Chapter 1231  Geometric Cross Section – Highways

1231.01  General

Geometric cross sections for state highways are governed by the need to balance performance metrics, the context, and selected design controls. The objective is to optimize the use of available public space while avoiding an unreasonable investment in right of way acquisition.

The term “highways” refers to all WSDOT roadways, including freeways. However, note that freeways have their own geometric cross section guidance. This chapter is not intended for freeway design. See Chapter 1232 for freeways.

1231.02  Design Up

Unless otherwise specified, use the “design up” method described in Chapter 1106 to choose a design element width when a range of widths is given in this chapter.

1231.03  Common Elements

The geometric cross sections shown in this chapter have many elements that are also common to facilities addressed in other chapters. The following chapters contain guidance related to these common geometric cross section elements:

- Lanes  Chapter 1231
- Shoulders, side slopes & ditches, medians & curbs  Chapter 1239
- Lateral clearance to curb or barrier  Chapter 1239
- Parking & streetside (behind the curb) elements  Chapter 1238
- Cross slope and superelevation  Chapter 1250

1231.04  Vehicle Lanes

1231.04(1)  Type of 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 bicycles. The target speed, modal priority, balance of performance needs, and transportation context are all considerations when determining size, type, and number of lanes.

Some common types of vehicle lanes include:
Through Lanes

Through lanes are the most common lane type. All highways have at least one lane in each direction to provide unimpeded traffic flow from Point A to Point B.

Turn Lanes

Dedicated turn lanes are separated from the through lanes and provide storage for turning vehicles waiting for a signal or gap in opposing traffic. 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, storage length, 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.

Bicycle Lanes

There are several different types of bicycle lanes and many different ways to arrange bike lanes within the geometric cross section (see Chapter 1520). Shoulders designed to function for bikes are not considered bike lanes.

Transit-Only Lanes

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 due to passenger loading needs for both the transit vehicle type and the stop locations. Develop widths for transit-only lanes with the partnering transit agency. See Chapter 1430 for additional information on Transit Facility considerations.

Auxiliary lanes

Auxiliary lanes enhance mobility performance for motor vehicles. See Chapter 1270 for design guidance and a detailed discussion on the types of auxiliary lanes.

Managed and Shared Lanes

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

- High occupancy vehicle (HOV) lanes (see Chapter 1410)
- High occupancy toll lanes (discuss with Tolling Division and see Chapter 1410)
- Hard shoulder running
- Peak hour use
- Bicycle shared lane (see Chapter 1520)
- Business access and transit (BAT) lane (see Chapter 1410, Arterial Street HOV)
1231.04(2) Lane Width

Lane width ranges for highways are listed in Exhibit 1231-1.

Exhibit 1231-1 Lane Widths for Highways

<table>
<thead>
<tr>
<th>Speed</th>
<th>Highway Type</th>
<th>Lane Width Range*</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Speed</td>
<td>Freeway (incl. Interstate)</td>
<td>See Chapter 1232</td>
</tr>
<tr>
<td></td>
<td>Other Highway</td>
<td>11' - 12'</td>
</tr>
<tr>
<td>Intermediate Speed</td>
<td>All</td>
<td>11' - 12'</td>
</tr>
<tr>
<td>Low Speed</td>
<td>All</td>
<td>10' - 12'</td>
</tr>
</tbody>
</table>

* The width shown is exclusive of the gutter if the gutter is a color that contrasts with the roadway.

1231.04(2)(a) Lane Width Considerations

Exhibit 1231-2 lists some considerations that may be helpful in choosing the most appropriate lane width from the range given in Exhibit 1231-1. This is not a comprehensive list. The considerations listed are meant to help understand the modal needs and function associated with different lane widths. Work with your Region Traffic Office when choosing lane widths.

Exhibit 1231-2 Lane Width Considerations

<table>
<thead>
<tr>
<th>Lane Width Considerations</th>
</tr>
</thead>
<tbody>
<tr>
<td>General</td>
</tr>
<tr>
<td>Roadways on curves, see Chapter 1240 Turning Roadway Widths</td>
</tr>
<tr>
<td>Narrower lanes may be used as part of a speed reduction strategy</td>
</tr>
<tr>
<td>Two-lane, two-way rural highways: 12 ft lanes provide clearance between large vehicles traveling in opposing directions. Especially beneficial when high volumes or high truck percentages expected</td>
</tr>
<tr>
<td>On multilane facilities with width constraints, utilizing narrower inside lanes may permit wider outside lanes for bicycles, freight, and transit</td>
</tr>
<tr>
<td>Reduced lane widths allow more lanes to be provided in areas with constraints and allow shorter pedestrian crossing times because of reduced crossing distances</td>
</tr>
<tr>
<td>Intermediate to High Speed</td>
</tr>
<tr>
<td>12 ft lanes provide increased benefit on high speed, free-flowing principle arterials</td>
</tr>
<tr>
<td>12 ft lanes provide increased benefit where there are higher truck volumes, especially for intermediate and high speed facilities</td>
</tr>
<tr>
<td>Safety and mobility performance difference between 11 ft and 12 ft lanes can be negligible. Work with Region Traffic Office to evaluate performance differences for the subject roadway</td>
</tr>
<tr>
<td>Low Speed</td>
</tr>
<tr>
<td>11 ft lanes are common on urban arterials</td>
</tr>
<tr>
<td>Lane widths of 10 ft may be appropriate in constrained areas with low truck and bus volume</td>
</tr>
<tr>
<td>In pedestrian oriented sections, 10 ft lanes can be beneficial in minimizing crossing distance</td>
</tr>
</tbody>
</table>
1231.05 Modally Integrated Cross Sections

WSDOT’s goal is to optimize existing system capacity through better interconnectivity of all transportation modes. Choosing the appropriate geometric cross section relies heavily on designing for the appropriate modes. See Chapter 1103 for guidance in selecting modes to accommodate and choosing modal priorities.

Once a decision is made regarding which modes to accommodate and which modes will have priority, a geometric cross section can be developed. The cross sections in this chapter are organized by modal priority for the following primary modes:

- Motor Vehicles, including freight
- Bicycles
- Pedestrians
- Transit

The cross-section examples shown in Exhibits 1231-3 through 1231-7 depict various combinations of elements that may be included in a cross section. The examples are intended 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 priority. It is expected that innovative project alternatives will result in diverse configurations that best balance baseline and contextual needs (see Chapter 1101).

Since the cross-sections shown are only examples, and are really combinations of various elements, it is important to read the guidance associated with the specific elements (see 1231.03) in order to understand the considerations that may affect a choice of width, and to understand documentation requirements.

The cross section examples provide a range of dimensions for different design elements. See Chapter 1106 for guidance regarding choosing a width when a range of widths is given.

Maintaining the continuity of a roadway is an important consideration, particularly for limited access and other high-speed highways. However, it is also appropriate to change continuity as context changes in order to influence driver behavior. When designing intentional changes to the continuity of the geometric cross section, 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).
1231.05(1)  Auto-and Freight Oriented Cross Sections

Exhibit 1231-3 shows examples of motorized vehicle-oriented designs. Motorized vehicles come in a variety of types which are operated on many vehicle lanes and parking 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. Within urban areas, placement of and sizing for loading areas within the parking areas can depend on the freight vehicle type.
Exhibit 1231-3  Motor Vehicle Oriented Cross Sections

Example A – High Speed (Non-Freeway)  
Median – Barrier Section Shown

Example B – Intermediate Speed

Notes:
[1] Overall median width and design will vary. Some median designs include barrier and some do not. See Chapters 1239 and 1600.
[2] See Chapter 1239 for guidance on choosing a dimension from the range given.
[3] See 1231.04 for guidance on choosing a dimension from the range given. See Chapter 1410 for guidance on HOV facilities.
[4] See Chapter 1232 to see if your roadway meets the definition of a freeway.
1231.05(2) Cross Sections Featuring Bicycle Facilities

Exhibit 1231-4 Example A features bicycle facilities at an intermediate-speed location. Bike lane location within the cross section depends largely on how cyclists will interact with the land use and potential modal conflicts. Locating bike lanes on the outside of the motor vehicle lanes can improve accessibility for bicyclists. 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.
Exhibit 1231-4  Cross Sections Featuring Bicycle Facilities

Example only: Number of lanes can vary

Example A
Intermediate Speed

Pedestrian Access Route Within Pedestrian Zone

Furnishing Zone (Optional)

5' Min. 2' – 8'

Bicycle Lane 4
3' – 7'

Buffer 4
2' – 3'

Vehicle Lane 11' – 12' (7)

Vehicle Lane 11' – 12' (7)

Median (Optional) Width Varies (6)

Vehicle Lane 11' – 12' (7)

Vehicle Lane 11' – 12' (7)

Buffer 4
2' – 3'

Bicycle Lane 4
3' – 7'

5' Min. 2' – 8'

Pedestrian Circulation Path (1)

Notes:

[1] See Chapter 1510.


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


[6] Overall median width and design will vary. See Chapter 1239.

[7] See 1231.04 for guidance on choosing a dimension from the range given.
1231.05(3) Cross Sections Featuring Pedestrian Facilities

Exhibit 1231-5 shows cross-section examples featuring pedestrian facilities. 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 elements. See Chapter 1238 for guidance regarding streetside elements.

The objective is to achieve the Pedestrian Circulation Path (PCP) necessary to support mobility, socioeconomic, and accessibility needs and provide access to intermodal connections. The configuration and dimension of streetside elements varies significantly depending on the performance needs being addressed. See Chapter 1510 for additional pedestrian design requirements and considerations.
Exhibit 1231-5 Cross Sections Featuring Pedestrian Facilities

Example only: Number of lanes can vary

Example A
Low Speed

Example B
Low Speed

Notes:
[1] See Chapter 1510.
[3] If no furnishing zone is provided, minimum width is exclusive of the curb width.
[5] Overall median width and design will vary. See Chapter 1239.
[6] See 1231.04 for guidance on choosing a dimension from the range given.
1231.05(4) Cross Sections Featuring Transit Facilities

Exhibit 1231-6 provides examples of different potential configurations oriented for the transit mode. Work with the transit provider to determine their ability to operate within a given cross-sectional arrangement. In general, transit configurations can be positioned toward the side or center of a roadway. Both side and 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 1231-6 Example A shows a central configuration for transit service that provides a separated bus-only lane. Other transit vehicle types may require different widths and may also require other center cross section configurations for passenger loading. Exhibit 1231-6 Example B shows a side configuration where transit vehicles occupy the outside lane. This example can also be configured as business access and transit [BAT] lanes. Note the importance of streetside elements to assist with intermodal connections. Exhibit 1231-6 Example C is an example of a type of special use lane for high-speed routes that are routinely congested. In this example, the shoulder allows the restricted use for buses.
Exhibit 1231-6 Cross Sections Featuring Transit Facilities

Example A: Low Speed
Example only: Number of lanes can vary
Vehicle Lane 10’ – 12’[H]
Median
Vehicle Lane 10’ – 12’[H]
Vehicle Lane – Bus Only (P) 11’ – 12’
Median
Vehicle Lane – Bus Only (P) 11’ – 12’
Vehicle Lane 10’ – 12’[H]
Furnishing Zone (2)[E] (Optional) 2’ – 8’
Vehicle Lane 10’ – 12’[H]
Ped. Zone (3)[E] 5’ – 10’
Pedestrian Circulation Path (1)[E]
The area behind the curb is also referred to as the “streetside.” See Chapter 1238

Example B: Low Speed
Example only: Number of lanes can vary
Vehicle Lane 10’ – 12’[H]
Vehicle Lane 10’ – 12’[H]
Vehicle Lane 10’ – 12’[H]
Vehicle Lane 10’ – 12’[H]
[Optional] (2)[E] 2’ – 8’
Pedestrian Circulation Path (1)[E]

Example C: High Speed
Example only: Number of lanes can vary
Vehicle Lane 10’ – 12’[H]
Bus Use Only Shoulder (P) 12’ - 14’
See Exhibit 1231-4 for lane and inside shoulder width ranges

Notes:
[1] See Chapter 1510.
[3] If no furnishing zone is provided, minimum width is exclusive of the curb width.
[5] Verify width needs with transit provider, including lift extension needs. See Chapter 1510 for Pedestrian Access Route requirements, which may be affected by presence of a shelter. See Chapter 1430 Transit Facilities.
[6] Median width and design will vary. See Chapter 1239
[7] Verify width needs with transit provider. See Chapter 1239 for bus use only shoulder, requires a Design Analysis.
[8] See 1231.04 for guidance on choosing a dimension from the range given.
[9] See Chapter 1239 for guidance on choosing a dimension from the range given.
1231.05(5) **Example Cross-Sections – Complete Streets**

Complete street configurations attempt to balance the performance needs of all users, regardless of age, ability, or mode. The general intent is to provide context-appropriate designs that enable safe access for all design users. It is always important to consider modal connectivity and conflicts that may occur with complete street configurations, particularly at intersections and/or transit stop locations.

There are different potential configurations for complete streets, such as:

- A rural two-lane highway with wide shoulders; the shoulders can be used by motor vehicles in emergencies and by pedestrians and bicyclists.
- An urban highway or street with vehicle lanes, bike lanes, bus lanes, and sidewalks.
- Retrofitting a highway or street to clearly mark and sign a shared-use lane.
- An urban highway that undergoes a “road diet” (see 1231.06) or installation of additional pedestrian crossings.

The low speed examples in Exhibit 1231-7 illustrate roadway cross sections that:

- Separate access lanes from through traffic lanes using curbed islands.
- Reduce conflicts between pedestrian, bike, transit and auto modes by separating them.
- Provide transit stops integrated with raised islands.
- May result in improved operations for all modes.
Exhibit 1231-7  Complete Street Cross Sections

Example A
High Speed

Example B
Low Speed

Example C
Low Speed

Notes:
[1] See Chapter 1510.
[3] If no furnishing zone is provided, minimum width is exclusive of the curb width.
[6] Overall median width and design will vary. See Chapter 1239.
[7] See 1231.04 for guidance on choosing a dimension from the range given.
[8] See Chapter 1239 for guidance on choosing a dimension from the range given.

The area behind the curb is also referred to as the "streetside" See Chapter 1238
1231.06 Road Diets and Retrofit Options

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 functions. 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 other 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. At intersections and access points, a road diet can improve sight distance, may improve access management along the road, 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 (see Chapter 540 for additional restrictions on the use of TWLTLs). 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.

Retrofit options refer to the application of lower-cost treatments that utilize paint and other delineation devices rather than hardscape features. See Chapter 1238 for more information on retrofit options such as relocating the curb, parklets and plazas.

1231.07 References

1231.07(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
1231.07(2) Supporting Information

FHWA Road Diet Informational Guide, FHWA, 2014
☞ 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
☞ www.wsdot.wa.gov/research/reports/fullreports/638.1.pdf

☞ www.nacto.org

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

A Policy on Design Standards Interstate System, AASHTO, 2005
☞ www.transportation.org/Pages/Default.aspx

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

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☞ www.trb.org/Main/Blurbs/171358.aspx

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