MTO Design Supplement

For
TAC Geometric Design Guide for Canadian Roads

Appendix 3 for Chapter 3

Alignment and Lane Configuration

~~October~~ ~~TBD~~July ~~2023~~2026

MTO Design Supplement
Appendix 3 for Chapter 3
Alignment and Lane Configuration

The following Design Supplements are applicable to *Chapter 3 – Alignment and Lane Configuration* of the *TAC Geometric Design Guide for Canadian Roads - June 2017:*

Section 3.1.1 – The Importance of Alignment and Lane Configuration Design

- This ~~Section~~ section is **~~Applicable~~ applicable** with the following **additional ~~Guidance~~guidance**:

  Fuel economy can be improved by minimizing~~/flattening~~ vertical grades. This may be considered in design if it does not compromise safety, drainage, sightlines, stopping sight distances, and is ~~economy~~economical and practical to do. Providing a flatter driving surface can result in less frequent braking, ~~lowered less differential~~smaller speed differentials~~s variability~~, and reduced accelerations and ~~/~~decelerations, therefore, reducing greenhouse gas emissions. ~~With that in mind~~In consideration of this, it is necessary to be ~~cognizant~~ mindful of the emissions associated with construction required to minimize~~ing/flattening~~ vertical grades that could potentially counteract the emissions savings (e.g., disrupting land, truck hauling, and material usage during construction).

Section 3.2.1.2 – Horizontal Alignment: Design Domain Control

- This ~~Section~~ section is **~~Applicable~~ applicable** with the following **additional ~~Guidance~~ guidance** for bullets 3 and 5:

  3. ~~Designer should consider F~~future conditions such as rain and snowfall should be considered when using predictive models for design. Additional information can be found in MTO's highway drainage policy: *Implementation of the Ministry's Climate Change Consideration in the Design of Highway Drainage Infrastructure – October 2016.* Land composition and prevalence of landslides should be considered when determining road alignment. Areas prone to landslides and soil movement should be avoided or

correctly reinforced to ensure safe conditions and avoid future maintenance costs.

5. Providing free--flow traffic conditions can help minimize congestion and associated emissions.

Section 3.2.2.4 – Maximum Superelevation: Design Domain

- This ~~Section~~ section is **~~Applicable~~ applicable** with the following **additional bullets**:
  - Drainage
  - Soil properties
  - -Local rain and snowfall patterns

Section 3.2.2.6 – Minimum Radius: Design Domain

- This ~~Section~~ section is **~~Applicable~~ applicable** along with **Exhibit -3A** which provides a set of 77 standard circular curve radii for use in design and construction. Using the standard circular curve radii provided in **Exhibit -3A** is no longer necessary. These are for general guidance and consistency in the standards as past provincial infrastructure has been built based on these radii. Since the integration of computer programs in highway design, designers ~~are deviating from these radii~~increasingly deviate from these values. However, for consistency and driver's' expectations, ~~selection of radii~~horizontal curvature should be as close as possible to the~~se~~ radii in **Exhibit -3A.**

Exhibit -3A

~~STANDARD CIRCULAR CURVES~~Standard Circular Curves

Radii in Meters						
45	100	180	340	600	1,150	2,500
50	105	190	350	650	1,200	3,000
55	110	200	380	700	1,250	3,500
60	115	210	400	750	1,300	4,000
65	120	220	420	800	1,400	4,500
70	125	230	450	850	1,500	5,000
75	130	240	475	900	1,600	6,000
80	140	250	500	950	1,700	7,000
85	150	280	525	1,000	1,800	8,000
90	160	300	550	1,050	2,000	9,000
95	170	320	575	1,100	2,200	10,000

Section 3.2.2.7 – Distribution of "E" and "F" Over a Range of Curves: Design Domain Urban Roadways: Design Domain Quantitative Aids

- This ~~Section~~ section is ~~**Applicable**~~**applicable**. Under this Section, a Subsection "*Urban Roadways: Design Domain Quantitative Aids"* discusses using alternative methods for providing superelevation rates for urban ~~high speed~~high-speed values. It references using values provided in Table 3.2.8 and Table 3.2.9 for maximum superelevation of 4% and 6% respectively. Whenever a designer uses this alternative method and values provided in Table 3.2.8 and Table 3.2.9, the designer should provide justification and document this in the design package.

Table 3.2.6 – Superelevation and Minimum Spiral Parameters, e_{max} = 0.06 m/m

- This table is **applicable**, including the following guidance for minimum horizontal curve radii for Normal Crown (NC) and Reverse Crown (RC) cross sections in **Exhibit 3-B**

Exhibit 3-B

Minimum Radii for Normal and Reverse Crown Cross Sections

	Design Speed (km/h)									
e	40	50	60	70	80	90	100	110	120	130
NC	740	1,050	1,440	1,910	2,360	2,880	3,510	4,060	4,770	5,240
RC	530	750	1,030	1,380	1,710	2,090	2,560	2,970	3,510	3,880

Table 3.2.7 – Superelevation and Minimum Spiral Parameters, e_{max} = 0.08 m/m

- Design speed 60 and radius 500 m: the spiral parameter 235 m is incorrect, and it is replaced with 135 m.

Section 3.2.3.5 – Spiral Parameter: Design Domain Application Heuristics

- This ~~Section~~ section is ~~**Applicable**~~ **applicable** along with **Exhibit -3C~~B~~** which provides standard spiral parameters for use in design. Using the standard spiral parameters provided in **Exhibit -3C~~B~~** is no longer necessary. These are for general guidance and consistency in the standards as past provincial infrastructure has been built based on these spiral parameters. Since the integration of computer programs in highway design, designers ~~are deviating from these radii~~increasingly deviate from these values.

However, for consistency and driver~~'~~s' expectations, selection of spiral parameters should be as close as possible to these spiral parameters in **Exhibit -3C~~B~~.**

Exhibit -3C~~B~~

~~STANDARD RANGE OF SPIRAL PARAMETERS A~~Standard Range of Spiral Parameters A (meters)

25	65	110	175	240	325	550	1,100
30	70	120	180	250	350	600	1,200
35	75	125	190	260	375	650	1,300
40	80	130	200	270	400	700	1,400
45	85	140	210	275	425	750	1,500
50	90	150	220	280	450	800	1,600
55	95	160	225	290	475	900	1,700
60	100	170	230	300	500	1,000	1,800

Note: Values above 700 m are beyond the normal range of application

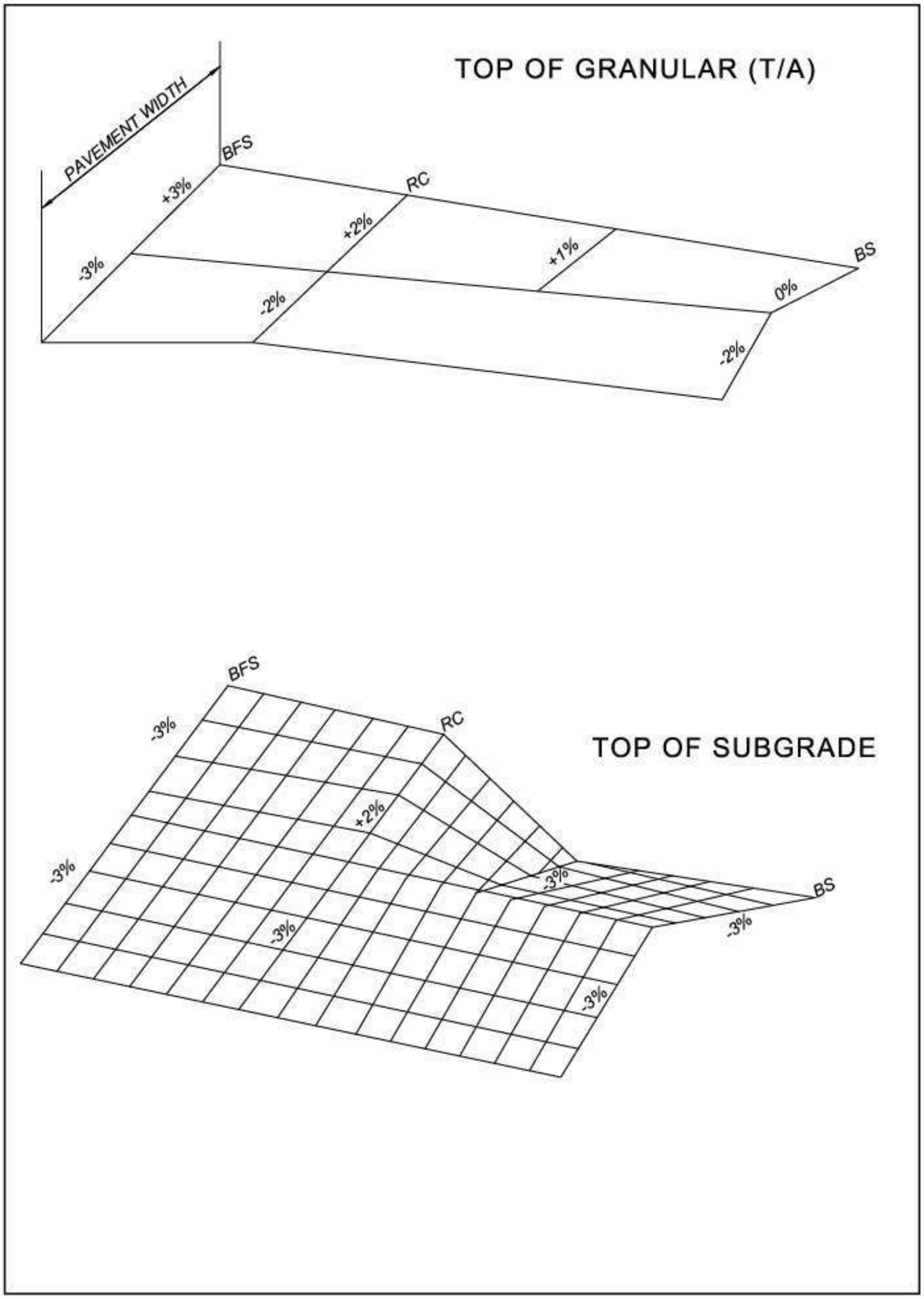
Section 3.2.4.5 – Superelevation Development: Design Domain General Application Heuristics

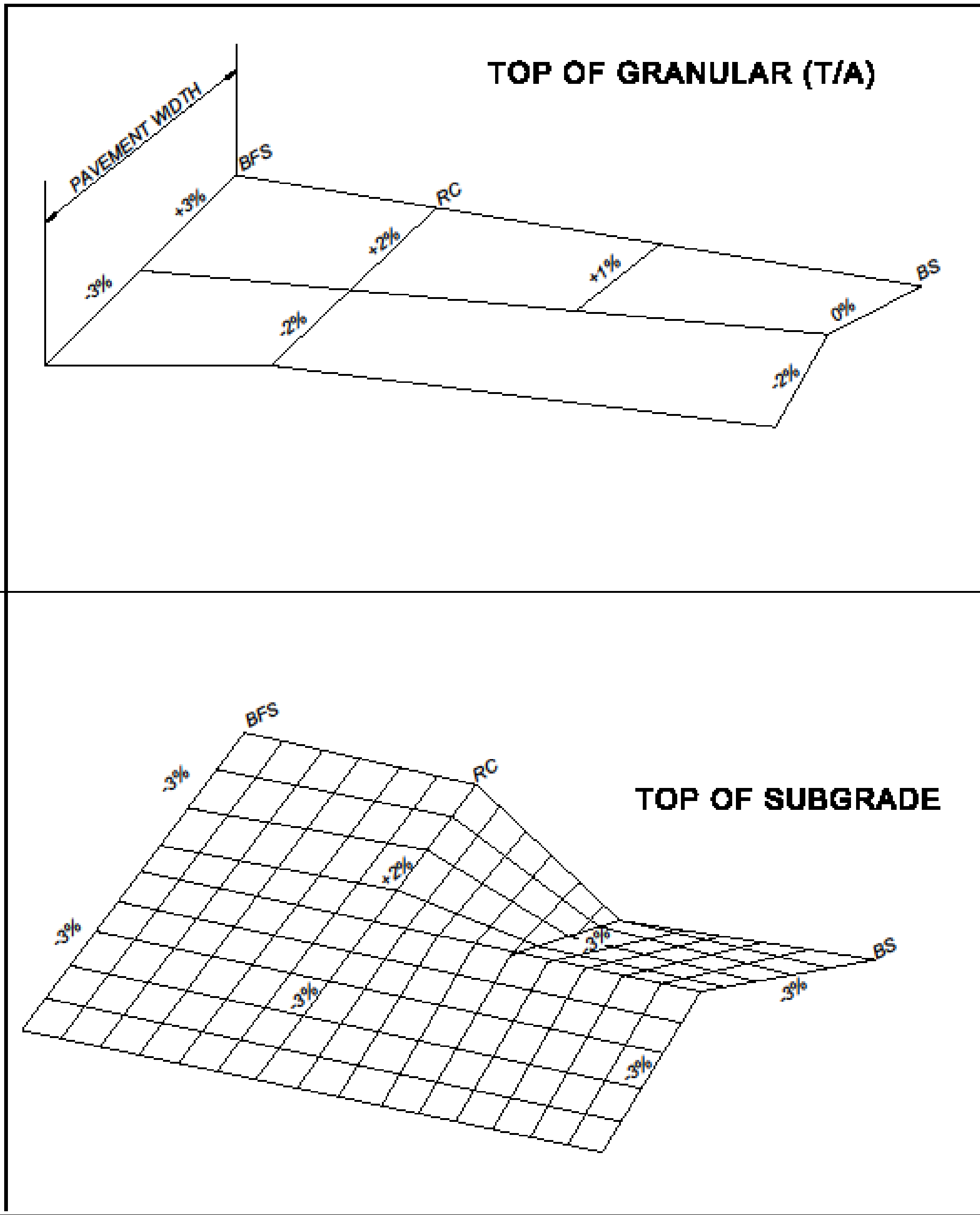
- This ~~Section~~ section is **~~Applicable~~ applicable** including the following **additional ~~Guidance~~guidance**:
- **Subgrade Transition into Superelevation**

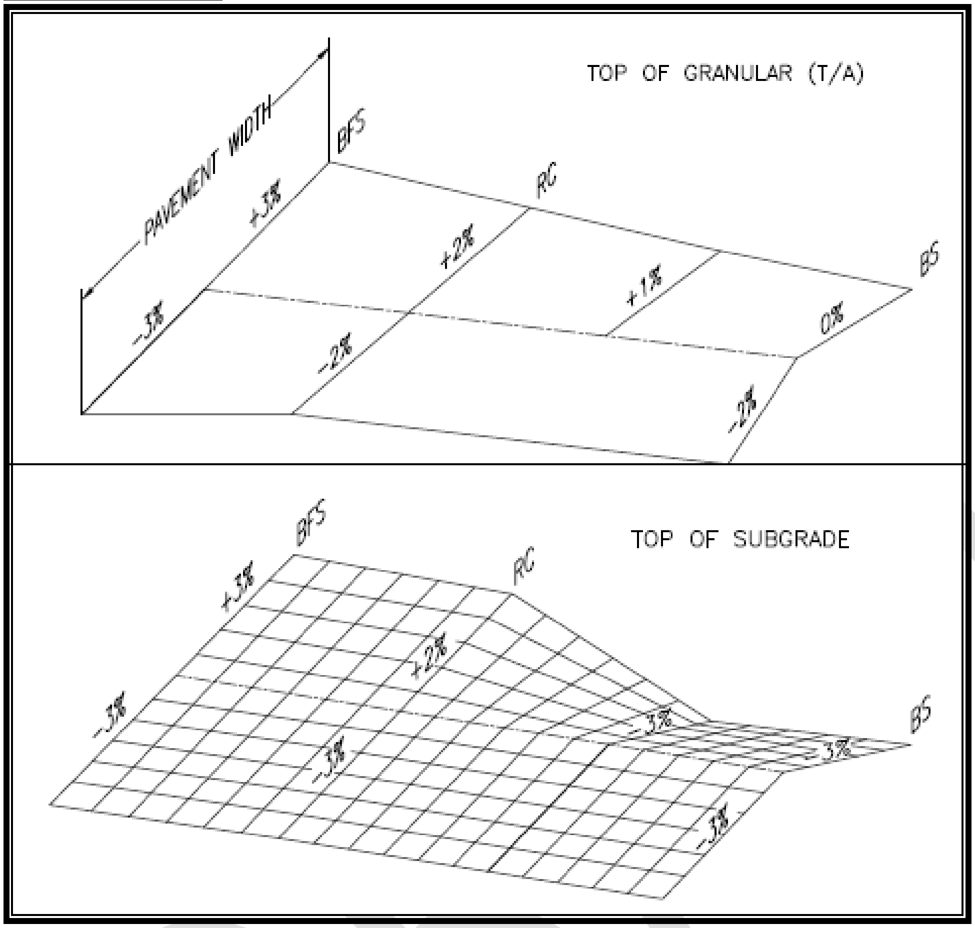
On tangent alignment, the subgrade should ~~be prepared having~~have a 3 percent ~~crown~~cross slope. When a tangent section meets with a horizontal curve, transitioning of the subgrade in superelevated sections starts from the Beginning of Superelevation (BS) to where it is parallel with the top of pavement as illustrated in **Exhibit -3D~~C~~**. An exception to this is on reverse crowns and curves with superelevation less than 3% where the subgrade superelevation should be 3%. For ~~more~~ additional detail, ~~the designer may~~ refer to *InRoads Preference* and *Standards Manual and MTO Customization Document.*

Exhibit -3D~~C~~

~~SUBGRADE TREATMENT IN SUPERELEVATION~~Subgrade Treatment in Superelevation


TOP OF GRANULAR (T/A)
PAVEMENT WIDTH
BFS
RC
BS
+3%
-3%
+2%
-2%
+1%
0%
-2%
TOP OF SUBGRADE
BFS
RC
BS
-3%
+2%
-3%
-3%
-3%
-3%
-3%


TOP OF GRANULAR (T/A)
PAVEMENT WIDTH
BFS
RC
BS
+3%
-3%
+2%
-2%
+1%
0%
-2%
TOP OF SUBGRADE
BFS
RC
BS
-3%
-3%
+2%
-3%
-3%
-3%
-3%



Section 3.2.4.6 – Methods of Developing Superelevation: Best Practices

- This ~~Section~~ section is ~~**Applicable**~~ **applicable** with the following **additional ~~Guidance~~ guidance for Divided Roadways**:

Divided Roadways

On divided roadways with wide medians, the median pavement edges are ~~usually~~ typically maintained at the same elevation as shown in **Exhibit -3E~~D~~** and, each pavement is revolved about the median edge as illustrated in *Chapter 3 - Alignment and Lane Configuration, Figure 3.2.8*.

On divided roadways with narrow medians consisting of a median barrier and paved shoulders, the median barrier edges at the two shoulders desirably should be at the same elevation, as shown in **Exhibit -3E~~D~~**.

On divided roadways where additional lanes are being added to the median and provision for the above treatment was not made in the original design, median shoulder edges will not be at the same elevation. This difference in elevation can be ~~taken up~~addressed with an asymmetric concrete median barrier, as shown in **Exhibit ~~-~~3E~~D~~**. The use of curb and gutter with any guide rail or barrier system is not recommended. For further guidance regarding use of curb and gutter refer to the ministry's *Roadside Design Manual.*

Smooth Profile of Traveled-Way Edges

Divided highways warrant ~~a~~ greater refinement in design and greater attention to appearance ~~than~~ compared to undivided two-lane highways because divided highways ~~usually~~ typically serve much greater traffic volumes at higher design speeds. The cost of refinement is insignificant compared with the construction cost of a divided highway. The diagrammatic profile shown in *Figure 3.2.8 – Three Methods of Superelevation Development on Divided Roadways* of *Chapter 3*, the tangent profile control lines result in angular breaks at various cross location of superelevation development denoted as '1' in the same Figure, for clarity it is also illustrated in **Exhibit ~~-~~3F~~E~~**. For general appearance and safety, these breaks should be rounded in final design by insertion of vertical curves. Angular breaks will be particularly noticeable where hard surfaces, such as concrete barrier or retaining wall, follow the edge of pavement profile. Even when the maximum relative gradient is used to define runoff length, the length of vertical curve does not need to be large to conform to the 0.67 percent break at 50 km/h design speed and 0.5 percent break at design speeds of 80 km/h and higher. Where the traveled way is revolved about an edge, these grade breaks are doubled to 1.33 percent for 50 km/h design speed and to 1.00 percent for design speeds of 80 km/h and higher. Greater lengths of vertical curve are obviously needed in these cases. Specific criteria have not been established for the lengths of vertical curves at the breaks in the diagrammatic profiles. For an approximate guide, however, the minimum vertical curve length in meters can be used as numerically equal to 0.2 times the design speed in kilometers per hour. Greater lengths are desirable where practical as the general profile condition may determine.

A second method uses a graphical approach to define the edge profile. The method essentially is one of spline-line development. In this method, the centerlines or other base profile, which typically ~~usually~~ is computed, is plotted on an appropriate vertical scale. Superelevation control points are in the form of the break points shown in *Figure 3.2.8* of *Chapter 3*. Then by means of a spline, curve template, ship curve, or circular curve, smooth, ~~-~~flowing lines are drawn to approximate the straight-line controls. The natural bending of a spline nearly always satisfies the need for minimum smoothing. Once the edge profiles are drawn in the proper relation to one another, elevations can be read at the appropriate intervals for construction.

Exhibit -3E~~D~~

~~APPLICATION OF SUPERELEVATION ON DIVIDED ROADWAYS~~Application of Superelevation on Divided Roadways

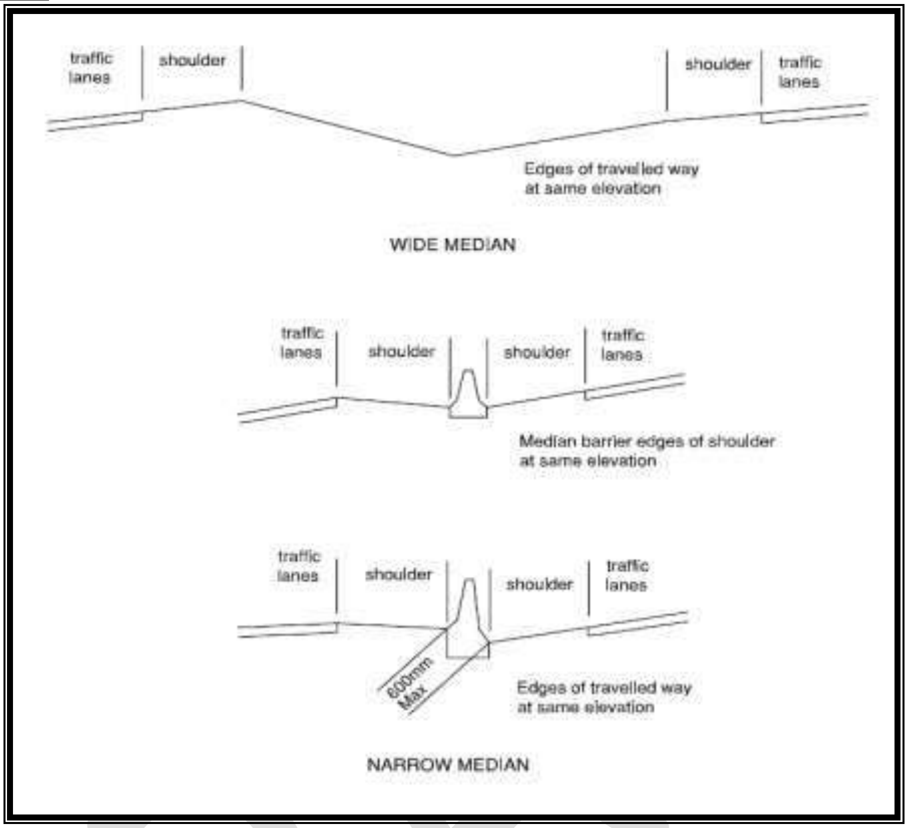
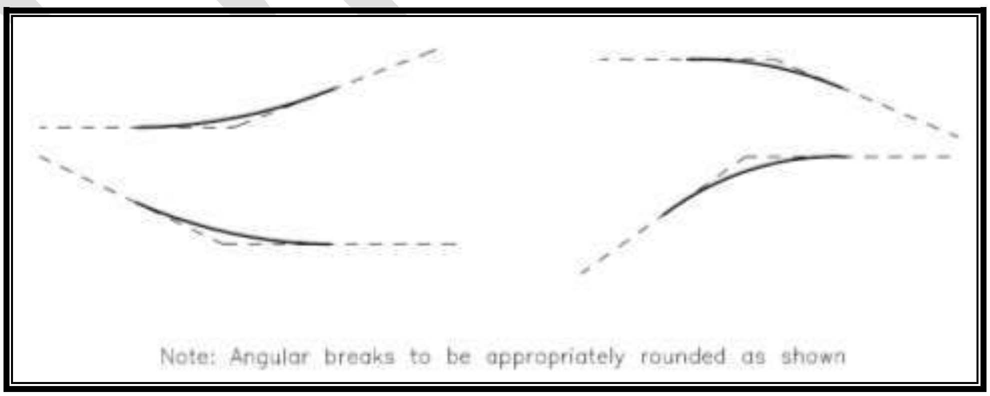


Exhibit -3F~~E~~

~~ANGULAR BREAKS IN DEVELOPMENT OF SUPERELEVATION ON DIVIDED ROADWAYS~~Angular Breaks in Development of Superelevation on Divided Roadways



Note: Exhibit 3-E should be read in conjunction of Figure 3.2.8 of Chapter 3

Section 3.2.5.3 – Lane Widening: Design Domain ~~——————~~Application Heuristics

- This ~~Section~~ section is **~~Applicable~~applicable**. Pavement widening values on curves for ~~few~~ common design vehicles such as Heavy Single Unit, Tractor Semi-Trailer (WB-20), and B-Train are provided in **Exhibit -3G~~F~~**, **Exhibit -3H~~G~~**, and **Exhibit -3I~~H~~** respectively by using the formula provided in *Figure 3.2.9* of *Chapter 3*. For other design vehicles, pavement widening values should be calculated using the same formula.

Table 3.2.14 - Pavement Widening Values on Curves for Heavy SU Trucks

- This Table is **~~Not~~ not** ~~Applicable~~ **applicable** and is **replaced** with **Exhibit -3G~~F~~.**

Exhibit ~~-~~3G~~F~~

Pavement Widening Values on Curves for Heavy Single-Unit Trucks

~~**PAVEMENT WIDENING VALUES ON CURVES FOR HEAVY SINGLE-UNIT TRUCKS**~~

PAVEMENT WIDTH 7.5 m									
	Design Speed (km/h)								
W (m)	50	60	70	80	90	100	110	120	130
	Range of Radii (m)								
1.75	50-55	55-60	-	-	-	-	-	-	-
1.50	60	65-70	-	-	-	-	-	-	-
1.25	65-75	75-80	90	-	-	-	-	-	-
1.00	80-95	85-105	95-115	-	-	-	-	-	-
0.75	100-120	110-130	120-150	130-160	-	-	-	-	-
0.50	125-170	140-190	160-210	170-240	190-250	250-300	340	-	-
0.25	180-250	200-300	220-350	250-400	280-450	320-525	350-575	420-650	525-700
PAVEMENT WIDTH 7.0 m									
2.00	50	55	-	-	-	-	-	-	-
1.75	55-60	60-65	-	-	-	-	-	-	-
1.50	65-70	70-80	-	-	-	-	-	-	-
1.25	75-90	85-100	90-110	-	-	-	-	-	-
1.00	95-115	105-125	115-140	130-150	-	-	-	-	-
0.75	120-150	130-170	150-200	160-220	190-250	250-280	-	-	-
0.50	160-240	180-280	210-320	230-350	280-400	300-450	340-500	-	-
0.25	250-475	300-550	340-650	380-750	420-900	475-1000	525-1150	-	-
PAVEMENT WIDTH 6.5 m									
2.00	50-60	55-65	-	-	-	-	-	-	-
1.75	65-70	70-75	-	-	-	-	-	-	-
1.50	75-85	80-95	90-105	-	-	-	-	-	-
1.25	90-110	100-120	110-130	130-150	-	-	-	-	-
1.00	115-140	125-160	140-180	160-200	190-230	-	-	-	-
0.75	150-220	170-250	190-280	210-320	240-350	-	-	-	-
0.50	230-400	280-475	300-550	340-600	380-700	-	-	-	-
0.25	420-1300	500-1600	575-2000	650-2200	750-2500	-	-	-	-
PAVEMENT WIDTH 6.0 m									
2.00	55-65	55-75	-	-	-	-	-	-	-
1.75	70-80	80-90	90-100	-	-	-	-	-	-
1.50	85-105	95-115	105-125	-	-	-	-	-	-
1.25	110-130	120-150	130-170	-	-	-	-	-	-
1.00	140-200	160-230	180-250	-	-	-	-	-	-
0.75	210-350	240-400	280-450	-	-	-	-	-	-

0.50	380-950	420-1150	475-1400	-	-	-	-	-	-
0.25	1000-10000	1200-10000	1500-10000	-	-	-	-	-	-

Table 3.2.15 - Pavement Widening Values on Curves for WB-20

- This Table is **~~Not~~ not ~~Applicable~~ applicable** and is **replaced** with **Exhibit -3H~~G~~.**

Exhibit -3H~~G~~

~~PAVEMENT WIDENING VALUES ON CURVES FOR TRACTOR-SEMI-TRAILER (WB-20) VEHICLES~~Pavement Widening Values on Curves for Tractor-Semi-Trailer (WB-20) Vehicles

PAVEMENT WIDTH 7.5 m									
	Design Speed (km/h)								
W (m)	**50**	**60**	**70**	**80**	**90**	**100**	**110**	**120**	**130**
	Range of Radii (m)								
2.00	50-105	55-110	85-110	-	-	-	-	-	-
1.75	110-120	115-125	115-125	130-140	-	-	-	-	-
1.50	125-140	130-140	130-140	150-160	-	-	-	-	-
1.25	150-160	150-170	150-170	170-190	190-200	-	-	-	-
1.00	170-200	180-210	180-210	200-240	210-250	250	-	-	-
0.75	210-250	220-250	220-250	250-300	280-320	280-350	340-380	-	-
0.50	280-340	280-350	280-350	320-420	340-450	380-500	400-425	420-575	525-600
0.25	350-525	380-575	380-575	450-650	475-750	525-800	550-900	600-950	650-1050
PAVEMENT WIDTH 7.0 m									
2.00	50-115	55-120	90-130	130	-	-	-	-	-
1.75	120-130	125-140	140-150	140-150	-	-	-	-	-
1.50	140-150	150-160	160-170	160-180	190-200	-	-	-	-
1.25	160-190	170-200	180-210	190-230	210-240	250	-	-	-
1.00	200-240	210-250	220-250	240-280	250-300	280-320	340-350	-	-
0.75	250-320	280-340	280-350	300-400	320-420	340-450	380-500	-	-
0.50	340-375	350-525	380-550	420-600	450-650	475-700	525-800	-	-
0.25	500-850	550-950	575-1100	650-1200	700-1300	750-1500	850-1600	-	-
PAVEMENT WIDTH 6.5 m									
2.00	50-130	55-130	90-140	130-150	-	-	-	-	-
1.75	140-150	140-160	150-170	160-180	190	-	-	-	-
1.50	160-180	170-190	180-200	190-220	200-230	-	-	-	-
1.25	190-230	200-240	210-250	230-280	240-300	-	-	-	-
1.00	240-300	250-320	280-350	300-350	320-400	-	-	-	-

0.75	320-420	340-475	380-500	380-550	420-600	-	-	-	-
0.50	450-750	500-800	525-900	575-1000	650-1100	-	-	-	-
0.25	800-2200	850-2500	950-2500	1050-3000	1150-3500	-	-	-	-

Table 3.2.16 - Pavement Widening Values on Curves for B-Train

- This Table is ~~**Not**~~ not ~~Applicable~~ applicable and is **replaced** with **Exhibit -3I~~H~~.**

Exhibit 3-I~~H~~

~~PAVEMENT WIDENING VALUES ON CURVES FOR B-TRAIN VEHICLES~~Pavement Widening Values on Curved for B-Train Vehicles

PAVEMENT WIDTH 7.5 m									
Design Speed (km/h)									
W (m)	**50**	**60**	**70**	**80**	**90**	**100**	**110**	**120**	**130**
	Range of Radii (m)								
2.00	50-95	55-100	90-105	-	-	-	-	-	-
1.75	100-105	105-110	110-120	-	-	-	-	-	-
1.50	110-125	115-130	125-140	130-140	-	-	-	-	-
1.25	130-140	140-150	150-160	150-170	-	-	-	-	-
1.00	150-180	160-190	170-200	180-220	190-230	250	-	-	-
0.75	190-220	200-240	210-250	230-280	240-300	280-320	340-350	-	-
0.50	230-300	250-320	280-350	300-400	320-420	340-450	380-500	420-525	525-575
0.25	320-475	340-525	380-575	420-600	450-700	475-750	525-800	550-900	600-1000
PAVEMENT WIDTH 7.0 m									
2.00	50-105	55-110	90-115	-	-	-	-	-	-
1.75	110-120	115-125	120-130	130-140	-	-	-	-	-
1.50	125-140	130-150	140-160	150-170	-	-	-	-	-
1.25	150-170	160-180	170-190	180-210	190-220	-	-	-	-
1.00	180-210	190-230	200-250	220-250	230-280	250-300	-	-	-
0.75	220-280	240-300	280-340	280-350	300-400	320-420	340-450	-	-
0.50	300-420	320-475	350-500	380-550	420-600	450-650	475-750	-	-
0.25	450-800	500-900	525-1000	575-1100	650-1250	700-1400	800-1500	-	-
PAVEMENT WIDTH 6.5 m									
2.00	50-115	55-120	90-130	130	-	-	-	-	-
1.75	120-130	125-140	140-150	140-160	-	-	-	-	-
1.50	140-160	150-170	160-180	170-200	190-210	-	-	-	-
1.25	170-200	180-220	190-230	210-250	220-250	-	-	-	-

1.00	210-250	230-280	240-320	280-340	280-350	-	-	-	-
0.75	280-380	300-420	340-475	350-500	380-550	-	-	-	-
0.50	400-650	450-750	500-850	525-950	575-1050	-	-	-	-
0.25	700-2000	800-2200	900-2500	1000-3000	1100-3500	-	-	-	-

Section 3.2.5.4 – Application of Widening on Curves: Best Practices

- This ~~Section~~ section is **~~Not~~ not ~~Applicable~~ applicable** and is **replaced** with the following ~~Guidance~~guidance:

  The pavement widening values provided in **Exhibit -3G~~F~~** to **Exhibit -3I~~H~~** represent the total amount of widening required.

  For new construction and reconstruction projects, curve widening should be applied by adding half of the total requirement to each side of the highway, with lane widths being equal throughout the curve. When widening values end~~ing~~ in 0.25 or 0.75 ~~and~~, equal division of the widening is not practical. A preferred treatment is to round the total widening value to a higher even ~~digit~~ decimal ~~before~~ and divid~~ing~~e in half. The normal shoulder width should be maintained over the length of curve widening.

  Since the amount of pavement widening is a function of the curve radius, the widening should be applied over the length of the spiral in such a fashion that a smooth edge of pavement is produced. For ~~un-spiraled~~ curves without spiral transitions the widening should be applied over the corresponding spiral length had the spiral been applied. The two methods illustrated in **Exhibit -3J~~I~~** and **Exhibit -3K~~J~~** may be applied to attain the pavement widening. For details refer to *Ontario Provincial Standards Drawings.*

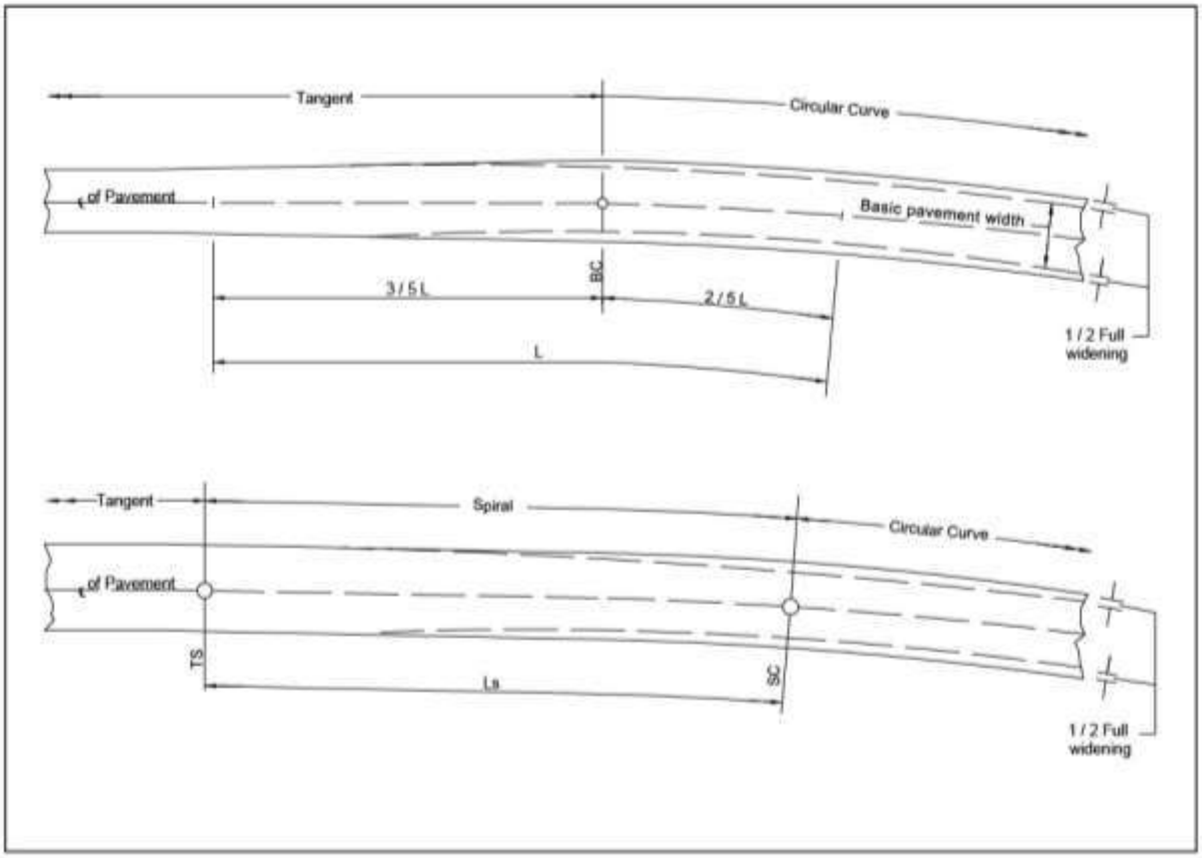
  Pavement widening may be warranted on several successive horizontal curves such that a significant length of highway has a continuous variation in pavement width. In such a situation, a wider pavement over the total section of highway should be considered. The amount of widening should be representative of the required widening on individual curves and not necessarily the widening required by the smallest radius curve. Alternatively, less widening could be applied over the total section with additional widening on the smaller radius curves.

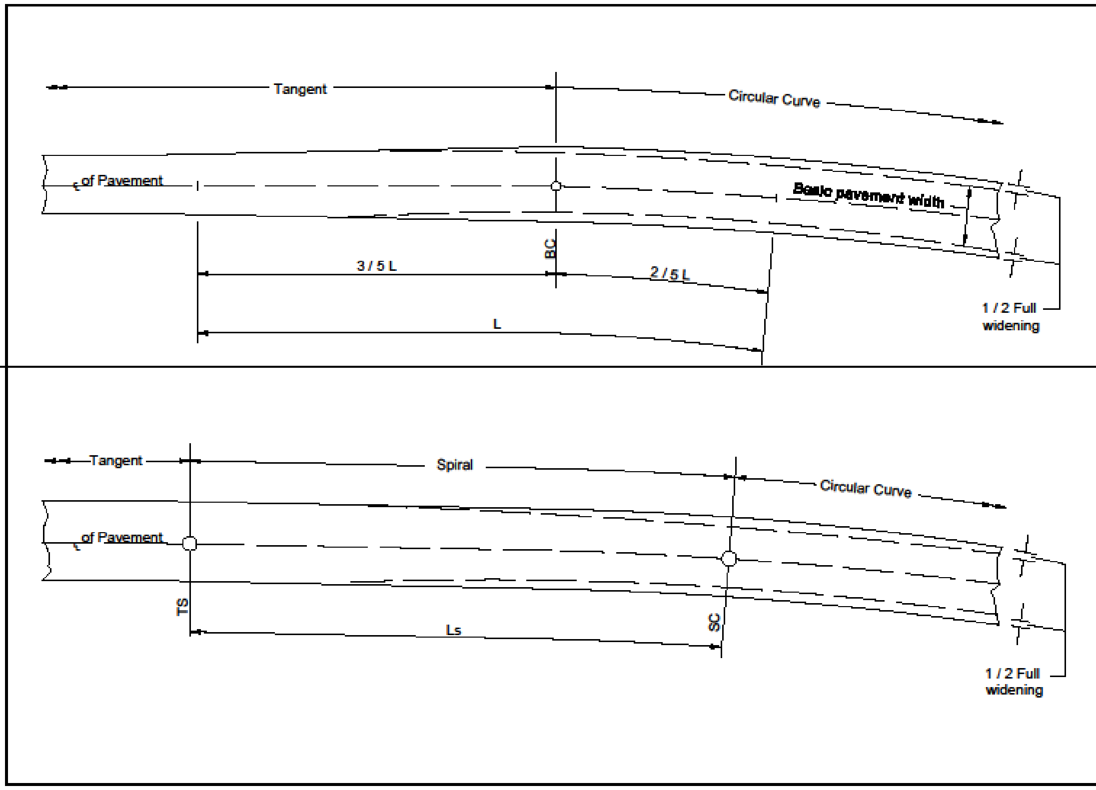
Each situation should be assessed independently considering how closely the warrants are met, the length of the highway section under consideration, the frequency of curves and the amount of widening required for each curve. A uniform pavement width is desirable but may not always be economically practical.

For guidance on the placement of edge line pavement marking in areas of curve widening, refer to *Ontario Traffic Manual (OTM) Book 11*.

EXHIBIT -3J~~I~~

W~~w~~idening on B~~b~~oth S~~s~~ides of C~~c~~urve W~~w~~ith or W~~w~~ithout S~~s~~piral 213.01


Tangent
Circular Curve
℄ of Pavement
Basic pavement width
BC
3 / 5 L
2 / 5 L
L
1 / 2 Full widening
Tangent
Spiral
Circular Curve
℄ of Pavement
TS
Ls
SC
1 / 2 Full widening


Tangent
Circular Curve
of Pavement
Basic pavement width
BC
3 / 5 L
2 / 5 L
L
1 / 2 Full widening
Tangent
Spiral
Circular Curve
of Pavement
TS
Ls
SC
1 / 2 Full widening

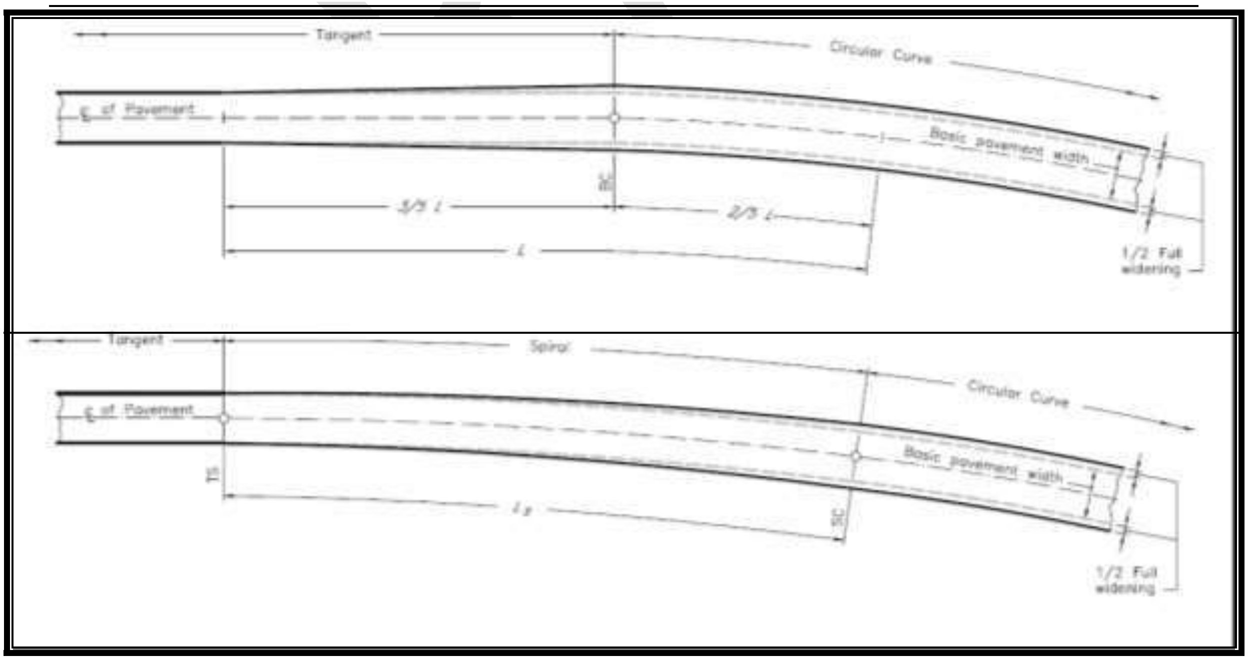
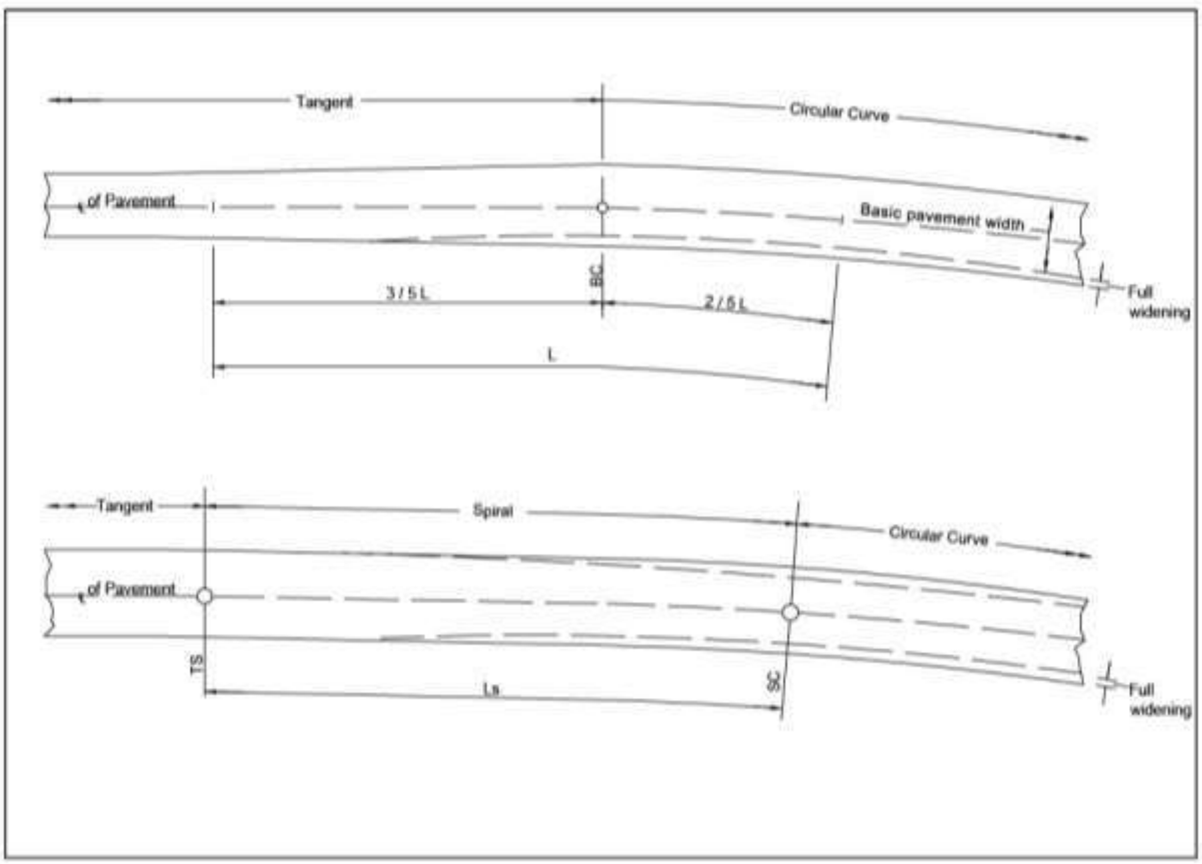
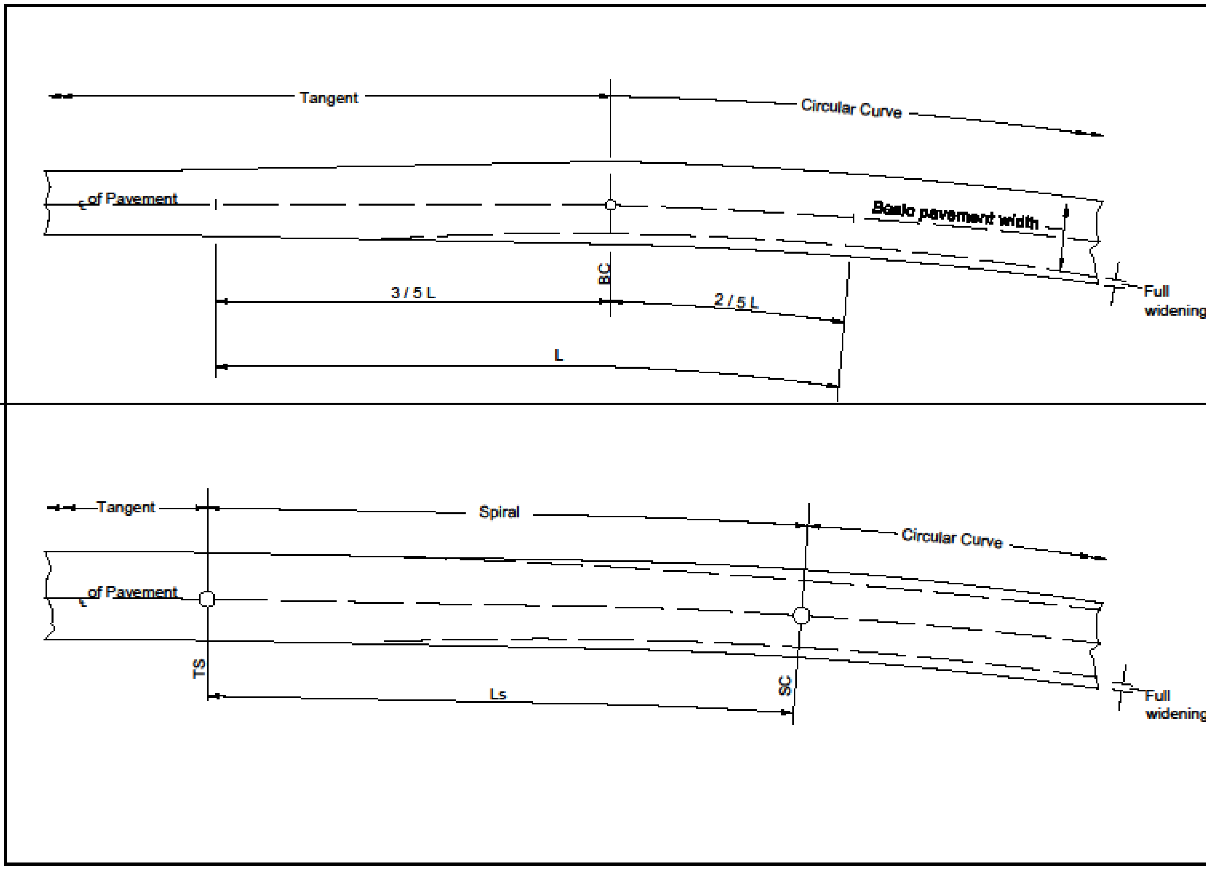
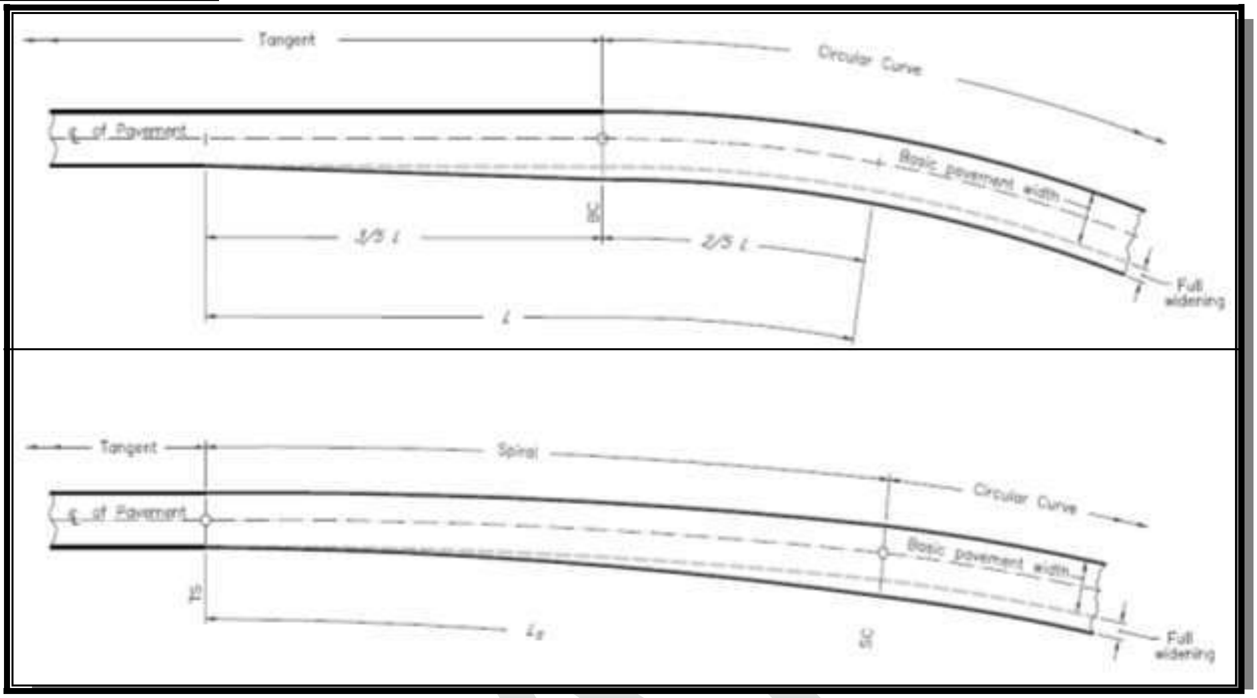

Tangent
Circular Curve
of Pavement
Basic pavement width
BC
1/2 Full widening
Tangent
Spiral
Circular Curve
of Pavement
Basic pavement width
TS
SC
1/2 Full widening

EXHIBIT ~~-~~3K~~J~~

W~~w~~idening on Inside~~NSIDE~~ of C~~c~~urves~~S~~ W~~w~~ith or W~~w~~ithout S~~s~~piral 213.01




Tangent
Circular Curve
of Pavement
Basic pavement width
BC
3 / 5 L
2 / 5 L
L
Full widening
Tangent
Spiral
Circular Curve
of Pavement
TS
Ls
SC
Full widening



Curve Widening on Resurfacing Projects

Curve widening on resurfacing projects should be carried out with a corresponding reduction in shoulder width to maintain the existing subgrade. A minimum shoulder width of 1.0 m gravel, or 0.5 m paved, must be maintained to provide the pavement with adequate lateral support. Additionally, minimum standards for shoulder widths, shoulder rounding, and clear zones must be adhered to.

An exception to the minimum shoulder width requirement may be considered in the application of resurfacing and curve widening to secondary highways, particularly those with low traffic volumes. Where the required curve widening closely approaches or exceeds the existing shoulder width, an acceptable and cost-effective design alternative to road widening may be to utilize the entire shoulder width to achieve the curve widening.

For resurfacing projects with no recycling, or with partial-depth recycling, widening values of 0.25 m may be ignored. If the widening requirement is 0.5 m or less, the total widening may be applied to the inside of curve to avoid application of a narrow strip of base pavement to both sides of the highway prior to resurfacing.

For resurfacing projects with full-depth recycling, curve widening should be applied by adding one half of the total requirement to each side. Widening values ending in 0.25 or 0.75 should be rounded to a higher even ~~digit~~ decimal ~~before~~ and divideding in half. For example, if 0.75 m total widening is required, it may be applied as 0.4 m oin each side (0.75+0.05)/2=0.4 m.

Section 3.2.6.1 – General Application (Horizontal Alignment: Design Domain Additional Application Heuristics)

- This ~~Section~~ section is **~~Applicable~~ applicable** with the following **additional ~~Guidance~~guidance**:
-
    - Horizontal curves should lead vertical curves.
    - At the end of a long tangent section, a transition of gradually decreasing radius should be introduced to allow ~~the a~~ drivers to adjust ~~his~~ their speed to the new condition. The additional length provides the opportunity for reducing speed safely.
    - Spirals should be used wherever possible rather than compounding circular curves.
    - The desirable horizontal curve radius for design speeds of 120 km/h and 130 km/h should be 1,700 m and 2,300 m respectively.

    Deviation from Standards

    For the most part in design, desirable standards should be observed, and minimum standards should be exceeded. However, in isolated instances where other controls pose a severe restraint in applying minimum standards, ~~substandard~~ non-standard horizontal geometry may be tolerated where there is no evidence of excessive collisions or other operational concerns associated with the geometry ~~of any geometric deficiency as indicated by the accident record~~. (See Chapter 1, section 1.2.3) In such cases, curves should have radii and superelevations corresponding to speeds ~~normally of~~ not ~~more~~ less than 10 km/h ~~less than~~below the design speed, and in no case more than 20 km/h less. ~~The designer should~~It should be demonstratesd with respect to safety and ~~economics~~ cost-effectiveness that application of a ~~substandard~~ non-standard curve is the optimum solution and this must be documented ~~this~~ in the design package. In assessing the implications of ~~employing~~ constructing ~~substandard~~ non-standard curves, the ~~designer should observe the~~ following principles apply:

- ~~Substandard~~ Non-standard horizontal curves are potentially hazardous since limiting values are based on lateral friction values and design speed and, therefore, near-limiting conditions occur frequently.
- ~~Substandard~~ Non-standard horizontal curves should not be introduced adjacent to areas where speeds might be higher than either posted speed or design speed, for example, following long tangents, or at the bottom of long descending~~down~~ grades.

Guidance on Railway Grade Crossing Regulations and Standards

Highway Design Office ~~prepared and~~ issued the *"MTO Railway Guidelines"* in March 2023. This Guideline is available on the MTO Technical Publication website at the following link:
https://www.library.mto.gov.on.ca/SydneyPLUS/TechPubs/Portal/tp/tdViews.aspx?lang=en-US.
In the search bar, type-in "MTO Railway Guidelines" and click search.

Section 3.2.6.3 – Horizontal Alignment and Lateral Clearances: Design Domain Quantitative Aids

- The **second paragraph** of this ~~Section~~ section is ~~**Not**~~ **not** ~~**Applicable**~~ **applicable** which references **Figure 3.2.12**.

Figure 3.2.12 – Lateral Clearances for Passing Sight Distance

- This Figure is ~~**Not**~~ **not** ~~**Applicable**~~ **applicable** and is **replaced** with the **Exhibit -3L~~K~~**.

•

Exhibit -3L~~K~~
~~LATERAL~~ Lateral ~~CLEARANCE~~ Clearance ~~FOR~~ for ~~PASSING~~ Passing ~~SIGHT~~ Sight ~~DISTANCE~~ Distance (m) for~~FOR~~ Two~~WO~~-Lane~~LANE~~ Highways~~IGHWAYS~~ (m)
(from centerline of inside lane to sight obstruction)

Design Speed (km/h)	30	40	50	60	70	80	90	100	110	120	130
Passing Sight Distance (m)	**120**	**140**	**160**	**180**	**210**	**245**	**280**	**320**	**355**	**395**	**440**
Radius (m)	**Lateral Clearance for Passing Sight Distance (m)**										
10000	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.4
7000	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.3	2.8	3.5
5000	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.6	3.2	3.9	4.8
4000	2.0	2.0	2.0	2.0	2.0	2.0	2.4	3.2	3.9	4.9	6.0
3000	2.0	2.0	2.0	2.0	2.0	2.5	3.3	4.3	5.2	6.5	8.1
2000	2.0	2.0	2.0	2.0	2.8	3.8	4.9	6.4	7.9	9.7	12.1
1500	2.0	2.0	2.1	2.7	3.7	5.0	6.5	8.5	10.5	13.0	16.1
1200	2.0	2.0	2.7	3.4	4.6	6.2	8.2	10.7	13.1	16.2	20.1
1000	2.0	2.4	3.2	4.0	5.5	7.5	9.8	12.8	15.7	19.4	24.1
900	2.0	2.7	3.6	4.5	6.1	8.3	10.9	14.2	17.4	21.6	26.8
800	2.2	3.1	4.0	5.1	6.9	9.4	12.2	15.9	19.6	24.3	-
700	2.6	3.5	4.6	5.8	7.9	10.7	14.0	18.2	22.4	27.7	
600	3.0	4.1	5.3	6.7	9.2	12.5	16.3	21.2	26.1	-	
500	3.6	4.9	6.4	8.1	11.0	14.9	19.5	25.4	-		
400	4.5	6.1	8.0	10.1	13.7	18.6	24.3	31.6			
350	5.1	7.0	9.1	11.5	15.6	21.2	27.6	-			
300	6.0	8.1	10.6	13.4	18.2	24.7	32.1				
250	7.2	9.7	12.7	16.0	21.7	29.4	-				
220	8.1	11.0	14.4	18.2	24.6	-					
200	8.9	12.1	15.8	19.9	26.9						
180	9.9	13.4	17.5	22.0	29.8						
160	11.1	15.1	19.6	24.7	-						
140	12.7	17.1	22.2	27.9							
120	14.7	19.8	25.7	32.2							
100	17.5	23.5	30.3	-							
90	19.3	25.9	33.3								
80	21.5	28.7	36.8								

70	24.2	32.2	-								
60	27.6	36.4									
50	31.9	41.5									

Section 3.3.2.3 – Maximum Grade: Design Domain Quantitative Aids
Section 3.3.2.4 – Maximum Grade: Design Domain Application Heuristics

- These two ~~Sections~~ sections are ~~**Applicable**~~ **applicable** except the reference to **Table 3.3.1** which is ~~**Not**~~ **not** ~~**Applicable**~~ **applicable** and is **replaced** with **Exhibit -3M~~L~~, Exhibit -3N~~M~~,** and **Exhibit -3O~~N~~.**
- The following sub-bullets are added under~~in~~ bullet # 6:
  - Local precipitation - rain and snowfall patterns
  - Drainage and susceptibility of erosion in the surrounding area
  -
- The following **additional** ~~**Guidance**~~ **guidance** is also ~~**Applicable**~~ **applicable** in these two ~~Sections~~sections:

  Trucks on Grades

  The effect of grades on truck speeds is much more pronounced than on speeds of passenger cars. The average speed of trucks on level sections of highway approximates the average speed of passenger cars. Trucks generally increase speed by up to 5 percent on downgrade and decrease speed by 7 percent or more on upgrades ~~as~~ compared to ~~their operation on~~ level terrain. On upgrades, the maximum speed that can be maintained by a truck is dependent primarily on the length and steepness of the grade and the truck's weight to ~~/~~power ratio, which is the gross vehicle weight divided by the net engine power. Other factors that affect the average truck speed on a grade are the entering speed, the aerodynamic~~s~~ resistance, ~~icy condition of the road~~winter road conditions, and ~~skill of the~~ driver skill.

Exhibit -3M~~L~~
~~MAXIMUM~~ Maximum ~~GRADES~~ Grades (~~PERCENT~~Percent) ~~FOR~~ for ~~RURAL~~ Rural ~~ROADS~~Roads

Design Speed km/h	Traffic Volume					
	AADT					
	>4,000	3,000-4,000	2,000-3,000	1,000-2,000	400-1,000	<400
	DHV					
	>600	450-600	300-450	150-300	60-150	<60

120	6 - 7	-	-	-	-	-
110	6 - 7	6 - 7	6 - 7	6 - 7	-	-
100	6 - 8	6 - 8	6 - 8	6 - 8	6 - 8	-
90	6 - 8	6 - 8	6 - 8	6 - 8	6 - 8	-
80	6 - 8	6 - 8	6 - 8	6 - 8	6 - 8	8
70	-	6 - 12	6 - 12	6 - 12	6 - 12	12
60	-	-	-	6 - 12	6 - 12	12
50	-	-	-	-	-	12

Exhibit -3N~~M~~

~~MAXIMUM~~ Maximum ~~GRADES~~ Grades (~~PERCENT~~Percent) ~~FOR~~ for ~~URBAN~~ Urban ~~ROADS~~ Roads

Design Speed km/h	Traffic Volume				
	AADT				
	>6,000	3,000-6,000	2,000-3,000	1,000-2,000	<1,000
	DHV				
	>600	300-600	200-300	100-200	<100
80	6 - 8	6 - 8	6 - 8	-	-
60-70	6 - 12	6 - 12	6 - 12	6 - 12	-
50	-	-	8 - 12	8 - 12	-
40-50	-	-	-	-	8 - 12

Exhibit -3O~~N~~

~~MAXIMUM~~ Maximum ~~GRADES~~ Grades (~~PERCENT~~Percent) ~~FOR~~ for ~~FREEWAYS~~Freeways

Design Speed km/h	Maximum Grade %
130	3
120	3
110	3 - 4
100	3 – 4
90	4 - 5

Section 3.3.2.5 – Minimum Grades: Design Domain Application Heuristics

- This section is **~~Applicable~~ applicable** including the following **additional ~~Guidance~~guidance**:

Standard minimum gradients for curbed and un-curbed roads and ditches are provided in **Exhibit -3P~~O~~**.

In case of any discrepancies between TAC and **Exhibit -3P~~O~~**, the Exhibit will govern. On roadways with curbs, drainage is generally adjacent to the curb and longitudinal gradients must be set ~~so as to~~to avoid excessive accumulation of water on the pavement. Minimum gradients shown in the table can be used for the normal conditions of rainfall and outlet spacing. In special cases hydraulic analysis should be carried out to determine where water might spread onto the adjacent travel lane.

Exhibit -3P~~O~~

M~~INIMUM GRADES~~inimum Grades

Design Element	**Grade**	
	Desirable Minimum	**Absolute Minimum**
Curbed Roads	0.5%	0.3%
Uncurbed Roads with Adequate Cross-Slope	0.5%	0.0%
Unlined Ditches	0.5%	0.1%

Section 3.3.3.2 – Crest Vertical Curves: Technical Foundation Element

This ~~Section~~ section is **~~Applicable~~ applicable** with the following **~~Modifications~~modifications**:

-
    - Driver's eye height should be 1.08 m for calculating K values for various sight distances.
    - Driver's eye height and object height for passing sight distance should be 1.08 m.

Section 3.3.3.3 – Crest Vertical Curves: Design Domain Quantitative Aid

- This ~~Section~~ section is **~~Applicable~~ applicable** with the following **~~Modifications~~modifications**:
    - Driver eye's height and object height for passing sight distance should be 1.08 m.
    - The example in the last paragraph is **~~Not~~ not ~~Applicable~~ applicable** and is

replaced with the following:

In order to maximize passing opportunities, K values for crest vertical curves should be chosen to achieve at least non-striping sight distance. Designers should strive to achieve 75% or greater passing opportunities over the length of road. For example, for a design speed of 110 km/h, the non-striping sight distance is 355 m, as provided in **Exhibit 3-Q~~P~~** below. This corresponds to a K value of 146.

Per the formula (*Equation 3.3.2 at page 3-58 of Chapter 3*):

$$K = \frac{S^2}{200\left(\sqrt{h_1}+\sqrt{h_2}\right)^2} \qquad (3.3.4)$$

$$K = 355^2/\left[200*\left(\sqrt{1.08}+\sqrt{1.08}\right)^2\right] = 146 \qquad (3.3.5)$$

Table 3.3.3 – K Factors to Provide Passing Sight Distance on Crest Vertical Curves

- This Table is ~~**Not**~~ **not** ~~**Applicable**~~ **applicable** and is **replaced** with **Exhibit -3Q~~P~~**.

Exhibit -3Q~~P~~

~~**K FACTORS TO PROVIDE PASSING SIGHT DISTANCE ON CREST VERTICAL CURV**~~**K Factors to Provide Passing Sight Distance on Crest Vertical Curves**~~**E**~~

Design Speed (km/h)	Passing Sight Distance (m)	Rate of Vertical Curvature (K)
30	120	17
40	140	23
50	160	30
60	180	38
70	210	51
80	245	69
90	280	91
100	320	119

110	355	146
120	395	181
130	440	224

Reference: Table 3-36 –A Policy on Geometric Design of Highways and Street, 7th Edition, AASHTO – 2018

Section 3.3.5.1 – Vertical Alignment Principles: Application Heuristics

- This ~~Section~~ section is ~~**Applicable**~~ **applicable** along with **Exhibit -3R~~Q~~**. In design and construction, standard K vertical curves should be selected from one of the values shown in **Exhibit -3R~~Q~~**. These are for general guidance and consistency in the standards as past provincial infrastructure has been built based on these K-values. Since the integration of computer programs in highway design, designers increasingly deviate from these~~are deviating from these~~ K-values. However, for consistency and driver~~'~~s' expectations, selection of K-values should be as close as possible to the values in **Exhibit -3R~~Q~~** ~~while other parameters are also meeting~~**.**

- Bullet point number 2 is not applicable and is replaced with the following:

  - The minimum length of a vertical curve in metres should not be less than the design speed in kilometres per hour.

  2.

Exhibit -3R~~Q~~

K – ~~STANDARD VERTICAL CURVE VALUES~~Standard Vertical Curve Values

4	5	8	10	12	15	18	20	25	30	35	40	45
50	60	70	80	90	100	120	150	180	200	230	250	300

Section 3.3.5.2 – Drainage: Application Heuristics

- Bullet~~ed~~ points numbers 5 and 6 are ~~**Not**~~ **not** ~~**Applicable**~~ **applicable** and are **replaced** with the following:

5. On flat crest and sag curves, storm water might run sufficiently slowly ~~so as to~~to spread onto the adjacent travelled lane. There is a level point at the crest of a vertical curve, but generally no difficulty with drainage on curbed pavements is experienced if the curve is sharp enough so that the minimum gradient of 0.30% is reached at a point about 15 m from the crest. This corresponds to a K value of 50. Where a crest of K value greater than 50 is used, special attention is needed to assure proper pavement drainage near the apex of the curve, for example, the application of more frequent catch basins.

6. For sag vertical curves the same criterion for crest curves applies, that is, the minimum grade of 0.30% is reached within 15 m of the level point. For a sag curve value of K greater than 50, special attention is required. Sag vertical curves normally occur in fill sections. In general, sag curves should be avoided in cut section since they often present drainage problems. If there are compelling reasons for a sag curve to occur in cut, for example, aesthetic considerations, precautions should be taken to ~~provide~~ ensure adequate drainage is provided. ~~This might be regarding the downstream side of a watercourse.~~

Section 3.3.5.3 – Snow: Application Heuristics

- This ~~Section~~ section is **~~Applicable~~ applicable** with the following **additional ~~Guidance~~ guidance** for Bullet # 1:
-

~~1.~~ Snow drift is becoming ~~even more pressing~~an increasing concern due to the increased frequency and severity ~~and frequency~~ of wind and snowfall events due to climate change.

1.

Section 3.3.5.5 – Vertical Clearances: Application Heuristics

- This ~~Section~~ section is **~~Not~~ not ~~Applicable~~ applicable** and is **replaced** with the following:

New Structures over Roadways

The minimum vertical clearance over the roadway for new structures shall be:

- 4.8 m for solid or cast-in-place concrete slab bridges~~.~~
- 5.0 m for all other vehicular bridges
- 5.3 m for pedestrian and bicycle bridges
- 4.5 m for small signs
- 4.8 m for railway bridges over roadways
- 5.3 m for fixed attachments, such as large sign panels, of sign support structures
- 5.6 m for the lowest structural members, such as bottom chord, of sign support structures

The minimum vertical clearance over sidewalks, bikeways and snowmobile trails shall be 2.5 m.

Consideration should be given to a higher clearance for snow grooming equipment where required.

These dimensions ~~take into account~~account for two resurfacings, live load deflection, foundation settlement, differential heaving of pavement and vehicle bounce.

All structures having a vertical clearance less than that specified above, shall require approval by the jurisdictional authority.

Existing Structures over Roadways
For existing structures where the highway is being resurfaced or reconstructed, the minimum vertical clearance over the roadway should be:

(A) For structures where the existing vertical clearance is equal to or greater than those specified “New Structures over Roadways”, the following shall apply:
- 4.7 m for solid or cast-in-place concrete slab bridges~~.~~
- 4.9 m for all other vehicular bridges
- 5.2 m for pedestrian and bicycle bridges
- 5.2 m for fixed attachments

(B) For structures where the existing clearance is equal to or less than those specified in (A), the existing clearance shall be maintained.

Note: All existing structures with a clearance of less than 4.5 m shall be signed accordingly. Bridges with ~~a clearance~~ less than 4.5 m of clearance haves historically been recorded in the Ontario Structure Clearance and Load Inventory System (OSCLIS). ~~Recently,~~ OSCLIS has been~~is~~ replaced with a new system known as Bridge Management System (BMS).

Bridges over Railways

Minimum vertical clearance over railways is 7.01 m (23 feet) measured from the top of rail. Allowance should be made for curvature and superelevation of the track. Temporary clearances during construction, both vertical and horizontal, shall be as specified by the railway or railways having jurisdiction over the tracks. For details, ~~designers are encouraged to~~ refer to latest edition of *"Standards Respecting Railway Clearances"* of Transport Canada. The current standard is TC E-05 of May 14, 1992.

Bridges over Non-Navigable Waterways

Vertical clearance between the lowest point of the soffit and the design high water level shall be sufficient to prevent damage to the structure by the action of flowing water, ice flows, ice jams or debris, and shall not be less than 1.0 m for freeways, arterial roads and collector roads and not less than 0.3 m for local roads. Lower clearances over non-navigable waterways may be used for low volume roads. Lower clearances may also be used, with approval from jurisdictional authority, where it is prohibitive to use this criterion.

The design high water level referred to above include the amount of backwater created by a bridge or culvert and is the higher of the water level corresponding to the design flood discharge under ice-free conditions and the highest recorded water level created by ice jams.

Bridges over Navigable Waterways

Navigational vertical clearance is dependent on the type of vessel using the waterway and should be determined in consultation with the Canadian Coast Guard and~~,~~ Department of Fisheries and Oceans.

Clearance should also conform to the requirements of the Navigation Protection Act of Canada (NPA). The water level used as a basis for measuring navigational clearance should be the maximum likely to occur during the navigation season.

Approach Grade Elevation

Where ~~the~~ geometric and other non-hydraulic considerations permit, freeboard from the edge of through traffic lanes to the design high-water shall be 1.0 m for freeways, arterial and collector roads and 0.3 m for other roads.

Where ~~the~~ geometric and other conditions permit, the approach roadway shall be placed at an elevation that will not be overtopped during the normal design flood but will maximize relief overflow during the regulatory or other extreme flood.

Freeboard for Routes under Structures Crossing Water

Freeboard for highways under bridges that cross water shall be in accordance with the freeboard criteria for the approach grade elevations.

Freeboard for walkways, cycle paths and maintenance access roads under structures crossing water shall be at least 1.0 m above the water level for spans of more than 6.0 m and at least 500 mm for spans of 6.0 m or less. These values shall be increased where high maintenance costs are likely to result from use of the minimum values.

Minimum Vertical Clearances for Aerial Cable Systems

The minimum vertical clearances for aerial cable systems shall be in accordance with the applicable Standard Drawings (OPSD or MTOD).

Airways over Roads

Minimum vertical clearance to airways is as indicated in *Figure 3.3.4* in the *TAC Geometric Design Guide for Canadian Roads – June 2017.* The dimensions are for guidance only and specific dimensions should be approved by the Regional Director of Civil Aviation, Transport Canada.

Construction Clearances

Construction clearances should conform to the requirements of the agency having jurisdiction over the roadway.

The minimum vertical clearances to temporary falsework shall be:

(I) 4.5 m for solid or cast-in-place concrete slab bridges over roadways~~.~~
(II) 5.0 m for all girders type vehicular bridges over roadways~~.~~

(III) 4.7 m for pedestrian or bicycle bridges over roadways

(IV) 4.5 m for railway bridges over roadways

Section 3.4.3 – Alignment Coordination: Design Domain Application Heuristics

- This ~~Section~~ section is **~~Applicable~~ applicable** with the following **additional ~~Guidance~~guidance**:
  - Short vertical curvature should not be introduced on horizontal curves and, when possible, vertical curves should be made long with the mid-points of horizontal and vertical curves coincident.
  - Horizontal curves seen from a distance tend to appear foreshortened and the radius should be made longer to avoid the appearance of a kink.
  - It should be remembered that horizontal and vertical alignments are the most permanent design elements of a highway, and once a facility is constructed, poorly designed combinations will~~, in all likelihood,~~ remain in operation and be experienced by road users for ~~many years~~decades.

Section 3.5.4 – Cross-Slope Arrangements: Application Heuristics

- This ~~Section~~ section is **~~Applicable~~ applicable** with the following **additional ~~Guidance~~guidance**:

Cross Slope on Wide Roadway Platforms

On tangents and curves with less than 3% superelevation with four or more lanes draining in the same direction, the guidance in the Longitudinal Grade and Cross Fall section of the MTO Highway Drainage Design Standards should be applied.

Cross-Slope and Superelevation for Resurfacing Projects

On reconstruction and/or re-alignment projects, cross-slope and superelevation desirably should be restored to design standards. However, on resurfacing projects restoration to acceptable standards should only be made if it can be justified. These justifications must be clearly stated in the Design Criteria and documented in detail in the project file. The following justification guidelines are suggested, but should be used with care and engineering judgement~~ on the part of the designer~~:

Cross-slope

During the preliminary design stage, the costs to restore a section of pavement to both acceptable tolerances and design cross-slope standards must be determined and carefully assessed.

Resurfacing of a pavement is normally undertaken to strengthen the pavement structure and restore ride and/or skid resistance. This resurfacing can be carried out by a conventional overlay on the existing surface with some padding, by partial depth removal, or by an in-place recycling process including hot- or ~~/~~cold-~~-~~in-place recycling. In conjunction with resurfacing to improve ride and pavement structure, cross-slope and superelevation correction may be incorporated to improve rideability ~~ability~~ and safety. Minimum acceptable standards are provided in *Table 3.5.1: Pavement Cross-Slope for Resurfacing* in *Chapter 3 – Alignment and Lane Configuration.*

Where a conventional resurfacing or in-place recycling project is undertaken, the conventional or recycled binder course must be thick enough to allow for cross-slope correction to an acceptable tolerance. Where partial depth removal of the pavement is undertaken, milling can be utilized to correct cross-slope or superelevation to an acceptable tolerance. The average cross-slope rate selected for a specific resurfacing project must be reasonably consistent throughout and within the acceptable tolerances outlined above.

Restoration to acceptable standards should be justified in terms of the service to ~~high speed~~high-speed traffic, potential reduction in ~~accident experience~~collisions and anticipated life expectancy of the project.

~~For example,~~A common example of a type of project where acceptable standards are applied is where resurfacing is ~~occasionally~~ programmed as a short-term improvement or “holding strategy” with the intention of carrying out more extensive work, such as road widening, in 5-10 years.

Restoration to acceptable standards may also be justified where new procedures with limited correction capabilities are being used.

Superelevation

Superelevation on curves may be less than design superelevation shown in *Table 3.2.5, Table 3.2.6,* and *Table 3.2.7 in Chapter 3.* Whenever superelevation is applied, which is less than design superelevation, the maximum speed must be based on the acceptable standard for the rate of superelevation and the maximum friction factor 'f' for the range of radii as shown in **Exhibit -3S~~R~~**.

In many cases design speed and posted speed are the same, particularly for low volume roads. To determine the need for superelevation correction, the following data should be obtained for each horizontal curve:

- E~~e~~xisting superelevation
- E~~e~~xisting radius
- ~~accident~~ Ccollision experience
- 85th percentile operating speed
- M~~m~~aximum safe speed as determined by *Table 3.2.5 to Table 3.2.7* in *Chapter 3 – Alignment and Lane Configuration~~.~~*

The existing superelevation curves may remain less than that shown in *Table 3.2.5* to *Table 3.2.7* of *Chapter 3 - Alignment and Lane Configuration* provided the following conditions are met:

- The collision history does not indicate a pattern of loss-of-control collisions that may be attributed to inadequate superelevation.~~re is no unusual accident collision experience, such as loss of control type that can may be related attributed to inadequate superelevation.~~
- The maximum speed given by *Table 3.2.5 to Table 3.2.7* in *Chapter 3 Alignment and Lane Configuration* based on the prevailing rate of superelevation and the maximum friction factor is at least 10 km/h higher than the 85th percentile operating speed. (Generally, the 85th percentile operating speed will be close to the posted speed limit but can be significantly higher.)

Where the above conditions are not met, corrections should be applied to make the superelevation as shown in *Table 3.2.5 to Table 3.2.7* of *Chapter 3 Alignment and Lane Configuration* as follows:

- D~~d~~esign standard, based on design speed~~, or~~

- A~~a~~cceptable standard, based on posted speed, or the 85th percentile operating speed plus 10 km/h, whichever is greater~~.~~

The cost of correction based on design and acceptable standards must be determined and ~~taken into account~~considered in selecting the course of action to be followed.

Shoulder

On resurfacing projects, the shoulder cross-slope or superelevation should be improved to the design standard regardless of the treatment of cross-slope and superelevation to the adjacent traffic lanes.

Exhibit -3S~~R~~

~~MAXIMUM SPEED (km/h) AT GIVEN SUPERELEVATION FOR RESURFACING PROJECTS~~

Maximum Speed (km/h) at Given Superelevation for Resurfacing Projects

RADIUS	SUPERELEVATION m/m										
m	-0.02	-0.01	0	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08
45	29	31	32	32	34	34	35	35	37	37	39
50	31	32	33	34	35	35	37	37	39	39	41
55	32	34	34	35	35	37	39	39	40	40	42
60	34	35	36	37	37	39	40	41	41	42	44
65	35	37	37	38	39	40	41	42	43	43	46
70	36	38	38	39	41	41	43	44	45	46	48
75	37	40	39	40	42	42	44	46	46	48	49
80	39	41	40	41	43	44	45	47	47	49	50
85	40	42	41	42	45	46	47	48	48	50	51
90	41	43	42	43	46	47	49	49	50	51	53
95	42	43	44	45	47	49	50	50	51	53	55
100	43	44	45	46	48	51	51	51	52	55	56
105	44	44	46	47	49	52	53	52	53	56	57
110	45	45	47	48	50	53	54	53	54	57	58
115	46	46	48	49	51	54	55	54	56	58	59
120	47	47	50	50	52	54	56	55	57	59	60
125	48	48	51	50	53	55	57	54	58	60	61
130	48	49	52	51	55	56	58	57	60	62	63
140	50	50	53	52	56	57	59	59	62	63	65
150	51	51	54	54	57	58	60	61	64	65	67
160	52	53	56	56	59	60	62	63	66	67	69
170	54	55	58	57	60	62	64	65	68	69	71
180	56	57	59	59	62	64	66	67	70	71	73
190	57	59	60	60	64	65	67	69	71	72	74
200	58	61	62	61	66	67	69	70	72	73	75
210	60	62	63	63	67	68	71	72	74	75	77
220	61	63	64	64	68	69	72	74	76	77	79
230	62	63	66	66	70	71	74	76	78	79	81
240	63	65	67	68	71	73	75	78	80	81	83
250	64	66	68	71	72	74	76	80	82	83	85
280	68	69	70	73	75	77	79	82	84	86	88
300	70	72	72	75	77	79	82	84	86	88	90
320	72	75	74	77	79	81	85	86	88	90	92
340	74	76	77	80	82	83	87	88	90	92	94
350	74	77	79	82	84	86	89	90	92	95	97
380	77	79	82	85	87	89	91	93	95	97	99
400	78	81	84	87	89	91	93	95	99	99	101

420	81	83	86	89	91	94	95	98	101	102	104
450	83	85	88	91	93	96	97	101	104	105	107
475	84	87	90	93	95	98	101	103	106	108	110
500	86	89	92	95	97	101	103	105	108	110	113
525	88	91	94	97	99	103	105	107	110	113	115
550	90	93	96	98	101	105	107	109	113	115	117
575	92	94	97	100	103	107	109	111	116	117	119
600	93	96	99	102	101	109	111	114	118	119	
650	96	99	102	105	109	111	114	117	120		
700	98	102	105	108	111	114	117	121			
750	101	105	107	111	115	116	121				
800	104	108	110	114	118	121					
850	107	110	112	117	121						
900	109	113	116	120							
950	111	115	118								
1000	113	117	121								
1050	115	119									
1100	117	121									
1150	18										
1170	119										

$$R = \frac{v^2}{127\,(e+f)}$$

~~the adjacent traffic lanes.~~

For resurfacing shoulders without adjacent curbs, the fill slope or cut side slope should be maintained. The increased depth of shoulder will necessitate a reduction in shoulder width as shown in **Exhibit -3T~~S~~**.

The resultant reduced shoulder width is acceptable provided both the following guidelines are met:

- The reduction in width is not more than 0.5 m~~.~~
- The usable shoulder width is not less than 1.0 m~~.~~

Where these guidelines are not met the shoulder should be widened to provide either:

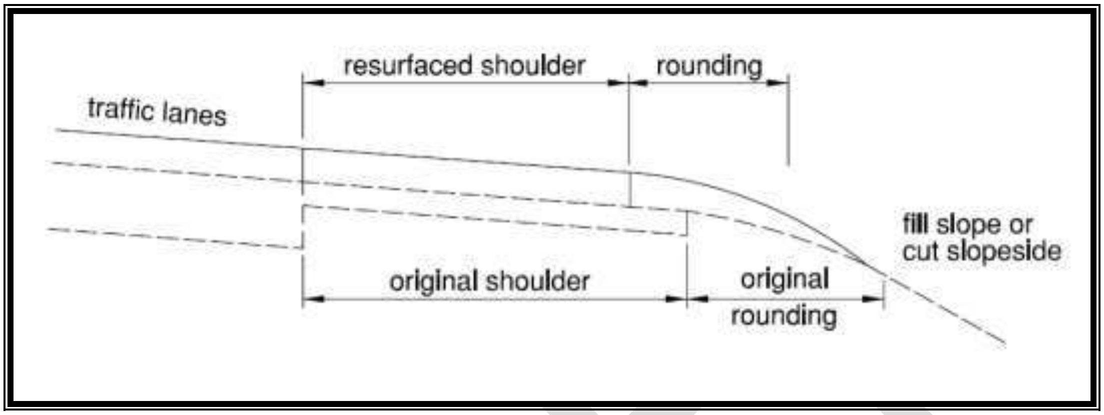
- An acceptable shoulder width equal to the width occurring on most of the project~~, or~~
- The standard width noted in the replaced *Section 4.4.2 of MTO Design Supplement*

The cost of widening to either of the above criteria should be compared.

If the shoulder requires widening over more than 10% of the project length, excluding intersection improvements, application of the standard width should be considered. Resurfacing of full or partially paved shoulders should be ~~dealt with~~addressed on a project-specific basis. The cross-slope or superelevation desirably should be as shown in the replaced *Section 4.4.4 of MTO Design Supplement.*

Exhibit -3T~~S~~

~~SHOULDER TREATMENT ON RESURFACING PROJECTS~~Shoulder Treatment on Resurfacing Projects



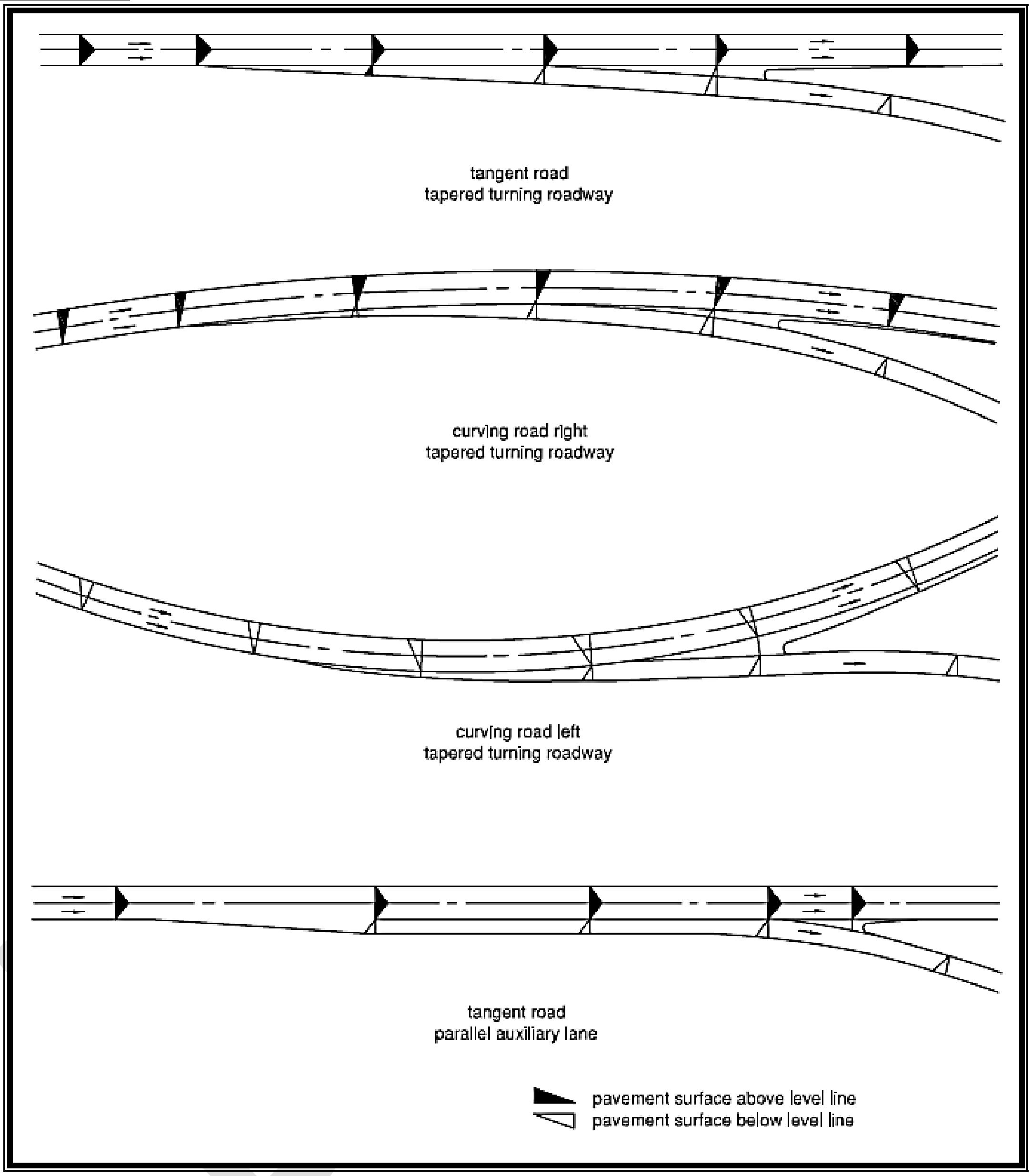
Section 3.5.5 – Cross-Slope Changes: Application Heuristics

- This ~~Section~~ section is **~~Applicable~~ applicable** with the following **additional ~~Guidance~~guidance**:

  Exhibit -3U~~T~~ illustrates the development of superelevation at a turning roadway exit terminal for alternative alignments and auxiliary lane treatments.

Exhibit -3U~~T~~

~~DEVELOPMENT OF SUPERELEVATION AT TURNING ROADWAY EXIT TERMINAL~~Development of Superelevation at Turning Roadway Exit Terminal



Section 3.6.2.1 – Technical Foundation

- This ~~Section~~ section is **~~Applicable~~ applicable** with the following **additional ~~Guidance~~guidance**:

  Designers should also consider strategies to alleviate congestion, when determining the number of lanes required to best accommodate free-flowing traffic conditions, with the goal of minimizing greenhouse gas emissions.

Section 3.6.3.2 – Application Heuristics

- Last two paragraphs of this section are **~~Not~~ not ~~Applicable~~ applicable** and are~~is~~ **replaced** with the following:

  Where an auxiliary lane is extended beyond an entrance to maintain both lane~~s~~ balance and basic lanes, the lane should be continued for at least 400 m, as shown in **Exhibit -3V~~U~~**, to permit entering traffic to ~~disperse~~ merge into the through lanes. Additional length is warranted if the:
  - Ramp traffic volume is high~~.~~
  - Truck traffic on the freeway is heavy~~.~~
  - Roadway is on an upgrade~~, or~~
  - L~~The l~~ane drop occurs at crest curve~~.~~

  In the case of an auxiliary lane introduced before an exit, the lane should be extended as shown in **Exhibit -3W~~V~~** to make full use of the capacity of the added lane.

Exhibit -3V~~U~~

~~AUXILIARY LANE EXTENDED BEYOND ENTRANCE~~Auxiliary Lane Extended Beyond Entrance

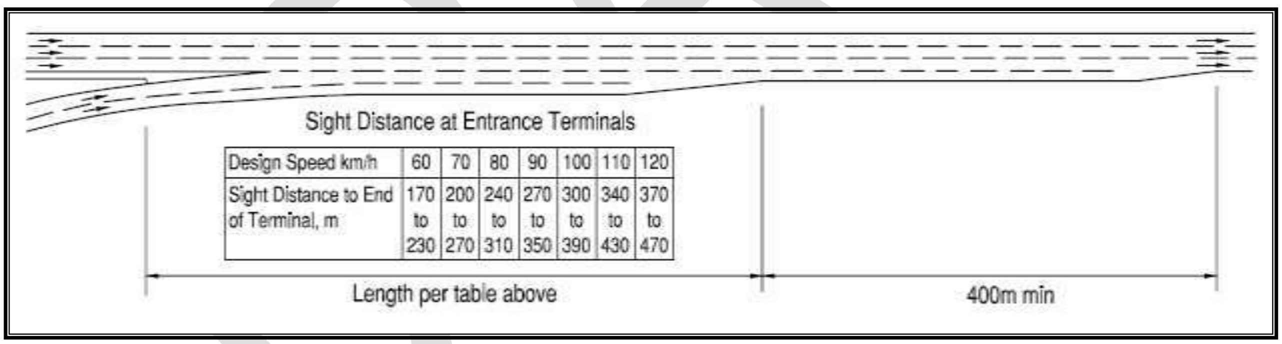
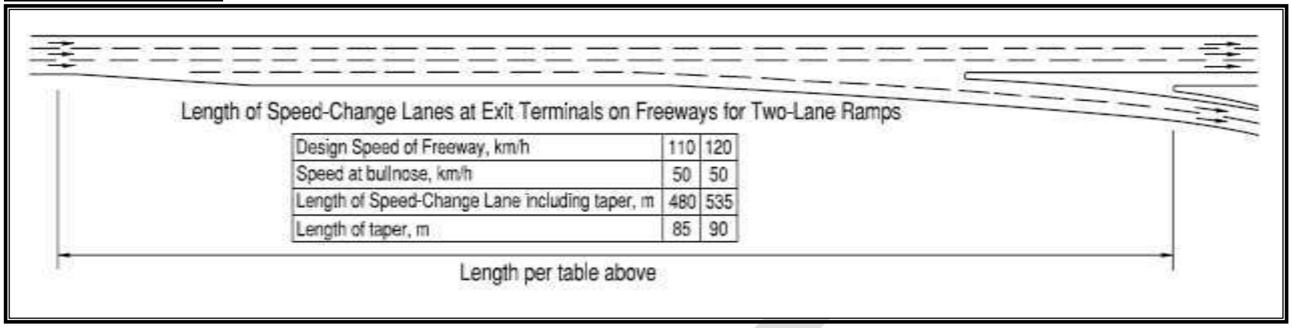


Exhibit -3W~~V~~

~~AUXILIARY LANE INTRODUCED BEFORE AN EXIT~~Auxiliary Lane Introduced Before an Exit



Design Speed of Freeway, km/h	110	120
Speed at bullnose, km/h	50	50
Length of Speed-Change Lane including taper, m	480	535
Length of taper, m	85	90

Section 3.6.4 – Express Collector Systems: Best Practices

- This ~~Section~~ section is **~~Applicable~~ applicable** with the following **additional ~~Guidance~~guidance**:

  A separated highway system using the express and collector lanes aims to allow for more efficient use of the highway which helps to lower overall emissions through more efficient travel. Express lanes allow vehicles to remain at more constant speeds without weaving in and out of traffic. This leads to less braking and speed variability in those lanes and hence the reduction of emissions from the vehicles in express lanes. Collector lanes aim to accommodate vehicles entering or exiting the highway and serve the same purpose of allowing for more efficient travel in the express lanes. ~~As well~~Additionally, separating the highway system into collector and expressway lanes allows one to continue to accommodate traffic in the event of a closure of the other ~~having to shut down~~.

Section 3.7.1.1. – Technical Foundation

- This ~~Section~~ section is **~~Applicable~~ applicable** with the following **additional ~~Guidance~~guidance**:

  With ~~good~~ effective lane balance practices, drivers are more likely to quickly recognize which lanes are suited for their travel needs and maintain free-~~-~~flow speeds. Good lane balance discourages unnecessary braking and reduces the amount of weaving to change lanes, in turn lowering vehicle emissions. It is recommended to conduct a detailed weaving analysis and/or micro simulation for safety and traffic operations.

Section 3.8.1 – Introduction

- This ~~Section~~ section is ~~**Applicable**~~ **applicable** with the following **additional ~~Guidance~~guidance**:

  In addition to climbing lanes being a safety feature, they can also prevent congestion, backups, and associated emissions. For example, on ~~hills~~up-grades, these lanes allow ~~road users~~drivers to pass slower-moving vehicles.

Section 3.8.2 – Grades and Operations: Technical Foundation

- This section is ~~**Applicable**~~ **applicable** with the following **additional ~~Guidance~~guidance**:

  A mass to ~~/~~power ratio of 120 grams per ~~/~~Watt should be used as representative of the size and type of vehicle for design control ~~within~~ on Ontario ~~right-of-ways~~highways.

Section 3.8.3.3 – Warrants for Multilane Roads

- This section is ~~**Not**~~ **not** ~~**Applicable**~~ **applicable** and is **replaced** with the following:

  Warrants on Multi-Lane (4 Lanes or more) Highways
  On a multi-lane highway, a drop in the level of service or a speed reduction of 15 km/h (critical length of grade), on the upgrade, should be regarded as an indication that a climbing lane may be required. To verify this, an operational analysis of the roadway should be performed, both for the approach segment and the upgrade.

  Should this analysis reveal that an additional lane is required on the upgrade, this is an indication that a climbing lane is warranted. However, the designer should then determine what the expected level of service is, on the upgrade, in the mixed vehicle lanes, after the climbing lane is constructed, to ensure that this will bring them up to the desired level of service.

  To determine the capacity of the climbing lane and the number of trucks which can realistically be expected to use it, use the following equations:

$$C_T = 2000/E_T$$

Where

C_T is the capacity of the climbing lane in vehicles per ~~/~~hour

And

E_T is the passenger car equivalent of trucks; refer to **Exhibit -3X~~W~~**

The climbing lane should operate at approximately the same volume to ~~/~~capacity (v/c) ratio (i.e. level of service) as the rest of the roadway, thus select the v/c ratio corresponding to the desired design level of service. The service flow for the climbing lane can then be calculated:

$$SF_T = C_T(v/c)_i$$

Where

SF_T is the service flow for the truck lane and $(v/c)_i$ is the v/c for LOS_i

This is the number of trucks that can reasonably be assumed to use the climbing lane. The remaining heavy vehicles will share the mixed traffic lanes.

Exhibit -3X~~W~~

~~PASSENGER CAR EQUIVALENTS ON EXTENDED GENERAL MULTI-LANE HIGHWAY SEGMENTS~~Passenger Car Equivalents on Extended General Multi-Lane Highway Segments

	Type of Terrain		
Factor	**Level**	**Rolling**	**Mountainous**
E_T (for trucks)	1.7	4.0	8.0
E_R (for RV's)	1.5	3.0	5.0
E_B (for buses)	1.6	3.0	4.0

Section 3.9.1 – Introduction

- This ~~Section~~ section is **~~Applicable~~ applicable** with the following **additional ~~Guidance~~guidance**:

Introducing a passing lane where appropriate will help alleviate queues and platoons along with increased frustration and risky driving behaviour in drivers resulting in unsafe manoeuv~~e~~res. Alleviating queues by the inclusion of passing lanes can help in reducing congestion and associated emissions.

Section 3.9.4.6 – Signing and Lane Marking

- This ~~Section~~ section is ~~**Applicable**~~ **applicable** ~~by using~~however the *MUTCDC (Manual of Uniform Control Devices for Canada)* is **replaced** with *Ontario Traffic Manual Books*. ~~instead of *MUTCDC (Manual of Uniform Control Devices for Canada).*~~

Section 3.9.3 – Best Practices: Warrants
Figure 3.9.2 – Typical Traffic Simulation Output of Percent Following and Correlation with LOS
Section 3.9.4 – Application Heuristics
Section 3.9.4.1 – System Consideration
Table 3.9.1 – Typical Passing L~~l~~ane Spacing

- These above noted Sections, Figure, and Table are ~~**Not**~~ **not** ~~**Applicable**~~**applicable**. Refer to *Section 6.3 Passing Lane Requirements of ministry's Capacity Analysis Manual – January 2016*.

MTO Design Supplement

For
TAC Geometric Design Guide (GDG) for Canadian Roads

Appendix 4 for Chapter 4

Cross Section Elements

~~October~~ July~~TBD~~ 202~~6~~3

MTO Design Supplement
Appendix 4 for Chapter 4
Cross Section Elements

The following design supplements are applicable to *Chapter 4 – Cross Section Elements of TAC Geometric Design Guide for Canadian Roads - June 2017:*

Figure 4.1.3 – Bicycle Facility Nomenclature

- This Figure is **~~Not~~ not ~~Applicable~~applicable**. ~~Designer should~~ R~~r~~efer to the ministry's *Bikeways Design Manual – March 2014* and Provincial Engineering Memorandum # 2018-07 dated October 22, 2018 *"Guidelines for Geometric Design of Cycling Facilities within Constrained Right-of-Ways".*

Section 4.2 – Lane Widths

- Under this ~~Section~~section, the following ~~Sub~~sub-sections and ~~Tables~~ tables are **~~Not~~ not ~~Applicable~~ applicable** and are **replaced** with the ~~Guidance~~ guidance and Exhibits provided below:
  - **Sub-section 4.2.1.1 – Technical Foundation**
  - **Sub-section 4.2.1.3 – Design Domain: Quantitative Aids**
  - **Table 4.2.1 – Through Lane Widths – Rural Roadways (Design Hour Directional Volume <= 450)**
  - **Table 4.2.2 – Through Lane Widths – Rural Roadways (Design Hour Directional Volume > 450)**
  - **Table 4.2.3 – Through Lane Widths – Urban Roadways**
  - **Sub-section 4.2.1.4 – Design Domain: Application Heuristics**

Guidance on Lane Widths

Introduction

Lane width and road surface condition~~ of the road surface~~ ~~have a~~ significantly influence ~~on~~ the safety and comfort of the travelling public.

Studies on 2-lane two-way highways with lane widths of less than 3.5 m~~ wide~~ and carrying moderate volumes of mixed traffic have ~~shown~~ indicated safety, capacity and operational concerns~~ of capacity and safety~~. To provide desirable clearance between commercial motor vehicles, lane widths of 3.75 m may be required. It is generally desirable to maintain this width ~~in~~ on high~~er~~-speed 2-lane roadways. Traffic volumes and the percentage of commercial vehicles are also important~~a~~ considerations.

The capacity of a road is markedly affected by lane width. For example, on 2-lane rural roads the capacities of 3.0 m and 3.25 m lanes are reduced to 77% and 83% respectively of the capacity provided by a lane width of 3.75 m. For 4-lane undivided highways these ratios are 88% and 94% respectively. In terms of capacity the effective width is further reduced by lateral obstructions less than 2.0 m from the edge of pavement or narrow shoulders.

Through Lanes

Standard lane widths on Provincial highways are provided in multiples of 0.25 m and generally range from 2.75 m to 3.75 m depending on ~~a number of~~several factors. Prior to adopting the metric system, lane widths were provided in the imperial system and ~~ranging~~ ranged from 9 ft to 12 ft ~~with an increment~~in increments of 1 foot. Lane widths on existing highways ~~from the previous measurement~~constructed according to the imperial system may be found as 3.35~~3~~ m (11 ft) or 3.66 m (12 ft).~~;~~ T~~t~~hese widths may be maintained as long as operational and safety concerns are not present since ~~studies have shown that~~ small sliver widening is rarely cost effective.

Values for lane widths for various functional classifications of roads are set out in the following paragraphs. These are general guidelines ~~to be followed when considering the selection of~~for selecting lane widths. Deviations from desirable design standards may be appropriate as outlined below, particularly for secondary highways. In general, higher design speeds warrant wider lanes. In addition, wider lanes are normally appropriate:

- F~~f~~or major highways which typically carry high volumes over long distances between ~~important~~ large regional centres~~.~~
- W~~w~~here warranted by type, size, and volume of commercial traffic~~.~~

Narrow lanes are appropriate for minor highways, which are typically local, low volume, short distance roads and provide access to recreational or resource areas.

On new construction and reconstruction projects, lane widths from the Tables **(Exhibit ~~-~~4A to Exhibit ~~-~~4B)** should be applied. Lane widths which are not in these two Exhibits are provided in texts.

In rugged terrain narrower lanes may be appropriate due to ~~by reason of~~ cost constraints and this consideration is reflected in the selection of design speed.

When a highway is to be resurfaced, consideration should be given to retaining the existing cross section dimensions where the dimensions in the Tables cannot be accommodated within the existing roadway. Alternatively, standard lane widths may be applied together with reduced shoulder width of 1.0 m gravel or 0.5 m paved for maintaining pavement support. Where the existing pavement is either fully or partially reclaimed or recycled, lane widths are determined as follows:

- ~~r~~Reclaimed to full depth and recycled:
  - T~~t~~he new pavement width should be the design standard.
- R~~r~~eclaimed to partial depth and recycled:
  - If the design standard is less than the new existing width, the new pavement width should be identical to the existing width.
  - Where partially or fully paved shoulders are required, consider providing the paved portion of the shoulder.
  - If the design standard is greater than the existing width, the design standard should be used. This practice should be applied regardless of shoulder surface treatment.

Where adjacent sections of secondary highways are to be resurfaced and reconstructed, different lane and shoulder widths are acceptable.

2-Lane Rural Roads

Lane widths for 2-lane King's Highways are shown in **Exhibit ~~-~~4A** and **Exhibit ~~-~~4B** for a range of volumes stated in terms of Annual Average Daily Traffic (AADT) and Design Hour Volume (DHV). If both are known, DHV should be used for design. Width adjustments for commercial motor vehicle percentages are indicated.

The selection of lane width for 2-lane rural roads is dependent primarily ~~in~~ on design speed, traffic volume and traffic ~~compassion~~composition. Service function and topography influence the selection of design speed and therefore have an ~~bearing~~impact on lane width.

Lane and shoulder widths may be designated on important long-distance highways to ensure continuity, regardless of traffic volumes.

Exhibit -4A

~~LANE WIDTH FOR 2-LANE RURAL HIGHWAYS~~Lane Width for 2-Lane Rural Highways

Design Speed km/h	Traffic Volume for Design Year					
	AADT					
	>4,000	3,000-4,000	2,000-3,000	1,000-2,000	400-1,000	<400
	DHV					
	>600	450-600	300-450	150-300	60-150	<60
130	3.75					
120	3.75	-	-	-	-	-
110	3.75	3.75	3.75	3.5C	-	-
100	3.75	3.5A	3.5B	3.5	3.5	-
90	3.5A	3.5A	3.5	3.25	3.25	-
80	3.5	3.5	3.25	3.25	3.25	3.25D
70	-	3.25	3.25	3.0	3.0	3.0
60	-	-	-	3.0	3.0	3.0
50	-	-	-	-	-	2.75

Notes:

- Minimum lane width for all paved 2-lane Highways is 3.5 m
- For design, use DHV if available~~.~~
- Lane width may be increased by 0.25 m to a maximum of 3.5 m if warranted by type, size and volume of commercial motor vehicles~~.~~

A. If commercial motor vehicle percentage exceeds 10% increase by one increment

B. If commercial motor vehicle percentage exceeds 15% increase by one increment

C. If commercial motor vehicle percentage exceeds 25% increase by one increment

D. 3.0 m may be acceptable where the type, size, and volume of trucks are not significant~~.~~

2-Lane and 4-Lane Undivided Urban Roads

Lane widths for 2-lane and 4-lane undivided urban roads are shown in **Exhibit -4B** for a range of design speeds from 40 km/h to 80 km/h and for ranges of traffic volumes stated in terms of AADT and DHV. No adjustment for commercial motor vehicle percentages is required for the use of this Table.

Exhibit -4B

~~LANE WIDTH FOR UNDIVIDED URBAN ROADS~~Lane Width for Undivided Urban Roads

Design Speed km/h	**Traffic Volume for Design Year**				
	AADT				
	>6,000	3,000-6,000	2,000-3,000	1,000-2,000	<1,000
	DHV				
	>600	300-600	200-300	100-200	<100
80	3.5 - 3.75*	3.5 - 3.75*	3.5	-	-
60-70	3.5	3.5**	3.25	3.25	-
50	-	-	3.0	3.0	-
40-50	-	-	-	-	2.75 - 3.0*
No. of lanes	4	2 - 4**	2	2	2

Notes:

- Minimum lane width for all paved 2-lane King's Highways is 3.5 m
- For design use DHV if available

  *****Upper value is desirable, lower value is acceptable

  ******Four lanes are appropriate in the upper part of this traffic range where there is a measurable capacity deficiency with only two lanes

4- Lane Undivided and Divided Rural Roads

Lane widths for 4-lane undivided and divided rural roads depend primarily on design speed and to a small degree on traffic volume or commercial motor vehicle percentages. Widths for 4-lane rural roads for design speed ≥ 100 km/h should be 3.75 m while 3.5 m width should be used for design speed less than 100 km/h.

4- Lane Divided Urban Roads

Lane widths for 4-lane divided urban roads depend only on design speed and not on traffic volume or commercial motor vehicle percentages. Lane widths for 4-lane divided roads for design speed ≥ 80 km/h should be 3.75 m while 3.5 m width should be used for design sp~~p~~
eed less than 80 km/h.

Freeways, Multilane Divided Urban Roads

For freeway and multi-lane divided roads, the width of the median lane should be 3.50 m while all other lanes should be 3.75 m, to minimize the overall pavement width. ~~The pavement may be striped in equal lane widths.~~

Section 4.2.2.2 – Centerline Rumble Strips: Best Practices

- This ~~Section~~ section is ~~**Applicable**~~ **applicable** with the following **additional guidance**:

Introduction

Centreline Rumble Strips (CRS) are a grooved formation installed on the centreline of the highway. The intention of CRS is to provide ~~the~~ motorists with both an audible and tactile warning that their vehicle has partially encroached over the centreline ~~onto~~ towards the path of opposing traffic ~~side of the highway~~. The audible warning to ~~the~~ motorists is produced by noise generated by the vehicle tires passing over the CRS. The tactile warning to ~~the~~ motorists is provided by vibration induced in the vehicle by the CRS. An encounter with CRS is ~~expected~~ intended to alert an inattentive motorist to steer back onto their side of the highway.

The approach to CRS installation should be proactive rather than reactive and may be in coordination with the Ontario Provincial Police (OPP) when needed. CRS shall be installed on sections of rural undivided highways as a safety measure to deter head-on collisions or opposite direction sideswipe collisions attributable to inattentive or drowsy drivers.

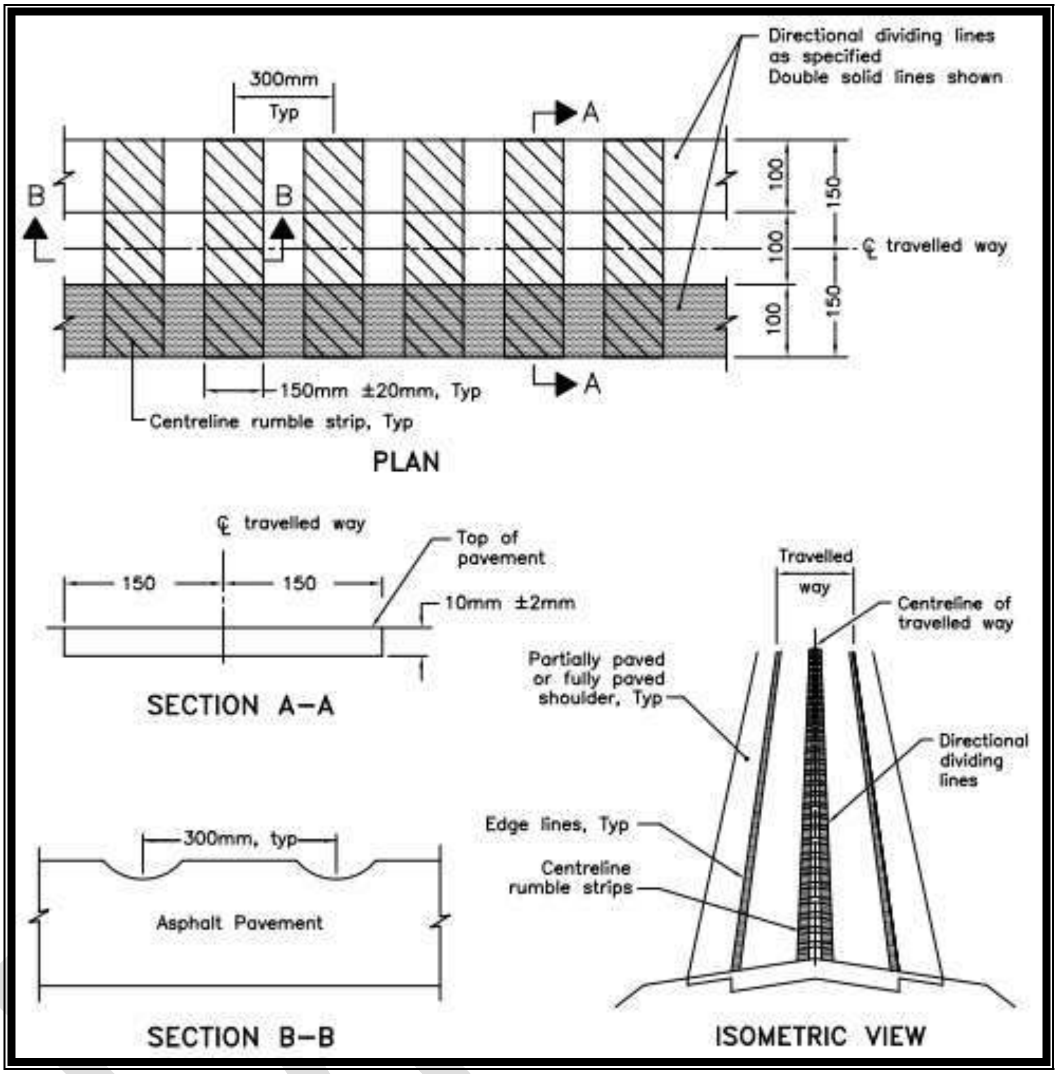
CRS shall be considered on sections of rural undivided highways where there is a history of head-on collisions or opposite-direction side swipe collisions attributable to inattentive or drowsy drivers.

Design Guidance and Installation Considerations

- The g~~G~~eneral arrangement of CRS in plan, section and isometric view is provided in **Exhibit -4C.**
- CRS shall be considered for installation on sections of rural high speed (posted speed ≥ 70 km/h) undivided highways. The consideration for installation shall be continuously~~all~~ along undivided highways in passing zones and in no-passing zones, and on curved and tangent sections.
- CRS may be considered for installation on sections of rural low speed (posted speed < 70 km/h) undivided highways identified through Traffic Engineering Software (collisions attributable to inattentive or drowsy drivers causing head-on or opposite direction side-swipe collisions).
- Regions shall make the decision for selection of section of highways considering technical and environmental aspects. Regions may involve the Ontario Provincial Police in the process.

Exhibit -4C

~~GENERAL ARRANGEMENTS OF CENTRELINE RUMBLE STRIPS~~General Arrangements of Centreline Rumble Strips



- ○ CRS may be installed either in conjunction with a construction project or as a retrofit by means of a separate contract. It is the responsibility of each Region to set priorities for the locations being considered for CRS.
- ○ All ministry contracts that include CRS shall use the Centreline Rumble Strips item.
- ○ CRS should not be installed on highways with lane widths less than 3.5 m adjacent to the centreline of highway unless identified through Traffic Engineering Software (collisions attributable to inattentive or drowsy drivers causing head-on or opposite direction side-swipe collisions).
- ○ On curved sections of highway where CRS are to be installed, pavement

widening on curves should be in accordance with *TAC Geometric Design Guide (GDG) -2017* and ministry's *Design Supplement for TAC GDG*.

- CRS may be installed in the centre of rural divided high speed (posted speed ≥ 70 km/h) highways with flush medians.
- CRS should only be installed in asphalt pavement that is in good condition. CRS should not be installed in asphalt pavement having moderate to very severe surface defects, distortions or cracking distresses that are extensive to throughout as defined in the Manual for Condition Rating of Flexible Pavements (SP-024) and as verified during site review.
- Where CRS are being considered as a retrofit project on highways that were recently paved, the existing pavement warranty shall be reviewed.
- CRS should not be installed in exposed concrete pavements.
- CRS should not be installed on bridges.
- Where there are noise sensitive areas (e.g., residential ~~build~~built-up areas~~s/urban~~) located closer than 100 m from the centreline of the highway, CRS should be discontinued 200 m on either side of the area.
- CRS should be discontinued 10 m in advance of the start of the corner radii of intersecting road or residential and commercial entrances as illustrated in **Exhibit -4D**.
- When planning, ~~/~~installing and ~~/~~designing CRS: 500 series standard drawings (MTODs), specification (OPSS), and Contract Design and Estimation Document (CDED) for CRS should be ~~considered~~used.
- Directional dividing pavement markings will need to be reinstated after installation of CRS.
- For inventory purposes, locations of all CRS being installed shall be documented describing their location by highway number, Linear Highway Referencing System's (LHRS) offsets, length, and installation date.

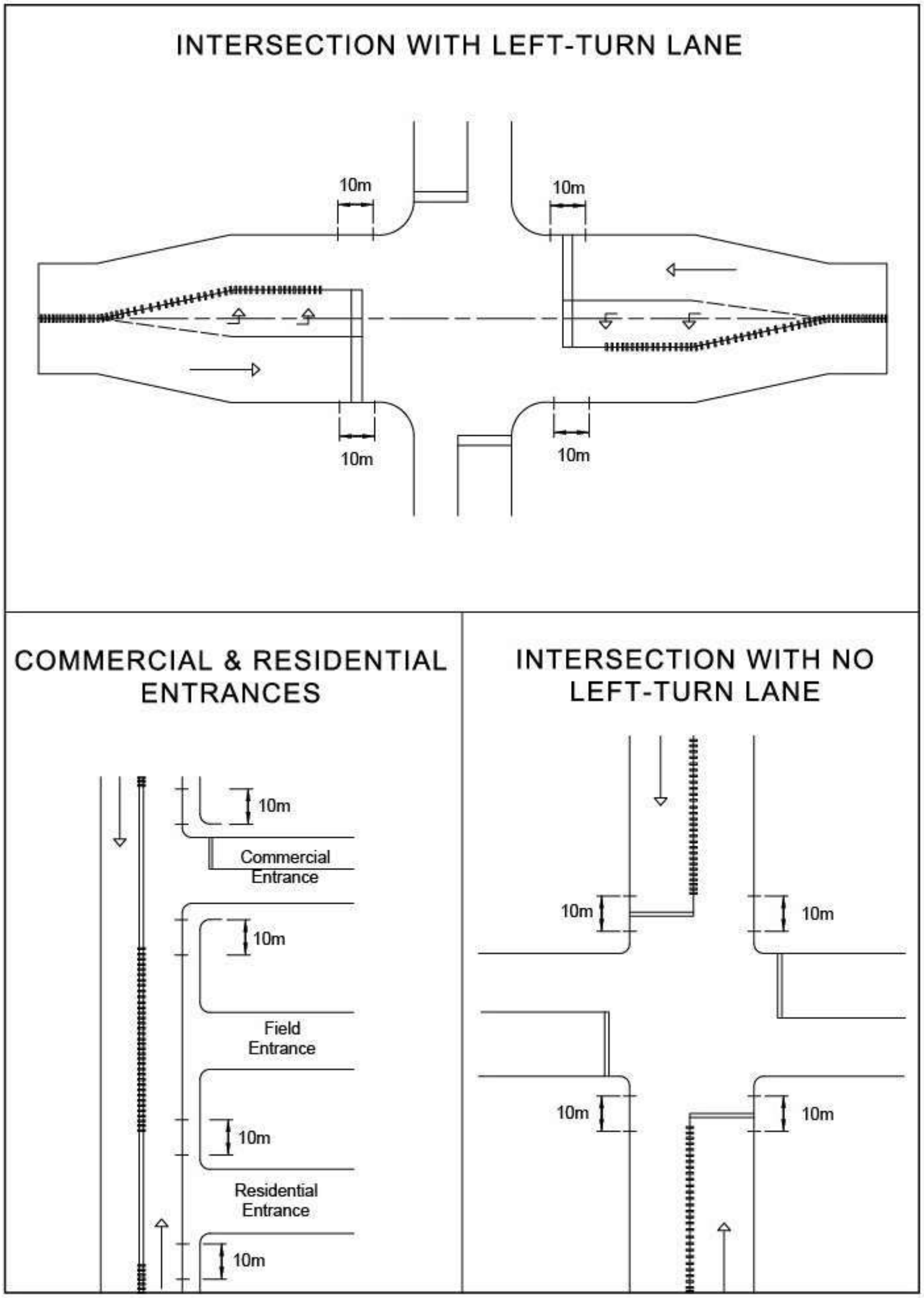
Figure 4.2.2 – Centreline Rumble Strips

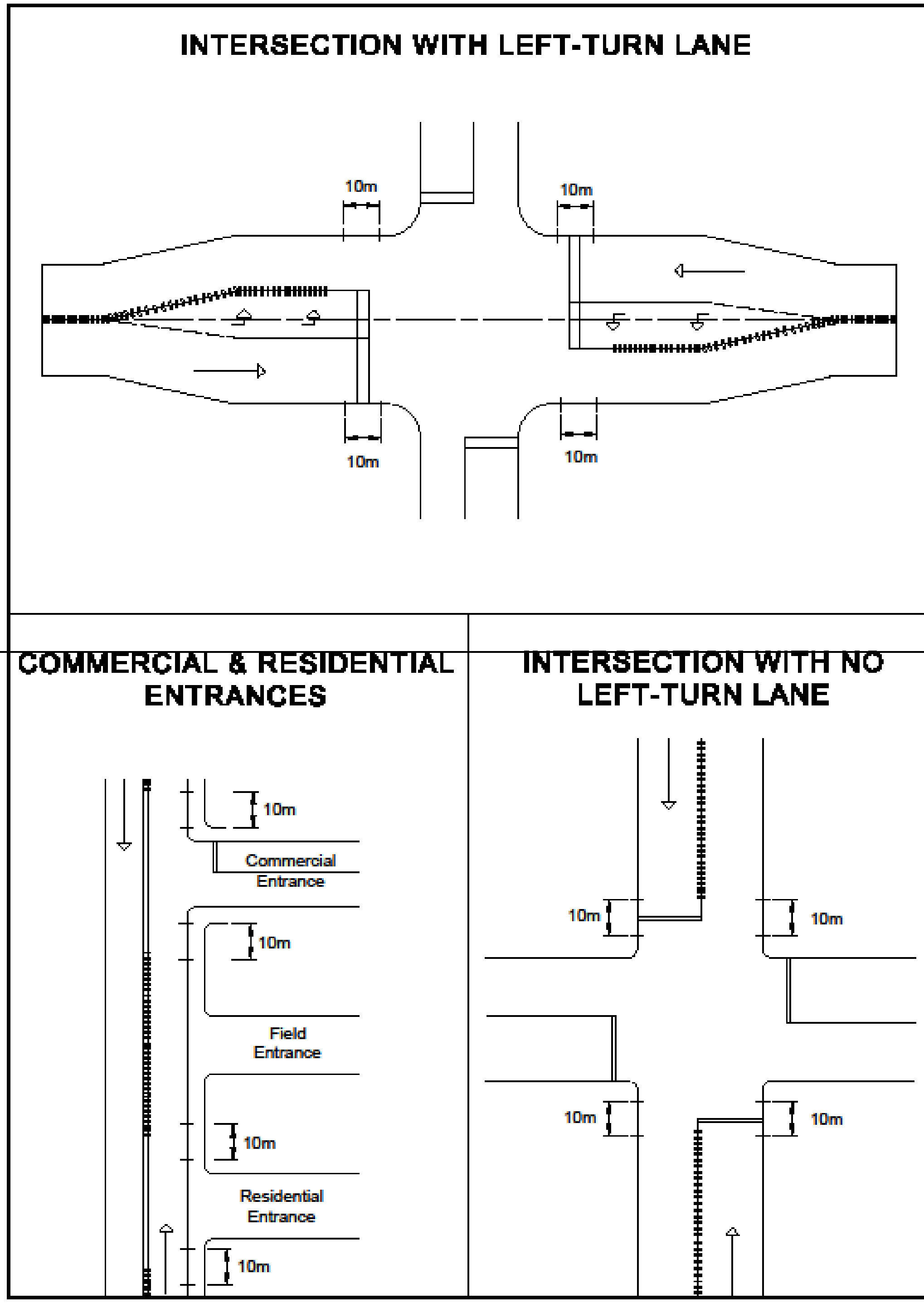
- This Figure is **~~Not~~ not ~~Applicable~~applicable**.

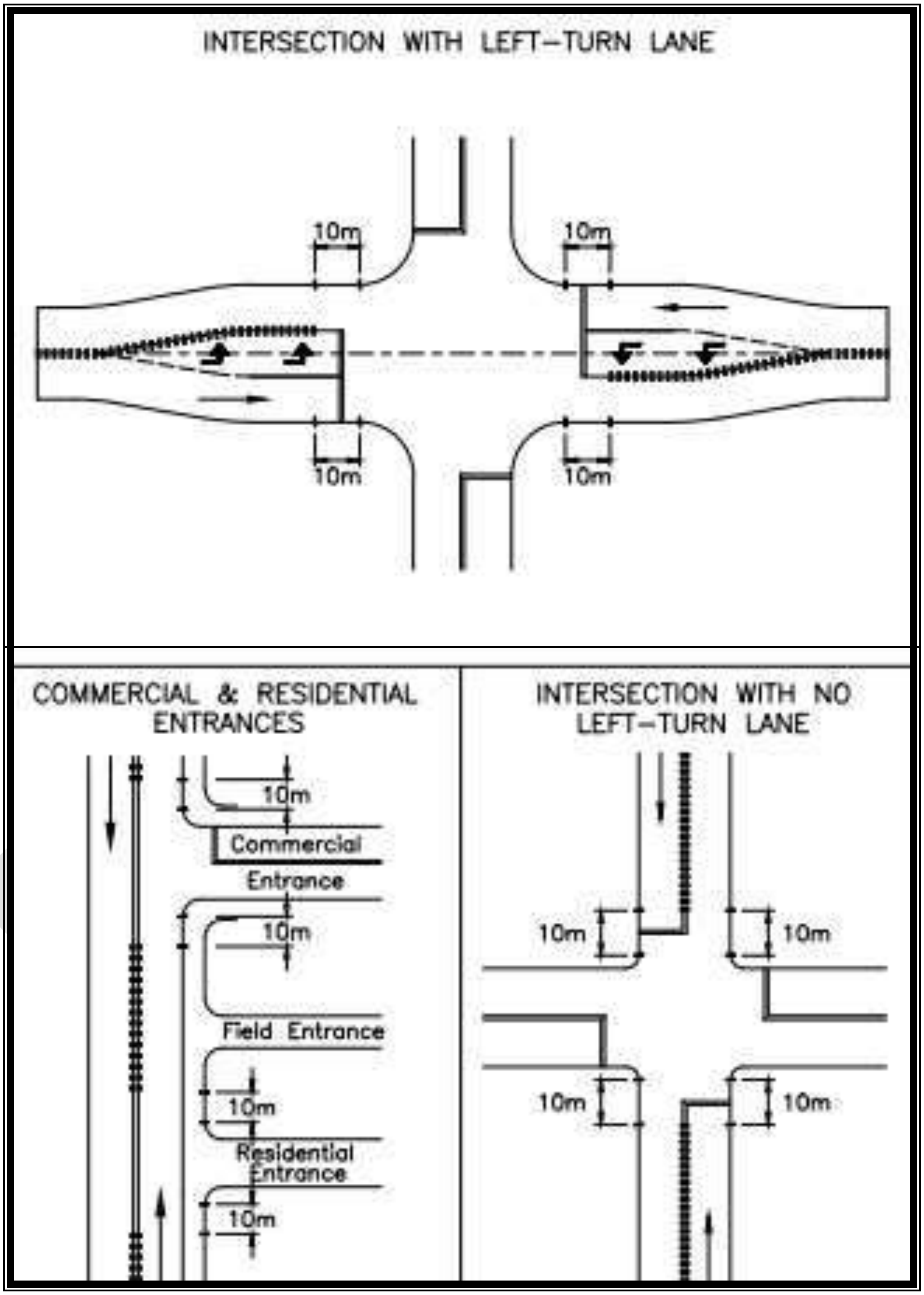
Exhibit -4D

~~CENTRELINE RUMBLE STRIPS AT INTERSECTIONS AND ENTRANCES~~Centreline Rumble Strips at

Intersections and Entrances




INTERSECTION WITH LEFT-TURN LANE
10m
10m
10m
10m
COMMERCIAL & RESIDENTIAL ENTRANCES
10m
Commercial Entrance
10m
Field Entrance
10m
Residential Entrance
10m
INTERSECTION WITH NO LEFT-TURN LANE
10m
10m
10m
10m



Section 4.3.2.1 – Passing and Climbing Lanes

- This ~~Section~~ section is **~~Not~~ not ~~Applicable~~ applicable** and is **replaced** with the following ~~Guidance~~guidance:

Truck Climbing Lanes

These are introduced on steep upgrades to provide a lane for commercial motor vehicles and other slow-moving vehicles whose speed drops more than 15 km/h because of the grade. The through uphill lanes are kept free for faster traffic. Truck-climbing lanes increase capacity, improve travel times, and reduce ~~accident~~ collision rates.

The width of ~~the~~ a truck-climbing lane may be 0.25 m less than the adjacent through lane, but it should not be less than 3.~~2~~5 m.

Passing Lanes

Passing lanes are similar to truck-climbing lanes but are not necessarily located on upgrades. Passing lanes are applied to 2-lane roads carrying large volumes of slow-moving vehicles (for example, recreational routes). A slow-moving vehicle will cause a queue to form because of lack of passing opportunity, sight distance restrictions or large volumes of opposing traffic. Passing lanes are introduced at intervals to allow following vehicles to overtake. Passing and climbing lanes also help ~~to~~ ensure that free-~~-~~flow traffic conditions can be achieved which results in less associated emissions from slower moving vehicles causing congestion.

The width of ~~the~~ a passing lane may be 0.25 m less than the adjacent through lane, but it should not be less than 3.25 m.

Section 4.3.2.2 – Right-Turn Lanes

- This ~~Section~~ section is **~~Not~~ not ~~Applicable~~ applicable** and is **replaced** with the following ~~Guidance~~guidance:

Right-turn lanes are auxiliary lanes added to the right of through lanes ahead of intersections to allow right-turning traffic to slow down before making the turn, without interfering with following through traffic, and to provide additional capacity at intersections. The lane may or may not lead directly into an exclusive right-turning roadway.

When the volume of right turning vehicles is such that it creates a hazard and reduces capacity at an intersection, consideration should be given to the provision of a deceleration lane in the form of a taper and parallel lane for the right turning traffic. The primary objective of providing a right turn lane at an unsignalized intersection is to improve safety and to maximize the capacity of a roadway by reducing the speed differential between the right turning vehicles and the other vehicles on the roadway.

Key Considerations for Right-Turn Lane Warrants:

The need for a right-turn lane shall be evaluated based on a combination of traffic volumes, operating speeds, safety performance, and site-specific conditions. Engineering judgment shall be applied in all cases and should be coordinated with Regional Traffic Section.

- **Safety Factor:** RTLs are often warranted to mitigate rear-end and side-swipe collisions between through vehicles and decelerating turning vehicles, and conflicts between right-turning vehicles and pedestrians or cyclists crossing the receiving roadway. Collision history, human factors, and site constraints shall be considered in determining the appropriateness of a right-turn lane installation.

- **Operating Speed:** Higher operating speeds increase safety risks associated with speed differentials between through and turning vehicles. As operating speed increases, a right-turn lane may be warranted at lower right-turn volumes.

- **Truck Percentage:** A high percentage of heavy vehicles may justify a right-turn lane at lower traffic volumes due to longer deceleration distances, slower turning speeds, and increased lane occupancy.

- **Traffic Volume Threshold Criteria:** Volume criterion is intended for application where the volume of intersecting traffic is the principal reason for considering installation of a right turn lane. Volume warrants for exclusive right-turn lanes (RTL) at unsignalized intersections are generally based on right-turn volume, through-traffic volume, and operating speeds.

At Unsignalized Intersection:

- A right-turn lane may be considered when through volumes exceed 300 – 400 and the right-turn volume exceeds 10% of the through volumes per hour (vph) on a high-speed rural highway.

These thresholds are indicative and shall be applied in conjunction with operating speed, collision history, roadway geometry, and engineering judgment.

The width of ~~the~~ a right-turn lane may be 0.25 m less than the adjacent through lane, but it should not be less than 3.25 m.

Section 4.3.2.3 – Left-Turn Lanes

- This ~~Section~~ section is **~~Not~~ not ~~Applicable~~ applicable** and is **replaced** with the following ~~Guidance~~guidance:

Left-Turn Lanes are auxiliary lanes added to the left of through traffic lanes to provide a refuge for left-turning traffic waiting to make the turn and to avoid interference with following through traffic. Left-turning traffic typically will move into the left-turning lane, slow down and wait for a suitable gap in oncoming traffic to make the turn. Left--turn~~m~~ lanes are used with and without medians.

The width of ~~the~~ a left-turn lane not adjacent to a median should be 0.25 m less than the adjacent through lane, but it should not be less than 3.25 m. Left-turn lanes adjacent to a raised median without a gutter should have the curb offset by 500 mm. Left-turn lanes adjacent to a raised or painted median should be not less than 3.0 m wide; gutter should not be considered part of the width of lane.

Section 4.3.2.4 – Parking Lanes

- This ~~Section~~ section is **~~Not~~ not ~~Applicable~~ applicable** and is **replaced** with the following ~~Guidance~~guidance:

Cross section design may include provision for parking. This is normally limited to urban roads. Parking facilities should offer safe and convenient access and egress for parking users and at the same time maintain safe and convenient operation for ~~other~~ through traffic.

Parking dimensions depend on the vehicle dimensions and steering geometry of vehicles to be parked, and on the form of parking provided. ~~Although there is a marked trend toward smaller cars in recent years which would suggest smaller parking dimensions, parking~~ Parking facilities should be able to accommodate most cars and dimensions should be adequate for all but the larger passenger vehicles.

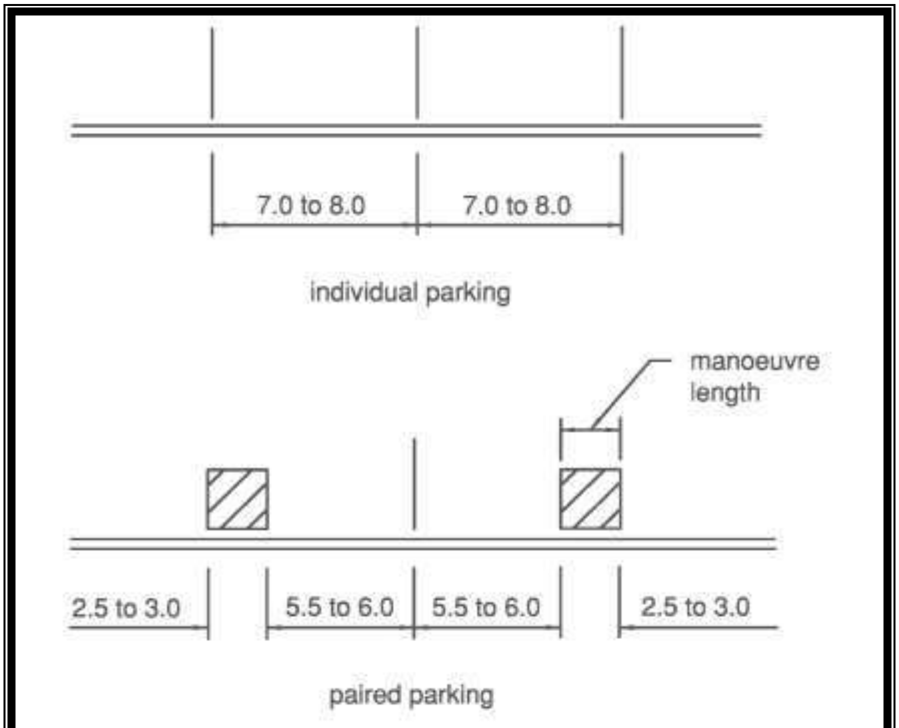
On-street parking is normally parallel or angled to the alignment of the roadway. Parking at right angles to the alignment offers the most efficient use in terms of parking area but is seldom considered for on-street parking since it ~~calls for~~requires a very wide cross section~~, and~~ is very interruptive to the flow of through traffic and provides the lowest quality sightlines, particularly for vehicles reversing out of a parking spot, increasing the potential for collisions.

For parallel parking the parking lane width for design speeds up to 70 km/h should be 2.5 m and for higher design speeds the width should be 3.0 m. Also, refer to the ministry's *Bikeways Design Manual – 2014* for minimum width at constrained locations.

In selecting a suitable stall length for parallel parking, consideration should be given to either individual stalls or to paired parking stalls, as shown in **Exhibit ~~-~~4E**. The individual stall provides for maneuvering within its own length, whereas in ~~the~~ a paired stall a manoeuv~~e~~ring area is delineated by paint and can be used by either of the two vehicles entering or leaving the two adjacent ~~areas~~stalls.

Exhibit ~~-~~4E

~~PARALLEL PARKING~~Parallel Parking



Parallel Parking Dimensions

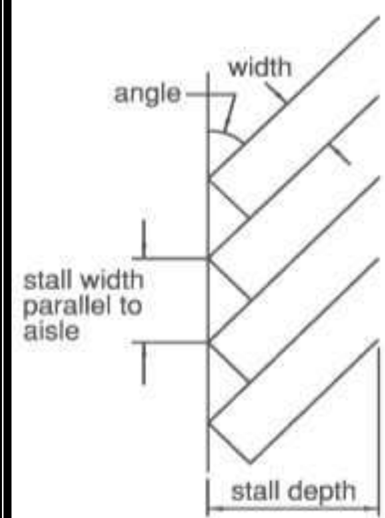
For individual parking stalls the length should be 7.0 m to 8.0 m to allow for a 6.0 m vehicle. ~~The~~ A smaller dimension may be used but shorter stalls cause drivers to take more time maneuvering and cause additional delay ~~and turbulence to~~for through traffic.

For paired parking stalls, the stall should be from 5.5 m to 6.0 m and the maneuver length from 2.5 m to 3.0 m. Since the maneuver area is used for two stalls, the average length of roadway per stall is 6.75 m to 7.5 m, a ~~saving over the individual stall~~reduction of 3.5% to 6% compared to individual stalls. Angle parking allows more vehicles to be parked in a given length of roadway than parallel parking; the higher the angle the more vehicles parked. Designers should also refer to the ministry's *Bikeways Design Manual – 2014* when providing the angle parking. Typical dimensions for angle parking are shown in **Exhibit 4F.**

The choice of angle is ~~usually~~ typically governed by available width. However, although a higher angle permits more vehicles to be parked in a given length of roadway and reduces wasted space~~area.,~~ ~~the~~Conversely, a higher angle increases maneuver time and, consequently, generates more ~~turbulence and~~ delay i~~t~~on ~~the~~ through traffic ~~flow~~. For ~~in~~on ~~-~~street angle parking, angles ~~in the~~from 45° to 60° ~~range~~ are normally used.

Exhibit -4F

~~ANGLE PARKING~~Angle Parking



Angle	Width m	Stall width parallel to aisle m	Stall depth m
45°	2.5	3.5	3.9
45°	2.75	3.9	3.9
45°	3.0	4.2	3.9
60°	2.5	2.9	4.8
60°	2.75	3.2	4.8
60°	3.0	3.5	4.8
75°	2.5	2.6	5.3
75°	2.75	2.8	5.3
75°	3.0	3.1	5.3
90°	2.5	2.5	5.5
90°	2.75	2.7	5.5
90°	3.0	3.0	5.5

Angle Parking Dimensions

Carpool Parking Facilities – Accessible Parking Spaces for Persons with Disabilities

All projects involving new or expanded carpool parking facilities shall comply with the barrier-free parking space requirements contained in the Ontario Realty Corporation (ORC) Standards for Barrier-Free Design of Ontario Government Facilities. These Standards ~~are intended to inform~~provide designers, contractors and government personnel~~, providing~~ services to the Government of Ontario ~~of the~~with minimum requirements for barrier-free design in Government of Ontario owned and occupied facilities. According to Section 4 of the Accessibility for Ontarians with Disability Act (AODA)~~ which does not apply retroactively~~, these Standards shall be applied and implemented on a “go-forward” basis on new carpool and expanded carpool facilities. The ORC~~se~~ Standards represent the minimum requirements regarding government facility accessibility. The ORC standards are:

- Provide~~d~~ a minimum number of barrier-free car parking spaces in each parking area per **Exhibit -4G** below:

Exhibit -4G

~~**MINIMUM BARRIER-FREE CAR PARKING SPACES**~~**Minimum Barrier-Free Car Parking Spaces**

Total Parking Spaces Provided	Minimum Barrier-free Spaces Required
1 – 10	1
11 – 20	2
21 – 50	3
51 – 75	4
76 – 100	5
101 – 200	6
Over 200	1 additional for each additional 100 spaces or part thereof

- In addition to the barrier-free car parking spaces, a minimum number of van parking spaces should be provided in each parking area per **Exhibit -4H**.

Exhibit -4H

~~**MINIMUM VAN PARKING SPACES**~~**Minimum Van Parking Spaces**

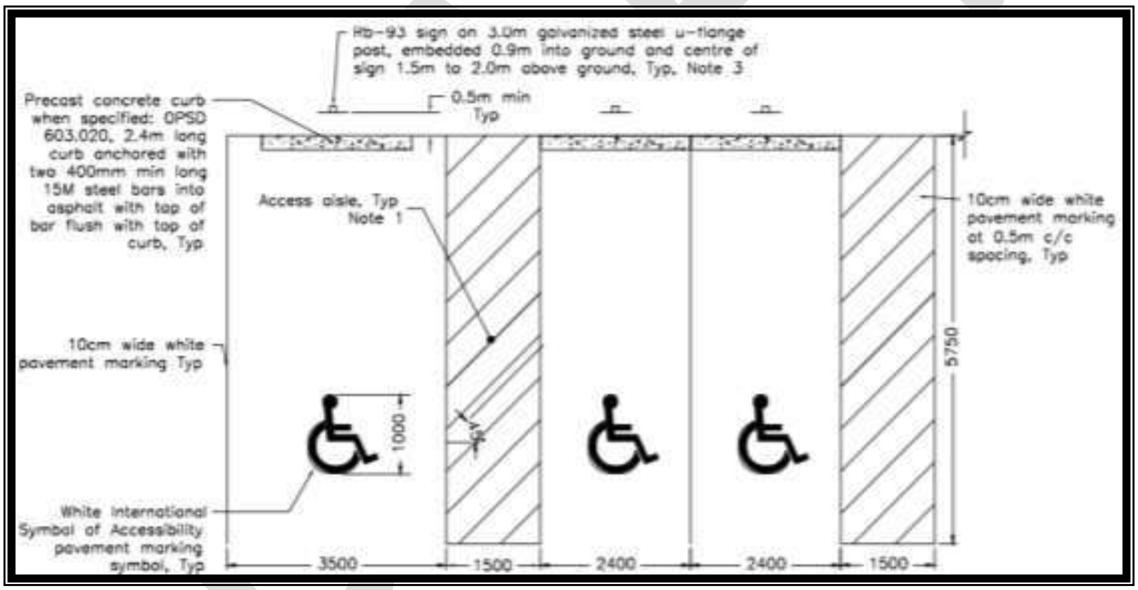
Total Parking Spaces Provided	Minimum Van Spaces Required
1 – 50	1
51 – 300	2
301 – 700	3
Over 700	4

- The surface of all barrier-free parking spaces must be level (maximum slope in any direction 2%), firm (no gravel) and slip-resistant. Pavement markings must use non-slip paint. Do not paint the entire surface of the parking space.

- Provide~~d~~ signage and pavement markings illustrated in **Exhibit -4I** (For details see 500 series MTOD) to designate the barrier-free spaces as reserved for permit-holders.
- A vertical post-mounted sign in front of the space, with the centre of the sign between 1500 mm and 2000 mm above the ground. Sign shall be in accordance with *Ontario Highway Traffic Act, Ontario Reg. 581*.~~; and~~
- A painted pavement marking in the centre of the space, in contrasting colour to the pavement, 1000 mm in length, with the International Symbol of Access.

Exhibit -4I

~~BARRIER-FREE PARKING SPACES – SIGNAGE AND PAVEMENT MARKINGS~~Barrier-Free Parking Spaces – Signage and Pavement Markings



Carpool Parking Facilities – Electric Vehicle Charging Stations

A 0.3 m wide painted buffer should be provided on both sides of a parking stall adjacent to a charging station for battery-electric vehicles. Charging stations should be aligned with the centre of each parking stall to allow for a vehicle to be able to charge on either side when parked.

Section 4.3.3.1 – Left-Turn Slip-Around Lane

- ~~This Section is Not Applicable and is replaced with the following Guidance:~~This section is **not applicable** and is **replaced** with the following guidance:

  Left-turn slip-around lanes may be used on 2-lane highways at 'T' intersections, where the left-turning traffic volumes do not warrant the standard left-turning treatment ~~-~~but may pose a ~~threat to the safety of~~collision risk for through traffic, and where existing by-passing vehicles ~~throw~~ track gravel from the shoulder onto the highway.

  The width of left-turn slip-around lanes should not be 0.25 m less than the width of the through lanes ~~but~~ and not less than 3.25 m. For more guidance on the design of left-turn slip-around lanes refer to *Chapter 9 – Intersections.*

Section 4.3.3.2 – Continuous Right-Turn or Left-Turn Lane For Access

- ~~This Section is Not Applicable and is replaced with the following Guidance:~~This section is **not applicable** and is **replaced** with the following guidance:

  Continuous two-way left-turn lanes (TWLTL) are introduced between through lanes in both directions to provide storage for left-turning vehicles from either direction ~~or~~ and are ~~usually~~ generally designated for left turns only throughout their length. This form of operation is well suited to 4-lane and multilane urban arterial roads where operating speeds are relatively low, in the range of 40 km/h to 70 km/h.

  Continuous ~~left-turn~~TWLTL's ~~lanes~~ provide access to closely spaced, low-volume commercial driveways along arterial or collector roads. ~~Continuous left-turn~~TWLTL's ~~lanes~~ may be inappropriate at many locations and conversion of existing ~~continuous left-turn lanes~~TWLTL's to non-traversable medians may be considered. From an access management perspective, they increase rather than control access opportunities.

  ~~Continuous left-turn lanes~~TWLTL's should be 4.8 m wide. The additional width ~~over~~ compared to the adjacent through lane recognizes that vehicles are making turning maneuvers from both directions simultaneously, and the additional width adds a measure of safety to mitigate potential head-on or sideswipe collisions. Lesser width to a minimum of 3.25 m may be applied where turning traffic is very low and operating speeds are less than 40 km/h. A 5.0 m wide lane may also be provided on undivided highways with four or more lanes where signalized intersections are present or may be added in the future to better accommodate the standard width for a left-turn lane adjacent to a raised median island. This will avoid the realignment of lanes in future.

Section 4.3.3.3 – Acceleration and Deceleration Lanes

- ~~This Section is Not Applicable and is replaced with the following Guidance:~~This section is **not applicable** and is **replaced** with the following guidance:

  Acceleration and deceleration lanes are auxiliary lanes adjacent to through lanes on freeways and arterial roads at intersections for vehicles changing speed at entrances and exits. They are also commonly known as Speed Change Lanes (SCL).
  - The width of acceleration and deceleration lanes should ~~not~~ be no more~~less~~ than 0.25 m narrower than the ~~width of the~~ adjacent through lane, ~~but~~ and not less than 3.25 m ~~in any case~~.
  - Further information on SCL is contained in *Chapter 9 – Intersections* and *Chapter 10 – Interchanges.*

Section 4.3.3.4 – Weaving Lanes

- ~~This Section is Not Applicable and is replaced with the following Guidance:~~This section is **not applicable** and is **replaced** with the following guidance:

  Weaving lanes are auxiliary lanes introduced between an entrance followed by an exit in close succession, ~~usually~~ typically less than 1,000 m, to minimize turbulence in the traffic stream and to maintain adequate capacity.

  The width of weaving lanes desirably should not be 0.25 m less than that of the through lane, ~~but~~ and not less than 3.25 m ~~in any case~~.

Section 4.3.3.5 – Transit Lanes

This ~~Section~~ section is ~~**Applicable**~~ **applicable except** for second and third bullet point.

The second bullet point is **replaced** with the following ~~Guidance~~guidance:

-

Where a contraflow or counter-flow lane is provided, the width should be 4.0 m for design speed greater than 60 km/h, and 3.75 m to 4.0 m for design speed equal to or less than 60 km/h.

Section 4.3.3.6 – Service or Frontage Road Lanes

- This ~~Section~~ section is ~~**Applicable**~~ **applicable** except all three bullet points in the ~~Section~~section. For more guidance refer to Chapter 4 of the latest edition of ministry's *"Highway Corridor Management Manual".*

The following additional Guidance is Applicable for Section 4.3~~.~~ – SPECIAL PURPOSE LANES

Bus Bays

Bus bays have the advantage of separating buses from other traffic during loading and unloading of passengers, however, they sometimes require additional right-of-way. To be fully effective~~,~~ a bay should include: a deceleration lane or taper to permit convenient entrance to the loading area, a standing space sufficiently long to accommodate the maximum number of buses expected at one time, and a merging lane to provide convenient re-entry into the through traffic lanes. The dimensions of these elements should encourage the bus driver to position the bus completely clear of the through lane of traffic. Ideally the deceleration and acceleration lanes should be sufficiently long so that all acceleration and deceleration is contained within them, however this is normally not feasible.

Taper lengths for deceleration and acceleration should be 25 m each. The loading area should be about 15 m per bus and the width should be 3.0 m to the edge of curb. For details refer to *OPSD 501.010.*

Ramps and Transfer Lanes

An interchange is an intersection of two ~~(~~or more~~)~~ roadways separated vertically, with at least one roadway for travel between them. These interconnecting roadways are called ramps. A ramp is also applied to separate right turn lanes at channelized at-grade intersections. Transfer lanes are roadways to provide for travel between express and collector lanes ~~and a collector road~~ or between a highway and a service road. A t~~T~~urning roadways ~~are~~ is a separate roadway or ramp to accommodate turning traffic at the intersection or interchange ~~of~~ between two roads. For more details see *Chapter 9, and 10 of TAC GDG 2017* along with *Appendices 9 and 10* of the ministry's *Design Supplement*.

The pavement width for single-lane ramps and transfer lanes is 4.75 m. The pavement width for ramps and transfer lanes of two or more lanes should be 3.75 m each and adjusted for curvature.

The pavement width of 4.75 m is based on the premise that interchanges carry sufficient single unit and semitrailer vehicles to govern design requirements. It also provides for widening on curves of radius greater than 50 m. For 50 m and smaller radii the width should be increased. Alternatively, the inside shoulder may be constructed with full-depth asphalt without any widening of the ramp lane to achieve~~s~~ the same result. For more guidance on the design refer to *Chapter 9 – Intersections* and *Appendix 9.*

Section 4.4.2 – Shoulder Width

- Within this ~~Section~~section, the following ~~Sub~~sub-sections and Tables are **~~Not~~ not ~~Applicable~~ applicable** and are **replaced** with the ~~Guidance~~ guidance and Exhibits provided below:
  - **Sub-section 4.4.2.1 – Design Domain: Quantitative Aids**
  - **Table 4.4.1 – Shoulder Widths for Undivided Rural Roads**
  - **Sub-section 4.4.2.2 - Design Domain: Application Heuristics**

Shoulder Width

For high-speed and/or high-volume highways the normal shoulder width is 3.0 m.

For highways of lower speed and/or lower volume, this width of shoulder is normally not justified, and a narrower shoulder may be applied.

The minimum shoulder width acceptable for pavement support is 0.5 m if the shoulder is paved, and 1.0 m if the shoulder is gravel surfaced.

It is desirable that a vehicle stopped on a shoulder for emergency reasons be clear of the pavement by at least 0.25 m and preferably 0.5 m. The minimum usable shoulder width required to accommodate a disabled vehicle is 2.0 m.

Where curb and gutter is placed at the outside edge of a shoulder, the gutter width is regarded as part of the usable shoulder width. Where a mountable curb and gutter is placed between the traffic lane and the shoulder, the entire ~~unit~~ curb and gutter is treated as part of the usable shoulder.

Where guide rails, walls or other obstructive elements are introduced adjacent to a shoulder, it is desirable that the shoulder be wide enough to allow for opening of a vehicle door. However, it is not always practical or economical to do so. -At the same time, excessive shoulder width should be avoided to prevent its misuse as a driving or parking lane. Shoulders wider than 3.0 m are not recommended.

Shoulders desirably should be continuous so that at any location along the roadway a driver can leave the traffic lanes to use the shoulder. If the shoulder is intermittent some drivers may find it necessary to stop in the traffic lane, causing a hazardous condition. However, it may not always be economical to maintain shoulder width in all cases as for example, in deep rock cuts.

Standard shoulder widths are ~~normally~~ provided in multiples of 0.5 m. Shoulder widths for undivided rural highways are given in **Exhibit- 4J**.

Exhibit -4J

~~SHOULDER WIDTH FOR UNDIVIDED KING'S HIGHWAYS AND SECONDARY HIGHWAYS~~Shoulder Width for Undivided King's Highways and Secondary Highways

Design Speed km/h	Traffic Volume for Design Year					
	AADT					
	>4,000	3,000-4,000	2,000-3,000	1,000-2,000	400-1,000	<400
	DHV					
	>600	450-600	300-450	150-300	60-150	<60
130	3.0	-	-	-	-	-

120	3.0	-	-	-	-	-
110	2.5[1]	2.5[1]	2.5	2.5	-	-
100	2.5[1]	2.5	2.5	2.0[3]	1.0	-
90	2.5	2.5	2.0[2]	2.0	1.0	-
80	2.5	2.5	2.0	2.0	1.0	1.0[4]
70	-	2.0	2.0	1.0	1.0	1.0[4]
60	-	-	-	1.0	1.0	1.0[4]
50	-	-	-	-	-	1.0[4]

Notes:

1. If commercial motor vehicle percentage exceeds 10% increase by 0.5 m
2. If commercial motor vehicle percentage exceeds 15% increase by 0.5 m
3. If commercial motor vehicle percentage exceeds 25% increase by 0.5 m
4. Shoulder width of 0.5 m is acceptable on two-lane roads where there is no foreseeable possibility of the road being paved within a 20-year period. Where roadside barrier is installed, shoulder width shall be 1.0 m.

- For design, use DHV if available.
- For Secondary Highways, if commercial motor vehicle percentages exceed 25% of AADT, or if AADT is >2000, shoulder width is to increase by 0.5 m.
- Minimum width for pavement support: 0.5 m paved, 1.0 m gravel surfaced.
- Minimum usable width for disabled vehicle: 2.0 m

For 4-lane divided highways, the following width of the shoulders shall be installed:

- R~~r~~ight shoulder shall be the same as for undivided highways, see **Exhibit -4J**.
- ~~l~~Left or median shoulder shall be 1.0 m.
- If highway has narrow median with barrier, left or median shoulder shall be 2.5 m. Shoulder width may be varied depending on type of barrier used.

For multi-lane divided highways, the following width of the shoulders shall be installed:

- R~~r~~ight shoulder shall be 3.0 m.
- L~~l~~eft or median shoulder shall be 2.5 m. If a median barrier system is placed, then median shoulder width varies according to the type of barrier used.

For all interchange ramps the right shoulder width shall be 2.5 m.

The right shoulder on a single-lane ramp may be partially paved or fully paved depending on rural or urban locations and maintenance considerations. The right shoulder of a ramp with two or more lanes shall normally be paved.

For interchange ramps the left shoulder width is dependent on the number of lanes at the bullnose as follows:

o S~~s~~ingle-lane ramp	1.0 m
o 2-lane ramp	1.0 m
o R~~r~~amps of more than two lanes	2.5 m

The left shoulder shall normally be paved.

The shoulder width for collector~~-distributor roads~~ lanes on urban freeways should be the same as those for express lanes.

The shoulder widths adjacent to acceleration, deceleration and weaving lanes on freeways shall be the same as those of the adjacent ramps.

For speed-change lanes at entrances and intersections on roads other than freeways, the shoulder width shall be 1.0 m. The transition in shoulder width should take place over the length of taper of the speed-change lane.

For truck-climbing and passing lanes the shoulder width should be the same as the shoulder width on the typical cross section for the roadway but may be reduced to not less than 1.0 m where the cost of maintaining the shoulder width is considered prohibitive, in which case the shoulder should be fully paved.

Fully Paved Shoulder

Full shoulder paving shall be warranted:

- ~~On all freeways on both left and right sides having three or more lanes in one direction.~~
- On ~~4-lane~~ all freeway and high-speed divided highways for the left and right shoulders.
- On all Major Capital Freeway Contracts involving new pavement construction, reconstruction or pavement rehabilitation.
    - The full width of pavement structure under the right shoulder ~~is to~~should be designed~~/strengthened~~ with sufficient pavement structure to

accommodate future traffic detours.

- In Urban areas:
  - W~~w~~here the sidewalk is located 3 m or less from the through lanes, and where reverse shoulders (i.e. shoulders sloped towards the travelled way) are utilized to suit existing condition.
  - W~~w~~here three or more adjacent commercial establishments are present.~~, or~~
  - W~~w~~here the total density of entrances (all types) exceeds 10 per 300 m per side.
  - O~~o~~n two-lane highway sections, shoulder paving shall be applied on both sides of the highway.
  - O~~o~~n highways with more than two lanes, shoulder paving shall apply only to the side on which the entrances are located.
- As protection against shoulder erosion on gradients. The conditions under which protective measures are warranted are:
  - G~~g~~radients less than 3%; no treatment is required.~~,~~
  - G~~g~~radient of 3% to 5%; treatment should be based on local considerations.~~,~~
  - G~~g~~radient greater than 5%; treatment advisable.

To prevent excessive shoulder erosion caused by stormwater, steep grades and superelevation, shoulder paving is an acceptable alternative to the application of mountable curb and gutter. The entire width of shoulder should be paved.

The beginning and termination points of fully paved shoulders sections should be tapered to the through pavement edge over a distance of 10 m per 0.5 m width.

Partially Paved Shoulders

Partially paved shoulders should be included on all two-lane King's highways unless otherwise recommended by the responsible Manager.

Partially paved shoulders are not normally used on secondary highways, however, at the discretion of the responsible Manager, and based on engineering ~~evaluation~~judgment, they may be provided. Appropriate documentation of the shoulder treatment and rationale should be included in the Design Criteria. Where a shoulder is partially paved, a width of 0.5 m closest to the adjacent travel lane is hard surfaced, ~~usually with asphalt, and~~with the remaining shoulder surface being~~is~~ gravel.

On existing highways having a median shoulder width and/or outside shoulder width ≤ 1.0 m,~~.~~ the full shoulder width should be paved to avoid the existence of a narrow gravel strip which is ~~extremely~~ difficult to maintain.

Partially paved shoulders should preferably be constructed in conjunction with resurfacing, reconstruction or new construction. In order to avoid a joint at the interface, partially paved shoulders are not normally placed adjacent to the existing pavement without resurfacing and constructability should be considered. A stand-alone partially paved shoulder retrofit may be justified based on continuity, median safety or maintenance considerations.

Partially paved shoulders should be carried through on passing lanes and truck-climbing lanes.

The beginning and termination points of 0.5 m wide partially paved shoulder sections should be tapered to the through pavement edge over a distance of 10 m. Exceptions to this are at speed-change lanes where the partially paved shoulder should be feathered into the auxiliary lane taper, or where the presence of curves would create discontinuity of the edge of paved surface.

As a general rule, continuous partially paved shoulders should terminate either at an intersection where there is a significant change in traffic volume or at locations where changes in the characteristics of roadside developments occur, such as the beginning of an urban cross section.

Section 4.4.3.2 – Shoulder Material

- This ~~Section~~ section is **~~Not~~ not ~~Applicable~~applicable**. Designers if interested should contact to the ministry's Engineering Materials Office.

Section 4.4.3.4 – Shoulder Rumble Strips

- ~~This Section is Not Applicable and is replaced with the following Guidance:~~This section is **not applicable** and is **replaced** with the following guidance:

Introduction

Shoulder Rumble Strips (SRS) are a cost-effective warning device intended to reduce Run-off-Road (R-o-R) type collisions. SRS is a grooved formation installed within the paved shoulder or partially paved shoulder on a highway. The ~~intention~~ purpose of SRS is to provide ~~the~~ motorists with both an audible and tactile warning that the vehicle has partially or completely departed the travelled way of a highway. An audible warning to ~~the~~ motorists is produced by noise generated by the vehicle tires passing over the SRS. A tactile warning to ~~the~~ motorists is provided by the vibration induced in the vehicle by the SRS. An encounter with SRS is expected to alert an inattentive motorist to steer the vehicle back onto the travelled ~~way~~ portion of the highway.

Implementations

- Decisions to install SRS shall consider the timing of planned rehabilitation and reconstruction work as budgets allow.
- The ~~Regions~~ Project Delivery areas should set priorities for the locations being considered for SRS. SRS may be installed either in conjunction with a construction project or as a retrofit by means of a separate contract.

Locations

SRS should be installed on all rural freeways and high-speed divided highways with fully paved shoulders or partially paved shoulders, both on the median side (left side) and outside (right side).

SRS should also be considered at the following locations where such SRS are considered to have a practical potential to reduce R-o-R type collisions:

- On urban freeways and rural highways with fully paved shoulders or partially paved shoulders.
- At certain critical locations such as on shoulders of approaches to narrow bridges or parapet walls, in gore or bull-nose areas, in advance of impact attenuators, in areas with narrow clear zones and at other critical locations.

SRS may be placed at locations where geometric deficiencies exist but shall not be considered as a method to correct geometric deficiencies.

General Guidance on SRS

- Typical ~~Design~~ design ~~Details~~ details for SRS are included in **Exhibit -4K, Exhibit -4L** and **Exhibit –4M**.
- Pavement condition and thickness on the shoulders may dictate whether it is feasible to install SRS. Such conditions should be verified by the appropriate ministry expertise areas.
- SRS can be constructed on either asphalt or concrete shoulders and should be milled in.
- All depressions of the Shoulder Rumble Strips should have a circular concave cross-section and the cutting tips on the milling head should produce a relatively smooth cut.

Design Considerations

- SRS should only be installed on paved shoulders that are in good condition, having a minimum asphalt thickness of 80 mm (2 lifts). In all cases, the depth of the SRS must be less than the depth of a single lift of asphalt. SRS should not be milled into existing shoulders having moderate to very severe surface defects, distortions or cracking distresses that are extensive to throughout as defined in the Manual for Condition Rating of Flexible Pavements (SP- 024) and as verified during a site review by the appropriate ministry ~~expertise areas~~staff.
- General details and isometric view of SRS in plan and cross section ~~is~~ are provided in **Exhibit 4-K.**
- Where SRS may be considered beneficial on a highway with an ~~O~~open-graded ~~F~~friction ~~C~~ course asphalt surface, the appropriate ministry ~~expertise areas~~office shall be consulted for recommendation prior to installation.
- An inspection of the proposed site of the SRS will be required to confirm the distance from the travelled way to any obstructions as the current machinery used to mill-in rumble strips requires a minimum lateral clearance of 0.85 m between the outside edge of the depression and any obstruction such as guide rail, concrete barrier, concrete curb, etc.
- The installation of SRS should be deferred if planned construction activities will

require diversion of traffic onto the shoulders for a substantial period.

- When SRS are being considered as a retrofit project on highways which were recently paved, the appropriate ministry ~~expertise areas~~staff shall be consulted to confirm that installation of the SRS will not invalidate any existing pavement warranty.
- SRS should be installed at right angle (90 degrees) to the direction of travel.
- At ~~freeway~~ entrance and exit terminals ~~and freeway exit terminals~~, SRS should start or end 10 m at the bullnose per **Exhibit -4L**.
- SRS should not be installed within 1.0 m of sawn and sealed transverse joints.
- SRS should not be installed within 1.0 m of sealed traffic counting loop detector lead wires.
- SRS should not be installed on bridge decks and overpass structures and within 1.0 m of expansion joint dams.
- SRS should not be installed across residential or commercial driveway entrances and intersecting roadways. Gaps in SRS installation should be provided in advance of and beyond commercial and residential entrances where motorists are likely to make frequent turns ~~on a continual basis~~.
- At residential or commercial driveway entrances and at intersections, SRS should stop 60 m in advance of the entrance or intersection and start 30 m beyond the entrance or intersection per **Exhibit -4M**. At right turn lanes or tapers, SRS should stop 30 m before the right turn lane or taper per **Exhibit -4M**.
- SRS should not be installed on highways with partially paved shoulders (0.5 m pavement width) that are designated as bicycle routes or have substantial volumes of bicycle traffic.
- Details of SRS are provided in 500 series MTODs.
- On bicycle routes, SRS should be installed per the guidance provided in 500 series MTODs.

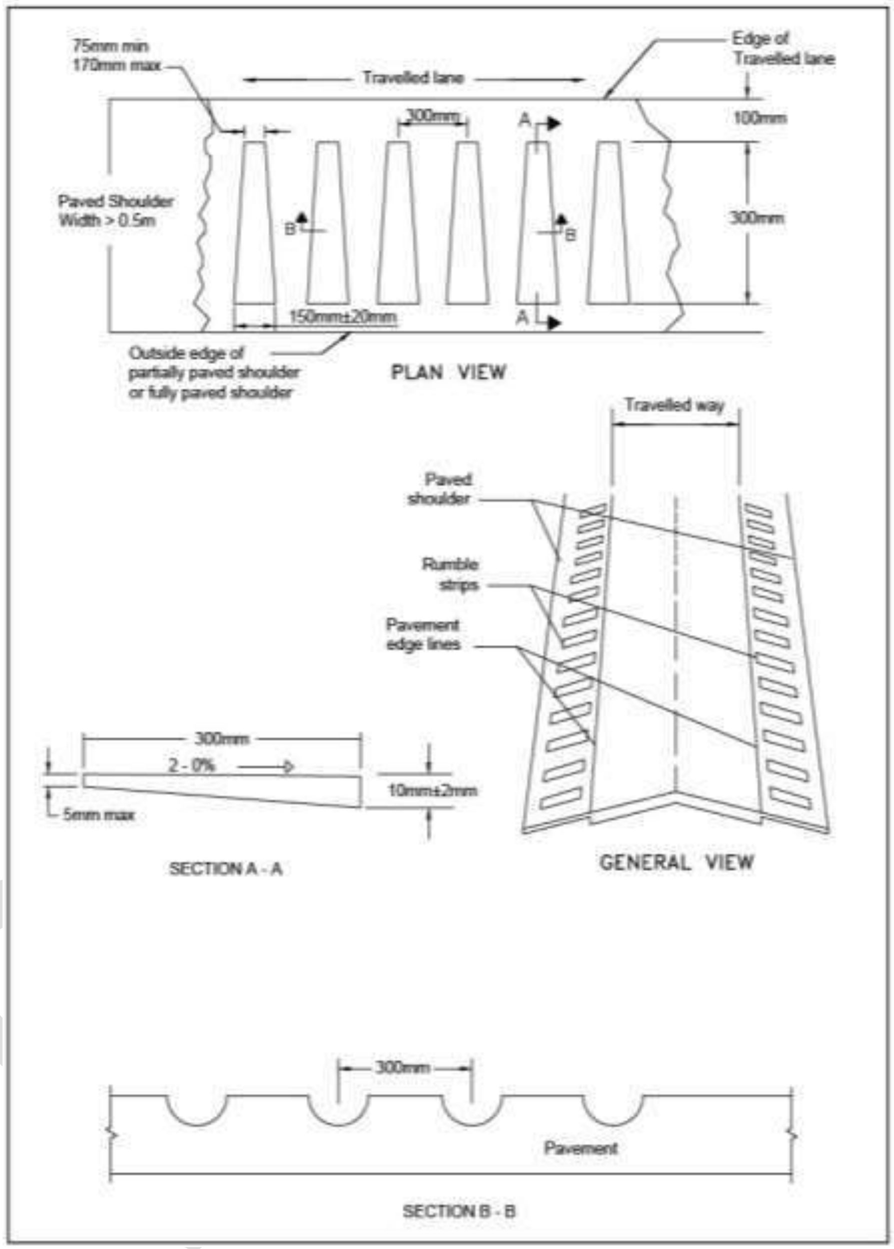
Maintenance Requirement

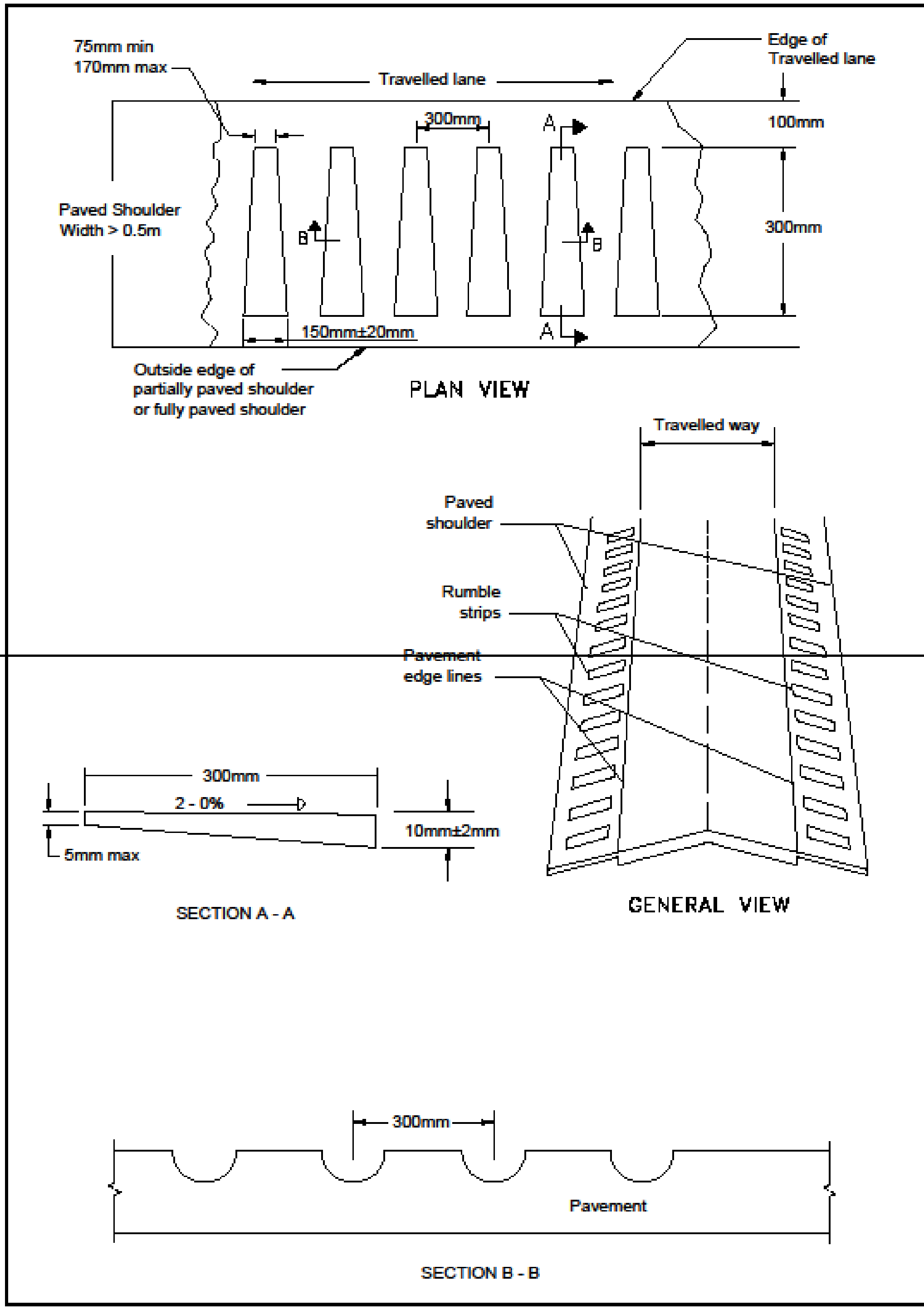
When grading the gravel shoulders adjacent to partially paved shoulders, care must be taken to ~~eliminate~~ prevent ~~getting~~ debris from accumulating in the SRS.

○

Exhibit -4K

~~GENERAL DETAILS OF SHOULDER RUMBLE STRIPS~~General Details of Shoulder Rumble Strips


75mm min
170mm max
Travelled lane
Edge of
Travelled lane
300mm
100mm
Paved Shoulder
Width > 0.5m
300mm
150mm±20mm
Outside edge of
partially paved shoulder
or fully paved shoulder
PLAN VIEW
Travelled way
Paved
shoulder
Rumble
strips
Pavement
edge lines
300mm
2 - 0%
10mm±2mm
5mm max
SECTION A - A
GENERAL VIEW
300mm
Pavement
SECTION B - B


75mm min
170mm max
Travelled lane
Edge of
Travelled lane
300mm
A
100mm
Paved Shoulder
Width > 0.5m
B
B
300mm
150mm±20mm
A
Outside edge of
partially paved shoulder
or fully paved shoulder
PLAN VIEW
Travelled way
Paved
shoulder
Rumble
strips
Pavement
edge lines
300mm
2 - 0%
10mm±2mm
5mm max
SECTION A - A
GENERAL VIEW
300mm
Pavement
SECTION B - B

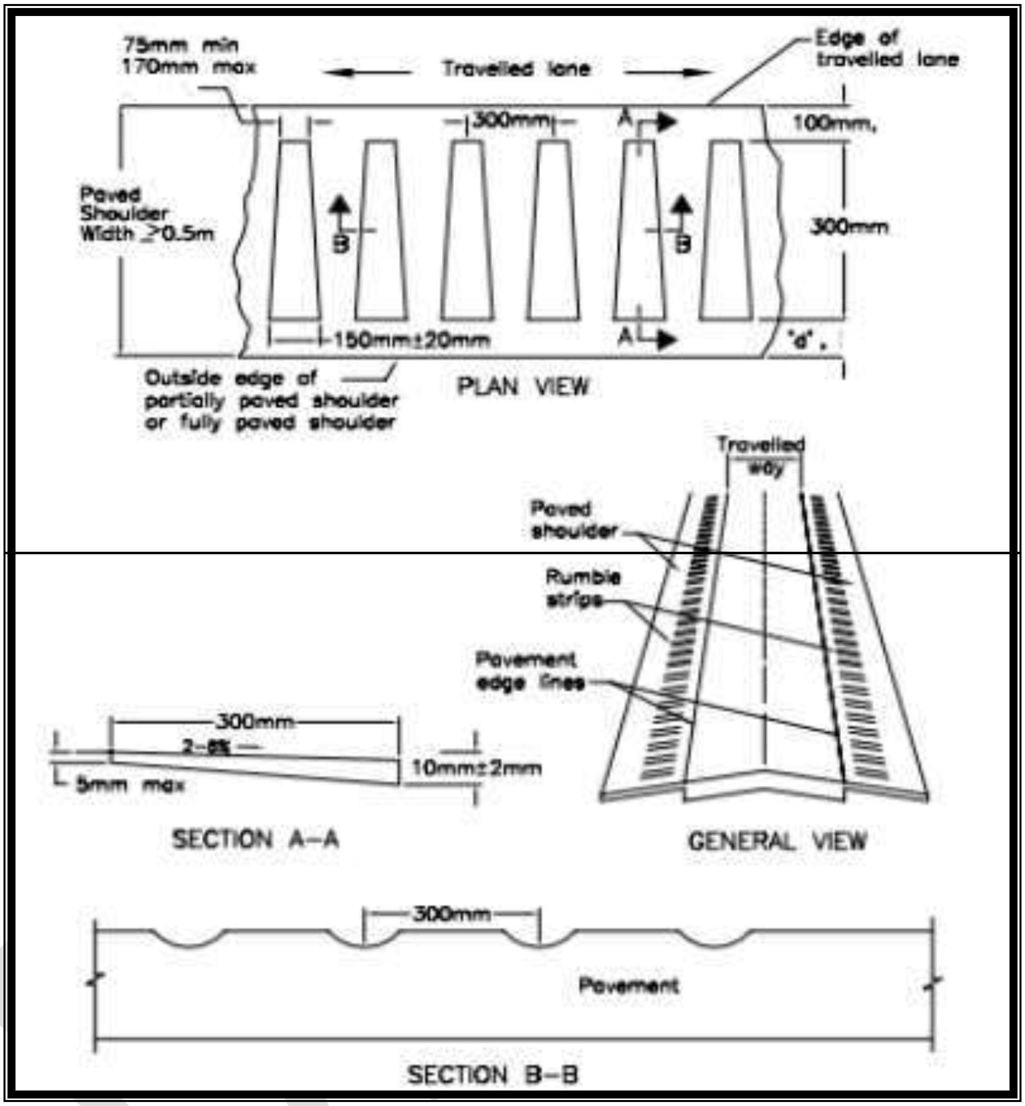
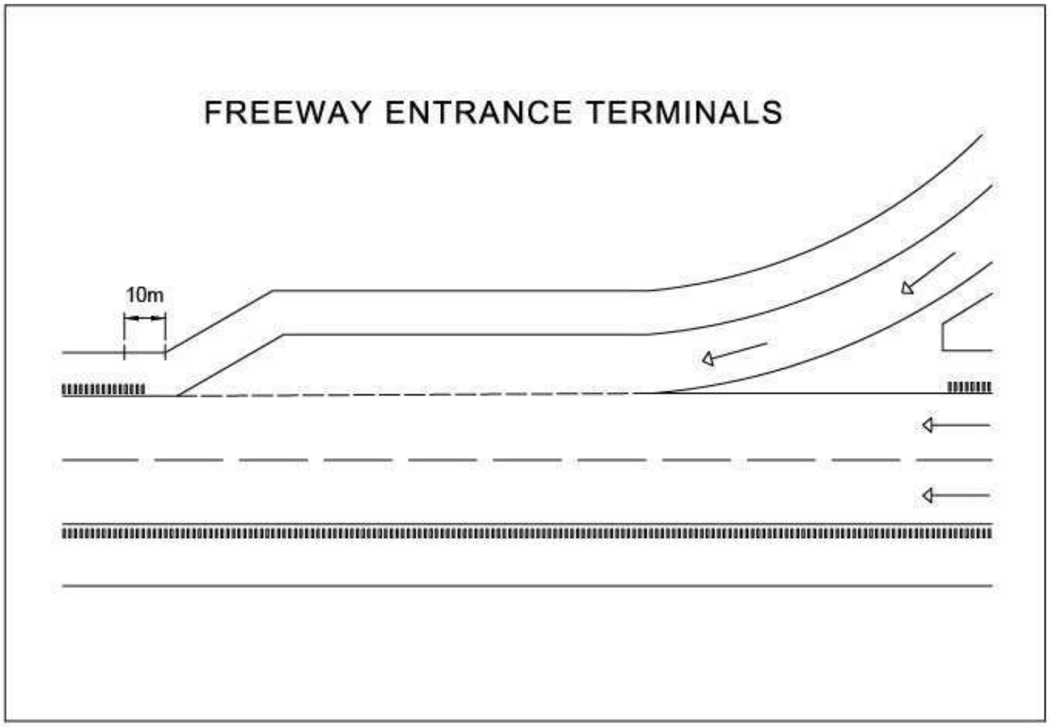
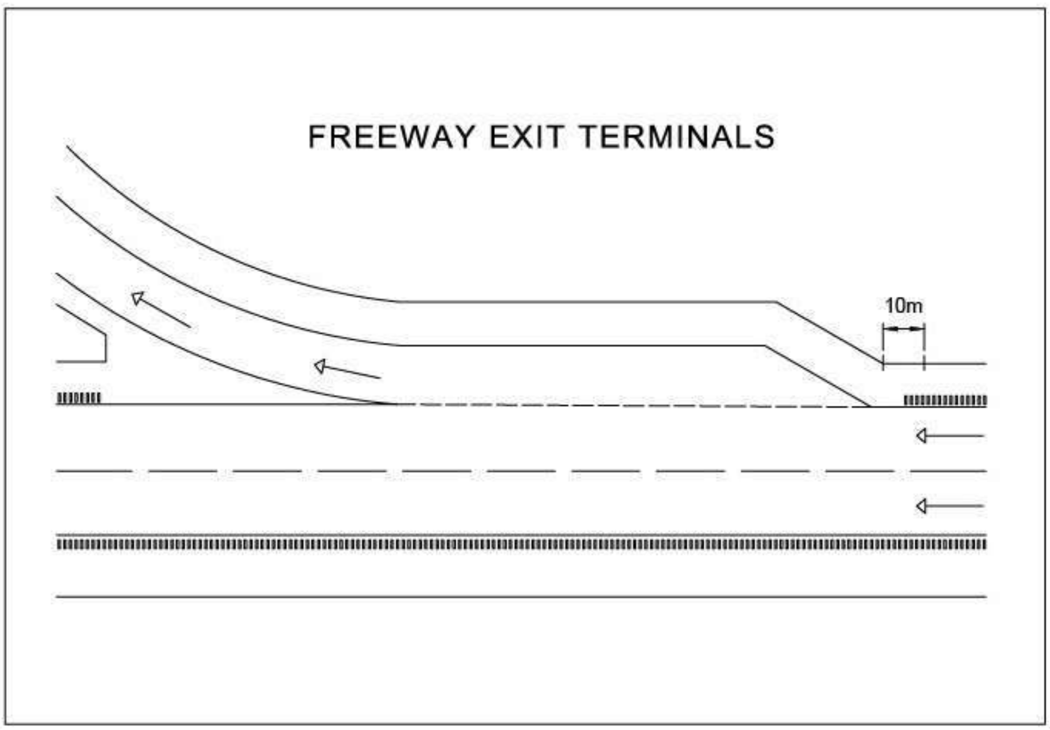
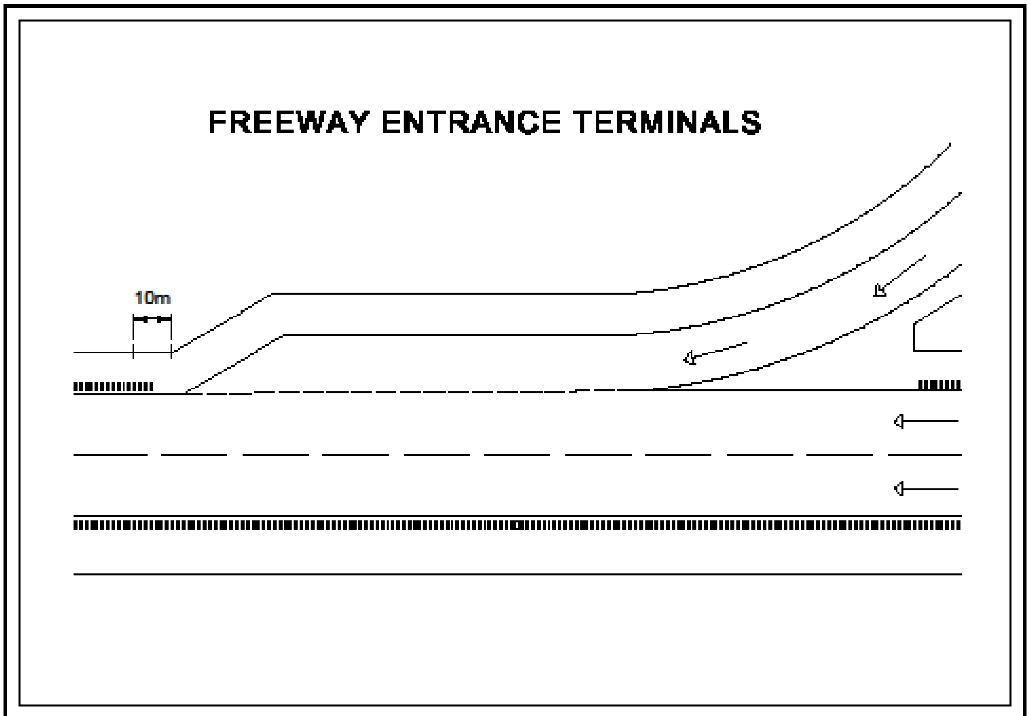

75mm min
170mm max
Travelled lane
Edge of travelled lane
300mm
100mm,
Paved Shoulder Width ≥0.5m
300mm
150mm±20mm
'd'
Outside edge of partially paved shoulder or fully paved shoulder
PLAN VIEW
Travelled way
Paved shoulder
Rumble strips
Pavement edge lines
300mm
2-8%
5mm max
10mm±2mm
SECTION A–A
GENERAL VIEW
300mm
Pavement
SECTION B–B

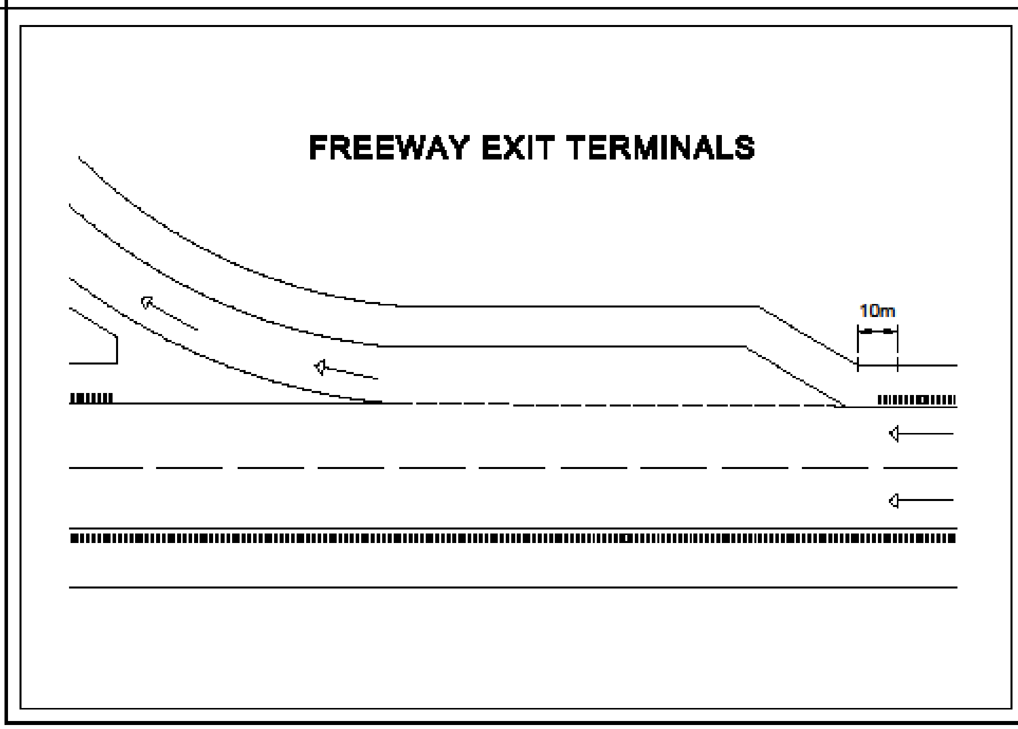
Exhibit -4L

~~SHOULDER RUMBLE STRIPS AT FREEWAY ENTRANCE AND EXIT~~Shoulder Rumble Strips at Freeway Entrance and Exit


FREEWAY ENTRANCE TERMINALS
10m


FREEWAY EXIT TERMINALS
10m


FREEWAY ENTRANCE TERMINALS
10m


FREEWAY EXIT TERMINALS
10m

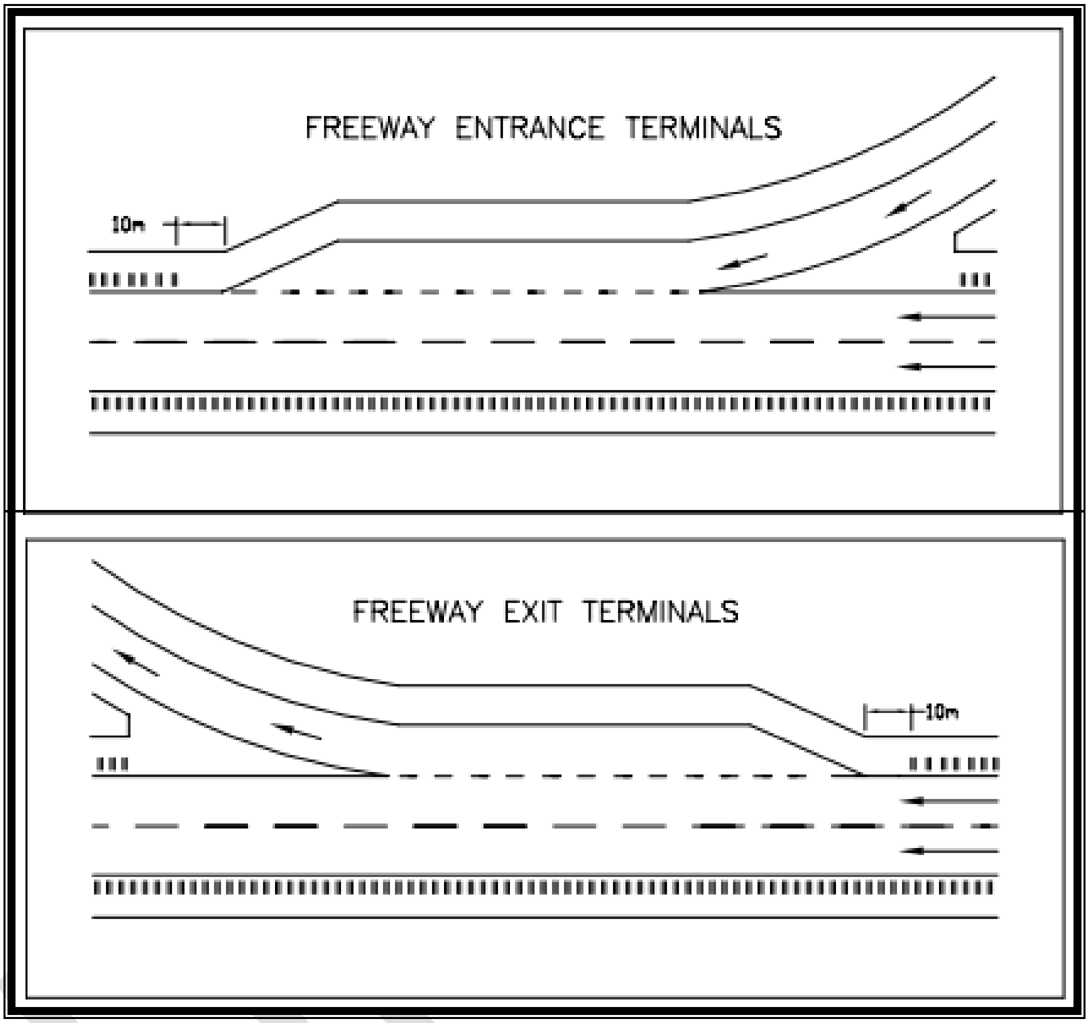
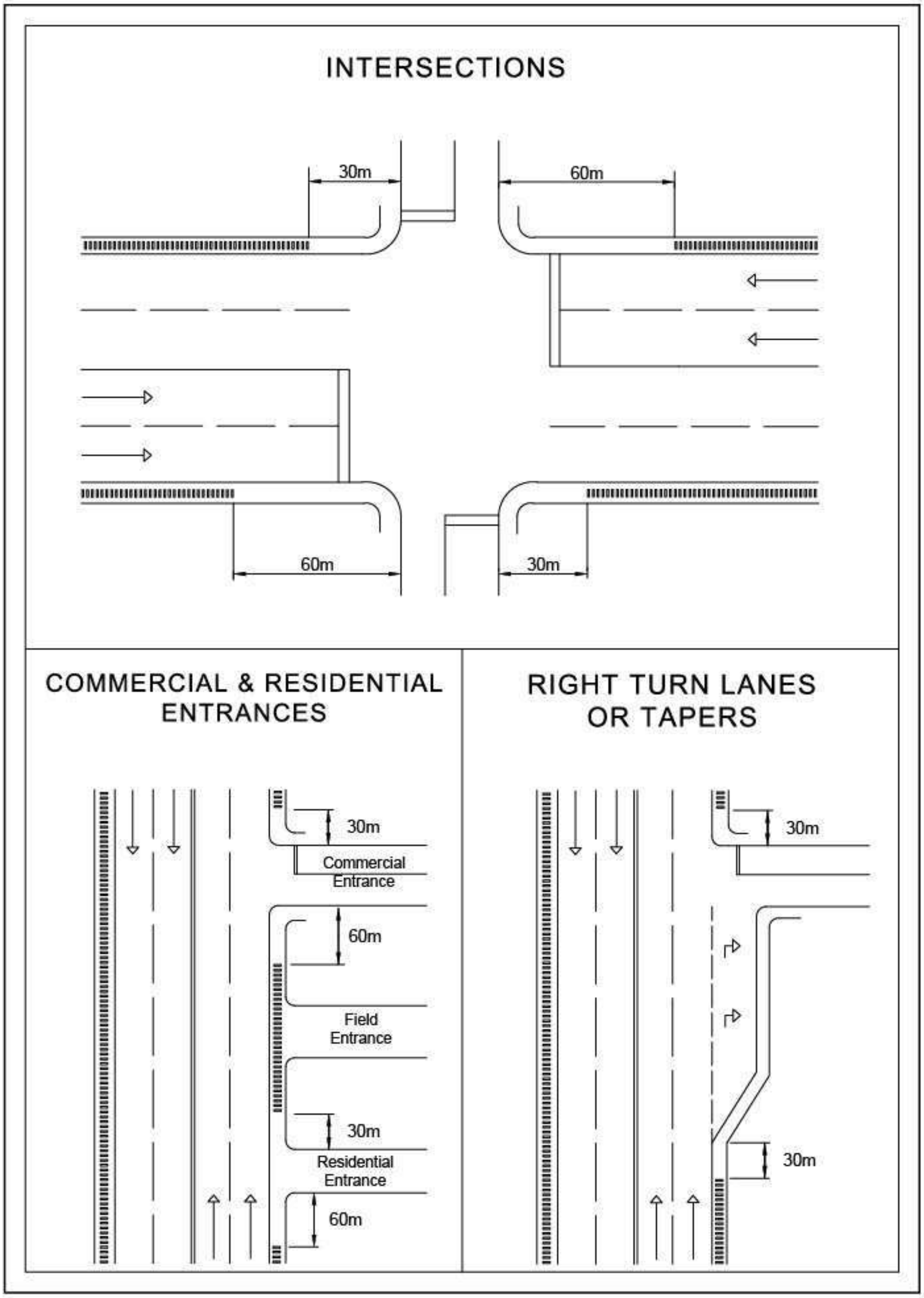
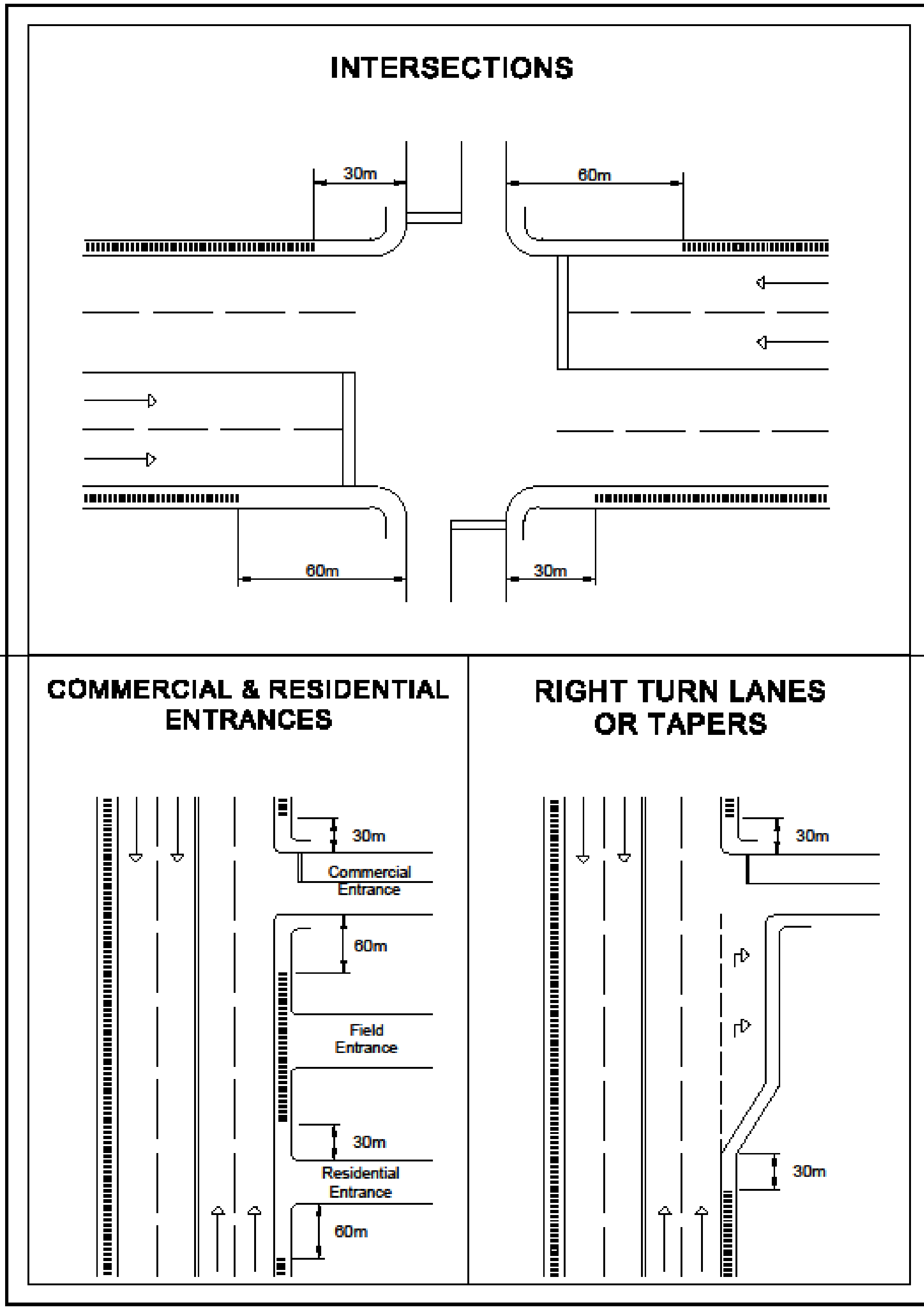

FREEWAY ENTRANCE TERMINALS
10m
FREEWAY EXIT TERMINALS
10m

Exhibit -4M

~~SHOULDER RUMBLE STRIPS AT INTERSECTIONS AND ENTRANCES~~Shoulder Rumble Strips at Intersections and Entrances




INTERSECTIONS
30m
60m
60m
30m
COMMERCIAL & RESIDENTIAL ENTRANCES
30m
Commercial Entrance
60m
Field Entrance
30m
Residential Entrance
60m
RIGHT TURN LANES OR TAPERS
30m
30m

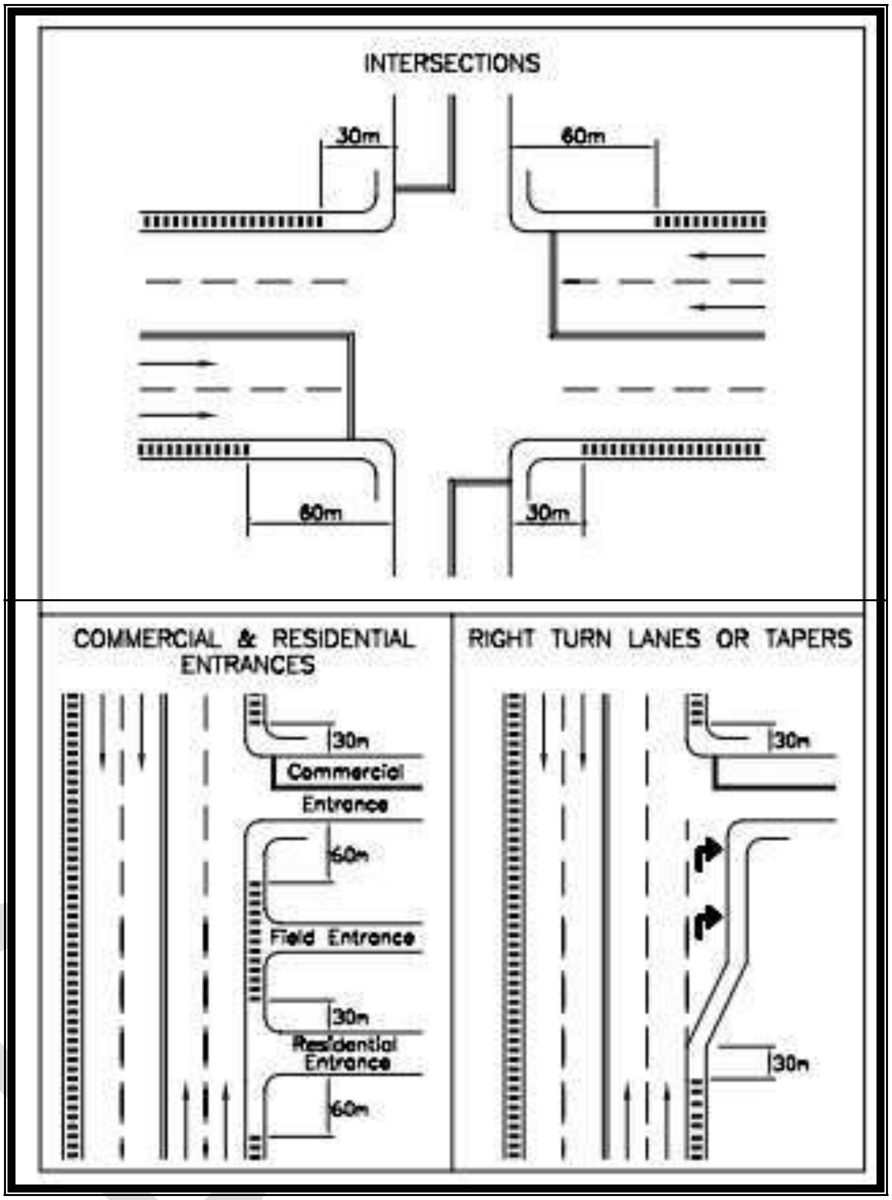


Figure 4.4.3. – Shoulder Rumble Strips

Figure 4.4.4. – Bicycle Friendly Shoulder Rumble Strips

- These Figures are **~~Not~~ not ~~Applicable~~applicable**.

Section 4.4.4 – Shoulder Cross Slopes: Best Practices

- This ~~Section~~ section is **~~Not~~ not ~~Application~~ applicable** and is **replaced** with the following ~~Guidance~~guidance:

Cross-Fall and Superelevation

Standard values for cross-fall and superelevation of shoulders on undivided and divided highways are listed and illustrated in **Exhibit -4N, Exhibit -4O, Exhibit -4P,** and **Exhibit -4Q**.

- On tangent, unpaved, partially paved, or paved — -0.06 m/m
- On the high side of superelevated sections, unpaved, partially paved, or paved. — see **Exhibit-4Q**
- On paved part of partially paved shoulder on high side or superelevated section — same as adjacent superelevation
- On the low side of superelevated sections, unpaved, partially paved, or paved. — -0.06 m/m

Exhibit -4N

~~UNPAVED SHOULDER CROSS-FALL~~Unpaved Shoulder Cross-Fall

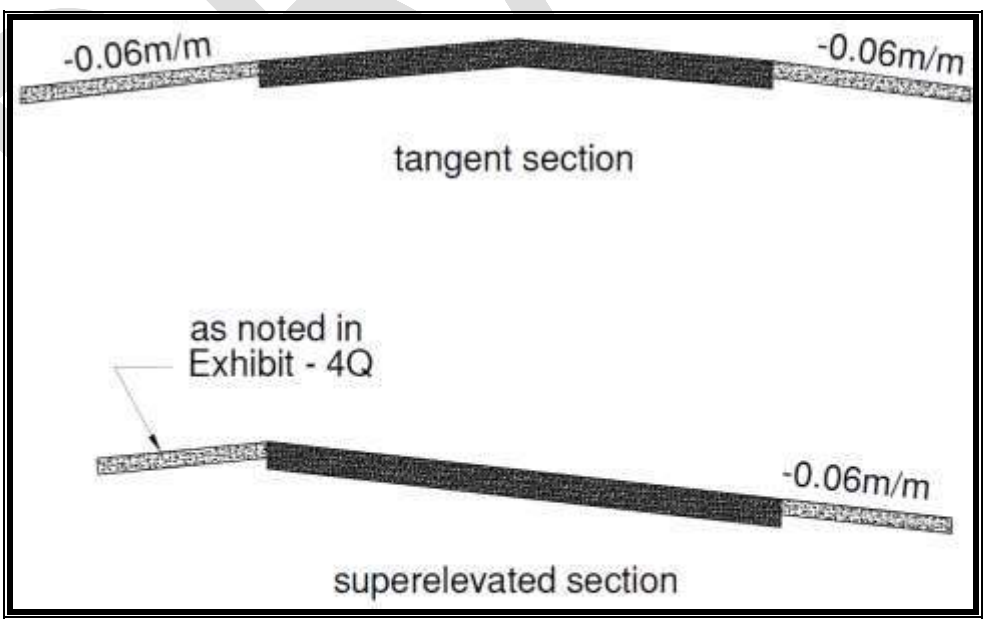


Exhibit -4O

~~PARTIALLY PAVED SHOULDER CROSS-FALL~~Partially Paved Shoulder Cross-Fall

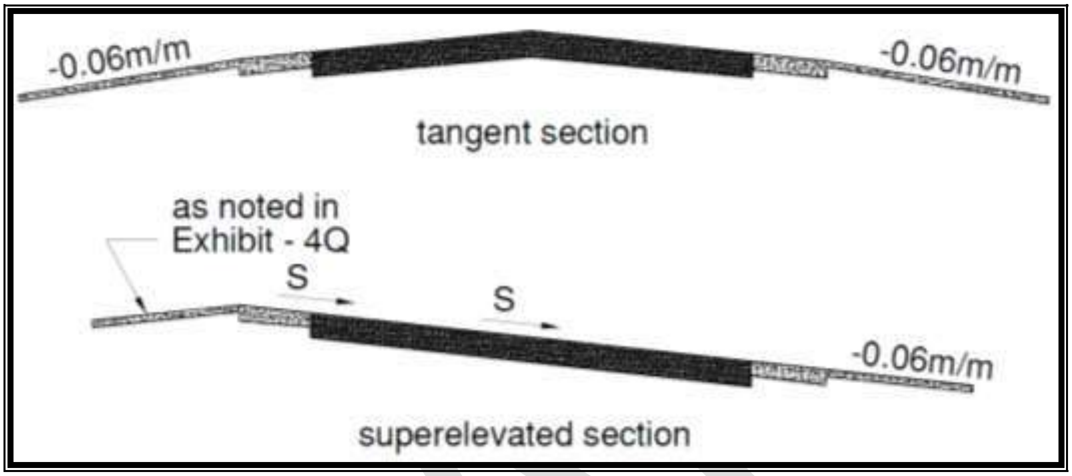
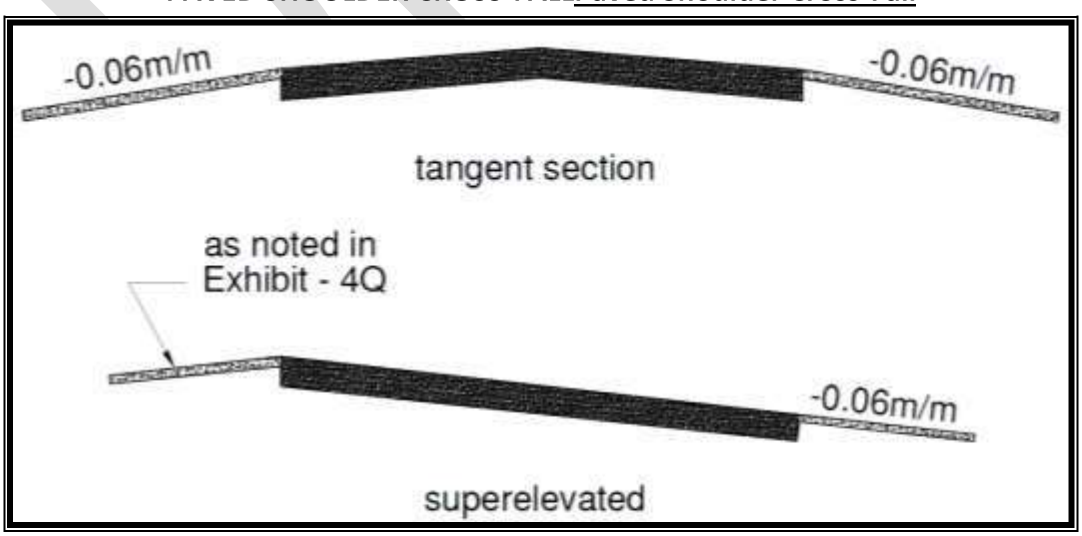


Figure 4.4.5 – Shoulder Cross Slope and Superelevation

- This Figure is **~~Not~~ not ~~Applicable~~ applicable** and **replaced** with **Exhibit -4N, Exhibit -4O, Exhibit -4P.**

Exhibit 4-P

~~PAVED SHOULDER CROSS-FALL~~Paved Shoulder Cross-Fall



Section 4.4.5 – Shoulder Rounding: Best Practices

- This ~~Section~~ section is **~~Not~~ not ~~Applicable~~applicable**. ~~Designer should r~~Refer to the latest edition of ministry's *Roadside Design Manual*.

Exhibit -4Q

~~SUPERELEVATION FOR SHOULDERS ON HIGH SIDE OF SUPERELEVATED SECTIONS~~Superelevation for Shoulders on High Side of Superelevated Sections

Adjacent Traffic Lane	+0.06	+0.05	+0.04	+0.03	+0.02	+0.01	0.00	-0.01	-0.02
Shoulder	-0.02	-0.02	-0.02	-0.03	-0.03	-0.03	-0.04	-0.05	-0.06

Section 4.5.3 - Arterials Road Medians: Application Heuristics

- This ~~Section~~ section is **~~Applicable~~ applicable except** point # 9.

Figure 4.5.2 – Arterials Medians

- This Figure is **~~Not~~ not ~~Applicable~~applicable**. The figure consists of four illustrations. For the Illustration in the upper left quadrant, designers may refer to 500 series MTODs. The remaining three illustrations are addressed in the ministry's *Roadside Design Manual.*

Section 4.7.2 – Curbs: Best Practices

This ~~Section~~ section is **~~Applicable~~ applicable** with the following **additional ~~Guidance~~guidance**:

-

Roadside erosion protection is required at structure approaches. Curb and gutter acting as an extension of the bridge parapet wall is the primary means of erosion control, although paved shoulders may be provided where practical. Curb and gutter should be extended a minimum of 20 m~~etres~~ beyond the structure when constructed on a rural cross section.

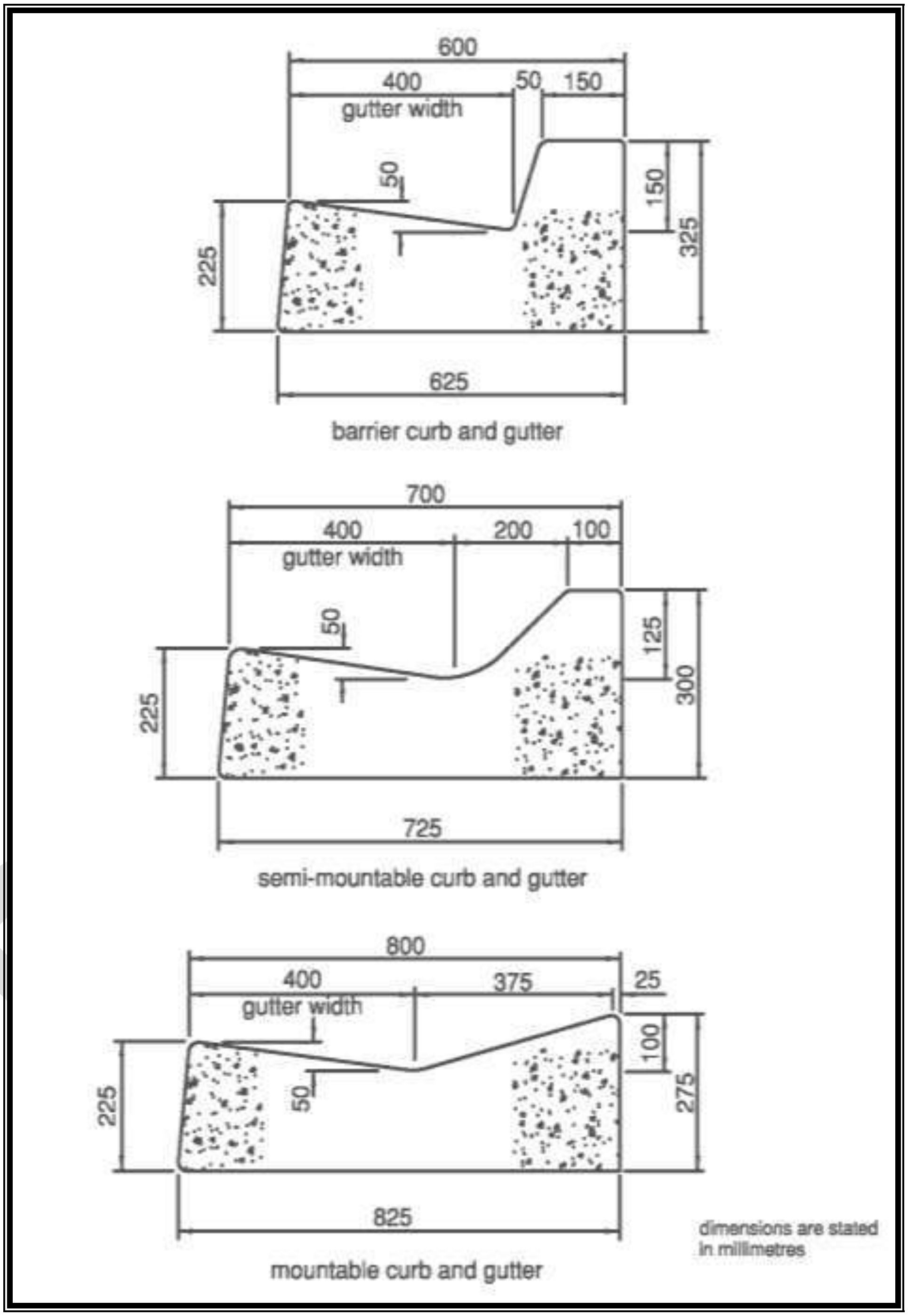
Barrier curbs should not be used adjacent to bridge parapets. A concrete parapet having a profile similar to that of a concrete median barrier is preferred. However, on urban roads where the cross section includes sidewalks on the approaches and the bridge, a barrier curb is carried across the bridge.

Figure 4.7.1 – Curb and Gutter Types

- This Figure is **~~Not~~ not ~~Applicable~~ applicable** and is **replaced** with **Exhibit -4R.** Designers may also refer to 600 series MTODs/OPSDs and RDM.

Exhibit -4R

Concrete~~ONCRETE~~ Curb~~URB~~ and~~AND~~ Gutter~~UTTER~~ Dimensions~~IMENSIONS~~



Mountable Curb Separating Channels

Mountable curb separating channels are designed to allow vehicles to cross them readily when required, particularly to accommodate off tracking of tractor-semitrailers when making turns. They may be used in high-speed urban and suburban facilities to provide drainage conveyance and functional separation between the travelled roadway and adjacent facilities (e.g., bicycle lanes, parking lanes, or boulevards), while maintaining the ability for vehicles to traverse the curb as needed.

An example of a mountable curb at a right-turn channelization is shown in **Exhibit 4S.**

Exhibit 4-S

~~MOUNTABLE CURBS SEPERATING CHANNELS~~Mountable Curbs Separating Channels

Section 4.8.2 – Rural Drainage Channels (Ditchline): Best Practices

- This ~~Section~~ section is **~~Not~~ not ~~Applicable~~ applicable** and is **replaced** with the following ~~Guidance~~guidance:

Slopes

Earth cut and fill slopes should be flattened and generally rounded to be consistent with the topography and the type of highway. Effective erosion control, maintenance costs, and adequate drainage of the subgrade are largely dependent upon proper shaping of the side slopes. Overall economy depends not only on the ~~element of first~~initial construction cost, but also on costs of maintenance for ~~of~~ which slope stability is a significant factor. In addition to these reasons for gentle and rounded slopes on any highway, the proximity of any urban highway to ~~the~~ development and residents of ~~the~~ a community ~~calls for~~warrants additional attention to slope treatment and the overall appearance.

On freeways and arterial roads with reasonably wide roadsides, side slopes on embankments and in cuts should be designed to provide a reasonable opportunity for recovery of an out-of-control vehicle. Where the roadside, at the point of departure, is reasonably flat, smooth and clear of fixed objects, many potential ~~accidents~~ collisions can be avoided. Flat and well-rounded side slopes simplify the establishment of turf and its subsequent maintenance. For detailed guidance on foreslopes,~~s about side slope beyond shoulder,~~ ~~designer should~~ refer to ministry's *Roadside Design Manual*.

Contour Design

Contour design is ~~usually~~ applied to residual areas of land in interchange areas between ramps, for noise berms and disposal areas. These areas can be graded with varying slopes to give an undulating and natural looking appearance. Contour design is carried out in conjunction with drainage design with consideration for safety and, where appropriate, in conjunction with landscaping. Residual pockets of land in interchange areas, particularly loop ramps, can be used to dispose of some surplus material and to minimize spoil. Conversely, they may be used to generate additional excavation and to minimize borrow.

Drainage Channels

Drainage channel cross sections must have adequate hydraulic capacity and should be designed to keep water velocities below the scour limits wherever possible. Generally additional capacity should be derived by widening channels. The depth must be a minimum of 0.5 m below the bottom of the subgrade to provide drainage of the pavement structure. The drainage channel therefore should be kept at an adequate depth below the pavement. Channels should have a streamlined cross section for safety, ease of maintenance, and to minimize snow drifting. In areas of rock cut where fallen boulders can be expected, it may be desirable to provide a wider drainage channel to collect the boulders. This ~~will~~ reduces the possibility of ~~the~~ boulders resting on the shoulder or ~~roadway, and~~roadway and ~~will~~ facilitate the ~~maintenance~~ clean-up of fallen rock. For further details, refer to the ministry's ~~*ministry's*~~ *Drainage Management Manual, Roadside Design Manual,* and 200-series OPSDs and MTODs ~~*Standard Drawings*~~.

Section 4.8.3 – Urban Strom Drainage: Best Practices

- This ~~Section~~ section is **~~Applicable~~ applicable** with the following **additional ~~Guidance~~guidance**:
-

Climate change shall be considered when undertaking the design of the Ministry of Transportation drainage infrastructure.- ~~Please~~ R~~r~~efer to the Implementation of the Ministry's Climate Change Consideration in the Design of Highway Drainage Infrastructure policy for more details.

With the increasing~~ed~~ frequency and duration of storm events, culverts, sewers, and catch basins can become more susceptible to blockages.- It is therefore desirable to perform increased routine maintenance and to ensure proper drainage can be ~~maintained~~provided at all times. ~~Designers are encouraged to~~ R~~r~~efer to the ministry's *Drainage Management Manual*, *Gravity Pipe Design Guidelines* and *Highway Drainage Design Standards*.

Table 4.8.1 – Guide for Lateral Spread of Surface Water Flow

- This Table is **~~Not~~ not ~~Applicable~~applicable**. ~~The designer should~~ R~~r~~efer to the ministry's *Highway Drainage Design Standards.*

Section 4.8.4 – Cross-fall (Slope): Best Practices

- This ~~Section~~ section is **~~Applicable~~ applicable except** point # 5. The following **additional ~~Guidance~~ guidance** is also applicable:

Cross-Fall Requirements

~~Cross slope and cross-fall terminologies may be interchangeably used in this section.~~
On 2-lane highways the pavement is normally crowned at the centreline and the pavement slopes down to either edge at a cross-fall rate of 2%.

On 4-lane undivided highways and 4-lane divided highways with a flush median, the crown is normally placed in the centre of the pavement of median, and cross-fall to either pavement edge is 2%.

On a 4-lane divided highway with a depressed median, the crown is normally placed at the centre of each roadway with a cross-fall of 2% to each edge. For roadways on structures, the cross-fall should be a minimum of 2%.

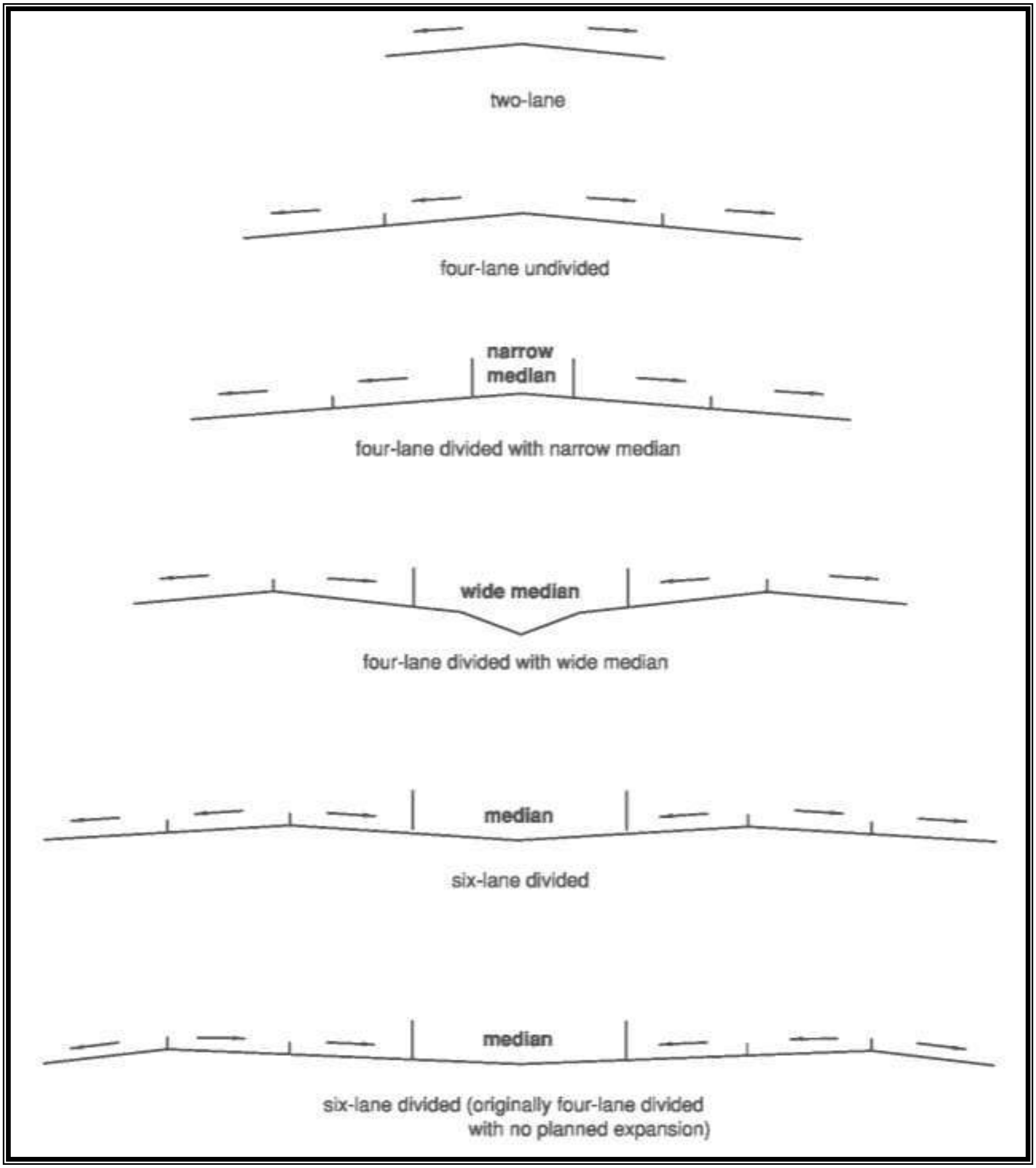
There are two reasons for this: the first is to permit storm water to drain to either side of the roadway; the second is to facilitate the treatment of the roadway with de-icing chemicals which are spread in a narrow strip about the crown line, allowing the action of traffic and cross-fall to further spread the chemicals across the entire pavement. If the road eventually requires expansion to six lanes by adding two lanes in the median, the additional lanes will slope toward the median.

If a 4-lane divided highway is to be expanded to six lanes within a short period of time of initial construction, it should be designed for six lanes and built without the median lanes initially, in this case both lanes of each roadway will slope towards the outer edge.

For 6-lane divided highways, the crown for each roadway is applied to the common edge of the centre and median lanes, the two outside lanes having a cross-fall of 2% towards the outside edge, and the median lane having a cross-fall of 2% draining towards the median. If this cross section is expanded to an 8-lane cross section with the additional lanes in the median, the additional lanes have 2% cross-fall applied draining towards the median. The above cross-fall requirements are illustrated in **Exhibit ~~4S~~4T.** Cross-fall on auxiliary lanes is the same as that of the adjacent through lane.

Exhibit 4-~~5~~T

~~APPLICATION OF 2% (NORMAL) CROSS-FALL ON TANGENT SECTION~~Application of 2% (Normal) Cross-Fall on Tangent Section



At intersections where two roads on tangent intersect, normal cross-fall is maintained on the major road, and cross-fall on the minor road is run out on the approaches to the intersection to match the profile of the major road. This treatment is typical of intersections controlled by a stop sign on the minor road. In the case of an intersection where the two roads are of equal importance, or where the intersection is signalized, the normal cross-fall is run out on all four approaches so that the cross-fall on each road matches the profile of the crossing road. Simply put, the pavements are warped to maintain smooth profiles for traffic on both roads.

Section 4.10.1.1 – Roads under Bridges: Design Domain and Application Heuristics

- This ~~Section~~ section is **~~Applicable~~ applicable except** point # 4 and with the following **additional ~~Guidance~~guidance**:

  With increased severity and frequency of storms it is recommended to have the primary road go over the secondary road in areas prone to flooding ~~when it makes sense to do so~~where appropriate.

Figure 4.10.1 – Horizontal Clearance at Bridges on Urban Arterial Roads (Underpass)
Figure 4.10.2 – Horizontal Clearance at Bridges on Urban Freeways (Underpass)

- These Figures are **~~Not~~ not ~~Applicable~~applicable**. General guidance is provided in the ministry's *Roadside Design Manual*. ~~Designer should also r~~Refer also to ministry's *Structural Manual.*

Section 4.10.1.2 – Roads on Bridges: Design Domain and Applications Heuristics

- ~~This Section is Not Applicable and is replaced with the following Guidance:~~This section is **not applicable** and is **replaced** with the following guidance:

  General

  The material contained in this section is intended to assist ~~the~~ designers when designing cross sections where bridges, retaining walls or other structures are required. This section gives direction in ~~setting~~ establishing structure dimensions that influence geometric design of horizontal alignment, vertical alignment, and cross sections. In general:

  - Bridges should be designed to match the geometric ~~requirements~~ attributes of the approach roadway.

- Where practicable, the horizontal centerline alignment on bridges should be on tangent or of constant radius of curvature.
- The cross section elements of roads on and under bridges should match those of the approach roadway.
- Sag curves on bridges should be avoided as much as possible.

Deck Width and Traffic Lanes

The number and width of through lanes and auxiliary lanes should be the same on the bridge deck as on the approach roadway. Traffic lane widths should be in accordance with **Section 4.2** and **Section 4.3**.

In general, the minimum acceptable bridge deck roadway width for two-way traffic is 8.5 m to allow for passing of snowplows on the bridge. To facilitate bridge rehabilitation, the bridge deck roadway width should accommodate ~~the~~ future staging requirements and be a minimum width, as shown in **Exhibit -4U~~T~~**, unless bridge closure would be acceptable during the required rehabilitation.

Exhibit 4-U~~T~~*

MINIMUM BRIDGE WIDTHS TO ACCOMMODATE FUTURE REHABILITATION

Roadway	Temp Clearance (m)	Barrier Overlap** (m)	Minimum Width (m)
Freeway	4.50	2.8	11.8
Trans-Canada	4.50	2.4	11.4
King's Highway	4.00	2.2	10.2
Secondary Highway / Arterial	3.75	1.7	9.2
Collector / Local Road	3.40	1.7	8.5

** Exhibit 4-T is intended for new construction of mainline bridges to accommodate future staging. -The minimum width is for future rehabs. The new design should meet all safety rules to account for barrier deflection width and Ministry of Labour requirements.*

***Barrier Overlap includes two positions of a Temporary Construction Barrier, plus the buffer distance behind for barrier deflection and overlap of the waterproofing and asphalt.*

Single lane bridges shall be between 4.0 m and 4.9 m wide, except for single lane ramp bridges that shall be a minimum of 4.75 m wide.

Provision of single lane bridges and narrower two-lane bridges may be permitted as shown in on low volume roadways in accordance with the Ministry's Guidelines for the Design of Bridges on Low Volume Roads.

Side Clearances on Bridges

Side clearance~~s~~ on a bridge decks is defined~~s~~ as the distance between the edge of the travelled way and the adjacent curb or barrier. It should be in accordance with **Exhibit ~~-~~4V~~U~~,** and **Exhibit ~~-~~4W~~V~~** for urban and rural structures.

Median Widths

The width of a median on a bridge should match that of the approach roadway.

Figure 4.10.3 – Horizontal Clearance on Bridges on Urban Arterial Roads
Figure 4.10.4 – Horizontal Clearance on Bridges on Urban Freeways (Overpass)

- These Figures are **~~Not~~ not ~~Applicable~~ applicable** and are~~is~~ **replaced** with **Exhibit ~~-~~4U.**

Exhibit -4V~~U~~

~~SIDE CLEARANCE ON BRIDGES~~Side Clearance on Bridges

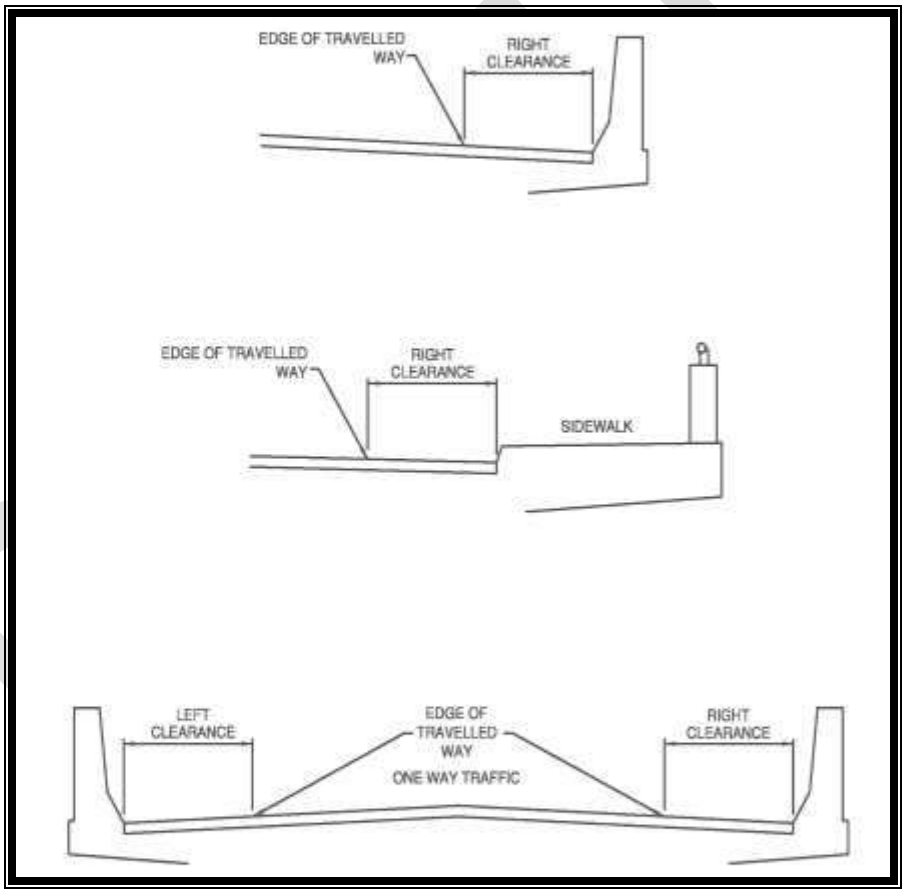


Table 4.10.1 – Horizontal Clearance at Bridges on Local and Collector Urban Roads

Table 4.10.2 – Horizontal Clearance at Bridges on Rural Roads

- ~~o~~ These two Tables are ~~**Not**~~ **not** ~~**Applicable**~~ **applicable** and are~~is~~ **replaced** with **Exhibit -4W~~V~~.**

Exhibit ~~-~~4W~~V~~

~~MINIMUM SIDE CLEARENCE AT BRIDGES~~Minimum Side Clearence at Bridges

Highway Classes	Design Speed (km/h)	Urban Roads			Rural Roads		
		Left	Right		Left	Right	
			No Sidewalk	Sidewalk		No Sidewalk	Sidewalk
FREEWAY 4-LANE DIVIDED	100 to 130	2.5 a	3.0 a		2.5 a	3.0 a	
FREEWAY MULTI-LANE DIVIDED	100 to 130	2.5 a	3.0 a		2.5 a	3.0 a	
ARTERIAL DIVIDED	90 to 110	2.0 a	2.5 a	1.5	2.0	3.0 a	
	80	2.0 a	2.0 a	1.5	1.5	2.5 a	
ARTERIAL UNDIVIDED	90 to 110	-	2.0	1.5	-	3.0 a	2.5 a
	80	-	2.0	1.5	-	2.5 a	2.0 b
COLLECTOR UNDIVIDED	90 to 100	-	1.25 c	1.0	-	2.5 a	1.5 c
	70 to 80	-	1.25 c	1.0	-	1.5 d	1.25
	60	-	1.0	1.0	-	1.5 d	1.25
LOCAL UNDIVIDED	60 to 80	-	1.0	0.5	-	1.25	0.5 d

Notes:

1. Consideration shall be made for accommodation of out of service vehicles and facilitation of snow removal activities when considering reduced side clearances on bridges.

~~1.~~2. If a barrier is to be placed between the sidewalk and roadway, then clearance should be the same as when there are no sidewalks.

~~2.~~3. All clearance should desirably meet requirements for sight distance.

~~3.~~4. The width of a median on a bridge should match that of the approach roadway.

~~4.~~5. L = length of bridge between centerline of abutment bearings.

a. For bridges with L>50 m, consider decreasing the clearances to 1.5 m.
b. For bridges with L>50 m, consider decreasing the clearance by up to 0.5 m.
c. For bridges with L>50 m, consider decreasing the clearance by 0.25 m.
d. For bridges with L>50 m, consider increasing the clearance by up to 0.75 m.
e. The values of the clearances given above are the minimum. Consider providing more than the minimum and justification should be documented.

Section 4.10.1.3 – Multi-Modal Configurations

- This section is **~~Not~~ not ~~Applicable~~ applicable** and is **replaced** with the following ~~Guidance~~guidance:~~.~~

Sidewalk, Bikeways and Curbs

According to the Ontario Regulation 413/12, now 191/11, which came into force on January 1, 2013, under the *"Accessibility for Ontarians with Disabilities~~y~~ Act (AODA) 2005",* the design of new bridges with sidewalks or bridge rehabilitations where the sidewalks are rehabilitated, unless otherwise permitted in *Section 80.31* of the *~~AODA~~ Regulation 191/11*, the minimum clear sidewalk width shall be 1500 mm. In addition, the minimum clear sidewalk width shall:

- B~~b~~e maintained over the entire length of the bridge and transition smoothly to the approaches.
- N~~n~~ot be reduced below 1500 mm by appurtenances such as guiderail connections to the bridge.~~, and~~
- A~~a~~pply to the clear surface of the sidewalk excluding surfaces of other elements such as curbs or tops of walls that are separated from the sidewalk by longitudinal joints.

~~o~~ Wider sidewalks should be considered in areas of high pedestrian traffic.

The above requirements are also illustrated in **Exhibit ~~-~~4X~~W~~.**

Where required, the widths of sidewalks and bikeways on bridge decks should meet the following requirements:

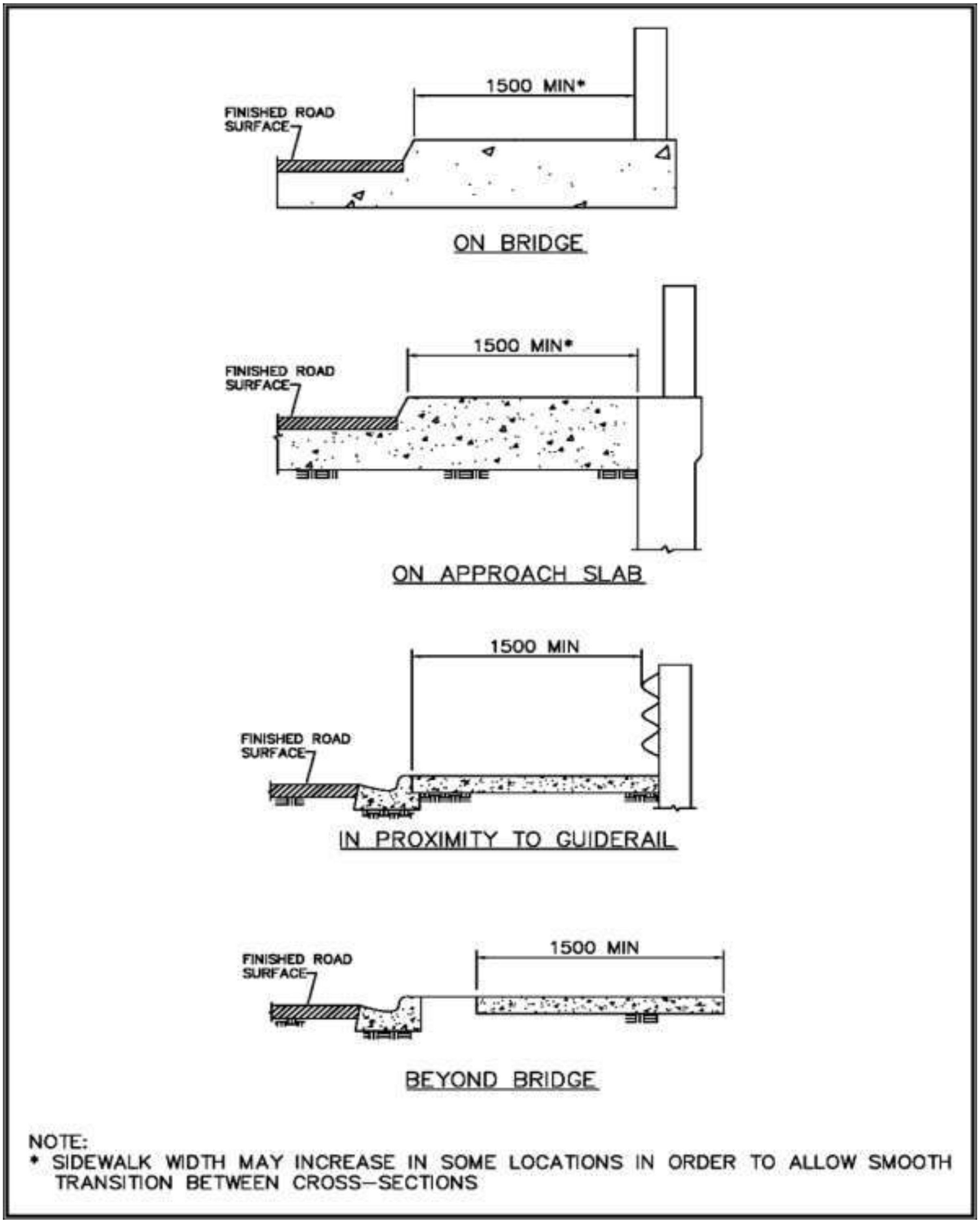
- The edge of a sidewalk adjacent to the roadway on a bridge should match that of the approach sidewalk.
- Where the approach roadway is not provided with a curb, the clear

sidewalk width should be at least 1.5 m.

- Paved bike lane and bikeway widths should be in accordance with the Ministry's *Bikeway Design Manual – March 2014*.
- The height of curbs should not be less than 150 mm above the adjacent roadway except to match the height of curbs on the approach roadway.
- Curbs should not be used in front of barrier walls except where the curb and the barrier wall are separated by a sidewalk.

Exhibit- 4X~~W~~

~~GUIDELINE FOR SIDEWALK WIDHTS ON BRIDGES~~Guideline for Sidewalk Widths on Bridges



The typical depth of concrete for sidewalks is 125 mm, increased to 150 mm across residential driveways, and 200 mm across commercial and industrial driveways.- The depth may be increased at the request of the Municipality providing the Municipality agrees to absorb the additional costs. The granular foundation depth is normally 100 mm for concrete sidewalk.- The granular quantity in tonnes is added to the appropriate granular tender item.- Unsuitable soils below the granular foundation are typically sub-excavated and replaced with suitable earth or select subgrade material.

Section 4.12.1 – Introduction

- This ~~Section~~ section is **~~Applicable~~ applicable** with the following **additional ~~Guidance~~guidance**:

  When designing highway infrastructure, it is important to consider how future rehabilitation and maintenance will be performed.- Congestion from construction staging accounts for a significant amount of greenhouse gases as space is constrained and often leads to reducing the number of lanes which can contribute to significant traffic backups.

  Ensuring adequate traffic flow during future construction staging can result in fewer emissions from vehicles idling ~~and start~~ and ~~/stop maneuvers~~in stop-and-go traffic conditions.- It is significantly easier to plan ahead rather than retrofit after the fact, especially in constrained situations. Additionally, when designing bridge spans, it is important to consider future widening and how construction staging can be accommodated.

Section 4.13 – Typical Cross Sections

- This ~~Section~~ section including all associated Figures (Figure 4.13.1 to Figure 4.13.13) is~~are~~ **~~Not~~ not ~~Applicable~~applicable**.