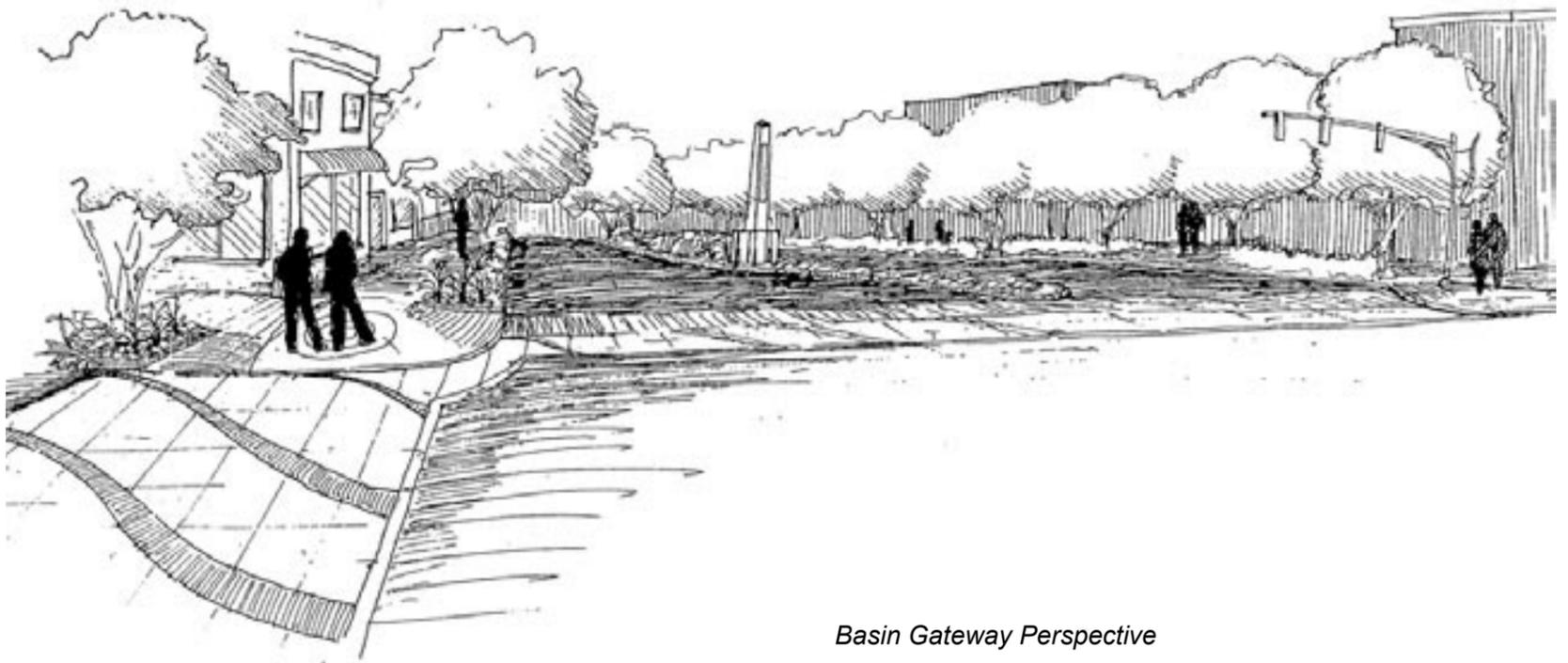
The RiverLink concept for connecting the westside of Long Beach allows for all types of movement, from human-powered to vehicular. Above all, it will promote inter-modal transit use, allowing a visitor to take his or her bike with them on the train or bus, get off at the designated connection, bike or walk along that marked pathway, and arrive at the destination park along the Los Angeles River. The built environment thematic design guidelines will provide a framework to design the physical features of the RiverLink system so they will fit in with the cultural and ecological character of adjacent neighborhoods. Thus, this concept will connect city to river, and will link people to the cultural and ecological heritage of the westside of Long Beach.

## GATEWAYS

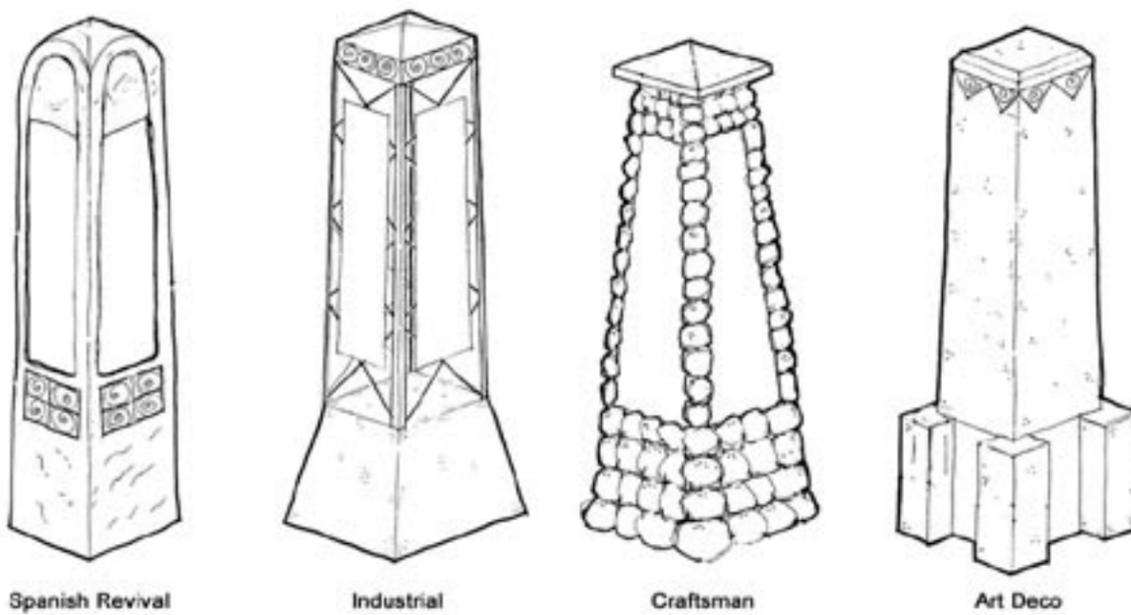
As described before, gateways are those points where a visitor begins the journey along a pathway towards a connection and/or destination. The Los Angeles River is the central feature of the RiverLink concept, which currently exists in Long Beach only as a concrete or rip-rap channel, with much of its natural hydrologic and geographic features distorted or lost to the infrastructure of urbanization. There are no significant entrance points into the river system, making it difficult for residents and visitors to recognize where they can enter the system. The RiverLink system attempts to reflect the natural river channel as defined by watershed topography.

*Design Response:* To signify entry into the RiverLink system, gateways will be placed throughout the system to denote the beginning of the pathways and other significant points. The Drake Greenbelt will have the most significant gateway, based on scale, to signify a major connection between downtown Long Beach and the river greenway.

A river gateway at the Golden Shore Wetlands will signify the beginning of the Los Angeles River and the southern end on the Long Beach reach, creating



*Basin Gateway Perspective*



Spanish Revival

Industrial

Craftsman

Art Deco

*RiverLink Basin Gateways*

a transition between the Los Angeles River and the San Pedro Bay. Another gateway will be placed on the channel berm just north of the potential Edison Yards site, just inside the borderline, to denote the northern end of Long Beach's reach of the Los Angeles River. These will resemble scaled-down versions of the RiverLink Gateway Monument located in Drake Greenbelt and will promote a continuation of the greenway system north along the Los Angeles River channel.

Monumental gateways will be created where pathways meet with the watershed ridgeline, denoting entrance into the RiverLink system. Gateways along the ridgeline will have a typical design; however the detailing of each gateway will match the thematic design guidelines appropriate for that neighborhood.

The design of the RiverLink gateways will assist residents and visitors in locating pathways that lead to the river greenway. They will be significant features of the neighborhoods in which they are located, and, through their associated landscaping treatments, will reveal the natural character of the westside of Long Beach that once existed.

## PATHWAYS

RiverLink pathways are the framework of the system. They facilitate free movement in and around the neighborhoods and toward the river greenway. The following criteria were established from the project goals and objectives to guide the design team in the successful design of the RiverLink pathways.

- Optimize transit connections by denoting existing bus stops.
- Encourage walking and bicycling by providing safe comfortable travel lanes.
- Optimize the urban forest by increasing the number of canopy trees and understory shrubs along the street edge.
- Enhance pedestrian safety by separating pedestrian traffic from vehicular traffic along the street.

- Provide amenity zones along the street for stopping and resting.
- Enhance wayfinding through signage, planting, and streetscape details.

By following these criteria, the design team was able to build a framework of approach for streetscape design and the unifying elements within the pathway system.

Based on the street classification and adjacent land use, functions and objectives are developed for each type of street. A major component of streetscape design is the use of street trees, which will constitute the urban forest. Along commercial or retail stretches, street trees are the most significant design element affecting shoppers. Trees ease the heat, glare, pollution, and dust from the roadway, while enhancing the aesthetic conditions along the street. The data below shows the air quality benefits of enhancing the urban forest along major streets.

Formal use of street trees is used to create rhythm and dynamism, visually denoting the RiverLink pathways leading into the river system. Typical design elements and materials, based on street classification, are discussed below.

## MAJOR ARTERIALS

### Typical Design Example: Anaheim Street

Major arterials are the spines of the city and carry the heavy crosstown traffic. Typically, these streets have two lanes of traffic each way separated by a planted median, and parallel parking lanes along the 8' to 10' sidewalks. Medians consist typically of sparsely planted

eucalyptus (*Eucalyptus sp.*) and queen palms (*Syagrus romanzoffiana*), neither of which provide adequate shade, wildlife habitat, or aesthetic definition to the street.

*Design Response:* The major constraint of streetscape design is that there is no apparent room to squeeze desired amenities into the existing infrastructure. The city has proposed in its redevelopment plans to relocate parallel parking from along major arterials to alleys behind the commercial lots where parking is needed. This creates an additional space on both sides of the roadway. The travel lanes are narrowed to minimum-allowed dimensions and the median is also reduced in size. The extra space is added to the sidewalks, creating a multiuse path and landscape lane that will separate the pedestrians from roadway traffic. A Class III bike route designation is given to the roadway because the streetscape improvements do not allow room for a striped lane. The multiuse path is primarily for pedestrians; however, it will be given a "Share-the-Path" designation allowing for slow-moving, localized bicycle traffic. The design team recognizes that commuter bicyclists may choose to use the roadway to avoid slower pedestrian travel, and local bike traffic may use the sidewalk regardless of posted signs, so the Share-the-Path designation provides a creative response to conflicting uses along the street. The landscape lane will provide amenities such as seating, trash and recycling receptacles, and map kiosks in areas along the pathway. These amenities will be spaced according to the commercial activity along the street. Plantings within the median and landscape lanes will gradually change based on the approximate historical vegetation patterns across the westside of Long Beach. This will create aesthetically pleasing, low water, low maintenance groupings of plants, bringing life back to the streets.

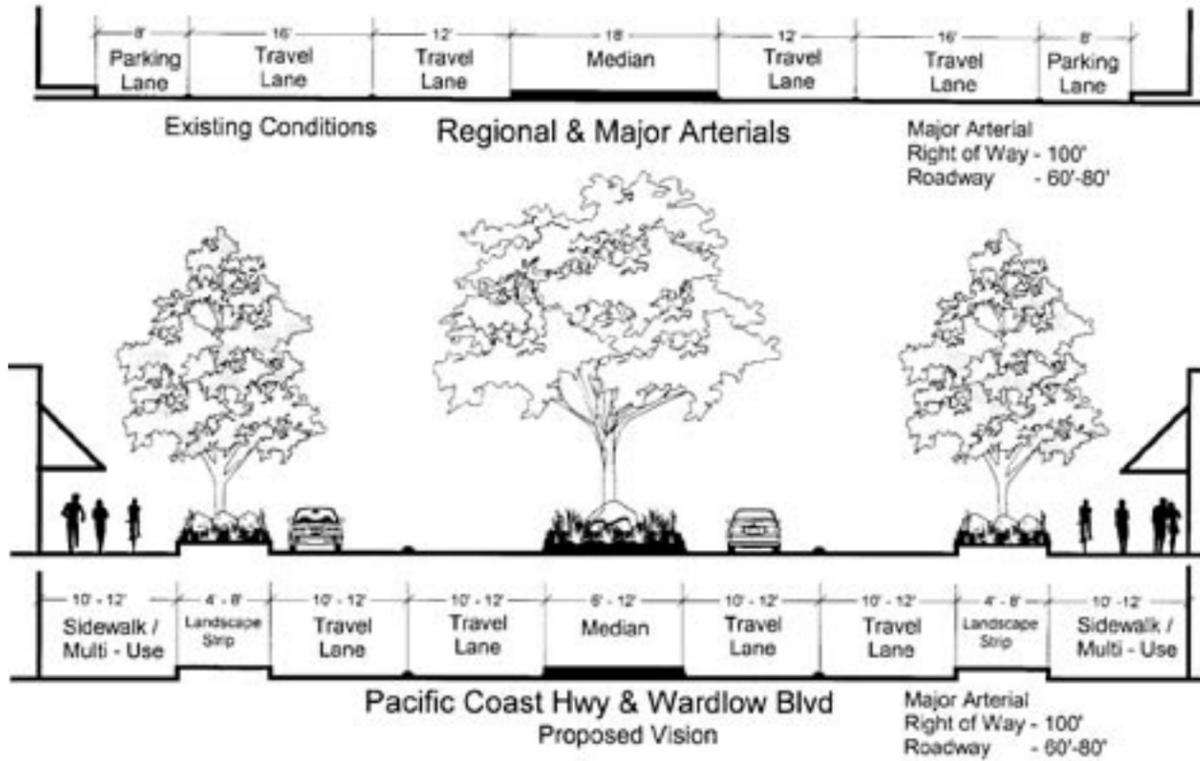
### Carbon Storage and Pollution Removal Data for Street Trees

Proposed Planting on Anaheim St. between Los Angeles River channel and Pacific Ave.

	Tree Count	Avg. DBH (in)	Carbon Storage (tons)	Carbon Sequestration (tons/year)	Ozone (O3) (lbs)	Sulphur dioxide (SO2) (lbs)	Nitrogen dioxide (NO2) (lbs)	PM10 (lbs)	Carbon monoxide (CO) (lbs)
<b>1st Year Planting</b>	132	5.00	7.98	0.18	8.00	2.70	4.20	7.40	0.90
<b>10 Year Growth</b>	132	10.00	26.79	0.60	26.60	8.90	13.80	24.70	3.00
<b>30 Year Growth</b>	132	19.00	90.21	0.16	65.40	21.90	33.90	60.70	7.20
<b>50 Year Growth</b>	132	29.00	117.12	0.20	85.00	28.50	44.00	78.80	9.40

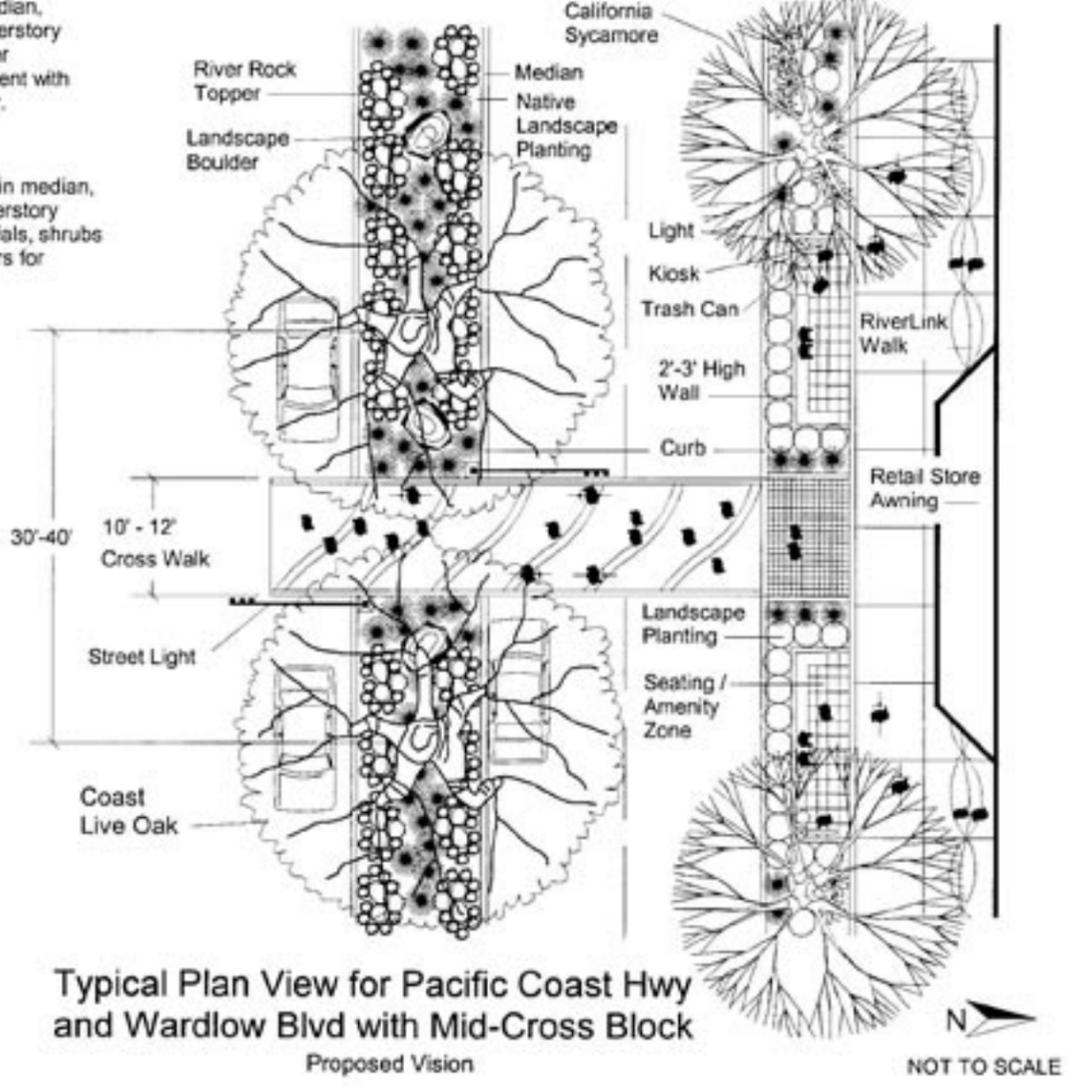
DBH = trunk diameter at breast height

PM10 = Particulate matter 10 microns or less in size

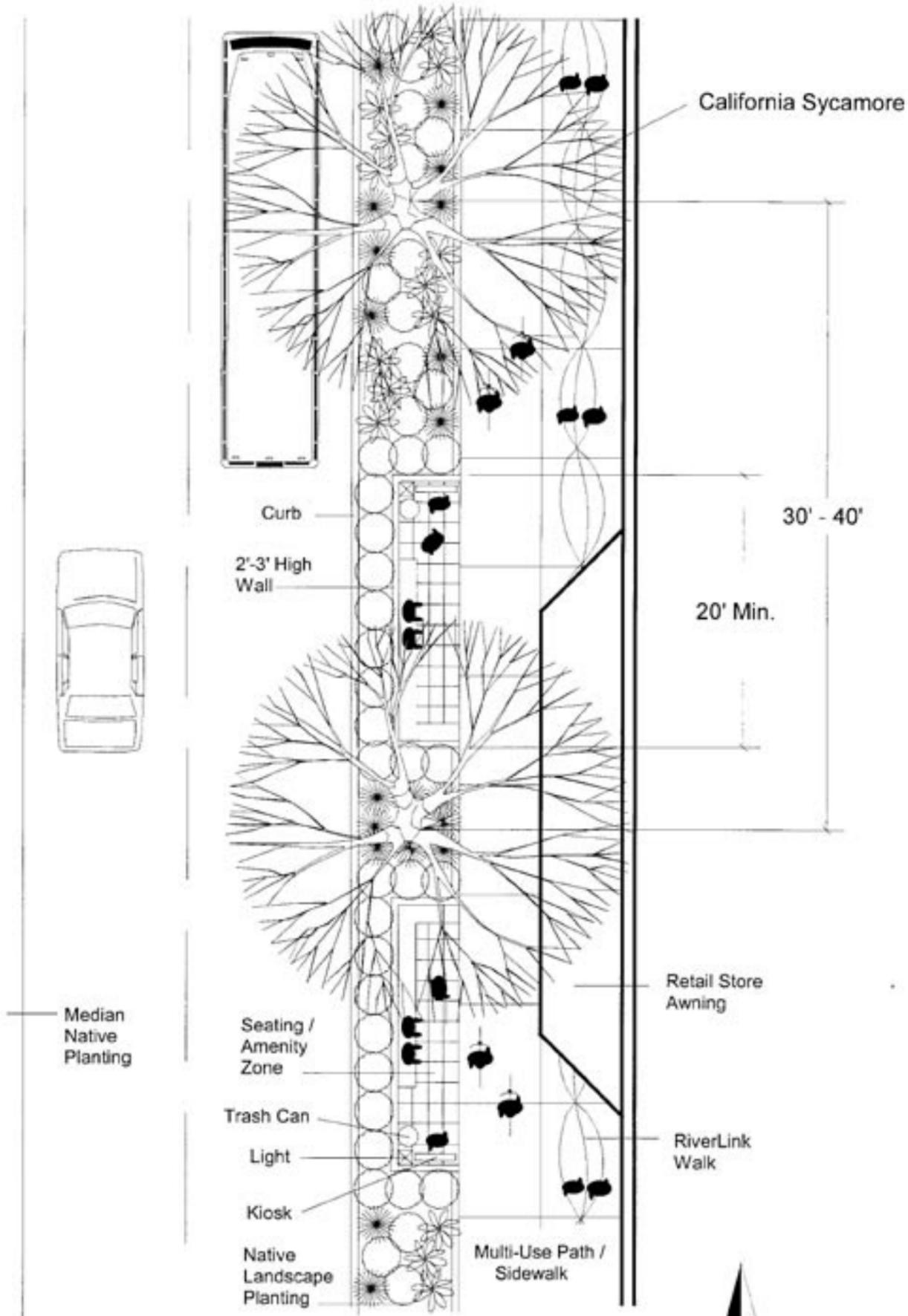


**Note:**  
Oak trees in median, plant native understory grasses and river boulders for accent with river rock topper.

**Note:**  
Sycamore trees in median, plant native understory grasses, perennials, shrubs and river boulders for accent.



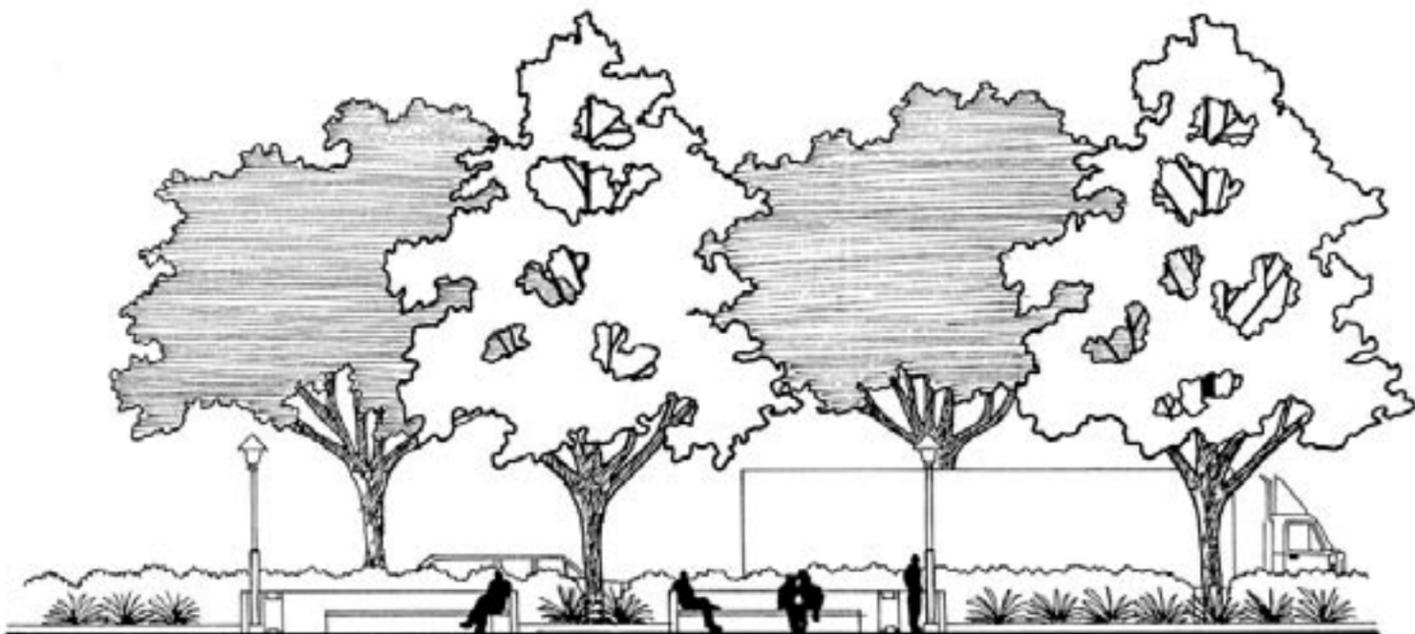
Regional or Major Arterial Streetscape Design



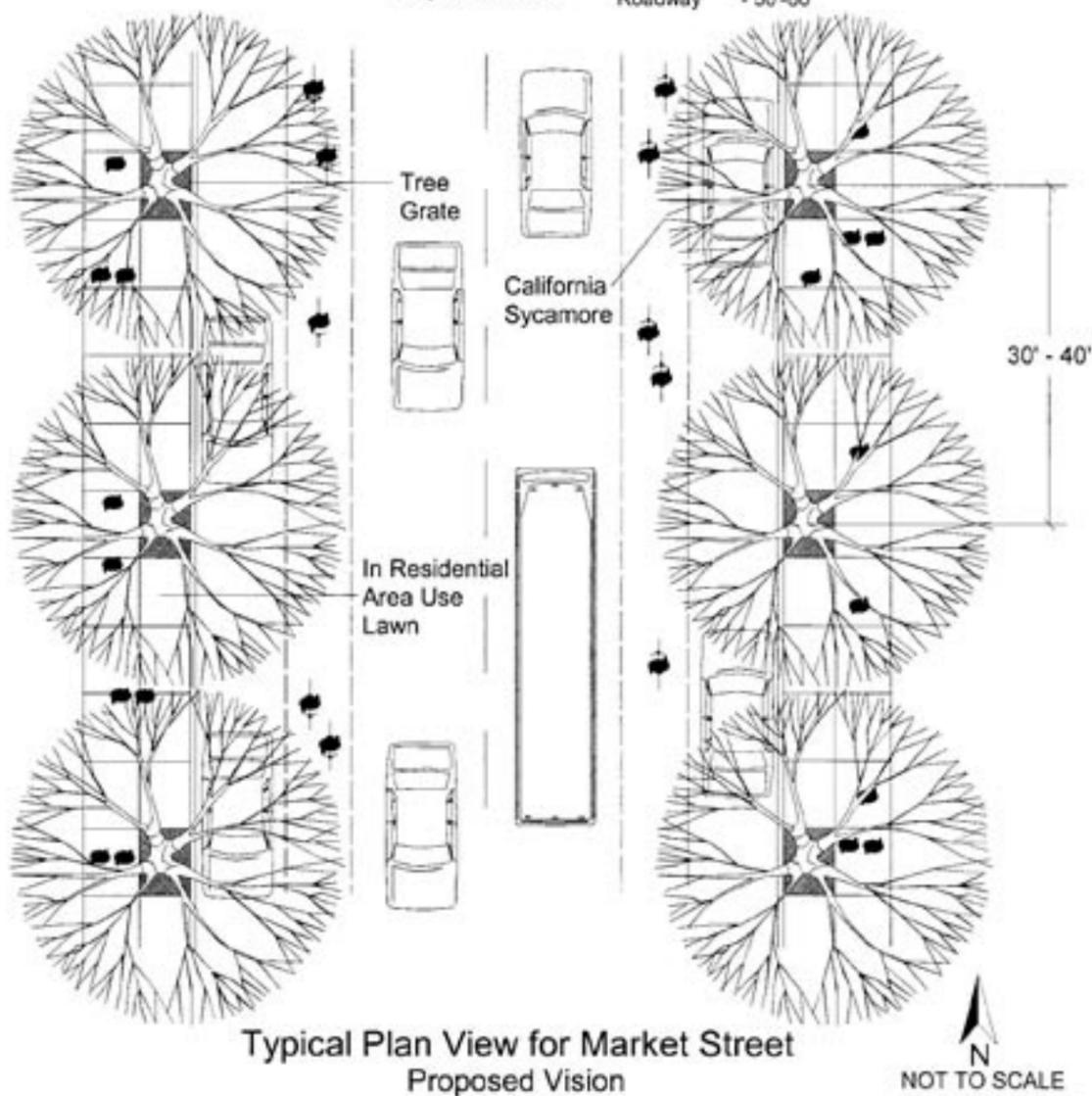
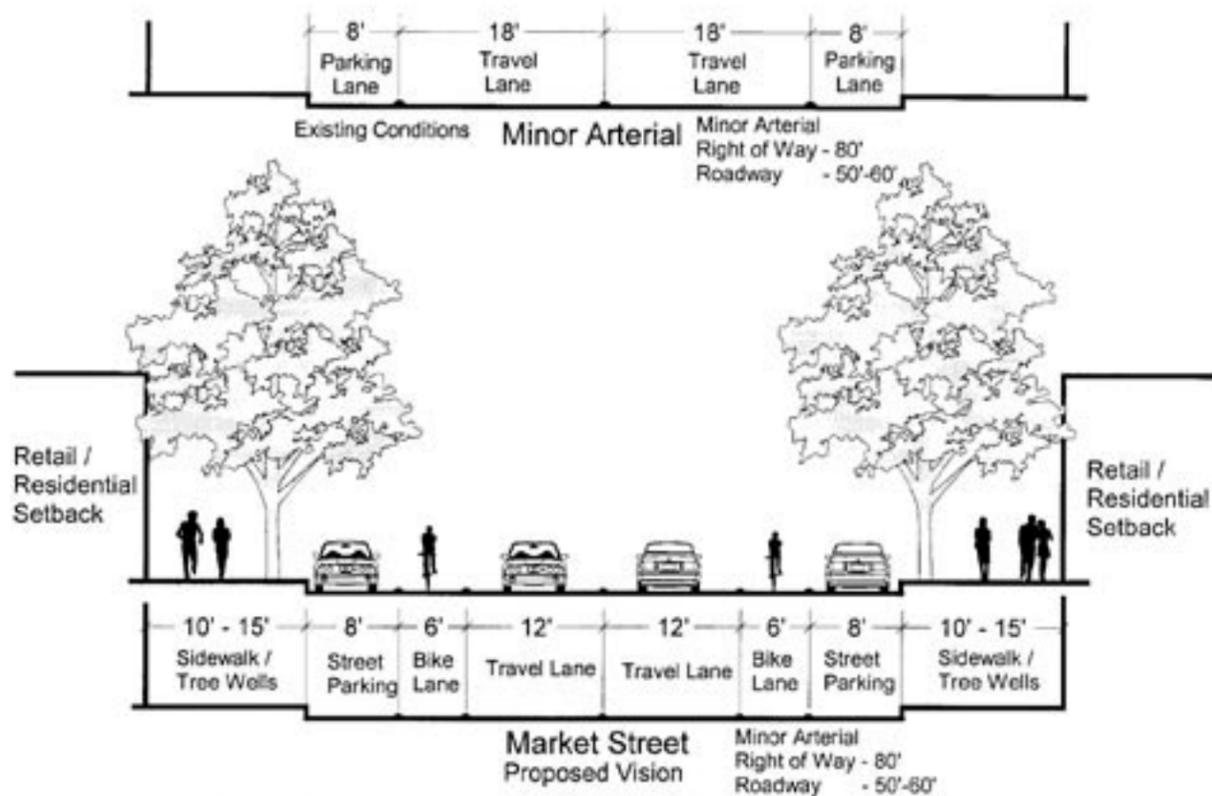
Typical Plan for Amenity Zones  
Proposed Vision



*Regional or Major Arterial Amenity Zone*



*Typical Amenity Zone Elevation*



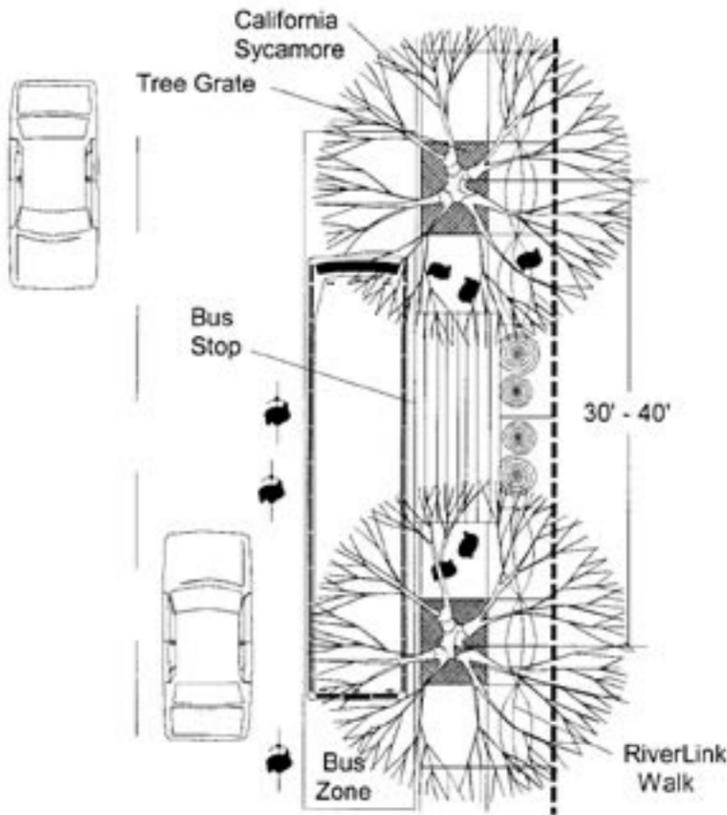
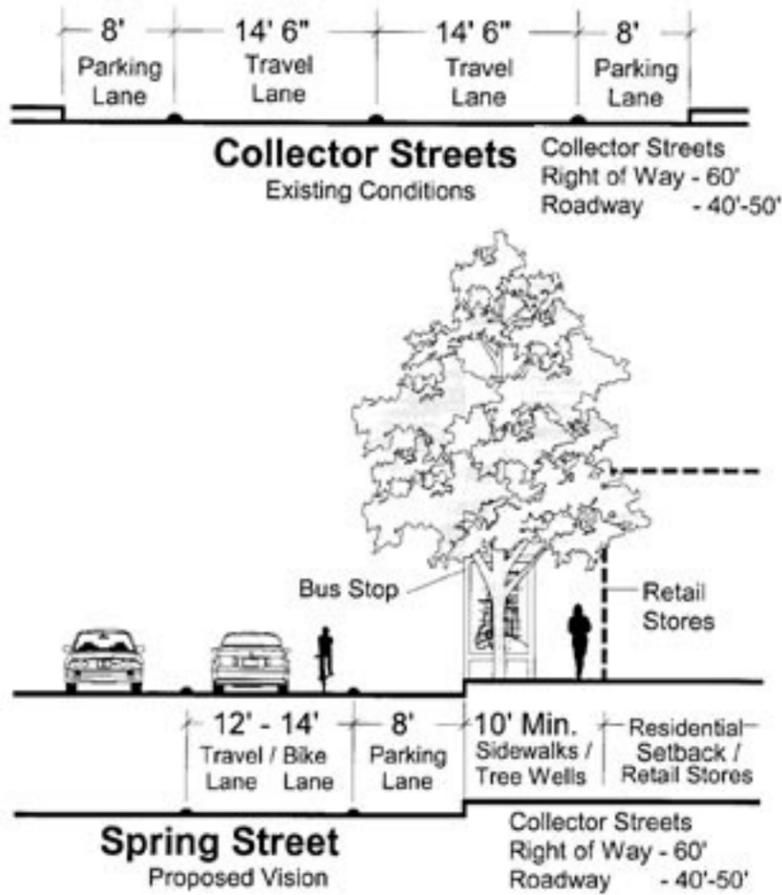
Minor Arterial Streetscape Design

## MINOR ARTERIALS

### Typical Design Example: Market Street

Like major arterials, minor arterials carry cross-town traffic, but they have less traffic volume. Typically in the westside of Long Beach, minor arterials have one wide lane of traffic going each way, with a parking lane abutting the curb. These streets do not have medians, and are lined with light industry, retail development, or residential homes. The sidewalks are generally 10' to 15' wide.

*Design Response:* Minor arterials have less traffic volume so the parallel parking is retained along the streets to serve as the major divide between pedestrians on the sidewalks and motorists. The travel lanes are narrowed to facilitate a Class II bike lane. The on-street parking does not allow for plantings along the curb except for evenly spaced trees in wells at least five feet minimum diameter. Tree grates used in the sidewalk will be ADA compliant with a smooth surface and slats perpendicular to traffic flow.



Typical Spring Street Plan with Bus Stop  
Proposed Vision NOT TO SCALE

Collector Streetscape Design

**COLLECTOR STREET**  
**Typical Design Example: Spring Street**

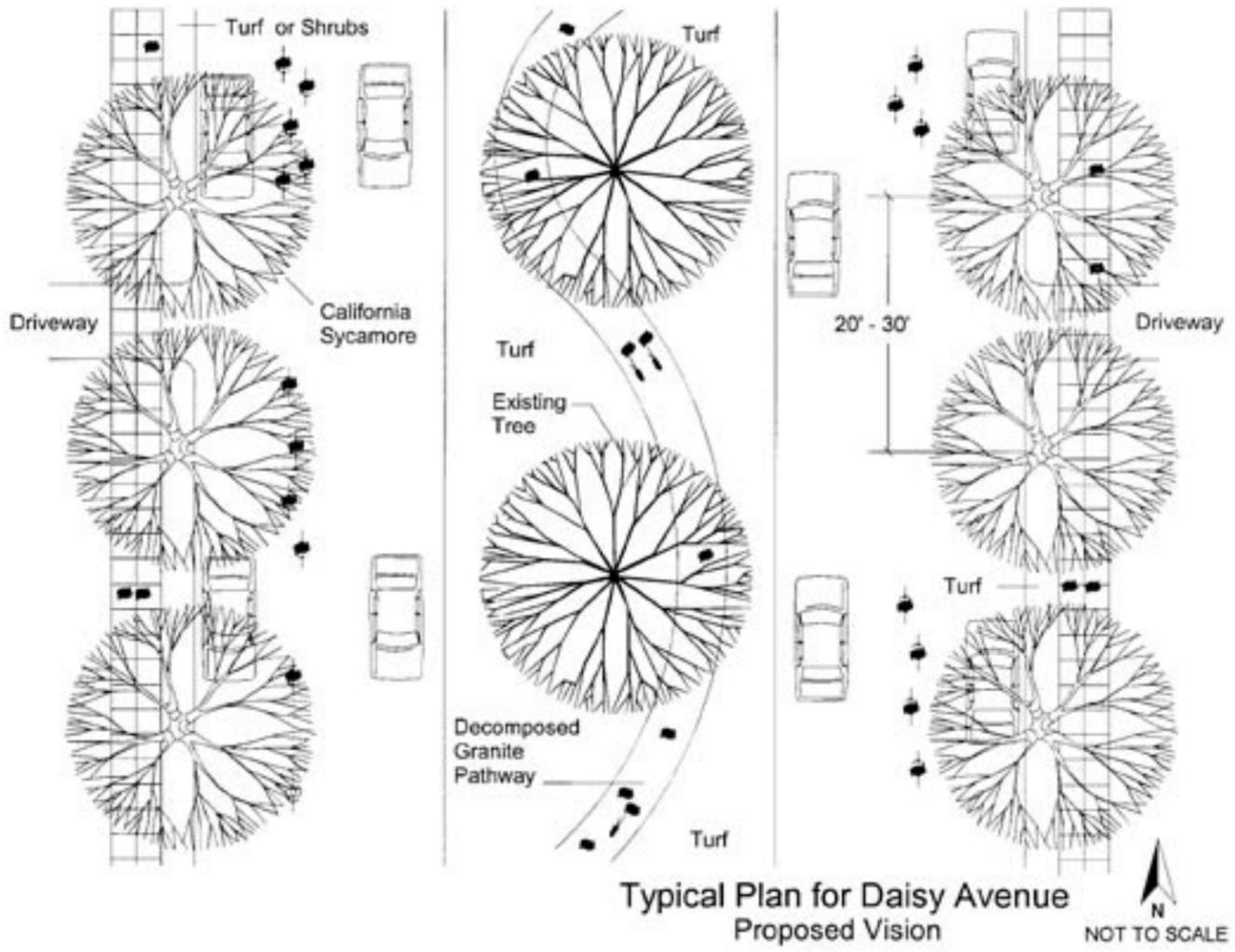
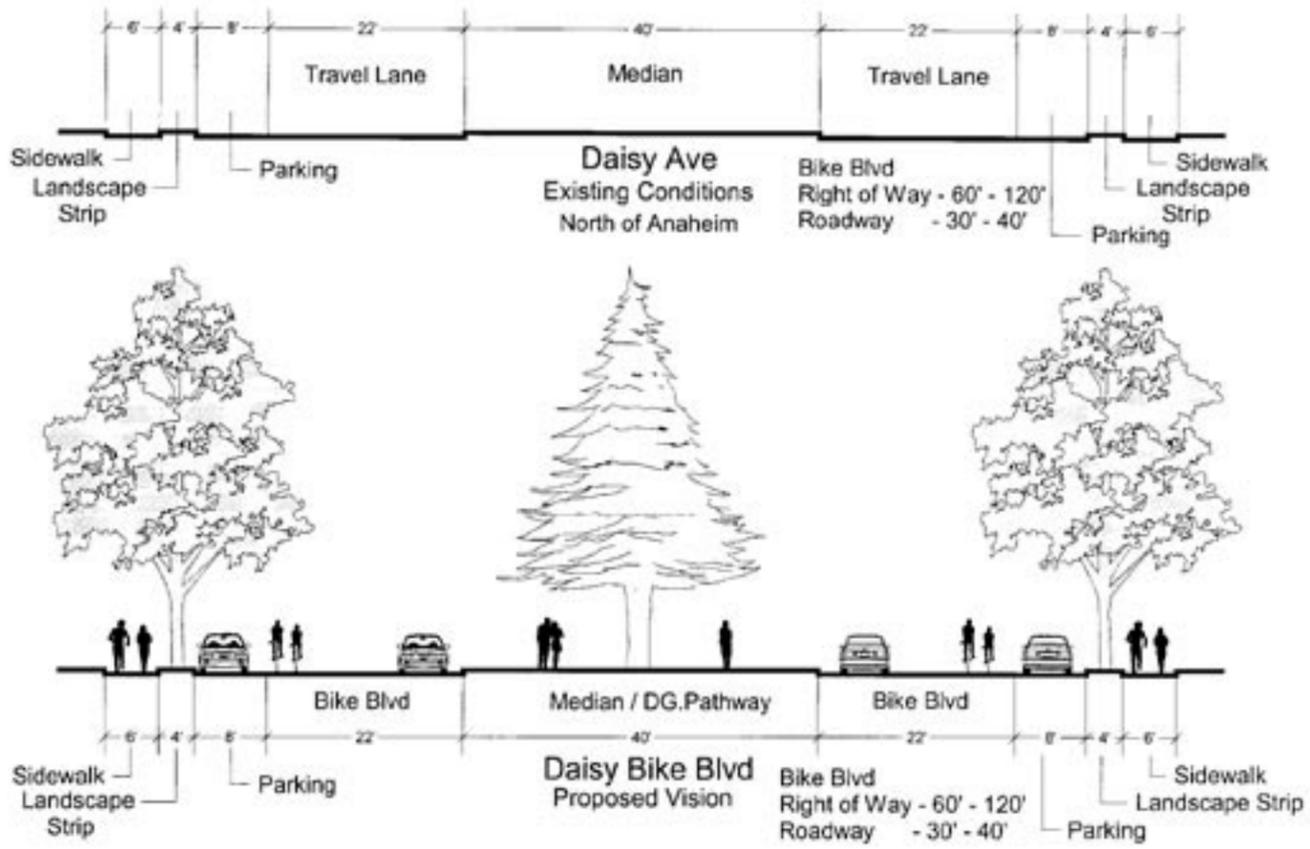
Collector streets pick up traffic from local neighborhoods and direct it to larger arterial streets. Typically, collector streets are lined with residential homes and some light commercial or retail development. As with the minor arterials, they have one lane of traffic in each direction and parking lanes along the curb.

*Design Response:* Along commercial and retail reaches, collector streetscape design mimics that of minor arterials. Parking will give way for bus stops where appropriate. Residential reaches are different in that they have narrower sidewalks and utilize tree lawns instead of tree wells and grates. Because there is less on-street parking in residential areas, tree lawns are planted with low maintenance shrubs and groundcovers, selected by city personnel and adjacent homeowners.

**PARKWAY:**  
**Typical Design Example: Daisy Avenue**

Parkways are local streets specially designed with park-like features. The RiverLink system does not designate local streets as connecting pathways because the design team does not want to increase traffic volumes along them. However, Daisy Avenue presents a unique opportunity to provide a valuable north/south bicycle connection. Portions of Daisy Avenue are designed as parkways with wide medians that can stage community events. The medians are flanked by one-way streets, and fronted with residential homes.

*Design Response:* Daisy Avenue is designated a bicycle boulevard to encourage and promote safe bicycle travel. Bicycle traffic on the street is greatly encouraged by assigning bicycles the right-of-way and restricting vehicles on the street to local traffic only. The landscaped median provides parkland for community members and rest spots for bike commuters. The median will retain most of the existing turf because of its value as a staging area for cultural events such as the Christmas Pageant. A pedestrian path weaves through the median and understory shrubs, and grasses will be planted under trees and at appropriate locations along the path.



*Parkway Streetscape Design*

## MEDIAN PLANTINGS

The median plantings use native trees, related plants, and stone spreads to denote inclusion in the RiverLink system and to show distance to the Los Angeles River greenway.

Each type of median planting has a specific grouping of understory shrubs or grasses that relates to an indicator tree, based on historical occurrence. They are inspired by the historic streambeds that once flowed freely to the Los Angeles River; instead of moving water to the Los Angeles River, they move people. There are three different types of median plantings to help orient and guide visitors along their way. The entire length of the east-west pathway streets and their associated medians will be divided into

approximate thirds and planted in the following manner. Tree specimen selection must be appropriate for use as urban street trees.

The following is the sequence of plantings starting at the gateways and moving towards the river:

1. After passing through a basin gateway connection, the medians in this section are planted with coast live oak trees (*Quercus agrifolia*), California coffeeberry (*Rhamnus californica*), and deer grass (*Muhlenbergia rigens*). Large granite boulders punctuate the plantings in these sections.
2. The median plantings midway through are planted with sycamore trees (*Planatnus sp.*), coyote bush (*Baccharis pilularis 'twin peaks #2'*), California encelia (*Encelia californica*),



**Alder Zone Plant Material**  
 Tree: White alder  
 Shrubs: Wild California rose, Black sage  
 Grass: common rush  
 Accent with spread decomposed granite

**Sycamore Zone Plant Material**  
 Tree: California Sycamore  
 Shrubs: Coyote bush, California encelia  
 Grass: Wild rye grass  
 Accented with river rock

**Oak Zone Plant Material**  
 Tree: Coast Live Oak  
 Shrub: California Coffeeberry  
 Grass: Deer Grass  
 Accented with large granite boulders

RiverLink Median Plantings Diagram



Oak Woodlands Median Streetscape

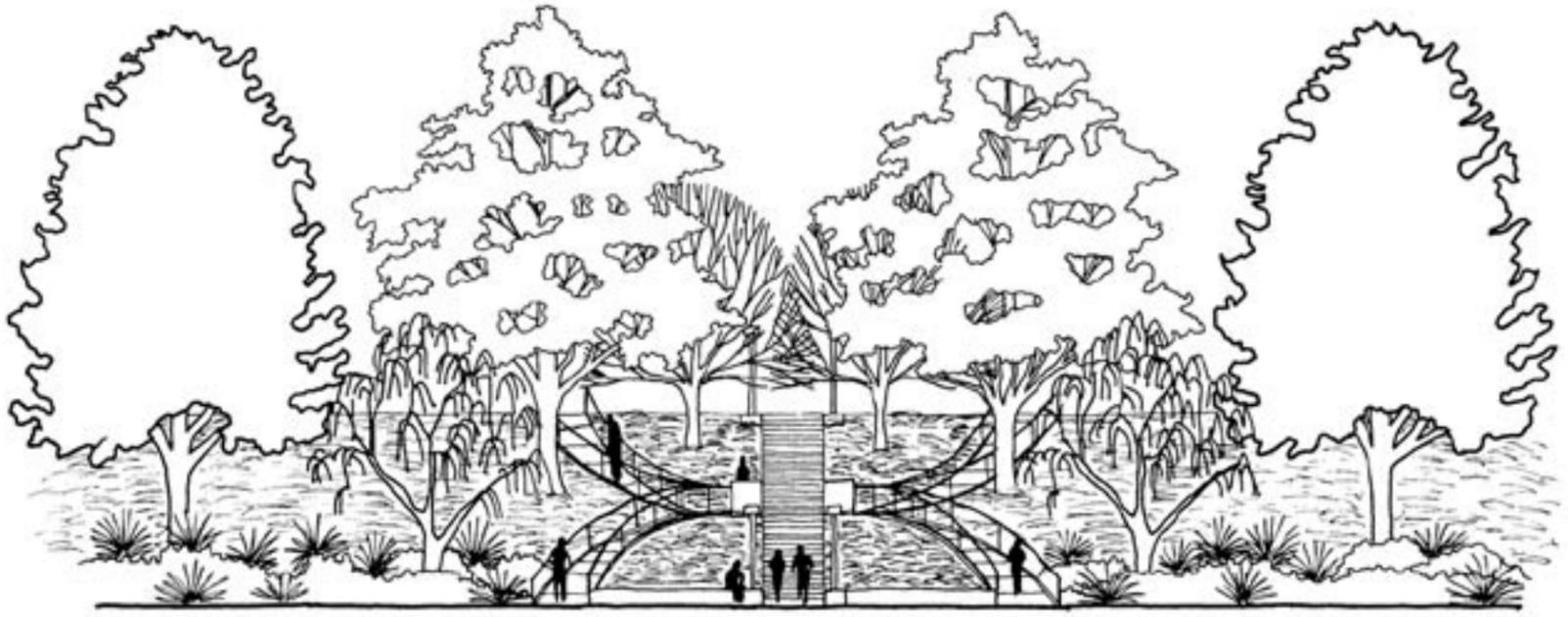


Sycamore Forest Median Streetscape



Cottonwood Grove

Alder Woodlands Median Streetscape  
 (Adapted from Lyle, 1999)



Typical Universal Access

and wild rye grass (*Elymus condensatus* 'canyon prince'). These medians are accented with river rock.

3. The medians located in the final third closest to the river are planted with white alder trees (*Alnus rhombifolia*), wild California rose (*Rosa californica*), black sage (*Salvia mellifera*), and common rush (*Juncus patens*). These medians are spread with decomposed granite.

4. At certain streets, namely at Willow Street, and to a lesser extent at Pacific Coast Highway, there are small pocket parks next to or straddling the eastside of the Los Angeles River bridges before entering into the RiverLink system. To aid travelers, residents, and area workers, the design team envisions picnic areas near the current sidewalks, with shady seating under cottonwood trees (*Populus fremontii*). There is also an opportunity for a picnic grove at Market Street just before entering the RiverLink system.

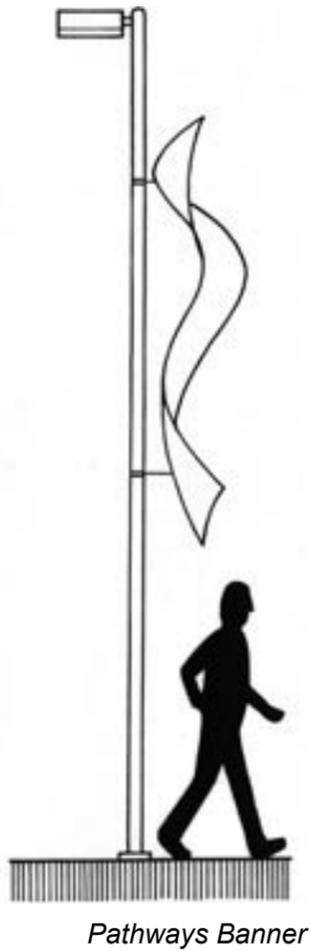
## LOS ANGELES RIVER GREENWAY

There are sections of the Los Angeles River greenway where abutting properties do not allow for parkland development, and thus, will not serve as destinations, but rather as pathways and connections. Typically, these areas have a landscape treatment on the down slope of the berm ending at the toe of the slope where the greenway meets the adjoining.

*Design Response:* The major concern in these areas is to provide a consistent landscape treatment along the river channel, creating pleasant pathways between the destinations. The typical landscape treatment, consisting of native plant species historically shown to have existed in the vicinity of Long Beach, can be applied anywhere along the river channel where there is no adjacent park site or greenbelt.



View of Spring Street Looking Toward River Channel



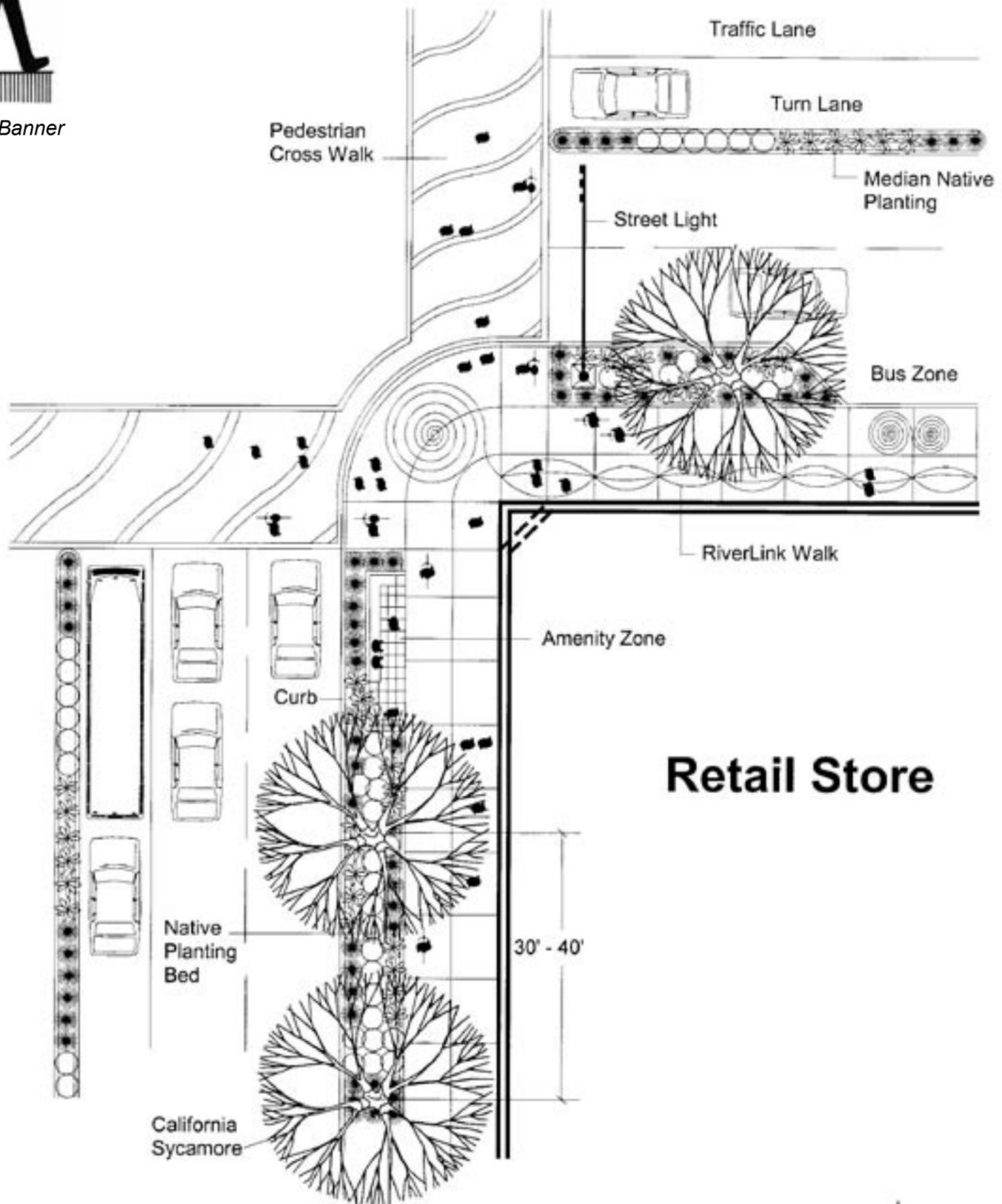
Pathways Banner

### Wayfinding

Wayfinding signs will visually orient visitors to the river greenway. There will be two types of wayfinding devices; large monolithic landmarks, and smaller map kiosks. The large landmark devices, visible from great distances, orient visitors as to where they are along the river greenway. These structures capture peoples' sightlines as they move along the river, drawing them toward destinations. The map kiosks assist in navigating around specific sites and parks. The top of the

map will always be oriented in the same direction as the reader to minimize disorientation, and simple internationally recognized symbols will be used when possible to denote amenities. Both wayfinding devices have a standard design concept, yet the elements of each will relate to thematic design guidelines.

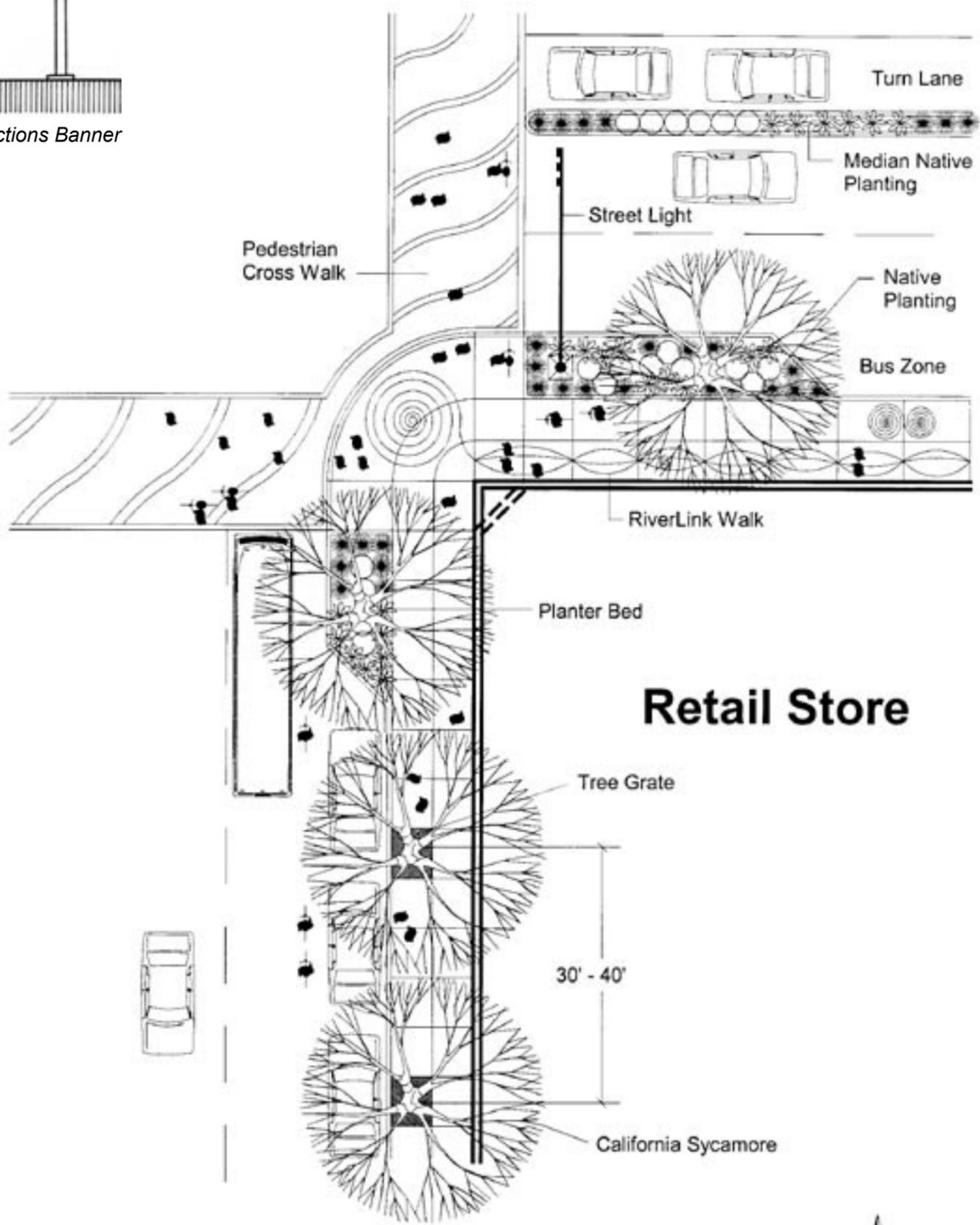
Directional signage is used to direct visitors towards streets accessing the Los Angeles River, directional signs should be clear and easily read from the pedestrian level as well as from an



Typical Plan View for Artesia Blvd and Atlantic Ave Street Intersection

Proposed Vision





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Typical Plan View for Anaheim Street and Magnolia Ave Intersection  
 Typical Plan View for Willow Street and Chestnut Ave Intersection NOT TO SCALE  
 Minor Arterial Streetscape Elements of Connections



automobile. They should have a standard look throughout RiverLink system in Long Beach.

Unifying design elements will be placed along the pathways to create a consistent image leading to the Los Angeles River. This will assist in wayfinding and navigation because people will instantly recognize which streets connect to the river greenway.

To signify pathways, imprints of the “RiverLink Walk” pattern will be imprinted onto the corresponding street sidewalk in the RiverLink system to signify the flow or direction to the river. Vertical elements, such as light poles with a RiverLink flow banner will help denote the way to Los Angeles River destinations. The design team recommends a standard streetlight design for the pathways, which will aesthetically connect people to the RiverLink system. The lighting fixtures will be designed to be energy efficient and will direct light downward to reduce glare into the night sky.

## CONNECTIONS

Connections are the elements of the system that link together pathways. Connections occur where existing transit routes intersect RiverLink pathways, whether pedestrian, bicycle, or vehicular, with particular attention given to mass transit stops or stations. These places signify areas of momentary collection before providing connection to the continuing system and the ultimate destination.

*Design Response:* To signify connections, imprints of swirls or eddies are stamped at corresponding areas in the RiverLink system. These will be placed at the foot of transit stops or entries into transit stations, and on the corners of the connection streets. In addition, a light pole with a swirl banner, as a vertical element, will denote points where connections occur.



*View of Golden Shore Wetlands with Bird Blind Overlooks and Los Angeles River Gateway*

# DESTINATIONS

Destinations are the centers of activity in the RiverLink system and are at the terminus of the pathways, providing valuable open space and parks along the Los Angeles River. Entrance and regulatory signs inform visitors of entrance points to the river greenway, as well as park rules and regulations. RiverLink entry signage to parks, greenways, and bikeways will take the place of those signs outlined in the Los Angeles River Master Plan. The signs may take a sculptural or artistic form, derived from the thematic design guidelines appropriate for those neighborhoods adjacent to the park site.

Beginning at the mouth of the river and working north, the destinations are: the Golden Shore Wetlands, the Drake Greenbelt, Magnolia Yards, the Wrigley Greenbelt, Wrigley Heights Park, the Dominguez Gap Wetlands, the Deforest Wetlands, and Deforest Park.

## Golden Shore Wetlands

The Golden Shore Wetlands are located near the mouth of the Los Angeles River along the east bank. These estuary wetlands were recently restored and are the first park attraction along the Los Angeles River greenway.

*Design Response:* Monitoring by professional wetlands restoration experts will continue on this site. The design team was not privy to the final plans for the site, nor to the progress of the restoration efforts to this point, but recommends a concept to augment the site that includes several elements appearing throughout the RiverLink system. The design team suggests the chain link fence be removed, and that signage be installed to mark entry, post park regulations, assist in wayfinding, and interpretation of the wetlands. The concept features RiverLink-style “overlook” bird-blinds and bird nesting structures that allow visitors to view the waterfowl and that provide for interpretive signage, while maintaining a physical and visual separation between people and the sensitive wildlife. Native landscape treatments with seating provide areas of shaded respite. A gateway signifies the beginning of the Los Angeles River just north of the site at the LARIO Bikeway.

Interpretive signs will educate visitors about the Golden Shore Wetlands. The RiverLink interpretive signs will take the place of the standard interpretive signs outlined by the Los Angeles River Master Plan, so that a more integral directional system can be achieved. These signs will tell about the physical, natural, and cultural history of the Los Angeles River and Golden Shore Wetlands. Interpretive signage will take on thematic design elements appropriate to adjacent neighborhoods.

## Drake Greenbelt

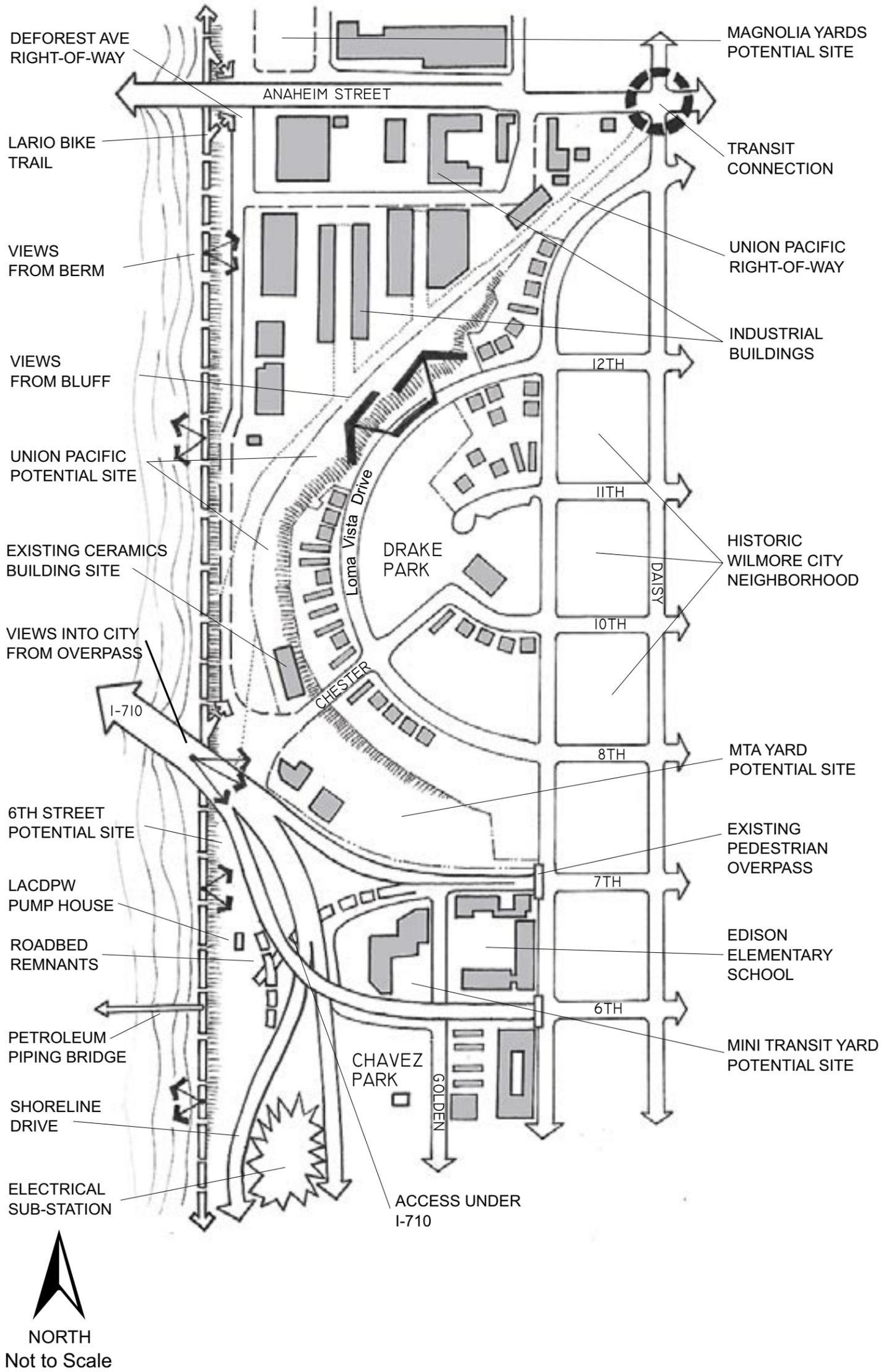
The Drake Greenbelt is a series of postindustrial sites adjacent to the existing Drake Park that will require linkages into the community and reclamation efforts by the City of Long Beach.

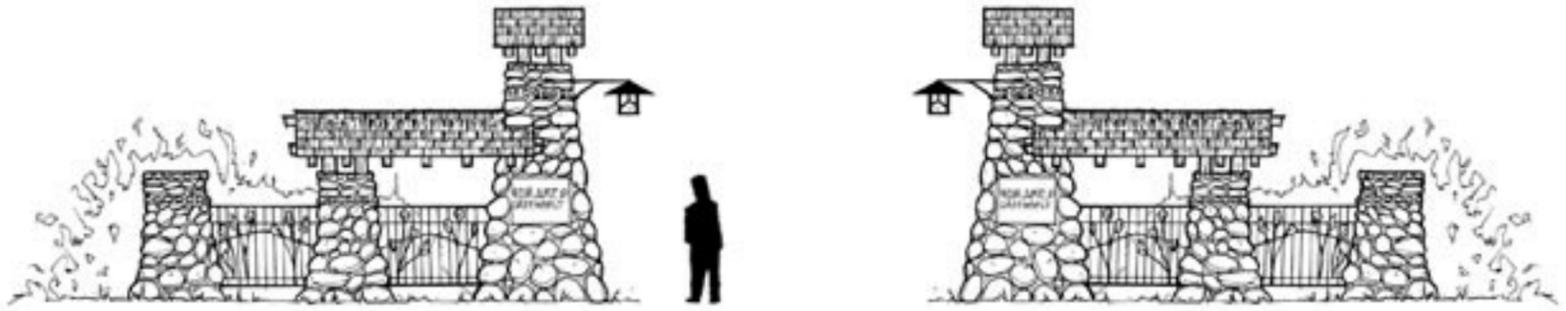
The site is approximately 32 acres, consisting of former Union Pacific Railroad properties and right-of-ways that stretch from Daisy Avenue southwest to the river channel. Much of this land has oil and heavy metal contamination. Views from Loma Vista Drive look out over the railroad property and into the southern end of Magnolia Yards. An existing ceramics warehouse sits adjacent to Chester Place and two MTA buildings are located across the street in the MTA Yards, which is contaminated with hydrocarbons and petrochemicals. Across the freeway, the MTA also owns a small parcel for mini-bus transit. This parcel has potential to be acquired as part of the Drake Greenbelt. West of the Mini-Transit buildings is a parcel of bare ground adjacent to the river channel which includes an LACDPW pump house and remnants of road construction that was never completed. Additionally, nesting sites for the federally threatened snowy plover (*Charadrius alexandrinus nivosus*) have been recorded on this bare site. Phytoremediation processes are recommended by the design team to assist in the reclamation of the site. It is important to note that the city will not purchase any of these properties until they receive a letter of “No Further Action” regarding the contamination cleanup.

Based on the project goals and community input, the following program was developed for the Drake Greenbelt:

- **Passive Recreation:** The community specifically asked for more passive recreational opportunities, such as walking trails, unprogrammed open spaces, and public forum spaces for informal gatherings. Active recreation was seen as too loud and disruptive to the environment.
- **Eco-Revelatory Design:** This site will include educational opportunities and interpretive signage showcasing the ecological systems acting on the site over time. This can be coordinated with local schools and community groups to encourage environmental learning.
- **Community-Building:** Areas will be incorporated that encourage activities to bring the community together. This fosters community strength and ownership in neighborhood parks; communities then work together to solve local issues.
- **Protection of threatened species habitat:** The Drake Greenbelt will preserve appropriate habitat areas for threatened species such as the snowy plover.

# Drake Greenbelt Site Analysis





*Drake Greenbelt Gateway at Anaheim Street and Daisy Avenue*

The following criteria were established from the project goals and objectives to guide the design team in the successful design of the Drake Greenbelt.

- Create connections to surrounding neighborhoods by connecting to existing sidewalks and pedestrian paths and linking to the bicycle network.

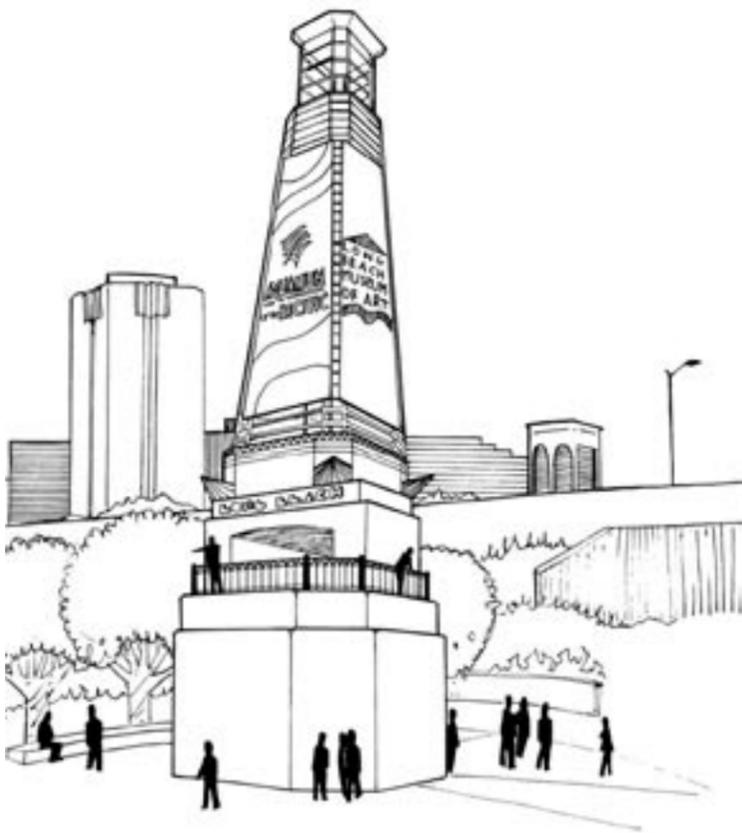
and by providing interpretive signage for those features.

The Drake Greenbelt amenities will have a Craftsman amenity style response due to its proximity to the Willmore City historic neighborhood, with its predominance of Craftsman- and Bungalow-style homes. Additionally, this will also match the recent erection of the Craftsman-styled recreation center in nearby Cesar Chavez Park, just south of the site.

### Gateways

Gateways into the Drake Greenbelt will display thematic designs of the Craftsman style and will be placed at the entry points on Chester Avenue, Deforest Avenue, Seventh Street, and at the intersection of Anaheim Street and Daisy Avenue. The gateway at Anaheim Street and Daisy Avenue is of major significance because it is a major transit connection in the RiverLink system.

Located between the terminus of Chester Place and the LARIO Bikeway is the RiverLink Gateway Plaza, which signifies the heart of entry from the city into the RiverLink system. At the south end of the plaza, rising over the park and visible from the freeway, is the Gateway Plaza Monument, designed and scaled to represent Long Beach's maritime, Art Deco and industrial influences combined with the prominent high-rise buildings of the downtown. The monument is intended to have large vertical panels in four directions to allow for changeable lithographic billboard style signage advertising city events like upcoming conventions, and attractions like the Aquarium of the Pacific and Long Beach Museum of Art exhibits. A beacon light on the apex will mark the city's place in the night sky and will be visible from the mountains to the sea.



*RiverLink Gateway Monument*

- Enhance educational opportunities by providing interpretive signage and outdoor classrooms for school use.
- Encourage the creative reuse of existing infrastructure by programming adaptable uses for renovated buildings.
- Encourage walking and bicycling by connecting to the proposed bicycle network and by providing safe paths wide enough to accommodate bikes and pedestrians.
- Optimize the urban forest with groupings of native trees and understory shrubs.
- Provide passive recreational opportunities, which will create a relaxing atmosphere in the park.
- Enhance community-building activities by creating spaces for activities such as performances or gardening.
- Enhance connections to the natural and physical environments by re-creating natural landscape features onsite, such as wetlands,

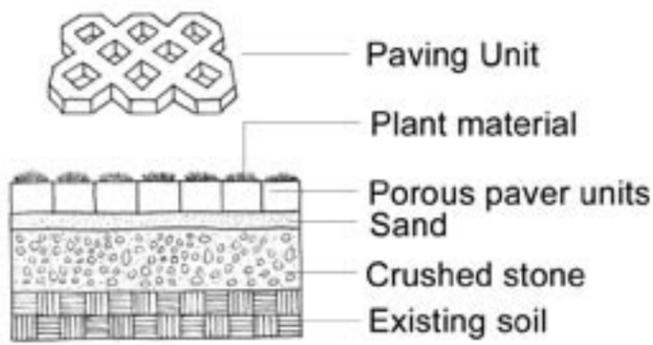
### Pathways

Pathways throughout the Drake Greenbelt will allow universal access and will direct visitors towards destinations with wayfinding devices such as landmark features and directional signage.

- Movement through the Greenbelt will be directed along paths that provide universal access to all. Pathways will be of two different widths: the main spine, 12-15 ft wide, allowing pedestrians and bicycles; and smaller paths, 8-10 ft wide for pedestrian-only travel. All paths have a maximum slope of less than 5%. The main spine will connect all the major features of the site and provide access to the LARIO Bikeway.

# Drake Greenbelt Site Plan





Permeable pavers offers specific and distinct advantages for controlling water runoff. Reinforced pavers can provide a highly durable, yet permeable grassy pavement surface capable of supporting vehicular loads, well suited for parking lots.

*Permeable Paving Detail*

- Wayfinding devices along the pathways will direct the visitor to different amenities associated with the greenbelt. To minimize disorientation, the top of the map kiosks will always face the same direction as the reader. Landmark features will denote special points of interest, will be visible from far distances, and will give visual clues about the relative location of amenities.

**Connections**

The community and the greenbelt are connected through culture and nature. This allows the site to reflect community changes over time.

**Cultural Connections**

- Pedestrian travel is promoted by creating connections to the existing Drake Park. Towards the north of the site, Loma Vista Drive will be split, creating two cul-de-sacs. Between the cul-de-sacs, ramped pathways connect the existing park on the upper part of the ridge with the new greenbelt below. This allows for free flow between the two parks so that

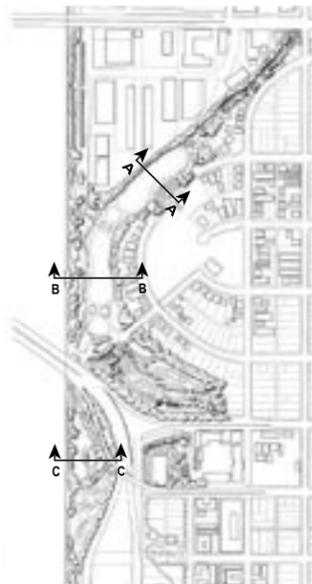
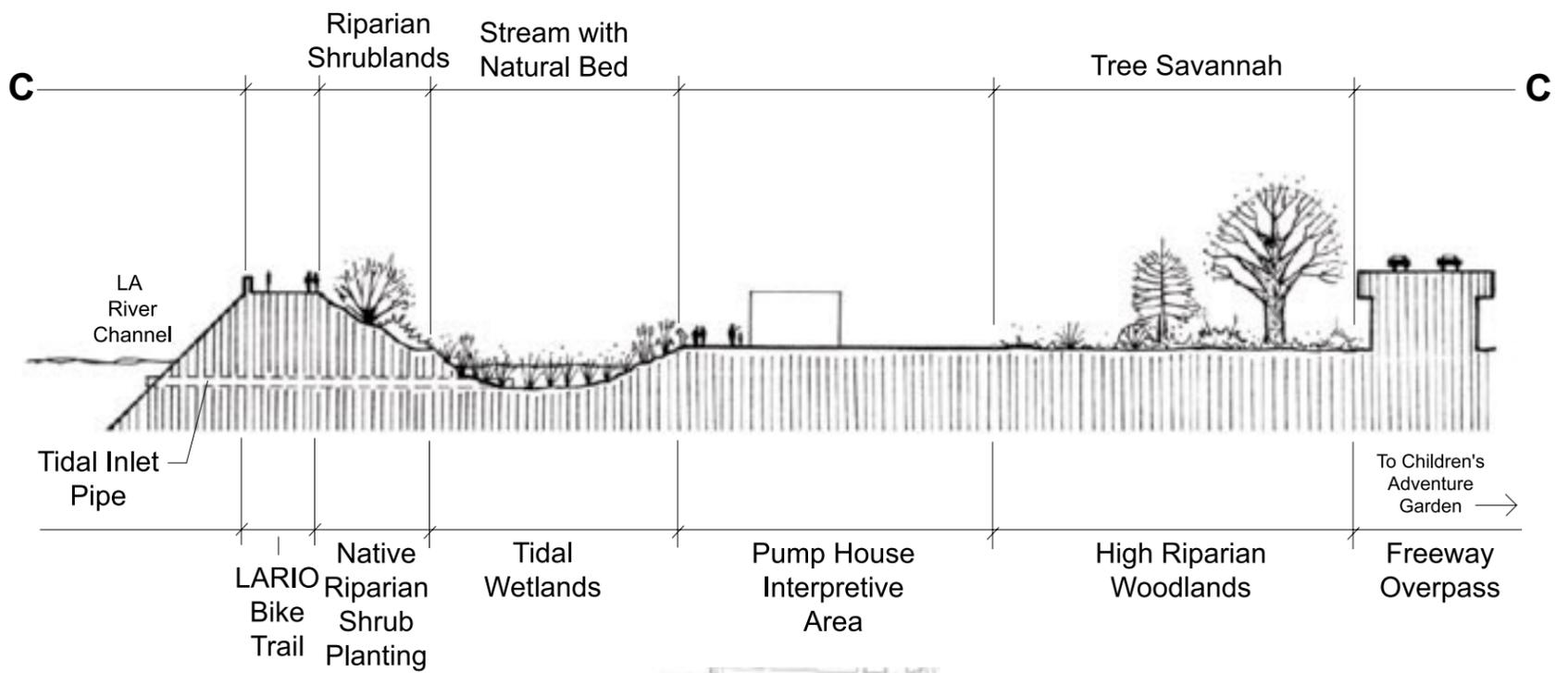
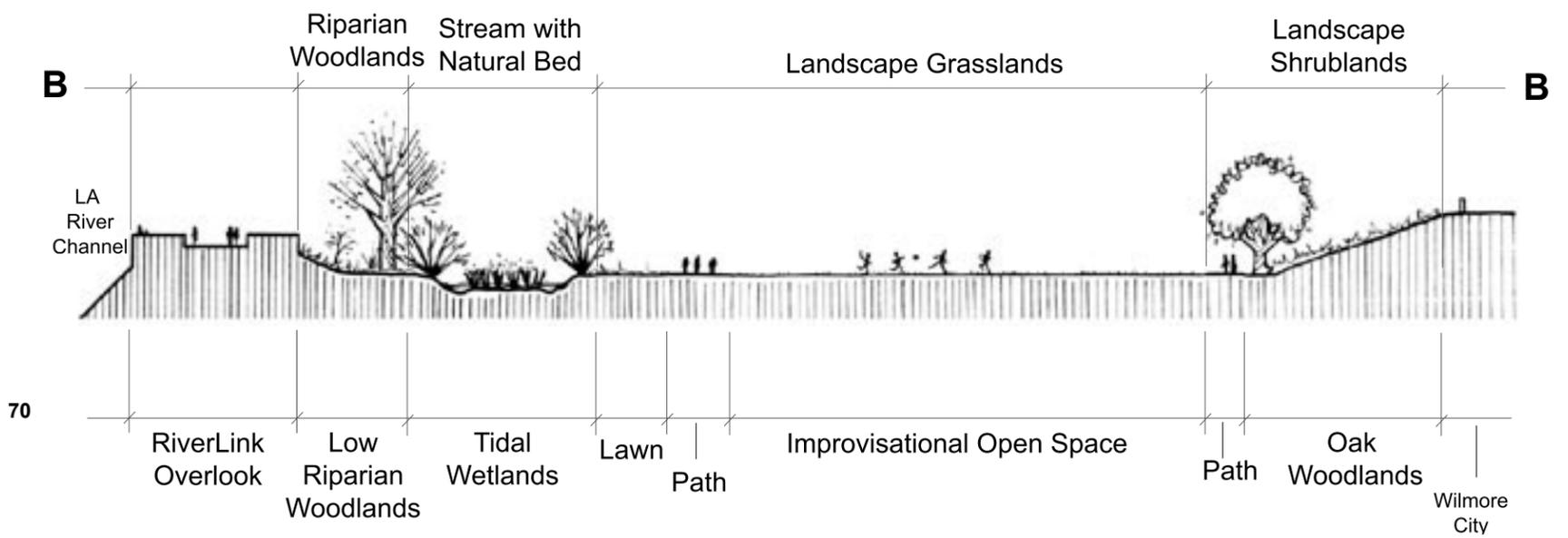
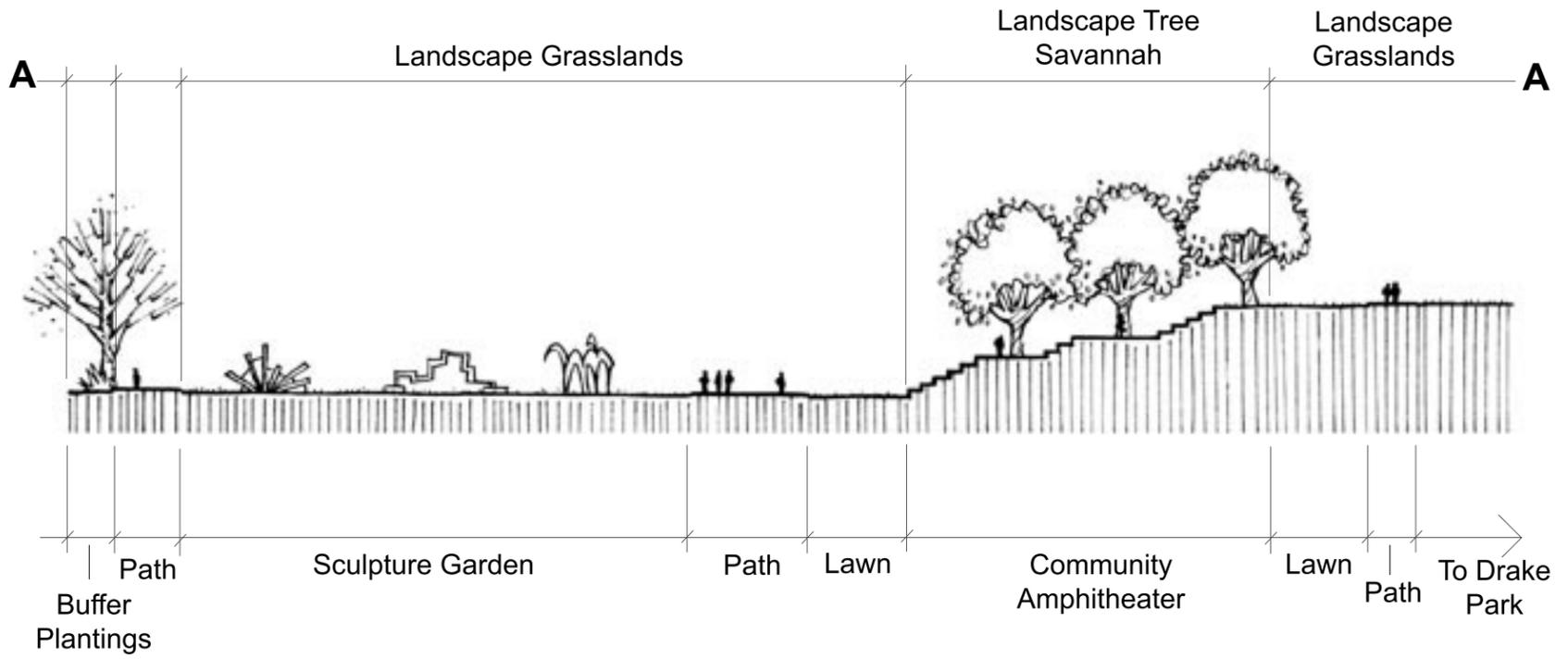
functionally, they begin to act as one. Another connection is created on the southern portion by enhancing Chester Avenue as it comes down the slope from the existing park. This road will terminate into a public space and nature center. The greenbelt will open to the community at Loma Vista Drive and Seventh Street, allowing pedestrian access. Pedestrian access is also created from the LARIO Bikeway. Current access points are enhanced at Anaheim Street, near the I-710 overpass, and at the Sixth Street Wetlands site, and one new access point is added at the terminus of Golden Avenue.

- Bicycle travel is promoted chiefly by enhancing access to the LARIO Bikeway at the aforementioned points, and by creating an access node at the intersection of Anaheim and Daisy Avenue. Designated as a bicycle boulevard, Daisy Avenue encourages the use of bikes, and the 14th Street Extension, located one block north of Anaheim Street, also promotes bicycle travel. Both create bicycle-friendly routes from surrounding neighborhoods into the greenbelt. Local riders can also access the site at Chester Avenue and through the bike tunnel at the Sixth



*Pathway from Anaheim Street and Daisy Avenue Gateway*

# Drake Greenbelt Sections



■ Design Concepts

# Drake Greenbelt Urban Demonstration Garden



# Drake Greenbelt Children's Adventure Garden



Street site. These routes allow passage through the main portion of the greenbelt, as well as easy access to the LARIO Bikeway.

Automobile access is not encouraged, though not ignored. It is reasonable to expect that some people will choose to drive to the park and others may need to drive due to handicaps, injuries, or other impairments. This type of access will be created at the terminus of Chester Place. A small parking lot serving the park and the demonstration garden will provide universal access to the greenbelt's amenities. Additional parking is also located on the Deforest Avenue right-of-way, featuring permeable paving surfaces to reduce runoff.

## Natural Connections

- Native and naturalized plantings will create connections between the greenbelt, the community, and the history of the area. Habitat classifications include landscape tree savannah, landscape forest, landscape grassland, emergent and tidal wetlands, and back dunes. Plantings consist of different aged plants that will regenerate themselves, building successional regenerative groupings of trees and shrubs.

- Wildlife value will be enhanced by the urban forest created in the greenbelt and along pathways. The re-created habitats will attract birds and small mammals using the Los Angeles River corridor into the greenbelt and will connect the people of the community to the place. A special back dunes habitat will be preserved and enhanced south of the Sixth Street wetlands to protect the threatened snowy plover, which has been recorded in the area. Prohibiting access and fencing off the area to park users and dogs will protect this habitat.

Tidal influences currently affect the river as far north as Anaheim Street. Wetlands using tidal currents will be re-created in the Sixth Street site, promoting habitat and educational opportunities through the demonstration of plants, wildlife, and natural processes. The tidal wetlands will not clean any pollution; they will serve only for recreation and the demonstration of this rare habitat.

## Destinations

Destinations in the Drake Greenbelt will provide amenities addressing the needs outlined by the community. The major destinations are designed

to be never more than a few hundred yards apart, which creates a relatively even distribution across the park. A rhythm is established along the paths by the continual recurrence of the destinations (Alexander, 1977).

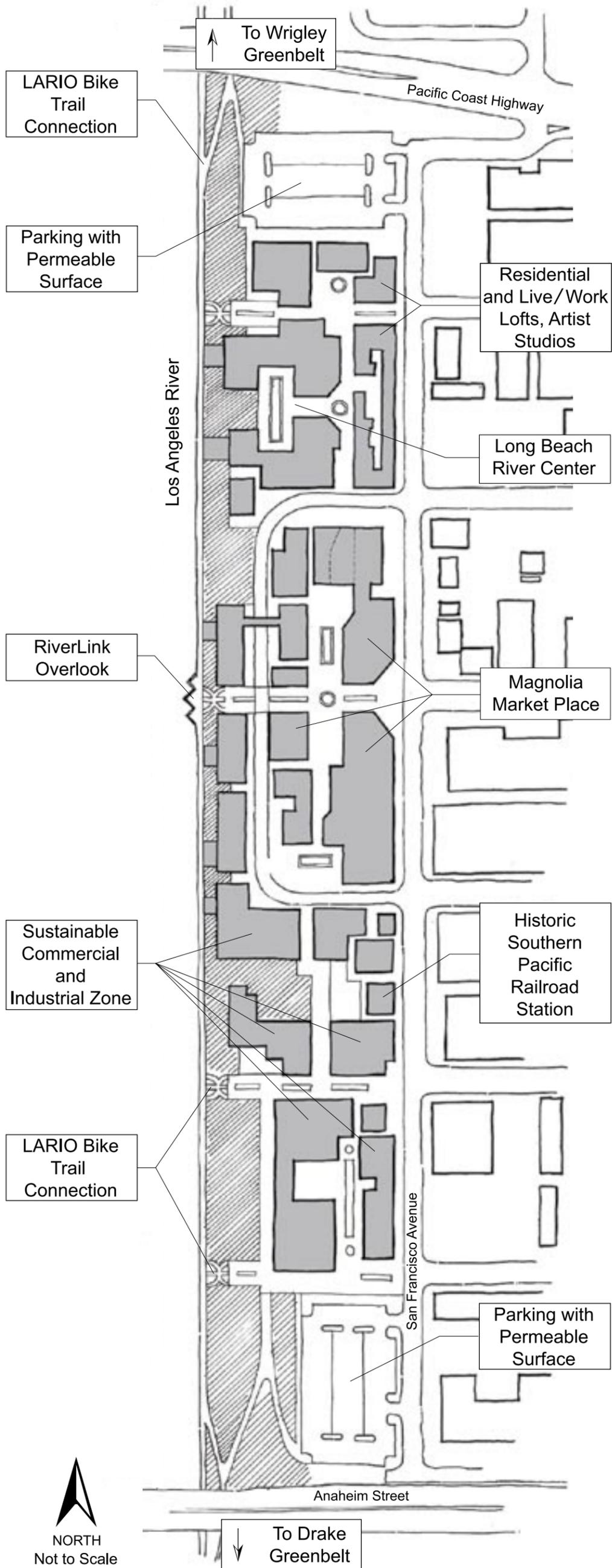
- Sculpture gardens line the pathway into the main portion of the greenbelt from the access node at Anaheim Street and Daisy Avenue. The public sculpture will be by local artists willing to participate in the project, and will change periodically.
- A community amphitheater will be located along the ridge between the existing Drake Park and the new greenbelt. This will become a place where the community can hold formal and informal gatherings and discussions, creating a safe place where different groups can come together. Local schools may also use the space for outdoor performances and educational series.
- The RiverLink Gateway Plaza, located at the terminus of Chester Avenue, will become a major gathering point for visitors to the site. It is the main public space of the site and will lead the visitor towards any amenity. The RiverLink Gateway Plaza will be the space most recognized by the community and will draw people because of its monumental landmark.
- Pathways weaving through the park define improvisational open spaces. These spaces have no specific programming; they are intended to be open areas for the use of the community. The lack of programming is integral to the design of these spaces, allowing them to be flexible. They can be used for outdoor fairs, farmers markets, or for an informal soccer game. To read more about the idea of improvisational open spaces, refer to Appendix E.
- The Urban Demonstration Garden will showcase planting strategies and design techniques for typical urban situations which residents may encounter. These demonstrations can include: removing lead from contaminated soil, retrofitting urban landscape, transforming a vacant lot into a community garden, reducing urban runoff, conserving water, and enhancing urban nature and urban habitat. A plant doctor can also be available so community members can pose plant questions. An urban nature center is located adjacent to the garden providing docents to maintain the garden as well as lead tours. The nature center will house several offices and a lecture room for community use. This center could expand into a functioning research center in the future if the opportunity arises.
- The Sixth Street wetlands will require piercing inflow and outflow openings through the river channel in order to use the tidal influences and river water to create perennial tidal wetlands along the foot of the berm. However, a compre-

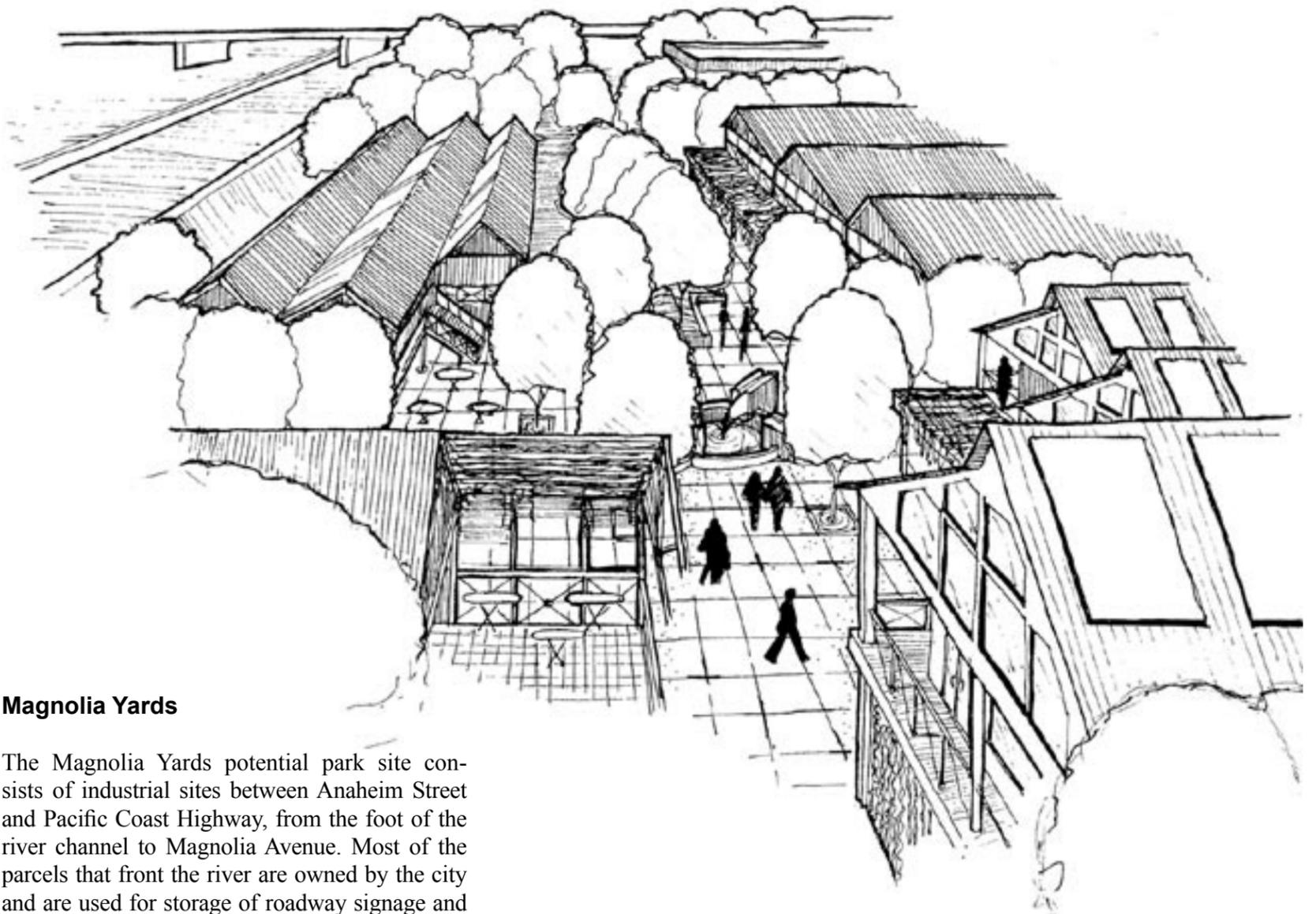
hensive engineering and hydrology study should be carried out to assess the feasibility of creating tidal-influenced wetlands at this site. Overlooks along the pathways will provide visitors areas to rest and bird-watch over the wetlands.

- The Wetlands Interpretive Station is located around the existing County of Los Angeles Department of Public Works Pump Station, which is still in active use. Service access will be provided to the pump house; however, the surrounding area will feature interpretive signage directed at the hydrologic and ecosystematic functions of the tidal wetlands.
- The Children's Adventure Garden sits adjacent to the existing Edison Elementary School, providing a safe place for children to play. The playground features spaces for both programmed and unprogrammed learning, and supports informal play by not posting any "no" signs. The site contains elevated walkways for adults, is buffered from heavy traffic, and is visually accessible, creating a safe space universally designed to include everyone (Westphal, 2003). The Mini-Transit building on the west side will remain and be adaptively reused to fit the new programs for the site. The building will provide sheltered classroom space associated with the school and the adventure playground, and will separate the playground from the community garden plots located on the northern and western portions of the site.

The community gardens provide valued garden space for the heavily urbanized area, and will be open to the public for a small security fee. Local schools can participate in the gardens, teaching students the value of growing their own food. This entire site provides an interactive learning experience for children, teaching the relevance of plants in everyday life, as well as the skills needed to grow food. It also provides adults with gardening opportunities and strengthens the community by providing an opportunity for intergenerational learning and sharing.

# Magnolia Yards Concept Plan





### Magnolia Yards

The Magnolia Yards potential park site consists of industrial sites between Anaheim Street and Pacific Coast Highway, from the foot of the river channel to Magnolia Avenue. Most of the parcels that front the river are owned by the city and are used for storage of roadway signage and construction materials. The city is currently in the process of transferring the stock and equipment at these sites to other locations south of the airport in order to make these sites available for possible redevelopment. The Magnolia Yards sites will have an industrial flavor to match the larger scales and utilitarian styles of the surrounding industrial buildings and the massive industrial infrastructure just below Pacific Coast Highway. Included in the southeast part of the property is the relocated Southern Pacific Rail Station, a historic landmark, which is a fine example of Spanish Mission architecture as seen in the early part of the 1900s.

The city desires to add live/work studio lofts to the area. This will help develop a warehouse district featuring galleries, small retail shops, and restaurants, as well as the studio lofts. Such development creates economic vitality in an underutilized area within walking distance of downtown Long Beach. The development area also boasts prime river frontage, good access to I-710 from Anaheim Street, and good access to the freight railway tracks. The development area encompasses the industrial zone just west of the Washington School to the east bank of the Los Angeles River. The focal point of this zone is the Magnolia Yards development and the planned 14th Street park extension, terminating at the yards with the Magnolia Market Place, the Long Beach River Center, a sustainable commercial and industrial zone, and a museum celebrating the city's history housed in the historic Southern Pacific Rail Station. The Magnolia Market Place will feature shops, restaurants and a regular farmers and artisans market. The Long Beach River Center will house educational facilities such as a community college extension focusing on sustainable trades and industry. The north end of the development site will feature residential lofts, live/work studios and galleries. These new uses will be housed in

former industrial buildings or on former industrial sites. In adaptive reuse of industrial buildings, the building shell can be upgraded and act as a tent over substructures built within, which house the individual shops and other leaseable units. If the bike station downtown needs to relocate, the design team recommends that a home be found for it in this area due to Magnolia Yards' proximity to the LARIO Bikeway.

A process called deconstruction can be used to remove existing buildings that cannot be reused. Deconstruction involves carefully dismantling the building to save intact building materials for future use. This process is labor intensive but can save money in the long-term, protect cultural heritage of architectural elements, and is more environmentally friendly than standard demolition practices. Deconstruction is best done with a labor force taken directly from the community, creating job experience and community support for the development project. Magnolia Yards is a wonderful opportunity to use deconstruction of unusable buildings as an educational tool, a sustainable job training initiative, and a community building experience.

The Magnolia Yards development and surrounding area will be designated a Sustainable Economic Empowerment Zone. The businesses in this type of zone strive "to slow the depletion of natural resources or sustain, restore and expand their availability" (Hawken, 2003). Additionally, these businesses must strive to lower pollution or be pollution-free, and to provide meaningful employment. The following are recommended types of businesses for the Sustainable Economic Empowerment Zone:

- Elimination of fossil fuel use
- Hydrogen fuel cell fabrication and hydrogen vehicle manufacturing
- Solar panel manufacturing and installation
- Wind power turbine manufacturing and installation
- Locally derived crafts and materials
- Cooperatives for skilled local trade persons
- Gallery space for local artisans
- Wholesale/retail markets for locally harvested and quarried materials
- Urban food production
- Cooperative farmers' market
- Health food markets
- Hydroponics food production
- Organic and native plant nurseries
- Pulling materials out of the waste stream
- Recycling facilities
- Salvage facilities for materials such as architectural salvage and used lumber
- Repair or retrofit facilities for manufactured items normally placed in landfills

The City of Long Beach can use the following criteria to select and plan for businesses that follow these manufacturing and/or business practices, and can offer incentives for starting or relocating to this zone:

- *All natural*: The sale and manufacture of products that contain no hormones, artificial flavorings, colorings, or preservatives.
- *Chemical-sensitivity safe*: The sale and manufacture of products that contain no synthetic dyes, fragrances, or harmful chemicals.
- *Cruelty free*: The sale and manufacture of products that cause no harm to animals during the making of the product.
- *Fair trade*: Manufacturing that guarantees a fair living wage to the local workers, as well as any workers located overseas.
- *Fossil fuel free*: The sale and manufacture of products using biological, climatological, and/or natural processes instead of industrial or chemical processes.

- *Non-toxic*: The sale and manufacture of products that contain no toxins or produce harmful effects in people, animals, or the environment.
- *Organic*: The sale and manufacture of products that contain ingredients grown and processed according to the USDA's National Organic Standards and the California Organic Foods Act of 1990.
- *Organic Foods Act*: using no synthetic pesticides, herbicides, artificial fertilizers, or genetically modified organisms.
- *Recyclable/reusable*: The sale and manufacture of products that are either made from recycled materials, are recyclable, or are easily reused.
- *Socially Responsible Businesses*: Businesses whose practices provide safe and healthy working conditions, fair wages and respect for their employees, here or overseas (Newman, 2003).

Businesses meeting these suggested criteria will be eligible for financial incentives because they enhance the city's social, natural, and economic environment. The design team suggests the City of Long Beach Economic Development Commission conduct an economic feasibility study for such a program. The design team anticipates this type of zone will match the city's 2010 strategic "Economic Opportunity for All" plan goals and will have possible public relations value that will give the city competitive advantage in attracting the regenerative and sustainable businesses of the 21st century (City of Long Beach, 2001).

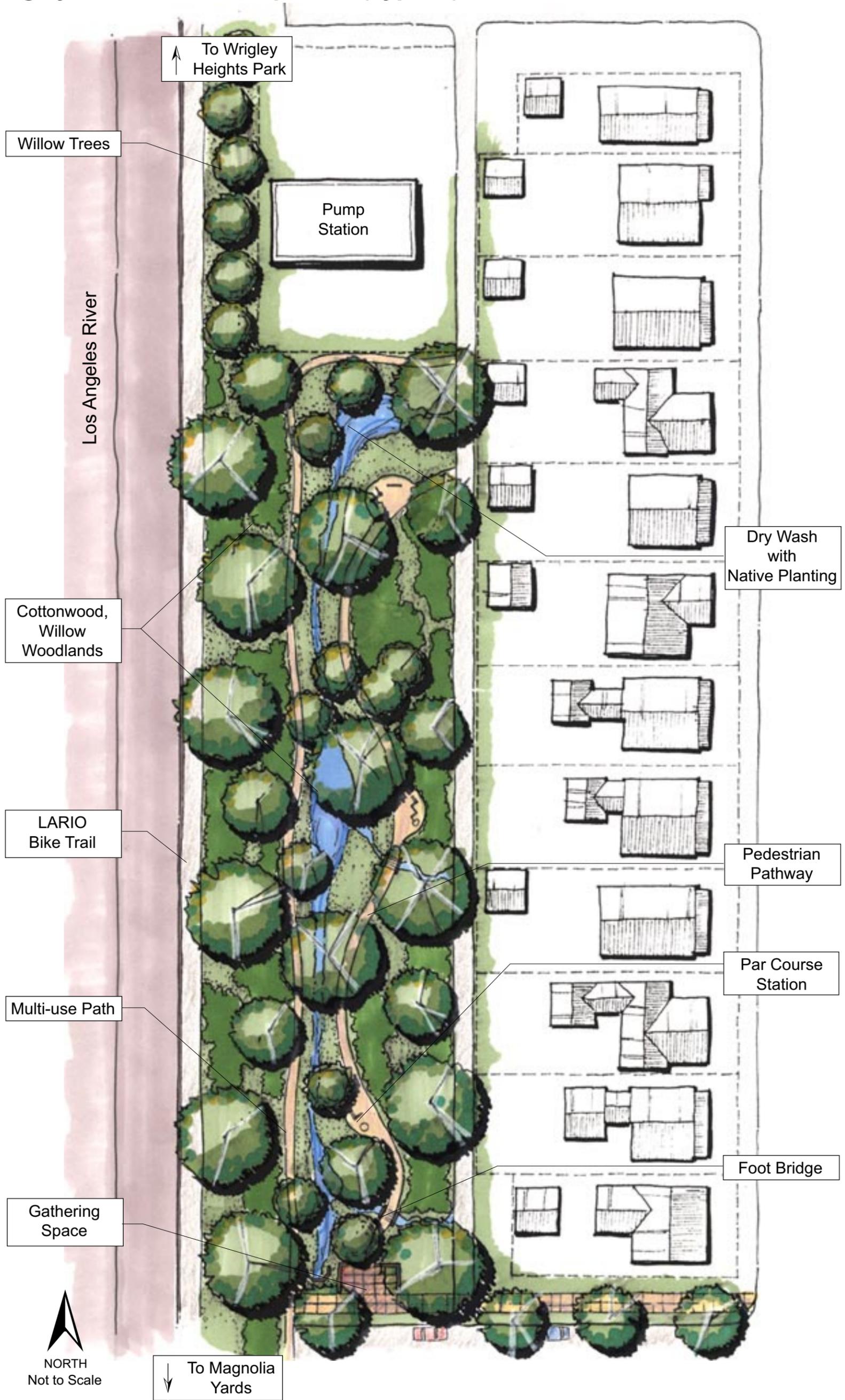
Furthermore, the design team suggests the city consider the following incentives, if economically feasible:

- Low interest loans and grants
- Property tax abatements, credits, deferment, and rebates
- Reductions in city fees, permit and services costs, and barter arrangements

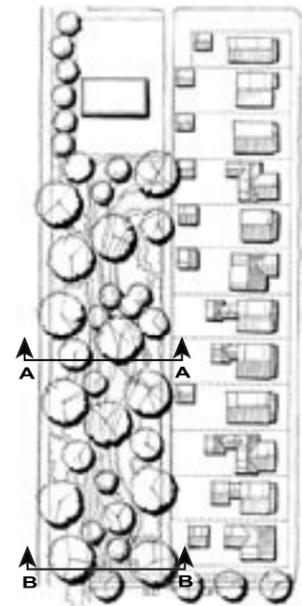
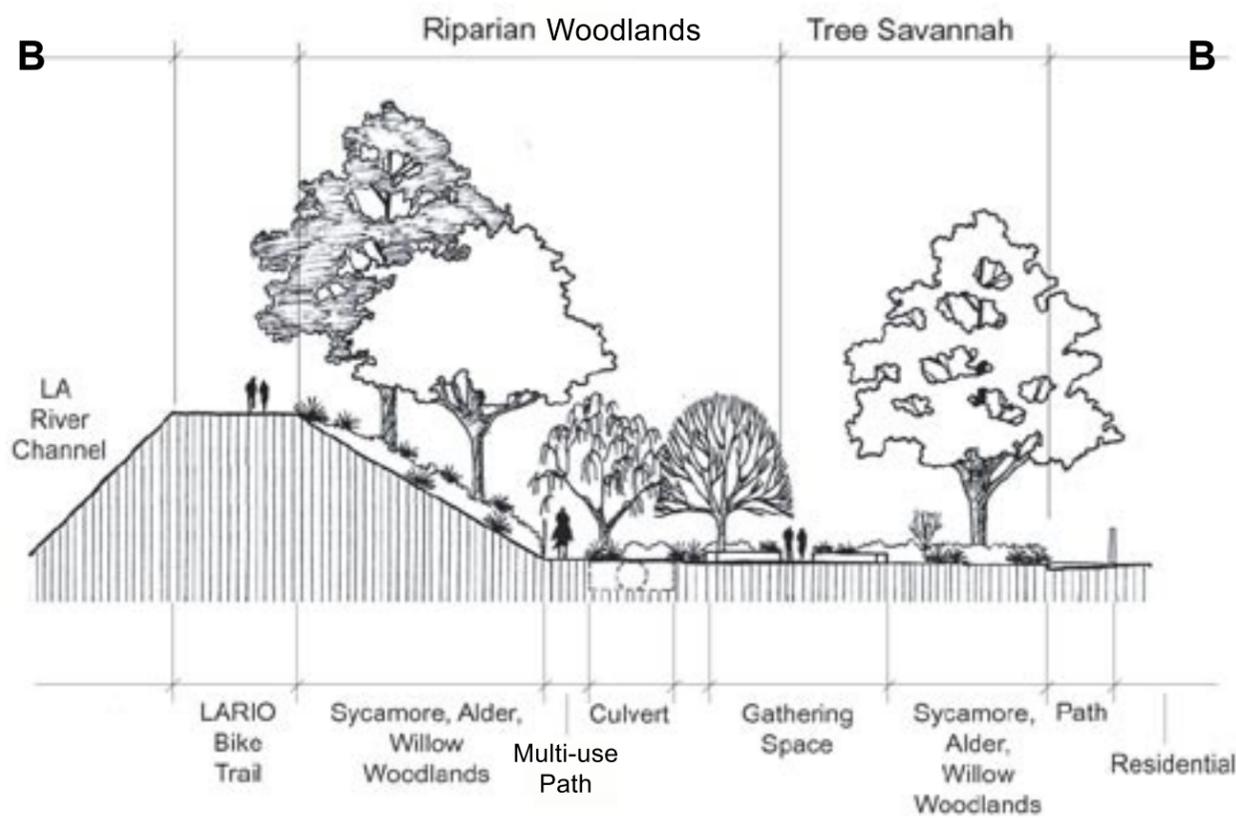
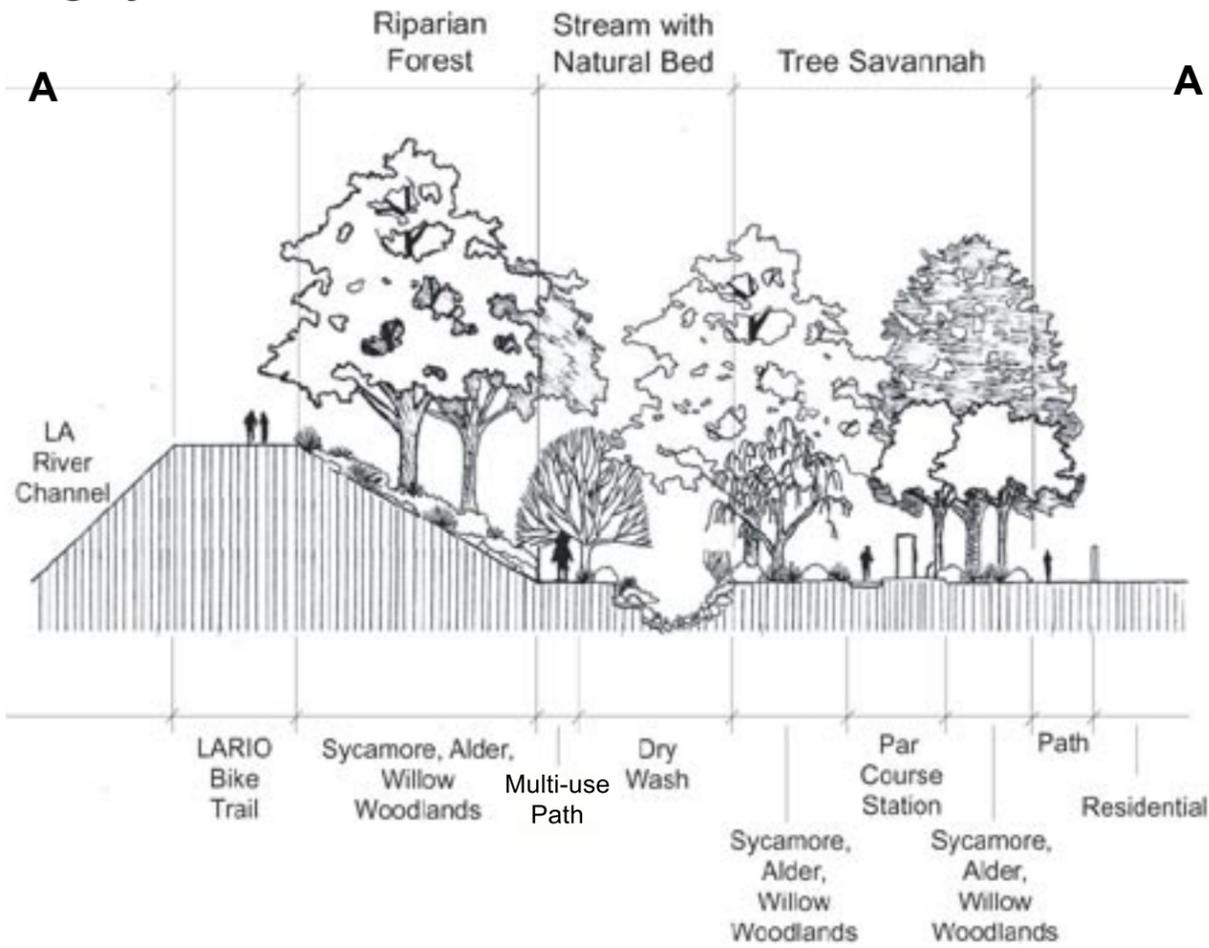
### Wrigley Greenbelt

The Wrigley Greenbelt occupies narrow properties along the river channel from Pacific Coast Highway north to Wardlow Avenue. These properties vary in width from 25 ft to 225 ft and provide an invaluable green link between the parks at Magnolia Yards and Drake Greenbelt, and the Wrigley Heights Park north of Wardlow. During the community outreach meetings, residents suggested that the Wrigley Greenbelt also provide an undulating "par course" pathway trail with fitness stations along the foot of the berm, planted with native trees and shrubs.

# Wrigley Greenbelt Concept Plan (Typical)



# Wrigley Greenbelt Sections



Wrigley Greenbelt Sections Map

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The Wrigley Heights sites and the Wrigley Greenbelt will exhibit Spanish Revival amenity style responses. This is due to predominance of Spanish Revival homes in this area, the neighborhood association identification with those styles, and the location of the Historic Rancho Los Cerritos, just northeast of the Wrigley Heights sites.

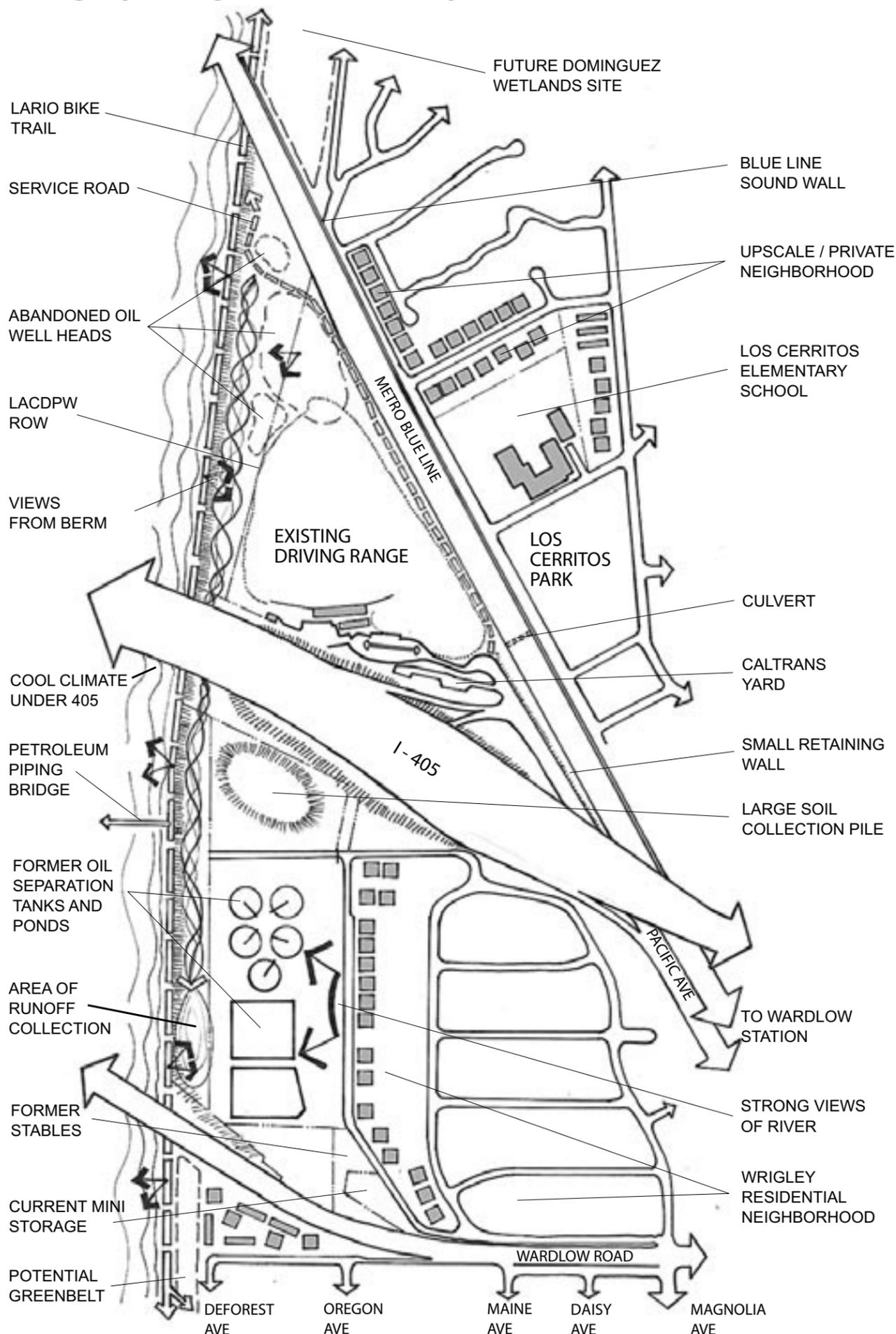
*Design Response:* The varying width of the properties constrains the activities that can happen on-site. The LARIO Bikeway continues along the top of the channel berm, however, smaller paths for pedestrian and slower moving bicycles will weave through the greenbelt at the foot of the slope. Consistent with the city's wishes for appropriate wetlands development, a narrow reed-rock filter bed will capture urban runoff occurring near the berm that does

not make it to the storm sewer system, and will direct it south through the greenbelt. This allows percolation into the groundwater aquifers while removing heavy sediments and chemicals from the water. Connections to the LARIO Bikeway will be enhanced near Hill and Spring Streets with handicap accessible ramping and stairway connections. A surrounding of riparian woodlands consisting of cottonwood trees (*Populus fremontii*), sycamores trees (*Planatnus sp.*) and willow trees (*Salix sp.*) denote these connections and provide shaded places of respite off the bike trail.

## Wrigley Heights Park

This 50-acre property has operated as a processing area to receive and treat brines and oil-waste fluids, to recover low-grade oil for resale, and

# Wrigley Heights Site Analysis



to discharge wastewater into the sewer system. The treatment plant consisted of five circular concrete skimming basins, two large collection ponds, and various aboveground storage tanks. Historically, an equestrian center operated on the southeast portion of the area. A small mini-storage facility is located next to the former stables. The site is bordered by the I-405 freeway to the north, Wardlow Road to the south, Golden Avenue to the east and the Los Angeles River to the west.

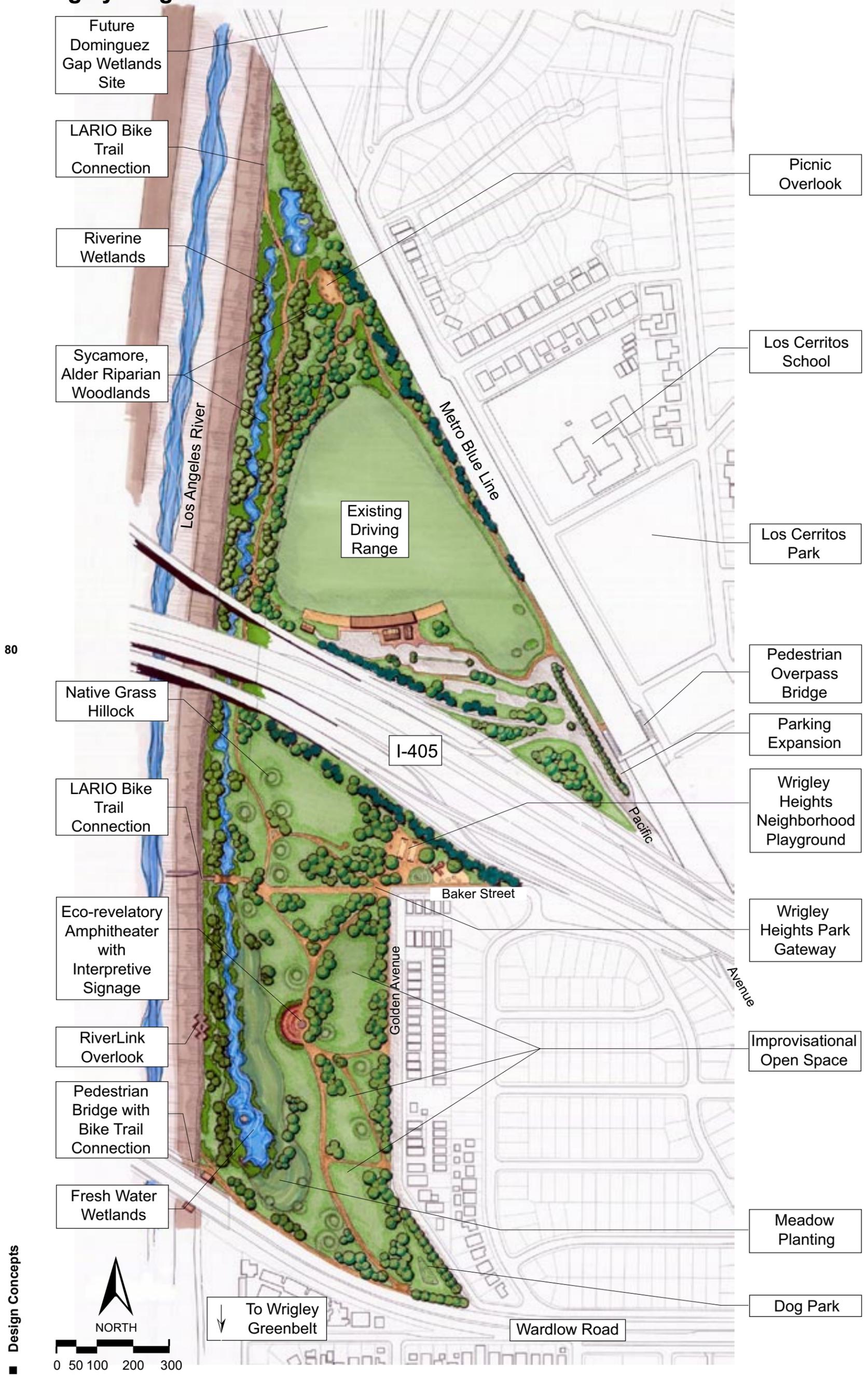
Because of the site's past use, remediation of contaminated soil must be accomplished prior to development of the community open space. The remediation process will involve three methods: (a) treat contaminated soil using onsite bioremediation, (b) incorporate soil into engineered sub-

base, (c) transport soil offsite which is beyond bioremediation methods.

Total petroleum-hydrocarbon affected soils will be excavated and treated using bioremediation onsite in a specially constructed treatment area. Prior to the introduction of crude-oil-impacted soil into the treatment areas, the native ground surface within the treatment areas will be compacted in order to minimize the potential for leaching, although the solubility of crude oil is low. Containment berms will be constructed around the perimeter of the treatment areas in order to contain surface water runoff.

The crude-oil-impacted soil is placed into a treatment area until it reaches a height of several feet. The upper one-foot of soil is then treated until it

# Wrigley Heights Park Site Plan



Future Dominguez Gap Wetlands Site

LARIO Bike Trail Connection

Riverine Wetlands

Sycamore, Alder Riparian Woodlands

Los Angeles River

Existing Driving Range

Metro Blue Line

Picnic Overlook

Los Cerritos School

Los Cerritos Park

80

Native Grass Hillock

I-405

Pedestrian Overpass Bridge

Parking Expansion

LARIO Bike Trail Connection

Wrigley Heights Neighborhood Playground

Pacific

Eco-revelatory Amphitheater with Interpretive Signage

Baker Street

Wrigley Heights Park Gateway

Avenue

RiverLink Overlook

Improvisational Open Space

Pedestrian Bridge with Bike Trail Connection

Golden Avenue

Fresh Water Wetlands

Meadow Planting

Design Concepts



NORTH

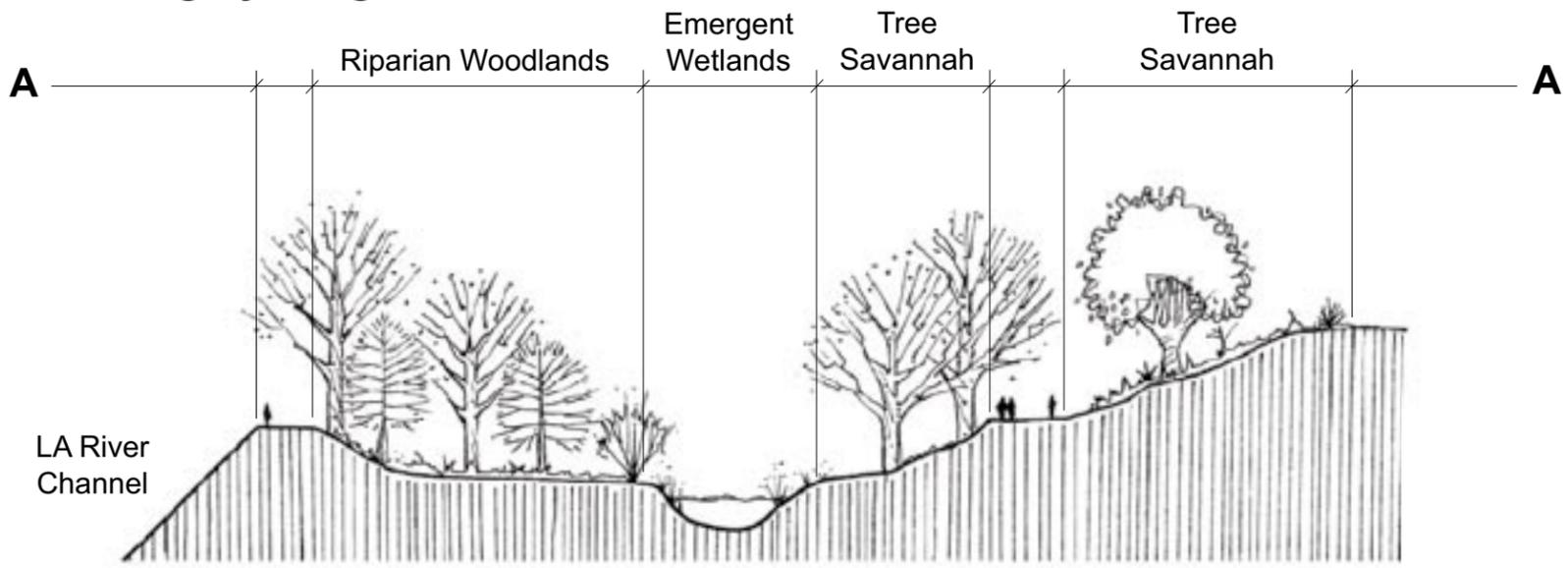
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To Wrigley Greenbelt

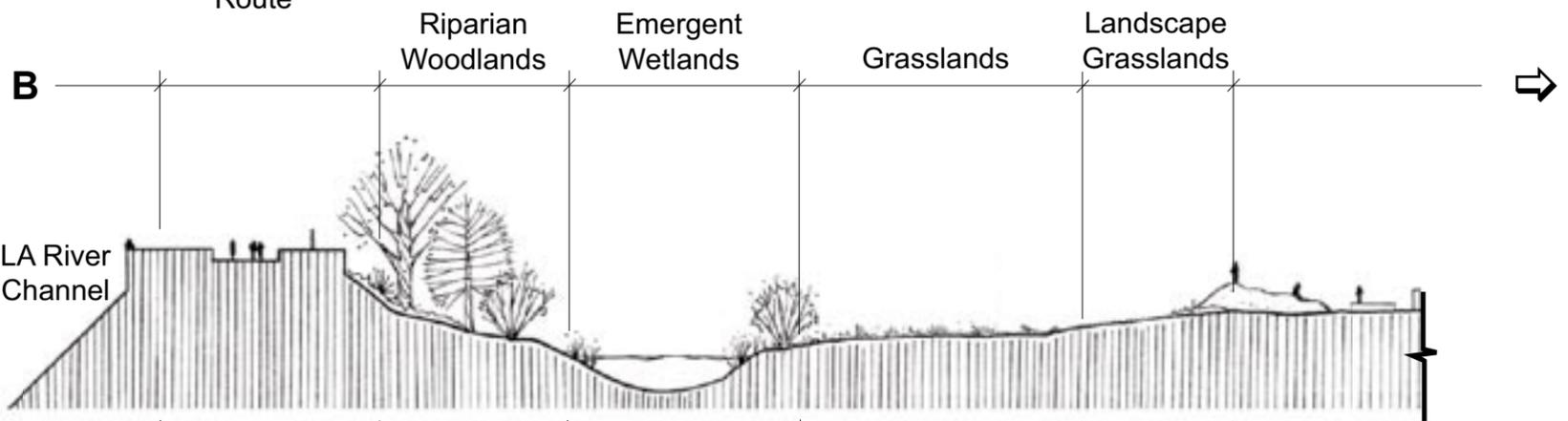
Wardlow Road

Dog Park

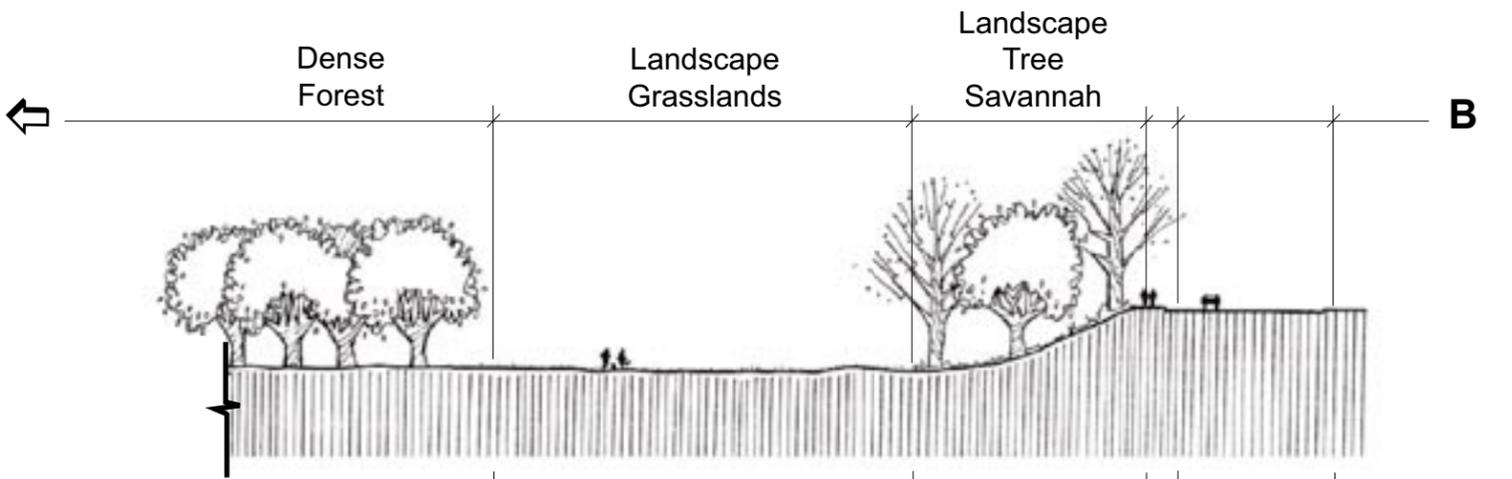
# Wrigley Heights Park Sections A and B



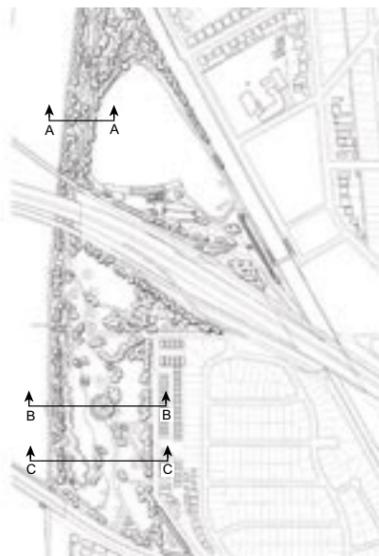
LARIO Bike Route    Sycamore, Alder, Willow Woodlands    Wetlands    Sycamore Woodlands    Path    Oak Woodlands (Buffer Planting)    Driving Range



RiverLink Overlook and LARIO Bike Trail    Sycamore, Alder, Willow Woodlands    Wetlands    Meadow Planting    Lawn    Eco-revelatory Amphitheater

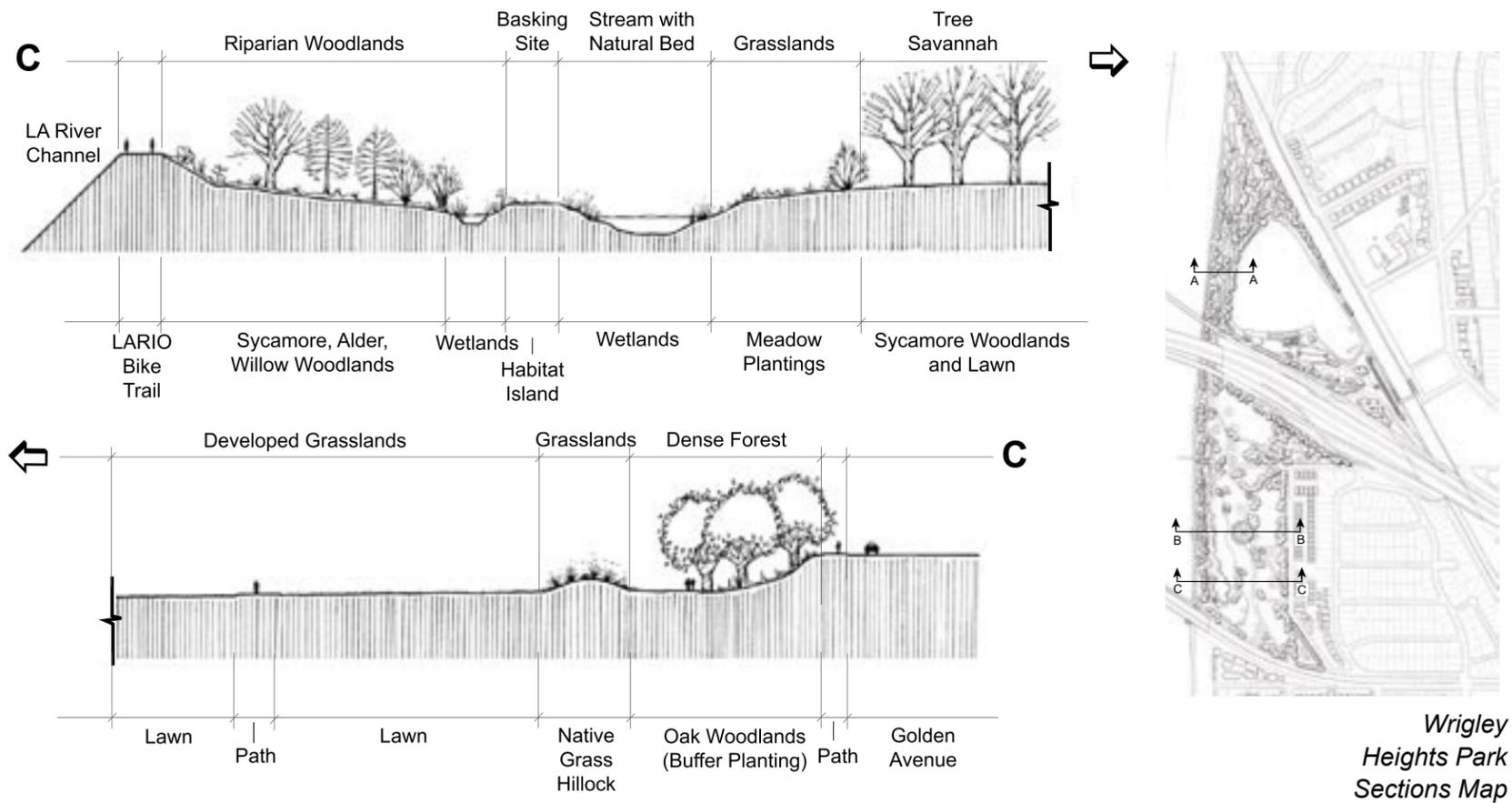


Oak Grove    Lawn    Oak, Sycamore Woodlands    Golden Side Avenue Walk    Residential



Wrigley Heights Park Sections Map

# Wrigley Heights Park Section C

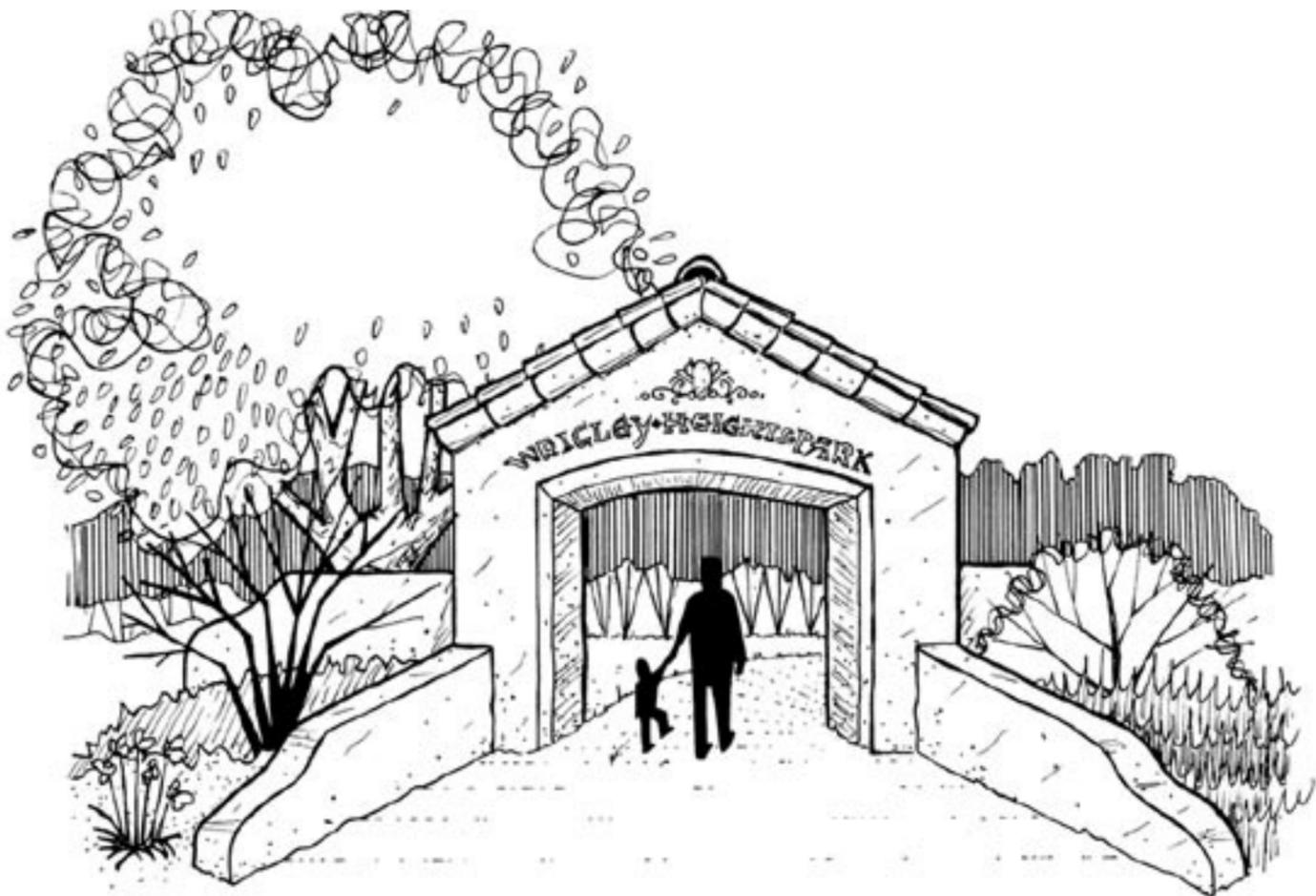


meets the treatment criteria. This upper one-foot is then removed and buried to prevent weeds from germinating while the treatment of the next one-foot of soil begins. This process is repeated until the crude-oil-impacted soil is cleaned and returned to the excavation pits.

Treatment consists of (a) mechanically discing and/or pulverizing the soil on a regular basis for aeration purposes, and (b) maintaining optimal moisture content through periodic watering in order to facilitate biodegradation by the indigenous soil bacteria. Bacteria activity will biologically degrade petroleum hydrocarbons present in the soil to an end product consisting primarily of carbon dioxide, biomass and water.

Based on the project goals and community input, the following program objectives were developed:

- **Passive Recreation**—The community specifically asked for more passive recreational opportunities, such as walking trails, unprogrammed open spaces, and public forum spaces for informal gatherings. The community was concerned that active recreation will bring too much traffic to the park.
- **Eco-Revelatory Design**—This site will provide educational opportunities and interpretive signage showcasing the ecological systems acting on the site over time. This includes educating through interpretive signage, about the process of moving from the oil industry past, through



Neighborhood Gateway at Wrigley Heights Park



*View of Pathways in Wrigley Heights Park*

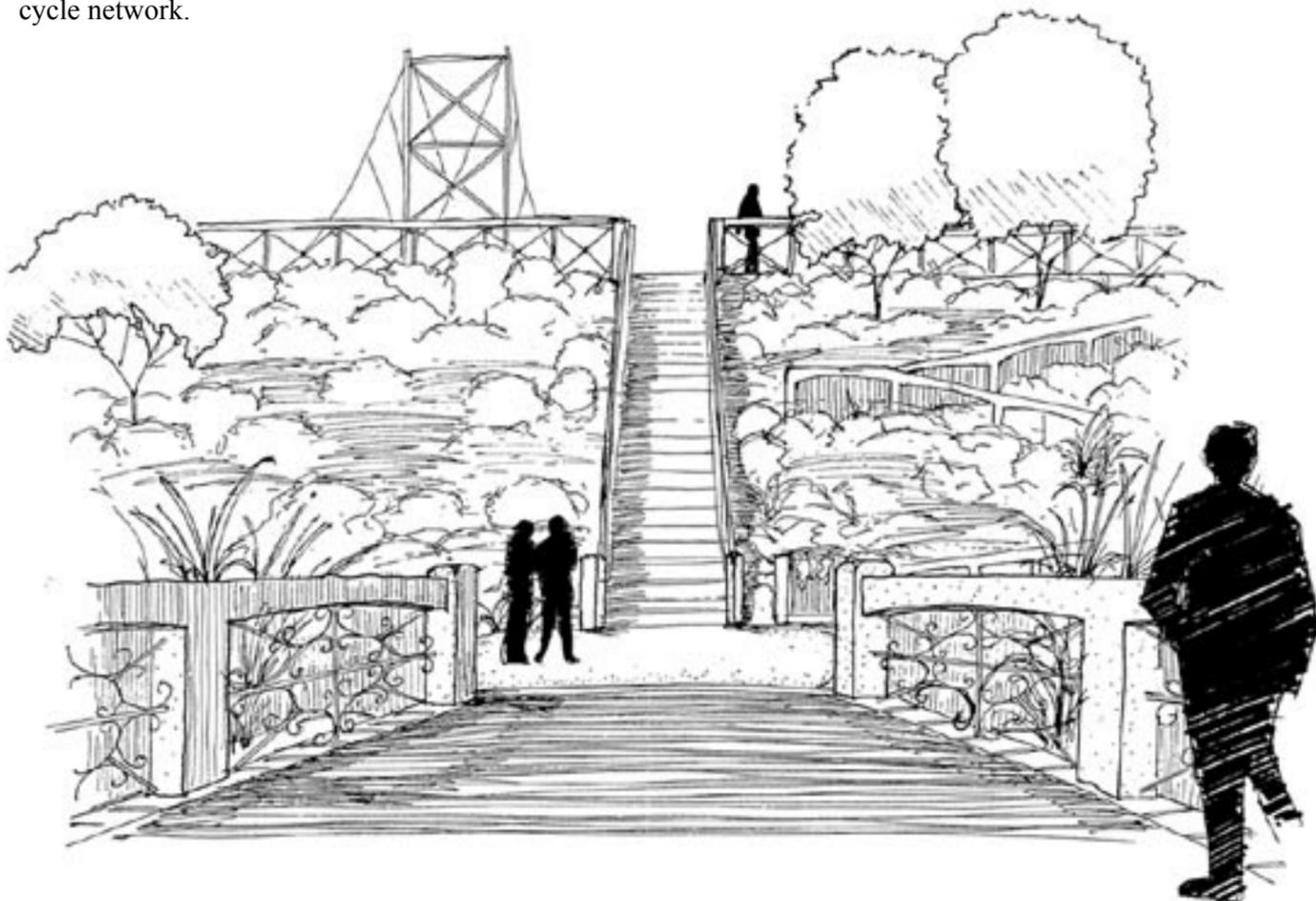
the present remediation efforts, and into the future as a neighborhood park. Local schools can coordinate their classes to take advantage of the educational value of the site.

- Site Remediation—Based on the prior uses of the site, much remediation would have to be done to correct the ecological damage. The community was very concerned that this be carried out in a timely, safe, and sensitive manner.

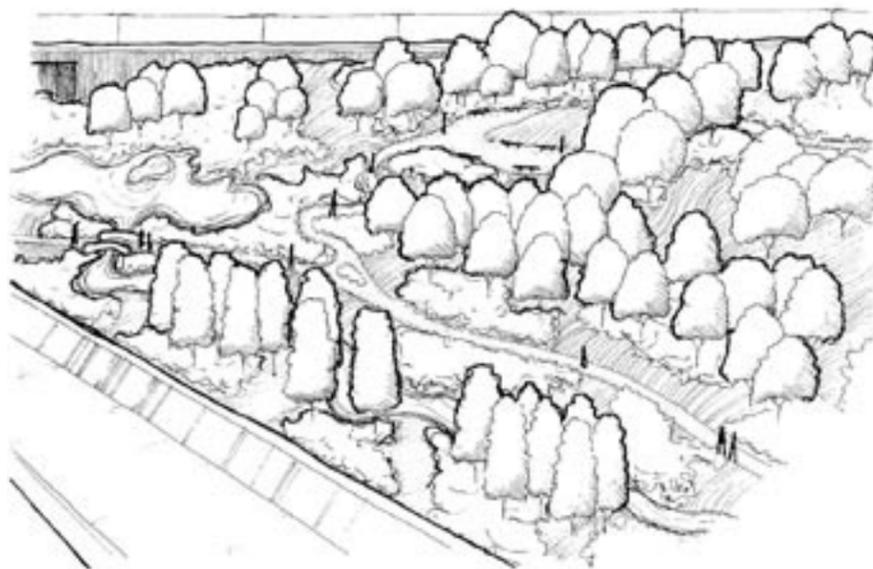
The following criteria were established from the project goals and objectives to guide the design team in the successful design of the Wrigley Heights Park:

- Create connections to surrounding neighborhoods by connecting to existing sidewalks and pedestrian paths and linking to the bicycle network.

- Enhance educational opportunities by interpretive signage and eco-revelatory site features.
- Encourage the creative reuse of existing infrastructure and damaged sites by remediating a former industrial brownfield, and using remnant features as site amenities.
- Encourage walking and bicycling by connecting into the proposed bicycle network and providing safe paths wide enough to accommodate bikes and pedestrians.
- Optimize the urban forest with groupings of native trees and understory shrubs.
- Provide passive recreational opportunities that create a relaxing atmosphere in the park.



*LARIO Bike Trail Access from Wrigley Heights Park*



Wrigley Heights Park Picnic Overlook

- Coordinate with the site remediation process by designing the park to take advantage of the phased cleanup process.
- Enhance connections to the natural and physical environments by re-creating natural landscape features onsite, such as wetlands, and by providing interpretive signage for those features.

### Conceptual Plan

#### Gateways

Gateways in Wrigley Heights Park will display thematic designs of the Spanish Revival style and will be placed at all the entry points on Golden Avenue and at the trailhead and pedestrian bridge

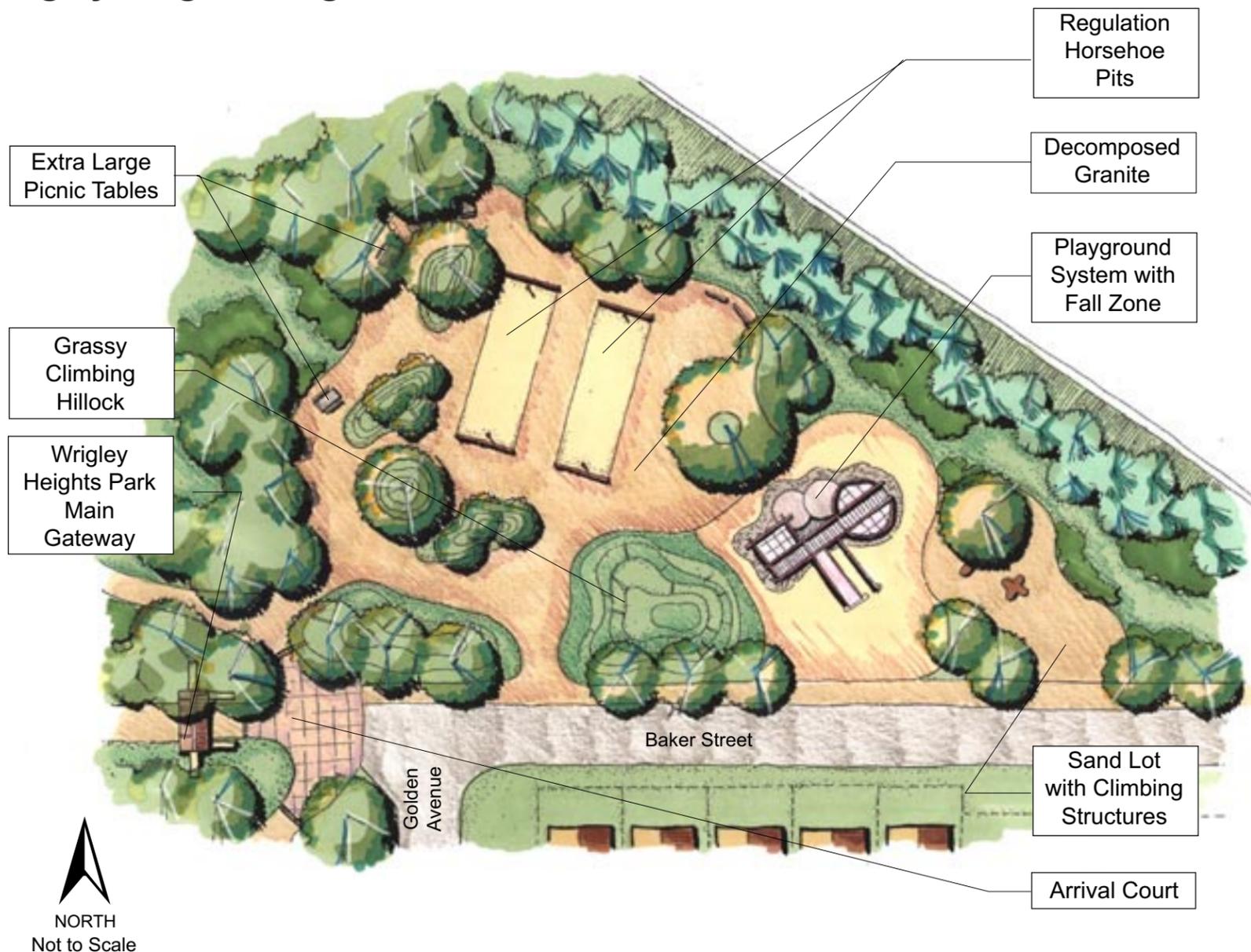
over the Metro Blue Line next to the planned parking expansion off Pacific Avenue. Their scale will be intimate so as to be unobtrusive to the surrounding residential neighborhoods.

#### Pathways

Pathways throughout the site will allow universal access and direct visitors towards destinations through wayfinding devices such as landmark features and directional signage.

- Movement through Wrigley Height Park will be directed along paths that provide universal access to all. Pathways will be of two different widths: the main spine, 12-15 ft wide, allowing pedestrians and bicycles, and smaller

## Wrigley Heights Neighborhood Mini-Park



paths, 8-10 ft wide, for pedestrian-only travel. The main spine will connect all the major features of the site and provide access to the LARIO Bikeway.

- Wayfinding devices along the pathways will direct the visitor to different amenities associated with the park. To minimize disorientation, the top of the map kiosks will always face the same direction as the reader. Landmark features will denote special points of interest, will be visible from far distances, and will give visual clues about the relative location of amenities.

### Connections

The community and Wrigley Heights Park are connected through culture and nature. This allows the site to reflect community changes over time.

#### Cultural Connections

- Pedestrian travel is promoted, creating an open edge along Golden Avenue opposite the Wrigley Heights neighborhood. Prescribed entrances are located at three points along this stretch; however the open edge will allow free-flowing movement between the neighborhood and the park, and will slow traffic along the road. A pedestrian overpass will span the Blue Line tracks and connect the historic Rancho Los Cerritos neighborhood to the northern portion of the park by way of signage and pedestrian trails. Additionally, pedestrian bridges will connect the LARIO Bikeway with the park, crossing over the open wetlands along the foot of the berm.
- Bicycle travel is promoted by creating access points to the LARIO Bikeway. Access from the neighborhood is from the northern end of Golden Avenue.
- The community is very much against added vehicular traffic, so all automobile access is directed to the expanded parking lot adjacent to the existing driving range. This allows universal access for disabled visitors and keeps parking away from the neighborhoods. Some minor on-street daytime-only parking will be provided along Golden Avenue to allow for school bus parking.

#### Natural Connections

- Native and naturalized plantings create connections between the park, the community and the history of the area. Habitat classifications include naturalized forest and shrubland, landscape tree savannah, landscape shrubland, naturalized grassland, naturalized tree savannah, open water wetlands, and naturalized dense forest. Plantings will consist of

different aged plants to build successional regenerative groupings of trees and shrubs. Native grasses will be introduced on the site via 50-foot diameter hillocks, which are located on top of where the monitoring wells were during the remediation process. The grasses will initially be contained to these hillocks, then as they mature, they will be allowed to spread out from the hillocks in a controlled fashion. The native grass introduction must be managed and weeded because of the nutrient-poor condition of the soil after the remediation process and the prevalence of invasive weed species in Southern California. Eventually, native grasslands will cover large portions of the site, creating greater wildlife habitat and aesthetic value in the park.

- Wildlife habitat will be enhanced by the urban forest created in the eastern parts of the site and the northern end near the Blue Line. The re-created habitats will attract birds and small mammals using the Los Angeles River corridor into the greenbelt and will connect the people of the community to the place.
- Open and emergent wetlands created along the foot of the berm will connect visitors to ecological systems that existed along the Los Angeles River prior to relocation and channelization. They will also assist in cleansing urban runoff before it is fed into the river channel.

### Destinations

Destinations in Wrigley Heights Park will provide amenities addressing the needs outlined by the community.

- The picnic overlook located at the very northern part of the park is a secluded nook in a naturalized setting. It overlooks the open wetlands and offers interpretive signage. Typical picnic facilities will be provided such as barbecue pits, cookers, ADA accessible concrete benches and tables, and waste receptacles.
- The existing public driving range will remain to offer recreational opportunities onsite. The range sits atop a capped brownfield site and its use is best left untouched for the time being. The surrounding landscape will be improved to shield golfers from other park activities and to lessen the effect of the driving range on park users.

- Open water and emergent wetlands are planned to stretch over 1/2 mile along the western edge of the park at the toe of the Los Angeles River channel berm. The planting of sycamore/alder woodland will enhance the current conditions and provide an estimated 10 acres of riparian woodland habitat. Based on the high water table, it is expected that ri-

parian woodlands would be sustainable once established. Wetland meadows will encircle these ponds as the topography allows. Interpretive signage along pathways will clue the visitor into the wetlands processes taking place. The water will finally discharge into the Los Angeles River at an existing storm water outlet south of Wardlow Road. The proposed design provides for the future opportunity to develop a hydrologic connection to the planned Dominguez Gap Wetlands Project, directly north of Wrigley Heights Park. Dominguez Gap is currently a water retention basin operated by the LACDPW. Water drawn from Dominguez Gap will require both an inlet pipe under the existing Metro Blue Line and a release pipe piercing the Los Angeles River channel. Both actions will require securing the approval of LACDPW and the USACE. A comprehensive engineering and hydrologic study should be carried out to assess the feasibility of connecting the Dominguez Gap Wetlands system into Wrigley Heights Park. Based on a feasibility study performed for the DeForest Wetlands, water from the Los Angeles River is currently a viable source. However, as programs to reduce runoff are implemented in the region, the quantity of water may become limited.

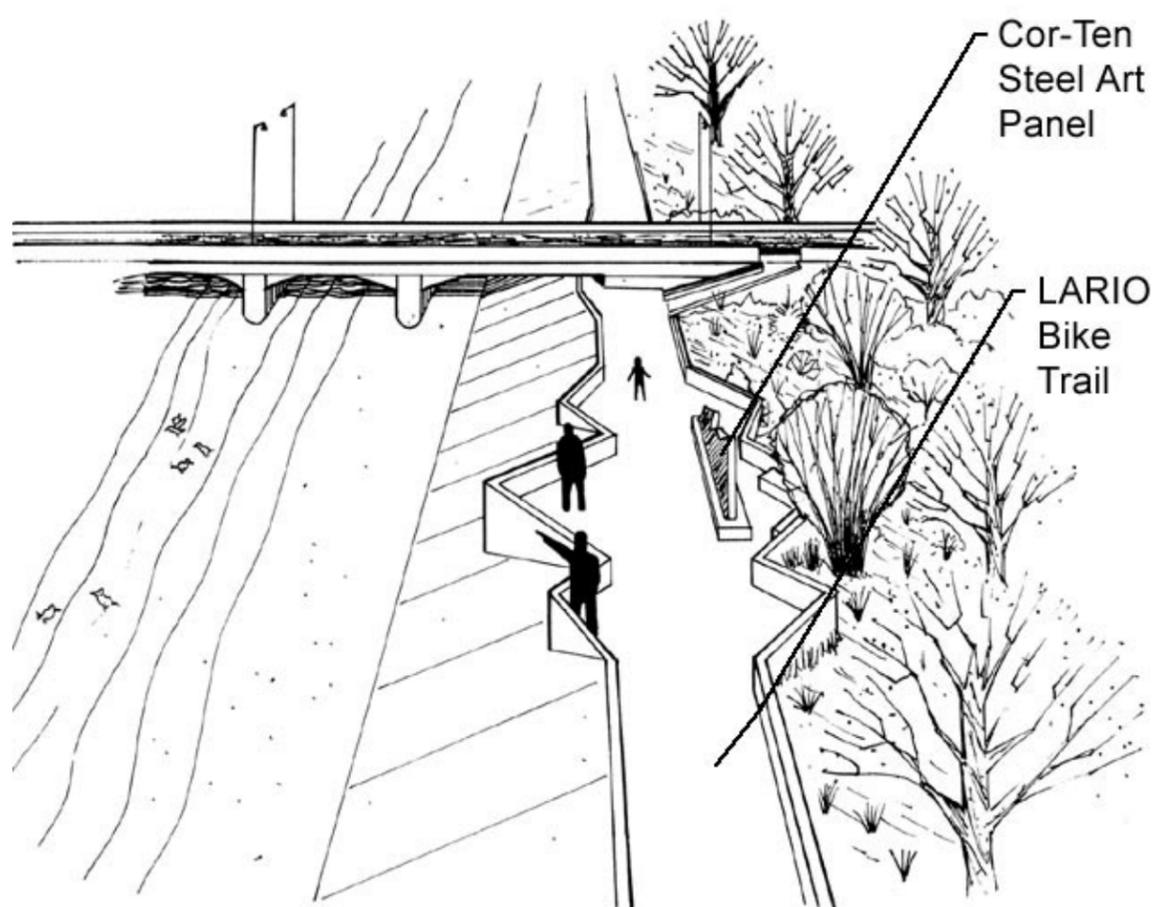
- The neighborhood mini-park features a tot-tot style playground with picnic and viewing areas for parents. It also features a grassy climbing hillock, two horseshoe pits, and chess tables. This corner of the site is currently owned by the city and is not contaminated, so no remediation work needs to take place. It

is recommended that this amenity be the first phase of any work to be done for the park so that the community immediately has the usable park space that they desperately want.

- The eco-revelatory amphitheater is located in the center of the main portion of the park and provides a common space for the community to use for public performances or forums. The shape is reflective of the circular skimming basins used to separate oil from water, located in the center of the contamination plume. Through interpretive signage, the amphitheater will showcase the remediation process.
- Pathways weaving through the park define improvisational open spaces. These spaces have no specific programming; they are intended to be open areas for use by the community. Located throughout the improvisational spaces are the monitoring-well hillocks explained earlier. The lack of programming is integral to the design of these open spaces, allowing them to be flexible. They can be used for outdoor fairs, small or large gatherings, or an informal soccer game. To read more about the idea of improvisational open spaces, refer to Appendix E.

#### RiverLink Overlooks

The design team envisions special destination overlooks to be placed along the LARIO Bikeway at areas of cultural and ecological significance to the RiverLink system. The Riverlink overlooks provide areas of viewing and gather-



*Typical RiverLink Overlook*



*Cor-Ten Steel Panel: Long Beach Memories*

ing along the bike trail. The angular shape outlined by the walls of the overlooks are inspired by the triangular Art Deco façade details found on many Long Beach buildings, bridges, pump stations, and port terminal buildings. Seating areas shaded by native plantings on the city-side of the berm will provide comfortable spots to rest. Adequate space is provided for clear access for Los Angeles County service and emergency vehicles to pass through. Additionally, the overlooks will not impede hydraulic conveyance of the flood control channel.

Each overlook is punctuated by a large, plasma cut, Cor-Ten steel panel that reflects the significance of that particular site or reach of the river. For instance, the Golden Shore Wetlands panel might have an ecological theme. Other ecological panels will be placed at areas of native plant and wetlands restoration, speaking to fauna and flora of the different habitat communities. At areas of cultural significance, such as Magnolia Yards, the panels will speak to cultural themes such Long Beach's past history, diversity, and industry (see detail). The design team suggests the city enlist local artists to help develop and create these panels through a design competition. The panels will be placed near the destination parks such as Drake Greenbelt, Wrigley Heights Park and at areas of connection like the intersections of Hill, Spring and Market and Long Beach Boulevard. The panels will act as wayfinding devices or landmarks that inform and entice visitors to move toward and along the Los Angeles River. The Cor-Ten steel can

withstand almost every environmental or urban condition and hazard, and will need little to no maintenance once erected.

### **Dominguez Gap Wetlands**

The Dominguez Gap is currently part of Los Angeles County Flood Control District. It consists of storm water holding basins and several pump houses along the river channel from north of the Metro Blue Line bridge, to the proposed Deforest Wetlands System just above the Long Beach Boulevard bridge. Urban runoff is directed into these basins and is retained until it reaches a certain level, when it is then pumped into the river. The Blue Line overpass creates a major edge between the Dominguez Gap and Wrigley Heights Park. Dominguez Gap lies adjacent to the Los Cerritos neighborhood and stretches behind the Virginia Country Club. There is a proposal to make the current system into a wetlands demonstration park using hydrologic connections to Los Angeles River water and/or other water sources. The design team was not privy to the proposal's details, but there is a strong likelihood that it will be approved because of the level of county and city interest and collaboration. There is a similar wetlands site proposed for Dominguez Gap, on the West Bank of the Los Angeles River, between Wardlow Road and the Union Pacific rail line or between Compton Creek's inlet and the Los Angeles River.



*Concept of Dominguez Gap Wetlands (Source: County of Los Angeles Dept. of Public Works, 2003)*

### **Deforest Wetlands**

The city has proposed wetlands development in Deforest, similar to those planned for Dominguez Gap. The firm of CH2M Hill has done an extensive feasibility study of this area and has developed several design concepts for the wetlands.

### **Deforest Park**

Deforest Park is an existing park and currently includes recreational facilities such as basketball and tennis courts, a recreation center, and the Deforest Nature Trail. The nature trail is overgrown with exotic plant species and needs significant help to restore it ecologically. Additionally, safety is a concern here because of vagrancy, and the lack of lighting, emergency phones, and exits. The LARIO Bikeway continues along the top of the channel berm; however there are few access points in the Deforest system. The city has well-developed plans for the Deforest Nature Trail, so the design team was directed only to connect the existing park with the river greenway treatment, thus creating a consistent theme along the edge of the Los Angeles River. The design team proposes that further research and work be done on the nature trail to restore both ecological and social balance. North Long Beach residents like having a nature trail, but feel that Deforest is unsafe. Bike access to Deforest should also be enhanced. ■



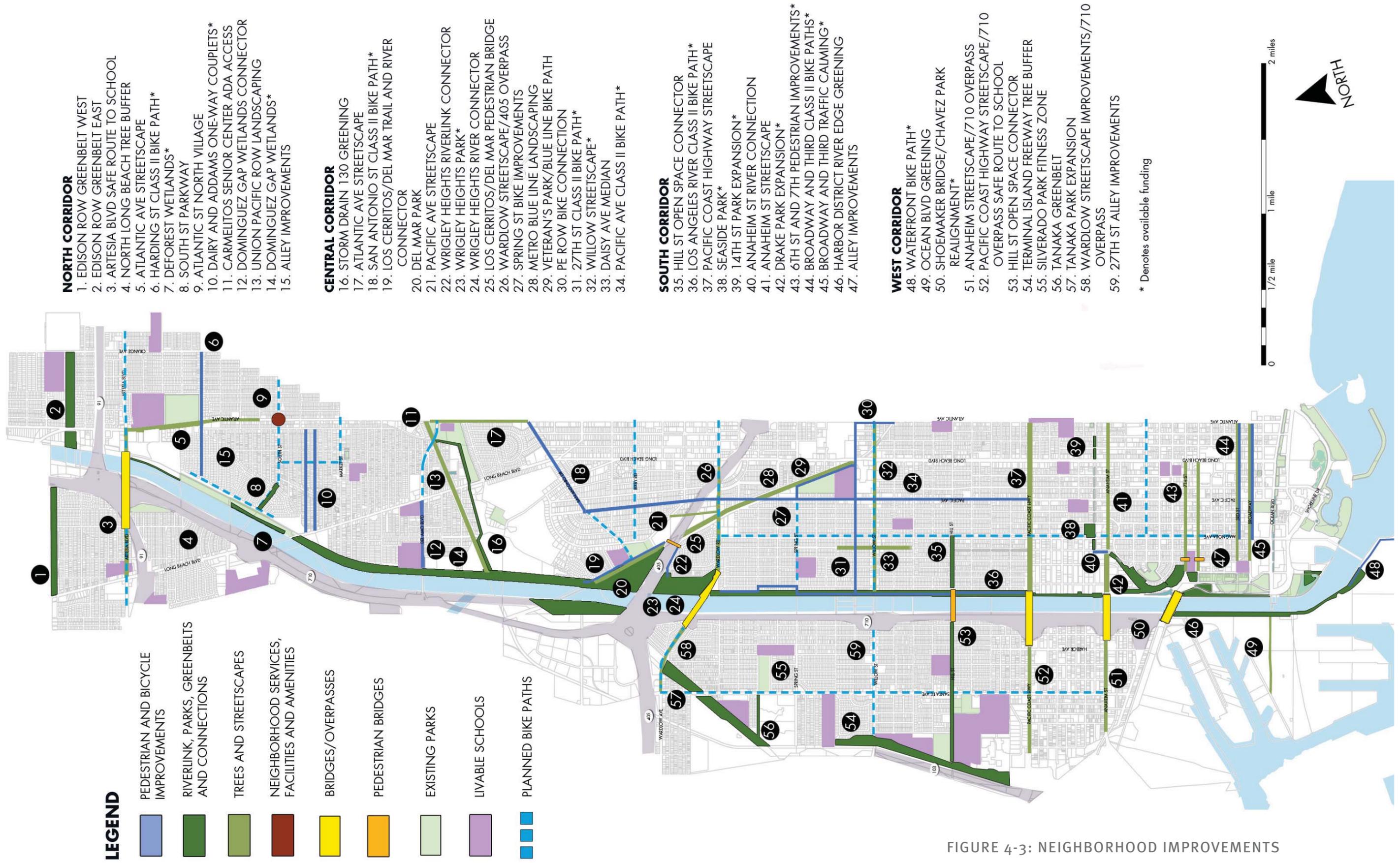


FIGURE 4-3: NEIGHBORHOOD IMPROVEMENTS



## NEIGHBORHOOD IMPROVEMENTS

In order to propose the most relevant community design recommendations for the I-710 corridor neighborhoods, the categorized comments from the Neighborhood Design Workshops were linked to physical locations within the planning area. A broad list of fifty-eight neighborhood improvement projects that together make up the proposed Community Livability Plan improvements emerged from this process, and is shown in Figure 4-3 and Tables 4-2 through 4-5. This list of projects is further described and illustrated at the end of this section.

The City of Long Beach departments can use the Neighborhood Improvements Map to support and enhance planning within the I-710 corridor, based on the foundation of a community vision for change in the neighborhoods. Some proposed improvements that are recommended in this Plan are funded and will be implemented in the short term. Other projects are longer-term opportunities of which the City must remain aware as ongoing planning continues in the corridor neighborhoods over time.

A number of categories of community design improvements have been identified, based on the concerns and desires expressed by the community as explained in Chapter 3. These categories are defined and described below, and correspond to the legend on the map included as Figure 4-3, Neighborhood Improvements.

In addition to the wealth of input received from participants in this project that has been related to specific locations within the corridor, and mapped, other input was received that is important but more general. Complete lists of both the location-specific and non-location-specific livability concerns, strengths and suggested changes made by the community in relation all categories of improvements is included in the Appendix to this Plan, and should be referred to by staff as City services are planned and budgets are developed. In the descriptions of the key categories of improvements that follow, reference is made to both mapped (location specific) improvements as well as those suggested that were not location specific, and which may be applied in various locations within the corridor neighborhoods.

**Pedestrian and Bicycle Improvements** Pedestrian improvements include repairs to existing trails and sidewalks, pedestrian lighting, enhanced signalization, intersections and crossings, and ADA improvements to facilitate access for the disabled. Bicycle improvements include construction of new Class I, II and III bicycle routes, repair of existing bike paths, and additional signage along existing routes. While specific opportunities to target these improvements have been identified and mapped, it is important to note that residents have also made comments about generally improving pedestrian safety and walkability in the corridor neighborhoods, and specifically about repairing and repaving sidewalks.

Further, pedestrian and bicycle improvements in corridor neighborhoods can also be tied to Transit-Oriented Development (TOD), which seeks to provide communities with transit options, decrease reliance on the automobile as the dominant mode of

### WE CAN MEASURE QUALITY OF LIFE IN A NEIGHBORHOOD BY:

Its physical condition; whether or not it is well connected by pathways for people, and comfortable to live and move around in

Its physical safety and the health of its residents

The presence of strong and active neighborhood groups and organizations, and residents taking advantage of local services and demonstrating community pride

Cultural and environmental resources that are being preserved, such as historic buildings, trees, landscaping and open space, and real architectural character

The prosperity of the neighborhood, its residents' levels of employment, and the health of its businesses

transit, and encourage the use of public transit, walking and bicycles. A major goal of the design of TODs is multi-modal connectivity—that is, integrating pedestrian and bicycle routes and facilities with nearby public transit lines in order to make it safer and easier to use alternate modes of transit. Achieving an enhanced level of multimodal connectivity is a key component of the recommendations of this Plan. Therefore, any new pedestrian and bicycle improvements in the corridor neighborhoods should be developed in order to enhance the accessibility, visibility and safety of public transit facilities. This is responsive to a series of comments made by residents about access to public transportation in the neighborhoods, and grouped under the Transportation and Goods Movement category of comments.

**RiverLink Parks, Greenbelts and Connections** The proposed RiverLink park system is identified in this category, as well as additional greenbelts and open space connections that will enhance RiverLink and access between the Los Angeles River and surrounding neighborhoods.

**Trees and Streetscapes** Includes tree planting and streetscape enhancement on roadway corridors. Improvements can include maintaining and protecting existing trees, and planting new trees, new planted medians and parkways, improved sidewalks, constructing green streets improvements to manage storm water, adding street lighting, signage, art and wayfinding. The recommendation relating to landscaping and buffering the Metro Blue Line, north of Willow Street, is also mapped as part of this category of improvements, though this is a project that specifically responds to a number of comments grouped under the Transportation and Goods Movement category.

While specific recommendations within this grouping of comments have been identified and mapped, other comments relating to the community's desire for additional tree planting in the City, as well as better maintenance of existing trees are important as well, and should be recognized. The City's current initiative to prepare an Urban Forest Master Plan for the City is critical in response to these comments, and should provide a forum for addressing the community's concerns. Further, City of Long Beach Neighborhood Services Bureau, Public Works Department, and non-profit community based initiatives to secure grant funding, as well as use already identified City funds to plant trees, are ongoing and responsive to the thrust of these comments as well.

**Neighborhood Services, Facilities and Amenities** This category of improvements is broad, and though only identified on the Neighborhood Improvements map at one location, was an important category of improvements for many residents participating in Neighborhood Design Workshops. Improvements suggested in this category range from constructing new public community facilities such as libraries, community centers, cultural centers, police and fire stations, to adding new community, childcare or after school programs or extending the hours at existing City facilities.

One specific project was identified and mapped that responds to typical concerns expressed by residents in relation to this category. This is the North Village Development on Atlantic Boulevard in North Long Beach, which is presently in design, and should be responsive to the expressed community vision for additional retail and

community facility opportunities in that location. A complete list of community concerns and desires for change expressed in relation to this category of improvements is included as an appendix to this document, and should be referred to by City staff as neighborhood services and community programming plans are developed and refined.

**Bridges/Overpasses** I-710 and LA River bridges have been identified as part of the Corridor Recommendations as a long term opportunity for replacement and improvement in connection with the I-710 Major Improvements Project. However, in the shorter term, improvements can be considered as well. Working within the existing bridge and overpass right of way widths, opportunities should be explored for improving sidewalks, providing some physical barrier between sidewalks and roadways, providing improved pedestrian and bicycle signage, adding pedestrian lighting, and improving crosswalks on freeway on ramps and off ramps.

**Pedestrian Bridges** A few pedestrian bridges have been constructed in the corridor area, primarily to link elementary schools to their surrounding neighborhoods. These facilities have been identified on the Neighborhood Improvements map. Potential improvements to them are identified in a single case study addressing the Los Cerritos bridge, and included in this Plan. However, these improvements, including lighting, paint, access and sidewalk upgrades, fencing upgrades, and potentially public art, can apply to all of the bridges in the corridor.

**Existing Parks** Each park located within the corridor is mapped as part of this category. The category responds to an area of high ranking strength, as well as concern and vision for change, based on Community Design Workshops input. Potential changes responsive to the intention of this category of improvements will include maintenance and upgrades at existing corridor parks, as well as additional sports and recreation facilities and programs. Specific changes have been suggested for the Jordan High School pool, Coolidge Park, DeForest Park, Scherer Park, Houghton Park, Cesar Chavez Park and Recreation Center, 14th Street Park, Los Cerritos Park and Veterans Park.

One specific example of potential park improvement has been identified at Silverado Park. This is identified as a Fitness Zone, in response to a specific workshop comment. Fitness zones – outdoor, publicly accessible gymnasium equipment areas – are already being installed in parks in Los Angeles County, and would likely be appropriate, and should be pursued, for multiple locations in parks within the corridor. A complete list of community concerns and changes expressed in this category of improvements is included in the Appendix to this Plan, and should be referred to by City Parks and Recreation staff as parks facilities and services plans are developed and refined.

**Livable Schools** Each existing school within the corridor is mapped and identified as a candidate for potential Livable Schools improvements. Potential improvements include: pedestrian and streetscape improvements adjacent to the campuses to facilitate students' safe routes to school, greening on campuses by removing asphalt on campus grounds and replacing it with planting or permeable surfaces, using green and energy efficient building materials and systems in campus construction, shad-



ing campus parking lots with trees, and providing better access for neighborhoods to school recreation facilities with joint use agreements. Long Beach Unified School District should consider incorporating Livable Schools principles into the implementation strategies for its current Facilities Master Plan. Other livability improvements at corridor schools include a program currently being piloted at Hudson Elementary School to test indoor air purification systems. Improvements such as this have been identified in the corridor wide recommendations addressed earlier in this chapter of the Plan.

**Planned Bike Paths** Includes bike path improvements identified in the City's Bicycle Master Plan, for which funding is not currently available. These are long-term plans to complete and improve the bicycle system in the city. There is a planning effort underway to update the Bicycle Master Plan which will incorporate the comments received within this planning effort.

Other important community design issue areas, based on community comments, are described below. While it is not possible to translate these comments into maps and target them to specific projects, this insight should be referenced by City staff as specific improvements are targeted in the I-710 corridor neighborhoods.

**Public Safety** Residents expressed concerns relating generally to crime, school safety, gang enforcement, police presence, staffing, visibility and patrols.

**Traffic and Parking** Specific suggestions have been made as part of this public process about traffic signal upgrades, needed traffic control measures and traffic calming opportunity areas, as well as on and off street parking problems, including those involving big rig trucks. It was not possible to evaluate and make recommendations relating to each of these suggestions, but they are important and can be taken into consideration by Public Works staff as traffic and parking planning processes move forward in the City, and as the Mobility element of the Long Beach 2030 Plan is developed. Discussions about the City's approved truck routes on arterial highways, and their livability impacts on corridor neighborhoods should also be a part of the City's Mobility element update.

**Code Enforcement** Concerns about graffiti and litter removal, as well as residential code violations have been expressed by the community as part of this planning process. These concerns have not been tied to specific locations within the corridor. However, proactive code enforcement initiatives in the City, such as Project Impact and the COPS Program, described in Chapter Two of this Plan, as well as the City's Neighborhood Improvement Strategy Areas (mapped in Figure 4-1, Community Assets), are all established mechanisms for addressing these issues.

**Streets and Alleys** Concerns about the ongoing maintenance and repair of corridor streets and alleys have been expressed by community members as well. General comments about alley repairs, and cleaning were made, as well as comments about alleys in specific locations in the south and west subareas of the corridor. In response to this, alley improvements are called out on the list of projects associated with the Neighborhood Improvements Map in this Plan. Further, an alley greening concept has been included among the Neighborhood Conceptual Plans included at the end of this chapter of the Plan.

**Public Art** Roughly a dozen comments have been made by residents about the need for more public art in the corridor during the Neighborhood Design Workshops. Suggestions have been made to incorporate more public art into existing park facilities, into neighborhoods and gateways, and into corridor transportation facilities. Opportunities to incorporate public art and high quality urban design elements into future I-710 projects should certainly be explored in the long term. In the short term, however, the City can take advantage of its newly formed pool of on-call artists, and seek to incorporate art elements into all of the public improvements projects that it constructs.

## CONCLUSION

Addressing the community's preferences relating to changes in the I-710 corridor neighborhoods will be a long-term process in the City. Given the diverse nature of the recommendations, this process will involve a number of City departments and local agencies. In order to compile the information included in this Plan about City initiatives, actions and plans in the corridor to date, as well as to develop the recommendations included here, it has been invaluable to work in collaboration with a wide range of City staff, as well as Port, LBUSD, Long Beach Transit, Metro, and others. Ensuring that a single forum is provided, in which staff from a wide range of disciplines can share information and strategize improvements in a coordinated fashion, and focus solely on the corridor neighborhoods and livability, as implementation goes forward, will continue to be a useful technique.



North Corridor Bird's Eye View



TABLE 4-2: NORTH CORRIDOR RECOMMENDATIONS

PROJECT	DESCRIPTION	RESPONSIBILITY	TIMELINE	IMPLEMENTATION/FUNDING
1. Edison ROW Greenbelt West	Greening of the Edison ROW west of the 710	DPRM	Long-term	DPRM, Possible state funding
2. Edison ROW Greenbelt East	Greening of the Edison ROW east of the 710	DPRM	Long-term	DPRM, Possible state funding
3. Artesia Blvd. Safe Route to School	Pedestrian, bridge and streetscape improvements between Long Beach Blvd. and Atlantic	DPW	Short-term	DPW, Safe Routes to Schools funding
4. North Long Beach Tree Buffer	Street tree planting in the residential neighborhoods adjacent to the 710, the 405, and the 91	DPW, DS	Short- and Long-term	DPW, Potentially Port of Long Beach, DS
5. Atlantic Ave. Streetscape	Pedestrian and open space improvements between South St. and Artesia as link between existing streetscape projects	DPW, DS	Long-term	DS, Possible state and federal funding
6. Harding St. Class II Bicycle Path*	Construction of class II bikeway along Harding per Bicycle Master Plan	DPW	Short-term	Funded
7. Deforest Wetlands*	Transform current nature trail area of DeForest Park into a wetlands park, per RiverLink plans	DPRM	Short-term	\$2.5 million awarded from LA County
8. South St. Parkway	Pedestrian and open space improvements and traffic calming measures along South St. between Dairy St. and the River	DPRM, DPW	Long-term	DPRM, Possible state and federal funding
9. Atlantic St. North Village	Enhanced neighborhood services, facilities, and parking in a new neighborhood center	DS	Short-term	DS, North Village Redevelopment Project in design now
10. Dairy and Addams One-Way Couplets	Multiple one way couplets in the Dairy and Addams neighborhoods to improve traffic, including couplets and additional streetscape and parking improvements at Ellis and 56th	DS, DPW	Short-term	DS, DPW
11. Carmelitos Senior Ctr. ADA Access	ADA improvements at Carmelitos to improve transit stop access and shopping center on Atlantic Blvd.	DPW	Long-term	DPW
12. Dominguez Gap Wetlands Connector	Proposed open space connection from east to the Dominguez Gap Wetlands	DPRM	Long-term	RiverLink, Possible state and federal funding or Port of Long Beach
13. Union Pacific Landscaping	Landscape improvements to rail corridor including the addition of screen fabric on bridge	DPRM, DS	Short-term	DS, DPRM
14. Dominguez Gap Wetlands*	Restored wetlands adjacent to the LA River	DPRM	Short-term	Funded, Under Construction
15. Alley Improvements	Alley improvements pilot project (location to be identified)	DPW	Long-term	DPW, Grant Funding

\* Denotes available funding

LEGEND

- Metro: Los Angeles County Metropolitan Transportation Authority
- Caltrans: California Department of Transportation
- DPW: City of Long Beach Department of Public Works
- DPRM: City of Long Beach Department of Parks, Recreation, and Marine
- LAC: Los Angeles County
- DS: City of Long Beach Development Services
- BNS: City of Long Beach Bureau of Neighborhood Services
- CLB: City of Long Beach - Multiple Departments



Central Corridor Bird's Eye View



# I-710 Corridor Project Draft EIR/EIS

## Preliminary Peer Review Findings



**City of Commerce**

August 21, 2012





### UPDATES/PROGRESS

- The DEIR/DEIS public review/comment period was extended by Caltrans to September 28, 2012.
- Project team held a business outreach meeting on July 30, 2012 at Rosewood Park Community Room. Many businesses potentially impacted by the project attended.
- Public Hearing on DEIR/DEIS was held at Rosewood Park Community Room on August 9, 2012.
- A community meeting will be held this Thursday (August 23rd) at Iglesia Bautista La Resurreccion at 1440 South Eastern.
- Draft comment letter submitted to City Council for initial review on September 4th.





## UPDATES/PROGRESS

- Project Team has indicated they would like to have the corridor cities select a preferred roadway alignment option sometime after the comment period closes & before the FEIR is released.
- For Commerce there are three Design Options:
  - Option 1 (Formerly Option J): Has "loop ramp" through Ayers Neighborhood.
  - Option 2 (Formerly Option M): Minimizes direct property impacts to Ayers, LAC prefers.
  - Option 3 (Base Option): Direct Washington Blvd ramps closed.
  - Ultimately the final option for Commerce may be a combination of design options ("hybrid").

## I-710 Corridor Project Draft EIR/EIS – Peer Review



- Objectives of Peer Review
  - Comprehensive review of the I-710 Corridor Draft EIR/EIS on behalf of the City of Commerce
    - Evaluate methodology used in impact analysis
    - Identify any erroneous or missing impact analysis
    - Identify any incomplete, inadequate, or missing mitigation measures
    - Identify opportunities for City review of future final plans, designs
    - Ensure City resources and concerns are adequately addressed and protected
  - Preparation of a comment letter on the Draft EIR/EIS to Caltrans/Metro on behalf of the City of Commerce
  - Close of public comment period: September 28, 2012



## I-710 Corridor Project Draft EIR/EIS – Peer Review



- Introduction: Peer Review Team
  - **PCR Services Corporation**
    - Anne Doehne Associate Principal, PCR Services Corporation
    - Heidi Rous CPP, Principal and Director of Air Quality, Climate & Acoustics Service
    - PCR Technical Staff
  - **Traffic Engineers: Fehr & Peers**
  - **Socioeconomic Consultant: HR&A Advisors, Inc.**
    - Community Impacts
  - **Geotechnical Engineers: Ninyo & Moore**



- “Comprehensive Review” of Draft EIR/EIS includes:
  - Chapter 1: Executive Summary
  - Chapter 2: Project Description
  - Chapter 3: Affected Environment
    - 23 subchapters addressing the full range of NEPA environmental topics
    - Construction impacts
    - Cumulative impacts
  - Chapter 4: CEQA
    - Full range of CEQA environmental topics
- All relevant Appendices and Technical Studies



## **I-710 Corridor Project Draft EIR/EIS – Peer Review**



- Final Comment Letter
  - Will be a formal comment letter submitted to Caltrans by the City of Commerce by the close of the comment period (September 28, 2012).
  - Will present the findings of the PCR Team's review of the Draft EIR/EIS, in the form of comments on specific environmental topics evaluated in the Draft EIR/EIS, as they pertain to the City of Commerce.
  - Will also reflect the input of City staff, elected officials, and members of the community to ensure key City resources and concerns are communicated.



# I-710 Corridor Project Draft EIR/EIS – Peer Review



## Preliminary Peer Review Findings





## I-710 Corridor Project Draft EIR/EIS – Peer Review



### Land Use

- **General Plan Policy Compliance.** The DEIR/DEIS addresses only the City's General Plan Transportation Element. A more thorough review of applicable General Plan Element goals/policies should be provided, including Community Development, Housing, Health and Safety, and Air Quality.
- **Division of an Established Community.** The DEIR/DEIS concludes project would not isolate/segregate residents without resources to relocate within their present communities, because adequate comparable replacement housing exists in neighboring cities. Given the limited replacement housing in Commerce, the DEIR/EIS should disclose the number/location of housing units to be acquired and evaluate impacts on community cohesion.



## I-710 Corridor Project Draft EIR/EIS – Peer Review



- **Community Impacts: Last Resort Housing.** City of Commerce should be consulted during Caltrans's consideration of Last Resort Housing for displaced residents.
- **Project Compatibility with Surrounding Land Uses.** Project compatibility with parks and rec facilities is discussed, but other incompatible uses in the study area (within 1/2-mile of mainline or ramp improvements) are not identified, or construction and permanent impacts are not characterized (e.g., Atlantic and Bristow Park Branch Libraries, Bandini Elementary School, the Dorothy Kirby Center confinement facility, places of worship). DEIR/DEIS should disclose all potentially affected land uses.



## Community Impacts

- Based on review of fiscal and economic data for each of the 3 Design Options, Commerce is disproportionately adversely affected compared to other cities along the I-710 corridor.
  - **Sales tax loss** ranges from 2.5%-4% of City revenue, and 32%-40% of corridor-wide loss
  - **Property tax loss** ranges from \$514K to \$736K, and 20-26% of corridor-wide loss
  - **Residential and nonresidential relocation** ranges from 66-166 properties, or 18%-36% of total corridor-wide relocations
  - **Employee Displacement** ranges from 446-510 jobs, or 7.8%-8.9% of employees currently in City, and 35%-38% of corridor-wide displacement



- However, none of the proposed mitigation measures acknowledge the scale of this disproportionate impact. The EJ chapter states two proposed mitigations/offsets: The addition of construction jobs along the corridor, including 9,650 for Commerce, as compensation; and a promise to “prioritize” efforts to successfully relocate businesses within the same City.
  - However, calculations supporting the construction job numbers were not provided and cannot be independently verified
  - Construction jobs are temporary and do not mitigate loss of permanent jobs
  - No details are provided about how Caltrans will prioritize relocation of businesses within the same City
- DEIR/DEIS mitigation measures for fiscal and economic impacts are largely nominal, and none are specific to Commerce.



- DEIR/DEIS provides only general estimates of economic and fiscal impacts to the City; it does not provide, as required under CEQA, an assessment of indirect impacts associated with Alternatives or Design Options.
  - Example: Loss of existing Washington Blvd freeway ramps under Design Option 3 could adversely affect businesses elsewhere in the City, which are collectively a major source of revenue for the City.
- Analysis of these impacts is still ongoing and final findings will be presented by the Project Team consultant HR&A Advisors.





## Utility/Emergency Services

- Mitigation Measure CON-3 requires preparation of Traffic Management Plans (TMPs) to reduce impacts on fire, law enforcement, and emergency service response times. Mitigation Measure CON-4 requires preparation of Specific Utility Relocation Plans to minimize impacts on emergency services. The City should request the opportunity to review and comment on these plans as they are prepared.
- Mitigation Measure CON-3 does not require the TMPs to identify construction staging areas. The City may want to request that this be addressed, especially in light of the three Design Options proposed within City limits.



- Option 3 would reduce access to/from I-710 and Washington Blvd, to/from I-710 and Pacific Pl, and to/from I 710 and Wardlow Rd. City should review permanent traffic impacts resulting as they pertain to emergency vehicle access. Additional upgrades to adjacent surface streets may be required to maintain emergency response times under Option 3 and may be a potential mitigation measure.
- DEIR/DEIS does not identify the Washington Blvd Improvement Project as a related project. The City should comment if there are concerns over utility conflicts along Washington Blvd.
- The City may choose to request a more detailed analysis with regard to emergency access and emergency response times in the area around Washington Blvd ramps.

## I-710 Corridor Project Draft EIR/EIS – Peer Review



- DEIR/DEIS does not address minor utility impacts within Commerce, but those could result in traffic impacts or disruptions to utility service. Per Mitigation Measure U&ES-2, Specific Utility Relocation Plans will be prepared to identify and minimize these impacts. The City should request an opportunity to review these, particularly with respect to utilities to be relocated along Slauson Ave, Atlantic Blvd, Bandini Blvd, and Sheila St.
- Preparation of the Comprehensive Utility Relocation Study for North Segments of I-710 (currently in prep by Metro) is not called out as a mitigation measure. Caltrans should consider doing so, and Commerce should request an opportunity to review the study.



## Traffic & Transportation

- Peak period parking restrictions are proposed along three major north-south corridors in Commerce. No analysis provided of utilization or whether displaced parking demand can be accommodated elsewhere. Potential socio-econ impacts should be evaluated.
- Given the size of some Commerce intersections, the standard signal timing assumptions used in DEIR/DEIS may not allow for adequate pedestrian crossing times. This may result in underestimation of vehicle delays for some intersections.
- Discrepancies between modeling assumptions and existing field conditions for 6 Commerce intersections were observed that may affect analysis by under-reporting delays and thus impacts.



## I-710 Corridor Project Draft EIR/EIS – Peer Review



- TIA leaves out major intersections in Commerce that may be affected by the proposed project, given their proximity to the I-710/I-5 interchange: Bandini Blvd & Garfield Ave, Telegraph Rd & Garfield Ave, and Atlantic Ave & Eastern Ave. Explanation of why these locations were not analyzed should be provided.
- No assessment of potential transit system impacts, including increased transit service time or changes to existing bus routes that would be required due to roadway changes. Analysis of these impacts should be requested.
- Mitigation measures for 3 intersections should be modified:
  - Slauson Ave & Eastern Ave: ROW acquisition along Slauson is necessary; secondary impacts are not evaluated.

## I-710 Corridor Project Draft EIR/EIS – Peer Review



- Slauson Ave & Garfield Ave: Would require right-of-way acquisition on the southeast quadrant of the intersection; secondary impacts not evaluated.
- Garfield Ave & Gage Ave: Would require major ROW acquisition and possibly building demo at intersection; secondary impacts not evaluated.
- City staff have indicated that there is potential need for a truck staging yard within Commerce, to relieve staging on Washington and Atlantic Blvds. It may be appropriate for the City to request the consideration of development of such a yard as a mitigation measure, if the nexus to an impact, such as congestion on these arterials as a result of the project, can be established. Project team traffic engineer is investigating.

## Visual Resources

- Visual simulations of proposed soundwall and berm treatments in the DEIR/DEIS show a Base Condition (i.e., standard Caltrans landscaping, including groundcover and some young trees) and an Enhanced Condition ("possible aesthetic treatments" with decorative masonry wall surface treatments and more vegetation, including vines and/or more mature trees). Caltrans will develop final treatments in consultation with community stakeholder groups. It is recommended that the City request Enhanced Condition treatment of sound walls and freeway edges/berms, especially in proximity to residential neighborhoods.





- The DEIR/DEIS provides Key Views of the project from 5 NW residential neighborhood vantages and identifies viewer sensitivity in those areas as high; these should be priorities for Enhanced Conditions. The City should determine if there are other visually sensitive areas where it wants Enhanced Conditions: other residential streets, parks, or city "gateways".
- City should request that existing low existing visual quality in visually sensitive areas (e.g., due to an existing freeway soundwall or electrical lines) not be a reason to rule out Enhanced Condition soundwall/berm treatment.
- As noted under Utility/Emergency Services, the City should request an opportunity to provide input into future draft Specific Utility Relocation Plans, since those may also have aesthetic impacts on residential or other visually sensitive locations.



## Cultural Resources

- Historic Property Survey Report submitted by Caltrans to the State Office of Office Historic Preservation (SHPO) lists only State Agency-designated Bridges. Commerce should request that Local Agency Bridges be added, if any exist in the City.
- The City of Commerce has criteria for local landmark designation, but surveyed properties in the APE were evaluated only for National and CA Register eligibility, not local eligibility. Some affected City properties may be eligible individually or as part of a district at the local level. Analysis against local criteria is needed.



## I-710 Corridor Project Draft EIR/EIS – Peer Review



### Hydrology & Floodplain

- DEIR/DEIS does not identify any flooding concerns in Commerce. Given to the Los Angeles River and reliance on pumps to drain portions of the I-710, the City should raise any specific flooding concerns in the vicinity of the freeway.
- Since proposed Alternatives/Options would increase the number of freeway lanes/associated impervious area and vehicle capacity, City should request that DEIR/DEIS provide additional detail concerning post-project surface runoff volumes, rates, and discharge locations onto City streets, especially if the City is aware of undersized, aging, or otherwise inadequate municipal storm drain infrastructure on its streets.



## Water Quality & Stormwater Runoff

- Project would increase impervious surface area, runoff volume, and pollutant loads, and require replacement or extension of existing drainage systems along the I-710 corridor. The City should request that it be consulted during development of design development, treatment, and operational BMPs that address the capture and treatment of runoff, once preferred Alt is selected.
  - Design development BMPs: preserve existing vegetation, provide slope protection with vegetation
  - Treatment BMPs: biofiltration swales, infiltration basins, media filters, detention basins, gross solids removal devices, and wet basins
  - Operational BMPs: Maintenance of storm drains, roads/bridges, vegetation



## I-710 Corridor Project Draft EIR/EIS – Peer Review



### Hazardous Waste/Materials

- DEIR/DEIS section relies on applicable Federal, State, and local lists to identify contaminated sites, and on applicable Federal, State, and local regulations to ensure remediation. If there are specific City concerns about sites listed in the DEIR/DEIS or that have been overlooked, those should be raised in City comments.





## Air Quality (Construction)

- **Need for Mitigation Measure to Reduce Significant Construction Impact.** DEIR/DEIS analyzed construction impacts on a regional basis for project as a whole, and for construction of maximum single segment. Daily emissions would exceed thresholds for all criteria air pollutants, on a worst-case overlapping day. For maximum single segment, only NOx exceeds threshold (3x applicable CEQA threshold).

Although Caltrans commits to 14 construction air quality mitigation measures, all but two are focused exclusively on lowering or controlling emissions of particulate matter (dust). The DEIR/DEIS does not contain specific mitigation measures to address the significant and unavoidable NOx impact.



## I-710 Corridor Project Draft EIR/EIS – Peer Review



Potential industry-accepted, commercially available strategies including engines certified to USEPA Tier 3 or 4 standards (or more stringent state-of-the-art standards applicable 10+ years from now) and use of newest, cleanest on-road haul trucks.

- **Need for Localized Construction Analysis:** Prior to final selection of Alternative and Design Options, Caltrans should provide focused assessment of localized construction impacts, including:
  - Discussion of potential near-roadway impacts from construction based on the SCAQMD Localized Significance Threshold (LST) methodology
  - Identification of potential sensitive receptors that could experience impacts in excess of the standards
  - Emissions from proposed rock crushing and cement plants, if plans include potentially locating these in Commerce



## **I-710 Corridor Project Draft EIR/EIS – Peer Review**



EIR/EIS mitigation measures could be strengthened to require the use of diesel particulate filters certified to the CARB Level 3 standards.

In addition, Caltrans should include a requirement for an “Air Quality Community Protection Plan” that includes provisions to temporarily relocate impacted residents, provide upgrades to residential air filtration systems, and provide a community liaison that is available to investigate and address air quality issues in the affected community.



## I-710 Corridor Project Draft EIR/EIS – Peer Review



### Air Quality (Operation)

- **Need to Analyze Potential for Increased Truck Queuing and Idling**
  - DEIR/DEIS does not discuss potential for increased truck queuing on local roadways (specifically Washington and Atlantic Boulevards)
  - Potential for increasing existing noise, air quality, and traffic/congestion issues
  - Possible mitigation includes off-street dedicated truck staging/queuing area



## **I-710 Corridor Project Draft EIR/EIS – Peer Review**



- **Need to Analyze and Reduce Potential Long-term Impacts to Near-Roadway Receptors**
  - DEIR/DEIS discusses respirable particulate matter (PM<sub>2.5</sub>) concentrations within 50 meters of the corridor in general terms.
  - Health Risk Assessment Technical Study indicates the potential to experience high levels of PM<sub>2.5</sub> extends into residential areas, in particular the Ayers and Northwest neighborhoods.
  - City should ask Caltrans to provide localized impact assessment for neighborhoods near to the main roadway and relocated on- and off-ramps.
  - Possible mitigation measures may include Caltrans providing long-term enhanced street sweeping, upgrades to residential air filtration systems, or other appropriate mitigation or avoidance strategies.

## Noise (Construction)

- **Need for Analysis of Nighttime Construction Impacts:** The DEIR/DEIS analyzed construction impacts using Caltrans' Noise Abatement Criteria (NAC). NAC criteria differ depending on the land use. However, NAC criteria do not take into account the sensitivity to nighttime noise. Nighttime noise is problematic for three reasons:
  - Introduced noise sources, such as heavy-duty construction equipment, is more noticeable when ambient levels are low;
  - More residents are at home in the evening and are more likely than industrial receptors to have their windows open or be outdoors, and
  - Nighttime noise can cause sleep disturbances.



## I-710 Corridor Project Draft EIR/EIS – Peer Review



- According to the City of Commerce Noise Standards, noise limits are 55 dBA during daytime (7 am to 7pm), 50 dBA during evening (7 pm to 10 pm), and 45 dBA during nighttime (10 pm to 7 am). Nighttime construction is allowed, but DEIR/DEIS analysis and mitigation did not use a more stringent set of nighttime thresholds, as many agencies/municipalities suggest.
- It is suggested that the City request Caltrans establish a “Noise Community Protection Plan” that includes provisions for a community liaison to investigate and address noise issues in the affected community; mandatory sound walls/blankets; construction-period monitoring; and strategies such as temporary relocation of severely impacted residents or permanent residential upgrades (i.e. new window systems and other noise dampening strategies).



# I-710 Corridor Project Draft EIR/EIS – Peer Review



## Q&A

## Comments





# Performance Evaluation of Air Filtration Devices

## FINAL REPORT

Prepared for the  
South Coast Air Quality Management District  
21865 Copley Dr, Diamond Bar, CA 91765

by

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## **DISCLAIMER**

The statements and conclusions in this report are those of the contractor and not necessarily those of the South Coast Air Quality Management District (AQMD). The mention of commercial products, their source, or their use in connection with material reported herein is not to be construed as actual or implied endorsement of such products.

## **ACKNOWLEDGEMENTS**

This report was prepared at the University of California, Riverside, Bourns College of Engineering-Center for Environmental Research and Technology (CE-CERT). The author would like to thank the following organization and individuals for their valuable contributions to this project: AQMD for providing the instruments to measure the targeted air pollutants; Dan Baldwin, Director of Risk Management, Facilities, and Fleet Services, Jurupa Unified School District, and Gary Dixon, Principal of Sunnyslope Elementary School, for allowing us access to the school site and a classroom in which to perform the measurements. Funding for this work was provided by AQMD.

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## EXECUTIVE SUMMARY

The goal of this testing program was to evaluate the ability of various air filtration devices to reduce the outdoor infiltrated concentrations of ultrafine particles (UFP; particles with an aerodynamic diameter equal or less than 100 nm) and black carbon (BC; an indicator of diesel particles) in a typical classroom setting. Over 150 manufacturers were contacted by South Coast Air Quality Management District (AQMD) staff, and nine companies participated in this program with a total 15 different air filtration devices submitted for testing. Specifically, ten panel filters, four stand-alone units, and one register system were submitted. All measurements were conducted between 07/08/10 and 08/03/10 by the University of California Riverside Center for Environmental Research & Technology (CE-CERT) in a portable classroom at Sunnyslope Elementary School in Riverside, CA. The use of this type of prefabricated structure is becoming more and more prevalent in United States public schools, and it has been estimated that in California, around one third of the students spend time in portable classrooms during a typical school day (Shendell et al. 2004).

For this program, UFP and BC were measured at different distances from the device tested and both indoors and outdoors, and each technology was examined for a minimum of six consecutive hours. Baseline measurements were taken before installing any of the air purification solutions to estimate the pre-existing relative and overall removal efficiencies of the classroom before modification. Measurements also included: (1) the pressure drop across the panel filters in the Heating, Ventilation, and Air Conditioning (HVAC) system, (2) the noise level and ozone generation of the stand-alone devices, and (3) the air exchange rate (AER) of the room.

For the purpose of this study, the performance of each air filtration device was estimated by measuring the relative and the overall particle removal efficiencies, which were defined as follows:

*Relative Removal Efficiency:* percentage reduction in the concentration of UFP (or BC) downstream of the device relative to its concurrent ambient (outdoor) level upstream of the HVAC, demonstrated during the six hour testing period

*Overall Removal Efficiency:* percentage reduction in the concentration of UFP (or BC) in the center of the classroom and at breathing height relative to its concurrent ambient (outdoor level), also demonstrated during the six hour testing period

Only air filtration devices that satisfied the following minimum pre-specified requirements were accepted as approved technologies:

- Overall removal efficiencies for UFP and BC of at least 85% (for panel filters and register systems)
- Relative removal efficiency for UFP and BC of at least 85% (for stand-alone units)
- Low pressure drop across the filter (for panel filters)
- No ozone generation (<5 ppb)
- A noise level below 45 decibels [db(A)] (for stand-alone units)

The main results of this testing program have been summarized below:

- For panel filters, the overall (and relative) particle removal efficiencies increased with increasing Minimum Efficiency Reporting Value (MERV) rating. The “Nanomax S-220” manufactured by IQAir (a MERV 16 panel filter) was the only HVAC-mounted device that satisfied the performance requirements set by AQMD, and its overall removal efficiencies were between 88 and 91% for UFP and BC, respectively.
- All stand-alone units appeared to have a substantially higher removal efficiency immediately downwind of the device (relative removal efficiency) than at breathing level (overall removal efficiency). This was due to the distance between the indoor real-time monitors and the air supply registers, the lower air flow rate “processed” by these air filtration devices relative to the flow rate supplied by the HVAC system, and other factors intrinsic to our particular classroom set-up. Therefore, relative removal efficiency was the most robust and appropriate measurement used to evaluate the performance of these types of devices. In this respect, all stand-alone units tested showed high removal efficiencies with values varying from 94 to 100% and between 83 and 94% for UFP and BC, respectively. However, only the “CleanZone SL” manufactured by IQAir did not exceed a noise level of 45 decibels [dB(A)], a threshold set by many school districts for new in-classroom equipment.
- All stand-alone units and the register mounted system (which employs an electrostatic filter) were found to generate no measureable ozone levels.

## INTRODUCTION

In 2009, the South Coast Air Quality Management District (AQMD) conducted a pilot study to investigate the effectiveness of different air purification systems/solutions in reducing the exposure of children to outdoor-infiltrated and indoor-generated air contaminants inside nine classrooms at three Southern California schools (AQMD, 2009). The introduction in their report notes that numerous epidemiological and toxicological studies have found positive associations between exposure to atmospheric particulate matter (PM) and adverse health effects (Pope and Dockery, 2006; Environmental Protection Agency Integrated Science Assessments, 2009). Although air quality standards have been established for outdoor ambient environments, a significant portion of human exposures to PM occurs indoors, where people spend around 85-90% of their time. Hence, it is important to understand and reduce the sources of both indoor and outdoor PM. Indoor PM consists of outdoor particles that have infiltrated indoors, particles emitted indoors (primary), and particles formed indoors (secondary) from precursors emitted both indoors and outdoors. Children are regarded as particularly susceptible to potential health hazards related to PM exposure, which includes asthma, lung inflammation, allergies and other types of respiratory and cardiovascular problems. School-aged children spend approximately 30% of their day in classrooms. For this reason, minimizing the concentration of PM (as well as that of other air contaminants) inside classrooms is important, especially at schools located in close proximity to roadways and other substantial sources of air pollution.

Earlier in 2010 AQMD released an Announcement of a Testing Opportunity of Air Filtration Technologies (PON2010-02) to solicit a list of qualified air filtration devices (panel filters, register-based air purifiers, and stand-alone units) to be used in the installation and maintenance of air filtration systems in Wilmington area schools using \$5.4 million in funds from the TraPac Settlement Special Revenue Fund. In accordance with AQMD's Procurement Policy and Procedure, notice of this testing opportunity was published in the Los Angeles Times, the Orange County Register, the San Bernardino Sun, and Riverside County Press Enterprise newspapers to leverage the most cost-effective method of outreach to the entire South Coast Air Basin. Additionally, potential vendors were notified utilizing AQMD's TAO mailing list and other mailing lists as appropriate and by conducting outreach at industry conferences.

To qualify for free testing of air filtration technologies for removal of ultrafine particles (UFP; particles with an aerodynamic diameter equal or less than 100 nm) and black carbon (BC; an indicator of diesel particles), 20" x 30" x 1" (or 2" maximum) deep panel filters and/or register-based air purifiers and/or stand-alone units were submitted by various US manufacturers to the University of California Riverside College of Engineering Center for Environmental Research & Technology (CE-CERT) between 05/07/10 and 06/30/10. Each manufacturer was allowed to submit no more than three air filtration technologies for testing. The specific goal of this program was to evaluate the efficiency of all received air filtration devices for reducing the outdoor-infiltrated and indoor-generated concentrations of UFP and BC in a typical classroom setting. All measurements were made in a portable classroom at Sunnyslope Elementary School in Riverside, California, from 07/08/10 through 08/03/10. Recently, the use of prefabricated, portable classrooms has increased in United States public schools, and in California approximately one of three students spends time inside this type of structure during a typical school day (Shendell et al. 2004).

Additional measurements conducted during this testing program also included: (1) the pressure drop across the panel filters in the Heating, Ventilation, and Air Conditioning (HVAC)

system, (2) the noise level and ozone generation of the stand-alone devices, and (3) the air exchange rate (AER) of the room.

Over 150 manufacturers were contacted by AQMD staff and nine manufacturers submitted a total of 15 different air filtration devices for evaluation (i.e. ten panel filters, four stand-alone units, and one register system). This report describes the procedure designed to assess the performance of all submitted air filtration systems and the main results of this testing program.

## EXPERIMENTAL PROCEDURES

### Testing Location

The performance evaluation of all submitted panel filters, stand-alone units, and of a register mounted system was conducted in a portable classroom located at Sunnyslope Elementary School, 7050 38th St, Riverside, CA (Figure 1) that was specifically selected for the purpose of this testing. This school is located within 1000 feet north of a major freeway (Pomona freeway) and the average fine particulate matter (PM<sub>2.5</sub>; particles with an aerodynamic diameter equal or less than 2.5 μm) concentration in this area is generally high. Pictures of the outside of the classroom are shown in the Appendix (Figures A-1 and A-2<sup>1</sup>).



**Figure 1** Aerial view of Sunnyslope Elementary School and of the surrounding area

The classroom is 39 feet long, 23 feet wide, and 8.5 feet high to the false ceiling (~10.5 feet to the permanent ceiling), and it is conditioned by an HVAC manufactured by BARD Inc. (model WH483-A10xx4xxx heat pump; Figure A-3). The setup of the equipment took place between 7/7/10 and 7/8/10 and all measurements were conducted on weekdays from 7/8/10

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<sup>1</sup> See Appendix

through 8/3/10. No children were present during testing. The measurement equipment was removed on 8/4/10.

### **Measurement Equipment Setup and Testing Procedure**

Ten panel filters, four stand-alone units, and one register system were installed inside the selected classroom (one at a time) according to the manufacturer specifications, and tested for their ability to reduce the indoor concentrations of UFP and BC. For this purpose, UFP and BC were measured at up to four positions using real-time analyzers connected to a central data logger (Figure 2):

*Position #1:* Outside the classroom and immediately upwind of the HVAC system intake (when testing panel filters, register systems, and stand-alone units)

*Position #2:* In the center of the classroom at about three feet from the floor (the approximate height of a child's head when seated), away from all registers, and just a few meters from the student area (when testing panel filters, register systems, and stand-alone units)

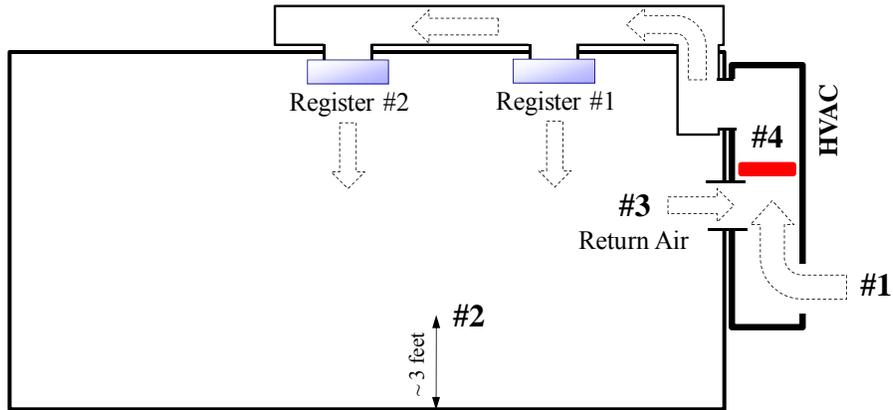
*Position #3:*

- a. Upstream of the return air intake duct in the classroom (when testing panel or register filters)
- b. As close to the air intake of the stand-alone as possible, with the HVAC system on, and with no filtration device mounted on the HVAC register (when testing stand-alone units)

*Position #4:*

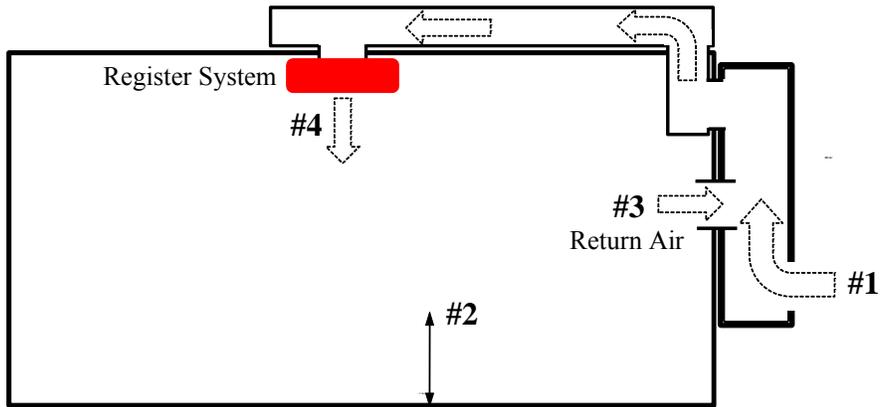
- a. As close to the downstream side of the filter or register systems as possible (when testing panel filters or register systems)
- b. As close to the outlet of the stand-alone as possible (when testing stand-alone units)

a)

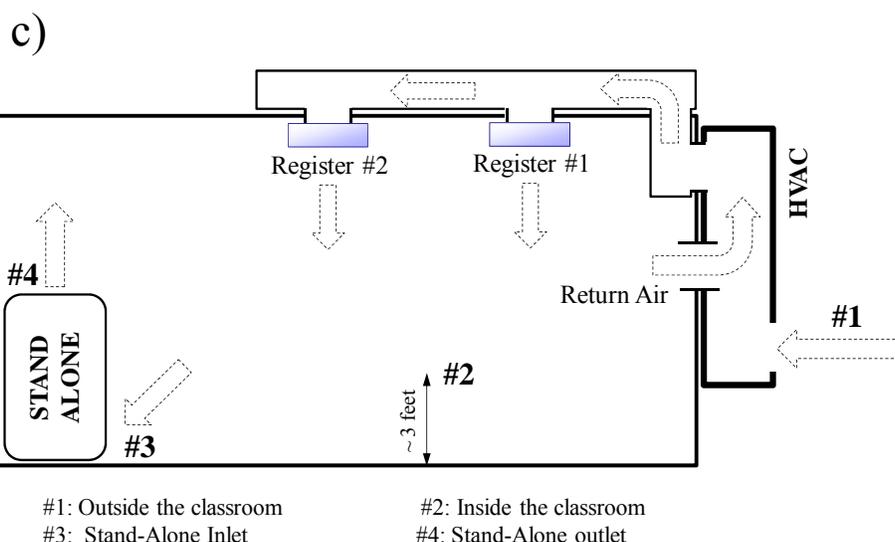


#1: Ambient / upstream of HVAC  
 #2: Classroom  
 #3: Upstream of return air duct  
 #4: Downstream of filter  
■ Panel Filter

b)



#1: Ambient / upstream of HVAC  
 #2: Classroom  
 #3: Upstream of return air duct  
 #4: Downstream of register  
■ Panel Filter



**Figure 2** Configuration used for testing the particle removal efficiency of a) panel filters, b) register systems, and c) stand-alone units. The approximate positions of the four mobile air monitoring stations that were used to measure the indoor (in-classroom) and ambient (outdoor) concentrations of UFP and BC are shown as numbers 1 through 4

It should be noted that one of the two outlet registers was properly sealed prior to testing any register systems (Figure 2b). Sampling at all positions was conducted in the morning / early afternoon for a minimum of six consecutive hours during which the HVAC system was operated at the normally used set point. All test measurements were conducted under the same repeatable conditions, with the HVAC system on and when the room was not occupied by students. When testing all air filtration devices the HVAC unit was set to control the room temperature to 74 °F and the fan was run continuously.

It is worth noting that while the standard MERV rating system for filters may adequately address PM<sub>2.5</sub> mass removal efficiency, these ratings do not address particles below 300 nm and fresh diesel PM which is mostly less than 200 nm. Thus, air filtration technologies are not typically tested for removal of smaller particles such as UFP and those particles containing most of the BC. Given the potential challenges of filtering out these smaller particles combined with evidence associating them with increased toxicity or cancer risk, the main focus of our testing program was on measuring the ability of commercial air filtration systems to remove UFP and BC from the indoor air of classrooms. For this purpose, four mobile air quality monitoring stations were used to measure the indoor and outdoor concentrations of these two targeted air pollutants (Figures A-4 and A-5). Each of these stations was comprised of a small table supporting the following instruments:

- A portable Aethalometer (model AE42, Magee Scientific, 2800 Adeline St., Berkeley CA 94703) to provide continuous BC concentration measurements (ng/m<sup>3</sup>) at five minute intervals. BC is a component of PM indicative of diesel and soot particles from combustion processes, and typically is found in smaller sized particles.

- A water-based condensation particle counter (CPC model 3781, TSI, 500 Cardigan Road, Shoreview, MN 55126) to provide continuous measurements of the particle number concentration ( $\#/cm^3$ ; an indicator of UFP) at one minute intervals. This CPC model measures the number of particles down to at least 10 nm in diameter.

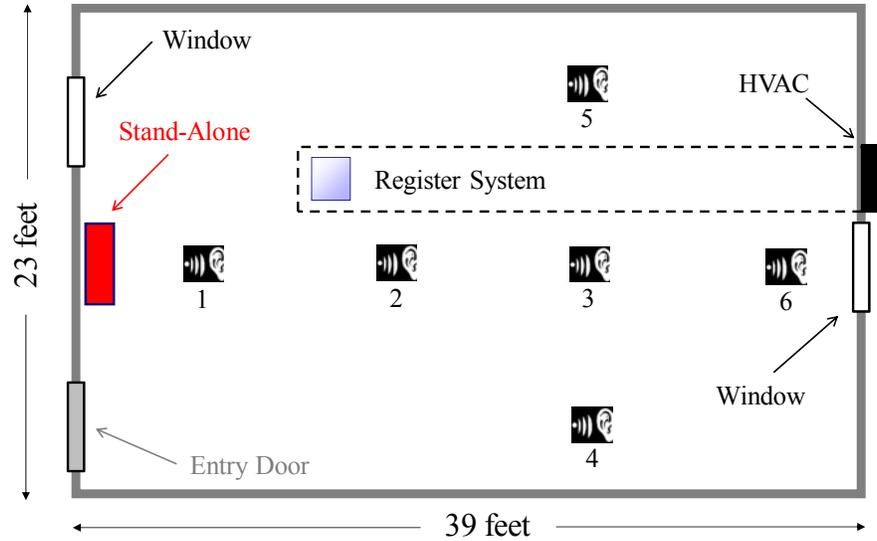
Before and after testing each air purification device, the four measurement stations were collocated inside the test class-room and all instruments run “side-by-side” for 30 minutes to provide quality assurance of the measurements, to estimate the precision characteristics, and to identify any potential problems. The onsite instrument operators maintained a written log-book of any conditions which may have affected the measurements. They also monitored the results as they were displayed on a computer screen and noted in the log-book if they observed any readings which appeared to be abnormal. At the end of each day of testing, the data were downloaded to a disc or a flash drive and given to the CE-CERT principal investigator (PI) for an initial evaluation.

### **Baseline Measurements**

Baseline measurements were taken before installing any of the air purification solutions to estimate the pre-existing relative and overall removal efficiencies of the classroom before modification. For this purpose a clean “low efficiency” panel filter (of the same type and brand usually employed by Sunnyslope Elementary School; Figures A-6 through A-8) was mounted inside the HVAC system and UFP and BC measured at positions 1 through 4 as described in the previous section (Figure 2a). In this case, sampling was conducted in the morning / early afternoon for five selected days from 07/08/10 to 07/14/10 and for a minimum of six hours per day during which the HVAC was operated at the normally used set point with the fan set to stay on. To ensure a more direct comparison between all devices tested, baseline conditions for stand-alone devices were established with the HVAC turned on but with no filtration device mounted on the HVAC register. All baseline measurements were conducted under repeatable conditions when the room was not occupied by students.

### **Additional Measurements**

A 0 to 1” water Magnehelic gauge was used to monitor the pressure drop across the HVAC filter. When evaluating the performance of air filtration devices using components that might generate ozone (e.g. air ionizer purifiers), an ozone detector (Dasibi model 1003AH) was used to measure any potential variations in the indoor concentration of this pollutant. Also, the noise level produced by the stand-alone units was measured at several locations in the room with an Extech 403407 decibel meter. The measurements were made with the HVAC off and with the meter pointed at the stand-alone unit while held at ~3 feet above the floor at the locations indicated in Figure 3. The distance from the stand-alone to the numbered locations are: 1 = 40”, 2 = 10’ 40”, 3 = 20’ 40”, 4 = 20’ 40” but 5’ north of position 3, 5 = 20’ 40” but 7’ south of position 3, and 6 = 30’ 40”.



**Figure 3** Schematic of the test classroom showing where the noise measurements were taken

The indoor-outdoor air exchange rate (AER;  $\text{hr}^{-1}$ ) of the test room was estimated by injecting a known amount of carbon monoxide (CO) into the HVAC ambient air intake and monitoring the decay with a commercial IR analyzer (Horiba PG250 multi-gas analyzer). Specifically, a Teflon tube connected to a cylinder containing 15% hydrogen ( $\text{H}_2$ ) in 85% CO was placed into the grill where ambient air enters the HVAC. The valve of the cylinder was then opened and the  $\text{H}_2/\text{CO}$  mixture flowed through a flow meter until at least 50 ppmv of CO had been injected into the room. No other significant source of CO was present inside the classroom when these measurements were taken. Assuming an exponential decay of particles, that AER and outdoor concentrations are constant during the decay period, and that indoor concentrations are well mixed, then:

$$C_t = e^{-(AER+k)t} C_0 \quad (1)$$

or,

$$\ln C_t = -(AER + k)t + \ln C_0 \quad (2)$$

where,  $C_t$  is the indoor CO concentration after time  $t$  (after the decay period),  $C_0$  is the initial peak CO concentration (right after CO emission), and  $k$  is the indoor loss rate for particles or gases ( $\text{hr}^{-1}$ ; Abt et al. 2000). Because  $k$  is rather negligible for CO, it was possible to estimate the AER for the test classroom directly from eq (2) by regressing  $\ln C_t$  over  $t$ .

## **HVAC Specifications**

While BARD has discontinued the production of the WH48 heat pump used in the test classroom, they have maintained all of the specification information for this and other discontinued models on their website. This state that the rated air flow rate for this particular model is 1550 cfm and that the total air flow at high speed will decrease from 1885 cfm at 0” water static pressure across the high speed tap to 1285 cfm at 0.4” water static pressure at the high speed tap. The ventilation flow (i.e. the flow of ambient air being mixed with the room return air flow) increases from ~10% at 0” water static pressure to ~25% at 0.4” water static pressure.

## **Devices Tested**

Nine different manufacturers participated in the testing program and a total of 15 different air filtration technologies were evaluated. Three of the submitted devices were not tested because of their incompatibility with the HVAC system or due to technical difficulties related to their installation. In particular, one of the panel filters submitted by Camil Farr was too large to be mounted in the BARD panel filter holder. The Genesis Air Photo-catalytic Panel, designed to be connected inside the solid aluminum ductwork employed in permanent buildings, did not fit inside the corrugated ductwork present in the portable classroom used for these tests. Environmental Dynamics Group submitted an electrostatic HVAC-based panel filter for which performance could not be evaluated because the unit was not supplied with the transformer required for its proper operation.

A list of all air filtration technologies submitted to and tested by CE-CERT along with the manufacturers’ names, model numbers, device dimensions, MERV rating and pressure drop across the filter (for panel filers only), and the corresponding IDs used throughout this report can be found in Table 1.

**Table 1** Information about all devices tested including manufacturers' names, model numbers, filter dimensions, MERV rating and pressure drop across the filter (for panel filters only), and the corresponding IDs used throughout this report

<b>Manufacturer</b>	<b>Model</b>	<b>Nominal Size</b>	<b>MERV rating</b>	<b>Delta P (inches water)</b>	<b>ID in report</b>
Existing Filter (Baseline)	NA	20" x 30" x 1"	8	0.14	EF-8
Camil Farr	30/30 <sup>®</sup> – M8	20" x 30" x 1"	8	0.10	CF-8
Air Cleaners, Inc.	Washable Electrostatic	20" x 30" x 1"	7	Not recorded	WE1-7
Air Cleaners, Inc.	Washable Electrostatic	20" x 30" x 2"	7	0.14	WE2-7
Freudenberg Filtration Technologies L. P.	Ultra 1500	20" x 30" x 1"	11	0.13	U-11
Freudenberg Filtration Technologies L. P.	Maxx 2000	20" x 30" x 1"	12	0.14	M-12
eSpin Technologies, Inc.	Exceed	20" x 30" x 2"	11	0.10	E-11
eSpin Technologies, Inc.	Exceed	20" x 30" x 2"	13	0.12	E-13
eSpin Technologies, Inc.	Exceed	20" x 30" x 2"	14	0.24	E-14
IQ Air	IQ Air MERV 13	20" x 30" x 2"	13	0.08	IQ-13
IQ Air	Nanomax S-220	20" x 30" x 2"	16	0.13	IQ-16
IQ Air	CleanZone SL	72" x 29" x 10"	500	NM	CZ
Pure Air	HPS 350	13" x 13" x 21.5"	140 - 350 <sup>2</sup>	NM	PA
NQ Industries Inc.	NQ400	32" x 26" x 13"	195 - 545 <sup>3</sup>	1.1 <sup>4</sup>	NQ-1
NQ Industries Inc.	NQ Clarifier	28" x 15" x 14"	350 <sup>5</sup>	NM	NQ-2
Environmental Dynamics Group, Inc.	1V8-4812-291/2	51" x 57" x 14"	NA	NM	EDG

NA = Not applicable

NM = Not measured

<sup>2</sup> Four switchable flow rates between 140 and 350 cfm; tested at 350 cfm

<sup>3</sup> Four switchable flow rates between 195 and 545 cfm; tested at 545 cfm. Also contains one UV lamp

<sup>4</sup> Reading on gage of NQ-1

<sup>5</sup> Variable speed fan up to a maximum flow rate of 350 cfm; tested at 350 cfm. Also contains two UV lamps

## Relative and Overall Removal Efficiency

The Relative Removal Efficiency of each air filtration device tested was estimated as:

- a) The percentage reduction in the concentration of UFP (or BC) downstream of the device tested (position #4; Figure 2) relative to its concurrent ambient (outdoor) level upstream of the HVAC (position #1), demonstrated during the six hour testing period.

$$RRE = 100 \times (P_{\#1} - P_{\#4})/P_{\#1} \quad (3)$$

Similarly, the Overall Removal Efficiency for each air filtration device tested was defined as the percentage reduction in the concentration of UFP (or BC) inside the classroom (position #2; Figure 2) relative to its concurrent ambient (outdoor) level (position #1), demonstrated during the six hour testing period.

$$ORE = 100 \times (P_{\#1} - P_{\#2})/P_{\#1} \quad (4)$$

where,

$P_{\#1}$  = particle number or BC concentration at position #1 (ambient) expressed in  $\#/cm^3$  and  $\mu g/m^3$ , respectively

$P_{\#4}$  = particle number or BC concentration at position #4 (downstream of the device) expressed in  $\#/cm^3$  and  $\mu g/m^3$ , respectively

$P_{\#2}$  = particle number or BC concentration in position #2 (inside the classroom and at breathing height) expressed in  $\#/cm^3$  and  $\mu g/m^3$ , respectively

Measurement days affected by exceptional meteorological conditions (e.g. rain) or instrument malfunction were discarded from these calculations.

Condensation Particle Counters were set to store the date and time, error flags, and particle concentration after every minute. After combining the four individual CPC measurements (positions 1 through 4; Figure 2) into a single file aligned by date and time, the relative and overall removal efficiencies for each device were calculated on a minute by minute basis and then averaged over the entire testing period. Similarly, Aethalometers were set to record the date and time, BC concentration, error flags, and other data after every 5 minutes. All data were analyzed and smoothed using the WUAQL AETHALOMETER DATA MASHER (Version 6.0h, May 22, 2008; Air Quality Laboratory at Washington University in St. Louis), and the four individual Aethalometer measurements (positions 1 through 4; Figure 2) were combined into a single file aligned by date and time. Also in this case, the five minute average removal efficiencies for BC were averaged over the entire testing interval.

## Performance Criteria

This testing procedure was designed to select the air filtration devices that provide the most substantial improvement in air quality with respect to baseline conditions. The best performing technologies are the ones that satisfy the following specifications set by AQMD:

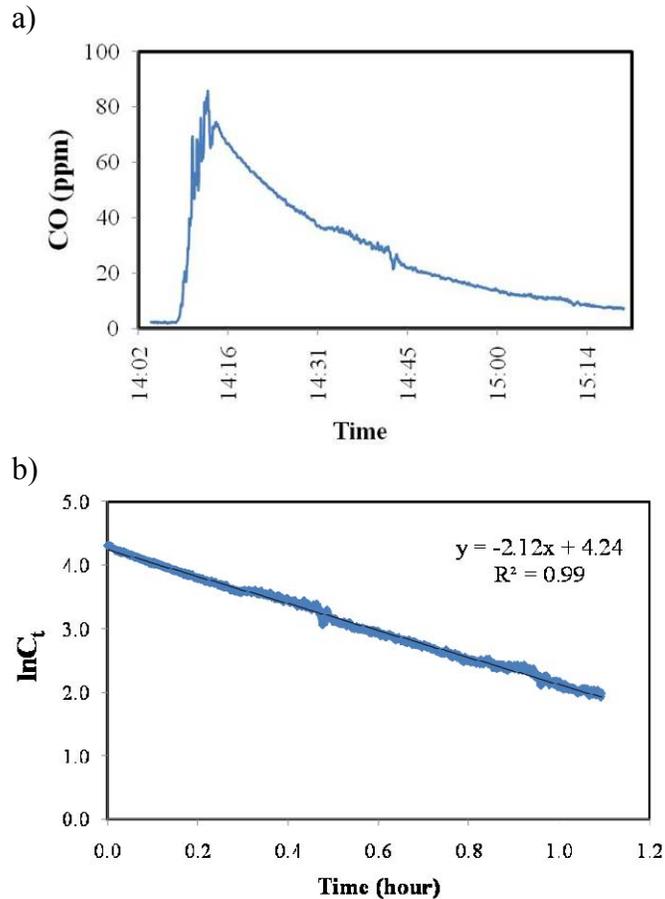
- High removal efficiency
  - For panel filters and register systems: both of these technologies are installed in line with the HVAC conditioning system, require forced air to work properly, and are characterized by a similar principal of operation. An *overall removal efficiency* for UFP and BC of at least 85% was set as the lowest acceptable performance requirement for all panel filters and register systems tested
  - For stand-alone systems: as described in more detail in the results section, the overall removal efficiency for stand-alone devices was affected by their relative distance to the air supply registers and by other factors intrinsic to the particular classroom set-up. Therefore, in this case the relative removal efficiency was found to be a better indicator of performance than the overall removal efficiency. A *relative removal efficiency* for UFP and BC of at least 85% was set as the lowest acceptable performance requirement for all stand-alone units tested
- Low pressure drop across the panel filters
- No ozone generation (<5 ppb)
- A noise level below 45 decibels [db(A)] to conform with the noise threshold set by many school districts for new in classroom equipment (for stand-alone units)

## TEST RESULTS

### Determination of the Air Exchange Rate

Measurements of the AER were conducted on 8/3/10. At that time a cylinder containing 15% hydrogen / 85% carbon monoxide with a flow meter attached to it was placed near the outside of the HVAC. A Teflon tube from the flow meter was inserted into the HVAC ambient air inlet grill and approximately 15 to 20 liters of the gas were injected into the HVAC to produce a CO concentration in the room of approximately 70 ppmv. Figure 4a shows the buildup and decay of CO in the room as recorded every second for about 1.5 hr by the Horiba PG250. The AER was then estimated from eq (2) by regressing  $\ln C_t$  over  $t$ , and it was found to be  $2.1 \text{ hr}^{-1}$  (Figure 4b). Only data from the moment CO peaked to the maximum concentration (after 10.3 minutes from the initial injection) to the end of the collection period (slightly before all CO exited the classroom) were considered in our calculations.

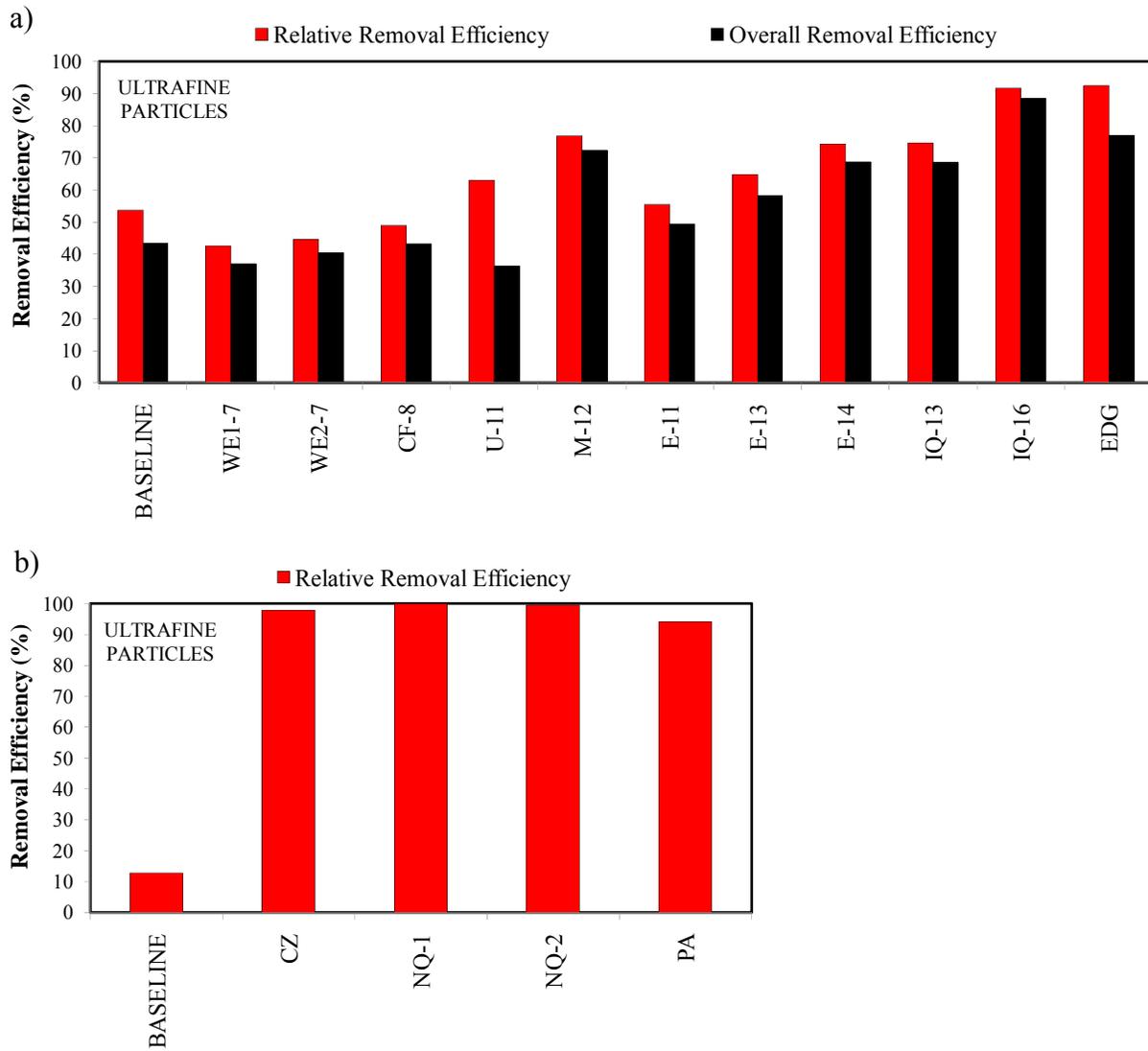
These results suggest that the AER of the test room in Sunnyslope was within the typical values reported for similar portable classrooms in other parts of Los Angeles County (Shendell et al. 2004), where ventilation rates were found to range between  $0.1$  and  $2.9 \text{ hr}^{-1}$ .



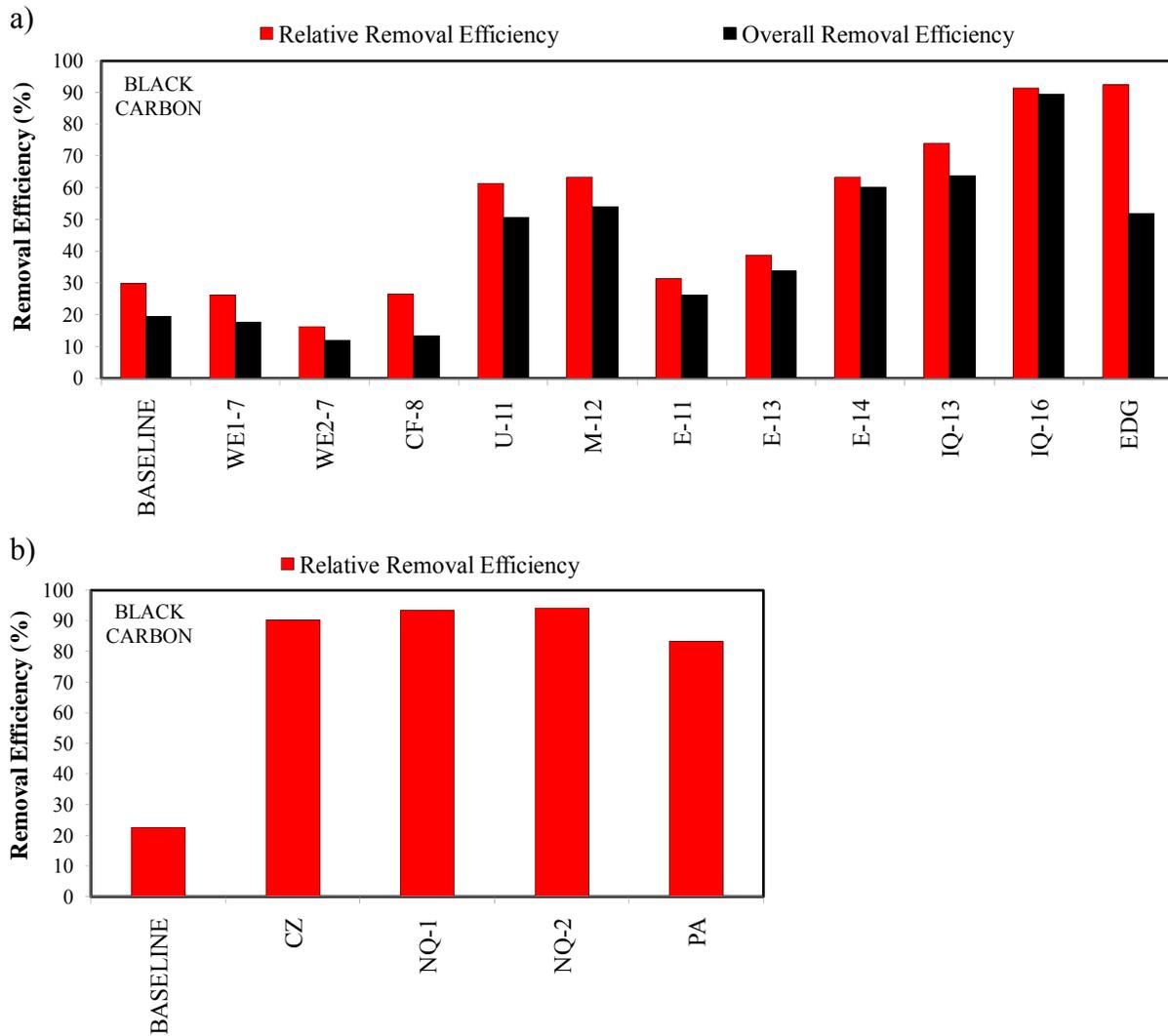
**Figure 4** Buildup and decay of CO in the room as recorded by the Horiba PG250 (a). The AER was estimated from eq (2) by regressing  $\ln C_t$  (ln-transformed concentration of CO) over  $t$  (time)

### Removal Efficiency

Figure 5 shows relative and overall UFP removal efficiencies for the register system and all panel filters (a), and for all stand-alone units (b) tested; results are compared to the corresponding baseline conditions. Similarly, Figure 6 illustrates relative and overall BC removal efficiencies for the register system and all panel filters (a), and for all stand-alone units (b) tested; also in this case, results are compared to the corresponding baseline conditions. Removal efficiency data have also been summarized in Tables 2 and 3.



**Figure 5** Relative and overall UFP removal efficiencies for the register system and all panel filters (a), and for all stand-alone units (b) tested. Corresponding baseline conditions are also included



**Figure 6** Relative and overall BC removal efficiencies for the register system and all panel filters (a), and for all stand-alone units (b) tested. Corresponding baseline conditions are also included

**Table 2** Relative and overall UFP removal efficiencies for all air filtration devices tested. Baseline conditions are also included

<b>REMOVAL EFFICIENCIES FOR UFP</b>			
<b>Panel Filters and Register Systems</b>			
<i>Manufacturer</i>	<i>ID</i>	<i>Relative Removal Efficiency</i>	<i>Overall Removal Efficiency</i>
	<b>BASELINE</b>	<b>54</b>	<b>43</b>
Air Cleaners, Inc.	WE1-7	43	37
Air Cleaners, Inc.	WE2-7	45	41
Camil Farr	CF-8	49	43
Freudenberg Filtration Technologies L.P.	U-11	63	36
Freudenberg Filtration Technologies L.P.	M-12	77	72
eSpin Technologies, Inc.	E-11	55	50
eSpin Technologies, Inc.	E-13	65	58
eSpin Technologies, Inc.	E-14	74	69
IQ Air	IQ-13	75	69
IQ Air	IQ-16	92	89
Environmental Dynamics Group, Inc.	EDG	93	77
<b>Stand-Alone Systems</b>			
<i>Manufacturer</i>	<i>ID</i>	<i>Relative Removal Efficiency</i>	<i>Overall Removal Efficiency</i>
	<b>BASELINE</b>	<b>13</b>	*
IQ Air	CZ	98	*
NQ Industries Inc.	NQ-1	100	*
NQ Industries Inc.	NQ-2	100	*
Pure Air	PA	94	*

**Table 3** Relative and overall BC removal efficiencies for all air filtration devices tested. Baseline conditions are also included

<b>REMOVAL EFFICIENCIES FOR BC</b>			
<b>Panel Filters and Register Systems</b>			
<i>Manufacturer</i>	<i>ID</i>	<i>Relative Removal Efficiency</i>	<i>Overall Removal Efficiency</i>
	<b>BASELINE</b>	<b>30</b>	<b>20</b>
Air Cleaners, Inc.	WE1-7	26	18
Air Cleaners, Inc.	WE2-7	16	12
Camil Farr	CF-8	26	13
Freudenberg Filtration Technologies L.P.	U-11	61	51
Freudenberg Filtration Technologies L.P.	M-12	63	54
eSpin Technologies, Inc.	E-11	31	26
eSpin Technologies, Inc.	E-13	39	34
eSpin Technologies, Inc.	E-14	63	60
IQ Air	IQ-13	74	64
IQ Air	IQ-16	91	89
Environmental Dynamics Group, Inc.	EDG	92	52
<b>Stand-Alone Systems</b>			
<i>Manufacturer</i>	<i>ID</i>	<i>Relative Removal Efficiency</i>	<i>Overall Removal Efficiency</i>
	<b>BASELINE</b>	<b>23</b>	*
IQ Air	CZ	90	*
NQ Industries Inc.	NQ-1	93	*
NQ Industries Inc.	NQ-2	94	*
Pure Air	PA	83	*

As expected, our data indicate that relative and overall removal efficiencies for all panel filters increase with increasing MERV rating. In particular, filters WE1-7 and WE2-7 (both rated as MERV 7) demonstrated the worst performance under this particular experimental set-up, with removal efficiencies varying from 37 to 45% for UFP and from 12 to 26% for BC (Tables 2 and 3). These values are similar to or lower than those observed during our baseline measurements and show no significant improvement in indoor air quality with respect to pre-testing conditions with a standard filter. Conversely, filter IQ-16 (MERV 16) was able to remove a more substantial portion of UFP and BC from the test classroom, and its overall removal efficiency was 89% for both UFP and BC. In this respect, the IQ-16 filter was the only panel filter that met the desired specifications set by AQMD and previously discussed under the Performance Evaluation section.

Over the short time span of these measurements there was no significant increase in the pressure drop across the panel filters tested (Table 1). The only register-system tested during this study (EDG) was characterized by overall removal efficiencies lower than the guideline value set by AQMD for this type of device, although the relative removal efficiency was higher than 85% for both UFP and BC. A potential explanation for this discrepancy may be unfiltered air flow escaping the register system in a way that would not affect measurements at position #4 but would affect measurements at position #2.

It is worth noting that when testing stand-alone units the concentration of UFP (or BC) inside the test classroom (position #2) was affected more by the classroom configuration, the proximity of the stand-alone device to the air supply registers, the relatively high AER ( $2.1 \text{ hr}^{-1}$ ), the relative distance between the indoor real-time monitors and the air supply registers, the lower air flow rate “processed” by these air filtration devices (between 350 and 545 cfm) relative to the flow rate handled by the HVAC system, and other factors intrinsic to this particular classroom set-up. The UFP and BC data obtained at positions #2 and #3 (Figure 2) and, thus, the overall removal efficiency of the stand-alone units were not considered in the determination of their performance. The outlet concentration (position #4) was used instead to evaluate the filtration ability of the unit itself (i.e. relative removal efficiency). In this respect, all stand-alone devices tested showed high relative removal efficiencies with values varying from 94 to 100% and from 83 to 94% for UFP and BC, respectively.

### **Sound Level Measurements**

As noted earlier, the sound level from the stand-alone units was measured at 6 different locations inside the test classroom (Figure 3). These readings were made because many school districts have established a noise level below 45 decibels [db(A)] for new in classroom equipment. Table 4 summarizes the noise level measurements made before and after turning the stand-alone units on. The only noise heard with the stand-alone units off was the clicking from a clock on the wall near the entrance door. None of the CPCs or Aethalometers were running at the time of these noise-level tests. According to our results only the IQ CleanZone SL meets the 45 db(A) noise requirement set by AQMD.

**Table 4** Noise level measurements for all stand-alone units

<b>NOISE LEVEL dB(A)</b>									
Location	Distance from source	IQ CleanZone SL		Pure Air HPS350		NQ400		NQ Clarifier	
		Off	On	Off	On	Off	On	Off	On
1*	40"	38.2	44.1	31.8	63.1	33.0	61.7	30.0	56.6
2*	10' 40"	35.1	43.0	30.5	57.1	30.6	58.6	32.2	53.5
3*	20' 40"	44.2	48.6	48.3	55.6	42.3	56.0	41.5	51.0
4**	20' 40"	39.2	41.2	38.5	53.4	42.0	54.4	39.8	50.6
5***	20' 40"	39.8	42.2	38.3	53.6	40.0	54.7	36.5	49.5
6****	30' 40"	43.9	47.0	45.7	53.2	44.8	53.7	47.0	48.5
<b>Average</b>			<b>44.4</b>		56.0		56.5		51.6

\* In direct line with stand alone unit

\*\* ~5' to left of direct line, but noise monitor was pointed toward stand alone.

\*\*\* ~7' to right of direct line, but noise monitor pointed toward stand alone.

\*\*\*\* Within 7' of rear wall

## Ozone Measurements

Both stand-alone units manufactured by NQ Industries (NQ-1 and NQ-2) have one or more ultraviolet lamps to remove germs and bacteria from the filtered air. Also, the register system by Environmental Dynamics Group, Inc. (EDG) is supplied with an electrostatic filter to enhance its performance. Therefore, these devices could potentially generate small but non negligible amounts of ozone, an air pollutant that may worsen chronic respiratory diseases such as asthma. Although we planned to monitor ozone upwind and downwind of these systems while they were in operation, because of a temporary malfunction of the ozone monitors this part of the testing protocol took place at the CE-CERT's lab. The results of our measurements indicated that these units do not generate any ozone.

## REFERENCES

- Abt, E., Suh, H.H., Catalano, P.J., Koutrakis, P. (2000) “Relative Contribution of Outdoor and Indoor Particle Sources to Indoor Concentrations”, *Environmental Science & Technology*, 34:3579-3587
- Pope, C. A. and Dockery D. W. (2006), “Health effects of fine particulate air pollution: Lines that connect”, *Journal of the Air & Waste Management Association*, 56:709-742
- Environmental Protection Agency Integrated Science Assessments (External Review Draft; 2009): <http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=201805>
- Shendell, D.G, Winer, A.M., Weker, R. and Colome, S.D. (2004) “Evidence of inadequate ventilation in portable classrooms: results of a pilot study in Los Angeles County”, *Indoor Air*, 2004; 14: 154–158
- South Coast Air Quality Management District & IQAir North America, (2009) “Pilot Study of High Performance Air Filtration for Classrooms Applications”

## APPENDIX



**Figure A-1** Front of portable classrooms at Sunnyslope elementary. All tests were conducted inside the center unit



**Figure A-2** Back of portable classrooms at Sunnyslope elementary. All tests were conducted inside the center unit



**Figure A-3** Bard WH483-A10xx4xxx heat pump

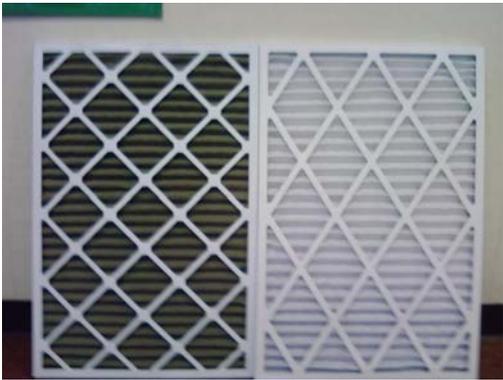
Draft Report: Performance Evaluation of Air Filtration Devices



**Figure A-4** CPC and Aethalometers used for measuring UFP and BC in ambient air and near the air return duct (positions #4 and #3, respectively)



**Figure A-5** CPC and Aethalometer used for measuring UFP and BC inside the classroom and at breathing level (position #2)



**Figure A-6** Left: Inlet side of the existing filter installed on 4/22/10, months before the beginning of our tests. Right: unused filter (of the same type and brand as the one on the left) used for the baseline measurements; installed on 7/7/10

## Draft Report: Performance Evaluation of Air Filtration Devices



**Figure A-7** Left: Outlet side of the existing filter installed on 4/22/10. Right: unused filter (of the same type and brand as the one on the left) used for the baseline measurements; installed on 7/7/10



**Figure A-8** Inlet side of the filter installed on 7/7/10 for the baseline measurements; removed on 7/14/10



AQMD

# Pilot Study of High Performance Air Filtration for Classrooms Applications

## Final Report

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## ABSTRACT

A pilot study was conducted between April and December 2008 to investigate the effectiveness of three different air purification systems in reducing the exposure of children to air contaminants inside nine classrooms at three Southern California schools (three classrooms per school). Two of them, Del Amo Elementary and Dominguez Elementary, are part of the Los Angeles Unified School District (LAUSD), while the third school, Hudson Elementary, is part of the Long Beach Unified School District (LBUSD). Continuous and integrated measurements were conducted to monitor the indoor and outdoor concentrations of the following species: ultrafine particles (UFP), particulate matter mass (both  $PM_{2.5}$  and  $PM_{10}$ ), black carbon (BC), and volatile organic compounds (VOCs). An HVAC-based high-performance panel filter (HP-PF), a register-based air purifier (RS), and a standalone system (SA) were tested alone and in different combinations for their ability to remove the monitored pollutants from the indoor air.

Overall, the coupling between a register system and a high-performance panel filter (RS + HP-PF) was the most effective solution for reducing the indoor concentrations of BC, UFP, and  $PM_{2.5}$ , with study average removal efficiencies varying from 87 to 96%. When using a HP-PF alone, reductions close to 90% were also obtained. Due to re-suspension of dust and other relatively large particles from common indoor activities such as walking and cleaning, the removal performance of  $PM_{10}$  was lower than that of other particle measurements (68% when using a RS + HP-PF combination). In all cases, air quality conditions were improved substantially with respect to the corresponding baseline (pre-existing) conditions, when removal efficiencies for the different particulate pollutants varied between 20% and 50%. Data obtained from the analysis of canister samples collected at Dominguez elementary showed that the total VOC removal performance of the register system (RS) was 28%. These values were substantially higher for the standalone unit (SA) operated with and without the use of the HVAC system (58 and 86%, respectively). Because gas-absorbing media may be subject to saturation after experiencing high short-term concentrations, the effectiveness, lifetime, costs, benefits, and maintenance of the gas removal systems tested in this pilot study must be further assessed before conclusions and recommendations can be made.

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## **INTRODUCTION**

### ***Background***

Numerous epidemiological and toxicological studies have found positive associations between exposure to atmospheric particulate matter (PM) and adverse health effects (Pope and Dockery, 2006; Environmental Protection Agency Integrated Science Assessments, 2009). Although air quality standards have been established for outdoor ambient environments, a significant portion of human exposures to PM occurs indoors, where people spend around 85-90% of their time. Hence, it is important to understand and reduce the sources of both indoor and outdoor PM. Indoor PM consists of outdoor particles that have infiltrated indoors, particles emitted indoors (primary), and particles formed indoors (secondary) from precursors emitted both indoors and outdoors.

Children are regarded as particularly susceptible to potential health hazards related to PM exposure, which include asthma, lung inflammation, allergies and other types of respiratory and cardiovascular problems. School-aged children spend approximately 30% of their day in classrooms. For this reason, minimizing the concentration of PM (as well as that of other air contaminants) inside classrooms is important, especially at schools located in close proximity to roadways and other substantial sources of air pollution. One approach is the installation of panel filters inside the Heating, Ventilating, and Air Conditioning (HVAC) system. Common medium performance filters with a Minimum Performance Reporting Value (MERV) of 7 (those installed in most commercial buildings) remove only a small fraction of the particles with aerodynamic diameters lower than 0.3  $\mu\text{m}$ , although higher removal efficiencies are generally achieved for larger particles. Diesel particulate matter, which is considered an air toxic, generally consists of particles less than 0.3  $\mu\text{m}$ . New evidence also suggests that ultrafine particles, less than 0.1  $\mu\text{m}$  by definition, have harmful health effects beyond those caused by particle mass.

Filtration in classrooms presents some unique challenges. The older HVAC systems that exist in older schools were not designed with air filtration in mind. The classroom is a noise sensitive environment, so filtration systems must meet strict decibel limits when in operation. Classrooms often have high ventilation rates with doors and windows that are frequently open to outside air. Finally, classrooms are large, densely occupied spaces with a lot of activity that can lead to indoor generation of particles and other pollutants.

### ***Objectives and Study Design***

The objective of this pilot study was to investigate the effectiveness of three different air purification systems/solutions in reducing the exposure of children to outdoor-infiltrated and indoor-generated air contaminants inside nine classrooms at three Southern California schools. To this end, the South Coast Air Quality Management District (SCAQMD; 21865 Copley Dr, Diamond Bar, CA 91765) worked in close collaboration with IQAir (IQAir North America, 10440 Ontiveros Place, Santa Fe Springs, CA 90670), a company that specializes in air purification solutions, and Thermal Comfort Systems (Thermal Comfort Systems Inc., 8038 Andasol Ave., Northridge, CA 91325), an HVAC contractor. Of particular interest was the removal of various sizes and types of particulate matter, especially the smaller sizes associated with diesel engine

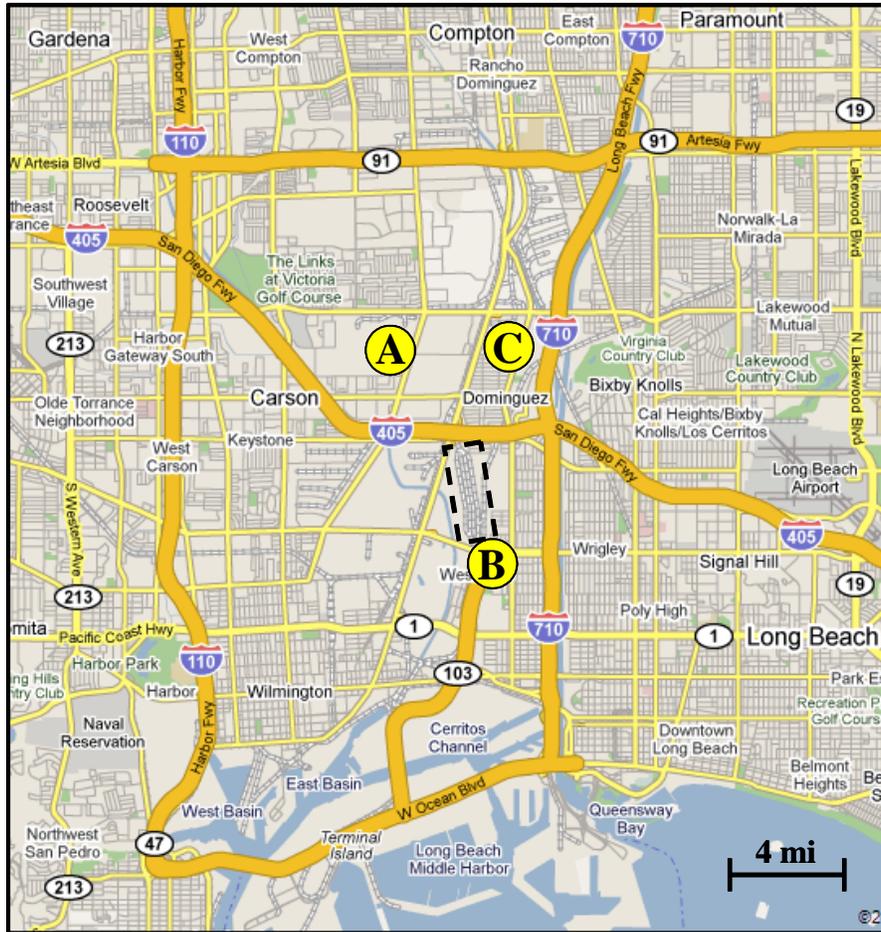
exhaust. Solutions for removing gaseous air contaminants that may be air toxics or cause odors were also examined. The types of pollutants for which the performance of the installed systems were tested are described below:

- Ultra-fine particles (UFPs; particles with an aerodynamic diameter less than 0.1  $\mu\text{m}$ ): UFP are primarily produced from the combustion of fossil fuels (e.g. motor-vehicle emissions). Recent health studies suggest that UFPs are more toxic than fine particles, possibly due to their chemical composition and their ability to penetrate cell walls, enter the blood stream, and translocate to organs throughout the body. UFP are currently unregulated in the United States.
- Fine PM ( $\text{PM}_{2.5}$ ; particles with an aerodynamic diameter less than 2.5  $\mu\text{m}$ ): Sources of  $\text{PM}_{2.5}$  include emissions from motor vehicles, power plants, residential wood burning, forest fires, agricultural burning, and other combustion activities. Fine particles have well established health effects, including multiple adverse respiratory and cardiovascular outcomes.  $\text{PM}_{2.5}$  is a U.S. Environmental Protection Agency (U.S. EPA) criteria pollutant for which there exist National Ambient Air Quality Standards (NAAQS).
- $\text{PM}_{10}$  (particles with an aerodynamic diameter less than 10  $\mu\text{m}$ ):  $\text{PM}_{10}$  includes all  $\text{PM}_{2.5}$  particles, but also larger particles between 2.5 and 10  $\mu\text{m}$  in diameter. Sources of these coarse particles include crushing or grinding operations, re-suspension of dust from vehicles traveling on roads, and other mechanical processes.  $\text{PM}_{10}$  is also a U.S. Environmental Protection Agency (U.S. EPA) criteria pollutant and also has associated National Ambient Air Quality Standards (NAAQS).
- Black Carbon (BC; sometimes referred to as soot; related closely to elemental carbon): BC is a component of PM and is formed through the incomplete combustion of fossil fuels and biomass, and is emitted from both natural and anthropogenic sources. Most atmospheric BC is in the fine or ultra-fine particle size ranges. The majority of BC in Southern California comes from diesel particulate matter (DPM) emissions. DPM is considered an air toxic by the State of California, and the SCAQMD has recently estimated that DPM accounts for more than 80% of the total cancer risk from air toxics in the South Coast Air Basin (MATES III Study, 2008).
- Volatile Organic Compounds (VOCs): these gases are emitted by a variety of evaporative processes and combustion sources, including paints, cleaning supplies, pesticides, building materials, household products, refineries, and mobile sources. Given some of the indoor sources, concentrations of many VOCs may be much higher indoors than outdoors (Jia et al., 2007; Bruno et al., 2008). Gasoline and diesel fuels are also important sources of VOCs. Exposure to many of these organic contaminants has also been associated with a wide array of toxic health effects.

## METHODS

### *Schools and Classrooms Characteristics*

Three elementary schools (all located in Southern Los Angeles County in the Carson-Long Beach area) were selected for this pilot study. Two of them, Del Amo Elementary and Dominguez Elementary, are part of the Los Angeles Unified School District (LAUSD), while the third school, Hudson Elementary, is part of the Long Beach Unified School District (LBUSD). All three schools are in close proximity to at least three large refineries and several heavily trafficked highways and freeways including the I-110, I-405, I-710, and CA-103 (Figure 1). The Los Angeles and Long Beach Port complexes and the Union Pacific Railroad Intermodal Container Transfer Facility (UPRR ICTF) are other major emissions sources in the area. The presence of these important emissions sources has led to local concerns about the air quality in the surrounding communities.



**Figure 1.** Map of the study area as obtained from Google Earth (Google Inc. 1400 Amphitheatre Pkwy, Mountain View, CA 94043). The yellow circles indicate the locations of the three elementary schools participating in this pilot study: Del Amo (A), Hudson (B), and Dominguez (C). The Union Pacific Railroad Intermodal Container Transfer Facility is marked by the black rectangle

At each of the three elementary schools, three classrooms with similar structural characteristics and ventilation conditions were selected to provide reproducible test conditions for the various air purification systems deployed. All classrooms (varying between 7533 and 9196 ft<sup>3</sup> in size) already included forced-air HVAC systems, although windows and doors were regularly used for additional ventilation. The most relevant characteristics of all nine classrooms are listed in Table 1, along with their respective identification numbers.

**Table 1.** Structural characteristics and ventilation conditions of the nine classrooms selected for this pilot study

	SCHOOL								
	DEL AMO			HUDSON			DOMINGUEZ		
<b>Classroom ID</b>	DA-6	DA-7	DA-8	H-11	H-15	H-52	DZ-7	DZ-9	DZ-11
<b>Total Number of Occupants</b>	18	19	22	21	11	17	28	28	29
<b>Room Size (ft)</b>	38×24×10	38×24×10	38×24×10	30×30×9	30×30×9	31×27×9	38×22×11	38×22×11	38×22×11
<b>Room Volume (ft<sup>3</sup>)</b>	9120	9120	9120	8100	8100	7533	9196	9196	9196
<b>HVAC System Type</b>	DW-M*	DW-M*	DW-M*	DM-ZR**	DM-ZR**	DR***	DR***	DR***	DR***
<b>HVAC Panel Filter Type</b>	2" Pleated	2" Fiberglass	1" Pleated	1" Pleated	1" Pleated				
<b>Filter Rating</b>	MERV 7	Unclassified	MERV 7	MERV 7	MERV 7				
<b>HVAC Operation</b>	Manual	Manual	Manual	Automatic	Automatic	Manual	Manual	Manual	Manual
<b>Number of Supply Vents</b>	1	1	1	1	1	4	3	3	3
<b>Supplied Airflow<sup>#</sup> (cfm)</b>	1200	1200	1250	840	903	1236	1642	1681	1772
<b>Air Exchange Rate</b>	7.9	7.9	8.2	6.2	6.7	9.8	10.7	11.0	11.5

\*DW-M = Ducted Wall-Mount

\*\*DM-ZR = Ducted Multi-Zone Rooftop

\*\*\*DR = Ducted Rooftop

<sup>#</sup>With existing panel filter

Prior to beginning this study, none of the selected classrooms featured any specific air purification device other than one or more medium performance panel filters (MERV 7) installed inside the respective HVAC systems. The typical replacement interval for these air filters is approximately three months according to schools schedules. The primary purpose of this panel filter is to remove coarser particles and dust to protect the HVAC system's heating and cooling coils. These filters generally provide little or no removal of smaller particles or gaseous pollutants.

***Air Purification Solutions***

Three different air purification solutions were tested for their ability to remove UFP, PM<sub>2.5</sub>, PM<sub>10</sub>, BC and, where possible, VOCs from the air stream:

- a) an HVAC-based high-performance panel filter (**HP-PF**),
- b) a register-based air purifier (here referred to as register system or **RS**), and
- c) a standalone system (**SA**).

All air purification solutions were provided, installed, and maintained by IQAir, and their primary features are summarized in Table 2.

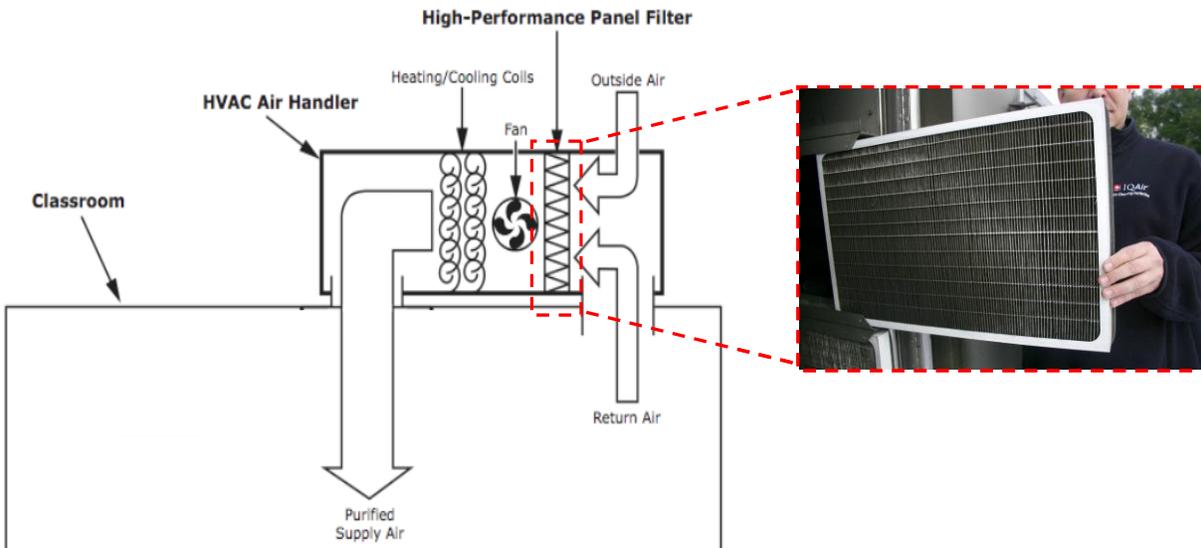
**Table 2.** Summary of the primary features of the three air purification devices adopted for this pilot study: high-performance panel filter (HP-PF), register system (RS), and standalone system (SA)

	High-performance Panel Filter (PF)	Register System (RS)	Standalone System (SA)
High UFP and PM <sub>2.5</sub> Filtration Efficiency	√	√	√
High Gas Phase Filtration Efficiency	0	√	√
Low Pressure Drop / High Air Flow	√	√	√
Low Noise	√	√	√
Low Maintenance	√	√	√
High Classroom Compatibility	√	√	√
No HVAC System Retrofit	√	0	√
Minimal Impact on Classroom Space	√	√	√
Low Power Consumption	N/A	N/A	√
Tamper-Resistant Design	N/A	N/A	√

√ = featured  
0 = not featured

### *High-performance panel filter (HP-PF)*

In most classrooms, the existing medium performance panel filters were replaced with one or more HP-PFs as shown to in Figure 2.



**Figure 2.** Schematic of a typical HVAC system. The picture on the right-hand side shows a typical high-performance panel filter (HP-PF) after several months of usage

Compared to standard/conventional medium performance MERV filters, the high-performance panel filters used for this pilot study are twice as thick (2” in depth) and have a much larger filter surface area (five to nine times larger). Due to the increased surface area and the special filter material used, they generally have similar air resistance properties as conventional filters and, thus, do not act to reduce the air flow through the HVAC system. Also, due to the increased surface area and specific design, these media have the potential to last longer than conventional filters before replacement is required. Because these filters are manufactured using a proprietary “nano-fiber” technology, their ability to remove UFPs and BC from the air stream is also higher. Table 3 shows a comparison between the characteristics of several conventional MERV filters available for residential and commercial applications and the HP-PF employed in this pilot study.

**Table 3.** Comparison between the main characteristics of several conventional MERV filters and the high-performance panel filters (HP-PF) tested in this study

Panel Filter Type	Filter Rating	Filter Efficiency (%) <sup>1</sup> at 0.3 µm   at 1.0 µm		Pressure Drop (in w.g.) <sup>2</sup>	Media Area (ft <sup>2</sup> )	Filter Life (months)	Filter Cost (\$)	Annual Filter Cost (\$)	Annual Maintenance Cost (\$) <sup>3</sup>	Total Annual Cost (\$)
<i>CONVENTIONAL PANEL FILTERS</i>										
Low Efficiency 2" Fiberglass	(unrated)	1	10	0.28	4.0	3	3 to 5	12 to 20	50	62 to 70
Medium Efficiency 1" Pleated	MERV 7	3	25	0.48	7.5	3	5 to 7	20 to 28	50	70 to 78
Medium Efficiency 2" Pleated	MERV 7	5	35	0.30	11.8	3	7 to 10	28 to 40	50	78 to 90
High Efficiency 2" Pleated	MERV 11	15	58	0.39	17.8	3	13 to 20	52 to 80	50	102 to 130
High Efficiency 2" Pleated	MERV 13	30	85	0.41	21.1	3	25 to 40	100 to 160	50	150 to 210
High Efficiency 2" Mini-Pleat	MERV 16	90	99	2.00	55.0	3	80	320	50	370
<i>PILOT STUDY HIGH-PERFORMANCE PANEL FILTER</i>										
High-performance 2" Mini-Pleat	MERV 16	93	99	0.38	60.0	6 to 12	120	120 to 240	13 to 25	133 to 245

Data are based on a nominal 24" × 24" filter size

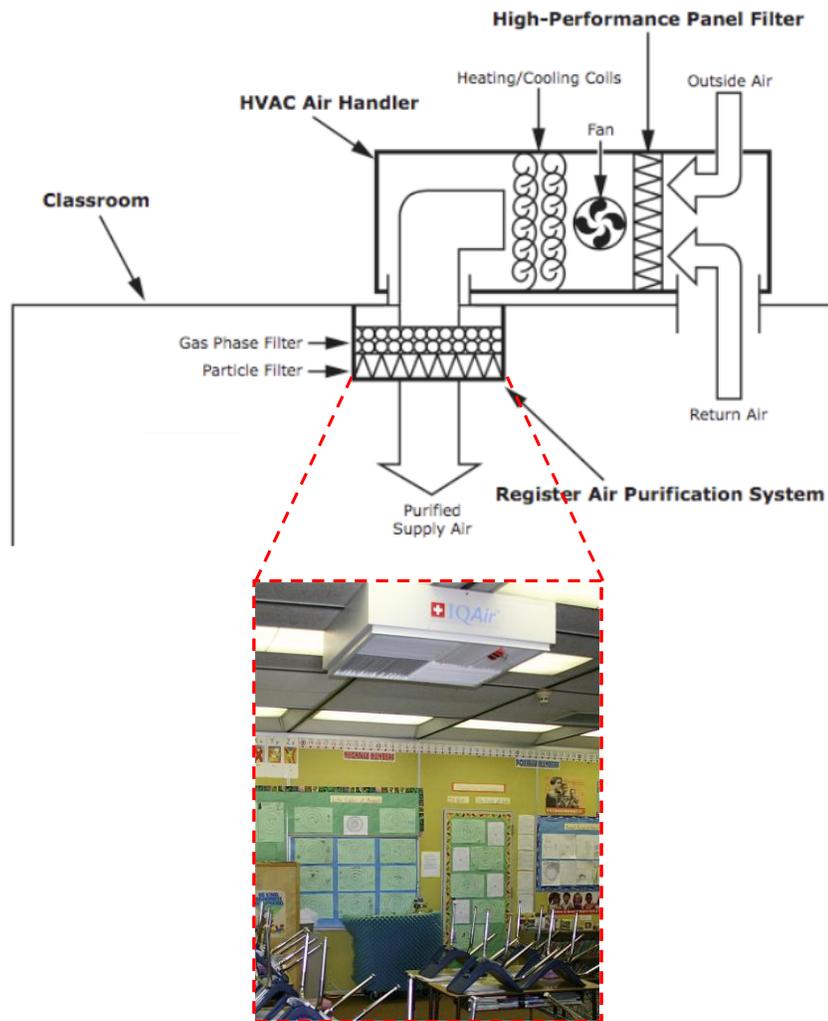
<sup>1</sup>Typical minimum efficiency at rated face velocity of 492 fpm

<sup>2</sup>Typical pressure drop of a new filter; based on a face velocity of 492 fpm

<sup>3</sup>Based on an estimated maintenance time of 15 min per filter change (at \$50/hr)

*Register system (RS)*

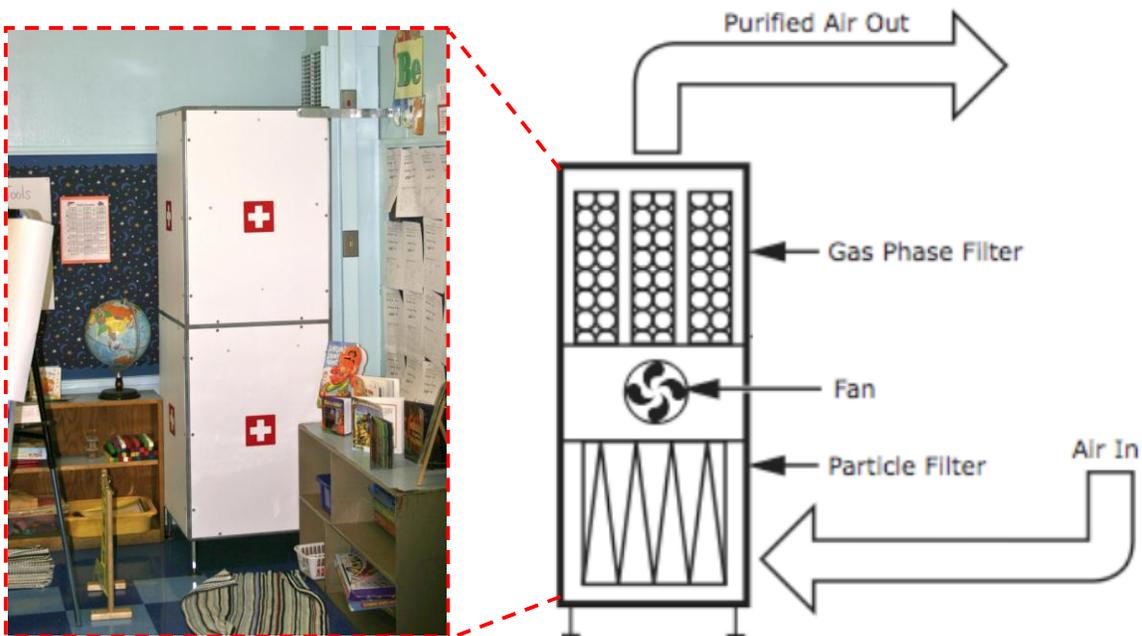
This device is installed directly on the HVAC register, where the air supply enters the room. The unit is equipped with a “nano-technology” filter media for the removal of PM and high-capacity gas phase filter cartridges to eliminate certain gaseous pollutants from the air stream (e.g. VOCs) (Figure 3). This particular design allows for a longer contact time between the filtration media and the gaseous pollutants than would be permitted by using an activated carbon panel filter in the HVAC system. Nevertheless, the RS does not reduce the overall HVAC system airflow if installed by a trained specialist.



**Figure 3.** Schematic of the register system (RS) as installed in one of the study classrooms. A high-performance panel filter (HP-PF) may also be installed in the HVAC air handler to provide additional particle filtration

### *Standalone system (SA)*

A standalone system (SA) is a self-contained air cleaning device that operates independently of a classroom's HVAC system. This air filtration system is 6 feet tall and has a footprint of about 4 ft<sup>2</sup> (Figure 4). The SA is tamper proof, runs on a standard power circuit, and is built with an energy efficient fan, located inside a specially designed box for ultra quiet operation (<45 db(A) at high airflow). Indoor air enters from the lower part of the system (about 6 inches off the ground) and passes, sequentially, through a large "nano-technology" filter media, for the removal of PM, and 12 high-capacity gas phase filter cartridges, for removal of the gaseous pollutants commonly found indoors (VOCs) (Figure 4).



**Figure 4.** Schematic of the standalone system (SA) as installed in one of the classrooms

The main characteristics of the SA tested in this pilot study have been summarized in Table 4 and compared to those of other typical "residential" and "commercial" standalone units available on the market. A major design consideration for the SA was low noise. Many school districts have set a 45db(A) noise threshold for new in classroom equipment. At this noise level, available residential and commercial air purification devices offer less than two air changes per hour (ACH) in a typical classroom. This SA unit offers more than five ACH.

**Table 4.** Comparison between the main features of the standalone system used for this pilot study and those of other commercially available standalone air purifiers

	<b>Residential Air Purifier</b>	<b>Commercial Standalone</b>	<b>Pilot Study Standalone</b>
Particle Filtration Technology	Electronic / Media	Electronic / Media	Media
Removal Efficiency at 0.3 $\mu\text{m}$ (%)	40 to 99	60 to 99	> 99
Maximum Airflow (cfm)	150 to 400	400 to 1200	1200
Airflow at 45 dB(A) (cfm)	25 to 100	100 to 200	800
Gas-phase Filtration Media (lb)	0.5 to 18	10 to 80	100
Price (\$)	200 to 1,000	1,500 to 12,000	8,500
Price / CFM at 45 db(A) (\$)	8 to 10	15 to 60	11
Classroom ACH at 45 db(A)*	0.2 to 0.7	0.7 to 1.3	5.3

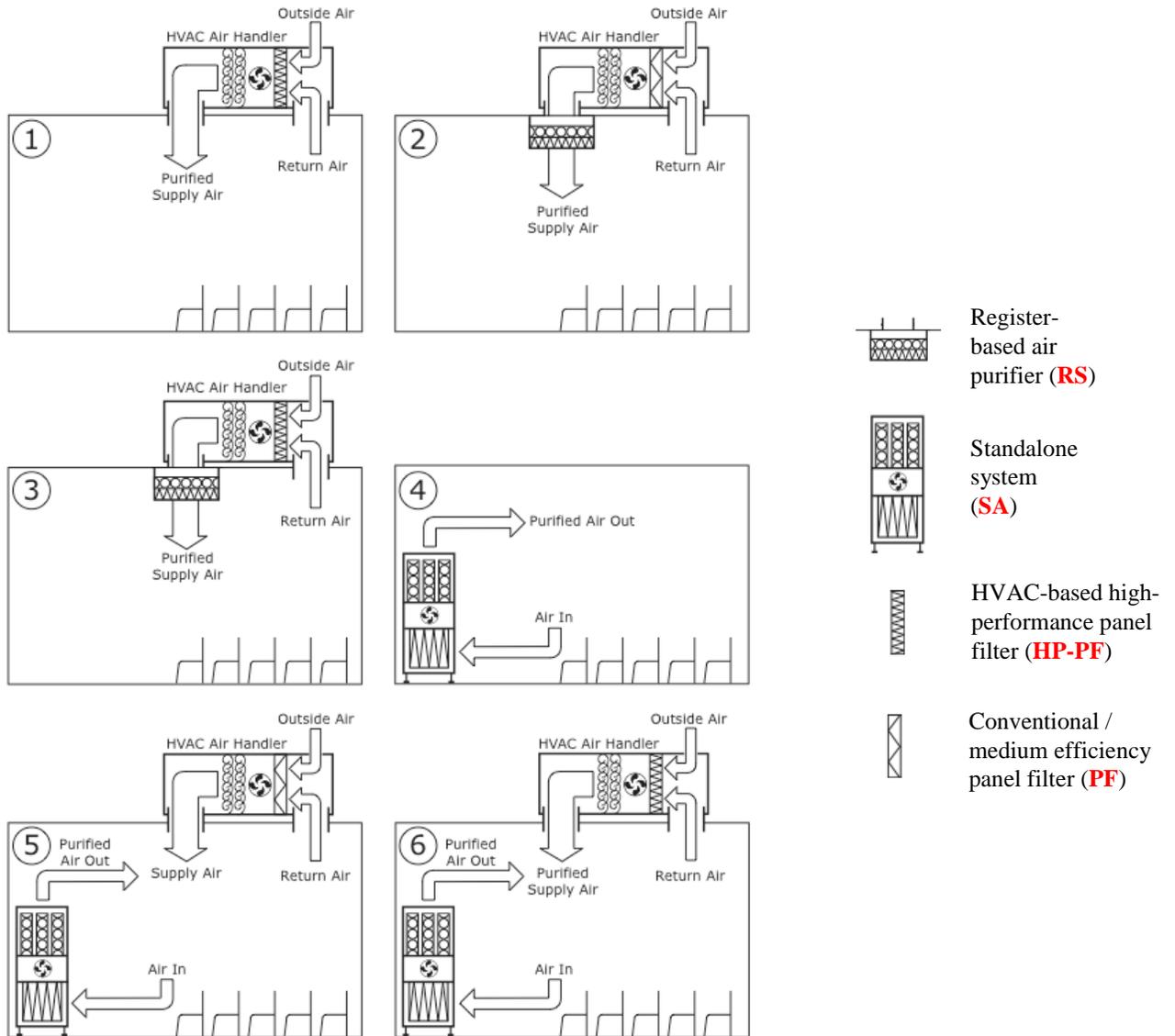
\*Air Changes per Hour (ACH) based on a 9000 ft<sup>3</sup> room

### ***In-classroom configurations***

Different combinations of the standalone system, HVAC-based high-performance panel filter, and register-based air purifier were used inside the studied classrooms to evaluate the performance of these air filtration devices:

1. High-performance panel filter alone: **HP-PF**
2. Register-based air purifier alone (RS). It should be noted that in some cases a conventional / medium performance panel filter (PF) was already installed inside the HVAC system prior to the beginning of the study: **RS+PF**
3. Register-based air purifier in conjunction with a high-performance panel filter: **RS + HP-PF**
4. Standalone system in classrooms with no HVAC running: **SA**
5. Standalone system in classrooms with a HVAC running, in which case a conventional / medium performance panel filter (PF) was already installed inside the HVAC system prior to the beginning of the study: **SA + PF**
6. Standalone system in conjunction with a high-performance panel filter: **SA + HP-PF**

A schematic representation of these six configurations is shown below (Figure 5).



**Figure 5.** Schematic representation of the six air purification solutions tested in this pilot study

### ***Indoor and outdoor measurements***

Four mobile air quality monitoring stations were used to measure the indoor and outdoor concentrations of the targeted air pollutants. Each of these stations was comprised of a mobile cart supporting the following instruments (Figure 6):

- A portable Aethalometer (model AE42, Magee Scientific, 2800 Adeline St., Berkeley CA 94703) to provide continuous measurements of BC concentrations ( $\text{ng}/\text{m}^3$ )
- A water-based condensation particle counter (CPC model 3781, TSI, 500 Cardigan Road, Shoreview, MN 55126) to provide continuous measurements of the particle number concentration ( $\#/ \text{cm}^3$ ), an indicator of UFPs
- A laser particle counter (IQAir ParticleScan Pro): for determining the number concentration ( $\#/ \text{cm}^3$ ) of particles down to  $0.3 \mu\text{m}$  in diameter. Since the  $\text{PM}_{2.5}$  particle mass concentration in urban areas tends to be dominated by particles in the  $0.3 - 1.0 \mu\text{m}$  range, this instrument provides a rough estimate of the  $\text{PM}_{2.5}$  mass.
- A laser-based particle mass monitor (Aerocet 531 Aerosol Particulate Profiler, MetOne; 1600 Washington Blvd., Grants Pass, Oregon 97526): to provide continuous measurements of the mass concentration ( $\mu\text{g}/\text{m}^3$ ) of both  $\text{PM}_{2.5}$  and  $\text{PM}_{10}$
- A low volume filter sampler (SKC Leland Legacy Sample Pump with SKC DPS Impactor, 863 Valley View Road Eighty Four, PA 15330): to collect time-integrated filter-based  $\text{PM}_{10}$  samples. Samples were collected at  $10\text{L}/\text{min}$  on  $47\text{mm}$  Teflon filters for the duration of a typical school day. These substrates were weighed before and after collection using a microbalance, and the  $\text{PM}_{10}$  concentration ( $\mu\text{g}/\text{m}^3$ ) was calculated by dividing the difference in  $\text{PM}_{10}$  mass by the corresponding sampling volume. These gravimetric measurements were considered as primary indicators of the  $\text{PM}_{10}$  mass.
- 6L EPA TO-15 SUMMA canisters: to collect time-integrated air samples over the course of a typical school day. Samples were then analyzed by gas chromatography-mass spectrometry (GC-MS) to measure the concentrations of 61 specific VOCs (ppbv).



**Figure 6.** One of the four mobile stations used to monitor the indoor and outdoor concentrations of the targeted air pollutants

At each school, one air quality monitoring cart was set-up outside to sample outdoor air. The remaining three stations were placed indoors, one in each classroom, near one of the walls and just a few meters away from the students. Measurements were made away from all air conditioning vents to better represent mixed indoor air quality conditions as experienced by students and teachers. All sensors and inlets were approximately three feet above the floor, or about the height of a child’s head when seated. The effectiveness of each of the tested air purification solutions was then evaluated by comparing the indoor concentrations of the targeted air pollutants to the corresponding outdoor levels. Baseline measurements were taken before installing any of the air purification solutions to estimate the pre-existing removal efficiencies of the classrooms before modification. Measurements that were found to be inaccurate or unrepresentative due to meteorological conditions (e.g. rain), improper cart placement, or instrument malfunction were not considered in the data analysis.

Before and after school hours, the four measurement stations were collocated in a storage room and the continuous instruments were run “side-by-side” to provide quality assurance of the measurements, to estimate the precision characteristics, and to identify any potential problems. Table 5 shows the specific air purification solutions that were tested inside each of the nine classrooms, along with the dates when all baseline and actual measurements were taken.

**Table 5.** Summary of the air purification solutions tested in each of the nine classrooms. The dates when all baseline and actual measurements were taken are also included

School / Class ID	Configurations Used			
	04 / 07-11 / 08	04 / 14-18 / 08	04 / 21-25 / 08	04 / 28 / 08 to 05 / 02 / 08
Del Amo / DA-6	Baseline	SA + PF	SA + PF	SA + HP-PF
Del Amo / DA-7	Baseline	RS	RS	RS
Del Amo / DA-8	Baseline	HP-PF	HP-PF	HP-PF
Hudson / H-11	05 / 12-16 / 08	05 / 19-23 / 08	05 / 26-30 / 08	06 / 02-06 / 08
Hudson / H-15	Baseline	HP-PF	RS + HP-PF	RS + HP-PF
Hudson / H-52	Baseline	HP-PF	RS + HP-PF	RS + HP-PF
Dominguez / DZ-7	11 / 18-26 / 08	12 / 01-05 / 08	12 / 08-12 / 08	12 / 15-19 / 08
Dominguez / DZ-9	Baseline	SA / SA + PF	SA + HP-PF	SA + HP-PF
Dominguez / DZ-11	Baseline	HP-PF	HP-PF	HP-PF
	Baseline	HP-PF	RS + HP-PF	RS + HP-PF

HP-PF = HVAC-based high-performance panel filter  
 RS = register-based air purifier  
 SA = stand alone system  
 PF = conventional / medium efficiency panel filter

The three schools were tested one at a time from April to December 2008 for a total of over 150 valid measurement days across all schools and classrooms. The period of sampling was during regularly scheduled school hours, with minor adjustments for school schedule changes.

## RESULTS AND DISCUSSION

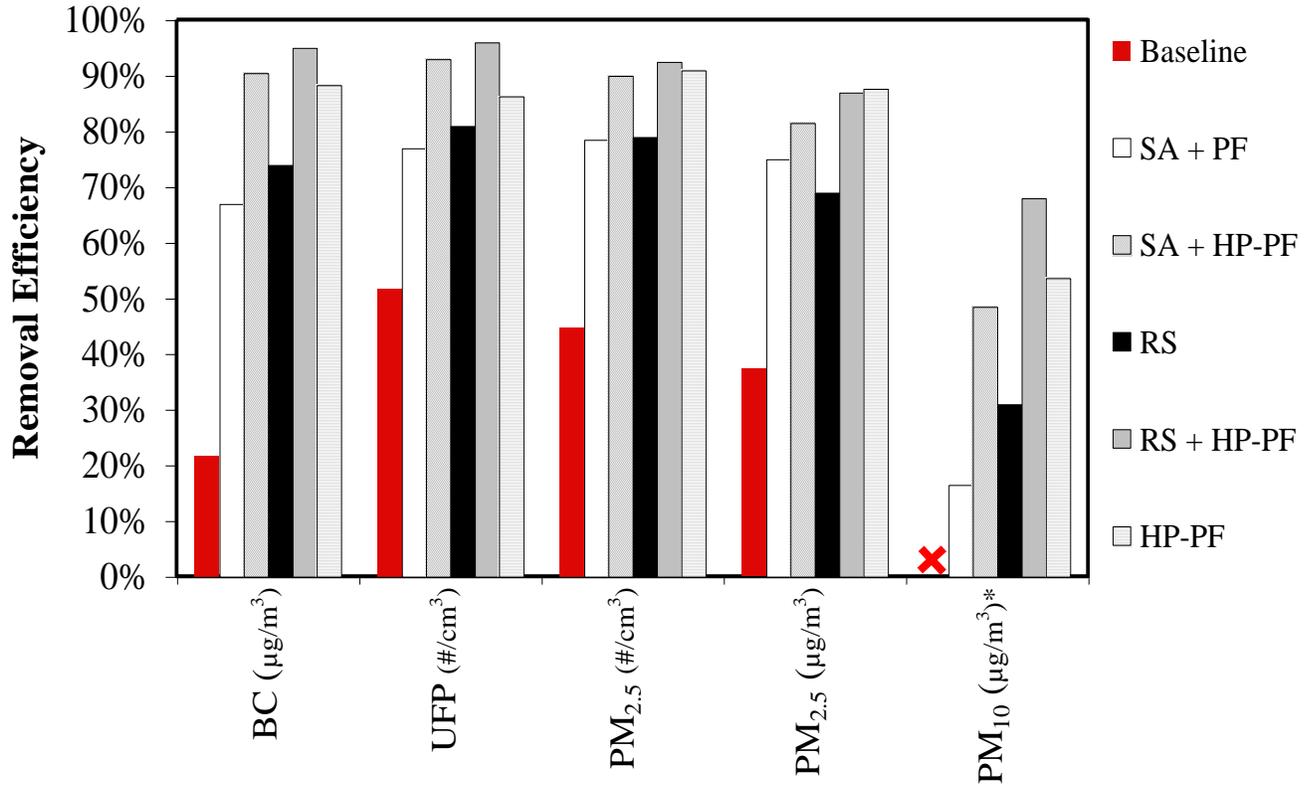
### *Removal of PM and other particle species*

Figure 7a summarizes the study average particle removal efficiencies (here defined as the percentage reduction in the indoor concentration of a particular pollutant relative to its concurrent outdoor concentration) achieved by the six air purification solutions. Indoor and outdoor mass and particle number concentrations were averaged over the duration of a typical school day and across all days, classrooms and schools. The corresponding study average particle removal efficiencies for each elementary school are shown in Figures 7b, 7c, and 7d for Del Amo, Hudson and Dominguez, respectively. Daily and weekly average indoor and outdoor concentrations of BC, UFP, PM<sub>2.5</sub> and PM<sub>10</sub> at all schools and classrooms are provided in APPENDIX A, along with the corresponding average indoor/outdoor ratios and removal efficiencies.

Overall, the combination of a register system and a high-performance panel filter (RS + HP-PF) was the most effective solution for reducing the indoor concentrations of BC, UFP, and PM<sub>2.5</sub> (both mass and particle count), with average removal efficiencies varying from 87 to 96% (Figure 7a). Replacing a conventional HVAC-based panel filter (PF) with a HP-PF resulted in a substantial reduction in the indoor levels of all particulate pollutants inside all classrooms, especially when this high-performance panel filter was operated in conjunction with other air filtration devices. When using the HP-PF alone, the study average removal efficiencies were also close to 90% (88, 86, 91, and 88%, for BC,

UFP, PM<sub>2.5</sub> count, and PM<sub>2.5</sub> mass, respectively). These average values are significantly higher than baseline (pre-existing) conditions, when removal efficiencies for the different pollutants were only about 20-50%.

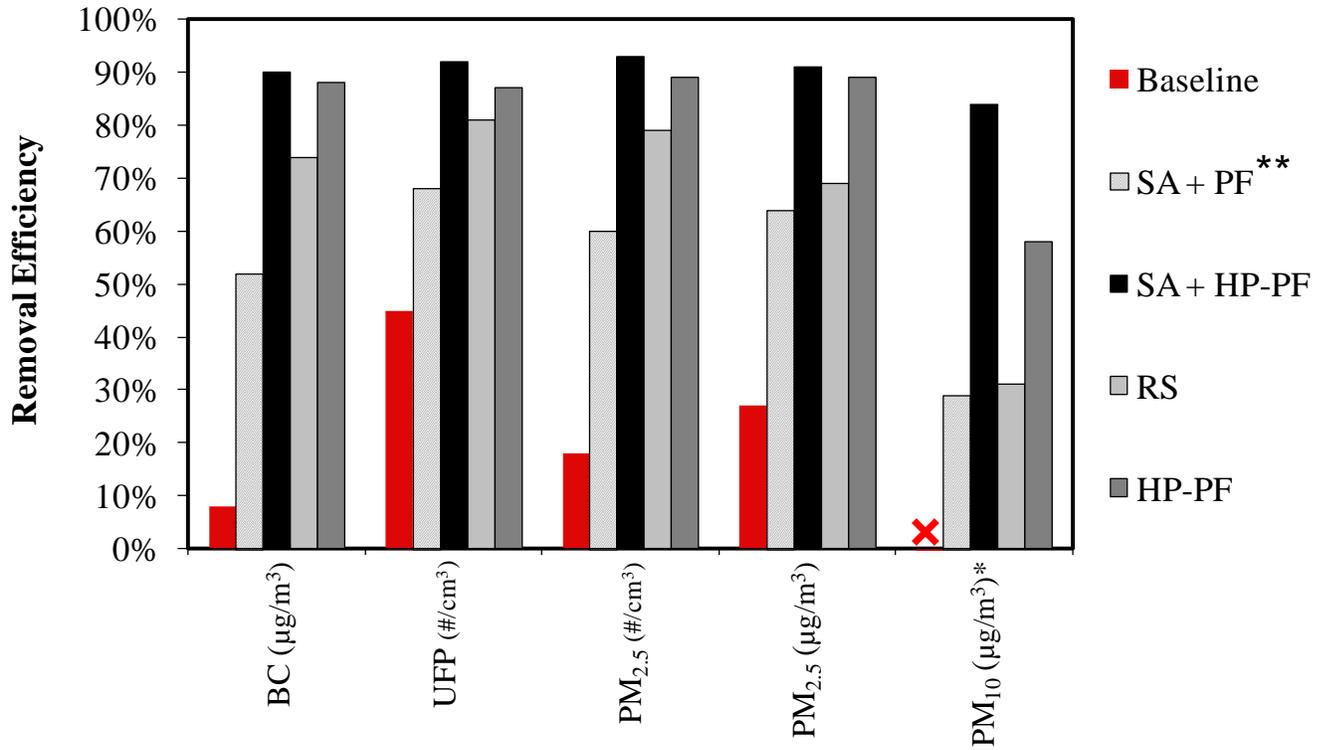
a) **ALL CLASSROOMS AT ALL SCHOOLS**



\* From gravimetric / filter measurements

✗ The PM<sub>10</sub> concentration was higher indoors than outdoors due to indoor sources

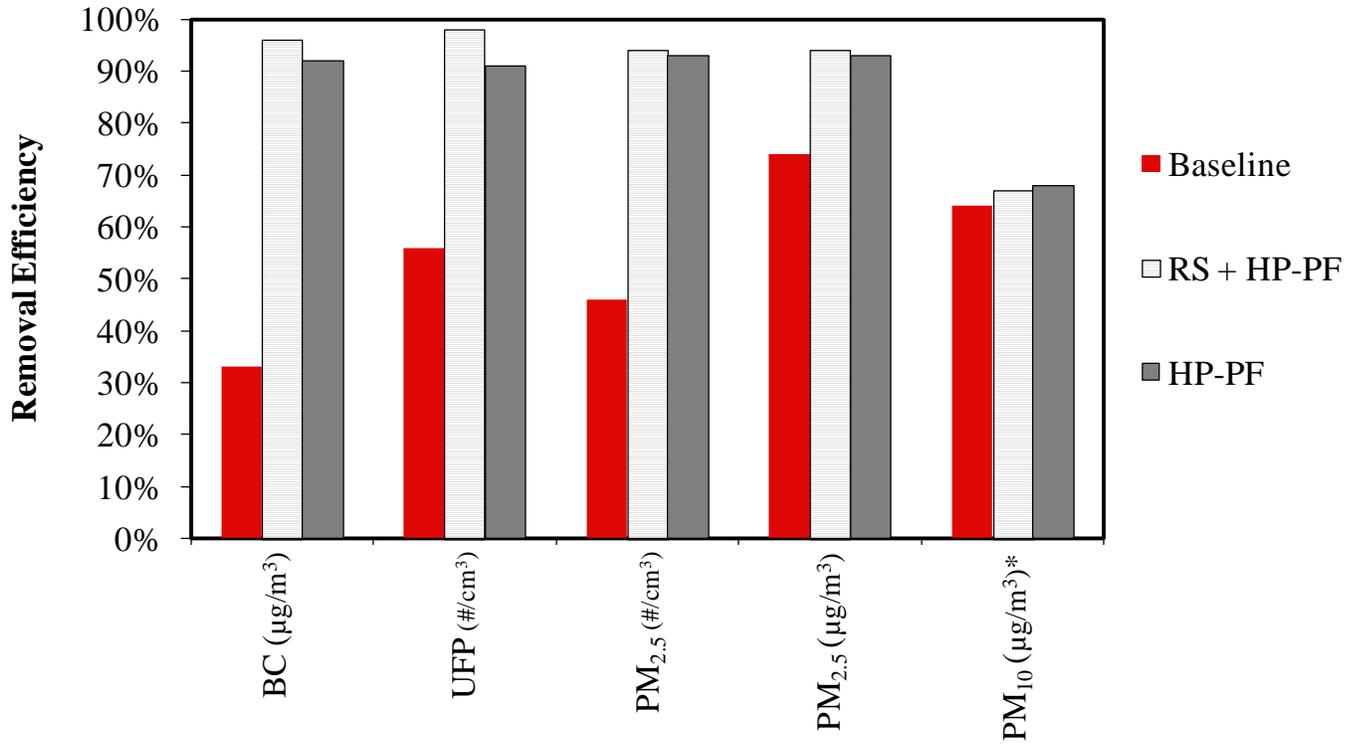
b) **DEL AMO ELEMENTARY SCHOOL**



\* From gravimetric / filter measurements \*\* With HVAC

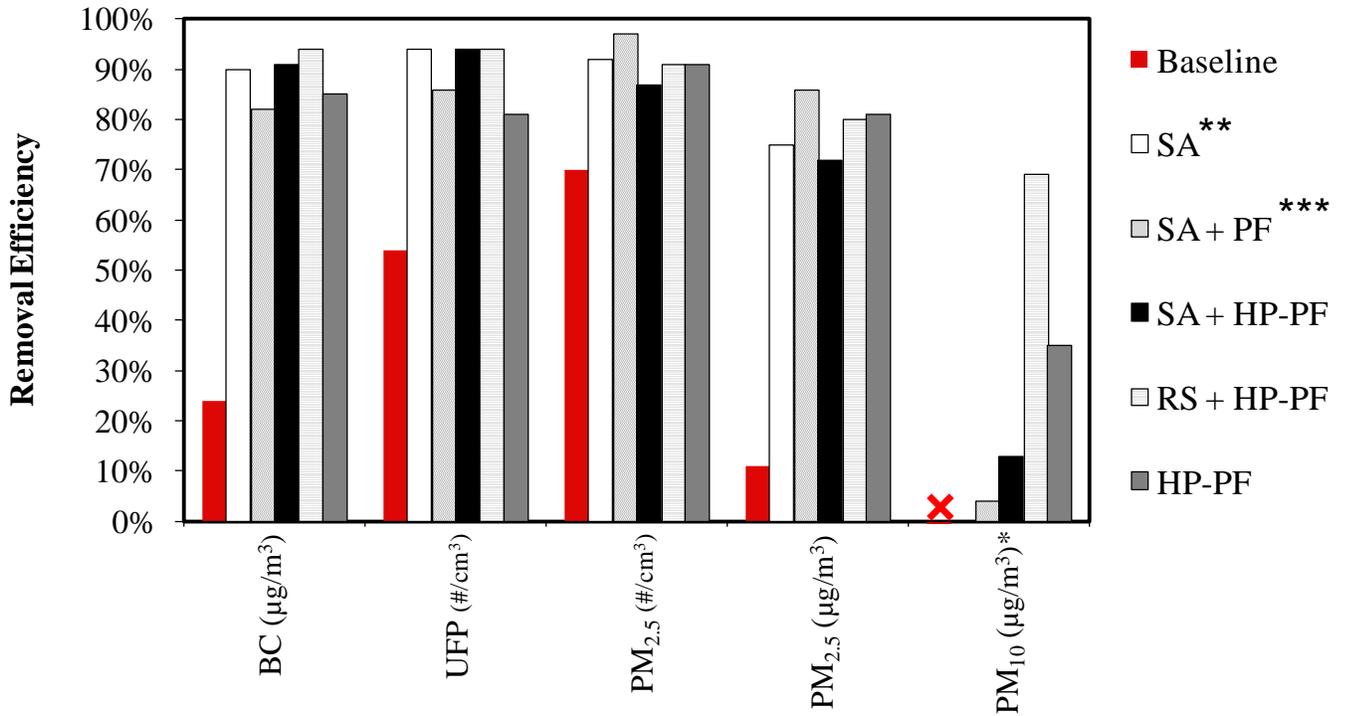
✗ The PM<sub>10</sub> concentration was higher indoors than outdoors due to indoor sources

c) **HUDSON ELEMENTARY SCHOOL**



\* From gravimetric / filter measurements

d) **DOMINGUEZ ELEMENTARY SCHOOL**



\* From gravimetric / filter measurements \*\* Without HVAC \*\*\* With HVAC

✗ The PM<sub>10</sub> concentration was higher indoors than outdoors because of indoor sources

**Figure 7.** Particle removal efficiencies (%) achieved by the six air purification solutions. Bars indicate data averaged a) at all schools and in all classrooms, b) at Del Amo, c) at Hudson, and d) at Dominguez

In all cases, air quality conditions were improved substantially with respect to the corresponding baseline measurements. The intra-classroom variability of the measured removal efficiencies was low, as indicated by the low standard deviations given in Table 6a. This reflects the fact that all air purification solutions were highly effective at all schools and in all classrooms, as confirmed by the particle removal performance data for each of the three elementary schools in Tables 6b (Del Amo), 6c (Hudson) and 6d (Dominguez).

The stand-alone system (SA) is well suited for indoor environments not equipped with an HVAC. In order to simulate conditions similar to those encountered in older classrooms not equipped with a forced air climate control device, the HVAC in room DZ-7 (at Dominguez) was intentionally turned off for part of the study. When the SA unit was running with the HVAC off, removal efficiencies were close to 90% for BC, UFP and PM<sub>2.5</sub> (count) (Table 6d). For BC and UFP, these percentages were slightly lower when the HVAC was running since more of the smaller particles (mostly unfiltered by the existing conventional panel filter) were entering the classrooms from outdoors. Overall, our results confirmed that conventional HVAC panel filters are not particularly effective in removing UFP, although they can be effective in removing coarser particles.

**Table 6.** Particle removal efficiencies (%) achieved by the six air purification solutions. Data represent averages a) at all schools and in all classrooms, b) at Del Amo, c) at Hudson, and d) at Dominguez

a)	ALL CLASSROOMS AND ALL SCHOOLS						
	Study days (#)	BC (%)	UFP (%)	PM <sub>2.5</sub> count (%)	PM <sub>2.5</sub> mass (%)	PM <sub>10</sub> gravimetric mass (%) <sup>1</sup>	PM <sub>10</sub> mass monitor (%) <sup>2</sup>
Baseline	48	22 ± 13	52 ± 17	45 ± 14	37 ± 26	-67 ± 156	13 ± 36
SA + PF**	14	67 ± 6	77 ± 6	79 ± 5	75 ± 5	17 ± 71	59 ± 9
SA + HP-PF	11	91 ± 6	93 ± 4	90 ± 3	82 ± 12	49 ± 16	53 ± 33
RS + PF	15	74 ± 20	81 ± 10	79 ± 17	69 ± 24	31 ± 55	22 ± 46
RS + HP-PF	35	95 ± 2	96 ± 3	93 ± 5	87 ± 11	68 ± 11	42 ± 28
HP-PF	35	88 ± 5	86 ± 7	91 ± 4	88 ± 8	54 ± 25	53 ± 31

b)	DEL AMO ELEMENTARY SCHOOL						
	Study days (#)	BC (%)	UFP (%)	PM <sub>2.5</sub> count (%)	PM <sub>2.5</sub> mass (%)	PM <sub>10</sub> gravimetric mass (%) <sup>1</sup>	PM <sub>10</sub> mass monitor (%) <sup>2</sup>
Baseline	15	8 ± 9	45 ± 16	18 ± 20	27 ± 17	-224 ± 278	26 ± 26
SA*	N/A	N/A ± N/A	N/A ± N/A	N/A ± N/A	N/A ± N/A	N/A ± N/A	N/A ± N/A
SA + PF**	10	52 ± 7	68 ± 6	60 ± 7	64 ± 5	29 ± 102	51 ± 9
SA + HP-PF	5	90 ± 5	92 ± 3	93 ± 1	91 ± 4	84 ± 11	74 ± 11
RS + PF	15	74 ± 20	81 ± 10	79 ± 17	69 ± 24	31 ± 55	22 ± 46
RS + HP-PF	N/A	N/A ± N/A	N/A ± N/A	N/A ± N/A	N/A ± N/A	N/A ± N/A	N/A ± N/A
HP-PF	15	88 ± 4	87 ± 4	89 ± 5	89 ± 5	58 ± 28	62 ± 13

c)	HUDSON ELEMENTARY SCHOOL						
	Study days (#)	BC (%)	UFP (%)	PM <sub>2.5</sub> count (%)	PM <sub>2.5</sub> mass (%)	PM <sub>10</sub> gravimetric mass (%) <sup>1</sup>	PM <sub>10</sub> mass monitor (%) <sup>2</sup>
Baseline	15	33 ± 9	56 ± 18	46 ± 11	74 ± 5	64 ± 28	54 ± 23
SA*	N/A	N/A ± N/A	N/A ± N/A	N/A ± N/A	N/A ± N/A	N/A ± N/A	N/A ± N/A
SA + PF**	N/A	N/A ± N/A	N/A ± N/A	N/A ± N/A	N/A ± N/A	N/A ± N/A	N/A ± N/A
SA + HP-PF	N/A	N/A ± N/A	N/A ± N/A	N/A ± N/A	N/A ± N/A	N/A ± N/A	N/A ± N/A
RS + PF	N/A	N/A ± N/A	N/A ± N/A	N/A ± N/A	N/A ± N/A	N/A ± N/A	N/A ± N/A
RS + HP-PF	27	96 ± 2	98 ± 2	94 ± 4	94 ± 5	67 ± 8	51 ± 30
HP-PF	15	92 ± 2	91 ± 4	93 ± 2	93 ± 4	68 ± 19	59 ± 33

d)	DOMINGUEZ ELEMENTARY SCHOOL						
	Study days (#)	BC (%)	UFP (%)	PM <sub>2.5</sub> count (%)	PM <sub>2.5</sub> mass (%)	PM <sub>10</sub> gravimetric mass (%) <sup>1</sup>	PM <sub>10</sub> mass monitor (%) <sup>2</sup>
Baseline	18	24 ± 21	54 ± 16	70 ± 11	11 ± 55	-40 ± 161	-42 ± 60
SA*	3	90 ± 4	94 ± 2	92 ± 6	75 ± 10	0 ± 34	31 ± 42
SA + PF**	4	82 ± 5	86 ± 5	97 ± 2	86 ± 4	4 ± 40	66 ± 8
SA + HP-PF	6	91 ± 6	94 ± 4	87 ± 5	72 ± 20	13 ± 20	32 ± 55
RS + PF	N/A	N/A ± N/A	N/A ± N/A	N/A ± N/A	N/A ± N/A	N/A ± N/A	N/A ± N/A
RS + HP-PF	8	94 ± 2	94 ± 3	91 ± 6	80 ± 17	69 ± 14	33 ± 25
HP-PF	18	85 ± 8	81 ± 13	91 ± 5	81 ± 16	35 ± 28	39 ± 48

Note: Negative removal efficiencies indicate the presence of an indoor source of PM<sub>10</sub>

<sup>1</sup>From gravimetric / filter measurements

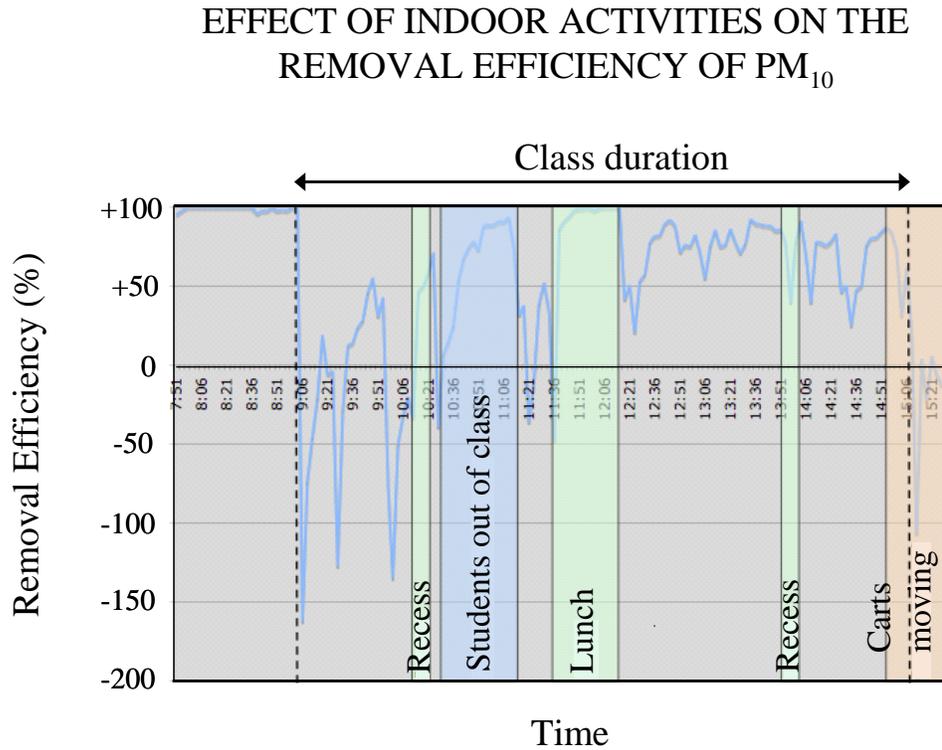
<sup>2</sup>Using a particle mass monitor

\*The HVAC system was turned off

\*\*Operated in conjunction with a standard (MERV 7) panel filter installed in the HVAC system

It should be noted that the negative removal efficiencies associated with several baseline PM<sub>10</sub> measurements indicate conditions where indoor concentrations were higher than the corresponding outdoor levels. This is likely due to re-suspension of dust and other relatively large particles caused by in-classroom activities such as walking and cleaning. Due to the presence of these indoor sources, the removal performance of PM<sub>10</sub> was lower than that of other particle measurements.

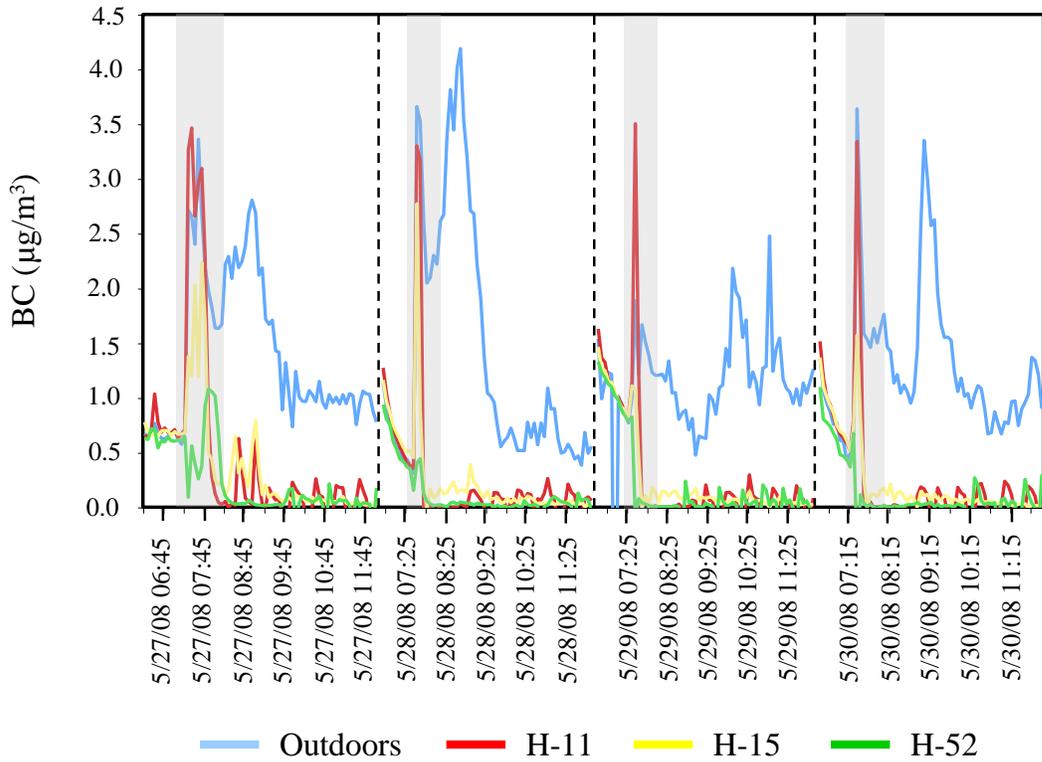
Figure 8 illustrates the effect of indoor activities on in-classroom PM<sub>10</sub> levels at Hudson Elementary School (Room H-15) on May 21, 2008. On this day removal efficiencies approached 100% before the school day started and during lunchtime (when students and staff members were outside the classroom) and were substantially lower when classes were in session.



**Figure 8.** Effect of indoor activities on the removal performance of PM<sub>10</sub> at Hudson elementary school (Room H-15) on May 21, 2008

Activities occurring immediately outside the school boundaries were observed to influence the indoor concentrations of some pollutants and, thus, their corresponding removal efficiencies. Figure 9 shows the effect of increased motor-vehicle emissions due to the morning drop-off of students (grey areas) on the outdoor concentrations of BC, and the associated spikes in indoor BC levels occurring just before the beginning of the school day, when the classroom doors were left open. Overall, these indoor peaks caused a relatively small decrease in the calculated removal performance when averaged over the course of the entire school day.

## EFFECT OF PRE-SCHOOL ACTIVITIES ON BC CONCENTRATIONS



**Figure 9.** Effect of before school activities on BC concentrations. Grey areas show an increase in both indoor and outdoor levels due to morning drop-off traffic

**Impact on the HVAC system airflow**

As discussed earlier, the high-performance panel filters (HP-PF) used for this pilot study are thicker than standard/conventional medium performance MERV filters. However, due to their increased surface area and proprietary “nano-fiber” design, they generally have similar air resistance properties as conventional filters and, thus, do not reduce the airflow through the HVAC system.

As shown in Table 7, replacing a conventional panel filter (PF; typically 1” in depth) with a thicker high-performance panel filter (HP-PF; 2” deep) did not alter the measured airflow in any of the studied classrooms. Adding a register system without upgrading to a high-performance panel filter (see the RS-PF configuration data below) reduced the HVAC system airflow by an average of 9%. This small reduction is due to the increased pressure drop resulting from the addition of a gas-phase filtration media. Using a register system while also upgrading to a high-performance panel filter (RS + HP-PF configuration in Table 7) altered the airflow by only 1-3%. At Hudson elementary school, installation of the register system in classrooms H-11 and H-15 required a widening of the connection to the supply duct. This caused an airflow increase between 17 and 24%.

**Table 7.** Effect of a high-performance panel filter (HP-PF) and/or a register system (RS) on the HVAC system airflow

DEL AMO ELEMENTARY SCHOOL						
	DA-6		DA-7		DA-8	
	Airflow (cfm)	Change (%)	Airflow (cfm)	Change (%)	Airflow (cfm)	Change (%)
Baseline	1200		1200		1250	
HP-PF	1210	1	N/A	N/A	1250	0
RS + PF	N/A	N/A	1090	-9	N/A	N/A

HUDSON ELEMENTARY SCHOOL						
	H-11		H-15		H-52	
	Airflow (cfm)	Change (%)	Airflow (cfm)	Change (%)	Airflow (cfm)	Change (%)
Baseline	840		903		1236	
HP-PF	844	0	913	1	1246	1
RS + HP-PF	1039	24	1054	17	1194	-3

DOMINGUEZ ELEMENTARY SCHOOL						
	DZ-7		DZ-9		DZ-11	
	Airflow (cfm)	Change (%)	Airflow (cfm)	Change (%)	Airflow (cfm)	Change (%)
Baseline	1642		1681		1722	
HP-PF	1661	1	1664	-1	1771	3
RS + HP-PF	N/A	N/A	N/A	N/A	1742	1

### Removal of VOCs

Although canister samples were collected at all schools and classrooms, and all samples were analyzed for VOCs, the data recovery at Del Amo and Hudson was insufficient to guarantee an adequate interpretation of the results. The detection limits of the analysis method used at those schools were not low enough to quantify most of the VOCs of interest. After the analysis methods were modified to correct for this problem, reliable VOC data were obtained for Dominguez elementary. Therefore, only VOC data from Dominguez are discussed in this section. Table 8 summarizes the removal efficiencies for:

- Total VOCs: expressed as the sum of 61 individual compounds and 53 unspiciated organic compounds
- Ethanol: a chemical emitted from both indoor and outdoor evaporative sources
- Benzene: a species mostly emitted from gasoline-powered vehicles. This compound was used here as an indicator of VOCs of outdoor origin

Daily average concentrations of individual VOCs measured at Dominguez elementary school (i.e. DZ-7, DZ-9, and DZ-11) are given in APPENDIX B.

**Table 8.** Average removal efficiencies of total VOCs, ethanol, and benzene at Dominguez elementary school

DOMINGUEZ ELEMENTARY SCHOOL				
	Study Days (#)	Total VOCs (%) <sup>1</sup>	Ethanol (%)	Benzene (%)
Baseline	18	-114 ± 731	-1230 ± 982	-11 ± 22
SA (HVAC off)*	3	15 ± 132	-349 ± 276	52 ± 35
SA + PF (HVAC on)**	4	19 ± 198	-587 ± 903	58 ± 33
SA + HP-PF	6	-6 ± 280	-929 ± 853	73 ± 11
RS	N/A	N/A ± N/A	N/A ± N/A	N/A ± N/A
RS + HP-PF	8	-3 ± 345	-534 ± 502	58 ± 49
HP-PF	18	-64 ± 404	-1111 ± 1164	1 ± 38

<sup>1</sup>Sum of 61 known VOCs and 53 unspiciated organic compounds

\*Operated with the HVAC system turned off

\*\*Operated with the HVAC system turned on

Large standard deviations reflect the wide concentration ranges for the different chemicals. As expected, existing and high-performance panel filters (PF and HP-PF, respectively) had virtually no effect on the VOC levels measured indoors, since these air filtration media did not include gas removal capabilities. The standalone system (SA) demonstrated a 52 to 73% removal performance for benzene.

At all three schools, the indoor concentrations of ethanol were consistently the highest among all measured VOCs and higher than outdoor levels. This organic

compound is a common solvent used in whiteboard markers, detergents and other cleaning products, and has several potential indoor sources. The negative removal efficiencies shown in Table 8 indicate that the indoor concentrations of some VOCs were often higher than the corresponding outdoor levels. Our findings are in line with those from previous research studies (Jia et al., 2007; Bruno et al., 2008), and confirm that several measured indoor VOCs are mostly of indoor origin. For this reason, a direct comparison of indoor and outdoor total VOC concentrations is not appropriate when significant indoor sources exist.

Therefore, classroom DZ-9, whose air conditioning system was equipped with a HP-PF and no gas phase filtration device, was used as the “baseline” (rather than the outdoor monitoring site) to better evaluate the actual effectiveness of the standalone unit (SA) and the register system (RS) installed in classrooms DZ-7 and DZ-11, respectively (Table 9). When compared to the control classroom (DZ-9), the removal efficiencies for total VOCs in classrooms DZ-7 and DZ-11 showed a reduction in gaseous pollutants with respect to baseline conditions.

**Table 9.** Average removal efficiencies of total VOCs with respect to a control classroom (DZ-9) not equipped with any gas phase filtration device. All data refer to measurements taken at Dominguez elementary school

DOMINGUEZ ELEMENTARY SCHOOL (removal efficiency with respect to classroom DZ-9)			
	Classroom Comparison <sup>1</sup>	Study Days (#)	Total VOCs (%) <sup>2</sup>
Baseline	DZ-7 & DZ-11 vs DZ-9	14	-31 ± 367
RS	DZ-11 vs DZ-9	10	-3 ± 521
SA (HVAC off)*	DZ-7 vs DZ-9	2	55 ± 50
SA + PF (HVAC on)**	DZ-7 vs DZ-9	8	27 ± 198

<sup>1</sup>DZ-9 = "control classroom" (HP-PF but no gas-phase filtration)

<sup>2</sup>Sum of 61 known VOCs and 53 unspecified organic compounds

\*Operated with the HVAC system turned off

\*\*Operated with the HVAC system turned on

Removal efficiencies corresponding to baseline measurements indicate that the total VOC concentration inside the two test rooms (DZ-7 and DZ-11) were, on average, 31% higher than that in the control classroom (DZ-9), probably because of differences in indoor activities (e.g. cleaning). Assuming this difference persisted throughout the entire duration of the study, the actual VOC removal performance of the register system (RS) was about 28% (-3% + 31%). Similarly, when normalizing for the initial conditions in the control classroom, the removal efficiencies of the standalone (SA) unit operated with and without the use of the HVAC system were about 58% (27% + 31%) and 86% (55% + 31%), respectively.

Overall, these solutions demonstrated some ability to reduce VOCs indoors, although not as consistently or effectively as the particle filtration. This may be due to the presence of one or more indoor sources of gaseous pollutants. The removal performance of gas-absorbing media (as opposed to filtration substrates) is dependent on media history and may be subject to saturation after experiencing high short-term concentrations or after longer-term use. Therefore, the lifetime, cost, benefits, and maintenance of the gas removal media must be further assessed before conclusions and recommendations can be made.

#### **ACKNOWLEDGEMENTS**

This pilot study was funded through the use of mitigation fees collected by the South Coast Air Quality Management District (SCAQMD) under Rule 1172 for VOC releases by local refineries. AQMD is the air pollution control agency for all of Orange County and urban portions of Los Angeles, Riverside and San Bernardino counties, the smoggiest region of the United States. IQAir North America, Inc., a leading specialist in air filtration solutions for homes, hospitals and schools, and Thermal Comfort Systems, specialist in HVAC system design, were selected by SCAQMD through a competitive bid process to provide for the design, engineering and installation of the air filtration devices used for this work.

## REFERENCES

Bruno, P., Caselli, M., De Gennaro, G., Iacobellis, S., and Tutino, M. (2008) "Monitoring of volatile organic compounds in non-residential indoor environments", *Indoor Air*, 18 (3): 250-256

Environmental Protection Agency Integrated Science Assessments (External Review Draft; 2009). <http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=201805>

Jia, C., Batterman, S. and Godwin, C. (2007) "VOCs in industrial, urban and suburban neighborhoods, Part 1: Indoor and outdoor concentrations, variation, and risk drivers", *Atmospheric Environment*, 42 (9): 2083-2100

MATES III Study, 2008 (<http://www.aqmd.gov/prdas/matesIII/matesIII.html>)

Pope, C. A., and Dockery, D. W. (2006) "Health effects of fine particulate air pollution: Lines that connect", *Journal of the Air & Waste Management Association*, 56: 709-742

**APPENDIX A.** Daily and weekly average indoor and outdoor concentrations of black carbon (BC), ultra-fine particles (UFP), fine particulate matter (PM<sub>2.5</sub>) and coarse PM (PM<sub>10</sub>) at all schools and classrooms. The corresponding average indoor / outdoor ratios and removal efficiencies are also included. Missing data (mostly due to instrument malfunction) and periods affected by rain have been highlighted in yellow. The air purification solutions adopted in each classroom have been summarized below each Table

**Del Amo Elementary School - Black Carbon**

Date	Average Outdoor Concentration (ng/m <sup>3</sup> )	Average Indoor Concentration (ng/m <sup>3</sup> )			Average Indoor/Outdoor Ratio			Average Removal Efficiency		
		DA-6	DA-7	DA-8	DA-6	DA-7	DA-8	DA-6	DA-7	DA-8
4/7/2008	1,611	1,392	1,490	1,465	0.86	0.92	0.91	14%	8%	9%
4/8/2008	948	902	1,094	887	0.95	1.15	0.94	5%	-15%	6%
4/9/2008	1,119	1,166	1,147	1,044	1.04	1.03	0.93	-4%	-3%	7%
4/10/2008	1,692	1,518	1,495	1,500	0.90	0.88	0.89	10%	12%	11%
4/11/2008	4,451	3,547	3,665	3,651	0.80	0.82	0.82	20%	18%	18%
Average (Week 1)	1,964	1,705	1,778	1,709	0.91	0.96	0.90	9%	4%	10%
Standard Deviation	1,426	1,056	1,071	1,117	0.09	0.13	0.05	9%	13%	5%
4/14/2008	3,688	1,802	383	410	0.49	0.10	0.11	51%	90%	89%
4/15/2008	1,128	595	851	93	0.53	0.75	0.08	47%	25%	92%
4/16/2008	1,353	824	703	333	0.61	0.52	0.25	39%	48%	75%
4/17/2008	4,392	2,301	1,656	435	0.52	0.38	0.10	48%	62%	90%
4/18/2008	3,387	1,752	1,061	254	0.52	0.31	0.07	48%	69%	93%
Average (Week 2)	2,789	1,455	931	305	0.53	0.41	0.12	47%	59%	88%
Standard Deviation	1,462	718	475	138	0.04	0.24	0.07	4%	24%	7%
4/21/2008	1,409	537	171	105	0.38	0.12	0.07	62%	88%	93%
4/22/2008	2,396	1,097	414	265	0.46	0.17	0.11	54%	83%	89%
4/23/2008	1,180	498	226	125	0.42	0.19	0.11	58%	81%	89%
4/24/2008	1,691	734	362	193	0.43	0.21	0.11	57%	79%	89%
4/25/2008	3,261	1,377	455	278	0.42	0.14	0.09	58%	86%	91%
Average (Week 3)	1,987	848	326	193	0.42	0.17	0.10	58%	83%	90%
Standard Deviation	846	379	122	79	0.03	0.04	0.02	3%	4%	2%
4/28/2008	3,789	209	349	375	0.06	0.09	0.10	94%	91%	90%
4/29/2008	1,908	135	269	279	0.07	0.14	0.15	93%	86%	85%
4/30/2008	1,077	104	108	127	0.10	0.10	0.12	90%	90%	88%
5/1/2008	1,055	191	156	160	0.18	0.15	0.15	82%	85%	85%
5/2/2008	3,338	292	1,899	505	0.09	0.57	0.15	91%	43%	85%
Average (Week 4)	2,233	186	556	289	0.10	0.21	0.13	90%	79%	87%
Standard Deviation	1,272	73	756	156	0.05	0.20	0.02	5%	20%	2%

School / Class ID	Configurations Used			
	04 / 07-11 / 08	04 / 14-18 / 08	04 / 21-25 / 08	04 / 28 / 08 to 05 / 02 / 08
Del Amo / DA-6	Baseline	SA + PF	SA + PF	SA + HP-PF
Del Amo / DA-7	Baseline	RS	RS	RS
Del Amo / DA-8	Baseline	HP-PF	HP-PF	HP-PF

HP-PF = HVAC-based high-performance panel filter  
 RS = register-based air purifier  
 SA = stand alone system  
 PF = conventional / medium efficiency panel filter

### Del Amo Elementary School - Ultra Fine Particles

Date	Average Outdoor Concentration (particles/cm <sup>3</sup> )	Average Indoor Concentration (particles/cm <sup>3</sup> )			Average Indoor/Outdoor Ratio			Average Removal Efficiency		
		DA-6	DA-7	DA-8	DA-6	DA-7	DA-8	DA-6	DA-7	DA-8
4/7/2008	34,674		25,215			0.73		27%		
4/8/2008	39,291	15,555	17,984	14,386	0.40	0.46	0.37	60%	54%	63%
4/9/2008	19,124	11,354	18,384	12,960	0.59	0.96	0.68	41%	4%	32%
4/10/2008	41,814	19,800	21,327	19,463	0.47	0.51	0.47	53%	49%	53%
4/11/2008	42,613	19,833	22,452	19,935	0.47	0.53	0.47	53%	47%	53%
<b>Average (Week 1)</b>	35,503	16,635	21,072	16,686	0.48	0.64	0.49	<b>52%</b>	<b>36%</b>	<b>51%</b>
<b>Standard Deviation</b>	9,665	4,054	2,996	3,533	0.08	0.21	0.13	<b>8%</b>	<b>21%</b>	<b>13%</b>
4/14/2008	53,086	16,017	6,724	7,303	0.30	0.13	0.14	70%	87%	86%
4/15/2008		7,878	8,865	10,233						
4/16/2008	35,591	14,757	14,140	8,932	0.41	0.40	0.25	59%	60%	75%
4/17/2008	55,384	13,945	12,367	5,628	0.25	0.22	0.10	75%	78%	90%
4/18/2008	35,185	14,434	11,992	4,979	0.41	0.34	0.14	59%	66%	86%
<b>Average (Week 2)</b>	44,812	13,406	10,818	7,415	0.34	0.27	0.16	<b>66%</b>	<b>73%</b>	<b>84%</b>
<b>Standard Deviation</b>	10,923	3,184	2,974	2,201	0.08	0.12	0.06	<b>8%</b>	<b>12%</b>	<b>6%</b>
4/21/2008	57,526	20,259	6,007	5,267	0.35	0.10	0.09	65%	90%	91%
4/22/2008	46,241	13,552	8,158	7,011	0.29	0.18	0.15	71%	82%	85%
4/23/2008	34,366	9,741	5,891	3,039	0.28	0.17	0.09	72%	83%	91%
4/24/2008	38,854	10,831	7,090	5,171	0.28	0.18	0.13	72%	82%	87%
4/25/2008	33,004	8,965	4,695	2,794	0.27	0.14	0.08	73%	86%	92%
<b>Average (Week 3)</b>	41,998	12,670	6,368	4,656	0.30	0.16	0.11	<b>70%</b>	<b>84%</b>	<b>89%</b>
<b>Standard Deviation</b>	10,101	4,585	1,312	1,751	0.03	0.03	0.03	<b>3%</b>	<b>3%</b>	<b>3%</b>
4/28/2008	40,429	2,179	4,967	5,287	0.05	0.12	0.13	95%	88%	87%
4/29/2008	57,136	3,963	7,457	7,819	0.07	0.13	0.14	93%	87%	86%
4/30/2008	30,692	1,909	2,347	3,136	0.06	0.08	0.10	94%	92%	90%
5/1/2008	37,507	4,076	4,677	3,640	0.11	0.12	0.10	89%	88%	90%
5/2/2008	34,214	3,845	12,424	4,961	0.11	0.36	0.14	89%	64%	86%
<b>Average (Week 4)</b>	39,996	3,194	6,374	4,968	0.08	0.16	0.12	<b>92%</b>	<b>84%</b>	<b>88%</b>
<b>Standard Deviation</b>	10,249	1,058	3,836	1,827	0.03	0.11	0.02	<b>3%</b>	<b>11%</b>	<b>2%</b>

School / Class ID	Configurations Used			
	04 / 07-11 / 08	04 / 14-18 / 08	04 / 21-25 / 08	04 / 28 / 08 to 05 / 02 / 08
Del Amo / DA-6	Baseline	SA + PF	SA + PF	SA + HP-PF
Del Amo / DA-7	Baseline	RS	RS	RS
Del Amo / DA-8	Baseline	HP-PF	HP-PF	HP-PF

HP-PF = HVAC-based high-performance panel filter

RS = register-based air purifier

SA = stand alone system

PF = conventional / medium efficiency panel filter

**Del Amo Elementary School - PM<sub>2.5</sub> (count)**

Date	Average Outdoor Concentration (particles/ft <sup>3</sup> )	Average Indoor Concentration (particles/ft <sup>3</sup> )			Average Indoor/Outdoor Ratio			Average Removal Efficiency		
		DA-6	DA-7	DA-8	DA-6	DA-7	DA-8	DA-6	DA-7	DA-8
4/7/2008		1,425,737								
4/8/2008	1,129,234	860,458	818,779	859,380	0.76	0.73	0.76	24%	27%	24%
4/9/2008	606,772		589,396	761,753		0.97	1.26		3%	-26%
4/10/2008	878,513		621,944	654,570		0.71	0.75		29%	25%
4/11/2008	1,657,318	1,007,993	1,686,712	1,092,355	0.61	1.02	0.66	39%	-2%	34%
<b>Average (Week 1)</b>	1,067,959	1,098,063	929,208	842,014	0.69	0.86	0.86	<b>31%</b>	<b>14%</b>	<b>14%</b>
<b>Standard Deviation</b>	447,095	293,205	515,070	186,681	0.11	0.16	0.27	<b>11%</b>	<b>16%</b>	<b>27%</b>
4/14/2008	1,510,925	608,865	153,470	164,656	0.40	0.10	0.11	60%	90%	89%
4/15/2008	1,448,473	675,560	901,449	87,792	0.47	0.62	0.06	53%	38%	94%
4/16/2008	1,448,590	823,550	755,949	363,943	0.57	0.52	0.25	43%	48%	75%
4/17/2008	2,375,182	935,700	625,960	216,222	0.39	0.26	0.09	61%	74%	91%
4/18/2008	3,303,699	1,068,499	835,426	206,160	0.32	0.25	0.06	68%	75%	94%
<b>Average (Week 2)</b>	2,017,374	822,435	654,451	207,755	0.43	0.35	0.11	<b>57%</b>	<b>65%</b>	<b>89%</b>
<b>Standard Deviation</b>	819,499	187,458	298,268	100,893	0.09	0.21	0.08	<b>9%</b>	<b>21%</b>	<b>8%</b>
4/21/2008	1,117,692	445,613	132,034	89,866	0.40	0.12	0.08	60%	88%	92%
4/22/2008	1,962,746	721,027	258,062	184,328	0.37	0.13	0.09	63%	87%	91%
4/23/2008	1,677,902	639,840	235,809	136,928	0.38	0.14	0.08	62%	86%	92%
4/24/2008	1,606,064	565,163	258,425	167,180	0.35	0.16	0.10	65%	84%	90%
4/25/2008	1,649,781	558,423	189,268	127,409	0.34	0.11	0.08	66%	89%	92%
<b>Average (Week 3)</b>	1,602,837	586,013	214,719	141,142	0.37	0.13	0.09	<b>63%</b>	<b>87%</b>	<b>91%</b>
<b>Standard Deviation</b>	305,266	102,511	54,125	36,669	0.02	0.02	0.01	<b>2%</b>	<b>2%</b>	<b>1%</b>
4/28/2008	1,284,388	94,732	159,555	165,842	0.07	0.12	0.13	93%	88%	87%
4/29/2008	2,011,522	121,487	205,529	272,593	0.06	0.10	0.14	94%	90%	86%
4/30/2008	1,367,829	108,012	120,466	153,098	0.08	0.09	0.11	92%	91%	89%
5/1/2008			143,394	155,073						
5/2/2008			791,947	275,170						
<b>Average (Week 4)</b>	1,554,580	108,077	284,178	204,355	0.07	0.10	0.13	<b>93%</b>	<b>90%</b>	<b>87%</b>
<b>Standard Deviation</b>	397,917	13,378	285,555	63,660	0.01	0.02	0.01	<b>1%</b>	<b>2%</b>	<b>1%</b>

School / Class ID	Configurations Used			
	04 / 07-11 / 08	04 / 14-18 / 08	04 / 21-25 / 08	04 / 28 / 08 to 05 / 02 / 08
Del Amo / DA-6	Baseline	SA + PF	SA + PF	SA + HP-PF
Del Amo / DA-7	Baseline	RS	RS	RS
Del Amo / DA-8	Baseline	HP-PF	HP-PF	HP-PF

HP-PF = HVAC-based high-performance panel filter  
 RS = register-based air purifier  
 SA = stand alone system  
 PF = conventional / medium efficiency panel filter

**Del Amo Elementary School - PM<sub>2.5</sub> (mass)**

Date	Average Outdoor Concentration (µg/m <sup>3</sup> )	Average Indoor Concentration (µg/m <sup>3</sup> )			Average Indoor/Outdoor Ratio			Average Removal Efficiency		
		DA-6	DA-7	DA-8	DA-6	DA-7	DA-8	DA-6	DA-7	DA-8
4/7/2008	8.74	10.50	6.68	6.51	1.20	0.76	74%	-20%	24%	26%
4/8/2008	14.25		10.54	7.04		0.74	0.49		26%	51%
4/9/2008	8.61	5.07	6.43	6.05	0.59	0.75	0.70	41%	25%	30%
4/10/2008	7.48	6.53	5.73	4.55	0.87	0.77	0.61	13%	23%	39%
4/11/2008	7.24	3.89	5.94	4.73	0.54	0.82	0.65	46%	18%	35%
<b>Average (Week 1)</b>	9.27	6.50	7.06	5.77	0.80	0.77	0.64	<b>20%</b>	<b>23%</b>	<b>36%</b>
<b>Standard Deviation</b>	2.86	2.88	1.98	1.10	0.31	0.03	0.10	<b>31%</b>	<b>3%</b>	<b>10%</b>
4/14/2008	10.14	3.61	1.93	0.90	0.36	0.19	0.09	64%	81%	91%
4/15/2008	15.06	4.75	12.40	1.15	0.32	0.82	0.08	68%	18%	92%
4/16/2008	12.49	5.44	9.75	3.31	0.44	0.78	0.26	56%	22%	74%
4/17/2008	10.60		5.21	0.62		0.49	0.06		51%	94%
4/18/2008	8.25	3.76	3.68	1.05	0.46	0.45	0.13	54%	55%	87%
<b>Average (Week 2)</b>	11.31	4.39	6.59	1.41	0.39	0.55	0.12	<b>61%</b>	<b>45%</b>	<b>88%</b>
<b>Standard Deviation</b>	2.58	0.86	4.35	1.08	0.07	0.26	0.08	<b>7%</b>	<b>26%</b>	<b>8%</b>
4/21/2008	10.99	3.56	2.28	0.81	0.32	0.21	0.07	68%	79%	93%
4/22/2008	11.03	3.65	1.82	1.31	0.33	0.17	0.12	67%	83%	88%
4/23/2008	8.59	2.81	2.54	1.18	0.33	0.30	0.14	67%	70%	86%
4/24/2008	12.72	4.27	2.74	1.70	0.34	0.22	0.13	66%	78%	87%
4/25/2008	7.09	2.44	1.31	0.52	0.34	0.19	0.07	66%	81%	93%
<b>Average (Week 3)</b>	10.08	3.35	2.14	1.10	0.33	0.21	0.11	<b>67%</b>	<b>79%</b>	<b>89%</b>
<b>Standard Deviation</b>	2.23	0.73	0.58	0.45	0.01	0.05	0.03	<b>1%</b>	<b>5%</b>	<b>3%</b>
4/28/2008	5.61	0.69	1.05	0.34	0.12	0.19	0.06	88%	81%	94%
4/29/2008	17.88	0.87	1.61	1.79	0.05	0.09	0.10	95%	91%	90%
4/30/2008	14.50	1.35	1.25	1.87	0.09	0.09	0.13	91%	91%	87%
5/1/2008	12.95	1.78	1.17	1.62	0.14	0.09	0.13	86%	91%	88%
5/2/2008	14.08	0.75	5.79	2.10	0.05	0.41	0.15	95%	59%	85%
<b>Average (Week 4)</b>	13.00	1.09	2.17	1.55	0.09	0.17	0.11	<b>91%</b>	<b>83%</b>	<b>89%</b>
<b>Standard Deviation</b>	4.52	0.46	2.03	0.69	0.04	0.14	0.03	<b>4%</b>	<b>14%</b>	<b>3%</b>

School / Class ID	Configurations Used			
	04 / 07-11 / 08	04 / 14-18 / 08	04 / 21-25 / 08	04 / 28 / 08 to 05 / 02 / 08
Del Amo / DA-6	Baseline	SA + PF	SA + PF	SA + HP-PF
Del Amo / DA-7	Baseline	RS	RS	RS
Del Amo / DA-8	Baseline	HP-PF	HP-PF	HP-PF

HP-PF = HVAC-based high-performance panel filter  
 RS = register-based air purifier  
 SA = stand alone system  
 PF = conventional / medium efficiency panel filter

**Del Amo Elementary School - PM<sub>10</sub> (from particle mass monitor measurements)**

Date	Average Outdoor Concentration (µg/m <sup>3</sup> )	Average Indoor Concentration (µg/m <sup>3</sup> )			Average Indoor/Outdoor Ratio			Average Removal Efficiency		
		DA-6	DA-7	DA-8	DA-6	DA-7	DA-8	DA-6	DA-7	DA-8
4/7/2008	35.78	35.22	28.42	21.97	0.98	0.79	61%	2%	21%	39%
4/8/2008	45.40		55.07	23.04		1.21	0.51		-21%	49%
4/9/2008	28.99	20.88	24.58	23.40	0.72	0.85	0.81	28%	15%	19%
4/10/2008	29.55	34.72	22.50	18.44	1.18	0.76	0.62	-18%	24%	38%
4/11/2008	41.44	11.06	25.65	20.46	0.27	0.62	0.49	73%	38%	51%
<b>Average (Week 1)</b>	36.23	25.47	31.25	21.46	0.79	0.85	0.61	<b>21%</b>	<b>15%</b>	<b>39%</b>
<b>Standard Deviation</b>	7.22	11.68	13.49	2.04	0.39	0.22	0.13	<b>39%</b>	<b>22%</b>	<b>13%</b>
4/14/2008	37.29	16.79	31.87	11.31	0.45	0.85	0.30	55%	15%	70%
4/15/2008	49.49	18.09	81.10	17.11	0.37	1.64	0.35	63%	-64%	65%
4/16/2008	43.89	27.44	75.71	22.75	0.63	1.72	0.52	37%	-72%	48%
4/17/2008	43.78		48.13	11.29		1.10	0.26		-10%	74%
4/18/2008	33.84	19.71	38.90	16.90	0.58	1.15	0.50	42%	-15%	50%
<b>Average (Week 2)</b>	41.66	20.51	55.14	15.87	0.51	1.29	0.38	<b>49%</b>	<b>-29%</b>	<b>62%</b>
<b>Standard Deviation</b>	6.14	4.77	22.09	4.79	0.12	0.37	0.12	<b>12%</b>	<b>37%</b>	<b>12%</b>
4/21/2008	45.13	17.94	31.35	14.58	0.40	0.69	0.32	60%	31%	68%
4/22/2008	39.96	23.99	20.92	18.86	0.60	0.52	0.47	40%	48%	53%
4/23/2008	33.54	14.53	32.46	18.54	0.43	0.97	0.55	57%	3%	45%
4/24/2008	40.68	21.02	26.43	21.74	0.52	0.65	0.53	48%	35%	47%
4/25/2008	35.52	15.42	18.02	10.66	0.43	0.51	0.30	57%	49%	70%
<b>Average (Week 3)</b>	38.96	18.58	25.83	16.88	0.48	0.67	0.44	<b>52%</b>	<b>33%</b>	<b>56%</b>
<b>Standard Deviation</b>	4.56	3.94	6.33	4.31	0.08	0.19	0.12	<b>8%</b>	<b>19%</b>	<b>12%</b>
4/28/2008	5.61	0.69	1.05	0.34	0.12	0.19	0.06	88%	81%	94%
4/29/2008	49.89	12.13	17.43	13.57	0.24	0.35	0.27	76%	65%	73%
4/30/2008	55.49	19.75	18.17	23.04	0.36	0.33	0.42	64%	67%	58%
5/1/2008	44.69	17.16	17.06	21.40	0.38	0.38	0.48	62%	62%	52%
5/2/2008	52.56	9.90	32.02	19.66	0.19	0.61	0.37	81%	39%	63%
<b>Average (Week 4)</b>	41.65	11.93	17.14	15.60	0.26	0.37	0.32	<b>74%</b>	<b>63%</b>	<b>68%</b>
<b>Standard Deviation</b>	20.53	7.40	10.97	9.25	0.11	0.15	0.16	<b>11%</b>	<b>15%</b>	<b>16%</b>

School / Class ID	Configurations Used			
	04 / 07-11 / 08	04 / 14-18 / 08	04 / 21-25 / 08	04 / 28 / 08 to 05 / 02 / 08
Del Amo / DA-6	Baseline	SA + PF	SA + PF	SA + HP-PF
Del Amo / DA-7	Baseline	RS	RS	RS
Del Amo / DA-8	Baseline	HP-PF	HP-PF	HP-PF

HP-PF = HVAC-based high-performance panel filter  
 RS = register-based air purifier  
 SA = stand alone system  
 PF = conventional / medium efficiency panel filter

**Del Amo Elementary School - PM<sub>10</sub> (from filter-based measurements)**

Date	Average Outdoor Concentration (µg/m <sup>3</sup> )	Average Indoor Concentration (µg/m <sup>3</sup> )			Average Indoor/Outdoor Ratio			Average Removal Efficiency		
		DA-6	DA-7	DA-8	DA-6	DA-7	DA-8	DA-6	DA-7	DA-8
4/7/2008	11	72	44	80	6.55	4.00	727%	-555%	-300%	-627%
4/8/2008	15		72	22		4.80	1.47		-380%	-47%
4/9/2008		66	60	11						
4/10/2008		53	29	65						
4/11/2008	64	47	29	43	0.73	0.45	0.67	27%	55%	33%
<b>Average (Week 1)</b>	30	60	47	44	3.64	3.08	3.14	<b>-264%</b>	<b>-208%</b>	<b>-214%</b>
<b>Standard Deviation</b>	30	12	19	29	4.11	2.31	3.60	<b>411%</b>	<b>231%</b>	<b>360%</b>
4/14/2008	83	87	150	11	1.05	1.81	0.13	-5%	-81%	87%
4/15/2008	61	25	76	52	0.41	1.25	0.85	59%	-25%	15%
4/16/2008	84	41	71	42	0.49	0.85	0.50	51%	15%	50%
4/17/2008	85	20	61	32	0.24	0.72	0.38	76%	28%	62%
4/18/2008	73	11	29	53	0.15	0.40	0.73	85%	60%	27%
<b>Average (Week 2)</b>	77	37	77	38	0.47	1.00	0.52	<b>53%</b>	<b>0%</b>	<b>48%</b>
<b>Standard Deviation</b>	10	30	45	17	0.35	0.54	0.28	<b>35%</b>	<b>54%</b>	<b>28%</b>
4/21/2008	100	71	31	11	0.71	0.31	0.11	29%	69%	89%
4/22/2008	14	49	26	14	3.50	1.86	1.00	-250%	-86%	0%
4/23/2008	110	11	46	21	0.10	0.42	0.19	90%	58%	81%
4/24/2008	61	20	33	43	0.33	0.54	0.70	67%	46%	30%
4/25/2008	73	12	29	21	0.16	0.40	0.29	84%	60%	71%
<b>Average (Week 3)</b>	72	33	33	22	0.96	0.70	0.46	<b>4%</b>	<b>30%</b>	<b>54%</b>
<b>Standard Deviation</b>	38	26	8	13	1.44	0.65	0.38	<b>144%</b>	<b>65%</b>	<b>38%</b>
4/28/2008	88	11	59	30	0.13	0.67	0.34	88%	33%	66%
4/29/2008	780	14	25	36	0.02	0.03	0.05	98%	97%	95%
4/30/2008	67	12	12	22	0.18	0.18	0.33	82%	82%	67%
5/1/2008	63	21	42	28	0.33	0.67	0.44	67%	33%	56%
5/2/2008	86	12	28	28	0.14	0.33	0.33	86%	67%	67%
<b>Average (Week 4)</b>	217	14	33	29	0.16	0.37	0.30	<b>84%</b>	<b>63%</b>	<b>70%</b>
<b>Standard Deviation</b>	315	4	18	5	0.11	0.29	0.15	<b>11%</b>	<b>29%</b>	<b>15%</b>

School / Class ID	Configurations Used			
	04 / 07-11 / 08	04 / 14-18 / 08	04 / 21-25 / 08	04 / 28 / 08 to 05 / 02 / 08
Del Amo / DA-6	Baseline	SA + PF	SA + PF	SA + HP-PF
Del Amo / DA-7	Baseline	RS	RS	RS
Del Amo / DA-8	Baseline	HP-PF	HP-PF	HP-PF

HP-PF = HVAC-based high-performance panel filter

RS = register-based air purifier

SA = stand alone system

PF = conventional / medium efficiency panel filter

## Hudson Elementary School - Black Carbon

Date	Average Outdoor Concentration (ng/m <sup>3</sup> )	Average Indoor Concentration (ng/m <sup>3</sup> )			Average Indoor/Outdoor Ratio			Average Removal Efficiency		
		H-11	H-15	H-52	H-11	H-15	H-52	H-11	H-15	H-52
5/12/2008	889	557	643	666	0.63	0.72	0.75	37%	28%	25%
5/13/2008	1,765	983	1,155	1,208	0.56	0.65	0.68	44%	35%	32%
5/14/2008	1,906	1,031	1,297	1,616	0.54	0.68	0.85	46%	32%	15%
5/15/2008	3,632	2,026	2,597	2,903	0.56	0.72	0.80	44%	28%	20%
5/16/2008	3,756	2,163	2,486	2,771	0.58	0.66	0.74	42%	34%	26%
<b>Average (Week 1)</b>	2,390	1,352	1,636	1,833	0.57	0.69	0.76	<b>43%</b>	<b>31%</b>	<b>24%</b>
<b>Standard Deviation</b>	1,253	704	863	978	0.03	0.03	0.06	<b>3%</b>	<b>3%</b>	<b>6%</b>
5/19/2008	2,007	78	97	194	0.04	0.05	0.10	96%	95%	90%
5/20/2008	1,066	74	71	96	0.07	0.07	0.09	93%	93%	91%
5/21/2008	1,344	104	75	111	0.08	0.06	0.08	92%	94%	92%
5/22/2008	903	95	67	82	0.11	0.07	0.09	89%	93%	91%
5/23/2008	731	68	71	73	0.09	0.10	0.10	91%	90%	90%
<b>Average (Week 2)</b>	1,210	84	76	111	0.08	0.07	0.09	<b>92%</b>	<b>93%</b>	<b>91%</b>
<b>Standard Deviation</b>	499	15	12	49	0.03	0.02	0.01	<b>3%</b>	<b>2%</b>	<b>1%</b>
5/26/2008										
5/27/2008	1,028	63	72	26	0.06	0.07	0.03	94%	93%	97%
5/28/2008	778	59	58	19	0.08	0.07	0.02	92%	93%	98%
5/29/2008	1,098	37	53	23	0.03	0.05	0.02	97%	95%	98%
5/30/2008	1,140	35	41	27	0.03	0.04	0.02	97%	96%	98%
<b>Average (Week 3)</b>	1,011	48	56	24	0.05	0.06	0.02	<b>95%</b>	<b>94%</b>	<b>98%</b>
<b>Standard Deviation</b>	162	15	13	4	0.02	0.02	0.00	<b>2%</b>	<b>2%</b>	<b>0%</b>
6/2/2008	1,128		45	36		0.04	0.03		96%	97%
6/3/2008	1,495	50	69	33	0.03	0.05	0.02	97%	95%	98%
6/4/2008	1,106	55	63	18	0.05	0.06	0.02	95%	94%	98%
6/5/2008	1,320	60	58	65	0.05	0.04	0.05	95%	96%	95%
6/6/2008	2,046	51	52	38	0.03	0.03	0.02	97%	97%	98%
<b>Average (Week 4)</b>	1,419	54	57	38	0.04	0.04	0.03	<b>96%</b>	<b>96%</b>	<b>97%</b>
<b>Standard Deviation</b>	384	5	9	17	0.01	0.01	0.01	<b>1%</b>	<b>1%</b>	<b>1%</b>

School / Class ID	Configurations Used			
	05 / 12-16 / 08	05 / 19-23 / 08	05 / 26-30 / 08	06 / 02-06 / 08
Hudson / H-11	Baseline	HP-PF	RS + HP-PF	RS + HP-PF
Hudson / H-15	Baseline	HP-PF	RS + HP-PF	RS + HP-PF
Hudson / H-52	Baseline	HP-PF	RS + HP-PF	RS + HP-PF

HP-PF = HVAC-based high-performance panel filter

RS = register-based air purifier

SA = stand alone system

PF = conventional / medium efficiency panel filter

### Hudson Elementary School - Ultra Fine Particles

Date	Average Outdoor Concentration (particles/cm <sup>3</sup> )	Average Indoor Concentration (particles/cm <sup>3</sup> )			Average Indoor/Outdoor Ratio			Average Removal Efficiency		
		H-11	H-15	H-52	H-11	H-15	H-52	H-11	H-15	H-52
5/12/2008	14,643	4,083	5,190	8,433	0.28	0.35	0.58	72%	65%	42%
5/13/2008	40,865	10,619	9,421	19,956	0.26	0.23	0.49	74%	77%	51%
5/14/2008	47,145	11,563	14,730	19,466	0.25	0.31	0.41	75%	69%	59%
5/15/2008	44,862	18,397	27,694	29,422	0.41	0.62	0.66	59%	38%	34%
5/16/2008	38,322	10,435	24,291	29,818	0.27	0.63	0.78	73%	37%	22%
<b>Average (Week 1)</b>	37,167	11,019	16,265	21,419	0.29	0.43	0.58	<b>71%</b>	<b>57%</b>	<b>42%</b>
<b>Standard Deviation</b>	13,049	5,083	9,577	8,792	0.07	0.18	0.14	<b>7%</b>	<b>18%</b>	<b>14%</b>
5/19/2008	38,368	1,835	2,732	5,456	0.05	0.07	0.14	95%	93%	86%
5/20/2008	17,442	755	2,099	2,033	0.04	0.12	0.12	96%	88%	88%
5/21/2008	80,163	6,255	4,714	10,681	0.08	0.06	0.13	92%	94%	87%
5/22/2008	27,886	1,381	1,291	3,353	0.05	0.05	0.12	95%	95%	88%
5/23/2008	20,524	1,792	1,367	3,214	0.09	0.07	0.16	91%	93%	84%
<b>Average (Week 2)</b>	36,877	2,404	2,440	4,947	0.06	0.07	0.13	<b>94%</b>	<b>93%</b>	<b>87%</b>
<b>Standard Deviation</b>	25,505	2,197	1,401	3,434	0.02	0.03	0.02	<b>2%</b>	<b>3%</b>	<b>2%</b>
5/26/2008										
5/27/2008	50,891	763	1,295	793	0.01	0.03	0.02	99%	97%	98%
5/28/2008	36,964	452	458	594	0.01	0.01	0.02	99%	99%	98%
5/29/2008	40,035	367	435	572	0.01	0.01	0.01	99%	99%	99%
5/30/2008	57,760	456	566	1,006	0.01	0.01	0.02	99%	99%	98%
<b>Average (Week 3)</b>	46,413	510	689	741	0.01	0.01	0.02	<b>99%</b>	<b>99%</b>	<b>98%</b>
<b>Standard Deviation</b>	9,639	174	408	203	0.00	0.01	0.00	<b>0%</b>	<b>1%</b>	<b>0%</b>
6/2/2008	35,495		430	426		0.01	0.01		99%	99%
6/3/2008	32,336		700	432		0.02	0.01		98%	99%
6/4/2008	18,941	1,656	393	346	0.09	0.02	0.02	91%	98%	98%
6/5/2008	39,083	53	570	3,727	0.00	0.01	0.10	100%	99%	90%
6/6/2008	43,572	609	607	950	0.01	0.01	0.02	99%	99%	98%
<b>Average (Week 4)</b>	33,885	773	540	1,176	0.03	0.02	0.03	<b>97%</b>	<b>98%</b>	<b>97%</b>
<b>Standard Deviation</b>	9,343	814	127	1,446	0.05	0.00	0.04	<b>5%</b>	<b>0%</b>	<b>4%</b>

School / Class ID	Configurations Used			
	05 / 12-16 / 08	05 / 19-23 / 08	05 / 26-30 / 08	06 / 02-06 / 08
Hudson / H-11	Baseline	HP-PF	RS + HP-PF	RS + HP-PF
Hudson / H-15	Baseline	HP-PF	RS + HP-PF	RS + HP-PF
Hudson / H-52	Baseline	HP-PF	RS + HP-PF	RS + HP-PF

HP-PF = HVAC-based high-performance panel filter

RS = register-based air purifier

SA = stand alone system

PF = conventional / medium efficiency panel filter

### Hudson Elementary School - PM<sub>2.5</sub> (count)

Date	Average Outdoor Concentration (particles/ft <sup>3</sup> )	Average Indoor Concentration (particles/ft <sup>3</sup> )			Average Indoor/Outdoor Ratio			Average Removal Efficiency		
		H-11	H-15	H-52	H-11	H-15	H-52	H-11	H-15	H-52
5/12/2008	1,109,627	576,204	511,734	718,130	0.52	0.46	0.65	48%	54%	35%
5/13/2008	1,850,803	757,977	897,986	1,156,730	0.41	0.49	0.62	59%	51%	38%
5/14/2008	1,760,128	682,498	838,534	1,199,580	0.39	0.48	0.68	61%	52%	32%
5/15/2008	1,839,611	767,375	1,011,002	1,191,460	0.42	0.55	0.65	58%	45%	35%
5/16/2008	1,128,564	525,461	723,482	781,768	0.47	0.64	0.69	53%	36%	31%
<b>Average (Week 1)</b>	1,537,747	661,903	796,548	1,009,534	0.44	0.52	0.66	<b>56%</b>	<b>48%</b>	<b>34%</b>
<b>Standard Deviation</b>	383,828	108,096	190,066	238,576	0.05	0.07	0.03	<b>5%</b>	<b>7%</b>	<b>3%</b>
5/19/2008	660,607	44,930	61,168	59,352	0.07	0.09	0.09	93%	91%	91%
5/20/2008	1,477,586	68,443	70,820	131,786	0.05	0.05	0.09	95%	95%	91%
5/21/2008	1,613,826	103,883	73,924	125,633	0.06	0.05	0.08	94%	95%	92%
5/22/2008	1,530,791	106,300	69,737	94,795	0.07	0.05	0.06	93%	95%	94%
5/23/2008	987,855	77,470	71,330	70,589	0.08	0.07	0.07	92%	93%	93%
<b>Average (Week 2)</b>	1,254,133	80,205	69,396	96,431	0.07	0.06	0.08	<b>93%</b>	<b>94%</b>	<b>92%</b>
<b>Standard Deviation</b>	412,015	25,650	4,850	32,203	0.01	0.02	0.01	<b>1%</b>	<b>2%</b>	<b>1%</b>
5/26/2008										
5/27/2008	440,181	52,467	51,042	26,303	0.12	0.12	0.06	88%	88%	94%
5/28/2008	362,533	66,769	46,541	18,906	0.18	0.13	0.05	82%	87%	95%
5/29/2008	369,467	33,173	50,616	17,735	0.09	0.14	0.05	91%	86%	95%
5/30/2008	529,995	35,119	28,628	23,916	0.07	0.05	0.05	93%	95%	95%
<b>Average (Week 3)</b>	425,544	46,882	44,207	21,715	0.11	0.11	0.05	<b>89%</b>	<b>89%</b>	<b>95%</b>
<b>Standard Deviation</b>	77,973	15,843	10,582	4,067	0.05	0.04	0.01	<b>5%</b>	<b>4%</b>	<b>1%</b>
6/2/2008	1,472,339		38,432	36,347		0.03	0.02		97%	98%
6/3/2008	2,102,152	56,800	81,009	39,991	0.03	0.04	0.02	97%	96%	98%
6/4/2008	1,346,575	64,055	66,975	19,669	0.05	0.05	0.01	95%	95%	99%
6/5/2008	1,167,940	77,692	56,657	29,352	0.07	0.05	0.03	93%	95%	97%
6/6/2008	998,499	67,890	40,091	24,490	0.07	0.04	0.02	93%	96%	98%
<b>Average (Week 4)</b>	1,417,501	66,609	56,633	29,970	0.05	0.04	0.02	<b>95%</b>	<b>96%</b>	<b>98%</b>
<b>Standard Deviation</b>	422,678	8,703	18,070	8,331	0.02	0.01	0.00	<b>2%</b>	<b>1%</b>	<b>0%</b>

School / Class ID	Configurations Used			
	<i>05 / 12-16 / 08</i>	<i>05 / 19-23 / 08</i>	<i>05 / 26-30 / 08</i>	<i>06 / 02-06 / 08</i>
Hudson / H-11	Baseline	HP-PF	RS + HP-PF	RS + HP-PF
Hudson / H-15	Baseline	HP-PF	RS + HP-PF	RS + HP-PF
Hudson / H-52	Baseline	HP-PF	RS + HP-PF	RS + HP-PF

HP-PF = HVAC-based high-performance panel filter  
 RS = register-based air purifier  
 SA = stand alone system  
 PF = conventional / medium efficiency panel filter

### Hudson Elementary School - PM<sub>2.5</sub> (mass)

Date	Average Outdoor Concentration (µg/m <sup>3</sup> )	Average Indoor Concentration (µg/m <sup>3</sup> )			Average Indoor/Outdoor Ratio			Average Removal Efficiency		
		H-11	H-15	H-52	H-11	H-15	H-52	H-11	H-15	H-52
5/12/2008	8.19	2.68	2.55	1.82	0.33	0.31	0.22	67%	69%	78%
5/13/2008	13.38	3.36	3.62	3.02	0.25	0.27	0.23	75%	73%	77%
5/14/2008	14.65	2.55	3.74	4.09	0.17	0.25	0.28	83%	75%	72%
5/15/2008	20.11	3.60	5.52	4.92	0.18	0.27	0.24	82%	73%	76%
5/16/2008	14.66	3.13	4.81	4.41	0.21	0.33	0.30	79%	67%	70%
<b>Average (Week 1)</b>	14.20	3.06	4.05	3.65	0.23	0.29	0.25	<b>77%</b>	<b>71%</b>	<b>75%</b>
<b>Standard Deviation</b>	4.25	0.45	1.15	1.23	0.06	0.03	0.03	<b>6%</b>	<b>3%</b>	<b>3%</b>
5/19/2008	7.86	0.56	0.84	0.04	0.07	0.11	0.01	93%	89%	99%
5/20/2008	6.19	1.00	0.82	0.28	0.16	0.13	0.05	84%	87%	95%
5/21/2008	14.18	1.37	0.79	0.28	0.10	0.06	0.02	90%	94%	98%
5/22/2008	29.03	2.09	1.00	0.93	0.07	0.03	0.03	93%	97%	97%
5/23/2008	17.46	1.32	1.20	0.29	0.08	0.07	0.02	92%	93%	98%
<b>Average (Week 2)</b>	14.95	1.27	0.93	0.37	0.10	0.08	0.02	<b>90%</b>	<b>92%</b>	<b>98%</b>
<b>Standard Deviation</b>	9.11	0.56	0.17	0.33	0.04	0.04	0.02	<b>4%</b>	<b>4%</b>	<b>2%</b>
5/26/2008										
5/27/2008	3.12	0.92	0.91	0.10	0.30	0.29	0.03	70%	71%	97%
5/28/2008	2.34	1.48	0.88		0.63	0.38		37%	62%	
5/29/2008	3.36	0.47	0.84	0.07	0.14	0.25	0.02	86%	75%	98%
5/30/2008	4.65	0.54	0.59	0.17	0.12	0.13	0.04	88%	87%	96%
<b>Average (Week 3)</b>	3.37	0.86	0.81	1.64	0.30	0.26	0.03	<b>70%</b>	<b>74%</b>	<b>97%</b>
<b>Standard Deviation</b>	0.96	0.46	0.15	3.05	0.24	0.10	0.01	<b>24%</b>	<b>10%</b>	<b>1%</b>
6/2/2008	12.73		0.49	0.45		0.04	0.04		96%	96%
6/3/2008	15.40	1.09	1.07	0.31	0.07	0.07	0.02	93%	93%	98%
6/4/2008	9.62	1.43	1.10	0.00	0.15	0.11	0.00	85%	89%	100%
6/5/2008	12.63	1.72	1.16	0.22	0.14	0.09	0.02	86%	91%	98%
6/6/2008	16.85	1.25	0.79	0.17	0.07	0.05	0.01	93%	95%	99%
<b>Average (Week 4)</b>	13.45	1.38	0.92	0.23	0.11	0.07	0.02	<b>89%</b>	<b>93%</b>	<b>98%</b>
<b>Standard Deviation</b>	2.80	0.27	0.28	0.17	0.04	0.03	0.01	<b>4%</b>	<b>3%</b>	<b>1%</b>

School / Class ID	Configurations Used			
	05 / 12-16 / 08	05 / 19-23 / 08	05 / 26-30 / 08	06 / 02-06 / 08
Hudson / H-11	Baseline	HP-PF	RS + HP-PF	RS + HP-PF
Hudson / H-15	Baseline	HP-PF	RS + HP-PF	RS + HP-PF
Hudson / H-52	Baseline	HP-PF	RS + HP-PF	RS + HP-PF

HP-PF = HVAC-based high-performance panel filter

RS = register-based air purifier

SA = stand alone system

PF = conventional / medium efficiency panel filter

### Hudson Elementary School - PM<sub>10</sub> (from particle mass monitor measurements)

Date	Average Outdoor Concentration (µg/m <sup>3</sup> )	Average Indoor Concentration (µg/m <sup>3</sup> )			Average Indoor/Outdoor Ratio			Average Removal Efficiency		
		H-11	H-15	H-52	H-11	H-15	H-52	H-11	H-15	H-52
5/12/2008	34.99	35.13	29.94	9.35	1.00	0.86	0.27	0%	14%	73%
5/13/2008	72.87	36.97	35.03	14.02	0.51	0.48	0.19	49%	52%	81%
5/14/2008	57.56	23.93	32.32	13.91	0.42	0.56	0.24	58%	44%	76%
5/15/2008	73.56	33.55	33.75	11.95	0.46	0.46	0.16	54%	54%	84%
5/16/2008	65.32	28.13	36.48	18.64	0.43	0.56	0.29	57%	44%	71%
<b>Average (Week 1)</b>	60.86	31.54	33.50	13.57	0.56	0.58	0.23	<b>44%</b>	<b>42%</b>	<b>77%</b>
<b>Standard Deviation</b>	15.86	5.38	2.52	3.41	0.25	0.16	0.05	<b>25%</b>	<b>16%</b>	<b>5%</b>
5/19/2008	44.62	22.67	31.37	3.21	0.51	0.70	0.07	49%	30%	93%
5/20/2008	29.90	32.03	32.45	7.32	1.07	1.09	0.24	-7%	-9%	76%
5/21/2008	99.04	30.71	30.14	5.48	0.31	0.30	0.06	69%	70%	94%
5/22/2008	97.14	48.80	26.72	6.28	0.50	0.28	0.06	50%	72%	94%
5/23/2008	62.98	28.55	30.00	3.31	0.45	0.48	0.05	55%	52%	95%
<b>Average (Week 2)</b>	66.74	32.55	30.14	5.12	0.57	0.57	0.10	<b>43%</b>	<b>43%</b>	<b>90%</b>
<b>Standard Deviation</b>	30.94	9.77	2.15	1.82	0.29	0.34	0.08	<b>29%</b>	<b>34%</b>	<b>8%</b>
5/26/2008										
5/27/2008	21.70	31.71	35.38	3.04	1.46	1.63	0.14	-46%	-63%	86%
5/28/2008	18.66	37.53	29.44		2.01	1.58		-101%	-58%	
5/29/2008	24.67	20.97	32.20	3.62	0.85	1.31	0.15	15%	-31%	85%
5/30/2008	28.26	22.01	18.07	6.19	0.78	0.64	0.22	22%	36%	78%
<b>Average (Week 3)</b>	23.32	28.06	28.77	5.26	1.28	1.29	0.17	<b>-28%</b>	<b>-29%</b>	<b>83%</b>
<b>Standard Deviation</b>	4.10	7.96	7.54	2.38	0.58	0.46	0.04	<b>58%</b>	<b>46%</b>	<b>4%</b>
6/2/2008	47.55		23.85	10.14		0.50	0.21		50%	79%
6/3/2008	55.46	33.55	38.16	8.32	0.61	0.69	0.15	39%	31%	85%
6/4/2008	42.76	37.37	37.82	3.91	0.87	0.88	0.09	13%	12%	91%
6/5/2008	48.79	40.38	34.67	7.35	0.83	0.71	0.15	17%	29%	85%
6/6/2008	58.51	34.10	23.89	6.60	0.58	0.41	0.11	42%	59%	89%
<b>Average (Week 4)</b>	50.61	36.35	31.68	7.27	0.72	0.64	0.14	<b>28%</b>	<b>36%</b>	<b>86%</b>
<b>Standard Deviation</b>	6.33	3.17	7.26	2.30	0.15	0.19	0.05	<b>15%</b>	<b>19%</b>	<b>5%</b>

School / Class ID	Configurations Used			
	05 / 12-16 / 08	05 / 19-23 / 08	05 / 26-30 / 08	06 / 02-06 / 08
Hudson / H-11	Baseline	HP-PF	RS + HP-PF	RS + HP-PF
Hudson / H-15	Baseline	HP-PF	RS + HP-PF	RS + HP-PF
Hudson / H-52	Baseline	HP-PF	RS + HP-PF	RS + HP-PF

HP-PF = HVAC-based high-performance panel filter

RS = register-based air purifier

SA = stand alone system

PF = conventional / medium efficiency panel filter

### Hudson Elementary School - PM<sub>10</sub> (from filter-based measurements)

Date	Average Outdoor Concentration (µg/m <sup>3</sup> )	Average Indoor Concentration (µg/m <sup>3</sup> )			Average Indoor/Outdoor Ratio			Average Removal Efficiency		
		H-11	H-15	H-52	H-11	H-15	H-52	H-11	H-15	H-52
5/12/2008	120	68		92	0.57		0.77	43%		23%
5/13/2008	110	46	20		0.42	0.18		58%	82%	
5/14/2008		45	43	24						
5/15/2008	130		42	26	0.00		0.20	100%		80%
5/16/2008		26		27						
<b>Average (Week 1)</b>	120	46	35	42	0.33	0.18	0.48	<b>67%</b>	<b>82%</b>	<b>52%</b>
<b>Standard Deviation</b>	10	17	13	33	0.29		0.40	<b>29%</b>		<b>40%</b>
5/19/2008	120	35		24	0.29		0.20	71%		80%
5/20/2008	78	29		61	0.37		0.78	63%		22%
5/21/2008	60	11		28	0.18		0.47	82%		53%
5/22/2008	130	39		29	0.30		0.22	70%		78%
5/23/2008	99	20		15	0.20		0.15	80%		85%
<b>Average (Week 2)</b>	97	27	46	31	0.27		0.36	<b>73%</b>		<b>64%</b>
<b>Standard Deviation</b>	29	11	19	17	0.08		0.26	<b>8%</b>		<b>26%</b>
5/26/2008										
5/27/2008	210	31		53	0.15		0.25	85%		75%
5/28/2008	120	34		23	0.28		0.19	72%		81%
5/29/2008	99	11		35	0.11		0.35	89%		65%
5/30/2008	87	20		19	0.23		0.22	77%		78%
<b>Average (Week 3)</b>	129	24	90	33	0.19		0.25	<b>81%</b>		<b>75%</b>
<b>Standard Deviation</b>	56	11	34	15	0.08		0.07	<b>8%</b>		<b>7%</b>
6/2/2008	120			41			0.34			66%
6/3/2008	110	30		30	0.27		0.27	73%		73%
6/4/2008	82	27		41	0.33		0.50	67%		50%
6/5/2008	100	35		36	0.35		0.36	65%		64%
6/6/2008	120	27		39	0.23		0.33	78%		68%
<b>Average (Week 4)</b>	106	30		37	0.29		0.36	<b>71%</b>		<b>64%</b>
<b>Standard Deviation</b>	16	4		5	0.06		0.08	<b>6%</b>		<b>8%</b>

School / Class ID	Configurations Used			
	05 / 12-16 / 08	05 / 19-23 / 08	05 / 26-30 / 08	06 / 02-06 / 08
Hudson / H-11	Baseline	HP-PF	RS + HP-PF	RS + HP-PF
Hudson / H-15	Baseline	HP-PF	RS + HP-PF	RS + HP-PF
Hudson / H-52	Baseline	HP-PF	RS + HP-PF	RS + HP-PF

HP-PF = HVAC-based high-performance panel filter

RS = register-based air purifier

SA = stand alone system

PF = conventional / medium efficiency panel filter

### Dominguez Elementary School - Black Carbon

Date	Average Outdoor Concentration (ng/m <sup>3</sup> )	Average Indoor Concentration (ng/m <sup>3</sup> )			Average Indoor/Outdoor Ratio			Average Removal Efficiency		
		DZ-7	DZ-9	DZ-11	DZ-7	DZ-9	DZ-11	DZ-7	DZ-9	DZ-11
11/17/2008										
11/18/2008	5,137	2,149	4,384	5,096	0.42	0.85	0.99	58%	15%	1%
11/19/2008	8,787	3,951	5,935	6,332	0.45	0.68	0.72	55%	32%	28%
11/20/2008	9,243	3,932	7,292	6,616	0.43	0.79	0.72	57%	21%	28%
11/21/2008	11,210	6,967	8,270	8,928	0.62	0.74	0.80	38%	26%	20%
<b>Average (Week 1)</b>	8,594	4,250	6,470	6,743	0.48	0.76	0.81	<b>52%</b>	<b>24%</b>	<b>19%</b>
<b>Standard Deviation</b>	2,533	1,999	1,688	1,599	0.10	0.08	0.13	<b>10%</b>	<b>8%</b>	<b>13%</b>
11/24/2008	4,474	2,918	4,828	4,903	0.65	1.08	1.10	35%	-8%	-10%
11/25/2008	5,234	4,005	4,944	5,166	0.77	0.94	0.99	23%	6%	1%
11/26/2008										
11/27/2008										
11/28/2008										
<b>Average (Week 2)</b>	4,854	3,462	4,886	5,035	0.71	1.01	1.04	<b>29%</b>	<b>-1%</b>	<b>-4%</b>
<b>Standard Deviation</b>	538	768	82	186	0.08	0.10	0.08	<b>8%</b>	<b>10%</b>	<b>8%</b>
12/1/2008	8,642	2,023	2,996	2,744	0.23	0.35	0.32	77%	65%	68%
12/2/2008	2,434	268	217	187	0.11	0.09	0.08	89%	91%	92%
12/3/2008	4,351	557	1,024	444	0.13	0.24	0.10	87%	76%	90%
12/4/2008	3,953	819	354	267	0.21	0.09	0.07	79%	91%	93%
12/5/2008	5,734	766	856	346	0.13	0.15	0.06	87%	85%	94%
<b>Average (Week 3)</b>	5,023	887	1,089	798	0.16	0.18	0.12	<b>84%</b>	<b>82%</b>	<b>88%</b>
<b>Standard Deviation</b>	2,340	671	1,117	1,092	0.05	0.11	0.11	<b>5%</b>	<b>11%</b>	<b>11%</b>
12/8/2008	2,112	290	269	105	0.14	0.13	0.05	86%	87%	95%
12/9/2008	5,452	549	816	311	0.10	0.15	0.06	90%	85%	94%
12/10/2008	2,819	136	351	249	0.05	0.12	0.09	95%	88%	91%
12/11/2008	9,169	515	892	222	0.06	0.10	0.02	94%	90%	98%
12/12/2008	4,670	342	687	444	0.07	0.15	0.10	93%	85%	90%
<b>Average (Week 4)</b>	4,844	366	603	266	0.08	0.13	0.06	<b>92%</b>	<b>87%</b>	<b>94%</b>
<b>Standard Deviation</b>	2,769	169	279	124	0.04	0.02	0.03	<b>4%</b>	<b>2%</b>	<b>3%</b>
12/15/2008										
12/16/2008	3,274	209	432	187	0.06	0.13	0.06	94%	87%	94%
12/17/2008										
12/18/2008	1,976	397	325	109	0.20	0.16	0.05	80%	84%	95%
12/19/2008	4,558	320	904	234	0.07	0.20	0.05	93%	80%	95%
<b>Average (Week 5)</b>	3,269	308	554	177	0.11	0.16	0.05	<b>89%</b>	<b>84%</b>	<b>95%</b>
<b>Standard Deviation</b>	1,291	95	308	63	0.08	0.03	0.00	<b>8%</b>	<b>3%</b>	<b>0%</b>

School / Class ID	Configurations Used			
	11 / 18-26 / 08	12 / 01-05 / 08	12 / 08-12 / 08	12 / 15-19 / 08
Dominguez / DZ-7	Baseline	SA / SA + PF	SA + HP-PF	SA + HP-PF
Dominguez / DZ-9	Baseline	HP-PF	HP-PF	HP-PF
Dominguez / DZ-11	Baseline	HP-PF	RS + HP-PF	RS + HP-PF

HP-PF = HVAC-based high-performance panel filter  
 RS = register-based air purifier  
 SA = stand alone system  
 PF = conventional / medium efficiency panel filter

### Dominguez Elementary School - Ultra Fine Particles

Date	Average Outdoor Concentration (particles/cm <sup>3</sup> )	Average Indoor Concentration (particles/cm <sup>3</sup> )			Average Indoor/Outdoor Ratio			Average Removal Efficiency		
		DZ-7	DZ-9	DZ-11	DZ-7	DZ-9	DZ-11	DZ-7	DZ-9	DZ-11
11/17/2008										
11/18/2008	25,476	5,422	12,344	12,550	0.21	0.48	0.49	79%	52%	51%
11/19/2008	42,651	9,488	19,540	24,676	0.22	0.46	0.58	78%	54%	42%
11/20/2008	39,794	10,924	24,111	21,528	0.27	0.61	0.54	73%	39%	46%
11/21/2008	38,976	12,874	18,814	22,150	0.33	0.48	0.57	67%	52%	43%
<b>Average (Week 1)</b>	36,724	9,677	18,702	20,226	0.26	0.51	0.55	<b>74%</b>	<b>49%</b>	<b>45%</b>
<b>Standard Deviation</b>	7,663	3,158	4,844	5,295	0.05	0.07	0.04	<b>5%</b>	<b>7%</b>	<b>4%</b>
11/24/2008	34,386	8,720	18,565	24,049	0.25	0.54	0.70	75%	46%	30%
11/25/2008	31,838	10,383	17,528	23,812	0.33	0.55	0.75	67%	45%	25%
11/26/2008										
11/27/2008										
11/28/2008										
<b>Average (Week 2)</b>	33,112	9,552	18,047	23,930	0.29	0.55	0.72	<b>71%</b>	<b>45%</b>	<b>28%</b>
<b>Standard Deviation</b>	1,802	1,176	733	168	0.05	0.01	0.03	<b>5%</b>	<b>1%</b>	<b>3%</b>
12/1/2008	41,439	8,349	9,891	13,190	0.20	0.24	0.32	80%	76%	68%
12/2/2008	17,370	1,000	1,962	1,613	0.06	0.11	0.09	94%	89%	91%
12/3/2008	16,420	1,805	3,508	2,413	0.11	0.21	0.15	89%	79%	85%
12/4/2008	16,970	2,768	2,214	1,469	0.16	0.13	0.09	84%	87%	91%
12/5/2008	29,061	2,522	5,130	2,277	0.09	0.18	0.08	91%	82%	92%
<b>Average (Week 3)</b>	24,252	3,289	4,541	4,192	0.12	0.17	0.14	<b>88%</b>	<b>83%</b>	<b>86%</b>
<b>Standard Deviation</b>	10,957	2,911	3,244	5,046	0.06	0.05	0.10	<b>6%</b>	<b>5%</b>	<b>10%</b>
12/8/2008	16,048	1,148	9,995	440	0.07	0.62	0.03	93%	38%	97%
12/9/2008	34,610	2,241	4,785	1,755	0.06	0.14	0.05	94%	86%	95%
12/10/2008	32,657	817	5,299	2,790	0.03	0.16	0.09	97%	84%	91%
12/11/2008	29,250	1,146	3,203	812	0.04	0.11	0.03	96%	89%	97%
12/12/2008	23,839	1,262	4,040	2,750	0.05	0.17	0.12	95%	83%	88%
<b>Average (Week 4)</b>	27,281	1,323	5,464	1,709	0.05	0.24	0.06	<b>95%</b>	<b>76%</b>	<b>94%</b>
<b>Standard Deviation</b>	7,492	539	2,653	1,080	0.02	0.22	0.04	<b>2%</b>	<b>22%</b>	<b>4%</b>
12/15/2008										
12/16/2008	26,441	1,066	4,072	1,209	0.04	0.15	0.05	96%	85%	95%
12/17/2008										
12/18/2008	23,513	3,355	2,871	1,283	0.14	0.12	0.05	86%	88%	95%
12/19/2008	28,783	1,247	7,747	2,101	0.04	0.27	0.07	96%	73%	93%
<b>Average (Week 5)</b>	26,246	1,889	4,897	1,531	0.08	0.18	0.06	<b>92%</b>	<b>82%</b>	<b>94%</b>
<b>Standard Deviation</b>	2,641	1,272	2,540	495	0.06	0.08	0.01	<b>6%</b>	<b>8%</b>	<b>1%</b>

School / Class ID	Configurations Used			
	11 / 18-26 / 08	12 / 01-05 / 08	12 / 08-12 / 08	12 / 15-19 / 08
Dominguez / DZ-7	Baseline	SA / SA + PF	SA + HP-PF	SA + HP-PF
Dominguez / DZ-9	Baseline	HP-PF	HP-PF	HP-PF
Dominguez / DZ-11	Baseline	HP-PF	RS + HP-PF	RS + HP-PF

HP-PF = HVAC-based high-performance panel filter  
 RS = register-based air purifier  
 SA = stand alone system  
 PF = conventional / medium efficiency panel filter

**Dominguez Elementary School - PM<sub>2.5</sub> (count)**

Date	Average Outdoor Concentration (particles/ft <sup>3</sup> )	Average Indoor Concentration (particles/ft <sup>3</sup> )			Average Indoor/Outdoor Ratio			Average Removal Efficiency		
		DZ-7	DZ-9	DZ-11	DZ-7	DZ-9	DZ-11	DZ-7	DZ-9	DZ-11
11/17/2008										
11/18/2008										
11/19/2008	8,866,226	1,411,242	2,600,108	3,571,960	0.16	0.29	0.40	84%	71%	60%
11/20/2008	8,237,390	1,286,754	3,015,586	2,734,509	0.16	0.37	0.33	84%	63%	67%
11/21/2008	7,625,250	1,471,170	2,634,126	3,393,425	0.19	0.35	0.45	81%	65%	55%
<b>Average (Week 1)</b>	<b>8,242,955</b>	<b>1,389,722</b>	<b>2,749,940</b>	<b>3,233,298</b>	<b>0.17</b>	<b>0.33</b>	<b>0.39</b>	<b>87%</b>	<b>75%</b>	<b>71%</b>
<b>Standard Deviation</b>	<b>620,507</b>	<b>94,073</b>	<b>230,684</b>	<b>441,091</b>	<b>0.02</b>	<b>0.04</b>	<b>0.06</b>	<b>9%</b>	<b>17%</b>	<b>20%</b>
11/24/2008	8,511,436	1,151,144	3,000,744	3,943,011	0.14	0.35	0.46	86%	65%	54%
11/25/2008	6,035,358	949,498	1,853,996	2,542,878	0.16	0.31	0.42	84%	69%	58%
11/26/2008										
11/27/2008										
11/28/2008										
<b>Average (Week 2)</b>	<b>7,273,397</b>	<b>1,050,321</b>	<b>2,427,370</b>	<b>3,242,944</b>	<b>0.15</b>	<b>0.33</b>	<b>0.44</b>	<b>85%</b>	<b>67%</b>	<b>56%</b>
<b>Standard Deviation</b>	<b>1,750,852</b>	<b>142,585</b>	<b>810,873</b>	<b>990,043</b>	<b>0.02</b>	<b>0.03</b>	<b>0.03</b>	<b>2%</b>	<b>3%</b>	<b>3%</b>
12/1/2008	7,115,843	375,673	1,197,684	1,210,391	0.05	0.17	0.17	95%	83%	83%
12/2/2008	6,472,443	120,635	344,786	289,496	0.02	0.05	0.04	98%	95%	96%
12/3/2008	10,298,411	190,597	1,628,370	753,983	0.02	0.16	0.07	98%	84%	93%
12/4/2008	10,129,374	294,693	520,489	458,324	0.03	0.05	0.05	97%	95%	95%
12/5/2008	5,018,869	103,392	368,715	228,546	0.02	0.07	0.05	98%	93%	95%
<b>Average (Week 3)</b>	<b>7,806,988</b>	<b>216,998</b>	<b>812,009</b>	<b>588,148</b>	<b>0.03</b>	<b>0.10</b>	<b>0.08</b>	<b>97%</b>	<b>90%</b>	<b>92%</b>
<b>Standard Deviation</b>	<b>2,325,563</b>	<b>116,301</b>	<b>573,363</b>	<b>403,128</b>	<b>0.01</b>	<b>0.06</b>	<b>0.05</b>	<b>1%</b>	<b>6%</b>	<b>5%</b>
12/8/2008	1,539,967	207,455	112,870		0.13	0.07		87%	93%	
12/9/2008	2,540,284	271,444	165,653	85,637	0.11	0.07	0.03	89%	93%	97%
12/10/2008	425,792	74,899	59,053	73,412	0.18	0.14	0.17	82%	86%	83%
12/11/2008	2,040,036	147,307	136,505	62,538	0.07	0.07	0.03	93%	93%	97%
12/12/2008	2,259,506	157,821	151,593	190,241	0.07	0.07	0.08	93%	93%	92%
<b>Average (Week 4)</b>	<b>1,761,117</b>	<b>171,785</b>	<b>125,135</b>	<b>102,957</b>	<b>0.11</b>	<b>0.08</b>	<b>0.08</b>	<b>89%</b>	<b>92%</b>	<b>92%</b>
<b>Standard Deviation</b>	<b>831,458</b>	<b>73,119</b>	<b>41,798</b>	<b>58,950</b>	<b>0.04</b>	<b>0.03</b>	<b>0.07</b>	<b>4%</b>	<b>3%</b>	<b>7%</b>
12/15/2008										
12/16/2008	518,108	83,088	73,452	54,664	0.16	0.14	0.11	84%	86%	89%
12/17/2008										
12/18/2008		148,282	83,984	1,067						
12/19/2008		108,951	203,523	2,678						
<b>Average (Week 5)</b>	<b>518,108</b>	<b>113,440</b>	<b>120,320</b>	<b>19,470</b>	<b>0.16</b>	<b>0.14</b>	<b>0.11</b>	<b>84%</b>	<b>86%</b>	<b>89%</b>
<b>Standard Deviation</b>		<b>32,828</b>	<b>72,249</b>	<b>30,490</b>						

School / Class ID	Configurations Used			
	11 / 18-26 / 08	12 / 01-05 / 08	12 / 08-12 / 08	12 / 15-19 / 08
Dominguez / DZ-7	Baseline	SA / SA + PF	SA + HP-PF	SA + HP-PF
Dominguez / DZ-9	Baseline	HP-PF	HP-PF	HP-PF
Dominguez / DZ-11	Baseline	HP-PF	RS + HP-PF	RS + HP-PF

HP-PF = HVAC-based high-performance panel filter  
 RS = register-based air purifier  
 SA = stand alone system  
 PF = conventional / medium efficiency panel filter

**Dominguez Elementary School - PM<sub>2.5</sub> (mass)**

Date	Average Outdoor Concentration (µg/m <sup>3</sup> )	Average Indoor Concentration (µg/m <sup>3</sup> )			Average Indoor/Outdoor Ratio			Average Removal Efficiency		
		DZ-7	DZ-9	DZ-11	DZ-7	DZ-9	DZ-11	DZ-7	DZ-9	DZ-11
11/17/2008										
11/18/2008	4.11	4.66	3.70	11.47	1.13	0.90	2.79	-13%	10%	-179%
11/19/2008	13.52	9.93	6.52	10.89	0.73	0.48	0.81	27%	52%	19%
11/20/2008	30.59	10.79	14.26	12.27	0.35	0.47	0.40	65%	53%	60%
11/21/2008	16.15	11.71	8.78	11.07	0.72	0.54	0.69	28%	46%	31%
<b>Average (Week 1)</b>	16.09	9.27	8.31	11.43	0.74	0.60	1.17	<b>26%</b>	<b>40%</b>	<b>-17%</b>
<b>Standard Deviation</b>	10.96	3.16	4.48	0.61	0.32	0.20	1.09	<b>32%</b>	<b>20%</b>	<b>109%</b>
11/24/2008	17.12	11.75	12.16	18.94	0.69	0.71	1.11	31%	29%	-11%
11/25/2008	12.77	15.62	11.33	17.13	1.22	0.89	1.34	-22%	11%	-34%
11/26/2008										
11/27/2008										
11/28/2008										
<b>Average (Week 2)</b>	14.95	13.69	11.74	18.04	0.95	0.80	1.22	<b>5%</b>	<b>20%</b>	<b>-22%</b>
<b>Standard Deviation</b>	3.07	2.73	0.58	1.28	0.38	0.13	0.17	<b>38%</b>	<b>13%</b>	<b>17%</b>
12/1/2008	17.46	3.27	5.87	3.81	0.19	0.34	0.22	81%	66%	78%
12/2/2008	9.45	2.08	0.87	0.87	0.22	0.09	0.09	78%	91%	91%
12/3/2008	35.25	3.24	8.29	2.21	0.09	0.24	0.06	91%	76%	94%
12/4/2008	27.93	4.50	1.85	1.27	0.16	0.07	0.05	84%	93%	95%
12/5/2008	13.35	1.84	1.71	1.22	0.14	0.13	0.09	86%	87%	91%
<b>Average (Week 3)</b>	20.69	2.99	3.72	1.87	0.16	0.17	0.10	<b>84%</b>	<b>83%</b>	<b>90%</b>
<b>Standard Deviation</b>	10.67	1.07	3.21	1.19	0.05	0.11	0.07	<b>5%</b>	<b>11%</b>	<b>7%</b>
12/8/2008	5.77	2.08	1.10	0.79	0.36	0.19	0.14	64%	81%	86%
12/9/2008	7.96	2.55	0.87	0.87	0.32	0.11	0.11	68%	89%	89%
12/10/2008	1.80	0.84	1.02	1.10	0.47	0.57	0.61	53%	43%	39%
12/11/2008	5.82	1.01	0.79	0.88	0.17	0.14	0.15	83%	86%	85%
12/12/2008	10.99	0.94	1.35	1.91	0.09	0.12	0.17	91%	88%	83%
<b>Average (Week 4)</b>	6.47	1.49	1.03	1.11	0.28	0.23	0.24	<b>72%</b>	<b>77%</b>	<b>76%</b>
<b>Standard Deviation</b>	3.37	0.78	0.22	0.46	0.15	0.20	0.21	<b>15%</b>	<b>20%</b>	<b>21%</b>
12/15/2008										
12/16/2008	3.31	0.55	0.41	0.57	0.17	0.12	0.17	83%	88%	83%
12/17/2008										
12/18/2008	1.29	0.73	0.75	0.14	0.57	0.58	0.11	43%	42%	89%
12/19/2008	6.18	0.59	1.48	0.68	0.10	0.24	0.11	90%	76%	89%
<b>Average (Week 5)</b>	3.59	0.63	0.88	0.46	0.28	0.31	0.13	<b>72%</b>	<b>69%</b>	<b>87%</b>
<b>Standard Deviation</b>	2.46	0.09	0.55	0.29	0.25	0.24	0.04	<b>25%</b>	<b>24%</b>	<b>4%</b>

School / Class ID	Configurations Used			
	<i>11 / 18-26 / 08</i>	<i>12 / 01-05 / 08</i>	<i>12 / 08-12 / 08</i>	<i>12 / 15-19 / 08</i>
Dominguez / DZ-7	Baseline	SA / SA + PF	SA + HP-PF	SA + HP-PF
Dominguez / DZ-9	Baseline	HP-PF	HP-PF	HP-PF
Dominguez / DZ-11	Baseline	HP-PF	RS + HP-PF	RS + HP-PF

HP-PF = HVAC-based high-performance panel filter  
 RS = register-based air purifier  
 SA = stand alone system  
 PF = conventional / medium efficiency panel filter

**Dominguez Elementary School - PM<sub>10</sub> (from particle mass monitor measurements)**

Date	Average Outdoor Concentration (µg/m <sup>3</sup> )	Average Indoor Concentration (µg/m <sup>3</sup> )			Average Indoor/Outdoor Ratio			Average Removal Efficiency		
		DZ-7	DZ-9	DZ-11	DZ-7	DZ-9	DZ-11	DZ-7	DZ-9	DZ-11
11/17/2008										
11/18/2008	51.98	64.34	34.38	91.83	1.24	0.66	1.77	-24%	34%	-77%
11/19/2008	52.85	73.95	47.85	79.93	1.40	0.91	1.51	-40%	9%	-51%
11/20/2008	84.85	62.75	69.89	85.40	0.74	0.82	1.01	26%	18%	-1%
11/21/2008	61.53	69.08	58.16	72.86	1.12	0.95	1.18	-12%	5%	-18%
<b>Average (Week 1)</b>	62.81	67.53	52.57	82.51	1.12	0.83	1.37	<b>-12%</b>	<b>17%</b>	<b>-37%</b>
<b>Standard Deviation</b>	15.32	5.06	15.11	8.06	0.28	0.13	0.34	<b>28%</b>	<b>13%</b>	<b>34%</b>
11/24/2008	50.13	74.55	76.61	135.45	1.49	1.53	2.70	-49%	-53%	-170%
11/25/2008	48.79	98.76	88.63	128.96	2.02	1.82	2.64	-102%	-82%	-164%
11/26/2008										
11/27/2008										
11/28/2008										
<b>Average (Week 2)</b>	49.46	86.66	82.62	132.21	1.76	1.67	2.67	<b>-76%</b>	<b>-67%</b>	<b>-167%</b>
<b>Standard Deviation</b>	0.95	17.12	8.49	4.59	0.38	0.20	0.04	<b>38%</b>	<b>20%</b>	<b>4%</b>
12/1/2008	86.09	27.81	54.38	37.73	0.32	0.63	0.44	68%	37%	56%
12/2/2008	25.06	26.79	16.38	15.78	1.07	0.65	0.63	-7%	35%	37%
12/3/2008	57.34	13.40	43.07	18.36	0.23	0.75	0.32	77%	25%	68%
12/4/2008	52.74	23.08	13.42	12.93	0.44	0.25	0.25	56%	75%	75%
12/5/2008	41.97	14.59	17.31	18.03	0.35	0.41	0.43	65%	59%	57%
<b>Average (Week 3)</b>	52.64	21.13	28.91	20.56	0.48	0.54	0.41	<b>52%</b>	<b>46%</b>	<b>59%</b>
<b>Standard Deviation</b>	22.45	6.76	18.58	9.84	0.34	0.20	0.15	<b>34%</b>	<b>20%</b>	<b>15%</b>
12/8/2008	28.57	21.91	19.27	18.93	0.77	0.67	0.66	23%	33%	34%
12/9/2008	39.04	23.09	11.40	17.01	0.59	0.29	0.44	41%	71%	56%
12/10/2008	21.52	11.43	16.69	18.02	0.53	0.78	0.84	47%	22%	16%
12/11/2008	44.75	11.02	12.31	15.96	0.25	0.28	0.36	75%	72%	64%
12/12/2008	46.70	11.24	18.51	24.48	0.24	0.40	0.52	76%	60%	48%
<b>Average (Week 4)</b>	36.12	15.74	15.63	18.88	0.48	0.48	0.56	<b>52%</b>	<b>52%</b>	<b>44%</b>
<b>Standard Deviation</b>	10.78	6.19	3.59	3.32	0.23	0.23	0.19	<b>23%</b>	<b>23%</b>	<b>19%</b>
12/15/2008										
12/16/2008	15.49	8.83	8.94	14.83	0.57	0.58	0.96	43%	42%	4%
12/17/2008										
12/18/2008	7.99	14.10	19.02	8.39	1.76	2.38	1.05	-76%	-138%	-5%
12/19/2008	27.12	10.76	23.70	14.98	0.40	0.87	0.55	60%	13%	45%
<b>Average (Week 5)</b>	16.87	11.23	17.22	12.73	0.91	1.28	0.85	<b>9%</b>	<b>-28%</b>	<b>15%</b>
<b>Standard Deviation</b>	9.64	2.66	7.54	3.76	0.74	0.97	0.26	<b>74%</b>	<b>97%</b>	<b>26%</b>

School / Class ID	Configurations Used			
	11 / 18-26 / 08	12 / 01-05 / 08	12 / 08-12 / 08	12 / 15-19 / 08
Dominguez / DZ-7	Baseline	SA + SA + PF	SA + HP-PF	SA + HP-PF
Dominguez / DZ-9	Baseline	HP-PF	HP-PF	HP-PF
Dominguez / DZ-11	Baseline	HP-PF	RS + HP-PF	RS + HP-PF

HP-PF = HVAC-based high-performance panel filter  
 RS = register-based air purifier  
 SA = stand alone system  
 PF = conventional / medium efficiency panel filter

**Dominguez Elementary School - PM<sub>10</sub> (from filter-based measurements)**

Date	Average Outdoor Concentration (µg/m <sup>3</sup> )	Average Indoor Concentration (µg/m <sup>3</sup> )			Average Indoor/Outdoor Ratio			Average Removal Efficiency		
		DZ-7	DZ-9	DZ-11	DZ-7	DZ-9	DZ-11	DZ-7	DZ-9	DZ-11
11/17/2008										
11/18/2008	720	940	740	310	1.31	1.03	0.43	-31%	-3%	57%
11/19/2008	290	100	250	160	0.34	0.86	0.55	66%	14%	45%
11/20/2008	33	220	150	38	6.67	4.55	1.15	-567%	-355%	-15%
11/21/2008	200	120	180	25	0.60	0.90	0.13	40%	10%	88%
<b>Average (Week 1)</b>	311	345	330	133	2.23	1.83	0.56	<b>-123%</b>	<b>-83%</b>	<b>44%</b>
<b>Standard Deviation</b>	293	400	277	133	2.99	1.81	0.43	<b>299%</b>	<b>181%</b>	<b>43%</b>
11/24/2008	180	220	200	180	1.22	1.11	1.00	-22%	-11%	0%
11/25/2008	150	220	140	140	1.47	0.93	0.93	-47%	7%	7%
11/26/2008										
11/27/2008										
11/28/2008										
<b>Average (Week 2)</b>	165	220	170	160	1.34	1.02	0.97	<b>-34%</b>	<b>-2%</b>	<b>3%</b>
<b>Standard Deviation</b>	21	0	42	28	0.17	0.13	0.05	<b>17%</b>	<b>13%</b>	<b>5%</b>
12/1/2008	180	280	180	82	1.56	1.00	0.46	-56%	0%	54%
12/2/2008	130	170	110	40	1.31	0.85	0.31	-31%	15%	69%
12/3/2008	150	110	120	36	0.73	0.80	0.24	27%	20%	76%
12/4/2008	140	120	90	36	0.86	0.64	0.26	14%	36%	74%
12/5/2008	130	91	87	41	0.70	0.67	0.32	30%	33%	68%
<b>Average (Week 3)</b>	146	154	117	47	1.03	0.79	0.32	<b>-3%</b>	<b>21%</b>	<b>68%</b>
<b>Standard Deviation</b>	21	76	38	20	0.38	0.14	0.08	<b>38%</b>	<b>14%</b>	<b>8%</b>
12/8/2008	140	150	120	25	1.07	0.86	0.18	-7%	14%	82%
12/9/2008	130	100	100	30	0.77	0.77	0.23	23%	23%	77%
12/10/2008	91	95	100	34	1.04	1.10	0.37	-4%	-10%	63%
12/11/2008	130	82	77	33	0.63	0.59	0.25	37%	41%	75%
12/12/2008	140	78	36	87	0.56	0.26	0.62	44%	74%	38%
<b>Average (Week 4)</b>	126	101	87	42	0.81	0.71	0.33	<b>19%</b>	<b>29%</b>	<b>67%</b>
<b>Standard Deviation</b>	20	29	32	26	0.23	0.31	0.18	<b>23%</b>	<b>31%</b>	<b>18%</b>
12/15/2008										
12/16/2008	91	84	70	30	0.92	0.77	0.33	8%	23%	67%
12/17/2008										
12/18/2008	71	79	68	17	1.11	0.96	0.24	-11%	4%	76%
12/19/2008	93	75	73	23	0.81	0.78	0.25	19%	22%	75%
<b>Average (Week 5)</b>	85	79	70	23	0.95	0.84	0.27	<b>5%</b>	<b>16%</b>	<b>73%</b>
<b>Standard Deviation</b>	12	5	3	7	0.15	0.10	0.05	<b>15%</b>	<b>10%</b>	<b>5%</b>

School / Class ID	Configurations Used			
	<i>11 / 18-26 / 08</i>	<i>12 / 01-05 / 08</i>	<i>12 / 08-12 / 08</i>	<i>12 / 15-19 / 08</i>
Dominguez / DZ-7	Baseline	SA / SA + PF	SA + HP-PF	SA + HP-PF
Dominguez / DZ-9	Baseline	HP-PF	HP-PF	HP-PF
Dominguez / DZ-11	Baseline	HP-PF	RS + HP-PF	RS + HP-PF

HP-PF = HVAC-based high-performance panel filter  
 RS = register-based air purifier  
 SA = stand alone system  
 PF = conventional / medium efficiency panel filter

**APPENDIX B.** Daily average concentrations of individual VOCs measured outside Dominguez elementary school and inside three of its classrooms (here referred to as DZ-7, DZ-9, and DZ-11)

**Dominguez Elementary School - Outdoor VOC data**

SPECIATED ORGANIC COMPOUNDS	Reporting Limit (ppbv)	Method Detection limit (ppbv)	VOC concentration (ppbv)					
			11/18/08	11/19/08	11/20/08	11/21/08	11/24/08	11/25/08
Propylene	1.0	0.04	7.7	5.7	4.5		4.7	3.2
Freon 12 (Dichlorodifluoromethane)	0.5	0.04	0.7	0.7	0.7		0.6	0.6
Freon 114(1,2-Dichlorotetrafluoroethan)	0.5	0.03	0.03		0.02		0.02	0.02
Chloromethane	0.5	0.08	0.6	0.7	0.6		0.6	0.6
Vinyl chloride	0.5	0.04						
Bromomethane	0.5	0.05			0.07			0.03
Ethanol	1.5	0.30	47	36	24	24	15	14
Freon 11(Trichlorofluoromethane)	0.5	0.04			0.3			0.2
Isopropyl alcohol(2-Propanol)	1.5	0.03	7.7	5.4	2.1	4.9	2	1.9
Freon 113(1,1,2-Trichlorotrifluoroethan)	0.5	0.06	0.07	0.06	0.06	0.07	0.06	0.06
Acetone	3.0	0.08	25	23	16	20	17	11
Carbon disulfide	1.0	0.04	0.04	0.06	0.03	0.04	0.04	0.01
Methylene chloride	1.5	0.04	1.2	1	0.6	1.1	0.6	0.4
Methyl-tert-butyl ether(MTBE)	0.5	0.05						
trans-1,2-Dichloroethene	0.5	0.04						
n-Hexane	0.5	0.03	1	1	1.2	1.2	0.5	0.4
1,-Dichloroethane	0.5	0.04						
Vinyl acetate	0.5	0.05						
2-Butanone(MEK)	1.5	0.07	1.8	3	3	1.9	1.8	0.9
cis-1,2-Dichloroethene	0.5	0.05						
Ethyl acetate	0.5	0.07	0.5	0.6	0.2	0.4	0.2	0.2
Chloroform	0.5	0.03		0.08	0.06	0.08	0.03	0.03
Tetrahydrofuran	0.5	0.07		0.2	0.2	0.3	0.3	0.2
1,1,1-Trichloroethane	0.5	0.04				0.02		
Cyclohexane	0.5	0.04	0.7	0.6	0.6	0.7	0.2	0.2
Carbon tetrachloride	0.5	0.04	0.08	0.07	0.07	0.07	0.07	0.06
n-Heptane	0.5	0.04	0.9	0.7	0.7	0.8	0.4	0.3
1,2-Dichloroethane	0.5	0.02						
Benzene	0.5	0.02	1.2	1.2	1	1.4	0.6	0.5
Trichloroethene	0.5	0.04	0.1	0.09	0.05	0.06	0.03	0.05
1,2-Dichloropropane	0.5	0.05						
Bromodichloromethane	0.5	0.04			0.04			
4-Methyl-2-pentanone(MIBK)	0.5	0.06		0.2	0.2	0.2	0.2	0.09
cis-1,3-Dichloropropene	0.5	0.04						
Toluene	0.5	0.05	5.2	4.8	3.8	5.5	2.2	1.8
trans-1,3-Dichloropropene	0.5	0.04						
1,1,2-Trichloroethane	0.5	0.06						
2-Hexanone(MBK)	1.5	0.05		0.2	0.4		0.1	
Tetrachloroethene	0.5	0.04	0.3	0.2	0.09	0.2	0.08	0.08
Dibromochloromethane	0.5	0.06	0.02		0.01			
1,2-Dibromoethane	0.5	0.06						
Chlorobenzene	0.5	0.04						
Ethylbenzene	0.5	0.05	0.7	0.8	0.6	0.8	0.4	0.3
Xylene (para & meta)	1.0	0.10	2.3	2.2	1.9	2.6	1.2	1
Xylene (Ortho)	0.5	0.05	0.9	0.9	0.8	1	0.5	0.4
Styrene	0.5	0.05	1.4	0.7	0.8	0.4	0.9	0.2
Bromoform	0.5	0.05			0.01			
1,1,2,2-Tetrachloroethane	0.5	0.08						
4-Ethyltoluene	0.5	0.06	0.8	0.8	0.6	0.9	0.4	0.3
1,3,5-Trimethylbenzene	0.5	0.05	0.2	0.2		0.3	0.1	0.09
1,2,4-Trimethylbenzene	0.5	0.08	0.8	0.7	0.6	0.9	0.4	0.3
1,3-Dichlorobenzene	0.5	0.06						
1,4-Dichlorobenzene	0.5	0.05	0.09	0.1	0.09		0.07	0.04
Benzyl chloride	0.5	0.06						
1,2-Dichlorobenzene	0.5	0.10			0.01			
1,2,4-Trichlorobenzene	1.0	0.10						
Hexachloro-1,3-butadiene	0.5	0.30	0.03	0.02				

## Dominguez Elementary School - Outdoor VOC data

SPECIATED ORGANIC COMPOUNDS	Reporting Limit (ppbv)	Method Detection limit (ppbv)	VOC concentration (ppbv)					
			11/26/08	12/1/08	12/2/08	12/3/08	12/4/08	12/5/08
Propylene	1.0	0.04		4.6	1.5		1.4	2.6
Freon 12 (Dichlorodifluoromethane)	0.5	0.04	1	0.5	0.5		0.4	0.6
Freon 114(1,2-Dichlorotetrafluoroethan)	0.5	0.03	0.02	0.01	0.02	0.05	0.04	0.05
Chloromethane	0.5	0.08	0.6	0.5	0.5	0.5	0.7	0.5
Vinyl chloride	0.5	0.04				0.06		
Bromomethane	0.5	0.05	0.03	0.07		0.07	0.04	
Ethanol	1.5	0.30	21	14	6.4	7	11	13
Freon 11(Trichlorofluoromethane)	0.5	0.04	0.4		0.2	0.2	0.2	0.4
Isopropyl alcohol(2-Propanol)	1.5	0.03	4.8	1.4	1.1	0.6	1.7	1.5
Freon 113(1,1,2-Trichlorotrifluoroethan)	0.5	0.06	0.07	0.07		0.1	0.07	0.08
Acetone	3.0	0.08	15	18	20	13	17	19
Carbon disulfide	1.0	0.04	0.03	0.03		0.08	0.07	0.1
Methylene chloride	1.5	0.04	0.2	0.4	0.1	0.3	0.4	0.5
Methyl-tert-butyl ether(MTBE)	0.5	0.05					0.04	
trans-1,2-Dichloroethene	0.5	0.04					0.03	
n-Hexane	0.5	0.03	0.2	1.4	0.3	0.3	0.3	0.5
1,-Dichloroethane	0.5	0.04					0.03	
Vinyl acetate	0.5	0.05					0.06	
2-Butanone(MEK)	1.5	0.07	1.6	2.5	5.4	2.3	4.4	1.5
cis-1,2-Dichloroethene	0.5	0.05					0.03	
Ethyl acetate	0.5	0.07					0.2	0.2
Chloroform	0.5	0.03		0.06		0.08	0.05	0.08
Tetrahydrofuran	0.5	0.07						
1,1,1-Trichloroethane	0.5	0.04					0.03	
Cyclohexane	0.5	0.04		0.7		0.2	0.2	0.3
Carbon tetrachloride	0.5	0.04	0.07	0.07	0.07	0.1	0.07	0.06
n-Heptane	0.5	0.04	0.3			0.2	0.2	0.4
1,2-Dichloroethane	0.5	0.02					0.05	
Benzene	0.5	0.02	0.3	1.2	0.2	0.4	0.3	0.8
Trichloroethene	0.5	0.04	0.03	0.05		0.06	0.09	0.05
1,2-Dichloropropane	0.5	0.05					0.04	
Bromodichloromethane	0.5	0.04				0.04	0.04	
4-Methyl-2-pentanone(MIBK)	0.5	0.06	0.08	0.08	0.1	0.1	0.2	0.09
cis-1,3-Dichloropropene	0.5	0.04					0.03	
Toluene	0.5	0.05	0.9	4.2	0.6	0.9	1.2	2.4
trans-1,3-Dichloropropene	0.5	0.04				0.03	0.03	0.03
1,1,2-Trichloroethane	0.5	0.06					0.04	
2-Hexanone(MBK)	1.5	0.05	0.3	0.2	0.4	0.3	0.9	0.1
Tetrachloroethene	0.5	0.04	0.02	0.09		0.07	0.07	0.09
Dibromochloromethane	0.5	0.06				0.04	0.02	
1,2-Dibromoethane	0.5	0.06					0.03	
Chlorobenzene	0.5	0.04					0.04	0.03
Ethylbenzene	0.5	0.05	0.2	0.6	0.08	0.2	0.2	0.3
Xylene (para & meta)	1.0	0.10	0.4	1.9	0.2	0.4	0.6	1
Xylene (Ortho)	0.5	0.05	0.2	0.8	0.1	0.2	0.3	0.4
Styrene	0.5	0.05	0.09	0.8	0.06	0.1	0.1	1
Bromoform	0.5	0.05					0.02	
1,1,2,2-Tetrachloroethane	0.5	0.08				0.06	0.06	0.04
4-Ethyltoluene	0.5	0.06	0.2	0.6	0.08	0.1	0.2	0.3
1,3,5-Trimethylbenzene	0.5	0.05	0.05	0.1	0.02	0.06		0.1
1,2,4-Trimethylbenzene	0.5	0.08	0.2	0.6	0.08	0.1	0.2	0.3
1,3-Dichlorobenzene	0.5	0.06				0.04	0.04	0.03
1,4-Dichlorobenzene	0.5	0.05	0.05	0.06		0.05	0.05	0.04
Benzyl chloride	0.5	0.06				0.04	0.05	
1,2-Dichlorobenzene	0.5	0.10	0.02			0.04	0.04	0.03
1,2,4-Trichlorobenzene	1.0	0.10	0.2			0.07	0.06	0.04
Hexachloro-1,3-butadiene	0.5	0.30	0.04			0.05	0.05	0.04

## Dominguez Elementary School - Outdoor VOC data

SPECIATED ORGANIC COMPOUNDS	Reporting Limit (ppbv)	Method Detection limit (ppbv)	VOC concentration (ppbv)					
			12/8/08	12/9/08	12/10/08	12/11/08	12/12/08	12/15/08
Propylene	1.0	0.04	1.2		1.6	2.3	2.6	1.1
Freon 12 (Dichlorodifluoromethane)	0.5	0.04	0.5	0.6	0.5	0.4	0.4	0.4
Freon 114(1,2-Dichlorotetrafluoroethan)	0.5	0.03	0.03	0.03	0.03	0.02	0.03	
Chloromethane	0.5	0.08	0.4	0.04	0.4	0.5	0.4	0.5
Vinyl chloride	0.5	0.04						
Bromomethane	0.5	0.05						
Ethanol	1.5	0.30	3.1	13	6.3	9.4	9.1	14
Freon 11(Trichlorofluoromethane)	0.5	0.04	0.3	0.3	0.3			0.2
Isopropyl alcohol(2-Propanol)	1.5	0.03	0.7	3.3	1	1.6		4.6
Freon 113(1,1,2-Trichlorotrifluoroethan)	0.5	0.06	0.08	0.08	0.08	0.05	0.06	0.05
Acetone	3.0	0.08	4.3	23	9.8	13	11	8
Carbon disulfide	1.0	0.04	0.03	0.05	0.04	0.04	0.04	0.01
Methylene chloride	1.5	0.04	0.2	0.5	0.3	0.5	0.5	
Methyl-tert-butyl ether(MTBE)	0.5	0.05						
trans-1,2-Dichloroethene	0.5	0.04						
n-Hexane	0.5	0.03	0.2	0.8	0.2	0.7	0.8	0.2
1,-Dichloroethane	0.5	0.04						
Vinyl acetate	0.5	0.05						
2-Butanone(MEK)	1.5	0.07	0.4	1.3	0.8	1.8	1.5	0.8
cis-1,2-Dichloroethene	0.5	0.05						
Ethyl acetate	0.5	0.07		0.4		0.1	0.2	
Chloroform	0.5	0.03	0.04	0.07				
Tetrahydrofuran	0.5	0.07		1.4				
1,1,1-Trichloroethane	0.5	0.04						
Cyclohexane	0.5	0.04	0.1	0.5	0.2	0.3	0.4	0.1
Carbon tetrachloride	0.5	0.04	0.08	0.07	0.07	0.05	0.06	0.06
n-Heptane	0.5	0.04	0.1	0.5		0.4	0.4	0.2
1,2-Dichloroethane	0.5	0.02						
Benzene	0.5	0.02	0.3	1.5	0.4	0.6	0.7	0.3
Trichloroethene	0.5	0.04	0.02	0.05	0.02	0.03	0.03	0.02
1,2-Dichloropropane	0.5	0.05						
Bromodichloromethane	0.5	0.04						
4-Methyl-2-pentanone(MIBK)	0.5	0.06	0.04	0.1	0.05	0.08	0.2	
cis-1,3-Dichloropropene	0.5	0.04						
Toluene	0.5	0.05	0.7	4.5	1.3	2.2	2.2	0.8
trans-1,3-Dichloropropene	0.5	0.04						
1,1,2-Trichloroethane	0.5	0.06						
2-Hexanone(MBK)	1.5	0.05	0.03		0.1	0.3	0.3	0.1
Tetrachloroethene	0.5	0.04	0.03	0.1	0.04	0.08	0.08	0.04
Dibromochloromethane	0.5	0.06						
1,2-Dibromoethane	0.5	0.06						
Chlorobenzene	0.5	0.04	0.01					
Ethylbenzene	0.5	0.05	0.1	0.6	0.2	0.4	0.4	0.2
Xylene (para & meta)	1.0	0.10	0.3	2.1	0.6	1.1	1.2	0.5
Xylene (Ortho)	0.5	0.05	0.1	0.8	0.2	0.4	0.4	0.2
Styrene	0.5	0.05	0.05	1.7	0.5	0.2	0.3	0.1
Bromoform	0.5	0.05						
1,1,2,2-Tetrachloroethane	0.5	0.08					0.06	
4-Ethyltoluene	0.5	0.06	0.1	0.6	0.2	0.3	0.4	0.2
1,3,5-Trimethylbenzene	0.5	0.05	0.03	0.2	0.05	0.09	0.1	0.05
1,2,4-Trimethylbenzene	0.5	0.08	0.1	0.6	0.2	0.3	0.4	0.2
1,3-Dichlorobenzene	0.5	0.06	0.01				0.03	
1,4-Dichlorobenzene	0.5	0.05	0.02	0.04	0.01	0.04	0.05	0.02
Benzyl chloride	0.5	0.06		0.02				
1,2-Dichlorobenzene	0.5	0.10	0.01			0.01	0.03	
1,2,4-Trichlorobenzene	1.0	0.10	0.02		0.02	0.05	0.08	0.03
Hexachloro-1,3-butadiene	0.5	0.30				0.02		

## Dominguez Elementary School - Outdoor VOC data

SPECIATED ORGANIC COMPOUNDS	Reporting Limit (ppbv)	Method Detection limit (ppbv)	VOC concentration (ppbv)			
			12/16/08	12/17/08	12/18/08	12/19/08
Propylene	1.0	0.04	2.4		1.4	2.6
Freon 12 (Dichlorodifluoromethane)	0.5	0.04	0.4	0.4	0.4	0.4
Freon 114(1,2-Dichlorotetrafluoroethan)	0.5	0.03				
Chloromethane	0.5	0.08	0.5	0.5	0.4	0.4
Vinyl chloride	0.5	0.04				
Bromomethane	0.5	0.05				
Ethanol	1.5	0.30	7.6	1.7	4.3	8.4
Freon 11(Trichlorofluoromethane)	0.5	0.04	0.2	0.2	0.2	0.2
Isopropyl alcohol(2-Propanol)	1.5	0.03	1.7			1.4
Freon 113(1,1,2-Trichlorotrifluoroethan)	0.5	0.06	0.06	0.05		
Acetone	3.0	0.08	10	1.2	6.8	13
Carbon disulfide	1.0	0.04			0.02	
Methylene chloride	1.5	0.04	0.3	0.08	0.1	0.3
Methyl-tert-butyl ether(MTBE)	0.5	0.05				
trans-1,2-Dichloroethene	0.5	0.04				
n-Hexane	0.5	0.03	0.3	0.03	0.2	0.3
1,-Dichloroethane	0.5	0.04				
Vinyl acetate	0.5	0.05				
2-Butanone(MEK)	1.5	0.07	0.9	0.1	1.1	1.3
cis-1,2-Dichloroethene	0.5	0.05				
Ethyl acetate	0.5	0.07				
Chloroform	0.5	0.03				
Tetrahydrofuran	0.5	0.07				
1,1,1-Trichloroethane	0.5	0.04				
Cyclohexane	0.5	0.04	0.2		0.1	0.2
Carbon tetrachloride	0.5	0.04	0.06	0.05	0.05	0.05
n-Heptane	0.5	0.04	0.5			0.4
1,2-Dichloroethane	0.5	0.02				
Benzene	0.5	0.02	0.5	0.1	0.3	0.6
Trichloroethene	0.5	0.04	0.02			0.02
1,2-Dichloropropane	0.5	0.05				
Bromodichloromethane	0.5	0.04				
4-Methyl-2-pentanone(MIBK)	0.5	0.06				
cis-1,3-Dichloropropene	0.5	0.04				
Toluene	0.5	0.05	1.4	0.2	0.8	1.8
trans-1,3-Dichloropropene	0.5	0.04				
1,1,2-Trichloroethane	0.5	0.06				
2-Hexanone(MBK)	1.5	0.05	0.1		0.2	0.3
Tetrachloroethene	0.5	0.04	0.06			0.04
Dibromochloromethane	0.5	0.06				
1,2-Dibromoethane	0.5	0.06				
Chlorobenzene	0.5	0.04				
Ethylbenzene	0.5	0.05	0.2	0.03	0.1	0.3
Xylene (para & meta)	1.0	0.10	0.7	0.09	0.4	0.9
Xylene (Ortho)	0.5	0.05	0.3	0.04	0.2	0.4
Styrene	0.5	0.05	0.2		0.04	0.7
Bromoform	0.5	0.05				
1,1,2,2-Tetrachloroethane	0.5	0.08				
4-Ethyltoluene	0.5	0.06	0.2	0.03	0.1	0.3
1,3,5-Trimethylbenzene	0.5	0.05		0.01	0.04	0.08
1,2,4-Trimethylbenzene	0.5	0.08	0.2	0.03	0.1	0.3
1,3-Dichlorobenzene	0.5	0.06				
1,4-Dichlorobenzene	0.5	0.05	0.01		0.01	0.02
Benzyl chloride	0.5	0.06				
1,2-Dichlorobenzene	0.5	0.10				
1,2,4-Trichlorobenzene	1.0	0.10				
Hexachloro-1,3-butadiene	0.5	0.30				

### Dominguez Elementary School - Outdoor VOC data

TENTATIVELY IDENTIFIED COMPOUNDS	Reporting Limit (ppbv)	Method Detection limit (ppbv)	VOC concentration (ppbv)						
			11/18/08	11/19/08	11/20/08	11/21/08	11/24/08	11/25/08	
2,2,3,3-Tetramethyl butane	N/A	N/A							
2,2,4-Trimethyl pentane	N/A	N/A							
2,2-Dimethyl hexane	N/A	N/A	2.1	2.1	2.1	2.5			
2,3-Dimethyl pentane	N/A	N/A	1.4	1.2	1	1.5			
2,4-Dimethyl hexane	N/A	N/A							
2-Methyl butane	N/A	N/A	7.8	7.9	9.2	9	4.2	3.6	
2-Methyl hexane	N/A	N/A	1.2			1.2			
2-Methyl pentane	N/A	N/A	3.2	3.3	3.5	3.9	1.6	1.3	
2-Pentene	N/A	N/A							
3-Methyl hexane	N/A	N/A	1.5	1.2	1.1	1.5			
3-Methyl pentane	N/A	N/A	1.7	1.8	2	2.1			
Acetaldehyde	N/A	N/A		1.6	2.1		1.8		
Butanal	N/A	N/A							
Butane	N/A	N/A	5.5	6.8	8.6	6.5	3.5	2.9	
Difluorochloromethane	N/A	N/A				5.6			
Heptanal	N/A	N/A							
Hexamethyl cyclotrisiloxane	N/A	N/A						2.6	
Isobutane	N/A	N/A	4.4	5.1	4.5	4.6	3.1	2.6	
Limonene	N/A	N/A							
Methyl cyclohexane	N/A	N/A							
Methyl cyclopentane	N/A	N/A	1.4	1.5	1.8	1.8			
Octamethyl cyclotrisiloxane	N/A	N/A							
Pentane	N/A	N/A	3.5	3.7			4.1	2.3	
Trimethyl silanol	N/A	N/A							

### Dominguez Elementary School - Outdoor VOC data

TENTATIVELY IDENTIFIED COMPOUNDS	Reporting Limit (ppbv)	Method Detection limit (ppbv)	VOC concentration (ppbv)						
			11/26/08	12/1/08	12/2/08	12/3/08	12/4/08	12/5/08	
2,2,3,3-Tetramethyl butane	N/A	N/A							
2,2,4-Trimethyl pentane	N/A	N/A							1.2
2,2-Dimethyl hexane	N/A	N/A							
2,3-Dimethyl pentane	N/A	N/A							
2,4-Dimethyl hexane	N/A	N/A							
2-Methyl butane	N/A	N/A	2.6	8.8	1.8	2.2	1.8	3.2	
2-Methyl hexane	N/A	N/A							
2-Methyl pentane	N/A	N/A		3.3					1.6
2-Pentene	N/A	N/A							
3-Methyl hexane	N/A	N/A		1.1					
3-Methyl pentane	N/A	N/A		2					
Acetaldehyde	N/A	N/A	2	2.1	4	2.8	2.4	1	
Butanal	N/A	N/A			1.3	1.1	1.7		
Butane	N/A	N/A	2.4	8.6	2.6	2.4	1.6	2.4	
Difluorochloromethane	N/A	N/A	2.6						
Heptanal	N/A	N/A	1.1						
Hexamethyl cyclotrisiloxane	N/A	N/A			2.3				
Isobutane	N/A	N/A	2.4	5.8	1.7		1.2	1.9	
Limonene	N/A	N/A							
Methyl cyclohexane	N/A	N/A		1					
Methyl cyclopentane	N/A	N/A		2.2					
Octamethyl cyclotrisiloxane	N/A	N/A			1.1				
Pentane	N/A	N/A		4.8					
Trimethyl silanol	N/A	N/A							

### Dominguez Elementary School - Outdoor VOC data

TENTATIVELY IDENTIFIED COMPOUNDS	Reporting Limit (ppbv)	Method Detection limit (ppbv)	VOC concentration (ppbv)					
			12/8/08	12/9/08	12/10/08	12/11/08	12/12/08	12/15/08
2,2,3,3-Tetramethyl butane	N/A	N/A				1.1	1.2	
2,2,4-Trimethyl pentane	N/A	N/A		1.9				
2,2-Dimethyl hexane	N/A	N/A						
2,3-Dimethyl pentane	N/A	N/A						
2,4-Dimethyl hexane	N/A	N/A						
2-Methyl butane	N/A	N/A	1.2	4.8	1.5	4	3.9	
2-Methyl hexane	N/A	N/A		1.1				
2-Methyl pentane	N/A	N/A				2.5	2.6	
2-Pentene	N/A	N/A		1.4				
3-Methyl hexane	N/A	N/A		1.4				
3-Methyl pentane	N/A	N/A				1.4	1.5	
Acetaldehyde	N/A	N/A						
Butanal	N/A	N/A						
Butane	N/A	N/A		3.5	1	2.5	2.6	
Difluorochloromethane	N/A	N/A						
Heptanal	N/A	N/A						
Hexamethyl cyclotrisiloxane	N/A	N/A						
Isobutane	N/A	N/A		2.1		1.4	1.4	
Limonene	N/A	N/A						
Methyl cyclohexane	N/A	N/A						
Methyl cyclopentane	N/A	N/A		1.5		1.2	1.2	
Octamethyl cyclotrisiloxane	N/A	N/A						
Pentane	N/A	N/A				1.7	1.7	
Trimethyl silanol	N/A	N/A						

### Dominguez Elementary School - Outdoor VOC data

TENTATIVELY IDENTIFIED COMPOUNDS	Reporting Limit (ppbv)	Method Detection limit (ppbv)	VOC concentration (ppbv)			
			12/16/08	12/17/08	12/18/08	12/19/08
2,2,3,3-Tetramethyl butane	N/A	N/A				
2,2,4-Trimethyl pentane	N/A	N/A				
2,2-Dimethyl hexane	N/A	N/A				
2,3-Dimethyl pentane	N/A	N/A				
2,4-Dimethyl hexane	N/A	N/A				1.1
2-Methyl butane	N/A	N/A	1.3			1.5
2-Methyl hexane	N/A	N/A				
2-Methyl pentane	N/A	N/A	1.1			
2-Pentene	N/A	N/A				
3-Methyl hexane	N/A	N/A				
3-Methyl pentane	N/A	N/A				
Acetaldehyde	N/A	N/A				
Butanal	N/A	N/A				
Butane	N/A	N/A				1.1
Difluorochloromethane	N/A	N/A				
Heptanal	N/A	N/A				
Hexamethyl cyclotrisiloxane	N/A	N/A				
Isobutane	N/A	N/A				
Limonene	N/A	N/A				
Methyl cyclohexane	N/A	N/A				
Methyl cyclopentane	N/A	N/A				
Octamethyl cyclotrisiloxane	N/A	N/A				
Pentane	N/A	N/A				
Trimethyl silanol	N/A	N/A	1.4			

## Dominguez Elementary School - Room 7 (DZ-7) VOC data

SPECIATED ORGANIC COMPOUNDS	Reporting Limit (ppbv)	Method Detection limit (ppbv)	VOC concentration (ppbv)					
			11/18/08	11/19/08	11/20/08	11/21/08	11/24/08	11/25/08
Propylene	1.0	0.04	9.5	4.4	3.4	5.9	5.3	2.8
Freon 12 (Dichlorodifluoromethane)	0.5	0.04	0.7	0.6	0.6	0.6	0.7	0.5
Freon 114(1,2-Dichlorotetrafluoroethan)	0.5	0.03			0.01		0.02	0.02
Chloromethane	0.5	0.08	0.8	0.9	0.7	0.8	0.6	0.92
Bromomethane	0.5	0.05			0.02	0.02		0.02
Ethanol	1.5	0.30	140	310	480	380	59	480
Freon 11(Trichlorofluoromethane)	0.5	0.04			0.3			
Isopropyl alcohol(2-Propanol)	1.5	0.03	14	35	39	31	6.9	32
Freon 113(1,1,2-Trichlorotrifluoroethan)	0.5	0.06	0.08	0.08	0.06	0.06	0.06	0.06
Acetone	3.0	0.08	37	44	22	35	16	33
1,1-Dichloroethene	0.5	0.03						
Carbon disulfide	1.0	0.04	0.08	0.08	0.08	0.07	0.06	0.1
Methylene chloride	1.5	0.04	1.8	1	0.6	2.2	0.7	0.5
n-Hexane	0.5	0.03	2.2	1	0.9	1.8	0.8	0.5
2-Butanone(MEK)	1.5	0.07	2.5	2.3	1.4	2.5	1.2	2.7
Ethyl acetate	0.5	0.07	1	0.7	0.3	0.5	0.3	0.3
Chloroform	0.5	0.03	0.1	0.07	0.06	0.1	0.06	0.05
Tetrahydrofuran	0.5	0.07	1.7	0.4	0.2	0.6	0.4	0.4
1,1,1-Trichloroethane	0.5	0.04			0.02			
Cyclohexane	0.5	0.04	1.5	0.8	0.5	3.3	0.5	0.4
Carbon tetrachloride	0.5	0.04	0.07	0.07	0.07	0.07	0.06	0.06
n-Heptane	0.5	0.04	2.6	1.9		1.1	0.8	
Benzene	0.5	0.02	2.1	1	0.8	1.6	1	0.6
Trichloroethene	0.5	0.04	0.05	0.05	0.04	0.06	0.03	0.06
Bromodichloromethane	0.5	0.04						
4-Methyl-2-pentanone(MIBK)	0.5	0.06	0.4	0.4	0.4	4	0.2	0.9
cis-1,3-Dichloropropene	0.5	0.04						
Toluene	0.5	0.05	8.3	4.2	2.8	7.2	4.5	3.2
trans-1,3-Dichloropropene	0.5	0.04						
1,1,2-Trichloroethane	0.5	0.06						
2-Hexanone(MBK)	1.5	0.05			0.1	0.2	0.2	0.5
Tetrachloroethene	0.5	0.04	0.3	0.1	0.08	0.4	0.1	0.1
Chlorobenzene	0.5	0.04						
Ethylbenzene	0.5	0.05	1.1	0.6	0.5	1.1	0.7	0.5
Xylene (para & meta)	1.0	0.10	3.9	1.8	1.5	3.7	2.3	1.4
Xylene (Ortho)	0.5	0.05	1.4	0.7	0.7	1.4	0.8	0.6
Styrene	0.5	0.05	1.3	0.5	0.4	0.7	0.4	0.6
1,1,2,2-Tetrachloroethane	0.5	0.08						
4-Ethyltoluene	0.5	0.06	1.3	0.7	0.6	1.2	0.7	0.5
1,3,5-Trimethylbenzene	0.5	0.05	0.4	0.2		0.4	0.2	0.2
1,2,4-Trimethylbenzene	0.5	0.08	1.4	0.8	0.6	1.3	0.7	0.6
1,3-Dichlorobenzene	0.5	0.06						
1,4-Dichlorobenzene	0.5	0.05	0.5	0.7	0.5	0.7	0.2	0.8
1,2-Dichlorobenzene	0.5	0.10						
1,2,4-Trichlorobenzene	1.0	0.10						
Hexachloro-1,3-butadiene	0.5	0.30		0.02				

## Dominguez Elementary School - Room 7 (DZ-7) VOC data

SPECIATED ORGANIC COMPOUNDS	Reporting Limit (ppbv)	Method Detection limit (ppbv)	VOC concentration (ppbv)						
			11/26/08	12/1/08	12/2/08	12/3/08	12/4/08	12/5/08	
Propylene	1.0	0.04	1.1	3					
Freon 12 (Dichlorodifluoromethane)	0.5	0.04	0.5	0.4	0.5	0.4	3.6	1.4	
Freon 114(1,2-Dichlorotetrafluoroethan)	0.5	0.03	0.02			0.03	0.04	0.05	
Chloromethane	0.5	0.08	0.9	0.7	0.8	1	0.7	0.7	
Bromomethane	0.5	0.05	0.02	0.04					
Ethanol	1.5	0.30	130	32	40	160	49	49	
Freon 11(Trichlorofluoromethane)	0.5	0.04	0.2			0.1	0.7	0.3	
Isopropyl alcohol(2-Propanol)	1.5	0.03	16	3.9	6.6	5.9	2.5	7.6	
Freon 113(1,1,2-Trichlorotrifluoroethan)	0.5	0.06	0.06			0.05	0.05		
Acetone	3.0	0.08	17	19	6.8	10	12	9	
1,1-Dichloroethene	0.5	0.03					0.02		
Carbon disulfide	1.0	0.04	0.04	0.02	0.02	0.08	0.07	0.09	
Methylene chloride	1.5	0.04	0.2	0.2	0.2	0.2	0.2	0.4	
n-Hexane	0.5	0.03	0.2	0.4	0.07	0.1	0.1	0.2	
2-Butanone(MEK)	1.5	0.07	0.5	3.3	0.2	1.4	1.4	0.4	
Ethyl acetate	0.5	0.07	0.3						
Chloroform	0.5	0.03				0.04	0.04		
Tetrahydrofuran	0.5	0.07							
1,1,1-Trichloroethane	0.5	0.04							
Cyclohexane	0.5	0.04	0.2	0.2	0.06	0.08	0.1	0.1	
Carbon tetrachloride	0.5	0.04	0.06			0.04	0.04	0.03	
n-Heptane	0.5	0.04				0.4		0.3	
Benzene	0.5	0.02	0.3	0.3	0.05	0.1	0.1	0.2	
Trichloroethene	0.5	0.04	0.02			0.03	0.03	0.04	
Bromodichloromethane	0.5	0.04							
4-Methyl-2-pentanone(MIBK)	0.5	0.06	0.2	0.1	0.4	0.1	0.1	0.1	
cis-1,3-Dichloropropene	0.5	0.04						0.02	
Toluene	0.5	0.05	1.3	0.9	0.1	0.2	0.3	0.7	
trans-1,3-Dichloropropene	0.5	0.04				0.02	0.02		
1,1,2-Trichloroethane	0.5	0.06					0.03		
2-Hexanone(MBK)	1.5	0.05		0.2		0.2	0.2		
Tetrachloroethene	0.5	0.04	0.03	0.02		0.03	0.04	0.05	
Chlorobenzene	0.5	0.04				0.03	0.03	0.03	
Ethylbenzene	0.5	0.05	0.2	0.1	0.03	0.06	0.08	0.1	
Xylene (para & meta)	1.0	0.10	0.6	0.4	0.06	0.1	0.2	0.3	
Xylene (Ortho)	0.5	0.05	0.3	0.2	0.03	0.07	0.08	0.2	
Styrene	0.5	0.05	0.2	0.1	0.02	0.04	0.05	0.1	
1,1,2,2-Tetrachloroethane	0.5	0.08					0.03	0.03	
4-Ethyltoluene	0.5	0.06	0.3	0.2	0.04	0.05	0.1	0.2	
1,3,5-Trimethylbenzene	0.5	0.05	0.08	0.04	0.01	0.03	0.05	0.07	
1,2,4-Trimethylbenzene	0.5	0.08	0.3	0.2	0.04	0.05	0.1	0.2	
1,3-Dichlorobenzene	0.5	0.06				0.03	0.03	0.03	
1,4-Dichlorobenzene	0.5	0.05	0.8	0.1	0.08	0.06	0.06	0.05	
1,2-Dichlorobenzene	0.5	0.10	0.02			0.03	0.03	0.03	
1,2,4-Trichlorobenzene	1.0	0.10				0.04	0.04	0.04	
Hexachloro-1,3-butadiene	0.5	0.30	0.03			0.03	0.04	0.03	

## Dominguez Elementary School - Room 7 (DZ-7) VOC data

SPECIATED ORGANIC COMPOUNDS	Reporting Limit (ppbv)	Method Detection limit (ppbv)	VOC concentration (ppbv)						
			12/8/08	12/9/08	12/10/08	12/11/08	12/12/08	12/15/08	
Propylene	1.0	0.04		1.8	1.7				
Freon 12 (Dichlorodifluoromethane)	0.5	0.04	1	6.3	0.6	0.8	0.5	0.5	
Freon 114(1,2-Dichlorotetrafluoroethan)	0.5	0.03	0.03	0.02					
Chloromethane	0.5	0.08	0.7	0.6		0.6	0.5	0.6	
Bromomethane	0.5	0.05							
Ethanol	1.5	0.30	22	26	35	34	68	27	
Freon 11(Trichlorofluoromethane)	0.5	0.04	0.3	1.1	0.3	0.2	0.2	0.2	
Isopropyl alcohol(2-Propanol)	1.5	0.03	3.6	3.7	4.6	3.6	14	3.6	
Freon 113(1,1,2-Trichlorotrifluoroethan)	0.5	0.06	0.03	0.03	0.03	0.02			
Acetone	3.0	0.08	11	14	9.1	9.2	20	10	
1,1-Dichloroethene	0.5	0.03	0.3						
Carbon disulfide	1.0	0.04	0.07	0.05	0.04	0.04	0.02	0.02	
Methylene chloride	1.5	0.04	0.3	0.5	0.3	0.4	0.6	0.3	
n-Hexane	0.5	0.03	0.08	0.1	0.09	0.1	0.2	0.09	
2-Butanone(MEK)	1.5	0.07	1	1.3	0.2	0.6	0.7	0.5	
Ethyl acetate	0.5	0.07					0.1		
Chloroform	0.5	0.03							0.02
Tetrahydrofuran	0.5	0.07							
1,1,1-Trichloroethane	0.5	0.04							
Cyclohexane	0.5	0.04	0.06	0.1	0.1	0.1	0.3	0.06	
Carbon tetrachloride	0.5	0.04	0.03	0.03	0.03				0.02
n-Heptane	0.5	0.04			0.1	0.5			
Benzene	0.5	0.02	0.1	0.2	0.1	0.2	0.1	0.1	
Trichloroethene	0.5	0.04	0.02	0.02					
Bromodichloromethane	0.5	0.04			0.01				
4-Methyl-2-pentanone(MIBK)	0.5	0.06	0.04	0.08	0.03		3	0.07	
cis-1,3-Dichloropropene	0.5	0.04							
Toluene	0.5	0.05	0.3	0.5	0.4	0.7	0.4	0.4	
trans-1,3-Dichloropropene	0.5	0.04							
1,1,2-Trichloroethane	0.5	0.06							
2-Hexanone(MBK)	1.5	0.05	0.1	0.2			0.08	0.07	
Tetrachloroethene	0.5	0.04	0.02	0.04	0.02	0.02			
Chlorobenzene	0.5	0.04	0.01						
Ethylbenzene	0.5	0.05	0.05	0.08	0.06	0.1	0.07	0.07	
Xylene (para & meta)	1.0	0.10	0.1	0.2	0.2	0.3	0.2	0.2	
Xylene (Ortho)	0.5	0.05	0.06	0.1	0.08	0.1	0.08	0.1	
Styrene	0.5	0.05	0.02	0.07	0.1	0.08	0.05	0.06	
1,1,2,2-Tetrachloroethane	0.5	0.08							
4-Ethyltoluene	0.5	0.06	0.05	0.08	0.07	0.1	0.07	0.1	
1,3,5-Trimethylbenzene	0.5	0.05	0.02	0.03	0.03	0.05		0.04	
1,2,4-Trimethylbenzene	0.5	0.08	0.05	0.08	0.07	0.2	0.07	0.1	
1,3-Dichlorobenzene	0.5	0.06	0.01	0.01					
1,4-Dichlorobenzene	0.5	0.05	0.04	0.05	0.02	0.02	0.01	0.07	
1,2-Dichlorobenzene	0.5	0.10	0.01	0.01					
1,2,4-Trichlorobenzene	1.0	0.10	0.02	0.02	0.02			0.03	
Hexachloro-1,3-butadiene	0.5	0.30	0.02	0.02	0.01				

## Dominguez Elementary School - Room 7 (DZ-7) VOC data

SPECIATED ORGANIC COMPOUNDS	Reporting Limit (ppbv)	Method Detection limit (ppbv)	VOC concentration (ppbv)			
			12/16/08	12/17/08	12/18/08	12/19/08
Propylene	1.0	0.04		1		1.5
Freon 12 (Dichlorodifluoromethane)	0.5	0.04	0.4	0.4	0.4	0.4
Freon 114(1,2-Dichlorotetrafluoroethan)	0.5	0.03				
Chloromethane	0.5	0.08	0.6	0.5	0.5	0.6
Bromomethane	0.5	0.05				
Ethanol	1.5	0.30	110	54	110	56
Freon 11(Trichlorofluoromethane)	0.5	0.04	0.2	0.2	0.2	0.2
Isopropyl alcohol(2-Propanol)	1.5	0.03	5.4	4.6	5.6	3.6
Freon 113(1,1,2-Trichlorotrifluoroethan)	0.5	0.06	0.02	0.04	0.02	
Acetone	3.0	0.08	7.9	6.5	11	14
1,1-Dichloroethene	0.5	0.03				
Carbon disulfide	1.0	0.04	0.06	0.01	0.03	
Methylene chloride	1.5	0.04	0.4	0.2	0.2	0.3
n-Hexane	0.5	0.03		0.1	0.09	0.1
2-Butanone(MEK)	1.5	0.07		0.4	0.8	0.8
Ethyl acetate	0.5	0.07		0.4	0.8	
Chloroform	0.5	0.03				
Tetrahydrofuran	0.5	0.07				
1,1,1-Trichloroethane	0.5	0.04				
Cyclohexane	0.5	0.04	0.08		0.1	0.1
Carbon tetrachloride	0.5	0.04		0.04	0.02	
n-Heptane	0.5	0.04			0.3	
Benzene	0.5	0.02	0.2	0.2	0.1	0.2
Trichloroethene	0.5	0.04				
Bromodichloromethane	0.5	0.04				
4-Methyl-2-pentanone(MIBK)	0.5	0.06	0.05	0.05	0.04	
cis-1,3-Dichloropropene	0.5	0.04				
Toluene	0.5	0.05	0.5	0.6	1.5	0.9
trans-1,3-Dichloropropene	0.5	0.04				
1,1,2-Trichloroethane	0.5	0.06				
2-Hexanone(MBK)	1.5	0.05				
Tetrachloroethene	0.5	0.04		0.02		
Chlorobenzene	0.5	0.04				
Ethylbenzene	0.5	0.05	0.09	0.1	0.05	0.1
Xylene (para & meta)	1.0	0.10	0.3	0.3	0.2	0.4
Xylene (Ortho)	0.5	0.05	0.4	0.1	0.06	0.2
Styrene	0.5	0.05	0.07	0.07	0.02	0.2
1,1,2,2-Tetrachloroethane	0.5	0.08				
4-Ethyltoluene	0.5	0.06	0.2	0.1	0.06	0.2
1,3,5-Trimethylbenzene	0.5	0.05	0.06	0.04	0.02	0.05
1,2,4-Trimethylbenzene	0.5	0.08	0.2	0.1	0.06	0.2
1,3-Dichlorobenzene	0.5	0.06	0.02			
1,4-Dichlorobenzene	0.5	0.05	0.05	0.04	0.04	0.04
1,2-Dichlorobenzene	0.5	0.10	0.02			
1,2,4-Trichlorobenzene	1.0	0.10	0.04			
Hexachloro-1,3-butadiene	0.5	0.30				

## Dominguez Elementary School - Room 7 (DZ-7) VOC data

TENTATIVELY IDENTIFIED COMPOUNDS	Reporting Limit (ppbv)	Method Detection limit (ppbv)	VOC concentration (ppbv)						
			11/18/08	11/19/08	11/20/08	11/21/08	11/24/08	11/25/08	
.alpha.-Pinene	N/A	N/A							
1,3-Pentadiene	N/A	N/A							
1-Butanol	N/A	N/A							2.9
1R-.alpha.-Pinene	N/A	N/A							
2,2,3,3-Tetramethyl butane	N/A	N/A		1.8	1.5			1.7	
2,2,4-Trimethyl pentane	N/A	N/A	4						
2,2-Dimethyl hexane	N/A	N/A					2.9		
2,3-Dimethyl pentane	N/A	N/A	2.7				1.9	1.2	
2,4-bis(trimethylsiloxane) Benzaldehyde	N/A	N/A			28				
2-Methyl butane	N/A	N/A	16	6.9	6	12		7.3	4.4
2-Methyl hexane	N/A	N/A	2.1						
2-Methyl pentane	N/A	N/A	6.4	2.8	2.4	4.9		2.8	
2-Methyl-1,3-butadiene	N/A	N/A		3.2	1.3	2.6			2.5
3-Methyl hexane	N/A	N/A	2.5			2		1.2	
3-Methyl pentane	N/A	N/A	3.5	1.5	1.4	2.6		1.5	
4-Ethyl-2,2,6,6-tetramethyl heptane	N/A	N/A							1.8
Acetaldehyde	N/A	N/A		1.6	1.3			1.5	3.1
Benzaldehyde	N/A	N/A	2.1	2	2.4	2.5		1.9	
Butanal	N/A	N/A							
Butane	N/A	N/A	11	5.3	5.4	8.4		5.3	3.6
Butyl ester acetic acid	N/A	N/A	8.8						
Decanal	N/A	N/A							
Difluorochloromethane	N/A	N/A							
D-Limonene	N/A	N/A	1.7	5.5	1.5	2.6			
Heptanal	N/A	N/A							
Hexamethyl cyclotrisiloxane	N/A	N/A						1	
Hexanal	N/A	N/A		1.2					1.8
Isobutane	N/A	N/A	7	3.3	12	5		3.8	2.2
Methyl cyclopentane	N/A	N/A	3	1.3	1.3	2.3		1.3	
Nonanal	N/A	N/A		1.2					2.3
Ocatanal	N/A	N/A							1.8
Octamethyl cyclotrisiloxane	N/A	N/A			68				
Pentane	N/A	N/A	6.1	3.1			5.4	3.1	2.8
Tridecane	N/A	N/A							

## Dominguez Elementary School - Room 7 (DZ-7) VOC data

TENTATIVELY IDENTIFIED COMPOUNDS	Reporting Limit (ppbv)	Method Detection limit (ppbv)	VOC concentration (ppbv)						
			11/26/08	12/1/08	12/2/08	12/3/08	12/4/08	12/5/08	
.alpha.-Pinene	N/A	N/A	1.2						
1,3-Pentadiene	N/A	N/A	2.2						
1-Butanol	N/A	N/A	1.8						
1R-.alpha.-Pinene	N/A	N/A							
2,2,3,3-Tetramethyl butane	N/A	N/A							
2,2,4-Trimethyl pentane	N/A	N/A							
2,2-Dimethyl hexane	N/A	N/A							
2,3-Dimethyl pentane	N/A	N/A							
2,4-bis(trimethylsiloxane) Benzaldehyde	N/A	N/A							
2-Methyl butane	N/A	N/A	2.6	2.8		2.1			1.3
2-Methyl hexane	N/A	N/A							
2-Methyl pentane	N/A	N/A							
2-Methyl-1,3-butadiene	N/A	N/A							
3-Methyl hexane	N/A	N/A							
3-Methyl pentane	N/A	N/A							
4-Ethyl-2,2,6,6-tetramethyl heptane	N/A	N/A							
Acetaldehyde	N/A	N/A		2.7		2.7		1.5	
Benzaldehyde	N/A	N/A							
Butanal	N/A	N/A				1.1		1	
Butane	N/A	N/A	2	3.4	1.8	1.9		1.1	1.6
Butyl ester acetic acid	N/A	N/A							
Decanal	N/A	N/A							
Difluorochloromethane	N/A	N/A			1.5				
D-Limonene	N/A	N/A	37						
Heptanal	N/A	N/A							
Hexamethyl cyclotrisiloxane	N/A	N/A							
Hexanal	N/A	N/A							
Isobutane	N/A	N/A	1.7	2.6	1.9	1.6		1.3	1.8
Methyl cyclopentane	N/A	N/A							
Nonanal	N/A	N/A	1.1						
Ocatanal	N/A	N/A							
Octamethyl cyclotrisiloxane	N/A	N/A		1					
Pentane	N/A	N/A		1.5					
Tridecane	N/A	N/A	1.1						

## Dominguez Elementary School - Room 7 (DZ-7) VOC data

TENTATIVELY IDENTIFIED COMPOUNDS	Reporting Limit (ppbv)	Method Detection limit (ppbv)	VOC concentration (ppbv)					
			12/8/08	12/9/08	12/10/08	12/11/08	12/12/08	12/15/08
.alpha.-Pinene	N/A	N/A						
1,3-Pentadiene	N/A	N/A						
1-Butanol	N/A	N/A						
1R-.alpha.-Pinene	N/A	N/A		1.9	4.1			
2,2,3,3-Tetramethyl butane	N/A	N/A						
2,2,4-Trimethyl pentane	N/A	N/A						
2,2-Dimethyl hexane	N/A	N/A		2.4				
2,3-Dimethyl pentane	N/A	N/A						
2,4-bis(trimethylsiloxane) Benzaldehyde	N/A	N/A						
2-Methyl butane	N/A	N/A					1.1	
2-Methyl hexane	N/A	N/A						
2-Methyl pentane	N/A	N/A						
2-Methyl-1,3-butadiene	N/A	N/A						
3-Methyl hexane	N/A	N/A			4.3			
3-Methyl pentane	N/A	N/A						
4-Ethyl-2,2,6,6-tetramethyl heptane	N/A	N/A						
Acetaldehyde	N/A	N/A						
Benzaldehyde	N/A	N/A		2.4				
Butanal	N/A	N/A		2				
Butane	N/A	N/A				1	1.8	
Butyl ester acetic acid	N/A	N/A						
Decanal	N/A	N/A		1.9				
Difluorochloromethane	N/A	N/A					1.9	
D-Limonene	N/A	N/A						
Heptanal	N/A	N/A		1.9				
Hexamethyl cyclotrisiloxane	N/A	N/A						
Hexanal	N/A	N/A						
Isobutane	N/A	N/A				1.3	1.3	
Methyl cyclopentane	N/A	N/A						
Nonanal	N/A	N/A						
Ocatanal	N/A	N/A		1.8				
Octamethyl cyclotrisiloxane	N/A	N/A						
Pentane	N/A	N/A						
Tridecane	N/A	N/A						

### Dominguez Elementary School - Room 7 (DZ-7) VOC data

TENTATIVELY IDENTIFIED COMPOUNDS	Reporting Limit (ppbv)	Method Detection limit (ppbv)	VOC concentration (ppbv)			
			12/16/08	12/17/08	12/18/08	12/19/08
.alpha.-Pinene	N/A	N/A				
1,3-Pentadiene	N/A	N/A				
1-Butanol	N/A	N/A				
1R-.alpha.-Pinene	N/A	N/A				
2,2,3,3-Tetramethyl butane	N/A	N/A				
2,2,4-Trimethyl pentane	N/A	N/A				
2,2-Dimethyl hexane	N/A	N/A				
2,3-Dimethyl pentane	N/A	N/A				
2,4-bis(trimethylsiloxane) Benzaldehyde	N/A	N/A				
2-Methyl butane	N/A	N/A				
2-Methyl hexane	N/A	N/A				
2-Methyl pentane	N/A	N/A				
2-Methyl-1,3-butadiene	N/A	N/A				
3-Methyl hexane	N/A	N/A				
3-Methyl pentane	N/A	N/A				
4-Ethyl-2,2,6,6-tetramethyl heptane	N/A	N/A				
Acetaldehyde	N/A	N/A				
Benzaldehyde	N/A	N/A				
Butanal	N/A	N/A				
Butane	N/A	N/A				1.2
Butyl ester acetic acid	N/A	N/A				
Decanal	N/A	N/A				
Difluorochloromethane	N/A	N/A				
D-Limonene	N/A	N/A				
Heptanal	N/A	N/A				
Hexamethyl cyclotrisiloxane	N/A	N/A				
Hexanal	N/A	N/A				
Isobutane	N/A	N/A				1
Methyl cyclopentane	N/A	N/A				
Nonanal	N/A	N/A				
Ocatanal	N/A	N/A				
Octamethyl cyclotrisiloxane	N/A	N/A				
Pentane	N/A	N/A				
Tridecane	N/A	N/A				

## Dominguez Elementary School - Room 9 (DZ-9) VOC data

SPECIATED ORGANIC COMPOUNDS	Reporting Limit (ppbv)	Method Detection limit (ppbv)	VOC concentration (ppbv)					
			11/18/08	11/19/08	11/20/08	11/21/08	11/24/08	11/25/08
Propylene	1.0	0.04			4.1		4.4	2.8
Freon 12 (Dichlorodifluoromethane)	0.5	0.04		0.6	0.6		0.6	0.5
Freon 114(1,2-Dichlorotetrafluoroethan)	0.5	0.03			0.02	0.02	0.02	0.02
Chloromethane	0.5	0.08	0.7	0.7	0.7	0.7	0.8	0.8
Vinyl chloride	0.5	0.04						
Bromomethane	0.5	0.05			0.05			0.02
Ethanol	1.5	0.30	200	580	150	120	520	180
Freon 11(Trichlorofluoromethane)	0.5	0.04			0.3			0.2
Isopropyl alcohol(2-Propanol)	1.5	0.03	17	160	20	92	270	200
Freon 113(1,1,2-Trichlorotrifluoroethan)	0.5	0.06		0.06	0.06	0.06	0.06	0.06
Acetone	3.0	0.08	25	27	17	27	31	26
Carbon disulfide	1.0	0.04	0.09	0.06	0.04	0.09	0.05	0.04
Methylene chloride	1.5	0.04	1.2	1	0.6	1.4	0.6	0.4
n-Hexane	0.5	0.03	1.1	1.3	1.4	1.2	0.7	0.5
2-Butanone(MEK)	1.5	0.07	1.8	2.2	2.5	2.3	2.3	2.5
cis-1,2-Dichloroethene	0.5	0.05						
Ethyl acetate	0.5	0.07	1.6	0.7	0.3	0.8	0.4	0.3
Chloroform	0.5	0.03	0.08	0.07	0.07	0.09	0.05	0.05
Tetrahydrofuran	0.5	0.07	0.5	0.2	0.1	0.4	0.3	0.2
1,1,1-Trichloroethane	0.5	0.04			0.02	0.02		
Cyclohexane	0.5	0.04	0.8	1.7	0.8	1.7	0.5	0.3
Carbon tetrachloride	0.5	0.04	0.07	0.07	0.07	0.07	0.06	0.06
n-Heptane	0.5	0.04	1.2	4.7	0.9	0.9	0.6	
Benzene	0.5	0.02	1.2	1.1	1.1	1.3	0.8	0.6
Trichloroethene	0.5	0.04	0.09	0.07	0.05	0.06	0.03	0.06
4-Methyl-2-pentanone(MIBK)	0.5	0.06	0.5	1.3	0.3	0.4	0.4	0.4
cis-1,3-Dichloropropene	0.5	0.04						
Toluene	0.5	0.05	5.4	5.1	4.3	6.4	3.8	3
trans-1,3-Dichloropropene	0.5	0.04						
2-Hexanone(MBK)	1.5	0.05		0.1	0.2	0.2	0.4	0.4
Tetrachloroethene	0.5	0.04	0.3	0.2	0.1	0.2	0.1	0.09
Dibromochloromethane	0.5	0.06						
Chlorobenzene	0.5	0.04						
Ethylbenzene	0.5	0.05	0.7	0.7	0.6	0.9	0.5	0.4
Xylene (para & meta)	1.0	0.10	2.4	2	1.8	2.9	1.7	1.1
Xylene (Ortho)	0.5	0.05	0.9	0.9	0.7	1.1	0.7	0.5
Styrene	0.5	0.05	1.1	0.6	0.6	0.5	1.1	0.4
1,1,2,2-Tetrachloroethane	0.5	0.08						
4-Ethyltoluene	0.5	0.06	0.8	0.7	0.6	0.9	0.6	0.4
1,3,5-Trimethylbenzene	0.5	0.05	0.2	0.2		0.3	0.2	0.1
1,2,4-Trimethylbenzene	0.5	0.08	0.9	0.7	0.6	1	0.7	0.5
1,3-Dichlorobenzene	0.5	0.06						
1,4-Dichlorobenzene	0.5	0.05	0.08	0.09	0.09	0.1	0.1	0.08
1,2-Dichlorobenzene	0.5	0.10						
1,2,4-Trichlorobenzene	1.0	0.10						
Hexachloro-1,3-butadiene	0.5	0.30		0.03				0.03

## Dominguez Elementary School - Room 9 (DZ-9) VOC data

SPECIATED ORGANIC COMPOUNDS	Reporting Limit (ppbv)	Method Detection limit (ppbv)	VOC concentration (ppbv)					
			11/26/08	12/1/08	12/2/08	12/3/08	12/4/08	12/5/08
Propylene	1.0	0.04	0.9	4	1.1	0.7	1.1	2.6
Freon 12 (Dichlorodifluoromethane)	0.5	0.04	0.5	0.5	0.4	0.4	0.5	0.6
Freon 114(1,2-Dichlorotetrafluoroethan)	0.5	0.03	0.02		0.02	0.04	0.05	0.05
Chloromethane	0.5	0.08	0.7	0.7	0.6	0.8	0.6	0.6
Vinyl chloride	0.5	0.04				0.04		
Bromomethane	0.5	0.05		0.05		0.05		
Ethanol	1.5	0.30	110	210	82	59	61	84
Freon 11(Trichlorofluoromethane)	0.5	0.04	0.2		0.2	0.3	0.3	0.4
Isopropyl alcohol(2-Propanol)	1.5	0.03	41	15	5.4	8.7	4.2	39
Freon 113(1,1,2-Trichlorotrifluoroethan)	0.5	0.06	0.06	0.06	0.07	0.09	0.08	0.1
Acetone	3.0	0.08	13	23	16	7.8	23	16
Carbon disulfide	1.0	0.04	0.03	0.04	0.05	0.07	0.09	0.1
Methylene chloride	1.5	0.04	0.2	0.4	0.1	0.2	0.4	0.5
n-Hexane	0.5	0.03	0.2	1.4	0.2	0.2	0.3	0.5
2-Butanone(MEK)	1.5	0.07	0.4	2.2	2.8	0.8	4	1
cis-1,2-Dichloroethene	0.5	0.05				0.02		
Ethyl acetate	0.5	0.07	0.4	0.3				0.2
Chloroform	0.5	0.03		0.06				0.08
Tetrahydrofuran	0.5	0.07		0.4				
1,1,1-Trichloroethane	0.5	0.04						
Cyclohexane	0.5	0.04	0.1	0.7	0.1	0.1	0.2	0.4
Carbon tetrachloride	0.5	0.04	0.06	0.07	0.07	0.08	0.07	0.07
n-Heptane	0.5	0.04			0.6		0.2	0.4
Benzene	0.5	0.02	0.2	1.2	0.2	0.2	0.4	0.9
Trichloroethene	0.5	0.04	0.02	0.04		0.03	0.07	0.05
4-Methyl-2-pentanone(MIBK)	0.5	0.06	0.1	0.2	0.2	0.2	0.2	0.08
cis-1,3-Dichloropropene	0.5	0.04				0.02		0.02
Toluene	0.5	0.05	1.2	4.9	0.8	0.6	1.2	2.6
trans-1,3-Dichloropropene	0.5	0.04				0.02	0.02	
2-Hexanone(MBK)	1.5	0.05		0.1	0.3		0.4	
Tetrachloroethene	0.5	0.04	0.02	0.06		0.05	0.07	0.1
Dibromochloromethane	0.5	0.06					0.02	0.02
Chlorobenzene	0.5	0.04						0.03
Ethylbenzene	0.5	0.05	0.2	0.6	0.09	0.1	0.2	0.4
Xylene (para & meta)	1.0	0.10	0.4	1.9	0.2	0.3	0.4	1.1
Xylene (Ortho)	0.5	0.05	0.2	0.8	0.1	0.2	0.2	0.4
Styrene	0.5	0.05	0.1	0.9	0.07	0.08	0.09	0.9
1,1,2,2-Tetrachloroethane	0.5	0.08						0.04
4-Ethyltoluene	0.5	0.06	0.2	0.7	0.1	0.2	0.2	0.4
1,3,5-Trimethylbenzene	0.5	0.05	0.05	0.2	0.03	0.09	0.06	0.1
1,2,4-Trimethylbenzene	0.5	0.08	0.2	0.7	0.1	0.3	0.2	0.4
1,3-Dichlorobenzene	0.5	0.06				0.03	0.03	0.03
1,4-Dichlorobenzene	0.5	0.05	0.06	0.1	0.03	0.04	0.04	0.05
1,2-Dichlorobenzene	0.5	0.10	0.02			0.03	0.03	0.03
1,2,4-Trichlorobenzene	1.0	0.10				0.04	0.04	0.03
Hexachloro-1,3-butadiene	0.5	0.30	0.03			0.03	0.03	0.03

## Dominguez Elementary School - Room 9 (DZ-9) VOC data

SPECIATED ORGANIC COMPOUNDS	Reporting Limit (ppbv)	Method Detection limit (ppbv)	VOC concentration (ppbv)					
			12/8/08	12/9/08	12/10/08	12/11/08	12/12/08	12/15/08
Propylene	1.0	0.04			1.4	4.9	2.6	1.1
Freon 12 (Dichlorodifluoromethane)	0.5	0.04	0.5	0.6	0.5	0.7	0.4	0.4
Freon 114(1,2-Dichlorotetrafluoroethan)	0.5	0.03	0.03	0.03	0.03			
Chloromethane	0.5	0.08	0.5	0.5	0.4	0.5	0.4	0.5
Vinyl chloride	0.5	0.04						
Bromomethane	0.5	0.05						
Ethanol	1.5	0.30	68	30	110	68	21	110
Freon 11(Trichlorofluoromethane)	0.5	0.04	0.3	0.3		0.4	0.2	0.2
Isopropyl alcohol(2-Propanol)	1.5	0.03	4.9	43	53	6.2	36	20
Freon 113(1,1,2-Trichlorotrifluoroethan)	0.5	0.06	0.09	0.09	0.08	0.06	0.06	0.05
Acetone	3.0	0.08	14	15	15	25	17	12
Carbon disulfide	1.0	0.04	0.03	0.05	0.05	0.03		
Methylene chloride	1.5	0.04	0.3	0.6	0.2	0.8	0.6	0.2
n-Hexane	0.5	0.03	0.2	0.5	0.6	0.9	0.6	0.2
2-Butanone(MEK)	1.5	0.07	1.7	0.9	1.2	2	2.4	1.3
cis-1,2-Dichloroethene	0.5	0.05						
Ethyl acetate	0.5	0.07	0.1	0.3		0.3	0.2	
Chloroform	0.5	0.03	0.06	0.06		0.07		
Tetrahydrofuran	0.5	0.07		0.7				
1,1,1-Trichloroethane	0.5	0.04						
Cyclohexane	0.5	0.04	0.2	0.3	1.1	0.6	0.4	0.2
Carbon tetrachloride	0.5	0.04	0.08	0.08	0.07	0.06	0.06	0.05
n-Heptane	0.5	0.04		0.5	1.6	0.8	0.6	0.6
Benzene	0.5	0.02	0.3	0.8	0.4	1.1	0.6	0.3
Trichloroethene	0.5	0.04	0.02	0.04	0.02	0.06	0.02	0.02
4-Methyl-2-pentanone(MIBK)	0.5	0.06	0.08	0.1	0.3	0.1	0.1	0.2
cis-1,3-Dichloropropene	0.5	0.04						
Toluene	0.5	0.05	1	2.2	1.4	4.4	2.3	0.8
trans-1,3-Dichloropropene	0.5	0.04						
2-Hexanone(MBK)	1.5	0.05	0.1		0.2	0.1	0.4	0.2
Tetrachloroethene	0.5	0.04	0.03	0.08	0.04	0.1	0.09	0.03
Dibromochloromethane	0.5	0.06						
Chlorobenzene	0.5	0.04						
Ethylbenzene	0.5	0.05	0.1	0.3	0.2	0.6	0.3	0.1
Xylene (para & meta)	1.0	0.10	0.4	1	0.8	1.9	1.1	0.4
Xylene (Ortho)	0.5	0.05	0.2	0.4	0.2	0.7	0.4	0.2
Styrene	0.5	0.05	0.07	0.4	0.6	0.7	0.3	0.1
1,1,2,2-Tetrachloroethane	0.5	0.08						
4-Ethyltoluene	0.5	0.06	0.1	0.3	0.2	0.6	0.3	0.1
1,3,5-Trimethylbenzene	0.5	0.05	0.04	0.1	0.06	0.2	0.1	0.05
1,2,4-Trimethylbenzene	0.5	0.08	0.1	0.3	0.2	0.6	0.4	0.2
1,3-Dichlorobenzene	0.5	0.06	0.01	0.01				
1,4-Dichlorobenzene	0.5	0.05	0.02	0.02	0.02	0.04	0.03	0.02
1,2-Dichlorobenzene	0.5	0.10	0.01	0.01		0.02	0.01	
1,2,4-Trichlorobenzene	1.0	0.10	0.02	0.02	0.02	0.04	0.04	0.03
Hexachloro-1,3-butadiene	0.5	0.30		0.01	0.01	0.02		

## Dominguez Elementary School - Room 9 (DZ-9) VOC data

SPECIATED ORGANIC COMPOUNDS	Reporting Limit (ppbv)	Method Detection limit (ppbv)	VOC concentration (ppbv)			
			12/16/08	12/17/08	12/18/08	12/19/08
Propylene	1.0	0.04		0.4	1.7	2.6
Freon 12 (Dichlorodifluoromethane)	0.5	0.04		0.4	0.4	0.4
Freon 114(1,2-Dichlorotetrafluoroethan)	0.5	0.03		0.02		
Chloromethane	0.5	0.08	0.4	0.5	0.4	0.4
Vinyl chloride	0.5	0.04				
Bromomethane	0.5	0.05				
Ethanol	1.5	0.30	54	76	52	40
Freon 11(Trichlorofluoromethane)	0.5	0.04	0.2	0.2	0.2	0.2
Isopropyl alcohol(2-Propanol)	1.5	0.03	2.4	2.7	9.6	31
Freon 113(1,1,2-Trichlorotrifluoroethan)	0.5	0.06		0.05	0.05	0.05
Acetone	3.0	0.08	19	5.8	9.9	16
Carbon disulfide	1.0	0.04	0.02	0.01	0.02	0.03
Methylene chloride	1.5	0.04	0.4	0.1	0.1	0.3
n-Hexane	0.5	0.03	0.3	0.1	0.3	0.4
2-Butanone(MEK)	1.5	0.07	2	0.2	0.9	1
cis-1,2-Dichloroethene	0.5	0.05				
Ethyl acetate	0.5	0.07		0.5		
Chloroform	0.5	0.03				
Tetrahydrofuran	0.5	0.07				
1,1,1-Trichloroethane	0.5	0.04				
Cyclohexane	0.5	0.04	0.3	0.2	0.3	0.3
Carbon tetrachloride	0.5	0.04	0.05	0.06	0.05	0.05
n-Heptane	0.5	0.04	3.7	3.9	1.3	1.4
Benzene	0.5	0.02	0.6	0.1		0.6
Trichloroethene	0.5	0.04		0.02		0.02
4-Methyl-2-pentanone(MIBK)	0.5	0.06	0.1	0.05	0.1	0.06
cis-1,3-Dichloropropene	0.5	0.04				
Toluene	0.5	0.05	1.7	0.4	6.5	2
trans-1,3-Dichloropropene	0.5	0.04				
2-Hexanone(MBK)	1.5	0.05			0.3	
Tetrachloroethene	0.5	0.04	0.06	0.02		0.04
Dibromochloromethane	0.5	0.06				
Chlorobenzene	0.5	0.04				
Ethylbenzene	0.5	0.05	0.2	0.05	0.2	0.3
Xylene (para & meta)	1.0	0.10	0.8	0.2	0.6	1
Xylene (Ortho)	0.5	0.05	0.3	0.08	0.3	0.4
Styrene	0.5	0.05	0.25	0.03	0.06	0.8
1,1,2,2-Tetrachloroethane	0.5	0.08				
4-Ethyltoluene	0.5	0.06	0.3	0.06	0.2	0.3
1,3,5-Trimethylbenzene	0.5	0.05	0.09	0.02	0.3	0.09
1,2,4-Trimethylbenzene	0.5	0.08	0.2	0.07	0.2	0.3
1,3-Dichlorobenzene	0.5	0.06				
1,4-Dichlorobenzene	0.5	0.05	0.02	0.02	0.02	0.03
1,2-Dichlorobenzene	0.5	0.10				
1,2,4-Trichlorobenzene	1.0	0.10				0.02
Hexachloro-1,3-butadiene	0.5	0.30				

## Dominguez Elementary School - Room 9 (DZ-9) VOC data

TENTATIVELY IDENTIFIED COMPOUNDS	Reporting Limit (ppbv)	Method Detection limit (ppbv)	VOC concentration (ppbv)					
			11/18/08	11/19/08	11/20/08	11/21/08	11/24/08	11/25/08
4-Bromofluorobenzene	N/A	N/A	9.84	10.13	10.69	11.36	11.97	11.86
1,3-Dimethyl cyclohexane	N/A	N/A						
1,3-Pentadiene	N/A	N/A	1.4					
1,4-Pentadiene	N/A	N/A						1.4
1-Butanol	N/A	N/A			1.2			1.9
1-Dodecene	N/A	N/A						
1S-.alpha.-Pinene	N/A	N/A						1.5
2,2,3,3-Tetramethyl butane	N/A	N/A			2.1			
2,2,4,6,6-Pentamethyl heptane	N/A	N/A		9.4		5.3		13
2,2,4-Trimethyl pentane	N/A	N/A	2.3	2.1			1.2	
2,2-Dimethyl hexane	N/A	N/A				2.4		
2,3,3-Trimethyl pentane	N/A	N/A						
2,3-Dimethyl pentane	N/A	N/A	1.5		1.1			
2-Methyl butane	N/A	N/A	8.2	7.4	9	8.9	5.3	3.8
2-Methyl hexane	N/A	N/A	1.3	1.4				
2-Methyl pentane	N/A	N/A	3.5	3.3	3.6	3.7	2	1.5
2-Methyl-1,3-butadiene	N/A	N/A	1.6				1.5	
3-Methyl butanal	N/A	N/A						
3-Methyl hexane	N/A	N/A	1.5	1.5	1.3	1.5		
3-Methyl pentane	N/A	N/A	1.9	1.8	2.1	2		
Acetaldehyde	N/A	N/A			1.6		2.4	2.4
Benzaldehyde	N/A	N/A				1.9	2	3
Butanal	N/A	N/A						
Butane	N/A	N/A	5.9	6.1	8.3	6.7	4.3	3.1
Difluorochloromethane	N/A	N/A	26	3.6		19		
D-Limonene	N/A	N/A	1.1			1.7		1.9
Heptanal	N/A	N/A						
Hexamethyl cyclotrisiloxane	N/A	N/A						
Hexanal	N/A	N/A						
Isobutane	N/A	N/A	4.6	4	5.1	4.6	3.5	2.2
Methyl cyclohexane	N/A	N/A			1.1			
Methyl cyclopentane	N/A	N/A	1.6	1.6	1.9	1.7		
Nonanal	N/A	N/A					2	2
Ocatanal	N/A	N/A					2	
Octamethyl cyclotrisiloxane	N/A	N/A					10	16
Octane	N/A	N/A						
Pentane	N/A	N/A	3.6	4		4.1	3	
trans-1,4-Dimethyl cyclohexane	N/A	N/A						

## Dominguez Elementary School - Room 9 (DZ-9) VOC data

TENTATIVELY IDENTIFIED COMPOUNDS	Reporting Limit (ppbv)	Method Detection limit (ppbv)	VOC concentration (ppbv)					
			11/26/08	12/1/08	12/2/08	12/3/08	12/4/08	12/5/08
4-Bromofluorobenzene	N/A	N/A	11.53	9.44	9.66	8.08	9.07	8.76
1,3-Dimethyl cyclohexane	N/A	N/A						
1,3-Pentadiene	N/A	N/A						
1,4-Pentadiene	N/A	N/A						
1-Butanol	N/A	N/A						
1-Dodecene	N/A	N/A			1			
1S-.alpha.-Pinene	N/A	N/A						
2,2,3,3-Tetramethyl butane	N/A	N/A						1.3
2,2,4,6,6-Pentamethyl heptane	N/A	N/A	1.1					
2,2,4-Trimethyl pentane	N/A	N/A						
2,2-Dimethyl hexane	N/A	N/A						
2,3,3-Trimethyl pentane	N/A	N/A						
2,3-Dimethyl pentane	N/A	N/A						
2-Methyl butane	N/A	N/A	2	8.5	2.1	1.3	1.9	3.5
2-Methyl hexane	N/A	N/A						
2-Methyl pentane	N/A	N/A		3.1				1.9
2-Methyl-1,3-butadiene	N/A	N/A		1.6				
3-Methyl butanal	N/A	N/A			1		1.1	
3-Methyl hexane	N/A	N/A						
3-Methyl pentane	N/A	N/A		1.9				
Acetaldehyde	N/A	N/A		1.6	2.6	1.2	3	
Benzaldehyde	N/A	N/A		1.4				
Butanal	N/A	N/A			1.1		2	
Butane	N/A	N/A	1.6	8.1	2.9	1.7	1.8	2.6
Difluorochloromethane	N/A	N/A						
D-Limonene	N/A	N/A	2.2					
Heptanal	N/A	N/A			1.1			
Hexamethyl cyclotrisiloxane	N/A	N/A		2.5				
Hexanal	N/A	N/A			1			
Isobutane	N/A	N/A	1.6	5.5	2.1	7	1.4	2.1
Methyl cyclohexane	N/A	N/A						
Methyl cyclopentane	N/A	N/A		2				
Nonanal	N/A	N/A			1.6			
Ocatanal	N/A	N/A			1.3			
Octamethyl cyclotrisiloxane	N/A	N/A	1.3	3.4				
Octane	N/A	N/A						
Pentane	N/A	N/A		4.8				
trans-1,4-Dimethyl cyclohexane	N/A	N/A						

## Dominguez Elementary School - Room 9 (DZ-9) VOC data

TENTATIVELY IDENTIFIED COMPOUNDS	Reporting Limit (ppbv)	Method Detection limit (ppbv)	VOC concentration (ppbv)					
			12/8/08	12/9/08	12/10/08	12/11/08	12/12/08	12/15/08
4-Bromofluorobenzene	N/A	N/A	8.61	8.41	8.22	9.55	9.52	10.21
1,3-Dimethyl cyclohexane	N/A	N/A						
1,3-Pentadiene	N/A	N/A						
1,4-Pentadiene	N/A	N/A						
1-Butanol	N/A	N/A			1.9			
1-Dodecene	N/A	N/A						
1S-.alpha.-Pinene	N/A	N/A						
2,2,3,3-Tetramethyl butane	N/A	N/A		1		1.9	1.1	
2,2,4,6,6-Pentamethyl heptane	N/A	N/A						
2,2,4-Trimethyl pentane	N/A	N/A						
2,2-Dimethyl hexane	N/A	N/A						
2,3,3-Trimethyl pentane	N/A	N/A						
2,3-Dimethyl pentane	N/A	N/A				1.6		
2-Methyl butane	N/A	N/A	1.2	2.7	1.4	4.5	3.2	
2-Methyl hexane	N/A	N/A			1.6	1.2		
2-Methyl pentane	N/A	N/A		1.7		3.2		
2-Methyl-1,3-butadiene	N/A	N/A						
3-Methyl butanal	N/A	N/A						
3-Methyl hexane	N/A	N/A			2.4	1.4		
3-Methyl pentane	N/A	N/A				1.8	1.2	
Acetaldehyde	N/A	N/A						
Benzaldehyde	N/A	N/A						
Butanal	N/A	N/A					1.1	
Butane	N/A	N/A	1	2.1	1.2	3.5	2.3	
Difluorochloromethane	N/A	N/A						
D-Limonene	N/A	N/A					2.3	
Heptanal	N/A	N/A						
Hexamethyl cyclotrisiloxane	N/A	N/A						
Hexanal	N/A	N/A						
Isobutane	N/A	N/A		1.3		1.8	1.6	
Methyl cyclohexane	N/A	N/A						
Methyl cyclopentane	N/A	N/A				1.5	1.1	
Nonanal	N/A	N/A						
Ocatanal	N/A	N/A			1.3			
Octamethyl cyclotrisiloxane	N/A	N/A						
Octane	N/A	N/A						
Pentane	N/A	N/A						
trans-1,4-Dimethyl cyclohexane	N/A	N/A						

## Dominguez Elementary School - Room 9 (DZ-9) VOC data

TENTATIVELY IDENTIFIED COMPOUNDS	Reporting Limit (ppbv)	Method Detection limit (ppbv)	VOC concentration (ppbv)			
			12/16/08	12/17/08	12/18/08	12/19/08
4-Bromofluorobenzene	N/A	N/A	9.66	9.52	9.74	10.01
1,3-Dimethyl cyclohexane	N/A	N/A			1.8	
1,3-Pentadiene	N/A	N/A				
1,4-Pentadiene	N/A	N/A				
1-Butanol	N/A	N/A				
1-Dodecene	N/A	N/A				
1S-.alpha.-Pinene	N/A	N/A				
2,2,3,3-Tetramethyl butane	N/A	N/A				
2,2,4,6,6-Pentamethyl heptane	N/A	N/A				
2,2,4-Trimethyl pentane	N/A	N/A				
2,2-Dimethyl hexane	N/A	N/A				
2,3,3-Trimethyl pentane	N/A	N/A	1.2			
2,3-Dimethyl pentane	N/A	N/A	1.4	1.1		
2-Methyl butane	N/A	N/A	1.6		1.1	1.5
2-Methyl hexane	N/A	N/A	2.4	2.2		
2-Methyl pentane	N/A	N/A	1.1			1.2
2-Methyl-1,3-butadiene	N/A	N/A				
3-Methyl butanal	N/A	N/A				
3-Methyl hexane	N/A	N/A	5	5.1	1.3	1.5
3-Methyl pentane	N/A	N/A				
Acetaldehyde	N/A	N/A	1.1			
Benzaldehyde	N/A	N/A				
Butanal	N/A	N/A				
Butane	N/A	N/A	1.2		1	1.2
Difluorochloromethane	N/A	N/A				
D-Limonene	N/A	N/A				
Heptanal	N/A	N/A				
Hexamethyl cyclotrisiloxane	N/A	N/A				
Hexanal	N/A	N/A				
Isobutane	N/A	N/A				
Methyl cyclohexane	N/A	N/A				
Methyl cyclopentane	N/A	N/A				
Nonanal	N/A	N/A				
Ocatanal	N/A	N/A				
Octamethyl cyclotrisiloxane	N/A	N/A				
Octane	N/A	N/A			2.7	
Pentane	N/A	N/A				
trans-1,4-Dimethyl cyclohexane	N/A	N/A			1	

## Dominguez Elementary School - Room 11 (DZ-11) VOC data

SPECIATED ORGANIC COMPOUNDS	Reporting Limit (ppbv)	Method Detection limit (ppbv)	VOC concentration (ppbv)					
			11/18/08	11/19/08	11/20/08	11/21/08	11/24/08	11/25/08
Propylene	1.0	0.04		5.4	3.7	6	4.5	2.9
Freon 12 (Dichlorodifluoromethane)	0.5	0.04		0.7	0.5	0.7	0.6	0.6
Freon 114(1,2-Dichlorotetrafluoroethan)	0.5	0.03			0.01		0.01	0.01
Chloromethane	0.5	0.08	0.9	0.8	0.7	0.8	0.8	0.8
Vinyl chloride	0.5	0.04						
Bromomethane	0.5	0.05			0.04	0.03		0.02
Ethanol	1.5	0.30	530	150	180	170	270	200
Freon 11(Trichlorofluoromethane)	0.5	0.04			0.3			0.2
Isopropyl alcohol(2-Propanol)	1.5	0.03	70	22	15	12	11	16
Freon 113(1,1,2-Trichlorotrifluoroethan)	0.5	0.06		0.07	0.06	0.06	0.06	0.06
Acetone	3.0	0.08	34	30	20	28	29	21
Carbon disulfide	1.0	0.04	0.08	0.07	0.07	0.05	0.06	0.06
Methylene chloride	1.5	0.04	1.3	1	0.6	1.8	0.6	0.4
n-Hexane	0.5	0.03	1.3	1.1	1.9	1.5	0.6	0.4
2-Butanone(MEK)	1.5	0.07	2.4	2.8	1.8	2.4	2.5	1.9
Ethyl acetate	0.5	0.07	0.9	0.5	0.3	0.5	0.2	0.2
Chloroform	0.5	0.03	0.1	0.08	0.06	0.09	0.05	0.05
Tetrahydrofuran	0.5	0.07	0.7	0.6	0.1	0.5	0.3	0.2
Cyclohexane	0.5	0.04	1	0.7	2.2	9.6	0.5	0.3
Carbon tetrachloride	0.5	0.04	0.07	0.07	0.07	0.07	0.06	0.07
n-Heptane	0.5	0.04	3.6	0.7	1.7	1.1	0.6	
Benzene	0.5	0.02	1.5	1.2	1	1.6	0.8	0.6
Trichloroethene	0.5	0.04	0.07	0.07	0.03	0.07	0.02	0.05
Bromodichloromethane	0.5	0.04						
4-Methyl-2-pentanone(MIBK)	0.5	0.06	42	0.4	0.7	0.5	0.3	0.7
cis-1,3-Dichloropropene	0.5	0.04						
Toluene	0.5	0.05	6.8	4.9	3.3	9.6	3.2	2.4
trans-1,3-Dichloropropene	0.5	0.04						
1,1,2-Trichloroethane	0.5	0.06						
2-Hexanone(MBK)	1.5	0.05		0.2	0.1		0.4	0.2
Tetrachloroethene	0.5	0.04	0.3	0.2	0.08	0.3	0.1	0.09
Chlorobenzene	0.5	0.04						
Ethylbenzene	0.5	0.05	0.9	0.8	0.5	1.7	0.5	0.4
Xylene (para & meta)	1.0	0.10	3.1	2.3	1.7	5.7	1.7	1.2
Xylene (Ortho)	0.5	0.05	1.1	0.9	0.7	1.7	0.7	0.6
Styrene	0.5	0.05	1.5	0.6	0.4	0.7	1.3	0.4
Bromoform	0.5	0.05			0.01			
1,1,2,2-Tetrachloroethane	0.5	0.08						
4-Ethyltoluene	0.5	0.06	1.1	0.8	0.6	1.2	0.6	0.5
1,3,5-Trimethylbenzene	0.5	0.05	0.3	0.2		0.3	0.2	0.1
1,2,4-Trimethylbenzene	0.5	0.08	1.1	0.8	0.6	1.2	0.6	0.5
1,3-Dichlorobenzene	0.5	0.06						
1,4-Dichlorobenzene	0.5	0.05	0.2	0.1	0.09	0.2	0.1	0.08
1,2-Dichlorobenzene	0.5	0.10						
1,2,4-Trichlorobenzene	1.0	0.10						
Hexachloro-1,3-butadiene	0.5	0.30	0.02					

## Dominguez Elementary School - Room 11 (DZ-11) VOC data

SPECIATED ORGANIC COMPOUNDS	Reporting Limit (ppbv)	Method Detection limit (ppbv)	VOC concentration (ppbv)						
			11/26/08	12/1/08	12/2/08	12/3/08	12/4/08	12/5/08	
Propylene	1.0	0.04	1.2	4.4					2.7
Freon 12 (Dichlorodifluoromethane)	0.5	0.04	0.5	0.4	0.5	0.4	0.5		0.6
Freon 114(1,2-Dichlorotetrafluoroethan)	0.5	0.03	0.01	0.01	0.01	0.04	0.04		0.06
Chloromethane	0.5	0.08	0.8	0.6	0.6	0.9	0.6		0.6
Vinyl chloride	0.5	0.04				0.05			
Bromomethane	0.5	0.05		0.06		0.05			
Ethanol	1.5	0.30	260	100	310	210	63		41
Freon 11(Trichlorofluoromethane)	0.5	0.04	0.2	0.2	0.2	0.2	0.3		0.4
Isopropyl alcohol(2-Propanol)	1.5	0.03	160	52	32	13	4.4		5.4
Freon 113(1,1,2-Trichlorotrifluoroethan)	0.5	0.06	0.06	0.06	0.06	0.09	0.09		0.1
Acetone	3.0	0.08	26	28	14	17	13		22
Carbon disulfide	1.0	0.04	0.03	0.06		0.07	0.04		0.1
Methylene chloride	1.5	0.04	0.2	0.4	0.2	0.3	0.4		0.6
n-Hexane	0.5	0.03	0.2	1.5	0.3	0.3	0.3		0.6
2-Butanone(MEK)	1.5	0.07	2.1	3.9	1.4	2	1.2		1.6
Ethyl acetate	0.5	0.07	0.2	0.3		0.3	0.2		0.3
Chloroform	0.5	0.03	0.03	0.06		0.06			0.09
Tetrahydrofuran	0.5	0.07							
Cyclohexane	0.5	0.04		0.7		0.2	0.2		0.4
Carbon tetrachloride	0.5	0.04	0.06	0.07	0.07	0.08	0.07		0.07
n-Heptane	0.5	0.04	1.4	1.3			0.2		0.5
Benzene	0.5	0.02	0.2	1.2	0.2	0.4	0.4		0.9
Trichloroethene	0.5	0.04	0.02	0.03		0.04	0.06		0.05
Bromodichloromethane	0.5	0.04				0.03			
4-Methyl-2-pentanone(MIBK)	0.5	0.06	2	0.4	0.1	0.2	0.2		0.2
cis-1,3-Dichloropropene	0.5	0.04				0.02			
Toluene	0.5	0.05	1	4.6	0.8	0.9	1		2.7
trans-1,3-Dichloropropene	0.5	0.04				0.02			0.02
1,1,2-Trichloroethane	0.5	0.06					0.03		
2-Hexanone(MBK)	1.5	0.05	0.2	0.4	0.2	0.2	0.1		0.1
Tetrachloroethene	0.5	0.04	0.03	0.08		0.06	0.07		0.1
Chlorobenzene	0.5	0.04					0.03		0.04
Ethylbenzene	0.5	0.05	0.2	0.6	0.1	0.2	0.2		0.4
Xylene (para & meta)	1.0	0.10	0.5	2	0.3	0.4	0.4		1.2
Xylene (Ortho)	0.5	0.05	0.3	0.9	0.2	0.2	0.2		0.5
Styrene	0.5	0.05	0.1	0.8	0.1	0.1	0.1		0.9
Bromoform	0.5	0.05							
1,1,2,2-Tetrachloroethane	0.5	0.08					0.03		0.04
4-Ethyltoluene	0.5	0.06	0.2	0.7	0.2	0.1	0.2		0.5
1,3,5-Trimethylbenzene	0.5	0.05	0.05	0.2	0.04	0.06	0.06		0.2
1,2,4-Trimethylbenzene	0.5	0.08	0.2	0.8	0.2	0.1	0.2		0.5
1,3-Dichlorobenzene	0.5	0.06				0.03	0.03		0.03
1,4-Dichlorobenzene	0.5	0.05	0.05	0.1	0.03	0.04	0.04		0.06
1,2-Dichlorobenzene	0.5	0.10				0.03	0.03		0.04
1,2,4-Trichlorobenzene	1.0	0.10				0.05	0.03		0.05
Hexachloro-1,3-butadiene	0.5	0.30				0.04	0.03		0.04

## Dominguez Elementary School - Room 11 (DZ-11) VOC data

SPECIATED ORGANIC COMPOUNDS	Reporting Limit (ppbv)	Method Detection limit (ppbv)	VOC concentration (ppbv)					
			12/8/08	12/9/08	12/10/08	12/11/08	12/12/08	12/15/08
Propylene	1.0	0.04	1				4.7	0.7
Freon 12 (Dichlorodifluoromethane)	0.5	0.04	0.5	0.5	0.6	0.6	0.6	0.4
Freon 114(1,2-Dichlorotetrafluoroethan)	0.5	0.03	0.03	0.02				
Chloromethane	0.5	0.08	0.5	0.5	0.4	0.6	0.5	0.5
Vinyl chloride	0.5	0.04						
Bromomethane	0.5	0.05						
Ethanol	1.5	0.30	18	42	6.4	60	23	99
Freon 11(Trichlorofluoromethane)	0.5	0.04	0.2	0.2	0.2	0.2	0.4	0.2
Isopropyl alcohol(2-Propanol)	1.5	0.03	35	8.4	4.2	7.9	3.2	13
Freon 113(1,1,2-Trichlorotrifluoroethan)	0.5	0.06	0.04	0.04			0.06	0.03
Acetone	3.0	0.08	14	15	5.9	19	19	15
Carbon disulfide	1.0	0.04	0.03	0.06	0.04	0.02	0.02	
Methylene chloride	1.5	0.04	0.2	0.5	0.2	0.5	0.8	0.3
n-Hexane	0.5	0.03	0.05	0.1	0.07	0.2	0.8	0.1
2-Butanone(MEK)	1.5	0.07	0.8	0.7	0.3	1.4	1.3	
Ethyl acetate	0.5	0.07					0.2	
Chloroform	0.5	0.03						
Tetrahydrofuran	0.5	0.07						
Cyclohexane	0.5	0.04	0.04	0.08		0.2	0.5	0.2
Carbon tetrachloride	0.5	0.04	0.03	0.03			0.06	
n-Heptane	0.5	0.04			0.1	0.2	0.6	
Benzene	0.5	0.02	0.07	0.2	0.2	0.1	1.1	0.06
Trichloroethene	0.5	0.04		0.02			0.06	
Bromodichloromethane	0.5	0.04						
4-Methyl-2-pentanone(MIBK)	0.5	0.06	0.04	0.09				2.9
cis-1,3-Dichloropropene	0.5	0.04						2.9
Toluene	0.5	0.05	0.1	0.4	0.5	0.5	3.8	
trans-1,3-Dichloropropene	0.5	0.04						
1,1,2-Trichloroethane	0.5	0.06						
2-Hexanone(MBK)	1.5	0.05		0.1		0.2		
Tetrachloroethene	0.5	0.04	0.01	0.03	0.02	0.02	0.1	
Chlorobenzene	0.5	0.04	0.01					
Ethylbenzene	0.5	0.05	0.03	0.07	0.07	0.08	0.6	0.03
Xylene (para & meta)	1.0	0.10	0.08	0.2	0.2	0.2	1.7	0.08
Xylene (Ortho)	0.5	0.05	0.04	0.1	0.1	0.1	0.6	0.03
Styrene	0.5	0.05	0.02	0.06	0.2	0.06	0.7	0.02
Bromoform	0.5	0.05						
1,1,2,2-Tetrachloroethane	0.5	0.08		0.03				
4-Ethyltoluene	0.5	0.06	0.04	0.07	0.1	0.08	0.5	0.03
1,3,5-Trimethylbenzene	0.5	0.05	0.02	0.03	0.05	0.03	0.1	0.01
1,2,4-Trimethylbenzene	0.5	0.08	0.04	0.08	0.2	0.08	0.5	0.04
1,3-Dichlorobenzene	0.5	0.06	0.01	0.01				
1,4-Dichlorobenzene	0.5	0.05	0.01	0.02	0.01	0.01	0.04	0.01
1,2-Dichlorobenzene	0.5	0.10						
1,2,4-Trichlorobenzene	1.0	0.10	0.02	0.02	0.02	0.02		0.02
Hexachloro-1,3-butadiene	0.5	0.30	0.01					

## Dominguez Elementary School - Room 11 (DZ-11) VOC data

SPECIATED ORGANIC COMPOUNDS	Reporting Limit (ppbv)	Method Detection limit (ppbv)	VOC concentration (ppbv)			
			12/16/08	12/17/08	12/18/08	12/19/08
Propylene	1.0	0.04			1.1	1.8
Freon 12 (Dichlorodifluoromethane)	0.5	0.04	0.4	0.4	0.4	0.4
Freon 114(1,2-Dichlorotetrafluoroethan)	0.5	0.03	0.02			
Chloromethane	0.5	0.08	0.5	0.6	0.5	0.5
Vinyl chloride	0.5	0.04				
Bromomethane	0.5	0.05				
Ethanol	1.5	0.30	110	150	58	32
Freon 11(Trichlorofluoromethane)	0.5	0.04	0.2	0.2	0.2	0.1
Isopropyl alcohol(2-Propanol)	1.5	0.03	18	20	10	5.4
Freon 113(1,1,2-Trichlorotrifluoroethan)	0.5	0.06			0.02	
Acetone	3.0	0.08	14	17	19	15
Carbon disulfide	1.0	0.04	0.04	0.01	0.03	
Methylene chloride	1.5	0.04	0.4	0.2	0.2	0.3
n-Hexane	0.5	0.03	0.1			0.05
2-Butanone(MEK)	1.5	0.07	0.3	0.6	1	
Ethyl acetate	0.5	0.07		0.2		
Chloroform	0.5	0.03				
Tetrahydrofuran	0.5	0.07				
Cyclohexane	0.5	0.04	0.1		0.05	
Carbon tetrachloride	0.5	0.04	0.03	0.02	0.02	
n-Heptane	0.5	0.04				
Benzene	0.5	0.02	0.2	0.03	0.05	0.09
Trichloroethene	0.5	0.04	0.02			
Bromodichloromethane	0.5	0.04				
4-Methyl-2-pentanone(MIBK)	0.5	0.06	6.6	3.5	0.2	0.8
cis-1,3-Dichloropropene	0.5	0.04				
Toluene	0.5	0.05	0.6	0.07	0.3	0.2
trans-1,3-Dichloropropene	0.5	0.04				
1,1,2-Trichloroethane	0.5	0.06				
2-Hexanone(MBK)	1.5	0.05		0.08	0.2	
Tetrachloroethene	0.5	0.04	0.03			
Chlorobenzene	0.5	0.04				
Ethylbenzene	0.5	0.05	0.1	0.02	0.03	0.05
Xylene (para & meta)	1.0	0.10	0.4	0.05	0.07	0.2
Xylene (Ortho)	0.5	0.05	0.2		0.04	0.06
Styrene	0.5	0.05	0.06			0.05
Bromoform	0.5	0.05				
1,1,2,2-Tetrachloroethane	0.5	0.08				
4-Ethyltoluene	0.5	0.06	0.2	0.02	0.03	0.05
1,3,5-Trimethylbenzene	0.5	0.05			0.01	0.02
1,2,4-Trimethylbenzene	0.5	0.08	0.2	0.02	0.03	0.05
1,3-Dichlorobenzene	0.5	0.06	0.01			
1,4-Dichlorobenzene	0.5	0.05	0.03			
1,2-Dichlorobenzene	0.5	0.10	0.01			
1,2,4-Trichlorobenzene	1.0	0.10	0.05			
Hexachloro-1,3-butadiene	0.5	0.30				

## Dominguez Elementary School - Room 11 (DZ-11) VOC data

TENTATIVELY IDENTIFIED COMPOUNDS	Reporting Limit (ppbv)	Method Detection limit (ppbv)	VOC concentration (ppbv)						
			11/18/08	11/19/08	11/20/08	11/21/08	11/24/08	11/25/08	
1,1-Difluoroethane	N/A	N/A							
1-Butanol	N/A	N/A							1.7
1-Dodecene	N/A	N/A							
2,2,3,3-Tetramethyl butane	N/A	N/A			2.1				
2,2,4,6,6-Pentamethyl heptane	N/A	N/A						1.2	
2,2,4-Trimethyl pentane	N/A	N/A	2.8						
2,2-Dimethyl hexane	N/A	N/A		2.1			3		
2,3-Dimethyl pentane	N/A	N/A	1.8	1.3	1.3	1.8			
2-Methyl butane	N/A	N/A	9.2	7.7	8.2	11		4.7	3.8
2-Methyl hexane	N/A	N/A	1.5		1.6	1.4			
2-Methyl pentane	N/A	N/A	4.1	3.2	3.6	4.6		2	1.4
2-Methyl-1,3-butadiene	N/A	N/A	2.6	1.8	1.3	1.7		1.4	1.1
3-Methyl butanal	N/A	N/A							
3-Methyl butane	N/A	N/A							
3-Methyl hexane	N/A	N/A	1.9		1.7	1.8		1.1	
3-Methyl pentane	N/A	N/A	2.1	1.8	2.2	2.5		1.1	
3-Methyl-1,2-butadiene	N/A	N/A							
Acetaldehyde	N/A	N/A	1.3	1.7	1.5			1.9	2.1
Benzaldehyde	N/A	N/A		1.4	1	1.5		1.8	1.6
Butanal	N/A	N/A							
Butane	N/A	N/A	6.4	6.4	7.5	7.9		3.9	3.1
Butyl ester acetic acid	N/A	N/A	8.8						
Difluorochloromethane	N/A	N/A	12						
D-Limonene	N/A	N/A					1.4		
Heptanal	N/A	N/A							
Hexamethyl cyclotrisiloxane	N/A	N/A						3.5	
Hexanal	N/A	N/A							
Isobutane	N/A	N/A	4.6	4.9	4.5	4.7		2.9	2.3
Methyl cyclohexane	N/A	N/A			1.2				
Methyl cyclopentane	N/A	N/A	1.8	1.4	2.3	2			
Naphthalene	N/A	N/A							
Nonanal	N/A	N/A							1.4
Ocatanal	N/A	N/A						1.1	1.3
Octamethyl cyclotrisiloxane	N/A	N/A						5.7	5.3
Pentanal	N/A	N/A							
Pentane	N/A	N/A	4.1	3.7		4.9		2.5	

## Dominguez Elementary School - Room 11 (DZ-11) VOC data

TENTATIVELY IDENTIFIED COMPOUNDS	Reporting Limit (ppbv)	Method Detection limit (ppbv)	VOC concentration (ppbv)						
			11/26/08	12/1/08	12/2/08	12/3/08	12/4/08	12/5/08	
1,1-Difluoroethane	N/A	N/A							
1-Butanol	N/A	N/A							
1-Dodecene	N/A	N/A			1				
2,2,3,3-Tetramethyl butane	N/A	N/A		1.6					
2,2,4,6,6-Pentamethyl heptane	N/A	N/A							
2,2,4-Trimethyl pentane	N/A	N/A							1.3
2,2-Dimethyl hexane	N/A	N/A							
2,3-Dimethyl pentane	N/A	N/A							
2-Methyl butane	N/A	N/A	2.1	8.7	2.2	2.1	2		3.9
2-Methyl hexane	N/A	N/A							
2-Methyl pentane	N/A	N/A		3.3					2
2-Methyl-1,3-butadiene	N/A	N/A	1.2						
3-Methyl butanal	N/A	N/A						1.1	
3-Methyl butane	N/A	N/A							1
3-Methyl hexane	N/A	N/A							
3-Methyl pentane	N/A	N/A			2.1				
3-Methyl-1,2-butadiene	N/A	N/A							1.2
Acetaldehyde	N/A	N/A	2.8	2.7	2.1	2.7			
Benzaldehyde	N/A	N/A	1.8	1.6					
Butanal	N/A	N/A			1.6	1.1			
Butane	N/A	N/A	2	8.5	2.6	2.5	1.8		2.9
Butyl ester acetic acid	N/A	N/A							
Difluorochloromethane	N/A	N/A							
D-Limonene	N/A	N/A						2.5	8
Heptanal	N/A	N/A			2.4				
Hexamethyl cyclotrisiloxane	N/A	N/A	3.3		1.2				
Hexanal	N/A	N/A			1.8				
Isobutane	N/A	N/A		5.6	2.3	1.8	1.3		2.6
Methyl cyclohexane	N/A	N/A							
Methyl cyclopentane	N/A	N/A		2.1					
Naphthalene	N/A	N/A							
Nonanal	N/A	N/A		1.7	1.7				
Ocatanal	N/A	N/A		1.6	1.8				
Octamethyl cyclotrisiloxane	N/A	N/A	6.9						
Pentanal	N/A	N/A			1.5				
Pentane	N/A	N/A							

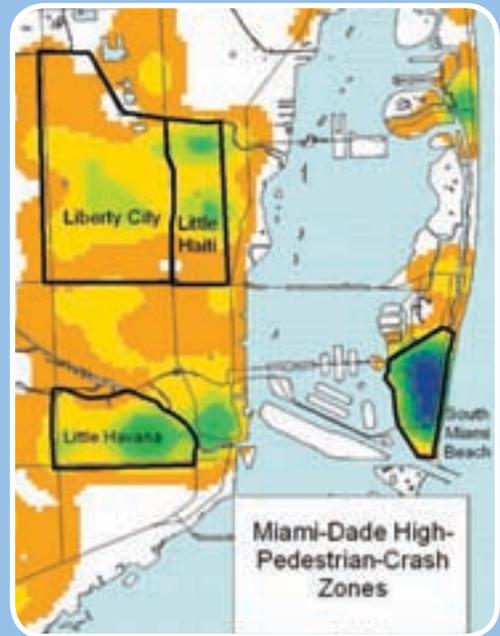
## Dominguez Elementary School - Room 11 (DZ-11) VOC data

TENTATIVELY IDENTIFIED COMPOUNDS	Reporting Limit (ppbv)	Method Detection limit (ppbv)	VOC concentration (ppbv)						
			12/8/08	12/9/08	12/10/08	12/11/08	12/12/08	12/15/08	
1,1-Difluoroethane	N/A	N/A				2.6			
1-Butanol	N/A	N/A							
1-Dodecene	N/A	N/A							
2,2,3,3-Tetramethyl butane	N/A	N/A							
2,2,4,6,6-Pentamethyl heptane	N/A	N/A							
2,2,4-Trimethyl pentane	N/A	N/A							
2,2-Dimethyl hexane	N/A	N/A							
2,3-Dimethyl pentane	N/A	N/A							
2-Methyl butane	N/A	N/A							
2-Methyl hexane	N/A	N/A							
2-Methyl pentane	N/A	N/A							
2-Methyl-1,3-butadiene	N/A	N/A							
3-Methyl butanal	N/A	N/A							
3-Methyl butane	N/A	N/A							
3-Methyl hexane	N/A	N/A							
3-Methyl pentane	N/A	N/A							
3-Methyl-1,2-butadiene	N/A	N/A							
Acetaldehyde	N/A	N/A							
Benzaldehyde	N/A	N/A							
Butanal	N/A	N/A							
Butane	N/A	N/A	1.3	2.1				3.4	1.1
Butyl ester acetic acid	N/A	N/A							
Difluorochloromethane	N/A	N/A							
D-Limonene	N/A	N/A							2.3
Heptanal	N/A	N/A							
Hexamethyl cyclotrisiloxane	N/A	N/A							
Hexanal	N/A	N/A							
Isobutane	N/A	N/A							
Methyl cyclohexane	N/A	N/A							
Methyl cyclopentane	N/A	N/A							
Naphthalene	N/A	N/A							
Nonanal	N/A	N/A							
Ocatanal	N/A	N/A							
Octamethyl cyclotrisiloxane	N/A	N/A							
Pentanal	N/A	N/A							
Pentane	N/A	N/A							

## Dominguez Elementary School - Room 11 (DZ-11) VOC data

TENTATIVELY IDENTIFIED COMPOUNDS	Reporting Limit (ppbv)	Method Detection limit (ppbv)	VOC concentration (ppbv)			
			12/16/08	12/17/08	12/18/08	12/19/08
1,1-Difluoroethane	N/A	N/A				
1-Butanol	N/A	N/A				
1-Dodecene	N/A	N/A				
2,2,3,3-Tetramethyl butane	N/A	N/A	1.1			
2,2,4,6,6-Pentamethyl heptane	N/A	N/A				
2,2,4-Trimethyl pentane	N/A	N/A				
2,2-Dimethyl hexane	N/A	N/A				
2,3-Dimethyl pentane	N/A	N/A				
2-Methyl butane	N/A	N/A				
2-Methyl hexane	N/A	N/A				
2-Methyl pentane	N/A	N/A				
2-Methyl-1,3-butadiene	N/A	N/A				
3-Methyl butanal	N/A	N/A				
3-Methyl butane	N/A	N/A				
3-Methyl hexane	N/A	N/A				
3-Methyl pentane	N/A	N/A				
3-Methyl-1,2-butadiene	N/A	N/A				
Acetaldehyde	N/A	N/A				
Benzaldehyde	N/A	N/A				
Butanal	N/A	N/A				
Butane	N/A	N/A	1.1			
Butyl ester acetic acid	N/A	N/A	1.6			
Difluorochloromethane	N/A	N/A				
D-Limonene	N/A	N/A				
Heptanal	N/A	N/A				
Hexamethyl cyclotrisiloxane	N/A	N/A				
Hexanal	N/A	N/A				
Isobutane	N/A	N/A	1.4			
Methyl cyclohexane	N/A	N/A				
Methyl cyclopentane	N/A	N/A				
Naphthalene	N/A	N/A	1.2			
Nonanal	N/A	N/A				
Ocatanal	N/A	N/A				
Octamethyl cyclotrisiloxane	N/A	N/A				
Pentanal	N/A	N/A				
Pentane	N/A	N/A				

# How to Develop a Pedestrian Safety Action Plan



Pedestrian and Bicycle  
Information Center

FHWA-SA-05-12

Revised March 2009



# How to Develop a Pedestrian Safety Action Plan

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## FINAL REPORT

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## Introduction

The purpose of this guide on “How to Develop a Pedestrian Safety Action Plan” is to present an overview and framework for state and local agencies to develop and implement a Pedestrian Safety Action Plan tailored to their specific problems and needs. A Pedestrian Safety Action Plan is a plan developed by community stakeholders that is intended to improve pedestrian safety in the community. An objective of the guide is to help state and local officials know where to begin to address pedestrian safety issues. It is also intended to assist agencies in further enhancing their existing pedestrian safety programs and activities, including identifying safety problems and selecting optimal solutions. This guide is primarily a reference for improving pedestrian safety through street redesign and the use of engineering countermeasures as well as other safety-related treatments and programs that involve the whole community. This guide can be used by engineers, planners, traffic safety and enforcement professionals, public health and injury prevention professionals, and decision-makers who have the responsibility of improving pedestrian safety at the state or local level.

### Pedestrian Safety Problem Background

Pedestrian crashes and the resulting deaths and injuries are a serious problem on our roadways. In 2004, 4,641 pedestrians were killed in traffic crashes, representing 12 percent of all roadway-related fatalities (National Highway Traffic Safety Administration, 2004). In urban areas, pedestrian deaths typically represent 25 to 40 percent of traffic fatalities. Approximately 70,000 pedestrians were injured on roadways in 2004, and many of these were severe injuries. While reducing pedestrian crashes has recently gained increasing priority among some state and local agencies as well as the U.S. Department of Transportation (DOT), more efforts and programs are needed to develop and implement effective strategies to reduce pedestrian-related injuries and deaths.

The safety literature reveals a variety of risk factors that influence pedestrian crashes and severity. For example, pedestrian crash risk increases on wide roads (four lanes or more) with high motor vehicle speeds and/or volumes. Intersections are more dif-

.....

“ *In a society that values choice and freedom, people should be able to walk safely, whether for fun and recreation, errands, getting to work or school, shopping, or other reasons.* ”

.....

For more crash statistics, see NHTSA's Traffic Safety Facts: 2004 Data, available at <http://www-nrd.nhtsa.dot.gov/pdf/nrd-30/ncsa/TSF2004/809913.pdf>

difficult to cross when pedestrians encounter wide crossing distances, wide turning radii, multiple turn lanes, or traffic control that is confusing or complex. Other high-risk factors include drug/alcohol use by motorists and pedestrians, lack of nighttime roadway lighting, and the lack of walkways along roads. Older pedestrians are much more susceptible to serious or fatal injuries because of their frailty, while young children (particularly males aged 5 to 9) are more likely to be struck by a motor vehicle after darting into the street (Campbell, 2004).

Many pedestrian crashes are the result of unsafe motor vehicle driver and pedestrian behaviors. Certain roadway design features can contribute to unsafe behaviors by pedestrians and motorists. For example, excessively-wide streets encourage higher motorist speeds. High-volume multilane roads with a lack of safe crossings at regular intervals can contribute to pedestrians crossing streets at unsafe locations, particularly those who cannot or will not walk great distances to signalized locations. Land use decisions can also result in areas that are unsafe for pedestrians. For example, separating residential areas from shopping areas with high-volume multilane roads forces some pedestrians to cross streets in places that may not be safe. These types of issues must also be addressed in long-term solutions for pedestrian safety.



**Walking is a basic human activity, and pedestrians are the lifeblood of many urban areas.**

The American Association of State Highway and Transportation Officials' (AASHTO, also called the Green Book) *A Policy on Geometric Design of Highways and Streets* states:

*"Pedestrians are a part of every roadway environment, and attention should be paid to their presence in rural as well as urban areas... pedestrians are the lifeblood of our urban areas, especially in the downtown and other retail areas"* (AASHTO, 2001).

The National Cooperative Highway Research Program (NCHRP) Report 500, Volume 10, *A Guide for Reducing Collisions Involving Pedestrians*, states:

*"Walking is a basic human activity, and almost everyone is a pedestrian at one time or another... Even though pedestrians are legitimate roadway users, they are frequently overlooked in the quest to build more sophisticated transportation systems. Whether building new infrastructure or renovating existing facilities, it should be assumed that people will walk, and plans should be made to accommodate pedestrians. Where people aren't walking, it is often because they are prevented or discouraged from doing so"* (Zegeer, Stutts, et al., 2004).

Unfortunately, many of our nation's streets and highways were primarily built to facilitate the smooth flow of motor vehicles. Yet, walking is the fundamental mode of human mobility; everyone is a pedestrian at some point in every journey that they take. This includes walking to a bus or walking to a parking lot. It includes people of all ages from children to older adults as well as pedestrians with visual and mobility impairments.

It is important to recognize that although many people choose to walk instead of drive as their only or primary mode of transportation, many others do not have the choice of driving. According to 2000 Census figures, nearly 15 percent of U.S. households do not own a vehicle. Also, 25 to 30 percent of U.S. citizens do not have a valid driver's license. This includes children under age 16, as well as many older and physically-impaired adults. This portion of our population should not be prevented from safe and reasonable opportunities to walk.

In a society that values choice and freedom, people should be able to walk safely, whether for fun and recreation, errands, getting to work or school, shopping, or other reasons. Many Americans want to be able to walk more if given the opportunity to do so. Yet, many street environments are often inhospitable and unsafe for walking.

Pedestrian safety and mobility must be elevated to a top priority for the situation to improve substantially. The engineers, planners, and other public officials in state and local agencies can leave an important legacy of improved walking conditions and fewer pedestrian crashes and injuries for future generations.

There are several objectives that transportation professionals should address to improve pedestrian safety and mobility (adapted from *A Guide for Reducing Collisions Involving Pedestrians*):

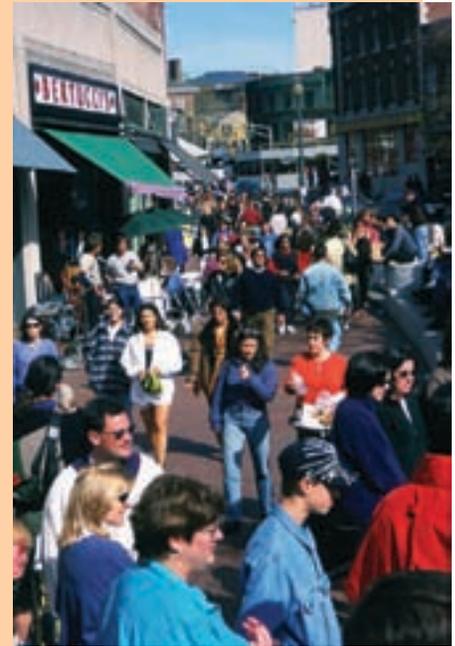
- Reduce the speed of motor vehicles.
- Reduce pedestrian risks at street crossing locations.
- Provide sidewalks and walkways separate from motor vehicle traffic.
- Improve awareness of and visibility between motor vehicles and pedestrians.
- Improve pedestrian and motorist behaviors.

A variety of strategies are available to improve pedestrian safety. A comprehensive approach involving the “three E’s” (Engineering, Education, and Enforcement), as well as making pedestrian-conscious land use decisions, is recommended. Engineers, educators, planners, and enforcement officials all play a role in helping to identify and implement effective safety improvements

## Guide Contents

This guide contains the following chapters:

- Chapter 1: Planning and Designing for Pedestrian Safety—The Big Picture.
- Chapter 2: Involving Stakeholders.
- Chapter 3: Collecting Data to Identify Pedestrian Safety Problems.
- Chapter 4: Analyzing Information and Prioritizing Concerns.
- Chapter 5: Selecting Safety Solutions.



Many Americans want to be given the opportunity to walk more, whether for fun and recreation, errands, shopping, or other reasons.

- Chapter 6: Providing Funding.
- Chapter 7: Creating the Pedestrian Safety Action Plan.

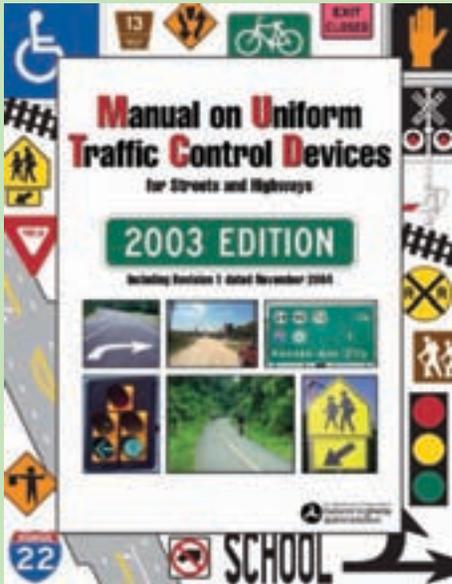
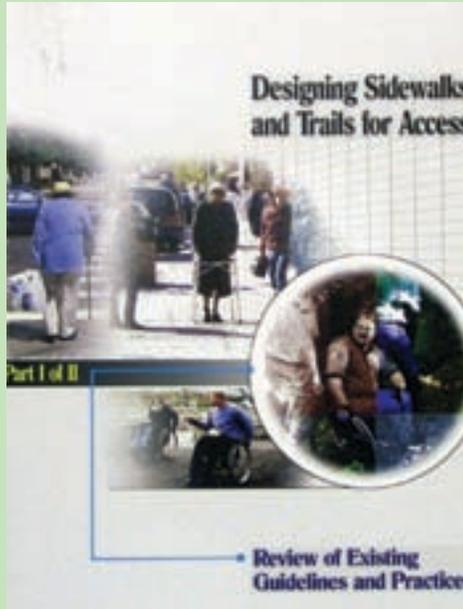
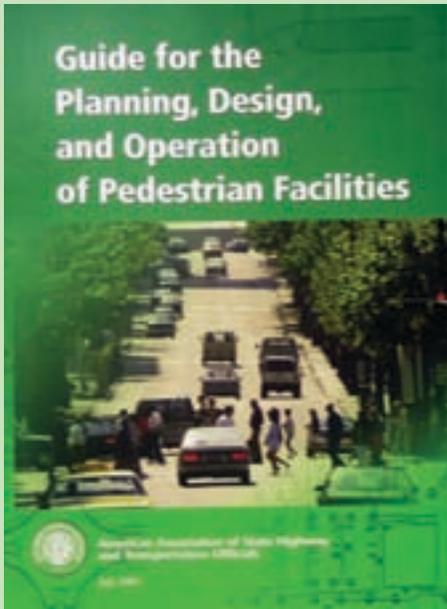
Chapter 7 provides the framework that state and local agencies can use to develop a customized Pedestrian Safety Action Plan. The concepts, principles, and information contained in this guide are based on national guidelines, including (among others):

- AASHTO
  - *Guide for the Planning, Design, and Operation of Pedestrian Facilities.*
- Federal Highway Administration (FHWA)
  - *Manual on Uniform Traffic Control Devices.*
  - *PEDSAFE: Pedestrian Safety Guide and Countermeasure Selection System.*
- Institute of Transportation Engineers (ITE)
  - *Traffic Control Devices Handbook.*
  - *Design and Safety of Pedestrian Facilities.*
- NCHRP
  - Report 500, Vol. 10, *A Guide for Reducing Collisions Involving Pedestrians*.

Pedestrian plans and design guidelines from local and state transportation agencies throughout the U.S. are referenced throughout this guide. Most of the facility recommendations and design principles given here are based on the latest pedestrian safety research, particularly FHWA and NCHRP research. This guide provides a framework for 1) reviewing pedestrian problem sites, roadway segments, and other targeted areas in an organized manner and 2) selecting and implementing appropriate safety measures.

## National Guidelines and Resources

### Design Guidelines



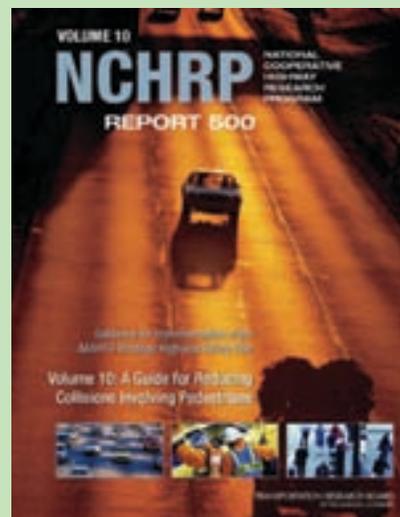
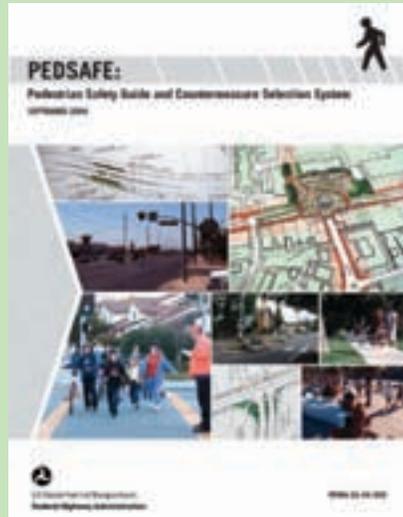
For descriptions of these documents and links to additional resources, see Appendix F.



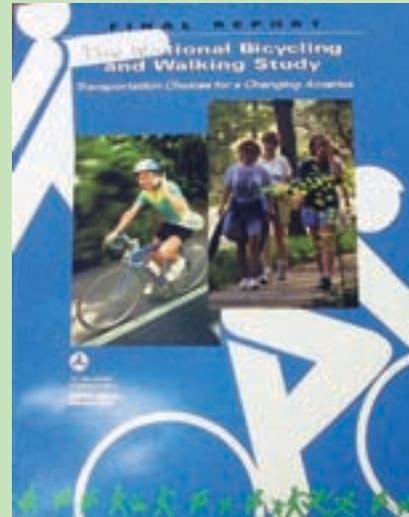
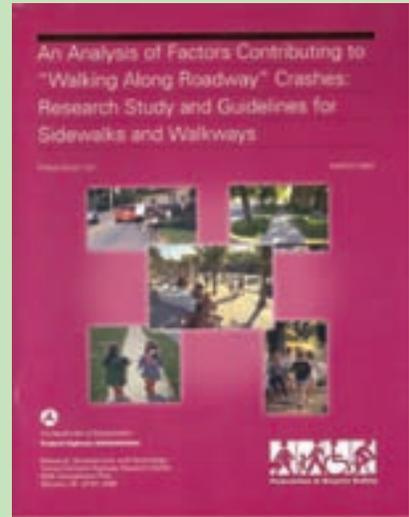
For descriptions of these documents and links to additional resources, see Appendix F.

## National Guidelines and Resources

### Countermeasure Selection Tools



### Research and Policy Tools





# Chapter 1: Planning and Designing for Pedestrian Safety— The Big Picture

The automobile has irrefutably altered the way in which transportation systems and the built environment are designed and constructed, often at the expense of pedestrians. In the majority of crashes between pedestrians and motor vehicles, the pedestrian is trying to navigate in an environment designed primarily for automobile use. This chapter explains how some common roadway design practices can have negative impacts on pedestrian travel and safety as well as the policies that have led to these design practices. It also discusses other major factors that affect pedestrian safety such as street connectivity, site design, land use, and access management. Next, it suggests changes that can lead to improvements in the pedestrian environment. Finally, it discusses the need to institutionalize these changes by reviewing, amending, and adopting policies and design guidelines to better accommodate pedestrian travel. It is important to be proactive as well as responsive to pedestrian safety problems. This chapter reflects the need to develop a Pedestrian Safety Action Plan both as a response to current design issues and as an effort to integrate pedestrians into the design process from the beginning to ensure the quality of future developments.

## Understanding Pedestrian Characteristics

Good pedestrian safety planning must include an understanding of the characteristics of pedestrians. With an understanding of pedestrian needs and characteristics, those involved in pedestrian safety planning can more effectively understand how new and existing facilities must operate, as well as how pedestrians will act when faced with certain conditions. Applying a practical understanding of pedestrian characteristics will provide insights when considering appropriate safety solutions and will particularly help ensure that facilities are inviting to pedestrians.

Important characteristics include understanding why and where pedestrians walk, what types of design features create a safer pedestrian environment, and what types of behavioral decisions pedestrians are likely to make. In addition, pedestrians also consist of specific populations with different characteristics, including children (who may be impulsive or unpredictable), persons with mobility impairments (who may require specific visibility devices or facility features), and senior citizens (who may require additional time for roadway crossings).

“*In the majority of crashes between pedestrians and motor vehicles, the pedestrian is trying to navigate in an environment designed primarily for automobile use.*”

The AASHTO *Guide for the Planning, Design, and Operation of Pedestrian Facilities* (2004) includes a comprehensive discussion of pedestrian characteristics and needs.

## Transportation Design and Policy Elements that Impact Pedestrian Safety

Several design practices and policies conceived to improve motor vehicle mobility are now recognized as barriers to a safe pedestrian environment. There are many factors that affect the safety and mobility of the pedestrian transportation network. The major planning, design, and policy elements that impact pedestrian safety include:



1. Street design.
2. Street connectivity.
3. Site design.
4. Land use.
5. Access management.

Because this guide includes a large section on improving pedestrian safety through street redesign and engineering-related crash countermeasures, it provides a more detailed focus on the street design elements and those policies influencing street design choices. The interrelated subjects of street connectivity, site design, land use, and access management—while major components of a well-built environment—will be discussed briefly within the context of providing safer pedestrian environments.

### Street Design

The traditional street system is based on a simple hierarchy: most trips originate on local streets; travelers are then ferried via collector streets to arterials, which are intended

Many arterial streets are designed to accommodate large volumes of fast moving vehicles, often a risk to pedestrian safety.

to carry large amounts of motor vehicle traffic long distances at higher speeds. This system is based on the assumption that most trips occur by motor vehicle, so most of the facilities are designed primarily for motor vehicle travel. The system results in street designs that do not serve pedestrians well for several reasons:

1. **They lack pedestrian facilities:** Some collector and arterial streets are built with inadequate or no sidewalks or walkways, discouraging or limiting safe pedestrian movement along streets. Continuous lighting may not exist to provide adequate nighttime pedestrian conditions.
2. **They are wide or have multiple lanes that are difficult to cross:** Since arterial roads are designed to facilitate smooth and efficient motor vehicle flow, they often have multiple lanes in each direction to accommodate high motor vehicle traffic volumes and also multiple turn lanes. The number of lanes a pedestrian must cross has a direct effect on the complexity of the crossing task and the pedestrian crash risk. The pedestrian must find an adequate gap in motor vehicle traffic, a task that increases exponentially with the number of lanes.

3. **They have high speeds:** Wide streets encourage and allow higher vehicle speeds, which relate directly to more severe injuries (to motorists and pedestrians) when a crash occurs; the majority of pedestrian crashes and most fatalities occur on higher speed arterials.
4. **They have complex intersections:** Typically, wide arterial streets have intersections that are even wider due to the addition of multiple turn lanes. They also often have large turning radii to allow larger vehicles, such as trucks and buses, to make turns easily and quickly. This requires pedestrians to cross longer distances and watch for more cars in more lanes, an often challenging and dangerous task. Skewed intersection designs and high vehicle right- and left-turn volumes at an intersection can also add complexity to the crossing task. Left turn arrows can also be confusing to pedestrians.
5. **They create long delays for pedestrians at intersections:** Wide intersections and those with multiple turn lanes create a long wait for pedestrians. At times, crossing prohibitions may be designated for one or more crosswalks to facilitate turning movements. If a crosswalk is closed, the pedestrian is left with three choices: cross illegally with no signal protection, walk a long distance around the intersection, or walk to another location to cross.
6. **They provide little “friction” to protect pedestrians:** Much of the traffic engineering philosophy of the last few decades has been aimed at stripping roads of “friction” (for example, removing trees, etc.) in order to facilitate motor vehicle traffic flow. This creates a barren, unsafe, and unattractive environment for pedestrians, often with high vehicle speeds.

Many of the solutions and designs proposed for increased pedestrian safety require revisiting some of these assumptions. But none of the proposed designs will create a less safe environment for motorists or other road users.

### *Design Speeds*

One important concept to understand is design speeds. According to the AASHTO Green Book (2001), the design speed of a roadway is the speed that is selected by the designer for determining the various geometric design features for the road. Although design speeds for rural roads are typically higher than for downtown urban streets, it is important to provide design speeds that account for the needs of pedestrians, bicyclists, and other road users. Lower design speeds may be achieved by providing such features as narrow street widths, on-street parking, tight turning radii, buffered sidewalks with street trees, short block lengths, short building setbacks, and streetlights.

It is also important to select a design speed for the type and purpose of the road. For example, on a low-volume, urban local street, it may be appropriate to provide narrow roadway widths and allow trees fairly close to the road. A suburban arterial street might typically have wider lanes, trees and utilities set back further from the road, and no on-street parking. Although a design speed may be higher on suburban arterial streets (compared to urban local or collector streets), it is still important to provide

pedestrian accommodations on such roads (e.g., well-designed sidewalks, safe street crossings, adequate lighting), since pedestrians in those situations should also be able to walk and cross streets safely

## Street Design Policies that have Affected Pedestrians

### *Achieving a Desired Level of Service*

Level of Service (LOS) for motor vehicle traffic is usually measured in letter grades A through F. LOS A describes free-flowing unimpeded motor vehicle traffic; LOS F is near gridlock. LOS D is typical of congested urban areas where streets are full and motor vehicle traffic is moving relatively slowly. It is not uncommon for intersections to operate at LOS F during the peak periods of traffic.

*See the Highway Capacity Manual for more on LOS. The HCM can be ordered from the Web site [http://trb.org/news/blurbs\\_detail.asp?id=1166](http://trb.org/news/blurbs_detail.asp?id=1166).*

The measurements and calculations needed to predict or determine LOS are quantitative. However, the desired LOS is often a political decision (or policy), based on how much congestion decision-makers assume the public will tolerate. Those communities that have sought to have motor vehicle traffic flow smoothly often have characteristically wide roads with minimal pedestrian accommodations. Consequently, they often experience higher crash rates for all roadway users, as both motorists and pedestrians suffer from the less safe conditions created to achieve these higher levels of vehicle mobility.



**Careful planning and design assures that even narrow streets such as the one pictured here remain accessible to emergency vehicles and other large vehicles such as school buses and moving vans.**

### *Accommodating Special Vehicles*

Roadway design is usually predicated on the concept of the “design vehicle.” The design vehicle is the largest vehicle that can be expected to use the road often enough to justify designing the roadway to accommodate that vehicle. Large design vehicles are commonly trucks and buses, including trash collection trucks, moving vans, school buses, and fire trucks. A typical design vehicle for local streets is known as an SU (Single Unit delivery truck), such as those used by UPS.

The most critical application of this concept is at intersections, where the radius is made large enough so the design vehicle can make a right turn without encroaching into the opposing lane. This can have a major negative effect on pedestrian safety and comfort, because a large radius allows passenger vehicles to make right turns at higher speeds and requires pedestrians to cross a longer distance. Large radii at intersections can contribute to a higher pedestrian crash risk as pedestrians are often hit by turning vehicles.

## Street Connectivity

Within the context of the previously described street hierarchy, local streets typically do not connect well to each other, arterial streets, or destinations such as transit stops

or stores. This leads to larger collector and arterial streets that convey heavy motor vehicle traffic. This discontinuous pattern of local streets limits travel choices for pedestrians to higher-risk arterial streets that reduce both comfort and safety. A lack of street connectivity leads to intersections that are few in number—but often large in size—that are more difficult for pedestrians to navigate. Many local streets have curvilinear or cul-de-sac designs that:

1. Limit pedestrians' ability to travel in the most direct path.
2. May be disorienting.
3. Increase the distances to destinations.
4. Increase pedestrian exposure time to other vehicles on the road.
5. Discourage walking because of the added travel distance to destinations.

Fewer people walking reduces the motorist's expectation of seeing pedestrians along and crossing streets.

These street designs have some negative impacts on motorists as well, increasing driving distance and time, and affecting the response time for emergency vehicles.

### Site Design

Many existing developments do not provide direct, clear, and convenient access for pedestrians. Pedestrians wishing to access a site may have to determine their own path and navigate through driveways, parking lots, landscaping, and other buildings in order to reach the destination. This often leads to confusion and conflicts between pedestrians and motorists, resulting in more pedestrian crashes.

### Land Use

The practice and evolution of land use planning is long, complex, and generally beyond the scope of this document; however, an acknowledgement of certain issues pertaining to pedestrian safety is in order. Land use practices that took shape after World War II have typically favored the segregation of land uses (e.g., commercial and employment areas, schools, and residences) and the concentration of commercial activities along auto-dominated arterial corridors. This has produced the following unintended consequences:

1. Trip origins and destinations are often far apart.
2. Longer travel distances lead to fewer people walking and more driving.

### Improving Connectivity of Local Streets

Street layout directly impacts the ability to walk or bike. Connected local streets, sidewalks, and bicycle facilities help reduce walking or biking distances, provide more choices on travel, including the use of more local streets, at the same time dispersing vehicle traffic. In this example, a path was created at the end of a neighborhood cul-de-sac to improve the connectivity of the streets for pedestrian and bicyclist use.



3. More people driving creates more hectic motor vehicle traffic conditions not conducive to safe pedestrian environments—those who do walk are exposed to long distances and high levels of risk when they walk along or try to cross busy high-speed arterial streets.
4. The premise that most trips will be made by automobile leads to street designs intended to accommodate only the automobile, built to handle large volumes of motor vehicle traffic; when this occurs, pedestrians are often minimally accommodated only as an afterthought, if at all.
5. Many of the destinations and commercial activities along a roadway corridor are also designed to serve motorists, fostering strip development with ample parking to capture passing motorists. As most of these destinations are located on arterials, they are hard for pedestrians to access.

The typical land use pattern of concentrating commercial activities along auto-dominated corridors creates generic-looking roads that are hard for pedestrians to cross. The safety consequences are evident when one analyzes crash data and sees that many pedestrian crashes occur along higher speed suburban corridors with few or no pedestrian facilities and very separated land uses.

### Access Management

According to AASHTO, access management “involves providing (or managing) access to land development while simultaneously preserving the flow of traffic on the surrounding roadway system in terms of safety, capacity, and speed” (AASHTO, 2001). It has widely been used to improve the efficiency and flow of motor vehicle traffic by limiting the number of driveways and intersections on arterials and highways. In some cases this has improved safety for pedestrians and motorists alike, but in other instances

it has had the unintended consequence of facilitating the design of larger intersections spaced far apart. These intersections are often difficult and unsafe for pedestrians to cross due to their size and large numbers of turning vehicles. Pedestrians wishing to cross at an intersection may have to walk long distances out of their way.

For communities that do not limit the number of driveways and intersections, the issue of intersection size and spacing may not be a problem, but an excessive number of driveways can create another problem. For pedestrians, every driveway is a potential conflict point. Vehicles pull in and out of commercial



**Poorly designed driveways can become conflict points for pedestrians and motorists.**

driveways continuously, and when driveways are designed like street intersections, turning speeds can be quite high. Too many driveways along a street without proper driveway design can also create a challenging walking environment for people with disabilities.

## Methods to Improve Pedestrian Safety at the Macro-Level

In addition to improving the compliance of all roadway users with traffic controls and laws, there are several measures that can be taken to improve conditions for pedestrians within these transportation conventions previously discussed. Improved pedestrian safety can be achieved in a variety of ways, including:

### *Street Design Improvements*

To make streets safer for pedestrians, planners, designers, engineers, and officials need to focus on:

- Slowing vehicle speeds.
- Reducing street crossing distances for pedestrians.
- Improving the visibility of pedestrians and motorists.
- Increasing the level of caution taken by pedestrians and motorists.
- Providing pedestrian facilities (sidewalks, crossing islands, etc.) where the needs and potential crash reductions are the greatest by establishing a routine system to identify gaps in the network along streets and highways, particularly in urban and suburban areas.

Achieving one or more of these objectives not only reduces the risk of pedestrian crashes, but also usually improves safety for motor vehicle drivers and passengers. Sometimes a design issue may result in a complication or delay to other roadway users, and transportation officials will have to make a choice to balance the competing interests. Officials may perceive these choices to be unpopular or difficult to make, especially for those whose job has been to move motor vehicle traffic and who may not be aware of values held by the community. However, most often a community will be supportive of improved pedestrian safety; it is important to educate and inform people about how and why certain choices are made (see Chapter 2 for a discussion on how to involve stakeholders).

To achieve these objectives, some policies may require rethinking or reprioritization. These include:

### Achieving a Desired Level of Service

Some effective pedestrian safety measures may increase motor vehicle travel time and have a slight negative impact on motor vehicle LOS. A rebalancing of the transportation system where pedestrian LOS and safety are included may sometimes mean a change in expectations about the priority that motor vehicle LOS is given in design and decision-making. If serious safety measures are to be achieved, the particular LOS may be lower for motor vehicles than if those measures were not taken. Improvements in capacity can be achieved in other ways: by

*For additional information on pedestrian-friendly street design, refer to the ITE Traffic Calming State of the Practice report, available online at: <http://www.ite.org/traffic/tcstate.htm>.*

*Other Web sites that provide useful information include: <http://www.walkable.org/> and <http://www.trafficcalming.org/>.*



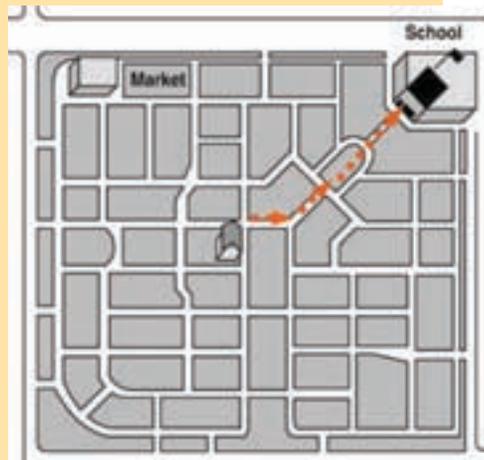
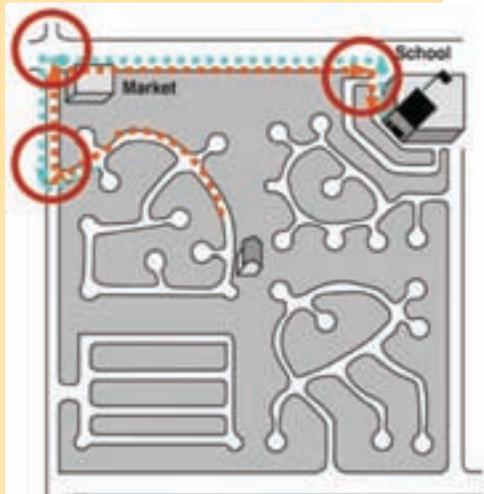
**Some wide streets are intimidating and unsafe for pedestrians (top photo), but wide streets can still be designed to work for pedestrians (bottom photo).**

expanding the capacity of other transportation options, re-thinking land use strategies, or determining where important destinations—such as schools—are to be located.

### Accommodating Special Vehicles

The conflict between vehicle accommodation and pedestrian safety is usually considered a design decision, but it is also a values (policy) decision. An intersection can be designed with a smaller radius than is typically used for a particular design vehicle, thereby increasing pedestrian safety by reducing crossing distance/exposure. The motor vehicle driver can still make the turn, but the truck will have to maneuver into an inside lane to complete the turn. Communities with streets designed around the

concept of “bigger is better” are communities that often provide poor pedestrian service and typically have poor pedestrian safety records. Conversely, communities that place a high priority on pedestrian safety and convenience do more to balance the needs of large vehicles with the needs of pedestrians in their street designs. This does not mean trucks, school buses, and fire trucks cannot use the streets—they are accommodated; they just usually need to travel at a lower speed and take care in making turns. Transportation professionals are asked to carefully weigh these factors when making street design decisions.



**In the top image, the residential streets are not well-connected and the pedestrian path is very long; below, connected streets provide a more direct route to the school.**

### *Street Connectivity Improvements*

Increasing street connectivity creates a safer, more pedestrian-friendly street system by:

- Reducing walking distances.
- Offering more route choices along quiet local streets.
- Dispersing motor vehicle traffic with more two-lane, neighborhood commercial streets, which relieves motor vehicle traffic from arterials to makes streets safer for pedestrians to walk along.
- Reducing the need for wide, difficult to cross streets and intersections by providing more connections.

Street connectivity with the transit network is very important. If people are to use transit, then their role as pedestrians on both ends of their trip is important and should be accommodated on well-connected streets.

Street connections are vital to pedestrians, and there are many things that can be done to improve the connectivity of existing street networks and plan for the connectivity of future developments. Here are a few potential solutions:

- Improve existing local street connectivity and circulation by adding sidewalks, paths, stairs/ramps, gates, etc. to link dead-end streets and cul-de-sacs to other

## Importance of Pedestrian Facilities in Disaster Preparedness

### State of New York

Mass evacuation on-foot is often the only available means for people to quickly escape terrorist attacks, sudden natural disasters, or to cope with other actions or incidents that may cause highway, transit and/or commuter rail systems to shut down for an undetermined period. Successful mass movement of pedestrians witnessed during the September 11, 2001 attacks in New York City, the August 2003 Northeast Power Outage, and the 2005 transit strikes show that walking is the most reliable and sustainable mode of transportation for overcoming obstacles.

From a design and operational standpoint, at-grade/street-level pedestrian access has been found to be the safest design feature for expediting pedestrian traffic movements when mass evacuation occurs. Inhibitors to mass evacuation (that should be avoided) include:

- Restricted at-grade pedestrian access due to longer blocks, fencing, and barriers.
- Pedestrian structures susceptible to movement and/or collapse (partial or total).
- Pedestrian tunnels susceptible to flooding or exit/entry obstructions.
- Building site and frontage design configurations that impede pedestrian traffic.



While vehicular travel lanes in urban main streets and central business/walking districts may experience surges of pedestrian traffic, adequate pedestrian facilities are still more suitable for use during more localized mass evacuations. This is because:

- Travel lanes may be clogged or obstructed with abandoned vehicles and/or debris.
- On-street and highway motor vehicle traffic may still be active during evacuation.
- Motorist panic and general confusion may make pedestrian use of roadways hazardous.
- Travel lanes may be restricted to emergency, military, or government uses.

When a major sub-regional or regional catastrophic event occurs, the pedestrian use of travel lanes must be included in transportation, law enforcement, emergency management, and military coordinated evacuation planning and recovery action plan efforts. This is important because major catastrophic events will involve massive pedestrian traffic surges at critical regional transportation bottlenecks and should be fully anticipated and strategically planned. Based on prior experience, travel lanes expected to carry the highest pedestrian volumes should be mapped and pre-designated for the quickest removal of any obstructions that might hinder rapid at-grade pedestrian evacuation.

This information provided by Jim Ercolano at the NYDOT. For more information, contact Mr. Ercolano at [jercolano@dot.state.ny.us](mailto:jercolano@dot.state.ny.us).

parts of the street network.

- Maintain a pedestrian connection (e.g., provide a path in the right-of-way or sidewalk easement) when a street is being severed (it is more difficult to purchase an easement for a connection later).
- Increase the number of access points to and from neighborhoods and other destinations, so not all trips are funneled through one or two large intersections or access points. More neighborhood travel options means less motor vehicle traffic on any given street.
- Design future developments with improved circulation patterns within neighborhoods so more neighborhood automobile trips can be taken on local streets, reducing the need to widen arterials. This may conflict with some traffic-calming techniques, but speeds can be controlled through other measures (see Chapter 5 for further discussion).

### *Site Design Improvements*

Both small-scale and large-scale developments should be directly accessible from the sidewalk through a safe and convenient sidewalk or pathway. Many communities are achieving better pedestrian safety records by requiring businesses and developments to



locate close to the street (with parking provided in the back) in more pedestrian-oriented site developments that balance auto access with pedestrian needs and facilities. This does not mean that auto access is denied; it is just managed more appropriately.

These site design goals are achieved by enacting local zoning ordinances, which must be enforced. These principles contribute greatly to the safety, comfort, and aesthetics of the walking experience.

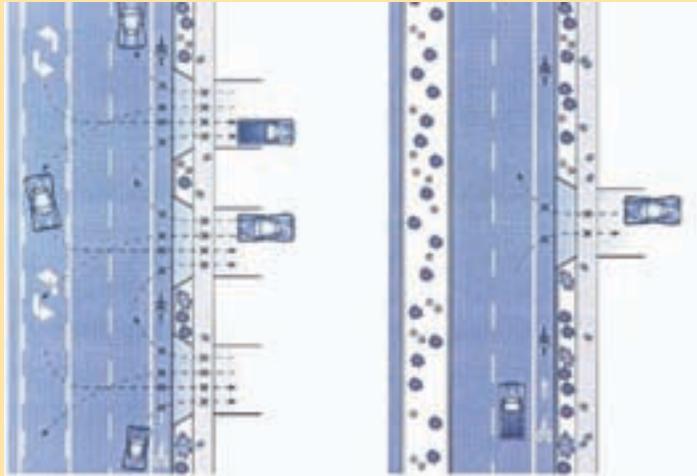
### *Land Use Improvements*

**Site design matters to pedestrians. In this example, the design of driveways, building setbacks, parking, buffers, and sidewalks all contribute to the safety of the walking environment.**

Land use planning has often been considered a discipline separate from transportation planning, street design, and traffic engineering, and insufficient emphasis has been placed on the coordination of the two planning processes. However, the relationship between land use and transportation is evident, and the responsibility to coordinate between the two is imperative. Some changes to land use patterns that may positively influence pedestrian safety include:

- Encouraging mixed-use development (such as allowing small-scale retail in neighborhoods or placing schools in the center of neighborhoods) to help create destinations within walking distance of where people live and work.
- Designing new neighborhoods in a cluster pattern with many destinations accessible on foot to residents.

Other ideas are detailed in Chapter 5.



Proper access management can control turning movements to reduce conflict points, encourage cluster development, improve street connectivity, and create more accessible land use patterns to improve the overall safety of the pedestrian environment.

### *Access Management Improvements*

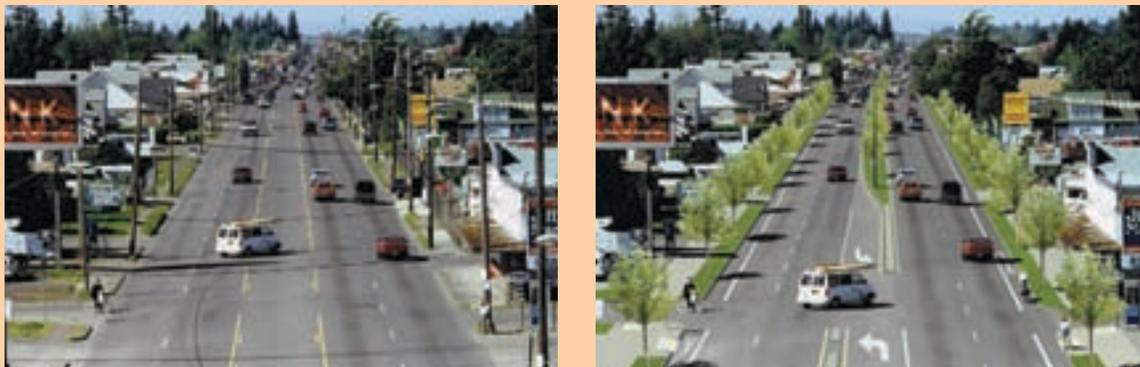
One of the most important access management techniques includes reducing conflicts at driveways to improve the walking environment. Some driveways can be closed—increasing the safety of both pedestrians and motorists—without impeding access to local businesses. Access management tools should not be used to reduce public street connections, especially pedestrian connections to the transportation network. Other access management goals can work in favor of pedestrians within the context of other important planning and policy issues, including:

- Constructing medians to control turning movements.
- Encouraging clustered development and mixed land uses.
- Improving street and neighborhood connectivity.
- Converting auto-oriented strip development into more accessible land use patterns more suitable for pedestrians.

### **Reviewing Pedestrian Policies and Design Guidelines to Improve Pedestrian Safety**

A multimodal approach to policy-making is needed. Agencies need to review their design guidelines and policies to ensure that quality facilities are provided with both developer-built and new agency-built roadway projects. New facilities must be fully accessible to all pedestrians. Chapter 5 provides a more complete list of common and effective practices that may serve as a template for reviewing the current status of agency policies and guidelines. It provides policies and design recommendations organized into the following sections:

1. Improvements along the road (on sidewalks, at driveways, etc.).
2. Improvements for crossing the road (at midblock locations and signalized/unsignalized intersections).
3. Transit improvements.
4. Speed control measures.
5. Land use and site design.



The image on the left provides the “before” view of a typical arterial street designed primarily for automobile use. In the “after” photo on the right, a digital illustration provides an example of how simple changes—access management, a raised median, bicycle lanes, sidewalks, and landscaping—can make such spaces more safe and appealing for pedestrians.

To list a few examples from the chapter:

- Sidewalks or walkways are desirable on most urban and suburban roadways, and efforts should be made to establish priorities for adding needed sidewalks.
- Pedestrian signals (i.e., WALK/DON’T WALK messages, symbolic hand/walking man messages) and marked crosswalks are desirable at all traffic signals where pedestrian crossing activity is expected, particularly at wide streets.
- Transit stops should be located where pedestrians can safely cross the street.

For more information, read Dan Burden’s essay, “How Can I Find and Help Build a Walkable Community” at <http://www.walkable.org/article1.htm>.

There are numerous other guidelines that can be used to identify design and traffic management practices to incorporate into appropriate agency manuals. The review of agency policies and design guidelines for pedestrian facilities should be a priority. Most improvements to the street/pedestrian infrastructure will be gradual and implemented over many years as a part of future development and roadway reconstruction projects.

#### *Finding the Appropriate Documents to Review*

In most communities, the built environment is governed by a variety of processes. In some communities, public works departments have developed their own guidelines for roadway design that may need to be revised to conform to recommended practices. In other localities, subdivision ordinances are the key element to be reviewed and updated to ensure the development of safe pedestrian facilities. It may be challenging to pinpoint what is wrong with those ordinances, what is missing, or what effect they are actually having on the built environment, but they provide a starting point for the review and comparison of policies and guidelines outlined in this guide. The process of plan review is also important, and transportation officials need to know what to look for in development proposals. This chapter and Chapter 5 provide important examples of both macro- and micro-level elements that should be considered in development plans to ensure the highest level of pedestrian safety.



## Chapter 2: Involving Stakeholders

Stakeholders include people who have a share or an interest in a particular policy, program, or project and may be affected by its implementation. Stakeholder involvement is an essential element in creating publicly supported and trusted policies, programs, and projects that reduce pedestrian crashes while creating livable, walkable communities.

Public participation is not an end in itself, but part of a broader process of sustainable development. Participation is an important mechanism that can help create trust and credibility with stakeholders. The public should be included throughout the planning process, and the participation of all interested and affected parties—including vulnerable and disadvantaged persons—must be promoted.

Public stakeholders should be seen as useful partners in bringing helpful information and judgment to the table. They often are the on-the-ground scouts who can identify problems, needs, and opportunities. Since the professional staff cannot be everywhere at all times, the public can serve as additional eyes and ears and be effective resources.

The extent of the processes in which local agencies involve the public will vary according to their size and budget. Some communities are better equipped to implement these strategies while others may not have the resources and staff to implement all the strategies, so some modification and “tailoring” of these recommendations may be required.

State and local agencies operate and relate to the public differently, so some modifications of the recommendations in this report will be needed to accommodate these differences.

“Stakeholder involvement is an essential element in creating publicly supported and trusted policies, programs, and projects that reduce pedestrian crashes while creating livable, walkable communities.”

## Public Involvement Through Meetings and Workshops

### Denver, CO

The City of Denver held two rounds of four public meetings at key points in the process of developing the Pedestrian Master Plan in order to identify all potential issues and problem locations within the pedestrian environment. A final ninth public meeting was held prior to finalization of the Pedestrian Master Plan.



During the first round of workshops, citizens were given the opportunity to comment on the general obstacles they faced in the pedestrian system and to provide information on ways to improve the infrastructure. During the second round of workshops, the public provided feedback on the proposed pedestrian routes, among other issues.

Public input was received not only from the workshops but also from email and facsimile. This input was used to develop policy and to prioritize projects. In addition to expert review and monitoring by the Advisory Team, input was also solicited from other City officials within various City departments. The plan was reviewed by several special interest groups, internal staff, the Planning Board, and the City Council prior to finalizing the Pedestrian Master Plan.

For more information, visit: [http://www.denvergov.org/transportation\\_planning/](http://www.denvergov.org/transportation_planning/).

### Who are the Stakeholders?

Stakeholders include five distinct groups:

1. Individual citizens.
2. Citizen-based organizations.
3. Public employees, officials, and agencies.
4. The private sector (including local business owners and developers).
5. The media.

All have a unique role to play and require a different strategy for involvement.

#### *Individual Citizens*

Requests from individual citizens are an important way for agencies to learn about problems at specific locations. Typically, citizens will contact agencies with a request for a particular treatment such as a marked crosswalk. While citizens may or may not have asked for the correct solution, they are likely to have identified a pedestrian problem. Sometimes, the problem citizens perceive is different than an analysis of data reveals. Consequently, the first step is to figure out the problem that the citizen is trying to solve. Sometimes it is obvious, other times it may require further communication with the citizen, a field visit, and an engineering study.

Responding to citizen requests can be a time-consuming task. Agencies should develop procedures for quickly determining which requests deserve a higher level of attention. Time and money are often best spent addressing the problems that are most likely to reduce pedestrian crashes. For example, in Seattle, the staff gets together once a week to review citizen requests to perform a quick assessment of needs and priorities, asking questions such as:

- What is the crash history?
- Have there been previous complaints?
- Is it a location with a high volume of pedestrians?
- Is it likely that this problem will cause a crash?
- Is there a clear design problem?
- Is it a maintenance problem?
- Would moving a transit stop eliminate the problem?
- Is there already a project in the area that will address the problem?

Using the collective memory of the group with some data, it is often possible to prioritize the requests and identify those that require further analysis. Citizens always deserve a response whether it is a phone call, email or letter. Most agencies already have procedures that dictate the appropriate way to respond.

One obstacle to receiving citizen requests and feedback is that citizens often do not know who they should address their concerns to or how. In a heavily populated county, there may be several municipalities with jurisdiction over local streets, as well as the county and state DOT, each with its own roads. Many citizens have little idea which agencies actually maintain the roadways and traffic signals and do not know who to turn to to make a request. One way to obtain more feedback from pedestrians is to increase and improve Web-based outreach programs. A highly visible link on a traffic agency Web site can help direct feedback to the best place or provide additional information. Another technique helpful to citizens may include posting an agency phone number or Web site on traffic signal controller boxes, typically located near the corners of signalized intersections, or in areas with high pedestrian activity.

## Public Involvement to Develop a Transportation Needs Database

### Portland, OR

Portland's Pedestrian Transportation Program has made use of the city's active and engaged citizenry to help identify, develop, and prioritize pedestrian projects and to create its 1998 Pedestrian Master Plan.

The city held a series of nine open houses in the spring of 1995 to solicit comments and needs requests for the Pedestrian Master Plan. Among other activities, attendees were offered the opportunity to "pin the tail on the problem" by filling out a card to identify a need and marking the location on a map with a numbered sticker. Later, a second series of nine Pedestrian Master Plan Workshops were held around the city to present the projects proposed in the Plan. Throughout the project, presentations were made upon request by neighborhoods and other groups in order to encourage further participation.

All the needs, requests, and project suggestions received during the open houses, district coalition presentations, and workshops for the Pedestrian Master Plan project were added to a database of information regarding neighborhood transportation needs. Also included in the database were suggestions or complaints collected through phone calls, letters, and various public presentations.

For more information, visit: <http://www.trans.ci.portland.or.us/plans/pedestrianmasterplan/default.htm> or <http://www.portlandtransportation.org>.

### *Citizen-Based Organizations*

Citizen-based organizations can roughly be divided into special interest groups such as a Pedestrian Advisory Board (PAB), and geographically-based groups where people are members by virtue of living or having a business in a particular neighborhood. Also included in this category are various advocacy and non-profit organizations. All these groups can play a critical role in creating a better walking environment.

#### Pedestrian Advisory Boards

State and local agencies should consider forming a Pedestrian Advisory Board (or Council or Committee) to obtain ongoing, good citizen input. It is an excellent way to get a better product while building support for agency policies, programs, projects and funding. Meeting times, places, and frequencies will vary depending on whether it is a state or local PAB. State PABs tend to only meet several times a year—often at locations around the state to accommodate its members. Local PABs usually meet monthly, often at the same location. It is preferable to have separate pedestrian and bicycle boards so that pedestrian boards can focus solely on pedestrian issues. If this can't be achieved, measures need to be made to ensure that both the pedestrian and bicycle modes get equal attention. Creating and running an effective PAB requires a thoughtful, purposeful, and informed strategy. See Appendix A for detailed recommendations on how to create and run a successful Board.

#### Geographically-Based Groups

Working with local neighborhood associations is another excellent way to get a better product while building support for agency policies, programs, projects, and funding. As with PABs, it requires a thoughtful, purposeful, and informed strategy.

## **Citizen's Pedestrian Advisory Board**

### **Oakland, CA**

The Citizen's Pedestrian Advisory Committee (CPAC) provided continuous public oversight and feedback during the development of the Pedestrian Master Plan. The CPAC was composed of district representatives appointed by each City Council member and one mayoral appointee from each of the Mayoral Commissions on Aging and Disability. Additional representatives of several community stakeholder groups including the Building Owner's and Manager's Association (BOMA), the Bicycle and Pedestrian Advisory Committee, and Urban Ecology also attended meetings. The CPAC met monthly for one and a half years to oversee the planning process.



For more information, visit: <http://www.oakland-net.com/government/pedestrian/index.html>.

### Advocacy and Non-Profit Groups

These organizations may represent a spectrum of interests, from promoting walking or advocating for the rights of people with varying disabilities, to protecting the environment or encouraging bicycle facility development. Often, these groups will have an interest in promoting pedestrian safety in concord with their overall objectives but may in other cases be opposed to certain changes. Agencies should be aware of these groups and work to include them in the public involvement process, forming partnerships when applicable.

### *Public Employees, Officials, and Agencies*

Public employees, elected officials, and local agencies are also stakeholders, but their level of participation in the public involvement process may differ, depending on the level at which the pedestrian safety action plan is meant to be implemented. A regional plan developed by a state, Metropolitan Planning Organization (MPO), county, or other similar government will most likely address these stakeholders in a different manner than local plans will. Public agencies are important stakeholders to the extent that the policies, projects, and programs developed in the plan affect their areas of responsibility. For example, a major arterial project is likely to have a significant impact on area drainage and therefore will require involvement and buy-in from the agency that manages surface water runoff. The same will be true for all major public and private utilities. Transit agencies are an important stakeholder group for projects related to pedestrian facilities and safety near and at transit stops. Agencies involved with Public Health may also take an interest in promoting pedestrian safety and be able to provide valuable resources and partnership opportunities. It is in the states' and localities' interest to build positive, working relationships with these individuals and agencies.

### *Private Sector*

The private sector includes individual business owners (e.g., local businesses or development firms) or more formal business-related organizations. Members of the private sector have an interest in the built environment from several perspectives: as members of the community, from an investment standpoint, and as users of the environment (e.g., employees or customers). Some will be interested in investing more—they may offer to provide financial resources to make improvements or help out with maintenance. Many businesses are important pedestrian generators that contribute to the life of a street and can affect a street's walkability; therefore, it is valuable to include these business owners when implementing a pedestrian safety action plan.

There are, of course, regulatory tools that impact the private sector, such as zoning or building regulations. Private individuals will be interested in participating in discussions that propose to make changes that will impact them as well.

Involving the business community may require a different approach than traditional public participation methods. Members of the private sector may not come to public meetings but respond better on a one-on-one basis or in forums dedicated to only

their participation where they will get a chance to meet and network with elected leaders.

### *The Media*

Media outlets have an interest in public welfare and information. Good working relationships with the media contribute to more effective pedestrian safety programs. It is important to develop strong lines of communication with media personnel so that they are able to give an informed, accurate report on the issues. Agencies can actively seek media coverage through press releases, news conferences, or other media events in order to provide information to the media in a planned and professional way. By including the media as a stakeholder group, state and local agencies will be able to make them part of the solution and avoid potential negative or ill-informed media coverage. They will gain more accurate publicity to spread awareness of pedestrian safety issues as well attention to what is being done at the state and local levels.

## General Strategies for Involving Stakeholders

### *Provide Quality Information*

Part of the strategy for working with stakeholders is to provide information that invites good input. Informed citizens and other groups are more likely to identify real problems and provide more constructive feedback on project proposals. A good Web site along with written information can be helpful. For example, it is often useful to provide information on when, where, and why marked crosswalks are installed. An informative Web site with answers to lists of Frequently Asked Questions (FAQs) can reduce the number of frivolous or misguided requests or complaints.

### *Include Both State and Local Agencies*

This activity is important for both local agencies and for state projects on state roads. Most policy, program, and project initiatives will be an activity for local agencies since they involve local residential and arterial streets. This, however, will vary from state to state. In some states, most arterial streets are state roads; in some big cities, very few arterials are state roads; in small towns, it is not uncommon for the two or three major roads running through the city to be state roads. Some cities are multijurisdictional (e.g., Las Vegas). Make sure all concerned agencies are involved.

### *Consider Neighborhood Plans*

Neighborhood (or sector) plans can be an excellent way to establish community priorities and generate support for pedestrian related safety improvements. Many cities have named neighborhood districts, each with its neighborhood plan. For example, Phoenix is subdivided into 15 urban villages, each with their own Village Planning Committee. In Seattle, the city has been divided into 38 neighborhood sub-areas. When given the opportunity to develop their own neighborhood plans, 34 of these sub-areas identified pedestrian safety issues as their top priorities. Transportation agencies should always look to these plans for guidance when developing policies, projects, and programs be-

*For more information on stakeholder involvement, see the Virginia Tech On-line toolbox "Partnerships and Participation in Planning" at <http://www.uap.vt.edu/cdrom/intro/index.htm> or read the FHWA document "Public Involvement Techniques for Transportation Decision-making" at <http://www.fhwa.dot.gov/reports/pittd/cover.htm>.*

cause these plans will only have value if they are used and referenced. More information about the Phoenix and Seattle plans is available in Appendix F. Also see previous section on Geographically-Based Groups.

### *Establish Venues for Participation*

Stakeholders should have multiple ways to participate. Outreach should include opportunities to attend public meetings, emails, telephone calls, and filling out comment forms. These approaches will result in a broader, more diverse group of citizens providing input that will increase project acceptance and success.

### *Hold Public Meetings or Events*

Public meetings and events can be an excellent way to solicit public input on plans and projects. They require structure and control in order to make progress and remain focused. Public meetings may have different formats or elements:

1. Open House with tables with project information—citizens get a chance to look at plans, write on the plans, ask questions, and talk face to face with project planners, designers, and managers.
2. Formal Presentation—citizens hear a formal presentation explaining the project, typically followed by a question and answer session.
3. Formal Public Testimony—this may be desired or mandatory at certain phases of a project.

While public meetings have value, it is also important for citizens to have other opportunities for providing feedback. Not everyone is willing or able to attend a public meeting. Sometimes hosting forums at different times (e.g., weekends) or providing childcare can help. Other ways of soliciting general input—such as charettes, walking meetings, Web surveys, etc.—should also be considered.

### *Create a Project-Specific Task Force*

A task force may be desirable and useful for large, complicated, and/or controversial projects. Typically, a task force will be more involved in the early stages of planning and design. When forming a task force, many of the same principles used for forming PABs will apply. It should represent the community, and roles and responsibilities should be clear. The task force should include both local residents and members from the larger community to provide a balanced representation of the community as a whole.



## Chapter 3: Collecting Data to Identify Pedestrian Safety Problems



Agencies need to know where pedestrian safety deficiencies exist, how extensive the safety problems are, and what new projects, programs, and policies can provide the biggest safety benefit, including those related to engineering, education, and enforcement. As discussed in Chapter 2, stakeholders can be a good resource in identifying safety concerns and deficiencies, and data may be required to verify these problems. Other deficiencies are identified by collecting data and developing procedures to analyze the data. This process occurs before an action plan can be formulated. While collecting and analyzing data are crucial, an agency should not spend excessive resources on this task to the point where there are no resources available for implementing safety improvements. It is important to know how much data and what types of data are needed to identify, prioritize, and implement safety projects (discussed in Chapter 4) as well as evaluate the effectiveness of completed safety improvements (discussed in Chapter 7).

“Crash, roadway, traffic, and other data are essential to identify pedestrian safety deficiencies and to select the appropriate improvements to make conditions safer for pedestrians and other roadway users.”

### Types of Safety Projects

Agencies should identify and prioritize the following types of projects for pedestrian safety improvements:

1. Spot Locations: individual intersections and non-intersections.
2. Corridors: may be roadway sections of 0.8 km to 8 km (0.5 mi to 5 mi) or more in length.
3. Targeted Areas: may be as small as a single neighborhood or business district to a large area where pedestrian crashes are disproportionately high.
4. Entire Jurisdictions: Some types of crashes are frequent but are scattered throughout an entire jurisdiction (i.e. they are not spot location- or area-specific). They must be addressed through system-wide changes, such as making it a policy to install pedestrian WALK/DON'T WALK signals at all traffic signals.

Agencies should challenge themselves to make safety improvements immediately and not wait until all data collection efforts are completed. Very little data are needed to

make simple, low-cost improvements such as the installation of advanced stop bars on multilane roads, or the upgrade or installation of warning signs where high numbers of pedestrians cross busy streets. Additionally, when there is a known problem spot location or targeted area, data should be collected immediately without waiting to complete larger, more comprehensive computerized databases which can take several years to develop. Early improvements will allow the community to understand the value of the pedestrian safety program and will encourage elected officials and staff to make further improvements.

### Information Needed to Identify and Quantify Pedestrian Safety Deficiencies

Crash, roadway, traffic, and other data are essential to identify pedestrian safety deficiencies and to select the appropriate improvements to make conditions safer for pedestrians and other roadway users. More data and higher quality data will typically give an agency more tools to identify and address safety problems. An agency cannot collect everything; it will have to prioritize its data needs. In some instances, improvements in databases or more accurate or timely data will enhance the ability to identify pedestrian deficiencies.

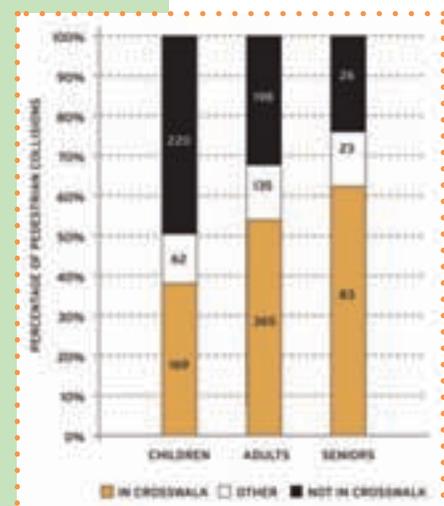
Every effort should be made to create geo-coded pedestrian crash databases that allow for easy identification of problem locations and areas. This is especially important for large agencies that may need to examine extensive areas and numerous pedestrian crash reports. Most crash reports do not include geo-coded location data, so agencies may need to rely on their expertise about their jurisdiction to properly geo-code crash locations. Once created, databases should be maintained and updated so they retain usefulness over time.

#### Pedestrian/Vehicle Crash Data

##### Oakland, CA

The Pedestrian Master Plan for the City of Oakland includes a lengthy description of pedestrian/vehicle crash data. The Oakland plan relies upon data collected from the Statewide Integrated Traffic Records System (SWITRS), a database of crash records collected by the California Highway Patrol (CHP) and local police throughout California. The document reveals rates of pedestrian crashes and the most common causes of pedestrian crashes, including percentages of crashes which were primarily the fault of the motorist versus the pedestrian. In addition to providing a map of pedestrian crashes, the plan outlines the intersections with the greatest number of pedestrian crashes, senior pedestrian crashes, and child pedestrian crashes and specifies which of the high pedestrian crash intersections are controlled by traffic signals. The plan reports groups most at risk of pedestrian injury by age and sex and highlights the times of day when pedestrians are most at risk of injury. Finally, the plan compares rates of pedestrian/vehicle crashes in Oakland with statewide averages.

For more information, visit: <http://www.oaklandnet.com/government/pedestrian/index.html>



The graph above from the Oakland plan displays the pedestrian action in vehicle collisions by age group.

Agencies need to review their capability to collect data and should ensure that they have sufficient staffing and training for this task. Data should only be collected if they will be used. Modest improvements in data may be more effective than collecting large quantities of additional data that an agency does not have the ability to manage. The following is a list of data that can be helpful in identifying and prioritizing pedestrian safety deficiencies.

### Elements of a good crash database:

- Inclusive of ALL pedestrian crashes available.
- Timely.
- Accurate (will require a review of police narrative).
- Geo-coded (with programs to assist in identifying problem locations).

### Crash Data

The most important data are pedestrian crash records. State and local agencies should collect and maintain crash data, and every effort should be made to include all pedestrian crashes. In some cases, pedestrian crash data collection efforts may be linked with data collection on bicycle crashes, because both are often not included in highway safety data. Agencies must understand the limitations of the state computerized crash databases; most only include crashes with motorized vehicles, and many non-injury pedestrian crashes or those involving minor injuries are unreported. There have been examples of agencies collaborating with hospitals to reduce non-reporting, but there may be some privacy issues associated with these efforts. Statewide crash data need to be timely and accurate so an agency can promptly identify and respond to a crash problem and monitor trends.

Having to wait several months for statewide computerized data can severely hamper an agency's ability to respond to a crash location, especially in rapidly developing areas. Collaboration between state and local agencies assures that all involved parties have access to current data.

If there is a long time lag in the availability of crash data, a local jurisdiction may need to maintain its own interim database to allow for timely identification of problem locations. Furthermore, the police should develop procedures to notify traffic or public works officials responsible for operating the roadway system when a serious pedestrian crash occurs in order to immediately assess the conditions. News reporters will often contact the traffic department as soon as they learn of a serious pedestrian crash. The traffic department should have the same timely information as the media.

### Police Reports

Computerized pedestrian crash data are essential to efficiently identify high-crash locations, corridors, and/or larger areas, but individual police reports are essential in documenting precisely where, how, and why each crash occurred. The most important part of the police crash report is the officer's narrative, and the police should thoroughly and precisely document crash details. Care should be taken with some of the information included in a police report. Some investigating police officers are not aware of the legal definition of an unmarked crosswalk, and sometimes a pedestrian in an unmarked crosswalk will incorrectly be listed "at fault" for not using a crosswalk. Educating officers in proper terminology and police training on pedestrian legislation can help reduce such errors. Rather than assign fault, it is better for police crash re-

For more information, refer to the study "Pedestrian and Bicycle Data Collection in United States Communities: Quantifying Use, Surveying Users, and Documenting Facility Extent" at [http://www.pedbikeinfo.org/pdf/casestudies/PBIC\\_Data\\_Collection\\_Case\\_Studies.pdf](http://www.pedbikeinfo.org/pdf/casestudies/PBIC_Data_Collection_Case_Studies.pdf).

ports to simply list actions in a neutral manner, such as “failed to yield while turning.” This makes it easier for analysts to classify and sort the data. Another common error in crash data is that the nearest intersection is coded when the crash really occurred at a midblock location.

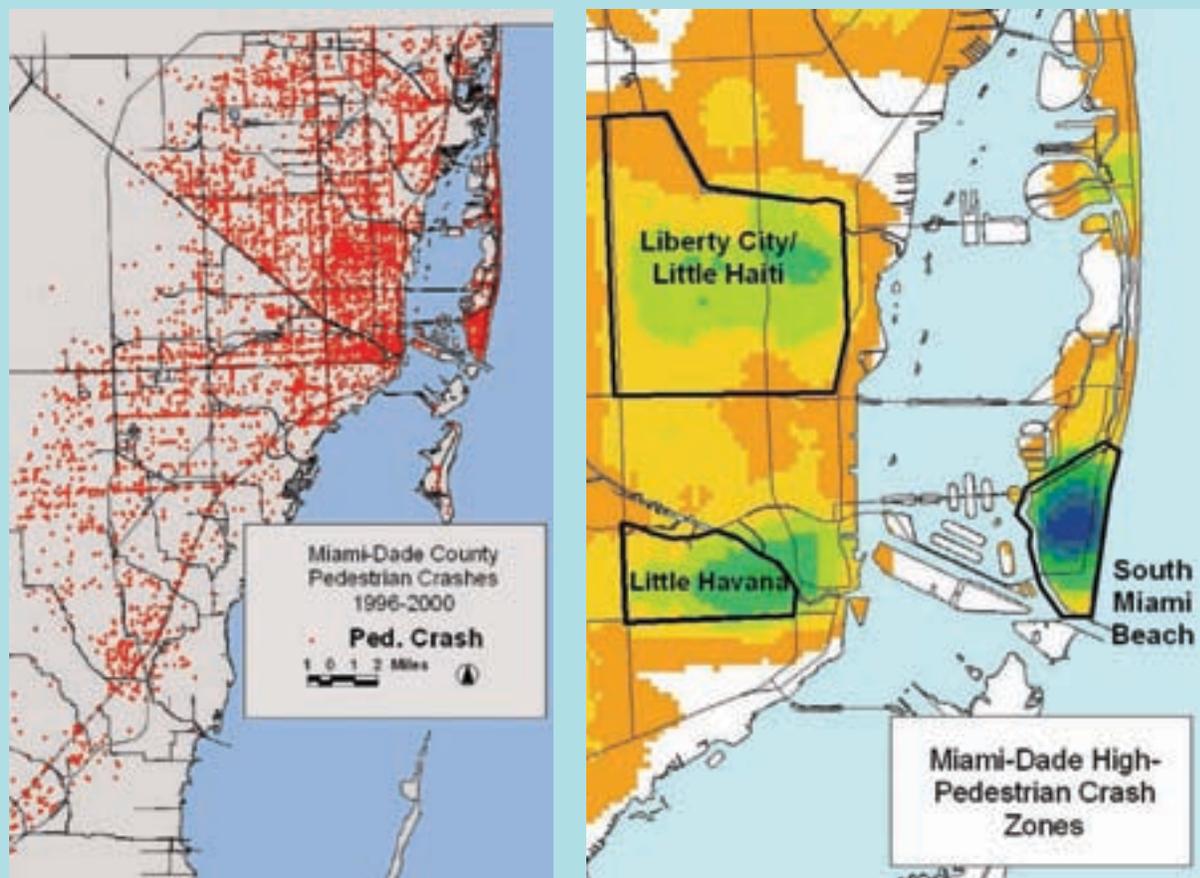
Some information may require follow-up investigation such as issuing citations or BAC/drug testing, which may not be recorded on the original police report. For serious injury or fatal crash reports there is often a supplemental police investigation that can provide considerably more details on the crash, including witness statements and a thorough investigation of roadway, motorist, and pedestrian conditions at the time of the crash.

## Pedestrian Crash Data

### Miami Dade, FL

The Miami-Dade County MPO has created a series of maps using Geographic Information Systems (GIS) software in order to identify high pedestrian crash areas to be addressed with pedestrian crash countermeasures. The maps shown below were created by the Miami-Dade MPO in conjunction with the National Highway Traffic Safety Administration (NHTSA) pedestrian safety demonstration project, which seeks to reduce the deaths, injuries, and associated crash costs within the county's urban setting. Miami-Dade County had a high number of pedestrian crashes and number of deaths and injuries relative to other counties in the state.

For more information, visit: [http://www.miamidade.gov/mpo/docs/MPO\\_ped\\_plan\\_2001.pdf](http://www.miamidade.gov/mpo/docs/MPO_ped_plan_2001.pdf).



System-wide crash data is needed to efficiently identify high crash corridors or areas, in addition to high crash locations. To identify high crash corridors or areas, three years of crash data is ideal, but as little as one year of crash data may be sufficient. Agencies should also review the types of information available in their computerized crash database so they have ready access to information such as the age of the pedestrian, physical condition of the pedestrian or motorist, behaviors of the pedestrian and motorist prior to the crash, direction of travel, and other details that can be used in identifying safety problems.

## Pedestrian Walking Tours

### Madison, WI

The Pedestrian Transportation Plan for Madison, Wisconsin includes a hypothetical walking tour to investigate situations pedestrians are likely to encounter. It focuses on questions such as 1) "Can I walk there?" that examines sidewalk access, continuity and connectivity of the pedestrian network, missing links, transit access, construction projects which close off

sidewalk access; 2) "Is walking convenient?" that examines land-use issues, street patterns, and crossings; 3) "Is walking safe?" a question examining curb ramps, sidewalks, and street crossings; and 4) "Is walking enjoyable?" examining buffers between

motor vehicle traffic and pedestrians and neighborhood character. Observing situations that pedestrians encounter suggests criteria that can be used to evaluate the pedestrian-friendliness of an area and standards that should be strived for in making Madison a better place to walk.

For more information, visit <http://www.cityofmadison.com/transp/PedTransPlanTableOfContents.html>.

Smaller agencies can also use the low tech method of identifying high crash corridors and other areas by developing manual pin maps or spot maps.

It is important to note, especially in relationship to crash data, that very little is known about pedestrian exposure. For instance, it is difficult to compare the crash records of two intersections without understanding the respective pedestrian exposures. When exposure data is not readily available (as it rarely is), many officials turn to surveys, behavior studies, and pedestrian counts to provide an approximation of exposure. In some cases, patterns of pedestrian crashes are not readily identifiable using GIS and crash data analysis alone. Because some pedestrian crashes are rarely repeatable, other types of data should also be used to identify where pedestrian safety improvements are needed. Specifically:

#### *Pedestrian Counts and Behavior Studies*

Ideally, collecting pedestrian counts and observing crossing behavior can be useful in understanding the pedestrian activity and in considering needs for facilities. Pedestrian crash data can be used to identify high crash loca-



**Pedestrian behavior researchers have found that pedestrians will often take the most direct route possible if other paths are not considered more safe or convenient.**

tions, corridors, areas, and jurisdictions; supplemental pedestrian volume and behavioral data can be valuable at those sites to provide insights into specific crash causes and potential countermeasures. Count and behavior studies are best employed when there is a decision (design or operational) to be made that the information can influence (i.e., is a traffic signal warranted?). However, low pedestrian counts should not be used as a justification to not take any action. If there is a clear indication that pedestrians need access to a destination, but roadway conditions are so intimidating that few people are seen walking, then a safety improvement can open up new opportunities for pedestrians.

Count and behavior studies (that include observing the number, age, or behavior of pedestrians) are typically needed to more fully assess pedestrian conditions and determine what type of improvements are needed. Because collecting this data is labor-intensive, many agencies do not collect system-wide pedestrian counts or behavior data. If the data are collected, it is helpful to maintain the data in an easily retrievable database. Due to budget constraints, it is acceptable to focus this data collection to areas of higher pedestrian concern. See Appendix B for details on how to conduct pedestrian counts and behavioral studies.

High pedestrian volumes do not necessarily result in high numbers of pedestrian crashes. In many downtown areas, pedestrian crashes are relatively low despite the high pedestrian and motor vehicle traffic volumes. This results from lower motor vehicle traffic speeds, short blocks, and a greater motorist expectation and awareness of pedestrians. Conversely, pedestrians can often be at greater risk in areas with low pedestrian use due to lower motorist expectation and awareness of pedestrians. But high pedestrian volumes can be used to justify a higher priority for pedestrian facility or traffic control improvements.

#### *Behavior Studies within Crash Site Reviews*

Reviewing pedestrian crash reports is another way to identify pedestrian safety deficiencies, but some deficiencies are not readily apparent by reviewing collision or condition diagrams or by simple field reviews or audits. Behavior studies of motorists and pedestrians at the particular crash site are needed to determine other factors that may be contributing to a pedestrian safety problem.

#### Assessing Pedestrian Behavior

After a pedestrian crash has occurred, safety officials often ask, “What was the pedestrian doing there? Why did the pedestrian cross there? Why didn’t he or she cross at the traffic signal or use the crosswalk?” Pedestrians will act according to human nature, most often taking the shortest or most convenient route between two points. Traffic controls that regulate motor vehicle traffic often do not meet the needs of pedestrians. “Thinking like a pedestrian” can help others to understand why a crash occurred and how to prevent one in the future by looking at the circumstances from the pedestrian’s perspective.

“Thinking like a pedestrian” is a process that analyzes factors such as the pedestrian and roadway environment and other conditions as well as the perceptions of safety to assess the pedestrian behavior. It also takes into account factors outside of the study area that may modify or develop pedestrian behaviors (e.g., a lack of sidewalks causes pedestrians to choose to walk in the roadway). It requires an evaluator to observe pedestrian movements at a site and then emulate those movements. This will give a true sense of what the pedestrian experiences. This process may have limitations when a pedestrian is intoxicated, under the influence of drugs, or is otherwise disoriented. See Appendix C for a detailed, step-by-step guide for performing this assessment.

### Assessing Motorist Behavior

The same “thinking like a pedestrian” process can be used for motor vehicle drivers. Street designs and traffic controls have been created primarily to facilitate motor vehicle traffic flow. Motorists respond by driving with the assumption that they will be able to drive at a reasonable speed with minimal interruptions. Major interruptions such as traffic signals at busy intersections are acceptable because the motorists understand the risk associated with the two conflicting traffic flows if controls were not in place. However, a vulnerable pedestrian is often not seen as a risk and motorists are often not willing to slow down or stop to let a pedestrian cross, especially when the motor vehicle driver is frustrated or traveling at a high speed. The pedestrian is seen as an interruption to smooth motor vehicle traffic flow. Also, a distracted motorist may not even see a pedestrian in time to slow down.

“Thinking like a motorist” is a process that analyzes factors such as driving environment, facilities, other conditions, and perceptions of safety to assess motorist behavior. It requires an evaluator to observe motorist behavior on site and then emulate these movements. This gives the evaluator a true sense of what the motorist experiences. The process has limitations in that the professional may assume the motorist did what the roadway and traffic control devices expected of them. The process is also limited when motorists are drunk, under the influence of drugs, fatigued, or distracted, such as talking on a cell phone without paying proper attention to the roadway environment. See Appendix C for further details on performing this type of assessment.

### *Roadway/Sidewalk Inventories*

Not all pedestrian deficiencies can be identified by crash data. Since pedestrian crashes at particular locations are relatively rare and random events in general, roadway infrastructure can be used to identify locations needing pedestrian facility improvements. While most pedestrians are not hit while walking along a road, the presence or absence of a sidewalk often determines when and where a pedestrian will cross a street. It can be difficult or expensive to create and maintain a database of roadway, sidewalk, and traffic characteristics for an entire city, county, state, agency, or system. In working to create such a database, an agency should begin by collecting data for arterial or major streets, and then phase in data collection on collector streets. Data collection for local streets may be limited to school walking routes or walkways near major pedestrian

destinations, such as parks, churches, community centers, senior centers, and medical facilities.

Inventories should include the presence (one side or both sides) and quality of sidewalks (width, surface condition, separation from traffic, accessibility, etc.). Roadway characteristics include street classification; posted speed limits; school zones; number of lanes; width of lanes; the presence of medians, traffic signals, or marked crosswalks; curb ramps; pedestrian regulatory, warning, and wayfinding signs; streetlights; and bike lanes. Inventories can also include other features such as school sites, major school crossings, walking routes, or school-specific signs and marking. Since transit stops are associated with high pedestrian activity, an inventory of transit stops is also useful. Other facilities that generate high levels of foot-traffic include parks, libraries, churches, community centers, and medical facilities. These inventories can help identify and prioritize where pedestrian improvements should be implemented.

Agencies can start building some of these inventories by reviewing up-to-date aerial photographs, or they may already exist in other computerized databases. However, sidewalk information generally cannot be accurately extracted from aerial photos; this information needs to be collected manually or extracted from photo-logs or video-logs. Sidewalk inventories can also be completed when pavement inventories are conducted. All the data should be in a GIS database that can be displayed on a computerized map or aerial photograph.

#### *Traffic Counts and Characteristics*

These data include Average Daily Traffic (ADT), peak hour motor vehicle traffic and the percentage of trucks in the traffic mix. Many agencies maintain motor vehicle traffic count maps showing flows on all arterial and most collector streets, and this information is generally updated every three to five years. Also, some agencies post the motor vehicle traffic volumes maps on their Web sites and are continuously updating the ADTs when new counts are made. Speed limit data files or maps are also maintained and updated by many agencies. Ideally these databases should be geo-coded and combined with roadway/sidewalk inventories; they can be used to help prioritize pedestrian improvements or to assess a location, corridor, or area for safety improvements. Jurisdictions can conduct pedestrian volume counts at intersections at the same time as they perform vehicle turning movement counts. These data are relevant to pedestrian safety as most severe injury pedestrian crashes typically occur in areas with high motor vehicle traffic speeds and on wide roadways which often have high motor vehicle traffic volumes.

Other inventories that can be compiled to assist agencies in keeping track of where pedestrian improvements are or should be made include:

### **Pedestrian Surveys State of Arizona**

The Arizona Department of Transportation gathered information from the public regarding walking and bicycling through the use of a survey. The survey solicited detailed information regarding the existing walking conditions and issues, the Plan, and potential improvements to walking and bicycling facilities. A summary of the comments received as well as a copy of the survey instrument are included in the 2003 Arizona Department of Transportation Statewide Bicycle and Pedestrian Plan.

For more information, visit: <http://www.azbikeped.org/statewide-bicycle-pedestrian-intro.html>.

## Census Data Use

### Cambridge, MA

The City of Cambridge included 1990 Census data in its 2000 Pedestrian Plan to reveal the role that walking plays in the City. The data show that of the city's 39,405 households, 11,107 (or 28.2 percent) have no car. The plan also reports Census data showing that 25.4 percent of Cambridge residents walk to work and 24.5 percent take transit. In addition, of the 107,000 people who work in Cambridge, 13.3 percent walk to work, and 21.3 percent take transit.

For more information, visit: [http://www.cambridgema.gov/~CDD/et/ped/plan/ped\\_plan.html](http://www.cambridgema.gov/~CDD/et/ped/plan/ped_plan.html).

- Street light inventories—single versus double sided lighting, spacing of lights, and the size of lights (level of illumination).
- Crosswalk inventories—location and type of crosswalk markings (especially helpful for maintenance activities).
- Inventories of school locations, crosswalk locations, and school-related signs.
- Inventories of pedestrian warning signs, and the last dates when the signs were replaced (to ensure retro-reflective signs are in place).
- Inventories of pedestrian generators such as parks, libraries, medical facilities, senior citizen homes, etc.

### *Pedestrian Surveys*

Travel surveys can provide a measure of pedestrian travel, including origins and destinations, trip purpose, and travel routes. This is especially helpful where an agency does not have the resources to conduct pedestrian counts. Travel surveys are generally done on a sample of the population and are extrapolated to represent the entire community. Travel surveys are generally conducted for all modes, including pedestrian travel. It is important to remember that bus riders are also pedestrians when they walk to and from transit stops on either end of their trip. Consider the language in which the survey is written; some areas (e.g., international areas) may have predominately non-English speaking populations.

Surveys also provide helpful information on the quality of the walking environment and unmet pedestrian needs, fears, or other concerns. Safety-related problems can be identified by these surveys as well as barriers to walking.

Surveys can be conducted over the phone, in person, or via the internet. Each method has advantages and disadvantages, and the surveys can be very labor intensive to collect. The length of the survey is important: complex or long surveys may not be returned. Short surveys will provide limited information but are more likely to be completed and returned.

Another form of pedestrian survey is a pre-addressed mail-back postcard that can be made available at community centers, libraries, on buses, etc. for pedestrians who face travel challenges along the sidewalk or at street crossings. They can be used to report the need for sidewalk repair, curb ramps, more crossing time at a traffic signal, etc. This service is ideal for getting feedback from pedestrians with disabilities. This survey should have check boxes for the most common problems, and should ask for the person's name and phone number for follow-up investigation. The public is the "eyes and ears" for a public agency, and this type of input from the public should be welcomed. Each complaint should be investigated, and the person who submitted the card should be contacted when the repair is completed. Other forms of public input are discussed in Chapter 2.

#### *Other Data Sources to Use: Census and NHTS*

Information obtained from the Census can be included in a plan to reveal the mode split for transport to and from work and the rate of auto ownership by census tract. The National Household Travel Survey (NHTS), a joint effort by the Bureau of Transportation Statistics and the Federal Highway Administration, includes information on both long-distance and local travel by the American public. The joint survey gathers trip-related data such as mode of transportation, duration, distance, and purpose of trip. Both sources also include demographic, geographic, and economic data, which can be used for analysis purposes. Census data typically are too coarse to identify problem areas, but can be a helpful tool for pedestrian safety advocacy.

#### *Audits*

An audit is another tool which can be used to assess the pedestrian needs of a community. Audits involve a review of all of the data for a location or travel corridor analyzed by a multi-disciplinary team independent of the site or project being audited that will include someone from the traffic and/or public works departments, police, and other agencies that serves pedestrians such as Neighborhood Services, Planning, Housing, or Development Services. A multi-disciplinary team will often allow a fresh look at pedestrian and motor vehicle traffic conditions at a location or along a corridor. A more detailed discussion on needs assessments and how to develop countermeasures appears in Chapter 4.

#### *Pedestrian Level of Service*

Many of the data collected in the aforementioned methods can be used in a Pedestrian Level of Service (PLOS) model which can determine areas where pedestrian levels of service are insufficient. PLOS models can focus on intersection crossings or road segments. A PLOS model describes in quantitative terms what the pedestrian experiences qualitatively. It is quite different from the LOS measures found in the *Highway Capacity Manual*, which essentially measures delay to the motorist or pedestrian caused by other vehicles on the road or pedestrians on the sidewalk. Rather, newer PLOS models developed and used take into account such measures as comfort and safety as well as ease of mobility.



The sidewalk in the top photo has a LOS “A” while the photo below has a LOS “F” according to the *Highway Capacity Manual* model that is based primarily on delay. Clearly, for pedestrians, mobility is not the only thing that determines the quality of the walking experience. This example illustrates the need for new PLOS models to take into account other factors such as safety and comfort. These factors can be measured both quantitatively and qualitatively in various types of PLOS models.

While typical PLOS analyses are strictly quantitative (number of lanes, conflicting volume, delay), the perceived LOS for pedestrians may involve more qualitative concerns. These qualitative variables—including the aesthetic quality of land use along the roadside or the quality of the sidewalk surface—may be collected separately in a “Walkability Audit.” Some qualitative factors can be measured quantitatively such as separation of sidewalk from traffic lanes, the amount of motor vehicle traffic, and presence of pedestrian enhancements such as shade trees and benches. Some PLOS models go further and include elements of the environment adjacent to the right-of-way, such as the presence, type, setback, and orientation of buildings. PLOS and walkability audits may also consider the difficulty of crossing the street, essentially a form of gap analysis. The greatest obstacles to safe crossings are a combination of high motor vehicle traffic speed and volumes, numerous travel lanes, and wide streets. While these measures of comfort or perceived safety clearly affect pedestrian walking decisions, they should be distinguished from the standardized LOS procedure to assure objective results.

A comprehensive PLOS measure captures the multifaceted complexity of pedestrian travel, from the ability to walk comfortably down a street, with interesting things to see along the way, to the ease and safety of crossing the street. No standardized PLOS procedure has yet been adopted. Several states, including Florida and Oregon, are in the process of developing PLOS models as one tool to be used to assess pedestrian conditions. The relative weight to place on various factors is being debated among practitioners. This process requires

substantial field investigation. The process involves listing all factors considered important to the comfort, convenience, and safety of the pedestrian. Scores are given to each factor, weighted as to their relative importance. Typical factors (both quantitative and qualitative) include but are not limited to:

PLOS variables for intersections include:

- Presence or absence of marked crosswalks.
- Width and quality of the crosswalks.
- Volume and speed of conflicting motor vehicle traffic.
- Width of street/number of travel lanes.
- Traffic control at crossings.
- Signal timing and displays.

- Curb radii.
- Existence of median islands or safety islands at crossings.

PLOS variables for road segments include:

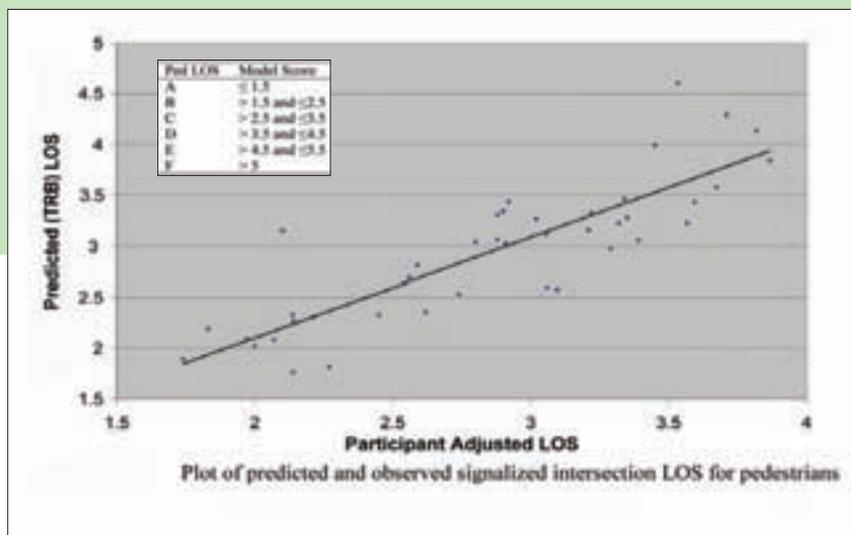
- Presence or absence of sidewalks.
- Width and quality of the sidewalks.
- Separation of the sidewalk from moving motor vehicle traffic.
- Presence of amenities such as benches and shade trees.
- Volume and speed of adjacent motor vehicle traffic.
- Width of adjacent street/number of travel lanes.
- Accessibility of adjacent land uses.

### Level of Service Model for Signalized Intersections for Pedestrians State of Florida

The Florida Department of Transportation uses a level of service (LOS) model to represent pedestrians' perceptions of crossings at signalized intersections. The model is more quantitative than others, considering geometric characteristics of intersections and adjacent streets. The model incorporates perceived safety/comfort (i.e., perceived exposure and conflicts) and operations (i.e., delay and signalization) to provide a measure of the pedestrian's perspective on how well an intersection's geometric and operational characteristics meet his or her needs. The general model for the Pedestrian LOS at intersections is highly reliable, has a high correlation with the average observations (see chart below), and is transferable to the vast majority of metropolitan areas in the United States. Studies of the model reveal that primary factors in the PLOS model for intersections include right-turn-on-red volumes for the street being crossed, permissive left turns from the street parallel to the crosswalk, motor vehicle volume on the street being crossed, midblock 85 percentile speed of the vehicles on the street being crossed, the number of lanes being crossed, the pedestrian's delay, and the presence or absence of right-turn channelization islands (Petritsch, 2005; FDOT, 2002).

For more information, see:

[http://www.dot.state.fl.us/safety/ped\\_bike/ped\\_bike\\_standards.htm](http://www.dot.state.fl.us/safety/ped_bike/ped_bike_standards.htm).



# Chapter 4: Analyzing Information and Prioritizing Concerns



.....  
“ *There will always be more improvements to be made than can be accommodated. Thus, a prioritization system needs to be developed to rank the various competing projects.* ”  
.....

Improving pedestrian safety in a community or region is typically the result of implementing different safety treatments and changing agency design policies. Crash countermeasures, or treatments intended to address pedestrian safety concerns, can take several different forms: operational and construction projects intended to fix specific problems; changes in design guidelines to help improve streets and intersections in future projects; and education and enforcement programs aimed at achieving changes in motorist and pedestrian behavior or attitude.

Projects involving pedestrian crash countermeasures can be further subdivided into:

- 1. Countermeasures for spot locations.
- 2. Countermeasures for corridors.
- 3. Countermeasures for targeted areas (including neighborhoods).
- 4. Countermeasures for general problems common to an entire jurisdiction.

This chapter presents methods to categorize concerns, identify locations, and address the issues of pedestrian safety through prioritizing improvements and utilizing other implementation strategies. A detailed discussion of actual countermeasures is provided in Chapter 5.

## **Categorizing Concerns for Pedestrian Safety**

A systematic procedure is needed to identify what (and where) countermeasures should be implemented to provide for a safer walking environment. There will always be more improvements to be made than can be accommodated. Thus, a prioritization

system needs to be developed to rank the various competing projects. Typically, the severity of pedestrian crashes is so disproportionately high compared to other motor vehicle crashes that the elimination of a few pedestrian crashes will result in a high safety dividend and high benefit/cost ratios.

Unlike vehicle crashes, crash rates for pedestrians are typically not used, since pedestrian volumes are usually not known. The crash to volume relationship for pedestrians is different than for vehicles. A single pedestrian crash at a low volume location will result in a high rate, while several crashes at a major downtown crossing may correspond to a low rate. Additionally, it is uncommon for agencies to invest extensive manpower to collect the system-wide pedestrian counts that are needed to develop rates; pedestrian crash rates would also need to account for motor vehicle volumes.

Instead, high pedestrian crash locations, corridors, and targeted areas should be initially identified by comparing the total number of pedestrian crashes. System-wide concerns for a jurisdiction can be inferred from the sum of all data.

Another method of identifying and prioritizing high crash locations is by using weighted pedestrian crash data, giving more weight to severe or fatal pedestrian crashes. When identifying and prioritizing high crash locations, three to five years of computerized crash data should be used. For prioritizing corridors or other targeted areas, one to three years of pedestrian data are acceptable.

The first step in determining the right countermeasure is to look at the problem and determine whether the problem is a spot problem, a problem evident in a targeted area or along a corridor, or a broader and more general problem that affects an entire jurisdiction.

1. A spot location problem is unique to one location.
2. A corridor problem may be evident at several sequential intersections or along the roadside of a corridor; to successfully reduce crashes, countermeasures need to be applied throughout the corridor, not just at a single location; fixing one location may leave other similar areas untreated.
3. A targeted area problem may repeat itself in a neighborhood or other area where conditions are similar throughout. Similar to the corridor problem, the nature of the roadway is such that fixing a spot area may leave other potential areas untreated; the solutions are very likely to be the same all around the neighborhood. A neighborhood or targeted area problem may be common throughout a local area due to unique circumstances such as a large university, commercial or business district, or other neighborhood characteristic.
4. An entire jurisdiction problem is common to an entire city, county, or state and is usually caused by an undesirable practice such as failing to routinely install sidewalks or paved shoulders for pedestrians or failing to provide streetlights.

Once it has been determined that a problem is one of these types, the next step is to determine whether the appropriate solution is an operational/construction, general design, or an education/enforcement countermeasure.

## Identifying High Crash Locations, Corridors, Targeted Areas, and Jurisdictions

Pedestrian safety problem locations, areas, and jurisdictions are most readily identified using computerized crash information.



Above is an example of a spot location where closing a driveway close to the intersection and constructing a sidewalk reduced the potential for pedestrian-motor vehicle conflicts.



In this corridor, pedestrian level lights and planter boxes have been added to buffer pedestrians from vehicle traffic and provide safer and more secure nighttime conditions.

### *Spot Locations*

For spot locations, countermeasures are most likely going to be operational/construction changes, but they could occasionally be changes to education/enforcement programs. Operational/construction countermeasures include anything from a change in crosswalk striping or signal timing to construction projects such as curb extensions, realignment of an intersection approach, or building a pedestrian crossing island. Education/enforcement solutions include spot enforcement of drivers-yield-to-pedestrian laws or education materials aimed at well-defined user group. Three to five years of pedestrian crash data are typically beneficial in identifying and prioritizing high crash locations.

### *Corridors*

For problems that occur along corridors, an assessment of the entire corridor is necessary. For analysis purposes, study areas can be subdivided into roadway segments of 0.8 km to 8 km (0.5 mi to 5 mi) in length. Crashes at first may seem to occur in undefined, almost random locations. A more thorough analysis may reveal patterns such as crashes occurring primarily at transit stops or at night. What seemed like an insurmountable problem can be tackled systematically and comprehensively by focusing one or two countermeasures throughout the corridor. For example, in the case of a predominance of nighttime crashes, improving illumination throughout the corridor may solve many problems.

In the case of transit-related crashes, working with the local transit provider to assess all bus stops may lead to simple solutions such as relocating, adding, or eliminating some stops, and implementing countermeasures to assist pedestrians in crossing the street at a limited number of critical locations. Two to three years of pedestrian crash data are typically sufficient for corridors.

### *Targeted Areas*

When identifying high crash targeted areas within the agency, geographic information system (GIS) data are important. Small communities or jurisdictions may be able to manually map pedestrian crashes, but this task is difficult and time-consuming for larger cities with several hundred annual pedestrian crashes. It is important that statewide computerized crash data systems allow for geographically mapping crashes for analyses purposes. One to three years of pedestrian crash data are reasonable to identify area-wide problems.

For targeted area problems occurring throughout a neighborhood, a similar approach to that outlined in corridor problems should be taken. Are there patterns, similarities, or a predominance of one crash type? Neighborhood problems may be more amenable to education/enforcement solutions, as the traffic that goes through a given neighborhood tends to be made up of the same travelers nearly every day. Engineering improvements can include area-wide traffic calming or the installation of sidewalks or streetlights. In some cases, changes in local, regional, or state policy may be necessary to allow or promote these improvements.

### *Jurisdiction-wide Problems*

For a problem that is common throughout an entire jurisdiction, agencies should ensure that their policies, plans, and engineering design guidelines adequately embrace the appropriate countermeasures. Problems in spot locations, targeted areas, corridors, and jurisdictions can often reveal a fundamental design flaw in the roadway; solutions then include changes in design guidelines. Chapter 5 provides a list of design solutions and countermeasures that should be incorporated into the agency's design manuals, practices, and procedures so all future road projects are designed with these safety features at the onset.

### *High Pedestrian Crash Potential*

A lack of pedestrian crashes does not mean that conditions are safe or ideal for pedestrians. Pedestrians may avoid certain areas because they perceive danger. Consequently, low pedestrian crash frequencies are not necessarily indicative of a safe facility, but may be a consequence of low or zero pedestrian activity. A pedestrian safety analysis should therefore go beyond just looking at pedestrian crashes.



**Traffic calming techniques, such as chicanes, were used in this targeted area to slow vehicle speeds on neighborhood streets.**



**An example of a jurisdictional change is a city-wide policy for the installation of ADA-compliant curb ramps.**

## Identifying Pedestrian Safety Concerns

### State of California

Some states, such as California, may have output reports (SWITRS, TASAS) that can be provided to assist jurisdictions in identifying their injury and fatality statistics beyond just numbers (e.g., crashes and victim data by hour of day, day of week, month, year, motorist data, vehicle data, victim gender, race, and age, extent of injury). In California, this information can be provided by the California Highway Patrol (CHP) or Caltrans. This information is easily obtained and analyzed to help further develop crash countermeasures. Analyzing the data can be performed with simple EXCEL spreadsheets or advanced packaged software, such as Crossroads or Intersection Magic, depending on the agency resources. The Metropolitan Transportation Commission (MTC) is working to develop an online toolkit to help Bay Area jurisdictions of all sizes to perform collision analyses using available data and to offer a variety of countermeasures for consideration. The toolkit is available online at: <http://www.mtc.ca.gov/planning/bicyclespedestrians/index.htm>.

Methods to identify pedestrian deficiencies at low-crash or no-crash locations involve an analysis of the roadway, traffic, and other agency databases. By looking at the deficiencies that occur at high crash locations, an agency should be able to identify other locations with similar deficiencies. Safety improvements that are successful at one location should be implemented at all similar locations. This requires an inventory of spot locations, corridors, or areas to allow an agency to identify those places that have similar characteristics as the high pedestrian crash sites. Field reviews and public input through surveys or workshops can help identify these locations.



**In this image, a team performs a roadway safety audit on a local roadway.**

how each pedestrian crash occurred, and what may be done to prevent future similar crashes. The outcome is a list of improvements that can be implemented to address those crashes and enhance safety. For crashes involving severe and fatal injuries, police investigations are available for in-depth and detailed reviews of how the crash occurred and may provide information on what may have prevented it. These typically include witness statements as well as more detailed investigations of motorist and

### Analyzing High Crash Locations, Corridors, or Areas

#### *Field Reviews*

Once high crash locations, corridors, or areas have been identified, individual crash reports, complete with the police narratives and other detailed information, should be used when conducting field reviews. The detailed crash information and field reviews can be used to identify

pedestrian behavior and site conditions at the time of the crash. See Chapter 3 for a more detailed discussion of crash site reviews.

### *Roadway Safety Audits and Reviews*

Roadway Safety Audit Reviews (RSARs) involve the use of a multi-disciplinary team approach to review and evaluate a location, corridor, or area after it is built or before it is open to the public. Audit review team participants should include a variety of transportation professionals such as a traffic engineering expert, a human factors expert, a police representative, or a Planning-Neighborhood Services specialist. This team is provided all of the crash history and other data for the crash location or study area such as pedestrian and motor vehicle traffic counts. In order to have the best chance of observing the pedestrian safety problems, the team should visit the site when conditions best simulate the problems. For instance, if crashes are happening at night, the team should visit the site at night. The multi-disciplinary team members visit the location or corridor together with each member making their own observations of vehicle, traffic and environmental conditions. The observations and suggested solutions are summarized in a report once the team has a chance to compare notes. Pedestrian safety improvements implemented at one location can be implemented at other similar locations, even where no pedestrian crashes have occurred. Roadway Safety Audits (RSAs) are similar to RSARs except they are conducted before the system is built.

Pedestrian crashes may continue to occur at locations or along corridors or targeted areas where safety improvements have been implemented. This phenomenon may occur because more pedestrians are willing to cross at locations with one or more engineering enhancements, thereby increasing exposure. This may also be an indication that engineering solutions alone will not result in totally safe conditions. A proper before-and-after evaluation of any treatment is essential to determine how effective it has been.

The occurrence of a seemingly illogical pedestrian crash after the implementation of a safety measure has sometimes been attributed to a pedestrian's lack of understanding of the roadway environment. It can equally be attributable to the motorist's lack of understanding of the roadway environment. In many cases, therefore, education and enforcement programs may be necessary to achieve a true safety benefit. There are few engineering projects that can prevent motorists or pedestrians from choosing to travel intoxicated or that can stop motorists from willfully breaking the law. Education and enforcement programs addressing pedestrian safety problems should also be carefully implemented and evaluated (see Chapter 5 for more details).

### **Roadway Safety Audits**

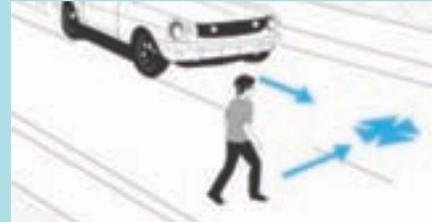
FHWA's Pedestrian Road Safety Audit Guidelines and Prompt Lists can be used to assess the safety of pedestrian facilities. The guidelines and prompt lists will help familiarize RSA teams with potential pedestrian issues and help them identify specific safety concerns related to pedestrian safety throughout the RSA process. For more information, visit <http://www.walkinginfo.org/library/details.cfm?id=3955>.

## Crash Typing

A crash type describes the pre-crash actions of the parties involved. When crashes in a database are “crash typed,” a pattern often emerges that helps safety officials identify what the problem is and what countermeasures are generally related to each crash type. The following six crash types are some of the most common pedestrian crash experiences:

### 1. Dart/Dash

The pedestrian walked or ran into the roadway at an intersection or midblock location and was struck by a vehicle. The motorist’s view of the pedestrian may have been blocked until an instant before the impact.



### 2. Multiple Threat/Trapped

The pedestrian entered the roadway in front of stopped or slowed traffic and was struck by a multiple-threat vehicle in an adjacent lane after becoming trapped in the middle of the roadway.



### 3. Through Vehicle at Unsignalized Location

The pedestrian was struck at an unsignalized intersection or midblock location. Either the motorist or the pedestrian may have failed to yield.



### 4. Turning Vehicle

The pedestrian was attempting to cross at an intersection, driveway, or alley and was struck by a vehicle that was turning right or left.



### 5. Through Vehicle at Signalized Location

The pedestrian was struck at a signalized intersection or midblock location by a vehicle that was traveling straight ahead.



### 6. Walking Along Roadway

The pedestrian was walking or running along the roadway and was struck from the front or from behind by a vehicle.



Other crash types include Working/Playing in roadway, Backing Vehicle, Bus-related, Crossing an Expressway, and Unique Midblock. For more details on the crash types and related countermeasures, see Chapter 3 of the “PEDSAFE: Pedestrian Safety Guide and Countermeasure Selection System” or find the “Crash Analysis” section in the on-line version at <http://www.walkinginfo.org/pedsafe>.

## Selecting the Appropriate Solutions

Once crash locations have been identified based on data analysis, crash patterns should be determined by narrowing in on specific crash types occurring at individual locations. If a pattern is observed, then it will be easier to select the solution that best applies to the crash type experienced. The Pedestrian and Bicycle Crash Analysis Tool (PBCAT) is a tool designed to assist transportation professionals in determining crash types based on data collected (see below). *PEDSAFE: Pedestrian Safety Guide and Countermeasure Selection System* (Harkey, 2004) is another resource for comparing crash types to appropriate countermeasures. It describes crash types and provides pedestrian crash statistics and includes descriptions of 49 different countermeasures or treatments that may be implemented to improve pedestrian safety and mobility. Also included are 71 case studies that illustrate the concepts applied in practice in a number of U.S. communities. Details about *PEDSAFE* are contained in Appendix F.

*To view PEDSAFE online, go to <http://www.walkinginfo.org/pedsafe>. To obtain a hard copy of PEDSAFE, please view the following link: [http://safety.fhwa.dot.gov/ped\\_bike/ped\\_bike\\_order.htm](http://safety.fhwa.dot.gov/ped_bike/ped_bike_order.htm)*

## Determining the Extent of Implementation

Once pedestrian safety solutions have been selected, the final decision is usually based on a combination of factors: is the project to be implemented in phases or all at once; is the project to be permanent or temporary; what are the cost constraints?

### FHWA's PBCAT Crash Typing Tool

The development of effective countermeasures to help prevent pedestrian crashes is often enhanced through the use of detailed computerized state crash files. Analysis of these data can provide information on where pedestrian crashes occur (city, street, intersection, two-lane road, etc.), when they occur (time of day, day of week, etc.), and characteristics of the people involved (age, gender, injury severity, etc.).

FHWA's Pedestrian and Bicycle Crash Analysis Tool (PBCAT) is a crash-typing software product intended to assist state and local transportation professionals in improving pedestrian safety through the development and analysis of a database containing details associated with crashes between motor vehicles and pedestrians or bicyclists. One of these details is the crash type, which describes the pre-crash actions of the parties involved. With the database developed, the software can then be used to produce reports and select countermeasures to address the problems identified. For further details about crash typing, see page 44.

For more information, visit: <http://www.walkinginfo.org/pc/pbcat.htm>.



The NCDOT Division of Bicycle and Pedestrian Transportation employs PBCAT on its Web site.

### *Phasing projects*

Phasing projects is most applicable to corridor or neighborhood/targeted problem areas. A desirable countermeasure may be very costly or politically challenging to implement all at once. Phasing allows certain elements to be implemented right away, as others wait further funding. There are several ways projects can be phased: geographically, by urgency, by opportunity, or by type of treatment.

Geographically—starting at one end of a corridor and completing it in units. For example, an 8 km (5 mi) corridor where a sidewalk is planned can be built in five 1.6 km (1 mi) sections over five years. This is a practical method, but may not address the most urgent needs first. Conversely, safety projects may be disbursed equally in different regions of a state or city so that all areas can share an improved safety for pedestrians and no areas feel slighted.

By urgency—treating the areas with the highest crash numbers or highest pedestrian activity first. This may seem logical and politically acceptable, but in reality there may be constraints that make the most needed areas the hardest to address. Reasons may include lack of right-of-way or topographical constraints.

By opportunity—if a certain type of treatment is needed up and down a corridor and it can be piggy-backed onto other planned projects in that corridor (such as maintenance or resurfacing projects), then it makes sense to implement these countermeasures along with the planned work.

By type of treatment—scheduling countermeasures by type of work. For example illumination may come first, as an agreement with the utility company makes it easy to do so right away. A more controversial countermeasure such as a traffic circle may have to wait until the political or design issues have been settled. Assuming both treatments will independently contribute to pedestrian safety, proceeding with one treatment while waiting for the other is acceptable.

### *Duration of Improvement*

Projects can be further subdivided into temporary and permanent categories.

In most cases, a permanent solution should be sought. It will cost the most, but will last for the duration of the roadway. A good estimate for the life of a permanent treatment such as a sidewalk is 20 years or more, but in reality they typically last much longer. In some cases, a temporary solution is more appropriate. This is the obvious choice where it is known a road is to be rebuilt soon, but the pedestrian safety needs must be addressed right away. There are other reasons to consider a temporary installation: if the solution is new and untested in the community or if the design cannot be finalized based on local conditions. A temporary installation can be used to gauge public acceptance and can be modified when user observations demonstrate corrections that may be helpful.

There are a variety of materials and designs that can be used for temporary solutions:

- Paint is the cheapest and can give an immediate impression of how the permanent solution will look and affect traffic operations; if simple lines are not enough to redirect traffic, hashing out areas with zebra stripes is often more effective at keeping cars out of certain areas; paint is very short term and should not be left in place for more than a few months, as it will wear out; nor should the experiment be considered a failure if motorists cross over the painted area, as there is really no physical barrier preventing them from doing so.
- Plastic posts or barrels provide more positive guidance and may last longer than paint.
- Plastic curbs offer a greater opportunity to create a picture of the proposed permanent solution, such as curb extensions or raised median islands.
- Concrete curbs can also be laid on the pavement; these are usually referred to as “wheel stops,” such as those found in parking lots. They are almost never used in the travel portion of the roadway but can be used as a substitute for a curb to protect a walkway. Wheel stops should be firmly anchored and supplemented with other measures. One potential disadvantage of wheel stops is that they may cause pedestrians to trip.

Temporary solutions should then be evaluated for their effectiveness. The techniques range from a full traffic study to observation and receiving public input. To warrant the time and expense of a traffic study, the temporary installation should closely resemble the final solution and therefore be made to look substantial—evaluating the effect of paint will not predict how a raised curb would perform.



### Temporary Project Solutions Bend, OR

The intersection in these photos was reconfigured in stages: first a curb was installed to redirect traffic at a right angle and the striping had to be redone to reflect the new geometry. Motorists and pedestrians were aware of the modified geometry and engineers were able to monitor its effect on traffic operations. In the second stage, the curbed area was filled with landscaping, offering a more permanent solution. This two-step process enabled the city to implement a change immediately and at a low cost. The more permanent landscaped solution had to be contracted out, a more time-consuming process. Temporary projects and strategically-phased solutions allow for fast implementation, leaving the agency time to consider more permanent alternatives.

Conversely, a temporary installation has its pitfalls, since plastic cones, posts, curbs, or orange barrels are usually not aesthetically pleasing, and may generate negative reactions just because it “looks cheap” or “ugly.” This can be mitigated by showing adjacent property owners an artist rendering of the completed project or photos of a similar treatment implemented elsewhere.

A temporary installation helps to identify unintended negative consequences. If the traffic study or public input indicates a problem, steps can be taken to redesign the countermeasure to avoid these consequences.

However, temporary installations may generate one major unintended consequence: total removal of the countermeasure because of negative public reactions. Complaints from a small but vocal minority may cause elected officials to bow to this pressure. The complaints often stem from the fact that some people simply do not like change, or the countermeasure affects their trip, requires them to drive more prudently, or creates a slightly longer distance. Opposition may also be generated from a lack of prior knowledge about the change or test. Garnering public support and buy-in from a citizen committee or stakeholders and effectively working and communicating with the community prior to implementing countermeasures will go a long way in blunting opposition before it is generated (see Chapter 2).

Bowing to pressure, removing the temporary installation, and then not installing the permanent countermeasure can have dire consequences for the intended beneficiaries: pedestrians. Many countermeasures such as curb extensions can be built right the first time with a great degree of confidence they will work as intended. Some users may complain, but rarely will an agency remove a permanent and fairly expensive feature if it is working as intended.

Safety evaluation results of temporary solutions should be shared with the public (area residents and/or business people, elected officials etc.). It should be made clear that the results may not be the same as the permanent solution, for the reasons cited above.

## **Prioritizing Pedestrian Improvements**

### *Initial Factors to Consider*

After all the steps outlined to this point have been implemented (stakeholder involvement, data collection and analyses, review of problem areas), the list of needed improvements may appear overwhelming at first. Pedestrian safety countermeasures can be prioritized taking into account the following factors:

#### Availability of Right-of-Way (ROW)

Most pedestrian safety countermeasures will not require additional ROW, as they usually involve road narrowing, striping, illumination, etc. Occasionally, additional ROW (or at least an easement) will be required, to create a sidewalk buffer for example. ROW negotiations can be lengthy, and it is best to start the process as soon as it is

determined the improvement is needed so the project is not unduly held up. A conceptual design should be enough to determine how much ROW will be needed, to help speed things along. Easements can often be obtained much quicker and at a much lower cost.

#### Federal and/or State Mandates

Certain countermeasures can be piggy-backed to projects scheduled to fulfill Federal or state requirements. ADA and curb ramp requirements are one example: if a safety countermeasure requires changing a corner radius, and the corner is slated for an ADA upgrade (ramp installation), the two projects can be combined for efficiency. Some Federal or state requirements are safety-related, such as upgrading deficient bridge guardrails; these projects should also include pedestrian safety measures.

#### Public Support

The data collection methods outlined in Chapter 3 will often make the most problematic areas rise to the surface. Yet there are some crashes that strike an emotional chord in the public, like when a child is hit while walking to school. This will create tremendous public support for a countermeasure that addresses this issue. The responsible agency should pursue a solution to this problem while not losing sight of the goal of making improvements where most crashes occur. Similarly, the solution should be one that improves pedestrian safety and is not a response that may make conditions less safe for motorists and pedestrians. However, responding positively to an emotionally-charged situation is an opportunity for the agency to pursue funding for other needed pedestrian crash countermeasures as well as gain acceptance of a fairly progressive countermeasure.

## Prioritization of Crosswalk Improvements

### Seattle, WA

Over 600 crosswalk locations were surveyed and divided into “compliant,” “possibly compliant,” and “non-compliant” using recommendations from a FHWA safety study (Zegeer et al., 2005). The possibly compliant and non-compliant locations were then mapped as shown below. It was immediately clear that most of the locations were along 12 corridors. This, combined with crash data, provided a list of prioritized corridors for making improvements. The crosswalk inventory allowed analysts to identify crosswalks with safety concerns and determine feasible safety measures for the prioritized list (Hefferan, 2004).



Legend: yellow dots indicate possibly compliant locations and red dots indicate non-compliant ones.

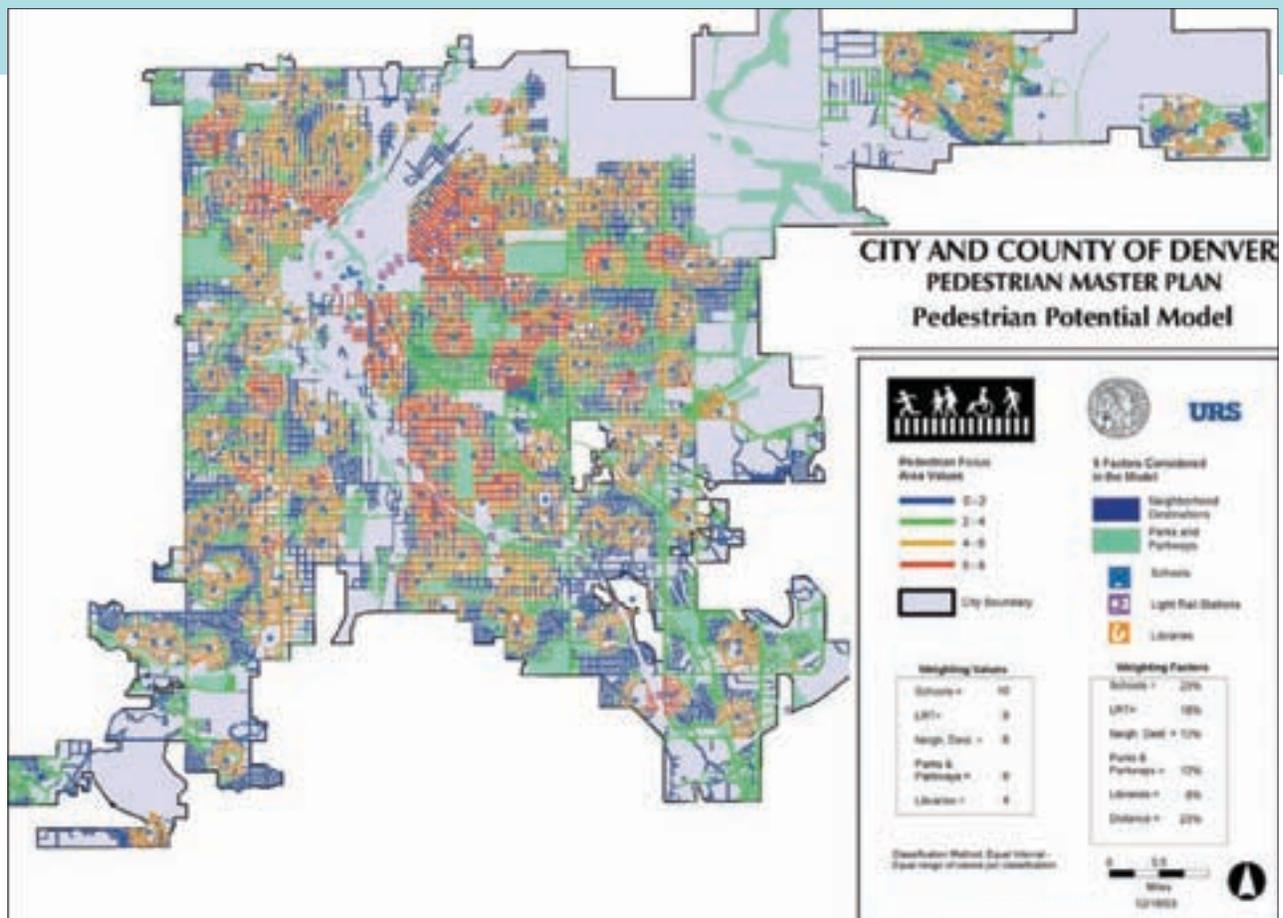
## Project Prioritization System

### Phoenix, AZ and Denver, CO

Phoenix, AZ has a sidewalk retrofit and street modernization program to build missing pieces of sidewalks and other street infrastructure improvements in developed neighborhoods. Projects are ranked based on various factors including the street classification (collector streets are given a higher priority than a local street) and the proximity to a pedestrian generator (school, church, park, or medical facility). Projects are assigned points in several such categories and are ranked in each of the eight Council Districts so that all parts of the City receive some safety and infrastructure improvements rather than all of the funding being directed to one area.

The Denver, CO pedestrian plan prioritized potential improvements using several different criteria. This criteria included a proximity analysis—an analysis of the presence of sidewalks and the proximity of facilities that are likely to generate pedestrian activity, including light rail transit stations, schools, parks and parkways, libraries, and neighborhood destinations. In addition, socio-economic data, existing sidewalk conditions, auto-pedestrian crash history, and pedestrian route proximity were used in the prioritization of projects. A project scored zero, one, or two points in each criteria or category; the maximum points a project could score was ten while zero was the lowest a project could score. This system of scoring projects based upon points they earn for each criteria allowed the Advisory Team to objectively determine the level of importance for each project and therefore the priority for project implementation and completion. See the image below for a geographical representation of the pedestrian potential model developed.

For more information, visit: <http://phoenix.gov/streets/index.html> or [http://www.denvergov.org/transportation\\_planning/](http://www.denvergov.org/transportation_planning/).



### Travel Demand

Though pedestrian crashes do not always correlate to pedestrian use (pedestrians often get hit in areas where fewer people walk), countermeasures in an area where there are many pedestrians will be easier to justify.

### Cost of Improvements

This is always an important factor in all decision-making: should an agency try to spread available funding to many low-cost countermeasures, or target funds for a few high-profile projects? Some of the most expensive countermeasures are not necessarily the most effective. The best examples are pedestrian bridges and underpasses: they can cost millions of dollars but get little use because of inconvenience or security concerns. Several new pedestrian signals can be installed for the cost of one tunnel or bridge. Conversely, inexpensive measures, such as improved striping, can be quickly implemented over an entire corridor or neighborhood for comparatively little cost.

### Funding

Some funding sources can only be used for limited applications. Many common funds can be used only for construction, only for education, or only for enforcement. This is not necessarily a limitation, as a typical safety program will involve all three components. If a funding source becomes available, but has limitations, this should not be an impediment to implementation—every funding opportunity should be seized as it becomes available (see Chapter 6 for more about funding).

### Safety Benefits

Decision-makers want to ensure the maximum cost-effectiveness, so the most effective countermeasures that offer the greatest safety benefits should be considered first. Some pedestrian safety countermeasure will have benefits for other road users, and some may have negative consequences for others. These issues need to be weighed against all other considerations. This highlights the need to develop a ranking system to prioritize projects.

## **Developing a Ranking System to Prioritize Projects**

Transportation agencies often develop a ranking system for making improvements such as surface preservation, modernization, or safety. Pedestrian safety countermeasures are no different. The idea is to assign scoring to the various criteria, weighting each one according to the values of the community, available funding, political climate etc. Other scoring factors can be added, and each one needs to be weighted so it represents an agreed-upon value.

### *Pedestrian Needs Index*

The primary input to a Pedestrian Needs Index (also called a Pedestrian Potential Index or Deficiencies Index) is pedestrian crash data. In addition to crash data, inventories of missing sidewalks, lighting, and other pedestrian facilities can be used to identify where upgrades are needed. Lists can be prioritized using pedestrian count

data or proximity to schools or other pedestrian generators. Projects should be reassessed and reprioritized annually, and funding should be assigned so that all regions within a state or an agency receive some level of pedestrian facility enhancements and all of the improvements are not concentrated in one area. Each agency should create its own Pedestrian Deficiency Index based on the resources available, and develop a point system to compare and assess various projects. Pedestrian crash history can be an input to this ranking system.

Category	Possible Points
Severity of problem (how many crashes have occurred or are likely to occur)	15
Effectiveness of solution	15
Probable use (travel demand)	15
Likelihood of funding	10
Feasibility (constructability: piggy-backing, available ROW, etc.)	15
Public support	15
Cost	15
Bonus: achieves other goals (motorist/bicyclist safety, aesthetics)	possible 10 points
<b>Total</b>	<b>100</b>

Above is an example of a ranking system used to establish pedestrian project priorities.

Any ranking system can be subject to personal bias if multiple observers or analysts contribute. A standardized form or checklist can enhance objectivity of the results. GIS methods can be used to automate the ranking process for large areas from a database. A scoring system where the total possible points add up to 100 makes it easier for the public to appreciate how a proposal fares; it also makes it easier to tweak individually weighted category scoring. Sample categories, with sample weightings, could be similar to the ones in the table at left.

The first attempt at a scoring and weighting system is rarely perfect. A Pedestrian Advisory Board (PAB) as described in Chapter 2 can help develop the ranking system. It should then be field-tested on real-world problem areas so that the results appear rational and those

projects that are obviously needed score highly. A potential downside is that a problem the public has identified as a major crisis may score low if it fails in several important categories. A scoring system created and backed by a PAB that represents the public's interests can help deflect criticism. It can also help ensure that projects that solve a real but ignored problem get the attention they deserve. However, if a scoring system is created and the high-scoring projects are not implemented, it may create a liability problem for the agency.

### **Legislative/Public Oversight**

As stated in Chapter 2 on stakeholders, prioritizing pedestrian safety projects transparently and based on good data and public input can help an agency make decisions that lead to the best projects being selected within their given funding limitations. It also

enables the agency to pursue its charter with assurance that it is accomplishing the goals it was set out to achieve: reduce pedestrian crash risks.

Legislative/public oversight helps establish goals, secure funding, etc. But much of what is known by professionals in the field of pedestrian safety may not be fully understood by the general public. The agency should operate in a climate of open communication and explain to the public, elected officials, and the media what it is doing as well as how and why. This will help ensure that the agency is allowed to pursue its mission and implement the best solutions to the most urgent problems without constant questioning or review. An effective solution that is installed quickly can demonstrate the agency's overall effectiveness in dealing with pedestrian safety problems and will facilitate future successes.

*Chapter 2 describes how to proceed with this information in a manner that ensures maximum effectiveness. Jurisdictions that have been given the responsibility of oversight to a Pedestrian Advisory Board (PAB) should trust the PAB to carry out its mission with minimal interference.*

## Chapter 5: Selecting Safety Solutions



Jurisdictions should ensure that all of their policies, plans, and engineering design guidelines include considerations for pedestrian safety. The design solutions mentioned in the first part of this chapter should not be viewed only as fixes to spot problems; they should be incorporated into the agency's design manuals, practices, and procedures so all future road projects are designed with appropriate access and safety features.

“*Measures to improve pedestrian safety should not be limited to engineering treatments; education and enforcement are also important for pedestrians.*”

This chapter explores the most commonly used and effective pedestrian crash countermeasures. Each is briefly described with available information concerning its effectiveness. A few other design considerations are also explained. Appendix H complements this chapter, providing a checklist of things to consider when implementing crash countermeasures. The chapter is organized into the following topics:

- Design Specifications and Guidelines.
- Engineering Solutions.
- Enforcement and Education Solutions.
- Policy and Planning Solutions.
- Countermeasures to be Used with Caution.
- Consequences of Countermeasures for Other Road Users.

### Design Specifications and Guidelines

There are numerous policy, planning, and design guidelines that transportation planners and engineers can use; however, only a few address pedestrian designs thoroughly. AASHTO has recently published the *Guide for the Planning, Design, and Operation of Pedestrian Facilities*. An example of a state pedestrian design guide is Washington DOT's *Pedestrian Facilities Guidebook*; one city/regional example is the *Planning and Designing for Pedestrians: Model Guidelines for the San Diego Region*. Additionally, FHWA has an excellent publication: *PEDSAFE: Pedestrian Safety Guide and Countermeasure Selection System* (FHWA-SA-04-003). The *Manual on Uniform Traffic Control Devices* (MUTCD) should be used for selecting appropriate traffic controls: signs, traffic signals, marked crosswalks,

and other pavement markings. See Appendix F for more information on these and other available references.

Many of the above-mentioned pedestrian policy, planning, and design guidelines—along with those in Appendix F—were used to develop the following list of some of the more effective countermeasures in terms of improving pedestrian safety. They should also be used by jurisdictions for guidance to fix spot problems and to update and improve agency design manuals, practices, and procedures.

## Engineering Solutions

The countermeasures presented here are organized according to the type of pedestrian crash.

### *Walking Along the Road Crashes*

#### Rural environments:

1. **Paved shoulders**—Paved shoulders provide room for pedestrians to walk separate from motor vehicle traffic in rural areas when providing sidewalks is not a feasible option. Paved shoulders also provide room for bicyclists. Paved shoulders have many safety and operational advantages for motor vehicle traffic as well. To be effective, paved shoulders should be 1.8 m (6 ft) wide or more; 1.2 m (4 ft) is considered the minimum acceptable width to accommodate pedestrians (AASHTO Green book, 2001). Rural environments near large urban areas or those experiencing rapid growth should be considered suburban, where sidewalks are the preferred pedestrian accommodation. Newly-developed communities should provide sidewalks and other pedestrian facilities.



**Paved shoulders offer pedestrians on rural roadways a safer place to walk.**

#### Urban and Suburban Environments:

1. **Sidewalks**—Sidewalks can eliminate most walking-along-the-road pedestrian crashes by providing positive separation from motor vehicle traffic. Continuous and connected sidewalks are needed along both sides of streets to prevent unnecessary street crossings. Sidewalks generally should not be placed immediately adjacent to moving motor vehicle traffic. Whenever possible, they should be buffered with a planter strip, parking lane, shoulder, or bike lane. This will increase pedestrian safety and comfort and can make it easier to meet the ADA requirement for a level passage through driveways and the requirement for a



**Sidewalks provide safe spaces for pedestrians to walk.**



**Driveways should be designed so that the sidewalk continues through the driveway in a relatively flat and level alignment.**



**Pedestrian-level light fixtures increase pedestrian visibility at night and provide a better sense of security.**

clear passage around utility poles, posts, fire hydrants, etc. (these can be placed in a landscaped buffer zone). Planter strips should be 1.5 m (5 ft) wide or greater; 1.8 m (6 ft) is a desirable minimum. Separated sidewalks should also be 1.5 m (5 ft) wide or greater; 1.8 m (6 ft) is a desirable minimum along arterial streets in non-commercial areas. Along arterials where there is no buffer, curbside sidewalks should be 3.0 m (10 ft) wide or greater. Sidewalks should provide a continuous effective width to prevent choke points from being created by street furniture. In downtown areas, considerations must be made for outdoor seating for restaurants. Rolled (mountable) curbs are not recommended. Continuous and connected sidewalks are needed along both sides of streets to prevent unnecessary street crossings.

2. **Driveways**—Well-defined driveways clearly mark the area where motorists will be crossing the pedestrian's path. Non-defined vehicle access points with continuous access to parking create a long conflict area between pedestrians and motorists. This added area of ambiguity complicates the motorist's task of watching for pedestrians.
3. **Driveway design and spacing**—driveways should be designed to look like driveways, not street intersections (sidewalks should continue through the driveway). Local policies should prohibit blocking the sidewalk at driveways and these policies should be enforced. Driveways should be kept as narrow as possible. The level of the sidewalk should be maintained, and the driveway should be sloped so that the motorist goes up and over the sidewalk. This will help with a number of goals: meeting ADA accessibility requirements will be easier, the fact that the pedestrian has the right-of-way will be clear, and motorists will need to slow down slightly to enter the driveway, which will help promote pedestrian safety. Driveways should be located away from intersections. The number of driveways should be minimized (consolidate whenever possible) to reduce the number of conflict points for pedestrians. This access management is also a safety advantage for motorists.
4. **Illumination**—Pedestrian crashes disproportionately occur at times of poor lighting (mostly dusk and nighttime). Illumination greatly increases the motorist's ability to see pedestrians walking along the road. Double-sided lighting should be provided along wide arterial streets to illuminate both sidewalks for the security and safety of the pedestrian. Light uniformity along a road is also important. Lights

should be spaced to minimize or eliminate dark areas along the road and sidewalks. For midblock and intersection crossings, it may be helpful to provide extra lighting to crossings with high nighttime pedestrian use.

### *Crossing the Road Crashes*

#### Midblock crashes:

1. **Pedestrian crossing island**—On two-way streets, a median island at uncontrolled locations can help reduce crashes by up to 40 percent. The benefits are greatest on busy multilane streets where gaps are few and difficult to find. A pedestrian crossing island breaks an otherwise difficult crossing maneuver into two easier steps: instead of needing to find a gap long enough to cross all lanes at ones, a pedestrian looks left, finds an acceptable gap in one direction only, crosses to the island, then looks right and finds a second gap.



**Pedestrian crossing islands provide a refuge when crossing wider roads.**

## **In-Street Pedestrian Crossing Signs**

### **State of Pennsylvania; State of New York; and Portland, OR**

In 2001, the State of Pennsylvania began providing municipalities with in-street pedestrian crossing signs. The in-street crossing signs are incorporated in the MUTCD in Section 2B.12. To date, more than 2,000 signs have been installed. The signs cost about \$200 each and are distributed to municipalities through the DOT regional offices. The signs are to be placed at unsignalized crossings on roadways with a speed limit of 56 km/h (35 mi/h) or less. The signs are typically set 1.5 to 3.0 m (5 to 10 ft) in advance of the crosswalk (attached to the pavement) but can be placed as far as 15.2 m (50 ft) from the crosswalk. A number of Pennsylvania municipalities have used the signs as a visible part of larger pedestrian safety programs, involving education, enforcement, and design components.

A study has been conducted evaluating the effects of pedestrian safety cones placed in streets in upstate New York, Long Island, and Portland, OR (Huang, 2000). The in-street pedestrian crossing cones, like the in-street pedestrian crossing signs, serve the same purpose: to display a consistent and accurate message, i.e., the relevant law for yielding to pedestrians. The study findings confirm that pedestrian safety cones can improve conditions for pedestrians who benefit from motorists' yielding to them. Findings suggests that motorists were more likely to yield to pedestrians after the signs had been placed on the roadway.



For more information, visit: <http://www.dot.state.pa.us> or <http://www.tfhrc.gov/safety/pedbike/pubs/00-098.pdf>.



**Two-stage crosswalks with fencing help direct pedestrians to look for vehicles coming from the right.**



**Curb extensions can increase the visibility of pedestrians and motorists.**



**Advance stop lines can help prevent multiple threat pedestrian crashes.**

2. Two-stage crosswalk with median fencing—Some agencies provide railings/fencing in the medians of multilane roads that channel pedestrians to the right, increasing the likelihood that they will look for vehicles coming from their right in the second half of the crossing. It should be mentioned, however, that these types of crossings can be problematic for pedestrians who are blind and for wheelchair users.
3. Curb extensions—On streets with on-street parking, curb extensions reduce the total crossing distance. Reducing the crossing distance helps pedestrians in two ways: it reduces the time they are exposed to moving traffic, and it makes it easier for pedestrians to assess and find an acceptable gap, as the time needed to cross is shorter. They also increase visibility: the waiting pedestrian can better see approaching motor vehicle traffic and motorists can better see pedestrians waiting to cross the road; their view is no longer blocked by parked cars. Curb extensions should be designed to accommodate storm water drainage and should never extend more than 1.8 m (6 ft).
4. Illumination—See discussion on page 56 concerning illumination.
5. Crosswalks at uncontrolled locations with advance stop bar (or yield line)—On multilane streets a common and often fatal crash type is the “multiple-threat” crash, in which a motorist in one lane stops to let a pedestrian cross, but so close to the crosswalk as to mask a motorist in the adjacent lane who is not slowing down. The second motorist does not have time to react and the pedestrian is struck at a high speed. The advance stop bar or yield line (accompanied with a R1-5 or R1-51a YIELD HERE TO PEDESTRIANS sign) requires all motorists to stop back (30 to 50 ft is desirable); when the first motorist stops at the stop bar, it allows the pedestrian to see if a motorist in the second lane is stopping. This enables the pedestrian to wait or step back if he or she has started to proceed into the second lane. While the advance stop bar with appropriate signing has the potential to reduce the probability of a multiple-threat crash, this is no guarantee that 1) all motorists will stop for pedestrians and 2) all stopping vehicles will necessarily stop at the stop line, potentially on high-speed roads. Therefore, it is important to carefully select locations for unsignalized crossings, even if the advance stop bar and signing is used. Also, such sites should be monitored to ensure that pedestrians are able to cross safely and if not,

## Advance Stop/Yield Markings

### Halifax, Nova Scotia, Canada

Crosswalks on streets with multilane, uncontrolled approaches are often associated with a type of pedestrian crash termed a multiple threat crash. A major factor contributing to this kind of crash is the fact that the yielding vehicle stops (or slows) too close to the crosswalk, screening the pedestrian from the view of another motorist fast approaching in the lane that the pedestrian is to cross next. One treatment that addresses the issue of multiple-threat crashes is the use of yield markings placed 9.1 to 15.2 m (30 to 50 ft) in advance of the crosswalks along with a “YIELD HERE TO PEDESTRIANS” sign placed adjacent to the markings (the sign is incorporated in MUTCD in Section 2B.11). Data show that this treatment can produce a marked reduction in multiple threat conflicts (Van Houten, 1988; Van Houten, 1992).

In a study conducted in Halifax, Nova Scotia, Canada, 24 crosswalks were randomly assigned to a treatment or control condition. Following a baseline measurement period, twelve of the streets had advance yield markings and the “YIELD HERE TO PEDESTRIAN” sign installed 7.0 m (23 ft) to 19.8 m (65 ft) in advance of the crosswalk. The remaining half of the crosswalks remained in the baseline condition and served as control sites. Each of the streets used in the study included multiple travel lanes in both directions or multiple lanes on a one-way street with a posted speed limit of 48 km/h (30 mi/h) (Van Houten, 2001).

The sign and markings increased the percentage of motorists yielding to pedestrians and decreased the percentage of motor vehicle/pedestrian conflicts at all 12 sites. For the control crosswalks, motorist-yielding behavior remained almost unchanged between the before- and after-treatment measurements. However, the percentage of motorists who yielded to pedestrians at crosswalks with the added sign and markings increased from around 70 to 75 percent to around 80 to 85 percent. Further, vehicle-pedestrian conflicts remained nearly constant for the control sites but declined from about 10 to 15 conflicts per 100 crossings to under 5 conflicts per 100 crossings at the treatment sites. Follow-up data collected six months after the markings and signs were introduced show no reduction in treatment effectiveness. These data are in accord with previous findings, which show that effects are maintained over time.

For more information, visit: <http://www.walkinginfo.org/pedsafe>.





**Traffic signals with pedestrian signals create a gap for pedestrians to cross intersections.**

then other treatments (e.g., traffic signals) should be considered.

6. Traffic signal with pedestrian signal displays—On busy multilane highways with significant volumes, a signal may be the only way to create a gap for pedestrians to cross. It is often difficult to meet the MUTCD warrants for a traffic signal based solely on existing pedestrian counts; it is often necessary to anticipate how many pedestrians might cross there once the signal is installed. All signals have associated operational and safety concerns that must be addressed, including the distance to adjacent signals.

#### Nighttime Pedestrian Crashes:

Many nighttime crashes can be prevented through better lighting. See previous discussion on illumination (page 56).

#### Intersection Straight-Through Crashes:

Most of the techniques described under midblock crashes are applicable at intersections for straight-through crashes: pedestrian crossing islands, curb extensions, illumination, and advance stop bars or yield lines.



**Wide radii (top) allow faster turning speeds and create unsafe pedestrian environments. A simple extension (bottom) can reduce the turning radius and vehicle turning speed as well as provide a safer crossing place for pedestrians.**

#### Intersection Right Turn Crashes (Signalized or Unsignalized):

1. Tighter radius—Tightening the intersection radius has many benefits for pedestrians: it shortens the crossing distance, brings the crosswalk closer to the intersection, increases visibility of the pedestrian or the approaching motor vehicle, slows right-turning vehicles, and it makes it much easier to install two ADA compliant curb ramps at each corner. The choice of a curb radius is dependent on the design vehicle and whether the street is a local residential street, a neighborhood collector, or a major arterial. This requires the designer to calculate the appropriate radius for each corner of an intersection and to accept occasional difficult turns for the rare event—for example a large moving truck turning onto a local street; this occurs seldom enough that there's little reason to provide large radii for truck turns onto local streets. The presence of on-street parking on both intersecting streets can also result in the opportunity to tighten the curb radius.
2. Curb extensions—See previous discussion on curb extensions on page 58.

3. **Pork-chop islands**—While right-turn slip lanes (also called channelized right-turn lanes) are often considered negative facilities for pedestrians (especially vision-impaired pedestrians) due to the emphasis on easy and fast motor vehicle travel, they can be designed to be less problematic. Where an exclusive right-turn lane is provided, a pork-chop island between the right-turn lane and the through lanes can shorten the crossing, resulting in less pedestrian exposure and improved signal timing. The island also enables pedestrians and motorists to negotiate one conflict separately from the others. A properly designed pork-chop island has the longer tail pointing upstream to the approaching right-turn motorist; this channelization brings the approaching motorist at close to a 90° angle, so the motorist is looking forward at the crosswalk; the crosswalk is placed one car length back from the intersection proper (the AASHTO Green Book now includes this better option). This enables the motorist to move forward once the pedestrian conflict has been resolved so the right-turning motorist can focus on traffic. The pedestrian then can cross to a shorter street crossing.



**Well-designed pork-chop islands can help pedestrians navigate an intersection more safely.**

#### Intersection Left-Turn Crashes:

1. **Median islands**—A median island helps channelize left-turning vehicles, slowing their speeds in the process. An island also gives pedestrians a refuge for long crossings or if a conflict cannot be avoided. However, signal phasing should ideally be designed to allow the pedestrian to cross the entire street during a single cycle.
2. **Curb ramp placement and design**—Poor ramp placement and design can make a street crossing more difficult and may lead to crashes. For example, poorly placed or oriented ramps force wheelchair users to make long detours and they may not cross in the allotted time at a signalized intersection; or they may force wheelchair users to cross outside the crosswalk lines at a location where motorists do not expect them. Proper ramp placement and design ensures that all users cross in crosswalks, close to the intersection, where motorists can see them, and without undue delay. Ramps must be wholly contained within the marked crosswalk area. Usually, this can only be accomplished if the curb radius is 7.6 m (25 ft) or less. Single ramps that direct the pedestrian into the middle of the intersection should be avoided (especially on arterial streets) but may be necessary where a large radius precludes the use of two ramps. Ramps must be designed to meet ADA Guidelines,



**Median islands provide a safe waiting place for pedestrians crossing multilane roads.**



**Well-designed curb ramps provide pedestrians with disabilities better access to the sidewalk system.**



**Crosswalks and pedestrian signals encourage pedestrians to cross at signalized intersections.**

and two ramps at a corner are generally preferred over single-ramp corners. ADA Guidelines can be found online at <http://www.access-board.gov/adaag/html/adaag.htm>.

#### Signalized Intersection Crashes:

All signalized intersections should have the following (unless no pedestrians are expected):

- Pedestrian signals are needed (pedestrian WALK/DON'T WALK signals) to ensure that a pedestrian knows when the signal phasing allows them to cross and when they should not be crossing. On one-way streets (or streets with unusual configuration) a pedestrian approaching from the opposite direction may not realize an intersection is signalized and cannot see the vehicle signal heads nor know when it is safe to cross if there is no pedestrian signal. The same is true for intersections with left turn arrows. Wide streets require more information on when to cross and when not to start crossing due to the long pedestrian clearance intervals that may exist.
- Marked crosswalks clearly indicate to the motorist where to expect pedestrians and help keep the crossing area clear of vehicles. It should be standard practice to mark all four legs of a signalized intersection unless unusual circumstances exist.
- A WALK signal (walking person symbol) should be long enough to get pedestrians started and a clearance interval (flashing upraised hand or DON'T WALK signal) long enough to ensure that a pedestrian can fully cross the entire street. While many agencies have traditionally used a 1.2 m/s (4 ft/s) assumed walking speed, slower walking speeds of 1.1 m/s (3.5 ft/s) or even 0.9 m/s (3 ft/s) may be appropriate at locations which have a substantial number of older pedestrians. The *Highway Capacity Manual* specifically recommends a slower walking speed when the percentage of walkers over the age of 65 represent 20 percent or more of the pedestrian population using that crossing (National Research Council, 2000). Another option is to consider the use of automatic pedestrian detectors, which can detect slower-moving pedestrians in a crosswalk and automatically extend the pedestrian clearance interval until the pedestrian is safely on the other side of the street (see link to recent research on automatic pedestrian detectors at the Pedestrian and Bicycle Information Center Web site: <http://www.walkinginfo.org/rd/>

technology.htm#peddetect). New detection methods such as video are being tested but some may still be expensive to implement.

- Push buttons, placed where a pedestrian who is in a wheelchair or is visually impaired can easily reach them, are often needed. They should be located so as to clearly indicate which crosswalk each button regulates for crossings in two different directions. The best practice is to provide push buttons mounted on two separate pedestals separated by at least 3 m (10 ft). Illuminated push buttons (that light up when activated) are used to notify the pedestrian that the actuated signal is working and/or connected. They increase the likelihood that pedestrians will actuate the push button and comply with the pedestrian signal. Push buttons are not used in downtown/central business districts and other area of high pedestrian use where pedestrians can be expected at every signal cycle. The pedestrian phase should be on recall at these locations. Push buttons should not be needed at fixed-time traffic signals where pedestrian crossings are reasonably expected on more than an occasional basis, and the crossing (WALK) interval should occur every signal cycle. The MUTCD Part 4 should be used to design signals to the latest accessibility standards (ADA); it is available online at <http://mutcd.fhwa.dot.gov/pdfs/2003/Ch4.pdf>.



**Push buttons such as this one should be placed where they can be easily accessed when waiting to cross an intersection.**

Many crashes occur while the pedestrian is crossing with the WALK signal, and some signal-timing techniques can help reduce the incidence of these crashes. Additional countermeasures at signalized locations may include:

1. Protected left-turn phases—This allows left-turning vehicles to have their own separate interval, which can also separate vehicle left-turning movement from pedestrian crossing intervals. Thus, pedestrians can cross without interference from left-turning motorists. Red and green left turn arrows are used to make it clear to motorists they must wait before turning left.
2. All-red phase—A short (i.e., 2 second) all-red interval may help prevent a crash resulting from a high-speed red-light runner hitting a pedestrian who has begun crossing with the WALK signal or who may have a slower walking speed and did not clear the crosswalk.
3. Lead Pedestrian interval (LPI)—The LPI can help reduce conflicts between turning vehicles and pedestrians



Countdown signals help pedestrians know how much time they have left to cross an intersection.

when turning vehicles encroach onto the crosswalk before pedestrians leave the curb. The LPI releases pedestrians (WALK phase) 3 to 5 seconds prior to the green light for vehicles. This enables pedestrians to enter and occupy the crosswalk before turning motorists enter it. This treatment is particularly effective where there is a double right or left turn movement.

4. Pedestrian countdown signal—This tells the pedestrian how much time is left in the pedestrian clearance interval (flashing DON'T WALK or upraised hand). This information encourages pedestrians to leave the crossing before the crossing time runs out and reduces the number of pedestrians who initiate a crossing too late in the cycle or who are still in the street at the end of the crossing interval. The countdown signal should begin during the pedes-

## Lead Pedestrian Intervals (LPIs)

### St. Petersburg, FL

A lead pedestrian interval was created for study at three signalized intersections in downtown St. Petersburg, Florida where pedestrian crossings occurred at the average rate of 60 per hour. An LPI is intended to decrease crashes that involve motor vehicles and pedestrians by separating them in time. The LPI permits pedestrians to gain a head start before turning vehicles are released. Following the introduction of the LPI, conflicts were virtually eliminated for pedestrians departing during the start of the WALK interval.



There were 44 total pretreatment observation periods at all three sites. During each of these sessions, the sites averaged between 2 and 3 conflicts per 100 pedestrians, with some periods having up to 5 conflicts per 100 pedestrians. After the LPI was installed, 34 of the 41 sessions had no conflicts, and no session had more than 2 conflicts per 100 pedestrians. This effect was noted for senior citizens and non-seniors alike. There was also a smaller reduction in conflicts during the remainder of the WALK interval. This reduction was likely the result of pedestrians claiming the right-of-way during the earlier portion of the WALK interval. The percentage of pedestrians yielding to vehicles also declined following the introduction of the LPI, and data showed that pedestrians tended to cross more lanes during the 3 second LPI the longer the intervention was in effect. This was likely the result of regular users discerning the presence of the LPI and modifying their behavior to utilize it to the fullest extent possible.

Over a period of four months at these three sites, no reduction in intersection effectiveness for motor vehicles was detected. Moreover, local authorities opted to retain the LPI in places where the range of permitted turning movements governed by the signal cycles allows safe use of the LPI. This intervention was shown to increase pedestrian safety and improve pedestrian comfort and perceived safety levels as well.

For more information, visit <http://www.walkinginfo.org/pedsafe> and read Case Study No. 65 and 66 (follow links to case studies in Florida and click on the two links to LPI studies).

trian clearance interval (flashing DON'T WALK) phase. The standards for pedestrian countdown signals can be found in Section 4E.07 of the MUTCD.

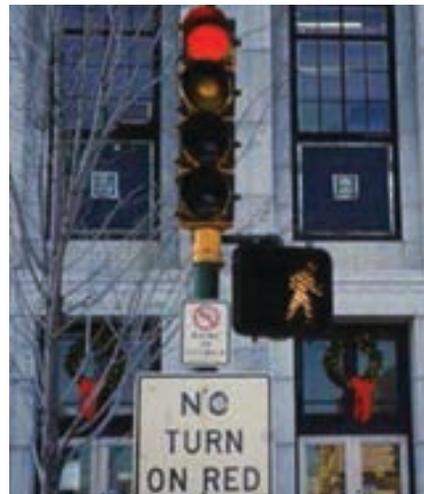
5. All-pedestrian phase (also known as Barnes dance or scramble phase)—By stopping all vehicle movements and allowing pedestrians to cross in all directions (including diagonally), virtually all conflicts are eliminated. But pedestrians are not allowed to cross during the regular motor vehicle phase, so motorists can turn without needing to yield to pedestrians. This introduces a third signal phase that generally increases delay for motorists and pedestrians. This signal phasing technique has been removed from many intersections as both pedestrians and motorists do not typically tolerate the extra delay, and such phasing may only be appropriate for a few central city crossing locations with very high pedestrian traffic, relatively low vehicle volumes, and a high number of turning conflicts. Also, where intersecting streets are narrow and cycle lengths are short, such timing schemes may be more practical, since increased delay will be less of a problem. The all-pedestrian phase may also be better when applied at intersections where all street approaches have a similar cross-section and traffic flow.
  
6. Prohibited right-turn-on-red at selected locations—Consideration should be made to prohibit right-turn-on-red (RTOR) at intersections where there are high volumes of pedestrians, particularly near schools, and/or where older pedestrians cross regularly. Placing NO TURN ON RED signs may also be appropriate at complex intersections (e.g., skewed intersections, intersections with more than four legs), and also where pedestrians are having trouble crossing on a WALK signal due to a high volume of right-turning motorists. It should be noted that at locations where RTOR is prohibited, right-turn-on-green collisions or conflicts with pedestrians may still occur.

#### Pedestrian Crashes on Road Sections:

1. Road diets—Reducing travel speeds and reducing the number of travel lanes a pedestrian has to cross are beneficial in all cases. One well-documented technique that accomplishes both goals is a “road diet” that takes a four-lane undivided street (two lanes in each direction) and reconfigures the lanes to two travel lanes, a center turn lane, and two bike lanes. The benefits for pedestrians include a shorter effective crossing, fewer lanes to cross, and slightly



**An all-pedestrian phase may be appropriate at certain intersections where there is a large volume of pedestrians crossing the street regularly.**



**Prohibiting certain turning movements may protect pedestrians in the crossing.**



**A road diet, such as the one above, may decrease motor vehicle travel speeds and reduce the number of lanes a pedestrian must cross.**



**Traffic calming devices such as this raised crosswalk help illuminate pedestrian crossings and slow motor vehicle traffic.**



**The decision for where to place bus stops, especially midblock bus stops, can impact pedestrian safety and can influence pedestrian travel and accessibility. They should always be located near a safe crossing location.**



**Transit stops need sidewalks with adequate width to accommodate waiting pedestrians.**

slower motor vehicle traffic speeds. The addition of a center-turn lane also creates space for pedestrian crossing islands. All this is accomplished without having to change the curb lines. The bike lanes add a buffer for pedestrians as well as a place for bicyclists to ride. The key to a successful road diet is to ensure that all signals are set up to handle expected volumes of left-turn movements and to monitor adjacent streets to ensure that they are not overly impacted by higher speed or higher volume motor vehicle traffic.

There are many variations on this road diet, for example reducing a multilane one-way street by one lane. A more expensive road diet can involve moving the curbs to actually narrow the roadway surface. A simpler road diet can involve narrowing the travel lanes to 10 or 11 ft to slow motor vehicle traffic speeds and create space for bike lanes that acts as a buffer for pedestrians.

2. **Traffic calming**—Within neighborhoods, traffic calming measures can be used to slow motor vehicle traffic, such as speed tables, speed humps, traffic circles, chokers, and chicanes, or to break up long stretches of straight streets. For more information on traffic calming devices and techniques, visit <http://www.trafficcalming.com>, <http://www.walkable.org>, or refer to *PEDSAFE* (Harkey, 2004) or other relative documents listed in the References section or in Appendix F.

### *Transit-Related Crashes*

A high number of pedestrian crashes are related to transit. Most involve a pedestrian crossing the street to get to a bus or after getting off the bus. All of the street-crossing techniques described so far are applicable to transit stops. All transit stops must be accessible to all pedestrians, and policies should include the following provisions:

- All stops should consider the safety of the pedestrian crossing. This does not necessarily mean a marked crosswalk at each stop location; rather, each stop should be placed where it is possible for a pedestrian to cross safely at or very near the stop.
- Transit (and school bus) stops must provide a safe place to stand and wait, even if there are no sidewalks. The lack of a defined waiting area is undesirable, especially for children.
- Sidewalks (or paved shoulders in rural areas) should be

built to provide pedestrian access to all transit stops.

- Lighting should be provided at or near all bus stop locations for security and safety reasons and to minimize vandalism.
- The transit agency should review all its stop locations to facilitate access and crossing.

Techniques include:

- Improve the pedestrian crossing (this may involve installing a new signal).
- Consolidate closely-spaced stops by eliminating some stops (this not only limits the number of crossings, but helps with transit efficiency as the buses stop less often).
- Place crosswalks (where warranted) behind the bus stop at midblock locations. This allows pedestrians to cross behind the bus, where they can see oncoming traffic; it also enables the bus driver to pull away without endangering pedestrians.
- Move stops to a location where it is easier to cross. This often involves decisions regarding nearside and farside locations at intersections. In general, farside locations are preferred for pedestrian safety, as pedestrians are encouraged to cross behind the bus, and the bus can leave without having to wait for pedestrians to cross. It also allows for right-turn-on-red movements on the nearside of the intersection. However, there are locations where a nearside stop may be more practical for operational and accessibility reasons.



**Transit stops should be well-designed with pedestrian needs in mind, including shelter, signs, lighting, sidewalks connecting to the pedestrian travel network, and bus loading areas that are wheelchair accessible.**

## Education Solutions

### *Overview*

Education plays an important role in the process to improve pedestrian safety. Education efforts can improve the ability of drivers and pedestrians to use and respond to the roadway environment safely and correctly. Education can complement enforcement programs to teach motorists and pedestrians about safe driving and crossing practices, as well as the laws that govern them.

Numerous research studies have supported the notion that education efforts can succeed in changing pedestrian and driver behaviors and reducing pedestrian crash risks and rates. Some of the successful earlier programs aimed at the conditions of those times include:

## Education Efforts Across the Nation

### Countywide Example

WalkSafe Miami is a program aimed at reducing the incidence of children struck by vehicles by educating elementary school-aged children, teachers, parents, and their communities about traffic safety. The program uses educational training, engineering modifications, and enforcement to help achieve its goal. The Miami-Dade Metropolitan Planning Organization (MPO) produced six different pedestrian education posters aimed at increasing pedestrian safety practices. The posters' safety messages were in English, Spanish, and Creole. They covered pedestrian-related topics ranging from interpreting pedestrian signals and being visible, to watching for turning cars and making eye contact with an oncoming motorist before crossing the street. The first of the posters were mounted in the county's 600 buses and most of the 135 MetroRail train cars free as a county public service beginning in July 2003.



### Statewide Example

One method for implementing educational programs to counter pedestrian crashes is to institutionalize pedestrian safety curricula in schools. US studies have shown that elementary school children (age 5-9) are more likely to be involved in a pedestrian crash than any other age group. This is particularly true in urban areas where there is heavy traffic and few pedestrian amenities. Maryland has a comprehensive, hands-on safety curriculum based on a building block approach; it contains a series of lessons teaching pedestrian safety skills to younger grades (e.g. K-2) and bicycling skills to older students (e.g., grades 3-5). There is an Administrator's Guide, Teacher's Guide, and Lesson Handbook for the program, developed by the City of Rockville. From initial roll-out in the fall of 2002 to the end of the 2003-04 school year, the program has reached over 7,000 Rockville students at 10 different elementary schools. The Maryland Pedestrian and Bicycle Safety Education Program has been made available to public and private schools, law enforcement agencies, and community organizations throughout Maryland. For more information, visit the Maryland Pedestrian and Bicycle Safety Education Program Web site at <http://www.rockvillemd.gov/recreation/bicycling/education-program.htm>.

### Nationwide Example



The FHWA Pedestrian Safety Campaign is "designed to help communities conduct their own multi-media public education and information campaign." The online document provides a step-by-step discussion of how to conduct a pedestrian safety marketing campaign. Starting with goals and strategies for a campaign, the guide elaborates on forming coalitions with other agencies and advocacy groups, provides hints on interacting with the media, and presents methods of campaign evaluation. The document further contains large amounts of actual campaign material and sample letters to aid agencies in the process of planning a public marketing campaign. For more information, visit: [http://safety.fhwa.dot.gov/local\\_program/pedcampaign/index.htm](http://safety.fhwa.dot.gov/local_program/pedcampaign/index.htm).

- The “Willy Whistle” pedestrian safety public information and education messages were used to teach child pedestrians ages 5 to 9 how to look before crossing the street and safely conduct a midblock crossing. An evaluation found that the education campaign resulted in significantly reducing the number of dart-out pedestrian crashes involving 3- to 7-year-old children by approximately 30 percent in the three test cities of Los Angeles, CA; Columbus, OH; and Milwaukee, WI (Blomberg et al., 1983). Part of this reduction may be attributed to PSAs that alerted parents to increase direct supervision of young children when outdoors, rather than changing the behavior of the young children. Subsequent research has found that educational videos alone can increase knowledge but usually result in little behavior change.
- An evaluation of the efficacy of the film, “And Keep on Looking,” targeting children in 4th through 7th grades, showed an increase in safe street-crossing knowledge for children ages 9 to 12 in Seattle, WA. An assessment in Milwaukee, WI indicated a pedestrian crash reduction of greater than 20 percent for children aged 9 to 12 compared with children in areas surrounding Milwaukee and in comparison cities (Preusser and Lund, 1988).

Recent studies have included education as part of a more comprehensive safety program and have shown similar successes:

- A 2007 study for NHTSA evaluated a pedestrian safety program consisting mostly of education and enforcement measures in Miami-Dade County. Countywide pedestrian crashes were reduced by 8 to 12 percent. The child pedestrian education program, “Walk Safe Miami,” was implemented in elementary schools throughout the county. There was a 22 percent reduction in child pedestrian crashes countywide in the first year after full program implementation. (See case study write-up on page 109).
- *Walk Smart Baltimore*, a comprehensive safety project was conducted in Baltimore, MD, aimed at reducing the pedestrian crash problem related to alcohol. Countermeasures were targeted to two “zones” in the city that accounted for 73 percent of the pedestrian alcohol-related crashes but only 21 percent of the land area. The countermeasures included a police training video, press kits for the local media, radio and TV PSAs, brochures, posters, and flyers. Using a surrogate measure of alcohol involvement in crashes, the project team found an overall 16 percent decrease in pedestrian crashes. The surrogate measure crashes decreased 22.3 percent in the zones where the majority of countermeasures were focused.

*Other evaluations of pedestrian education programs can be found in the Online Library at [www.walkinginfo.org](http://www.walkinginfo.org).*



**Left-turning vehicle failing to yield to pedestrians at an intersection.**



**Pedestrians failing to obey a traffic signal.**

Education is an important and effective part of a pedestrian safety program, but having streets designed for pedestrians is a prerequisite. **Most education campaigns will have limited long-term success if the streets are designed for high-speed traffic and do not safely accommodate all users.**

While many education programs have shown positive results in improving pedestrian safety, others have failed to demonstrate significant improvements. This is likely because not all education efforts have all the necessary components for success or are not tailored to meet the needs of the community. To ensure the most effective and successful education programs, an agency should:

- Understand the local context and apply messages to the appropriate audience.
- Combine and coordinate the education program with other planning, engineering, and enforcement measures.
- Use both concentrated short and long-term efforts.
- When appropriate, supplement informational programs (i.e., programs using PSAs or other passive education techniques) with opportunities to put learning into practice (i.e., skills training or active education).

#### *Defining Education-Related Problems and Goals*

Education programs and campaigns work best when there is a clear understanding of the audience, the objective, and the messages to be conveyed. Such programs produce the greatest safety benefits when they are part of a long-term program and not just designed to achieve short-term changes. The education program should target a real and specific community problem. In some cases, behavior-related problems are a symptom of other concerns, such as poor street design or lack of enforcement; in these cases, education should be coupled with additional measures to treat all of the underlying factors related to the concern. Examples of common pedestrian-related problems that can be addressed (in-part) through education include:

- Pedestrians at an intersection don't appear to understand the newly-installed pedestrian signals and/or don't choose to activate them. The novelty of the signal requires some additional information on its meaning and use.
- Pedestrians do not think they have enough time to cross at a traffic signal.
- Drivers don't yield to pedestrians in crosswalks.
- Parents don't understand the need to supervise children under the age of 10 when they are walking.

- Children ages 10 to 18 don't know where or how to safely cross a street to get to school.
- Motorists are speeding in neighborhoods.
- Commuters in the downtown area aren't taking advantage of non-motorized modes of travel.
- Pedestrian crashes are occurring in an area with a concentration of bars due to pedestrian drinking and walking.
- Designers and engineers aren't using pedestrian-friendly design practices.

Though there are many studies showing that education can have an impact, it is equally relevant to consider local conditions and factors to develop an education program tailored to the community. The goals of an education program should be specific, measurable, and related to the problems identified. For instance, if an intersection safety study reveals that only 20 percent of pedestrians are activating the push-button (assuming the button is properly designed and located and works correctly) for a crossing signal, an education campaign can be developed to focus on increasing pedestrians' understanding of the existence and benefits of the crossing features. The goal should be to increase activation of the push-button and safe crossing behavior. Establishing baseline conditions helps in setting realistic goals and evaluating program effectiveness.

### *Targeting Specific Audiences*

There are major differences in the knowledge of safe pedestrian practices, walking abilities, behavioral patterns, and learning capacities of different groups of pedestrians and other road users. Because of this, education programs need to be tailored to the specific audiences and types of safety problems they intend to address, and to the behaviors they seek to modify. Common audiences for focused, pedestrian-related education programs include:

1. Road users, including:
  - a. Child pedestrians (several different age groups)
  - b. High school and college age pedestrians
  - c. Adults
  - d. Older pedestrians (65+)
  - e. Drivers
  - f. Alcohol consumers (especially heavy drinkers)
2. Commuters/employees
3. Transportation officials and decision makers, including engineers, planners, developers, local officials/leaders, and law enforcement officers.



**Educational messages and strategies used to convey them should be tailored to a particular audience and goal.**



**Especially for child audiences, it is important to consider when and how the audience should receive information.**



**Education campaigns can teach children about safe pedestrian practices.**

*More details and examples of pedestrian safety programs are provided in NCHRP Report 500, Volume 10, "A Guide for Reducing Collisions Involving Pedestrians," (2004), which can be found at the site: <http://www.national-academies.org>.*



**Safe Routes to School programs provide communities with strategies to make walking to school safer.**

These audiences can be reached in a variety of ways: through public awareness campaigns reaching a broad group of people at once; through interventions targeting narrow groups or situations; or through an intermediary—such as a pediatrician, a parent, or a grandparent—targeting people on a one-on-one basis.

For an education program to be successful, it is important to consider:

1. When and how the audience should receive information—for instance, children, depending on their developmental level, may not be able to understand certain messages or complicated images used to convey messages.
2. Demographic factors—for example, the percentage of non-English speakers in a community affects the development of the educational materials. Educational materials in several languages and/or a range of distribution methods (e.g., PSAs, posters, or presentations to neighborhood groups) may be needed for certain populations.

The following section provides important safety messages and strategies for conveying those messages to each of the aforementioned groups. Based on identified safety concerns, goals, and other considerations (e.g., available resources, etc.), each community should determine the most important group or groups to target in an education program and the appropriate strategy to use.

#### *Key Educational Messages and Strategies for Targeted Audiences*

Educational messages for road users commonly focus on improving personal safety and obedience to traffic laws. Campaigns aimed at commuters or employees often focus on messages to encourage drivers to use carpools or transit, or to consider non-motorized transportation modes. Education and training programs aimed at transportation officials and decision makers usually focus on encouraging stronger support for policies, programs, and facilities that promote safe walking.

The following sections provide more detailed educational messages that could be incorporated into education campaigns and strategies that could be used to target the audiences described earlier.

#### Educating child (elementary and middle school) pedestrians

Being struck by a car is a leading cause of death and injury to children. Children, especially males age 5 to 9, are at high risk

of being hit in a pedestrian crash. Young children are frequently struck on the neighborhood streets near their homes. The task of teaching pedestrian safety to children is complicated by their level of development. To obtain significant results, education programs must improve knowledge and awareness and teach skills appropriate for the level of development of the children they target. One excellent resource for educating children about pedestrian and bicycle safety skills is the Education section of the National Center for Safe Routes to School Online Guide (available at <http://www.saferoutesinfo.org/guide/education/index.cfm>). It describes what groups to bring together to educate children (including parents, caregivers, and teachers) and others who need to know about children's needs and abilities as bicyclists and pedestrians (including drivers and neighbors). It also addresses when education programs need to take place.

*The NCSRTS Resource Center contains tip sheets for parents and other adults for teaching pedestrian safety to children. See [www.saferoutesinfo.org/resources/education\\_tip-sheets.cfm](http://www.saferoutesinfo.org/resources/education_tip-sheets.cfm).*

The Education section of the SRTS Guide by the National Center for Safe Routes to School describes key messages for children (primarily elementary age) ([http://www.saferoutesinfo.org/guide/education/key\\_messages\\_for\\_children.cfm#health](http://www.saferoutesinfo.org/guide/education/key_messages_for_children.cfm#health)), including:

- Pedestrian safety skills.
- Personal safety.
- Health and environmental benefits of walking.

### National Safe Routes to School Program Nationwide

Through the 2005 passage of the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU), Congress designated a total of \$612 million toward developing the National Safe Routes to School Program. The Program provides funds to the states to substantially improve the ability of primary and middle school students to walk and bicycle to school safely.

Each state administers its own program and develops its own procedures to solicit and select projects for funding. The program establishes two distinct types of funding opportunities: infrastructure projects, such as engineering improvements; and non-infrastructure related activities, such as education, enforcement, and encouragement programs.

For more information on the National Safe Routes to School Program, go to the FHWA Web site <http://safety.fhwa.dot.gov/saferoutes/> or the National Center for Safe Routes to School Web site <http://www.saferoutesinfo.org/>.



Mapping best routes to school (above) and participating in SRTS programs can help provide school children with safer trips to school and back.

The National Center for Safe Routes to School Online Guide's section on Education ([http://www.saferoutesinfo.org/guide/education/strategies\\_for\\_educating\\_children.cfm](http://www.saferoutesinfo.org/guide/education/strategies_for_educating_children.cfm)) also addresses various strategies to educate children, including:

- One-time instruction (such as an assembly).
- Classroom or physical education lessons (e.g., stand-alone, integrated, or comprehensive curriculum for every grade).
- Parent involvement strategies for at-home education.
- Structured skills practice (e.g., class-based lessons, after-school programs, or one-time events such as bike and pedestrian rodeos).
- Traffic safety quizzes or games that can be used at safety fairs for children; traffic safety information that can be made into games, coloring books, or other activity books.

One key message to emphasize in child and parent education programs is that children through the age of 10 should be supervised by an adult whenever walking or crossing the street.

## Mapping Out A Safer Community: Safe Routes to School Detroit, Michigan

The following content is taken directly from the site, <http://maps.culma.wayne.edu/community.htm>:

"In Detroit, neighborhood crime, gang activity, unrestrained dogs, and declining or dangerous properties affect students' safety to and from school. To help address a broad range of community safety concerns, The Urban Safety Program partners with schools and community groups to implement the "Mapping Out A Safer Community" program. In this program, Detroit middle school students receive



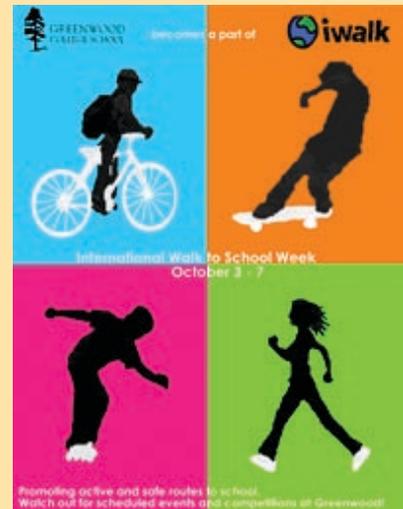
instruction in state-of-the-art computerized mapping (a.k.a. GIS-geographic information systems) and portable computing to study neighborhoods near their school. Using PocketPCs, students map locations and characteristics of dangerous properties, take photographs, and research property ownership. They also set priorities and identify the most problematic locations near their school. Properties with the most egregious violations, known as "The Dirty Dozen", offer a compelling picture of hazards Detroit children face daily. This information is presented to community leaders and city officials who attempt to correct dangerous situations.

To date, the Urban Safety Program has worked with students from: Foch Middle School, Butzel Middle School, Spain Middle School, Finney High School, and community-based after school and summer programs. For more information, visit the Web site <http://maps.culma.wayne.edu/index.htm>."

## Sustainable Transportation Education Project (STEP) Various Cities in Canada

The Sustainable Transportation Education Program (STEP) was developed by Green Communities Canada to test various approaches to engaging high school students in sustainable transportation issues. It was piloted in urban and rural (Peterborough, Markham, and Toronto) schools in Ontario, Canada. The program helped schools tackle transportation problems while increasing awareness and education about air quality, climate change, and healthy lifestyle issues. The program involved student-led events and activities, such as climate change presentations, a campaign against car idling, and participation in Walk to School Week. It also included classroom resources regarding sustainable transportation that could be incorporated into the curriculum of communications technology, geography, science, and civics courses. Additionally, traffic surveys were conducted with high school populations; these can be adapted for use by environmental clubs, environmental science, geography, social studies, civics or other courses.

For detailed case studies and reports, as well as downloadable resources related to the STEP program, visit the site <http://www.saferoutestoschool.ca/index.php?page=step>.



There is less information available on messages and strategies targeting middle-school age children. What is known is that middle school children still need skills practice as well as exposure to messages that convey the importance of walking and safety. To be effective, these messages should be conveyed within themes that matter to that age group, such as fitness and independence. Pre-teen audiences can be difficult to reach, so creativity is a must in any educational effort. Some potential strategies for targeting middle-school-age children include:

- Put them in control—Organize a student committee to address the problem of safety, physical inactivity, or issues related to excess weight. Ask them to come up with contests or program ideas.
- Integrate walking into the culture in a subtle way—Have teachers and administrators walk on local field trips.
- Start a Kids Teaching Kids program—Middle school students can develop a safety assembly for elementary students and then deliver it (or high school students can deliver it to middle schools). Make sure that the student teachers are well-trained to convey correct strategies and that the teaching is within the children’s developmental level.
- Use multimedia to convey messages—Consider the use of music, video games, and computer software in addition to traditional media. Ask students to consider how many

songs have the word “walk” in the title. Think about using “walk” songs as “music of the week” or as links in a class assembly about walking to school. California’s Rad Rider Web site ([www.radrider.com](http://www.radrider.com)) has bicycle safety messages incorporated into an online comic book and safety tests; the site also offers a bicycle stunt show. See the example on page 74 on how GIS and PocketPC technology has been used to engage youth in pedestrian safety issues.

### Educating high school and college-age pedestrians

High school and college-age students represent unique pedestrian education opportunities and challenges. High school students are probably the least likely of any student age group to walk to school, either because their high schools are sited in areas where they are unable to walk safely to school, or because they want to take advantage of newfound driving privileges. However, ignoring high school populations for education programs would be missing an important opportunity to engage young drivers (and pedestrians) in safety issues. One excellent way to reach high school students is to couple pedestrian and safety issues with broader concerns about transportation, health, and the environment. Almost every high school has an environmental club or other group that will help champion these messages; at the high school level, messages that come from peer groups may be better received than messages coming from teachers, parents, or other authorities.



**Many college-age students are more likely to walk and bike than drive on campus.**

Many college-age students are more likely to walk and bike than drive on campus. This is due to restricted campus parking; the expense of car ownership; and the fact that students are young, able, and generally more physically fit than other age groups. They are an ideal target for pedestrian safety and promotion campaigns. However, college-age students also tend to take more risks than many other age groups, such as older pedestrians. They have a stronger perception of “invincibility,” and may be apathetic to safety outreach initiatives. Also, alcohol can be a factor, even for campuses that are technically “dry.”

Several universities have developed education programs and campaigns in partnership with their Parking and Transportation Services Office or Department of Public Safety. The College of New Jersey and the University of Kentucky distribute a student-oriented pamphlet of “tips, guidelines, and resources” for getting around the campus “quickly, conveniently, and safely.” Key messages include:

- Reasons to walk or bike:
  - Save money.
  - Stay healthy (avoid the “Freshman 15”).
  - Avoid vehicle parking hassles.
- Tips for crossing campus safely on foot:
  - Cross the street at marked crosswalks or at intersections, and observe traffic-control signals. At intersections, watch for turning vehicles that may not be yielding to pedestrians.
  - Yield to motor vehicles and bicyclists when you are not in a crosswalk or are not crossing at an intersection.
  - Stay to the right on shared pathways and avoid walking in “bike only” lanes.
  - While walking or jogging alongside a road without sidewalks, always walk or jog facing traffic.
  - Make eye contact with oncoming motorists and cyclists, indicate your intention to cross (e.g., extend your arm, place a foot in the crosswalk, or lean toward the crossing), and wait for the driver to slow or stop.
  - Avoid cell phone use when walking in congested areas or crossing busy streets; wear bright colors and walk in well-lighted areas at night; don’t step into the street from behind an obstruction.

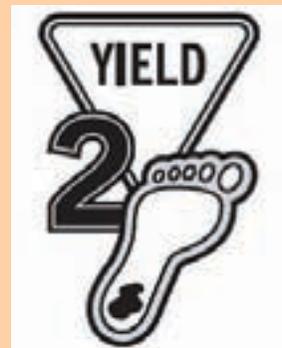
Some important strategies for educating high school and college-age pedestrians include:

- Develop partnerships for education programs—with Parking and Transportation Services Office, Department of Public Safety, campus health organizations, public health/

*For more links to educational strategies for various audiences, visit <http://www.walkinginfo.org/education/messages.cfm>.*

## University of North Carolina “Yield to Heels” Campus Safety Campaign Chapel Hill, North Carolina

The University of North Carolina’s “Yield to Heels” campaign is an ongoing pedestrian safety awareness campaign implemented by the UNC Department of Public Safety and the UNC Highway Safety Research Center. The “Yield to Heels” campaign intends to remove myths about traffic and pedestrians and make helpful information about pedestrian safety available to the University community. The campaign focuses on three main messages for pedestrians, drivers and bicyclists: Be Aware, Be Safe, and Be Considerate. It involves high-visibility posters and signs; handing out promotional materials, coupons, and giveaways (such as tee-shirts and retro-reflective gear); as well as issuing warnings to pedestrians and drivers observed breaking the laws during the campaign effort. See the campaign Web site (<http://www.hsrc.unc.edu/y2h/>) for the event flier, a description of student-oriented pedestrian safety messages, and other helpful links.



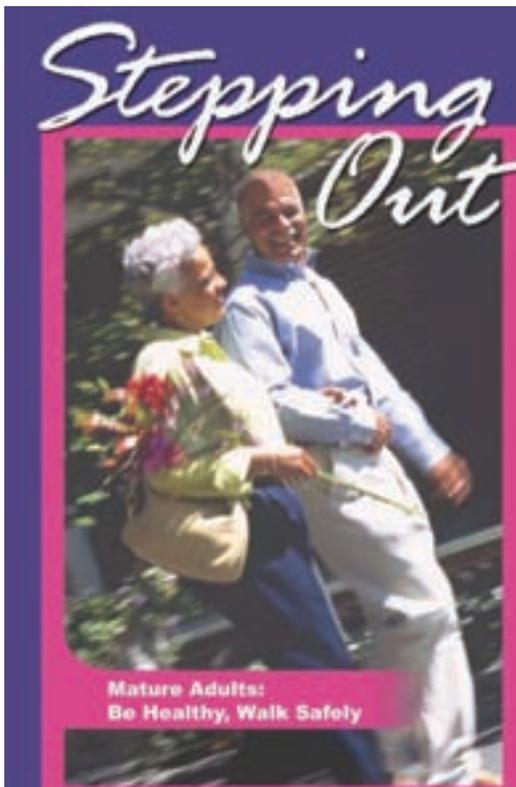
injury prevention alliances or student associations, or other student groups such as walking/bicycling clubs or environmental groups.

- Take advantage of campus life and university events—distribute pamphlets or other materials at new student orientations, large student assemblies (such as sporting events), or through campus housing.
- Give incentives—While distributing safety messages, garner student interest by giving away food, wristbands, retro-reflective gear, posters, coupons for local restaurants, or other freebies.
- Tailor a program to relate to specific student population needs and interests—This helps engage students in understanding why pedestrian safety is important and how it affects them directly. They learn what they can do, both personally and as part of the school or college/university, to improve pedestrian safety and increase walking on campus and beyond.

#### Educating adult pedestrians

The challenge of walking along and crossing streets can make a casualty of even a fit, healthy, and alert adult. Bad weather, fast-moving traffic, and inattention by drivers or pedestrians can make situations worse. Some general pedestrian safety messages include:

- Make yourself visible to drivers
  - Wear retro-reflective materials and bright/light colored clothing.
  - Carry a flashlight when walking at night.
  - Use caution when wearing headphones and talking on cell phones while walking, especially when crossing the street.
  - Stand clear of buses, hedges, parked cars or other obstacles before stepping into the street so drivers can see you.
- Avoid dangerous behaviors
  - Always walk on the sidewalk; if there is no sidewalk, walk facing traffic.
  - Stay sober; walking while impaired increases your chance of being struck.
  - Don't assume vehicles will stop; make eye contact with drivers and wait until they show signs of slowing or stopping for you.

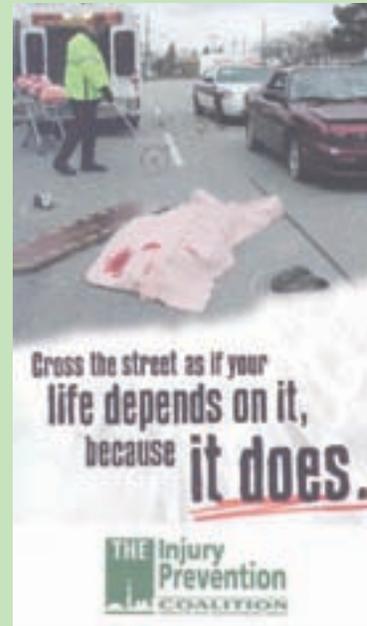


Brochures and educational handouts can be used to spread adult pedestrian safety messages.

## “Cross the Street As If Your Life Depends On It” Education Campaign

Greater Toronto Area, Ontario, Canada

In 2002, Toronto experienced one of the worst years in terms of pedestrian fatalities. The Injury Prevention Coalition began a campaign to increase citizen awareness and reduce pedestrian deaths and injuries in the Greater Toronto Area. Ads were developed with the slogan, “Cross The Street As If Your Life Depends On It, Because It Does.” Posters and safety brochures were sent to 900 different community agencies, all with the dramatic photo of a staged pedestrian fatality scene. These community agencies included health services, police and fire stations, parks and recreations centers, senior centers, licensing centers, and more. Additionally, ads were placed in 30 bus shelters at key intersections, and a short slide show was developed to be shown in local movie theatres, which directed viewers to a Web site with further information. The media launch for the event was covered by several city newspapers. Over 867,000 people viewed the pedestrian safety ad showed in movie theatres. The media images and brochures were evaluated for the effectiveness of the message, and both were found to educate readers and viewers, and bring up previous information regarding pedestrian safety. For more information, visit <http://www.sunnybrook.ca/programs/trauma/injuryprevent/injurypreventtipc>.



- o Cross with traffic signals and not against the DON'T WALK signal.
- o Don't rely solely on pedestrian signals; look before you cross the road.
- o Watch for cars backing up in parking lots and near on-street parking spaces.
- Look before you take a step
  - o Cross streets at marked crosswalks or at intersections, if possible.
  - o Look left, right, behind, and left again before crossing a street or stepping into traffic.
  - o Watch for turning vehicles; make sure the driver sees you and will stop.
  - o When crossing multiple lanes, look across all lanes you must cross and visually clear each lane before proceeding.

*For more information on pedestrian education and enforcement measures, read Chapter 8 of NHTSA's "Countermeasures That Work" document, available online at <http://www.nhtsa.gov/staticfiles/DOT/NHTSA/Traffic%20Injury%20Control/Articles/Associated%20Files/HS810891.pdf>.*

Strategies for educating adult pedestrians include:

- Incorporate pedestrian safety messages into public relations efforts (news releases, fact sheets for local officials, press events, etc.).



**Making presentations at group meetings with older pedestrians is one strategy for educating senior pedestrians.**

- Highlight pedestrian facilities when introducing new infrastructure.
- Create a Web-based pedestrian safety quiz on a local agency Web site for the purpose of educating pedestrians.

#### Educating older pedestrians (65+)

For older pedestrians, whether they are in good health or not, walking can provide strong health and quality of life benefits. However, research has shown that older pedestrians are often overrepresented in fatal pedestrian crashes. If they survive the crash, they may be disabled or confined to a nursing home. Older adults are often struck while crossing streets in crosswalks or by drivers making turning movements through crosswalks.

Older adults can be receptive to well-crafted safety messages. In addition to the general messages described in the “Adult Pedestrian” section, key messages for older pedestrians could include:

- The threats presented by cars making turns.
- Tips for crossing intersections slowly but safely, including waiting for a ‘fresh’ green light before crossing at a signal.
- Good choices of footwear (for better traction) and visible clothing (bright and retro-reflective) for walking at night.
- Tips for avoiding backing vehicles, including watching for back-up lights on vehicles or listening for engine noise before walking behind vehicles.

Strategies for educating older pedestrians include:

- Initiate campaigns to targeted settings/situations where older pedestrians may be concentrated (e.g., retirement communities, healthcare clinics/hospitals, libraries, churches, etc.).
- Contact established organizations, such as AARP, or community centers that may already have a strong network with the older pedestrian community.

#### Educating drivers

An important educational feature is how motorists come to think of pedestrians. Most motorists do not adequately look for pedestrians, and this is, in part, a result of how public or law enforcement officials educate them and enforce (or fail to enforce) certain behaviors. In pedestrian-vehicle crashes, the pedestrians are often blamed, even when the motorist was at fault because of the underlying assumption is that streets are

primarily for motorists. Educators and law enforcement officers need to work to change these views to ensure that pedestrians are accepted as legitimate users of the street network.

Roadway safety is a shared responsibility, and motorists have their fair share of things to do to comply with the rules of the road and help keep pedestrians safe. Some general driver safety messages include:

- Watch for pedestrians at all times
  - Scan the road and the sides of the road ahead for potential pedestrians.
  - Before making a turn, look in all directions for pedestrians crossing.
  - Don't drive distracted or after consuming alcohol or other drugs.
  - Do not talk on a cell phone while driving.
  - For maximum visibility, keep your windshield clean and headlights on.
- Yield to pedestrians at crossings
  - Yield to pedestrians at crosswalks, whether marked or unmarked.
  - Yield to pedestrians when making right or left turns at intersections.
  - Do not park in or block crosswalks. Provide a safety zone for pedestrians.
- Drive within the posted speed limit and avoid aggressive maneuvers
  - If you are traveling on a road with more than one lane of traffic, be especially aware of motor vehicles stopped for crossing pedestrians. Do not pass the stopped vehicles.
  - Obey speed limits and come to a complete stop at stop signs and signals.
  - Always be prepared to stop for pedestrians.

Strategies for educating drivers include:

- Plug into local media—have driver safety awareness campaigns on TV, in radio traffic-watch PSAs, and in newspapers; host a commute-time radio talk series on pedestrian safety issues, or develop an ad campaign to be displayed on billboards, in parking garages, or in other places most visible to drivers.
- Place and distribute driver safety material alongside pedestrian safety material. Most walkers are drivers, too.

- Couple education with enforcement to reinforce driver knowledge of and compliance with pedestrian-related laws.
- Add pedestrian safety information to state driver's license manuals and maps where traffic safety tips provided by a state or community are displayed.
- Create Web-based traffic safety quizzes (that include pedestrian safety questions) on a local agency Web site for the purpose of educating drivers.
- Use engineering treatments (such as roadway signs and in-street signs) to alert drivers to pedestrians and spread educational messages about yielding to pedestrians. See the Engineering treatments section for more engineering tools related to educating drivers.



**Excessive drinking can pose a serious concern for pedestrians and drivers alike.**

### Educating alcohol consumers

Most people know the risks of drinking and driving, but what many people may not know is that excessive drinking can have the same deadly consequences for pedestrians. Alcohol plays an important factor in one-third of all pedestrian deaths—this number is based on pedestrians who have been drinking and doesn't include drinking on the part of the driver. Alcohol-related pedestrian deaths often involve males and occur at night, especially on weekends. Unfortunately there are typically no 'drunk pedestrian' laws that allow police officers to arrest and easily remove a pedestrian from harm's way. The problem of alcohol-impaired drivers and pedestrians is complex and requires a multifaceted approach including both education-based programs as well as other intervention methods, including engineering and enforcement.

Alcohol impairs physical agility and balance. It also adversely affects vision, judgment, and other thought processes, which become extremely important when pedestrians try to cross the road. It is widely accepted that the alcohol-impaired driver is a major threat to pedestrians and all other road users. Researchers have also found that for a pedestrian, high levels of blood alcohol are associated with an increased risk of being hit by a motor vehicle. The following messages for alcohol consumers are described in the NHTSA resource guide, *The Facts: Impaired Pedestrians*:

For motorists:

- Do not drive impaired. It slows your reaction time, impairs your judgment, and affects your alertness and coordination.

- When you drive, particularly at night around populated areas, watch for sudden, unexpected movements by pedestrians. Scan the road widely and often, and prepare for the unexpected. Slow down!
- If you know someone who has been drinking and is planning to walk, call them a cab or offer to drive or escort them, even if it is only a short distance.

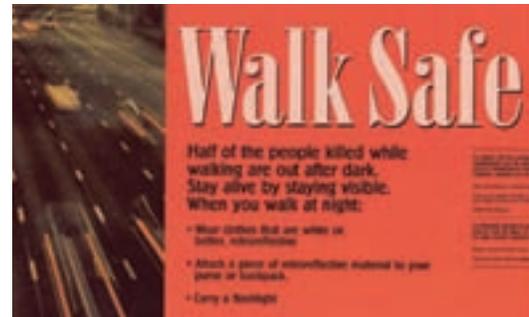
For pedestrians:

- Remember that alcohol affects your balance, impairs your judgment, and reduces your alertness and coordination. It can also affect your vision.
- Limit how much alcohol you consume, especially if you plan to walk. Do not fool yourself about your ability to walk in traffic safely.
- Be more visible to traffic by carrying a flashlight or wearing retro-reflective clothing at night. During the day, wearing fluorescent colors is best. Wearing white, especially at night, is not enough for you to be seen adequately by motorists.
- If you know someone who has been drinking and is planning to walk, offer to call them a cab or escort them, even if it is only for a short distance.

One strategy for educating alcohol consumers is to initiate public awareness and education campaigns to inform pedestrians and alert drivers about the hazards associated with walking while impaired. It is also important to train law enforcement officers and point-of-sale personnel about impaired pedestrian issues and the dangers of over-serving in general.

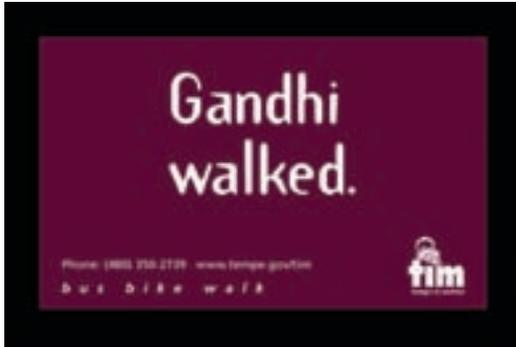
The following are some additional strategies that could be combined with public awareness campaigns to provide a more comprehensive approach to the alcohol issue:

- Develop or amend local or state laws that control the availability of alcohol (e.g., laws that dictate when bars must close, etc.).
- Develop or amend laws to allow police to arrest or detain a pedestrian if they are out walking impaired and may harm themselves or others.
- Work with health officials, employment centers, and other related groups for the early identification and treatment of persons with alcohol problems.
- Address environmental issues (e.g., through improved lighting, speed control measures on commercial strips, etc.) and devise different interventions for use on high-



**Most alcohol-related crashes occur at night. Safety messages aimed at alcohol consumers and intermediaries should describe ways for pedestrians to be more visible at night.**

speed roads in rural areas and medium-speed roads in urban areas where there is a pattern of drunk pedestrians being struck by motorists. See the Engineering solutions described in the first part of Chapter 5 for more strategies related to environmental issues.



**Educating employees about the benefits of walking, and encouraging commuters to consider walking can be an important part of a company or agency's traffic safety program.**

*For more information on business-based walking programs, visit <http://www.americanheart.org/presenter.jhtml?identifier=3040830>.*

*For more information on promoting walking, visit: <http://www.walkinginfo.org/promote/strategies.cfm>.*

### Educating commuters/employees

There are many who drive to work daily who could walk, bicycle, or take transit. Often, this creates unnecessary roadway congestion, which may lead to increases in motorist-pedestrian crashes, as well as increases in pollution. Many communities and local agencies have transportation demand management (TDM) programs, which aim to educate road users about their commute choices, provide incentives and alternatives to reduce driving to work, and can result in more efficient use of transportation resources. Educating commuters about travel options, benefits, and safe practices is an important component of any comprehensive pedestrian education program. The key to encouraging more commuters to travel by foot is to educate them on the benefits of walking and the feasibility of doing it.

Educating employees about the benefits of walking and safe walking/driving habits can be part of a company or agency traffic safety program. It is not uncommon for large companies to institute a driver safety program to reduce the chance that their employees will get into a crash, keep insurance premiums low, and help reduce the company's exposure to tort liability by reducing crashes. Some companies, such as Dow Chemical, require employees to take a traffic safety and map reading course before being allowed to travel for the company. Others require employees to take a mandatory defensive driving course every couple of years. Companies can include information on safe walking practices and driving practices around pedestrians in their curricula.

The following are some ideas for marketing non-motorized travel modes, and providing choices and incentives for walking as part of a commute, drawn from the Victoria Transport Policy Institute (<http://www.vtpi.org/tdm/index.php#incentives>):

- Hold bicycling and walking events and activities, particularly on trails and cycling routes.
- Develop bicycling and walking commute campaigns; these can involve contests as to which workers and worksites commute most by nonmotorized modes.
- Provide and promote bicycle parking, showering, and

clothes changing facilities at worksites, transportation terminals, and other destinations.

- Develop and distribute education materials and programs that teach cycling skills.
- Create walking and bicycling maps showing recommended routes and facilities, roadway conditions (shoulders, traffic volumes, special barriers to cycling, etc.), hills, recreational facilities, and other information helpful to pedestrians and bicyclists.
- Develop tourist promotion materials highlighting bicycling and walking.
- Create a Multi-Modal Access Guide, which includes maps and other information on how to walk and cycle to a particular destination.
- Employers (including public agencies) can create a mandatory defensive driving program to improve the safety of their employees and reduce their tort liability. This campaign should include pedestrian safety information.

#### Educating elected officials, transportation officials and decision-makers

Educating the pedestrian alone is not enough. An effective program to improve pedestrian safety and mobility should also address those responsible for approving, planning, designing, and developing a safe pedestrian network. Elected officials, transportation officials, and other decision-makers must have buy-in on the importance of walking and the need for safe walking conditions. Otherwise, they may not provide the resources to address the problems. Their support for pedestrian education programs, stepped-up enforcement activities, and infrastructure improvements is crucial. It is important for elected officials and transportation decision-makers to understand and believe that:

- Walking is an integral and critical part of the transportation system.
- The presence of pedestrians is a good indication of the health and vitality of a community.
- Walking is the most basic form of transportation, and yet also the easiest to overlook or take for granted.
- Designing a safe, convenient, and comfortable walking environment requires careful planning, engineering, attention to detail, and ongoing maintenance and care.
- Physical improvements must go hand in hand with land use control, legal changes, enforcement, education, and a complete package of measures that require coordination and support from politicians as well as professionals.

## Get Active Orlando

### Orlando, Florida

Orlando's expansive program, Get Active Orlando, (funded by Active Living By Design) aims to encourage and facilitate walking and biking in the downtown area. Get Active Orlando's vision is to establish downtown Orlando and its adjacent neighborhoods as an "Active Living District," with residents, employees, and others in the downtown area routinely making the active choices in an environment that encourages safe physical activity. The Get Active Orlando partnership plans to develop and implement a campaign that focuses on the importance of daily active living and is developing a "Point of Choice" campaign that educates people on their options for active traveling. For more information, visit <http://www.activeliving.org/node/291?tab=summary>.



Some strategies for educating elected officials and transportation officials and other decision-makers include:

- Show the facts—improve data to better describe the nature of the pedestrian problem in the community and to justify attention to pedestrian concerns.
- Conduct internal campaigns within the organization to build staff support for the pedestrian safety program (in-house meetings, newsletters, forums, etc.).
- Develop relationships and partner with other agencies (such as transit agencies, public health agencies, police departments, etc.) that have an interest in pedestrian issues and a responsibility for the public welfare.
- Plan events and activities that encourage officials to walk with an escort that can point out challenges and potential solutions.
- Partner with safety groups, community groups, homeowners associations, and others to lobby to politicians and decision-makers at the local and state level.



**An effective program to improve pedestrian safety and mobility should include elected officials and transportation decision-makers responsible for approving, planning, designing, and developing a safe pedestrian network.**

## Enforcement Solutions

### *Overview*

Programs to improve pedestrian safety should consider enforcement activities, in addition to engineering and education strategies. Enforcement, as well as education, teaches motorists and pedestrians about traffic safety and the laws that govern their rights and responsibilities.

The main goal for enforcement strategies is to deter unsafe driver and pedestrian behavior and to encourage all road users to obey traffic laws and share the road safely. Enforcement is one strategy to improve pedestrian safety, but enforcement alone will not likely have a long-term effect. Communities must combine enforcement, engineering and education strategies to address specific needs and achieve long-term results.

An important issue is motorists' awareness of the presence of pedestrians. Many motorists do not routinely look for and yield to pedestrians. The pedestrians are often blamed in pedestrian-vehicle crashes because of the underlying assumption that roadways are primarily for motorists. Law makers, local officials, and law enforcement officers need to work to change these views to ensure that pedestrians are accepted as legitimate users of the street network. Motorists need to be taught and reminded that pedestrians are more difficult to see than motor vehicles and

therefore conscious efforts are needed to reach for pedestrians in order to avoid collisions.

Furthermore, the Uniform Vehicle Code (UVC), that contains the vehicle and traffic laws of the United States, and most state laws require drivers to exercise due care any time they see a pedestrian in the roadway. The UVC was established by the national committee on Uniform Traffic Laws and Ordinances—a private, non-profit membership organization—as a set of guidelines related to motor vehicle safety. These guidelines or model legislation are then adopted by states as is or with changes to wording as each state chooses. UVC Section 11-504 states that “Notwithstanding other provisions of this chapter or the provisions of any local ordinance, every driver of a vehicle shall exercise due care to avoid colliding with any pedestrian. . . . and shall give an audible signal when necessary, and shall exercise proper care and precaution upon observing any child or any obviously confused, incapacitated or intoxicated person.”

Complementary enforcement, education and engineering measures increase the effectiveness of safety programs. For example, to encourage more motorist yielding to pedestrians in crosswalks, the roadway should be designed to promote lower motor vehicle speeds and provide clear sight lines between drivers and walkers. Police enforcement should give warnings and tickets

### Enforcement Programs Work

Enforcement programs increase the percentage of motorists yielding to pedestrians and also motorist awareness of pedestrians. They can also target motorists that are speeding or those that pass vehicles that are yielding to pedestrians. Malenfant and Van Houten (1989) measured large increases in yielding behavior in three Canadian cities employing enforcement complemented with educational outreach and several engineering interventions. Although safety may have been greatly influenced by the engineering interventions, the enforcement component increased yielding behavior (Malenfant, 1989).



More recently, this program has been applied to increase yielding behavior in Miami Beach, Florida. Data collected to date show that yielding has increased in both corridors following the introduction of the program and that maintenance strategies are working to maintain the increase in yielding behavior. Data also indicated that enforcement tactics for increasing yielding behavior to pedestrians in marked crosswalks at uncontrolled locations can be applied at other crosswalk locations.

For more information, visit: <http://www.hsrc.unc.edu/pdf/pedbike/99090.PDF>.

to violating motorists. Simultaneous public education programs should be used to educate the public about the importance of motorist compliance to such laws and the possible consequences of not doing so. A pedestrian safety program in Miami-Dade County, Florida, that incorporated engineering, education and enforcement components reduced pedestrian crash rates. (For more information, see *Comprehensive Approaches* on page 108 and 109.)

The public typically thinks of enforcement as officers writing tickets. In reality, enforcement should be a network of community members working together to promote safe walking and driving. This can be accomplished through safety awareness, education, and, where necessary, the use of warnings and/or ticketing for dangerous and illegal behaviors. Enforcement entails members of the community working in conjunction with law enforcement. Working together to enforce rules for reasonable and careful walking and driving makes it safer and easier for everyone to walk.



**Enforcement should include a network of community members working together to promote safe walking and driving.**

A critical factor in conducting pedestrian enforcement is having support from important stakeholders including local politicians and traffic court judges as well as law enforcement personnel. Politicians can ensure financial support for programs, and judges, once they understand the magnitude of the problem and how a particular enforcement program is conducted, may be more likely to convict violators. This is critical as law enforcement officers may not continue to write citations if they are consistently thrown out in court.

An adequate level of enforcement is needed to control motorist and pedestrian behavior, especially in school zones. Studies by Van Houten (2004) and others have found that enforcement aimed at motorists is more effective than enforcement aimed at pedestrians. “Anti-jaywalking” campaigns have proven ineffective and very unpopular. Police interaction with pedestrians should focus on education and warnings rather than giving citations. It has generally been more effective to cite motorists for violations related to pedestrian safety. While the laws clearly explain the dual responsibility of motorists and pedestrians, the reality is that the greatest threat to safety is a motorist who is operating a heavy motor vehicle, often at relatively high speeds. Also, enforcement programs that involve frequent and reasonable motorist penalties are more effective than enforcement that is less frequent but imposes high penalties for a motorist violation.

Police resources should be used to enforce pedestrian crossing rights and to control motorist speeds. This requires speed limits to be established at reasonable and desirable levels. Police departments should undertake training programs so that the police officers who are responsible for enforcement programs understand the laws and issues surrounding pedestrian safety.

#### *Existing Pedestrian and Traffic Laws and their Enforcement*

Many laws and ordinances addressing the safety of pedestrians currently exist. The Resource Guide on Laws Related to Pedestrian and Bicycle Safety includes provisions of vehicle and traffic laws for every state in the U.S. that may affect pedestrian or bicycle safety. The Guide also contains existing state laws and local ordinances that are not included in the Uniform Vehicle Code, but have been implemented in one or more states or municipalities and are considered to have a positive effect on pedestrian or bicycle safety. Model legislation designed to enhance pedestrian safety is also included. The Guide is available as a download or can be ordered from the NHTSA Web site. (See <http://www.nhtsa.dot.gov/people/injury/pedbimot/bike/resourceguide/index.html>.)

A comprehensive enforcement program includes reviewing existing relevant laws in a given locality. If necessary, modifications to the laws to improve the safety of pedestrians can be explored. A team of law enforcement officials, city attorneys, traffic court personnel and other interested stakeholders should review laws and ordinances that impact pedestrian safety, compare them with existing model ordinances, and consider changing them to increase the safety benefit to pedestrians. For example, statutes that require drivers to yield to a pedestrian standing on the curb at a crosswalk are stronger than those that say you must only yield to pedestrians in the crosswalk. Statutes that require drivers traveling in both directions to yield can reduce the number of pedestrians trapped in the center of the roadway. Changes to laws or ordinances should be made first at the state level, and then at the local level. Any changes or additions need to be publicized to the public to have any positive effect.

#### *Identifying Unsafe Behaviors*

Effective enforcement programs, like any safety efforts, first must identify unsafe behaviors of drivers and pedestrians, and then select appropriate strategies for improving these behaviors. There are many ways to identify unsafe behaviors; an observation of driver and pedestrian activity is a good way to



**Enforcement programs that involve frequent and reasonable motorist penalties are more effective than enforcement that is less frequent but imposes high penalties for a motorist violation.**

start. Speed measurements and examination of recent crash reports provide additional information. Collecting data to identify pedestrian safety problems is discussed in Chapter 3 and approaches used to analyze this information are discussed in Chapter 4. To start, look for the common unsafe behaviors listed below when observing traffic.



**Motorist fails to yield to pedestrian in crosswalk.**

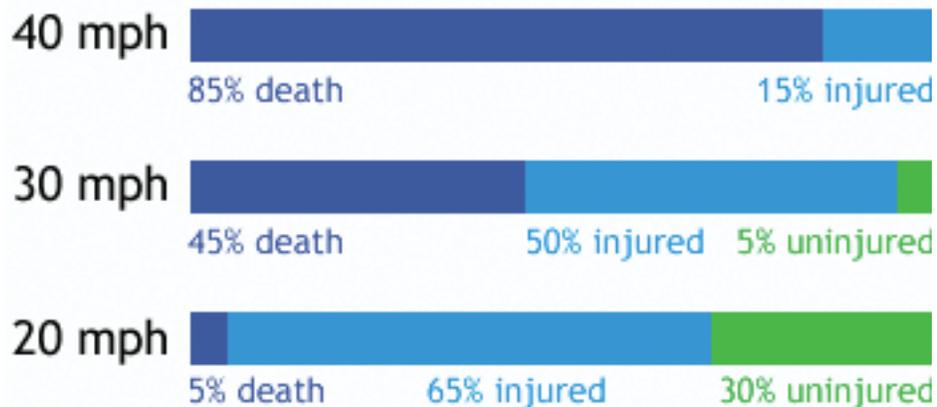
### Driver Behaviors

Unsafe motorist behaviors may include the following:

- Speeding, especially through residential streets and school zones. (Speed is directly related to crash severity and is also a likely factor in crash causation.)
- Failing to yield to pedestrians, especially in crosswalks. (The law requires drivers to yield or stop for pedestrians in crosswalks — it's a law that is often ignored.)
- Running red lights or STOP signs.
- Passing cars stopped for pedestrians crossing the street.
- Passing stopped school buses.
- Parking or stopping in crosswalks.
- Failing to yield to pedestrians when making right or left turns.
- Failing to yield to pedestrians on sidewalks when entering or leaving driveways or alleys.
- Driving while distracted.

Some drivers don't think about the risks they create. A driver may not think going 10 mph over the speed limit will be noticeably less safe, especially on a wide, inviting street. Nevertheless, just a 10 mph difference in speed can greatly affect vehicle stopping distance and greatly affects whether a pedestrian lives or dies when struck by a car. In a 20 mph impact, a pedestrian

### **Pedestrian Injuries at Impact Speeds**



**If a pedestrian is hit by a motor vehicle traveling 40 mph, the risk of dying increases to 85 percent.**

has about a 5 percent chance of dying when hit by a car. At 30 mph, the chance of dying increases to roughly 45 percent. If a pedestrian is hit by a motor vehicle traveling 40 mph, the risk of dying increases to 85 percent (see graph below).

### Pedestrian Behaviors

A critical component of enforcement activities is ensuring that pedestrians know and follow the safety rules whether or not they are laws. Some unsafe pedestrian behaviors that enforcement can influence include:

- Crossing a street at an undesirable location.
- Not looking left, right and left again before crossing the street.
- Not continuing to look for traffic while crossing.
- Darting out between parked cars and trucks.
- Not stopping and looking any time before stepping in front of a vehicle or obstacle that is blocking the view of traffic.
- Wearing dark clothes when there is poor lighting.
- Not following the directions of traffic signals or crossing guards.
- Walking along a street with their back to traffic.

Using information obtained from crash and other data, the review of relevant laws, and direct observation of behavior, a team of law enforcement officers, traffic officials and other stakeholders can develop a plan and determine strategies to use to enforce laws and improve the safety of pedestrians.

### *Role of Law Enforcement Officers*

Law enforcement officers see the consequences of motor vehicle crashes and the behaviors that cause these consequences. It is vital that they connect the two. From conducting education and enforcement campaigns to identifying unsafe conditions, law enforcement officers can play multiple roles. Demands on a law enforcement department and the level of participation they can offer vary among communities. It is important to understand the level of resources available for local law enforcement. Some communities reserve law enforcement resources for situations where pedestrians face direct or demonstrated harm, or when unsafe behaviors persist despite engineering improvements.



**Pedestrian signal violations can lead to crashes.**



**Enforcement measures can be taken to help encourage safer motorist habits.**



**Law enforcement officers can help improve pedestrian safety in a number of ways, including evaluating traffic concerns, providing enforcement presence, and educating members of the community.**

### *Types of Law Enforcement Officers*

State police or highway patrols, sheriff departments and local law enforcement agencies all may be partners in a pedestrian safety program. There are at least three general types of law enforcement officers that typically assist pedestrian safety efforts:

- **Traffic Enforcement Specialists/Motor Officers**—These officers are assigned to specialize in traffic enforcement. They respond quickly to traffic safety hot-spots. Often these officers utilize motorcycles, and are often referred to as ‘motor officers’.
- **Community Action Officers (CAOs)/Precinct Officers**—These officers are generally assigned to a specific portion of the city and work on problem areas. While they do not specialize in traffic enforcement, they can be called in for enforcement activities and help coordinate with motor officers.
- **School Resource Officers (SROs)**—Some law enforcement officers are assigned to schools and concentrate on special problems such as gangs, drugs, and other problems. They can also be used to help solve special traffic problems on or near a school campus and can coordinate with the motor officers and CAOs.

Officers can serve in the following ways:

- Teach members of the community to recognize and understand traffic, pedestrian and bike safety problems. In addition to participating in community meetings, school safety assemblies, and safety fairs, educational efforts can include pedestrian and bicycle rodeos and providing media interviews on traffic safety issues.
- Evaluate local traffic concerns, observe problem areas and behaviors, and provide input about safety improvements. Law enforcement officials can be a valuable part of a safety audit team.
- Provide an enforcement presence that discourages dangerous behaviors. For example, this may involve issuing warnings to drivers breaking traffic laws. Drivers who have made a minor error will often respond to a warning from an officer by being more careful. Drivers who continue to violate traffic laws need to be ticketed.
- Collaborate with traffic engineers and other stakeholders regarding problem areas.

### *Community Enforcement Approach*

Members of a community can work together to improve safety behaviors in many ways. Neighborhood speed watch programs and yard sign campaigns can provide opportunities for residents to educate drivers about the consequences of excessive driving speeds, while simultaneously making drivers aware that the neighborhood is concerned about safety. The community can work together to improve the safety of children walking to school by developing school crossing guard programs and safe routes to school walking plans. All adults in a community need to be good role models for their children and others by driving safely, by actively looking left-right-left before entering the street, by crossing streets at prescribed locations such as marked crosswalks when they are available, and by following other traffic rules.

### Neighborhood Speed Watch

Neighborhood Speed Watch programs are a traffic-related variation of neighborhood watch or crime watch programs. Such programs encourage residents to take an active role in changing the behavior of motorists on their neighborhood streets by helping raise public awareness and educate drivers about the negative impact of speeding. Residents record the speed, and the license plate and vehicle information of speeding motor vehicles using radar units borrowed from a local law enforcement agency. This information along with a letter is sent to the owners of the vehicles informing them of the observed violation and encouraging them or other drivers of their vehicles to drive in compliance with the posted speed limit. This type of awareness encourages some speeding drivers to slow down, but it often has limited long-term effectiveness in changing the problem, and many people are reluctant to ‘tattle’ on their fellow residents. Neighborhood Speed Watch programs can educate neighbors about the issue and help boost support for long-term solutions, such as traffic calming. Drivers also learn that residents will not tolerate speeding in their neighborhoods. This program is more effective when implemented along with a neighborhood education program involving distributing traffic safety information through door hangers or other means.

The organization of neighborhood speed watch programs can vary. Some jurisdictions have “Citizen’s Patrol” elements in the police department and others have neighborhood volunteers to oversee the program.



**Neighborhood speed watch programs can increase motorists’ awareness of their speeds and the posted speed limits.**

*For more information on local neighborhood speed watch programs, visit <http://www.slcgov.com/transportation/TrafficManagement/speed-watch.htm> and <http://www.ci.seattle.wa.us/transportation/speedwatch.htm>.*



Yard sign campaigns remind drivers to slow down.

### Slow Down Yard Sign Campaigns and Pace Car Campaigns

Slow down yard sign campaigns allow residents to participate in reminding drivers to slow down. Neighborhood leaders, safety advocates and law enforcement officials work in partnership to identify problem areas, recruit residents to post yard signs, organize distribution of yard signs, garner media attention, and evaluate the effectiveness of the campaign. Slow down yard sign campaigns may be conducted along with other speed enforcement efforts, such as progressive ticketing campaigns, and other safety efforts, such as neighborhood pace car campaigns and the use of speed radar trailers.

An evaluation of a yard sign campaign by the Safe Community Coalition of Madison and Dane County, Wisconsin, concluded that the signs are noticed and people do slow down when the signs are up, especially when speed boards are used to show drivers their approaching speed.

### **“KEEP KIDS ALIVE, DRIVE 25” Campaign**

#### **Omaha, Nebraska**

Speeding in residential areas is all too common and renders neighborhoods unsafe for children and other pedestrians. Beginning in 1998, a local resident of Omaha, Nebraska started a grassroots education campaign to reduce residential speeding, a campaign that has since spread to over 240 communities all over the US. Collaborations between local residents, schools, neighborhood associations, local businesses, law enforcement, and traffic engineering and transportation departments improved mutual trust and strengthened opportunities to get the message out.

The education program was founded on the recognition that the majority of speeders in neighborhoods are residents themselves and that most speeders simply aren't paying attention. Elements of the public awareness campaign have included street and yard signs, brochures, bumper stickers, trash can decals and even public service announcements, all containing the dramatic and effective slogan, “Keep Kids Alive, Drive 25.” Other slogans expanded the message outside the neighborhood: “No Need to Speed,” “STOP. Take 3 To See,” “Check Your Speed,” and a Spanish language version, “Mantenga A Los Niños Vivos, Maneje A 25.” Funding has come through both the sale of related educational products as well as partnerships with local businesses. For example, Radio Disney sponsored public service announcements in Omaha, and Blue-Cross-Blue Shield of Nebraska underwrote the cost of bumper stickers. In some cases, local departments of transportation have sponsored joint enforcement or engineering efforts, such as the installation of radar trailers and street signs.



The campaign has been a widely recognized success. The first study of effectiveness, conducted in Ocean-side, CA, found a 16 percent decrease in average speed of vehicles in targeted neighborhoods. A similar success was found in Omaha, where 75 percent of drivers braked when passing a yard sign. For more information, contact Tom Everson at [Tom@kkad25.org](mailto:Tom@kkad25.org) or visit [www.keepkidsavlivedrive25.org](http://www.keepkidsavlivedrive25.org).

Neighborhood pace car programs aim to make neighborhoods safer for pedestrians, bicyclists and drivers. Resident pace car drivers agree to drive courteously, at or below the speed limit, and follow other traffic laws. Programs usually require interested residents to register as a pace car driver, sign a pledge to abide by the rules, and display a Pace Car bumper sticker on their vehicle.

### Neighborhood Fight Back Programs

Neighborhood Fight Back programs are collaborative efforts between local governments and concerned residents to address crime, blight and other issues negatively impacting their neighborhoods. Though typically used to address illegal drug and other criminal activity, traffic and pedestrian safety is another area of concern targeted by Fight Back programs. The local government provides multi-agency support over a limited period of time to concentrate enforcement activities in specific neighborhoods.

### Adult School Crossing Guards

Well-trained adult school crossing guards can play a key role in promoting safe driver and pedestrian behaviors at crosswalks near schools. They help children cross the street safely and remind drivers of the presence of pedestrians. A guard helps children develop the skills to cross streets safely at all times. Adult school crossing guards can be parent volunteers, school staff or paid personnel. Annual classroom and field training for adult school crossing guards as well as special uniforms or equipment to increase visibility are recommended, and in some locations required. For more information, visit [http://www.saferoutes-info.org/guide/crossing\\_guard/index.cfm](http://www.saferoutes-info.org/guide/crossing_guard/index.cfm).

### Safe Routes to School Programs

Safe Routes to School (SRTS) is a national program teaching education, enforcement, engineering, and encouragement strategies for communities to make walking to school safe and more widespread. The main goal for SRTS enforcement strategies is to deter unsafe behaviors of drivers, pedestrians, and bicyclists, and to encourage all road users to obey traffic laws and share the road safely. Enforcement used alone will not likely have a long-term effect. Communities must utilize a combination of strategies to address the specific needs of their schools and achieve long-term results.

*For more information on pace car programs, visit [http://www.ci.madison.wi.us/health/pubnews/pdf\\_files/yardsign.pdf](http://www.ci.madison.wi.us/health/pubnews/pdf_files/yardsign.pdf).*

*For information on neighborhood fight back programs, visit <http://phoenix.gov/NSD/fightback.html> and <http://www.asu.edu/copp/morrison/public/FightBackEvaluation.pdf>.*



**Trained adult school crossing guards play a key role in promoting safe driver and pedestrian behaviors near schools.**

*To learn more about Safe Routes to School, go to <http://www.saferoutesinfo.org>. FHWA program guidance for Safe Routes to School is available at <http://safety.fhwa.dot.gov/saferoutes/srtsguidance.htm>.*



2. Use public awareness and education first. Public awareness and education is effective when applied prior to law enforcement activities. The awareness and education messages should inform people of the problem and why enforcement action is needed. This will generate public support and help offset complaints from those who are caught breaking the law. The public then needs to know what the enforcement activities will be and when they will start, as tickets are more likely to hold up in court when this groundwork has been done. Mass mailing and media campaigns using local television stations, radio and newspapers may help spread the message. Radio 'traffic watch' programs are an excellent way to spread the traffic safety message. Portable speed limit signs and speed reader boards are effective tools for providing real time speed information to drivers. For some drivers, raising that awareness may be enough to cause them to alter their behavior.
3. Provide officer training. Officer training is critical to an effective law enforcement program. The training should occur prior to the start of an enforcement program and include information on why, what, when, where and how law enforcement should occur to maximize behavior change, and to reduce the number of crashes involving pedestrians. Existing laws that impact pedestrian safety should be reviewed and discussed. For example, the officers need to know the definition of crosswalks includes unmarked crosswalks and they need to know pedestrian and motorist rights and responsibilities in crosswalks.
4. Follow up. Enforcement activities, regardless of the specific method used, require follow-up to maintain their effectiveness. To measure the impact of an enforcement activity in a specific situation, make a quick study before and after the enforcement effort. Before-and-after studies do not have to be elaborate. They can be as simple as measuring speeds, or observing behaviors at crosswalks and parent drop-off and pick-up zones. Examine the results and decide on the next steps. If the results are positive, the method used was likely effective in improving behavior. If the results indicate little change in unsafe behaviors, perhaps another method should be used. Even with initial success, communities will need to repeat enforcement efforts periodically in order to sustain improvements in drivers' behaviors.



**Officer training is critical to an effective law enforcement program.**

### *Law Enforcement Methods*

Law enforcement can use a variety of methods that utilize technology and personnel to raise awareness and educate motorists about driving behaviors and their relationship to safety. A variety of law enforcement methods can help change unsafe behaviors, making walking safer and more attractive.



Speed trailers may be temporary or permanent devices to help monitor the speed of vehicles, especially inside neighborhoods.

### Traffic Complaint Hot Line

Agencies can establish a central hot line phone number or Web site address for citizen traffic complaints. This allows police to coordinate their responses and concentrate on areas where there are numerous complaints. Traffic complaints are often associated with pedestrian crossings and other violations relating to pedestrian safety such as speeding. Where traffic complaint hot lines have been established, most of the calls are about traffic problems at or near schools. It is important for police to follow up with the complainant on the enforcement action and citations written. The complainants need to be told to provide information on the time of day and day of week when the violations are most prevalent to allow the police to better focus their resources. The police must then analyze the complaint to determine if it is truly the problem or merely a symptom of an underlying cause.

### Radar Speed Trailers and Active Speed Monitors

Fixed motorist feedback signs or movable radar speed trailers can be used as part of a community education and enforcement program. The more effective units have bright strobe lights that will flash like a photo-enforcement camera or display red and blue flashing lights when motorists exceed a preset speed. Radar trailers are moved to different locations and are occasionally supplemented with motor officer enforcement. Some radar speed trailers can record speed data and traffic counts by 15-minute or hourly intervals throughout the day. This is useful information to compare to speeds prior to and following trailer placement. Radar speed trailers have limited long-term effectiveness if left in place. If moved around on a somewhat random schedule and augmented by ticketing, they can have long-term benefits. They can also be useful in educating people and helping to boost support for other long-term solutions.



Active speed monitors are permanent devices to keep drivers aware of their speeds and the need to slow down.

Active speed monitors are permanent devices to keep drivers aware of their speeds and the need to slow down. They are typically mounted in conjunction with a speed limit sign and visually display drivers' real-time speeds as they pass. Drivers see

how fast they are actually driving compared to the posted speed limit. Some active speed monitors are solar-powered.

### Progressive Ticketing

Progressive ticketing is a method for introducing ticketing through a three-staged process. Issuing tickets is the most severe strategy of an enforcement program. It is usually reserved for changing unsafe behaviors that other strategies failed to change or that pose a real threat to the safety of pedestrians and drivers. However, some communities actively advertise that the police will cite drivers for the more egregious violations, such as motorists speeding more than 20 mph over the posted speed limit.

There are three main steps of an effective progressive ticketing program:

1. **Educate**—Establish community awareness of the problem. The public needs to understand that drivers are speeding and the consequences of this speeding for people's safety. Raising awareness about the problem will change some behaviors and create public support for, or at least understanding of, the enforcement efforts to follow. The start of a safety campaign can be done as a part of a press conference.
2. **Warn**—When violations are observed, give motorists written warnings instead of citations. This allows police to stop motorists for lesser violations. This educational stop allows the officers to hand out safety literature that indicates what harm is caused by excessive speed and the stopping distances required by higher speeds. Motorists are often relieved that the officer did not give them a citation and may heed the warning. There are times during the warning period when some discretionary citations will be given for the more flagrant violations.

Beginning a ticketing program with education and warnings provides time to build support for the program as well as time for offenders to change behaviors. Issuing warnings allows police to contact up to 20 times more non-compliant drivers than does ticketing. In addition, the high frequency of stops ensures not only that many people directly make contact with law enforcement, but also that many others witness these stops and are prompted to start to obey the rules.



**Begin a ticketing program with education and warnings.**



Law enforcers participate in pedestrian decoy operations.

3. Ticket—Finally, after the warning time expires and offenders continue their unsafe behaviors, officers should issue tickets. Ticketing also gives the program credibility by showing that law enforcement is doing exactly what they said they would do if unsafe behavior did not change. Unfortunately, for some people receiving a ticket and experiencing the consequences is necessary, with the hopes of encouraging them to become safer drivers.

Pedestrian Decoy Operations

Pedestrian decoy operations are carefully designed and thoroughly coordinated activities to warn motorists that the yield-to-pedestrian laws will be enforced at target locations. Officers prepare a site ahead of time by establishing the safe stopping distance to a crosswalk, with a 16 km/h (10 mi/h) over the speed limit leeway. Cones are set out in that location. An officer in plain clothes steps into the crosswalk just before a vehicle



**Heed the Speed Nationwide**

The Heed the Speed neighborhood safety program is a combined education and enforcement neighborhood safety program that has been evaluated by NHTSA. The traffic safety campaign is conducted with active neighborhood participation using a public information campaign and a short (i.e., three month), intensive police enforcement campaign. Warnings are given out at first, followed by citations by the end of the three-month period. The education component involves community meetings to get the word out about the consequences to pedestrians and motorists of speeding and how it affects insurance rates. Residents are asked to voluntarily comply with the speed limits. Safety articles are written in community newsletters and local newspapers about the dangers and consequences of speeding. Nearby high schools and car dealerships are contacted with the same information. Residents are provided with yard signs with the HEED THE SPEED safety message.

Heed the Speed safety campaigns have proven to be effective in reducing motorists' speeds in neighborhoods. The campaign in the above two photos included adding visual illusion speed humps to the pavement to encourage slower driving speeds.

Radar speed trailers and radar speed training of new officers in these neighborhoods help to provide a high level of police visibility. The program is repeated at intervals when speeds increase. Machine speed studies can be used to record and monitor speed results.

passes the cone. This gives the motorist plenty of time to yield to the pedestrian. If the motorist doesn't yield, either a warning or a citation is given to the driver, based on the severity of the incident. The most effective campaigns have been accompanied by an extensive media blitz ahead of time. All the interactions can be recorded on video so if motorists dispute a ticket, their behavior can be viewed by the courts. This usually leads to a guilty plea. These campaigns have proven to be very popular, as pedestrians are happy to see enforcement oriented at motorists, who often act aggressively towards pedestrians. The use of law enforcement officers as decoy pedestrians provides the officer with first-hand experience as a pedestrian at a difficult and busy crossing.

### Photo Enforcement

Automated photo speed enforcement (photo radar) and red light enforcement take a real-time photo of traffic to record vehicle speeds and behaviors. It can be used to document speeders and those who drive dangerously through crosswalks. In several evaluations, the presence of photo enforcement at intersections has resulted in fewer drivers running red lights and a decline in speeds and collisions. The mere presence or threat of photo speed enforcement may result in better driver compliance and behavior.

Automated photo speed enforcement is just one of many tools law enforcement has to influence driver behavior and reduce vehicle speed. Laws on the use of photo enforcement vary from state to state, and some states currently do not allow this type of enforcement. Photo radar systems typically operate on set speed thresholds, (e.g., 11 mph or more over the posted speed limit) only capturing images of motor vehicles moving at or above the established threshold. When a violation occurs, the system captures speed data, as well as images of the motor vehicle (and in some systems the driver) at the time of the violation. Citations are typically issued through the mail to the registered owner of the vehicle after a review of the vehicle and registration information is completed.

Photo enforcement technology does not replace traditional methods of traffic enforcement. Rather, it serves as a supplement to traditional traffic enforcement techniques, in addition to education and engineering efforts designed to enhance traffic safety.

Communities wishing to apply this technology to their traffic safety efforts should consult with local courts, prosecuting au-



**A van equipped with photo enforcement technology can be used at several locations where speeding threatens pedestrian safety.**

*For more research and information on photo enforcement, see:*

*Case Study 67, Red Light Camera Enforcement, Boulder Colorado. In PEDSAFE: Pedestrian Safety Guide and Countermeasure Selection System, September, 2004. FHWA-SA-04-003 U.S. Department of Transportation Federal Highway Administration. Available online at [www.walkinginfo.org/pedsafe/case\\_studies2.cfm?op=L&subop=I&state\\_name=Colorado](http://www.walkinginfo.org/pedsafe/case_studies2.cfm?op=L&subop=I&state_name=Colorado).*

*Case Study 68, Red Light Photo Enforcement, West Hollywood, California. In PEDSAFE: Pedestrian Safety Guide and Countermeasure Selection System, September, 2004. FHWA-SA-04-003 U.S. Department of Transportation Federal Highway Administration. Available online at [www.walkinginfo.org/pedsafe/case\\_studies2.cfm?op=L&subop=I&state\\_name=California](http://www.walkinginfo.org/pedsafe/case_studies2.cfm?op=L&subop=I&state_name=California).*

**“Decoy”  
Pedestrian Cross-  
ing the Street  
in Enforcement  
Operation.**

## **Pedestrian Decoy Operation City of Miami Beach**

Van Houten and Malenfant (2004) conducted a study of driver yielding behavior at four crosswalks in each of two—an east and west—high crash corridors in the City of Miami Beach. Police teams were situated at eight selected crosswalks. Each team included a decoy pedestrian who crossed the street when other pedestrians were not present, and a spotter who radioed failure to yield violations to other officers who flagged the violators and gave them a verbal warning (or citation) and an enforcement flyer.



**Enforcement  
Operations in  
Miami-Dade.**

The police stopped 1,562 motorists for failing to yield to pedestrians over the period of a year, with 1,218 of these stopped during the first two weeks of the program (Van Houten and Malenfant, 2004). Three hundred seven citations were issued, of which 188 were given during the first eight weeks of the program. At baseline, 3.3 percent and 18.2 percent of the drivers yielded to pedestrians in the west and east corridors respectfully. The introduction of the enforcement program at the four sites in the west corridor led to an increase in yielding to 27.6 percent during the first week of the program while no increase in yielding occurred at the untreated east corridor. The introduction of the enforcement operations in the east corridor led to an increase in yielding to 28.8 percent in this corridor, while increased yielding was maintained in the west corridor. Monthly follow-up data indicated that the gains produced by the program were maintained in the absence of high levels of police enforcement with overall yielding rates of 27.8 percent in the west corridor and 34.1 percent in the east corridor during the follow-up data collection (Van Houten and Malenfant, 2004).

Additionally, police officers in Miami Beach and Miami Springs received training on pedestrian safety and enforcement activities that have been used to address a variety of violations and behaviors that often lead to collisions between pedestrians and motor vehicles (Zegeer et al, 2007).

thorities, law enforcement and community groups in the planning and development of their photo enforcement programs. Some states may not allow photo enforcement in general, but may permit it in school zones. Also, in some locations where photo enforcement is not permitted, citizen advocates can petition their legislators to permit its use. Photo enforcement provides communities with a highly flexible tool that can be deployed when and where it is needed for maximum effect. Most systems also capture data on traffic flow and average speeds, enabling communities to measure the effectiveness of the deployments in relation to crash data for the area.

A permanent, fixed photo speed enforcement camera in a neighborhood will almost never be financially viable, but a mobile photo speed unit that can be carried in vans provides a feasible alternative. Such mobile units can provide excellent citywide coverage for problem areas. In these cases, a vendor can operate the equipment, but a police officer must review the photos and approve the citations before they are issued. The implementation of any photo enforcement program should be carefully planned, have reasonable and attainable expectations, and include public input and political support. It should also emphasize the safety benefits rather than the monetary benefits, as the public may be against these devices if raising revenue is emphasized. Alerting the public to the photo speed enforcement effort before it begins is critical to avoid negative publicity. Visible warning signs should be placed in advance of the camera location before the effort begins so drivers will understand what will happen. An effective photo enforcement program will allow for the continuous two-way exchange of information with the community and have the flexibility to meet changing traffic safety issues and concerns.

#### Double Fines in School Zones and Other Special Interest Areas

Strict enforcement of speed laws in school zones and other locations where pedestrian traffic is high, or crash data suggests that speeding may be a factor in pedestrian crashes, can improve the safety for pedestrians and drivers. Along with school zones, senior centers, park and recreation facilities, college campuses, hospitals and shopping areas are some of the locations that may warrant special attention by law enforcement officials to discourage speeding and encourage proper behavior for yielding to pedestrians who are crossing roadways. A zero tolerance policy for speeders in these special areas, and even an increase in fines for drivers who violate the posted speed limit, are potential approaches.

## Double Fines in School Zones

### State of Washington

In 1997, Washington State enacted legislation that doubled the basic fine for drivers speeding in a school zone. This fine cannot be waived, suspended or reduced. One-half of the revenue generated is directed into an account managed by the State's Governor's Highway Safety Office (the Washington Traffic Safety Commission), which is designed to enhance safety in school zones and student transportation. The legislation allows \$1.5 million to be spent per biennium, with \$1 million for law enforcement and \$500,000 for public education. Funds for law enforcement are available to agencies through an application process. These funds can be used to purchase equipment—such as radars, computers, patrol cars or motorcycles—that improves safety in school zones or student transportation. The public education funds make it possible to produce and disseminate products, such as public service announcements, radio and bus ads, and crossing guard equipment. The funds have also been used to provide mini-grants to support International Walk to School Day celebrations around the state and have paid for the creation and distribution of the School Administrator's Guide to Pedestrian Safety and the School Safety Resource Kit.

Through proactive enforcement, where law enforcement officers are focusing on school zone safety, communities have seen reductions in collisions in school zones. For example, collision rates in school zones have declined by 23 percent in Bremerton, Washington, and by 13 percent in Tumwater, Washington.



*Defining the 3 E's: Engineering, Education, and Enforcement. Sometimes other groups like to add other E's as well: Encouragement, Emergency Services, Evaluation.*

### Building Partnerships and Coordination with Other E's

Developing and implementing a successful education or enforcement program cannot be achieved by any one organization or agency—it takes a team effort. The benefits of effective partnerships and collaboration include:

- Strength in numbers.
- Additional resources, expertise, and funding.
- Well-coordinated and more efficient use of resources.
- Better anticipation of program obstacles and potential solutions.

Identifying all interested or potentially affected parties will help ensure success. A successful partnership will include:

- Policy and decision makers.
- Engineers and transportation planners.
- Educators (including teachers, principals, school board

members etc.).

- Law enforcement officers and judges.
- Advocates and community representatives.
- Health and safety professionals.
- Transit officials.
- Media.

Some strategies for building effective partnerships include:

- Understand the issues and the purpose of the partnership.
- Seek to interest agencies and encourage cooperation.
- Establish agreed-upon, long-term goals, strategies, and responsibilities.
- Create achievable short-term goals to show progress and early successes.

More information on building partnerships and working with stakeholders is provided in Chapter 2.

## Media's Role in Education and Enforcement

All the components of a good education and enforcement program—creating awareness, alerting the public, and enforcing safe practices—benefit from media coverage. For enforcement events, the goal is to garner substantial media attention and edu-

### Building Partnerships

#### Portland, Oregon

At the Oregon Department of Transportation in Portland, OR, a forward-thinking manager brought together a diverse coalition of community groups to form a Community and School Traffic Safety Partnership. Included in the partnership are school boards, neighborhood associations, businesses, nonprofits, elder advocacy groups, insurance providers, enforcement agencies, and bike and pedestrian advocacy groups. The coalition implements a wide variety of programs with success, such as an interactive half hour sidewalk pedestrian presentation. Another innovative program is the crosswalk enforcement action, where the ODOT partners with police enforcement to pull over anyone violating a monitored intersection for half an hour, during which a representative acts as a pedestrian repeatedly crossing the road. Both drivers and pedestrians are stopped and given an informational pamphlet and, in certain cases, a citation. This active enforcement action is performed wherever requested by a community.

The partnered organizations play an active role in the program as well. For example, various senior centers work closely with representatives from the ODOT to address problem areas and to develop localized pedestrian maps for use by members and residents. The maps show all points of interest including transit stops, benches, water fountains, curb cuts, and more, and designate a prioritized route to frequent destinations. Suggestions for revision are solicited from residents themselves, a bilingual explanation of signals is included, and the maps are distributed at the senior center and by local Meals on Wheels partners. For more information, contact Sharon White at (503) 823-7100.

cate the public to change behavior, not issue numerous tickets. If 10 motorists receive tickets and 100,000 people hear about it, the enforcement effort will have a more significant impact than if officers issue 100 tickets and only the recipients know what happened. The key to a successful campaign is to provide information before the education or enforcement event occurs to encourage community support and facilitate positive coverage. Without such prior notification, motorists may claim to be caught by surprise, which can lead to negative publicity.



**Informed members of communities can talk to media to raise awareness of pedestrian safety issues.**

There are many ways to involve the media. For example:

- Neighborhood groups or community leaders can hold a press conference to talk about pedestrian safety and tell the public that they are requesting more enforcement or are implementing an education campaign.
- Organizers can provide the press with packets of information about walking and safety statistics. Press packets can include frequently asked questions to help a reporter ask the right questions in an interview.
- Informed members of the community can be available to talk to the media. A child who is well-versed in the pedestrian problems in the neighborhood can provide an important perspective. Hearing a child explain how difficult it is to cross a street will have a bigger impact than reading a statistic. Properly educated police and elected officials can also deliver a powerful message.

The entire community can be made aware of the pedestrian safety program in a variety of ways to ensure they know what will happen before the program begins in force. Event organizers can:

- Publish an article in the local newspaper or in a neighborhood newsletter.
- Send an e-mail to residents.
- Put up speed reader boards so drivers see for themselves what their speeds are compared to posted speeds.
- Post information signs near where the enforcement or education effort will occur.
- Post yard signs in their front yards to get the message out.
- Participate in media events and community safety fairs.

In ethnically diverse communities, providing safety messages to the public in various languages and with culturally-relevant messages will be critical for the success of the effort. Some safety out-reach efforts may require bilingual staff to provide the safety message to all targeted groups.

## Finding Funding and Support

Successful education and enforcement programs need long-term funding and support. This can be through local or regional agency budgets, support and contributions provided by local businesses or other stakeholders and partners (such as area hospitals or advocacy groups like Safe Kids), or state and federal grants. Chapter 6 and Appendix D provide information on funding strategies and sources for pedestrian projects.

### Comprehensive Pedestrian Safety Program Burlington, Vermont

The Burlington Department of Public Works launched an annual pedestrian safety campaign in the summer of 2006, based on materials in FHWA's Pedestrian Safety Toolkit. The campaign included engineering, education, and enforcement components.

For the engineering component, the town worked to develop a multi-modal transportation improvement plan; improve pedestrian access to transit and to the waterfront; and facilitate the development of pedestrian improvements to Cliff Street and other locations. On the enforcement side, the department worked with the Mayor and the Police Department to distribute educational materials to violators, with specific information targeted at motorists, cyclists, pedestrians. Extra enforcement in the downtown area focused on bicycle- and pedestrian-related violations. For the education component, public service announcements were broadcast over radio and television and displayed on safety slides at the downtown cinema. The Department of Public Works collaborated with the Mayor, Police Department, and local advocacy organizations to develop press releases and hold press conferences highlighting safety initiatives, using the media to spread the message. Additionally, safety coupons were designed and distributed for discounts on retro-reflective clothing and other safety products. For more information visit: <http://www.dpw.ci.burlington.vt.us/transportation/bikewalk/safety/>.



Example FHWA safety campaign materials are available online at [http://safety.fhwa.dot.gov/local\\_program/pedcampaign/index.htm](http://safety.fhwa.dot.gov/local_program/pedcampaign/index.htm).

## Comprehensive Pedestrian Safety Programs

### Hamilton Township, New Jersey

From 1998 to 2004, Hamilton Township experienced 23 pedestrian crashes and 6 deaths along the same corridor. At the end of 2004, the Township began a concerted safety campaign involving education, engineering, and enforcement solutions.

Several low cost measures were taken immediately, including fencing along the highway medians, temporary message signs to pedestrians and drivers, improved intersection markings, countdown signals, and revised intersection timing. Longer-term solutions were also planned, including median barriers, sidewalks, and pedestrian overpasses. To educate the public, flyers were distributed at intersections and to pedestrians crossing at unsafe and unauthorized locations. Presentations were given at schools and community centers in addition to radio and television messages. Additionally, the city undertook an aggressive enforcement effort, issuing summonses to jaywalkers rather than warnings. The Police Department increased traffic enforcement along the route by 600 percent and established a traffic safety coordinator. The New Jersey Division of Highway Safety helped establish funds for the creation of a Traffic Safety Unit dedicated to pedestrian and other traffic safety concerns.

From 2005 to 2006, there were two pedestrian crashes, as compared with 10 in 2004 alone. For more information, contact Chief of Police, Jay McKeen at: [jmckeem@townshipofhamilton.com](mailto:jmckeem@townshipofhamilton.com).

## Measuring Program Effectiveness

Measuring program effectiveness is important to:

- Show an outcome that demonstrates that the program met or exceeded the objectives.
- Help determine if the program needs to be adjusted or changed.
- Document and justify the need for continued funding or program expansion.
- Provide guidance for other communities looking to implement a similar program.

Program measures must relate to the objectives established for the program, and should include observable phenomena—things that can be seen and quantified. Outcomes to be measured could include:

- Number of crashes, injuries, and fatalities.
- Behaviors of pedestrians (such as looking, crossing, and yielding), and drivers (such as speeding and yielding).
- Citations issued/enforcement hours.
- Number of people walking.
- Knowledge, opinions, and attitudes.
- Changes in organizational activity/procedures.

## Pedestrian Safety Demonstration

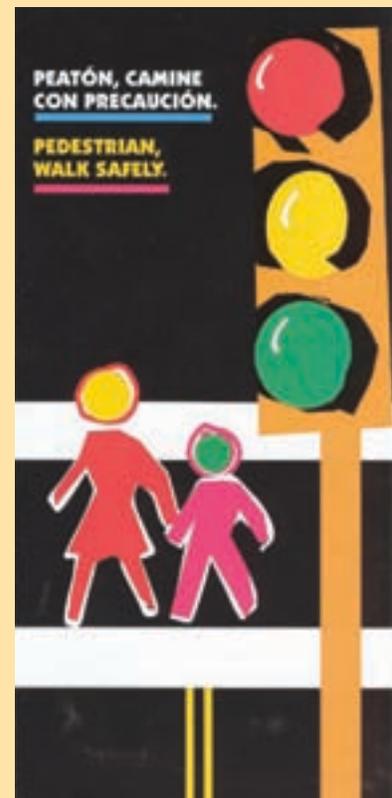
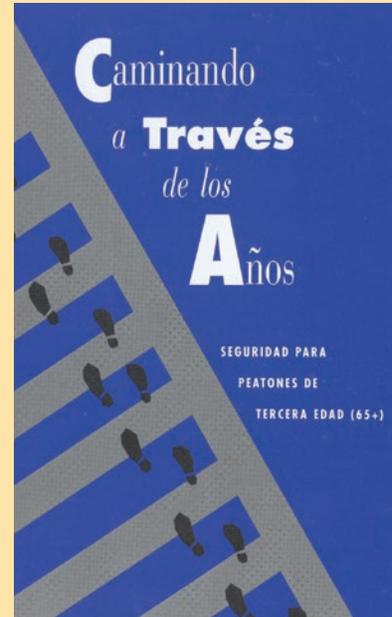
### Miami-Dade County, Florida

A multidisciplinary team took part in a long-term effort to educate drivers and pedestrians, and enforce laws in high-crash locations and zones in Miami-Dade County, Florida. Using pedestrian crash data from 1996-2001, four zones were identified as having abnormally high pedestrian crash experiences. Based on locational crash characteristics, as well as pedestrian (age, ethnicity) factors, a total of 16 different types of education, enforcement, and engineering treatments were selected and targeted to reduce pedestrian crashes.

Education strategies included interactive programs, workshops, and events; brochures, videos, and posters in several languages (including Spanish and Creole), and giveaways. The education programs were targeted at specific audiences (e.g., children walking to school, older pedestrians, etc.), and materials and communication strategies were tailored to those groups. For more information on the education program targeting children, visit [www.walksafe.us](http://www.walksafe.us). The enforcement effort involved conducting officer training in pedestrian safety enforcement at the City of Miami Beach Police Department. This enforcement program complemented other countermeasures in South Beach that were implemented during the Miami-Dade Demonstration project. It also included a Driver Yielding Program that targeted drivers at crosswalks to try to increase awareness and yielding behaviors. The engineering component involved several studies to identify high pedestrian crash corridors, prioritize locations, and help select countermeasures. Over \$6.5M in pedestrian safety projects were programmed or implemented on these corridors as a result.

A before-after study was used with three separate control groups to evaluate the effects of the combined pedestrian safety program on pedestrian crashes. A three-year “after” period was used (2002-2004). Multivariate intervention auto-regressive integrated moving average (ARIMA) time series analysis was used, along with non-parametric (i.e., Mann-Whitney) U-tests to test for statistically significant differences in pedestrian crash experiences. Results showed that the pedestrian safety program reduced Countywide pedestrian crash rates by between 8.5 percent and 13.3 percent, depending on which control group was used. This effect translated to approximately 180 fewer crashes each year in Miami-Dade County for the first two years (2003 and 2004) after the study period ended. The greatest reductions were found in pedestrian crashes among children, where there was a 32 percent reduction in child pedestrian crashes in the four zones, and a 22 percent reduction Countywide. Educational and other measures to reduce crashes involving older pedestrians showed no effect. A number of lessons learned were identified for future implementation of such a program by other jurisdictions.

For more information, contact Charlie Zegeer at [zegeer@claire.hsrb.unc.edu](mailto:zegeer@claire.hsrb.unc.edu) or 919-962-7801.





Having good plans and policies in place to support walking enables safer streets for pedestrians.



Designing streets with pedestrians in mind can result in streets that are pedestrian-friendly with lower vehicle speeds (bottom photo) rather than higher-speed auto-oriented (top photo) designs.

For more information about pedestrian-friendly site design, see Georgia's "Site Design for Pedestrians" Toolkit at [http://www.dot.state.ga.us/DOT/plan-prog/planning/projects/bicycle/ped\\_facilities\\_guide/10\\_site\\_design\\_for\\_pedestrians.pdf](http://www.dot.state.ga.us/DOT/plan-prog/planning/projects/bicycle/ped_facilities_guide/10_site_design_for_pedestrians.pdf). Other site design resources can be found in Appendix G.

How and when a program/project is evaluated is determined by the objectives and activities of the project. It is easier to measure the success of a program if decisions are made about what to measure and how/when to evaluate it before implementing the program. Appendix E provides guidance on evaluating pedestrian safety plans; much of this information can be applied to evaluating pedestrian education or enforcement programs.

## Comprehensive Approaches

Successful approaches to improve pedestrian safety usually involve a comprehensive program that includes elements of engineering, planning, education, and enforcement measures. The sidebars on pages 107 through 109 show some examples.

## Policy and Planning Solutions

Over and beyond incorporating features designed specifically to improve pedestrian safety, there are many aspects of general street design that result in safer conditions for pedestrians:

### General Street Design

1. **Speed control**—For many pedestrian crashes, speed is an important factor; high speeds reduce the possibility of crash avoidance, and increase the likelihood of a severe injury or fatality. Cities that have made concerted efforts to reduce pedestrian crashes use speed reduction as a primary tool. Speed reduction must be a matter of both policy (by setting lower speed limits) and design. However, simply lowering speed limits on streets where motorists can go fast is usually ineffective. Streets must be redesigned to encourage lower speeds.
2. **Traffic Calming**—Local agencies often develop plans and policies for using a variety of traffic calming measures for reducing pedestrian and/or other crash types on local and neighborhood streets. Such measures include, speed tables, traffic circles, speed humps, chokers, and chicanes, to break up long straight stretches of straight streets and to reduce vehicle speeds and/or reduce cut-through motor vehicle traffic.
3. **Residential Street Design**—Many residential streets built in the last few decades have been built too wide and without interruptions for long distances, encouraging higher speeds than appropriate for streets where children are frequently expected. Most small children who are involved in a crash

are hit within a block of their homes. Features of residential streets that are safe for pedestrians include narrow width, on-street parking, tight curb radii, short block length, buffered sidewalks with street trees, short building setbacks, and streetlights.

### *Land Use and Site Design*

Land use patterns can have an impact on pedestrian crashes. Many pedestrian crashes occur in suburban, auto-oriented locations. One reason is motorists simply do not expect pedestrians on some streets, but are much more highly aware of their presence on streets where pedestrian use is high. Other reasons include higher driving speeds in suburban areas and possibly diminished motorist reaction times or their willingness to slow and yield to crossing pedestrians. The following land use and site design techniques can help manage speed and therefore lower crash rates:

1. **Buildings that define streets**—Buildings located at the back of the sidewalk give the motorist sense of enclosure; buildings set far back, with large parking lots in front, create the illusion of a wide road which encourages higher speeds and discourages walking.
2. **Mixed-use development**—Buildings with retail on the bottom, housing on the top encourage pedestrian activity. This includes parking garages, office buildings and fast food restaurants.
3. **Street connectivity**—Lack of street-connectivity and pedestrian connections discourages walking because of the added travel distance to reach destinations. Long super blocks also reduce pedestrian crossing opportunities; midblock crossings should be provided about every 91 m (300 ft)—the length of a typical urban block.
4. **Curb/Parking Management**—Curb management practices (such as painted curbs) can be used to regulate parking. Parking should not be placed between the sidewalk and a building, as stated previously. The principles of access management should be extended to parking: single lots serving multiple stores are preferred over single stores each with its own parking and driveway.

These site design practices need to be incorporated in city codes for future development. Also, many retail outlets such as fast food restaurants are remodeled or rebuilt about every ten years,

## Land Use Policies State of Pennsylvania

New land use policies will help remedy future developments but will not solve the immediate problems in urban and suburban areas, where existing land uses do not accommodate—much less encourage—walking or bicycling. Therefore, the Pennsylvania Statewide Bicycle and Pedestrian Master Plan includes a section on retrofitting existing land uses to serve pedestrians. It provides guidance on downtown redevelopment, “pedestrianizing” existing retail/office developments, and retrofitting suburban residential neighborhoods, including recommendations such as:

- Maximize pedestrian transit access to the site from adjacent land uses.
- Improve the layout of buildings and parking lots.
- Bring destinations closer to home.
- Encourage denser development or redevelopment.
- Provide sidewalks and street trees.
- Reduce the speed of automobile traffic.
- Provide off-road internal pathway systems.
- Provide “pocket” parks and community green space.

For more information, visit: <http://www.dot.state.pa.us>.



**Curb management (such as painted curbs to keep cars away from the marked crosswalk) would help this pedestrian to better see cars approaching the intersection. In this case, a curb extension would also help the pedestrian to better see cars approaching the crossing.**



**Traffic signal installations may be the only solution to enable pedestrians to cross some busy, multilane streets. However, signals do not solve all pedestrian crossing problems and should be used with caution.**

which may present opportunities to implement new site design requirements to retrofit existing facilities, such as installing sidewalks with a planting strip.

### Countermeasures to be Used with Caution

Concerned citizens and elected officials often respond to a tragic pedestrian crash with a call for an immediate solution. Among the most commonly requested solutions are a traffic signal, a flasher, a pedestrian bridge or underpass, or a marked crosswalk. While these all can be an effective solution in certain places, in some instances they are not appropriate or effective.

#### *Traffic Signals*

The primary purpose of a traffic signal is to create gaps in motor vehicle traffic that otherwise would be hard to find. The MUTCD warns against the overuse of signals for a variety of reasons. Used inappropriately, traffic signals may increase crashes. See MUTCD Chapter 4 for information on signal warrants (<http://mutcd.fhwa.dot.gov/pdfs/2003/Ch4.pdf>).

Traffic signals can range from \$35,000 to \$300,000 for one intersection, if no associated road widening is necessary. Furthermore, resources are needed for annual maintenance of the signal.

In many cases, the only solution to crossing a busy, multilane arterial street is to install a pedestrian crossing signal. This is especially true in locations where there is not another signal for 0.4 km (0.25 mi) or more in an area with lots of pedestrian activity.

Traffic signals (with pedestrian displays) are one possible option to be considered in helping to get pedestrians safely across busy streets. Adding a traffic signal, however, does not guarantee safety for a pedestrian, since some motorists run red lights and some turning motorists fail to yield to a pedestrian in a crosswalk during the WALK interval; also, some pedestrians will cross against the traffic signals.

#### *Pedestrian Bridge or Underpass*

A popular but often ineffective countermeasure is to install a pedestrian bridge or underpass. These solutions are appealing because they give the impression of complete separation of pedestrians from motor vehicle traffic. In theory this is true, but in practice this rarely occurs for several reasons:

- Bridges and underpasses are so expensive, they cannot be provided at most locations where pedestrians may want to cross.
- Underpasses are often prone to security concerns due to low visibility.
- The inconvenience of out-of-distance travel is high, up to 305 m (1,000 ft) or more, because of the need to provide accessible ramps; many pedestrians will not walk this extra distance and cross at-grade.
- To be effective, there has to be a self-enforcing feature that requires the pedestrian to use the bridge, such as topography, or fencing along one side of the street or in the median for several hundred feet on either side of the grade-separated crossing.

These reasons explain why pedestrian bridges or underpasses are under-used, and motorists are frustrated when they see pedestrians crossing in the vicinity of an bridge or underpass; this in turn increases the risk to pedestrians crossing at grade.

The high cost of a pedestrian bridge or underpass (from several hundred thousand to several million dollars) makes them impractical for all but a few locations. Many pedestrian crossing islands with illumination can be provided for the cost of one bridge; along a corridor with multiple crossing points, the crossing islands are a more effective use of resources.

#### *Marked Crosswalks without Additional Treatments*

Marked crosswalks tell the pedestrian where to cross. For example, where sight distance is compromised, it may be desirable to direct the pedestrian to the location where the site distance is best. Marked crosswalks also tell the motorist to expect pedestrians at a particular location, but motorists on higher-speed streets frequently cannot see them until it is too late to stop. Without other safety features mentioned thus far (islands, curb extensions, illumination etc.), marked crosswalks on their own do not necessarily increase the security of a pedestrian crossing the street. Zegeer et al. (2005) have completed an exhaustive study on the effectiveness of marked crosswalks, which can be downloaded at <http://www.walkinginfo.org/rd/devices.htm#cros1>. In general, the following principles apply to the installation of marked crosswalks alone (i.e., without other substantial pedestrian treatments):

- On two-lane streets, a crosswalk can be marked without compromising pedestrian safety.
- On multilane streets with an average daily traffic (ADT)



**Pedestrian bridges should be convenient for pedestrians (see top photo); otherwise they will not be used (as in bottom photo).**



**The underpass in the top photo is not well-lit or secure. Underpasses should be designed so that they are safe for pedestrians to use (see better example in bottom photo).**

## Summary of Marked Crosswalk Study (Zegeer et al., 2005)

Roadway Type (Number of Travel Lanes and Median Type)	Vehicle ADT < 9,000			Vehicle ADT >9000 to 12,000			Vehicle ADT >12,000 - 15,000			Vehicle ADT > 15,000		
	Speed Limit**											
	≤ 30 mi/h	35 mi/h	40 mi/h	≤ 30 mi/h	35 mi/h	40 mi/h	≤ 30 mi/h	35 mi/h	40 mi/h	≤ 30 mi/h	35 mi/h	40 mi/h
2 Lanes	C	C	P	C	C	P	C	C	N	C	P	N
3 Lanes	C	C	P	C	P	P	P	P	N	P	N	N
Multi-Lane (4 or More Lanes) With Raised Median***	C	C	P	C	P	N	P	P	N	N	N	N
Multi-Lane (4 or More Lanes) Without Raised Median	C	P	N	P	P	N	N	N	N	N	N	N

C = Candidate site for marked crosswalks.

P = Possible increase in pedestrian crash risk may occur if crosswalk markings are added without other pedestrian facility enhancements.

N = Marked crosswalks alone are insufficient and pedestrian crash risk may increase when providing marked crosswalks alone. Consider using other treatments such as traffic signals with pedestrian signals where warranted or other substantial crossing improvements to increase crossing safety.

of up to 15,000 vehicles per day (VPD) and a median or island, crosswalk can be marked without compromising pedestrian safety.

- On streets with an ADT over 12,000 (or 15,000 with a median) marked crosswalks on their own are not recommended; other, more substantial, measures are needed to provide a safe pedestrian crossing.

At locations where crosswalks alone are not appropriate (e.g., on multilane roads with ADTs above about 12,000), the study recommends consideration of more substantial pedestrian crossing treatments, such as enhanced nighttime lighting, traffic and pedestrian signals (if warranted), among others. Marked crosswalks should be given priority where there is an expectation of regular pedestrian activity such as near a school, park, or other generator.

As stated in the report, “the results of this study should not be misused as justification to do nothing to help pedestrians to safely cross streets. Instead, pedestrian crossing problems and needs should be routinely identified, and appropriate solutions should be selected to improve pedestrian safety and access. Deciding where to mark or not mark a crosswalk is only one consideration in meeting that objective” (Zegeer et al., 2005).

### *Textured and/or Colored Crosswalks*

Textured or colored crosswalks are often requested based on the assumption that they stand out and are more visible by motorists. In many cases, the opposite is true: red or gray pavers are barely visible from afar, and they disappear from sight completely at dusk or at night. Textured crosswalks are difficult for pedestrians in wheelchairs or with walkers or canes; their efforts

when crossing the street should not be impeded. If a community decides to implement colored crosswalks, it is best to color the pavement around a conventional, high-visibility white crosswalk; this way it really does stand out and is smooth.

### Assessing the Effects of Treatments on Other Road Users

Many pedestrian problems result from auto-oriented designs that didn't take pedestrian safety into account; for example, adding turn lanes at an intersection without considering the effect on pedestrian crossing distance. The same principle applies to pedestrian countermeasures: a solution that benefits pedestrians at one location may have negative effects on other users of the street, intersection, corridor or neighborhood. For example, street diverters to reduce cut-through traffic on a local street may increase turn movements at an intersection at the edge of the neighborhood.

Each solution should be evaluated for unintended negative consequences, or consequences that may need further mitigation. A solution should not be rejected just because it has a negative impact on other users, nor is a benefit/cost analysis needed in every case. A common example is the dilemma associated with placing median pedestrian crossing islands on commercially-developed arterials. The crossing island is typically a safety benefit to the pedestrian, but may restrict left turns into a driveway or side-street. Usually, an island can be designed to aid motorists and pedestrians. At times driveways can be moved or combined to adequately serve the adjacent land uses. In cases where this cannot be done, decision makers have to choose between a higher level of pedestrian safety and accommodating land use access for motorists or look into other alternatives.

Many of the recommended pedestrian safety improvements may also have safety benefits for motor vehicle traffic. Common examples include medians, which have been shown to reduce motor vehicle crashes, traffic calming that slows traffic (slower speeds equate to fewer and less severe crashes), and simplified intersections that are easier for motorists to negotiate, and right turn "pork-chop" islands which make it easier to time traffic signals.

#### *Safety Effects on Other Roadway Users*

##### Bicyclists

Bicyclists should not be negatively impacted by pedestrian treatments. In general, most designs that make roads safer and more



**A safe roadway environment will take into account all modes of travel.**

comfortable for pedestrians also benefit cyclists, especially measures that slow traffic, or that narrow or reduce motor vehicle traffic lanes to create more space for other users. But certain countermeasures may impact bicyclists; others are perceived by bicyclists to be dangerous, but in reality they do not have negative impacts based on crashes— sometimes it is a matter of perception.

Pedestrian crash countermeasures that may impact bicyclists negatively include speed bumps (which are typically only allowed in shopping centers), curb extensions that protrude into the bike lane (those more than 1.8 m [6 ft] wide), and street closures with no bicycle access. Countermeasures that should be considered in the context of protecting bicycle safety include on-street parking, narrow lanes, curb extensions, and chicanes.



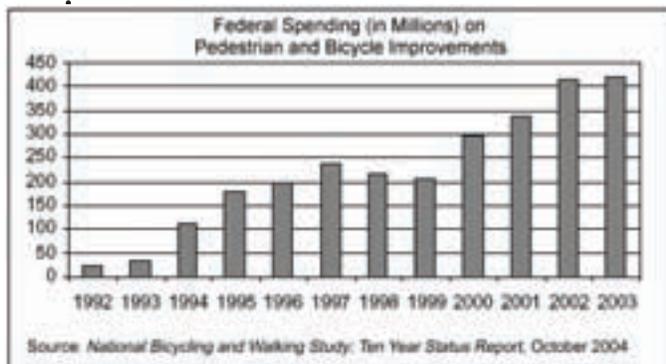
**Improvements made for the safety of vulnerable populations (such as clearly defining the pedestrian path) also benefit other roadway users.**

### Meeting the Safety Needs of All Pedestrians

Safety improvements should meet the needs of all pedestrians to the maximum extent possible. Improvements that benefit young children, older persons, and people with vision, mobility, or hearing impairments also increase the safety of all pedestrians.

Federal (and some state) laws and regulations spell out what must be done to accommodate pedestrians with disabilities. When facilities are provided for pedestrians, they must be accessible for persons with disabilities unless that is not physically feasible.

The most current accessible design requirements can be found at <http://www.access-board.gov/>. Designing Sidewalks and Trails for Access, Parts 1 and 2, provide the state of the practice for applying the American with Disabilities Act and similar requirements to pedestrian facilities. Find Part one at: <http://www.fhwa.dot.gov/environment/bikeped/access-1.htm> and Part 2 at: <http://www.fhwa.dot.gov/environment/sidewalk2/>.



## Chapter 6: Providing Funding

Funding is critical to implementation. It can be the enabler for making improvements that reduce crashes, or it can be the barrier that prevents needed improvements from being made. With most state and local governments facing severe budget constraints, allocating funds to address pedestrian safety issues can be a challenge. Nevertheless, some states and urban areas are achieving very low pedestrian crash numbers in spite of limited funding. The challenge is to figure out how these outcomes are being achieved and then apply them to states and communities with high numbers of pedestrian crashes.

### Commitment to Safety

Achieving better outcomes always begins with a commitment to safety for all modes. It should be the number one priority of state and local transportation agencies. Once this commitment is made, it allows transportation agencies to allocate funds to reducing all crash types, including pedestrian crashes. Projects that only focus on reducing congestion or motor vehicle crashes may jeopardize the safety of pedestrians and bicyclists.

A simple benefit/cost analysis is an excellent way to justify and increase expenditures on pedestrian improvements. Most of the improvements that reduce pedestrian crashes are relatively inexpensive when compared to efforts to reduce motor vehicle crashes. It costs an agency less, per crash, to reduce pedestrian crashes than motor vehicle crashes. It may not cost the agency anything if it is a policy change or a change in a design standard that leads to fewer pedestrian crashes. For example, almost all Seattle arterial streets are designed to a 48 km/h (30 mi/h) design speed, which is the legal speed limit unless otherwise posted. This is one of the reasons Seattle has one of the lowest pedestrian fatality rates in the nation; Seattle has made a commitment to safety as the number one priority.

“Most of the improvements that reduce pedestrian crashes are relatively inexpensive when compared to efforts to reduce motor vehicle crashes.”

## Funding Strategies

The following funding strategies can be applied to finance pedestrian safety improvements:

- Routine accommodation in new projects.
- Partnerships.
- Dedicated funds and set asides.
- Annual maintenance budget.

### *Routine Accommodation in New Projects*

Routinely including pedestrian facilities with other roadway improvement projects is a cost-effective strategy for reducing pedestrian crashes and encouraging more walking. The construction of good pedestrian infrastructure as part of normal public and private development and the adoption of good traffic management practices are known as “routine accommodation.” The majority of pedestrian infrastructure is built in conjunction with other projects: pedestrian crossings are built in conjunction with the construction of intersections; pedestrian signals are installed in conjunctions with traffic signals; and most sidewalks in residential neighborhoods are built as part of private, residential housing construction. The same applies to traffic management practices: high visibility crosswalks can be marked after pavement overlays as a matter of standard practice.

Routine accommodation allows for significant improvements over time, even if there is no special funding available for pedestrian safety improvements. Chapter 5 provides a list of standardized traffic management and design practices that will reduce crashes over time. Routine accommodation for new projects does not diminish the importance of immediately addressing high crash locations, corridors, and other targeted areas immediately.

### *Partnerships*

Both public works and many private development projects provide partnership opportunities for making improvements to increase pedestrian safety in addition to what might be accomplished through routine accommodation. For example, opportunities to construct sidewalks can be provided with resurfacing projects; opportunities for placing utilities underground (and thus eliminating obstructions on sidewalks) can be found with other projects. There are opportunities to develop partnerships around the following project types:

### Voluntary/No Cost Improvements

Many projects will generate some neighborhood concern or opposition. More often than not, public and private projects include some pedestrian amenities, supported by the neighborhood, to build good will. In other cases, there may be a common benefit. Private developers and other agencies are often willing to make needed pedestrian

safety improvements, as a safer, more accessible development is more attractive to potential tenants or customers.

### Required Restoration and Mitigation

Large projects present an opportunity for significant pedestrian improvements. For example, a new development may generate enough traffic to warrant a signal near a school or other pedestrian destination. Utility work next to a roadway or in an abandoned railroad line can provide an opportunity for constructing a sidewalk or pathway.

### Combined Improvements

Combined improvements involve grouping smaller projects with an existing funded project. Funding improvements as part of larger projects creates economies of scale. For example, if there is a public works project to construct a concrete roadway, it may be cheaper to add construction of sidewalks on nearby streets instead of building them as a separate project. It may also be advantageous to provide funding for a spot improvement such as a midblock crossing where pedestrians are expected to cross. Not only are costs reduced when two types of work are combined into one project, but other advantages include reduced impact to traffic, residents, and businesses.

### *Dedicated Funds and Set Asides*

Some states, MPOs (Metropolitan Planning Organizations) and local governments have set aside dedicated funds for pedestrian and/or bicycle improvements. Set asides are either a percentage of a larger fund; for example, a percentage of Federal funds (beyond the mandated Federal Enhancement fund) for pedestrian and/or bicycle projects; or set asides with an independent funding source; typical examples include developer funds (funds deposited by developers into a centralized fund or escrow account for future use), resource funds (taxes on extracted natural resources such as gravel or oil), and real estate excise funds.

## **Partnership Opportunities: Universities**

### **Chapel Hill, North Carolina**

The University of North Carolina at Chapel Hill is centered in the heart of downtown. The University currently maintains an extensive network of sidewalks that are internal to UNC property. In addition, the UNC Department of Transportation and Parking makes periodic recommendations to the Town about UNC off-campus sidewalk needs. These projects do not fall under University jurisdiction but impact pedestrian traffic (mostly UNC students and employees) going to and from the University. Some of these off-campus projects have evolved into “joint projects” financed by both entities.

One such project included an investigation of pedestrian safety risk locations on and around campus performed by the University of North Carolina Chancellor’s Pedestrian Safety Committee (UNC Pedestrian Safety Committee), working with the University community, the Town of Chapel Hill, and the North Carolina Department of Transportation. Based on the results of the study, this group was able to improve signage, modify roadways and crosswalks, increase enforcement, and create a long-term plan for pedestrian safety on the 740 acre campus.

For more information, visit: <http://townhall.townofchapelhill.org/planning/bikeped/bikepedplan.htm>.



While dedicated funds and set asides are possible funding sources, they should not be a substitute for routine accommodation. For example, funding for shoulder and sidewalk improvements should be routine practice and not paid for through set aside funds. In general, changing policy to include pedestrian improvements in all programs and projects will produce more funding than set asides.

### *Annual Maintenance Budget*

Existing annual maintenance budgets can be used to make small but important pedestrian improvements. For example, limited budgets for painting marked crosswalks can be focused around schools and high crash locations. Crosswalks can be widened or changed to high-visibility markings when they are scheduled to be repainted. Crosswalk signs scheduled for replacement can be upgraded to the brighter fluorescent yellow-green signs that have been adopted by the MUTCD as an option for pedestrian and bicycle warning signs.

### **Dedicated Funds** **State of Wisconsin**

The Wisconsin Department of Transportation currently funds sidewalks and other pedestrian facilities through many different state and Federal programs. Since 1990, WisDOT has included sidewalks in construction projects along a State Trunk Highway (STH) if the local municipality agrees to pay 25 percent of the cost and agrees to accept responsibility for future sidewalk repair, maintenance, and spot replacement. WisDOT will pay the full cost to replace existing sidewalks when they must be replaced due to WisDOT action (i.e. roadway-widening projects that require the removal of sidewalks). WisDOT administers Federal funds for local road projects that are eligible to include sidewalks and other pedestrian facilities. These projects generally require a 20 percent local match while Federal funds cover the remaining 80 percent of expenses. Through General Transportation Aids (GTAs), WisDOT helps fund local sidewalk construction and replacement work as well as all other pedestrian-related work, such as crosswalk painting and crossing signal installation, on a partial reimbursement basis.

Another major source of funding for pedestrian projects is the Statewide Multimodal Improvement Program (SMIP). This includes the following components:

- An enhancement program for local and state highway enhancements.
- A surface transportation program.
- A surface transportation program discretionary (STP-D).
- An urban surface transportation program (STP-U).
- A congestion mitigation and air quality program (CMAQ).
- A hazard elimination program.
- Interstate maintenance.
- National highway system funds.
- A highway bridge replacement and rehabilitation program.
- A transportation and community and system preservation pilot program.

For more information, visit: <http://www.dot.wisconsin.gov/projects/state/ped2020.htm>.

## Revising Funding Selection Criteria State of New Jersey

In New Jersey's Statewide Bicycle and Pedestrian Master Plan, the section on "Implementing the Plan" includes a list of funding strategies. One such strategy involves working through Metropolitan Planning Organizations to revise Transportation Improvement Program (TIP) project selection criteria to promote bicycle and pedestrian projects and ensure that an adequate percentage of transportation funding is used for pedestrian and bicycle transportation facilities.

Another strategy involves partnering with various agencies: the Office of Travel and Tourism within the NJ Commerce and Economic Growth Commission to provide grants in support of walking tours and events; the NJ Department of Law and Public Safety to make use of NHTSA (Section 402) funds for pedestrian program activities that deal with safety and enforcement; and the NJ Department of Environmental Protection to pursue funding sources for trails to augment existing National Recreational Trails and Green Acres funding.

The plan also states that counties are responsible for routinely funding pedestrian improvements and incorporating incidental improvements into roadway projects. Municipalities are to dedicate funds for independent pedestrian projects and establish funding sources for pedestrian improvements related to roadway projects (land use/recreation fees, general funds, etc.).

For more information, visit: <http://www.bikemap.com/RBA/>.

### *Funding Criteria*

State and local governments typically use multiple funding sources for transportation projects, from Federal grants to gas taxes to general tax revenues. These sources often have funding criteria that determine what projects are eligible. Funding criteria are reviewed and updated periodically; they can be rewritten to increase funding for pedestrian safety projects. There are two ways these sources can be levied to make pedestrian safety improvements: 1) The funding criteria should give higher scores to projects that include pedestrian safety elements; and 2) The funding criteria should allow for good pedestrian projects (those likely to reduce crashes) to compete for the funding. Some states have constitutional provisions banning the use of gas taxes for anything but highway projects; but the definition of "highway" should include pedestrian facilities such as sidewalks.

### **Major Funding Sources**

Federal funding for pedestrian improvements has increased dramatically in the last 12 or so years. Prior to the 1990s only a few million dollars a year of Federal funds were being invested in bicycle or pedestrian facilities. While the energy crisis of the early 1970s had spawned new interest and some modest government initiatives to make improvements, very little money from the government at any level was invested in bicycle and pedestrian facilities. Likewise, the outdoor recreation industry and business community in general provided very little funding for facilities, planning, programs, or organizational development. Throughout the late 1970s and 1980s, the largest

amounts of funds for bicycling and walking were invested by state and local parks agencies building multi-use trails; however, even these levels of investment were very small compared to what is happening today.

### *Federal Funds*

#### Transportation Funds

The Safe, Accountable, Flexible, Efficient Transportation Equity Act—A Legacy for Users (SAFETEA-LU), passed in August 2005, authorized \$286.4 billion in Federal gas tax revenue and other Federal funds over five years for all modes of surface transportation, including highways, bus and rail transit, bicycling, and walking. Walking and bicycling improvements are not only eligible to receive funding from most of the transportation funds made available by SAFETEA-LU, but “shall be considered, where appropriate, in conjunction with all new construction and reconstruction of transportation facilities, except where bicycle and pedestrian use are not permitted” (23 U.S.C., §217 (g) (1)).

*For the most current FHWA Program Guidance, visit the Web site: <http://www.fhwa.dot.gov/environment/bikeped/guidance.htm>.*

*The full memo can be viewed at <http://www.fhwa.dot.gov/environment/bikeped/memo.htm>.*

In a February 1999 Guidance memo (still in effect), FHWA stated,

*“We expect every transportation agency to make accommodation for bicycling and walking a routine part of their planning, design, construction, operations and maintenance activities... Bicycling and walking ought to be accommodated, as an element of good planning, design, and operation, in all new transportation projects unless there are substantial safety or cost reasons for not doing so... Even where circumstances are exceptional and bicycle use and walking are either prohibited or made incompatible, States, MPOs, and local governments must still ensure that bicycle and pedestrian access along the corridor served by the new or improved facility is not made more difficult or impossible. Maintaining access to the transportation system for nonmotorized users is not an optional activity” (FHWA, 1999).*

This memo (FHWA, 1999) also spelled out planning requirements for nonmotorized facilities. “States and metropolitan areas (with populations of more than 50,000) are required to plan for the “development and integrated management and operations of transportation systems and facilities (including pedestrian walkways and bicycle transportation facilities) that will function as an intermodal transportation system...” (based on 23 U.S.C., §134 (a)(3) and 23 U.S.C., §135 (a)(3)).

#### Non-Transportation Funds

Outside of the Federal transportation programs there are a wide range of other Federal funds that can be used for walking facilities. Community Development Block Grants through the Department of Housing and Urban Development (HUD) are a likely source of funds for community-based projects such as commercial district streetscape improvements, sidewalk improvements, Safe Routes to School, or other neighborhood-based walking facilities that improve local transportation or help revitalize neighborhoods. The National Transportation Enhancements Clearinghouse has prepared a useful Technical Brief: Financing and Funding for Trails that cites over

## Funding Examples from around the Nation

### Creative Local Partnerships

- Selling bricks for local sidewalk projects, especially those in historic areas or on downtown Main Streets, is increasingly common. Donor names are engraved in each brick, and a tremendous amount of publicity and community support is purchased along with basic construction materials. Portland, Oregon's downtown Pioneer Square is a good example of such a project.
- A pivotal 40-acre section of the Ice Age Trail between the cities of Madison and Verona, Wisconsin, was acquired with the help of the Madison Area Youth Soccer Association. The soccer association agreed to a fifty year lease of 30 acres of the parcel for a soccer complex, providing a substantial part of the \$600,000 acquisition price.
- The City of Phoenix partners with school boards to provide funding for the Safe Routes to School program. A part of the funding is a result of a grant from the Governor's Office of Highway Safety; \$27,000 for additional police enforcement at schools and brighter safety vests for crossing guards. The Maricopa Association of Governments (MAG) has partnered with Phoenix to expand the school crossing guard training across the entire metropolitan area. Any community can adopt the Phoenix School Safety program if there is the political will to fund the program elements and devote the resources to school crossing safety. For more on this example, see: [http://www.iwalktoschool.org/award\\_app\\_template.cfm?ID=196](http://www.iwalktoschool.org/award_app_template.cfm?ID=196).
- In Chapel Hill, North Carolina, localized requests can be granted through a public improvement petition and assessment fee alternative when neighborhoods support the construction of a sidewalk in their area and are willing to be assessed for all or part of the project cost.

### Dedicated Funding From State Transportation Revenues

- Since the mid-90s, California Highway Patrol (CHP) has been awarded pedestrian safety corridor grants through the State Office of Traffic Safety (OTS). The CHP uses a formula to assess and rate the most severe corridors in the state in terms of crashes, fatalities, and injuries. The OTS typically awards two grants per year spanning over a 12-month period in an amount of \$100,000. Typical goals are a 10 to 15 percent reduction in crashes and a 5 to 10 percent reduction in fatalities and injuries. Since inception, favorable results have been recorded with the program expanding each year. Ginny Mecham (GMecham@chp.ca.gov) and Ophelia Torpey (OTorpey@chp.ca.gov) can both be reached at 916-657-7222 for more information about this program.
- In Indiana, motorists are paying extra for special license plates that benefit greenways, open space, parks, and trails. In 1995 about \$1.9 million was netted from sale of 75,740 plates. The plates cost an additional \$35, of which \$25 goes to the Indiana Heritage Trust. Maine and Florida use similar license plate fee add-ons for conservation, parks, and bicycle and pedestrian program funding.
- By constitutional amendment, Oregon dedicates one percent of state gas-tax revenue to providing improvements for bicycling and walking on state-managed highways. Michigan also has a one percent law.

thirty Federal and national funding sources that could be used to help fund bicycling and walking facilities and/or programs, especially trails: <http://www.enhancements.org>.

#### *State and Local Funds*

States typically raise revenue for highway and transportation infrastructure through a state motor-vehicle fuel tax and/or vehicle licensing fees. Similar to the Federal legislation, laws in many states make most pedestrian programs eligible for funding. In some states, use of funds may be limited to improvements on state owned and operated facilities.

Some examples of revenue streams used by local communities to improve conditions for pedestrians include: special bond issues, dedications of a portion of local sales taxes or a voter-approved sales tax increase, and the use of the annual capital improvement budgets of Public Works and/or Parks agencies.

#### *Private Sector Funds*

#### Foundations

A wide range of foundations have provided funding for walking projects and programs. A few national and large regional foundations have supported the national organizations involved in bicycle and pedestrian policy advocacy. However, it is usually the regional and local foundations that get involved in funding particular pedestrian projects. These same foundations may also fund statewide and local advocacy efforts. The best way to find such foundations is through the research and information services provided by the National Foundation Center. They maintain a huge store of information including the guidelines and application procedures for most foundations as well as their past funding records. They can be reached online at: <http://www.fdncenter.org>.

#### Developer Funded Projects

In some cases, developers are required to provide funding for roadway improvement projects that will build sidewalks, walkways and trails. In other cases, developers are required to build off-site improvements, largely in response to master plans or stipulations on their development. While in the latter case, they may not be providing funding to the agency to build the project, the result may be the same.

See Appendix D for a list of these and other funding sources.



## Chapter 7: Creating the Pedestrian Safety Action Plan

Implementing changes to reduce pedestrian crashes requires an action plan that takes identified countermeasures and puts them into a practical and achievable strategy that allows progress to be measured over time. Creating a pedestrian safety action plan is the culmination of effective stakeholder involvement, problem identification, and prioritization of solutions. It can be thought of as going from the “where” to the “what” to the “how.”

The quality and effectiveness of an action plan does not depend on its length or depth. The key is to come up with a plan that effectively focuses resources on making the changes that reduce the greatest number of crashes. Short, straightforward, and well thought out plans are the most easily implemented. Appendix I contains a checklist of things to consider when developing a safety action plan.

A pedestrian safety action plan should incorporate the following steps:

- Step 1: Define Objectives.
- Step 2: Identify Locations.
- Step 3: Select Countermeasures.
- Step 4: Develop an Implementation Strategy.
- Step 5: Institutionalize Changes to Planning and Design Standards.
- Step 6: Consider Land Use, Zoning and Site Design Issues.
- Step 7: Reinforce Commitment.
- Step 8: Evaluate Results.

### Step 1: Define Objectives

The key to a successful pedestrian safety action plan is to clearly state its purpose at the very beginning. In addition to the general goal of improving pedestrian safety, an agency should define specific and measurable objectives that can later be used to evaluate the level of success of the program.

“Implementation requires the ongoing commitment of an entire transportation agency. Momentum will only be achieved over time through constant attention and action.”

Explicit goals of a pedestrian safety action plan include a target percentage reduction of pedestrian crashes in defined locations or areas. More specifically, it ought to be stated what types of pedestrian crashes shall be reduced (walk to school, multiple threat crashes, etc.).

While the action plan typically emphasizes safety goals of reducing crash frequency or severity (of certain types of crashes in specific areas), the plan may also include more general objectives such as increased pedestrian activity or enhanced walkability of a community.

## Step 2: Identify Locations

Chapters 3 and 4 discuss how to use crash and other data to identify where improvements need to be made and provide guidance on how to organize and prioritize locations. Using this information, the first step in writing an action plan is to compile lists of actual locations. High crash or high-risk locations should be organized into four categories:

1. Spot locations.
2. Corridors.
3. Targeted areas (including neighborhoods).
4. Entire jurisdictions.

## Step 3: Select Countermeasures

Chapter 4 provides guidance on how to identify and prioritize countermeasures to address different types of crashes. Using this information, the third step in completing an action plan is to identify engineering, educational, and enforcement countermeasures that can be implemented over time. Specifically:

1. For each high crash location, create a list of appropriate countermeasures based on the collision history and local conditions; include everything from simple measures such as spot speed enforcement, to more complex measures such as installing a new traffic signal.
2. For each high crash corridor and neighborhood/targeted area, identify needed countermeasures; for example, by reorganizing all the bus stops along a corridor, it may be possible to direct pedestrians to signalized crossing locations and away from crossings at uncontrolled intersections.
3. For all locations, identify countermeasures that will be installed everywhere as a matter of “routine accommodation” (discussed in Chapter 6). Chapter 5 provides

### Implementation Plan Example Oakland, CA

The Oakland Pedestrian Master Plan includes a chapter which identifies implementation policies, priority projects, staffing needs, and funding sources to ensure that pedestrian projects are managed, funded, and implemented. The plan specifies five goals to promote Oakland as a walkable city, including: pedestrian safety, access, streetscaping and land use, education, and implementation. General plan policies are listed to support each of these goals. The section also includes 20 years of priority projects to improve safety, access, and streetscaping for pedestrians in the City of Oakland. Projects are prioritized in two phases: projects to be completed within 1 to 5 years and projects to be completed within 6 to 20 years.

For more information, visit: <http://www.oaklandnet.com/government/pedestrian/index.html>.

lists of highly effective countermeasures that should be incorporated into agency design manuals and routinely applied to all public and private projects.

#### **Step 4: Develop an Implementation Strategy**

The fourth step in creating an implementation plan is to identify “how” improvements will be made. This requires commitment of the entire agency, not just one or two people focusing on pedestrian safety. It requires public involvement and political will (Chapter 2) and agency resources (Chapter 6). It can also involve phasing and making use of temporary measures (Chapter 4).

##### *Timing as an Implementation Strategy*

Critical to implementing an action plan is maintaining ongoing, continuous progress. Small, immediate changes that are highly visible create the momentum and support needed to make the more costly and substantive changes that require more time.

Proposed improvements identified in Step 3 of the plan should be divided into three categories: simple measures, moderately complex measures, and complex measures. More complex measures may require more time, money, and coordination among different departments and agencies.

Simple, moderately complex, and complex countermeasures will require different time lines. All treatments can begin immediately and continue into the future in parallel. The improvements requiring the least amount of time and resources will likely be completed first, and those that require the most will be completed later as resources allow.

This approach also helps to address liability concerns. While no agency can be expected to address all issues at once, an agency must be able to demonstrate that it has a well-conceived and systematic implementation plan for making improvements over time.

The timing approach that divides improvements into simple, moderately complex, and complex measures should be done within the context of addressing high crash locations, corridors, and neighborhoods (or places with high crash potential). Some examples include:

1. A simple strategy may propose that over a three-year period, all school zone signs will be upgraded, starting with high crash locations, corridors and neighborhoods; new crosswalks and spot police enforcement may also be simple strategies.
2. A moderately complex strategy may be to upgrade lighting at unmarked crosswalks over a six-year period, starting with high crash locations, corridors, and neighborhoods/targeted areas; other moderately complex solutions may be signal changes, retiming, roadway restriping, or institutionalizing safety education programs in schools.

## Timing as an Implementation Strategy

The following examples are case studies from PEDSAFE that each deal with countermeasure implementations ranging from simple to complex:

### Simple Solutions: Radar Trailers in Neighborhoods

For the past ten years, residents of Bellevue, WA have been able to request city-owned portable radar trailers to target excessive speeds along corridors and in neighborhoods. The trailers have resulted in average speed reductions of 4.8 to 8.0 km/h (3 to 5 mi/h), are very popular, and cost relatively little.



### Moderately Complex Solutions: Traffic Calming

In an effort to improve the safety of neighborhood children going to and from school and reduce vehicle speeds, Cambridge, MA implemented several traffic calming measures along Granite Street, including curb extensions, a raised crosswalk, and a raised intersection. The 85th percentile motor vehicle speed was reduced from 28 mi/h to 45 to 38 km/h (24 mi/h) after the improvements.



### Complex Solutions: Area Revitalization

Wall Street in Asheville, NC is an aesthetically re-designed downtown center of economic activity. What once originated as a delivery alley has now been transformed into a walkable and livable streetscape conducive to pedestrian activity on wide sidewalks. Average vehicle speeds are below 32 km/h (20 mi/h) on the adjacent one-way street.



3. A complex strategy may be to reconstruct major intersections over a ten-year period, again starting with high crash locations, corridors, and neighborhoods/targeted areas; others may include acquiring right-of-way, realigning roadways, or revitalizing areas.

Built into this approach is the concept of phasing. For example, a high crash intersection may initially only get new ladder style crosswalk markings and a temporary median island or warning signs, with more complex measures (such as the installation of a traffic signal with pedestrian signals or a roadway narrowing treatment) to be added later when funding becomes available. This approach also allows for temporary improvements such as painted curb extensions that can be installed as a low cost strategy until funding can be found for permanent curb revisions.

Using the list of effective measures from Chapter 5, agencies can develop a matrix or other system of organization to provide an easy and effective way to set program objectives and track simple, moderately complex, and complex measures over time. Measures listed in an action plan will vary somewhat based on local conditions, crash patterns, and priorities; state and local agencies are also likely to focus on different measures.

### **Step 5: Institutionalize Changes to Planning and Design Standards**

Design and traffic management practices that can lead to a reduction in pedestrian crashes should be incorporated into all appropriate planning, design, and maintenance manuals as well as standard specifications. This is referred to as institutionalization. It ensures that good design will automatically occur with all future agency projects and programs as a matter of routine accommodation. It provides the basis for installing countermeasures such as marked crosswalks and pedestrian signals at all signalized intersections. However, it is not always enough to have the best standards in the correct manuals; continued training may be necessary to ensure that all responsible parties understand the standards and interpret and apply them consistently and accurately.

Appendix F provides a list of recommended publications that address pedestrian policies and designs. It also provides a list of key policy and design issues that should be addressed first if pedestrian crashes are to be reduced. Institutionalizing good design and traffic management practices for pedestrians may take some time, some issues may be controversial, and it may require several iterations to complete all the changes. However, it is one of the most important and effective ways to reduce pedestrian crashes over time and should be vigorously pursued.

It is important to be aware of problems that may occur during project implementation, construction, or maintenance that may lead to a pedestrian crash if certain precautions are not taken. For example, closing sidewalks during a sidewalk repair or maintenance can cause pedestrians to be forced to walk in the travel lane or to cross the street to use the sidewalk on the other side. Pedestrians should never be forced to walk in the travel lane unless the lane is barricaded off and the route is made to be accessible. Construction zone provisions that accommodate pedestrian safety should be an important part of the new policies and practices adopted (institutionalized) by the

## Examples of Comprehensive Plans

### Plan Components of the Florida State Highway Safety Plan

The Florida State Highway Safety Plan includes the following elements:

1. Identify high pedestrian crash corridors or areas.
2. Analyze corridors and areas of pedestrian crash patterns and causal factors.
3. Apply multimodal level of service analysis to supplement crash data.
4. Implement pedestrian education programs.
5. Set priorities based on crashes, percentage of walkers, etc.
6. Include sidewalks in all applicable new construction, widening, and resurfacing projects (on and off-system).
7. Implement traffic calming strategies.
8. Increase enforcement of pedestrian laws.

### The Washington D.C. Pedestrian Safety and Accessibility Program

The Washington D.C. Pedestrian Safety and Accessibility Program is an example of a comprehensive pedestrian safety program. The primary goal of the program is to reduce pedestrian fatalities and injuries. The secondary goals of the program are to increase walking trips and transit use while achieving reductions in motorized trips. The program features four main categories of strategies, including: Networking and Coalition Building; Education; Engineering, Planning, and Design; and Enforcement and Regulation.

The Networking and Coalition Building component involves coordination among numerous agencies, including the District Department of Transportation, the Department of Motor Vehicles, the Department of Health, the Department of Public Schools, Washington Metropolitan Area Transit Authority, the Metropolitan Washington Council of Governments, and the Metropolitan Police Department.

The Education component includes increasing outreach and awareness of pedestrian safety and accessibility issues, the provision of educational materials in English and Spanish, the preparation of a toolkit of resources and lessons for schools, and participation in the "International Walk to School Day."

The Engineering, Planning, and Design component includes targeting high-risk locations; improving data collection, analysis, and problem identification; deploying the necessary engineering countermeasures; adopting Pedestrian-Oriented Developmental Regulations; integrating pedestrian accommodation issues into the planning, design, and approval processes; and advocating for the construction of light rail.

The Enforcement and Regulation component of the program involves targeting enforcement zones; enforcing existing motorist, bicyclist, and pedestrian laws; reviewing existing motorist, bicyclist, and pedestrian laws and advocating for stiffer penalties; pursuing professional training and education; advocating for innovative policing (officers on bikes, horses, and skates); reviewing right-turn-on-red and left-turn regulations; and enforcing harsher penalties for speeding, especially in school areas.

*For more information on these two plans, visit the site <http://www.dot.state.fl.us/safety/TransSafEng/strategic-plandocs/Strategic%20Hwy%20Safety%20Plan%205-8-03.pdf>.*

agency. To prevent causing problems in work zones, adequate signing and/or provisions must be made to direct pedestrians to safe paths and/or to provide safe street crossings to sidewalks on the other side of the street. A good resource on this topic is Chapter 13 in the *Traffic Control Devices Handbook* (Pline, 2001).

For purposes of an implementation plan, an agency must commit to reviewing and revising its planning and design guidelines and specifications. Using the information in Chapter 5, the agency should list the design and policy changes that need to be incorporated into its documents and create a time line for completing the changes.

### **Step 6: Consider Land Use, Zoning, and Site Design Issues**

As noted in Chapter 1, there is a direct relationship between land use and pedestrian safety. Land use affects motorist speed, trip frequency, and behavior. It also affects pedestrian trip frequency and behavior. Communities that have been successful in implementing various land use, zoning, and site design regulations have often been successful in reducing their number of pedestrian crashes. Land use and development patterns should encourage pedestrian trips. Provisions should be created for pedestrian facilities, and developers should be required to provide pedestrian infrastructure (e.g., sidewalks) along roads in new developments.

While it is recognized that transportation agencies, especially those at the state level, may have a limited ability to directly affect land use, zoning, and site design, there is a very direct relationship between land use and transportation planning. New roads open up new areas for development and new development creates demands for new roads. Furthermore, planning and zoning departments and those agency functions involved with reviewing and approving private and public developments should be thoroughly involved in the process to promote pedestrian-friendly and safe infrastructure and roadway designs. Effective stakeholder participation is one way that broad support for changes to land use policies might be built during the pedestrian safety planning process.

Chapter 5 lists some of the most highly effective land use, zoning, and site design measures for reducing pedestrian crashes and creating a more pedestrian-friendly walking environment. For purposes of an implementation plan, an agency should recognize the importance of land use and commit to working with the appropriate parties in implementing some or all of the measures listed in Chapter 5.

### **Step 7: Reinforce Commitment**

Implementation requires the ongoing commitment of an entire transportation agency. Momentum will only be achieved over time through constant attention and action.

There are many things an agency can do to achieve ongoing commitment to pedestrian safety. An agency should choose the strategies that work and incorporate them into its implementation plan. The following is a short list of strategies used by various transportation agencies in communities that have been successful in reducing pedestrian crashes over time:

- Provide ongoing internal training to ensure that designs do not inadvertently impact pedestrian mobility and safety.
- Provide ongoing external training to help the public focus on changes that will improve pedestrian safety.
- Have transportation agencies write Requests for Proposals (RFPs) that require appropriate pedestrian expertise.
- Institute an award system to acknowledge good projects that provide safer conditions for pedestrians.
- Work cooperatively with the Health Department on pedestrian safety research or education programs.

### **Step 8: Evaluate Results**

A successful pedestrian safety plan must contain a mechanism to evaluate results. This ensures that implemented countermeasures are effective in reducing crashes and improving safety and helps ensure future funding opportunities if the plan is perceived as a success. In order to perform a thorough evaluation, the specific objectives of the Pedestrian Safety Action Plan need to be defined early-on in the process. Given limited resources, it is critical that the most effective countermeasures are identified and pursued when prioritizing improvements. Most communities that fail to reduce pedestrian crashes do so not because of a lack of funds, but because they do not implement the right countermeasures and make the right changes to agency design and management policies. This may be because they fail to continually evaluate the results to see if their efforts are actually reducing crashes. Evaluation means that implementation plans are not static documents—they should change over time as various crash countermeasures are tried and evaluated.

A key prerequisite to any evaluation process is to quantify the before conditions and track changes in the after condition. The data collection efforts discussed previously in Chapter 3 ought to be maintained throughout the implementation of the pedestrian safety plan. Appendix E elaborates on specific evaluation techniques.

Combining a record of successful projects is very helpful in showing progress over time. Good safety plans will include a comprehensive documentation of successful projects or institutional changes. It is also important to note that in some cases, the number of pedestrian crashes may not go down due to the fact that pedestrian activity and access has been increased. In these instances, the rate of pedestrian crashes may have decreased, and a well-documented evaluation of results is needed to provide the most accurate measure of success.



## References

### National Guides and Major Research Documents

American Association of State Highway and Transportation Officials, *A Policy on Geometric Design of Highways and Streets*, Washington, D.C., 2001.

American Association of State Highway and Transportation Officials, *Guide for the Planning, Design, and Operation of Pedestrian Facilities*, Washington, D.C., July 2004.

Axelson, P.W., D.A. Chesney, D.V. Galvan, J.B. Kirschbaum, P.E. Longmuir, C. Lyons, and K.M. Wong, *Designing Sidewalks and Trails for Access, Part I of II: Review of Existing Guidelines and Practices*, Federal Highway Administration, Washington, D.C., 1999. Available online at <http://www.fhwa.dot.gov/environment/bikeped/access-1.htm>, accessed June 10, 2004.

Blomberg, R.D., D.F. Preusser, A. Hale, and W.A. Leaf, *Experimental Field Test of Proposed Pedestrian Safety Messages: Vol. II: Child Messages*, National Highway Safety Administration, Report No. DOT HS 806 522, Washington, DC, November, 1983.

Campbell, B., C.V. Zegeer, H. Huang, and M. Cynecki, *A Review of Pedestrian Safety Research in the U.S. and Abroad*, Federal Highway Administration, McLean, VA, January 2004.

Federal Highway Administration, “FHWA Guidance—Bicycle and Pedestrian Provisions of Federal Transportation Legislation”, February 24, 1999. Available online at <http://www.fhwa.dot.gov/environment/bikeped/bp-guid.htm>, accessed January 2, 2006.

Federal Highway Administration, *Manual on Uniform Traffic Control Devices for Streets and Highways*, Washington, D.C., 2003. Available online at <http://mutcd.fhwa.dot.gov>.

Harkey, David L., and C.V. Zegeer, *PEDSAFE: Pedestrian Safety Guide and Countermeasure Selection System*, Federal Highway Administration, Washington D.C., September 2004. Available online at <http://www.walkinginfo.org>.

Institute of Transportation Engineers, *Design and Safety of Pedestrian Facilities: A Recommended Practice of the Institute of Transportation Engineers*, Washington, D.C., March 1998. Available online [http://safety.fhwa.dot.gov/ped\\_bike/docs/designsafety.pdf](http://safety.fhwa.dot.gov/ped_bike/docs/designsafety.pdf).

- Institute of Transportation Engineers, *Traditional Neighborhood Development Street Design Guidelines: Recommended Practice*, Washington, D.C., 1999.
- Institute of Transportation Engineers, *Traffic Engineering Handbook*, Prentice Hall, Englewood Cliffs, NJ, 1999 (draft). Available for purchase online at <http://www.ite.org>.
- Institute of Transportation Engineers, *Transportation and Traffic Engineering Handbook*, Washington, D.C., 1990.
- Kirschbaum, J.B., P.W. Axelson, P.E. Longmuir, K.M. Mispagel, J.A. Stein, and D.A. Yamada, *Designing Sidewalks and Trails for Access, Part II of II: Review of Existing Guidelines and Practices*, Federal Highway Administration, Washington, D.C., 2001. Available online at <http://www.fhwa.dot.gov/environment/sidewalk2/>, accessed June 10, 2004.
- McMahon, Patrick J., C.V. Zegeer, Chandler Duncan, Richard L. Knoblauch, J. Richard Stewart, and Asad K. Khattak, *An Analysis of Factors Contributing to 'Walking Along Roadway' Crashes: Research Study and Guidelines for Sidewalks and Walkways*, Federal Highway Administration, McLean, VA, March 2002.
- National Research Council, Transportation Research Board, *Highway Capacity Manual*, Washington, D.C., 2000.
- Pline, J., ed., "Chapter 13: Pedestrians," *Traffic Control Devices Handbook*, Institute of Transportation Engineers, Washington, D.C., 2001.
- Preusser, D.F. and A.K. Lund, *And Keep on Looking: A Film to Reduce Pedestrian Crashes Among 9 to 12 year Olds*, Journal of Safety Research, Vol. 19:177-185, 1988.
- U.S. Access Board and the Federal Highway Administration, *Accessible Rights-of-Way: A Design Guide*, Washington, D.C. Available online at <http://www.access-board.gov/prowac/guide/PROWGuide.htm>, accessed January 19, 2006.
- Zegeer, C.V., C. Seiderman, P. Lagerwey, M. Cynecki, M. Ronkin, and R. Schneider, *Pedestrian Facilities User Guide: Providing Safety and Mobility*, Federal Highway Administration, McLean, VA, 2002. Available online at <http://www.walkinginfo.org>.
- Zegeer, C., D. Henderson, R. Blomberg, L. Marchetti, S. Masten, Y. Fan, A. Brown, L. Thomas, J. Stutts, Evaluation of the Miami-Dade Pedestrian Safety Demonstration Project, National Highway Traffic Safety Administration, Washington, D.C., 2007.
- Zegeer, C.V., Jane Stutts, Herman Huang, Michael J. Cynecki, Ron Van Houten, Barbara Alberson, Ronald Pfefer, Timothy R. Neuman, Kevin L. Slack, Kelly K Hardy, *NCHRP Report 500, Vol. 10: A Guide for Reducing Collisions Involving Pedestrians*, Transportation Research Board, Washington, D.C., 2004.
- Zegeer, Charles V., Richard Stewart, Herman H. Huang, Peter A. Lagerwey, John Feganes, and B.J. Campbell, *Safety Effects of Marked versus Unmarked Crosswalks at Uncontrolled Locations*, Federal Highway Administration, McLean, VA, September 2005. Available online at <http://www.walkinginfo.org>.

Zegeer, C.V., *The National Bicycling and Walking Study: Transportation Choices for a Changing America*, Final Report, USDOT, FHWA, Washington, D.C., 1994. Available online at <http://www.fhwa.dot.gov/environment/bikeped/study.htm>.

## Local Plans

City and County of Denver, *Pedestrian Master Plan (Draft)*, Denver, CO, April 2004. Available online at [http://www.denvergov.org/Transportation\\_Planning/141113406template3jump.asp](http://www.denvergov.org/Transportation_Planning/141113406template3jump.asp).

City of Bellevue, Transportation Department, *Pedestrian and Bicycle Transportation Plan Update*, Bellevue, WA, October 1999. Available online at <http://www.ci.bellevue.wa.us/departments/Transportation/pdf/PedBikePlan99.pdf>.

City of Cambridge, Community Development Department, *Pedestrian Plan*, Cambridge, MA, 2000. Available online at [http://www.cambridgema.gov/~CDD/et/ped/plan/ped\\_plan.html](http://www.cambridgema.gov/~CDD/et/ped/plan/ped_plan.html).

City of Madison, *Pedestrian Transportation Plan*, Madison, WI, September 1997. Available online at <http://www.cityofmadison.com/transp/PedTransPlanTableOfContents.html>.

City of Marina, *Marina Pedestrian and Bicycle Master Plan (Draft)*, Marina, CA, August 2003. Available online at <http://www.lgc.org/marina/>.

City of Oakland, *Pedestrian Master Plan*, Oakland, CA, August 2002. Available online at <http://www.oaklandnet.com/government/pedestrian/index.html>.

City of Portland, Offices of Transportation, Transportation Engineering and Development, *Pedestrian Transportation Program, Portland Pedestrian Master Plan*, Portland, OR, June 1998. Available online at <https://www.portlandonline.com>.

City of Sacramento, Department of Public Works, Traffic Engineering Division, *Pedestrian Safety Guidelines*, Sacramento, CA, January 2003. Available online at [http://www.cityofsacramento.org/dsd/dev\\_eng\\_finance/entitlements/pdfs/ped\\_safety.pdf](http://www.cityofsacramento.org/dsd/dev_eng_finance/entitlements/pdfs/ped_safety.pdf).

Maricopa Association of Governments, *Pedestrian Plan 2000*, Phoenix, AZ, December 1999. Available online at [http://www.mag.maricopa.gov/pdf/cms.resource/ped-plan2000sum-web\\_427.pdf](http://www.mag.maricopa.gov/pdf/cms.resource/ped-plan2000sum-web_427.pdf).

Puget Sound Regional Council, Association of Washington Cities, and County Road Administration Board, *Pedestrian Facilities Guidebook: Incorporating Pedestrians Into Washington's Transportation System*, Washington State Department of Transportation, September 1997. Available online at <http://www.psrc.org/projects/nonmotorized/strategy.pdf>.

SANDAG (San Diego's Regional Planning Agency), *Planning and Designing for Pedestrians: Model Guidelines for the San Diego Region*, San Diego, CA, June 2002. Available online at [http://www.sandag.org/uploads/publicationid/publicationid\\_713\\_3269.pdf](http://www.sandag.org/uploads/publicationid/publicationid_713_3269.pdf).

Town of Chapel Hill, *Pedestrian Plan Policies and Guidelines*, Chapel Hill, NC, May 1994.

## State Plans

Alaska Department of Transportation and Public Facilities, *Alaska Bicycle and Pedestrian Plan—An Integral Part of Vision 2020: Alaska's Long-Range Statewide Transportation Plan*, March 1995. Available online at <http://ntl.bts.gov/DOCS/IGLOO.html>, accessed June 17, 2005.

Arizona Department of Transportation, *Statewide Bicycle and Pedestrian Plan*, August 2003. Available online at <http://www.azbikeped.org/statewide-bicycle-pedestrian-intro.html>.

Caltrans, *Pedestrian and Bicycle Facilities in California: Technical Reference Report*, March 2004.

Commonwealth of Pennsylvania, Department of Transportation, *Statewide Bicycle and Pedestrian Master Plan: Pedestrian Facility Planning and Design Guidelines*, April 1996. Available online at <http://www.dot.state.pa.us>.

Florida Department of Transportation, *Florida Pedestrian Planning and Design Handbook*, Tallahassee, FL, March 1997. Available online at [http://www.dot.state.fl.us/safety/ped\\_bike/ped\\_bike\\_standards.htm#Florida%20Ped%20Handbook](http://www.dot.state.fl.us/safety/ped_bike/ped_bike_standards.htm#Florida%20Ped%20Handbook).

Georgia Department of Transportation, *Pedestrian and Streetscape Guide*, September 2003. Available online at [http://www.dot.state.ga.us/dot/plan-prog/planning/projects/bicycle/images/ped\\_streetscape\\_guide\\_june05.pdf](http://www.dot.state.ga.us/dot/plan-prog/planning/projects/bicycle/images/ped_streetscape_guide_june05.pdf).

Government of the District of Columbia, *District of Columbia Traffic Calming Policies and Guidelines*, District Department of Transportation, 2002. Available online at [http://www.ddot.dc.gov/ddot/lib/ddot/services/pdf/traffic\\_calming.pdf](http://www.ddot.dc.gov/ddot/lib/ddot/services/pdf/traffic_calming.pdf).

Idaho Transportation Board, *Idaho Bicycle and Pedestrian Transportation Plan*, January 1995. Available online at <http://itd.idaho.gov/planning/reports/bikepedplan/idt.pdf>.

National Center for Bicycling and Walking, *Vermont Pedestrian and Bicycle Facility Planning and Design Manual*, Vermont Agency of Transportation, December 2002. Available online at <http://www.aot.state.vt.us/progdev/Documents/LTF/FinalPedestrianAndBicycleFacility/PedBikeTOC.html>.

New Jersey Department of Transportation, *Statewide Bicycle and Pedestrian Master Plan: Phase 2*, no date. Available online at <http://www.bikemap.com/RBA/NJBikePed.pdf>.

North Carolina Department of Transportation, Division of Bicycle and Pedestrian Transportation, *Bicycling and Walking in North Carolina: A Long-Range Transportation Plan*, November 1996. Available online at <http://www.ncdot.org/transit/bicycle/about/longrangeplan2.pdf>.

Oregon Department of Transportation, *Oregon Bicycle and Pedestrian Plan*, 1995. Available online at [http://www.oregon.gov/ODOT/HWY/BIKEPED/docs/or\\_bicycle\\_ped\\_plan.pdf](http://www.oregon.gov/ODOT/HWY/BIKEPED/docs/or_bicycle_ped_plan.pdf).

Transportation and Growth Management, *Main Street...when a highway runs through it: A Handbook for Oregon Communities*, Oregon Department of Transportation and the Oregon Department of Land Conservation and Development, November 1999. Available online at <http://egov.oregon.gov/LCD/TGM/docs/mainstreet.pdf>.

Virginia Department of Transportation, *VTrans 2025 Statewide Pedestrian Plan*, 2004. Available online at <http://www.sotrans.state.va.us/VTrans/home.htm>.

Washington DOT, Bicycle and Pedestrian Program, *Pedestrian Facilities Guidebook*, Olympia, WA, September 1997. Available online at <http://www.wsdot.wa.gov/EESC/Design/DesignManual/desEnglish/1025-E.pdf>.

Wisconsin DOT, Division of Transportation Investment Management, Bureau of Planning, *Wisconsin Pedestrian Policy Plan 2020*, March 2002. Available online at <http://www.dot.wisconsin.gov/projects/state/ped2020.htm>.

Zegeer, C.V., Herman Huang, David Harkey, and Michael J. Cynecki, *Planning and Designing Local Pedestrian Facilities*, State of North Carolina, Department of Transportation, 1997. Available online at [http://www.ncdot.org/transit/bicycle/projects/resources/projects\\_peddesign.html](http://www.ncdot.org/transit/bicycle/projects/resources/projects_peddesign.html).

## Web Sites

Association of Pedestrian and Bicycle Professionals. Available online at <http://www.apbp.org/website/>.

Burden, Dan. "How Can I Find and Help Build a Walkable Community" Available online at <http://www.walkable.org/article1.htm>.

Congress for the New Urbanism Web site. Available online at <http://www.cnu.org>.

Federal Highway Administration, Congestion Mitigation and Air Quality Improvement Program Fact Sheet. Available online at: <http://ops.fhwa.dot.gov/safetea/congairfactsheet.htm>.

Federal Highway Administration, Federal Lands Highway Division, SAFETEA-LU: Review of the Federal Lands Highway Program and Other Related Provisions. Available online at: <http://www.fhwa.dot.gov/flh/flhfs051028.htm>.

Federal Highway Administration, Good Practices Guide for Bicycle Safety Education—Evaluation. Available online at <http://www.bicyclinginfo.org/ee/bestguidedoc.html#evaluation>.

Federal Highway Administration, Pedestrian Safety Campaign. Available online at [safety.fhwa.dot.gov/local\\_program/pedcampaign/index.htm](http://safety.fhwa.dot.gov/local_program/pedcampaign/index.htm).

Federal Highway Administration, Pedestrian Safety Web site. Available online at [http://safety.fhwa.dot.gov/ped\\_bike/ped/index.htm](http://safety.fhwa.dot.gov/ped_bike/ped/index.htm).

Federal Highway Administration, "Public Involvement Techniques for Transportation Decision-Making." Available at <http://www.fhwa.dot.gov/reports/pittd/cover.htm>.

Federal Highway Administration, Fact Sheets on Highway Provisions. Available online at: <http://www.fhwa.dot.gov/safetealu/factsheets.htm>.

Federal Highway Administration, National Scenic Byways Program: Grant Guidance. Available online at: <http://www.bywaysonline.org/grants/guidance/>.

Federal Highway Administration, Recreational Trails Program. Available online at: <http://www.fhwa.dot.gov/environment/rectrails/>.

Federal Highway Administration, Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU). Available online at: <http://www.fhwa.dot.gov/safetealu/>.

Federal Highway Administration, Section 402 Highway Safety Funds. Available online at: [http://safety.fhwa.dot.gov/state\\_program/section402/](http://safety.fhwa.dot.gov/state_program/section402/).

Federal Transit Administration, Grant Programs. Available online at: [http://www.fta.dot.gov/25\\_ENG\\_HTML.htm](http://www.fta.dot.gov/25_ENG_HTML.htm).

Feet First Pedestrian Advocacy. Available online at <http://www.feetfirst.info/>.

Maryland Pedestrian and Bicycle Safety Education Program. Available online at <http://www.rockvillemd.gov/recreation/bicycling/education-program.htm>.

National Transportation Enhancements Clearinghouse. Available online at: <http://www.enhancements.org/>.

Pedestrian and Bicycle Crash Analysis Tool. Available online at <http://www.walkinginfo.org/pc/pbcat.htm>.

Street Design Guidelines. Available online at <http://www.walkable.org>.

The Facts: Impaired Pedestrians. Available online at <http://www.nhtsa.dot.gov/people/outreach/safesobr/17qp/impaired.html>.

Traffic Calming Information. Available online at <http://www.trafficcalming.com>.

University of Kansas Community Toolbox. Available online at <http://ctb.ku.edu>.

U.S. Access board Web site. Available online at <http://www.access-board.gov/>.

U.S. Census Bureau Web site. Available online at <http://www.census.gov/>.

Victoria Transport Policy Institute. Available online at <http://www.vtpi.org/tdm/index.php#incentives>.

Victoria Transport Policy Institute Online TDM Encyclopedia. Available online at <http://www.vtpi.org/tdm/>.

Virginia Tech On-line Toolbox, "Partnerships and Participation in Planning." Available online at <http://www.uap.vt.edu/cdrom/>.

Walk to School Day International Award Applications. Available online at [http://www.iwalktoschool.org/award\\_app\\_template.cfm?ID=196](http://www.iwalktoschool.org/award_app_template.cfm?ID=196).

### Other Research Documents

Federal Highway Administration, *Canadian Research on Pedestrian Safety*, McLean, VA, December 1999b. Available online at <http://www.hsrc.unc.edu/pdf/pedbike/99090.PDF>.

Federal Highway Administration, *FHWA Study Tour for Pedestrian and Bicyclist Safety in England, Germany, and the Netherlands*, Report No. FHWA/PL-95/006, Washington, DC, 1994.

Federal Highway Administration, *Pedestrian/Bicyclist Safety Resource Set (CD-ROM)*, Report No. FHWA-SA-00-005, 2000. Available online at <http://safety.fhwa.dot.gov/fourthlevel/newprod.htm#set>, accessed April 24, 2004.

Florida Department of Transportation, *2002 Quality/Level of Service Handbook*, FDOT: Tallahassee, 2002.

Harkey, D., J. Mekemson, M. Chen, and K. Krull, *Pedestrian and Bicycle Crash Analysis Tool (PBCAT) User's Manual*, Report No. FHWA-RD-99-192, Federal Highway Administration, Washington, DC, June 2000.

Hefferan, Jennifer R. and Peter Lagerwey, "The City of Seattle, WA, USA Crosswalk Inventory and Improvement Plan," *ITE Journal*, January 2004.

Huang, Herman, C.V. Zegeer, Richard Nassi, and Barry Fairfax, *The Effects of Innovative Pedestrian Signs at Unsignalized Locations: A Tale of Three Treatments*, Report No. FHWA-RD-00-098, Federal Highway Administration, McLean, VA, August 2000. Available online at <http://www.tfhr.gov/safety/pedbike/pubs/00-098.pdf>.

Hunter, W., J. Stutts, W. Pein, and C. Cox, *Pedestrian and Bicycle Crash Types of the Early 1990's*, Report No. FHWA-RD-95-163, Federal Highway Administration, Washington, DC, 1995.

Malenfant, L. and R. Van Houten, "Increasing the Percentage of Drivers Yielding to Pedestrians in Three Canadian Cities with a Multifaceted Safety Program," *Health Education Research*, Vol. 5, 1989, pp. 274-279.

National Highway Traffic Safety Administration. *Traffic Safety Facts: 2004 Data*. DOT HS 809 913. Available online at <http://www-nrd.nhtsa.dot.gov/pdf/nrd-30/nca/TSF2004/809913.pdf>.

Noyce, David A. and R. Dharmaraju, *An Evaluation of Technologies for Automated Detection and Classification of Pedestrians and Bicyclists*, Federal Highway Administration, Massachusetts Highway Administration, and University of Massachusetts Trans-

portation Center, May 2002. Available online at <http://www.walkinginfo.org/pdf/UMTCBikeReport02-01.pdf>, accessed August 2005.

Petritsch, Theodore A. Bruce W. Landis, Peyton S. McLeod, Herman F. Huang, Srikeyan Challa, "Level of Service Model for Signalized Intersections for Pedestrians," TRB 2005 Annual Meeting CD-ROM, 2005.

Reschovsky, C., "Journey to Work: 2000," *Census 2000 Brief*, US Department of Commerce, Census Bureau, Washington, DC, March 2004. Available online at <http://www.census.gov/prod/2004pubs/c2kbr-33.pdf>, accessed April 23, 2003.

Robertson, Douglas, "Chapter 13: Pedestrian Studies," *Manual of Transportation Engineering Studies*, Institute of Transportation Engineers, Washington, D.C., 2000.

Schneider, Robert, Robert Patton, Jennifer Toole, Craig Raborn, *Pedestrian and Bicycle Data Collection in United States Communities: Quantifying Use, Surveying Users, and Documenting Facility Extent*, Federal Highway Administration, January 2005. Available online at <http://www.pedbikeinfo.org>.

U.S. Department of Justice, *The Americans With Disabilities Act Title II Technical Assistance Manual*, Covering State and Local Governments, November 1993.

U.S. Department of Transportation, *National Bicycling and Walking Study Five Year Status Report*, Federal Highway Administration, Washington, DC, 1999. Available online at <http://www.fhwa.dot.gov/environment/bikeped/study.htm>.

Van Houten, R. and L. Malenfant, *Canadian Research on Pedestrian Safety*, Federal Highway Administration, Washington, DC, January 1999. Available online at <http://www.fhwa.dot.gov/tfhrc/safety/pubs/99090/99090.pdf>.

Van Houten, R. and L. Malenfant, "The Influence of Signs Prompting Motorists to Yield 50 ft (15.5 m) before Marked Crosswalks on Motor Vehicle-Pedestrian Conflicts at Crosswalks with Pedestrian Activated Flashing Lights," *Accident Analysis and Prevention*, Vol. 24, 1992, pp. 217-225.

Van Houten, R., D. McCusker, and L. Malenfant, "Advance Yield Markings: Reducing Motor Vehicle-Pedestrian Conflicts at Multilane Crosswalks with Uncontrolled Approach," *Transportation Research Record 1773*, TRB, National Research Council, Washington, DC, 2001, pp. 69-74. Available online at <http://www.cers-safety.com/advanceyieldmarkings.pdf>.

Van Houten, R., "The Effects of Advance Stop Lines and Sign Prompts on Pedestrian Safety in Crosswalks on Multilane Highways," *Journal of Applied Behavior Analysis* 21, 1988, pp. 245-251. Available online at <http://www.pubmedcentral.nih.gov/picrender.fcgi?artid=1286120&blobtype=pdf>.



## Appendix A: How to Create and Run an Effective Pedestrian Advisory Board

### Step 1: Create an Official PAB

Pedestrian Advisory Boards (PABs) should be created through an official action. At the local level, local officials can pass a resolution; at the state level, it may be an agency directive or a law passed by state legislators. Creating an official PAB is important for two reasons:

1. The creation of the PAB will immediately make decision-makers aware of the Board and its importance while also educating them on important pedestrian issues; and
2. An official PAB cannot be easily disbanded or ignored when the decision-makers change (e.g. new department director, mayor, or governor).

### Step 2: Recruit and Interview PAB Members

PABs should be made up of about eight to fifteen people—any fewer, and participants will be overwhelmed; any more, and the size can become unmanageable. Often state PABS are larger than local PABs. It is useful to have up to 15 people for a few reasons: it can be difficult to get anything done if some do not show up for a meeting; there is always attrition for unrelated reasons (e.g., people moving); when the group is established, it can more effectively work in subcommittees if more people are involved. Appointments should be staggered to avoid large turnover and promote continuity. In order to prevent discontinuity, the Chair position should not be a rotating position.

To create an effective, balanced, and diversified PAB, all prospective candidates should be recruited and interviewed. Simply contacting various organizations and asking them to send a representative is not enough; openings should be advertised through local media sources or political offices. A letter of interest and a resume should be required. People who invest their time are more likely to be committed PAB members. The interview should be like any other job interview. For example, interviews could be conducted by a representative from the executive office (mayor or city manager), the person who will be staffing the PAB, and a current PAB member.

There are three qualities to look for in prospective PAB members:

1. Candidates need to have the interests of the broader community in mind rather than be focused on an issue close to home (e.g. a stop sign on their street), or they are likely to leave once their issue has been addressed..
2. Candidates should have a history of volunteerism; experienced volunteers will be more likely to attend meetings and commit the time needed to make the PAB successful.
3. Candidates need to be good listeners and have a collaborative approach to problem solving.

Since PABs are advisory, they will only be effective and legitimate if their members reflect the community they represent. Gender, race, age, type of walker (casual to fitness walkers), and the geographic location of residence for each applicant should be considered to ensure a balanced, representative board.

### **Step 3: Determine Logistic Support**

The local or state agency should make it very clear from the beginning what services can and cannot be provided to a PAB. Staffing a PAB should require about four to eight hours a month. Direct services should be limited to providing a meeting place and attending meetings. Minutes and meeting notices are typically done by the Board members—email makes this easy—but can also be done by a secretary on loan to the Board from a state or local agency. A PAB may benefit from secretarial support to take notes or transcribe audio tapes, write minutes, send out announcements, make copies, schedule rooms, etc. However, the more the board members take responsibility for their logistics, the more invested and effective they will be.

### **Step 4: Provide PAB Members with Timely and Useful Information**

The most important role for local and state agency staff is to provide the PAB with timely and useful information so their input is effective. PAB members are volunteers who are giving of their limited time to the community and their time should be well spent. For example, board members need to know when they can provide comments on an Environmental Impact Statement (EIS) or a major public works project.

An informed PAB will be a better board. For example, in Seattle, PAB members get together once a year for an all day, facilitated retreat. As part of the retreat, Seattle Department of Transportation staff conducts a short training session on pedestrian design issues. One of the purposes of the training is to help participants better understand things that can't be changed (e.g. shape and color of a regulatory sign) versus things that involve more choices and engineering judgment (e.g. determining the number of lanes needed on an arterial that is being reconstructed).

### **Step 5: Set the PAB Agenda**

The Board Chair should coordinate with agency staff and departmental representatives (listed in Step 3) to develop a list of topics for Board review and input. The rela-

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tionship of the agency with the Chair is critical to the success of the Board. Typically, PABs will want to provide input on agency policies, programs, and projects. Board meetings should feature a presentation on one of these topics. This makes every meeting important and ensures good attendance and participation. The Chair (not agency staff) should invite the program/project manager to participate and present at a PAB meeting. The person who staffs the PAB should help with the presentation. This builds teamwork and can make presenting to a citizen's group a positive experience.

## Appendix B: How to Conduct Pedestrian Counts and Behavior Studies



### Step 1: Determine Study Location and Scope

When conducting a pedestrian study it is important to identify the exact location of where the data is to be collected. Counts at intersections or along short segments of streets may include an observation of the location where the pedestrians are crossing (intersection versus midblock, in or outside of the crosswalk, and which crosswalk at an intersection is to be studied).

### Step 2: Decide on Types of Studies to Perform

Pedestrian studies may include collecting data on pedestrian volumes, walking speeds, gaps in motor vehicle traffic, conflicts between vehicles and pedestrians, or pedestrian behavior. The type of study should be determined based on what problems exist at a location and should aim to assist in selecting appropriate countermeasures.

### Step 3: General Observation of the Study Site and Pedestrians

Before starting the actual data collection, the analysts should familiarize themselves with the study location and note the types of signal control, the location of crosswalks and markings and other features such as sight distance restrictions. It is also appropriate to note general observations of pedestrian behavior such as walking patterns and compliance with signal control devices.

### Step 4: Develop a Data Collection Plan

It is important to create a plan for what type of data will be collected and during what time period. Depending on the specific geometry of the site, locations need to be identified where the analyst can readily observe all necessary data. Pedestrian count and behavior data should focus on the time of day or day of week when a concern exists. This could include times with high or low pedestrian volumes, depending on when pedestrian crashes occurred. Pedestrian counts at schools should be conducted during school arrival or departure times and the duration may be limited to the start

## Pedestrian Count Examples

### Manual Pedestrian Counts

A number of localities around the country collect manual counts on a regular basis. The Washington, D.C. District Department of Transportation conducts pedestrian counts at each leg of approximately 100 intersections annually. The District of Columbia has been taking pedestrian counts at intersections and other pedestrian crossing locations for over 20 years. Counts are currently on file for approximately five to ten percent of the 13,000 intersections in the District.

In Albuquerque, New Mexico, the Mid-Region Council of Governments (MRCOG) collects bicycle and pedestrian counts at all signalized intersections in Albuquerque (more than 500 sites) on a three-year cycle.

### Automated Pedestrian Counts

A number of agencies have installed infrared devices to collect automated counts of pedestrians, as well as bicyclists. The City Government of Cheyenne, Wyoming has installed an infrared counter to take the path counts on the Dry Creek Greenway. In Licking County, Ohio, the Licking County Area Transportation Study has installed infrared counters in 11 locations along a shared-use path system.

The Massachusetts Highway Department and the University of Massachusetts Transportation Center have installed an infrared sensor placed above the Norwottuck Rail Trail at the end of Route 116 underpass in Amherst, MA. The Autosense II sensor was placed on an underpass structure, 5.4 m (18 ft) above the trail, in order that pedestrians and bicyclists passing underneath the device could be detected. The active infrared sensor detected pedestrians and bicyclists with two separate infrared beams (Noyce, 2002). For more information, visit: <http://www.walkinginfo.org/pdf/UMTCBikeReport02-01.pdf>.

A variety of types of technologies are available for automated counting of pedestrians. These technologies are evaluated in detail in the research paper, "An Evaluation of Technologies for Automated Detection and Classification of Pedestrians and Bicyclists," which is available online at <http://www.walkinginfo.org/pdf/UMTCBikeReport02-01.pdf>.

and end of the school day. Concerns along bus routes should focus on the peak commute times or whenever pedestrian crashes are occurring. Pedestrian concerns in a business area may include both the peak commute times and the midday lunch period. If there is a nighttime pedestrian safety concern, nighttime counts and observations should be made. The study duration should be matched to signal warrants in the MUTCD and other local or state requirements. In general, the duration of a study may vary from an hour to multiple days, possibly affecting the personnel requirements.

### Step 5: Collect the Data

The actual data collection process varies depending on the type of study. Examples of study types include:

- Volume Study: Pedestrian counts can be performed manually using tally sheets, mechanical count boards, or electronic count boards. There are also technologies available to perform automated pedestrian counts, including video detection,

infrared, or microwave technology. When pedestrian counts are made, they are generally short-term counts of two to four hours. In rare instances, counts may be made for up to eight hours. Counts should ideally be summarized by 15-minute intervals, but hourly summaries are also acceptable. If 15-minute intervals are used, a single individual may be able to count each movement of a busy intersection in an hour. Pedestrian activity along a sidewalk or in a crossing may be recorded on a video camera and then reviewed at a later date at high speed to save time. If pedestrian counts are very high, a single observer can be used to conduct the count from a videotape by reviewing the videotape slowly.

- **Walking Speed Study:** Determining average pedestrian walking speeds is necessary for pedestrian signal warrants, pedestrian signal timing and other applications. Walking speed studies are especially important when the average walking speed is significantly different from the typically assumed 1.0 to 1.2 m/s (3.5 to 4 ft/s). The difference may be due to pedestrian characteristics such as high volumes, age distribution, pedestrian cell phone use, level of physical fitness, and disabilities; or it can be related to geometric characteristics of the study site such as steep grades, narrow sidewalks, and shared-use paths. Adverse weather conditions including rain, snow and wind may also affect walking speeds in coastal or mountain regions.
- **Gap Study:** In some cases it may be necessary to analyze gaps in the motor vehicle traffic stream at pedestrian crossing locations to determine appropriate crossing treatments. For example, the MUTCD warrants a pedestrian signal if the frequency of crossable gaps falls below a certain threshold.
- **Behavior Study:** While general observations on pedestrian behavior should be made before any detailed data is collected, there may be situations where a more in-depth analysis of pedestrian behavior is appropriate. Elements of pedestrian behavior of interest may include the occurrence of pedestrian-vehicle conflicts, an assessment of pedestrian understanding and compliance with traffic control devices, or other exhibited behavior, such as running, or hesitating. Measures of effectiveness of behavioral studies can be quantitative (number of conflicts or violations), but may also be more qualitative in nature (pedestrians seem to be unclear about meaning of signs).

### **Step 6: Analyze the Data**

It is good practice to decide on the method of data analysis prior to collecting the data. This will assure that all necessary information is in fact collected and will be available during data extraction and analysis. Depending on the type and extent of the study, it may be appropriate to consult a statistician to assure that large amounts of data (especially before-and-after or time series data) are properly interpreted.



## Appendix C: How to Conduct Pedestrian and Motorist Behavior Assessments

### Step 1: Understand the Human Element of a Crash

First and foremost on the observer's mind should be the realization that, in most cases, the pedestrian did not walk into the street with the intention of being struck. Similarly, the motorist involved in a pedestrian crash did not collide with the pedestrian intentionally. If the motorist could have avoided the crash, he or she would have done so. Crashes can result from:

- Motorist or pedestrian inattention.
- Poor judgment on the part of the motorist or pedestrian (possibly a factor of age [young and elderly pedestrians and motorists], mental or physical disabilities, fatigue, or drug/alcohol use).
- Miscalculation of risks.
- Pedestrians not understanding the speed of an approaching vehicle.
- Motorists miscalculating their own speed.
- Pedestrians assuming that approaching motorists see them and will react to them.
- Motorists not understanding the speed and direction of a pedestrian, or unexpected pedestrian movement.
- Visual screens (parked or stopped vehicles, landscaping) or insufficient lighting.

### Step 2: Observe Pedestrian and Motorist Movements

The best way to conduct the process of “thinking like a pedestrian” is to first observe pedestrian movements. In many cases, pedestrians will follow a variety of patterns in areas with a high number of crashes. For example, some pedestrians will wait at a signalized intersection and cross on the WALK signal, while others will cross against the signal when they see a gap in motor vehicle traffic.

Next, observe motorist movements to “think like a motorist.” In many cases, motorists appear to travel oblivious to the presence of pedestrians. Observers should note their movements. For example, some motorists at a signalized intersection will yield to

pedestrians while turning right or left when the pedestrians are in the crosswalk, while others will try to drive around the pedestrian and through the crosswalk as soon as there is a sufficient gap to do so.

### **Step 3: “Walk a Mile” in Their Shoes**

The observer should begin where the pedestrians initiate their movements, preferably under typical conditions (including at night), and look up and down the street to see what the pedestrian sees. With all due caution, the observer should then attempt to emulate the observed movement without placing himself or herself at risk. At times, an illegal maneuver may be safer than the legal or intended movement.

To focus on the motorist’s experience, the observer should also drive through the area and make the observed movements, preferably under typical conditions (including at night), and look up and down the street to see if there are any pedestrians in the problem areas identified earlier. With all due caution, the observer should then attempt to emulate the observed vehicle movement (again, without placing anyone at risk).

### **Step 4: Record Objective and Subjective Observations**

The observer should then note what he or she saw, heard, felt, including a subjective evaluation such as the relative safety of both the pedestrian and motorist maneuvers observed and experienced. Objective observations can point out design flaws such as poor sight distance, or other roadway features. The subjective evaluation may lead to an observation such as “no wonder pedestrians do not cross there—it is so far away from the bus stop” or “I can see why the motorist could have missed seeing the pedestrian crossing—that billboard is so distracting.” The observer should note these behaviors uncritically and record these movements.

### **Step 5: Visualize a Solution**

The observer then should take a step further and imagine a pedestrian safety solution that better accommodates the pedestrian’s needs as well as the motorist’s. With that solution in mind, the observer should again cross the road making the movement as if the solution were in place (if possible), as well as drive along the roadway. This process may require the use of spotters to watch for approaching motor vehicle traffic and pedestrians and ensure that no one is placed at undue risk.



## Appendix D: List of Funding Sources

### Federal

A brief description of various federal funding sources available is listed below. For more detailed information, please see Appendix 2 of the “FHWA Guidance—Bicycle and Pedestrian Provisions of Federal Transportation Legislation” (FHWA, 1999), available online at <http://www.fhwa.dot.gov/environment/bikeped/bp-guid.htm>.

*Safe, Accountable, Flexible, Efficient Transportation Equity Act—A Legacy for Users (SAFETEA-LU)*

SAFETEA-LU was signed into law on August 10, 2005. It represents the largest surface transportation investment in U.S. history and contains a number of provisions to address pedestrian safety, many of which are highlighted below. More information can be found at: <http://www.fhwa.dot.gov/safetealu/>.

*Surface Transportation Program (STP)*

The Surface Transportation Program provides flexible funding to states which can be used on a wide variety of projects including pedestrian improvements. States should consider the STP as a primary source of funds for pedestrian projects because of its broad eligibility requirements. More information can be found at: <http://www.fhwa.dot.gov/safetealu/factsheets/stp.htm>.

*Transportation Enhancement Program (TE)*

Transportation Enhancements funds are available for communities to help expand transportation choices such as safe pedestrian facilities. These provisions include funding for non-construction safety-related activities, including pedestrian safety training. More information can be found at: <http://www.enhancements.org/>.

*Congestion Mitigation and Air Quality Improvement Program (CMAQ)*

The CMAQ Program provides funding for air quality non-attainment areas. Programs and projects that contribute to air quality improvements and reduce congestion can be provided funding through the CMAQ Program. These funds can be used for a variety of pedestrian projects including constructing pedestrian walkways and non-construction projects such as maps and brochures. More information can be found at: <http://ops.fhwa.dot.gov/safetea/congairfactsheet.htm>.

*Highway Bridge Program*

The Highway Bridge Program provides funds to replace or rehabilitate highway bridges. Sidewalks and pathways under crossings or bridges can be built as part of bridge rehabilitation. More information can be found at <http://www.fhwa.dot.gov/safetealu/factsheets/bridge.htm>.

*National Highway System Program (NHS)*

This program provides funding for improvements to roads that are part of the National Highway System, which includes the Interstate System and other arterial routes. Funding can be used for pedestrian facilities along NHS routes. More information can be found at: <http://www.fhwa.dot.gov/safetealu/factsheets/nhs.htm>.

*Federal Lands Highway Program (FLHP)*

These funds are available for transportation planning, research, engineering, and construction on Federal lands. This funding can be used for pedestrian facilities within these lands. More information can be found at: <http://www.fhwa.dot.gov/flh/flhfs051028.htm>.

*Highway Safety Improvement Program (HSIP)*

The Highway Safety Improvement Program provides funding to reduce the number and severity of traffic fatalities and injuries on all public roads including publicly-owned pedestrian pathways and trails. More information can be found at: <http://www.fhwa.dot.gov/safetealu/factsheets/hsip.htm>.

*Railway-Highway Crossings*

There is also specific funding to reduce the number and severity of traffic fatalities and injuries at public highway-rail grade crossings by reducing the hazards to vehicles and pedestrians and installation of protective devices at crossings. More information can be found at: <http://www.fhwa.dot.gov/safetealu/factsheets/railcrossings.htm>.

*Recreational Trails Program (RTP)*

The Recreational Trails Program provides funding to develop recreational trails and related facilities for both motorized and non-motorized uses. More information can be found at: <http://www.fhwa.dot.gov/environment/rectrails/>.

*National Scenic Byways Program*

Funding is available for the construction of pedestrian facilities along state and national scenic byways. More information can be found at: <http://www.bywaysonline.org/grants/guidance/>.

*Safe Routes to School Program (SR2S)*

The Safe Routes to School Program provides funding to enable and encourage children to walk to school safely. Included in this program are infrastructure funds, which are used to assess and make improvements to the walking and bicycling physical environment around schools, and non-infrastructure funds, which are used to educate or encourage children to walk or bike to school. More information can be found at: [http://www.saferoutesinfo.org/legislation\\_funding/](http://www.saferoutesinfo.org/legislation_funding/).

*Metropolitan and Statewide Planning Funds*

These funds are available for states and metropolitan areas for transportation planning and research. Statewide and metropolitan planning funds can be used for pedestrian plans. More information can be found at: <http://www.fhwa.dot.gov/safetealu/factsheets/mp.htm> and <http://www.fhwa.dot.gov/safetealu/factsheets/statewide.htm>.

*State and Community Highway Safety Grant Program (Section 402)*

The National Highway Traffic Safety Administration helps administer this program which can be used for pedestrian safety initiatives. More information can be found at: [http://safety.fhwa.dot.gov/state\\_program/section402/](http://safety.fhwa.dot.gov/state_program/section402/).

*Federal Transit Administration Grants (FTA)*

The Federal Transit Administration offers many grants to improve transit systems, which includes pedestrian access and walkways. More information can be found at: [http://www.fta.dot.gov/25\\_ENG\\_HTML.htm](http://www.fta.dot.gov/25_ENG_HTML.htm).

*Community Development Block Grants (HUD)*

The U.S. Department of Housing and Urban Development administers the Community Development Block Grants. These grants assist low- and moderate-income neighborhoods and can be used for pedestrian enhancement projects such as sidewalk installation or repair. More information can be found at: <http://www.hud.gov/offices/cpd/communitydevelopment/programs/index.cfm>.

## State

In addition to federal funding, there are also many sources of state funding that can be used for pedestrian safety projects. Review the statewide pedestrian master plan, if one is available, for information on sources specific to the state. State DOTs may also provide information on their Web sites as to available funding mechanisms. Many of the examples below are from the *Arizona Statewide Bicycle and Pedestrian Plan* (Arizona DOT, 2003) and the *Alaska Bicycle and Pedestrian Plan* (Alaska DOT and Public Facilities, 1995). Although each state will differ, some funding examples include:

- Capital Budgets.
- Legislative Discretionary Funding.
- Local Service Roads and Trails (LSR&T).
- Trails, Footpaths, and Campsites.
- Operating Budgets.
- State Funds as Federal Match.
- State Sales Tax.
- Highway User Revenue Fund (HURF).
- Local Transportation Assistance Fund (LTAF).
- State Park Heritage Fund.
- Game and Fish Department Heritage Fund.
- Growing Smarter Planning Grant Program.
- State Highway Fund.
- State bicyclist and pedestrian grants.
- Special transportation funds (financed by state sales tax).
- Transportation/Growth Management Programs.
- Specialty license tag fees.

## Regional

The following are two common examples of regional funding that may be available:

- Association of Governments (or Regional Planning Council) Funds.
- Municipal Planning Organization Budgets.

## Local

Local funding resources can also be used for pedestrian safety projects. These will vary greatly from place to place. Details for many of the examples below can be found in the *Arizona Statewide Bicycle and Pedestrian Plan* (Arizona DOT, 2003) or in *Main Street...when a highway runs through it: A Handbook for Oregon Communities* (Transportation and Growth Management, 1999). These plans provide excellent examples of the type of local funding sources that may be available. A general list of local funds includes:

- General Funds (from property taxes and gas tax revenues).
- Development Impact Fees.
- Parks and Recreation Funds.

- 
- Flood Control District Funds.
  - Revenue and General Obligation Bonds.
  - Tribal Casino Revenues (depending on the state).
  - Local Funds as Federal Match.
  - Special Bond levies.
  - Transportation Impact fees.
  - System development charges.
  - Local Improvement Districts.
  - Charges to adjacent property owners.
  - Cooperative projects with utility districts, etc.
  - Urban renewal district.
  - Economic improvement district.
  - Business improvement district.

### **Private**

Funding can also be found in the private sector. Some sources include:

- Developer off-site improvements (not money, but they are improvements).
- Dedications.
- Contributions.
- Corporate underwriting.
- Donations of right of way/easements.
- Clubs, groups, and volunteers.
- Grants and loans.

## Appendix E: Evaluation of a Pedestrian Safety Plan



Evaluation serves as a tool to guide the efforts of the project staff, to demonstrate project success to the public, and to assure continued support from sponsors. The extent and methods of evaluation may differ for pedestrian safety plans on the local, MPO or state level, but the general principles stay the same. A thorough evaluation of a pedestrian safety plan investigates effectiveness of countermeasures, monitors public opinion, and constantly reassesses the actual program plan.

### Countermeasure Evaluation

Implemented treatments should generally be evaluated in terms of their overall effectiveness, which typically has already been done by national research institutes and other agencies (at least for the treatments discussed in Chapter 7). But the usefulness of any treatment in reducing pedestrian crashes is likely to vary across locations. The following questions should be asked:

- Is the treatment effective (in general)?
- Does the treatment work as intended?
- How did the treatment affect drivers and vehicle LOS?

### Public Opinion Evaluation

Stakeholder involvement early in the plan development process is important for improving the quality of the plan. Chapter 2 discusses the importance of stakeholder involvement to both tailor the action plan to the (perceived) needs of the community and continuously update the public of the progress of implementation. The main questions to ask are:

- Does the program address the needs of the community?
- Is the general public aware of the program?
- Is the program well received?
- Is there opposition by certain groups?

## Before-and-After Evaluation Study Examples

### University Place, WA; Portland, OR; and Boulder, CO

A number of agencies have performed evaluations of pedestrian safety before-and-after improvements were made to a facility. While many of the assessments focus upon travel speeds, others examine vehicle volumes, number of conflicts, and number of incidents before and after facility improvements.

The City of University Place, Washington built and transformed a major corridor, Bridgeport Way, into an inviting main street that would allow pedestrians and bicyclists to move about comfortably and safely while still accommodating vehicular movement through the corridor. The improvements included the placement of sidewalks and bicycle lanes along both sides of the corridor, as well as planter strips buffering the road from the sidewalk. A median and street lighting were also added, among other improvements. The City analyzed speed and accident data before and after the construction of the Bridgeport Way improvements. The project's traffic calming features reduced speeds by 13 percent and reduced crashes by 60 percent compared to pre-improvement conditions.



In Portland, Oregon, a variety of traffic calming techniques were implemented along SE Harold Street, including the construction of one median island, eleven speed humps placed 91 to 274 m (300 to 900 ft) apart, and curb extensions at five intersections. A before-and-after evaluation revealed that traffic volumes had decreased from a range of 3,400 to 4,800 vehicles per day (vpd) to a range of 2,000 to 3,500 vpd. The 1,600 vpd average drop in daily traffic is a reduction of 37 percent. This drop presumably represents cut-through motorists who found the speed humps to be inconvenient. The 85th percentile speed on SE Harold prior to project construction ranged from 59 to 64 km/h (37 to 40 mi/h). Measurement since speed hump construction shows an average decrease in the 85th percentile speed of 9.6 km/h (6 mi/h).



**Bridgeport Way in University Place, WA before (above) and after (below) improvements were made.**

In Boulder, Colorado, high traffic volumes and speeds were creating an unsafe and unpleasant walking and bicycling environment along 55th Street. A Capital Improvement Project was implemented to provide improved bicycle and pedestrian facilities in the corridor, and to provide some traffic calming for vehicles. Continuous sidewalks and bicycle lanes were provided along the street, as well as a bicycle/pedestrian underpass, two raised crossings and one raised intersection, with pedestrian refuge islands at both of the raised crossing locations. Data collected by the city staff indicate that both travel speeds and traffic volumes decreased following completion of the project. The 85th percentile speeds decreased from 67 km/h (42 mi/h) before the project to 61 km/h (38 mi/h) after the project. Average vpd decreased from 12,400 before the project to 9,400 after the project.

For more information, visit <http://www.walkinginfo.org/pedsafe> and find the case studies relating the details of these improvements.

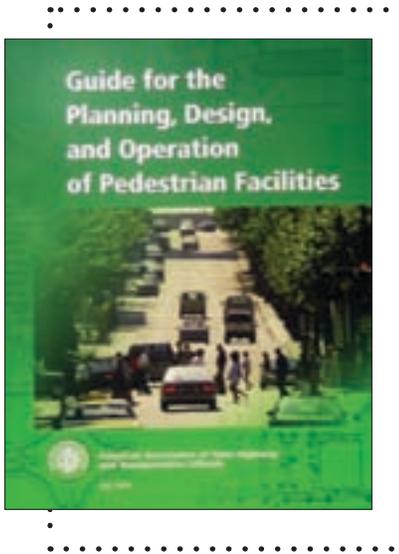
## Program Plan Evaluation

It is furthermore important to assess if the overall objectives of the program plan have been achieved. Depending on the specific objectives, questions could include:

- Did the overall number of pedestrian crashes decrease?
- Do stakeholders perceive that roads are safer?
- Are agencies collaborating on efforts?
- Did the design manuals get updated with new policies and countermeasures?
- Have proposed procedures been adopted by agencies?

An important precondition to program evaluation is that goals are formulated early-on in the process. If assessment results can be matched to explicitly stated goals, the success in achieving those objectives can be demonstrated and decisions can be made on how to improve or modify the program if necessary. To assure proper evaluation, it should be included in the project budget from the beginning. Types of evaluation include:

- Before and After Studies—Typical measures of effectiveness for pedestrian safety projects include crash frequency, number of crossing events, or number of observed conflicts (a short-term proxy measure for actual crashes), yielding rates.
- Public Surveys—Surveys could include opinion polls about the program, knowledge tests following an education campaign, or questionnaires investigating perceived safety of improved intersections.
- Expert Rating—The project team could hire experts on pedestrian safety to evaluate (or re-evaluate) an intersection, a corridor, or the general safety of a community.



## Appendix F: Reference Guide and Plan Summaries

### National Guides

#### *Guide for the Planning, Design and Operation of Pedestrian Facilities (2004)*

The American Association of State and Highway Transportation Officials (AASHTO) *Guide for the Planning, Design and Operation of Pedestrian Facilities* presents effective measures for accommodating pedestrians on public rights-of-way. The guide recognizes the profound effect that land use planning and site design have on pedestrian mobility and addresses these topics as well. The guide can be purchased through the AASHTO Web site at <http://www.aashto.org>.

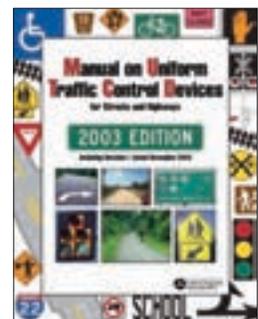
#### *Designing Sidewalks and Trails for Access, Parts 1 (1999) and 2 (2001)*

The guides *Designing Sidewalks and Trails for Access Parts 1 and 2* provide the state of the practice for applying the American with Disabilities Act (ADA) and similar requirements to pedestrian facilities. Find Part one at: <http://www.fhwa.dot.gov/environment/bikeped/access-1.htm> and Part 2 at: <http://www.fhwa.dot.gov/environment/sidewalk2/>.



#### *Manual on Uniform Traffic Control Devices (2003)*

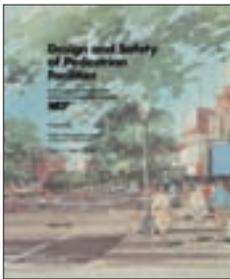
The *Manual on Uniform Traffic Control Devices (MUTCD)* defines the standards used by road managers nationwide to install and maintain traffic control devices on all streets and highways. The *MUTCD* is published by the Federal Highway Administration (FHWA). The *MUTCD* audience includes the insurance industry, law enforcement agencies, academic institutions, private industry, and construction and engineering professionals. Find the document at <http://mutcd.fhwa.dot.gov/pdfs/2003r1/pdf-index.htm>.





*Traffic Control Devices Handbook (2004)*

The *Traffic Control Devices Handbook (TCDH)* was prepared by the Institute of Transportation Engineers (ITE) to augment the *MUTCD* as adopted nationally by the Federal Highway Administration. While the *MUTCD* outlines the design and application of traffic control devices on public roadways in the United States, criteria and data to make decisions on the use of a device and its application are not always fully covered in the *MUTCD*. This Handbook bridges the gap between the *MUTCD* provisions and those decisions to be made in the field on device usage and application. The Handbook can be ordered through the Institute of Transportation Engineers online bookstore at <http://www.ite.org>.



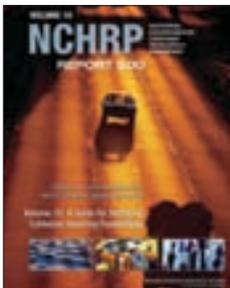
*Design and Safety of Pedestrian Facilities, A Recommended Practice of the Institute of Transportation Engineers (1998)*

*Design and Safety of Pedestrian Facilities, A Recommended Practice of the Institute of Transportation Engineers* is intended to provide guidance on how to implement a comprehensive program of engineering, education and enforcement to improve safety for pedestrians. Find the document at [http://safety.fhwa.dot.gov/ped\\_bike/docs/designsafety.pdf](http://safety.fhwa.dot.gov/ped_bike/docs/designsafety.pdf).



*Pedsafe: The Pedestrian Safety Guide and Countermeasure Selection System (2004)*

*Pedsafe: The Pedestrian Safety Guide and Countermeasure Selection System* is intended to provide practitioners with the latest information available for improving the safety and mobility of those who walk. The online tools provide the user with a list of possible engineering, education, or enforcement treatments to improve pedestrian safety and/or mobility based on user input about a specific location. It can be found at <http://www.walkinginfo.org/pedsafe/>.



*A Guide for Reducing Collisions Involving Pedestrians (2004)*

The National Cooperative Highway Research Program (NCHRP) Report 500, Volume 10: *A Guide for Reducing Collisions Involving Pedestrians* provides strategies that can be employed to reduce the number of collisions involving pedestrians. The NCHRP Report 500, Volume 10 can be purchased through the Transportation Research Board Web site at <http://www.trb.org>.



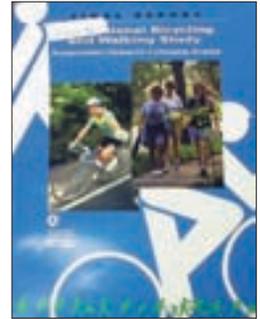
*A Review of Pedestrian Safety Research in the United States and Abroad (2004)*

The purpose of this report is to provide an overview of research studies on pedestrian safety in the United States and abroad. Readers will find details of pedestrian crash characteristics, measures of pedestrian exposure and hazard, and specific roadway features and their effects on pedestrian safety. Such features include crosswalks and alternative crossing treatments, signalization, signing, pedestrian refuge islands, provisions for pedestrians with disabilities, bus stop locations, school crossing measures, reflectorization and conspicuity, grade-separated crossings, traffic-calming measures, and sidewalks and paths. Pedestrian educational and enforcement programs

are also discussed. Review this document online at [http://www.walkinginfo.org/pdf/PedSynth/Ped\\_Synthesis\\_Report.pdf](http://www.walkinginfo.org/pdf/PedSynth/Ped_Synthesis_Report.pdf).

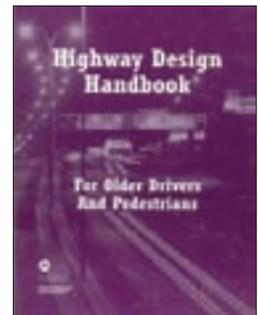
*National Bicycling and Walking Study (1994)*

The *National Bicycling and Walking Study* includes a series of 24 case studies highlighting model activities conducted with respect to bicycle and pedestrian planning. The *National Bicycle and Walking Study* presents a plan of action for activities at the Federal, state, and local levels for increasing the amount of walking and bicycling in the United States. A five-year status report on the *National Bicycling and Walking Study* was published in 1999. A ten-year status report on the study was published in 2004. Selected case studies included in the 1994 *National Bicycling and Walking Study* can be obtained through the National Transportation Library at <http://ntl.bts.gov/DOCS/nbws.html>. The 1999 five-year status report is available through the FHWA Web site at <http://www.fhwa.dot.gov/environment/bikeped/study.htm>. The 2004 ten-year status report is available at <http://www.fhwa.dot.gov/environment/bikeped/study/>.



*Highway Design Handbook for Older Drivers and Pedestrians (2001)*

The *Highway Design Handbook for Older Drivers and Pedestrians* provides recommendations that upon implementation may remedy deficient designs that disproportionately penalize older road users due to changes in functional ability experienced with normal aging. These may be most urgently needed where a crash problem with older drivers or pedestrians has already been demonstrated; however, the greater benefit arguably lies in designing safer new roads and identifying and modifying problems with existing roads before statistics reveal a crash problem. The engineering enhancements described in this document should benefit all road users, not just older persons. The document is available online at <http://www.tfhr.gov/humanfac/01103/coverfront.htm#toc>.



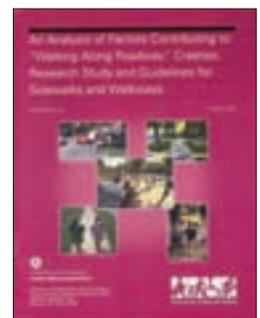
*Safety Effects of Marked versus Unmarked Crosswalks at Uncontrolled Locations (2005)*

*Safety Effects of Marked versus Unmarked Crosswalks at Uncontrolled Locations: Final Report and Recommended Guidelines* presents the results of a study that examined the safety of pedestrians at uncontrolled crosswalks and provides recommended guidelines for pedestrian crossings. Review this document online at <http://www.walkinginfo.org/pdf/r&d/safetyeffects.pdf>.



*An Analysis of Factors Contributing to “Walking Along Roadway” Crashes: Research Study and Guidelines for Sidewalks and Walkways (2002)*

*An Analysis of Factors Contributing to “Walking Along Roadway” Crashes: Research Study and Guidelines for Sidewalks and Walkways* summarizes the results of a study that examined the safety impacts of having sidewalks and walkways along roadways. The document also provides guidelines and recommendations for providing such facilities. Review this document online at <http://www.walkinginfo.org/pdf/r&d/SidewalkReport.pdf>.





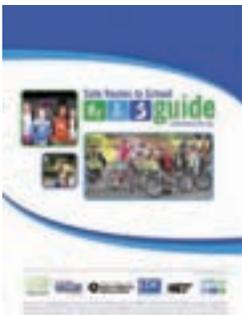
### *Resource Guide on Laws Related to Pedestrian and Bicycle Safety*

This Guide presents a selection of vehicle and traffic law provisions from the Uniform Vehicle Code prepared by the National Committee on Uniform Traffic Laws and Ordinances (NCUTLO), other state laws and local ordinances that have a positive effect on pedestrian or bicycle safety, and model laws prepared or adapted to meet specific safety needs. The safety relevance of each provision is assessed in terms of its likely effects on the causes of bicycle or pedestrian crashes with motor vehicles, the prevention or reduction of bicyclist or pedestrian injuries and possible effects on pedestrian and bicycle injury-producing situations that do not involve motor vehicles. Each provision is cross-referenced to a description of how the concept is implemented in each state. The Guide is available as a download or can be ordered from the NHTSA Web site. <http://www.nhtsa.dot.gov/people/injury/pedbimot/bike/resourceguide/index.html>.



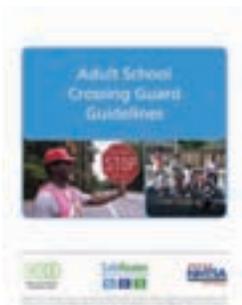
### *Bicycle and Pedestrian Safety Resource Guide (2005)*

The Bicycle and Pedestrian Safety Resource Guide is a compilation of existing and proposed countermeasures to help solve a range of bicycle and pedestrian safety problems. The Guide was prepared for the bicycle and pedestrian safety professionals and others who are developing programs at the state or community level. The Guide is available for download from NHTSA's Web site at <http://www.nhtsa.dot.gov/people/injury/pedbimot/bike/BikePedestrian/index.htm>.



### *Safe Routes to School Guide (2006)*

The Safe Routes to School Guide is a comprehensive online reference manual designed to support communities in developing Safe Routes to School programs. The guide was developed by the Pedestrian and Bicycle Information Center (PBIC) in collaboration with SRTS experts from around the country and support from the National Highway Traffic Safety Administration (NHTSA), Federal Highway Administration (FHWA), Centers for Disease Control and Prevention (CDC) and Institute of Transportation Engineers (ITE). Find the Guide at <http://www.saferoutesinfo.org/guide/>.



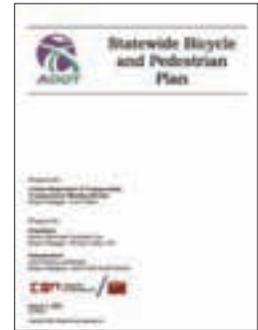
### *Adult School Crossing Guard Guidelines*

The Adult School Crossing Guard Guidelines outline the role of the adult school crossing guard and the elements of a crossing guard program. The guide was prepared by the National Center for Safe Routes to School and the Pedestrian and Bicycle Information Center with funding from the National Highway Traffic Safety Administration and can be found at [http://www.saferoutesinfo.org/guide/crossing\\_guard/index.cfm](http://www.saferoutesinfo.org/guide/crossing_guard/index.cfm).

## State Guides

### *Arizona: Statewide Bicycle and Pedestrian Plan (2003)*

This is a guide for making pedestrian-related transportation decisions at the state and local level. The plan provides a long-term agenda for implementing a system of pedestrian facilities on the ADOT State Highway System and seeks to coordinate the relationship between ADOT and smaller jurisdictions. The plan described state policies and codes that affect pedestrian planning and provides a matrix of creative ordinances from around the nation, encouraging localities to implement and follow them. It contains an informative table on potential funding opportunities and resources that consist of project type, required matching funds, deadlines, etc. The plan is well-organized and presents a great example of citizen participation and stakeholder involvement. Development of the plan involved a comprehensive steering committee of representatives from pedestrian activist organizations, municipalities, state engineering agencies, a review committee, and engineering input. Find the document at <http://www.azbikeped.org/statewide-bicycle-pedestrian-intro.html>.



### *New Jersey: Statewide Bicycle and Pedestrian Master Plan, Phase 2 (2004)*

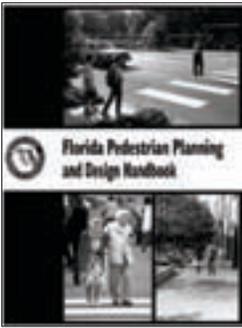
This plan provides clear guidance for the most effective use of Federal, state, and local resources to implement pedestrian and bicycle facilities. The stated goals and objectives are supported with proposed performance measures to determine the effectiveness and critical success factors. The plan presents a good example of how to use GIS analysis to prioritize the improvement of pedestrian facilities around the state. It used demand forecasting (showing pedestrian trips by census tract and roadway crossability) and suitability forecasting (calculating the suitability of making capital investments) to identify and prioritize project locations. Summarized in a matrix form, the implementation section includes several strategies and assigns responsibility to various agencies and organizations. This document is available online at <http://www.bikemap.com/RBA/NJBikePed.pdf>.



### *Virginia: VTrans 2025 Statewide Pedestrian Plan (2004)*

This plan is a tool for establishing a consistent approach to integrate a consideration for walking into transportation planning in Virginia. The preliminary draft remains general, providing a basic framework of the vision, strategies, and action items. It discusses several influences on the need to offer and operate pedestrian facilities, including Federal legislation such as the Intermodal Surface Transportation Efficiency Act (ISTEA), ADA accessibility requirements, and Virginia Department of Transportation policies. The plan reveals a regional program for obtaining public input, holding twelve public stakeholder meetings across the state. It acknowledges that disagreements exist on how to accommodate pedestrians and that there is a need to arrive at a cooperative solution. For more information, see the Web site <http://www.transportation.virginia.gov/VTrans/home.htm>.





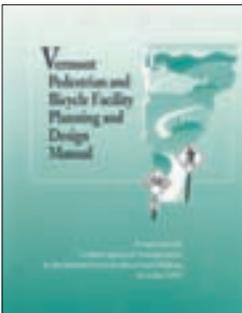
*Florida: Pedestrian Planning and Design Handbook (1996)*

The plan presents guidelines, standards, and criteria for pedestrian planning and facilities. It is intended as a reference for any locality, agency, organization, group, or citizen interested in improving the walking environment. It offers an overview of the pedestrian planning process and discusses the various steps of public involvement, data collection, development of goals and strategies, and implementation resources. The plan provides a comprehensive analysis of pedestrian-motor vehicle crashes in the state. It discusses the design details of roadway crossings, intersection treatments, and traffic calming strategies as well as presents other pedestrian considerations such as signage and signalization, school/work zone practices, and street lighting. A chapter is devoted to each element and includes recommendations, maintenance, and further references. This document can be downloaded from the site [http://www.dot.state.fl.us/safety/ped\\_bike/ped\\_bike\\_standards.htm#Florida%20Ped%20Handbook](http://www.dot.state.fl.us/safety/ped_bike/ped_bike_standards.htm#Florida%20Ped%20Handbook).



*Georgia: Pedestrian and Streetscape Guide (2003)*

The guide focuses on the design of pedestrian environments and streetscape facilities. It offers technical information on “best practices” that apply to situations encountered in project development. It provides a thorough examination of pedestrian characteristics and factors that influence pedestrian travel. The guide supplies an interesting spatial analysis, diagramming the space needs for different types of pedestrians—adults, children, elders, and those with disabilities. It discusses ways to prioritize projects using Geographic Information Systems (GIS), referencing the Latent Demand Model and Portland, OR’s Pedestrian Potential Index. The bulk of the guide exists in several toolkits, each devoted to different subjects. The toolkits begin with general design guidelines and move into more specific topics such as accessibility, school zones, trails and paths, sidewalks, crossings, etc. Detailed facility diagrams provide useful technical information for other agencies and localities. This report can be found at [http://www.dot.state.ga.us/dot/plan-prog/planning/projects/bicycle/ped\\_facilities\\_guide/index.shtml](http://www.dot.state.ga.us/dot/plan-prog/planning/projects/bicycle/ped_facilities_guide/index.shtml).

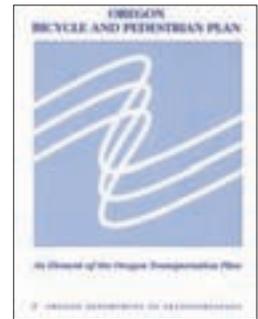


*Vermont: Pedestrian and Bicycle Facility Planning and Design Manual (2002)*

The manual assists agencies, organizations, and citizens with the planning, design, construction, and maintenance of pedestrian facilities in a variety of settings. It incorporates a separate analysis of characteristics of traffic-related pedestrian fatalities and common characteristics of pedestrian crashes. It primarily focuses on the sidewalk environment adjacent to the roadway, considering width, slope, surface, and access points. The supporting street cross-sections give a clear representation of desired space and scale. The manual also recognizes special treatment of pedestrian planning for rural areas. Visit the Web site <http://www.aot.state.vt.us/progdev/Documents/LTF/FinalPedestrianAndBicycleFacility/PedBikeTOC.html> for more information.

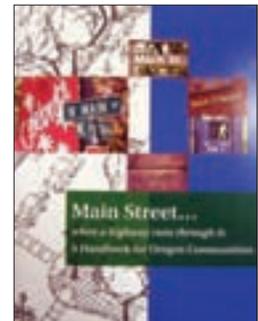
*Oregon: Bicycle and Pedestrian Plan (1995)*

This is one of the first plans developed to promote walking. It is in-depth and informative, addressing various aspects of pedestrian planning. The plan is divided into two sections—policy/action planning and network planning—with the purpose of presenting ODOT with general principles and policies for providing walkways along state highways. It provides a framework for cooperation between ODOT and local jurisdictions and offers guidance to cities and counties wanting to develop local pedestrian plans. The plan presents an overview of existing legislation relating to pedestrians, describes the current conditions statewide, and suggests implementation actions to ensure achievement of stated goals and policies. It contains clear, measured diagrams and street cross-sections of most desirable design facilities. The Oregon plan can be read and ordered online at [http://www.oregon.gov/ODOT/HWY/BIKEPED/docs/or\\_bicycle\\_ped\\_plan.pdf](http://www.oregon.gov/ODOT/HWY/BIKEPED/docs/or_bicycle_ped_plan.pdf).



*Oregon: Main Street...when a highway runs through it: A Handbook for Oregon Communities (1999)*

This handbook was designed for communities that are working together to enhance the vitality of a main street which also serves as a state highway. It describes the many tools available to identify the problems and figure out good solutions to strike a balance between the needs of pedestrians, shoppers, employees, business owners, and residents with the needs of through traffic—both auto and freight—to move safely and efficiently over longer distances. It can be found at <http://egov.oregon.gov/LCD/TGM/docs/mainstreet.pdf>.



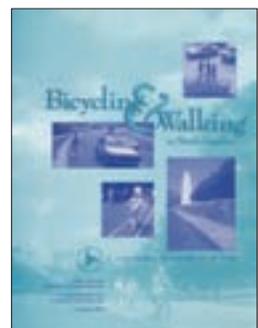
*California: Pedestrian and Bicycle Facilities in California, Technical Reference Report (2005)*

Caltrans' *Technical Reference Report* is intended to help accommodate pedestrian transportation throughout the State of California. It is intended as a resource for professionals, agency staff, and citizens. Through the collection of demographic and pedestrian collision data, the report makes a strong case for the need to improve pedestrian facilities. It contains a grant source matrix that shows available funding by agency, amount, deadline, and requirements. The bulk of the report is related to pedestrian travel, organized from broad topics to design detail. Each page contains a description and discussion of a different element, drawing, diagram or photo that enables standard and innovative practices to be easily understood. This document can be found at <http://www.dot.ca.gov/hq/traffops/survey/pedestrian/pedbike.htm>.

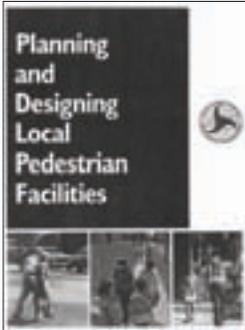


*North Carolina: Bicycling and Walking in North Carolina, A Long Range Transportation Plan (1996)*

Developed by the Office of Bicycle and Pedestrian Transportation of the NCDOT, this pedestrian plan builds upon the NC long-range transportation plan, elaborating on the goals, focus areas, and programming specific to walking. It also demonstrates a technique for performing a statewide inventory: in the plan-making process, city managers or mayors of NC communities with populations of at least 1,000 were surveyed for information on the community's walking environment. The plan summed the



individual data to obtain the total miles of a particular pedestrian facility in the state. The plan also discusses crash data and reviews relevant pedestrian content of different Metropolitan Planning Organization (MPO) plans. The plan formulates actions, supplies funding sources/levels, and calls for an evaluation of projects. This document is available at <http://www.ncdot.org/transit/bicycle/about/longrangeplan2.pdf>.



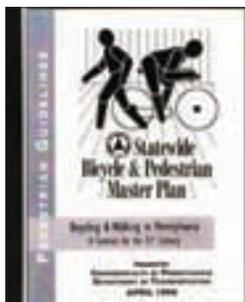
*North Carolina: Planning and Designing Local Pedestrian Facilities (1997)*

The *Local Pedestrian Facilities* manual provides suggestions and guidelines for local planners and traffic engineers to increase pedestrian safety and friendliness. The manual demonstrates design details for pedestrian treatments and traffic calming. It contains a table of sidewalk placement and width recommendations according to street type and gives individual consideration to pedestrians with disabilities as well as pedestrians in school and work zones. The manual focuses on signage and signalization, treatments often overlooked in pedestrian design manuals. The manual finishes with a comprehensive matrix summarizing pedestrian problems and possible solutions. It can be ordered online at [http://www.ncdot.org/transit/bicycle/projects/resources/projects\\_peddesign.html](http://www.ncdot.org/transit/bicycle/projects/resources/projects_peddesign.html).



*Washington: Pedestrian Facilities Guidebook (1997)*

The purpose of the *Pedestrian Facilities Guidebook* is to assist various agencies and organizations in pedestrian planning and encourage good design practices when developing these spaces. It discusses the importance of construction, maintenance, and operations. The guidebook presents the needs and characteristics of pedestrians and then provides several toolkits, highlighting important information in boxes, tables, diagrams, and graphs. The guidebook gives attention to the spatial needs of all types of pedestrians. The toolkits address the design of important walking facilities like trails, sidewalks, intersections, and crossings, and they also discuss important accessibility issues and school zone safety. The guidebook provides an opportunity for citizen comments through a request form and a detailed resource guide. For further information, visit the Web site <http://www.wsdot.wa.gov/EESC/Design/DesignManual/desEnglish/1025-E.pdf>.

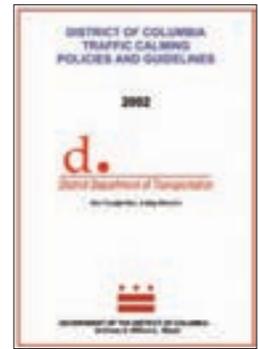


*Pennsylvania: Pedestrian Planning and Design Guidelines (1996)*

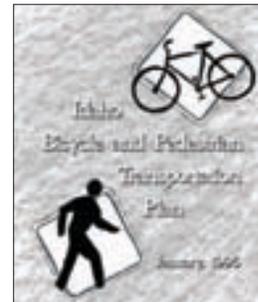
The *Pedestrian Planning and Design Guidelines* is one part of the *Statewide Bicycle and Pedestrian Master Plan* for Pennsylvania. The plan-making process involved a comprehensive public outreach program that held workshops across the state, established a toll-free number and questionnaire, and included representatives from several stakeholder groups. The *Pedestrian Planning and Design Guidelines* act as a guide for PENNDOT and localities to make the current transportation system more accessible to pedestrians. The guide recognizes the importance of incorporating pedestrians into land use and planning policies and discusses ways to retro-fit existing developments to better serve pedestrians. The design guidelines focus on best practices for sidewalks, intersections, and other crossings. This document can be found by visiting <http://www.dot.state.pa.us>.

*District of Columbia: Traffic Calming Policies and Guidelines (2002)*

To reduce the negative impact of motor vehicle use and ensure overall safety, the *District of Columbia Traffic Calming Policies and Guidelines* provide a process for involving the public in implementing traffic calming measures. It supplies a formal request form for citizens and describes the process from request to implementation. The document presents criteria for rating and selecting traffic calming projects when competing for specific funding. Also, it describes and diagrams traffic calming measures approved for the District of Columbia. The document is available at [http://www.ddot.dc.gov/ddot/lib/ddot/services/pdf/traffic\\_calming.pdf](http://www.ddot.dc.gov/ddot/lib/ddot/services/pdf/traffic_calming.pdf).

*Idaho: Bicycle and Pedestrian Transportation Plan (1995)*

This document serves as a first step in establishing a statewide vision and comprehensive approach to pedestrian transportation planning. It provides a clear, simple statement of goals and objectives as well as action strategies, policies, statutes, and design standards that can be used to meet those goals. It provides guidelines pertaining to pedestrian facilities combined with helpful planning and design information for local agencies. It can be found at <http://itd.idaho.gov/planning/reports/bikepedplan/idt.pdf>.

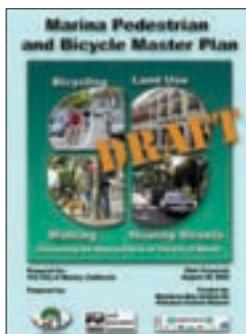
*Wisconsin: Pedestrian Policy Plan 2020 (2001)*

This statewide pedestrian plan focuses on the policies and programs that will help improve conditions for walking. The plan was conceived with assistance from the Pedestrian Plan Citizen's Advisory Committee and citizens around the state provided additional insights, suggestions, and reactions through public sessions and hearings as well as focus group meetings; this enables the plan to better reflect citizen concerns. The plan is meant to be used by local traffic officials seeking guidance to meet pedestrian needs on local road systems. It can be found at <http://www.dot.wisconsin.gov/projects/state/ped2020.htm>.

**Local Guides***Denver, CO: Pedestrian Master Plan (2004)*

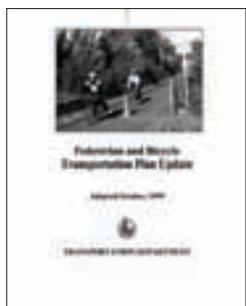
The plan establishes a city-wide pedestrian network. It uses a detailed development process that incorporates existing conditions assessment, existing plans, GIS studies, public involvement, and policy review. Development of the plan included two rounds of public workshops and input from an inter-agency advisory team. The plan uses GIS analysis to measure potential pedestrian activity by locating concentrations of pedestrian destinations; GIS allows for a systematic strategy for building, improving, and maintaining the pedestrian infrastructure. The plan prioritizes projects with a scoring system and provides several funding sources. It can be found at [http://www.denvergov.org/Transportation\\_Planning/141113406template3jump.asp](http://www.denvergov.org/Transportation_Planning/141113406template3jump.asp).





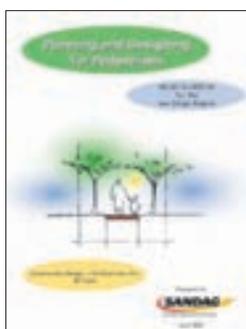
*Marina, CA: Pedestrian and Bicycle Master Plan (2003)*

This plan contains a clear outline and discussion of goals and action strategies. It offers a comprehensive street inventory and assessment of deficiencies. The plan suggests changes to the pedestrian environment and sets guidelines for different size roadways. It uses several graphic examples, describes design details, and mentions proper placement to enhance the walking environment. The plan can be downloaded from the Web site <http://www.lgc.org/marina/>.



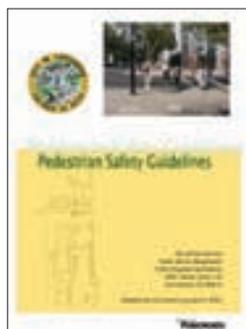
*Bellevue, WA: Pedestrian and Bicycle Transportation Plan Update (1999)*

This is a policy-oriented document that aims to revise the 30-year plan. It presents key issues that have appeared during the implementation of pedestrian facilities, proving to be a helpful resource for localities considering such improvements. The document emphasizes the importance of maintenance policies. It supplies an organized, informative table that contains description, justification, cost, priority, and jurisdiction of projects. Find this document online at <http://www.ci.bellevue.wa.us/departments/Transportation/pdf/PedBikePlan99.pdf>.



*San Diego, CA: Planning and Designing for Pedestrians, Model Guidelines for the San Diego Region (2002)*

These guidelines provide an extremely thorough look at how to plan and design for the pedestrian. The plan discusses the land use and community structure elements that affect the pedestrian environment. It contains a comprehensive list of site and design details that includes information on considerations, guidelines, example images, and technical diagrams. The pedestrian measures index is a good tool for identifying appropriate countermeasure to use depending on roadway volume and speed. To download this plan, go to the site [http://www.sandag.org/uploads/publicationid/publicationid\\_713\\_3269.pdf](http://www.sandag.org/uploads/publicationid/publicationid_713_3269.pdf).



*Sacramento, CA: Pedestrian Safety Guidelines (2003)*

These guidelines focus on street crossing treatments at controlled and uncontrolled intersections, discussing tools such as pavement marking and signal options and giving attention to roadway design. The guidelines create a four level system to address crosswalk placement for uncontrolled locations as well as a matrix of appropriate treatments for streets with different numbers of lanes, average daily traffic volume (ADT), and posted speed. The Sacramento plan is available online at [http://www.cityofsacramento.org/dsd/dev\\_eng\\_finance/entitlements/pdfs/ped\\_safety.pdf](http://www.cityofsacramento.org/dsd/dev_eng_finance/entitlements/pdfs/ped_safety.pdf).



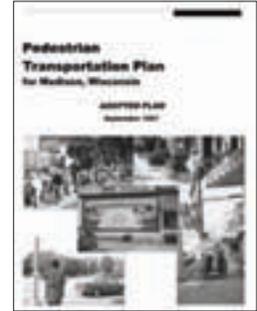
*Portland, OR: Pedestrian Master Plan (1998)*

The *Master Plan* outlines an action plan to achieve the city's pedestrian-oriented goals. To identify needed improvements, the plan used a rigorous identification process, including several opportunities for public input. Data collection included citizen requests, street inventories, and an examination of crash data. Using GIS mapping capabilities, it developed a Pedestrian Potential Index, which measures the strength of

environmental factors (policy, proximity, and quantitative) that favor walking, and a Deficiency Index, which measures how critically pedestrian improvements are needed based on traffic volumes, crash data, and a lack of sidewalks. The plan contains a section on sources and strategies for obtaining funding. It also presents a graph of the past pedestrian funding and gives five different scenarios for the implementation of future pedestrian improvements. For more on this plan, visit the Web site <https://www.portlandonline.com/shared/cfm/image.cfm?id=90244>.

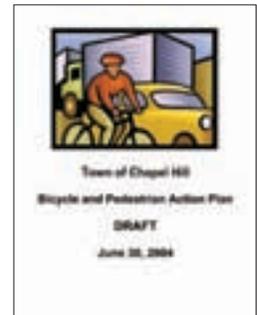
*Madison, WI: Pedestrian Transportation Plan (1997)*

This plan dedicates a significant section to the history and importance of pedestrian planning, as well as “thinking like a pedestrian.” It includes a hypothetical walking tour of photographs that reveal possible locations for pedestrian improvements. It incorporates planning, design, and maintenance into long-term goals and objectives. The plan emphasizes the importance of education and encouragement of pedestrian travel as integral to the success of pedestrian transportation. For more on this plan, visit the site <http://www.cityofmadison.com/transp/PedTransPlanTableOfContents.html>.



*Chapel Hill, NC: Bicycle and Pedestrian Action Plan (2004)*

This is a concise, general plan that provides a foundation for future pedestrian planning. The plan contains information on policies and guidelines that should be used in planning for future pedestrian needs. It discusses how to encourage pedestrian movement, highlighting characteristics and influences on pedestrian travel. The plan reinforces design guidelines from previous studies and establishes local standards for streets. Finally, it addresses the role of the state, MPO, university and private developers in the identification of projects and funding process. This plan is available at <http://townhall.townofchapelhill.org/planning/bikeped/bikepedplan.htm>.



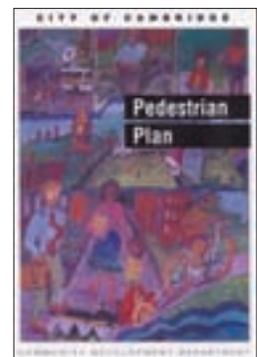
*Oakland, CA: Pedestrian Master Plan (2002)*

The plan is a fine example of how to examine census information and pedestrian collision data, showing graphs on speed, location, time of day, age, etc. The development of the plan involved an extensive community outreach process with technical and citizen advisory board, as well as neighborhood meetings. The plan identifies a pedestrian route system through the city from the specified criteria and then focuses improvements in those areas first. It contains comprehensive descriptions and graphics of design details and provides a detailed implementation plan with prioritization and cost of individual projects. To find this plan online, go to <http://www.oaklandnet.com/government/pedestrian/index.html>.

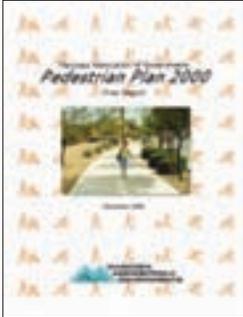


*Cambridge, MA: Pedestrian Plan (2000)*

This is a beautiful and creative plan that addresses safety and walkability. It begins with general pedestrian issues and then moves on to specific action in Cambridge. The analysis tools include census data and an examination of the pedestrian environment. The plan separates pedestrian design guidelines from roadway issues and vehicular



movements, allowing for the safety issues to be addressed from different, independent viewpoints. For the pedestrian improvements specific to Cambridge, the plan classifies the city into nodes, spines, and other areas pedestrians are most likely use. It then presents needed actions to improve the space. This plan is available at [http://www.cambridgema.gov/~CDD/et/ped/plan/ped\\_plan.html](http://www.cambridgema.gov/~CDD/et/ped/plan/ped_plan.html).



*Phoenix, AZ: Pedestrian Plan 2000 (1999)*

The Maricopa Association of Governments plan promotes the accommodation of pedestrian travel throughout the low-density, automobile-oriented Phoenix metropolitan area. It uses a two-step process in creating roadway design guidelines: (1) the Latent Demand Model estimates potential pedestrian activity based upon the frequency and proximity of adjacent trip generators, and (2) the Roadside Pedestrian Condition Model analysis statistically separates results based on roadway and traffic variables. The focus of the plan is on providing sidewalks and lateral separation (buffer). The online version of this document is available at [http://www.mag.maricopa.gov/pdf/cms.resource/ped-plan2000sum-web\\_427.pdf](http://www.mag.maricopa.gov/pdf/cms.resource/ped-plan2000sum-web_427.pdf).



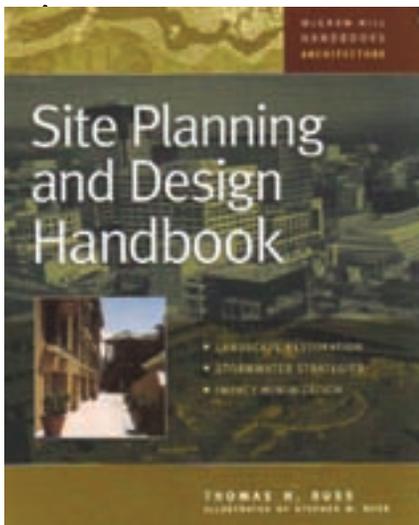
*Seattle, WA: Regional Bicycle and Pedestrian Implementation Strategy for the Central Puget Sound Region (2002)*

This regional plan identifies more than 2,000 miles of needed bike lanes and paths and pedestrian improvements around activity centers. It can be found online at <http://www.psrc.org/projects/nonmotorized/strategy.pdf>.



*Boulder, CO: Transportation Master Plan (2003)*

Pedestrian planning is fully integrated into the Boulder, CO *Transportation Master Plan*. The plan outlines modal split targets of 15 percent by bike and 24 percent by foot by 2020 and offers a variety of resources to transportation officials seeking to increase pedestrian travel. More about the plan and its elements can be found at <http://www.ci.boulder.co.us/publicworks/depts/transportation/tmp.html>.



## Appendix G: Pedestrian-Related Land Use Planning Resources

### Access Management

*Access Management Awareness Project*, Iowa State University. Available online at <http://www.ctre.iastate.edu/Research/access/> (includes report, case studies, and toolkit).

Giguere, Ronald K., *Access Management in the New Millennium*, TRB Committee on Access Management (A1D07). Available online at <http://gulliver.trb.org/publications/millennium/00000.pdf>.

TRB Access Management Committee. Available online at <http://www.accessmanagement.gov/>.

*Access Management*, Victoria Transport Policy Institute. Available online at <http://www.vtpi.org/tm/tm1.htm>.

### Site Planning and Design

*Design and Safety of Pedestrian Facilities: A Proposed Recommended Practice of the Institute of Transportation Engineers*, ITE Technical Council Committee 5A-5.

Jarvis, Frederick D., *Site Planning and Community Design for Great Neighborhoods*, Home Builder Press, 1993.

Lynch, Kevin, *Site Planning*, MIT Press, 1984.

Rubenstein, Harvey M., *Pedestrian Malls, Streetscapes, and Urban Spaces*, Wiley, 1992.

Untermann, Richard K., *Accommodating the Pedestrian, Adapting Towns and Neighborhoods for Walking and Bicycling*, Van Nostrand Reinhold Company, 1984.

Russ, Thomas H., *Site Planning and Design Handbook*, McGraw Hill: Boston, Massachusetts, 2002.

Vernez-Moudon, Anne, et al., *Effects of Site Design on Pedestrian Travel in Mixed-Use Medium Density Environments*, Transportation Research Record 1587. Available online at <http://www.enhancements.org/trb%5C1578-07.pdf>.

### Street Connectivity

Dill, Jennifer, *Measuring Network Connectivity for Bicycling and Walking*, School of Urban Studies and Planning, Portland State University. Available online at [http://web.pdx.edu/~jdill/Dill\\_ACSP\\_paper\\_2003.pdf](http://web.pdx.edu/~jdill/Dill_ACSP_paper_2003.pdf)), 2003.

Handy, Susan, R. Paterson, and K. Butler, *Planning for Street Connectivity: Getting from Here to There*, Planning Advisory Service Report 515, American Planning Association, 2004.

*Roadway Connectivity: Creating More Connected Roadway and Pathway Networks*. Available online at <http://www.vtppi.org/tdm/tdm116.htm>.

### Transit Accessibility

Jeng, One-Jang and George Fallat, *Pedestrian Safety and Mobility Aids for Crossings at Bus Stops*, Report No. FHWA-NJ-2003-013, Federal Highway Administration, Washington, D.C., September 2003. Available online at [http://www.transportation.njit.edu/nctip/final\\_report/PedestrianSafety.pdf](http://www.transportation.njit.edu/nctip/final_report/PedestrianSafety.pdf).

Khan, Arif., *Pedestrian-Transit Connection Analysis*, Alta Planning and Design, Portland, OR. Available online at [http://www.americawalks.org/PDF\\_PAPE/Khan.pdf](http://www.americawalks.org/PDF_PAPE/Khan.pdf).

Moundon, Anne Vernez and Paul M. Hess, *Pedestrian Safety and Transit Corridors*, Washington State Transportation Center, Report No. WA-RD-556.1, Washington Department of Transportation, January 2003. Available online at [http://www.wsdot.wa.gov/ppsc/research/CompleteReports/WARD556\\_1Ped\\_Safe\\_Transit\\_Corridor.pdf](http://www.wsdot.wa.gov/ppsc/research/CompleteReports/WARD556_1Ped_Safe_Transit_Corridor.pdf).

Texas Transportation Institute (TTI), *Guidelines for the Location and Design of Bus Stops*, Transit Cooperative Research Program, No. 19, National Academy Press, Washington, D.C., 1996. Available online at [http://trb.org/news/blurb\\_detail.asp?ID=2597](http://trb.org/news/blurb_detail.asp?ID=2597).

Transportation Resource Associates, *Transit Bus Safety Program*, Federal Transit Association, Washington, D.C., March 2001.

Tucker, Lisa E., *Safer Stops for Vulnerable Customers*, Report No. NCTR-473-13, National Center for Transit Research (NCTR), US-DOT, Washington D.C., March 2003. Available online at [http://www.dot.state.fl.us/research-center/Completed\\_Proj/Summary\\_PTO/FDOT\\_BC137\\_38\\_SS.pdf](http://www.dot.state.fl.us/research-center/Completed_Proj/Summary_PTO/FDOT_BC137_38_SS.pdf).



## Appendix H: Checklist for Engineering and Planning Solutions

This section lists effective and commonly used pedestrian crash countermeasures, each with a brief description. It follows the outline provided in Chapter 5, although the order may be slightly different in some places. Please fill in the blanks with information on whether or not your agency has adopted these practices; if not, what changes in your policies would be required for these countermeasures to become “routine accommodation”?

### I. Walking Along the Road Crashes

#### *Rural environments*

Paved shoulders provide room for pedestrians to walk away from traffic; they also provide room for bicyclists and increase safety for motor vehicle operators. To be effective, paved shoulders should be 1.8 m (6 ft) wide or more; 1.2 m (4 ft) is considered the minimum acceptable width.

- Do you routinely provide paved shoulders on rural highways and trunk roads?  
Yes / No
- If yes, please state your policy: \_\_\_\_\_
- If not, what change(s) need to be instituted to ensure shoulders are routinely provided? \_\_\_\_\_

#### *Urban and suburban environments*

Sidewalks reduce walk-along-the-road crashes by providing positive separation from traffic. Continuous and connected sidewalks are needed along both sides of streets to prevent unnecessary street crossings. Sidewalks should be buffered with a planter strip to increase pedestrian safety and comfort; separation makes it easier to meet ADA requirements for a continuous level passage and for a clear passage around obstacles.

- Do you routinely provide sidewalks on urban and suburban arterials? Yes / No
- If yes, please state your policy: \_\_\_\_\_
- If so, what is the standard width? \_\_\_\_\_
- Are your sidewalks curbtight or separated? \_\_\_\_\_
- What change(s) need to be instituted to ensure separated sidewalks are routinely provided? \_\_\_\_\_

Driveways clearly mark the area where motorists will be crossing the pedestrian's path. Continuous access to parking creates long conflict areas between pedestrians and motorists; this ambiguity complicates the motorist's task of watching for pedestrians.

- Do you routinely ensure that access points are limited and well defined? Yes / No
- If yes, please state your policy: \_\_\_\_\_
- If not, what change(s) need to be instituted to ensure access points are well defined? \_\_\_\_\_

Driveways should be designed to look like driveways, not street intersections: sidewalks should continue through the driveway, the level of the sidewalk should be maintained, and the driveway should be sloped so that the motorist goes up and over the sidewalk. Driveways should be away from intersections. The number and width of driveways should be minimized.

- Do you routinely require that driveways be located away from intersections and designed to look like driveways, not intersections? Yes/No
- If yes, please state your policy: \_\_\_\_\_
- If not, what change(s) need to be instituted to ensure driveways are properly designed and located? \_\_\_\_\_

Illumination greatly increases the motorist's ability to see pedestrians walking along the road at night. Double-sided lighting illuminates both sidewalks for increased pedestrian safety.

- Do you routinely provide illumination on both sides of the street? Yes / No
- If yes, please state your policy: \_\_\_\_\_
- If not, what change(s) need to be instituted to ensure streets are well lit? \_\_\_\_\_

## II. Crossing the Road Crashes

Pedestrian crossing islands reduce crashes substantially at uncontrolled locations, especially on busy multilane streets where gaps are difficult to find. An island breaks an otherwise complex crossing maneuver into two easier steps: a pedestrian looks left, finds an acceptable gap in one direction, crosses to the island, then looks right and finds a second gap.

Do you routinely provide pedestrian crossing islands at identified crossing points?

Yes / No

If yes, please state your policy: \_\_\_\_\_

If not, what change(s) need to be instituted to ensure islands are provided?

\_\_\_\_\_  
\_\_\_\_\_

Curb extensions reduce the total crossing distance on streets with on-street parking and increase visibility: the waiting pedestrian can better see approaching traffic and motorists can better see pedestrians waiting to cross the road, as their view is no longer blocked by parked cars.

Do you routinely provide curb extensions at identified crossing points? Yes / No

If yes, please state your policy: \_\_\_\_\_

If not, what change(s) need to be instituted to ensure curb extensions are provided?

\_\_\_\_\_  
\_\_\_\_\_

Illumination greatly increases the motorist's ability to see pedestrians crossing the road. Increased lighting should be provided at the primary crossing points. Double-sided lighting should be provided along wide arterial streets; this enables motorists to see pedestrians along the road, who may decide to cross anywhere, anytime.

Do you routinely provide illumination at identified crossing points? Yes / No

If yes, please state your policy: \_\_\_\_\_

If not, what change(s) need to be instituted to ensure illumination is provided?

\_\_\_\_\_  
\_\_\_\_\_

### III. Popular Crossing Solutions and How to Improve Them

The public often responds to a tragic pedestrian crash with a call for an immediate solution. Commonly requested solutions include traffic signals, flashers, overcrossings or undercrossings, or marked crosswalks. While these can be effective solutions in certain places, in some instances they are not appropriate or effective.

#### *Traffic Signals*

The primary purpose of a traffic signal is to create gaps in traffic that otherwise would be hard to find. The MUTCD warns against the overuse of signals for a variety of reasons. Inappropriate traffic signals may increase crashes. Traffic signals are expensive, from \$35,000 to \$300,000 for one intersection, not including any associated road widening.

But in some cases, the only solution to crossing a busy, multilane arterial street is to install a pedestrian crossing signal. This is especially true in locations where there is no other signal for 0.4 km (0.25 mi) or more in an area with lots of pedestrian activity.

### Improving Traffic Signals

Traffic signals may be the only way to create a gap for pedestrians to cross busy multi-lane highways with significant volumes. Since it is difficult to meet MUTCD warrants for a pedestrian signal based solely on existing pedestrian counts, it may be necessary to anticipate how many pedestrians might cross once a signal is installed. A median island and a two-stage pedestrian crossing help reduce impacts on traffic flow: the pedestrian stops one direction of traffic at a time, and the two crossings are separated at a fenced-in median island.

Do you install traffic signals based on anticipated pedestrian volumes? Yes / No

If yes, please state your policy: \_\_\_\_\_

If not, what change(s) need to be instituted so warranted signals are provided?

\_\_\_\_\_

### *Overcrossing or Undercrossing*

These solutions are appealing because they give the impression of complete separation of pedestrians from motor vehicle traffic. In practice, this rarely occurs because:

1. Overcrossings and undercrossings are expensive and cannot be provided at most locations where pedestrians want to cross.
2. Undercrossing are often prone to security problems due to low visibility.
3. The out-of-distance travel is so inconvenient many pedestrians will refuse to walk this extra distance and cross at-grade.
4. Overcrossings or undercrossings are seldom used, and motorists are frustrated when they see pedestrians crossing in the vicinity of an overcrossing or undercrossing; this in turn increases the risk to pedestrians crossing at grade.

The high cost of an overcrossing or undercrossing makes them impractical for all but a few locations.

### Improving Overcrossings and Undercrossings

Do you install separated crossings based on well-defined criteria? Yes / No

If yes, please state your policy: \_\_\_\_\_

If not, what change(s) need to be instituted so separated crossings are provided only where warranted? \_\_\_\_\_

\_\_\_\_\_

### *Marked Crosswalks Without Additional Crossing Treatments*

Marked crosswalks (without additional crossing treatments) should only be installed where there is an expectation of a significant number of pedestrians such as near a school, park or other generator. Without the associated features mentioned so far (islands, curb extensions, illumination etc.), marked crosswalks on their own do not

necessarily increase the security of a pedestrian crossing the street. The most recent study on marked crosswalks can be downloaded at <http://www.walkinginfo.org/rd/devices.htm>. In general, the results can be summarized as follows:

- Two-lane roads: no significant difference in crashes.
- Multilane roads (three or more lanes):
  - Under 12,000 ADT: no significant difference in crashes.
  - Over 12,000 ADT without median: crashes at marked crosswalks > crashes at unmarked crosswalks.
  - Over 15,000 ADT and with median: crashes at marked crosswalks > crashes at unmarked crosswalks.

The study also made the following observations:

- Medians reduce crashes by 40 percent.
- Pedestrians over 65 are over-represented in crashes relative to crossing volumes.
- No evidence was found to indicate that pedestrians are less vigilant in marked crosswalks.
- Looking behavior increased significantly after crosswalks were installed.

Do you have a program for evaluating, upgrading and installing marked crosswalks at unsignalized locations? Yes / No

If yes, please state your policy: \_\_\_\_\_

If not, what change(s) are needed to ensure that this occurs?

\_\_\_\_\_

Textured and/or colored crosswalks are another popular request. In reality, they are often less visible to motorists than white marked crosswalks, may create maintenance problems, and are difficult for pedestrians with disabilities to negotiate.

### Improving Marked Crosswalks

Using high visibility markings ensures that motorists see the crosswalk as well as the pedestrian.

Do you routinely install high-visibility crosswalks? Yes / No

If yes, please state your policy: \_\_\_\_\_

If not, what change(s) need to be instituted to ensure that high-visibility crosswalks are provided?

\_\_\_\_\_

Crosswalks with advance stop bars (or yield lines) help prevent “multiple-threat” crashes on multilane streets. These occur when a motorist in the outside lane stops to let a pedestrian cross and—by stopping so close to the crosswalk—masks a vehicle in the adjacent lane who is not slowing down. The second motorist does not have time to react, and the pedestrian is struck at high speed. The advance stop bar (or yield line)

encourages the first motorist to stop back 9.1 m (30 ft)—plus or minus a distance—so the pedestrian can see if a motorist in the second lane is not stopping. This enables the pedestrian to wait or even pull back if he has started to proceed into the second lane.

Do you routinely install advance stop bars at crosswalks on multilane streets?

Yes / No

If yes, please state your policy: \_\_\_\_\_

If not, what change(s) need to be instituted to ensure that advance stop bars are provided?

\_\_\_\_\_  
\_\_\_\_\_

Proper signing increases the motorist's awareness of a pedestrian crossing.

Do you routinely provide signing at pedestrian crossings? Yes / No

If yes, please state your policy: \_\_\_\_\_

If not, what change(s) need to be instituted to ensure that signing is provided?

\_\_\_\_\_  
\_\_\_\_\_

Illumination increases the motorist's ability to see pedestrians crossing the road.

Do you routinely provide illumination at pedestrian crossings? Yes / No

If yes, please state your policy: \_\_\_\_\_

If not, what change(s) need to be instituted to ensure that illumination is provided?

\_\_\_\_\_  
\_\_\_\_\_

#### **IV. Intersection Geometry**

Intersection geometry has a profound effect on pedestrian safety as it determines to a large extent whether or not motorists will perceive pedestrians, the length of crosswalks, and the speed of approaching and turning vehicles.

Do you have an intersection design policy that takes pedestrian safety into account?

Yes / No

If yes, please state your policy: \_\_\_\_\_

If not, what change(s) need to be instituted to ensure that pedestrian safety is considered?

\_\_\_\_\_  
\_\_\_\_\_

Tighter radii benefit pedestrians by shortening the crossing distance, bringing crosswalks closer to the intersection, increasing visibility of pedestrians, and slowing right-turning vehicles. The appropriate radius must be calculated for each corner of an intersection; difficult turns for the occasional event are acceptable (for example a large moving truck turning onto a local street).

- Do you routinely encourage tight radii at urban/suburban intersections? Yes / No
- If yes, please state your policy: \_\_\_\_\_
- If not, what change(s) need to be instituted to ensure that tight radii are provided?

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Pork-chop islands between an exclusive right-turn lane and through lanes shorten the crossing distance, reduce pedestrian exposure and improve signal timing. The island enables pedestrians and motorists to negotiate one conflict separately from the others. The island should have the longer tail pointing upstream to the approaching right-turn motorist; so motorists approach at close to 90° and are looking at the crosswalk. The crosswalk is placed one car length back from the intersecting street so the motorist can move forward once the pedestrian conflict has been resolved. The right-turning motorist can focus on traffic and the pedestrian can focus on cross or through traffic.

- Do you routinely provide pedestrian-friendly pork-chop islands (long tail design) at right-turn lanes? Yes / No
- If so, are they designed to enhance pedestrian safety?
- If not, what change(s) need to be instituted to ensure that well designed islands are provided?

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Median islands channelize and slow down left-turning vehicles. An island provides pedestrians a refuge for long, unsignalized crossings or if a conflict cannot be avoided, though signalized intersections should be designed to allow pedestrians to cross the entire street during a single signal cycle.

- Do you routinely provide median islands at intersections? Yes / No
- If so, are signals times so pedestrians can cross in one cycle?
- If not, what change(s) need to be instituted to ensure that islands are provided?

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Proper crosswalk and curb ramp placement and design ensures that all users cross in crosswalks, close to the intersection, where motorists can see them, and without undue delay. Ramps (wings not included) must be wholly contained within the marked crosswalk. Poorly placed or oriented ramps force wheelchair users to make long detours and they may not cross in the allotted time at a signalized intersection; they may be crossing outside the crosswalk lines where motorists do not expect them.

- Do you routinely provide crosswalks and ramps at all corners of all intersections?  
Yes / No
- If yes, please state your policy: \_\_\_\_\_
- If so, are they designed to enhance pedestrian safety?

- If not, what change(s) need to be instituted to ensure that crosswalks and ramps are provided?

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## V. Signalized Intersections

All signalized intersections where pedestrians are reasonably expected to cross should have the elements described in the following sections.

Pedestrian signals ensure that pedestrians know when the signal phasing allows them to cross, and when they should not be crossing. On one-way streets a pedestrian approaching from the opposite direction cannot see the vehicle signal heads and may not realize an intersection is signalized, nor know when it is safe to cross. Left turn arrows are not visible to the pedestrian.

- Do you routinely provide pedestrian signals at signalized intersections? Yes / No

If yes, please state your policy: \_\_\_\_\_

- If not, what change(s) need to be instituted to ensure that pedestrian signals are provided?

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Marked crosswalks indicate to the motorist where to expect pedestrians and help keep the crossing area clear of vehicles. All legs of a signalized intersection should be marked.

- Do you routinely provide marked crosswalks at signalized intersections? Yes / No

If yes, please state your policy: \_\_\_\_\_

- If not, what change(s) need to be instituted to ensure crosswalks are provided?

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It is important to provide a WALK signal long enough to get pedestrians started, and a clearance interval long enough to ensure that a pedestrian can fully cross the street. Traditionally, 1.2 m/s (4 ft/s) is assumed adequate, though 1.1 m/s (3.5 ft/s) or even 0.9 m/s (3.0 ft/s) may be appropriate at locations that have a substantial number of older pedestrians or pedestrians with mobility impairments.

- Are your signals timed to give pedestrians adequate time to cross? Yes / No

If yes, please state your policy: \_\_\_\_\_

- If not, what change(s) need to be instituted to ensure enough time is provided?

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Push buttons should be located where a pedestrian who is in a wheelchair or is visually-impaired can easily reach them, and positioned so that they clearly indicate which

crosswalk the button regulates. Push buttons mounted on two separate pedestals work best, as it is nearly impossible to place two push buttons correctly on one signal pole. Push buttons are not needed in downtown/central business districts and other area of high pedestrian use where pedestrians can be expected at every signal cycle.

Do you routinely place pedestrian push buttons where they can be reached?

Yes / No

If yes, please state your policy: \_\_\_\_\_

Do you routinely avoid using pedestrian push buttons in downtown/central business districts and other areas of high pedestrian use? Yes/No

If not (either question), what change(s) need to be instituted to ensure that push buttons are accessible?

\_\_\_\_\_

\_\_\_\_\_

Signal timing techniques to reduce the incidence of crashes that occur while the pedestrian is crossing with the WALK signal include:

1. Protected left-turn phases that allow pedestrians to cross without interference from left-turning motorists. Red (then green) left turn arrows make it clear to motorists they must wait before turning (especially important where there are double right or double left turns).

Do you routinely provide protected left turns at signalized intersections? Yes / No

If yes, please state your policy: \_\_\_\_\_

If not, what change(s) need to be instituted to ensure that protection is provided?

\_\_\_\_\_

\_\_\_\_\_

2. Lead Pedestrian Intervals (LPIs) reduce conflicts between turning vehicles and pedestrians when turning vehicles encroach onto the crosswalk before pedestrians leave the curb. The LPI releases pedestrians 3 to 5 seconds prior to the green light for vehicles so pedestrians can enter and occupy the crosswalk before turning motorists enter it.

Do you provide an LPI at signalized intersections with known turning conflicts?

Yes / No

If yes, please state your policy: \_\_\_\_\_

If not, what change(s) need to be instituted to provide a LPI where helpful?

\_\_\_\_\_

\_\_\_\_\_

3. Pedestrian countdown signals indicate to the pedestrian how much time is left in the pedestrian clearance interval, encourage pedestrians to finish crossing before the crossing time runs out, and reduce the number of pedestrians who initiate a crossing too late in the cycle.

- Do you provide countdowns at signalized intersections where it would help?  
Yes / No
- If yes, please state your policy: \_\_\_\_\_
- If not, what change(s) need to be instituted to provide countdowns where helpful?  
\_\_\_\_\_  
\_\_\_\_\_

## VI. Other Techniques to Create a Better Pedestrian Environment

### *Road Diets*

Reducing the number of travel lanes a pedestrian has to cross can be beneficial to all users. A well-documented technique takes a four-lane undivided street (two lanes in each direction) and reconfigures it to two travel lanes, a center-turn lane, and two bike lanes (without changing the curb lines). The benefits for pedestrians include fewer lanes to cross and slower traffic speeds. The center-turn lane also creates space for pedestrian crossing islands. The bike lanes add a buffer for pedestrians as well as a place for bicyclists to ride. Variations include reducing a multilane one-way street by one lane; narrowing the travel lanes to slow traffic and create space for bike lanes; or moving the curbs in to narrow the roadway.

- Do you routinely consider reducing the number of travel lanes where practical?  
Yes / No
- If yes, please state your policy: \_\_\_\_\_
- If not, what change(s) need to be instituted to ensure that road diets are considered?  
\_\_\_\_\_  
\_\_\_\_\_

### *Arterial Street Design*

High speeds make it harder to avoid a crash and increase the severity of a crash or the likelihood of a fatality. Speed reduction should be a primary tool in reducing pedestrian crashes. Simply lowering speed limits is usually ineffective. Streets must be redesigned to encourage lower speeds.

- Are your design standards predicated on slow speeds in urban environments?  
Yes / No
- If yes, please state your policy: \_\_\_\_\_
- If not, what change(s) need to be instituted to ensure that speeds are reasonable in urban areas?  
\_\_\_\_\_  
\_\_\_\_\_

### *Residential Street Design and Traffic Calming*

Residential streets built in the last few decades are often wide and barren, encouraging speeds higher than appropriate for streets where children can be expected. Good

residential street designs are narrow and have on-street parking, tight curb radii, short block length, buffered sidewalks with street trees, short building setbacks, and street-lights.

- Have you adopted pedestrian-oriented residential street design standards? Yes / No
- If yes, please state your policy: \_\_\_\_\_
- If not, what change(s) need to be instituted to change your standards?

\_\_\_\_\_

\_\_\_\_\_

Traffic calming slows traffic inside neighborhoods. Common techniques include speed tables or humps, traffic circles, diverters, chokers, and chicanes to break up long, straight streets.

- Do you routinely consider traffic calming on neighborhood streets? Yes / No
- If yes, please state your policy: \_\_\_\_\_
- If not, what change(s) are needed to institutionalize traffic claming?

\_\_\_\_\_

\_\_\_\_\_

## VII. Transit-related Crashes

Many crashes involve a pedestrian crossing the street to access transit. All street-crossing techniques are applicable to transit stops. Transit providers and road authorities should ensure that all transit stops are accessible to all pedestrians. The following policies are recommended:

All stops should consider the safety of the pedestrian crossing—not necessarily a marked crosswalk at each stop location; rather, locating stops where it is possible for a pedestrian to cross safely at or very near the stop.

- Do you collaborate with transit providers to ensure pedestrians can cross the street wherever there is a transit stop? Yes / No
- If yes, please state your policy: \_\_\_\_\_
- If not, what change(s) need to be instituted to ensure that transit stops are safer?

\_\_\_\_\_

\_\_\_\_\_

Provide a safe place to stand and wait at transit and school bus stops, even if there are no sidewalks. Transit stops with a lack of space push people out into the roadway.

- Do you collaborate with transit providers to ensure stops have a hard surface? Yes / No
- If yes, please state your policy: \_\_\_\_\_
- If not, what change(s) need to be instituted to ensure transit stops are paved?

\_\_\_\_\_

\_\_\_\_\_

Sidewalks or paved shoulders provide pedestrian access to all transit stops.

- Do you collaborate with transit providers to ensure stops are accessible? Yes / No  
 If yes, please state your policy: \_\_\_\_\_  
 If not, what change(s) need to be instituted to ensure transit stops are accessible?

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Lighting should be provided at or near all bus stop locations.

- Do you collaborate with transit providers to ensure stops are lit? Yes / No  
 If yes, please state your policy: \_\_\_\_\_  
 If not, what change(s) need to be instituted to ensure transit stops are lit?

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The transit agency should also review all its stop locations to facilitate access and crossing. Techniques include:

1. Eliminating or moving transit stops in areas that are hard to cross.
2. Consolidating closely-spaced stops to limit the number of crossings and improve transit efficiency (as the buses stop less often).
3. Moving stops to a location where it is easier to cross. In general, farside locations are preferred for pedestrian safety, as pedestrians can cross behind the bus and the bus can leave without having to wait for pedestrians to cross. However, there are locations where a nearside stop may be safer and better for operational reasons.
4. Placing crosswalks (where warranted) behind the bus stop at midblock locations so pedestrians can cross behind the bus, where they can see oncoming traffic; it also enables the bus driver to pull away without endangering pedestrians.

Transit providers also have their concerns:

1. Bus stops should be easily accessible: a stop should not be moved to a far side location if this location requires a lot of out-of-direction travel for users.
2. Bus stops should be located where the motorist can easily stop and move back into traffic again.
3. Bus stops need to be located where passengers with disabilities can board the bus.

- Do you collaborate with transit providers to ensure stops are practical? Yes / No  
 If yes, please state your policy: \_\_\_\_\_  
 If not, what change(s) need to be instituted to ensure transit stops meet the transit provider's needs?

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## VIII. Planning Solutions

### *Land Use and Site Design*

Land use patterns impact pedestrian crashes and the general feasibility of walking. Pedestrian crash severity is higher in suburban, auto-oriented locations where speeds are faster and motorists do not expect pedestrians. Pedestrian crashes are less severe in established, traditional urban areas where motorists are more aware of pedestrians. Sample land use and site design techniques that can encourage more walking and help manage speed and therefore affect crash rates include:

Buildings should define streets. Buildings located at the back of the sidewalk give the motorist sense of enclosure; buildings set back with large parking lots in front create wide high-speed roads. Mixed-use development can encourage walking trips and enhance the pedestrian environment. Buildings with retail on the bottom and housing on the top encourage pedestrian activity.

Street connectivity encourages walking because of the reduced travel distance to reach destinations (cul-de-sacs without connector paths reduce pedestrian connectivity).

Parking should not be placed between the sidewalk and buildings; on-street parking can be a very effective way to slow traffic and encourage pedestrian-oriented development. The principles of access management should be extended to parking: single lots serving multiple stores are preferred over single stores each with its own parking lot and driveway.

- Have you adopted city codes for future development that create a pedestrian-friendly environment? Yes / No
- If yes, please state your policy: \_\_\_\_\_
- If not, what change(s) need to be instituted to change codes?  
\_\_\_\_\_  
\_\_\_\_\_

# Appendix I: Checklist for Pedestrian Safety Action Plan Elements



This checklist provides effective and commonly used elements of a Pedestrian Safety Action Plan (PSAP). The template generally follows the outline of the *How to Develop a Pedestrian Safety Action Plan* guide.

To the extent possible, please fill in the blanks prior to the training workshop. On day two of the training workshop, this checklist will be used to conduct a guided exercise to create an outline that can later be used as a basis for a PSAP.

## I. Goals and Objectives

Commitment to safety for all modes should be the number one goal and priority of state and local transportation agencies. Once this commitment is made, it allows transportation agencies to allocate funds to reducing all crash types, including pedestrian crashes.

- Do you have a clearly stated commitment to safety as your number one priority?  
Yes / No
- If yes, please state: \_\_\_\_\_
- If not, what change(s) need to be instituted to ensure that safety becomes the number one priority of your agency? \_\_\_\_\_

Clear objectives are needed for a pedestrian plan to be successful in reducing pedestrian crashes. They allow for the development of practical and achievable strategies; they also provide a way to measure progress over time. To be effective, objectives must be specific and measurable.

- Do you have a clearly stated objective for reducing pedestrian crashes? Yes / No
- If yes, please state: \_\_\_\_\_

- If not, what change(s) need to be instituted to ensure that objectives are adopted?

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## II. Stakeholders

Individual stakeholder involvement is an excellent way to get a better product. Public stakeholders should be viewed as partners who are the on-the-ground scouts who can identify problems, needs and opportunities. To be effective, stakeholders must be involved in a regular, ongoing and systematic way.

- Do you routinely provide for individual stakeholder involvement? Yes / No

- If yes, please describe: \_\_\_\_\_

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- If not, what change(s) need to be instituted to ensure that stakeholders are routinely involved?

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A Pedestrian Advisory Board (PAB) is another excellent way to get a better product. They also build public support for policies, programs, and projects to reduce pedestrian crashes. To be effective, stakeholders must be involved in the review of policies, programs and projects.

- Do you have a PAB that regularly reviews policies, programs, and projects?  
Yes / No

- If yes, please describe: \_\_\_\_\_

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- If not, what change(s) need to be instituted to ensure the creation of an effective PAB?

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Public agency staff in other agencies are also stakeholders. Building positive, working relationships is essential for coordination on regional planning issues; it also provides a way to coordinate on solving specific problems such as identifying high crash locations where additional enforcement may be needed, and coordinating transit stops with crossing locations.

- Do you routinely coordinate with other agencies on crash, transit, etc., issues?  
Yes / No

- If yes, please describe: \_\_\_\_\_

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- If not, what change(s) need to be instituted to ensure you coordinate with other agencies?

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### III. Data Collection

Computerized, timely, geo-coded pedestrian crash data are essential to identify high-crash locations, corridors, and/or larger areas and to select appropriate improvements to make conditions safer for pedestrians and other roadway users.

- Do you routinely collect pedestrian crash data? Yes / No
- If yes, please describe: \_\_\_\_\_  
\_\_\_\_\_
- If not, what change(s) need to be instituted to ensure that crash data are routinely collected?

Pedestrian counts along with crossing observations can be very useful in understanding pedestrian behavior and in considering the need for facilities. Counts and behavior studies, when combined with crash data, can also provide insights into specific crash causes and potential countermeasures.

- Do you routinely collect pedestrian counts and complete crossing observations? Yes / No
- If yes, please describe: \_\_\_\_\_  
\_\_\_\_\_
- If not, what change(s) need to be instituted to ensure that pedestrian counts and observations are routinely completed?  
\_\_\_\_\_  
\_\_\_\_\_

Sidewalk and marked crosswalk (at uncontrolled locations) inventories help identify system gaps and unsafe conditions. When combined with crash data, pedestrian counts, and traffic characteristics, they can be very useful in prioritizing locations for countermeasures and other improvements.

- Do you routinely inventory sidewalks and marked crosswalks? Yes / No
- If yes, please describe: \_\_\_\_\_  
\_\_\_\_\_
- If not, what change(s) need to be instituted to ensure that inventories of sidewalks and marked crosswalks are routinely completed?  
\_\_\_\_\_  
\_\_\_\_\_

Inventories of traffic characteristics (such as ADT, road widths, and speeds) help identify likely crash locations. When combined with actual crash data and pedestrian counts, they can be very useful in prioritizing locations for countermeasures and other improvements.

- Do you routinely inventory roadway ADT, widths and speeds? Yes / No
- If yes, please describe: \_\_\_\_\_  
\_\_\_\_\_

- If not, what change(s) need to be instituted to ensure that ADT, width and speed information is routinely collected and coded?

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#### IV. Analyzing Information and Prioritizing Concerns

Categorizing pedestrian crash data should be done to determine whether they are occurring at a) spot locations, b) along corridors, c) in a neighborhood area, or d) throughout an entire jurisdiction (poor standard practice such as failing to install pedestrian indicators at signals). Once categorized, this information can be used to focus resources and prioritize projects.

- Do you routinely categorize pedestrian crash data? Yes / No

- If yes, please describe: \_\_\_\_\_

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- If not, what change(s) need to be instituted to ensure that crash data is routinely categorized?

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Conducting field reviews and safety audits can be used to identify how each pedestrian crash occurred, and what may be done to prevent future similar crashes. The outcome is a list of improvements that can be implemented to address those crashes and enhance safety.

- Do you routinely conduct field reviews and safety audits? Yes / No

- If yes, please describe: \_\_\_\_\_

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- If not, what change(s) need to be instituted to ensure that field reviews and safety audits are routinely completed? \_\_\_\_\_

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Crash typing describes the pre-crash actions of the parties involved. When crashes are “crash typed,” a pattern often emerges that helps identify what the problem is and what countermeasures are generally related to each crash type. Crash typing is particularly useful in developing education and enforcement strategies.

- Do you routinely “crash type” your pedestrian crash data? Yes / No

- If yes, please describe: \_\_\_\_\_

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- If not, what change(s) need to be instituted to ensure that crash typing is routinely completed? \_\_\_\_\_

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Prioritizing pedestrian safety improvements is the final step once all appropriate data has been collected. Priorities should be established based on a variety of factors including safety consequences, cost, travel demand, availability of right-of-way, federal

and/or state mandates and public support. Solutions can be phased and divided into temporary or permanent improvements.

- Do you routinely prioritize (rank) pedestrian safety improvements? Yes / No
- If yes, please describe: \_\_\_\_\_
- If not, what change(s) need to be instituted to ensure that safety improvements are routinely prioritized? \_\_\_\_\_

## V. Providing Funding

Routine accommodation for pedestrians in all projects, programs and maintenance activities is the most cost-effective funding strategy for reducing pedestrian crashes and encouraging more walking. The majority of pedestrian infrastructure is built in conjunction with other projects. It allows for significant improvements over time, even if there is no special funding available for pedestrian safety improvements.

- Do you routinely include pedestrian safety improvements in all projects, programs, and maintenance activities? Yes / No
- If yes, please describe: \_\_\_\_\_
- If not, what change(s) need to be instituted to ensure that pedestrian safety improvements are included? \_\_\_\_\_

Dedicated funds and set-asides for pedestrian projects allow for immediate action in addressing high crash locations, corridors, and other targeted areas. They can be federal, state or local funds and are often a percentage of another fund.

- Do you routinely set aside funds that are dedicated to pedestrian safety? Yes / No
- If yes, please describe: \_\_\_\_\_
- If not, what change(s) need to be instituted to ensure that funds are routinely set aside? \_\_\_\_\_

## VI. Creating the Pedestrian Safety Action Plan

A Pedestrian Safety Action Plan focuses resources on making the changes that reduce the greatest number of pedestrian crashes. To be effective, it must provide a framework for involving stakeholders, collecting and analyzing data, selecting countermeasures, developing implementation strategies and providing funding.

- Do you have a Pedestrian Safety Action Plan that includes all these elements?  
Yes / No

- 
- If yes, please describe: \_\_\_\_\_  
\_\_\_\_\_
- If not, what change(s) need to be instituted to ensure that a comprehensive plan is created? \_\_\_\_\_  
\_\_\_\_\_

Evaluation of results ensures that implemented solutions are effective in reducing crashes and improving the safety and accessibility of pedestrian facilities; it also helps ensure future funding opportunities if the plan is perceived as a success. Success should be measured against the objectives set forth in the Pedestrian Safety Action Plan—typically to reduce pedestrian crashes by a certain percentage.

- Do you routinely evaluate results of your efforts to reduce pedestrian crashes?  
Yes / No
- If yes, please describe: \_\_\_\_\_  
\_\_\_\_\_
- If not, what change(s) need to be instituted to ensure that regular evaluation occurs?  
\_\_\_\_\_  
\_\_\_\_\_

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