Report

Associated Engineering | GLOBAL PERSPECTIVE. LOCAL FOCUS.

District of Summerland

Dam Safety Review

December 2010

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REPORT

1 Introduction

The District of Summerland is located on the west side of Okanagan Lake, about 45 km south of Kelowna and 15 km north of Penticton. The Corporation of the District of Summerland owns and operates a number of dams. The dams are used as raw water storage facilities.

In April, 2010, the District contracted a Dam Safety Review team from Associated Engineering and Golder Associates to inspect and provide dam safety reviews of the following dams:

- Headwaters No.1
- Headwaters No. 2
- Headwaters No. 3
- Headwaters No. 4
- Crescent (Paul) Reservoir
- Whitehead Reservoir
- Aeneas (Eneas) Reservoir
- Tsuh (Deer) Reservoir
- Isintok Reservoir
- Summerland Reservoir
- Garnett (previously Garnet) Reservoir

Thirsk Dam, one of the District's two Very High Consequence Dams, was not included in this review, as that dam was rehabilitated as recently as 2007. Headwaters No 1 Dam was inspected in June 1998 and is currently part of a maintenance upgrading program.

The Dams impound water within two main watersheds within the District of Summerland water supply system: Trout Creek and Aeneas Creek. A general location plan is shown in **Figure 1**.

The dams were reviewed according to the Dam Safety Guidelines established by Canadian Dam Safety Association, January 1, 2007, as well as the minimum criteria developed by the Ministry of Environment – Dam Safety Branch in 2010, see **Appendix D**.

2 Dam Safety Review

2.1 General Background

The object of a dam safety review is to assess the performance of the dam as the dam ages, redefining operational and maintenance requirements and ensuring public and environmental safety. The Review process includes an assessment of the current condition of a dam, its related control and emergency structures and the operation and maintenance policies, and recommend identify any deficiency in the safety of the dam. The Review must:

- Meet the requirements of the BC Dam Safety Regulation and the reviewer should utilize the CDA Guidelines as the principle source of standard engineering practice for dam safety.
- Identify, at the outset, possible hazards and associated failure modes of the dam, based on an examination of available information.
- Initially assess potential hazards, with the team then assessing the existing safety management of the dam, and compares design criteria to current requirements and standards.
- Produce outcomes that provide:
  - Confirmation that all things necessary to confirm the safety of the dam are in place, are current and appropriate, and are being followed; or
  - Identification of issues/deficiencies for further investigation in a separate project.

Under Section 7 of the BC Dam Safety Regulation, owners of dams classified as High or Very High Consequence of Failure are required to undertake periodic DSRs. Please see Schedule 1 of the Dam Safety Regulations, Downstream Consequence Classification Guide and Schedule 2 to determine the frequency for preparing DSRs. The Canadian Dam Association (CDA) defines a Dam Safety Review as:

> "A 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."

The ideal Dam Safety Management System, **Figure 2-1** provides the owner with a process of assuring compliance to the BC Dam Safety Regulations and at the same time allowing non-compliance items to be identified and categorized. This allows the Owner to define risk and enable capital expenditure to be prioritized.

It is the responsibility of the dam owner to review the Dam Safety Review report. A copy of this report should be forwarded to the responsible Dam Safety Officer at the Ministry of Environment.

Figure 1. District of Summerland Watersheds and Sub-Catchments - Taken from WMC (2005)

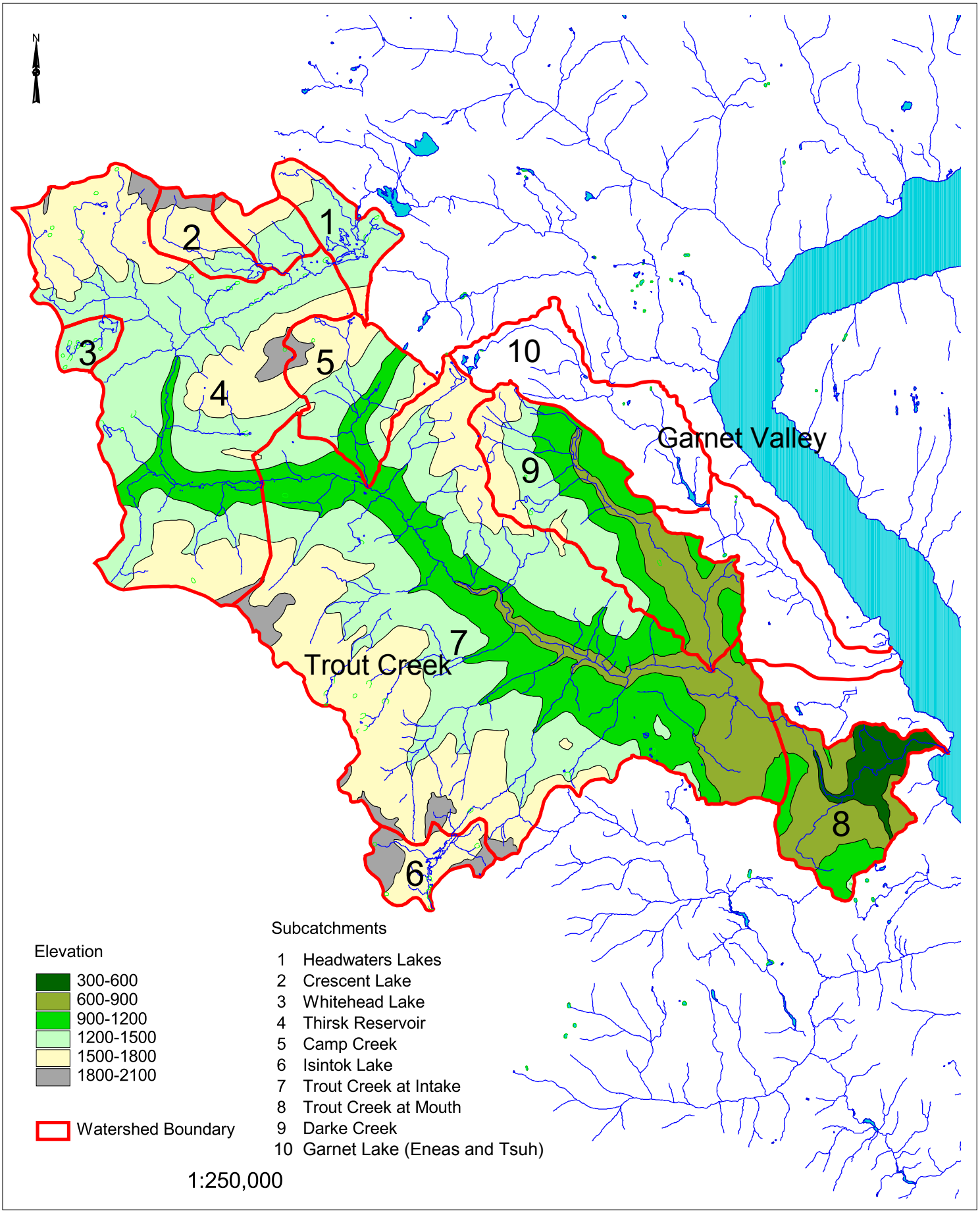
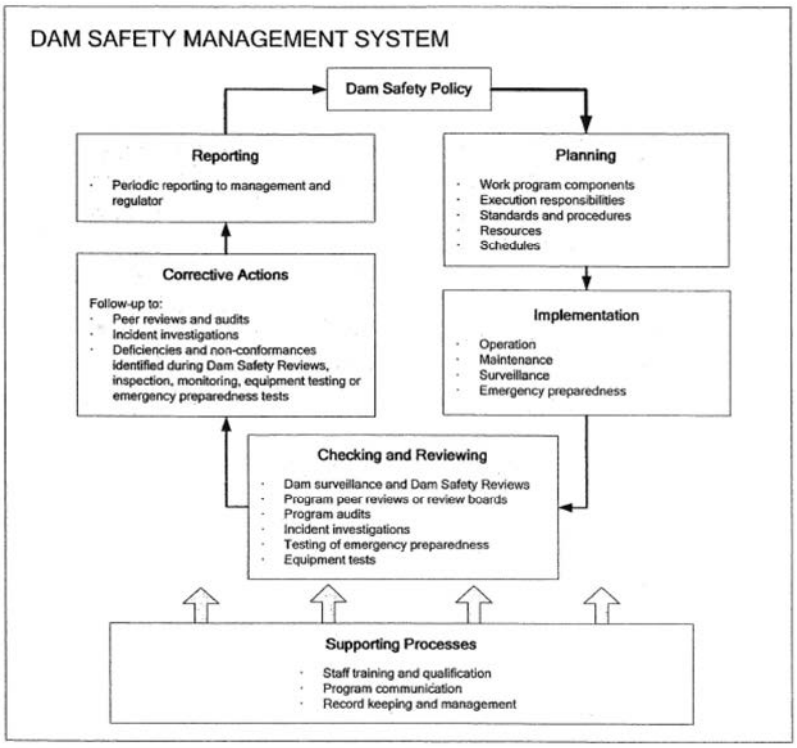


Figure 2-1
Ministry of Environment – Description of a Dam Safety Management System



2.2 Review Process

All of the structures within this report are considered small dams, consisting of earthfill embankments with gated low level outlet works and side channel spillways.

2.3 Review of Reservoir Operations

A project initiation meeting was held with Mr. Shawn Hughes and Mr. Scott Lee from the District of Summerland. These gentlemen are responsible for the day to day operations of the water system, and for the dam operations. Operational plans were reviewed. Requirements for dam owners under the Dam Safety Regulation (inspection frequency, OMS & EPP requirements, etc.) were analyzed based on current guidelines (MOE, 2010).

All the dams impound water in Reservoirs within the Summerland System. Only three dams are operated frequently for water supply, Thirsk Dam, Garnett Reservoir and the Summerland Reservoir. The Summerland water supply comes from two watersheds, Trout Creek and Aeneas Creek.

2.3.1 Trout Creek

Thirsk Dam and Summerland Reservoir
The reservoir operating rules for the Trout Creek Watershed are based on parameters developed by Summit (2007) for the District of Summerland. Under normal operations, water is released from Thirsk to Summerland Reservoir, as required. Under normal conditions, the reservoirs upstream of Thirsk are not part of operations. Under more extreme dry circumstances, where Thirsk Reservoir levels drop, then live storage in the upstream reservoirs may be accessed for water supply downstream.

Under extreme wet conditions, or where flood conditions exist, the reservoirs should be assumed to be full, and would spill immediately. **Figure 1** outlines the sub-catchments of each reservoir. Flood water is spilled as follows:

- Headwaters No.1 flows to Thirsk Reservoir.
- Headwaters Reservoirs Numbers 2, 3 and 4 flows through Headwater Dam No. 1.
- Crescent Reservoir flows directly to Thirsk Reservoir.
- Whitehead Reservoir flows to Thirsk Reservoir.
- Isintok Reservoir is routed via Trout Creek to Okanagan Lake.
- Tsuh Reservoir is routed via Tsuh Creek to Trout Creek to Okanagan Lake.
- Thirsk Reservoir is routed via Trout Creek to Okanagan Lake.

Summerland Reservoir
The Summerland Reservoir levels are controlled by channel supply from intake structure off Trout Creek. The dam itself is constructed from gravelly material local to the area, and is prone to seepage. Immediately downstream of the structure are residences and orchard farmland.

2.3.2 Garnett Reservoir

The Aenas Creek Watershed, upstream of the Garnett dam, supplies between 5 and 10 percent of the District of Summerland water supply. This watershed includes Finley Creek, Lapsley Creek and two small high-level reservoirs, Aeneas Reservoir and Tsuh Reservoir. The bulk of this water supply is for municipal and agricultural purposes.

Under extreme wet conditions, or where flood conditions exist, Aeneas and Tsuh are always assumed to be full and spill immediately.

- Aeneas and Tsuh Reservoir flow into Garnett Reservoir,
- Garnett spills are routed to Okanagan Lake.

3 Site Inspection of Dams and Ancillary Structures

Site inspections were completed on four different days. Inspection sheets provided by the Ministry of Environment were completed, and converted to a database, and detailed in **Appendix A**.

Each dam was inspected based on the following work plan:

- Detailed inspection of the seepage, seepage damage, overtopping, ground conditions and other geotechnical or structural components affecting the stability of the dam.
- Detailed inspection of the low level outlet structure, including concrete condition, gate operations, riprap condition and general operations.
- Detailed inspection of the service and emergency spillways, including concrete quality, cracking, debris levels, riprap quality and downstream conditions.
- A review of personal safety aspects, including level of access to the public.
- Advising the District of Summerland of any items requiring immediate attention.

4 Dam Breach Issues

Dam breaches can generally be by sunny day failure, flood failures or Acts of God.

- Sunny day failures can result from simple structural failures to failures of individual components, such as a broken low level outlet structure, piping, erosion or failure of the spillway structure, plugged filter systems, or other similar failures caused by inadequate maintenance, upgrades or monitoring.
- Flood failures can occur to any component of the dam, and result generally from the additional erosive forces and forces overcoming a spillway system that is inadequately sized or maintained.
- Acts of God, such as earthquakes, lightning strikes or tornadoes.

Table 4-1 summarizes breach issues for the District's Dams. These issues form part of the Hazard Consequence Classification in Section 5.

Table 4-1
Summary of Dam Breach Modes and Concerns

	Hazard Classification	Likely Failure Mode	Downstream Development	Comments
Headwaters No. 1 (includes flows cascaded from breach of Headwaters 2, 3, 4 or Crescent Reservoir)	Low	Flood	None	Cascade into Thirsk Reservoir
Crescent	Very Low	Flood		Cascades into Thirsk
Whitehead	Very Low	Flood		Cascades into Thirsk
Summerland Reservoir	High	Sunny Day	Ranches, farmland	Loss of supply intake to Town, houses immediately downstream,
Isintok	High	Flood	Lower Summerland, Okanagan Lake	Disruption to flows in Trout Creek, supply to town.
Garnett Dam (includes flows cascaded from breach of Aeneas or Tsuh Dams)	Very High	Flood	Ranches, Farmland, environmental	Loss of supply to 10 percent of District, downstream farmland, road, some loss of life.

5 Hazard Consequence Classification Review

The BC Dam Safety Division has provided a document called the Interim Consequence Classification Policy for Dams in British Columbia, February 2010.

The BC Dam Safety Hazard Classification System is based on 1999 Canadian Dam Association (CDA) guidelines, but updated in 2010 to accommodate the 2007 CDA guidelines, **Table 5-1**. There is currently a caveat in the BC regulations that dam safety reviews constructed prior to 2007 can continue to be classified under the 1999 definitions (No High-High or High-Low classifications). Classifications are generally based on the incremental losses that a failure of a dam might inflict on downstream areas, upstream areas or at the dam location. Incremental losses are those over and

above losses which might have occurred for the same natural event or conditions, had the dam not failed. The incremental losses from a dam failure are evaluated in terms of three consequence categories:

- Loss of life.
- Economic value of other losses and/or damage to property.
- Other less quantifiable consequences related to social, cultural, and environmental damages.

Table 5-1
Consequence Classifications (BC Ministry of Environment, 2010)

Consequence Classifications	Loss of Life		Persons at Risk (CDA Only)	Economic and Social Losses[2]		Environmental and Cultural Losses		Consequence Classifications
BC Dam Safety Regulation	BC Reg.[3]	CDA		BC Reg.[4]	CDA	BC Reg.	CDA	CDA 2007
Very High	>100	>100	Permanent Residents	>$100M Very High Infrastructure; Public, Commercial, Residential	Extreme - Critical Infrastructure or Services	Nationally & Provincially Important Habitat & Sites - Restoration Chance Low	Major Loss of Critical Habitat - No Restoration Possible	Extreme
High (High[5])	< 100	< 100		< 100M Substantial Infrastructure; Public, Commercial	Very High - Important Infrastructure or Services	Same as Above but Restoration Chance High	Significant Loss of Critical Habitat - Restoration Possible	Very High
High (Low[5])	< 10	< 10		< $10M Same as Above	High – Infrastructure, Public Trans & Commercial	Same as Above	Significant Loss of Important Habitat - Restoration Possible	High
Low	Some Possible	Unspecified[6]	Temporary Only	< $1M Limited Infrastructure; Public, Commercial	Temporary & Infrequent	Regionally Important Habitat & Sites - Restoration Chance High	No Significant Loss of Habitat - Restoration Possible	Significant
Very Low	Minimal	0	None	< $100K Minimal	Low	No Significant Loss of Habitat or Sites	Minimal Short Term Loss	Low

[2] CDA name this category 'Infrastructure & Economics'
[3] Conservative estimate of loss of life amongst population affected by the flood waters (may equal Population at Risk)
[4] Dollar values from year 2000
[5] Internal "High" sub-classification used for Dam Safety Program risk-based assessment.
[6] Significant category may not always line up with Low (BC Reg). A temporary population (e.g. in recreation al areas) could be quite large and a "sunny-day" failure could result in multiple fatalities.

Table 5-2 provides the results of our analysis of each dam's hazard consequence.

Table 5-2
Summary of Hazard Categories (using CDA 2007)

Dam	Loss of Life	Economic and Social Losses	Environmental and Cultural Losses	Overall Hazard Classification
Headwaters 1	Very Low	Low	Very Low	Very Low
Headwaters 2	Very Low	Very Low	Very Low	Very Low
Headwaters 3	Very Low	Very Low	Very Low	Very Low
Headwaters 4	Very Low	Very Low	Very Low	Very Low
Crescent Reservoir	Very Low	Very Low	Very Low	Very Low
Whitehead Reservoir	Very Low	Very Low	Very Low	Very Low
Aeneas Reservoir	Very Low	Very Low	Very Low	Very Low
Isintok Reservoir	Very Low	High	High	High
Tsuh Reservoir	Very Low	Very low	Very Low	Very Low
Garnett Reservoir	High	Very High	High	Very High
Summerland Reservoir	Low	High	Very Low	High

Our dam safety review team reviewed each dam's historical hazard consequence rating, then revised, where required, the consequence classification from our findings in this report, including inspection of the dam sites, observations of the upstream and downstream conditions and estimating the consequences of dam failure. The evaluation of potential losses, both with and without dam failure, are normally based on inundation studies and should consider existing and anticipated future downstream development and land uses. No inundation studies have been completed for any of the dams examined.

The three higher consequence dams, Garnett Reservoir, Isintok and the Summerland Reservoir are determined as follows:

Garnett Dam
A breach at this dam can cause significant Economic and social losses in the Summerland area. Drinking water supply to the valley residents would be compromised, and the erosion and deposition on agricultural lands downstream would be very significant. There is only one access road along the creek. This road would likely be destroyed or compromised, restricting emergency access to both the dam operations and downstream affected stakeholders. Classification: Very High.

Isintok
This reservoir is the only small reservoir on the Trout Creek system that does not cascade into Thirsk Dam. The result of a breach of this dam would likely be significant damage to Trout Creek. As with Testalinden Creek in 2010, the quantity of material routed to the downstream reaches of Trout Creek could be up to 10 times the Reservoir volume. This could impact Highway 97,

agricultural properties and the lower town near Okanagan Lake. A dam breach study is recommended. Classification: High.

Summerland Reservoir

A breach of the Summerland Reservoir would affect a number of residences immediately downstream of the structure. While the volumes of water are small, the impact to lives and agricultural properties are potentially significant. The only breach scenario is a sunny day breach, as the only inflow is from a channel and intake off Trout Creek. There is a negligible watershed. There is an electronic level sensor and alarm system at the structure to warn staff of operational issues at Summerland Reservoir. Classification: High.

6 Review of Inflow Design Floods and Structure Capacity

A review of Inflow Design Floods for all reservoirs was performed to review spillway capacity requirements. In each instance, we examined or estimated the Inflow Design Flood for the dam, and determined if the spillway structures could meet the required capacities within their current freeboard conditions.

Since little is known of the design characteristics of each dam, it is up to the dam safety reviewer to determine the appropriate Inflow Design Flood. Table 6-1 below describes Inflow Design Flood (IDF) minimum requirements for various Hazard Consequences.

Table 6-1
Suggested IDF and Earthquake Factors (CDA 2007)

Dam class [note 1]	AEP	
	IDF [note 2]	EDGM [note 3]
Low	1/100	1/500
Significant	Between 1/100 and 1/1000 [note 4]	1/1000
High	1/3 between 1/1000 and PMF [note 5]	1/2500 [note 6]
Very high	2/3 between 1/1000 and PMF [note 5]	1/5000 [note 6]
Extreme	PMF [note 5]	1/10,000

Acronyms: AEP, annual exceedance probability; EDGM, earthquake design ground motion; IDF, inflow design flood; PMF, probable maximum flood.

Note 1. As defined in Table 2-1, Dam Classification.

Note 2. Extrapolation of flood statistics beyond 1/1000 year flood (10^{-3} AEP) is discouraged.

Note 3. AEP levels for EDGM are to be used for mean rather than median estimates of the hazard.

Note 4. Selected on the basis of incremental flood analysis, exposure, and consequences of failure.

Note 5. PMF has no associated AEP. The flood defined as "1/3 between 1/1000 year and PMF" or "2/3 between 1/1000 year and PMF" has no defined AEP.

Note 6. The EDGM value must be justified to demonstrate conformance to societal norms of acceptable risk. Justification can be provided with the help of failure modes analysis focused on the particular modes that can contribute to failure initiated by a seismic event. If the justification cannot be provided, the EDGM should be 1/10,000.

Out of the 11 reservoirs examined in this review, three can be classified as high consequence. Initially, we assume examined all high consequence dams for 1:1000 year flood should be the minimum design IDF for these structures. The remaining 8 reservoirs had Very Low consequence ratings, requiring 1:100 year IDF. We analyzed these structures for a 1:100 and 1:200 year storm, as several historical criteria assumed this flood assessment.

Inflow Design Floods would likely result from the combination of severe rainfall and snow-melt events. As there are no past hydrological studies of each specific dam, the reviewers performed a review of flood parameters to assess dam safety concerns. The review team examined various flood routing methodologies.

6.1 Rational Method

Regional methodology is generally considered suspect for watershed smaller than 10 km^2; therefore, the Rational Formula is commonly used to estimate design peak flows for small watersheds in B.C. (Coulson 1991). The basic assumptions of the Rational Formula are as follows:

a. Rainfall occurs at a uniform intensity for a duration at least equal to the time-of-concentration[1];
b. Rainfall occurs at a uniform intensity over the entire area of the watershed; and
c. A single runoff coefficient is representative of the entire are of the watershed.

The Rational Formula equation used to calculate the IDF discharge for the Summerland reservoirs are:

$$Q_{pIDF} = \frac{0.28CPA}{T_c}$$

And:

$$T_c = \frac{(n\,L)^{0.467} S^{-0.234}}{1.65}$$

where:

Q_{pIDF} = IDF discharge (m^3/s);
C = runoff coefficient (dimensionless);
P = total precipitation occurring within the time-of-concentration (mm), during the 1:100 or 1:1000 maximum precipitation event;
A = drainage area (km^2); and
T_c = time-of-concentration (hrs).
n = Roughness coefficient
L = Watershed Length (km)
S = Watershed Slope

[1] This is the time required for surface runoff generated at the most distant point in the drainage basin to reach the point-of-interest.

The derived factors are found in **Tables 6-2** and **Table 6-3**. A detailed process is provided in **Appendix D**. We also examined the effects for a different hydrologic zone such as Penticton. It should also be noted that dam sites are approximately 1000 metres higher than most Environment Canada weather stations in the area.

6.2 Other historical IDF Calculations

Designs in both the Okanagan and by recent designs in the interior of British Columbia were examined for similar sized reservoirs and structures for their hydraulic considerations. The CDA Guidelines suggest a minimum of IDF of 1:100 for Very Low Consequence dams. Most other analyses in the Okanagan start at 1:200, and account for local weather patterns, and the effects of pine beetle and other elevation factors.

Notes:

- Coulson (1973) summarized from past experience and observations that Inflow Design Floods have ranged between 50 to 150 cfs/square mile of watershed in the Okanagan Regional. In very small and high elevation watersheds, however, he felt that potential snowmelt and rainfall conditions would prevail, and that the peak inflows of 228 cfs/square mile were more reliable.

- During a review of the Garnett dam safety, Imada (1999) noted that other similar sized dams within BC Hydro were designed to 1:1000 storms, where the spillway capacities were calculated between 2.7 and 3.0 cfs per square mile of watershed.

- Hay (2007) reviewed Trout Creek, **Table 6-4**. It was also reported in this study that the Mountain Pine Beetle infestation and climate change could significantly affect runoff capacity requirements.

Table 6-2
Summary of Inflow Design Flood Reviews

	Trout Creek Watershed						Garnet Valley Watershed	
	HW 1	HW 2-4	Crescent	Whitehead	Isintok	Tsuh	Aeneas	Garnett
A (ha)	1,918	500	1,554	540	1,640	244	310	10,000
A (km^2)	19.2	5.0	15.5	5.4	16.4	2.4	3.1	100.0
L (m)	6,650	6,650	2,000	2,000	4,260	1,000	2,000	16,000
L (km)	6.7	6.7	2.0	2.0	4.3	1.0	2.0	16.0
n	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80
S	0.069	0.069	0.020	0.106	0.223	0.143	0.100	0.040
C	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
C_{100}	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31
C_{1000}	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38
Tc (hr)	2.5	2.5	1.9	1.3	1.5	0.9	1.3	4.2
Tc (min)	149	149	113	77	92	52	78	254
i_{100} (mm/h)	9	9	11	17	14	19	17	7
i_{1000} (mm/h)	26	26	31	34	38	52	42	18
P_{100} (mm)	22	22	21	22	21	16	22	28
P_{1000} (mm)	64	64	58	43	58	45	54	76
Capacities from Rational Equation (m^3/s)								
$Q_{Rational\ 1:100}$	15.1	3.9	15.0	8.0	20.1	4.1	4.6	58.6
$Q_{Rational\ 1:1000}$	52.4	13.7	50.6	19.3	65.4	13.3	13.7	189.0
Other estimates for 1:200 storm from past designs or studies (m^3/s)								
$Q_{0.93\ m3/s/km2}$	17.8	4.7	14.5	5.0	15.3	2.3	2.9	93.0
$Q_{50cfs/mi2}$	10.5	2.7	8.5	3.0	9.0	1.3	1.7	54.7
$Q_{Hay\&Co\ 1:200}$								11.4
Other estimates for 1:1000 storm from past designs or studies (m^3/s)								
$Q_{228cfs/mi2\text{-}Coulson(1973)}$	47.8	12.5	38.7	13.5	40.9	6.1	7.7	
$Q_{150cfs/mi2}$	31.5	8.2	25.5	8.9	26.9	4.0	5.1	164.0
$Q_{BCHydro\text{-}LOW}$	51.8	13.5	42.0	14.6	44.3	6.6	8.4	270.0
$Q_{BCHydro\text{-}HIGH}$	57.5	15.0	46.6	16.2	49.2	7.3	9.3	300.0
Recommended IDF - 2010	15.1	3.9	15.0	8.0	65.4	4.1	4.6	164.0
Volume of Runoff (Q . T_c) (m^3)	134,590	35,090	101,530	36,910	359,530	12,580	21,480	2,499,410

Table 6-3
Review of Spillway or Flood Control Capacities Based on IDF

	Hazard Classification	IDF	Weir Type	Base Weir Length (m)	Estimated Capacity: Maximum Q_c (m^3)	Estimated Capacity: Depth of Spillway (m)	Required Capacity: IDF Q_r (m^3/s)	Required Capacity: Minimum Depth d_r (m)	Comments
Headwaters 1	Very Low	1:100	Rectangular	9.14	32.2	1.53	15.0	0.92	Ok
Headwaters 2	Very Low	1:100	Trapezoid	3.00	15.8	1.57	3.9	1.40	Ok
Headwaters 3	Very Low	1:100	Trapezoid	2.40	15.8	1.57	3.9	1.40	Ok
Headwaters 4	Very Low	1:100	Trapezoid	3.00	15.8	1.57	3.9	1.40	Ok
Crescent Lake	Very Low	1:100	Rectangular	8.50	24.5	1.34	14.5	0.95	Ok
Isintok	High	1:1000	Rectangular	4.00	41.0	3.12	40.9	3.14	Requires Further Review
Whitehead	Very Low	1:100	Trapezoid	5.79	21.5	1.15	13.5	0.51	Ok
Garnett Dam	High	1:1000	Cipolletti	12.20	70.0	2.12	164.0	3.74	Requires Further Review
Aeneas	Very Low	1:100	Rectangular	4.57	11.2	1.20	7.7	0.95	Ok
Tsuh Dam	Very Low	1:100	Trapezoid	3.00	10.9	1.07	6.1	0.79	Ok
Intake Dam	High	N/A	None						N/A

IDF - Inflow Design Flood
Current assumes maximum spillway capacity without overtopping the dam but using the full freeboard.

Table 6-4
Trout Creek Watershed Flood at Entrance to Okanagan Lake (Hay, 2007)

Return Period (years)	Peak Discharge (m^3/s)
2	22.9
5	34.7
10	42.1
20	49.0
50	57.7
100	64.0
200	70.3

6.3 Discussion

Inflow Design Floods – Low or Very Low Consequence Dams

- The eight Very Low consequence dams were constructed in remote uplands, and are typically above 1200 m in elevation. Although the dams pose little risk to downstream users or uses, the Emergency Flood Control structures must still be adequately designed to pass floods between the 1:200 year and 1:1000 events.
- Upon review of the designs, the flood control structures on Headwaters, Crescent Reservoir, Whitehead Reservoir, Aeneas and Tsuh are adequately sized to pass the IDF.
- Headwaters No. 1 is a Low Consequence dam. There is a minor risk that there could be

temporary silt overload in Thirsk Dam. This can only be confirmed with further study. If Thirsk were somehow found to fail under this scenario, then Headwaters No. 1 could be upgraded to a High Consequence dam.

Inflow Design Floods – High Consequence Dams

- The flood control structures on two of the three High Consequence dams must pass at least the 1:1000 year flood, and possibly higher.
- Isintok Dam spillway size may require further review. As the spill into Isintok Creek could significantly impact lower Trout Creek, it will be important to review IDF requirements for this reservoir. It is currently undersized for a 1:1000 year storm consistent with the analysis above.
- The Very High Consequence Rating requires that the Garnett Dam spillway be sized for a storm 2/3 somewhere between 1:1000 and the PMF. Regardless, the spillway is too small for the 1:1000 storm, and therefore requires review. In addition, the channel capacity downstream of the spillway is restricted by a culvert crossing that would be immediately washed out. Access to the dam in these emergency circumstances would be a significant challenge.
- The Summerland Reservoir dam IDF is not based on watershed parameters, but canal operational failure. It is not applicable in this circumstance.

Notes on Climate Change

- The issue of climate change on inflow design floods in the Okanagan has been discussed in recent years. It is generally accepted at this time that climate change would reduce the quantity of storage, as noted in Water Management Consultants (2005). The District has increased storage at the Thirsk Reservoir in 2007.
- Concerning dam safety, climate change would likely affect the severity of storms, and render past return storm analyses as suspect. The only spillway of concern at this time is at Garnett Valley. Long term climate change would likely only exacerbate this issue.

7 Review of Dam Design and Construction

As part of the inspection process, each dam design was reviewed, where possible, and compared to current design practices. Most of the very low consequence dams in the District of Summerland are earthen dams constructed of homogeneous materials. Detailed Inspection sheets containing results of individual inspections can be found in Appendix A. Photographs from each inspection are found in the accompanying CD ROM disk. Some photos with key issues itemized in **Appendix C**.

7.1 Structural Stability

The stability of the upstream and downstream slopes of the District's dams was reviewed and assessed. The dam sections analyzed were based on descriptions provided in the Operation and Maintenance Manual for the Water Storage Dams and an assumed phreatic surface based on observed seepage and location of the full supply level from HWL to the toe of slope.

Static and pseudo static analyses of the dams were undertaken. The analyses considered the consequence of full rapid drawdown under static and pseudo static conditions.

The choice of the peak horizontal ground acceleration used in the analyses was based on the screening level consequence category. The maximum design earthquake (MDE) used in this stability assessment of the Districts earthen dams was obtained from CDA 2007, summarized in **Table 7.1**. The 1998 dam safety review values are included for comparison. The selection of the appropriate annual probability of exceedance was based on the level consequence category.

Table 7.1
Annual Probability of Exceedance versus
Peak Ground Acceleration (PGA (%g))

1998 (Coursier Dam - Revelstoke)		2010 (NBCC 2005 1:2475 yr)	
Annual Probability of Exceedance	**Peak Ground Acceleration (%g)**	**Annual Probability of Exceedance**	**Peak Ground Acceleration (%g)**
0.001	6. 5	EDGM (low) = 1/500	8.0
0.0001	22.0	EDGM (High) = 1/2500	14.0

As in the previous dam safety inspections, there was a lack of as-constructed information available. We assumed that the dams consisted of a homogeneous section. A friction angle of 32 degrees and a γ = 19.5 kN/m^3 was used for the dam fills and foundation soils, respectively. **Table 7-2** summarizes generally accepted minimum factors of safety for various loading conditions.

Table 7-2
Loading Conditions and Minimum Accepted Factor of Safety

Loading Conditions	Minimum Accepted Factor of Safety	
	1998	2010
Steady-State Seepage with Full Reservoir	1.5	1.5
Full Rapid Drawdown	1.2 – 1.3	1.2 – 1.3
Earthquake	1.2	1.2

Table 7-3 summarizes the factors of safety for the various dams. Note that D/S and U/S stand for downstream and upstream, respectively.

Table 7-3
Factors of Safety for the Assessed Dams

DAM	Factor of Safety		
	Static	Earthquake Event	
		1/2500	1/500
Headwater No. 1	1.9	>1.2	>1.4
Headwater No. 2	2.5	-	>1.5
Headwater No. 3	2.4	-	>1.5
Headwater No. 4	2.2	-	>1.5
Crescent Reservoir	1.49	-	1.2
Whitehead Reservoir	1.8	-	1.3
Isintok Reservoir	1.75	-	1.32
Summerland Reservoir	-	-	-
Aeneas Reservoir	1.6	-	1.3
Tsuh Reservoir	1.9	-	1.4
Garnett Reservoir	1.3	0.87 - 0.99	<1.1

Table 7-4
Comments on Stability of Dams

	Meets minimum factor of safety requirement for slope failures?	Meets minimum safety factor for combined rapid drawdown and a 0.001 earthquake?	Meets minimum safety factor required for stability under rapid drawdown condition?
Headwaters 1	Yes	Questionable	Yes
Headwaters 2	No – slightly low, but acceptable		No
Headwaters 3	Yes	Yes – Slightly low, but acceptable	Yes
Headwaters 4	Yes	Questionable	Yes
Crescent Reservoir	Yes	Questionable	Yes
Isintok	No – Upstream Slope is slightly lower.	Questionable	Yes
Whitehead	No – slightly low, but acceptable	Questionable	Yes
Summerland Reservoir Dam	Yes	Questionable	Yes
Garnett Dam	No	No - Severely compromised under both a 0.001 and 0.0001 earthquake event. This includes full rapid drawdown of the reservoir.	No - Severely compromised under both a 0.001 and 0.0001 earthquake event. This includes full rapid drawdown of the reservoir.
Aeneas Dam	Yes	Questionable	
Tsuh Dam	Yes	Questionable	

8 Operations, Maintenance and Surveillance Review and Compliance

A review of procedures and methods used to operate the dam during normal and emergency conditions was performed. This review included:

- Dam maintenance records for any errors, omissions and deficiencies.
- Safety related documentation regarding the facility.
- Current dam management practices.

Dam Maintenance Records (notes are included in the inspection checklist in Appendix A)

- Generally, the dams are all well maintained. Due to the remote nature of several of the very low consequence dams, operations are limited to spill control. The low level outlets remain closed unless there is a need for additional water downstream, or that a lower reservoir level is required.
- Upgrades since the last Dam Safety Review:
  - District appears to have been diligent in the removal of brush and trees in all the dams. Some additional care should be given to maintaining some of the gates and concrete structures in working order. Some structures had plugging issues, and gates were sometimes difficult to seal completely.
  - Upgrades were completed on Headwaters No. 1 dam to improve the structural factor of safety.
  - Some of the recommended upgrades from the 1999 Dam Safety Review were not completed. Some of these upgrades are included in the recommendations in this report.
  - There have been no reports of emergencies within the last 10 years. All maintenance activities have been documented.

Safety Compliance

- Public Safety:
  - Most of the high elevation dams in the District include forestry campgrounds, recreational trails and forestry roads within their watersheds. There are apparently blue “Watershed Protection Zone” signs on most of the reservoirs. The review team only saw one sign advising the public that the reservoirs impounded by these dams were for water consumption by the District of Summerland (Isintok). Signs should be noticeable at all access points.
  - Notable exceptions:
    - Garnett Reservoir: The District has fenced around the dam and spillway area, and particularly along the Garnett Valley road.
    - Isintok: There is a sign advising the public to avoid using the dam. Foot and wheel tracks are evidence that the public does not heed the warnings.
    - Headwaters dams: There are forestry campgrounds with signs limiting fires.

- Vehicular Traffic
  - Isintok: Isintok's granular sand slopes appear to be highly erosive, and subject to rutting from vehicular traffic. This traffic could be restricted by installing a large rock at key entry points. While it will be impossible to limit all traffic, it is hoped to keep larger vehicles out; particularly off the slopes of the dam.

- Water Quality Safety
  - The potential for pollutants entering the system is relatively low. As with any remote Reservoir or reservoir, there is the potential for point source pollutants entering the system. There are also always the potential of criminal acts, however there is little surveillance available to monitor this.

- Operations Safety.
  - Staff follow general safety practices as dictated through WCB. The OMS report loosely refers to these practices. This protocol should be updated to 2010 requirements. These practices include communications, travel practices, weather, first aid, etc.
  - The noticeable items to the review team were:
    - Communications: Both regular and emergency communications are impossible on many of the dams. Use of a satellite phone is spotty at best. A communications plan should be included in the OMS plan update.
    - Access to Tsuh and Aeneas Reservoir dams is very difficult. There are many risks along the forestry roads. The roads are full of sharp rocks, twists and fallen trees. Simple protocols such as spare tires, first aid kits, weather safety kids and flares are suggestions.
    - There is no path to get to Tsuh Dam. There should at least be an ATV path.

Current Dam Management Practices

The last Operations and Maintenance manual for the Summerland Water Storage Dams was one prepared by UMA in 1991. This report recommended that at the end of the irrigation season the reservoirs should be at low levels in order to prevent ice build-up on the spillways during winter operation and to provide potential for some attenuation of peak flood flows in the following spring. The storage of some flood runoff in the spring reduces the possibility of spillway channel erosion

Water Management Consultants (2005) recommended that the District not generally operate the reservoirs explicitly for flood control in the late fall. If there is a large snowpack in a given year, Summerland operators now pre-spill from the reservoirs; not compromising normal water supply storage and refilling.

Recommendation

The Operations, Maintenance and Surveillance Manual requires updating. The manual must include dam management practices for each dam. This manual should have appendices which

include all current inspections, and a checklist of required practices. The manual can also include the Emergency Preparedness Plan and any Response Plans as discussed in the next section.

9 Emergency Preparedness Plan (EPP) Review

The team conducted a review of the Emergency Preparedness Plan. The District's EPP for all its small dams are in one document. A second meeting with Mr. Scott Morgan of the Ministry of Environment discussed all operations and maintenance. Current Emergency Preparedness Plans, O&M Manuals and inspection documentation were reviewed at this meeting.

Recommended Changes

- The Plan itself should be arranged in such a format that it can be easily accessed by any staff member during an emergency.
- Telephone numbers of all emergency contacts, available local contractors, helicopter contacts, the RCMP and the BC Government Emergency Contact.
- A copy of the District of Summerland Emergency Response Plan, and those to be contacted.
- All flood inundation mapping for all dams, including potential road washout locations.
- Design information on each specific dam.
- The EPP user must be aware to contact landowners immediately downstream of Summerland Reservoir when a potential or imminent breach scenario occurs. Landowners further downstream may be contacted using public radio or other services.
- Maps of access routes are required for each dam. This mapping should include recommended transportation, and an estimate of time required based on either direction.
- Helicopter Access should describe potential location of nearest landing area in vicinity of the dam.
- The Contact list should be updated regularly.
- A separate EPP file should be created for Garnett Reservoir dam.

10 Conclusions and Recommendations

A dam safety review was conducted for ten dams within the District of Summerland water supply system. The dams impound water within the District's two main watersheds, Trout Creek and Garnett Valley.

Detailed results of the review are included in the report. A summary of these conclusions and recommendations are presented in **Table 10-1** below.

Table 10-1
Comments, Concerns and Recommendations

Item	Comments or Concerns	Recommendations
Headwaters No. 1	• Risk of pluggage at spillway from downed logs. During major event, these can block the spillway	• Low Hazard Consequence Dam • Remove logs where possible. • Add log boom • Cut and remove brush and trees in spillway riprap.
Headwaters No. 2	• Low Level Outlet - Corrugated pipe is failing slightly (see photo). • Gate leaks slightly, but not a concern.	• Very Low Hazard Consequence Dam • Monitor annually at outlet for pipeline condition. • Remove logs around spillway. • Maintain earth spillway elevations where machinery available. • Flush outlet regularly
Headwaters No. 3	• Maintenance required on low level outlet. Cleaning and Rock removal. • Gate leaks slightly, but not a concern.	• Very Low Hazard Consequence Dam • Minor Maintenance only. • Remove logs around spillway. • Maintain earth spillway elevations where machinery available. • Flush outlet regularly.
Headwaters No 4	• Maintenance required on low level outlet. Cleaning and Rock removal. • Gate leaks slightly, but not a concern. • Minor seepage along south edge of outlet channel.	• Very Low Hazard Consequence Dam • Minor Maintenance only. • Remove logs around spillway. • Maintain earth spillway elevations where machinery available.
Crescent (Paul) Reservoir	• Old low level outlet has been plugged, but there is debris. Seepage is evident around the outlet. • Spillway debris evident. • Seepage along south side of low level outlet, D/S of toe of dam.	• Very Low Hazard Consequence Dam • Add log boom away from the spillway. • Monitor the old inlet and outlet of the low level outlet structure. • Visually monitor seepage flows around old outlet during regular maintenance visits. Report any changes to clarity or volumes.

Item	Comments or Concerns	Recommendations
Whitehead Reservoir	• Further review is required to determine freeboard requirement for this dam. Stated as 1.15 m, but looks more like 800 mm. Water level should be lowered. • Low level outlet concrete has failed. Significant sloughing of earth. • Spillway contains debris.	• Very Low Hazard Consequence Dam • Repair or replace concrete outlet structure. • Clear vegetation and re-grade spillway channel. • Examine design of dam and reservoir. • Reservoir should be operated at or lower than it high water level. This allows access over the spillway to the main dam.
Aeneas Reservoir	• Spillway concrete has failed. Will not survive major flow event. • Very difficult dam to access. • Gate Handle difficult to turn.	• Very Low Hazard Consequence Dam • Clean out outlet pipeline and outlet channel. • Repair or replace spillway. • Maintain log removal around spillway entrance. • Monitor logs around the inlet gate stem.
Tsuh (Deer) Reservoir	• Presently accessible only by foot or boat. • Log debris. Brush was cleared while at site. Log boom would prevent some pluggage at the spillway channel inlet.	• Very Low Hazard Consequence Dam • Construct vehicle access to dam. • Clean out the outlet pipe on regular basis. • Inspect the inlet structure. Clear area as required.
Isintok Reservoir	• Significant evidence of public traffic on both slopes of dam. • Old gravel pit adjacent to dam used as motocross track. • Soil sloughed around Gate handle. Difficult to turn. • Downstream flooding could directly affect Summerland downstream.	• High Hazard Consequence Dam • Further review is required to determine if the spillway capacity can meet the 1:1000 flow. From our initial review, it is slightly lower than the required capacity. • Flood inundation study required to determine effects of breach. • Maintenance required on surface of dam. Remove ruts. • Additional public signage • Add vehicle barriers or large rock to restrict access to larger vehicles. • Keep vehicles off the slopes.
Garnett Reservoir	• The spillway is obstructed by a road and culvert. The culvert and road access will most likely be destroyed in a significant storm event. The last time this access was destroyed was in 1980. The District considers this as a sacrificial crossing during a major storm event. • The spillway capacity is likely lower than the required IDF and freeboard. • Based on comparisons with other dams and similar watersheds, IDF is higher than current capacity of this Very High Consequence Dam. • Spillway design parameters, including joints between slabs and side walls improperly sealed, side	• Very High Consequence Dam • New 3 m wide toe berm starting about 4.5 m below the top of dam required to reach a Factor of Safety of 1.2 for a 1/2500 year earthquake event. • Immediately review hydrology and hydraulics of Garnett Reservoir watershed. • Flood Inundation study for downstream of the Garnett Dam. • Determine adequacy of flood routing facilities based on review. • Continue to monitor seepage. • Continue to remove tree and brush growth.

Item	Comments or Concerns	Recommendations
	walls showing minor signs of settling, minor concrete spalling on downstream slabs, absence of wing walls at extremity of downstream slab to minimize lateral effects (roller) during high discharges. • Factor of safety estimated at 0.87, and is below the minimum 1.2 CDA requirement for earthquake event.	
Summerland Reservoir	• First dam safety review for the Summerland Reservoir. • No watershed. • Only flood scenario is sunny day breach from overtopping. • Houses and agricultural area immediately downstream.	• High Hazard Consequence Dam. • Monitor water levels and operate accordingly. • Examine overtopping protection options along the channel system.
EPP	• The District has an Emergency Preparedness Plan. • There is a lack of understanding of the consequences of a dam breach.	• More detail is required within the plan. • The District should exercise the plan, and determine areas of improvement. • Staff should be made aware of the importance of dam safety, and the extreme consequences of a failure.
O, M & S	• The District operates and maintains the dams responsibly. • The dams are old, subject to extreme conditions, and require on-going maintenance. • The flood control structures are beginning to age.	• Budget is required to begin upgrading the low level outlets. This includes gate seal replacement, gear replacements and riprap repair. • Access to Aeneas and Tsuh Dams is poor. This lack of access is one reason why the reservoirs are not maintained as much as the others.

11 References

- Associated Engineering, 1997. Water System Master Plan, Report to the District of Summerland.
- Canadian Dam Association, Dam Safety Guidelines, 2007 (http://www.cda.ca)
- Coulson and Obedkoff. March 1998. British Columbia Streamflow Inventory.
- Letvak, D.B. 1989. Water Supply Analysis for Trout Creek and the District of Summerland, BC Ministry of Environment.
- Ministry of Environment, 2008. Plan Submission Guidelines, Water Stewardship Division
- Ministry of Environment, 2010. Interim Consequence Classification Policy for Dams in British Columbia,
- Natural Resources Canada – Earthquakes (http://earthquakescanada.nrcan.gc.ca/index-eng.php)
- Reksten, D.E. 1973. Trout Creek Water Supply for the District of Summerland, BC Ministry of Environment.
- UMA. 1991. Water Storage Dams, Operation and Maintenance Manual. Report to the District of Summerland.
- US Dept. of the Interior, 1987. Design of Small Dams, BUREC, Third Edition.
- Washington State Dam Safety. (http://www.ecy.wa.gov/programs/wr/dams/GuidanceDocs.html)
- Water Management Consultants. April 2005. Trout Creek Water Supply System – Water Use Plan. Technical Background Document on Hydrology, Water Usage and Reservoir Operations.
- Weiss, E. 1981. Trout Creek Water Supply Study, BC Ministry of Environment.

REPORT

Appendix A - Site Inspections

Dam Safety Review Check Sheet

Dam: District of Summerland Dams D#: Date of DSR: Spring 2010

Owner: District of Summerland Engineer: Rod MacLean, P. Eng./Gerald Imada, P. Eng.

Engineering Firm: Associated/Golder Report file No.:

DSR Guideline Section No.:	DSR Content:	Done or not done?		Comments:
2.2.	Site Inspection performed?	Yes ☒	No ☐	
2.2.	Dam Owner interviewed?	Yes ☒	No ☐	
2.3.	Dam data and Records compiled?	Yes ☐	No ☒	Not part of report/ in Summerland
2.4.	Consequence Classification reviewed?	Yes ☒	No ☐	
	Dam Breach Calculation, done?	Yes ☐	No ☒	Further inundation study recommended for Garnet and Isintok Reservoirs.
2.5.	Dam Safety Analysis, done?	Yes ☒	No ☐	
	- Hazards and Failure Modes & effects identified?	Yes ☒	No ☐	
	- Flood Capacity assessed?	Yes ☒	No ☐	
	- Seismic Stability assessed?	Yes ☒	No ☐	
	- Deficiencies documented?	Yes ☒	No ☐	
2.6.	OMS reviewed?	Yes ☒	No ☐	
	OMS Compliance determined?	Yes ☒	No ☐	
2.7.	Emergency Preparedness Plan reviewed?	Yes ☒	No ☐	
2.8.	Public Safety & Security looked at?	Yes ☒	No ☐	
2.9.	Dam Safety Management System reviewed?	Yes ☒	No ☐	

3. Dam Safety Review Report presented? Yes ☐ No ☐ To be confirmed

- Recommendations made? Yes ☒ No ☐

General Comments:

Reviewed by: Rod MacLean/Gerald Imada/Ed Bird Date reviewed:

December 23, 2010

Dam Safety Inspection Checklist

Name of Dam	**Headwaters No. 1**	Inspection Date	30-Apr-10	Observed Conditions
Current Weather:	**Cloudy-Some Sun**	Previous Week:		S- Satisfactory
Name of Creek, Stream, River	**Trout Creek**			F - Fair
Water Licence:				P - Poor
Owners Name	**The Corporation of the District of Summerland**			U - Unsatisfactory
Address	**13211 Henry Avenue**			Ni - Not Inspected
City	**Summerland**	Postal Code	**V0H 1Z0**	
Telephone	**250-404-3000**	Alternate Phone		
Email				

Pre-Inspection Interview with Owner

* See Past Reports or other File Information

Owner or Representative present?	**No**
How long have you owned the dam?	**1962**
Any Prior problems?	**Yes**
Repairs or Modifications? (where, when)	**1999 - Seepage Repairs**
Past Failures/Incidents/Breach?	**Instability - 1970**
Works Currently Fully Operational?	

Design report and plans availabl **Yes** Dam Material Known? **Yes** Foundation? **Yes**

Was the dam designed by an Engineer?	**NO-Yes**	Company	**1999 - UMA Engineering**
Are dam construction details known?	**YES**	Where?	**1999 Design Report**

Downstream Consequence Classification - Current

Dam Safety Regulation **Low** CDA Guidelines:

Dam Information

Type of Dam:	**Earth Embankment**	Max. Height of Dam:	**1282.45 m (6.71 m)**
Spillway Elevation:	**1280.92 m**	Spillway Width:	**9.14 m**
Freeboard (@full supply level)	**1.53 m**	Freeboard (at time of visit)	
Reservoir Storage Volume	**2,611 ML (Live)**	Licenced Storage Volume	

Dam Environment

Drainage Area Size		**36 km^2**	Reservoir Area:		
Inflow Design Flood:	Q m^3/s	**13**	Flood AEP (Return Period)	**200 yr IDF (0.52 m FB)**	
Other Inflow Study:	Q m^3/s		Flood AEP (Return Period)		

Post Inspection Evaluation - Elaborate in the Inspection Report as required

Evaluate any new development in the inundation zone downstream

Should new development initiate a review of the Consequence Classification?

OMS Manual Current?	**NO**	OMS Adequate?		OMS being followed?	
EPP Manual Current?		EPP Adequate?		EPP being exercised?	
DSR Required?		DSR completed date?		Deficiencies Addressed?	

Site Access - site access adequate for safe operation and maintenance?

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

Inspected by: Rod MacLean, P. Eng. (Associated Engineering)
Gerald Imada, P. Eng. (Golder Associates)

	Required Action				
	None	Monitor	Maintenance	Repair	Not Applicable

Embankment Dam

1. Upstream Slope

VEGETATION — ☐ None ☒ Monitor ☐ Maintenance ☐ Repair ☐ Not Applicable

Type **Some Grass** Location Near water edge

Recommendations:

SLOPE PROTECTION — ☐ None ☒ Monitor ☐ Maintenance ☐ Repair ☐ Not Applicable

Type None/Sparse/Dense

Notes

EROSION — ☐ None ☒ Monitor ☐ Maintenance ☐ Repair ☐ Not Applicable

Type (wave/runoff/unknown)

Length Width

Notes **Minor Wave**

INSTABILITIES — ☐ None ☒ Monitor ☐ Maintenance ☐ Repair ☐ Not Applicable

Slides (Yes/No/Could not Inspect)

Length Width Location

Notes/Causes **None**

Cracks (Transverse/Longitudinal/Other) — ☐ None ☒ Monitor ☐ Maintenance ☐ Repair ☐ Not Applicable

Quantity Length Width

Location

Notes/Causes **None**

Bulges/Depressions/Hummocky — ☐ None ☒ Monitor ☐ Maintenance ☐ Repair ☐ Not Applicable

Size Height Depth

Location

Notes/Causes **None**

OTHER — ☐ None ☒ Monitor ☐ Maintenance ☐ Repair ☐ Not Applicable

Burrows, Ruts, Other Concerns

Location

Notes/Causes **None**

2. Crest

ACCESS — ☐ None ☒ Monitor ☐ Maintenance ☐ Repair ☐ Not Applicable

Is there public access to the crest? YES

Is the crest marked or signed? NO

Is vehicle access to the crest restricted? NO

VEGETATION

Trees NO — ☐ None ☒ Monitor ☐ Maintenance ☐ Repair ☐ Not Applicable

Location

Notes

Brush NONE — ☐ None ☒ Monitor ☐ Maintenance ☐ Repair ☐ Not Applicable

Location

Notes

Ground Cover BARE — ☐ None ☒ Monitor ☐ Maintenance ☐ Repair ☐ Not Applicable

Quantity (bare/sparse/adequate/dense)

Appearance (too tall/too short/good)

Notes

EROSION NONE — ☐ None ☒ Monitor ☐ Maintenance ☐ Repair ☐ Not Applicable

Type (wave/runoff/unknown)

Length Width

Notes

SETTLEMENT NONE — ☐ None ☒ Monitor ☐ Maintenance ☐ Repair ☐ Not Applicable

Location

Notes/Causes

	Required Action				
	None	Monitor	Maintenance	Repair	Not Applicable
INSTABILITIES	☐	☒	☐	☐	☐
Cracks (Transverse/Longitudinal/Other) NONE					
Quantity ____ Length ____ Width ____					
Location ____					
Notes/Causes ____					
OTHER					
Burrows, Ruts, Other Concerns	☐	☒	☐	☐	☐
Location ____					
Notes/Causes ____					

3. Downstream Slope

VEGETATION	☐	☒	☐	☐	☐
Trees NO					
Location ____					
Notes ____					
Brush SPARSE	☐	☒	☐	☐	☐
Location ____					
Notes ____					
Ground Cover GRASS	☐	☒	☐	☐	☐
Notes SPARSE ____					
SLOPE PROTECTION	☐	☒	☐	☐	☐
Type NONE					
Notes ____					
EROSION	☐	☒	☐	☐	☐
Location ATV-MOTORCYCLE TRAFFIC					
Notes MINOR ____					
INSTABILITIES NONE	☐	☒	☐	☐	☐
Slides Length ____ Width ____ Location ____					
Notes/Causes ____					
Cracks (Transverse/Longitudinal/Other) NONE	☐	☒	☐	☐	☐
Quantity ____ Length ____ Width ____					
Location ____					
Notes/Causes ____					
Bulges/Depressions/Hummocky NONE	☐	☒	☐	☐	☐
Size ____ Height ____ Depth ____					
Location ____					
Notes/Causes ____					
OTHER					
Burrows, Ruts, Other Concerns NONE	☐	☒	☐	☐	☐
Location ____					
Notes/Causes ____					
SEEPAGE	☐	☒	☐	☐	☐
Wet Area/Flow/Boil/Sinkhole ALONG D/S TOE					
Flow Rate ____					
Location ____					
Aquatic Vegetation (Yes/No) YES					
Rust Colored Deposits (Yes/No) NO					
Sediment in Flow (Yes/No) NO					
Other ____					
Notes/Causes ____					
EMBANKMENT DRAINS NONE FOUND	☐	☐	☐	☐	☒
Type ____					
Flow rate ____ Size ____ Number ____					
Location ____					
Notes ____					
MONITORING INSTRUMENTATION CONDITION	☐	☐	☒	☐	☐
☑ None found ☑ Piezometers ☐ Weir ☐ Flume					
Notes VERIFICATION REQUIRED - THERE WAS A STEEL PIPE.					

	Required Action				
	None	Monitor	Maintenance	Repair	Not Applicable
Spillway					
GENERAL CONDITIONS					
Type Concrete Rectangular Weir	☐	☒	☐	☐	☐
Notes					
1. Spillway Crest or Control Section					
OBSTRUCTION	☐	☐	☒	☐	☐
Debris ***Yes***					
Location ***Some logs and debris upstream of the spillway.***					
Notes ***None in the spillway section***					
Vegetation None/Sparse/Dense					
Location ***Downstream - Within Riprap***					
Notes ***If significant movement of the debris upstream, then spillway would be easily plugged***					
Other (beaver activity, trash rack problems, etc.)					
Evidence of old log boom. Broken.					
SPILLWAY CREST MATERIALS	☒	☐	☐	☐	☐
Condition ***Concrete***					
Notes					
OTHER SPILLWAY CREST PROBLEMS					
Damage ***If water were to crest, eddy erosion would occur around abutments***	☐	☐	☐	☒	☐
Location					
Notes/Cause ***Additional Riprap required***					
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 ***Rock Lined Channel***					
Notes ***Larger bushes should be cleared downstream***					

Low Level Outlet

	Required Action				
	None	Monitor	Maintenance	Repair	Not Applicable
GENERAL					
Type ***Gated Pipe Structure*** ☐ None	X				
ACCESS TO VALVE/GATE	X				
☐ Not accessible ☑ From shore ☐ Walkway ☐ By boat ☐ Other					
Notes ***Locked - Functional***					
Walkway Condition ***N/A***					
LOW LEVEL OUTLET COMPONENTS					
Valve Control Device		X			
☑ Yes ☐ None ☐ No Stem ☐ Damaged stem ☐ Other					
Other/Notes					
Operational?		X			
☑ Yes ☐ No ☐ Poorly ☐ Not tested					
Notes					
Valve / Gate		X			
Location ***Upstream Slanted***					
Condition ***Under water***					
Leakage ☑ Yes ☐ No			X		
Flow Rate **Negligible**					
Outlet Pipe	X				
☑ Metal ☐ Plastic ☐ Concrete ☐ Other					
Diameter ***600 mm***					
Condition ***Good***					
Outlet Obstruction (note vegetation, sediment blockage, etc.)					
Notes ***None***					
OUTLET EROSION CONTROL STRUCTURE		X			
Type ***Rock riprap - Concrete***					
Concrete Condition ***Good***		X			
Outlet Area Seepage		X			
Description ***Minor***					
Flow Estimate					
Location					
Undermining		X			
Location ***None***					
Notes/Cause:					
Downstream Channel ***Into larger swamp***		X			
Free Draining? ***Yes***					
Blockages or Potential Blockages? ***No***					
Erosion Control? Rip-Rap? ***Some - Adequate***					

Dam Safety Inspection Checklist

Name of Dam	**Headwaters No. 2**	Inspection Date	**30-Apr-10**	Observed Conditions
Current Weather:	**Cloudy**	Previous Week:		S- Satisfactory
Name of Creek, Stream, River	**Trout Creek**			F - Fair
Water Licence:				P - Poor
Owners Name	**The Corporation of the District of Summerland**			U - Unsatisfactory
Address	**13211 Henry Avenue**			Ni - Not Inspected
City	**Summerland**	Postal Code	**V0H 1Z0**	
Telephone	**250-404-3000**	Alternate Phone		
Email				

Pre-Inspection Interview with Owner

* See Past Reports or other File Information

Owner or Representative present?	**No**
How long have you owned the dam?	**1966**
Any Prior problems?	**No**
Repairs or Modifications? (where, when)	**No**
Past Failures/Incidents/Breach?	**No**
Works Currently Fully Operational?	**Yes**

Design report and plans availabl **No** Dam Material Known? **Yes** Foundation? **Yes**

Was the dam designed by an Engineer? **Unknown** Company

Are dam construction details known? **No** Where?

Downstream Consequence Classification - Current

Dam Safety Regulation **High** CDA Guidelines:

Dam Information

Type of Dam:	**Earth Embankment**	Max. Height of Dam:	
Spillway Elevation:		Spillway Width:	**3 m**
Freeboard (@full supply level)		Freeboard (at time of visit)	
Reservoir Storage Volume	**ML (Live)**	Licenced Storage Volume	

Dam Environment

Drainage Area Size	**36 km^2**	Reservoir Area:	
Inflow Design Flood: Q m^3/s	**13**	Flood AEP (Return Period)	**200 yr IDF (0.52 m FB)**
Other Inflow Study: Q m^3/s		Flood AEP (Return Period)	

Post Inspection Evaluation - Elaborate in the Inspection Report as required

Evaluate any new development in the inundation zone downstream **Headwaters 1 is downstream**

Should new development initiate a review of the Consequence Classification? **No**

OMS Manual Current?	**NO**	OMS Adequate?	**Yes**	OMS being followed?	**Yes**
EPP Manual Current?		EPP Adequate?		EPP being exercised?	
DSR Required?	**No**	DSR completed date?		Deficiencies Addressed?	**No**

Site Access - site access adequate for safe operation and maintenance? **Yes**

Any other concerns in the watershed that could impact the dam? **No**

Inspected by: Rod MacLean, P. Eng. (Associated Engineering)
Gerald Imada, P. Eng. (Golder Associates)

	Required Action				
	None	Monitor	Maintenance	Repair	Not Applicable

Embankment Dam

1. Upstream Slope

VEGETATION — ☐ None ☒ Monitor ☐ Maintenance ☐ Repair ☐ Not Applicable

Type **Some Grass** Location Near water edge

Recommendations:

SLOPE PROTECTION — ☐ None ☒ Monitor ☐ Maintenance ☐ Repair ☐ Not Applicable

Type None/Sparse/Dense

Notes

EROSION — ☐ None ☒ Monitor ☐ Maintenance ☐ Repair ☐ Not Applicable

Type (wave/runoff/unknown)

Length Width

Notes **Minor Wave**

INSTABILITIES — ☐ None ☒ Monitor ☐ Maintenance ☐ Repair ☐ Not Applicable

Slides (Yes/No/Could not Inspect)

Length Width Location

Notes/Causes **None**

Cracks (Transverse/Longitudinal/Other) — ☐ None ☒ Monitor ☐ Maintenance ☐ Repair ☐ Not Applicable

Quantity Length Width

Location

Notes/Causes **None**

Bulges/Depressions/Hummocky — ☐ None ☒ Monitor ☐ Maintenance ☐ Repair ☐ Not Applicable

Size Height Depth

Location

Notes/Causes **None**

OTHER — ☐ None ☒ Monitor ☐ Maintenance ☐ Repair ☐ Not Applicable

Burrows, Ruts, Other Concerns

Location

Notes/Causes **None**

2. Crest

ACCESS — ☐ None ☒ Monitor ☐ Maintenance ☐ Repair ☐ Not Applicable

Is there public access to the crest? YES

Is the crest marked or signed? NO

Is vehicle access to the crest restricted? NO

VEGETATION

Trees NO — ☐ None ☒ Monitor ☐ Maintenance ☐ Repair ☐ Not Applicable

Location

Notes

Brush NONE — ☐ None ☒ Monitor ☐ Maintenance ☐ Repair ☐ Not Applicable

Location

Notes

Ground Cover BARE — ☐ None ☒ Monitor ☐ Maintenance ☐ Repair ☐ Not Applicable

Quantity (bare/sparse/adequate/dense)

Appearance (too tall/too short/good)

Notes

EROSION NONE — ☐ None ☒ Monitor ☐ Maintenance ☐ Repair ☐ Not Applicable

Type (wave/runoff/unknown)

Length Width

Notes

SETTLEMENT NONE — ☐ None ☒ Monitor ☐ Maintenance ☐ Repair ☐ Not Applicable

Location

Notes/Causes

	Required Action				
	None	Monitor	Maintenance	Repair	Not Applicable
INSTABILITIES	☐	☒	☐	☐	☐
Cracks (Transverse/Longitudinal/Other) NONE					
Quantity _____ Length _____ Width _____					
Location _____					
Notes/Causes _____					
OTHER					
Burrows, Ruts, Other Concerns	☐	☒	☐	☐	☐
Location _____					
Notes/Causes _____					

3. Downstream Slope

VEGETATION	☐	☒	☐	☐	☐
Trees NO					
Location _____					
Notes _____					
Brush SPARSE	☐	☒	☐	☐	☐
Location _____					
Notes _____					
Ground Cover BARE	☐	☒	☐	☐	☐
Notes _____					
SLOPE PROTECTION	☐	☒	☐	☐	☐
Type NONE					
Notes _____					
EROSION	☐	☒	☐	☐	☐
Location NONE					
Notes _____					
INSTABILITIES NONE	☐	☒	☐	☐	☐
Slides Length _____ Width _____ Location _____					
Notes/Causes _____					
Cracks (Transverse/Longitudinal/Other) NONE	☐	☒	☐	☐	☐
Quantity _____ Length _____ Width _____					
Location _____					
Notes/Causes _____					
Bulges/Depressions/Hummocky NONE	☐	☒	☐	☐	☐
Size _____ Height _____ Depth _____					
Location _____					
Notes/Causes _____					
OTHER					
Burrows, Ruts, Other Concerns NONE	☐	☒	☐	☐	☐
Location _____					
Notes/Causes _____					
SEEPAGE	☐	☒	☐	☐	☐
Wet Area/Flow/Boil/Sinkhole NONE					
Flow Rate _____					
Location _____					
Aquatic Vegetation (Yes/No)					
Rust Colored Deposits (Yes/No)					
Sediment in Flow (Yes/No)					
Other _____					
Notes/Causes _____					
EMBANKMENT DRAINS NONE FOUND	☐	☐	☐	☐	☒
Type _____					
Flow rate _____ Size _____ Number _____					
Location _____					
Notes _____					
MONITORING INSTRUMENTATION CONDITION	☐	☐	☐	☐	☒
☑ None found ☐ Piezometers ☐ Weir ☐ Flume					
Notes _____					

	Required Action				
	None	Monitor	Maintenance	Repair	Not Applicable

Spillway

GENERAL CONDITIONS

Type ***Earthen Emergency Spillway - Concrete Brig*** | | X | | | |

Notes ***North of the dam - Cut through woods***

1. Spillway Crest or Control Section

OBSTRUCTION | | X | | | |

Debris ***Yes***

Location ***Large log used to protect the wooden bridge.***

Notes ***None in the spillway section***

Vegetation Sparse

Location ***Well maintained. No riprap***

Notes

Other (beaver activity, trash rack problems, etc.)

Log boom intact at mouth.

SPILLWAY CREST MATERIALS | | X | | | |

Condition ***Earthen - 3:1 sideslopes***

Notes

OTHER SPILLWAY CREST PROBLEMS

Damage ***None*** | | | | | X |

Location

Notes/Cause

2. Spillway Conveyance Section: Channel, Chute or Conduit

OPEN CHANNEL CROSS SECTION OK | | X | | | |

CHANNEL OBSTRUCTION None | | X | | | |

SPILLWAY CONVEYANCE MATERIALS | | X | | | |

OTHER SPILLWAY CONVEYANCE PROBLEMS

Damage | X | | | | |

Location

Notes/Cause

3. Energy-Dissipating or Terminal Section

EROSION CONTROL STRUCTURE | | X | | | |

Type ***Earthen channel through woods***

Notes

Low Level Outlet

	Required Action				
	None	Monitor	Maintenance	Repair	Not Applicable
GENERAL					
Type ***Gated Pipe Structure*** ☐ None	X				
ACCESS TO VALVE/GATE	X				
☐ Not accessible ☑ From shore ☐ Walkway ☐ By boat ☐ Other					
Notes ***Locked - Functional***					
Walkway Condition ***N/A***					
LOW LEVEL OUTLET COMPONENTS					
Valve Control Device		X			
☑ Yes ☐ None ☐ No Stem ☐ Damaged stem ☐ Other					
Other/Notes					
Operational?		X			
☑ Yes ☐ No ☐ Poorly ☐ Not tested					
Notes **Opened valve, but could not close tight.**					
Valve / Gate		X			
Location ***Upstream Slanted***					
Condition ***Under water***					
Leakage ☑ Yes ☐ No		X			
Flow Rate **Negligible**					
Outlet Pipe			X		
☑ Metal ☐ Plastic ☐ Concrete ☐ Other					
Diameter ***450 mm***					
Condition ***Partial deformity near outlet. Capacity reduced by ~5%.***					
Outlet Obstruction (note vegetation, sediment blockage, etc.)					
Notes ***None - but some moss around the outlet mouth***					
OUTLET EROSION CONTROL STRUCTURE		X			
Type ***Concrete***					
Concrete Condition ***Good***		X			
Outlet Area Seepage		X			
Description ***None***					
Flow Estimate					
Location					
Undermining		X			
Location ***None***					
Notes/Cause:					
Downstream Channel ***Into channel, and swamp downstream***		X			
Free Draining? ***Yes***					
Blockages or Potential Blockages? ***No***					
Erosion Control? Rip-Rap? ***Some - Adequate***					

Dam Safety Inspection Checklist

Name of Dam	**Headwaters No. 3**	Inspection Date	30-Apr-10	Observed Conditions
Current Weather:	**Cloudy-Some sun**	Previous Week:		S- Satisfactory
Name of Creek, Stream, River	**Trout Creek**			F - Fair
Water Licence:				P - Poor
Owners Name	**The Corporation of the District of Summerland**			U - Unsatisfactory
Address	**13211 Henry Avenue**			Ni - Not Inspected
City	**Summerland**	Postal Code	**V0H 1Z0**	
Telephone	**250-404-3000**	Alternate Phone		
Email				

Pre-Inspection Interview with Owner

* See Past Reports or other File Information

Owner or Representative present?	**No**
How long have you owned the dam?	**1930's**
Any Prior problems?	**No**
Repairs or Modifications? (where, when)	**No**
Past Failures/Incidents/Breach?	**No**
Works Currently Fully Operational?	**Yes**

Design report and plans availabl **Yes** Dam Material Known? **Yes** Foundation? **Yes**

Was the dam designed by an Engineer? **Unknown** Company

Are dam construction details known? **Unknown** Where?

Downstream Consequence Classification - Current

Dam Safety Regulation **High** CDA Guidelines:

Dam Information

Type of Dam:	***Earth Embankment***	Max. Height of Dam:	**88.85 (6.25**
Spillway Elevation:	***1292.35***	Spillway Width:	**2.5 m - Trapezoid**
Freeboard (@full supply level)	***3.17 m***	Freeboard (at time of visit)	***1.57 m***
Reservoir Storage Volume	***618 ML***	Licenced Storage Volume	***618 ML***

Dam Environment

Drainage Area Size		**36 km^2 (all headwaters)**	Reservoir Area:	***23 ha***
Inflow Design Flood:	Q m^3/s	**12.5**	Flood AEP (Return Period)	**200 yr IDF**
Other Inflow Study:	Q m^3/s		Flood AEP (Return Period)	

Post Inspection Evaluation - Elaborate in the Inspection Report as required

Evaluate any new development in the inundation zone downstream				**Headwaters 1 is downstream**	
Should new development initiate a review of the Consequence Classification?				**No**	
OMS Manual Current?	**NO**	OMS Adequate?	**Yes**	OMS being followed?	**Yes**
EPP Manual Current?	Yes	EPP Adequate?	Yes	EPP being exercised?	**Yes**
DSR Required?	**Yes**	DSR completed date?	06/10	Deficiencies Addressed?	**Yes**
Site Access - site access adequate for safe operation and maintenance?					**Yes**
Any other concerns in the watershed that could impact the dam?					**No**

Inspected by: Rod MacLean, P. Eng. (Associated Engineering)
Gerald Imada, P. Eng. (Golder Associates)

	Required Action				
	None	Monitor	Maintenance	Repair	Not Applicable
Embankment Dam					
1. Upstream Slope					
VEGETATION	☐	☒	☐	☐	☐
Type **Some Grass** Location Above high water line					
Recommendations:					
SLOPE PROTECTION	☐	☒	☐	☐	☐
Type None/Sparse/Dense NONE					
Notes					
EROSION	☐	☒	☐	☐	☐
Type (wave/runoff/unknown)					
Length Width					
Notes **Minor Wave**					
INSTABILITIES	☐	☒	☐	☐	☐
Slides (Yes/No/Could not Inspect)					
Length Width Location					
Notes/Causes **None**					
Cracks (Transverse/Longitudinal/Other)	☐	☒	☐	☐	☐
Quantity Length Width					
Location					
Notes/Causes **None**					
Bulges/Depressions/Hummocky	☐	☒	☐	☐	☐
Size Height Depth					
Location					
Notes/Causes **None**					
OTHER	☐	☒	☐	☐	☐
Burrows, Ruts, Other Concerns					
Location					
Notes/Causes **None**					
2. Crest					
ACCESS	☐	☒	☐	☐	☐
Is there public access to the crest? YES					
Is the crest marked or signed? NO					
Is vehicle access to the crest restricted? NO					
VEGETATION					
Trees NO	☐	☒	☐	☐	☐
Location					
Notes					
Brush NONE	☐	☒	☐	☐	☐
Location					
Notes					
Ground Cover BARE	☐	☒	☐	☐	☐
Quantity (bare/sparse/adequate/dense)					
Appearance (too tall/too short/good)					
Notes					
EROSION NONE	☐	☒	☐	☐	☐
Type (wave/runoff/unknown)					
Length Width					
Notes					
SETTLEMENT NONE	☐	☒	☐	☐	☐
Location					
Notes/Causes					

	Required Action				
	None	Monitor	Maintenance	Repair	Not Applicable
INSTABILITIES	☐	☒	☐	☐	☐
Cracks (Transverse/Longitudinal/Other) NONE					
Quantity ____ Length ____ Width ____					
Location ____					
Notes/Causes ____					
OTHER					
Burrows, Ruts, Other Concerns	☐	☒	☐	☐	☐
Location ____					
Notes/Causes ____					

3. Downstream Slope

VEGETATION	☐	☒	☐	☐	☐
Trees NO					
Location ____					
Notes ____					
Brush SPARSE	☐	☒	☐	☐	☐
Location ____					
Notes ____					
Ground Cover GRASS	☐	☒	☐	☐	☐
Notes ____					
SLOPE PROTECTION	☐	☒	☐	☐	☐
Type GRASS					
Notes ____					
EROSION	☐	☒	☐	☐	☐
Location NONE					
Notes ____					
INSTABILITIES NONE	☐	☒	☐	☐	☐
Slides Length ____ Width ____ Location ____					
Notes/Causes ____					
Cracks (Transverse/Longitudinal/Other) NONE	☐	☒	☐	☐	☐
Quantity ____ Length ____ Width ____					
Location ____					
Notes/Causes ____					
Bulges/Depressions/Hummocky NONE	☐	☒	☐	☐	☐
Size ____ Height ____ Depth ____					
Location ____					
Notes/Causes ____					
OTHER					
Burrows, Ruts, Other Concerns NONE	☐	☒	☐	☐	☐
Location ____					
Notes/Causes ____					
SEEPAGE	☐	☒	☐	☐	☐
Wet Area/Flow/Boil/Sinkhole NONE					
Flow Rate ____					
Location ____					
Aquatic Vegetation (Yes/No)					
Rust Colored Deposits (Yes/No)					
Sediment in Flow (Yes/No)					
Other ____					
Notes/Causes ____					
EMBANKMENT DRAINS NONE FOUND	☐	☐	☐	☐	☒
Type ____					
Flow rate ____ Size ____ Number ____					
Location ____					
Notes ____					
MONITORING INSTRUMENTATION CONDITION	☐	☐	☐	☐	☒
☑ None found ☐ Piezometers ☐ Weir ☐ Flume					
Notes ____					

	Required Action				
	None	Monitor	Maintenance	Repair	Not Applicable
Spillway					
GENERAL CONDITIONS					
Type ***Earthen Emergency Spillway - Concrete Sill***	☐	☒	☐	☐	☐
Notes ***West end of dam***					
1. Spillway Crest or Control Section					
OBSTRUCTION	☐	☐	☒	☐	☐
Debris ***Some***					
Location ***Logs in the lake and just downstream of concrete.***					
Notes ***Some noted in the channel***					
Vegetation Sparse					
Location ***Well maintained. No riprap***					
Notes					
Other (beaver activity, trash rack problems, etc.)					
Log boom intact at mouth.					
SPILLWAY CREST MATERIALS	☐	☒	☐	☐	☐
Condition ***Concrete - Rectangular***					
Notes Maintains water level and crosses road.					
OTHER SPILLWAY CREST PROBLEMS					
Damage ***None***	☒	☐	☐	☐	☐
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 Channel is rectangular and cut through the woods. Prone to tree fall.	☐	☐	☒	☐	☐
Location Downstream Channel					
Notes/Cause Constant flows from the lake					
3. Energy-Dissipating or Terminal Section					
EROSION CONTROL STRUCTURE	☐	☒	☐	☐	☐
Type ***Pond at the end.***					
Notes					

Low Level Outlet

	Required Action				
	None	Monitor	Maintenance	Repair	Not Applicable

GENERAL — None [X]

Type ***Gated Pipe Structure*** [ ] None

ACCESS TO VALVE/GATE — None [X]

[ ] Not accessible [✓] From shore [ ] Walkway [ ] By boat [ ] Other

Notes ***Locked - Functional - Stem slightly bent - Wheel cracked and welded***

Walkway Condition ***N/A***

LOW LEVEL OUTLET COMPONENTS

Valve Control Device — Monitor [X]

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

Other/Notes

Operational? — Monitor [X]

[✓] Yes [ ] No [ ] Poorly [ ] Not tested

Notes

Valve / Gate — Monitor [X]

Location ***Upstream Slanted***

Condition ***Under water***

Leakage [✓] Yes [ ] No — Monitor [X]

Flow Rate **Minor**

Outlet Pipe — Maintenance [X]

[ ] Metal [ ] Plastic [✓] Concrete [✓] Other Concrete arch Pipeline

Diameter ***450 mm***

Condition ***Good condition***

Outlet Obstruction (note vegetation, sediment blockage, etc.)

Notes ***Yes - Rocks and debris have plugged the structure. Significant iron deposits***

OUTLET EROSION CONTROL STRUCTURE — Monitor [X]

Type ***Concrete***

Concrete Condition ***Good*** — Monitor [X]

Outlet Area Seepage — Maintenance [X]

Description ***Some - Evidence of riprap failure***

Flow Estimate

Location

Undermining — Maintenance [X]

Location ***Some***

Notes/Cause: Outlet and channel level are flat sloped. Evidence of earth movement

Downstream Channel ***Into channel, and swamp downstream*** — Maintenance [X]

Free Draining? ***Yes***

Blockages or Potential Blockages? ***Some fallen trees***

Erosion Control? Rip-Rap? ***Some - Could use some adjustments***

Dam Safety Inspection Checklist

Name of Dam	**Headwaters No. 4**	Inspection Date	30-Apr-10	Observed Conditions
Current Weather:	Cloudy-Some Sun	Previous Week:		S- Satisfactory
Name of Creek, Stream, River	**Trout Creek**			F - Fair
Water Licence:				P - Poor
Owners Name	**The Corporation of the District of Summerland**			U - Unsatisfactory
Address	**13211 Henry Avenue**			Ni - Not Inspected
City	**Summerland**	Postal Code	**V0H 1Z0**	
Telephone	**250-404-3000**	Alternate Phone		
Email				

Pre-Inspection Interview with Owner

* See Past Reports or other File Information

Owner or Representative present?	**No**
How long have you owned the dam?	**1930's**
Any Prior problems?	**No**
Repairs or Modifications? (where, when)	**No**
Past Failures/Incidents/Breach?	**No**
Works Currently Fully Operational?	**Yes**

Design report and plans availabl **Yes** Dam Material Known? **Yes** Foundation? **Yes**

Was the dam designed by an Engineer? **Unknown** Company

Are dam construction details known? **Unknown** Where?

Downstream Consequence Classification - Current

Dam Safety Regulation **High** CDA Guidelines:

Dam Information

Type of Dam:	***Earth Embankment***	Max. Height of Dam:	**1295.28** 8.96 m
Spillway Elevation:	***1292.05***	Spillway Width:	**2 m**
Freeboard (@full supply level)	***3.23 m***	Freeboard (at time of visit)	***3 m***
Reservoir Storage Volume	***504 ML (409 ac-ft)***	Licenced Storage Volume	***5240 ML (All)***

Dam Environment

Drainage Area Size	**25 km^2 (all headwaters)**	Reservoir Area:	***45 acres***
Inflow Design Flood: Q m^3/s	**13**	Flood AEP (Return Period)	**200 yr IDF (0.52 m FB)**
Other Inflow Study: Q m^3/s		Flood AEP (Return Period)	

Post Inspection Evaluation - Elaborate in the Inspection Report as required

Evaluate any new development in the inundation zone downstream					**Headwaters 1 is downstream**
Should new development initiate a review of the Consequence Classification?					**No**
OMS Manual Current?	**NO**	OMS Adequate?	**Yes**	OMS being followed?	**Yes**
EPP Manual Current?		EPP Adequate?		EPP being exercised?	
DSR Required?	**No**	DSR completed date?		Deficiencies Addressed?	**No**
Site Access - site access adequate for safe operation and maintenance?					**Yes**
Any other concerns in the watershed that could impact the dam?					**No**

Inspected by: Rod MacLean, P. Eng. (Associated Engineering)
Gerald Imada, P. Eng. (Golder Associates)

	Required Action				
	None	Monitor	Maintenance	Repair	Not Applicable

Embankment Dam

1. Upstream Slope

VEGETATION — ☐ None ☒ Monitor ☐ Maintenance ☐ Repair ☐ Not Applicable

Type **None** Location

Recommendations:

SLOPE PROTECTION — ☐ None ☒ Monitor ☐ Maintenance ☐ Repair ☐ Not Applicable

Type None/Sparse/Dense NONE

Notes

EROSION — ☐ None ☒ Monitor ☐ Maintenance ☐ Repair ☐ Not Applicable

Type (wave/runoff/unknown)

Length Width

Notes **Minor Wave**

INSTABILITIES — ☐ None ☒ Monitor ☐ Maintenance ☐ Repair ☐ Not Applicable

Slides (Yes/No/Could not Inspect)

Length Width Location

Notes/Causes **None**

Cracks (Transverse/Longitudinal/Other) — ☐ None ☒ Monitor ☐ Maintenance ☐ Repair ☐ Not Applicable

Quantity Length Width

Location

Notes/Causes **None**

Bulges/Depressions/Hummocky — ☐ None ☒ Monitor ☐ Maintenance ☐ Repair ☐ Not Applicable

Size Height Depth

Location

Notes/Causes **None**

OTHER — ☐ None ☒ Monitor ☐ Maintenance ☐ Repair ☐ Not Applicable

Burrows, Ruts, Other Concerns

Location

Notes/Causes **None**

2. Crest

ACCESS — ☐ None ☒ Monitor ☐ Maintenance ☐ Repair ☐ Not Applicable

Is there public access to the crest? YES

Is the crest marked or signed? NO

Is vehicle access to the crest restricted? NO

VEGETATION

Trees **NO** — ☐ None ☒ Monitor ☐ Maintenance ☐ Repair ☐ Not Applicable

Location

Notes

Brush **NONE** — ☐ None ☒ Monitor ☐ Maintenance ☐ Repair ☐ Not Applicable

Location

Notes

Ground Cover **BARE** — ☐ None ☒ Monitor ☐ Maintenance ☐ Repair ☐ Not Applicable

Quantity (bare/sparse/adequate/dense)

Appearance (too tall/too short/good)

Notes

EROSION **NONE** — ☐ None ☒ Monitor ☐ Maintenance ☐ Repair ☐ Not Applicable

Type (wave/runoff/unknown)

Length Width

Notes

SETTLEMENT **NONE** — ☐ None ☒ Monitor ☐ Maintenance ☐ Repair ☐ Not Applicable

Location

Notes/Causes

	Required Action				
	None	Monitor	Maintenance	Repair	Not Applicable
INSTABILITIES	☐	☒	☐	☐	☐
Cracks (Transverse/Longitudinal/Other) NONE					
Quantity ____ Length ____ Width ____					
Location ____					
Notes/Causes ____					
OTHER					
Burrows, Ruts, Other Concerns	☐	☒	☐	☐	☐
Location ____					
Notes/Causes ____					

3. Downstream Slope

VEGETATION	☐	☒	☐	☐	☐
Trees NO					
Location ____					
Notes ____					
Brush SPARSE	☐	☒	☐	☐	☐
Location ____					
Notes ____					
Ground Cover BARE	☐	☒	☐	☐	☐
Notes ____					
SLOPE PROTECTION	☐	☒	☐	☐	☐
Type NONE					
Notes ____					
EROSION	☐	☒	☐	☐	☐
Location NONE					
Notes ____					
INSTABILITIES NONE	☐	☒	☐	☐	☐
Slides Length ____ Width ____ Location ____					
Notes/Causes ____					
Cracks (Transverse/Longitudinal/Other) NONE	☐	☒	☐	☐	☐
Quantity ____ Length ____ Width ____					
Location ____					
Notes/Causes ____					
Bulges/Depressions/Hummocky NONE	☐	☒	☐	☐	☐
Size ____ Height ____ Depth ____					
Location ____					
Notes/Causes ____					
OTHER					
Burrows, Ruts, Other Concerns NONE	☐	☒	☐	☐	☐
Location ____					
Notes/Causes ____					
SEEPAGE	☐	☒	☐	☐	☐
Wet Area/Flow/Boil/Sinkhole VERY MINOR					
Flow Rate ____					
Location AROUND OUTLET STRUCTURE					
Aquatic Vegetation (Yes/No) NO					
Rust Colored Deposits (Yes/No) YES					
Sediment in Flow (Yes/No) NO					
Other ____					
Notes/Causes ____					
EMBANKMENT DRAINS NONE FOUND	☐	☐	☐	☐	☒
Type ____					
Flow rate ____ Size ____ Number ____					
Location ____					
Notes ____					
MONITORING INSTRUMENTATION CONDITION	☐	☐	☐	☐	☒
☑ None found ☐ Piezometers ☐ Weir ☐ Flume					
Notes ____					

	Required Action				
	None	Monitor	Maintenance	Repair	Not Applicable
Spillway					
GENERAL CONDITIONS					
Type ***Earthen Emergency Spillway - with Concrete Rectangular Inlet***	☐	☒	☐	☐	☐
Notes ***Sound-West end of dam***					
1. Spillway Crest or Control Section					
OBSTRUCTION	☐	☒	☐	☐	☐
Debris ***Some***					
Location ***Logs in the lake and just downstream of concrete.***					
Notes					
Vegetation Sparse					
Location ***Well maintained. No riprap***					
Notes					
Other (beaver activity, trash rack problems, etc.)					
Log boom intact at mouth.					
SPILLWAY CREST MATERIALS	☐	☒	☐	☐	☐
Condition ***Concrete - Rectangular***					
Notes Maintains water level and crosses road.					
OTHER SPILLWAY CREST PROBLEMS					
Damage ***None***	☒	☐	☐	☐	☐
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 Channel is cut through the woods	☐	☒	☐	☐	☐
Location					
Notes/Cause Constant flows from the lake					
3. Energy-Dissipating or Terminal Section					
EROSION CONTROL STRUCTURE	☐	☒	☐	☐	☐
Type ***Pond at the end.***					
Notes					

Low Level Outlet

	Required Action				
	None	Monitor	Maintenance	Repair	Not Applicable
GENERAL	☐	☒	☐	☐	☐
Type ***Gated Pipe Structure*** ☐ None					
ACCESS TO VALVE/GATE	☐	☒	☐	☐	☐
☐ Not accessible ☑ From shore ☐ Walkway ☐ By boat ☐ Other					
Notes ***Locked - Functional***					
Walkway Condition ***N/A***					
LOW LEVEL OUTLET COMPONENTS					
Valve Control Device	☐	☒	☐	☐	☐
☑ Yes ☐ None ☐ No Stem ☐ Damaged stem ☐ Other					
Other/Notes					
Operational?	☐	☐	☒	☐	☐
☑ Yes ☐ No ☐ Poorly ☐ Not tested					
Notes Some Leakage					
Valve / Gate	☐	☒	☐	☐	☐
Location ***Upstream Slanted***					
Condition ***Under water***					
Leakage ☑ Yes ☐ No	☐	☒	☐	☐	☐
Flow Rate **Negligible**					
Outlet Pipe	☐	☒	☐	☐	☐
☐ Metal ☐ Plastic ☑ Concrete ☐ Other					
Diameter ***450 mm***					
Condition ***Good condition***					
Outlet Obstruction (note vegetation, sediment blockage, etc.)					
Notes ***Minor***					
OUTLET EROSION CONTROL STRUCTURE	☐	☒	☐	☐	☐
Type ***Concrete***					
Concrete Condition ***Good***	☐	☒	☐	☐	☐
Outlet Area Seepage	☐	☒	☐	☐	☐
Description ***Some growth***					
Flow Estimate					
Location					
Undermining	☐	☒	☐	☐	☐
Location ***Negligible***					
Notes/Cause: Outlet and channel level are flat sloped. Evidence of earth movement					
Downstream Channel ***Into channel, and swamp downstream***	☐	☒	☐	☐	☐
Free Draining? ***Yes***					
Blockages or Potential Blockages? ***Monitor***					
Erosion Control? Rip-Rap? ***Good***					

Dam Safety Inspection Checklist

Name of Dam	**Crescent Lake**	Inspection Date	30-Apr-10	Observed Conditions
Current Weather:	Sunny-Some cloud	Previous Week:		S- Satisfactory
Name of Creek, Stream, River		**Trout Creek**		F - Fair
Water Licence:				P - Poor
Owners Name	**The Corporation of the District of Summerland**			U - Unsatisfactory
Address	**13211 Henry Avenue**			Ni - Not Inspected
City	**Summerland**	Postal Code	**V0H 1Z0**	
Telephone	**250-404-3000**	Alternate Phone		
Email				

Pre-Inspection Interview with Owner

* See Past Reports or other File Information

Owner or Representative present?	**No**
How long have you owned the dam?	**1930's**
Any Prior problems?	**No**
Repairs or Modifications? (where, when)	**No**
Past Failures/Incidents/Breach?	**No**
Works Currently Fully Operational?	**Yes**

Design report and plans available?	**No**	Dam Material Known?	**No**	Foundation?	**No**
Was the dam designed by an Engineer?	**Unknown**	Company			
Are dam construction details known?	**Unknown**	Where?			
Downstream Consequence Classification - Current					
Dam Safety Regulation	**Very Low**	CDA Guidelines:			

Dam Information

Type of Dam:	***Zoned Earthfill***	Max. Height of Dam:	**5.93 m**
Spillway Elevation:	***1355.32 m***	Spillway Width:	**8.51 m**
Freeboard (@full supply level)	***1.34 m***	Freeboard (at time of visit)	***1.2 m***
Reservoir Storage Volume	***769 ML***	Licenced Storage Volume	***1683 ML***

Dam Environment

Drainage Area Size	1554 ha	Reservoir Area:	159 ha	
Inflow Design Flood: Q m^3/s	**12.5**	Flood AEP (Return Period)	**200 yr IDF**	
Other Inflow Study: Q m^3/s		Flood AEP (Return Period)		

Post Inspection Evaluation - Elaborate in the Inspection Report as required

Evaluate any new development in the inundation zone downstream			**No**		
Should new development initiate a review of the Consequence Classification?			**No**		
OMS Manual Current?	**Yes**	OMS Adequate?	**Yes**	OMS being followed?	**Yes**
EPP Manual Current?	**Yes**	EPP Adequate?	**Yes**	EPP being exercised?	**Yes**
DSR Required?	**No**	DSR completed date?		Deficiencies Addressed?	**No**
Site Access - site access adequate for safe operation and maintenance?					**Yes**
Any other concerns in the watershed that could impact the dam?					**No**

Inspected by: Rod MacLean, P. Eng. (Associated Engineering)
Gerald Imada, P. Eng. (Golder Associates)

	Required Action				
	None	Monitor	Maintenance	Repair	Not Applicable

Embankment Dam

1. Upstream Slope

VEGETATION — ☐ ☒ ☐ ☐ ☐

Type **Some Grass** Location **Above high water**

Recommendations:

SLOPE PROTECTION — ☐ ☒ ☐ ☐ ☐

Type None/Sparse/Dense

Notes

EROSION — ☐ ☒ ☐ ☐ ☐

Type (wave/runoff/unknown)

Length Width

Notes **Minor Wave**

INSTABILITIES — ☐ ☒ ☐ ☐ ☐

Slides (Yes/No/Could not Inspect) NONE

Length Width Location

Notes/Causes

Cracks (Transverse/Longitudinal/Other) NONE — ☐ ☒ ☐ ☐ ☐

Quantity Length Width

Location

Notes/Causes **None**

Bulges/Depressions/Hummocky — ☐ ☒ ☐ ☐ ☐

Size Height Depth

Location

Notes/Causes **None**

OTHER — ☐ ☒ ☐ ☐ ☐

Burrows, Ruts, Other Concerns **BURROWS**

Location **Small Rodents**

Notes/Causes

2. Crest

ACCESS — ☐ ☒ ☐ ☐ ☐

Is there public access to the crest? YES

Is the crest marked or signed? NO

Is vehicle access to the crest restricted? NO

VEGETATION

Trees NO — ☐ ☒ ☐ ☐ ☐

Location

Notes

Brush NONE — ☐ ☒ ☐ ☐ ☐

Location

Notes

Ground Cover BARE — ☐ ☒ ☐ ☐ ☐

Quantity (bare/sparse/adequate/dense)

Appearance (too tall/too short/good)

Notes

EROSION NONE — ☐ ☒ ☐ ☐ ☐

Type (wave/runoff/unknown)

Length Width

Notes

SETTLEMENT NONE — ☐ ☒ ☐ ☐ ☐

Location

Notes/Causes

										Required Action				
										None	Monitor	Maintenance	Repair	Not Applicable
INSTABILITIES										☐	☒	☐	☐	☐
Cracks (Transverse/Longitudinal/Other)								NONE						
	Quantity		Length		Width									
	Location													
	Notes/Causes													
OTHER														
Burrows, Ruts, Other Concerns								NONE		☐	☒	☐	☐	☐
	Location													
	Notes/Causes													

3. Downstream Slope

VEGETATION										☐	☒	☐	☐	☐
Trees		NO												
	Location													
	Notes													
Brush		NONE								☐	☒	☐	☐	☐
	Location													
	Notes													
Ground Cover		GRASS								☐	☒	☐	☐	☐
	Notes													
SLOPE PROTECTION										☐	☒	☐	☐	☐
Type		NONE												
	Notes													
EROSION										☐	☒	☐	☐	☐
	Location	NONE												
	Notes													
INSTABILITIES		NONE								☐	☒	☐	☐	☐
Slides	Length		Width		Location									
	Notes/Causes													
Cracks (Transverse/Longitudinal/Other)								NONE		☐	☒	☐	☐	☐
	Quantity		Length		Width									
	Location													
	Notes/Causes													
Bulges/Depressions/Hummocky				NONE						☐	☒	☐	☐	☐
	Size		Height		Depth									
	Location													
	Notes/Causes													
OTHER														
Burrows, Ruts, Other Concerns				SMALL RODENTS						☐	☒	☐	☐	☐
	Location													
	Notes/Causes													
SEEPAGE										☐	☒	☐	☐	☐
Wet Area/Flow/Boil/Sinkhole				WET AREAS										
	Flow Rate													
	Location													
	Aquatic Vegetation			(Yes/No)										
	Rust Colored Deposits			(Yes/No)										
	Sediment in Flow			(Yes/No)										
	Other													
	Notes/Causes													
EMBANKMENT DRAINS			NONE FOUND							☐	☐	☐	☐	☒
Type														
Flow rate			Size		Number									
Location														
Notes														
MONITORING INSTRUMENTATION CONDITION										☐	☐	☐	☐	☒
☑ None found		☐ Piezometers			☐ Weir			☐ Flume						
Notes														

	Required Action				
	None	Monitor	Maintenance	Repair	Not Applicable

Spillway

GENERAL CONDITIONS

Type ***Earthen Channel Spillway - Stepped Concrete Outlet*** | ☐ | ☒ | ☐ | ☐ | ☐ |

Notes ***East end of Saddle Dam - Flowing Eastward***

1. Spillway Crest or Control Section

OBSTRUCTION | ☐ | ☐ | ☒ | ☐ | ☐ |

Debris

Location ***Some logs and debris lodged in Channel and concrete***

Notes ***Log (Boom?) across front of structure***

Vegetation Sparse

Location ***Well maintained.***

Notes

Other (beaver activity, trash rack problems, etc.)

No Log Boom

SPILLWAY CREST MATERIALS | ☐ | ☒ | ☐ | ☐ | ☐ |

Condition ***Concrete - Rectangular***

Notes Spilling at time (approximately 15 cm)

OTHER SPILLWAY CREST PROBLEMS

Damage None | ☐ | ☒ | ☐ | ☐ | ☐ |

Location

Notes/Cause

2. Spillway Conveyance Section: Channel, Chute or Conduit

OPEN CHANNEL CROSS SECTION GOOD | ☐ | ☒ | ☐ | ☐ | ☐ |

CHANNEL OBSTRUCTION NONE | ☐ | ☒ | ☐ | ☐ | ☐ |

SPILLWAY CONVEYANCE MATERIALS | ☐ | ☐ | ☐ | ☐ | ☐ |

OTHER SPILLWAY CONVEYANCE PROBLEMS NONE

Damage | ☐ | ☒ | ☐ | ☐ | ☐ |

Location

Notes/Cause

3. Energy-Dissipating or Terminal Section

EROSION CONTROL STRUCTURE | ☐ | ☒ | ☐ | ☐ | ☐ |

Type ***ROCK LINED CHANNEL***

Notes

Low Level Outlet

	Required Action				
	None	Monitor	Maintenance	Repair	Not Applicable
GENERAL					
Type ***Gated Pipe Structure*** ☐ None	☐	☒	☐	☐	☐
ACCESS TO VALVE/GATE	☒	☐	☐	☐	☐
☐ Not accessible ☑ From shore ☐ Walkway ☐ By boat ☐ Other					
Notes ***Locked - Not tested, but appears functional***					
Walkway Condition ***N/A***					
LOW LEVEL OUTLET COMPONENTS					
Valve Control Device	☐	☒	☐	☐	☐
☑ Yes ☐ None ☐ No Stem ☐ Damaged stem ☐ Other					
Other/Notes					
Operational?	☐	☒	☐	☐	☐
☑ Yes ☐ No ☐ Poorly ☐ Not tested					
Notes Some Leakage					
Valve / Gate	☐	☒	☐	☐	☐
Location ***Slanted Gate***					
Condition ***Under water***					
Leakage ☑ Yes ☐ No	☐	☒	☐	☐	☐
Flow Rate **MINOR**					
Outlet Pipe	☐	☒	☐	☐	☐
☐ Metal ☐ Plastic ☑ Concrete ☐ Other					
Diameter ***600 mm***					
Condition ***Good condition***					
Outlet Obstruction (note vegetation, sediment blockage, etc.)					
Notes					
OUTLET EROSION CONTROL STRUCTURE	☐	☒	☐	☐	☐
Type ***Concrete***					
Concrete Condition ***Good***	☐	☒	☐	☐	☐
Outlet Area Seepage	☐	☒	☐	☐	☐
Description					
Flow Estimate					
Location					
Undermining	☐	☒	☐	☐	☐
Location ***Little***					
Notes/Cause:					
Downstream Channel ***Channel cut into Bank, some sloughing***	☐	☒	☐	☐	☐
Free Draining? ***Yes***					
Blockages or Potential Blockages? ***Monitor***					
Erosion Control? Rip-Rap? ***Monitor***					

Dam Safety Inspection Checklist

Name of Dam	**Intake Pond**	Inspection Date	**15-Jul-10**	Observed Conditions
Current Weather:	**Cloudy**	Previous Week:		S- Satisfactory
Name of Creek, Stream, River	**Trout Creek**			F - Fair
Water Licence:				P - Poor
Owners Name	**The Corporation of the District of Summerland**			U - Unsatisfactory
Address	**13211 Henry Avenue**			Ni - Not Inspected
City	**Summerland**	Postal Code	**V0H 1Z0**	
Telephone	**250-404-3000**	Alternate Phone		
Email				

Pre-Inspection Interview with Owner

* See Past Reports or other File Information

Owner or Representative present?	**No**
How long have you owned the dam?	
Any Prior problems?	**No**
Repairs or Modifications? (where, when)	**No**
Past Failures/Incidents/Breach?	**No**
Works Currently Fully Operational?	**Yes**

Design report and plans availabl **No** Dam Material Known? **No** Foundation? **No**

Was the dam designed by an Engineer? **Unknown** Company

Are dam construction details known? **No** Where?

Downstream Consequence Classification - Current

Dam Safety Regulation **High** CDA Guidelines: High

Dam Information

Type of Dam:	**Earth Embankment**	Max. Height of Dam:	**Approximately 3 m**
Spillway Elevation:		Spillway Width:	**None**
Freeboard (@full supply level)		Freeboard (at time of visit)	
Reservoir Storage Volume	**Approx**	Licenced Storage Volume	

Dam Environment

Drainage Area Size	**<1 ha**	Reservoir Area:	1 ha
Inflow Design Flood: Q m^3/s		Flood AEP (Return Period)	**200 yr IDF (0.52 m FB)**
Other Inflow Study: Q m^3/s		Flood AEP (Return Period)	

Post Inspection Evaluation - Elaborate in the Inspection Report as required

Evaluate any new development in the inundation zone downstream				**Yes**	
Should new development initiate a review of the Consequence Classification?				**No**	
OMS Manual Current?	**NO**	OMS Adequate?	**Yes**	OMS being followed?	**Yes**
EPP Manual Current?		EPP Adequate?		EPP being exercised?	
DSR Required?	**No**	DSR completed date?		Deficiencies Addressed?	**No**
Site Access - site access adequate for safe operation and maintenance?					**Yes**
Any other concerns in the watershed that could impact the dam?					**No**

Inspected by: Rod MacLean, P. Eng. (Associated Engineering)
Gerald Imada, P. Eng. (Golder Associates)

	Required Action				
	None	Monitor	Maintenance	Repair	Not Applicable

Embankment Dam

1. Upstream Slope

VEGETATION — Monitor

Type **Some Grass** Location Near water edge

Recommendations:

SLOPE PROTECTION — Monitor

Type None/Sparse/Dense

Notes

EROSION — Monitor

Type (wave/runoff/unknown)

Length Width

Notes

INSTABILITIES — Monitor

Slides (Yes/No/Could not Inspect)

Length Width Location

Notes/Causes **None**

Cracks (Transverse/Longitudinal/Other) — Monitor

Quantity Length Width

Location

Notes/Causes **None**

Bulges/Depressions/Hummocky — Monitor

Size Height Depth

Location

Notes/Causes **None**

OTHER — Monitor

Burrows, Ruts, Other Concerns

Location

Notes/Causes **None**

2. Crest

ACCESS — Monitor

Is there public access to the crest? YES

Is the crest marked or signed? NO

Is vehicle access to the crest restricted? NO

VEGETATION

Trees NO — Monitor

Location

Notes

Brush NONE — Monitor

Location

Notes

Ground Cover BARE — Monitor

Quantity (bare/sparse/adequate/dense)

Appearance (too tall/too short/good)

Notes

EROSION NONE — Monitor

Type (wave/runoff/unknown)

Length Width

Notes

SETTLEMENT NONE — Monitor

Location

Notes/Causes

	Required Action				
	None	Monitor	Maintenance	Repair	Not Applicable
INSTABILITIES	☐	☒	☐	☐	☐
Cracks (Transverse/Longitudinal/Other) NONE					
Quantity _____ Length _____ Width _____					
Location _____					
Notes/Causes _____					
OTHER					
Burrows, Ruts, Other Concerns	☐	☒	☐	☐	☐
Location _____					
Notes/Causes _____					

3. Downstream Slope

VEGETATION	☐	☒	☐	☐	☐
Trees NO					
Location _____					
Notes _____					
Brush SPARSE	☐	☒	☐	☐	☐
Location _____					
Notes _____					
Ground Cover BARE	☐	☒	☐	☐	☐
Notes _____					
SLOPE PROTECTION	☐	☒	☐	☐	☐
Type NONE					
Notes _____					
EROSION	☐	☒	☐	☐	☐
Location NONE					
Notes _____					
INSTABILITIES NONE	☐	☒	☐	☐	☐
Slides Length _____ Width _____ Location _____					
Notes/Causes _____					
Cracks (Transverse/Longitudinal/Other) NONE	☐	☒	☐	☐	☐
Quantity _____ Length _____ Width _____					
Location _____					
Notes/Causes _____					
Bulges/Depressions/Hummocky NONE	☐	☒	☐	☐	☐
Size _____ Height _____ Depth _____					
Location _____					
Notes/Causes _____					
OTHER					
Burrows, Ruts, Other Concerns NONE	☐	☒	☐	☐	☐
Location _____					
Notes/Causes _____					
SEEPAGE	☐	☒	☐	☐	☐
Wet Area/Flow/Boil/Sinkhole NONE					
Flow Rate _____					
Location _____					
Aquatic Vegetation (Yes/No)					
Rust Colored Deposits (Yes/No)					
Sediment in Flow (Yes/No)					
Other _____					
Notes/Causes _____					
EMBANKMENT DRAINS NONE FOUND	☐	☐	☐	☐	☒
Type _____					
Flow rate _____ Size _____ Number _____					
Location _____					
Notes _____					
MONITORING INSTRUMENTATION CONDITION	☐	☐	☐	☐	☒
☑ None found ☐ Piezometers ☐ Weir ☐ Flume					
Notes _____					

	Required Action				
	None	Monitor	Maintenance	Repair	Not Applicable
Spillway					
GENERAL CONDITIONS					
Type ***NONE***		X			
Notes					
1. Spillway Crest or Control Section					
OBSTRUCTION	X				
Debris					
Location					
Notes					
Vegetation Sparse					
Location					
Notes					
Other (beaver activity, trash rack problems, etc.)					
Log boom intact at mouth.					
SPILLWAY CREST MATERIALS	X				
Condition ***Earthen - 3:1 sideslopes***					
Notes					
OTHER SPILLWAY CREST PROBLEMS					
Damage ***None***	X				
Location					
Notes/Cause					
2. Spillway Conveyance Section: Channel, Chute or Conduit					
OPEN CHANNEL CROSS SECTION OK	X				
CHANNEL OBSTRUCTION None	X				
SPILLWAY CONVEYANCE MATERIALS	X				
OTHER SPILLWAY CONVEYANCE PROBLEMS					
Damage	X				
Location					
Notes/Cause					
3. Energy-Dissipating or Terminal Section					
EROSION CONTROL STRUCTURE	X				
Type ***None***					
Notes					

Low Level Outlet

	Required Action				
	None	Monitor	Maintenance	Repair	Not Applicable
GENERAL					
Type ***Intake pipeline into WTP*** ☐ None	X				
ACCESS TO VALVE/GATE	X				
☐ Not accessible ☑ From shore ☐ Walkway ☐ By boat ☐ Other					
Notes ***Automated indoors***					
Walkway Condition ***N/A***					
LOW LEVEL OUTLET COMPONENTS					
Valve Control Device		X			
☑ Yes ☐ None ☐ No Stem ☐ Damaged stem ☐ Other					
Other/Notes					
Operational?		X			
☑ Yes ☐ No ☐ Poorly ☐ Not tested					
Notes					
Valve / Gate		X			
Location ***Control Building***					
Condition ***Good***					
Leakage ☑ Yes ☐ No		X			
Flow Rate **None**					
Outlet Pipe	X				
☑ Metal ☐ Plastic ☐ Concrete ☐ Other					
Diameter ***Unknown***					
Condition ***Unknown***					
Outlet Obstruction (note vegetation, sediment blockage, etc.)					
Notes					
OUTLET EROSION CONTROL STRUCTURE	X				
Type					
Concrete Condition	X				
Outlet Area Seepage	X				
Description					
Flow Estimate					
Location					
Undermining	X				
Location					
Notes/Cause:					
Downstream Channel	X				
Free Draining?					
Blockages or Potential Blockages?					
Erosion Control? Rip-Rap?					

Dam Safety Inspection Checklist

Name of Dam	**Isintok Lake**	Inspection Date	15-Jul-10	Observed Conditions
Current Weather:	**Sunny**	Previous Week:		S- Satisfactory
Name of Creek, Stream, River	**Isintok Creek**			F - Fair
Water Licence:	**CL16414**			P - Poor
Owners Name	**The Corporation of the District of Summerland**			U - Unsatisfactory
Address	**13211 Henry Avenue**			Ni - Not Inspected
City	**Summerland**	Postal Code	**V0H 1Z0**	
Telephone	**250-404-3000**	Alternate Phone		
Email				

Pre-Inspection Interview with Owner

* See Past Reports or other File Information

Owner or Representative present?	**Yes**				
How long have you owned the dam?	**1930's**				
Any Prior problems?	**No**				
Repairs or Modifications? (where, when)	**No**				
Past Failures/Incidents/Breach?	**No**				
Works Currently Fully Operational?	**Yes**				
Design report and plans available?	**No**	Dam Material Known?	**No**	Foundation?	**No**
Was the dam designed by an Engineer?	**Unknown**	Company			
Are dam construction details known?	**Unknown**	Where?			
Downstream Consequence Classification - Current					
Dam Safety Regulation	**Very Low**	CDA Guidelines:			

Dam Information

Type of Dam:	***Earth Embankment***	Max. Height of Dam:	**10.57 m**
Spillway Elevation:	***1645.62***	Spillway Width:	**4 m**
Freeboard (@full supply level)	***3.12 m***	Freeboard (at time of visit)	***3 m***
Reservoir Storage Volume	***1385 ML***	Licenced Storage Volume	***1665 ML***

Dam Environment

Drainage Area Size	**1640 ha**	Reservoir Area:	***86 ha***	
Inflow Design Flood:	Q m^3/s	**44**	Flood AEP (Return Period)	1:200 year
Other Inflow Study:	Q m^3/s		Flood AEP (Return Period)	

Post Inspection Evaluation - Elaborate in the Inspection Report as required

Evaluate any new development in the inundation zone downstream			**No**		
Should new development initiate a review of the Consequence Classification?			**No**		
OMS Manual Current?	**Yes**	OMS Adequate?	**Yes**	OMS being followed?	**Yes**
EPP Manual Current?	Yes	EPP Adequate?	Yes	EPP being exercised?	**Yes**
DSR Required?	**No**	DSR completed date?	6/10	Deficiencies Addressed?	**No**
Site Access - site access adequate for safe operation and maintenance?					**Yes**
Any other concerns in the watershed that could impact the dam?					**No**

Inspected by: Rod MacLean, P. Eng. (Associated Engineering)
Gerald Imada, P. Eng. (Golder Associates)

	Required Action				
	None	Monitor	Maintenance	Repair	Not Applicable

Embankment Dam

1. Upstream Slope

VEGETATION — Monitor

Type **Some Grass** Location

Recommendations:

SLOPE PROTECTION NONE — Maintenance

Type None/Sparse/Dense

Notes

EROSION — Maintenance

Type (wave/runoff/unknown)

Length Width

Notes **Minor Wave/ VEHICLE TRAFFIC**

INSTABILITIES — Monitor

Slides (Yes/No/Could not Inspect) NONE

Length Width Location

Notes/Causes

Cracks (Transverse/Longitudinal/Other) NONE — Monitor

Quantity Length Width

Location

Notes/Causes **None**

Bulges/Depressions/Hummocky — Monitor

Size Height Depth

Location

Notes/Causes **None**

OTHER — Monitor

Burrows, Ruts, Other Concerns **BURROWS**

Location Crest

Notes/Causes **ATV's and Motorcycle access**

2. Crest

ACCESS — Monitor

Is there public access to the crest? YES

Is the crest marked or signed? NO

Is vehicle access to the crest restricted? NO

VEGETATION

Trees NO — Monitor

Location

Notes

Brush NONE — Monitor

Location

Notes

Ground Cover BARE — Monitor

Quantity (bare/sparse/adequate/dense)

Appearance (too tall/too short/good)

Notes

EROSION — Monitor

Type (wave/runoff/unknown)

Length Width

Notes **Vehicle Traffic**

SETTLEMENT NONE — Monitor

Location

Notes/Causes

											Required Action				
											None	Monitor	Maintenance	Repair	Not Applicable
INSTABILITIES											☐	☒	☐	☐	☐
Cracks (Transverse/Longitudinal/Other)							NONE								
	Quantity		Length		Width										
	Location														
	Notes/Causes														
OTHER															
Burrows, Ruts, Other Concerns							NONE				☐	☒	☐	☐	☐
	Location														
	Notes/Causes														

3. Downstream Slope

VEGETATION											☐	☐	☒	☐	☐
Trees		YES													
	Location	Small fir trees - Very sparse													
	Notes														
Brush		NONE									☐	☒	☐	☐	☐
	Location														
	Notes														
Ground Cover		GRASS									☐	☒	☐	☐	☐
	Notes	very sparse													
SLOPE PROTECTION											☐	☒	☐	☐	☐
Type		NONE													
	Notes														
EROSION											☐	☒	☐	☐	☐
	Location	NONE													
	Notes														
INSTABILITIES		NONE									☐	☒	☐	☐	☐
Slides	Length		Width		Location										
	Notes/Causes														
Cracks (Transverse/Longitudinal/Other)							NONE				☐	☒	☐	☐	☐
	Quantity		Length		Width										
	Location														
	Notes/Causes														
Bulges/Depressions/Hummocky				NONE							☐	☒	☐	☐	☐
	Size		Height		Depth										
	Location														
	Notes/Causes														
OTHER															
Burrows, Ruts, Other Concerns				Ruts							☐	☒	☐	☐	☐
	Location		Vehicle Traffic												
	Notes/Causes														
SEEPAGE											☐	☒	☐	☐	☐
Wet Area/Flow/Boil/Sinkhole				**WET AREAS**											
	Flow Rate	**Minor at time of inspection**													
	Location	**Both on Northa nd south side of Outlet**													
	Aquatic Vegetation			(Yes/No)	**YES**										
	Rust Colored Deposits			(Yes/No)	**NO**										
	Sediment in Flow			(Yes/No)	**NO**										
	Other														
	Notes/Causes														
EMBANKMENT DRAINS			NONE FOUND								☐	☐	☐	☐	☒
Type															
Flow rate			Size		Number										
Location															
Notes															
MONITORING INSTRUMENTATION CONDITION											☐	☐	☐	☐	☒
☑ None found	☐ Piezometers		☐ Weir		☐ Flume										
Notes															

	Required Action				
	None	Monitor	Maintenance	Repair	Not Applicable

Spillway

GENERAL CONDITIONS

Type ***Earthen Channel Spillway - Concrete Sill and Sidewalls*** | ☐ | ☒ | ☐ | ☐ | ☐ |

Notes

1. Spillway Crest or Control Section

OBSTRUCTION | ☐ | ☒ | ☐ | ☐ | ☐ |

Debris

Location ***No***

Notes

	Non	Mor	Mai	Rep	Not

Vegetation Sparse

Location ***Well maintained.***

Notes

Other (beaver activity, trash rack problems, etc.)

No Log Boom

SPILLWAY CREST MATERIALS | ☐ | ☒ | ☐ | ☐ | ☐ |

Condition ***Concrete - Rectangular***

Notes Little flow

OTHER SPILLWAY CREST PROBLEMS

Damage None | ☒ | ☐ | ☐ | ☐ | ☐ |

Location

Notes/Cause

2. Spillway Conveyance Section: Channel, Chute or Conduit

OPEN CHANNEL CROSS SECTION Trapezoidal - Creek | ☐ | ☒ | ☐ | ☐ | ☐ |

CHANNEL OBSTRUCTION None | ☐ | ☒ | ☐ | ☐ | ☐ |

SPILLWAY CONVEYANCE MATERIALS Creek bed | ☐ | ☒ | ☐ | ☐ | ☐ |

OTHER SPILLWAY CONVEYANCE PROBLEMS

Damage | ☐ | ☒ | ☐ | ☐ | ☐ |

Location

Notes/Cause

3. Energy-Dissipating or Terminal Section

EROSION CONTROL STRUCTURE | ☐ | ☒ | ☐ | ☐ | ☐ |

Type ***None***

Notes

	Required Action				
	None	Monitor	Maintenance	Repair	Not Applicable

Low Level Outlet

GENERAL

Type ***Gated Pipe Structure*** ☐ None

☐	☒	☐	☐	☐	

ACCESS TO VALVE/GATE

☐ Not accessible ☑ From shore ☐ Walkway ☐ By boat ☐ Other

Notes ***Locked - Not tested, but appears functional***

Walkway Condition ***N/A***

☒	☐	☐	☐	☐	

LOW LEVEL OUTLET COMPONENTS

Valve Control Device

☑ Yes ☐ None ☐ No Stem ☐ Damaged stem ☐ Other

Other/Notes

☐	☒	☐	☐	☐	

Operational?

☑ Yes ☐ No ☐ Poorly ☐ Not tested

Notes Some Leakage

☐	☒	☐	☐	☐	

Valve / Gate

Location ***Slanted Gate***

Condition ***Under water***

☐	☒	☐	☐	☐	

Leakage ☑ Yes ☐ No

Flow Rate **Negligible**

☐	☒	☐	☐	☐	

Outlet Pipe

☐ Metal ☐ Plastic ☑ Concrete ☐ Other

Diameter ***600 mm***

Condition ***Good condition***

Outlet Obstruction (note vegetation, sediment blockage, etc.)

Notes

☐	☒	☐	☐	☐	

OUTLET EROSION CONTROL STRUCTURE

Type ***Concrete***

☐	☒	☐	☐	☐	

Concrete Condition ***Good***

☐	☒	☐	☐	☐	

Outlet Area Seepage

Description

Flow Estimate

Location

☐	☒	☐	☐	☐	

Undermining

Location ***Little***

Notes/Cause:

☐	☒	☐	☐	☐	

Downstream Channel ***Channel cut into Bank, some sloughing***

Free Draining? ***Yes***

Blockages or Potential Blockages? ***Monitor***

Erosion Control? Rip-Rap? ***Monitor***

Dam Safety Inspection Checklist

Name of Dam	**Eneas Lake**	Inspection Date	22-Jun-10	Observed Conditions
Current Weather:	Rain	Previous Week:		S- Satisfactory
Name of Creek, Stream, River	**Eneas Creek**			F - Fair
Water Licence:	CL16416			P - Poor
Owners Name	**The Corporation of the District of Summerland**			U - Unsatisfactory
Address	**13211 Henry Avenue**			Ni - Not Inspected
City	**Summerland**	Postal Code	**V0H 1Z0**	
Telephone	**250-404-3000**	Alternate Phone		
Email				

Pre-Inspection Interview with Owner

* See Past Reports or other File Information

Owner or Representative present?	**No**
How long have you owned the dam?	**1930's**
Any Prior problems?	**No**
Repairs or Modifications? (where, when)	**No**
Past Failures/Incidents/Breach?	**No**
Works Currently Fully Operational?	**Yes**

Design report and plans availabl **No** Dam Material Known? **No** Foundation? **No**

Was the dam designed by an Engineer? **Unknown** Company

Are dam construction details known? **Unknown** Where?

Downstream Consequence Classification - Current

Dam Safety Regulation **Very Low** CDA Guidelines:

Dam Information

Type of Dam:	***Earth Embankment***	Max. Height of Dam:	**1563.20**
Spillway Elevation:	***1560.2***	Spillway Width:	**2.5 m**
Freeboard (@full supply level)	***1.2 m***	Freeboard (at time of visit)	***1.2 m***
Reservoir Storage Volume	***153 ML***	Licenced Storage Volume	***616.5***

Dam Environment

Drainage Area Size	310 ha	Reservoir Area:	7 ha
Inflow Design Flood: Q m^3/s	**7.7**	Flood AEP (Return Period)	**200 yr IDF**
Other Inflow Study: Q m^3/s		Flood AEP (Return Period)	

Post Inspection Evaluation - Elaborate in the Inspection Report as required

Evaluate any new development in the inundation zone downstream				**No**	
Should new development initiate a review of the Consequence Classification?				**No**	
OMS Manual Current?	**NO**	OMS Adequate?	**Yes**	OMS being followed?	**Yes**
EPP Manual Current?		EPP Adequate?		EPP being exercised?	
DSR Required?	**No**	DSR completed date?		Deficiencies Addressed?	**No**
Site Access - site access adequate for safe operation and maintenance?					**Yes**
Any other concerns in the watershed that could impact the dam?					**No**

Inspected by: Rod MacLean, P. Eng. (Associated Engineering)
Gerald Imada, P. Eng. (Golder Associates)

	Required Action				
	None	Monitor	Maintenance	Repair	Not Applicable

Embankment Dam

1. Upstream Slope

VEGETATION ☐ ☒ ☐ ☐ ☐

Type **Small Shrubs/Grass** Location

Recommendations:

SLOPE PROTECTION ☐ ☒ ☐ ☐ ☐

Type None/Sparse/Dense

Notes Shrubs, grass and cluster of boulders near spillway

EROSION ☐ ☒ ☐ ☐ ☐

Type (wave/runoff/unknown) NONE

Length Width

Notes **None Noted**

INSTABILITIES ☐ ☒ ☐ ☐ ☐

Slides (Yes/No/Could not Inspect) NONE

Length Width Location

Notes/Causes

Cracks (Transverse/Longitudinal/Other) NONE ☐ ☒ ☐ ☐ ☐

Quantity Length Width

Location

Notes/Causes **None**

Bulges/Depressions/Hummocky ☐ ☒ ☐ ☐ ☐

Size Height Depth

Location

Notes/Causes **None**

OTHER ☐ ☒ ☐ ☐ ☐

Burrows, Ruts, Other Concern **BURROWS**

Location **Small Rodents**

Notes/Causes

2. Crest

ACCESS ☐ ☒ ☐ ☐ ☐

Is there public access to the crest? YES

Is the crest marked or signed? NO

Is vehicle access to the crest restricted? NO

VEGETATION

Trees NO ☐ ☒ ☐ ☐ ☐

Location

Notes

Brush NONE ☐ ☒ ☐ ☐ ☐

Location

Notes

Ground Cover BARE ☐ ☒ ☐ ☐ ☐

Quantity (bare/sparse/adequate/dense)

Appearance (too tall/too short/good)

Notes

EROSION NONE ☐ ☒ ☐ ☐ ☐

Type (wave/runoff/unknown)

Length Width

Notes

SETTLEMENT NONE ☐ ☒ ☐ ☐ ☐

Location

Notes/Causes

	Required Action				
	None	Monitor	Maintenance	Repair	Not Applicable
INSTABILITIES	☐	☒	☐	☐	☐
Cracks (Transverse/Longitudinal/Other) NONE					
Quantity _____ Length _____ Width _____					
Location _____					
Notes/Causes _____					
OTHER					
Burrows, Ruts, Other Concerns NONE	☐	☒	☐	☐	☐
Location _____					
Notes/Causes _____					

3. Downstream Slope

VEGETATION	☐	☒	☐	☐	☐
Trees NO					
Location _____					
Notes _____					
Brush NONE	☐	☒	☐	☐	☐
Location _____					
Notes _____					
Ground Cover GRASS	☐	☒	☐	☐	☐
Notes Moderate Cover					
SLOPE PROTECTION	☐	☒	☐	☐	☐
Type NONE					
Notes Grass and shrubs					
EROSION	☐	☒	☐	☐	☐
Location NONE					
Notes _____					
INSTABILITIES NONE	☐	☒	☐	☐	☐
Slides Length _____ Width _____ Location _____					
Notes/Causes _____					
Cracks (Transverse/Longitudinal/Other) NONE	☐	☒	☐	☐	☐
Quantity _____ Length _____ Width _____					
Location _____					
Notes/Causes _____					
Bulges/Depressions/Hummocky NONE	☐	☒	☐	☐	☐
Size _____ Height _____ Depth _____					
Location _____					
Notes/Causes _____					
OTHER					
Burrows, Ruts, Other Concerns SMALL RODENTS	☐	☒	☐	☐	☐
Location _____					
Notes/Causes _____					
SEEPAGE	☐	☒	☐	☐	☐
Wet Area/Flow/Boil/Sinkhole WET AREAS					
Flow Rate _____					
Location _____					
Aquatic Vegetation (Yes/No)					
Rust Colored Deposits (Yes/No)					
Sediment in Flow (Yes/No)					
Other _____					
Notes/Causes _____					
EMBANKMENT DRAINS NONE FOUND	☐	☐	☐	☐	☒
Type _____					
Flow rate _____ Size _____ Number _____					
Location _____					
Notes _____					
MONITORING INSTRUMENTATION CONDITION	☐	☐	☐	☐	☒
☑ None found ☐ Piezometers ☐ Weir ☐ Flume					
Notes _____					

	Required Action				
	None	Monitor	Maintenance	Repair	Not Applicable
Spillway					
GENERAL CONDITIONS					
Type ***Concrete Apron with wingwalls***	☐	☐	☐	☒	☐
Notes ***Upper part of walls braced to prevent inward tilt***					
1. Spillway Crest or Control Section					
OBSTRUCTION	☐	☒	☐	☐	☐
Debris ***Some***					
Location ***Some logs and debris lodged in Channel and concrete***					
Notes ***Log (Boom?) across front of structure***					
Vegetation Sparse					
Location ***Soil has subsided***					
Notes					
Other (beaver activity, trash rack problems, etc.)					
No Log Boom					
SPILLWAY CREST MATERIALS	☐	☒	☐	☐	☐
Condition ***Concrete - Rectangular (4.57 m wide)***					
Notes Spilling at time (approximately 15 cm)					
OTHER SPILLWAY CREST PROBLEMS					
Damage See above	☒	☐	☐	☐	☐
Location					
Notes/Cause					
2. Spillway Conveyance Section: Channel, Chute or Conduit					
OPEN CHANNEL CROSS SECTION Rectangular	☐	☐	☐	☒	☐
CHANNEL OBSTRUCTION Concrete Abutment - Off Vertical	☐	☐	☐	☒	☐
Ground has subsided around concrete					
SPILLWAY CONVEYANCE MATERIALS Walls - Failing	☐	☐	☐	☒	☐
Pressure on Vertical walls					
OTHER SPILLWAY CONVEYANCE PROBLEMS					
Damage	☐	☐	☒	☐	☐
Location Channel cut through woods					
Notes/Cause Some rocks, debris and logs					
3. Energy-Dissipating or Terminal Section					
EROSION CONTROL STRUCTURE	☐	☒	☐	☐	☐
Type ***None***					
Riprap Channel					
Notes ***Temporary footbridge could plug spillway in major event.***					

Low Level Outlet

	Required Action				
	None	Monitor	Maintenance	Repair	Not Applicable
GENERAL					
Type ***Gated Pipe Structure*** ☐ None	☐	X	☐	☐	☐
ACCESS TO VALVE/GATE	X	☐	☐	☐	☐
☐ Not accessible ☑ From shore ☐ Walkway ☐ By boat ☐ Other					
Notes ***Locked - Not tested, but appears functional***					
Walkway Condition ***N/A***					
LOW LEVEL OUTLET COMPONENTS					
Valve Control Device	☐	X	☐	☐	☐
☑ Yes ☐ None ☐ No Stem ☐ Damaged stem ☐ Other					
Other/Notes Unknown. We had worries it might not seal properly.					
Operational?	☐	☐	X	☐	☐
☑ Yes ☐ No ☐ Poorly ☐ Not tested					
Notes Some Leakage					
Valve / Gate	☐	X	☐	☐	☐
Location ***Slanted Gate***					
Condition ***Gate Requires Key***					
Leakage ☑ Yes ☐ No	☐	X	☐	☐	☐
Flow Rate **Negligible**					
Outlet Pipe	☐	X	☐	☐	☐
☐ Metal ☐ Plastic ☑ Concrete ☐ Other					
Diameter ***600 mm - Approximately 23 m long***					
Condition ***Good condition***					
Outlet Obstruction (note vegetation, sediment blockage, etc.)					
Notes ***Several Logs***					
OUTLET EROSION CONTROL STRUCTURE	☐	X	☐	☐	☐
Type ***Concrete***					
Concrete Condition ***Good***	☐	X	☐	☐	☐
Outlet Area Seepage	☐	X	☐	☐	☐
Description					
Flow Estimate					
Location					
Undermining	☐	X	☐	☐	☐
Location ***Little***					
Notes/Cause:					
Downstream Channel ***Channel cut into Bank, some sloughing***	☐	☐	X	☐	☐
Free Draining? ***Yes***					
Blockages or Potential Blockages? ***Some rock and debris inside***					
Erosion Control? Rip-Rap? ***Adequate***					

Dam Safety Inspection Checklist

Name of Dam	**Garnet Dam**	Inspection Date	29-Apr-10	Observed Conditions
Weather:	Overcast - Cool	Previous Week:		S- Satisfactory
Name of Creek, Stream, River	**Eneas Creek**			F - Fair
Water Licence:				P - Poor
Owners Name	**The Corporation of the District of Summerland**			U - Unsatisfactory
Address	**13211 Henry Avenue**			Ni - Not Inspected
City	**Summerland**	Postal Code	**V0H 1Z0**	
Telephone	**250-404-3000**	Alternate Phone		
Email				

Pre-Inspection Interview with Owner

* See Past Reports or other File Information

Owner or Representative present?	**No**
How long have you owned the dam?	**1930's**
Any Prior problems?	**No**
Repairs or Modifications? (where, when)	**No**
Past Failures/Incidents/Breach?	**No**
Works Currently Fully Operational?	**Yes**

Design report and plans availabl **Yes** Dam Material Known? **Yes** Foundation? **Yes**

Was the dam designed by an Engineer? **Unknown** Company

Are dam construction details known? **Unknown** Where?

Downstream Consequence Classification - Current

Dam Safety Regulation **High** CDA Guidelines:

Dam Information

Type of Dam:	***Earth Embankment***	Max. Height of Dam:	**634.84**
Spillway Elevation:	***632.72***	Spillway Width:	**12.2 m**
Freeboard (@full supply level)	***2.12 m***	Freeboard (at time of visit)	***2.2 m***
Reservoir Storage Volume	***2304 ML (Live)***	Licenced Storage Volume	***1850 ML***

Dam Environment

Drainage Area Size	**5680 ha**	Reservoir Area:	***97 acres***
Inflow Design Flood:	Q m^3/s	Flood AEP (Return Period)	
Other Inflow Study:	Q m^3/s	Flood AEP (Return Period)	

Post Inspection Evaluation - Elaborate in the Inspection Report as required

Evaluate any new development in the inundation zone downstream			**No**		
Should new development initiate a review of the Consequence Classification?			**No**		
OMS Manual Current?	**NO**	OMS Adequate?	**Yes**	OMS being followed?	**Yes**
EPP Manual Current?		EPP Adequate?	Yes	EPP being exercised?	**Yes**
DSR Required?		DSR completed date?	06/10	Deficiencies Addressed?	**No**
Site Access - site access adequate for safe operation and maintenance?					**Yes**
Any other concerns in the watershed that could impact the dam?					**No**

Inspected by: Rod MacLean, P. Eng. (Associated Engineering)
Gerald Imada, P. Eng. (Golder Associates)

	Required Action				
	None	Monitor	Maintenance	Repair	Not Applicable

Embankment Dam

1. Upstream Slope

VEGETATION — Monitor

Type **Little** Location **Above high water**

Recommendations:

SLOPE PROTECTION NONE — Monitor

Type None/Sparse/Dense

Notes

EROSION — Monitor

Type (wave/runoff/unknown)

Length Width

Notes **Minor Wave erosion**

INSTABILITIES — Monitor

Slides (Yes/No/Could not Inspect) NONE

Length Width Location

Notes/Causes

Cracks (Transverse/Longitudinal/Other) NONE — Monitor

Quantity Length Width

Location

Notes/Causes **None**

Bulges/Depressions/Hummocky — Monitor

Size Height Depth

Location

Notes/Causes **None**

OTHER — Monitor

Burrows, Ruts, Other Concern **BURROWS**

Location **Small Rodents**

Notes/Causes

2. Crest

ACCESS — Monitor

Is there public access to the crest? YES

Is the crest marked or signed? NO

Is vehicle access to the crest restricted? NO

VEGETATION

Trees NO — Monitor

Location

Notes

Brush NONE — Monitor

Location

Notes

Ground Cover BARE — Monitor

Quantity (bare/sparse/adequate/dense)

Appearance (too tall/too short/good)

Notes

EROSION NONE — Monitor

Type (wave/runoff/unknown)

Length Width

Notes

SETTLEMENT NONE — Monitor

Location

Notes/Causes

	Required Action				
	None	Monitor	Maintenance	Repair	Not Applicable
INSTABILITIES	X				
Cracks (Transverse/Longitudinal/Other) NONE					
Quantity ____ Length ____ Width ____					
Location ____					
Notes/Causes ____					
OTHER					
Burrows, Ruts, Other Concerns NONE	X				
Location ____					
Notes/Causes ____					

3. Downstream Slope

VEGETATION	X				
Trees NO					
Location ____					
Notes ____					
Brush NONE	X				
Location ____					
Notes ____					
Ground Cover GRASS	X				
Notes ____					
SLOPE PROTECTION	X				
Type NONE					
Notes ____					
EROSION		X			
Location NONE					
Notes ____					
INSTABILITIES NONE		X			
Slides Length ____ Width ____ Location ____					
Notes/Causes ____					
Cracks (Transverse/Longitudinal/Other) NONE		X			
Quantity ____ Length ____ Width ____					
Location ____					
Notes/Causes ____					
Bulges/Depressions/Hummocky NONE		X			
Size ____ Height ____ Depth ____					
Location ____					
Notes/Causes ____					
OTHER					
Burrows, Ruts, Other Concerns NONE		X			
Location ____					
Notes/Causes ____					
SEEPAGE		X			
Wet Area/Flow/Boil/Sinkhole Minor Seepage					
Flow Rate ____					
Location West side @ toe					
Aquatic Vegetation (Yes/No) YES					
Rust Colored Deposits (Yes/No) YES					
Sediment in Flow (Yes/No) NO					
Other ____					
Notes/Causes ____					
EMBANKMENT DRAINS NONE FOUND		X			
Type ____					
Flow rate ____ Size ____ Number ____					
Location ____					
Notes ____					
MONITORING INSTRUMENTATION CONDITION		X			
☐ None found! ☐ Piezometers ☑ Weir ☐ Flume					
Notes 2 weirs. One in seepage area and one at outlet structure.					

	Required Action				
	None	Monitor	Maintenance	Repair	Not Applicable
Spillway					
GENERAL CONDITIONS					
Type ***Concrete Spillway and Channel***			X		
Notes ***East side of dam***					
1. Spillway Crest or Control Section					
OBSTRUCTION		X			
Debris ***Some***					
Location ***Logs in the lake and just downstream of concrete.***					
Notes					
Vegetation Sparse					
Location ***Minor grass growing in expansion joints***					
Notes					
Other (beaver activity, trash rack problems, etc.)					
Log boom intact at mouth.					
SPILLWAY CREST MATERIALS		X			
Condition ***Concrete - Rectangular***					
Notes Maintains water level. - Mild vertical cracks					
OTHER SPILLWAY CREST PROBLEMS					
Damage ***None***	X				
Location					
Notes/Cause					
2. Spillway Conveyance Section: Channel, Chute or Conduit					
OPEN CHANNEL CROSS SECTION Riprap		X			
CHANNEL OBSTRUCTION Access road crosses spillway channel		X			
SPILLWAY CONVEYANCE MATERIALS		X			
OTHER SPILLWAY CONVEYANCE PROBLEMS					
Damage Culvert Crossing at road is not large enough and will wash away in major flood				X	
Location					
Notes/Cause Access will be compromised in large storm.					
3. Energy-Dissipating or Terminal Section					
EROSION CONTROL STRUCTURE	x				
Type ***NONE***					
Notes					

Low Level Outlet

	Required Action				
	None	Monitor	Maintenance	Repair	Not Applicable
GENERAL	☐	☒	☐	☐	☐
Type ***Gated Pipe Structure*** ☐ None					
ACCESS TO VALVE/GATE	☒	☐	☐	☐	☐
☐ Not accessible ☑ From shore ☐ Walkway ☐ By boat ☐ Other					
Notes ***Locked - Functional***					
Walkway Condition ***N/A***					
LOW LEVEL OUTLET COMPONENTS					
Valve Control Device	☐	☒	☐	☐	☐
☑ Yes ☐ None ☐ No Stem ☐ Damaged stem ☐ Other					
Other/Notes Hand Wheel is broken					
Operational?	☐	☐	☐	☒	☐
☑ Yes ☐ No ☐ Poorly ☐ Not tested					
Notes					
Valve / Gate	☐	☒	☐	☐	☐
Location ***Vertical Gate in Chamber***					
Condition ***Under water***					
Leakage ☑ Yes ☐ No	☐	☒	☐	☐	☐
Flow Rate **Negligible**					
Outlet Pipe	☐	☒	☐	☐	☐
☐ Metal ☐ Plastic ☑ Concrete ☐ Other					
Diameter ***600 mm***					
Condition ***Good condition***					
Outlet Obstruction (note vegetation, sediment blockage, etc.)					
Notes					
OUTLET EROSION CONTROL STRUCTURE	☐	☒	☐	☐	☐
Type ***Concrete***					
Concrete Condition ***Good***	☐	☒	☐	☐	☐
Outlet Area Seepage	☐	☒	☐	☐	☐
Description ***Some growth***					
Flow Estimate					
Location					
Undermining	☐	☒	☐	☐	☐
Location ***Negligible***					
Notes/Cause: Outlet and channel level are flat sloped. Evidence of earth movement					
Downstream Channel ***Into channel, and swamp downstream***	☐	☒	☐	☐	☐
Free Draining? ***Yes***					
Blockages or Potential Blockages? ***Monitor***					
Erosion Control? Rip-Rap? ***Good***					

Dam Safety Inspection Checklist

Name of Dam	**Tsuh Lake**	Inspection Date	**22-Jun-10**	Observed Conditions
Current Weather:	**Rain-Warm**	Previous Week:	**Rain-Cool**	S- Satisfactory
Name of Creek, Stream, River	**Findlay Creek**			F - Fair
Water Licence:	CL 16414			P - Poor
Owners Name	**The Corporation of the District of Summerland**			U - Unsatisfactory
Address	**13211 Henry Avenue**			Ni - Not Inspected
City	**Summerland**	Postal Code	**V0H 1Z0**	
Telephone	**250-404-3000**	Alternate Phone		
Email				

Pre-Inspection Interview with Owner

* See Past Reports or other File Information

Owner or Representative present?	**No**
How long have you owned the dam?	**1930's**
Any Prior problems?	**No**
Repairs or Modifications? (where, when)	**No**
Past Failures/Incidents/Breach?	**No**
Works Currently Fully Operational?	**Yes**

Design report and plans availabl **No** Dam Material Known? **No** Foundation? **No**

Was the dam designed by an Engineer? **Unknown** Company

Are dam construction details known? **Unknown** Where?

Downstream Consequence Classification - Current

Dam Safety Regulation **High** CDA Guidelines:

Dam Information

Type of Dam:	***Earth Embankment***	Max. Height of Dam:	**1569.72**
Spillway Elevation:	***1568.65***	Spillway Width:	**3.05 m**
Freeboard (@full supply level)	***1.07***	Freeboard (at time of visit)	***1 m***
Reservoir Storage Volume	***309 ML***	Licenced Storage Volume	***300***

Dam Environment

Drainage Area Size	**244 ha**	Reservoir Area:	52 ac
Inflow Design Flood: Q m^3/s	**6.1**	Flood AEP (Return Period)	**1:200**
Other Inflow Study: Q m^3/s		Flood AEP (Return Period)	

Post Inspection Evaluation - Elaborate in the Inspection Report as required

Evaluate any new development in the inundation zone downstream				**No**	
Should new development initiate a review of the Consequence Classification?				**No**	
OMS Manual Current?	**NO**	OMS Adequate?	**Yes**	OMS being followed?	**Yes**
EPP Manual Current?	Yes	EPP Adequate?	Yes	EPP being exercised?	**Yes**
DSR Required?	**No**	DSR completed date?		Deficiencies Addressed?	**No**
Site Access - site access adequate for safe operation and maintenance?					**Yes**
Any other concerns in the watershed that could impact the dam?					**No**

Inspected by: Rod MacLean, P. Eng. (Associated Engineering)
Gerald Imada, P. Eng. (Golder Associates)

	Required Action				
	None	Monitor	Maintenance	Repair	Not Applicable

Embankment Dam

1. Upstream Slope

VEGETATION — ☐ ☐ ☒ ☐ ☐

Type **Some Grass** Location Near water edge

Recommendations: Excessive Growth

SLOPE PROTECTION — ☐ ☒ ☐ ☐ ☐

Type None/Sparse/Dense

Notes

EROSION — ☐ ☒ ☐ ☐ ☐

Type (wave/runoff/unknown)

Length Width

Notes **Minor Wave**

INSTABILITIES — ☐ ☒ ☐ ☐ ☐

Slides (Yes/No/Could not Inspect)

Length Width Location

Notes/Causes **None**

Cracks (Transverse/Longitudinal/Other) — ☐ ☒ ☐ ☐ ☐

Quantity Length Width

Location

Notes/Causes **None**

Bulges/Depressions/Hummocky — ☐ ☒ ☐ ☐ ☐

Size Height Depth

Location

Notes/Causes **None**

OTHER — ☐ ☒ ☐ ☐ ☐

Burrows, Ruts, Other Concerns

Location

Notes/Causes **None**

2. Crest

ACCESS — ☐ ☒ ☐ ☐ ☐

Is there public access to the crest? YES

Is the crest marked or signed? NO

Is vehicle access to the crest restricted? NO

VEGETATION

Trees NO — ☐ ☒ ☐ ☐ ☐

Location

Notes

Brush NONE — ☐ ☒ ☐ ☐ ☐

Location

Notes

Ground Cover BARE — ☐ ☒ ☐ ☐ ☐

Quantity (bare/sparse/adequate/dense)

Appearance (too tall/too short/good)

Notes

EROSION NONE — ☐ ☒ ☐ ☐ ☐

Type (wave/runoff/unknown)

Length Width

Notes

SETTLEMENT NONE — ☐ ☒ ☐ ☐ ☐

Location

Notes/Causes

	Required Action				
	None	Monitor	Maintenance	Repair	Not Applicable
INSTABILITIES	☐	☒	☐	☐	☐
Cracks (Transverse/Longitudinal/Other) NONE					
Quantity ____ Length ____ Width ____					
Location ____					
Notes/Causes ____					
OTHER					
Burrows, Ruts, Other Concerns	☐	☒	☐	☐	☐
Location ____					
Notes/Causes ____					

3. Downstream Slope

VEGETATION	☐	☒	☐	☐	☐
Trees NO					
Location ____					
Notes ____					
Brush SPARSE	☐	☒	☐	☐	☐
Location ____					
Notes ____					
Ground Cover BARE	☐	☒	☐	☐	☐
Notes ____					
SLOPE PROTECTION	☐	☒	☐	☐	☐
Type NONE					
Notes ____					
EROSION	☐	☒	☐	☐	☐
Location NONE					
Notes ____					
INSTABILITIES NONE	☐	☒	☐	☐	☐
Slides Length ____ Width ____ Location ____					
Notes/Causes ____					
Cracks (Transverse/Longitudinal/Other) NONE	☐	☒	☐	☐	☐
Quantity ____ Length ____ Width ____					
Location ____					
Notes/Causes ____					
Bulges/Depressions/Hummocky NONE	☐	☒	☐	☐	☐
Size ____ Height ____ Depth ____					
Location ____					
Notes/Causes ____					
OTHER					
Burrows, Ruts, Other Concerns NONE	☐	☒	☐	☐	☐
Location ____					
Notes/Causes ____					
SEEPAGE	☐	☒	☐	☐	☐
Wet Area/Flow/Boil/Sinkhole Wet Area					
Flow Rate Low					
Location Left side of outlet, and along of abutment					
Aquatic Vegetation (Yes/No)					
Rust Colored Deposits (Yes/No)					
Sediment in Flow (Yes/No)					
Other ____					
Notes/Causes ____					
EMBANKMENT DRAINS NONE FOUND	☐	☐	☐	☐	☒
Type ____					
Flow rate ____ Size ____ Number ____					
Location ____					
Notes ____					
MONITORING INSTRUMENTATION CONDITION	☐	☐	☐	☐	☒
☑ None found ☐ Piezometers ☐ Weir ☐ Flume					
Notes ____					

	Required Action				
	None	Monitor	Maintenance	Repair	Not Applicable

Spillway

GENERAL CONDITIONS

Type ***Earthen Channel Spillway - Trapezoid Concrete Weir*** | | X | | | |

Notes ***South of Dam - Flowing South***

1. Spillway Crest or Control Section

OBSTRUCTION | | X | | | |

Debris ***Being cut when we were there.***

Location ***Open***

Notes ***No Log Boom***

Vegetation Sparse

Location ***Well maintained.***

Notes ***Lots of mosquitos***

Other (beaver activity, trash rack problems, etc.)

SPILLWAY CREST MATERIALS | | X | | | |

Condition ***Concrete - Trapezoidal***

Notes Spilling at time (approximately 15 cm)

OTHER SPILLWAY CREST PROBLEMS

Damage None | X | | | | |

Location

Notes/Cause

2. Spillway Conveyance Section: Channel, Chute or Conduit

OPEN CHANNEL CROSS SECTION | | X | | | |

CHANNEL OBSTRUCTION | | X | | | |

SPILLWAY CONVEYANCE MATERIALS | | X | | | |

OTHER SPILLWAY CONVEYANCE PROBLEMS

Damage No access to dam when spillway in operation. | | X | | | |

Location

Notes/Cause

3. Energy-Dissipating or Terminal Section

EROSION CONTROL STRUCTURE | | X | | | |

Type ***None***

Notes

Low Level Outlet

	Required Action				
	None	Monitor	Maintenance	Repair	Not Applicable
GENERAL	☐	☒	☐	☐	☐
Type ***Gated Pipe Structure*** ☐ None					
ACCESS TO VALVE/GATE	☒	☐	☐	☐	☐
☐ Not accessible ☑ From shore ☐ Walkway ☐ By boat ☐ Other					
Notes ***Locked - Not tested, but appears functional***					
Walkway Condition ***N/A***					
LOW LEVEL OUTLET COMPONENTS					
Valve Control Device	☐	☒	☐	☐	☐
☑ Yes ☐ None ☐ No Stem ☐ Damaged stem ☐ Other					
Other/Notes					
Operational?	☐	☐	☒	☐	☐
☑ Yes ☐ No ☐ Poorly ☐ Not tested					
Notes Some Leakage - Approximately 1/2 cfs					
Valve / Gate	☐	☒	☐	☐	☐
Location ***Slanted Gate***					
Condition ***Under water***					
Leakage ☑ Yes ☐ No	☐	☒	☐	☐	☐
Flow Rate **Negligible**					
Outlet Pipe	☐	☒	☐	☐	☐
☑ Metal ☐ Plastic ☐ Concrete ☐ Other					
Diameter ***600 mm***					
Condition ***Good condition***					
Outlet Obstruction (note vegetation, sediment blockage, etc.)					
Notes ***Sediment should be kept clear.***					
OUTLET EROSION CONTROL STRUCTURE	☐	☒	☐	☐	☐
Type ***Concrete***					
Concrete Condition ***Good***	☐	☒	☐	☐	☐
Outlet Area Seepage	☐	☒	☐	☐	☐
Description					
Flow Estimate					
Location					
Undermining	☐	☒	☐	☐	☐
Location ***End was clogged with rocks, but cleaned after.***					
Notes/Cause: **Was cleaned out while at the site.**					
Downstream Channel ***Channel cut into Bank, some sloughing***	☐	☐	☒	☐	☐
Free Draining? ***Yes***					
Blockages or Potential Blockages? ***Monitor***					
Erosion Control? Rip-Rap? ***Fair - Could use some maintenance***					

Dam Safety Inspection Checklist

Name of Dam	**Whitehead Lake**	Inspection Date	30-Apr-10	Observed Conditions
Current Weather:		Previous Week:		S- Satisfactory
Name of Creek, Stream, River	**Trout Creek**			F - Fair
Water Licence:				P - Poor
Owners Name	**The Corporation of the District of Summerland**			U - Unsatisfactory
Address	**13211 Henry Avenue**			Ni - Not Inspected
City	**Summerland**	Postal Code	**V0H 1Z0**	
Telephone	**250-404-3000**	Alternate Phone		
Email				

Pre-Inspection Interview with Owner

* See Past Reports or other File Information

Owner or Representative present?	**No**
How long have you owned the dam?	**1930's**
Any Prior problems?	**No**
Repairs or Modifications? (where, when)	**No**
Past Failures/Incidents/Breach?	**No**
Works Currently Fully Operational?	**Yes**

Design report and plans availabl **Yes** Dam Material Known? **Yes** Foundation? **Yes**

Was the dam designed by an Engineer? **Unknown** Company

Are dam construction details known? **Unknown** Where?

Downstream Consequence Classification - Current

Dam Safety Regulation **High** CDA Guidelines:

Dam Information

Type of Dam:	***Earth Embankment***	Max. Height of Dam:	**1440.73 m (5.67 m)**
Spillway Elevation:	***1439.59***	Spillway Width:	**5.79 m**
Freeboard (@full supply level)	***1.15 m***	Freeboard (at time of visit)	***1.2 m***
Reservoir Storage Volume	***1013 ML***	Licenced Storage Volume	***1134 ML (920 ac-ft)***

Dam Environment

Drainage Area Size		**540 ha**	Reservoir Area:	***44.8 ha***
Inflow Design Flood:	Q m^3/s	**13.5**	Flood AEP (Return Period)	**1:200**
Other Inflow Study:	Q m^3/s		Flood AEP (Return Period)	

Post Inspection Evaluation - Elaborate in the Inspection Report as required

Evaluate any new development in the inundation zone downstream				**No**	
Should new development initiate a review of the Consequence Classification?				**No**	
OMS Manual Current?	**Yes**	OMS Adequate?	**Yes**	OMS being followed?	**Yes**
EPP Manual Current?	Yes	EPP Adequate?	Yes	EPP being exercised?	**Yes**
DSR Required?		DSR completed date?	6/10	Deficiencies Addressed?	**No**
Site Access - site access adequate for safe operation and maintenance?					**Yes**
Any other concerns in the watershed that could impact the dam?					**No**

Inspected by: Rod MacLean, P. Eng. (Associated Engineering)
Gerald Imada, P. Eng. (Golder Associates)

	Required Action				
	None	Monitor	Maintenance	Repair	Not Applicable

Embankment Dam

1. Upstream Slope

VEGETATION — Monitor: X

Type **Sparse grass/brush** Location

Recommendations:

SLOPE PROTECTION — Monitor: X

Type None/Sparse/Dense Grass

Notes

EROSION — Monitor: X

Type (wave/runoff/unknown)

Length Width

Notes **Minor Wave**

INSTABILITIES — Monitor: X

Slides (Yes/No/Could not Inspect)

Length Width Location

Notes/Causes **None**

Cracks (Transverse/Longitudinal/Other) — Monitor: X

Quantity Length Width

Location

Notes/Causes **None**

Bulges/Depressions/Hummocky — Monitor: X

Size Height Depth

Location

Notes/Causes **None**

OTHER — Monitor: X

Burrows, Ruts, Other Concerns

Location

Notes/Causes **None**

2. Crest

ACCESS — Monitor: X

Is there public access to the crest? YES

Is the crest marked or signed? NO

Is vehicle access to the crest restricted? NO

VEGETATION

Trees NO — Monitor: X

Location

Notes

Brush NONE — Monitor: X

Location

Notes

Ground Cover BARE — Monitor: X

Quantity (bare/sparse/adequate/dense)

Appearance (too tall/too short/good)

Notes

EROSION NONE — Monitor: X

Type (wave/runoff/unknown)

Length Width

Notes

SETTLEMENT NONE — Monitor: X

Location

Notes/Causes

	Required Action				
	None	Monitor	Maintenance	Repair	Not Applicable
INSTABILITIES	☐	☒	☐	☐	☐
Cracks (Transverse/Longitudinal/Other) NONE					
Quantity ____ Length ____ Width ____					
Location ____					
Notes/Causes ____					
OTHER					
Burrows, Ruts, Other Concerns	☐	☒	☐	☐	☐
Location ____					
Notes/Causes ____					

3. Downstream Slope

VEGETATION	☐	☒	☐	☐	☐
Trees NO					
Location ____					
Notes ____					
Brush SPARSE	☐	☒	☐	☐	☐
Location ____					
Notes ____					
Ground Cover BARE	☐	☒	☐	☐	☐
Notes ____					
SLOPE PROTECTION	☐	☒	☐	☐	☐
Type Grass					
Notes Some cobbles and boulders					
EROSION	☐	☒	☐	☐	☐
Location NONE					
Notes ____					
INSTABILITIES NONE	☐	☒	☐	☐	☐
Slides Length ____ Width ____ Location ____					
Notes/Causes ____					
Cracks (Transverse/Longitudinal/Other) NONE	☐	☒	☐	☐	☐
Quantity ____ Length ____ Width ____					
Location ____					
Notes/Causes ____					
Bulges/Depressions/Hummocky NONE	☐	☒	☐	☐	☐
Size ____ Height ____ Depth ____					
Location ____					
Notes/Causes ____					
OTHER					
Burrows, Ruts, Other Concerns NONE	☐	☒	☐	☐	☐
Location ____					
Notes/Causes ____					
SEEPAGE	☐	☒	☐	☐	☐
Wet Area/Flow/Boil/Sinkhole WET AREA					
Flow Rate ____					
Location COULD BE SNOWMELT					
Aquatic Vegetation (Yes/No)					
Rust Colored Deposits (Yes/No)					
Sediment in Flow (Yes/No)					
Other ____					
Notes/Causes ____					
EMBANKMENT DRAINS NONE FOUND	☐	☐	☐	☐	☒
Type ____					
Flow rate ____ Size ____ Number ____					
Location ____					
Notes ____					
MONITORING INSTRUMENTATION CONDITION	☐	☐	☐	☐	☒
☑ None found ☐ Piezometers ☐ Weir ☐ Flume					
Notes ____					

	Required Action				
	None	Monitor	Maintenance	Repair	Not Applicable
Spillway					
GENERAL CONDITIONS					
Type ***Earthen Channel Spillway - Concrete Spton***	☐	☒	☐	☐	☐
Notes ***East side of dam - Flowing North***					
1. Spillway Crest or Control Section					
OBSTRUCTION	☐	☒	☐	☐	☐
Debris ***Little***					
Location ***Some logs and debris lodged in Channel***					
Notes					
Vegetation Sparse					
Location ***Well maintained.***					
Notes					
Other (beaver activity, trash rack problems, etc.)					
No Log Boom					
SPILLWAY CREST MATERIALS	☐	☒	☐	☐	☐
Condition ***Concrete - Trapezoidal***					
Notes Maintains water level.					
OTHER SPILLWAY CREST PROBLEMS					
Damage ***No access to dam when spillway in operation***	☒	☐	☐	☐	☐
Location Water spilling - approx .5 m above spillway					
Notes/Cause					
2. Spillway Conveyance Section: Channel, Chute or Conduit					
OPEN CHANNEL CROSS SECTION	☐	☒	☐	☐	☐
CHANNEL OBSTRUCTION	☐	☒	☐	☐	☐
SPILLWAY CONVEYANCE MATERIALS	☐	☒	☐	☐	☐
OTHER SPILLWAY CONVEYANCE PROBLEMS					
Damage No access to dam when spillway in operation.	☐	☒	☐	☐	☐
Location					
Notes/Cause					
3. Energy-Dissipating or Terminal Section					
EROSION CONTROL STRUCTURE	☐	☒	☐	☐	☐
Type ***None***					
Notes					

Low Level Outlet

	Required Action				
	None	Monitor	Maintenance	Repair	Not Applicable
GENERAL	☐	☒	☐	☐	☐
Type ***Gated Pipe Structure*** ☐ None					
ACCESS TO VALVE/GATE	☒	☐	☐	☐	☐
☐ Not accessible ☑ From shore ☐ Walkway ☐ By boat ☐ Other					
Notes ***Locked - Not tested, but appears functional***					
Walkway Condition ***N/A***					
LOW LEVEL OUTLET COMPONENTS					
Valve Control Device	☐	☒	☐	☐	☐
☑ Yes ☐ None ☐ No Stem ☐ Damaged stem ☐ Other					
Other/Notes					
Operational?	☐	☒	☐	☐	☐
☑ Yes ☐ No ☐ Poorly ☐ Not tested					
Notes Some Leakage					
Valve / Gate	☐	☒	☐	☐	☐
Location ***Slanted Gate***					
Condition ***Under water***					
Leakage ☑ Yes ☐ No	☐	☒	☐	☐	☐
Flow Rate **Negligible**					
Outlet Pipe	☐	☒	☐	☐	☐
☐ Metal ☐ Plastic ☑ Concrete ☐ Other					
Diameter ***600 mm***					
Condition ***Good condition***					
Outlet Obstruction (note vegetation, sediment blockage, etc.)					
Notes					
OUTLET EROSION CONTROL STRUCTURE	☐	☒	☐	☐	☐
Type ***Concrete***					
Concrete Condition ***Poor - Cracked and failed wingwalls on end***	☐	☐	☐	☒	☐
Outlet Area Seepage	☐	☐	☐	☒	☐
Description ***Some seepage, including filter pipe***					
Flow Estimate					
Location At outlet					
Undermining	☐	☐	☐	☒	☐
Location ***Embankment is pressuring against the structure.***					
Notes/Cause: Riprap has shifted as well.					
Downstream Channel ***Channel cut into woods. Some seepage***	☐	☐	☐	☒	☐
Free Draining? ***Yes***					
Blockages or Potential Blockages? ***Monitor***					
Erosion Control? Rip-Rap? ***Needs work***					

REPORT

Appendix B – Hydraulics Calculations

Hydraulic Analysis (Background information for Tables 6-2 and 6-3 in Report)

The Rational Formula equation used to calculate the IDF discharge is:

$$Q_{pIDF} = \frac{0.28\,CPA}{T_c} \qquad \text{(Coulson, 1991)}$$

$$T_c = \frac{(nL)^{0.467}}{1.65\,S^{0.234}}$$

where:

Q_{pIDF} = IDF discharge (m^3/s);
C = runoff coefficient (dimensionless);
P = total precipitation occurring within the time-of-concentration (mm), during the maximum precipitation;
A = drainage area (km^2); and
T_c = time-of-concentration (hrs).
n = Roughness coefficient
L = Watershed Length (km)
S = Watershed Slope

TABLE 3. Runoff Coefficient (C)

SURFACE COVER / PHYSIOGRAPHY	IMPER-MEABLE	FORESTED	AGRICUL-TURAL	RURAL	URBAN
mountain	1.00	0.90	-	-	-
steep slope	0.95	0.80	-	-	-
moderate slope	0.90	0.65	0.50	0.75	0.85
rolling terrain	0.85	0.50	0.40	0.65	0.80
flat	0.80	0.40	0.30	0.55	0.75
RI 10-25 years	+0.05	+0.02	+0.07	+0.05	+0.05
RI > 25 years	+0.10	+0.05	+0.15	+0.10	+0.10
Snowmelt	+0.10	+0.10	+0.10	+0.10	+0.10

C Factor Derivation (Lindsey et al. 1992)

TABLE 4. Roughness Coefficient (n)

SURFACE COVER	n
smooth impervious	0.02
smooth bare packed soil	0.10
poor grass, row crops	0.20
rough bare soil	0.30
pasture or range land	0.40
deciduous timber land	0.60
coniferous timber land	0.70
timber land with deep litter	0.80

Table 1: Runoff coefficients for the Rational method

Hydrologic Soil Group	A			B			C			D		
Recurrence Interval	5	10	100	5	10	100	5	10	100	5	10	100
Land Use Or Surface Characteristics												
Business:												
A. Commercial Area	.75	.80	.95	.80	.85	.95	.80	.85	.95	.85	.90	.95
B. Neighborhood Area	.50	.55	.65	.55	.60	.70	.60	.65	.75	.65	.70	.80
Residential:												
A. Single Family	.25	.25	.30	.30	.35	.40	.40	.45	.50	.45	.50	.55
B. Multi-Unit (Detached)	.35	.40	.45	.40	.45	.50	.45	.50	.55	.50	.55	.65
C. Multi-Unit (Attached)	.45	.50	.55	.50	.55	.65	.55	.60	.70	.60	.65	.75
D. 1/2 Lot Or Larger	.20	.20	.25	.25	.25	.30	.35	.40	.45	.40	.45	.50
E. Apartments	.50	.55	.60	.55	.60	.70	.60	.65	.75	.65	.70	.80
Industrial												
A. Light Areas	.55	.60	.70	.60	.65	.75	.65	.70	.80	.70	.75	.90
B. Heavy Areas	.75	.80	.95	.80	.85	.95	.80	.85	.95	.80	.85	.95
Parks, Cemeteries												
Playgrounds	.10	.10	.15	.20	.20	.25	.30	.35	.40	.35	.40	.45
Schools	.30	.35	.40	.40	.45	.50	.45	.50	.55	.50	.55	.65
Railroad Yard Areas	.20	.20	.25	.30	.35	.40	.40	.45	.45	.45	.50	.55
Streets												
A. Paved	.85	.90	.95	.85	.90	.95	.85	.90	.95	.85	.90	.95
B. Gravel	.25	.25	.30	.35	.40	.45	.40	.45	.50	.40	.45	.50
Drives, Walks, &												
Roofs	.85	.90	.95	.85	.90	.95	.85	.90	.95	.85	.90	.95
Lawns												
A. 50%-75% Grass												
(Fair Condition)	.10	.10	.15	.20	.20	.25	.30	.35	.40	.30	.35	.40
B. 75% Or More Grass												
(Good Condition)	.05	.05	.10	.15	.15	.20	.25	.25	.30	.30	.35	.40
Undeveloped Surface[1] (By Slope)[2]												
A. Flat (0-1%)	0.04-0.09			0.07-0.12			0.11-0.16			0.15-0.20		
B. Average (2-6%)	0.09-0.14			0.12-0.17			0.16-0.21			0.20-0.25		
C. Steep	0.13-0.18			0.18-0.24			0.23-0.31			0.28-0.38		

[1] Undeveloped Surface Definition: Forest and agricultural land, open space.
[2] Source: Storm Drainage Design Manual, Erie and Niagara Counties Regional Planning Board.

Runoff coefficient. The runoff coefficient (C) represents the integrated effects of infiltration, evaporation, retention, flow routing, and interception; all of which affect the time distribution and peak rate of runoff. The runoff coefficient is the variable of the Rational method least-susceptible to precise determination and requires judgment and understanding on the part of the designer. While engineering judgment will always be required in the selection of runoff coefficients, a typical coefficient represents the integrated effects of many drainage basin parameters. The Engineer should realize that the C values shown in Table 1 are typical values, and may have to be adjusted if the site deviates from typical conditions such as an increase or decrease in percent impervious.

The values are presented for different surface characteristics, as well as for different aggregate land uses. The coefficient for various surface areas can be used to develop a composite value for a different land use. The runoff values for business, residential, industrial, schools, and railroad yard areas are an average of all surfaces typically found in the particular land use.

The hydrologic soil groups, as defined by NRCS soil scientists and used in Table 1 are:

a. **Group A.** Soils having low runoff potential and a high infiltration rate, even when thoroughly wetted, consisting chiefly of deep, well- to excessively well-drained sands or gravels.

b. **Group B.** Soils having a moderate infiltration rate when thoroughly wetted, consisting chiefly of moderately-deep to deep, moderately-well to well-drained soils, with moderately-fine to moderately-coarse texture.

c. **Group C.** Soils having a slow infiltration rate when thoroughly wetted, consisting chiefly of soils with a layer that impedes downward movement of water or soils with moderately-fine to fine texture.

d. **Group D.** Soils having high runoff potential and a very slow infiltration rate when thoroughly wetted, consisting chiefly of clay soils with a high swelling potential, soils with a

5. **Adjustment of C values.** For larger storm events (less-frequent, higher-intensity storms), use multipliers in Table 2 to adjust the 5-year C values.

Table 2: Frequency factors for Rational formula

Recurrence Interval (years)	C_f
25	1.1
50	1.2
100	1.25

1000 1.5

For the Summerland dams IDF, the C value was examined in Table 3 in Coulson (1991) which expresses C as a function of the surface cover (impermeable, forested, agricultural, rural, or urban) and physiography (mountain, steep slope, moderate slope, rolling terrain, or flat). This table is inconsistent with other C values derived from the US Corps of Engineers and state C factors (as suggested table above. The C factor is therefore calculated (somewhat conservatively) using the process above. We have also included a measure for melting snow's contribution to the runoff event by adding a constant (0.10) to the runoff coefficient. For T_c, the value was taken from Figure 1 in Coulson (1991); in which curves relating T_c to A are presented for different physiographic classifications. The value of P was taken from the intensity-duration-frequency (IDF) curve developed for Summerland (Environment Canada 2010) extrapolated to the required storm rainfall intensity. Table 7-2 presents the parameters used and the estimated IDF discharge.

	Trout Creek Watershed						Garnet Valley Watershed	
	HW 1	HW 2-4	Crescent	Whitehead	Isintok	Tsuh	Aeneas	Garnett
A (ha)	1,918	500	1,554	540	1,640	244	310	10,000
A (km^2)	19.2	5.0	15.5	5.4	16.4	2.4	3.1	100.0
L (m)	6,650	6,650	2,000	2,000	4,260	1,000	2,000	16,000
L (km)	6.7	6.7	2.0	2.0	4.3	1.0	2.0	16.0
n	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80
S	0.069	0.069	0.020	0.106	0.223	0.143	0.100	0.040
C	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
C_{100}	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31
C_{1000}	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38
Tc (hr)	2.5	2.5	1.9	1.3	1.5	0.9	1.3	4.2
Tc (min)	149	149	113	77	92	52	78	254
i_{100} (mm/h)	9	9	11	17	14	19	17	7
i_{1000} (mm/h)	26	26	31	34	38	52	42	18
P_{100} (mm)	22	22	21	22	21	16	22	28
P_{1000} (mm)	64	64	58	43	58	45	54	76
Capacities from Rational Equation (m^3/s)								
$Q_{Rational\ 1:100}$	15.1	3.9	15.0	8.0	20.1	4.1	4.6	58.6
$Q_{Rational\ 1:1000}$	52.4	13.7	50.6	19.3	65.4	13.3	13.7	189.0
Other estimates for 1:200 storm from past designs or studies (m^3/s)								
$Q_{0.93\ m3/s/km2}$	17.8	4.7	14.5	5.0	15.3	2.3	2.9	93.0
$Q_{50cfs/mi2}$	10.5	2.7	8.5	3.0	9.0	1.3	1.7	54.7
$Q_{Hay\&Co\ 1:200}$								11.4
Other estimates for 1:1000 storm from past designs or studies (m^3/s)								
$Q_{228cfs/mi2\text{-}Coulson(1973)}$	47.8	12.5	38.7	13.5	40.9	6.1	7.7	
$Q_{150cfs/mi2}$	31.5	8.2	25.5	8.9	26.9	4.0	5.1	164.0
$Q_{BCHydro\text{-}LOW}$	51.8	13.5	42.0	14.6	44.3	6.6	8.4	270.0
$Q_{BCHydro\text{-}HIGH}$	57.5	15.0	46.6	16.2	49.2	7.3	9.3	300.0
Recommended IDF - 2010	15.1	3.9	15.0	8.0	40.9	4.1	4.6	164.0
Volume of Runoff (Q . T_c) (m^3)	134,590	35,090	101,530	36,910	224,620	12,580	21,480	2,499,410

Structure Hydraulic Analysis

	Hazard Classification	IDF	Weir Type	Base Weir Length (m)	Estimated Capacity: Maximum Q_c (m^3)	Estimated Capacity: Depth of Spillway (m)	Required Capacity: IDF Q_r (m^3/s)	Required Capacity: Minimum Depth d_r (m)	Comments
Headwaters 1	Very Low	1:100	Rectangular	9.14	32.2	1.53	15.0	0.92	Ok
Headwaters 2	Very Low	1:100	Trapezoid	3.00	15.8	1.57	3.9	1.40	Ok
Headwaters 3	Very Low	1:100	Trapezoid	2.40	15.8	1.57	3.9	1.40	Ok
Headwaters 4	Very Low	1:100	Trapezoid	3.00	15.8	1.57	3.9	1.40	Ok
Crescent Lake	Very Low	1:100	Rectangular	8.50	24.5	1.34	15.0	0.97	Ok
Isintok	High	1:1000	Rectangular	4.00	41.0	3.12	40.9	3.14	Requires Further Review
Whitehead	Very Low	1:100	Trapezoid	5.79	21.5	1.15	8.0	0.51	Ok
Garnett Dam	High	1:1000	Cipolletti	12.20	70.0	2.12	164.0	3.74	Requires Further Review
Aeneas	Very Low	1:100	Rectangular	4.57	11.2	1.20	4.6	0.67	Ok
Tsuh Dam	Very Low	1:100	Trapezoid	3.00	10.9	1.07	4.1	0.79	Ok
Intake Dam	High	N/A	None						N/A

IDF - Inflow Design Flood
Current assumes maximum spillway capacity without overtopping the dam but using the full freeboard.
Weir Types:

	Equation (cfs)	
Cipolletti	$Q = 3.367\ L\ H^{3/2}$	
Rectangular	$Q = 3.33\ L\ H^{3/2}$	
Trapezoid	$v = R^{2/3}\ S^{1/2}$	C
	$Q = vA$	3.367
		3.33

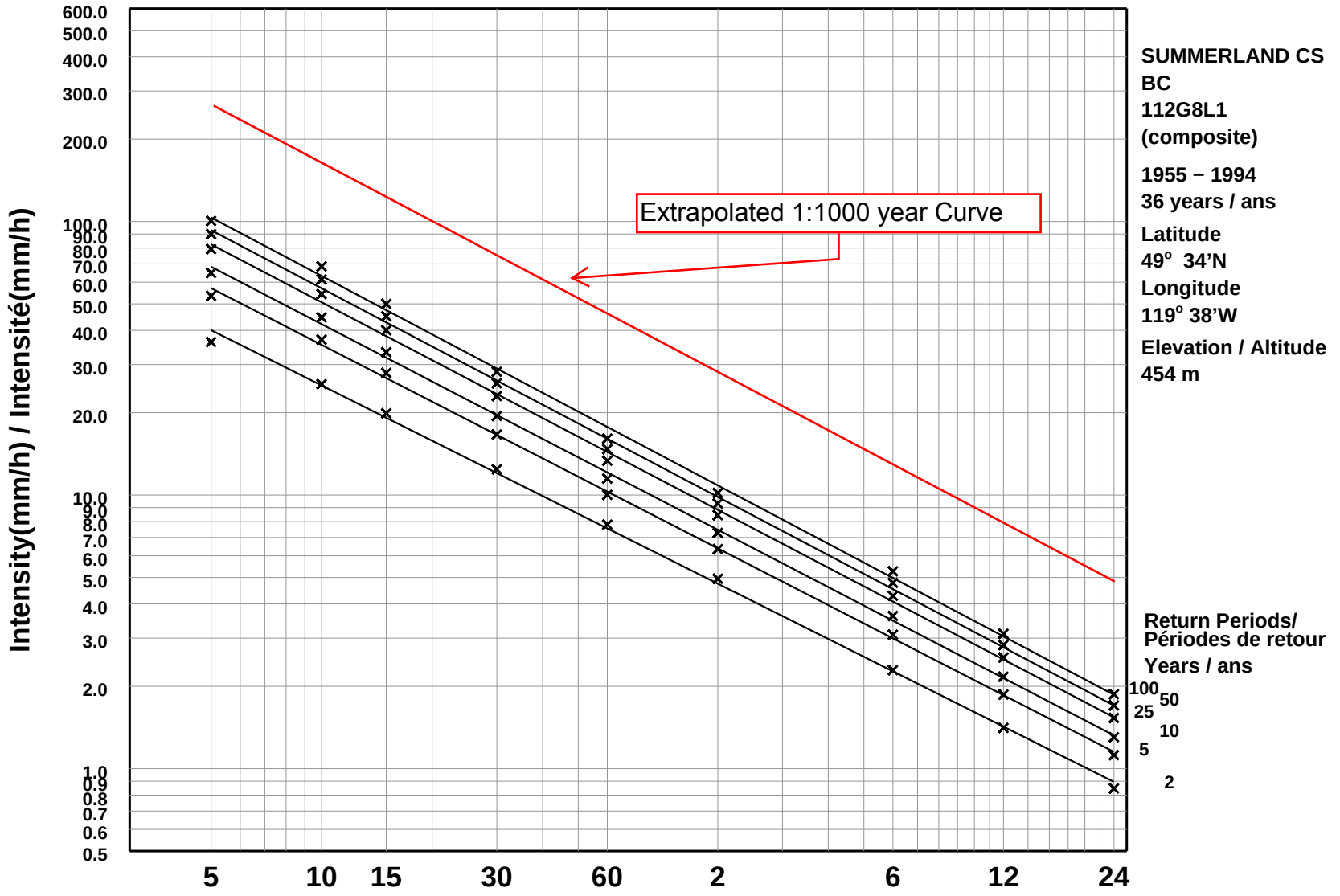
Trapezoid Spillway Channel Parameters

	Units	Tsuh	Whitehead	Headwaters 2,3 & 4
n		0.04	0.04	0.04
S		0.01	0.01	0.01
b	m	3	5.79	2
Freeboard	m	1.07	1.15	1.57
Z		2	2.273	1.5
A	m^2	5.50	9.66	6.84
wp	m	7.79	11.50	7.66
R	m	0.71	0.84	0.89
v	m/s	1.98	2.23	2.32
Q	m^3/s	10.91	21.51	15.85

Short Duration Rainfall Intensity−Duration−Frequency Data

2010/04/13

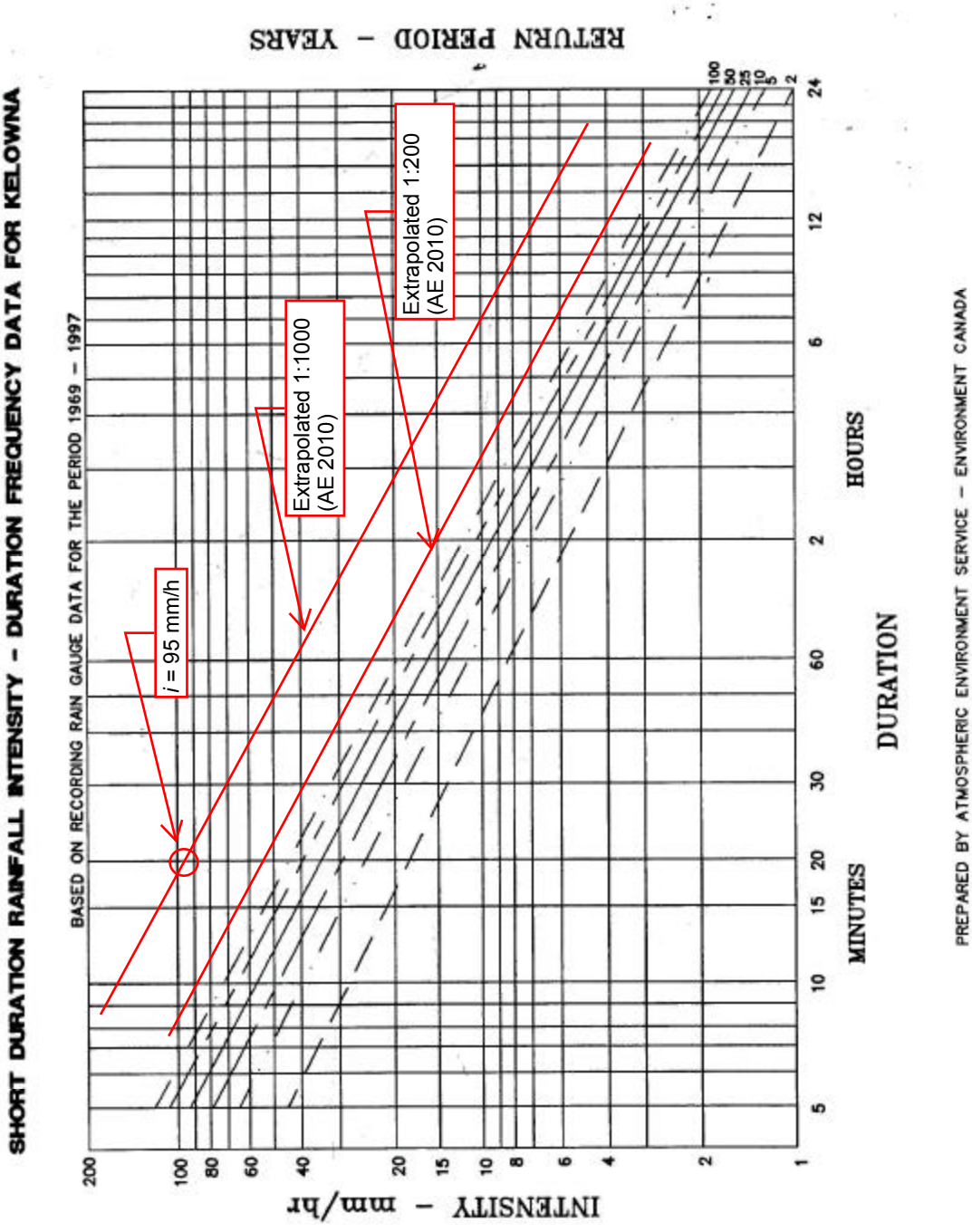
Données sur l'intensité, la durée et la fréquence des chutes de pluie de courte durée



Environment Canada Environnement Canada

Canada

STANDARD DETAIL DRAWINGS



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IDF CURVES

DATE: MAY08/02

SS-S56

District of Summerland Dam Safety Review _ Hazard Consequence Table

Dam		Consequences of Failure		Site Inspection	Owner Interview	Data & Records			Dam Safety Management			Public Security or Safety
	Existing Hazard Classification	Potential Downstream Affected Areas following a breach	Consequences			Inundation Study or Mapping?	OMS Manuals	EPP/ ERP?	New Revised Hazard Classification	EPP/ERP?	Recommended IDF	
Headwaters No. 1 Dam	Very Low	Upper Trout Creek Minor Forestry Roads Flow into Trout Creek upstream of Thirsk Dam	Breaches Minor Water Quality Issues in Thirsk Dam Extreme low risk of Thirsk Dam failure.	√	√	No	No - in files only	Yes	Very Low	Reviewed every 10 years	1:100 to 1:1000	Minor local issues
Headwaters No. 2 Dam	Very Low	Upper Trout Creek Flows into Headwaters 1	Potential damage issues with Headwaters 1	√	√	No	No - in files only	Yes	Very Low	Reviewed every 10 years	1:100 to 1:1000	Negligible Risk
Headwaters No. 3 Dam	Very Low	Upper Trout Creek Flows into Headwaters 1	Potential damage issues with Headwaters 1	√	√	No	No - in files only	Yes	Very Low	Reviewed every 10 years	1:100 to 1:1000	Negligible Risk
Headwaters No. 4 Dam	Very Low	Upper Trout Creek Flows into Headwaters 1	Potential damage issues with Headwaters 1	√	√	No	No - in files only	Yes	Very Low	Reviewed every 10 years	1:100 to 1:1000	Negligible Risk
Whitehead Reservoir Dam	Very Low	Upper Trout Creek Flow from breach enters upstream of Thirsk Dam	Minor forestry road failures. Minor Water Quality Issues in Thirsk Dam Extreme low risk of Thirsk Dam failure.	√	√	No	No - in files only	Yes	Very Low	Reviewed every 10 years	1:100 to 1:1000	Negligible Risk
Isintok Dam	High	Isintok Creek 12 km away from Trout Creek Isintok Creek Bed Secondary Forest Service Road Princeton-Summerland Highway Okanagan Lake (34 km) Highway 97	Short term compromise to Summerland water supply Significant Erosion Reconstruction Likely Negligible Negligible Negligible	√	√	No	No - in files only	Yes	High	Reviewed every 10 years	0.736111111	Negligible Risk
Crescent Dam	Very Low	Upper Trout Creek		√	√	No	No - in files only	Yes	Very Low	Reviewed every 10 years	1:100 to 1:1000	Negligible Risk
Tsuh (Deer) Reservoir Dam	Very Low	Extremely difficult access 4 km to Forest Road Crossing Additional 2.5 km to Trout Creek	Machinery repair Evacuations by helicopter only. Likely culvert and road failure Downstream of Thirsk. Short term compromise to Summerland water supply	√	√	No	No - in files only	Yes	Very Low	Reviewed every 10 years	1:100 to 1:1000	None
Aeneas Reservoir Dam	Very Low	Extremely difficult access Garnett Valley Reservoir	Machinery repair Evacuations by helicopter only. Negligible effects from Breach. Too little water.	√	√	No	No - in files only	Yes	Very Low	Reviewed every 10 years	1:100 to 1:1000	None
Garnett Reservoir Dam	High	Garnett Dam Access Road Garnett Valley Road Houses along Garnett Creek flood plain starting at 3.4 km from dam. Water Supply to area	Failure likely Significant Risk of failure along creek bed. Significant Risk of damage and loss of life. Significant compromise to Summerland water supply along Garnett Valley.	√	√	No	No - in files only	Reviewed every 5 years	High	Reviewed every 5 years	PMF - Sunny Day Breach - Full Reservoir Condition	Significant - Water Supply Cutoff to 2000 population.
Summerland Reservoir	N/A	No Spillway Sunny Day Failure: ie. Broken Gate on River System Houses and Agricultural Property	Low Risk - Only scenario where overtopping can occur. Potential Loss of Life Potential Loss of Agricultural Land	√	√	High	No - in files only	Reviewed every 5 years	Very High None	Reviewed every 5 years	PMF	Significant - Water Supply Cutoff to Summerland

Appendix C - Photos

1. Headwaters No.1

Photo 1.1. U/S Slope of dam – Good condition

Photo 1.2. Emergency Spillway – Concrete is structurally sound. Note backfill needs and brush removal on far abutment.

Headwaters No.1 (Cont'd)

Photo 1.3. Low Level Outlet Structure

Photo 1.4. General Note: D/S Berm constructed in 2000.

2. Headwaters No. 2

Photo 2.1 Slopes of dam – Good condition

Photo 2.2 Emergency Spillway – Good condition. Requires monitoring for excessive public access and placement of logs and bridges.

Headwaters No. 2 (Cont'd)

Photo 2.3 Low Level Outlet Structure – Deflection in outlet of CSP pipe. Monitor for further deflections or failure. Requires more frequent exercise to clear dirt and debris.

Photo 2.4. General Note: Outlet Structure in good shape. .

3. Headwaters No. 3

Photo 3.1 Low Level Outlet – Backfill and replacement of riprap required around structure. Rocks, debris and dirt clog outlet.

Photo 3.2 Emergency Spillway – Signs of significant use. Channel requires shaping. Potential for log jam is high.

Headwaters No. 3 (Cont'd)

Photo 3.3 Low Level Outlet Structure – parabolic channel in good condition. Requires more frequent exercise to clear dirt and debris.

Photo 3.4. General Note: Low Level Gate in fair condition.

4. Headwaters No. 4

Photo 4.1 U/S Slope of dam – Good condition. Note old log boom.

Photo 4.2 Emergency Spillway – Not well defined. Channel requires shaping. Some minor potential for log jams.

Headwaters No. 4 (Cont'd)

Photo 4.3 Low Level Outlet Structure – Backfill and riprap should be maintained. Rock was plugging outlet at time of inspection. Requires more frequent exercise to clear dirt and debris.

Photo 4.4. General Note: Concrete Conduit in good condition.

5. Crescent Reservoir

Photo 5.1 U/S Slope of dam – Fair-Good condition. Note old vertical intake pipe.

Photo 5.2 Emergency Spillway – Operational. Log boom operational. Required minor cleaning and debris removal.

Crescent Reservoir (Cont'd)

Photo 5.3 Low Level Outlet Structure – Earth backfill is sloughing over the concrete outlet. Brush has been removed. Maintenance required, including additional riprap.

Photo 5.4. General Note: Old outlet structure has minor leakage. Frequent monitoring recommended.

6. Whitehead Reservoir

Photo 6.1 Looking across spillway and along center of dam. Water level was at or over FSL at inspection. Difficult to cross to visit dam.

Photo 6.2 Emergency Spillway Channel – Operational. Channel maintenance and cleaning required on a regular basis.

Whitehead Reservoir (Cont'd)

Photo 6.3 Low Level Outlet Structure – Concrete has failed in all directions. Earth sloughing.

Photo 6.4. General Note: Concrete failure and significant Seepage.

7. Aeneas Reservoir

Photo 7.1 D/S abutment. Note low level outlet on right.

Photo 7.2 Emergency Spillway. Significant earth slouging and lack of riprap on both sides of vertical walls. Concrete failed in several locations.

Aeneas Reservoir (Cont'd)

Photo 7.3 Low Level Outlet – concrete in good shape. Backfill and riprap require maintenance around structure. Some earth sloughing. Clean out of debris required.

Photo 7.4. Emergency Spillway: Brush intrusion, earth sloughing, excess debris and concrete failures.

8. Tsuh Reservoir

Photo 8.1 Looking at U/S face of dam and spillway. Inspection is after 800 m hike through steep forest.

Photo 8.2 Emergency Spillway. Channel through dam. Minor brush removal required. (Performed during site visit). Note concrete entrance. No log boom.

Tsuh Reservoir (Cont'd)

Photo 8.3 Low Level Outlet – concrete in good shape. Backfill and riprap require maintenance around structure. Some earth sloughing. Maintenance was performed during inspection.

Photo 8.4 Low Level Outlet – Corrugated Steel pipe in fair condition.

9. Isintok Reservoir

Photo 9.1 Significant footprints and traffic marks on gravelly sand material. Crest or road is undefined. Note gravel pit is popular motocross location.

Photo 9.2 Low Level Outlet gate – Adjustment of backfill required to operate gate.

Isintok Reservoir (Cont'd)

Photo 9.3 Low Level Outlet – concrete in good shape. Some seepage from abutment at structure. Some flow. Note water, but no flow from outlet.

Photo 9.4 Emergency Spillway – Log Boom, channel in good condition.

10. Summerland Reservoir

Photo 10.1 U/S pond level. Additional crest protection (note vehicle)

Photo 10.2 From top of dam. Pond elevation is maintained approximately 3 m below top of dam. No emergency spillway.

Summerland Reservoir (Cont'd)

Photo 10.3 Summerland intake control buildings.

Photo 10.4 Groundwater intrusion along left edge of pond. Not part of dam.

11. Garnett Reservoir

Photo 11.1 U/S Embankment – 1:1 slope, no riprap. Some erosion at base.

Photo 11.2 D/S Embankment – Steep slope. Riprap is not well defined.

Garnett Reservoir (Cont'd)

Photo 11.3 Emergency Spillway – Concrete spillway. Some shifting and cracking in concrete. Minor debris. Note road and safety fence.

Photo 11.4 Emergency Spillway – Access Road and culvert. Good riprap cover. Culvert and road would likely be destroyed in a major storm event.

Garnett Reservoir (Cont'd)

Photo 11.5 Low Level Outlet – Handwheel requires replacement.

Photo 11.6 Low Level Outlet. Good condition. Seepage flow is from drain outlet beside the structure.

REPORT

Appendix D – Dam Safety Guidelines

BRITISH COLUMBIA
The Best Place on Earth

Interim Consequence Classification Policy For Dams in British Columbia

February 2010

Background

In 1999 the Canadian Dam Association (CDA) published Dam Safety Guidelines to establish safety requirements for new and existing dams, enable the consistent evaluation of dam safety deficiencies and to provide a basis for dam safety legislation and regulation. The 1999 CDA Guidelines defined 4 dam classifications in Table 1-1, "Classification of Dams in terms of Consequence of Failure". In February 2000, the BC Dam Safety Regulation, under the *Water Act* of BC, was enacted. The BC Dam Safety Regulation also defined 4 dam classifications in Schedule 1, "Downstream Consequence Classification Guide". The two systems are similar; both use the same classification names, but Schedule 1 defines the classifications in greater detail than Table 1-1. An important distinction to note is that Dam Safety Regulation classifications are for **dam owner** requirements and the CDA Guidelines classifications are for **dam design** criteria.

The Water Stewardship Division has assigned consequence classifications to most of the 1,980 dams in BC based on available information and using Schedule 1. Many dam owners or their engineering consultants have undertaken dam break inundation studies which have confirmed the consequence classifications or provided evidence for a revised classification. As of June 2008, the numbers of dams in the 4 consequence classifications is as follows: Very High – 31, High – 257, Low – 498, Very Low or not regulated[1] – 1194.

Canadian Dam Association 2007 Dam Safety Guidelines

The CDA Guidelines were completely rewritten and published in 2007 along with a binder of Technical Bulletins. One important change is the new consequence classification system as described in Table 2-1 "Dam Classification". Table 2-1 describes 5 new consequence classifications that are described in more detail than the 1999 CDA Table 1-1. It is possible to make a reasonably good conversion table between the new CDA Classification table and Schedule 1 in the Dam Safety Regulation. Please see the comparison table attached.

[1] These dams would be one of the following: too small, removed, not yet constructed or unclassified.

Ministry of Environment	Dam Safety Section Management and Standards Branch Water Stewardship Division	Mailing Address: PO Box 9340 Stn Prov Govt Victoria BC V8W 9M1 Telephone: 250-387-3263 Facsimile: 250-952-6792	Location: 3rd Floor, 395 Waterfront Cres Victoria BC V8T 5K7

Consequence Classifications BC Dam Safety Regulation	Loss of Life		*Persons at Risk (CDA Only)*	Economic and Social Losses[2]		Environmental and Cultural Losses		Consequence Classifications CDA 2007
	BC Reg.[3]	CDA		BC Reg.[4]	CDA	BC Reg.	CDA	
Very High	>100	>100	*Permanent Residents*	>$100M Very High Infrastructure; Public, Commercial, Residential	Extreme - Critical Infrastructure or Services	Nationally & Provincially Important Habitat & Sites - Restoration Chance Low	Major Loss of Critical Habitat - No Restoration Possible	**Extreme**
High (High[5])	< 100	< 100		< 100M Substantial Infrastructure; Public, Commercial	Very High - Important Infrastructure or Services	Same as Above but Restoration Chance High	Significant Loss of Critical Habitat - Restoration Possible	**Very High**
High (Low[5])	< 10	< 10		< $10M Same as Above	High – Infrastructure, Public Trans & Commercial	Same as Above	Significant Loss of Important Habitat - Restoration Possible	**High**
Low	Some Possible	Unspecified[6]	*Temporary Only*	< $1M Limited Infrastructure; Public, Commercial	Temporary & Infrequent	Regionally Important Habitat & Sites - Restoration Chance High	No Significant Loss of Habitat - Restoration Possible	**Significant**
Very Low	Minimal	0	*None*	< $100K Minimal	Low	No Significant Loss of Habitat or Sites	Minimal Short Term Loss	**Low**

[2] CDA name this category „Infrastructure & Economics"
[3] Conservative estimate of loss of life amongst population affected by the flood waters (may equal Population at Risk)
[4] Dollar values from year 2000
[5] Internal "High" sub-classification used for Dam Safety Program risk-based assessment.
[6] Significant category may not always line up with Low (BC Reg). A temporary population (e.g. in recreation al areas) could be quite large and a "sunny-day" failure could result in multiple fatalities.

Interim Policy for using both classification systems

The Water Stewardship Division (WSD) may recommend that the 2007 CDA Dam Safety Guidelines consequence classification system be incorporated into the Dam Safety Regulation if that regulation is revised. For the time being, the interim policy on the application of the Regulation with respect to the revised 2007 CDA guidelines has 2 parts as follows:

1. For the purpose of undertaking Dam Safety Reviews (by review engineers) and plans review for new and existing dams (by the Dam Safety Officers) the dams should be classified under both the Dam Safety Regulation and the 2007 CDA Dam Safety Guidelines. The attached comparison chart shows how the WSD interprets the two different classifications and where the 2 consequence classification ratings align. Dam review engineers may use their discretion when they assign consequence classifications based on the 2 systems.

2. Until further notice, for the purpose of reviewing dam design criteria only, the 1999 CDA Guidelines may be used for dams constructed before 2008 (see CDA 1999 Tables 5-1 & 6-1). The main reason for this policy is the change in the Inflow Design Flood (IDF) and Maximum Design Earthquake[7] (MDE) recommended for the "High" consequence dams in the 2007 CDA Guidelines (see CDA 2007 Table 6-1). The 2007 CDA Guidelines suggest 3 classes where a permanent population is at risk (High, Very High and Extreme). For dams where less than 10 people are at risk (High), this results in a recommendation for a more conservative IDF and MDE than the 1999 guidelines. Some owners of dams classified as "High" consequence have previously been informed that a minimum IDF and MDE of 1:1000 would be acceptable. It would be inappropriate now to require that the higher 2007 CDA Guidelines IDF and MDE be applied immediately. However, the WSD recommends that the owner make every effort to move toward these new design criteria targets as soon as possible.

Glen Davidson, P.Eng.
Comptroller of Water Rights

[7] Now called *earthquake design ground motion* (EDGM) in the 2007 CDA Guidelines

Table 1-1 CDA Dam Safety Guidelines 1999

TABLE 1-1
CLASSIFICATION OF DAMS
IN TERMS OF CONSEQUENCES OF FAILURE

CONSEQUENCE CATEGORY	POTENTIAL INCREMENTAL CONSEQUENCES OF FAILURE [a]	
	LIFE SAFETY [b]	SOCIOECONOMIC FINANCIAL & ENVIRONMENTAL [b] [c]
VERY HIGH	Large number of fatalities	Extreme damages
HIGH	Some fatalities	Large damages
LOW	No fatalities anticipated	Moderate damages
VERY LOW	No fatalities	Minor damages beyond owner's property

[a] Incremental to the impacts which would occur under the same natural conditions (flood, earthquake or other event) but without failure of the dam. The consequence (i.e. loss of life or economic losses) with the higher rating determines which category is assigned to the structure. In the case of tailings dams, consequence categories should be assigned for each stage in the life cycle of the dam.

[b] The criteria which define the Consequence Categories should be established between the Owner and regulatory authorities, consistent with societal expectations. Where regulatory authorities do not exist, or do not provide guidance, the criteria should be set by the Owner to be consistent with societal expectations. The criteria may be based on levels of risk which are acceptable or tolerable to society.

[c] The Owner may wish to establish separate corporate financial criteria which reflect their ability to absorb or otherwise manage the direct financial loss to their business and their liability for damage to others.

Schedule 1 – Dam Safety Regulation, Feb. 2000

Downstream Consequence Classification Guide

Rating	Loss of Life	Economic and Social Loss	Environmental and Cultural Losses
VERY HIGH	Large potential for multiple loss of life involving residents and working, travelling and/or recreating public. Development within inundation area (the area that could be flooded if the dam fails) typically includes communities, extensive commercial and work areas, main highways, railways, and locations of concentrated recreational activity. Estimated fatalities could exceed 100.	Very high economic losses affecting infrastructure, public and commercial facilities in and beyond inundation area. Typically includes destruction of or extensive damage to large residential areas, concentrated commercial land uses, highways, railways, power lines, pipelines and other utilities. Estimated direct and indirect (interruption of service) costs could exceed $100 million.	Loss or significant deterioration of nationally or provincially important fisheries habitat (including water quality), wildlife habitat, rare and/or endangered species, unique landscapes or sites of cultural significance. Feasibility and/or practicality of restoration and/or compensation is low.
HIGH	Some potential for multiple loss of life involving residents, and working, travelling and/or recreating public. Development within inundation area typically includes highways and railways, commercial and work areas, locations of concentrated recreational activity and scattered residences. Estimated fatalities less than 100.	Substantial economic losses affecting infrastructure, public and commercial facilities in and beyond inundation area. Typically includes destruction of or extensive damage to concentrated commercial land uses, highways, railways, power lines, pipelines and other utilities. Scattered residences may be destroyed or severely damaged. Estimated direct and indirect (interruption of service) costs could exceed $1 million.	Loss or significant deterioration of nationally or provincially important fisheries habitat (including water quality), wildlife habitat, rare and/or endangered species, unique landscapes or sites of cultural significance. Feasibility and practicality of restoration and/or compensation is high.
LOW	Low potential for multiple loss of life. Inundation area is typically undeveloped except for minor roads, temporarily inhabited or non- residential farms and rural activities. There must be a reliable element of natural warning if larger development exists.	Low economic losses to limited infrastructure, public and commercial activities. Estimated direct and indirect (interruption of service) costs could exceed $100 000.	Loss or significant deterioration of regionally important fisheries habitat (including water quality), wildlife habitat, rare and endangered species, unique landscapes or sites of cultural significance. Feasibility and practicality of restoration and/or compensation is high. Includes situations where recovery would occur with time without restoration.
VERY LOW	Minimal potential for any loss of life. The inundation area is typically undeveloped.	Minimal economic losses typically limited to owner's property not to exceed $100 000. Virtually no potential exists for future development of other land uses within the foreseeable future.	No significant loss or deterioration of fisheries habitat, wildlife habitat, rare or endangered species, unique landscapes or sites of cultural significance.

Table 2-1 CDA Dam Safety Guidelines 2007

Table 2-1: Dam Classification

Dam class	Population at risk [note 1]	Incremental losses		
		Loss of life [note 2]	Environmental and cultural values	Infrastructure and economics
Low	None	0	Minimal short-term loss No long-term loss	Low economic losses; area contains limited infrastructure or services
Significant	Temporary only	Unspecified	No significant loss or deterioration of fish or wildlife habitat Loss of marginal habitat only Restoration or compensation in kind highly possible	Losses to recreational facilities, seasonal workplaces, and infrequently used transportation routes
High	Permanent	10 or fewer	Significant loss or deterioration of *important* fish or wildlife habitat Restoration or compensation in kind highly possible	High economic losses affecting infrastructure, public transportation, and commercial facilities
Very high	Permanent	100 or fewer	Significant loss or deterioration of *critical* fish or wildlife habitat Restoration or compensation in kind possible but impractical	Very high economic losses affecting important infrastructure or services (e.g., highway, industrial facility, storage facilities for dangerous substances)
Extreme	Permanent	More than 100	Major loss of *critical* fish or wildlife habitat Restoration or compensation in kind impossible	Extreme losses affecting critical infrastructure or services (e.g., hospital, major industrial complex, major storage facilities for dangerous substances)

Note 1. Definitions for population at risk:

None—There is no identifiable population at risk, so there is no possibility of loss of life other than through unforeseeable misadventure.

Temporary—People are only temporarily in the dam-breach inundation zone (e.g., seasonal cottage use, passing through on transportation routes, participating in recreational activities).

Permanent—The population at risk is ordinarily located in the dam-breach inundation zone (e.g., as permanent residents); three consequence classes (high, very high, extreme) are proposed to allow for more detailed estimates of potential loss of life (to assist in decision-making if the appropriate analysis is carried out).

Note 2. Implications for loss of life:

Unspecified—The appropriate level of safety required at a dam where people are temporarily at risk depends on the number of people, the exposure time, the nature of their activity, and other conditions. A higher class could be appropriate, depending on the requirements. However, the design flood requirement, for example, might not be higher if the temporary population is not likely to be present during the flood season.

Table 5-1 CDA Dam Safety Guidelines 1999

TABLE 5-1
USUAL MINIMUM CRITERIA FOR DESIGN EARTHQUAKES

CONSEQUENCE CATEGORY [a]	MAXIMUM DESIGN EARTHQUAKE (MDE)	
	DETERMINISTICALLY DERIVED	PROBABILISTICALLY DERIVED (Annual exceedance probability)
Very High	MCE [b]	1/10,000
High	50% to 100% MCE [c] [d]	1/1000 to 1/10,000 [d]
Low	- [e]	1/100 to 1/1000 [e]

[a] See Section 1.4 for consequence classification.

[b] For a recognised fault or geographically defined tectonic province, the Maximum Credible Earthquake (MCE) is the largest reasonably conceivable earthquake that appears possible. For a dam site, MCE ground motions are the most severe ground motions capable of being produced at the site under the presently known or interpreted tectonic framework.

[c] MDE firm ground accelerations and velocities can be taken as 50% to 100% of MCE values. For design purposes the magnitude should remain the same as the MCE.

[d] In the High Consequence category, the MDE is based on the consequences of failure. For example, if one incremental fatality would result from failure, an AEP of 1/1000 may be acceptable, but for consequences approaching those of a Very High Consequence dam, design earthquakes approaching the MCE would be required.

[e] If a Low Consequence structure cannot withstand the minimum criteria, the level of upgrading may be determined by economic risk analysis, with consideration of environmental and social impacts.

Table 6-1 CDA Dam Safety Guidelines 1999

TABLE 6-1
USUAL MINIMUM CRITERIA FOR INFLOW DESIGN FLOODS

CONSEQUENCE CATEGORY [a]	INFLOW DESIGN FLOOD (IDF)
Very High	Probable Maximum Flood (PMF) [b]
High	Annual Exceedance Probability (AEP) between 1/1000 and the PMF [c]
Low	AEP between 1/100 and 1/1000 [c] [d]

[a] See Section 1.4 for consequence classification

[b] An appropriate level of conservatism shall be applied to loads from this event, to reduce the risks of dam failure to tolerable values. Thus, the probability of dam failure could be much lower than the probability of extreme event loading.

[c] Within the High Consequence category, the IDF is based on the consequences of failure. For example, if one incremental fatality would result from failure, an AEP of 1/1000 could be acceptable, but for consequences approaching those of a Very High Consequence dam, design floods approaching the PMF would be required.

[d] If a Low Consequence structure cannot withstand the minimum criteria, the level of upgrading may be determined by economic risk analysis, with consideration of environmental and social impacts.

Table 6-1 CDA Dam Safety Guidelines 2007

Table 6-1: Suggested Design Flood and Earthquake Levels (for Use in Deterministic Assessments)

Dam class [note 1]	AEP	
	IDF [note 2]	EDGM [note 3]
Low	1/100	1/500
Significant	Between 1/100 and 1/1000 [note 4]	1/1000
High	1/3 between 1/1000 and PMF [note 5]	1/2500 [note 6]
Very high	2/3 between 1/1000 and PMF [note 5]	1/5000 [note 6]
Extreme	PMF [note 5]	1/10,000

Acronyms: AEP, annual exceedance probability; EDGM, earthquake design ground motion; IDF, inflow design flood; PMF, probable maximum flood.

Note 1. As defined in Table 2-1, Dam Classification.

Note 2. Extrapolation of flood statistics beyond 1/1000 year flood (10^{-3} AEP) is discouraged.

Note 3. AEP levels for EDGM are to be used for mean rather than median estimates of the hazard.

Note 4. Selected on the basis of incremental flood analysis, exposure, and consequences of failure.

Note 5. PMF has no associated AEP. The flood defined as "1/3 between 1/1000 year and PMF" or "2/3 between 1/1000 year and PMF" has no defined AEP.

Note 6. The EDGM value must be justified to demonstrate conformance to societal norms of acceptable risk. Justification can be provided with the help of failure modes analysis focused on the particular modes that can contribute to failure initiated by a seismic event. If the justification cannot be provided, the EDGM should be 1/10,000.