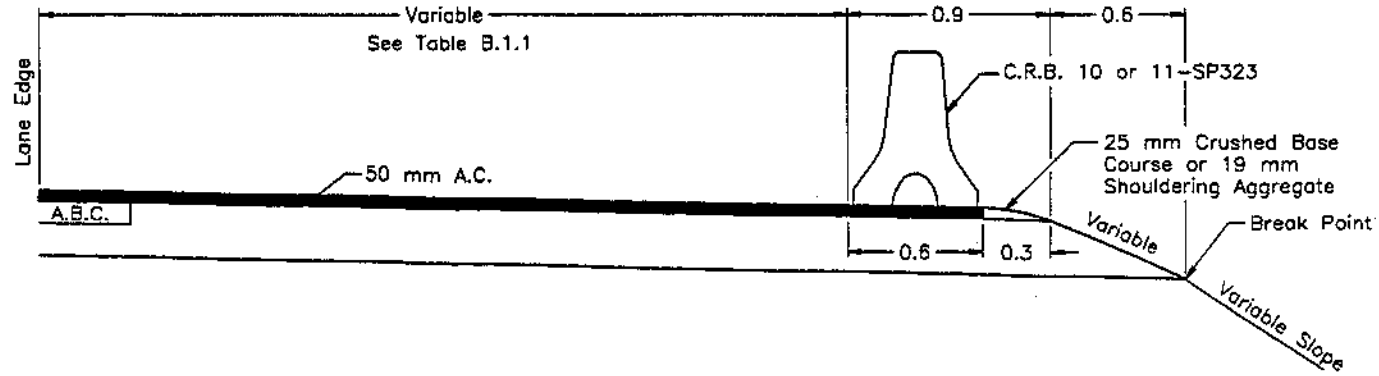
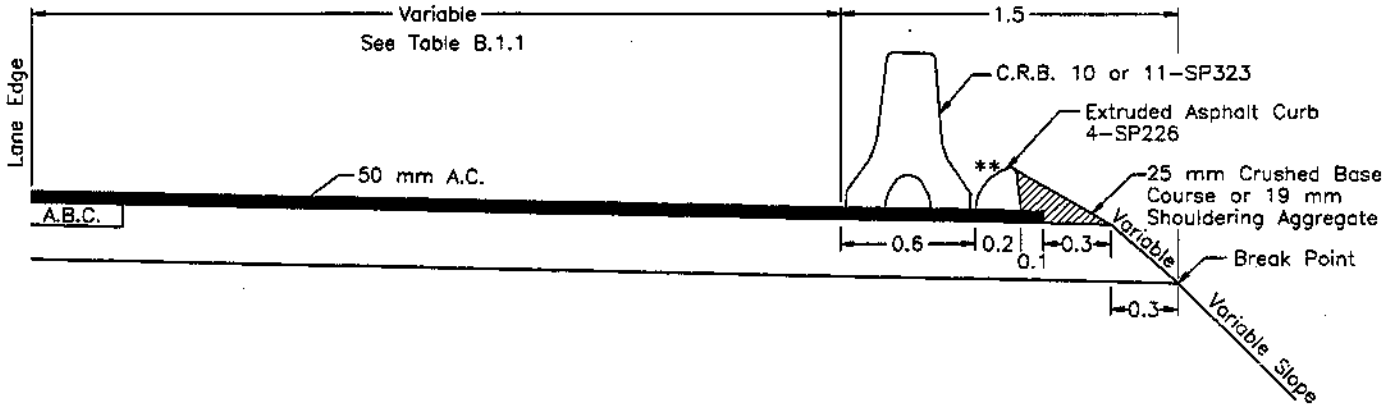
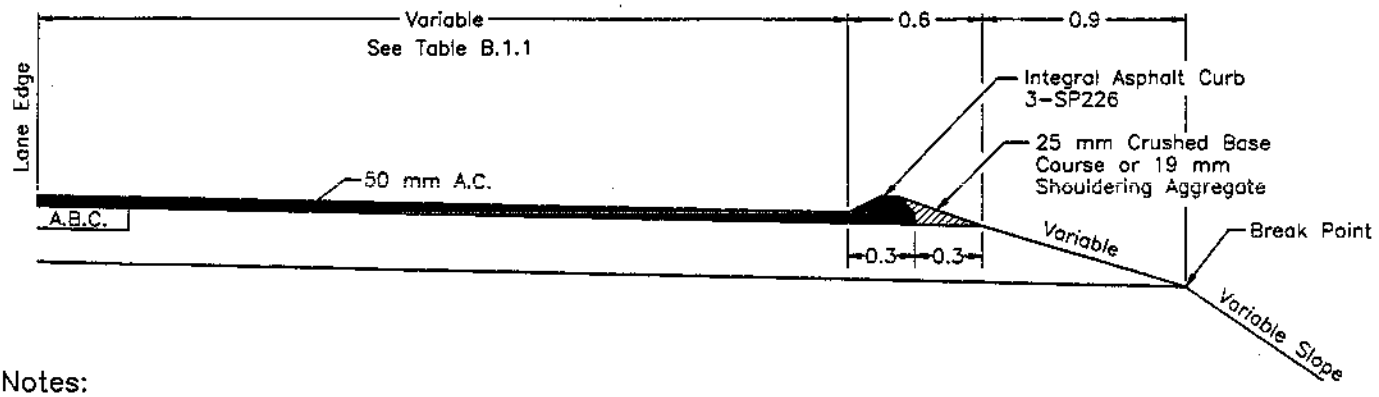






Notes:

Barrier and/or curbing on truck lanes added to 2 lane roads must be a minimum of 1.3 m from the lane edge.

Barrier and/or curbing on truck lanes added to 4 lane roads must be a minimum of 1.0 m from the lane edge.

Machine laid extruded asphalt curb may be incorporated behind C.R.B., prior to it's installation, in areas of potential drainage erosion (bridge abutments, sag vertical curves etc.)

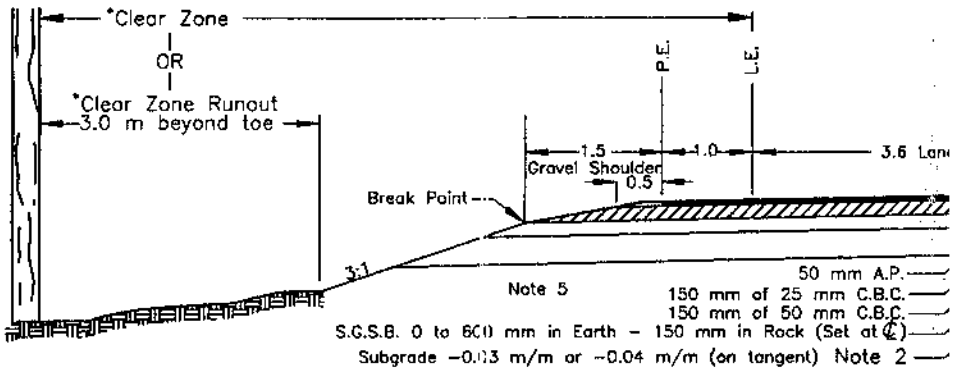
**This type of curb must not be placed in front of the concrete barrier.

SHOULDER DETAIL WITH ROADSIDE BARRIER & DRAINAGE CURB

Highway Engineering Design Manual

B.2-1 ERRATA

November, 1992



*Use Clear Zone Table values when the fill height is less than 1.0 m. When height is greater than 1.0 m, provide 3.0 m Runout beyond the toe. Runout slope to be 4:1 or flatter.

Notes:

1. For shoulder bikeway width, refer to Table
2. -0.04 m/m is used in earth to facilitate drainag when directed by Geotechnical Branch.
3. For rock ditch details, refer to B.2-3
4. For roadside barrier and drainage curb deta refer to B.2-1
5. These are typical gravel depths to be used the absence of geotechnical investigation

Clear Zone

(Distance from Lane Edge in metres)

Design Speed (km/h)	Clear Zone m
50	3.5
60	3.5
70	4.5
80	4.5

1. The minimum size open culvert installation under a highway or main road shall be 600 mm diameter.

2. The minimum size frontage road culvert shall be 500 mm diameter.

3. The minimum size driveway culvert shall be 400 mm diameter.

4. Culverts shall be designed to be of a size to carry flow in the 50 to 200 year return period range ponded to the crown.

   Examples of when the various return periods should be used are as follows:-

   50 year — For low volume roads with shallow fill in undeveloped areas.

   100 year — Normal design except when the conditions stated for the 50 or 200 year return period are applicable.

   200 year — (a) For highways in developed areas where flood damage is a possibility. (In some instances where the upstream flood levels are critical, it may be necessary to design the culvert so as not to increase the upstream water levels).

   (b) When requested by Ministry of Environment.

5. A culvert list and summary shall be made on forms H 741 and H 742 for each project.

   When submitting a project for Contract, a copy of the list and summary shall be forwarded to the Contract Documents Officer.

   For helical pipe the length breakdown in multiples of 4, 5 or 7 m must be listed.

Culvert Size

The following minimum culvert diameters are recommended:

- The minimum size culvert under a highway or main road shall be 600 mm diameter.
- The minimum size frontage road culvert shall be 500 mm diameter.
- The minimum size driveway culvert shall be 400 mm diameter.

Skew

A skew angle shall be designated for all installations. The skew angle is the angle measured from the centerline of the highway ahead to the centerline of the culvert, measured in a clockwise direction. The normal range is from 45 to 135 degrees.

A cross culvert from a highway ditch in cut shall be installed on a skew to facilitate inlet pickup.

For information on culvert skew, refer to:

- *CSPI Handbook of Steel Drainage and Highway Construction Products (2002), p. 199.*

Slope

Culverts should generally be placed on the stream grade. If possible, culverts should ideally be placed slightly steeper than the critical slope for the size and type of pipe used. This is usually between 1.0 to 2.2%, however the desirable minimum gradient is 0.5% to prevent sedimentation. The desired maximum gradient is 20% for CSP and 10% for concrete pipes.

For culverts on steep grades, the stability of the upstream bed material should be reviewed to ensure the culvert invert is not abraded by the bed load. Additional features including thicker walls, wear resistant coatings, and armoured and paved inverts should be considered.

For culverts required to provide fish passage, the culvert slope may have to be less than 0.5% to minimize velocities. Special culvert enhancements to provide fish passage may also be considered.

In some instances a culvert may be located at a grade change in a channel bed (e.g. break point between steep mountain flow and floodplain flow). This is the worst place for debris deposition therefore mitigative measures such as a debris basin or smooth flow transition should be considered.

For information on culvert slopes, refer to:

- *CSPI Handbook of Steel Drainage and Highway Construction Products (2002), p.196.*
- *RTAC Drainage Manual Volume 2 (1987), pp. 4.12.*
- *Land Development Guidelines for the Protection of Aquatic Habitat (1993), p. 73.*

Invert Elevations at Streams

Culvert inverts should be at least one quarter of the rise below the average natural channel bed up to a maximum depth of 1 m. Exceptions to the recommended invert depth may be considered when site specific features would require special attention (i.e. fish passage; bedrock).

Length

Culverts shall extend at least 0.5 to 0.7 m beyond the toe of slope to accommodate possible sloughing. If riprap is to be placed at the culvert ends, the end extensions should be adjusted accordingly. The total culvert length shall be rounded up to the nearest 1.0 m. CSP stock pipe lengths are 6 m, however, other lengths are available.

For a SPCSP or concrete box culvert, the extension beyond the toe may be greater than 0.7 m due to the length of the prefabricated sections.

As part of final construction clean up, the embankment shall be built-up around the culvert end to limit protrusion to less than 150 mm. Culvert ends shall be step-bevelled, where appropriate.

For information on culvert length, refer to:

- *CSPI Handbook of Steel Drainage and Highway Construction Products (2002), p. 197.*

Wall Thickness and Height of Cover Requirements

The Canadian Highway Bridge Design Code (CHBDC) indicates that the provisions of Section 7 of the code apply only to buried structures with span (DH) greater than 3000 mm, but the CHBDC does not provide design guidance for smaller structures.

Buried structures with spans less than or equal to 3000 mm may also be designed to CHBDC S6-06 Section 7 (except that the design live load vehicle shall be the BCL-625 per the BC MoT Supplement to CHBDC S6-06), or the Designer shall use empirical methods, current practice and manufacturer's literature and solutions that have a proven record of success for small diameter culverts.

Maximum and minimum height of cover and minimum wall thickness shall be per manufacturer's specifications. CSP wall thickness and height of cover are shown in **Tables HC-1 to HC -12 in** the following:

- *CSPI Handbook of Steel Drainage and Highway Construction Products (2002),*

SPCSP, concrete pipe, and PVC/HDPE wall thickness shall be obtained from manufacturer specifications.