Parks Canada Parcs Canada

Western and Northern Canada

Johnson Lake Dams
(Banff National Park)
2012 Engineering Inspection Report

Prepared for the Banff National Park by:

Jim Reeves, P.Eng, MASc
Civil Engineer – Western and Northern Canada

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Johnson Lake Dams
Banff National Park
Engineering Inspection Report

EXECUTIVE SUMMARY

Strategic Asset Management, Parks Canada Agency, Calgary Office was engaged by the Banff Field Unit to undertake a Engineering Inspection of the East and West Dams of Johnson Lake.

The Dam Engineering Inspection Report was undertaken in accordance with the requirements of the PCA Directive for Dam Safety Program (DDSP) 2009.

Based on the results of the investigation, analysis and asset of the dams, a series of recommendations were developed during the report writing and are listed at the conclusion of the report.

The main deficiency identified during the Johnson Lake Dams Engineering Investigation is the presence of a failure scarp on the downstream embankment of the east dam. An interim solution to address the deficiency is the construction of a toe berm which would mitigate risk until a dam safety review was completed.

1.0 Introduction

A dam's lifecycle follows a number of phases from construction to decommissioning/dismantling. During the course of the dam's lifecycle there are times when the dam requires maintenance, repairs or upgrades. For a dam to continue to serve its intended purpose there is a need for formal maintenance procedures and as conditions change a need to repair or upgrade the dam. When deficiencies are identified the dam owner can either classify the deficiency as repairable through normal maintenance practices or requiring repairs or upgrades. Maintenance involves, but is not limited to, grass cutting, debris removal and vegetation management. Repairs are more complex and require a formal design implemented under the supervision of a professional engineer.

2.0 General Description

The Johnson Lake Dams are located at the West and East Ends of Johnson Lake, situated in Banff National Park and have associated with them asset numbers 05050 and 05052 respectively. Johnson Lake is located approximately 6.4 km north east of the Town of Banff, AB at co-ordinates 51 11 49 N 115 29 04 W. The lake can be accessed via Lake Minnewanka Scenic Drive to the Johnson Lake Road turnoff. Travel the Johnson Lake Road approximately 2 km to the Johnson Lake parking lot and picnic area **(Appendix I)**. Access to the east end dam can be done via a pedestrian trail or maintenance road located along the hydro easement on the south side of the lake.

Johnson Lake Dams impound approximately 400,000 m^3. The west and east end dams are approximately 2.5 and 1.5 m high respectively. At the time of the writing of this report there was no information available on the dam's composition or the date of construction. The dams are earthen dams. Efforts have been made to capture the information through consultation with the Banff Field Unit and TransAlta who, it has been suggested, may have been involved in the construction. No further information has been forthcoming.

The survey and inspections of the two dams were completed August 20, 2012. The day was sunny with clear skies and a temperature of 20 ^{0} C. Grounds were wet to saturated in some locations as a result of rains which occurred the previous day.

3.0 Routine Inspections

Since the last engineering inspection that was done in June, 2009, a total of two (2) Routine Inspections have been carried out between the months of October, 2011 to June, 2012. No significant changes were noted at the West Dam during this period. Seepage at the toe of the West Dam continues with no notable changes in flow. Increased wave erosion has been noted along upstream bank of East Dam.

4.0 Engineering Inspection

4.1 West End Dam

4.1.1 General

The average dam height was found to be 2.5 m with a maximum height of 2.7 m. The average dam width measured at the crest was found to be 3.0 m. The minimum freeboard height was found to be 0.9 m. The dam's length was found to be approximately 90 m. The dam has an uncontrolled spillway which acts in a secondary role as abutments for a pedestrian bridge. It was noted that during the course of that day the dam saw a higher than expected volume of pedestrian traffic. The beach at the north end of the dam attracts a large volume of visitors who utilize the dam for exercise and nature walks.

4.1.2 Deficiencies Observed

Vegetation *(Photo 11)*: High standing coniferous trees were observed on the downstream embankment on either side of the creek. Vegetation types can either reinforce or compromise the dam's structure. Coniferous trees can have an aggressive weed like root network characterized by fine roots which run horizontally about 75 – 125 mm beneath the soil with an associated tap root. Tap roots some trees have been observed to reach depths of 15 – 20 m. Research has been ongoing observing the impacts of vegetation on dam stability. Coniferous trees can have root systems that can reinforce the dam's structural integrity as long as the tree is kept healthy over the life cycle period of the dam. Rotting root systems can result in preferential flow paths resulting in piping.

The upstream embankment is covered in wild grass. A healthy uniform cover of this type of vegetation is desired. The root system supporting grass growth helps stabilize dam embankments.

Seepage *(Photos 9)*: Seepage was observed at the toe of the downstream embankment to the south of the creek. There is always some degree of seepage observed on earthen dams as increased sub-surface hydrostatic heads seek the course of least resistance through the dam embankment. If seepage forces are high, embankment material can be carried away with the migrating water resulting in increased flows and removal of more dam material. This action is referred to as piping. At the point where the water is seeping from the embankment ongoing monitoring should be done of the material type, size and water flow to determine whether the piping is increasing in flow and size. It is critical that the responsible personnel are aware whether the seepage is increasing or maintain a steady state.

4.1.3 Categorization

4.1.3.1 Condition Rating

Based on this recent inspection, the Risk to Asset (RTA) remains at a rating of "C" (Poor) and the Level of Service (LOS) remains at a rating of "C" (Poor). As a result, the Overall Condition Rating remains a "C" (Poor), primarily due to the intrusive root systems and observed seepage at the downstream toe.

4.1.3.2 Hazard Classification

The dam is classified as a "Low' hazard.

4.1.4 Recommendations

Johnson Lake East Dam has deficiencies that will require ongoing monitoring at a more frequent rate.

4.1.4.1 Mitigating Measures

Vegetation: Maintain existing low growing grassy vegetation. Regular mowing operations are essential to facilitate inspection when monitoring cracking, animal burrows, surface erosion, and seepage. Newly established saplings should be removed as their roots systems have not yet established themselves to a depth of compromising the dam's structure. Existing high standing trees should be considered for removal as part of a dam recapitalization project.

Seepage: Regular monitoring of the flow volume and material, seepage exit, and size of wet area should be practised. The individual doing the inspection should make it a point to observe the seeping water for flow carrying soil particles. A small weir made of local material (sand bags) could be constructed to monitor water flows and soil migration.

4.2 East End Dam

4.2.1 General

The average dam height was found to be 1.5 m with a maximum height of 2.3 m. The average dam width measured at the crest was found to be 1.8 m. The minimum freeboard height was found to be 0.15 m. The dam's length was found to be approximately 110 m. The survey base was left at Control Point 1, West end dam while surveying the East end dam. There was difficulty in establishing and maintaining connection with a sufficient number of satellites and therefore there was an ongoing need to re-establish a connection with the satellites. This may be attributed to the height of the deciduous trees on the downstream embankment, west end of dam.

4.2.2 Deficiencies Observed

Failure Scarp *(Photos 25):* There is a notable curved scarp located on the downstream embankment at the west end of the dam. The scarp is approximately 7m in length and 150 mm at its deepest point. Located down slope of the scarp were zones of bulging. The combination of the scarps geometry and two ground movements (vertical displacement and bulging) are indications of a slope failure. There is insufficient information to determine whether the failure is rotational or translational. Failures of this type can occur slowly or suddenly and are the result of either a loss in soil strength or a change in the embankment geometry. A major contributor to a loss in soil strength is a change in effective stress caused by increased pore water pressures.

Vegetation *(Photos 22):* High standing deciduous trees (Poplar) were observed on the downstream embankment at the west end of the dam. Vegetation types can either reinforce or compromise the dam's structure. Poplars have an aggressive weed like root network characterized by pencil like strands with a woody bark that run horizontally about 75 – 125 mm beneath the soil. Tree root systems may compromise the dam's structure either through overturning leading to large root-soil plates or when root systems rot result in preferential flow paths resulting in piping.

The upstream embankment is covered in wild grass. A healthy uniform cover of this type of vegetation is desired. The root system supporting grass growth helps stabilize dam embankments. The most notable undesirable vegetation on the upstream embankment is shrubs located at the east end of the dam on a protruding section of the embankment. Shrubs roots can be either tuberous or fibrous and impose different risks to the dam's structure. Fibrous roots are fine, thin branching configurations that form a dense mat near the surface of the soil. Tuberous roots are a thick structure of the shrub which extends below the surface of the ground to varying depths.

Embankment Erosion *(Photos18):* There is a localized area of wave erosion on the upstream embankment mid-dam. Flagstone has been placed to serve as riprap to mitigate ongoing deterioration by absorbing and deflecting wave energy. The spacing of the stone helps trap the water and mitigate erosion of the unprotected embankment. Some flagstone has been undermined and has migrated down the embankment to a point of being less effective. The crest of the dam has noticeably narrowed as a result of the erosion.

Overtopping *(Photo 21):* A 0.1 m^2 square, 7 m long concrete beam has been placed on the top of the embankment just east of the location of the shrubs. The beam appears to have been placed to mitigate damage caused by overtopping. Overtopping has eroded the dam crest and downstream embankment carrying dam material to the toe of the embankment. Maintenance material has been placed to reestablish the crest of the dam. Ongoing overtopping has eroded the maintenance material displacing it to the downstream embankment and toe. Minimum freeboard measurements were found to be 120 mm.

Rutting *(Photo 25):* Uniformly spaced rutting was noted at the west end of the dam. This implies that vehicles with narrow wheel bases had traversed the dam's crest. Rutting indicates an insufficient degree of compaction of the dam's crest material to support the intended loading. After further investigation it was discovered that the Field Unit had mobilized construction equipment to the site to support maintenance operations.

Debris *(Photo16):* There was a moderate amount of deadfall debris located on the upstream side west end of the dam.

4.2.3 Categorization

4.2.3.1 Condition Rating

Based on this recent inspection, the Risk to Asset (RTA) remains at a rating of "C" (Poor) and the Level of Service (LOS) remains at a rating of "C" (Poor). As a result, the Overall Condition Rating remains a "C" (Poor), primarily due to the identified scarp, overtopping and intrusive root systems from problematic vegetation.

4.2.3.2 Hazard Classification

The dam is classified as a "Low" hazard.

4.2.4 Recommendations

Johnson Lake East Dam has deficiencies that will require ongoing monitoring at a more frequent rate.

4.2.4.1 Mitigating Measures

Failure Scarp: Lacking the information detailing the soil qualities at the observed location of the scarp it is difficult to determine proper mitigating measures. It is recommended that a toe berm be established at the location of the scarp to limit future movement until a formal Dam Safety Review can be done.

Vegetation: Maintain existing low growing grassy vegetation. Regular mowing operations are essential to facilitate inspection when monitoring cracking, animal burrows, surface erosion, and seepage. Newly established saplings should be removed as their roots systems have not yet established themselves to a depth of compromising the dam's structure. Existing high standing trees should be considered for removal as part of a dam recapitalization project.

Embankment Erosion: Bank hardening should be re-established. The depth of the bank hardening material perpendicular to the embankment should a minimum of two layers of the previously used flagstone. The flagstone should be constructed over a layer of geotextile filter cloth overlaying a layer of gravel. A maximum of a 1:2 slope should be used with the flagstone placed as to not incur any toe erosion and downward movement of the bank hardening material.

Overtopping: Freeboard design heights vary depending on the dam materials resistance to waves and overtopping, wind velocity and effective fetch, reservoir depth and potential settlement of the dam crest. Observed effects of overtopping suggest the dam crest needs to be regraded to an elevation which incorporates a minimum of a 0.3 m freeboard or drawdown the reservoir to an elevation that will attain a minimum of a 0.3 m freeboard.

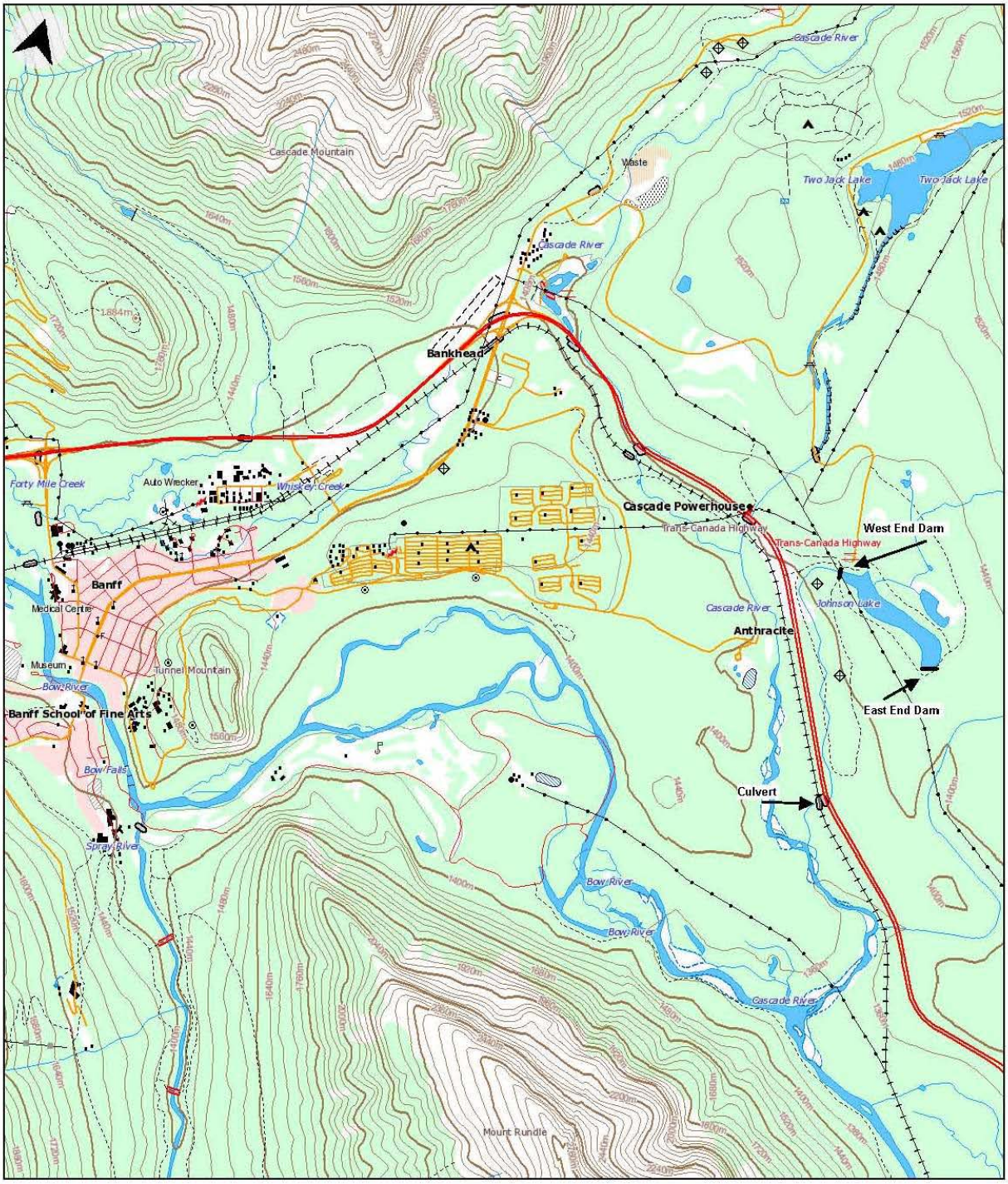
Rutting: Rutting is a sign that vehicles for which the dam was not designed to support had traversed the dam.

Debris: Existing deadfall does not appear to pose a threat to the dam at this time. As part of the maintenance cycle the debris should be removed

Note:

Recommendations made here are short term solutions to mitigate recurring damage before a proper Dam Safety Review can be completed.

Appendix I – Johnson Lake Dams - Location Map



Location of the Johnson Lake Dams and the highway culvert located downstream

Original Map Scale 1:20 000

Map from the Natural Resources Canada Web Site (The Atlas of Canada; http://atlas.nrcan.gc.ca/site/english/index.html)

Appendix II – Johnson Lake Dams - Engineer Inspection Reports

Parks Canada Agency

DAM ENGINEERING INSPECTION FORM

SECTION I - IDENTIFICATION OF THE DAM

Name of the dam	**Johnson Lake - East End**
AMS Asset Number	5052
Field Unit (# 22)	Banff Field Unit
National Park (NP) Historic Site (NHS)	**Banff National Park**
Access route	1 km walking trail from west end of the lake (See West End Dam)
Coordinates (dd/mm/ss)	N 51° 11' 37" W 115° 28' 39"

SECTION II - INSPECTION LEADER

Name	Jim Reeves	Function	Strategic Asset Management Advisor
Address	Rm 1550, 635 8 Ave SW Calgary, AB T2P 3M3	Phone Cellular	403-292-4504 403-604-9836
Email	Jim.Reeves@pc.gc.ca	Fax	403-292-4652

Signature _____ Date: _____

SECTION III - DOCUMENTS IN HAND

Last Inspection Report Yes ☐ No ☐ Reviewed ☐ _____

- Date of last Routine ☐ or Engineering ☐ Inspection (dd - MONTH - yyyy) _____

Dam Data Sheet Yes ☐ No ☐ Reviewed ☐ _____

Drawings and/or Sketches Yes ☐ No ☐ Reviewed ☐ _____

SECTION IV - FIELD CONDITIONS

Site access Unrestricted ☒ Locked gate ☐ Road: closed ☐ unpractical ☐ _____

Actual weather Dry ☒ Wet ☐ Snow ☐ Other ☐ _____

Previous day weather Dry ☐ Wet ☒ Snow ☐ Other ☐ _____

Ground condition Dry ☐ Wet ☐ Snow cover ☐ Other ☐ moist

Reservoir level Above (+) / Below (-) ☐ Spillway Sill: ____ m ☐ Dam Crest: ____ m ☐ Gage Rod: ____ m

Spillway(s) flowing Yes ☐ No ☐ Don't know ☐ _____

Outlet(s) in use Yes ☐ No ☐ Don't know ☐ _____

Additional comments --> _____

SECTION V - DEFICIENCIES NOTED

- *This checklist form is specifically suited for an earthfill dam with an uncontrolled concrete spillway and standard outlet*
- *In accordance with recognized conventions, the Left and Right side are determined by looking downstream*
- *Locate, Sketch, Measure and Photograph or film deficiencies whenever applicable*
- *Comment on the condition of known deficiencies (Highlighted) which have been observed on previous inspections*
- *Deterioration on concrete components includes: cracking, spalling, holes, rebars exposed, efflorescence, weathering …*
- *Send original form to Asset Manager / Advisor and copy to Dam Safety Engineer / C.E.T*

RESERVOIR / BANK — Inaccessible ☐

Type of deficiencies		Observations (location, orientation, extent, depth, size, amount, changes, …)	Photos/films
A1 Erosion / Slide / Slough	☐		
A2 Floating debris	☐		
A3 Beaver activity	☐		
A4 Other -->	☐		

Additional comments -->

UPSTREAM SLOPE — Inaccessible ☐

Type of deficiencies		Observations (location, orientation, extent, depth, size, amount, changes, …)	Photos/films
B1 Displaced Riprap	☐		
B2 Wave Erosion	☒	middle of dam, upstream	
B3 Longitudinal cracks	☐		
B4 Slide / Slough	☐		
B5 Excessive vegetation	☒	Bushes, vegetation	
B6 Burrows	☐		
B7 Sinkhole	☐		
B8 Other --> Erosion	☒	Bank hardening due to erosion	

Additional comments -->

CREST — Inaccessible ☐

Type of deficiencies		Observations (location, orientation, extent, depth, size, amount, changes, …)	Photos/films
C1 Excessive vegetation	☐		
C2 Longitudinal cracks	☐		
C3 Transverse cracks	☐		
C4 Drying cracks	☐		
C5 Rut	☐		
C6 Depressions / Settlements	☐		
C7 Erosion	☐		
C8 Sinkhole	☐		
C9 Lateral movement	☐		
C10 Burrows	☐		
C11 Other -->	☐		

Additional comments -->

DOWNSTREAM SLOPE — Inaccessible ☐

Type of deficiencies		Observations (location, orientation, extent, depth, size, amount, changes, ...)	Photos/films
D1 Excessive vegetation	☒	poplar, large trees	
D2 Longitudinal cracks	☐		
D3 Slide / Slough	☒	Slumping located about 1/3 of the distance from west end	
D4 Seepage / Wet Area	☐	Flow ☐ Clear ☐ Colored ☐	
D5 Sinkhole / Cave in	☐		
D6 Erosion / Rutting	☐		
D7 Burrows	☐		
D8 Other --> over topping	☒	possible over topping	

Additional comments -->

DOWNSTREAM TOE — Inaccessible ☐

Type of deficiencies		Observations (location, orientation, extent, depth, size, amount, changes, ...)	Photos/films
E1 Excessive vegetation	☒	Bushes, trees, conifers	
E2 Seepage / Wet Area	☐	Flow ☐ Clear ☐ Colored ☐	
E3 Ponded Water	☐	Clear ☐ Colored ☐	
E4 Deficient drainage	☐		
E5 Other -->	☐		

Additional comments -->

ABUTMENTS — Inaccessible ☐

Type of deficiencies		Observations (location, orientation, extent, depth, size, amount, changes, ...)	Photos/films
F1 Excessive vegetation	☐		
F2 Seepage / Wet area	☐	Flow ☐ Clear ☐ Colored ☐	
F3 Erosion	☐		
F4 Burrows	☐		
F5 Other --> debris	☒	logs on west upstream,	

Additional comments -->

☐ No Spillway Found — SPILLWAY (S) - including conduit(s) and/or channel(s) — Inaccessible ☐

Type of deficiencies		Observations (location, orientation, extent, depth, size, amount, changes, ...)	Photos/films
G1 Structural	☐		
G2 Joints defective	☐		
G3 Seepage / Wet area	☐	Flow ☐ Clear ☐ Colored ☐	
G4 Displacement	☐		
G5 Erosion / Slide	☐		
G6 Undermining	☐		
G7 Flow Obstruction	☐	Beaver dam ☐ Debris ☐ Vegetation ☐ other ☐ -->	
G8 Leakage	☐		
G9 Other -->	☐		

Additional comments -->

☐ No Outlet Found **OUTLET (S)** - including conduit(s) and inlet(s) Inaccessible ☐

Type of deficiencies		Observations (location, orientation, extent, depth, size, amount, changes, ...)	Photos/films
H1 Structural	☐		
H2 Mechanism damage	☐		
H3 Seepage / Wet area	☐	Flow ☐ Clear ☐ Colored ☐	
H4 Leakage	☐	Clear ☐ Colored ☐	
H5 Obstruction	☐	Beaver dam ☐ Debris ☐ Vegetation ☐ other ☐ -->	
H6 Corrosion	☐		
H7 Defective conduits	☐	Cracks ☐ Holes ☐ Open joints ☐ other ☐ -->	
H8 Other -->	☐		

Additional comments -->

SECTION VI - SKETCHES

Parks Canada Agency

DAM ENGINEERING INSPECTION FORM

SECTION I - IDENTIFICATION OF THE DAM

Name of the dam **Johnson Lake - West End**

AMS Asset Number 5050

Field Unit (# 22) Banff Field Unit

National Park (NP) / Historic Site (NHS) **Banff National Park**

Access route Johnson Lake Picnic Area Road via Minnewanka Scenic Dr

Coordinates (dd/mm/ss) N 51° 11' 55" W 115° 29' 25"

SECTION II - INSPECTION LEADER

Name	Jim Reeves	Function	Strategic Asset Management Advisor
Address	Rm 1550, 635 8 Ave SW Calgary, AB T2P 3M3	Phone Cellular	403-292-4504 403-604-9836
Email	Jim.Reeves@pc.gc.ca	Fax	403-292-4652

Signature _____ Date: _____

SECTION III - DOCUMENTS IN HAND

Last Inspection Report Yes ☐ No ☐ Reviewed ☐ _____

- Date of last Routine ☐ or Engineering ☐ Inspection (dd - MONTH - yyyy) _____

Dam Data Sheet Yes ☐ No ☐ Reviewed ☐ _____

Drawings and/or Sketches Yes ☐ No ☐ Reviewed ☐ _____

SECTION IV - FIELD CONDITIONS

Site access Unrestricted ☒ Locked gate ☐ Road: closed ☐ unpractical ☐ _____

Actual weather Dry ☒ Wet ☐ Snow ☐ Other ☐ _____

Previous day weather Dry ☐ Wet ☒ Snow ☐ Other ☐ _____

Ground condition Dry ☐ Wet ☐ Snow cover ☐ Other ☒ moist

Reservoir level (Above (+) / Below (-)) Spillway Sill: _____ m ☐ Dam Crest: 0.36 m ☐ Gage Rod: _____ m

Spillway(s) flowing Yes ☒ No ☐ Don't know ☐ _____

Outlet(s) in use Yes ☐ No ☐ Don't know ☐ _____

Additional comments --> _____

SECTION V - DEFICIENCIES NOTED

- *This checklist form is specifically suited for an earthfill dam with an uncontrolled concrete spillway and standard outlet*
- *In accordance with recognized conventions, the Left and Right side are determined by looking downstream*
- *Locate, Sketch, Measure and Photograph or film deficiencies whenever applicable*
- *Comment on the condition of known deficiencies (Highlighted) which have been observed on previous inspections*
- *Deterioration on concrete components includes: cracking, spalling, holes, rebars exposed, efflorescence, weathering …*
- *Send original form to Asset Manager / Advisor and copy to Dam Safety Engineer / C.E.T*

RESERVOIR / BANK

Inaccessible ☐

	Type of deficiencies		Observations (location, orientation, extent, depth, size, amount, changes, …)	Photos/films
A1	Erosion / Slide / Slough	☐		
A2	Floating debris	☐		
A3	Beaver activity	☐		
A4	Other --> _____	☐		

Additional comments --> _____

UPSTREAM SLOPE

Inaccessible ☐

	Type of deficiencies		Observations (location, orientation, extent, depth, size, amount, changes, …)	Photos/films
B1	Displaced Riprap	☐		
B2	Wave Erosion	☐		
B3	Longitudinal cracks	☐		
B4	Slide / Slough	☐		
B5	Excessive vegetation	☐		
B6	Burrows	☐		
B7	Sinkhole	☐		
B8	Other --> _____	☐		

Additional comments --> _____

CREST

Inaccessible ☐

	Type of deficiencies		Observations (location, orientation, extent, depth, size, amount, changes, …)	Photos/films
C1	Excessive vegetation	☐		
C2	Longitudinal cracks	☐		
C3	Transverse cracks	☐		
C4	Drying cracks	☐		
C5	Rut	☐		
C6	Depressions / Settlements	☐		
C7	Erosion	☐		
C8	Sinkhole	☐		
C9	Lateral movement	☐		
C10	Burrows	☐		
C11	Other --> _____	☐		

Additional comments --> _____

DOWNSTREAM SLOPE — Inaccessible ☐

Type of deficiencies		Observations (location, orientation, extent, depth, size, amount, changes, …)	Photos/films
D1 Excessive vegetation	☐		
D2 Longitudinal cracks	☐		
D3 Slide / Slough	☐		
D4 Seepage / Wet area	☐	Flow ☐ Clear ☐ Colored ☐	
D5 Sinkhole / Cave in	☐		
D6 Erosion / Rutting	☐		
D7 Burrows	☐		
D8 Other -->	☐		

Additional comments -->

DOWNSTREAM TOE — Inaccessible ☐

Type of deficiencies		Observations (location, orientation, extent, depth, size, amount, changes, …)	Photos/films
E1 Excessive vegetation	☒	Coniferous trees	
E2 Seepage / Wet area	☒	both sides of creek Flow ☒ Clear ☒ Colored ☐	
E3 Ponded water	☐	Clear ☐ Colored ☐	
E4 Deficient drainage	☐		
E5 Other -->	☐		

Additional comments --> fine silt on downstream of seepage, apparent notable seepage on east downstre (oily deposit)

ABUTMENTS — Inaccessible ☐

Type of deficiencies		Observations (location, orientation, extent, depth, size, amount, changes, …)	Photos/films
F1 Excessive vegetation	☐		
F2 Seepage / Wet area	☐	Flow ☐ Clear ☐ Colored ☐	
F3 Erosion	☐		
F4 Burrows	☐		
F5 Other -->	☐		

Additional comments -->

☐ No Spillway Found — SPILLWAY (S) - including conduit(s) and/or channel(s) — Inaccessible ☐

Type of deficiencies		Observations (location, orientation, extent, depth, size, amount, changes, …)	Photos/films
G1 Structural	☐		
G2 Joints defective	☐		
G3 Seepage / Wet area	☐	Flow ☐ Clear ☐ Colored ☐	
G4 Displacement	☐		
G5 Erosion / Slide	☐		
G6 Undermining	☐		
G7 Flow Obstruction	☐	Beaver dam ☐ Debris ☐ Vegetation ☐ other ☐ -->	
G8 Leakage	☐		
G9 Other -->	☐		

Additional comments -->

☐ No Outlet Found **OUTLET (S)** - including conduit(s) and inlet(s) Inaccessible ☐

	Type of deficiencies		Observations (location, orientation, extent, depth, size, amount, changes, ...)	Photos/films
H1	Structural	☐		
H2	Mechanism damage	☐		
H3	Seepage / Wet area	☐	Flow ☐ Clear ☐ Colored ☐	
H4	Leakage	☐	Clear ☐ Colored ☐	
H5	Obstruction	☐	Beaver dam ☐ Debris ☐ Vegetation ☐ other ☐ -->	
H6	Corrosion	☐		
H7	Defective conduits	☐	Cracks ☐ Holes ☐ Open joints ☐ other ☐ -->	
H8	Other -->	☐		

Additional comments -->

SECTION VI - SKETCHES

Appendix III
Johnson Lake Dams – Topographic Plans

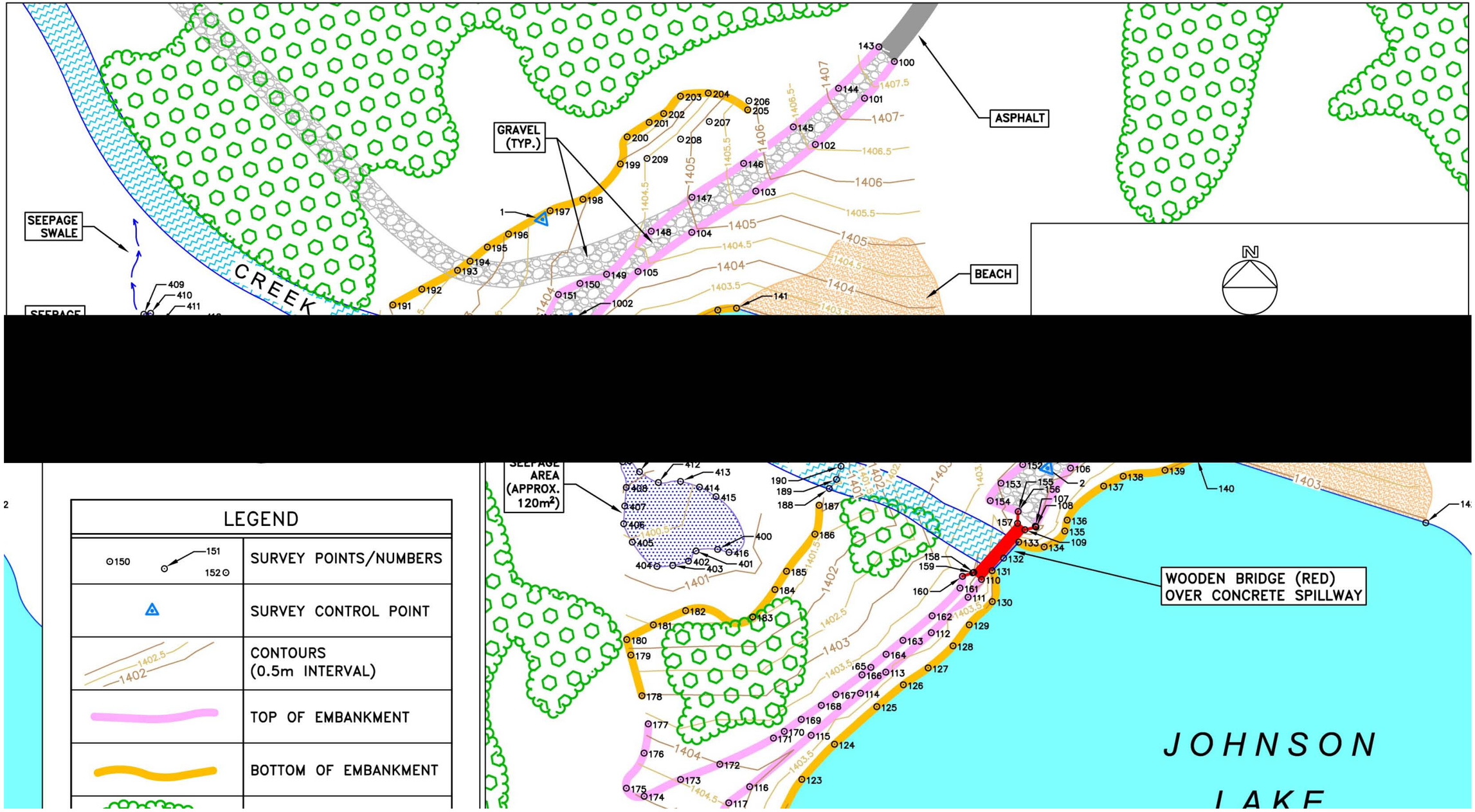


Figure 1 West Dam Topographic

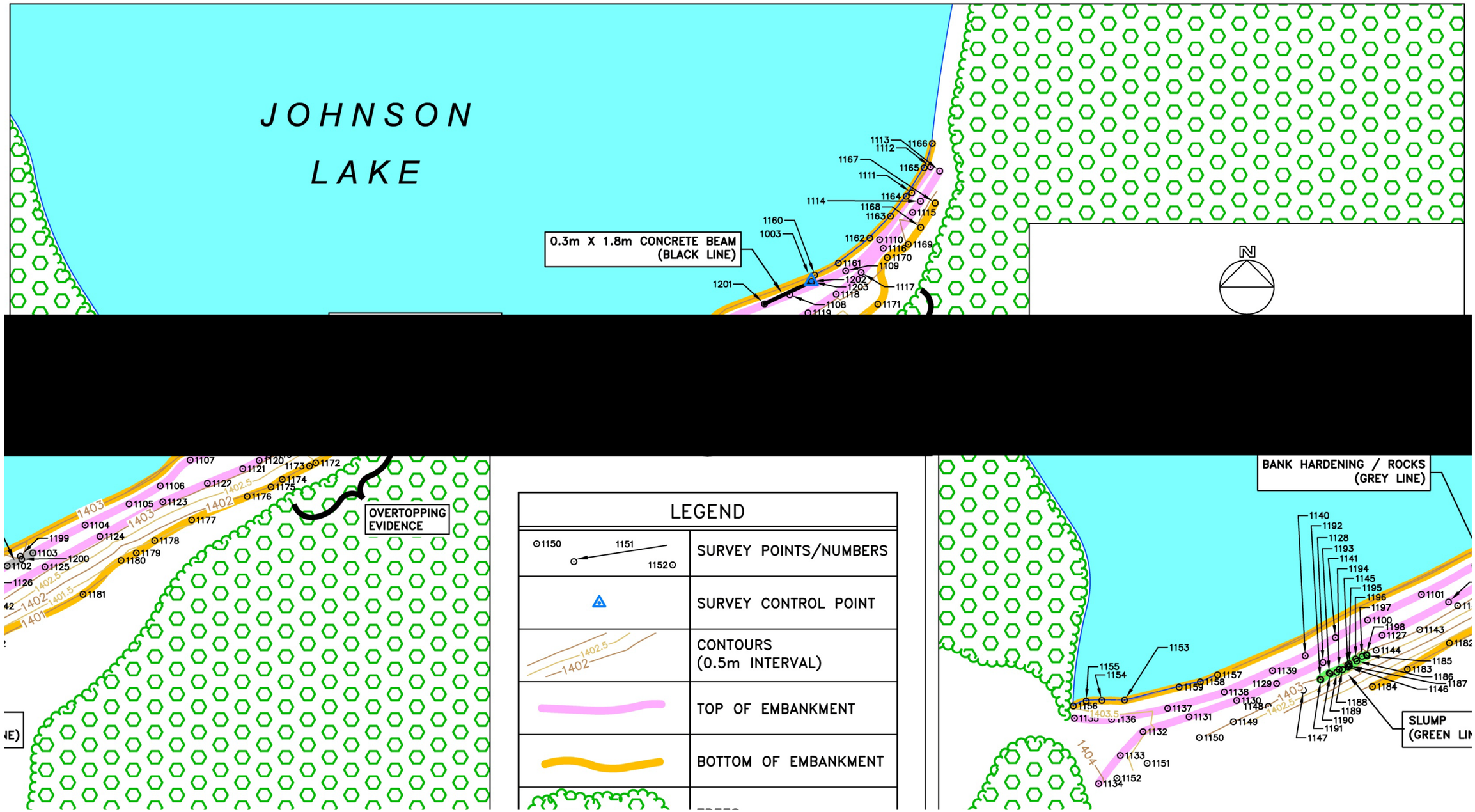


Figure 2 East Dam Topographic Survey

Appendix IV – Johnson Lake Dams - Inspection Photographs

Photo 1 West Dam - looking south from parking area

Photo 2 West Dam - looking west from beach

Photo 3 West Dam - North side of spillway

Photo 4 West Dam - South side of spillway

Photo 5 West Dam - Spillway bridge looking south

Photo 6 West Dam - Upstream bank looking south

Photo 7 West Dam - Looking north

Photo 8

Photo 10 West Dam - Seepage location

Photo 11

Photo 13 West Dam - Downstream creek looking towards spillway

Photo 14

Photo 17 West Dam - Looking south along toe of bank

Photo 16 West Dam - Downstream bank looking north

Photo 18 East Dam - Looking towards west abutment

Photo 19 East Dam - Debris accumulating at west end of dam

Photo 20 East Dam - Looking towards east abutment

Photo 21

Photo 22 East Dam - Looking towards east abutment

Photo 23

Photo 25 East Dam - Evidence of overtopping

Photo 27 East Dam - West end vegetation on downstream bank

Photo 28 East Dam - Looking West on downstream bank

Photo 29 East Dam - Looking south