British Columbia Forest Service

FOREST ROAD STANDARDS

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Province of British Columbia
Ministry of Forests

BRITISH COLUMBIA FOREST SERVICE

FOREST ROAD STANDARDS

Standards for the Planning, Location, Design, Construction, Maintenance and Deactivation of Forest Roads

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MINISTRY OF FORESTS

FOREST ROAD STANDARDS

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1.0 PREFACE

These Forest Road Standards establish minimum engineering criteria for the planning, location, design, construction, maintenance, and deactivation of forest roads, including bridges, major culverts, and drainage works in the Province of British Columbia.

Apply these Standards judiciously to suit the large variety of forest roads. Append additional supporting design and construction specifications to these Standards to address site specific conditions.

These Standards are intended to represent current and sound forest engineering practices. They will be amended, from time to time, to allow for changes in technology, or for better solutions as they become known. These Standards shall only be altered or changed by Engineering, Ministry of Forests, Victoria.

2.0 ROAD DEVELOPMENT

Incorporate into the forest management process the following factors in the planning, location, and design of all forest roads, and associated bridges and major culverts:

- safety;
- protection of soils, site productivity, fisheries, water quality and other resource values;
- visual impact;
- economy and efficiency.

2.1 Route Planning

(a) Carry out an access development study to find the most efficient log transportation network within the restrictions imposed by the terrain, timber harvesting methods and other resource demands, while minimizing the impact on the environment. An access development study consists of both a pre-field investigation (office study) and field reconnaissance.

(b) Incorporate the following information as part of the access development study:

- the overall area to be developed;
- timber harvesting systems and layout;
- primary access corridors and options, and areas of critical engineering control;

- existing transportation networks;
- potential environmental problem areas;
- life expectancy of roads;
- periods of use (seasonal or all-weather use) and anticipated volumes and types of traffic;
- preliminary road design criteria, such as road width, design speed, adverse and favourable grades, for each segment of the proposed road.

(c) Minimize the length of and number of roads built in conjunction with logging layout using Integrated Resource and Total Chance Planning, and considering the allowable level of site disturbance.

(d) Present and summarize the study findings in a written report, including drawings showing the proposed access corridors and options, and other related elements.

2.2 Reconnaissance

(a) Carry out a reconnaissance for each forest road prior to road location survey and design, to select and mark the best location (alignment and grades) for the road within and along the approved route corridor. Reconnaissance consists of both a pre-field investigation (office study) and a ground traverse of the approved route corridor.

Use all available information, such as access development study reports, aerial photographs, topographic surveys, soil and landform maps, and other soils and geologic information, to select suitable road locations.

(b) Position roads away from water bodies and wetlands. Identify and record locations of all continuous and intermittent drainage flow channels, springs, seeps, and moist areas that should be accounted for, to minimize impact on streamflow, surface erosion, water quality and slope stability. Consider vegetated buffer strips located adjacent to watercourses where the surface soil erosion hazard is high.

(c) Locate roads to avoid known hazards, such as ground water seepage, clay strata, concave slopes and steeply dipping rock layers.

(d) Avoid areas of potential open-slope instability, surface soil erosion potential and/or gully instability. Locate roads on benches, ridge tops and flatter slopes to minimize erosion. Avoid areas with high mass wasting or erosion hazard, including downslope sensitive areas.

(e) Cross streams at locations where channel and bank disturbance will be minimized. Keep the number of stream crossings to a minimum.

(f) Keep road gradients as low as practicable.

(g) Consider the maximum angle of repose of cut and fill slopes when locating, designing and constructing roads.

2.3 Road Location Survey

The minimum acceptable road location survey accuracies for P-Line surveys are a relative horizontal precision of at least 1:600, and vertical accuracy of ± 1 m for each km of traverse.

2.4 Road Design

(a) Design all forest roads (i.e., generate an L-line) to provide the suitable horizontal and vertical geometry that will minimize soils to be moved, minimize impact on other resources and facilitate proper drainage, with due consideration of travel speeds and stopping distances. Use roadway design criteria and dimensions shown in Table 1, and Figure 1.

Table 1 Summary of Alignment Controls for Forest Roads

Design Speed (km/h)	Minimum Stopping Sight Distance (m)		Minimum Passing Sight Distance for 2-lane Roads(m)	Horizontal Curves Minimum Radius of Curve (m)	Vertical Curvature[4] for Minimum Stopping Sight Distance				Maximum Road Gradient[1]				
					Single Lane Two-Way Roads		Two Lane and Single Lane One-Way Roads		F		A		Switch-backs
	Single Lane Two Way Roads	Two-lane and single lane one-way roads			Crest, k	Sag, k	Crest, k	Sag, k	S	P[2]	S	P[3]	
20	40	20	-	15					16%	18% for distance less than 150 m.	9%	12% for distance less than 100 m.	8%
30	60	30	250	35	4	11	3	4	12%	14% for distance less than 150 m.	8%	10% for distance less than 100 m.	8%
40	90	45	290	65	9	19	5	7					
50	130	65	340	100	18	29	12	12					
60	170	85	420	140	31	41	18	18					
70	220	110	480	190	52	55	30	25	8%	10% for distance less than 200 m.	6%	8% for distance less than 100 m.	6%
80	280	140	560	250	84	71	50	30					

F = favourable grade
A = adverse grade
S = sustained grade
P = short-pitch

1 (i) There are no absolute rules for establishing maximum road gradient. Maximum grades cannot generally be established without performing an analysis to determine the most economical grade for the site specific conditions encountered. The maximum grade selected for design purposes may also depend on other factors such as: topography and environmental considerations; the resistance to erosion of the road surface material, and the soil in the adjacent drainage ditches; the life expectancy and standard of road, periods of use (seasonal or all weather use), and road surfacing materials as it relates to traction; types of vehicles and traffic, and traffic volumes.

(ii) Where possible, gradients below maximum should be used. Where safety of users and environmental concerns can be addressed satisfactorily, and where construction costs are severely impacted by using maximum grades, steeper grades may be tolerated.

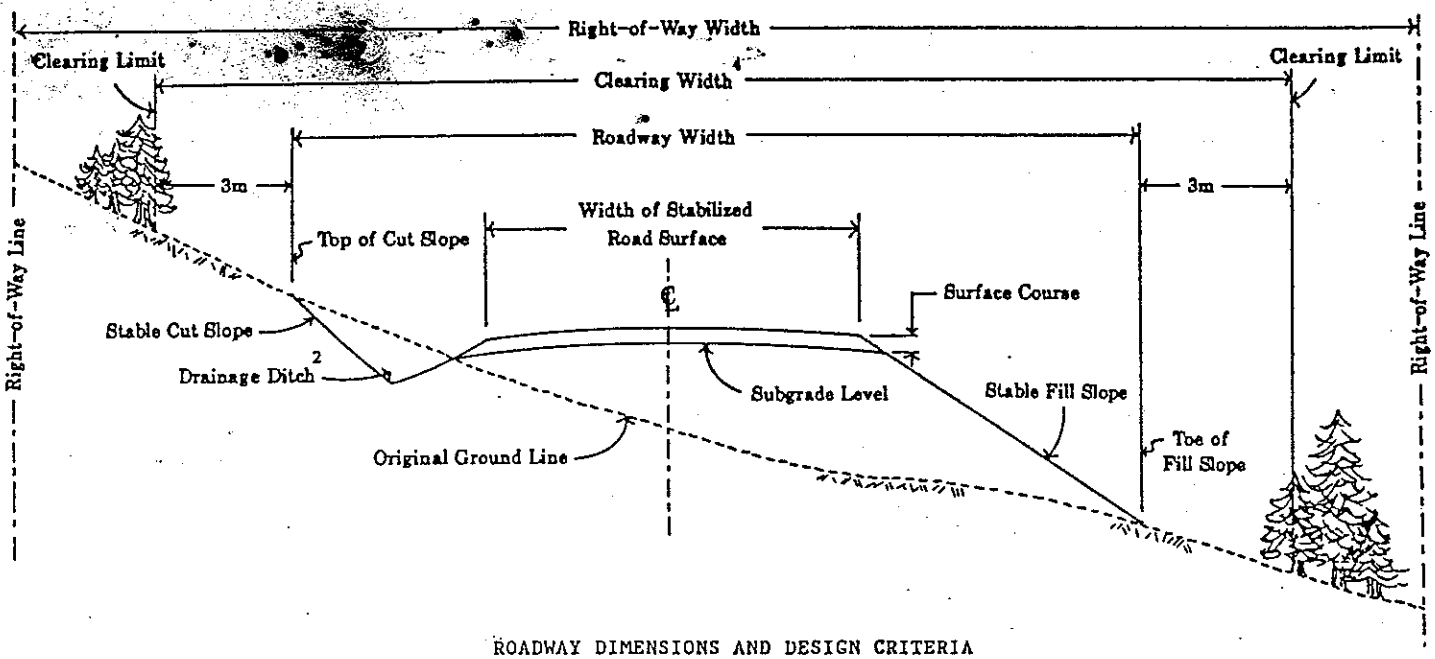
(iii) Apply other grade restrictions in special situations:
- on horizontal curves sharper than 80 m radius, reduce the adverse maximum grade by 0.5 percent for every 10 metre reduction in radius;
- as required at bridge approaches, and at highway and railway crossings.

2 Design maximum short-pitch favourable grades so that they are followed or preceded by a section of slack grade. The average grade over this segment of the road should be less than the specified sustained maximum.

3 Design maximum short-pitch adverse grades as momentum grades.

4 K = L/A, where L = length of vertical curve in metres and should not be less than design speed in km/h, and A = algebraic difference in grades percent. Crest vertical curvature k for stopping sight distance for two lane and single lane one way roads is based on a height of driver's eye of 1.05 m and a fixed object height of 0.15 m. Crest vertical curvature k for stopping sight distance for one lane, two way roads is based on a height of driver's eye of 1.05 m and the height of the opposing vehicle taken to be 1.30 m. Sag vertical curvature for stopping sight distance is based on a headlight height of 0.6 m and an angle of the light beam upward from the plane of the vehicle equal to 1 degree.

Figure 1: Roadway Cross-section



ROADWAY DIMENSIONS AND DESIGN CRITERIA

ROAD CLASS	DESCRIPTION	WIDTH (m) OF STABILIZED ROAD SURFACE	WIDTH OF TURNOUT[1](m)	MINIMUM (m) CLEARING WIDTH	MINIMUM DESIGN SPEED[3]km/h
CLASS 1	Double Lane Off-Highway	10	None	35	
CLASS 2	Double Lane Off-Highway	9	None	30	50
CLASS 3	Double Lane On-Highway	8	None	30	
CLASS 4	Single Lane Off-Highway	6	10	25	
CLASS 5	Single Lane On-Highway	5	10	20	30
CLASS 6	Single Lane On-Highway	4	8	20	20

NOTE: [1] The turnout width provided in the table above includes the width of the stabilized road surface.

[2] Use a minimum ditch depth equal to 1.5 times the culvert diameter, but not less than 700 mm.

[3] The minimum design speed may be less than indicated on certain segments of road to accommodate terrain, ensure user safety and maximize economy of construction.

[4] Points located 3 m beyond the top of cuts and 3 m beyond the toe of fills define the clearing width boundaries. The clearing width is typically less, but may be equal to, the right-of-way width.

(b) Provide a minimum of 3 intervisible turnouts per kilometre on single-lane roads. Provide a useable length of 30 m, including tapers, and a width as per Figure 1.

(c) Double-lane all blind curves. For other curves, allow extra width, if required, to accommodate side tracking of truck-trailer units, as per Table 2.

Table 2 Widenings on Curves

Minimum Subgrade Widths for Single-Lane Roads* on Curves

Radius of Curve (m)	Pole and Triaxle Trailer Configuration	Lowbeds
	Minimum Subgrade Width (m)	Minimum Subgrade Width (m)
180	4.0	4.3
90	4.5	5.3
60	5.0	5.8
45	5.0	6.0
35	5.5	6.5
25	6.0	7.5
20	7.0	8.0
15	8.0	9.0

NOTE: Increased subgrade widths shown in this table do not allow for the path of the overhang of long logs or any off tracking slippage of the truck or trailer due to poor road conditions.

* For two-lane roads or turnouts, it is assumed that the second vehicle is a car, or single unit truck, therefore add 4.0 m for pole and triaxle trailer configurations and 4.5 m for lowbeds.

(d) At each road junction, provide for a suitable stopping distance. Design roads to intersect at right angles, wherever possible.

(e) Provide for ditches and an adequate number of culverts of proper size and alignment to handle peak runoffs, to minimize water movement along ditches and the road surface.

(f) Size culverts for established watercourses to safely pass high water discharge without increasing stream velocity. Position these culverts on the line and grade of the original stream channel, if feasible. If possible, improve the inlet condition and reduce the erosion potential with some channel improvement. Minimize disturbance of the stream banks.

(g) Provide for sufficient cross-drain culverts at intervals necessary to minimize erosion of the roadside ditchline. Maximum spacing intervals for cross-drain culverts between established watercourses are shown in Table 3.

Table 3

Maximum Culvert Spacing for Forest Roads

EROSION HAZARD MORE THAN 50% BY SOIL TYPE	SLIGHT HARDPAN, SOLID ROCK	MODERATE GRAVEL, COBBLES	HIGH SANDS, SILTS, CLAYS
Road Gradient			
0-3%	350 m	300 m	250 m
3-8%	250 m	200 m	150 m
8-15%	200 m	150 m	100 m
15%+	150 m	100 m	Less than 100 m

Note:

- Reduce the spacing between culverts as required to prevent excessive accumulation of water in the ditches, particularly at road junctions, and along road segments with steep uphill side slopes, and along areas of seepage or piping in cuts. Examine the downslope on which the culvert will discharge. If extensive erosion or mass-wasting may occur, change the location to suit the situation.

(h) Skew cross drainage culverts to the road centreline by 3 degrees for each 1 percent that the road grade exceeds 3 percent, to a maximum of 45 degrees, with a maximum slope of 2 percent to divert ditch line water into the culvert.

(i) Use a culvert length measured along the invert equal to the distance between the toes of the embankment plus 1 m in gravelly soils, or 2 m in silty soils.

(j) Size culverts using the following conditions at design flow capacity:

- For sizing of culverts on roads whose life expectancy is 3 years or less, use the 25-year return period for high water. For longer-term roads, use the 50-year return period. For roads that cross fish-bearing streams, consult with the applicable agency for the appropriate return period and other relevant design criteria.

- Use minimum culvert sizes of 400 mm and 500 mm, east and west of the Cascade Mountains, respectively, and 600 mm on the west coast of Vancouver Island.

(k) Prepare appropriate drawings and specifications.

3.0 ROAD CONSTRUCTION

Obtain all necessary approvals for the location, timing and method of construction for all bridges, culverts, roads and other related structures, prior to commencement of the project.

3.1 Right-of-Way Clearing, Grubbing, and Stripping

Mark the clearing width boundaries before right-of-way clearing, grubbing and stripping (see Figure 1).

(a) Fell, remove and dispose of all standing or fallen woody vegetation, including trees, logs, and shrubs within the clearing width.

(b) Fell all trees away from watercourses. If a tree should be felled into water, it must be skidded out before being delimbed, topped or bucked.

(c) Remove all snags and danger trees located along the boundaries of the clearing width.

(d) Recover and protect merchantable logs before constructing the road subgrade. Use logs as required for road corduroy, culverts and local material bridges, providing their use is economical.

(e) After clearing the right-of-way, remove and burn or bury all stumps, roots and logs embedded within a nominal depth of 0.6 m below the ground line.

(f) After grubbing, remove and dispose of any material within the roadway width that is not suitable for constructing road embankments. Examples of unsuitable materials include organic silts (topsoil), soft clays and peats.

(g) Where overlanding is required to cross soft ground, the existing vegetative material may be left in its natural state once the merchantable wood is removed.

(h) Incorporate these measures in disposal operations:

- where the material is to be buried, place a minimum of 0.5 m thickness of inorganic material over all debris. Carry out burying operations within the right-of-way width, but outside the road prism. Widen the cleared area if necessary, to ensure that burying operations do not cause fill to be placed against standing timber.
- after burning any debris, bury the remnants as described above.

3.2 Subgrade Construction

(a) Minimize soil disturbance by constructing road subgrades when the moisture conditions are favourable. Protect the shorelines of watercourses (seasonal and continuous), including shoreline vegetation, from potential damage caused by road building activities.

(b) Provide and maintain proper drainage by installing adequately sized culverts, together with a ditching network, as subgrade construction work proceeds. Keep culverts, ditchlines and bridge sites clean during and after construction.

(c) Use only inorganic materials for subgrade construction. Place fills in horizontal lifts not exceeding 300 mm loose thickness and compact at optimum moisture content with suitable equipment as required.

(d) Do not place fill material below the high water level of adjacent water courses, whether these are continuous or seasonal. Removal of gravel from a stream channel or the use of construction equipment in streams without prior approval from appropriate agencies is prohibited.

(e) Prevent damage, through controlled blasting techniques and other suitable measures, to standing or felled timber during drilling and blasting operations.

(f) Avoid road building across sensitive sites wherever possible. Apply road construction techniques, such as planned and careful balancing of cuts and fills, full bench construction and end hauling, and use suitable excavating equipment, to minimize excavation and sidecasting on terrain having high surface erosion or mass wasting hazard. Placement of side-cast fill materials for

road construction is not permitted where surface soil erosion or mass wasting could result in sediment being transported to streams, lakes or bogs. Do not sidecast onto or into plantations, visually sensitive slopes, unstable slopes, gullies, other problem slopes or areas, any body of water, or private property.

(g) Locate end haul and deleterious substance disposal sites in stable areas away from streams or drainage courses. Groom disposal sites and leave them in an environmentally stable state to permit grass seeding or tree planting.

(h) Cut slope and fill slope angles as depicted on the road cross-section in Figure 1 of these Standards, particularly for roads located within domestic watersheds,shall not exceed the angle of repose of the soils materials. Place rip rap or install retaining walls where needed to achieve the natural angle of repose of cuts and fills. Do not allow root mats to overhang the back slope on the up-hill side of the road.

(i) Locate and develop borrow pits, quarries and waste areas to minimize surface soil erosion. In pits and quarries, cut the sideslopes of the excavation to the natural angle of repose of the in-situ materials, or flatter if necessary, to allow safe working conditions. Control seepage and surface runoff water to maintain stable cut slopes in the excavation, and to prevent eroded soil materials or other deleterious materials from entering watercourses.

(j) Conform with all applicable legislation/regulations regarding operational and user safety, including those of the Workers' Compensation Board.

(k) Locate fuel storage facilities and refuelling depots away from water bodies and wetlands. Ensure by location or containment that these sites do not drain toward water courses.

3.3 Drainage Works

(a) Locate, design and construct road drainage works to intercept, collect and remove surface and subsurface water runoff from the road, cut and fill slopes. Convey this runoff onto stable land areas.

(b) Install culverts:

(i) at all crossings of established permanent or seasonal watercourses, or where bridge structures are not required;

(ii) at locations and in numbers as required to intercept sidehill drainage (springs, small creeks and ground water seepage) in the ditchline.

(c) Direct all drainage water so that it does not pass over fills or collect in cuts, borrow areas or waste dumps. Provide temporary culverts or cross drainage ditches, during the pioneering stage of road subgrade construction, at locations where sediment transport or surface erosion of the exposed subgrade soils will have adverse impacts on other resources or on the stability of the road or surrounding soils.

(d) Do not drain roadside ditches directly into a watercourse. Install ditch blocks immediately downstream of all culvert inlets. Construct the crest of ditchblocks lower than grade level.

(e) Construct settling ponds adjacent to every cross-drain culvert, to a minimum depth of 400 mm below invert level and prior to the confluence of the ditchline and any watercourse.

(f) Install culverts in accordance with the manufacturer's specifications and instructions.

(g) Use culverts of sufficient length to ensure that the inlet and the outlet cannot become blocked by the encroachment of road embankment fill materials. Unless culvert end walls are provided, construct fill slopes to a stable angle or repose. Do not end culverts with a cascade.

(h) Protect unstable or erodible fill at culvert outlets with flumes or other erosion resistant material. Protect inlets as required to prevent scour and erosion.

(i) Do not ford creeks except during the installation of drainage structures and only then with prior approval.

(j) Install clearly visible culvert markers.

3.4 Road Surfacing

(a) Apply a suitable road surfacing material across the road subgrade surface, as required, to prevent roadway erosion and to carry the vehicle design loads.

3.5 Revegetation

(a) Enhance slope stability and improve aesthetics and wildlife habitat along the road by suitable revegetation on road cut and fill slopes and on excavation waste and borrow pit areas.

4.0 BRIDGES AND MAJOR CULVERTS

4.1 Design Criteria

(a) All bridges and major culverts shall be designed by a professional engineer registered in the Province of British Columbia, except for:

- single span temporary log bridges on timber cribs or sills having a superstructure sized from tables or design aids that have been prepared by a professional engineer;

- culvert installations with (1) a design discharge of less than 6 m^3/sec or, (2) a diameter less than 1.8 m and fill cover not deeper than the culvert diameter.

(b) Design bridge and major culvert structures using the following flood discharge criteria:

	Projected Service Life	Maximum Instantaneous Discharge
Major Culverts	up to 50 years	100-year flood
Permanent Bridges	up to 50 years	100-year flood
Semi-Permanent Bridges	10 to 25 years	100-year flood
Temporary Bridges	up to 15 years	25-year flood

(c) Design all permanent bridges using the latest code requirements of the Canadian Standards Association (CSA) CAN3-S6. Use the vehicle loading diagrams provided in Figure 2 of these Standards to design for unbalanced and eccentric wheel load patterns.

(d) Design permanent bridges for 500,000 cycles of design load.

(e) When locating bridges, minimize stream bed disturbance, especially for fish-bearing streams. Where the streambank must be disturbed, consider using graded riprap, vegetative cover, or other means to reduce soil movement into the stream or river. Make referrals to applicable agencies at the preliminary design stage, including an approval under the Navigable Waters Protection Act, if required.

(f) Prepare complete design drawings and technical specifications.

4.2 Material Standards

(a) Specify materials using the current edition of relevant Canadian Standards Association (CSA) or, in the absence of CSA Standards, the American Society for Testing and Materials (ASTM) Standards, with exceptions or restrictions as follows:

- For log bridges, use log stringers that:

  (i) match reasonably in diameter and taper;

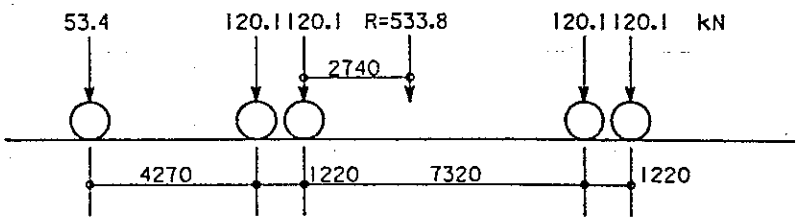
  (ii) are free of decay and excessive sweep;

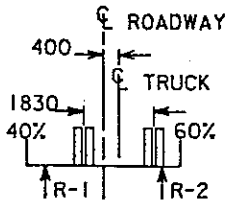
  (iii) have spiral grain less than 1 in 8;

Figure 2: Vehicle Loading Diagrams

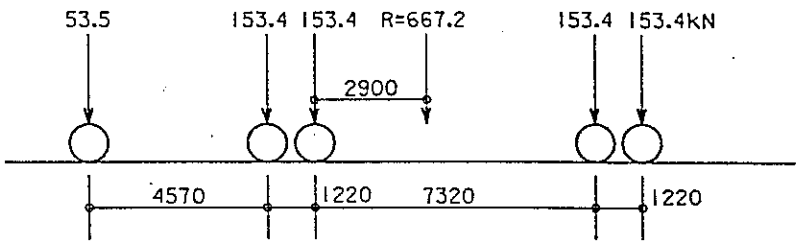
Logging Truck axle and wheel loads on Forest Road Bridges.

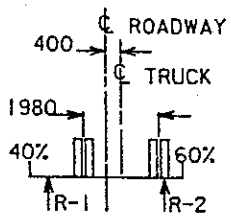
LOADING DIAGRAM **L-60** ON HIGHWAY G.V.W. = 54 430 Kg.



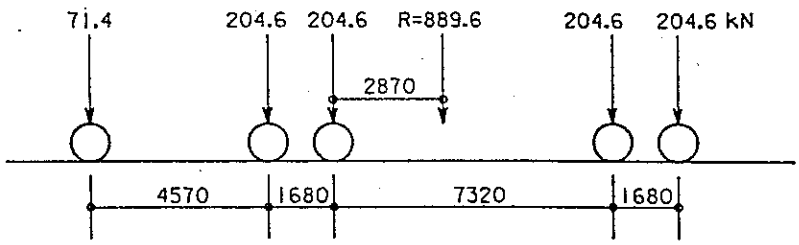


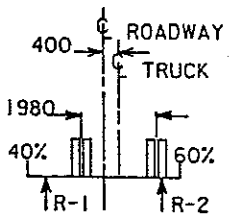
LOADING DIAGRAM **L-75** OFF HIGHWAY G.V.W. = 68 040 Kg



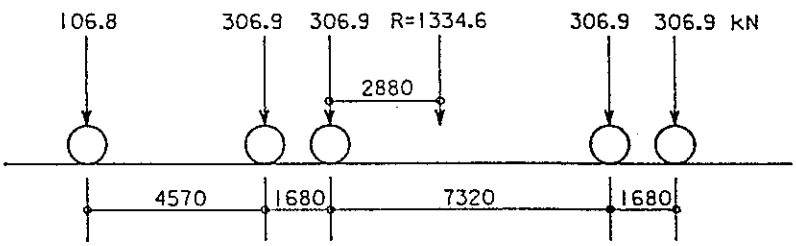


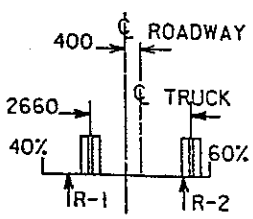
LOADING DIAGRAM **L-100** OFF HIGHWAY G.V.W. = 90 680 Kg.





LOADING DIAGRAM **L-150** OFF HIGHWAY G.V.W. = 136 090 Kg.





(iv) have knots less than 125 mm along the bottom edge of the middle half of the log;

(v) have all bark removed.

- Treated timber shall be coast Douglas fir or pine, pressure treated with a suitable oil-borne preservative as per the latest requirements of (CSA) Standard 080. Wherever possible, correctly frame the treated timber prior to treatment. Keep field fabrication to a minimum.

- Use structural steel that conforms to the latest requirements of CSA Standard G.40.21. For permanent and semi-permanent bridges, use weathering steel, grade 350AT (Category 2 or 3), or hot-dip galvanized mild steel.

- Requirements for concrete mixes are shown in Table 4.

Table 4 Concrete Mix Requirements

Structural Components	Minimum Compressive Strength @ 28 Days(MPa)	Maximum Nominal Size of Aggregate (mm)
Deck Slab, Girders, Stringers	30	20
Piers and Abutments	30	28
Footings	30	28
Filling Pipe Piles	20	28
Keyways between Box Stringers	35	12

NOTE: Support concrete strength used by results of tests as per the latest code requirements of (CSA) CAN3-A23.1. Determine on a site-specific basis such factors as air content, maximum slump and maximum water content ratio by mass.

(b) Note the material standards on the construction drawings or in technical specifications.

(c) Obtain and keep records of mill certificates, radiographic tests and other pertinent fabrication data.

4.3 Construction Practices

(a) Carry out bridge construction in accordance with the approved design drawings and technical specifications, using sound bridge construction practices. Incorporate the requirements of other agencies, particularly regarding construction techniques and timing, where applicable.

4.4 Quality Assurance

(a) Inspect all bridge and major culvert projects during construction stages where elements may be hidden from view or at other key times.

(b) Obtain and keep records of pile driving, concrete test results and other pertinent field construction data.

(c) Where design was required to be carried out by a professional engineer, compliance with design drawings shall be certified by a professional engineer upon completion of construction. As-built drawings shall be kept on file for future reference.

4.5 In-Service Evaluation of Bridges and Major Culverts

(a) Inspect all bridges and major culverts once every two years or after unusually heavy floods or other unexpected events that are likely to damage the structure. Keep records of inspection, noting the general condition of all components.

(b) Where deficiencies affecting structural integrity of a bridge are suspect or determined, the structure shall be inspected and evaluated by a professional engineer according to the latest code requirements of (CSA) CAN3-S6. The engineer, at his professional discretion, may establish a more frequent inspection schedule for older structures.

5.0 MAINTENANCE OF ROADS, BRIDGES AND CULVERTS

5.1 Maintenance Objectives

(a) Carry out regular road maintenance as required during log haul and subsequent active road use to achieve the following:

Long-term resource management goals:

- to protect the road for present and future use
- to minimize environmental impact
- to optimize safe access within reasonable economic constraints

Short-term operational goals:

- to optimize the sum of capital costs, operating (log hauling) costs and maintenance costs

(b) Ensure that:

- maintenance operations prevent deterioration of the road subgrade, cut and fill slopes, bridges and associated drainage works
- the road conditions meet the safety requirements of all users
- the potential for surface erosion and water quality degradation is minimized

5.2 Surface Maintenance

(a) Carry out brushing and vegetation control along the right-of-way to:

- permit effective ditchline and running surface maintenance;
- facilitate snow removal;
- promote early drying out and use of the road after spring break-up;
- allow safe sight distances for the design speed of the road.

(b) Remove and dispose of all snags, danger trees and other obstructions and potential hazards along the right-of-way.

(c) Seed the cut slopes, fill slopes and ditches with grasses and legumes to minimize surface erosion of exposed soils.

(d) Clean and grade ditches, clean and repair culvert inlets, outlets, catch basins and flumes, and replace/repair culverts, flumes and rip rap, head walls and spillways, particularly during and after major storms and heavy runoff and at the completion of yarding and loading operations, to prevent clogging and damage of drainage systems and to minimize the potential of washouts.

(e) Grade the road surface and bridge approaches and gravel decks to preserve the running surface and maintain the optimum travel speed of the road.

(f) Carry out minor repairs such as: filling minor scours or washouts, repairing frost boils, spot gravelling or gravelling of short sections to repair, smooth and strengthen the running surface; bridge deck cleaning (washing, sweeping, etc.); repairs/replacement of bridge curbs, rails, delineators, fender logs and running planks; repair of cattleguards; patching of concrete bridge decks; painting, applying preservative treatment, and tightening nuts on bolts; and all snowplowing and sanding.

5.3 Structural Maintenance

(a) Carry out structural maintenance operations as required to ensure that any component of a road/bridge system will fulfill its designed function for the intended period of use prior to road/bridge deactivation. Consider these measures:

- repair or replace damaged bridge structural members (abutments, piers, ties, stringers, needle beams, structural curb beams);
- repair stream channel and scour protection;
- replace dilapidated bridges and major culverts that are unable to carry the service loads;
- repair major culvert headwalls and spillways;
- repair the road subgrade;
- replace the running surface;
- repair all major landslides, rockfalls and other sites of significant hazard;
- replace cattleguards.

6.0 DEACTIVATION OF ROADS

(a) Upon cessation of log haul and other active road use and corresponding regular maintenance, implement a lower maintenance regime for roads that will: remain open for limited access; close temporarily; or close permanently. Erect adequate barriers and warning signs. Modify the road surface to permit collected drainage water to flow with little or no maintenance. In the absence of regular road maintenance, create essentially maintenance-free pathways on erosion resistant materials (i.e., erosion-resistant in relation to gradient) for:

- all surface waters flowing in defined channels as either permanent or intermittent streams;
- all subsurface waters intercepted by road cuts; and
- all overland flow generated by rainfall or snowmelt on compacted and/or exposed mineral soil surfaces of road cutslopes, fillslopes or road surfaces.

(b) Consider these resource management factors to decide on the required type and extent of road deactivation measures:

- the anticipated time until the road will again be regularly maintained;
- the type of use(s) anticipated until that time (e.g., for further timber development, silviculture, protection, recreation, other resource/industry and public needs, particularly for accessible main roads);

- the ability (physical and tenurial) of licensees or operators to perform future regular road maintenance works;
- the road-specific physical, topographical, climatic, and environmental setting;
- road management recommendations produced by the Coordinated Access Management Planning (CAMP) process.

6.1 Deactivation Measures to Permit Four-Wheel Drive Access

Use these deactivation measures to permit four-wheel drive access on roads that are proposed to be regularly maintained and used for log hauling or other active use in the future:

(a) Carry out any required cleaning of ditches, cross-drainage culverts, settling basins, and stream crossings to ensure the unimpeded flow of all surface drainage waters.

(b) Repair and replace temporary bridges, as required.

(c) Construct typical cross ditches (waterbars) along the road to preserve the integrity of the road surface and surfacing materials (see Figure 3). Cross-ditch at spacings sensitive to local topography and climate, road gradient and grade breaks, and road and ditch materials, to minimize the risk of drainage waters accumulating and being diverted down roads.

Figure 3: Typical Cross-Ditch (Waterbar)

CROSS-DITCH (WATERBAR) CONSTRUCTION

1. Excavate a cross-ditch into the roadbed, extending from the cut slope or road ditchline, across the road surface, and beyond the shoulder of the road on the down slope side. Excavate the cross-ditch using hand equipment, or by grader, bulldozer, backhoe or other such bladed equipment.

2. Physically block the road ditchline at a location immediately downgrade of the cross-ditch inlet to deflect water flow into the cross-ditch.

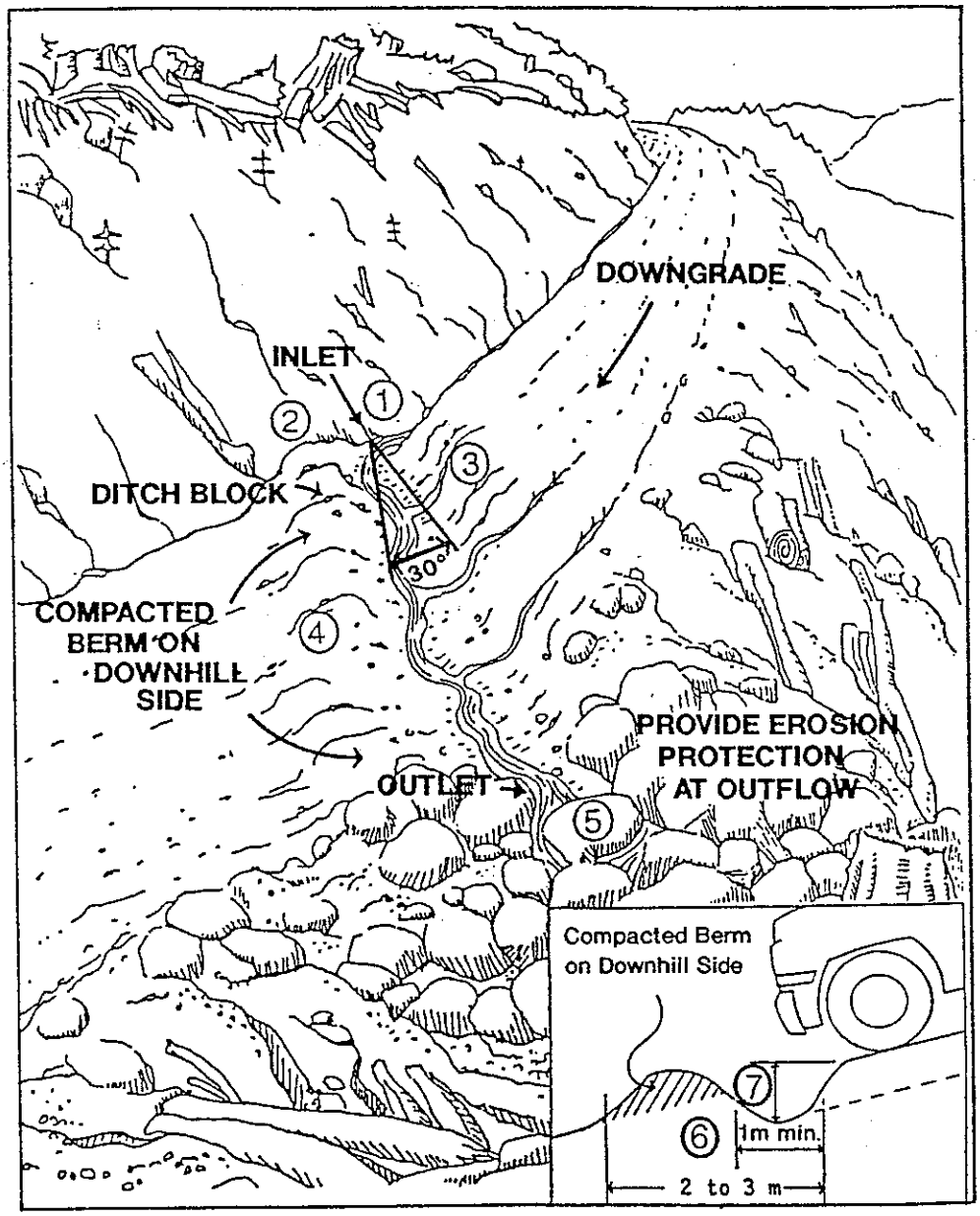
3. Construct the cross-ditch at a minimum skew angle of 30 degrees to the road ditchline.

4. Spread the excavation waste materials on the downgrade side of the cross-ditch to form a berm. Compact the berm to form a coherent mass.

5. Disperse outflow waters onto a stable slope, and provide erosion protection, as necessary at the outflow.

6. Construct the cross-ditch-berm in a manner that will permit 4-wheel drive access, where required. The minimum acceptable width of the cross-ditch trench is 1 m. Construct the cross-ditch-berm so that its overall width is about 2 to 3 m.

7. Use a minimum cross-ditch depth equal to the depth of the ditchline at the inlet side, but not less than 300 mm. Excavate to a minimum depth of 400 m at the outlet side.



Space these cross ditches in a manner that will:

(i) reduce the amount of surface water runoff or water velocity buildup;

(ii) intercept roadside ditch and road surface water and direct and disperse it back into its natural drainage pattern;

(iii) avoid directing water onto unstable or erodible natural or fill materials or toward other sensitive sites on the downslope side of the road.

(d) Back up all existing cross drain and stream culverts on branch roads by similarly sized open cross ditches. Construct these cross ditches a short distance down grade of these culverts, and ensure that they are constructed in a manner to handle flows should the primary culvert fail.

(e) Remove or breach any berms that may exist along the road edge, and re-establish the road crown, or outslope/inslope as appropriate.

6.2 Deactivation Measures for Temporary Road Closure

Use these long-term deactivation measures to close roads temporarily, in cases where roads will not be used for an extended period of time.

(a) Carry out any required cleaning of ditches, cross-drainage culverts, settling basins, and stream crossings to ensure the unimpeded flow of all surface drainage waters;

(b) Restore the natural flow patterns (that have been disrupted by road construction) and prevent surface water from entering new channels. Several key locations require cross ditches:

(i) replace all existing culverts on spur roads with similarly sized open cross ditches;

(ii) back up all existing cross drain and stream culverts on branch roads by similarly sized open cross ditches. Construct these cross ditches a short distance down grade of these culverts, and ensure that they are constructed in a manner to handle flows should the primary culvert fail;

(iii) construct a cross ditch slightly downgrade of a site of moderate ground water seepage or ephemeral stream channel;

(iv) construct cross ditches at sites of through cuts and switchbacks and at road junctions;

(c) After restoring the natural flow patterns by measures as described above, construct additional cross ditches along the road as per Section 6.1 of these Standards.

(d) Remove Temporary Bridges.

(e) Outslope or inslope the road surface, remove or breach any berms that may exist along the road edge, and re-establish cross-ditches, as required.

(f) Consider the use of additional measures as listed below for: roads on extremely steep slopes; roads on incompetent bedrock - no firm bench; roads constructed with excessive sidecast and fill in unstable positions; roads that have potential for large fill or sidecast failures; roads that exhibit tension cracks and roads through areas of high to extreme landslide hazard.

- partial or complete pulling back, as required, of unstable fill and sidecast (e.g. where severely tension-cracked) with backhoe, or resloping (with irregular surface) to near the original ground surface profile;
- controlled release by explosives of dry, marginally stable materials;
- revegetate.

6.3 Deactivation Measures for Permanent Road Closure

Use these extensive deactivation measures, to close roads permanently, where it is clear that the road is redundant or abandoned:

(a) Remove all culverts and replace with similarly sized open cross ditches and remove all bridges, to ensure unimpeded flow of surface water.

(b) Construct additional cross ditches at other appropriate key locations and along the road, outslope or inslope the road surface as required, and remove or breach berms, all as per Section 6.2 of these Standards.

(c) If the objective is to return the site to productive forest, also:

- decompact the road surface to an average depth of 0.5 m, using a subsoiler or equivalent tillage implement;
- seed the road surface and associated denuded surfaces with an appropriate erosion-control mix and complete fertilizer amendment (subject to watershed restrictions);
- plant suitable conifers.

(d) Consider the use of additional measures as listed below for: roads on extremely steep slopes; roads on incompetent bedrock - no firm bench; roads constructed with excessive sidecast and fill in unstable positions; roads that have potential for large fill or sidecast failures; roads that exhibit tension cracks along major sections and roads through areas of high to extreme landslide hazard.

- partial or complete pulling back, as required, of unstable fill and sidecast (e.g. where severely tension-cracked) with backhoe, or resloping (with irregular surface) to near the original ground surface profile;

- controlled release by explosives of dry, marginally stable materials;
- revegetation.

APPENDIX A

GLOSSARY

This is a compendium of words, terminology and phrases, which are used in these Standards.

Active road means a road that is required for use on a continuous basis, except for seasonal breaks, and requires corresponding continuous road maintenance.

Angle of Repose means the slope angle at which the soil particles are stable.

Cross ditch (Water Bar) means a ditch cut across a road designed to intercept surface and ditch water and to direct it across the road into stable vegetative matter or rip rap.

Inactive Road is considered to be any road where active use is no longer required.

Legume Species means any plant of the family "Leguminosoe" that is a soil improving plant (i.e. alfalfa, peas).

Overlanding means placing road construction fills directly over organic soil and stumps and other vegetative materials left in their natural state because of soft ground conditions.

Permanent bridge means any bridge having all of its major components constructed of steel, concrete or timber that has been pressure-treated with a suitable preservative.

Road or forest road means any of the following categories of roads built originally for timber harvesting or other forest management activities:

- Forest Service road (F.S.R.)
- Operations road

Sedimentation means the process of subsidence and deposition of suspended matter carried in water by gravity, usually the result of reduction of water velocity below the point at which it can transport the material in suspended form.

Semi-permanent bridge means any bridge having a substantial proportion of its components constructed of steel, concrete or timber that has been pressure-treated with a suitable preservative.

Structural maintenance means the substantial repair or replacement of bridges, reconstruction of, or repairs to, road subgrades, replacement of culverts, renewal or surfacing, and other major repairs as are necessary to protect and preserve roads and the surrounding environment.

Surface maintenance means the routine operations necessary to preserve the running surface of the roads, to maintain drainage and to keep the right-of-way in an orderly condition.

Temporary bridge means any bridge having most of its components constructed of untreated wood.

25-year, 50-year, and 100-year Flood means a maximum instantaneous streamflow discharge that has the probability of occurring once in 25, 50, and 100 years respectively.

APPENDIX B

LIST OF RESOURCE AGENCIES

The referral phase solicits a technical review and input from other concerned resource agencies identified during the planning phase. This review process identifies the detailed constraints that will be placed upon the proposed road construction. To be viable, the referral process relies upon continuity of communication between concerned parties to resolve anticipated problems before they become problems. The Ministry of Forests initially receives all timber harvesting access proposals. Refer to the following agencies, as applicable:

AGENCY	WHEN TO CONTACT
• Ministry of Environment, Water Management Branch	- Any time water quality may be affected.
• Ministry of Environment, Recreational Fisheries Branch and Wildlife Branch	- Any time potential fish and/or wildlife habitat may be affected.
• Ministry of Transportation and Highways	- Junctions or crossings of public roads railway or pipeline crossings if utility company is provincially registered.

• Ministry of Municipal Affairs, Recreation and Culture	– All roads that may impact areas of archaeological importance.
• The Irrigation Districts	– Any time development is proposed within the Irrigation District watershed.
• Federal Department of Fisheries and Oceans	– Any time a crossing of an anadromous (salt water migrating fish) stream is proposed or any time there is a potential impact on salt water bodies.
• National Energy Board	– If crossing a pipeline of an extra-provincially registered company.
• Railway Transport Committee, Canadian Transport Commission	– If crossing a railway of an extra-provincially registered company in compliance with general order E-4.
• Applicable Utility Companies	– Crossing of powerline rights-of-way (BCHPA or WKP&L or B.C. Tel).
• Ministry of Transport Canadian Coast Guard	– Navigable water crossing (undefined under Navigable Water Protection Act).
• Mineral claim holders	– Any time the road proposed conflicts with improvements upon the mineral claim.

APPENDIX C

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