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510
LOW-VOLUME ROADS

Where there are existing agreements between the Ministry of Transportation & Infrastructure and other parties, those agreements shall prevail.

510.01 GENERAL

The following is the design policy and practice of the Ministry of Transportation and Infrastructure for Low-Volume Roads (referred to as LVRs).

Definition

A low-volume road (LVR) is a road with an Average Daily Traffic (ADT) not exceeding 200 and whose service functions are oriented toward **rural road systems**.

A low-volume road may be to or within an **isolated community**, a **recreation** road or a **resource** development road. LVRs do not include subdivision roads design standards.

Traffic Volumes

Daily traffic volumes on LVRs tend to vary significantly due to the seasonal nature of these roads which often are built to serve a single purpose. Use the average daily traffic for a time period corresponding to the season or periods of high use (this will be during summer in most cases; but may be during winter for low-volume roads accessing winter recreation areas such as ski hill access roads).

If the periods of high use are short but numerous (for example, two or three consecutive days for more than twelve times a year), an economic analysis may be required to determine whether to use the LVR or other higher standards.

If official land use planning reports are available, the designer may use future traffic volumes that are contained in these studies. All traffic projections used for design should meet the approval of the ministry's regional planning and traffic engineering staff.

The designer should project volumes 20 years after construction to set the Design Volume. However, if traffic projections are too uncertain to justify the additional cost of using a higher design class, a shorter period such as the 10-year projection may be used. If low growth is expected (1% per year or less), the current ADT is appropriate.

Accommodating Cyclists

Because of the low traffic volumes encountered on LVRs, it is generally not cost-effective to design specifically for bikeways. The time gaps between the arrivals of opposing vehicles are large enough for advancing traffic to easily overtake cyclists by crossing the centerline.

However, in summer recreation areas where there is documented, constant, heavy cycle traffic, a site specific evaluation may be undertaken to evaluate if the cycling traffic can be accommodated safely and cost effectively. Where the need for bikeways on LVRs is justified, consult Chapter 5 of the *TAC Geometric Design Guide* for bikeway design widths. A bikeway should not be designed for a gravel road.

Most LVRs are designed for speeds of 80 km/h or higher. For these and for the few LVRs designed for 60 or 70 km/h, the shoulder bikeway is adequate. For the occasional LVR designed for 50 km/h or less, the 4.0 m shared roadway lanes (paved) may be used.

510.02 TYPES OF LVRs

LVRs are categorized by TAC according to their traffic and land services:

Category A: Rural road system and roads to and within isolated communities. These roads serve both functions of providing direct access to adjacent properties and access to land in low density remote areas.

Category B: Recreational roads. These provide access to provincial and federal parks and resort developments.

Category C: Resource development roads. These roads provide a link from remote resource development areas to the provincial highway system and ports or railheads. They do not include private access roads and logging roads within a tree farm license which come under the jurisdiction of the Ministry of Forests, Lands, and Natural Resource Operations.

In selecting design criteria for a particular LVR, the designer should consider its main service function. Should the road serve more than one function, the design standard corresponding to the highest service function should be used.

510.03 DESIGN SPEED

The single most important design decision for a LVR is the selection of the design speed. The width of the LVR is dependent on the design speed as are significant characteristics of the vertical and horizontal alignments.

In selecting the design speed, the designer should consider driver's expectations. Driver's expectations are governed by several factors such as the type of terrain, the road service function or category and the trip length.

For example: For a particular "Category A" road that provides short distance access from the highway system to a few farms in mountainous terrain, operating speeds of 30 to 70 km/h may be adequate. If the terrain is flat and the farms are spaced far in between, say one kilometre or more, a design speed of 80 or 90 km/h may be more appropriate to match drivers' expectations. Although both cases fall in the same service function, the choices for design speed are significantly different, so are the resulting alignments. A wrong selection of the design speed may have serious consequences to the construction and operational costs and the safety of road users. Table 510.A, following, gives a range of design speeds for various functions.

Table 510.A Design Speeds for Low-Volume Roads

Service Type	Design Speed
Category A: Rural road systems and roads to or within isolated communities	30 - 90 (see note)
Category B: Recreational roads	
-primary	50 - 90 (see note)
-perimeter	30 - 80 (see note)
-internal	30 - 50 (see note)
Category C: Resource development roads	30 - 90 (see note)

Note: Most LVRs serve a mix of short and long distance trips and have a legal speed limit at 80 km/h. Therefore, the design speed for LVRs should be 80 km/h or higher in most instances; particularly roads serving trips in excess of 5 kilometres in length and resource access roads used by heavy truck traffic in excess of 15 trucks per day. **The designer should not use design speeds less than 80 km/h without specific approval by the regional Executive Director or the project Technical Review Committee.** A typical road designed at less than 80 km/h, would be a short, discontinuous road less than 5 kilometres serving local, short distance trips.

510.04 ALIGNMENT ELEMENTS

For a general discussion on the basis for alignment elements, refer to Chapter 300 of this manual and Chapter 3 of the *TAC Geometric Design Guide*. The following is a brief listing of parameter values for alignment elements that are specific to LVRs.

Sight Distance

1) Stopping Sight Distance

The minimum stopping sight distance is similar to that of other roads (see Section 330.03 in this manual and Chapter 2 Section 2.5.3 of the *TAC Geometric Design Guide*) and is listed in Table 510.B for the range of design speeds used for LVRs. Deceleration rates for gravel roads are taken to be the same as that for pavements in poor condition under wet conditions. Table 510.C shows Stopping Sight Distance for various grades.

Table 510.B Min. SSD Low-Volume Roads

Design Speed (km/h)	Minimum SSD (m)
30	35
40	50
50	65
60	85
70	105
80	130
90	160

Source: AASHTO 2011 "Table 3-1: Stopping Sight Distance on Level Roadways," *A Policy on Geometric Design of Highways and Streets, 6th Edition*

Table 510.C SSD for Various Grades

Design Speed (km/h)	Stopping Sight Distance (m)									
	Downgrade					Upgrade				
	-3%	-6%	-9%	-12%	-14%	3%	6%	9%	12%	14%
30	35	35	35	37	39	31	30	29	29	29
40	50	50	53	56	59	45	44	43	42	41
50	66	70	74	79	83	61	59	58	56	55
60	87	92	97	105	*	80	77	75	73	*
70	110	116	124	134	*	100	97	93	90	*
80	136	144	154	*	*	123	118	114	*	*
90	164	174	187	*	*	148	141	136	*	*

Source: AASHTO 2011 "Table 3-2: Stopping Sight Distance on Grades," *A Policy on Geometric Design of Highways and Streets, 6th Edition*

(*) These grades are outside the range for LVR design

Shaded cell value has been increased from the calculated value shown in AASHTO Table 3-2 so it is not less than the design SSD in Table 510.B

2) Minimum Passing Sight Distance

Refer to Chapter 2 Section 2.5.4 of the *TAC Geometric Design Guide* for a discussion of Passing Sight Distance (PSD). On two-lane two-way LVRs, the passing sight distance is not considered to be a crucial minimum design element. However, it is recommended and desirable to provide PSD as often as economically feasible on low-volume roads, most of which serve long distance trips and have a design speed of 80 km/h or higher. Table 510.D below gives the passing sight distances for LVRs.

To reduce opportunities for unsafe passing maneuvers on long sections without PSD, the designer may consider providing slow moving vehicle pullouts (refer to section 910).

Table 510.D Min. PSD Low-Volume Roads

(refer to TAC Table 2.5.4)

Design Speed km/h	PSD m
30	220
40	290
50	350
60	410
70	490
80	550
90	610

3) Decision Sight Distance

Decision sight distance (DSD) is not a requirement which is cost-effective on LVRs. See Chapter 2 Section 2.5.5 in the *TAC Geometric Design Guide* for discussion of DSD. DSD should be considered, particularly near intersections, if no additional costs are incurred.

510.05 HORIZONTAL ALIGNMENT

The same principles are used for LVRs as for two lane roads of higher classification. Refer to Section 330 for a general discussion on horizontal alignment.

Side friction factors for gravel roads are taken to be the same as the side friction factors for wet pavement conditions. *TAC Geometric Design Guide* Table 3.2.1 gives the maximum values for safe side friction for speeds of 40 km/h and higher. The maximum side friction value used for a design speed of 30 km/h is 0.17.

Design superelevation rates are discussed in Section 330. The **normal cross fall is 0.02 m/m on paved roads and 0.04 m/m on gravel roads**. Maximum superelevation rates of 0.06 or 0.08 are used on LVRs.

Tables 510.E and 510.F show the superelevation and minimum spiral lengths where a maximum superelevation of 0.06 is used on LVRs with a normal cross fall of 0.02 and 0.04 respectively. Tables 510.G and 510.H are for a maximum superelevation of 0.08.

For consistency, use the same chart for **all horizontal curves** on the same highway or homogeneous road section. A homogeneous road section starts and ends when there is a clear break in the driving environment. This may happen at a major junction, a destination point such as a populated settlement or a major change in topography.

Intersections and accesses should not be located on curves which have a superelevation higher than 0.06.

On LVRs which are designed for speeds greater than 40 km/h, spirals should be used. For design speeds of 30 and 40 km/h, the use of spirals is optional. Refer to Section 3.2.4 of the *TAC Geometric Design Guide* for development of superelevation with and without spirals.

Table 510.E - Superelevation Chart for E max. 0.06m/m for Paved Roads Normal Crown 0.02 m/m

Speed	30		40		50		60		70		80		90		
Radius	e	Ls	e	Ls	e	Ls	e	Ls	e	Ls	e	Ls	e	Ls	Radius
8000	NC		NC		NC		NC		NC		NC		NC		8000
5000	NC		NC		NC		NC		NC		NC		NC		5000
3000	NC		NC		NC		NC		NC		RC	40	RC	50	3000
2000	NC		NC		NC		NC		RC	40	RC	40	0.023	50	2000
1500	NC		NC		NC		RC	40	0.020	40	0.024	40	0.029	50	1500
1200	NC		NC		NC		RC	40	0.023	40	0.028	40	0.033	50	1200
1000	NC		NC		RC	30	0.021	40	0.027	40	0.032	40	0.037	50	1000
900	NC		NC		RC	30	0.023	40	0.028	40	0.034	40	0.039	50	900
800	NC		NC		RC	30	0.025	40	0.031	40	0.036	40	0.042	50	800
700	NC		NC		0.021	30	0.027	40	0.033	40	0.039	40	0.045	50	700
650	NC		RC	30	0.022	30	0.029	40	0.035	40	0.041	40	0.046	50	650
600	NC		RC	30	0.023	30	0.030	40	0.037	40	0.042	40	0.048	50	600
550	NC		RC	30	0.025	30	0.032	40	0.038	40	0.044	40	0.050	50	550
525	NC		RC	30	0.026	30	0.033	40	0.039	40	0.045	40	0.051	50	525
500	NC		RC	30	0.027	30	0.034	40	0.040	40	0.046	40	0.052	50	500
475	NC		0.020	30	0.028	30	0.035	40	0.041	40	0.047	40	0.053	60	475
450	NC		0.021	30	0.029	30	0.036	40	0.043	40	0.049	50	0.054	60	450
425	NC		0.022	30	0.030	30	0.037	40	0.044	40	0.050	50	0.055	60	425
400	NC		0.023	30	0.031	30	0.038	40	0.045	40	0.051	50	0.057	70	400
380	RC	30	0.024	30	0.032	30	0.039	40	0.046	40	0.052	50	0.058	70	380
360	RC	30	0.025	30	0.033	30	0.041	40	0.047	40	0.053	50	0.059	70	360
340	RC	30	0.026	30	0.034	30	0.042	40	0.048	40	0.054	50	0.060	80	340
320	RC	30	0.027	30	0.035	30	0.043	40	0.050	40	0.056	60	**Min R 340m**		
300	RC	30	0.028	30	0.037	30	0.044	40	0.051	40	0.057	60			
290	RC	30	0.028	30	0.037	30	0.045	40	0.052	40	0.057	60			
280	RC	30	0.029	30	0.038	30	0.046	40	0.052	50	0.058	70			
270	0.020	30	0.030	30	0.039	30	0.047	40	0.053	50	0.059	70			
260	0.020	30	0.030	30	0.040	30	0.047	40	0.054	50	0.059	70			
250	0.021	30	0.031	30	0.040	30	0.048	40	0.055	50	0.060	70			
240	0.022	30	0.032	30	0.041	30	0.049	40	0.055	50	**Min R 250m**				
230	0.022	30	0.033	30	0.042	30	0.050	40	0.056	60					
220	0.023	30	0.034	30	0.043	30	0.051	40	0.057	60					
210	0.024	30	0.035	30	0.044	30	0.052	40	0.058	60					
200	0.025	30	0.036	30	0.045	30	0.053	40	0.059	60					
190	0.026	30	0.037	30	0.046	30	0.054	40	0.060	70					
180	0.027	30	0.038	30	0.047	40	0.055	40	**Min R 190m**						
170	0.028	30	0.039	30	0.048	40	0.056	50							
160	0.029	30	0.040	30	0.049	40	0.057	50							
150	0.030	30	0.041	30	0.051	40	0.058	50							
145	0.031	30	0.042	30	0.051	40	0.059	50							
140	0.031	30	0.043	30	0.052	40	0.059	50							
135	0.032	30	0.044	30	0.053	40	0.060	60							
130	0.033	30	0.044	30	0.054	40	**Min R 135m**								
125	0.033	30	0.045	30	0.054	40									
120	0.034	30	0.046	30	0.055	40									
115	0.035	30	0.047	30	0.056	40									
110	0.036	30	0.048	30	0.057	40									
105	0.037	30	0.049	30	0.057	50									
100	0.038	30	0.050	30	0.058	50									
95	0.039	30	0.051	30	0.059	50									
90	0.040	30	0.052	40	0.060	50									
85	0.041	30	0.053	40	**Min R 90m**										
80	0.042	30	0.054	40											
75	0.044	30	0.055	40											
70	0.045	30	0.056	40											
65	0.047	30	0.058	40											
60	0.048	30	0.059	40											
55	0.050	30	0.060	40											
50	0.052	30	**Min R 55m**												
45	0.054	30													
40	0.056	30													
35	0.058	30													
30	0.060	30													
	Min R 30m														

Table 510.F - Superelevation Chart for E max. 0.06m/m for Gravel Surfaces Normal Crown 0.04 m/m

Speed	30		40		50		60		70		80		90		
Radius	e	Ls	e	Ls	e	Ls	e	Ls	e	Ls	e	Ls	e	Ls	Radius
8000	NC		NC		NC		NC		NC		NC		NC		8000
5000	NC		NC		NC		NC		NC		NC		RC		5000
3000	NC		NC		NC		NC		RC	40	RC	40	RC	50	3000
2000	NC		NC		NC		RC	40	RC	40	RC	40	RC	50	2000
1500	NC		NC		RC	30	RC	40	RC	40	RC	40	RC	50	1500
1200	NC		NC		RC	30	RC	40	RC	40	RC	40	RC	50	1200
1000	NC		NC		RC	30	RC	40	RC	40	RC	40	RC	50	1000
900	NC		RC	30	RC	30	RC	40	RC	40	RC	40	RC	50	900
800	NC		RC	30	RC	30	RC	40	RC	40	RC	40	0.042	50	800
700	NC		RC	30	RC	30	RC	40	RC	40	RC	40	0.045	50	700
650	NC		RC	30	RC	30	RC	40	RC	40	0.041	40	0.046	50	650
600	NC		RC	30	RC	30	RC	40	RC	40	0.042	40	0.048	50	600
550	RC	30	RC	30	RC	30	RC	40	RC	40	0.044	40	0.050	50	550
525	RC	30	RC	30	RC	30	RC	40	RC	40	0.045	40	0.051	50	525
500	RC	30	RC	30	RC	30	RC	40	RC	40	0.046	40	0.052	50	500
475	RC	30	RC	30	RC	30	RC	40	0.041	40	0.047	40	0.053	60	475
450	RC	30	RC	30	RC	30	RC	40	0.043	40	0.049	50	0.054	60	450
425	RC	30	RC	30	RC	30	RC	40	0.044	40	0.050	50	0.055	60	425
400	RC	30	RC	30	RC	30	RC	40	0.045	40	0.051	50	0.057	70	400
380	RC	30	RC	30	RC	30	RC	40	0.046	40	0.052	50	0.058	70	380
360	RC	30	RC	30	RC	30	0.041	40	0.047	40	0.053	50	0.059	70	360
340	RC	30	RC	30	RC	30	0.042	40	0.048	40	0.054	50	0.060	80	340
320	RC	30	RC	30	RC	30	0.043	40	0.050	40	0.056	60	**Min R 340m**		
300	RC	30	RC	30	RC	30	0.044	40	0.051	40	0.057	60			
290	RC	30	RC	30	RC	30	0.045	40	0.052	40	0.057	60			
280	RC	30	RC	30	RC	30	0.046	40	0.052	50	0.058	70			
270	RC	30	RC	30	RC	30	0.047	40	0.053	50	0.059	70			
260	RC	30	RC	30	RC	30	0.047	40	0.054	50	0.059	70			
250	RC	30	RC	30	RC	30	0.048	40	0.055	50	0.060	70			
240	RC	30	RC	30	0.041	30	0.049	40	0.055	50	**Min R 250m**				
230	RC	30	RC	30	0.042	30	0.050	40	0.056	60					
220	RC	30	RC	30	0.043	30	0.051	40	0.057	60					
210	RC	30	RC	30	0.044	30	0.052	40	0.058	60					
200	RC	30	RC	30	0.045	30	0.053	40	0.059	60					
190	RC	30	RC	30	0.046	30	0.054	40	0.060	70					
180	RC	30	RC	30	0.047	40	0.055	50	**Min R 190m**						
170	RC	30	RC	30	0.048	40	0.056	50							
160	RC	30	RC	30	0.049	40	0.057	50							
150	RC	30	0.041	30	0.051	40	0.058	50							
145	RC	30	0.042	30	0.051	40	0.059	50							
140	RC	30	0.043	30	0.052	40	0.059	50							
135	RC	30	0.044	30	0.053	40	0.060	60							
130	RC	30	0.044	30	0.054	40	**Min R 135m**								
125	RC	30	0.045	30	0.054	40									
120	RC	30	0.046	30	0.055	40									
115	RC	30	0.047	30	0.056	40									
110	RC	30	0.048	30	0.057	40									
105	RC	30	0.049	30	0.057	50									
100	RC	30	0.050	30	0.058	50									
95	RC	30	0.051	30	0.059	50									
90	RC	30	0.052	40	0.060	50									
85	0.041	30	0.053	40	**Min R 90m**										
80	0.042	30	0.054	40											
75	0.044	30	0.055	40											
70	0.045	30	0.056	40											
65	0.047	30	0.058	40											
60	0.048	30	0.059	40											
55	0.050	30	0.060	40											
50	0.052	30	**Min R 55m**												
45	0.054	30													
40	0.056	30													
35	0.058	30													
30	0.060	30													
	Min R 30m														

Table 510.G - Superelevation Chart for E max. 0.08 m/m for Paved Roads Normal Crown 0.02 m/m

Speed	30		40		50		60		70		80		90		
Radius	e	Ls	e	Ls	e	Ls	e	Ls	e	Ls	e	Ls	e	Ls	Radius
8000	NC		NC		NC		NC		NC		NC		NC		8000
5000	NC		NC		NC		NC		NC		NC		NC		5000
3000	NC		NC		NC		NC		RC	40	RC	40	RC	50	3000
2000	NC		NC		NC		RC	40	RC	40	0.021	40	0.026	50	2000
1500	NC		NC		RC	30	RC	40	0.021	40	0.027	40	0.032	50	1500
1200	NC		NC		RC	30	0.020	40	0.026	40	0.031	40	0.038	50	1200
1000	NC		NC		RC	30	0.023	40	0.029	40	0.036	40	0.043	50	1000
900	NC		RC	30	RC	30	0.025	40	0.032	40	0.039	40	0.046	50	900
800	NC		RC	30	0.020	30	0.027	40	0.035	40	0.042	40	0.049	50	800
700	NC		RC	30	0.023	30	0.030	40	0.038	40	0.046	40	0.053	50	700
650	NC		RC	30	0.024	30	0.032	40	0.040	40	0.048	40	0.056	50	650
600	NC		RC	30	0.026	30	0.034	40	0.042	40	0.050	40	0.058	50	600
550	NC		RC	30	0.028	30	0.036	40	0.045	40	0.053	40	0.061	50	550
525	NC		RC	30	0.029	30	0.037	40	0.046	40	0.054	40	0.063	50	525
500	NC		0.021	30	0.030	30	0.039	40	0.048	40	0.056	50	0.064	50	500
475	NC		0.022	30	0.031	30	0.040	40	0.049	40	0.058	50	0.066	60	475
450	NC		0.023	30	0.032	30	0.042	40	0.051	40	0.059	50	0.068	60	450
425	NC		0.024	30	0.033	30	0.043	40	0.052	40	0.061	50	0.069	60	425
400	NC		0.025	30	0.035	30	0.045	40	0.054	40	0.063	50	0.071	70	400
380	RC	30	0.026	30	0.036	30	0.046	40	0.056	40	0.065	50	0.073	70	380
360	RC	30	0.027	30	0.038	30	0.048	40	0.057	40	0.066	50	0.075	70	360
340	RC	30	0.028	30	0.039	30	0.050	40	0.059	40	0.068	60	0.077	80	340
320	RC	30	0.029	30	0.041	30	0.051	40	0.061	40	0.070	60	0.078	80	320
300	RC	30	0.031	30	0.042	30	0.053	40	0.063	50	0.072	60	0.080	90	300
290	0.020	30	0.032	30	0.043	30	0.054	40	0.064	50	0.073	70	**Min R 300m**		
280	0.021	30	0.033	30	0.044	30	0.055	40	0.065	50	0.074	70			
270	0.021	30	0.033	30	0.045	30	0.056	40	0.066	50	0.075	70			
260	0.022	30	0.034	30	0.046	30	0.058	40	0.068	50	0.076	70			
250	0.023	30	0.035	30	0.048	30	0.059	40	0.069	50	0.077	70			
240	0.024	30	0.036	30	0.049	30	0.060	40	0.070	50	0.079	80			
230	0.024	30	0.037	30	0.050	40	0.061	40	0.071	60	0.080	80			
220	0.025	30	0.039	30	0.051	40	0.063	40	0.073	60	**Min R 230m**				
210	0.026	30	0.040	30	0.053	40	0.064	40	0.074	60					
200	0.027	30	0.041	30	0.054	40	0.066	40	0.075	60					
190	0.028	30	0.042	30	0.056	40	0.067	40	0.077	70					
180	0.029	30	0.044	30	0.057	50	0.069	50	0.078	70					
170	0.031	30	0.045	30	0.059	50	0.070	50	0.080	70					
160	0.032	30	0.047	30	0.061	50	0.072	50	**Min R 170m**						
150	0.034	30	0.049	30	0.063	50	0.074	50							
145	0.035	30	0.050	30	0.064	50	0.075	60							
140	0.035	30	0.051	30	0.065	50	0.076	60							
135	0.036	30	0.052	30	0.066	50	0.077	60							
130	0.037	30	0.053	30	0.067	50	0.078	60							
125	0.038	30	0.054	30	0.068	50	0.079	60							
120	0.039	30	0.055	30	0.069	50	0.080	70							
115	0.040	30	0.057	30	0.071	50	**Min R 120m**								
110	0.042	30	0.058	30	0.072	50									
105	0.043	30	0.059	30	0.073	50									
100	0.044	30	0.061	30	0.075	50									
95	0.046	30	0.062	30	0.076	60									
90	0.047	30	0.064	40	0.078	60									
85	0.049	30	0.066	40	0.079	60									
80	0.051	30	0.067	40	0.080	60									
75	0.052	30	0.069	40	**Min R 80m**										
70	0.054	30	0.071	40											
65	0.057	30	0.073	40											
60	0.059	30	0.075	40											
55	0.061	30	0.078	40											
50	0.064	30	0.080	40											
45	0.067	30	**Min R 50m**												
40	0.071	30													
35	0.074	30													
30	0.080	30													
	Min R 30m														

Table 510.H - Superelevation Chart for E max. 0.08 m/m for Gravel Surfaces Normal Crown 0.04 m/m

Speed	30		40		50		60		70		80		90		
Radius	e	Ls	e	Ls	e	Ls	e	Ls	e	Ls	e	Ls	e	Ls	Radius
8000	NC		NC		NC		NC		NC		NC		NC		8000
5000	NC		NC		NC		NC		NC		NC		RC		5000
3000	NC		NC		NC		NC		RC	40	RC	40	RC	50	3000
2000	NC		NC		NC		RC	40	RC	40	RC	40	RC	50	2000
1500	NC		NC		RC	30	RC	40	RC	40	RC	40	RC	50	1500
1200	NC		NC		RC	30	RC	40	RC	40	RC	40	RC	50	1200
1000	NC		NC		RC	30	RC	40	RC	40	RC	40	0.043	50	1000
900	NC		RC	30	RC	30	RC	40	RC	40	RC	40	0.046	50	900
800	NC		RC	30	RC	30	RC	40	RC	40	0.042	40	0.049	50	800
700	NC		RC	30	RC	30	RC	40	RC	40	0.046	40	0.053	50	700
650	NC		RC	30	RC	30	RC	40	0.040	40	0.048	40	0.056	50	650
600	NC		RC	30	RC	30	RC	40	0.042	40	0.050	40	0.058	50	600
550	RC	30	RC	30	RC	30	RC	40	0.045	40	0.053	40	0.061	50	550
525	RC	30	RC	30	RC	30	RC	40	0.046	40	0.054	40	0.063	50	525
500	RC	30	RC	30	RC	30	RC	40	0.048	40	0.056	50	0.064	50	500
475	RC	30	RC	30	RC	0	0.040	40	0.049	40	0.058	50	0.066	60	475
450	RC	30	RC	30	RC	30	0.042	40	0.051	40	0.059	50	0.068	60	450
425	RC	30	RC	30	RC	30	0.043	40	0.052	40	0.061	50	0.069	60	425
400	RC	30	RC	30	RC	30	0.045	40	0.054	40	0.063	50	0.071	70	400
380	RC	30	RC	30	RC	30	0.046	40	0.056	40	0.065	50	0.073	70	380
360	RC	30	RC	30	RC	30	0.048	40	0.057	40	0.066	50	0.075	70	360
340	RC	30	RC	30	RC	30	0.050	40	0.059	40	0.068	60	0.077	80	340
320	RC	30	RC	30	0.041	30	0.051	40	0.061	40	0.070	60	0.078	80	320
300	RC	30	RC	30	0.042	30	0.053	40	0.063	50	0.072	60	0.080	90	300
290	RC	30	RC	30	0.043	30	0.054	40	0.064	50	0.073	70	**Min R 300m**		
280	RC	30	RC	30	0.044	30	0.055	40	0.065	50	0.074	70			
270	RC	30	RC	30	0.045	30	0.056	40	0.066	50	0.075	70			
260	RC	30	RC	30	0.046	30	0.058	40	0.068	50	0.076	70			
250	RC	30	RC	30	0.048	30	0.059	40	0.069	50	0.077	70			
240	RC	30	RC	30	0.049	30	0.060	40	0.070	50	0.079	80			
230	RC	30	RC	30	0.050	40	0.061	40	0.071	60	0.080	80			
220	RC	30	RC	30	0.051	40	0.063	40	0.073	60	**Min R 250m**				
210	RC	30	RC	30	0.053	40	0.064	40	0.074	60					
200	RC	30	RC	30	0.054	40	0.066	40	0.075	60					
190	RC	30	RC	30	0.056	40	0.067	40	0.077	70					
180	RC	30	RC	30	0.057	50	0.069	50	0.078	70					
170	RC	30	RC	30	0.059	50	0.070	50	0.080	70					
160	RC	30	RC	30	0.061	50	0.072	50	**Min R 170m**						
150	RC	30	0.049	30	0.063	50	0.074	50							
145	RC	30	0.050	30	0.064	50	0.075	60							
140	RC	30	0.051	30	0.065	50	0.076	60							
135	RC	30	0.052	30	0.066	50	0.077	60							
130	RC	30	0.053	30	0.067	50	0.078	60							
125	RC	30	0.054	30	0.068	50	0.079	60							
120	RC	30	0.055	30	0.069	50	0.080	70							
115	0.040	30	0.057	30	0.071	50	**Min R 120m**								
110	0.042	30	0.058	30	0.072	50									
105	0.043	30	0.059	30	0.073	50									
100	0.044	30	0.061	30	0.075	50									
95	0.046	30	0.062	30	0.076	60									
90	0.047	30	0.064	40	0.078	60									
85	0.049	30	0.066	40	0.079	60									
80	0.051	30	0.067	40	0.080	60									
75	0.052	30	0.069	40	**Min R 80m**										
70	0.054	30	0.071	40											
65	0.057	30	0.073	40											
60	0.059	30	0.075	40											
55	0.061	30	0.078	40											
50	0.064	30	0.080	40											
45	0.067	30	**Min R 55m**												
40	0.071	30													
35	0.074	30													
30	0.079	30													
	Min R 30m														

510.06 VERTICAL ALIGNMENT

Refer to Table 510.J for maximum grades and Section 330.01 for minimum radius on downgrades.

Crest vertical curves are designed for stopping sight distance using 1.08 m for the height of driver's eye and 150 mm for the fixed object height.

Sag vertical curves are designed for stopping sight distance using the headlight control criteria.

See Table 510.I for minimum K values for Sag and Crest Vertical Curves on low-volume roads.

The minimum length of vertical curve should be equal to the Design Speed.

Table 510.I Vertical Curves on LVR's

Design Speed	Minimum SSD	Minimum Curve K	
km/h	m	Sag	Crest
30	35	6	4
40	50	9	7
50	65	13	11
60	85	18	18
70	105	23	28
80	130	30	42
90	185*	45	85

* Represents 1 second of additional perception/reaction time (based on interpretation of 1976 RTAC *Geometric Design Standards for Canadian Roads and Streets*, section B.2.5)

Table 510.J Maximum Grades

Design Speed (km/h)	**30**		**40**		**50**		**60**		**70**		**80**	
Topography	**R**	**M**	**R**	**M**	**R**	**M**	**R**	**M**	**R**	**M**	**R**	**M**
LVR	11	14	11	14	10	14	10	13	9	12	8	10

Source: 1994 *BC Highway Engineering Design Manual*, Table 350.A

R refers to rolling topography, **M** refers to mountainous topography.
These grades may be exceeded by 2% only for grade lengths of 500 metres or less.

510.07 CROSS SECTION ELEMENTS

Cross-section Types

The majority of low-volume roads built in British Columbia are two-lane, two-way LVRs. Refer to Figure 510.P. One-lane LVRs are very seldom designed and are, therefore, not covered in this chapter.

The designer should not design a one lane LVR without the approval of the Chief Engineer or the Director, Highway Design & Survey Engineering.

A) Two-lane LVRs

The roadway widths are dependent on the design speed, the amount of truck traffic and the type of surface. The shoulder width is the minimum that will provide lateral support for the pavement. There is no allowance for emergency parking as there are ample gaps in the opposing traffic stream to permit a safe passage around parked vehicles.

B) One-lane LVRs

One-lane LVRs are not common but they may be suitable in very special circumstances when the right-of-way is limited, such as in very rough terrain. One-lane LVRs can be designed for one-way or two-way traffic.

C) Peace District LVRs

(refer to Technical Circular T-3/03)

Within the Peace District, concerns were raised with the traditional roadway template having a paved surface that is too narrow, and side slopes that are too steep, to properly accommodate the large vehicles in use by agriculture and industry. Where economically feasible, the Peace District template will incorporate a 9.0 metre hard surfaced top with 3 or 4 to 1 side slopes. Refer to Figure 510.Q.

Certain factors may make this new template more expensive. These factors include right-of-way requirements, very large fills or large excavations. In addition, there may be some low volume local or primarily residential roads where industrial or agricultural traffic volumes are low enough that the Peace District template is deemed to be an inappropriate standard.

Where the costs associated with the new template are felt to be excessive, or where industrial or agricultural traffic volumes are low enough not to warrant application of the full template width, options for incremental improvement will be discussed with stakeholders to determine the best value approach on specific roads or sections of roads.

Exceptions to this standard will only be considered, as outlined above, after stakeholder consultation and review of appropriate road template standards to be applied for the given road. At a minimum, stakeholder consultations will include MLAs, the Regional Transportation Advisory Committee, and Rural Roads Task Forces.

Exceptions must be approved by the Chief Engineer, or designate.

Cross Section Elements for LVRs

Refer to Figure 510.P with these two tables.

Table 510.K Cross Section Elements for Two-lane LVRs - Gravel Top

Design Speed (km/h)	Roadway Width(1) (m)		Normal X-Fall (m/m)	Fill Slope(2)
	ADTT>15(3)	ADTT<15(3)		
80 - 90	8.0	7.5(4)	0.04	2:1
30 - 70(5)	7.5(4)	7.0(4)	0.04	2:1

Table 510.L Cross Section Elements for Two-lane LVRs - Paved Top

Design Speed (km/h)	Lane Width(1) (m)		Unpaved(1) Shoulder (m)	Normal X-Fall (m/m)	Fill Slope(2)
	ADTT>15(3)	ADTT<15(3)			
80 - 90	3.6	3.5	0.5	0.02	2:1
50 - 60 - 70(5)	3.5	3.25(4)	0.5	0.02	2:1
30 -40(5)	3.25(4)	3.25(4)	0.5	0.02	2:1

(1) Where CRB is used, widen the roadway or pavement by 0.6 m on the barrier side of the roadway.

(2) In mountainous terrain, when fill heights exceed 3.0 metres or when environmental, R/W or other economic constraints dictate, a slope of 1.5:1 may be appropriate. For high fill heights, the traffic barrier warrant should be examined. Maximum side slopes of 1.25:1 are suggested for rock grading.

Maximum back slopes of 1.5:1 are suggested for earth grading if the stability of local soils permits. For cut sections in solid rock, refer to the appropriate drawing in Chapter 400.

(3) ADTT = Average Daily Truck Traffic. A truck is defined as a Medium Single Unit (MSU) or larger vehicle. See Chapter 2 Section 2.4 in the *TAC Geometric Design Guide* and Section 720 in this Manual for a discussion on Design Vehicles.

(4) To avoid shoulder degradation on paved LVRs and crossing of centreline on gravel LVRs, these widths should be increased on curves. The amount of additional widening is related to curvature and speed. See Chapter 3 Section 3.2.5 of the *TAC Geometric Design Guide* for a discussion on Lane Widening on Curves.

(5) Approval from the regional Executive Director or the project Technical Review Committee is required for design speeds less than 80 km/h.

510.08 CLEAR ZONE

There is no clear zone applied to LVRs with regards to slope treatment. However, the utility pole offset is applied. Utility poles must be placed within 2 metres of the R/W or 3 metres from the toe of fill, whichever gives the greater offset from the lane edge.

510.09 BARRIER FLARES

The flares for both roadside barrier and bridge ends are a function of volumes under 200 ADT and are shown in Table 510.N. For the "2/3" flare, the flare rate or angle has been maintained, while the length and thus the offset have been reduced.

For the "1/3" flare, the "2/3" Ya has been kept, with the minimal Xa to develop the offset. This Xa is a function of the connection flexure between pieces of barrier. Figure 510.M shows the decision tree to the appropriate treatment.

Where a full flare or a "2/3" flare is required, the designer should evaluate the economics of using the required Xa with an attenuator and no flare. To simplify the comparison, evaluate capital costs of the flare vs. capital cost of the attenuator, without a flare. See 510.12 for Flare Adjustment rationale.

510.10 ROADSIDE BARRIER

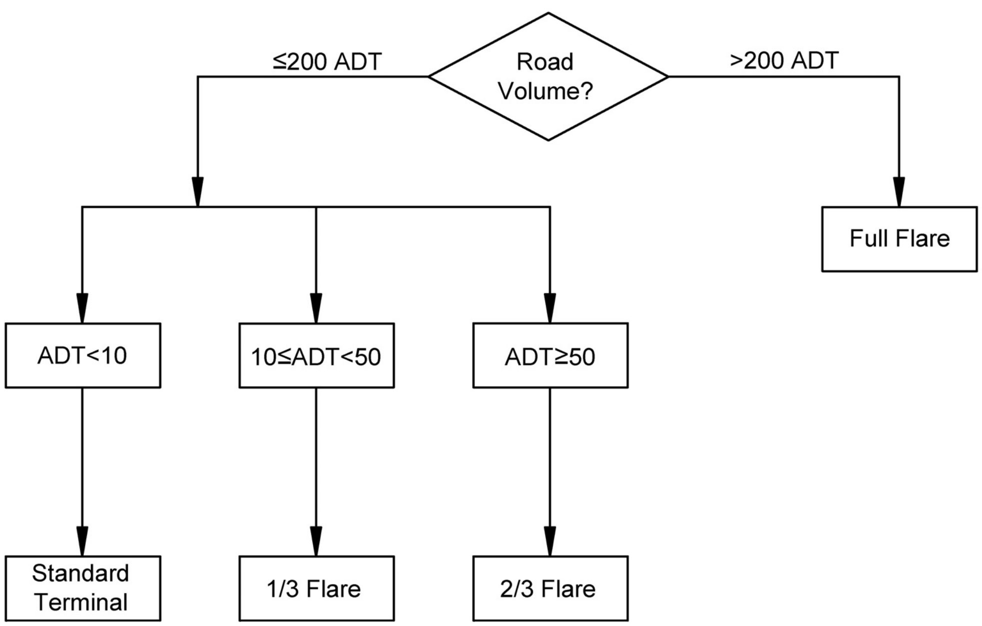
Barrier need is determined with the Roadside Barrier Index Warrant, in Chapter 600, Safety Elements. To accommodate the barrier, add 0.6 metres width to the side of the road where the barrier is to be placed.

510.11 LOW-VOLUME BRIDGES

All bridges shall have an end treatment. Figure 510.M is the decision tree to the appropriate treatment on bridges.

The Structural Engineering Branch and Traffic & Highway Safety Branch are to be contacted regarding connection details to various bridge ends.

Figure 510.M Barrier Flare Decision Tree



Full Flares are shown in Chapter 600: Figure 640.C for Roadside Barrier and Figure 640.D for Bridge Ends. Reduced flares are shown in Tables 510.N. The notations "2/3" and "1/3" are nominal descriptors; the actual lengths are a function of discrete barrier pieces, connection details and the ability to flex the barrier at their individual connections.

Table 510.N Adjusted Flares for Roadside Barrier
(taken from the 1994 *Highway Engineering Design Manual*) *

Speed	"2/3" Flare			"1/3" Flare		
km/h	**Xa**	**Ya**	**# of CRB's**	**Xa**	**Ya**	**# of CRB's**
30	12.3	2.0	5	4.9	1.0	2
40	14.8	2.0	6	14.8	2.0	6
50	17.4	2.1	7	14.8	2.1	6
60	22.4	2.1	9	14.8	2.1	6
70	27.4	2.2	11	14.8	2.2	6
80	32.4	2.3	13	15.0	2.3	6
90	37.4	2.3	15	17.5	2.3	7
100	39.9	2.3	16	20.0	2.3	8

Xa dimensions do not include a CTB-2 Transition piece and the need for pairs of CRBs (H&E) on Bridge End Flares. These are minimum dimensions and should be exceeded where feasible.

Contact Structural Engineering Branch for specific connection details. Should the connection detail not require a CTB-2, add an extra piece of CRB.

* The adjusted Xa and Ya values are based on the full flare dimensions from the 1994 *Highway Engineering Design Manual*. The full flare dimensions from 1994 are larger than the current flare dimensions shown in Chapter 600. Maintaining the 1994 Ya offset is preferred for introducing the start of the barrier compared to using the current flare dimensions which would result in a smaller Ya.

510.12 FLARE ADJUSTMENT

There may be cases where more barrier length should be used than that arrived at through Figure 510.M. This can be caused by specific site conditions.

For example, it may not be cost-effective to build the bridge end or embankment protection flare in the required location, because of the expense incurred in building the embankment for the flare.

In this case, it may be less expensive to have additional barrier, parallel to the road that extends further to a more acceptable location. See Figure 640.E for some sample treatments.

Where full size or “2/3” flares are required, consider using the required Xa with an attenuator and no flare.

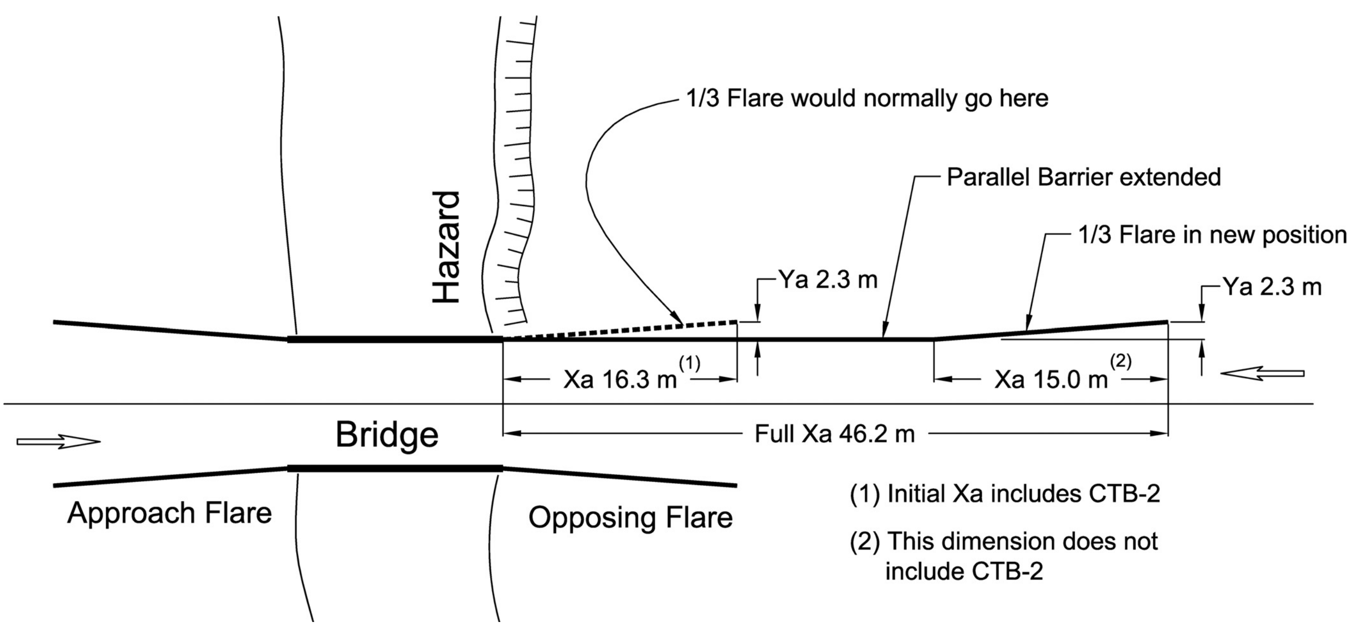
In another typical situation, there may be sufficient space for the flare at the bridge approach. However, the barrier may have to be extended to shield a hazard on the side of the road.

For this case, the barrier length should be extended, parallel to the lane edge, to prevent an errant vehicle that leaves the road from reaching the hazard. The required flare is simply shifted to the end of the parallel barrier and placed using the same Xa and Ya as would otherwise be used.

In the example shown in Figure 510.O, it is determined that a "1/3" flare is necessary for a bridge end treatment at 80 km/h. The Xa value is 15.0 m plus 1.3 m for CTB-2, the Ya is 2.3 m. However, there is a sharp drop-off to the river below. To prevent a vehicle that leaves the road in advance of the "1/3" flare bridge end treatment from reaching the drop off, the total length required is equal to the full Xa value of 46.2 m. The solution is to insert 12 pieces (30 m) of CRB at the bridge end after the CTB-2, parallel to the road, and to place the "1/3" flare at the end of this barrier run.

A prudent design should also recognize that barrier flare ends should not be placed at awkward locations in the alignment, such as just beyond vertical curves or on the outside of sharp horizontal curves at the end of tangent sections.

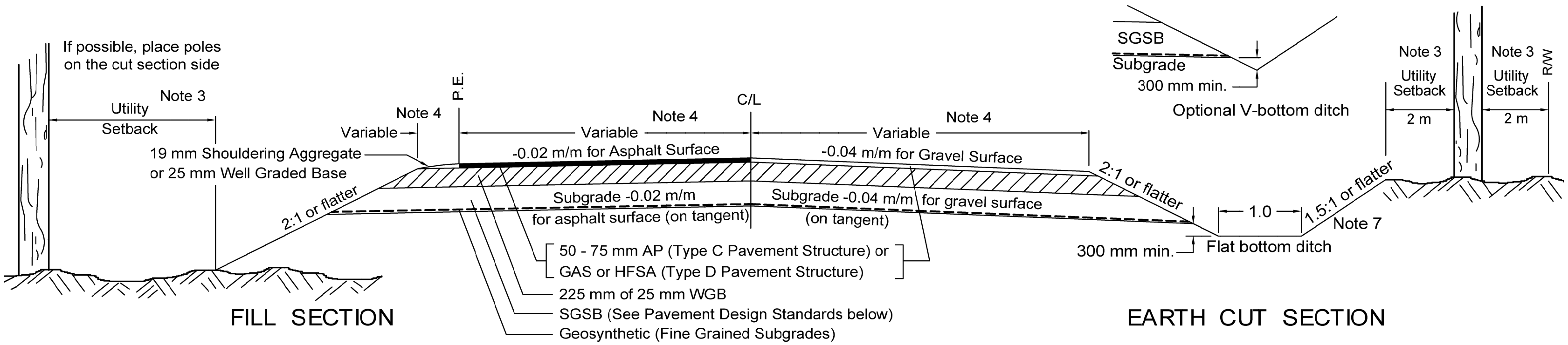
Figure 510.O Example Flare Adjustment to Shield a Hazard at an LVR Bridge Approach



Because of the narrowness of LVR's, there is no difference between Approach and Opposing Flares.

Figure 510.P Cross Section for Low-Volume Roads

N.T.S.



PAVEMENT DESIGN STANDARDS - Structure shown above is for "Equivalent Single Axle Loads (ESAL's)" <100,000. See 1410.07.02

<u>MINIMUM SGSB THICKNESSES</u>

- 150 mm SGSB on Coarse Grained Subgrades with USCS of GW/GP/GM/GC/SW/SP/SM/SC and BR (bedrock).
- 300 mm SGSB on Fine Grained Subgrades with USCS of ML/CL/OL/MH/CH/OH and PT, and must include a suitable geosynthetic separator (see 1410.07.04).
- No SGSB is required in exceptional circumstances where the following criteria have been met:

Structural Design Criteria

and

Subgrade material satisfies SGSB gradation and construction criteria (i.e. rutting criteria) in accordance with the latest version of B.C. MoTI Design Build Standard Specifications for Highway Construction - Section 202 "GRANULAR SURFACING, BASE AND SUB-BASES"

- All levelling materials applied directly to blasted rock cuts shall be of SGSB quality.
- Pavement structure designs deemed to be governed by adverse groundwater or frost concerns must be reviewed by a Ministry Geotechnical and Materials Engineer.
- Any variance proposed to decrease base course thicknesses, or use a CBC other than WGB, or eliminate geosynthetic from the typical above must be reviewed by a Ministry Geotechnical and Materials Engineer.
- A Geotechnical Engineer (P.Eng.) registered with APEGBC must certify that the minimum base course thicknesses provided above are satisfactory for the traffic volumes, traffic loading and the soil, groundwater and frost susceptibility conditions at the site. Any changes to base course thicknesses requires P.Eng. certification and is to be reviewed by a Ministry Geotechnical and Materials Engineer. The certification is to be based on a site specific geotechnical investigation. Refer to 1410.01.02.01 for Engineer of Record guidelines.

Notes:

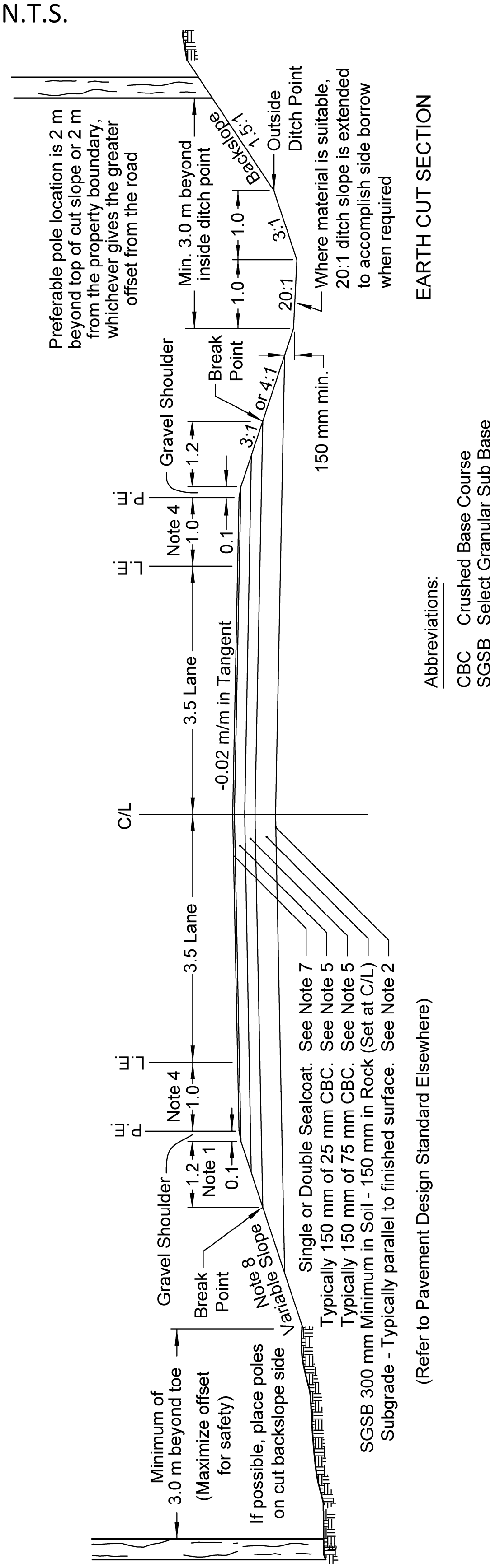
1. For bikeway design, see Section 510.01
2. For roadside barrier details, see Section 510.09
3. Utility setback is 3 m from the base of fill and 2 m from the top of cut slope, or 2 m from the property boundary, whichever gives the greater offset from the road
4. For variable shoulder and top widths, refer to Tables 510.K and L
5. For rock ditches, see the LVR detail on Figure 440.H
6. A flat bottom ditch is preferred for handling design flows and providing snow storage
7. Depending on the type of soil, backslopes will usually need to be flatter than 1.5:1

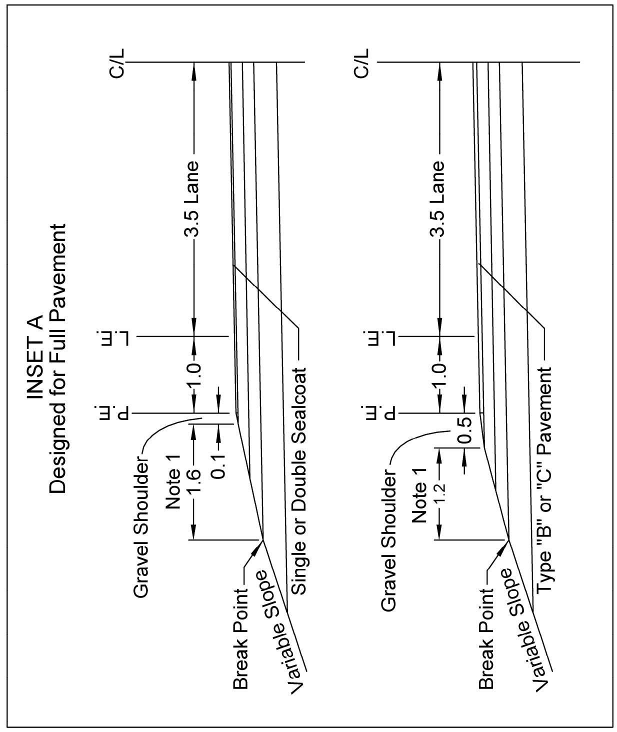
<u>Abbreviations:</u>

AP	Asphalt Pavement
CBC	Crushed Base Course
GAS	Graded Aggregate Seal
HFSA	High Fines Surfacing Aggregate
SGSB	Select Granular Sub-Base
USCS	Unified Soils Classification System
WGB	Well Graded Base

Figure 510.Q Cross Section for Peace District Low-Volume Roads

N.T.S.





Notes:

1. Sealcoat offset to Break Point should be increased to 1.6 m if full pavement is anticipated within 20 year window. See Inset A.
2. -0.03 or -0.04 m/m is used in earth to facilitate drainage, when directed by a Ministry Geotechnical Engineer.
3. For rock ditch details, refer to Figure 440.H.
4. For CRB, 1.3 m is required to the barrier face. See Figure 440.F for slope modification above Break Point.
5. A Geotechnical Engineer (P.Eng.) registered with APEGBC must certify that the minimum base course thicknesses provided above are satisfactory for the traffic volumes, traffic loading and the soil, groundwater and frost susceptibility conditions at the site. Any changes to base course thicknesses requires P.Eng. certification and is to be reviewed by a Ministry Geotechnical and Materials Engineer. The certification is to be based on a site specific geotechnical investigation.
6. Design Speeds 50 - 80 km/h.
7. Sealcoat is a single (19 mm) or double (38 mm) lift. Pavement is typically Type 'B' (75 mm) or Type 'C' (50 mm).
8. Desirable fill slope is 4:1 or flatter. Other influences may necessitate steeper slopes, which may require barrier.