

MINISTRY OF WATER, LAND AND AIR PROTECTION

Standard template (New Works)

< **Local Authority Name** >

**For < Watercourse Name >  
FLOOD MITIGATION WORKS**

**OPERATION AND MAINTENANCE MANUAL**

< Date of Report >

**File:** \_\_\_\_\_

< Local Authority Name >  
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**OPERATION AND MAINTENANCE MANUAL**

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**ISSUE AND APPROVAL LIST**

ISSUE NO.	ISSUE DATE	DIKE AUTHORITY APPROVAL	WLAP AUTHORITY APPROVAL	DESCRIPTION
		Signature  Name  Title  Date	Signature  Name  Title  Date	
		Signature  Name  Title  Date	Signature  Name  Title  Date	
		Signature  Name  Title  Date	Signature  Name  Title  Date	

< Local Authority Name >  
< Watercourse Name > **FLOOD MITIGATION WORKS**

**OPERATION AND MAINTENANCE MANUAL**

## **1.0 GENERAL**

Regular inspection and maintenance of flood mitigation works is necessary to maintain the dependability of the flood mitigation system. The flood mitigation system refers to the integration of all of the components and activities that are required to ensure the long term ongoing protection of habitable areas during peak flows up to the design flood event. It includes (but not necessarily limited to) the following:

- the flood mitigation works (the Works);
- an Operation and Maintenance (O&M) manual;
- the legal access agreements, which are needed for the works but may also extend beyond the immediate vicinity of the works to facilitate access for the removal of sediment build-up and log debris jams; and
- other components implemented to ensure public safety (such as emergency operations plans and procedures, warning systems, and flood monitoring operations).

### **1.1 Responsibilities**

The responsibility for dike operation and maintenance rests with the <Local Diking Authority> (hereinafter referred to as “The Local Diking Authority”) as indicated by the terms of the Agreement dated <dates>. A copy of this agreement is contained in Appendix A.

### **1.2 Purpose**

The purpose of this manual is to provide general instructions, methods, techniques and data pertinent to the inspection, operation and maintenance of the Local Diking Authority’s flood mitigation works on < Watercourse Name > .

### **1.3 Definition**

The term “operation and maintenance” in this manual refers to all works and activities that are required to operate and maintain the flood mitigation works to the design standard. It includes the repair and restoration of the flood mitigation works <and the removal of sediment build-up and debris from the channel> after flood events with magnitudes up to and including the magnitude of a design flood event.

## 1.4 Description of Works

The works generally consists of:

- a)
- b)
- c)
- d)

## 1.5 Stream Behaviour and Historical Records

Hydrometric records, including if available, annual peak flow and stage (water level) information as well as mean monthly and annual flow data for < water course name > are included in Appendix B. High-water due to <cause > of < water course name > usually occurs between <high-water dates > but may occur at any time due to unusual precipitation/temperature. Include comments on any of the following if appropriate:

- sediment aggradation/degradation
- log debris jams
- avulsions
- erosion / scour depths

## 1.6 Dike Right-of-Way

Right-of-way for dike construction and maintenance and all necessary approvals were obtained by the Local Diking Authority. Available details are included in Appendix F. Additional pertinent information should be added to this appendix as it becomes available. Copies should also be provided to the Inspector of Dikes office for inclusion in the Master Copy.

## 1.7 List of Concerned Agencies

A LIST OF AGENCIES CONCERNED WITH FLOOD MITIGATION WORKS IS CONTAINED IN APPENDIX C.

## 2.0 LEGISLATION

The principal legislation relating to flood mitigation works is listed below. However, it should be noted that there may be other relevant federal or provincial acts or regulations, or municipal or local by-laws which may apply to the ownership, operation or maintenance of these works.

## 2.1 Dike Maintenance Act

The principal legislation pertinent to diking is the *Dike Maintenance Act*, a copy of which is included as Appendix D ([http://www.qp.gov.bc.ca/statreg/stat/D/96095\\_01.htm](http://www.qp.gov.bc.ca/statreg/stat/D/96095_01.htm)).

The Inspector of Dikes office located in Surrey (see Appendix C) is responsible for the establishment of policy, procedures and regulations for the dike safety program throughout the Province of British Columbia.

Any proposal for construction activities on, through or adjacent to flood control works must be approved by the Deputy Inspector of Dikes for your area (see Appendix C) prior to implementation (refer to Section 2(4) of the *Dike Maintenance Act*). A drawing and written description of the proposal must be submitted to the Deputy Inspector of Dikes office for review and approval. The object of the review is to ensure that the safety afforded by the flood protection system is not reduced. Certain special measures such as seepage cut off collars and time of year restrictions may be imposed to ensure the integrity of the flood protection system.

The Deputy Inspector of Dikes also monitors the performance of the Local Diking Authority and notes any deficiencies in its maintenance program.

## 2.2 Water Act

All work in and about streams or other watercourses is subject to approval under Section 9 of the *Water Act* and the regulations under this section. The Regional Water Manager in Land and Water BC Inc. (see Appendix C) should be consulted as to the approval process for all projects that necessitate activity within the ‘natural boundaries’ of a watercourse.

## 2.3 Fisheries Acts

The Federal Department of Fisheries and Oceans is responsible, under the *Fisheries Act* (R.S.C., 1985, C.F-14), to protect fish and fish habitat in “waters frequented by fish”. This includes protection from any work in or near these waters. Pacific salmon are a federally managed resource.

The Provincial Ministry of Water, Land and Air Protection, Fisheries Branch is responsible for management of steelhead, trout, char and other non-salmonid freshwater species under the *Fisheries Act*. The definitions of fish and fish habitat under the *Fisheries Act* are as follows:

Fish: all fish, shellfish, crustaceans and marine animals, and the eggs, spawn, spat and juvenile stages of fish, shellfish, crustaceans and marine animals.

Fish Habitat: at the spawning grounds, nursery, rearing, food supply and migration areas on which fish depend directly or indirectly in order to carry out their life processes.

All developments in or adjacent to waters containing fish or fish habitat, whether marine or fresh water, require the approval of the Department of Fisheries and Oceans (DFO) and Ministry of Water, Land and Air Protection (Fisheries Branch) representative in your area (see Appendix C).

#### **2.4 Land Act** (regarding removal of gravel from streambeds)

Where the streambed is on Crown land, Land and Water BC Inc. (see Appendix C) is the lead agency in terms of gravel removal (as they are the landowner). On privately owned streambeds, you must deal directly with the landowner.

#### **2.5 Forest Act** (regarding removal of merchantable wood debris from streambeds)

In all cases the Ministry of Forests must be consulted as to the approval process for removing merchantable wood debris from streambeds.

### **3.0 CONTROLS**

Using the legislation referred to in 2.0 as a reference, the Local Diking Authority should control development or construction on, through or in the vicinity of the flood mitigation works, so that such activity does not reduce the existing standard of flood protection. Activity outside the dike right-of-way should be in accordance with accepted floodplain management practice as established by the Flood Hazard Management Section, Ministry of Water, Land and Air Protection and administered by local government.

#### **3.1 Excavation**

Excavation adjacent to dikes, bank protection or other flood protection structures should be discouraged, but where such excavation is necessary, expert advice should be obtained to ensure that the excavation does not destabilize the flood mitigation works.

#### **3.2 Pipes & Cables**

Where pipes, cables or other works must pass through or along the dikes, the correct use of seepage collars and compacted backfill materials is mandatory. Rupture resistant pipe, with mechanical or equivalent joints which will not separate under settlement, shall be used where pipe is laid within the design dike section. Material excavated to install the works should be replaced with backfill material of equivalent flood resistant quality and in a manner that will not reduce the standard of protection.

#### **3.3 Encroachment**

Trees or tall shrubs should not be allowed to encroach on the dike. Buildings or other obstructions should not be allowed within the right-of-way or situated in a position that would impede dike maintenance work or the functioning of designated floodway corridors.

### **3.4 Access**

Access to the dike crest, slopes and adjacent bank protection should be maintained to permit inspection, maintenance and repair of the flood mitigation works.

### **3.5 Proposed Works**

Any work or works proposed on or in the immediate vicinity of flood control works comprising the dikes, bank protection, structures or internal drainage works, should be reviewed by the Local Diking Authority, the Deputy Inspector of Dikes, and other affected regulatory agencies before work proceeds (see Section 2.0).

### **3.6 Sediment Removal**

Sediment removal from the river channel should not be undertaken in a manner which may jeopardize the dike. Excavation on the river side should generally be undertaken a safe distance away from the toe of any riprap as determined by an engineer or the DIOD and, as a guide it, should not extend below a 3:1 (3 horizontal metres for each vertical metre) line from the dike crest. If sediment removal is required, the local Diking Authority will apply to Land and Water BC Inc. (Appendix C) for the necessary sediment removal permit and for approval under Section 9 of the Water Act to conduct work in and about the stream.

## **4.0 INSPECTION OF FLOOD MITIGATION WORKS**

It is the responsibility of the Local Diking Authority to conduct dike inspections.

### **4.1 Routine Annual Inspection**

At least once a year the entire diking system should be inspected by the owner for need of routine maintenance. This inspection should be scheduled early enough prior to the flood season to allow adequate time for any required work to be completed prior to high water conditions.

The inspector should look for and note any of the following items:

- a) the extent of vegetation growth and the presence of trees;
- b) any damage to the dike slopes;
- c) any obvious low spots along the dike crest;
- d) animal burrows;
- e) any unauthorized excavation or construction in, on or adjacent to the dike. If deemed to be detrimental to the integrity or performance of the flood mitigation works, the Inspector of Dikes or the Deputy Inspector of Dikes may order corrective action as indicated in the *Dike Maintenance Act* (Appendix D).

- f) signs of erosion of the riverbank or damage to the existing bank protection. During the inspection attention should be given to:
  - i) loss of rock from the existing protective layer;
  - ii) slumping of the slope;
  - iii) erosion or scour of the riverbank immediately upstream or downstream of the bank protection, or at the toe of the slope or riprap. In some cases, an underwater survey of the slope may be advisable to determine the degree of any toe scour;
  - iv) weathering or abrasion of rock particles;
  - v) loss of, or significant changes to, the overbank area which could endanger the dike.
- g) the condition of the floodbox flap gates as to the ability to open and close freely and provide a watertight seal when shut;
- h) any access obstructions to the dike and along the dike crest;
- i) the condition of all fences, gates and locks and the availability of keys;
- j) the condition of pumps and pump stations both structurally and functionally;
- k) damage to the water level gauges and their legibility;
- l) debris or other problems at intakes (trash racks)

A written report on the results of the inspection should be prepared and submitted to the Deputy Inspector of Dikes and the necessary work scheduled for completion prior to the next flood period.

#### **4.2 Inspections During High Water Events**

Additional dike inspections or patrols should be carried out during high water events to monitor the performance of the flood control works and take corrective action as required, see section 6.0 Emergency Measures and Repair Work.

Prior to flood seasons, the Snow Survey Bulletin should be consulted for information regarding the predicted runoff volumes. During high water events, local water level gauges should be monitored regularly and the readings recorded for long-term reference. Dike patrol frequency should increase as the water levels approach critical conditions, and should be continuous while the level is within 1.0 m of the dike crest. The patrol crews are to observe and report to the Local Diking Authority any occurrences that could signal a weakening of the works, such as:

- a) Seepage: Seepage through the dike and at the landside toe of the dike is to be expected at high flood levels. This seepage is considered to be normal provided flows are not excessive or concentrated in the form of piping or boils.

Piping results where fill is transported by the seepage flow; this can be identified either as suspended silts (murky water) or visible grain particles. This process enlarges or progresses toward the river at an increasing rate. Eventually an open path is created and the dike is breached.

The piping process is sometimes indicated by boils, small upwellings which can appear at considerable distances inland from the inside toe of the dike, and which are caused by excessive seepage pressure.

Close attention should be paid to seepage, as an increase or concentration of seepage flows can threaten the safety of the dike.

- b) Sloughing and/or erosion of the dike slopes (gullying).
- c) Settlement of the dike crest and slopes (depressions).
- d) Areas of low freeboard.
- e) Cracking of the dike crest or slopes:
  - i) desiccation cracking: forms in random, honeycomb patterns and is serious only when deep.
  - ii) transverse cracking: forms perpendicular to the dike alignment and can easily create a seepage path.
  - iii) longitudinal cracking: forms parallel to the dike alignment and may indicate the start of a slide or slump. May result from toe erosion, differential settlement or saturation.
- f) Erosion of the riverbank adjacent to the dike.
- g) Sloughing and/or erosion of bank protection works. Critical areas should be closely inspected during and after high water events.
- h) Debris accumulation at floodboxes, flap gates and trash racks.
- i) Pumps not operating properly.
- j) Stream blockages or shifts in flow direction due to log and debris or ice jams, especially near bridges or other constrictions.
- k) Seepage along cables or pipes or concrete box culverts that transverse the dike fill.

A dike inspection log should be kept by the owner to record all inspections. An example log is illustrated in Appendix E.

### **4.3 Special Inspection Considerations**

< insert special considerations >

## **5.0 MAINTENANCE OF FLOOD MITIGATION WORKS**

### **5.1 Dike Maintenance**

The essential dike maintenance activities include the following:

a) **Repair of Dike Slope Damage**

Damage to dike slopes should be repaired as soon as possible by the addition and compaction of appropriate earth fill materials to restore the slope to original condition.

b) **Trimming of Vegetation Growth**

Vegetation on the dike side slopes should ideally consist of closely trimmed grass. The dike slopes should be cut at least once annually. Tree and brush growth should be removed for the following reasons:

- i) The vegetation attracts burrowing animals whose burrows are detrimental to the dike stability.
- ii) Tall vegetation obscures signs of seepage or damage to the dike which may thus go undetected and eventually cause dike failure.
- iii) Tree roots, when they decompose, can encourage the development of pipes, and consequent dike failure.
- iv) Large trees pose an additional threat to dike stability, especially during flood events when the dike structure becomes saturated. High winds and overbank erosion during floods can cause trees to fall resulting in the displacement of dike fill material and possible failure of the dike. In coastal regions especially, these conditions may occur simultaneously.

c) **Restoration of Dike Crest Elevation**

Every three to four years the dike crest profile should be surveyed and compared to the design profile. Any low areas should be raised by the addition of crushed gravel surfacing, prior to grading of the whole dike crest as required to maintain a smooth riding surface. Geodetic benchmark information is located in Appendix G.

d) **Animal Burrows**

If animal holes or burrows are discovered during inspection, they should be excavated and backfilled with compacted material. Trapping of the animals may be

advisable in such areas after consultation with local Fish and Wildlife authorities (see Appendix C).

e) **Repairing Fences and Gates**

It is recommended that access to dikes be restricted to authorized vehicles only. All fences and gates should be kept in good condition. All locks for the gates should be in good working order, with keys readily available at all times since emergency dike access may be necessary at any time, e.g. for fire-fighting, rescue, etc. There are to be no obstacles placed which prevent access by authorized vehicles.

f) **Water Level Gauges**

Water level gauges, if installed, are in key locations as shown on Drawing No. \_\_\_\_\_, \_\_\_\_\_, contained in Appendix G. The gauges should be inspected annually, repaired and re-levelled if necessary, so that they can be readily observed by dike inspection personnel at all times. Care should be taken to ensure that the gauges are always maintained to the correct GSC datum:

Gauge A	metres GSC
Gauge B	metres GSC

Where a gauge has to be established or re-established, or where there is reason to doubt the gauge datum, both the Deputy Inspector of Dikes and the Ministry of Environment, Lands and Parks, Technical Support Section must be informed so that appropriate action can be taken.

## 5.2 **Bank Protection Maintenance (Repair)**

Bank protection usually comprises angular pieces of blasted rock placed over a granular filter layer. The rock gradation and maximum size is determined by the stream velocity and slope of the bank. The bank protection will require varying degrees of maintenance depending upon the degree and frequency of exposure to stream flow or wave action.

Repair should be made by the addition of suitably graded rock riprap. A riprap specification chart is located in Appendix G. The rock should be placed by backhoe, hydraulic excavator, or clamshell to fit tightly together and form a smooth continuous slope.

If a major failure of the bank protection occurs, specialist advice should be obtained prior to undertaking a repair. Approval must be obtained from the Deputy Inspector of Dikes or the Regional Land and Water Manager (see Appendix C) before commencing repair work within the wetted perimeter of the channel.

## 5.3 **Floodbox Maintenance**

The purpose of a floodbox is to allow the gravity discharge of internal drainage water from behind the dike into the main watercourse during times when the external water level is

lower than the level behind the dike. A floodbox generally consists of a culvert through the dike with a flap gate at the outlet. Trash racks may be fitted at the inlet and/or the outlet.

Maintenance of a floodbox consists of cleaning the inlet and outlet of any accumulated debris and sediment to ensure water can flow freely through the culvert. The flap gate should be periodically cleaned and lubricated to ensure that it swings freely and closes properly with a good seal.

The dike slopes adjacent to the floodbox should be kept clear of trees and brush to allow unimpeded inspection of the inlet and outlet of the floodbox.

All inspections should include a check for signs of sloughing which could block the inlet to the floodbox. Both the inlet and the outlet should be checked for signs of erosion or undermining of the structure.

All gates, trash racks and miscellaneous metal should be inspected periodically for excessive wear or deterioration. Metal culvert pipe should be checked internally, where possible, for signs of corrosion and deformation. Corrosion at exposed outlets in proximity of the sea is very common.

Concrete inlet and outlet structures should be inspected for evidence of cracking or spalling. Concrete pipe culverts should be inspected for excessive joint involvement, loss of joint sealant and leaks at joints.

Floodboxes should be checked regularly in areas where beavers are present since they can plug culverts or construct dams very quickly. Unusually high water levels are a good indication of beaver activity. Culverts should be cleared immediately before the situation becomes more difficult to rectify.

#### **5.4 Pump Station Maintenance**

During times of high water in the main watercourse when the floodboxes are closed, internal drainage water must be either stored or discharged by pumping.

Pump stations generally have operation and maintenance manuals specific to each installation and these should be referred to.

During dike inspections the following items at pump stations should be checked:

- the area adjacent to the pump discharge for signs of erosion or instability;
- the operation of the pump discharge flap gate for signs of possible leakage;
- the accumulation of debris on the trash screen or at the flap gate and the need for removal;
- any signs of leakage through the dike on the landside slope at the location where the discharge pipe crosses the dike.

## 5.5 Special Maintenance Considerations

< insert special maintenance considerations such as >

Creek bed Erosion or Sedimentation

- Bed Erosion and Design Allowances
- Sedimentation and Design Allowances
- Procedure for Establishing the Need for Sediment/Debris Removal
- Log and Debris Jam Removal

## 5.6 Annual and 20 Year Routine Maintenance Cost Projections

< insert costs projections from APPENDIX I (see Section 6.9 for details) >

## 6.0 EMERGENCY MEASURES

It would be advisable to prepare a flood contingency plan in conjunction with the local Provincial Emergency Program Zone Manager (see Appendix C).

If there is a threat to the safety of a dike, the Local Diking Authority may carry out any work that is essential to prevent the dike or bank protection from failing. Environmental agencies will be available to advise local diking authorities as to good environmental practice.

The Local Diking Authority is responsible to ensure there is adequate personnel, equipment and materials readily available to respond to emergency conditions. As the river rises to critical levels, crews should be prepared to undertake emergency repairs as outlined below.

### 6.1 Active boiling

The simplest and most effective method of treating an active boil (one that is carrying sand and silt) is to construct an impervious ring around it of a sufficient height to stop the transportation of solid material. It should not be built to a height which stops the flow of clear water because of the probability of building up an excessive local pressure head, which could cause dike failure or additional boils nearby. Concrete well rings, short pieces of large diameter pipe, earth berms, sheet steel pilings, etc., can all be used, but the most generally accepted method is using sandbag rings.

The recommended method of building a sandbag containment ring is as follows:

- Scarify the base for the ring (internal diameter of which should be at least 1-1/2 times the contemplated height) to provide a watertight bond between the natural ground and the sack ring (a very important step).
- Lay sacks in a ring around the boil and surrounding weak ground starting at its outer edge and working towards the centre. Joints are staggered and loose earth is used as a mortar.

- When the proper height is reached (when clear water only is being discharged) a “V”-shaped drain constructed of wood or sheet metal should be inserted near the top of the ring to carry off the water in a more controlled manner in the most desirable direction.
- An alternative method of controlling an active boil is by placing a blanket of pea gravel or other free-draining gravel over it. The thickness of the gravel blanket must be increased until the seepage water runs clean. Note: When soil conditions are such that boils occur, it will probably be impossible or imprudent to bring loaded dump trucks into the area, and over the dike crest. First consideration should be given to methods that do not impose heavy loads on the ground adjacent to the boils.
- All flowing inactive boils should be flagged and closely monitored throughout the flood period in case they start to transport solids.

The flood emergency organization and the Regional Land and Water Management Office should be alerted under the following situations:

- the active area of boiling is extensive;
- there is an extensive area of inactive boils and the river level is expected to rise.

## **6.2 Seepage and Piping**

During high water events the land side slope and toe should be monitored for excessive seepage and possible piping problems. Where seepage on the dikes’ landside slope leads to soggy unstable conditions, free draining fill berms may be added. Where time permits, expert advice should be obtained, if possible, before taking corrective action.

## **6.3 Riverside Erosion**

Where river currents are eroding the face of the dike or nearby overbank, additional large rock riprap should be placed with an excavator or end-dumped if the site is accessible to heavy equipment and safe for operation; however, expert advice should, if possible, be obtained.

## **6.4 Saturation**

If high water levels are sustained for some time and the dikes become thoroughly saturated, it may become necessary to restrict traffic on the dike crest road.

## **6.5 Local Overtopping**

As the prediction of flood profiles is uncertain, and because dikes often have varying freeboard, patrols should be advised to pay close attention to lower than average freeboard.

Once water flows over the dike crest, fill is usually washed away creating a breach, which is impossible to close until the water levels equalize and much damage has resulted. It is, therefore, imperative that overtopping be prevented.

Traditionally, sand bags are considered for raising low sections of dike. However, progress is slow and an excessive amount of labour is required. Sand bags should normally only be considered for raising short sections of dike. As an alternative to sandbags, reinforced plastic sheeting can be used to contain loose granular or other fill. Heavy equipment and trucks can be used to raise a dike provided the work is done well in advance of high river levels. No heavy equipment should be allowed on the dike when the water level is near the top of the dike as the vibration might cause a failure. See Section 6.7 for emergency warning.

## **6.6 Internal Drainage**

Local runoff and drainage will not escape once floodboxes close in diked areas, which lack adequate permanent pumping facilities. Temporary pumping of local drainage, or interception and diversion of inflow from higher elevations, may be necessary to alleviate this condition.

A regularly updated list of potential pump and generator suppliers, together with their required delivery and setup times, should be maintained in Appendix H.

## **6.7 Emergency Warning**

Should the possibility of uncontrollable dike failure arise, the local RCMP MUST be alerted immediately. Unless advised otherwise by the RCMP, the Local Authority should confine its efforts to preventing flooding while ensuring the safety of its workers. The RCMP will be responsible for advice to the public. A formal request for Provincial Assistance should be directed to the Provincial Emergency Program Zone Manager, who should be provided with as much information as possible.

## **6.8 Special Emergency Measures and Repair Work Considerations**

<Indicate location of local quarries and gravel pits.>

Note: Names and phone numbers of suppliers and construction equipment should be listed in Appendix H and constantly updated for emergency use.

## **6.9 Maintenance, Repair & Restoration Cost Projections**

< insert annualized costs projections based on routine annual maintenance, emergency response, and an estimated range of projected flood restoration and repair costs (say 5, 20, 50, 100, 200 yrs) up to and including the 1:200 year return event – provide details in APPENDIX I >

## 7.0 REPAIRS & RESTORATION WORK

1. Minor Repairs: Minor repairs are covered in Section 5.0 of this manual
2. Major Repairs & Restoration: Major repairs and restoration such as dike rebuilding, raising or widening, removal of in-stream sediment aggradation and log and debris jams, and work that involves breaching of existing dikes such as floodbox replacement, requires expert engineering advice as well as notification of the Regional Land and Water Manager and the Deputy Inspector of Dikes. Engineering advice should also be obtained regarding permanent repair and restoration work following emergency conditions. All cases of severe damage should, if possible, be recorded with photographs, dates and times of the occurrences.
3. Responsibility for Repairs & Restoration: The < \_\_\_\_\_ Mitigation Works > (the “Works”) are designed to provide protection to habitable areas of development up to the design event. Repairs and restoration of the “Works” as a result of damage, as well as the removal of sediment and debris aggradation from the channel, that is caused by floods with magnitudes up to and including the magnitude of the design are the responsibility of the < Local Diking Authority >.
4. Maintenance, Repair & Restoration Cost Projections – see Section 6.9. Annualized costs projections based on routine annual maintenance, emergency response, and an estimated range of projected flood restoration and repair costs (say 5, 20, 50, 100, 200 yrs) up to and including the 1:200 year return event are provided in APPENDIX I. These costs include estimated costs associated with undertaking maintenance works, especially sediment and log debris removal, in accordance with the environmental requirements of the fish agencies >

## 8.0 RECORDS

The most up-to-date drawings available showing the existing flood mitigation works are located in Appendix G. These drawings should be kept available as a reference tool for staff assigned the duty of operating and maintaining the flood mitigation system. Elevations and cross-sectional information are especially useful should repair works become necessary.

Cases of severe damage to flood protection works during high water conditions should be recorded with photographs, and records should be kept of dike inspection logs, gauge readings and high water marks. Also, a detailed record history of all major repair work must be made and kept with as constructed drawings. Repair records should include dates, stationing and/or location of repairs, dimensions and specifications for materials used, a description of the probable or apparent failure process, and “before” and “after” photos of the repairs.

A detailed record of all sediment and log debris jam removal must be kept with the as-constructed drawings and inspection reports. This must include channel surveys before and after sediment removal, and sediment volumes removed.

Annual inspection reports should be sent to the Deputy Inspector of Dikes.

**APPENDIX A**

MAINTENANCE AGREEMENT

**APPENDIX B**

HISTORICAL STREAM FLOW RECORDS AND GAUGE INFORMATION

**APPENDIX C**

AGENCIES CONCERNED WITH FLOOD CONTROL WORK

**APPENDIX D**

“DIKE MAINTENANCE ACT”

**APPENDIX E**

SAMPLE DIKE INSPECTION LOG

**APPENDIX F**

RIGHT-OF-WAY AGREEMENTS

**APPENDIX G**

AS-CONSTRUCTED DRAWINGS  
(Geodetic Bench Mark Information)  
(Rock Riprap Specifications)

**APPENDIX H**

LIST OF SUPPLIERS AND CONSTRUCTION EQUIPMENT

Company Name	Phone No.	Item

**APPENDIX I**

**MAINTENANCE AND EMERGENCY REPAIR COST PROJECTIONS**

## Summary of Legislation Applicable to Flood Protection Works

( modified from: Dike O&M Manual, April 2001 - Table 3)

Legislation	Type of Work Proposed	Contact Authority* (for information & direction)
<ul style="list-style-type: none"> <li>▪ Written approval from the Office of the Inspector of Dikes (MELP) is required, as per the Dike Maintenance Act, prior to the start of any construction work on or near flood protection works. Approvals from other government offices may also be required.</li> </ul>		
<ul style="list-style-type: none"> <li>▪ Dike Maintenance Act</li> </ul>	<ul style="list-style-type: none"> <li>▪ Proposed work at or near existing flood protection works</li> <li>▪ Proposed new flood protection works.</li> </ul>	<ul style="list-style-type: none"> <li>▪ WLAP</li> </ul>
<ul style="list-style-type: none"> <li>▪ Water Act</li> </ul>	<ul style="list-style-type: none"> <li>▪ Any work proposed in and about watercourses.</li> <li>▪ Any instream work or crossings.</li> <li>▪ Proposed gravel or sediment removal or excavation.</li> </ul>	<ul style="list-style-type: none"> <li>▪ LWBC</li> </ul>
<ul style="list-style-type: none"> <li>▪ Canada Fisheries Act</li> </ul>	<ul style="list-style-type: none"> <li>▪ Any proposed work or vegetation removal in or adjacent to waters frequented by fish or containing fish habitat (marine or fresh water).</li> </ul>	<ul style="list-style-type: none"> <li>▪ WLAP</li> <li>▪ DFO.</li> </ul>
<ul style="list-style-type: none"> <li>▪ Land Act</li> </ul>	<ul style="list-style-type: none"> <li>▪ Proposed gravel removal / borrowing</li> </ul>	<ul style="list-style-type: none"> <li>▪ LWBC (where the stream-bed is on Crown Land).</li> </ul>
<ul style="list-style-type: none"> <li>▪ Forest Act</li> </ul>	<ul style="list-style-type: none"> <li>▪ Removal of merchantable trees and wood from Crown land including streambeds and banks.</li> </ul>	<ul style="list-style-type: none"> <li>▪ MOF.</li> </ul>
<ul style="list-style-type: none"> <li>▪ Navigable Waters Protection Act</li> </ul>	<ul style="list-style-type: none"> <li>▪ All proposed work within, above or under the wetted perimeter of a navigable water (defined in the Act).</li> </ul>	<ul style="list-style-type: none"> <li>▪ MOT.</li> </ul>
<ul style="list-style-type: none"> <li>▪ BC Environmental Assessment Act</li> </ul>	<ul style="list-style-type: none"> <li>▪ Major projects. (Legislation under development.)</li> </ul>	<ul style="list-style-type: none"> <li>▪ MSRM / WLAP.</li> </ul>
<ul style="list-style-type: none"> <li>▪ Local Government Act</li> </ul>	<ul style="list-style-type: none"> <li>▪ Provides for formation of bylaws and Improvement Districts.</li> <li>▪ Authorizes new Diking Authorities.</li> <li>▪ Provides authority for local government to regulate diking works.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Local Government.</li> <li>▪ MCAWS</li> </ul>
<ul style="list-style-type: none"> <li>▪ Emergency Program Act</li> </ul>	<ul style="list-style-type: none"> <li>▪ Requires a local government to establish and maintain and emergency management plan.</li> <li>▪ Provides local government authority to declare a state of emergency.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Local Government.</li> </ul>
<ul style="list-style-type: none"> <li>▪ Other Legislation (local bylaws, etc)</li> <li>▪</li> <li>▪</li> </ul>	<ul style="list-style-type: none"> <li>▪</li> <li>▪</li> </ul>	<ul style="list-style-type: none"> <li>▪</li> </ul>

WLAP: BC Ministry of Water, Land & Air Protection.

MSRM: BC Ministry of Sustainable Resource Management

MOT: Minister of Transport (Government of Canada)

DFO: Department of Fisheries and Oceans (Government of Canada)

MOF: BC Ministry of Forests.

BCAL: BC Assets & Land Corporation

PEP: BC Provincial Emergency Program

For further information on legislation relevant to flood protection works, see Guidelines for Management of Flood Protection Works in British Columbia (1), and [www.qp.gov.bc.ca/statreg/](http://www.qp.gov.bc.ca/statreg/)

## Summary of Relevant Available Guides

( From Dike O&M Manual, April 2001 - Table 4)

Information covered	Guide	Date of publication
<ul style="list-style-type: none"> <li>▪ Summary of <b>legislation &amp; regulation</b> relevant to flood protection works.</li> <li>▪ Approvals &amp; controls under the Dike Maintenance Act.</li> <li>▪ Responsibilities for flood management.</li> <li>▪ Overview of operation, maintenance, &amp; emergency measures.</li> <li>▪ Checklists.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Guidelines for Management of Flood Protection Works in British Columbia (1)</li> <li>▪</li> <li>▪</li> <li>▪</li> </ul>	<ul style="list-style-type: none"> <li>▪ March</li> <li>▪ 1999</li> </ul>
<ul style="list-style-type: none"> <li>▪ Responsibility of local government for flood hazard management and <b>development in flood prone areas</b>:</li> <li>▪ Authority and regulation,</li> <li>▪ Implementation of controls,</li> <li>▪ Official Community Plans,</li> <li>▪ Floodplain bylaws.</li> <li>▪ Steps in preparation of a floodplain bylaw (including a sample bylaw).</li> </ul>	<ul style="list-style-type: none"> <li>▪ Regulatory Tools for Flood Hazard Management</li> <li>▪ A Guide for Local Government (2)</li> <li>▪</li> <li>▪</li> <li>▪</li> </ul>	<ul style="list-style-type: none"> <li>▪ March</li> <li>▪ 2000</li> </ul>
<ul style="list-style-type: none"> <li>▪ A complete guide to <b>inspection</b> of flood protection works including dikes and appurtenances.</li> <li>▪ Inspection scheduling, preparation, record keeping, report forms, patrol logs, etc.</li> <li>▪ Field guides to identifying problems.</li> <li>▪ Explanation of typical issues affecting flood protection works.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Flood Protection Works Inspection Guide (3)</li> <li>▪</li> <li>▪</li> <li>▪</li> <li>▪</li> </ul>	<ul style="list-style-type: none"> <li>▪ March</li> <li>▪ 2000</li> </ul>
<ul style="list-style-type: none"> <li>▪ Guide to design and placement of riprap for bank and slope protection.</li> <li>▪ Design considerations.</li> <li>▪ Construction practices and placement.</li> <li>▪ Emergency repair.</li> <li>▪ Maintenance.</li> <li>▪ Technical appendix.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Riprap Design and Construction Guide (4)</li> <li>▪</li> <li>▪</li> <li>▪</li> <li>▪</li> </ul>	<ul style="list-style-type: none"> <li>▪ March</li> <li>▪ 2000</li> </ul>
<ul style="list-style-type: none"> <li>▪ Minimum standards for vegetation management on flood control structures.</li> <li>▪ Environmentally sensitive approach to vegetation control.</li> <li>▪ Consideration of fish habitat and dike maintenance activities.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Environmental Guidelines for Vegetation Management on Flood Protection Works to Protect Public Safety and the Environment (5)</li> </ul>	<ul style="list-style-type: none"> <li>▪ March</li> <li>▪ 1999</li> </ul>
<ul style="list-style-type: none"> <li>▪ Responsibilities under the Emergency Preparedness Act (EPA).</li> <li>▪ Flood response activities.</li> <li>▪ BC Flood Plan</li> </ul>	<ul style="list-style-type: none"> <li>▪ Water Related Hazards</li> <li>▪ Emergency Response Plan and Procedures (6)</li> </ul>	<ul style="list-style-type: none"> <li>▪ February</li> <li>▪ 1998</li> </ul>
<ul style="list-style-type: none"> <li>▪ Emergency planning and preparedness in B.C.</li> </ul>	<ul style="list-style-type: none"> <li>▪ See web site: <a href="http://www.pep.bc.ca">www.pep.bc.ca</a></li> </ul>	<ul style="list-style-type: none"> <li>▪</li> </ul>
<ul style="list-style-type: none"> <li>▪ Local Guides (<i>eg. Gravel removal guide in Chilliwack</i>)</li> </ul>	<ul style="list-style-type: none"> <li>▪</li> </ul>	<ul style="list-style-type: none"> <li>▪</li> </ul>