

Appendix C. Roadway Improvement Measures

Table C-1 describes the menu of potential crossing treatments along a pathway through the EBMUD Aqueduct ROW.

Table C-1: Roadway Improvement Measures for Pathway Crossings

Measure	Description	Benefits	Application
<i>Traffic Control Countermeasures</i>			
Traffic Signal or All-Way Stop	Conventional traffic control devices with warrants for use based on the Manual on Uniform Control Devices (MUTCD).	Reduces pedestrian-vehicle conflicts.	Must meet warrants based on traffic and pedestrian and bicycle volumes; however, exceptions are possible based on demonstrated safety concerns (collision history).
Flashing Beacons	Flashing amber lights are installed on overhead or post mounted signs, in advance of the crosswalk or at the entrance to the crosswalk. Can be pedestrian/ bicycle activated by a push button or by auto-detection using detection cameras.	Blinking lights during pedestrian/bicycle crossing times increase the number of drivers yielding for pedestrians/ bicyclists and reduces vehicle conflicts. This measure can also improve conditions on multi-lane roadways.	Best used in places where motorists cannot see a traditional sign due to topography or other barriers.
In-Roadway Warning Lights	Both sides of a crosswalk are lined with pavement markers, often containing an amber LED strobe light. The lights may be push-button activated or activated with pedestrian/ bicycle detection.	This measure provides a dynamic visual cue, and is increasingly effective in bad weather.	May not be appropriate in areas with heavy winter weather due to high maintenance costs. May not be appropriate for locations with bright sunlight. May not be appropriate on high speed roads. Lights may cause confusion when pedestrians fail to activate and/or falsely activate system.

Table C-1: Roadway Improvement Measures for Pathway Crossings (continued)

Measure	Description	Benefits	Application
High-Visibility Signs and Markings	High-visibility markings include a family of crosswalk striping styles including the “ladder” and the “triple four.” One style, the zebra-style crosswalk pavement markings, were once popular in Europe, but have been phased out because the signal-controlled puffin is more effective. High-visibility fluorescent yellow green signs are approved and posted at crossings to increase the visibility of a pedestrian/ bicycle crossing ahead.	FHWA recently ended its approval process for the experimental use of fluorescent yellow crosswalk markings and found that they had no discernable benefit over white or yellow markings. No other colors were tested beyond yellow and white crosswalk markings.	Beneficial in areas with high pedestrian activity, as near schools, and in areas where travel speeds are high and/or motorist visibility is low.
Advanced Yield Lines	Standard white stop or yield limit lines are placed in advance of marked, uncontrolled crosswalks.	Measure increases the pedestrian and bicyclists’ visibility to motorists, reduces the number of vehicles encroaching on the crosswalk, and improves general pedestrian/ bicycle conditions on multi-lane roadways. It is an affordable option.	Useful in areas where pedestrian/ bicycle visibility is low and in areas with aggressive drivers, as advance limit lines will help prevent drivers from encroaching on the crosswalk. Addresses the multiple-threat collision on multi-lane roads.
Speed Feedback Sign	High-visibility sign that tells drivers their speeds versus the posted speed limit.	Reduces vehicle speeds and makes drivers aware of the posted speed limit.	Best in locations where vehicle speeds are of concern.

Table C-1: Roadway Improvement Measures for Pathway Crossings (continued)

Measure	Description	Benefits	Application
<i>Geometric Treatments</i>			
Median Refuge Island	Raised islands are placed in the center of a roadway, separating opposing lanes of traffic with cutouts for accessibility along the pedestrian/ bicycle path.	This measure allows pedestrians and bicyclists to focus on each direction of traffic one direction at a time, and the refuge provides pedestrians with a better view of oncoming traffic as well as allowing drivers to see pedestrians more easily. It can also split up a multi-lane road and act as a supplement to additional pedestrian/ bicycle tools.	Recommended for multi-lane roads wide enough to accommodate an ADA-accessible median.
Staggered Median Refuge Island	This measure is similar to traditional median refuge islands; the only difference is that the crosswalks in the roadway are staggered such that a pedestrian crosses half the street and then must walk towards oncoming traffic to reach the second half of the crosswalk. This measure must be designed for accessibility by including rails and truncated domes to direct sight-impaired pedestrians along the path of travel.	Benefits of this tool include an increase in the concentration of pedestrians/ bicyclists at a crossing and the provision of better traffic views for pedestrians/ bicyclists. Motorists are better able to see pedestrians/ bicyclists as they travel through the staggered refuge.	Best used on multi-lane roads with obstructed pedestrian visibility (because they provide pedestrians a better view of oncoming traffic and allow drivers to more clearly see pedestrians) or with offset intersections.

Table C-1: Roadway Improvement Measures for Pathway Crossings (continued)

Measure	Description	Benefits	Application
Curb Extension	Also known as a bulb-out, this traffic-calming measure is meant to slow traffic and increase driver awareness. It consists of an extension of the curb into the street, making the pedestrian/ bicycle space (sidewalk) wider.	Curb extensions narrow the distance that a pedestrian or bicyclist has to cross and increases the sidewalk space on the corners. They also improve emergency vehicle access ⁴⁸ and make it difficult for drivers to turn illegally.	Due to the high cost of installation, this tool would only be suitable on streets with high pedestrian/ bicycle activity, on-street parking, and infrequent (or no) curb-edge transit service. Often used in combination with crosswalks or other markings.
Curb Ramps	Curb ramps are sloped ramps that are constructed at the edge of a curb (normally at intersections) as a transition between the sidewalk and a crosswalk. Ramps may be widened at pathway entrances, but should be designed to look distinct from a regular driveway entrance ⁴⁹ . Bollards or other pathway treatments can be used to distinguish the pathway entrance.	Curb ramps provide easy access between the sidewalk and roadway for people using wheelchairs, strollers, walkers, crutches, handcarts, bicycles, and also for pedestrians with mobility impairments who have trouble stepping up and down high curbs.	Curb ramps must be installed at all intersections and mid-block locations where pedestrian crossings exist, as mandated by federal legislation (1973 Rehabilitation Act and 1990 Americans with Disabilities Act). Where feasible, separate curb ramps for each crosswalk at an intersection should be provided rather than having a single ramp at a corner for both crosswalks.

⁴⁸ Emergency access is often improved through the use of curb extensions if intersections are kept clear of parked cars. Fire engines and other emergency vehicles can climb a curb where they would not be able to move a parked car. At midblock locations, curb extensions can keep fire hydrants clear of parked cars and make them more accessible.

⁴⁹ The width of the ramp should be at least as wide as the average width of the trail to improve safety for users who will be traveling at various speeds. In addition, the overall width of the trail should be increased, so the curb ramp can be slightly offset to the side.

(Source: <http://www.fhwa.dot.gov/environment/sidewalk2/sidewalks216.htm>)

Table C-1: Roadway Improvement Measures for Pathway Crossings (continued)

Measure	Description	Benefits	Application
Raised Crosswalk	A crosswalk whose surface is elevated above the travel lanes.	Attracts drivers' attention; encourages lower travel speeds by providing visual and tactile feedback when approaching the crosswalk.	Appropriate for multi-lane roadways, roadways with lower speed limits that are not emergency routes, and roadways with high levels of pedestrian/ bicycle activity, such as near schools, shopping malls, etc.
<i>Pedestrian & Bicycle Access and Amenities</i>			
Marked Crosswalk	Marked crosswalks should be installed to provide designated pedestrian crossings at major pedestrian generators, crossings with significant pedestrian volumes (at least 15 per hour), crossings with high vehicle-pedestrian collisions, and other areas based on engineering judgment.	Marked crosswalks provide a designated crossing, which may improve walkability and reduce jaywalking.	Marked crosswalks alone should not be installed on multi-lane roads with more than about 10,000 vehicles/ day. Enhanced crosswalk treatments (as presented in this table) should supplement the marked crosswalk, particularly with limited visibility, high motor vehicle speeds or more than two lanes of traffic.
Accessibility Upgrades	Treatments such as audible pedestrian signals, accessible push buttons, and truncated domes should be installed at crossings to accommodate disabled pedestrians.	Improves accessibility of pedestrian facilities for all users.	Appropriate accessibility upgrades should be provided for all pedestrian facilities following a citywide ADA Transition Plan.
Pedestrian/Bicycle Countdown Signal	Displays a "countdown" of the number of seconds remaining for the pedestrian/ bicycle crossing interval. In some jurisdictions the countdown includes the walk phase. In other jurisdictions, the countdown is only displayed during the flashing don't walk phase.	Increases pedestrian/ bicycle awareness and allows them the flexibility to know when to speed up if the pedestrian/ bicycle phase is about to expire.	Pedestrian signals should be prioritized for areas with pedestrian activity, roadways with high volumes of vehicular traffic, multi-lane roadways, and areas with elderly or disabled persons (who may walk slower than others may).

Table C-1: Roadway Improvement Measures for Pathway Crossings (continued)

Measure	Description	Benefits	Application
Bicycle Wait Area	Painted wait area adjacent to the sidewalk curb where bicyclists can safely wait to make a two-legged turn and be visible to drivers.	Accommodates bicyclists making a two-legged left turn across a wide roadway by providing a dedicated space to wait for the signal.	Best used on multi-lane roads that are difficult for bicyclists to make left turns.
<i>Pathway Speed Control</i>			
Bollards	A short vertical post used to define pathway and roadway areas and control vehicle, pedestrian and bicycle movements	The diagonal layout of bollards will make the space between the bollards appear narrower, slowing bicyclists and deterring motorcyclists from entering the trail.	Bollards can be placed at pathway access points to separate the pathway from motor vehicles and to warn and slow bicyclists as they approach street crossings. Bollards should be spaced to provide access by people using wheelchairs. A trail sign post can be incorporated into the bollard layout.