MTO Design Supplement

For
TAC Geometric Design Guide (GDG) for Canadian Roads

Appendix 5 for Chapter 5

Bicycle Integrated Design

~~October~~ July~~TBD~~ 2026~~3~~

MTO Design Supplement
Appendix 5 for Chapter 5
Bicycle Integrated Design

The following design supplements are applicable to *Chapter 5 – Bicycle Integrated Design of TAC Geometric Design Guide for Canadian Roads - June 2017*:

Chapter 5 – Bicycle Integrated Design

- This Chapter in its entirety is **~~Not~~ not ~~Applicable~~ applicable** for the planning and design of bikeway facilities on provincial highways network.
- ~~Designer should use~~Refer to the ministry's *Bikeway Design Manual - March 2014* for the planning and design of bikeways on provincial highways.
- The ministry *Bikeway Design Manual – March 2014* can be accessed at the ministry's Technical Publications website:

  https://www.library.mto.gov.on.ca/SydneyPLUS/TechPubs/Portal/tp/tdViews.aspx?lang=en-US

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MTO Design Supplement

For
TAC Geometric Design Guide (GDG) for Canadian Roads

Appendix 6 for Chapter 6

Pedestrian Integrated Design

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

MTO Design Supplement
Appendix 6 for Chapter 6
Pedestrian Integrated Design

The following design supplements are applicable to *Chapter 6 – Pedestrian Integrated Design of the TAC Geometric Design Guide for Canadian Roads - June 2017:*

Section 6.1 – Pedestrian Design Focus

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

  All pedestrian facility designs must be in compliance with the *Highway Traffic Act* and the *Accessibility for Ontarians with Disabilities Act*, and all associated regulations under these Acts.

Section 6.3.1.3 – Furnishing Zone

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

  Standard widths for furnishing zones are 3.0 m for arterial roads and 2.0 m for collector and local roads. The desirable minimum width for furnishing zones is 1.5 m.

  Where property is limited or where sidewalks must be wider than the minimum requirement to accommodate pedestrian traffic, furnishing zones may be narrower than the desirable dimensions and in some cases may be omitted entirely. Examples ~~are in~~include downtown areas or ~~in~~ areas fully developed with retail stores and offices.

  Furnishing zones are ~~usually~~ typically sloped towards the roadway to facilitate drainage. They are normally surfaced with turf, in which case the cross fall is 0.04 m/m. The area of the boulevard immediately adjacent to the roadway may be finished with a hardsurface treatment to avoid deterioration of turf due to winter road clearing operations. The hard-~~-~~surface setback width is normally 0.75 m and is ~~usually~~ typically applied to urban conditions where this problem is anticipated.

Materials commonly used for hard-~~-~~surface treatments include ~~are~~:

- Granular
- Asphalt
- Concrete
- Paving Stone

In urban areas where the sidewalk is located 3.0 m or less from the traffic lanes and where a reverse shoulder is utilized as a furnishing zone to suit existing conditions, the shoulder should be fully paved.

Section 6.4.1 - Crosswalks

- Title of this Section is **replaced** with “Crosswalks and Crossovers”
- This Section is **replaced** with the following:
  Crosswalks and crossovers are designated areas where~~for~~ pedestrians ~~to~~ cross a roadway, at intersections and mid-blocks respectively.

Section 6.4.1.1 - Intersection Crosswalks

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

  In Ontario, all signal and stop-controlled legs of an intersection are considered to contain crosswalks by default, whether or not they are marked. If a crosswalk at an intersection is unmarked, it is typically defined by the space within the extension of lines directly connecting the sidewalks on opposite sides of the roadway. ~~Should a~~Where sidewalks ~~or sidewalks~~do not exist, the crosswalk would connect the space located between the curb line or edge of roadway and the adjacent property line.

  At signalized intersections, all crosswalks with pedestrian signals shall be marked. At unsignalized intersections, crosswalk markings may be used in accordance with the

Ontario Traffic Manual Books.

Additionally, consideration should be given to crosswalk markings under the following conditions:

- At an offset or complex intersection, to show pedestrians the shortest route across with the least exposure to vehicular traffic and conflicts.
- At an intersection with visibility constraints, to position pedestrians where they can best be seen by oncoming traffic.
- At an intersection within a school zone.

The components of different types of crosswalks are provided in Tables 3A through 3F of the *TAC Pedestrian Crossing Control Guide* and Chapter 6 of *Ontario Traffic Manual (OTM) Book 15*.

Prohibiting pedestrian crossing at an intersection leg is sometimes implemented for safety or operational reasons. This practice should only be justified based on the needs of all intersection users, and ~~the~~ designers should consider the negative impacts on pedestrian walking distance and delay. Non-compliance can be a problem. See Section 6.5.5 for guidance ~~to~~ regarding physical barriers to assist with compliance, if the prohibition is fully justified.

Crossing distance on wide roadways can be reduced ~~through the use of~~using curb extensions (Section 6.4.3) or median refuge islands. Median refuge islands break the crossing into shorter individual segments and are described in *TAC Synthesis of Practices for Median Design*. The minimum width of a median intended to function as a pedestrian refuge island is 2.4 m.

Section 6.4.1.2 – Mid-block Crosswalks

- In this section, “Crosswalks” is **replaced** with “Crossovers”. *Ontario Traffic Manual* (*OTM) Book 15* is also Applicable.
- This section is **applicable** with the **addition** of the following:

Sidewalks crossing free-flow ramps accessing or egressing controlled-access highways with~~y~~ posted speed limits of 70 km/h or greater should be constructed as unmarked crossings.

Section 6.4.1.3 – Offset Mid-block Crosswalks

- In this section, “Crosswalks” is **replaced** with “Crossovers”.

Figure 6.4.1 – Median Refuge Islands and Offset Crosswalks at Unsignalized Mid-block Crossings

- In this section, “Crosswalks” is **replaced** with “Crossovers”.

Section 6.4.5 – Crosswalk Location

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

  At locations where pedestrian and traffic volumes are ~~prohibitive~~sufficiently high, a grade-separated crossing facility should be considered. Section 8 of *Ontario Traffic Manual Book 15* provides further guidance.

Section 6.4.6.1 – Parts of the Curb Ramps

- This ~~Section~~ section is ~~**Applicable**~~ **applicable** **except** first and fifth bullet points which are provided below respectively:

  - Ramp – the transitional slope between two surfaces (typically a sidewalk and a roadway crosswalk). The ramp shall have a maximum slope of 1:10 (10%) where the elevation difference is greater than 75 mm and less than 200 mm or 1:8 (12.5%) when the elevation difference is less than 75 mm. The recommended width of the ramp, exclusive of flared sides, is 1.2 m to provide continuity with the practical lower limit of the pedestrian through zone. A curb ramp shall be hard-surfaced and comply with Section 80.26 of Ontario Regulation 191/11 under the Accessibility for Ontarians with Disabilities Act.

- Tactile Walking Surface Indicator (TWSI) – a warning treatment that alerts the pedestrian to the presence of a street crossing through a tactile surface and/or contrasting colour. Examples of TWSI materials include tactile dome pads or directional tiles. TWSIs shall comply with the requirements of Section 80.26 of Ontario Regulation 191/11 under the Accessibility for Ontarians with Disabilities Act. A curb ramp shall be hard-~~-~~surfaced and comply with requirements described in Accessible Design for the Built Environment (CSA, 2012).

Additional guidance on the placement of TWSI~~'~~s is provided below:

Implementation of TWSI~~'~~s should be done on a "go-forward" basis. Retrofitting of existing paths of travel is not required unless the intersection is being redeveloped. In general, TWSIs should be provided when:

~~a)~~ ~~n~~New sidewalk and/or curb is required at a new intersection~~,~~

a)

b) ~~b)~~ A~~a~~n existing intersection is being reconstructed or widened which impacts the existing curb ramps~~,~~

c) ~~c)~~ T~~t~~he existing sidewalk and/or curb requires replacement due to condition~~, or~~

d) ~~d)~~ T~~t~~he existing sidewalk and/or curb must be removed and replaced due to new traffic signal installation or other work~~.~~

In all other cases, existing sidewalk ramps in accordance with 300-series OPSDs may remain in place and should not be retrofitted with tactile walking surface indicator plates.

TWSI~~'~~s shall be provided for curb ramps leading to crosswalks at signalized and stop controlled intersections, as well as on curb ramps leading to crossovers.

Section 6.4.6.2 – Types of Curb Ramps

- This ~~Section~~ section is **~~Applicable~~ applicable except** the following:
  - Third paragraph is ~~Not~~ not ~~Applicable~~applicable.
  - Fourth paragraph is ~~Not~~ not ~~Applicable~~ applicable and replaced with the following:

    To form a section of full curb height of 150 mm between perpendicular curb ramps, a minimum separation of 3 m ~~of separation~~ between ~~the~~ curb ramps is required for the flares along the arc. On corner radii greater than 5 m or when sidewalks are separated from the curb by a furnishing zone, perpendicular curb ramps should be used, and crosswalk locations chosen accordingly as discussed in Section 6.4.5. The sidewalk should be adjusted to lead to the perpendicular curb ramp. However, in highly constrained situations, such as a 5 m radius corner with narrow sidewalks and no furnishing zones, the curb height between perpendicular ramps may be reduced to a minimum of 75 mm to achieve closer ramp spacing.

Figure 6.4.8 – Recommended Curb Ramp Configurations and Dimensions

- Fig. A for Parallel Curb Ramp is **n~~N~~ot a~~A~~pplicable** because TWSI location and orientation as depicted in the figure is not in compliance with *Accessibility for Ontarians with Disabilities Act.*
- Fig. B for Depressed Corner Ramp is **n~~N~~ot ~~A~~applicable**.

Section 6.4.7 - Pedestrian Signals

- The first paragraph is **~~Not~~ not ~~Applicable~~ applicable** and is **replaced** with the following:

  Pedestrian signal indicators display whether pedestrians have adequate time to begin crossing a roadway at a signalized crosswalk. Installation of pedestrian signals at new and redeveloped signalized intersections shall be in accordance with *HSBM Traffic Office #2017-01*, *February 2017*. Where feasible, and particularly in areas with high pedestrian volumes (e.g., central business districts, routes to schools), consideration should be given to automatically displaying the walk signal ~~automatically~~ as part of the signal phasing. Where pedestrian volumes are high, a separate pedestrian-only signal phase may be beneficial.

- References to *MUTCDC, Canadian Capacity Guide*, and *TAC Pedestrian Crossing Control Guide* are replaced with *Ontario Traffic Manual Books (OTM), OTM Book 12*, and *OTM Book 15* respectively.

Section 6.4.8 – Driveways and Alleys Crossing the Sidewalk

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

  At driveway entrances, barrier or semi-mountable curbs should be replaced by a mountable curb to provide convenient vehicle access and egress ~~for vehicles~~. The length of mountable curb for residential driveways should be equal to the width of the driveway plus 1.5 m on either side. For residential parking lots, apartments, and institutional developments the length should be the driveway width plus 3.0 m on either side. The slope of the driveway between the sidewalk and the road should not exceed 10%. Refer to *300-series Ontario Provincial Standard Drawings (OPSDs)*.

Figure 6.4.9 - Driveway Crossing Styles

- Figure D, TWSI location and orientation depicted is not in compliance with *Accessibility for Ontarians with Disabilities Act* requirements.

Section 6.5.1 - Surface Type, Grade and Cross-Slope

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

  Walking surfaces shall be firm, even, and allow for good traction in all weather conditions. The maximum recommended grade for sidewalks is 1:20 (5%), although steeper grades for sidewalks, not exceeding the slope of the adjacent roadway are permitted. Intermittent landings, and/or parallel accessible ramps are recommended at intervals of no more than 9.0 m where the slope exceeds 1:20.

  Cross-slopes should provide adequate drainage while ~~allowing~~ maintaining comfort and traction for pedestrians, especially wheelchair users. A cross-slope of 2.0% is recommended, although cross slopes of up to 3.0% on mainline sidewalks and up to 5% across short driveways are acceptable.

Section 6.5.2 - Accessible Ramps and Stairways

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

  Ramps and stairways shall be designed in accordance ~~to conform to~~ with the *Accessibility for Ontarians with Disabilities Act* and associated regulations under the Act.

Section 6.5.4.1 - Pedestrian Through Zones
Section 6.5.4.2 - Intersections

- The above noted ~~Sections~~ sections are both **~~Applicable~~ applicable** with the note that *TAC Guide for Design of Roadway Lighting* is **~~Not~~ not ~~Applicable~~ applicable** and is **replaced** with the ministry directive *PLNG-B-05, Ministry Policy for Highway Illumination.*

Section 6.5.4.2 - Intersections

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

  The ministry directive *PLNG-B-05, Ministry Policy for Highway Illumination* shall be used to determine the warrants for lighting for intersection. For roundabouts, the “Roundabout Lighting Policy” of the ministry shall be used.

Section 6.5.4.3 - Mid-Block Crossovers

- In this section, “Crosswalks” is **replaced** with “Crossovers”.

Section 6.5.6.2 - Walkable Shoulders

- The third sentence is **deleted** and is **replaced** with the following:

If shoulders are also to be accessible to cyclists, refer to the ministry's *Bikeways Design Manual.*

Section 6.5.6.5 – Winter Access and Maintenance Considerations

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

  With increasing storm events, ~~more~~ greater consideration should be given to ~~towards extra~~ additional snow removal, maintenance, and storage ~~should be given.~~ Best~~It is a good~~ practices ~~to~~include clearing drainage grates and culverts more frequently as debris accumulation can overwhelm drainage infrastructure and impede pedestrian travel.

Section 6.5.7 – Stormwater Features / Landscaping / Trees

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

  The Inclusion of vegetation and other landscaping ~~architecture~~features can act as a carbon sink, ~~s~~ absorbing carbon dioxide. Landscaping also has the added benefits of improving drainage, providing soil stability, reducing erosion, improving air quality, countering snow/wind drifts and reducing driver stress.

  Vegetation can be used ~~as a measure~~ to ~~reduce~~mitigate the ~~impacts of the~~urban heat-island effect. Road surfaces absorb—rather than reflect—the sun's heat, causing surface temperatures and overall ambient temperatures to rise. Heat islands increase overall electricity demand because of the need to air condition surrounding buildings. This is of particular concern in highly urbanized areas. Having vegetation in these areas can cool the surrounding environment and reduce the resultant electrical demand.

Section 6.6.2 - Pedestrian Integration at Roundabouts

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

  In addition to ensuring pedestrian safety throughout roundabouts, the ~~inclusion~~ accommodation of bicycles and transit~~s~~ may need to be considered in the planning process.

- The last paragraph is **replaced** with the following:

  For detailed design guidance regarding roundabouts, including accessible design features, refer to *DCSO PEM 2017–05 – Implementation of Canadian Roundabout Design Guide and MTO Design Exceptions dated September 19, 2017.*

Section 6.6.6.2 – Maintenance Considerations

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

  When determining maintenance strategies, consideration should be ~~made~~ given ~~for~~to increases in the frequency and severity of extreme weather events due to climate change. Increasing storm events can result in debris accumulation that can overwhelm drainage infrastructure and impede pedestrian travel. As a result, best~~it is a good~~ practices ~~to~~include clearing drainage grates and culverts ~~more~~ frequently.

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MTO Design Supplement

For
TAC Geometric Design Guide (GDG) for Canadian Roads

Appendix 7 for Chapter 7

Roadside Design

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

MTO Design Supplement
Appendix 7 for Chapter 7
Roadside Design

The following design supplements are applicable to *Chapter 7 – Roadside Design of TAC Geometric Design Guide for Canadian Roads June 2017*:

Chapter 7 – Roadside Design

- This Chapter in its entirety is **~~Not~~ not ~~Applicable~~ applicable** for the planning and design of facilities on provincial highways network.
- The ministry's *Roadside Design Manual (latest edition)* should be used for the planning and design of provincial highways.
- The ministry *Roadside Design Manual* can be accessed at the ministry's Technical Publication website: https://www.library.mto.gov.on.ca/SydneyPLUS/TechPubs/Portal/tp/tdViews.aspx?lang=en-US

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MTO Design Supplement

For
TAC Geometric Design Guide (GDG) for Canadian Roads

Appendix 8 for Chapter 8

Access

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

MTO Design Supplement
Appendix 8 for Chapter 8
Access

The following Design Supplements are applicable to *Chapter 8 – Access of the TAC Geometric Design Guide for Canadian Roads - June 2017*:

General

The ministry has statutory authority to control access to all provincial highways and within the MTO Permit Control Area, as defined by the *Public Transportation and Highway Improvement Act (PTHIA).*~~-~~ In accordance with the *PTHIA*, the ministry has well-~~-~~established processes for access management, including policies, procedures, and guidelines to assist in understanding requirements for permit applications within the MTO's jurisdiction and control.

For guidance related to access management within the MTO Permit Control Area, Chapter 8 – Access of the *TAC Geometric Design Guide* should be used in conjunction with this Design Supplement Appendix and the latest ministry *Highway Corridor Management Manual (HCMM).*

In any instance where Chapter 8 of the *TAC Geometric Design Guide* is not consistent with the *HCMM*, the ~~latter~~ HCMM shall take precedence.

Section 8.1.3 – Building Set-Back Guidelines

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

  The guidance for minimum building setbacks from a provincial highway right of way is provided in the latest MTO Highway Corridor Management policies and directives, in accordance with the *PTHIA*. Where ~~construction~~development~~/building~~ is proposed within the MTO Permit Control Area, Chapter 2 of the ministry~~'s~~ *HCMM* should be consulted for the application of setbacks. For setbacks related to signs, also refer to Chapter 5 of the *HCMM*.

Section 8.1.4 – Pedestrian and Cyclist Considerations

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

  The ministry has issued the *Bikeways Design Manual (BDM)* in March 2014.- The guidelines presented in the *BDM* should be applied in the design of on-road and off-road bicycle facilities located within the provincial rights-of-way.

Section 8.1.5 – Capacity Considerations

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

  For a detailed discussion of~~n~~ capacity analysis on various types of highways and intersections, ~~the designer should~~ refer to the ministry's *Capacity Analysis Manual (CAM) - January 2016.*

  ~~The designer should also r~~Refer to the *HCMM*, MTODs and OPSDs for guidance ~~regarding~~ on entrance design.- In accordance with the PTHIA, where required for the MTO Permit application(s), capacity analysis should be done as part of a Traffic Impact Study (TIS). ~~The~~ Traffic Impact Studies~~y~~ should be carried out according to the latest ministry's TIS Guideline. The appropriateness of an increased intersection capacity must be carefully considered, including corresponding design elements, alternatives and impacts (e.g. left turns, entrances, signalization, roundabouts, grade separation, etc.), in keeping with *HCMM* principles and intersection spacing requirements.

  Consideration should be given to reducing~~e~~ traffic congestion and providing~~e~~ free--flow conditions where operationally feasible. By reducing stop-and-go conditions, fuel efficiency can be achieved. ~~A~~ R~~r~~educing~~tion in~~ idling, excessive braking, acceleration~~s~~, and deceleration~~s~~ of vehicles can reduce greenhouse gas emissions ~~released~~. Left turn lanes, channelization, and roundabouts are some options that can be used to alleviate traffic congestion.

Section 8.2.2 – Access Types

- This ~~Section~~ section including all ~~Sub~~sub-sections from 8.2.2.1 to 8.2.2.10 and Figure 8.2.1 are **~~Not~~ not ~~Applicable~~applicable**. ~~Designer should~~ R~~r~~efer to *Section 4.4 – Types of Access Connections* of the *HCMM.*

Section 8.2.3 – Access Classification System

- This ~~Section~~ section including Table 8.2.1 – Access Levels Keyed to Road Type are **~~Not~~ not ~~Applicable~~applicable**. ~~Designer should~~ R~~r~~efer to *Section 4.5.2 – Classification Systems* of the *HCMM.*

Section 8.3 – Access Management by Design Classification

- This ~~Section~~ section including all ~~Sub~~sub-sections from 8.3.1 to 8.3.5 are **~~Not~~ not ~~Applicable~~applicable**. ~~Designer should r~~Refer to *Section 4.5.3 – Access Management Classification System – Definitions* of the *HCMM.* Also, refer to Section 4.6 of the *HCMM* for guidance on access management for~~to~~ highways within the jurisdiction and control of the ministry.

Section 8.4.3 – Distance from Interchanges and Intersections

- This ~~Section~~ section is **~~Not~~ not ~~Applicable~~applicable**. ~~Designers should r~~Refer to Section 4.6 of the *HCMM* which provides ~~guidance on~~ spacing requirements ~~valid for~~applicable to permit applications within the jurisdiction and control of the ministry.

Section 8.4.10 – Auxiliary Lanes

- This ~~Section~~ section is **~~Applicable~~ applicable** with ~~the~~ **additional guidance** provided in *Section 8.1.5 – Capacity Considerations* above and in Chapter 9 of the *TAC GDG June 2017*.

Section 8.5 – Continuous Right-Turn Auxiliary Lanes on Divided Arterials

- This ~~Section~~ section including all ~~Sub~~sub-sections from 8.5.1 to 8.5.2-8.5.2.4, Figures 8.5.1 to 8.5.7, and Table 8.5.1 are **~~Not~~ not ~~Applicable~~applicable**.

Section 8.7 – Service (Frontage) Roads

- This ~~Section~~ section is **applicable except** for Sub-sections 8.7.2 and 8.7.3, Figures 8.7.1 to 8.7.5, and Table 8.7.1, which are **~~Not~~ not ~~Applicable~~applicable**. ~~Designer should~~ R~~r~~efer to *Section 8.1.3 – Building Set~~-~~b~~B~~ack Guidelines* above.

Section 8.8 – Corner Clearance at Major Intersections

- This ~~Section~~ section including all s~~S~~ub-sections from 8.8.1 to 8.8.2, and Figures from 8.8.1 to 8.8.2 are **~~Not~~ not ~~Applicable~~applicable**. ~~Designer should r~~Refer to *Section 4.6* of the *HCMM* for guidance on minimum and ~~/~~desirable distances from intersections and ~~/~~interchange areas along provincial highways and municipal roads.

Section 8.9.3 – Sight Distance

- This ~~Section~~ section is **~~Not~~ not ~~Applicable~~applicable.** ~~Designer should r~~Refer to *Chapter 9* of *TAC GDG,* and the *MTO Design Supplement* to *Chapter 9* for guidance on intersection sight distance standards.

Section 8.9.5 – Width

- This ~~Section~~ section is **~~Applicable~~ applicable except** Table 8.9.1 – *Typical Driveway Dimensions*. ~~Designer should r~~Refer to the *HCMM, MTODs and OPSDs* as applicable for guidance on dimensions for the design of entrances that are within the jurisdiction and control of the ministry.

Section 8.9.7 – Corner Clearances at Minor Intersections

- This ~~Section~~ section is **~~Not~~ not ~~Applicable~~applicable**. ~~Designer should r~~Refer to *Section 4.6* of the *HCMM* for guidance on minimum and ~~/~~desirable distances from intersection and ~~/~~interchange areas along provincial highways and municipal roads.

Section 8.9.8 – Spacing of Adjacent Driveways

- This ~~Section~~ section including Figure 8.9.2 and Table 8.9.2 are **~~Not~~ not ~~Applicable~~applicable**. ~~Designer should r~~Refer to *Section 4.6* of the *HCMM* for guidance on applicable entrance spacing within the jurisdiction and control of the ministry.

Section 8.9.10 – Clear Throat Lengths

- This ~~Section~~ section and its associated Table 8.9.3 are **~~Not~~ not ~~Applicable~~applicable**. ~~Designer should r~~Refer to *Section 4.6.7* of the *HCMM* which provides guidance on access connection depths at intersections on provincial highways.

MTO Design Supplement

For
TAC Geometric Design Guide for Canadian Roads

Appendix 9 for Chapter 9

Intersections

~~October~~ ~~TBD~~July 2026~~3~~

MTO Design Supplement
Appendix 9 for Chapter 9
Intersections

The following Design Supplements are applicable to *Chapter 9 – Intersections* of the *TAC Geometric Design Guide for Canadian Roads - June 2017:*

Section 9.4.2.2 – Collectors

- ~~This Section~~This section is **~~Not Applicable~~not applicable**.

Section 9.4.2.3 – Locals

- ~~This Section~~This section is **~~Not Applicable~~not applicable**.

Section 9.4.2.4 – Cross Roadway Intersection Spacing Adjacent to Interchanges
Figure 9.4.2 – Cross Road Intersection Spacing Adjacent to Interchanges
Figure 9.4.3 – Intersection Spacing / Channelization Treatment at Diamond Interchanges

- ~~This Section~~These~~is~~ sections and the Figures are **~~Not Applicable~~not applicable**. Refer to Chapter 8 – Access and Appendix 8 of the MTO Design Supplement for criteria to determine access connection offset spacing to interchanges.

Section 9.4.4 – Design Options for Urban Residential Areas

- ~~This Section~~This section is **~~Not Applicable~~not applicable**.

Section 9.5.1

- The last sentence in this ~~Section~~ section ~~should be~~is **replaced** with “Reference ~~can~~ may also be made to Transport Canada’s Grade Crossings – Handbook”.

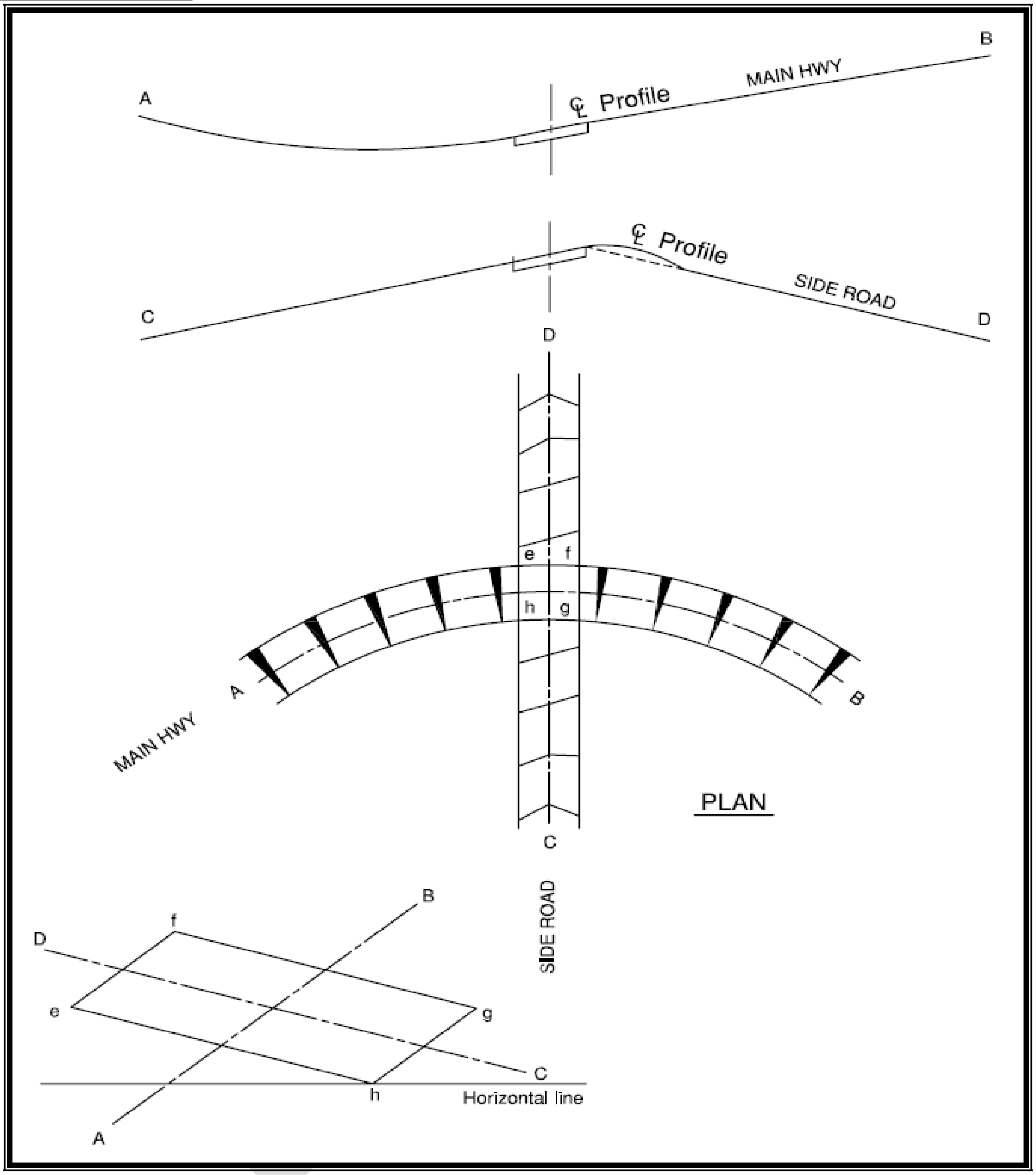
Section 9.7.4 – Combined Vertical and Horizontal Alignment

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

  "If the terrain conditions are such that a "break" in cross slope is required between the edge of pavement of the main highway and the sideroad, the effect of roll-over must be taken into consideration from an operational and visual point of view. The difference should desirably be 4% and not exceed 6%, see **Exhibit -9A**."

Exhibit -9A

~~PAVEMENT CROSS SECTIONS - SIDE ROAD PROFILE ADJUSTMENT~~Pavement Cross Sections – Side Road Profile Adjustment



Section 9.9: AASHTO Intersection Sight Distance Model

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

Highways with design speeds of 120 and 130 km/h are typically fully controlled access freeways with accesses provided through interchanges. Public-use at-grade intersections on such facilities are strongly discouraged. Where at-grade accesses for maintenance and emergency use on a freeway cannot be avoided, designers should ensure that all required sight distances are provided, desirably well in excess of minimum values.

Section 9.9.2 – Sight Triangles

- ~~This Section~~This section ~~is Applicable~~is **applicable** including the following ~~**additional Guidance**~~**additional guidance** adopted from the AASHTO Green Book ***"****A Policy on Geometric Design of Highways and Streets – 2018 7th Edition"*:

Identification of Sight Obstructions within Sight triangles

The profiles of the intersecting roadways should be designed to provide the recommended sight distances for drivers on the intersecting approaches. Within a sight triangle, any object at a height above the elevation of the adjacent roadways that would obstruct ~~the~~ a driver's view should be removed or lowered, if practical. Such objects may include buildings, parked vehicles, highway structures, roadside hardware, hedges, trees, bushes, unmowed grass, tall crops, walls, fences, and the terrain itself. Particular attention should be given to the evaluation of clear sight triangles at interchange ramp/crossroad intersections where features such as bridge railings, piers, and abutments are potential sight obstructions.

The determination of whether an object constitutes a ~~sight~~ visual obstruction should consider both the horizontal and vertical alignment of both intersecting roadways, as well as the height and position of the object. In making this determination, it should be assumed that ~~the~~ a driver's eye is 1.08 m above the roadway surface and that the object to be seen is 1.08 m above the surface of the intersecting road.

This object height is based on a vehicle height of 1.33 m, which represents the 15th percentile of vehicle heights in the current passenger car ~~population~~ fleet less an allowance of 250 mm. This allowance represents a near-maximum value for the portion of a passenger car height that needs to be visible for another driver to recognize it as the object. The use of an object height equal to the driver eye height makes intersection sight distances reciprocal (i.e., if one driver can see another vehicle, then the driver of that vehicle can also see the first vehicle).

Where the sight-distance value used in design is based on a single-unit or combination truck as the design vehicle, it is also appropriate to use the eye height of a truck driver in checking sight obstructions. The recommended value of a truck driver's eye height is 2.33 m above the roadway surface.

Section 9.9.2.2 – Departure Sight Triangle

- ~~This Section~~This section is **~~Not Applicable~~not applicable** and is **replaced** with the following *(Adopted from AASHTO's Green Book "A Policy on Geometric Design of Highways and Streets – 2018 7th Edition")*:

A second type of clear sight triangle provides sight distance sufficient for a stopped driver on a minor-road approach to depart from the intersection and enter or cross the major road. *Figure 9.9.2 of Chapter 9 (Applicable)* shows typical departure sight triangles to the left and to the right of the location of a stopped vehicle on the minor road.

Departure sight triangles should be provided in each quadrant of each intersection approach controlled by stop or yield signs. Departure sight triangles should also be provided for ~~some~~ signalized intersection approaches from which stopped vehicles may enter or cross a major road on which traffic is not required to stop *(see Case D – Intersection with Traffic Signal Control).* Distance a_2 in *Figure 9.9.2* is equal to distance a_1 plus the width of the lane(s) departing from the intersection on the major road to the right. Distance a_2 should also include the width of any median present on the major road, unless the median is wide enough to permit a vehicle to stop before entering or crossing the roadway beyond the median. The appropriate measurement of distances a_1 and a_2 for departure sight triangles depends on the placement of any marked stop line that may be present and may therefore vary with site-specific conditions.

The recommended dimensions of the clear sight triangle for desirable traffic operations where stopped vehicles enter or cross a major road are based on assumptions derived from field observations of driver gap-acceptance behavior. The provision of clear sight triangles ~~like~~such as those shown in *Figure 9.9.2* also allows ~~the~~ drivers of vehicles on the major road to see any vehicles stopped on the minor-road approach and to be prepared to slow or stop, if needed.

Section 9.9.2.3 – Intersection Control

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

  Case B – Intersections with Stop Control on the Minor Road
  While all vehicles must stop on the minor road at the stop-controlled intersection, approach sight triangles like those shown in *Figure 9.9.1 of Chapter 9* are desirable in the event a driver violates the stop sign. In this situation, a clear approach sight triangle may allow a driver on the major road to detect a vehicle on an intersecting approach, perceive if the approaching vehicle is complying with the stop condition, and take action to avoid a collision if necessary.

  The majority of stop sign violations are in the form of rolling stops, where the vehicle approaching the stop bar is slowing, but not stopping, and proceeds through the intersection. To account for this behaviour and to ensure adequate intervisibility at an intersection with stop control on the minor road, ~~the designer should provide~~ clear sight triangles should be provided based on the design speed on the major road and an assumed speed of 30 km/h on the minor road.

  The length of the legs on the approach sight triangle, shown as a1 and b in Figure 9.9.1 of Chapter 9, may be derived from Table 9.9.1 of Chapter 9, which shows the distance traveled by an approaching vehicle during perception-reaction and braking time as a function of the design speed of the roadway. For example, at an intersection with a design speed of 80 km/h for the major road and 30 km/h for the minor road with stop control, the approach sight triangle would have legs extending 75 m and 25 m along the major and minor roadways, respectively. Distance a2, which is defined in Section 9.9.2.1 of Chapter 9, can also be derived from Table 9.9.1 of Chapter 9 and adding the applicable lane and median widths. In the event the grade along the intersection approach exceeds 3%, the leg along that approach should be adjusted by multiplying the length derived from Table 9.9.1 of Chapter 9 by the appropriate adjustment factor from Table 9.9.2 of Chapter 9.

  Although desirable, approach sight triangles like those shown in Figure 9.9.1 of Chapter

9 may not be required at intersections with stop control, where the need to stop is determined by the traffic control devices. It is expected ~~the~~ that ~~designer will exercise~~ sound engineering judgment will be used when considering approach sight triangles for selected road facilities. Consideration should also be given to further expanding clear sight triangles at intersections with a history of collisions to provide better intervisibility.

Section 9.11 – Sight Distance at Bridge Structures

- In the third paragraph, Object Height should be **replaced** ~~to~~ with 1.08 m.

Section 9.12 – Widening Through Signalized Intersection

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

  If a lane is to be added before and after the intersection for enhancing traffic operation, the lane should be aligned, and there should ~~not~~ be ~~any~~ no lateral offset between the departing end and beginning of receiving lane of the added lane through the intersection.

Section 9.13.2 – Corner Radius Considerations and Design

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

  Where vehicles will make a right turn from the edge of one traveled way to the near edge of the receiving traveled way, the corner radii should be based on minimum turning path of the selected design vehicles. The sharpest turn that can be made by each design vehicle can be ~~find out~~determined with the help of data provided in *Chapter 2 – Design Controls, Classification and Consistency*. The maximum assumed speed of selected design vehicle may be equal to or less than 15 km/h when developing swept path and consequently offers some leeway in driver behavior for making right turn at the intersection. The turning path of the selected design vehicle should be checked against the proposed plan layout to verify that the turn can be accomplished. Turning templates or turning path software compatible with computer-aided design and drafting systems should be utilized to check turning radii of various vehicles for a specific design.

Design Vehicles

The physical dimensions and performance characteristics of various sizes of vehicles using the highway system ~~form positive~~serve as primary controls in geometric design. For this reason, it is necessary to evaluate all vehicle types, select general class groupings and develop representative sized vehicles within each class for use in design ~~use~~. ~~In the process~~When a design vehicle is established,~~ and~~ it is defined as a motor vehicle of selected dimension and operating characteristics and is a representative unit in its class or vehicle group. The selected design vehicle is used to establish geometric design controls for specific turning requirements for the purpose of accommodating vehicular movements of a designated type.

Selection of Design Vehicle

All intersections should be designed using the Medium Single-Unit (MSU) truck as design vehicle unless the area is part of a highway bus route or has the potential to be used as an inter-city bus route, then the Inter-City (I-BUS) bus should be used as a minimum for design purposes.

At intersections where traffic counts indicate~~reveal~~ that tractor-semitrailer traffic is predominant, a design vehicle for tractor-semitrailer combinations should be considered in design when the following applies:

- If the number of turning tractor-semitrailer combinations WB-15 type is equal to or exceeds 10 vehicles per hour (vph) in design hourly volume (dhv) and the turning traffic volume exceeds 100 vph in dhv, ~~as per~~based on traffic counts, then WB-15 vehicle should be used as a minimum for design.
- If the number of turning tractor-semitrailer combinations WB-17.5 type or larger exceeds 1 vph in dhv and the turning volume exceeds 100 vph in dhv, then the WB-17.5 design vehicle should be given consideration.
- If the number of turning tractor-semitrailer combinations WB-20.5 types exceeds 1 vph in dhv and the turning volume exceeds 100 vph in dhv, then the WB-20.5 design vehicle should be given consideration.

Intersections should be designed to accommodate tractor-semitrailer by providing the extra space demanded by such trucks negotiating turns. Operational and context

~~demands~~characteristics, e.g., feeder routes to and from freight terminals and industrial areas etc. should be given consideration. The choice of ~~the~~ design vehicle should be based on local traffic counts with consideration to potential future traffic growth, particularly if the highway is in an area where industrial or resource development is planned.

Design Vehicle's Turning Paths

The principal factors and dimensions of the selected design vehicle affecting the intersection design are:

- T~~t~~he minimum turning radius~~,~~
- T~~t~~he wheelbase~~,~~
- T~~t~~he path of the inner rear wheel~~,~~
- T~~t~~he front overhang~~,~~
- T~~t~~he operational speed of the turning vehicle~~, and~~
- ~~Tthe d~~Driver performance ~~or driving~~and operating characteristics

The geometric configuration of the intersection and the selected design vehicle size should satisfy the following conditions:

- The turning path of the vehicle's wheels stays within the paved area of the roadway~~, and~~
- T~~t~~he swept path of the vehicle's~~'~~ body avoids all other vehicles and fixed objects~~.~~

The turning path of each design vehicle is the minimum attainable at a selected speed and a minimum turning radius is slightly above the minimum performance capability of the vehicles in the design vehicle type e.g., turning radius 14 m; turning capability 13.5 m. The turning speed of the vehicle for the minimum radius is less than 15 km/h.

Low-Speed Off-tracking

When a large truck is driven at low speed with the left front wheel following a specified curve, called the turning radius, the rear wheels of the vehicle track inside those at the front and produce low-speed off-tracking. The ~~demand for~~ space required for ~~while~~ turning is based ~~up~~on the phenomenon of low-speed off-tracking.

High-Speed Off-tracking

When a vehicle makes a turn at high speed, the rear of the vehicle moves outward because of the lateral acceleration of the vehicle as it negotiates a horizontal curve at higher speeds. High speed off-tracking is a function not only of truck characteristics and roadway geometrics, but also of vehicle speed and the vehicle's~~'~~ suspension, tire and loading characteristics. For design purposes, the pavement widening provided on turns to compensate for low-speed off-tracking is considered adequate for high-speed off-tracking.

Widening of the Side Road at Intersections

When trucks are an important factor in a left-~~-~~turning movement to a side road, it is generally ~~usually becomes~~ necessary to widen the throat of the side road to accommodate wheels of the turning vehicle, thus avoiding tracking onto the shoulder, or interfering with a vehicle standing on the side road.

An area designed to represent an island is utilized in the throat to guide the vehicle and control the turning maneuver. The need for an island and its configuration is determined using ~~design vehicle~~ turning characteristics of the selected design vehicle and varies with:

- The type of vehicle~~,~~
- T~~t~~he width of highway cross-section~~, and~~
- T~~t~~he angle of intersection~~.~~

For illustrations see **Exhibit -9B** and **Exhibit -9C**.

Exhibit -9B

~~WIDENING OF SIDE ROAD AT T-INTERSECTIONS (TURNING 90 DEGREES)~~Widening of Side Road at T-Intersections (Turning 90 Degrees)

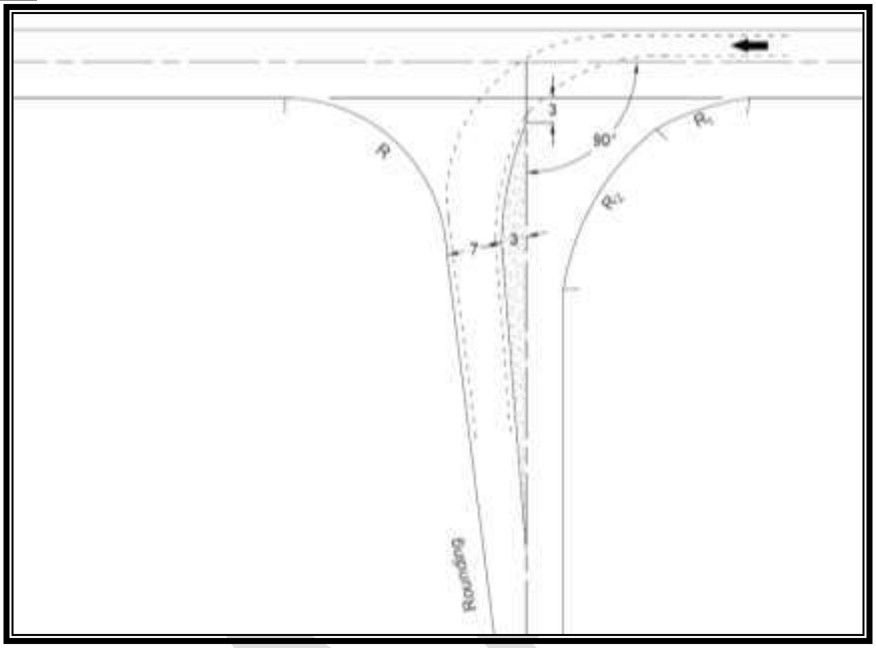
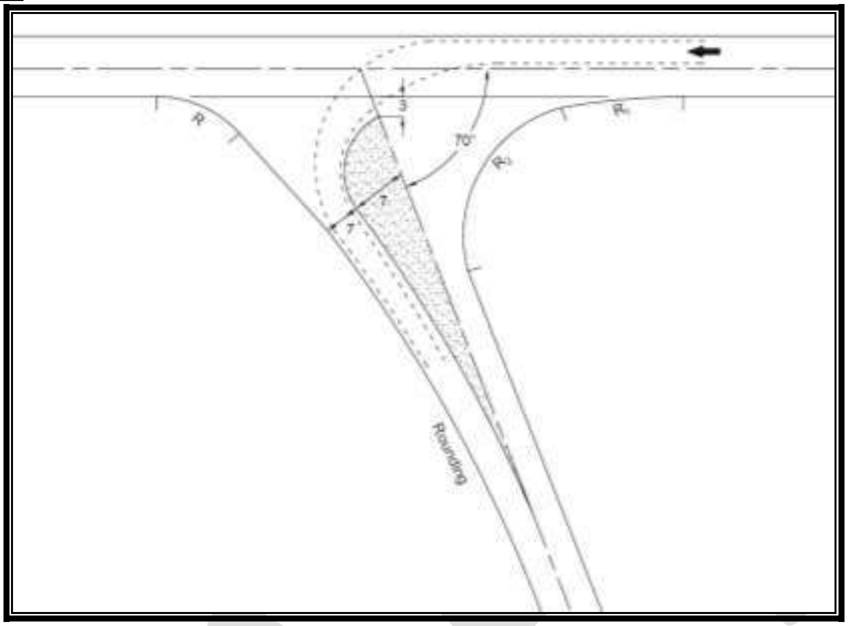


Exhibit -9C

~~WIDENING OF SIDE ROAD AT T-INTERSECTIONS (TURNING 110 DEGREES)~~Widening of Side Road at T-Intersections (Turning 110 Degrees)

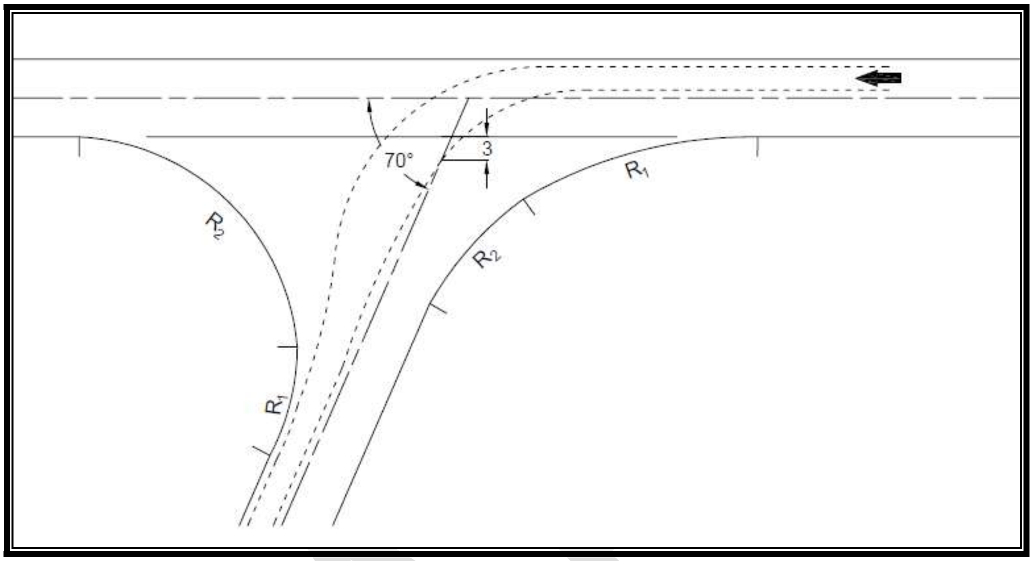


An intersection design having an adverse turning angle as shown in **Exhibit -9C** is not a desirable standard but acceptable. However, it can be improved by realignment of the side road to form approximately or close to a 90° intersection angle with the main highway.

Where the turning angle is less than 90° and favourable to the turning maneuver, and where trucks turning left from the highway do not encroach on the shoulder, it is not necessary to widen the side road cross-section as the pavement widening is provided by the edge of pavement design, consisting of two-centre compound curves for right-turn movements of commercial vehicles. See **Exhibit -9D**.

Exhibit -9D

~~WIDENING OF SIDE ROAD AT T-INTERSECTIONS (TURNING 70 DEGREES)~~Widening of Side Road at T-Intersections (Turning 70 Degrees)



In the case of a cross intersection where widening the side road is necessary, the approach lanes for the advancing traffic are adjusted to ~~line up~~align with the continuation of these lanes on the opposite side of the intersection. This provides a smooth alignment for the side road traffic flow. See **Exhibit -9E**.

Special Design Considerations: Farm Vehicles and Long Combination Vehicles

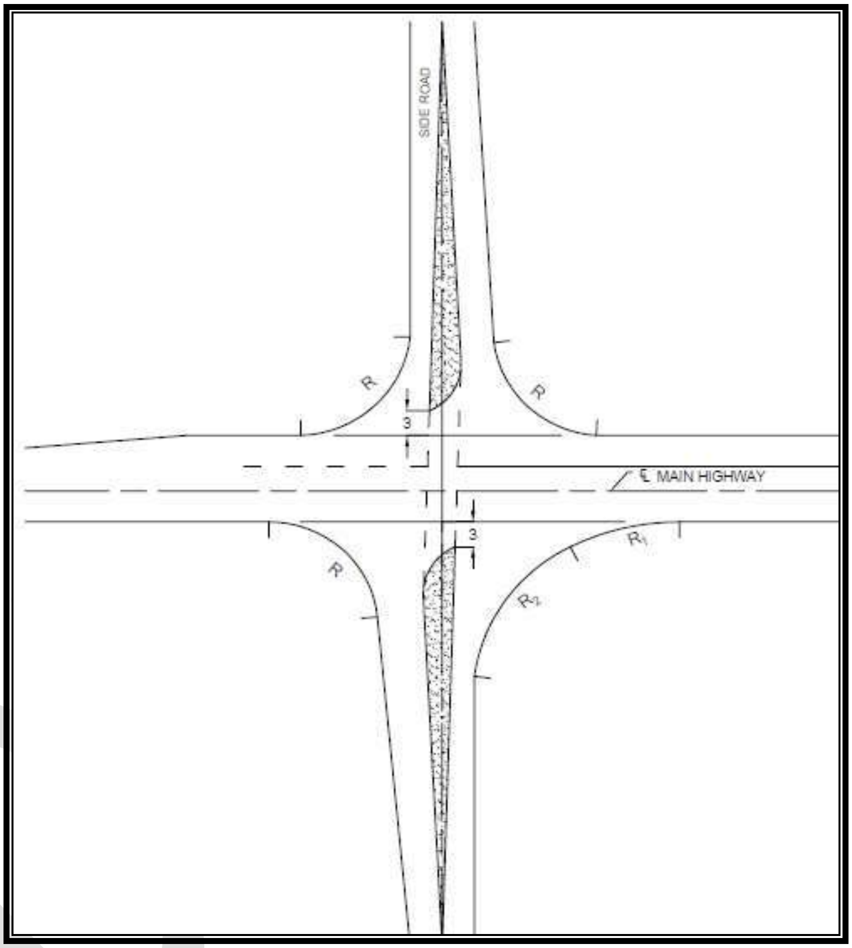
In ~~highly mechanized~~ agricultural areas where ~~the~~ heavy and large ~~size~~ equipment is often moved along the highway system, at grade intersections should be designed to accommodate ~~the~~ turning maneuvers for such vehicles. As a general rule, the dimensions, which include axle spacing, front and rear overhang and width of the equipment, are obtained and the pavement width requirements determined. The computerized method is recommended to simulate the turning path of other than standard design vehicles and ascertain space and layout requirements. When farm vehicles are under consideration~~s~~, it is recommended to ~~involve~~ consult the Ontario Federation of Agriculture (OFA) for ~~selection~~ dimensions and operating characteristics of farm vehicles specific to the area~~/equipment~~.

When an intersection is located on a designated highway route for long combination vehicles (LCV) or ~~potentially~~ the highway will potentially be a designated route in future for LCVs, the intersection should be designed to accommodate LCVs. For further guidance contact ~~Design Standards & Specification~~Highway Design Office or refer to

"LCV – Best Practices Guide". ~~developed by Design Standards & Specification Office.~~

Exhibit 9-E

~~WIDENING OF SIDE ROAD AT CROSS INTERSECTIONS~~Widening of Side Road at Cross Intersections



Section 9.13.2.2 – Circular Curve

- ~~This Section~~This section ~~is Applicable~~is **applicable** including **Exhibit -9F**:

Exhibit 9-F

~~MINIMUM CIRCULAR CURVES AT SIMPLE OPEN THROAT INTERSECTIONS~~

~~FOR URBAN OR RURAL AREAS~~Minimum Circular Curves at Simple Open Throat Intersections for Urban or Rural Areas

	CIRCULAR CURVES FOR DESIGN VEHICLES * SU: STOP CONDITION R = 15 YIELD CONDITION R = 18 B-12: STOP CONDITION R = 18 YIELD CONDITION R = 20								
	R = 15 m			R = 18 m			R = 20 m		
Δ°	T	E	L	T	E	L	T	E	L
70	10.50	3.31	18.33	12.60	3.97	21.99	14.00	4.42	24.43
75	11.51	3.91	19.63	13.81	4.69	23.56	15.35	5.21	26.18
80	12.59	4.58	20.94	15.10	5.50	25.13	16.78	6.11	27.93
85	13.74	5.35	22.25	16.49	6.41	26.70	18.33	7.13	29.67
90	15.00	6.21	23.56	18.00	7.46	28.27	20.00	8.28	31.42
95	16.37	7.20	24.87	19.64	8.64	29.85	21.83	9.60	33.16
100	17.88	8.34	26.18	21.45	10.00	31.42	23.84	11.11	34.91
105	19.55	9.64	27.49	23.46	11.57	32.99	26.06	12.85	36.65
110	21.42	11.15	28.80	25.71	13.38	34.56	28.56	14.87	38.40

Notes

*Edge of pavement design for P-design vehicle: R = 10 m – urban areas
R = 15 m – rural areas

For minor-local roads the radius (R) may be reduced to 5 m in urban areas and 10 m in rural areas.

Section 9.13.2.3 – Two-Centred Compound Circular Curve

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

Two-centred compound circular curves are~~is~~ useful ~~to~~ for facilitating~~e~~ ~~the~~ right-turning

~~manoeuvre of~~ tractor-semitrailer combinations. Minimum curve combinations ~~have been selected~~are provided for ~~the~~ WB-15 and WB-17.5 design vehicles, see **Exhibit -9G**. This exhibit provides radius~~ii~~ combinations (R_2 & R_1) for angles of turn between 70° and 110° at 5° intervals.

For intersection angles lying between those shown in the **Exhibit -9G** and for intersections on curves alignment use the **Exhibit -9G** and recalculate the appropriate curve data or by graphical means obtain best fitting combination of radii close to the standard.

The lengths of the tangents of the compound circular curve (a & b) can be calculated by using the formula:

$$T_1 = R_1 \tan \Delta_1/2 \text{ and } T_2 = R_2 \tan \Delta_2/2$$

The length of curve (L_1 and L_2) can be calculated by using the formula:

$$L_1 = \pi R_1 \Delta_1/180° \text{ and } L_1 = \pi R_1 \Delta_2/180°$$

The two-centred compound curve is the preferred design for all types of large trucks and fits the minimum path of the design semi-trailer combination adequately.

When pedestrians are a consideration at a signalized wide-open throat intersection the “walk” and clearance times may be affected, hence providing adequate service and protection for pedestrians may be required.

Exhibit -9G

~~MINIMUM TWO-CENTRED COMPOUND CIRCULAR CURVES AT SIMPLE OPEN THROAT INTERSECTIONS FOR URBAN AND RURAL AREAS~~Minimum Two-Centered Compound Circular Curves at Simple Open Throat Intersections for Urban and Rural Areas

STOP CONDITION			YIELD CONDITION		
WB-15 DESIGN VEHICLE					
Δ°	**R_2**	**R_1**	**Δ°**	**R_2**	**R_1**
70-74	18	80	70-73	21	130
75-84	17	80	74-79	20	130
85-91	16	80	80-89	19	130
92-99	15	80	90-101	18	130
100-110	14	90	102-109	17	140
			110	16	150
WB-17.5 DESIGN VEHICLE					
Δ°	**R_2**	**R_1**	**Δ°**	**R_2**	**R_1**
70-71	22	110	70-71	24	130

72-74	21	110	72-76	23	130
75-77	21	110	77-85	22	130
78-83	19	110	86-94	21	130
84-90	18	110	95-96	20	130
91-94	17	110	97-105	19	140
95-99	16	110			
100-110	15	120	106-110	18	140

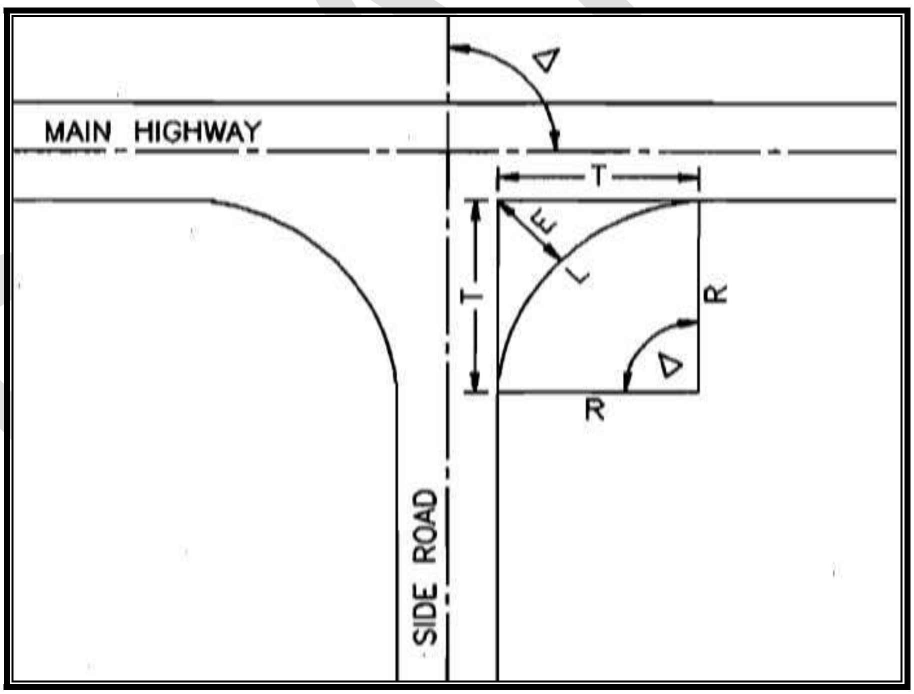
Note: Below the dark thick line channelization may be required

Figure 9.13.4 – Edge of Pavement Design – Circular Curve

- This Figure is ~~**Not Applicable**~~**not applicable** and **replaced** with **Exhibit -9H.**

Exhibit -9H

~~EDGE OF PAVEMENT DESIGN FOR PASSENGER CAR, SINGLE-UNIT TRUCK, AND BUS~~Edge of Pavement Design for Passenger Car, Single-Unit Truck, and Bus



Section 9.14.3 – Design Elements for Right-Turn Tapers Without Auxiliary Lanes

- ~~This Section~~This section ~~is Applicable~~is **applicable except** the last sentence and is **replaced** with "tapers are justified only~~ design justifiedy~~ for a maximum design speed of 70 km/h. For speeds greater than 70 km/h,~~ the~~ deceleration of turning vehicles will start on the through lane. Where the turning vehicles significantly impede the through traffic flow, a taper plus parallel lane should be considered~~ation should be given to the design technique of taper plus parallel lane~~."

Table 9.14.1 – Right-Turn Tapers Without Auxiliary Lanes

- This Table is ~~**Not Applicable**~~**not applicable** and is **replaced** with **Exhibit -9I**.

Exhibit -9I

~~**RIGHT-TURN TAPERS WITHOUT AUXILIARY LANES**~~**Right-Turn Tapers Without Auxiliary Lanes**

Design Speed (km/h)	Taper Length (m)	Horizontal Curve*
50	50	500
60	60	750
70	70	1000

Note:
* Flat radii as indicated can be used rather than tangent alignment for right-turn tapers.

Section 9.14.4 – Design Elements for Right-Turn Tapers with Auxiliary Lanes

- ~~This Section~~This section ~~is Applicable~~is **applicable** including the following **additional guidance**:
  - When the volume of right--turning vehicles is such that it creates a hazard and reduces capacity at an intersection, a deceleration lane in the form ~~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 should be considered.

- The width of the parallel lane (w) may be 0.25 m less than the width of the adjacent through lane, but should not be less than 3.25 m.
- Similar to the right-turn taper design, a 30 m recovery taper with a 1.5 m offset should be applied beyond the intersection when using the taper and parallel lane design on two-lane highways. It is not required on a four-lane highway, at 'T' intersections or where a left-turn lane has been provided.
- Equation 9.14.1 is only applicable for determining right-turn storage length.
- For left-turn storage length at unsignalized intersections, refer to **Appendix 9A**.
- For left-turn storage length at signalized intersections, refer to the latest edition of *Traffic Signal and Timing Policy # 2010-02* issued by Traffic ~~Policy~~ Office.

Table 9.14.2 – Right-Turn Taper with Parallel Deceleration Lane Design

- This Table is **~~Not Applicable~~not applicable** and is **replaced** with **Exhibit -9J**.

Exhibit -9J

~~RIGHT-TURN TAPER WITH PARALLEL DECELERATION LANE LENGTHS*~~Right-Turn Taper With Parallel Deceleration Lane Lengths*

Highway Design Speed (km/h)	Length of Taper (m)	Length of Parallel Lane (m)	Total Length of Deceleration Lane (m)
50	40	20	60
60	50	30	80
70	60	45	105
80	70	60	130
90	75	70	145
100	80	85	165
110	85	100	185
120	90	110	200

Note:

*: Flat Grade 2% or Less

Table 9.14.3 – Grade Factors for Deceleration Length

- This Table is ~~**Not Applicable**~~**not applicable** and is **replaced** with **Exhibit -9K**.

Exhibit -9K

~~**GRADE FACTORS FOR DECELETARION LENGTH**~~**Grade Factors for Deceleration Length**

ALL DESIGN SPEEDS km/h	DOWN GRADE %	GRADE FACTOR > 1	UP GRADE %	GRADE FACTOR ≤ 1
	8 – 7	1.5	2 – 3	1.0
	7 – 6	1.4	3 – 4	0.9
	6 – 5	1.4	4 – 5	0.9
	5 – 4	1.3	5 – 6	0.8
	4 – 3	1.2	6 – 7	0.8
	3 – 2	1.1	7 – 8	0.7

Section 9.15.2 – Smart Channels

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

Angle of Intersection with Cross Street

The alignment of a channelized right-turn lane and the angle between the channelized right-turn roadway and the cross street has ~~great~~ a significant effect on safety and capacity. This can be set up ~~in~~ two different ~~angles~~ways:

- Wide entry angle to the left~~, and~~
- Narrow entry angle to the left

Both types of design are illustrated in **Exhibit -9L**. Traditionally ~~and typically,~~ channelized right-turns have been designed with wide entry angle to the left. The wide entry angle design has an island that is typically shaped like an equilateral triangle. This type of design is appropriate for use in channelized right-turn lanes with either yield control or no-control for vehicles at the entry to the cross street where higher turning speeds are appropriate and active transportation (pedestrians and bicyclists) use is limited. ~~While t~~The narrow entry angle to the left is a newer design technique and is typically shaped like an isosceles triangle. This design can be used with stop sign control or traffic signal control for vehicles at the entry to the cross street. Yield control can also be used with this design where the angle of entry and sight distance along the cross street are appropriate. This design encourages lower turning speeds and improves driver~~'s~~s' views of pedestrians waiting to cross.

Exhibit -9L

~~CHANNELIZED RIGHT-TURN DESIGN~~Channelized Right-Turn Design

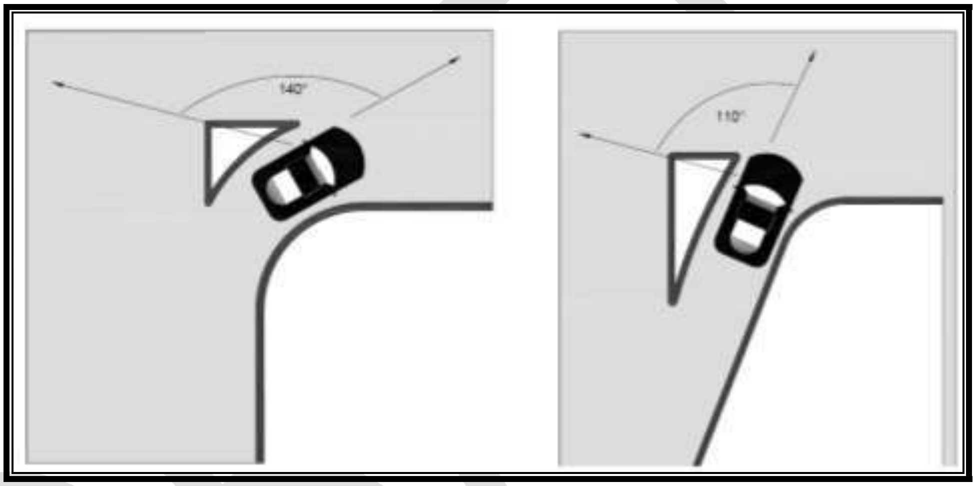
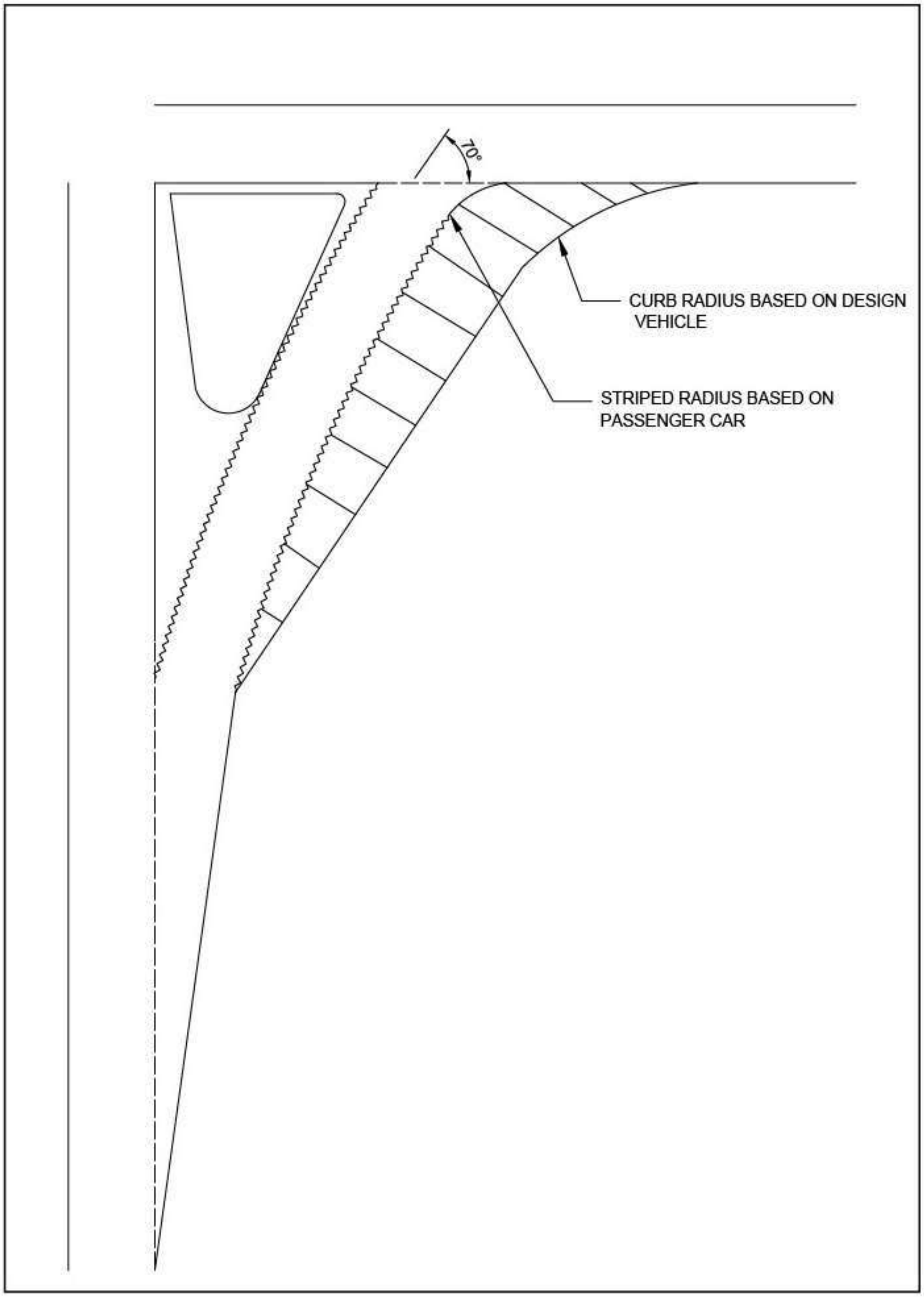


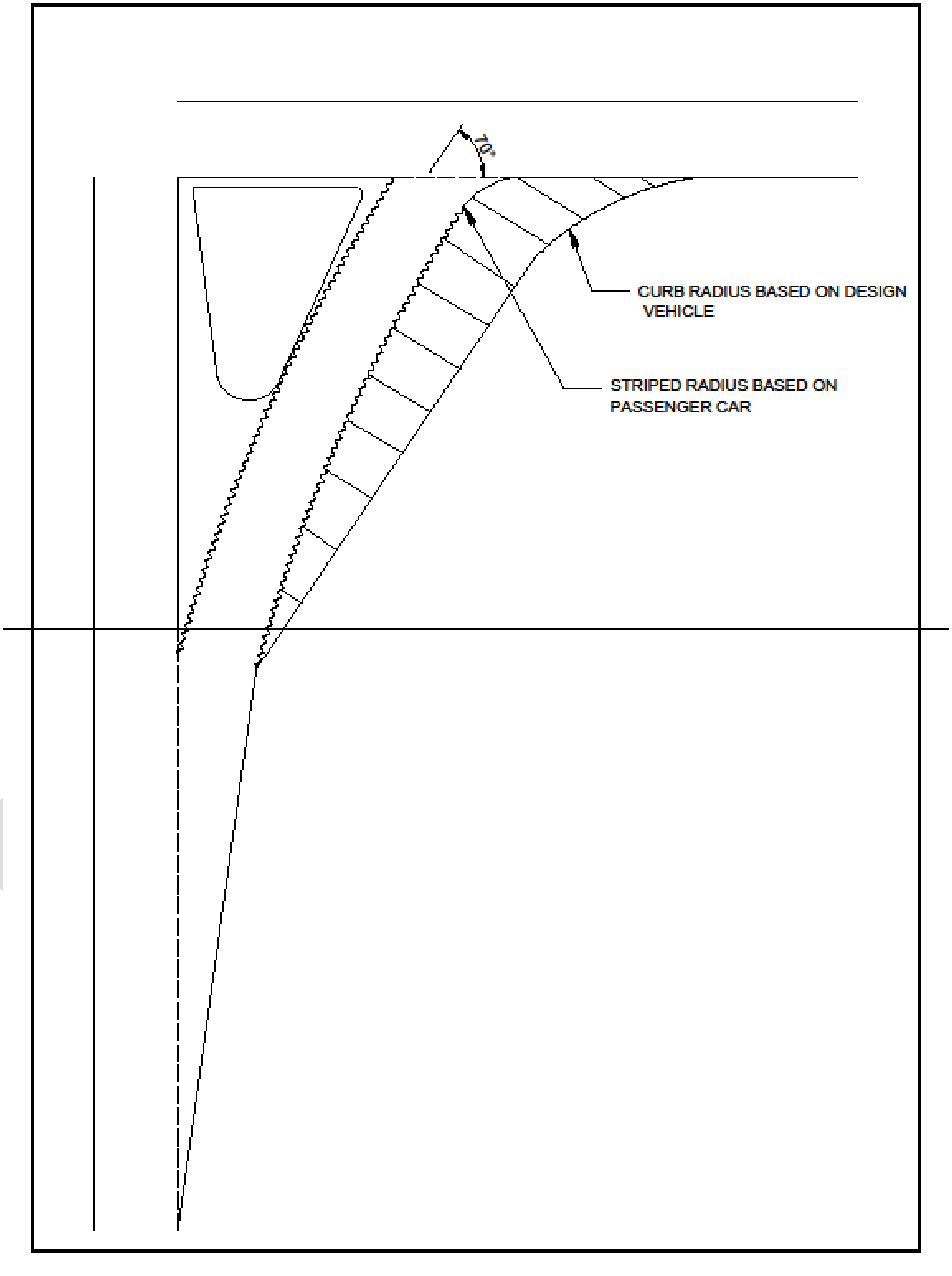
Figure 9.15.1 – Right-Turn Channelization, "Smart Channel" Example Configuration

- This Figure ~~is Applicable~~is **applicable** including the **Exhibit -9M and Exhibit -9N**.

Exhibit -9M

~~RIGHT-TURN CHANNELIZATION "SMART CHANNEL" DIRECT TAPERS DESIGN~~Right-Turn Channelization "Smart Channel" Direct Tapers Design


70°
CURB RADIUS BASED ON DESIGN VEHICLE
STRIPED RADIUS BASED ON PASSENGER CAR


70°
CURB RADIUS BASED ON DESIGN VEHICLE
STRIPED RADIUS BASED ON PASSENGER CAR

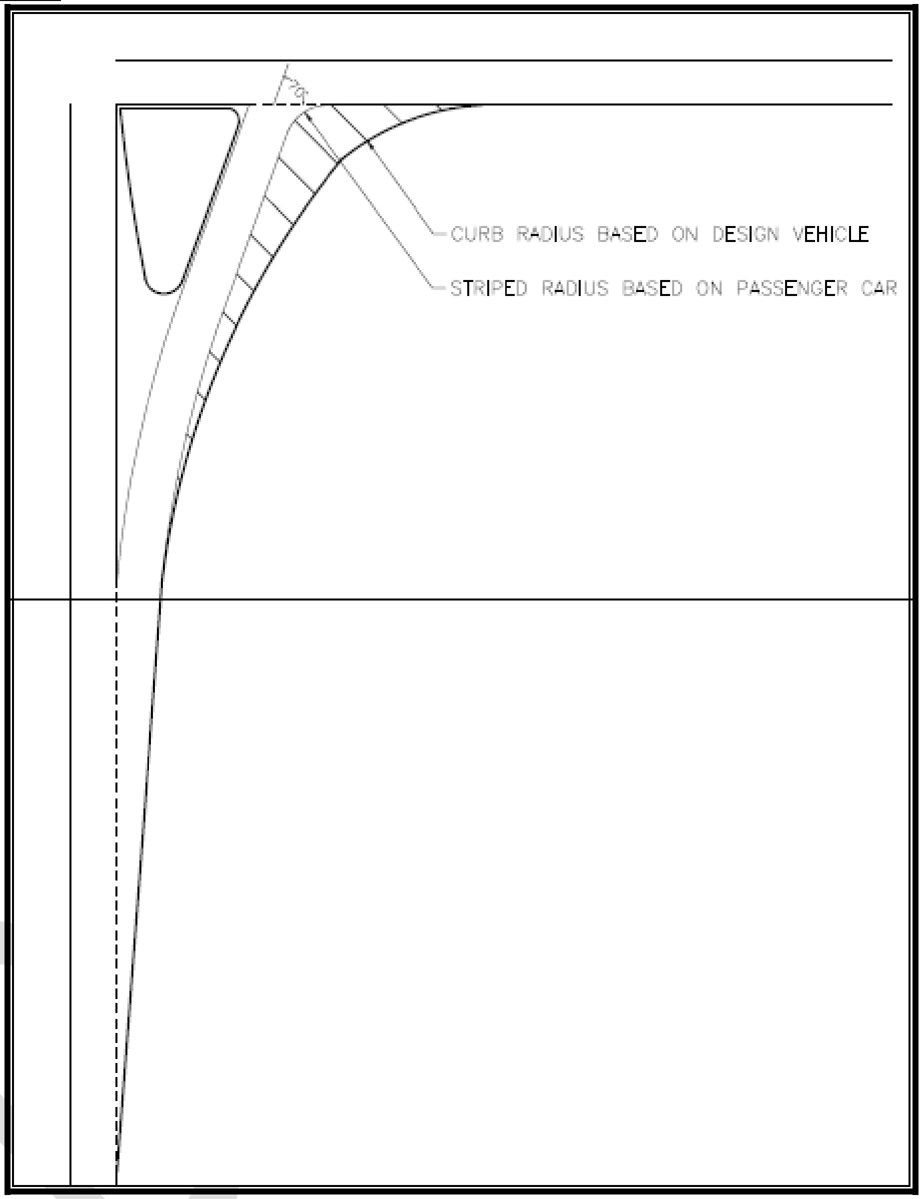
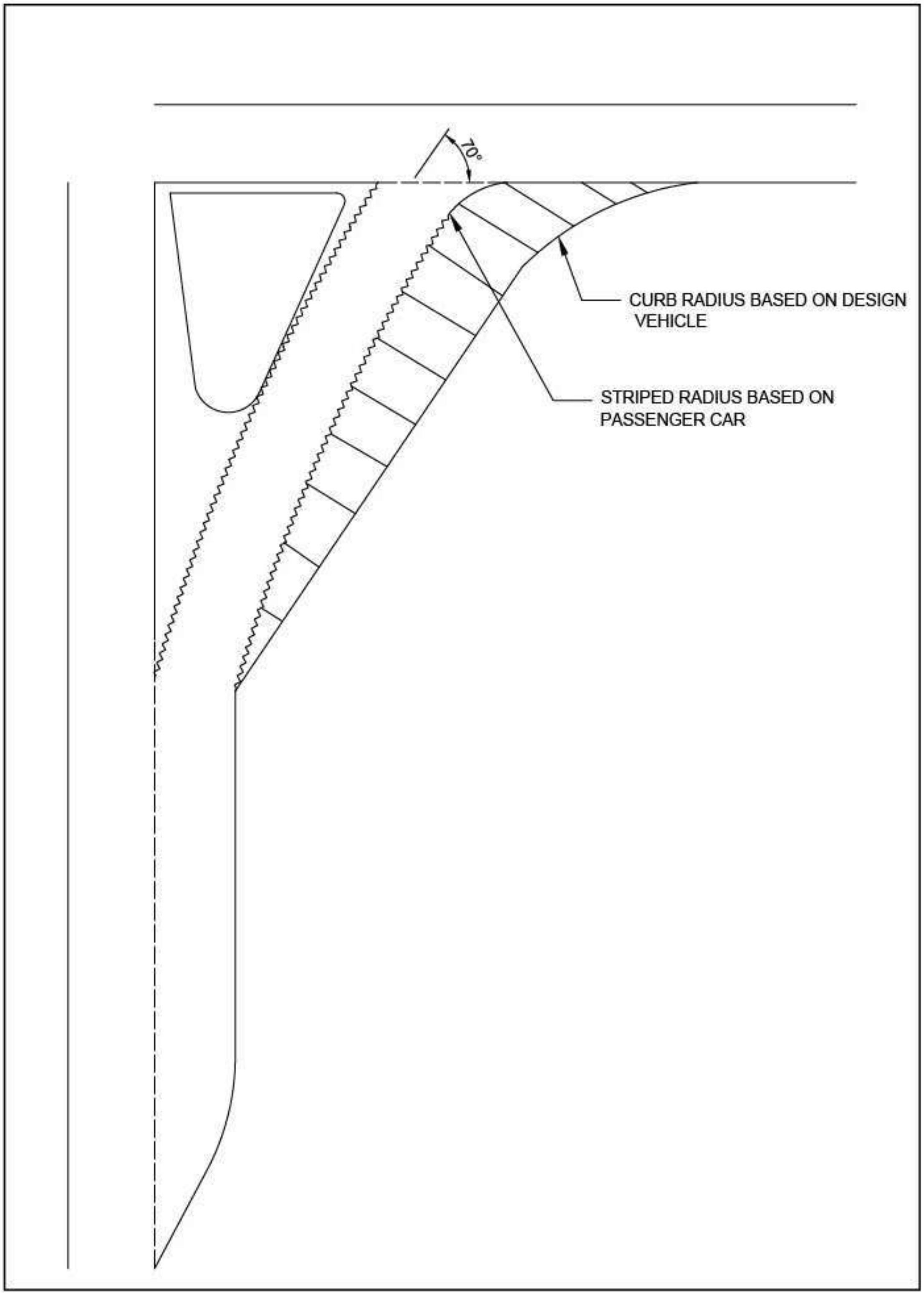
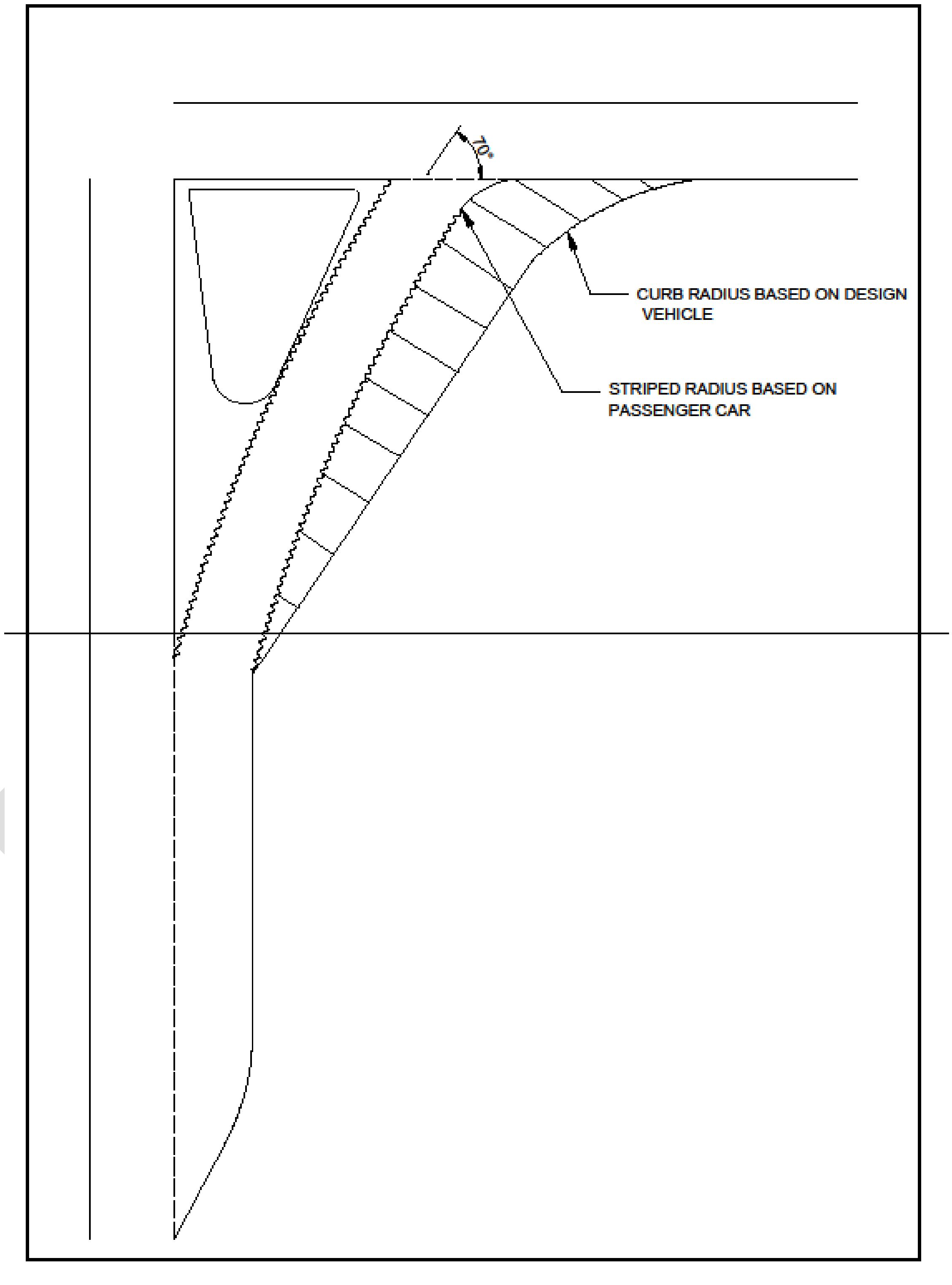
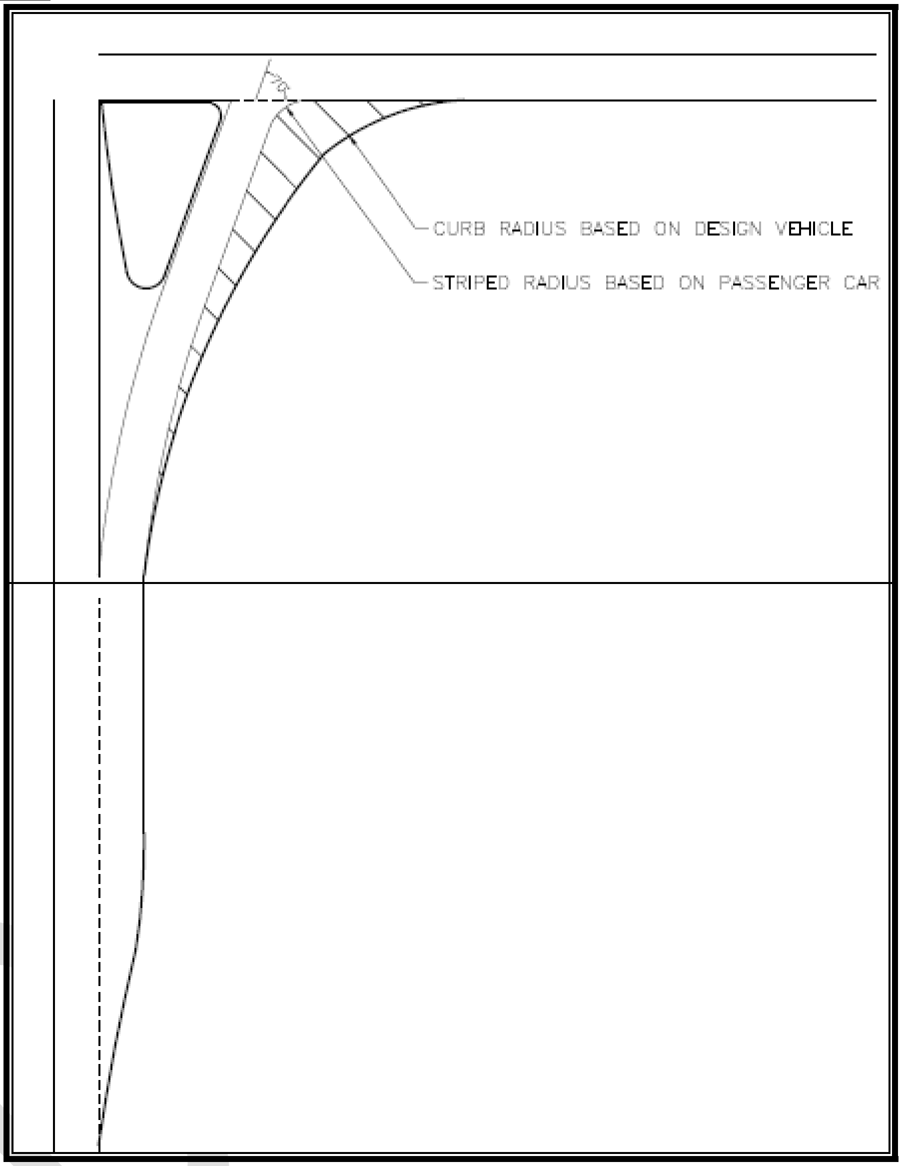

CURB RADIUS BASED ON DESIGN VEHICLE
STRIPED RADIUS BASED ON PASSENGER CAR

Exhibit -9N

~~RIGHT-TURN CHANNELIZATION "SMART CHANNEL" TAPERS AND PARALLEL DESIGN~~Right-Turn Channelization "Smart Channel" Tapers and Parallel Design


70°
CURB RADIUS BASED ON DESIGN VEHICLE
STRIPED RADIUS BASED ON PASSENGER CAR


70°
CURB RADIUS BASED ON DESIGN VEHICLE
STRIPED RADIUS BASED ON PASSENGER CAR



Section 9.15.9.1 – Overview

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

All raised medians and permanent channelization islands are to be bounded by curb and gutter.

Section 9.15.9.7 – Divisional

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

  At signalized intersections having cross-sections of five lanes or more, including left-turn lanes, divisional islands shall be used. Opposing approaches should ~~carefully~~ be designed for geometric continuity by providing the same cross section on both sides of the intersection.

  Divisional islands may be considered at signalized intersections with four lane cross-sections depending on the signalization requirements.

  Divisional islands should not be used at signalized intersections where the geometrics will result in only a single lane between the divisional island and the edge of the road or another island. If such a case arises because the islands are required for locating signal poles due to left--turn phasing requirements, consideration should be given to adding an auxiliary lane through the intersection.

  Opposing divisional islands are designed at 'T'-intersections where the left-turn lane is to be provided in one direction only from the major road or at 'Cross' intersections where ~~the~~ left-turns ~~is~~ are prohibited in one direction by traffic regulations (one-way traffic). ~~t~~This layout provides for a permissive or an advanced green left-turn operation. This is illustrated in *Figure 9.15.5: Opposing Divisional Island – Chapter 9 of TAC GDG.*

  The offset divisional island design is used where left-turn lanes are required at 'Cross' intersections. The islands are offset by 0.5 m from the centre line. This is illustrated in *Figure 9.15.6: Offset Divisional Islands – Chapter 9 of TAC GDG.* The offset divisional islands often are introduced at 'T'-intersections having five lanes or more where future conversion to a 'Cross' intersection is expected, or, to facilitate a fully protected left-turn phasing traffic operation. Proper evaluation of the anticipated type of traffic operation should be carried out for both present and future traffic demands.

  The location or set back of the raised islands from the centre of the intersection is determined ~~by applying appropriate design vehicle~~based on turning maneuvers of the selected design vehicle. For 90° or near 90° intersections ~~the~~ a distance of 15 m accommodates the WB-15 design vehicle turns. However, it is necessary to check the local traffic composition and future conditions for the suitable design vehicle application. ~~The location of the p~~Pedestrian crosswalk markings should be applied ~~as indicated in~~according to the Ontario Traffic Manual~~s~~ and raised islands should not extend into crosswalks~~the pedestrian area~~.

Raised c~~C~~urb islands are sometimes difficult to perceive at night and may become ~~road~~ hazards. This~~ condition~~ can be ~~alleviated~~mitigated by providing partial illumination at the intersection~~ with partial illumination~~.

Barrier curb at signalized intersections should be used according to the policy ~~provided~~ in the ministry's *Roadside Design Manual, Section 2.3.9*.

Section 9.15.9.10 – Minimum Size

- ~~This Section~~This section ~~is Applicable~~is **applicable** ~~except~~except for the second paragraph. The second paragraph is **replaced** with the following:

  ~~The ~~D~~d~~ivisional islands ~~are ~~should be a minimum of 2 m wide, including curb and gutter, and are ~~usually ~~typically 30 m long (15 m minimum). ~~The ~~Divisional islands, when used in conjunction with a 3 m wide left-turn storage lane from each direction, are offset, providing an overall minimum pavement width of 5 m between opposing through lanes.

Section 9.15.9.12 – Bikeway Facilities at Channelized Turn Lanes
Figure 9.15.9 – Bike Lane at Right-~~-~~Turn Channel

- ~~This Section~~This section and Figure are **~~Not Applicable~~not applicable**. Refer to ministry's *Bikeway Design Manual – March 2014.*

Table 9.16.1 – Design Width for Turning Roadways at Intersections

- This Table is **~~Not Applicable~~not applicable** and is **replaced** with **Exhibit ~~-~~9O**.

Section 9.16.3 – Turning Roadway Widths

- ~~This Section~~This section ~~is Applicable~~is **applicable** including the following **additional**

guidance:

Width of Pavement for Ramp Design

The pavement width required on a separate right-~~-~~turn lane to accommodate the off-tracking of the wheels of the selected~~a~~ design vehicle increases as the radius decreases, **Exhibit -9O** provides the required width for three different scenarios. Turning template software ~~through computer~~ should be used to ~~see if widening is required~~determine widening requirements. Pavement widening when required, is applied to the circular curve of the ramp. The minimum pavement width to be used is 4.75 m~~ except under special circumstances~~.

On separate turn lanes with spirals, where extra width is required, the pavement width should be 4.75 m at the beginning of the first spiral and increased throughout the length of the spiral to reach its design width at the beginning of the circular curve. T~~t~~he design width is ~~held~~ maintained throughout the curve, then diminishes to 4.75 m throughout the second spiral, refer to *Figure 9.16.1: Turning Roadway with Spirals* of *Chapter 9.*

Exhibit -9O

~~DESIGN WIDTHS FOR TURNING ROADWAYS AT INTERSECTIONS~~Design Widths for Turning Roadways at Intersections

Radius on Inner Edge of Pavement R (m)	**PAVEMENT WIDTH IN METRES FOR:**								
	CASE I 1 lane – 1 way operation – no provision for passing a stalled vehicle			**CASE II** 1 lane – 1 way operation – with provision for passing a stalled vehicle			**CASE III** 2 lane operation - either one way or two way		
	Design Traffic Conditions								
	A	**B**	**C***	**A**	**B**	**C**	**A**	**B**	**C**
15	5.50	5.50	7.00	7.00	7.75	9.00	9.50	10.75	13.00
20	5.50	5.50	7.00	7.00	7.75	8.75	9.50	10.75	13.00
25	4.75	5.00	5.75	6.50	7.00	8.25	8.75	10.00	11.50
30	4.50	4.75	5.50	6.00	6.75	7.75	8.50	9.50	10.75
40	4.25	4.75	5.25	6.00	6.75	7.50	8.50	9.25	10.50
45	4.25	4.75	5.00	6.00	6.50	7.25	8.50	9.00	10.25
50	4.25	4.75	5.00	6.00	6.50	7.25	8.25	9.00	10.00
60	4.00	4.75	4.75	5.75	6.50	7.00	8.25	8.75	9.50
80	4.00	4.75	4.75	5.75	6.25	7.00	8.25	8.75	9.25
100	4.00	4.50	4.75	5.50	6.25	6.75	8.00	8.50	9.00
125	4.00	4.50	4.75	5.50	6.00	6.75	8.00	8.50	8.75
150	3.75	4.50	4.50	5.50	6.00	6.75	8.00	8.25	8.75
TANGENT	3.75	4.50	4.50	5.50	5.75	6.50	7.75	7.75	8.25
Semi-mountable and Mountable Curbs	none			none			none		
Barrier Curbs; One Side Two Sides	add 0.25 m add 0.50 m			none add 0.25 m			add 0.25 m add 0.50 m		
Stabilized Shoulder; One or both sides	none			deduct shoulder width; minimum pavement width as under CASE I			deduct 0.50 m where shoulder is 1 m or wider		

Note: Mountable curbs with aprons may be provided where constraints prevent the provision of standard design widths of turning roadways for ~~given~~the selected design vehicles

Design Traffic Condition A – Predominantly P vehicles, but some considerations for SU trucks.
Design Traffic Condition B – Sufficient SU vehicles to govern design, but some condition for semitrailer.

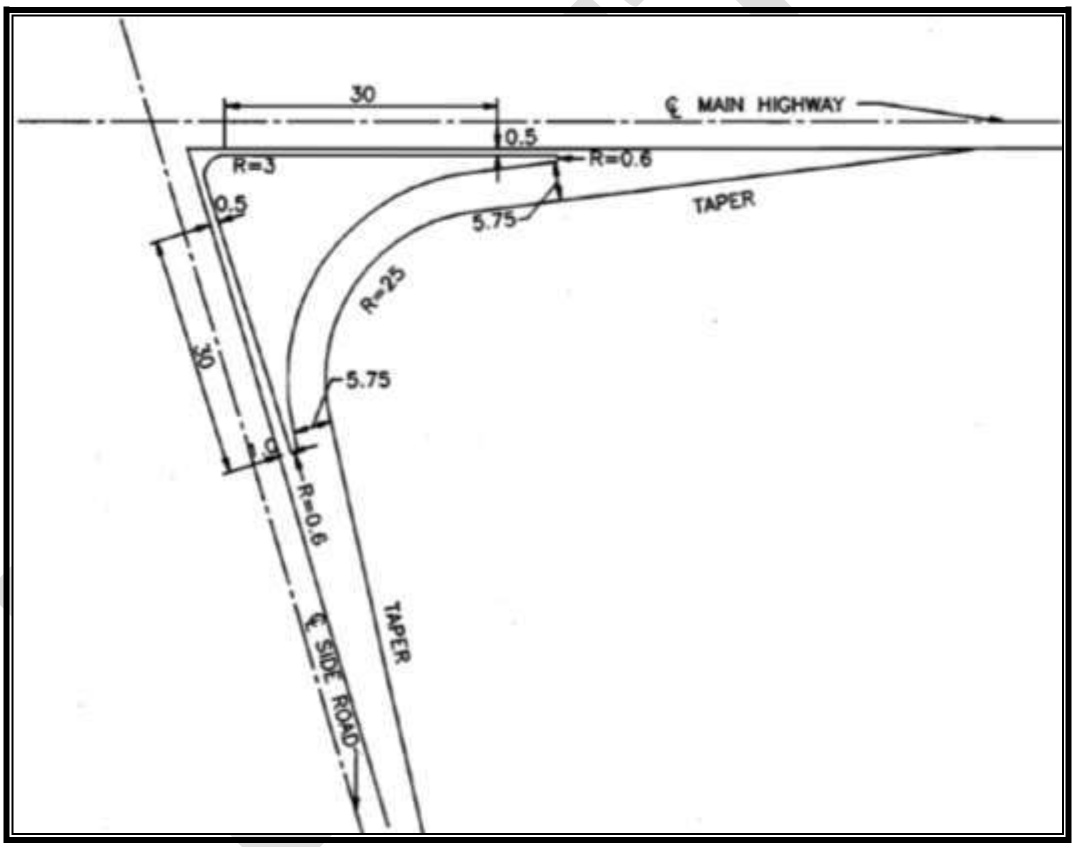
Design Traffic Condition C – Sufficient semitrailer, and semitrailer/trailer combinations WB-15 or WB-17.5

* CASE I, Design Traffic Condition is mostly applied to ministry designs.

Where no spirals are used, the required extra pavement width is applied uniformly throughout the circular curve which is illustrated in **Exhibit ~~-~~9P**.

Exhibit -9P

~~RAMP DESIGNWITHOUT SPIRALS (SIDE ROAD TO MAIN HIGHWAY)~~Ramp Design Without Spirals (Side Road to Main Highway)



Section 9.16.6 – Method of Lane Drop for Dual Lane Right-Turning Roadway

- Second paragraph of this ~~Section~~ section is **~~Not Applicable~~not applicable**.

Figure 9.16.3 – Lane Drop, Dual Lane Right~~-~~-Turning Roadway

- Illustration (a) – [tapered design (suitable for high-speed turning roadway with good sight distance)] of this Figure is ~~**Not Applicable**~~**not applicable**.

Section 9.17.2.1 – Volume Warrants

- ~~This Section~~This section ~~is Applicable~~is **applicable**. More details are provided in **Appendix 9A**.

Section 9.17.2.2 – Safety Warrants

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

  The warrant graphs provided in Appendix 9A, based on vehicles operating at the design speed indicated, show the conditions when left-~~-~~turn storage lanes should be added or where traffic signals are to be considered.

  Exhibit -9Q illustrates the upstream functional area of an intersection in relation to the components of deceleration lane length, which consists of the perception-reaction distance, the lane-~~-~~change~~s~~ and deceleration distance, and the storage length.

  It may not be practical to provide the full recommended length of ~~the~~ turn lane for deceleration due to constraints such as restricted right-of-way, distance available between adjacent intersections and storage needs. However, research has demonstrated that providing a left~~-~~ and right-turn lane on any intersection approach ~~has~~ provides ~~a~~ substantial ~~crash~~ collision reduction benefits[1]. Therefore, turn lanes should be installed where warranted, even where the distances of **Exhibit -9R** cannot be achieved.

Figure 9.17.1 – Left-Turn Lane, Pictorial Description of Terms

- This Figure is ~~**Not Applicable**~~**not applicable** and is **replaced** with **Exhibit -9Q.**

Section 9.17.3 – Approach and Departure Tapers

- ~~This Section~~This section ~~is Applicable~~is **applicable** including the following **additional**

guidance:

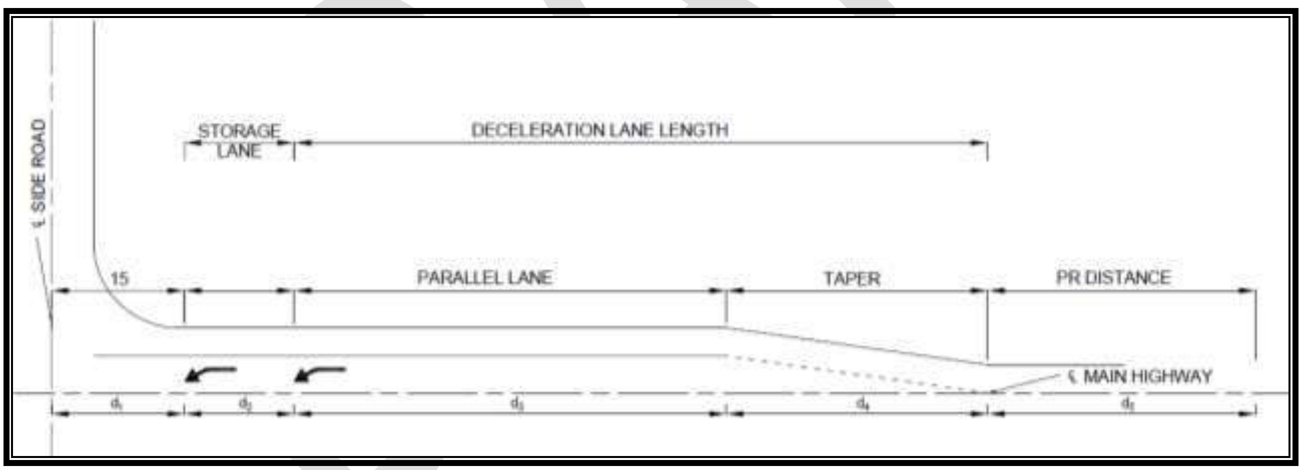
Taper Length

Long tapers approximate the path drivers follow when entering an auxiliary lane from a high-speed through lane. However, with exceptionally long tapers some through drivers may tend to drift into the deceleration lane especially when the taper is on a horizontal curve. In addition, long tapers may constrain the lateral movement of a driver desiring to enter the auxiliary lanes.

The width of left-~~-~~turn lanes should be one increment (0.25 m) less than the through lane with a minimum of 3.25 m and separated from through lanes by a solid painted line and indicated by painted arrow according to ~~the~~ *OTM Book 11 – Pavement, Hazard and Delineation Markings.*

Exhibit 9-Q

~~LEFT-TURN LANE, COMPONENETS OF DECELERATION LANE LENGTH~~Left-Turn Lane, Components of Deceleration Lane Length



Notes:

- d_1 = 15 m is the assumed distance from minor roadway centerlines to auxiliary lane.
- d_2 = storage length for stopped vehicles waiting to turn.
- d_3 = distance travelled during deceleration after lane change
- d_4 = distance travelled while decelerating and changing lanes from through-lane into turn-lane.
- d_5 = percetion and reaction distance travelled while driver recognizes upcoming turn lane and prepares for the left maneuver.

For grades greater than 2%, the length of deceleration lane should be corrected according to the factors shown in **Exhibit -9K**. The corrected deceleration length is calculated by multiplying the deceleration length (**Exhibit- 9R**) with correction factor (**Exhibit 9-K**). One-third (1/3) of the extra length may be added ~~in~~ to the parallel portion while two-third (2/3) may be added ~~in~~ to the taper length. The length of taper, parallel, horizontal curve to smooth taper, and corresponding design speeds are provided in **Exhibit -9R.**

Example

For a design speed of 100 km/h and a downgrade of 5%
Total deceleration length (taper + parallel) = 160+70 = 230 m
5% downgrade correction factor = 1.3
Corrected deceleration length = 1.3x230 = 299 m (say 300 m)
Extra length beyond original = 300-230 = 70 m
Adding 2/3rd in taper portion = 70x2/3 = 46.7 (say 45 m)
Remaining 1/3rd in parallel portion = 70-45 = 25 m
Now, corrected taper length = 160+45 = 205 m, and
Corrected parallel length = 70+25 = 95 m

Table 9.17.1 – Approach and Departure Taper Ratios and Lengths for Left Turns at Intersections

- This Table is ~~**Not Applicable**~~**not applicable** and is **replaced** with **Exhibit -9R.**

Exhibit 9-R

~~**DECELERATION LENGTH FOR LEFT-TURN LANES, 2-LANES AND 4-LANE HIGHWAYS FLAT GRADE 2% OR LESS**~~**Deceleration Length for Left-Turn Lanes, 2-Lanes and 4-Lane Highways Flat Grade 2% or Less**

Design Speed (km/h)	Deceleration Length		Horizontal Curve to Smooth Taper R (m)
	Taper (m)	Parallel (m)	
50	85	20	500
60	100	30	750
70	115	40	1000
80	130	50	1200
90	145	60	1500
100	160	70	2000
110	170	80	2500

Section 9.17.4 - Single Left-Turn Lanes

- The final paragraph in this section is **deleted** and **replaced** with the following guidance:

At crossing intersections, where a left-turn lane is warranted on the main road according to Appendix 9A in one direction only, it is recommended to construct a left-turn lane in the opposite direction unless doing so is impractical. Generally, construction of an opposing left-turn lane requires only marginal additional platform expansion compared to that required to accommodate a departure taper as shown in Figure 9.17.3. Construction of an opposing left-turn lane avoids a situation where a driver waiting to turn left without a left-turn lane has their view of opposing through traffic obstructed by a vehicle turning left from the opposing left-turn lane, or a similar scenario where a vehicle treats the space between through lanes at the departure taper as a left-turn lane, potentially obstructing the view of opposing through traffic for a driver turning from the left-turn lane. Both situations effectively function as a negative-offset left turn and can result in serious high-speed, high-angle collisions when left-turning motorists do not properly identify opposing through movements.

Section 9.17.4.2 – Deceleration Requirements

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

The designer may have to determine which distance ~~would be~~is appropriate for ~~the~~ a driver to brake comfortably. ~~The designer should choose amongst the worlds of~~ D~~d~~esirable, acceptable and minimum values may apply ~~based~~depending on ~~-~~site-specific conditions. For parallel lane length only, it is desirable to include perception-reaction time however~~but~~ in ~~acceptable~~ practice, provision of length to accommodate perception-reaction time may not be feasible or ~~and not~~ cost-~~-~~effective. It is assumed that when a driver enters a left-turn lane (taper) they should be expecting to brake. In most cases ~~the~~ a driver ~~would be~~is expect~~ed~~ing to already be reducing~~transition~~ their speed as they go through the taper using perception-reaction time.~~-~~ According to

Section 9.17.3 decision sight distance should be considered in taper length to accommodate perception-reaction distance. Using minimum design values exclusively~~s all the way around in the process~~ should be avoided. The minimum desirable length of the taper and parallel length combined should not be less than the stopping sight distance provided in *Table 2.5.2* of *Chapter 2.*

Section 9.17.4.5 – Left-Turn Lanes on Both Approaches

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

  Positive Offset for Left-Turn Lanes

  A potential for conflict exists when vehicles in opposing left-turn lanes on the major road block ~~the~~ drivers' views of approaching traffic. A left-turning driver's view of opposing through traffic may be blocked by left-turning vehicles on the opposite approach. When left-turning traffic has a permissive green signal phase, this may lead to collisions between vehicles turning left from the major road and through vehicles on the opposing major-road approach[2]. To reduce the potential for ~~crashes~~ collisions of this type, the left-turn lanes can be offset by moving them laterally, so that vehicles in opposing lanes no longer obstruct the opposing driver. This helps improve safety and operations of the left-turn movement by improving driver ~~acceptance~~ perception of gaps in opposing through traffic. This is especially true for older drivers who may have difficulty judging gaps in front of oncoming vehicles. The effectiveness of this technique is greatest where signal operations include permissive signal phasing or permissive/protected phasing for left-turning movements. Positive offset for left-turn lanes is illustrated in **Exhibit ~~-~~9S**.

  The advantages of offsetting the left-turn lanes are: better visibility of opposing through traffic, decreased possibility of conflict between opposing left-turn movements within the intersection, and more left-turn vehicles served in a given period, particularly at a signalized intersection.

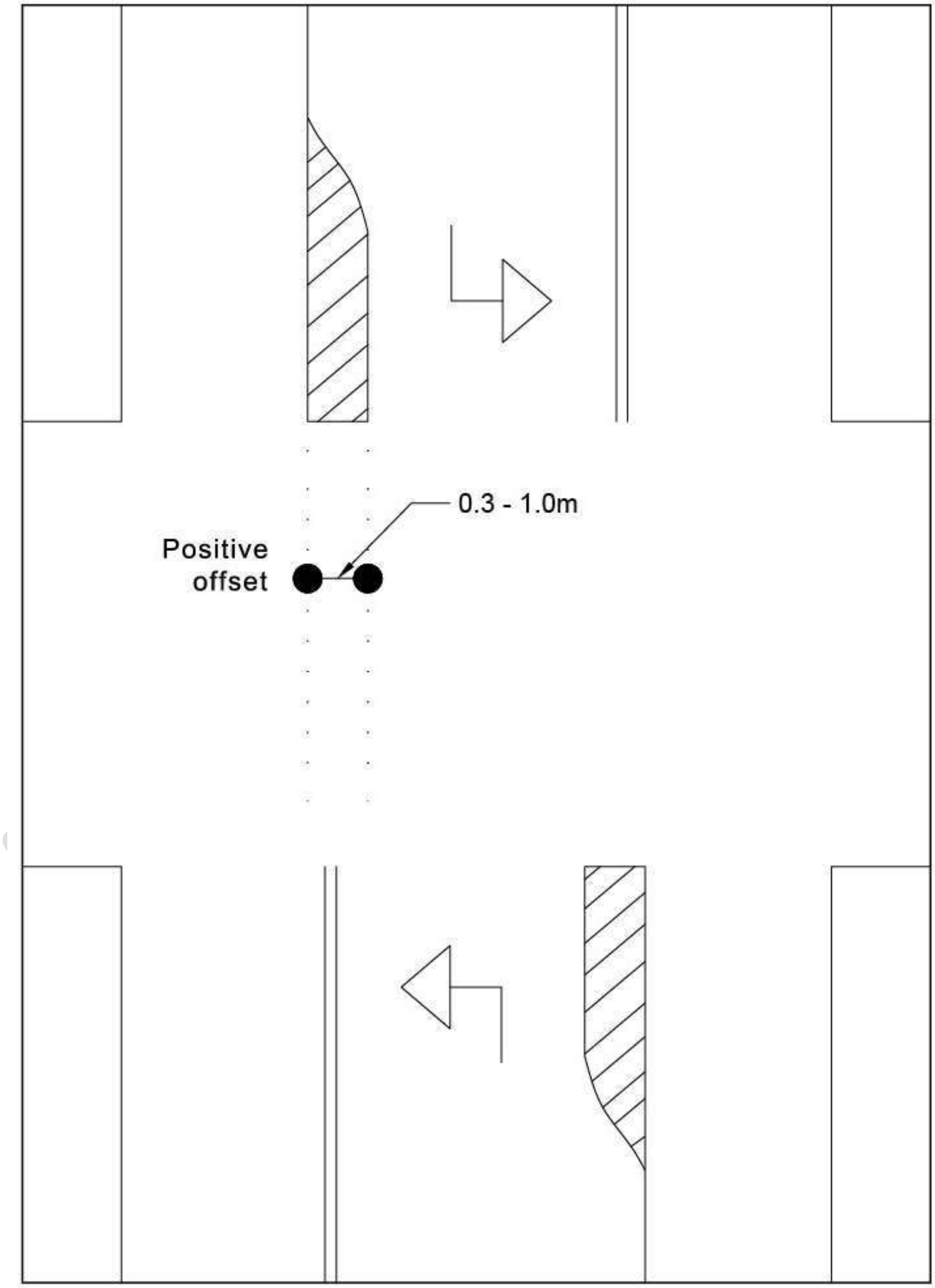
  Positive offset for left-turn lane should be provided if median is wider than 5.4 m. The width of left-turn lane should not be less than 3.25 m. One method for laterally shifting left-turning vehicles is to narrow the turn lane width using pavement markings, which~~. This is accomplished by painting a wider stripe at the right side of the left-turn lane,~~

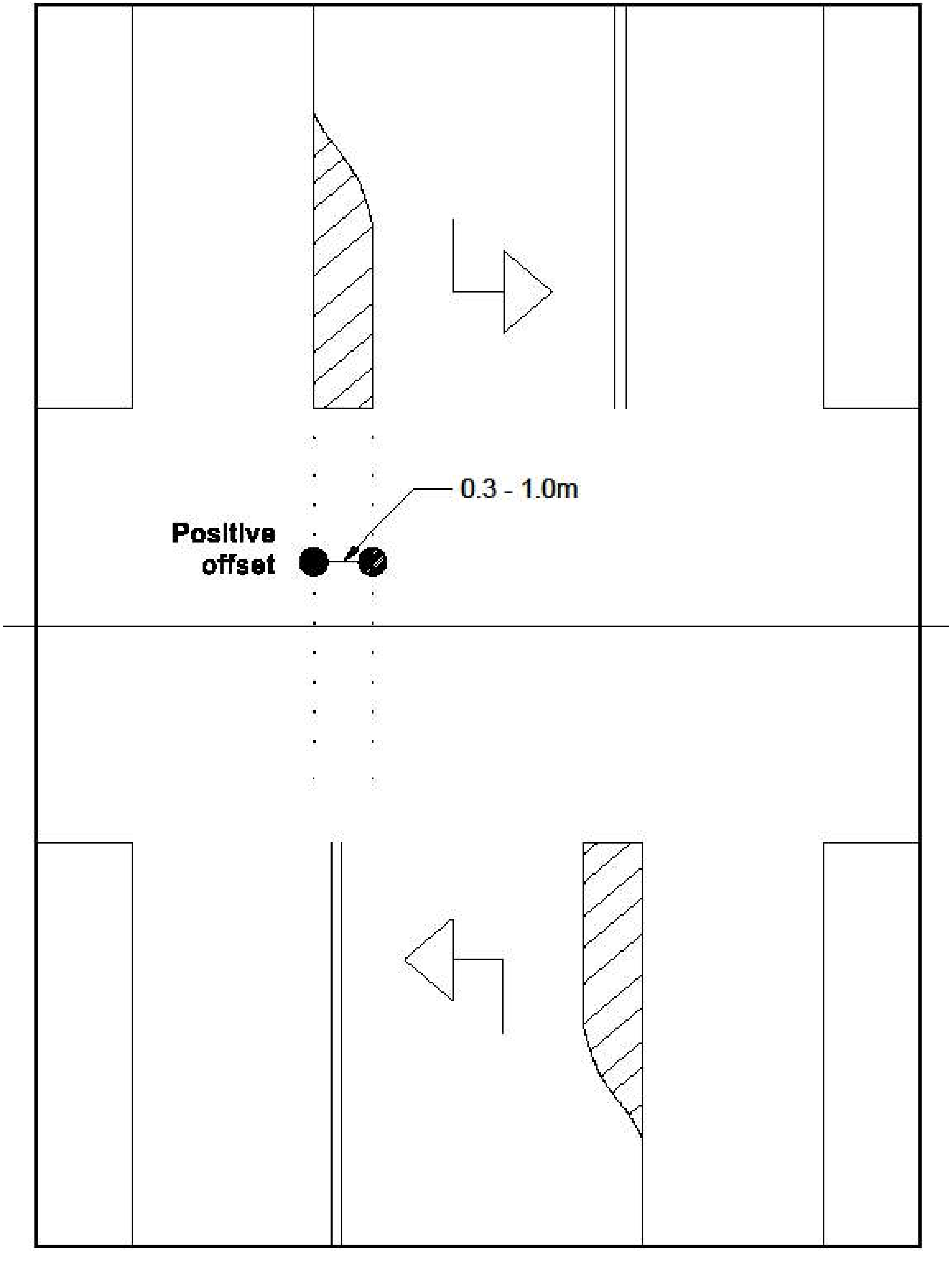
~~which~~ causes left-turning vehicles to position themselves closer to the median. The width of these lines ~~ranged~~ ranges from 0.3 m to 1.0 m. The wider the left-turn lane line used to offset vehicles, the greater~~st~~ the effect on improving sight distance.

Two types of painting: Parallel or Tapered can be installed to achieve positive offset at the intersections. This is illustrated in **Exhibit -9T** and **Exhibit -9U** respectively.

Exhibit 9-S

~~POSITIVE OFFSET FOR LEFT-TURN LANE~~Positive Offset for Left-Turn Lane


0.3 - 1.0m
Positive
offset


0.3 - 1.0m
Positive
offset

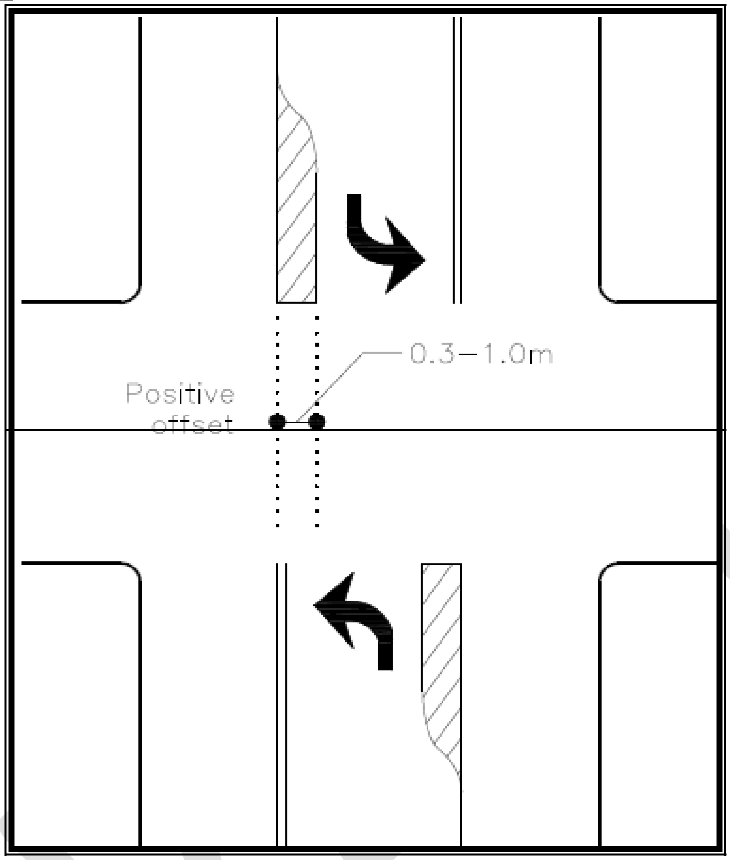


Exhibit -9T

~~PARALLEL POSITIVE OFFSET FOR LEFT-TURN LANE~~Parallel Positive Offset for Left-Turn Lane

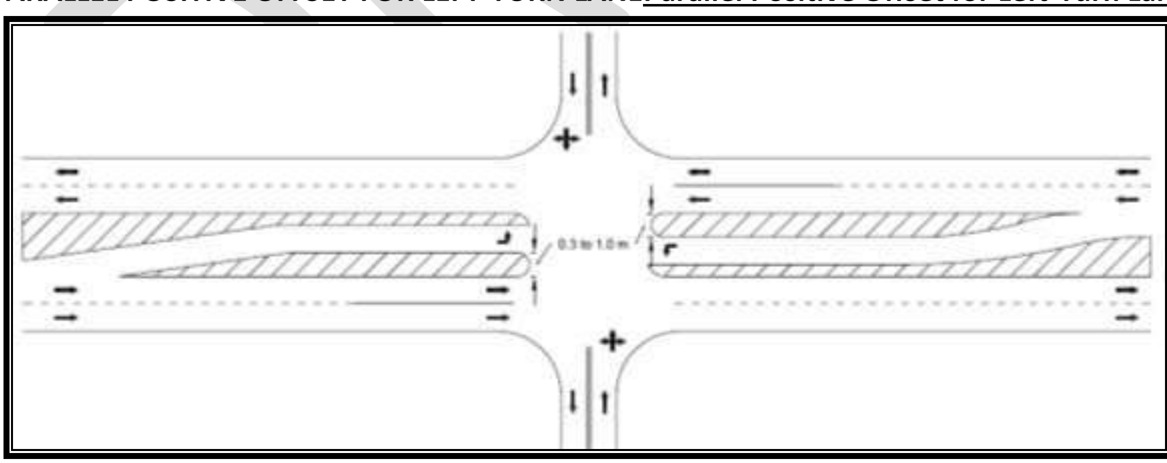
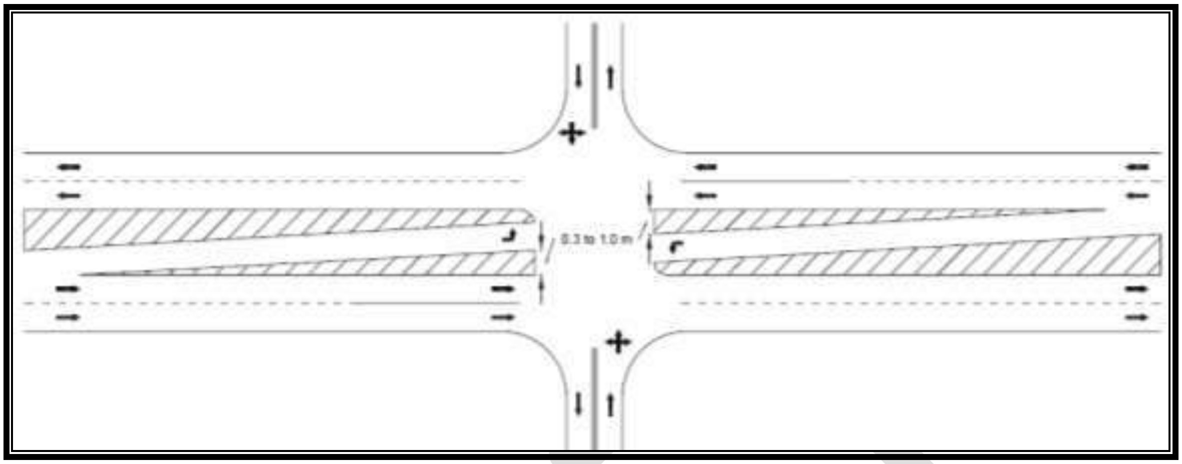


Exhibit -9U

~~TAPERED POSITIVE OFFSET FOR LEFT-TURN LANE~~Tapered Positive Offset for Left-Turn Lane



Section 9.17.5.1 – Double Left-Turn Lanes

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

  This additional guidance is also applicable for double right-turn lanes. Occasionally, the two-abreast turning maneuvers may lead to sideswipe ~~crashes~~collisions. These usually result from ~~too sharp~~ a turning radius that is too sharp or a roadway that is too narrow. The receiving leg of the intersection should have adequate width to accommodate two lanes of turning traffic. Capacity benefits can be achieved if the receiving leg width is wider~~.~~ h~~H~~owever, ~~the~~ capacity notwithstanding, the trade-offs for wider crossing distances include longer crosswalk distances for pedestrians (leading to longer clearance times in the signal cycle), a large overall intersection footprint, high turning speed, and increased cost to construct and maintain additional pavement area.

  Double left and right-turn lanes are becoming more widely used at signalized intersections and ramp terminals where traffic volume has~~ve~~ increased beyond the design volume of the original single left and right-turn lane. The following are design considerations for double turning lanes:

  - Width of receiving leg~~,~~
  - Width of intersection to accommodate the two vehicles turning abreast~~,~~
  - Location of downstream conflict points~~,~~

- Weaving movements downstream of turn~~,~~
- Potential of pedestrian conflict~~, and~~
- Consideration for median refuge for pedestrians given long pedestrian crossing lengths~~.~~

Design Vehicle

Off-tracking and swept path width are important factors in designing double left and right-turn lanes. At such locations, vehicles should be able to turn side-by-side without encroaching upon the adjacent turn lane. ~~The designer should consider~~ A~~a~~ WB-20.5 design vehicle in the outside lane and a medium single-unit (MSU) truck in the inside lane should be used when ~~developing~~ determining the swept path. ~~The designer may replace~~ T~~t~~he MSU may be replaced with another larger or smaller design vehicle based on turning vehicle classification count, traffic analysis, safety review, and engineering judgement. If the intersection is located on Long Combination Vehicle (LCV) route, consideration of LCV should be in the outside lane while MSU and other vehicle (based on the above guidance) should be considered in the inside lane however as LCVs are permitted to straddle adjacent parallel lanes, the Traffic section should be consulted to determine if this accommodation is necessary.

Section 9.18.2 – Divided Roadways

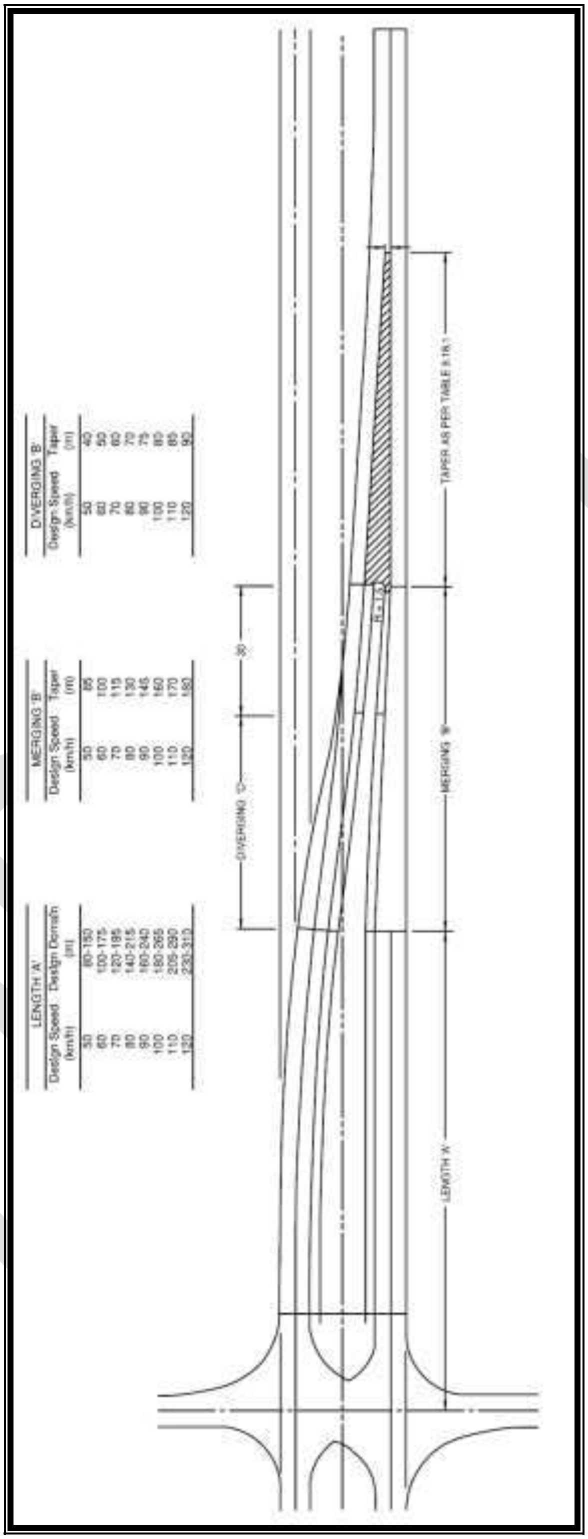
- ~~This Section~~This section ~~is Applicable~~is **applicable** including ~~the~~ **Exhibit -9V**:

Exhibit 9-V

~~**TRANSITION BETWEEN FOUR-LANE AND TWO-LANE HIGHWAY**~~

~~**MERGE ON TANGENT ALIGNMENT**~~ **Transition Between Four-Lane and Two-Lane Highway**

Merge on Tangent Alignment



Section 9.19.1 – Use and Function

Section 9.19.2 – Elements of Design

- These ~~Sections~~ sections are **~~Not Applicable~~not applicable** and are **replaced** with the following:

The outline and size of median openings at signalized or unsignalized intersections depend~~s~~ on the median width and ~~is~~ are determined by the turning requirements of the selected design vehicle. Median end designs ~~generally in use~~ are:

  - ~~1.~~ Semi-circle (simple bullnose)
  - ~~2.~~ Bullet-nose
  - ~~3.~~ Flat nose

Semi-circular median opening design is used for narrow medians up to 5 m in width.

Bullet-nose shape median end design is required for medians ranging from 5 to 15 m in width. The size of opening and the shape of the bullet-nose is designed ~~by the use of~~using a WB-17.5 (WB 17.5 is ~~taken~~ shown as the design vehicle for turning template illustration). The bullet-nose radius~~i~~ of the median opening guides the turning truck into the desirable path and lane. This design permits simultaneous left-~~-~~turn movements for trucks from each direction on the highway as well as turns from the s~~r~~ide road and it allows a minimum width of median opening between bullnoses. See **Exhibit -9W**.

Flat-nose median opening design is ~~developed~~ required for wide medians of 25 m or more with the ends flattened in shape, parallel to the intersecting road centre line. This design affords a higher degree of operational advantage over the narrow bullet-nose median openings, permitting the WB-17.5 (WB 17.5 is shown~~taken~~ as the design vehicle for turning template illustration) to pause off the through pavement while waiting for an opening and to pass each other when turning. ~~Vehicles~~ Drivers crossing the highway relate better to the flat-nosed opening and to the through lanes of the highway and drivers stopped in the median opening have a greater sense of security to the front and rear of their vehicles. See **Exhibit- 9X**.

Exhibit -9W and **Exhibit -9X** show the median opening requirements with a two-lane side road. Similar design principles, based on the turning requirements of the WB-17.5 design vehicle, are to be followed for the median opening design with a four-lane side road.

The design of the separate left-~~-~~turn lane for divided highways at median openings consists of the following:

- ~~a~~A storage lane ‘S’ with variable length beginning approximately 5 m from the bullnose. See Graph in **Exhibit -9A32 of Appendix 9A** for storage lane length.~~,~~
- A~~a~~ parallel lane.~~,~~
- A~~a~~ taper.~~.~~

For lengths of parallel lane and taper see **Exhibit -9Y**. The length of the deceleration lane is based on comfortable braking requirement. For design purposes it is assumed that:

- ~~d~~Drivers entering the deceleration lanes travel at average ~~running~~ operating speed.~~,~~
- H~~h~~alf of the taper is suitable for deceleration and is to be included in the required length.~~.~~

Storage lane ‘S’ at signalized intersection can be determined from the *Traffic Signal and Timing Policy # 2010-02* issued by Traffic ~~Policy~~ Office.

Exhibit -9W

~~DESIGN OF MEDIAN OPENING – NARROW MEDIAN BULLET-NOSE DESIGN~~Design of Median Opening – Narrow Median Bullet-Nose Design

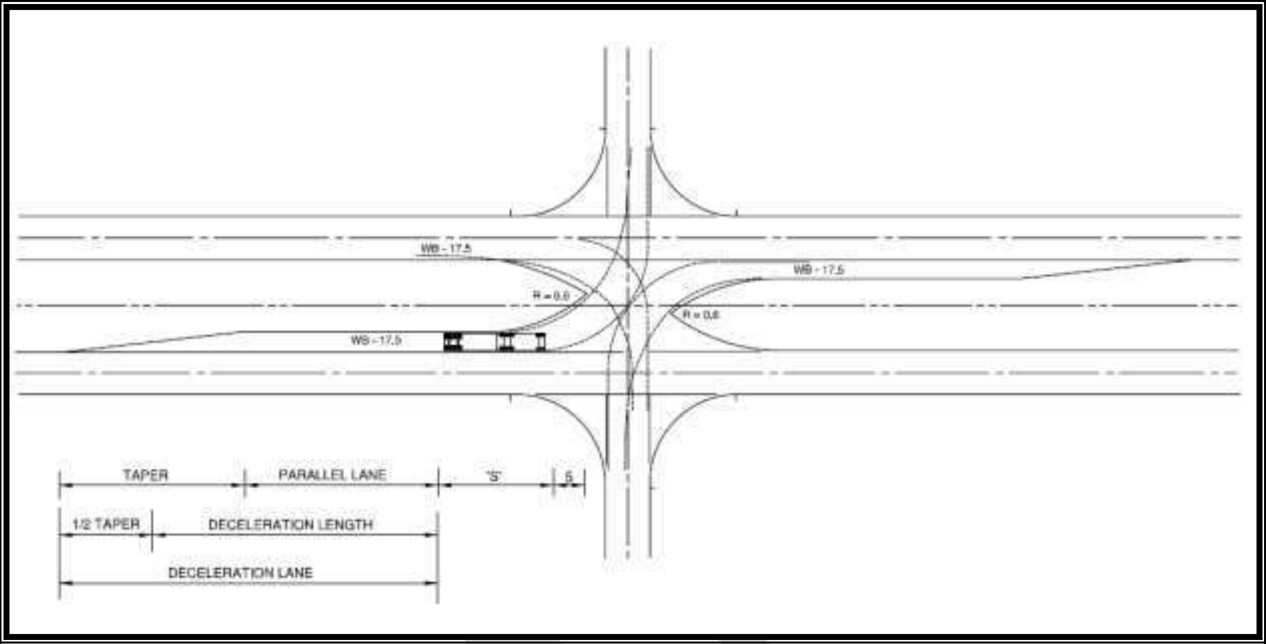


Exhibit -9X

~~DESIGN OF MEDIAN OPENING – NARROW MEDIAN~~

~~FLAT-NOSE DESIGN~~**Design of Median Opening – Narrow Median Flat-Nose Design**

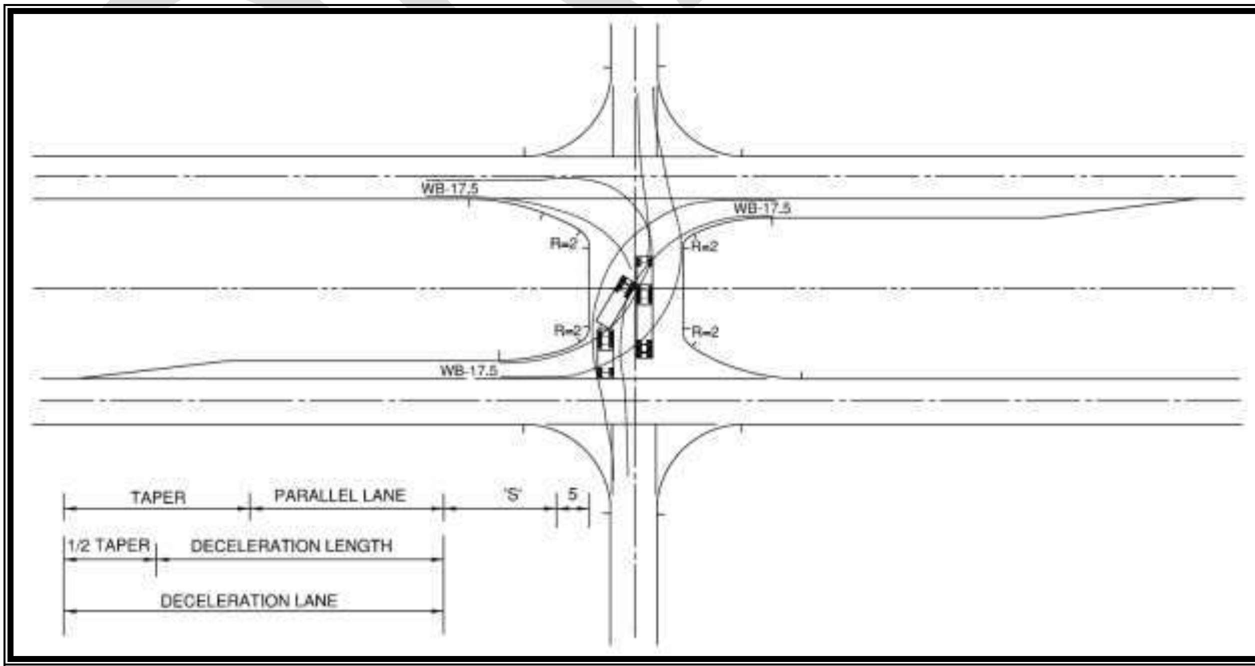


Exhibit -9Y

~~**DECELERATION LENGTHS FOR LEFT TURN LANES**~~

~~**AT MEDIAN OPENING DESIGN**~~**Deceleration Lengths for Left-Turn Lanes at Median Opening Design**

Design Speed km/h	50	60	70	80	90	100	110	120
Taper (m)	40	50	60	70	75	80	85	90
Parallel Lane (m)	35	45	60	70	80	95	110	120
Deceleration Lane (m)	75	95	120	140	155	175	195	210
Deceleration Length (m)	55	70	90	105	118	135	153	165
Storage Lane 'S'	VARIABLE							

Table 9.21.1 – Roundabout Categories and Characteristics

- This Table is ~~**Not Applicable**~~**not applicable** and is **replaced** with **Exhibit -9Z**.

Exhibit -9Z

~~**ROUNDABOUT CATEGORIES AND CHARACTERISTICS**~~**Roundabout Categories and Characteristics**

DESIGN ELEMENTS	SINGLE-LANE ROUNDABOUT	MULTILANE ROUNDABOUT
Desirable Maximum Entry Design Speed	30 to 40 km/h	40 to 50 km/h
Maximum Number of Entering Lanes per Approach	One	Two or Three
Typical Inscribed Circle Diameter (ICD)	27 to 55 m*	46 to 91 m up to three-lane
Central Island Treatment	Raised with traversable apron	Raised (may have traversable apron)
Typical Daily Service Volumes on 4-Leg	Up to approximately	Up to

Roundabout Below Which may be Expected to Operate Without Requiring a Detailed Capacity Analysis (veh/day)	25,000**	approximately 45,000 for two-lane roundabout

* Maximum ICD should not be greater than 46 m unless exceptional circumstances like more than four legs or design vehicle larger than WB-20.
** Operational analysis needed to verify upper limit for specific applications or for roundabouts with more than two lanes or four legs.

Section 9.21.1 – Mini-Roundabouts

Figure 9.21.1 – Features of a Typical Mini-Roundabout

- ~~This Section~~This section and Figure are **~~Not Applicable~~not applicable**
-

Additional Guidance for Roundabouts

~~The designer should R~~Refer to Highway Design Office policy memo # 2017-05 for *TAC Roundabout Design Guide – January 2017 and MTO Design Exceptions dated September 19, 2017.* They are available on the ministry Technical Publication website at: https://www.library.mto.gov.on.ca/SydneyPLUS/TechPubs/Portal/tp/tdViews.aspx?lang=en-US

~~**Section - %Section**~~

~~**Two-Leg Displaced Left-Turn Intersection in Charlottetown, PEI**~~:

- ~~L~~
- ~~N~~

REFERENCES:

1. Harwood, D. W., K. M. Bruce, I. B. Potts, D. J. Torbic, K. R. Richard, E. R. Kohlman Rabbani, E. Hauer, L. Elefteriadou. *Safety Effectiveness of Intersection Left- and Right-Turn Lanes,* Report No. FHWA-RD-02-089. Federal Highway Administration, U.S. Department of Transportation, Washington, DC, July 2002.
2. National Cooperative Highway Research Program Report 500, Guidance for Implementation of the AASHTO Strategic Highway Safety Plan, Volume 12: *A Guide for Reducing Collisions at Signalized Intersections.* Transportation Research Board 2004.