



Ministry of
Forests and
Range



IPP Waterpower Projects

MoFR Design Criteria for Works that may Impact Forest Roads or Timber Tenures

(Working Draft – July 7, 2005)



Upper Mamquam Waterpower Project, Squamish Forest District
Penstock Pipe Installation Downhill of Mamquam Forest Service Road, September 2004

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Introduction

These design criteria, prepared by the Ministry of Forests and Range (MOFR), will be of use to professionals designing waterpower project works proposed within or adjacent to an existing forest road right-of-way. The detailed design work is typically carried out during Step 8 of the LWBC application process for waterpower projects. This document should be read together with LWBC's **Appendix I, *Waterpower Projects: Guidelines for Works that may Impact Forest Roads or Timber Tenures***, available from the LWBC web site

<http://www.lwbc.bc.ca/02land/tenuring/waterpower/app/html> or from the MOFR web site http://www.for.gov.bc.ca/hth/engineering/publications_guidebooks.htm.

The **definitions of terms** used in this document may be found in the following parts, divisions, and sections of the Forest Planning and Practices Regulation under the *Forest and Range Practices Act* available at <http://www.for.gov.bc.ca/tasb/legsregs/frpa/frparegs/forplanprac/fppr.htm#section76>:

Part 1 Interpretation: Section 1 (Definitions), Section 3 (Damage to the Environment)

Part 2 Forest Stewardship Plans: Sections 4.1 to 10

Part 4 Practice Requirements: Division 1 (Soils), Division 3 (Riparian Areas), Division 4 (Watersheds), Division 5 (Biodiversity), Division 6 (General Wildlife Measures and Resource Features)

Part 5 Roads

General

1.01 The *design engineer* retained by the waterpower project proponent should supervise the preparation of plans showing the design and layout of the project and preparation of plans suitable for the construction. The design of works within a forest road right-of-way, including the modification or realignment of a forest road to accommodate the general arrangement of the works, should provide for or consider all the following:

- a) the safety of all workers and users of the road;
- b) the topography of the area and the gradient of the road corridor;
- c) the drainage of water in the area including the existing road drainage system;
- d) the stability of terrain in the area including the stability of the road prism and stability of the works within or immediately adjacent to an existing forest road right-of-way;
- e) the effect of the works on the road and associated infrastructure, and on the environment, forest resources, and other social and economic values;
- f) issues of importance or concern to the MOFR and industrial road users, and proposed mitigation and compensation measures, as identified in the proponent's Summary Report prepared in Step 6 of the LWBC process;
- g) the results of a terrain stability assessment including any drainage plan prepared for the affected area during that assessment;
- h) operational requirements, including:
 - (i) the short- and long-term maintenance and erosion control of any large scale cut slopes required for installation of the works,
 - (ii) placement of pits, quarries, and waste areas,
 - (iii) the storage of building materials and equipment,
 - (iv) the amount of area required to operate equipment within the *clearing width* of the road, including equipment turnaround sites,
 - (v) fencing and other ancillary structures.

Roads and associated structures

1.02 Design, construct and operate works within a forest road right-of-way to:

- a) ensure that the road and associated structures (e.g., road surfacing materials, ford crossings, ditches, culverts, bridges, etc.) remain structurally sound;

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- b) avoid impacting the stability of road fill and cut slopes;
 - c) ensure safe use of the road.

Damage to the environment

- 1.03 Ensure that the works do not cause damage to the environment, where damage means any of the following that fundamentally and adversely alters an ecosystem:
- a) a landslide;
 - b) a gully process;
 - c) a fan destabilization;
 - d) soil disturbance;
 - e) the deposit into a stream, wetland or lake of a petroleum product, a fluid used to service industrial equipment, or any other similar harmful substance;
 - f) a landslide that enters a fish stream.

Landslides, gully processes, fan destabilization

- 1.04 Ensure that the works do not cause a landslide, or an adverse gully process, or fan destabilization that place human life at risk, and that can damage property, infrastructure, and forest resources. Elements at risk of damage or loss must be identified during the planning and design process so that development activities are suitably designed to prevent harmful effects. Forest resources include the following eleven values listed in section 149(1) of the Forest and Range Practices Act (FRPA):
- a) **Biodiversity:** Retain old forest and other age classes consistent with land use objectives established by government in the FRPA for the area under development.
 - b) **Cultural heritage resources:** Identify cultural heritage resources and establish appropriate management mechanisms to prevent impacts.
 - c) **Fish:** Conserve fish, fish habitat, water quality, quantity, and timing of flow in community watersheds and watersheds that have significant downstream fisheries values.
 - d) **Forage and associated plant communities:** Conserve forest cover and forage over an area necessary for winter survival of ungulate species (e.g., deer, elk, moose, and caribou), recognizing regional variance in the ecology of ungulate species.
 - e) **Recreation resources:** Recreation resources are comprised of 2 components: 1) recreation resource management – the identification, protection and management of the Provincial forest recreation resource; 2) recreation use management – the provision of safe, sanitary, socially acceptable and environmentally sound recreation sites and recreation trails for public use.
 - f) **Resource features:** Protect other unique resource features, such as salt deposits or an eagle wintering area.
 - g) **Soils:** Protect soil properties, including the physical, chemical, and biological attributes in addition to the natural drainage patterns of the site.
 - h) **Timber:** Protect timber values.
 - i) **Visual quality:** Achieve visual quality objectives within scenic areas.
 - j) **Water:** Stream channel dynamics, aquatic ecosystems, fish and fish habitat, and the water quality of all streams, lakes, and wetlands, including water quality in community watersheds, will not be harmfully impacted.
 - k) **Wildlife:** Retain ecologically suitable wildlife trees in quantity, quality, and distribution typical of naturally occurring stand structure.

Natural surface drainage patterns

- 1.05 Maintain natural surface drainage patterns on the area within the road right-of-way and in adjacent or connected areas affected by the works both during and after construction.

Restrictions in a riparian management area

- 1.06 Do not construct works along a forest road (including relocating a road) within a riparian management area, unless approval has been granted by the forest district manager.
- 1.07 Do not remove gravel or other fill from within a riparian management area in the process of constructing or maintaining the works, unless exempted by the district manager and unless
- a) the gravel or fill is within a road prism,
 - b) the gravel or fill is at a stream crossing, or
 - c) there is no other practicable option.

Restrictions in a riparian reserve zone

- 1.08 Do not cut, modify or remove trees in a riparian reserve zone, except for the following purposes:
- a) felling or modifying a tree that is a safety hazard, if there is no other practicable option for addressing the safety hazard;
 - b) constructing a stream crossing;
 - c) felling or modifying a tree that has been windthrown or has been damaged by fire, insects, disease or other causes, if the felling or modifying will not have a material adverse impact on the riparian reserve zone.
- 1.09 A tree that is felled, topped, pruned, or modified under paragraph 4.9 can be removed only if the removal will not have a material adverse effect on the riparian reserve zone.

Restrictions in a riparian management zone

- 1.10 Where authorization is given to cut, modify or remove trees within a riparian management zone for an S4, S5 or S6 stream that has trees that contribute significantly to the maintenance of stream bank or channel stability, retain enough trees adjacent to the stream to maintain the stream bank or channel stability, if the stream is:
- a) a direct tributary to an S1, S2 or S3 stream,
 - b) flows directly into the ocean, at a point near to or where one or more of the following is located:
 - (i) a herring spawning area;
 - (ii) a shellfish bed;
 - (iii) a saltwater marsh area;
 - (iv) an aquaculture site;
 - (v) a juvenile salmonid rearing area or an adult salmon holding area, or
 - c) flows directly into the ocean at a point near to the location of an area referred to in paragraph (b) and failure to maintain stream bank or channel stability will have a material adverse impact on that area.

Temperature sensitive streams

- 1.11 Where trees are felled, modified, or removed within a riparian management area adjacent to a temperature sensitive stream, or a stream that is a direct tributary to a temperature sensitive stream, retain either or both of the following in an amount sufficient to prevent the temperature

of the temperature sensitive stream from increasing to an extent that would have a material adverse impact on fish:

- a) streamside trees whose crowns provide shade to the stream;
- b) understory vegetation that provides shade to the stream.

Stream crossings

- 1.12 Where a stream crossing is built as part of the works, locate, build and use the crossing in a manner that (a) protects the stream channel and stream bank immediately above and below the stream crossing, and (b) mitigates disturbance to the stream channel and stream bank at the crossing.

Fish passage

- 1.13 Ensure that activities do not have a material adverse effect on fish passage in a fish stream. However, with approval from the Ministry of Environment and Department of Fisheries and Oceans Canada (migratory fish), the proponent may temporarily have a material adverse effect on fish passage to construct the works, including a stream crossing, if
- a) fish are not migrating or spawning, and
 - b) the source of the material adverse effect is removed immediately on completion of the construction.

Protection of fish and fish habitat

- 1.14 Unless exempted by the Ministry of Environment (Part 7 of the Water Regulation, pursuant to section 9 of the Water Act) and Department of Fisheries and Oceans Canada (migratory fish), conduct the activities at a time and in a manner that is unlikely to harm fish or destroy, damage or harmfully alter fish habitat.

Watersheds -- protecting water quality

- 1.15 Ensure that the activities do not cause material that is harmful to human health to be deposited in, or transported to, water that is diverted for human consumption by a licensed waterworks.

Licensed waterworks and community watersheds

- 1.16 Ensure that the activities do not damage a licensed waterworks.
- 1.17 Do not cut or remove timber or construct works within a community watershed if these activities occur within a 100 m radius upslope of a licensed waterworks where the water is diverted for human consumption, unless the activities will not increase sediment delivery to the intake.
- 1.18 Do not cut or remove timber or construct works on an area that is within a community watershed, if such activities would cause sediment that would be harmful to human health to enter a stream, wetland or lake from which water is being diverted for human consumption by a licensed waterworks.

Buried penstock

- 1.19 Where a penstock will be buried across a road, design the penstock to withstand fully loaded off-highway trucks and off-highway equipment, and for a minimum L-165 (off-highway) vehicle loading. Higher design vehicle loading may be required. Always consult with the forest district office in the case of a Forest Service road, and with a permit holder if the road is under a Road Permit or Special Use Permit, to confirm the design vehicle loading. Provide sufficient soil cover over the penstock and ensure proper compaction of backfill materials. Ensure that the works do not restrict or constrict the crossing road width, and ensure that road maintenance / repair activities can be carried out as required without conflict.
- 1.20 Do not bury penstocks within the ditch lines of any roads. Approval of the forest district office in the case of a Forest Service road, and a permit holder in the case of a road under Road Permit

or Special Use Permit, is required where it is proposed to locate a buried penstock within the running width of the road.

- 1.21 Buried penstock designs should incorporate measures to allow required maintenance of the works at least over the life of the project.
- 1.22 Mark the crossing in the field where a buried penstock crosses the road.

Design of bridges

- 1.23 Where a new bridge is built, or an existing bridge is modified or repaired, for the purpose of constructing the works within the forest road right-of-way ensure that the design and fabrication of the bridge:
 - a) meets or exceeds standards applicable to roads at the time the design or fabrication is done, in respect of
 - i) bridge design, as established by the Canadian Standards Association, Canadian Highway Bridge Design Code, CAN/CSA-S6, and
 - ii) soil properties, as they apply to bridge piers and abutments, as established by the Canadian Foundation Engineering Manual, and
 - b) takes into account the effect of logging trucks with unbalanced loads and off-centre driving.
- 1.24 For bridges on FSRs, the MOFR is responsible for determining appropriate design and construction specifications, and the proponent must consult with the Bridge Engineer at the Regional Forest Office. The MOFR Forest Service Bridge Design and Construction Manual provides the minimum expected administrative processes and specifications for the design, fabrication and construction of FSR bridges. This manual is available at http://www.for.gov.bc.ca/hth/engineering/publications_guidebooks.htm
- 1.25 For bridges on permitted roads other than FSRs, consult with the forest district manager **and** the permit holder about design criteria.

Peak flow – bridges and stream culverts

- 1.26 If authorized to build / modify/ repair a bridge across a stream or to install a culvert in a stream for the purpose of constructing the works, ensure that the bridge or culvert is designed to pass a stream flow having a 100-year peak flow return period.
- 1.27 A bridge may be built / modified/ repaired to a lesser peak flow return period provided all the following conditions are met:
 - a) the bridge will pass the flow that will occur during the period the bridge remains on the site,
 - b) the construction of the bridge occurs during a period of low flow, and
 - c) the bridge, or a component of the bridge that is vulnerable to damage by high flow, is removed before any period of high flow begins.
- 1.28 A stream culvert that will not conform to a 100-year peak flow return period may be installed if all the following conditions are met:
 - a) the installation is temporary and the proponent does not expect to subsequently install a replacement culvert at that location,
 - b) the stream in which the culvert is being installed is not a fish stream,
 - c) the culvert will pass the flow that will occur during the period the culvert remains on the site,
 - d) the installation of the culvert occurs during a period of low flow, and
 - e) the culvert is removed before any period of high flow begins.

Structural defects

- 1.29 If authorized to build/ modify/ repair a bridge on a road for the purpose of constructing the works, ensure that one or more of the following is carried out if a structural defect or deficiency occurs:
- a) correct the defect or deficiency to the extent necessary to protect (i) industrial users of the bridge, and (ii) downstream property, improvements or forest resources that could be affected if the bridge fails;
 - b) close, remove or replace the bridge;
 - c) restrict traffic loads to a safe level;
 - d) place a sign, on each bridge approach, stating the maximum load capacity of the bridge.

Culvert fabrication

- 1.30 If authorized to build a culvert on a road for the purpose of constructing the works, fabricate all permanent culvert materials according to:
- a) culvert fabrication standards, as established by the Canadian Standards Association, Corrugated Steel Pipe Products, CSA G401 and Plastic Nonpressure Pipe Compendium, section B182.8 of the B1800 Series, that are applicable to roads at the time of the fabrication, or
 - b) standards that ensure at least the same strength and durability as the standards referred to in paragraph (a).

Construction records

- 1.31 If authorized to build a bridge or major culvert on a forest road for the purpose of constructing the works, carry out the following:
- a) prepare or obtain (i) pile driving records, (ii) for new materials used to build the bridge or major culvert, mill test certificates, in-plant steel fabrication drawings, and concrete test results, (iii) soil compaction results, and (iv) other relevant field and construction data;
 - b) prepare as-built drawings of the bridge or major culvert;
 - c) submit all information to the forest district manager in the case of a FSR, and to the permit holder in the case of a road under Road Permit or Special Use Permit.

Transmission line

- 1.32 It is possible that the transmission lines for the project could be located within the forest road right-of-way, and / or could make a single or multiple overhead crossings of the road. Design for horizontal clearances from roadside poles to accommodate industrial traffic through road curvatures and to allow safe trailer tracking for over length loads. Carefully design pole guy line clearances to avoid unduly restricting industrial traffic. All transmission poles / towers and guy poles are to be located outside road ditch lines and well clear of all running surfaces of roads to allow off-highway movement of industrial traffic, and a minimum of 3.0 metres from the edge of the road running surface. For off-highway log haul roads, this distance should be increased to facilitate the turning radius of over length log haul trailer loads (combined vehicle and load lengths can range between about 27 to 30 meters). The placement of the transmission lines, poles / towers, and guy poles should be designed considering the requirements for long term road maintenance activities and possible future modifications within the road prism and clearing width of the road.
- 1.33 Typically, all overhead crossings require a minimum vertical clearance of 53.0 ft from the road surface to the lowest point of the conductor to facilitate the movement of fully assembled logging machinery such as grapple loaders. This includes 10 feet clear distance as required by Workers Compensation Board Occupational Health and Safety regulations based on a phase to phase of 750V to 75KV. Additional clearance may be required to ensure that there is no restriction on forest road traffic, or on harvesting operations or other industrial activities.

Always confirm the requirements for minimum vertical clearances with the forest district office and BC Hydro or British Columbia Transmission Corporation, as appropriate.

- 1.34 Design all overhead line crossings of roads to be at a right angle to minimize the distance of the crossing. Multiple line crossings of roads should be avoided and may be unacceptable on some roads.
- 1.35 If it is necessary to cut or limb any standing timber within the road right-of-way to facilitate the pole and line installation, a **Licence to Cut** will be required from the forest district office. All slash and related debris must be disposed of to the satisfaction of the forest official.
- 1.36 If applicable, there must be provision in the transmission line design to accommodate planned future forest road development within a specific watershed and requirements for minimum vertical clearances of all overhead transmission lines where they will cross over future forest road rights-of-way. Always consult with the forest district office and timber tenure holders to understand and confirm the forestry operations planned for a given watershed.
- 1.37 If applicable, there must be provision in the transmission line design to accommodate future helicopter harvesting operations. This may include the incorporation of regularly spaced buried sections of the transmission line to facilitate helicopter yarding if the forest district manager or forest agreement holders have identified this as an issue of concern. The spacing and width of yarding corridors would have to be discussed with the forest district manager and affected forest agreement holders.

Preliminary design drawings

- 1.38 Preliminary design drawings showing the design and layout of the project and plans suitable for the construction of the project within affected road corridors should be submitted to the MOFR and other government agencies and to affected permit holders, including the *Independent Engineer*, for review and comment. The proponent should retain a Terrain Stability Professional to review and comment on the preliminary design drawings to ensure that the design and construction specifications for the project have properly addressed the landslide and sedimentation hazards and risks along the road corridor, and in adjacent areas or connected areas to the road corridor, that could be adversely affected by the works.
- 1.39 Design drawings must include detailed notes, and “process-based” and “results-based” specifications, as appropriate, to ensure that the works during or after construction will not result in an adverse effect to elements at risk. Technical specifications for construction should include specifications for material types, subgrade preparation, compaction, drainage, quality control, etc.

Final design drawings and specifications

- 1.40 The design engineer should appropriately address all review comments during the preparation of final design drawings and specifications before stamping them “For Construction.” All final design drawings and specifications stamped “For Construction” must be signed and sealed by the professional engineer taking responsibility for the design. Without exception, the design engineer should be familiar with coastal and local forest road construction and maintenance practices where the waterpower project works will be located within or adjacent to a forest road right-of-way.
- 1.41 Before construction of the works commences, the design engineer may be required to provide a statement in a separate letter that the final design drawings were prepared consistent with the design criteria in this document and in accordance with the recommendations of the Terrain Stability Professional, and Independent Engineer.

Helpful references

The reference documents listed below provide helpful information about acceptable **forest road practices** and technical processes that will assist the proponent to meet the intent of the design criteria in this document. Where design and field services are carried out by a registered professional, that person must choose methods and techniques that best serve the individual project objectives, consistent with the design criteria in this document.

Forest Road Regulation (Transition Version Pre-January 31, 2004) under the Forest Practices Code of BC Act available at
<http://www.for.gov.bc.ca/tasb/legsregs/archive/fpc/fpcaregs/forroad/froadr.htm>

The following parts, divisions, and sections of the Forest Planning and Practices Regulation under the Forest and Range Practices Act available at
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- Part 1 – Interpretation: Section 1 (Definitions), Section 3 (Damage to the Environment)
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- Part 5 – Roads

Forest Practices Code of British Columbia Act guidebooks, in particular the Forest Road Engineering Guidebook (June 2002), Gully Assessment Procedures Guidebook, Mapping and Assessing Terrain Stability Guidebook, Soil Rehabilitation Guidebook, Fish-Stream Crossing Guidebook (March 2002) available at the following ministry website:
[\[http://www.for.gov.bc.ca/tasb/legsregs/fpc/FPCGUIDE/Guidetoc.htm\]](http://www.for.gov.bc.ca/tasb/legsregs/fpc/FPCGUIDE/Guidetoc.htm)

Forest Road Regulation (Pre-January 31, 2004) of the *Forest Practices Code of British Columbia Act* available at the following website:
[\[http://www.for.gov.bc.ca/tasb/legsregs/archive/fpc/fpcaregs/fpcaregs.htm\]](http://www.for.gov.bc.ca/tasb/legsregs/archive/fpc/fpcaregs/fpcaregs.htm)

Best Management Practices Handbook: Hillslope Restoration in British Columbia (November 2001) is available at the following website:
[\[http://www.for.gov.bc.ca/hth/engineering%20new/Publications%20Guidebooks.htm\]](http://www.for.gov.bc.ca/hth/engineering%20new/Publications%20Guidebooks.htm)

References listed on the Division of Engineers and Geoscientists in the Forest Sector website:
<http://www.degifs.com> <http://www.degifs.com/pdf/GoS0404.pdf>

Wise M.P., Moore, G.D. and VanDine, D.F (eds), 2004. Landslide risk case studies in forest development planning and operations. British Columbia Ministry of Forests, Research Branch, Victoria, BC, Land Management Handbook No 56, 199p, also on the internet at:
[\[http://www.for.gov.bc.ca/hfd/pubs/Docs/Lmh/Lmh56.htm\]](http://www.for.gov.bc.ca/hfd/pubs/Docs/Lmh/Lmh56.htm)

Association of Professional Engineers and Geoscientists of British Columbia (APEGBC). 2003. Guidelines for terrain stability assessments in the forest sector. Burnaby, B.C. October 2003. <http://www.apeg.bc.ca/library/practiceguidelines.html>