

# 3 Project Goals and Design Guidelines

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Based on the analysis of the unique project context presented in Section 2, this section summarizes the key goals, and priorities for the project and provides detailed suggested design guidelines.

In the context of a transportation project's formal review process, a formal "Purpose and Need" statement is developed and refined. For this statement, a project's "Need" is an identified transportation deficiency or problem, and its "Purpose" is the set of objectives that will be met to address the transportation deficiency.<sup>1</sup>

To fully capture the community's ideas, concerns, and issues and what these mean in terms of design priorities, this section provides both a formal purpose and need statement and a somewhat broader account of community goals and priorities. Combined, these provide the criteria used to develop specific design guidelines presented in this Section, and to assess conceptual design alternatives in Section 4.

### 3.1 Purpose and Need

Highway 101 has been a major transportation asset to the City of Santa Rosa since its construction in the late 1950's, but because the freeway bisects the city it has had significant impacts on travel options, particularly for cyclists and pedestrians in the area north of College Avenue near the Santa Rosa Junior College (SRJC) and Santa Rosa High School (SRHS) campuses. In this area there are no separated bicycle/pedestrian crossings of 101 and the two available roadway crossings, at College Avenue and Steele Lane, present challenges to cyclists and pedestrians because they are spaced one mile apart, have high traffic volumes, and have multiple intersections with freeway ramps and major north-south streets.

On the east side of 101, the SRJC Santa Rosa Campus has close to 23,000 students and is the second largest employer in the Sonoma County.<sup>2</sup> Because 74% of students and 92% of staff arrive to campus by automobile,<sup>3</sup> the SRJC generates high volumes of traffic. Despite the recent construction of a large parking garage on the SRJC campus, the streets near the SRJC campus continue to suffer from traffic congestion and insufficient parking. Recent plans indicate that this area is expected to draw increasing numbers of pedestrians and cyclists, and specific infrastructure improvements have been proposed to accommodate them.<sup>4</sup>

On the west side of 101 between College Avenue and Steele Lane various development trends combine to increase the need for local VMT reduction and for safe alternatives for east-west bicycle and pedestrian travel across Highway 101. These include the addition of between 500-1,000 housing units within 1/4 mile of the proposed overcrossing's western terminus,<sup>5</sup> an east-west bicycle boulevard at Jennings, increasingly pedestrian oriented retail at the Coddington Mall, a north-south

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<sup>1</sup> [http://www.dot.ca.gov/hq/env/emo/definition\\_background.htm](http://www.dot.ca.gov/hq/env/emo/definition_background.htm)

<sup>2</sup> SRJC Fact Book 2008

<sup>3</sup> SRJC Bicycle Survey, Fall 2005

<sup>4</sup> Mendocino Avenue Corridor Plan (May 20, 2009, Final Plan); SRJC 2006-2008 Operational Parking & Transportation Plan.

<sup>5</sup> "Jennings Court" at 1080 Jennings Ave, 55-unit HUD-financed senior affordable apartment complex on one acre lot; "The Crossings at Santa Rosa" at 820 Jennings Ave, 48-unit apartment building reserved for families earning from 30 to 50 percent of the area median income for Sonoma County, as published by HUD; 1020 and 1060 Jennings Ave, proposed 310-unit apartment complex on approximately 11.87 acres, plus a 2.22 acre neighborhood park; "Monte Vista Apartments" at 1421 Range Ave, 107-unit affordable apartment complex consisting of clusters of townhouses and flats on a 3.91 acre triangular site; "Arroyo Point Apartments" at 1090 Jennings Ave, 70 new affordable for-rent homes.

bicycle/pedestrian pathway along the proposed Sonoma Marin Area Rail Transit (SMART) line, and a proposed SMART station near Guerneville Road.

The purpose of the project is to close an existing and increasingly significant gap in the local and regional transportation network. The project would also help improve safety for bicyclists and pedestrians, support revitalization of the area west of Highway 101, help mitigate pressures on the existing automobile infrastructure on the east side of 101 near the SRJC, provide quality of life benefits for the general Santa Rosa population in the form of VMT reduction and recreational opportunities, and improve travel opportunities including safer routes to transit for commuters, students, and low income and other disadvantaged residents.

#### *Project Purpose*

The project would close a significant gap in the transportation network through the following actions:

- Offering a regional east-west connector over Highway 101 for the City and County.
- Offering a safer and more enjoyable alternative for crossing 101 compared to existing roadway crossings at Steele Lane and College Avenue.
- Offering more direct connections for bicycles and pedestrians crossing 101 to important origins and destinations including SMART, SRJC, SRHS, the proposed Jennings Ave east-west Bicycle Boulevard, Coddington Mall, the SMART bicycle/pedestrian trail pathway, and housing developments along Range Avenue.

#### *Project Need*

The needs for the project can be discerned from negative characteristics that exist in the project area and from expected changes that significantly expand existing needs:

- Highway 101 creates a barrier to east-west travel and neighborhood coherence.
- Existing east-west routes at Steele Lane and College Avenue do not adequately attract and serve bicycles and pedestrians because a) people are concerned for their safety when crossing the multiple existing arterial intersections and un-signalized on and off ramps near Highway 101, and b) the one-mile distance between existing crossings results in trip lengths exceeding a comfortable range for pedestrians and many cyclists.
- Traffic congestion problems and parking shortages in the SRJC area persist despite the recent addition of a 1100 space parking garage on the SRJC campus.
- A new light rail transit station projected to serve over 1,300 people each day with approximately 500 of these not arriving or departing by automobile<sup>6</sup> is planned for the west side of 101 near Guerneville Road.
- Proposed high density housing in the project area<sup>7</sup> will significantly increase residential population in the immediate project area. Recent housing developments in the project area are

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<sup>6</sup> Email from John Nemeth, Rail Planning Manager for SMART, based on 2005 SMART Final EIR.

reserved for low-income and elderly residents; populations that rely more heavily on alternative transportation modes.

- A number of alternative transportation improvements are slated for the project area including the Jennings Avenue Bike Route, the SMART light rail station, pedestrian-oriented improvements on Mendocino Avenue, bicycle and pedestrian improvements on the SRJC campus, striped bike lanes along Mendocino Avenue (2009), and a multi-use pathway along the proposed light rail route.

## 3.2 Community Goals & Priorities

The Santa Rosa community has expressed a desire to complete a project expeditiously and without compromising safety features or the ability of the project to accommodate and encourage bicycling and walking for many years to come. Following is a summary of the strongest and most widely-held positions regarding the project and what these mean in terms of design direction and alternatives assessment.

*Key Priorities:*

- 1. Schedule:** Bring a project to fruition expeditiously:
  - a. Reject alternatives that involve potentially significant impacts to existing uses that could result in lengthy environmental review process.
  - b. Seek solutions that offer high feasibility and ease of implementation.
- 2. Design to Induce Demand:** Entice more people to choose transit, biking, and walking by creating a facility which is:
  - a. **Safe;** providing a safer crossing alternative than College Avenue and Steele Lane underpasses.
  - b. **Special and Attractive;** a point of civic pride. The project should be designed to be exciting and inviting.
  - c. **Comfort and Capacity;** the design should aim for a high quality user experience for all types of users. It should accommodate the disparate needs of bikes and pedestrians, and individuals with disabilities, and expected increases in demand.
  - d. **Facilitate Use of Transit;** alternatives which make direct connections to existing and future transit should be given greater weight than alternatives which make more indirect connections to transit.
  - e. **Link the project with new development.**

## 3.3 Project Opportunities

Construction projects often offer potential additional benefits not strictly within scope of objectives defined for the project. While it is important that opportunities not become distractions to the core project objectives, it is valuable to keep in mind where context analysis has identified improvements that could be realized with little or no additional expenditure. For the current project, these include:

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<sup>7</sup> 280 housing units have been added in the past 5 years within ¼ mile of the west touchdown of the proposed Highway 101 crossing location. Current zoning allows for future development adding as many as 310 housing units within ¼ mile of the proposed crossing location.

- The project can help invigorate pedestrian/bicycle and transit-oriented development in its immediate vicinity.
- Because of its prominent location on the Highway 101 corridor, the project could provide a symbolic gateway to Santa Rosa and a source of civic pride for residents.
- The City has determined that a small park should be included when land on the west side of 101 is developed. Because a bike/pedestrian pathway is compatible with a community park, and can serve as a green buffer zone between development tracts, if the west approach to a crossing goes through this land, design integration should be considered.
- The eastern portion of Bear Cub Way, and the western end of the former railroad right-of-way east of 101 (Myer's Restaurant Supply parking lot) are both currently characterized by large expanses of asphalt, without trees or other landscaping to soften the landscape and reduce storm water runoff. The scale and character of these areas could be improved by landscaping included in a bridge crossing project.
- The SRJC campus is heavily used by pedestrians, yet some routes do not provide for adequate separation from motor vehicles, and a number of pathways on the campus are too narrow. This project could serve as an impetus for bike/pedestrian infrastructure improvements on the SRJC campus.

### 3.4 Design Guidelines

#### 3.4.1 Summary of Design Guidelines

To meet the project goals, it is recommended that detailed design guidelines be formally adopted at the outset of the PID phase of the project. Suggested design guidelines are provided on the following pages. Below is a summary of key parameters:

- Clear width of the traveled way shall be 15.5 feet (minimum width 2-way bike + separate minimum width pedestrian sidewalk)
- A 1:20 ramp slope.
- A minimum radius of curvature of 154 feet. A preferred minimum radius of curvature of 261 feet.
- Fencing that is highly transparent both when viewed perpendicularly, from the freeway, and at very acute angles on the bridge.
- Within and near the missile-proof fencing enclosure, minimum direct visibility should be 65 feet.
- A handrail at 42 inches above the traveled way serving the pedestrian sidewalk.
- A minimum cross-slope of 2%.
- LED-based lighting directed on the traveled way from below eye-level.
- Maximum integration with new planting and landscaping along ramps, including trees where feasible.

For comparison purposes, we have provided the following table comparing guidelines for key west coast agencies.

Agency	Maximum Grade	Reference
WSDOT	5%	1
ODOT	5%	2
AASHTO	5%	3
CALTRANS	5%	4
Minimum Curve Radius*		
WSDOT	260 ft	1
ODOT	Not specified	2
AASHTO	225 ft	3
CALTRANS	261 ft	4

\*with superelevation of 2% and design speed of 30 mph

	Minimum Width	Desirable Width	Reference
WSDOT	14 ft (10+2+2)	16 ft (12+2+2)	1
ODOT	14 ft (10+2+2)	16 ft (10+3+3)	2
City of Vancouver	12 ft	18-20 ft	5
City of Portland	14 ft (10+2+2)	16 ft (12+2+2)	6
CALTRANS (Class 1)	12 ft (8+2+2)	18 ft (12+3+3)	4

References: 1. Chapter 1025 - WSDOT Design Manual (2006); 2. Oregon Bicycle and Pedestrian Plan (1995). AASHTO Guide for the Development of Bicycle Facilities (1999). 4. Caltrans Highway Design Manual Sec. 1003.1 (2006) 5. Portland Pedestrian Design Guide (1998) 6. City of Vancouver Standard Plan Number T29-43 (2007)

### 3.4.2 Width and User Separation

#### *Discussion*

Multi-use trail recommendations are generally consistent regarding appropriate two-way trail widths. With 5 feet as the standard for a single bike lane, guidelines commonly state that 10 to 12 feet are needed for overall width, and that 8 feet may suffice only when warranted by special circumstances such as very little use by pedestrians, gentle grades, and excellent sightlines. Overall widths of up to 22 feet are recommended if: a) the path is likely to be shared with pedestrians, joggers, and in-line skaters, b) bikes may ride two abreast, c) maintenance vehicles will need access, d) there are steep and/or long grades, or e) substantial bike volume is expected.

Recognizing the importance of user safety and quality of experience, recommended minimum widths for bicycle/pedestrian bridges have generally been increased over the past decade from 8 feet to 12 or more feet.

Clear width greater than 12 feet should be used, if possible, where the traveled way is constrained by fences, curbs, or guardrails, since the width criteria given above for multi-use pathways assume an open pathway with no guardrails and 2 to 3 feet of clear graded area on each side. When guardrails are placed at the immediate edge of a pathway, the effective usable width is reduced by an amount called the “shy” distance. The width of multi-use trails should be increased by shy distances whenever fencing or guardrails are needed.

As a rule of thumb for freeway crossings, each additional foot of width costs approximately \$150,000, and most of that incremental cost is for the main span structure. While required minimum distances from intermittent obstructions is 2 feet, and 3 to 4 feet are recommended,<sup>8</sup> the shy distance from continuous objects like fences or walls may be reduced to as little as one foot, according to some

<sup>8</sup> Caltrans Highway Design Manual, page 1000-4

experts. The *Caltrans Highway Design Manual* appears to support this by saying, “If a wide path is paved contiguous with a continuous fixed object (e.g. block wall), a 4” white edge stripe, one foot from the fixed object, is recommended to minimize the likelihood of a bicyclist hitting it.”<sup>9</sup>

The question of whether to physically separate slower moving users from faster moving users also plays into the question of overall width. Because it is anticipated the proposed bridge will need to serve a relatively high number of both bicyclists and pedestrians per day, we recommend the design should employ a mode separation device such as the low angled curb, like the one used on the Berkeley I-80 bicycle/pedestrian bridge. Use of an angled or rolled curb with a raised pedestrian sidewalk has generally been received favorably because:

- it is well-understood and would not need to rely on signage to be successful due to a strong association with vehicular streets and sidewalks.
- it allows for a lower guardrail height adjacent to the sidewalk, thus improving views and openness.
- it creates a sense of refuge for pedestrians from higher speed traffic.
- it allows for reduced shy distances.

If feasible, permanent, aesthetically-pleasing striping using integral pavement coloring is also appropriate for this project.

#### *Specific Recommended Guidelines*

- Minimum width of the traveled way of 15.5 feet, consisting of: a 5 foot wide raised sidewalk; an approximately 6 inch wide, 3 inch high, rolled curb; two 4 foot wide bike lanes, each having minimum 1 foot wide continuously paved shy distances at their outer edges.
- The shy distance shall be defined using 4” wide continuous white stripes, and the two bike lanes shall be separated by a 6” wide dashed yellow stripe.
- The preferred sidewalk width shall be 5.5 feet; however, increases in sidewalk width shall not be considered unless the bike lane widths have been increased to at least 5 feet.

### **3.4.3 Approach slope and resting spots**

#### *Discussion*

A 1:20 (5%) slope is the steepest rise which meets ADA criteria for a sidewalk. Any steeper slope is formally classified as a ramp and requires flat landing spots every 30 vertical inches as well as special guardrail and curb details.

Generally, a 1:12 slope reduces the total ramp length by about 30%; this represents significant savings in construction costs. However, the difficulties that steep grades create for children, seniors, and other users, as well as the additional costs and functional disadvantages for non-wheelchair users associated with the special ADA features required on steeper slopes, outweigh, in our judgment, the cost and geometric advantages of using a ramp with a slope steeper than 5%. Simply put, the functional, safety, and quality of user experience goals identified by the Santa Rosa community for this project are unlikely to be achieved using 1:12 ramp slopes.

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<sup>9</sup> Caltrans Highway Design Manual, page 1000-4

For all alignments considered, the ramps will very likely be over 400 feet long, and various guidelines would indicate that a resting or stopping point somewhere along the traveled way is advisable. This resting point can be combined with a viewing spot, and can be a physical respite where pedestrians or wheelchair users can pull off the main pathway with higher travel speed. Most relevant regulations and design guidelines have special provisions for particularly long ramps. For example, California ADA requirements specify that a long, continuously sloped sidewalk must include a flat resting spot at least every 400 feet,<sup>1</sup> Florida's Department of Transportation (DOT) identifies grades steeper than 5% as undesirable for multi-use trails, especially for segments longer than 500 feet,<sup>3</sup> and Caltrans bikeway design guidelines call for a maximum 5% slope and a recommended 2% slope on bikeway segments longer than 150 meters (492 feet) which are intended to accommodate a wide range of riders.

Judging from the public's input during the two community meetings, this population of potential users regards safety and usability as two of the most important bridge features. An overwhelming majority of meeting attendees expressed that existing bicycle/pedestrian facilities design standards for safety and comfort are inadequate and should be substantially exceeded. Design to maximize user comfort is important for encouraging future demand.

#### *Specific Recommended Guidelines*

- A 1:20 slope shall be used on the approaches.

#### **3.4.4 Surface of Traveled Way and Adjacent Areas**

Color coding to distinguish between slow-and fast-moving-user portions of the traveled way is desirable.

A smooth riding surface is important to all wheeled users, however, skid resistant qualities must not be sacrificed.

#### *Specific Recommended Guidelines*

- Use a light sponge float finish on concrete surfaces. Coarse broom or burlap drag finishes on concrete surfaces can present a hazard to in-line skaters and other small-wheeled users and are therefore unacceptable. A highly troweled finish is equally unacceptable because it can become slippery under wet conditions.
- Edge protection for paved approach pathways should be provided to prevent edge raveling and consequent narrowing of the effective traveled way.
- Wherever possible, grass is the preferred ground cover for areas adjacent to paved pathways without guardrails. This is especially true at curves and near the bottom of the approach ramps where higher speeds will contribute to the possibility of wheeled users losing control.
- All expansion or construction joints in the traveled way shall be bicycle-safe and shall meet ADA requirements for maximum vertical allowances.
- Speed bumps and other traffic calming devices used for automobiles have been shown to be unsafe for multi-use trails, thus speed bumps, bump strips, and other pavement modifications intended to warn, slow, or calm traffic shall not be used.

### 3.4.5 Railing and Fencing

#### Discussion

There are four fundamental cross-section conditions for the traveled way affecting guardrail and fencing geometry:

- paved open pathway with no guardrails
- paved pathway with guardrail on one or both sides (*may not be applicable*)
- free-span with guardrails only
- free-span with guardrails and missile-proof fencing

Additionally, curves, a steep grade, or a sidewalk may each have an effect on how guardrails and fencing should be configured.

Railing requirements differ according to the location of the pathway (height above the ground and whether roadways run below), the type of user (pedestrians and people with wheelchairs or bicyclists), and the slope of the pathway.

Various experts, as well as design precedents in Europe and the United States, indicate that a “flatrail”, also referred to as a “rubrail”, is the preferred type of handrail next to a bikeway for safety reasons. Bicycle handlebars do not get caught up in flatrails as easily as in standard round handrails with exposed supporting brackets. Flatrails, as a consequence, have the additional advantage of reducing the shy distance required.

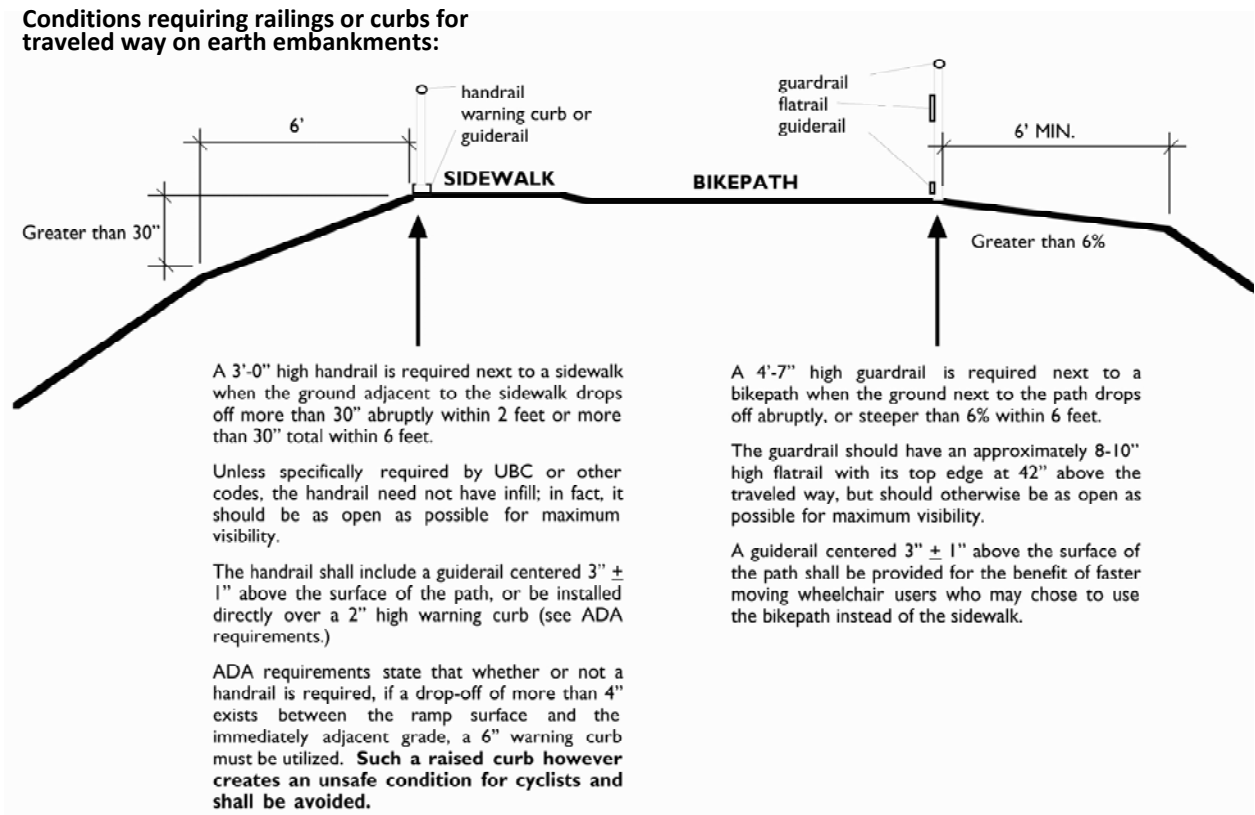


Figure 3.1 Conditions requiring railings or curbs for traveled way on earth embankments.

Since cyclists have a higher center of gravity than pedestrians, in addition to a handrail, most guidelines specify that a higher guardrail be provided on bikeways to prevent toppling. Generally, the recommended bicycle guardrail height is 4'-6".

While railings are necessary under certain conditions, bikeways with graded or grassy buffer zones instead of railings are safer. Thus, for safety, conditions requiring railing and fencing should be avoided wherever possible. When railings are necessary next to bike lanes, the possibility of increased bicycle lane widths should be explored.

#### Protective Fencing:

Caltrans historically requires a type 3 "missile-proof" fencing (2" openings) configuration on the portion of the pedestrian structure directly above the roadway.<sup>10</sup> This fencing is intended to prevent crossing users from throwing objects into the roadway. This enclosure must be at least 2.51 meters (8'-3") high and extend 0.915 meters (3 feet) inward at the top.<sup>11</sup> The new standard is 1" mesh with 10' straight fencing, which creates less of a closed-in feeling, but blocks incident views more due to the tighter mesh openings.

While missile-proof fencing will only be required on the main span and parts of the approaches, it will be a prominent visual element on the most visible portion of the facility. The community's feedback from the 1<sup>st</sup> Public Meeting indicated that high transparency was identified as a key design criteria for both safety and aesthetics. Alternatives to standard Caltrans missile-proof enclosure geometry, supporting framework, and chain link infill material should be explored and evaluated in terms of cost, sightlines, and aesthetics.

#### *Specific Recommended Guidelines*

- The Caltrans Memo to Bridge Designers, the Uniform Building Code, and ADA standards all require railing for pathways when a drop-off greater than 30 inches exists at the path edge.
- The accepted minimum guardrail height for pedestrians and wheelchairs is 42 inches above the pathway or sidewalk surface.<sup>12</sup>
- As per Caltrans publications,<sup>13</sup> the minimum railing height is 4'-6" alongside bikeways without fencing, with the exception allowed that "a lower rail may be used if a curbed sidewalk separates the bikeway from the railing."<sup>14</sup> To better serve pedestrians, and minimize visual mass, a round handrail rather than a flat rubrail is recommended.
- Missile-proof fencing shall be highly transparent both when viewed perpendicularly, from the freeway, and at very acute angles, from on the bridge.

#### **3.4.6 Design Speed**

- Caltrans has established 40 km/h (25 mph) as the minimum design speed for Class I bike paths and 50 km/h for bike paths with long downgrades steeper than 4%.

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<sup>10</sup> Caltrans Highway Design Manual, page 200-43

<sup>11</sup> Caltrans Highway Design Manual, pages 200-43 to 200-47. Note that Caltrans prefers a 10-foot enclosure height.

<sup>12</sup> Caltrans Memo to Bridge Designers, section 13-1; CalDAG, page 173; 1994 Uniform Building Code, section 509.2

<sup>13</sup> Caltrans Highway Design Manual, page 200-47

<sup>14</sup> *ibid.*

### 3.4.7 Cross-Slope or Superelevation

- A minimum cross-slope of 2% should be provided on all paved surfaces to ensure adequate drainage. Sloping in one direction should be used instead of crowning.
- Cross-slopes steeper than 2% should only be considered at critical curves and should only be used where a separate sidewalk facility with cross-slopes no greater than 2% is provided.

While steeper cross-slopes would assist bicyclists and other faster moving users, cross-slopes in excess of 2% are reportedly disconcerting and potentially unsafe for wheelchairs.

### 3.4.8 Curves

Caltrans bikeway design criteria establish minimum radii of curvature as follows:

Design Speed	Minimum Radius of Curvature (Caltrans bikeway guidelines) <sup>15</sup>
25mph	154 feet
30mph	261 feet

#### *Specific Recommended Guidelines*

- A minimum radius of curvature of 154 feet. A preferred minimum radius of curvature of 261 feet.

Note: This criteria may not be feasible for the Elliott Avenue location. A Caltrans design exception would be required, and measures such as increased widths to mitigate the functional and safety issues associated with tight turns on ramps should be included if possible.

### 3.4.9 Sightlines

Caltrans bikeway guidelines provide sight stopping distance guidelines as follows:<sup>16</sup>

Slope	Design speed	Required stopping distance
5% downgrade	30mph	279 feet
flat (0%)	25mph	170 feet
5% upgrade	20mph	138 feet

<sup>15</sup> Caltrans Highway Design Manual, page 1000-9

<sup>16</sup> Caltrans Highway Design Manual, page 1000-10

The Federal Highway Administration (FHWA) publication *Bicycling and Walking in the Nineties and Beyond* gives significantly shorter bicycle stopping sight distances as general guidelines: 20 meters (65 feet) for 0% grade and 40 meters (131 feet) for downhill slopes.

Caltrans design guidelines indicate that both ascending and descending sight stopping distances should be taken into account in establishing sightlines at curves where objects at the inside of the curve may completely block views.

#### *Specific Recommended Guidelines*

##### Sightlines in general:

- Because traffic noise on the overcrossing will generally exceed levels adequate to hear approaching cyclists, clear sightlines are of primary importance to ensure safety. Maximum visibility by one bridge user of other bridge users should be established as a design goal.

##### Sightlines on approach ramps:

- People at the top of the ramp (where the alignment crosses the Caltrans right-of-way) shall be able to see others within the top half of the ramp—including any resting platform. People mid-way down the ramp shall be able to see other bridge users on the lower half of the ramp and in the touchdown area.

Note: This recommendation is not intended to prevent tree or shrub planting in the approach areas. However, to achieve the intent of the recommendation, special attention should be given to the selection, maintenance, and locations of trees and shrubs.

##### Sightlines within the Caltrans right-of-way:

Where the overcrossing passes through Caltrans right-of-way, required missile-proof fencing will create a condition where the open path becomes similar to an enclosed corridor, and sightlines will be affected.

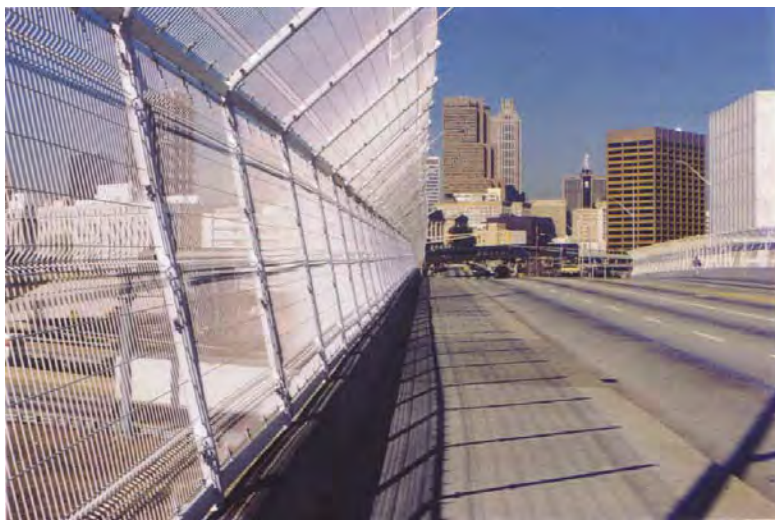
Visibility issues are very important from both a crime- and accident-safety point of view, and will have a strong impact on the success of the architectural space created (see figures below). Visibility issues created by a missile-proof fencing enclosure can be simulated using computer modeling.

On a straight, fenced pathway the angle of incidence of the viewer's sightline with the fencing becomes increasingly acute with increasing distance from the viewer. When the angle of incidence becomes sufficiently acute, the view through the fencing becomes completely obscured and a tunnel effect is created. This angle is denoted  $\beta$  (Beta) and is given for various types of fencing in **Error! Reference source not found.** below.

On a curved, fenced pathway, looking toward points just around the curve, one cannot see through fence-enclosure materials. However, as the angle of viewing incidence increases, visibility of the traveled path, albeit through the fencing, is regained. The distance between these two visible sections is the length of the blind area, and is denoted L.

Type of fencing material	Construction	Beta (observed)	Beta (calculated)
2" chain link (galvanized)	1/8" SQ. @ 2" O.C.	6.0°	-
Omega	0.192" diam. @ 2" O.C.	-	6.8°
Typical steel picket fence	3/4" SQ. @ 4 3/4" O.C.	12.2°	10.9°
1" "prison" chain link (vinyl coated)	1/8" diam. @ 1" O.C.	20.0°	-

**Table 3.1** Angles of incidence at which view through fencing becomes obscured



**Figure 3.2** Angled Missile-proof Fencing in Atlanta, GA (photos courtesy Omega Co.)



**Figure 3.3** Fencing on both the Jack London Square/Oakland Amtrak Station Bridge (top) and the Emeryville Amtrak Station Bridge (above) show high transparency when viewed from a distance.



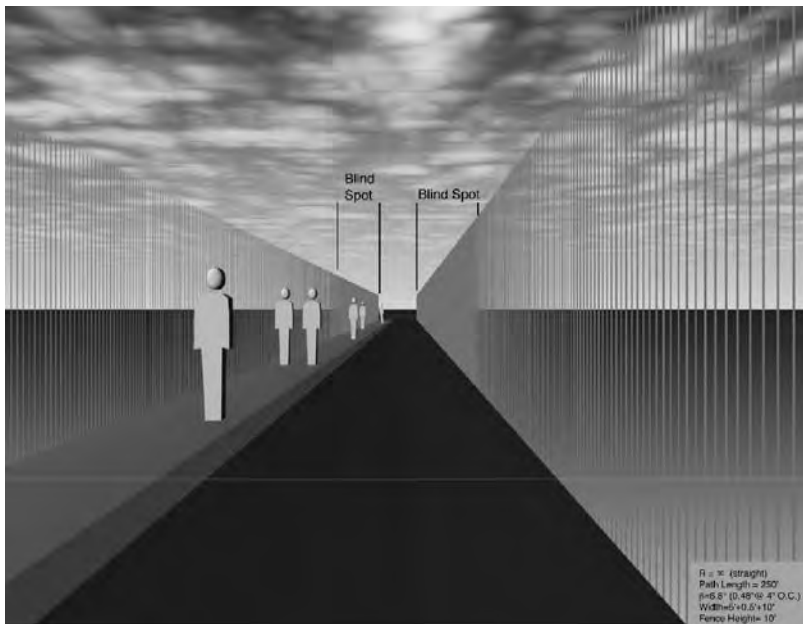
**Figure 3.4** Fencing on Pedestrian Bridge at Jack London Square, Oakland retains its transparency for people crossing the tracks.



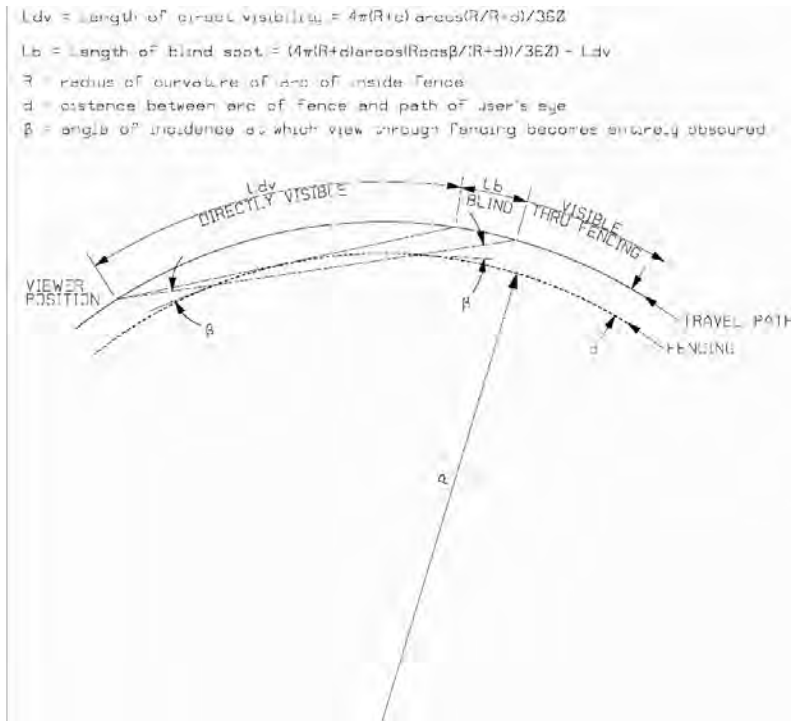
**Figure 3.5** Pedestrian Bridge at Amtrak Station Emeryville is opaque for users.



**Figure 3.6** Blind Spots on curved pathways.



**Figure 3.7** Blind spots on straight pathways.



**Figure 3.8** Sightline Geometry for Curving Fenced-in Pathways.

Assuming a highly transparent fencing material ( $\beta=7^\circ$ ), but otherwise worst case conditions, consider a cyclist riding in a curving bike lane such that his line of sight is only three feet from the fencing on the inside of the curve ( $d=3'$ ). To avoid hitting an obstacle or a stopped bridge user ahead on the  $d=3'$  travel path, visibility must be adequate, both directly and through the fencing.

Analytical results indicate that for these conditions, curves with a radius of tighter than 100 feet will result in a moving blind spot only approximately five feet long. However, due to the tightness of the curve, the rider will have less than 50 feet to stop if an obstruction in the line of travel is for some reason not visible through the fencing ahead of the blind spot. This translates to an adequate stopping distance only if the rider is going 9 mph or less. Based on stopping distance guidelines noted above, a 65-foot direct visibility minimum stopping distance,  $L_{dv}$ , is probably more appropriate. This translates to a minimum radius of curvature of 175 feet.

At radii of curvature greater than approximately 300 feet, the length of the blind spot becomes longer than 25 feet and the sense of openness of the bridge becomes compromised. Therefore, for  $\beta=7^\circ$  fencing materials, radii of curvature in the 175 to 300 foot range results in optimal visibility conditions (see figure below).

Note that for curved pathways, sight distances and blind areas can be significantly improved by altering the configuration of the fencing itself.

Bridge cross-section configurations which increase the effective length of “d” by placing or curving the inside fencing away from the edge of the traveled pathway are encouraged.

Greater direct visibility may actually reduce overall visibility. At radii of curvature greater than 1,000', direct visibility is available for over 155 feet, and thus meets the Caltrans criteria for 40 km/h sight

stopping distances. Notably, however, straight paths and radii of curvature over 1,000 feet actually result in significantly less visibility of the traveled way beyond this directly visible area and create less openness.

For example, on a straight path, even if a viewer is 5 feet from the fencing and a fencing material with a low  $\beta$  is used ( $\beta=7^\circ$ ), visibility through the fencing will only be possible for approximately 40 feet. Thus, even with very transparent fencing materials, if the traveled way alignment is straight over the freeway, most of the approximately 250 feet of the main-span structure will appear as a tunnel to the user. The negative impact of this tunnel effect must be weighed against the need to provide adequate direct visibility.

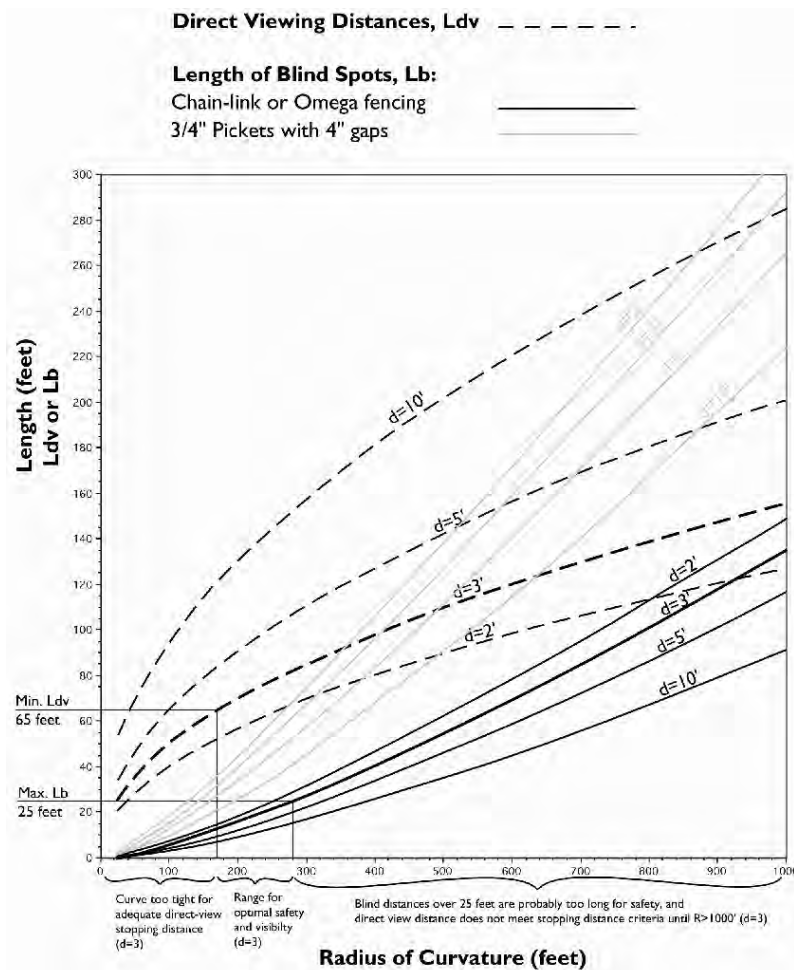


Figure 3.9 Direct Viewing Distances and Length of Blind Spots.

With fencing materials having a large  $\beta$  value, although transparency may be very high when viewed perpendicularly, the tunnel effect can be quite pronounced. Consequently, materials having high  $\beta$  values are probably unacceptable for a fenced pathway as long as that required for the proposed bicycle footbridge.

Additionally, it should be noted that straight fenced pathways with a turn at the end create a static rather than a moving blind spot. This blind spot can be visualized as appearing just around the corner at the end of the “tunnel.” Especially from a crime-safety point of view, creating such a hidden spot should be avoided if possible. As indicated in the figure below, the size of this static blind spot does not decrease significantly until a user actually reaches the turn.

Distance from 50' radius turn (on straight pathway)	Length of blind spot ( $\beta=7^\circ$ )
250'	60'
100'	31'
50'	26'

**Table 3.2** Static Blind Spots on Straight Fenced-in Pathways

*Specific Recommended Guidelines*

- Within and near the missile-proof fencing enclosure, minimum direct visibility should be 65 feet.
- The radius of curvature of the inside line of the missile-proof fencing should be in the range of 175 to 300 feet.
- If radii larger than 300 feet prove necessary due to structural, geometric, or other constraints, then a radius of curvature of at least 1,000 feet should be used for the missile proof fencing enclosure, but a straight segment is preferred.

**3.4.10 Minimum Clearances**

- The preferred distance from the path edge to trees, signposts, and other obstructions is 3 feet. The minimum distance from the path edge to trees, signposts, and other obstructions is 2 feet.<sup>17</sup>
- The minimum vertical clearance is 10 feet above traveled way
- The minimum horizontal to obstructions is 2 foot.
- At Caltrans R/W, the minimum vertical above paved surface is 5.6 meters (18.37 feet).
- Culverts or pipes running under pathway shall extend at least 10 feet from pathway

**3.4.11 Miscellaneous Safety Features**

*Signage and Striping*

Signage should not take the place of good geometrics. From the Florida DOT design manual: “Some pavement marking materials are slippery when wet and should be avoided in favor of more skid resistant materials. Adding grit to thermoplastic increases skid resistance.”<sup>18</sup>

- Only skid resistant pavement marking materials should be used.

<sup>17</sup> Caltrans Highway Design Manual, page 1000-4

<sup>18</sup> Florida, page 5-24

- Painted pavement signage indicating separate bicycle and pedestrian pathways should be provided at the bottom of each approach ramp and intermittently along the entire facility.

### Gratings

- Gratings should be avoided within the traveled way. If unavoidable, gratings shall be oriented with the long openings perpendicular to the path of travel in compliance with ADA standards.<sup>19</sup>

### Lighting

For accident safety reasons, lighting of the traveled way surface shall be the first priority in lighting design. ADA requirements for clearance at light fixtures and other obstructions in the traveled way are not adequate for the safety of cyclists, skaters, and other faster moving users.

- According to Caltrans as well as the Florida DOT guidelines, average maintained illumination level of 5 lux to 22 lux should be considered; higher levels should be considered if special security problems exist.<sup>20</sup>
- Lighting directed on the traveled way from below eye-level.
- All light fixtures shall be placed outside the traveled way and should meet vertical clearance requirements noted above. ADA standards allowing light posts and other obstructions within the traveled way shall not be considered acceptable.
- To minimize maintenance costs, LED-based fixtures should be used wherever feasible.

### Emergency Telephones

- One pay telephone or special police call box should be considered at each touchdown plaza.

### Vehicle Access Restriction & Emergency Vehicle Access

- Use of bollards shall be avoided. Alternative, safer methods of restricting automobile access should be used wherever possible.

### Graffiti

Because graffiti removal programs, which do not result in immediate removal (within 48 hours) often prove ineffective, graffiti deterrence, through design, is preferred. Actual graffiti removal, even when facilitated by graffiti-proofing surface treatments, is often impractical or cannot be done quickly enough to deter additional graffiti and accessible surfaces will be tagged with graffiti.

- Large flat surfaces, as well as lighting which highlights flat surfaces, should be avoided.
- For surfaces which may be accessible to graffiti artists, surface treatments which accept cover-up paint should be chosen.

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<sup>19</sup> CalDAG, page 182

<sup>20</sup> Caltrans Highway Design Manual, page 1000-15