Alberta
TRANSPORTATION

HIGHWAY GEOMETRIC

DESIGN GUIDE

URBAN SUPPLEMENT (DRAFT – Nov. 2003)

**SUPPLEMENT TO THE
HIGHWAY GEOMETRIC
DESIGN GUIDE
1999 EDITION**

HIGHWAY GEOMETRIC DESIGN GUIDE URBAN SUPPLEMENT (DRAFT – NOV. 2003)

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BASIC DESIGN GUIDELINES

U.A.1 INTRODUCTION

This document provides supplemental guidelines to the Highway Geometric Design Guide 1999 Edition for the urban highway network of Alberta Transportation. This and all subsequent sections of this supplemental guide are to be used in conjunction with that document.

The intent of this supplement is to provide designers and planners with a basic set of guidelines to use when designing a roadway through urban areas. Much of the information already contained in the Highway Geometric Design Guide is applicable to both rural and urban roadways. Therefore the designer is expected to apply the guidelines from this supplement as necessary to best suit the requirements of the roadway being designed or upgraded. This guide is not intended as a substitute for engineering judgement.

U.A.2 SERVICE CLASSIFICATION SYSTEM

U.A.2.1 General

The primary function of Alberta Transportation's highway network is to provide international, national and provincial connections between cities, towns and villages, whereas urban roadway networks provide connections on a local scale within a city, town or village. These conflicting functions present a challenge to Alberta Transportation.

Many of the provincial highways that pass through urban municipalities are also a major Arterial road within the municipality. Therefore, the design of these roadways must reflect the requirements of the roadway as part of a provincial network as well as a part of a local network. This is especially critical on existing roadways, as development has probably already occurred adjacent to the road right of way. If a new road is proposed there may be an opportunity to avoid major developed areas and retain many of the characteristics of the rural classification as access management may be easier and a higher level of service for the roadway possible.

The Service Classification System as described in Section A.2 of the Highway Geometric Design Guide was developed in 1997 to categorize Alberta's highway network and its associated characteristics. Urban roadways have some different characteristics and may have different design designations even though they are part of the same Service Classification as the rural highway to which they are connected.

Although the design designation of the urban classification system (Freeway, Expressway, Arterial, Collector, and Local) are similar to the rural classifications, the characteristics of the subdivisions are notably different. Generally, urban highways have lower design speeds yet carry higher volumes of traffic. These and other differences are most evident in the Arterial and Collector classifications of roadway. A significant portion of Alberta's highways that pass through existing towns and cities fall under the Collector or Arterial classifications.

Table U.A.1 lists the typical characteristics of the various classifications of urban roadways.

Table U.A.1 Typical Characteristics of Urban Roadways for New Construction

	Freeways	Expressways	Arterials		Collectors		Locals	
			Major	Minor	Residential	Indust./Comm.	Residential	Indust./Comm.
Highway Service Classification	Class 1A Class 1B	Class 1A Class 1B	Class 1A Class 1B Class 2	Class 1B Class 2 Class 3	Class 2 Class 3		Not applicable	
Traffic service function	Optimum mobility	Traffic movement	Traffic movement	Traffic movement	Traffic movement and land access of equal importance		Traffic movement secondary consideration	
Land service / access	No access	No access	Rigid access control	Some access control	Traffic movement and land access of equal importance		Land access primary function	
Traffic volume (veh/day) (typical)	>20,000	>10,000	5,000-30,000	3,000-20,000	<8,000	1,000-12,000	<1,000	<3,000
Flow characteristics	Free-flow (grade separated)	Uninterrupted flow except at signals	Uninterrupted flow except at signals and crosswalks		Interrupted flow		Interrupted flow	
Design speed (km/h)	80-130	80-130	60-100	50-80	50-70		30-60	
Average running speeds (km/h) (off-peak)	70-110	60-90	50-90	40-60	30-70		20-40	
Vehicle type	All types up to 20% trucks	All types up to 20% trucks	All types up to 20% trucks	All types	Passenger and service vehicles	All types	Passenger and service vehicles	All types
Desirable connections	Grade Separated Only	Arterials, expressways, freeways	Collectors, arterials, expressways, freeways		Locals, collectors, arterials		Public lanes, locals, collectors	
Transit service	Express buses only	Express buses only	Express and local buses permitted		Permitted		Generally avoided	
Accommodation of cyclists	None	No separate bikeway	Lane widening or separate facilities desirable		No restrictions or special facilities		No restrictions or special facilities	
Accommodation of pedestrians	None	No separate walkway	Sidewalks may be provided with separation from traffic lanes preferred		Sidewalks provided both sides	Sidewalks provided where required	Sidewalks normally on one or both sides	Sidewalks provided where required
Parking (typically)	Prohibited	Prohibited	Prohibited	Peak hour restrictions	Few restrictions other than peak hour		No restrictions or restrictions one side only	
Min. intersection spacing[1] (m)	3,200 (between interchanges)	800	400[4]	200[4]	60		60	
Right-of-way width (m) (typically)	>60[3]	>45[3]	20[2] - 45[3]		20-24		15-22	
Number of Basic Lanes	≥4 for LOS	≥4 for LOS	2-4		≤6,000 AADT – 2 >6,000 AADT – 4		2	

Notes:

1. Designers should refer to Alberta Transportation's Access Management Guidelines for determination of the allowable spacing for each classification.
2. Arterial rights-of-way 20 m in width applicable to retrofit conditions only.
3. Wider rights-of-way are often required to accommodate other facilities such as utilities, noise mitigation installations, bikeways, and landscaping. For new streets, the immediate provision of wider rights-of-way may be considered to accommodate such facilities.
4. On divided Arterials, a right-in, right-out intersection without a median opening may be permitted at a minimum distance of 100 m from an adjacent all-direction intersection.

U.A.2.2 Description of Classifications

Below are brief descriptions of each urban highway classification:

Freeway

Freeways accommodate high volumes of traffic moving at high speeds under free-flow conditions. Urban Freeways connect primary areas of traffic generation and are generally connected to rural highways with a high service classification. They are intended to serve traffic between large residential areas, industrial or commercial concentrations and the central business district. To provide optimum mobility and safety for through traffic, direct land access is eliminated. No parking, unloading of goods, bicycle or pedestrian traffic is permitted.

Expressway

Expressways carry large volumes of all types of vehicles at medium to high speeds, at a slightly higher level of service than major Arterials. Some intersections with major roads are grade separated to provide free flow conditions. At-grade signalized intersections are widely spaced to minimize the number of conflict points and increase traffic mobility. Left and right turn bays are provided at all at-grade intersections and the possible requirement for double left-turn bays is a typical design consideration. Expressways are sometimes a staged development phase to a future freeway. Access to adjacent lands is prohibited to preserve a high level of service and enhance safety.

Arterial

The major Arterial system typically interconnects the major development areas in an urban setting including central business districts, large industrial centres, major residential communities, large district shopping centres, and other major activity centres. Left and right turn bays are normally provided at all intersections along major Arterials with the possible requirement for double left turn lanes at principal intersections being a typical design consideration. The accommodation of large trucks is typically a primary design consideration, particularly at the intersections with significant truck volumes.

Minor Arterials typically interconnect residential, shopping, employment and recreational activity areas at the community level.

Arterials are typically located along a boundary of, rather than passing through, residential neighbourhoods. Sidewalks for pedestrians may be provided on one or both sides of an Arterial road, preferably set back from the traffic lanes. Cyclists are typically accommodated by wider outside traffic lanes or separate facilities (bicycle pathways).

Subdivision of Arterials into major and minor Arterials provides for varying degrees of access control, intersection spacing, and intersection treatments as required for mobility and safety.

Collector

Collector roads provide both land access and mobility within residential, commercial and industrial areas. Defining classification subgroups of residential Collectors and industrial or commercial Collectors provide for differences in geometric design features associated with the presence of significant truck volumes in industrial and commercial areas. Residential Collectors may be required to accommodate transit buses.

Local

Local roads provide land access and occur in most developed areas, giving rise to Local residential, commercial or industrial roads.

Dividing the Local road classification into residential, industrial and commercial subgroups provides for the definition of different geometric design features in consideration of the significant truck volumes typical to industrial and commercial areas. Separating residential Local roads from other roads also aids in defining design parameters that assist in enhancing the quality of life in residential neighborhoods.

U.A.2.3 Selection of Classification

In selecting the roadway classification and designation of a highway through a municipality, the designer should work in cooperation with municipal representatives to ensure an appropriate designation is selected.

Using the information gathered and Table U.A.1 as a guide, the appropriate design classification and designation can be selected. The potential classification must be compared to the rural classification leading up to the municipality. If the urban classification is lower than the approaching rural highway, it must be increased to match that of the approaching highway. The following table shows corresponding rural and urban classifications.

Table U.A.2 Rural-Urban Classification Correlation

Highway Service Classification	Design Classification or Descriptor
Class 1A	Freeway or Expressway
Class 1B	Expressway, Major or Minor Arterial
Class 2	Major, Minor Arterial or Collector
Class 3	Minor Arterial or Collector

As a minimum, the classification through an urban area shall match the equivalent rural classification leading up to the municipality. Since traffic volume and other factors are to be considered, the urban classification may, at times, be higher than that the appropriate classification outside of town.

To determine the minimum classification of roadway required through town, the following factors should be considered:

- Existing and future adjacent land use
- Service function of the roadway. Is the roadway primarily for traffic movement or land access?
- Current and projected traffic volumes. There may be substantial traffic originating within municipal boundaries that must be accommodated in addition to the through (highway) traffic. To determine the traffic volumes and movements, a traffic study may be required.
- Flow characteristics of the proposed highway. Is there on street parking, pedestrians or intersections?
- Average running speed of the traffic operating under off peak conditions. In a retrofit situation this can be measured.
- In the case of an existing roadway, what is the existing posted speed. Is the posted speed a function of the roadway conditions or a desire by the municipality to set it at such a speed?
- Design characteristics of the existing roadway such as horizontal and vertical geometry.
- Frequency of intersections and accesses. Alberta Transportation's Access Management guidelines should be followed.
- Types of vehicles. Will heavy truck traffic, passenger cars, buses and emergency vehicles be using the roadway?
- Right of way width available for the roadway. Can additional width be acquired or is it necessary to stay within the existing?

U.A.3 DESIGN DESIGNATION

U.A.3.1 Description of Design Designation

Design designation is an alphanumeric abbreviation that identifies the principal design values for a highway. Examples of some of the urban design designations are noted below.

Table U.A.3.1 Description of Design Designations

Design Designation	Description
UFD-820.8-110 UAD-820.8-110	UFD (UAD) - Urban Freeway (or Arterial) Divided (Two roadways) 820.8 - 8 Lanes with 20.8 m of finished pavement width per roadway 110 - Design Speed (km/h)
UFD-616.6-110 UAD-616.6-110	UFD (UAD) - Urban Freeway (or Arterial) Divided (Two roadways) 616.6 - 6 Lanes with 16.6 m of finished pavement width per roadway 110 - Design Speed (km/h)
UFD-412.4-110 UAD-412.4-110	UFD (UAD) – Urban Freeway (or Arterial) Divided (Two roadways) 412.4 - 4 Lanes with 12.4 m of finished pavement width per roadway 110 - Design Speed (km/h)
UED-614.6-90 UAD-614.6-90	UED (UAD) – Urban Expressway (or Arterial) Divided (Two roadways) 614.6 - 6 Lanes with 14.6 m of finished roadway width per roadway 90 - Design Speed (km/h)
UED-410.4-90 UAD-410.4-90	UED (UAD) – Urban Expressway (or Arterial) Divided (Two roadways) 410.4 - 4 Lanes with 10.4 m of finished roadway width per roadway 90 - Design Speed (km/h)
UAD-611.1-80	UAD – Urban Arterial Divided (Two roadways) 611.1 - 6 Lanes with 11.1 m of finished roadway width per roadway 80 - Design Speed (km/h)
UAD-407.4-80	UAD – Urban Arterial Divided (Two roadways) 407.4 - 4 Lanes with 7.4 m of finished roadway width per roadway 80 - Design Speed (km/h)
UAD-611.6-70	UAD – Urban Arterial Divided (Two roadways) 611.1 - 6 Lanes with 11.6 m of finished roadway width per roadway 80 - Design Speed (km/h)
UAD-407.9-70	UAD – Urban Arterial Divided (Two roadways) 407.4 - 4 Lanes with 7.9 m of finished roadway width per roadway 80 - Design Speed (km/h)
UAU-209.0-70	UAU - Urban Arterial Undivided 209.0 - 2 Lanes with 9 m of finished roadway width 70 - Design Speed (km/h)
UCU-414.0-70	UCU – Urban Collector Undivided 414.4 - 4 Lanes with 14 m of finished roadway width 70 - Design Speed (km/h)
ULU-209.0-70	ULU – Urban Local Undivided 209.0 - 2 Lanes with 9 m of finished roadway width 70 - Design Speed (km/h)

Note: Finished roadway width includes shoulders for each direction of travel.

U.A.3.2 Selection of Design Designation

As with the selection of the design descriptor, continuity of roadway configuration, e.g. divided or undivided is desirable. Continuity of speed is also desirable, but not often practical or achievable. Generally, design speeds used in urban areas are substantially less than those used in rural areas. The Highway Service Classification must be maintained through municipalities. However, the spacing of accesses, design speed, number of lanes, presence of parking lanes may not be the same as in the rural setting and some tradeoffs may be practical and reasonable when local use of the highway is taken into consideration.

The following table is a correlation between the current rural designations and the proposed urban designations. When selecting an urban designation, as a minimum, the designer should strive to provide the Suggested Design Designation.

Table U.A.3.2 Coordination of Rural and Urban Design Designations

Rural Designation	Suggested Design Designation in Urban Setting
RFD – 130	UFD – 110
RAD – 130	UAD–110 or UED–90
RAU – 214.4 -120 (future 4 lane)	UED – 90
RAU – 213.0 -110 RAU – 212.0 -110 RAU – 211.0 - 110	UAD – 407.4-80 or UAU – 211-70
RAU – 210 -110 RAU – 209 -110	UAD – 407.9-60 or UAU – 210 - 70
RCU – 209 -110 RCU – 208 -110	UCU – 211.0-60
All Local Roads	ULU

Note: The pavement width has been omitted from the table in some cases because it was not relevant to the comparison.

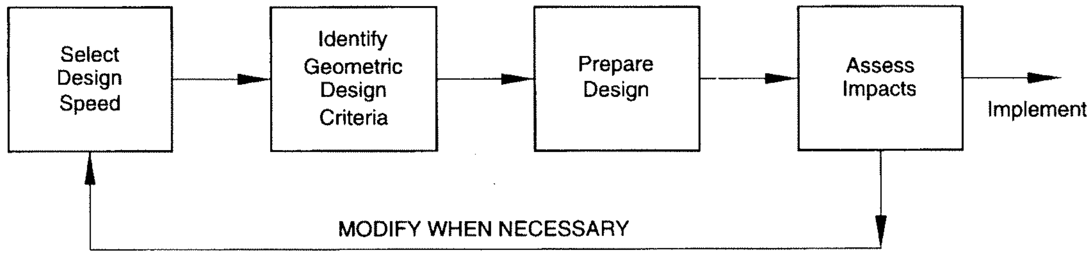
U.A.4 DESIGN SPEED

Generally, when selecting the standards to be applied to a given roadway, the basic parameter for the selection of geometric standards is design speed. In urban conditions for new construction or major reconstruction this same approach applies. When setting the design speed, service classification and roadway function need to be considered.

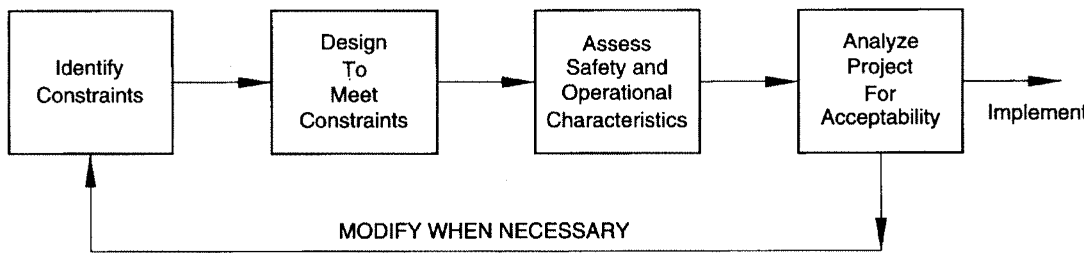
It is desirable to provide a reasonable degree of consistency in the design speeds, operating speeds and subsequently the posted speed selected within each classification subgroup or group. For example, the posted speed for all minor Arterial roads within a municipality should be identical or near identical and typically the design speed is 10 km/h higher than the posted speed. Where the legal speed limit is not readily available, designers may obtain this information from the Department. Where the speed limit is not posted in urban municipalities, the legal speed limit is 50 km/h. Driver expectations are met in this manner. When selecting a design speed for a given roadway within a municipality, the designer should review the design speed of similar roadways before making a final decision.

Many urban roadways traverse existing built up areas where the physical, environmental and property constraints are frequently the prevailing controls rather than the design speed. Typical geometric design practice considers the constraints imposed and then analyzes the design for acceptability from the safety and operational points of view. If the analysis concludes that the design is unacceptable, revisions are required to minimize the influence of constraints or to modify the expectations of the driver. The differences between the two approaches (that for new urban construction projects and that for severely controlled urban retrofit projects) are illustrated in the following flow chart:

New Construction



Retrofit with Physical Constraints



On rural highways or on high-speed urban facilities most vehicles are able to travel at or near the safe speed determined by geometric design elements. On Arterial roads the top speeds for several hours of the day are frequently limited or regulated to those at which the recurring peak volumes can be handled. Speeds are governed by the presence of other vehicles traveling en masse, both in and across the through lanes and by traffic control devices rather than by the physical characteristics of the roadway. At low to moderate volumes, speeds are typically governed by such factors as speed limits, mid-block friction and intersectional friction. When Arterial road improvements are being planned, factors such as speed limits, presence of pedestrians and cyclists, physical and economic constraints, and likely running speeds that can be attained during off peak hours should be considered in the selection of the design speed.

For consistency of design in urban locations, the designations in Table U.A.7, at the end of this chapter, are suggested for use when designing an urban roadway. However, a designer may select a different design speed if conditions dictate. The following table lists some suggested design speeds for urban roadways. As indicated, there is some flexibility in the range of speeds that can be used for each classification.

Table U.A.4 Suggested Design Speeds for Design Classifications

Design Classification	Suggested Design Speed Ranges (km/h)
Urban Freeways	100 -130
Urban Expressways	80 -130
Urban Arterials – Major Divided	60 -100
Urban Arterials – Minor Arterial	50-80
Urban Collectors – Residential or Industrial/Commercial	50 -70
Urban Locals – Residential or Industrial/Commercial	30 - 60

When selecting the design speed of a roadway through an urban area the designer must again respect the classification of the roadway leading up to the municipality. The following table represents the allowable reduction in design speed as a rural roadway enters an urban municipality.

Table U.A.5 Rural/Urban Design Speed Correlation

Rural Designation	Suggested Minimum Design Speed for Urban Segment
RFD – 130 km/h	110 km/h
RAD – 120 to130 km/h	90 km/h
RAU – 110 km/h	60 - 90 km/h
RCU – 110 km/h	60 - 90 km/h
RLU – 100 to110 km/h	60 - 70 km/h
RLU – 60 to 90 km/h	30 – 60 km/h

In retrofit situations, exceptions may be made to the above guidelines if it is determined that the selection of a given design speed results in unreasonable costs. Justification of the exception may be based on safety, recognition of the urban nature of the traffic and roadway use, increased conflicts, etc. Exceptions should be evaluated on a case-by-case basis and justification documented as to why a reduction is design speed is warranted.

U.A.5 GENERAL DESIGN CONTROLS AND GUIDELINES FOR URBAN HIGHWAYS

Table U.A.7 is a summary of the design guidelines for urban roadways that should be used when passing through urban municipalities. Some of the designations, such as those for Freeways and Expressways, are closely linked to the high-speed rural Freeways and Arterials given in Table A-7 of the Highway Geometric Design Guide. The major differences are in the lower speed Arterial, Collector and Local roads.

Table U.A.7 Design Guidelines for Urban Highways

		UFD-820.8-110 UAD-820.8-110	UFD-616.6-110 UAD-616.6-110	UFD-412.4-110 UAD-412.4-110	UED-614.6-90 UAD-614.6-90	UED-410.4-90 UAD-410.4-90	UAD-611.1-80 UAD-407.4-80	UAD-611.6-70 UAD-407.9-70	UAU-209.0-70 UCU-414.0-70 UCU-209.0-70	ULU-209.0-60 PAVED
DESIGN DESIGNATION										
DESIGN SPEED (km/h)		110	110	110	90	90	80	70	70	60
HORIZONTAL ALIGNMENT	MIN. CURVE RADIUS (m)	600	600	600	300	300	250	190	190	130
	SPIRAL PARAMETER A	REFER TO SUPERELEVATION TABLES FOR MINIMUM AND DESIRABLE "A" PARAMETERS								
SUPERELEVATION		6%	6%	6%	6%	6%	4% 6%	4% 6%	2% 4%	NOT REQUIRED
VERTICAL ALIGNMENT $K=\frac{L(m)}{A(\%)}$	CREST K: PASSING SIGHT K	WHERE THIS IS A CONSIDERATION, REFER TO THE ALBERTA TRANSPORTATION HIGHWAY GEOMETRIC DESIGN GUIDE.								
	CREST K: MIN. STOPPING SIGHT K	100	100	100	55	55	35	25	25	15
	SAG K: MINIMUM K	60	60	60	40	40	35	25	25	20
	SAG K: COMFORT MINIMUM (ILLUMINATED SECTIONS ONLY)	30	30	30	21	21	17	13	13	10
	DECISION SIGHT DISTANCE (m)	330 - 430	330 - 430	330 - 430	280 - 360	300 - 390	230 - 310	200 - 270	200 - 270	170 - 230
	GRADIENT - DESIRABLE MAXIMUM %	3	3	3	6	6	6	6	8	8
CROSS SECTION	LANE WIDTH (m)	3.7, 3.7, 3.7, 3.7	3.7, 3.7, 3.7	3.7, 3.7	3.7, 3.7, 3.7	3.7, 3.7	3.7, 3.7, 3.7 3.7, 3.7	3.7, 3.7, 4.2 3.7, 4.2	4 @ 3.5 4.5, 4.5 4.5, 4.5	4.5, 4.5
	RIGHT SHOULDER WIDTH (m)	3.0	3.0	3.0	2.0	2.0	-	-		-
	LEFT SHOULDER WIDTH (m)	3.0	2.5	2.0	1.5	1.0	-	-	-	-
	FINISHED PAVEMENT WIDTH (m)	2 AT 20.8	2 AT 16.6	2 AT 12.4	2 @ 14.6	2 @ 10.4	2 @ 11.1 2 @ 7.4	2 @ 11.6 2 @ 7.9	14.0 9.0	9.0
	MEDIAN WIDTH RURAL (m)	WHERE RURAL STANDARDS ARE TO BE USED, REFER TO THE ALBERTA TRANSPORTATION HIGHWAY GEOMETRIC DESIGN GUIDE.								
	MEDIAN WIDTH URBAN (m)	7.8 MEDIAN WITH BARRIER	15.2 MEDIAN DEPRESSED	22.6 MEDIAN DEPRESSED	6.0 RAISED MEDIAN	13.4 MEDIAN DEPRESSED	6.0 RAISED MEDIAN	6.0 FOR DIVIDED	NONE	NONE
	DITCH WIDTH - RURAL (m)	4.0 ROUNDED	4.0 ROUNDED	4.0 ROUNDED	4.0 ROUNDED	4.0 ROUNDED	3.5	3.5	3.0	3.0
	SIDESLOPE RATIO ON FILLS - NORMAL	6:1	6:1	6:1	6:1	5:1	4:1	4:1	4:1	4:1
	SIDESLOPE RATIO ON FILLS - MAXIMUM	3:1 OVER 6.5m	3:1 OVER 6.5m	3:1 OVER 6.5m	3:1 OVER 6.5m	3:1 OVER 6.5m	3:1 OVER 4m	3:1 OVER 4m	2:1 WITH BARRIER	2:1 WITH BARRIER
	BACKSLOPE RATIO - NORMAL	5:1	5:1	5:1	5:1	5:1 4:1	3:1	3:1	3:1	3:1
	BACKSLOPE RATIO - MAXIMUM	3:1	3:1	3:1	3:1	3:1	2.5:1	2.5:1	2:1	2:1
BASIC R/W WIDTH	URBAN AREA (m) - MINIUMUM	70	60	50	60	50	45	38 - 45	22 - 27	20
	MAX. [THROUGH UNDEVELOPED CROWN OWNED LAND (m)]									
	SEMI - URBAN AREA (m)	MAY USE TYPICAL RURAL RIGHT-OF-WAY WIDTHS IF APPROPRIATE								

Note: Table U.A-7 continued on next page

GENERAL NOTES

1. The following notes highlight certain key issues only. For a more thorough explanation, refer to Chapter B of the text.
2. Minimum design values for horizontal and vertical curvature should be reserved only for critical locations, with better standards being used in the majority of cases. A section of road might be designed to meet all minimum standards, but could still result in an unsatisfactory overall design.
3. Horizontal and vertical alignments are the most permanent design elements of a highway, and once a facility is constructed, poorly designed features will remain and be viewed by road users for many years. The importance of the initial design cannot, thus, be overemphasized.
4. Horizontal and vertical alignment coordination principles as outlined in Section B.4 of the Geometric Design Guide are to be given serious consideration during the location and design phases of the project.
5. A design speed lower than the normal standard for a certain section of roadway is sometimes used in rugged or mountainous terrain; however, the design speed is not normally reduced by more than 20 - 30 km/h. Such a section must be carefully designed so that there are no abrupt changes in alignment or surprises for the driver.
6. The median widths for the UFD-820.8-110 to UFD-412.4-110 are based on the ultimate configuration being a UFD-820.8-110. If the ultimate configuration is a UFD-616.6-110 then the median widths will be 15.4m for the UFD-412.4-110 and 8.0m for the UFD-616.6-110
7. UED-410.4-90 is Stage I for the ultimate UED-613.6-90.

Notes: Horizontal Alignment Design

1. Because many UAD, UAU, and UCU are generally retrofitted instead of new construction, alternate method of superelevation may be required. Refer to the superelevation chart in Section B to determine allowable superelevation/radius relationships.
2. Alignment should be as directional as possible but should be consistent with topography and with preserving developed properties and community values.
3. The minimum radius curve for the applicable design speed should be reserved for critical locations, and otherwise avoided wherever possible.
4. In general, the deflection angle of each curve should be as small as the physical conditions permit so that the highway will be as directional as possible. A deflection angle of 60 degrees or less is desirable and should be strived for.
5. Consistent alignment should always be sought. Sharp curves are not to be introduced at the ends of long tangents or at or near the top of a pronounced vertical curve. Similarly, a minimum radius curve should generally not be introduced at the bottom of a long, steep grade.
6. For small deflection angles, curves should be suffiently long to avoid the appearance of a kink. A minimum curve length of 300m - 400m is suggested. A deflection angle of 0°30' or less does not require a curve.
7. Spirals are to be used on all curves requiring superelevation to provide a proper transition from tangent to curve.
8. Horizontal sight distances are to be verified on all curves. Where in a cut section or treed area where a high percentage of trucks are anticipated, truck braking requirements may dictate the minimum radius of curve required for a certain design speed and should be considered during the route location phase of the project.
9. Maximum superelevation through an intersection should be 4%.
10. For a UED that may have an intersection on a curve, the first choice would be to select a radius large enough from the e max = 6% chart. This enables the superelevation = 4%. If this is not practical, then use the e max = 4% chart.

Notes: Vertical Alignment Design

1. For multi-lane highways, the upper end of the stopping sight Ks should be used as a minimum wherever practical. The upper end of the range was calculated assuming the design speed. Design speed distances should be considered in specific cases where more complex driving situations are anticipated (e.g., intersections, exits, etc.).
2. The crest K values apply when the length of vertical curve is greater than the applicable sight distance. For curves where the length is less than the sight distance, $K = (2\ S/A) - 200(\sqrt{h_1} + \sqrt{h_2})^2/A^2$. As well, the length of both crest and sag vertical curves in metres should always be as great or greater than the design speed in km/h.
3. Minimum sag K values are based on stopping sight distance and a headlight beam sloping upward at an angle of one degree from the plane of the vehicle. Lower K values may be allowable in certain situations, particularly for high speed conditions, as stopping sight distance values may exceed pavement visibility distances afforded by headlights.
4. Decision sight distances should be considered for crests near major intersections. Each major intersection should be checked on a site specific basis and analyzed individually to determine if decision sight distance is achieved. The bottom end of the range is suitable for simple situations; the top end of the end is for complex situations. Intersection sight distance requirements must also be met.
5. The Gradient - Desirable Maximum percentage category provides maximum gradients that should not be exceeded wherever practical. The maximum gradient is site specific. In situations depending on the maximum gradient, an economic analysis should be undertaken to determine the suitable maximum gradient for that section of roadway. This economic analysis should consider road user costs as well as construction costs.
6. As a general rule, vertical alignment with a series of successive sharp crest and sag curves should be avoided as it gives the impression of a roller coaster and has operational and safety disadvantages.

Alberta TRANSPORTATION

TABLE U.A.7

Date: AUGUST, 2003

DESIGN GUIDELINES FOR URBAN HIGHWAYS

Prepared By: CS	Checked By: TCG	Scale: N.T.S.

GRAPHICS FILE: A-22•01.07.03.dgn

CHAPTER U.B
ALIGNMENT ELEMENTS

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CHAPTER U.B
ALIGNMENT ELEMENTS

U.B.1 INTRODUCTION

Although the Highway Geometric Design Guide was primarily developed with rural roadways in mind, the majority of the design parameters regarding horizontal and vertical geometry are equally applicable to urban roadways.

U.B.2 SIGHT DISTANCE

In an urban setting the intersectional sight distance, decision sight distance and stopping sight distance are of primary concern. Passing is generally not allowed in urban settings. Accordingly, passing sight distance and non-striping sight distances are normally not an issue.

The criteria for measuring sight distances are the same for urban and rural conditions. In urban settings there may be more distractions and complex information that a driver must process as they proceed down a busy urban street. Accordingly, a designer should provide sight distances that are above the minimum stopping sight distance and closer to the decision sight distances. All intersections shall provide, at least, the minimum sight distance required for all design vehicles to make all movements safely.

U.B.3 HORIZONTAL ALIGNMENT

U.B.3.6 Rates of Superelevation for Design

U.B.3.6.2 Superelevation Rates

In urban areas the maximum superelevation values used on Alberta Transportation roadways can range from 0.02 m/m to 0.06 m/m. The following values indicate the generally allowable superelevation rates:

1. Locals – generally normal crown.
2. Collectors – used occasionally with maximum rates of 0.02 m/m (adverse crown) or 0.04 m/m
3. Minor Arterials – 0.04 m/m to 0.06 m/m
4. Major Arterials – 0.06 m/m
5. Expressways and Freeways –0.06 m/m
6. Interchange ramps – 0.06 m/m

- A maximum superelevation of 0.04 m/m may be used for an urban roadway system, and is appropriate where surface icing and interrupted flow is expected.
- Superelevation rates in excess of 0.04 m/m are not recommended where curved alignments pass through existing or future intersections.
- It is generally recognized that on low speed (30 to 70 km/h) urban roads, drivers have developed a higher threshold of discomfort through conditioning, and are willing to accept more lateral friction than in rural or higher speed (> 70km/h) urban conditions.
- For urban Freeways and Expressways the superelevation rates should be designed the same as for rural roadways. Table B.3.6a of the Highway Geometric Design Guide should be used.
- For high-speed Arterials where intersections are widely spaced and access is restricted the designer should use Table B.3.6a of the Highway Geometric Design Guide. Table U.B.3.1 excerpted from the TAC Geometric Design Guide for Canadian Roads may be used in localized areas where there is an intersection on a

- curve. This table is derived using the same methods as Table B.3.6a and the superelevation rates are based on low lateral friction values and a low maximum superelevation rate.
- For low speed Arterials, the roadway should first be assessed to determine if the superelevation Tables B.3.6a or U.B.3.1 can be applied. If constraints do not allow use of either of these tables, Table U.B.3.2 or U.B.3.3 excerpted from the TAC Geometric Design Guide for Canadian Roads may be used.
- The superelevation rates given in Tables U.B.3.2 and U.B.3.3 are derived using higher lateral friction values than those given in Tables U.B.3.6a and U.B.3.1.

Should the designer wish to review further information on the development of superelevation rates in an urban setting, the designer may refer to the TAC Geometric Design Guide for Canadian Roads – 1999 Edition or AASHTO's A Policy on Geometric Design of Highways and Streets, 2001.

U.B.4 VERTICAL ALIGNMENT

U.B.4.1 General Controls for Vertical Alignment

- The provision of decision sight distance is desirable at all approaches to intersections or gore points for turning roadways and interchange ramps
- Flattening roadway cross-slopes to 1% is useful in avoiding abrupt changes in grade though the intersection.
- The profile and offset of existing and proposed utilities should be considered in urban areas.
- Proposed grades must consider existing and future driveways and intersections.

The following vertical clearances should be maintained to the underside of structures/signals/pedestrian crossing structures, etc:

Table U.B.4 Minimum Vertical Clearances Below Structures

Obstacle	Minimum Clearance
High Load Corridor	9.0 m
Truck Route	5.4 m
Pedestrian Crossings/Traffic Signal Heads	Add 0.3 m to the above clearances
Trains Tracks (Trains under roadway)	7.1 m to underside of structure
Trains Tracks (Trains over roadway)	Same as roadway clearances above

Minimum vertical clearance for bikeways is 2.5 m, although it is desirable to provide 3.6 m in order to provide access for service vehicles. Similar clearances are normally provided for sidewalks since cyclists may use the sidewalk.

U.B.4.2 Maximum Gradient

- Table U.A.7 provides the desirable maximum gradient that should be used for each design designation.

The maximum grade through intersections for lower speed Arterials ($\leq$ 70 km/h) can be 4%. Higher speed Arterials should be limited to 3% maximum grade through intersections. Vertical alignments should favor the principal traffic flow.

Table U.B.3.1 Superelevation and Minimum Spiral Parameters, $e_{max} = 0.04$ m/m

Design Speed (km/h)	40			50			60			70			80			90			100		
		A			A			A			A			A			A			A	
Radius (m)	e	2 lane	4 lane	e	2 lane	4 lane	e	2 lane	4 lane	e	2 lane	4 lane	e	2 lane	4 lane	e	2 lane	4 lane	e	2 lane	4 lane
7000	NC			NC			NC			NC			NC			NC			NC		
5000	NC			NC			NC			NC			NC			NC			NC		
4000	NC			NC			NC			NC			NC			NC			NC		
3000	NC			NC			NC			NC			NC			NC			RC	410	410
2000	NC			NC			NC			NC			RC	300	300	RC	315	315	RC	335	335
1500	NC			NC			NC			RC	240	240	RC	260	260	RC	275	275	0.022	290	290
1200	NC			NC			NC			RC	215	215	RC	230	230	0.021	245	245	0.026	260	260
1000	NC			NC			RC	180	180	RC	200	200	0.020	210	210	0.025	225	225	0.030	235	235
900	NC			NC			RC	175	175	RC	190	190	0.021	200	200	0.027	210	210	0.032	225	225
800	NC			NC			RC	165	165	RC	180	180	0.023	190	190	0.029	200	200	0.034	210	210
700	NC			RC	140	140	RC	150	150	0.020	165	165	0.026	175	175	0.032	185	185	0.036	200	200
600	NC			RC	130	130	RC	140	140	0.023	155	155	0.029	165	165	0.035	175	175	0.039	190	190
500	NC			RC	120	120	0.021	130	130	0.026	140	140	0.033	150	150	0.038	160	160	0.040	190	190
400	RC	95	95	RC	105	105	0.025	115	115	0.031	125	125	0.037	135	135	0.040	160	160	0.040	190	190
350	RC	90	90	0.020	100	100	0.027	110	110	0.033	120	120	0.039	135	135	0.040	160	160	min R = 490		
300	RC	80	80	0.023	90	90	0.031	100	100	0.036	110	110	0.040	135	135	min R = 380					
250	RC	75	75	0.026	85	85	0.034	90	90	0.038	110	110	0.040	135	135						
220	RC	70	70	0.029	80	80	0.036	90	90	0.039	110	110	min R = 280								
200	0.021	65	65	0.031	75	75	0.038	90	90	0.040	110	110									
180	0.023	65	65	0.033	70	70	0.039	90	90	0.040	110	110									
160	0.025	60	60	0.035	70	70	0.040	90	90	min R = 200											
140	0.028	55	55	0.037	70	70	0.040	90	90												
120	0.031	50	55	0.039	70	70	min R = 150														
100	0.034	50	50	0.040	70	70															
90	0.036	50	50	0.040	70	70															
80	0.038	50	50	min R = 100																	
70	0.040	50	50																		
60	0.040	50	50																		
	0.040	50	50																		
	min R = 60																				

$e_{max} = 0.04$

Notes:

- *e* is superelevation
- *A* is spiral parameter in metres
- NC is normal cross section
- RC is remove adverse crown and superelevate at normal rate
- Spiral length, L = A2 / Radius
- Spiral parameters are minimum and higher values may be used
- For 6 lane pavement: above the dashed line use 4 lane values,
- below the dashed line, use 4 lane values x 1.15.
- A divided road having a median less than 3 m wide may be treated as a single pavement.

Table U.B.3.2 Superelevation Rate for Urban Design, $e_{max} = 0.04$ m/m

Radius (m)	Design Speed (km/h)							
	30	40	50	60	70	80	90	100
7000	NC	NC	NC	NC	NC	NC	NC	NC
5000	↓	↓	↓	↓	↓	↓	↓	↓
4000	↓	↓	↓	↓	↓	↓	↓	NC
3000	↓	↓	↓	↓	↓	NC	NC	RC
2000	↓	↓	↓	↓	NC	RC	RC	↓
1500	↓	↓	↓	NC	RC	↓	↓	↓
1200	↓	↓	↓	RC	↓	↓	↓	↓
1000	↓	↓	↓	↓	↓	↓	↓	↓
900	↓	↓	NC	↓	↓	↓	↓	↓
800	↓	↓	RC	↓	↓	↓	↓	↓
700	↓	NC	↓	↓	↓	↓	↓	RC
600	↓	RC	↓	↓	↓	↓	RC	0.027
500	NC	↓	↓	↓	↓	↓	0.022	0.039
400	RC	↓	↓	↓	↓	RC	0.036	Min R=490
350	↓	↓	↓	↓	↓	0.026	Min R=380	
300	↓	↓	↓	↓	RC	0.035		
250	↓	↓	↓	↓	0.027	Min R=280		
200	↓	↓	↓	RC	0.040			
180	↓	↓	↓	0.021	Min R=200			
160	↓	↓	↓	0.027				
140	↓	↓	↓	0.035				
120	↓	↓	RC	Min R=130				
100	↓	↓	0.026					
90	↓	↓	0.032					
80	↓	↓	0.039					
70	↓	RC	Min R=80					
60	↓	0.022						
50	↓	0.032						
40	↓	Min R=45						
30	RC							
20	0.040							
	Min R=20							
min. radius for normal crown	420	660	950	1290	1680	2130	2620	3180
min. radius for reverse crown	30	65	115	185	290	400	530	690

e_{max} = 0.04 m/m
NC = normal crown (-0.02 m/m)
RC = reverse crown (+0.02 m/m)

Table U.B.3.3 Superelevation Rate for Urban Design, $e_{max} = 0.06$ m/m

Radius	Design Speed (km/h)							
(m)	30	40	50	60	70	80	90	100
7000	NC	NC	NC	NC	NC	NC	NC	NC
5000	↓	↓	↓	↓	↓	↓	↓	↓
4000	↓	↓	↓	↓	↓	↓	↓	NC
3000	↓	↓	↓	↓	↓	NC	NC	RC
2000	↓	↓	↓	↓	NC	RC	RC	↓
1500	↓	↓	↓	NC	RC	↓	↓	↓
1200	↓	↓	↓	RC	↓	↓	↓	↓
1000	↓	↓	↓	↓	↓	↓	↓	↓
900	↓	↓	NC	↓	↓	↓	↓	↓
800	↓	↓	RC	↓	↓	↓	↓	RC
700	↓	NC	↓	↓	↓	↓	↓	0.025
600	↓	RC	↓	↓	↓	↓	RC	0.035
500	NC	↓	↓	↓	↓	RC	0.030	0.048
400	RC	↓	↓	↓	↓	0.026	0.045	Min R=440
350	↓	↓	↓	↓	RC	0.035	0.056	
300	↓	↓	↓	↓	0.025	0.045	Min R=340	
250	↓	↓	↓	RC	0.036	Min R=250		
200	↓	↓	↓	0.024	0.053			
180	↓	↓	↓	0.030	Min R=190			
160	↓	↓	↓	0.037				
140	↓	↓	RC	0.046				
120	↓	↓	0.026	Min R=120				
100	↓	↓	0.036					
90	↓	↓	0.043					
80	↓	RC	0.052					
70	↓	0.024	Min R=75					
60	↓	0.032						
50	↓	0.044						
40	RC	Min R=40						
30	0.030							
20	0.056							
	Min R=20							
min. radius for normal crown	420	660	950	1290	1680	2130	2620	3180
min. radius for reverse crown	40	80	135	220	330	450	600	770

$e_{max} = 0.06$ m/m
NC = normal crown (-0.02 m/m)
RC = reverse crown (+0.02 m/m)

U.B.4.3 Minimum Gradient

- Minimum grade should be 0.5%. An absolute minimum of 0.35% may be considered in a retrofit situation where it means the retention, rather than the removal of existing pavement.
- Maintain a minimum grade of 0.6% along curb returns and a minimum of 1.0% towards the curb line within the limits of an intersection; e.g. the resultant slope of the crossfall and longitudinal gradient should be a minimum of 1%.
- Check grades on flat crest and sag curves to ensure the slope is a minimum of 0.35% at 15 m from the crest or sag. On crest curves there is no problem if the 0.35% point is 15 m from the crest ($K \leq 43$). If using a $K>43$, additional measures such as increasing the number of catch basins may be required. In sag curves, false grading of the gutter at 0.35% to the low point is allowable.

U.B.4.4 Vertical Curves

- The minimum vertical curve length is not limited to 120 m and will depend on the design speed and sight distance.
- Most urban areas incorporate a street lighting system. Therefore, in these cases it is acceptable to design vertical curvature to comfort control rather than headlight control.
- Avoid sag curves on bridge decks, where possible, to avoid complications with deck drainage and bridge design and construction.
- When a major road and a minor road intersect the profile and cross slope of the major road is carried through the intersection and the minor road adjusted accordingly.
- If two similarly classified roads intersect, the profile and cross-slope of each is adjusted to balance the influence.

CHAPTER U.C CROSS-SECTION ELEMENTS

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The cross sections discussed in this chapter refer to full urban sections with curb and gutter on both sides of the roadway. However, because of staging the Freeway and Expressway cross-sections may be initially constructed as rural sections with depressed median and ditches. Similarly, Arterial, Collector and Local roadways may initially be built as a rural cross section initially and either retained in this configuration or converted to an urban cross section later as the need arises. The Highway Geometric Design Guide illustrates the semi-urban sections that should be used.

U.C.1 CROSS-SLOPE REQUIREMENTS

Cross slope for urban sections is generally 2% in the directions shown on the typical cross sections in this Section.

U.C.2 LANE WIDTHS

The lane widths indicated in Section C.2 of the Highway Geometric Design Guide are applicable to urban sections with the exception that the width of the right-hand curb lane on lower speed (< 80 km/h) Arterials is 4.2 m. The wider lane may be achieved by reducing the gutter pan width on each side to 0.25 m instead of the standard value of 0.5 m. This practice is followed by many urban municipalities in order to better accommodate on-road bicycle traffic. Alternatively, on new construction projects the additional 0.5 m of lane width is provided on the right side of urban roadways with a design speed of 70 to 80 km/h in order to achieve the desired offset from the travel lane to the curb face.

Figures U.C.8.1a through U.C.8.1e show recommended typical sections for low speed urban roadways. Figures C-6.2a through C-6.2c from the Highway Geometric Design Guide illustrate the recommended typical sections for high speed urban roadways. These figures were originally developed for use in a rural to semi-urban environment, but can also be applied to an urban environment.

Typically, Local roads in residential and industrial areas allow parking. If parking is prohibited, the recommended cross-section width should remain to allow for turning or stopped vehicles. In residential areas there is a need to accommodate service vehicles and the occasional large truck (e.g. moving truck) traveling through the area. Generally, curb return radii are not sized to accommodate such a design vehicle and the ability to use the entire roadway width at the intersections, no parking zones near intersections and absence of raised islands or channelization will allow a large truck to successfully complete the turning manoeuver.

Parallel parking may also be allowed on roadways classified as Collectors and minor Arterials as long as the through lanes provide adequate capacity. A passenger car parked adjacent to a curb will occupy, on average, approximately 2.1 m of street width.

The determination of the parking lane width should consider the appropriate width for future use as a through lane either continuously or during peak hours. In the case of Arterials, if determined that it is unlikely the parking lane will not be used as a through lane, a lane width as low as 2.4 m may be acceptable. Parking lane widths do not include the gutter pan dimensions, which in practice may be used for parking. The length of a typical parallel parking stall is 7.0 to 8.0 m.

The following table summarizes when parking can be considered and the recommended parking lane widths.

Table U.C.1 Parking Locations and Widths

Road Classification	Parking	Parking Lane Width
Freeway	Prohibited	N/A
Expressway	Prohibited	N/A
Major Arterial	Prohibited	N/A
Minor Arterial	Restricted	3.0 to 3.5 m (2.4 m if not a future through lane)
Collector	Permitted	2.1 to 2.4 m Residential 2.4 to 3.3 m Commercial - Industrial

U.C.3 SHOULDERS

Shoulders will only be required on the higher speed Freeways and Expressways and will generally follow the guidelines of Section C.3 of the Highway Geometric Design Guide. Table U.A.7 and the typical sections indicate the recommended shoulder widths.

U.C.5 ROADSIDE DESIGN

On Alberta Transportation roadways within an urban setting the designer should adhere to the clear zone requirements as indicated in Table C.5.2a of the Highway Geometric Design Guide. This will apply to the installation of trees, signal poles, illumination poles, fire hydrants and other street furniture that may be located within the right of way. The following guidelines for clear zones should also be considered when designing in an urban environment:

Vegetation

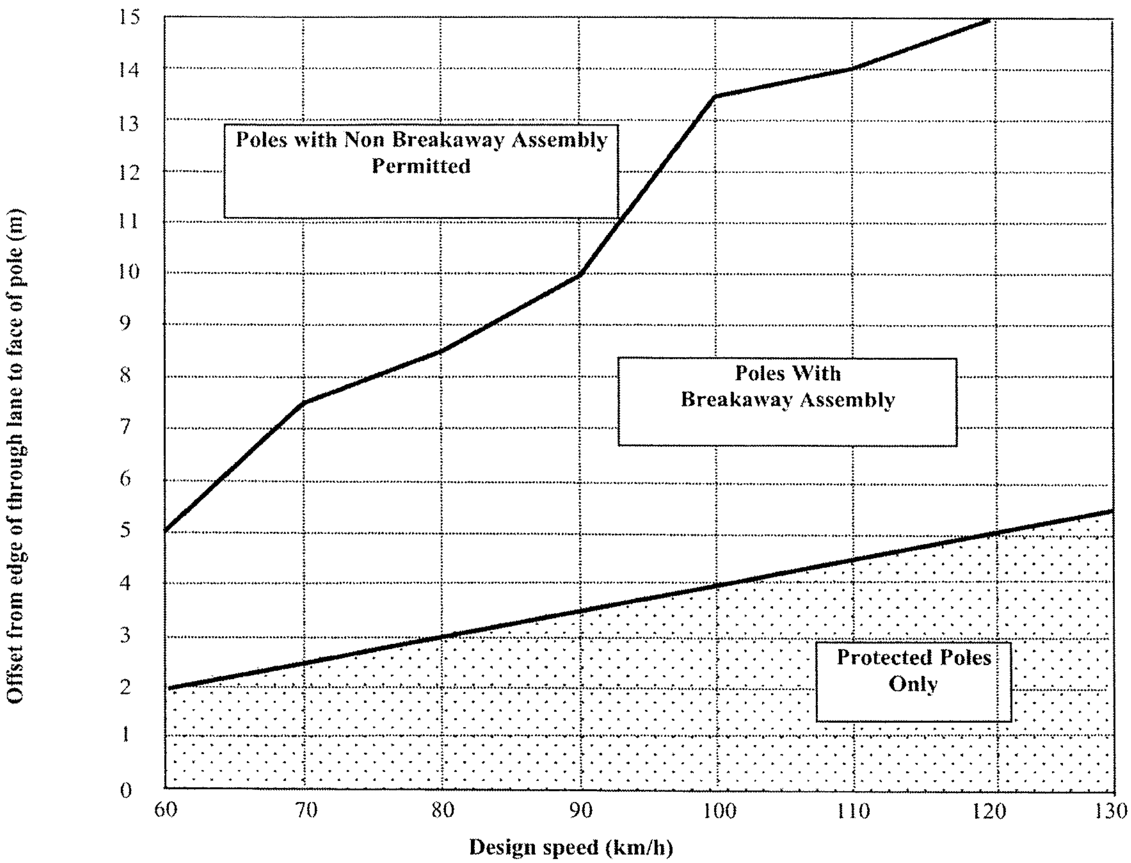
- Trees should not be planted within the clear zone. If they are, they should be less than 150 mm in diameter when they are mature.
- For small trees planted in groups, the equivalent diameter is based on the combined cross-section area and should not exceed 150 mm when they are mature.
- Existing large trees within the clear zone should be removed or protected.
- Roadside barriers should only be used to protect trees when the severity of striking the tree is greater than that of striking the barrier.
- Sight lines for decision, stopping or intersection sight distances should not be adversely impacted by any planted vegetation.

Streetlighting Poles

- Lighting poles may be either the break-away, yielding or non-breakaway (rigid) types. The selection of the appropriate type depends on offset, application, presence of pedestrians, and design speed of the roadway.
- Yielding poles are normally used along roadways with speeds ≤ 80 km/h, at intersections, and along roadways adjacent to sidewalks and playgrounds.
- Breakaway poles are generally used on roadways with design speeds > 80 km/h and where pedestrians are not present.
- Non–breakaway poles shall be located outside the clear zone.

- Figure U.C.5.1 excerpted from Alberta Transportation's Highway Lighting Design Guide summarizes the suggested application of various types of poles as related to lateral offset and design speed.

Figure U.C.5.1 Allowable Pole Setbacks



Signal Poles and Service Poles

- Supports for traffic signal poles are not usually of the break-away type because of the potential consequences of the loss of a signal at the intersection and the potential of the pole falling and causing additional damage.
- Traffic signal poles on high speed roadways (> 80 km/h) should be placed as far away from the roadside as practical.
- Fire hydrants should be placed away from the roadway as far as possible, but they must still be accessible to emergency personnel. Generally, there should be no fire hydrants near the travel lanes on Freeways, Expressways or divided Arterials.

Utility Poles

- Utility poles should be located where they are least likely to be struck.

- If utility poles are within the clear zone, consideration should be given to burying the utilities, providing a barrier in front of the poles, or relocating the poles outside the clear zone.
- For large utility poles or structures, such as those for transmission lines, that are within the clear zone provision of a barrier in front of the poles should be considered.

Signs

- Sign supports and barrier requirements should follow Alberta Transportation's current Roadside Barrier Practices.
- Small signs (< 5 m^2) should be installed such that the bottom of the sign panel is a minimum of 2.1 m above ground.

U.C.6 MEDIANS AND OUTER SEPARATIONS

In general, the median for an urban Arterial will be a 5.5 m wide raised section (face to face). This will allow for a 3.5 m wide left-turn lane with space for signal poles and signing as required. On higher speed Freeways and Expressways, where additional lanes will be required at a later date, depressed medians may be used as an interim stage in the urban design. As shown in Figures U.C.8.1a through U.C.8.1e, the median may be left flush for a lower speed Arterial, but on a higher speed Expressway can be replaced with a barrier and shoulders.

When a frontage road runs parallel to an urban Arterial, an outer separation is required between the Arterial road and the frontage road. The width of the separation depends on whether the frontage road operates as a one-way or a two-way road. When a two-way frontage road is provided, the driver must contend with the approaching traffic from both the frontage road and the Arterial. Therefore, sufficient distance must be provided to minimize the effects of the approaching traffic particularly headlight glare on non-illuminated sections. Separation widths in the range of 4.0 to 6.0 m are typical for this application. The recommended minimum is 3.0 m, however, the minimum width will typically be governed by the clearances required for installation of street lighting poles.

With one-way frontage roads, the separation distance does not need to be as wide. However, a minimum width of 3.0 m should still be provided.

When a frontage road intersects a cross street the width of the separation between the Arterial road intersection and the frontage road intersection must be increased substantially to accommodate vehicle storage and turning movement requirements. This can usually be achieved by bulbing of the frontage road. The setback distance will be determined by the amount of storage required between the arterial/cross-street intersection and the frontage road/cross-street intersection, as well as, the turning radii required to accommodate the design vehicles.

U.C.7 OFF ROAD ELEMENTS

U.C.7.1 Boulevards

Boulevards on urban sections serve as a safety separation as well as a location for surface and underground utilities, traffic signs and other control devices, as well as snow storage. The incorporation of boulevards is particularly important for streets with design speeds greater than 60 km/h.

The standard widths for boulevards are 3.0 m for Arterials and 2.0 m for Collectors and Locals. Location of the lighting poles is an important consideration when setting the boulevard width. For example, positioning the sidewalk behind the lighting poles effectively separates the pedestrians and the traffic. However, from a vehicle safety perspective it may be better to place the poles in the border area behind the sidewalk, as well as providing a suitable boulevard width to separate pedestrians from vehicular traffic.

U.C.7.2 Pedestrian Environments

The principles of Section C.7 of the Highway Geometric Design Guide will apply for pedestrian environments. Most urban streets with the exception of Freeways, Expressways and some high-speed Arterials accommodate pedestrian traffic through the use of sidewalks or pathways. For the controlled access roadways mentioned above, pedestrian accommodation adjacent to the roadway is typically discouraged and provided in other areas.

Existing Policies and Guidelines

Generally, Alberta Transportation does not restrict the use of highways by pedestrian or bicycle traffic, but does not provide specific facilities to accommodate these modes of travel. Concessions are made to bicycle travel on some highways where the width of the grooved rumble strips installed on 1.8 m or wider highway shoulders been reduced to 300 mm. In addition, rumble strips are not used in urban areas due to the nuisance effect of the noise.

In the Alberta Transportation's Pathways Guidelines the points that are relevant to geometric standards development are:

- Provision of sidewalks or pathways will be evaluated on a case by case basis.
- Cross slope for sidewalks on bridges shall be 2%.
- Adjacent to a roadway with open drainage the provision of parallel bicycle paths or pedestrian sidewalks, if warranted, should be between the ditch and the right-of-way limit where the posted speed > 70 km/hr.
- Pathways are not allowed within the road right-of-way where posted speeds of 80 km/h or higher exist or are proposed.
- Pathways adjacent to Arterial roadways with posted speeds ≤ 70 km/h are allowed where safety is not compromised.
- Sidewalks may be provided adjacent to lower speed (posted speed ≤70 km/h) roadways in situations that are fully developed. Where the posted speed is ≤60 km/h and where a barrier curb and generally illumination exists, the sidewalk may exist adjacent to the highway without a boulevard or landscaped separation.
- Pedestrian crossings will not be permitted at free flow systems interchanges.
- Pedestrian crossings may be permitted at non-systems interchanges and Arterial roadways where safety is not compromised.
- TAC guidelines will generally be used to determine the width of sidewalks, pathways and combined use trails. The following table excerpted from the TAC Geometric Design Guide for Canadian Roads summarizes these guidelines for pathways and combined use trails.

Table U.C.7
Pathway and Combined Use Trail Widths

Classification	Lane Width (m) Design Domain
Two-way, exclusive	2.5 – 3.5
Two-way, shared with pedestrians	3.0 – 4.0
One-way, exclusive	1.5 – 2.0
One-way, shared with pedestrians	2.0 – 3.0

Note: A horizontal clearance of 600 mm is maintained between a bikeway and a lateral obstruction. Curbing, in excess of 150 mm in height, is regarded as a lateral obstruction.

In Section C.7.1.2 of the Highway Geometric Design Guide, Alberta Transportation lists 'Principles of Good Design'. These principles should be followed.

In Section C.7.1.4 of the Highway Geometric Design Guide, it is noted that "On major Arterial roads, where higher speeds and higher traffic volumes are expected, a 3.0 m offset between curb and sidewalk is desirable. A grass surface may be used to provide a contrasting colour and texture for the boulevard." It should be noted that much of this is related to clear zones, which are listed in Table C.5.2 of the Highway Geometric Design Guide, and encroachment rates onto the roadside.

In addition to the points listed in Section C.7 of the Highway Geometric Design Guide, the following additional points should be considered in determining the need for a sidewalk or pathway and the design parameters to use for this sidewalk or pathway.

- When constructing new roads or reconstructing existing roads through an urban municipality, Alberta Transportation will work with the urban municipality to achieve continuity of their proposed bicycle paths and sidewalks.
- Currently, Alberta Transportation has no warrants for determining whether to provide sidewalks. Each candidate location is assessed on an case-by-case basis.
- Where property is limited or where sidewalks have to be wider than usual to accommodate pedestrian traffic, boulevards may be narrower than the standard width and in some cases omitted entirely. Examples of where this may occur are in downtown areas or in areas fully developed with retail stores and offices.

If there is a demonstrated need for bicycle facilities on the roadway, where the design speed is < 80 km/h, either a delineated bicycle lane or wide curb lane may be used. Bicycle lanes are typically 1.2 to 1.8 m wide while wide curb lanes are typically 4.2 m wide.

Both bicycle lanes and wide curb lanes can and should be used to improve riding conditions for bicyclists. Bicycle lanes are preferred by cyclists and could be considered where the number of potential cyclists is relatively high and where there is adequate width for at least a 1.2 m wide bicycle lane. Where the design speed is 80 km/h or greater, cyclists on an urban cross-section highway can only be accommodated on a separate bicycle path or on the shoulder of a rural cross-section highway.

General considerations for pedestrians and bicycles include:

- No provision of a parallel bicycle path or pedestrian sidewalk will be allowed on existing and proposed limited access Freeways.
- Bicycle use of the paved, outside shoulders should not be prohibited except on limited access Freeways.

- Generally, the minimum width of a sidewalk should be 1.8 m. The absolute minimum unobstructed width should be 1.5 m. A wider sidewalk may be warranted in areas of high pedestrian use.
- The minimum two-way bicycle or combined use trail width should be 3.0 m.
- On bridges, pedestrian or bicycle movements shall be separated from vehicular traffic by an approved barrier.

U.C.7.4 Curb and Gutter

U.C.7.4.1 General

Curbs are used on all types of low speed roadways and can provide drainage control, roadway edge delineation, reduce right-of-way requirements, improve aesthetics, delineate between vehicular and pedestrian areas and assist in access management and roadway development control. However, the type and location of curbs affects driver behaviour and in turn the function and safety of a highway. Therefore, in the interests of safety, caution should be exercised in the use of curbs on roadways with design speeds > 70 km/h.

U.C.7.4.2 Curb and Gutter Configuration

The standard dimensions for curb and gutter are outlined in Section C.7.4 of the Highway Geometric Design Guide.

U.C.7.4.3 Curb and Gutter Placement

For low speed roadways (design speed ≤70 km/h), a 150 mm high barrier curb (vertical face curb) may be placed at the edge of the traveled way. However, it is preferable that the curb face be offset by 0.25 to 0.50 m. Curbs for medians and islands or where curb is introduced intermittently along roadways should be offset 0.5 m from the traveled way.

Barrier curb should not be used along Freeways, Expressways or high speed Arterials (design speed > 70 km/h). If a curb is needed, it should be a sloped or rolled face curb located at or beyond the outer edge of the shoulder. An additional 0.5 m wide tapered offset and sloping end treatment should be provided at the point where the curb begins.

When using curbs in conjunction with traffic barriers, the type and height of barrier must be reviewed. Ideally, the curb should be located flush with or behind the face of the traffic barrier. Curbs placed in front of traffic barriers can result in unpredictable impact trajectories.

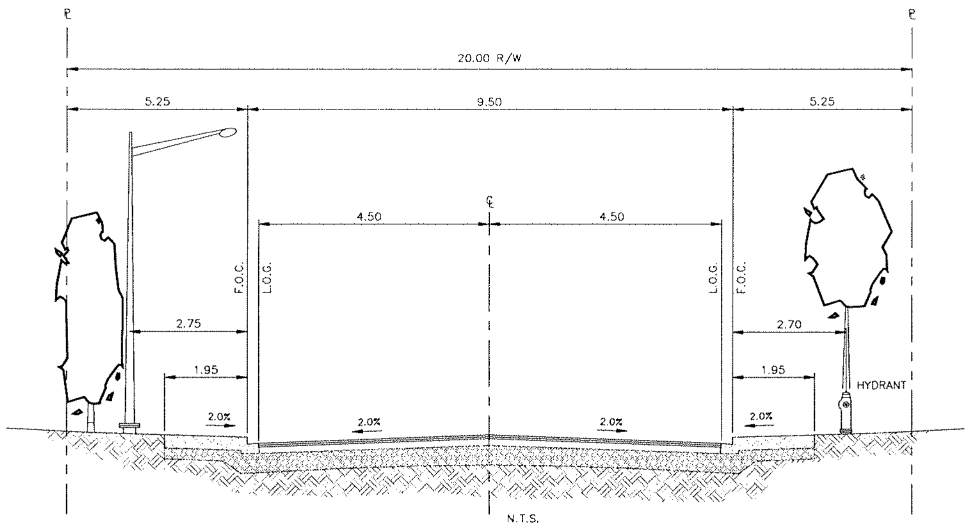
If a curb is used in conjunction with a traffic barrier, it should be a sloped or rolled face curb. If a barrier curb is used its height should be limited to 100 mm.

Generally, curbs should not be used in conjunction with concrete median barriers. Improperly placed curbs may cause errant vehicles to vault the concrete median barrier or to strike it, causing the vehicle to overturn. For a more complete discussion on curb usage and location refer to AASHTO's Roadside Design Guide.

U.C.8 TYPICAL CROSS-SECTIONS

Typical cross sections for urban highways are shown in Figures U.C.8.1a through U.C.8.1e.

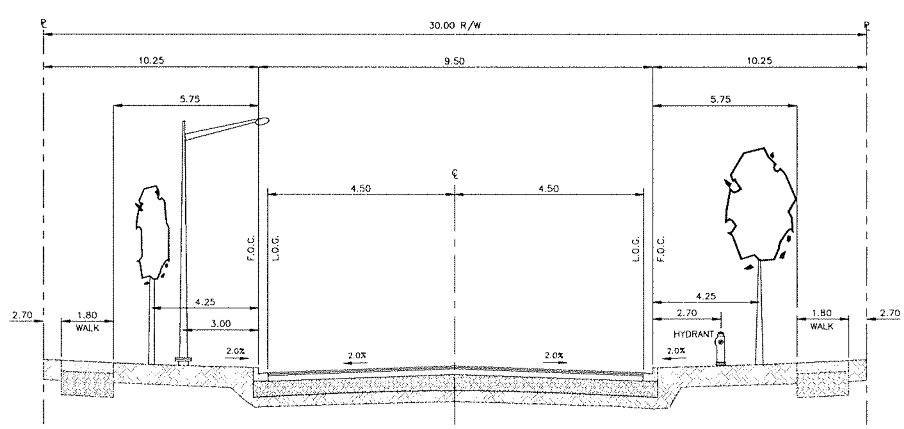
Figure U.C.8.1a



NOTES:
- GUTTER ASSUMED TO BE 250MM
  F.O.C. = FACE OF CURB
  L.O.G. = LIP OF GUTTER
- STREET FURNITURE SHOULD BE LOCATED OUTSIDE THE CLEAR ZONE OR BE CRASH FRIENDLY (SEE TABLE C.5.2a OF THE HIGHWAY GEOMETRIC DESIGN GUIDE FOR FURTHER GUIDANCE)
- ALL STREET LIGHT POLES TO UTILIZE BREAK-AWAY BASES (SEE FIGURE U.C.5.1)
- HYDRANT LOCATIONS BASED ON PUMPER TRUCK CONNECTION REQUIREMENTS
- SIDEWALKS, PATHWAYS, HYDRANTS AND TREES BY OTHERS.

ULU 209.0 – 60

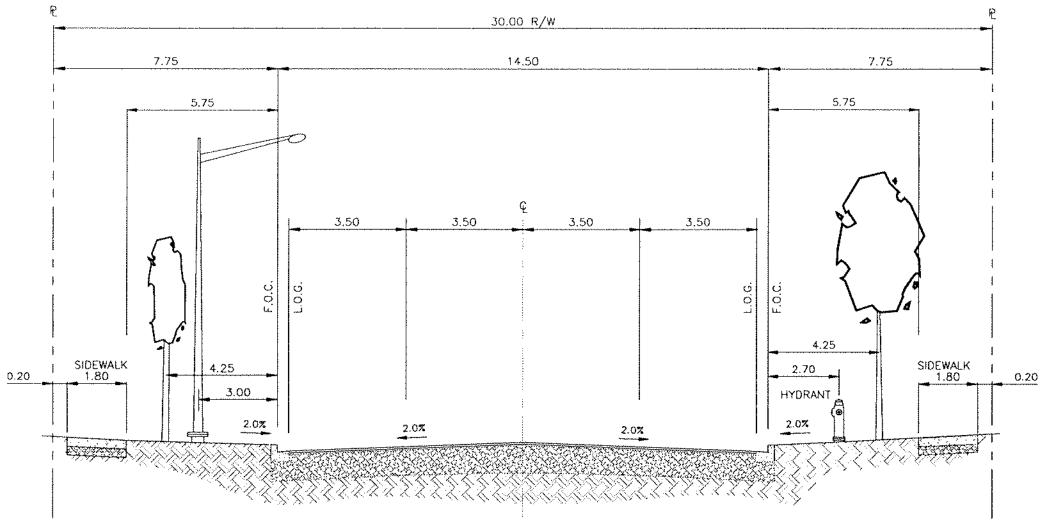
Figure U.C.8.1b



NOTES:
- GUTTER ASSUMED TO BE 250MM
  F.O.C. = FACE OF CURB
  L.O.G. = LIP OF GUTTER
- STREET FURNITURE SHOULD BE LOCATED OUTSIDE THE CLEAR ZONE OR BE CRASH FRIENDLY (SEE TABLE C.5.2a OF THE HIGHWAY GEOMETRIC DESIGN GUIDE FOR FURTHER GUIDANCE)
- ALL STREET LIGHT POLES TO UTILIZE BREAK-AWAY BASES (SEE FIGURE U.C.5.1)
- HYDRANT LOCATIONS BASED ON PUMPER TRUCK CONNECTION REQUIREMENTS
- SIDEWALKS, PATHWAYS, HYDRANTS AND TREES BY OTHERS.

UCU 209.0 – 70
UAU 209.0 – 70

Figure U.C.8.1c

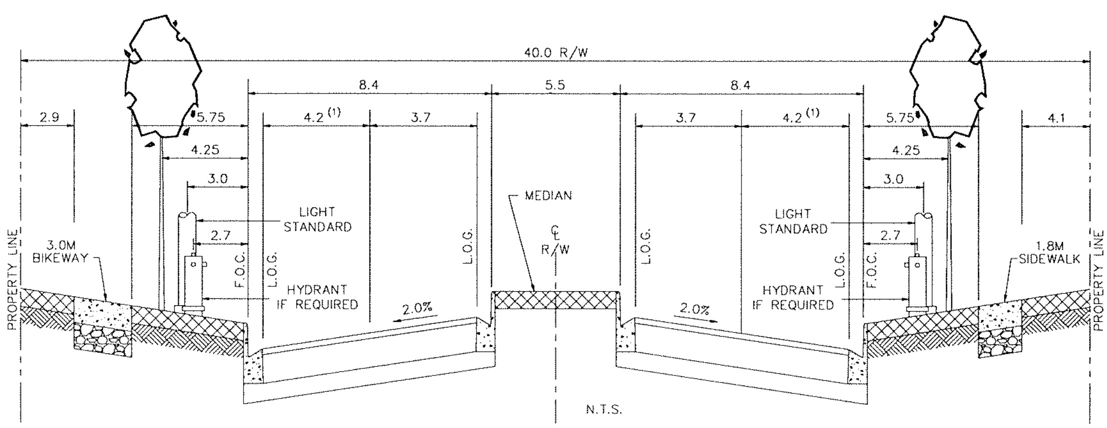


N.T.S.

NOTES:
- GUTTER ASSUMED TO BE 250MM
  F.O.C. = FACE OF CURB
  L.O.G. = LIP OF GUTTER
- STREET FURNITURE SHOULD BE LOCATED OUTSIDE THE CLEAR ZONE OR BE CRASH FRIENDLY (SEE TABLE C.5.2a OF THE HIGHWAY GEOMETRIC DESIGN GUIDE FOR FURTHER GUIDANCE)
- ALL STREET LIGHT POLES TO UTILIZE BREAK-AWAY BASES (SEE FIGURE U.C.5.1)
- HYDRANT LOCATIONS BASED ON PUMPER TRUCK CONNECTION REQUIREMENTS
- SIDEWALKS, PATHWAYS, HYDRANTS AND TREES BY OTHERS.

UCU 414.0 – 70

Figure U.C.8.1d

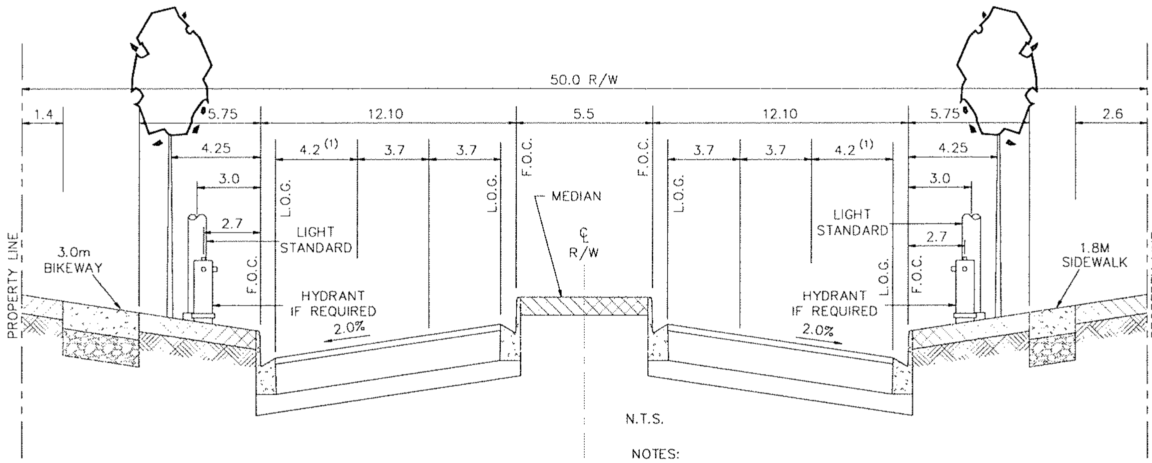


N.T.S.

NOTES:
(1) ON THE UAD 80 SECTION THIS LANE WIDTH MAY BE REDUCED TO 3.7M WHERE SEPARATE BIKE FACILITIES ARE PROVIDED
- GUTTER ASSUMED TO BE 250MM
- USE MOUNTABLE CURB WHEN DESIGN SPEED EXCEEDS 70 KM/H
- STREET FURNITURE SHOULD BE LOCATED OUTSIDE THE CLEAR ZONE OR BE CRASH FRIENDLY (SEE TABLE C.5.2a OF THE HIGHWAY GEOMETRIC DESIGN GUIDE FOR FURTHER GUIDANCE)
- ALL STREET LIGHT POLES TO UTILIZE BREAK-AWAY BASES (SEE FIGURE U.C.5.1)
- HYDRANT LOCATIONS BASED ON PUMPER TRUCK CONNECTION REQUIREMENTS
- SIDEWALKS, PATHWAYS, HYDRANTS AND TREES BY OTHERS.
  F.O.C. = FACE OF CURB
  L.O.G. = LIP OF GUTTER

UAD 407.9 – 70
UAD 407.4 – 80 (2)

U.C.8.1e



NOTES:

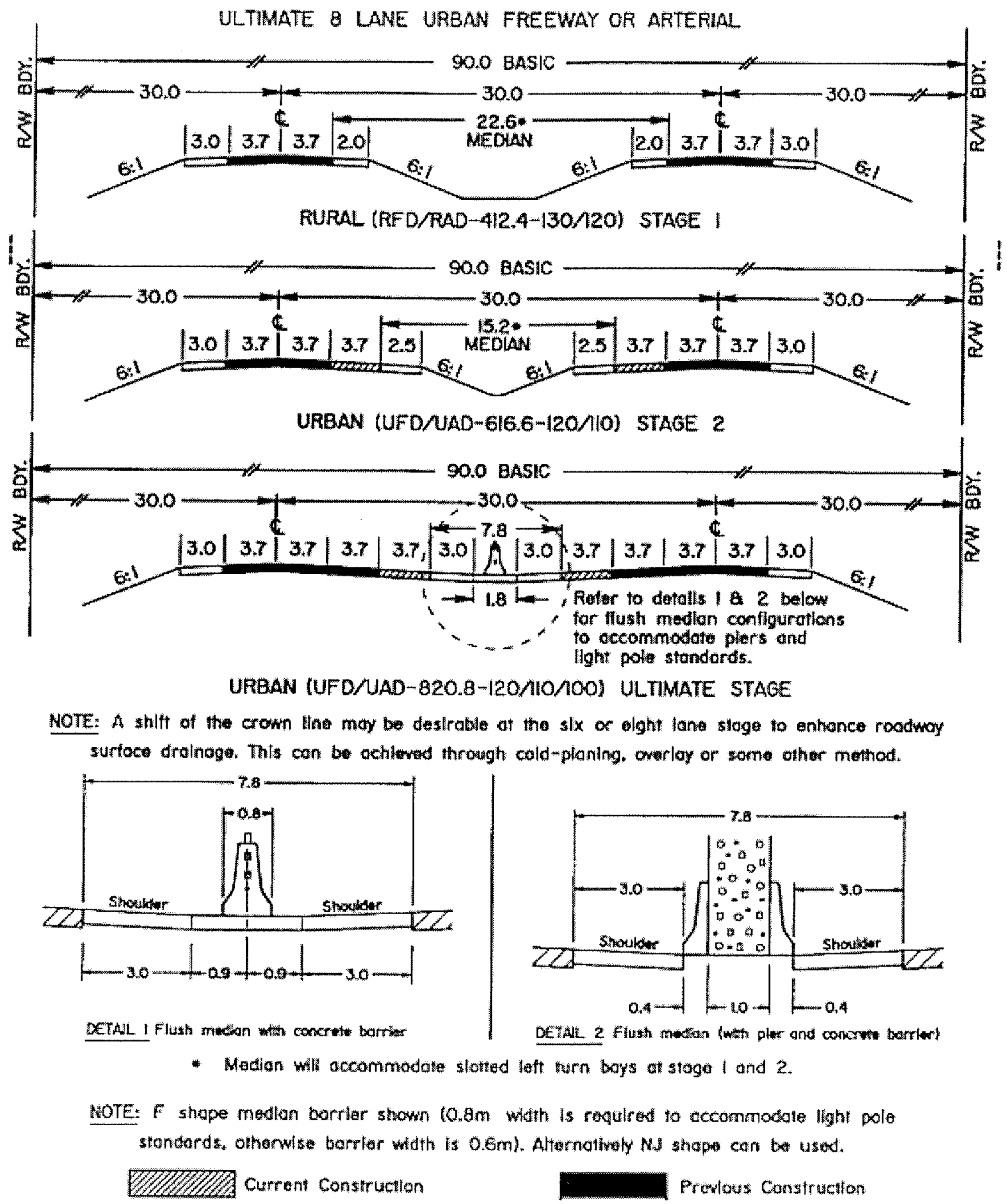
(1) ON THE UAD 80 SECTION THIS LANE WIDTH MAY BE REDUCED TO 3.7M WHERE SEPARATE BIKE FACILITIES ARE PROVIDED

- GUTTER ASSUMED TO BE 250MM
- USE MOUNTABLE CURB WHEN DESIGN SPEED EXCEEDS 70 KM/H
- STREET FURNITURE SHOULD BE LOCATED OUTSIDE THE CLEAR ZONE OR BE CRASH FRIENDLY (SEE TABLE C.5.2a OF THE HIGHWAY GEOMETRIC DESIGN GUIDE FOR FURTHER GUIDANCE)
- ALL STREET LIGHT POLES TO UTILIZE BREAK-AWAY BASES (SEE FIGURE U.C.5.1)
- HYDRANT LOCATIONS BASED ON PUMPER TRUCK CONNECTION REQUIREMENTS
- SIDEWALKS, PATHWAYS, HYDRANTS AND TREES BY OTHERS.

F.O.C. = FACE OF CURB
L.O.G. = LIP OF GUTTER

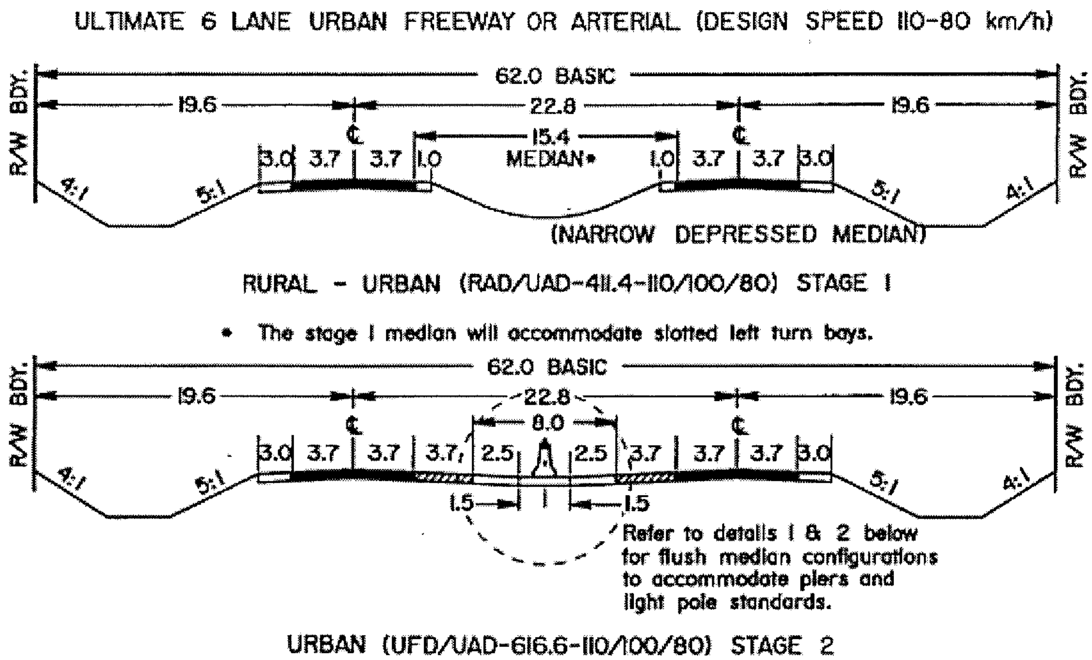
UAD 611.6 – 70
UAD 611.1 – 80(2)

Figure U.C.6.2a
Rural – Urban Multi-Lane Divided Highway Typical Cross sections

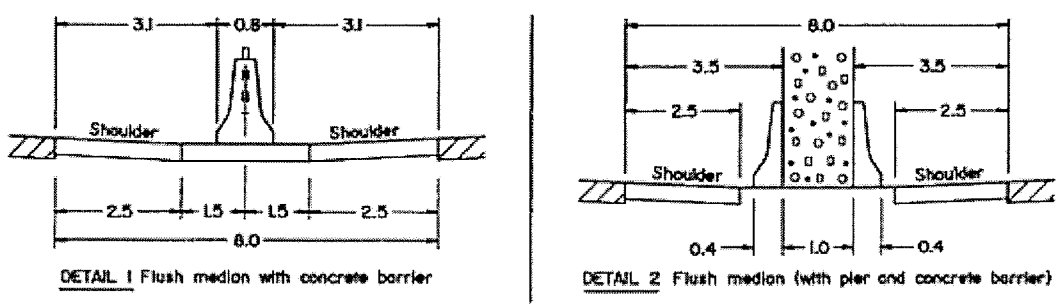


Source: Alberta Transportation Highway Geometric Design Guide

Figure U.C.6.2b
Rural – Urban Multi-Lane Divided Highway Typical Cross Sections



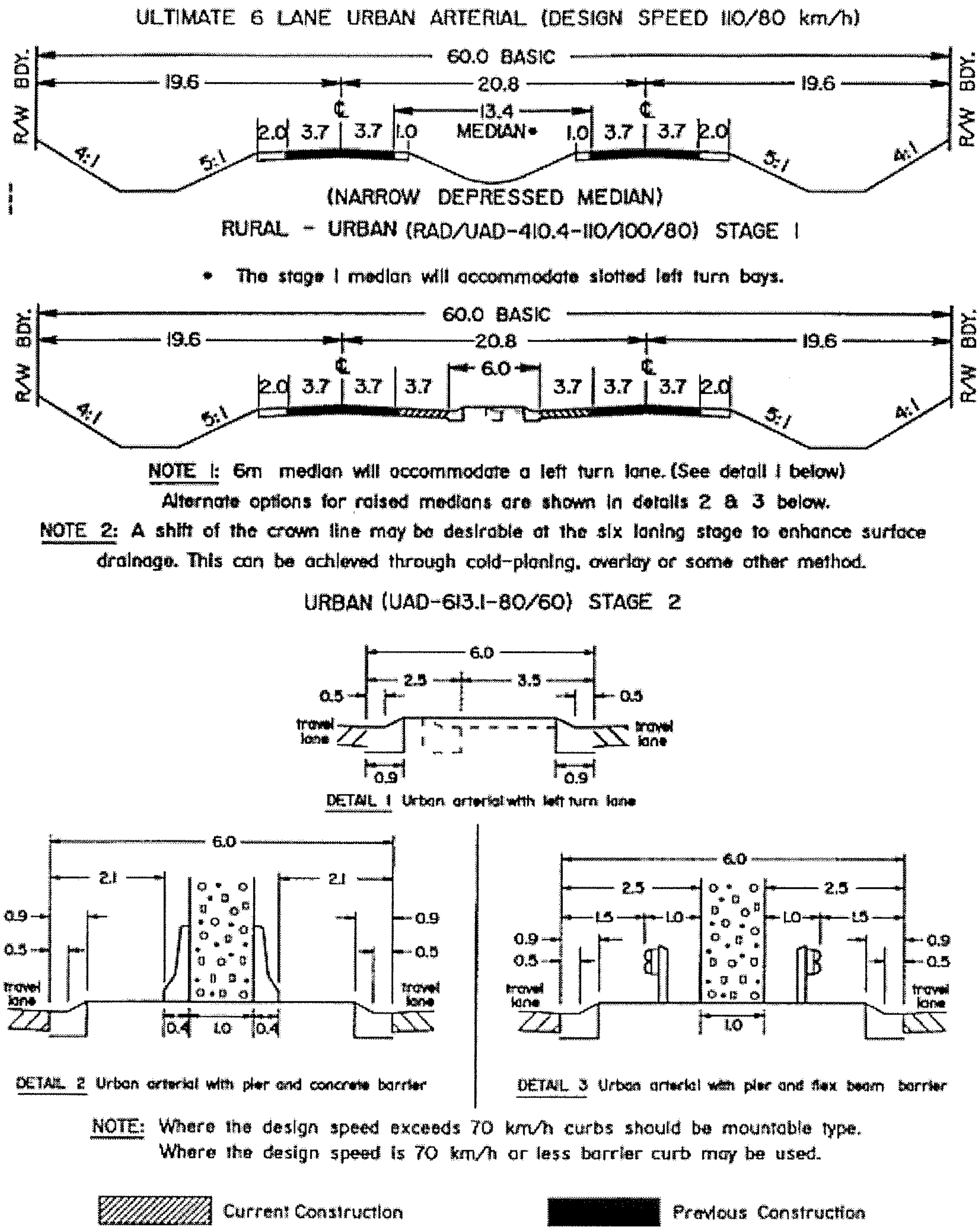
NOTE: A shift of the crown line may be desirable at the six laning stage to enhance surface drainage. This can be achieved through cold-planing, overlay or some other method.



NOTE: F shape median barrier shown (0.8m width is required to accommodate light pole standards, otherwise barrier width is 0.6m). Alternatively NJ shape can be used.

Source: Alberta Transportation Highway Geometric Design Guide

Figure U.C.6.2c
Rural – Urban Multi-Lane Divided Highway Typical Cross Sections



Source: Alberta Transportation Highway Geometric Design Guide

CHAPTER U.D
AT-GRADE INTERSECTIONS

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CHAPTER U.D AT-GRADE INTERSECTIONS

U.D.1 INTRODUCTION

U.D.1.4 Design Considerations

Generally, the design of at-grade intersections depend upon many variables including existing topography, site geometry, traffic volumes, turning volumes, design vehicles and signal timing, if traffic signals exist. It is recommended that intersectional requirements be determined by an intersectional analysis that considers these and any other operational factors.

The Highway Geometric Design Guide has extensive information on the design of intersections and much of it is applicable to intersections in urban areas as well as rural areas. The following points should also be considered when designing intersections in urban areas

General

- Where Alberta Transportation's Highway Pavement Marking Guide does not apply, the selection and design of pavement marking for an urban area should follow the latest edition of the Transportation Association of Canada's Manual of Uniform Traffic Control Devices for Canada.
- Some encroachment on other lanes by occasional large turning vehicles is tolerable.
- If right-of-way constraints are a concern in retrofit situations, reduced boulevard, median, lane, and sidewalk widths can be considered.
- For the purpose of sight distance assessment, signalized intersections are considered to function as an intersection with stop control in all directions.

Horizontal Alignment

- Small shifts of up to 1.5 m in the horizontal alignment across intersections are acceptable, when it is not feasible to correct.
- Sight distance triangles appropriate to the type of traffic control (e.g. stop, yield, traffic signal) should be maintained clear of obstructions at urban intersections.

Vertical Alignment

- Grade breaks of 0.5% to 2.0% across an intersection are tolerable at 70 to 80 km/h.
- Grade breaks of 3% to 4% are tolerable at design speeds of 50 km/h or less provided the sight distance is adequate.

Intersection Lane Requirements

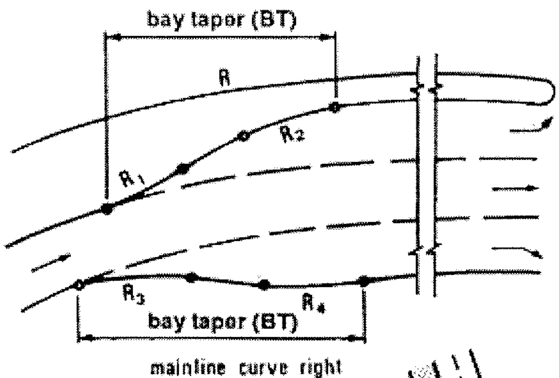
- When designing intersections in an urban environment the roadway width and corner radii should be designed to shorten pedestrian crossing distances.
- Turn bay tapers on curves should be distinctive enough to discourage through traffic from drifting into the turn lane. Figure U.D.1.4a at the end of this section illustrates the recommended design of right and left turn bays on curves.

- Slotted left turn lanes should be designed in the initial stages of a Freeway and Expressway design because of the increased safety resulting from the improved visibility for left turning vehicles. Typically, the median is wide enough in the initial stages to accommodate this design. Figure U.D.1.4b at the end of this section illustrates a typical slotted left turn design.
- The introduction of a left turn lane at an intersection of an Arterial roadway that does not have an existing median shall be designed by introducing a median to protect the left turning vehicles. Typical examples of an introduced left turn median are illustrated in Figure U.D.1.4c at the end of this section.
- Channelized right turns should be designed in the initial stages of a Freeway and Expressway design, because it's likely the roadway will be carrying large trucks and the speeds will be higher.
- Islands less than 6 m^2 in area shall not be used.
- Turning movement templates shall be used to confirm all movements for the design vehicle can be accommodated. Typically, a channelized right turn lane will be 6.0 m wide.
- Two-way left turn lanes will not be used on Alberta Transportation roadways through urban municipalities. Access to adjacent property and crossing roadways will be as per Alberta Transportation's Access Management Guidelines. Left turning vehicles will generally be accommodated at turn lanes protected by a concrete median.

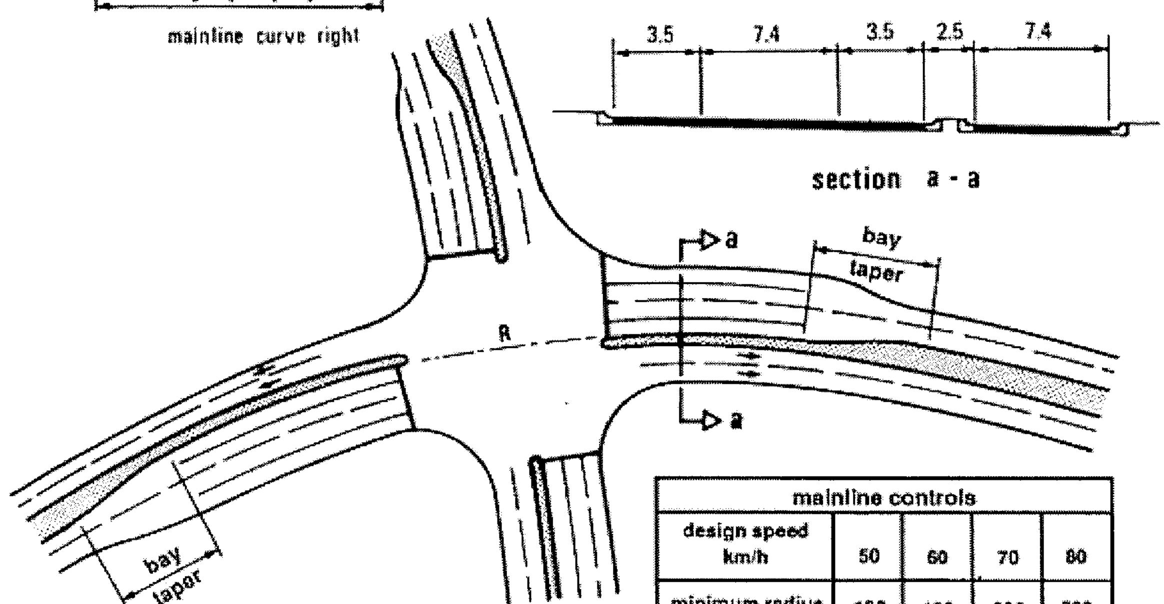
Intersection Spacing

Generally, intersection spacing on all Alberta Transportation roadways will follow the current edition of Alberta Transportation's Access Management Guidelines. The spacing given in Table U.A.1 is typical and may be used in the absence of project specific guidance from Alberta Transportation. Figure U.D.1.4d at the end of this section provides information on the recommended spacing of intersections adjacent to interchanges.

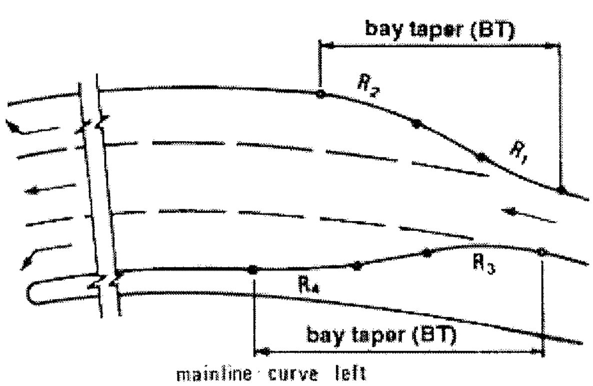
Figure U.D.1.4a Intersection on Curve



turn lane controls[1]					
R ≥	100	250	350	600	800
T	20	25	30	35	50
R_1	30	55	80	105	150
R_2	25	35	50	70	150



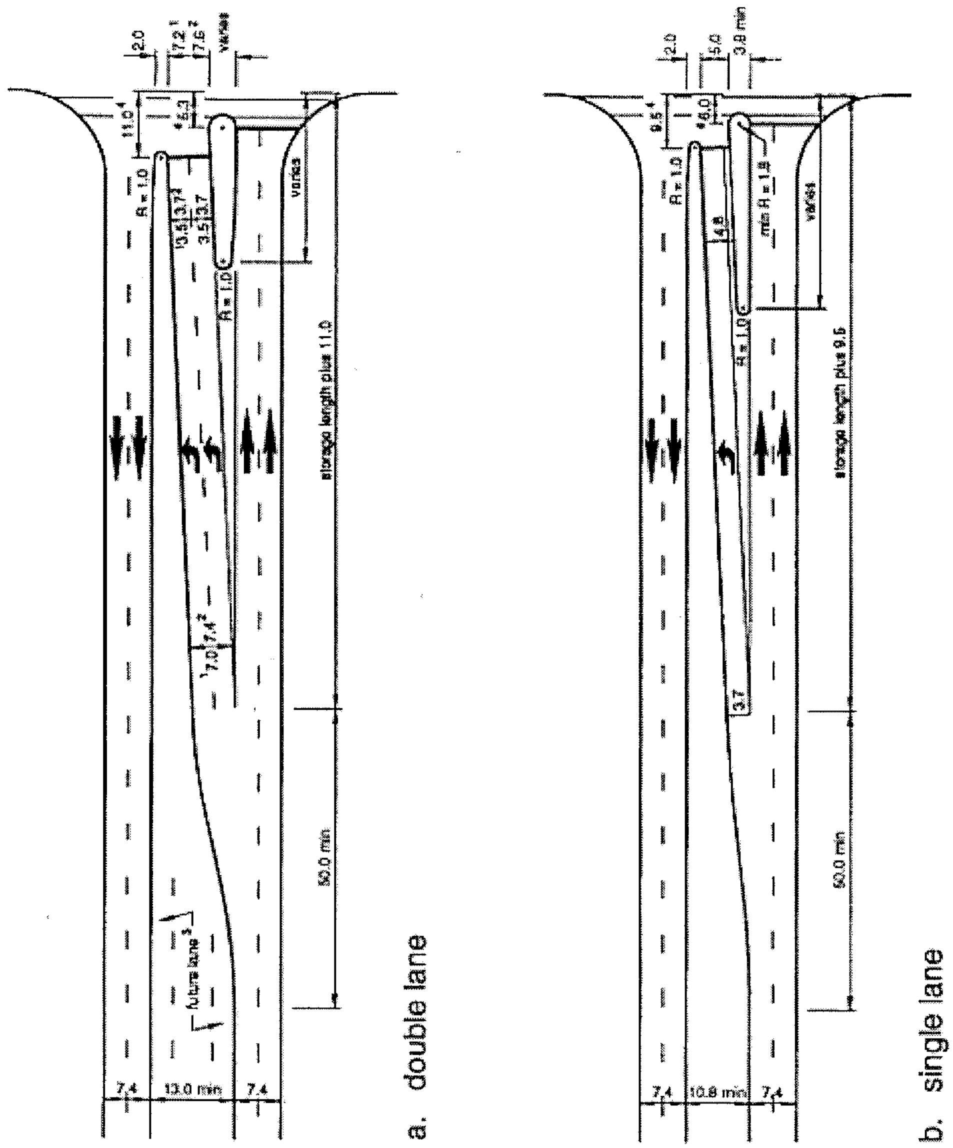
mainline controls				
design speed km/h	50	60	70	80
minimum radius	100	150	200	280
desirable radius	500	500	500	500
maximum e	0.04	0.04	0.04	0.04



turn lane controls[1]					
R ≥	100	250	350	600	800
T	20	25	30	35	50
R_3	25	35	50	70	150
R_4	30	55	80	105	150

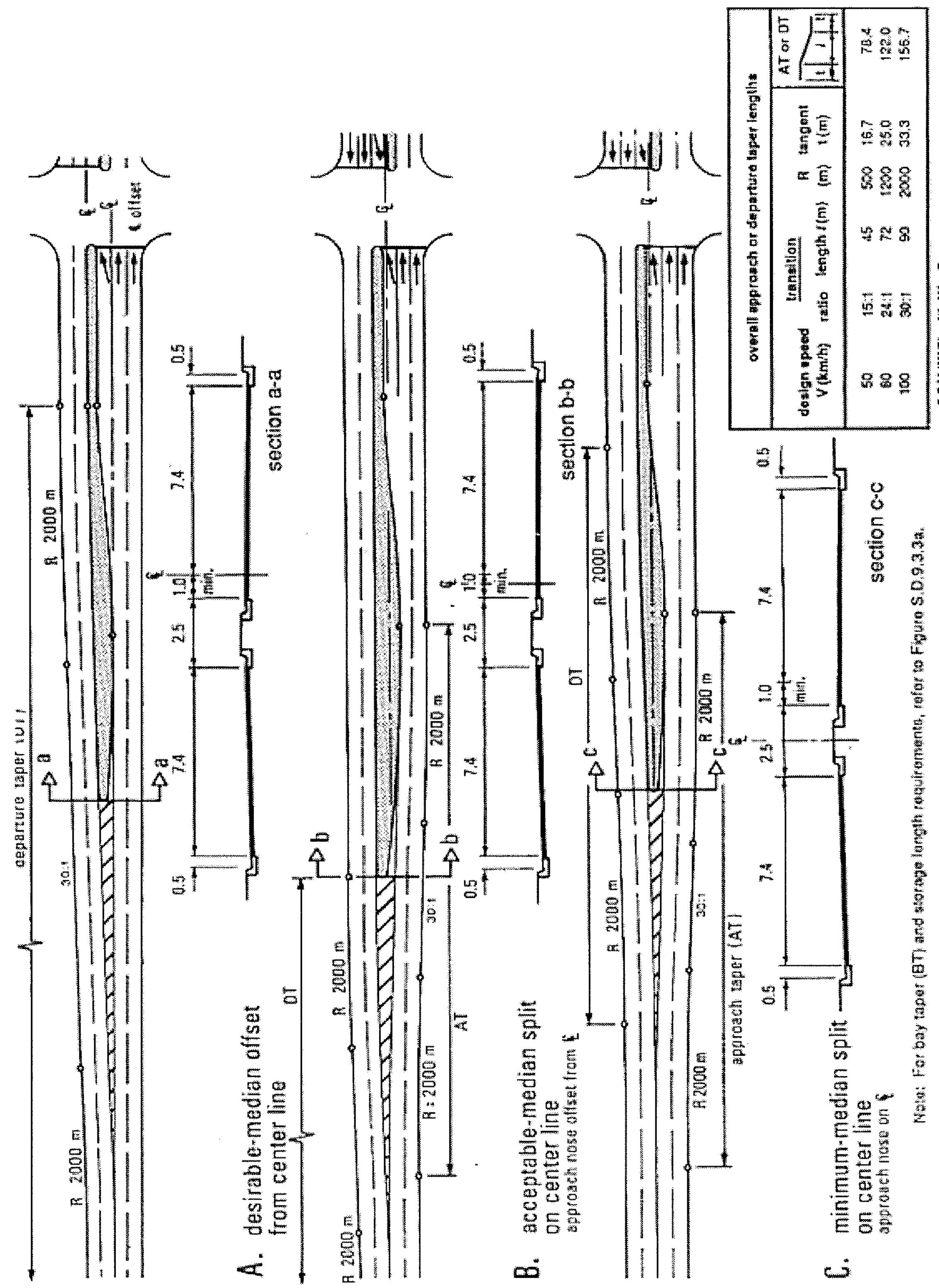
Notes:

Figure U.D.1.4b Typical slotted left-turn lane designs



Notes: 1. Based on predominately P vehicles with consideration for SU vehicles.
2. *Based on sufficient SU vehicles to govern design.*
3. Slot design eliminated when future lanes added in median area.
4. All nose locations to be checked using design vehicle turning templates.

Figure U.D.1.4c Introduced Median

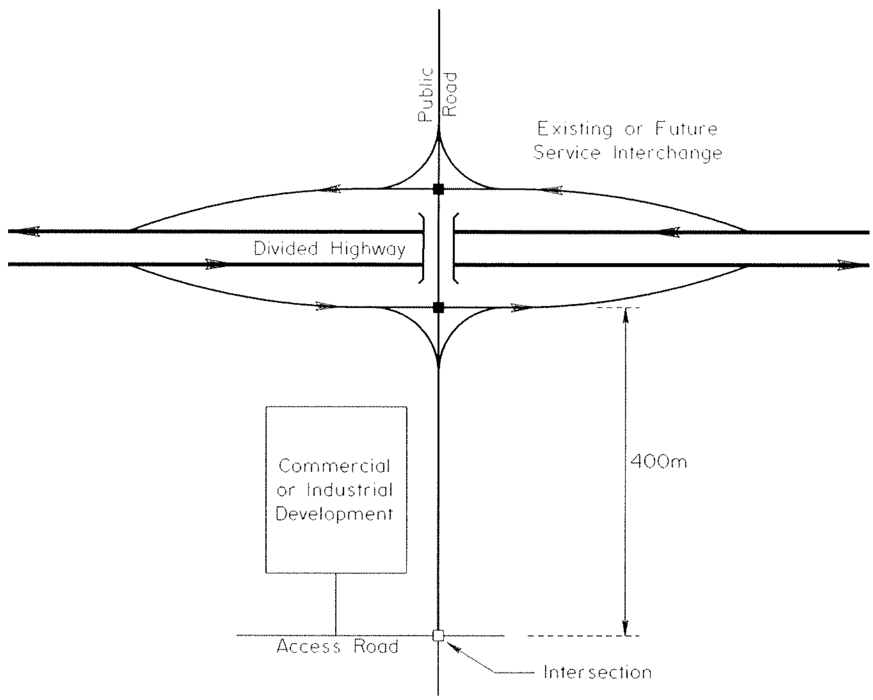


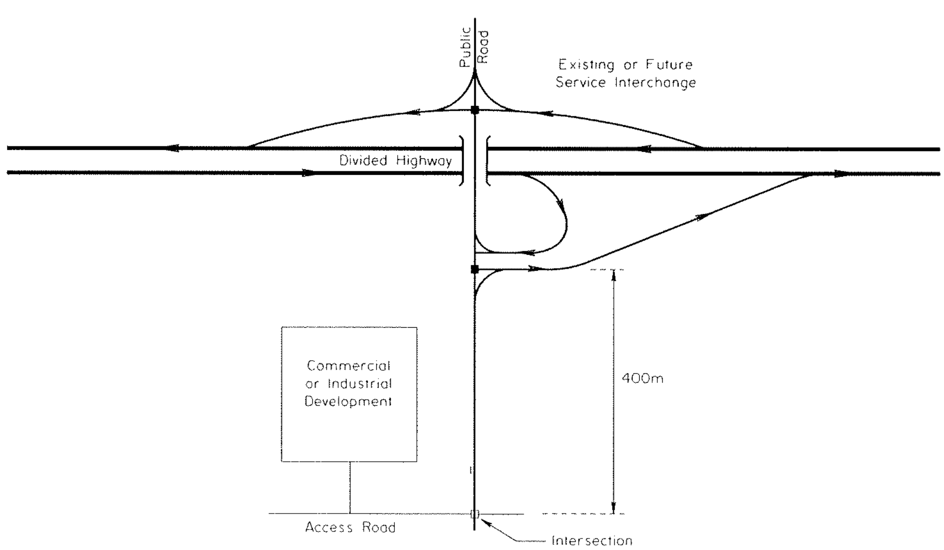
overall approach or departure taper lengths

design speed V (km/h)	transition ratio	transition length ℓ (m)	R (m)	tangent t (m)	AT or DT
50	15:1	45	500	16.7	78.4
80	24:1	72	1200	25.0	122.0
100	30:1	90	2000	33.3	156.7

* 0.3 V (W/2) with W = 6 m

Figure U.D.1.4.d Cross Road Intersection Spacing Adjacent to Interchanges





U.D.5 DESIGN VEHICLE

The following table lists the types of design vehicles and intersection configurations that are typically used when developing intersection designs in urban areas.

Table U.D.5.1 Design Vehicles and Intersection Configurations

Intersecting Roadways	Design Vehicle	Min. Radius (90° Intersection Angle)	Type of Intersection
Local Residential to Local Residential	SU	9.0 m	Simple Radius
Local Residential or Residential Collector to Residential Collector	SU or BUS	7.5 m to 11.0 m May need larger radius for larger bus	Simple Radius
Local Commercial to Local Commercial or Collector	SU or WB12	9.0 m to 15.0 m	Simple Radius
Local Industrial to Local Industrial or Collector	WB15	11.0 m to 20.0 m or 36.0 m - 12.0 m - 36.0 m	Simple Radius or 3 Centred
Collector or Arterial to Arterial	WB21	9.0m to 15.0m or 55.0 m - 18.0 m - 55.0 m or 60.0 m - 35.0 m - 60.0 m (with island)	Simple Radius or 3 Centred or Channelized
Divided Arterial to Divided Arterial	WB21	60.0 m - 35.0 m - 60.0 m (with island)	3 Centred Channelized
Provincial Highway and Municipal Truck Route	WB36	60.0m - 35.0m - 60.0m (with island)	3 Centred Channelized
Provincial Highway and Local Road	P	6.0 m to 9.0 m	Simple Radius
Provincial Highway and Collector	SU or BUS	7.5 m to 11.0 m May need larger radius for larger bus	Simple Radius
Interchange Ramp Terminals	WB36	60.0 m - 35.0 m - 60.0 m (with island)	3 Centred Channelized
Interchange terminals along High Long Combination Vehicle Route and Log Haul Routes	As per existing notes in the Geometric Design Guide		

Note:

1. Turning templates or a design vehicle tracking program are to be used to confirm the layout.
2. Combinations of tapers and two centred curves may be used in some locations to suit the design vehicle and the angle of intersection.
3. Refer to Tables D.5.2a and D.5.2b, and Figures D-5.2a and D-5.2b in the Alberta Transportation Highway Geometric Design Guide for design parameters.

The following points are to be considered along with the above table:

- The design vehicles and radii listed in the table are minimums. The designer must investigate the current and future uses of the intersection and consult with other affected road authorities to ensure that an appropriate design vehicle is selected.
- In general, the intersection should be designed to account for the largest vehicle that is using the intersection with some frequency. Typically, this means daily use. If that vehicle differs from that shown in the table, the intersection should be designed to accommodate it.
- Generally, for the design of public intersections, the "medium" turning template should be used. This allows vehicles to turn at the intersection without having to stop or travel at extremely low speeds.
- The radii given in the above table are for intersections at 90 degrees. The geometry of the intersection will change as it deviates away from 90 degrees. In such cases the designer should check the turning paths of the vehicle to determine the most appropriate radius.
- Simple radii greater than 12.0 m are not recommended, unless there is channelization, where there may be pedestrians crossing because of the increased pedestrian crossing distance.
- Two centred curves may also be effective in place of the three centred curves indicated. Two centred curves are preferred where vehicles are expected to stop, whereas three centred curves allow vehicles to turn at slightly higher speeds and may be more desirable for yield conditions or for vehicles exiting the highways.
- In industrial areas, two or three centred curves are commonly required to accommodate truck movements. Raised islands are usually omitted because of the low pedestrian volumes and the additional pavement area gives trucks more manoeuvering area.
- The designer should ensure that the intersection geometrics accommodate the swept path of the design vehicle. This is especially important for large tractor-trailers.
- Where pedestrian movements are a factor, the impact of choosing various edge of pavement layouts on cross-walk locations should be considered.
- All of the design vehicles likely to use the intersection should be used in the analysis of the horizontal and vertical sight distances at the intersection.

U.D.6 INTERSECTION ELEMENTS

U.D.6.1 Guidelines for Right and Left Turn Bays

When designing an intersection in an urban environment, a detailed traffic analysis shall be conducted for the proposed intersections along the route. The traffic analysis will determine the need for right or left turn lanes beyond the general criteria outlined in the following sections. It will also determine the required length of storage for the turn lanes.

For determination of the overall intersection configuration, storage lengths and operations, a target Level of Service (LOS) of "D" should be used in the analysis. Individual movements within the intersection may be worse than "D", but as long as the overall intersection is operating at a LOS of "D" it may be considered acceptable. If any movement is operating at a LOS of E or F, the designer will have to decide if it will have a detrimental impact on the overall operation of the intersection and if further improvements are warranted.

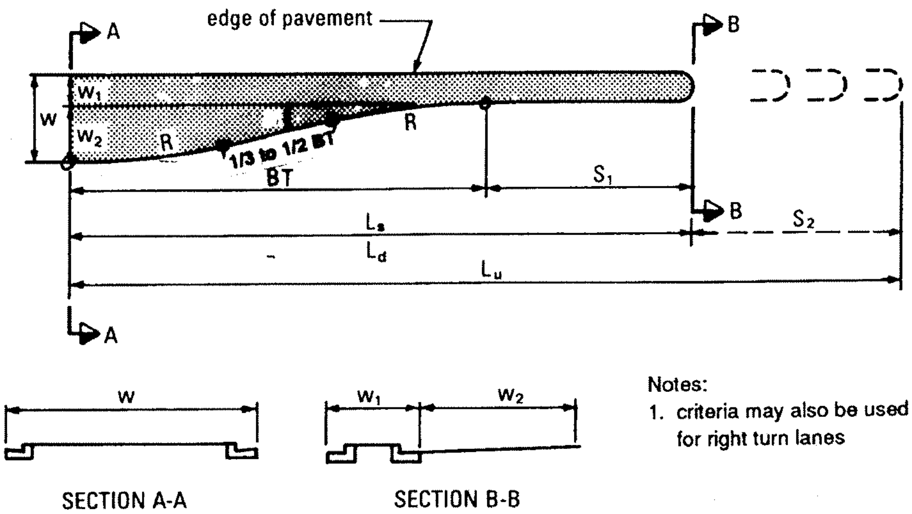
Left Turn Lanes

Left turn lanes shall be designed on Arterials at all intersections with other Arterials or Collectors and at-grade intersection with Expressways.

Left turn lanes in an urban environment are usually designed using a bay taper with reverse curves to smooth the alignment. Figure U.D.6.1a illustrates the recommended bay taper design. The distances indicated are good for grades of 2% or less. Correction factors will need to be applied to the deceleration distance for grades steeper than 2%.

This design is typical for speeds ≤80 km/h and the taper length is considered part of the length available for deceleration. In an urban environment it is often not feasible to provide adequate deceleration length in addition to the required storage length. In these cases, the bay taper plus the storage length must be at least equal to the deceleration distance. When designing to higher speeds, consideration should be given to the providing the deceleration distance in addition to the required storage length.

Figure U.D.6.1a
Left Turn Bay and Taper with Symmetrical Reverse Curves



Notes:
1. criteria may also be used for right turn lanes

$S = \frac{NL}{30}$

median widths (m) (based on 0.5 m gutter)	W	W_1	W_2
des	6.0	2.5	3.5

Bay Tapers – Symmetrical Reverse Curves

design speed (km/h)	Length (BT) (m)	Radii (R) (m)	deceleration length (Ld) (m)
50	40	90	75
60	50	150	90
70	60	220	110
80	70	300	130
90	70	300	150
100	70	300	170

BT - bay taper; S_1 - storage length with signals; S_2 - storage length without signals
L_s - bay length for signalized intersection $L_s = BT + S_1$ or L_d min
L_u - bay length for unsignalized intersection $L_u = L_d + S_2$
L_d - deceleration distance to a comfortable stop

As an estimate of the required storage for left turn lanes, the following formula may be used. For an unsignalized intersection, the storage is based on the number of vehicles that are likely to arrive in 2 minutes.

$S = \frac{NL}{30}$ Where S= Storage length (m)
N= design volume of turning vehicles (v/h)
L= length (m) occupied by each vehicle

At signalized intersections, the storage lane length should accommodate about 1.5 times the average number of vehicles to be stored per cycle for roadways with design speeds ≤60 km/h and 2.0 times the average number of vehicles for design speeds > 60 km/h.

The storage length calculated above should be checked against capacity analysis to ensure an acceptable level of service.

The storage length for left turning lanes should be made sufficiently long enough so that vehicles queued in the through lanes do not block the entrance to the turning lane and vehicles in the turn lane do not queue back into the through lane.

Right Turn Lanes

Right turn lanes shall be designed on all Major Arterials at intersections with other Arterials, Collectors and at-grade intersections with Expressways.

The following guidelines can be used to determine if a right turn lane may be needed at other intersections.

Unsignalized Intersections

- When the volume of decelerating vehicles compared with the through traffic causes undue hazard.

Signalized Intersections

- A right turn lane without separate signal indication may be required when the volume of right turning traffic is 10% to 20 % of the total approaching traffic.
- A right turn with separate indication may be required when right-turn traffic is greater than 20% of the total approaching traffic.

The bay taper design for a right turn lane is designed in the same manner as the bay taper for a left-turn lane.

As an estimate of the required storage for right turn lanes, the following formula may be used. For an unsignalized intersection, the storage is based on the number of vehicles that are likely to arrive in 2 minutes.

$$S=\frac{NL}{60}$$

Where S= Storage length (m)
N= design volume of turning vehicles (v/h)
L= length (m) occupied by each vehicle

At signalized intersections, the storage lane length should accommodate about 1.5 times the average number of vehicles to be stored per cycle for roadways with design speeds ≤60 km/h and 2.0 times the average number of vehicles for design speeds > 60 km/h.

The storage length calculated above should be checked against capacity analysis to ensure an acceptable level of service.

The storage length for right turning lanes should be made sufficiently long enough so that vehicles queued in the through lanes do not block the entrance to the turning lane and vehicles in the turn lane do not queue back into the through lane.

Alternative Right Turn Designs

Figure U.D.6.1b illustrates the typical layout and dimensions for four types of right turn designs: stop, yield, merge and added lane. It is important that the form of traffic control be selected to suit the design.

Separate turning roadways for right turns may be introduced by either a right turn auxiliary lane or a taper. The auxiliary lane design provides for more storage on the through lanes prior to the right turn lane being blocked. It also provides for less deceleration of turning traffic within the through lanes. As a result, the auxiliary lane design is often preferred.

In retrofit situations, it may be necessary to provide less than the typical radii for the right turn designs shown on Figure U.D.6.1b. Vehicle turning templates should be used to assess the implications of the reduced radii on traffic operation at the intersection.

1) Stop Design

The right turn design for a stop condition at an intersection normally consists of a simple radius. The radius chosen is a function of a number of factors including the following:

- The types of vehicles that are prevalent in the traffic stream, which is largely a function of service classification and land use.
- The width available on the approach and departure legs for the vehicles to make the turn, that is, if the turn must be made from and to a standard lane width, the corner radii must accommodate at least the minimum turning path for the chosen design vehicle.
- Whether or not pedestrian crossing volumes are significant, since increased corner radii have a direct impact on increased pedestrian crossing distances and may also influence signal timing. Simple radii no greater than 12.0 m are preferred where pedestrians are a key design consideration.
- In a retrofit situation, physical constraints or right-of-way restrictions may influence the size of the simple radius for the right turn design.

Based on the design vehicle, Table U.D.5.1 summarizes the typical dimensions for simple corner radii that can be applied to a stop condition.

2) Yield Design

At major intersections, such as Arterial/Arterial or Arterial/Collector intersections, or within industrial areas, the right turn design for a yield condition is typically a three centred curve with sufficient radii to provide a small island. In industrial areas, the raised island is normally omitted to provide more manoeuvering area for large turning trucks. The three-centred curve may be preceded on the approach leg by either a right turn auxiliary lane or a taper. The auxiliary lane design is more common in urban areas and is typically applied in consideration of capacity and storage requirements.

In the design of a three centred curve for a yield condition, the radii chosen should typically accommodate the "medium" turning path of the selected design vehicles and provide a near minimum island size. The radii and island shape are selected to provide an appropriate intersecting angle, between the right turning vehicle and the through traffic stream, at the point of convergence. A minimum angle of 60° provides the driver with a good view of the approaching traffic stream for the decision to stop or proceed. The minimum radii combination used to provide a small island is typically at or near 50.0 m - 15.0 m - 50.0 m, with an offset of 1.5 m to the middle radius. Three centred curves with radii in the range of 36.0 m - 12.0 m - 36.0 m, with a 0.6 m offset and without a raised direction island, are typical of right-turn yield designs that accommodate SU vehicles and transit buses.

At the intersection of two Local roads or a Local and a Collector, particularly in residential areas, the right turn design for a yield condition is normally a simple radius without an island, as previously described for the stop condition.

3) Merge Design

Merge right turn designs are applicable for conditions where a turning speed of > 40 km/h is desired at the intersection for capacity or operational reasons. Designs of this type are normally used at Freeway and Expressway ramp terminals, and for connections onto high speed Arterials. The application of the merge design is also a function of volume. If the merging volumes are too high, the result can be congestion, in which case an added lane design is preferred.

For the merge condition, the minimum radius of the right turn lane is determined on the basis of design speed and superelevation rate.

A right turn auxiliary lane or a taper of adequate length to provide the necessary deceleration length may be used to introduce a right turn. The acceleration area is designed on the basis of interchange entrance terminal requirements. The deceleration and acceleration distances are based on assumed running speeds, which are less than the design speeds. Refer to the TAC's Geometric Design Guide for Canadian Roads for design of the merge tapers.

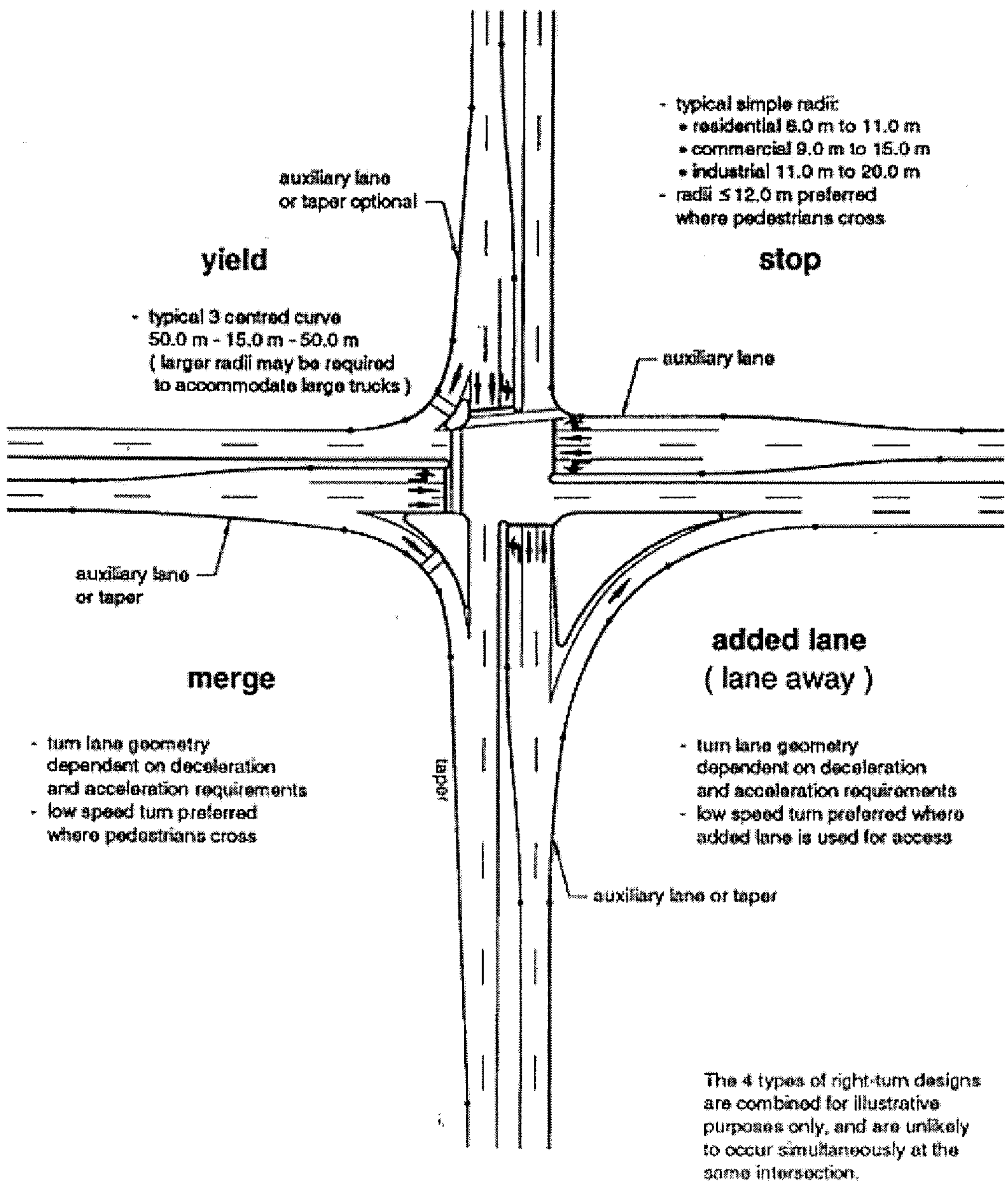
4) Added Lane (Lane Away) Design

The added lane (lane away) right turn design is normally selected on the basis of capacity considerations. This design is also appropriate at an intersection where an auxiliary lane is introduced for access purposes.

The radii for right turn designs are selected on the basis of desired operational characteristics, particularly speed. If the added lane is an auxiliary lane used for access purposes, radii providing lower turning speeds, ≤40 km/h, are suitable. Where the added lane is an additional through lane on a high speed street, the right turn design can vary substantially.

Where no right-of-way, physical constraints or intersection spacing limitations are present and there are no pedestrian crossing considerations, the right turn is often designed to minimize the speed differential between the vehicles on the adjacent through lane and the turning vehicles on the added lane at the convergence and divergence points.

Figure U.D.6.1b
Typical Right-turn Designs



CHAPTER U.E
INTERCHANGES

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U.E.2 RAMPS

Ramp terminals can be designed as Tapered or Parallel Lane Terminals. Figure U.E.2 at the end of the section illustrates the two types of terminal designs.

Alberta Transportation generally uses the Tapered Exit and Entrance Terminal design. However, there are times when a parallel lane design may be beneficial. The following paragraphs discuss some of the advantages and disadvantages of the parallel lanes and tapered lanes and list some of the situations where a parallel lane should be considered.

Table U.E.2 Comparison of Tapered versus Parallel Lane Entrances and Exits

Tapered Entrance	**Parallel Lane Entrance**
Acceleration length is accomplished on the ramp upstream of the point of convergence of the two roadways.	Acceleration length is generally measured from the point where the left edge of the traveled way of the ramp joins the traveled way of the freeway, to the beginning of the downstream taper. Part of the ramp may be considered in the acceleration length if the radius is large enough.
	The process of entering the freeway is similar to a lane change to the left. The driver is able to use the side-view and rear-view mirrors to monitor the surrounding traffic.
	A long acceleration lane provides more time for the merging traffic to find an opening in the through-traffic stream
On a two lane taper entrance the left lane is the merging lane and the right lane is carried through as the added lane. This results in an "inside merge" where the merging traffic is sandwiched between the through traffic and the added lanes of the ramp.	On a two-lane entrance terminal the right lane of the ramp is carried through as the added lane and the left lane is forced to merge with the through lane.

Tapered Exit	**Parallel Lane Exit**
The taper type exit fits the direct path preferred by most drivers	Short taper and added lane width at the beginning of the parallel lane is very apparent and provides an inviting exit area.
Vehicles leave the through lanes at relatively high speeds reducing the risk of rear-end collisions as a result of deceleration on the through lane	Operates best when drivers chose to exit early and decelerate in the parallel lane. Drivers that do not exit early will likely make a more abrupt reverse curve maneuver which is somewhat unnatural and may result in slowing down in the through lane.
	Parallel lane provides storage for queuing vehicles.
	Two lane parallel exit terminals require an exiting vehicle to make more lane changes than the taper design
General	**General**
A taper design on a left hand curved alignment would result in a tangential alignment for the edge of pavement and may be confusing to the driver.	Parallel lanes are preferred on sharp curves such as those on roadways of 80 km/h or less. At exits they are less likely to confuse through traffic and on entrances they will usually result in smoother merging operations. Short tapers on exits provide a visual cue that a ramp is beginning.

Since the Tapered Exit and Entrance Terminal design is the predominant type of ramp within the province, deviations from this type would violate driver expectancy and should be avoided if possible. However, there are situations where parallel lane ramp terminals may be more beneficial. If the designer is faced with any of the following situations a parallel lane could be considered:

1. The ramp terminal is on a crest curve and the decision sight distance to the bullnose cannot be achieved with a standard exit terminal.
2. The ramp terminal is on a crest curve and the sight distance to the end of the taper cannot be achieved with a standard entrance terminal.
3. An entrance ramp is on an up-grade and additional acceleration length is required to get vehicles up to speed before entering the through traffic.
4. Spacing of successive exits and entrances may be such that a continuous parallel lane between them would provide additional capacity and operational benefits.
5. Two lane entrances and exits may be better served using a parallel lane design.
6. Exits and entrances on tight curves would benefit from a parallel lane design.
7. Exit ramps on left-handed curves have a tendency to lead drivers off the through lanes. If possible they should be avoided. However, if they are designed, a parallel lane with a short taper (30 m long) will provide a visual cue that a ramp is

beginning. If possible, the parallel lane should begin upstream or downstream of the tangent to curve (or spiral), but never at the tangent to curve (or spiral) as it will appear as an extension of the tangent and confuse drivers. The preferred design, which will usually avoid operation problems, is to begin the parallel lane a considerable distance upstream of the beginning of the curve (Tangent to Curve or Spiral – TC or TS).

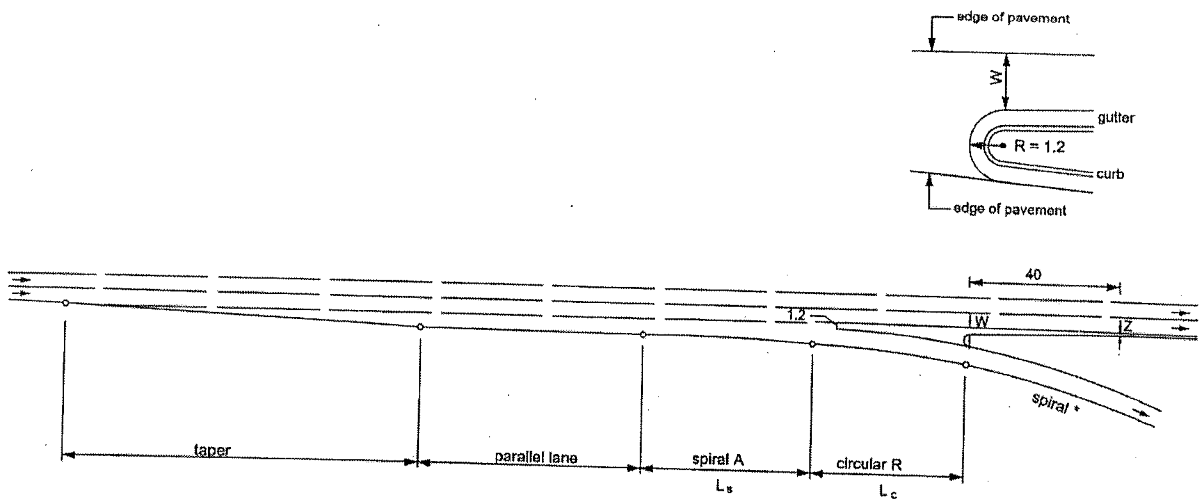
8. Generally, tapered designs require less property and are less costly for the same length of ramp. However, at times other factors, such as when crossing bridges, may come into play and warrant that a cost analysis be undertaken to determine if a taper or parallel lane design is more economical.
9. For additional technical details on parallel lane designs refer to the latest edition of the TAC Geometric Design Guide for Canadian Roads.

E.3 Reference Documents

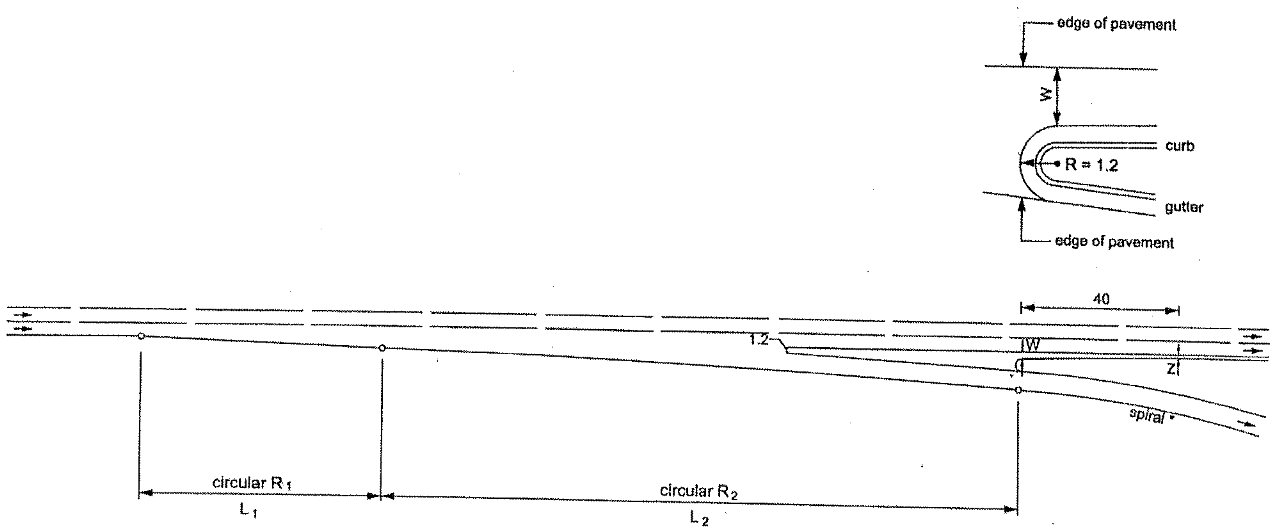
As this Design Guide does not fully cover the subject of Interchange Design, designers are referred to the following documents for additional information.

- Highway Geometric Design Guide 1999 – Alberta Transportation
- Geometric Design Guide For Canadian Roads (1999) – TAC
- A Policy on Geometric Design of Highways and Streets (2001) - AASHTO
- Highway Capacity Manual (2000) – FHWA

Figure U.E.2
Tapered and Parallel Lane Exits



Parallel Lane Exit



Tapered Lane Exit

CHAPTER U.G
3R/4R GEOMETRIC DESIGN GUIDELINES

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CHAPTER U.G
3R/4R GEOMETRIC DESIGN GUIDELINES

U.G.1 INTRODUCTION

This section provides guidelines that supplement those contained in Chapter G of the Highway Geometric Design Guide. This section is to be used in conjunction with that document.

As noted in the introduction to Chapter G, 3R projects include resurfacing, restoration or rehabilitation of existing paved roads; 4R projects include reconstruction in addition to resurfacing, restoration or rehabilitation. Generally, 3R/4R improvements are intended to provide cost-effective safety enhancements, while extending the life of a paved highway.

U.G.1.1 Guidelines for Initial Review

The premise of Chapter G, 3R/4R Geometric Design Guidelines assumes that there are situations where based upon a cost-benefit analysis, major reconstruction of a highway provides little advantage. Selective improvements rather than major reconstruction will extend and optimize the effective service life of an existing highway providing sufficient safety and operational characteristics.

Similar to the initial review process for a rural highway, a review of the existing conditions such as service classification, traffic volumes, level of service, pavement width, collision rate, and roadway geometry is required. As it is expected that most of the urban highway network is through developed areas, additional constraints due to adjacent developments, access points, on-street parking, or pedestrian, bicycle and transit requirements will need to be considered.

Potential 3R/4R projects in urban settings could range from minor improvements to a full assessment of safety. In the latter case, a traffic operations review and a safety audit would be needed to assess the cost versus benefits of possible improvements.

U.G.1.2 Minimum Lane Widths and Horizontal Clearances

The previous supplemental chapters of this document such as Chapter U.A, Basic Design Principles and Chapter U.C, Cross Section Elements establish minimum lane widths and horizontal clearances. Accommodation for bicycles, pedestrians, transit and parking will have to be considered. In addition, offsets to boulevard sidewalks, monolithic sidewalks, streetlighting poles, street furniture and other landscaping features will need to be reviewed.

U.G.2 HORIZONTAL CURVATURE

Improvements to horizontal curvature should be reviewed to address areas where existing curvature does not meet current guidelines for new construction. Factors such as superelevation rate, collision rate, intersections or hazards on curve, consistency with highway alignment, horizontal-vertical alignment coordination, road user savings due to lower vehicle running costs and small deflection angles should all be considered.

However, available right-of-way and adjacent developments may restrict implementation of some or all of the potential geometric improvements. Benefit-cost analysis should be used to determine if improvements are justified.

U.G.3 VERTICAL CURVATURE

Improvements to vertical curvature should be reviewed to address areas where existing curvature does not meet current guidelines for new construction.

As with horizontal alignment, available right-of-way and adjacent developments may restrict some or all potential vertical curvature improvements. Benefit-cost analysis should be used to determine if improvements are justified.

U.G.4 INTERSECTIONS

Similar to horizontal and vertical alignments, intersections in urban areas are generally constrained by adjacent development, restricted right-of-way and other surface features often not prevalent in rural settings. Designers should refer to Chapter D, At-Grade Intersections to check all aspects of existing intersections, such as layout, access locations, gradients, superelevation and capacity.

Intersections should be reviewed to ensure that all vehicles that use them on a regular basis can be safely accommodated through the intersection. The collision history at each intersection should also be checked before deciding if corrective measures are appropriate. Intersectional analysis in urban settings is often complicated by the existence of traffic control signals, the adequacy of which will also have to be assessed in any review.

U.G.5 PASSING OPPORTUNITY

For two-lane undivided roadways in an urban setting, passing is not usually allowed due to available geometric parameters, increased incidence of access points, possibility of pedestrian traffic, cyclists and on-street parking.

Capacity of the highway is a function of number of lanes, lane geometry, traffic signal timing, existence of pedestrians and on-street parking.

U.G.6 ROADSIDE DESIGN

Roadside design in urban situations differs from rural settings in that the design speeds are usually lower. Furthermore in some instances, due to lower design and operating speeds and existence of barrier curb, the clear zone requirements are substantially less thus eliminating the need for traffic barriers. All existing traffic barrier installations should be reviewed to determine if replacement is necessary or if some other mitigative measure is more cost effective.

U.G.7 SUPERELEVATION

This section is to be used when there are existing horizontal curves that will not be improved and the adequacy of the existing superelevation needs to be assessed.

Typically for urban Arterial roads, a maximum superelevation rate of 0.06 m/m as summarized in Table U.B.3.3 is utilized. However, in urban settings, depending upon roadway classification and design speed, a maximum superelevation rate of 0.04 m/m as shown in Table U.B.3.1 may also be considered. The ball-bank indicator test may be used to determine the need for speed advisory tabs on signs at horizontal curve locations.