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The Governments of Canada and of British Columbia are committed to working with industry partners. Opinions expressed in this document are those of Interior Dams Inc and the authors of included resources which are not necessarily those of the Governments of Canada and of British Columbia or the Investment Agriculture Foundation.
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Province of BC Dam Safety Staff

## FOR GENERAL INQUIRIES RELATED TO DAM SAFETY, PLEASE EMAIL:  DAM.SAFETY@GOV.BC.CA

### DAM SAFETY SECTION (responsible for dams equal to or greater than 9 metres in height)

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<td><strong>WEST COAST</strong></td>
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Print Date: 2016-08-22
PURPOSE OF BINDER

Keeping a dam safe requires the implementation of a system. That system is made up of many parts and goes beyond meeting regulations or dam inspection. The system should include components that will outline, document, plan and direct all decisions and activities during the life of the dam. Having a Dam Safety Management System in place is one of the key guiding principals of the Canadian Dam Association:

"A dam safety management system, incorporating policies, responsibilities, plans and procedures, documentation, training, and review and correction of deficiencies and nonconformances, shall be in place." (CDA Dam Safety Guidelines 2007-2013 Edition)

This binder and its resources have been developed to “strengthen the knowledge and capacity of agricultural dam owners to fulfill the Water Sustainability Act and Dam Safety Regulation” (Cariboo Cattlemen Association, 2016). The binder’s purpose is to serve as a template for implementing a Dam Safety Management System (DSMS) and is intended for small dams located in the province of British Columbia, Canada.
Notes to users:

This binder is divided into 10-tabs. The tabs cover the various components of a DSMS. Where possible, resources and guidance documents have been included to help users understand what to do and how to do it. In addition, the inclusion of checklists, templates and document placeholders have been added to provide examples. The binder is intended to offer a framework that can be adopted and customized to systematically organize, record and direct all the activities involved in dam ownership.

This binder contains unaltered copies of freely available dam safety resources from the dam safety section of the Ministry of Forests Lands and Natural Resource Operations (FLNRO) website. These may be revised without notice and become out of date.

The user of this Dam Safety Management Binder should check for updates and keep the binder’s resources current as may be appropriate for their dam. Content created during the development of this binder include the Cariboo Cattlemen Association and Interior Dams logos to differentiate them from other content. This binder is provided as-is and it is the responsibility of the dam owner to ensure their DSMS is appropriate for the complexity of their dam. Digital hyperlinked copies of this binder and supplementary resources have been included on a CD at the back of this hard-copy.

Binder Note: To aid users of this binder and its resources, notes and page numbers have been added to re-printed documents. These notes have been included in red text preceded by the words **Binder Note**.
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1

DAM SAFETY BACKGROUND & REGULATIONS
Dam Safety Management System (CDA, 2007)
DAM SAFETY REGULATION & INFORMATION SHEETS
INTRODUCTION

The BC Dam Safety Regulation was first passed into law under the Water Act as Regulation 44/2000, effective February 11, 2000. This regulation was repealed and replaced with the Dam Safety Regulation (O.I.C. 114, B.C. Reg. 40/2016) under the Water Sustainability Act, effective February 29, 2016.

The objective of the regulation is to mitigate loss of life and damage to property and the environment from a dam breach by requiring dam owners to inspect their own dams, undertake proper maintenance on them, and ensure that these dams meet ongoing engineering standards.

WATER SUSTAINABILITY ACT

The Water Act was replaced with the Water Sustainability Act (Act) on February 29, 2016. The new Act has authority over dams (considered works) and holds owners of dams liable for any damage caused by the construction, operation or failure of their dam. Under the Act, owners of dams are responsible for obtaining a water licence and complying with its terms and conditions.

TO WHOM THE REGULATION APPLIES

The regulation applies to owners of dams that store or divert water from a stream or aquifer or both (see Part 1, Section 1 of the regulation for a full definition of “owner” and “dam”). The height, storage capacity and dam failure consequence classification of the dam determines which parts of the regulation, if any, apply (Figure A):

1. Owners of Minor Dams, that meet the following criteria are exempt from the entire regulation unless the Comptroller of Water Rights (comptroller) or water manager determines otherwise:
   - less than 7.5 metres in height, and
   - able to impound no more than 10,000 m³ of water.

2. With the exception of the exempt minor dams above and regardless of consequence classification, dam height, or storage volume all dam owners must comply with all parts of the regulation except Part 3.

3. The entire regulation applies to owners of dams that meet the criteria specified in Part 3, Section 7:
   - 1 metre or more in height and capable of impounding a volume of water greater than 1,000,000 m³,
   - 2.5 metres or more in height and capable of impounding a volume of water greater than 30,000 m³,
   - 7.5 metres or more in height, or
   - Classified as significant, high, very high or extreme failure consequence.

CLASSIFICATION SYSTEM

All dams are classified according to their potential consequence of failure. Owners of dams have varying levels of obligations under the regulation which are directly related to the dam’s failure consequence classification (see Schedule 1 of the regulation).

REGULATION REQUIREMENTS

All owners of dams, other than owners of minor dams, must satisfy the requirements specified in Part 2, and may also need to meet requirements in Part 4 and Part 5.

1. The ongoing regulatory requirements for all dams, except the exempt minor dams include:
   - determine the dam failure consequence classification, and annually review and if necessary revise and submit to the Dam Safety Officer for acceptance,
   - comply with the provisions of the regulation that apply to a dam having that consequence classification,
   - properly inspect, maintain and repair their dam in a manner that keeps the dam in good operating condition, and

Page 1
2. Owners of dams meeting the criteria set out in Part 3, Section 7 of the regulation must undertake the following:

- prevent unauthorized operation of their dam.
- prepare, review and update the operation, maintenance and surveillance plan and dam emergency plan (except for low consequence dams) and submit to the Dam Safety Officer for acceptance,
- as part of the Dam Emergency Plan, prepare a record containing information to be submitted to the local emergency authorities for the purpose of their preparing local emergency plans,
- prepare and erect signage at all dams located on Crown Land (except for low consequence dams) notifying passersby to report any problems to the owner of the dam and/or the emergency response authorities,
- obtain authorization under the Act when alterations or improvements to, or replacement of their dam is considered,
- operate their dam in a manner, and initiate remedial actions, that will safeguard the public and dam in response to hazardous conditions at their dam,
- prepare a plan in response to any potential safety hazard,
- notify and get authorization from the Dam Safety Officer prior to removing, decommissioning, deactivating or stopping normal operation of their dam,
- report all significant findings resulting from inspections and/or dam safety reviews to the Dam Safety Officer,
- install any instrumentation necessary to adequately monitor the performance of a dam,
- carry out dam safety reviews (except for low and significant consequence dams), and
- submit to the Dam Safety Officer, upon request, records relating to the inspection, test or review carried out in relation to their dam including recorded data on the dam, reservoir, downstream area, or watershed upstream of the dam.

3. Additional requirements for all dam owners may include:

- where there are two or more owners of a dam, these owners must designate one of the owners for the purpose of receiving, providing and retaining information and records in relation to the dam,
- where there are two or more owners of a dam, an owner may be exempt from the requirements of this regulation if the comptroller is satisfied that proper arrangements have been made for one or more of the other owners to take on responsibility for their dam and the owner holds no more than 5% of the total storage rights in respect of the dam, and
- an owner of a dam may be required to obtain independent expert advice in relation to an issue respecting their dam, with qualifications and experience in dam design, construction and analysis or in dam operation and maintenance or in hydraulic, hydrological, geological, geotechnical, mechanical or structural analysis.

**TRANSITION**

To allow owners sufficient time to meet new requirements in the regulation, transitional provisions are included. These are found in Part 5 of the regulation.

**ROLE OF THE RESPONSIBLE MINISTRY**

The comptroller instituted the Provincial Dam Safety Program in 1967. The program's goal is to set design, construction, maintenance, and surveillance standards, and assist dam owners in meeting these standards.

Dam Safety Officers, located in each region and in Victoria, protect public safety by monitoring and auditing the activities of dam owners, providing education and awareness training and taking compliance and enforcement action when necessary.

The Dam Safety Regulation is an important component of the Provincial Dam Safety Program’s objective to minimize the impact of dam failures.

**MORE INFORMATION**

The regulation and more information on dam safety can be obtained from the Dam Safety Program website: http://www2.gov.bc.ca/gov/content/environment/air-land-water/water/drought-flooding-dikes-dams/dam-safety

Or by contacting:

- Dam Safety Section
- Water Management Branch
- PO Box 9340 Stn Prov Govt
- Victoria BC V8W 9M1

Email: dam.safety@gov.bc.ca

Visit the Canadian Dam Associations’ Dam Safety Guidelines and website at http://www.cda.ca/
Figure A. Graph of dam height vs. dam storage capacity which, along with dam failure consequence classification, determines what parts of the Dam Safety Regulation applies.
SIGNAGE MANDATE

As specified in the British Columbia Dam Safety Regulation, as of November 30, 2011, all owners of dams located partially or entirely on Crown Land and that have a classification of significant, high, very high or extreme must post signs at those dams in the manner described in the Regulation. The signage mandate has been reiterated in the 2016 Dam Safety Regulation (hyperlink) under Section 11 and this Information Sheet has been updated accordingly. Under the 2016 regulation, owners of dams that are on land that is surrounded by or adjacent to Crown Land are also subject to the signage mandate. The requirement for signage on dams is a commitment that meets one of the twelve recommendations put forward by David Morhart, Deputy Solicitor General in his report entitled Review of the Testalinden Dam Failure (July 2010). Recommendation #3 states: The Ministry of Environment (now the Ministry of Forest, Lands & Natural Resource Operations) should consider implementing signage to make it clear to passersby that the structure is a dam and to provide direction and emergency contact information, including contact information for the owner, to report any issues observed.”

GENERAL SIGNAGE CRITERIA AND INFORMATION FOR DAM OWNERS

1. Considerations for Signs
   - Background colour and reflectivity can affect the visibility of safety signs. Low light conditions may reduce visibility and make existing signs ineffective.
   - Use of a reflective background material can increase visibility.
   - Signs usually consist of dark lettering on light backgrounds or vice versa to ensure legibility.
   - Keeping signage consistent increases recognition by the public.
   - Where possible, sign placement should consider sun and glare, shadows, orientation and visitor safety.
   - As a general rule, place signs on the right hand side (when facing the dam crest) of the approach to the dam.
   - Sign placement should not interfere with the normal operation of the dam.
   - Sign placement should not be too close to trees or foliage that could cover the face of the sign.

2. Materials and Cost
   Dam owners are responsible for the cost, installation and maintenance of signs on their dams. Costs vary greatly with quantity, size, location and type of material used. Posts should be constructed of metal or other durable material. Commonly used materials for signs are:
   - Marine quality, ¾ inch plywood,
   - Medium density Fiberboard (MDF), and
   - Aluminum.

   The post kits (post, sleeves, bolts and anchor) required will depend on the situation and sign material chosen. For installation at provincial dams, the posts chosen were 3.6 metres long and 57 mm in diameter. The anchor was 1050 mm long and 64 mm in diameter. Each post kit weighed about 23 kilograms. Installation costs vary depending on the location of the dam, type of installation required and whether installed by the dam owner or contractor.
3. **Maintenance**

Inspection and maintenance procedures for the signs must be included by the dam owner in the dam’s Operation, Maintenance and Surveillance manual. Standard maintenance plans should address physical damage, visibility, legibility and appearance. Key concepts of a maintenance plan should include:

- Frequent inspections to ensure that signs are maintained and repaired as needed – include sign check as part of the surveillance and formal inspection of the dam and include procedures into the dam’s Operation, Maintenance & Surveillance manual.
- Taking precautions to reduce vandalism to the signs,
- Repairing or replacing damaged signs quickly,
- Checking the reflectivity of signs that are meant to be seen at night, and
- Updating protocols for employees and/or visitors to report damage.

Experience suggests that annual maintenance of signs averages about 30% of the initial cost as signs are common targets for graffiti and gun shots.

4. **Specifications for Signs**

Signs must conform to the specifications provided in the Dam Safety Regulation. This includes but is not limited to:

- Signs must be at least 75 centimetres high and 60 centimetres wide.
- Lettering on the sign must be clearly visible under all seasonal conditions from 15 meters.
- The sign must contain the following information and be in the following format:

```
<DAM NAME>
<STREAM NAME>

IF YOU SEE ANY DAM SAFETY CONCERNS, PLEASE CONTACT: <DAM OWNER NAME>
DAY: ___-____-____
NIGHT: ___-____-____
PROVINCIAL EMERGENCY PROGRAM
1-800-663-3456
```

*For Example:*

![Image of a sign with contact information]

**MORE INFORMATION**

Information on dam safety is available on the BC Government Dam Safety Website: Website UPDATE???

Or, can be obtained from your local Dam Safety Officer or by contacting:

- Dam Safety Section
- Water Management Branch
- PO Box 9340 Stn Prov Govt
- Victoria BC V8W 9M1
Water Sustainability Act
DAM SAFETY REGULATION

Note: Check the Cumulative Regulation Bulletin 2015 and 2016 for any non-consolidated amendments to this regulation that may be in effect.

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Part 1 — Definitions, Interpretation and Application

Definitions and interpretation
1 (1) In this regulation:
   "Act" means the Water Sustainability Act;
   "classification" means the classification of a dam determined in accordance with section 3 [dam failure consequences classification] or 31 [transition — dam failure consequences classification];
   "dam" means
   (a) a barrier constructed for the purpose of enabling the storage or diversion of water diverted from a stream or an aquifer, or both, and
   (b) other works that are incidental to or necessary for the barrier described in paragraph (a);
   "dam safety officer" means an engineer or an officer who is designated in writing by the comptroller as a dam safety officer;
   "emergency plan", in relation to a dam, means
   (a) a plan
       (i) that, immediately before February 29, 2016, was the emergency preparedness plan for the dam under the former regulation, or
       (ii) that is prepared under section 9 [dam emergency plan] by an owner of the dam and accepted by a dam safety officer, and
   (b) the revisions, if any, to the plan referred to in paragraph (a) (i) or (ii), as applicable, set out in a record prepared by an owner of the dam and accepted by a dam safety officer;
   "engineering professional" means a person who is
   (a) a professional engineer as defined in the Engineers and Geoscientists Act, or
   (b) a holder of a limited licence under the Engineers and Geoscientists Act that permits the person to practise professional engineering and who is acting within the scope of the limited licence;
   "formal inspection", in relation to a dam, means a thorough on-site inspection of the dam and dam site conducted by a person who is an owner of the dam or an agent of an owner of the dam and who is responsible for the safety of the dam;
   "former regulation" means the British Columbia Dam Safety Regulation, B.C. Reg. 44/2000;
   "hazardous conditions", in relation to a dam, means conditions, including, without limitation, defects or insufficiencies of the dam, that
   (a) are or are likely to be hazardous to the dam, or
   (b) may reasonably be anticipated to cause all or part of the dam, or any operation or action at or in connection with the dam, to be or become potentially hazardous to
(i) public safety,
(ii) the environment, or
(iii) land or other property;

"instrumentation", in relation to a dam, means instruments and equipment used to measure the following:

(a) hydrological and hydraulic characteristics in relation to the dam, including, without limitation,
   (i) water levels in the dam and reservoir and at the weirs, and
   (ii) water flow throughout the dam;
(b) water clarity in the reservoir and below the dam;
(c) seismic, geological and geotechnical characteristics in relation to the dam, including, without limitation, movement of the dam, seismic activity, pore pressures and stresses applied to the dam;
(d) temperature variations of the dam;
(e) weather conditions that may affect the operation of the dam;
(f) other parameters in relation to the dam;

"jurisdictional area", in relation to a local emergency authority, means the jurisdictional area, as defined in the Emergency Program Act, for which the local authority has responsibility under that Act;

"local authority" has the same meaning as in the Emergency Program Act;

"local emergency authority", in relation to a dam, means a local authority that is, under subsection (2), a local emergency authority for the dam;

"operation, maintenance and surveillance manual", in relation to a dam, means

(a) a manual
   (i) that, immediately before February 29, 2016, was the operation, maintenance and surveillance manual for the dam under the former regulation, or
   (ii) that is prepared under section 8 [operation, maintenance and surveillance manual] by an owner of the dam and accepted by a dam safety officer, and
(b) the revisions, if any, to the manual referred to in paragraph (a) (i) or (ii), as applicable, set out in a record prepared by an owner of the dam and accepted by a dam safety officer;

"owner", in relation to a dam, means

(a) the following persons:
   (i) a person who is a licensee in relation to a licence for the dam;
   (ii) a person who must under the Act, but does not, hold a licence for the dam;
   (iii) a person who was a licensee in relation to a licence for the dam immediately before the suspension, cancellation, termination or abandonment of the licence, and
(b) if there is no person to whom paragraph (a) applies, the following persons:
   (i) an owner, as defined in the Act, of the land on which the dam is located;
   (ii) a person who had the dam constructed;

"potential safety hazard", in relation to a dam, means conditions that are not yet, but have the potential to become, hazardous conditions in relation to the dam;

"Provincial Emergency Program" means the Provincial Emergency Program continued under section 2 (1) [Provincial Emergency Program] of the Emergency Program Act;

"site surveillance" means the monitoring of a dam and the area surrounding or adjacent to the dam

(a) through visual observation, and
(b) if there is instrumentation relating to the dam, through the systematic collection of instrumentation readings and analysis and interpretation of the readings;

"submit", in relation to a record that, under this regulation, must or may be submitted to a dam safety officer, means submit the record in the manner required under section 25 [submission of records to and acceptance of records by dam safety officer].

(2) For the purposes of the definition of "local emergency authority" in subsection (1), a local authority is a local emergency authority for a dam if any land in the jurisdictional area of the local authority

(a) is in the immediate vicinity of the dam or the reservoir of the dam, or
(b) is downstream or downslope of the dam and may be adversely affected by
   (i) a complete or partial collapse of the dam, or
   (ii) an uncontrolled release of all or part of the water impounded by the dam.
(3) For the purposes of this regulation, the construction of a newly constructed dam is conclusively deemed to be completed on the date on which the dam first becomes capable of storing or diverting water.

(4) For the purposes of sections 2 (1) [application of regulation to minor dam] and 7 [application of Part 3], the height of a dam is the vertical distance to the top of the dam measured,
(a) in the case of a dam across a stream, from the natural bed of the stream at the downstream outside limit of the dam, and
(b) in the case of a dam that is not across a stream, from the lowest elevation at the outside limit of the dam.

Application of regulation to minor dam

2 (1) Unless otherwise ordered under subsection (2), this regulation does not apply to a dam that meets both of the following criteria:
(a) the dam is less than 7.5 m in height;
(b) the dam is capable of impounding at full supply level a maximum total storage volume of water in the reservoir of the dam of 10 000 m³ or less.

(2) Subject to section 7 [application of Part 3], the comptroller or a water manager may order that this regulation applies to a dam described in subsection (1) of this section if the comptroller or water manager is satisfied that the dam is or may become potentially hazardous to
(a) public safety,
(b) the environment, or
(c) land or other property.

Part 2 — Requirements Applicable to All Dams

Dam failure consequences classification

3 (1) An owner of a newly constructed dam must, as soon as practicable and, in any event, no later than 60 days, after completion of the construction of the dam,
(a) determine the classification of the dam in accordance with section 2 [determination of classification] of Schedule 1, and
(b) submit to a dam safety officer, immediately after the determination is completed, a record setting out a proposed classification for the dam.

(2) An owner of a dam for which the classification has been determined under the former regulation or this regulation must,
(a) no less frequently than is specified in item 1 of the table in Schedule 2 for the classification of the dam, redetermine the classification of the dam in accordance with section 2 of Schedule 1 to assess whether the classification of the dam has changed, and
(b) if the classification of the dam has changed, submit to a dam safety officer, immediately after the redetermination is completed, a record setting out a proposed new classification for the dam.

(3) Despite subsections (1) and (2), the comptroller or a water manager may order an owner of a dam to comply with subsection (1) or (2), as applicable, on or before a specified date.

(4) On receipt of a record under subsection (1) (b) or (2) (b) or paragraph (b) (ii) of this subsection from an owner of a dam proposing a classification, or a new classification, for the dam, or on receipt of information or records from an owner of a dam under paragraph (b) (i) of this subsection, a dam safety officer must give written notice to the owner of the dam who submitted the record or the information or records, as the case may be, advising that
(a) the dam safety officer has accepted the classification, or new classification, proposed by the owner, or
(b) the dam safety officer has not accepted the classification, or new classification, proposed by the owner and requiring the owner to submit to the dam safety officer, on or before the date specified by the dam safety officer, either of the following:
(i) information or records, or further information or records, as the case may be, that demonstrate that the classification, or new classification, proposed by the owner is correct;
(ii) a record setting out a different proposed classification, or new classification, as the case may be, for the dam.

(5) In the case of a dam described in subsection (1),
(a) until a record setting out a proposed classification for the dam is submitted under subsection (1) (b), the classification of the dam is deemed, for the purposes of this regulation, to be significant, and
(b) between the date on which the record referred to in paragraph (a) of this subsection is submitted to a dam safety officer and the date on which a dam safety officer gives notice under subsection (4) (a) in relation to the dam,
(i) if the proposed classification for the dam is high, very high or extreme, the classification of the dam is deemed, for the purposes of this regulation, to be the proposed classification, and
(ii) if the proposed classification for the dam is low or significant, the classification of the dam is deemed, for the purposes of this regulation, to be significant.

(6) In the case of a dam described in subsection (2) in respect of which an owner of the dam submits under subsection (2) (b) a record setting out a proposed new classification for the dam, between the date on which the record is submitted and the date on which a dam safety officer gives notice under subsection (4) (a) in relation to the dam, the classification of the dam is deemed, for the purposes of this regulation, to be the more severe in consequence of the existing classification and the proposed new classification.

(7) Despite subsections (5) and (6), if the comptroller or a water manager makes an order under subsection (3),

(a) the comptroller or water manager may, in the order, specify a classification for the dam that applies between the date on which the order is made and the date on which a dam safety officer gives notice under subsection (4) (a) in relation to the dam, and
(b) the classification of the dam is, during the period described in paragraph (a) of this subsection, deemed for the purposes of this regulation to be the classification specified in the order.

(8) For certainty, the requirements of this regulation that apply in relation to a classification of a dam also apply in relation to a deemed classification of the dam under subsection (5), (6) or (7).

(9) When a dam safety officer gives notice under subsection (4) (a) in relation to a dam, the classification of the dam for the purposes of this regulation is the classification accepted by the dam safety officer as set out in the notice.

Owner must comply on determination or change of classification

4 Subject to this regulation, if the classification of a dam is determined for the first time or changes, an owner of the dam must, as soon as practicable after the owner becomes aware of the classification, or changed classification, as the case may be, comply with the provisions of this regulation that apply to a dam having that classification or changed classification.

Responsibility of owner for dam condition and safety

5 (1) An owner of a dam must properly inspect, maintain and repair the dam and related works in a manner that keeps the dam and works in good operating condition.

(2) An owner of a dam must exercise reasonable care to avoid the risk of significant harm resulting from a defect, insufficiency or failure of the dam or other conditions at the dam or operations or actions at or in connection with the dam to any of the following:

(a) public safety;
(b) the environment;
(c) land or other property.

Prevention of unauthorized operation

6 An owner of a dam must exercise reasonable care to safeguard the dam from unauthorized operation.

Part 3 — Requirements Applicable to Certain Dams

Division 1 — Application of Part 3

Application of Part 3

7 This Part applies in relation to a dam if the dam meets the criteria set out in one or more of the following paragraphs:

(a) the dam is

(i) 1 m or more in height, and
(ii) capable of impounding at full supply level a total storage volume of water in the reservoir of the dam greater than 1 000 000 m³;

(b) the dam is

(i) 2.5 m or more in height, and
(ii) capable of impounding at full supply level a total storage volume of water in the reservoir of the dam greater than 30 000 m³;

(c) the dam is 7.5 m or more in height;

(d) the dam has a classification of significant, high, very high or extreme.
Division 2 — General Safety Requirements

Operation, maintenance and surveillance manual

8 (1) An owner of a dam for which there is not already an operation, maintenance and surveillance manual and that has a classification of significant, high, very high or extreme must
(a) prepare a manual, in the form and with the content specified by the comptroller or a water manager, that describes the operation, maintenance and surveillance procedures for the dam, and
(b) submit the manual to a dam safety officer for acceptance by the dam safety officer.

(2) Subject to subsection (3), an owner of a newly constructed dam must comply with subsection (1) as soon as practicable and, in any event, no later than 60 days, after completion of the construction of the dam.

(3) The comptroller or a water manager may order an owner of a dam to comply with subsection (1) on or before a specified date.

(4) An owner of a dam for which there is an operation, maintenance and surveillance manual must, no less frequently than is specified in item 8 of the table in Schedule 2 for the classification of the dam,
(a) review and, if necessary, revise the operation, maintenance and surveillance manual, and
(b) submit to a dam safety officer, for acceptance by the dam safety officer,
(i) a record setting out the revisions, if any, or
(ii) a written report advising that no revisions are necessary.

(5) Despite subsection (4), if the classification of a dam for which there is an operation, maintenance and surveillance manual changes to a classification that is more severe in consequence, an owner of the dam must comply with subsection (4) (a) and (b) as soon as practicable after the owner becomes aware of the change of classification or on or before a later date specified by a dam safety officer.

(6) An owner of a dam must follow the operation, maintenance and surveillance manual, if any, for the dam.

Dam emergency plan

9 (1) An owner of a dam for which there is not already an emergency plan and that has a classification of significant, high, very high or extreme must
(a) prepare a plan, in the form and with the content specified by the comptroller or a water manager, that includes
(i) a record describing the actions to be taken by the owner if there is an emergency at the dam, and
(ii) a record containing information for the use of the local emergency authorities for the dam for the purpose of preparing local emergency plans under the Emergency Program Act, and
(b) submit the plan to a dam safety officer for acceptance by the dam safety officer.

(2) Subject to subsection (3), an owner of a newly constructed dam must comply with subsection (1) as soon as practicable and, in any event, no later than 60 days, after completion of the construction of the dam.

(3) The comptroller or a water manager may order an owner of a dam to comply with subsection (1) on or before a specified date.

(4) A record described in subsection (1) (a) (i) must include contact information for the persons and the government agencies and other organizations that are to be contacted by the owner of the dam if there is an emergency at the dam.

(5) A record described in subsection (1) (a) (ii) must include the name and contact information of the person who is the emergency contact for the dam.

(6) An owner of a dam must, promptly after a plan prepared for the dam under subsection (1) is accepted by a dam safety officer, deliver a copy of the record described in subsection (1) (a) (ii) to each local emergency authority for the dam.

(7) An owner of a dam for which there is an emergency plan must, no less frequently than is specified in item 6 of the table in Schedule 2 for the classification of the dam,
(a) review and, if necessary, revise the names and contact information in the records described in subsections (4) and (5) of this section, and
(b) submit to a dam safety officer, for acceptance by the dam safety officer,
(i) a record setting out the revisions, if any, or
(ii) a written report advising that no revisions are necessary.

(8) Subject to subsection (7), an owner of a dam for which there is an emergency plan must, no less frequently than is specified in item 8 of the table in Schedule 2 for the classification of the dam,
(a) review and, if necessary, revise the emergency plan, and
(b) if the record is revised, submit the revised record to a dam safety officer for acceptance by the dam safety officer.

(9) Despite subsection (8), if the classification of a dam for which there is an emergency plan changes to a classification that is more severe in consequence, an owner of the dam must comply with subsection (8) (a) and (b) as soon as practicable after the owner becomes aware of the change of classification or on or before a later date specified by a dam safety officer.

(10) If a record described in subsection (1) (a) (ii) for a dam is revised under this regulation, an owner of the dam must, promptly after the revision is accepted by a dam safety officer, deliver a copy of the revised record to each local emergency authority for the dam.

Record identifying emergency contact

10 (1) An owner of a dam that has a classification of low must

(a) prepare a record, in the form and with the content specified by the comptroller or a water manager, that sets out the name and contact information of the person who is the emergency contact for the dam,

(b) submit the record to a dam safety officer, and

(c) deliver a copy of the record to each local emergency authority for the dam.

(2) Subject to subsection (3), an owner of a newly constructed dam must comply with subsection (1) as soon as practicable and, in any event, no later than 60 days, after completion of the construction of the dam.

(3) A dam safety officer may specify a date on or before which an owner of a dam must comply with subsection (1) and, if the dam safety officer specifies a date, the owner must comply with subsection (1) on or before the specified date.

(4) An owner of a dam for which a record referred to in subsection (1) has been prepared must, no less frequently than is specified in item 7 of the table in Schedule 2 for the classification of the dam,

(a) review and, if necessary, revise the record, and

(b) if the record is revised,

(i) submit the revised record to a dam safety officer, and

(ii) deliver a copy of the revised record to each local emergency authority for the dam.

(5) If none of the owners of a dam have complied with subsection (1) within the required time, a dam safety officer may designate one of the owners of the dam to be the emergency contact for the dam.

(6) An owner of a dam who becomes the emergency contact for the dam under this section must, as soon as practicable, give to each other owner whose address is known to the owner written notice that the owner is the emergency contact.

Signs must be posted

11 (1) In this section:

"emergency contact", in relation to a dam, means the person identified as the emergency contact for the dam in the record referred to in section 9 (5) [dam emergency plan];

"sign" means a sign that meets the requirements of subsection (4).

(2) Subject to subsection (3), an owner of a dam that has a classification of significant, high, very high or extreme and that is located partly or entirely on Crown land, or on land that is surrounded by or adjacent to Crown land, must ensure that 2 signs are at all times posted,

(a) at each end of the top of the dam, or

(b) if a sign posted at an end of the top of the dam would not be clearly visible under all seasonal conditions to persons approaching the dam, at another location on Crown land at which the sign would be so visible.

(3) An owner of a dam is required to post only one sign under subsection (2) if a dam safety officer considers it would be impractical or unnecessary to post the other sign.

(4) Each sign that must be posted under subsection (2) must meet all of the following requirements:

(a) the sign must contain, in lettering that is clearly legible from a distance of 15 m, the following information:

(i) the name of the dam;

(ii) if the dam impounds water from a stream, the name of the stream;

(iii) the following words: "If you see any dam safety concerns, please contact: ", followed by

(A) the name and emergency telephone numbers for day and for night of the emergency contact for the dam, and

(B) the emergency telephone number for the Provincial Emergency Program;

(b) the sign must be at least 75 cm high and 60 cm wide;

(c) the sign must be clearly visible under all seasonal conditions to persons approaching the dam;
(d) the sign and the post, if any, must be constructed from metal or other durable materials having strength suited to the location of the sign and the local environmental conditions;
(e) the sign must meet the other requirements, if any, specified by the comptroller or a water manager.

(5) An owner of a dam may, under this section, post a sign on Crown land whether or not the owner has any other authority to occupy the Crown land.
(6) This section is subject to the requirements of any other enactment that relate to the location, appearance or construction of a sign referred to in this section.

Division 3 — Activities at or near Dam

Authorization, change approval or order for alteration or improvement to or replacement of dam

12 An alteration or improvement to or replacement of all or part of a dam must be authorized under the Act by an authorization, change approval or order unless the alteration, improvement or replacement is for the purpose of
(a) routine maintenance of the dam or related works,
(b) addressing hazardous conditions in relation to the dam in accordance with section 14 (1) [hazardous conditions], or
(c) conducting an investigation described in section 16 [invasive investigations] in accordance with that section.

Requirements if alteration or improvement to or replacement of dam

13 (1) An owner of a dam must, within 30 days after completion of an alteration or improvement to or replacement of all or part of the dam, submit to a dam safety officer
(a) a written report on the work and the manner in which the alteration, improvement or replacement was performed, and
(b) a copy of the as-built drawings.
(2) A report under subsection (1) (a) may be combined with a report under section 14 (2) (a) [hazardous conditions], 15 (2) (a) [potential safety hazard] or 17 (5) [removing, decommissioning, deactivating or stopping operation of dam].
(3) An owner of a dam must, promptly after an alteration or improvement to or replacement of all or part of the dam is completed,
(a) review and, if necessary, revise the operation, maintenance and surveillance manual and the emergency plan, if any, for the dam, and
(b) submit to a dam safety officer for acceptance by the dam safety officer,
(i) a record setting out the revisions, if any, or
(ii) a written report advising that no revisions are necessary.

Hazardous conditions

14 (1) An owner of a dam who becomes aware of hazardous conditions in relation to the dam must promptly do all of the following:
(a) follow the emergency plan, if any, for the dam;
(b) operate the dam in a manner, and initiate any remedial actions, including modifying the operations at the dam, that will
(i) safeguard the public, and
(ii) minimize damage to the environment or land or other property;
(c) inform the following persons and other entities of the nature of the hazardous conditions:
(i) the Provincial Emergency Program;
(ii) persons who are in the immediate vicinity of the dam;
(iii) the local emergency authorities for the dam whose jurisdictional areas may be adversely affected by the hazardous conditions;
(d) if the nature of the hazardous conditions places persons in imminent danger,
(i) advise persons who are in the immediate vicinity of the dam to vacate the endangered area, and
(ii) inform the local emergency authorities for the dam whose jurisdictional areas may be adversely affected by the hazardous conditions of the imminent danger;
(e) inform the comptroller, a water manager or a dam safety officer of
(i) the nature of the hazardous conditions,
(ii) the actions being taken by the owner to rectify the hazardous conditions, and
(iii) the time and exact nature of the information given under this section to any person in relation to the hazardous conditions;
f) perform such further hazard response activities as the comptroller or a water manager orders.

(2) An owner of a dam must, as soon as practicable and, in any event, no later than 30 days, after hazardous conditions at the dam have been rectified, submit to a dam safety officer:
(a) a written report on the actions taken by the owner to rectify the hazardous conditions and the effectiveness of those actions, and
(b) on request of the dam safety officer, copies of records in the custody or under the control of the owner in relation to those actions.

Potential safety hazard
15 (1) An owner of a dam who becomes aware of a potential safety hazard in relation to the dam must do all of the following:
(a) promptly notify a dam safety officer of the potential safety hazard;
(b) on or before the date specified by a dam safety officer
   (i) prepare a plan, in the form and with the content specified by the dam safety officer, that sets out, in order of priority, any actions required to rectify the potential safety hazard, and
   (ii) submit the plan to a dam safety officer for acceptance by the dam safety officer;
(c) if the plan referred to in paragraph (b) is accepted by a dam safety officer, implement the plan, on or before the date specified by a dam safety officer, in the order of priority identified in the plan and in accordance with any requirements or conditions specified in an authorization, change approval or order.

(2) An owner of a dam must, as soon as practicable and, in any event, no later than 30 days, after a potential safety hazard at a dam has been rectified, submit to a dam safety officer:
(a) a written report on the actions taken by the owner to rectify the potential safety hazard and the effectiveness of those actions, and
(b) on request of the dam safety officer, copies of records in the custody or under the control of the owner in relation to those actions.

Invasive investigations
16 (1) In this section, "invasive investigation" means an investigation that involves drilling, trenching, excavating a test pit or performing another invasive activity within or in close proximity to a dam.

(2) An owner of a dam who intends to conduct an invasive investigation must,
(a) at least 60 days before the date on which the owner expects the invasive investigation to begin, give to a dam safety officer written notice of the proposed investigation, and
(b) at least 30 days before the date on which the owner expects the invasive investigation to begin
   (i) prepare a plan, in the form and with the content specified by a dam safety officer, in relation to the invasive investigation, and
   (ii) submit the plan to a dam safety officer for acceptance by the dam safety officer.

(3) An owner of a dam must not begin an invasive investigation until a plan referred to in subsection (2) (b) has been accepted by a dam safety officer.

(4) An owner of a dam must ensure that all drilling, trenching, test pit excavations and other invasive activities involved in an invasive investigation are directly supervised by an engineering professional who has qualifications and experience in dam design, construction and analysis.

Removing, decommissioning, deactivating or stopping operation of dam
17 (1) In this section, "restricted activity" means any of the following:
(a) removing all or a significant part of a dam;
(b) decommissioning a dam;
(c) deactivating a dam, or stopping the normal operation of a dam, for a period longer than one year.

(2) An owner of a dam who intends to perform a restricted activity must,
(a) at least 120 days before the date on which the owner expects to begin work on the restricted activity, give to a dam safety officer written notice of the proposed restricted activity, and
(b) at least 90 days before the date on which the owner expects to begin work on the restricted activity,
   (i) prepare a plan, in the form and with the content specified by a dam safety officer, in relation to the activity, and
   (ii) submit the plan to a dam safety officer for acceptance by the dam safety officer.
(3) An owner of a dam must not begin work on a restricted activity until a plan referred to in subsection (2) (b) has been accepted by a dam safety officer.

(4) Without limiting subsection (3), an owner of a dam must notify a dam safety officer of the owner’s intention to begin work on a restricted activity at least 30 days before the date on which the owner expects to begin the work.

(5) An owner of a dam who has performed a restricted activity must submit to a dam safety officer, for acceptance by the dam safety officer, a written report on the work performed and the manner in which it was performed, no later than 60 days after completion of the restricted activity or on or before a later date specified by a dam safety officer.

(6) An owner of a dam who is performing or has performed work in relation to a restricted activity must take such further actions as the comptroller or a water manager orders to mitigate any adverse impact on

(a) a person,
(b) the environment, or
(c) land or other property.

Division 4 — Monitoring and Review of Dam Safety

Site surveillance, formal inspections and tests

18 An owner of a dam must do all of the following:

(a) in order to assess the condition of the dam during the operation of the dam or the alteration or improvement to or replacement of the dam, conduct

(i) a site surveillance of the dam no less frequently than is specified in item 2 of the table in Schedule 2 for the classification of the dam, and
(ii) a formal inspection of the dam no less frequently than is specified in item 3 of the table in Schedule 2 for the classification of the dam;

(b) test, no less frequently than is specified in item 4 of the table in Schedule 2 for the classification of the dam, the operation of

(i) the outlet facilities, spillway gates and other mechanical components of the dam, and
(ii) the electrical and communication equipment relating to the dam;

(c) promptly after an activity described in this section has been performed, record the results of the activity.

Instrumentation

19 (1) An owner of a dam must do all of the following:

(a) install the instrumentation necessary to adequately monitor the dam and the area surrounding or adjacent to the dam;
(b) maintain or replace the instrumentation referred to in paragraph (a) to ensure continuity of readings;
(c) collect readings from the instrumentation referred to in paragraph (a) and analyze and interpret the readings no less frequently than is specified in item 5 of the table in Schedule 2 for the classification of the dam.

(2) An owner of a dam who intends to install, modify, replace or remove instrumentation relating to the dam must submit to a dam safety officer, for acceptance by the dam safety officer,

(a) a record describing the proposed installation, modification, replacement or removal at least 60 days before the date on which the owner expects the installation, modification, replacement or removal to occur, or
(b) an annual plan outlining all installations, modifications, replacements and removals of instrumentation proposed for the following year.

(3) An owner of a dam must not install, modify, replace or remove instrumentation relating to the dam until the record or plan referred to in subsection (2) (a) or (b), as applicable, has been accepted by a dam safety officer.

Dam safety review and report

20 (1) An owner of a dam that has a classification of high, very high or extreme must, no less frequently than is specified in item 9 of the table in Schedule 2 for the classification of the dam,

(a) ensure that an engineering professional who has qualifications and experience in dam safety analysis

(i) carries out a review, in accordance with the requirements of the comptroller or a water manager,

(A) to determine if the dam is safe, and
(B) if it is determined that the dam is not safe, to determine what actions are required to make the dam safe, and
(ii) prepares, in the form and with the content specified by the comptroller or a water manager, a report on the safety of the dam, and
b) submit to a dam safety officer, for acceptance by the dam safety officer, a copy of the report referred to in paragraph (a) (ii).

(2) Despite subsection (1), if the classification of a dam changes to a classification that is more severe in consequence, other than a change from a low classification to a significant classification, an owner of the dam must comply with subsection (1) (a) and (b) on or before December 31 of the calendar year that is 2 years after the calendar year in which the classification changes, unless the comptroller or a water manager specifies another date.

**Division 5 — Information and Records to Be Submitted**

**Information and records to be submitted to dam safety officer**

21 (1) In this section, "inspection", in relation to a dam, includes, without limitation, site surveillance of the dam and a formal inspection of the dam.

(2) An owner of a dam must, on request of a dam safety officer, submit to the dam safety officer, in the form, with the content and on or before the date specified by the dam safety officer, the following records relating to an inspection, test or review carried out in relation to a dam:

a) a record setting out the results of the inspection, test or review;

b) records setting out the data obtained from any test or measurement taken, and analysis and interpretation of the data, including, but not limited to,

i) a record setting out instrumentation readings, and analysis and interpretation of the readings,

ii) visual records or observations,

iii) drawings,

iv) soil, aggregate and concrete test results, and

v) any other test results.

(3) Despite subsection (2), an owner of a dam must promptly submit to a dam safety officer the records referred to in that subsection if an inspection, test or review carried out in relation to the dam reveals hazardous conditions or a potential safety hazard.

(4) A dam safety officer may request an owner of a dam to submit to the dam safety officer any of the following information and records that the dam safety officer considers necessary to evaluate the condition or the hazard potential of the dam and operations and actions at or in connection with the dam:

a) information and records relating to the dam and those operations and actions, including, but not limited to,

i) information and records respecting hydraulic, hydrological, seismic, geological and geotechnical characteristics, conditions and concerns,

ii) foundation investigation results,

iii) design details and as-built drawings,

iv) structural analyses,

v) construction records,

vi) operation manuals,

vii) records relating to instrumentation,

viii) safety reports,

ix) inundation studies, and

x) plans, that have not been previously submitted to a dam safety officer, to be implemented if there is an emergency at the dam;

b) the following records relating to the design or construction of the dam or an alteration to or improvement or replacement of the dam:

i) drawings, including, without limitation, plans and as-built drawings;

ii) design notes and specifications;

iii) hydraulic, hydrological, geological and geotechnical data;

iv) reports and other similar records;

c) information and records, including, without limitation, information and records respecting hydraulic, hydrological, seismic, geological and geotechnical characteristics, conditions and concerns, relating to the following:

i) the nature and use of the land that is in the immediate vicinity of the dam or the reservoir of the dam, downstream of the dam or downslope of the dam;

ii) the nature and use of the stream or aquifer from which the water is being stored or diverted;

d) information relating to the watershed upstream of the dam.

(5) An owner of a dam, must, on receiving a request of a dam safety officer under subsection (4), submit the requested information or record in the form, with the content and on or before the date specified by the dam safety officer.

(6) If information or a record in relation to a dam that is required to be submitted to a dam safety officer under this section does not exist or is otherwise not available for submission, the
comptroller or a water manager may order an owner of the dam to conduct an inspection, investigation, survey or test, or prepare a record in relation to an inspection, investigation, survey or test, that is necessary to provide the information or record.

Part 4 — General

Division 1 — Dams with Multiple Owners

Owners' designate

22 (1) The owners of a dam in respect of which there are 2 or more owners must, on request of a dam safety officer and on or before the date specified by the dam safety officer,
   (a) designate one of the owners for the purposes of receiving, providing and retaining information and records in relation to the dam as required or authorized by this regulation, and
   (b) submit to the dam safety officer the designated owner's name, address and other contact information as required by the dam safety officer.

(2) If the owners of a dam to which subsection (1) applies have not complied with that subsection within the specified time, a dam safety officer may designate one of the owners for the purposes of this section.

(3) An owner of a dam who is designated under this section must, as soon as practicable after the designation, give to each other owner whose address is known to the owner written notice of the designation.

Compliance by any owner satisfies requirement

23 For certainty, if a dam has 2 or more owners, a requirement imposed by this regulation on an owner of the dam is satisfied if any of the owners of the dam complies with the requirement.

Exemption for owner of dam with multiple owners

24 An owner of a dam in respect of which there are 2 or more owners is exempt from the requirements of this regulation in relation to the dam if
   (a) the comptroller is satisfied that proper arrangements have been made for one or more of the other owners to take responsibility for meeting the requirements of this regulation in relation to the dam, and
   (b) either of the following applies in relation to the owner:
      (i) all the owners have agreed that one or more of the other owners acceptable to the comptroller are to be responsible for the dam;
      (ii) the owner holds rights to store not greater than 5% of the quantity of water the storage rights to which are granted under the Act in respect of the dam.

Division 2 — Records

Submission of records to and acceptance of records by dam safety officer

25 (1) A record that under this regulation must or may be submitted to a dam safety officer must be submitted in the manner specified by the dam safety officer.

(2) If a record submitted under this regulation by an owner of a dam to a dam safety officer for acceptance by the dam safety officer
   (a) is not in the form or does not contain the content required under this regulation, or
   (b) if there are no requirements under this regulation as to the form or content of the record, is not acceptable in form or content to the dam safety officer,
   the dam safety officer may give to the owner written notice advising that the record has not been accepted, specifying the deficiencies in the record and requiring that they be rectified.

(3) If a dam safety officer gives notice to an owner of a dam under subsection (2) in relation to a record,
   (a) the owner must promptly rectify the deficiencies specified in the notice, and
   (b) the dam safety officer is not required to accept the record until the owner has rectified the deficiencies specified in the notice.

(4) If a dam safety officer accepts a record that was submitted under this regulation to the dam safety officer for acceptance, the dam safety officer must give written notice of the acceptance to the owner of the dam who submitted the record.

(5) For the purposes of this regulation, a record relating to a dam is accepted by a dam safety officer when the dam safety officer gives notice under subsection (4) in relation to the record.

Retention of records
26 (1) For the purposes of section 116 (1) [records and reporting] of the Act, each person who is or was an owner of a dam must keep information or a record described in section 116 (1) (a), (b) or (c) of the Act that relates to the dam for the period between

(a) the date on which the information or record is obtained or prepared by the person, and
(b) the date that is 10 years after the date on which written notice is given to a dam safety officer, by a person who is an owner of the dam when the dam is decommissioned, stating that the decommissioning of the dam is complete and the dam has been completely removed.

(2) Subsection (1) does not apply to a person in relation to information or a record if another person has been designated under section 22 [owners’ designate] for the purpose of retaining the information or record.

(3) For the purposes of section 116 (1) (b) of the Act, an owner of a dam must, in addition to the records referred to in section 116 (1) (a) or (c) of the Act, keep all other information and records in relation to the dam that, under this regulation, the owner is, or may be, required to submit to the comptroller, a water manager, an engineer or a dam safety officer.

Division 3 — Advice of Independent Expert

Advice of independent expert may be required

27 (1) If the comptroller or a water manager considers it advisable to obtain independent expert advice in relation to an issue respecting a dam or works relating to a dam, the comptroller or water manager may order an owner of the dam to retain an independent expert, satisfactory to the comptroller or water manager, who has qualifications and experience described in subsection (2), to prepare a written report on resolving the issue.

(2) An independent expert retained under subsection (1) must have the following qualifications and experience:

(a) in the case of an issue respecting a dam, qualifications and experience in dam design, construction and analysis or in dam operation and maintenance, as appropriate; 
(b) in the case of an issue respecting works relating to a dam, qualifications and experience in hydraulic, hydrological, geological, geotechnical, mechanical or structural engineering or other discipline, as appropriate.

(3) An owner of a dam who is ordered by the comptroller or a water manager to retain an independent expert under subsection (1) must submit to the comptroller or water manager a copy of the written report referred to in that subsection promptly after the owner receives the report.

Division 4 — Offences

General offences

28 (1) An owner of a dam who does any of the following commits an offence:

(a) fails to determine under section 3 (1) (a) [dam failure consequences classification], or redetermine under section 3 (2) (a), the classification of the dam as and when required to do so;
(b) fails to submit to a dam safety officer a record under section 3 (1) (b) setting out a proposed classification for the dam, or a record under section 3 (2) (b) setting out a proposed new classification for the dam, as and when required to do so;
(c) fails to properly inspect, maintain or repair the dam or related works contrary to section 5 (1) [responsibility of owner for dam condition and safety];
(d) fails to exercise reasonable care to avoid the risk of significant harm as required under section 5 (2);
(e) fails to exercise reasonable care to safeguard the dam from unauthorized operation contrary to section 6 [prevention of unauthorized operation].

(2) An owner of a dam who does any of the following commits an offence:

(a) fails to review or revise the operation, maintenance and surveillance manual for the dam as and when required to do so under section 8 (4) (a) or (5) [operation, maintenance and surveillance manual] or 13 (3) (a) [requirements if alteration or improvement to or replacement of dam];
(b) fails to submit to a dam safety officer the applicable record in relation to a review of the operation, maintenance and surveillance manual for the dam as and when required to do so under section 8 (4) (b) or (5) or 13 (3) (b);
(c) fails to follow the operation, maintenance and surveillance manual for the dam contrary to section 8 (6);
(d) fails to deliver a record to a local emergency authority for the dam as and when required to do so under section 9 (6) or (10) [dam emergency plan] or section 10 (4) (b) (ii) [record identifying emergency contact];
(e) fails to review or revise the emergency plan for the dam as and when required to do so under section 9 (7) (a), (8) (a) or (9) or 13 (3) (a);
(f) fails to submit to a dam safety officer the applicable record in relation to a review of the emergency plan for the dam as and when required to do so under section 9 (7) (b), (8) (b) or (9) or 13 (3) (b);
(g) fails to comply with section 10 (1) (a), (b) or (c) on or before the date specified by a dam safety officer contrary to section 10 (3);
(h) fails to review or revise the record setting out the name and contact information for the emergency contact for the dam as and when required to do so under section 10 (4) (a);
(i) fails to submit to a dam safety officer the applicable record in relation to a review of the record referred to in paragraph (h) as and when required to do so under section 10 (4) (b) (i);
(j) contravenes section 11 [signs must be posted].

(3) An owner of a dam who does any of the following commits an offence:
(a) fails to submit to a dam safety officer a written report or other record as and when required to do so under section 13 (1), 14 (2) [hazardous conditions], 15 (2) [potential safety hazard] or 17 (5) [removing, decommissioning, deactivating or stopping operation of dam];
(b) fails to notify a dam safety officer of a potential safety hazard in relation to the dam as and when required to do so under section 15 (1) (a);
(c) fails to give notice of a proposed activity in relation to the dam as and when required to do so under section 16 (2) (a) [invasive investigations] or 17 (2) (a) or (4);
(d) fails to prepare or submit to a dam safety officer a plan for an activity in relation to the dam as and when required to do so under section 15 (1) (b) (i) or (ii), 16 (2) (b) (i) or (ii) or 17 (2) (b) (i) or (ii);
(e) fails to implement a plan in relation to a potential safety hazard at the dam as and when required to do so under section 15 (1) (c);
(f) begins an activity referred to in section 16 or 17 in relation to the dam before a plan respecting the activity has been accepted by a dam safety officer contrary to section 16 (3) or 17 (3), as applicable;
(g) fails to ensure that an invasive activity is directly supervised by an engineering professional who has qualifications and experience as required under section 16 (4).

(4) An owner of a dam who does any of the following commits an offence:
(a) fails to conduct a site surveillance of the dam as and when required to do so under section 18 (a) (i) [site surveillance, formal inspections and tests];
(b) fails to conduct a formal inspection of the dam as and when required to do so under section 18 (a) (ii);
(c) fails to test the operation of mechanical components of the dam as and when required to do so under section 18 (b) (i);
(d) fails to test the operation of electrical or communication equipment relating to the dam as and when required to do so under section 18 (b) (ii);
(e) fails to record the results of an activity referred to in paragraph (a), (b), (c) or (d) when required to do so under section 18 (c);
(f) fails to install, maintain or replace instrumentation relating to the dam as required under section 19 (1) (a) or (b) [instrumentation];
(g) fails to collect, analyze or interpret readings from instrumentation relating to the dam as and when required to do so under section 19 (1) (c);
(h) fails to submit to a dam safety officer a record or a plan for a proposed installation, modification, replacement or removal of instrumentation relating to the dam as and when required to do so under section 19 (2);
(i) installs, modifies, replaces or removes instrumentation relating to the dam before the notice or plan referred to in paragraph (h) has been accepted by a dam safety officer contrary to section 19 (3);
(j) fails to ensure that an engineering professional who has qualifications and experience as required under section 20 (1) [dam safety review and report] carries out a review of, and prepares a report on, the safety of the dam as and when required to do so under section 20 (1) (a) or (2);
(k) fails to submit to a dam safety officer the report referred to in paragraph (j) as and when required to do so under section 20 (1) (b) or (2);
(l) fails to submit to a dam safety officer information or a record in relation to the dam as and when required to do so under section 21 (2), (3) or (5) [information and records to be submitted to dam safety officer];

(m) fails to submit to the comptroller or a water manager a copy of a report of an independent expert in relation to the dam as and when required to do so under section 27 (3) [advice of independent expert may be required].

(5) An owner of a dam who commits an offence under this section is liable on conviction to the following:

(a) in the case of an offence that is not a continuing offence, a fine of not more than $200 000 or imprisonment for not longer than 6 months, or both;

(b) in the case of a continuing offence, a fine of not more than $200 000 for each day the offence is continued or imprisonment for not longer than 6 months, or both.

High penalty offences

29 (1) An owner of a dam who does any of the following commits an offence:

(a) fails to follow the emergency plan for the dam contrary to section 14 (1) (a) [hazardous conditions];

(b) fails to operate the dam or initiate a remedial action at the dam contrary to section 14 (1) (b);

(c) fails to inform or advise a person or other entity respecting hazardous conditions in relation to the dam contrary to section 14 (1) (c) or (d);

(d) fails to inform the comptroller, a water manager or a dam safety officer respecting hazardous conditions in relation to the dam as and when required to do so under section 14 (1) (e).

(2) An owner of a dam who commits an offence under this section is liable on conviction to the following:

(a) in the case of an offence that is not a continuing offence, a fine of not more than $1 000 000 or imprisonment for not longer than one year, or both;

(b) in the case of a continuing offence, a fine of not more than $1 000 000 for each day the offence is continued or imprisonment for not longer than one year, or both.

Part 5 — Transition

Definition of previously unregulated dam

30 In this Part, “previously unregulated dam” means a dam

(a) to which, immediately before February 29, 2016, the former regulation did not apply, and

(b) to which Part 3 [Requirements Applicable to Certain Dams] of this regulation applies.

Transition — dam failure consequences classification

31 (1) If, immediately before February 29, 2016, the former regulation did not apply in relation to a dam, an owner of the dam must, on or before December 31, 2016,

(a) determine the classification of the dam in accordance with section 2 [determination of classification] of Schedule 1, and

(b) submit to a dam safety officer, immediately after the determination is completed, a record setting out a proposed classification for the dam.

(2) Section 3 (4), (5), (8) and (9) [dam failure consequences classification] applies in relation to a dam described in subsection (1) of this section as if it were a dam described in section 3 (1).

(3) An owner of a dam who, in 2015, conducted a review of conditions downstream of the dam under section 6.1 of the former regulation must begin complying with section 3 (2) of this regulation in 2016.

(4) An owner of a dam who, between January 1, 2016 and February 28, 2016, conducted a review of conditions downstream of the dam under section 6.1 of the former regulation must begin complying with section 3 (2) of this regulation in 2017.

(5) If, immediately before February 29, 2016, section 6.1 of the former regulation applied in relation to a dam and a review of conditions downstream of the dam was not conducted under that section between January 1, 2015 and February 28, 2016, an owner of the dam must comply with section 3 (2) of this regulation on or before March 31, 2016.

(6) Section 3 (4), (6), (8) and (9) applies in relation to a dam described in subsection (3), (4) or (5) of this section as if it were a dam described in section 3 (2).

(7) The classification of a dam to which the former regulation applied immediately before February 29, 2016 continues, for the purposes of this regulation, to be the classification of the dam under the former regulation until the date on which the classification is determined in accordance with this section.

Transition — operation, maintenance and surveillance manual
(1) An owner of a previously unregulated dam that has a classification of significant, high, very high or extreme must comply with section 8 (1) (a) and (b) [operation, maintenance and surveillance manual] within one year after the date on which a dam safety officer gives notice to an owner of the dam that the dam safety officer accepts a proposed classification for the dam under section 31.

(2) If, between January 1, 2006 and December 31, 2015, an operation, maintenance and surveillance manual was submitted to a dam safety officer under section 3 (2) (b) of the former regulation in relation to a dam that has a classification of very high, and subsection (3) of this section does not apply in relation to the dam, an owner of the dam need not comply with section 8 (4) (a) and (b) of this regulation in respect of the first review of the operation, maintenance and surveillance manual until the calendar year that is 10 years after the calendar year that includes the date on which the operation, maintenance and surveillance manual was submitted to the dam safety officer under section 3 (2) (b) of the former regulation.

(3) If the most recent review of the operation, maintenance and surveillance manual for a dam that has a classification of very high was completed under section 3 (3.1) of the former regulation between January 1, 2006 and December 31, 2015, an owner of the dam need not comply with section 8 (4) (a) and (b) of this regulation in respect of the immediately following review of the operation, maintenance and surveillance manual until the calendar year that is 10 years after the calendar year that includes the date on which the most recent review of the operation, maintenance and surveillance manual was completed under section 3 (3.1) of the former regulation.

Transition — dam emergency plan

(1) An owner of a previously unregulated dam that has a classification of significant, high, very high or extreme must comply with section 9 (1) (a) and (b) [dam emergency plan] within one year after the date on which a dam safety officer gives notice to an owner of the dam that the dam safety officer accepts a proposed classification for the dam under section 31 [transition — dam failure consequences classification].

(2) Despite section 9, if, immediately before February 29, 2016, there was, under the former regulation, an emergency preparedness plan for a dam, an owner of the dam must, on or before March 31, 2017,

(a) review and, if necessary, revise the plan to ensure that it contains the record described in section 9 (1) (a) (ii),
(b) submit to a dam safety officer, for acceptance by the dam safety officer,
( (i) a record setting out the revisions, if any, or
(ii) a written report advising that no revisions are necessary, and
(c) deliver a copy of the record described in section 9 (1) (a) (ii) to each local emergency authority for the dam.

(3) If, between January 1, 2006 and December 31, 2015, an emergency preparedness plan was submitted to a dam safety officer under section 3.1 (1) (b) of the former regulation in relation to a dam that has a classification of very high, and subsection (4) of this section does not apply in relation to the dam, an owner of the dam need not comply with section 9 (8) (a) and (b) of this regulation in respect of the first review of the emergency plan for the dam until the calendar year that is 10 years after the calendar year that includes the date on which the emergency preparedness plan was submitted to the dam safety officer under section 3.1 (1) (b) of the former regulation.

(4) If the most recent review of the emergency preparedness plan for a dam that has a classification of very high was completed under section 3.1 (3) of the former regulation between January 1, 2006 and December 31, 2015, an owner of the dam need not comply with section 9 (8) (a) and (b) of this regulation in respect of the immediately following review of the emergency plan for the dam until the calendar year that is 10 years after the calendar year that includes the date on which the most recent review of the emergency preparedness plan was completed under section 3.1 (3) of the former regulation.

Transition — record identifying emergency contact

An owner of a dam, other than a newly constructed dam, need not comply with section 10 [record identifying emergency contact] until March 31, 2017.

Transition — signs

An owner of a previously unregulated dam need not comply with section 11 [signs must be posted] until October 1, 2016.

Transition — monitoring and review of dam safety

(1) For the purposes of section 18 (a) [site surveillance, formal inspections and tests], an owner of a previously unregulated dam must, on or before November 1, 2016,

(a) begin site surveillance of the dam, and
(b) conduct the first formal inspection of the dam.
(2) For the purposes of section 18 (b), an owner of a previously unregulated dam must, on or before November 1, 2016, conduct the first tests of the operation of
(a) the outlet facilities, spillway gates and other mechanical components of the dam, and
(b) the electrical and communication equipment relating to the dam.

(3) For the purposes of section 19 (1) (c) [instrumentation], an owner of a previously unregulated dam must, on or before November 1, 2016, begin collecting, analyzing and interpreting readings from the instrumentation relating to the dam.

(4) An owner of a previously unregulated dam that has a classification of high, very high or extreme must comply with section 20 (1) (a) and (b) [dam safety review and report] within 5 years after the date on which a dam safety officer gives notice to an owner of the dam that the dam safety officer accepts a proposed classification for the dam under section 31 [transition — dam failure consequences classification].

Transition — general offences
37 (1) An owner of a dam who does any of the following commits an offence:
(a) fails to determine under section 31 (1) (a) [transition — dam failure consequences classification] or redetermine under section 31 (3), (4) or (5) the classification of the dam as and when required to do so;
(b) fails to submit to a dam safety officer a record under section 31 (1) (b) setting out a proposed classification for the dam, or a record under section 31 (3), (4) or (5) setting out a proposed new classification for the dam, as and when required to do so;
(c) fails to prepare an operation, maintenance and surveillance manual for the dam as and when required to do so under section 32 (1) [transition — operation, maintenance and surveillance manual];
(d) fails to submit to a dam safety officer the operation, maintenance and surveillance manual for the dam as and when required to do so under section 32 (1);
(e) fails to prepare an emergency plan for the dam as and when required to do so under section 33 (1) [transition — dam emergency plan];
(f) fails to submit to a dam safety officer the emergency plan for the dam as and when required to do so under section 33 (1);
(g) fails to review or revise the emergency plan for the dam as and when required to do so under section 33 (2) (a);
(h) fails to submit to a dam safety officer the applicable record in relation to a review of the emergency plan for the dam as and when required to do so under section 33 (2) (b);
(i) fails to deliver a record to a local emergency authority for the dam as and when required to do so under section 33 (2) (c).

(2) An owner of a dam who does any of the following commits an offence:
(a) fails to conduct a site surveillance of the dam as and when required to do so under section 36 (1) (a);
(b) fails to conduct a formal inspection of the dam as and when required to do so under section 36 (1) (b);
(c) fails to test the operation of mechanical components of the dam as and when required to do so under section 36 (2) (a);
(d) fails to test the operation of electrical or communication equipment relating to the dam as and when required to do so under section 36 (2) (b);
(e) fails to collect, analyze or interpret readings from instrumentation relating to the dam as and when required to do so under section 36 (3);
(f) fails to ensure that an engineering professional who has qualifications and experience as required under section 20 (1) [dam safety review and report] carries out a review of, and prepares a report on, the safety of the dam as and when required to do so under section 36 (4);
(g) fails to submit to a dam safety officer the report referred to in paragraph (f) as and when required to do so under section 36 (4).

(3) A person who commits an offence under this section is liable on conviction to the following:
(a) in the case of an offence that is not a continuing offence, a fine of not more than $200 000 or imprisonment for not longer than 6 months, or both;
(b) in the case of a continuing offence, a fine of not more than $200 000 for each day the offence is continued or imprisonment for not longer than 6 months, or both.

Schedule 1
(sections 3 (1) and (2) and 31 (1))
Dam Classification
Definitions
1 In this Schedule:

"category", in relation to consequences of failure, means one of the following:
(a) loss of life;
(b) environmental and cultural values;
(c) infrastructure and economics;

"consequences of failure" means losses or damages that are caused by a failure of a dam;
"failure", in relation to a dam, means an uncontrolled release of all or part of the water impounded by the dam, whether or not caused by a collapse of the dam.

Determination of classification
2 (1) For the purposes of this regulation, the classification of a dam is to be determined in accordance with the following steps:

(a) for each category of consequences of failure in columns 3, 4 and 5 of the table, identify the losses or damages specified in the applicable column that most closely describe the losses or damages that are the most severe potential consequences of a failure of the dam;
(b) identify the dam failure consequences classification that is specified in column 1 of the table for the losses or damages referred to in paragraph (a) for each category;
(c) the dam failure consequences classification identified under paragraph (b) with the most severe potential consequences is the classification of the dam.

(2) For the purposes of identifying the consequences of failure in column 3 of the table, the descriptions in column 2 of the table of the population of individuals that may be at risk if there were a failure of the dam are to be considered.

<table>
<thead>
<tr>
<th>Item</th>
<th>Column 1</th>
<th>Column 2</th>
<th>Column 3</th>
<th>Column 4</th>
<th>Column 5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Dam failure consequences classification</td>
<td>Population at risk</td>
<td>Loss of life</td>
<td>Environmental and cultural values</td>
<td>Infrastructure and economics</td>
</tr>
<tr>
<td>1</td>
<td>low</td>
<td>none(^1)</td>
<td>no possibility of loss of life other than through unforeseeable misadventure</td>
<td>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, (c) unique landscapes, or (d) sites having significant cultural value</td>
<td>minimal economic losses mostly limited to the dam owner's property, with virtually no pre-existing potential for development within the dam inundation zone</td>
</tr>
<tr>
<td>2</td>
<td>significant</td>
<td>temporary only(^2)</td>
<td>low potential for multiple loss of life</td>
<td>no significant loss or deterioration of (a) important fisheries habitat or important wildlife habitat, (b) rare or endangered species, (c) unique landscapes, or (d) sites having significant cultural value, and restoration or compensation in kind is highly possible</td>
<td>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</td>
</tr>
<tr>
<td>3</td>
<td>high</td>
<td>permanent(^3)</td>
<td>10 or fewer</td>
<td>significant loss or deterioration of (a) important fisheries habitat or important wildlife habitat, (b) rare or endangered species, (c) unique landscapes, or (d) sites having significant cultural value, and restoration or compensation in kind is highly possible</td>
<td>high economic losses affecting infrastructure, public transportation or services or commercial facilities, or some destruction of or some severe damage to scattered residential buildings</td>
</tr>
<tr>
<td>4</td>
<td>very high</td>
<td>permanent(^3)</td>
<td>100 or fewer</td>
<td>significant loss or deterioration of</td>
<td>very high economic</td>
</tr>
</tbody>
</table>
(a) critical fisheries habitat or critical wildlife habitat, (b) rare or endangered species, (c) unique landscapes, or (d) sites having significant cultural value, and restoration or compensation in kind is possible but impractical.

5. extreme permanent permanent more than 100 major loss or deterioration of (a) critical fisheries habitat or critical wildlife habitat, (b) rare or endangered species, (c) unique landscapes, or (d) sites having significant cultural value, 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.

1. There is no identifiable population at risk.
2. 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.
3. The population at risk is ordinarily or regularly located in the dam-breach inundation zone, whether to live, work or recreate.

**Schedule 2**
*(sections 3 (2), 8 (4), 9 (7) and (8), 10 (4), 18, 19 (1) and 20 (1))*

### Minimum Frequency of Safety Activities

#### Interpretation of Schedule

1. In this Schedule:
   - "annually" means once in each calendar year;
   - "dam safety review" means a review carried out by an engineering professional under section 20 [dam safety review and report];
   - "DEP" means the emergency plan for a dam;
   - "DSO" means a dam safety officer;
   - "monthly" means once in each calendar month;
   - "OMS manual" means the operation, maintenance and surveillance manual for a dam;
   - "quarterly" means once in each calendar quarter;
   - "semi-annually" means once in the period between January 1 and June 30 and once in the period between July 1 and December 31 of each calendar year.

#### Frequency of activities

2. (1) Column 1 of the table sets out an activity that must be carried out by an owner of a dam under Part 2 [Requirements Applicable to All Dams] or 3 [Requirements Applicable to Certain Dams], as indicated in the table, and column 2, 3, 4, 5 or 6 of the table sets out the minimum frequency with which the activity must be carried out for each classification.

   (2) If the minimum frequency with which an activity referred to in column 1 of the table must be carried out under subsection (1) is every 7 years or every 10 years, the minimum frequency is once in the period between the date on which the activity was previously carried out and December 31 of the calendar year that is 7 years or 10 years, as the case may be, after the calendar year that includes the date on which the activity was previously carried out.

#### Table

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<tr>
<th>Item</th>
<th>Column 1</th>
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<th>Column 4</th>
<th>Column 5</th>
<th>Column 6</th>
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</thead>
<tbody>
<tr>
<td>Activity</td>
<td>Frequency of Activity</td>
<td>Extreme classification</td>
<td>Very high classification</td>
<td>High classification</td>
<td>Significant classification</td>
<td>Low classification</td>
</tr>
<tr>
<td>1 redetermine classification of dam and, if necessary submit to DSO written notice of proposed new classification</td>
<td>annually</td>
<td>annually</td>
<td>annually</td>
<td>annually</td>
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<td>Requirements under Part 3</td>
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<td>2</td>
<td>conduct site surveillance weekly unless otherwise specified in the OMS manual</td>
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<td>conduct formal inspection semi-annually</td>
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<td>4</td>
<td>test operation of (a) mechanical components of dam, and (b) electrical and communication equipment annually unless otherwise specified in the OMS manual annually unless otherwise specified in the OMS manual annually unless otherwise specified in the OMS manual annually unless otherwise specified in the OMS manual annually</td>
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<td>collect readings from instrumentation and analyze and interpret the readings annually unless otherwise specified in the OMS manual annually unless otherwise specified in the OMS manual annually unless otherwise specified in the OMS manual annually unless otherwise specified in the OMS manual annually unless otherwise specified in the OMS manual annually unless otherwise specified in the OMS manual annually unless otherwise specified in the OMS manual annually unless otherwise specified in the OMS manual annually unless otherwise specified in the OMS manual annually unless otherwise specified in the OMS manual annually unless otherwise specified in the OMS manual annually unless otherwise specified in the OMS manual annually unless otherwise specified in the OMS manual annually unless otherwise specified in the OMS manual annually unless otherwise specified in the OMS manual annually unless otherwise specified in the OMS manual annually unless otherwise specified in the OMS manual annually unless otherwise specified in the OMS manual annually unless otherwise specified in the OMS manual annually unless otherwise specified in the OMS manual annually unless otherwise specified in the OMS manual annually unless otherwise specified in the OMS manual annually unless otherwise specified in the OMS manual annually unless otherwise specified in the OMS manual annually unless otherwise specified in the OMS manual annually unless otherwise specified in the OMS manual annually unless otherwise specified in the OMS manual annually unless otherwise specified in the OMS manual annually unless otherwise specified in the OMS manual annually unless otherwise specified in the OMS manu</td>
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<td>review contact information in DEP, revise if necessary and report to DSO annually</td>
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<td>7</td>
<td>review emergency contact information and, if necessary, revise and submit revision to DSO not applicable not applicable not applicable not applicable annually</td>
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<td>8</td>
<td>review OMS manual and DEP, revise if necessary and report to DSO every 7 years every 7 years every 10 years every 10 years not applicable</td>
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<td>9</td>
<td>ensure dam safety review carried out and submit report to DSO every 7 years every 10 years every 10 years not applicable not applicable</td>
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GUIDANCE MANUAL - DEFINITIONS
SECTION 1
DEFINITIONS

Abutment
That part of the valley side against which the dam is constructed.

Appurtenances
Structures and equipment on a project site, other than the embankment itself. They include, but are not limited to facilities, such as spillways, log booms, intake towers, powerhouse structures, tunnels, canals, penstocks, low-level outlets, surge tanks and towers, gate hoist mechanisms and their supporting structures, and all critical water control and release facilities. Also included are mechanical and electrical control and stand-by power supply equipment located in the powerhouse or in remote control centers.

Breach of Dam
The uncontrolled release of the contents of a reservoir through collapse of the dam or appurtenant structures.

Comptroller
A person employed by the government and designated in writing by the minister as the Comptroller of Water Rights and includes any persons designated in writing by the minister as acting, deputy or assistant comptrollers.

Consequences of Dam Failure
Impacts in the downstream as well as upstream areas of the dam resulting from failure of the dam or its appurtenances. Refer to Schedule 1 of the Dam Safety Regulation.

Crest of Dam
Elevation of the uppermost surface of a dam proper, not taking into account any camber allowed for settlement, curbs, parapets, guard rails or other structures that are not a part of the main water-retaining structure. This elevation may be roadway, walkway or the non-overflow section of a dam.

Dam
A man made barrier that would create a water storage reservoir or divert water. “Dam” is herein defined to include works (appurtenances) incidental to, necessary for, or in connection with, the barrier.

Dam Owner
A person, including a company, organization, government unit, public utility, corporation or other entity, which either holds a water licence to operate a dam or retains the legal property title on the dam site, dam and/or reservoir, or a person who acts as the principal agent of the dam owner and which is responsible for the safety of the dam.

Dam Safety Officer
An engineer or officer who is designated in writing by the comptroller as a dam safety officer.

Binder Note: DSO

Binder Note: Water Sustainability Act

Dam Safety Regulation
Means the British Columbia Dam Safety Regulation passed into law under the Water Act whose objective is to mitigate loss of life and damage to property and the environment from a dam breach by requiring dam owners to inspect their own dams, undertake proper maintenance on them, and ensure that these dams meet ongoing engineering standards.
**Section 1 - Definitions**

- **Dam Safety Review**: Comprehensive formal review carried out at scheduled intervals to determine whether an existing dam is safe, and if it is not safe, to determine what improvements are required. *Binder Note: A Dam safety Review can be an Audit Style*

- **Drawdown**: The resultant lowering of water surface level due to controlled release of water from the reservoir.

- **Earthfill Dam**: See “Embankment Dam”.

- **Embankment Dam**: Any dam constructed of natural excavated materials placed without addition of binding materials other than those inherent in the natural material. The materials are usually obtained at or near the dam site. Embankment dams are usually referred to by type such as Earthfill or Rockfill. The term Embankment Dam is used to indicate a zoned fill dam involving selected areas of rock, gravel and impervious zones or a homogeneous earthfill dam which is not necessarily zoned.

- **EMBC**: See PEP

- **Emergency**: In terms of dam operation, any condition which develops naturally or unexpectedly, endangers the integrity of the dam and upstream or downstream property or life, and requires immediate action.

- **Dam Emergency Plan (DEP)**: Document which contains procedures for dealing with various emergencies, as well as communication directories and may contain inundation maps showing upstream and downstream water levels and times of arrival of floods which would result from the failure of the dam or its appurtenances.

- **Engineer**: A professional engineer employed by the government and designated in writing by the Comptroller of Water Rights as an engineer and includes a regional water manager.

- **Failure of Dam**: In terms of structural integrity, the uncontrolled release of the contents of a reservoir through collapse of the dam or some part of it; in terms of performance to fulfil its intended function, the inability of a dam to perform functions such as water supply or prevention of excessive seepage.

- **Formal Inspection**: An inspection of the dam to observe its condition. A formal inspection is intended to be more thorough than a routine surveillance inspection. These inspections are carried out by the appropriate representative of the dam owner responsible for safety surveillance (i.e. the dam owner or owners engineering consultant).

- **Foundation**: Rock and/or soil mass that forms a base for the structure, including it abutments.

- **Freeboard**: Vertical distance between the dam crest and the reservoir water surface. The more specific term “normal (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). The term
<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
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<tbody>
<tr>
<td><strong>Minimum (Net) Freeboard</strong></td>
<td>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.</td>
</tr>
<tr>
<td><strong>Full Supply Level</strong></td>
<td>Maximum normal operating water surface level of a reservoir (also called maximum normal reservoir water level). Generally the spillway sill elevation.</td>
</tr>
<tr>
<td><strong>Gate</strong></td>
<td>A general term for any mechanical device to control the flow of water in intakes, outlet works and over controlled spillways.</td>
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</tbody>
</table>
| **Height of Dam**                         | The vertical distance to the top (crest) of a dam measured:  
  a) in the case of a stream across a stream, from the natural bed of the stream at the downstream outside limit of the dam, or  
  b) in the case of a dam that is not across a stream, from the lowest elevation at the outside limit of the dam.                                                                                                                                                                                                 |
| **Homogeneous Earthfill Dam**             | An embankment type dam constructed of more or less uniform earth materials throughout, except for possible inclusion of internal drains or blanket drains. Used to differentiate this type of dam from a zoned earthfill dam.                                                                                                           |
| **Inspection**                            | See “Formal Inspection” & “Surveillance Inspection”                                                                                                                                                                                                                                                                                             |
| **Instrumentation**                       | Devices which are installed in or near a dam to monitor the dam and impoundment. These devices may include but are not limited to survey monuments and stations, inclinometers, extensometers, piezometers, measuring weirs.                                                                                                                     |
| **Internal Drain or Drainage Blanket**    | A layer of pervious material in a dam to facilitate drainage.                                                                                                                                                                                                                                                                                   |
| **Internal (piping) Erosion**             | The progressive erosion of material from within a dam caused by seepage, appearing downstream as a hole or seam discharging water that contains solid particles.                                                                                                                                                                                                |
| **Log-Boom**                              | A series of floating logs connected (preferably with boom chain) end to end, and placed on the reservoir surface at a line just upstream of the dam in order to collect trash, ice and floating debris and prevent their entrance to spillway or outlet works.                                                                                           |
| **Low-Level Outlet**                      | A conduit through the dam to allow for controlled release of the reservoir contents. Also see “Outlet Works”.                                                                                                                                                                                                                                       |
| **Maintenance**                           | Those tasks accepted as routine in keeping the dam and appurtenant works in a serviceable condition. It is not to be confused with alterations.                                                                                                                                                                                                       |
| **Outlet Gate**                           | See “Gate”.                                                                                                                                                                                                                                                                                                                                   |
| **Outlet Works** | Combination of intake structure, gates, conduits, tunnels, flow controls and energy dissipation devices to allow the release of water from a dam. |
| **Owner** | See “Dam Owner” |
| **Piping** | See “Internal Erosion”. |
| **Professional Engineer** | A person who is registered or licenced 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; A person employed by the Crown and designated in writing by the minister as a regional water manager and includes 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. |
| **Repair** | To essentially restore a dam to its approved design condition. Many older dams may be required to be upgraded to current design standards if there is a difference between the initial approved design and current design standards. |
| **Reservoir** | Water body impounded by one or more dams, inclusive of its shores and banks and of any facility or installation necessary for its operation. |
| **Right Abutment** | The abutment on the right-hand side of an observer when looking downstream. |
| **Riprap** | Layered broken (angular) rock or precast blocks, generally placed on the upstream slopes of an embankment or along a water course as protection against wave action, erosion or scour. Riprap should be properly placed by mechanical methods and in some cases is hand placed. It consists of pieces of relatively large size as distinguished from a gravel blanket. |
| **Rockfill Dam** | See “Embankment Dam”. |
| **Safe Dam** | Dam which does not impose an unacceptable risk to people or property, and which meets safety criteria that are acceptable to the government, the engineering profession and the public. |
| **SCADA** | Acronym for Supervisory Control and Data Acquisition, a computer system for gathering and analyzing real time data. SCADA systems can be used to monitor and control various components of a dam. |

**Section 1 - Definitions**
<table>
<thead>
<tr>
<th>Term</th>
<th>Description</th>
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<tr>
<td>Spillway</td>
<td>Weir, channel, conduit, tunnel, gate or other structure designed to permit discharges from the reservoir.</td>
</tr>
<tr>
<td>Spillway Sill</td>
<td>The control level of the spillway overflow section.</td>
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<tr>
<td>Stoplogs</td>
<td>Large logs, timbers, concrete or steel beams stacked vertically on each other so as to close off entrance to dam outlets or penstocks. Normally stoplogs are used intermittently as temporary outlet gates in order to effect repairs or replacements to the permanent facilities.</td>
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<tr>
<td>Storage</td>
<td>The collection, impounding and conservation of water. Type of storage are:</td>
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<tr>
<td>Natural Storage</td>
<td>what is/was the natural body of water (i.e. the existing lake or pond).</td>
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<tr>
<td>Dead Storage</td>
<td>created storage not accessible with the permanent outlet works. This is normally between the upstream toe and the outlet sill. It may include what was natural storage if the toe of the dam is constructed below the natural lake outlet.</td>
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<td>Live Storage</td>
<td>the accessible storage, typically from low level outlet sill to spillway sill.</td>
</tr>
<tr>
<td>Licence Storage</td>
<td>typically includes dead storage plus live storage.</td>
</tr>
<tr>
<td>Surcharge Storage</td>
<td>typically from the spillway sill to design flood level.</td>
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<tr>
<td>Tailwater Level</td>
<td>Level of water in the discharge channel immediately downstream of a dam.</td>
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<td>Toe of Dam</td>
<td>Junction of the downstream (or upstream) face of dam with the ground surface (foundation). Sometimes “heel” is used to define the upstream toe of a concrete gravity dam.</td>
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<td>Top of Dam</td>
<td>See “Crest of Dam”.</td>
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<td>Trashrack</td>
<td>A screen or grill structure placed at the inlet end of penstocks and low level outlets to prevent the entrance of logs, timbers, trash or other debris from the reservoir.</td>
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<tr>
<td>Surveillance Inspection</td>
<td>An inspection performed by the dam owner as a regular part of their routine maintenance activities.</td>
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<tr>
<td>Works</td>
<td>Anything capable of or used for diverting, storing, measuring, conserving, conveying, retarding, confining or using water, or producing, measuring, transmitting or using electricity.</td>
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<tr>
<td>Zoned Earthfill Dam</td>
<td>See “Embankment Dam”.</td>
</tr>
</tbody>
</table>
Typical Features of an Embankment Dam
GUIDANCE MANUAL – BACKGROUND
1. **What is a Dam?**

Simply stated, a dam is a man made barrier constructed for the purpose of storing water. Commonly used dam related terminology can be found in Section 1, Definitions, located at the beginning of this guide book.

The two most common types of dams constructed around the world are embankment dams and concrete dams. The majority of the approximately 2600 dams constructed in British Columbia are earthfill embankment dams.

A dam consists of a variety of different components, each having its own unique potential problem area and inspection requirement. The main components that make up a dam include: earth or concrete barrier, abutments, foundation, outlet, spillway and gates. See Figure No. 1 for the principle parts of a dam, Figure No. 2 for a typical cross section and Figure No. 3 for a typical catchment area.

2. **Why should a Dam Owner have a Dam Safety Program?**

Dams, by their very nature, create risks. Although these risks may be minimal, they can increase substantially without proper maintenance. Many subtle signs which can be symptomatic of larger problems may go unnoticed for a variety of reasons. Sooner or later these problems will become apparent even to the untrained eye. However, by the time a problem has progressed to this point, potential risk has greatly increased and repairs can become complex and extremely expensive. In most situations a Dam Safety Program that includes regular preventative maintenance, routine surveillance inspections, and the identification of problems in their early stages will ensure that the dam remains in good operating condition.
3. Who is Responsible for Dam Safety?

In all cases, dam owners are clearly responsible for the safe operation and maintenance of their dams. English common law, on which our legal system is based, considers dams to be inherently dangerous structures and those who own dams are liable for any damages that are caused by them.

Binder Note: Water Sustainability Act

The Water Act of British Columbia requires that a water licence be issued if water is to be stored and works constructed. The registered licensee, be it a private individual or a corporation thus becomes the ‘dam owner’. Section 21(1) of the Water Act states:

“A licensee, holder of an approval or person who makes a change in and about a stream in accordance with the regulations must

Binder Note: See Water Sustainability Act

4. What is Expected of the Dam Owner?

The dam owner’s expected actions include:

- thorough surveillance inspections, accurate monitoring when required;
- recording and interpreting information gained from inspection and monitoring;
- regularly scheduled routine maintenance;
- making required repairs in a timely manner;
- preparing Operation, Maintenance & Surveillance plans and manual when required;
- preparing Dam Emergency Plans when required; and
- operating the dam in a way that will give the greatest assurance of safety.

The required intensity of effort will vary in relation to the loss that would be experienced in terms of loss of life, the downstream development, and the value of the structure itself.

By having a Dam Safety Program, for even the smallest dams, the owner benefits by:

- protecting his/her investment,
- being able to recognize problems in their early stages and eliminate them before they become complex and expensive,
- minimizing risks to others and potential liability in case of failure,
- having a secure source of water,
- conserving a valuable resource, namely water.

(a) exercise reasonable care to avoid damaging land, works, trees or other property, and
(b) make full compensation to the owners for damage or loss resulting from construction, maintenance, use, operation or failure of the works.”

Or in other words, the dam owner is responsible for ensuring that their dam and appurtenant works are structurally sound, operated safely and maintained adequately to prevent loss of life, damage to the environment, or adverse social impact such as loss of communal water supply or infrastructure from a dam failure.
5. What is the Provincial Dam Safety Program?

The Provincial Dam Safety Program was instituted by the Comptroller of Water Rights in 1967 as an aid to dam owners for the purpose of ensuring that their structures are designed, constructed and maintained according to acceptable standards for public safety. The Provincial Dam Safety Program encompasses two components, regional (Provincial Government, Regional Offices) and headquarters (Water Management Branch, Victoria). See Page 56 for contact information.

Dam Safety Officers located in each region and in Victoria are responsible for ensuring that the dams in their jurisdiction do not pose an unacceptable risk to life, property and/or the environment. In general, headquarters jurisdiction covers dams over 9 metres in height, the majority of which are owned by local authorities, large corporations and power utilities. The regional jurisdiction, on the other hand, covers dams under 9 metres in height which are generally owned and operated by dam owners in dealing with specific problems is found in Section 7.

The following can be found in Section 8:
- a guide for preparing a Operation, Maintenance and Surveillance plan,
- a deficiency checklist and,
- a dam inspection checklist/formal report form.

It is important to note that the probability of small dams failing can be much higher than larger dams due to the lack of owner resources resulting in poorer maintenance. Even a relatively small dam can have severe consequences in the event of a failure. Therefore, the Provincial Dam Safety Program places a high priority on ensuring the safety of all dams in BC.

6. What will I find in this Booklet?

Section 1 contains common Definitions. Section 2 is an Introduction to Dam Safety, Section 3 describes Modes of Dam Failures, Sections 4 and 5 provide details on Inspecting and Maintaining Dams and Section 6 outlines how to set up an Operation, Maintenance and Surveillance Plan. A Self Help Guide to assist dam owners in dealing with specific problems is found in Section 7.

Note: Additional copies of the checklists can be obtained from your regional Water Management Offices and our website: www.env.gov.bc.ca/wsd/

Figure No. 3 - Typical Catchment Area
GUIDANCE MANUAL - DAM FAILURES
1. Historic Dam Failures in British Columbia
There have been dam failures in British Columbia from as far back as the turn of the century to as recently as June 13, 2010. The following are examples:

- In 1912, a small water supply dam servicing the coal shipping port of Union Bay on Vancouver Island failed, killing one man and causing extensive damage to property and the coal loading port facilities.
- In 1941, a 10 metre high dam located above the town of Penticton failed resulting in severe damage to the downstream area. If the dam had failed with today’s population living below, damage to business and property would be extensive and loss of life would have been likely.
- On May 27, 1995, a 5 metre high earthfill irrigation dam failed causing approximately half a million dollars damage. The sudden release of 150 acre-feet of storage killed 48 head of cattle, destroyed 1.5 kilometers of public road, damaged 100 acres of hay field and introduced 700,000 cubic metres of debris into the Quesnel River. Three ranchers barely escaped with their lives.

2. What Can Cause a Dam to Fail?
Dams can develop problems or fail for a number of reasons. Deficiencies in the design, poor construction practices/materials, inadequate spillway capacity and poor foundation conditions are the most common structural failure. During operation a dam can develop problems or fail for reasons related to poor operations and maintenance, or conditions beyond the control of the owner/operator. Although rare, failures can and do occur.

3. Modes of Embankment Dam Failures
There are three predominant causes of embankment dam failures: External Erosion Failures, Internal Erosion Failures and Structural Failures. These failures are outlined by types, characteristics, causes and preventative measures in Tables 1, 2, and 3 on pages 15 & 16.

a) External Erosion Failure
External erosion failure may result from: the uncontrolled flow of water over the dam, around the dam, and adjacent to the dam, plus the erosive action of water on the dam. Earth embankment dams are particularly susceptible to external erosion failure since the fill material erodes easily with relatively low velocity flows.

If adverse conditions occur the reservoir may rise to a level above the crest of the dam causing the stored water to flow over the crest. This flow may then start eroding the embankment material. If severe erosion damage is
not dealt with immediately, embankment failures can result.

b) Internal Erosion (Piping) Failure
While dams are designed to be as impervious as possible, some water does manage to flow through, under or around them. This is referred to as seepage. Seepage can appear as a soft wet area, as standing water or, in some cases, as a flowing spring. Clear seepage is generally not a serious problem if adequate drains and filters are provided to prevent the transport of fill material (see typical cross-section of a dam, Figure 2) and if the seepage water is not allowed to pond at the downstream toe. Seepage can emerge on the downstream slopes, below the toe of the dam or on the downstream abutments.

The presence of seepage may be identified by a change in vegetation. Once identified, the seepage area should be defined and marked with stakes or pegs, so that any variation in size can be noted. Seepage areas on the downstream slope should be considered serious and closely watched as it can lead to a slope failure. Seepage water which is dirty is indicative that erosion of the fill material is occurring which may lead to the failure of the dam by progressive erosion (piping) if remedial action is not taken.

c) Structural Failure
Structural failure can occur in the abutments, foundation and the embankment slopes. Factors which affect structural stability can include poor foundation conditions, poor construction practices and poor fill materials or inadequate slopes and seepage.

Structural failure of a dam can be observed in its early stages by the presence of cracks, excessive settlement and misalignment of the crest. Cracks can appear on the crest or the slopes and can be longitudinal or transverse. The types of cracks, their causes and consequences are illustrated in the Self-Help Guide of Section 7. The development of a slope failure from longitudinal cracking and the development of a failure from transverse cracking are shown in Figures 8 and 9 respectively.

Structural failure can also occur in appurtenant works including spillway structures, outlets and gates. Failure of these structures may lead to the failure of the dam.

4. Modes of Concrete Dam Failures
Although people tend to think of concrete dams as more permanent structures than embankment dams, failure of a concrete dam is often more catastrophic. Because they have less obvious symptoms prior to failure, collapse may be very rapid, with little or no advance warning. Concrete dams are nearly immune to the kinds of failures that affect embankment dams, such as erosion during overtopping, embankment instability, and piping failures. Concrete dam failures, by contrast, usually fall into one of the following categories:

- Overturning or Sliding, resulting from erosion of the supporting foundation and/or abutments,
• Abutment or foundation failure due to over-stressing, or
• Structural failure of concrete unable to sustain imposed loads.

Figure No. 6 - Ellis Creek Dam Failure (near Penticton) 1941.

Table 1 - External

<table>
<thead>
<tr>
<th>Form of External Erosion Failure</th>
<th>Characteristics</th>
<th>Causes</th>
<th>Preventative Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overtopping erosion</td>
<td>Flood water flows over embankment washing out the dam</td>
<td>Inadequate spillway capacity</td>
<td>Design the spillway with adequate capacity</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Improper operation of diversion-fed reservoirs</td>
<td>Stop diversion into storage when reservoir is full</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Clogging of spillway with debris</td>
<td>Install logboom where possible and periodically remove debris</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Insufficient freeboard due to settlement or erosion of embankment</td>
<td>Regrade crest to design elevation. Draw down reservoir through low level outlet</td>
</tr>
<tr>
<td>Wave erosion</td>
<td>Upstream slope eroded</td>
<td>Inadequate riprap or lack of filters</td>
<td>Place layered riprap and filters</td>
</tr>
<tr>
<td>Toe erosion</td>
<td>Erosion of embankment toe near spillway or outlet</td>
<td>Spillway or outlet located too close to dam</td>
<td>Discharge water away from the embankment and provide erosion protection</td>
</tr>
<tr>
<td>Surface erosion</td>
<td>Surface runoff from rain or snowmelt eroding the down-steam slope of dam</td>
<td>Poor surface drainage and lack of adequate grass cover on the downstream slope</td>
<td>Provide drains or ensure adequate grass cover on the downstream face</td>
</tr>
</tbody>
</table>
### Table 2 - Internal Erosion Failure

<table>
<thead>
<tr>
<th>Form of Internal Erosion Failure</th>
<th>Characteristics</th>
<th>Causes</th>
<th>Preventative Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Piping</td>
<td>Progressive internal erosion of material usually starting from downstream side of dam or foundation and progressing upstream, eventually leading to a breach</td>
<td>Concentrated seepage, Seepage along conduit, Leaking conduit, Tree roots</td>
<td>Install toe drains or filters, Grout along conduit to fill voids or replace conduit, Seal joints, reline conduit, Remove before they become a problem</td>
</tr>
</tbody>
</table>

### Table 3 - Structural Failures

<table>
<thead>
<tr>
<th>Type of Structural Failure</th>
<th>Characteristics</th>
<th>Causes</th>
<th>Preventative Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foundation failure</td>
<td>Sliding of one or both slopes with heaving of the toe in direction of movement</td>
<td>Soft or weak foundation, Excess water pressure in foundation</td>
<td>Flatten slope. Construct toe berms, Provide drains and filters</td>
</tr>
<tr>
<td>Upstream slope failure</td>
<td>Slide in upstream slope</td>
<td>Slope too steep, Rapid reservoir drawdown</td>
<td>Flatten slope, Construct berm, Avoid rapid lowering of reservoir</td>
</tr>
<tr>
<td>Downstream slope failure</td>
<td>Slide in downstream slope</td>
<td>Slope too steep, Saturation of slope by seepage, Corroded outlet works</td>
<td>Flatten Slope, Construct toe berm, Provide proper drainage by installing filter blanket or toe filters, Inspect and repair any corrosion</td>
</tr>
<tr>
<td>Spillway failure</td>
<td>Overtopping of the dam</td>
<td>Spillway blocked or undersized for the design flood, Seepage along the spillway walls</td>
<td>Install a log boom to prevent debris from entering, replace spillway with one of adequate size, Monitor for seepage and repair if excessive. See “Piping” Table 2</td>
</tr>
<tr>
<td>Reservoir bank slide</td>
<td>Slough or slide into the reservoir may cause overtopping of the dam if sufficiently large and occurring quickly</td>
<td>Toe of unstable slope saturated by impounded water</td>
<td>Stabilize slope by adding berm material or draining, Maintain reservoir elevation below slide area</td>
</tr>
</tbody>
</table>
**Figure No. 7 - Development of a Slope Failure from Longitudinal Cracking**

**A - Longitudinal cracks form and runoff water enters**

**B - Cracks widen and the ground settles on one side of the crack**

**C - The slope fails**
A - Initial Transverse Cracking
Often caused by settlement, foundation problems or placement of fill over steep abutments.

B - Progression of Transverse Cracking to a point below the waterline
Water from the reservoir begins to flow through the crack.

C - Transverse Cracking progressed to an overtopping situation
Condition has progressed to a point of imminent failure.

Figure No. 8 - Development of a Failure From Transverse Cracking.
2 DAM CLASSIFICATION
Dam Safety Management System (CDA, 2007)
DAM CLASSIFICATION - INTRODUCTION
**DAM CLASSIFICATION INTRODUCTION**

The classification of all dams must be determined based on the consequences of that dam failing. This determination must estimate the consequences for *loss of life, environmental and cultural values, and infrastructure and economy* and be classified as *Low, Significant, High, Very High, or Extreme* as outlined by the regulation.

This determination of classification is most often in the form of an Inundation Study. This study is usually completed by an independent qualified practitioner at the time of construction or during dam safety reviews. This estimate should be supported by dam breach calculations accompanied by inundation mapping. It should indicate the area that would be inundated, the depth and velocity of the flood waters, and the length of time that the area would be inundated. In many cases, the simplified *“Estimating Dam Break Downstream Inundation”* method can be used. A copy of the estimate should be submitted to the DSO for acceptance in accordance with the regulation and kept on file by the dam owner.

Under the new Dam Safety Regulation, the dam owner is required to *“redetermine classification of dam and, if necessary submit to DSO written notice of proposed new classification”* (Dam Safety Regulation – Schedule 2 Frequency of activities Table). For all dam classifications under the regulation, this should be completed annually. This redetermination is typically in the form of an update to the on file estimate and is usually conducted by the owner or the owner’s representative. A form has been included in this binder to record the date when this is performed.

*Quote from “Consequence of Failure Classification Guideline” – Page 2*
http://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/dam-safety/con_class_guidelines_for_dsos-2016.pdf

The consequences of failure should be evaluated for all three categories in Schedule 1 of the Dam Safety Regulation: loss of life, environment and cultural values, and infrastructure and economics. The category with the worst potential consequences is the classification of the dam as per Section 2 of Schedule 1 of the Dam Safety Regulation. The CDA Guidelines suggest the same thing:

> Environmental, cultural, and third-party economic losses should be estimated separately and taken into account in assigning a dam to a class. The class should be determined by the highest potential consequences, whether loss of life or environmental, cultural, or economic losses. (CDA Guidelines, Section 2.5.4 Dam Classification)

The consequence classification of a dam is used to determine design criteria in the CDA Guidelines and the frequency of safety activities (surveillance, inspection etc.) in Schedule 2 of the regulation.

*Quote from “Estimating Dam Break Downstream Inundation”*
http://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/dam-safety/estimating_downstream_inundation-2016.pdf

In order to determine the failure consequence classification for dams in BC, a number of things must be considered including: the population at risk, the estimated loss of life, the cultural and environmental consequences, the economic losses and the impact on infrastructure. The first steps...
are to determine the area that will be inundated, the depth and velocity of the flood waters and the length of time that the area will be inundated. This document outlines a simplified method for assessing the impact of the downstream inundation. This guideline is intended to be used for small dams (under 15 meters in height) but the principles apply to all dams. Please also refer to the Canadian Dam Association (CDA) Technical Bulletin, “Inundation, Consequences and Classification for Dam Safety”, 2007.

If this simplified method provides a clearly defined failure consequence classification then a consequence classification can be assigned. If the results are uncertain, the highest possible consequence classification can be accepted or a more detailed consequence assessment can be conducted. For larger structures or structures with complicated downstream channel conditions more detailed inundation studies are probably required.

See tables in the Dam Safety Regulation on pages 36 and 37 of this binder for the description of each failure classification as well as the frequency of activities that must be performed.
RECORD OF DETERMINATION OF CLASSIFICATION
KEEP A COPY OF A DETERMINATION OF CLASSIFICATION HERE (INUNDATION STUDY OR EQUIVALENT) -->
RECORD OF RE-DETERMINATION OF CLASSIFICATION
KEEP A LOG OF CLASSIFICATION RE-DETERMINATIONS HERE -->
Quotation from regulation:

(2) An owner of a dam for which the classification has been determined under the former regulation or this regulation must,

(a) no less frequently than is specified in item 1 of the table in Schedule 2 for the classification of the dam, redetermine the classification of the dam in accordance with section 2 of Schedule 1 to assess whether the classification of the dam has changed, and

(b) if the classification of the dam has changed, submit to a dam safety officer, immediately after the redetermination is completed, a record setting out a proposed new classification for the dam.

A re-determination is required annually for most dams. If a change to the classification is appropriate, consult the regulation for information on how to proceed.

CURRENT DAM CLASSIFICATION: _______________________________

<table>
<thead>
<tr>
<th>DATE</th>
<th>RE-DETERMINED CLASSIFICATION</th>
<th>NOTES</th>
</tr>
</thead>
</table>
3 OPERATIONS MAINTENANCE SURVEILLANCE
Dam Safety Management System (CDA, 2007)
1. Operation, Maintenance and Surveillance (OM&S) Plan

The objective in formulating an operation, maintenance and surveillance (inspection) plan is to provide the greatest possible assurance of the safety of the dam and continuous operation of the reservoir.

An effective plan provides all the information and instruction needed to allow an inexperienced person to perform all actions required to operate the dam safely and in the case of an emergency to provide protection and/or notification to the public downstream.

Among the items addressed are the operation of the outlet gate and the spillway, the surveillance (inspection) schedule of the dam, the monitoring of the dam’s performance, the recording and interpreting of the results of the surveillance and monitoring, the development of a Dam Emergency Plan and the performance of all required maintenance.

By creating and using an OM & S plan, the dam owner can expect these benefits:
- Assure the safety of the dam and the continuous operation of the reservoir,
- Operating the water usage in the best manner possible,
- Minimizing the need for costly repairs,
- Extending the useful life of the structure.

A simplified guide for preparing an OM&S plan is located in Section 8 to aid the dam owner in the development of their plan. Binder Note: Tab 3

2. Assembling an OM&S Plan

Assembling the required information and writing the OM&S plan is the responsibility of the dam owner. The OMS plan should include the following (if available):

a) Information

Maps, plans, and other sources should be reviewed for dimensions and descriptions that will provide a clear picture of the location, make-up, and function of each part of the dam. Especially important are:

- The water licence number along with a copy of the licence,
- detailed description of how to access the dam along with a map,
- overall dimensions of the dam and spillway,
- outlet configuration and operation,
- drainage systems and outfall locations,
- location and detail of monitoring points,
- capacity table for the reservoir,
- discharge table for the outlet and spillway,
- location and capacity of inflow and outflow structures,
- how is the dam and reservoir operated i.e. fall and winter drawdown, minimum and maximum releases,
- expected inflows i.e. low flow, design flood inflow,
- watershed considerations upstream and downstream of dam,
- record of past inspections, monitoring, repairs, and operating problems,
- photographs, taken annually and kept on file for comparison and reference.

b) Outlet And Reservoir Operating Instructions

A clear step-by-step set of instructions for operating the outlet system should be drawn up. Proper sequence to be followed in opening and closing gates, gate usage for low and high flow, opening ranges where excessive vibration is experienced, and operating problems particular to a specific gate should be listed.

Instructions concerning the general operation of the reservoir, including the regulation of inflow and outflow structures, should be clearly described. These will address maximum storage elevations to be observed in anticipation of spring runoff or winter and spring storms, as well as maximum and/or minimum permissible outlet releases, maximum and/or minimum reservoir storage, operation of the outlet to limit or prevent excessive spillway flows, and periodic closure of the outlet to permit a thorough outlet inspection.

Note: If a SCADA system is used to remotely operate
equipment or monitor flows or water levels, there must be a “feed back” to the controller to confirm that the desired action has occurred.

c) Surveillance (Inspections)
Frequent periodic surveillance is essential in efforts to assure the safety of the dam and to identify areas requiring maintenance before major problems develop. The OM&S plan should identify any areas requiring special or more frequent surveillance. Using the dam inspection checklist found in Section 8 will allow inspection findings to be assessed more clearly.

d) Monitoring Instructions
The benefits of monitoring the dam can only be achieved if the observations are recorded in an orderly way, then put into a form that will allow the data to be seen as a performance record.
A site plan identifying each monitoring point for the dam is required. Each of these monitoring points plus any seepage or other areas needing special attention should be kept clear of obscuring growth and be permanently marked so they can be found during surveillance. Instruction on how to make and record each measurement or observation must be provided.

e) Maintenance Instructions
Any special instructions for performing periodic maintenance should be given in detail. This will allow new personnel to understand the task and experienced personnel to make sure they have completed the work properly. All required maintenance work should be identified and listed.

f) Schedule
Once the various required tasks have been identified, a schedule showing the frequency for each task needs to be drawn up which meets or exceeds the requirements listed in “Schedule 2” of the Dam Safety Regulation.

Note: The Consequence classification of all dams have been determined by the Dam Safety Officer. Any submission for revision must be made to the Dam Safety Officer.

Further information on dam consequence classification and scheduling of inspection, maintenance and monitoring can be obtained from your Dam Safety Officer.

*Figure No. 20 - Outlet discharge weir*

 section 6 - operation, maintenance and surveillance plan

---

**Section 6 - Operation, Maintenance and Surveillance Plan**

**Figure No. 20 - Outlet discharge weir**
By conscientiously following a well-thought-out OMS plan the dam owner can expect:
• Maximum assurance of a safe dam;
• Maximum assurance of uninterrupted service for the dam and reservoir;
• Reduced maintenance cost; and
• An extended useful life for the dam.

i) Assigning Responsibility
After the OM&S plan has been written, reviewed, and found acceptable, the owner needs to identify who will carry out the various duties. Copies of the completed plan should be distributed to and reviewed with each participant.

j) Dam Emergency Plan
If a dam is designed according to sound engineering principles and is well constructed and maintained, the possibility of failure is extremely remote. If, however, potential failure of a dam poses a hazard to life and property, the dam owner must have an emergency preparedness plan to deal with any potential problems. This plan should address the following:
• Who will be affected and how can they be contacted?

Persons immediately downstream should be notified as well as local authorities so they can co-ordinate evacuation plans if necessary.

A template for preparing a Dam Emergency Plan, is provided in the Dam Safety in BC website. Contact your Dam Safety Officer for more information.

By conscientiously following a well-thought-out OMS plan the dam owner can expect:
• Maximum assurance of a safe dam;
• Maximum assurance of uninterrupted service for the dam and reservoir;
• Reduced maintenance cost; and
• An extended useful life for the dam.

3. Summary
A Guide for Preparing an OM&S plan is located in Section 8 to aid the dam owner in the development of their plan.

This OM&S Plan must be reviewed by the Dam Owner annually to ensure contact names and phone numbers are kept up to date. All holders of the OM&S Plan must be sent copies of any revisions. See the table in Schedule 2 of the Dam Safety Regulation for required frequency of all activities under the regulation including the Dam Emergency Plan.

Figure No.21 - Inspecting a spillway training wall.
OPERATIONS MAINTENANCE & SURVEILLANCE PLAN
OPERATION, MAINTENANCE & SURVEILLANCE PLAN

Binder Note: This template is meant to be customized to your dam's requirements.

Dam Name: ___________________________ Water Licence No.: ____________
Owner’s Name: ___________________________ Phone #: ____________
Stream Name: ___________________________ Reservoir Name: ______________
Dam Location: Latitude: ____________ Longitude: ______ Map Sheet No. ___

LIST INDIVIDUALS WHO ARE RESPONSIBLE FOR:

<table>
<thead>
<tr>
<th>Name</th>
<th>Title</th>
<th>Phone #</th>
</tr>
</thead>
<tbody>
<tr>
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<td></td>
</tr>
</tbody>
</table>

Operation:__________________________________________
Maintenance:________________________________________
Inspections:_________________________________________
Instrumentation:_____________________________________

PHYSICAL DESCRIPTION:

Dam Height: ___________________________ Dam Type: ____________________
Length: ___________________________ Crest Width: ____________________
Reservoir Capacity: ____________ Reservoir Area: ________________
Spillway Capacity: ____________ Design Flood Inflow: ______________
Watershed Area: ________________ Purpose of Dam: __________________
Consequence Classification: __________________

ACCESS TO DAM: (describe road access to dam from nearest center, attach map to this Plan)

_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________

LIST SIGNIFICANT STRUCTURES DOWNSTREAM OF DAM: (i.e., access road, railroad, subdivision etc.)

_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________

Page 1 of 4
LIST ALL HYDRAULIC WORKS: (i.e., spillway, outlet, stoplogs, gates, valves etc. (include capacity, dimensions, locations etc.))


LIST PROCEDURES FOR RESERVOIR OPERATION: (i.e., how is reservoir level controlled? what is the anticipated reservoir level for any given time of year? when are the drawdown and filling periods? what are the operation procedures during floods?)


LIST ALL ITEMS REQUIRING ROUTINE MAINTENANCE: (include type of maintenance to be performed, scheduling of maintenance, record keeping, etc.)

Binder Note: Include maintenance plans here. Record of completed maintenance to be kept in Tab 4.
LIST ALL INSTRUMENTATION, FREQUENCY OF MONITORING, AND METHOD OF RECORD KEEPING: (i.e., seepage measurement weir, reservoir level gauge, piezometers, etc.)

Binder Note: Include monitoring plan here. Copy of monitoring records to be kept in Tab 4.

<table>
<thead>
<tr>
<th>Instrumentation</th>
<th>Frequency of Monitoring</th>
<th>Method of Record Keeping</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
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</tbody>
</table>

LIST OF EQUIPMENT TO BE PERIODICALLY TEST OPERATED: (i.e., gates, valves, hoists, etc. include frequency of test operation)

Binder Note: Include equipment testing plans here. Copy of completed equipment tests to be kept in Tab 4.

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Frequency of Test Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

LIST ALL COMPONENTS REQUIRING ROUTINE VISUAL INSPECTIONS: (include schedule) (e.g. weekly, monthly, quarterly, annually etc.)

Binder Note: Include surveillance plans here. Copy of completed surveillance forms to be kept in Tab 4.

<table>
<thead>
<tr>
<th>Component</th>
<th>Inspection Schedule</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Page 3 of 4
ANNUAL FORMAL INSPECTIONS BY OWNER: (include; time of year when performed, special items to be examined, reviewed, and/or test operated)

Binder Note: Include inspection plans here. Copy of completed formal and routine inspections to be kept in Tab 4.

---

ATTACH THE FOLLOWING INFORMATION TO THIS PLAN:

- All dam design plans including as-built, if available.
- A location map showing the dam location relative to major roads and/or communities.
- All past inspection reports. Binder Note: See Tab 4
- An inspection checklist. Binder Note: See Tab 4
- A log showing repairs done and operating problems. Binder Note: See Tab 4
RECORD OF DESIGN DRAWINGS, SPECS, SITE PLANS, ETC
INSERT ALL DESIGN DRAWINGS, SPECS, SITE PLANS, LOCATION MAPS ETC HERE -->
4 OMS ACTIVITIES
Dam Safety Management System (CDA, 2007)
Things To Watch For
SECTION 4
INSPECTIONS

1. Inspection Guidelines
The purpose of a dam inspection program is to identify problems and/or unsafe conditions. Inspection is an integral part of a proper maintenance program for a dam. Failure to correct identified maintenance and repair items could result in the failure of a dam. See Figure No. 10 for indicators of potential problems. Watch for the noted indicators during all surveillance inspections.

2. When should an Inspection be done?

a) Performing Surveillance Inspections
on a regular basis, as part of the routine maintenance is the most economical means of assuring the safety and long life of the structure. Routine surveillance inspections are a straightforward procedure that allows any properly trained person to make an accurate assessment of a dam’s condition. The inspection involves careful examination of the surface of all parts of the structure.

Routine surveillance inspections should be carried out as appropriate for the item being inspected and the frequency based upon the dam’s consequence classification (refer to Schedule 2 of the Dam Safety Regulation). Table 4 on page 22 lists some common problems associated with small dams and suggested times for enhanced surveillance and inspection.

Reduced frequencies of the routine surveillance inspections may need to be selected to suit seasonal conditions (i.e. snowcover). Seepage readings (or any other condition that is subject to change) should be measured and recorded. Reservoir level, operational conditions, outlet and spillway releases should also be recorded as this may give insight into any deficiencies found on the dam.

Some of the best times to look at a dam are:
- In the late spring or early summer when the reservoir is at Full Supply Level (FSL) (seepage which might occur under, through or around the dam will be most noticeable at FSL), In the late summer or early fall when the reservoir is drawn down (exposing the upstream face to allow for closer inspection),
- after severe weather events such as heavy rainfall, flooding, windstorms, severe icing, rapid snowmelt, etc.,
- After a severe seismic event.

b) Formal Inspections - are intended to be a more thorough inspection performed by the appropriate representative of the owner (i.e. the individual responsible for safety surveillance). The frequency required for formal inspection and maintenance based on consequence classification can be found in Schedule 2 of the
Figure No. 10 - Potential Problem Indicators
Dam Safety Regulation, a copy of which can be obtained from any Regional office as well as the website. The formal inspection shall be recorded in a formal inspection report and kept by the dam owner as an historical record. Depending on the complexity of the dam, the consequence classification of the dam and the requirements of the Dam Safety Officer, use of the Dam Inspection Checklist, located in Section 8, may be all that is required. A more comprehensive inspection checklist “Inspection Checklist for Dam Safety Reviews” is available on the website. Copies of these reports may be requested by the Dam Safety Officer for audit.

Note: Evaluation of the conditions downstream of the dam must be undertaken at the same time as the formal inspection to ensure the consequence classification of the dam has not changed. Any changes must be reported to the Dam Safety Officer. A list of Regional and Headquarters (Victoria) Offices and their telephone numbers can be found on page 56 and on our website.

c) A Dam Safety Review - involves the collection of all available dam records, field inspections, detailed investigations and possibly laboratory testing. It then proceeds with a check of structural stability and operational safety of the dam, beginning with a reappraisal of basic features and design assumptions.

The level of detail required in a Dam Safety Review should be proportional with the importance and complexity of the dam, as well as the consequences of failure.

Refer to the guide for preparation of a Dam Safety Review on our Website: www.env.gov.bc.ca/bsd/

3. What equipment is required to do an Inspection?

The purpose of a dam safety inspection is to gather and record facts that may have an impact on the safety of the dam. Use the SMPL (Simple) rule for all recordings:

S Sketch the deficiency and note its important characteristics.

M Measure the deficiency.

P Photograph the deficiency or describe its characteristics in writing.

L Locate the deficiency relative to some standard reference point.

The following are a few of the basic items that aide the owner in doing a surveillance inspection:

- clip board
- tape measure/ruler
- field notebook/inspection checklist
- camera/video
- pencils and a flashlight.

4. What is involved in an Inspection?

It is helpful to have a system or method of inspection which can be repeated consistently. By organizing and listing the various components of a dam in the form of an inspection report, a methodical approach for inspection can be easily developed. A dam inspection checklist can be found in Section 8 of this booklet. It is recommended that the dam owner download a copy of the Inspection Checklist from the website and modify it to suit the requirements of each individual dam.

A review of notes from previous inspections, photographs and ‘As Constructed’ drawings, if available, should precede the actual field inspection. This will allow comparison of the present condition to the ‘As Constructed’ condition or its condition at the time of the previous inspections.

The inspection itself should include all of the components of the dam; the crest, upstream and downstream embankments, the abutments, the spillway, the reservoir banks, and the area below the dam. Any gates or control valves associated with the spillway and/or low level outlet should be inspected and tested if possible to ensure that they are operational. This includes a close examination of all accessible moving parts.

The inlet and outlet structures should be inspected with close attention given to the internal condition of any conduit, pipes or access wells. Anything unusual or anything that has changed since the last inspection should be noted (i.e. new or increased erosion, settlement, cracks, seepage or wet areas).

Photographs should be taken during the inspection. Many of the problems which a dam may develop do not happen over night but can take months or years to become obvious. By comparing photographs from previous inspections to the present, many of the subtle changes in a dam’s condition can be noted. Potential problems can be obscured by the excessive growth of vegetation.
Table 4 - Suggested Surveillance Schedule

Below is a summary of the most common problems associated with small dams and a suggested time for inspection.

<table>
<thead>
<tr>
<th>Location</th>
<th>Problem</th>
<th>Occurrence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upstream slope</td>
<td>Slope failure.</td>
<td>After rapid drawdown.</td>
</tr>
<tr>
<td></td>
<td>Displacement of slope protection.</td>
<td>After severe wind storms, icing or heavy rain.</td>
</tr>
<tr>
<td></td>
<td>Tree or shrub growth.</td>
<td>Year round.</td>
</tr>
<tr>
<td>Crest</td>
<td>Settlement.</td>
<td>After heavy rain.</td>
</tr>
<tr>
<td></td>
<td>Rutting.</td>
<td>Autumn.</td>
</tr>
<tr>
<td></td>
<td>Tree and shrub growth.</td>
<td>Year round.</td>
</tr>
<tr>
<td>Downstream slope</td>
<td>Seepage.</td>
<td>When reservoir is at Full Supply Level (F.S.L.)</td>
</tr>
<tr>
<td></td>
<td>Slope failure.</td>
<td>When seepage is evident downstream slope.</td>
</tr>
<tr>
<td></td>
<td>Rodent burrows.</td>
<td>Spring and fall.</td>
</tr>
<tr>
<td></td>
<td>Tree and shrub growth.</td>
<td>Year round.</td>
</tr>
<tr>
<td>Downstream toe</td>
<td>Seepage.</td>
<td>During high reservoir levels.</td>
</tr>
<tr>
<td></td>
<td>Bulging - indicating a slide.</td>
<td>After high reservoir levels.</td>
</tr>
<tr>
<td></td>
<td>Tree and shrub growth.</td>
<td>Year round.</td>
</tr>
</tbody>
</table>
Table 5 - Minimum Suggested Inspection and Surveillance Frequency

See Schedule 2, of the Dam Safety Regulation
5. Inspection of Embankment Dams

The external surfaces of an embankment dam can often provide clues to the behaviour of the interior of the structure. For this reason, a thorough examination of all exposed surfaces of the dam should be made.

The embankment should be carefully examined for any evidence of displacement, cracks, sinkholes, springs, and wet spots. Any of these conditions may be in a developing mode and, if they worsen and are not corrected, ultimately could lead to failure of the embankment.

The following are the main components of an embankment dam and some inspection tips:

a) The Crest

The crest is generally the main access to most dams. It is often used as a crossing for farm equipment, for livestock, for recreational vehicles and as a public access road. This traffic as well as excessive vegetation can obscure the signs of any problems which may be present. For this reason, very close attention must be paid to the crest during an inspection (see the Self Help Guide in Section 7). The crest should be inspected for the following most threatening deficiencies:

**LONGITUDINAL CRACKING** which can indicate localized instability, differential settlement, and/or movement between adjacent sections of the embankment. (see figure No. 12)

**TRANSVERSE CRACKING** which can indicate differential settlement or movement between adjacent segments of the dam. (see figure No. 11)

**MISALIGNMENT** which can indicate relative movement between adjacent portions of the dam in directions perpendicular to the axis of the dam.

Note: It is emphasized that, should any of the above conditions be discovered during an inspection, the owner should contact the Dam Safety Officer in your region immediately. The services of a qualified Professional Engineering Consultant may be required.

Other deficiencies which should be inspected for are:
- Narrowing of crest width from erosion.
- Low areas caused by erosion or settlement (this is of concern because it reduces the freeboard).
- Ruts caused by vehicle or livestock traffic which allow water to pond.
- Animal burrowing.
- Excessive vegetation
- Sinkholes or any unexplained hole or cavity which might indicate internal erosion.

b) Upstream Slope

If the reservoir is maintained at its Full Supply Level (FSL), most of the upstream slope of the dam will be submerged. In this case, only the upstream slope above the water level can be inspected. The inspection of the rest of the slope should be carried out when the water level is low.

The upstream slope should be inspected for the following deficiencies:
- Slope erosion from wave action.
- Displacement or loss of rip rap.
Slides are easily spotted and require immediate evaluation by a qualified Professional Engineer and notification of your Provincial Dam Safety Officer. There are, however, early warning signs of a slide. A bulge in the embankment or vertical displacement at a crack in the embankment may indicate sliding.

Seepage occurs at all dams in varying degrees. The most potentially dangerous condition is the appearance of seepage on the downstream face above the toe of the dam. Seepage on the downstream slope can lead to a slide or failure of the dam by internal erosion (piping). The degree of concentration and the rate of flow should be noted. The presence of fines (silt) in the seepage flow, making it appear dirty or murky, would indicate the possibility of internal erosion (piping).

Other deficiencies which should be inspected for are:
- Bulges on the lower areas of the slope which may indicate instability.
- Depressions or unexplained holes which might indicate internal erosion (piping).
- Excess vegetation, especially trees which can severely weaken the slope.
- Erosion caused by runoff.
- Rutting caused by livestock traffic.
- Animal burrowing.
- Standing or ponded water at the downstream toe which can cause slope instability.

d) Abutment
Abutments should be inspected for the following deficiencies:
- Seepage, especially at the abutment/embankment contact zone (called groins).
- Erosion of the abutment/embankment contact.
- Any other signs of abutment instability such as cracking or material displacement.

e) Downstream Toe
This area includes the area immediately below the dam up to and including the toe. The main problems or signs of problems which can develop in this area are seepage related. For example:
- Wet, marshy ground or standing water.
- Active sand boils (the ejection of sand and water resulting from piping).
- Seepage areas (these should be marked and their...
dimensions estimated for comparison during future inspections).
- Seepage flows (should be estimated).
- Seepage or precipitation which ponds at the downstream toe.

6. Inspection of Concrete Dams

Concrete dams encompass a variety of structures which include gravity, slab and buttress, multiple arch, and single arch dams. Masonry dams may be considered as a gravity structure with many joints. Regardless of the type, all dams are subject to the same basic considerations with respect to safety.

Concrete dams fail for reasons different than earth dams. Several of these more serious problems are discussed below:

**STRUCTURAL CRACKS**
Cracks caused by overstressing of portions of the dam and result from inadequate design, poor construction techniques, or faulty materials. Structural cracks are often irregular, meaning they run at an angle to the major axes of the dam and may exhibit abrupt changes in direction. These cracks also have noticeable radial, transverse, or vertical displacement.

**FOUNDATION or ABUTMENT WEAKNESS**
Concrete dams transfer substantial load to the abutments and foundation. Although the concrete of the dam may endure, the natural terrain may crack, crumble, or move in a massive slide. If this occurs, support for the dam is lost, causing it to fail. Impending failure of the foundation or abutments is difficult to detect because initial movements are often very small.

**DETERIORATION due to ALKALI-AGGREGATE REACTION**
Severe deterioration can result from a chemical reaction between alkali present in cements and certain forms of silica present in some aggregates. This chemical reaction produces by-products in the form of silica gels which cause expansion and loss of strength within the concrete.

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7. Inspection of Appurtenant Works

The appurtenant works are structures or machinery that are auxiliary to dams which are built to operate and/or maintain dams. Appurtenant works include; outlets, spillways, gates, powerhouses, tunnels etc.. The following are inspection tips for some of the appurtenant works:

**a) Spillway**
The main function of a spillway is to provide a safe evacuation route for excess water that has entered the reservoir after a large storm or rapid snow-melt. If the spillway is of inadequate size the dam can overtop. Overtopping is the main cause of dam failure. Defects in the spillway or in its design may cause the dam to fail by rapid erosion produced by floodwater going over the crest. A properly designed and maintained spillway provides adequate freeboard to account for infrequent rain storms that may raise the level of the reservoir above the designed full supply level and still account for wave run up on the upstream slope without overtopping the dam.

There are four major types of problems that can prevent a spillway from functioning properly. As soon as any of these problems is identified, remedial steps must be taken in order to correct the defect.

**Obstruction** - The spillway channel may be obstructed by excessive growth of grass and weeds, thick brush, trees, debris, beaver dams, snowdrifts, or landslide deposits. An obstructed spillway will...
Lack of Erosion Protection - When a large storm occurs, the spillway is expected to carry a large amount of water for many hours. Severe erosion damage or complete washout could result if the spillway lacks the ability to resist erosion. If the spillway is excavated through rock or lined with concrete, erosion is usually not a concern. But if the spillway is excavated in sandy, deteriorated granite, clay, or silt deposits, erosion protection is very important. Generally, resistance to erosion can be increased if the spillway channel has a mild slope, or if it is covered with grass or armoured with riprap.

Deterioration - A spillway cannot be expected to perform properly if it has undergone deterioration. Deterioration includes collapse of side slopes, weathering of material, disintegration of riprap, breakdown of concrete lining, erosion of approach section, sloughing of chute channel, excessive siltation of stilling basin or discharge channel, and loss of protective material which can cause severe erosion. Remedial actions must be taken as soon as any sign of deterioration has been detected.

Cracks - Cracks in concrete lining are commonly encountered in the spillway channel. The cracks may be caused by uneven foundation settlement, slab displacement, or excessive earth or water pressure. Large cracks will allow water to wash out fine materials below or behind the concrete slab, causing erosion and leading to more cracks. An extensive crack can cause the concrete slab to be severely displaced. Consequently, the slab may be dislodged and washed away by the flow.

b) Outlet
Outlets come in a range of designs, sizes, materials and types of control (see Figure 14). Most control mechanisms and conduits are usually submerged and not easily accessible for inspection and maintenance. For this reason they are often neglected and serious problems may develop and go unnoticed. These problems can range from the control works becoming inoperable to the conduit deteriorating to the point where the embankment can fail (see Figures 15 and 16).

Proper inspection of the outlet usually requires advance planning to allow outflows to be shut off and inundated areas to be pumped out. Inspection can then usually determine if a problem exists with the outlet. If the conduit
is 1.0 m or greater in diameter, an internal inspection is highly recommended.

**Note:** Internal inspection of an outlet pipe is possible down to approximately 0.6 metres diameter. Most outlets are considered a confined space and therefore are hazardous. The Workers’ Compensation Board of British Columbia’s Industrial Health and Safety Regulations section on ‘Entry into a confined space’ must be followed.

Outlet works should be inspected for the following deficiencies:

- Damaged control valve or gate mechanism.
- Silted inlet - a buildup of silt can usually be prevented by periodically operating the outlet.
- Deteriorated inlet and outlet structures (usually constructed of concrete).
- Dirty/murky or silty water, flowing from the conduit or around it, could indicate that internal erosion may be occurring.
- Piping along the conduit can result in internal erosion and sloughing which may appear as a low area or sinkhole on the crest.
- Erosion at the low level outlet.
- Corrosion and perforations along the conduit.
- Joint separations along the conduit particularly if the conduit is constructed or corrugated steel pipe using seepage collars.

**Note:** In most cases services of a qualified Professional Engineering Consultant will be required to recommend corrective action when these problems are found.

c) Gates

The operability of a dam’s outlet gates is essential to the safe and satisfactory operation of the dam. On reservoirs used for recreation, fish propagation, or other uses for which release of water is not required, an operable outlet, as with all dams, provides the only means for the emergency drawdown of the reservoir, thereby being essential to the safety of the dam.

The main deficiencies to look for on gates are as follows:

- Lack of readily accessible operating controls.
- Rusted or non-lubricated valve stem threads.
- Debris lodged in the intake.
- Vandalism of the gate controls.
- Ice damage.

**d) Signs/Signage**

For some dam owners in B.C. there is a requirement under the Dam Safety Regulation to post signs indicating 24 hour emergency contact information should a problem at a dam be observed. The purpose of these signs is to help ensure that there is a minimum of delay in safeguarding the dam and the area downstream.

These Regulations specify such things as size of the sign, size of lettering on the sign etc.

The main deficiencies to look for are the effects of vandalism, readability, overgrowth by foliage and out of date text and contact numbers.

8. **Summary**

All Formal Inspection Reports should be kept by the dam owner as an historical record of the performance of the dam. Depending on the complexity of the dam, the consequence classification of the dam and the requirements of the Dam Safety Officer, a completed copy of the Dam Inspection Checklist, located in Section 8, may be satisfactory. Based on the consequence classification, copies of these reports may be required by the Dam Safety Officer.

**Note:** Evaluation of the conditions downstream of the dam must be undertaken at the same time as the formal inspection to ensure the consequence classification of the dam has not changed. Any changes must be reported to the Dam Safety Officer.

Two copies of the Dam Inspection Checklist are located in Section 8. This checklist can also be used as a guide during routine surveillance inspections. Additional copies should be photocopied by yourself or obtained from your local Dam Safety Officer.

Further information on the frequency of dam inspections, the recording and reporting requirements of these inspections and the methods of inspection and repair can be obtained from your Dam Safety Officer.

The services of a qualified Professional Engineering Consultant may be required for serious problems.
Best protection from ice and water damage. The downstream side of the gate can be inspected in the dry. By blocking the inlet, the well and conduit can be drained for maintenance and repairs.

May be difficult to service unless it is installed in a dry well. Conduit upstream of valve is under constant pressure from reservoir head.

Slidegate and control may be damaged by ice, leaving system inoperable.

Slidegate, control and catwalk may be damaged by ice, leaving system inoperable. Catwalk requires additional maintence to remain in a safe usable condition.

Entire conduit is under constant pressure from reservoir head. This design would not be allowed on new or replacement outlets. See potential failure scenario Figure No. 16, page 31.

Figure No. 14 - Most Common Types of Low Level Outlet Controls
Figure No. 15 - Development of a Sinkhole and Failure Resulting from a Hole or Joint Separation in the Conduit.

A - Hole develops in conduit, eroding embankment

B - Hole in Conduit enlarges, cavity develops. Debris partially blocks outlet.

C - Sinkhole develops, complete failure is probable.
Figure No. 16 - Development of a Piping Failure Resulting from a Hole in a Conduit with a Downstream Valve.

A - Hole develops in conduit with downstream valve which is under constant pressure from reservoir head.

B - Hole enlarges allowing increased flow and a piping failure begins.

C - Reservoir drains through the conduit.
1. Commitment to Maintenance
One of the responsibilities of owning and operating a dam, regardless of its size, is the commitment to maintain it. When minor problems are identified during an inspection, they should be dealt with as quickly as possible. A program of regular preventative maintenance will stop many of these problems from developing in the first place. If a change or deterioration of the conditions of the dam is noted in its early stages, repairs to remedy the situation can often be completed with minimal expense. If the problem is not detected or if it is ignored, repairs may become complex and very expensive. If a dam is left to deteriorate, failure will eventually result.

2. Embankment Dam Maintenance
Earthfill structures require maintenance work directed at controlling seepage and erosion, in order to prevent deterioration of structures and development of seepage paths.
Annual or long-term maintenance programs for earthfill structures may include regular control of vegetation and burrowing animals, rip-rap and crest maintenance and repair, slope stabilization, drainage system maintenance, removal of upstream debris, and maintenance of instrumentation.

a) Vegetation Control
The first maintenance requirement is to keep all portions of the dam clear of unwanted vegetative growth. (see Figures No. 17 & 18 for before and after views). Excessive growth is harmful in the following ways:
- It can obscure the view of the embankment and prevent a thorough inspection for possible cracks or other evidence of problems on the dam.
- Large trees could be uprooted during a storm and the resulting large hole left by the root system could lead to breaching of the dam.
- Some root systems can decay and rot, providing a tunnel for water to pass through (called piping).
- Root systems can cause the uplift of concrete slabs or structures.
- Weeds can discourage the growth of desirable grasses.

b) Crest and Slope Stability
Deterioration of the surface of an earth dam may occur for a number of reasons. For example, wave action may cut scarps into the upstream slope, vehicles may cause ruts in the crest, or runoff waters may leave erosion gullies on the downstream slope. Damage of this nature must be repaired on a continuing basis.

| Conditions such as embankment slides, structural cracking, sand boils, and sinkholes threaten the safety of the dam and require that you notify your Dam Safety Officer. The services of a Professional Engineering Consultant may be required. |

c) Burrowing Animal Control
Rodents can cause a variety of different types of damage to a dam. The type of treatment depends upon the nature of the damage. Further information on rodent control and methods of repairing rodent damage can be obtained from your Dam Safety Officer. Permits may be required from the Wildlife Branch of the Provincial Government before undertaking rodent control.

3. Concrete Dam Maintenance
Generally speaking, concrete is a reasonably durable material. However, because of the environment in which it is used, concrete does deteriorate over the years, and this process is accelerated by exposure to extreme weather conditions. The most common form of failure is the breakdown of the surface layers of concrete as evidenced by the scaling, surface cracking and pitting which becomes very noticeable.

A more serious form of failure is indicated by the appearance of structural cracking in the concrete. The most common cause for this type of failure is the increase in stress that the concrete is subjected to and usually results from the uneven settlement of the structure or from unequal or excessive earth pressures against the
Note: Large structural cracks threaten the safety of the dam and require that you contact your Dam Safety Officer. The services of a qualified Professional Engineering Consultant may be required.

Annual or long-term maintenance programs for concrete structures should include, but not be limited to, regular cleaning of drains and drainage systems, maintenance of sealing systems, pumping equipment, monitoring equipment and instrumentation required to assure the safety of the structure.

4. Appurtenant Works Maintenance

Maintenance requirements may apply to all appurtenant works, including mechanical and electrical components, which are essential to dam safety. The following are a few of the appurtenant works that require maintenance:

- spillways,
- outlets,
- gates,
- hoists,
- stoplogs,
- log-booms,
- normal and emergency lighting
  and
- pumps.

a) Spillway Maintenance

A spillway should always be kept free of obstruction, have the ability to resist erosion, and be protected from deterioration. Removal of material blocking the spillway is necessary to allow unrestricted outflow. Some routine maintenance items may include:

- remove floating debris from the reservoir (particularly around the spillway entrance) and dispose of it away from the dam and above the flood water level,
- repair or replace any substandard part of the debris containment boom (log-boom), i.e. boom sticks (logs), chains, cables and anchors,
- remove any soil, sediment, or rock fall that has entered the spillway channel,
- remove any beaver dams.

b) Outlet Gate Maintenance

The simplest procedure which can be used to insure the...
continued operability of the outlet gates is to cycle all gates through their full operating range at least once, preferably twice annually. As cycling of gates under full reservoir head could result in large outlet discharges, it is recommended that gate cycling be scheduled during periods of low storage. If this cannot be done, cycling should be done during periods of low stream flows. If large releases are anticipated, outlet testing should be done only after coordinating releases with Dam Safety Officers and notification of downstream residents and water users. Notification should also be given to the local fisheries officer.

Cycling of the gates prevents the buildup of rust on contact surfaces of the operating mechanism and the possible seizure of the operating mechanism as contact surfaces rust together.

5. Summary

It should be emphasized that a dam and reservoir represent not only a potential public hazard, but also a substantial investment. The dam’s owner can identify any changes in previously noted conditions that indicate a safety problem. A conscientious annual maintenance program will address and control most potential problems.

Maintenance solutions for specific problems are outlined in the Self Help Guide in Section 7, under ‘Recommended Action’. Some routine maintenance items may include:
- Removing debris
- Re-grading the crest and/or access road
- Adding riprap when required
- Sealing joints in concrete facings
- Cleaning drain pipes and outfalls
- Maintaining protection for monitoring points
- Maintaining security for operating equipment

Further information on maintenance can be obtained from your Dam Safety Officer.

Note: When operating the outlet, excessive force should not be needed nor should it be applied to either raise or lower the gate. Most hoisting mechanisms are designed to operate satisfactorily with a maximum force of 40 pounds on the operating handle or wheel. If excessive force is needed, problems may have developed with the outlet installation which are causing binding in the mechanical system. The application of excessive force may irreversibly bind the gate or damage the outlet works.

Note: Contact your Dam Safety Officer if you encounter conditions which may threaten the safety of the dam such as embankment slides, structural cracking, boils and sinkholes. The services of a qualified Professional Engineering Consultant may be required.

Figure No. 19 - Intake Control Access Structure Failure
# Identifying Problems and Solutions: A Self-Help Guide

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# Deficiency Checklist

If you find deficiencies with any component of your dam, use the following table to guide you to the relevant section of the [SELF-HELP GUIDE](#) in the Appendix of the Inspection and Maintenance of Small Dams booklet.

Binder Note: Sections numbers referenced in this Deficiency Checklist can be found in the Tab Numbers noted in right column.

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1. Reservoir Problems

1 - Slides and Sloughs

Causes:
1. Ice action and wave erosion which creates vertical slopes.
2. Steep slopes left unsupported by erosion.
3. Toe of slope becomes saturated by the reservoir.

Concerns:
1. The slides or slough area may endanger the embankment.
2. Waves caused by a slide may endanger the embankment.

Recommended Action:
1. Monitor the area and notify your Dam Safety Officer if the embankment is threatened. The services of a qualified Professional Engineering Consultant may be required.

2 - Floating Debris

Causes:
1. Beaver activity.
2. Heavy runoff.

Concern:
1. Debris may block spillway or outlet.

Recommended Action:
1. Install trash racks or floating booms where necessary and clean them as required.

3 - Beaver Activity

Cause:
1. A favourable habitat.

Concern:
1. Beaver activity may block spillway or outlet causing water to rise and overtop the embankment.

Recommended Action:
1. Remove the beaver dam.
2. Contact the Wildlife Branch of the Provincial Government re: relocating the beaver.
2. Crest Problems

1 - Excessive Vegetation

Causes:
1. Lack of maintenance.
2. Neglect.

Concerns:
1. Prevents a thorough inspection.
2. Obscures any problems which might exist.
3. Root system can weaken the embankment and result in a failure.
4. Prevents easy access.
5. Provides a habitat for unwanted burrowing animals.

Recommended Action
1. Remove excessive vegetation and root system
2. Remove cuttings and debris from embankment area.
3. The embankment should be seeded with an appropriate grass.
4. Prevent or remove re-occurring growth as part of a regular maintenance program.

2 - Rodent Activity

Cause:
1. Burrowing animals.

Concerns:
1. Can weaken the embankment.
2. Can cause a piping failure.

Recommended Action:
1. Control rodents.
2. Remove favourable habitat conditions.
3. Backfill rodent burrows with compacted fill or a pumped grout.

3 - Ruts Along Crest

Causes:
1. Heavy vehicles, farm equipment or livestock traffic.
2. Lack of maintenance or inadequate crest surfacing.

Concerns:
1. Allows continued rutting.
2. Allows standing water to collect and saturate the crest.
3. Vehicles crossing the crest can get stuck causing further damage.

Recommended Action:
1. Re grade and recompact crest to original elevation with a camber to the upstream slope which will encourage proper drainage of runoff back into the reservoir.
2. Provide surface resistant to rutting such as placement of crushed gravel surfacing.
2. Crest Problems (cont.)

4 - Drying Cracks

Cause:
1. Crest material expands and contracts with alternating wet and dry weather.

Concern:
1. Provides an entrance point for surface water which can saturate the crest material.

Recommended Action:
1. Regrade or tight blade the crest if necessary.

5 - Longitudinal Cracking

Causes:
1. Uneven settlement within the embankment or foundation.
2. Initial stage of a slope failure or embankment slide.

Concerns:
1. Results in an area of high instability.
2. Can lead to future movements or failure (see Figure 8, page 17).
3. Provides an entry point for surface water which can promote movement.
4. Can reduce the effective crest width.

Recommended Action:
1. Notify your Dam Safety Officer. The services of a qualified Professional Engineering Consultant may be required to determined the cause and recommend a plan of action.
2. The crack(s) should be monitored.
3. A lower reservoir operating level may be required.

6 - Transverse Cracking

Causes:
1. Uneven movement between two adjacent segments of the embankment.
2. Instability of the embankment or foundation.

Concerns:
1. Provides an entry point for surface water.
2. Creates an area of structural weakness which could result in further movements or failure.
3. May create a seepage path from the reservoir and a potential piping failure (see Figure 9, page 18).

Recommended Action:
1. Notify your Dam Safety Officer. The services of a qualified Professional Engineering Consultant may be required to determined the cause and recommend a plan of action.
2. The crack(s) should be excavated and back-filled with compacted material to prevent seepage.
3. Area should be closely monitored for future movement.
2. Crest Problems (cont.)

7 - Low Area on the Crest

Causes:
1. Excessive settlement of the embankment material or the foundation.
2. Internal erosion of the embankment material.
3. Prolonged erosion from wind or water.
4. Poor construction practices.

Concerns:
1. Reduced freeboard for safe routing of floodwater.
2. Floodwater may overtop the embankment in the low area rather than passing through the spillway.

Recommended Action:
1. Notify your Dam Safety Officer. The services of a qualified Professional Engineering Consultant may be required to determine the cause and recommend a plan of action.

8 - Sinkhole on the Crest

Causes:
1. Burrowing animals.
2. Internal erosion from seepage piping or a hole in the conduit.

Concerns:
1. Sloughing/caving can occur in the sinkhole leading to embankment instability and development of a low area.
2. Provides an entrance point for surface water.
3. Depending on size and depth, may lead to a failure.

Recommended Action:
1. Notify your Dam Safety Officer. The services of a qualified Professional Engineering Consultant may be required to determine the cause and recommend a plan of action.
3. Upstream Slope Problems

1 - Erosion (Beaching and Scarps)

Causes:
1. Wave or ice action.
2. Local settlement.
3. Inadequate erosion protection.

Concerns:
1. Continued erosion can reduce crest width and height leading to a possible overtopping.
2. May cause increased seepage.

Recommended Action:
1. Regrade the upstream slope to the original design grade.
2. Provide adequate slope protection.

2 - Displaced and Broken Down Riprap

Causes:
1. Wave or ice action.
2. Poor quality riprap.
3. Same size rock (improperly designed), leaving gaps which allow waves to erode underlying material.

Concerns:
1. Allows increasing erosion which can reduce the width and height of the embankment.

Recommended Action:
1. Re-establish adequate slope protection with underlying filter bed.
2. Repair erosion damage with properly designed erosion protection.

3 - Burrowing Animal Activity

Cause:
1. A habitat which encourages beaver and muskrat activity.

Concern:
2. Burrowing can weaken the embankment and lead to its failure.

Recommended Action:
1. Remove the burrowing animals.
2. Compact the burrows with compacted fill or a pumped grout.
3. Remove the supporting habitat.
3. Upstream Slope Problems (cont.)

4 - Excessive Vegetation and Trees

Causes:
1. Neglect.
2. Poor maintenance procedures.

Concerns:
1. Can obscure serious problem which may exist.
2. Root systems can penetrate and weaken the embankment and create seepage paths.

Recommended Action:
1. Remove excessive vegetation.
2. Keep vegetation under control as part of a regular maintenance program.

5 - Large Cracks

Causes:
1. A foundation failure.
2. Localized instability.

Concerns:
1. Almost always precedes a slope failure or large scale settlement.

Recommended Action:
1. The reservoir should be drawn down.
2. Notify your Dam Safety Officer. The services of a qualified Professional Engineering Consultant may be required to determined the cause and recommend a plan of action.

6 - Slide or Slump

Causes:
1. Foundation failure.
2. Too steep a slope.
3. A rapid draw down of the reservoir.

Concerns:
1. Can lead to a failure of the dam.
2. Slide debris can block low level outlets.

Recommended Action:
1. Draw the reservoir down.
2. Notify your Dam Safety Officer. The services of a qualified Professional Engineering Consultant may be required to determined the cause and recommend a plan of action.
3. Upstream Slope Problems (cont.)

7 - Sinkhole

**Cause:**
1. Concentrated seepage begins to “pipe” embankment material through the dam. This loss of material causes the inlet of the “pipe” to collapse forming a sinkhole.

**Concern:**
1. Usually results in a piping failure.

**Recommended Action:**
1. Draw the reservoir down.
2. Look for other sinkholes and their exits.
3. Examine outflow for dirty water.
4. Notify your Dam Safety Officer. The services of a qualified Professional Engineering Consultant may be required to determined the cause and recommend a plan of action.

4. Downstream Slope Problems

1 - Longitudinal Cracking

**Causes:**
1. Drying and shrinking of embankment material.
2. Settlement of embankment of foundation material.

**Concerns:**
1. Provides an entry point for surface water.
2. Causes embankment instability.
3. Can be an early warning of a slope failure, slide or slump.

**Recommended Action:**
1. Drying cracks should be sealed.
2. Notify your Dam Safety Officer. The services of a qualified Professional Engineering Consultant may be required to determined the cause and recommend a plan of action.

2 - Slump / Slide

**Causes:**
1. Too steep a slope.
2. Loss of embankment material strength from settlement or excessive seepage.

**Concerns:**
1. Can cause additional slumps/slide.
2. Can lead to embankment failure.

**Recommended Action:**
1. Draw down the reservoir.
2. Notify your Dam Safety Officer. The services of a qualified Professional Engineering Consultant may be required to determined the cause and recommend a plan of action.
4. Downstream Slope Problems (cont.)

3 - Wet Areas / Seepage

**Causes:**
1. Seepage through the embankment or under the foundation.
2. Surface water entering through cracks or animal burrows.

**Concern:**
1. Creates slope instability which can lead to a failure.
2. Indicates the possibility of internal erosion (piping).

**Recommended action:**
1. Monitor the area for a change in size.
2. Monitor seepage outflow, if any, for dirty water which would indicate internal erosion (piping).
3. If dirty water is seen notify your Dam Safety Officer. The services of a qualified Professional Engineering Consultant may be required to determine the cause and recommend a plan of action.

4 - Cave in / Collapse

**Causes:**
1. Poor compaction during construction.
2. Internal erosion (piping) through the embankment or foundation.
3. Animal burrowing.

**Concerns:**
1. Can cause increased seepage.
2. Indicates a potential for failure.

**Recommended action:**
1. Monitor the area for change.
2. Notify your Dam Safety Officer. The services of a qualified Professional Engineering Consultant may be required to determine the cause and recommend a plan of action.

5 - Erosion / Rutting

**Causes:**
1. Livestock traffic.
2. Surface runoff.
3. Poorly protected slope.

**Concerns:**
1. Encourages further erosion.

**Recommended action:**
1. Regrade slope and sow a cover crop.
2. Keep livestock off embankment.
5. Downstream Toe Problems

1 - Seepage Water Exiting as a Sand or Water Boil

Causes:
1. A concentrated seepage path or pipe has developed through the foundation.
2. A layer of sand or gravel in the foundation being charged by the reservoir.

Concern:
1. Dirty seepage water is an indication that piping may be occurring and may result in a piping failure of the foundation and ultimately the embankment.

Recommended Action:
1. The outflow should be examined for dirty water.
2. The area and flow should be monitored and the reservoir drawn down if flows increase.
3. Notify your Dam Safety Officer.
4. The services of a qualified Professional Engineering Consultant may be required.

2 - Standing / Ponded Water at the Downstream Toe

Causes:
1. Heavy seepage.
2. Surface runoff.
3. Poor drainage away from the toe.

Concerns:
1. Obscures source and makes flow rates difficult to estimate.
2. Saturates and destabilizes the downstream slope.
3. Can result in slope failure.

Recommended Action:
1. Provide and adequate drainage system to prevent ponding.
2. Identify source of water and consult a Professional Engineer if necessary.

6. Downstream Abutment Problems

1 - Wet Areas or Water Exiting from Downstream Abutment

Cause:
1. A seepage path or “pipe” passing around the embankment through the natural abutment material.

Concern:
1. May result in an abutment piping failure.

Recommended Action:
1. Monitor the area and flow for change and the presence of dirty water.
2. Notify your Dam Safety Officer.
3. The services of a qualified qualified Professional Engineering Consultant is required if the seepage flow increases and dirty water is present.
7. Low Level Outlet Problems

1 - Inoperable Low Level Outlet Control

Causes:
1. Deterioration of concrete. Excessive force applied to a jammed control stem.
2. Inadequate or broken stem guides. Lack of maintenance requiring excessive pressure to operate the gate.
3. Lack of maintenance causing guides to bind to stem and break when gate is jammed.
4. Corrosion, cavitation, impact from water borne debris.

Concerns:
1. Gate control becomes inoperable preventing a draw down of the reservoir, if required, and preventing passage of water for downstream uses.
2. If gate is jammed open, reservoir operating levels cannot be maintained and water is wasted.

Recommended Action:
1. Use of the outlet control should be minimized until all damaged components are repaired.
2. Institute a regular maintenance program to ensure control system is fully operable.

2 - Perforated Conduit

Causes:
1. Corrosion
2. Joint separation.

Concern:
1. May lead to serious internal erosion and a possible piping failure (see Figs. 16 and 17 on pp. 30 & 31).

Recommended Action:
1. Notify your Dam Safety Officer. The services of a qualified Professional Engineering Consultant may be required to determined the cause and recommend a plan of action.
8. Spillway Problems

1 - Eroded Channel / Slide

Causes:
1. Inadequate erosion protection.
2. Too steep a gradient.

Concerns:
1. Channel erosion deepens and generally works its way upstream.
2. Can result in the reservoir draining through the eroded channel.

Recommended Action:
1. Repair the eroded area with compacted fill.
2. Provide adequate erosion protection.
3. Regrade the channel if necessary.

2 - Blocked Channel

Causes:
1. Floating debris from the reservoir.
3. Man-made.

Concerns:
1. May restrict spillway channel flow causing the embankment to overtop.

Recommended Action:
1. Remove the blockage.
2. Prevent future blockages.
3. Install trash racks if necessary.

3 - Other Problems

There are many problems that can develop depending of the type of spillway and the materials it is constructed from. If the spillway develops problems which go unnoticed the embankment may be endangered.

Recommended action:
1. Ensure that the capacity of the spillway matches the design flood inflow.
2. Regularly inspect and maintain the spillway.
3. Remove any blockage of the spillway.
4. If uncertain about a particular problem, an engineer should be consulted.
DAM MAINTENANCE & EQUIPMENT TESTING RECORDS
KEEP A LOG OF ALL COMPLETED MAINTENANCE & EQUIPMENT TESTS HERE
Keep a log of all maintenance and/or equipment inspections here below. A template for equipment tests has been included on the next page.

**DAM NAME:**

<table>
<thead>
<tr>
<th>DATE</th>
<th>DAM MAINTENANCE OR EQUIPMENT TEST PERFORMED</th>
</tr>
</thead>
</table>
**CHECKLIST FOR EQUIPMENT INSPECTION – TEMPLATE**

This template is meant to be customized by the owner.

<table>
<thead>
<tr>
<th>Item</th>
<th>✔</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Slide Gates</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inspect gate seals for leakage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inspect stem threads for debris or damage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inspect gate body and thimble for wear or damage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Check all mechanical components for tightness</td>
<td></td>
<td></td>
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<tr>
<td>Inspect and lubricate operator/handwheel</td>
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<td></td>
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<tr>
<td>Gate cycles full open to full closed</td>
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<tr>
<td>Remove any debris</td>
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<tr>
<td><strong>Gate valves</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inspect valve seals for leakage</td>
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<td></td>
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<tr>
<td>Inspect stem threads for debris or damage</td>
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<td></td>
</tr>
<tr>
<td>Inspect valve body for wear or damage</td>
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<tr>
<td>Check all mechanical components for tightness</td>
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<td></td>
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<tr>
<td>Inspect and lubricate valve operator/handwheel</td>
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<td></td>
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<tr>
<td>Valve cycles full open to full closed</td>
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<tr>
<td>Remove any debris</td>
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<tr>
<td><strong>Butterfly valves</strong></td>
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<td></td>
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<tr>
<td>Inspect valve seals for leakage</td>
<td></td>
<td></td>
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<tr>
<td>Lubricate gate bearings</td>
<td></td>
<td></td>
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<tr>
<td>Inspect valve body and disk for wear or damage</td>
<td></td>
<td></td>
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<tr>
<td>Check all mechanical components for tightness</td>
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<tr>
<td>Inspect and lubricate valve operator/handwheel</td>
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<tr>
<td>Valve cycles full open to full closed</td>
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<tr>
<td>Remove any debris</td>
<td></td>
<td></td>
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<tr>
<td><strong>Stoplogs</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Check stoplogs for rot or damage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Check stoplog guides for rust or damage</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Log Boom</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inspect logs (or floating barriers) for buoyancy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Check chain/cable holes (maintain 0.5m from end)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inspect boom chains/cables for damage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Check anchor and anchor chain connections</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Does the boom extend shore to shore?</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Diversion Structures</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inspect diversion structure and associated equipment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Check fish barriers</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Remote Monitoring and Control</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inspect all monitoring equipment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Verify monitoring is reading correctly</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test remote controls and verify operation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test remote control set points, limit switches, etc</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Item</td>
<td>✔</td>
<td>Notes</td>
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</tr>
<tr>
<td><strong>Back up Power supply</strong></td>
<td></td>
<td></td>
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<tr>
<td>Test operate back up power supply</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Gasoline engine</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test operate engine</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Change oil and fuel filters</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inspect throttle linkage, spark plugs, ignition system, battery</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Check engine coolant level</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inspect exhaust pipe and muffler</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fill gas tank and add conditioner</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Check battery electrolyte level, specific gravity, condition of leads</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Drive motor AC or DC</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test operate motor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lubricate motor bearings</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Measure resistance of windings</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Record current readings with motor under load</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inspect contractor and control wiring</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Electric drive motor</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test operate motor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lubricate bearings</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Measure resistance of windings and controls</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Check brake solenoid and measure its resistance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Check contactor assembly, control wirings and heaters</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Gearbox</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Check oil level and for water in the oil</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inspect gearbox heaters</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inspect condition of gears</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inspect and lubricate gear change mechanism and couplings</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Inspected by: (Sign) (Print) (Date)
Approved by: (Sign) (Print) (Date)
SITE SURVEILLANCE RECORDS
KEEP A COPY OF ALL COMPLETED SURVEILLANCE FORMS HERE   -->
SITE SURVEILLANCE  
(For Concrete Dams) 

It is recommended that you customize this form for your dam

Dam Name: ________________________  Dam File #: ________________________

Inspection Date: ________________  Frequency of Inspections: ________________

Your Name: ________________________  Other Participants: ________________________

Was the spillway flowing?  If yes, what was the water depth over the spillway sill? _______

Y  N  (circle one)  If no, how far was the water below the spillway sill level? _______

Was the low level outlet open?  If yes, what was the approximate discharge rate? _______

Y  N  (circle one)

Are the following components of your dam in SATISFACTORY CONDITION? Yes or No?

Check box if applicable - Please refer to the Inspection and Maintenance of Dams manual for dam inspection information

<table>
<thead>
<tr>
<th>CONCRETE STRUCTURE</th>
<th>OUTLET</th>
<th>SPILLWAY</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Alignment</td>
<td>1. Outlet Pipe</td>
<td>1. Debris Boom</td>
</tr>
<tr>
<td>2. Joint Filler</td>
<td>2. Energy Dissipater</td>
<td>2. Entrance</td>
</tr>
<tr>
<td>5. Public safety signs</td>
<td>5. Outlet Channel</td>
<td>5. Walls</td>
</tr>
<tr>
<td></td>
<td>7. Outlet Controls</td>
<td>7. Channel Slopes</td>
</tr>
</tbody>
</table>

Were any of the following POTENTIAL PROBLEM INDICATORS found?

<table>
<thead>
<tr>
<th>INDICATOR</th>
<th>CONCRETE STRUCTURE</th>
<th>OUTLET</th>
<th>SPILLWAY</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Seepage</td>
<td>YES  NO</td>
<td>YES  NO</td>
<td>YES  NO</td>
</tr>
<tr>
<td>b) External Erosion</td>
<td>YES  NO</td>
<td>YES  NO</td>
<td>YES  NO</td>
</tr>
<tr>
<td>c) Cracks</td>
<td>YES  NO</td>
<td>YES  NO</td>
<td>YES  NO</td>
</tr>
<tr>
<td>d) Settlement</td>
<td>YES  NO</td>
<td>YES  NO</td>
<td>YES  NO</td>
</tr>
<tr>
<td>e) Horizontal Movement</td>
<td>YES  NO</td>
<td>YES  NO</td>
<td>YES  NO</td>
</tr>
<tr>
<td>f) Excessive Debris</td>
<td>YES  NO</td>
<td>YES  NO</td>
<td>YES  NO</td>
</tr>
<tr>
<td>g) Vegetation</td>
<td>YES  NO</td>
<td>YES  NO</td>
<td>YES  NO</td>
</tr>
</tbody>
</table>

Comment on any problems, concerns or deficiencies found:

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

• Complete and file this report form weekly or as required in your OMS manual.
• This form may also be used for monthly inspections of significant failure consequence dams or for quarterly inspections for low failure consequence dams (see Schedule 2 of the Dam Safety Regulation).
• Documentation of your site surveillance may be requested by a Provincial Dam Safety Officer.

Updated: September 2014
SITE SURVEILLANCE
(For Concrete Dams)

It is recommended that you customize this form for your dam

Sketch

Updated: September 2014
SITE SURVEILLANCE  
(For Dams with Earth or Rock Embankments) 

It is recommended that you customize this form for your dam

Dam Name: ____________________________ Dam File #: ____________________________

Inspection Date: ____________________________ Frequency of Inspections: ____________________________

Your Name: ____________________________ Other Participants: ____________________________

Was the spillway flowing? If yes, what was the water depth over the spillway sill? _______

Y   N (circle one) If no, how far was the water below the spillway sill level? _______

Was the low level outlet open? If yes, what was the approximate discharge rate? _______

Y   N (circle one)

Are the following components of your dam in SATISFACTORY CONDITION? Yes or No?

Check box if applicable - Please refer to the Inspection and Maintenance of Dams manual for dam inspection information

<table>
<thead>
<tr>
<th>EMBANKMENT</th>
<th>OUTLET</th>
<th>SPILLWAY</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. U/S Slope</td>
<td>1. Outlet Pipe</td>
<td>1. Debris Boom</td>
</tr>
<tr>
<td>2. Crest</td>
<td>2. Energy Dissipater</td>
<td>2. Entrance</td>
</tr>
<tr>
<td>5. Seepage Weirs</td>
<td>5. Outlet Channel</td>
<td>5. Walls</td>
</tr>
</tbody>
</table>

Were any of the following POTENTIAL PROBLEM INDICATORS found?

<table>
<thead>
<tr>
<th>INDICATOR</th>
<th>EMBANKMENT</th>
<th>OUTLET</th>
<th>SPILLWAY</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Seepage</td>
<td>YES</td>
<td>NO</td>
<td>YES</td>
</tr>
<tr>
<td>b) External Erosion</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c) Cracks</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>d) Settlement</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>e) Sloughing / Slides</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>f) Animal Activity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>g) Excessive Growth</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>h) Excessive Debris</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Comment on any problems, concerns or deficiencies found:

• Complete and file this report form weekly or as required in your OMS manual.
• This form may also be used for monthly inspections of significant failure consequence dams or for quarterly inspections for low failure consequence dams (see Schedule 2 of the Dam Safety Regulation).
• Documentation of your site surveillance may be requested by a Provincial Dam Safety Officer.

Updated: September 2014
SITE SURVEILLANCE
(For Dams with Earth or Rock Embankments)

It is recommended that you customize this form for your dam

Sketch
FORMAL ANNUAL INSPECTION RECORDS
KEEP A COPY OF ALL COMPLETED FORMAL ANNUAL INSPECTIONS HERE -->
Formal Annual Inspection  

Pre-Inspection Information

It is recommended that you customize this form to fit your dam.

Name of Dam: ____________________  Inspection Date: ____________________

Current Weather: __________________  Weather During Last Week: __________________

Name of Creek, Stream, River: __________________  Water Licence #: __________________

Dam Owner: ________________________________________________________________

Address: ________________________________________________________________

City, Province: __________________  Postal Code: __________________

Name of Principle Contact Person: ____________________________________________

Principle Contact's Bus Phone: __________________  Principle Contact's Cell Phone: __________________

Principle Contact's Email: ____________________________________________________

Person Responsible for this Inspection: __________________  Phone #: __________________

Other Inspection Participants: ________________________________________________

Date of Last Annual Inspection: __________________  Was last Annual Inspection Report reviewed?: __________________

Were dam deficiencies identified that required follow-up?: __________________

Date of Last Dam Safety Report (DSR): __________________  Was last DSR Report reviewed?: __________________

Were recommendations from the last DSR Report implemented?: __________________

Repairs or modifications since last formal inspection? (where, when) __________________________________________________________

Failures/Incidents/Breaches since last formal inspection? __________________________________________________________

Has all the maintenance done in the last year been documented?: __________________

Are the Works Currently Fully Operational?: __________________

Dam Information

Type of Dam: __________________  Max. Height of Dam: __________________

Are dam materials well known?: __________________  Are foundation conditions well known?: __________________

Are dam construction details well known?: __________________  Construction Date: __________________

Failure Consequence Classification

Circle current Failure Consequence Classification (based on BC Dam Safety Regulation)

Low  Significant  High  Very High  Extreme

Hydrology

Drainage Area Size: __________________  Reservoir Area: __________________

Inflow Design Flood (IDF): __________________ m³/s  IDF Return Period: __________

1000 yr Flood: __________________ m³/s  (If available): __________

Probable Maximum Flood: __________________ m³/s  (If available): __________

Spillway Crest Elevation: __________________  Spillway Width: __________________

Spillway Capacity: __________________  Net Freeboard (while spillway passing IDF): __________

Gross Freeboard (@ full supply level): __________________  Freeboard (at time of visit): __________________

Reservoir Storage Volume: __________________  Licenced Storage Volume: __________________

Emergency Preparedness Plan (EPP)

Has the emergency contact information in the EPP been updated this year and distributed as required?: __________________

Other Key Information

Person Responsible for Formal Inspection: __________________  Date: __________________
### Embankment Dam

#### 1. Upstream Slope

<table>
<thead>
<tr>
<th>VEGETATION</th>
<th>Type</th>
<th>Yes/No</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recommendations:</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| SLOPE PROTECTION | Type | None/Grass/Riprap/Other | | |
| Notes | | | |

| EROSION | Yes/No | Location |
| Type | Wave/Runoff/Unknown |
| Length | Width |
| Notes | | |

| INSTABILITIES | Slides | Yes/No/Could not Inspect |
| Length | Width | Location |
| Notes/Causes | | |

| Cracks | Yes/No | Transverse/Longitudinal/Other |
| Quantity | Length | Width |
| Location | | |
| Notes/Causes | | |

| Bulges/Depressions/Hummocky | Yes/No |
| Size | Height | Depth |
| Location | | |
| Notes/Causes | | |

| OTHER | Burrows, Ruts, Other Concerns |
| Location | |
| Notes/Causes | |

#### 2. Crest

| ACCESS | Is there public access to the crest? (Yes/No) |
| Is the crest marked or signed? (Yes/No) |
| Is vehicle access to the crest restricted? (Yes/No) |

| VEGETATION | Trees | Yes/No |
| Location | |
| Notes | |

| Brush | None/Sparse/Dense |
| Location | |
| Notes | |

| Ground Cover | Bare/Grass/Other |
| Quantity (bare/sparse/adequate/dense) |
| Appearance (too tall/too short/good) |
| Notes | |

| EROSION | Yes/No | Location |
| Type | Wave/Runoff/Unknown |
| Length | Width |
| Notes | | |

| SETTLEMENT | Location |
| Notes/Causes | | |
## Instabilities

### Cracks
- **Type**: Transverse/Longitudinal/Other
- **Quantity**: Length
- **Width**: Location
- **Notes/CAUSES**: None

### OTHER
- **Burrows, Ruts, Other Concerns**: Location
- **Notes/CAUSES**: None

## 3. Downstream Slope

### Vegetation
- **Trees**: Location
- **Notes**: None

- **Brush**: None/Sparse/Dense
- **Location**: None
- **Notes**: None

- **Ground Cover**: Bare/Grass/Other
- **Notes**: None

### Slope Protection
- **Type**: None/Grass/Other
- **Notes**: None

### Erosion
- **Yes/No**: Location
- **Notes**: None

### Instabilities
- **Slides**: Length
- **Width**: Location
- **Notes/CAUSES**: None

- **Cracks**: Yes/No
- **Transverse/Longitudinal/Other**: Location
- **Notes/CAUSES**: None

- **Bulges/Depressions/Hummocky**: Yes/No
- **Size**: Height
- **Depth**: Location
- **Notes/CAUSES**: None

### Other
- **Burrows, Ruts, Other Concerns**: Location
- **Notes/CAUSES**: None

### Seepage
- **Wet Area/Flow/Boil/Sinkhole**: Location
- **Aquatic Vegetation**: Yes/No
- **Rust Colored Deposits**: Yes/No
- **Sediment in Flow**: Yes/No
- **Other**: Notes

### Embankment Drains
- **Yes/No**: Location
- **Type**: Flow rate
- **Size**: Number
- **Location**: None
- **Notes**: None

### Monitoring Instrumentation Condition
- **None found**: Location
- **Piezometers**: Location
- **Weir**: Location
- **Flume**: Location
- **Notes**: None
**Concrete Dam**

1. **Upstream Side and Crest**

**ALIGNMENT/OFFSETS**
- Movement at Joints? 
- Settlement? 

**JOINT FILLER**
- Any Loss? 
- Vegetation? 

**UNUSUAL CRACKS**
- New? 
- Efflorescence? 
- Displacement? 

**DETERIORATION**
- Concrete Breakdown? Diagnosis: 
- Erosion 
- Scour 

2. **Downstream Side**

**ALIGNMENT/OFFSETS**
- Movement at Joints? 
- Settlement? 

**JOINT FILLER**
- Any Loss? 
- Vegetation? 

**UNUSUAL CRACKS**
- New? Type? 
- Efflorescence? 
- Displacement? 

**DETERIORATION**
- Concrete Breakdown? Diagnosis: 
- Erosion 
- Scour 

**UNUSUAL LEAKAGE**
- Increase? Clear? 
- Weir? Flow Estimate? 

**DRAINS**
- Flow? Calcite Build-up? 

---

**Required Action**

- Photo #s

- None
- Monitor
- Maintenance
- Repair
- N / A
### Spillway

**GENERAL CONDITIONS**

- **Type**: Gated? - Yes/No
- **Notes**

1. **Spillway Crest or Control Section**

#### OBSTRUCTION

- **Debris**: Yes/No
- **Location**
- **Notes**
- **Vegetation**: None/Sparse/Dense
- **Location**
- **Notes**
- **Other**: (beaver activity, trash rack problems, etc.)

#### LOG BOOM

- **Condition**: Yes/No
- **Required?**: Yes/No
- **Logs**: Yes/No
- **Connections**: Yes/No
- **Anchors**: Yes/No

#### SPILLWAY CREST MATERIALS

- **Condition**
- **Notes**

#### SPILLWAY GATES

- **Yes/No**
- **Type**:

#### OTHER SPILLWAY CREST PROBLEMS

- **Damage**
- **Location**
- **Notes/Cause**

2. **Spillway Conveyance Section: Channel, Chute or Conduit**

#### OPEN CHANNEL CROSS SECTION

#### CHANNEL OBSTRUCTION

#### SPILLWAY CONVEYANCE MATERIALS

#### OTHER SPILLWAY CONVEYANCE PROBLEMS

- **Damage**
- **Location**
- **Notes/Cause**

3. **Energy-Dissipating or Terminal Section**

#### EROSION CONTROL STRUCTURE

- **Type**: Endwall/Headwall/Plunge pool/impact basin/Baffled chute/Rock lined channel/Other/None
- **Notes**
# Low Level Outlet

## GENERAL

**Gate Type**

- [ ] None

## ACCESS TO VALVE/GATE

Under all circumstances? **Yes/No**

- [ ] Not accessible
- [ ] from shore
- [ ] Walkway
- [ ] By boat
- [ ] Other

**Walkway Condition**

## LOW LEVEL OUTLET COMPONENTS

**Valve Control Device**

- [ ] Yes
- [ ] None
- [ ] No Stem
- [ ] Damaged stem
- [ ] Other

**Operational under all conditions?**

- [ ] Yes
- [ ] No
- [ ] Poorly

**Tested Annually?** **Yes/No**

**Tested as per OMS manual?** **Yes/No**

**Notes**

## Valve / Gate

**Location**

**Condition**

## Leakage

- [ ] Yes
- [ ] No

**Flow Rate**

## Outlet Pipe

- [ ] Metal
- [ ] Plastic
- [ ] Concrete
- [ ] Other

**Diameter**

**Condition**

**Outlet Obstruction**

(note vegetation, sediment blockage, etc.)

**Notes**

## OUTLET EROSION CONTROL STRUCTURE

**Type**

**Concrete Condition**

**Outlet Area Seepage**

**Description**

**Flow Estimate**

**Location**

**Undermining**

**Location**

**Notes/Cause:**

**Downstream Channel**

**Free Draining?**

**Blockages or Potential Blockages?**

**Erosion Control? Rip-Rap?**

---

**November 2013**

Page 6 of 8
**Other Key Information**

Is site access adequate for safe operation, maintenance and surveillance?  

Instrumentation adequate for site conditions?  

Are there concerns about reservoir slope stability?  

Any other concerns in the watershed that could impact the dam?  

Operational Constraints that impact Dam Safety?  

Are the required Public Safety signs in place (for dams on Crown land)?  

Other comments on Public Safety:  

Should new development in the downstream inundation zone initiate a review of the Failure Consequence Classification?:  

Yes/no?  Comments:  

**Maintenance**

In the last year have the spillway gates been exercised and tested in accordance with the OMS?  

If so, when and by whom?  

In the last year has the low level outlet gate been exercised and tested in accordance with the OMS?  

If so, when and by whom?  

Is the instrumentation well maintained?  

**NOTES:**
SKETCH OF ISSUES:
INSTRUMENTATION AND MONITORING RECORDS
KEEP A LOG OF ALL INSTRUMENTATION AND MONITORING HERE   -->

DAM INCIDENTS
KEEP A LOG OF DAM INCIDENTS HERE
Facility: <insert project name>  Event Date: 

Dam Safety Engineer (Responsible Engineer or Owner):

Description of Incident:
<briefly describe the incident in a sentence>

Systems Operated As Intended:  Action Needed:
Yes/No  Yes/No

Background:
<describe incident, include pertinent site condition such as reservoir elevations & weather, exact location, personnel present, actions taken.>
<include any data from historic performance - instrument response, weather, elevations & photographs>

Analysis:
<describe investigation, observations, what was done, include photographs>
<include any data from instrument response, charts-time series, weather, elevations & photographs.>

Recommendations:
<describe what should be done next, including reporting, repairs & monitoring.>

Distribution:
1. Engineering
2. Facility Operations
3. File

Attachments:
<include repair specifications, plans, correspondence including emails, extra photographs>
5 EMERGENCY RESPONSE
Dam Safety Management System (CDA, 2007)
EMERGENCY DAM ASSESSMENT & RESPONSE
Emergency Dam Assessment and Immediate Response Plan

*If you have a concern about the safety of a dam call the BC Dam Safety Program at 250 952 6790 during office hours.*

*If you have a serious concern and it is outside office hours call Emergency Management BC at 1-800-663-3456.*
Emergency Dam Assessment

Dam Safety Deficiencies
The following diagram illustrates a number of dam safety deficiencies. During times of high reservoir levels and large spillway flows, these deficiencies pose a greater threat to the safety of the dam and should be investigated thoroughly. If the deficiency is considered a threat to the integrity of the dam, it should be reported immediately and appropriate action taken to alleviate the problem. Note: The area downstream of the dam should be considered when determining the potential risk the dam poses (i.e. what is the risk to life, property and/or the environment?).
EMERGENCY DAM ASSESSMENT

Dam Name: __________________________ Date: _________________________________
Your Name: __________________________ Weather Condition: ______________________

Was the spillway flowing? **Y** If yes, what was the approximate flow rate? __________

If no, then how far was the reservoir drawn down below the spillway sill level? ______________

Was the outlet open? **N** If yes, what was the approximate discharge rate? ______

Refer to the *DAM SAFETY EMERGENCIES AND IMMEDIATE RESPONSE ACTIONS* list on Pages 4 and 5, if any of the following **DEFICIENCIES** are found? (Circle Deficiency)

Refer to *DAM DEFICIENCIES*, Page 6, for an explanation of Problems and Causes.

<table>
<thead>
<tr>
<th>DEFICIENCIES</th>
<th>POTENTIAL PROBLEM AND IMMEDIATE RESPONSE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>EMBANKMENT</td>
</tr>
<tr>
<td>OVERTOPPING</td>
<td>A or B</td>
</tr>
<tr>
<td>SEEPAGE</td>
<td>G or H</td>
</tr>
<tr>
<td>EXCESSIVE DEBRIS</td>
<td></td>
</tr>
<tr>
<td>EROSION</td>
<td>C or G</td>
</tr>
<tr>
<td>SETTLEMENT</td>
<td>C or I</td>
</tr>
<tr>
<td>CRACKS</td>
<td>F or I</td>
</tr>
<tr>
<td>EXCESSIVE GROWTH</td>
<td>G or H</td>
</tr>
<tr>
<td>SLIDES/SLOUGHING</td>
<td>F</td>
</tr>
<tr>
<td>BOILS</td>
<td>G or H</td>
</tr>
<tr>
<td>RODENT BURROWS</td>
<td>G or H or I</td>
</tr>
<tr>
<td>CONCRETE DAMAGE</td>
<td>J</td>
</tr>
</tbody>
</table>

NOTES:

_________________________________________________________________________

_________________________________________________________________________

_________________________________________________________________________

_________________________________________________________________________

_________________________________________________________________________

_________________________________________________________________________

_________________________________________________________________________
DAM SAFETY EMERGENCIES & IMMEDIATE RESPONSE ACTIONS

A. OVERTOPPING BY FLOODWATER

- Open outlet to its maximum safe capacity.
- Place sandbags along the crest to increase freeboard and force more water through the spillway and outlet.
- Provide erosion-resistant protection to the downstream slope by placing plastic sheets or other materials over eroding areas.
- Divert floodwater around the reservoir basin if possible.
- Create additional spillway capacity by making a controlled breach in a low embankment or dyke section where the foundation materials are erosion resistant.

B. OVERTOPPING DUE TO BLOCKED SPILLWAY CHANNEL

- Open outlet to its maximum safe capacity.
- If the reservoir does not drop with outlet open then slowly remove debris blocking the spillway channel to allow more water through the spillway. (Note, rapid removal of the spillway blockage may result in extensive flooding downstream. Only if there is an immediate threat to the integrity of the dam should the blockage be removed rapidly.)
- If debris cannot be removed then follow the response action noted above under ‘Overtopping by Floodwater’. (Note: During times of large storm events, high inflow and high reservoir levels, debris resting along the reservoir shoreline can be washed into the reservoir and drawn up to the spillway entrance. This debris should be monitored and removed if it threatens to block the spillway or break the log boom.)

C. LOSS OF FREEBOARD OR DAM CROSS SECTION DUE TO STORM WAVE EROSION

- Place additional riprap or sandbags in damaged areas to prevent further embankment erosion.
- Lower the water level to an elevation below the damaged area.
- Restore freeboard with sandbags or earth and rock fill.
- Continue close inspection of the damaged area until the storm is over.

D. FAILURE OF APPURTENANT STRUCTURES SUCH AS OUTLETS OR SPILLWAYS

- Implement temporary measures to protect the damaged structure, such as closing an outlet or providing temporary protection for a damaged spillway.
- Lower the water level to a safe elevation. If the outlet is inoperable, pumping, siphoning or a controlled breach may be required.
- Uncontrolled seepage alongside the structure may cause damage or failure.

E. SPILLWAY CHANNEL EROSION THREATENING RESERVOIR EVACUATION

- Reduce the flow over the spillway by fully opening the main outlet
- Provide temporary protection at the point of erosion by placing sandbags, riprap materials or plastic sheets weighted with sandbags.
- When inflow subsides, lower the water to a safe level.
- Continue operating at a low water level in order to minimize spillway flow.
F. SLIDES ON THE UPSTREAM OR DOWNSTREAM SLOPE OF THE EMBANKMENT

- Lower the water level at a rate and to an elevation considered safe given the slide condition. If the outlet is damaged or blocked, pumping, siphoning or a controlled breach may be required.
- Restore lost freeboard if required by placing sandbags or filling in the top of the slide.
- Stabilize slides on the downstream slope by weighting the toe area with additional soil, rock or gravel.

G. EROSIONAL FLOWS (PIPING) THROUGH THE EMBANKMENT, FOUNDATION OR ABUTMENTS

- Plug the flow with whatever material is available (hay bales, bentonite or plastic sheeting if the entrance to the leak is in the reservoir basin).
- Lower the water level until the flow decreases to a non-erosive velocity or until it stops.
- Place protective sand and gravel filter over the exit area to hold materials in place.
- Continue lowering the water level until a safe elevation is reached.
- Continue operating at a reduced level until repairs can be made.
- Note: this flow may originate alongside an outlet of spillway structure (see section D).

H. EXCESSIVE (NON-EROSIONAL) SEEPAGE AND HIGH LEVEL SATURATION OF THE EMBANKMENT

- Lower the water to a safe level.
- Continue frequent monitoring for signs of slides, cracking or concentrated seepage.
- Continue operation at a reduced level until repairs can be made.

I. EXCESSIVE SETTLEMENT OF THE EMBANKMENT

- Lower the water level by releasing it through the outlet or by pumping, siphoning or a controlled breach.
- If necessary, restore freeboard, preferably by placing sandbags.
- Lower water to a safe level.
- Continue operating at a reduced level until repairs can be made.

J. LOSS OF ABUTMENT SUPPORT OR EXTENSIVE CRACKING IN CONCRETE DAMS

- Lower the water to a safe level by releasing it through the outlet.
- Implement notification procedures.
- Attempt to block water movement through the dam by placing plastic sheets on the upstream face.
### DAM SAFETY PROBLEM INDICATORS: Causes & Potential Problem

The following table lists some *Potential Problems* (worst case scenario) associated with *Problem Indicators* that may be seen during an Assessment of a Dam along with some likely *Causes*:

<table>
<thead>
<tr>
<th>PROBLEM INDICATORS</th>
<th>CAUSE</th>
<th>POTENTIAL PROBLEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduced Freeboard</td>
<td>Flood Water</td>
<td>Overtopping/Embankment Failure</td>
</tr>
<tr>
<td>Reduced Freeboard</td>
<td>Blocked Spillway Channel</td>
<td>Overtopping/Embankment Failure</td>
</tr>
<tr>
<td>Reduced Freeboard or Dam Cross Section</td>
<td>Storm Wave Erosion</td>
<td>Overtopping/Embankment Failure</td>
</tr>
<tr>
<td>Cloudy Seepage through the Embankment, Foundation or Abutments</td>
<td>Poor Internal Drainage, Seepage Removing Embankment Material (Piping)</td>
<td>Piping/Embankment Failure</td>
</tr>
<tr>
<td>Excessive Clear Seepage and High Level Saturation of the Embankment</td>
<td>Poor Internal Drainage</td>
<td>May Lead to Piping Failure</td>
</tr>
<tr>
<td>Damage to Appurtenant Works</td>
<td>Poor Maintenance, Flood Water and/or Debris Damage etc.</td>
<td>Safe Operation of the Dam Impaired</td>
</tr>
<tr>
<td>Spillway Channel Erosion</td>
<td>High Spillway Flows, Poor Spillway Construction etc.</td>
<td>Uncontrolled Reservoir Release</td>
</tr>
<tr>
<td>Embankment Slides/Sloughs</td>
<td>Structural Deficiency, Saturated Embankment etc.</td>
<td>Embankment Failure</td>
</tr>
<tr>
<td>Excessive Settlement of the Embankment</td>
<td>Structural Deficiency, Foundation Deficiency etc.</td>
<td>Overtopping/Embankment Failure</td>
</tr>
<tr>
<td>Extensive Cracking in Concrete Dams</td>
<td>Structural Deficiency</td>
<td>Uncontrolled Reservoir Release</td>
</tr>
<tr>
<td>Broken Log Boom</td>
<td>Poor Construction or Maintenance, Excessive Force on Boom due to Excessive Debris etc.</td>
<td>Spillway Channel Blocked, Safe Operation and Maintenance of Dam Impaired.</td>
</tr>
</tbody>
</table>
DAM EMERGENCY PLAN (DEP)
INSERT RECORD OF UPDATED AND SUBMITTED DAM EMERGENCY PLAN  -->
Guide & Template for Preparing a Dam Emergency Plan (DEP) in British Columbia

Dam Safety Program

Ministry of Forests, Lands and Natural Resource Operations

Rev.2 Dec 13, 2016
Guide & Template for Preparing a Dam Emergency Plan (DEP) in British Columbia

**Background:**

Emergency response procedures and emergency preparedness plans have been a recommended best dam safety management practice since 1984 in British Columbia. The previous British Columbia Dam Safety Regulation, *Water Act*, required all owners of dams with a consequence classification of significant or higher to prepare an emergency plan, called an Emergency Preparedness Plan (EPP), for their dams.

In 2016, the *Water Sustainability Act* and Dam Safety Regulation replaced the *Water Act* and British Columbia Dam Safety Regulation. The new regulation still requires owners of dams to prepare an emergency plan, now called a Dam Emergency Plan (DEP), however with some differences including what they must contain, what must be done with them, and the date by which they must be prepared and submitted for acceptance by the Dam Safety Officer (DSO). The dam owner may modify the existing EPP and submit it to the DSO for acceptance.

**Requirement:**

As per Sections 9 and 33 of the Dam Safety Regulation, *Water Sustainability Act*, an owner of a dam that has a consequence of failure classification of significant, high, very high or extreme must prepare a Dam Emergency Plan (DEP) that includes:

(i) a record describing the actions to be taken by the owner if there is an emergency at the dam, and

(ii) a record containing information for the use of the local emergency authorities for the dam for the purpose of preparing local emergency plans under the Emergency Program Act.

This guideline and the accompanying DEP template and example DEP were developed to assist dam owners in preparing their DEP.

**Template Origin:**

The Canadian Dam Association (CDA) provides guidance, in their Dam Safety Guidelines, on Emergency Preparedness for dam owners, local emergency authorities and communities. As well as this, the Association of State Dam Safety Officials (ASDSO) and the National Dam Safety Review Board (NDSRB) in the United States have developed an EAP Resource Center to provide dam owners with simple and low cost tools for creating and implementing an Emergency Action Plan (EAP) at their dam(s).

The *Guide & Template for Preparing a Dam Emergency Plan (DEP) in British Columbia* has been adapted from the CDA guidelines and ASDSO EAP Resource Center for use by dam owners in British Columbia to assist in the preparation of their mandatory Dam Emergency Plan. The DEP template is intended for smaller to mid-sized dams but could also be adapted to larger dams.

**What’s New?**

The new DEP is similar in part to the former EPP as it must describe the actions to be taken by the dam owner if a hazardous condition or potential safety hazard at the dam is detected. However, in addition, Section 9(1)(a)(ii) of the Regulation now requires that the DEP include a record containing
specific information about the dam to be used by local emergency authorities (as defined in Part 1, Section 1(2) of the Regulation) for their local emergency plan; a plan mandated under the Emergency Program Act. To prepare this record, the DEP template is designed so that several parts of the DEP can be easily separated to become the record described under Section 9(1)(a)(ii) of the Regulation for provision to local emergency authorities. Those portions of the DEP that make up this record from the template are: Sections 1, 2 & 4.1 and Appendix A (A-1, A-2 & A-3).

It is recognized that many dam owners currently have Emergency Preparedness Plans in place. Section 33 (Transition – Dam Emergency Plan) of the Regulation outlines the date of the next review of this document and when changes, if any, must be submitted to the Dam Safety Officer for acceptance. Existing EPP’s may be acceptable as long as the Regulation requirement outlined in section 9(1)(a)(ii) is fulfilled. The DEP template is only a suggested model of an acceptable DEP and there is no requirement to follow it as long as the information contained in the DEP is acceptable to the Dam Safety Officer (Section 9(1)(b). For owners of previously unregulated dams, Section 33(1) of the Regulation provides timelines for submission of the DEP.

Using the DEP Template:

As every dam owner and their dam are unique, so are DEPs. Therefore the DEP template must be modified to reflect your dam’s requirements. To assist dam owners, the main components of an acceptable DEP are laid out in the DEP template. To complete the DEP the dam owner needs to follow the instructions below and insert dam specific text into the greyed boxes below to begin inserting the text throughout the template. Using the Microsoft WORD feature “find and replace”, dam specific text can be inserted with names and words that apply to the dam, location, personnel, and associated agencies. For example, “dam name” should be replaced by the name of the dam and “dam owner” by the name of the dam owner (as specified in the Dam Safety Regulation under the definition of “owner”).

Below is a list of the insertions, customizations and specific preparations for your DEP such as maps, plans and emergency contact personnel.

Cover page
- “Find and replace”: dam name,
- “Find and replace”: stream name,
- “Find and replace”: dam file number, (see annual Dam Status Report Form or contact DSO)
- Create and add a local area map or photo of dam
- “Find and replace”: dam owner (i.e. licensee or, if more than one licensee, the dam owner’s designate (see Section 22(1) of the Dam Safety Regulation)),
- “Find and replace”: DEP author (person or consultant who prepared DEP)
- Insert: Copy #, revision # and date of last updated

Section 2 – Basic DEP Data
- 2.1 – Fill in the blanks or “choose and item” from the choices provided
- Write the directions on how to get to the dam; include notes on gates and road junctions
- Create and add an access map to the dam

Section 4.2 – Step 3 Notification and Communication
- Complete the three example emergency messages
Section 6 & 7

- List of holders of copies of the DEP including:
  - “Find and replace”: local emergency authority (see Section 1(2) of the Dam Safety Regulation, also see page 5 for more information)
  - “Find and replace”: dam safety officer (see Dam Safety Website for Dam Safety Officer contacts)
- Maintain a record of revisions made to the DEP

Appendix A

- Dam owner’s contacts including: (note; for small dams there may be few people knowledgeable about the dam, however there should be a minimum 2 contacts listed)
  - “Find and replace”: emergency contact for the dam (dam owner’s emergency contact as per Section 9(5) of the Dam Safety Regulation)
  - “Find and replace”: principal dam contact (dam owner’s principal contact), and
  - “Find and replace”: alternate dam contact (dam owner’s secondary contact)
- Evacuation Area Map – Please see FAQ’s on page 6
- List of persons in the immediate vicinity of the dam to be evacuated (note: these are considered the persons located immediately downstream and adjacent to the dam where available warning time is very limited and where local emergency authorities could not be expected to respond in time) – Please see FAQs on pages 5 & 6

Appendix B (List persons to notify if a problem is discovered at the dam)

- Emergency Management BC (the 24 hour call center number is already listed in the template)
- Local Emergency Authority emergency contact number – see FAQs on page 6
- Dam Owner’s Technical Expert (most typically the engineering consultant who is familiar with the dam)
- Dam Safety Officer

Appendix B (List of other useful resources)

- Other emergency service contacts (such as alternate Technical Expert, RCMP, Search and Rescue etc.)
- Emergency response resources (such as heavy equipment services, construction supplies, helicopter charter, boat, ATV & snowmobile rentals etc.)

Appendix C:

- Plan drawing(s) of the dam (at minimum, a plan view of the dam showing pertinent design details and site map of the dam should be included for reference). Refer to any additional plans or pertinent information included in the dam’s Operation Maintenance & Surveillance (OMS) manual.

Appendix F:

- dam name and dam file number to be filled in.

Also there are instructions in the template highlighted in light blue which are to be removed for the final product.
**What to do once DEP template has been completed:**

Once the dam owner has completed the DEP, the DEP needs to be forwarded to the Dam Safety Officer for acceptance. The Dam Safety Officer may return the DEP to the owner with suggestions for improvement if not satisfied with the DEP. Once accepted by the Dam Safety Officer, and as per Section 9(10) of the Regulation, the dam owner must then forward relevant sections of the DEP to the local emergency authority for the purpose of the local emergency authority’s preparation of their own local emergency plans under the *Emergency Program Act*. Once again, those portions of the DEP that make up this record from the template are: *Sections 1, 2 & 4.1 and Appendix A (A-1, A-2 & A-3).*

**FAQs:**

**Q:** I am required to notify “persons in the immediate vicinity of the dam to be evacuated” if I discover a *potential dam failure situation* or a *dam failure appears imminent* or *is in progress*. How do I determine who these persons in the immediate vicinity are?

**A:** First understand that “persons in the immediate vicinity of the dam to be evacuated” are defined by the CDA as the *persons located immediately downstream and adjacent to the dam where available warning time is very limited and where local emergency authorities could not be expected to respond in time*. Therefore, these would include persons living, recreating or otherwise close to the dam that would have very little warning time should evacuation be required. The distance below the dam that might be considered ‘immediate vicinity’ depends on factors such as reservoir size, local topography and stream slope (steepness), and local use and ease of access by persons to areas close to the dam.

Although there is no ‘absolute right answer’, the best way to determine who these persons in the immediate vicinity may be is to either; drive downstream of your dam and note persons living (or working) in the areas along the stream (taking note of who they are) or, use Google Earth (or some other map with imaging) and look for homes or businesses located along the stream downstream of the dam. In both cases best judgment should be used to determine how far downstream you need to go (i.e. would a call from the dam owner be more timely than from the local emergency authority?). You must also consider others, for example, those who may be cut off by loss of their access road or owners of downstream dams. Every dam is unique and you will need to consider your dam’s specific situation.

As well as contact persons in the immediate vicinity you are responsible to notify the local emergency authority if you discover a *potential dam failure situation* or a *dam failure appears imminent* or *is in progress*, and it is the local emergency authority that is then responsible to notify and, if necessary, evacuate persons in imminent danger from an endangered area. The reason it is recommended that the dam owner take on the role of notifying persons close to the dam is because the local emergency authority may not have the time or immediate resources to undertake this function in as timely a manner as the dam owner.

Your Dam Safety Officer may be able to assist you in determining the “immediate vicinity” if required.
Note: if your dam has a consequence of failure classification of significant, by definition you may not have persons that would be considered in the endangered zone and therefore this list may not be required in your DEP. Please confirm with your Dam Safety Officer.

Q: I am required to prepare an “evacuation area map” but I am not sure how to do this.

A: Evacuation area maps are different from dam break inundation maps. The CDA discusses inundation mapping which includes peak flood arrival times, depth of flow, velocity of flow along with impacted infrastructure including roads. Although these are all extremely useful information for emergency planning and decision-making, this information requires considerable expertise to develop. Typically this type of detailed inundation mapping is only required for dams that have a consequence of failure classification of very high and extreme. Dams with a consequence of failure classification of high are required to undertake a Dam Safety Review and during this process the dam owner’s engineering consultant may have already prepared an inundation or evacuation area map. If not, however, these dam owners can develop a basic evacuation area map by first performing a simplified dam break analysis to estimate flood flow, then estimating the possible flooded area through both investigating the downstream area of the dam both on the ground and through the use of Google Earth (or some other map with current imaging) and using your best judgment.

Remember to think about access roads that may be washed out and persons that may be stranded as well as homes located in the valley bottoms close to the stream. Don’t focus on the entire flood zone but on homes that most likely will be impacted.

Again, your Dam Safety Officer may be able to assist you on how to prepare an “evacuation area map” if required.

Note: if your dam has a consequence of failure classification of significant, by definition you may not have persons that would be considered in the endangered zone, however access roads may be impacted and is something to consider on the evacuation map. Evacuation area map would be a very simple look at possible areas that could be impacted by a dam failure.

Q: I am required to send a portion of the DEP to the Local Emergency Authority. How do I get more information about my Local Emergency Authority and how do I determine who my contact person is?

A: The “Emergency Management BC” web site has a section called “Local Authority Emergency Management Programs”. This section describes how local governments have the responsibility to lead the initial response to emergencies and disasters in their communities. Local governments prepare emergency plans and maintain an emergency management organization. From this web site you can also access information about the BC Emergency Management System including applicable legislation. There is also a link to the Civic Info BC Directory from which you can search for the Local Emergency Authority(s) responsible for the area around your dam and the downstream area.
Dam Emergency Plan (DEP)

**Dam Owner:** dam owner

**Prepared By:** DEP author

**Copy # of #**

**Revision:** Revision #

**Reviewed and Updated:** Click here to enter a date.

Binder Note: The template is intended to be distributed in a digital Microsoft Word format (.docx) for editing. ONLY the guidance portion of the document have been included in this section.

A copy of this digital file is included on a CD located at the back of this binder.

Rev.2 Dec 13, 2016
Dam Safety Management System (CDA, 2007)
1. POLICY STATEMENT

Extreme (E), Very High (VH) and High (H) Consequence Classification dams will be audited at least every 5 years. Significant (S) Consequence Classification dams will be audited at least every 10 years and the Low (L) Consequence Classification dams will not be included in the audit program at this time.

2. DEFINITIONS

Relevant terms are defined in the British Columbia Dam Safety Regulation as well as in the Water Act.

3. PREFACE

The Dam Safety Audit Program was developed by Land and Water BC Inc. in 2003 as an additional dam safety compliance tool under the Dam Safety Compliance Strategy. This policy updates the Strategy by including a revised Dam Audit Check Sheet.

In all cases, dam owners are clearly responsible for the inspection, safe operation and maintenance of their dams. English common law, on which our legal system is based, considers dams to be “inherently dangerous structures” and those who own dams are liable for damages that are caused by the dam.

Under the authority of British Columbia Dam Safety Regulation, the Ministry of Forests, Lands and Natural Resource Operation operates a dam safety program to regulate dam owners to ensure that their structures are designed, constructed and maintained according to acceptable standards for public safety. The Ministry also has a “duty of care” responsibility to regulate dam owners under the Water Act of British Columbia.

The Audit Program has been developed to determine whether dam owners are in compliance with the British Columbia Dam Safety Regulation.

It is important to note that the Dam Safety Audit Program is not designed as a method for correcting deficiencies. Deficiencies will be addressed using the existing Risk Based Classification and Monitoring procedure. The Dam Safety Officer will give a copy of a “Dam Audit Check Sheet” to the owner (see Audit Procedure below).

Appendix 1 provides the revised Dam Audit Check Sheet.

Appendix 2 provides the Dam Failure Probability Guideline.
4. STRATEGIC PRINCIPLES

1) **Owner Responsibility** – Dam owners are responsible for the inspection, safe operation and maintenance of their structures.

2) **Consequence Classification** – Dams with higher downstream consequence classifications, as defined in Schedule 1 of the [British Columbia Dam Safety Regulation](#), will be audited more frequently than those with lower classifications.

3) **Balanced Priorities** – Implementation of the audit program must be balanced with other dam safety priorities. Dam Safety Officers spend between 50% and 100% of their time on dam safety work. As a guide, no more than 30% of their dam safety work time should normally be used to conduct audits.

5. AUDIT PROCEDURES

Dam Safety Officers will create an annual audit schedule as part of their personal work plan. Dam Safety Officers will schedule audits of dams in the same area and combine the audits with other work to maximize the use of field time.

Dam Safety Officers will complete a “Dam Audit Check Sheet” (see Appendix 1) and will provide a copy to the owner on site. Also, when possible Dam Safety Officers should complete a dam inspection with the owner while on site.

Audit information will be entered into the dam registry in E-Licensing and the dam file upon return to the office. Consequence classification, probability of failure and risk level will be reassessed and entered into the dam registry (Appendices 1 and 2).

The Dam Safety Officer will send a follow up letter to the dam owner outlining the findings of the audit including, compliance with the British Columbia Dam Safety Regulation, site observations and recommendations.

If a hazardous condition is uncovered during an audit, the Dam Safety Officer will attend to the situation immediately.

The Dam Safety Compliance Strategy, September 17th, 2002 and the 1998 Policy and Procedures Manual, Section 7, subsection 07.01.04 – Risk Based Classification and Monitoring are still in effect.

Also, Dam Safety Officers should also be familiar with the Dam Failure Probability Guideline (Appendix 1 and 2).
Appendix 1: Dam Audit Check Sheet

DAM AUDIT PROGRAM
DAM AUDIT CHECK SHEET

Dam: _______________________________ Date: ________________

<table>
<thead>
<tr>
<th>Failure Consequence Rating</th>
<th>E</th>
<th>VH</th>
<th>H</th>
<th>S</th>
<th>L</th>
<th>Risk Level: (see over)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Failure Probability Rating</td>
<td>Lrg</td>
<td>Mod</td>
<td>Sm</td>
<td>VSm</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

This Audit is not an Inspection of the dam. The dam owner is responsible for dam inspections.

DAM SAFETY REGULATION REQUIREMENTS

Consequence Rating Appropriate? | Yes | No | N/A | Follow Up? |
Alterations or Hazards occurred recently? | | | | |
Owner Reported any recent alterations or hazards? | | | | |
Emergency Plan Prepared? | | | | |
Emergency Plan Submitted and Updated? | | | | |
OMS Plan Prepared? | | | | |
OMS Plan Submitted? | | | | |
Reservoir Operation as per OMS Manual? | | | | |
Maintenance Suitable? | | | | |
Surveillance Suitable? | | | | |
Annual Inspection Suitable? | | | | |
Sign posted on dam? (Crown land only) | | | | |
Dam Safety Review Status Acceptable? | | | | |

Comments & Site Observations: __________________________________________
_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________

Dam Owner / agent present for audit? | Y | N | Copy given to Dam Owner / agent? | Y | N |
Printed Name of Dam Safety Officer | | Signature | Date |
Printed Name of Dam Owner / agent | | Signature | Date |

Printed: Sep 2011 White: Water Management Branch – Dam Safety Yellow: Dam Owner
Appendix 1, continued

FAILURE PROBABILITY RATING GUIDELINES

<table>
<thead>
<tr>
<th>RATING</th>
<th>GENERAL GUIDELINES FOR ALLOCATING RATINGS</th>
</tr>
</thead>
<tbody>
<tr>
<td>LARGE</td>
<td>• Uncorrected design, construction, structural and/or operational deficiencies that could clearly lead to uncontrolled reservoir release. If the dam owner is actively working on an approved project to correct the deficiency the rating can be reduced to MODERATE. Owner exhibits reluctance to operate in a safe and timely manner, or is incapable of doing so; all unlicensed dams are allocated this rating.</td>
</tr>
<tr>
<td>MODERATE</td>
<td>• Uncorrected design, construction, structural and/or operational deficiencies that could potentially lead to uncontrolled reservoir release. Owner exhibits reluctance to undertake and report on annual inspection, or is incapable of doing so. Design and operation lacks redundancy, e.g. no back-up power for electrical gates.</td>
</tr>
<tr>
<td>SMALL</td>
<td>• Design and/or performance deficiencies may exist, but are actively monitored and are not expected to significantly increase failure potential over the near term. Design and operation exhibits redundancy.</td>
</tr>
<tr>
<td>VERY SMALL</td>
<td>• Dams that are breached, partially breached, reservoir drained or otherwise safeguarded. Failure modes analysis indicates very low probability of failure (e.g., robust concrete gravity dam).</td>
</tr>
</tbody>
</table>

RISK LEVEL CHART *

<table>
<thead>
<tr>
<th>Failure Probability Rating</th>
<th>Failure Consequence Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Extreme</td>
</tr>
<tr>
<td>Large</td>
<td>1</td>
</tr>
<tr>
<td>Moderate</td>
<td>2</td>
</tr>
<tr>
<td>Small</td>
<td>3</td>
</tr>
<tr>
<td>Very Small</td>
<td>3</td>
</tr>
</tbody>
</table>

1) ALERT (immediate attention required):
   Enhanced monitoring / consultants involved / repairs ASAP / may restrict reservoir operation / EPP reviewed / CWR or RWLM notified, possible Order

2) CAUTION (considerable work to do):
   Increased monitoring / planning for rehab / may modify reservoir operation / EPP reviewed / may request submission of Inspection Report (perhaps weekly), OMS, or early DSR / CWR or RWLM made aware of situation

3) STABLE:
   Regular owner inspections plus monitoring operation under peak loading / rehab hazardous conditions / may request submission of Annual Inspection Report, OMS, or early DSR / may audit on an increased frequency

4) NO CONCERNS:
   Included in regular audit program to identify any changes / normal operation

5) EFFECTUAL (significant and low consequence dams ONLY):
   Significant consequence dams included in regular audit program to monitor failure consequence only / normal operation

*Note: The risk level chart is only a guide. If the Dam Safety Officer deem the risk level of the dam to be different than that prescribed by the risk level chart, the rationale for the variation should be provided by the Dam Safety Officer in the Comments & Site Observations field on the first page.

* Schedule 1, Dam Safety Regulation, BC Reg. 108/2011
* Low consequence dams are not included in the audit program at this time.

Printed: Sep 2011 White: Water Management Branch – Dam Safety Yellow: Dam Owner
## Appendix 2: Dam Failure Probability Rating Guideline

<table>
<thead>
<tr>
<th>RATING</th>
<th>GENERAL GUIDELINES FOR ALLOCATING RATINGS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>(NOTE: Apply highest rating, only one bullet required)</strong></td>
</tr>
<tr>
<td>LARGE</td>
<td>• Uncorrected design, construction, structural and/or operational deficiencies that could <em>clearly</em> lead to uncontrolled reservoir release. If the dam owner is actively working on an <em>approved</em> project to correct the deficiency the rating can be reduced to MODERATE.</td>
</tr>
<tr>
<td></td>
<td>• Owner exhibits reluctance to operate in a safe and timely manner, or is incapable of doing so; all unlicensed dams are allocated this rating.</td>
</tr>
<tr>
<td>MODERATE</td>
<td>• Uncorrected design, construction, structural and/or operational deficiencies that could <em>potentially</em> lead to uncontrolled reservoir release.</td>
</tr>
<tr>
<td></td>
<td>• Owner exhibits reluctance to undertake and report on annual inspection, or is incapable of doing so.</td>
</tr>
<tr>
<td></td>
<td>• Design and operation lacks redundancy, e.g., no back-up power for electrical gates.</td>
</tr>
<tr>
<td>SMALL</td>
<td>• Design and/or performance deficiencies may exist, but are actively monitored and are not expected to significantly increase failure potential over the near term.</td>
</tr>
<tr>
<td></td>
<td>• Design and operation exhibits redundancy</td>
</tr>
<tr>
<td>VERY SMALL</td>
<td>• Dams that are breached, partially breached, reservoir drained or otherwise safeguarded.</td>
</tr>
<tr>
<td></td>
<td>• Failure modes analysis indicates very low probability of failure (e.g., robust concrete gravity dam).</td>
</tr>
</tbody>
</table>
INFORMATION SHEET

ANNUAL DAM STATUS REPORT

INTRODUCTION
The B.C. Dam Safety Regulation was passed into law under the Water Act effective February 11, 2000. This regulation was repealed and replaced by the Dam Safety Regulation (Regulation) under the new Water Sustainability Act (WSA) on February 29, 2016. The objective of the Regulation is to enhance public safety and mitigate damage to property and the environment from a dam breach by requiring dam owners to adequately inspect and properly maintain their dams, and ensure that their dams meet applicable engineering standards.

BC DAM SAFETY COMPLIANCE PROGRAM
The purpose of the dam safety compliance program is to protect public safety, the environment and property by promoting awareness of and compliance with the Dam Safety Regulation. Dam Safety Officers conduct periodic audits, provide education to dam owners, and maintain information on every regulated dam in the province. As part of this program, owners of high, very high and extreme failure consequence classification dams must complete and submit an annual status report for each dam they own.

ANNUAL REPORTING BY DAM OWNERS
At the end of November of each year, a form is sent to the principal contact on record for every high, very high and extreme failure consequence classification dam in B.C. A principal contact is either the dam owner, the owner’s representative or, if there is more than one owner, the owners’ designate.

On the form, principal contacts are required to provide factual information related to their dam safety program including: formal inspections, site surveillance, Dam Safety Review, Operation, Maintenance and Surveillance Manual, Dam Emergency Plan, and indicate whether any new dam safety concerns have been identified in the past year. An explanation of the required information is provided on the back of the form.

More information and copies of the current form are available under the Compliance and Enforcement section of the Dam Safety Program website or can be obtained from a Dam Safety Officer.

COMPLIANCE AND ENFORCEMENT
Completing and submitting the Dam Status Report is a mandatory requirement under the WSA when requested by the Comptroller of Water Rights. Failure to comply with the WSA or the Regulation may result in escalating enforcement action being taken which may include: a fine of $230, an order to drain the reservoir, charges under the WSA or Regulation, or cancellation of the water licence.

OFFENCES UNDER THE WATER SUSTAINABILITY ACT
Failure to comply with the Regulation is an offence under the WSA. Please refer to the following information on general offences under s.106 of the WSA:

(5) A person who does any of the following commits an offence:

(p) fails to keep information or records required to be kept under section 116 (1) [records and reporting];

(q) fails to keep information or records for the prescribed period contrary to section 116 (1);

(r) fails to produce records when required under section 116 (2) (a);

(u) knowingly contravenes section 116 (5).

(6) A person who commits an offence under this section is liable on conviction to the following:

(a) in the case of an offence that is not a continuing offence, a fine of not more than $200 000 or imprisonment for not longer than 6 months, or both;

(b) in the case of a continuing offence, a fine of not more than $200 000 for each day the offence is continued or imprisonment for not longer than 6 months, or both.

MORE INFORMATION
Dam Safety Section
Water Management Branch
PO Box 9340 Stn Prov Govt
Victoria BC  V8W 9M1
Email: dam.safety@gov.bc.ca
Website: www.gov.bc.ca/water

Updated: November 2016
RECORD OF AUDITS PERFORMED
RECORD OF DAM SAFETY STATUS REPORTS
KEEP A RECORD OF ALL SUBMITTED DAM SAFETY STATUS REPORTS HERE -->
2016 DAM STATUS REPORT FORM
FOR OWNERS OF HIGH, VERY HIGH & EXTREME CONSEQUENCE DAMS

COMPLETED FORM MUST BE SUBMITTED BY FEBRUARY 1, 2017

By Mail: Dam Safety Section, Water Management Branch
Ministry of Forests, Lands and Natural Resource Operations, Victoria BC
Please mail to the address located on the bottom of this page.

By Fax: 250-356-0605
By email: dam.safety@gov.bc.ca

Please fill in Dam Name, Failure Consequence Class, and contact information: name, address, phone # & e-mail below:

Please read the information overleaf (page 2) before completing this form. For more information, see the Compliance and Enforcement section of our website: www.gov.bc.ca/water.

1. Have you received a copy of the Dam Safety Regulation (February 29, 2016)?   Yes ☐ No ☐
2. Has your Formal Inspection for 2016 been completed?     Yes ☐ No ☐
   Inspected By: Owner ☐ Other ☐ Who?
   Comments: _____________________________________________________________
3. Did you undertake regular (see page 2) Site Surveillance?   Yes ☐ No ☐
   Comments: _____________________________________________________________
4. Have any new dam safety concerns been identified this year (2016)?   Yes ☐ No ☐
   If yes, please elaborate: ___________________________________________________
5. If yes to #4: Has a plan been prepared to address the safety concern(s)? Yes ☐ No ☐ N/A ☐
   Comments: _____________________________________________________________
6. In what year was your Dam Safety Review last carried out by a qualified Professional Engineer? OR check box if no Dam Safety Review has ever been carried on the dam – NO DSR ☐
7. In what year was your Operation, Maintenance & Surveillance Manual last updated?
8a. In what year was your Dam Emergency Plan (formerly EPP) last updated?
8b. Have you submitted a copy of the updated DEP to the local emergency authority?   Yes ☐ No ☐
9. Is the emergency contact information in your Dam Emergency Plan up-to-date?   Yes ☐ No ☐
10. Has there been any land use development downstream of your dam in the last year that might affect the failure consequence classification? Yes ☐ No ☐
    If Yes, please elaborate: ___________________________________________________

Additional comments or suggestions: ____________________________________________

Submitted by: ___________________________________ Date: __________________
Position: ___________________________________ Phone: __________________
Email address: ____________________________________________________________
(2) **Formal Inspection** is defined in the Dam Safety Regulation (Regulation) as “a thorough on-site inspection of the dam and dam site conducted by a person who is an owner of the dam or an agent of an owner of the dam and who is responsible for the safety of the dam”. The Inspection & Maintenance of Dams manual is available on the Dam Safety website and a Dam Inspection & Maintenance course is available through the BC Water & Waste Association (www.bcwwa.org). Many dam owners hire an engineering consultant to inspect their dams, but this is not a requirement. The minimum frequency for formal inspections is annually for high and very-high consequence dams and semi-annually for extreme consequence dams. A formal inspection report must be recorded and kept by the dam owner and must be available for review by the Dam Safety Officer (DSO) on request.

(3) **Site Surveillance** is defined in the Regulation as “the monitoring of a dam and the area surrounding or adjacent to the dam through visual observation, and if there is instrumentation relating to the dam, through the systematic collection of instrumentation readings and analysis and interpretation of the readings”. Site surveillance is usually performed on a weekly basis for all high, very high and extreme consequence dams; see Schedule 2 of the Regulation for the minimum frequency of safety activities. Site surveillance may be conducted at a reduced frequency to suit seasonal conditions (e.g. snow cover); however, these conditions and the reduced frequency must be described in the dam’s Operation, Maintenance & Surveillance Manual*.

(4 & 5) **Dam Safety Concerns**: The DSO is available to discuss any concern you may have about the safety of the dam and can assist you to determine the severity of an issue. A dam owner must report any potential safety hazard to a DSO. Please see section 14, Hazardous conditions, and section 15, Potential safety hazard, of the Regulation for further actions required by the dam owner.

(6) **Dam Safety Reviews** (DSRs) are comprehensive formal evaluations by a qualified engineer conducted every 10 years for high and very high consequence dams and every 7 years for extreme consequence dams to determine whether an existing dam meets current engineering standards. DSRs shall be carried out in accordance with the Regulation, APEGBC’s DSR Guideline and the Canadian Dam Association (CDA) Guideline. A link to the APEGBC’s DSR Guideline is available at www.apeg.bc.ca. The CDA Guidelines can be purchased at www.cda.ca.

(7 & 8) **Operation, Maintenance and Surveillance (OMS) Manual & Dam Emergency Plan (DEP) Requirements**: Dam owners are required to have an OMS manual and a DEP (formerly Emergency Preparedness Plan (EPP)). The OMS and DEP must be reviewed and updated at least every 7 years for very high and extreme consequence dams, and at least every 10 years for high consequence dams. For guidance on the information to submit to the local emergency authority, refer to the Guide & Template for Preparing a Dam Emergency Plan (DEP) in British Columbia available on the Dam Safety website.

(9) **Emergency Contact Information**: Dam owners are required to annually review and, if necessary, revise the emergency contact information in their DEP, and submit revised information to the DSO and to the local emergency authority.

(10) **Downstream Conditions**: Dam owners must review conditions downstream of their dams annually and notify the DSO if there are changes (e.g. land development) that might result in a change in the failure consequence classification of the dam.

Dam owners must operate and maintain their dams in accordance with the Water Sustainability Act (WSA), the Regulation, any applicable authorization, and any order that is made under the WSA.

*Note: simplified versions of DEP and OMS for less complex dams may be acceptable (see templates in the Guidebook entitled Inspection & Maintenance of Dams, available on the Dam Safety Website at: www.gov.bc.ca/water).*
RECORD OF REGULATORY CORRESPONDENCE
KEEP A RECORD OF REGULATORY CORRESPONDENCE HERE
7 DAM SAFETY REVIEWS
Dam Safety Management System (CDA, 2007)
INTRODUCTION

As per the Dam Safety Regulation (Regulation), owners of high, very high or extreme failure consequence classification dams are required to complete a Dam Safety Review (DSR) every 7 or 10 years, as specified in item 9 of the table in Schedule 2 of the Regulation.

The objective of the DSR, prepared by a professional engineer with qualifications and experience in dam safety analysis, is to determine if the dam under review is safe as per Section 20 of the Regulation.

Dam safety reviews require a systematic review and evaluation of all aspects of the design, construction, maintenance, operation, processes and systems affecting a dam’s safety, including the dam safety management system.

NEW GUIDELINES

In July 2013, the Association of Professional Engineers and Geoscientists of BC (APEGBC) published the Professional Practice Guidelines – Legislated Dam Safety Reviews. This document replaces the BC Dam Safety Review Guidelines (version 3 - Nov 2012) and is effective immediately.

The Guidelines assist in project organization and determination of responsibilities, and provide general principles governing dam safety analysis, quality assurance/quality control, and report presentation.

WHY IT WAS DEVELOPED

Feedback from dam owners, qualified professionals and Dam Safety Officers had identified shortcomings with the DSR process. Some of these included:

- Where to find a qualified professional?
- What should be included in an RFP?

Qualified Professionals

- Minimum qualifications/experience required?
- Dealing with significant information gaps
- Minimum requirements for a DSR report to be accepted by the regulator?
- More guidance in dam safety analysis.

Regulatory Authority

- Quality of work varied greatly.
- Many components of DSR were missing.

The new guidelines are meant to ensure that dam owners receive a valuable product; assist practitioners in self assessing whether they are qualified by training or experience to undertake and accept responsibility for legislated dam safety reviews, and ultimately provide greater protection to the public by raising the overall quality and consistency in the reporting of dam safety reviews.

Qualified professional engineers may now add their name to APEGBC’s Discrete Scope Projects Directory based on self-declarations indicating they are qualified by training or experience to provide engineering in the area of Dam Safety Analysis. This directory is available to the public in searching for qualified professionals.

HIGHLIGHTS

The Guidelines aim to clearly identify the roles and responsibilities of the dam owner, the qualified professional and the regulator authority.

They introduce the Dam Safety Review Assurance Statement that must be completed by the Professional Engineer / Qualified Professional attesting that the dam is “reasonably safe”, is...
“reasonably safe” revealing deficiencies and/or non-conformances, or “not safe” revealing deficiencies and/or non-conformances which require urgent action.

The term “reasonably safe” is intended to mean that the dam owner has implemented all dam safety management measures which conform to those norms that are considered by the Regulatory Authority and the engineering profession to reasonably reflect established engineering and dam safety management practices. This term is considered by the Regulatory Authority to be equivalent to the Dam Safety Regulation term of “safe”.

REGULATORY REQUIREMENTS

The types of dam safety review can be broadly considered to cover a spectrum ranging from a comprehensive to an audit-type review and detailed design and performance review. It is the regulatory authority’s expectation that the default type that must be carried out by a dam owner under the provision of the Regulation is a comprehensive review. An audit style review will not be accepted unless prior written approval has been provided by the Regulatory Authority.

Dam Safety Review reports will only be accepted if they are considered complete, which includes a completed and sealed/signed Dam Safety Review Assurance Statement.

Should the result of the Dam Safety Review determine that the dam is “not safe” then it is the obligation of the dam owner to promptly follow the direction provided in Section 14 or 15 of the Regulation.

MORE INFORMATION

More information on dam safety can be obtained from the Responsible Ministry by contacting:

Dam Safety Section
Water Management Branch
PO Box 9340 Stn Prov Govt
Victoria BC V8W 9M1

Or the BC Dam Safety Program’s Website:
http://www2.gov.bc.ca/gov/content?id=60AD5E15F2B943B192222DD348AED117

The Association of Professional Engineers and Geoscientists of BC’s Professional Practices – Legislated Dam Safety Review Guidelines and Discrete Scope Projects Directory can be found at: www.apeg.bc.ca

* The Regulatory Authority refers to the Responsible Ministry and includes a Dam Safety Officer, or the Comptroller or Regional Water Manager.
# Dam Safety Review Check Sheet

Binder Note: Internal checklist used by Dam Safety Officers - useful to check your DSR reports prior to submitting

<table>
<thead>
<tr>
<th>Dam:</th>
<th>D#:</th>
<th>Date of DSR:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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<thead>
<tr>
<th>Dam Owner:</th>
<th>QP Engineer:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Engineering Firm:</th>
<th>Review Engineer:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DSR Guidelines</th>
<th>Completed?</th>
<th>Comments</th>
</tr>
</thead>
</table>

## Phase 1 - Review of Available Information and Data

Records should include reports from previous DSRs, design calculations, as-built drawings, updated drawings, data from hydrological, structural and operational monitoring, all safety inspection reports, etc.

<table>
<thead>
<tr>
<th>Data &amp; records compiled?</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Documentation list provided?</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Informational gaps identified?</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

## Phase 2 - Field Review

The extent of a field review should be identified beforehand, but as a minimum include: upstream areas including reservoir slopes; abutment areas; upstream slopes or faces of the dam, where visible; dam crest; downstream slopes or faces, and toe areas; spillway and stilling basin (includes flow control equipment and power sources); drainage systems and discharge points; and areas downstream of the dam site that may be impacted in a breach.

<table>
<thead>
<tr>
<th>Site inspection performed?</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Confirmed proper functioning of equip.?</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Debris Management system assessed?</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Monitoring system analysis completed?</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Communications system assessed?</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Operating personnel Interviewed?</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>OMS reviewed?</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>EPP reviewed?</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Maintenance records reviewed?</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

## Phase 3 – Consequence Classification Review

<table>
<thead>
<tr>
<th>Dam breach calculation done?</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flood routing &amp; inundation mapping done?</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Inundation area reviewed for changes?</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Change in consequence recommended?</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

## Phase 4 – Dam Safety Analysis

<table>
<thead>
<tr>
<th>Internal &amp; External hazards(^1) identified?</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Failure modes(^2) &amp; effects identified?</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Hazards &amp; Failure Modes matrix provided?</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

**Hydrotechnical assessment**

<table>
<thead>
<tr>
<th>1:1,000, PMF and IDF calculated?</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spillway capacity meets/exceeds IDF?</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Wind setup &amp; wave runup calculated?</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Freeboard adequate(^3)?</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

**Geotechnical assessment\(^4\)**

---

1. Binder Note: Internal checklist used by Dam Safety Officers - useful to check your DSR reports prior to submitting
2. \(^1\)\(^2\)\(^3\)\(^4\) Refer to specific guidelines or standards for each category.
3. \(^3\)\(^4\) Additional comments or notes may be included in the comments section.
<table>
<thead>
<tr>
<th>Question</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>EDGM has been established?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Static stability assessed?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rapid drawdown assessed?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seismic (pseudo static) stability assessed?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Liquefaction (settlement)?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Internal Erosion (seepage &amp; piping potential)?</td>
<td></td>
<td></td>
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<tr>
<td>Deficiencies documented?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Dam safety management system**

Review should consider policy development, planning, training, implementation of procedures, checking, corrective action, and reporting.

<table>
<thead>
<tr>
<th>Question</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>OMS compliant?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EPP compliant?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Site and operating equipment secured from vandalism?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surveillance and inspection adequate to document dam performance? (eg. Seepage, instrumentation, documentation, etc.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surveillance adequate to discover and promptly address vandalism?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Has staff/owner had formal training?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Roles, responsibilities, and authorities are clearly assigned?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Key activities are clearly assigned?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Personnel understand their roles &amp; responsibilities?</td>
<td></td>
<td></td>
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<tr>
<td>OMS activities are carried out and documented?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Incidents are reported and addressed?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Safety measures recommended in previous DSR reports have been carried out?</td>
<td></td>
<td></td>
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</tbody>
</table>

**Phase 4 – Dam Safety Review report**

<table>
<thead>
<tr>
<th>Question</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Executive summary?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Introduction – purpose &amp; scope?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>General description of dam, reservoir and areas downstream that may be impacted?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Summary of findings of previous DSRs?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Summary of owner’s compliance record?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Details of all design assumptions?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Summary of design calculations performed to support the technical analyses?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Details of the assessment of each component of the dam?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Details of the assessment of the OMS?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Question</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>-------------------------------------------------------------------------</td>
<td>-----</td>
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</tr>
<tr>
<td>Details of the review of the EPP/ERP?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Summary of staff interview Q&amp;A?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conclusions supported with clear rationale?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recommendations provided?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prioritization of recommendations?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dam Safety Review Assurance Statement completed?</td>
<td></td>
<td></td>
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<tr>
<td>Report accepted?</td>
<td></td>
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</tr>
</tbody>
</table>

Note: The Qualified Professional Engineer is referred to APEGBC’s *Professional Practice Guidelines –Legislated Dam Safety Reviews in BC V2.0* and the CDA’s *Dam Safety Guidelines (2013)* and accompanying Technical Bulletins for additional information.

**General Comments:**

**Reviewed by:**

**Review date:**
Endnotes

1 **External hazard type**

- **Meteorological events.**
  - Floods, intense rain events (causing local erosion, landslides etc.), temperature extremes and the effects of ice, lightning strikes and wind storms.

- **Seismic events.**
  - Natural and those caused by economic activity such as mining or even reservoir induced seismicity. The fact that areas without active seismicity can be disturbed by distant earthquakes should not be ignored.

- **Reservoir environment.**
  - Includes all reservoir rim features including upstream dams, slopes around the reservoir, overhead off spillways etc. that pose a threat.
  - Reservoir environment also includes any deleterious substances, or burrowing or other animals, that can affect the physical performance of the dam.

- **Terrorist attacks and vandalism.**
  - Including vandalism and sabotage by various groups ranging from local disaffected individuals, through domestic terrorism and international terrorism.

**Internal hazard type**

- Errors and omissions in the design of the dam and water conveyance structures including inadequate consideration of the performance of the reservoir rim and upstream dams.
- Construction errors or design compromises to accommodate natural or imposed deviations from the design assumptions.
- Maintenance procedure errors where maintenance requirements are not fully defined at the design stage.
- Errors and omissions in the development and maintenance of operating rules or means of verifying adequate operation (e.g. infrastructure problems with water level recorders).

The internal hazard types are further subdivided into “sources”:

- **Water barrier**
- **Hydraulic structures**
- **Mechanical and Electrical sub-systems**
- **Infrastructure and Plans**

2 **Failure Modes**

- **Overtopping failure mode**
  - Inadequate freeboard leading to the flow of water over the crest of the dam in a manner not intended or provided for in the design, construction, maintenance and operation of the dam.

- **Collapse failure mode**
  - Inadequate internal resistance to the hydraulic forces applied to the dam, foundations and abutments while being hydraulically operated in accordance with the design intent.

- **Conveyance failure mode**
  - Loss of control of the flows through and around the dam.

- **Combinations of Hazards and Failure Modes**
Freeboard (taken from Plan Submission Requirements for the Construction and Rehabilitation of Dams)

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 the 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.

Slope Stability of Embankment Dams

- Seepage analysis
- Seepage Control
- Granular Filter Design
- Surface Erosion
- Seismic Stability Analysis
- Liquefaction Potential

Deficiencies are to be characterized as Actual, Potential or Non-Conformance (see “Dam Safety
Expectations & Definitions of Deficiencies and Non-Conformances” in the DSR Section of the MFLNR Dam
Safety Program website).

Definitions of Deficiencies and Non-Conformances

1) Deficiencies:
   a) Actual – An unacceptable dam performance condition has been confirmed, based on the CDA
      Guidelines, BC Dam Safety Regulations or other specified safety standard. Identification of an actual
deficiency generally leads to an appropriate corrective action or directly to a capital improvement
      project
      i) (An) Normal Load – Load which is expected to occur during the life of a dam.
      ii) (Au) Unlikely Load – Load which could occur under unusual load (large earthquake or flood)
   b) Potential – There is a reason to expect that an unacceptable condition might exist, but has not been
      confirmed. Identification of a potential deficiency generally leads to a Deficiency Investigation
      i) (Pn) Normal Load – Load which is expected to occur during the life of a dam.
      ii) (Pu) Unlikely Load – Load which could occur under unusual load (large earthquake or flood)
      iii) (Pq) Quick – Potential deficiency that cannot be confirmed but can be readily eliminated by a
          specific action.
      iv) (Pd) Difficult - Potential deficiency that is difficult or impossible to prove or disprove.

2) Non-Conformances: Established procedures, systems and instructions are not being followed, or, they
   are inadequate or inappropriate and should be revised.
   a) Operational (NCo), Maintenance (NCm), Surveillance (NCs)
   b) Information (NCi) – information is insufficient to confirm adequacy of dam or physical infrastructure
      for dam safety.
   c) Other Procedures (NCp) – other procedures, to be specified
RECORD OF DAM SAFETY REVIEWS
KEEP A RECORD OF ALL DAM SAFETY REVIEWS PERFORMED HERE
Dam Safety Management System (CDA, 2007)
DESIGN REPORTS, TECHNICAL MEMOS, ETC
KEEP A RECORD OF ALL DESIGN REPORTS, TECHNICAL MEMOS, ETC HERE -->
9 PLANNED AND SCHEDULED WORKS
DOCUMENT AND PRIORITIZE PLANNED UPRADES OR REPAIRS HERE -->
Regulations, Guidelines and Templates

**Dam Safety Regulation**
(February 2016, 33-pages)

**CONTENT & NOTES**
- The Dam Safety Regulation replaces the British Columbia Dam Safety Regulation and came into force February 29, 2016. This regulation requires dam owners to properly maintain, inspect and ensure their dams meet ongoing engineering standards to minimize the risk to people, property, and the environment.
- A dam is now defined by the regulation to include barriers that store or divert water from a stream or an aquifer or both and includes other works incidental to or necessary for the barrier.
- The regulation applies to all dams except minor dams (less than 7.5m in height and being capable of impounding 10,000m³ or less of water). Additional requirements (Part 3) are applicable to dams that are larger than minor dams as described by the regulation.
- All owners (except owners of minor dams) are required to do the following on an annual basis: review downstream conditions; re-assess the appropriateness of the dam’s failure consequence classification; notify a provincial Dam Safety Officer (DSO) if classification has changed; and, meet the safety requirements associated with their existing or new classification as defined by the regulation.
- Dam owners must have a new Dam Emergency Plan (DEP) prepared that contains 2 parts: 1) describe what actions an owner must undertake in the case of an emergency, and 2) key dam information and emergency contacts; this must be provided to local emergency authorities and the DSO for acceptance. Note: owners of low consequence dams are only required to submit the emergency contacts to local emergency authorities and the DSO and are not required to have or submit a DEP.

**Benefits**
- This regulation defines a minimum duty of care which benefits people, property, and the environment.
- The regulation is set-out in a simple and straightforward manner which can be easily understood.

**Plans Submission Guidelines for the Construction and Rehabilitation of Dams**
(May 2016, 28-pages)
Available at: [http://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/dam-safety/plan_submission_requirements_2016_v_12.pdf](http://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/dam-safety/plan_submission_requirements_2016_v_12.pdf)

**CONTENT & NOTES**
- This document assists the approval process for the construction of a new dam or rehabilitating an existing dam in accordance with the Water Sustainability Act and other legislation.
- It gives guidance regarding review standards, design criteria, and the preparation of applicable documents required to obtain approval. These documents include design
drawings, construction supervision plans, environmental management plans, and draft dam documents (such as draft OMS and DEP).

- This document also provides minimum design standards for all dams in British Columbia whether they are existing or new.

**BENEFITS**

- The document provides a useful guideline to follow for the planning, preparation, and execution of construction and rehabilitation.
- Design guidelines aid dam owners in determining if their dams meet the minimum requirements. In addition, the design standards may provide dam owners with simple solutions that can be easily implement on their dams (such as construction specifications for the construction of log booms).

Guide & Template for Preparing a Dam Emergency Plan (DEP) in BC – Information Sheet
(June 2016, 2-pages)

**CONTENT & NOTES**

- Clarifies the requirement for the Dam Emergency Plan (DEP) under the new Water Sustainability Act and the Dam Safety Regulation.
- Differences between the previously required Emergency Preparedness Plan (EPP) and the new DEP are outlined.

**BENEFITS**

- This document provides fast-facts for dam owners on preparing their DEPs to conform to the new Emergency Program Act, Water Sustainability Act, and the Dam Safety Regulation.
CONSEQUENCE OF FAILURE CLASSIFICATION GUIDES

Estimating Dam Break Downstream Inundation
(January 2016, 15-pages)
Available at: http://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/dam-safety/estimating_downstream_inundation-2016.pdf

CONTENT & NOTES
• The document provides a useful simplified method to estimate the consequence classification of small dams (<15m total height).  
• The document is written such that dam owners may be able to understand the importance and intent of the exercise.  
• Most dam owners may not be able to estimate their dam’s consequence classification using this document due to its technical nature and the concepts used in its approach.

BENEFITS
• This document informs owners of a simplified option to perform a dam break downstream inundation estimate. Where this approach is applicable, it can considerably lower the costs associated with making an estimate using other engineering best practices.

Consequence of Failure Classification Guideline
(January 2016, 20-pages)
Available at: http://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/dam-safety/con_class_guidelines_for_dsos-2016.pdf

CONTENT & NOTES
• The document gives guidance to DSOs when reviewing or estimating consequence of failure classifications for dams within British Columbia.  
• The guidance in this document provides definitions of terminology used in the regulation and provides direct references to other non-MFLNRO guidelines.

BENEFITS
• The document provides background and context to understand how DSOs and the regulation set a dam’s consequence of failure classification.  
• May not be as useful for dam owners as it would be for their consultants.
PROCURING A QUALIFIED PROFESSIONAL

Request for Proposals for Dam Safety Reviews
(December 2013, 7-pages)
Available at: http://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/natural-resource-use/land-water-use/water-use/dam-safety/dam-safety-reviews/rfp-dam_safety_review-initialdraft.docx

CONTENT & NOTES
- The document contains a sample Request for Proposal (RFP) to help dam owners.

BENEFITS
- This document provides a simple template for dam owners to invite qualified professionals to perform a DSR on their dam.

Discrete Scope Directory – Association of Professional Engineers and Geoscientists of BC
(October 27, 2016, 322-pages)
Available at: https://www.apeg.bc.ca/getmedia/5f98016b-3da2-41aa-b45e-c4ec70be5e1f/Discrete-Scope-Directory.pdf.aspx

CONTENT & NOTES
- This document has been published by the Association of Professional Engineers and Geoscientists of BC (APEGBC). and provides a list of engineering firms and/or individuals that are licensed in British Columbia to perform discrete scope projects such as Dam Safety Reviews and other similar dam safety related work.
- This document is compiled on the basis of self-declarations and is categorized by region and scope of work. Since it is relatively new, there may be other professionals in your area that are not yet listed.

BENEFITS
- This document is a simple system that can connect dam owners to qualified professionals that perform work in dam safety.
- The document has a category entitled “Dams and Flooding”. By searching the pdf document for this category, a list of professionals in any particular region of BC can be easily found.

APEGBC Professional Practice Guidelines for Dam Safety Reviews – Information Sheet
(unknown, 2-pages)
Available at: http://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/dam-safety/2016_info_sheet_dsr_guidelines_feb_25_2.pdf

CONTENT & NOTES
- The document provides fast-facts for the APEGBC Professional Practice Guidelines for Legislated Dam Safety Reviews.

BENEFITS
- It helps dam owners understand the main intent of Dam Safety Reviews. This also aids the dam owner in the procurement of a qualified professional.
DAM SAFETY RELATED FUNDING

Environmental Farm Plan Program
(December 2013, 7-pages)
Available at: https://www.bcac.bc.ca/ardcorp/program/environmental-farm-plan-program
Or call: 1-866-522-3447

CONTENT & NOTES
- The B.C. Agricultural Research & Development Corporation (ARDCorp) delivers resources to improve the long-term profitability of ranchers and agricultural producers.
- ARDCorp provides funding and assistance for a variety of producer-focused programs for which eligible BC farmers and ranchers are free to apply.

BENEFITS
- This program providing services to farmers that assists in achieving the purpose of the BC Agriculture Council.
- This program gives access to funding for dam safety related work.

JOINT WORKS AGREEMENT – For Dams with Multiple Owners

Joint Works Agreement for Dams with Multiple Owners
(January 2016, 2-pages)
Available at: http://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/dam-safety/joint_works_agreement_2016_update.pdf

CONTENT & NOTES
- This is a simple 2-page template that forms an agreement between water license holders.
- The template agreement has provision for the allocation of costs, responsibilities, and other general administration of dam ownership.

BENEFITS
- This template provides shared dam owners a non-bias legal administrative framework for managing their dam(s).
## SUMMARY OF DAM SAFETY DOCUMENTS ON PROVINCIAL SITE

<table>
<thead>
<tr>
<th>#</th>
<th>Title</th>
<th>Date Updated</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Water Sustainability Act</td>
<td>(May 2014, 128-pages)</td>
</tr>
<tr>
<td>2</td>
<td>Dam Safety Regulation</td>
<td>(Feb. 2016, 33-pages)</td>
</tr>
<tr>
<td>3</td>
<td>Dam Safety Regulation Brochure</td>
<td>(Feb. 2016, 2-pages)</td>
</tr>
<tr>
<td>4</td>
<td>Dam Safety Regulation Information Sheet – Application of the Dam Safety Regulation</td>
<td>(Mar. 2016, 3-pages)</td>
</tr>
<tr>
<td>5</td>
<td>Emergency Program Act</td>
<td>(1996, 6-pages)</td>
</tr>
<tr>
<td>6</td>
<td>Dam Safety Audit Program – Policy</td>
<td>(Dec. 2013, 8-pages)</td>
</tr>
<tr>
<td>7</td>
<td>Dam Safety Audit Program – Audit Check Sheet</td>
<td>(Jan. 2016, 15-pages)</td>
</tr>
<tr>
<td>9</td>
<td>Site Surveillance – Checklist for Concrete Dams</td>
<td>(Sep. 2014, 2-pages)</td>
</tr>
<tr>
<td>10</td>
<td>Site Surveillance – Checklist for Dams with Earth or Rock Embankments</td>
<td>(Sep. 2014, 2-pages)</td>
</tr>
<tr>
<td>11</td>
<td>Formal Annual Inspection - Checklist</td>
<td>(Nov. 2013, 8-pages)</td>
</tr>
<tr>
<td>12</td>
<td>Operation, Maintenance &amp; Surveillance Plan</td>
<td>(Unknown, 4-pages)</td>
</tr>
<tr>
<td>13</td>
<td>Plan Submission Guidelines for the Construction and Rehabilitation of Dams</td>
<td>(May 2016, 28-pages)</td>
</tr>
<tr>
<td>14</td>
<td>Plans Review Checklist 2011 – To be used by DSO when reviewing</td>
<td>(June 2011, 10-pages)</td>
</tr>
<tr>
<td>15</td>
<td>Public Safety Signage Requirements for Dams on Crown Land</td>
<td>(Feb. 2016, 2-pages)</td>
</tr>
<tr>
<td>16</td>
<td>Guide &amp; Template for Preparing a Dam Emergency Plan (DEP) in BC – Info Sheet</td>
<td>(June 2016, 2-pages)</td>
</tr>
<tr>
<td>17</td>
<td>Guide &amp; Template for Preparing a Dam Emergency Plan in BC</td>
<td>(June 2016, 42-pages)</td>
</tr>
<tr>
<td>18</td>
<td>Emergency Dam Assessment &amp; Immediate Response Actions</td>
<td>(Nov. 2013, 6-pages)</td>
</tr>
<tr>
<td>19</td>
<td>Estimating Dam Break Downstream Inundation</td>
<td>(Jan. 2016, 15-pages)</td>
</tr>
<tr>
<td>20</td>
<td>Consequence of Failure Classification Guideline</td>
<td>(Jan. 2016, 20-pages)</td>
</tr>
<tr>
<td>21</td>
<td>APEGBC Professional Practice Guidelines for Legislated DSRs</td>
<td>(Mar. 2014, 88-pages)</td>
</tr>
<tr>
<td>22</td>
<td>APEGBC Professional Practice Guidelines for DSRs – Info Sheet</td>
<td>(Unknown, 2-pages)</td>
</tr>
<tr>
<td>23</td>
<td>Dam Safety Expectations &amp; Definitions of Deficiencies and Non-Conformances</td>
<td>(Nov. 2013, 8-pages)</td>
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<td>24</td>
<td>Field Review Checklist for Dam Safety Reviews</td>
<td>(Nov. 2013, 8-pages)</td>
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<td>25</td>
<td>Dam Safety Review Check Sheet - September 2015</td>
<td>(Sep. 2015, 5-pages)</td>
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<td>26</td>
<td>Request for Proposals for Dam Safety Reviews</td>
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<td>27</td>
<td>HFMM – Introduction</td>
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<td>28</td>
<td>HFMM – Analysis Procedure</td>
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<td>29</td>
<td>HFMM – Chart of Global Failure Modes</td>
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<td>Joint Works Agreement for Dams with Multiple Owners</td>
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<td>Dam Status Report Form</td>
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Date of last link update: November 10, 2016
All documents have been included digitally on a CD located at the back of the Binder