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LAKE GERALDINE DAM
SAFETY INSPECTION
IQALUIT, NUNAVUT
Final Report

PRODUCED FOR: THE CITY OF IQALUIT

PRODUCED BY: CONCENTRIC ASSOCIATES INTERNATIONAL INCORPORATED

CONCENTRIC REFERENCE NUMBER: 15-6279-B

DATE: NOVEMBER 05, 2015

EXECUTIVE SUMMARY

The City Of Iqaluit retained Concentric Associates International Incorporated (Concentric), in August 2015, to prepare a Dam Safety Inspection (DSI) for the Lake Geraldine Dam.

The DSI was conducted during the period September 23 - 24, 2015, in general accordance with the Dam Safety Guidelines, (*DSG2007*) prepared by the Canadian Dam Association.

Observations:

No significant changes in the overall condition of the Dam and the retention berms were observed since the previous DSI which was conducted in 2014.

Representative existing conditions have been documented by photographs in Appendix A.

The required documentation (discussed further below) under the Canadian Dam Safety Guidelines is not up to date, and remains incomplete.

As a result of the DSI, the following observations, conclusions and recommendations have been made regarding Lake Geraldine Dam:

1. In accordance with Section 2 of the 2007 DSG (Revised 2013), the potential consequence of failure of the Lake Geraldine Dam was assessed. We confirm that it remains under a "Very High" dam consequence class.
2. The addition of a remote surveillance camera is recommended.
3. The Permanent Record File, Logbook, and Operation and Surveillance manual require updating for 2015.
4. The Emergency Preparedness Plan (EPP) reportedly prepared by others for the City should be reviewed and any incomplete items resolved, and the document added to the permanent document file.
5. A new DSI is required in 2016.
6. A new Dam Safety Review (DSR) will be required in 2018.
7. Consideration should be given to implementing a pore-water pressure monitoring program leading up to the next DSR in 2018, to assist with seepage and deformation assessments.
8. It is recommended that a Seismic Hazard Assessment (SHA) be conducted prior to the next DSR (2018).
9. It is recommended that the monthly berm monitoring program be implemented to monitor the observed active leakage identified in previous DSI's.
10. Maintenance and repairs to the north access road is recommended.
11. Additional ballast/rip-rap is recommended at the:
    - South end of the central berm.
    - East elevation of the central berm. (upstream elevation).

- Within the downstream drainage channel at the base of the spillway.

12. Exercising and testing of the valves within the valve chamber are recommended prior to the next maintenance cycle.
13. New signage (in all required languages) should be installed at the two access roads and around the periphery of the dam. Signage should be in conformance with the Dam Safety Guidelines.
14. Repairs noted within the DSI prepared by McMillen-LLC including repairs to the spalling concrete and deteriorated sealant joints should be integrated into the 2016 repair program.

Maintenance repairs for the concrete dam and berms are currently scheduled for the summer of 2016.

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1. INTRODUCTION & SCOPE OF WORK

This current Dam Safety Inspection (DSI) has been prepared in accordance with the requirement of the 2007 Dam Safety Guidelines (DSG). The last major revisions to the DSG were published in 2013. The DSG applies, in general, to those structures that are at least 2.5 meters in height, and which have at least 30,000 cubic meters of storage capacity. The Lake Geraldine Dam exceeds these minimum requirements.

A DSI is an inspection and reporting process, conducted at regular intervals, that involves completion of items in accordance with the DSG. The DSI forms part of the record documentation of history, condition, repairs, alterations, monitoring, operating, safety and emergency procedures.

The frequency of DSI's varies depending on potential consequences of dam failure, the presence of changes in external hazards, the result of surveillance, and the demonstrated performance. For dam structures where there are significant implications for population at risk, loss of life, environmental and cultural values, infrastructure and economical losses, the frequency of DSI's will increase. In the case of the Lake Geraldine Dam, the DSI should be conducted annually.

This DSI is a visual inspection to identify any changes in condition, or any observed concerns. A DSI may trigger repairs, or changes in standard operating procedures.

The level of detail required to conduct a DSI is influenced by several factors as follows:

- Basis of previous assessments
- Complexity of the dam
- Continuity of surveillance and records
- Internal and external hazards
- Operating history
- Dam performance and age
- Need for public protection during operation

The following is a summary of the scope of work for this assignment. The DSI report is the primary deliverable, and has been prepared in accordance with the DSG document.

- Review available record documentation;
- Conduct a visual on-site assessment;
- Prepare a photographic record documenting general and representative conditions;
- Identify, characterize, and risk-assess any actual or potential concerns;
- Prepare a written report summarizing our observations, items of concern, and recommendations;
- Indicate any recommended repairs;

- Prioritize action items; and,
- Submit final documents in electronic format and hard copy.

1.1 Description of Structure

The dam is comprised of a concrete section (incorporating a concrete spillway) and earth berms to the north and south. The 15.3m wide spillway has an upper elevation of 111.33m (the new operating level of the reservoir) while the concrete sections on either side of the spillway have an elevation of 112.28 m. At the operating level of the reservoir, the dam has approximately 0.95 m of freeboard. The southern section of the concrete dam extends approximately 39.1 m to the south rock abutment. The northern section of the concrete dam extends 13.3 m to the north of the spillway section, where it joins the earth berm. The north berm extends approximately 135 m to the north rock abutment. A new earth berm (approximately 68.5m long) was installed in a valley to the south of the existing structures in 2006. The berm sections of the dam incorporate a concrete cutoff wall which is reportedly founded in rock and has an upper elevation of 112.30 m (approximately 0.97m of freeboard). The concrete section of the dam is also reportedly founded in rock.

2. HISTORY & BACKGROUND

Throughout the time span of available historical data, which extends back to 1984, there have been numerous events relating to the safety and serviceability of the dam structures. The following is a summary of available historical data, including; repair programs, past Dam Safety Reviews (DSR's) and DSI's:

- In November 1984 joint and patch repairs were made to localized areas on the upstream side of the spillway structure by diving contractors. Reporting was minimal.
- In June 1990 an inspection report of the structure by diving contractors was made following construction blasting. The 1984 repair areas were also assessed. The 1984 repairs were noted to have generally deteriorated. No conclusions were made. Reporting was minimal.
- In June 1990 a visual inspection report was prepared for the City by an engineering consultant, as a result of the construction blast. No significant damage was noted, and no recommendations were made for repair.
- In July 1990 a dam inspection and stability report was conducted for the City by an engineering consultant. Recommendations were made regarding repair of leaking joints, and provisions to increase stability should the dam be raised in the future.
- In September 1990, a diving contractor performed crack repairs and prepared an inspection report. Repair material used was oakum. These repairs appeared to generally address areas observed in the June 1990 diving inspection. Reporting was minimal.
- In October 1997 a visual inspection report was prepared for the City by an engineering consultant. Leaking cracks were identified; however, these were not viewed as being structurally significant. It was recommended that leaking cracks be chemically grouted. This work was not done.

- In June 1998, a study was prepared for the Department Of Public Works by an engineering consultant to assess the hydrological impact of a dam failure on a proposed downstream hospital site.
- A diving inspection was reportedly carried out in 1999. A report was not submitted. A video record was provided. The video provides images of the water intake, but no record of the condition of the dam.
- In 2001, a DSR was conducted for the Lake Geraldine Dam and Sewage Lagoon.
- In 2002, the dam was visually assessed, a diving inspection performed, and a DSI was prepared, which cited the need for grouting repairs to actively leaking cracks.
- In 2003, grouting repairs were undertaken, primarily to seal actively leaking cracks, in particular, a larger flow crack on the south transition of spillway and gravity sections. A DSI report was prepared.
- A geotechnical report was completed in 2005 prior to the vertical expansion.
- A DSI report was prepared in 2005 and 2006.
- A DSR was conducted in 2006 because of the modifications (vertical extension) to the Lake Geraldine Dam in 2005 and 2006
- No DSI's were conducted in 2007 or 2008.
- DSI's were conducted in 2009, 2010, 2011 and 2012.
- An Underwater Survey was conducted in 2010.
- An Inundation Study for the Emergency Preparedness Plan was conducted in 2011/2012.
- Grouting repairs were completed in 2011.
- Repairs to the North Berm were conducted in 2012 due to the washout event of 2010.
- In August 2012, Concentric provided periodic monitoring of water accumulation areas on both sides of the vehicle access ramp. These areas were initially identified in 2010.
- In 2011 and 2012, Concentric investigated the suspect areas and conducted limited invasive openings to determine if a source was the 2006 cut-off wall interface. These investigations were inconclusive.
- In August 2012 monitoring confirmed little or no water accumulation in summer months. The water accumulations were most evident in late winter and early spring.
- In June 2013, Concentric prepared a scope of work for a proposed 12 month monitoring term, commencing August, 2013.
- Dam Safety Inspection October 2014, completed by McMillen LLC.

4. LAKE GERALDINE 2015 DAM DSI

4.1 Dam Classification (DSG Section 2)

Based on the Dam Safety Guidelines, and the dam structure itself, the Lake Geraldine Dam has a "Very High" Dam Classification. The "Very High" dam consequence class is

assigned by the DSG, in the case of population at risk if the population at risk is ordinarily located in the dam-breach inundation zone (permanent residents).

In the case of incremental losses, a "Very High" dam consequence classification is assigned for the three sub-categories as follows:

a) Incremental Loss of Life: if the loss of life is fewer than 100 persons.

b) Incremental Losses in Environmental and Cultural Values: if there is significant loss or deterioration of critical fish or wildlife habitat, but the restoration or compensation for the loss is possible but impractical.

c) Incremental Losses in Infrastructure and Economics: if there are very high economic losses affecting important infrastructure or services (e.g., Highway, industrial facilities, storage facilities for dangerous substances).

In the case of the Lake Geraldine Dam, both a) and c) are deemed to apply.

Under the guidelines it is required to have a Dam Safety Review every five (5) years for those structures with a "Very High" dam consequence class.

4.2 Site Review

A visual site inspection of the dam structures was performed on September 23 – 24, 2015. The inspection was non-invasive in nature, and did not include an underwater survey or assessment.

A summary of observed conditions is as follows:

- The reservoir level was at capacity (the top of the spillway) at the time of our review.
- No significant changes were noted in the general condition of the concrete and earthworks portions of the dam.
- Areas of active seepage/leakage were observed to be occurring at locations identified in previous DSI's.
- The visible portions of the concrete structures are generally in good condition. There was no evidence of distress or overstressing of any portion of the visible concrete structures.
- No significant changes in the concrete structure were observed however, relatively minor seepage through the dam was observed within the spillway, north and south abutments.
- The north and central berms appeared to be in a stable condition. Slopes of 2H:1V appeared to be maintained on the downstream, rip-rap, and in the upstream rock fill.
- Minor erosion of the top of the berm was observed at the interface between the north abutment and south-end of the central berm.
- Displacement and erosion of the granular fill and exposure of the geotextile fabric was observed along the east elevation (upstream) at south end of the central berm.
- Displacement of the rock fill and exposure of the geotextile fabric was observed within the downstream drainage channel at the base of the concrete spillway.

- Signage around the dam facility is in disrepair, or missing entirely.
- Minor erosion of the north access road has begun to occur.
- The steel cover atop the valve chamber adjacent to the south side of the concrete spillway had been removed and evidence of unauthorized access were apparent within the chamber. The City of Iqaluit was notified and maintenance staff was dispatched to re-install the cover. The valve controls within the chamber appear to be in an advanced state of corrosion.
- Seepage within the berm is controlled by the concrete cutoff wall; however, no consideration has been made for the monitoring of hydraulic gradients across the berm.

5. SUMMARY RECOMMENDATIONS & REQUIRED ACTION

Based on our inspection, review, and analyses, we summarize the results of this DSI as follows:

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6. LIMITATIONS

This report was prepared for the sole use of The City of Iqaluit.

This report was prepared exclusively for the purposed project and site locations outlined in this report.

The report is based on information provided to, or obtained by Concentric as indicated in the report, and applies solely to site conditions existing at the time of the site investigations.

Concentric's report represents a review of available information with an established work scope, schedule, and budget.

The material in the report reflects Concentric's judgement in light of the information available to it at the time of preparation.

Any uses that a third party makes of this report, or any reliance on decisions made based on it, are the responsibilities of such third parties.

Concentric accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made based on this report.

Should there be any questions, please contact the undersigned.

Yours sincerely,

Concentric Associates International Incorporated

Randy Scott

Allan Murray, P. Eng.
President

APPENDIX A
Site Photographs

Photo 1: Main dam structure

Photo 2: West elevation of the north and center berms.

Photo 3: East elevation of the north berm.

Photo 4: West elevation of the center berm, note the seepage at the base of the berm.

Photo 5: East elevation of the center berm, note the exposed geotextile membrane.

Photo 6: West elevation of the center berm and dam, note the exposed geotextile membrane within the spillway channel.