CITY OF ELK GROVE

Bicycle, Pedestrian, & Trails Master Plan

Appendix A. Design Protocols

MAY 2021

Prepared for the City of Elk Grove by GHD Inc.
with support from Toole Design Group, LLC & AIM Consulting, Inc.

All photos by GVP Studios except where noted

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Introduction

This appendix of the Elk Grove Bicycle, Pedestrian, and Multi-Use Trails Plan provides Design Protocols for Elk Grove's active transportation network. The following Design Protocols are presented to direct the planning, design, construction, and maintenance of bicycle, pedestrian, and trails facilities in Elk Grove. Some items are mandatory (i.e., standards typically utilize the word "shall," "must," or "will"), whereas others are advisory (i.e., guidelines typically utilize the words "may" and "should"). Items that are advisory in this Plan may become mandatory to a project through conditioning.

The Design Protocols reflect national best practices to ensure consistency and quality as Elk Grove's active transportation network develops over time. The information provided is compatible with the guidance provided at federal, state, and local levels. Reference documents are listed below.

At a minimum, all bicycle, pedestrian, and trail facilities within the city shall comply with Chapter 100 Basic Design Policies of the Caltrans *Highway Design Manual* and shall be designed in accordance with the most up-to-date federal and State accessibility requirements.

At the same time, the guidance in this chapter needs to also be implemented with engineering judgment. The Design Protocols integrate design flexibility that supports active transportation while meeting requirements mandated by local, state, and federal authorities.

Reference Documents

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

Guide for the Development of Bicycle Facilities, 2012 (new edition forthcoming)

FEDERAL HIGHWAY ADMINISTRATION (FHWA)

Manual of Uniform Traffic Control Devices, 2012
Bikeway Selection Guide, 2019
Separated Bike Lane Planning and Design Guide, 2015
Safe Transportation for Every Pedestrian (STEP) Program
Achieving Multimodal Networks: Applying Design Flexibility and Reducing Conflicts, 2016
Small Town and Rural Multimodal Networks Guide, 2016
Accessible Shared Streets: Notable Practices and Considerations for Accommodating Pedestrian with Vision Disabilities, 2017

FHWA AND RAILS TO TRAILS COALITION

Shared-Use Path Level of Service Calculator, 2006

US ACCESS BOARD

Proposed Accessibility Guidelines for Pedestrian Facilities in the Public Right-of-Way (PROWAG), 2011
Americans with Disabilities Act and Architectural Barriers Act Standards for Accessibility Design, 2010

CALTRANS

Highway Design Manual (HDM), 2019
Class IV Bikeway Design Guidance (Design Information Bulletin 89-01), 2018
California Manual on Uniform Traffic Control Devices (CA MUTCD), 2014
California Standard Plans, 2020
California Standard Specifications, 2020

NATIONAL ASSOCIATION OF CITY TRANSPORTATION OFFICIALS (NACTO)

Urban Bikeway Design Guide, 2012
Urban Street Design Guide, *2013*
Transit Street Design Guide, 2016

ASSOCIATION OF PEDESTRIAN AND BICYCLE PROFESSIONALS (APBP)

Essentials of Bike Parking: Selecting and Installing Bike Parking that Works, 2015

CITY OF ELK GROVE

City of Elk Grove Improvement Standards Manual, 2020
City of Elk Grove Standard Drawings, 2018

Document Organization

The Design Protocols include four main sections, described below.

MULTIMODAL DESIGN PRINCIPLES

The Design Protocols were developed based on a set of overarching design principles centered on the intended users of Elk Grove's active transportation network, their characteristics, needs, and how they should best be accommodated. Focusing on the design user shifts the focus from decision-making based simply on what is feasible to solutions that result in a successful multimodal network attractive to Elk Grove residents and visitors.

BICYCLE DESIGN PROTOCOLS

The Caltrans *Highway Design Manual* (HDM) Chapter 1000, Design Informational Bulletin (DIB) 89-01, the FHWA *Separated Bike Lane Planning and Design Guide*, and the AASHTO *Guide for the Development of Bicycle Facilities* address many aspects of the design of bicycle facilities. In addition, the APBP *Essentials of Bicycle Parking* addresses bicycle parking facilities. This section is intended to complement existing design references by providing more detailed guidance on facility selection, intersection treatments, and best practices based on the comfort, safety, and convenience of the intended design users.

PEDESTRIAN DESIGN PROTOCOLS

The Caltrans *Highway Design Manual (*HDM) provides basic design guidance for pedestrian facilities as an important but secondary function of highways but stops short of providing design guidance for different types of streets and pedestrian facilities. It recognizes that, "Most local agencies in California have adopted varying design standards for urban and rural areas, as well as more specific requirements that are applicable to residential settings, downtowns, special districts, and other place types. These standards are typically tied to zoning requirements for land use established by local agencies. These land use decisions should consider the ultimate need for public right-of-way, including the transportation needs of bicyclists and pedestrians," (105.02).

The HDM also provides guidance on determining the width of pedestrian facilities based on capacity, using the Level of Service (LOS) metric from the AASHTO's *A Policy on Geometric Design of Highways and Streets.*

The guidance in this chapter is intended to supplement existing federal, statewide, and local guidance and provide local design context. It also recognizes and addresses that walking is a vital part of any transportation network, active or motorized, and the design of pedestrian facilities must reflect and respond to the comfort, safety, and convenience of people walking.

MULTI-USE TRAIL PROTOCOLS

The design of multi-use trails is addressed in the HDM Chapter 1000 along with other bicycle facilities. The AASHTO *Guide for the Development of Bicycle Facilities* also provides trail guidance and reflects current best practices. This section of the Design Protocols addresses the design of trails, so they reflect Elk Grove's unique context and setting as well as a range of potential users (including bicyclists, pedestrians, other non-motorized users, and equestrians).

Alignment with Plan Goals and Vision

The Design Protocols were developed to meet the vision and goals of the Bicycle, Pedestrian, and Trails Master Plan. Below are the Plan goals with corresponding multimodal design principles. Note that accessibility is assumed to be inherent in all objectives.

GOAL 1: INCREASE BICYCLING AND WALKING

GOAL 2: SUPPORT A CULTURE WHERE WALKING AND BICYCLING ARE SAFE AND CONVENIENT TRANSPORTATION OPTIONS

Bikeways should be designed to be comfortable, intuitive, and easy to use and understand for bicyclists of all ages and abilities as well as other roadway users such as micro mobility users (e.g., people using e-scooters). Pedestrian facilities should be designed to not only be safe and accessible but also attractive.

The paths on which people travel (i.e., the bike, pedestrian, or trail facilities) should incorporate elements that make the experience of travel comfortable, pleasurable, and fun.

Design Principles

- Design for All Ages and Abilities
- Path as Place

GOAL 3: PROMOTE SAFE BEHAVIOR BY ALL ROAD USERS

Bicycle, pedestrian, and trail facilities should accommodate the diverse range of users in a way that reduces conflicts between bicyclists and other roadway users including drivers, pedestrians, and users of micro mobility devices by making it easy and intuitive for people to use the roadway as intended.

Design Principles

- Right Design Invites Right Use

GOAL 4: IMPROVE CONNECTIVITY AND ACCESSIBILITY

Bicycle, pedestrian, and trail facilities should be designed with consistency and should connect seamlessly to destinations and other facilities. They should be continuous, direct, and convenient.

GOAL 5: IMPROVE REGULAR TRAIL MAINTENANCE

Bicycle, pedestrian, and trail facilities should be maintained to ensure the longevity and safety of the existing and future network. Trail widths should accommodate maintenance vehicles and equipment wherever possible. Pavement materials should be selected for durability to reduce the cost and frequency of future replacements or repairs. Plantings that are water efficient and require little maintenance should be used to minimize water consumption and obstructions to sightlines.

Design Principles

- Consistency and Connectivity

Multimodal Design Principles

DESIGN FOR ALL AGES AND ABILITIES

Several studies have shown that most people feel safer and more comfortable bicycling on streets with low vehicle volumes and speeds, or on higher speed and higher volume streets with increased separation and protection from vehicle traffic. In fact, approximately half of the population has little tolerance for interacting with vehicles unless vehicle speeds and volumes are very low.[1]

As indicated in the Existing Conditions (p. 20), decreasing the Level of Traffic Stress and improving comfort on bikeways better meets the need of "Interested but Concerned" bicyclists. These bicyclists represent the largest potential for mode shift away from private vehicles in Elk Grove. Designing bicycle facilities as described above (i.e., greater separation on roads with higher traffic volumes and speeds) not only increases comfort for bicyclists, but also accommodates a wider range of bicyclists with varied biking abilities and ages. The term All Ages and Abilities is used to describe bicycle facilities designed for people from age 8 to 80.

PATH AS PLACE

Beyond safety and functionality, the quality of the travel environment has a big effect on bicyclists, pedestrians, equestrians, and other active transportation users. A high-quality active transportation environment that addresses physical comfort and has visual interest and coherent wayfinding is likely to draw more users and result in more enjoyable trips. The design of bicycle, pedestrian, and trail facilities should consider the needs of the users as well as physical context. Elements that can make a path more of a place include street trees and plantings; shade; opportunities for seating, resting, and gathering; wayfinding signs and cues; human-scaled urban details like windows and modulation in building facades; and separation from parking lots.

RIGHT DESIGN INVITES RIGHT USE

Whether bicyclists and pedestrians have exclusive spaces like bike lanes and sidewalks, are combined on multi-use paths, or just encounter one another at intersections or driveways, effective design can ensure that the interactions between modes minimize the potential for conflicts. Bicycle, pedestrian, and trail facilities should be designed to accommodate these interactions by being intuitive to understand and navigate, organizing users, indicating proper positioning, and creating predictable movement. A large part of this approach is understanding the operational spaces of each user type, accounting for the speed differential between people who walk and people who bike, and accounting for the expected volume and mix of users.

CONSISTENCY AND CONNECTIVITY

With higher density urban development in the west and central parts of Elk Grove and lower density rural residential neighborhoods in the northeastern portion of the city, active transportation facilities may differ across the city. However, it is important to balance context-sensitive active transportation facilities and cohesive, consistently designed facilities that make the entire system easy to understand and use. Consistency is an important part of creating a safe active transportation network.

Rights-of-way, land uses, and other conditions vary even on the same roadway, and sometimes facility types must change in response. Creating seamless connections and transitions between destinations and facility types, for example between a multi-use trail and bike lanes, ensures that these connections do not pose barriers for users. Connections between facilities and to destinations should be direct, intuitive to navigate,

[1] Dill, D. and N. McNeil. Revisiting the Four Types of Cyclists. In Transportation Research Record 2587. TRB, National Research Council, Washington, DC, 2016

and closely spaced. The more connections a network has, the more useful it is to users.

ACCESSIBILITY

The requirement to provide equivalent access to facilities for all individuals, regardless of disability, is stated in several laws adopted at both the state and federal levels. Two of the most notable references are the Americans with Disabilities Act of 1990 (ADA) and Section 4450 of the California Government Code. Title II of the ADA prohibits discrimination on the basis of disability by state and local governments (public entities). This means that a public entity may not deny the benefits of its programs, activities, and services to individuals with disabilities because its facilities are inaccessible. A public entity's services, programs, or activities must be readily accessible to and usable by individuals with disabilities. Sections 4450 through 4460 of the California Government Code require that buildings, structures, sidewalks, curbs, and related facilities that are constructed using any state funds, or the funds of cities, counties, or other political subdivisions, be accessible to and usable by the physically disabled. The FHWA has directed Caltrans to use the ADA *Accessibility Guidelines for Buildings and Facilities* as the federal design guidelines for pedestrian accessibility. This information, as well as additional guidelines for complying with ADA, is contained in Chapter 1000 of the Caltrans *Highway Design Manual*.

All bicycle, pedestrian, and trail facilities within the City shall comply with Chapter 1000 Basic Design Policies of the Caltrans Highway Design Manual and shall be designed in accordance with the most up-to-date federal and State ADA requirements.

It is important to note that many people with disabilities are dependent on active transportation and transit networks. Design for the safety, comfort, convenience, and dignity of all people (a practice called Universal Design) should be standard beyond basic compliance with accessibility requirements. When active transportation facilities address the needs of the city's most vulnerable users, all users benefit.

Bicycle Design Protocols

Introduction

Bicycle facilities within the city shall be designed in accordance with Chapter 1000 "Bicycle Transportation Design" of the Caltrans *Highway Design Manual*. Other resources useful in facility planning and design include Chapter 9 from the FHWA *Manual on Uniform Traffic Control Devices* (MUTCD) and Caltrans *Manual on Uniform Traffic Control Devices* (CA MUTCD) and the *Guide for Development of Bicycle Facilities* by the American Association of State Highway and Transportation Officials.

Bicycle Facility Selection

To achieve the Plan's goals of increasing bicycling and walking and supporting a culture where walking and bicycling are a safe, convenient transportation option, the selection of bicycle facility types should be based on the intended design users and respond to roadway characteristics and use. For Elk Grove, this means focusing on the "Interested but Concerned" group of cyclists, as described in the Existing Conditions chapter.

Table 1. Examples of Interested but Concerned Bicyclists

		
A mother and daughter who enjoy Saturday rides along the Laguna Creek Trail to Laguna Village. Concern about crossing a busy road prevents them from riding together to the child's elementary school during the week.	A 45-year-old father of two who was just diagnosed with pre-diabetes. His doctor encouraged him to be more active, so he's been thinking about doing short errands by bike. As a motorist, he feels uncomfortable passing bicyclists, so he isn't sure he'd feel comfortable as a bicyclist sharing the road with cars.	A resident who just started a new job at Apple. He enjoys riding in his neighborhood as long as he stays on quiet streets or the sidewalk. He'd like to be able to ride to work and other destinations, but he's uncomfortable crossing busy roads and intersections along the way.

Interested but Concerned bicyclists prefer physical separation as traffic volumes and speeds increase and also desire intersections where bicycle travel is designed for rather than accommodated (e.g., crossing a major street at a signal, rather than waiting for a gap in traffic and rushing across multiple or fast-moving travel lanes).

The bikeway facility selection charts on the following pages identify bikeway facilities that improve the operating environment for this bicyclist type at different roadway speeds and traffic volumes. The "Enthusiastic and Confident" bicyclist will also prefer bikeway treatments noted in this chart. As Elk Grove's goal is to increase bicycling, it is appropriate to select facility types based on this chart. Per the AASHTO facility section chart below, consider roadway speeds and volumes when determining the appropriate bike facility.

In addition to roadway characteristics, consider pedestrian and bicycle volumes or, in the absence of volume, consider land use. It is important to note that a physically separated facility means a separated bike lane or multi-use path, separated from traffic by parking, posts, curb, or other similar mechanisms.

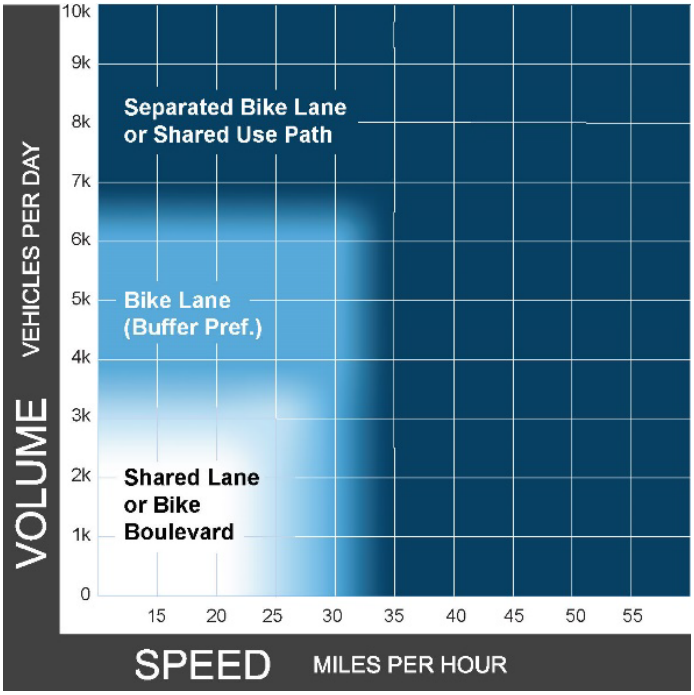


Figure 1. Bikeway facility selection chart

Source: Draft AASHTO Bikeway Design Guide, 2019.
Notes:

1. *Chart assumes the project involves reconstruction or retrofit in constrained conditions. For new construction, follow recommended shoulder widths in the AASHTO Green Book.*
2. *A separated multi-use pathway (Class I) is a suitable alternative to providing paved shoulders.*
3. *Charts assumes operating speeds are similar to posted speeds. If they differ, use operating speed rather than posted speed.*
4. *If the percentage of heavy vehicles is greater than 10%, consider providing a wider shoulder or a separated pathway (Class I).*

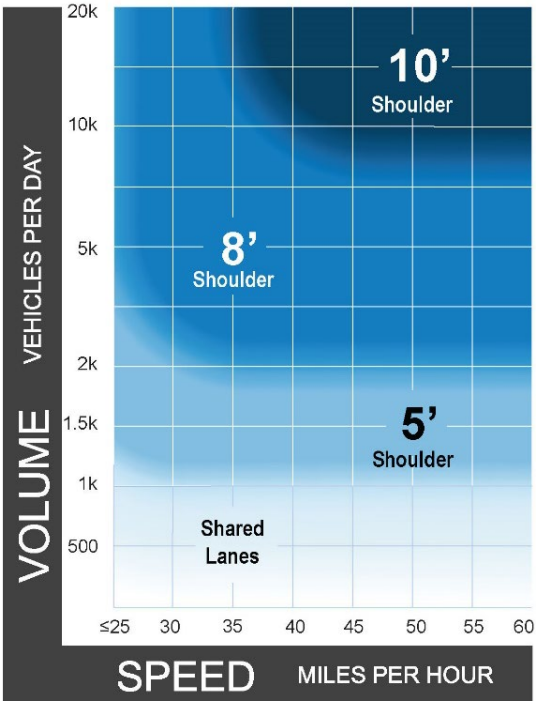
Shoulder Widths for Rural Roadways

In rural areas, such as in eastern Elk Grove, paved roadway shoulders are oftentimes the most appropriate and feasible treatment to accommodate bicyclists and pedestrians. Figure 2 provides guidance for selecting shoulder widths on such roadways. When selecting a minimum shoulder width, the decision should be based on traffic volumes and posted speeds. For the purposes of determining the appropriate shoulder width, it is assumed that posted speeds are approximately the same as operating speeds. If operating speeds differ from posted speeds, then operating speed should be used instead of posted speed. Note that pedestrian needs differ from bicyclists', and provision and width of a shoulder as a pedestrian facility should be evaluated separately.

Bicycle Facility Types

The recommended bikeways included in the proposed bicycle network range from off-street multi-use paths to shared lane bike routes. Descriptions of bikeway facility types are provided on the following page.

Figure 2. Shoulder width selection chart



Source: AASHTO Bikeway Design Guide, 2019. Chart assumes operating speeds are similar to posted speeds. If they differ, use operating speed rather than posted speed.

Table 2. Bicycle Facility Types

CLASS I MULTI-USE PATHS

Class I multi-use paths are paved trails completely separate from the street. They allow two-way travel by people walking and bicycling and are considered the most comfortable facilities for children and inexperienced bicyclists as there are few potential conflicts with people driving.

CLASS III BICYCLE ROUTES

Class II bicycle lanes are striped preferential lanes in the roadway for one-way bicycle travel. Some bicycle lanes include a striped buffer on one or both sides of the lane to increase separation from the traffic lane or from parked cars, where people may open doors into the bicycle lane.

Credit: Toole Design

CLASS III BICYCLE ROUTES

Class III bicycle routes are signed routes where people bicycling share a travel lane with people driving. Because they are shared facilities, bicycle routes are typically appropriate only on quiet, low speed streets with relatively low traffic volumes. Some bicycle routes include shared lane markings or "sharrows" that recommend proper bicycle positioning in the center of the travel lane and alert drivers that bicyclists may be present. Others include more robust traffic calming features to promote safety and comfort for people bicycling and are known as "bicycle boulevards.

Credit: Toole Design

CLASS IV SEPARATED BIKEWAYS

Class IV separated bikeways are on-street bicycle facilities that are physically separated from motor vehicle traffic by a vertical element or barrier such as a curb, bollards, or vehicle parking lane. They can allow for one- or two-way travel on one or both sides of the roadway.

Design Vehicle

It is important to consider different ages, abilities, riding styles, and bicycle types when designing bicycle facilities. Even if the number of bicyclists with specialized operating characteristics is small, their comfort and safety is still important. Some examples of varied bicycle design vehicles include:

- Families that bike use a variety of different types of bikes as their children grow into independent bicyclists. Cargo bikes and trail-alongs are longer, and sometimes wider, and thus must be accounted for in intersection queuing areas, at trail crossings, and through turns.
- Parents riding with children who are newly independent cyclists need space to ride alongside their small riding companions, as those kids may wobble or weave.
- Riders of e-bikes operate similarly to other cyclists but need space to pass slower riders.
- Riders of adaptive bikes like handcycles and recumbent bikes are typically lower to the ground, so visibility considerations amongst other bicyclists and at intersections are different.

Credit: Toole Design

Figure 3. Design Vehicle

Local Context and Other Users

It is important to understand the local context in the siting and design of bikeways, and to anticipate and design for interactions with other users. Bicycle facilities are often, but not always, intended for exclusive use by bicyclists, but that doesn't mean bicyclists won't encounter pedestrians, vehicles, and other active transportation users. Class IV bikeways, for example, can be sited adjacent to and at the same level as a sidewalk, creating the possibility of pedestrians—particularly people with vision disabilities--encroaching on the bikeway, or vice-versa. Commercial driveways can also be potential high conflict areas. Providing additional operating space, using geometric design to organize and guide users, and adding elements like pavement markings, colored paving, texture, and signs are tools that are commonly used to make bikeways responsive to site-specific conditions.

Intersections

Intersections are often one of the most challenging and high-stress parts of the bicycle network to navigate. In many cases, bike lanes end before the intersection (e.g., bike lane striping does not continue all the way to the stop bar) and are not carried through to the other side, causing confusion and stress for bicyclists as well as drivers. In addition, signalized intersections oftentimes do not detect bicyclists or require bicyclists to wait extended periods of time to cross. Unsignalized crossings can also be challenging to navigate and may require long waiting times for a gap in vehicular traffic to cross.

Treatments that enhance safety and comfort at intersections can significantly improve the riding experience throughout the network. Intersection treatments may include signal improvements, geometric changes, or supplementary pavement markings, signage, and lighting.

Intersection treatments for bicyclists provide the following functions:

- Show bicyclists and drivers where to safely position themselves
- Enhance visibility of bicyclist's path of travel
- Provide dedicated space and time (e.g., a dedicated signal phase) for bicyclists to travel through an intersection
- Reduce conflicts with vehicle movements
- Reduce turning vehicle speeds
- Provide confirmation and positioning for actuating signals

While these improvements may be completed as opportunities arise (e.g., as part of routine resurfacing or street improvement projects), the City should strive to complete a series of improvements to intersections as low-stress corridors in the proposed bicycle network are implemented. This coordinated approach will enable bicyclists to travel along continuous low-stress routes.

Figure 4. Bicycle Intersection Treatment

Bikeway Preferred and Minimum Widths

The following table presents preferred and minimum widths for different bikeway classifications that should be used for new construction.

Table 3. Summary of Bikeway Design Protocols

Class II	Class II Enhanced	Class III	Class IV
LOCATION			
Bike Lanes	Buffered Bike Lanes	Bike Route or Bike Boulevard	One-way Protected Bikeways Two-way PBLs
Delineated within roadway, adjacent to curb or parking lane	Delineated within roadway, adjacent to curb or parking lane	Within roadway	Within roadway, adjacent to curb (street level) or adjacent sidewalk (sidewalk level)
GEOMETRICS*			
Minimum of 6 ft for roadways posted 40 mph or higher (preferred), Minimum of 5 ft for all other roads, These are both preferably exclusive of gutter pan, but at least 36" of the bikeway must be on the same surface as the vehicular travel lane	See bike lanes; buffer width dependent on roadway speeds, volumes, and % of heavy vehicles; 18 in. minimum	Bike boulevards include traffic calming treatments to ensure lower speed and lower volume vehicular traffic	7 ft (preferred), 5 ft (minimum) for one-way 12 ft (preferred), 10 ft (minimum) for two-way Buffer width >3 ft (preferred), 2 or 3 ft (minimum) for street level PBLs, depending on presence of parking lane Buffer width 1.5 ft (minimum) for sidewalk level PBLs
SURFACING			
Same as roadway	Same as roadway	Same as roadway	Same as roadway (street level) Asphalt, to differentiate from walking space (sidewalk level)

Class II	Class II Enhanced	Class III	Class IV
SIGNAGE AND STRIPING			
Delineated with 6 or 8 in white lines Bike lane word or symbol shall be placed at the beginning of the bikeway and at regular intervals up to 0.5 mile, also at far side of all arterial crossings and at decision points Regulatory and wayfinding signs	Delineated with 6 or 8 in white lines Bike lane word or symbol shall be placed at the beginning of the bikeway and at regular intervals up to 0.5 miles, also at far side of all arterial crossings and at decision points Regulatory and wayfinding signs	Shared lane markings (SLMs): 4 ft min. from curb without parking, 11 ft minimum from curb with parking SLMs should be placed up to every 250 ft along a route and at decision points where route turns Regulatory and wayfinding signs	PBL delineated with painted buffer (6 or 8 in white lines) or physical buffer Bike lane word or symbol shall be placed at the beginning of the bikeway and at regular intervals up to 0.5 mile, also at far side of all arterial crossings and at decision points Regulatory and wayfinding signs
CROSSINGS/INTERSECTION TREATMENTS			
Bike lane extension markings at intersections Painted conflict markings at locations/driveway with high right turn volumes, high conflict/collision rates, or high conflict potential due to converging maneuvers Two-stage turn box: at multi-lane intersections where there are large bike left turn volumes Bike box: to facilitate left turns for bicyclists, group bicyclists together to clear an intersection quickly, to reduce turn conflicts, or facilitate a Leading Pedestrian Interval		Wayfinding signage and SLMs as needed	Protected intersection treatments (preferred), which create bicyclist separation from vehicles in time and space Bike lane extension markings at intersections
AMENITIES			
Wayfinding signage		Wayfinding signage	Wayfinding signage

* *CTHMD Ch. 1000, AASHTO Guide for the Development of Bicycle Facilities, DIB 89,* Width per City standard

For additional information, reference the City Improvement Standards

Bicycle Intersection Toolbox

Most bicycle facilities cross streets, driveways, or alleys at multiple locations along a corridor. At these locations, the crossings should be designed to 1) delineate a preferred path for people bicycling through the intersection and 2) encourage driver yielding behavior, where applicable. Bicycle crossings may be supplemented with green pavement, yield lines, and/or regulatory signs.

Credit: Toole Design

BIKE LANE EXTENSION MARKINGS

Bike lane extension markings are designed to improve visibility, alert all roadway users of expected bicyclist behavior, and reduce conflicts with turning vehicles

PAINTED CONFLICT AREA MARKINGS

Similar to bike lane extensions, conflict area markings are intended to improve visibility, alert all roadway users of expected behaviors, and reduce bicyclists' conflicts with turning motor vehicles. Per the Manual on Traffic Control Devices (MUTCD), conflict area markings must be used in tandem with Class II bike lanes or Class IV separated bikeways.

Credit: Toole Design

BIKE BOX

A bike box provides dedicated space between the crosswalk and motor vehicle stop line where bicyclists can queue during a red light at signalized intersections. Bike boxes allow bicyclists to take a position in front of motor vehicles at the intersection, which improves visibility and motorist awareness and allows bicyclists to "claim the lane," if desired. Bike boxes aid bicyclists in making left turning maneuvers at intersections and provide more queuing space for multiple bicyclists than a typical bike lane.

Credit: Toole Design

TWO-STAGE TURN BOX

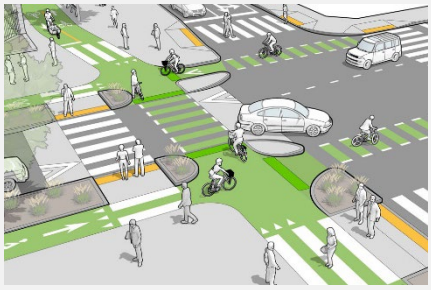
The two-stage turn box designates a space outside the path of traffic for bicyclists to wait while performing a two-stage turn at an intersection. Two-stage turn queue boxes may be used with any type of bicycle facility. A two-stage turn queue box should be considered where separated bike lanes are continued up to an intersection and a protected intersection is not provided

Credit: Toole Design

BICYCLE DETECTION

The California MUTCD Supplement requires the provision of bicycle and motorcycle detection on all new and modified approaches to traffic actuated signals. Bicycle detection at signalized intersections can provide a substantial safety improvement for bicyclists and motorists. Detection for vehicles and bicycles is usually provided via metal-detecting "loop detectors," which trigger a green light when they sense metal nearby.

Video and radar detection systems can also be used to detect bicycles and the City is currently focusing on replacing loops with video detection as feasible and is now considering this practice standard for future development.



Credit: Tool Design

PROTECTED INTERSECTION

Protected intersections are set back from parallel motor vehicle traffic, providing a dedicated path for bicyclists moving through the intersection. A corner island separates bikes from motor vehicles and prevents motor vehicles from encroaching on the bikeway. This configuration reduces the crossing distance for bicyclists and pedestrians traveling through the intersection and encourages safer turning movements. Protected intersections should be considered as an option at locations where separated bike lanes are continued up to an intersection. They may be implemented at signalized and stop-controlled intersections.

WAYFINDING SIGNAGE

A well-planned and attractive system of destination signs, trail maps, and markers can greatly enhance bikeway facilities by signaling their presence and location to motorists, bicyclists, pedestrians, and other users. By leading people to bikeways and trails, effective signage can encourage more people to bicycle and walk. All wayfinding signs and bicycle striping on public roadways in Elk Grove shall conform to the guidelines laid out in the Caltrans *Highway Design Manual* Chapter 1000 and the CA MUTCD Supplement. Signs should be designed to convey direction, destination, distance, and distinction. The City should consider using D11-1 Bike Route Signs in conjunction with the D1 Bicycle Guide Signs as part of the wayfinding system. These signs should be installed at key points along on-street corridors directing bicyclists to transit stations, trails, and other major destinations like schools, parks, civic buildings, and shopping centers.

SAFETY AND SECURITY

Security or perceived security may be an issue, especially along portions of Class I multi-use trails, overcrossings, and under crossings. The following actions are recommended to address these concerns.

The Sacramento County BMP (2011) provides a broad list of recommendations to ensure the safety and security of bicycle facilities. The following recommendations have been extracted from this resource and should be incorporated into the planning and development of bicycle facilities in the city whenever possible.

- Maintain adequate recording and response mechanisms for reported safety problems.
- Respond to crash investigations with appropriate design or operation improvements.

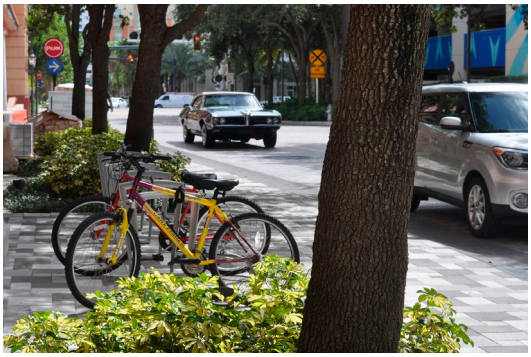
Bike Parking

In order to encourage bicycling, it is essential that bicyclists are able to lock their bicycles at a secure and convenient location, usually adjacent to their destination. If the bicycle will be parked for several hours, a bike locker or other means of secure, long-term bike parking —such as bicycle racks in an enclosed, weather protected area—is desirable.

Factors to consider when planning for bike parking include the type of trip being made, weather conditions, and perceived safety and security of the area.

Short-term Bicycle Parking Facilities

Short-term parking is defined as a few hours or less; the key to success is accessibility and convenience. Well-sited and designed bicycle parking keeps the right-of-way organized and makes it work better for all users.



Credit: Toole Design

Credit: Toole Design

Figure 5. (Top) On-street bike parking. (Bottom) Well-sited bike racks with cargo bike

Bike Rack Siting and Placement

- Bike parking should be located close to and visible from the entrance of a destination, ideally within 50 feet. It should be placed in a location with good public visibility to ensure public surveillance.
- Bicycle parking spaces should be a minimum of 6 to 8 feet long (longer to accommodate cargo bikes, trailers, and similar accessories) and 2.5 to 3 feet wide, with sufficient overhead clearance. Single racks can be easily accommodated in the furnishing zone of a sidewalk, placed parallel to the curb.
- Bicycle racks or lockers should be securely anchored to a surface or structure.
- Bicycle racks should allow the frame and at least one wheel to be locked to the rack.
- Bicycle racks should allow for two points of contact between the bicycle and rack to ensure bicycles remain upright, decreasing potential for blocking other parts of the right-of-way and damage to bicycles.
- Racks should have a minimum of 24 inches and ideally 36 inches of clearance from all directions from any vertical obstructions such as parked cars, other racks, walls, and landscaping.
- The siting of racks on a sidewalk should consider the need for a 4-foot absolute minimum pedestrian through zone (6-foot preferred minimum).

In addition to along sidewalks and building faces, bike parking can be accommodated in many locations within the public right-of-way: in "leftover" or otherwise unusable spaces, such as next to angled parking, under building awnings for protection, and at corners where parking is prohibited to ensure street visibility.

Preferred Bike Rack

Based on best practice for simplicity of design, cost, and theft resistance, the preferred short-term bicycle rack design is the "Inverted-U" style rack (Figure 9). These racks offer a simple, secure design for placement where space is limited. When installing more than one, racks should be 3 to 4 feet apart and at least 2.5 feet from other objects.

Bike Corrals

On-street bike corrals can be used to meet higher bike parking demand in a small area and free up sidewalks for pedestrian activity. They can be installed along the curb, in place of one or two vehicle parking spaces, or in areas where parking is not allowed, such as at corners. Bike corrals are typically configured to accommodate 6-12 bicycles. They are usually demarcated with pavement markings, parking stops, and flex posts, but they can also provide opportunities for incorporation of shelters and public art. Bike corrals should be designed to prevent encroachment by parking or driving vehicles.

Monitored Event Parking

Accommodating larger scale bike parking at events, even smaller weekly events like the Farmer's Market, through the installation of temporary bike parking areas is an excellent way to bolster visibility and support of bikes and even reduce congestion. Event parking can include valet bike parking, or simply the provision of many temporary racks, which are often available for rent from private vendors, or provided by bike valet providers

Credit: Toole Design

Credit: Toole Design

Figure 6. (Top) On-Street Bike Corral. (Bottom) Preferred Bike Rack

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Figure 7. Recommended Long-Term Bicycle Parking Facilities: Bike locker (Top) Bicycle Stations (Bottom), or Bicycle Cages/Room (Not Pictured)

Long-term Bicycle Parking Facilities

Long-term bicycle parking facilities are intended to provide secure bicycle storage for commuters and other long-term users. Long-term bicycle parking is appropriate at park and ride lots, transit centers, schools, and employment centers (i.e., anywhere where bicyclists will leave their bicycles for more than a few hours). For long-term bicycle parking, security and weather-protection are more critical than convenience, though good lighting and a sense of personal safety are also important.

Long-term facilities protect the entire bicycle, components, and accessories against theft and inclement weather. Examples of long-term bicycle parking facilities, shown in Figure 11, include lockers, bicycle cages, stations/check-in facilities, monitored parking, and bike parking rooms within buildings. Electronic bike lockers provide secure individualized parking that can be accessed with an electronic card. Unlike standard key lockers which provide one key for one renter, a single e-locker can be rented by multiple bicyclists each week by using smart card technology. The improved efficiency translates into greater availability and is a popular option at transit stations. Each parking space in a bike locker, cage, or room should be accessible without moving another bicycle. Generally, about 5 feet of maneuvering space should be provided behind bicycle parking spaces. Covered long-term bicycle parking facilities are preferred.

Bicycle Parking on Private Property

Safe and secure bike parking, both short and long-term, is a concern for people who bike to work, people who live in apartments or other small dwellings that may not have space for bicycle storage within the dwelling itself, and people shopping. The City requires developers of both multifamily housing and commercial properties to plan for bicycle parking, both outside and inside buildings.

Multi-Use Trail Design Protocols

The City has adopted the following trail design protocols below to direct the planning, design, construction, and maintenance of trails in the City.

Introduction

Unlike the design of on-street bikeways, which must fit within a given roadway curb-to-curb width and compete for space with other modes of travel, there is typically more latitude in the design of trails (especially when they are sited within a separate right-of-way). This flexibility, combined with the separation from vehicle traffic, provides the opportunity to meet the needs of a wider range of users and also to respond to the physical setting and surrounding landscaping. As a result, trails can become the most widely used part of the active transportation network by providing a safe, secure, comfortable, and enjoyable user experience for everyone in the community. One notable exception is trails along streams which may present their own constraints to trail design, though trail design in these situations should still seek to accommodate a wide range of users.

The following protocols address siting and design protocols, trail design, landscaping, signage and markings, and amenities.

General Siting and Design Protocols

CONNECTIVITY WITH SURROUNDING LAND USES

Trail connectivity shall be provided to surrounding land uses. Where trail corridors abut commercial and office areas, trail access shall be provided to those areas where appropriate. Where trail corridors abut residential neighborhoods, trail access shall be provided at regular intervals of approximately 600 feet. Where possible, trails shall be incorporated into parks and open spaces.

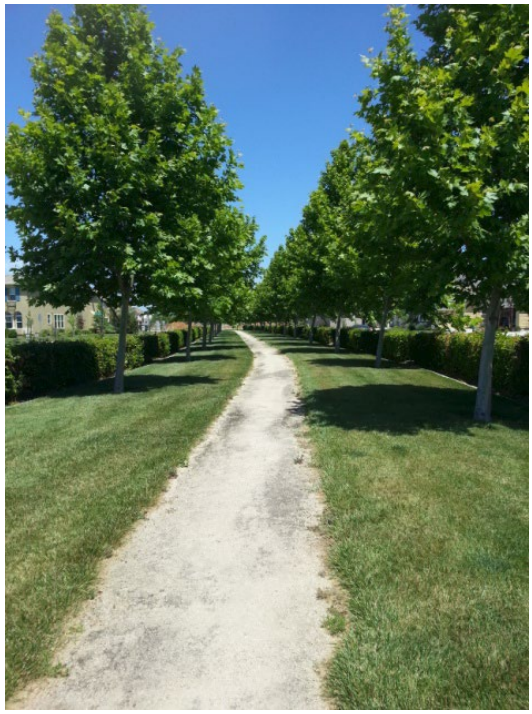

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Figure 9. Trail that is compatible with the surrounding landscape

COMPATIBILITY WITH SURROUNDING LAND USES

Trail design shall be compatible with surrounding land uses. The design of trails shall provide a degree of privacy to surrounding residences, but still allow for informal monitoring of the trail. Trails shall be designed in cooperation with adjacent property owners in order to minimize adverse impacts on adjacent land uses.

Trails shall be designed to be easily accessible via bicycle or on foot to reduce the need for parking and trailheads.

DESIGN AND COMPATIBILITY WITH SURROUNDING LANDSCAPE

In general, trails shall be designed to blend in with the surrounding landscape, shall use materials and colors that are not in contrast to the surrounding context, and, where possible, shall have alignments that are in conformance with land contours. Trail design and locations shall avoid site-specific hazardous conditions, avoid impacting potential habitat or other sensitive

areas, and not exacerbate flood conditions. It is encouraged that trail design enhance habitat for native species. Trails that parallel streams shall be located beyond wetlands, the riparian corridor, and the 10-year floodplain, where possible. Environmental sensitivity shall also inform the design of any trail crossing over a drainage channel; crossings should be arched wherever possible to minimize impacts and maintenance costs. Consultation with City engineers and regional resource agencies may be necessary in order to develop trail designs that minimize environmental impacts.

COMPATIBILITY WITH USER CHARACTERISTICS AND NEEDS

Trails design shall result in facilities that are welcoming to all user types and are easy and enjoyable for users of all ages and abilities. The design of trails shall be compliant with federal and State access requirements. They should accommodate a wider range of active transportation modes, including inline skating, scooters, e-scooters, pedal bikes, e-bikes, adaptive and recumbent bikes, skateboards, longboards, and other mobility devices. Trails should accommodate both recreational and transportation-focused trip types as well as other non-motorized users, including people walking, jogging, dog walking, riding cargo bikes and using bike trailers, pushing strollers, and participating in school group activities.

TRAIL CROSSINGS

At-grade roadway crossings that interrupt existing Class I trails shall be limited where possible to reduce interactions and conflicts between trail users and vehicles. Grade separated crossings are preferred along Class I trails, especially across major roads, to create a more enjoyable and comfortable trail experience.

TRAIL ALIGNMENT

The City uses the Caltrans Highway Design Manual Chapter 1000 standards for Class I trail alignment specifications. Trail alignment design shall be based on a 20 MPH, 25 MPH, or 30 MPH design speed. Wherever practical, trails should be normally crowned and should not be superelevated. The minimum horizontal alignment radius without superelevation is 100 feet for 20 miles per hour, 180 feet for 25 miles per hour, and 320 feet for 30 miles per hour.

Trail Dimensions and Clearance

OPPORTUNITIES FOR CALTRANS HIGHWAY DESIGN MANUAL CHAPTER 1000 STANDARDS

Wherever possible and especially where regional funding is desired, the design of combined bicycle and pedestrian facilities shall meet the Caltrans Highway Design Manual Chapter 1000 standards for Class I bikeways. These standards pertain to trail tread widths, horizontal and vertical clearances, design speeds, cross-slopes, and stopping distances.

TRAIL CORRIDOR WIDTH

A trail corridor is defined as the area within which a trail is constructed, along with landscaping and any other improvements necessary to ensure the operation of the trail. In general, trail corridors shall be as wide as possible, and at minimum, address the need for trail maintenance and emergency access where appropriate. Trail corridors shall be wider than trail tread widths to ensure flexibility in alignment possibilities for aesthetic value, safety considerations due to site conditions, and avoidance of possible habitat or other sensitive areas. Trail corridor easements shall coincide, where possible, with easement boundaries to ensure flexibility in alignment possibilities. In some cases, trail corridors will need to be narrower than would be typically desired—for instance, in infill situations where limited space is available to complete a trail connection or along a roadway where the right-of-way is narrow. In these cases, a narrow trail

corridor may be used at the discretion of the Public Works Director or their designee. Similarly, accessibility by maintenance and emergency vehicles, although desired, may not be possible on all trails.

CAPACITY AND USER MIX

The capacity of the trail system shall be a primary design focus. Trails shall be designed to accommodate expected volumes and mix of users. For instance, some features such as the trail tread width may need to be increased beyond the minimum specified in order to provide adequate capacity.

In determining the projected volume of users, trail designers should consider the area the trail serves, the number of entry points, the variety of destinations the trail services, and the trail's role in the active transportation network, as either a major or minor trail.

Trails shall be designed to accommodate two-way traffic for all user groups. Trails shall be designed to accommodate as many trail user groups as possible. In order to facilitate increased access to trails for users of varying abilities, rest areas and other trail amenities shall be provided, and steep grades shall be avoided (while in some limited circumstances the grade may be up to 8.3 percent for short distances, the maximum recommended grade is 5 percent, and it is recommended that sustained grades be limited to a maximum of 2 percent).

DESIGN TO MINIMIZE POTENTIAL USER CONFLICTS

The design of trails shall reduce potential conflicts between different user groups. Pedestrian and bicycle trail users may share combined facilities, but additional trail width may be required to allow generous passing areas on portions of the trail where high use is expected.

To the greatest extent possible, equestrian trails shall be separated from other user groups, through the use of buffers, vegetation, or grade separation.

EQUESTRIAN TRAILS

Equestrian trail treads shall be separated from other user trail treads by a minimum horizontal distance of 5 feet wherever possible, and a wider separation is encouraged. The minimum equestrian trail tread width is 5 feet, although it may be as narrow as 3 feet (with passing areas at reasonable intervals) in constrained locations. The trail tread width shall be clear of all obstructions. Trail horizontal clearances/shoulders are not required unless site conditions require them for safety. The minimum vertical clearance for equestrian trail tread is 12 feet above the tread and any horizontal clearances/shoulders. At site-specific locations, a lower clearance may be allowed (e.g., at bridge undercrossing), but in no case shall clearance be less than 10 feet.

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Figure 10. Trail that accommodates a mix of user types

Figure 11. Equestrian on trail

BICYCLE AND PEDESTRIAN TRAILS

The minimum bicycle and pedestrian trail right of way shall be 25 feet, which is consistent with minimum landscaping setback requirements for trails adjacent to roadways. Wherever feasible, the preferred width for trail right of way is 40 feet. A width of 40 feet accommodates a paved multi-use path, shoulders, retaining walls, landscaping, maintenance access, and if appropriate, separation for equestrians. The tread width shall be 10 feet of paved trail, which is consistent with Cosumnes CSD fire standards so that trails can double as fire roads. An increased trail tread width of up to 12 feet is preferred and may be required in order for the trail to provide appropriate capacity. There shall also be a graded shoulder immediately adjacent to either side of the paved surface, 3 ft preferred and 2 ft minimum. This graded shoulder should also provide the required horizontal clearance. These dimensions shall be clear of all obstructions. Additional shoulder and horizontal clearance width are not required except where there are site conditions that necessitate additional horizontal clearance for safety. The minimum width for the paved surface may be as narrow as 8 feet and the graded shoulders may be eliminated for short distances (i.e., less than 1000 feet), only in special site-specific circumstances where the terrain makes the implementation of these standards unsafe or impossible. For example, this exception may be granted if the trail is to be placed in a narrow trail infill situation where development on either side has already occurred, or if there are continuous site constraints such as a creek or vertical objects on either side of the trail. The minimum vertical clearance for bicycle and pedestrian trail tread widths is 10 feet above the tread and any horizontal clearances/shoulders. At site-specific locations, a lower clearance may be allowed (e.g., at bridge under crossings), but in no case shall clearance be less than 10 feet.

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Figure 12. Pedestrian along Laguna Creek, an example of a standard bicycle/pedestrian trail with a 10' width

Bikeway Preferred and Minimum Widths

The following table presents design protocols for Multi-Use Class I Trails, including preferred and minimum widths.

Table 4. Class I Trail Protocols

CLASS I TRAIL PROTOCOLS	CLASS I
Location	Separate right of way or adjacent to roadways
Geometrics*	12 ft (preferred), 10 ft wide (minimum); with 2 ft shoulders on each side within a 40 ft right of way
Surfacing	• Asphalt pathway with decomposed granite shoulders or native material that is harrowed and free from debris • Geotech report required with clay soils
Signage and Striping	• 4 in yellow centerline and edge lines at connections to roadways and along curves • Stop/yield signs at crossings • Wayfinding signs
Crossings/ Intersection Treatments	High-visibility trail crossing markings, warning signage, and/or actuated flashing beacons; refer to City Traffic Engineer for guidance
Amenities	Trailheads, informational signs, wayfinding, trash receptacles, seating

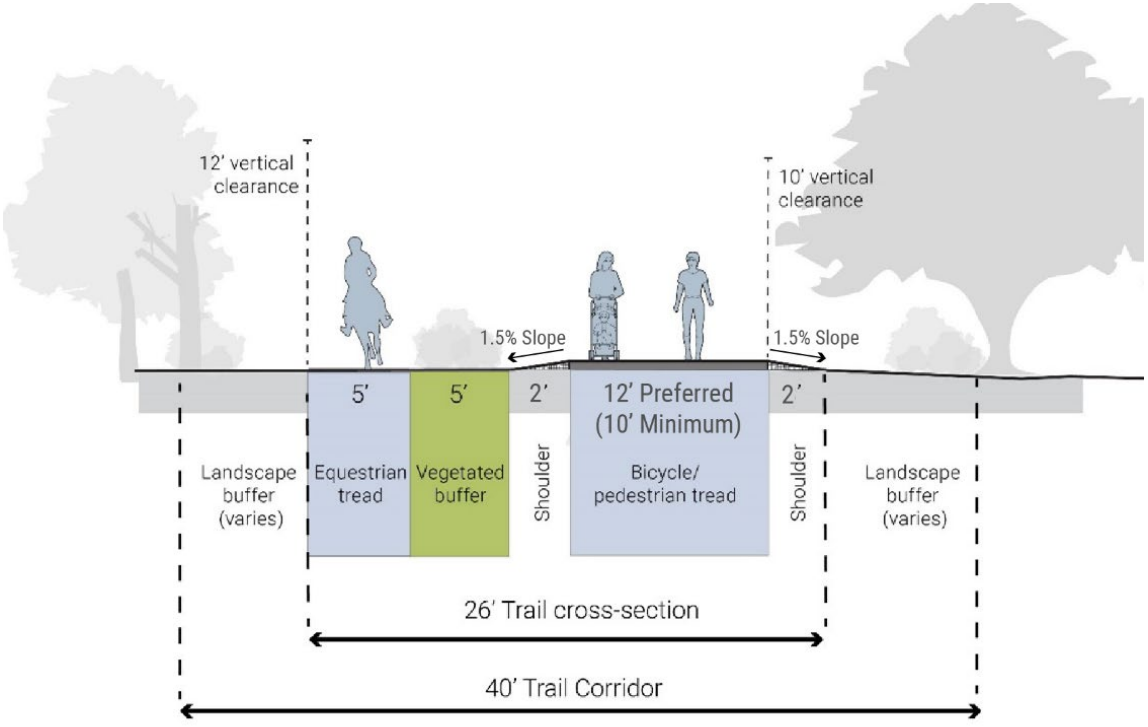

Figure 13. Trail cross-section protocols

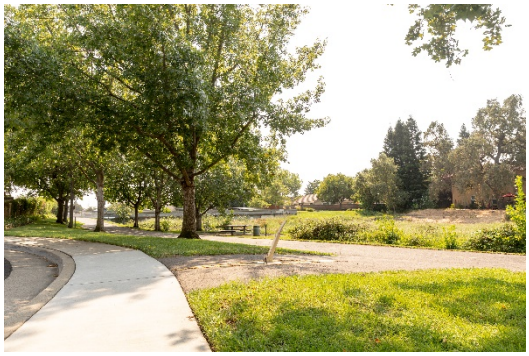

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Figure 14. Paved trail connecting to a sidewalk

TRAIL FOUNDATION

All trails shall be designed with consideration given to the structural characteristics of underlying soils and expected loadings. Loadings include typical trail use as well as maintenance vehicles and emergency vehicles. Trail foundations, and in particular, edges, shall assure trail longevity and shall support the weight of motorized vehicles required for emergencies and/or maintenance operations. Compressible, Clay, saturated, or other adverse subsurface foundation conditions should be mitigated prior to construction. The Trail pavement design should be designed with a Traffic Index (TI) of 5 with a 20-year design life.

SURFACE MATERIALS FOR BICYCLE AND PEDESTRIAN TRAIL TREADS

Trail surfaces shall be a minimum of 3 inches of Mot Mix Asphalt over 8 inches of Class 2 Aggregate Base. Permeable pavement may also be considered, as well as other materials that may aid in safety, landscaping maintenance, and/or trail user comfort. The paved surface of bicycle and pedestrian trail treads shall be of environmentally friendly recycled content wherever possible. Surface materials shall also be skid resistant. Increased thicknesses and content of surface materials shall be considered in order to improve durability. In limited circumstances, it may be permissible to temporarily open a trail prior to the installation of paving. The graded shoulder immediately adjacent to the paved surface shall be composed of decomposed granite. Shoulder in fill shall have an edge treatment sufficient to support the shoulder such as a concrete or aluminum edging.

SURFACE MATERIALS FOR EQUESTRIAN TRAIL TREADS

Like the graded shoulders of bicycle and pedestrian trails, equestrian trail treads are required to be composed of decomposed granite or native material that is thoroughly harrowed, free from debris (roots, gravel, and cobble, etc.), and suitable for use after inclement weather.

SURFACE QUALITY

All trail treads shall have continuous surface quality. If repairs are made to trail surfaces, they shall provide for a surface that is as smooth as the original surface. Additionally, drainage grates, manhole covers, driveways, or similar obstructions shall be located and installed to promote safety of trail users. Considerations include the design of all drainage grates and avoiding the construction of vertical lips between materials or keeping them to the maximum allowed by accessibility standards.

DRAINAGE

Trail treads shall be designed to prevent runoff from being erosive to their surface or of surrounding soils and vegetation. If collected, trail runoff shall be discharged in such a manner that prevents erosion and impacts to surrounding vegetation and should be conveyed to an area where natural treatment can occur prior to discharge to creeks or streams. Any drainage ditches and grates that are used shall be placed in locations so as to not present obstacles or hazards to trail users.

CROSS-SLOPE

Trails surfacing and shoulders shall have a cross-slope of 1.5 percent or as needed to ensure proper drainage but still conform to accessibility guidelines. Sloping in one direction only or a crowned trail is allowed.

Landscaping

PLANTING PALETTE

Plant materials shall be selected for their year-round vigor and shall be planted to have an immediate and ongoing aesthetic effect, as well to reduce urban the heat island effect. Preference should be given to use of native plants which are consistent with the trail location and provide habitat suitable for native species. Plant materials shall range in sizes from groundcovers, small shrubs (minimum size: 1 gallon), large shrubs (minimum size: 5 gallons), and trees (minimum size: 15 gallons for large trees, 24-inch box for smaller trees).

The trail planting palette may incorporate plants used elsewhere in the surrounding developed areas. Project proponents are also welcome to recommend landscape plant materials that meet the City's criteria for approval. Plant materials are being tested all the time and new or hybridized plants are welcome. Care shall be given to not utilize surface rooting trees near trails in order to lessen the likelihood of tree roots affecting the trail surface. Plant materials used shall not be toxic to humans or animals. Plant litter shall not pose a hazard to trail users (e.g., eucalyptus trees drop branches and leaves that can be trip hazards; some grasses and bushes have thorny seeds that can puncture bicycle tires).

Refer to Appendix D for a list of City-recommended plant materials. These trees, shrubs, perennials, and grasses are drought-tolerant or require low water use. There are two sizes of trees in the palette: trees that are large and can overhang the trails, and small trees for trails in electrical power line corridors. (Power companies have special requirements for plant materials within their easements.) Many trees listed in the palette have some sort of fruit, berry, cone, or acorn, as these are common features to most plants. The shrubs and perennials listed in the palette are low- spreading plants or grow 3 feet high or less. Smaller growing plants may have to be planted in masses but will require less maintenance.

Figure 15. Oak tree along Laguna Creek Trail

DESIGN FOR LOW MAINTENANCE, WATER EFFICIENCY, AND DROUGHT TOLERANCE

Landscaping along trails shall be designed for low maintenance, water efficiency, and drought tolerance, especially through the broad use of native and drought-tolerant plant materials, the use of efficient/water-conserving irrigation systems, the grouping of plants with similar water needs, and the use of mulch. Chapter 14.10 of the Elk Grove Municipal Code contains water-efficient landscape requirements for new and remodeled commercial developments that may be adapted for trail planting and irrigation. Most plant materials grown in plant nurseries are watered at least daily depending on the climate, and most drought-tolerant plants will need to be weaned from the nursery watering and have an automatic spray, bubbler, or drip irrigation system installed. Irrigation systems should be designed to ensure the establishment and perpetuation of plant materials. One potential issue with drip irrigation systems are blockages in the drip line, resulting in plants dying before maintenance staff can repair the drip line. A spray or bubbler irrigation system allows the maintenance staff to visually inspect

the system and the amount of water being applied. Three-inch-deep wood chip mulch is recommended around and under shrubs and trees. Mulch helps retain moisture in the ground and reduce weed growth and maintenance.

PLACEMENT OF PLANT MATERIALS

Consideration shall be given to the placement of trees and shrubs in order to provide shade at regular intervals, especially at waysides, and not obscure views of significant features such as trailheads, trail crossings, and trail amenities, among others. Shrubs and trees may also be used to help screen undesirable views or ground-mounted equipment from the trail. Plant materials should be carefully placed at trailheads, staging areas, and trail crossings so that they do not interfere with necessary sight distances.

Placement of plant materials should also be based on the availability or need for irrigation. Trails through open space or along creek without irrigation should have limited native plantings that can easily be established without continuous truck watering.

NATURAL SURVEILLANCE

Applying the principles of Crime Prevention Through Environmental Design (CPTED) will enhance natural surveillance that helps to deter crime and unwanted behavior along the trail network. Some key principles of CPTED that apply to landscaping include:

- Vegetation should be located and maintained so that formal and informal monitoring of the trails is unimpaired. Corridors should be visually unobstructed by maintaining a minimum two-foot horizontal clearance from the paved edge of the trail and a preferred vertical clearance of ten feet (minimum of eight-foot vertical clearance)
- Vegetation that appears well-maintained and cared for demonstrates clear ownership and investment and discourages unwanted use
- Strategically place vegetation to prevent access to areas restricted from the public
- Maintain tree canopy so that it does not interfere with lighting fixtures

VEGETATION CONTROL

To maintain a smooth trail surface for the safety of all users and to maintain the integrity and durability of the trail surface, the following vegetation management strategies are recommended.

- Use of a soil sterilant is required below all paved tread widths in order to prevent possible weed growth through trail surfaces.
- Root barriers guards shall be installed wherever trees are planted closer than 4 feet to paved tread widths. Root barriers shall be installed to extend at least 24 inches deep and to a distance of 10 linear feet from either side of the tree's trunk along the paved tread width or as approved by the City Engineer.

HEIGHT OF VEGETATION

In order to enhance visibility and reduce hiding places, the minimum vertical clearance for trees along trails is 10 feet from the surface of the trail to the lowest branch. Shrubs, such as in buffers, should not exceed 3 feet in height.

LIGHTING

Lighting shall only be used at localized points where necessary for trail safety and security, as determined by the Director of Public Works or their designee. For example, lighting shall be considered where there are trail crossings with streets or potential conflicts along paths, or through under crossings/tunnels for security and personal comfort. Trail lighting shall be designed to minimize light pollution.

FENCING

Fencing shall not be a component of trails unless necessary for safety reasons or avoidance of sensitive areas, or if directly adjacent to private property. When fencing is necessary and the trail is adjacent to open space, the fencing shall be open, see-through material (e.g., wrought iron) for scenic and safety reasons and to deter illegal dumping into the natural area. Post–and-cable fencing shall be used between trails and naturally sensitive areas.

Figure 16. Vegetation enhances the trail experience

Trail Signage and Markings

TYPES OF TRAIL SIGNAGE

A variety of signage types may be installed along trails. Signage shall be attractive, easily readable at varying speeds and distances, and provide a hierarchy of information. QR codes, which provide instantaneous links to websites, can be used in places where trail users are expected or invited to stop, such as at informational kiosks. In general, signage types include:

- Regulatory (e.g., indicates trail speed limit, clarifies right-of-way at intersections, lists hours of operation, lists activities that are restricted)
- Safety-oriented (e.g., provides notification of potential hazards, identifies when there is a convergence of trail user types, lists emergency contact information)
- Behavioral (e.g., lists codes of trail conduct, clarifies trail user rights-of-way and yield information, clarifies trail etiquette)
- Directional/wayfinding (e.g., identifies the trail and distances to popular destinations, provides mileage information, identifies cross-street names). The City should continue to use the G72(CA) Signs as part of the City's trail wayfinding system.
- Informational (e.g., identifies trail amenities and characteristics, lists trail maintenance and graffiti/vandalism abatement contact information, lists contact information to find out more about the city trail system, indicates that the trail is publicly owned)
- Educational/interpretive (e.g., provides descriptions of adjacent natural features or cultural resources, provides information on local watersheds)

REQUIRED SIGNAGE STANDARDS

Trail signage shall meet all applicable signage standards where necessary, including ADA Accessibility Guidelines and Applicable Title 24 California Codes, Caltrans *Highway Design Manual* Chapter 1000, CAMUTCD, the City Municipal Code, the City Police Department policies and standards, and the Cosumnes Community Services District (CCSD) regulations. Standards cover topics such as signage shapes, colors, dimensions, lettering, symbols, word messages, borders, and signage placement locations, heights, orientation, and offsets.

Figure 17. Signage along the Laguna Creek Trail

SIGNAGE LOCATIONS

Signage shall be provided at all of the following locations:

- At-grade street and railroad crossings and transitions. Signage for at-grade street crossings and transitions shall conform to all applicable standards. Detectable warnings shall be installed to assist trail users with visual impairments. The use of accessible pedestrian signals shall be considered in locations with signalized traffic control or active warning beacons for the cross-street. In advance of at-grade trail crossings with streets, trail users shall also be notified of the crossing, if the trail continues beyond the street or ends at the street, and if the crossing offers an opportunity to transition to an on-street facility, such as sidewalks or bicycle lanes. Signage shall be installed to notify motorists of upcoming trail crossings.
- Convergence of user groups. Approximately 100-200 feet in advance of any bicycle and pedestrian trail convergences with an equestrian trail, notification shall be posted along both trails regarding the convergence.

- Horizontal and vertical clearances. There may be instances where the minimum horizontal and vertical clearances cannot be accommodated, such as at bridge under crossings. In these instances, warning signage shall be placed on either side of the obstruction feature, and notification shall be posted 100-200 ft in advance of the obstruction to inform trail users of such conditions and appropriate behavior (e.g., reducing speeds or dismounting).
- Trail inundation (flooding). Notification shall be posted in advance of all possible trail inundation locations. This is typically done by operations and maintenance staff who perform regular inspections.
- Trailheads and staging areas. Notification of any trail regulations, trail codes of conduct, trail amenities and characteristics, emergency contact information, and trail maintenance contact information shall be posted at trailheads and staging areas. Brochures and maps may also be placed at these locations. The use of QR codes and audible informational signs shall also be considered.

SIGNAGE PLACEMENT AND LOCATION FREQUENCY

The frequency of signage locations shall depend upon the signage type/purpose. The number and location of signs shall be carefully considered, as a lack of signage or poorly located signage can create hazardous situations for trail users and an overabundance of trail signs can affect the aesthetic quality of the trail experience and decrease signage effectiveness. Signage may be placed at alternating sides of the trail and may be double-sided. In general, directional signage shall be placed at all trailheads/staging areas, major intersections, and turns and approximately every quarter mile as necessary.

SIGNAGE MATERIALS, CONSTRUCTION, AND INSTALLATION

Trail signage shall be of durable materials and shall be constructed and installed to be resistant to weather, vandalism, and theft.

CENTERLINE STRIPING

Reflective trail centerline striping is typically used to encourage trail users to stay to the right to avoid oncoming traffic and conflicts. Centerline striping is recommended at trail crossing approaches, when a trail is likely to be heavily used by two-way traffic, on curves with restricted sight distance, and where nighttime use is expected (and the trail is not illuminated). Striping is also recommended when tread widths run along continuous fixed objects (e.g., walls, fencing) so that users have improved ability to navigate their proximity to the object. On higher volume trails, striping can also be used to indicate separate sections for walking and bicycling.

TRAIL ENTRANCE BARRIERS

Low landscaping, knock-down trail bollards, or other forgiving entrance barriers shall be used at trail entrances as a deterrent to unauthorized motor vehicles. The use of barriers should not pose a safety hazard to trail users. The spacing of entrance barriers shall be wide enough to permit the passage of wheelchairs, bicycle-towed trailers, and adult tricycles, but shall not be wide enough to accommodate motor vehicles. Care shall be taken to carefully mark and ensure the visibility of entrance barriers through the use of reflective

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Figure 18. Shade structure/rest area

pavement markings and reflective markers on the barrier itself. A single reflective knock-down trail bollard at the middle of a trail entrance is an appropriate deterrent depending on trail width and cross-section, allows maintenance and emergency vehicles to quickly access the trail, and prevents trail users from having to navigate multiple bollards.

Trail Amenities

TRAIL STAGING AREAS AND TRAILHEAD GENERAL CONSIDERATIONS

Care must be given to the design and maintenance of trail staging areas and trailheads since they provide an initial impression of trail condition and amenities provided.

TRAIL AMENITIES

Trail amenities shall be provided for all potential trail user groups. Amenities include year-round shade areas/structures, water fountains, trash cans, pet waste bag stations, benches, public art, emergency equipment (e.g., call boxes), signage, educational kiosks or interpretive signage, bicycle racks, equestrian hitching posts, restrooms, picnic facilities, warm-up/stretching areas, and dog parks. These amenities should be provided frequently, but their locations, especially restrooms and water fountains, may be influenced by their proximity to existing utilities. Trail amenities shall also be located such that they can be monitored easily for security and lighted if necessary. Trail amenities shall be designed to be easy to maintain and constructed to be resistant to weather, vandalism, and theft. Trash cans shall be designed and located to be easily serviceable.

ACCESSIBILITY CONSIDERATIONS FOR TRAIL AMENITIES

Picnic areas, restrooms, parking areas, and other facilities along trails and at staging areas shall be accessible to all trail users. Rest areas with benches shall be provided at reasonable intervals, the frequency of which shall vary depending on the terrain, surroundings, available shade. Benches at rest areas shall have backrests and armrests to assist in resting and getting up from the bench. See the Introduction for additional accessibility guidelines.

SHADE AND TREES

Given the hot, dry climate of Elk Grove in the summer, it is important to provide shade trees along trails at regular intervals. Native trees should be provided along creeks and other natural drainages to help provide comfortable streamside viewing. Provision of shade trees, shade structures, or locations that provide other sources of shade should be considered for bench locations.

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Figure 19. Pet waste station along a trail

Table 5. Trail Amenities Placement Protocols

TRAIL AMENITIES	PLACEMENT
Seating	• Near scenic views, parks and playgrounds, and dog parks • Approximately every half mile • Consider available shade, lighting, and other pleasant or unpleasant surroundings, which will be site-specific
Wayfinding Signage	• Crossings and transitions • Approximately 100-200 feet in advance of trail convergences • Trailheads and staging areas • Approximately every half mile
Etiquette Signage	• Approximately 100-200 feet in advance of trail convergences • Trailheads and staging areas
Waste Receptacles	• Crossings and transitions • Trailheads and staging areas • Locations that are easily accessed by maintenance vehicles
Pet Waste Stations	• Crossings and transitions • Trailheads and staging areas • Locations that are easily accessed by maintenance vehicles

Note: These placements are not meant to be prescriptive; rather, they are meant to illustrate locations where amenities may be well-suited to meet the needs of trail users. Placement of tail amenities will be context and site specific and, as such, may also be well-placed in other areas not listed here.

Trail Crossings

The primary goal of the design of trail crossings is to prevent collisions. Trail crossings shall be designed so that they are intuitive to understand and easy for all users, as well as safe and comfortable to use.

Trail crossings are also natural nexus points and thus provide an opportunity for trail amenities like wayfinding signage, seating, trash receptacles, and water fountains to boost the convenience and comfort of the trail experience.

CLEAR ASSIGNMENT OF RIGHT OF WAY

The right of way at at-grade crossings shall be clearly assigned, given that conflicting traffic streams intersect one another at crossings. In assigning right of way, consideration shall be given to the behavior of trail users (e.g., delay tolerance, desire to maintain momentum, or children's traffic knowledge).

SIGHT DISTANCES AND TRAIL USER VISIBILITY

Intersection sight distances at crossings enable both trail users and motorists to anticipate and avoid collisions with one another.

Sight distances should be calculated for each crossing using both vehicle and trail user speeds and traffic control types. Where approach and departure sight triangles cannot be met or obstructions cannot to removed, traffic control devices, or geometric changes should be used to address sight distance concerns. Adequate warning signs shall be provided to allow bicyclists to stop before reaching the intersection, especially on downgrades. Stop signs shall be located as close as possible to the desired stopping point. Signage shall be placed so that it is not ambiguous as to which user it applies to.

CROSSING APPROACHES AND TRANSITIONS

Crossing approaches shall have a relatively flat grade. Ten-foot non-skid paved aprons at crossings shall be provided where trail treads are otherwise unpaved to accommodate the transition in trail tread surface out of the crossing area. Roadway surfaces near crossings shall be designed to minimize roadway debris blown into the trail surfaces.

EG BPTMP (2014)

Figure 20. (Top) Trail crossing with clear visibility and right of way assignment. (Bottom) Bridge crossing a natural feature

Crossings can be entrance and exit points for the trail system, so likely turning movements might be accommodated by flaring curb cuts to facilitate right turns for bicycles and other users on wheels. Ramps and curb cuts at crossings shall be the same width as the trail or wider in order to minimize user conflicts. Curb cuts with ramps and detectable warning surfaces shall also be provided to ensure a smooth transition to the crossing surface and comply with accessibility guidelines.

CROSSING TREATMENTS

Trail crossings shall be designed to make right of way assignment clear, through signs and pavement markings, and to slow and organize trail users as they cross. Crossing treatments must also indicate to drivers that motor vehicles are prohibited on the trail. Geometric changes, low plantings, pavement markings (i.e., "Road Ahead" or "Slow"), and flexible (i.e., knock-down) bollards can be used for crossing treatments. Minor crossings (driveways and low-volume streets) shall feature signs and markings. At uncontrolled locations, such as mid-block crossings, high-visibility treatments like flashing beacons, pedestrian signals, and high-visibility crosswalks and signage shall be used to increase awareness of the crossing.

AT-GRADE CROSSING TRAFFIC CONTROL DEVICES

Crossings may include traffic control devices to facilitate movements across busy streets. Devices to actuate traffic control (e.g., push buttons) should be installed such that all mounted trail users (i.e., bicyclists and equestrians) can use them without dismounting. Accessible pedestrian signals with vibro-tactile indicators shall be installed at these locations.

AT-GRADE TRAIL CROSSING LOCATIONS

All at-grade trail crossings must occur in predictable locations and where trail users will be clearly visible. Locations of at-grade road crossings may be influenced by motorized traffic volume, speeds, and road widths. Trails should cross at right angles with roadways and railroad tracks.

EG BPTMP (2014)

Figure 21. Grade separated trail alongside a roadway

At intersections, it is important to consider opportunities to reduce corner radii to slow motorists making right turns across the trail crossing as well as adjustments to traffic signals to enhance crossing convenience (e.g., restricting turning movements, providing leading pedestrian intervals, and establishing an all-red phase to allow for trail crossings). It is generally permissible for trail at-grade crossings with collector and local streets to occur at mid-block locations if vehicle speeds are under 30 mph and vehicle volumes allow for adequate gaps in traffic. In these situations, careful consideration shall be given to traffic control devices, the possibility for the use of refuge islands, access control, and pavement markings and illumination. If raised crossings are used, edges of the crossing shall be visually delineated (e.g., with pavement markings or different paving materials).

AT-GRADE CROSSING ACCESSIBILITY CONSIDERATIONS

At-grade crossings shall be accessible to the full range of trail users, which requires design that reflects the navigability and crossing times required for trail users of various abilities and modes. Considerations shall include but are not limited to the dimensions of the path of travel, grades and surfacing at curb cuts, the availability of detectable warning signals, and the maintenance of a clear crossing free of barriers, obstacles, and hazards. Refuge islands shall be considered where high-volume roadway traffic and/or speeds create unacceptable conditions for path users, roadway width is excessive given the available crossing time, or where the crossing will be used by a number of people who will cross more slowly (e.g., older adults, children, and people with disabilities). Refuge islands shall be large enough to accommodate platoons of users and provide enough distance from passing motorists for trail users to feel safe. See the Introduction for information and guidelines on accessibility.

AT-GRADE TRAIL CROSSINGS AT RAILROADS

The most desirable crossing is a perpendicular crossing, and at least 60 degrees is preferred (45 degrees minimum). If an angle is required, then the use of durable flangeway filler strips could be used on low-speed railroad tracks to increase crossing safety for trail users. The trail could also be widened (which might necessitate acquiring additional right-of-way) at the crossing so that users can choose their desired crossing angle.

GRADE-SEPARATED CROSSINGS

Grade-separated trail crossings may be planned for and pursued as a last resort, when other design options have been exhausted.

Candidate locations for grade-separated crossings include barriers like highways, roadway crossings around schools and parks where there are young trail users, and roadway crossings along trails that are particularly high in usage. In limited instances where public funding for a grade-separated crossing might not be immediately forthcoming, it may be permissible to construct an interim at-grade crossing.

GRADE-SEPARATED CROSSING DESIGN CONSIDERATIONS

In order to ensure that grade-separated crossings are well used, these crossings shall be located such that they allow for a direct route of travel relative to any nearby at-grade crossings. Further, they shall have a grade that is flat enough to accommodate differences in trail user abilities, and they shall be designed so that trail user entrapment areas are not created. In general, the trail shall not narrow at overpasses or underpasses and approaches may be flared to allow for improved clearance. Other trail user provisions shall be considered 1000 feet on either side of the bridge to ensure a safe transition. Planking for overpasses and underpasses shall be angled at 45 degrees or more to prevent diversion of bicycle wheels.

EG BPTMP (2014)

Figure 22. Trail etiquette sign

User Management

TRAIL ETIQUETTE

In keeping with the rules established for regional trails like the American River Parkway, the right of way rules for Class I bikeways in the City are as follows:

- Bicyclists should keep to the right lane, except to pass.
- Bicyclists should announce by voice or by bell, when passing pedestrians or slower bicyclists.
- Pedestrians should keep to the left lane, so they can see approaching cyclists.
- Faster traffic should yield to slower traffic. Bicyclists should yield when entering and crossing trails.
- Bicyclists should pull off of the trail if they need to stop.
- Equestrians should travel at a safe speed and let others know if it is safe to pass their horse. Typically, all users yield to and pause for equestrians.

Providing adequate trail width, especially in cases where there are either many more bicyclists than pedestrians, will help reduce the potential for conflicts between users.

Safety and Security Considerations

Security or perceived security may be an issue, especially along portions of Class I multi-use trails, overcrossings, and under crossings. The following actions are recommended to address these concerns specifically for Class I multi-use trails:

- Manage vegetation so corridors are visually unobstructed by maintaining a minimum two-foot horizontal clearance from the paved edge of Class I facilities, in accordance with the Caltrans Highway Design Manual Chapter 1000. The minimum vertical clearance from vegetation should be 8 feet and where practical, the preferred clearance is 10 feet.
- Provide adequate lighting at tunnels, under crossings, and overcrossings.
- Place benches and other path amenities at locations with good visual surveillance and high activity.
- Provide mileage markers at half-mile increments and clear directional signage for orientation.
- Create a "Path Watch Program" involving local residents, which is a program that provides an opportunity for local residents to become actively involved in creating inviting spaces for residents and families to enjoy trail facilities safely.

Security on the trail system will largely be provided through the informal monitoring of the trail by trail users. Security shall also be facilitated through the design of the trail system elements (including but not limited to horizontal clearances, signage, landscaping, lighting) and through the enforcement of security by the Elk Grove Police Department.

SECURITY

Trail user security on the trail system will largely be provided through the informal monitoring of the trail by other trail users. Security shall also be facilitated through the design of the trail system elements (including but not limited to horizontal clearances, signage, landscaping, lighting, and location of amenities) as well as Crime Prevention through Environmental Design tenets.

Pedestrian Design Protocols

Introduction

Whether driving, biking, or taking transit, all trips start with and end with a walk. The design of pedestrian facilities shall account for both travel along roadways and travel across roadways to ensure that all waking trips, whether long or short, are safe and comfortable.

All pedestrian facilities in the city shall be designed in compliance with Caltrans *Highway Design Manual* Chapter 1000, Topic 105 – Pedestrian Facilities. This chapter covers sidewalk design (e.g., standard minimum width, crossings, maintenance), pedestrian grade separations, accessibility requirements, and location and design of curb ramps. Further resources for the planning and design of pedestrian facilities include:

- Pedestrian Facilities Users Guide – Providing Safety and Mobility, 2002, FHWA
- Design Guidance for Accommodating Bicycle and Pedestrian Travel: A Recommended Approach, FHWA
- Manual on Uniform Traffic Control Devices (MUTCD), FHWA
- Safe Transportation for Every Pedestrian (STEP), FHWA
- Small Town and Rural Multimodal Networks Guide, FHWA
- Americans with Disabilities Act Accessibility Guidelines (ADAAG) for Buildings and Facilities, US Access Board
- Proposed Guidelines for Pedestrian Facilities in the Public Right-of-Way (PROWAG) Accessibility Guidelines, US Access Board
- Rural Road Improvement Standards

In addition, recommendations and best practices for pedestrian facility enhancements are outlined below.

Sidewalks: Travel along the Roadway

Sidewalks in Elk Grove should be designed to be both functional and inviting. Providing adequate width and a well-maintained surface free of major cracks and root upheavals is an important start. A buffer from motor vehicle travel lanes, provided by a row of parallel parking, a bike lane, or street trees or plantings, vastly improves the experience of walking by providing separation from the roadway. Street trees also provide needed shade. Seating is an important need for younger and older users, and benches should be provided at regular intervals in areas where there are higher pedestrian volumes. The character along the property line is also important. Sidewalks adjacent to surface parking lots should be buffered by low walls or vegetation. Ideally, buildings are set close to the property line closest to the roadway, to provide a sense of enclosure and visual interest, as long as they feature façades with windows and pedestrian-scale detailing.

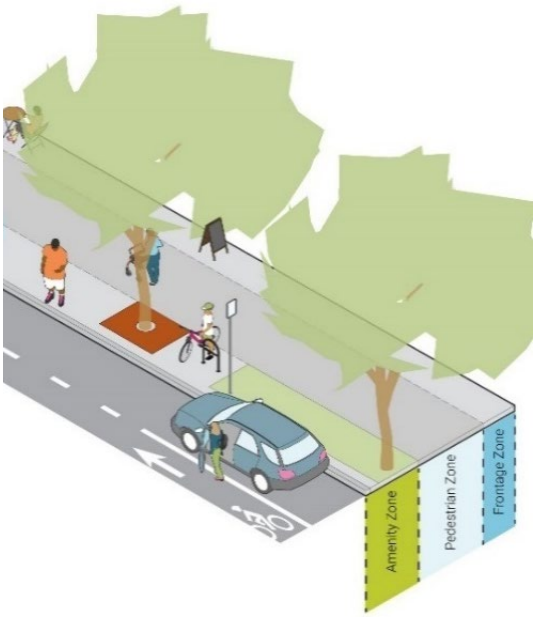


Figure 23. Sidewalk zones

SIDEWALK WIDTHS

The minimum desirable width for a sidewalk in Elk Grove is 5 feet. In areas where higher pedestrian volumes can be expected, such as business districts, widths of 8 to 10 feet are desirable. The City of Elk Grove Improvements Standards Manual should be consulted for information on exact sidewalk widths depending on land use and location. A sidewalk consists of several zones, each dictated by the type of street, as shown below.

Table 6. Sidewalk Zones and Widths

ZONE	WIDTHS
The **Frontage Zone**, along the property line, which allow for door swings and other building features. Wider widths accommodate café seating.	Refer to the City of Elk Grove Improvement Standards
The **Pedestrian Zone**, which includes the pedestrian walking zone. Some factors that would call for a wider Pedestrian Zone include more intense land use and presence of a transit line.	Refer to the City of Elk Grove Improvement Standards
The **Amenity Zone,** located immediately adjacent to the curb, accommodates people stepping out of parked cars, parking meters, signs, street trees, lighting, transit stops, and bike parking.	Refer to the City of Elk Grove Improvement Standards

Rural Roadway Improvement Protocols

Sidewalks may not be feasible or appropriate on rural roadways. Paved shoulders and shared use paths can provide safe, physical or visually separated space for walking along rural roadways. In case where these options are not feasible, there are some strategies than can be used to increase safety and comfort. These center on increasing driver awareness through additional lighting and signs and increasing reaction time by reducing speed limits.

Crossings: Travel Across the Roadway

CROSSING ENHANCEMENTS

Well-designed street crossings are vital for improving pedestrian mobility and connecting neighborhoods. Well-marked, high-visibility pedestrian crossings prepare drivers for the likelihood of encountering a pedestrian. They also create an atmosphere of walkability and safety for pedestrians. For instance, if pedestrians must travel substantial distances out of their way to use a crossing at a controlled intersection, there is often an increase in crossing at unmarked mid-block locations, which increases the risk of pedestrian/vehicle collisions.

As with sidewalks, street crossings are particularly important near key destinations such as schools, transit stops, parks, and other pedestrian activity generators. Where trails intersect with roadways, careful design of the intersection is necessary to ensure that the crossing is safe and convenient for all road and trail users. The addition of new street crossings may be most effective where there are existing safety deficiencies and a high demand for street crossings.

FHWA provides a variety of resources to help designers select the most appropriate crossing treatment. Table 7, from the FHWA Guide for Improving Pedestrian Safety at Uncontrolled Crossing Locations, provides pedestrian crash countermeasures to consider based on roadway configuration, posted speed limit, and AADT.

Overall, the goal of street crossing treatments is to reduce pedestrian and bicyclist exposure time to vehicles, and to increase visibility and predictability.

The following toolbox provides a list of sidewalk and crosswalk enhancement devices that can be used to improve the safety and walkability of the pedestrian environment.

Figure 24. Signalized pedestrian crossing in Elk Grove

Table 7. FHWA Guide for Pedestrian Crash Countermeasure Selection

Roadway Configuration	Posted Speed Limit and AADT								
	Vehicle AADT <9,000			Vehicle AADT 9,000–15,000			Vehicle AADT >15,000		
	≤30 mph	35 mph	≥40 mph	≤30 mph	35 mph	≥40 mph	≤30 mph	35 mph	≥40 mph
2 lanes (1 lane in each direction)	❶ 2 4 5 6	❶ 5 6 7 9	① 5 6 ❼ ❾	❶ 4 5 6	❶ 5 6 7 9	① 5 6 ❼ ❾	❶ 4 5 6 7 9	① 5 6 7 9	① 5 6 ❾
3 lanes with raised median (1 lane in each direction)	❶ 2 3 4 5	❶ ❸ 5 7 9	① ❸ 5 ❼ ❾	① 3 4 5	① ❸ 5 ❼ ❾	① ❸ 5 ❼ ❾	① ❸ 4 5 7 9	① ❸ 5 ❼ ❾	① ❸ 5 ❾
3 lanes w/o raised median (1 lane in each direction with a two-way left-turn lane)	❶ 2 3 4 5 6 7 9	❶ ❸ 5 6 7 9	① ❸ 5 6 ❾	① 3 4 5 6 7 9	① ❸ 5 6 ❼ ❾	① ❸ 5 6 ❾	① ❸ 4 5 6 7 9	① ❸ 5 6 ❾	① ❸ 5 6 ❾
4+ lanes with raised median (2 or more lanes in each direction)	❶ ❸ 5 7 8 9	❶ ❸ 5 7 8 9	① ❸ 5 8 ❾	① ❸ 5 7 8 9	① ❸ 5 ❼ 8 ❾	① ❸ 5 8 ❾	① ❸ 5 ❼ 8 ❾	① ❸ 5 8 ❾	① ❸ 5 8 ❾
4+ lanes w/o raised median (2 or more lanes in each direction)	❶ ❸ 5 6 7 8 9	① ❸ 5 ❻ 7 8 9	① ❸ 5 ❻ 8 ❾	① ❸ 5 ❻ 7 8 9	① ❸ 5 ❻ ❼ 8 ❾	① ❸ 5 ❻ 8 ❾	① ❸ 5 ❻ ❼ 8 ❾	① ❸ 5 ❻ 8 ❾	① ❸ 5 ❻ 8 ❾

Given the set of conditions in a cell,

- \# Signifies that the countermeasure is a candidate treatment at a marked uncontrolled crossing location.
- ● Signifies that the countermeasure should always be considered, but not mandated or required, based upon engineering judgment at a marked uncontrolled crossing location.
- ○ Signifies that crosswalk visibility enhancements should always occur in conjunction with other identified countermeasures.*

The absence of a number signifies that the countermeasure is generally not an appropriate treatment, but exceptions may be considered following engineering judgment.

1. High-visibility crosswalk markings, parking restrictions on crosswalk approach, adequate nighttime lighting levels, and crossing warning signs
2. Raised crosswalk
3. Advance Yield Here To (Stop Here For) Pedestrians sign and yield (stop) line
4. In-Street Pedestrian Crossing sign
5. Curb extension
6. Pedestrian refuge island
7. Rectangular Rapid-Flashing Beacon (RRFB)**
8. Road Diet
9. Pedestrian Hybrid Beacon (PHB)**

*Refer to Chapter 4 of the Guide for Improving Pedestrian Safety at Uncontrolled Crossing Locations for more information about using multiple countermeasures and a list of studies that informed the development of this table.

**It should be noted that the PHB and RRFB are not both installed at the same crossing location.

Pedestrian Intersection Enhancement Toolbox

Credit: Toole Design

REDUCE CORNER RADII AND PROVIDE DIRECTIONAL CURB RAMPS

Smaller corner radii are one of the most important tools for creating safe crossings for pedestrians at intersections. Reduced radii force drivers to turn more slowly (i.e. 15 mph) and better align cars to approach and enter a crosswalk with better visibility of crossing pedestrians. They also provide the opportunity to create directional curb ramps that align with crosswalks in each direction, thus creating shorter and more direct pedestrian crossings. Curb radii can be adapted through retrofit, as shown in the example.

Credit: Toole Design

CURB EXTENSIONS/BULB-OUTS

Curb extensions can be installed at intersections or mid-block locations to extend the curb and pedestrian space further into the roadway, helping to shorten the length of crosswalks. They serve to calm vehicular traffic by narrowing the roadway and improving visibility of pedestrians.

EG BPTMP (2014)

PEDESTRIAN ISLANDS

Raised pedestrian islands can be placed in the center of a wide roadway with cutouts along the pedestrian path and may be located at intersections or mid-block crossings. Islands provide pedestrians with a safe place to stop at the midpoint of a roadway before crossing the remaining distance. Center turn lanes may be converted into crossing islands, or they may be accommodated by reducing travel lane widths or removing travel or parking lanes entirely.

Credit: Toole Design

High-Visibility Crosswalk Signage and Striping

Marked crosswalks guide pedestrians and alert drivers to a crossing location, so it is important that both drivers and pedestrians clearly see the crossings. High-visibility crosswalk signage and striping treatments include markings made of longer-lasting plastic or epoxy materials embedded with reflective glass beads, ladder marking design (rather than traditional parallel line crosswalk design), and yellow or fluorescent pedestrian warning signs.

Credit: Toole Design

RAISED CROSSWALK

Raised pedestrian crosswalks serve as traffic-calming measures by extending the sidewalk across the road and ramping motor vehicles up to sidewalk height. They act as speed humps to slow vehicular traffic, allow pedestrians to cross at a nearly constant grade, and increase pedestrian conspicuity.

COLORED AND TEXTURED PAVEMENT

Colored or textured paving materials can be used to call attention to sidewalks and crossings and distinguish them as part of the pedestrian realm.

Credit: Toole Design

TRUCK APRONS AND SLOW TURN WEDGES

Truck aprons, made of durable contrasting materials, can be used to reduce a corner radius visually. They alter the effective turning movement of vehicles while allowing a wider actual radius for trucks, buses, and other heavy vehicles.

Slow turn wedges are typically flex posts or rubber curbs and bollards that are installed to guide drivers into slower turns to reduce pedestrian crossing exposure and increase pedestrian visibility.

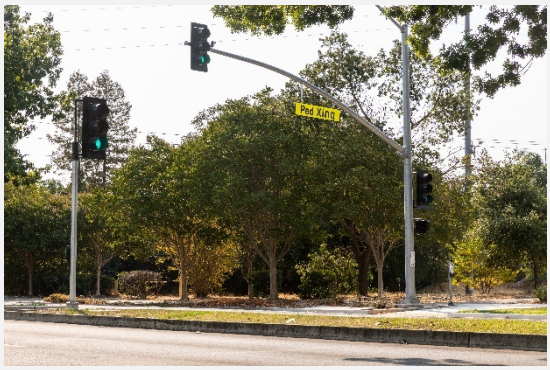
PEDESTRIAN SIGNAL HEAD

A pedestrian signal head is a conventional traffic control device used at intersections and mid-block locations with traffic signals. Pedestrian signal heads indicate to pedestrians when it is safe to cross an intersection by displaying a lighted sign with a "Walk" symbol (walking person) or "Do Not Walk" symbol (raised hand). In areas of high pedestrian activity, an option is to set pedestrian signals to automatic recall so that pushbuttons are not required. Countdown pedestrian signal heads are the new standard for pedestrian signals, per the California MUTCD. Countdown signals indicate how many seconds remain to cross the street and allow pedestrians the flexibility to speed up if the crossing time is about to expire. Accessible Pedestrian Signals (APS), which provide vibrotactile, beeping or chirping, and sometimes verbal signals, are designed to help visually impaired pedestrians safely cross an intersection. They should be installed at all new signalized locations, where there has been a request, where there is potential demand, or where traffic volumes or intersection complexity would make it challenging for people with vision disabilities to safely navigate the crossings.

Two additional signalization tools that provide safety benefits to active transportation users are protected left turns and Leading Pedestrian Intervals (LPIs). Protected turn phases greatly reduce the potential for conflict between left turning vehicles, especially on high-volume, multi-lane roadways, and crossing pedestrians. LPIs give pedestrians a Walk signal 3 to 7 seconds before vehicles traveling in the same direction receive a green signal, enabling pedestrians to establish right of way in the crosswalk and have priority over turning vehicles. LPIs are recommended in areas with high pedestrian demand or a collision history.

RECTANGULAR RAPID FLASH BEACONS

Rectangular Rapid Flashing Beacons (RRFBs) are used at uncontrolled locations to increase the visibility of and yielding to crossing pedestrians by motorists. The flashing beacons are installed with crosswalk markings and are activated by the crosswalk user rather than flashing at all times. Studies suggest that RRFBs can significantly increase vehicle yielding rates compared to standard pedestrian warning signs alone.



PEDESTRIAN ACTIVATED TRAFFIC SIGNAL

Pedestrian-activated signals allow pedestrians and bicyclists to stop traffic to cross high-volume streets. This type of signal may be used in lieu of a full signal that meets any of the traffic signal control warrants in the MUTCD. It may also be used at locations which do not meet traffic signal warrants but where assistance is needed for pedestrians or bicyclists to cross a high-volume arterial street.

Credit: Toole Design

LIGHTING

Street lighting is one of the most effective ways to improve pedestrian safety and comfort. Properly lit intersections and pedestrian-scale lighting along sidewalks ensure that movement along and across the roadway feels safe for pedestrians and ensures that pedestrians are visible to drivers.

CUT THROUGHS

Cut throughs between parking lots, business districts, neighborhoods, and cul-de-sacs provide continuity and convenience for pedestrians and bicyclists. Where roadway networks are circuitous, development has occurred over time, or other barriers exist, pedestrian connectivity can suffer due to lack of connection, out of direction travel, or other barriers.

All trips start and end with walking. The experience and needs of pedestrians differ from all other modes – pedestrians are more vulnerable to the impacts of roadways design to favor drivers, to climate, and to land use. It is thus important to consider the pedestrian environment as a whole—not just sidewalks and intersections, but the experience created by the pedestrian's surroundings.