

I-80 Design Criteria

Pennsylvania Department of Transportation, District 5-0
 Agreement No. E02656, Monroe County
 SR 0080, Section 17M

Design Element	Criteria Source	Standard Criteria	Applied Criteria	Comments
Functional Classification Terrain	Functional Classification Map AASHTO Greenbook pg 231	Urban Interstate Rolling	Urban Interstate Rolling	ITMS Data Attached
Lane Widths	DM2 pg 1-32	4 or More 12'-0" Lanes	4-6 12'-0" lanes	
Shoulder Width	DM2 pg 1-32	10'-0" Right Shoulder 8'-0" Graded, 4'-0" Paved Left Shoulder (Medians Only)	12'-0" Right Shoulder 10'-0" Median Shoulder	12' used because truck traffic > 250 DDHV, shoulder widths provided in scope (attached)
Median Width	DM2 pg 1-32	2 Lane Directional: 10'-0" Min 3+ Lane Directional: 22'-0" Min	26'-0" Min Max = 6.0%	Two 12'-0" Shoulders and a 2'-0" Median Barrier, Truck Traffic > 250
Cross Slope / Superlevation	DM2 pg 1-32	Min = 2.0%	Min = 2.0%	
Bridge Width	DM2 pg 1-32	Lane Widths + Right Shoulder + 6'-0" Left Shoulder	Lane Widths + Right Shoulder + 6'-0" Left Shoulder	
Vertical Grades	2005 AASHTO Publication pg. 3	Max = 4%	Max. = 4%	
	DM2 pg 1-32	Min = 0.5%	Min = 0.5%	
Lateral Clearance to Structures	DM2 pg 4-3	14' Lateral Clearance to front face of barrier protectings walls or piers	14' Min	
Vertical Clearance	AASHTO Green Book pg 506 & DM2 Sect. 2.20 pg 2-47	16'-0" Min. + 6" for resurfacing	16'-6"	
Horizontal Curvature	AASHTO Green Book, Exhibit 3-15 pg 147	Min Radius = 1,330'	Min Radius = 1,330'	
Compound Curve Ratio	AASHTO Green Book, pg 201	1.5:1	1.5:1	
Clear Zone Widths	DM2 Chapter 12	See Table 12.1	See Table 12.1	See attached table
Guide Rail and Median Barrier	DM2 Chapter 12	See Table 12.3	See Table 12.3	See attached table
Design Speed	DM2 Chapter 12	50 - 70 MPH	60 MPH	Posted at 50MPH
Vertical Sight Distance	AASHTO Green Book, Exhibit 3-72, pg 272	Stopping Sight Distance = 570'	Stopping Sight Distance = 570'	

NOTES:

1) The design criteria for this project are taken from PENNDOT Publication 13M, *Design Manual Part 2 (Aug 2009 ED)*; 2005 AASHTO Publication, *A Policy on Design Standards - Interstate System*; and the AASHTO Greenbook, 2004 Edition

Interchange 303 - PA611 Design Criteria
 Pennsylvania Department of Transportation, District 5-0
 Agreement No. E02656, Monroe County
 SR 0080, Section 17M

Design Element	Criteria Source	Standard Criteria	Applied Criteria	Comments
Functional Classification Roadway Typology	Functional Class Map DM2 pg 1-7	Urban Minor Arterial Regional Suburban Corridor	Urban Minor Arterial Regional Suburban Corridor	ITMS Data Attached
Terrain	DM2, pg 2-11 AASHTO Greenbook pg 231	Rolling	Rolling	
Lane Widths	DM2 pg 1-12	11' - 12'	11'-12'	
Shoulder Width	DM2 pg 1-12	8'-12'	8'-12'	
Bike Lane	DM2 pg 1-12	6' (if no shoulder)	NA	Match existing section
Median Width (if needed)	DM2 pg 1-12	16' - 18' For Left Turn; 6' to 8' for Peds	16' - 18' For Left Turn; 6' to 8' for Peds	
Curb Return	DM2 pg 1-12	30' - 50'	NA	No curbs on existing roadway
Travel Lanes	DM2 pg 1-12	4 - 6	4	
Cross Slope / Superelevation	DM2 pg 1-12	Max = 6.0%	Max = 6.0%	
		Min = 2.0%	Min = 2.0%	
Bridge Width	DM2 pg 1-12	Lane Width + Shoulder each side	Lane Width + Shoulder each side	
Vertical Grades	AASHTO Greenbook, pg 472	Max. = 7%	Max. = 7%	
	DM2 pg 1-12	Min = 0.5%	Min = 0.5%	
Vertical Clearance	DM2 pg 2-50	16' 0" MIN + 6" for resurfacing	16'-6" Min	
Lateral Clearance to Structures	DM2 pg 4-3	14' Lateral Clearance to front face of barrier protectings walls or piers	14'-0"	
Horizontal Curvature	AASHTO Green Book, pg 147	Min Radius = 643'	Min Radius = 643'	
Compound Curve Ratio	AASHTO Green Book, pg 201	1.5:1	1.5:1	
Compound Curve Length	AASHTO Green Book, pg 202	60' to 200' minimum	See exhibit 3-42, pg 202	
Clear Zone Widths	DM2 Chapter 12	See Table 12.1	See Table 12.1	See attached Table
Guide Rail and Median Barrier	DM2 Chapter 12	See Table 12.3	See Table 12.3	See attached Table
Desired Operating Speed	DM2 pg 1-12 & 2-11	35 - 55 MPH	45 MPH	Posted 45MPH
Sight Distance (minimum)	AASHTO Green Book, Exhibit 7-1 pg 445	Stopping Sight Distance= 360'	Stopping Sight Distance = 360'	

NOTES:

1) The design criteria for this project are taken from PENNDOT Publication 13M, Design Manual Part 2 (Aug 2009 ED); 2005 AASHTO Publication, A Policy on Design Standards - Interstate System;

Inerchange 304 - US-209 Design Criteria
 Pennsylvania Department of Transportation, District 5-0
 Agreement No. E02656, Monroe County
 SR 0080, Section 17M

Design Element	Criteria Source	Standard Criteria	Applied Criteria	Comments
Functional Classification Roadway Typology	Functional Classification Map DM2, pg 2-17	Urban Other Principal Arterial Urban Non-Interstate	Urban Other Principal Arterial Urban Non-Interstate	ITMS Data Attached
Terrain	DM2, pg 2-11 AASHTO Greenbook pg 231	Rolling	Rolling	
Lane Widths	DM2 pg 1-32	4 or More 12'-0" Lanes	4 12'-0" lanes	
Shoulder Width	DM2 pg 1-32	10'-0" Right Shoulder 8'-0" Graded, 4'-0" Paved Left Shoulder (Medians Only)	12'-0" Right Shoulder 10'-0" Median Shoulder	12' used because truck traffic > 250 DDHV
Median Width	DM2 pg 1-32	2 Lane Directional: 10'-0" Min	10'-0" Min	
Cross Slope / Superelevation	DM2 pg 1-32	Max = 6.0%	Max = 6.0%	
		Min = 2.0%	Min = 2.0%	
Bridge Width	DM2 pg 1-32	Lane Widths + Right Shoulder + 6'-0" Left Shoulder	Lane Widths + Right Shoulder + 6'-0" Left Shoulder	
Vertical Grades	2005 AASHTO Publication pg. 3 DM2 pg 1-32	Max = 4%	Max. = 4%	
		Min = 0.5%	Min = 0.5%	
Lateral Clearance to Structures	DM2 pg 4-3	14" Lateral Clearance to front face of barrier protectings walls or piers	14' Min	
Vertical Clearance	AASHTO Green Book pg 506 & DM2 Sect. 2.20 pg 2-47	16'-0" Min. + 6" for resurfacing	16'-6"	
Horizontal Curvature	AASHTO Green Book, Exhibit 3-15 pg 147	Min Radius = 1,330'	Min Radius = 1,330'	
Compound Curve Ratio	AASHTO Green Book, pg 201	1.5:1	1.5:1	
Clear Zone Widths	DM2 Chapter 12	See Table 12.1	See Table 12.1	See attached table
Guide Rail and Median Barrier	DM2 Chapter 12	See Table 12.3	See Table 12.3	See attached table
		DM2 Chapter 12	60 MPH	Posted at 55MPH
Vertical Sight Distance	AASHTO Green Book, Exhibit 3-72, pg 272	Stopping Sight Distance = 570'	Stopping Sight Distance = 570'	

NOTES:

1) The design criteria for this project are taken from PENNDOT Publication 13M, *Design Manual Part 2 (Aug 2009 ED)* and *The AASHTO Greenbook, 2004 Edition*

Interchange 305 - SR2012, West Main Street Design Criteria

Pennsylvania Department of Transportation, District 5-0
 Agreement No. E02656, Monroe County
 SR 0080, Section 17M

Design Element	Criteria Source	Standard Criteria	Applied Criteria	Comments
Functional Classification	DM2 pg 1-7 & 1-16	Urban - Other Principal Arterial	Urban - Other Principal Arterial	ITMS Data attached
Roadway Typology	DM2 pg 2-11, AASHTO Greenbook pg 231	Community Arterial Suburban Corridor	Community Arterial Suburban Corridor	
Terrain		Rolling	Rolling	
Lane Widths	DM2 pg 1-16	11' - 12'	11' - 12'	
Shoulder Width	DM2 pg 1-16	8' to 10'	8' - 10'	
Bike Lane	DM2 pg 1-16	5' - 6' (if no shoulder)	NA	Match existing section
Parking Lane	DM2 pg 1-16	NA	NA	Match existing section
Median Width (if needed)	DM2 pg 1-16	16' - 18' For Left Turn	Not Needed	
Curb Return	DM2 pg 1-16	12' - 18' For Left Turn; 6' to 8' for Peds		
Travel Lanes	DM2 pg 1-16	25'-50'	25'-50'	
		2 - 4	2	
Cross Slope / Superelevation	DM2 pg 1-16	Max = 6.0%	Max = 6.0%	
		Min = 2.0%	Min = 2.0%	
Bridge Width	DM2 pg 1-16	Lane Widths plus Shoulder each side	Lane Widths plus Shoulder each side	
Vertical Grades	AASHTO Green Book, Exhibit 7-10 pg 472	Max. = 8%	Max. = 8%	
	DM2 pg 1-16	Min = 0.5%	Min = 0.5%	
Vertical Clearance	DM2 section 2.20 pg 2-50	16' 0" MIN + 6" for resurfacing	16' 6"	
Lateral Clearance to Structures	DM2 pg 4-3	14' Lateral Clearance to front face of barrier protectings walls or piers	14'-0" Min	
Horizontal Curvature	AASHTO Green Book, pg 168	Min Radius = 485'	Min Radius = 485'	
Compound Curve Ratio	AASHTO Green Book, pg 201	1.5:1	1.5:1	
Clear Sidewalk Width	DM2 pg 1-16	5' - 6'	5' - 6'	
Buffer	DM2 pg 1-16	5' - 10'	5' - 10'	
Shy Distance	DM2 pg 1-16	NA	NA	
Total Sidewalk Width	DM2 pg 1-16	5' - 6'	5' - 6'	
Clear Zone Widths	DM2 Chapter 12	Table 12.1	Table 12.1	See attached table
Desired Operating Speed	DM2 pg 1-7 & 1-16	35 - 55 MPH	40 MPH	Posted 40MPH
Sight Distance (minimum)	AASHTO Green Book, Exhibit 7-1 pg 445	Stopping Sight Distance= 305' Passing Sight Distance= 1470'	Stopping Sight Distance = 305' Passing Sight Distance = 1470'	

NOTES:

1) The design criteria for this project are taken from PENNDOT Publication 13M, *Design Manual Part 2 (Aug 2009 ED)* and *The AASHTO Greenbook, 2004 Edition*

Interchange 306 - SR2004, Dreher Ave Design Criteria
 Pennsylvania Department of Transportation, District 5-0
 Agreement No. E02656, Monroe County
 SR 0080, Section 17M

Design Element	Criteria Source	Standard Criteria	Applied Criteria	Comments
Functional Classification	Functional Class Map	Urban - Minor Arterial	Urban - Minor Arterial	
Roadway Typology	DM2 pg 1-7 & 1-16	Community Arterial Suburban Neighborhood	Community Arterial Suburban Neighborhood	iTMS Data attached
Terrain	DM2 pg 2-11, AASHTO Greenbook pg 231	Rolling	Rolling	
Lane Widths	DM2 pg 1-16	10' - 12'	10' - 12'	
Shoulder Width	DM2 pg 1-16	4' to 8' (if no parking or bike lane)	4' - 8'	
Bike Lane	DM2 pg 1-16	5' - 6' (if no shoulder)	NA	Match existing section
Parking Lane	DM2 pg 1-16	7' to 8' Parallel	NA	Match existing section
Median Width (if needed)	DM2 pg 1-16	16' - 18' For Left Turn	Not Needed	
Curb Return	DM2 pg 1-16	12' - 18' For Left Turn; 6' to 8' for Peds		
Travel Lanes	DM2 pg 1-16	25'-35'	25'-35'	
		2 - 4	2	
Cross Slope / Superelevation	DM2 pg 1-16	Max = 6.0%	Max = 6.0%	3% min Cross Slope recommended for DS < 40 MPH; 3% Cross Slope may be on Tangents if vertical grade < 1%
		Min = 2.0%, 3.0% Desired	Min = 2.0%, 3.0% Desired	
Bridge Width	DM2 pg 1-16	Lane Widths plus Shoulders each side	Lane Widths plus Shoulders each side	
Vertical Grades	AASHTO Green Book, Exhibit 7-10 pg 472	Max. = 8%	Max. = 8%	
	DM2 pg 1-16	Min = 0.5%	Min = 0.5%	
Vertical Clearance	DM2 section 2.20 pg 2-50	16' 0" MIN + 6" for resurfacing	16' 6"	
Lateral Clearance to Structures	DM2 pg 4-3	14' Lateral Clearance to front face of barrier protecting walls or piers		
Horizontal Curvature	AASHTO Green Book, pg 168	Min Radius = 340'	14'-0" Min	
Compound Curve Ratio	AASHTO Green Book, pg 201	1.5:1	Min Radius = 485'	
Clear Sidewalk Width	DM2 pg 1-16	5'	1.5:1	
Buffer	DM2 pg 1-16	6'+	5'	
Total Sidewalk Width	DM2 pg 1-16	5'	6'+	
Clear Zone Widths	DM2 Chapter 12	Table 12.1	Table 12.1	See attached table
Desired Operating Speed	DM2 pg 1-7 & 1-16	30-35 MPH	35 MPH	Posted 35MPH
Sight Distance (minimum)	AASHTO Green Book, Exhibit 7-1 pg 445	Stopping Sight Distance= 250'	Stopping Sight Distance = 250'	
		Passing Sight Distance= 1280'	Passing Sight Distance = 1280'	

NOTES:

1) The design criteria for this project are taken from PENNDOT Publication 13M, *Design Manual Part 2 (Aug 2009 ED)* and *The AASHTO Greenbook, 2004 Edition*

Interchange 307 - PA611 Design Criteria
 Pennsylvania Department of Transportation, District 5-0
 Agreement No. E02656, Monroe County
 SR 0080, Section 17M

Design Element	Criteria Source	Standard Criteria	Applied Criteria	Comments
Functional Classification Roadway Typology	Functional Class Map DM2 pg 1-7 & 1-16 DM2 pg 2-11, AASHTO Greenbook pg 231	Urban - Minor Arterial Community Arterial Suburban Neighborhood	Urban - Minor Arterial Community Arterial Suburban Neighborhood	iTMS Data attached
Terrain		Rolling	Rolling	
Lane Widths	DM2 pg 1-16	11' - 12'	11' - 12'	
Shoulder Width	DM2 pg 1-16	8' to 10'	8' - 10'	
Bike Lane	DM2 pg 1-16	6' (if no shoulder)	NA	Match existing section
Parking Lane	DM2 pg 1-16	7' to 8' Parallel	NA	Match existing section
Median Width (if needed)	DM2 pg 1-16	12' - 18' For Left Turn; 6' to 8' for Peds	12' - 18' For Left Turn; 6' to 8' for Peds	
Curb Return	DM2 pg 1-16	25'-50'	25'-50'	
Travel Lanes	DM2 pg 1-16	2 - 4	2	
Cross Slope / Superlevation	DM2 pg 1-16	Max = 6.0% Min = 2.0%	Max = 6.0% Min = 2.0%	
Bridge Width	DM2 pg 1-16	Lane Widths plus Shoulders each side	Lane Widths plus Shoulders each side	
Vertical Grades	AASHTO Greenbook pg 472 DM2 pg 1-16	Max. = 8% Min = 0.5%	Max. = 8% Min = 0.5%	
Vertical Clearance	DM2 pg 2-50	16' 0" MIN + 6' for resurfacing	16' 6"	
Lateral Clearance to Structures	DM2 pg 4-3	14' Lateral Clearance to front face of barrier protectings walls or piers Min Radius = 340'	14'-0" Min Min Radius = 340'	
Horizontal Curvature	AASHTO Green Book, pg 168			
Compound Curve Ratio	AASHTO Green Book, pg 201			
Clear Zone Widths	DM2 Chapter 12	Table 12.1	Table 12.1	See attached table
Guide Rail and Median Barrier	DM2 Chapter 12	Table 12.3	Table 12.3	See attached table
Desired Operating Speed	DM2 pg 1-16 & pg 2-11	35-50 MPH	35 MPH	Posted 35MPH
Sight Distance	DM2 pg 1-16 & AASHTO Greenbook pg 445	Stopping Sight Distance= 250'	Stopping Sight Distance = 250'	

NOTES:

1) The design criteria for this project are taken from PENNDOT Publication 13M, *Design Manual Part 2 (Aug 2009 ED)* and *The AASHTO Greenbook, 2004 Edition*

Interchange 307 - SR191 Design Criteria
 Pennsylvania Department of Transportation, District 5-0
 Agreement No. E02656, Monroe County
 SR 0080, Section 17M

Design Element	Criteria Source	Standard Criteria	Applied Criteria	Comments
Functional Classification Roadway Typology	Functional Class Map DM2 pg 1-7 & 1-16	Urban Other Principal Arterial Community Arterial Suburban Corridor	Urban Other Principal Arterial Community Arterial Suburban Corridor	iTMS Data attached
Terrain	DM2 pg 2-11, AASHTO Greenbook pg 231	Rolling	Rolling	
Lane Widths	DM2 pg 1-16	11' - 12'	11' - 12'	
Shoulder Width	DM2 pg 1-16	8' to 10'	8' - 10'	
Bike Lane	DM2 pg 1-16	5'-6' (if no shoulder)	NA	Match existing section
Median Width (if needed)	DM2 pg 1-16	12' - 18' For Left Turn; 6' to 8' for Peds	12' - 16' For Left Turn; 6' to 8' for Peds	
Curb Return	DM2 pg 1-16	25'-50'	25'-50'	
Travel Lanes	DM2 pg 1-16	2 - 4	2	
Cross Slope / Superlevation	DM2 pg 1-16	Max = 6.0% Min = 2.0%	Max = 6.0% Min = 2.0%	
Bridge Width	DM2 pg 1-16	Lane Widths plus Shoulders each side	Lane Widths plus Shoulders each side	
Vertical Grades	AASHTO Greenbook pg 472	Max. = 8%	Max. = 8%	
Vertical Clearance	DM2 pg 1-16	Min = 0.5%	Min = 0.5%	
Lateral Clearance to Structures	DM2 pg 2-50	16' 0" MIN + 6" for resurfacing	16'-6" Min	
Horizontal Curvature	DM2 pg 4-3	14' Lateral Clearance to front face of barrier protectings walls or piers	14'-0" Min	
Compound Curve Ratio	AASHTO Green Book, pg 168	Min Radius = 340'	Min Radius = 340'	
Clear Zone Widths	AASHTO Green Book, pg 201	1.5:1	1.5:1	
Guide Rail and Median Barrier	DM2 Chapter 12	Table 12.1	Table 12.1	See attached table
Desired Operating Speed	DM2 Chapter 12	Table 12.3	Table 12.3	See attached table
Sight Distance	DM2 pg 1-16 & pg 2-11 DM2 pg 1-16 & AASHTO Greenbook pg 445	35-50 MPH Stopping Sight Distance= 250'	35 MPH Stopping Sight Distance = 250'	Posted 35MPH

NOTES:

1) The design criteria for this project are taken from PENNDOT Publication 13M, *Design Manual Part 2 (Aug 2009 ED)* and *The AASHTO Greenbook, 2004 Edition*

I-80 Design Criteria

Pennsylvania Department of Transportation, District 5-0
 Agreement No. E02656, Monroe County
 SR 0080, Section 17M

Design Element	Criteria Source	Standard Criteria	Applied Criteria	Comments
Functional Classification	DM2 pg 1-7 & Functional Classification Map	Regional Arterial Suburban Corridor	Regional Arterial Suburban Corridor	
Terrain	PENNDOT	Rolling	Rolling	
Lane Widths	DM2 pg 1-12	11' - 12'	12'-0"	
Shoulder Width	DM2 pg 1-12	8' - 12'	10' RT; 4' LT	
Bike Lane	DM2 pg 1-12	6' (if No Shoulder)	NA	
Median Width (if needed)	DM2 pg 1-12	16' - 18' for LT Turn; 6' - 8' for Peds Only	10'	Min 4' - 6' OK in areas without at-grade intersections per AASHTO Green Book pg 456
Curb Return	DM2 pg 1-12	30' - 50'	NA	
Travel Lanes	DM2 pg 1-12	4-6	4	
Cross Slope / Superlevation	DM2 pg 1-12	Max = 6.0% Min = 2.0%	Max = 6.0% Min = 2.0%	
Bridge Width	DM2 pg 1-12	Pavement Width + Shoulder each side	Pavement Width + 10' RT Shld + 4' LT Shld	For bridges over 200' length shoulder may be reduced to 4' on each side (Note 16 DM-2 pg 1-13) & AASHTO Green Book pg 455
Vertical Grades	AASHTO Green Book, pg 472 DM2 pg 1-12	Max = 7% - 5% Min = 0.5%	Max. = 7% Min = 0.5%	
Vertical Clearance	DM2 pg 2-47	16'-6" (Min.)	16'-6" (Min.)	
Horizontal Clearance	DM2 pg 4-3	14' Lateral Clearance to front face of barrier protectings walls or piers	14'-0"	
Horizontal Curvature	AASHTO Green Book, pg 168	Min Radius = 340' - 1060'	Min Radius = 833'	
Compound Curve Ratio	AASHTO Green Book, pg 201	1.5:1	1.5:1	
Clear Zone Widths	DM2 pg 1-12	See DM-2, Chapter 12	See DM-2, Chapter 12	
Guide Rail and Median Barrier	DM2 pg 1-12	See DM-2, Chapter 12	See DM-2, Chapter 12	
Desired Operating Speed	DM2 pg 1-12 & pg 2-11	35 - 55 MPH	50 MPH	
Sight Distance	DM2 pg 1-12 & AASHTO Green Book pg 445	Stopping Sight Distance=250' - 495'	Stopping Sight Distance = 425'	

NOTES:

1) The design criteria for this project are taken from PENNDOT Publication 13M, *Design Manual Part 2 (Aug 2009 ED)*

I-80 Design Criteria

Pennsylvania Department of Transportation, District 5-0
 Agreement No. E02656, Monroe County
 SR 0080, Section 17M

Design Element	Criteria Source	Standard Criteria	Applied Criteria	Comments
Functional Classification	DM2 pg 1-7 & Functional Class Map	Community Arterial (Town/Village/Neighborhood)	Community Arterial (Town/Village/Neighborhood)	
Terrain	PENNDOT, AASHTO pg 231	Rolling	Rolling	
Lane Widths	DM2 pg 1-16	10' - 12'	12'	
Shoulder Width	DM2 pg 1-16	4' to 6' (if no parking or bike lane)	6'	
Bike Lane	DM2 pg 1-16	5' - 6'	NA	Not provided to match adjoining section
Parking Lane	DM2 pg 1-16	7' to 8' Parallel	NA	Not provided to match adjoining section
Median Width (if needed)	DM2 pg 1-16	16' - 18' For Left Turn	NA	Not Needed
Curb Return	DM2 pg 1-16	12' - 18' For Left Turn; 6' to 8' for Peds	15' - 30'	Should be as small as possible
Travel Lanes	DM2 pg 1-16	2 - 4	2 - 4	
Cross Slope / Superelevation	DM2 pg 1-16	Max = 6.0% Min = 3.0%	Max = 6.0% Min = 3.0%	3% min Cross Slope recommended for DS < 40 MPH; 3% min Cross Slope recommended on Targets if Vert. Grade < 1%
Bridge Width	DM2 pg 1-16	Lane Widths plus Shoulder each side	Lane Widths plus Shoulder each side	Bridges over 200' in length, shoulder may be 4' each side; On curbed approaches: curb to curb width = bridge width
Vertical Grades	AASHTO Green Book, Exhibit 7-10 pg 472	Max = 8% Min = 0.5% - 0.75% (if curbed)	Max = 8% Min = 0.5% - 0.75%	0.75% Min Recommended Grade on Curbed Sections
Vertical Clearance	DM2 section 2.20 pg 2-47	16' 0" MIN + 6" for resurfacing	16' 6"	
Horizontal Clearance	DM2 pg 4-3	14' Lateral Clearance to front face of barrier protectings walls or piers	14'-0"	
Horizontal Curvature	AASHTO Green Book, pg 147	Min Radius = 144' - 231'	Min Radius = 340'	
Compound Curve Ratio	AASHTO Green Book, pg 201	1.5:1	1.5:1	(in the direction of sharper curvature)
Compound Curve Length	AASHTO Green Book, pg 202	60' to 200' minimum	See exhibit 3-42, pg 202	(min length of compound curve)
Clear Sidewalk Width	DM2 pg 1-16	6' - 8'	6'	Need to check vs future pedestrian volumes
Buffer	DM2 pg 1-16	4' - 6'	4'	(grass area between shldr & sidewalk)
Shy Distance	DM2 pg 1-16	0' - 2'	0'	
Total Sidewalk Width	DM2 pg 1-16	10' - 16'	10'-0"	
Clear Zone Widths	DM2 pg 1-16	See DM-2, Chapter 12	See DM-2, Chapter 12	
Desired Operating Speed	DM2 pg 1-7 & 1-16	25 - 55 MPH	35 MPH	
Sight Distance (minimum)	AASHTO Green Book, Exhibit 7-1 pg 445	Stopping Sight Distance= 250' Passing Sight Distance= 1280'	Stopping Sight Distance = 250' Passing Sight Distance = 1280'	

NOTES:

1) The design criteria for this project are taken from PENNDOT Publication 13M, *Design Manual Part 2 (Aug 2009 ED)*

I-80 Design Criteria
 Pennsylvania Department of Transportation, District 5-0
 Agreement No. E02656, Monroe County
 SR 0080, Section 17M

Design Element	Criteria Source	Standard Criteria	Applied Criteria	Comments
Functional Classification	DM2 pg 1-7 & Functional Class Map	Community Arterial (Town/Village/Neighborhood)	Community Arterial (Town/Village/Neighborhood)	
Terrain	PENNDOT, AASHTO pg 231	Rolling	Rolling	
Lane Widths	DM2 pg 1-16	10' - 12'	12'	
Shoulder Width	DM2 pg 1-16	4' to 6' (if no parking or bike lane)	6'	
Bike Lane	DM2 pg 1-16	5' - 6'	NA	Not provided to match adjoining section
Parking Lane	DM2 pg 1-16	7' to 8' Parallel	NA	Not provided to match adjoining section
Median Width (if needed)	DM2 pg 1-16	16' - 18' For Left Turn	NA	Not Needed
Curb Return	DM2 pg 1-16	12' - 18' For Left Turn; 6' to 8' for Peds	15' - 30'	Should be as small as possible
Travel Lanes	DM2 pg 1-16	2 - 4	2 - 4	
Cross Slope / Superelevation	DM2 pg 1-16	Max = 6.0% Min = 3.0%	Max = 6.0% Min = 3.0%	3% min Cross Slope recommended for DS < 40 MPH; 3% min Cross Slope recommended on Targets if Vert. Grade < 1%
Bridge Width	DM2 pg 1-16	Lane Widths plus Shoulder each side	Lane Widths plus Shoulder each side	Bridges over 200' in length, shoulder may be 4' each side; On curbed approaches: curb to curb width = bridge width
Vertical Grades	AASHTO Green Book, Exhibit 7-10 pg 472	Max. = 8% Min = 0.5% - 0.75% (if curbed)	Max. = 8% Min = 0.5% - 0.75%	0.75% Min Recommended Grade on Curbed Sections
Vertical Clearance	DM2 section 2.20 pg 2-47	16' 0" MIN + 6" for resurfacing	16' 6"	
Horizontal Clearance	DM2 pg 4-3	14' Lateral Clearance to front face of barrier protectings walls or piers	14'-0"	
Horizontal Curvature	AASHTO Green Book, pg 147	Min Radius = 144' - 231'	Min Radius = 340'	
Compound Curve Ratio	AASHTO Green Book, pg 201	1.5:1	1.5:1	(in the direction of sharper curvature)
Compound Curve Length	AASHTO Green Book, pg 202	60' to 200' minimum	See exhibit 3-42, pg 202	(min length of compound curve)
Clear Sidewalk Width	DM2 pg 1-16	6' - 8'	6'	Need to check vs future pedestrian volumes
Buffer	DM2 pg 1-16	4' - 6'	4'	(grass area between shldr & sidewalk)
Shy Distance	DM2 pg 1-16	0' - 2'	0'	
Total Sidewalk Width	DM2 pg 1-16	10' - 16'	10'-0"	
Clear Zone Widths	DM2 pg 1-16	See DM-2, Chapter 12	See DM-2, Chapter 12	
Desired Operating Speed	DM2 pg 1-7 & 1-16	25 - 55 MPH	35 MPH	
Sight Distance (minimum)	AASHTO Green Book, Exhibit 7-1 pg 445	Stopping Sight Distance= 250' Passing Sight Distance= 1280'	Stopping Sight Distance = 250' Passing Sight Distance = 1280'	

NOTES:

1) The design criteria for this project are taken from PENNDOT Publication 13M, *Design Manual Part 2 (Aug 2009 ED)*

**TABLE 1.2
 ROADWAY TYPOLOGIES**

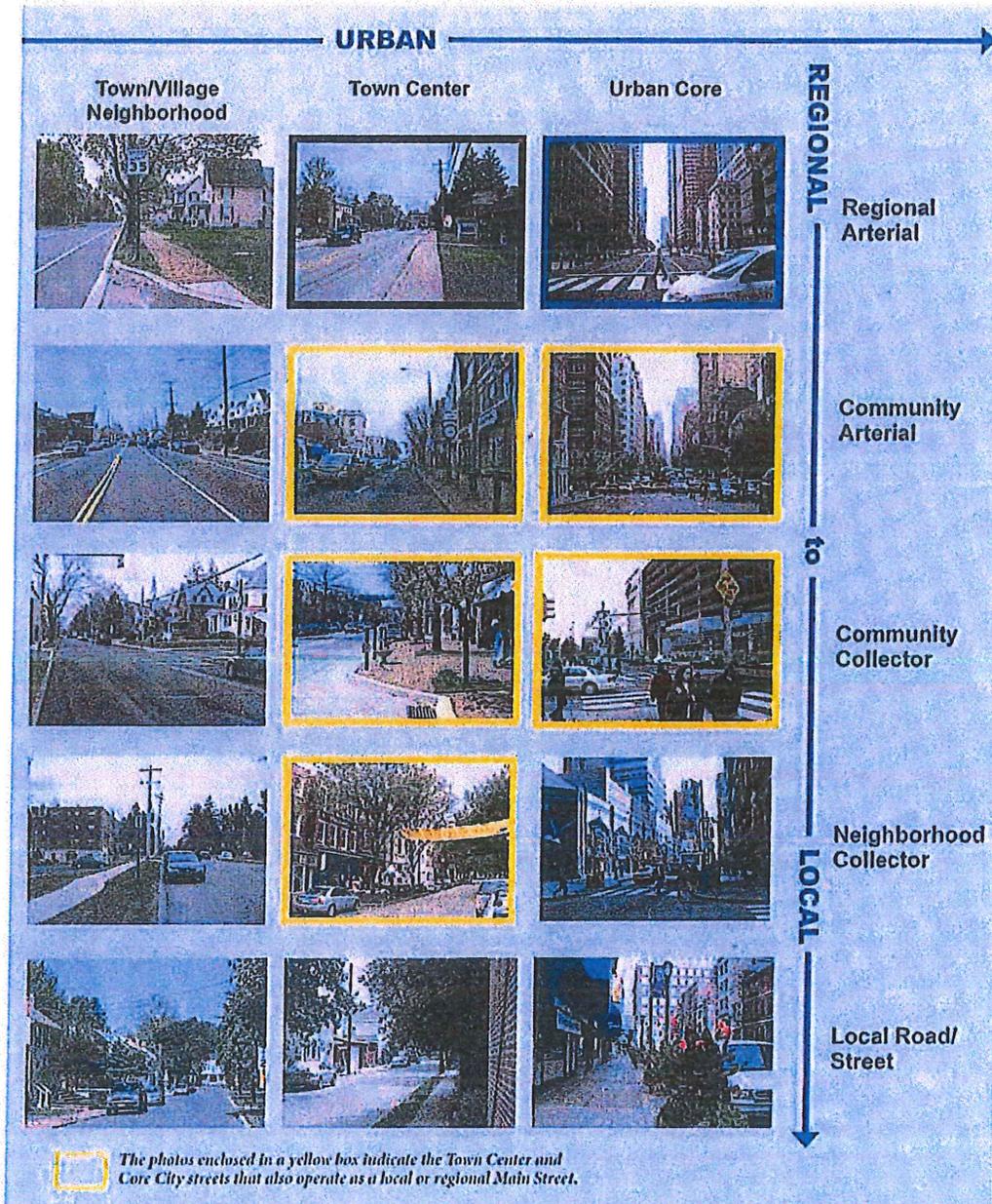
ROADWAY CLASS	ROADWAY TYPE	DESIRED OPERATING SPEED	AVERAGE TRIP LENGTH	VOLUME	INTERSECTION SPACING	COMMENTS
Arterial	Regional	50-90 km/h (30-55 mph)	24-56 km (15-35 mi)	10,000-40,000 veh/day	200-400 m (660-1,320 ft)	Roadways in this category would be considered "Principal Arterial" in traditional functional classification.
Arterial	Community	40-90 km/h (25-55 mph)	11-40 km (7-25 mi)	5,000-25,000 veh/day	90-400 m (300-1,320 ft)	Often classified as "Minor Arterial" in traditional classification but may include road segments classified as "Principal Arterial".
Collector	Community	40-90 km/h (25-55 mph)	8-16 km (5-10 mi)	5,000-15,000 veh/day	90-200 m (300-660 ft)	Often similar in appearance to a community arterial. Typically classified as "Major Collector".
Collector	Neighborhood	40-60 km/h (25-35 mph)	< 11 km (< 7 mi)	< 6,000 veh/day	90-200 m (300-660 ft)	Similar in appearance to local roadways. Typically classified as "Minor Collector".
Local	Local	30-50 km/h (20-30 mph)	< 8 km (< 5 mi)	< 3,000 veh/day	60-200 m (200-660 ft)	

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**FIGURE 1.2
ILLUSTRATED ROADWAY TYPOLOGIES**



**FIGURE 1.2 (CONTINUED)
 ILLUSTRATED ROADWAY TYPOLOGIES**



**TABLE 1.4 (ENGLISH)
MATRIX OF DESIGN VALUES - COMMUNITY ARTERIAL**

Community Arterial	Rural	Suburban Neighborhood	Suburban Corridor	Suburban Center	Town/Village Neighborhood	Town/Village Center	Urban Core
Lane Width ¹	11' to 12'	10' to 12'	11' to 12'	10' to 12'	10' to 12'	10' to 12'	10' to 12'
Shoulder Width ^{2,3}	8' to 10'	(if No Parking or Bike Lane) 4' to 8'	8' to 10'	(if No Parking or Bike Lane) 4' to 6'	(if No Parking or Bike Lane) 4' to 6'	(if No Parking or Bike Lane) 4' to 6'	(if No Parking or Bike Lane) 4' to 6'
Parking Lane ¹⁶	NA	7' to 8' Parallel	NA	8' Parallel	7' to 8' Parallel	7' to 8' Parallel	7' to 8' Parallel
Bike Lane ⁴	NA	(if No Shoulder) 5' to 6'	(if No Shoulder) 5' to 6'	5' to 6'	5' to 6'	5' to 6'	5' to 6'
Median (if needed)	4' to 6'	16' to 18' for Left Turn 12' to 18' for Left Turn; 6' to 8' for Pedestrians	16' to 18' for Left Turn 12' to 18' for Left Turn; 6' to 8' for Pedestrians	16' to 18' for Left Turn 12' to 18' for Left Turn; 6' to 8' for Pedestrians	16' to 18' for Left Turn 12' to 18' for Left Turn; 6' to 8' for Pedestrians	16' to 18' for Left Turn 12' to 18' for Left Turn; 6' to 8' for Pedestrians	16' to 18' for Left Turn 12' to 18' for Left Turn; 6' to 8' for Pedestrians
Curb Return ⁵	25' to 50'	25' to 35'	25' to 50'	20' to 40'	15' to 30'	15' to 35'	15' to 40'
Travel Lanes	2 to 4	2 to 4	2 to 4	2 to 4	2 to 4	2 to 4	2 to 4
Cross Slopes (Minimum) ^{6,7}	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%
Cross Slopes (Maximum) ⁸	8.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%
Bridge Widths (Two-Lane Facilities) ^{9, 10, 17}	Lane Widths Plus Shoulders Each Side	Lane Widths Plus Shoulders Each Side	Lane Widths Plus Shoulders Each Side	Lane Widths Plus Shoulders Each Side	Lane Widths Plus Shoulders Each Side	Lane Widths Plus Shoulders Each Side	Lane Widths Plus Shoulders Each Side
Bridge Widths (Four-Lane Facilities) ^{9, 10, 17}	Lane Widths Plus Shoulders Each Side	Lane Widths Plus Shoulders Each Side	Lane Widths Plus Shoulders Each Side	Lane Widths Plus Shoulders Each Side	Lane Widths Plus Shoulders Each Side	Lane Widths Plus Shoulders Each Side	Lane Widths Plus Shoulders Each Side
Vertical Grades (Minimum) ¹¹	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%
Vertical Clearance (Minimum)	16'-0", See Chapter 2	16'-0", See Chapter 2	16'-0", See Chapter 2	16'-0", See Chapter 2	16'-0", See Chapter 2	16'-0", See Chapter 2	16'-0", See Chapter 2
Clear Sidewalk Width	NA	5'	5' to 6'	6'	6' to 8'	6' to 10'	8' to 14'
Buffer ¹³	NA	6'+	5' to 10'	4' to 6'	4' to 6'	4' to 6'	4' to 6'
Shy Distance	NA	NA	NA	0' to 2'	0' to 2'	2'	2'
Total Sidewalk Width	NA	5'	5' to 6'	10' to 14'	10' to 16'	12' to 18'	14' to 22'
Clear Zone Widths ¹⁴	See Chapter 12	See Chapter 12	See Chapter 12	See Chapter 12	See Chapter 12	See Chapter 12	See Chapter 12
Right-of-Way Widths ¹⁵	Varies	Varies	Varies	Varies	Varies	Varies	Varies
Desired Operating Speed (Design Speed)	35-55 mph	30-35 mph	35-50 mph	30 mph	25-30 mph	25-30 mph	25-30 mph
Stopping and Passing Sight Distances (Minimum)	2004 AASHTO Green Book, Exhibit 7-1	2004 AASHTO Green Book, Exhibit 7-1	2004 AASHTO Green Book, Exhibit 7-1	2004 AASHTO Green Book, Exhibit 7-1	2004 AASHTO Green Book, Exhibit 7-1	2004 AASHTO Green Book, Exhibit 7-1	2004 AASHTO Green Book, Exhibit 7-1
Vertical Grades (Maximum)	2004 AASHTO Green Book, Exhibit 7-2	2004 AASHTO Green Book, Exhibit 7-10					

**TABLE 1.3 (ENGLISH)
MATRIX OF DESIGN VALUES – REGIONAL ARTERIAL**

Regional Arterial	Rural	Suburban Neighborhood	Suburban Corridor	Suburban Center	Town/Village Neighborhood	Town/Village Center	Urban Core
Lane Width ¹	11' to 12'	11' to 12'	11' to 12'	11' to 12'	10' to 12'	10' to 12'	10' to 12'
Shoulder Width ^{2,3}	8' to 10'	8' to 10'	8' to 12'	4' to 6' (if No Parking or Bike Lane)	4' to 6' (if No Parking or Bike Lane)	4' to 6' (if No Parking or Bike Lane)	4' to 6' (if No Parking or Bike Lane)
Parking Lane	NA	NA	NA	8' Parallel	8' Parallel	8' Parallel	8' Parallel
Bike Lane ⁴	NA	5' to 6' (if No Shoulder)	6'	5' to 6'	5' to 6'	5' to 6'	5' to 6'
Median (if needed)	4' to 6'	16' to 18' for Left Turn; 6' to 8' for Pedestrians Only	16' to 18' for Left Turn; 6' to 8' for Pedestrians Only	16' to 18' for Left Turn; 6' to 8' for Pedestrians Only	16' to 18' for Left Turn; 6' to 8' for Pedestrians Only	16' to 18' for Left Turn; 6' to 8' for Pedestrians Only	16' to 18' for Left Turn; 6' to 8' for Pedestrians Only
Curb Return ⁵	30' to 50'	25' to 35'	30' to 50'	25' to 50'	15' to 40'	15' to 40'	15' to 40'
Travel Lanes	2 to 6	2 to 6	4 to 6	4 to 6	2 to 4	2 to 4	2 to 6
Cross Slopes (Minimum) ^{6,7}	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%
Cross Slopes (Maximum) ⁸	8.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%
Bridge Widths (Two-Lane Facilities) ^{9, 10, 16}	Lane Widths Plus Shoulders Each Side	Lane Widths Plus Shoulders Each Side	Lane Widths Plus Shoulders Each Side	Lane Widths Plus Shoulders Each Side	Lane Widths Plus Shoulders Each Side	Lane Widths Plus Shoulders Each Side	Lane Widths Plus Shoulders Each Side
Bridge Widths (Four-Lane or More Facilities) ^{9, 10, 16}	Lane Widths Plus Shoulders Each Side	Lane Widths Plus Shoulders Each Side	Lane Widths Plus Shoulders Each Side	Lane Widths Plus Shoulders Each Side	Lane Widths Plus Shoulders Each Side	Lane Widths Plus Shoulders Each Side	Lane Widths Plus Shoulders Each Side
Vertical Grades (Minimum) ¹¹	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%
Vertical Clearance (Minimum)	16'-0", See Chapter 2	16'-0", See Chapter 2	16'-0", See Chapter 2	16'-0", See Chapter 2	16'-0", See Chapter 2	16'-0", See Chapter 2	16'-0", See Chapter 2
Clear Sidewalk Width	NA	5'	5' to 6'	5' to 6'	6' to 8'	6' to 10'	6' to 12'
Buffer ¹³	NA	6'+	6' to 10'	4' to 6'	4' to 6'	4' to 6'	4' to 6'
Sight Distance	NA	NA	NA	0' to 2'	0' to 2'	2'	2'
Total Sidewalk Width	NA	5'	5' to 6'	9' to 14'	10' to 16'	12' to 18'	12' to 20'
Clear Zone Widths ¹⁴	See Chapter 12	See Chapter 12	See Chapter 12	See Chapter 12	See Chapter 12	See Chapter 12	See Chapter 12
Right-of-Way Widths ¹⁵	Varies	Varies	Varies	Varies	Varies	Varies	Varies
Desired Operating Speed (Design Speed)	45-55 mph	35-40 mph	35-55 mph	30-35 mph	30-35 mph	30-35 mph	30-35 mph
Stopping and Passing Sight Distances (Minimum)	2004 AASHTO Green Book, Exhibit 7-1	2004 AASHTO Green Book, Exhibit 7-1	2004 AASHTO Green Book, Exhibit 7-1	2004 AASHTO Green Book, Exhibit 7-1	2004 AASHTO Green Book, Exhibit 7-1	2004 AASHTO Green Book, Exhibit 7-1	2004 AASHTO Green Book, Exhibit 7-1
Vertical Grades (Maximum)	2004 AASHTO Green Book, Exhibit 7-2	2004 AASHTO Green Book, Exhibit 7-10					

**TABLE 1.3 (ENGLISH) (CONTINUED)
MATRIX OF DESIGN VALUES - REGIONAL ARTERIAL**

1	12' preferred for regular transit routes, and heavy truck volumes > 5%, particularly for design speeds of 35 mph or greater. A 1' to 2' offset to the curb is desirable. 14' for an outside lane with no shoulder or bike lane, if optimal accommodation for bicyclists is desired.
2	Shoulders should only be installed in urban contexts as a retrofit of wide travel lanes to accommodate bicyclists. For rural divided arterials with three or more lanes in each direction, a 10' wide left shoulder within the median is desirable.
3	Paving for railroad grade crossings shall extend 2' beyond the extreme rails for the full graded width of the highway.
4	Design of bike lanes should be considered when identified as part of the Engineering & Environmental (E&E) Scoping process. For additional guidance, refer to Publication 10A, Design Manual, Part 1A, <i>Transportation Engineering Procedures</i> , Appendix J, Bicycle and Pedestrian Checklist.
5	Curb return radius should be as small as possible. Number of lanes, on street parking, bike lanes, and shoulders should be utilized to determine effective radius.
6	Cross slopes of 3.0% are recommended for design speeds less than 40 mph.
7	In curbed areas with longitudinal slopes of 1% or less, 3.0% cross slopes may be used on tangents.
8	For additional guidance, refer to Chapter 2, Sections 2.13.B, Rates of Superelevation and 2.13.C, Maximum Superelevation.
9	On curbed approaches, the minimum bridge width may equal the curb-to-curb width. Where pedestrian traffic is anticipated, provisions for a sidewalk, preferably on the outside of the parapet, should be considered and shall meet the Department's Standards and requirements (see Chapter 6). Where paved or curbed parking lanes exist or have been approved for construction on approaches, the clear roadway width of the proposed bridge in each case shall be determined by the Central Office, Bureau of Design upon receipt of the District Executive's recommendation.
10	For appropriate bridge widths, refer to the Minimum Width Criteria for Bridges.
11	Recommended minimum grade of 0.75% on curbed sections.
12	The Roadside design values should be considered and implemented as feasible and reasonable; however, Chapter 6, <i>Pedestrian Facilities</i> , should still be used for minimum design criteria. ADA accommodations must be addressed in accordance with ADA policy.
13	Buffer is assumed to be planted area (grass, shrubs and/or trees) for suburban neighborhood and corridor contexts; street furniture/car door zone for other land use contexts. Minimum of 6' for transit zones.
14	Center piers are not desirable. Increase bridge span where necessary to provide for required horizontal stopping sight distance. Provide clearance for guide rail in front of substructures if protection is required. For offset distances to substructure units, see Publication 15M, Design Manual, Part 4, <i>Structures</i> .
15	No minimum right-of-way width is suggested. The procurement of sufficient right-of-way width should be based on the preferable dimensions for all the elements of the composite highway cross section and should be adequate to accommodate the construction and proper maintenance of the highway throughout the project. Future widening should be considered and, where needed for safety, additional right-of-way may be required for adequate sight distance. For additional information on right-of-way widths, refer to the 2004 AASHTO Green Book.
16	For long bridges over 200' in length, the shoulder width may be 4' on each side.

**TABLE 1.4 (ENGLISH) (CONTINUED)
MATRIX OF DESIGN VALUES – COMMUNITY ARTERIAL**

1	12' preferred for regular transit routes, and heavy truck volumes > 5%, particularly for design speeds of 35 mph or greater. A 1' to 2' offset to the curb is desirable. 14' for an outside lane with no shoulder or bike lane, if optimal accommodation for bicyclists is desired.
2	Shoulders should be installed in urban contexts only as part of a retrofit of wide travel lanes to accommodate bicyclists.
3	Paving for railroad grade crossings shall extend 2' beyond the extreme rails for the full graded width of the highway.
4	Design of bike lanes should be considered when identified as part of the Engineering & Environmental (E&E) Scoping process. For additional guidance, refer to Publication 10A, Design Manual, Part 1A, <i>Transportation Engineering Procedures</i> , Appendix J, Bicycle and Pedestrian Checklist.
5	Curb Return radius should be as small as possible. Number of lanes, on street parking, bike lanes, and shoulders should be utilized to determine effective radius.
6	Cross slopes of 3.0% are recommended for design speeds less than 40 mph.
7	In curbed areas with longitudinal slopes of 1% or less, 3.0% cross slopes may be used on tangents.
8	For additional guidance, refer to Chapter 2, Sections 2.13.B, Rates of Superelevation and 2.13.C, Maximum Superelevation.
9	On curbed approaches, the minimum bridge width may equal the curb-to-curb width. Where pedestrian traffic is anticipated, provisions for a sidewalk, preferably on the outside of the parapet, should be considered and shall meet the Department's Standards and requirements (see Chapter 6). Where paved or curbed parking lanes exist or have been approved for construction on approaches, the clear roadway width of the proposed bridge in each case shall be determined by the Central Office, Bureau of Design upon receipt of the District Executive's recommendation.
10	For appropriate bridge widths, refer to the Minimum Width Criteria for Bridges.
11	Recommended minimum grade of 0.75% on curbed sections.
12	The Roadside design values should be considered and implemented as feasible and reasonable; however, Chapter 6, Pedestrian Facilities, should still be used for minimum design criteria. ADA accommodations must be addressed in accordance with ADA policy.
13	Buffer is assumed to be planted area (grass, shrubs and/or trees) for suburban neighborhood and corridor contexts; street furniture/car door zone for other land use contexts. Minimum of 6' for transit zones.
14	Center piers are not desirable. Increase bridge span where necessary to provide for required horizontal stopping sight distance. Provide clearance for guide rail in front of substructures if protection is required. For offset distances to substructure units, see Publication 15M, Design Manual, Part 4, Structures.
15	No minimum right-of-way width is suggested. The procurement of sufficient right-of-way width should be based on the preferable dimensions for all the elements of the composite highway cross section and should be adequate to accommodate the construction and proper maintenance of the highway throughout the project. Future widening should be considered and, where needed for safety, additional right-of-way may be required for adequate sight distance. For additional information on right-of-way widths, refer to the 2004 AASHTO Green Book.
16	7' parking lanes on this roadway type to be considered in appropriate conditions.
17	For long bridges over 200' in length, the shoulder width may be 4' on each side.

**TABLE 1.8 (ENGLISH)
MATRIX OF DESIGN VALUES – LIMITED ACCESS FREEWAY**

	Rural Interstate	Rural Non-Interstate	Urban Interstate	Urban Non-Interstate
Limited Access Freeway				
Lane Widths ¹	4 or More 12'-0" Lanes	4 or More 12'-0" Lanes ²	4 or More 12'-0" Lanes	4 or More 12'-0" Lanes ²
Shoulder Widths ^{3, 4, 5}	10'-0" Right Shoulder 8'-0" Graded, 4'-0" Paved Left Shoulder (Medians Only)	10'-0" Right Shoulder 8'-0" Graded, 4'-0" Paved Left Shoulder (Medians Only)	10'-0" Right Shoulder 8'-0" Graded, 4'-0" Paved Left Shoulder (Medians Only)	10'-0" Right Shoulder 8'-0" Graded, 4'-0" Paved Left Shoulder (Medians Only)
Median Widths	10'-0" to 50'-0" ^{6, 7} (Mountainous) 36'-0" to 100'-0" ⁸ (Level or Rolling)	10'-0" to 100'-0" ^{6, 7, 8}	10'-0" ⁶	10'-0" ⁶
Gross Slopes (Minimum)	2.0%	2.0%	2.0%	2.0%
Gross Slopes (Maximum)	8.0%	8.0%	6.0%	6.0%
Bridge Widths ^{9, 10}	Lane Widths Plus Right Shoulder Plus 6'-0" Left Shoulder	Lane Widths Plus Right Shoulder Plus 6'-0" Left Shoulder	Lane Widths Plus Right Shoulder Plus 6'-0" Left Shoulder	Lane Widths Plus Right Shoulder Plus 6'-0" Left Shoulder
Vertical Grades (Minimum)	0.5%	0.5%	0.5%	0.5%
Vertical Clearance (Minimum)	16'-0", See Chapter 2	16'-0", See Chapter 2	16'-0", See Chapter 2	16'-0", See Chapter 2
Clear Zone Widths ¹¹	See Chapter 12	See Chapter 12	See Chapter 12	See Chapter 12
Right-of-Way Widths ¹²	Varies	Varies	Varies	Varies
Design Speed ¹³	70 mph	70 mph	50-70 mph	50-70 mph
Stopping Sight Distances (Minimum)	2004 AASHTO Green Book, Exhibit 3-72	2004 AASHTO Green Book, Exhibit 3-72	2004 AASHTO Green Book, Exhibit 3-72	2004 AASHTO Green Book, Exhibit 3-72
Vertical Grades (Maximum) ^{14, 15}	2004 AASHTO Green Book, Exhibit 8-1	2004 AASHTO Green Book, Exhibit 8-1	2004 AASHTO Green Book, Exhibit 8-1	2004 AASHTO Green Book, Exhibit 8-1

**TABLE 1.8 (ENGLISH) (CONTINUED)
MATRIX OF DESIGN VALUES - LIMITED ACCESS FREEWAY**

1	Number of lanes determined by lane capacity design for selected Level of Service.
2	Paving for railroad grade crossings shall extend 2' beyond the extreme rails for the full graded width of the highway.
3	Where truck traffic exceeds 250 DDHV, a paved width of 12' for the right shoulder should be considered.
4	On sections with six or more lanes, a paved width of 10' for the left shoulder should be provided. Where truck traffic exceeds 250 DDHV, a paved width of 12' for the left shoulder should be considered.
5	In mountainous terrain, a reduced paved shoulder width together with a minimal median width may be used to reduce the high costs associated with providing a full width roadway cross section. In these instances, a 8' minimum paved right shoulder and a 4' minimum paved left shoulder may be used on a traveled way consisting of four or six lanes. Where eight or more lanes are provided, a 8' minimum paved shoulder width should be used on both sides.
6	Use a minimum width of 10' for a two-lane directional facility which provides for two 4' shoulders and a 2' median barrier. For three or more lane directional facilities, the minimum width is 22' and preferably 26' where DDHV is greater than 250 Trucks.
7	All median widths 20' or less should be paved. When Type 1 shoulders are specified for the 4' median shoulders, Type 3 shoulders may be used for the remainder if the remaining width is 8' or greater.
8	The 100' dimension shown in the 2004 AASHTO Green Book, Exhibit 8-3B permits the designer to use independent profiles in rolling terrain to blend the freeway more appropriately with the environment while maintaining flat slopes for vehicle recovery.
9	Selection of single or dual structures shall be made based on an economic analysis. Such items as structure length and width, horizontal and vertical curvature and ramp geometry shall be considered.
10	Provide 12' left shoulder for bridges carrying three or more through lanes. Auxiliary lanes shall not be counted as through lanes.
11	Center piers are not desirable. Increase bridge span where necessary to provide for required horizontal stopping sight distance. Provide clearance for guide rail in front of substructures if protection is required. For offset distances to substructure units, see Publication 15M, Design Manual, Part 4, Structures.
12	No minimum right-of-way width is suggested. The procurement of sufficient right-of-way width should be based on the preferable dimensions for all the elements of the composite highway cross section and should be adequate to accommodate the construction and proper maintenance of the highway throughout the project. Future widening should be considered and, where needed for safety, additional right-of-way may be required for adequate sight distance. For additional information on right-of-way widths, refer to the 2004 AASHTO Green Book.
13	Where terrain is mountainous, a design speed from 50 to 60 mph may be used. In urban areas, the design speed shall be at least 50 mph.
14	For short grades less than 500' and for one-way downgrades, maximum grades may be up to 1% steeper.
15	Grades up to 1% steeper than the value shown in Exhibit 8-1 may be provided in urban areas with crucial right-of-way constraints or where needed in mountainous terrain.

c. **Running Speed.** The speed at which an individual vehicle travels over a highway section, defined as the length of the highway section divided by the running time required for the vehicle to travel through the section.

6. **Traffic Flow Relationships.** Traffic flow conditions on roadways can be characterized by the volume flow rate expressed in vehicles per hour, the average speed in kilometers per hour (miles per hour) and the traffic density in vehicles per kilometer (vehicles per mile). Generalized speed-volume-density relationships are shown in the 2004 AASHTO Green Book, Chapter 2, Exhibit 2-30.

D. **Safety.** The section "Safety" in the 2004 AASHTO Green Book, Chapter 2 discusses how a viable safety evaluation and improvement program is a vital part of the overall highway improvement program. Areas of primary importance include the identification of potential safety problems, the evaluation of the effectiveness of alternative solutions, and the programming of available funds for the most effective improvements.

E. **Environment.** The section "Environment" in the 2004 AASHTO Green Book, Chapter 2 discusses how a highway should be considered as an element of the total environment. Because highway location and design decisions have an effect on the development of adjacent areas, it is important that environmental variables be given full consideration. Also, care should be exercised to ensure that applicable local, state, and federal environmental requirements are met.

F. **Economic Analysis.** Highway economics is concerned with the cost of a proposed improvement and the benefits resulting from it. The AASHTO publication, "User Benefit Analysis for Highways", may be used to perform economic analysis of proposed highway improvements.

2.20 VERTICAL CLEARANCE REQUIREMENTS

Vertical clearance represents one of the key highway elements or features as the controlling criteria for developing geometric design for both highway and bridge projects.

As such, the clearances presented in this Section represent the minimum acceptable criteria and shall be used as the required vertical control for all new structures, superstructure replacements and reconstructed pavements on or over the highway based on the functional classification of the facility. Vertical clearance shall apply to the required clearance over the entire roadway width and the usable width of the shoulders and shall also include auxiliary lanes, when applicable, to structures passing over the highway facility. Where a bridge deck is to be replaced or a portion of the superstructure is to be replaced, achievement of the vertical clearance requirements should be considered. The minimum vertical clearance required shall preferably be maintained within the recovery area.

All structures having a vertical clearance below the minimum acceptable criteria should ultimately be considered for improvement of clearance. When the vertical clearance requirements cannot be achieved, justification to support a design exception submission request shall be provided.

A. **Strategic Highway Network (STRAHNET).** The Surface Deployment and Distribution Command Transportation Engineering Agency (SDDCTEA) of the Department of Defense has developed and continues to refine the Strategic Highway Network (STRAHNET). The STRAHNET is a system of highways that provides defense access, continuity and emergency capabilities for movements of personnel and equipment in both peacetime and wartime. The STRAHNET includes all Interstate highways in Pennsylvania (including the Pennsylvania Turnpike) and has been incorporated into the National Highway System (NHS). Figure 2.10 shows the highway facilities that are designated as part of the STRAHNET, including major STRAHNET connectors to military facilities.

All highway facilities on the STRAHNET require the following vertical clearance:

THE VERTICAL CLEARANCE AT ALL UNDERPASSES SHALL BE AT LEAST 4.9 m (16 ft, 0 in) PLUS AN ALLOWANCE OF UP TO 0.15 m (6 in) TO ACCOMMODATE FUTURE RESURFACING.

crossings, appearance, or aesthetic dimension relations; and cost factors such as lengthy depressed sections of roadway.

The lateral clearances for major roadway underpasses are illustrated in the 2004 AASHTO Green Book, Chapter 10, Exhibit 10-6. For a two-lane roadway or an undivided multilane roadway, the minimum lateral clearance from the edge of the traveled way to the face of the protective barrier should be the normal shoulder width. On divided highways, the clearances on the left side of each roadway are usually governed by the median width. A minimum median width of 3.0 m (10 ft) may be used on a four-lane roadway to provide 1.2 m (4 ft) shoulders and rigid median barrier. For a roadway with six or more lanes, the minimum median width should be 6.6 m (22 ft) to provide 3.0 m (10 ft) shoulders and a rigid median barrier. Where structural design makes it necessary to reduce their horizontal clearance through an underpass, the change in lateral width should be accomplished through gradual adjustments in the cross section of the approach roadway rather than abruptly at the structure. Such transitions in width may have a longitudinal/lateral ratio of $0.6 \times$ design speed to 1 for a design speed in kilometers per hour (design speed to 1 for a design speed in miles per hour). For lateral width "flare" transitions, refer to [Chapter 12, Table 12.7](#) (Flare Rates for Barrier Design).

For new or reconstruction projects, the minimum lateral clearance from the edge of the pavement to the face of the protective barrier in front of retaining walls and bridge substructures including piers, columns, and abutments shall be 4300 mm (14 ft) unless supporting documentation is provided. A design exception for lateral clearance will not be required if 4300 mm (14 ft) of lateral clearance is not provided; however, other geometric criteria such as required shoulder width and sight distance must still be met unless properly justified through the design exception process.

Sound barrier walls shall be located as far away as possible from the edge of traveled way while still providing the maximum benefit for insertion loss. Positive protection is required as per Publication 218M, *Standards for Bridge Design*, for sound barrier walls located within the clear zone. When a sound barrier wall protected by a concrete barrier is constructed along a highway or when a concrete barrier alone is constructed along a highway, the barrier shall be located no closer than the outer edge of shoulder and preferably should be located 0.6 m (2 ft) beyond the outer edge of shoulder.

Positive protection shall be provided when substructure units, retaining walls, or sound barrier walls must be placed within the clear zone width identified in [Chapter 12, Table 12.1](#).

For the vertical clearance requirements of all structures, refer to [Chapter 2, Section 2.20](#).

D. Overpass Roadways. The roadway dimensional design of an overpass or other bridge should be the same as that of the basic roadway in cross section dimensions unless the cost becomes prohibitive. The use of bridge railings, lateral clearances and median treatment should be as specified in Publication 15M, Design Manual, Part 4, *Structures*, and Publication 218M, *Standards for Bridge Design*.

E. Longitudinal Distance to Attain Grade Separation. The longitudinal distance needed for adequate design of a grade separation depends on the design speed, the roadway gradient and the amount of rise or fall needed to achieve the separation. To determine whether or not a grade separation is practical for given conditions, Exhibit 10-8 from Chapter 10 of the 2004 AASHTO Green Book should be used as a guide for preliminary design to determine horizontal distance in flat terrain. The figure also may serve as a general guide in other than flat terrain and adjustments can be made in the length of the terminal vertical curves.

F. Grade Separations Without Ramps. There are many situations where grade separations are constructed without the provision of ramps. In other situations, despite sufficient traffic demand, ramps may be omitted: (1) to avoid having interchanges so close to each other that signing and operation would be difficult, (2) to eliminate interference with large highway traffic volumes and (3) to increase safety and mobility by concentrating turning traffic where it is practical to provide adequate ramp systems.

For additional guidelines and criteria for the procedures, considerations and geometric design features for grade separation structures, refer to the section "Grade Separations without Ramps" in the 2004 AASHTO Green Book, Chapter 10.

METRIC						US Customary					
Design Speed (km/h)	Maximum e (%)	Maximum f	Total (e/100 + f)	Calculated Radius (m)	Rounded Radius (m)	Design Speed (mph)	Maximum e (%)	Maximum f	Total (e/100 + f)	Calculated Radius (ft)	Rounded Radius (ft)
15	4.0	0.40	0.44	4.0	4	10	4.0	0.38	0.42	15.9	16
20	4.0	0.35	0.39	8.1	8	15	4.0	0.32	0.36	41.7	42
30	4.0	0.28	0.32	22.1	22	20	4.0	0.27	0.31	86.0	86
40	4.0	0.23	0.27	46.7	47	25	4.0	0.23	0.27	154.3	154
50	4.0	0.19	0.23	85.6	86	30	4.0	0.20	0.24	250.0	250
60	4.0	0.17	0.21	135.0	135	35	4.0	0.18	0.22	371.2	371
70	4.0	0.15	0.19	203.1	203	40	4.0	0.16	0.20	533.3	533
80	4.0	0.14	0.18	280.0	280	45	4.0	0.15	0.19	710.5	711
90	4.0	0.13	0.17	375.2	375	50	4.0	0.14	0.18	925.9	926
100	4.0	0.12	0.16	492.1	492	55	4.0	0.13	0.17	1186.3	1190
						60	4.0	0.12	0.16	1500.0	1500
15	6.0	0.40	0.46	3.9	4	10	6.0	0.38	0.44	15.2	15
20	6.0	0.35	0.41	7.7	8	15	6.0	0.32	0.38	39.5	39
30	6.0	0.28	0.34	20.8	21	20	6.0	0.27	0.33	80.8	81
40	6.0	0.23	0.29	43.4	43	25	6.0	0.23	0.29	143.7	144
50	6.0	0.19	0.25	78.7	79	30	6.0	0.20	0.26	230.0	231
60	6.0	0.17	0.23	123.2	123	35	6.0	0.18	0.24	340.3	340
70	6.0	0.15	0.21	183.7	184	40	6.0	0.16	0.22	484.8	485
80	6.0	0.14	0.20	252.0	252	45	6.0	0.15	0.21	642.9	643
90	6.0	0.13	0.19	335.7	336	50	6.0	0.14	0.20	833.3	833
100	6.0	0.12	0.18	437.4	437	55	6.0	0.13	0.19	1061.4	1060
110	6.0	0.11	0.17	560.4	560	60	6.0	0.12	0.18	1333.3	1330
120	6.0	0.09	0.15	755.9	756	65	6.0	0.11	0.17	1656.9	1660
130	6.0	0.08	0.14	950.5	951	70	6.0	0.10	0.16	2041.7	2040
						75	6.0	0.09	0.15	2500.0	2500
						80	6.0	0.08	0.14	3047.6	3050
15	8.0	0.40	0.48	3.7	4	10	8.0	0.38	0.46	14.5	14
20	8.0	0.35	0.43	7.3	7	15	8.0	0.32	0.40	37.5	38
30	8.0	0.28	0.36	19.7	20	20	8.0	0.27	0.35	76.2	76
40	8.0	0.23	0.31	40.6	41	25	8.0	0.23	0.31	134.4	134
50	8.0	0.19	0.27	72.9	73	30	8.0	0.20	0.28	214.3	214
60	8.0	0.17	0.25	113.4	113	35	8.0	0.18	0.26	314.1	314
70	8.0	0.15	0.23	167.8	168	40	8.0	0.16	0.24	444.4	444
80	8.0	0.14	0.22	229.1	229	45	8.0	0.15	0.23	587.0	587
90	8.0	0.13	0.21	303.7	304	50	8.0	0.14	0.22	757.6	758
100	8.0	0.12	0.20	393.7	394	55	8.0	0.13	0.21	960.3	960
110	8.0	0.11	0.19	501.5	501	60	8.0	0.12	0.20	1200.0	1200
120	8.0	0.09	0.17	667.0	667	65	8.0	0.11	0.19	1482.5	1480
130	8.0	0.08	0.16	831.7	832	70	8.0	0.10	0.18	1814.8	1810
						75	8.0	0.09	0.17	2205.9	2210
						80	8.0	0.08	0.16	2666.7	2670
15	10.0	0.40	0.50	3.5	4	10	10.0	0.38	0.48	13.9	14
20	10.0	0.35	0.45	7.0	7	15	10.0	0.32	0.42	35.7	36
30	10.0	0.28	0.38	18.6	19	20	10.0	0.27	0.37	72.1	72
40	10.0	0.23	0.33	38.2	38	25	10.0	0.23	0.33	126.3	126
50	10.0	0.19	0.29	67.9	68	30	10.0	0.20	0.30	200.0	200
60	10.0	0.17	0.27	105.0	105	35	10.0	0.18	0.28	291.7	292
70	10.0	0.15	0.25	154.3	154	40	10.0	0.16	0.26	410.3	410
80	10.0	0.14	0.24	210.0	210	45	10.0	0.15	0.25	540.0	540
90	10.0	0.13	0.23	277.3	277	50	10.0	0.14	0.24	694.4	694
100	10.0	0.12	0.22	357.9	358	55	10.0	0.13	0.23	876.8	877
110	10.0	0.11	0.21	453.7	454	60	10.0	0.12	0.22	1090.9	1090
120	10.0	0.09	0.19	596.8	597	65	10.0	0.11	0.21	1341.3	1340
130	10.0	0.08	0.18	739.3	739	70	10.0	0.10	0.20	1633.3	1630
						75	10.0	0.09	0.19	1973.7	1970
						80	10.0	0.08	0.18	2370.4	2370
15	12.0	0.40	0.52	3.4	3	10	12.0	0.38	0.50	13.3	13
20	12.0	0.35	0.47	6.7	7	15	12.0	0.32	0.44	34.1	34
30	12.0	0.28	0.40	17.7	18	20	12.0	0.27	0.39	68.4	68
40	12.0	0.23	0.35	36.0	36	25	12.0	0.23	0.35	119.0	119
50	12.0	0.19	0.31	63.5	64	30	12.0	0.20	0.32	187.5	188
60	12.0	0.17	0.29	97.7	98	35	12.0	0.18	0.30	272.2	272
70	12.0	0.15	0.27	142.9	143	40	12.0	0.16	0.28	381.0	381
80	12.0	0.14	0.26	193.8	194	45	12.0	0.15	0.27	500.0	500
90	12.0	0.13	0.25	255.1	255	50	12.0	0.14	0.26	641.0	641
100	12.0	0.12	0.24	328.1	328	55	12.0	0.13	0.25	806.7	807
110	12.0	0.11	0.23	414.2	414	60	12.0	0.12	0.24	1000.0	1000
120	12.0	0.09	0.21	539.9	540	65	12.0	0.11	0.23	1224.6	1220
130	12.0	0.08	0.20	665.4	665	70	12.0	0.10	0.22	1484.8	1480
						75	12.0	0.09	0.21	1785.7	1790
						80	12.0	0.08	0.20	2133.3	2130

Note: In recognition of safety considerations, use of $e_{max} = 4.0\%$ should be limited to urban conditions.

Exhibit 3-15. Minimum Radius Using Limiting Values of e and f

METRIC

e (%)	V _d = 20 km/h		V _d = 30 km/h		V _d = 40 km/h		V _d = 50 km/h		V _d = 60 km/h		V _d = 70 km/h		V _d = 80 km/h		V _d = 90 km/h		V _d = 100 km/h		V _d = 110 km/h		V _d = 120 km/h		V _d = 130 km/h	
	R (m)	R (m)	R (m)	R (m)	R (m)	R (m)	R (m)	R (m)	R (m)	R (m)														
1.5	194	421	738	1050	1440	1910	2590	3510	4660	6060	7810	10000	12800	16300	20600	26700	34600	44400	57100	73000	93000	118000	150000	190000
2.0	136	289	525	750	1030	1380	1810	2350	3040	3910	5000	6400	8200	10500	13500	17300	22000	28400	36600	47000	60000	76000	96000	122000
2.2	128	283	485	688	940	1260	1660	2160	2800	3580	4550	5800	7350	9300	11800	15000	19000	24500	31500	40000	50500	64000	81000	102000
2.4	108	236	415	589	805	1090	1440	1860	2380	3060	3880	4900	6150	7700	9600	12000	15000	19500	25000	32000	40500	51000	64000	80000
2.6	97	210	372	540	746	1000	1300	1680	2160	2760	3480	4350	5400	6700	8300	10200	12600	15800	20000	25500	32500	40500	50000	62000
2.8	87	192	334	488	676	910	1150	1460	1840	2320	2900	3580	4350	5300	6450	7850	9500	11500	14000	17500	21500	26500	32500	39500
3.0	78	170	304	443	615	831	1050	1320	1670	2100	2600	3180	3850	4600	5500	6550	7800	9300	11000	13200	15800	19000	22500	27000
3.2	70	152	282	402	561	761	959	1190	1470	1820	2250	2750	3300	3950	4700	5550	6500	7650	9000	10600	12600	15000	17800	21000
3.4	64	133	258	368	511	697	897	1100	1360	1700	2080	2500	2950	3500	4150	4850	5650	6550	7550	8700	10000	11600	13600	16000
3.6	51	113	206	299	422	562	729	892	1080	1340	1640	1980	2380	2850	3350	3900	4500	5150	5850	6650	7550	8550	9650	10800
3.8	42	96	177	254	362	485	625	774	933	1100	1320	1580	1880	2250	2650	3100	3600	4150	4750	5400	6100	6850	7700	8600
4.0	36	82	155	221	315	415	535	655	785	920	1060	1250	1480	1750	2050	2400	2800	3250	3700	4200	4750	5350	6000	6700
4.2	31	72	136	193	274	353	446	538	635	735	840	955	1080	1220	1380	1560	1750	1950	2200	2450	2750	3100	3450	3850
4.4	27	63	121	172	243	313	383	458	538	620	705	795	890	990	1100	1220	1350	1500	1650	1850	2050	2300	2550	2850
4.6	24	56	108	152	213	273	333	398	468	543	623	708	798	893	993	1103	1223	1373	1523	1723	1923	2173	2423	2723
4.8	21	50	97	136	190	245	298	358	423	493	568	643	723	803	888	983	1083	1203	1343	1493	1693	1893	2143	2393
5.0	19	46	88	122	166	215	265	315	370	430	495	565	640	715	795	880	970	1070	1180	1300	1440	1600	1760	1920
5.2	17	42	81	110	148	192	235	280	325	375	430	490	555	620	690	765	845	930	1020	1120	1230	1350	1480	1620
5.4	15	38	74	99	132	170	208	248	290	335	385	440	495	555	615	680	750	820	895	975	1060	1150	1250	1350
5.6	13	34	67	89	117	150	182	218	255	295	340	385	435	485	540	595	650	710	770	830	895	960	1030	1100
5.8	11	30	60	80	103	130	158	190	220	255	290	325	365	405	450	495	540	590	640	690	740	790	840	890
6.0	8	21	43	58	75	95	115	135	155	175	195	215	235	255	275	295	315	335	355	375	395	415	435	455

Exhibit 3-26. Minimum Radii for Design Superelevation Rates, Design Speeds, and e_{max} = 6%

US CUSTOMARY

e (%)	V _d = 15 mph		V _d = 20 mph		V _d = 25 mph		V _d = 30 mph		V _d = 35 mph		V _d = 40 mph		V _d = 45 mph		V _d = 50 mph		V _d = 55 mph		V _d = 60 mph		V _d = 65 mph		V _d = 70 mph		V _d = 75 mph		V _d = 80 mph	
	R (ft)	R (ft)																										
1.5	660	1580	2280	3130	4100	5230	6460	7870	9400	11000	12600	14100	15700	17300	19000	20600	22200	23800	25400	27000	28600	30200	31800	33400	35000	36600	38200	39800
2.0	463	1020	1650	2240	2950	3700	4500	5300	6100	6900	7700	8500	9300	10100	10900	11700	12500	13300	14100	14900	15700	16500	17300	18100	18900	19700	20500	21300
2.2	432	924	1450	2000	2630	3300	3970	4640	5310	5980	6650	7320	7990	8660	9330	10000	10670	11340	12010	12680	13350	14020	14690	15360	16030	16700	17370	18040
2.4	394	834	1300	1790	2360	3000	3630	4260	4890	5520	6150	6780	7410	8040	8670	9300	9930	10560	11190	11820	12450	13080	13710	14340	14970	15600	16230	16860
2.6	356	751	1100	1500	1900	2400	2850	3300	3750	4200	4650	5100	5550	6000	6450	6900	7350	7800	8250	8700	9150	9600	10050	10500	10950	11400	11850	12300
2.8	318	664	940	1260	1620	2040	2400	2760	3120	3480	3840	4200	4560	4920	5280	5640	6000	6360	6720	7080	7440	7800	8160	8520	8880	9240	9600	9960
3.0	280	586	850	1100	1400	1760	2060	2360	2660	2960	3260	3560	3860	4160	4460	4760	5060	5360	5660	5960	6260	6560	6860	7160	7460	7760	8060	8360
3.2	242	508	740	960	1200	1500	1760	2020	2280	2540	2800	3060	3320	3580	3840	4100	4360	4620	4880	5140	5400	5660	5920	6180	6440	6700	6960	7220
3.4	204	422	630	820	1020	1260	1460	1660	1860	2060	2260	2460	2660	2860	3060	3260	3460	3660	3860	4060	4260	4460	4660	4860	5060	5260	5460	5660
3.6	166	358	530	690	860	1040	1220	1380	1560	1740	1920	2100	2280	2460	2640	2820	3000	3180	3360	3540	3720	3900	4080	4260	4440	4620	4800	4980
3.8	128	270	400	520	640	760	880	1000	1120	1240	1360	1480	1600	1720	1840	1960	2080	2200	2320	2440	2560	2680	2800	2920	3040	3160	3280	3400
4.0	90	192	280	360	440	520	600	680	760	840	920	1000	1080	1160	1240	1320	1400	1480	1560	1640	1720	1800	1880	1960	2040	2120	2200	2280
4.2	81	166	240	310	380	450	520	590	660	730	800	870	940	1010	1080	1150	1220	1290	1360	1430	1500	1570	1640	1710	1780	1850	1920	1990
4.4	72	146	210	270	330	390	450	510	570	630	690	750	810	870	930	990	1050	1110	1170	1230	1290	1350	1410	1470	1530	1590	1650	1710
4.6	63	126	180	230	280	330	380	430	480	530	580	630	680	730	780	830	880	930	980	1030	1080	1130	1180	1230	1280	1330	1380	1430
4.8	54	108	150	190	230	270	310	350	390	430	470	510	550	590	630	670	710	750	790	830	870	910	950	990	1030	1070	1110	1150
5.0	45	90	120	150	180	210	240	270	300	330	360	390	420	450	480	510	540	570	600	630	660	690	720	750	780	810	840	870
5.2	36	72	96	120	144	168	192	216	240	264	288	312	336	360	384	408	432	456	480	504	528	552	576	600	624	648	672	696
5.4	27	54	72	90	108	126	144	162	180	198	216	234	252	270	288	306	324	342	360	378	396	414	432	450	468	486	504	522
5.6	18	36	48	60	72	84	96	108	120	132	144	156	168	180	192	204	216	228	240	252	264	276	288	300	312	324	336	348
5.8	14	28	36	44	52	60	68	76	84	92	100	108	116	124	132	140	148	156	164	172	180	188	196	204	212	220	228	236
6.0	8	16	21	26	31	36	41	46	51	56	61	66	71	76	81	86	91	96	101	106	111	116	121	126	131	136	141	146

Exhibit 3-26. Minimum Radii for Design Superelevation Rates, Design Speeds, and e_{max} = 6%

Compound curves at intersections for which the radius of one curve is more than twice the radius of the other should have either a spiral or a circular curve of intermediate radius inserted between the two. If, in such instances, the calculated length of spiral is less than 30 m [100 ft], it is suggested that a length of at least 30 m [100 ft] be used.

Compound Circular Curves

Compound circular curves are advantageous in effecting desirable shapes of turning roadways for at-grade intersections and for interchange ramps. Where circular arcs of widely different radii are joined, however, the alignment appears abrupt or forced, and the travel paths of vehicles need considerable steering effort.

On compound curves for open highways, it is generally accepted that the ratio of the flatter radius to the sharper radius should not exceed 1.5:1. For compound curves at intersections where drivers accept more rapid changes in direction and speed, the radius of the flatter arc can be as much as 100 percent greater than the radius of the sharper arc, a ratio of 2:1. The ratio of 2:1 for the sharper curves used at intersections results in approximately the same difference (about 10 km/h [6 mph]) in average running speeds for the two curves. These curves are compounded as for a ratio of 1.5:1 on the flatter curves used on the open highway. General observations on ramps having differences in radii with a ratio of 2:1 indicate that both operation and appearance normally are satisfactory.

Where practical, a smaller difference in radii should be used. A desirable maximum ratio is 1.75:1. Where the ratio is greater than 2:1, a suitable length of spiral or a circular arc of intermediate radius should be inserted between the two curves. In the case of very sharp curves designed to accommodate minimum turning paths of vehicles, it is not practical to apply this ratio control. In this case, compound curves should be developed that fit closely to the path of the design vehicle to be accommodated, for which higher ratios may be necessary needed as shown in Chapter 9.

Curves that are compounded should not be too short or their effectiveness in enabling smooth transitions from tangent or flat-curve to sharp-curve operation may be lost. In a series of curves of decreasing radii, each curve should be long enough to enable the driver to decelerate at a reasonable rate, which at intersections is assumed to be not more than 5 km/h/s [3 mph/s], although 3 km/h/s [2 mph/s] is desirable. Minimum curve lengths that meet these criteria based on the running speeds shown in Exhibit 3-14, are indicated in Exhibit 3-42. They are based on a deceleration of 5 km/h/s [3 mph/s], and a desirable minimum deceleration of 3 km/h/s [2 mph/s]. The latter deceleration rate indicates very light braking, because deceleration in gear alone generally results in overall rates between 1.5 and 2.5 km/h/s [1 and 1.5 mph/s].

Metric				US Customary			
Design speed (km/h)	Stopping sight distance (m)	Rate of vertical curvature, K^a		Design speed (mph)	Stopping sight distance (ft)	Rate of vertical curvature, K^a	
		Calculated	Design			Calculated	Design
20	20	0.6	1	15	80	3.0	3
30	35	1.9	2	20	115	6.1	7
40	50	3.8	4	25	155	11.1	12
50	65	6.4	7	30	200	18.5	19
60	85	11.0	11	35	250	29.0	29
70	105	16.8	17	40	305	43.1	44
80	130	25.7	26	45	360	60.1	61
90	160	38.9	39	50	425	83.7	84
100	185	52.0	52	55	495	113.5	114
110	220	73.6	74	60	570	150.6	151
120	250	95.0	95	65	645	192.8	193
130	285	123.4	124	70	730	246.9	247
				75	820	311.6	312
				80	910	383.7	384

^a Rate of vertical curvature, K , is the length of curve per percent algebraic difference in intersecting grades (A). $K = L/A$

Exhibit 3-72. Design Controls for Stopping Sight Distance and for Crest Vertical Curves

Metric			US Customary		
Design speed (km/h)	Passing sight distance (m)	Rate of vertical curvature, K^a design	Design speed (mph)	Passing sight distance (ft)	Rate of vertical curvature, K^a design
30	200	46	20	710	180
40	270	84	25	900	289
50	345	138	30	1090	424
60	410	195	35	1280	585
70	485	272	40	1470	772
80	540	338	45	1625	943
90	615	438	50	1835	1203
100	670	520	55	1985	1407
110	730	617	60	2135	1628
120	775	695	65	2285	1865
130	815	769	70	2480	2197
			75	2580	2377
			80	2680	2565

Note: ^aRate of vertical curvature, K , is the length of curve per percent algebraic difference in intersecting grades (A). $K = L/A$

Exhibit 3-73. Design Controls for Crest Vertical Curves Based on Passing Sight Distance

Generally, it is impractical to design crest vertical curves to provide for passing sight distance because of high cost where crest cuts are involved and the difficulty of fitting the resulting long vertical curves to the terrain, particularly for high-speed roads. Passing sight

Type of terrain	Metric			US Customary		
	Design speed (km/h) for specified design volume (veh/day)			Design speed (mph) for specified design volume (veh/day)		
	0 to 400	400 to 2000	over 2000	0 to 400	400 to 2000	over 2000
Level	60	80	100	40	50	60
Rolling	50	60	80	30	40	50
Mountainous	30	50	60	20	30	40

Note: Where practical, design speeds higher than those shown should be considered.

Exhibit 6-1. Minimum Design Speeds for Rural Collectors

Metric				US Customary			
Design speed	Design stopping sight distance	Rate of vertical curvature, K^a		Design speed	Design stopping sight distance	Rate of vertical curvature, K^a	
(km/h)	(m)	Crest	Sag	(mph)	(ft)	Crest	Sag
20	20	1	3	15	80	3	10
30	35	2	6	20	115	7	17
40	50	4	9	25	155	12	26
50	65	7	13	30	200	19	37
60	85	11	18	35	250	29	49
70	105	17	23	40	305	44	64
80	130	26	30	45	360	61	79
90	160	39	38	50	425	84	96
100	185	52	45	55	495	114	115
				60	570	151	136

^a Rate of vertical curvature, K , is the length of curve per percent algebraic difference in the intersecting grades (i.e., $K = L/A$). (See Chapter 3 for details.)

Exhibit 6-2. Design Controls for Stopping Sight Distance and for Crest and Sag Vertical Curves

Metric		US Customary			
Design speed (km/h)	Design passing sight distance (m)	Rate of vertical curvature, K^a (m/%)	Design speed (mph)	Design passing sight distance (ft)	Rate of vertical curvature, K^a (ft/%)
30	200	46	20	710	180
40	270	84	25	900	289
50	345	138	30	1090	424
60	410	195	35	1280	585
70	485	272	40	1470	772
80	540	338	45	1625	943
90	615	438	50	1835	1203
100	670	520	55	1985	1407
			60	2135	1628

^a Rate of vertical curvature, K , is the length of curve per percent algebraic difference in the intersecting grades (i.e., $K = L/A$). (See Chapter 3 for details.)

Exhibit 6-3. Design Controls for Crest Vertical Curves Based on Passing Sight Distance

Type of terrain	Metric																
	Maximum grade (%) for specified design speed (km/h)					US Customary Maximum grade (%) for specified design speed (mph)											
Level	30	40	50	60	70	80	90	100	20	25	30	35	40	45	50	55	60
Rolling	7	7	7	7	7	6	6	5	7	7	7	7	7	7	7	6	6
Mountainous	10	10	9	8	8	7	7	6	10	10	9	9	8	8	7	7	6
	12	11	10	10	10	9	9	8	12	11	10	10	10	10	9	9	8

Notes: Short lengths of grade in rural areas, such as grades less than 150 m [500 ft] in length, one-way downgrades, and grades on low-volume rural collectors may be up to 2 percent steeper than the grades shown above.

Exhibit 6-4. Maximum Grades for Rural Collectors

Sight Distance

Sight distance is directly related to and varies appreciably with design speed. Stopping sight distance, a key safety-related design element, should be provided through the length of the roadway. Passing and decision sight distances influence roadway operations and should be provided wherever practical. Providing decision sight distance at locations where complex decisions are made greatly enhances the chances that drivers will be able to safely accomplish maneuvers. Examples of locations where complex decisions are required include high-volume intersections, transitions in roadway width, and transitions in the number of lanes. Provision for adequate sight distance on rural arterials, which may combine both high speeds and high traffic volumes, can be complex. Exhibit 7-1 presents the recommended minimum values of stopping and passing sight distance. Refer to Chapter 3 for a comprehensive discussion of sight distance and for tabulated values for decision sight distance.

Metric			US Customary		
Design speed (km/h)	Minimum stopping sight distance (m)	Minimum passing sight distance (m)	Design speed (mph)	Minimum stopping sight distance (ft)	Minimum passing sight distance (ft)
50	65	345	30	200	1090
60	85	410	35	250	1280
70	105	485	40	305	1470
80	130	540	45	360	1625
90	160	615	50	425	1835
100	185	670	55	495	1985
110	220	730	60	570	2135
120	250	775	65	645	2285
130	285	815	70	730	2480
			75	820	2580
			80	910	2680

Exhibit 7-1. Minimum Sight Distances for Arterials

Ideally, intersections and railroad crossings should be grade separated or provided with adequate sight distance. Intersections should be placed in sag and/or tangent locations, where practical, to allow maximum visibility of the roadway and pavement markings.

Alignment

A smooth flowing alignment is desirable on a rural arterial. Changes in alignment, both horizontal and vertical, should be so gradual that they will not surprise the driver. Roads with adequate alignment usually operate more efficiently and safely than roads with poor alignment, even where improved signing and pavement marking are provided; therefore, adequate alignment should be provided wherever practical.

guidance applicable to both rural and urban arterials is presented in the section on “Superelevated Cross Sections” in the earlier discussion of rural arterials in this chapter.

Type of terrain	Metric						US Customary						
	Maximum grade (%) for specified design speed (km/h)						Maximum grade (%) for specified design speed (mph)						
	50	60	70	80	90	100	30	35	40	45	50	55	60
Level	8	7	6	6	5	5	8	7	7	6	6	5	5
Rolling	9	8	7	7	6	6	9	8	8	7	7	6	6
Mountainous	11	10	9	9	8	8	11	10	10	9	9	8	8

Exhibit 7-10. Maximum Grades for Urban Arterials

Cross Slope

Sufficient cross slope for adequate pavement drainage is important on urban arterials. The typical problems related to splashing and hydroplaning are compounded by heavy traffic volumes and curbed sections, especially for high speeds. Cross slopes should range from 1.5 to 3 percent; the lower portion of this range is appropriate where drainage flow is across a single lane and higher values are appropriate where flow is across several lanes. Even higher cross-slope rates may be used for parking lanes. The overall cross section should provide a smooth appearance without sharp breaks. Because urban arterials are often curbed, it is necessary to provide for longitudinal as well as cross-slope drainage. The use of higher cross-slope rates also reduces flow on the roadway and ponding of water due to pavement irregularities and rutting. The section on “Cross Slopes” in Chapter 4 provides additional guidance.

Vertical Clearances

New or reconstructed structures should provide 4.9-m [16-ft] vertical clearance over the entire roadway width. Existing structures that provide clearance of 4.3 m [14 ft], if allowed by local statute, may be retained. In highly urbanized areas, a minimum clearance of 4.3 m [14 ft] may be provided if there is an alternate route with 4.9-m [16-ft] clearance. Structures should provide additional clearance for future resurfacing of the underpassing road.

Lane Widths

Lane widths may vary from 3.0 to 3.6 m [10 to 12 ft]. Lane widths of 3.0 m [10 ft] may be used in highly restricted areas having little or no truck traffic. Lane widths of 3.3 m [11 ft] are used quite extensively for urban arterial street designs. The 3.6-m [12-ft] lane widths are most desirable and should be used, where practical, on higher speed, free-flowing, principal arterials.

interchange facilities and the need for frequent changes in speed make it desirable to use flat grades wherever practical. On sustained upgrades, the need for climbing lanes should be investigated, as discussed in Chapter 3.

Type of Terrain	Metric						US Customary						
	Design Speeds (km/h)						Design Speeds (mph)						
	80	90	100	110	120	130	50	55	60	65	70	75	80
	Grades (%) ^a						Grades (%) ^a						
Level	4	4	3	3	3	3	4	4	3	3	3	3	3
Rolling	5	5	4	4	4	4	5	5	4	4	4	4	4
Mountainous	6	6	6	5	—	—	6	6	6	5	5	—	—

^a Grades 1% steeper than the value shown may be provided in mountainous terrain or in urban areas with crucial right-of-way controls.

Exhibit 8-1. Maximum Grades for Rural and Urban Freeways

Structures

The design of bridges, culverts, walls, tunnels, and other structures should be in accordance with the principles of the current *Standard Specifications for Highway Bridges (2)* or with the *AASHTO LRFD Bridge Design Specifications (3)*. Structures carrying freeway traffic should provide an MS 18 [HS 20–44] design loading.

The clear width on bridges carrying freeway traffic should be as wide as the approach roadway, as discussed in Chapter 10. On bridges longer than 60 m [200 ft], some economy in substructure costs may be gained by building a single structure rather than twin parallel structures. In such cases, the approach shoulder widths are provided and a median barrier is extended across the bridge.

Structures carrying ramps should provide a clear width equal to the ramp width and paved shoulders. Clear widths for structures carrying auxiliary lanes are discussed in Chapter 10.

The structure width and lateral clearance of highways and streets overpassing or underpassing the freeway are dependent on the functional classification of the highway or street as discussed in Chapters 5, 6, and 7.

Vertical Clearance

The vertical clearance to structures passing over freeways should be at least 4.9 m [16 ft] over the entire roadway width, including auxiliary lanes and the usable width of shoulders (with an allowance for future resurfacing). In highly developed urban areas, where attainment of the 4.9-m [16-ft] clearance would be unreasonably costly, a minimum clearance of 4.3 m [14 ft] may be used if there is an alternate freeway facility with the minimum 4.9-m [16-ft] clearance.

**TABLE 12.1 (ENGLISH)
CLEAR ZONE WIDTH
(in feet from edge of through traveled way)**

DESIGN SPEED	DESIGN ADT	FORESLOPE			BACKSLOPE		
		1V:6H OR FLATTER	1V:5H TO 1V:4H	1V:3H	1V:3H	1V:5H TO 1V:4H	1V:6H OR FLATTER
40 mph or less	Under 750	7	7	**	7	7	7
	750 - 1500	10	12	**	10	10	10
	1500 - 6000	12	14	**	12	12	12
	Over 6000	14	16	**	14	14	14
45-50 mph	Under 750	10	12	**	8	8	10
	750 - 1500	14	16	**	10	12	14
	1500 - 6000	16	20	**	12	14	16
	Over 6000	20	24	**	14	18	20
55 mph	Under 750	12	14	**	8	10	10
	750 - 1500	16	20	**	10	14	16
	1500 - 6000	20	24	**	14	16	20
	Over 6000	22	26	**	16	20	22
60 mph	Under 750	16	20	**	10	12	14
	750 - 1500	20	26	**	12	16	20
	1500 - 6000	26	30	**	14	18	24
	Over 6000	30	30	**	20	24	26
65-70 mph	Under 750	18	20	**	10	14	14
	750 - 1500	24	28	**	12	18	20
	1500 - 6000	28	30	**	16	22	26
	Over 6000	30	30	**	22	26	28

** Since recovery is less likely on the unshielded, traversable 1V:3H slopes, consider removal of fixed objects present beyond the toe of these slopes. Determination of the width of the recovery area provided, if any, at the toe of slope should take into consideration right-of-way availability, environmental concerns, economic factors, safety needs, and crash histories. Also, the distance between the edge of the through traveled lane and the beginning of the 1V:3H slope should influence the recovery area provided at the toe of slope.

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Reviewer: *[Signature]*

To determine the need for guide rail, refer to Section 12.4, Barrier Placement, and the preceding sections of this Chapter. Additional selection guidelines and criteria for standard and nonstandard conditions are presented below in Sections 12.3.D and 12.3.E.

**TABLE 12.3 (METRIC)
GUIDE RAIL AND MEDIAN BARRIER SYSTEMS**

TYPE DESIGNATION	DESCRIPTION	MOUNTING HEIGHT	MINIMUM UNOBSTRUCTED DISTANCE	POST SPACING
2 - W	WEAK POST W-BEAM GUIDE RAIL (NORMAL POST SPACING)	815 mm TO TOP OF BEAM	2.1 m	3810 mm
2 - WC	WEAK POST W-BEAM GUIDE RAIL (CLOSE POST SPACING)	815 mm TO TOP OF BEAM	1.5 m	1905 mm
2 - WCC	WEAK POST W-BEAM GUIDE RAIL (VERY CLOSE POST SPACING)	815 mm TO TOP OF BEAM	1.2 m	952.5 mm
2 - S	STRONG POST W-BEAM GUIDE RAIL (NORMAL POST SPACING)	706 mm TO TOP OF BEAM	0.9 m	1905 mm
2 - SC	STRONG POST W-BEAM GUIDE RAIL (CLOSE POST SPACING)	706 mm TO TOP OF BEAM	0.6 m	952.5 mm
2 - SCC	STRONG POST W-BEAM GUIDE RAIL (VERY CLOSE POST SPACING)	706 mm TO TOP OF BEAM	0.3 m	476.25 mm
2 - WM	WEAK POST W-BEAM MEDIAN BARRIER	815 mm TO TOP OF BARRIER	2.1 m	3810 mm
—	CONCRETE MEDIAN BARRIER SINGLE & DOUBLE FACE	810 mm TO TOP OF BARRIER	0.0 m	—
—	CONCRETE GLARE SCREEN	1270 mm TO TOP OF BARRIER (TYP)	0.0 m	—

**TABLE 12.3 (ENGLISH)
GUIDE RAIL AND MEDIAN BARRIER SYSTEMS**

TYPE DESIGNATION	DESCRIPTION	MOUNTING HEIGHT	MINIMUM UNOBSTRUCTED DISTANCE	POST SPACING
2 - W	WEAK POST W-BEAM GUIDE RAIL (NORMAL POST SPACING)	32" TO TOP OF BEAM	7' - 0"	12' - 6"
2 - WC	WEAK POST W-BEAM GUIDE RAIL (CLOSE POST SPACING)	32" TO TOP OF BEAM	5' - 0"	6' - 3"
2 - WCC	WEAK POST W-BEAM GUIDE RAIL (VERY CLOSE POST SPACING)	32" TO TOP OF BEAM	4' - 0"	3' - 1 1/2"
2 - S	STRONG POST W-BEAM GUIDE RAIL (NORMAL POST SPACING)	27 3/4" TO TOP OF BEAM	3' - 0"	6' - 3"
2 - SC	STRONG POST W-BEAM GUIDE RAIL (CLOSE POST SPACING)	27 3/4" TO TOP OF BEAM	2' - 0"	3' - 1 1/2"
2 - SCC	STRONG POST W-BEAM GUIDE RAIL (VERY CLOSE POST SPACING)	27 3/4" TO TOP OF BEAM	1' - 0"	1' - 6 3/4"
2 - WM	WEAK POST W-BEAM MEDIAN BARRIER	32" TO TOP OF BARRIER	7' - 0"	12' - 6"
—	CONCRETE MEDIAN BARRIER SINGLE & DOUBLE FACE	32" TO TOP OF BARRIER	0' - 0"	—
—	CONCRETE GLARE SCREEN	50" TO TOP OF BARRIER (TYP)	0' - 0"	—

CHAPTER 1

GENERAL DESIGN

1.0 INTRODUCTION

The purpose of this Manual is to provide its users with the current, uniform procedures and guidelines for the application and design of safe, convenient, efficient and attractive highways that are compatible with their service characteristics and that optimally satisfy the needs of highway users while maintaining the integrity of the environment.

This Manual does not attempt to encompass the total scope of important, published information and literature relative to the formulation of highway design criteria, policies and procedures. Sources of additional publications and related material which may complement the concepts contained herein include the following:

- Publication 408, *Specifications*, and associated changes, Pennsylvania Department of Transportation (PENNDOT).
- *A Policy on Geometric Design of Highways and Streets*, 2004 AASHTO Publication.*
- *Roadside Design Guide*, 2006 AASHTO Publication.**
- *Highway Capacity Manual*, Transportation Research Board, 2000 or newer edition.***
- *Manual on Uniform Traffic Control Devices*, Federal Highway Administration, 2003 or newer edition.****
- *A Policy on Design Standards---Interstate System*, 2005 AASHTO Publication.

Initiative should be exercised to utilize the most appropriate design values within the given ranges based upon the project context and roadway typology wherever practicable and within reasonable economic limitations and sound engineering judgment. When design criteria presented in this Manual differs from criteria presented in other sources, this Manual shall take precedence. However, for Federal-aid projects on the National Highway System (NHS), this Manual only takes precedence when criteria in this Manual exceed the criteria in the 2004 AASHTO Green Book and the 2005 AASHTO publication, *A Policy on Design Standards---Interstate System* (for Interstate Federal-aid projects). The design criteria and text presented herein provide guidance to the designer by referencing a range of values for critical dimensions.

Since the concepts, practices and procedures described in this Manual are subject to future change, the contents shall be updated accordingly to reflect those changes in order to retain its usefulness. The Highway Quality Assurance Division, Bureau of Design shall be responsible for keeping the Manual current by incorporating revisions, additions or deletions when required.

Whenever a District Executive determines that modifications or additions are required to improve the current design criteria in this Manual, the following procedures shall be followed:

1. The recommended modifications or additions shall be transmitted to the Director, Bureau of Design with the following information:

* Hereinafter referred to as the 2004 AASHTO Green Book.

** Hereinafter referred to as the AASHTO Roadside Design Guide.

*** Hereinafter referred to as the *HCM*.

**** Hereinafter referred to as the *MUTCD*.

RIGHT-OF-WAY

Right-of-Way

The width of right-of-way shall be sufficient to accommodate the roadway cross section elements and requisite appurtenances necessary for an adequate facility in the design year and for known future improvements.

Control of Access

Access to the interstate system shall be fully controlled. The interstate highway shall be grade separated at all railroad crossings and selected public crossroads. At-grade intersections shall not be allowed. To accomplish this, the intersecting roads are to be grade separated, terminated, rerouted, and/or intercepted by frontage roads. Access is to be achieved by interchanges at selected public roads.

Access control shall extend the full length of ramps and terminals on the crossroad. Such control shall either be acquired outright prior to construction or by the construction of frontage roads or by a combination of both.

Access control beyond the ramp terminals should be affected by purchasing access rights, providing frontage roads, controlling added corner right-of-way areas, or prohibiting driveways. Such control should extend beyond the ramp terminal at least 30 m (100 ft) in urban areas and 90 m (300 ft) in rural areas. However, in areas of high traffic volume, where exists the potential for development which would create operational or safety problems, longer lengths of access control should be provided.

GEOMETRIC CONTROLS AND CRITERIA

Design Speed

A minimum design speed of 110 km/h (70 mph) should be used for rural areas. Where terrain is mountainous, a design speed from 80 to 100 km/h (50 to 60 mph) may be used. In urban areas, the design speed shall be at least 80 km/h (50 mph).

Sight Distance

The minimum stopping sight distance shall be the values established in the current edition of AASHTO's *A Policy on Geometric Design of Highways and Streets* for the appropriate design speed.

Curvature and Superelevation

Curvature, superelevation, and allied features, such as transition curves, shall be correlated with the design speed in accordance with the current edition of AASHTO's *A Policy on Geometric Design of Highways and Streets*.

Gradients

Maximum grades as a function of the design speed and the type of terrain are shown in the following table:

Type of Terrain	Metric						U.S. Customary							
	Design Speed (km/h)						Design Speed (mph)							
	80	90	100	110	120	130	50	55	60	65	70	75	80	
	Grades (%)*						Grades (%)*							
Level	4	4	3	3	3	3	4	4	3	3	3	3	3	
Rolling	5	5	4	4	4	4	5	5	4	4	4	4	4	
Mountainous	6	6	6	5	-	-	6	6	6	5	5	-	-	

* Grades up to one percent steeper than the value shown may be provided in urban areas with crucial right-of-way constraints or where needed in mountainous terrain.

CROSS SECTION ELEMENTS

Number of Lanes

A minimum of four traffic lanes shall be provided on the interstate system. The number of lanes shall be sufficient to accommodate the DHV at an acceptable level of service for the applicable conditions. A capacity analysis using the design year traffic should be performed to determine the number of lanes required to achieve the acceptable level of service. Refer to AASHTO's *A Policy on Geometric Design of Highways and Streets* for guidance in the selection of level of service.

On ascending grades, which exceed the critical design length, a climbing lane analysis should be performed and climbing lanes added where appropriate. Likewise, on extended lengths of maximum or near maximum descending grades, emergency escape ramps should be added where an analysis indicates they are required.

Width of Traffic Lanes

All traffic lanes shall be at least 3.6 m (12 ft) wide.

Shoulders

The paved width of the right shoulder shall not be less than 3.0 m (10 ft). Where truck traffic exceeds 250 DDHV, a paved shoulder width of 3.6 m (12 ft) should be considered. On a four-lane section, the paved width of the left shoulder shall be at least 1.2 m (4 ft). On sections with six or more lanes, a 3.0 m (10 ft) paved width for the left shoulder should be provided. Where truck traffic exceeds 250 DDHV, a paved width of 3.6 m (12 ft) should be considered.

In mountainous terrain, a reduced paved shoulder width together with a minimal median width may be used to reduce the high costs associated with providing a full width roadway cross section. In these instances, a 2.4 m (8 ft) minimum paved right shoulder and a 1.2 m (4 ft) minimum paved left shoulder may be used on a traveled way consisting of four or six lanes. Where eight or more lanes are provided, a 2.4 m (8 ft) minimum paved shoulder width should be used on both sides.

Pavement and Shoulder Cross Slope

On tangent sections, the pavement cross slope shall be a minimum of 1.5 percent and desirably two percent. In areas of intense rainfall, the cross slope may be increased to 2.5 percent. Paved shoulders should have a cross slope in the range of two to six percent but not less than the cross slope of the adjacent pavement.

Sideslopes

Foreslopes within the clear zone should not be steeper than 1V:4H and desirably should be 1V:6H or flatter. Where steeper slopes are used within the clear zone, roadside barriers shall be installed where warranted by the criteria in the current edition of AASHTO's *Roadside Design Guide*.

Medians

Medians in rural areas in level or rolling topography shall be at least 11 m (36 ft) wide. Medians in urban or mountainous areas shall be at least 3.0 m (10 ft) wide. AASHTO's *Roadside Design Guide* should be consulted to determine the details and warrants, based on consideration of average daily traffic, median width, and crash history, for barrier installation in the median. When economically feasible, consideration should be given to decking over the opening between parallel structures and extending a median barrier across the deck. Where continuous decking is not feasible, median barriers or guardrails should be installed to stop or redirect an errant vehicle safely.

Horizontal Clearance to Obstructions

The width of the clear recovery area shall be commensurate with the design speed and roadside conditions, and be determined through application of the currently accepted procedures in the AASHTO *Roadside Design Guide*. To the extent practicable, the piers and abutments of overcrossing structures should be designed to provide a horizontal clearance equal to the clear recovery area.

In restricted areas, it may be necessary to construct barriers, walls, piers, abutments or other unyielding objects nearer to the traveled way than the width required for a clear recovery area. Fixed objects within the limits of the clear recovery area shall be made breakaway, made yielding, or be shielded by installation of crashworthy barriers or attenuators. The minimum horizontal clearance from the edge of the traveled way to the face of the barrier shall be consistent with the requirements for the paved shoulder width.

Curbs

Vertical curbs shall not be used. Sloping curbs, when used, should be located at the outer edge of the paved shoulder. The height of sloping curb should be limited to 100 mm (4 in).

The use of curbs in conjunction with guardrail is discouraged. When the installation of curb is necessary in conjunction with a guardrail, the face of the curb should be located behind the face of the guardrail, or at least no closer to the traveled way than the face of the guardrail. AASHTO's *Roadside Design Guide* should be consulted for detailed information concerning installation of curb in conjunction with guardrail.

INTERCHANGES

Interchanges shall be provided between all intersecting interstate routes, between other selected access-controlled highways, and at other selected public highways to facilitate the distribution of traffic. Each interchange shall provide for all traffic movements.

The ramp curvature, pavement widths, and related elements, which constitute an interchange, shall be adequate to accommodate the appropriate design vehicles.

Spacing of interchanges has a significant effect on the operation of interstate highways. In areas of concentrated development, proper spacing may be difficult to obtain because of demand for frequent access. As a rule, minimum spacing should be 1.5 km (1 mi) in urban areas and 5 km (3 mi) in rural areas, based on crossroad to crossroad spacing. In urban areas, spacing of less than 1.5 km (1 mi) may be developed by grade-separated ramps or by collector-distributor roads.

BRIDGES AND OTHER STRUCTURES

General

The following standards apply to interstate highway bridges, overpasses and underpasses. Standards for crossroad overpasses and underpasses are to be those of the crossroad.

Vertical Clearance

On all rural sections, the clear height of structures shall be not less than 4.9 m (16 ft) over the entire roadway width, including the width of paved shoulder. In urban areas, the 4.9 m (16 ft) clearance shall apply at least to a single interstate routing. On other interstate urban routes, the clear height shall be not less than 4.3 m (14 ft). An allowance should be made for future resurfacing. The vertical clearance to sign trusses and pedestrian overpasses shall be 5.1 m (17 ft). On interstate urban routes with less than the 4.9 m (16 ft) clearance, the vertical clearance to sign trusses shall be 0.3 m (1 ft) greater than the minimum clearance of other structures. The vertical clearance from the deck to the cross bracing on through truss structures shall also be a minimum of 5.1 m (17 ft).

Cross Section

The width of all bridges, including grade separation structures, measured between rails, parapets, or barriers shall equal the full paved width of the approach roadways. The approach roadway includes the width of paved shoulders. Long bridges, defined as bridges having an overall length in excess of 60 m (200 ft), may have a lesser width. Such bridges shall be analyzed individually. On long bridges, offsets to parapet, rail or barrier shall be at least 1.2 m (4 ft) measured from the edge of the nearest traffic lane on both the left and the right.

Structural Capacity

All new bridges shall have at least an MS 18 (HS 20) structural capacity. A bridge can remain in place if the operating rating capacity can safely service the system for an additional 20-year service life.

Existing Bridges to Remain in Place

Mainline bridges on the interstate system and bridges on routes to be incorporated into the system may remain in place if, as a minimum, they meet the following: a) the bridge cross section consists of 3.6 m (12 ft) lanes, 3.0 m (10 ft) shoulder on the right and 1.1 m (3.5 ft) shoulder on the left; b) for long bridges, the offset to the face of parapet or bridge rail on both the left and right is 1.1 m (3.5 ft) measured from the edge of the nearest traveled lane; c) bridge railing shall meet or be upgraded to current standards.

- length. Even in this case, the alignment may be unpleasant in appearance when both curves are clearly visible for some distance ahead.
- To avoid the appearance of inconsistent distortion, the horizontal alignment should be coordinated carefully with the profile design. General controls for this coordination are discussed in the section of this chapter on “Combination of Horizontal and Vertical Alignment.”

VERTICAL ALIGNMENT

Terrain

The topography of the land traversed has an influence on the alignment of roads and streets. Topography affects horizontal alignment, but has an even more pronounced effect on vertical alignment. To characterize variations in topography, engineers generally separate it into three classifications according to terrain.

In level terrain, highway sight distances, as governed by both horizontal and vertical restrictions, are generally long or can be made to be so without construction difficulty or major expense.

In rolling terrain, natural slopes consistently rise above and fall below the road or street grade, and occasional steep slopes offer some restriction to normal horizontal and vertical roadway alignment.

In mountainous terrain, longitudinal and transverse changes in the elevation of the ground with respect to the road or street are abrupt, and benching and side hill excavation are frequently needed to obtain acceptable horizontal and vertical alignment.

Terrain classifications pertain to the general character of a specific route corridor. Routes in valleys, passes, or mountainous areas that have all the characteristics of roads or streets traversing level or rolling terrain should be classified as level or rolling. In general, rolling terrain generates steeper grades than level terrain, causing trucks to reduce speeds below those of passenger cars; mountainous terrain has even greater effects, causing some trucks to operate at crawl speeds.

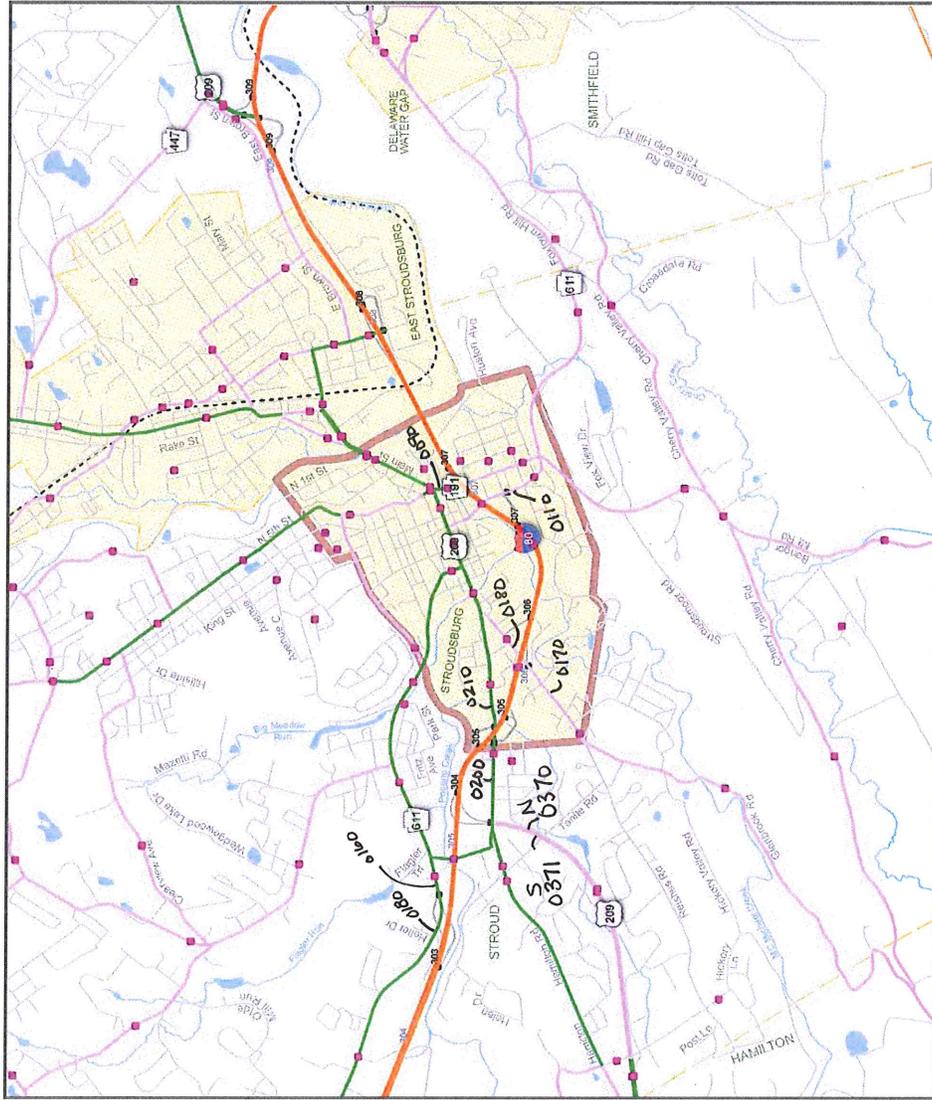
Grades

Roads and streets should be designed to encourage uniform operation throughout. As discussed earlier in this chapter, design speeds are used as a means toward this end by correlation of various geometric features of the road or street. Design criteria have been determined for many highway features, but few conclusions have been reached on the appropriate relationship of roadway grades to design speed. Vehicle operating characteristics on grades are discussed and established relationships of grades and their lengths to design speed are developed below.

I-80 Reconstruction

Map Legend

- Traffic Sites
- AADT 20,000 - 50,000
- AADT 10,000 - 20,000
- AADT < 10,000
- Exits
- Interstates
- State Routes
- Local Roads
- Rail
- Selected Municipality
- Municipality Boundaries
- Water
- Cities / Boroughs
- District Boundary
- Route Shields
- Ab123 Text Labels



2/4/2013 1:32 PM



SITE NO: 3784	
County	MONROE (45)
Route	0080
Segment	3064
Dir	E
Current Avg Daily Traffic	28146
Current Avg Daily Truck Volume	6192
K Factor	9
D Factor	65
T Factor	10
Truck Percent	22
Base Traffic Year	2010
Traffic Pattern Group	URBAN - INTERSTATE

Job# 40284833
 Calc# 1
 Page 39
 Project: I-80 Reconstruction
 Originator: JWC
 Reviewer: JWC



SITE NO: 3779	
County	MONROE (45)
Route	0080
Segment	3011
Dir	W
Current Avg Daily Traffic	27195
Current Avg Daily Truck Volume	5581
K Factor	8
D Factor	55
T Factor	15
Truck Percent	21
Base Traffic Year	2011
Traffic Pattern Group	URBAN - INTERSTATE

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Int. 303

SITE NO: 10792

County	MONROE (45)
Route	0611
Segment	0180
Dir	B
Current Avg Daily Traffic	15894
Current Avg Daily Truck Volume	664
K Factor	10
D Factor	55
T Factor	4
Truck Percent	4
Base Traffic Year	2009
Traffic Pattern Group	URBAN - MINOR ARTERIALS, COLLECTORS, LOCAL ROADS

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Reviewer:



Int. 303

SITE NO: 6947	
County	MONROE (45)
Route	0611
Segment	0160
Dir	B
Current Avg Daily Traffic	18648
Current Avg Daily Truck Volume	559
K Factor	11
D Factor	55
T Factor	2
Truck Percent	3
Base Traffic Year	2008
Traffic Pattern Group	URBAN - MINOR ARTERIALS, COLLECTORS, LOCAL ROADS

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Reviewer:



Int. 304

SITE NO: 3796	
County	MONROE (45)
Route	0209
Segment	0370
Dir	N
Current Avg Daily Traffic	8959
Current Avg Daily Truck Volume	718
K Factor	9
D Factor	70
T Factor	5
Truck Percent	8
Base Traffic Year	2011
Traffic Pattern Group	URBAN - OTHER PRINCIPAL ARTERIALS

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Int. 304

SITE NO: 3796	
County	MONROE (45)
Route	0209
Segment	0371
Dir	S
Current Avg Daily Traffic	8960
Current Avg Daily Truck Volume	643
K Factor	9
D Factor	70
T Factor	5
Truck Percent	7
Base Traffic Year	2011
Traffic Pattern Group	URBAN - OTHER PRINCIPAL ARTERIALS

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Int. 305

SITE NO: 31422

County	MONROE (45)
Route	2012
Segment	0200
Dir	B
Current Avg Daily Traffic	12947
Current Avg Daily Truck Volume	485
K Factor	9
D Factor	55
T Factor	3
Truck Percent	4
Base Traffic Year	2008
Traffic Pattern Group	URBAN - MINOR ARTERIALS, COLLECTORS, LOCAL ROADS



Posted 40 mph

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Reviewer:

Int. 305

SITE NO: 6908	
County	MONROE (45)
Route	2012
Segment	0210
Dir	B
Current Avg Daily Traffic	11324
Current Avg Daily Truck Volume	793
K Factor	13
D Factor	55
T Factor	4
Truck Percent	7
Base Traffic Year	2008
Traffic Pattern Group	URBAN - OTHER PRINCIPAL ARTERIALS

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Reviewer: ZLZ



Int. 306

SITE NO: 17163	
County	MONROE (45)
Route	2004
Segment	0180
Dir	B
Current Avg Daily Traffic	3773
Current Avg Daily Truck Volume	134
K Factor	11
D Factor	65
T Factor	7
Truck Percent	4
Base Traffic Year	2009
Traffic Pattern Group	URBAN - <u>MINOR ARTERIALS</u> , COLLECTORS, LOCAL ROADS

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Originator: JLR 2/28/15
Reviewer:



FCMap

posted speed = 35 mph

Int. 306

SITE NO: 6920

County	MONROE (45)
Route	2004
Segment	0170
Dir	B
Current Avg Daily Traffic	3455
Current Avg Daily Truck Volume	100
K Factor	9
D Factor	60
T Factor	4
Truck Percent	3
Base Traffic Year	2011
Traffic Pattern Group	URBAN - MINOR ARTERIALS, COLLECTORS, LOCAL ROADS

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Originator: JMB CLK/13
Reviewer:



Int 307 (WB 1-80)

SITE NO: 25156	
County	MONROE (45)
Route	0191
Segment	0090
Dir	B
Current Avg Daily Traffic	12378
Current Avg Daily Truck Volume	495
K Factor	11
D Factor	55
T Factor	2
Truck Percent	4
Base Traffic Year	2009
Traffic Pattern Group	URBAN - OTHER PRINCIPAL ARTERIALS

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Originator: JMK
Reviewer: JMK



Posted 35 mph

Int. 307 (EB I-80)

SITE NO: 25189	
County	MONROE (45)
Route	0611
Segment	0110
Dir	B
Current Avg Daily Traffic	8871
Current Avg Daily Truck Volume	444
K Factor	10
D Factor	55
T Factor	3
Truck Percent	5
Base Traffic Year	2006
Traffic Pattern Group	URBAN - <u>MINOR</u> <u>ARTERIALS</u> , COLLECTORS, LOCAL ROADS

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Originator: JAC ZLS/JS
Reviewer:



Posted 35 mph