Chapter 1230 Geometric Cross Section

1230.01 General

Geometric cross sections for state highways are governed by the need to balance identified performance metrics (see Chapters 1101 and 1104), the context (see Chapter 1102) and selected design controls (see Chapter 1103). The objective is to optimize the use of available public space and/or reasonable investment in right of way acquisition. The geometric cross section is composed of multiple lateral design elements such as lanes, shoulders, medians, bike facilities, and sidewalks. The design task is to select and size these elements according to, designated performance target(s), design controls, and context. There is flexibility in the selection of design elements, dimensioning (see Chapter 1106), and configurations to obtain the desired level of performance for a given mode and/or context.

1230.02 Context and Modally Integrated Cross Sections

The geometric cross section of a roadway is composed of different zones. The cross-section examples shown in Exhibits 1230-2a through 1230-6d depict various configurations that may be included in a cross section. The examples are included to stimulate designer creativity and awareness of modal accommodations, and are not intended to be standard cross sections to be reproduced for a given modal orientation. The cross section examples show what is possible for specific contexts and performance needs. It is expected that project alternatives will innovative diverse configurations to best balance baseline and contextual needs (see Chapter 1101) for the modes and contexts represented. The cross section examples present ranges to achieve different performance needs.

The cross section configurations also provide a range of dimensions for different design elements that are the basis of dimensioning an element (see 1230.03). For a more detailed explanation of each cross section zone or element that makes up a cross section, see 1230.04. Higher-range values are presented as boundaries to consider for cost; however, exceeding those ranges in median, streetside, and roadside design is acceptable and encouraged in some contexts and is situationally dependent.

1230.02(1) Jurisdictional Design and Maintenance

On all state highways in rural locations outside of cities or towns or limited access design areas, geometric design is to be consistent with this *Design Manual*.

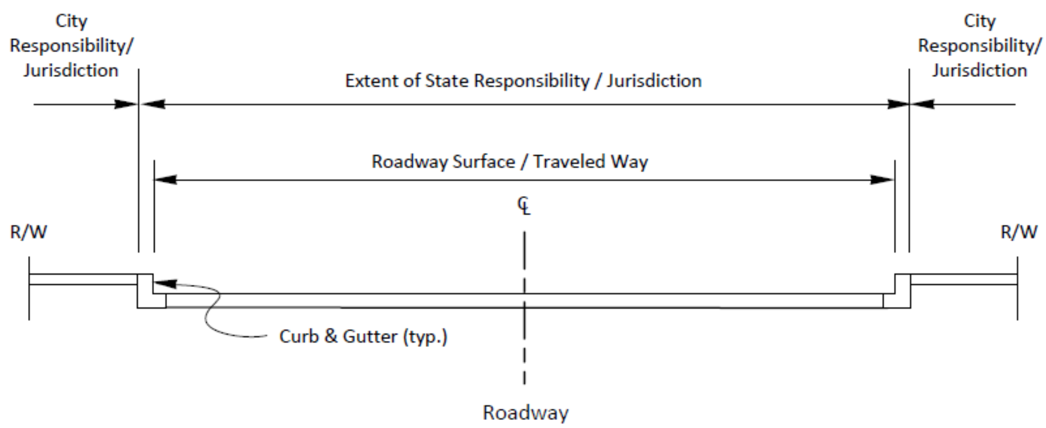
On state highways within an incorporated city or town, develop design features in cooperation with the local agency. For NHS routes, use the *Design Manual*. For non-NHS routes, the *Local*

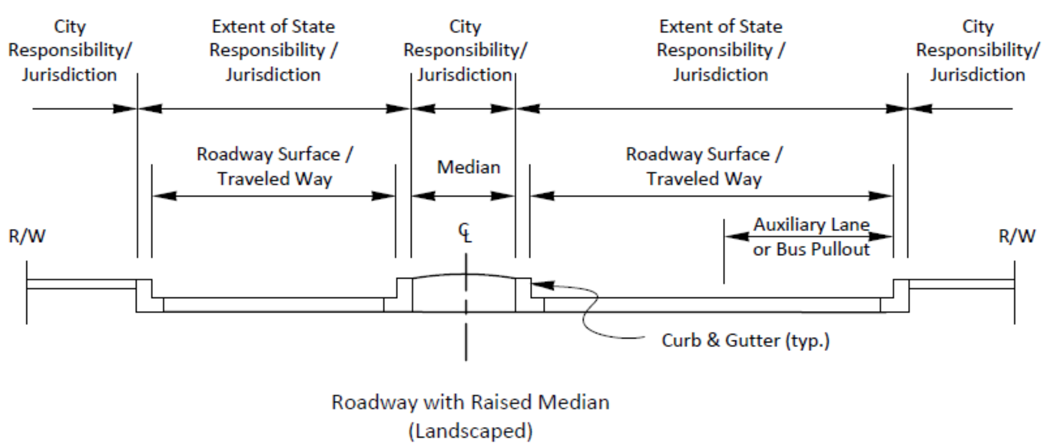
Agency Guidelines may be used for dimensioning design elements using the Criteria Based Method. However, use of Quantitative Methods for dimensioning design elements may provide additional flexibility and is recommended (see Chapter 1106 for additional information about the dimensioning methods).

Cross-sectional design within incorporated cities or towns can get complicated due to the joint-jurisdictional authority. WSDOT typically has jurisdiction of the traveled way zone, and cities typically have jurisdiction of the streetside zones (see Exhibit 1230-1). When no curb is present, the city or town holds responsibility for the roadside beyond the paved shoulder. Despite the jurisdictional differences, it is extremely important to cooperatively determine a cross-sectional design. Design elements within the streetside or roadside zones are necessary to emphasize the traveled way zone design, and vice-versa.

Refer to Chapter 301 for additional information on jurisdictional maintenance responsibilities and considerations for maintenance agreements

Exhibit 1230-1 State and City Jurisdictional Responsibilities





1230.02(2) Pedestrian-Oriented Cross Sections

Exhibits 1230-2a and 1230-2b are cross-section examples prioritized for pedestrian mode. The pedestrian mode is a vital transportation mode, since for most people nearly every trip at least begins and ends by walking. Roadway facilities prioritized for pedestrians emphasize streetside zone elements. The objective is to achieve the Pedestrian Circulation Path (PCP) necessary to support the mobility, socioeconomic, and accessibility needs for the mode and context, and/or the pedestrian needs necessary for mobility, safety, and accessibility to intermodal connections. The configuration and dimension of streetside zone elements varies significantly depending on the performance metrics being addressed. (See Chapter 1510 for additional pedestrian design requirements and considerations.)

1230.02(3) Bicycle-Oriented Cross Sections

Exhibit 1230-3a is an example cross section oriented for bicyclists on an intermediate-speed location. The decision on where to place the bike lane within the cross section depends largely on the type of land use and how cyclists will interact with the land use and potential modal conflicts. Locating bike lanes on the outside of the motor vehicle lanes can better enable meeting accessibility performance needs. If cyclist mobility performance is a primary concern or intermodal conflicts (such as transit stop locations) are present, locating bike facilities in

the center of the roadway may be more appropriate. Whether or not a bike lane buffer is needed depends mostly on the target speed and average daily traffic (ADT) of the facility; the intent of bike buffers or other protected bike facilities is to address safety performance for cyclists. Buffers and other means of modal segregation also benefit motor vehicle drivers and pedestrians by showing allocated spaces. Both roadway bike lane configurations and bike facility selection are discussed in more detail in Chapter 1520; some considerations are also provided in Exhibit 1230-3b.

1230.02(4) Transit-Oriented Cross Sections

Exhibits 1230-4a through 1230-4c provide examples of different potential configurations oriented for the transit mode. Cross section design for the transit mode relies on managing multiple modal conflicts and competing performance with other modes. Ultimately, transit providers must determine their ability to operate within a given cross-sectional arrangement. In general, transit configurations can be oriented toward the side or center of a roadway section. This is true for many different forms of transit vehicles (such as such as various fixed guideway transit vehicles and bus types). Either side or center configurations can be implemented with medians or outer separations to improve safety performance for intermodal connections or mobility performance for the transit service.

Exhibit 1230-4a shows a central configuration for transit service that provides a separated bus-only lanes cross section for transit operations. Other transit vehicle types may require different widths and may also require other center cross section configurations for passenger loading. Consider increasing lane widths on turning roadways (see Chapter 1240). Exhibit 1230-4b shows a side configuration where transit vehicles occupy the outside lane, this example can also be configured as business access and transit [BAT] lanes like those found in the Seattle area. Note the importance of streetside zone elements to assist with intermodal connections. Exhibit 1230-4c is an example of a type of special use lane for high-speed and routinely congested routes. In this example, the shoulder allows the restricted use for buses. This configuration requires additional treatments at on-/off-ramps and/or intersections, and other operational and maintenance considerations.

1230.02(5) Freight- and Auto-Oriented Cross Sections

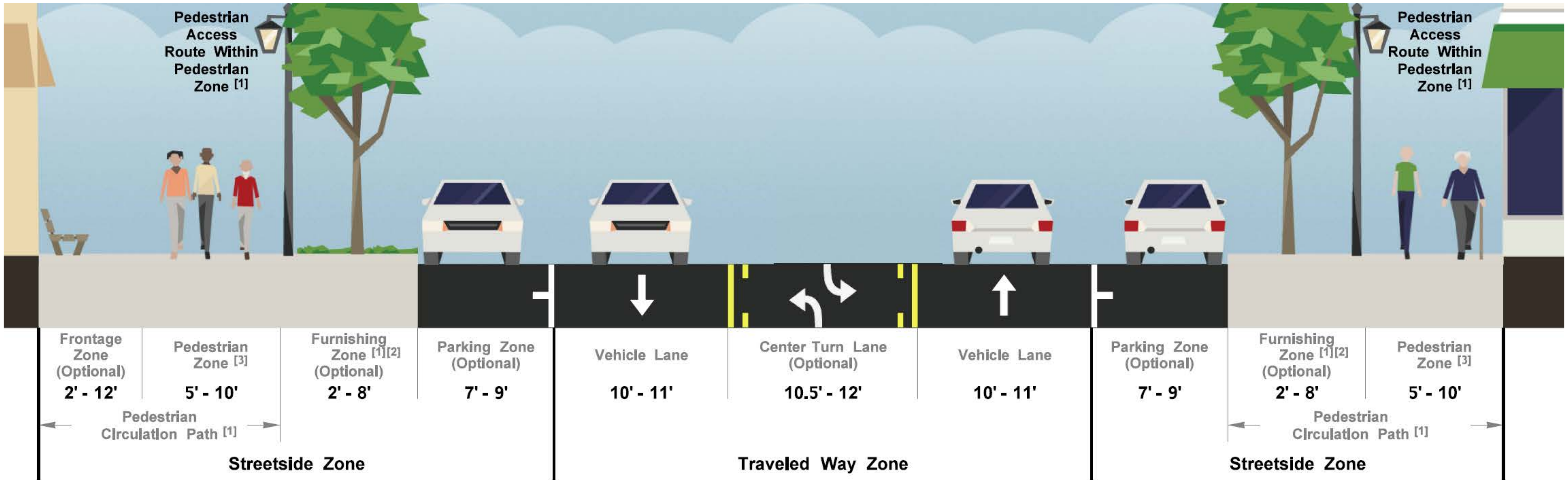
Exhibits 1230-5a through 1230-5c are examples of a motorized vehicle-oriented design. Motorized vehicles come in a variety of types, which cohabitate on many vehicle lanes and parking zone areas. The performance needs of freight and other automotive vehicle types are often similar. However, certain truck vehicle types may require additional turning roadway width for off-tracking (see Chapter 1240), or at other locations a truck climbing lane may be needed to facilitate mobility performance (see Chapter 1270). Generally, lane width within suburban and urban contexts is less critical for mobility and safety performance than in rural and high-speed contexts. An understanding of the needs of the type of freight truck should be vetted when designing for freight accessibility performance for more urban land uses. Generally, within urban areas, placement of and sizing for loading areas within the parking zone can depend on the freight vehicle type.

1230.02(6) Complete Street Cross Sections

Complete street configurations attempt to balance the performance needs of all users, regardless of age, ability, or mode. The general intent is to provide designs that enable the safe access for all design users with respect to context. In this way, many rural two-lane highways with wide shoulders for auto emergency use, as well as pedestrian and bicycle use, are considered complete streets; just as an urban section with vehicle lanes, bike lanes, bus lanes, and sidewalks would be considered a complete street. There are many different potential configurations for complete streets that provide equity to the design users present. In some cases, achieving a complete street is as simple as retrofitting the street to clearly mark and sign a shared-use lane. In other more complex environments with distinctive modal compatibilities, it may take the form of actually converting the roadway using a “road diet” application (see 1230.02(6)(a)), reconfiguring the roadway cross section, or installing additional pedestrian crossings with greater frequency; see below for more detail on various configurations.

Utilizing different road types is one way to implement complete streets. Exhibit 1230-6c shows a multiway boulevard road type cross section, defined by the outer separation between the vehicle lanes and shared-use service lane. The service lane in this configuration enables land use accessibility and motor vehicle mobility by segregating the lanes. In this example, transit and bike conflicts are removed, and land use accessibility performance is provided by use of the service lane. It is important to recognize intermodal connectivity and conflicts that may occur with complete street configurations, particularly at nodes and/or transit stop locations.

Exhibit 1230-2a Pedestrian-Oriented Example Cross Section



Notes:

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[1] See Chapter 1510

[2] Minimum width specified is exclusive of the curb width

[3] If no furnishing zone is provided, minimum width is exclusive of the curb width

[4] See Chapter 1520 for bike facility selection and different configurations

[5] Verify width needs with transit provider, and see Chapter 1430

[6] Overall median width and design will vary depending on alignment design, available right of way, median function and other constraints.

[7] When using criteria-based dimensioning method (see Chapter 1106) on high speed (see Chapter 1103) facilities, lane widths are 12 feet minimum. Two-lane high speed highways may have an 11ft minimum lane width.

[8] When the criteria-based dimensioning method (see Chapter 1106) is used for high-speed (see Chapter 1103) facilities, inside shoulders must be 4ft minimum on facilities up to 4 lanes, and 10 ft minimum on 6 lane facilities. In mountainous terrain, inside shoulder may be reduced to 4ft on facilities up to 6 lanes.

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Exhibit 1230-2b Pedestrian-Oriented Example Cross Section

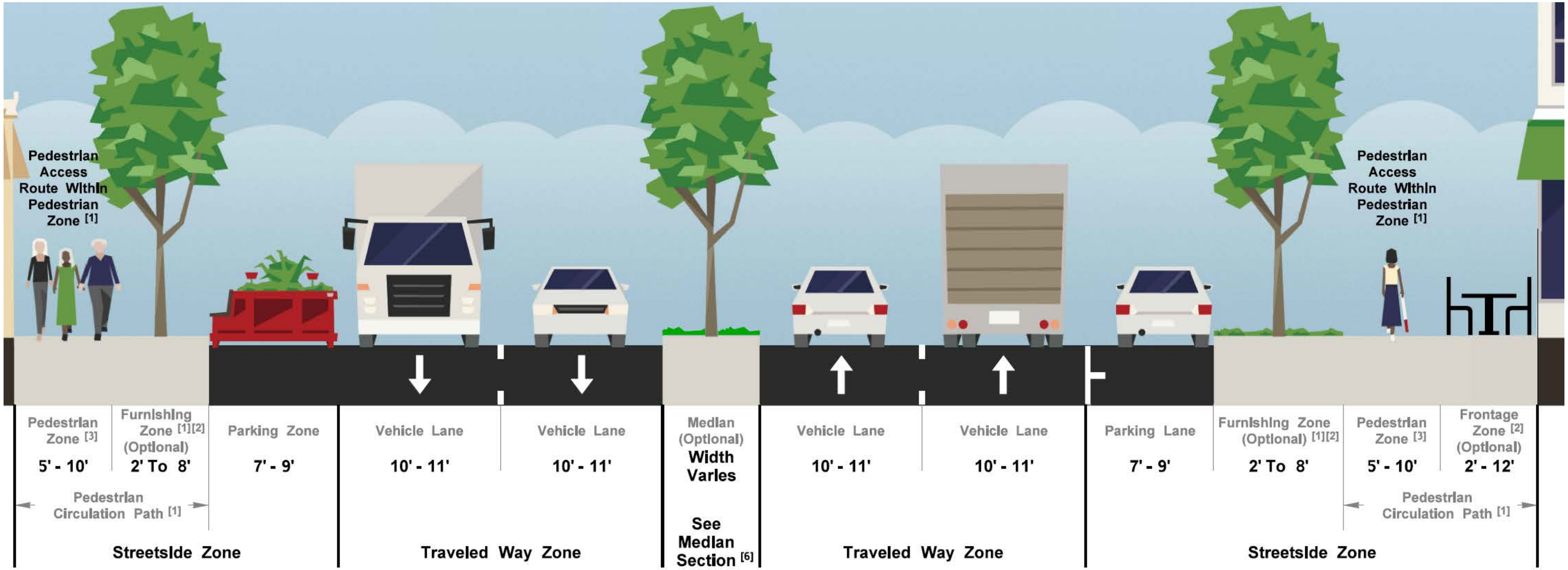

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Exhibit 1230-3a Bicycle-Oriented Example Cross Section for Intermediate-Speed Locations

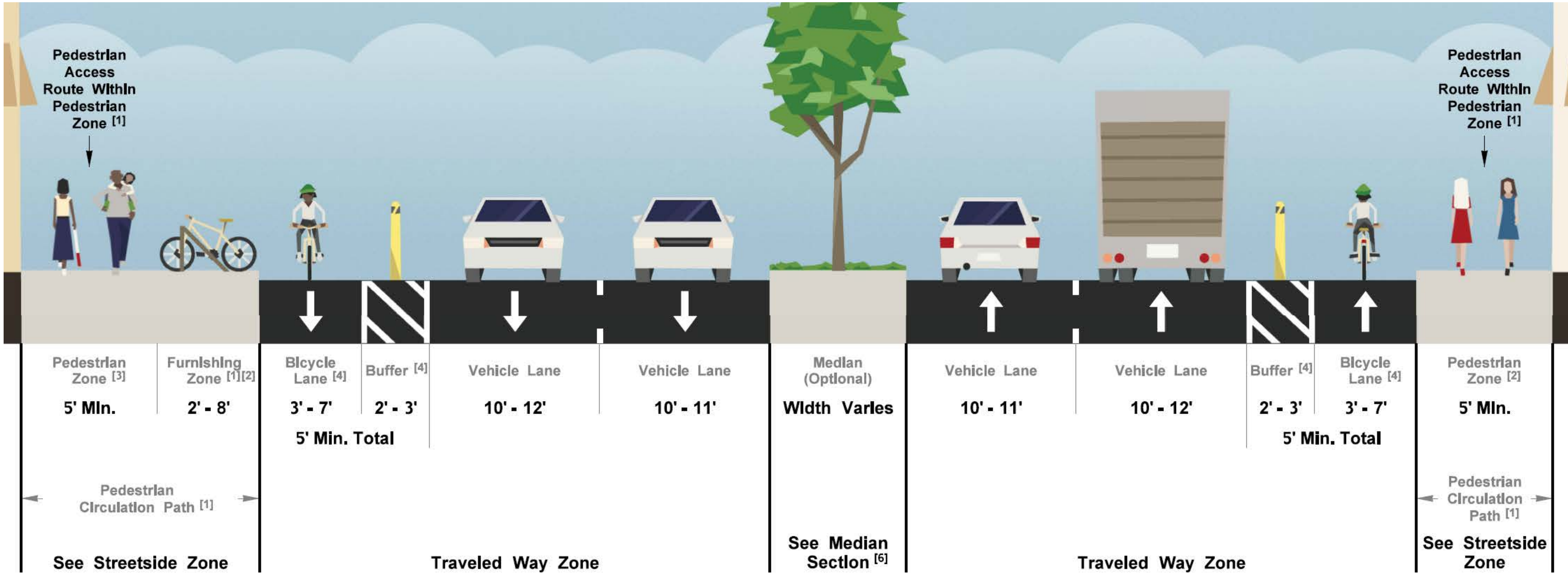

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Exhibit 1230-3b Bicycle-Oriented Example Cross Section for Low-Speed Location

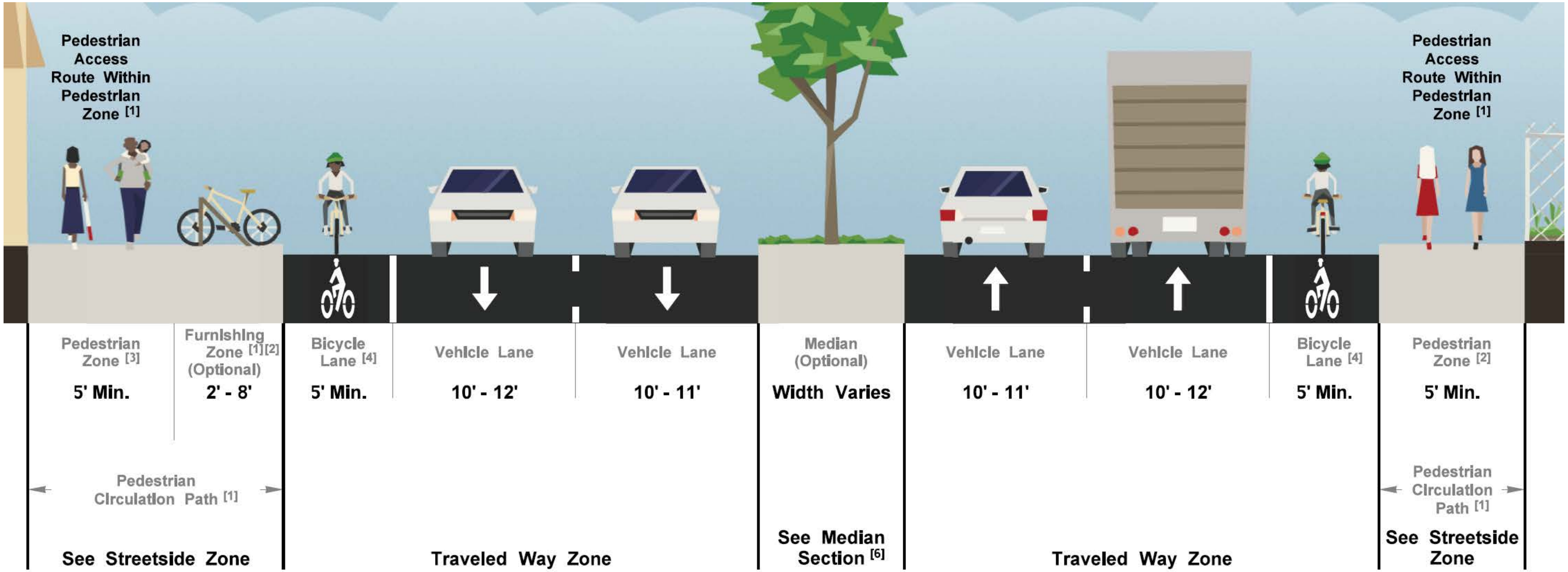

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Exhibit 1230-4a Transit-Oriented Cross Section Transit Boulevard

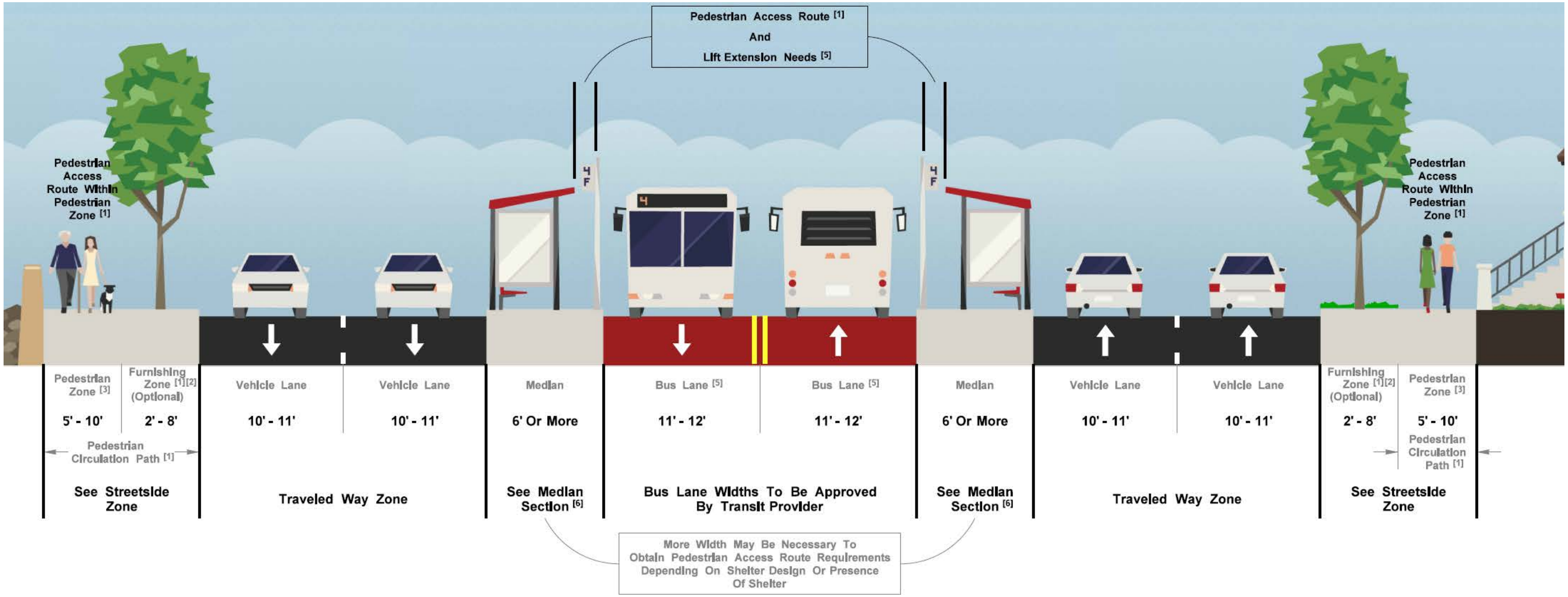

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Exhibit 1230-4b Transit-Oriented Cross Section

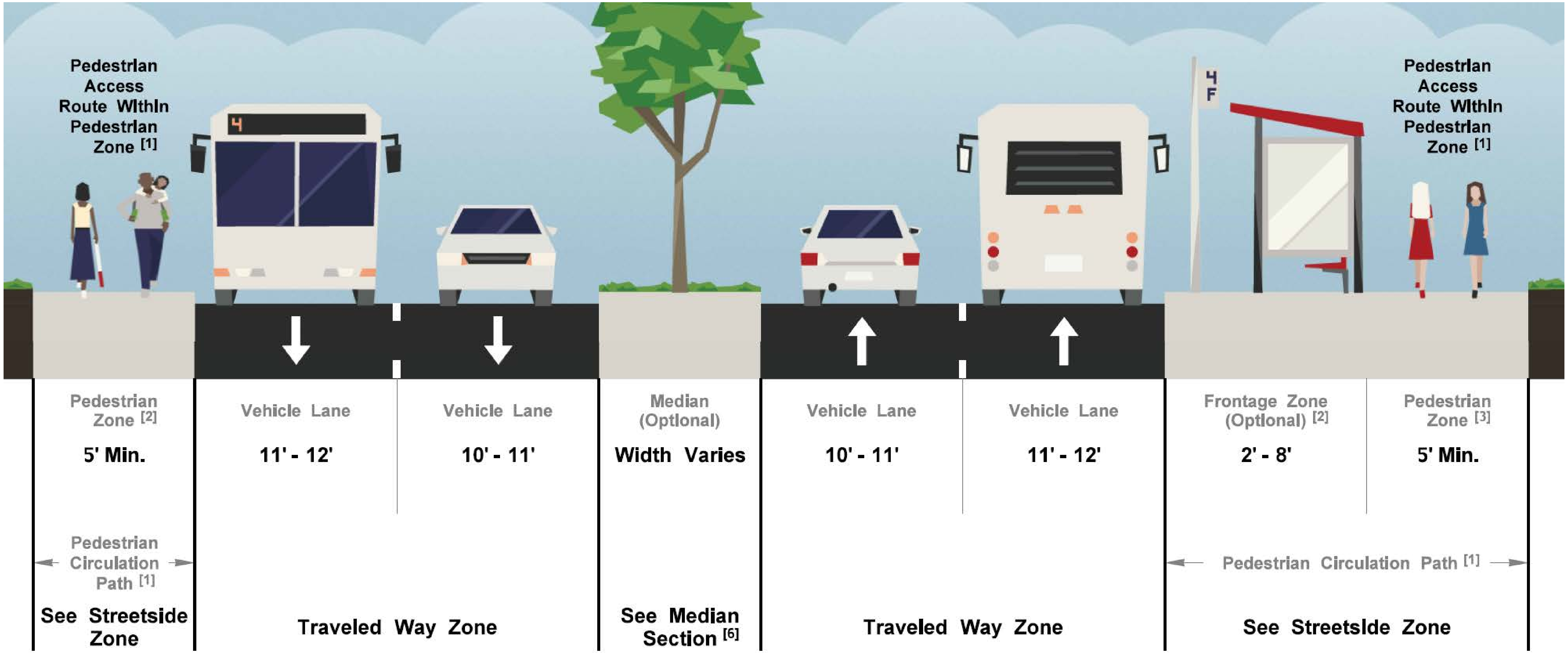

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Exhibit 1230-4c Transit-Oriented Cross Section Hard Running Shoulder

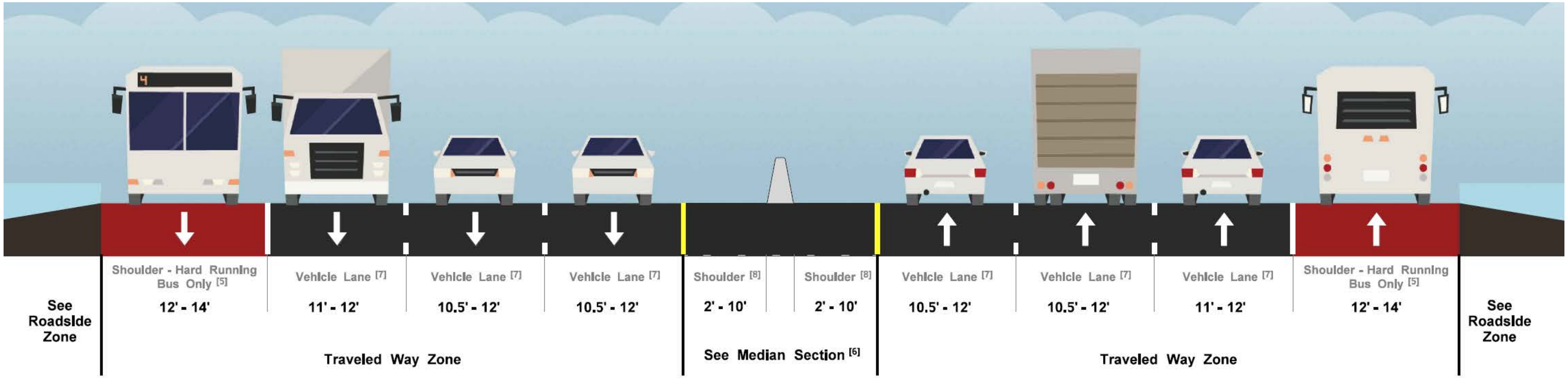

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Exhibit 1230-5a Motorized Vehicle-Oriented Cross Section

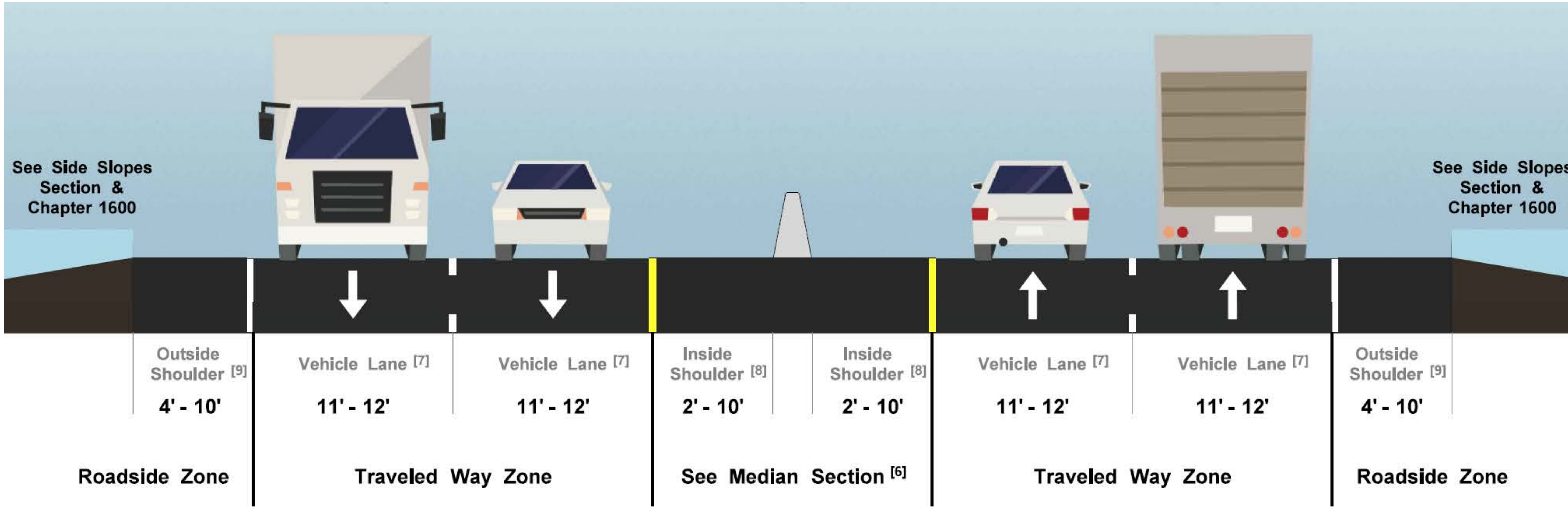

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Exhibit 1230-5b Motorized Vehicle-Oriented Cross Section

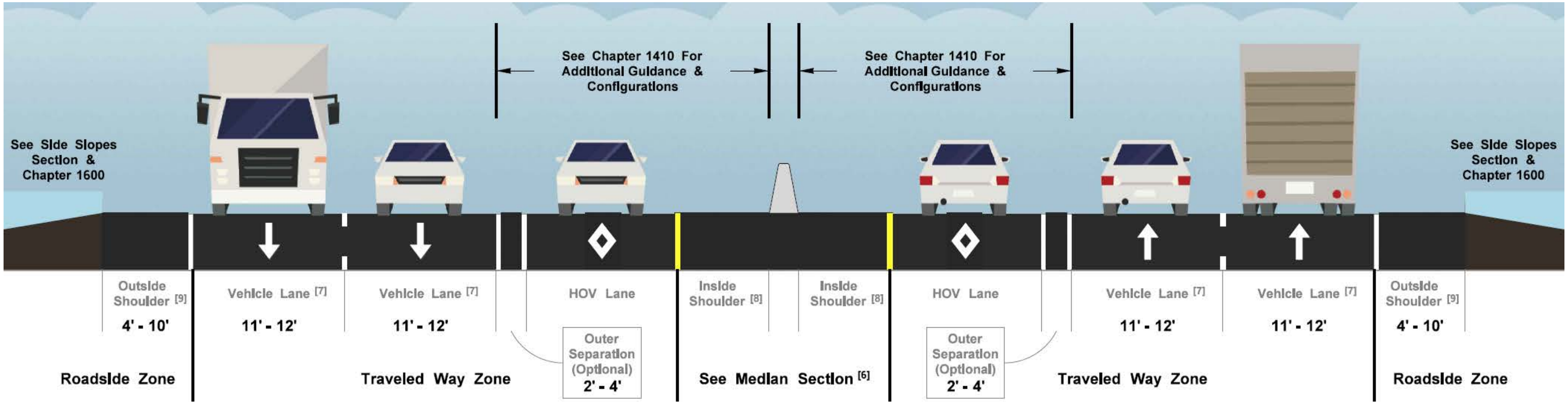

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Exhibit 1230-5c Motorized Vehicle-Oriented Cross Section

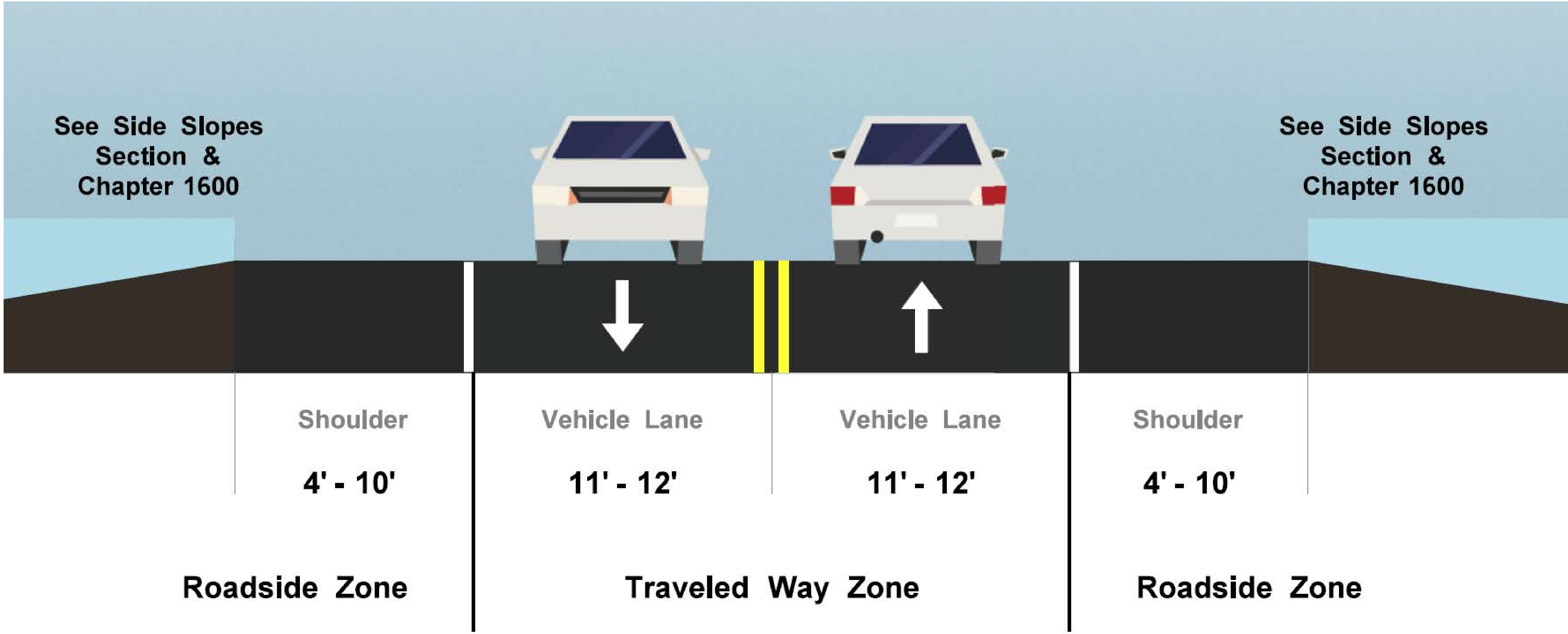

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Exhibit 1230-6a Complete Street – High-Speed Example Cross Section

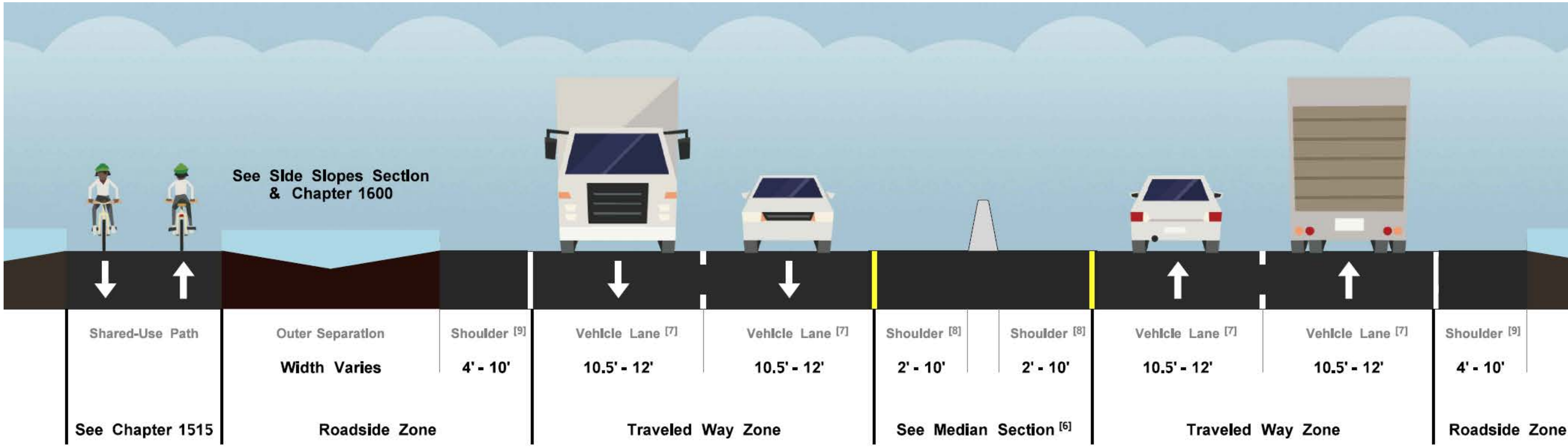

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Exhibit 1230-6b Complete Street – Intermediate-Speed Example Cross Section

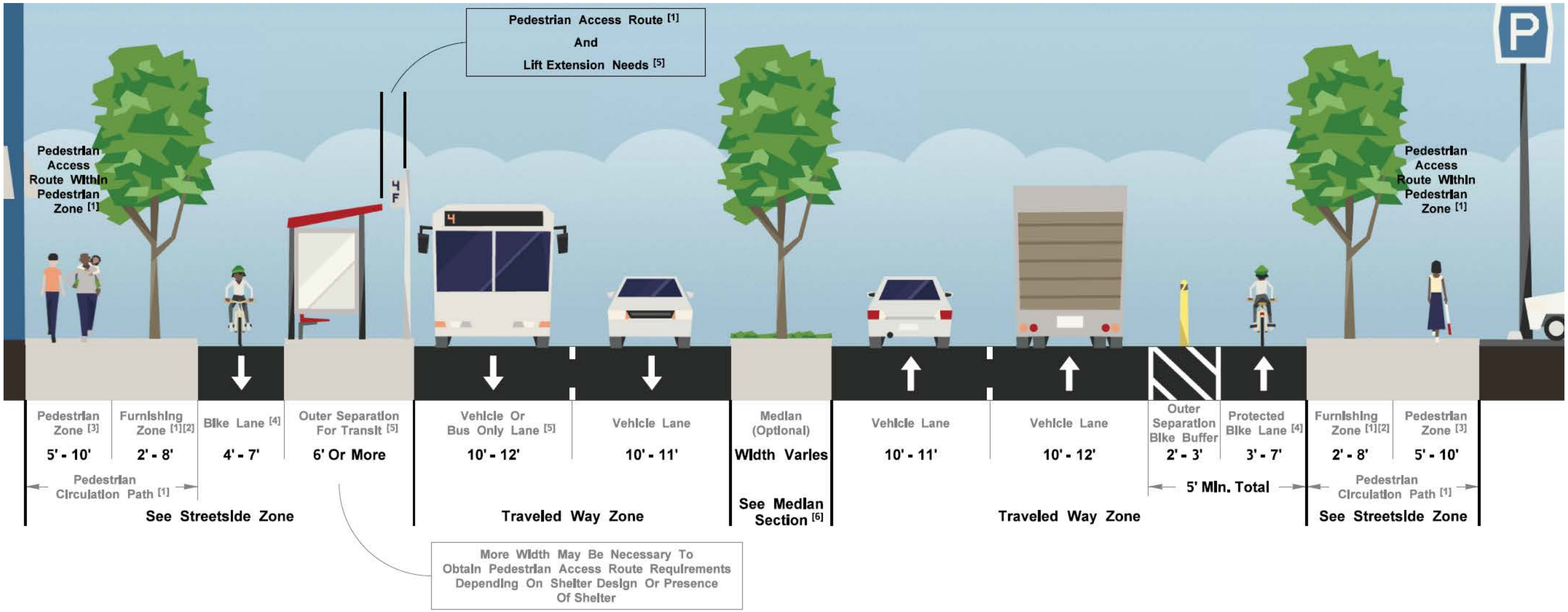

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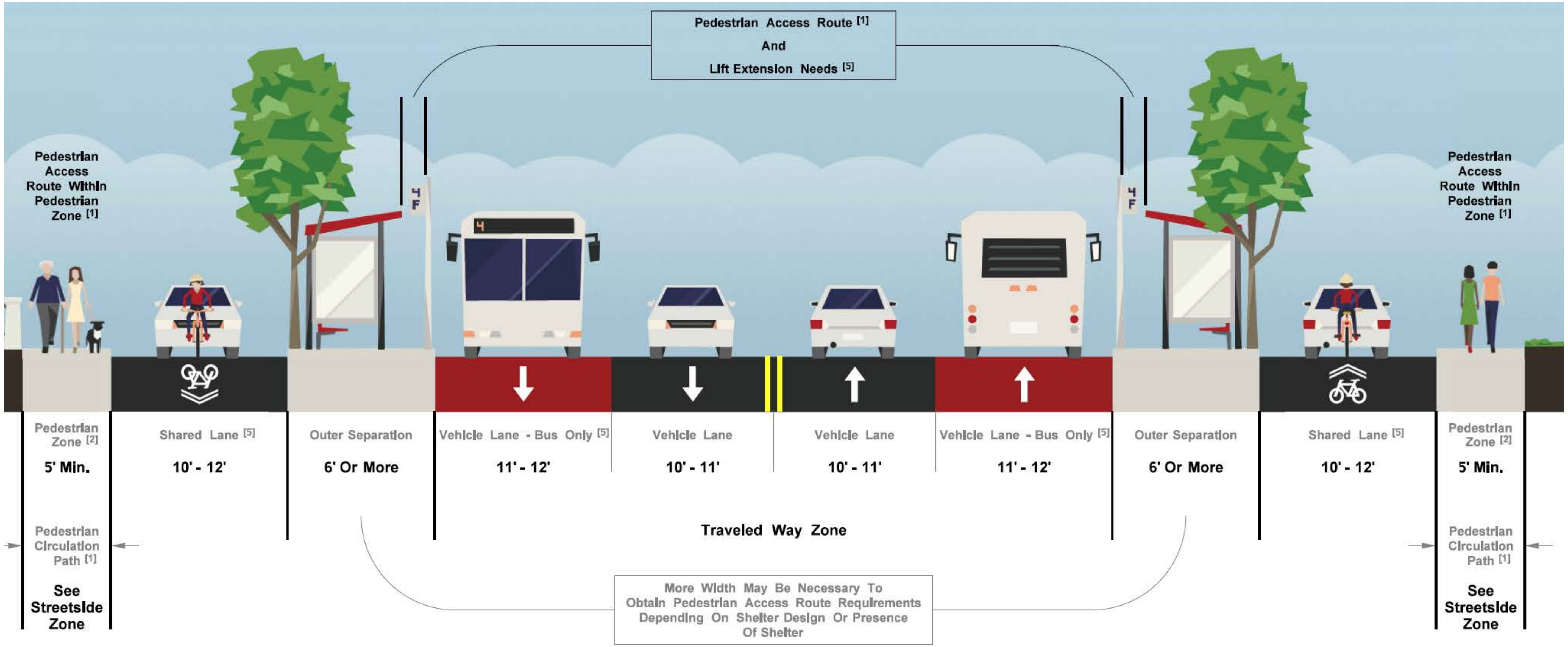
Exhibit 1230-6c Complete Street – Low- to Intermediate-Speed Multiway Boulevard Example Cross Section



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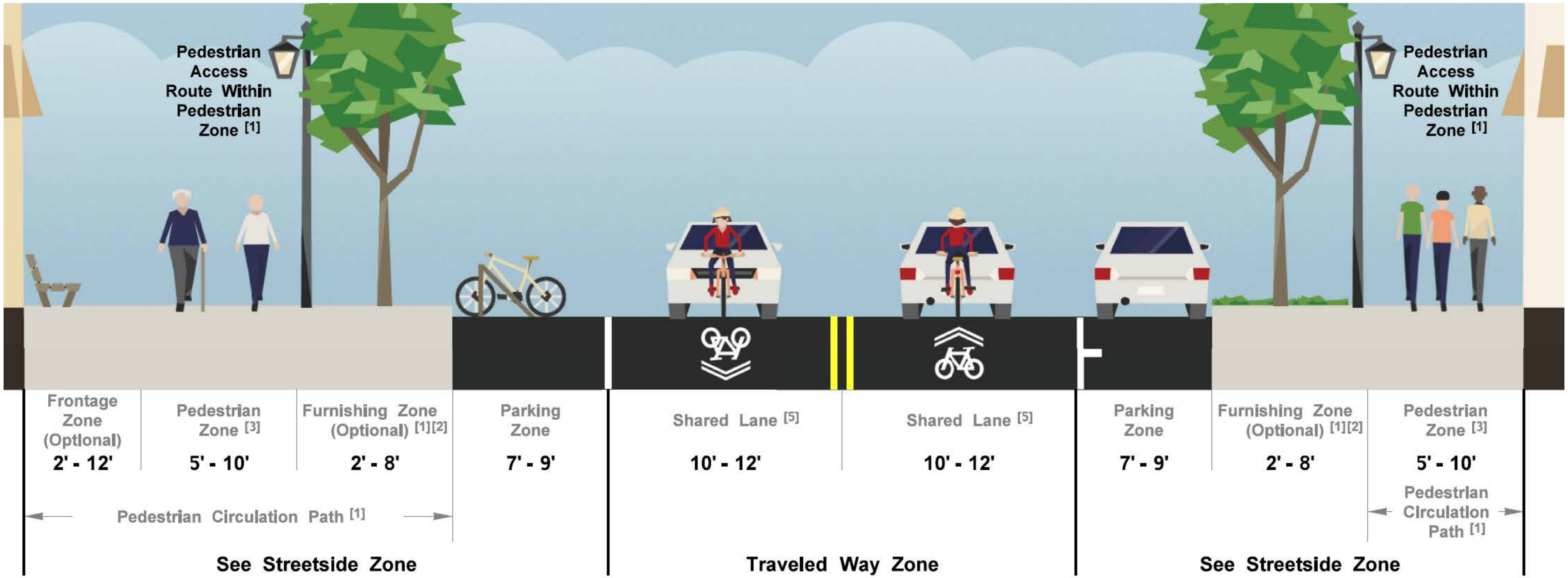
- [3] If no furnishing zone is provided, minimum width is exclusive of the curb width
- [4] See Chapter 1520 for bike facility selection and different configurations
- [5] Verify width needs with transit provider, and see Chapter 1430
- [6] Overall median width and design will vary depending on alignment design, available right of way, median function and other constraints.
- [7] When using criteria-based dimensioning method (see Chapter 1106) on high speed (see Chapter 1103) facilities, lane widths are 12 feet minimum. Two-lane high speed highways may have an 11ft minimum lane width.
- [8] When the criteria-based dimensioning method (see Chapter 1106) is used for high-speed (see Chapter 1103) facilities, inside shoulders must be 4ft minimum on facilities up to 4 lanes, and 10 ft minimum on 6 lane facilities. In mountainous terrain, inside shoulder may be reduced to 4ft on facilities up to 6 lanes.
- [9] When the criteria-based dimensioning method (see Chapter 1106) is used for high-speed (see Chapter 1103) facilities, outside shoulders must be 10ft minimum. In mountainous terrain, outside shoulder may be reduced to 8ft on facilities up to 6 lanes. Two-lane high speed highways may have an 8ft minimum outside shoulder, and may be reduced to 4ft with justification.

Exhibit 1230-6d Complete Street – Low-Speed Main Street Example Cross Section



Notes:

These notes are repeated on Exhibits 1230-2a through 1230-6d. Locate notes on each drawing for applicability.

[1] See Chapter 1510

[2] Minimum width specified is exclusive of the curb width

[3] If no furnishing zone is provided, minimum width is exclusive of the curb width

[4] See Chapter 1520 for bike facility selection and different configurations

[5] Verify width needs with transit provider, and see Chapter 1430

[6] Overall median width and design will vary depending on alignment design, available right of way, median function and other constraints.

[7] When using criteria-based dimensioning method (see Chapter 1106) on high speed (see Chapter 1103) facilities, lane widths are 12 feet minimum. Two-lane high speed highways may have an 11ft minimum lane width.

[8] When the criteria-based dimensioning method (see Chapter 1106) is used for high-speed (see Chapter 1103) facilities, inside shoulders must be 4ft minimum on facilities up to 4 lanes, and 10 ft minimum on 6 lane facilities. In mountainous terrain, inside shoulder may be reduced to 4ft on facilities up to 6 lanes.

[9] When the criteria-based dimensioning method (see Chapter 1106) is used for high-speed (see Chapter 1103) facilities, outside shoulders must be 10ft minimum. In mountainous terrain, outside shoulder may be reduced to 8ft on facilities up to 6 lanes. Two-lane high speed highways may have an 8ft minimum outside shoulder, and may be reduced to 4ft with justification.

1230.02(6)(a) Road Diets

Generally, road diets refer to converting four-lane undivided highways to three lanes with the center lane for left turning movements and the remaining outside space repurposed for bicyclists or other function. The center lane can consist of a two-way left-turn lane (TWLTL) or can be dedicated for directional left turns either by paint or median treatments. The choice of how to configure the center lane depends largely on balancing the resulting safety and accessibility performance of different modes and land uses.

The application of road diets also has the benefit of reallocating existing space within a cross section, which provides distinct opportunities to improve roadway bicycle facilities and/or elements of the streetside or roadside zones. At nodes and access points, a road diet can improve intersection sight distance, and in some cases improve mobility performance, for motorists.

The success of road diet implementation varies due to a number of factors such as signal spacing and timing, access connection density, modal priority, and average daily traffic (ADT). ADT is a reasonable indicator for implementation. FHWA recommends limiting road diet applications to roadways of 20,000 ADT or less, although road diets have been successful at locations with 25,000 ADT in various parts of the country. Motor vehicle mobility performance is most likely deemed the primary measure of success for the road diet configurations with higher ADT values described. However, locations with a different modal priority and higher ADT may still be candidates for road diets. The Region Traffic Engineer must approve road diet applications on state highways.

1230.02(6)(b) Retrofit Options

Retrofit options refer to the application of lower-cost treatments that utilize paint and other delineation devices rather than hardscape features. Retrofit applications are particularly useful when:

- Construction will occur in phases over a timeline greater than one year between phases where overlapping areas of work occur, or when elements or features are funded by a partnering agency.
- Implementing speed management treatments (see Chapter 1103) that, after evaluating their effectiveness, may need to be reconfigured.
- Funding is unable to adequately accomplish the identified scope of work.

Applied retrofit options may require additional maintenance over long-duration applications. Coordination with maintenance jurisdictions as described in Chapter 301 is critical to evaluating the potential maintenance outcomes for retrofit options being considered. The retrofit options discussed within the following subsections, are more likely to be applied in urban context settings. Note that cities over 25,000 population will have the responsibility of maintaining any retrofit delineation, and it will be critical to ensure they have the resources to maintain striped retrofit features.

The following subsections describe several common applications of retrofit options.

1230.02(6)(b)(1) Relocate Curbs

Changes to the geometric cross section may involve relocating the existing curb. While installing a new curb may be preferred, there are a number of additional considerations (like stormwater conveyance) that make relocating curb lines cost-prohibitive. However, there are multiple retrofit solutions that can provide effective accommodation including, but not limited to:

- Striping combined with MUTCD-approved channelization devices.
- Curb extensions offset from the original curb. Depending on the use of the new curbed section, retrofit designs may include slotted grates tying the existing curb and new curb together, while maintaining the original stormwater conveyance system.
- Colorized pavement to delineate a change of use.

Use retrofit features as a low-cost solution to create wider sidewalk areas, curb extensions, bicycle parking areas, parklet areas, and/or green street low-impact development solutions.

Downtown City of Olympia 5th Avenue Curb Retrofit. Note that retrofits like this must comply with 1510.07(1)(c), see Chapter 1510.

"Moving the Curb" Photo courtesy of NACTO.org

1230.02(6)(b)(2) Parklets and Plazas

Parklets and plazas reuse existing right of way in urban and rural town centers, providing public space to support the economic vitality and social livability performance of a particular context. As geometric cross sections are reconfigured, spaces may become available at nodes or where repurposing a parking zone area into either plazas or parklets. The primary intent of presenting these treatments is for low-speed roadways or main streets with volumes at or below 20,000 ADT. However, there are many potential constraints external to the engineering design that may need resolution before application. Consult with Real Estate Services to discuss the specific property management-related concerns and any potential lease and/or economic payment considerations proportionally appropriate for utilization of the highway space in this manner, as further detailed in RCW 47.24.020(15).

A parklet specifically uses the parking zone to create a space for pedestrians. A common application provides seating accommodations to support local restaurants and shops. Parklet designs will vary depending on local jurisdiction regulations, but they typically include railing and/or planter boxes to provide a separation of uses between people and traffic. Parklet design should not cover catch basins or other features that may require frequent maintenance. Parklets interact with motorized vehicle traffic best when placed on tangent alignments.

Plazas can reuse right of way to define a relatively large common public space. Plazas are typically associated with a central gathering location for special events, and will likely have limited application on Washington state highways.

1230.03 Cross Section Zones and Elements

The geometric cross section of a roadway is comprised of different zones. Examples are shown in Exhibits 1230-2a through 1230-6d, but these examples are not the only cross-sectional options available. Which zones to apply depends on the performance needs, context (see Chapter 1102) and design controls (see Chapter 1103) determined for a particular location. Which zonal design elements apply, and how they are configured within each zone, depends largely on the balance of performance needs determined and the context identified. The following subsection list the cross-sectional zones and their design elements.

Maintaining the continuity of a roadway is an important consideration in alternative formulation, particularly for limited access and other high-speed highways. However, it is also appropriate to intentionally change continuity in response to obvious changes in context, in order to impact driver behavior. When designing intentional changes to the continuity of the geometric cross section, it is important to consider what is needed to enable the transition. High-speed to low-speed changes will need to transition the geometric cross section over a distance utilizing a speed transition segment (see Chapter 1103). At other locations where low target speeds are already established, roadway changes can be more oriented around maintaining speed and operations.

1230.03(1) Traveled Way Zone

The traveled way zone refers to any lanes or buffers contained within either the edge lines or curbing when stripes are not provided, excluding any parking areas that may be present. The traveled way zone is typically only provided for motorized vehicles and bicycle modes. The traveled way zone includes all auxiliary and special-use lanes, and is therefore different from the term traveled way, which is used in other applications of roadway design.

1230.03(1)(a) Vehicle Lanes

There are many types of lanes that may exist in a cross section and each has its own purpose and sizing needs. General-purpose traffic lanes need to accommodate a variety of vehicle types, including buses, freight vehicles, personal automotive vehicles, and in some cases bicycles. The target speed, modal priority, balance of performance needs, and transportation context are all considerations when determining size, type, and number of lanes. In addition, see Chapter 1106 for design element dimensioning methods. Note that if the criteria-based dimensioning method is used for determining lane widths on high speed (see Chapter 1103) National Highway System (NHS) facilities then the following apply:

- Lane widths are to be 12ft minimum.
- Two-lane highways may have an 11ft lane width.

1230.03(1)(a)(1) Turn Lanes

Dedicated turn lanes provide storage for turning vehicles waiting for a signal or gap in opposing traffic, separated from the through lanes. There are a number of different types of turn lanes, which are discussed in detail in Chapter 1310. Turn lanes are critical to meet mobility and accessibility performance for motorized and bicycle modes. Traffic analysis determines the type and number of turn lanes that are needed to achieve the balance of multimodal performance needs.

Turn lanes present potential conflicts, particularly with bicyclists and pedestrians. (See Chapters 1510 and 1520 for additional discussion on ways to mitigate for these conflicts.)

1230.03(1)(a)(2) Bicycle Lane

There are several different types of bicycle lanes and many different ways to arrange bike lanes within the geometric cross section. (See Chapter 1520 for different bike lane types.) In general, the minimum total width for a single-direction bike lane within the traveled way zone is 5 feet, including buffer width that may be applied. Two-way bike lane facilities require a minimum width of 8 feet, excluding a minimum 2-foot buffer when adjacent to traffic or parking lanes.

Shoulders designed to function for bikes are not considered bike lanes. (See 1230.03(2)(b)(1) and Chapter 1520 for additional information.)

1230.03(1)(a)(3) Transit-Only Lane

Transit-only lanes are ideal for improving transit mobility performance and segregating heavily used or complex intermodal connections. There are many different ways to configure these within a geometric cross section. Some configurations are limited based on the type of transit vehicle due to passenger loading needs for both the vehicle type and at the stop locations. Develop widths for transit only lanes with the partnering transit agency. (See Chapter 1430 for additional information on Transit Facility considerations.)

1230.03(1)(a)(4) Managed and Shared Lane

There are many different types of managed and shared lanes. Some examples of managed lanes include:

- High occupancy vehicle (HOV) lanes (see Chapter 1410)
- High occupancy toll lanes (discuss with Tolling Division and see Chapter 1410)
- Hard-running shoulder (see Exhibit 1230-4c)
- Peak hour use

Shared lanes consist of mixing modes and are designed to address specific performance outcomes. Examples include:

- Bicycle shared lane (see Chapter 1520)
- Business access and transit (BAT) lane

1230.03(1)(a)(5) Auxiliary Lanes

Auxiliary lanes assist with obtaining mobility performance for motor vehicle modes. They include many types of functions that depend on the transportation context or environmental conditions at a specific location. (See Chapter 1270 for a detailed discussion on the types of and design guidance for auxiliary lanes.)

1230.03(1)(b) Service Lanes, Frontage Roads, and Collector-Distributor Roads

On some road and street types, a service lane is utilized to separate the throughput and local accessibility needs. The service lane will generally target no more than a 25 mph operating speed. The service lane is generally separated from the main line by an outer separation median (see examples in Exhibits 1230-6a through 1230-6d and 1230.04). This service lane design segregates it from the functions of the main line, making it an ideal location for on-street parking, freight-loading areas, and potentially shared vehicle and bicycle lanes. Depending on how the service lane is treated at the intersections, it may be appropriate for transit services. The service lane presents an ideal opportunity for managing access, allowing minor side streets to intersect with the service lane rather than complicating the main line through movement. These intersection designs can potentially benefit main line operations by prioritizing which crossroads have fully directional intersections.

On higher-speed facilities in more rural environments, frontage roads provide the same functional accessibility purpose as a service lane in a city, but usually target higher operating speeds consistent with the context environment.

The primary purpose for city service lanes and rural frontage roads is to respond to local land use performance needs. Designs that support service lanes or frontage roads are recommended to include those roadways as part of a turnback agreement, or within a maintenance agreement (see Chapter 301), to clarify or further define jurisdictional responsibilities associated with the service lane, frontage road, and any associated outer separations.

Collector-distributor (C-D) roads serve a similar function as service lanes and frontage roads. Instead of providing for local land use access, C-D roads enable mobility and access performance between transportation facilities and are used exclusively on freeway applications. WSDOT maintains ownership of C-D roads. (See Chapter 1360 for more information.)

1230.03(2) Streetside and Roadside Zones

The decision to design for either a streetside or roadside zone outside the traveled way zone largely depends on the land use and transportation contexts. In general, streetside zones are used in low to intermediate target speed locations and typically within suburban or urban land use areas and rural towns. Roadside zones are typically used for intermediate- to high-speed roadways in rural areas outside of towns, on full and partial limited access facilities, or on some managed access class 1 and 2 roadways.

1230.03(2)(a) Streetside Zones

The streetside zone can be used to meet the performance needs of the pedestrian mode and land use. A robust streetside design may allocate much of the available public space as both a pedestrian thoroughfare and a destination, which is desirable in many urban core and main street contexts to help promote economic vitality. In other contexts, the streetside configuration may assist with reinforcing the target speed and still provide for a minimal pedestrian thoroughfare.

WSDOT uses terminology to describe four streetside zones: frontage zone, pedestrian zone, furnishing zone, and parking zone. Information about each zone is provided below. Note, when partnering with some local agencies, they may identify more streetside zones that have specific functions according to their policy. In these cases, it is appropriate to identify the zones recognized by the partnering agency. The pedestrian zone will always be present in streetside design, but other zones are optional depending on the modal and contextual performance needs and desired balance of performance needs within the available right of way.

The Americans with Disabilities Act (ADA) requires specific design element dimensions for streetside zones, depending on configuration. In general, the pedestrian zone and frontage zone will always be part of the pedestrian circulation path (PCP). The furnishing zone may or may not be part of the PCP, depending on how it is designed. (See Chapter 1510 for detailed accessibility criteria and design guidance for pedestrian facilities.)

1230.03(2)(a)(1) Frontage Zone

The frontage zone serves the retail functions found within certain contexts. The primary purpose is access to retail space without interfering with the required pedestrian access route (PAR) within the pedestrian zone. If there is not a retail or residential access need immediately adjacent to the streetside zone, then it may not be prudent to utilize the cross-sectional width for a frontage zone purpose. The frontage zone may also provide space for temporary retail product displays, advertisements, and/or outdoor seating for customers. If no frontage zone exists by private ownership or is required by municipal codes, discuss how frontage zone uses and features may be accommodated within the public right of way and any documentation that may be necessary with Real Estate Services.

1230.03(2)(a)(2) Pedestrian Zone

The pedestrian zone is completely within the PCP and is the streetside zone within which a PAR must be provided. Consider meeting PAR criteria within the entire width of the pedestrian zone when feasible. Also consider exceeding minimum width values for the pedestrian zone elements depending on the land use and transportation context needs. A generous pedestrian zone width promotes the necessary mobility and accessibility typically anticipated within some urban and suburban contexts. (See Chapter 1510 for detailed accessibility criteria and design guidance for pedestrian facilities.)

1230.03(2)(a)(3) Furnishing Zone

The furnishing zone provides area for multiple functions. It is commonly used to promote environmental and aesthetic features that improve people's experience—like street trees, benches, planter boxes, and artwork—while providing for the safe travel of the various modes through modal segregation or clearance to obstructions. Involve the local agency, regional Landscape Architect, responsible maintenance jurisdiction(s), urban forestry experts, human factors experts, and safety professionals to consider and determine what constitutes optimal vegetation types in terms of plant and road maintenance, operations, landscape, roadway, roadside, and potential modal interactions within the furnishing zone to ensure vegetation aspects are well planned.

Traffic signs, parking meters, transit shelters/stops, and bike racks are also generally found within this zone. Other width accommodations for on-street parking may be needed for vehicle overhang or entering/exiting movements when a parking zone is applied. Coordinate with Region Program Management to understand potential funding limitations for furnishing zone features described within this section. Partnerships or grants may be necessary to complete all desired features within the furnishing zone.

1230.03(2)(a)(4) Parking Zone

The parking zone allows width for on-street parking typically provided in urban design areas and rural town center context segments, but is not necessarily required. On-street parking can help to visually narrow the street in places to assist in conveying the surrounding context for the segment. Refer to municipal codes regarding parking requirements, and coordinate with the municipality involved. Also, if on-street parking will be either delineated or metered, the ADA has requirements on the number and configuration of parking stalls for people with disabilities. Consult with a regional ADA subject matter expert. On-street parking can be either parallel or angled. However, angled parking on any state route requires approval from the State Traffic Engineer.

If angled parking is part of an alternative, request approval through the region Traffic Office. Provide an engineering study, to be approved by the State Traffic Engineer, with the request documenting that the parking will not unduly reduce safety and that the roadway is of sufficient width that parking will not interfere with the normal movement of traffic. If angled parking is approved, provide for vehicle overhang within the furnishing zone. Consider back-in angled parking if bike lanes are present to improve conflict management through increased visibility.

When designing for the parking zone locations for freight loading areas, it is important to consider both the delivery vehicle size and how the vehicle loading/unloading is done. Consult with business owners and freight carriers to locate and configure the freight loading areas throughout the alignment.

1230.03(2)(b) Roadside Zones

Roadside zones are typically applied to limited access facilities designed for intermediate to high target speeds, some managed access class 1 and 2 facilities, or rural highways. The roadside zone is composed of shoulders and side slopes designed with considerations for clear zone or mitigation features.

1230.03(2)(b)(1) Shoulders

Shoulders are typically considered for high- or intermediate-speed limited access facilities, some rural contexts, as well as intermediate-speed locations that do not have streetside zones. Intermediate-speed locations in suburban and urban contexts that utilize streetside zones do not need to include a shoulder, unless determined to be necessary by safety performance analysis or engineering judgment. If the criteria-based dimensioning method (see Chapter 1106) is used to determine shoulder widths the following must be applied for high speed NHS facilities (See Chapter 1103):

- Inside shoulders are to be 4ft minimum on facilities up to 4 lanes, and 10 ft minimum on 6 lane facilities. In mountainous terrain, inside shoulder may be reduced to 4ft on facilities up to 6 lanes.
- Outside shoulders are to be 10ft minimum. In mountainous terrain, outside shoulder may be reduced to 8ft on facilities up to 6 lanes. Two-lane high speed highways may have an 8ft minimum outside shoulder, and may be reduced to 4ft with justification.

In other situations the shoulder width is controlled by its intended functional use and its contribution to achieving the desired safety performance when balanced with other design elements. Functional uses and recommended shoulder widths are given in Exhibit 1230-7. In addition to the functions in Exhibit 1230-7, shoulders also:

- Provide space to escape potential collisions or reduce their severity.
- Provide a sense of openness, contributing to driver ease at higher speeds.
- Reduce seepage adjacent to the traveled way by discharging stormwater farther away.

Exhibit 1230-7 Shoulder Functional Uses and Width Considerations

Shoulder Function	Shoulder Width Guidance
Stopping out of the traffic lanes	8 ft – 12 ft [1]
Minimum lateral clearance	2 ft [2]
Hard-running shoulder	11 ft to 14 ft [6]
Bicycle use	4 ft [3]
Pedestrian use	4 ft [3]
Large-vehicle off-tracking on curves	See Chapter 1240
U-turn turnouts	Varies – See Chapter 1310
Maintenance operations	Varies [4]
Law enforcement	8 ft [5]
Bus stops	See Chapter 1430
Slow-vehicle turnouts and shoulder driving	See Chapter 1270
Ramp meter storage	8 – 12ft [1]
HOV bypass	10 – 14ft [6]
Ferry holding	8 ft – 12ft
For use as a lane during reconstruction of the through lanes	8 ft – 12ft
Structural support of pavement	2 ft
Improve sight distance in cut sections	See Chapter 1260

Notes:

[1] 10-ft minimum recommended for freight or transit vehicles.

[2] See Chapters 1600 and 1610.

[3] Minimum usable shoulder width for bicycles, additional width is recommended when combined with shoulder rumble strips, curb, or barrier (see Chapter 1600 and the *Standard Plans*). For guidance, see Chapter 1520 for accommodating bicycles and Chapter 1510 for accommodating pedestrians.

[4] 10-ft usable width to park a maintenance truck out of the through lane; 12-ft width (14-ft preferred) for equipment with outriggers to work out of traffic.

[5] For additional information, see Chapters 1410 and 1720.

[6] Selected width should be determined with transit provider, and consider any lateral clearance concerns.

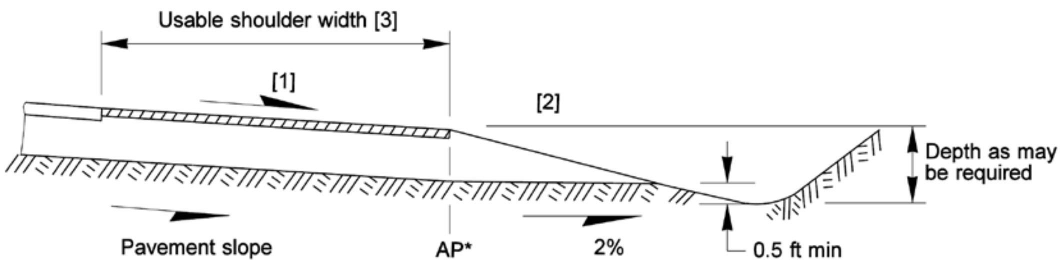
Contact the Area Maintenance Superintendent to determine the shoulder width for maintenance operations. In some cases, a continuous width is not necessary; instead, the focus is placing the shoulder width near assets with high-frequency maintenance needs. Compare the added cost of the wider shoulders to the added benefits to maintenance operations as well as other benefits that may be derived (see Chapter 301).

The usable shoulder is the width necessary for a vehicle to stop out of traffic. Usable shoulder width is less than the constructed shoulder width when vertical features (such as traffic barrier or walls) are at the edge of the shoulder. This is because drivers tend to shy away from the vertical feature. For traffic barrier shy distance widening, see Chapter 1610.

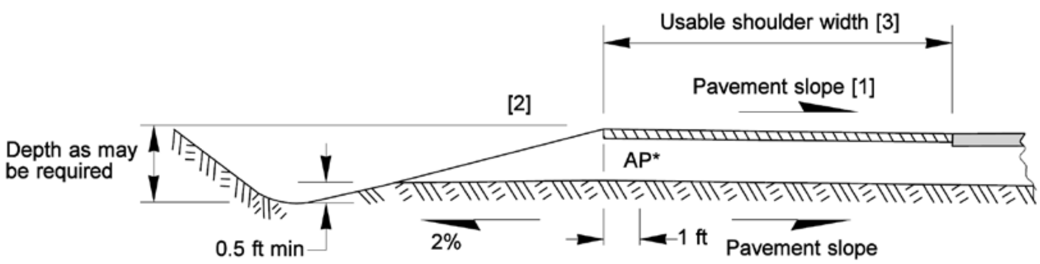
Shoulder widths greater than 10 feet may encourage use as a travel lane. Therefore, use shoulders wider than this only to meet one of the listed functions (see Exhibit 1230-7).

When walls are placed adjacent to shoulders, see Chapter 730 for barrier guidance.

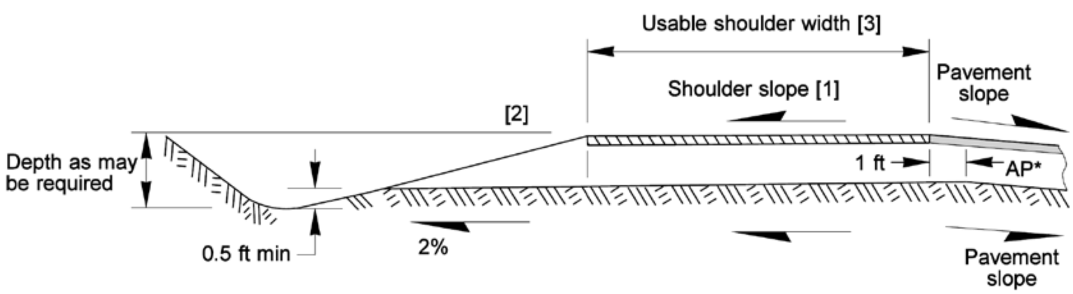
Exhibit 1230-8a Shoulder Details



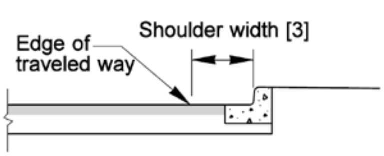
Shoulder Design on the Low Side of the Roadway for Cross Slopes Greater Than 2%



Shoulder Design on the High Side of the Roadway on Curves and Divided Roadways Shoulder Slopes With Roadway



Shoulder Design on the High Side of the Roadway on Curves and Divided Roadways Shoulder Slopes Away From Roadway



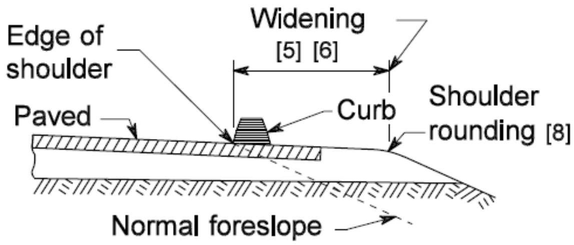
Shoulder Design with Curb [4] [5]

*AP = Angle point in the subgrade

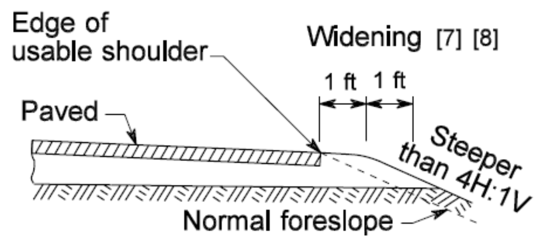
Note:

For applicable notes, see Exhibit 1230-8b.

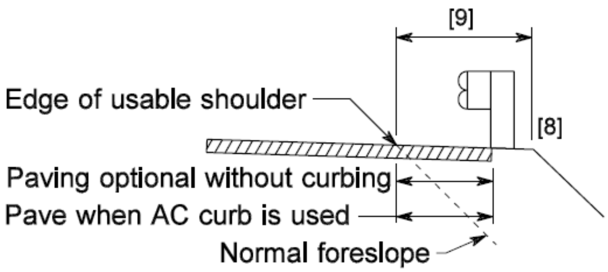
Exhibit 1230-8b Shoulder Details



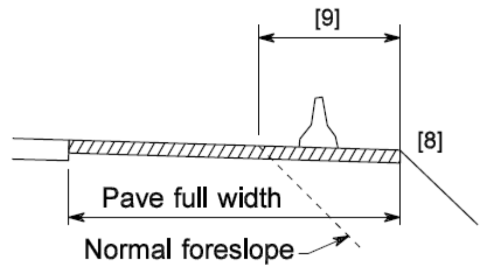
Asphalt Concrete Curb Placement



Shoulder Rounding [2]



Shoulder Widening for Guardrail



Shoulder Widening for Barrier

Notes:

[1] Shoulder cross slopes are normally the same as the cross slopes for adjacent lanes. (For examples and additional information for locations where it may be desirable to have a shoulder cross slope different than the adjacent lane, see 1230.06(1).

[2] Provide widening and slope rounding outside the usable shoulder when foreslope is steeper than 4H:1V.

[3] For shoulder width, see Exhibit 1230-7 and Chapters 1360 and 1520.

[4] For additional requirements for sidewalks, see Chapter 1510.

[5] See 1230.05 for curb design guidance.

[6] Provide paved shoulders wherever extruded curb is placed. (See the *Standard Plans* for additional details and dimensions.)

[7] When rounding is provided, consider uniform application on all ramps and crossroads, as well as the main roadway. End rounding on the crossroad just beyond the ramp terminals and at a similar location where only a grade separation is involved.

[8] When widening beyond the edge of usable shoulder for curb, barrier, or other purposes, additional widening for slope rounding may be omitted.

[9] For widening guidelines for guardrail and concrete barrier, see Chapter 1610.

General:

On divided multilane highways, see Exhibits 1230-14a through 1230-14c for additional details for median shoulders.

1230.03(2)(b)(2) Side Slopes

The design for side slopes can affect shoulder design, clear zone requirements, and whether or not traffic barrier is necessary. Side slopes are more commonly encountered in high-speed and/or rural contexts. The following guidance may not apply to cross section design if streetside elements are present or employed in the design (See 1230.03(2)(a) and Chapter 1510 for further information). After the foreslope has been determined, use the guidance in Chapter 1600 to determine the need for a traffic barrier.

When designing side slopes, attempt to fit the slope selected for any cut or fill into the existing terrain to give a smooth transitional blend from the construction to the existing landscape when practicable. Flatter slopes are desirable, especially with higher posted speeds and when the associated cost does not significantly exceed other design options. Side slopes not steeper than 4H:1V, with smooth transitions where the slope changes, will provide a reasonable opportunity to recover control of an errant vehicle. Side slopes designed to 4H:1V or flatter are preferred. Provide widening and slope rounding outside the usable shoulder when foreslope is steeper than 4H:1V. Do not disturb existing stable cut slopes just to meet the a 4H:1V side slope preference. When an existing slope is to be revised, document the reason for the change.

3H:1V side slopes are traversable, but not necessarily recoverable. If providing 3H:1V slopes, consider placement of a flat area extending from the toe of the cut slope for errant vehicle recovery (see Chapter 1600). Where mowing is contemplated, provide slopes not steeper than 3H:1V to allow for mowing. If there will be continuous traffic barrier on a fill slope, and mowing is not contemplated, the slope may be steeper than 3H:1V. When providing side slopes steeper than 3H:1V, document the reason for the decision.

Where unusual geological features or soil conditions exist, treatment of the slopes depends upon results of a review of the location by the Region Materials Engineer (RME).

Do not install traffic barrier unless an object or condition is present that calls for mitigation in accordance with Chapter 1600 criteria. The steepest slope is determined by the soil conditions. Where favorable soil conditions exist, higher fill slopes may be as steep as 1½H:1V. (See Chapter 1600 for clear zone and barrier criteria.)

If borrow is necessary, consider obtaining it by flattening cut slopes uniformly on one or both sides of the highway. Where considering wasting excess material on an existing side slope, consult the RME to verify that the foundation soil will support the additional material.

Provide for drainage from the roadway surface and drainage in ditches (see Chapter 800). For drainage ditches, see 1230.03(2)(b)(5).At locations where vegetated filter areas or detention facilities will be established to improve highway runoff water quality, provide appropriate slope, space, and soil conditions for that purpose. (See the *Highway Runoff Manual* for design criteria and additional guidance.)

Except under guardrail installations, it is desirable to plant and establish low-growing vegetation on nonpaved roadsides. This type of treatment relies on the placement of a lift of compost or topsoil over base course material in the roadway cross section. Consult with the area Maintenance Superintendent and the region Landscape Architect to determine the appropriate configuration of the roadway cross section and soil and plant specifications.

Flatten crossroad and road approach foreslopes to 6H:1V, where feasible, and consider at least to 4H:1V. Provide smooth transitions between the main line foreslopes and the crossroad or road approach foreslopes. Where possible, move the crossroad or road approach drainage away from the main line. This can locate the pipe outside the Design Clear Zone and reduce the length of pipe.

Provide slope treatment as shown in the *Standard Plans* at the top of roadway cut slopes except for cuts in solid rock. Unless Class B slope treatment is called for, Class A slope treatment is used. Call for Class B slope treatment where space is limited, such as where right of way is restricted.

1230.03(2)(b)(3) Roadway Sections in Rock Cuts

Typical sections for rock cuts, illustrated in Exhibits 1230-9a and 1230-9b, are guides for the design and construction of roadways through rock cuts. Changes in slope or fallout area are recommended when justified. Base the selection of the appropriate sections on an engineering study and the recommendations of the RME and region Landscape Architect. Obtain concurrence from the Headquarters (HQ) Materials Lab.

There are two basic design treatments applicable to rock excavation (see Exhibits 1230-9a and 1230-9b). Design A applies to most rock cuts. Design B is a talus slope treatment.

a. Design A

This design is shown in stage development to aid the designer in selecting an appropriate section for site conditions in regard to backslope, probable rockfall, hardness of rock, and so on.

The following guidelines apply to the various stages shown in Exhibit 1230-9a:

- **Stage 1** is used where the anticipated quantity of rockfall is small, adequate fallout width can be provided, and the rock slope is ½H:1V or steeper. Controlled blasting is recommended in conjunction with Stage 1 construction.
- **Stage 2** is used when a “rocks in the road” problem exists or is anticipated. Consider it on flat slopes where rocks are apt to roll rather than fall.
- **Stage 3** represents the full implementation of all protection and safety measures applicable to rock control. Use it when extreme rockfall conditions exist.

Show Stage 3 as the ultimate stage for future construction in the Plans, Specifications, and Estimates (PS&E) if there is any possibility that it will be needed.

The use of Stage 2 or Stage 3 alternatives (concrete barrier) is based on the designer’s analysis of the particular site. Considerations include maintenance; size and amount of rockfall; probable velocities; availability of materials; ditch capacity; adjacent traffic volumes; distance from traveled lane; and impact severity. Incorporate removable sections in the barrier at approximately 200-foot intervals. Provide appropriate terminal treatment (see Chapter 1610).

Occasionally, the existing ground above the top of the cut is on a slope approximating the design cut slope. The height (H) is to include the existing slope or that portion that can logically be considered part of the cut. Select cut slopes for a project that provide stability for the existing material.

Benches may be used to increase slope stability; however, the use of benches may alter the design given in Exhibit 1230-9a.

The necessity for benches, as well as their width and vertical spacing, is established after an evaluation of slope stability. Make benches at least 20 feet wide. Provide access for maintenance equipment to the lowest bench and to the higher benches if feasible. Greater traffic benefits in the form of added safety, increased horizontal sight distance on curves, and other desirable attributes may be realized from widening a cut rather than benching.

b. Design B

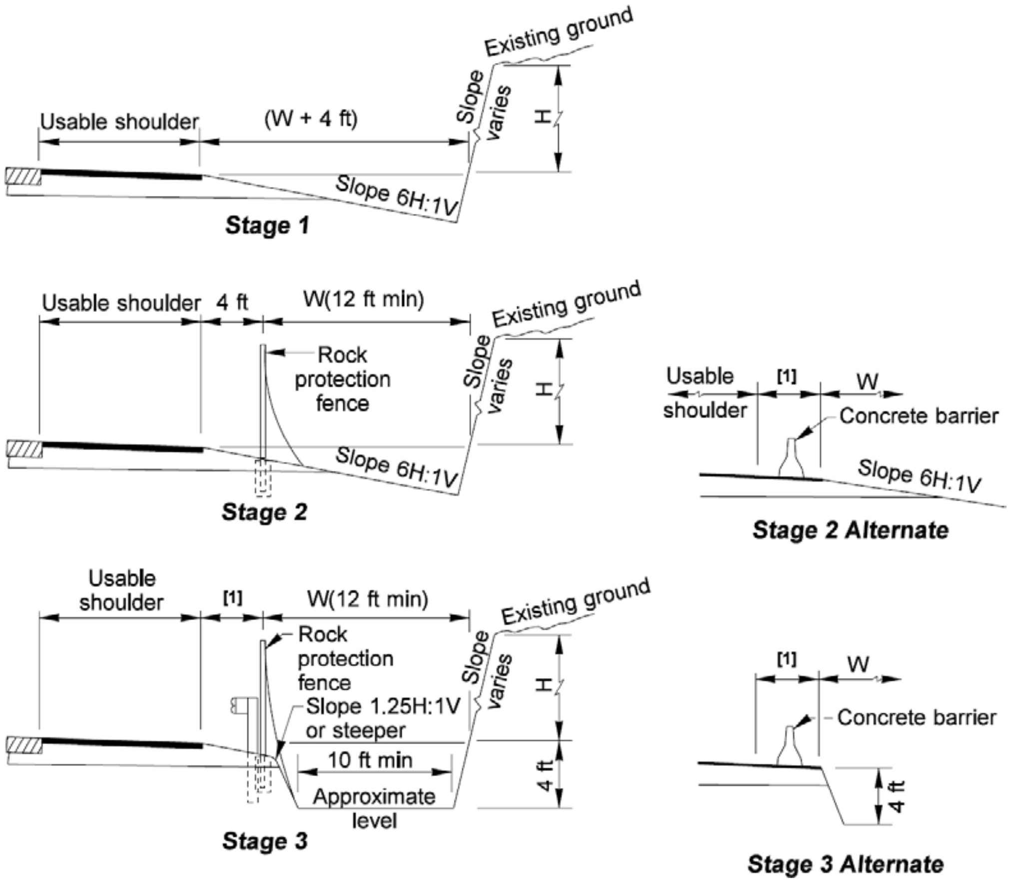
A talus slope treatment is shown in Exhibit 1230-9b. The rock protection fence is placed at any one of the three positions shown, but not in more than one position at a particular location. Consult with the RME for the placement of the rock protection fence in talus slope areas.

- **Fence position a** is used when the cliff generates boulders less than 0.25 yd3 in size and the length of the slope is greater than 350 feet.
- **Fence position b** is the preferred location for most applications.
- **Fence position c** is used when the cliff generates boulders greater than 0.25 yd3 in size regardless of the length of the slope. On short slopes, this may require placing the fence less than 100 feet from the base of the cliff.
- Use of gabions may be considered instead of the rock protection shown in fence position a. Because gabion treatment is considered similar to a wall, provide appropriate face and end protection (see Chapters 730 and 1610).

Use of the alternate shoulder barrier is based on the designer’s analysis of the particular site. Considerations similar to those given for Design A alternatives apply.

Evaluate the need for rock protection treatments other than those described above for cut slopes that have relatively uniform spalling surfaces (consult with the RME).

Exhibit 1230-9a Roadway Sections in Rock Cuts: Design A



Rock Slope	H (ft)	W (ft)
Near Vertical	20 – 30	12
	30 – 60	15
	> 60	20
0.25H:1V through 0.50H:1V	20 – 30	12
	30 – 60	15
	60 – 100	20
	>100	25

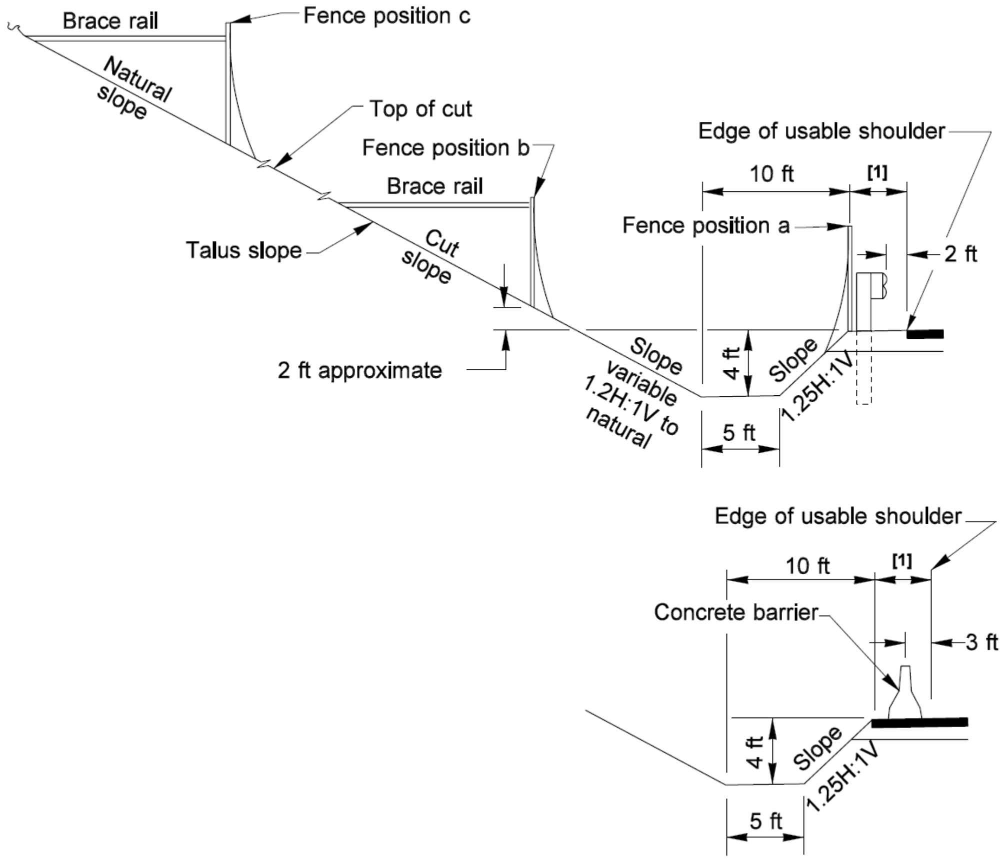
Note:

[1] For widening for guardrail and concrete barrier, see Chapter 1610.

General:

- Treat cut heights less than 20 feet as a normal roadway unless otherwise determined by the RME.
- Stage 2 and Stage 3 Alternates may be used when site conditions dictate.
- Fence may be used in conjunction with the Stage 3 Alternate. (See Chapter 1600 for clear zone guidelines.)

Exhibit 1230-9b Roadway Sections in Rock Cuts: Design B



Shoulder Barrier Alternate

Note:

[1] For widening for guardrail and concrete barrier, see Chapter 1610.

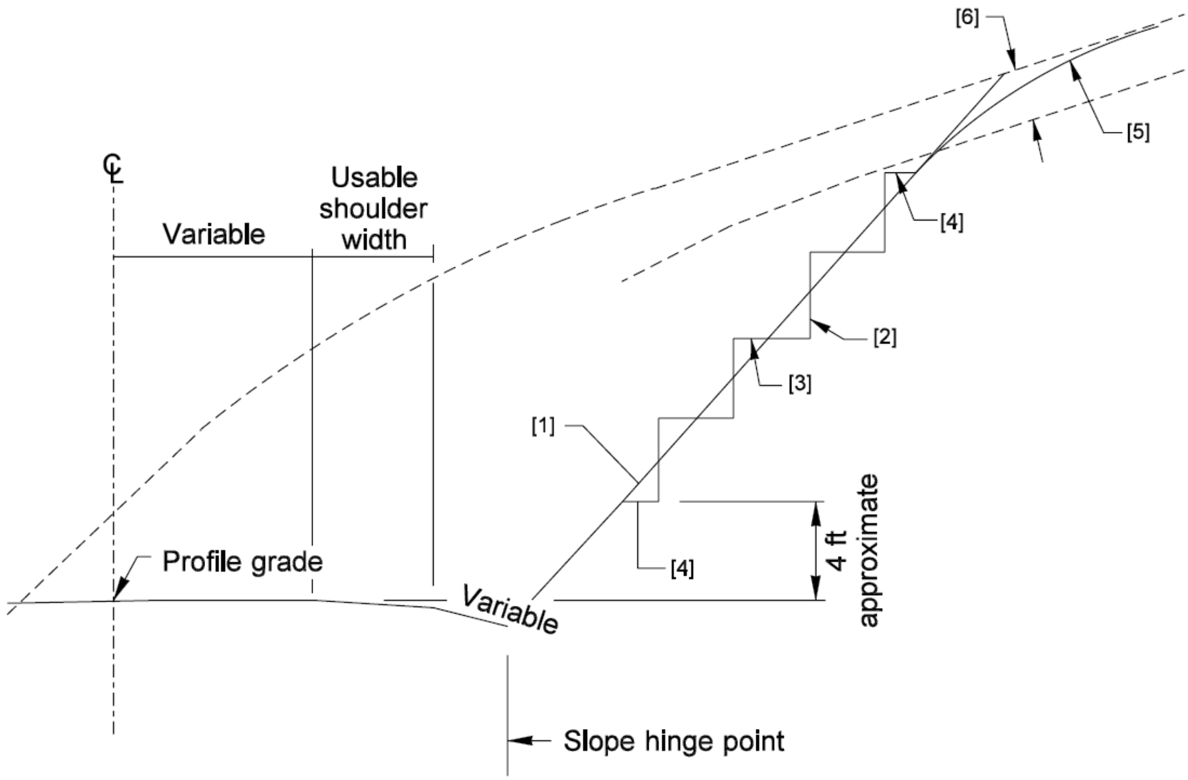
General:

- Ordinarily, place fence within a zone of 100 feet to 200 feet maximum from base of cliff, measured along the slope.
- Rock protection fence may be used in conjunction with the Shoulder Barrier Alternate when site conditions dictate.

1230.03(2)(b)(4) Stepped Slopes

Stepped slopes are a construction method intended to promote early establishment of vegetative cover on the slopes. They consist of a series of small horizontal steps or terraces on the face of the cut slope. Soil conditions dictate the feasibility and necessity of stepped slopes. They are to be considered on the recommendation of the RME (see Chapter 610). Consult the region landscape personnel for appropriate design and vegetative materials to be used. (See Exhibit 1230-10 for stepped slope design details.)

Exhibit 1230-10 Stepped Slope Design



Notes:

[1] Staked slope line: Maximum slope 1H:1V.

[2] Step rise: Height variable 1 foot to 2 feet.

[3] Step tread: Width = staked slope ratio x step rise.

[4] Step termini: Width ½-step tread width.

[5] Slope rounding.

[6] Overburden area: Variable slope ratio.

1230.03(2)(b)(5) Drainage Ditches

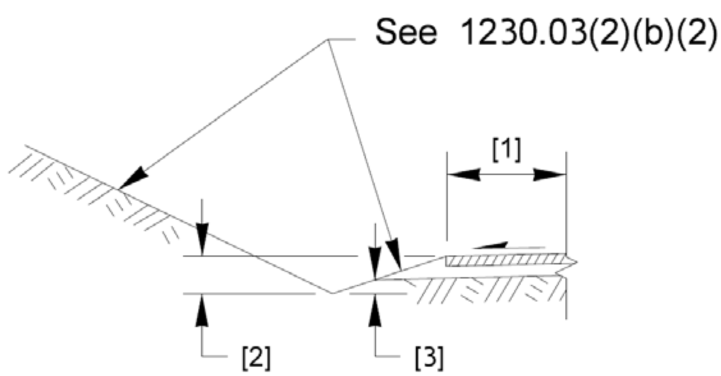
Exhibit 1230-11 provides general information regarding drainage ditch design. Where a drainage ditch is located adjacent to the toe of a side slope, consider the stability of the foreslope and backslope. A drainage ditch placed immediately adjacent to the toe of side slopes has the effect of increasing the height of the side slope by the depth of the ditch. In cases where the foundation soil is weak, the extra height could result in an side slope failure. As a general rule, the weaker the foundation and the higher the side slopes, the farther the ditch should be from the toe of slope. Consult the RME for the proper ditch location.

When topographic restrictions exist, consider an enclosed drainage system with appropriate inlets and outlets. Do not steepen slopes to provide lateral clearance from toe of slope to ditch location, thereby necessitating traffic barriers or other protective devices.

Maintenance operations are also facilitated by adequate width between the toe of the slope and an adjacent drainage ditch. Where this type of facility is anticipated, provide sufficient right of way for access to the facility and place the drainage ditch near the right of way line.

Provide for disposition of the drainage collected by ditches in regard to siltation of adjacent property, erosion, and other undesirable effects. This may also apply to the top of cut slope ditches.

Exhibit 1230-11 Drainage Ditch Detail



Notes:

[1] Roadway width determined by various sections within this chapter, and by design element dimensioning (see Chapter 1106).

[2] 1.5 ft minimum, unless otherwise determined by drainage design.

[3] 0.5 ft minimum from bottom of subgrade or design water surface elevation.

1230.03(2)(b)(6) Bridge End Slopes

Bridge end slopes are determined by several factors, including context, fill height, depth of cut, soil stability, and horizontal and vertical alignment. Coordinate bridge end slope treatment with the HQ Bridge and Structures Office (see Chapter 720).

Early in the bridge plan development, determine preliminary bridge geometrics, end slope rates, and toe of slope treatments. Exhibit 1230-12a provides guidelines for use of slope rates and toe of slope treatments for overcrossings. Exhibit 1230-12b shows toe of slope treatments to be used on the various toe conditions.

Exhibit 1230-12a Bridge End Slopes

<table>
<tr><th>Bridge End Condition</th><th colspan="2">Toe of Slope End Slope Rate</th><th colspan="2">Lower Roadway Treatment [1]</th><th>Slope Rate</th></tr>
<tr><td rowspan="2">End Piers on Fill</td><td>Height</td><td>Rate</td><td>Posted speed of lower roadway</td><td>Treatment</td><td></td></tr>
<tr><td>≤ 35 ft
> 35 ft</td><td>1¾H:1V
2H:1V [2]</td><td>> 50 mph
≤ 50 mph</td><td>Rounding
No rounding</td><td></td></tr>
<tr><td>End Piers in Cut</td><td colspan="2">Match lower roadway slope [3]</td><td colspan="2">No rounding, toe at centerline of the lower roadway ditch.</td><td>[4]</td></tr>
<tr><td>Lower Roadway in Cut</td><td colspan="2">Match lower roadway slope [3]</td><td colspan="2">No rounding, toe at centerline of the lower roadway ditch.</td><td>[4]</td></tr>
<tr><td rowspan="2">Ends in Partial Cut and Fill</td><td colspan="2">When the cut depth is > 5 ft and length is > 100 ft, match cut slope of the lower roadway</td><td colspan="2">When the cut depth is > 5 ft and length is > 100 ft, no rounding, toe at centerline of the lower roadway ditch</td><td>[4]</td></tr>
<tr><td colspan="2">When the cut depth is ≤ 5 ft or the length is ≤ 100 ft, it is designer's choice</td><td colspan="2">When the cut depth is ≤ 5 ft or the length is ≤ 100 ft, it is designer's choice</td><td>[4]</td></tr>
</table>

Notes:

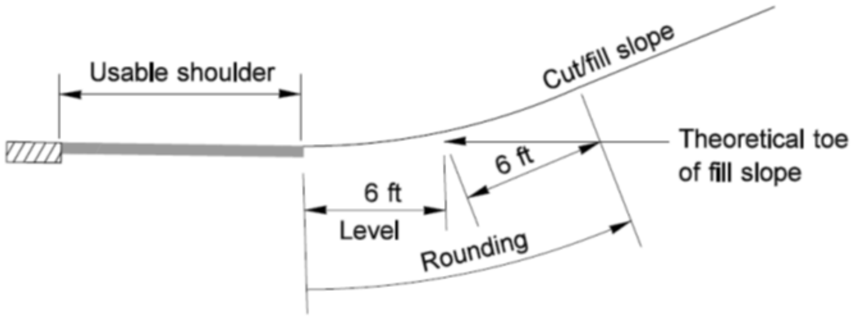
[1] See Exhibit 1230-12b.

[2] Slope may be 1¾H:1V in special cases.

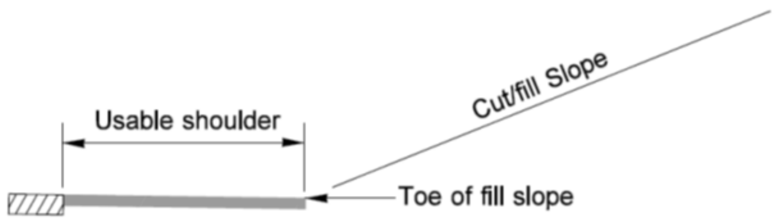
[3] In interchange areas, continuity may require variations.

[4] See 1230.03(2)(b).

Exhibit 1230-12b Bridge Side Slope Details



Rounding



No Rounding

Toe at ℄ of Roadway Ditch

1230.04 Medians and Outer Separations

Medians are either restrictive or nonrestrictive. Restrictive medians limit motor vehicle encroachment physically, using raised curb, fixed delineators, vegetative strips, or vegetative depressions. Nonrestrictive medians limit motor vehicle encroachment legally, and use pavement markings to define locations where turns are permissible. The main function of an outer separation is to separate the main roadway from a frontage road, service lane, or for modal segregation. Consider medians or outer separations to optimize the desired performance objective, such as safety, throughput operations, pedestrian mobility needs, etc.

The primary functions of a median or outer separation are to:

- Separate traffic (such as with HOT lanes) and/or modal users (such as bike buffers).
- Separate differing alignments on divided highways.
- Reduce head-on collisions.
- Manage speed.
- Provide an refuge area for emergency parking.
- Allow for future widening of a planned phase.
- Separate collector-distributor lanes, weight stations, or rest areas.
- Accommodate drainage facilities.
- Accommodate bridge piers at undercrossings.
- Provide vehicle storage space for crossing and left-turn movements at intersections.
- Accommodate headlight glare screens, including planted or natural foliage.
- Provide recovery areas for errant or disabled vehicles.
- Accommodate pedestrian refuge area at crossing locations.
- Provide storage space for snow and water from traffic lanes.
- Provide increased safety, comfort, and ease of operations for different modes.
- Control access.
- Provide enforcement areas.

The width of a median is measured from edge of traveled way to edge of traveled way and includes shoulder and shy (see Chapter 1610) width, if provided. Median widths can vary greatly based on the functional use of the median, target speed, and context. Guidance for median widths depending on their function and context is given in Exhibits 1230-13 and 1230-15.

1230.04(1) Intermediate- to High-Speed Median Design

Exhibit 1230-13 gives additional width considerations for median functions common on high-speed facilities. Depending on the context and performance needs, this guidance may also apply to intermediate speed facilities as well.

When the horizontal and vertical alignments of the two roadways of a divided highway are independent of one another, determine median side slopes in conformance with 1230.03(2)(b)(2) and chapters 1600 and 1610. Independent horizontal and vertical alignment, rather than parallel alignment, allows for reduced grading or cut sections.

Considerable latitude in grading treatment is intended on wide, variable-width medians, provided the minimum performance needs are met or exceeded. Unnecessary clearing, grubbing, and grading are undesirable within wide medians. Use selective thinning and limited reshaping of the natural ground when feasible. For median clear zone criteria, see Chapter 1600, and for slopes between the face of traffic barriers and the traveled way, see Chapter 1610.

In areas where land is expensive, make an economic comparison of wide medians to narrow medians with barrier. Consider right of way, construction, maintenance, and collision costs. The widths of medians need not be uniform. Make the transition between median widths as long as practical. (See Chapter 1210 for minimum taper lengths.)

When using concrete barriers in depressed medians or on curves, provide for surface drainage on both sides of the barrier. The transverse notches in the base of precast concrete barrier are not intended to be used as a drainage feature, but rather as pick-up points when placing the sections.

At locations where the median will be used to allow vehicles to make a U-turn, consider increasing the width to meet the needs of the selected design vehicles making the U-turn. (For information on U-turn locations, see Chapter 1310.) Document the selected design vehicle and provide alternate route information for vehicles not serviced by the U-turn.

Where feasible widen medians at intersections on rural divided multilane highways. Provide sufficient width to store vehicles crossing the expressway or entering the expressway with a left turn.

When the median is to be landscaped or where rigid objects are to be placed in the median, see Chapter 1600 for traffic barrier and clear zone guidance. When the median will transition for use as a left-turn lane, see Chapter 1310 for left-turn lane design considerations.

Exhibit 1230-13 High- to Intermediate-Speed Median Functions and Guidance

Median Functional Use	Width Guidance
Separating opposing traffic	6 ft or more [1] and see Chapters 1600 and 1610
Separating alignments	Varies See 1230.03(2)(b)(2) and Chapters 1600 and 1610 [2]
Recovery/Refuge areas for errant vehicles	See 1230.03(2)(b)(2) and Chapter 1600
Median signing and illumination – Undivided highways and ramps	6 ft [1] or as recommended for signing and illumination design
Storage space for snow	Consult Region Maintenance
Enforcement areas	Consult with Washington State Patrol
Vehicle storage space for crossing at intersections	See Chapter 1310, and consult with region traffic engineer
Median U-turn	See Chapter 1310
Outer separation for frontage or collector-distributer	6 ft – or more [1] and see Chapters 1600 and 1610
Transit use	Varies; discuss with Transit Agency [3]

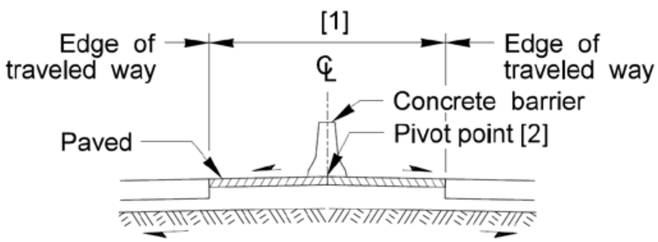
Notes:

[1] Conduct safety performance analysis and include potential countermeasures identified to obtain the desired safety performance. Consult with maintenance; additional width may be appropriate for unconstrained right of way locations, maintenance functions, or for divided highways on independent alignments.

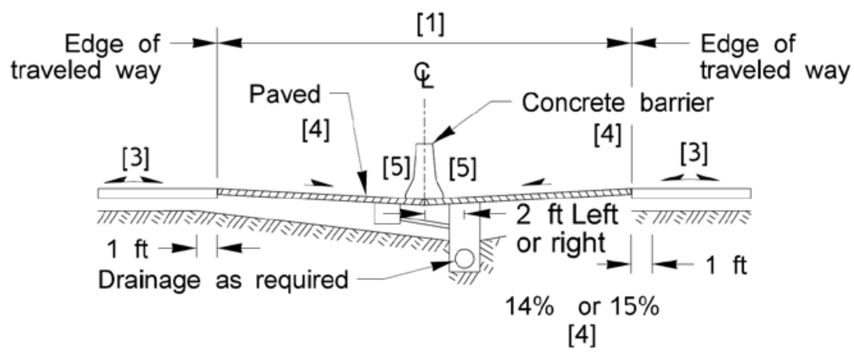
[2] Recommend an economic comparison of wide medians to narrow medians with barrier.

[3] For planning and scoping purposes, 32 ft can be the assumed minimum for two-way transit operations or 22 ft for one-way transit operations.

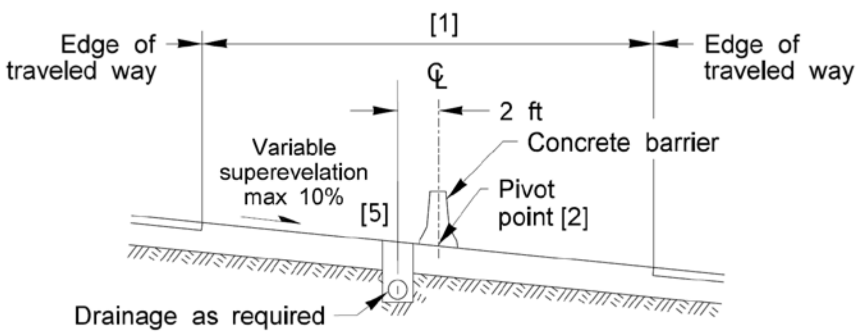
Exhibit 1230-14a Divided Highway Median Sections



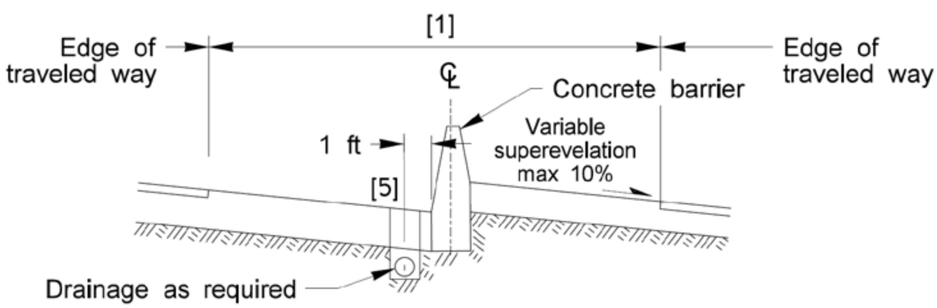
Design A: Crowned Median



Design: B Depressed Median



Alternate Design 1: Treatment on Curves

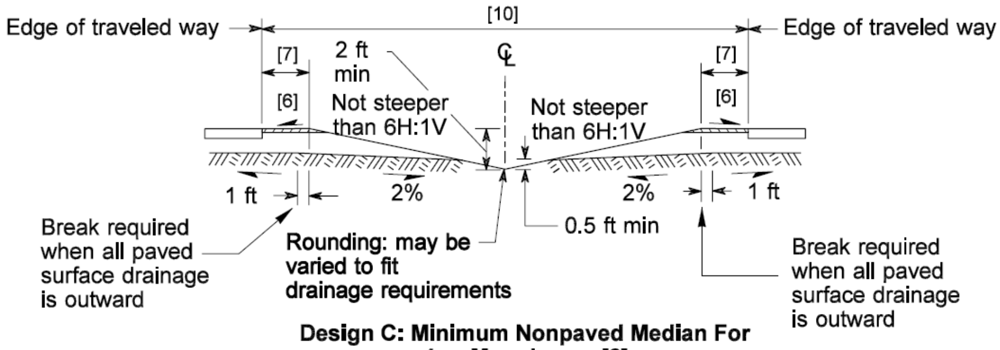


Alternate Design 2: No Fixed Pivot Point [2]

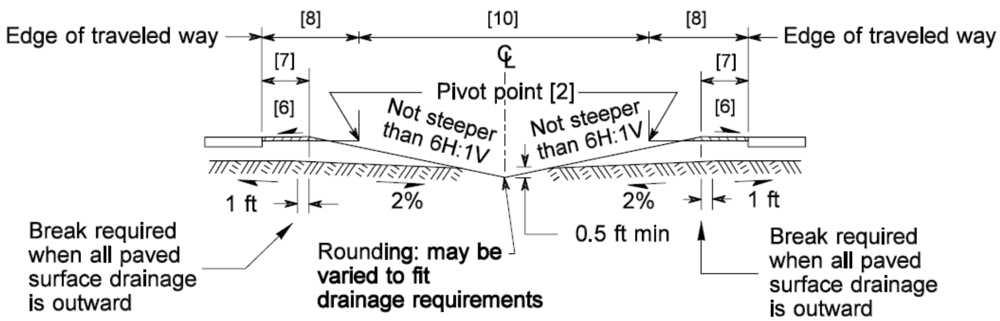
Note:

For applicable notes, see Exhibit 1230-14c.

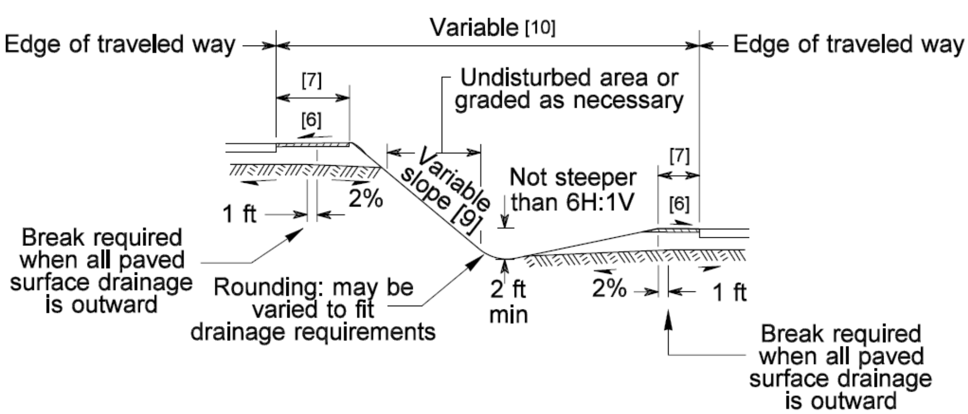
Exhibit 1230-14b Divided Highway Median Sections



Design C: Minimum Nonpaved Median For 4 or More Lanes [2]



Design D: Minimum for 4 or More Lanes With Future Lanes in Median

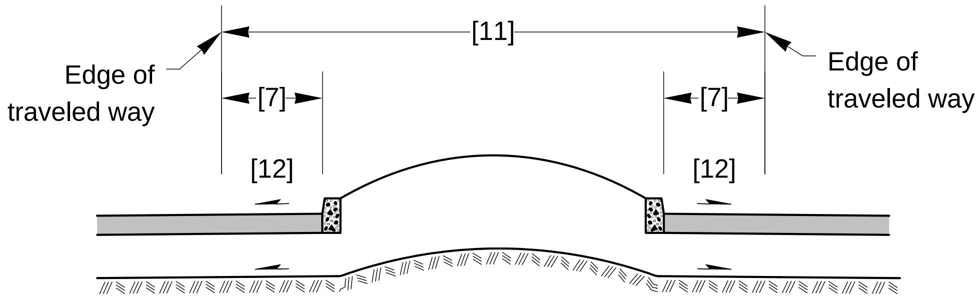


Design E: Minimum for 4 or More Lanes With Independent Alignment

Note:

For applicable notes, see Exhibit 1230-14c.

Exhibit 1230-14c Divided Highway Median Sections



Design F: Raised Median[13]

Notes:

[1] For minimum median width, see Exhibit 1230-13.

[2] Consider vertical clearances, drainage, and aesthetics when locating the pivot point.

[3] Generally, slope pavement away from the median. When barrier is present and the roadway is in a superelevation, size the shoulder so that standing water is not in the travel lane. Where appropriate, a crowned roadway section may be used in conjunction with the depressed median.

[4] Design B may be used uniformly on both tangents and horizontal curves. Use Alternate Design 1 or Alternate Design 2 when the "rollover" between the shoulder and the inside lane on the high side of a superelevated curve exceeds 8%. Provide suitable transitions at each end of the curve for the various conditions encountered in applying the alternate to the basic median design.

[5] Method of drainage pickup to be determined by the designer.

[6] Median shoulders normally slope in the same direction and rate as the adjacent through lane. (See 1230.06(1) for examples and additional information for locations where it may be desirable to have a shoulder cross slope different than the adjacent lane.)

[7] For minimum shoulder width, see Exhibit 1230-7.

[8] Future lane width of a planned phase.

[9] Widen and round foreslopes steeper than 4H:1V, as shown in Exhibit 1230-8b.

[10] Designs C, D, and E are rural high-speed median designs. (See Exhibit 1230-13 for recommended median widths.)

[11] For minimum median width, see Exhibit 1230-13. Raised medians may be paved or landscaped. For clear zone and barrier guidelines when fixed objects or trees are in the median, see Chapter 1600.

[12] Lane and shoulders normally slope away from raised medians. When they slope toward the median, provide for drainage.

[13] See 1230.05 for curb design guidance.

1230.04(2) Low- to Intermediate-Speed Median Design

Exhibit 1230-15 provides design guidance to consider for medians within low-speed transportation contexts. Depending on the context and performance needs, this guidance may also apply to intermediate speed facilities as well. In low-speed urban and suburban contexts, clear zone criteria (see Chapter 1600) is not required, but should be considered as a countermeasure to mitigate safety performance determined from quantitative safety analysis.

A common form of restrictive median on urban managed access highways is the raised median. For more information on traffic volume thresholds for restrictive medians on managed access highways, see Chapter 540.

Exhibit 1230-15 Low- to Intermediate-Speed Median Functions and Guidance

Median Functional Use	Width Guidance
Access Control – Restrictive	Width of raised median feature [1] [2]
Access Control – Non-restrictive	1 ft minimum [3]
Pedestrian refuge for crossing locations	6 ft minimum, excluding curb width (see Chapter 1510)
Speed management and/or aesthetic design – Vegetated	Varies [2] [4] (see Chapter 1103)
Drainage or treatment facilities	Varies [5]
Bike buffer treatment	2 ft – 3 ft (see Chapter 1520)
Transit connection	5 ft – 10 ft [6] (see Chapter 1430)
Outer separation used for a pedestrian zone	9 ft – 16 ft [4] [7] [8]

Notes:

[1] The width of a raised median can be minimized by using a dual-faced cement concrete traffic curb, a precast traffic curb, or an extruded curb.

[2] Consider width necessary for lateral clearance.

[3] 2 ft minimum if adjacent lane widths are less than 11 ft.

[4] Consult Region Landscape Architect; width will depend on type of plantings. Over-excavation may be necessary to prepare soil for the selected plantings to ensure mature heights are obtained.

[5] Consult Hydraulic Report for width necessary for drainage or treatment facilities.

[6] Consult with the transit provider. If a transit shelter is planned, a minimum 5 ft clear area measured from the edge of shelter roofing to face of curb width, is necessary for pedestrians to move to and around the shelter and for lift extension (see Chapter 1430).

[7] Consider width needed for plantings or street furniture to create the appropriate pedestrian zone segregation and environment.

[8] See also Chapter 1510

1230.05 Curbs

Curbs are designated as either vertical or sloped. Vertical curbs have a face batter not flatter than 1H:3V. Sloped curbs have a sloping face that is more readily traversed.

Curbs can also be classified as mountable. Mountable curbs are sloped curb with a height of 6 inches or less; 4 inches or less is recommended. When the face slope is steeper than 1H:1V, the height of a mountable curb is limited to 4 inches or less.

(a) Use vertical curbs with a height of 6 inches or more:

- To inhibit vehicles from leaving the roadway on low-speed roadways.
- To discourage vehicles from leaving low- and intermediate-speed roadways.
- For walkway and pedestrian refuge separations.
- For raised islands on which a traffic signal or traffic signal hardware is located.
- For expediting transfer times for transit partners on low- speed roadways in urban and suburban contexts (verify curb height needed with transit provider).

(b) Consider vertical curbs with a height of 6 inches or more:

- To inhibit midblock left turns.
- For divisional and channelizing islands.
- For landscaped islands.
- Stormwater conveyance

(c) Provide sloped curbs where a curb is needed but vertical curb is not suitable.

(d) Provide mountable curbs where a curb is needed and accommodation for specific design users makes it necessary.

In general, curbs are not recommended on high-speed facilities. Avoid using curbs if the same objective can be attained with pavement markings. However, 4-inch-high sloped curbs may be considered on high-speed facilities to control drainage or for access control. Locate sloped curb no closer to the traveled way than the outer edge of the shoulder. Provide sloping end treatments where the curb is introduced and terminated. 6-inch-high sloped curbs may be considered on high-speed urban and suburban contexts where streetside zones are provided or where traffic movements are to be restricted. Provide justification for the use of vertical curb when applied to high-speed facilities.

Intermediate speed facilities may use vertical or sloped curbs, however, consider sloped curbs for intermediate target speeds. Consider use of 12-inch to 18-inch vertical curb when analysis demonstrates a need to reduce lane departure concerns on intermediate-speed facilities. All curb types are appropriate for low-speed facilities.

Where curbing is to be provided, provide a design that collects the surface water at the curb and drains it without ponding or flowing across the roadway, as much as practicable to meet the safety and mobility performance needs for a project.

In some areas, curb may be needed to control runoff water until ground cover is attained to control erosion. Plan to remove the curb when the ground cover becomes adequate. Arrange for curb removal with region maintenance staff as part of the future maintenance plans (see Maintenance Owner's Manual guidance in Chapter 301). When curb is used in conjunction with guardrail, see Chapter 1610 for guidance. For existing curb, particularly on high-speed facilities, evaluate the continued need for the curb. Remove curbing that is no longer needed.

When an overlay will reduce the height of a curb, evaluate grinding (or replacing the curb) to maintain curb height if recommended by the pavement design. (See 1230.06(1) for shoulder cross slope considerations.) To maintain or restore curb height, consider lowering the existing pavement level and improving cross slope by grinding before an asphalt overlay or as determined by the pavement design. The cross slope of the shoulder may be steepened to maximize curb height and minimize other related impacts.

Curbs can hamper snow-removal operations. In areas of heavy snowfall, get the Area Maintenance Superintendent's review for the use of curbing.

For curbs at traffic islands, see Chapter 1310. For curbs at roundabouts, see Chapter 1320 and the *Standard Plans*.

1230.06 Cross Slope

The cross slope on tangents and curves is a main element in roadway design. The cross slope or crown on tangent sections and large radius curves is complicated by the following two contradicting controls:

- Reasonably steep cross slopes aid in water runoff and minimize ponding as a result of pavement imperfections and unequal settlement.
- Steeper cross slopes are noticeable in steering, increase the tendency for vehicles to drift to the low side of the roadway, and increase the susceptibility of vehicles to slide to the side on icy or wet pavements.

A 2% cross slope is normally used for tangents and large-radius curves on high and intermediate pavement types, although cross slopes may vary from the target 2%.

The algebraic difference in cross slopes is an operational factor during a passing maneuver on a two-lane two-way roadway. Its influence increases when increased traffic volumes decrease the number and size of available passing opportunities.

On ramps with metering, consider how cross slopes can impact driver comfort within the queue. Additionally, larger cross slopes may present concerns about maintaining vehicle lateral position within the queue lane, depending on weather and resulting pavement conditions.

A somewhat steeper cross slope may be needed to facilitate recommended drainage design, even though this might be less desirable from an operational point of view. In such areas, consider not exceeding design cross slopes of 2.5% with an algebraic difference of 5%.

For a two-lane two-way roadway, provide an algebraic difference to meet the appropriate conditions stated above except when drainage design recommends otherwise.

1230.06(1) Shoulder Cross Slope

Shoulder cross slopes are normally the same as the cross slopes for adjacent lanes. With justification, shoulder slopes may be increased to 6%. On the high side of a roadway with a plane section, such as a turning roadway in superelevation, the shoulder may slope in the opposite direction from the adjacent lane. The maximum difference in slopes between the lane and the shoulder is 8%. Locations where it may be desirable to have a shoulder slope different than the adjacent lane are:

- Where curbing is used.
- Where shoulder surface is bituminous, gravel, or crushed rock.
- Where overlays are planned and it is desirable to maintain the grade at the edge of the shoulder.
- On divided highways with depressed medians where it is desirable to drain the runoff into the median.
- On the high side of the superelevation on curves where it is desirable to drain stormwater or meltwater away from the roadway.

Where extruded curb is used, see the *Standard Plans* for placement (see 1230.05 for additional information on curbs). Widening is also normally provided where traffic barrier is installed (see Chapter 1610 and the *Standard Plans*).

On ramps with metering, where the shoulder is or could be utilized for queuing, consider how the shoulder cross slope can impact driver comfort within the queue. Additionally, larger shoulder cross slopes may present concerns of maintaining vehicle lateral position within the queue lane, depending on weather and resulting pavement conditions.

Exhibits 1230-7 through 1230-8b present shoulder details and guidelines.

1230.07 Structure Width

Provide a structure width necessary to achieve the desired safety and operational performance of the modal priorities (see Chapter 1103). While it is preferred not to alter the continuity of a roadway, there may be situations where providing a structure width more or less than the roadway approaching the structure is appropriate. For additional information regarding structures, see Chapter 710.

1230.08 Documentation

Document selected design elements in Section 6 of the Basis of Design (BOD), when applicable (see Chapters 1100 and 1105), and document selected dimensions and dimensioning method utilized (see Chapter 1106) in the Design Parameter Sheets:

www.wsdot.wa.gov/Design/Support.htm

1230.09 References

1230.09(1) Design Guidance

Highway Runoff Manual, M 31-16, WSDOT

Local Agency Guidelines (LAG), M 36-63, WSDOT

Plans Preparation Manual, M 22-31, WSDOT

Standard Plans for Road, Bridge, and Municipal Construction (*Standard Plans*), M 21-01, WSDOT

Standard Specifications for Road, Bridge, and Municipal Construction (Standard Specifications), M 41-10, WSDOT

1230.09(2) Supporting Information

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www.safety.fhwa.dot.gov/road_diets/info_guide/

Understanding Flexibility in Transportation Design – Washington, WA-RD 638.1, Washington State Department of Transportation, 2005
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Urban Street Design Guide, National Association of City Transportation Officials, New York, NY, 2013 www.nacto.org

Designing Walkable Thoroughfares: A Context Sensitive Approach, Institute of Transportation Engineers, Washington D.C., 2010. www.ite.org

Guide for Geometric Design of Transit Facilities on Highways and Streets, AASHTO, Washington, D.C., 2011 www.transportation.org/Pages/Default.aspx

A Policy on Geometric Design of Highways and Streets (Green Book), AASHTO, current edition
www.transportation.org/Pages/Default.aspx

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http://www.trb.org/Main/Blurbs/168619.aspx

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http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_505.pdf