Chapter 5
Facility Type - Freeway, Expressway, and Interstate

Legend

	Multimodal Application Example
	Context-Sensitive Solutions Application Example
	Performance-Based Practical Design Application Example
	Multimodal (MM)
	Context-Sensitive Solutions (CSS)
	Performance-Based Practical Design (PBPD)
	Web link for additional information
	AASHTO-Specific Information

Chapter

5

5 Facility Type – Freeway, Expressway, and Interstate

Freeway, Expressway, and Interstate

Context Classifications: C1 Rural Mountainous Environment, C2 Rural Places, C3 Suburban Places, C4 Traditional Neighborhoods, C5 Downtown Places, C6 Urban Core.

A facility generally described as a Major Arterial that has strict access controls. Access to a Freeway, Expressway, or Interstate is managed at specific locations that are sufficiently spaced apart to facilitate effective free-flow travel along these roadways. Freeways and Interstates only have grade-separated intersections from a Major Arterial; Expressways can have either at-grade or grade-separated intersections.

5.1 Introduction

The guidelines in this chapter apply to facilities defined as Freeways, Expressways, and Interstates, consistent with the definitions in Chapter 1 of this Guide and Chapter 8 of the American Association of State Highway and Transportation Officials (AASHTO) A Policy on Geometric Design of Highways and Streets (the Green Book) (2018 AASHTO GDHS) (AASHTO, 2018).

The use of the term "Freeway" in this chapter applies to Freeways, Expressways, or Interstates.

The functional classification for existing facilities in Colorado is already defined and can be found on the Colorado Department of Transportation (CDOT) Online Transportation Information System (OTIS) (CDOT, n.d.). Detailed information about functional classifications in the *CDOT Roadway Functional Classification Guidance Manual* (CDOT, 2019). Refer to Chapter 1 of this Guide for definitions of functional classifications, facility types, and context classifications that are used in this chapter.

Use this link to access CDOT's Roadway Functional Classification Guidance Manual (CDOT, 2019): [*https://www.codot.gov/business/designsupport/bulletins_manuals/cdot-roadway-design-guide-2018/2018-rev-rdg/dg18-01-revs*](https://www.codot.gov/business/designsupport/bulletins_manuals/cdot-roadway-design-guide-2018/2018-rev-rdg/dg18-01-revs)

A Freeway or Interstate is a divided highway with full control of access and two or more through lanes for the exclusive use of traffic in each direction. Traffic flow on a Freeway is unhindered because there are no traffic signals, intersections, or at grade crossings with other roads, railways, or multiuse paths. A helpful concept to commit to memory is that a Freeway and Interstate is "free" of at-grade crossings or intersections that are not part of an interchange design. Full control of access is the condition where the right of owners or occupants of abutting land to access a Freeway is fully controlled by a public authority. Access connections to a Freeway are at selected public roads only. Crossings at grade or direct private driveway connections are prohibited. For more information on Freeway access, refer to the Colorado State Highway Access Code (State of Colorado, 2002).

Use this link to access the Colorado State Access Code (State of Colorado, 2012): [*https://www.codot.gov/business/permits/accesspermits/references/601_1_accesscode_march2002_.pdf/view*](https://www.codot.gov/business/permits/accesspermits/references/601_1_accesscode_march2002_.pdf/view)

The guidelines in this chapter apply to Freeways in all context classifications (C1, C2, C3 C4, C5, and C6). They apply to both urban and rural Freeways, except where noted. Essential Freeway elements include medians; grade separations; ramps; and in some cases, frontage or collector roads.

5.2 Rural Freeway, Expressway, and Interstate

5.2.1 Alignment and Profile

A rural Freeway should have smooth-flowing horizontal and vertical alignments. Consistent typical sections along a Freeway enhance driver expectations, resulting in a safer Freeway. Changing median widths should be avoided where practical.

A rural Freeway can usually be constructed near ground level with a smooth and relatively flat profile. The profile of a Freeway in a rural context classification is controlled more by drainage and earthwork considerations and less by the need for frequent grade separations and interchanges. In mountainous areas, topographic elements, such as rivers and terrain, have a greater impact on Freeway design.

5.2.2 Medians

Median widths of 30 to 100 feet are common on a rural Freeway. A median should provide a minimum of 6-foot paved shoulders and 6:1 foreslopes with a recoverable median ditch that is designed to prevent saturation of the roadway substructure and can adequately manage the surface runoff from the Freeway section until the water can be conveyed away the median area. A wider median accommodates independent profiles in rolling terrain to blend a Freeway more appropriately with the environment while maintaining flat slopes for vehicle recovery. In flat terrain, a wider median is also suitable when designing for the future addition of traffic lanes.

Where the terrain is extremely rolling or mountainous, a wide variable median may be desirable. When geographic constraints prohibit use of a wide median, independent roadway alignments, both horizontally and vertically, may provide the best opportunity to blend a Freeway into the natural topography. Proper foreslopes and backslopes used within the clear zone can accommodate safe vehicle recovery. The remaining median width, outside of the clear zone, may be left in its natural state of vegetation, trees, and rock outcroppings. In areas where right of way restrictions dictate, or in extreme terrain, narrower median widths with barriers may be necessary.

In some context classifications, such as C1 and C2, large Freeway rights-of-way can provide opportunity for bicycle facilities. The designer should determine nearby facilities and potential gaps caused by the Freeway facility.

Emergency crossovers on a rural Freeway are normally provided where interchange spacing exceeds 5 miles. Between interchanges, emergency crossovers are spaced at 3- to 4-mile intervals. Maintenance crossovers may be required at one or both ends of interchange facilities for snow removal and at other locations to facilitate maintenance operations. Crossovers should not be located closer than 1,500 feet to the end of a speed-change taper of a ramp or to any structure. Crossover foreslopes shall be no steeper than 10:1. Crossovers should be located where minimum stopping sight distance can be provided in both directions and preferably should not be located within curves.

The width of the crossover should be sufficient to provide vehicle storage out of the traveled way and safe turning movements; and the crossover should have a surface capable of supporting the maintenance equipment used on it. Crossovers should not be placed in restricted-width medians unless the median width is sufficient to safely accommodate a vehicle length of 25 feet or more.

Installation of median cable rail should be considered wherever possible to prevent vehicles from crossing medians into opposing traffic lanes or to contain roadside departures.

Use this link to access the CDOT Cable Barrier Guide (CDOT, 2017):
https://www.codot.gov/business/designsupport/bulletins_manuals/cable-barrier-guide/cable-barrier-guide

For further information on medians, refer to the AASHTO *Roadside Design Guide* (AASHTO, 2011).

5.2.3 Sideslopes

Flat or rounded sideslopes, fitting with the topography and consistent with available right of way, should be provided on a rural Freeway. Foreslopes of 6:1 or flatter are recommended in cut sections and for fills of moderate height. Where fill heights are intermediate, a combination of recoverable and traversable slopes may be used to provide the acceptable vehicle recovery area. For high fills, steeper slopes protected by guardrail may be necessary. It is preferred to have backslopes of 3:1 or flatter to accommodate better slope stability, landscaping, and erosion control practices and for ease of maintenance operations.

5.2.4 Frontage Roads

Refer to the 2018 AASHTO GDHS.

5.3 Urban Freeway, Expressway, and Interstate

5.3.1 Alignments

An appropriate balance of vertical and horizontal alignments will create an easily understood facility for the user to navigate and optimizing the construction costs to make the roadway economically feasible.

Refer to Chapter 3, Section 3.5.2, of the 2018 AASHTO GDHS for information on General Design Controls including alignments.

5.3.2 Medians

The desirable median width for a four-lane urban Freeway is 14 feet or greater. A 14-foot median accommodates two 6-foot paved shoulders and a 2-foot median barrier. Additional horizontal clearance may be required to provide minimum stopping sight distance along the inside lane on sharper curves. A desirable feature is a wider clearance area for vehicle storage in case of a vehicle break down.

A wide median width can be used for the addition of Bus Rapid Transit (BRT) lanes, High Occupancy Vehicle (HOV) lanes, or Managed Lanes. In addition to HOV lanes, Express Lanes and Peak Period Shoulder Lanes (PPSL) are examples of Managed Lanes in Colorado.

Median crossovers for emergency or maintenance purposes are generally not warranted on urban Freeways because of the close spacing of interchange facilities, extensive development of the abutting street network, and a desire to prevent vehicles from making u-turns on the Freeway.

Considering the needs of the users within an urban area and how they travel from location to location, including travel modes, is critical to determining the capacity expansion of a Freeway system. Using the principles of Context-Sensitive Solutions (CSS) to engage the public to identify their needs, identifies ways to accommodate travel modes that are most effective for all users.

BRT lanes, HOV lanes, and multimodal transit stops (mobility hubs) are often integrated with Freeway, Expressway, and Interstate operations to promote faster more consistent travel for alternative modes of transportation. Integrating these alternative transportation options increases the efficiency of the transportation system when expanding the facilities is not feasible or cost-effective.

5.4 Highway Capacity (Transportation Facility Operations)

5.4.1 Highway Capacity Manual

Freeways typically have uninterrupted traffic flows. Considerations for Freeway capacity include lane capacity for efficient vehicle passage based on average daily traffic and peak hour traffic volumes, as well as current and future traffic volumes 20 or more years into the future.

Access or cross-street activity on a Freeway is often accomplished with grade-separated interchanges. Cross section widths and lane capacity must be closely coordinated with interchange design, so the structures can adequately accommodate existing and future traffic volumes.

Adequate intersection capacity at an interchange prevents traffic queues at the intersection from backing onto a Freeway. Backups onto a through lane create safety issues, such as speed differentials and unanticipated congestion on a Freeway, which can result in primary and secondary traffic crashes.

Refer to Chapter 2, Section 2.4, of the 2018 AASHTO GDHS for information on Freeway capacity.

5.4.2 Rural Freeway Capacity

In a rural setting, a driver has different expectations about the Freeway capacity than in an urban setting. In a rural setting, a driver is typically traveling for a long period of time over longer distances, and the expectation is to travel nearly unimpeded with little or no traffic congestion, maintaining a constant travel speed at or near the design speed for the Freeway. For these reasons, rural Freeway design capacity tends to target a level of service (LOS) of C (stable flow rate) or better.

Refer to Chapter 2, Section 2.4.5, of the 2018 AASHTO GDHS for information on Levels of Service.

5.4.3 Urban Freeway Capacity

In an urban setting, a driver has a higher tolerance level for congestion if the trip is faster than on the local street system. A certain level of congestion is acceptable if a constant flow of traffic is maintained with only infrequent stop and go traffic conditions.

Depending upon the existing level of congestion, urban Freeway capacity may be designed to a future condition of LOS D or E. LOS D (approaching unstable flow) is the desired operational goal for a future design year of 20 years or more. If the cost of construction to achieve LOS D is prohibitive, designing to an LOS E may be necessary and is acceptable.

5.4.4 Factors Other Than Traffic Volume That Affect Operating Conditions

Refer to Chapter 2, Section 2.4.4, of the 2018 AASHTO GDHS for information on these factors.

5.4.5 Transit

With the increased emphasis on promoting alternative modes of travel, Freeway design should consider transit in a capacity analysis. If transit exists or is planned, Freeway access to transit and multimodal hubs must be designed for easy access. Guidance on how to accommodate transit activity is contained in the NACTO *Transit Street Design Guide* (NACTO, n.d.).

Use this link to access NACTO Transit Street Design Guide (NACTO, n.d.): https://nacto.org/publication/transit-street-design-guide/transit-system-strategies/

5.4.6 Design Service Flow Rates

In general, the design service flow rate is defined as, the maximum hourly vehicular volume that can pass through a Freeway element at the selected LOS for the facility. Refer to Chapter 2, Section 2.4.3.1 of the 2018 AASHTO GDHS for information on design service flow rates.

5.5 General Design Considerations

Local agencies desiring to use federal funds must design projects to meet or exceed the design standards or the minimums presented in the 2018 AASHTO GDHS and in this design guide. The use of federal funds requires that the National Environmental Policy Act (NEPA) process be followed. Historic districts require special consideration that may require consultation with the State Historic Preservation Office (SHPO).

5.6 Design Speed

Design speeds ranging from 55 to 75 mph are typically considered for a Freeway, depending on available right of way, terrain, adjacent development, and other area controls.

Freeway and interstate design speed is the prevailing speed a driver chooses under low-volume conditions when the interaction between vehicles and the influence of traffic control devices is minimal. Freeways must be designed so that the desired posted speed can be maintained in a free-flow condition. Access movements and congestion can interrupt the free-flow condition. These can be avoided through the design of roadway geometry, traffic operations, grade separated intersections, as well as median type, access point density, number of lanes, lane width, and segment length.

Designers need to recognize conditions where actual operating speeds may exceed the posted speed and consider those nuances in the overall design of a segment. For example, a Freeway or interstate with relatively low traffic volumes may create a sense of confidence for the driver to drive faster than the posted speed. If the design of a segment of Freeway cannot easily accommodate the prevailing or posted speed for the corridor, the common practice is to post an advisory speed sign in advance of the varying low speed curves to alert drivers to adjust to a lower safe operating speed.

For new and reconstructed facilities, the designer should strive to design the Freeway segment to the appropriate standards, in order to maintain the designated posted speed.

The nature of the surroundings in all Context Classifications can directly influence the design speed considerations for a Freeway segment. The designer needs to recognize how the context classification might influence the design speed and consider what measures can be used to influence driver expectations to maintain appropriate safe operating speeds.

5.7 Design Traffic Volume

The basis of traffic design is to calculate the anticipated Design Hour Volume (DHV) of traffic projected to a future design year. During the project's planning stage, the region traffic engineer can provide current design hour traffic volumes, predict future design hour traffic volumes, and determine the future design year that is appropriate for the project. A simple resurfacing project may only need a future DHV of 10 years, while a major rehabilitation or reconstruction project may require a DHV of 20 years. Freeway designs will typically require a 20-year design hour volume estimate at a minimum. The DHV and desired LOS for the Freeway determines the necessary lane requirements for the Freeway.

5.8 Level of Service

Understanding LOS and how it impacts the Freeway must take several factors into consideration. In Freeway design, the desired LOS will depend on the context and future needs. Refer to Table 2-3 in Chapter 2 of the 2018 AASHTO GDHS, which gives a range of LOS for Freeways depending upon the context the Freeway is operating in. Also Refer to the *Highway Capacity Manual* (TRB, 2022) for further information and considerations for Freeway LOS.

5.9 Multimodal Accommodations

Freeway design should consider multimodal operations within and adjacent to the facility. For example, a Freeway may include transit operations in the median, on a reinforced shoulder, or on a separate transit track, like high-speed passenger rail. While the high-speed travel lanes are not appropriate for bicycle and pedestrian use, the Freeway itself should not be a barrier to these modes. Designers should consider how to provide connectivity for bicycles and pedestrians, and design easy access to multimodal hubs.

5.9.1 Transit

Generally, a Freeway will not have transit stops within its right of way. However, there may be multimodal hubs off alignment where transit vehicles stop, for example intercity buses. These vehicles require easy on and off Freeway access to facilitate efficient movements.

A Freeway may have specific lanes for bus rapid transit service or tolls and managed lanes within its right of way, and provisions must be made on the Freeway for on and off access.

5.9.2 Bicycles

It is common for bicycle and pedestrian shared-use trails to run adjacent to Freeways or cross them as part of the transportation network. Considerations for accommodating bicycle and pedestrian connections in Freeway design are encouraged. These considerations should separate bicycles and pedestrians from the traffic flow with buffers and grade-separated crossings.

Refer to Chapter 2, Section 2.7, of the 2018 AASHTO GDHS for more information.

5.9.3 Pedestrians

Pedestrian facilities should be separated from high-speed traffic on a Freeway. If pedestrian activity is to be accommodated, it should be done through the local street, along a frontage road, or on a detached trail system to effectively keep the pedestrian separated at a safe distance from the high-speed traffic.

Refer to Chapter 2, Section 2.6.1, of the 2018 AASHTO GDHS for more information.

5.9.4 Motorized Vehicles

Design vehicle considerations may be different on a Freeway used by larger or even oversized vehicles for interstate or inter-regional travel. Designing a Freeway for the largest appropriate vehicle is critical to preventing bottlenecks and safety issues along the roadway. Many Freeway corridors have height restrictions due to the existing grade separated crossing elevations above the Freeway. As grade crossings are improved the Freeway vertical profile and clearances should be investigated and improved if the purpose and need can accommodate that change.

Refer to Chapter 2, Section 2.8, of the 2018 AASHTO GDHS for more information on design vehicles.

5.10 Accessible Design

When designing the separated trail or pedestrian crossings at an interchange or intersection, the designer must determine if current ADA accommodations are compliant or if they need to be improved or upgraded to meet standards. American with Disabilities Act (ADA) elements are unique to each location and require a level of design detail that cannot be short-cut. In rolling or mountainous terrain, the length, grade, and requirement for flat rest areas becomes a factor in trail design to meet ADA standards.

CDOT follows design and construction guidance and standards found in the U.S. Department of Transportation ADA Standards for Transportation Facilities (USDOT, 2006), the U.S. Department of Justice 2020 ADA Standards for Accessible Design (U.S. Department of Justice, 2020), Americans with Disabilities Act Architectural Guidelines for Buildings and Facilities (ADAAG) (U.S. Access Board, 2002), and the *Manual on Uniform Traffic Control Devices for Streets and Highways* (FHWA, [2009] 2022). In addition, CDOT adopted the Proposed Right-of-Way Accessibility Guidelines (PROWAG) for curb ramps, which also provides design guidance for sign heights and pedestrian pushbuttons for traffic signals (U.S. Access Board, 2011). The designer should evaluate innovative ways to shorten pedestrian crossings at intersections to provide the greatest safety to the pedestrian. If the intersection is signalized, PROWAG guidance is highly recommended to provide the highest level of ADA accommodations.

Refer to Chapter 12 of this Guide for information on PROWAG.

Refer to Chapter 2, Section 2.6.7, of the 2018 AASHTO GDHS for more information.

Use this link to access CDOT's ADA resources for engineers:
https://www.codot.gov/business/civilrights/ada/resources-engineers

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5.11 Access Control and Access Management

- Difference between a Freeway and an expressway.
- State of Colorado State Highway Access Code (State of Colorado, 2012).
- Interchange and intersection spacing.
- Frontage roads and collector systems to maintain a level of Freeway or Interstate.

Safety and improved mobility are considerations for access control and access management. Different types of Freeways have different access requirements. An interstate Freeway is highly controlled with access only via a grade-separated interchange. On a rural expressway, access points are allowed directly to the highway and may be at grade rather than grade separated. The number of expressway accesses may be limited and spaced farther apart to improve free flow conditions. A hybrid expressway has both grade-separated and at-grade access control.

The access classification and design standards can change based on projected traffic volumes and capacity needs. The design needs to take future traffic growth into consideration so that these changes can be accommodated when needed.

If there is transit on the Freeway, Expressway, or Interstate, or is planned, priority access should be considered.

Refer to Chapter 2, Section 2.5.1, of the 2018 AASHTO GDHS and Chapter 11 of this Guide for further information.

5.12 Horizontal and Vertical Geometry

A Freeway is thought of as a "long travel" route for inter-regional or interstate travel where a driver is expecting to travel long distances. Horizontal and vertical alignments that are more gradual and predictable to the driver are appropriate for a higher design speed up to 75 or even 80 mph.

Refer to Chapter 8 of the 2018 AASHTO GDHS for further information.

5.13 Alignments

The designer should strive to meet design standards for the alignment of a Freeway segment unless there are contextual influences that limit the ability to design to the standard.

If the design standard cannot be met, PBPD principles can be leveraged to make data-driven decisions on how to modify or adjust the Freeway design to address the needs.

Refer to Chapter 6 of this design guide and Chapter 8, Section 3.3.4, of the 2018 AASHTO GDHS for additional information on Freeway alignments.

5.14 Grades

The maximum grade for a Freeway is a function of terrain or context classification (urban or rural) and design speed. Refer to Table 8-1 in the 2018 AASHTO GDHS for grades in urban and rural settings.

There are locations where grades cannot meet 2018 AASHTO GDHS standards because of the costs and the impact to adjacent uses or the environment.

A PBPD analysis of the current roadway operations, crashes, etc., may reveal that the current condition is acceptable, or may identify specific hot spots in the segment where there is a problem. PBPD may help to determine how the budget can be used most effectively to improve those specific locations.

5.15 Vertical Curves

Design controls for vertical sag and crest curves are provided in Chapter 3, Section 3.4.6.2 Crest Vertical Curves (Table 3-35, Table 3-36 and Table 3-37) of the 2018 AASHTO GDHS. Criteria for measuring stopping sight distance include an eye height of 3.5 feet and an object height of 2.0 feet. Passing sight distance criteria include an eye height of 3.5 feet and the object height of 3.5 feet.

The designer may need to introduce a gradual sag vertical curve to develop sufficient vertical clearance under a Freeway overpass. Ideally, a vertical clearance across the entire roadway should be at least 17 feet.

Refer to Chapter 8, Section 8.2.9, of the 2018 AASHTO GDHS for further information on vertical clearances for Freeways.

5.16 Cross-Slope and Superelevation

A typical cross-slope on a Freeway in Colorado is generally 2% to the outside of the roadway prism. Superelevation can vary from 2% to 8% depending upon the radius of curvature and design speed. An urban Freeway is allowed a maximum superelevation of 6%, and Colorado limits the maximum superelevation rate to 8% for rural facilities because of the frequent snow and icing conditions that occur across the state.

A detailed discussion of superelevation is found in Chapter 6 of this Guide; more information can be found in the CDOT Standard Plans - M&S Standards M-203-11 (CDOT, 2019).

Use this link to access CDOT Standard Plans - M &S Standards (CDOT, 2019): *https://www.codot.gov/business/designsupport/2019-and-2012-m-standards/2019-m-standards-plans/2019-m-standards-plan-sheets/2019-m-standards*

5.17 Cross Section Elements

Cross section elements of a Freeway include travel lanes, inside and outside shoulders, median, topographic elements, etc. These elements are typically determined through the planning process and the context classification (refer to Chapter 1 of this Guide). The designer must determine what can be implemented within a project's budget and contextual constraints. Cross section elements of a Freeway can vary across segments; the transitions between the variations should be gradual and predictable for a driver to interpret easily.

PBPD plays a key role in developing cross sections. Good data analysis will help define the cross sectional elements and the widths that are appropriate to accommodate all roadway uses. Desired widths are as follows:

- Freeway travel lanes should be a minimum of 12 feet wide. For narrower lane widths, there needs to be a clear rationale on why. Narrower lane widths may require changes in the design speed and final posted speed if implemented.
- Auxiliary lanes along a Freeway should be 12 feet wide and accommodate WB-67 truck turning movements at intersections off the Freeway.
- The width of inside and outside paved shoulders can vary and depends on the rural or urban context. Ideally, the inside shoulder should be a minimum of 6 feet wide if a barrier is present; wider is preferred. The outside shoulder width should be a minimum 8 feet wide, enough to accommodate vehicle breakdowns outside of the traveled lane. In highly constrained urban

corridors, the inside shoulder may be less than 6 feet with a barrier that separates opposing lanes of traffic.

- A median is desired on a Freeway to separate opposing directions of travel. On a rural Freeway, a vegetated depressed median is common, and the median width is directly influenced by the clear zone requirements for both directions of travel. In urban areas, a median may include paved shoulders, BRT lanes, or HOV or Express Lanes in both directions of travel separated by a median barrier. Median width on an urban Freeway depends on the design speed and whether or not there is a barrier.

A Freeway generally is not designed for pedestrian or bicycle activity because of the high speeds of traffic, the uninterrupted traffic flow, and the need to separate slower pedestrian and bicycle movements from these vehicles. Similarly, transit stops are not included on a Freeway because this interrupts traffic flow and would be unsafe.

The designer, however, needs to look at the contextual elements of the Freeway, which may require adding amenities for bicycles and pedestrians in the form of a separated pathway outside of the Freeway's roadway prism. Additionally, if a Freeway supports interregional transit services, connections to and from the Freeway to a multimodal hub may be necessary. All of this is determined in the planning stages of a project using a CSS analysis.

Refer to Chapter 6 of this Guide and to Chapter 8, Section 8.2, of the 2018 AASHTO GDHS for further information on design considerations for a Freeway.

5.18 Median Type

Refer to Chapter 8, Section 8.3.2, of the 2018 AASHTO GDHS for further information on medians for a Freeway.

5.19 Drainage

The principal objective in drainage design is to control the presence and flow of water on a Freeway surface such that users are not placed in an unsafe situation during storm events. Proper drainage design prevents ponding of water along the Freeway and prevents overtopping of the Freeway during severe storms.

Drainage facilities are designed to carry water across the right of way and to remove stormwater from the Freeway itself. These facilities can include bridges, box culverts, pipe crossings, median or edge drains, stormwater detention ponds, sediment catchments, and storm sewer systems.

To provide for proper drainage on a Freeway, it is desirable to use a minimum crown slope of 2.0% (0.02 foot/foot), particularly where the surrounding terrain is relatively flat. This reduces ponding areas that can contribute to vehicles hydroplaning, deterioration of pavements, and impacting driver visibility.

Drainage requirements for a rural Freeway can vary significantly from an urban Freeway. A rural Freeway may have a depressed median with cross drains to convey drainage under the Freeway to the outside shoulder area.

An urban Freeway may have entire storm sewer systems to capture impermeable runoff along the median area to convey it off the roadway without carrying it directly across the traveled lanes. An urban depressed Freeway may have even more complicated drainage requirements because the roadway is lower than the surrounding terrain. Many times, an urban Freeway (and occasionally a rural Freeway) fall under the designation of Municipal Separate Storm Sewer System (MS4) requirements. The designer must have discussions with the project hydraulics engineer and the environmental staff to fully understand the expectations and requirements for stormwater management on the project. This may also include discussions with the local agency that is ultimately responsible for the stormwater requirements.

For additional information, refer to the CDOT *Drainage Design Manual* (CDOT, 2019).

5.20 Types of Freeways

5.20.1 Depressed Freeways

Information for the following is found in Chapter 8 of the 2018 AASHTO GDHS:

- Slopes and walls.
- Typical cross section.
- Restricted cross section.
- Walled cross section.

5.20.2 Elevated Freeways

Information for the following is found in Chapter 8 of the 2018 AASHTO GDHS:

- Medians.
- Ramps and terminals.
- Frontage roads.
- Clearance to building lines.
- Typical cross section.
- Viaduct freeways without ramps.
- Two-way viaduct freeways with ramps.
- Freeways on earth embankments.

5.20.3 Ground-Level Freeways

Information for the following is found in Chapter 8 of the 2018 AASHTO GDHS:

- Typical cross sections.
- Restricted cross sections.

5.20.4 Combination-Type Freeways

Information for the following is found in Chapter 8 of the 2018 AASHTO GDHS:

- Profile control.
- Cross section control.

5.20.5 Special Freeway Designs

Information for the following is found in Chapter 8 of the 2018 AASHTO GDHS:

- Reverse-flow roadways.
- Dual-divided freeways.
- Freeways with collector-distributor roads.

5.20.6 Accommodation of Transit and High-Occupancy Vehicle Facilities

Information for the following is found in Chapter 8 of the 2018 AASHTO GDHS:

- Buses.
- Rail transit.