



## **Plan Submission Requirements for the Construction and Rehabilitation of Dams**



## **BC Dam Safety Guidelines**

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## A. PREAMBLE

This Plan Submission Requirements Guideline is developed to assist you in obtaining approval for constructing a new dam or rehabilitating an existing dam. To obtain authorization, the following plan submission requirements must be followed.

The diversion and use of water in British Columbia requires a water license issued pursuant to the *Water Act* administered by either the Water Management Branch or the Regional Resource Authorizations units of the Ministry of Forests, Lands and Natural Resource Operations (FLNRO). Further, the *Regional Water Manager* or the *Comptroller of Water Rights* must grant authorization prior to the construction or rehabilitation of any *dam* under Section 4 of the BC Dam Safety Regulation. This authorization may be in the form of a water license, approval, order or letter.

For construction of a new dam, use this guideline in conjunction with the water license application package. If you are considering the development of a waterpower project in association with these works, you will want to refer to the [\*Clean Energy Production in BC: An Inter-agency Guidebook for Proponents \(Chapter 5: Water Power\)\*](#). A copy can be found on the website: [www.env.gov.bc.ca/wsd/water\\_rights/waterpower/](http://www.env.gov.bc.ca/wsd/water_rights/waterpower/).

FLNRO staff will review the information submitted and determine the official classification; size and scope of the proposed project; and the appropriate plan submission requirements<sup>1</sup>. Where a new license is involved, these requirements will be set out in an attachment to the water license. Most information contained in this guide will likely be required prior to the issuance of a water license. Where repairs or rehabilitation of an existing, licensed dam is involved, you must request a determination of plan submission requirements for your project from the Dam Safety Officer.

Exceptions to these requirements are:

- *minor repairs and routine maintenance* to existing licensed works as designated in the Operation, Maintenance and Surveillance Manual,
- those works not requiring submission of plans as set out in the *Water Act*, Part 7 regulations,
- dams that do not meet the criteria stipulated in Section 2, Application, Dam Safety Regulation,
- tailing impoundment dams under the jurisdiction of Ministry of Energy and Mines, and

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<sup>1</sup> For a copy of the WSD's [Plan Review Checklist](#) please contact your Dam Safety Officer

- emergency work performed under Section 8 of the Dam Safety Regulation.

If you are unsure of your particular situation contact the Dam Safety Officer for your area (see Appendix 5 - Contact Information).

Deviations from these plan submission requirements will only be considered under special circumstances, where they can be justified and safety issues are not compromised. A written request containing justification for all deviations must be submitted to the Dam Safety Officer with a complete list of requirements that would not be met, the reasons why, and how they would be addressed. A decision will be made and you will be informed as soon as possible.

The Environmental Assessment Office (EAO) of BC may consider large projects that meet the following requirements as reviewable:

- the new dam is over 15 metres in height or impounds 10 million m<sup>3</sup> of water,
- the new dam or rehabilitation creates or increases the reservoir area by 20 hectares, or
- any dam facility that is, or was, permitted to impound 10 million m<sup>3</sup> of water or more that is being decommissioned or removed.

Please contact the EAO if your project meets any of these criteria.

### **DESIGN CRITERIA**

Please be aware that these plan submission guidelines are not intended for large dams as defined by the International Commission on Large Dams (ICOLD) although many of the principles described apply to large dams. For more information visit ICOLD's web site at: <http://www.icold-cigb.net/>.

The design criteria applied to dams in BC is determined principally by the Canadian Dam Association (CDA) Guidelines although other texts and guidelines may be acceptable. In addition, some specific minimum design standards have been developed by the BC Dam Safety Program for small dams with a potential consequence rating less than Very High (see Appendix 1). These minimum design standards are described in Appendix 2.

### **B. SERVICES OF A PROFESSIONAL ENGINEER**

Construction of a dam and related works is a complex undertaking involving knowledge in many fields of engineering. The consequences of a dam failure could be severe and the owner may be liable for any and all damages. Life, property, the environment and your investment all may be affected by a dam failure.

Therefore, for all dams except those with a "low" consequence of failure classification, FLNRO will require that you contract the



services of a *professional engineer* who is registered in BC and has experience in dam design and construction. FLNRO also recommends that those proponents who have a dam with a low consequence also seek the services of a professional engineer.

The role of the professional engineer is to design the dam, manage and/or supervise construction of the dam and compile other required information (i.e. OMS & EPP, as built drawings etc.). It is a good idea to have a joint meeting with the engineer and FLNRO staff prior to submitting support information. For additional information refer to Appendix 3 "Procuring the Services of a Professional Engineer".

### **C. REVIEW STANDARDS & DESIGN CRITERIA**

FLNRO will review the submitted information to ensure the proposed project will be constructed in a manner that provides the appropriate level of security to life, property and the environment. This review is undertaken to determine if the submitted information conforms to accepted practices, the *Water Act* and its regulations.

The review is also intended to address issues of safety directly related to the structural stability and integrity of the completed project. These issues include longevity, ease of operator/owner maintenance and repair. The review does not extend to more general issues, such as worker safety, which are not directly related to the structural stability and integrity of the project. The proponent must seek consultation with other regulatory agencies including Fisheries and Oceans (Canada), Ministry of Energy, Mines, and Natural Gas, WorkSafeBC, etc.

Documents which contain deficiencies will be identified to the owner or the project engineer. Changes may be required to conform to accepted practice.

Where differences of opinion arise on the suitability of certain practices and cannot be readily resolved, the burden of proof will rest on the owner and/or project engineer to demonstrate the suitability of the proposed plan or action.

All revisions to plans or drawings previously submitted for review must be accompanied by a complete detailed list of revisions made specifying where the revisions are located. FLNRO will make every effort to ensure that plans are reviewed in a timely manner and the proponent be contacted directly as soon as possible.

### **D. SUBMISSION OF PLANS AND OTHER INFORMATION**

The following information provides proponents (water licensees, applicants or potential applicants for a water license) with our requirements for the submission of plans, drawings, reports and other information.



Hazardous works may include penstocks, dugouts, ditches etc.

Reference is made to dams throughout, however, these requirements may be applied to any licensed works that could create a hazardous situation or are a safety concern of the Dam Safety Officer, Regional Water Manager or Comptroller.

Any changes in land development adjacent to or downstream of the dam may affect the consequence classification. A change in the classification may result in a change in plan submission requirements. Incomplete submissions are unacceptable and will be returned.

Submission Requirements

The following information is required:

- Development Report
- Design Plans and specifications
- Construction Supervision Plan and Schedule
- Environmental Monitoring Plan
- Draft Operation Maintenance and Surveillance Manual
- Draft Emergency Preparedness Plan

Development Report

***Development Report***

This report is not required for those dams with a consequence rating of Low.

A Development Report contains the various engineering investigations and pertinent project information. It forms an important element of the project design documents and supports the development of the plans and specifications. Development reports shall be comprehensive in description of the various investigations and analyses. The report will include all design, environmental, and safety factors considered with the project and must bear the seal and signature of the project engineer.

The report for new project construction shall include, as a minimum, the items listed below. For modifications of existing dams, design reports shall include, as a minimum, those items listed which represent changed conditions from original construction or which address items that have not been previously addressed in prior reports that were submitted to the Dam Safety Officer.

Development Report  
Contents

Contents of Development Reports:

- (a) A description of the basic purposes of the project, normal operational characteristics and any unique or important design considerations associated with the site or project configuration.
- (b) A description and assessment of the site geology, seismicity and geotechnical considerations including a presentation of the

findings from subsurface explorations based on test pits and/or boring logs; field tests; laboratory testing and classification of samples.

(c) Design features including:

- A description and assessment of the climatic and hydrologic characteristics of the site and tributary watershed including a listing of all sources of inflow to the reservoir; the inflow design flood and reservoir elevations; and any other pertinent bathymetric information.
- Information relating to the type, class and description of all materials to be used, including any fill.
- Description of moisture conditioning and compaction to be used and how it will be addressed for all earthen zones;
- Description of any concrete or other structural components

(d) An assessment of the consequences in the event of dam failure on downstream areas, including:

- The downstream consequence classification as defined by Schedule 1 located in Appendix 1 which reflects the current and proposed conditions of development in downstream areas and a description of how the downstream impacts relate to the chosen rating. The most serious potential consequences of failure of those listed shall be used to establish the appropriate downstream consequence classification. Please note the Regional Dam Safety Officer is responsible for deciding the final consequence rating.
- An estimation of the magnitude of the dam break flood hydrographs resulting from various hypothetical dam failure scenarios occurring with the reservoir at normal storage elevation and maximum storage elevation.
- A general description of the areas downstream of the dam that could be affected by floodwater from a dam failure;
- For those structures that pose risk to human life, an inundation map delineating the maximum extent of flooding anticipated by a sudden breach. The mapping will continue downstream until the expected flooding is within the 100 year floodplain elevation.

(e) An assessment of the potential impacts, including but not limited to; instream uses, fish, wildlife, water quality, domestic and other water uses, reservoir and stream channel slope stability, private and crown land, and historical significance and aboriginal rights. Any mitigation measures will also be included.

- (f) An archaeological assessment of all lands impacted by the works may be required.

**Design Plans and Specifications**

***Design Plans and Specifications***

Plans shall be drawn up to detail the configuration and specifications of the dam and its associated works. The plans and specifications must contain sufficient detail to totally depict the proposed construction work and shall be submitted to the Dam Safety Officer for review and acceptance.

The following items, as a minimum, shall be included as part of the design plans:

**Design Plan Contents**

- project location and vicinity maps;
- site map of dam and reservoir area showing unique and natural features, property boundaries and appurtenances; at a scale of 1:1000 or larger (ie 1:500 is larger),
- sectional view along longitudinal axis of dam and foundation, at a scale of 1:250 or larger,
- cross-sectional view of dam at location of maximum height, at a scale of 1:75 or larger,
- cross-sectional views and profiles of spillway(s), outlet facilities and other appurtenances, at a scale of 1:50 and 1:100 or larger respectively,
- any instrumentation, dewatering routes or other pertinent information, and
- borrow pit and spoil disposal areas.

**Construction Supervision Plan**

***Construction Supervision Plan***

For all dams, a plan shall be submitted to the Dam Safety Officer describing how adequate and competent construction supervision will be provided.

**Construction Supervision Plan Contents**

The Construction Supervision Plan shall, as a minimum, include:

- a description of construction management organization and responsibilities,
- details for diversion, dewatering and handling runoff and potential siltation problems at the site,
- details for providing flow to the downstream channel for ecosystems, fish life, water users and water quality,
- a listing of construction activities related to critical project elements and planned inspection effort including staffing level, responsibilities, frequency and duration of site visits,
- a description of the quality assurance testing program which describes the type of test, general frequency, acceptable results,



handling of deficient materials and the individuals responsible for overseeing the testing,

- description of the technical records handling and the content and frequency of construction progress reports, and
- a detailed construction schedule showing the proposed start dates and duration of construction activities.

Environmental  
Management Plan

### ***Environmental Management Plan***

Those projects deemed to have significant environmental impacts during the construction may require a separate plan detailing how the impacts to the environment will be monitored. Depending on the scale of impacts, a requirement of the license to commence construction or license will be to retain an acceptable person to implement and manage the accepted Environmental Management Plan.

Draft OMS Manual

### ***Draft Operation Maintenance and Surveillance Manual***

An Operation, Maintenance and Surveillance (OMS) manual provides all the information and instruction needed to allow an individual to perform all the actions necessary to provide safe operation, routine maintenance and regular inspection of the dam.

An OMS manual is required for all dams except those with a consequence rating of Low. For those structures, the creation of an OMS manual is at the discretion of the project owner unless notified in writing. OMS manuals, however, are recommended for all projects.

As part of the submission package, the proponent shall provide a draft OMS manual to the Dam Safety Officer for review and acceptance. After the Dam has been operating for 1 year, the final OMS manual shall be submitted. The owner is responsible for providing upgrades and revisions to all holders of copies of the manual, including the Dam Safety Officer.

Most problems occur  
on the first filling  
of the reservoir

The manual shall describe procedures for operation of the project under normal and extreme reservoir inflow conditions and provide technical guidance and procedures for monitoring, inspection and short and long term maintenance. **It must also contain a surveillance schedule for the first filling.** The manual shall, as a minimum, contain the following items:

- (a) contact information and identification of the individuals responsible for implementing the plan,
- (b) a project data sheet describing the pertinent features of the dam and reservoir, including the spillway(s), outlet works and appurtenant structures and their locations at the dam site,
- (c) a copy of the current as-built or record drawings,

- (d) the rules and procedures used to regulate reservoir levels and project operation for various inflows and for both normal and unusual seasonal conditions, including a graphic rule curve,
- (e) a description of each hydraulic feature used to regulate or release water, including information on proper operation and scheduled maintenance,
- (f) a surveillance schedule as per Schedule 2 of the Dam Safety Regulation,
- (g) a listing of the items requiring periodic monitoring, the frequency of monitoring and procedures for monitoring, measuring and record keeping,
- (h) a listing of the items requiring periodic maintenance and procedures for conducting and documenting maintenance and recording of problems,
- (i) a listing of the items to be inspected or test operated, the frequency and procedures for conducting the same and the procedures for documenting the findings.

If the project is a Water Power Project, a report on the operating parameters and procedures (OPP) of the authorized works is required (please refer to the Guide for Waterpower Projects). This OPP shall be incorporated into the final OMS manual and describe the operating procedures during normal times while the OMS will describe the operating procedures during extreme flood events and scheduled maintenance.

For more information on OMS manuals, please refer to the document entitled [Inspection and Maintenance of Dams, Dam Safety Guidelines](#) available at all FLNRO office's and on the Dam Safety website

[http://www.env.gov.bc.ca/wsd/public\\_safety/dam\\_safety/index.html](http://www.env.gov.bc.ca/wsd/public_safety/dam_safety/index.html).

This document contains valuable information regarding inspection and maintenance of dams as well as an OMS minimum requirements [template](#). In addition, the section on OMS in the Canadian Dam Association guidelines should be consulted.

### ***Draft Emergency Preparedness Plan***

An Emergency Preparedness Plan (EPP) provides all the information and instruction needed to allow an individual to respond to an emergency related to the dam.

An EPP is required for all dams with a consequence rating of Significant, High, Very High, and Extreme. The creation of an EPP for those dams with a consequence rating of Low is at the discretion of the owner unless notified in writing. It is strongly recommended that all dams have an EPP in place and kept in a convenient

location. The submission of this document is not required for those existing structures undergoing rehabilitation if there is a current EPP.

Many dam owners include the EPP as a section in the OMS manual. The EPP should be highly visible if it is placed in the OMS manual.

Essential elements of a Dam Emergency Preparedness Plan include:

1. A *response strategy* that protects the public (early notification),
2. A clearly defined *notification chart* that includes key stakeholders (local government etc.),
3. An *EPP distribution* that includes key stakeholders for an integrated response,
4. *Recognition of the local authority* Emergency Operation Centre (EOC), (agency representation),
5. “Dam Breach” *inundation map(s)* (multiple release scenarios),
6. *Listing of key infrastructure* which could be affected by a dam failure, and
7. A *schedule* to exercise your plan with all stakeholders.

The EPP shall also, as a minimum, include the following operational information:

- (a) emergency assessment procedures,
- (b) emergency action plans,
- (c) emergency notification procedures with flow chart,
- (d) communication system details,
- (e) access routes to dam for all seasons and extreme conditions,
- (f) response plans during periods of darkness and adverse weather,
- (g) lists of local contractors/equipment operators, material suppliers etc., and
- (h) lists of emergency power sources locations.

For more information on Emergency Preparedness Plans, please refer to the document entitled [Inspection and Maintenance of Dams, Dam Safety Guidelines](#) available at all FLNRO office's and on the Dam Safety website

[http://www.env.gov.bc.ca/wsd/public\\_safety/dam\\_safety/index.html](http://www.env.gov.bc.ca/wsd/public_safety/dam_safety/index.html).

That document contains further information valuable to creating a clear and concise EPP. It also identifies the minimum requirements through the use of an outline [template](#). In addition, the section on EPPs in the Canadian Dam Association guidelines should be consulted.

EPP Elements

EPP Contents

## **E. ISSUANCE OF WRITTEN LEAVE TO COMMENCE CONSTRUCTION**

All construction to all or any part of a dam, that is not considered to be maintenance work or emergency work, is considered to be an alteration of a dam under Section 4 of the Dam Safety Regulation. Alterations must be authorized by an approval, licence or order under the Water Act. A clause pertaining to written leave to commence construction will be included in the approval, order or licence.

After FLNRO has determined all other required information has been submitted and conforms to accepted practices and the *Water Act*, written *leave to commence construction* will be sent to the licensee.

**Construction shall not commence until written leave to commence construction has been issued by the Dam Safety Officer.**

Receiving leave to commence construction does not absolve an owner of any responsibilities or liabilities. The owner shall make all necessary notifications, obtain all other permits, licenses and authorizations required. This includes permission to access either Crown or private lands.

The mobilization of equipment, stripping and grubbing and other site access and preparation work may be acceptable prior to receipt of written leave to commence construction if all work is subject to:

- an issued water license or approval,
- the supervision of qualified personnel,
- no permanent features of the project are initiated, and
- all regulatory and land access requirements have been met.

You must also observe the BC Heritage Conservation Act and understand that it is an offence for any person to knowingly remove, destroy or alter a heritage site or object. Upon discovery any archaeological material, you must take all reasonable precautions to avoid direct impact with such material and immediately notify FLNRO Archaeological Branch.

Depending on the size, scope and geographical location of your project, you may be required to provide an archaeological impact assessment and/or a traditional use survey of the area affected by your project. You will be notified of this requirement by FLNRO.

## **F. ROLES DURING CONSTRUCTION**

The owner is responsible for ensuring all aspects of construction are carried out appropriately and safely. You must notify all parties



affected by the construction or alteration of operation of the dam. This may include the provision of alternate water supplies for those affected.

FLNRO staff may inspect the site to confirm that construction is progressing according to accepted plans, specifications and practices. Construction may be stopped if any discrepancies or problems are noted during the inspection. The owner is responsible for all associated costs.

### **G. CONSTRUCTION CHANGES**

All projects receiving leave to commence construction shall be constructed in accordance with accepted plans and specifications. The supervising personnel will report any significant departures from the approved plans and specifications prior to those alterations occurring. All changes will be noted on the as-built or record drawings submitted to the Dam Safety Officer after the completion of construction.

### **H. DECLARATION OF CONSTRUCTION COMPLETION**

Within 30 days following substantial completion of construction or modification of the dam, the supervising engineer or owner shall submit to the Dam Safety Officer, Regional Water Manager or Comptroller of Water Rights a letter declaring the project to be constructed in accordance with the accepted plans and specifications.

### **I. COMMENCING OR RESUMING RESERVOIR OPERATIONS**

Following the substantial completion of construction the owner shall arrange a meeting with FLNRO staff, the owner, operator, the project engineer and any other interested person agreed to by this group. The purpose of the meeting will be to review, discuss and resolve any problems or changes made during construction, the procedure and timing for commencing use of the works and reservoir and any other outstanding issues.

Filling of the reservoir must not commence until this meeting has been held and all outstanding issues addressed to the satisfaction of the Dam Safety Officer.

The Dam Safety Officer will grant Leave to Commence Diversion, in writing, when use of the dam and initial filling of the reservoir may begin.

## J. ADDITIONAL PROJECT INFORMATION

### ***Construction Records***

For those dams with a consequence classification of Significant, High, Very High, and Extreme the project engineer shall submit a report within 120 days following completion of construction or modification of a dam. This report shall include:

- a summary of results from field testing of materials used in construction, identifying both representative values and the range of test values,
- a discussion of any notable items encountered during construction,
- one complete set of drawings depicting the as-built condition of the dam, and
- any other pertinent information.

### ***Dam Safety Review***

A Dam Safety Review (DSR) is a comprehensive formal evaluation performed at regular intervals to determine whether an existing dam is safe or contains some deficiencies and reviews the consequence rating. DSRs shall be carried out in accordance with the Dam Safety Regulations and submitted to the Dam Safety Officer. In addition, the section on DSRs in the Canadian Dam Association guidelines should be consulted.

### ***Suspension, Closure or Abandonment of a dam***

The owner must provide the Dam Safety Officer with 60 days notice before decommissioning, abandoning, or embarking on any significant partial or complete removal of the dam. Also, 60 day notice must be received prior to the suspension of normal operation where the suspension of operation will last for one year or more.

Notification should include:

- the dates of the proposed changes,
- details of the proposal,
- drawings of any changes to the works, and
- details of site restoration.

Additionally, the owner must notify the Dam Safety Officer 14 days before commencing any work under the approved plan

### ***Notification of New Owners***

Ownership of a dam involves a significant responsibility. When an owner sells or transfers their interest in a dam to another party, the owner should make that party aware of their responsibilities to

operate, inspect, maintain and repair the dam. There should be a complete transfer of documentation, including licenses, permits, reports, manuals, plans, drawings, agreements, etc., about the dam to the new owners and a specified date that ownership changes.

Note: Carrying this out in a proper and timely manner could reduce your exposure to liability.

### **CDA**

The Canadian Dam Association (CDA) is an organisation of groups or individuals with an interest in dam safety including dam owners, engineering consultants and government representatives. Through the combined effort of these members, the association has published Dam Safety Guidelines, the purpose of which is to:

- define requirements and outline guidelines so the safety of existing dams can be investigated and identified in a consistent and adequate manner across Canada,
- enable the consistent evaluation of dam safety deficiencies leading to the construction of improvements which contribute to dam safety, and
- provide a basis for dam safety legislation and regulation.

FLNRO has adopted several sections of these guidelines into their plan submission requirements. The CDA can be contacted at:

P.O. Box 4490, South Edmonton Postal Station

Edmonton, Alberta, Canada T6E 4X7

Tel: (403) 422-1356

Fax: (403) 427-6334

Web: [www.cda.ca](http://www.cda.ca)

### **Further Reference**

The intent of this document is to provide a complete list of all potential requirements. However, other requirements may become necessary due to the type of project proposed, advances in technology or an oversight in compiling this information. FLNRO may require other information be submitted at any time. Further information may be obtained at an FLNRO office, please refer to Appendix 5 for your local office, or alternatively, please visit our FLNRO website at:

[http://www.env.gov.bc.ca/wsd/public\\_safety/dam\\_safety/index.html](http://www.env.gov.bc.ca/wsd/public_safety/dam_safety/index.html).



## Appendix 1: DOWNSTREAM CONSEQUENCE CLASSIFICATION GUIDE

### Dam Safety Regulation Schedule 1

#### How to use this table

Find the appropriate rating in the far left column by reading the other 4 columns for the five ratings and note the highest potential consequence rating that applies to your dam, for each column. The classification of your dam is the highest rating.

Dam failure consequences classification	Population at risk	Consequences of failure		
		Loss of life	Environment and cultural values	Infrastructure and economics
Low	None <sup>1</sup>	There is no possibility of loss of life other than through unforeseeable misadventure.	Minimal short-term loss or deterioration and no long-term loss or deterioration of (a) fisheries habitat or wildlife habitat, (b) rare or endangered species, or (c) unique landscapes or sites of cultural significance.	Minimal economic losses mostly limited to the dam owner's property, with virtually no pre-existing potential for development within the dam inundation zone.
Significant	Temporary only <sup>2</sup>	Low potential for multiple loss of life.	No significant loss or deterioration of (a) important fisheries habitat or important wildlife habitat, (b) rare or endangered species, or (c) unique landscapes or sites of cultural significance, and restoration or compensation in kind is highly possible.	Low economic losses affecting limited infrastructure and residential buildings, public transportation or services or commercial facilities, or some destruction of or damage to locations used occasionally and irregularly for temporary purposes.
High	Permanent <sup>3</sup>	10 or fewer	Significant loss or deterioration of (a) important fisheries habitat or important wildlife habitat, (b) rare or endangered species, or (c) unique landscapes or sites of cultural significance, and restoration or compensation in kind is highly possible.	High economic losses affecting infrastructure, public transportation or services or commercial facilities, or some destruction of or some severe damage to scattered residential buildings.
Very High	Permanent <sup>3</sup>	100 or fewer	Significant loss or deterioration of (a) critical fisheries habitat or critical wildlife habitat, (b) rare or endangered species, or (c) unique landscapes or sites of cultural significance, and restoration or compensation in kind is possible but impractical.	Very high economic losses affecting important infrastructure, public transportation or services or commercial facilities, or some destruction of or some severe damage to residential areas.
Extreme	Permanent <sup>3</sup>	More than 100	Major loss or deterioration of (a) critical fisheries habitat or critical wildlife habitat, (b) rare or endangered species, or (c) unique landscapes or sites of cultural significance, and restoration or compensation in kind is impossible.	Extremely high economic losses affecting critical infrastructure, public transportation or services or commercial facilities, or some destruction of or some severe damage to residential areas.

<sup>1</sup> There is no identifiable population at risk.

<sup>2</sup> People are only occasionally and irregularly in the dam-breach inundation zone, for example stopping temporarily, passing through on transportation routes or participating in recreational activities.

<sup>3</sup> The population at risk is ordinarily or regularly located in the dam-breach inundation zone, whether to live, work or recreate.



## Appendix 2: MINIMUM DESIGN STANDARDS FOR DAMS

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### A. PREAMBLE

These minimum design standards are intended for use by water license applicants, licensees, their agents or consultants for the submission of plans, information and the construction of dams. They provide proponents with an understanding and direction regarding the **minimum** acceptable design standards. They have been developed by the BC Dam Safety Program for dams which are *not* large dams under the ICOLD definition and have a potential consequence rating of *less than* Very High.

The design criteria applied to dams in BC is determined principally by the CDA which is based on the CDA dam classifications. The CDA dam classifications are essentially the same as the BC Dam Safety Regulation classifications. These minimum design standards, therefore, are to be used in conjunction with the CDA Guidelines.

### B. INTRODUCTION

A variety of works are authorized under the *Water Act*, including water storage dams and works considered to be hazardous. This appendix for the Minimum Design Standards for Dams applies to any works providing a potential threat to life, property and the environment, as determined by the Dam Safety Officer. Dams or berms that store liquid other than water from a stream (surface water), are regulated under other provincial statutes.

Deviations from these minimum standards for dams will only be considered under special circumstances (i.e. where it can be justified and safety issues are not compromised). A written request containing justification for all deviations must be submitted to the Dam Safety Officer with a complete list of works that would not meet the minimum standards, the reasons why, and how they would be addressed. A decision will be made and you will be informed in writing as soon as possible.

Some diversion structures, pipes, flumes, and ditches may be considered as Hazardous Works

## **C. PROJECT SPECIFIC WORKS**

Each project is unique and presents challenges. This section includes some of the works that typically provide concerns for dams. The Comptroller, Regional Water Manager or the Dam Safety Officer may require additional design, construction and maintenance requirements over and above that contained in this document. However, the following sections are provided to outline the *minimum* standards allowed by WSD.

### **Low Level Outlets (Sluice Pipes)**

It is a requirement that all dams constructed on or obstructing a stream channel or lake outlet shall have a *low level outlet*. Sediment Pond Dams that are licensed under the *Water Act* may not require a low level outlet if emergency reservoir evacuation plans are outlined in the OMS Manual or EPP.

The low level outlet shall be:

- (a) set to the same elevation as the natural stream channel and on firm foundation,
- (b) set with a slope that allows complete drainage of the pipe and prevents back flooding of the pipe from the downstream channel,
- (c) constructed in such a manner that it directs all water away from the dam without ponding,
- (d) constructed in such a manner that prevents erosion or undermining of any structure or channel at full discharge,
- (e) constructed in a manner that facilitates an adequate inspection as described in the OMS manual OR a minimum diameter of 0.6m, and
- (f) constructed of the following:
  - cast in place reinforced concrete (a galvanized pipe or other thin walled pipe may be used as an inside form),
  - pre-cast concrete pipe set in a bedding of cast in-place concrete with suitable waterstops, or
  - suitable thick walled pipe with welded or water tight flanged joints in a bedding of concrete.

Consideration should be given to making concrete pours into an unformed excavated trench where foundation materials are suitable.

### **Gate Works**

The gates on all low-level outlets shall:

- (a) be placed on the upstream side of the dam,
- (b) operate easily over their full diameter,
- (c) provide a water tight seal,

- (d) be readily operable during all water level fluctuations and reservoir conditions, and
- (e) be made secure to prevent any vandalism or misuse.

In addition, all dams with gates placed in wells set into the embankment shall be designed for seepage resistance where water may enter the embankment or where works are subject to *hydrostatic pressure*.

### **Spillways**

All dams must have one or more spillways exhibiting the following characteristics:

- capable of passing the Inflow Design Flood (IDF)<sup>2</sup> with low level outlet gates closed and adequate freeboard (see section on Freeboard below),
- constructed a minimum 4 metres wide to reduce the probability of debris blockage (or have redundancy designed into the freeboard; see section on Freeboard below),
- constructed on undisturbed ground, *not* on embankment fill,
- protected against erosion within the channel and at the outfall,
- protected against debris build-up or damage,
- protected against landslides, livestock damage, and trees,
- no provisions are to be made for the future installation of flashboards, temporary or otherwise, and
- no pipes are to be used as spillways.

In addition, the Canadian Dam Association's Technical Bulletin entitled Hydrotechnical Considerations for Dam Safety, Section 5.0, should be consulted.

### **Freeboard**<sup>3</sup>

The objective of having freeboard is to ensure that a safety margin is maintained at all times in order to restrict overtopping of the dam from:

- flood water inflow,
- wind setup and wave runup,
- landslide and seismic motion,
- settlement,
- malfunction of structures (i.e. spillway blockages), and

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<sup>2</sup> The IDF is defined in the CDA Dam Safety Guidelines 2007 and quantified for the appropriate consequence classification in Table 6-1.

<sup>3</sup> Freeboard is defined in the CDA Dam Safety Guidelines 2007, and the 2007 CDA Technical Bulletin entitled Hydrotechnical Considerations for Dam Safety.

- other uncertainties in design, construction and operation.

Two types of freeboard are discussed below; normal and minimum. Regardless of which freeboard is used in the dam design, both require the spillway be able pass the IDF (see section on Spillway above).

- (a) **Normal Freeboard** (or Gross Freeboard) is the difference of elevation between the lowest elevation of the top of the dam (or top of impervious core) and the maximum reservoir operating level (full supply level, often the spillway sill elevation).
- (b) **Minimum Freeboard** (or Net Freeboard) is the difference of elevation between the lowest elevation of the top of the dam (or top of impervious core) and the maximum water level of the reservoir should the Inflow Design Flood (IDF) occur.

To prevent overtopping and provide redundancies in the dam design, the following freeboard standards shall be applied:

The *normal* freeboard shall be at least 1.0m in combination with a spillway width of at least 4 metres.

If the design engineer wants to present a case for a spillway width of less than 4 metres wide, the *minimum* freeboard shall be at least 1.0m. A spillway width of less than 4 metres wide is not recommended for High and Very High consequence dams.

In addition, the Canadian Dam Association's Technical Bulletin entitled Hydrotechnical Considerations for Dam Safety, Section 6.0, should be consulted.

### **Earth Embankments**

The following minimum standards shall be applied:

- embankments and other works shall be constructed on a sound foundation free of any loose or liquefiable soils and organic materials or soils,
- embankments shall be constructed with an adequate key trench such that seepage through the foundation will be eliminated or minimized,
- embankment crest shall be at minimum width as provided by the formula  $W_m=0.2H_m+3$  where  $W_m$  is the crest width in metres and  $H_m$  is the embankment height in metres,
- embankments to be used for vehicle movement must have appropriate materials and facilities on the travel surface,
- embankment fill shall be suitably compacted and have adequate and stable side slopes capable of resisting erosive forces,
- slopes for an earth embankment shall be a minimum of 2.5:1 (Horizontal:Vertical) on the downstream slope and 3:1 on the upstream slope unless it can be shown that the dam embankment

and slope design is adequately stable and can withstand all foreseeable loading conditions, and

- all seepage drains shall be designed and constructed to allow ease of maintenance, observation and measurement of any discharge.

### **Log Booms**

A well constructed and secured spillway log boom may be required to control spillway debris for the following reasons:

- floating debris, especially large logs and floating peat islands, can be drawn into a spillway entrance by high flow or pushed in by wind blocking the spillway,
- high winds, large waves, large accumulations of debris or ice pressure can exert a very strong force on a log boom, breaking the boom at a number of locations including the chains, anchors, connections (shackles, bolts, etc.) or the logs,
- a broken log boom becomes a hazard if the boom logs are caught in the spillway, and
- the failure of the boom will usually take place just when it is needed (i.e. when the reservoir level is high and there is debris pushing against it).

For these reasons, the log boom shall be constructed to the following specifications or equivalent unless it can be justified otherwise (Low consequence dams are excluded):

#### **a) Logs:**

- shall be minimum 0.3m in diameter, and
- shall be peeled and made of a species that floats such as pine, spruce and not hemlock;

#### **b) Chain holes:**

- bored at least 0.5 metres from ends;

#### **c) Boom chains:**

- ring and toggle type, chain 20 mm, 2.8 m long standard, or
- 80,000 lb. ultimate test (standard strength);

#### **d) Anchors:**

- buried lock blocks are usually adequate for smaller reservoirs (lock block minimum specifications: 1.5m x 0.75m x 0.75m, 2 tonnes), and
- can be used as shore or underwater anchors;

#### **e) Anchor chains:**

- generally the same as boom chains but longer, 3m suggested;

#### **f) Cables:**

- identical breaking strength as approved chain,

- continuous from shore anchor to shore anchor, and
- ends connected using cable clamps - log staples should only be used to secure cable alongside logs.

### **Diversion Structures**

Diversion structures are works used to remove water from a source but does not include the transport or storage of water. As they are constructed in the water, special care must be taken around these structures. The design, construction, operation and routine maintenance of diversion structures will include the capability to:

- control the diversion of water at appropriate rates for license and, if necessary, any competing uses including instream values (i.e. fish life), handling freshet flows and being operated without instream work being required annually or frequently,
- prevent unnecessary blockage or other obstruction of water flow or the passage of aquatic life,
- prevent entry by fish and debris,
- prevent destruction or deterioration of fish and fish habitat and
- minimize impact on the stream channel dynamics including natural flow regime, channel grade, accretion or erosion.

## **Appendix 3: PROCURING THE SERVICES OF A PROFESSIONAL ENGINEER**

### **A. DAM MAINTENANCE AND OWNER RESPONSIBILITY**

Dam owners receive important benefits from the reservoir impounded by the dam. The responsibility owner's hold for understanding the laws and regulations associated with proper dam maintenance, and the technical procedures for keeping these structures safe, is significant. This understanding could determine whether an owner will reap the benefits associated with responsible dam ownership or pay the costs resulting from improper dam maintenance.

As a dam owner, you are liable for the water stored behind your dam and any damage caused by it. Therefore, proper operation, maintenance, repair, and rehabilitation of a dam are key elements in preventing a failure, limiting your liability, and maintaining your water resource.

One of the most important procedures for ensuring proper maintenance of the dam is procuring the services of a professional engineer. The following information is designed to answer the most commonly asked questions about hiring an engineer.

#### **WHY DO I NEED AN ENGINEER?**

All dams meeting government regulatory definitions - no matter what the size or level of engineering - will deteriorate with time. Periodic inspection, proper maintenance, and occasional repair and rehabilitation are inevitable. An owner needs the expertise of an engineer to perform detailed construction designs, inspections or evaluate and supervise corrective measures at a dam.

An engineer can investigate the problem and recommend a course of action, which may include the design of corrective measures and the preparation of construction plans and specifications. The engineer also can assist in selecting a contractor and will provide valuable construction inspection and supervision services.

#### **WHAT TYPE OF ENGINEER SHOULD I HIRE?**

It is essential to select someone with a professional engineer (P. Eng.) certification, with a background in civil engineering, who is competent in the field of dam safety. Important criteria to look for in a prospective engineer include the following:

- a licensed professional engineer that is a current member of the Professional Engineers and Geoscientist of British Columbia,
- experience in dam design and construction, relative to the scope of the project,

- a knowledge of the rules and regulations governing dam design, construction and environmental issues in British Columbia, and
- specific experience in the problem area (e.g., hydrology, hydraulics, structural or geotechnical engineering).

### **HOW DO I CHOOSE AN ENGINEER WHO IS BEST FOR MY NEEDS?**

There are three basic strategies for selecting engineering consulting services. These selection strategies are:

- Qualification-Based
- Fee-Based
- Intermediate

#### **QUALIFICATION-BASED**

Qualification-Based selection means that the knowledge, experience, and ingenuity of the engineer are the determining factors in making the selection. This strategy is advantageous when the owner is uncertain about the exact problem or the best solution to the problem.

When Qualification-Based selection is used, several engineering firms submit their technical qualifications, experience with similar projects, reputation with existing clients, and any other factors pertaining to the specific project. The owner then selects the three most qualified firms to make brief presentations outlining a cost-effective and innovative approach to the problem. Based upon these presentations, the owner chooses the most qualified engineer to develop a scope of work.

When agreement on the scope of work is achieved, the engineer and the owner negotiate a price that is fair and reasonable to both parties. If an agreement cannot be reached, negotiations start with the second-ranked engineer. In this selection process, price is the main factor, but only after the most qualified engineer has been identified.

#### **FEE-BASED**

Fee-Based selection means that the engineer's fee is the only determining factor in making the selection. It is advantageous when the owner knows exactly what is needed and can clearly define the scope of work before meeting with an engineer. In this case, the engineer is requested to prepare the designs and bid documents or conduct investigations as the owner specifies. This usually means getting a job done using "cookbook" solutions-with little room for innovation.



A strict Fee-Based selection often means that the engineer selected may not be qualified to do the work, especially if the bidding is open to anyone and/or the scope of work is poorly defined.

### **INTERMEDIATE**

The Intermediate option is a cross between the Qualification-Based selection and Fee-Based selection processes. The Intermediate option requires that the owner pre-qualify engineers that are asked to submit a fee-based proposal. This process ensures a higher certainty that the work will be of superior quality, but requires the owner to clearly define the scope of work. Without a clearly defined scope of work, the owner could receive a wide range of fee proposal, depending on the consulting engineer's interpretation of the project.

### **B. FOR CONSIDERATION**

Request references from the engineer. Contact the reference to discuss the engineer's performance. Look at projects that have been completed under the engineer's leadership. Request to review government files of projects the engineer has undertaken to see if the process went smoothly. Carefully consider your selection of an engineer. A little work on your part in selecting the engineer may save you money in the future.

Maintain an open line of communication with regulatory agencies, particularly WSD Staff. Discuss an engineer's recommended course of action to verify that regulatory requirements will be satisfied.

Educate yourself in the basics of dam safety and be knowledgeable regarding the laws and conditions you must meet.

### **C. ACKNOWLEDGMENT**

Association of State Dam Safety Officials,  
450 Old East Vine Street, Lexington Kentucky 40507  
Tel. (606) 257-5140

## Appendix 4: DEFINITIONS

Note: these definitions relate to this document and the plan submission requirements

### Dam

#### “Dam”

- (a) a barrier constructed across a stream or
- (b) a barrier constructed off-stream and supplied by diversion of water from a stream for the purpose of enabling the storage or diversion of water, and includes all works which are incidental to or necessary for the barrier.

These standards apply to:

- (i) A dam 1 metre or more in height and is capable of impounding 1,000,000 m<sup>3</sup> of water or more;
- (ii) A dam 2.5 metres or more in height and is capable of impounding 30,000m<sup>3</sup> of water;
- (iii) A dam 7.5 metres or more in height;
- (iv) A dam that does not meet the criteria under paragraph (i), (ii), or (iii) but has the downstream consequence classification under Schedule 1 of Significant, High, Very High, or Extreme.

“Height” is defined in Section 1, Definitions, Dam Safety Regulation.

### Hazardous Works

#### “Hazardous Works”

Works that, whether constructed or proposed, pose a threat to life, property or the environment. It includes those works that pose a threat due to poor quality design, construction, maintenance and operation. (See definition of Works)

### Inflow Design Flood

#### "Inflow Design Flood"

The most severe inflow flood (peak, volume, shape, duration, timing) for which a dam and its associated facilities are designed. The consequence of dam failure will reflect the size of the selected IDF.

### Hydrostatic Pressure

#### “Hydrostatic Pressure”

The pressure or force exerted by water.

For example, the pressure placed on a dam’s facilities (pipes etc.) or embankments increases as the height of the water body increases causing increased stresses which may result in increases in seepage, leakage, damage or failures.

### Leave to commence construction

#### “Leave to commence construction”

A phrase used in clauses of many water Licenses requiring written confirmation from the Comptroller of Water Rights or the Regional Water Manager that the licensee has reviewed the proposal, addressed all of their concerns with you and do not object to the start of construction as proposed, subject to all conditions indicated.

**Low Level outlet****“Low Level outlet” or “Sluice pipe”**

A conduit through the dam to allow for controlled release of the reservoir contents.

**Minor Repairs and Routine Maintenance****“minor repairs and routine maintenance”**

Restoration work that is minor in scope and not a change from the authorized works. It does not cause a negative impact on the stream.

**Professional Engineer****“Professional Engineer”**

A person who is registered or Licensed under provisions of the Engineers Act, 1979, RS Chapter 109 of the Province of British Columbia and has knowledge, skills and experience in dam design, construction and maintenance.

**Regional Water Manager****“Regional Water Manager”**

A person employed by the Crown and designated in writing by the minister as a regional water manager and includes a person designated in writing by the minister as an acting or assistant regional water manager. Reference to the Regional Water Manager means the designated person for the geographic location or Water District where the works are located.

**Wave run-up****“Wave run-up”**

The effect that occurs as waves, travelling toward the dam, approach and wash over the upstream face of the dam. Some factors affecting the amount of wave run-up are wind speed and direction, length of fetch (approach affected by wind) depth of water and the slope and texture of the upstream face of the dam.

**Works****“Works”**

- (a) anything capable of or used for
  - (i) diverting, storing, measuring, conserving, conveying, retarding, confining or using water,
  - (ii) producing, measuring, transmitting or using electricity, or
- (b) booms and piles placed in a stream,
- (c) obstructions placed in or removed from streams or the banks or beds of streams, and
- (d) changes in and about a stream, and includes access roads to any of them.

## **Appendix 5: Ministry of Forests, Lands, and Natural Operations Contact Information**

For further information or comments on these Plan Submission Guidelines contact your nearest Dam Safety Officer. A Dam Safety Officer contact list can be found on our website at: [http://www.env.gov.bc.ca/wsd/public\\_safety/dam\\_safety/](http://www.env.gov.bc.ca/wsd/public_safety/dam_safety/)

Information can also be found through FrontCounter BC by calling toll free at 1 877 855 3222 (or if calling from outside North America, ++1 604 586 4400). For more information about FrontCounter BC (including office locations and water licence application information, refer to the website:

<http://www.frontcounterbc.gov.bc.ca/contact/index.html> which is the responsibility of the Integrated Land Management Bureau (ILMB) offices listed below.

For Dams over 9 metres in height and/or to obtain additional information on the Dam Safety Program, contact:

### **Dam Safety Section**

Water Management Branch

Resource Stewardship Division

Ministry of Forests, Lands, and Natural Resource Operations

PO Box 9340 Stn Prov Govt

Victoria BC V8W 9M1

Phone: (250) 387-3263

Fax: (250) 952-6792