Urban Streets Roadway Design Criteria for Posted Speed Limits of 40 mph or Less

Functional Class	Design Year ADT Thresholds at Levels of Service C, D & E [1]				Design Basis	Roadway Criteria [9]						
						Travel Lanes			Roadway (Face of Curb to Face of Curb) Width (feet)[4]			
									No Parking[6,7]		Parking [6,7]	
	Scenarios	C[2] LOS 4.0 ADTs (DHVs)	D LOS 5.0 ADTs (DHVs)	Middle E LOS 5.5 ADTs (DHVs)	Urban Design Class [Design Speed] (mph)[3]	No.	Lane Widths (feet)[5]	Median Widths (feet)	Range of Normal Widths[8]	Range of Widths including Bike Accommodations/ Lanes	Range of Normal Widths[8]	Range of Widths including Bike Accommodations/ Lanes
Locals	N/A	Low Volume Residential (0-250 ADT)			1a **[20-25]**	1	**12**	No	**N/A**	**N/A**	**28**	**N/A**
		Volume not a consideration			1b **[25-30**(20)**]**	2	**10-12** (9)	No	**24-28** (22)	**32-36** (30)	**36-40** (32)	**46-56** (44)
Arterials and Collectors	N/A	≤ 4,500 ADT (660 DHV)			2a **[30-45]**	2	**11-12** (10)	No	**34-36** (24)	**34-36** (32)	**46-48** (34)	**48-56** (46)
	Worst Best	6,500 (1086) 20,000 (2260)	7,500 (1170) 22,500 (2475)	8,000 (1216) 25,000 (2700)	2b **[30-45]**	2	**11-12** (10)	No	**34-36** (24)	**34-36** (32)	**46-48** (34)	**48-56** (46)
	Worst Best	16,000-(1888) 41,000 (4100)	17,500 (2048) 47,000 (4610)	18,000 (2088) 50,500 (4900)	3 **[30-45]**	4	**11-12** (10)	No	**48-60** (44)	**56-60** (52)	**68-72** (54)	**70-80** (66)
	Worst Best	22,000 (2440) 41,500 (4110)	22,750 (2500) 47,000 (4610)	23,000 (2530) 51,000 (4950)	4 **[30-45]**	4	**11-12** (10)	**14-30** (6)	**2 @ 26-28** (2 @ 24)	**2 @ 30-32** (2 @ 28)	**2 @ 36-38** (2 @ 29)	**2 @ 37-42** (2 @ 35)
Arterials	Worst Best	35,500 (3660) 68,000 (6390)	37,500 (3790) 76,000 (7070)	38,500 (3850) 81,500 (7580)	5 **[30-45]**	6	**11-12** (10)	**14-30** (6)	**2 @ 36-40** (2 @34)	**2 @ 41-44** (2 @ 38)	**2 @ 47-50** (2 @ 39)	**2 @ 48-54** (2 @ 45)

Upper values are shown in **bold** and Lower values are shown in parentheses. Use of values below existing roadway dimensions are to be justified by completing environmental process, predictive safety and benefit/cost analyses.

See page 2 of this attachment for superscript notes.

Superscript Notes:

1 ADT thresholds represent typical "Worst" Case and "Best" Case scenarios for Levels of Service (LOS) C, D and middle E. These volumes are based on the 2000 Highway Capacity Manual using the assumptions shown in Attachment 1.4. See Section 1.5, "Travel Lanes" section for guidance on use of "worst" and "best" case thresholds. See FDM 11-5-3 for further guidance on acceptable LOS for Corridors 2030 Routes, Non-Corridors 2030 rural roadways, roadways in small urban areas (Pop. < 50,000), and roadways in Urbanized areas (Pop. > 50,000).

2 LOS C is not obtainable if the traffic signal density is greater than 5 signals per mile.

3 Design Speeds should be 5 mph greater than the posted speeds.

4 Based on 2-foot gutter widths. Gutter widths of 1-foot may be used when appropriate. If 1-foot gutters are used, then the face-to-face widths might differ from values shown in the table.

5 Gutter widths are not included.
Lane widths for Federally Designated Long Truck (i.e. the "National Network" as defined in 23 CFR Part 658) Routes are 12-foot (11-foot minimum), but there shall be at least one 12-foot lane in each direction. Wide curb lanes, as discussed in Section 1.5, "Travel Lanes", meets the 12-foot truck lane criteria.
Lane widths for NHS Routes and Arterials and Collectors that are not Federally Designated Truck Routes are 12-foot (11-foot minimum) if truck and bus volumes exceed an average of 200/lane/day for undivided roadways, and 300/lane/day for divided roadways (e.g., the threshold for urban design class 3 (4-lane undivided) is 4 x 200 = 800 trucks per day; the threshold for urban design class 4 (4-lane divided) is 4 x 300 = 1,200 trucks per day).

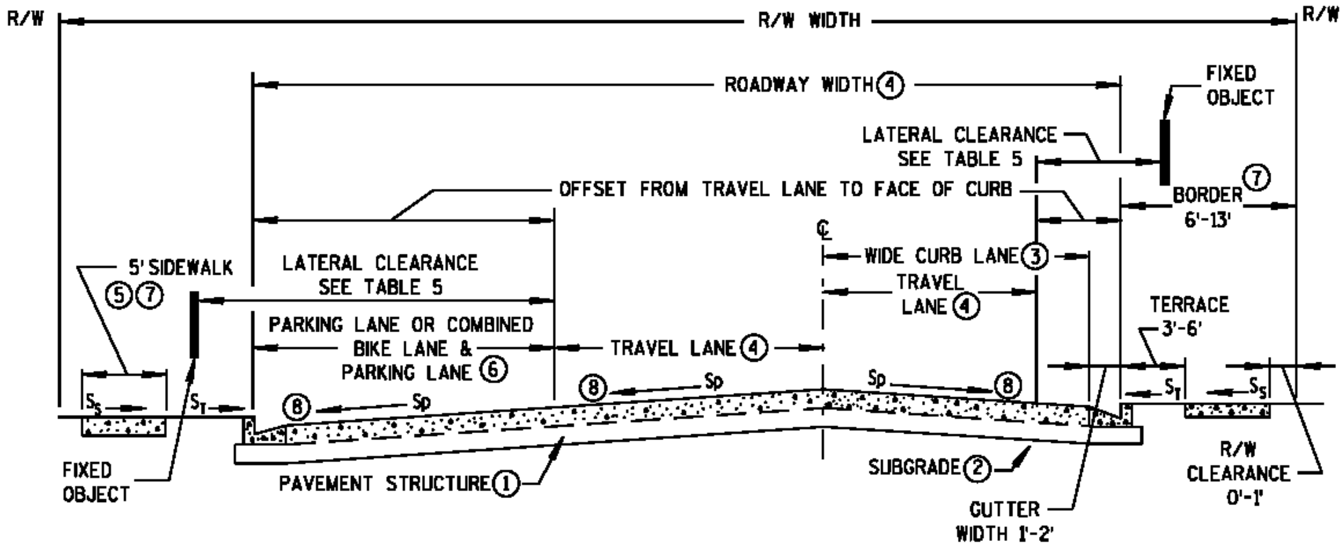
6 Two lane Connecting Highways and STHs should have curb to curb widths of 36 feet if no provisions for parking are to be made. Designs that use parking lanes are discouraged.

7 Department policy in conformance with Federal policy, Wis. Stat. Section 84.01(35) and Connections 2030 shall give due consideration to establishing bikeways and pedestrian ways on new construction and reconstruction highway projects (including pavement replacement projects) funded in whole or part from state or federal funds. FDM 11-46 provides guidance on the process and evaluation analyses. In addition, certain bicycle and pedestrian design practices are required when applicable, e.g., curb ramps and bicycle-acceptable grates.

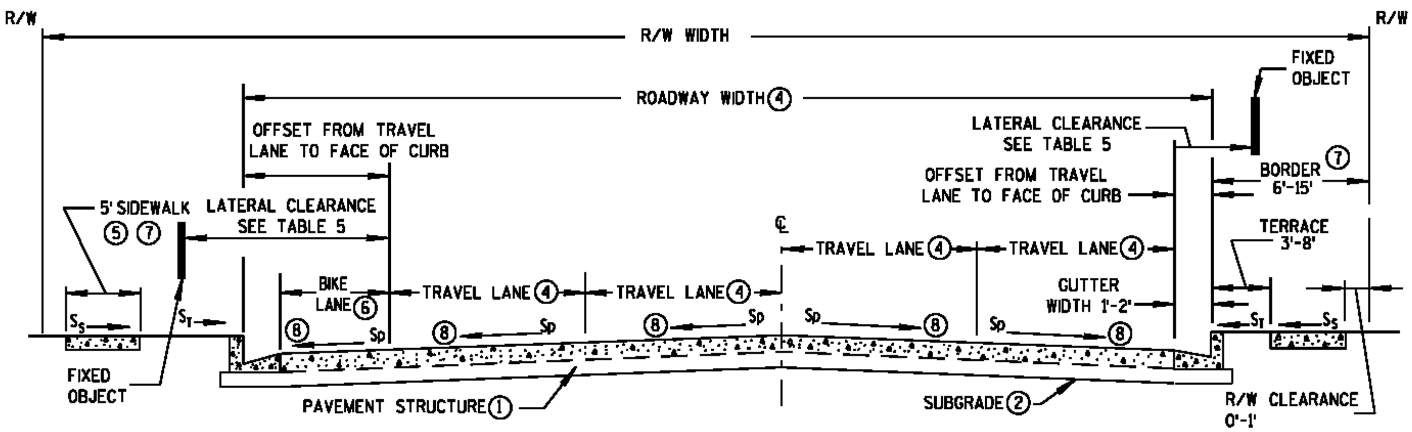
See FDM 11-46 for additional information and guidance on bicycle and pedestrian accommodations and policies.

8 The upper ranges of values include the additional roadway widths between the outside edges of the outside travel lanes and the faces of curbs to provide wide curb lanes as discussed in FDM 11-20-1.5, "Travel Lanes", or to provide for the various urban needs as listed in FDM 11-20-1.6, "Auxiliary and Parking Lanes".

9 See FDM 11-35-1.2.3 for bridge width criteria for urban roadways.



Urban Design Classes 1b, 2a & 2b



Urban Design Class 3

Notes:

① Pavement structure, materials and dimensions vary according to individual project subgrade and traffic conditions.

② Subgrade cross slopes are parallel to pavement cross slopes (S_P).

③ FDM 11-20-1.5 discusses “Wide Curb Lanes”. See FDM 11-46-15.3 for limits on wide curb lane longitudinal joint placements for concrete pavement thicknesses less than 10 inches.

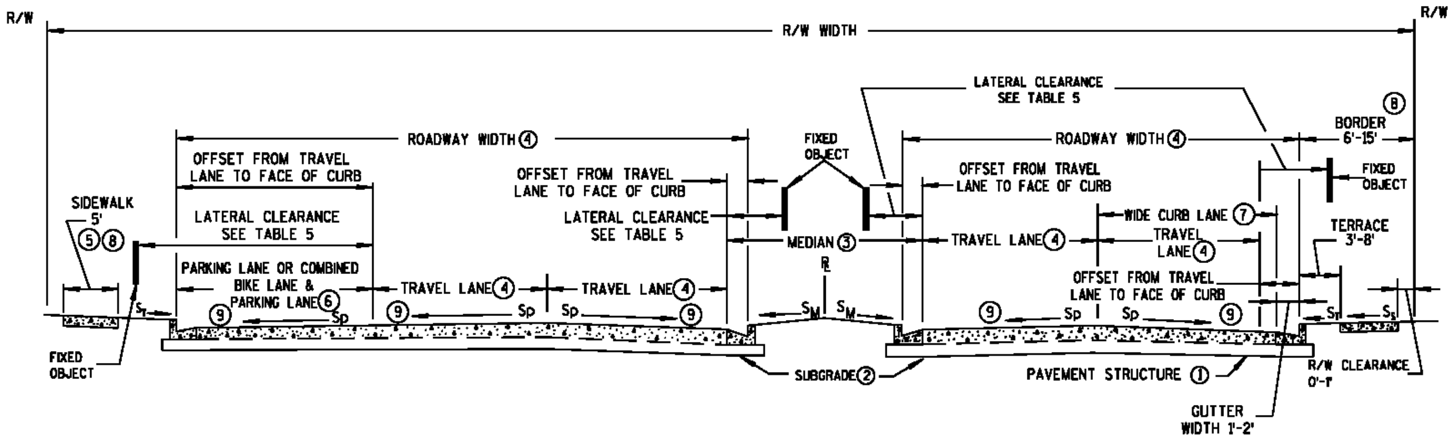
④ Attachment 1.1 shows travel lane widths and roadway widths.

⑤ The 5-foot sidewalk widths shown are for residential areas where the sidewalks are adjacent to terraces. Sidewalks are to be 6-foot wide if adjacent to the backs of curbs. Sidewalk widths are typically 6-12 feet in central business districts or in high pedestrian retail areas or where stores are directly abutting sidewalks.

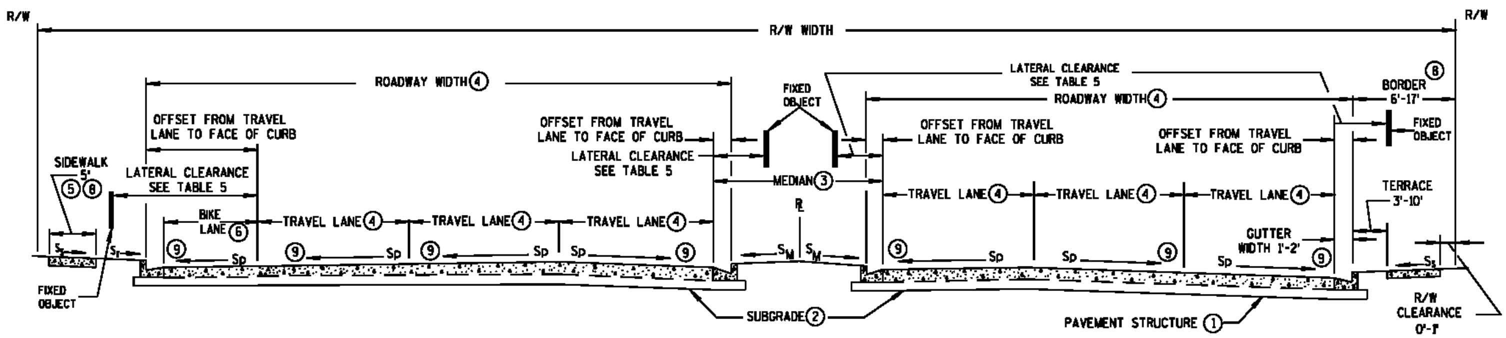
⑥ Table 1.4 shows parking lane widths; FDM 11-46-15 has guidance on bike lanes and on combined bike lanes and parking lanes; Attachment 1.1 shows roadway width design values.

⑦ FDM 11-46-5.2 (Urban Borders and Zone System) discusses borders including widths and slopes for sidewalks and terraces.
S_T = Terrace cross slopes = 4% typical. Grass = 4% lower min., Paved = 2% lower min./ 2% upper minimum when adjacent to on-street parking. See FDM 11-46-5.2.2 (Terraces).
S_S = Sidewalk cross slopes = 1.5%, ± 0.5% construction tolerance.

⑧ Table 1.1 shows pavement cross slopes.
S_P = Pavement cross slopes = 2% lower minimum.



Urban Design Class 4



Urban Design Class 5

Notes:

① Pavement structure, materials and dimensions vary according to individual project subgrade and traffic conditions.

② Subgrade cross slopes are parallel to pavement cross slopes (S_P).

③ FDM 11-20-1.4 (Medians), discusses medians for urban streets. Attachment 1.1 shows the range of median widths to use. S_M = Median cross slopes = 2% (paved) / 4% (grass)

④ Attachment 1.1 shows travel lane widths and roadway widths.

⑤ The 5-foot sidewalk widths shown are for residential areas where the sidewalks are adjacent to 3 foot or wider terraces. Sidewalks are to be 6-foot wide if adjacent to terraces less than 3-foot wide. Sidewalk widths are typically 6-12 feet in central business districts or in high pedestrian retail areas or where stores are directly abutting sidewalks.

⑥ Table 1.4 shows parking lane widths; FDM 11-46-15 has guidance on bike lanes and on combined bike lanes and parking lanes.

⑦ FDM 11-20-1.5 (Travel Lanes) discusses "Wide Curb Lanes". See FDM 11-46-15.3 for limits on wide curb lane longitudinal joint placements for concrete pavement thicknesses less than 10 inches.

⑧ Refer to FDM 11-46-5.2 (Urban Borders and Zone System).
S_T = Terrace cross slopes = 4% lower minimum for grass. 2% lower minimum for paved/ 2% upper minimum when adjacent to on-street parking.
S_S = Sidewalk cross slopes = 1.5%, ± 0.5% construction tolerance.

⑨ Table 1.1 shows pavement cross slopes.
S_P = Pavement cross slopes = 2% lower minimum.

Urban Class	Traffic Factors	Lane Width (feet)	% Trucks	Parking/Bus Stops	% Grade	Adjusted Saturation Flow Rate (pcphgpl)	% Turns from Exclusive Lanes	Number of Through Lanes One Direction	Free Flow Speed (FFS)	HCM Urban Class	Median	Left-turn Bays	Number of Signalized Intersections (Actuated)	Arrival Type	Cycle Length (C)	Effective Green Ratio (g/c)
2b																
Worst	K30	10	6	Yes	4	1700	10	1	35	3	No	No	1	3	80	0.45
Case									30	4			4	4		
	59/41								30	4			7	4		
	Directional															
	Distribution	12+	2	No	0	1900	10	1	35	3	No	Yes	1	4	110	0.55
Best									30	4			4	5		
Case	1.00 PHF								30	4			7	5		
3																
Worst	K30	10	6	Yes	4	1700	10	2	40	2	No	No	1	3	90	0.40
Case									35	3			4	4		
	59/41								30	4			7	4		
	Directional															
	Distribution	12	2	No	0	1900	10	2	40	2	No	Yes	1	4	110	0.50
									35	3			4	5		
Best	1.00 PHF								30	4			7	5		
Case																
4																
Worst	K30	10	6	Yes	4	1700	10	2	40	2	Yes	No	1	3	90	0.45
Case									35	3			4	4		
	59/41								30	4			7	4		
	Directional															
	Distribution	12	2	No	0	1900	10	2	40	2	Yes	Yes	1	4	110	0.50
Best									35	3			4	5		
Case	1.00 PHF								30	4			7	5		
5																
Worst	K30	10	7.5	Yes	4	1700	10	3	40	2	Yes	No	1	3	90	0.45
Case									35	3			4	4		
	59/41								30	4			7	4		
	Directional															
	Distribution	12	4	No	0	1900	10	3	40	2	Yes	Yes	1	4	110	0.50
Best									35	3			4	5		
Case	1.00 PHF								30	4			7	5		

Design Class[1]	Design ADT	No. of Lanes	Lane Widths By Posted Speed[2]		Median Width[3]	Shoulder (Curb Offset) Width Based on Posted Speed[4]				
						45 mph (By Level of Development)				
			45-50 mph	55 mph		Undeveloped	Developing[5]	Developed[5]	50-55 mph	Bike Lanes[5]
Collectors & Locals										
UCL1	0-400	2	**11-12** (10)	**11-12** (10)		**2** (1.8)	**2** (1.8)	**2** (1)	**2**	**5**
UCL2	400-1500	2	**11-12**	**11-12**		**6** (5)	**6** (1.8)	**4-6** (1-1.8)	**6**	**5-6**
UCL3	1500-2000	2	**11-12**	**12**		**6**	**6** (1.8)	**4-6** (1-1.8)	**6**	**5-6**
UCL4	2000-3500	2	**12**	**12**		**6**	**6** (1.8)	**4-6** (1-1.8)	**6**	**5-6**
UCL5	3500-20,000	2	**12**	**12**		**8**	**8** (1.8)	**4-8** (1-1.8)	**8**	**5-8**
	20,000-42,000	4	**12**	**12**	30	**6L** (4L) **10R**	**6L** (1.8L) **10R** (1.8L)	1.8-6L 4-10R	**6L** **10R**	10
Arterials										
UA1	Under 3500	2	**12**	**12**		**6**	**6** (1.8)	**4-6** (1-1.8)	**6**	5-6
UA2	3500-17,000[A] 3500-19,000[B]	2	**12**	**12**		**10** (8)	**10** (1.8)	**4-10** (1-1.8)	**10 (8)**	10
UA3	17,000-39,000[A] 19,000-42,000[B]	4	**12**	**12**	30	**6L** (4L) **10R**	**6L** (1.8L) **10R** (1.8R)	**1.8-6L** (1L) **4-10R (1-1.8R)**	**6L (4L)** **10R**	10
		6	**12**	**12**	30	**10L and 10R**	**10L and 10R** (1.8L & 1.8R)	**1.8-10L** **4-10R (1-1.8R)**	**10L & 10R**	10
See FDM 11-35-1.2.3 for bridge width criteria for urban roadways.										

Recommended Clear Zone or Lateral Clearance Based on Posted Speed Limit			
45 mph (By Level of Development)			50-55 mph
Undeveloped	Developing	Developed	
Provide Rural Clear Zone. See FDM 11-15 Attachment Att.1.9 Consult with Local Unit of Government or Maintaining Authority as to need for future sidewalk and terraces.	Provide Rural Clear Zone until development occurs. See FDM 11-15 Attachment 1.9 & FDM 11-20-1 Coordinate sidewalk and terrace widths with local unit of government or maintaining authority.	Provide lateral clearance per FDM 11-20 Table 1.5. If sidewalk is not present, discuss construction of sidewalk and terrace with the local unit of government or maintaining authority.	Use rural clear zone. See FDM 11-15 Attachment 1.9.
Lateral Clearance is important to provide on all roadways			

Upper values are shown in **bold** and Lower values are shown in parentheses.

See page 2 of this attachment for superscript notes.

NOTES:

A For Corridors 2030 Backbone and Connector Routes.

B For Other Principal and Minor Arterials.

1 The top of the traffic volume range for design class UA2 is 17,000 ADT and for design class UA3 is 39,000 ADT for Corridors 2030 Routes (LOS threshold of 4.0) and 19,000 ADT and 42,000 ADT for a Non-corridors 2030 Routes (LOS trigger of 5.0). These volumes are based on the 2000 Highway Capacity Manual assuming; level terrain, 12-foot lanes, ≥ 6-foot shoulders, 10% trucks, K30 design factor, and 59/41 directional split,1 signal/mile, g/c=.55. See FDM 11-5-3 for additional information on thresholds and levels of service for different facility types and the respective numerical values.

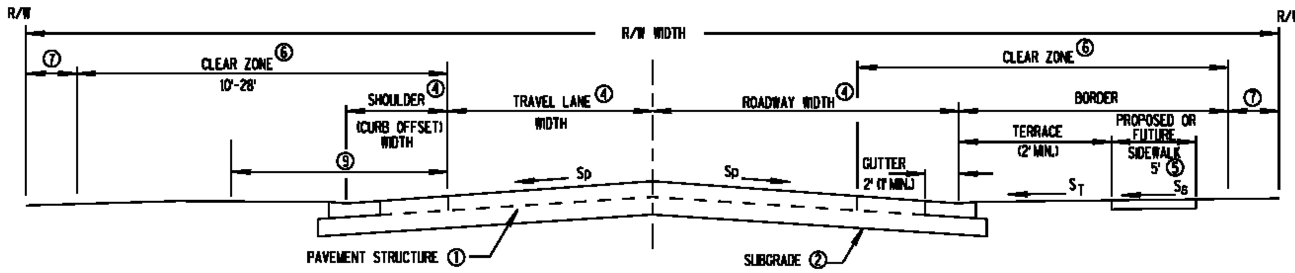
2 Design Speeds should be 5 mph greater than the posted speeds.

3 Provides room for clear zones in one direction for up to 60 mph design speeds and for future cable-guard median barriers. Provides Upper width needed for single movement truck turning maneuvers.

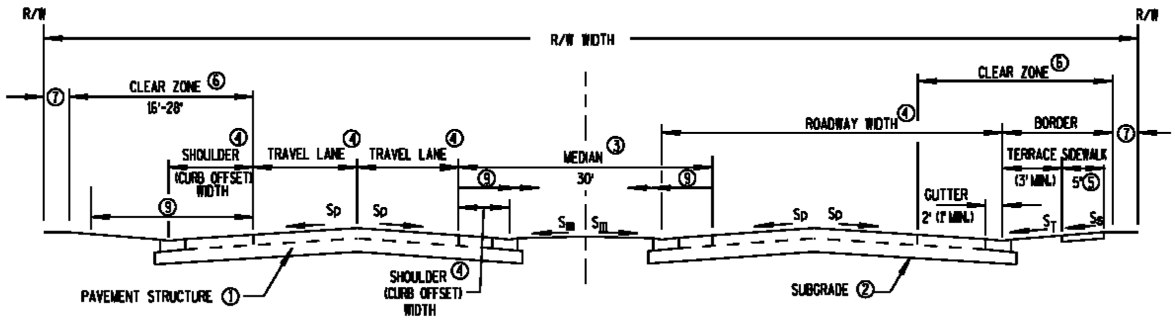
4 Curbs should be eliminated if possible. Use sloped curbs when posted speed limits are 45 mph or greater. See FDM 11-20-1.

5 Department policy is in conformance with Federal policy, Wis. Stat. Section 84.01(35) and Connections 2030 shall give due consideration to establishing bikeways and pedestrian ways on new construction and reconstruction highway projects funded in whole or part from state or federal funds. FDM 11-46 provides guidance on the process and evaluation analyses.

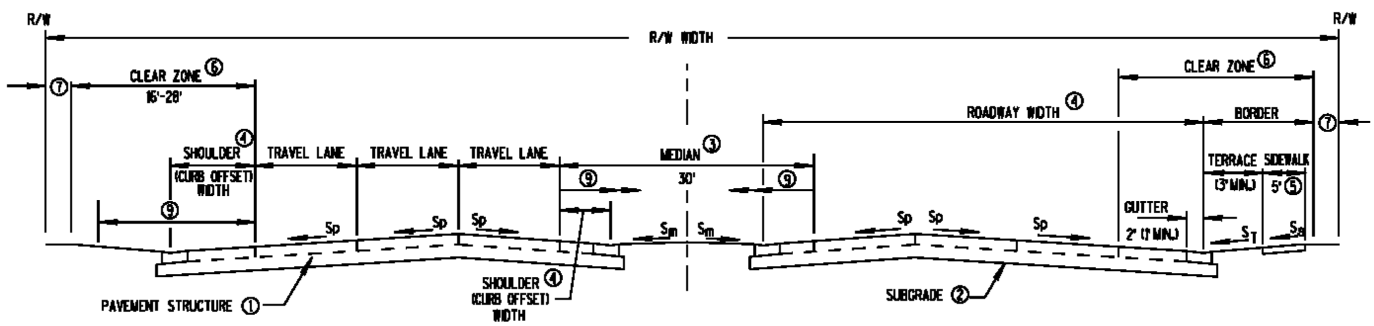
In addition, certain bicycle and pedestrian design practices are required when applicable, e.g., curb ramps and bicycle-acceptable grates. See FDM 11-46 for additional information and guidance on bicycle and pedestrian accommodations and policies.



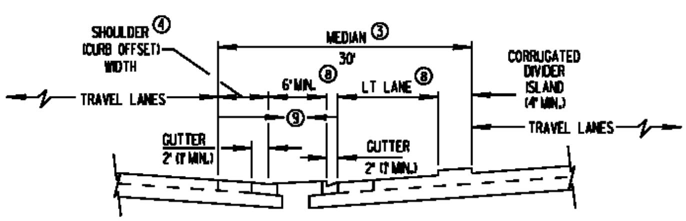
2-LANE TRANSITIONAL/HIGH SPEED URBAN CROSS SECTION



4-LANE TRANSITIONAL/HIGH SPEED URBAN CROSS SECTION



6-LANE TRANSITIONAL/HIGH SPEED URBAN CROSS SECTION



LT LANE TYPICAL CROSS SECTION

TYPICAL TRANSITIONAL/HIGH SPEED URBAN STREET CROSS SECTIONS

① Pavement structure, materials and dimensions vary according to individual project subgrade and traffic conditions.

② Subgrade slopes are parallel to pavements.

③ See discussion on “medians” for values.

⑤ Values given in FDM 11-20 Attachment 1.5

④ See FDM 11-46-5 for sidewalk information. See FDM 11-46-15.6 for shared-use path information.⑥ See discussion on clear zones and lateral clearances in FDM 11-20 Table 1.5.

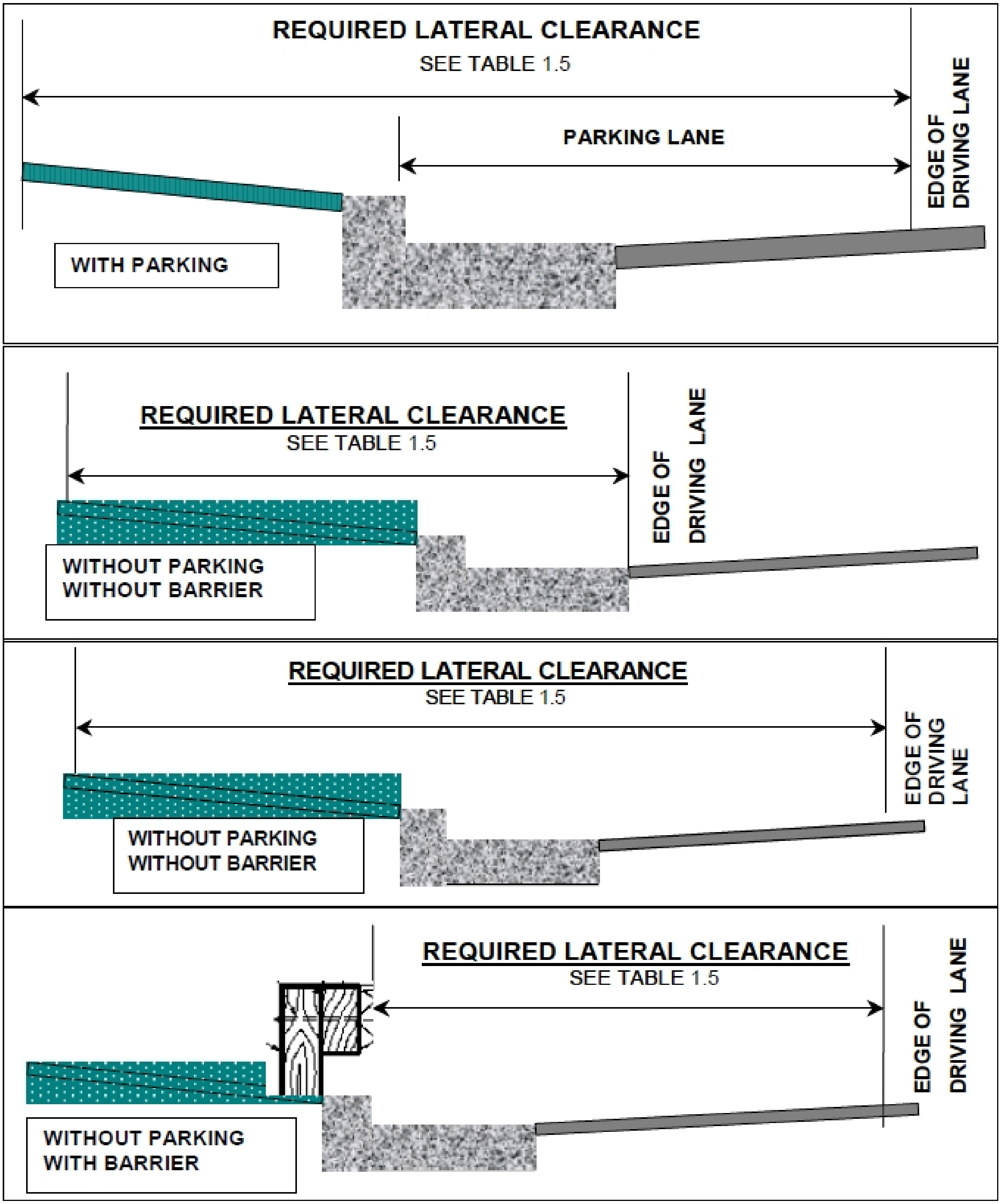
Border: S_T = Terrace cross slopes = 4% lower minimum for grass. 2% lower minimum for paved/ 2% upper minimum when adjacent to on-street parking. See FDM 11-46-5.2.2.

Border: S_S = Sidewalk cross slopes = 1.5%. $\pm$ 0.5% construction tolerance.

⑦ Additional widths as needed for utilities

⑧ Values given in FDM 11-25-5.

⑨ Lateral clearances. See FDM 11-20 Table 1.5



Urban Lateral Clearance

Run off the Road (ROR) Frequency Calculator

(The run off the road frequency spreadsheet calculator can be found at: FDM 11-20 A1.8 File1)

Run off the road frequency calculator is based on guidance provided by AASHTO Highway Safety Manual Chapter 12. Use this calculator on urban, suburban and roadways that transition from urban areas to high speed rural highways.

This calculator generates an approximate change in discreet fixed object hazard impacts for roadsides (i.e. right side of the roadway). A discrete fixed object hazard is any individual object that is 4 or more inches in diameter (e.g. poles, trees, rocks, luminaries) or will grow to be greater than 4 inches in diameter. In addition, a discrete fixed object hazard is taller than 4 inches on a 5-foot chord. Continuous hazards (e.g. barrier systems, bridge abutments, buildings) cannot be evaluated using this calculator.

Research indicates that it is difficult for an errant vehicle to slip between fixed objects that are spaced 25 feet or less apart. Treat similar discreet fixed object hazards that are 25 feet apart or less as a continuous hazard.

The Highway Safety Manual indicates that breakaway hazards are not to be included. However, this calculator deals with frequency of crashes and not severity of crashes. Installing breakaway hardware will increase the number of recorded run off the road crashes. Include large breakaway features (e.g. breakaway luminaries, large guide signs on breakaway features). Individual signs installed on breakaway 4"x6" post do not need to be included in the analysis.

Include signal, railroad crossing devices, and fire hydrants in the frequency calculator. These devices typically have an exception to allow the use of non-breakaway features (See 2011 AASHTO Roadside Design Guide for more discussion). If the frequency of ROR crashes is equal to or above the threshold for documentation, provide discussion that these fixed objects have an exception in the DSR.

In certain situations, light pole can be non-break away (e.g. high mast lighting, areas where there is a high pedestrian density…). If using non-break away light poles and frequency of ROR crash is equal to or above the threshold for documentation, provide discussion on why non-break away light poles are being used. Discuss methods to mitigate the likelihood of ROR crashes with light poles.

The calculator can be set up to generate the frequency of roadside crashes for one side of the roadside (i.e. Number of Right Side(s) of the roadway =1) or both roadsides (i.e. Number of Right Side(s) of the roadway =2). If the density of fixed objects is similar on both sides of the roadway, the number of Right(s) of the roadway should be set at 2. If there is a significant difference in the density of fixed objects on one side of the roadway (e.g. utility poles are on one side of the roadway and not the other) set the Number of Right Side(s) of the roadway to 1 and analyze each side of the roadway separately.

The calculator cannot calculate increase in crash frequency due to hazards in a median. Although the calculator cannot calculate a change in crash frequency for medians, other research indicates that increasing fixed object density in the median increases ROR crashes.

Typically, use the mathematical average offset from edge of marked lane to discrete fixed object hazards in calculator. The maximum offset from edge of lane is 30 feet. If an object is beyond 30 feet from the edge of marked lane, assume the offset to that hazard is 30 feet. If a lane is not marked, follow guidance in FDM 11-45-20.5.

Review distribution of discreet hazard offsets. If the distribution is skewed by a few discreet fixed objects that are far from the roadway use median value (see example below). A few fixed object hazards that are 30 ft from the edge of marked lane can significantly change the crash frequency.

Example 1:

Roadway Type:	4-Lane Undivided
Number of Right Side(s) of Road:	2
Average Offset to Hazard (FT):	See below
Number of Hazards:	11
Length of Analysis (FT):	1000

Discrete Fixed Object Hazard Distribution

Number	Offset (FT)
1	5
2	30
3	5
4	5
5	5
6	5
7	7
8	7
9	5
10	30
11	30

		CMF
Average	12.2	1.30
Median	5	1.54

Difference in Crash Frequency	24%

Use logical segments to review run off the road frequency (e.g. intersection to intersection, intersection to bridge…). Review logical segments for areas with similar discrete fixed object hazards density. Including areas with significant differences in discreet fixed object density can dilute the change in run off the road frequency (e.g. a park within a logical segment may skew the results. See example below).

Example:

Compare two 500 ft long segments of a 2 Lane Undivided roadway

Only 1 side of the roadway is being analyzed (Number of Right Side(s) of Road=1)

Segment 1 has 2 discrete fixed object hazards 5 feet from the roadway.

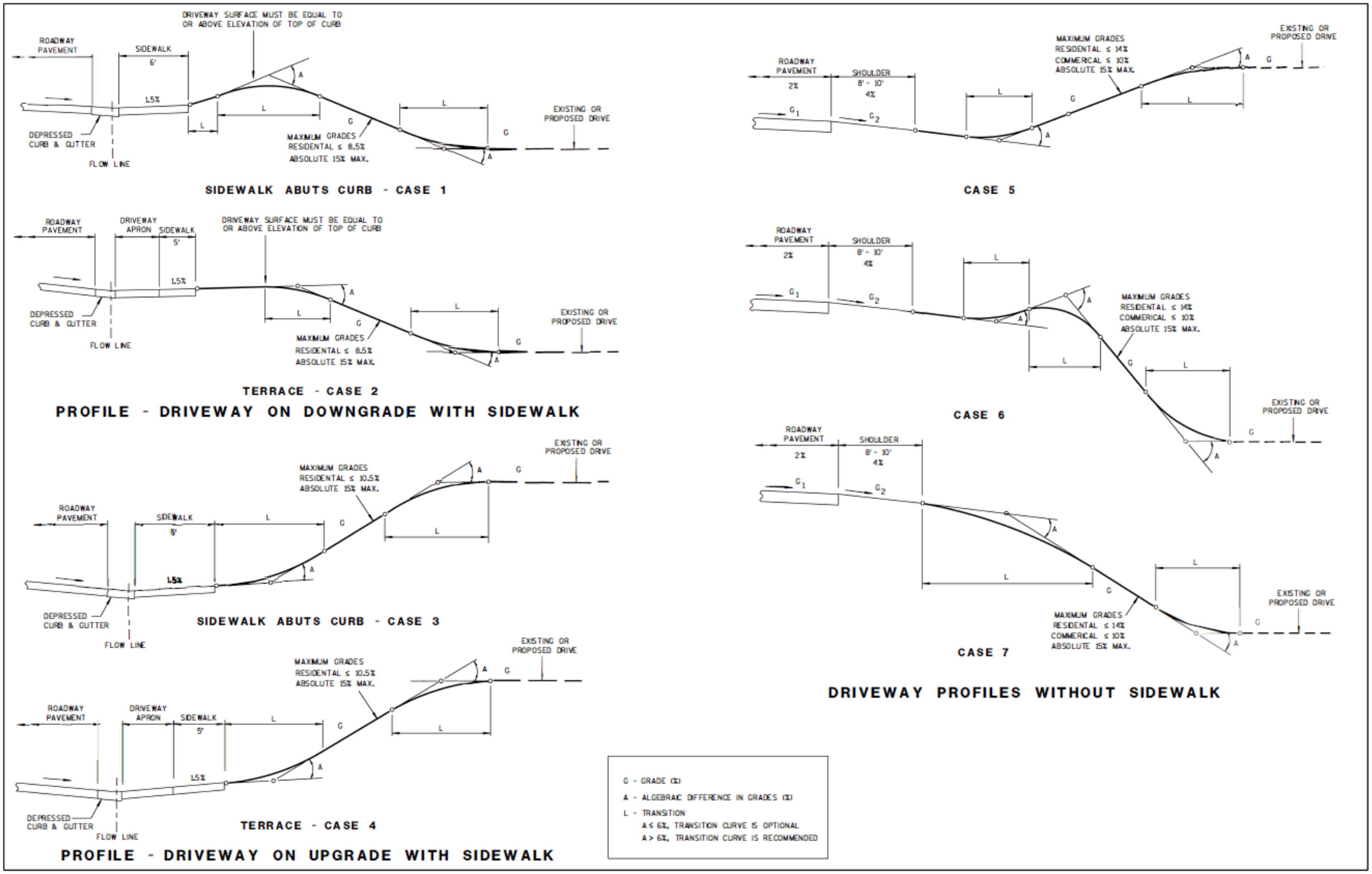
Segment 2 has 11 discrete fixed object hazards 5 feet from the roadway.

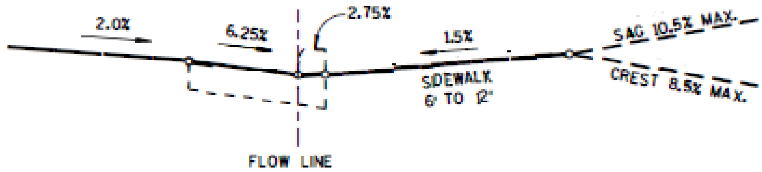
Segment 1 CMF (Crash Modification Factor) is 1.11.

Segment 2 CMF is 1.85.

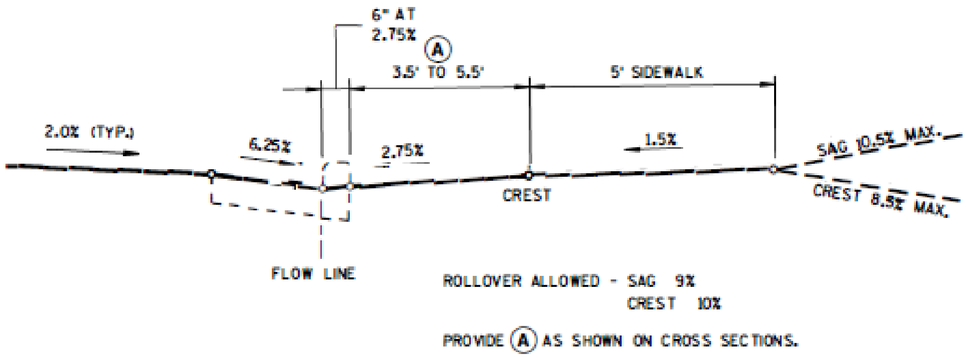
If both segments were combined in to one 1,000-foot long segment the CMF would be 1.48. Breaking the analysis into smaller segments of similar density will help project staff locate areas where adding additional fixed objects should be avoided and areas where adding fixed objects are less likely to influence ROR.

For more information on CMFs, review AASHTO’s Highway Safety Manual.

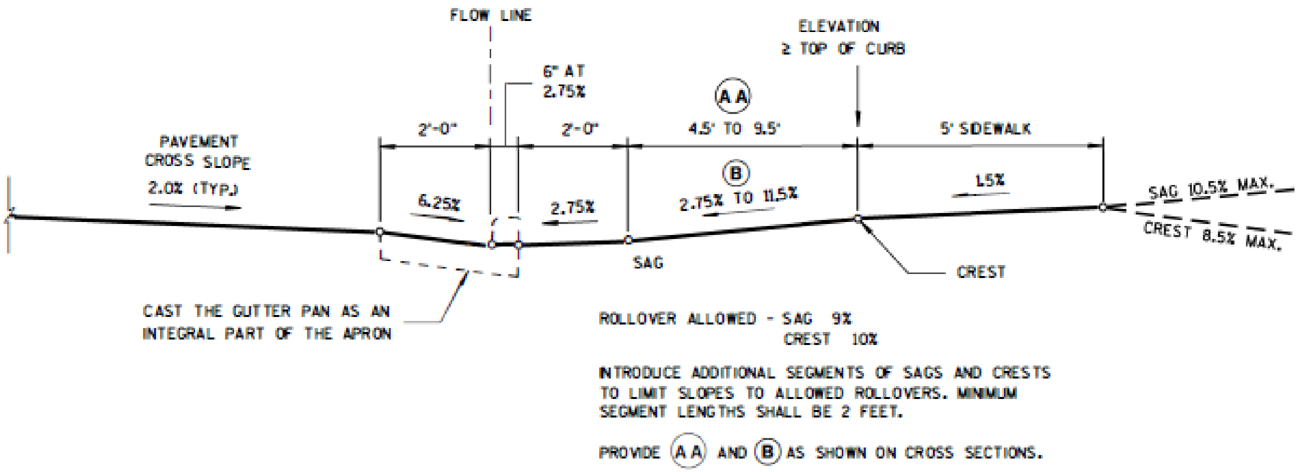

DRIVEWAY SURFACE MUST BE EQUAL TO OR ABOVE ELEVATION OF TOP OF CURB
ROADWAY PAVEMENT
SIDEWALK
6'
1.5%
DEPRESSED CURB & GUTTER
FLOW LINE
MAXIMUM GRADES
RESIDENTAL ≤ 8.5%
ABSOLUTE 15% MAX.
EXISTING OR PROPOSED DRIVE
SIDEWALK ABUTS CURB - CASE 1
DRIVEWAY APRON
SIDEWALK
5'
TERRACE - CASE 2
PROFILE - DRIVEWAY ON DOWNGRADE WITH SIDEWALK
MAXIMUM GRADES
RESIDENTAL ≤ 10.5%
ABSOLUTE 15% MAX.
SIDEWALK ABUTS CURB - CASE 3
TERRACE - CASE 4
PROFILE - DRIVEWAY ON UPGRADE WITH SIDEWALK
SHOULDER
8' - 10'
4%
2%
MAXIMUM GRADES
RESIDENTAL ≤ 14%
COMMERICAL ≤ 10%
ABSOLUTE 15% MAX.
CASE 5
CASE 6
CASE 7
DRIVEWAY PROFILES WITHOUT SIDEWALK
G - GRADE (%)
A - ALGEBRAIC DIFFERENCE IN GRADES (%)
L - TRANSITION
A ≤ 6%, TRANSITION CURVE IS OPTIONAL
A > 6%, TRANSITION CURVE IS RECOMMENDED



TYPE X DRIVEWAY



TYPE Y DRIVEWAY



TYPE Z DRIVEWAY