



Toolkit

The Bay Trail Toolkit (Toolkit) describes and illustrates design solutions that represent creative responses and best practices for use by government agencies and developers, as well as their qualified trail design professionals in planning, designing, and developing any Bay Trail segment. The Toolkit is intended as an aid in addressing common design issues that could exist along the Bay Trail. Although the Toolkit provides examples of design solutions, it is not meant to preclude creativity in design based on individual project site and contextual considerations or as exemplified in other agency or industry standards and guidelines.

The Toolkit is to be used in combination with the California Department of Transportation's standards and additional guidelines contained in the Highway Design Manual (HDM) for bikeways, as well as other national, state, regional and local municipality guidelines about shared-use trails. Appendix A includes a partial list of references for more information.

SELECTED TERMINOLOGY USED IN THE TOOLKIT

“**Shared-Use Trail**” is used to describe the Bay Trail where it provides a completely separated right-of-way for exclusive non-motorized use with cross-flow minimized to the extent possible. A shared-use trail is used by people of all shapes, sizes, ages, and abilities generally defined as either bicyclists or pedestrians. A shared-use trail is analogous to the terms “Class I Bikeway” and “Bike Path” used in the HDM and the term “Shared-Use Path” used by the American Association of State Highway Transportation Officials.

“**Trail**” refers to the paved, or in limited cases, natural surface portion of the Bay Trail that defines the user’s travel space. In cases where the Bay Trail passes through heavily used areas such as urban plazas, striped pavement edge markings may define the trail.

“**Trail Shoulder**” refers to a clear level area immediately adjacent to the trail that provides a safety buffer for the trail bicyclist. The trail shoulder is often used by pedestrians for jogging or walking out of the path of bicycles and other higher-speed trail users.

“**Cycle Track**”, also referred to as a “Class IV” bicycle facility, is an exclusive bicycle facility that mimics the experience of the Bay Trail, but in a street environment. A cycle track is physically separated from motor traffic and distinct from a sidewalk used by pedestrians. Pedestrian facilities must be provided in conjunction with a cycle track to be considered a completed Bay Trail segment.

This section addresses the following topics:

-  5.1 The Essential Bay Trail
-  5.2 Bay Trail in Special Circumstances
-  5.3 Wayfinding and Bay Trail Logo
-  5.4 Integration into the Local Street System
-  5.5 Rail and Light-Rail Lines
-  5.6 Over or Under
-  5.7 Sea-Level Rise
-  5.8 Wildlife Compatibility
-  5.9 Sustainability
-  5.10 Trail Amenities
-  5.11 Security, Vandalism, and Privacy

5.1 THE ESSENTIAL BAY TRAIL

Trail Geometrics

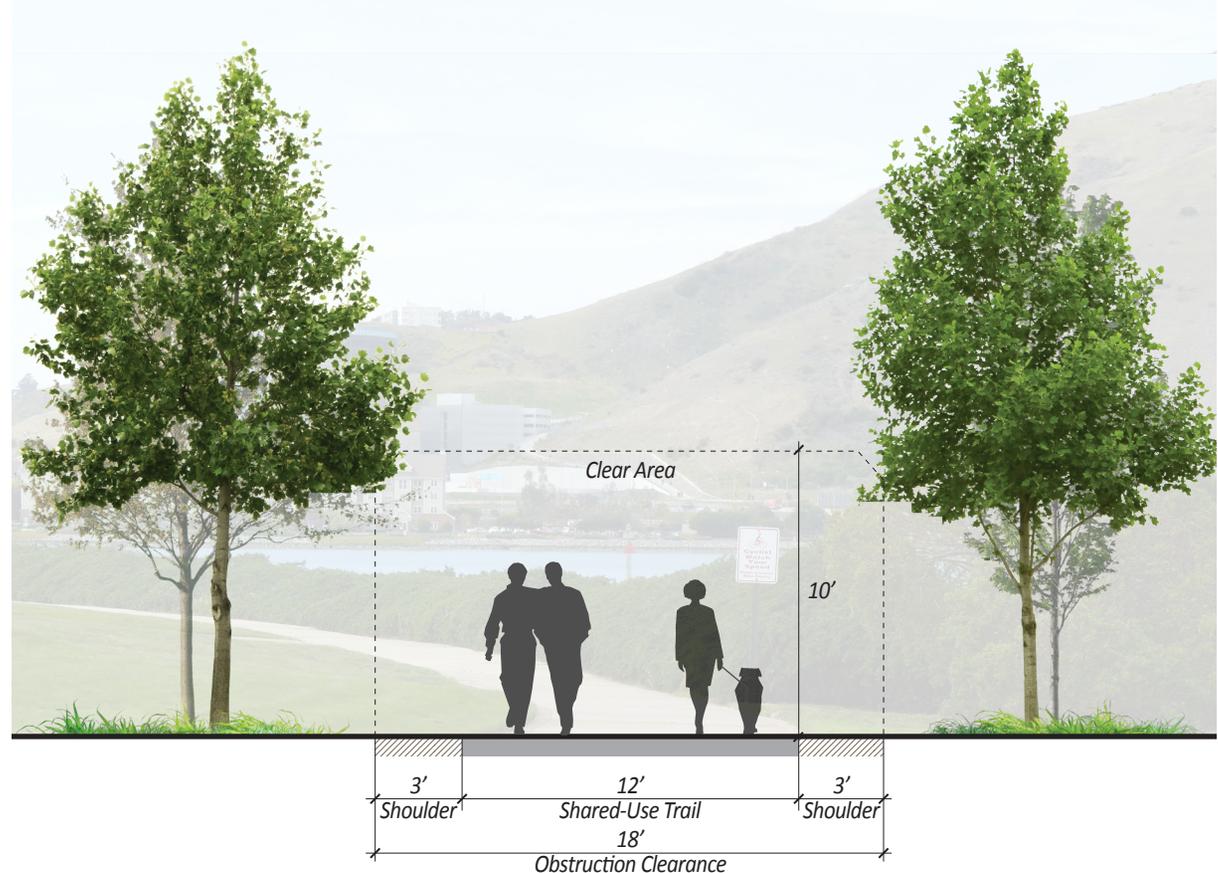
- **Trail Width:** The standard width of the Bay Trail is 12 feet whether paved or natural surface materials. An additional 3-foot shoulder free from obstructions should be provided on each side. The Bay Trail and its clear space should consist of a minimum 18-foot width. The trail and shoulder widths are considered minimum standards necessary to



accommodate a typical level of use along the Bay Trail when completed. In many instances, projected use levels may be high, and therefore Bay Trail width should be wider, such as along urban waterfront promenades. If use levels are anticipated to be extremely high, consideration should be given to separating fast-moving users (e.g., bicyclists,

rollerbladers, or skateboarders) from slower-moving pedestrians. There are a variety of methods to do so, such as pavement striping or inclusion of physical barriers (see Section 5.2. Bay Trail in Special Circumstances). In any case, all Bay Trail users should be able to enjoy a Bay experience, including Bay views.

FIGURE 5-1: OPTIMUM TRAIL WIDTH



- Horizontal Trail Alignment:** The horizontal alignment of the Bay Trail, as a paved shared-use facility, may be defined in many cases by a bicycle design speed that could be 20 miles per hour or higher. However, the Bay Trail is one of the most popular shared-use trails in the Bay Area. Lower design speeds and trail traffic calming devices could be considered for 1) crowded areas, 2) locations where considerable cross-traffic is projected, and 3) locations with sharp horizontal curvatures where right-of-way widths are constrained.
- Alternative Surfaces:** In limited circumstances, compacted gravel surfacing or other natural material, such as decomposed granite that is firm and stable and meets accessibility requirements, may be appropriate. Examples include along the trail near sensitive habitats where paving is discouraged by the managing agency, or along levees where a paved trail would require frequent maintenance and present safety concerns.

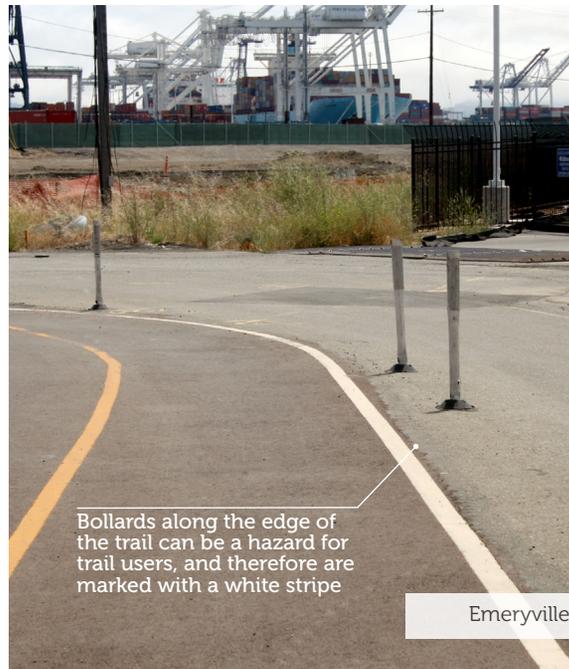
Obstructions and Clearances

The Bay Trail includes a zone around the trail free of any perpendicular or overhead obstructions. Obstructions may present hazards to safe, unimpeded trail use. Obstructions may also limit sight lines and/or funnel trail users toward the center of the trail, hence effectively narrowing the width of the useable trail surface.

Horizontal Obstructions

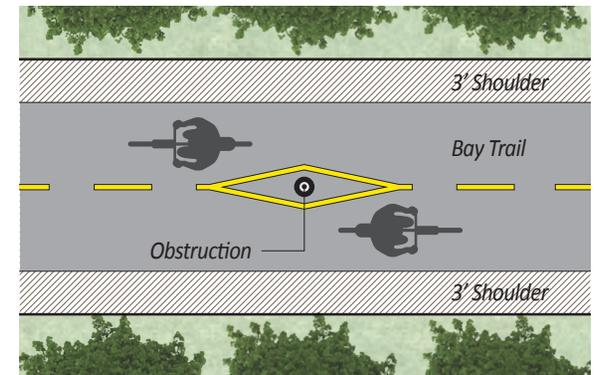
There are many types of horizontal obstructions such as:

- Bollards
- Lights poles and fixtures
- Sign poles and signs of all types
- Bicycle racks
- Benches and drinking fountains
- Fences and walls
- Railings
- Utility boxes
- Curbs
- Boulders
- Landscaping
- Drains



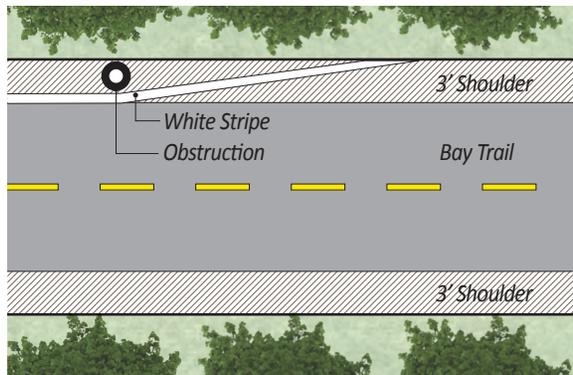
Obstructions within the Trail

When obstructions, such as bollards, are within the trail, solid yellow diamond pavement markings should be used. The bollard or other obstruction should also be identified with yellow reflective tape.

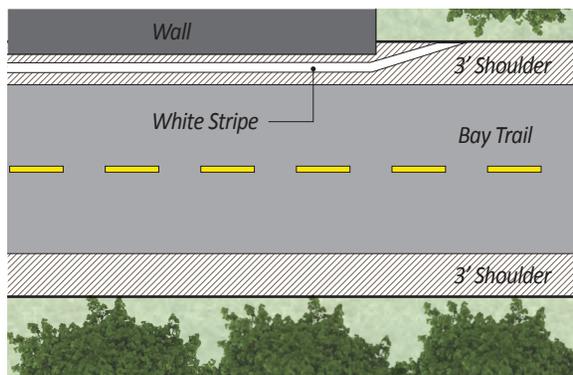


Obstructions within the Trail Shoulder

When an obstruction is within the trail shoulder width of 3 feet, a solid white stripe should be located along the edge of the trail to visually notify the Bay Trail user about the presence of the obstruction and to avoid it.



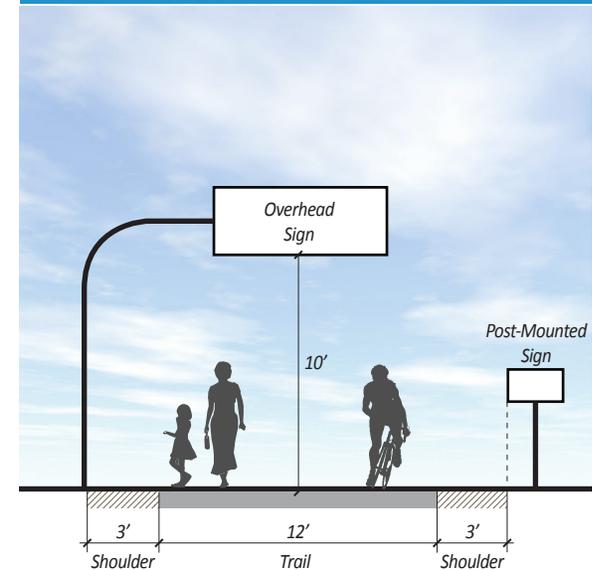
When located within 3 feet of the paved trail, all curbs, freestanding walls, railings on bridges and boardwalks, and retaining walls should be treated as obstructions. There should be a continuous white stripe at the edge of the trail for the length of the feature.



Vertical Clearance

- Vertical clearances include such items as:
 - Undercrossing and tunnel ceilings
 - Overhanging trees
 - Signs
 - Overhead security fencing
- A 10-foot vertical clearance across the width of the Bay Trail and shoulders is desirable. This clearance applies to signs, overhead fencing, tunnel ceiling heights, and vegetation.

FIGURE 5-2: VERTICAL CLEARANCE

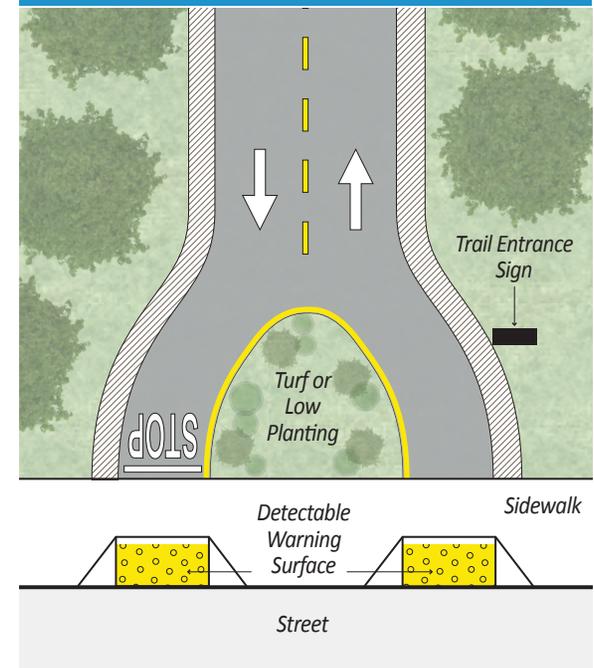


Barrier Treatments for Trail Entryways

- **Bollards**, whether stand-alone or grouped together, are often used to discourage non-authorized motor vehicles from accessing the Bay Trail. Installing bollards or other barrier treatments should be considered only as a last resort and only if there is a documented problem.
- **Fold-down/collapsible bollards** should not be installed along the Bay Trail because they can be a hazard to users.
- **Other design elements** that would help discourage motorized vehicles from entering the Bay Trail are:
 - ▶ Gateway design with a strong sense of identity and transition
 - ▶ Entry signage
 - ▶ Prohibition signage with associated fine for violations
 - ▶ Ramps and trail shoulders that look like a shared-use trail, not a driveway
 - ▶ Split-path entry into inbound and outbound lanes divided by a narrow median. This also has the added benefit of alerting cyclists about the intersection ahead and the need to slow down.



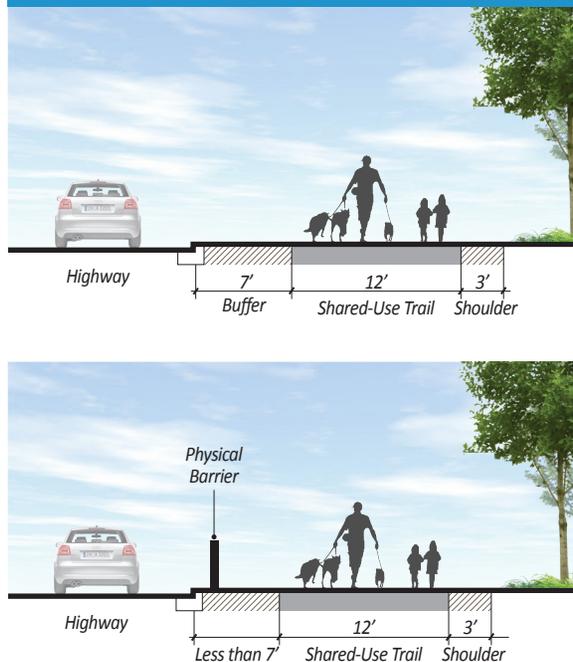
FIGURE 5-3: TYPICAL SPLIT-PATH ENTRY DESIGN



Clearance Between the Bay Trail and Streets and Highways

- The separation between the edge of the Bay Trail and the edge of a parallel road or street should be at least 7 feet.
- If the trail is less than 7 feet away from the street, a fence or other physical barrier separation should be included to prevent the Bay Trail user from straying into the street. A physical barrier should be at the outside edge of the shoulder (3 feet away from the trail) unless obstacle striping is used at the edge of the trail.

FIGURE 5-4: CLEARANCE BETWEEN THE BAY TRAIL AND STREETS



Railings and Visibility

In some situations, the Bay Trail may need to include protective railings. Generally, railing design and materials should preserve views to the Bay and should relate to the architectural or landscape style of the surrounding area. There are three types of railings that could be used along the Bay Trail:

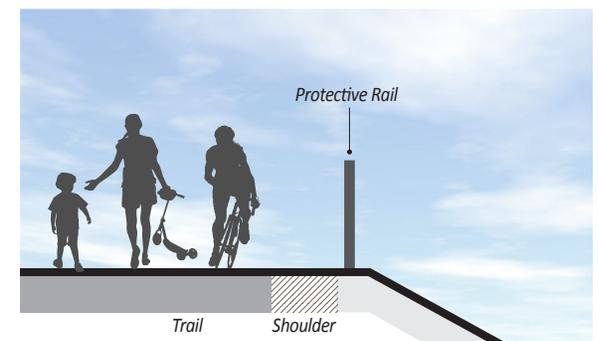
- **Guard Rails:** used to prevent the trail user from falling off a bridge or boardwalk. The height above the adjacent ground or water surface that is used is established by local code. Typically this is 30 inches with no opening greater than 4 inches. Design considerations about guard rails include:
 - ▶ Allowing maximum views, especially on bridges. Using vertical pickets or horizontal wire cables is recommended.
 - ▶ Providing additional hand rails for accessibility purposes.



- ▶ Including wide “rub rails” in some settings to reduce the likelihood that a bicyclist’s handlebar might be caught by the railing.
- **Hand Rails:** used for accessibility purposes on slopes and to help prevent the trail user from going off the trail. Hand rails must meet the dimensioning requirements of the U.S. Access Board and may have broad openings that do not constrain views.



- **Protective Rails:** used to help prevent the trail user from going off the trail into a dangerous situation such as a steep side slope. Like hand rails, protective rails may have broad openings.



Signs and Markings (see also Wayfinding and Bay Trail Identity)

- **Signs:** Prohibition, regulatory, and warning signs are an integral part of the Bay Trail. While they are a key component in managing Bay Trail use, signs should be used only when needed. The use and placement of signs and markings are dependent on specific site circumstances.
- **Pavement Markings:** Common pavement markings stenciled on the trail and used to direct and manage use along the Bay Trail include:
 - ▶ Solid yellow center lines to separate directions of travel and indicate no passing by trail users. A solid center line stripe is commonly used in heavily travelled sections of trail or around blind turns.



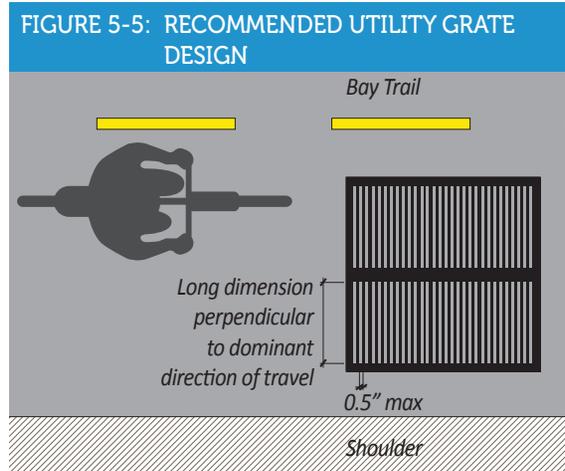
- ▶ Striped yellow center line to separate directions of travel along heavily used sections of trail but where view lines allow passing.
- ▶ Solid yellow markings to inform the trail user of obstructions within the trail (see “Obstructions and Clearances” in Section 5.1).
- ▶ Solid white shoulder stripes to delineate the edge of the trail or to inform the trail user of obstructions.
- ▶ Solid white stripes to separate users into individual lanes.
- ▶ White bicyclist and pedestrian symbols with arrows stenciled on the trail to indicate individual lanes and direction of travel.
- ▶ White railroad crossing, road crossing, stop, or yield markings.
- ▶ Multiple colors and patterns at crosswalks (see “Intersection Crossings” in Section 5.4).



Underground Utilities

These consist of electrical, communications, water, sanitary sewer, or stormwater utility systems.

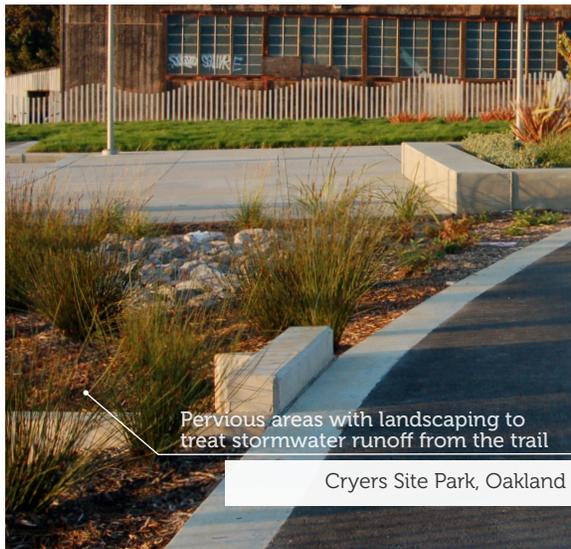
- Where underground utilities exist within the Bay Trail corridor, utility lines and access covers should be located away from the Bay Trail and shoulders, not within the trail.
- If unavoidable and when within the Bay Trail or shoulders:
 - ▶ Utility covers should meet accessibility guidelines.
 - ▶ Utility grates with openings, such as catch basins or drop inlets for stormwater, should be bicycle-safe to prevent a bicycle wheel from catching or falling into the slots of the grate.



Managing Water Quality

A paved Bay Trail has runoff and, when the trail is used by service vehicles, that runoff may enter the Bay. Design of the Bay Trail should:

- Reduce trail runoff by minimizing impervious areas that are directly connected to a storm drain system.
- Use permeable paving systems such as porous concrete, porous asphalt, or permeable pavers, where possible. If appropriate to the surrounding setting, use permeable gravel.
- Direct runoff from the trail's impervious areas to pervious areas and/or small swales or retention areas with landscaping that are outside the trail shoulder.



Cryers Site Park, Oakland

Mandatory Design Safety Standards and Common Design Exceptions

The HDM contains selected mandatory design safety standards that apply to bikeways. “Mandatory Design Safety Standards” are those requirements presented in the HDM that are considered most essential to achievement of overall design objectives and use the word “shall”. Many pertain to requirements of law or regulation.

In certain instances the Bay Trail will need to accommodate the mandatory design safety standards. Mandatory standards related to trails address:

- Width of paved trail and shoulders
- Horizontal clearance to obstructions



Porous Asphalt (Top) and Permeable Pavers (Bottom)

- Clear width between railings on structures
- Vertical clearance to obstructions
- Separation between the edge of the trail and the edge of a traveled way
- Design speed
- Stopping sight distance
- Location in the median of a freeway or expressway
- Fold-down posts or bollards

Where mandatory safety design standards required by the managing or funding agency for the Bay Trail cannot be achieved, a design exception should be documented and additional design considerations should be taken into account. The common scenarios include:

- Horizontal alignment geometrics and the need to reduce speed limits, provide center line striping, and assure visibility around curves.
- Reduced trail widths and the need to provide smooth transitions, safety signs, and/or pavement markings.
- Obstacles within the shoulder of the trail and the need to provide pavement markings and /or signs to notify the user of their presence.

5.2 BAY TRAIL IN SPECIAL CIRCUMSTANCES

Bay Trail in High Use Areas

On high-volume sections of the Bay Trail, consider separating bicycle and pedestrian use of the trail to both facilitate use and to discourage user conflicts related to different travel speeds. In all cases separated facilities need to provide all trail users with a Bay experience. Separating bicycle and pedestrian use of the trail can be done in a variety of ways, each of which involves a wider trail corridor. Design options are:

- a wider trail with striping and pavement markings to separate bicyclists from pedestrians (Figure 5-6, #2).
- 5- to 6-foot shoulders on one side of the trail or both, with signs and/or pavement markings directing pedestrian use to the shoulder (Figure 5-6, #3).
- two paths separated by landscaping (Figure 5-6, #4 and #5).



FIGURE 5-6: OPTIONAL TRAIL DESIGNS



Bay Trail in a Limited Right-of-Way

In some conditions, it is not feasible to fit the Bay Trail into the available right-of-way. Alternatives to consider that would assure continuity of the Bay Trail include:

- **Cycle Tracks (Class IV Bikeway):** In some areas, Bay Trail bicyclists may need to ride on city streets. In these instances, it may be necessary to redesign an adjacent street right-of-way to create a dedicated cycle track with pedestrians using the sidewalk. This is particularly relevant where there is a limited number of driveway crossings that would conflict with bicycle use. Bay Trail cycle tracks should include:
 - ▶ A 12-foot-wide two-way bicycle facility.
 - ▶ A parallel physical barrier (guardrails, raised medians, or permanent bollards) to protect Bay Trail cyclists from adjacent motor vehicle traffic. Permanent physical barriers are preferred to parked cars.
 - ▶ A yellow dashed center line stripe and white edge striping.
 - ▶ Where the cycle track is at the same grade as either parking or a pedestrian sidewalk, different pavement color/texture could be used to visually separate the cycle track.
 - ▶ While two-way cycle tracks are recommended, in some instances one-way protected cycle tracks on each side of the street could be considered. An example would be updating existing Class II Bicycle Lanes to one-way protected cycle tracks to avoid reconfiguring intersections.

FIGURE 5-7: CYCLE TRACK BUFFERED BY PERMANENT BOLLARDS AND PARKING

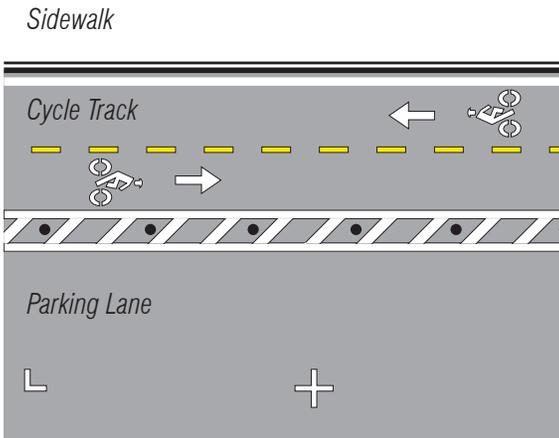
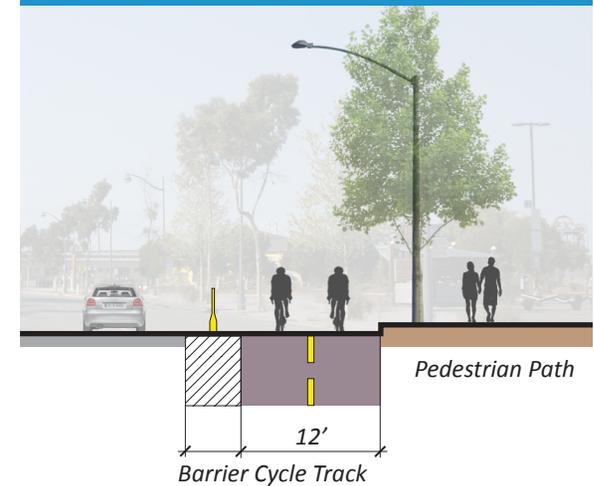


FIGURE 5-8: CYCLE TRACK SEPARATED FROM TRAFFIC LANE



- Class II Bicycle Lanes:** In some urban cases there may be physical conditions where it is not possible to develop a cycle track within the width of the road right-of-way, even with the option of reconfiguring or downsizing traffic lanes. In such situations, consider a Class II Bicycle Lane with pedestrians using the sidewalk. A Class II Bicycle Lane serving as the Bay Trail should begin and end at traffic controlled intersections. The Bay Trail bicycle lane should be 5 feet wide unless the posted traffic speed limit is greater than 40 miles per hour, where the bicycle lane should be 6 feet wide. The bike facility should be signed as the Bay Trail with appropriate directional signs, safety signs and markings, and/or other bicycle signal control devices at intersections to safely connect with the shared-use portions of the Bay Trail.



Bike Lane along the Embarcadero
Source: BCDC

Bay Trail to Destinations

There are settings where the Bay Trail takes on the role of a point access trail leading to a destination but not continuing beyond it. Examples include connections to ferry terminals, a visitor center, marinas, or wildlife overlooks. These segments of the Bay Trail, depending on the managing agency involved, may have restrictions about use or requirements regarding types of trail surfacing.

- Trail Geometrics:** Generally the trail geometrics should be the same in these situations as any segment of the Bay Trail. In those segments the width of the trail should be at least 8 feet to accommodate pedestrians, bicyclists, and service and emergency vehicle access.

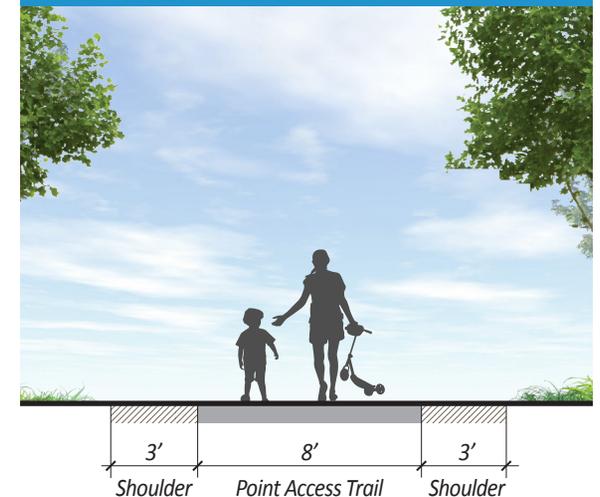


Point Access Trail in Heron's Head Park

- Alternative Surfaces:** In selected circumstances, compacted gravel surfacing or other natural material, such as decomposed granite that is firm and stable and meets accessibility requirements, may be possible.



FIGURE 5-9: POINT ACCESS TRAIL GEOMETRICS



5.3 WAYFINDING AND BAY TRAIL LOGO

The Bay Trail is a significant public circulation feature and should be visually identifiable. The primary means of identification is through use of the Bay Trail logo signage. The length of the Bay Trail and diversity of environments through which it weaves makes it a spectacular trail, as well as a challenge to mark. With this in mind:

- The Bay Trail logo should be easy for anyone to recognize from near (small signs) or far (large signs).
- Recognition of the Bay Trail is critical to inform users that they have arrived at the trail, direct users along the trail, and in some cases, to inform users that they are still on the trail and have not made a wrong turn.

The Bay Trail logo identifies trails within the Bay Trail system as distinct from other connecting trails. As an icon, the logo sign may be used for both identification and directional purposes. It should be used in conjunction with other directional, management, prohibition, and warning signs of the managing agency. The Bay Trail logo should only be used on the Bay Trail itself. Signs directing people to the Bay Trail should not use the logo and should instead spell out “San Francisco Bay Trail.”

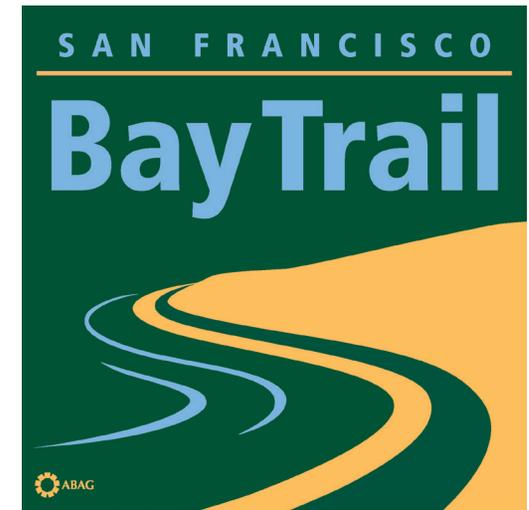
Identification Logo Sign

The size of a Bay Trail logo sign should be based on scale of the surrounding environment and infrastructure as well as the user group.

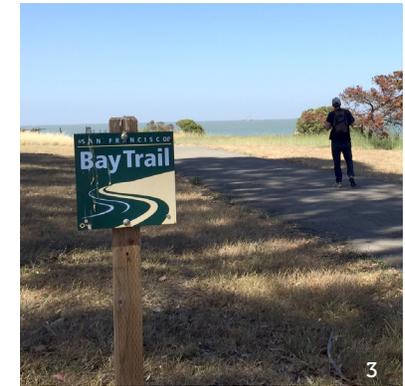
There are three standard sizes of Bay Trail logo signs:

- **Large** Bay Trail logo signs (18" x 18") should be located within the user's view at the entrance from a trailhead to each Bay Trail segment, and where a large visible sign is needed to identify the trail crossing a street. This size of logo sign is useful to both trail users and passing motorists.
- **Medium** Bay Trail logo signs (12" x 12") should be located at intersections with other trails, on long trail stretches with intersections, and along urban streets where the Bay Trail consists of sidewalks and either Class II bicycle lanes or a Class IV cycle track.
- **Small** Bay Trail logo signs (3" x 3") should be used in park settings and also be located along the trail or when either: the pedestrian portion of the Bay Trail is along sidewalks with adjacent cycle tracks or Class II bicycle lanes; or there are long segments of Bay Trail that run on or parallel to city streets where there are many intersections.

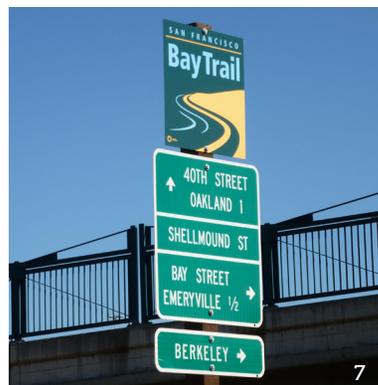
FIGURE 5-10: VARIOUS TYPES AND SIZES OF BAY TRAIL SIGNS



Ideally, there should be one of the above Bay Trail signs at appropriate intervals to reassure trail users they are still on the Bay Trail. Once a user has entered the trail and where long segments exist without intersections, no further Bay Trail signs are needed. However Bay Trail logo signs are needed at entryways and for wayfinding/direction purposes. In urban areas where the Bay Trail crosses streets or intersects with other pedestrian and bicycle facilities, Bay Trail logo signs are needed at more frequent intervals. While a 1/4 mile interval is reasonably appropriate, shorter intervals may be needed where there are numerous intersections or along Bay Trail cycle tracks.



1. Bay Trail Logo, Wayfinding, + Management Signs, San Mateo
2. Bay Trail Logo + Bicycle Lane Sign, Richmond
3. Medium Size Bay Trail Logo, Heron's Head Park
4. Bay Trail Logo + Wayfinding Map, Richmond | Source: Flickr (SF Bay Trail Project)
5. Bay Trail 3' Diameter Surface Plate Concept
6. Bay Trail Logo + Funding Partners, Oakland
7. Bay Trail Logo + Directional Signs, Emeryville | Source: Flickr (SF Bay Trail Project)
8. Bay Trail Logo + Wayfinding Map, Ferry Point Loop
9. Bay Trail Logo, Management + Wayfinding Signs, Emeryville



The Bay Trail identification logo sign may be used on its own or in combination with other management or creative wayfinding signs. Examples include combining signs with that of the San Francisco Bay Water Trail or the San Francisco Bay Conservation and Development Commission's public shoreline access signage. When possible, place Bay Trail logo signs on existing sign or utility poles if such location clearly meets wayfinding sign needs and goals.

Using the Bay Trail logo as a painted pavement marking is discouraged unless long-term maintenance can be assured. Large logos made of a durable material and embedded in the trail pavement, similar to cast iron utility covers, could be a viable alternative to pavement logo paintings.

Directional

Along the Bay Trail, the logo sign could be complemented with arrows in advance of a trail intersection to indicate the direction of the Bay Trail.

Other Applications

- Where the construction of a segment of the Bay Trail is recognized as a collaboration of many public and non-profit organizations.
- Where construction of a segment of the Bay Trail has been supported by a grant from the Bay Trail Project.
- On interpretive signs that inform and educate visitors about historical, cultural and natural features along the trail.
- On wayfinding map signs.
- On a temporary construction sign along the Bay Trail.

FIGURE 5-11: DIRECTIONAL BAY TRAIL SIGNAGE



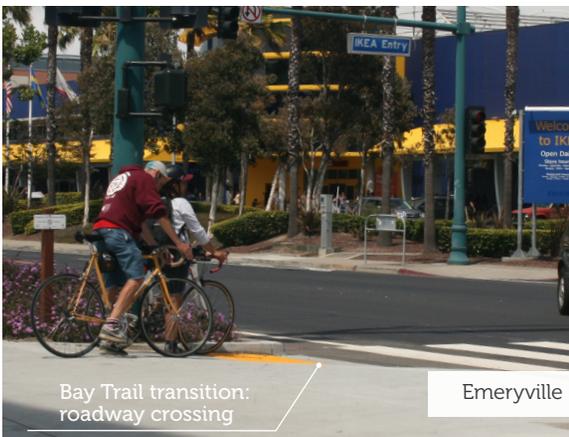
Eden Landing Ecological Reserve
Source: Flickr (SF Bay Trail Project)

5.4 INTEGRATION INTO THE LOCAL STREET SYSTEM

Transitions to/from On-Street Facilities

There are locations where the Bay Trail will transition from a separate shared-use trail to an on-street bicycle facility and sidewalk. To ensure a smooth and safe transition, different design considerations should be given to pedestrians and bicyclists.

FIGURE 5-12: BICYCLE CROSSING WARNING SIGNS



- **Pedestrians**
 - ▶ Provide wayfinding signage at decision-making points.
 - ▶ Where pedestrians need to cross the street to get to the Bay Trail, design crosswalks as specified in the next section, “Street Crossings.”
- **Bicyclists:** It is a challenge to provide a safe roadway crossing when bicyclists need to cross the street to join the trail. If not adequately designed, then bicyclists may ride illegally on the sidewalk or the wrong way in a bicycle lane. Bicycle transitions to the Bay Trail from a street should:
 - ▶ Be made at a location where the motorists have positive traffic control (e.g., stop signs or signalized crossings and intersections).
 - ▶ Provide advance warning signs to inform motorists on the roadway that the Bay Trail crossing is approaching and to look for bicyclists as well as pedestrians.
 - ▶ Provide advance warning signs to inform bicyclists on the roadway that the Bay Trail is approaching and that they need to cross the street.

Street Crossings

The Bay Trail at times crosses local streets. Trail design for street crossings varies depending on whether the crossing is midblock or at an existing intersection of two streets. Both cases meet the definition of a “Bicycle Path Crossing” as defined

by the California Vehicle Code (CVC 231.6). Stop controls, other warning signs, or designs to slow cars and/or trail users at the crossing could be considered.

- Where there is no traffic signal, then design of the Bay Trail crossing should employ any number of tools including high visibility pavement markings, trail and roadway crossing signs, and median pedestrian (and bicycle) refuges if possible. This applies to scenarios both when the motorists have the right-of-way and when they don’t.
- If the motorist does have the right-of-way, additional design tools such as rectangular rapid flashing beacons or pedestrian hybrid beacons should be considered.

Assigning the Right-of-Way

The total and relative volumes of use between the trail and roadway determine who has the right-of-way and the type of traffic controls to use at a particular intersection of the Bay Trail with a roadway. All trail users (pedestrians, bicyclists, others) should be counted in the trail volume.

- When the Bay Trail intersects a local or collector street, the right-of-way typically goes to the roadway. If sight distance is adequate, a YIELD sign can be used in lieu of a STOP sign for the trail user. Where the volume on the roadway increases and becomes more difficult to cross, a median

- **Trail not Shared by Bicycles and Pedestrians:**

When bicyclists and pedestrians are on two separate trails or on the same trail separated through pavement markings:

- ▶ Use ladder/zebra style pavement markings for the pedestrians and outside parallel lines for the bike crosswalk with no markings in the center where the bicyclists would ride. Each crosswalk should be approximately the width of the approaching pedestrian and bicycle trails, respectively.
- ▶ Use a non-slippery green-colored pavement surface when not signalized, understanding that use of solid colored pavement surface presents ongoing maintenance requirements.



Intersection Crossings

Guidelines for mid-block crossings also apply to where the Bay Trail crosses at an existing intersection of two roadways. Additionally, the following three design scenarios can be applied to intersection crossings.

- Providing bicycle-specific traffic signals (also known as signal “heads”). These should be used in conjunction with standard pedestrian signals at a signalized intersection with timing appropriate to the trail users.
- Coordinating with existing crosswalk design at the intersection on a site-specific basis.
- Assuring curb cuts and truncated domes cover the full width of the trail.



1. Bicycle-specific traffic signals, New York
2. Pavement markings indicating a bicycle crosswalk, Austin, Texas
3. Outside parallel lines for a bicycle crosswalk
4. Colored paving for bike crossing, Torino
5. Colored paving for bike crossing
6. placeholder
7. placeholder

5.5 RAIL AND LIGHT-RAIL LINES

No national standards or guidelines dictate rail-with-trail facility design. Therefore special care must be taken to ensure that the safety of trail users is protected when near a rail facility. Safety includes preventing physical contact and, depending on the speed of the train, the possibility of ballast or other material being ejected from the train onto the trail.

■ Paralleling an Active Rail Line

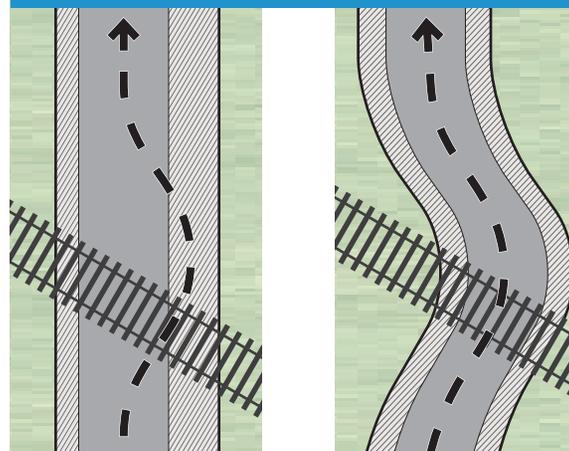
- ▶ The maximum setback possible should be made between the Bay Trail and an active railroad track.
- ▶ A 6-foot-high fence or physical barrier should separate the trail from active



railroad tracks. Fence meshing or rails should be sized and spaced to prevent climbing. Depending on the surrounding land use circumstances, there may be additional safety requirements placed on the managing agency (see also Security, Vandalism, and Privacy in Section 5.11).

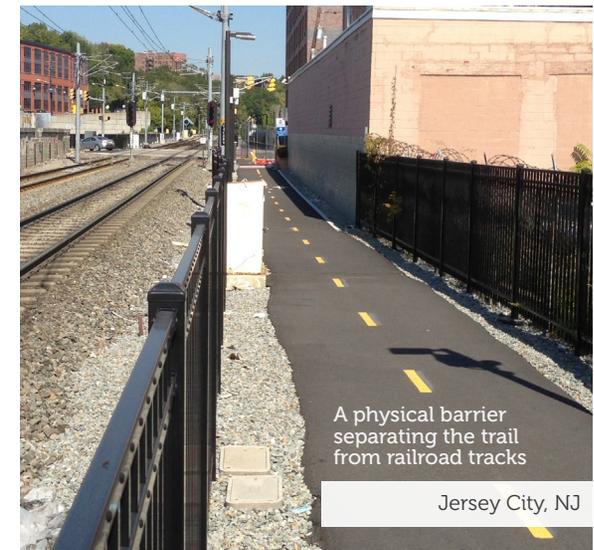
- ▶ A combination of vegetation, ditches, berms and elevation changes combined with fencing could be used to enhance the separation.
- **At-Grade Rail Crossings:** All railroad crossings are regulated by the California Public Utilities Commission (CPUC) and all new trail crossings must be approved by the CPUC. An at-grade rail or light-rail crossing could be considered where bridges or undercrossings are not feasible, or where trail use levels are low. Special care must be taken to ensure

FIGURE 5-15: WIDENED SHOULDER OR PERPENDICULAR CROSSING (PREFERRED)



that the safety of users is protected at rail crossings. The crossing should:

- ▶ Be at least as wide as the trail and shoulders.
- ▶ Be straight and at right angles to the rails.
- ▶ Have clear line-of-sight up and down the track corridor.
- ▶ Include a smooth surface transitioning over the tracks.
- ▶ Include flangeway filling strips to accommodate U.S. Access Board guidelines for pedestrians.
- ▶ Include active crossing warning systems (crossing guards and signals) as required.
- ▶ For trail segments crossing railroad tracks and where a skewed angle is unavoidable, the shoulder width of the trail could be widened to permit bicyclists to cross at right angles.



5.6 OVER OR UNDER

The edges of the San Francisco Bay include many circumstances where the Bay Trail must go over or under obstacles, such as freeways, streets, railroads, rivers, and the Bay's waters to achieve continuity.

Ramps

- Going either up or down involves ramping. Accessibility guidelines for ramps related to grades, rails, and resting places apply to the Bay Trail.

Bridges, Viaducts, and Boardwalks

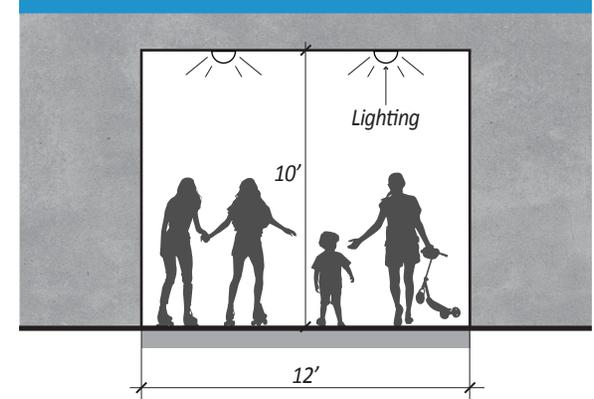
- The clear, unobstructed width of the Bay Trail between railings should be at least 12 feet.
- Structures could be designed to carry service and emergency vehicles.
- The clearing height from overhead obstructions, including fencing, should be 10 feet.
- The design style of these Bay Trail features should be one that is compatible with surrounding land uses, habitats, and adjacent developments.

Tunnels

- The clear, unobstructed width of the Bay Trail between tunnel walls should be at least 12 feet.

- The ceiling height should be at least 10 feet.
- Additional lighting or security cameras may be required by the managing agency.
- If the tunnel is prone to flooding, cautionary signs and/or possible trail closure mechanisms (e.g., red and white striped gate arms, warning lights) should be considered along with adequate drainage and pump designs.

FIGURE 5-16: TUNNEL CLEARANCE



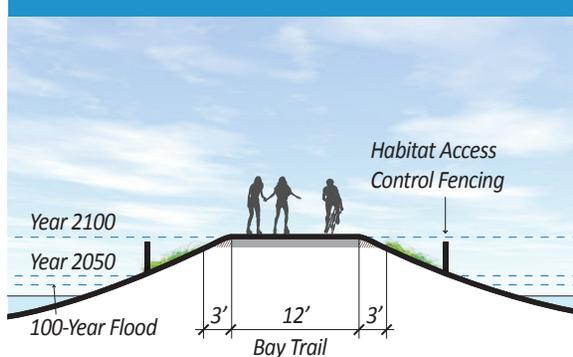
San Mateo Creek Bridge

5.7 SEA LEVEL RISE

While the Bay Trail is ideally located at the edge of the Bay to enjoy views of the water, that proximity often creates a vulnerability to rising sea levels. When at the edge of the Bay, a new segment of the Bay Trail may also afford the opportunity of protecting inland areas from the effects of sea level rise.

- **Elevation:** The elevation of the Bay Trail should accommodate projected future sea level rise and should be coordinated with the San Francisco Bay Conservation and Development Commission and other regulatory agencies.
 - ▶ The base trail elevation should ideally be set above the projected high water line.
 - ▶ For bridge and boardwalk segments of the Bay Trail, the lower support surface should be set above the projected high water line.
 - ▶ Where space is limited, the Bay Trail

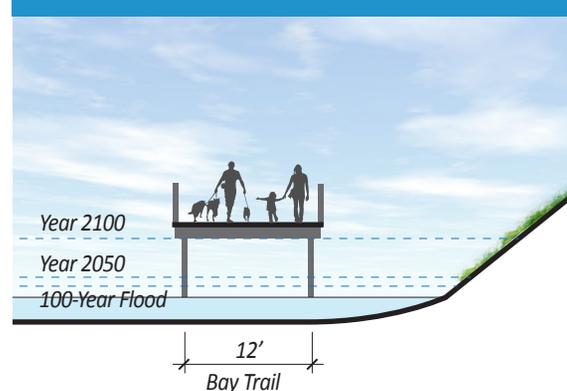
FIGURE 5-17: GRADE-LEVEL TRAIL SEGMENT



may need to be cantilevered or elevated above the shoreline. In some instances, additional clear vertical space should be allotted so that boats may navigate under the bridge or boardwalk.

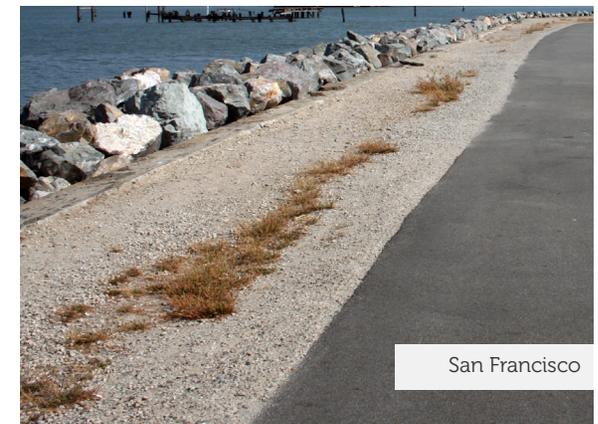
- ▶ Selected segments of the Bay Trail may be designed as a “floating trail” changing elevations with the tides.
- **Materials:** Bridges and boardwalk sections of the Bay Trail that may be subject to direct tidal effects should be concrete or other suitable materials that can withstand the corrosion effects of salt water. Boardwalks should be constructed either with a concrete surface or planks that are oriented horizontally to the direction of bicycle travel and placed closely together to essentially have no gaps. Where the Bay Trail is located on top of a levee:
 - ▶ Riprap revetments should be constructed of properly sized and placed materials that meet sound engineering criteria for durability, density and porosity. The

FIGURE 5-18: BOARDWALK TRAIL SEGMENT



material should be generally spheroid-shaped and placed outside the trail shoulder width of 3 feet.

- ▶ Concrete rubble, asphalt concrete, concrete pieces with exposed rebar and large or odd-shaped pieces of concrete should not be used.
- ▶ Riprap material should be placed so that a permanent shoreline is established by means of an engineered slope not steeper than a ratio of two (horizontal) to one (vertical).
- ▶ Riprap erosion control structures should include the placement of a filter layer protected by riprap material of sufficient size to withstand wind and wave conditions at the site.
- ▶ Where marsh establishment has a reasonable chance of success, the design of the trail’s protective structure should include provisions for non-structural methods, such as establishing marsh and transitional upland vegetation as part of the protective structure.



5.8 WILDLIFE COMPATIBILITY

By its very definition and location adjacent to the San Francisco Bay, the Bay Trail physically and visually shares the margins of the Bay with hundreds of aquatic, terrestrial, and avian species. Some of these species are endangered, and without stewardship, face decline. Depending on the site circumstances, there are a number of tools the managing agency can use to minimize public access and wildlife compatibility conflicts.



Alignment: The Bay Trail should be configured to provide trail users with a fulfilling, varied, and interesting access experience while encouraging users to stay in designated areas and limiting the creation of informal routes. The Bay Trail alignment should follow the perimeter of sensitive habitat areas rather than bisecting them.



Parking and Staging: Because use levels along the Bay Trail typically decrease the further away from a trailhead, Bay Trail parking and staging areas should be sited away from the most sensitive habitats.



Education: Interpretive signs should be located at staging areas, and at transition points where the Bay Trail nears or is adjacent to sensitive habitat areas to:

- ▶ Increase knowledge of users (regarding wildlife and the implications of users' actions).
- ▶ Foster public support for conservation and restoration programs.
- ▶ Educate the visitor about the natural resources of the area.



Observation Points: At strategic locations observation points off of the Bay Trail could be provided to direct use, allow desired visual access, and limit direct proximity to wildlife. Observation points would help provide predictability of human use, increasing the ability of wildlife to adapt to human activity. The observation points should accommodate both the individual trail user and small groups. They may include interpretive panels to educate the user and provide telescopes that will allow views and further discourage access into the habitat area.

Physical and Visual Separation: One or a combination of the following features should be used to physically and visually separate the Bay Trail from habitat areas.



Habitat Access Control Fencing: 4-foot-high wildlife-friendly fencing that includes a gap of 4 to 6 inches at the base to allow wildlife movement underneath. Signs should be posted at regular intervals along the fence stating "no access; protected wildlife area". The fencing should be set back from the trail and located at a lower elevation to allow users to experience unobstructed distant views to the Bay.



Open Space Buffers: An upland buffer between the Bay Trail and wetland areas. The width should vary and could include screening vegetation and habitat access control fencing.



Moats and Wetlands: A series of seasonal wetland areas and extended drainage channels parallel to the Bay Trail. These can provide additional physical barriers to discourage users from leaving the trail and entering sensitive habitat areas.



Vegetation: Screening vegetation strategically used near the trail to physically separate the Bay Trail from selected high value Bay

habitats while still allowing views to the surrounding mountains and ridgelines. Vegetation can:

- Provide a physical barrier to keep Bay Trail users out of sensitive areas.
- Provide a “natural” barrier that also enhances native plant communities.
- Help control erosion.
- Provide additional wildlife habitat/wildlife cover.



Materials Used for Perching:

Not providing raptors perching opportunities near Bay wetlands is important to protect many species. To avoid perching habitat within or near protected species habitat the Bay Trail should:

- ▶ Avoid use of tall signs as much as practical.
- ▶ Assure the diameter of the top rail of bridge and boardwalk railings are scaled to be a “no perch” feature for raptors.



Lighting: Locate night lighting away from sensitive habitat areas.



- 1. placeholder
- 2. placeholder
- 3. placeholder
- 4. placeholder
- 5. placeholder
- 6. placeholder
- 7. placeholder

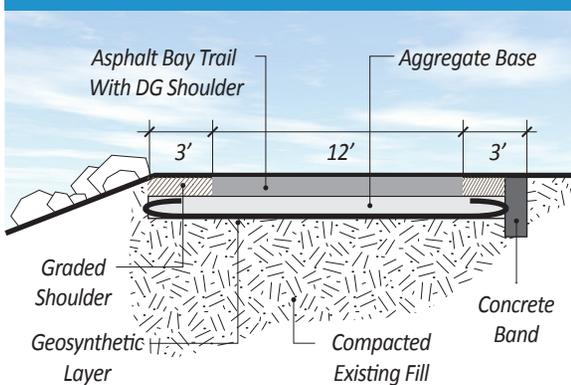
5.9 SUSTAINABILITY

The Bay Trail should be designed to maximize sustainability in terms of materials selection and design. For many managing agencies, the typical project life of an asphalt trail is 25 years. There are a number of design considerations that can reduce ongoing maintenance costs and extend the life of the trail.

Trail Structure

- ▶ Over time, a concrete trail will need less maintenance than asphalt; and an asphalt trail less maintenance than a gravel or natural surface one.
- ▶ Base the trail cross-section on geotechnical recommendations emphasizing durability whether for pedestrian/bicycle loads or accommodating use by service and emergency vehicles.
- ▶ Design foundations/footings for

FIGURE 5-19: TRAIL STRUCTURE



retaining walls and bridge structures on a conservative assumption regarding earthquake hazards. Where possible, avoid designing for a pedestrian load only.

Drainage

- ▶ Assure there is no overspray from adjacent irrigation systems onto the trail.
- ▶ Assure there is positive drainage away from the trail and that there are no standing puddles created from stormwater, storm surges, or irrigation.
- ▶ Direct all trail drainage through water quality systems or use permeable paving systems.

Edging

- ▶ Consider specifying flush concrete header curbs (unless the trail is concrete) along the trail edge to reduce maintenance and retain integrity over time.
- ▶ For trail shoulders, use natural surface stabilizers.

FIGURE 5-20: DRAINAGE

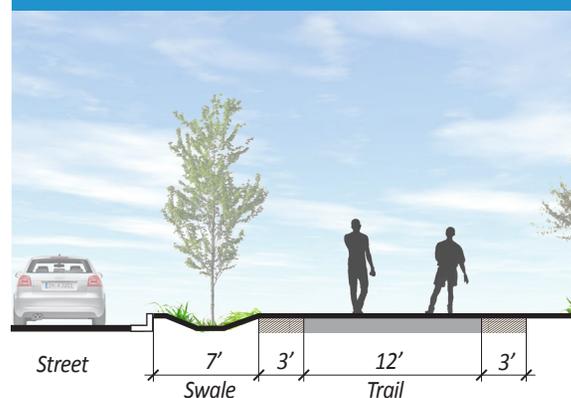
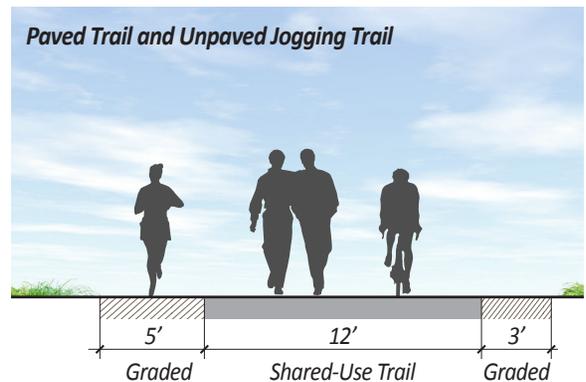
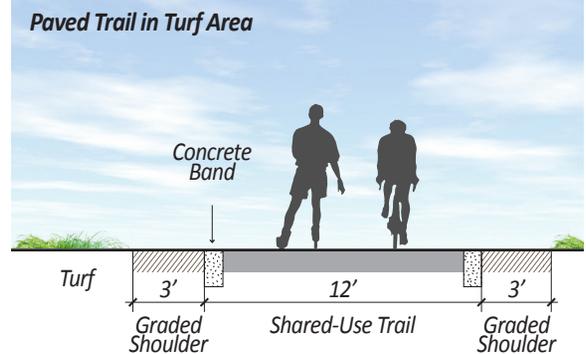
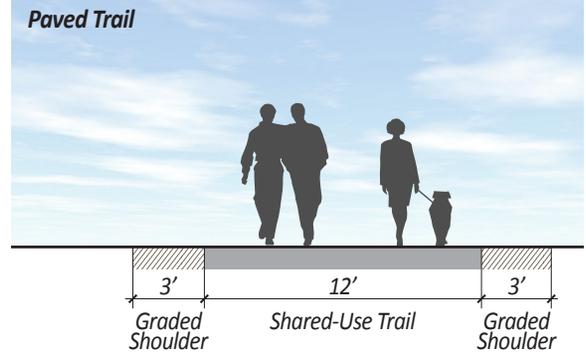


FIGURE 5-21: EDGING OPTIONS



Trail-Related Furnishings and Materials

- ▶ Specify site furnishings that are:
 - Durable to minimize maintenance requirements.
 - Composed of recycled, recyclable, reused materials, and/or certified “sustainably” produced lumber where appropriate.
- ▶ Specify energy-efficient lighting suitable for a Bayside environment.

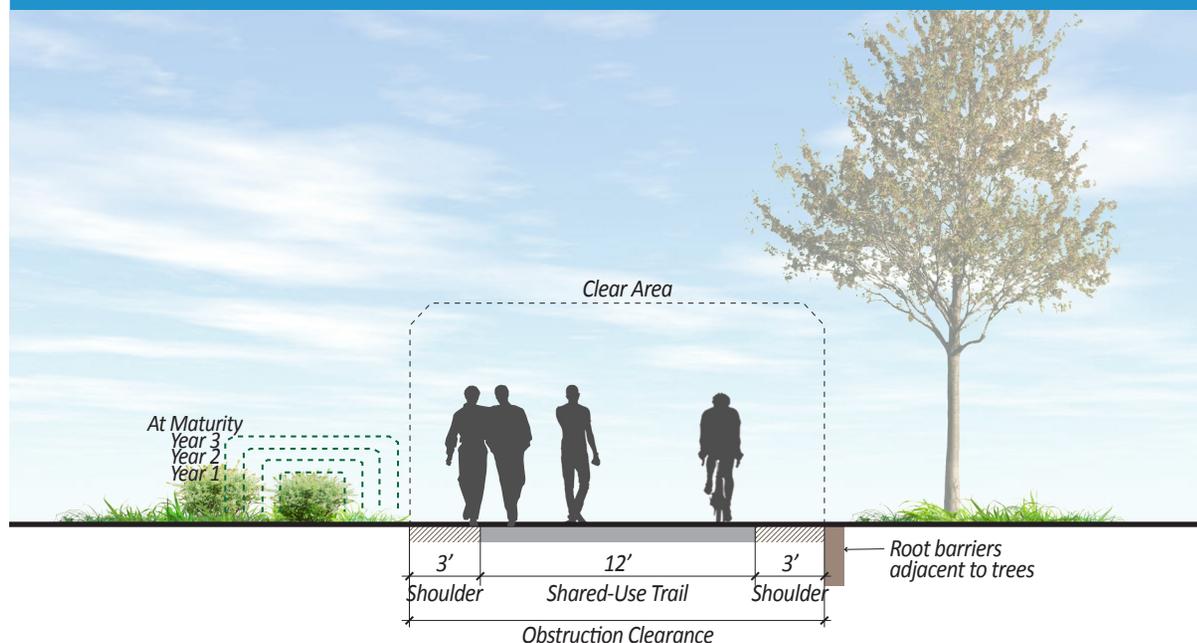
Landscaping

- ▶ Specify “Bay-Friendly Landscape” materials, particularly mulch to nurture the soil, conserve water, and enhance

wildlife habitat while also protecting the water quality of the Bay.

- ▶ Design trailside landscaping to preserve and dramatize Bay views.
- ▶ Use native plants local to the area that provide habitat for wildlife wherever possible.
- ▶ Select and locate trees and shrubs to reflect their growth rates and sizes as they relate to maintaining the obstacle clearances of the Bay Trail to minimize need for landscape maintenance.
- ▶ When trees are planted near the trail, include root barriers along the edge of the trail shoulder for a distance of 20 feet centered on the tree.

FIGURE 5-22: LANDSCAPING CONSIDERING PLANTS' GROWTH RATES



5.10 TRAIL AMENITIES

Specifying trail amenities should involve consistency with the site's characteristics, the managing agency's overall design guidelines, and be appropriate for anticipated levels of use.

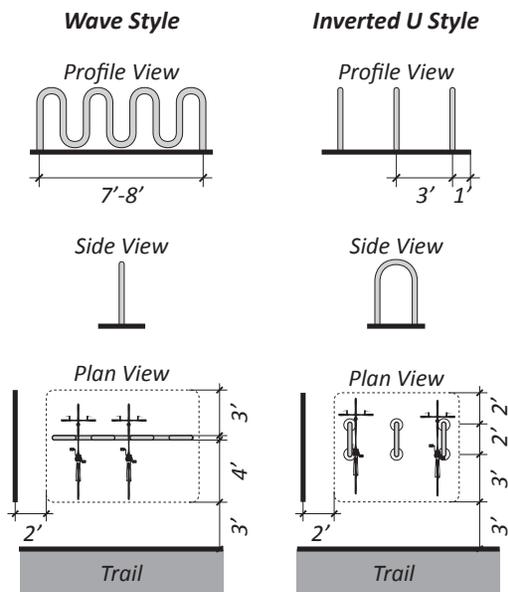
Trailside Seating

- ▶ Assure trail seating is accessible and outside the clear space of the Bay Trail.
- ▶ Orient seating toward Bay views or vistas of opposite shores or landmarks, such as bridges or towers.
- ▶ Provide elevated overlook places to sit away from the trail for viewing the Bay where possible.
- ▶ Provide various seating choices. In addition to fixed benches with and without backs, some seating could be in the form of chairs, picnic tables, retaining walls, planter seats, grass berms, and steps.
- ▶ Consider wind-protected seating where the Bay shoreline setting is often cool and breezy.
- ▶ Locate seating at regular intervals along the trail based on the surrounding environment, land uses, and level of use.
- ▶ Provide shade, or place seating where shade is available.



1. Seating oriented toward Bay views, Oakland
2. Seating in the form of retaining walls
3. Seating and public art, Oakland
4. Benches with shade, San Francisco
5. Picnic chairs
6. Benches located outside of the clear space of the trail, Emeryville
7. Elevated outlook with benches, San Mateo

FIGURE 5-23: BIKE PARKING DESIGN



Bicycle Racks

- ▶ Anticipate the need for bicycle racks or other storage devices particularly where the Bay Trail is associated with parks, other transit facilities or visitor-serving destination points.
- ▶ Assure bicycles attached to bicycle racks are located outside the clear space of the Bay Trail.

Drinking Fountains

- ▶ Provide a source of drinking water at a minimum of 2-mile intervals along the trail where possible. This could be through stand-alone drinking fountains or at convenience stores associated with a marina or other commercial development.

Restrooms

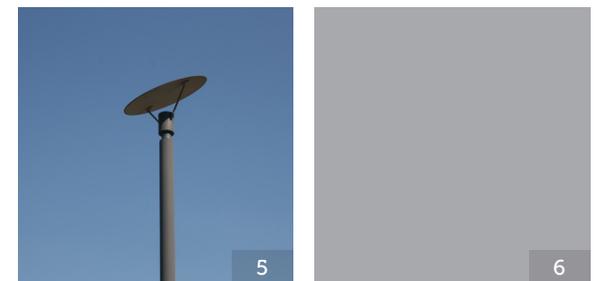
- ▶ Provide restrooms at a minimum of 1-mile intervals along the trail, where feasible and based on the surrounding environment and level of use.
- ▶ Restrooms may be at Bay Trail staging areas, along the trail, or associated with restrooms of other Bayside uses such as at San Francisco Bay Area Water Trail launch locations, ferry terminals, harbor masters, shoreline commercial areas, or parks.

Lighting

- ▶ Provide lighting along the Bay Trail based on the surrounding land use requirements and need for security.
- ▶ Avoid lighting that would conflict with wildlife habitat.
- ▶ Assure that lighting fixtures are located outside the shoulder of the Bay Trail.
- ▶ Use energy-efficient lighting that conforms to the managing agency’s standards including emergency fire egress requirements from nearby buildings as appropriate.

Other Trail Amenity Considerations

- ▶ Where space away from the shoulder of the trail is available on a bridge or trail structure over water, consider providing fishing pole holders on the railing and fish cleaning stations.
- ▶ Additional trail-related amenities may include such items as:
 - Bicycle repair stations at selected locations



1. Water fountain, San Francisco
2. Bicycle repair station, Emeryville
3. Pedestrian-scale lighting
4. Lighting on the Berkeley pedestrian/bicycle bridge, Berkeley
5. Energy-efficient lighting
6. Placeholder

- Trash and recycling containers at trail entrances
- Pet waste stations at trail entrances

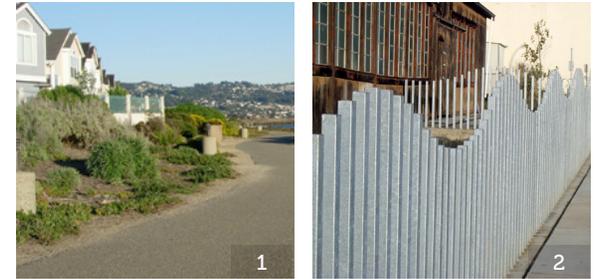
5.11 SECURITY, VANDALISM, AND PRIVACY

A sense of personal safety is important for the Bay Trail user. This generally means being on a trail that is well used, has open visibility along and across the trail, avoids concealed or isolated areas, and may include lighting and/or security cameras. Achieving this goal needs to be balanced with providing security for selected adjacent land uses.

The Bay Trail may pass through or adjacent to any number of land uses that are considered national security risks and are governed by standards and guidelines of the U.S. Department of Homeland Security. The design need is to balance security and privacy with trail user experience. The design should create a positive user experience that does not include undue visual barriers for the trail users while maintaining security and privacy

for the adjacent land use. Typical trail provisions involve assuring that all trail users stay on the trail, that the adjacent lands are secure from physical entry, visual intrusions, and protected from objects that may be tossed from the trail. Typical design tools may include providing any or all of the following:

- **Setbacks:** Sufficient horizontal distance between the trail and the secure area so an object could not enter the secure area.
- **Fencing:** High-security fencing.
- **Visual Barriers:** Screening with fencing systems, walls, or vegetation.
- **Lighting:** Full trail and adjacent area lighting.
- **Camera Surveillance:** 24-hour and full coverage video systems tied either to police departments or the adjacent property owners' security systems.



1. Vegetated buffer for privacy, Richmond | Source: Flickr (Joel Williams)
2. Decorative fence, Oakland
3. Wooden fencing, Portland
4. placeholder - security fencing

FIGURE 5-24: BUFFER DESIGN OPTIONS

