MONTANA DEPARTMENT OF TRANSPORTATION

GEOMETRIC DESIGN STANDARDS

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MDT Geometric Design Standards

1.0 INTRODUCTION

The *MDT Geometric Design Standards* provide design criteria summary tables for the geometric design of MDT rural and urban facilities. Chapter 2: Basic Design Controls of the *MDT Road Design Manual (RDM)* outlines the basic design controls for the criteria presented in this document. The selection of design values depends on the functional classification of the highway facility. Descriptions for each functional classification category are provided in Chapter 2, Section 2.2 of the *RDM*. The most recent version of the MDT Functional Classification Map is provided at the following link on the Montana State Official Website.

Chapter 2 of the *MDT Road Design Manual* outlines the basic design controls for the criteria presented in this document.

MDT Functional Classification Map

Note that, in general, National Highway System (NHS) facilities within the current Federal-aid system will be designed using the design criteria presented in the freeway tables (Exhibits 1 and 7) and the rural/urban principal arterial tables (Exhibits 2 and 8). Federal code identifies the America Association of State Highway and Transportation Officials (AASHTO) *A Policy on Geometric Design of Highways and Streets* (*Green Book*) and the supplemental *A Policy on Design Standards Interstate System* as the minimum standard of design for use on the NHS *(1, 2)*. Flexibility in design exists even within full AASHTO standards, and MDT has established standards for some criteria for use on the NHS, within Montana, where AASHTO provides only general guidance or a range of acceptable values. If differences exist between values presented here and in AASHTO, the more conservative values will control for all NHS routes. This is particularly important when routes are added to or removed from the NHS, when revisions to AASHTO standards are made, and when design speeds above the minimum shown are selected.

Local agencies may have developed their own geometric design criteria for local facilities. If a facility is not on the State highway system, it may be acceptable to use the local agency criteria where there are conflicts with the MDT design criteria. Decisions to use local agency criteria should be made by the design team on a case-by-case basis.

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The design criteria summary tables are intended to provide a resource for the design team to have a concise listing of design values. However, the design team should review Chapter 2 of the *RDM* and additional *RDM* section references for more information on the design elements. In addition, the tables include footnotes, which are identified by a number in parentheses (e.g., (6)) and are critical to the proper use of the design tables.

1.1 Route Segment Plan

The Route Segment Plan is based on functional classification, traffic volumes, and route continuity. The purpose is to identify and define a consistent pavement width to be used when reconstruction or major widening is conducted on a route segment. For NHS roadways, the criteria provided in the AASHTO *Green Book* and the supplemental *A Policy on Design Standards Interstate System* set the minimum standards (1, 2). The MDT Route Segment Plan Map is provided at the following link on the MDT Website.

MDT Route Segment Plan Map

Chapters 2 and 5 of the RDM provide additional information regarding the roadway width decision process for MDT. Additional roadway width design information for various types of facilities can be found in the AASHTO *Green Book* and the *Guidelines for Nomination and Development of Pavement Projects* (1, 3).

2.0 GEOMETRIC DESIGN CRITERIA FOR RURAL FACILITIES

The following summary tables present geometric design criteria for all facilities within rural areas, including National Highway System (NHS) routes. All rural freeways and rural principal arterials are NHS routes. Rural areas are those places outside the boundaries of urban areas.

2.1 Rural Freeways (NHS – Interstate)

Exhibit 1 Geometric Design Criteria for Rural Freeways (NHS - Interstate)

Design Element			RDM Section	Design Criteria	
Design Control	Design Speed (minimum)	Level	2.5	70 mph	
		Rolling		70 mph	
		Mountainous		50 mph	
Roadway Elements	Minimum Number of Travel Lanes		5.2	4 (minimum of 2 in each direction)	
	Travel Lane Width		5.2	12 ft	
	Shoulder Width	Outside Shoulder	5.2	10 ft (1)	
		Inside Shoulder		4 ft (2)	
	Cross Slope	Travel Lane	5.2	2%	
		Shoulder		2% (3)	
	Median Width	Level	5.3	Minimum: 36 ft	
		Rolling		Minimum: 36 ft	
		Mountainous		Minimum: 16 ft (4)	
Cut Sections	Ditch	Inslope	5.4	6:1 (Width: 10 ft)	
		Width	5.4	10 ft Min.	
		Slope		20:1 towards backslope	
	Backslope; Cut Depth at Slope Stake (5)	0 – 5 ft	5.4	5:1	
		5 - 10 ft		Level/Rolling: 4:1; Mountainous: 3:1	
		10 - 15 ft		Level/Rolling: 3:1; Mountainous: 2:1	
		> 15 ft		Level/Rolling: 2:1; Mountainous: 1.5:1	
Fill Slopes	Fill Height at Slope Stake (6)	0 – 10 ft	5.4	6:1	
		10 – 20 ft		4:1	
		20 – 30 ft		3:1	
		> 30 ft		2:1	
Alignment Elements	DESIGN SPEED		2.5	70 mph	50 mph
	Stopping Sight Distance		2.8	730 ft	425 ft
	Minimum Radius (e = 8.0%)		3.2	1,810 ft	760 ft
	Spiral Curve Selection		See Chapter 3, Section 3.2 of the RDM		
	Superelevation Rate (7)		3.3	e_{max} = 8.0%	
	Vertical Curve Length	Crest	See Chapter 4, Section 4.4 of the RDM		
		Sag			
	Maximum Grade	Level	4.3	3%	
		Rolling		4%	
		Mountainous		5% (8)	
	Minimum Vertical Clearance (9)		4.5	17.0 ft	

Rural Freeways (NHS - Interstate) Footnotes

1. **Outside Shoulder Width.** In mountainous terrain, these may be reduced to a 6-foot minimum width where costs would be prohibitive to provide wider shoulders.
2. **Inside Shoulder Width.** The following will apply:
    a. For 3 or more through lanes in one direction, inside shoulders will be 10 feet wide.
    b. Where vertical elements (other than abutments, piers or walls) in the median are more than 1 foot high, the minimum offset from the edge of travel lane to the element is 4 feet.
3. **Shoulder Cross Slope.** Existing shoulder slopes on freeways may be 3.75 percent. If the proposed pavement work is resurfacing, the existing 3.75 percent slope may be retained. If the proposed pavement work is full-depth reconstruction or major rehabilitation, the shoulder slope should match the cross slope of the traveled way, typically 2 percent.
4. **Minimum Median Width.** The minimum median width of 10 feet may be used in areas of rugged mountainous terrain. It may also be used on any long and unusually costly bridges. The minimum median width should be the combined width of the two inside shoulders and the width of the base of the barrier (e.g., 4-foot shoulder, 2-foot barrier, and 4-foot shoulder).
5. **Cut Slopes (Rock).** The backslope through rock cut sections will be determined by the Geotechnical Section based on its field investigation.
6. **Fill Slopes (Rock).** In rock fills over 10 feet high, the typical fill slope is 1.5:1. In rock fills less than or equal to 10 feet, the typical slope is 6:1.
7. **Superelevation Rate.** See Chapter 3, Section 3.3 of the *RDM* for superelevation rates based on design speed and curve radii.
8. **Maximum Grade (Mountainous).** Gradients of up to 7-percent may be provided where needed in mountainous terrain.
9. **Minimum Vertical Clearance.** The clearances apply to a freeway passing under a bridge. The minimum clearance includes a 6-inch additional allowance for future overlays.

2.2 Rural Principal Arterials (NHS - Non Interstate)

Exhibit 2
Geometric Design Criteria for Rural Principal Arterials (NHS - Non Interstate)

Design Element			RDM Section	Design Criteria		
Design Control	Design Speed (minimum)	Level	2.5	70 mph		
		Rolling		60 mph		
		Mountainous		50 mph		
Roadway Elements	Travel Lane Width		5.2	12 ft [1]		
	Shoulder Width		5.2	Varies [1]		
	Cross Slope	Travel Lane	5.2	2%		
		Shoulder		2%		
	Median Width		5.3	Varies [2]		
Cut Sections	Ditch	Inslope	5.4	6:1 (Width: 10 ft)		
		Width	5.4	10 ft Min.		
		Slope		20:1 towards backslope		
	Backslope Cut Depth at Slope Stake [3]	0 – 5 ft	5.4	5:1		
		5 – 10 ft		Level/Rolling: 4:1; Mountainous: 3:1		
		10 – 15 ft		Level/Rolling: 3:1; Mountainous: 2:1		
		15 – 20 ft		Level/Rolling: 2:1; Mountainous: 1.5:1		
		> 20 ft		1.5:1		
Fill Slopes	Fill Height at Slope Stake [4]	0 – 10 ft	5.4	6:1		
		10 – 20 ft		4:1		
		20 – 30 ft		3:1		
		> 30 ft		2:1		
Alignment Elements	DESIGN SPEED		2.5	70 mph	60 mph	50 mph
	Stopping Sight Distance		2.8	730 ft	570 ft	425 ft
	Passing Sight Distance		2.8	1,200 ft	1000 ft	800 ft
	Minimum Radius (e=8.0%)		3.2	1,810 ft	1,200 ft	760 ft
	Spiral Curve Selection		See Chapter 3, Section 3.2 of the *RDM*			
	Superelevation Rate [5]		3.3	e_{max} = 8.0%		
	Vertical Curve Length	Crest	See Chapter 4, Section 4.4 of the *RDM*			
		Sag				
	Maximum Grade	Level	4.3	3%		
		Rolling		4%		
		Mountainous		7%		
	Minimum Vertical Clearance [6]		4.5	17.0 ft		

Rural Principal Arterials (NHS - Non Interstate) Footnotes

1. **Travel Lane/Shoulder Width.** Roadway width is based on the Route Segment Map described in Section 1.1 or the AASHTO *Green Book* standards, whichever value is more conservative. The AASHTO *Green Book* provides values for minimum width of traveled way and usable shoulder for rural arterials.
2. **Median Width.** For two-way, left-turn lanes in rural conditions, the minimum width is 14 feet. See Chapter 5, Section 5.3 of the *RDM* for additional information on median widths.
3. **Cut Slopes (Rock).** The backslope through rock cut sections will be determined by the Geotechnical Section based on its field investigation.
4. **Fill Slopes (Rock).** In rock fills over 10 feet high, the typical fill slope is 1.5:1. In rock fills less than or equal to 10 feet, the typical slope is 6:1.
5. **Superelevation Rate.** See Chapter 3, Section 3.3 of the *RDM* for superelevation rates based on design speed and curve radii.
6. **Minimum Vertical Clearance.** The clearances apply to the arterial passing under a bridge. The minimum clearance includes a 6-inch additional allowance for future overlays.

2.3 Rural Minor Arterials (Non-NHS Primary)

Exhibit 3 Geometric Design Criteria for Rural Minor Arterials

Design Element			RDM Section	Design Criteria		
Design Control	Design Speed	Level	2.5	60 mph		
		Rolling		55 mph		
		Mountainous		45 mph		
Roadway Elements	Travel Lane Width		5.2	12 ft [1]		
	Shoulder Width		5.2	Varies [1]		
	Cross Slope	Travel Lane	5.2	2%		
		Shoulder		2%		
	Median Width		5.3	Varies [2]		
Cut Sections	Ditch	Inslope	5.4	6:1 (Width: 10 ft)		
		Width	5.4	10 ft Min.		
		Slope		20:1 towards backslope		
	Backslope Cut Depth at Slope Stake [3]	0 – 5 ft	5.4	5:1		
		5 – 10 ft		Level/Rolling: 4:1; Mountainous: 3:1		
		10 – 15 ft		Level/Rolling: 3:1; Mountainous: 2:1		
		15 – 20 ft		Level/Rolling: 2:1; Mountainous: 1.5:1		
		> 20 ft		1.5:1		
Fill Slopes	Fill Height at Slope Stake [4]	0 – 10 ft	5.4	6:1		
		10 – 20 ft		4:1		
		20 – 30 ft		3:1		
		> 30 ft		2:1		
Alignment Elements	DESIGN SPEED		2.5	60 mph	55 mph	45 mph
	Stopping Sight Distance		2.8	570 ft	495 ft	360 ft
	Passing Sight Distance		2.8	1,000 ft	900 ft	700 ft
	Minimum Radius (e=8.0%)		3.2	1,200 ft	960 ft	590 ft
	Spiral Curve Selection		See Chapter 3, Section 3.2 of the *RDM*			
	Superelevation Rate [5]		3.3	e_{max} = 8.0%		
	Vertical Curve Length	Crest	See Chapter 4, Section 4.4 of the *RDM*			
		Sag				
	Maximum Grade	Level	4.3	3%		
		Rolling		4%		
		Mountainous		7%		
	Minimum Vertical Clearance [6]		4.5	17.0 ft		

Rural Minor Arterials Footnotes

1. **Travel Lane/Shoulder Width.** Roadway width is based on the Route Segment Map described in Section 1.1.
2. **Median Width.** For two-way, left-turn lanes in rural conditions, the minimum width is 14 feet. See Chapter 5, Section 5.3 of the *RDM* for additional information on median widths.
3. **Cut Slopes (Rock).** The backslope through rock cut sections will be determined by the Geotechnical Section based on its field investigation.
4. **Fill Slopes (Rock).** In rock fills over 10 feet high, the typical fill slope is 1.5:1. In rock fills less than or equal to 10 feet, the typical slope is 6:1.
5. **Superelevation Rate.** See Chapter 3, Section 3.3 of the *RDM* for superelevation rates based on design speed and curve radii.
6. **Minimum Vertical Clearance.** The clearances apply to the arterial passing under a bridge. The minimum clearance includes a 6-inch additional allowance for future overlays.

2.4 Rural Collectors (Secondary System)

Exhibit 4 Geometric Design Criteria for Rural Collectors

Design Element			RDM Section	Design Criteria				
Design Control	Design Speed	Level	2.5	60 mph				
		Rolling		50 mph				
		Mountainous		45 mph				
Roadway Elements	TRAFFIC	Current AADT	2.6	0-299	300-999	1,000-1,999	2,000-3,000	> 3,000
		DHV		50-99	100-199	200-299	300-400	>400
	Roadway Width (Travel Lanes & Shoulders)		5.2	24 ft	28 ft	32 ft	36 ft	40 ft
	Cross Slope	Travel Lane	5.2	2%				
		Shoulder		2%				
	Median Width		5.3	Varies [1]				
Cut Section	Ditch [2]	Inslope	5.4	DHV 200 — 6:1 (Width: 10 ft); DHV < 200 — 4:1 (Width: 6 ft)				
		Width	5.4	10 ft Min.				
		Slope		20:1 towards backslope				
	Backslope Cut Depth at Slope Stake [3]	0 – 5 ft	5.4	5:1				
		5 – 10 ft		Level/Rolling: 4:1; Mountainous: 3:1				
		10 – 15 ft		Level/Rolling: 3:1; Mountainous: 2:1				
		15 – 20 ft		Level/Rolling: 2:1; Mountainous: 1.5:1				
		> 20 ft		1.5:1				
Fill Slopes	Fill Height at Slope Stake [4]	0 – 10 ft	5.4	DHV ≥ 200 - 6:1; DHV < 200 — 4:1				
		10 – 20 ft		DHV ≥ 200 - 4:1; DHV < 200 — 3:1				
		20 – 30 ft		3:1				
		> 30 ft		2:1				
Alignment Elements	DESIGN SPEED		2.5	60 mph		50 mph		45 mph
	Stopping Sight Distance		2.8	570 ft		425 ft		360 ft
	Passing Sight Distance		2.8	1,000 ft		800 ft		700 ft
	Minimum Radius (e=8.0%)		3.2	1,200 ft		760 ft		590 ft
	Spiral Curve Selection		See Chapter 3, Section 3.2 of the *RDM*					
	Superelevation Rate [5]		3.3	e_{max} = 8.0%				
	Vertical Curve Length	Crest	See Chapter 4, Section 4.4 of the *RDM*					
		Sag						
	Maximum Grade	Level	4.3	5%				
		Rolling		7%				
		Mountainous		10%				
	Minimum Vertical Clearance[6]		4.5	16.5 ft				

Rural Collector Roads Footnotes

1. **Median Width.** For two-way, left-turn lanes in rural conditions, the minimum width is 14 feet. See Chapter 5, Section 5.3 of the *RDM* for additional information on median widths.
2. **Ditch.** A V-ditch may be used with an approved design exception. For backslopes steeper than 4:1, place the toe of the backslope outside the clear zone.
3. **Cut Slopes.** The design team should attempt to locate backslopes steeper than 4:1 outside the clear zone. The backslope through rock cut sections will be determined by the Geotechnical Section based on its field investigation. At a maximum, the backslope typically will not exceed 0.25:1. For large cuts, benching of the backslope may be required.
4. **Fill Slopes (Rock).** In rock fills over 10 feet high, the typical fill slope is 1.5:1. In rock fills less than or equal to 10 feet, the typical slope is 6:1.
5. **Superelevation Rate.** See Chapter 3, Section 3.3 of the *RDM* for superelevation rates based on design speed and curve radii.
6. **Minimum Vertical Clearance.** The clearances apply to the collector passing under a bridge. The minimum clearance includes a 6-inch additional allowance for future overlays.

2.5 Guidance for Rural Local Roads

Exhibit 5
Guidance for Rural Local Roads

Design Element			RDM Section	Design Criteria		
Design Controls	Current AADT		2.6	≤ 300 (1)		
	Design Speed	Paved Surface	2.5	50 mph (2)		
		Gravel Surface		45 mph (2)		
Roadway Elements	Minimum Roadway Width		5.2	24 ft (3)		
	Cross Slope	Travel Lane	5.2	Paved: 2% Gravel: 3%		
		Shoulder		Paved: 2% Gravel: 3%		
	Median Width		5.3	Varies (4)		
Cut Sections	Inslope		5.4	4:1		
	Ditch (5)		5.4	V-Ditch (1.5 ft Depth)		
	Backslope Cut Depth at Slope Stake (6)	0 – 5 ft	5.4	4:1		
		5 – 10 ft		Level/Rolling: 3:1; Mountainous: 2:1		
		10 – 15 ft		Level/Rolling: 2:1; Mountainous: 1.5:1		
		> 15 ft		1.5:1		
Fill Slopes	Fill Height at Slope Stake (7)	0 – 10 ft	5.4	4:1		
		10 – 20 ft		3:1		
		> 20 ft		1.5:1		
Alignment Elements	DESIGN SPEED		2.5	50 mph	45 mph	30 mph(2)
	Stopping Sight Distance		2.8	425 ft	360 ft	200 ft
	Passing Sight Distance		2.8	800 ft	700 ft	500 ft
	Minimum Radius		3.2	760 ft	560 ft	205 ft
	Spiral Curve Selection		3.2	e ≥ 7%	N/A	N/A
	Superelevation Rate (8)		3.3	e_{max} = 8.0%	e_{max} = 4%	e_{max} = 4%
	Vertical Curve Length	Crest	See Chapter 4, Section 4.4 of the *RDM*			
		Sag				
	Maximum Grade	Level	4.3	6%	7%	7%
		Rolling		8%	9%	10%
		Mountainous		10%	10%	10%
	Minimum Vertical Clearance (9)		4.5	14.5 ft		

Rural Local Roads Footnotes

1. **AADT.** For local rural roads with current AADT > 300 and/or functionally classified as a rural collector, the design criteria for rural collector roads should be used (Exhibit 4). For local roads with current AADT ≤ 300 design the project using one of the following:
    a. County standards – note that many counties do not have standards
    b. The design criteria provided in Exhibit 5
    c. AASHTO's *Guidelines for Geometric Design of Very Low-Volume Local Roads (4)*. Use these guidelines only if it is not practical to meet the criteria in Exhibit 5.
2. **Design Speed.** See Chapter 2, Section 2.5 of the *RDM* for selection of design speed. For local roads requiring a higher design speed, the criteria for rural collector roads should be used (Exhibit 4). A 30 mph design speed may be used, but only if the adjacent terrain presents obstacles that render the use of a higher design speed impractical. A formal design exception for design speed is not required for rural local roads. However, deviation from the design speeds in Exhibit 5 must be documented in the PFR, AGR and SOW reports.
3. **Roadway Width.** The bridge width, adjacent paved traveled way width and county standards should be considered when establishing a roadway width, if greater than the minimum. Bridges will typically provide a minimum roadway width of 28 feet. This width should be utilized to the end of the approach guardrail.
4. **Median Width.** For two-way, left-turn lanes in rural conditions, the minimum width is 14 feet. See Chapter 5, Section 5.3 of the *RDM* for additional information on median widths.
5. **Ditch.** V-ditches can be used without prior approval. The design team should attempt to make the ditch traversable or locate it outside of the clear zone.
6. **Cut Slopes (Rock).** The backslope through rock cut sections will be determined by the Geotechnical Section based on its field investigation.
7. **Fill Slopes.** In rock fills over 10 feet high, the typical fill slope is 1.5:1. In rock fills less than or equal to 10 feet, the typical fill slope is 4:1. In earth fills where the fill depth greater than 20 feet, the use of steeper than 1.5:1 slopes may be used if justified by a slope stability analysis.
8. **Superelevation Rate.** See Chapter 3, Section 3.3 of the RDM for superelevation rates based on design speed and curve radii. Refer to AASHTO's *Guidelines for Geometric Design of Very Low-Volume Local Roads (4)* and assume 5 mph reduction in design speed for determining superelevation for design speeds 45 mph or less.
9. **Minimum Vertical Clearance.** The clearances apply to the local road passing under a bridge. The minimum clearance includes a 6-inch additional allowance for future overlays.

3.0 GEOMETRIC DESIGN STANDARDS FOR URBAN AND DEVELOPED AREAS

The following summary tables provide geometric design criteria for MDT facilities within urban and developed areas, including NHS routes. All urban freeways and urban principal arterial are NHS routes. The following provides descriptions for various types of urban areas:

Urban Areas. Those places within boundaries set by the responsible State and local officials or a place that has urbanized characteristics. Urban areas have three subcategories:

- **Urbanized Areas.** Those areas with a population greater than 50,000, as designated by the Bureau of the Census.
- **Small Urban Areas.** Those areas with a population greater than 5,000 and not within any Urbanized Areas.
- **Transitional Areas.** Those areas providing connections between urban and rural areas.

In those situations where adjacent development, other physical features or environmental features or factors limit the standards to which a facility can be constructed, exceptions to standards must be approved to deviate to lesser design criteria. In design practice, these Urban Standards must be supplemented with criteria from *AASHTO Green Book*, current edition, for those elements of design not included herein and for those transitional or undeveloped areas based upon their existing operating conditions *(1)*.

3.1 Urban Road Design

The following provides some basic references for design elements not included in the urban geometric design criteria tables. The design team should read the footnotes associated with the referenced tables and should consider other related text and tables in the *AASHTO Green Book (1).* In addition, Chapter 8 of the *RDM* provides additional information on design elements and considerations for facilities in urban, urbanized, and transitional areas.

- **Intersection Design.** The design vehicle must be identified based upon the functional intent of the intersecting roadways. The passage should be made from the near lane directly into a departure lane on the downstream approach. The design vehicle shall not encroach on an opposing traffic lane. However, in an urban setting and based on project context, the design team should coordinate with local agencies to establish the appropriate design approach for trucks.
- **Right-of-way.** The right-of-way should not be less than required for all design elements specified in the geometric design criteria tables in this section.
- **Clear Zone.** The design team should reference the *AASHTO Roadside Design Guide* and Chapter 9 of the *RDM* for clear zone guidelines *(5)*.
- **Landscaping.** Landscaping will be included as an element to be considered in the design of all urban streets.

3.2 Sidewalks

The installation of all new sidewalks will comply with the standards outlined in Exhibit 6. Additional design considerations for pedestrian facilities are provided in Chapter 7 and Chapter 8 of the *RDM.*

Exhibit 6
Geometric Design Criteria for Sidewalks

Minimum Width [(a)]	60 inches (for passage) 36 inches (minimum continuous clear width) – ***See additional note below***
Cross Slopes	1V:50H (maximum)
Gradient [(b)]	5-percent (maximum)
Buffer [(c)]	18 inches
Note: A minimum sidewalk width of 48 inches is recommended by the AASHTO Guide for Planning, Design and Operation of Pedestrian Facilities (6)	

(a) The clear width is exclusive of the curb width. Where it is impractical to provide the minimum clear width of 60 inches, provide a minimum 36-inch clear width and 60 inch-by-60 inch clear passing spaces at 200-foot minimum intervals.

(b) The sidewalk gradient should typically follow the roadway gradient. Where the roadway gradient exceeds 5-percent, a maximum sidewalk gradient of 5-percent should be maintained unless it is impractical to do so.

(c) Where there is a drop-off next to the sidewalk that could pose a fall hazard (ditches, embankments steeper than 1:3), provide an 18-inch wide buffer between the edge of the sidewalk and the hazard.

3.3 Urban Freeways (NHS - Interstate)

Exhibit 7 Geometric Design Criteria for Urban Freeways (NHS - Interstate)

Design Element			RDM Section	Design Criteria
Design Control	Design Speed (minimum)	Level	2.5	50 mph
		Rolling		
		Mountainous		
Roadway Elements	Minimum Number of Travel Lanes		5.2	4 (minimum of 2 in each direction)
	Travel Lane Width		5.2	12 ft
	Shoulder Width	Outside Shoulder	5.2	10 ft (1)
		Inside Shoulder		4 ft (2)
	Cross Slope	Travel Lane	5.2	2%
		Shoulder		2% (3)
	Median Width	Level	5.3	Minimum: 16 ft (4)
		Rolling		
		Mountainous		
Cut Sections(5)	Ditch	Inslope	5.4	6:1 (Width: 6 ft)
		Width	5.4	10 ft
		Slope		20:1 towards backslope
	Backslope Cut Depth at Slope Stake (6)	0 – 5 ft	5.4	5:1
		5 – 10 ft		3:1
		10 – 15 ft		2:1
		> 15 ft		1.5:1
Fill Slopes(5)	Fill Height at Slope Stake (7)	0 – 10 ft	5.4	6:1
		10 – 20 ft		4:1
		20 – 30 ft		3:1
		> 30 ft		2:1
Alignment Elements	DESIGN SPEED		2.5	50 mph
	Stopping Sight Distance		2.8	425 ft
	Minimum Radius (e = 8.0%)		3.2	760 ft
	Spiral Curve Selection		See Chapter 3, Section 3.2 of the *RDM*	
	Superelevation Rate (8)		3.3	e_{max} = 8.0%
	Vertical Curve Length	Crest	See Chapter 4, Section 4.4 of the *RDM*	
		Sag		
	Maximum Grade(9)	Level	4.3	4%
		Rolling		5%
		Mountainous		6%
	Minimum Vertical Clearance (10)		4.5	17.0 ft

Urban Freeways (NHS - Interstate) Footnotes

1. **Outside Shoulder Width.** In mountainous terrain, these may be reduced to a minimum width of 8 feet where costs would be prohibitive to provide wider shoulders.
2. **Inside Shoulder Width.** The following apply:
    a. For 3 or more through lanes in one direction, inside shoulders shall be 10 feet wide.
    b. Where continuous curbs are used in narrow medians on ramps, the inside shoulder width should desirably be 2 feet and a minimum of 1 foot.
    c. Where vertical elements (other than abutments, piers or walls) in the median are more than 1 foot high, the minimum offset from the edge of travel lane to the element is 4 feet.
3. **Shoulder Cross Slope.** Existing shoulder slopes on existing freeways may be 3.75 percent. If the proposed pavement work is resurfacing, the existing 3.75 percent slope may be retained. If the proposed pavement work is full-depth reconstruction or major rehabilitation, the shoulder slope should match the cross slope of the traveled way, typically 2 percent.
4. **Minimum Median Width.** The minimum median width of 10 feet may be used in urban areas with high right-of-way costs and in rugged mountainous terrain. It may also be used on any long and unusually costly bridges. The minimum median width should be the width of the two inside shoulders and the width of the base of the barrier.
5. The design information for cut and fill slopes are intended to provide design guidance and are not MDT standards
6. **Cut Slopes (Rock).** The backslope through rock cut sections will be determined by the Geotechnical Section based on its field investigation. At a maximum, the backslope typically will not exceed 0.25:1. For large cuts, benching of the backslope may be required.
7. **Fill Slopes (Rock).** In rock fills over 10 feet high, the typical fill slope is 1.5:1. In rock fills less than or equal to 10 feet, the typical slope is 6:1.
8. **Superelevation Rate.** See Chapter 3, Section 3.3 of the *RDM* for superelevation rates based on design speed and curve radii.
9. **Maximum Grade (Level, Rolling, and Mountainous).** Grades 1% steeper than the value shown may be provided in urban areas with right-of-way constraints or where needed in mountainous terrain.
10. **Minimum Vertical Clearance.** The clearances apply to a freeway passing under a bridge. The minimum clearance includes a 6-inch additional allowance for future overlays.

3.4 Urban Principal Arterials (NHS - Non Interstate) [1]

Exhibit 8 Geometric Design Criteria for Urban Principal Arterials (NHS — Non Interstate)

Design Element			RDM Section	Curbed	Shouldered
Design Control	Design Speed [2]		2.5	40 mph	40 mph
Roadway Elements	Travel Lane Width[3]		5.2	12 ft	
	Minimum Roadway Width		5.2	28 ft [4]	36 ft
	Shoulder Width	Outside	5.2	0	6 ft
		Inside		N/A	
	Cross Slope	Travel Lane	5.2	2% Typical [5]	2%
		Shoulder		2% Typical [5]	2%
	Minimum Median Width		5.3	Raised: 4 ft [6]	
	TWLTL Width [7]		5.2	12 ft	
	Bicycle Lane Width [8]		5.2	4 ft	
	Parking Lane Width [9]		5.2	10 ft [10]	N/A
Cut Section	Ditch Slope [11]		5.4	4:1	
Alignment Elements [16]	DESIGN SPEED		2.5	40 mph	
	Stopping Sight Distance [12]		2.8	305 ft	
	Intersection Sight Distance [13]		2.8	195 ft	
	Minimum Radius		3.2	533 ft	
	Superelevation Rate [14]		3.3	e_{max} = 4.0%	
	Vertical Curve Length	Crest	See Chapter 4, Section 4.4 of the *RDM*		
		Sag			
	Maximum Grade	Level	4.3	6%	
		Rolling		7%	
		Mountainous		9%	
	Minimum Vertical Clearance [15]		4.5	17.0 ft	

Urban Principal Arterials (NHS — Non Interstate) Footnotes

1. Federal functional classification defined by MDT and approved by the Montana Transportation Commission and the FHWA.
2. The design speed for urban principal arterials should match the conditions and driver expectancy. In the transitional areas between rural and urban sections of roadway, the use of the criteria for rural principal arterials may be appropriate. However, the determination of the design speed for transitional areas should be based on consideration of roadside development, number and type of approaches, lane configuration and traffic control devices.
3. For multilane facilities, the interior lane width is 11 feet and the exterior lane width is 12 feet.
4. The lane width does not include the gutter section. Add three feet where wide curb lane is provided for accommodating bicycles.
5. Cross Slopes (Curbed). The cross slope may be between 1-percent and 4-percent, depending on site conditions.
6. The raised median width needs to be added to the exclusive left-turn lane width. See Chapter 5, Section 5.3 of the *RDM* for additional information on median width.
7. This is also applicable for an exclusive left-turn lane with a flush median.
8. The bicycle lane width can include the shoulder width if there is no parking. A 5-foot width is recommended from the face of curb, guardrail or other roadside barriers. An increased lane width is recommended where the percentage of trucks or buses is high. See the *AASHTO Guide for the Development of Bicycle Facilities* for additional information *(7)*.
9. Includes the width of the gutter section.
10. 8 feet may be acceptable when the lane is not likely to become a traffic lane in the foreseeable future.
11. The design team should try to provide recoverable fill slopes within the clear zone, where feasible. If the use of a v-ditch is necessary, it should be traversable or the hinge point should be located outside of the clear zone.
12. See Chapter 2, Section 2.8 of the *RDM* and the *AASHTO Green Book* for additional information regarding stopping sight distance *(1)*.
13. See Chapter 2, Section 2.8 of the *RDM* and the *AASHTO Green Book* for additional information *(1)*.
14. See Chapter 3, Section 3.3 of the *RDM* for superelevation rates based on design speed and curve radii.
15. The clearances apply to the arterial passing under a bridge. The minimum clearance includes a 6-inch additional allowance for future overlays.

3.5 Urban Minor Arterials [1]

Exhibit 9 Geometric Design Criteria for Urban Minor Arterials

Design Element			RDM Section	Curbed	Shouldered
Design Control	Design Speed [2]		2.5	35 mph	35 mph
Roadway Elements	Travel Lane Width[3]		5.2	11 ft	
	Minimum Roadway Width		5.2	26 ft [4]	30 ft
	Shoulder Width	Outside	5.2	varies	4 ft
		Inside		N/A	
	Cross Slope	Travel Lane	5.2	2% Typical [5]	2%
		Shoulder		2% Typical [5]	2%
	Minimum Median Width		5.3	Raised: 4 ft [6]	
	TWLTL Width [7]		5.2	11 ft	
	Bicycle Lane Width [8]		5.2	4 ft	
	Parking Lane Width [9]		5.2	10 ft [10]	N/A
Cut Section	Ditch Slope [11]		5.4	4:1	
Alignment Elements [16]	DESIGN SPEED		2.5	35 mph	
	Stopping Sight Distance [12]		2.8	250 ft	
	Intersection Sight Distance [13]		2.8	165 ft	
	Minimum Radius		3.2	371 ft	
	Superelevation Rate [14]		3.3	e_{max} = 4.0%	
	Vertical Curve Length	Crest	See Chapter 4, Section 4.4 of the *RDM*		
		Sag			
	Maximum Grade	Level	4.3	6%	
		Rolling		7%	
		Mountainous		9%	
	Minimum Vertical Clearance [15]		4.5	17.0 ft	

Urban Minor Arterials Footnotes

1. Federal functional classification defined by MDT and approved by the Montana Transportation Commission and the FHWA.
2. The design speed for urban minor arterials should match the conditions and driver expectancy. In the transitional areas between rural and urban sections of roadway, the use of the criteria for rural minor arterials may be appropriate. However, the determination of the design speed for transitional areas should be based on consideration of roadside development, number and type of approaches, lane configuration and traffic control devices.
3. For multilane facilities, the interior and exterior lane width is 11 feet.
4. The lane width does not include the gutter section. Add three feet where wide curb lane is provided for accommodating bicycles.
5. Cross Slopes (Curbed). The cross slope may be between 1-percent and 4-percent, depending on site conditions.
6. The raised median width needs to be added to the exclusive left-turn lane width. See Chapter 5, Section 5.3 of the *RDM* for additional information on median width.
7. This is also applicable for an exclusive left-turn lane with a flush median.
8. The bicycle lane width can include the shoulder width if there is no parking. A 5-foot width is recommended from the face of curb, guardrail or other roadside barriers. An increased lane width is recommended where the percentage of trucks or buses is high. See the *AASHTO Guide for the Development of Bicycle Facilities* for additional information *(7)*.
9. Includes the width of the gutter section.
10. 8 feet may be acceptable when the lane is not likely to become a traffic lane in the foreseeable future.
11. Slopes steeper than 4:1 should be used only when achieving a 4:1 slope is not feasible. The preferred ditch width is 10 feet. However, site constraints often make the use of this width not feasible. If the use of a v-ditch is necessary, it should be traversable or the hinge point should be located outside of the clear zone. A design exception is required for the use of a narrower ditch.
12. The stopping sight distance must be adjusted for higher design speeds and grades. See Chapter 2, Section 2.8 of the *RDM* and the *AASHTO Green Book* for additional information *(1)*.
13. See Chapter 2, Section 2.8 of the *RDM* and the *AASHTO Green Book (1)*.
14. See Chapter 3, Section 3.3 of the *RDM* for superelevation rates based on design speed and curve radii.
15. The clearances apply to the arterial passing under a bridge. The minimum clearance includes a 6-inch additional allowance for future overlays.

3.6 Urban Collector Streets [1]

Exhibit 10 Geometric Design Criteria for Urban Collector Streets

Design Element			Manual Section	Design Criteria	
				Curbed	Shouldered
Design Control	Design Speed [2]		2.5	30 mph	30 mph
Roadway Elements	Travel Lane Width		5.2	10 ft [3]	
	Shoulder Width	Outside	5.2	0 ft	4 ft [4]
		Inside		N/A	
	Cross Slope	Travel	5.2	2% Typical [5]	2%
		Shoulder		2% Typical [5]	2%
	Minimum Median Width		5.3	Raised: 4 ft [6]	
	TWLTL Width [7]		5.2	11 ft	
	Bicycle Lane Width [8]		5.2	4 ft	
	Parking Lane Width [9]		5.2	8 ft	
Earth Cut Section	Ditch Slope [10]		5.4	4:1	
Alignment Elements [15]	DESIGN SPEED		2.5	30 mph	
	Stopping Sight Distance [11]		2.8	200 ft	
	Intersection Sight Distance [12]		2.8	140 ft	
	Minimum Radius (@ e_{max} = 4%)		3.2	250 ft	
	Spiral Curve Selection		See Chapter 3, Section 3.2		
	Superelevation Rate [13]		3.3	e_{max} = 4.0%	
	Vertical Curve Length	Crest	See Chapter 4, Section 4.4		
		Sag			
	Maximum Grade	Level	4.3	9%	
		Rolling		10%	
		Mt		10%	
	Minimum Vertical Clearance [14]		4.5	16.5’	

Mt: Mountainous

Urban Collector Streets Footnotes

1. Federal functional classification defined by MDT and approved by the Montana Transportation Commission and the FHWA.
2. The design speed for urban collectors should match the conditions and driver expectancy. In the transitional areas between rural and urban sections of roadway, the use of the criteria for rural collectors may be appropriate. However, the determination of the design speed for transitional areas should be based on consideration of roadside development, number and type of approaches, lane configuration and traffic control devices.
3. The lane width does not include the gutter section. Add three feet where wide curb lane is provided for accommodating bicycles.
4. Shouldered cross-section only.
5. Cross Slopes (Curbed). The cross slope may be between 1-percent and 4-percent, depending on site conditions.
6. The raised median width needs to be added to the exclusive left-turn lane width. See Chapter 5, Section 5.3 of the *RDM* for additional information on median width.
7. This is also applicable for an exclusive left-turn lane with a flush median. For exclusive turn lanes, use 11 feet for collectors that primarily serve commercial/industrial areas.
8. The bicycle lane width can include the shoulder width if there is no parking. A 5-foot width is recommended from the face of curb, guardrail or other roadside barriers. An increased lane width is recommended where the percentage of trucks or buses is high. See the *AASHTO Guide for the Development of Bicycle Facilities* for additional information *(7)*.
9. Includes the width of the gutter section.
10. Slopes steeper than 4:1 should be used only when achieving a 4:1 slope is not feasible. The preferred ditch width is 10 feet. However, site constraints often make the use of this width not feasible. If the use of a v-ditch is necessary, it should be traversable or the hinge point should be located outside of the clear zone. A design exception is required for the use of a narrower ditch.
11. See Chapter 2, Section 2.8 of the *RDM* and the *AASHTO Green Book* for additional information regarding stopping sight distance *(1)*.
12. See Chapter 2, Section 2.8 of the *RDM* and the *AASHTO Green Book* for additional information *(1)*.
13. See Chapter 3, Section 3.3 of the *RDM* for superelevation rates based on design speed and curve radii.
14. The clearances apply to the collector passing under a bridge. The minimum clearance includes a 6-inch additional allowance for future overlays.

4.0 REFERENCES

1. AASHTO. *A Policy on Geometric Design of Highways and Streets.* Washington, D.C.: AASHTO, 2011.
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