City of Davis
Public Works Department
2016 Street Standards

Approved
Council October 4th, 2016

SECTION V
TRANSPORTATION SYSTEMS DESIGN

A. GENERAL

The intent of this section is to describe the most common practices in the City of Davis concerning streets, bicycle and pedestrian systems design and improvements. Almost all significant transportation elements are reviewed during the approval of a General Plan, Zoning and Tentative Map for a project. Most street arrangements are reviewed by the City Engineer during the preparation of the Environmental documents for the project.

1. Reference Design Documents

These design standards are prepared with consideration of the referenced design documents below. The Project Engineer shall refer to the latest editions of these documents for details which may not appear herein or which may have been duly revised and adopted.

These referenced design documents are listed in the general order of precedence:

(a) City of Davis, General Plan – Transportation Element
(b) City of Davis, Municipal Code
(c) National Association of City Transportation Officials Design Guide (NACTO Design Guide)
(d) State of California, Governor's Office of Planning and Research
(e) Caltrans Highway Design Manual (HDM)
(f) California Manual on Uniform Traffic Control Devices (CA MUTCD)
(g) Public Works Standard Specifications
(h) City of Davis, Beyond Platinum Bicycle Action Plan
(i) City of Davis, Climate Action and Adaptation Plan
(j) Project EIRs, Traffic Studies, and Discretionary Approvals
(k) Other Public Works Design Standards Sections (i.e. Utilities/Electrical System)

2. Preliminary Site Plan Approval

All transportation system arrangements require approval of a Preliminary Site Plan by the City Engineer before the Project Engineer begins preparation of the Improvement Plans. A PW approved tentative map, which has been reviewed by the City Engineer, will generally suffice as an approved Preliminary Site Plan.

3. Types of Streets

The following section provides definitions of typical street types and applications. Typical Street Sections are included within Appendix A of these Design Standards.

a. Major Arterial

Major Arterial streets are continuous, located to serve large traffic volumes and designed to minimize access to abutting property via driveways, alleys and business entrances. Streets feeding into major arterials should be spaced at one-quarter-mile intervals. Major arterials should not penetrate neighborhoods and should be planned to eliminate through traffic in residential neighborhoods and adjacent to schools.

b. Minor Arterial

Minor Arterials streets are continuous, located to provide a direct route between, but not through, separate neighborhoods. Minor arterials should be planned to eliminate through traffic in residential neighborhoods and adjacent to schools.

c. Collector Street

Collector Streets are non-continuous, located to collect traffic from local streets and distribute it to minor and major arterials. The difference, other than size, between a collector and an arterial is that a collector penetrates a neighborhood, while an arterial does not.

d. Local Street

Local streets, not identified as a collector or arterial, provide access to abutting property and designed not to accommodate or encourage through trips.

e. Modified Local Street

Modified Local Streets are similar to local street, but with additional right-of-way. Modified local streets are typically used for higher volume local streets, particularly with high bicycle volumes.

f. Cul-de-sac

Cul-de-sacs are local street terminating in a turning area and generally not exceeding 400 feet in length.

g. Downtown Street

Downtown Streets are fully improved streets located in the "Downtown" area as defined within the Core Area Specific Plan.

h. Intersection (Includes Roundabouts)

An intersection is the general area where two or more roadways join or cross, including the roadway and roadside facilities for movements in that area.

A roundabout is a type of circular intersection with specific geometric and traffic control features that in combination lower speed operations and lower speed differentials among all users immediately prior to, through, and beyond the intersection. Vehicles shall follow the "yield upon entry" rule for traffic approaching the roundabout's circulatory roadway.

i. Alley

An alley is a road passing through a continuous row of houses, buildings, etc. that permits access from the local street network to backyards, garages, etc.

j. Rural Street

Rural streets, not identified as a collector or arterial, are located outside the urbanized area, provide access to abutting property and designed not to accommodate or encourage through trips.

k. Private Roads

Private Roads are small, privately owned and maintained streets serving more than 3 and less than 10 single-family lots (or the equivalent).

4. Elements of Streets

The following section provides definitions of common street elements and applications.

a. Moving Lanes

Moving Lanes, also identified as Travel Lanes, are primarily designed to carry vehicular traffic. May or may not be delineated with striping.

b. Two-Way Left-Turn Lane

Two-Way Left-Turn Lane include a paved center turn lane for the use of left turning and merging traffic on Minor Arterials.

c. Center Median

Center Medians include landscaped center island between opposing vehicular lanes on Major Arterials and some Minor Arterials.

d. Shared-Use Paths (Class I)

Shared-Use Paths, also identified as bike or bicycle paths, are improved off-street facilities for transporting pedestrian and bicycle traffic.

e. Bicycle Lanes (Class II)

Bicycle Lanes are immediately adjacent to the outside travel lane for the purpose of carrying bicycles. Citywide Existing Bicycle Lane alignments are shown in the General Plan. Bicycle lanes with buffer separation shall be included adjacent to the outside travel lane.

f. Bike Route (Class III)

Bike Routes are travel ways providing service to both vehicular and bicycle traffic. Bike Routes shall be delineated using Bike Route chevron markings.

g. Separated Bikeway (Class IV)

Separated Bikeways and Two-way Separated Bikeways, also identified as cycle tracks, are for the exclusive use of bicycles and includes a separation required between bicycle traffic and vehicular traffic. Bikeway separation for moving lanes shall be provided by the following methods: grade separation, flexible posts, inflexible physical barriers, or on-street parking.

h. Pedestrian Way

Pedestrian ways are facilities designed solely for pedestrians (sidewalks) or to be shared by pedestrians and bicycles.

i. Curb Lane

The Curb Lane is the travel lane closest to the curb and gutter of a roadway. Curb lane widths shall be increased by 1’ to accommodate user “shy distance”.

j. Turn lane

A Turn Lanes is a lane marked for left or right turning vehicles only. Either uniform width or tapered to provide for acceleration (speeding up and slowing down) and merging with traffic.

k. On-Street Parking

On-Street Parking are paved area on the street immediately adjacent to concrete curb for parking motor vehicles and bicycles.

l. Transit Turnouts

Transit Turnouts are areas for the sole purpose of bus stops, including area for shelter/bench and bike parking.

m. Driveways

Driveways provide a way or place in private ownership and provide connection with public streets for the owner and those having express or implied permission from the owner but not by other members of the public.

n. Common Driveways

Common Driveways are privately owned and maintained streets serving up to 3 single family lots.

B. HORIZONTAL ALIGNMENT REQUIREMENTS FOR STREETS

The following requirements shall be used in the design of the horizontal alignment of public and private street and bike paths.

1. Section Requirements

The geometric cross-section of the street shall conform to the General Plan and as otherwise approved by the City Council. Street sections and elevations shall be symmetrical about the street centerline. Non-symmetrical street sections require special approval by the City Engineer. Typical Street Sections are included within Appendix A.

Street Classification :	Major Arterial	Minor Arterial	Collector	Modified Local	Local	Cul-de-sac	Alley	Downtown Street
Right of Way (ROW) Width	102'-146'	75'	62'	50'	44'	38'	20’	80'
Roadway Width[2]	70'-96'	42'-72'	34'-56'	34'-50'	34'-50'	27'	20'	50'
Median Width	16'	Varies	-	-	-	-	-	-
No. of Travel Lanes	4	2	2	2	2	2	-	2
Travel Lane No. 1 - Lane Width[1]	10'	10'	10'	10'	10'	10'	-	10'
Travel Lane No. 2 - Lane Width[1]	10.5'	-	-	-	-	-	-	-
Bike Lane (Class II) [1]	Yes	Yes	Yes	Yes	-	-	-	Yes
Bike Lane (Class III)	-	-	Yes	Yes	Yes	-	-	Yes
Bike Lane (Class IV)	Yes	Yes	Yes	-	-	-	-	-
Bike Lane (Class IV) Width (Min)	7'	7'	7'	-	-	-	-	-
Bike Lane (Class IV) Buffer Type	R or F	P, R or F	P, R or F	-	-	-	-	-
Bike Lane (Class II & IV) Buffer Width (Min)	3'	3'	3'	-	-	-	-	-
Bike Lane Width (Min)	7'	7'	7'	-	-	-	-	7'
Parking Lane Width (Max)	7'	7'	7'	7'	7'	7'	-	7'
Sidewalk Width (Min)	6'	6'	6'	6'	6'	6'	-	15'
Landscape Buffer (Min)	6'	6'	4'	-	-	-	-	-
Shared-Use Path?	Yes	Varies	-	-	-	-	-	-
Shared-Use Path Width	12'	12'	-	-	-	-	-	-
Left Turn Lanes Req'd?	Yes	Yes	Varies	Varies	-	-	-	Varies
Left Turn Lane Width	10'-11'	10'	10'	10'	-	-	-	10'
Right Turn Lane Width	11'	11'	-	-	-	-	-	-
Design Speed	40 mph	35 mph	30 mph	25 mph	25 mph	20 mph	5 mph	20 mph
Driveway & Street Access	Limited	Limited	Limited	Unlimited	Unlimited	Unlimited	XX	XX
								Yes (inverted 'T')

1. 1’ Shoulder shall be included when travel lanes or bike lanes is adjacent to vertical face
2. Roadway width applies to new roadways. Existing roadway widths may vary
3. Standard buffer width shall be 3-ft. In constrained areas, buffer width may be reduced to 2-ft with approval from City Engineer

P = Physical barrier for buffered bike lane (Class IV)

R = Raised or grade-separated barrier for buffered bike lane (Class IV)

F = Flexible barrier for buffered bike lane (Class IV)

2. Design Speed and Sight Distance

All features of the street improvement and design shall be based on the following design speed and minimum stopping sight distance requirements. Deviation from these requirements will require review by the City Traffic Engineer, the Bicycling Transportation and Street Safety Commission (BTSSC), and approval by the City Council.

Table B-2: Design Speeds and Minimum Sight Distances on Level Roadways		
Street Classification	Design Speed	Minimum Stopping Sight Distance
Major Arterial	40 mph	300 Feet
Minor Arterial	35 mph	250 Feet
Collector	30 mph	200 Feet
Modified Local	25 mph	150 Feet
Local	25 mph	150 Feet
Downtown Street	20 mph	125 Feet
Cul-de-sac, etc.	20 mph	125 Feet
Private Street	20 mph	125 Feet
Alley	5 mph	25 Feet

3. Curves

Horizontal curves shall be used to provide a change in horizontal alignment. Minor directional changes may be accommodated at intersections, subject to City Engineer review.

a. Minimum Horizontal Curve Radii by Street Classifications

The minimum horizontal curve radii at the facility centerline shall be designed in general accordance with the following table.

Minimum Horizontal Curve Radii	
Street Classification	Minimum Curve Radii
Major Arterial	550 feet
Minor Arterial	425 feet
Collector	300 feet
Modified Local	225 feet
Local	225 feet
Rural	130 feet
Downtown Street	130 feet
Intersection (includes Roundabouts)	130 feet
Cul-de-sac	130 feet
Shared-Use Path	50 feet
Private Street	50 feet
Alley	40 feet

b. Tangents

Tangents between horizontal curves shall be provided on all streets. The minimum tangent length shall be 150 on Arterials and 50 feet on other streets. Tangent lengths may be reduced for curve radii larger than the minimum required, subject to City Engineer approval.

4. Intersections

a. Basic Layout Criteria

The following table shall be used as a guide in determining the various improvements to be installed at each type of intersection. Where two dissimilar types of street intersect, the requirements for the larger capacity facility shall determine the minimum design criteria.

Basic Intersection Requirements			
Street Classification	Intersection Spacing	Turn Lane Provisions	Intersection Control Provisions
Major Arterial	1000 ft	Left	Signalized or Roundabout[1]
Minor Arterial	500 feet	Two-Way	Signalized, Stop Controlled or Roundabout[1]
Collector	300 feet	No	Stop Controlled
Locals, Cul-de-Sacs, and etc.	200 feet	No	As Needed
Bike Paths	Mid-block or corners	N/A	As Needed
Private	100 feet	No	As Needed

[1] Requires special approval by City Engineer

b. Turning movements

The design of intersection turning movements should minimize conflicts between vehicles, pedestrians, and bicycles while providing adequate curb radii for the design vehicle.

Intersection design vehicles are subject to City Engineer approval. Most intersections shall provide for turning movements of CA legal highway trucks unless identified as a restricted route. Caltrans turn movement templates shall verify the ability of design vehicles to negotiate the various turns. Appropriate signage shall identify intersections with prohibited U-turn movements.

c. Corner Sight Distance

Corner sight distance shall be provided at all intersections and crossings and designed for the intersecting street design speed and stopping sight distance. Intersections shall provide line-of-sight between users for the minimum stopping sight distance, and include a 5 feet offset line-of-sight buffer. Areas requiring corner sight distance shall limit the height of landscaping and visual obstructions to 30 inches above the paved travel way. Appendix A includes Visual Sight Clearance Standard Drawings.

d. Corner Radius Requirements

The minimum radii requirements at intersection corners shall be as follows, with exceptions to accommodate design vehicles as approved by the City Engineer:

Radius Requirements at Corners	
Street Classification	Minimum Radius @ Curb Line
Major Arterials	35 feet
Minor Arterials	35 feet
Collectors	30 feet
Locals and Cul-de-Sacs, etc.	25 feet
Bike Paths	20 feet

5. Cul-de-sac

An approved cul-de-sac shall be provided at the ends of all public streets, whether the end is temporary or permanent. The standard cul-de-sac design shall be used whenever feasible. Acceptable alternates shall provide for turning movements of City Fire Trucks and other vehicles. Shared-use paths that terminate at a cul-de-sac shall end in an approved curb ramp.

6. Driveways

A driveway shall be provided for connection of any on-site roadway or parking area to a public street. All driveways shall be designed to meet handicap accessibility requirements.

Driveway Requirements	
Type of Use	Minimum-Maximum Width
Industrial	25 feet
Commercial	25 feet

Multiple Family	20-35 feet
Residential	12-30 feet
Shared-Use Paths	8-12 feet

7. Transitions

All transitions where a lane is dropped or shifted shall be tapered to allow traffic to safely merge into the remaining lane of traffic.. The minimum transition distance on any street shall be 90 feet. Lane transitions shall follow CA MUTCD Figure 3B-14(CA).

For Speeds 45mph or more; L = WS

And

For Speeds 40mph or less; $L = WS^2/60$ with

L= Length in Feet, S = Design Speed in mph, W = offset in feet

C. VERTICAL ALIGNMENT REQUIREMENTS FOR STREETS

Properly designed vertical curves should provide adequate sight distance, safety, comfortable driving, and good drainage.

1. Basic Criteria

Streets vertical alignments shall be designed in accordance with the design speed and sight distance requirements in Table B-2 of these Design Standards.

2. Grade (Longitudinal Slopes)

It is desirable to provide the flattest grade practicable. Often longitudinal grades are controlled by drainage requirements. The minimum slope for concrete curb and gutter shall be 0.35% on tangents and sections where the radius is greater than 100 feet; The minimum slope for concrete curb and gutter shall be 0.50% for sections where the radius is less than 100 feet. Slopes above 6.0% shall require special approval by the City Engineer.

3. Vertical Curves

Vertical curves shall be designed per the Caltrans HDM. A vertical curve shall be provided whenever the change in grade exceeds 2.0%. The minimum lengths of vertical curves shall be 100 feet for Arterials and Collector Streets; and 50 feet for remaining streets.

4. Cross Slopes

The street grades and elevations shall be designed to provide good positive runoff of rainfall throughout the entire section.

a. New Construction: Full or Half Street Section

The design pavement cross slope shall be 2.0% from centerline to gutter lip. This cross slope may be decreased to 1.5% at intersections. Design cross slope above 2.0% shall require special approval by the City Engineer.

b. Construction Adjacent to Existing Streets

The design pavement cross slope shall be a minimum of 1.5% and a maximum of 4.0%, from the conform point on the existing pavement to the lip of gutter. The existing pavement shall be overlaid with new pavement and/or removed and replaced with new pavements as needed to meet these requirements. Changes from the existing slopes shall require approval by the City Engineer.

Cross-sections shall be provided at a minimum interval of 25 feet, or as required by City Engineer, to verify the design cross slopes. Cross-sections may be submitted as a separate document from the Plan Set. The cross-sections shall include: existing pavement

grades, existing adjacent ground elevations, proposed pavement grades, proposed pavement elevations, conform points, proposed curb and gutter elevation; and station of cross-section.

5. Pavement Transitions

Transitions shall be designed to provide a smooth ride at the posted speed. New pavement shall conform to existing pavement such that the finish surface is flush. When new pavement sections overlay and conform to the existing pavement section, existing pavement shall be planed to allow minimum 2 inch new pavement overlay. Abrupt vertical transitions or feathering of pavement (gradually decreasing pavement thickness) to achieve a smooth transition is not allowed.

D. PEDESTRIAN AND HANDICAP ACCESSABILITY

Sidewalks shall be designed to serve all users. Pedestrian facility design and operation must comply with the accessibility standards in the Americans with Disabilities Act (ADA) of 1990. Design should also address accessible pedestrian signals, markings, and signage. Temporary and alternate pedestrian routes where sidewalks are obstructed by work zones must meet accessibility standards, as well.

In residential areas, alternate locations of pedestrian ways not adjacent to the street may be acceptable. All such alternate locations require review by the City Engineer, BTSSC and approval of the City Council.

Dual curb ramps shall be provided at all corners, intersections and locations where a person is expected to cross the street. Ramps shall be provided on both sides of the street and opposite each other. All delineated crossings with curb ramps shall be perpendicular to the street centerline.

E. STREET STRUCTURAL DESIGN

Pavement structure for public streets and paths shall provide adequate strength, ride quality, and durability to carry projected traffic loads for the minimum 20 year design life. The Project Engineer shall consider the anticipated construction traffic within the calculation of design life of street facilities. Pavement structure sections shall be designed in conformance with Caltrans HDM methods and the requirements of these standards.

1. Basic Design

Pavement Structures shall be designed with consideration of project soil properties and the design traffic index. The project's soil properties shall be identified within the Project Soils Report and determined through materials testing. The design traffic index shall be the greater of either the traffic index requirements or approved Traffic Study recommendation.

Traffic Index Requirements	
Street Classification	Minimum Traffic Index
Major Arterials	9.0
Minor Arterials	7.0
Collectors	7.0
Modified Locals	6.0
Locals	5.0
Cul-de-Sacs, etc.	4.5
Private	4.0

2. Underdrains

The Project Soils report shall indicate the ability of subsurface soils to infiltrate and transport drainage water. Underdrains may be required for streets underlain with very permeability soils, and streets located in all areas west of Highway 113 (Aspen, Stonegate, Evergreen, etc.) or within the Covell Park subdivisions (including Northstar).

F. LANDSCAPE REQUIREMENTS

Medians and other bare ground areas of all new streets shall be fully landscaped with irrigation. The landscaping shall meet City requirements for low water use and durability. Landscape irrigation shall be contained within landscape areas. The minimum

width of any landscape area shall be 4 feet. Landscaping shall meet visual sight clearance requirements identified in these Standards.

In medians, a suitable 2 foot wide buffer, such as decomposed granite, shall be provided between the landscaped area and the median curb. The median landscaped areas shall be edged with wood headers, such as are used along the edges of bike paths.

All median landscaping will be subject to the review of PCS.

G. SHARED-USE PATH AND BICYCLE FACILITY DESIGN

All Bicycle facility designs shall conform to the requirements contained in the Caltrans Highway Design Manual, Chapter 1000, "Bikeway Planning and Design", and to the requirements of these standards.

1. Shared-Use Path Design Requirements

The City's Shared-Use Path and Bicycle Design requirements are equivalent to the Caltrans HDM Class I Bikeway design requirements.

Shared-Use Path designs shall conform with these Design Standards and the Caltrans HDM. Shared-Use Path design condition not addressed within these design standards or the Caltrans HDM shall be subject to City Engineer approval.

a. Horizontal Alignment

The minimum centerline curve radius on shared-use paths shall reference HDM Table 1003.1 for design speeds and minimum curve radius. At intersections with other paths, the minimum radius along the edge of path shall be 20 feet, except for special situations subject to City Engineer review.

b. Width

Shared-use path widths shall be a minimum 12-foot paved path. Shared-Use Path shoulders shall be minimum 2 feet and be composed of an all-weather surface that is vegetation free. Clearance to obstructions shall be minimum 3 feet from the Shared-Use Path. Shared-Use path widths less than the specified minimums shall be determined by FHWA "Shared-Use Calculator" and are subject to City Engineer approval.

c. Grade (Longitudinal Slopes)

The maximum allowable grade for Shared-Use Path shall be 4.9%. Any change in grade exceeding 2.0% shall be accomplished using a vertical curve. Vertical curve length shall be the greater of the minimum length of crest vertical curves or 50 feet. Shared-Use Paths may be constructed at level grade provided that there is adequate cross-slope to facilitate drainage.

d. Cross-Slope and Drainage

Shared-used path cross-slope shall slope at 2.0% perpendicular to the path direction. The path shoulder shall slope away from the traveled way at 2.0% to 5.0%. Suitable drainage improvements shall be provided in the vicinity of the path such that 10-year design storm water flows shall not encroach onto the Shared-Use Path.

e. Pavement Structure

The minimum Shared-Use Path structure section shall be 6-inches of Portland Cement Concrete over 4-inches aggregate base and 6-inches compacted subgrade. Appendix A includes Shared-Use Path Standard Details. Asphalt Concrete may be used in-lieu of Portland Cement Concrete in situations subject to City Engineer approval.

f. Lighting

Standard Post-Top Street Lights shall be near all path intersection, connections to adjacent streets, within sag curves, and at intervals not to exceed 135 feet. Post-Top Street Lights shall be a minimum height of 14 feet, and be installed with 1-foot offset from the edge of the shoulder. Post-Top Luminaires shall be LED and provide 5 to 22 Lux illuminance.

g. Delineation and Signing

Shared-use path delineation stripping shall not be applied expect at tunnels and sharp turn approaches. At Tunnels and sharp turn approaches, delineation stripping shall be in general accordance with California MUTCD Section 9C.

2. Bike Lane Design Requirements

The City's Bike Lane requirements are equivalent to the Caltrans highway design manual Class II Bikeway design requirements.

Bike Lanes shall be provided for each direction of travel for Major Arterials, Minor Arterials, Collector streets, and Modified Local Streets and shall be located immediately adjacent to the outside travel Lane.

a. Width

Bike lanes shall be minimum 7 feet wide. Bike lanes adjacent to on-street parking shall be minimum 8 feet wide and include delineation separating the bike and parking lanes.

b. Clearance

The minimum vertical clearance to any overhead obstruction shall conform to the adjacent street minimum requirement.

c. Grade (Longitudinal Slopes)

Grades shall match adjacent street grade.

d. Cross Slope

Cross slopes away from the adjacent streets shall be between a minimum 1.5% and maximum 5.0%.

e. Pavement Structure

Pavement structure shall match the minimum structural section as required for street design.

f. Lighting

Lighting shall be consistent with adjacent street standard lighting specifications.

g. Delineation and Signing

Bike lane delineation shall be in accordance with California MUTCD Section 9C; signage shall be in accordance with California MUTCD Section 9B. Parking Lane adjacent to Bike Lane shall be delineated with a solid stripe, and shall include inverted "T" delineated parking stalls. Delineation and signing not addressed within California MUTCD shall be subject to City Engineer approval.

3. Separated Bikeway (Class IV) Design Requirements

The City's Separated Bikeways are equivalent to the Caltrans Highway Design Manual Class IV Bikeway design requirements. Class IV bikeways are the preferred treatment on arterials and collector roads.

A Class IV Bikeway (separated bikeway) is a bikeway for the exclusive use of bicycles and includes a separation required between the separated bikeway and the through vehicular traffic. The separation may include, but is not limited to, grade separation, flexible posts, inflexible physical barriers, or on-street parking. Separated bikeways typically operate as one-way bikeway facilities in the same direction as vehicular traffic on the same side of the roadway. However, two-way separated bikeways can also be used, usually in lower speed (35 miles per hour or less) environments. For the separated bikeway in higher speed environments, an inflexible physical barrier should be considered. On one-way streets, the one-way separated bikeway may be on either side of vehicular traffic, but they are usually favored to be on the left side of vehicular traffic in order to avoid conflicts with transit vehicle operations, unless a design accounts for these conflicts on the right side of vehicular traffic.

Where there is on-street parking, the separated bikeway is typically between the parking and the sidewalk. The separated bikeway may also be raised vertically to an elevation higher than the finished grade of the roadway; but should not be raised at intersections, alleys and driveways. When a separated bikeway converts a portion of a sidewalk or is at the same grade and adjacent to the sidewalk, it is at a different grade from the roadway and separated by a curb/vertical taper; with this option, the sidewalk portion used for the separated bikeway can no longer be used by pedestrians. In order to separate pedestrians a continuous detectable vertical element (barrier, planters, etc.) is needed, but with periodic openings for bicyclists to access buildings; so this option should not be implemented with parking because access to parked vehicles and the sidewalk would mostly be blocked. As is necessary, vehicles will need to cross the separated bikeway to access driveways and alleys. Also, pedestrians will need to cross the separated bikeway from parked vehicles or transit facilities.

Where on-street accessible parking is proposed for the block, it may be better to avoid the side of the block face adjacent to the separated bikeway. The federal Public Rights-of-Way Accessibility Guidelines contains the accessible parking provisions on a block perimeter basis. However, if accessible parking is required on the block face adjacent to the separated bikeway, the separated bikeway will have to be modified.

a. Community Context

Separated bikeways afford some bicyclists a greater sense of comfort and usability, thereby increasing the number of bicyclists on the roadways. The development of a well-conceived bikeway network that includes separated bikeways can have a positive effect on bicyclist and motorist behavior and on the community.

Providing an interconnected network of bikeways along with education and enforcement can improve the safety and access for bicyclists. The decision as to which Class of bikeway to use should be made in coordination with the local agency that the facility travels through. Regarding the various bikeways, there is potential overlap of bikeway designations, so the following helps to clarify the distinction:

- A contraflow bike lane is a Class II Bikeway that is designed for travel in the opposite direction as vehicular traffic. However, contraflow bike lanes are not placed on two-way roadways. See the CA MUTCD Part 9 for more information.
- A buffered bike lane is a Class II Bikeway that has a marked buffer without the Class IV Bikeway separation between the bike lane and the vehicular traffic lane. See the CA MUTCD Part 9 for more information. If a marked buffer is provided with the Class IV Bikeway separation, this is considered a separated bikeway.
- A two-way bikeway adjacent to the roadway is typically a bike path (Class I Bikeway) and can be for the exclusive use of bicycles if there is an adjacent pedestrian facility (e.g., a sidewalk) per CVC 21966. However, if the Class IV Bikeway separation is used, this is regarded as a separated bikeway. See the HDM Index 1003.1 for more information.

In many contexts, it may be appropriate to have the various bikeway classifications interconnect in an overall network. Also, it may not be appropriate or feasible to have a continuous separated bikeway through certain street environments, as in a street with many driveways. A bike lane may perform better in this context.

The FHWA has issued an Interim Approval (IA-14) for the optional use of green colored pavement in marked bicycle lanes and extensions of bicycle lanes through intersections and other traffic conflict areas. Green paint shall only be used at high conflict zones.

b. Crossing Points: Intersections, Alleys and Driveways

Intersections

The usability and safety of the separated facility depends heavily on the manner in which intersections, including the pedestrian facilities, interact with and connect to the separated bikeway and bikeway network. As such, it is critical that careful thought and planning go into the design of all intersections located along a bikeway.

Intersection design should strive to minimize conflict points between the separated bikeway user and the crossing motorized traffic and pedestrians. Providing space for motorists to wait while yielding to bicyclists and pedestrians, separating bicycle crossing from pedestrian crossing, and providing space for turning and queuing bicyclists should be considered. If on a sidewalk, bicyclists and pedestrians should be separated with push buttons placed to accommodate separated crossings together with appropriate signs and markings.

Separated bikeways should also be separated from crosswalks at intersections to discourage bicyclists from mixing with pedestrians, such that the separated bikeway path of travel will be adjacent to the crosswalk. Sometimes it may be desirable to direct the bicyclist to cross the intersection similar to crossings for Class II bikeways (bike lanes). To accomplish this, the separated bikeway should end and become a bike lane and continue with the operations of a bike lane prior to and through the intersection; typically, the separation feature will terminate before the intersection and resume after the intersection (unless a separation is designed at the intersection). However, the markings may extend through the intersection denoting the separated bikeway projection as dotted white lines and/or with green colored pavement. See the CA MUTCD Part 9.

At intersections, right-turn lanes may necessitate that the separated bikeway be modified or terminated. If terminated before the intersection, the approach markings can be the same as a bike lane positioned to the left side of the right-turn lane. See the CA MUTCD Part 9. If it is desired to maintain the separated bikeway path through the intersection, Figures 22, 23, 25 and 26 in the FHWA Guide may be used. However, Figure 23 will necessitate an interruption to allow a vehicle to cross the separated bikeway; therefore, the separated bikeway marking should be dotted. When using the Figure 22 option, consider utilizing the CA MUTCD Part 4 guidance to provide a bicycle signal in order to eliminate conflicts between turning vehicular traffic and bicycles proceeding straight through the intersection in the separated bikeway. Figures 25 and 26 are without the right-turn lanes.
At an interchange it may be better to discontinue the separated bikeway so that it would function as a bike lane due to the weaving of entry and exits vehicles on the local road. See the CA MUTCD Part 9.

Alleys and Driveways

Separated bikeways at alleys and driveways should remain as a separated bikeway facility. However, the physical separation feature, such as flexible posts, planters, etc. will be discontinued at alley or driveway locations. The separation markings may continue at these locations. For example, see Figure 14 of the FHWA Guide.

Marking the separated bikeway with green colored pavement may be only at high conflict zones.

Loading and Unloading Zones and Valet Parking

Loading and unloading zones or valet parking pick-up or drop-off should take place in the standard parking space adjacent to the marked buffer separating the separated bikeway. Additionally, a modification to the separated bikeway may be necessary, e.g., narrowing the separated bikeway width and/or raising the separated bikeway. See Figures 20, 21 and page 101 of the FHWA Guide. However, due to anticipated high levels of pedestrian activity, consideration should be given to discontinue the separated bikeway before the loading and unloading zone or valet parking area and be designed as a bike lane or buffered bike lane to the left of the parking area, and then resume as a separated bikeway thereafter.

b. Separated Bikeway (Class IV) Design Criteria

Separations

Bikeway separation shall include one of the following to discourage the intrusion of motor vehicles into the bikeway:

Inflexible Physical Barriers (Preferred)
Barrier, railing, landscape planters or similar. A 10-foot to 20-foot on- center spacing or continuous inflexible physical barrier should be used.

Flexible Posts
Class 1 Flexible Posts or similar. See the CA MUTCD Part 3. A 10-foot to 20-foot on- center spacing should be used. Flexible post type requires approval from the City Engineer.

Bikeway Grade Separation
A vertical alignment that is on a different elevation from the adjacent roadway. The horizontal alignment may also be separate from the roadway.. Grade separation transition shall include 4:1 sloped 6-inch curb adjacent to travel way or parking. Sidewalks adjacent to bikeway shall be separated by clear delineation.

On-Street Parking
Parking allowed all times of the day, except for maintenance (parking can include bicycle parking). If continuous inflexible physical barriers, raised island or curb/dike are used in the buffer, an opening should be such that a 5-foot minimum clear width is provided for pedestrians to access their vehicle and the sidewalk.

Also, this placement should be designed to accommodate drainage. In the case of a separated bikeway on a hill, a curb or dike is required in order for the wheels of parked vehicles to be turned against, per CVC 22509.

Raised Island
Raised channelization islands that may include landscaping and signs/markers per the CA MUTCD Part 2. Drainage design for runoff is also needed.

Separation Width

The separation includes a width or buffer:

Inflexible Physical Barrier
An inflexible physical barrier should be used in lower speed environments (where the posted speed is 35 miles per hour or less). An inflexible physical barrier should be placed in a marked buffer of 3 feet wide, with 2 feet minimum width. In higher speed environments a concrete barrier should be used. On a sidewalk, the separation may include the inflexible physical barrier 1.5 feet minimum from face of curb.

Flexible Posts
The flexible posts should be placed in the center of a marked buffer that is 3 feet wide, with 2 feet being the minimum width. For the separated bikeway on a sidewalk, the separation may include the flexible posts 1.5 feet minimum from face of curb.

Grade Separation
For a separated bikeway on the same grade as a sidewalk, the separated bikeway separation width should be 1.5 feet minimum including the curb width; note, this portion of the sidewalk can no longer be used by pedestrians. If the separated bikeway is in the roadbed and is raised, the vertical taper occurs in the buffer between the separated bikeway and the vehicular traffic lanes. The vertical taper is included in the buffer width of 3 feet, with 2 feet being the minimum where there is no parking; with parking this width should be 3 feet minimum. See Section 3.5 of this DIB for raised separated bikeway and vertical taper guidance.

On-Street Parking
A marked buffer between the on-street parking and the separated bikeway should be a minimum width of 3 feet. However, at on-street accessible parking the minimum width is 5 feet.

Raised Island
Raised islands may be between the separated bikeway and vehicular traffic or parking. These should be 3 feet if no parking is allowed, with 2 feet being the minimum width; 1-foot if used with flexible posts. Three feet is the minimum width with parking.

Separated Bikeway Width

Separated bikeway width is designated by the clearance between markings, inflexible physical barriers, bridge barriers or railings, and curbs.

The separated bikeway clear width should be 7 feet minimum width for one-way travel when adjacent to a roadway. For two-way travel, the same width as a Class I Bikeway (bike path) should apply.

Separated Bikeway Approach Tapers

Separated bikeway approach tapers will occur primarily at intersections, but may occur at other locations depending on the presence of traffic signal hardware, etc. For example, reducing the separated bikeway width may be required due to the presence of accessible parking, bus stops, or transit stations. A 10:1 separated bikeway approach taper transition is preferred, with 5:1 being the minimum.

Raised Separated Bikeways

If the separated bikeway is to be raised, it should be designed to accommodate drainage. A raised separated bikeway should be elevated 6 inches minimum above the finished grade, but no higher than the adjacent curb in order to allow drainage towards the street unless some other drainage design is implemented. A vertical tapered edge should be 4:1 or flatter occurring in the marked buffer.

4. Bicycle Intersections and Street Connections

All Bicycle facilities shall be connected to the City Street system at regular intervals as approved by City Engineer and/or as required by the General Plan, project documents or project approvals.

a. Shared-Use Path Connections – Arterials

Shared-Use Paths make an at-grade crossing of an Arterial shall be accomplished at an intersection. The bike/pedestrian traffic shall utilize the bike/pedestrian features provided at the signalized adjacent on-street Bike Lane.

Other connections which originate along an Arterial shall use the City Standard Plan Case A ramp to provide access to the adjacent on-street Bike Lane. Curbs adjacent to path connections shall be vertical and painted red to prohibit parking. Red painted curbs shall be sufficiently long to comply with the visual sight clearance requirements identified in these Standards.

b. Shared-Use Path Connections – Other Streets

Bike Paths shall connect to Collector and Local Streets using the City standard plan for Bicycle/Pedestrian Path Entrance. The Path Entrance shall be located where it does not conflict with other traffic movements. Curbs adjacent to path connections shall be vertical and painted red to prohibit parking; red painted curbs shall be sufficiently long to comply with visual sight clearance requirements identified in these Standards.

5. Grade Separations – Overcrossing and Undercrossing

Bicycle Path Grade separations structures shall be provided as indicated in the City General Plan and at the locations specified by the City Engineer, or as may be required in the Project approvals. All design details of grade separations are subject to review by the BTSSC and shall require approval by City Engineer.

The type of structure, overcrossing (above street level) or undercrossing (below street level) shall be determined by the interactions of factors, such as, but not limited to: public safety, economics of construction, right of way availability, interference with other utilities and improvements.

Experience has shown that undercrossings are generally the most economical means of crossing other transportation features. Generally undercrossing designs shall conform to the details shown within Appendices A of these Design Standards. Although specific requirements are not included herein for bridges, the applicable portions of the undercrossing criteria shall be applied to bridge crossing design. The remainder of this section is devoted to undercrossing design criteria.

a. Horizontal Alignment

The Bicycle Path undercrossing alignment shall generally be placed perpendicular to the centerline of the street, highway or railroad being crossed. HDM Chapter 1000 should be referenced for required design speeds and curve radii.

Streets intersecting bicycle undercrossing may drop parking lanes and two-way left turn lanes to reduce undercrossing length. Adequate transition distances for dropped lanes shall be provided in accordance with these Standards. Parking lanes shall not be eliminated for cases with high parking demands. Two-way turn lanes shall not be eliminated for cases with insufficient transition distance to the nearest intersection(s).

b. Clearances

The total nominal clear area shall be 8 feet high and 12 feet wide. A minimum clear area of 10 feet wide and 8 feet high shall be provided for the use of bicyclists and pedestrians. See HDM 1003.1.3 – Clearance to Obstructions. At least 2 feet horizontal clearance shall be provided along each side of the path. Minor intrusions (lighting fixtures, structural fillets, etc.) into the horizontal clearance zones alongside the path are acceptable.

c. Sight Distance

Sight distance shall be based on HDM 1003.1.11 – Stopping Sight Distance.

d. Slope Requirements

The grade of an ascending or descending path shall not exceed a slope of 4.9%. Path cross slopes within the structure limits shall be 1.0% to 2.0%. Undercrossing cross slope within structure shall slope one direction and longitudinal slopes shall slope away from the center of the structure.

e. Lighting

Undercrossing structure lighting shall be mounted 13 feet on center, consist of LED bulbs, provide 5 to 22 Lux illuminance, and be protected with impact resistant covers. Lighting conduits shall consist of ¾-inch rigid tubing flush mounted to the wall.

Undercrossing approach lighting shall consist of standard Post-Top Street Light at intervals not to exceed 135 feet. Post-Top Street Lights shall be a minimum height of 14 feet and installed with 1-foot offset from the edge of shoulder. Post-Top Luminaires shall be LED and provide 5 to 22 Lux illuminance.

f. Retaining Walls and Side Slopes

Retaining walls and/or toe slopes shall be located at least 2 feet outside the Bike Path edge of travel way as it descends to the structure entrance. The side slope around the descending path shall not exceed a ratio of 2:1 (horizontal:vertical). Retaining walls may be required in constrained areas, as approved by the City Engineer.

g. Wing Walls

Wing walls shall be provided at the ends of the tunnel. The interior angle between the approaching path and the wing portions shall be at least 45°.

h. Safety Fencing

Fencing shall be provided continuously along the tops of any walls, which exceed a height or 30 inches. Fencing along the path shall be placed 1 foot minimum outside the edge of shoulder with no exposed posts facing the path. Any fencing adjacent to the back edge of sidewalk shall conform fully to the requirements of the Uniform Building Code for railing.

i. Drainage

Adequate drainage facilities, including any required pump stations, shall be provided to prevent storm water runoff from entering the tunnel. Drainage water shall collect via a pipe system at both ends of the undercrossing structure.

H. TRANSIT FACILITIES DESIGN

1. Bus Stops

Bus stops shall be 80’ in length and should be provided at the far side of the intersections. New bus stops shall be constructed out of Portland cement concrete. The curb for the length of the bus stop shall be painted red and the bike lane shall have striping Detail 39A.

2. Bicycle-Bus Conflicts

TCRP Report 183 – A Guidebook on Transit-Supportive Roadway Strategies offers guidance on managing bike/bus conflicts. Bus stops shall be designed to the Raised Bike Lane (preferred) or Exclusive Bike lane design, as approved by the City Engineer.

I. DELINAEATION AND SIGNING

Delineation (Striping and messages or legends) and signing shall be provided on all streets, whether public or private. All striping and signing shall comply with applicable Federal, State and Local, Laws (including Ordinances and Codes) rules and regulations.

The preliminary layout for all striping and signing will be subject to the review of the City Engineer and may be subject to review by the BTSSC.

1. City of Davis Pavement Markings

All legends and messages shall be placed on the pavement using the City of Davis standard templates. As provided in the Standard Specifications, these templates can be borrowed by Contractors. The project Engineer shall check with City Engineer to determine differences in dimension from the Caltrans standards.

2. Standard Signs and Stripes

All signs and striping patterns shall conform to the California MUTCD, except where otherwise modified. The standard sign and striping detail numbers used on the Plans shall be the same as assigned in the California MUTCD.

3. Installation of Signs

All signs on development projects will be installed by the Contractor. Signs on City projects may be installed by PW, as determined by the City Engineer.

4. Striping and Signing Requirements

Striping and Signing shall conform to the California MUTCD. The following table lists signing and striping requirements for the various types of streets.

Minimum Striping and Signing Requirements			
Sign and Stripe Combination	Caltrans References	Type of Street	Comments on Usage
Yellow Centerline	Detail 2 Detail 1	Arterials Collectors	Use as required for centerline stripe.
Double Yellow Centerline	Detail 22 Detail 21	Arterials & Collector ↓	Use as required for centerline stripe.
Two-way left turn lanes	Detail 32 Detail 31	Arterials & Collectors ↓	Use when there is a two-way left turn lane. Change to double yellow for turn pockets at intersections.
Lane lines	Detail 9, 10	Arterials	Use as lane line on multi-lane arterials.
Bike Lane lines	12" Solid White	Arterials and Collectors	Use to delineate bike lane when between thru-lane parking. Change to skip pattern at intersections.
Bike Lane lines	12" Skip White	Arterials and Collectors	Use at approach to all intersections. Pattern: 96' of 12' solid, 4' skip.
Crosswalks	12" Solid White, 10" Apart	All Streets	Place crosswalks at all signalized intersections and as required. Use crosswalks at school crossings and bike path crossings.

A setback for stop bars shall be 8 feet at crosswalks and delineated with a 6” white stripe. Standard crosswalk markings shall be the continental style crosswalk.

Minimum Striping and Signing Requirements			
Sign and Stripe Combination	Caltrans References	Type of Street	Comments on Usage
Stop Sign Stop Bar (Street Name Sign)	R1 (24" std) 12" White	All	Placed on intersecting streets at intersections with "Through Streets" and as required by code. Street name sign is the only other sign which may be mounted on the same pole with the stop sign.
Stop Legend	City "STOP"	Arterials and Collectors	Stop legend is 8' from stop bar.
Yield Sign	R1-2	Arterials	Place on near side of handicap ramp and sidewalk at "Free-right" turns at intersections with Arterials
Bike Lane Signs Bike Lane Legend	R81 CA MUTCD 9c-3 Helmeted Bicyclist	Bike Lanes	Place at the beginning and end of bike lanes, and at all intersections. Install at intervals of 400' +/- along bike lane.

End Bike Lane	R81/R81B	Bike Lanes	Place sign at the end of bike lane.
Fire Hydrant Markers	Blue reflector	All fire hydrants	Place 1' right or left of centerline toward fire hydrant. Place 1' right of left edgeline in streets with medians.
Street Name Signs	City Standard	All intersections	At signalized intersections, place on each signal pole. At other arterial & collector intersections, place at diagonally opposed corners. All local and smaller intersections get one sign.
Speed Limit Signs	R2 (24" x 30") R2-4 & R3	All streets as required	Speed limit signs are placed at changes in speed zones at generally near each arterial intersection.
No. left, right, or U-turn signs	R16,R16B R17, R17B R19, R34, R34A, R73-3	All Streets	Used as needed to notify traffic of prohibited movements. No U-turn signs required at all arterial intersections with free-right turns. Use R73-3 on signal mast arms at intersections.
No parking signs Red Painted curb	R26, R28 R30 to R30B	All Streets	Used as needed to indicate no parking zones. Face and top of curb are painted red. Red curb is also required at fire hydrants.
Radar warning & Speed Limit	R48 (30") R2 (36" x 45")	All Streets	Placed at City limits for approaching traffic.

Minimum Striping and Signing Requirements			
Sign and Stripe Combination	Caltrans References	Type of Street	Comments on Usage
Handicap sign and painted legends	R99 Blue wheelchair symbol	Handicap Parking	Use at all handicap parking spaces. Place sign and painted legend.
Pavement Transition Arrow Legends	W11 (24")	At lane drops	Use where a thru-lane is merged with an adjacent lane. Place sign at beginning of merge. Place 3 arrows evenly spaced.
Signal Ahead Sign	W41 (36") City "	All streets	Use on all streets at the approach to the first signal along the street. Subsequent signals do not require this sign. Use at approaches from City to County.
Railroad sign	W47/W48	All railroads	Place at approaches to all railroad crossings.
School Zones	W63/W65 W65/R2/R72 W65-1 W66/W66A W64	At Schools	Place appropriate signs as authorized by Council to delineate school zones. See Safe Route Plans. See Ch 10 Traffic Manual
Stop Ahead legend	City Std.	All streets	Use as directed.
Turn Arrows	City Std.	All streets	Use as directed in turn lanes.
Turn Arrows	City Std.	All streets	Use as directed to indicated thru-lanes at intersections.
Left Turn Pockets	City Std. Left Arrows, "Left Turn Only", 8" stripe, 12" stop bar.	At Intersections	Use as directed to indicated left turn lane at intersections. Minimum length is 90'. Use crosswalk of stop bar, place 8" stripe to separate pocket from adjacent thru-lane. Use double yellow to separate adjacent opposing lane.
Other Signs, Stripes, and Legends	Per Traffic Manual	All streets	Use signs, stripes, and legends as directed by City Engineer and in accordance with the Traffic Manual.

5. Mounting Details

All signs shall be mounted so that the lower edge is at least 7 feet above the finish grade. The signs shall be placed so that they are 2 feet horizontally away from the edge of pavement or traveled way. The preferred location for signs is on street light poles, in which case three signs may be mounted on the same street light. Street name signs at signalized intersections shall be mounted on the signal mast arm so that they face oncoming traffic. Parking signs shall be double-sided.