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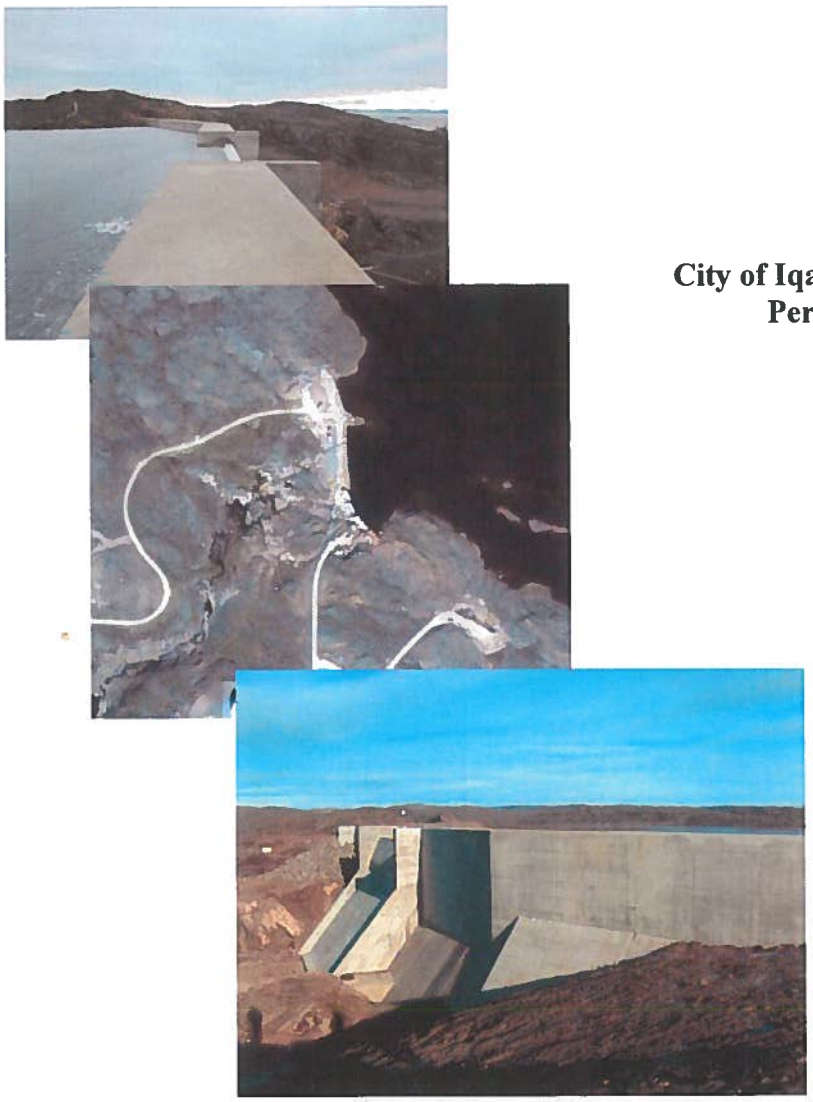

City of Iqaluit Geraldine Dam
Permanent Record File
Iqaluit, Nunavut

PRODUCED FOR:
City of Iqaluit

PRODUCED BY:
CONCENTRIC ASSOCIATES INTERNATIONAL INCORPORATED

CONCENTRIC REFERENCE NUMBER:
11-3717

DATE:
November 4, 2011

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Annual Update Pages

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Instructions

The annual update pages are to be completed on an annual basis. It is recommended that updating occur no later than 13 months after the previous update, and no earlier than 11 months after the previous update.

The update description should contain a brief and concise summary of any additions to the Permanent Record File (PRF) since the last update. Typically this would include a new DSI/DSR, any repairs/maintenance activities, updates to the Permanent Log Book (PLB), new construction, alteration, supplementary historical documents, etc.

The individual that fills in the Name & Signature space in the update pages below will be referred to henceforth in the PRF as the *responsible person*. That person shall be a competent third-party professional retained by the City of Iqaluit, through the Engineering Department.

Please refer to the following example:

Date	Update Notes	Name & Signature
January 2004	Completion of DSI by Dillion; a copy has been added to Tab 6.	ALLAN MURRAY
February 2005	Completion of DSI in February 2005 by Concentric; a copy has been added to Tab 6.	ALLAN MURRAY
December 22 2006	Completion of DSR/ DSI in December 2006 by Concentric; a copy has been added to Tab 6.	ALLAN MURRAY

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Date	Update Notes	Name & Signature
December 11 2006	Completion of DSR dated December 11 2006 by Concentric; copy added to Tab 6. The raising of the earth embankments and concrete gravity dam section was completed in 2006, see Tab 7.	Allan Murray
January 10, 2007	Revisions to and resubmission of DSR	Allan Murray
October 29, 2009	Completion and submission of DSI dated October 29, 2009, by Concentric	Allan Murray
August 12, 2010	Completion of underwater survey by Arctic Divers	Allan Murray
November 23, 2010	Completion and submission of DSI dated November 23, 2010, by Concentric	Allan Murray
May 5, 2011	Berm Investigation by Concentric dated May 5, 2011	Allan Murray

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Date	Update Notes	Name & Signature
July 2011	Grout repairs co-ordinated by Concentric	Steve Parker

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Introduction

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Introduction

The Canadian Dam Safety Guidelines (DSG's) requires that all structures exceeding prescribed height and volume minimums be subject to Dam Safety Reviews (DSR's) and Dam Safety Inspections (DSI's) at regular intervals. The DSR forms a baseline of dam history, condition, repair requirements, and extensive documentation of monitoring, operating, safety and emergency procedures.

The Geraldine dam falls under the requirements of the DSG's. The first DSR conducted on the dam was completed in 2002. The second DSR was completed in 2007. Unless significant alterations to the dam are undertaken, the next DSR will be required in 2017.

The DSG's stipulate that a Permanent Record File (PRF), suitable for transfer to the regulatory agency, (in this case the Nunavut Water Board), should be maintained as an ongoing historical reference. The file is required to contain the following:

- History and Background (Tab 3)
- Operations, Maintenance & Surveillance (OMS) Manual (Tab 4)
- Permanent Log Book (PLB) (Tab 5)
- Records of all DSR's and DSI's (Tab 6)
- As-Built Drawings (And Design Data) (Tab 7)

This PRF requires updating in accordance with the instructions of Tab 1.

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History & Background

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History & Background

In the late 1950's, the demand for a reliable year round source of water in the City of Iqaluit (then Frobisher Bay) resulted in the construction of a cast in place concrete gravity dam, and a section of earth berm with a central cast in place concrete cut off wall. The project was designed and built by the Department Of National Defense. According to the literature, the original construction took place circa 1958.

Since that time, as the City has grown and water demands have risen, the dam has been raised four times to increase the storage capacity.

The first height increase of 0.3m reportedly took place in 1979. This involved a concrete extension, which was dowelled into the existing structure.

The second construction took place in 1985, and increased the height of the spillway structure by approximately 1.15m. The embankment portion was widened and heightened as well to accommodate the increased storage capacity. Again, the extension was constructed of concrete dowelled into the existing structure, and incorporated a steel formwork frame over the spillway section.

The third extension was done in 1995, and increased the height of the gravity dam structure by a further 1.5m of concrete, with a corresponding increase in berm geometry. Based on analysis done prior to the extension, it was determined that the gravity dam would not have an adequate factor of safety against overturning if the extension was simply "dowelled-in" as before. The 1995 alteration therefore included an extensive rock-anchoring program for the gravity dam portion to provide the required stability to the structure.

The latest extension was completed in two phases over 2005/06. Additional rock anchors were installed in 2005 in preparation for a further height extension of 2m in 2006. The existing embankments were enlarged and the existing cut-of-walls were extended in height. A new embankment and cut off wall were installed to the south of the existing dam structures.

In the time span of the available historical data, which extends back to 1984, there have been only a few notable events relating to the safety and serviceability of the dam structures.

- 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 (3) 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 (4) 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 (5,6) 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 (7). 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 (10) 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 (11) 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.

- A DSR (the first on record) was completed in 2002.

- DSI's were conducted in 2002, 2003, 2005, and in 2006 (as part of the DSR)

- Epoxy injection of cracks was completed in 2003, and again in 2005.

- A DSR was completed in 2006 and the final report submitted in January 2007. The DSR was initiated by the dam expansion project.

- DSI's were completed in 2009 and 2010. A DSI was not completed in 2007 or 2008.

- An underwater survey was completed in 2010.

- A grouting program was slated for 2010 but was deferred to 2011.

- The 2011 grouting program is to include berm repairs due to wave scour that occurred in the summer of 2010.

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Overview of Dam, October 2001

Overview of Dam expansion, August 2006

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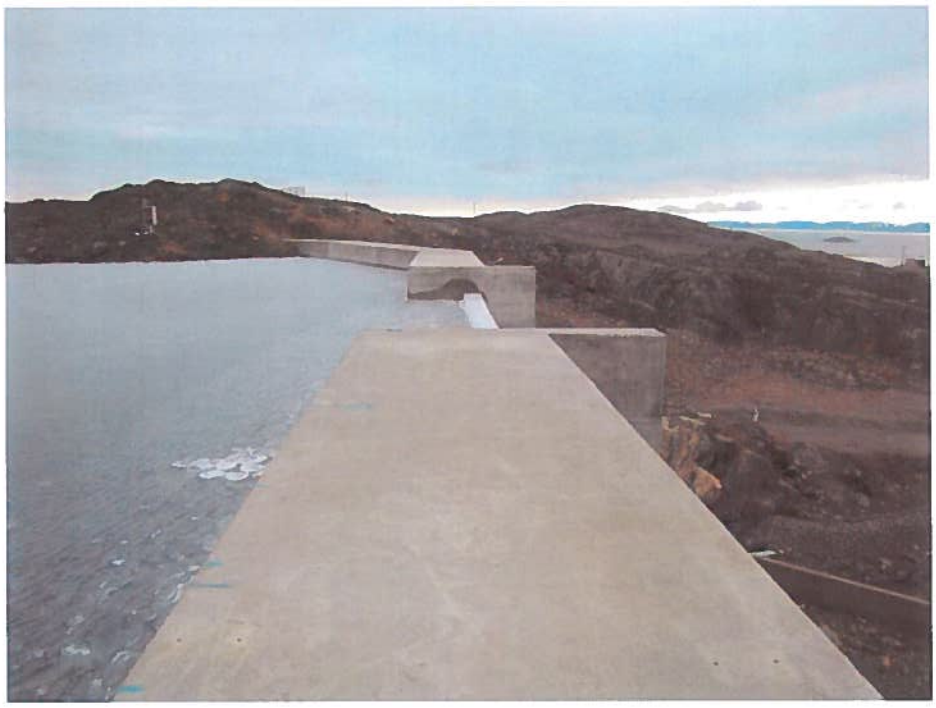
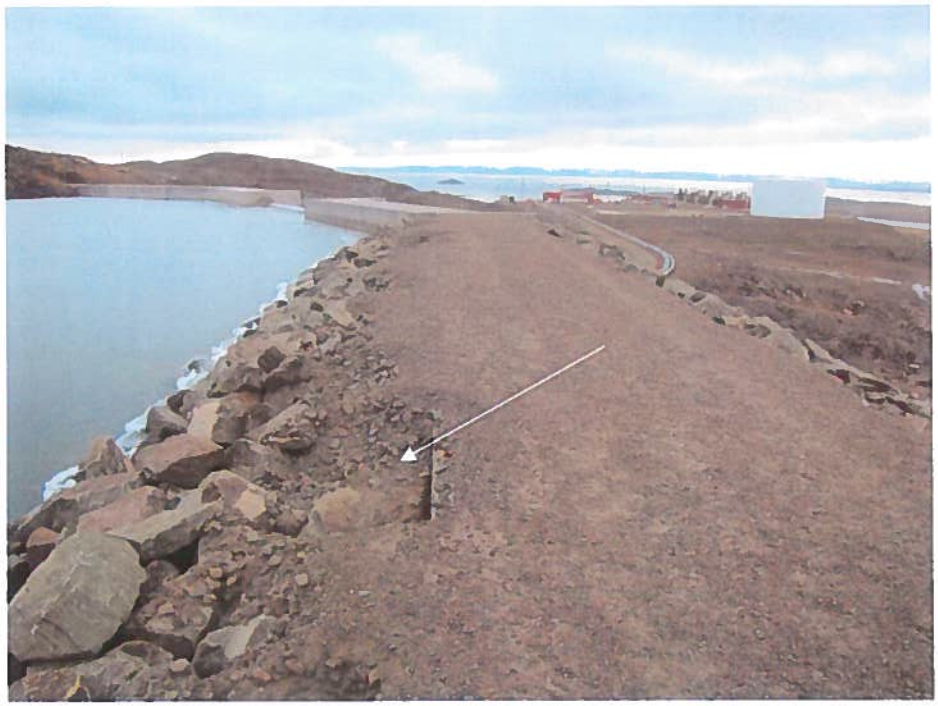


Overview of Concrete Structures & Spillway; Upstream Face; 2010



North Berm Localized Wave Scour; 2010.

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Satellite image of Lake Geraldine and Dam – Google maps 2007

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Overview of Downstream Face; 2010; Note Leakage (at arrow)

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Operations Maintenance & Surveillance Manual

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Operation Maintenance & Surveillance (OMS) Manual

The DSG's require that a dam Operation, Maintenance, and Surveillance (OMS) Manual be provided for every dam structure to which the DSG's apply.

This manual has been prepared in general compliance with the DSG's, and commensurate with the complexity of the dam. The dam has no operable controls, systems and/or components, with the exception of the outlet/supply lines and valves. For this reason the OMS Manual is a fairly brief and rudimentary document.

The following headings are as suggested in the DSG's:

General Description, History, Location, & Access

For a general description, brief history, and photographic record, please refer to Tab 3.

Access to the dam is via Saputi Road. The service roads from the power plant lead directly to the dam.

Chain of Operational Responsibilities

The responsible persons for the Geraldine Dam are, in ascending order:

- Plant Operator*: **Robert Brouillet**
- Utilidor Foreman*: **Shaun Holmes**
- Public Works Operations Superintendent*: **Frank Ford**
- Director of Public Works: **Vacant**
- **Director of Engineering** **Meagan Leach**
- Chief Administrative Officer: **John Hussey**

*These individuals are responsible for regularly scheduled inspections other than DSR's and DSI's.

Requirements for Staff Training

No specific training is warranted

Responsibility and Mechanism for Review and Update

The OMS Manual should be reviewed at each annual update, see Tab 1.

If significant changes/alterations have occurred during the previous year, the OMS manual should be updated/revised to reflect these changes/alterations as appropriate.

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The responsibility for review, updating and revisions to the OMS lies with the responsible person identified in Tab 1.

Requirements for Operation, Maintenance and Surveillance

Lake Geraldine is retained by a structure consisting of a cast in place concrete gravity dam incorporating a spillway section and a cast in place concrete cut-off wall and embankment. There are no significant operating controls, systems, or components.

Operation

The word "operation" in the DSG's is associated with the premise that "the operation of a dam shall not violate any important design assumptions that could impair the safety of the dam." Review of Section 3.2 of the DSG indicates that this section applies to more complex dams with operable flow control equipment, ice rakes, trash racks, penstocks, etc. Simply stated, the dam is not really "operable".

Maintenance

Maintenance procedures as described in Section 3.3 of the DSG are intended to ensure that the structures are maintained in a safe and serviceable condition. In this section the term "maintenance" is intended to mean significant, and not minor, maintenance.

Ordinarily, major maintenance would be triggered by a DSR or DSI, or a regularly scheduled inspection by the Plant Operator, Utilidor Foreman, or Public Works Operations Superintendent.

In the event that major maintenance is warranted in the interval between DSI's, the proposed maintenance and/or concern should be immediately brought to the attention of the responsible person. A decision would then be made on what action to take. Any major maintenance/repairs should be documented in accordance with Tabs 1,5, and 7.

Surveillance & Monitoring

Surveillance and monitoring as described in Section 3.4 of the DSG are intended to ensure that a reasonable degree of inspection and monitoring are undertaken.

Approximately twice per year (recommended times for inspection are early June and mid October) regularly scheduled inspection by the Plant Operator, Utilidor Foreman, or Public Works Operations Superintendent should be conducted and noted in the PLB in Tab 5. The control valve, access, and structure should be inspected for proper operation.

Under the DSG's annual inspections (DSI's) are mandated annually. The DSI's should be conducted by the responsible person, who should also be a professional engineer licensed to practice in Nunavut.

The dam should be inspected immediately after any unusual event such as seismic disturbance, impact damage, vandalism, extreme weather, etc.

There is no set interval for diving inspections; they are conducted in accordance with any recommendations made in the DSI's.

Emergency Preparedness

Section 4 of the DSG's involves Emergency Preparedness. The primary requirement is that an Emergency Preparedness Plan (EPP) exists. An EPP should describe the actions to be taken by the owner and operator in the event of an emergency. The EPP should include the following:

- Emergency identification and evaluation
- Preventative action
- Notification procedure and flowchart
- Response during darkness, adverse weather, etc.
- Available resources and their allocation
- Inundation maps, based on an Inundation Study

Currently an Emergency Preparedness Plan (EPP) does not exist. It is expected that the EPP would be completed in the future.

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Permanent Log Book

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Instructions

The DSG's require that a Permanent Log Book (PLB) shall be provided for every dam structure to which the DSG's apply. The logbook should contain notations or records of the following:

- Changes to normal operation
- Unusual events or conditions
- Inspection activity
- Weather conditions and trends
- Unusual maintenance activities
- Tests of any control equipment

The Permanent Log Book (PLB) is to be updated in accordance with these instructions. All updates should be completed either on the same day as the event noted or within 24 hours of the event. The PLB should be updated by the person that undertakes the particular inspection.

The outlet/supply lines and valves should be inspected for proper operation during the twice yearly regularly scheduled inspections.

Please refer to the following example:

Date	Reason for Inspection	Actions Required	Name & Signature
August 15 2006	DSI/DSR Conducted by Concentric	Nothing immediate; report will be added to the PRF in Tab 6	
June 30 2005	Regular Inspection by Plant Foreman	None	
August 6 2005	Unscheduled Inspection by Plant Foreman due to seismic activity.	No obvious problems. Continue to monitor, another inspection will be done tomorrow.	

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Date	Reason for Inspection	Actions Required	Name & Signature
August 15 2006	DSI/DSR conducted by Concentric	• Permanent Record file required • Conduct DSI in 2007 • Conduct underwater inspection in 2007 • The city does not have sufficient record documentation on file.	Allan Murray
October 21 2009	DSI Conducted by Concentric	• Implement grouting program in 2010 • Update PRF • Prepare EPP	Allan Murray
August 12 2010	Underwater Survey.	Coordinate with grouting program.	Allan Murray
October 18 2010	Wind Events.	Review, assessment, and repair to localized areas of sloughing/scour due to wave action.	Allan Murray
November 1 2010	DSI	• Short and long term repairs to north berm • Implement grouting program for 2011. • Update PRF & DSI in 2011. • Develop EPP.	Allan Murray

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Date	Reason for Inspection	Actions Required	Name & Signature

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Dam Safety Reviews & Dam Safety Inspections

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Instructions

This Section contains copies of all Dam Safety Inspections and Dam safety Reviews conducted on Geraldine Dam. The documents should remain in chronological order.

Whenever a new document is added it should be noted in the Annual Update Pages, (Tab 1), a notation of the associated site inspection should be noted in the Permanent Log Book, (Tab 5), and added to the register in this Section, below.

REGISTER of DAM SAFETY REVIEWS & INSPECTIONS

Date	Document
February 2002	Dam Safety Review by Trow
January 2003	Dam Safety Inspection by Dillon.
January 2004	Dam Safety Inspection by Dillon.
February 2005	Dam Safety Inspection by Concentric.
December, 2006	Dam Safety Review by Concentric.

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REGISTER of DAM SAFETY REVIEWS & INSPECTIONS

Date	Document
October 29, 2009	Dam Safety Inspection (DSI) by Concentric.
August 12, 2010	Underwater Survey by Arctic Divers – although not a DSI or DSR, this complementary report is included here for continuity.
November 23, 2010	Dam Safety Inspection (DSI) by Concentric.

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CITY OF IQALUIT
DAM SAFETY REVIEW FOR
LAKE GERALDINE DAM

Trow Consulting Engineers Ltd.

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Executive Summary

The City Of Iqaluit retained Trow Consulting Engineers Ltd., (Trow), in October 2001, to prepare a Dam Safety Review (DSR) for the Lake Geraldine Dam.

The DSR was conducted in October and November 2001, in accordance with the Dam Safety Guidelines, (DSG) prepared by the Canadian Dam Association.

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

1. The dam has been classified as having a High Consequence Category.

2. The concrete gravity sections of the dam is in a safe and serviceable condition at this time, and are in general compliance with the required design and performance standards of the DSG, where applicable and appropriate for the structure. Safety improvements are not required at this time.

3. The embankment section of the dam is in a serviceable condition at this time, however, concerns exist with the future stability of the steeper sloped areas. This portion of the dam does not meet the design and performance standards of Sections 5 and 8 of the DSG. Specifically, factors of safety for dynamic and static stability are significantly lower than required minimums, particularly on the steeper upstream face of the embankment. It is recommended that the design of safety improvements be undertaken, for implementation in 2002.

4. The entire dam is in non-compliance with the requirements of Sections 3 and 4 of the DSG. The following documents do not exist at this time:

   - Permanent File
   - OMS Manual
   - Logbook
   - Emergency Preparedness Plan

   The above documents need to be developed and maintained. An understanding to proceed with the creation of these documents should be demonstrated as soon as practically possible.

5. The structures should have a Dam Safety Inspection (DSI) conducted in 2002. This is essentially a yearly non-invasive review comprising a visual inspection to identify any changes in condition, or any observed concerns.

6. An underwater inspection of the submerged structures should be done in 2002. This inspection should be coordinated with, and be under the direction of, the DSI recommended in Item 5, above.

1. Introduction & Scope Of Work

The Nunavut Water Board, as a condition of the City's water licence, required the City Of Iqaluit to complete an inspection of the Lake Geraldine Dam in accordance with the Canadian Dam Association publication, Dam Safety Guidelines (DSG), published in January 1999.

The DSG applies 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 minimums.

The DSG document is far reaching in terms of applicability and requirements for conformance. This is understandable as the type and complexity of structures that fall under the jurisdiction of the document varies considerably, from relatively small and simple embankments or dikes to massive and complex dams associated with hydroelectric generating facilities, irrigation, flood control, etc.

The DSG requires that all structures exceeding the height and volume minimums described above be classified according to their "consequence category", that is, the consequence of dam failure in terms of life safety, and socio-economic impact. The category assigned may range from very low to very high. The consequence category dictates the requirement and frequency of Dam Safety Reviews.

A Dam Safety Review (DSR) is a comprehensive, formal review process, conducted at regular intervals, that involves completion of checklist items in accordance with the Dam Safety Guidelines. The DSR forms a baseline of dam history, condition, repair requirements, and extensive documentation of monitoring, operating, safety and emergency procedures.

The frequency of DSR's varies depending on consequence category. For structures where significant life safety and/or socio-economic consequence exist, the DSR is usually conducted every five (5) to ten (10) years. In the case of the Lake Geraldine Dam, the required interval is seven (7) years.

It is required in the DSG document that in the interval between DSR's, a Dam Safety Inspection (DSI) would be performed on an annual basis. The DSI is a much less comprehensive review, comprising a visual inspection to identify any changes in condition, or any observed concerns. The results of the DSI are incorporated into the DSR documentation. A DSI may trigger repairs, or changes in standard operating procedures.

Under the current DSG, a DSR was required for the Lake Geraldine Dam simply because no previous DSR exists.

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

- Importance of structure
- Complexity of structure
- Consequences of failure

- Completeness, continuity, and availability of record documentation
- Current condition

Reasonably extensive documentation exists for the Lake Geraldine Dam, however, as this will be the benchmark document for any subsequent inspection, we have included a complete review of the required tasks.

A summary of the methodology to complete the work is presented below:

1. Acquired and assembled chronological documentation, including but not limited to:

    - Design Documents
    - Repair Specifications
    - Past Condition Assessment Reports
    - Records of Alteration

    The bulk of the record documents were retrieved from the City records.

2. Reviewed all available record documentation.

3. Performed a site inspection to assess the current condition of the structures. No invasive work was performed; the condition assessment was visual in nature. Invasive assessment was not believed necessary given the amount of record documentation available.

4. Interviewed maintenance and management personnel as required and appropriate.

5. Executed the DSR checklist of items.

6. Preparation of the draft DSR report, complete with site surveys, photographs, structural sections, field notes, discussions and recommendations as required and appropriate. Submission to and discussion with the City Engineer.

7. Submission of the final DSR report.

2. HISTORY & BACKGROUND

In the following chronological summary, record documents have been referenced. After each reference, a number appears in parenthesis. That number corresponds to tabulated record document numbers in Section 4, where details are provided on the document source.

2.1 Reservoir

The City of Iqaluit derives its water supply from Lake Geraldine, which is retained by a structure consisting of a cast in place concrete gravity dam incorporating a spillway section and a cast in place concrete cut-off wall and embankment. All concrete structures are believed to be founded on rock, and engage rock at their abutments.

Lake Geraldine is a natural body of water in an irregularly shaped basin. It is fed by rainfall and snow/ice melt from a watershed with an area of approximately 385 hectares.

2.2 History

In the late 1950's, the demand for a reliable year round source of water resulted in the construction of a cast in place concrete gravity dam, and a section of earth berm with a central cast in place concrete cut off wall. The project was designed and built by the Department Of National Defense. According to the literature, the original construction took place circa 1958.

Since that time, as the City has grown and water demands have risen, the dam has been raised three times to increase the storage capacity.

The first height increase of 0.3m reportedly took place in 1979. This involved a concrete extension, which was dowelled into the existing structure.

The second construction took place in 1985, and increased the height of the spillway structure by approximately 1.15m. The embankment portion was widened aand heightened as well to accommodate the increased storage capacity. Again, the extension was constructed of concrete dowelled into the existing structure, and incorporated a steel formwork frame over the spillway section, which remains to this day.

The third extension was done in 1995, and increased the height of the gravity dam structure by a further 1.5m of concrete, with a corresponding increase in berm geometry. Based on analysis done prior to the extension, it was determined that the gravity dam would not have an adequate factor of safety against overturning if the extension was simply "dowelled-in" as before. The 1995 alteration therefore included an extensive rock-anchoring program for the gravity dam portion to provide the required stability to the structure.

In the time span of the available historical data, which extends back to 1984, there have been only a few notable events relating to the safety and serviceability of the dam structures.

- 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 (3) 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 (4) 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 (5,6) 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 (7). 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 (10) 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 (11) 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.

2.3 Description Of Structure

A general arrangement drawing of the dam is provided in Appendix 4 of this report. The concrete sections on either side of the spillway have an elevation of 110.28 m, with the crest of the 15.7 m wide spillway section being at elevation of approximately 109.33 m, which represents the normal operating level of the lake. At this level, the dam has

approximately 0.95 m of freeboard. The southern section of the dam extends approximately 32.7 m to the south rock abutment. The northern concrete section of the dam extends 13.3 m to the north of the spillway section, where it joins an extended, narrow (~200 mm wide) concrete cut-off wall, which is supported on both sides by a sand & gravel and rock fill embankment. The embankment cut-off wall extends approximately 80 m to the north rock abutment. The concrete dam and the concrete cut-off wall are reportedly founded on bedrock. The top of the concrete cut-off wall is reportedly at elevation 110.30 with the top of the embankment being at elevation 110.50m. It is therefore our understanding that the elevation of the top of the concrete cut-off wall in the embankment portion of the dam is at least equal to the elevation of the top of the concrete gravity dam portion of the dam.

2.4 Relevant Record Documents

The following documentation has been utilized in the preparation of this report. Other record documentation was provided but not directly applicable to the DSR.

TABLE I
RELEVANT RECORD DOCUMENTATION
LAKE GERALDINE DAM

No.	Date	Description	Author
1	December 1957	Water Storage Dam at Lake Geraldine (3 Drawings)	DND
2	August 1984	Lake Geraldine Water Supply Report	OMM
3	January 1985	Water Supply Improvement Report	OMM
4	June 1990	General Diving Report	Arctic Divers
5	June 1990	Dam Inspection for Blast Damage	Hardy BBT
6	July 1990	Dam Inspection & Leakage Repair	Acres
7	July 1990	Dam Stability	Acres
8	Sept. 1990	Diving Report	Arctic Divers
9	Feb. 1995	Lake Geraldine Storage Report	OMM
10	June 1995	Lake Geraldine Storage Design Dwgs. & Specifications	OMM
11	October 1997	Dam Inspection	Trow
12	June 1998	Dam Failure Study	EBA

3. Commentary On Dam Safety Review Requirements

According to the Dam Safety Guidelines, the document applies 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 minimums.

The Dam Safety Guidelines document is far reaching in terms of applicability and requirements for conformance. This is understandable as the type and complexity of structures that fall under the jurisdiction of the document varies considerably, from relatively small and simple embankments or dikes to massive and complex dams associated with hydroelectric generating facilities, irrigation, flood control, etc.

The document requires a systematic checklist review, which includes the following items. For each item, the applicable Section number from the Dam Safety Guidelines is shown in parenthesis.

1. Dam Classification (1)
2. Site Inspection (2)
3. Design & Construction Review: (2)
   - 3.1. Earthquakes (5)
   - 3.2. Floods (6)
   - 3.3. Discharge Facilities (7)
   - 3.4. Geotechnical Considerations (8)
   - 3.5. Concrete Structures (9)
   - 3.6. Reservoir & Environment (10)
   - 3.7. Construction (11)
4. Operation & Testing (2,3)
5. Maintenance (2,3)
6. Surveillance & Monitoring (2,3)
7. Emergency Preparedness (2,4)
8. Compliance With Previous Reviews (2)

4. Lake Geraldine Dam DSR

DAM CLASSIFICATION (DSG SECTION 1)

Based on the Dam Safety Guidelines, and the dam structure itself, the Lake Geraldine Dam has a consequence category of "High" for both the *Life Safety* and *Socioeconomic, Financial and Environmental* categories. The "High" classification is assigned by the DSG, in the case of life safety, if loss of life would likely occur as a result of dam failure. A "High" category is assigned in the socioeconomic category if, in the event of a dam failure, the cost to the community in terms of social and financial impact would be significant. Under the guidelines it is required to have a Dam Safety Review every seven (7) years for those structures with a high consequence category.

SITE INSPECTION (DSG SECTION 2)

A visual site inspection of the dam structures was performed in October 2001. The inspection was non-invasive in nature, and did not include an underwater assessment. A photographic and video record of our inspection was made, and appends this report.

A summary of observed conditions is as follows:

- The visible portions of the concrete structures are generally in good condition with minor concrete durability issues, such as localized scaling and spalling, visible. In addition, a few localized areas exhibited concrete spalling due to embedded formwork remnants.

- Several actively seeping cracks were observed. These cracks are generally vertical in orientation and hairline in width, as would be expected for shrinkage (non-structural) cracking. The location and extent of shrinkage cracking has not changed significantly since the 1997 inspection. The recommendation from the 1997 report to chemically grout actively leaking cracks was not carried out.

- The rate of leakage through the control joint south of the spillway section has not changed significantly since the 1997 inspection. Some digging is required here to expose the joint down to rock and determine whether an upstream or downstream repair is likely to be more successful.

- There was no evidence of distress or overstressing of any portion of the visible concrete structures.

- Minor corrosion of the 1985 spillway extension frame. As this frame was primarily used for forming, cleaning and re-painting are considered to be desirable, albeit cosmetic repairs.

- The north cut-off wall, including the embankment section, appears to be founded on bedrock. The crest width of the embankment is approximately 4.5 m to 5.0 m, with a wider section near the north abutment. The crest material consists of granular material.

- The upstream side slopes of the embankment section consist of 300 mm to 600 mm sized rock fill, placed at a relatively flat slope near the northern abutment but at a much steeper angle near the interface with the concrete gravity section of the dam (i.e. slope angles appeared to be approximately at 1.25H:1.0V). An approximately 20 m length of the upstream slope, just north of the concrete gravity dam terminus, extending ~ 1.0 m to 1.5 m into the crest, has slumped by approximately 100 mm. This is believed to be a result of the overly steep side slopes in this area.

- The downstream slope of the embankment section ranges from approximately 1.5H:1V at the deepest section to 3H:1V in the shallow areas. The downstream face is protected with a layer of minus 300 mm sized rock fill.

DESIGN & CONSTRUCTION REVIEW (DSG SECTION 2)

This section constitutes the bulk of the Dam Safety Review process. The intent is to determine if the existing dam configuration satisfies performance criteria given in the DSG for safety and serviceability, in response to likely loads impinging on the structure. We have followed the format in the DSG document for convenience and clarity.

Earthquakes (DSG Section 5)

According to the DSG, dams shall be evaluated to withstand a Maximum Design Earthquake (MDE) without release of the reservoir. For a High Consequence Category, the DSG requires evaluation at 50% - 100% of the Maximum Credible Earthquake (MCE). To paraphrase the DSG, the MCE is defined as the largest reasonably conceivable earthquake that appears possible under the presently known tectonic framework.

Concrete Gravity Dam Portion

For the concrete portions of the dam, two sections were assessed; the spillway section and the gravity dam itself. For each section, the worst case was assessed, which corresponded to the maximum retained height, that is, the maximum distance from the lake bottom at the base of the dam, to the crest of the dam. As the lake bottom tends to undulate, the retained height varies to some degree.

Our analysis has based the MCE on statistical seismic data in the National Building Code (NBC) 1997, specifically zonal velocities and accelerations for the Iqaluit area. The calculation involves deriving a resultant force proportional to the mass of the structure, and includes an allowance for the inertial effect of the retained water. We have used 100% of the calculated MCE as our Maximum Design Earthquake. That value is 68 kN

per meter width of the gravity dam section, and 73 kN per meter width of the spillway section. Summary calculations append this report.

The MDE loads were applied in combination with other loads in accordance with Section 9.4 of the DSG, Load Combinations, Concrete Structures.

In the load combination case involving the MDE, the overall contribution of seismic loads is less than 10%, and is not considered significant compared to uplift and hydrostatic forces, and therefore does not govern the performance of the structure.

Embankment Dam Portion

Stability analyses indicate somewhat lower than acceptable factors of safety for the upper shallow section of the steeper slope along the downstream face of the embankment under the design seismic conditions, assuming a horizontal and vertical acceleration of 0.1g. However, the main body of the downstream embankment is considered stable under earthquake loading conditions. The upstream section of the embankment has factors of safety of less than 1, indicating potentially unstable conditions. Since the main lower section of the embankment was originally constructed and compacted in the dry, a liquefaction type of failure is not anticipated. Remediation of the upstream section is recommended, and is discussed below.

Floods (DSG Section 6)

According to the DSG, dams shall be evaluated to safely pass an Inflow Design Flood (IDF), which is based on Consequence Category and the Probable Maximum Flood (PMF). The PMF is an estimate of the most severe "reasonably possible" flood at a particular location and time of year. For a High Consequence Category, the DSG requires an IDF with an Annual Exceedence Probability (AEP) of between 1/1000 and the PMF.

For this review, the Inflow Design Flood (IDF) used had an AEP of 1:1000 years. The IDF was determined through statistical analysis. The maximum daily flow rates for the nearby Sylvia Grinnel River was used in the analysis. The drainage area for the river is approximately 298,000 hectares. There are 29 years of flow measurements with 17 years that include the maximum daily discharge. To determine the IDF seventeen years of data were ranked in descending order. The Cunane formula was used to plot the data on lognormal probability paper. The 1:1000 year maximum daily discharge for the Sylvia Grinnel River was estimated with this method as 765 cubic meters per second. The flow was then transferred to the 385 hectare Lake Geraldine drainage area.

The results indicate that the estimated maximum daily inflow for Lake Geraldine is 14.1 (m^3/s).

To estimate the flow capacity of the existing spillway configuration, the weir formula is used to estimate the flow, as follows:

$Q = CLH^{3/2}$ (ft^3/s)

With C = 3.9 (weir coefficient)
L = 49.2 feet (15.7 metres)
H = 3 feet 1.5 inches (0.95 metres)

Therefore, Q = 1056 ft^3/s (30.0 m^3/s)

It should be noted that the difference between drainage areas in the analysis is large therefore some errors may occur. However the above calculations show that the spillway can handle significantly higher flows.

Based on our analysis, the spillway structure, in its current configuration, can safely pass the estimated Inflow Design Flood.

Discharge Facilities (DSG Section 7)

Section 7 of the DSG has a broad applicability that includes flow control equipment, instrumentation, and emergency backup equipment, which are relevant to more complex structures. In the case of the Lake Geraldine Dam, the applicability really only involves the spillway section.

According to the DSG, discharge facilities shall be capable of passing an Inflow Design Flood (IDF) without adversely affecting the freeboard. Freeboard is defined as the vertical distance between the water surface elevation and the lowest elevation of the top of the containment structure.

The freeboard should satisfy the requirements of section 7.2 of the DSG, Freeboard. That section indicates that sufficient freeboard be provided such that the percentage of overtopping waves during extreme flood or wind conditions is limited to an amount that would not lead to dam failure.

The Lake Geraldine Dam essentially has only one effective discharge facility, that being the spillway section. Normal water levels are at or slightly below the spillway discharge elevation, which yields a freeboard of approximately 0.95m (3 feet 1.5 inches).

Based on our analysis, the spillway is capable of passing an Inflow Design Flood. Wave action overtopping the gravity structure is not considered significant given the relatively small fetch of the lake.

Section 7 also requires consideration of the following for discharge facilities:

- Resistance to erosion
- Capability to pass floating debris

Erosion is not considered significant because of the rock foundation and concrete construction. Floating debris has historically not been a problem because of geographic location. The spillway dimensions and configuration are such that there are no obstructions to impede debris.

Geotechnical Considerations (DSG Section 8)

Section 8 of the DSG presents Geotechnical considerations for proposed dams, as well as for several configurations of existing dams.

Concrete Gravity Dam Portion

Not applicable, due to the dam being concrete on a competent rock foundation.

Embankment Dam Portion

The stability of the deepest section of the embankment section of the dam was analysed under various loading conditions. Static stability analyses, under both normal and flood level lake conditions on the upstream side of the dam, were carried out.

The Dam Safety Guidelines require a minimum factor of safety of 1.5 for steady state seepage conditions with a maximum storage pool. The stability analyses indicate a low factor of safety (~1.205) along the steep face of the dam and 1.34 for a deeper-seated failure.

With a maximum upstream water level, the dam has a factor of safety of 1.44 against a total failure, which would cause a major breach in the dam. The compacted granular fill and the presence of the concrete cut-off wall provides some stability, but their primary function is to maintain a low phreatic (water) level across the embankment, and the overall contribution of the cut-off wall to the embankment dam stability is not significant.

The upstream side of the embankment, with its steep slopes, appears to be potentially unstable. Some slumping of a section of the embankment was observed during the site visit. Factors of safety range from 1.025 to 1.168, which is considerably less than required.

Concrete Structures (DSG Section 9)

Section 9 of the DSG applies to concrete structures founded on strong, competent rock. Based on our review of the record data, and the dam performance over the last 43 years, it is believed that the foundations are indeed competent rock, and that invasive conformation and/or assessment is not warranted at this time.

Our assessment follows the format of Section 9 as follows:

Section 9.2 – Condition Of Structures And Site

The structure was visually inspected on site as described above. At the time of our visit, we did not observe any conditions that would adversely affect the structural adequacy and/or performance.

Observations that are considered minor at this time include:

- Several shrinkage cracks, actively seeping at a low rate.
- One joint leak estimated at 2-4 liters per minute, south of the spillway section.
- A few areas of spalling and delamination, due to embedded formwork.
- Corrosion of the 1985 spillway extension frame.

No general concrete deterioration problems were noted.

Section 9.3 – Loads

Loads used in our assessment of structural stability were in conformance with this sub-section, with the exception that Temperature (T) and backfill/silt deposit loads (S) were not considered applicable.

Temperature effects were not considered due to the relatively small size and length of the gravity dam.

Backfill/silt loads were not considered as there is no evidence of significant silt accumulation in the documentation.

A summary of loads considered is as follows:

- D Dead loads of permanent structures
- H, H_F Maximum normal and flood headwater levels, respectively
- U Internal (uplift) water pressure
- I Thrust created by an ice sheet
- Q Maximum design earthquake

Section 9.4 – Load Combinations

Load combinations used in our assessment of structural stability were in conformance with this sub-section, with the exception that the "Unusual Loading" case was not considered applicable. A summary of load combinations considered is as follows:

- Usual $D+H+I+U$
- Flood $D+H_F+U$
- Earthquake $D+H+Q+U_Q$

Section 9.5 – Design And Analysis

A static and seismic analysis was performed on the dam using the above loads and combinations, and considering the following:

- Sliding
- Overturning
- Overstressing

Based on our analysis, and site inspection, the dam structure is deemed adequate to resist the above effects. The minimum factor of safety for overturning and sliding were calculated to be 1.33 and 1.72, respectively.

Typically, we would require minimum factors of safety for overturning and sliding of 1.5 and 2.0, respectively, for an existing structure.

Although the calculated values are slightly below our usual norms of acceptance, it is our opinion that the stability of the dam is adequate and would satisfy minimum factors of safety under more sophisticated analysis, for the following reasons:

1. The calculated factors are for the worst case load combination at the spillway section, which is the weakest link of the structure. The section was analyzed as if it was a stand-alone structure. In reality, the spillway section is relatively narrow in elevation, and directly engages the wing walls of the gravity section at each end. Given these boundary conditions, we believe the factor of safety would be similar to the 1.6 calculated for the gravity section.

2. The sliding calculation does not take into account the resistance offered by the rock anchors, which is significant, and would likely result in a factor of safety against sliding well in excess of 2.0.

Copies of our sliding and overturning calculations append the report.

Section 9.6 – Performance Indicators

The DSG recommends that the assessment of concrete dams include the following performance indicators:

- Position of resultant force
- Normal stresses at the heel and toe
- Sliding factors
- Observed conditions, based on records of permanent monitoring equipment such as joint meters, plumb lines, monument displacement, piezometric pressures, extensometers, and accelograms.

We have determined that the resultant force for the "Usual" load case is within the middle third of the section, as required. Normal stresses are also within acceptable limits.

Expressions to determine sliding factors are not considered applicable due to the rock anchor retrofit program of 1995. To our knowledge, no permanent monitoring instrumentation exists at or remote from the site.

Section 9.7 – Acceptance Criteria

This sub-section presents commonly accepted values for sliding factors. As mentioned above, the expressions for sliding factors are not considered applicable due to the rock anchor retrofit program of 1995. Concrete strength factors are within acceptable limits.

Reservoir & Environment (DSG Section 10)

According to the DSG, the following conditions should be assessed as they relate to the reservoir and environment:

a) The stability of slopes around the reservoir rim.
b) Detrimental affects of groundwater, reservoir water, soil, etc., on dam safety.
c) Silt deposition affecting discharge facilities or dam stability.
d) Hazards to local ecology.
e) Reservoir draw down capability.
f) Reservoir debris and ice should not present an unacceptable risk to dam safety.

The above items are discussed below:

The reservoir rim is a natural rock formation with mild to moderate gradient, and no history of instability.

No detrimental effects, such as aggressive chemical agents, are believed to exist in the groundwater or soils; there is certainly no evidence to warrant consideration.

As discussed above, there is no evidence of significant silt deposits behind the dam.

No significant ecological hazards are known to exist in the reservoir area.

Based on our review and inspection, the only significant items are e), reservoir draw down capability; and f), reservoir ice and debris as it relates to dam safety

Regarding item e), the reservoir does not have rapid draw down capability. Section 10.5 of the DSG indicates a requirement for rapid draw down for those dams subject to severe damage by earthquake, or where a high potential for internal erosion exists. In our opinion, these risk factors do not apply, and rapid draw down is not required.

Regarding item f), we have allowed for ice thrust in our stability analysis. We note that the ice thrust loads may be reduced by partial draw down of the reservoir before major ice loads are developed; this was discussed in the July 1990 Acres report. Debris has historically not been a problem, however, it should be cleared periodically from the upstream face to allow underwater inspections.

Construction (DSG Section 11)

This section applies to new construction and therefore is not applicable.

OPERATION & TESTING (DSG SECTION 2)

The applicable reference section of the DSG is Section 3: Operation, Maintenance, and Surveillance.

The interpretation of this section of the DSG requires clarification on the meaning and intent of the words "operation" and "testing". In this section of the DSG, "testing" generally refers to the testing of equipment required to operate discharge facilities. In the case of the Lake Geraldine Dam, the primary discharge facility is the spillway section. No actual equipment exists. Therefore, there is no testing requirement for this structure.

The word "operation" in the DSG is associated with the premise that "the operation of a dam shall not violate any important design assumptions that could impair the safety of the dam." Review of Section 3.2 of the DSG indicates that this section applies to more complex dams with operable flow control equipment, ice rakes, trash racks, penstocks, etc. Simply stated, the Lake Geraldine Dam is not really "operable".

Notwithstanding these limitations, there should be some basic operational procedures for ice management and cleaning of upstream debris that would form part of the OMS Manual (see below).

Other applicable requirements of Section 3 are described below.

In the DSR checklist of required items, the DSG indicate that a Permanent Record File (PRF) suitable for transfer to the regulatory agency be maintained as an ongoing historical reference. The file should contain the following:

- OMS Manual (see below)
- Permanent Log Book (see below)
- History and photographic record
- As-Built Drawings
- Performance reports
- All design data
- Records of all inspections and DSR's

Based on our review and correspondence, a PRF does not exist, however, most of the raw data is

readily available.

The DSG indicate that a dam Operation, Maintenance, and Surveillance (OMS) Manual shall be provided for every dam structure. The manual may be quite involved depending on the complexity of the dam. For the Lake Geraldine Dam, an acceptable manual would likely be relatively simple and concise. The manual should contain information and procedures that include the following:

- General description, history, location, access, etc.
- Chain of operational responsibilities
- Requirements for training of involved staff
- Responsibility and mechanism for review and update, including DSR input
- Requirements for operation, maintenance and surveillance as per Sections 3.2, 3.3, and 3.4 of the DSG (See below)

Based on our review and correspondence, an OMS Manual does not exist.

The DSG indicate that a Permanent Logbook shall be provided for every dam structure. The logbook should contain notations or records of the following:

- Changes to normal operation
- Unusual events or conditions
- Inspection activity
- Weather conditions and trends
- Unusual maintenance activities
- Tests of any control equipment

Based on our review and correspondence, a Permanent Logbook does not exist.

MAINTENANCE (DSG SECTION 2)

The applicable reference section of the DSG is Section 3: Operation, Maintenance, and Surveillance.

Maintenance Procedures (MPS) as described in Section 3.3 of the DSG are intended to ensure that the structures are maintained in a safe and serviceable condition.

No formal Maintenance Procedures exist. These should form part of the OMS Manual.

SURVEILLANCE & MONITORING (DSG SECTION 2)

The applicable reference section of the DSG is Section 3: Operation, Maintenance, and Surveillance.

Surveillance Procedures (SPS) as described in Section 3.4 of the DSG are intended to ensure adequate inspection and monitoring. Applicable considerations are as follows:

a) Procedures or requirements for routine visual inspection by staff, including inspection records.
b) Procedures for implementation of any required action as a result of a routine inspection.
c) Procedures or requirements for more detailed regular inspections, such as underwater assessments.
d) Procedures or requirements for special inspections due to extreme events or unusual observations.

No formal Surveillance Procedures exist. These should form part of the OMS Manual.

EMERGENCY PREPAREDNESS (DSG SECTION 2)

Section 4 of the DSG involves Emergency Preparedness. The primary requirement is that an Emergency Preparedness Plan (EPP) exists. An EPP should describe the actions to be taken by the owner and operator in the event of an emergency. The EPP should include the following:

- Emergency identification and evaluation
- Preventative action
- Notification procedure and flowchart
- Response during darkness, adverse weather, etc.
- Available resources and their allocation
- Inundation maps, based on an Inundation Study

Based on our review and correspondence, no formal Emergency Preparedness Plan exists.

COMPLIANCE WITH PREVIOUS REVIEWS (DSG SECTION 2)

No previous Dam Safety Review documents exist at this time.

5. Summary

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

1. In accordance with Section 1 of the DSG, the dam has been classified as having a High Consequence Category.

2. The concrete gravity section of the dam is in a safe and serviceable condition at this time, with no significant changes in visible condition compared to the last (1997) inspection. These sections of the dam are in general compliance with the required design and performance standards of the DSG, Sections 5 through 11, where applicable and appropriate for the structure, as discussed above. Safety improvements are therefore not recommended at this time.

3. The embankment section of the dam is in a serviceable condition at this time, however, concerns exist with the future stability of the steeper sloped areas, particularly on the upstream face. This section of the dam is in general compliance with the required design and performance standards of the DSG, Sections 5 through 11, with the exception of Sections 5 and 8, which involve stability considerations. Safety improvements are recommended below.

4. The dam is in non-compliance with the requirements of Sections 3 and 4 of the DSG. The following documents do not exist at this time:

    - Permanent File
    - Operation, Maintenance & Surveillance Manual
    - Logbook
    - Emergency Preparedness Plan

5. Based on the available record documentation, the submerged portion of the dam has not had assessment **and** reporting of any kind completed since 1990. Although a diving video was reportedly prepared in 1999, there does not appear to be a **thorough** assessment and report prepared over the entire documentation period (45 years).

6. Recommendations & Required Action

1. The structures should have a Dam Safety Inspection (DSI) conducted in 2002, preferably by mid-October of that year. This is essentially a yearly non-invasive review comprising a visual inspection to identify any changes in condition, or any observed concerns. The summary written report generated would form a permanent record document to be included in the Permanent Record File.

2. An underwater inspection, assessment, and detailed reporting of the submerged structures should be considered in 2002. This inspection should be coordinated with, and be under the direction of, the DSI recommended in Item 1, above. Underwater inspections should be carried out with at least the same frequency as Dam Safety Reviews, i.e. every seven years.

3. The embankment portion of the dam does not meet the requirements of Sections 5 and 8 of the DSG. Specifically, factors of safety for dynamic and static stability are significantly lower than required minimums, particularly on the steeper upstream face of the embankment. At this time, it is recommended that provisions be made for the design of repairs, which should be implemented in 2002. Repairs would likely include flattening of upstream slopes.

4. The dam is in non-compliance with the requirements of Sections 3 and 4 of the DSG. The following documents need to be developed and maintained.

    - Permanent File
    - Operation, Maintenance & Surveillance Manual
    - Logbook
    - Emergency Preparedness Plan

5. Conduct a Dam Safety Review by the year 2009.

In terms of time to compliance, it is our opinion that an understanding to proceed be demonstrated as soon as practically possible so as to show intent to comply with the DSG.

We would be pleased to discuss this report with you at your convenience.

Yours truly,

Trow Consulting Engineers Ltd.

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Prepared By:

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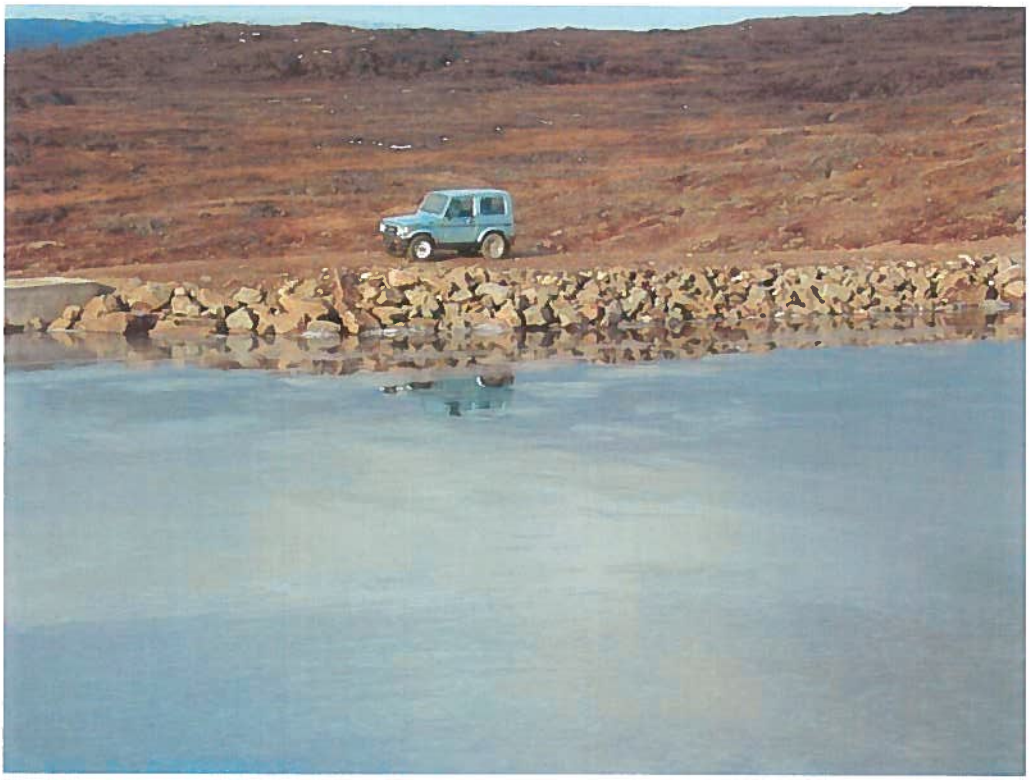
APPENDIX 1
SITE PHOTOGRAPHS
LAKE GERALDINE DAM

Photograph No. 1 – Lake Geraldine Dam overview, upstream side, looking northwest.

Photograph No. 2 – Top of Gravity Dam, looking northwest.

Photograph No. 3 – Spillway section, looking northwest.

Photograph No. 4 – Lake Geraldine Reservoir, looking northwest to embankment portion of dam. Spillway section is at extreme left.



Photograph No. 5 – Close-up of embankment portion at tie-in with Gravity section (at left), upstream face.

Photograph No. 6 – Close up of embankment portion at north termination, upstream face.

Photograph No. 7 – Overview of north end of Gravity elevation and Spillway elevation. Note leaching cracks on Gravity face.

Photograph No. 8 – Overview of southern portion of Spillway section, and south Gravity elevation. Note leaching cracks in Gravity face.

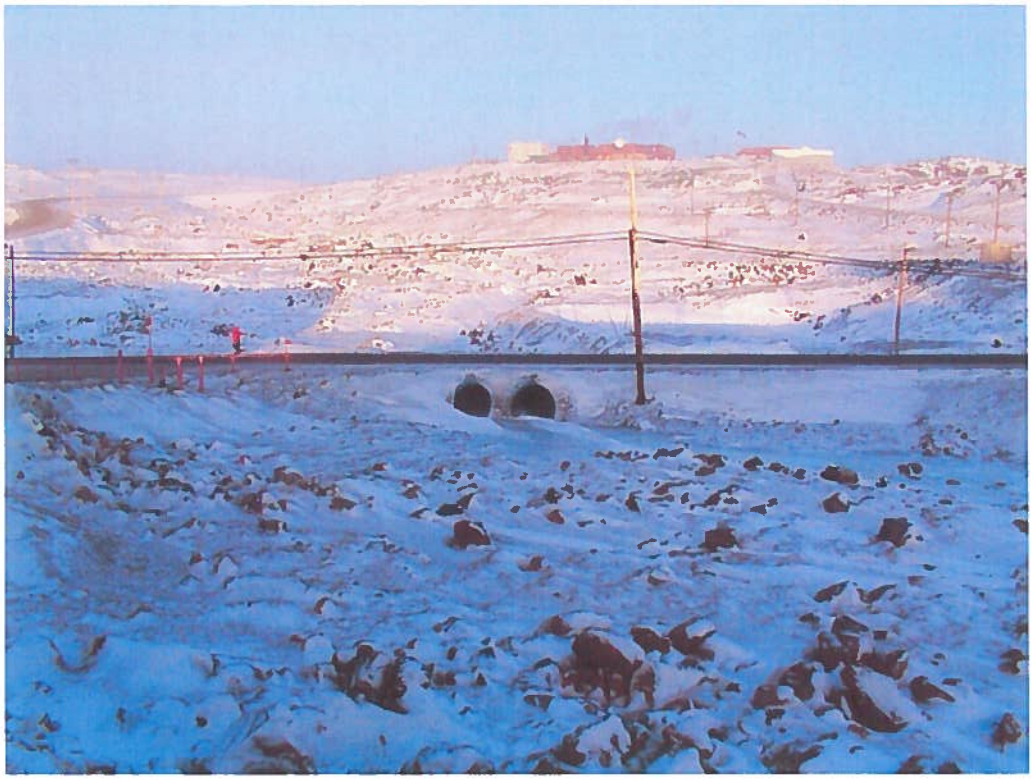
Photograph No. 9 – Overview of south Gravity elevation. Note leaching cracks.

Photograph No. 10 – Southern terminus of Gravity section.

APPENDIX 2
SITE PHOTOGRAPHS
LAKE GERALDINE DAM
DAMAGE PATH

Photograph No. 1 – Looking upstream at Basin, southwest of Dam (in background).

Photograph No. 2 – Looking upstream at Power Station Road Crossing. This crossing would be the first washed out (#1) in the event of a dam breach.



Photograph No. 3 – Looking upstream at Apex Road Crossing, Power Station in background. A second washout (#2) would be expected here.

Photograph No. 4 – Moving further downstream to Old Riverbed, looking north, just west of UIVVAQ Road.

Photograph No. 5 – Further downstream, looking north at bridge to Frobisher Inn. This bridge would likely be lost in the event of a dam breach.

Photograph No. 6 – Looking upstream at UIVVAQ Road Crossing, which would be road washout #3.

Photograph No. 7 – Further downstream, looking northeast along Nanvq Street. Housing is in the damage path.

Photograph No. 8 – Moving further downstream to Ikaluit Street Crossing, which would be washout #4.

Photograph No. 9 – Moving further downstream to Sinnz Street Crossing, which would be washout #5. All buildings are in damage path.

Photograph No. 10 – Terminus of Breach Flow at Frobisher Bay Beach.

APPENDIX 3
SUMMARY STABILITY CALCULATIONS
LAKE GERALDINE DAM

APPENDIX 4
GENERAL ARRANGEMENT DRAWING
LAKE GERALDINE DAM

APPENDIX 5
VIDEO RECORD
LAKE GERALDINE DAM

Lake Geraldine Dam
Dam Safety Inspection

Draft Report

January 9, 2003

City of Iqaluit

02-0823-0100

Submitted by

Dillon Consulting Limited

1. INTRODUCTION

The Canadian Dam Safety Guidelines (DSG) requires that all structures exceeding prescribed height and volume minimums be subject to Dam Safety Reviews (DSR) and Dam Safety Inspections (DSI.) at regular intervals.

A DSR is a comprehensive, formal review process, that involves completion of checklist items in accordance with the Dam Safety Guidelines. The DSR forms a baseline of dam history, condition, repair requirements, and extensive documentation of monitoring, operating, safety and emergency procedures.

Lake Geraldine Dam requires a DSR every seven (7) years. The first DSR was conducted in 2001.

It is required in the DSG document that in the interval between DSR's, a Dam Safety Inspection (DSI) be performed on an annual basis. The DSI is a much less comprehensive review, comprising a visual inspection only to identify any changes in condition, or any observed concerns.

2. BACKGROUND

For a much more detailed historical perspective, refer to the DSR completed in 2001.

The City of Iqaluit derives its water supply from Lake Geraldine, which is retained by a structure consisting of a cast in place concrete gravity dam incorporating a spillway section and a cast in place concrete cut-off wall and embankment. All concrete structures are believed to be founded on rock, and engage rock at their abutments.

Lake Geraldine is a natural body of water in an irregularly shaped basin. It is fed by rainfall and snow/ice melt from a watershed with an area of approximately 385 hectares.

A general arrangement drawing of the dam is provided in Appendix 4 of the DSR.

3. SITE INSPECTION

A visual site inspection of the dam structures was performed in August 2002. The inspection was non-invasive in nature, and included an underwater visual assessment. A video record of the underwater inspection was made, and appends this report.

A summary of observed conditions is as follows:

- The visible portions of the concrete structures are generally in good condition with minor localized scaling and spalling visible. No appreciable changes in the condition of the concrete were noted. The actively seeping cracks that were observed in 2001 are, for the most part, unchanged. These cracks are generally vertical in orientation and hairline in width, as would be expected for shrinkage (non-structural) cracking.

- The rate of leakage through the control joint south of the spillway section has not changed significantly since the 2001 inspection. Some digging is recommended here to expose the joint down to rock and determine whether an upstream or downstream repair is likely to be more successful.

- There was no evidence of distress or overstressing of any portion of the visible concrete structures.

- Minor corrosion of the 1985 spillway extension frame continues. As this frame was primarily used for forming, cleaning and re-painting are considered to be desirable, albeit cosmetic repairs.

- We noted a significantly increased flow at a joint location midway up the dam elevation, at the junction of the spillway section and the south gravity section. This area was reviewed on the upstream face by underwater video, see below.

- The embankment portions of the dam do not appear to have changed appreciably in slope/stability since the 2001 inspection.

4. UNDERWATER VIDEO INSPECTION

An underwater inspection was carried out by Nunavut Safety Services on September 3, 2002, under the direction of Dillon Consulting Limited.

The conditions for the video were good in that the water clarity was excellent except near the base of the dam when sediment was disturbed.

The video indicated in general no severe deterioration or sediment build-up. Numerous discarded items and scrap/litter are visible in the immediate upstream area. The control/expansion joints exhibit general deterioration of their filler material.

In addition to the video overview, the vertical transition joint at the south end of the spillway, where the spillway section ties into the south portion of the dam structure, was visually assessed in detail.

The video of this area clearly shows an area of deterioration on the upstream side of this transition. The deterioration begins just below the 1985 spillway extension (the rusty steel plate section) and extends downwards perhaps two feet. This coincides roughly with the point of emergence on the downstream face. Particulate matter in the water can be seen accelerating towards and disappearing into a hole in the deteriorated area.

5. RECOMMENDATIONS

1. Undertake a Dam Safety Inspection (DSI) in 2003.

2. Rehabilitate all upstream joints in 2003, including the leakage area identified in the underwater video. Engineering design is required.

3. Complete the remaining outstanding items identified in the 2001 DSR document, as follows:

    - Complete the non-compliance requirements of Section Nos. 3 and 4 of the DSG;
        - Permanent file
        - Operation, Maintenance and Surveillance Manual
        - Logbook
        - Emergency Prepardness Plan
    - Upgrade the embankment portion of the dam - engineering design is required prior to implementation.

Our File: 50-2000-3901

December 3, 2002

City of Iqaluit
P.O. Box 460
Iqaluit, Nunavut
X0A 0H0

Attention: Mr. Matthew Hough, P.Eng.
Director, Engineering

Frobisher Bridge Condition Assessment

Dear Mr. Hough:

Enclosed is a draft copy of our Dam Safety Inspection for the Lake Geraldine Dam.

Please review the draft report and provide any comments at your convenience.

Yours sincerely,

DILLON CONSULTING LIMITED

Allan Murray, P.Eng.
Project Manager

ADM:dmb

Encl.

Lake Geraldine Dam
Dam Safety Inspection

Report

January 7, 2004

City of Iqaluit

02-0823-0100

Submitted by

Dillon Consulting Limited

1. INTRODUCTION

The Canadian Dam Safety Guidelines (DSG) requires that all structures exceeding prescribed height and volume minimums be subject to Dam Safety Reviews (DSR) and Dam Safety Inspections (DSI) at regular intervals.

A DSR is a comprehensive, formal review process that involves completion of checklist items in accordance with the Dam Safety Guidelines. The DSR forms a baseline of dam history, condition, repair requirements, and extensive documentation of monitoring, operating, safety and emergency procedures.

Lake Geraldine Dam requires a DSR every seven (7) years. The first DSR was conducted in 2001.

It is required in the DSG document that in the interval between DSR's, a Dam Safety Inspection be performed on an annual basis. The DSI is a much less comprehensive review, comprising a visual inspection only to identify any changes in condition, or any observed concerns.

The last DSI was conducted in August 2002, followed by a report dated January 9, 2003.

2. BACKGROUND

For a much more detailed historical perspective, refer to the DSR completed in 2001.

The City of Iqaluit derives its water supply from Lake Geraldine, which is retained by a structure consisting of a cast in place concrete gravity dam incorporating a spillway section and a cast in place concrete cut-off wall and embankment. All concrete structures are believed to be founded on rock, and engage rock at their abutments.

Lake Geraldine is a natural body of water in an irregularly shaped basin. It is fed by rainfall and snow/ice melt from a watershed with an area of approximately 385 hectares.

A general arrangement drawing of the dam is provided in Appendix 4 of the DSR.

3. SUMMARY OF PREVIOUS DSI (AUGUST 2002)

1. The visible portions of the concrete structures are generally in good condition with localized scaling and spalling visible. No appreciable changes in the condition of the concrete were noted. The actively seeping shrinkage cracks that were observed in 2001 are, for the most part, unchanged.

2. The rate of leakage through the control joint south of the spillway section has not changed significantly since the 2001 inspection.

3. There was no evidence of distress or overstressing of any portion of the visible concrete structures.

4. Minor corrosion of the 1985 spillway extension frame continues

5. Significantly increased flow was noted at a joint location midway up the dam elevation, at the junction of the spillway section and the south gravity section. This area was reviewed on the upstream face by underwater video.

6. The embankment portions of the dam do not appear to have changed appreciably in slope/stability since the 2001 inspection.

4. SITE INSPECTIONS – MAY 2003 AND OCTOBER 2003

In May of 2003, the dam was visually inspected and was observed to be, in general, in a similar condition as found in August 2002. The only exception concerns item 6, above, where we noted additional slumping of upstream fills. The leaks described in items 2 and 5, above, had been recommended for repair in the previous DSI, along with less active leaks.

In October 2003 the repair work (crack injection) was performed by Bellai. A follow-up inspection in October 2003 confirmed that the dominant leaks and a number of the lesser leaks had been sealed.

5. RECOMMENDATIONS

1. Undertake a Dam Safety Inspection (DSI) in 2004.

2. Assess repair performance.

3. Complete the remaining outstanding items identified in the 2001 DSR document, as follows:

- Complete the non-compliance requirements of Section Nos. 3 and 4 of the DSG;
    - Permanent file
    - Operation, Maintenance and Surveillance Manual
    - Logbook
    - Emergency Preparedness Plan
- Upgrade the embankment portion of the dam - engineering design is required prior to implementation.

Our File: 02-0823-0100

January 7, 2004

City of Iqaluit
P.O. Box 460
Iqaluit, Nunavut
X0A 0H0

Attention: Mr. Brad Sokach
Director of Engineering

Lake Geraldine Dam Safety Inspection
Purchase Order No. 018967

Dear Mr. Sokach:

Enclosed is a copy of our 2003 Dam Safety Inspection for the Lake Geraldine Dam.

Should there be any questions, please contact the undersigned.

Yours sincerely,

DILLON CONSULTING LIMITED

Allan D. Murray, P.Eng.
Project Manager

ADM:elz

Encl.

CONCENTRIC

Concentric Associates International

Lake Geraldine Dam
Iqaluit, Nunavut
Dam Safety Inspection

February 16, 2005
REPORT

Produced For:
THE CITY OF IQALUIT, NUNAVUT

Produced By:
CONCENTRIC ASSOCIATES INTERNATIONAL

Concentric Project Reference Number:
04-1166

Lake Geraldine Dam
Iqaluit, Nunavut
Dam Safety Inspection

CONTENTS

1. EXECUTIVE SUMMARY

Concentric Associates International Inc., (Concentric) was retained by the City of Iqaluit, to undertake a Dam Safety Inspection (DSI) of the Lake Geraldine Dam. The scope of work for the assignment has been undertaken in accordance with Concentric's proposal 04-1166, dated November 19, 2004.

The site inspection and reporting were conducted on February 9, 10 and 11, 2005, by Allan Murray, P.Eng., of Concentric. Snow and ice cover did not allow adequate assessment of the structure. It is strongly recommended that the next DSI be conducted prior to October 2005.

OBSERVATIONS:

- No significant changes in condition were observed since the previous DSI

RECOMMENDATIONS:

1. Preparation of the required Operation & Safety Manual, Emergency Preparedness Plan, Logbook, and Permanent File, remains delinquent, despite initial identification for compliance in 2001, and repeated non-compliance in 2002, 2003, and 2004. Steps should be taken to address this issue in 2005, as continued non-compliance negates the purpose, and validity, of the entire process, that began in 2001 with the Dam Safety Review (DSR).

2. Undertake the next DSI prior to October 2005.

3. Reassess the performance of the 2003 crack injection program as part of the 2005 DSI.

4. Upgrade the embankment portion of the dam in 2005 as recommended in previous DSI's - engineering design is required prior to implementation.

5. The ground upwelling at the south end of the dam, noted in previous DSI reports, is still present, as evidenced by an ice outcropping at the location of leakage. This leakage should be reviewed in the summer of 2005 and if deemed necessary, repaired by excavation and injection in the fall of 2005.

6. The proposed dam raising project anticipated for summer 2005 will necessitate a new DSR. The DSR is recommended within the first year after construction; in the interim, the DSI recommended for later this year should note and summarize construction activities.

2. INTRODUCTION

Concentric Associates International Inc., (Concentric) was retained by the City of Iqaluit, to undertake a Dam Safety Inspection (DSI) of the Lake Geraldine Dam. The dam is located in Iqaluit, Nunavut.

This assignment and the scope of work described herein has been undertaken in accordance with Concentric's proposal 04-1166, dated November 19, 2004.

The site visit and reporting were conducted on February 9, 10 and 11, 2005.

Allan Murray, P.Eng., of Concentric, met with the following personnel at the City of Iqaluit:

- Brad Sokach, Director of Engineering, City of Iqaluit
- Geoff Baker, Project Manager, City of Iqaluit Department of Engineering

This report summarizes our terms of reference for the assignment, observations, conclusions and recommended action.

3. BACKGROUND

The Canadian Dam Safety Guidelines (DSG) requires that all structures exceeding prescribed height and volume minimums be subject to Dam Safety Reviews (DSR's) and Dam Safety Inspections (DSI's) at regular intervals.

A DSR is a comprehensive, formal review process that involves completion of checklist items in accordance with the Dam Safety Guidelines. The DSR forms a baseline of dam history, condition, repair requirements, and extensive documentation of monitoring, operating, safety and emergency procedures.

The Lake Geraldine Dam requires a DSR every seven (7) years. The DSR for the facility was conducted in 2001.

It is required in the DSG document that in the interval between DSR's, a Dam Safety Inspection be performed on an annual basis. The DSI is a much less comprehensive review, comprising a visual inspection only to identify any changes in condition, or any observed concerns.

A detailed historical perspective may be referenced in the DSR on file with the City of Iqaluit.

4. SCOPE OF SERVICES

Our directive has been to undertake a Dam Safety Inspection (DSI) in accordance with the DSG, for the Lake Geraldine Dam. The inspection consisted of an on-site visual assessment, notation of any significant changes in condition since the last available DSI, preparation of a written report in a format compatible with the DSR, and a photographic record.

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, to be provided by the City
- Review, in particular, reports and/or repairs/upgrades conducted since the 2001 DSR
- Interview and/or solicit input from maintenance personnel and City Administration regarding operating performance, concerns, incidents, repairs, and any notable concerns
- Conduct a visual on-site assessment of the sewage lagoon
- 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
- Submit final documents in electronic format and hard copy

Limitations

At the time of the inspections, visual acuity of the site was difficult due to snow and ice accumulation. Snow and ice cover did not allow adequate assessment of the structures. It is strongly recommended that the next DSI be conducted prior to October 2005.

5. SUMMARY OF PREVIOUS DSI'S

The following is a summary of observations and recommendations made from the previous DSI's:

Both the 2002 (Report 02-0823) and 2003 (Report 02-0823-0100) DSI's described below were prepared by Dillon Consulting Limited.

January 9, 2003 (2002) DSI

- The visible portions of the concrete structures are generally in good condition with localized scaling and spalling visible. No appreciable changes in the condition of the concrete were noted. The actively seeping shrinkage cracks that were observed in 2001 are, for the most part, unchanged.
- The rate of leakage through the control joint south of the spillway section has not changed significantly since the 2001 inspection.
- There was no evidence of distress or overstressing of any portion of the visible concrete structures.
- Minor corrosion of the 1985 spillway extension frame continues
- Significantly increased flow was noted at a joint location midway up the dam elevation, at the junction of the spillway section and the south gravity section. This area was reviewed on the upstream face by underwater video.
- The embankment portions of the dam do not appear to have changed appreciably in slope/stability since the 2001 inspection.

The following action was recommended:

- Undertake a Dam Safety Inspection (DSI) in 2004.
- Repair locations of significant and/or chronic leakage.
- Complete the remaining outstanding non-compliance requirements of Section Nos. 3 and 4 of the DSG, identified in the 2001 DSR document, as follows:
  - Permanent file
  - Operation, Maintenance and Surveillance Manual
  - Logbook
  - Emergency Preparedness Plan
- Upgrade the embankment portion of the dam - engineering design is required prior to implementation.

January 7, 2004 (2003) DSI

In May of 2003, the dam was visually inspected and was observed to be, in general, in a similar condition as found in August 2002. The only exception concerned the north berm section, where additional slumping of upstream fills was noted. The leakage that had been recommended for repair in the previous DSI was slated for construction in 2003.

In October 2003 the repair work (crack injection) was performed by Bellai Brothers Construction. A follow-up inspection in October 2003 confirmed that the prominent leaks and a number of the lesser leaks had been sealed.

The following action was recommended:

- Undertake a Dam Safety Inspection (DSI) in 2004.
- Assess repair performance in 2004.
- Complete the remaining outstanding non-compliance requirements of Section Nos. 3 and 4 of the DSG, identified in the 2001 DSR document, as follows:
  - Permanent file
  - Operation, Maintenance and Surveillance Manual
  - Logbook
  - Emergency Preparedness Plan
- Upgrade the embankment portion of the dam - engineering design is required prior to implementation.

6. COMMENTARY ON DAM SAFETY GUIDELINES

The Canadian Dam Association publication, Dam Safety Guidelines (DSG), governs the nature and frequency of inspection and review activities for structures which fall under its umbrella criteria.

The DSG applies 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 DSG document is far reaching in terms of applicability and requirements for conformance. This is understandable as the type and complexity of structures that fall under the jurisdiction of the document varies considerably, from relatively small and simple embankments or dikes to massive and complex dams associated with hydroelectric generating facilities, irrigation, flood control, etc.

The DSG requires that all structures exceeding the height and volume minimums described above be classified according to their "consequence category", that is, the consequence of dam failure in terms of life safety, and socio-economic impact. The category assigned may range from very low to very high. The consequence category dictates the requirement and frequency of Dam Safety Reviews.

A Dam Safety Review (DSR) is a comprehensive, formal review process, conducted at regular intervals, that involves completion of checklist items in accordance with the Dam Safety Guidelines. The DSR forms a baseline of dam history, condition, repair requirements, and extensive documentation of monitoring, operating, safety and emergency procedures.

The frequency of DSR's varies depending on consequence category. For structures where significant life safety and/or socio-economic consequence exist, the DSR is usually conducted every five (5) to ten (10) years. Lake Geraldine Dam requires a DSR every seven (7) years. The initial DSR for the facility was conducted in 2001; therefore, the Lake Geraldine Dam is due for an updated DSR in 2008. If significant alterations to the structure take place before this date, an updated DSR would be required.

It is required in the DSG document that in the interval between DSR's, a Dam Safety Inspection (DSI) would be performed on an annual basis. The DSI is a much less comprehensive review, comprising a visual inspection to identify any changes in condition, or any observed concerns. The results of the DSI are incorporated into the DSR documentation. A DSI may trigger repairs, or changes in standard operating procedures.

7. OBSERVATIONS

The dam structure was accessed on foot. The review was hampered by considerable accumulation of snow and ice. Based on our limited visual assessment we have the following comments:

- The primary leakage addressed by polyurethane injection in 2003 appears to be performing adequately.
- Evidence of small volume seepage exists at some hairline crack locations.
- The ground upwelling at the south end of the dam, noted in previous DSI reports, is still present, as evidenced by an ice outcropping at the location of leakage. This leakage should be reviewed in the summer of 2005 and if deemed necessary, repaired by excavation and injection in the fall of 2005.

Overall, the condition of the structure has not changed significantly since the previous DSI.

We were advised by the Department of Engineering that a vertical expansion of the dam is being contemplated for the summer of 2005.

8. RECOMMENDATIONS

The following actions are recommended:

1. Preparation of the required Operation & Safety Manual, Emergency Preparedness Plan, Logbook, and Permanent File, remains delinquent, despite initial identification for compliance in 2001, and repeated non-compliance in 2002, 2003, and 2004. Steps should be taken to address this issue in 2005, as continued non-compliance negates the purpose, and validity, of the entire process, that began in 2001 with the Dam Safety Review (DSR).

2. Undertake the next DSI prior to October 2005.

3. Reassess the performance of the 2003 crack injection program as part of the 2005 DSI.

4. Upgrade the embankment portion of the dam in 2005 as recommended in previous DSI's - engineering design is required prior to implementation.

5. The ground upwelling at the south end of the dam, noted in previous DSI reports, is still present, as evidenced by an ice outcropping at the location of leakage. This leakage should be reviewed in the summer of 2005 and if deemed necessary, repaired by excavation and injection in the fall of 2005.

6. The proposed dam raising project anticipated for summer 2005 will necessitate a new DSR. The DSR is recommended within the first year after construction; in the interim, the DSI recommended for later this year should note and summarize construction activities.

We would be pleased to discuss this report with you.

Should there be any questions, please contact the undersigned.

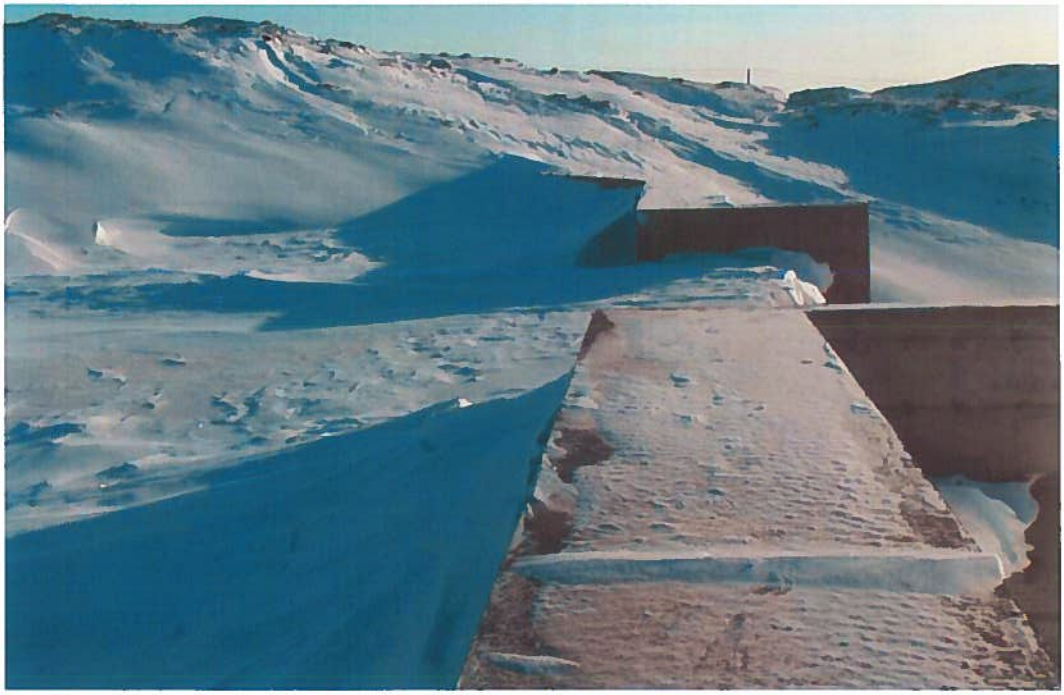
Yours truly,

Concentric Associates International Inc.,

Allan D. Murray, P.Eng.,
Project Manager

APPENDIX A
Photographs

Photograph 1
Overview of Lake Geraldine Dam from the south



Photograph 2
Overview of top of dam from the north

Photograph 3
Overview, upstream face of Lake Geraldine Dam berm section, from the north

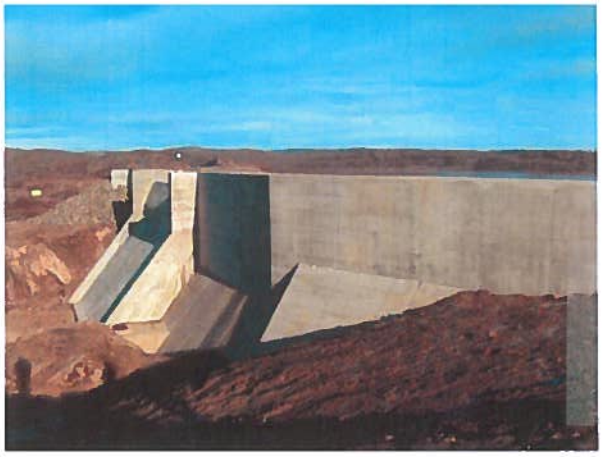
Photograph 4
Overview, downstream face of Lake Geraldine Dam berm section, from the south

Concentric Associates International Incorporated

LAKE GERALDINE DAM

DAM SAFETY REVIEW

DECEMBER 11, 2006



PRODUCED FOR:

THE CITY OF IQALUIT

PRODUCED BY:

CONCENTRIC ASSOCIATES
INTERNATIONAL INCORPORATED

CONCENTRIC PROJECT REFERENCE NUMBER:

06-1429

Lake Geraldine Dam
Dam Safety Review

TABLE OF CONTENTS

EXECUTIVE SUMMARY

The City Of Iqaluit retained Concentric Associates International Incorporated (Concentric), in September 2006, to prepare a Dam Safety Review (DSR) for the Lake Geraldine Dam.

The DSR was conducted during the period October through December 2006, in accordance with the Dam Safety Guidelines, (*DSG January 1999*) prepared by the Canadian Dam Association.

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

1. This DSR is incomplete due to design documentation requested, but not provided by the design engineer, see below.

2. In accordance with Section 1 of the DSG, the dam continues to operate under a High Consequence Category.

3. Raising of the earth embankments and concrete gravity dam section was completed in 2006. The design review for the new dam structure has been limited to visual information obtained on site and incomplete design documentation provided by the design engineer Trow Associates (Trow). Design calculations, material testing reports and site reports do not appear to be on record with the city, and were requested of, but not provided by, Trow. These documents should be kept in the permanent file and provided to complete this, and subsequent, Dam Safety Reviews.

4. Rock Anchors were added in 2005. Based on the limited information provided, we were not able to confirm with certainty if the rock anchors were sufficiently pretension to resist over stressing of the rock foundation at the new reservoir level under ice loading conditions.

5. No permanent instrumentation was added during the 2006 dam raising. The monitoring and instrumentation of the dam does not appear to meet the recommendations of the DSG

6. As per the previous DSG, the dam is still in non-compliance with the requirements of Sections 3 and 4 of the DSG. The following documents do not exist at this time:

    - Permanent File
    - OMS Manual
    - Logbook
    - Emergency Preparedness Plan

5. A Dam Safety Inspection (DSI) should be conducted in 2007. This is essentially a yearly non-invasive review comprising a visual inspection to identify any changes in condition, or any observed concerns. The DSI conducted in 2006 identified leakage through the spillway which requires follow-up in 2007.

6. An underwater inspection of the submerged structures should be done in 2007. This inspection should be coordinated with, and be under the direction of, the DSI recommended in Item 5, above.

7. A future DSR should be scheduled for no later than 2013.

1. INTRODUCTION & SCOPE OF WORK

Significant modifications to the Lake Geraldine Dam in 2005 and 2006 triggered the requirement for a Dam Safety Review (DSR), in accordance with the Canadian Dam Association publication, Dam Safety Guidelines (DSG), published in January 1999.

The DSG applies 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 minimums.

The DSG document is far reaching in terms of applicability and requirements for conformance. This is understandable as the type and complexity of structures that fall under the jurisdiction of the document varies considerably, from relatively small and simple embankments or dikes to massive and complex dams associated with hydroelectric generating facilities, irrigation, flood control, etc.

The DSG requires that all structures exceeding the height and volume minimums described above be classified according to their "consequence category", that is, the consequence of dam failure in terms of life safety, and socio-economic impact. The category assigned may range from very low to very high. The consequence category dictates the requirement and frequency of Dam Safety Reviews.

A Dam Safety Review (DSR) is a comprehensive, formal review process, conducted at regular intervals, that involves completion of checklist items in accordance with the Dam Safety Guidelines. The DSR forms a baseline of dam history, condition, repair requirements, and extensive documentation of monitoring, operating, safety and emergency procedures.

The frequency of DSR's varies depending on consequence category. For structures where significant life safety and/or socio-economic consequence exist, the DSR is usually conducted every five (5) to ten (10) years. In the case of the Lake Geraldine Dam, the required interval is seven (7) years.

It is required in the DSG document that in the interval between DSR's, a Dam Safety Inspection (DSI) would be performed on an annual basis. The DSI is a much less comprehensive review, comprising a visual inspection to identify any changes in condition, or any observed concerns. The results of the DSI are incorporated into the DSR documentation. A DSI may trigger repairs, or changes in standard operating procedures.

Under the current DSG, a DSR was required for the Lake Geraldine Dam due to the "major modification to the original design or design criteria" represented by the raising and reinforcing program undertaken over the summer of 2006

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

- Importance of structure
- Complexity of structure
- Consequences of failure
- Completeness, continuity, and availability of record documentation

- Current condition

A summary of the methodology to complete the work is presented below:

1. Acquisition and assembly of chronological documentation, including but not limited to:
    - Design Documents
    - Repair Specifications
    - Past Condition Assessment Reports
    - Records of Alteration
2. Review of all available record documentation.
3. Perform a site inspection to assess the current condition of the structures. No invasive work was performed; the condition assessment was visual in nature. Invasive assessment was not believed necessary given the amount of record documentation available.
4. Interview maintenance and management personnel as required and appropriate.
5. Execute the DSR checklist of items.
6. Prepare the draft DSR report, complete with site surveys, photographs, structural sections, field notes, discussions and recommendations as required and appropriate. Submission to and discussion with the City Engineer.
7. Submit the final DSR report.

2. HISTORY & BACKGROUND

In the following chronological summary, record documents have been referenced. After each reference, a number appears in parenthesis. That number corresponds to tabulated record document numbers in Section 4, where details are provided on the document source.

2.1 Reservoir

The City of Iqaluit derives its water supply from Lake Geraldine, which is retained by a structure consisting of a cast in place concrete gravity dam incorporating a spillway section and a cast in place concrete cut-off wall and embankment. All concrete structures are believed to be founded on rock, and engage rock at their abutments.

Lake Geraldine is a natural body of water in an irregularly shaped basin. It is fed by rainfall and snow/ice melt from a watershed with an area of approximately 385 hectares.

2.2 History

In the late 1950's, the demand for a reliable year round source of water resulted in the construction of a cast in place concrete gravity dam, and a section of earth berm with a central cast in place concrete cut off wall. The project was designed and built by the Department Of National Defense. According to the literature, the original construction took place circa 1958.

Since that time, as the City has grown and water demands have risen, the dam has been raised four times to increase the storage capacity.

The first height increase of 0.3m reportedly took place in 1979. This involved a concrete extension, which was dowelled into the existing structure.

The second construction took place in 1985, and increased the height of the spillway structure by approximately 1.15m. The embankment portion was widened and heightened as well to accommodate the increased storage capacity. Again, the extension was constructed of concrete dowelled into the existing structure, and incorporated a steel formwork frame over the spillway section.

The third extension was done in 1995, and increased the height of the gravity dam structure by a further 1.5m of concrete, with a corresponding increase in berm geometry. Based on analysis done prior to the extension, it was determined that the gravity dam would not have an adequate factor of safety against overturning if the extension was simply "dowelled-in" as before. The 1995 alteration therefore included an extensive rock-anchoring program for the gravity dam portion to provide the required stability to the structure.

The latest extension was completed in two phases over 2005/06. Additional rock anchors were installed thought the gravity dam in 2005 in preparation for a further height extension

of 2m in 2006. The existing embankments were enlarged and the existing cut-of-walls were extended in height. A new embankment and cut off wall were installed to the south of the existing dam structures.

In the time span of the available historical data, which extends back to 1984, there have been only a few notable events relating to the safety and serviceability of the dam structures.

- 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 (3) 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 (4) 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 (5,6) 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 (7). 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 (10) 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 (11) 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.

- A previous DSR (the first on record) was conducted in 2001

- DSI's were conducted in 2004 and 2006. The 2006 DSI was done in conjunction with this report.

2.3 Description of Structure

The dam is comprised of a concrete section (incorporating a concrete spillway) and earth embankments 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 embankment. The central and northern earth embankments extend approximately 135 m to the north rock abutment. A new earth embankment (approximately 68.5m long) was installed in a valley to the south of the existing structures in 2006. The embankment sections of the dam incorporate a concrete cutoff 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.

2.4 Relevant Record Documents

The following documentation has been utilized in the preparation of this report. Other record documentation was provided but not directly applicable to the DSR.

TABLE I
RELEVANT RECORD DOCUMENTATION
LAKE GERALDINE DAM

No.	Date	Description	Author
1	December 1957	Water Storage Dam at Lake Geraldine (3 Drawings)	DND
2	August 1984	Lake Geraldine Water Supply Report	OMM
3	January 1985	Water Supply Improvement Report	OMM
4	June 1990	General Diving Report	Arctic Divers
5	June 1990	Dam Inspection for Blast Damage	Hardy BBT
6	July 1990	Dam Inspection & Leakage Repair	Acres
7	July 1990	Dam Stability	Acres
8	Sept. 1990	Diving Report	Arctic Divers
9	Feb. 1995	Lake Geraldine Storage Report	OMM
10	June 1995	Lake Geraldine Storage Design Dwgs. & Specifications	OMM
11	October 1997	Dam Inspection	Trow
12	June 1998	Dam Failure Study	EBA
13	March 2002	Dam Safety Review	Trow

14	August 2003	Lake Geraldine Dam Repairs 2003	Dillon
15	February 2005	Dam Safety Inspection	Concentric
16	March 2005	Geotechnical Investigation	Trow
17	May 2005	Lake Geraldine Dam Rock Anchors 2005 (Specifications and 4 Drawings)	Trow
18	February 2006	Lake Geraldine Dam Earth and Concrete Work 2006 (Specifications and 11 Drawings)	Trow

3. COMMENTARY ON DAM SAFETY REVIEW REQUIREMENTS

According to the Dam Safety Guidelines, the document applies 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 minimums.

The Dam Safety Guidelines document is far reaching in terms of applicability and requirements for conformance. This is understandable as the type and complexity of structures that fall under the jurisdiction of the document varies considerably, from relatively small and simple embankments or dikes to massive and complex dams associated with hydroelectric generating facilities, irrigation, flood control, etc.

The document requires a systematic checklist review, which includes the following items. For each item, the applicable Section number from the Dam Safety Guidelines is shown in parenthesis.

1. Dam Classification (1)
2. Site Inspection (2)
3. Design & Construction Review: (2)
    - 3.1. Earthquakes (5)
    - 3.2. Floods (6)
    - 3.3. Discharge Facilities (7)
    - 3.4. Geotechnical Considerations (8)
    - 3.5. Concrete Structures (9)
    - 3.6. Reservoir & Environment (10)
    - 3.7. Construction (11)
4. Operation & Testing (2,3)
5. Maintenance (2,3)
6. Surveillance & Monitoring (2,3)
7. Emergency Preparedness (2,4)
8. Compliance With Previous Reviews (2)

3 LAKE GERALDINE DAM DSR

DAM CLASSIFICATION (DSG SECTION 1)

Based on the Dam Safety Guidelines, and the dam structure itself, the Lake Geraldine Dam has a consequence category of "High" for both the *Life Safety* and *Socioeconomic, Financial and Environmental* categories. The "High" classification is assigned by the DSG, in the case of life safety, if loss of life would likely occur as a result of dam failure. A "High" category is assigned in the socioeconomic category if, in the event of a dam failure, the cost to the community in terms of social and financial impact would be significant. Under the guidelines it is required to have a Dam Safety Review every seven (7) years for those structures with a high consequence category.

SITE INSPECTION (DSG SECTION 2)

A visual site inspection of the dam structures was performed in October 2006. The inspection was non-invasive in nature, and did not include an underwater assessment.

A summary of observed conditions is as follows:

- 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.
- The north and central embankments appeared to be in a stable condition. Slopes of 2H:1V appeared to be maintained on the down stream rip-rap and in the up stream rock fill.
- There was a slight rise in the reservoir level however most of the extension had not been impacted.
- The reservoir level had yet to have an impact on the south embankment.
- A leak was noted in the spillway portion of the dam; this leak was estimated at perhaps 30-40 litres per minute. This leak should be re-assessed in the spring of 2007 in conjunction with the 2007 DSI and appropriate measures taken.

DESIGN & CONSTRUCTION REVIEW (DSG SECTION 2)

This section constitutes the bulk of the Dam Safety Review process. The intent is to determine if the existing dam configuration satisfies performance criteria given in the DSG for safety and serviceability, in response to likely loads impinging on the structure. We have followed the format in the DSG document for convenience and clarity.

Earthquakes (DSG Section 5)

According to the DSG, dams shall be evaluated to withstand a Maximum Design Earthquake (MDE) without release of the reservoir. For a High Consequence Category, the DSG requires evaluation at 50% - 100% of the Maximum Credible Earthquake (MCE). To paraphrase the DSG, the MCE is defined as the largest reasonably conceivable earthquake that appears possible under the presently known tectonic framework.

Concrete Gravity Dam Portion

For the concrete portions of the dam, two sections were assessed; the spillway section and the gravity dam itself. For each section, the worst case was assessed, which corresponded to the maximum retained height, that is, the maximum distance from the lake bottom at the base of the dam, to the crest of the dam. As the lake bottom tends to undulate, the retained height varies to some degree.

The MDE loads were applied in combination with other loads in accordance with Section 9.4 of the DSG, Load Combinations, Concrete Structures.

In the load combination case involving the MDE, the overall contribution of seismic loads is less than 10%, and is not considered significant compared to uplift and hydrostatic forces, and therefore does not govern the performance of the structure.

Embankment Dam Portion

The configuration of the embankment portion of the dam has been substantially modified. At present the available information is considered to be too limited to perform a comprehensive review. Once sufficient design and construction documentation becomes available this section can be finalized. In the continuing absence of such documentation independent material testing and design analysis will have to be performed to complete this section of the DSR.

Floods (DSG Section 6)

According to the DSG, dams shall be evaluated to safely pass an Inflow Design Flood (IDF), which is based on Consequence Category and the Probable Maximum Flood (PMF). The PMF is an estimate of the most severe "reasonably possible" flood at a particular location and time of year. For a High Consequence Category, the DSG requires an IDF with an Annual Exceedence Probability (AEP) of between 1/1000 and the PMF.

The contributory area for the reservoir is essentially the water shed of the Sylvia Grinnel River. As the 2006 dam raising has not intersected additional drainage areas we deem the inflow characteristics on the reservoir and dam structure to be unchanged. The spillway characteristics (freeboard and width) have also been maintained with the new dam structure. As climate data has not indicated a significant change in rain and snow events, the statistical

flood analysis carried out with the 2001 DSR is considered to be still valid and the dam is considered to safely meet the requirements of the DSG.

Discharge Facilities (DSG Section 7)

Section 7 of the DSG has a broad applicability that includes flow control equipment, instrumentation, and emergency backup equipment, which are relevant to more complex structures. In the case of the Lake Geraldine Dam, the applicability only involves the spillway section.

As per the previous section significant changes have not been made or occurred with respect to the freeboard of the dam and the Inflow Design Flood. Other factors affecting the discharge facilities such as wave height (related to the fetch of the lake) and the accumulation of floating debris have also not changed significantly. We therefore consider the analysis of the previous DSR to be valid. The dam structure therefore meets the requirements of the DSG.

Geotechnical Considerations (DSG Section 8)

Section 8 of the DSG presents Geotechnical considerations for proposed dams, as well as for several configurations of existing dams.

Concrete Gravity Dam Portion

For dams on rock foundations the DSG indicates that geotechnical investigations and design should be sufficient to ensure that *foundation stability*, *shear strength parameters* and *seepage and drainage* issues are identified and addressed.

The March 2005 Geotechnical Investigation indicates that two boreholes were drilled in the vicinity of the gravity dam. The bedrock in this area is categorized as gneiss: with a quality range of very poor to excellent; an allowable bearing pressure in excess of 480 kPa; and an (estimated minimum) residual angle of friction of 23 degrees. Parameters for the use of rock anchors in the design of the dam are also stated in the March 2005 Geotechnical Investigation.

Information indicates that a peak angle of internal friction of 40 degrees has been used with respect to design of the gravity portion of the dam against sliding. The March 2005 report explicitly states that a residual angle of internal friction of 23 degrees should be used with respect to resistance to sliding.

Our review of the present dam configuration indicates that *seepage and drainage* are not presently areas of concern. *Shear strength parameters* are such that rock anchors are required to act in shear at the rock/dam interface. A review of the structural drawings would indicate that the listed factors of safety against sliding do not utilise the geotechnical recommendations. Our review of the installation requirements for the rock anchors could

not confirm with certainty that the *foundation stability* was adequate at the operating level of the reservoir under the listed ice load conditions.

Embankment Dam Portion

The DSG groups embankment dams and dams on soil foundations into the same general category. Seven sub-categories are listed for embankment dams: *monitoring and instrumentation*; *stability and deformation*; *seepage and drainage*; *cracking*; *surface erosion*; *liquefaction*; and *earthquake resistance*.

The raising of the reservoir has entailed increasing the height of the central, north and installation of a new south berm. The general construction methodology has been to leave the existing berm structures in place, extend the height of the existing cutoff wall and install the new structures over the existing berm materials. The cutoff wall for the new south berm has also been extended into rock while the new berm is founded on the native overburden. Cutoffs are installed to reduce seepage and uplift in the down stream embankment structure and add little in the way of extra stability. It is generally accepted that, where suitable soils are available, and earth core will be safer and more durable than concrete. The concrete cutoff is deemed to be a necessity of cost and the scarcity of appropriate materials.

8.2.1 Monitoring and instrumentation:

Given the available documentation, a consistent monitoring program does not appear to exist and no active instrumentation equipment has been installed. Engineering inspection reports are limited to those listed in table 1 and any record of city staff performing regular monitoring is not available. The current monitoring and instrumentation program is deemed to not meet the requirements of the DSG.

8.2.2 Stability and deformations:

The configuration of the embankment portion of the dam has been substantially modified. At present the available information is considered to be too limited to perform a comprehensive review. Once sufficient design and construction documentation becomes available this section can be finalized. In the continuing absence of such documentation independent material testing and design analysis will have to be performed to complete this section of the DSR.

8.2.3 Seepage and Drainage:

Seepage is controlled by the concrete cutoff wall; however, no consideration has been made for the monitoring of hydraulic gradients across the embankment. As stated above, concrete cutoffs are less safe and less durable than a properly designed earth core. Steady state seepage is more constant in an earth core dam and will not be significantly impacted by movement and shifting materials. Filter and drainage requirements become less critical for a concrete cutoff wall, however, continual monitoring of the hydraulic gradient becomes more important. Installation of piezometers in the down stream embankment would allow monitoring of the operational pore-water pressure and infer the condition of the concrete

cutoff wall. Information would be used to: verify seepage rates through the embankment; verify slope stability calculations; and locate problem areas along the length of the dam. It was identified in the geotechnical investigation that, within the north berm, a section of the original cutoff wall was not founded in rock. Although we can infer that the dam has performed adequately regardless of this condition, the raising of the reservoir would effectively increase: the head of water on the upstream face of the cutoff; the seepage rates across the breach; and the piping and uplift forces acting on the downstream embankment structure. Although the geotechnical investigation recommended that this section of the cutoff be grouted to rock, we have no record of this repair taking place. Given the assumption that the concrete cutoff wall is intact and founded in rock, we deem the requirements of the DSG to be met. However this assumption would be confirmed through the installation of proper instrumentation in accordance with section 8.2.1 of the DSG.

8.2.4 Cracking:

Cracking is typically more relevant to earth core dams. Given the rock facing and the concrete cutoff, the current configuration of the dam is deemed to meet the requirements of the DSG.

8.2.5 Surface Erosion:

Both upstream and downstream embankment slopes are faced in rock. The requirements of the DSG are therefore deemed to be met.

8.2.6 Liquefaction:

No materials identified in the geotechnical investigation appear to be susceptible to liquefaction. The requirements of the DSG are therefore deemed to be met.

8.2.7 Earthquake Resistance:

At present, the available information is considered to be too limited to perform a comprehensive review. Once sufficient design and construction documentation becomes available this section can be finalized. In the continuing absence of such documentation independent material testing and design analysis will have to be performed to complete this section of the DSR.

Concrete Structures (DSG Section 9)

Where the embankment structures predominantly fall under Section 8.2 of the DSG, Section 9 outlines the requirements for concrete structures. The DSG reviews the performance of concrete structures by the following sub-categories: *General*; *Condition of Structures and Sites*; *Loads*; *Load Combinations*; *Design Analysis*; *Performance Indicators*; and *Acceptance Criteria*.

In being provided with the tender drawings and specifications, we deem there to be sufficient documentation to complete a basic review of the design. However, certain concerns have been raised and will have to be addressed in a more comprehensive review of the design.

This review cannot be completed without further information being supplied by the design engineer (Trow). Without independent confirmation of these deficiencies, the dam does not meet the requirements of the DSG.

9.2 Condition of Structures and Site:

The structure was visually inspected on site. At the time of our visit, we did not observe any conditions that would adversely affect the structural adequacy and/or performance. The concrete structure is generally considered to be new with no deficiencies noted.

9.3 Loads:

The loads under consideration are listed as follows:

- Dead loads (D).
- Normal headwater level (H).
- Headwater level due to Inflow Design Flood (H_F).
- Internal water pressure and foundation uplift forces (U).
- Static and dynamic thrust created by an ice sheet (I).

Loads associated with the Maximum Design Earthquake (Q) are not listed on the drawings. Rock anchors are not listed in the DSG (herein denoted as R). Silt and back fill loads (S) are not deemed to be an issue given the past history and construction of the dam. Temperature loads (T) are generally not considered for gravity dams.

9.4 Load combinations:

Of the load combinations listed in the DSG the three which are most relevant to the dam raising are:

9.4.1 Usual Loading: D+H+I+U+R

9.4.3 Flood Loading: D+H_F+U+R

9.4.4 Earthquake Loading: D+H+Q+U+R

9.5 Design and Analysis:

The DSG allows for the load combinations listed in section 9.4 to qualify to be treated as static load cases. Under the assumption that Ice has no (or little) impact on the flood and earthquake loading cases, the usual loading case governs. Given the prescribed loading, the dam must be designed to resist and prevent:

- Sliding at the dam/foundation interface, within the dam and at any plane in the foundation.
- Overturning
- Overstressing of the concrete dam or foundation

- Excessive seepage through the foundation or joints in the concrete dam.

Given the above, we undertook a rigid body analysis of the dam structure utilising 2 dimensional models of the dam at select locations. In general, our analysis revealed the following:

- The loads listed on the structural drawings appear to be realistic.
- The original rock anchors (1995) do not appear to have been utilised in the resistance calculations.
- The free body diagrams indicated on the drawings appear to represent the worst case (highest head) for both the spillway and the typical gravity dam sections.
- Discrepancies between the angle of internal friction used on the drawings and the recommended value indicated in the Geotechnical Investigation report friction remain unexplained.
- To accurately determine the factor of safety against sliding (sliding factor), the angle of internal friction, angle of sliding friction (or coefficient of friction) and estimate-able anchor tensions would have to be known. Given the information provided, the lowest limit on the sliding factor would be approximately 1.6.
- Provided the full service load of the rock anchors is mobilised, analysing the dam at the critical sections indicated that the minimum factor of safety against overturning is approximately 1.5
- Pressures at the toe of the dam are highly dependant on the tension in the rock anchors. Without additional information (regarding the installation and pre loading of the rock anchors) it is possible that allowable pressures are exceeded at the operating level of the reservoir under ice load condition (the usual load case).
- Negative pressures are indicated in the heel of the dam.
- Seepage is not currently considered to be an issue.

9.6 Performance Indicators:

The DSG recommends that the assessment of concrete dams include the following performance indicators:

- Position of resultant force
- Normal stresses at the heel and toe
- Average shear stresses acting on the surface
- Sliding factors
- Observed conditions of the structure and site

Position of resultant force: Analysis using service load limits for rock anchors indicates that the position of the resultant force at the critical sections is outside the middle third of the dam. The present increased reliance on the rock anchor installation results in a resisting structure acting outside the parameters of a traditional gravity dam. For traditional gravity dams, the position of the resultant force is recognised as a more useful performance indicator than safety factors against overturning. Given the limited amount of information provided by the designer, the tensions in the rock anchors under the usual load condition are assumed to be less than the service loads listed on the drawings. As such, the resultant force would be located even further away from the middle third. Given the specific nature of the dam to resist overturning forces, the factor of safety against overturning becomes the only performance indicator in this regard.

Normal stresses in heel and toe: Stresses at the heel and toe of the dam are highly dependant on the actual tension forces in the rock anchors. Given the procedural directions indicated on drawings and specifications for the rock anchor installation, it appears as though the anchors were pre-tensioned in the rock but released in the concrete prior to final grouting. Without additional information it would seem that there exists a scenario whereby estimate-able tensions will not be present in the rock anchors until rotations in the dam begin to occur. If this is the case, the stress values in the toe will exceed the allowable limits and the dam will be operating outside its performance indicators.

Shear stresses: The DSG states that: *"In rigid body analysis, the net calculated driving force is usually considered to be uniformly distributed over the zone of calculated compression" (DSG January 1999 pg. 9-7).* As the zone of compression is dependant on estimate-able values of tension in the rock anchors, the shear strength in the lower sections of concrete and rock should be taken as zero.

Sliding Factors: Sliding factors are equated with the available shear strength over the net driving force. This is generally considered to require checks with respect to limits of either sliding or shear. As such the resisting mechanisms in the lower sections of the dam become dependant on sliding at the dam foundation interface and shear in the rock anchors. Depending on the interpretation, the equations listed on the drawings appear to be conservative in this respect.

Observable Conditions: To our knowledge, measure records do not exist and no attempt has been made to map either monumental displacements in the dam or the hydrostatic gradient. Our site observations were made during a transitory point in the reservoir filling and provide little value in terms of the dam's performance.

9.7 Acceptance Criteria

In general, the level information and documents leads us to the following conclusions:

1. The requirements for residual sliding factors are deemed to be met (*RSF > 1.5 DSG January 1999 pg. 9-11*).
2. Without additional information, overstressing in the rock is deemed to be a potential concern.

Reservoir & Environment (DSG Section 10)

10.1 Reservoir Debris and Ice: Accumulation and management of excessive debris is considered unlikely and is not an issue at this time. Ice movements and accumulations appear to have been well accounted for in the listed loads for the new dam structure. However the tension envelope of the rock anchors will have to be confirmed.

10.2 Reservoir Rim: The majority of the reservoir rim is a natural rock formation with mild to moderate gradient, and no history of instability. The Geotechnical Investigation indicates three separate locations where the reservoir level may rise above the level of the bed rock and into the earth overburden. The location of the new south berm has been identified as the only area of concern and is deemed to have been adequately protected with the new berm and cutoff wall.

10.3 Water Quality: Given the location of the dam, the reservoir and dam structure are not deemed to be subjected to man-made chemicals. The reservoir has not historically been subjected to detrimental mineral depositions or marine salts.

10.4 Sedimentation and Silting: Silt accumulation behind the dam has historically not been a problem

10.5 Reservoir Drawdown Capability: Marginal drawdown capabilities can only be said to exist via the pump housing for the existing water supply system. It was noted in the previous DSR that, during the operation of the reservoir at the design head, it may be prudent to drawdown the reservoir under extreme ice load conditions. It is currently unknown whether the drawdown capabilities of the pump house have ever been established. Rapid drawdown capabilities cannot be said to exist.

10.6 Ecology: No significant ecological hazards are known to exist.

Construction (DSG Section 11)

The DSG section on Construction predominantly deals with the responsibilities of the engineer during construction. In essence the Engineer is responsible for ensuring that the work is carried out in conformance with the design and specifications. The engineer should be on site to review, mediate, document and approve: all key phases of the work; any deviation from the design intent; and any required deviations from the specifications. *"Documentation should include photographs, written explanations, as-built drawings and results of all quality control tests with date and test sample location"(DSG January 1999 Pg. 11-1).*

Such information represents the basis for the only relevant record of the constructed dam and as such should have been provided to the owner as part of the permanent file and for future reference. As this information has not been forwarded to us we cannot comment on the completeness of this part of the DSG.

OPERATION, MAINTENANCE AND SURVEILLANCE (DSG SECTION 3)

The 2006 dam raising has generally accepted the original passive operation of the dam structure. As such the previous DSR is still considered to be valid.

Still of primary concern is the lack of any available permanent record file. Such files *"should be maintained as an ongoing history available for general use and reference" (DSG January 1999 pg 3-2)*. The file should contain the following:

- Operation, Maintenance and Surveillance Manual (OMS).
- Instructions given by regulatory agencies, dam designer or other authority, and the record of compliance and details of any remedial action.
- As-built drawings from original construction and all subsequent construction phases
- Readings on any instrumentation and summary reports of dam performance.
- All design data including both original and modifications or revisions
- All inspections and Dam Safety Reviews
- Chronological history of the structure.
- Photographic record

Given the currently completed dam raising, additional design and construction related documents would form a large part of the permanent file. These documents do not appear to have been supplied to the City.

As with the previous DSG the Permanent Record File OMS and logbook have yet to be initiated.

EMERGENCY PREPAREDNESS (DSG SECTION 4)

"An Emergency Preparedness Plan (EPP) shall be prepared, tested, issued and maintained for any dam including a dam under construction, or a cofferdam, whose failure could be expected to result in loss of life as well as for any dam for which advance warning would reduce upstream or downstream damage" (DSG January 1999 pg. 4-1). The EPP should include the following:

- Emergency identification and evaluation
- Preventative actions (where available)
- Notification procedure
- Notification flowchart
- Communication systems
- Access to site.
- Response during periods of darkness
- Response during periods of adverse weather
- Sources of equipment
- Stockpiling supplies and materials
- Emergency power sources, if required
- Inundation maps

- Warning systems (if used)

As with the previous DSG an EPP has yet to be formulated in draft or otherwise.

COMPLIANCE WITH PREVIOUS REVIEWS (DSG SECTION 2)

1. Dam Safety Inspections have not been completed within the recommended time frame.
2. No record of subsequent underwater inspections exists.
3. The 2006 earth works supersede previous concerns with the earth embankment structures.
4. The dam is still in non-compliance with the requirements of Sections 3 and 4 of the DSG.
5. The current Dam Safety Review has been initiated in response to the just completed with respect to the raising of the level of the reservoir.

4 SUMMARY

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

1. In accordance with Section 1 of the DSG, the dam continues to operate under a High Consequence Category.

2. The raising of the earth embankments and concrete gravity dam section was completed in 2006. The design review for the new dam structure has been limited to visual information obtained on site and tender documents provided by the design engineer (Trow). Design calculations, material testing reports and site reports do not appear to be on record with the city. These documents were requested of, but not supplied by, Trow. These documents belong in the permanent file and are required to complete this, and subsequent, Dam Safety Reviews.

3. Rock Anchors were added in 2005. Based on the information provided, there is enough evidence to establish reasonable doubt that rock anchors were properly pretensioned such that they would behave as desired under ice loading conditions. Because of the limited information provided by Trow, we cannot confirm this with certainty.

4. No permanent instrumentation was added during the 2006 dam raising. The monitoring and instrumentation of the dam does not appear to meet the recommendations of the DSG

5. As per the previous DSG, the dam is still in non-compliance with the requirements of Sections 3 and 4 of the DSG. The following documents do not exist at this time:

    - Permanent File
    - OMS Manual
    - Logbook
    - Emergency Preparedness Plan

8. A Dam Safety Inspection (DSI) should be conducted in 2007. This is essentially a yearly non-invasive review comprising a visual inspection to identify any changes in condition, or any observed concerns. The 2007 DSI should follow-up on spillway leakage observed in October 2006.

9. An underwater inspection of the submerged structures should be done in 2007. This inspection should be coordinated with, and be under the direction of, the DSI recommended in Item 5, above.

10. A future DSR should be scheduled for no later than 2013.

7. RECOMMENDATIONS AND REQUIRED ACTION

1. The current lack of design and construction documentation is of primary concern. The absence of this documentation has resulted in specific items being labelled as incomplete and/or non-compliant with respect to the DSR. The City should ensure that all relevant as built records, design calculations, site reports are obtained from the engineer of record (Trow) and kept as part of the permanent file (see below).

2. Discrepancies with the 2005/06 design and 2005 geotechnical investigation report should be formally justified.

3. The design review for the embankment structure has been labelled as incomplete. Either sufficient documentation of the design and construction will have to be provided or an independent analysis will have to be prepared.

4. The engineer of record will have to provide formal justification of the performance envelope for the rock anchors. The current level of information indicates that overstressing of the rock foundation will occur under the usual load case. In the event that sufficient information is unavailable, additional analysis will have to be performed and safety measures implemented (if required).

5. The lack of permanent instrumentation should be formally justified or the long term performance of concrete cutoff wall will have to be adequately accounted for in the design of the earth embankments (yet to be provided).

6. The dam is still in non-compliance with the requirements of Sections 3 and 4 of the DSG. The following documents need to be developed and maintained.

    - Permanent File
    - Operation, Maintenance & Surveillance Manual
    - Logbook
    - Emergency Preparedness Plan

7. A Dam Safety Inspection (DSI) should be conducted in 2007. This is essentially a yearly non-invasive review comprising a visual inspection to identify any changes in condition, or any observed concerns.

8. An underwater inspection of the submerged structures should be done in 2007. This inspection should be coordinated with, and be under the direction of, the DSI recommended in Item 5, above.

9. A future DSR should be scheduled for no later than 2013.

Should there be any questions, please contact the undersigned.

Yours sincerely,

Concentric Associates International Incorporated

Henry Hutchison, P.Eng., B.Arch.

Allan Murray P. Eng.

APPENDIX A: SITE PHOTOGRAPHS

CONCENTRIC

Concentric Associates International Incorporated

Lake Geraldine Dam
Iqaluit, Nunavut
Dam Safety Inspection

October 29, 2009
REPORT

Produced For:
THE CITY OF IQALUIT

Produced By:
CONCENTRIC ASSOCIATES INTERNATIONAL INCORPORATED

Concentric Project Reference Number:
09-2922

Lake Geraldine Dam
Iqaluit, Nunavut
Dam Safety Inspection

CONTENTS

1. EXECUTIVE SUMMARY

Concentric Associates International Inc., (Concentric) was retained by the City of Iqaluit, to undertake a Dam Safety Inspection (DSI) of the Lake Geraldine Dam. The scope of work for the assignment has been undertaken in accordance with Concentric's proposal 09-2922 dated October 15 2009.

The site inspection was conducted on October 21, 2009, by Allan Murray, P.Eng., of Concentric.

It is recommended that the next DSI be conducted prior to October 2010.

OBSERVATIONS:

With the exception of the following items, no significant changes in condition of the concrete dam structure and retention berms were observed since the previous DSI, which was conducted in 2006.

- A significant leak has developed in the concrete dam structure south of the spillway section.
- Upwelling along the south concrete wing wall appears to have increased moderately since originally identified in 1997.

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.

RECOMMENDATIONS:

1. A grouting program should be designed for implementation in 2010 to address observed leakage.
2. Preparation of the required Operation & Safety Manual, Logbook, and Permanent File was completed in 2007; however, the documents require updating.
3. The Emergency Preparedness Plan has not been completed. This is considered a high priority.
4. Remote and possibly site based monitoring equipment should be researched, design/specified, and installed.
5. An underwater survey should be conducted prior to August 2010.
6. Complete the next DSI prior to October 2010.

2. INTRODUCTION

Concentric Associates International Inc., (Concentric) was retained by the City of Iqaluit, to undertake a Dam Safety Inspection (DSI) of the Lake Geraldine Dam located in Iqaluit, Nunavut.

This assignment and the scope of work described herein has been undertaken in accordance with Concentric's proposal 09-2922 submitted on October 15, 2009.

The site visit was conducted on October 21, 2009.

Allan Murray, P.Eng., of Concentric, met with the following personnel at the City of Iqaluit:

- Paul Clow, Director of Engineering, City of Iqaluit

This report summarizes our terms of reference for the assignment, observations, conclusions and recommended action.

3. BACKGROUND

The Canadian Dam Safety Guidelines (DSG) requires that all structures exceeding prescribed height and volume minimums be subject to Dam Safety Reviews (DSR's) and Dam Safety Inspections (DSI's) at regular intervals.

A DSR is a comprehensive, formal review process that involves completion of checklist items in accordance with the Dam Safety Guidelines. The DSR forms a baseline of dam history, condition, repair requirements, and extensive documentation of monitoring, operating, safety and emergency procedures.

The Lake Geraldine Dam requires a DSR every seven (7) years. The last DSR was conducted in 2006 by Concentric.

It is required in the DSG document that in the interval between DSR's, a Dam Safety Inspection be performed on an annual basis. The DSI is a much less comprehensive review, comprising a visual inspection only to identify any changes in condition, or any observed concerns.

A detailed historical perspective may be referenced in the DSR on file with the City of Iqaluit.

4. SCOPE OF SERVICES

Our directive has been to undertake a Dam Safety Inspection (DSI) in accordance with the DSG, for the Lake Geraldine Dam. The inspection consisted of an on-site visual assessment, notation of any significant changes in condition since the last available DSI, preparation of a written report in a format compatible with the DSR, and a photographic record.

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 of the sewage lagoon
- 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
- Submit final documents in electronic format and hard copy

Limitations

The DSI is based on visual assessment; no invasive inspection/assessment was done.

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

5. SUMMARY OF PREVIOUS DSI'S

The original DSR was conducted in 2001. In 2005, a major alteration to the dam was designed, and implemented over a two (2) year period. The major alteration triggered the requirement for a revised DSR. The DSR was prepared by Concentric in late 2006.

There has been no DSI undertaken since 2006.

This DSI should be read in conjunction with the current DSR, which contains the historical record, the bulk of which is not repeated here.

A summary of observed conditions and recommendations from the 2006 DSI (with updated information added as appropriate) is as follows:

- 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.
- The embankments (berms) appeared to be in a stable condition. Slopes of 2H:1V were maintained on the downstream rip-rap and in the upstream rock fill.
- Most of the vertical extension had not been impacted by rising water levels.
- A leak was noted in the spillway portion of the dam; this leak was subsequently repaired in 2007.
- The required Operation & Safety Manual, Logbook, and Permanent File were prepared in 2007 however they have not been updated.
- The Emergency Preparedness Plan has not been done.
- An underwater survey has not been completed since 2002.

6. COMMENTARY ON DAM SAFETY GUIDELINES

The Canadian Dam Association publication, Dam Safety Guidelines (DSG), governs the nature and frequency of inspection and review activities for structures which fall under its umbrella criteria.

The DSG applies 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 DSG document is far reaching in terms of applicability and requirements for conformance. This is understandable as the type and complexity of structures that fall under the jurisdiction of the document varies considerably, from relatively small and simple embankments or dikes to massive and complex dams associated with hydroelectric generating facilities, irrigation, flood control, etc.

The DSG requires that all structures exceeding the height and volume minimums described above be classified according to their "consequence category", that is, the consequence of dam failure in terms of life safety, and socio-economic impact. The category assigned may range from very low to very high. The consequence category dictates the requirement and frequency of Dam Safety Reviews.

A Dam Safety Review (DSR) is a comprehensive, formal review process, conducted at regular intervals, that involves completion of checklist items in accordance with the Dam Safety Guidelines.

The DSR forms a baseline of dam history, condition, repair requirements, and extensive documentation of monitoring, operating, safety and emergency procedures.

The frequency of DSR's varies depending on consequence category. For structures where significant life safety and/or socio-economic consequence exist, the DSR is usually conducted every five (5) to ten (10) years. The Lake Geraldine Dam requires a DSR every seven (7) years. The current DSR for the Lake Geraldine Dam was conducted in 2006; therefore, the Lake Geraldine Dam is due for an updated DSR in 2013. If significant alterations (not including repairs that do not change the height or volume of the structure) to the structure take place before this date, an updated DSR would be required.

It is required in the DSG document that in the interval between DSR's, a Dam Safety Inspection (DSI) would be performed on an annual basis. The DSI is a much less comprehensive review, comprising a visual inspection to identify any changes in condition, or any observed concerns. The results of the DSI are incorporated into the DSR documentation. A DSI may trigger repairs, or changes in standard operating procedures.

7. OBSERVATIONS

The Lake Geraldine Dam was accessed on foot. Based on our visual assessment we have the following comments:

- The concrete portions of the dam structure are in general unchanged from that observed for the 2006 DSI.
- The berm structures are in general unchanged from that observed for the 2006 DSI.
- A significant leak has developed in the concrete dam structure south of the spillway section.
- Upwelling along the south concrete wing wall appears to have increased moderately since originally identified in 1997.

To our knowledge, the required documentation (discussed previously) under the Canadian Dam Safety Guidelines is not up to date, and remains incomplete.

Specifically, the Permanent Record File, Logbook, and Operation & Safety Manual have not been updated.

The Emergency Preparedness Plan has not been completed.

8. RECOMMENDATIONS

The following actions are recommended:

1. A grouting program should be designed for implementation in 2010 to address the observed leakage. The grouting program should include injection of the vertical and transverse joints in the vicinity of the above grade leak in the concrete section south of the spillway.

   A grouting program should also target the upwelling source. It is possible that the underwater survey (recommended below) will assist in assessing the source and developing a repair strategy.
2. Preparation of the required Operation & Safety Manual, Logbook, and Permanent File was completed in 2007; however, the documents require updating.
3. The Emergency Preparedness Plan has not been completed. Given the vertical extension of the dam in 2006, we view this requirement as high priority. The Emergency Preparedness Plan should be completed in 2010.
4. In concert with Item 3 above, and the DSG's, remote, and possibly site based monitoring equipment should be installed at the dam. This will require some research, and a design/specification process.
5. An underwater survey should be conducted prior to August 2010.
6. Complete the next DSI prior to October 2010.

We would be pleased to discuss this report with you. Should there be any questions, please contact the undersigned.

Yours truly,

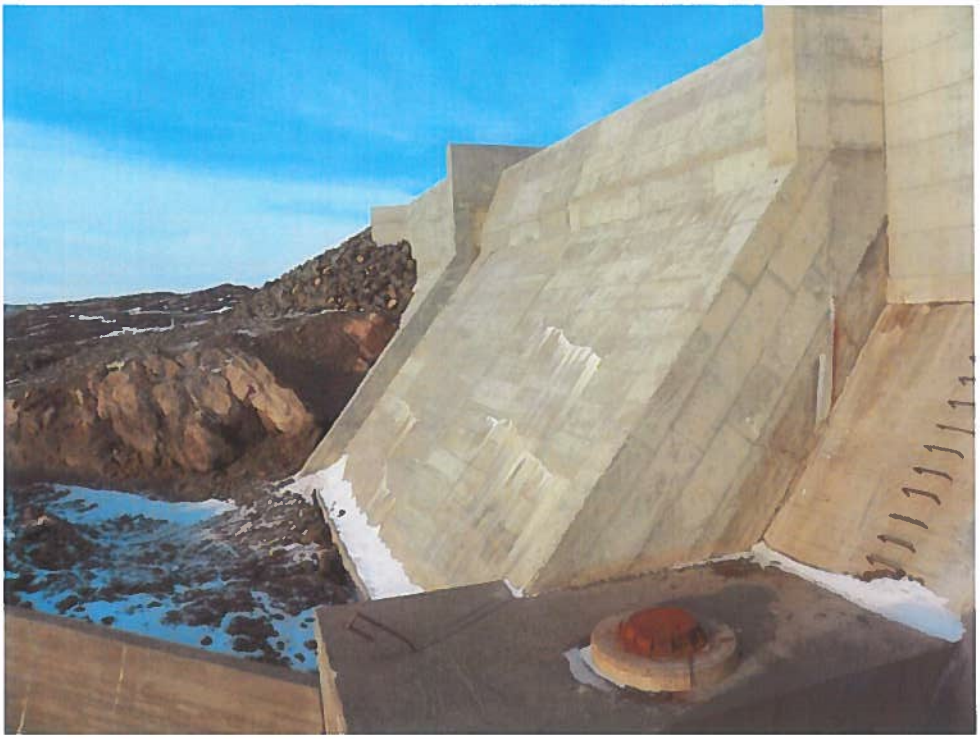
Concentric Associates International Incorporated

Allan Murray, P.Eng.,

APPENDIX A
Photographs

Photograph 1
Overview of North berm.

Photograph 2
Overview of upstream face of concrete structure.



Photograph 3
Overview of spillway section, downstream face.

Photograph 4
Overview of South berm.

Photograph 5
New leak South of spillway section.

Photograph 6
Upwelling area previously identified in 1997.

Date: Aug. 12, 2010

Client: Concentric Associates International Incorporated

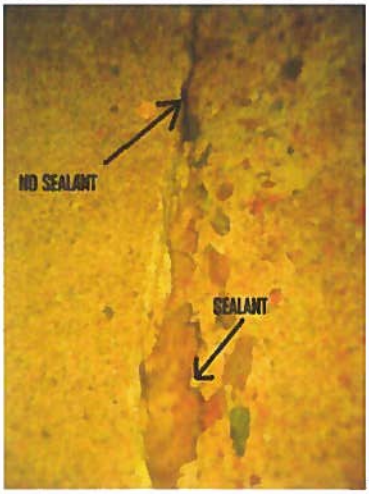
Location: Geraldine Dam, Iqaluit, NU

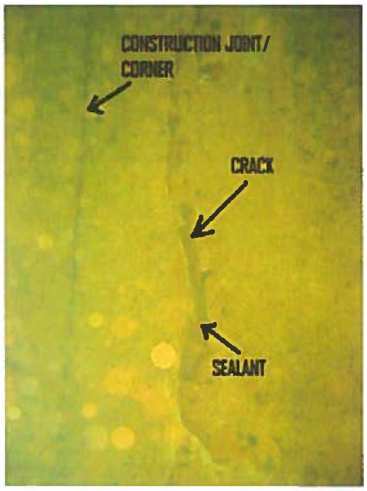
Job Scope:
• Perform an underwater visual inspection of the upstream concrete face of the dam.
• The diver shall note on the drawings provided areas of deterioration, including but not limited to; concrete deterioration, cracking, erosion, etc. Additional attention is required at locations where leaking is observed on the downstream side of the dam, along expansion joints, construction joints, and where the dam meets the lake bed.
• The diver shall visually inspect the entire length of the dam, at 1m depth intervals starting at the surface. The diver shall make all efforts to limit disturbances to the surrounding lake bed to provide adequate clarity during inspection.
• The diver shall take photographic images of areas of concern; concrete deterioration, cracking, etc. A full underwater video record of the inspection shall also be undertaken.
• The diver shall provide adequate lighting during the inspection at all times.

Crew: Jason Golka
Dave Podealuk
Dylan Lukenbill

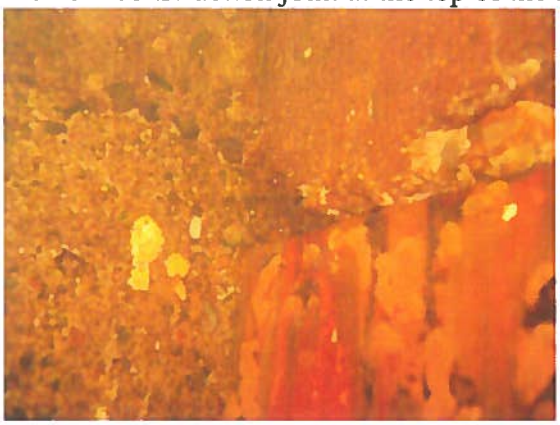
Summary: Overall, the dam is in excellent condition. All of the concrete is intact and there are no signs of degradation. There are some spots on the downstream side that show a minimal amount of leakage. These were noted by the client previous to the inspection. The upstream side however, does not yield much evidence of these leaks. The diver found only one crack on the upstream side of the dam and it had already been filled with some sort of sealant. The crack was however in line with one of the leaks on the downstream side.
The other leaks are minimal and the water is likely moving though a cold joint or expansion joint, and would be difficult to find due to the lack of flow. The diver did note that the new addition to the dam had sealant in the expansion joints but only at the top. It appears as though the sealant was used when the expansion to the dam was done. There is no evidence of sealant lower on the dam. It is assumed that the workers placed the sealant down to the water at the time, and that was all that could be reached. Note: The leaks found on the downstream side are well below the new addition to the dam where there is no sealant in the expansion joints.

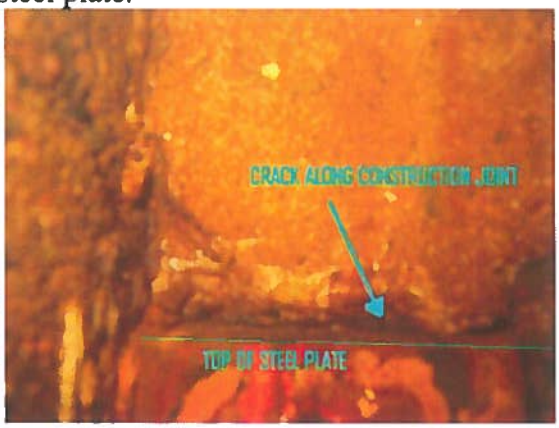
These photos were taken of the crack found about +8050mm from line D, very close to line E, and between elevation 2 and 3 on the drawing.
The crack seems to have had some type of sealant injected into it, and is also in line with one of the leaks found on the downstream side.



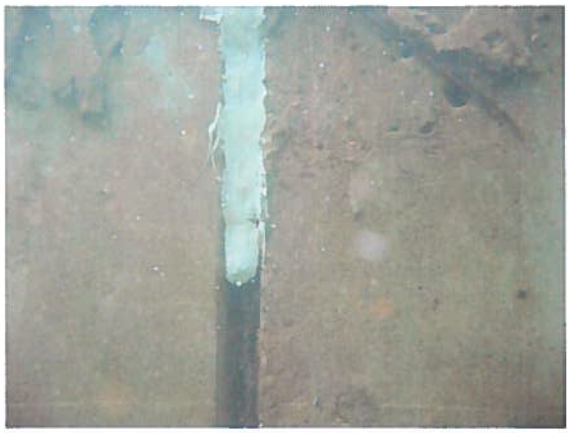


The top of the crack starts at the construction joint between the old concrete and the newer addition. It runs almost parallel with the construction joint in the corner down to the next construction joint at the top of the steel plate.





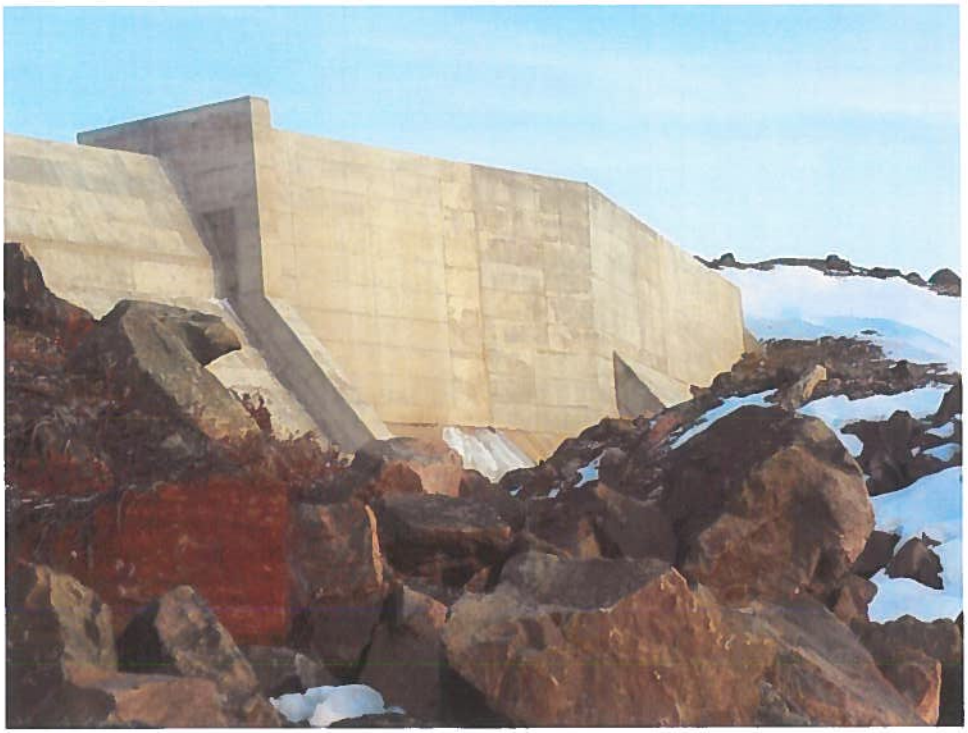
The photos below show the sealant in the expansion joints. This sealant does not go beyond the new concrete. The photos clearly show that there was no sealant in the joint previous to the placement of the sealant shown. All of the expansion joints look like this. More visual evidence can be seen in the video that was produced.



Concentric Associates International Incorporated

Lake Geraldine Dam
Iqaluit, Nunavut
Dam Safety Inspection

November 23 2010
REPORT



Produced For:
THE CITY OF IQALUIT

Produced By:
CONCENTRIC ASSOCIATES INTERNATIONAL INCORPORATED

Concentric Project Reference Number:
10-3496

CONCENTRIC

Concentric Associates International Incorporated

Lake Geraldine Dam
Iqaluit, Nunavut
Dam Safety Inspection

CONTENTS

1. EXECUTIVE SUMMARY

Concentric Associates International Inc., (Concentric) was retained by the City of Iqaluit, to undertake a Dam Safety Inspection (DSI) of the Lake Geraldine Dam. The scope of work for the assignment has been undertaken in accordance with Concentric's proposal (No. 10-3496) and dated October 27, 2010.

The site inspection was conducted on November 1, 2010, by Allan Murray, P.Eng., and Chileab Yue, of Concentric.

It is recommended that the next DSI be conducted prior to November 2010.

OBSERVATIONS:

With the exception of the following items, no significant changes in condition of the concrete dam structure and retention berms were observed since the previous DSI, which was conducted in 2009.

- A significant leak has developed in the north berm in the vicinity of the vehicular access ramp.
- Localized wash outs along the north berm have developed due to wind events in October 2010.

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.

RECOMMENDATIONS:

1. A grouting program should be implemented in 2011 to address observed leakage. This program was originally recommended for 2010 but the construction phase was deferred to 2011 at the request of the City and after dialogue with Concentric.
2. Repairs to the north berm are required in the short term, and in 2011, to address localized wash outs.
3. Leakage through the north berm requires assessment and repair in 2011.
4. Preparation of the required Operation & Safety Manual, Logbook, and Permanent File was completed in 2007; however, the documents require updating.
5. The Emergency Preparedness Plan has not been completed. This is considered a high priority.
6. Complete the next DSI prior to November 2011.

2. INTRODUCTION

Concentric Associates International Inc., (Concentric) was retained by the City of Iqaluit, to undertake a Dam Safety Inspection (DSI) of the Lake Geraldine Dam located in Iqaluit, Nunavut.

This assignment and the scope of work described herein have been undertaken in accordance with Concentric's proposal (No. 10-3496) and dated October 27, 2010.

The site visit was conducted on November 1, 2010.

This report summarizes our terms of reference for the assignment, observations, conclusions and recommended action.

3. BACKGROUND

The Canadian Dam Safety Guidelines (DSG) requires that all structures exceeding prescribed height and volume minimums be subject to Dam Safety Reviews (DSR's) and Dam Safety Inspections (DSI's) at regular intervals.

A DSR is a comprehensive, formal review process that involves completion of checklist items in accordance with the Dam Safety Guidelines. The DSR forms a baseline of dam history, condition, repair requirements, and extensive documentation of monitoring, operating, safety and emergency procedures.

The Lake Geraldine Dam requires a DSR every seven (7) years. The last DSR was conducted in 2006 by Concentric; another DSR should not be required until 2013 unless the structures are significantly altered.

It is required in the DSG document that in the interval between DSR's, a Dam Safety Inspection be performed on an annual basis. The DSI is a much less comprehensive review, comprising a visual inspection only to identify any changes in condition, or any observed concerns.

A detailed historical perspective may be referenced in the DSR on file with the City of Iqaluit.

4. SCOPE OF SERVICES

Our directive has been to undertake a Dam Safety Inspection (DSI) in accordance with the DSG, for the Lake Geraldine Dam. The inspection consisted of an on-site visual assessment, notation of any significant changes in condition since the last available DSI, preparation of a written report in a format compatible with the DSR, and a photographic record.

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 of the dam.
- 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
- Submit final documents in electronic format and hard copy

Limitations

The DSI is based on visual assessment; no invasive inspection/assessment was done.

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

5. SUMMARY OF PREVIOUS DSI

The original DSR was conducted in 2001. In 2005, a major alteration to the dam was designed, and implemented over a two (2) year period. The major alteration triggered the requirement for a revised DSR. The DSR was prepared by Concentric in late 2006.

The previous DSI's were conducted by Concentric in 2006 and 2009.

This DSI should be read in conjunction with the current DSR, which contains the historical record; the bulk of which is not repeated here.

A summary of observed conditions and recommendations from the 2009 DSI (in italics; with updated information added in non-italics as appropriate) is as follows:

- *A grouting program should be designed for implementation in 2010 to address the observed leakage. The grouting program should include injection of the vertical and transverse joints in the vicinity of the above grade leak in the concrete section south of the spillway.*

  This program was originally recommended for 2010 and the design documents were completed in 2010 by Concentric. The construction phase was deferred to 2011 at the request of the City and after dialogue with Concentric.

- *A grouting program should also target the upwelling source. It is possible that the underwater survey (recommended below) will assist in assessing the source and developing a repair strategy.*

  This area will be included in the 2011 grouting program as appropriate.

- *Preparation of the required Operation & Safety Manual, Logbook, and Permanent File was completed in 2007; however, the documents require updating.*

  To our knowledge no updating has been done since 2007.

- *The Emergency Preparedness Plan (EPP) has not been completed. Given the vertical extension of the dam in 2006, we view this requirement as high priority. The Emergency Preparedness Plan should be completed in 2010.*

  To our knowledge the EPP has not been completed.

- *In concert with the EPP above, and the DSG's, remote, and possibly site based monitoring equipment should be installed at the dam. This will require some research, and a design/specification process.*

The requirement for monitoring equipment will be determined by the EPP.

- *An underwater survey should be conducted prior to August 2010.*

  The underwater survey was completed in the summer of 2010.

- *Complete the next DSI prior to October 2010.*

  The DSI was completed in 2010.

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6. COMMENTARY ON DAM SAFETY GUIDELINES

The Canadian Dam Association publication, Dam Safety Guidelines (DSG), governs the nature and frequency of inspection and review activities for structures which fall under its umbrella criteria.

The DSG applies 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 DSG document is far reaching in terms of applicability and requirements for conformance. This is understandable as the type and complexity of structures that fall under the jurisdiction of the document varies considerably, from relatively small and simple embankments or dikes to massive and complex dams associated with hydroelectric generating facilities, irrigation, flood control, etc.

The DSG requires that all structures exceeding the height and volume minimums described above be classified according to their "consequence category", that is, the consequence of dam failure in terms of life safety, and socio-economic impact. The category assigned may range from very low to very high. The consequence category dictates the requirement and frequency of Dam Safety Reviews.

A Dam Safety Review (DSR) is a comprehensive, formal review process, conducted at regular intervals, that involves completion of checklist items in accordance with the Dam Safety Guidelines.

The DSR forms a baseline of dam history, condition, repair requirements, and extensive documentation of monitoring, operating, safety and emergency procedures.

The frequency of DSR's varies depending on consequence category. For structures where significant life safety and/or socio-economic consequence exist, the DSR is usually conducted every five (5) to ten (10) years. The Lake Geraldine Dam requires a DSR every seven (7) years. The current DSR for the Lake Geraldine Dam was conducted in 2006; therefore, the Lake Geraldine Dam is due for an updated DSR in 2013. If significant alterations (not including repairs that do not change the height or volume of the structure) to the structure take place before this date, an updated DSR would be required.

It is required in the DSG document that in the interval between DSR's, a Dam Safety Inspection (DSI) would be performed on an annual basis. The DSI is a much less comprehensive review, comprising a visual inspection to identify any changes in condition, or any observed concerns. The results of the DSI are incorporated into the DSR documentation. A DSI may trigger repairs, or changes in standard operating procedures.

7. OBSERVATIONS

The Lake Geraldine Dam was accessed on foot. Based on our visual assessment we have the following comments:

- The visible concrete portions of the dam structure are in general unchanged from that observed for the 2009 DSI.
- The level of the Lake Geraldine reservoir has increased at least 0.6 metres since October 2009. The water level was within approximately 0.2m of the spillway crest at the time of our recent inspection; i.e. close to capacity.
- The berm structures exhibit the following issues:
    - Through leakage has developed in the north berm in the vicinity (both north and south sides) of the vehicular access ramp. The location is coincident with a change in direction of the berm.
    - Localized wash-outs have occurred on the upstream face of the north berm. It was reported that these wash outs developed as a result of wind events during the week of October 18, 2010. The larger armour stone remains however sections of the roadbed have been washed out.
- The leak in the concrete dam structure south of the spillway section that was identified in the 2009 DSI has not changed significantly.
- Upwelling along the south concrete wing wall appears has not changed significantly since the 2009 DSI.

To our knowledge, the required documentation (discussed previously) under the Canadian Dam Safety Guidelines is not up to date, and remains incomplete.

Specifically, the Permanent Record File, Logbook, and Operation & Safety Manual have not been updated.

To our knowledge, the Emergency Preparedness Plan (EPP) has not been completed.

8. DISCUSSION

The following issues are discussed in more detail:

Localized Wash Out

It was reported that, at times during the wind events, waves were overtopping the berm. High winds from the east were reported over several days.

Wave action as a result of high winds caused the erosion of granular material and the exposure of the concrete cutoff wall within the north berm.

A review of design drawings for the north berm wall, (Trow Associates Inc. Drawing BD2, Lake Geraldine Earth & Concrete Work 2006, June 2006) noted that the proposed construction of the north berm of the Lake Geraldine reservoir comprises a 200 mm thick concrete cutoff wall with rock fill on the upstream face (at a slope of 2:1 from the top) and 250 mm minus granular covered with 600 mm rip rap on the downstream face (at a slope of 2:1 from the top). The top of the berm is approximately 2.4 metres wide with a 2% slope towards the downstream face of the berm.

A cursory visual inspection of the north berm wall noted that, in general, the berm is constructed in accordance with the Drawing BD2.

In general, the rock fill is an effective barrier against erosion along the north berm wall. Only in extreme cases will wave action erode the granular material in this area.

As a short term solution, all areas of erosion should be filled with rock of similar size to the existing rock fill.

As per the design, the vehicular roadbed extends over the cut-off wall on the upstream side of the berm a distance of perhaps 1.2 metres. The roadbed material is a much finer granular than the rip rap, with the visual appearance of pit run gravel. This material was what washed out during the wind events.

The vehicular roadbed on the downstream side of the cut-off wall has adequate width for vehicular traffic.

In the longer term, we recommend filling the upstream berm with rock up to and slightly above the top of the cutoff wall and thus eliminate a 1.2 metre width of the vehicular roadbed.

Leakage at Vehicular Access Ramp

Through leakage in the north berm was observed on both the north and south sides of the vehicular access ramp.

This leakage was not observed at the time of the 2009 DSI, however, at that time there was more snow and ice cover.

There are several potential sources for the water flow at the base of the downstream face of the berm.

Given the wave overtopping during the wind events there would have been a significant amount of water that crossed over the concrete cut-off wall and then made its way through and out the base of the berm on the downstream side. One would expect that outflow to have ceased shortly after the waves subsided, and certainly within a few days.

The dam vertical extension in 2006 included a corresponding vertical extension to the concrete cut-off wall; details on the record drawings show a proprietary (Sika) product placed as a waterstop between the older and newer sections. This detail could be a source of leakage.

There could be leakage (upwelling) at the interface between the cut-off wall and the bedrock that it is reportedly founded in. The reservoir is at its highest levels ever and thus hydrostatic pressures are as well.

A workmanship or durability detail may exist in the cut-off wall in the vicinity; perhaps at the change in direction of the berm, which is coincident with the vehicular access ramp.

The actual cause of the leakage cannot be determined without considerably more investigation, and invasive assessment.

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9. RECOMMENDATIONS

The following actions are recommended:

1. The grouting program originally designated for implementation in 2010 was designed in 2010; however, the implementation phase was deferred to 2011 by the City, and after dialogue with Concentric. Implementation is recommended for 2011.
2. The localized wash outs from the wind events of 2010 require repair. As a short term interim measure, all areas of erosion should be filled with rock of similar size to the existing rock fill. In the longer term, the upstream berm should be filled with rock up to and slightly above the top of the cutoff wall, and thus eliminate a 1.2 metre width of the vehicular roadbed.
3. The through leakage in the north berm at the vehicular access ramp requires investigation and repair in 2011. An investigative program will be prepared if requested by the City.
4. Preparation of the required Operation & Safety Manual, Logbook, and Permanent File was completed in 2007; however, the documents require updating. To our knowledge this has not been done.
5. The Emergency Preparedness Plan (EPP) was recommended for completion in 2010. To our knowledge the EPP has not been completed. The Emergency Preparedness Plan should be completed in 2011.
6. Complete the next DSI prior to November 2011.

We would be pleased to discuss this report with you. Should there be any questions, please contact the undersigned.

Yours truly,

Concentric Associates International Incorporated

Chileab Yue
Iqaluit Branch Manager

Allan Murray, P.Eng.
Partner

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APPENDIX A
Photographs

Photograph 1
Overview of Dam Structure; from the Northwest.

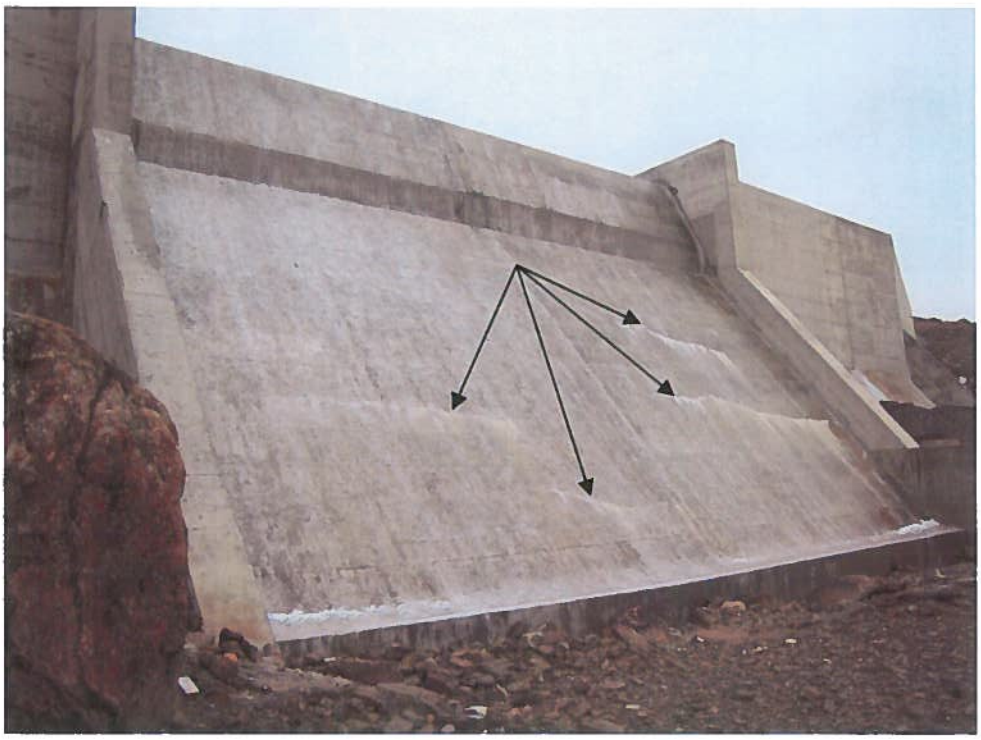
Photograph 2
Overview of North Berm, Downstream Face. Note leakage just north of ramp access.

Photograph 3
North Berm at South side of ramp access; note leakage.

Photograph 4
Southern portion of North Berm, upstream face; note localized washouts due to wave action.

Photograph 5
Overview of spillway; note water level near capacity; approx. 0.6m higher than October 2009.

Photograph 6
Leakage at North end of Spillway; similar to 2009 DSI.



Photograph 7
Leaching cracks in Spillway face; Similar to 2009 DSI.

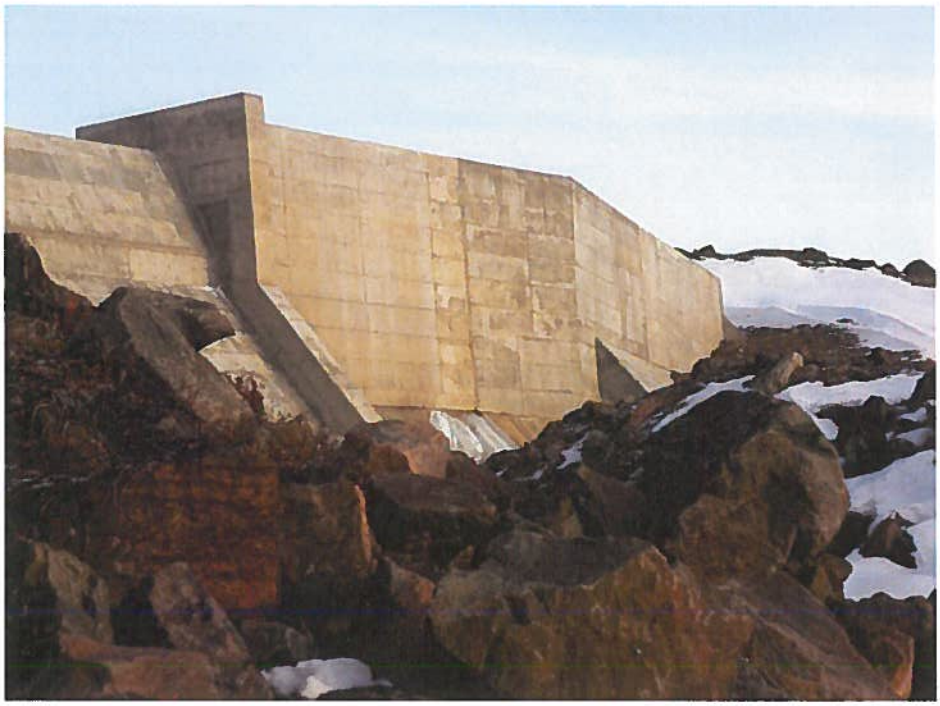
Photograph 8
Leakage at South Gravity section; Similar to 2009 DSI.

CONCENTRIC

Concentric Associates International Incorporated

Lake Geraldine Dam
Iqaluit, Nunavut
Dam Safety Inspection

September 21, 2011
REPORT



Produced For:
THE CITY OF IQALUIT

Produced By:
CONCENTRIC ASSOCIATES INTERNATIONAL INCORPORATED

Concentric Project Reference Number:
11-4000

Lake Geraldine Dam
Iqaluit, Nunavut
Dam Safety Inspection

CONTENTS

1. EXECUTIVE SUMMARY

Concentric Associates International Inc., (Concentric) was retained by the City of Iqaluit, to undertake a Dam Safety Inspection (DSI) of the Lake Geraldine Dam. The scope of work for the assignment has been undertaken in accordance with Concentric's proposal to the City.

The site inspection was conducted on September 21, 2011, by Allan Murray, P.Eng., of Concentric.

It is recommended that the next DSI be conducted prior to October 2012.

OBSERVATIONS:

With the exception of the following items, no significant changes in condition of the concrete dam structure and retention berms were observed since the previous DSI, which was conducted in 2009.

- A grouting program was conducted in 2011 which has addressed the leakage areas identified in the previous DSI.
- Upwelling along the south concrete wing wall appears similar to that observed in 2009.
- North berm repairs are required due to loss of fills on the upstream face.
- Very little leakage was noted at the North berm access ramp where previously observed in 2010.

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.

RECOMMENDATIONS:

1. Complete repairs to the North berm prior to October 2012.
2. Monitor leakage at the North berm access ramp area.
3. Complete the next DSI prior to October 2012.

2. INTRODUCTION

Concentric Associates International Inc., (Concentric) was retained by the City of Iqaluit, to undertake a Dam Safety Inspection (DSI) of the Lake Geraldine Dam located in Iqaluit, Nunavut.

This assignment and the scope of work described herein has been undertaken in accordance with Concentric's proposal to the City.

The site visit was conducted on September 14, 2011.

This report summarizes our terms of reference for the assignment, observations, conclusions and recommended action.

3. BACKGROUND

The Canadian Dam Safety Guidelines (DSG) requires that all structures exceeding prescribed height and volume minimums be subject to Dam Safety Reviews (DSR's) and Dam Safety Inspections (DSI's) at regular intervals.

A DSR is a comprehensive, formal review process that involves completion of checklist items in accordance with the Dam Safety Guidelines. The DSR forms a baseline of dam history, condition, repair requirements, and extensive documentation of monitoring, operating, safety and emergency procedures.

The Lake Geraldine Dam requires a DSR every seven (7) years. The last DSR was conducted in 2009 by Concentric.

It is required in the DSG document that in the interval between DSR's, a Dam Safety Inspection be performed on an annual basis. The DSI is a much less comprehensive review, comprising a visual inspection only to identify any changes in condition, or any observed concerns.

A detailed historical perspective may be referenced in the DSR on file with the City of Iqaluit.

4. SCOPE OF SERVICES

Our directive has been to undertake a Dam Safety Inspection (DSI) in accordance with the DSG, for the Lake Geraldine Dam. The inspection consisted of an on-site visual assessment, notation of any significant changes in condition since the last available DSI, preparation of a written report in a format compatible with the DSR, and a photographic record.

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 of the sewage lagoon
- 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
- Submit final documents in electronic format and hard copy

Limitations

The DSI is based on visual assessment; no invasive inspection/assessment was done.

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

5. SUMMARY OF PREVIOUS DSI'S

The original DSR was conducted in 2001. In 2005, a major alteration to the dam was designed, and implemented over a two (2) year period. The major alteration triggered the requirement for a revised DSR. The DSR was prepared by Concentric in late 2006.

The most recent DSI was completed by Concentric in 2009.

This DSI should be read in conjunction with the current DSR, which contains the historical record, the bulk of which is not repeated here.

A summary of observed conditions and recommendations from the 2009 DSI (with updated information added as appropriate) is as follows:

- The concrete portions of the dam structure are in general unchanged from that observed for the 2006 DSI.
- The berm structures are in general unchanged from that observed for the 2006 DSI.
- A significant leak has developed in the concrete dam structure south of the spillway section.
- Upwelling along the south concrete wing wall appears to have increased moderately since originally identified in 1997.
- A grouting program should be designed for implementation in 2010 to address the observed leakage areas.
- The Operation & Safety Manual, Logbook, and Permanent File documents require updating.
- The Emergency Preparedness Plan should be completed in 2010.
- An underwater survey should be conducted prior to August 2010.
- Complete the next DSI prior to October 2010.

6. COMMENTARY ON DAM SAFETY GUIDELINES

The Canadian Dam Association publication, Dam Safety Guidelines (DSG), governs the nature and frequency of inspection and review activities for structures which fall under its umbrella criteria.

The DSG applies 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 DSG document is far reaching in terms of applicability and requirements for conformance. This is understandable as the type and complexity of structures that fall under the jurisdiction of the document varies considerably, from relatively small and simple embankments or dikes to massive and complex dams associated with hydroelectric generating facilities, irrigation, flood control, etc.

The DSG requires that all structures exceeding the height and volume minimums described above be classified according to their "consequence category", that is, the consequence of dam failure in terms of life safety, and socio-economic impact. The category assigned may range from very low to very high. The consequence category dictates the requirement and frequency of Dam Safety Reviews.

A Dam Safety Review (DSR) is a comprehensive, formal review process, conducted at regular intervals, that involves completion of checklist items in accordance with the Dam Safety Guidelines.

The DSR forms a baseline of dam history, condition, repair requirements, and extensive documentation of monitoring, operating, safety and emergency procedures.

The frequency of DSR's varies depending on consequence category. For structures where significant life safety and/or socio-economic consequence exist, the DSR is usually conducted every five (5) to ten (10) years. The Lake Geraldine Dam requires a DSR every seven (7) years. The current DSR for the Lake Geraldine Dam was conducted in 2006; therefore, the Lake Geraldine Dam is due for an updated DSR in 2013. If significant alterations (not including repairs that do not change the height or volume of the structure) to the structure take place before this date, an updated DSR would be required.

It is required in the DSG document that in the interval between DSR's, a Dam Safety Inspection (DSI) would be performed on an annual basis. The DSI is a much less comprehensive review, comprising a visual inspection to identify any changes in condition, or any observed concerns. The results of the DSI are incorporated into the DSR documentation. A DSI may trigger repairs, or changes in standard operating procedures.

7. OBSERVATIONS

The Lake Geraldine Dam was accessed on foot. Based on our visual assessment we have the following comments:

- The concrete portions of the dam structure are in general unchanged from that observed for the 2009 DSI.
- The north berm structure has experienced considerable scour and loss of granular fill due to wave action from wind events; the severity has increased over the last 2 years as the reservoir level has begun to approach maximum.
- A grouting program was completed in August 2011; based in part on the results of an underwater survey commissioned in 2010. The grouting program had been slated for 2010 but was deferred one year to accommodate budgetary constraints. The grouting program appears to have been, in general, effective.
- Upwelling along the south concrete wing wall appears unchanged from the 2009 DSI.
- The (previous) leakage sites on both sides of the vehicle access ramp to the North berm exhibit little or no leakage.

The required documentation (discussed previously) under the Canadian Dam Safety Guidelines, was updated in 2011.

The Emergency Preparedness Plan has not yet been completed; however, we have been advised by the City that this task is now in progress.

8. RECOMMENDATIONS

The following actions are recommended:

1. A repair of the damage to the North berm is required in 2012. An engineered tender package should be prepared which should include provisions for long term stability of the berm.

2. Continue to monitor the leakage sites on each side of the access ramp to the North berm.

3. Once the Emergency Preparedness Plan is complete, it should be integrated with the dam record documentation and Permanent Record File.

4. Complete the next DSI prior to October 2012.

We would be pleased to discuss this report with you. Should there be any questions, please contact the undersigned.

Yours truly,

Concentric Associates International Incorporated

Allan Murray, P.Eng.,
Project Manager

APPENDIX A
Photographs

Photograph 1
Overview of South berm.

Photograph 2
Overview of spillway – note overtopping (maximum lake level)

Photograph 3
2011 grouting repair area – concrete is damp only with no running water.

Photograph 4
Overview of North berm – note extensive loss of material from wave action.

Photograph 5
North side of access ramp – note previously wet area now dry.

Photograph 6
South side of access ramp – note slight leakage only compared to previously.

Iqaluit

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As Built Drawings

CONCENTRIC

Iqaluit
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Instructions

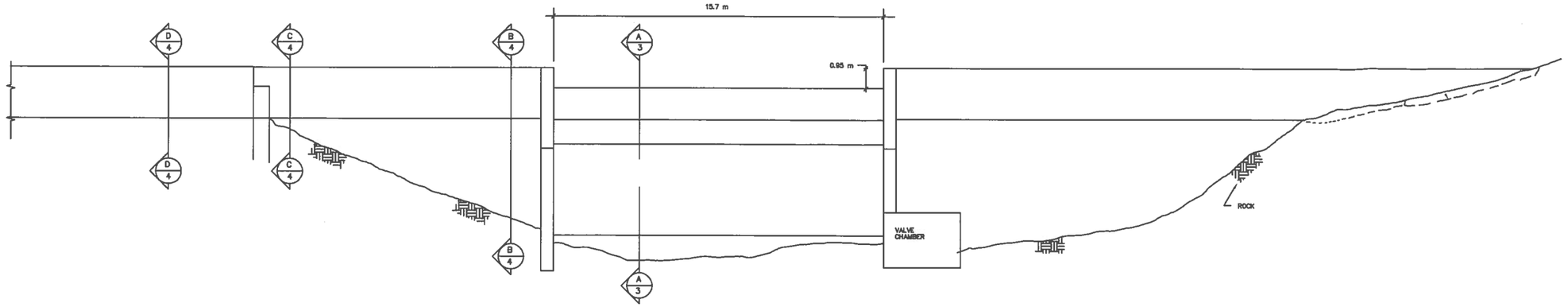
This Section contains copies of all As Built drawings available for the LG Dam. The documents should remain in chronological order.

Whenever a new drawing is added it should be noted in the Annual Update Pages, (Tab 1), a notation of the associated site inspection should be noted in the Permanent Log Book, (Tab 5), and added to the register in this Section, below.

REGISTER of AS BUILT DRAWINGS

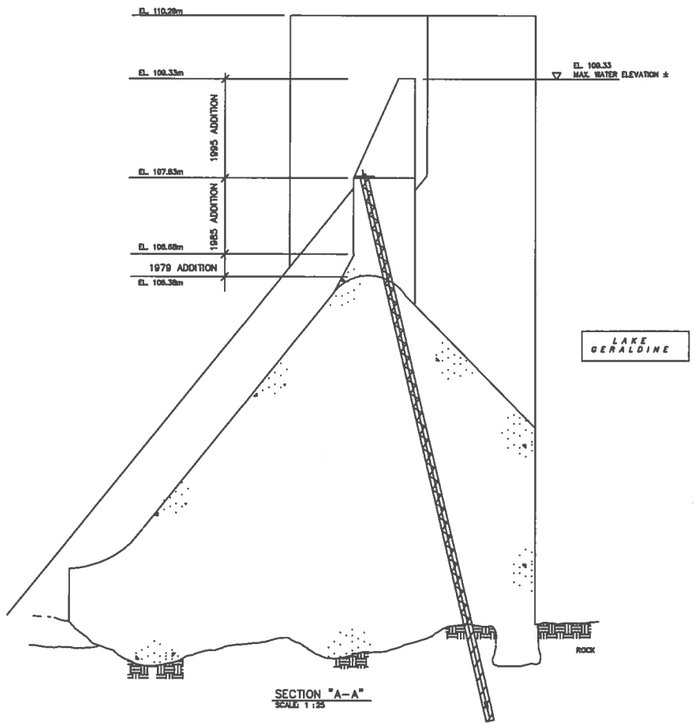
Date	Document
Oct 2001	General Arrangement Drawing by Trow
2005-2006	Lake Geraldine Earth and Concrete Work Drawings by Trow
July 2011	Lake Geraldine Dam and Water Treatment Plant Grouting Program Drawings and Specifications by Concentric

CONCENTRIC



DOWNSTREAM ELEVATION

SCALE NTS



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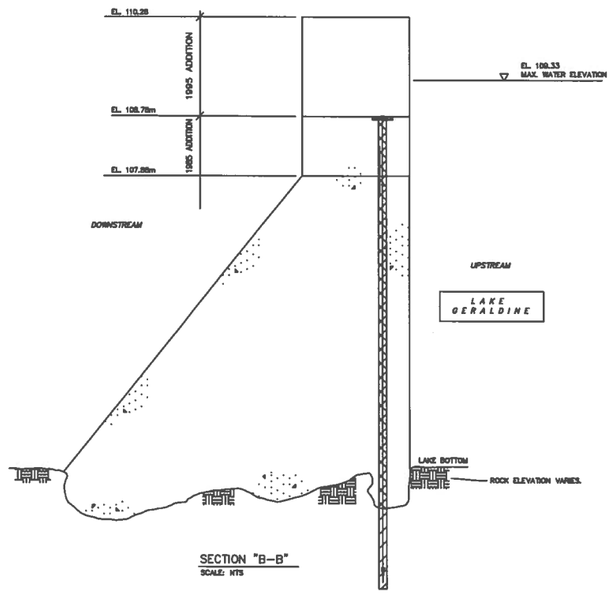

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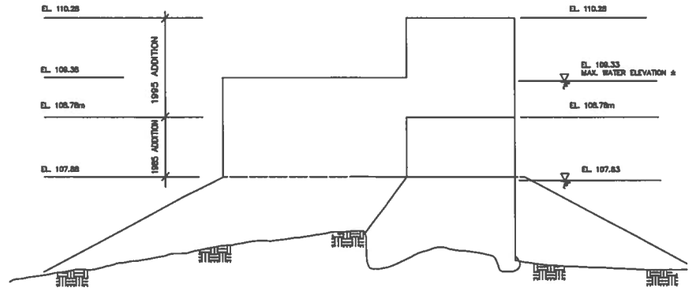

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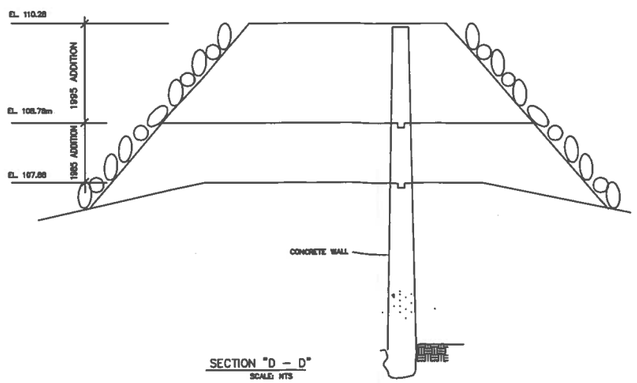

SECTION "D – D"

SCALE: NTS

Trow

Trow Consulting Engineers Ltd.
15 Cuddy Boulevard
London, Ontario, N5V 5Y3

NO.	REVISION	DATE

Client:
CITY OF IQALUIT

Project Name:
LAKE GERALDINE DAM

Project Address:
IQALUIT, NUNAVUT

Sheet Title:
GENERAL ARRANGEMENT

Design:	
Drawn: S.M.	
Approv.:	
Scale: NOT TO SCALE	
Date: October 2001	

Project No.
MU15152

Dwg. No.
1
OF 1

CITY OF IQALUIT

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LAKE GERALDINE
EARTH AND CONCRETE WORK - 2006

Trow Associates Inc.

154 Colonnade Road South
Nepean, Ontario K2E 7J5

Tel: (613) 225-9940
Fax: (613) 225-7337

LIST OF DRAWINGS

CIVIL DRAWINGS

SP1 SITE PLAN
BD1 BERM DETAILS
BD2 BERM DETAILS
BM1 BEST MANAGEMENT PRACTICES PLAN

STRUCTURAL DRAWINGS

S1 PLAN AND ELEVATION
S2 SECTION "A-A"
S3 SECTION "B-B"
S4 SECTION "C-C"
S5 SECTION "D-D"
S6 SECTIONS "E-E", "F-F", "G-G" & "H-H"
S7 SECTIONS "J-J" & "K-K"

ROCK ANCHORS - 2005
(FOR REFERENCE ONLY)

RA1 PLAN AND ELEVATION

LAKE GERALDINE

PROPOSED NEW WATER LEVEL

PROPOSED CONCRETE CUT OFF WALL EXTENSION TO BE SOCKETED 0.5m INTO THE BEDROCK AT THE BASE AND NORTH SIDE

NORTH BERM APROX. 55.50m

ROCK FILL 2:1 SLOPE

RIPRAP ROCK FILL SAND & GRAVEL 2:1 SLOPE

EXISTING ACCESS ROAD TO BE RAISED & REGRADED. SEE DETAIL DWG BD1-T1

2:1 SLOPE

CENTRAL BERM APROX. 78.0m

ROCK FILL 2:1 SLOPE

RIPRAP ROCK FILL SAND & GRAVEL 2:1 SLOPE

UNLIT OF ROAD RECHARGING

SPILLWAY

SOUTH DAM

TOE OF SLOPE NOT TO ENTER WATER COURSE

BH#2 102.27

BH#3 104.33

PROPOSED SOUTH DAM EXTENSION 8.0m LENGTH TOP 112.28m

PROPOSED NEW CONCRETE CUT OFF WALL TO BE SOCKETED 0.5m INTO THE BEDROCK AT THE BASE AND BOTH SIDES

BH#4 109.98

PROPOSED SOUTH BERM APROX. 68.5m

2:1 SLOPE

2:1 SLOPE

KEY PLAN

LEGEND

PERMIT OF PRACTICE
TROW ASSOCIATES INC.
Signature
Date
PERMIT NUMBER P184
The Association of Professional Engineers Geologists and Geophysicists of the NWT/NU

NO.	DESCRIPTION	DATE	BY	APP'D
3	ISSUED AS CONTRACT DOCUMENTS	14/06/06	ABZ	SLB
2	ISSUED FOR TENDER	07/04/06	ABZ	SLB
1	95% SUBMISSION	28/02/06	ABZ	SLB
NO.	REVISION	DD/MM/YR	A.B.C.	A.B.C.
No.	DESCRIPTION	DATE	BY	APP'D

REVISIONS

REGISTERED PROFESSIONAL ENGINEER S.L. BURDEN LICENSEE N.W.T.

REGISTERED PROFESSIONAL ENGINEER A.R. ABOZARAD LICENSEE NWT/NU

Trow Associates Inc.
154 Colonnade Road South, Nepean, Ontario
(613) 225-9940
(613) 225-7337

CLIENT
CITY OF IQALUIT

PROJECT
LAKE GERALDINE
EARTH & CONCRETE WORK
2006

TITLE
SITE PLAN

design by	A.B.Z	project no.	DTCD000176160
drawn by	A.B.Z	drawing no.	SP1
checked by	S.B		
date	07-01-2005		
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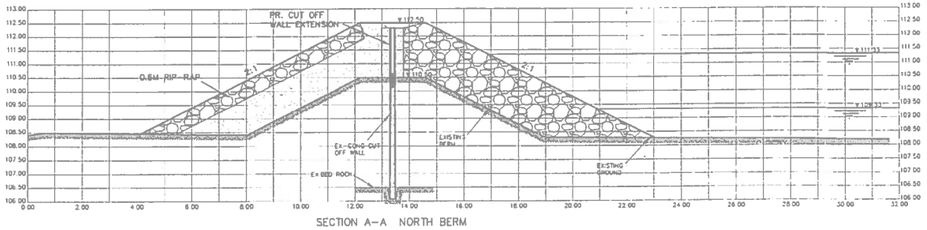
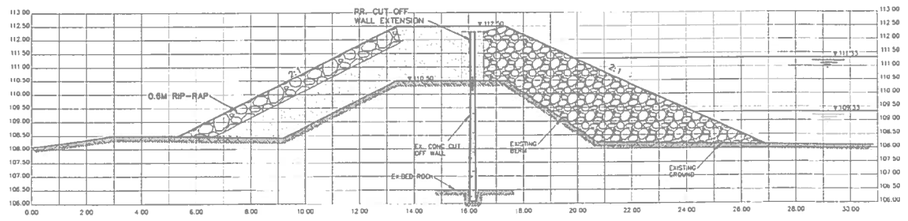
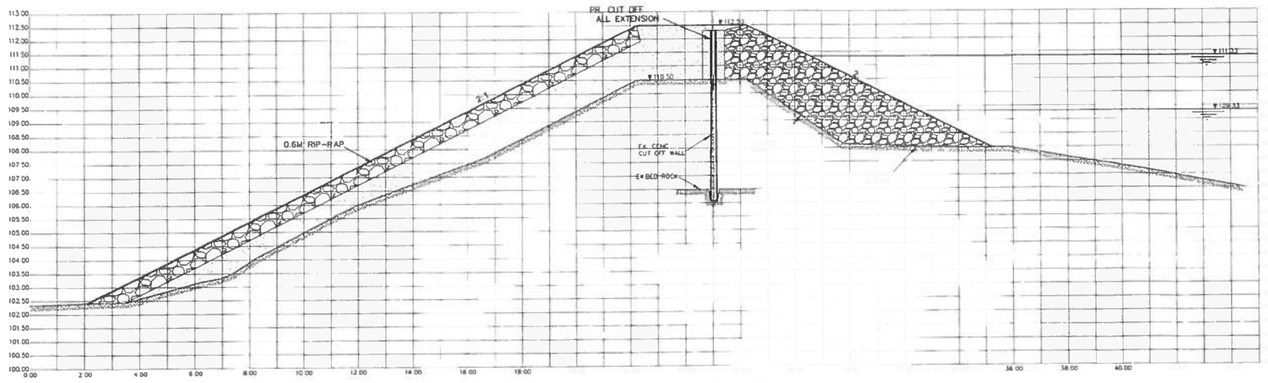


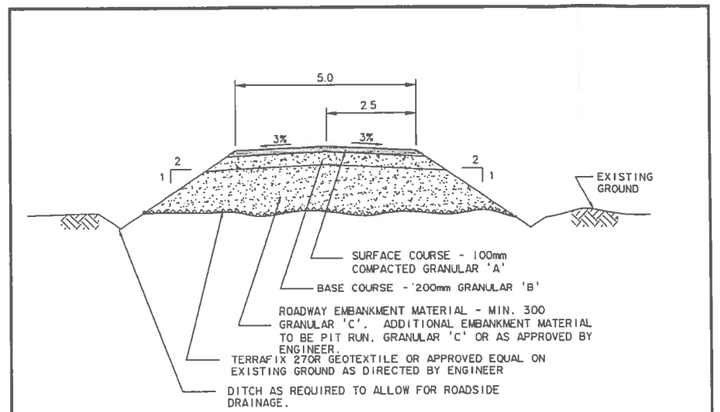
SECTION A–A NORTH BERM



SECTION B–B CENTRAL BERM



SECTION C–C CENTRAL BERM



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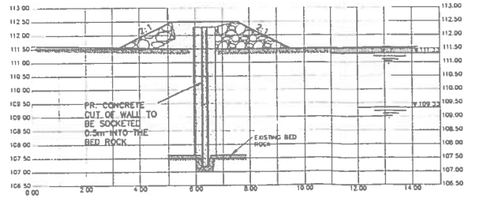
	SCALE: NTS	DATE: MAR. 2004	T–1



SECTION D–D SOUTH BERM

KEY PLAN

LEGEND

PR. SAND & GRAVEL FILL

PR. ROCK FILL

PR. SAND FILL

PERMIT OF PRACTICE
TROW ASSOCIATES INC.
Signature
Date June 16/06
PERMIT NUMBER: P184
The Association of Professional Engineers Geologists and Geophysicists of the NWT/NU

NO.	DESCRIPTION	DATE	BY	APP'D
3	ISSUED AS CONTRACT DOCUMENTS	14/06/06	ABZ	SLB
2	ISSUED FOR TENDER	07/04/06	ABZ	SLB
1	95% SUBMISSION	28/02/06	ABZ	SLB
NO.	REVISION	DD/MM/YR	A.B.C.	A.B.C

REVISIONS

REGISTERED PROFESSIONAL ENGINEERS — S.L. BURDEN — LICENSEE — N.W.T.

REGISTERED PROFESSIONAL ENGINEERS — A.R. ABDZARAD — LICENSEE — NWT/NU

Trow Associates Inc.
154 Colonnade Road South, Nepean, Ontario
(613) 225-9640
(613) 225-7337

CLIENT: CITY OF IQALUIT

PROJECT: LAKE GERALDINE EARTH & CONCRETE WORK 2006

TITLE: BERM DETAILS

design by	A B Z	project no.	DICD00017610
drawn by	A B Z	drawing no.	BD1
checked by	S.B		
date	07-01-2005		
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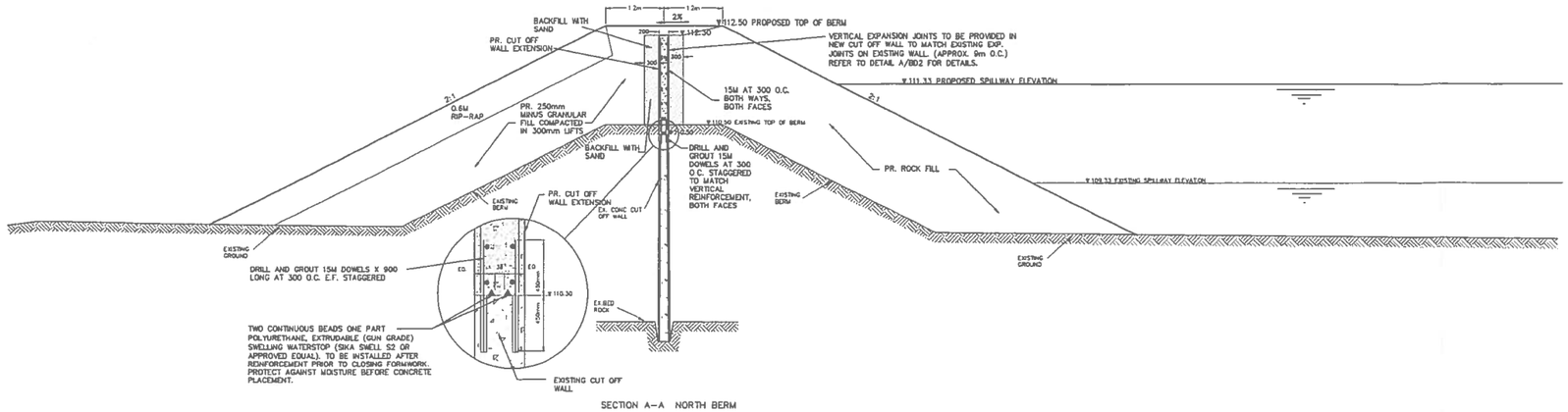

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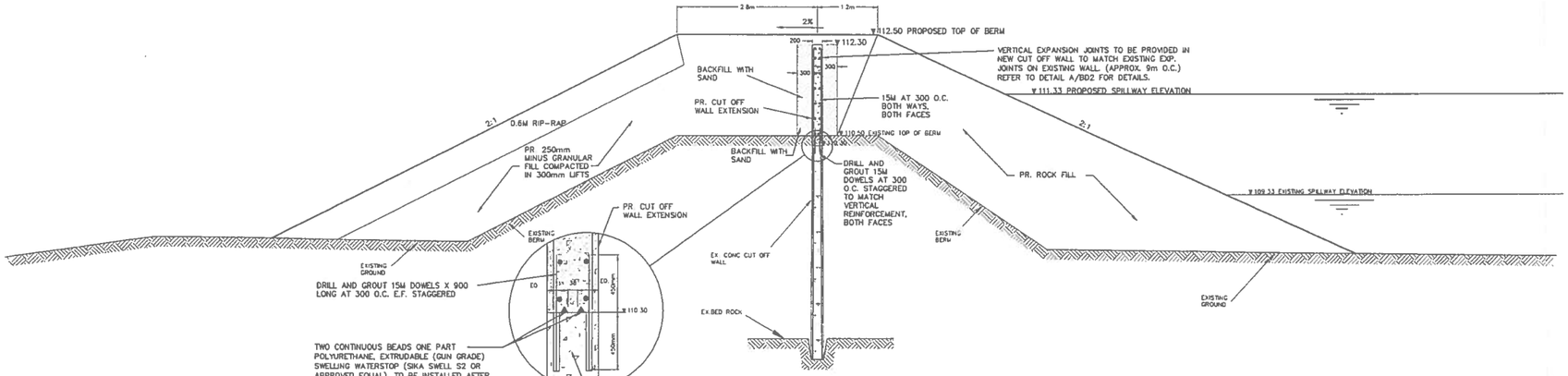

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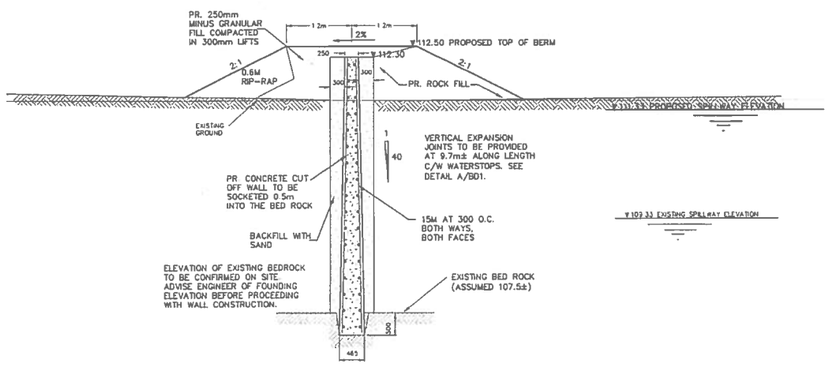

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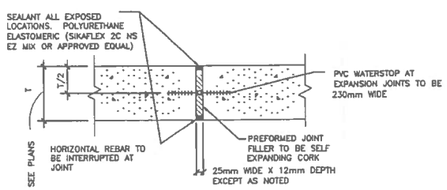


VERTICAL EXPANSION JOINT DETAIL

NTS

A
BD2

KEY PLAN

LEGEND

PERMIT OF PRACTICE
TROW ASSOCIATES INC.
Signature
Date June 16/06
PERMIT NUMBER P184
The Association of Professional Engineers Geologists and Geophysicists of the NWT/NU

NO.	DESCRIPTION	DATE	BY	APP'D
3	ISSUED AS CONTRACT DOCUMENTS	14/06/06	ABZ	SLB
2	ISSUED FOR TENDER	07/04/06	ABZ	SLB
1	95% SUBMISSION	28/02/06	ABZ	SLB
NO.	REVISION	DD/MM/YR	A.B.C.	A.B.C.

REVISIONS

REGISTERED PROFESSIONAL ENGINEER S.L. BURDEN LICENSEE N.W.T.

REGISTERED PROFESSIONAL ENGINEER A.R.ABOZARAD LICENSEE NWT/NU

Trow Associates Inc.
154 Colonnade Road South, Nepean, Ontario
(613) 225-9940
(613) 225-7337

CLIENT
CITY OF IQALUIT

PROJECT
LAKE GERALDINE
EARTH & CONCRETE WORK
2006

TITLE
BERM DETAILS

design by	A.B.Z	project no.	DTCD000176160
drawn by	A.B.Z	drawing no.	BD2
checked by	S.B		
date	07-01-2005		
scale	1:50		

BEST MANAGEMENT PRACTICES

SOURCE CONTROL (BEST MANAGEMENT PRACTICES) FOR THIS SITE INCLUDE THE FOLLOWING:

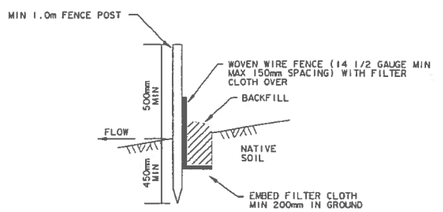
EROSION AND SEDIMENT CONTROLS DURING CONSTRUCTION.

CONTROL OF EROSION ON CONSTRUCTION SITES AND THE REMOVAL OF SEDIMENTS FROM CONSTRUCTION SITE RUN-OFF IS VERY IMPORTANT FOR DOWNSTREAM AREAS ARE TO BE PROTECTED. DURING ALL CONSTRUCTION, EROSION AND SEDIMENTATION SHOULD BE CONTROLLED BY THE FOLLOWING TECHNIQUES:

1. LIMITING THE EXTENT OF EXPOSED SOILS AT ANY GIVEN TIME.
2. INSTALL SILT FENCE AS SHAWN TO PREVENT SEDIMENT FROM ENTERING EXISTING CONVEYANCE SYSTEMS.
3. NO REFUELING OR CLEANING OF EQUIPMENT NEAR DRAINAGE COURSE.
4. PROVIDE SEDIMENT TRAPS AND BASINS DURING DEWATERING.
5. ESTABLISH MATERIALS STOCKPILES AWAY FROM WATER COURSES.
6. PREVENT CONSTRUCTION EQUIPMENT TRAFFIC IN THE RECEIVING DRAINGE COURSE.
7. PLAN CONSTRUCTION PROPER TIMES TO AVOID FLOODING.
8. A VISUAL INSPECTION TO BE DONE DAILY ON SEDIMENT CONTROL BARRIERS AND ANY DAMAGE REPAIRED IMMEDIATELY. CARE WILL BE TAKEN TO PREVENT DAMAGE DURING CONSTRUCTION OPERATIONS.
9. IN SOME CASES SOME BARRIERS MAY BE REMOVED TEMPORARILY TO ACCOMODATE THE CONSTRUCTION OPERATIONS. THE AFFECTED BARRIERS WILL BE REINSTATED AT NIGHT WHEN CONSTRUCTION IS COMPLETED. NO REMOVAL WILL OCCUR IF THERE IS A RUN OFF OR PREDICTED RAIN FALL UNLESS A NEW DEVICE HAS BEEN INSTALLED DOWNSTREAM.
10. THE SEDIMENT CONTROL DEVICES WILL BE CLEANED OF ACCUMULATED SILT AS REQUIRED. THE DEPOSITS WILL BE DISPOSED OF AS PER THE REQUIREMENTS OF THE CONTRACT.

THE FOLLOWING PRACTICES WILL BE FOLLOWED AFTER EVERY RAINFALL TO GUARANTEE THE PROPER PERFORMANCE:

1. VERIFY THAT WATER IS NOT FLOWING UNDER SILT FENCE.
2. BUILT-UP MATERIAL SHOULD BE REMOVED WHEN IT REACHES A DEPTH EQUAL TO HALF THE HEIGHT OF THE FENCE.



TOE-IN-METHOD FOR SILT FENCE

N.T.S.

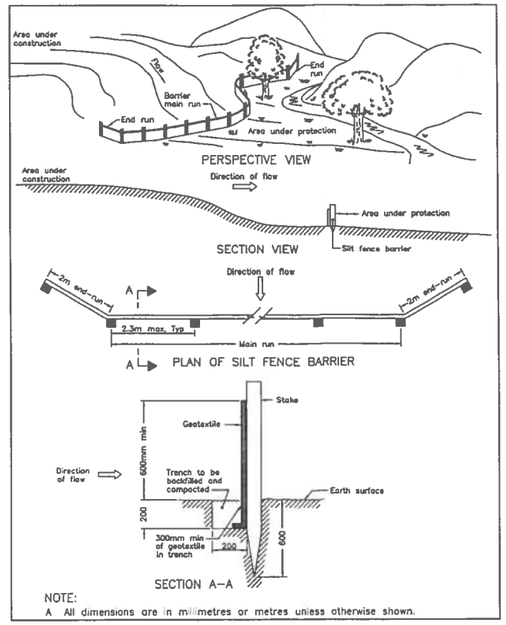
NOTES:

1. WOVEN WIRE FENCE TO BE FASTENED SECURELY TO FENCE POSTS WITH WIRE TIES OR STAPLES.
2. FILTER CLOTH TO BE FASTENED SECURELY TO WOVEN WIRE FENCE WITH TIES SPACED EVERY 0.6m AT TOP AND MID SECTION.
3. WHEN TWO SECTIONS OF FILTER CLOTH ADJOIN EACH OTHER THEY SHALL BE OVERLAPPED BY 150mm AND FOLDED.
4. MAINTENANCE SHALL BE PERFORMED AS NEEDED AND MATERIAL REMOVED WHEN "BULGES" DEVELOP IN THE SILT FENCE

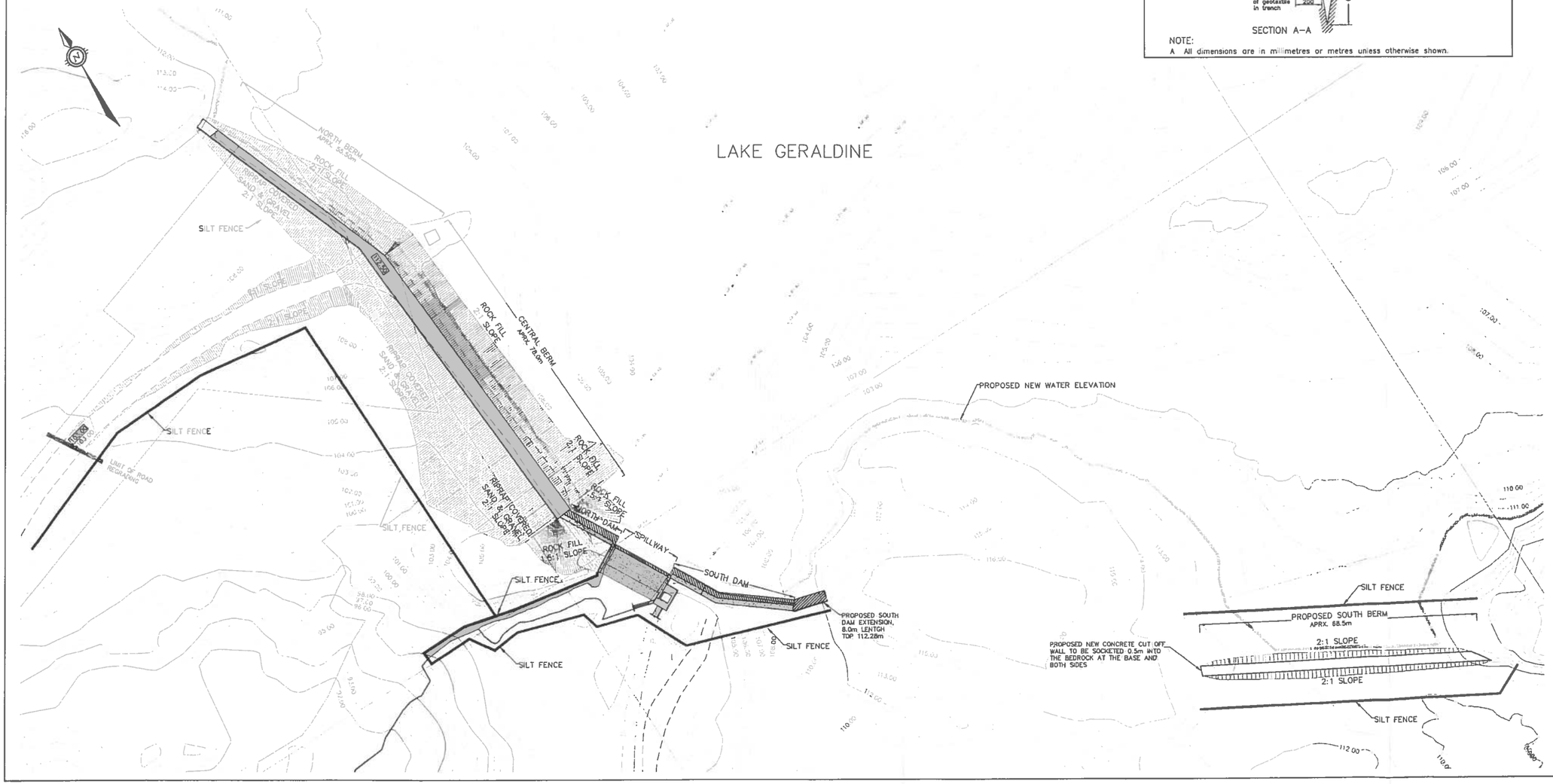
POSTS: STEEL EITHER 'T' OR 'U' TYPE HARDWOOD (50mm x 50mm)

FENCE: WOVEN WIRE, 14 Ga. 150mm MAX MESH OPENING.

FILTER CLOTH: FILTER X, MARIFI P-100 STABI-LINKA T140N OR EQUAL.



NOTE:
A All dimensions are in millimetres or metres unless otherwise shown.



KEY PLAN

LEGEND

PERMIT OF PRACTICE
TROW ASSOCIATES INC.
Signature
Date 16/06/06
PERMIT NUMBER: P184
The Association of Professional Engineers, Geologists and Geophysicists of the NWT/NU

NO.	DESCRIPTION	DATE	BY	APP'D
3	ISSUED AS CONTRACT DOCUMENTS	14/06/06	ABZ	SLB
2	ISSUED FOR TENDER	07/04/06	ABZ	SLB
1	95% SUBMISSION	28/02/06	ABZ	SLB
NO.	REVISION	DD/MM/YR	A.B.C	A.B.C

REVISIONS

REGISTERED PROFESSIONAL ENGINEER S.L. MURDEN LICENSEE N.W.T.

REGISTERED PROFESSIONAL ENGINEER A.R. ABDZARAD LICENSEE NWT/NU

Trow Associates Inc.
154 Colonnade Road South, Nepean, Ontario
(613) 225-9940
(613) 225-7337

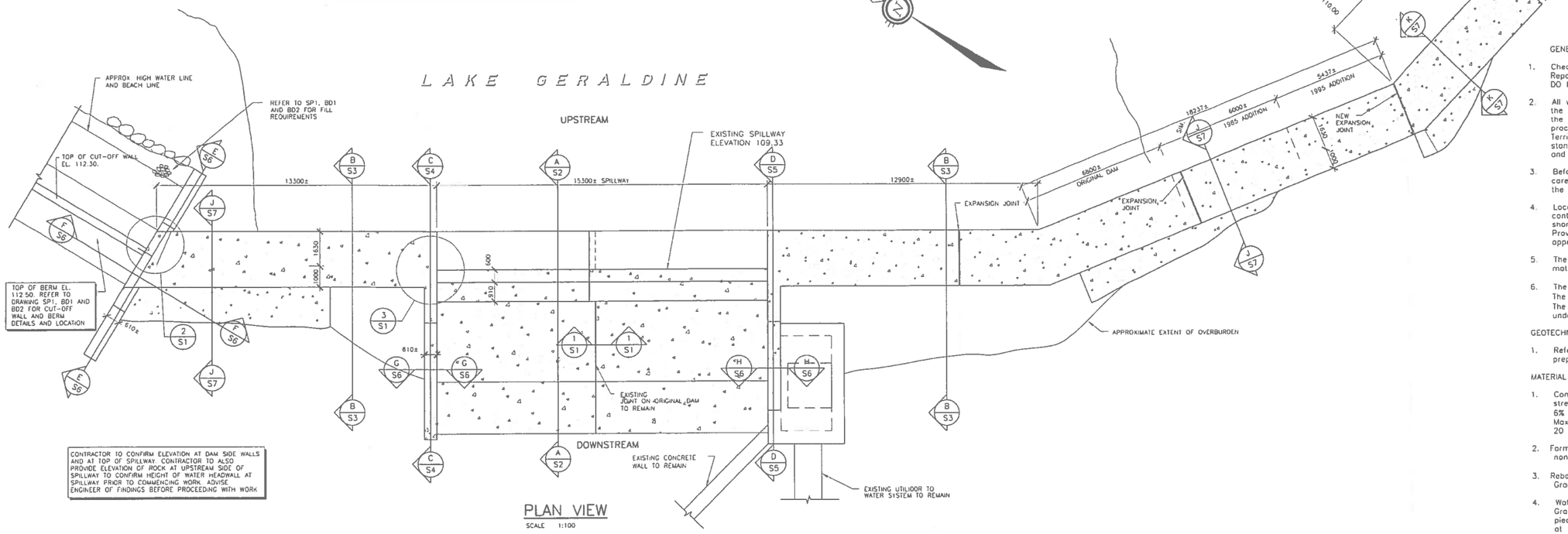
CLIENT: CITY OF IQALUIT

PROJECT: LAKE GERALDINE EARTH & CONCRETE WORK 2006

TITLE: BEST MANAGEMENT PRACTICES PLAN

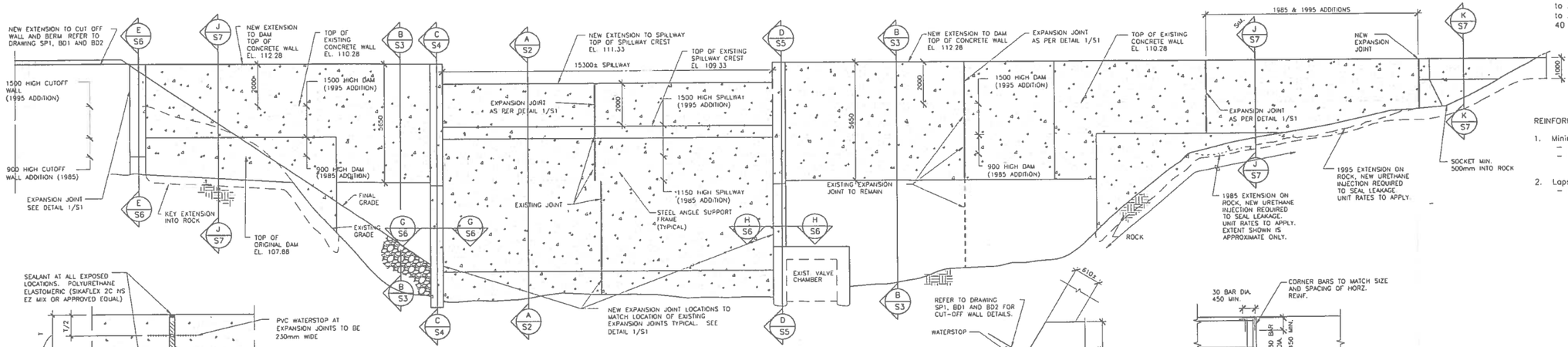
design by	A.B.Z	project no.	DTC000017816D
drawn by	A.B.Z	drawing no.	BM1
checked by	S.B		
date	15-03-2006		
scale	H 1:500		

EPOXY CRACK INJECTION OF EXISTING DAM PRIOR TO NEW CONCRETE.
CONTRACTOR TO INCLUDE FOR 110 LINEAR METERS OF LOW PRESSURE EPOXY CRACK INJECTION TO EXISTING CRACKS IN DAM DOWNSTREAM, UPSTREAM AND TOP SURFACES WHICH ARE EXPOSED TO AIR. ADDITIONAL WORK MAY BE AUTHORIZED AT UNIT RATES PROVIDED ON THE TENDER FORM.

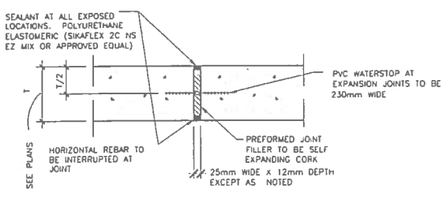


CONTRACTOR TO CONFIRM ELEVATION AT DAM SIDE WALLS AND AT TOP OF SPILLWAY. CONTRACTOR TO ALSO PROVIDE ELEVATION OF ROCK AT UPSTREAM SIDE OF SPILLWAY TO CONFIRM HEIGHT OF WATER HEADWALL AT SPILLWAY PRIOR TO COMMENCING WORK. ADVISE ENGINEER OF FINDINGS BEFORE PROCEEDING WITH WORK

PLAN VIEW
SCALE 1:100

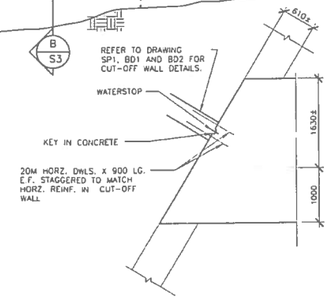


DOWNSTREAM ELEVATION
SCALE 1:100

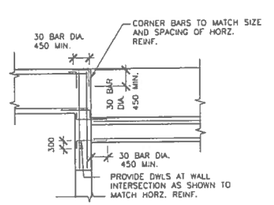


VERTICAL EXPANSION JOINT DETAIL
NTS — 1/S1

NOTE:
"ORIGINAL DAM AND 1985 ADDITION DIMENSIONS" REPRODUCED FROM DRAWINGS 84-4428-1, 84-4428-2 AND 88-4428-3 DATED 3 MARCH 1986. "1995 ADDITION" DIMENSIONS REPRODUCED FROM DRAWINGS 95-10047-1-2, 94-10047-1-3 & 94-10047-1-4 DATED 19 NOVEMBER 1996 PREPARED BY OLIVER MANGIONE McCALLA & ASSOCIATES LTD. CONTRACTOR TO VERIFY ACCURACY OF DIMENSIONS ON SITE AND REPORT ANY DISCREPANCIES TO ENGINEER BEFORE PROCEEDING WITH WORK.



DETAIL
N.T.S — 2/S1



DETAIL – PLAN
JOINT BETWEEN SPILLWAY AND WING WALL

DETAIL
N.T.S — 3/S1

ISSUED FOR CONSTRUCTION	no.	2
	date	29/06/06
	by	KAB
TENDER ISSUE	no.	1
	date	10/04/06
	by	KAB
95% SUBMISSION	no.	0
	date	28/02/06
	by	KAB

REVISIONS

NOTES: GENERAL CONTRACTOR TO VERIFY ALL DIMENSIONS WITH FINAL ARCHITECTURAL AND MECHANICAL DRAWINGS. NOTIFY THE ENGINEERS OF ANY ERRORS AND / OR OMISSIONS PRIOR TO CONSTRUCTION FOR DIRECTION. DO NOT SCALE THIS DRAWING.

GENERAL NOTES

1. Check all dimensions on drawings with other drawings. Report any inconsistencies before proceeding with the work. DO NOT SCALE THESE DRAWINGS.
2. All work shall comply with current provisions of the Dam Safety Guideline, National Building Code 1995, the Workplace Safety and Insurance Board and best trade practices. Work shall comply with all local and Territorial regulations and with applicable C.S.A. standards. In all cases, the latest editions of codes and standards shall apply unless noted otherwise.
3. Before submitting tenders contractors shall carefully examine existing conditions to establish the extent of the work.
4. Locate all buried services priar to excavation. The contractor shall be responsible for all temporary bracing, shoring and dewatering necessary to undertake the work. Provide engineered drawings for same for review and approval of Engineer.
5. The contractor is responsible for removing excess materials and cleaning up on completion of the work.
6. The term "ORIGINAL" denotes structure prior to 1985 raise. The term "EXISTING" denotes structure after 1985 raise. The term "NEW" denotes components to be constructed under this contract.

GEOTECHNICAL INFORMATION

1. Refer to Geotechnical Report No. OTGE00017616B prepared by Traw Associates Inc. dated January 2005

MATERIAL SPECIFICATIONS

1. Concrete – materials to CSA-A23.1-00. Compressive strength minimum 30 MPa for all structural concrete. 6% +/- 1% entrained air for all concrete. Maximum slump 75 mm. Maximum aggregate size 20 mm. Type 10 cement.
2. Formwork – to CSA-A23.1-00. Form release agent shall be nonstaining, compatible with finishes where applicable.
3. Rebar – deformed billet steel bars to CAN/CSA G30.18-M, Grade 400. Type W for welded rebar.
4. Waterstops – 150mm x 6mm extruded ribbed PVC Arctic Grade waterstops with shop welded corner and intersecting pieces with legs not less than 300mm long typical. Except at Expansion Joints where 230mm wide waterstops required. See plan for locations. Minimum tensile strength of 12 MPa to ASTM D412, method A DIE "C" : maximum elongation 275% to ASTM D412 DIE "C" method : minimum tear resistance 40 kN/m to ASTM D624, DIE "B".

REINFORCEMENT PLACEMENT

1. Minimum clear cover
   - For concrete placed against earth.....75 mm
   - For concrete placed in forms but in contact with earth or weather.....50 mm
2. Laps
   - lap all bars 36 bar diameters or 450 mm minimum, whichever is greater, unless otherwise indicated

PERMIT TO PRACTICE
TROW ASSOCIATES INC.
Signature
Date June 29/2006
PERMIT NUMBER: P184
The Association of Professional Engineers, Geologists and Geophysicists of the NWT/NU

Trow Associates Inc.
Trow 54 Antares Road South, Ottawa, Ontario K2E 7J8
Tel: (613) 226-6860 Fax: (613) 225-7337

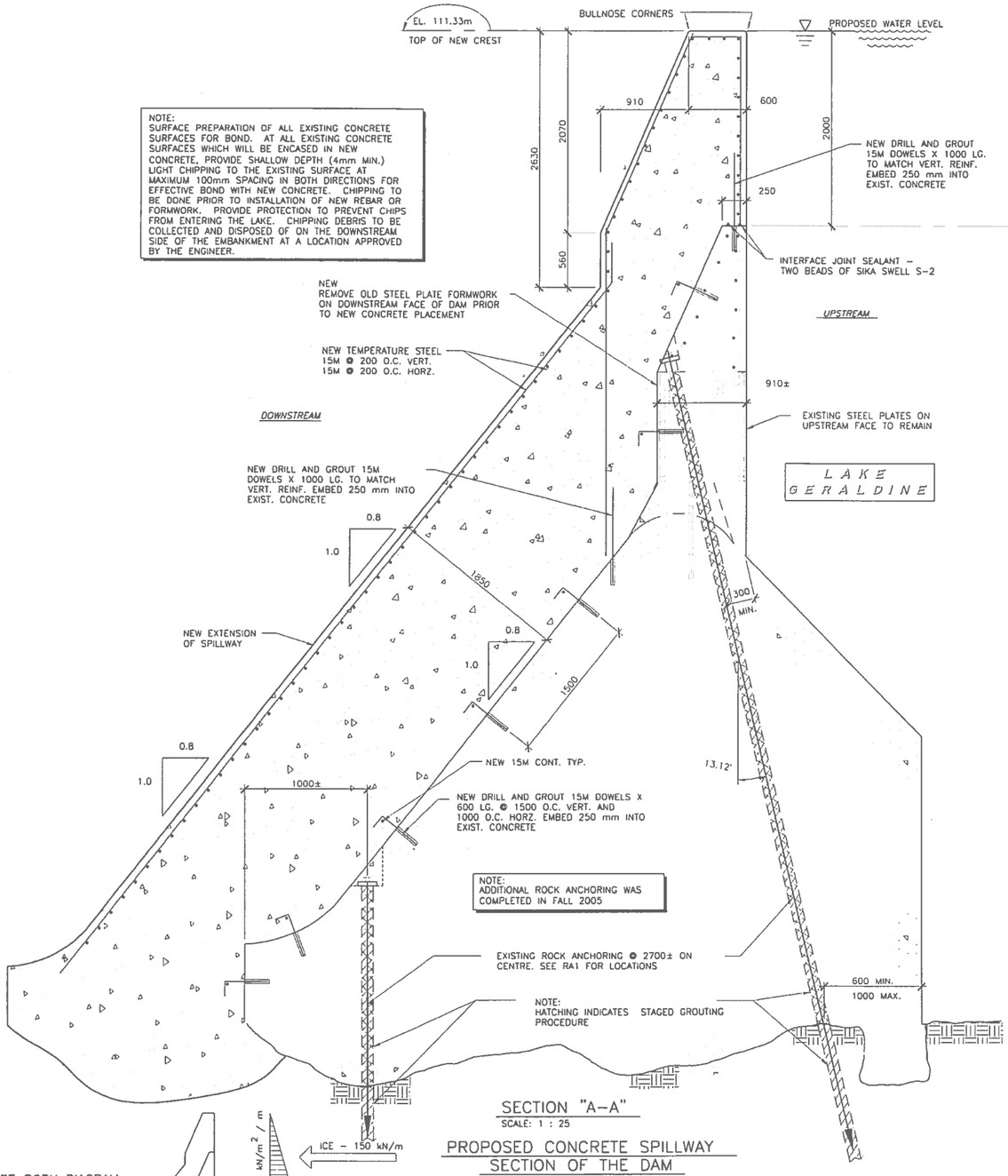
CLIENT: CITY OF IQALUIT

PROJECT: LAKE GERALDINE DAM EARTH AND CONCRETE WORK – 2006

DRAWING: PLAN AND ELEVATION

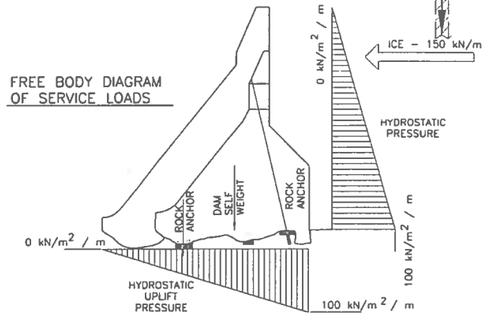
design by	K.A.B	project no.	OTBS00017616C
drawn by	R.L. / M.N.	drawing no.	S1
checked by	R.W.P.		
date	SEPT. 2005	revision no.	2
scale	AS NOTED		

NOTE:
SURFACE PREPARATION OF ALL EXISTING CONCRETE SURFACES FOR BOND. AT ALL EXISTING CONCRETE SURFACES WHICH WILL BE ENCASED IN NEW CONCRETE, PROVIDE SHALLOW DEPTH (4mm MIN.) LIGHT CHIPPING TO THE EXISTING SURFACE AT MAXIMUM 100mm SPACING IN BOTH DIRECTIONS FOR EFFECTIVE BOND WITH NEW CONCRETE. CHIPPING TO BE DONE PRIOR TO INSTALLATION OF NEW REBAR OR FORMWORK. PROVIDE PROTECTION TO PREVENT CHIPS FROM ENTERING THE LAKE. CHIPPING DEBRIS TO BE COLLECTED AND DISPOSED OF ON THE DOWNSTREAM SIDE OF THE EMBANKMENT AT A LOCATION APPROVED BY THE ENGINEER.



SECTION "A-A"
SCALE: 1 : 25

PROPOSED CONCRETE SPILLWAY SECTION OF THE DAM

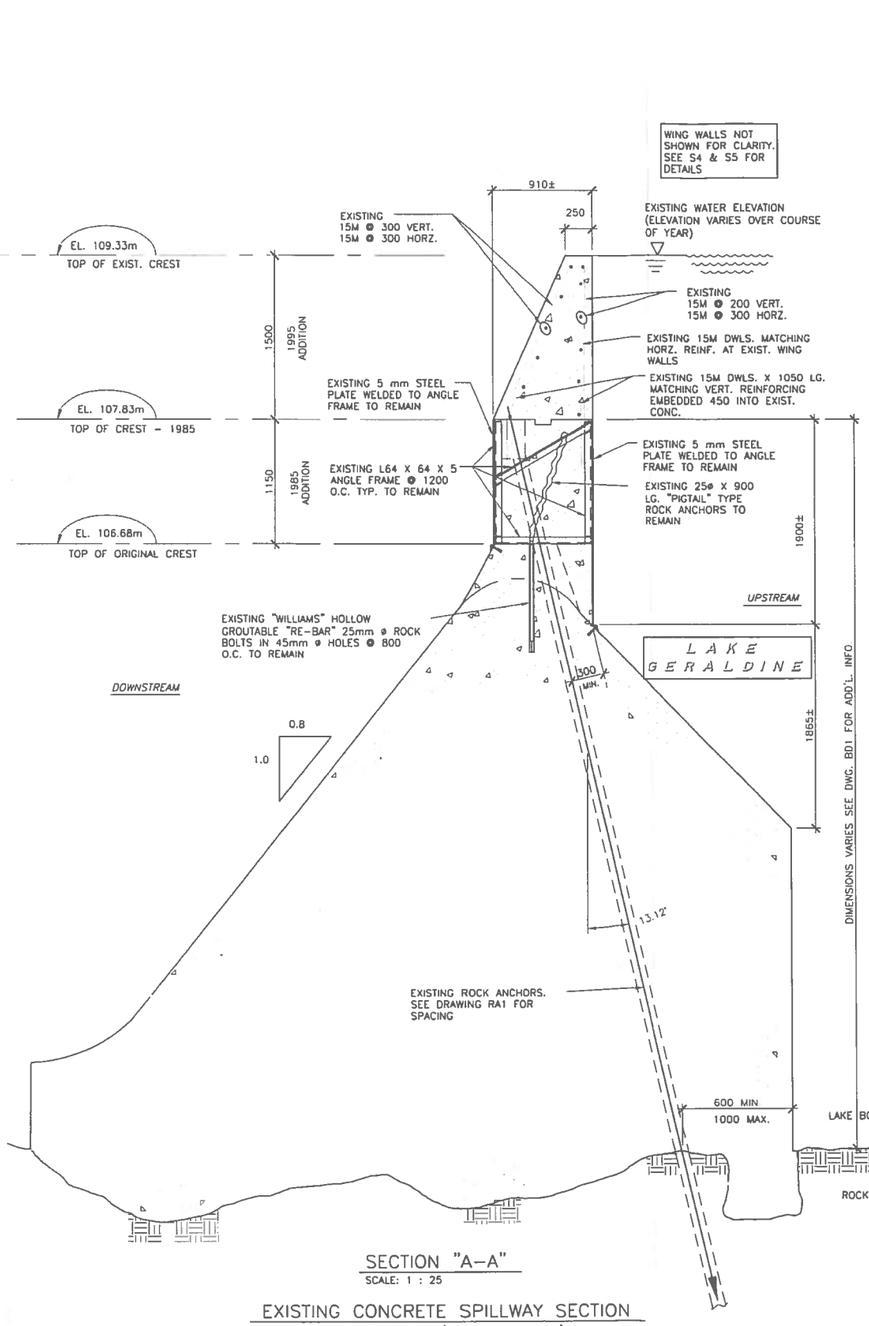


FACTORS OF SAFETY

OVERTURNING	1.5
SLIDING	1.93

WHERE F.S (SLIDING) = $\frac{\text{TAN } 40^\circ\ (Rv) + \text{SHEAR CAPACITY OF ANCHORS}}{Rh}$

Rv = RESULTANT OF VERTICAL LOADS (kN)
Rh = RESULTANT OF HORIZONTAL LOADS (kN)



SECTION "A-A"
SCALE: 1 : 25

EXISTING CONCRETE SPILLWAY SECTION OF THE DAM (CIRCA 1995)

NOTE:
"ORIGINAL DAM AND 1985 ADDITION DIMENSIONS" REPRODUCED FROM DRAWINGS 84-4428-1, 84-4428-2 AND 88-4428-3 DATED 3 MARCH 1986. "1995 ADDITION" DIMENSIONS REPRODUCED FROM DRAWINGS 95-10047-1-2, 94-10047-1-3 & 94-10047-1-4 DATED 19 NOVEMBER 1996 PREPARED BY OLIVER MANGIONE McCALLA & ASSOCIATES LTD. CONTRACTOR TO VERIFY ACCURACY OF DIMENSIONS ON SITE AND REPORT ANY DISCREPANCIES TO ENGINEER BEFORE PROCEEDING WITH WORK.

ISSUED FOR CONSTRUCTION	no. 2 date 29/06/06 by KAB
TENDER ISSUE	no. 1 date 10/04/06 by KAB
95% SUBMISSION	no. 0 date 28/02/06 by KAB

REVISIONS

NOTES: GENERAL CONTRACTOR TO VERIFY ALL DIMENSIONS WITH FINAL ARCHITECTURAL AND MECHANICAL DRAWINGS. NOTIFY THE ENGINEERS OF ANY ERRORS AND / OR OMISSIONS PRIOR TO CONSTRUCTION FOR DIRECTION. DO NOT SCALE THIS DRAWING.

APEGGN PROFESSIONAL ENGINEER 2006/06/29 K.A. BAKER LICENCE No. L1 CORPORATE No. P184 N.W.T.

PERMIT TO PRACTICE
TROW ASSOCIATES INC.
Signature Karen A. Baker
Date April 29/2006
PERMIT NUMBER: P184
The Association of Professional Engineers, Geologists and Geophysicists of the NWT/NU

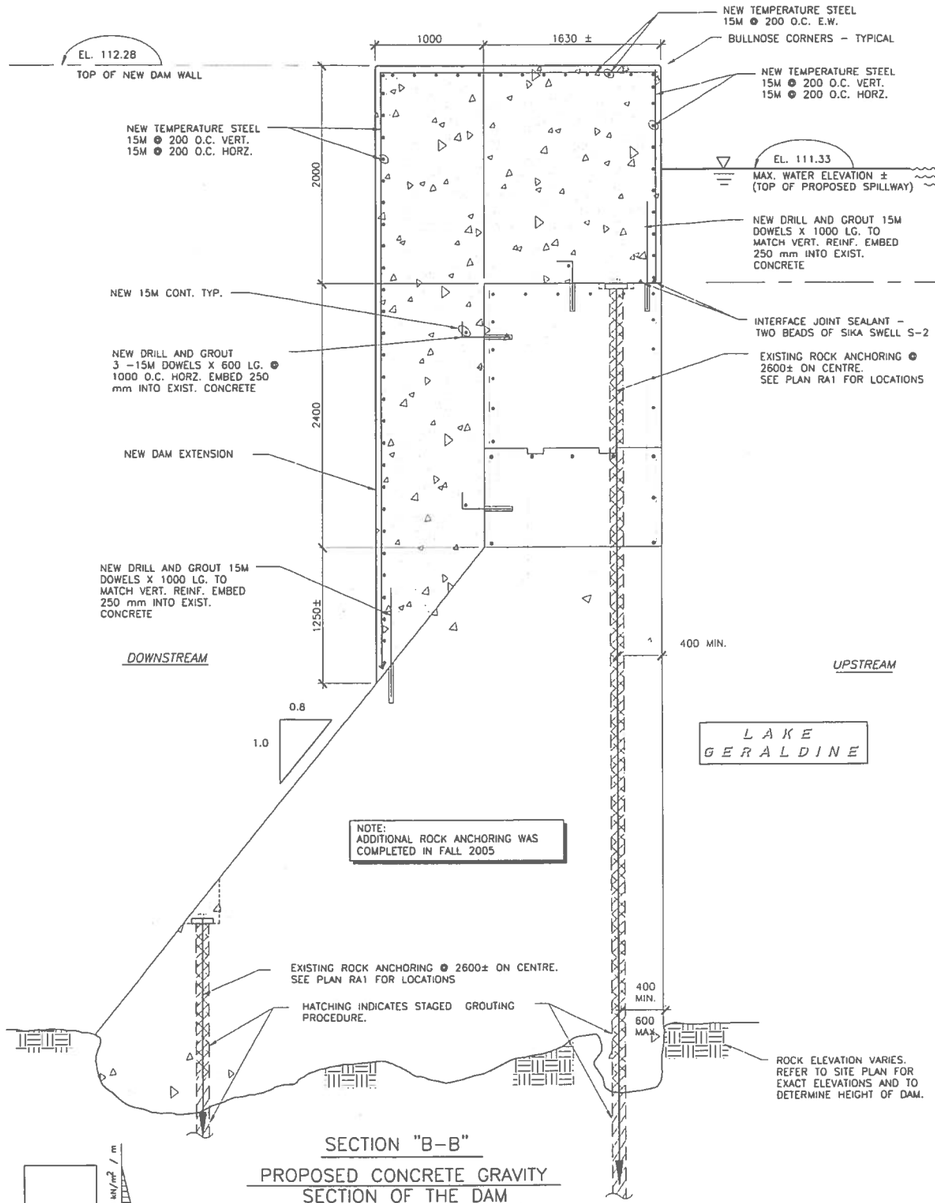
Trow Associates Inc.
Trow 154 Colonnade Road South, Ottawa, Ontario K2E 7J5 Tel: (613) 226-0647 Fax: (613) 225-7337

CLIENT
CITY OF IQALUIT

PROJECT
LAKE GERALDINE DAM EARTH AND CONCRETE WORK - 2006

DRAWING
SECTION "A-A"

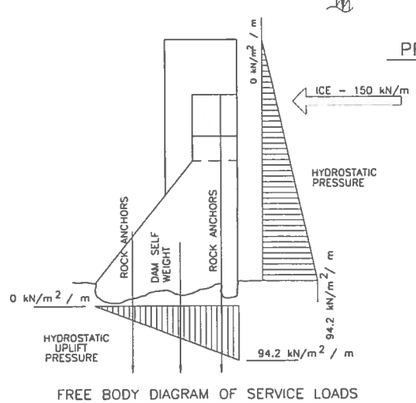
design by	K.A.B.	project no.	01BS000176 16C
drawn by	M.N.	drawing no.	S2
checked by	K.A.B. / R.W.P.		
date	FEB. 2006		
scale	AS NOTED	revision no.	2



SECTION "B–B"

PROPOSED CONCRETE GRAVITY
SECTION OF THE DAM

SCALE: 1 : 25



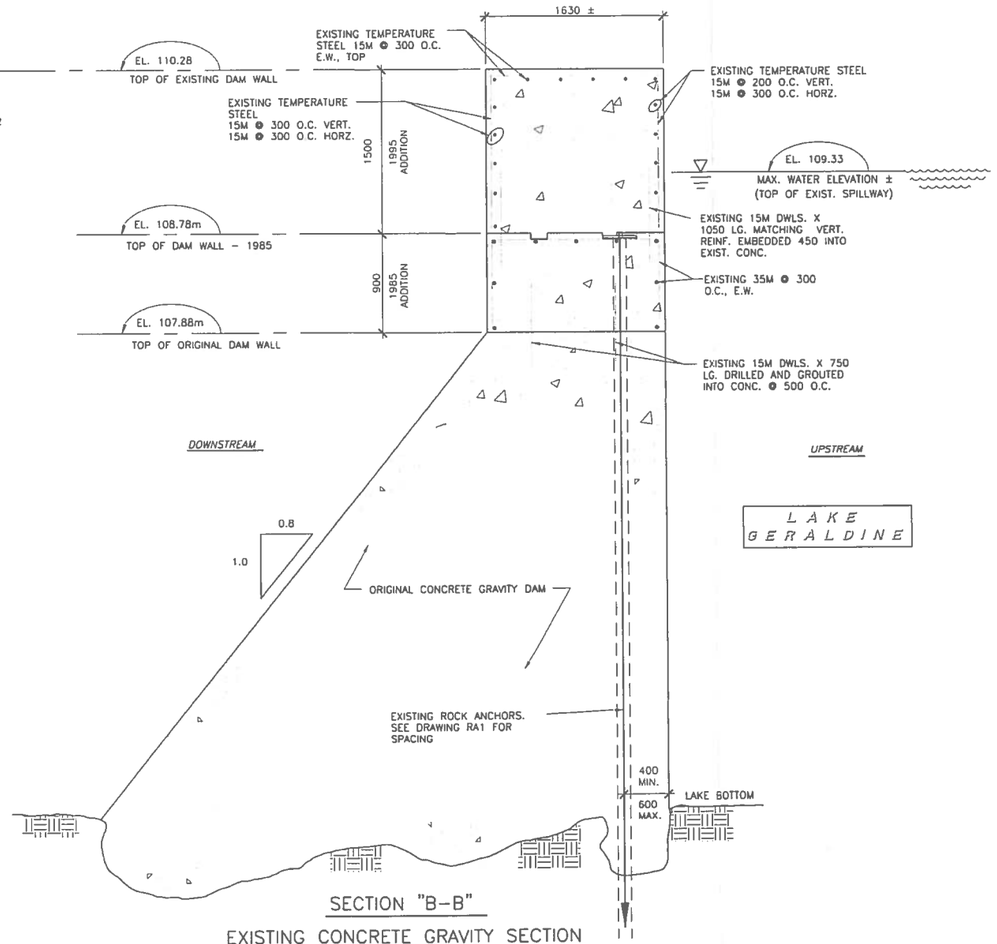
FREE BODY DIAGRAM OF SERVICE LOADS

FACTORS OF SAFETY

OVERTURNING 1.5
SLIDING 2.0

WHERE F.S (SLIDING) = $\frac{\text{TAN } 40^\circ\ (Rv) + \text{SHEAR CAPACITY OF ANCHORS}}{Rh}$

Rv = RESULTANT OF VERTICAL LOADS (kN) (NOT SHOWN)
Rh = RESULTANT OF HORIZONTAL LOADS (kN) (NOT SHOWN)



SECTION "B–B"

EXISTING CONCRETE GRAVITY SECTION
OF THE DAM (CIRCA 1995)

SCALE 1 : 25

NOTE:
"ORIGINAL DAM AND 1985 ADDITION DIMENSIONS" REPRODUCED FROM DRAWINGS 84–4428–1, 84–4428–2 AND 88–4428–3 DATED 3 MARCH 1986. "1995 ADDITION" DIMENSIONS REPRODUCED FROM DRAWINGS 95–10047–1–2, 94–10047–1–3 & 94–10047–1–4 DATED 19 NOVEMBER 1998 PREPARED BY OLIVER MANGIONE McCALLA & ASSOCIATES LTD. CONTRACTOR TO VERIFY ACCURACY OF DIMENSIONS ON SITE AND REPORT ANY DISCREPANCIES TO ENGINEER BEFORE PROCEEDING WITH WORK.

ISSUED FOR CONSTRUCTION	no. 2 date 29/06/06 by KAB
TENDER ISSUE	no. 1 date 10/04/06 by KAB
95% SUBMISSION	no. 0 date 28/02/06 by KAB

REVISIONS

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PERMIT TO PRACTICE
TROW ASSOCIATES INC.
Signature K.A.B. Baker
Date June 29/2006
PERMIT NUMBER: P184
The Association of Professional Engineers, Geologists and Geophysicists of the NWT/NU

Trow Associates Inc.
Trow 134 Colonnade Road South, Nepean, Ontario K2E 7J8
Tel: (613) 225-9640 Fax: (613) 225-7337

CLIENT
CITY OF IQALUIT

PROJECT
LAKE GERALDINE DAM
EARTH AND CONCRETE
WORK – 2006

DRAWING
SECTION "B–B"

design by	K.A.B.
drawn by	M.N.
checked by	K.A.B./R.W.P.
date	FEB. 2006
scale	AS NOTED
project no.	OTBS00017616C
drawing no.	S3
revision no.	2

ISSUED FOR CONSTRUCTION	no. 2 date 29/06/06 by KAB
TENDER ISSUE	no. 1 date 10/04/06 by KAB
95% SUBMISSION	no. 0 date 28/02/06 by KAB

REVISIONS

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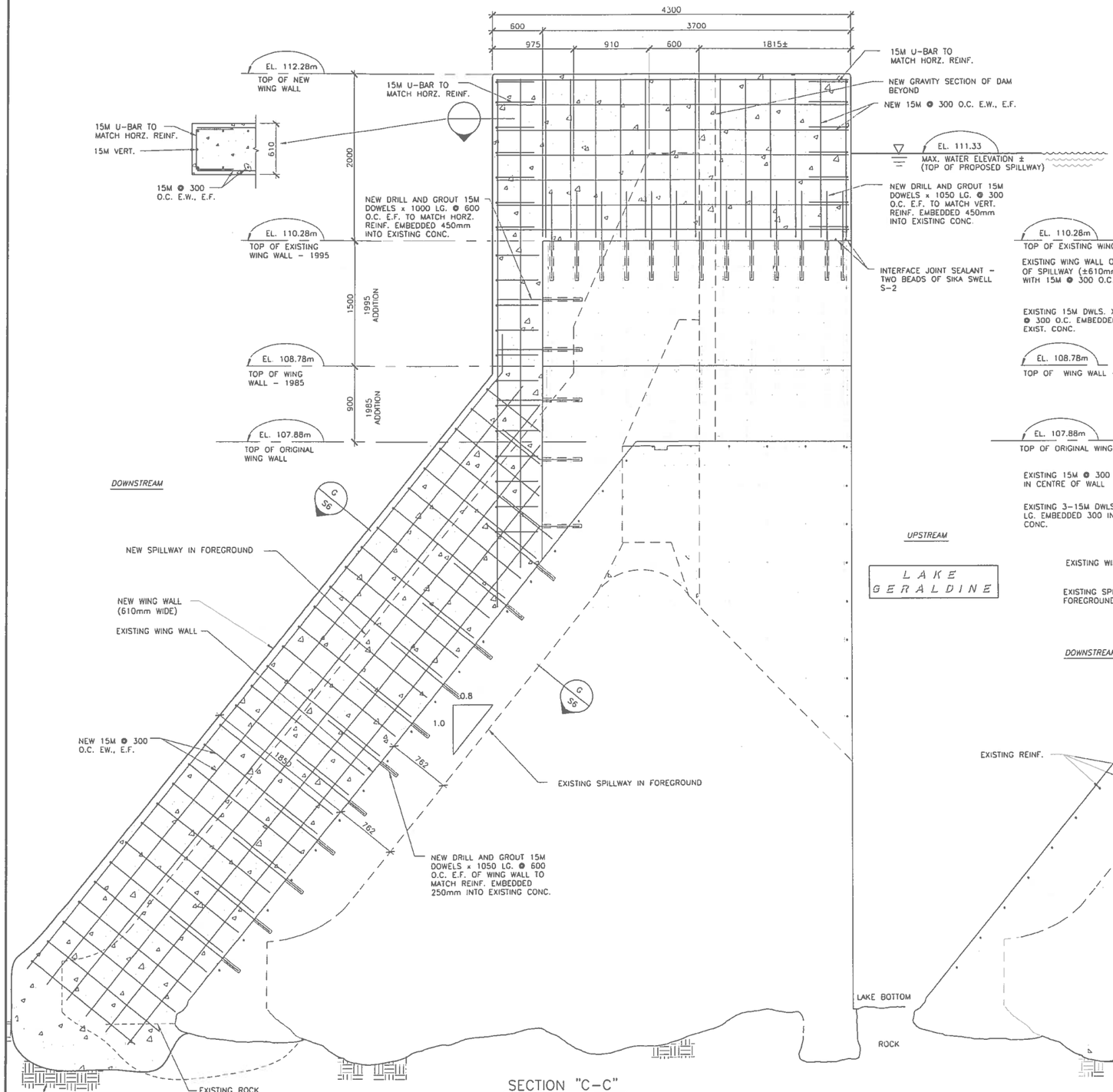
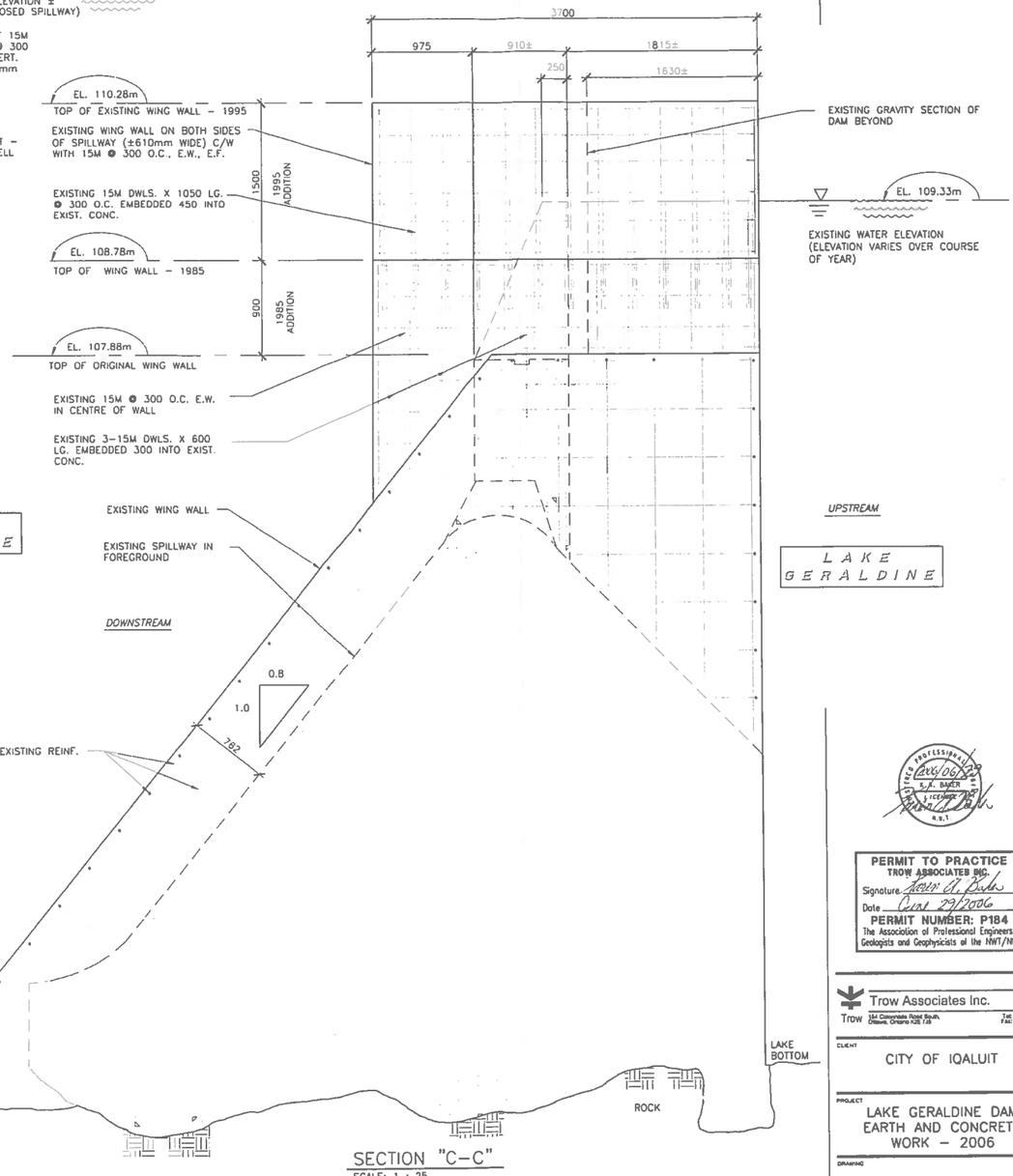


SECTION "C-C"
SCALE: 1 : 25

PROPOSED CONCRETE WING WALL
SECTION OF THE DAM



SECTION "C-C"
SCALE: 1 : 25

EXISTING CONCRETE WING WALL
SECTION OF THE DAM (CIRCA 1995)

NOTE:
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29/06/06
K.A. BAKER
LICENSEE
N.W.T.

PERMIT TO PRACTICE
TROW ASSOCIATES INC.
Signature Kevin A. Baker
Date June 29/2006
PERMIT NUMBER: P184
The Association of Professional Engineers, Geologists and Geophysicists of the NWT/NU

Trow Associates Inc.
Trow 184 Colonnade Road South, Ottawa, Ontario K2E 7J8 Tel (613) 225-9640 Fax (613) 225-7337

CLIENT: CITY OF IQALUIT

PROJECT: LAKE GERALDINE DAM EARTH AND CONCRETE WORK - 2006

DRAWING: SECTION "C-C"

design by	K.A.B.	project no	01B500017616C
drawn by	M.N.	drawing no	S4
checked by	R.W.P.		
date	FEB. 2006		
scale	AS NOTED	revision no.	2

ISSUED FOR CONSTRUCTION	no. 2 date 29/06/06 by KAB
TENDER ISSUE	no. 1 date 10/04/06 by KAB
95% SUBMISSION	no. 0 date 28/02/06 by KAB

REVISIONS

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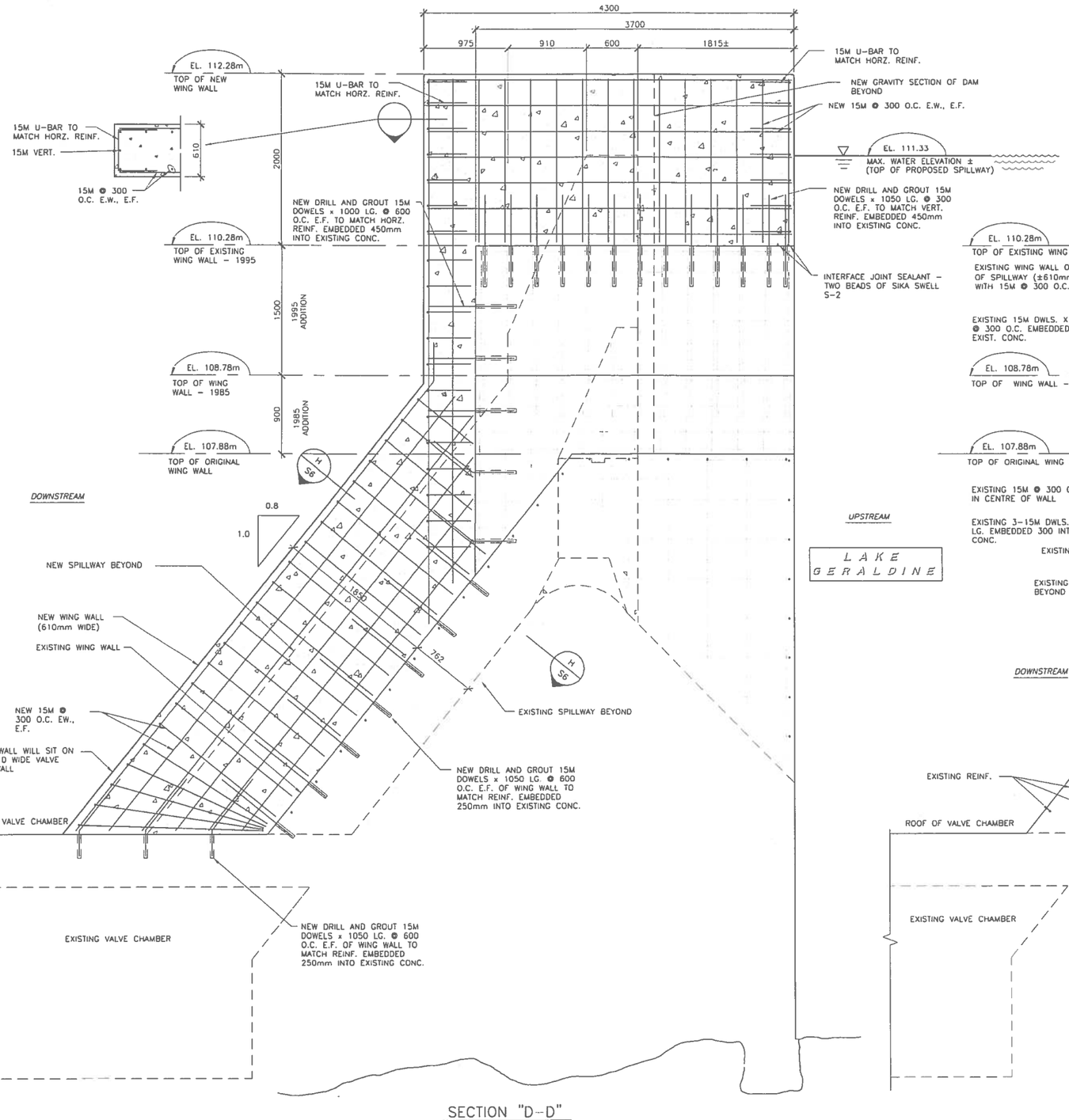
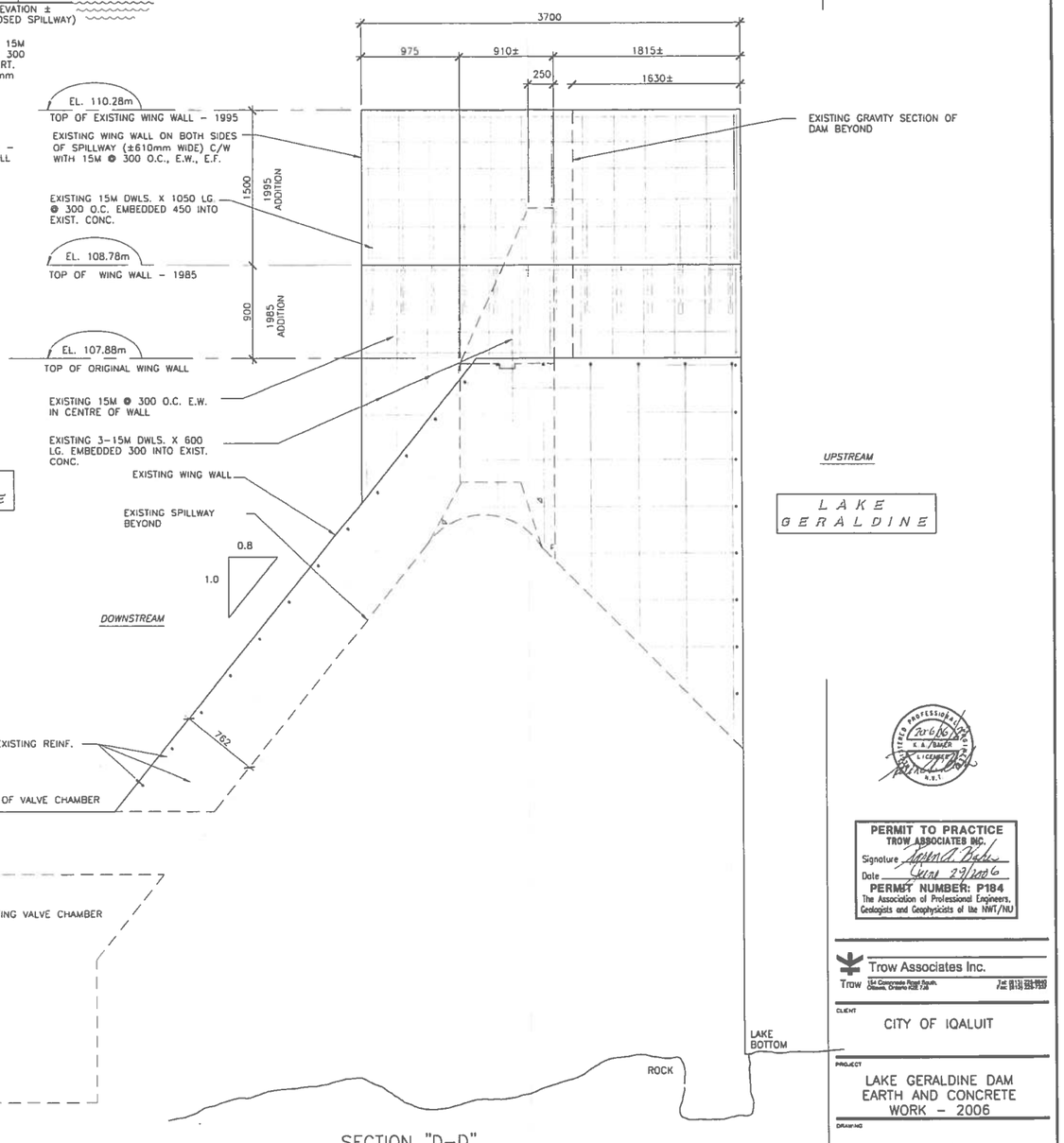


SECTION "D-D"
SCALE: 1 : 25

PROPOSED CONCRETE WING WALL
SECTION OF THE DAM

NOTE:
"ORIGINAL DAM AND 1985 ADDITION DIMENSIONS" REPRODUCED FROM DRAWINGS 84-4428-1, 84-4428-2 AND 88-4428-3 DATED 3 MARCH 1986. "1995 ADDITION" DIMENSIONS REPRODUCED FROM DRAWINGS 95-10047-1-2, 94-10047-1-3 & 94-10047-1-4 DATED 19 NOVEMBER 1996 PREPARED BY OLIVER MANGIONE McCALLA & ASSOCIATES LTD. CONTRACTOR TO VERIFY ACCURACY OF DIMENSIONS ON SITE AND REPORT ANY DISCREPANCIES TO ENGINEER BEFORE PROCEEDING WITH WORK.



SECTION "D-D"
SCALE: 1 : 25

EXISTING CONCRETE WING WALL
SECTION OF THE DAM (CIRCA 1995)

PERMIT TO PRACTICE
TROW ASSOCIATES INC.
Signature _____
Date June 29/2006
PERMIT NUMBER: P184
The Association of Professional Engineers, Geologists and Geophysicists of the NWT/NU

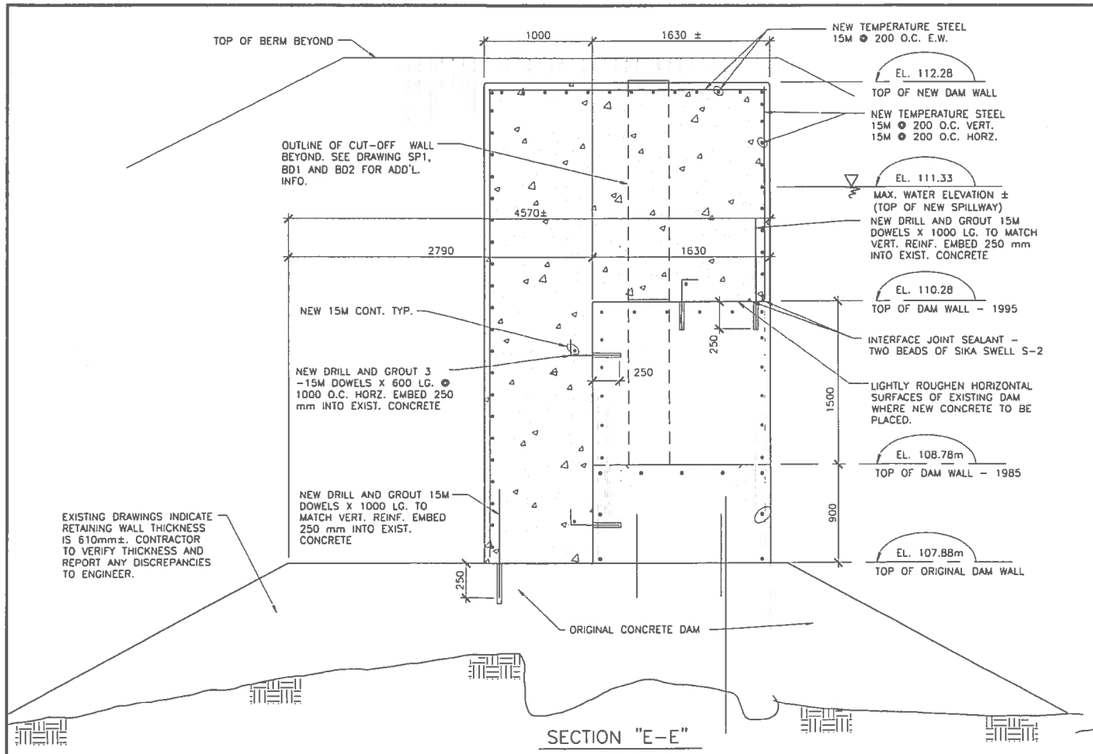
Trow Associates Inc.
Trow 114 Corporate Road South, Ottawa, Ontario K2E 7J8 Tel: (613) 225-9500 Fax: (613) 225-9502

CLIENT
CITY OF IQALUIT

PROJECT
LAKE GERALDINE DAM
EARTH AND CONCRETE
WORK - 2006

DRAWING
SECTION "D-D"

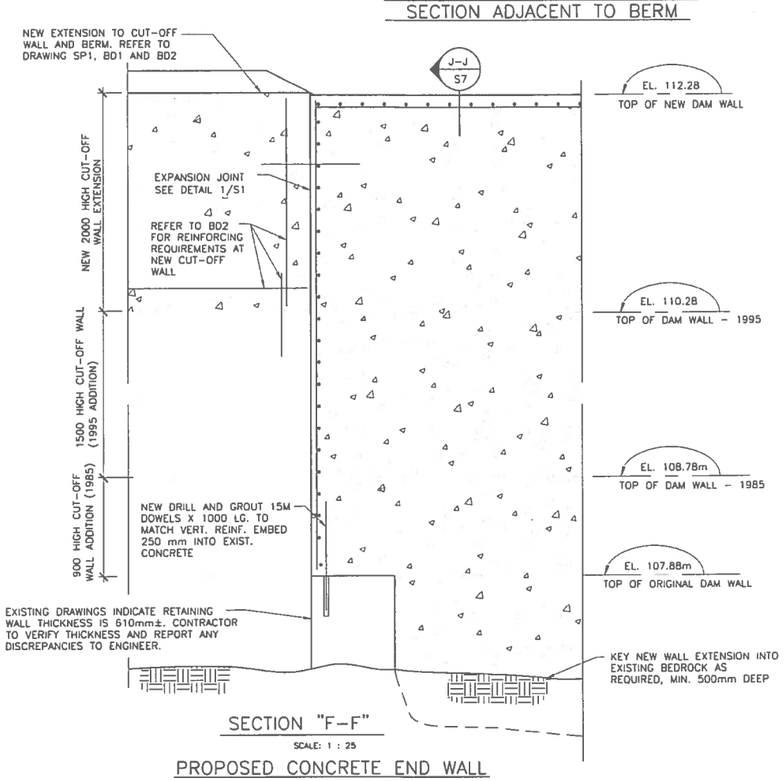
design by	K.A.B.	project no. QTBS00Q17616C
drawn by	M.N.	drawing no. S5
checked by	K.A.B./R.W.P.	
date	FEB. 2006	
scale	AS NOTED	revision no. 2



SECTION "E-E"

SCALE: 1 : 25

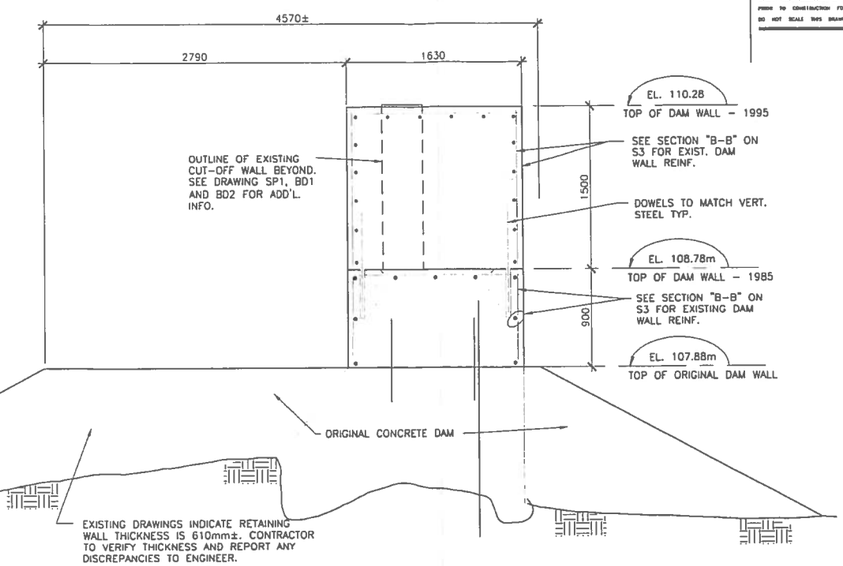
PROPOSED CONCRETE END WALL SECTION ADJACENT TO BERM



SECTION "F-F"

SCALE: 1 : 25

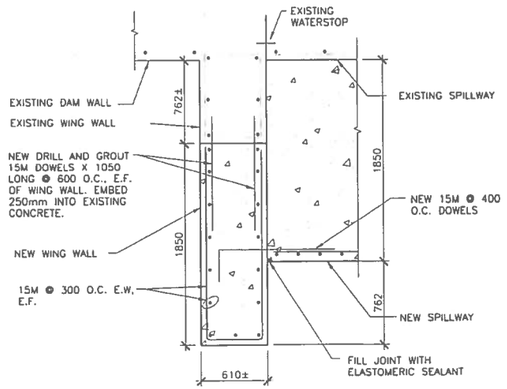
PROPOSED CONCRETE END WALL SECTION ADJACENT TO BERM



SECTION "E-E"

SCALE: 1 : 25

EXISTING CONCRETE END WALL SECTION ADJACENT TO BERM



SECTION "G-G"

SCALE: 1 : 25

SECTION "H-H"

OPPOSITE HAND

PROPOSED CONCRETE WING WALL

ISSUED FOR CONSTRUCTION	no. 2 date 29/06/06 by KAB
TENDER ISSUE	no. 1 date 10/04/06 by KAB
95% SUBMISSION	no. 0 date 28/02/06 by KAB

REVISIONS

NOTES: GENERAL CONTRACTOR TO VERIFY ALL DIMENSIONS WITH FINAL ARCHITECTURAL AND MECHANICAL DRAWINGS. NOTIFY THE ENGINEERS OF ANY ERRORS AND / OR OMISSIONS PRIOR TO CONSTRUCTION FOR CORRECTION. DO NOT SCALE THIS DRAWING.

PERMIT TO PRACTICE
TROW ASSOCIATES INC.
Signature
Date June 29/2006
PERMIT NUMBER: P184
The Association of Professional Engineers, Geologists and Geophysicists of the NWT/NU

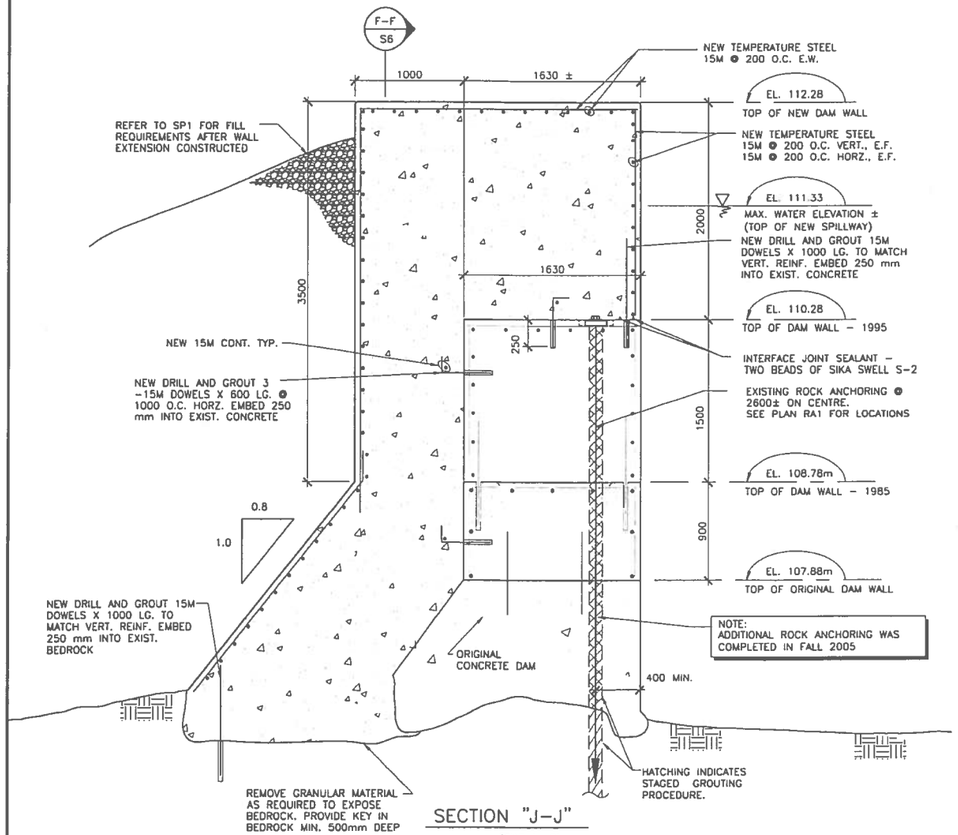
Trow Associates Inc.
Trow 144 Colonnade Road South, Ottawa, Ontario K2E 7J8
Tel: (613) 225-9500 Fax: (613) 225-7337

CLIENT
CITY OF IQALUIT

PROJECT
LAKE GERALDINE DAM
EARTH AND CONCRETE
WORK - 2006

DRAWING
SECTIONS "E-E", "F-F", "G-G" & "H-H"

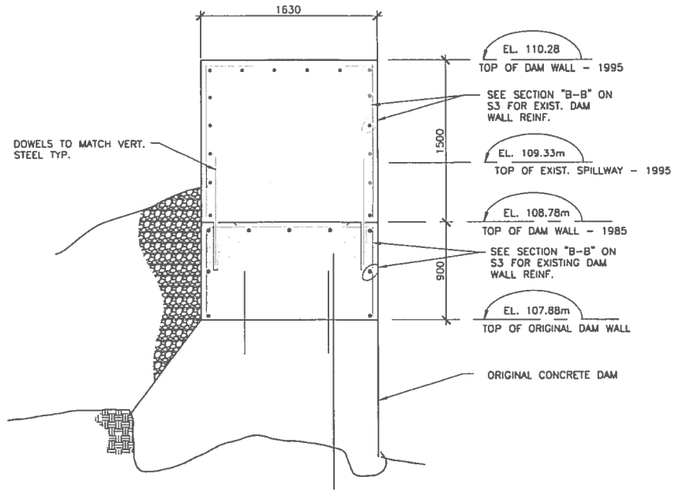
design by	K.A.B.	project no.	QTBS00017616C
drawn by	M.N.	drawing no.	
checked by	K.A.B./R.W.P.		S6
date	FEB. 2006		
scale	AS NOTED	revision no.	2



SECTION "J-J"

SCALE: 1 : 25

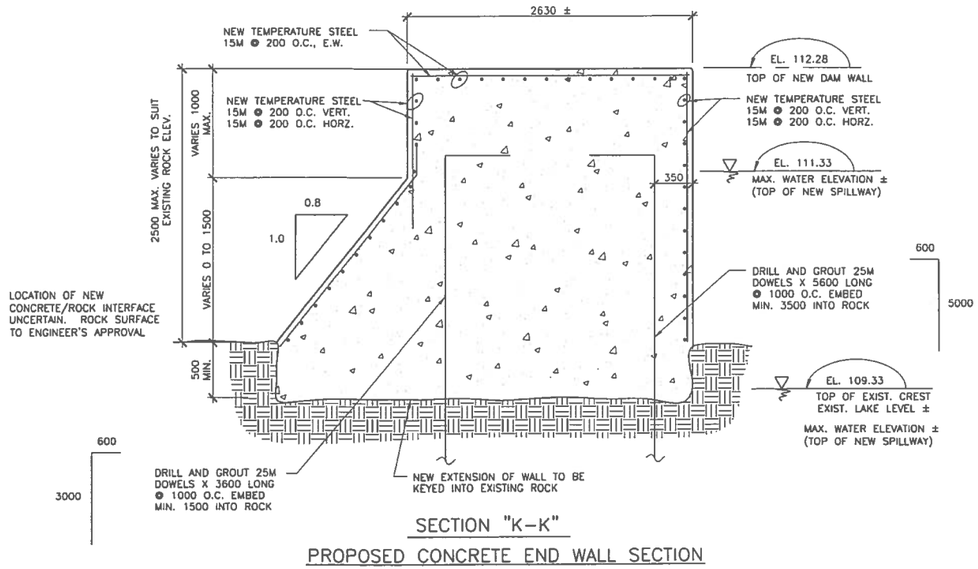
PROPOSED CONCRETE END WALL
SECTION ADJACENT TO BERM



SECTION "J-J"

SCALE: 1 : 25

EXISTING CONCRETE END WALL
SECTION ADJACENT TO BERM



NOTE: THIS CONSTRUCTION AT DAM NORTH END MAY BE NEW OR BELOW EXISTING LAKE ELEVATION. CONTRACTOR TO ALLOW FOR DEWATERING OR SUBMERGED WORK TO ENGINEER'S APPROVAL.

SECTION "K-K"

PROPOSED CONCRETE END WALL SECTION

SCALE: 1 : 25

ISSUED FOR CONSTRUCTION	no. 2 date 29/06/06 by KAB
TENDER ISSUE	no. 1 date 10/04/06 by KAB
95% SUBMISSION	no. 0 date 28/02/06 by KAB

REVISIONS

NOTES: GENERAL CONTRACTOR TO VERIFY ALL DIMENSIONS WITH FINAL ARCHITECTURAL AND MECHANICAL DRAWINGS. NOTIFY THE ENGINEERS OF ANY ERRORS AND / OR OMISSIONS PRIOR TO CONSTRUCTION FOR DIRECTION. DO NOT SCALE THIS DRAWING.

K.A.B. BAKER LICENCE N.W.T.

PERMIT TO PRACTICE
TROW ASSOCIATES INC.
Signature
Date June 29/2006
PERMIT NUMBER: P184
The Association of Professional Engineers, Geologists and Geophysicists of the NWT/NU

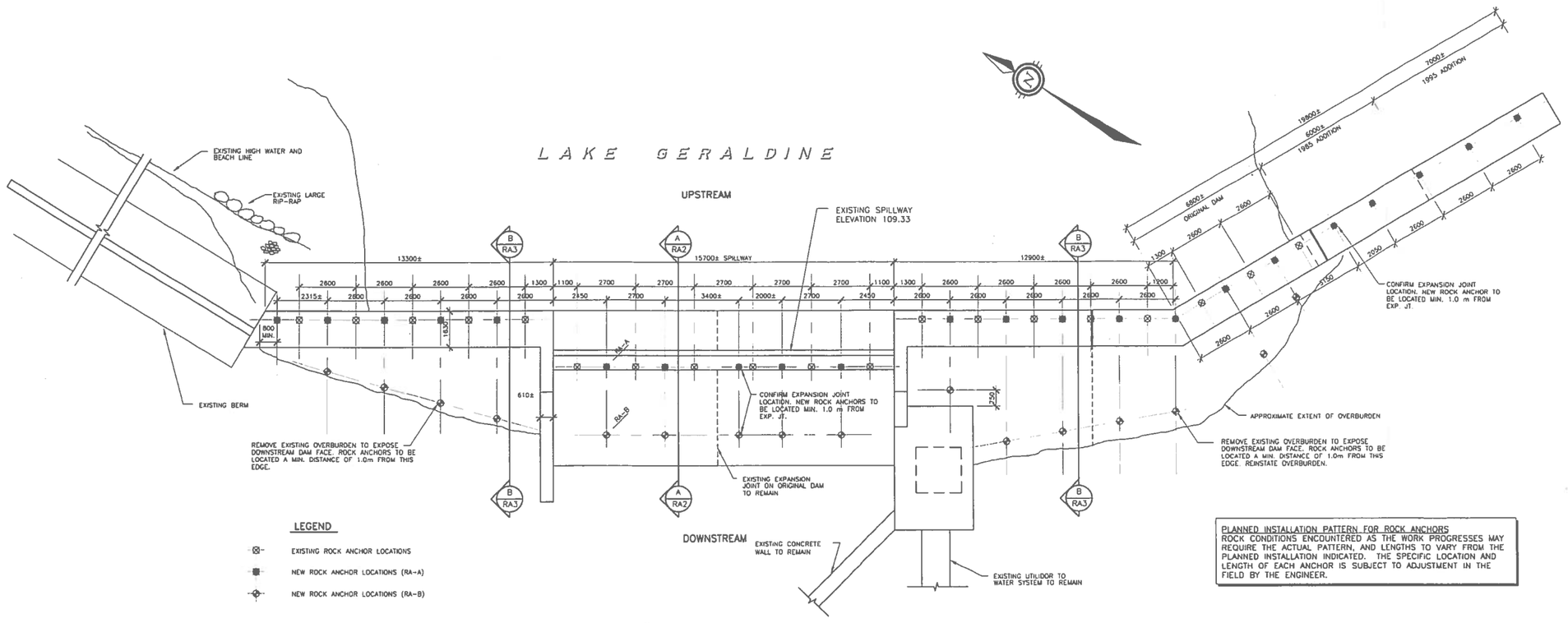
Trow Associates Inc.
Trow 144 Colonnade Road South, Ottawa, Ontario K2E 7J8
Tel: (613) 226-7381 Fax: (613) 226-7337

CLIENT
CITY OF IQALUIT

PROJECT
LAKE GERALDINE DAM
EARTH AND CONCRETE
WORK - 2006

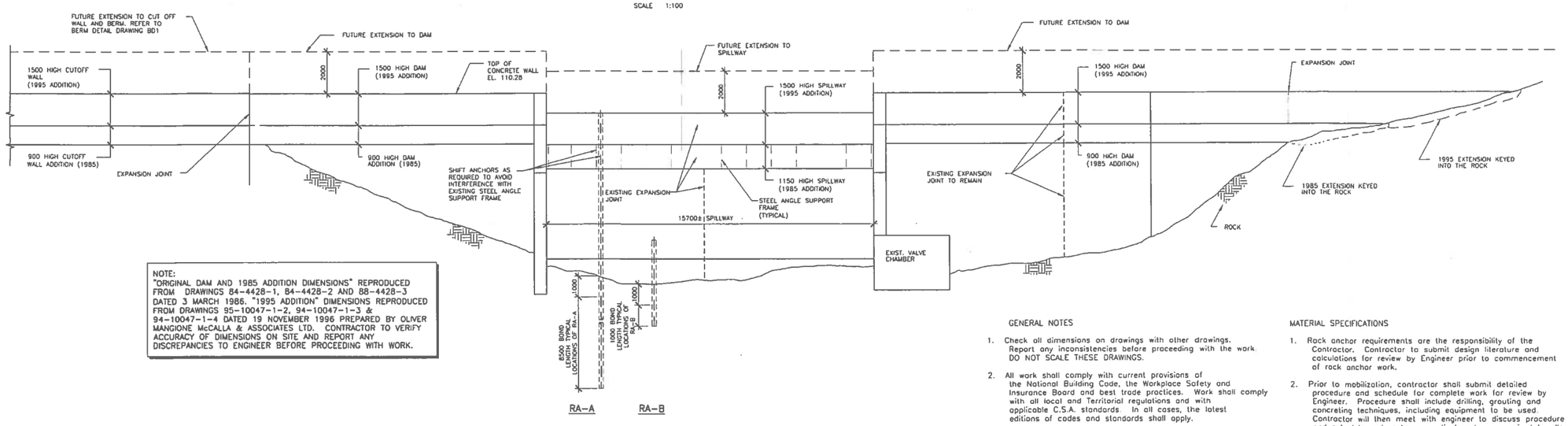
DRAWING
SECTIONS "J-J" & "K-K"

design by	K.A.B.	project no.	01BS000176 16C
drawn by	M.N.	drawing no.	S7
checked by	K.A.B./R.W.P.		
date	FEB. 2006		
scale	AS NOTED	revision no.	2



PLAN VIEW

SCALE 1:100



NOTE:
"ORIGINAL DAM AND 1985 ADDITION DIMENSIONS" REPRODUCED FROM DRAWINGS 84-4428-1, 84-4428-2 AND 88-4428-3 DATED 3 MARCH 1986. "1995 ADDITION" DIMENSIONS REPRODUCED FROM DRAWINGS 95-10047-1-2, 94-10047-1-3 & 94-10047-1-4 DATED 19 NOVEMBER 1996 PREPARED BY OLIVER MANGIONE McCALLA & ASSOCIATES LTD. CONTRACTOR TO VERIFY ACCURACY OF DIMENSIONS ON SITE AND REPORT ANY DISCREPANCIES TO ENGINEER BEFORE PROCEEDING WITH WORK.

DOWNSTREAM ELEVATION

SCALE 1:100

GENERAL NOTES

1. Check all dimensions on drawings with other drawings. Report any inconsistencies before proceeding with the work. DO NOT SCALE THESE DRAWINGS.
2. All work shall comply with current provisions of the National Building Code, the Workplace Safety and Insurance Board and best trade practices. Work shall comply with all local and Territorial regulations and with applicable C.S.A. standards. In all cases, the latest editions of codes and standards shall apply.
3. Before submitting tenders contractors shall carefully examine existing conditions to establish the extent of the work.
4. Locate all buried services prior to excavation. The contractor shall be responsible for all temporary bracing, shoring and dewatering necessary to undertake the work. Provide engineered drawings for some for review and approval of Engineer.
5. The contractor is responsible for removing excess materials and cleaning up on completion of the work.

GEOTECHNICAL INFORMATION

1. Refer to Geotechnical Report No. OTGE00017616B prepared by Trow Associates Inc. dated March 2005

MATERIAL SPECIFICATIONS

1. Rock anchor requirements are the responsibility of the Contractor. Contractor to submit design literature and calculations for review by Engineer prior to commencement of rock anchor work.
2. Prior to mobilization, contractor shall submit detailed procedure and schedule for complete work for review by Engineer. Procedure shall include drilling, grouting and concreting techniques, including equipment to be used. Contractor will then meet with engineer to discuss procedure and schedule and make any adjustments as required to allow work to be conducted in a safe and timely manner.
3. Contractor shall submit detailed drawings and calculations of proposed rock anchoring system for review by Engineer prior to commencement of work. Details will include length of embedment into rock, hole sizes, grout, theoretical rock and concrete stresses, tensioning procedure's and all other considerations as detailed on these drawings and specifications.
4. The term "ORIGINAL" denotes structure prior to 1985 raise. The term "EXISTING" denotes structure after 1985 raise. The terms "NEW" denotes components to be constructed under this contract.

REINFORCEMENT PLACEMENT

1. Rock Anchors – cover as specified on the drawings.

ISSUED FOR ROCK ANCHOR TENDER — no. 0, date 16/06/05, by KAB

REVISIONS

NOTES: GENERAL CONTRACTOR TO VERIFY ALL DIMENSIONS WITH FINAL ARCHITECTURAL AND MECHANICAL DRAWINGS. NOTIFY THE ENGINEER OF ANY ERRORS AND / OR OMISSIONS PRIOR TO CONSTRUCTION FOR DIRECTION. DO NOT SCALE THIS DRAWING.

REGISTERED PROFESSIONAL ENGINEER — Karen A. Baker — K.A. BAKER — N.W.T. — 06/06/16

LICENSED PROFESSIONAL ENGINEER — R.W. POTTER — PROVINCE OF ONTARIO

PERMIT TO PRACTICE
TROW ASSOCIATES INC.
Signature Karen A. Baker
Date June 27/2005
PERMIT NUMBER: P184
The Association of Professional Engineers, Geologists and Geophysicists of the NWT/NU

Trow Associates Inc.
Trow 14 Colonnade Road South, Ottawa, Ontario K2E 7J5
Tel: (613) 225-9502 Fax: (613) 225-7337

CLIENT: CITY OF IQALUIT

PROJECT: LAKE GERALDINE DAM ROCK ANCHORS – 2005

DRAWING: PLAN AND ELEVATION

design by	K.A.B.	project no. OTB500017616C
drawn by	R.L./M.N.	drawing no. RA1
checked by	R.W.P.	
date	MAY 2005	
scale	AS NOTED	revision no. 0

Rock Anchors - 2005

EL. 111.33m
TOP OF PROPOSED CREST

PROPOSED WATER LEVEL

CUT POST-TENSIONING ANCHORAGE POCKET IN EXISTING CONCRETE AND GROUT FILL AS REQUIRED FOR BEARING AND FOR INFILL OF POCKET ON COMPLETION

FUTURE EXTENSION OF SPILLWAY

DOWNSTREAM

UPSTREAM

910±

LAKE GERALDINE

1850

300 MIN.

0.8
1.0

13.12°

1000±

CUT POST-TENSIONING ANCHORAGE POCKET IN EXISTING CONCRETE AND GROUT FILL AS REQUIRED FOR BEARING AND FOR INFILL OF POCKET ON COMPLETION

NOTE:
ROCK ANCHORING TO BE COMPLETED PRIOR TO COMMENCEMENT OF REINFORCED CONCRETE EXTENSION PLACEMENT

NEW ROCK ANCHORING @ 2700± ON CENTRE SEE RA1 FOR LOCATIONS

TYPE RA-B
NEW ROCK ANCHORS TO BE DESIGNED FOR SERVICE LOAD FOR SHEAR OF 344 kN/m. SEE GENERAL NOTES OPTION 4.0m LONG, 46mm ø, GRADE 835/1030 MPa ANCHORS, 2m INTO ROCK OR APPROVED EQUAL.

NOTE:
HATCHING INDICATES STAGED GROUTING PROCEDURE

600 MIN.
1000 MAX.

SECTION "A-A"
SCALE: 1 : 25

PROPOSED CONCRETE SPILLWAY SECTION OF THE DAM

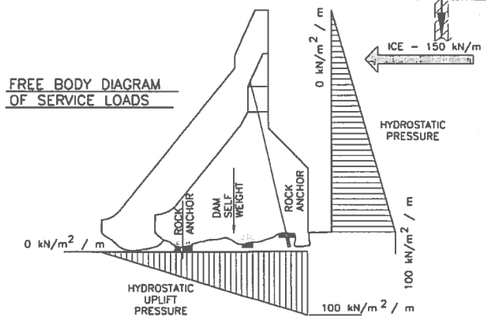
FACTORS OF SAFETY

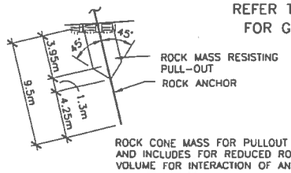
OVERTURNING 1.5
SLIDING 1.93

WHERE F.S (SLIDING) = TAN 40° (Rv) + SHEAR CAPACITY OF ANCHORS / Rh

Rv = RESULTANT OF VERTICAL LOADS (kN)
Rh = RESULTANT OF HORIZONTAL LOADS (kN)

FREE BODY DIAGRAM OF SERVICE LOADS





ROCK CONE MASS FOR PULLOUT BASED ON AND INCLUDES FOR REDUCED ROCK VOLUME FOR INTERACTION OF ANCHORS

TYPE RA-A
NEW ROCK ANCHORS TO BE DESIGNED FOR SERVICE LOAD OF 388 kN/m. OPTION - 17m LONG, 46mm ø, GRADE 835/1030 MPa ANCHORS, 9.5m INTO ROCK OR APPROVED EQUAL

THE FOLLOWING PROCEDURE SHALL BE USED FOR ALL ROCK ANCHORS.
1. PRE-TENSION ANCHOR TO ACHIEVE SERVICE LOAD OF 388 kN PER METRE LENGTH OF DAM.
2. GROUT ANCHOR IN ROCK ONLY AND ALLOW TO SET.
3. RELIEVE PRE-TENSION LOAD AT TOP END OF ANCHOR.
4. GROUT BALANCE OF LENGTH OF ANCHOR IN CONCRETE DAM.

REFER TO DRAWING RA1 FOR GENERAL NOTES

WING WALL NOT SHOWN FOR CLARITY

910±

250

EXISTING 15M @ 300 VERT. 15M @ 300 HORZ.

EXISTING WATER ELEVATION (ELEVATION VARIES OVER COURSE OF YEAR)

EL. 109.33m
TOP OF EXIST. CREST

EXISTING 15M @ 200 VERT. 15M @ 300 HORZ.

EXISTING 15M DWLS. MATCHING HORZ. REINF. AT EXIST. WING WALLS

EXISTING 15M DWLS. X 1050 LG. MATCHING VERT. REINFORCING EMBEDDED 450 INTO EXIST. CONC.

1500 1995 ADDITION

EXISTING 5 mm STEEL PLATE WELDED TO ANGLE FRAME TO REMAIN

EL. 107.83m
TOP OF CREST - 1985

EXISTING 5 mm STEEL PLATE WELDED TO ANGLE FRAME TO REMAIN

EXISTING L64 X 64 X 5 ANGLE FRAME @ 1200 O.C. TYP. TO REMAIN

1150 1985 ADDITION

EXISTING 25ø X 900 LG. "PIGTAIL" TYPE ROCK ANCHORS TO REMAIN

1900±

EL. 106.68m
TOP OF ORIGINAL CREST

EXISTING "WILLIAMS" HOLLOW GROUTABLE "RE-BAR" 25mm ø ROCK BOLTS IN 45mm ø HOLES @ 800 O.C. TO REMAIN

UPSTREAM

DOWNSTREAM

LAKE GERALDINE

300 MIN.

0.8
1.0

1865±

DIMENSIONS VARIES SEE DWG. BD1 FOR ADD'L. INFO.

13.12°

EXISTING ROCK ANCHORS. SEE DRAWING RA1 FOR SPACING

600 MIN.
1000 MAX.

LAKE BOTTOM

ROCK

EXISTING CONCRETE SPILLWAY SECTION OF THE DAM
SCALE 1 : 25

NOTE:
"ORIGINAL DAM AND 1985 ADDITION DIMENSIONS" REPRODUCED FROM DRAWINGS 84-4428-1, 84-4428-2 AND 88-4428-3 DATED 3 MARCH 1986. "1995 ADDITION" DIMENSIONS REPRODUCED FROM DRAWINGS 95-10047-1-2, 94-10047-1-3 & 94-10047-1-4 DATED 19 NOVEMBER 1996 PREPARED BY OLIVER MANGIONE McCALLA & ASSOCIATES LTD. CONTRACTOR TO VERIFY ACCURACY OF DIMENSIONS ON SITE AND REPORT ANY DISCREPANCIES TO ENGINEER BEFORE PROCEEDING WITH WORK.

ISSUED FOR ROCK ANCHOR TENDER — no. 0, date 16/06/05, by KAB

REVISIONS

NOTES: GENERAL CONTRACTOR TO VERIFY ALL DIMENSIONS WITH FINAL ARCHITECTURAL AND MECHANICAL DRAWINGS. REPORT THE ENGINEERS OF ANY ERRORS AND / OR OMISSIONS PRIOR TO CONSTRUCTION FOR DIRECTION. DO NOT SCALE THIS DRAWING.

K.A. BAKER LICENSEE 2005/06/27 N.W.T.

R.W. POTTER 2005.06.27 PROVINCE OF ONTARIO

PERMIT TO PRACTICE
TROW ASSOCIATES INC.
Signature Karen A. Baker
Date June 27/2005
PERMIT NUMBER: P184
The Association of Professional Engineers, Geologists and Geophysicists of the NWT/NU

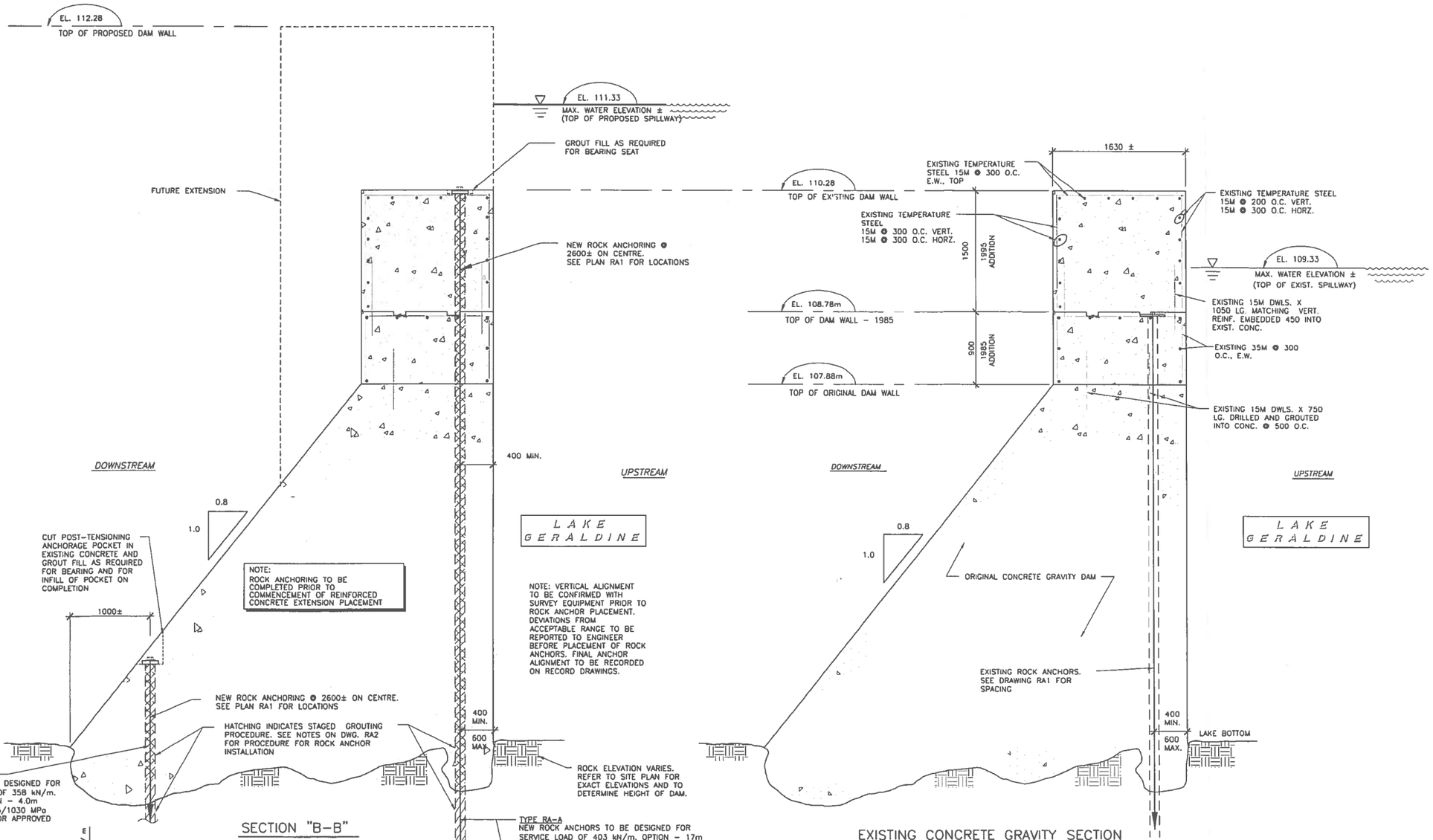
Trow Associates Inc.
Trow 154 Colonnade Road South, Ottawa, Ontario K2E 7J5
Tel (613) 225-9460 Fax (613) 225 7337

CLIENT
CITY OF IQALUIT

PROJECT
LAKE GERALDINE DAM
ROCK ANCHORS - 2005

DRAWING
SECTIONS AND DETAILS

design by	K.A.B.	project no.	01BSG0017616C
drawn by	M.N.	drawing no.	RA2
checked by	R.W.P.		
date	MAY 2005		
scale	AS NOTED	revision no.	0



ISSUED FOR ROCK ANCHOR TENDER — no. 0, date 16/06/05, by KAB

REVISIONS

NOTES: GENERAL CONTRACTOR TO VERIFY ALL DIMENSIONS WITH FINAL ARCHITECTURAL AND MECHANICAL DRAWINGS. NOTIFY THE ENGINEERS OF ANY ERRORS AND / OR OMISSIONS PRIOR TO CONSTRUCTION FOR DIRECTION. DO NOT SCALE THIS DRAWING.

REGISTERED PROFESSIONAL ENGINEER — K.A. BAKER — LICENCE No. L0305/04 — N.W.T.

LICENCED PROFESSIONAL ENGINEER — R.W. POTTER — PROVINCE OF ONTARIO

PERMIT TO PRACTICE
TROW ASSOCIATES INC.
Signature Kristen A. Baker
Date June 27/2005
PERMIT NUMBER: P184
The Association of Professional Engineers, Geologists and Geophysicists of the NWT/NU

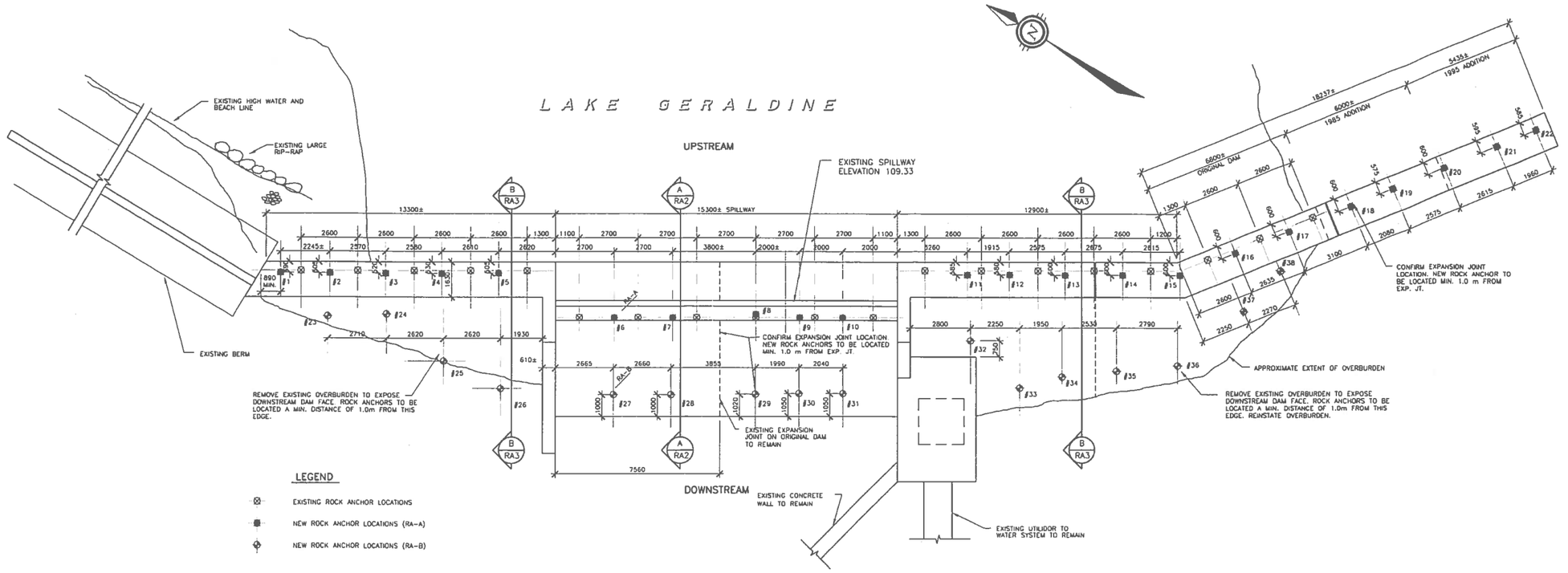
Trow Associates Inc.
Trow — 144 Colonnade Road South, Ottawa, Ontario K2E 7J5 — Tel (613) 225-9460 Fax (613) 225-7337

CLIENT: CITY OF IQALUIT

PROJECT: LAKE GERALDINE DAM ROCK ANCHORS - 2005

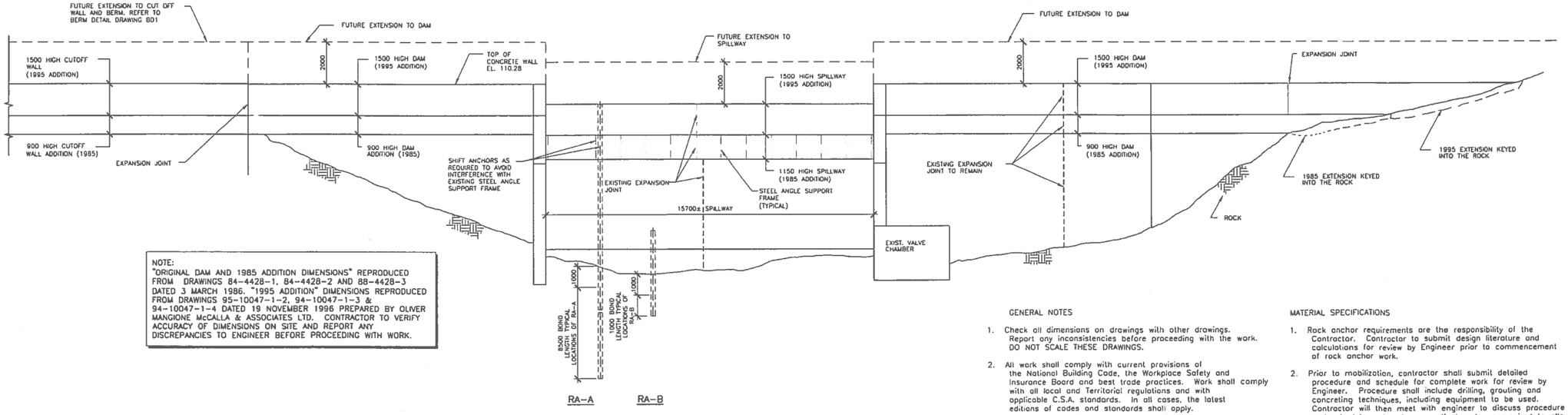
DRAWING: SECTIONS AND DETAILS

design by	K.A.B.	project no.	OTBS000176I6C
drawn by	M.N.	drawing no.	RA3
checked by	R.W.P.		
date	MAY 2005		
scale	AS NOTED	revision no.	0



PLAN VIEW

SCALE 1:100



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DOWNSTREAM ELEVATION

SCALE 1:100

GENERAL NOTES

1. Check all dimensions on drawings with other drawings. Report any inconsistencies before proceeding with the work. DO NOT SCALE THESE DRAWINGS.
2. All work shall comply with current provisions of the National Building Code, the Workplace Safety and Insurance Board and best trade practices. Work shall comply with all local and Territorial regulations and with applicable C.S.A. standards. In all cases, the latest editions of codes and standards shall apply.
3. Before submitting tenders contractors shall carefully examine existing conditions to establish the extent of the work.
4. Locate all buried services prior to excavation. The contractor shall be responsible for all temporary bracing, shoring and dewatering necessary to undertake the work. Provide engineered drawings for same for review and approval of Engineer.
5. The contractor is responsible for removing excess materials and cleaning up on completion of the work.

GEOTECHNICAL INFORMATION

1. Refer to Geotechnical Report No. OTGE00017616B prepared by Trow Associates Inc. dated March 2005

MATERIAL SPECIFICATIONS

1. Rock anchor requirements are the responsibility of the Contractor. Contractor to submit design literature and calculations for review by Engineer prior to commencement of rock anchor work.
2. Prior to mobilization, contractor shall submit detailed procedure and schedule for complete work for review by Engineer. Procedure shall include drilling, grouting and concreting techniques, including equipment to be used. Contractor will then meet with engineer to discuss procedure and schedule and make any adjustments as required to allow work to be conducted in a safe and timely manner.
3. Contractor shall submit detailed drawings and calculations of proposed rock anchoring system for review by Engineer prior to commencement of work. Details will include length of embedment into rock, hole sizes, grout, theoretical rock and concrete stresses, tensioning procedure's and all other considerations as detailed on these drawings and specifications.
4. The term "ORIGINAL" denotes structure prior to 1985 raise. The term "EXISTING" denotes structure after 1985 raise. The terms "NEW" denotes components to be constructed under this contract.

REINFORCEMENT PLACEMENT

1. Rock Anchors – cover as specified on the drawings.

RECORD DRAWING	no. 1 date 28/02/06 by KAB
ISSUED FOR ROCK ANCHOR TENDER	no. 0 date 15/06/05 by KAB

REVISIONS

NOTES: GENERAL CONTRACTOR TO VERIFY ALL DIMENSIONS WITH FINAL ARCHITECTURAL AND MECHANICAL DRAWINGS. NOTIFY THE ENGINEER OF ANY ERRORS AND / OR OMISSIONS PRIOR TO CONSTRUCTION FOR DIRECTION. DO NOT SCALE THIS DRAWING.

FOR REFERENCE ONLY N.I.C.

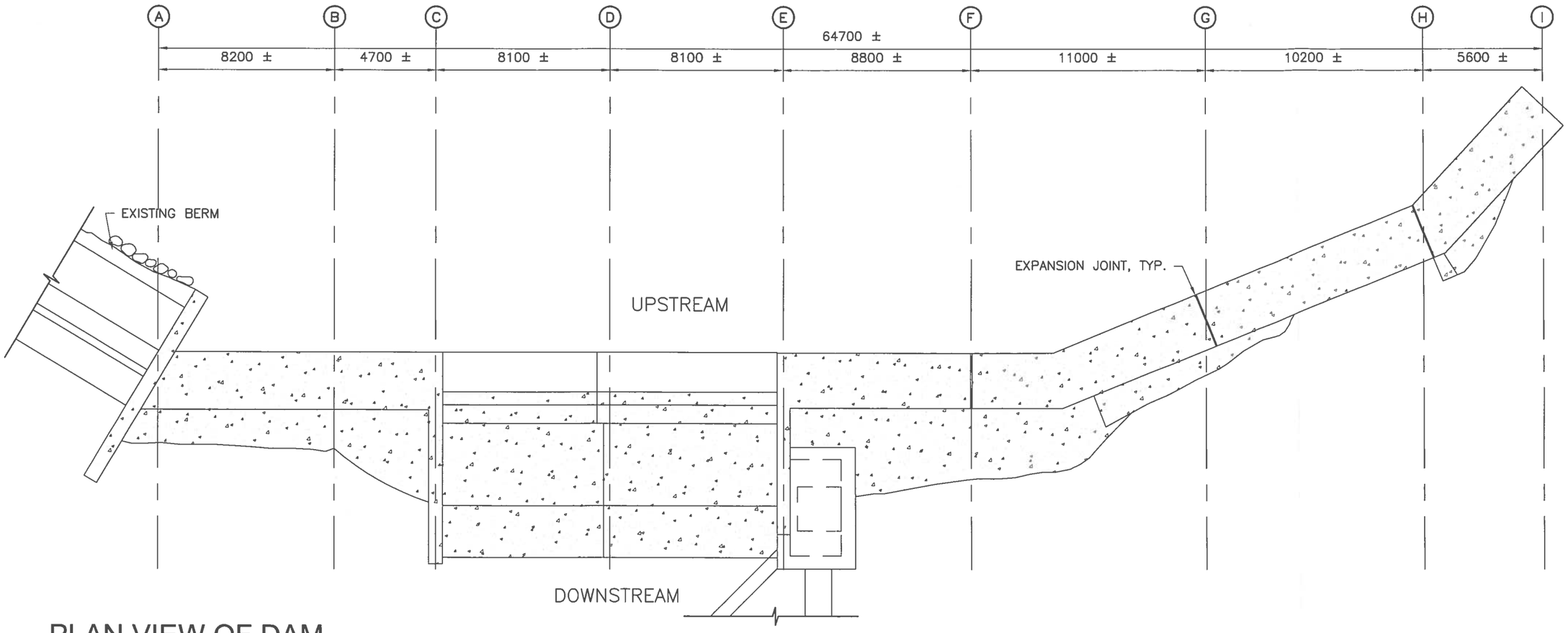
Trow Associates Inc.
TROW 184 Colonnade Road South, Ottawa, Ontario K2E 7J8
Tel (613) 226-7381 Fax (613) 226-7337

CLIENT: CITY OF IQALUIT

PROJECT: LAKE GERALDINE DAM ROCK ANCHORS – 2005

DRAWING: PLAN AND ELEVATION

design by	K.A.B.	project no.	OTBS00017616C
drawn by	R.L./M.N.	drawing no.	RA1
checked by	R.W.P.		
date	MAY 2005		
scale	AS NOTED	revision no.	1



PLAN VIEW OF DAM

SCALE: 1:200

GENERAL NOTES:

1. ALL WORK TO BE PERFORMED IN ACCORDANCE WITH APPLICABLE LEGISLATION AND REGULATIONS INCLUDING, BUT NOT LIMITED TO, OCCUPATIONAL HEALTH AND SAFETY ACT AND REGULATIONS.
2. THE CONTRACTOR SHALL AS PART OF THEIR WORK, CHECK AND VERIFY ALL DIMENSIONS AND ELEVATIONS AND REPORT ANY DISCREPANCIES TO THE ENGINEER BEFORE PROCEEDING WITH CONSTRUCTION.
3. CONTRACTOR IS RESPONSIBLE FOR PROVIDING FALL PROTECTION FOR WORK PERFORMED WHEN A FALL HAZARD EXISTS.
4. CONTRACTOR IS RESPONSIBLE FOR PROVIDING ADEQUATE SAFETY BARRIERS/ HOARDING DURING THE CONSTRUCTION PHASE.

POLYURETHANE INJECTION

1. THE INJECTION RESIN TO BE USED IS: FLEXIBLE WATER REACTIVE POLYURETHANE RESIN AS MANUFACTURED BY MME MULTIURETHANES LTD.
2. AREAS REQUIRING REPAIR ARE IDENTIFIED ON THE DRAWINGS. CONTRACTOR SHALL CONFIRM WITH THE CONSULTANT THE EXACT AREAS PRIOR TO COMMENCING WORK.
3. CONTRACTOR SHALL MAKE REPAIRS WHERE REQUIRED UNDER THE DIRECTION OF THE SPECIFICATIONS AND THE MANUFACTURERS RECOMMENDATIONS FOR CRACK INJECTION TECHNIQUES.

ENVIRONMENTAL REQUIREMENTS

1. THE CONTRACTOR SHALL ENSURE COMPLIANCE WITH ALL MUNICIPAL, TERRITORIAL, AND FEDERAL AUTHORITIES HAVING JURISDICTION OVER THE DURATION OF THE PROJECT.
2. WHERE NOTIFICATION, EVALUATION, AND APPROVALS ARE REQUIRED FOR THE WORK, THE CONTRACTOR SHALL BE RESPONSIBLE FOR SUPPLYING THE REQUIRED INFORMATION AND PAYMENT OF ASSOCIATED FEES OR PERMITS.
3. THE NOTIFICATION AND APPROVAL PROCESS SHALL INCLUDE, BUT IS NOT LIMITED TO, CONSTRUCTION OVER A WATERCOURSE (DEPARTMENT OF FISHERIES & OCEANS) DISPOSAL OF MATERIALS, (CITY OF IQALUIT) AND ENVIRONMENTAL COMPLIANCE (MINISTRY OF ENVIRONMENT).

CONCENTRIC ASSOCIATES INTERNATIONAL INCORPORATED
OTTAWA 1-866-919-4530
LONDON 1-866-919-4531
IQALUIT 1-866-919-4533

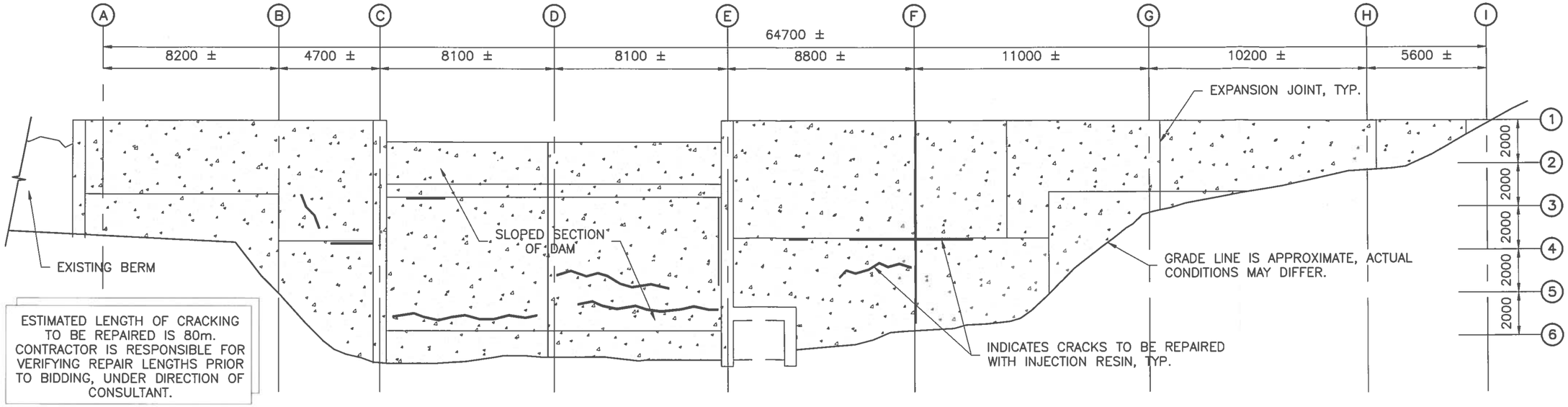
CLIENT NAME:
THE CITY OF IQALUIT
PROJECT ADDRESS:
LAKE GERALDINE DAM
IQALUIT, NUNAVUT

PROJECT NAME:
LAKE GERALDINE DAM & WATER TREATMENT PLANT GROUTING PROGRAM
DRAWING TITLE:
PLAN VIEW OF DAM

DESIGN: STP
DRAWN: ADM
DATE: JUNE/2010
FILE No: 10-3171

NO.	REVISION	DATE
1	FOR TENDER	JULY 7, 2011
2		
3		

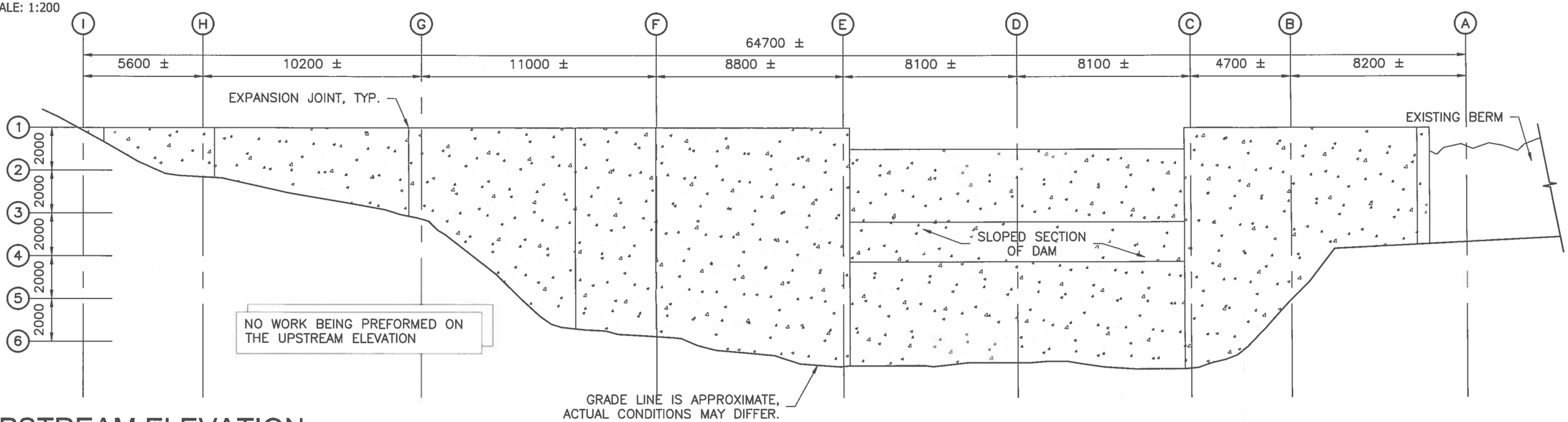
SHEET No.
A1



ESTIMATED LENGTH OF CRACKING TO BE REPAIRED IS 80m. CONTRACTOR IS RESPONSIBLE FOR VERIFYING REPAIR LENGTHS PRIOR TO BIDDING, UNDER DIRECTION OF CONSULTANT.

DOWNSTREAM ELEVATION

SCALE: 1:200



UPSTREAM ELEVATION

SCALE: 1:200

CONCENTRIC ASSOCIATES INTERNATIONAL INCORPORATED

OTTAWA 1-866-919-4530
LONDON 1-866-919-4531
IQALUIT 1-866-919-4533

CLIENT NAME:
THE CITY OF IQALUIT

PROJECT ADDRESS:
LAKE GERALDINE DAM
IQALUIT, NUNAVUT

PROJECT NAME:
LAKE GERALDINE DAM & WATER TREATMENT PLANT GROUTING PROGRAM

DRAWING TITLE:
DOWNSTREAM AND UPSTREAM ELEVATION

DESIGN: STP
DRAWN: ADM
DATE: JUNE/2010
FILE No: 10-3171

NO.	REVISION	DATE
1	FOR TENDER	JULY 7, 2011
2		
3		

SHEET No.
A2

CITY OF IQALUIT
LAKE GERALDINE DAM & WATER TREATMENT PLANT GROUTING PROGRAM

TENDER PACKAGE

JULY 7, 2011

PRODUCED BY:
CONCENTRIC ASSOCIATES INTERNATIONAL INC.

CONCENTRIC PROJECT NUMBER:
10-3171

IT.2 Receipt of Tenders

2.1 Tenders must be received at the Closing Location by the City on or before the exact time and date fixed as the Closing Time.

2.2 It is the responsibility of the Tenderer to ensure that its Tender is received at the Closing Location before the Closing Time and the Tenderer assumes the entire risk of failure of the City to receive any tender at the Closing Location before the Closing Time.

2.3 Any Tenders received after the Closing Time shall be rejected and returned unopened to the Tenderer. If only one Tender is received and that Tender is received late, the Tender may be accepted at the sole discretion of the City.

2.4 Tenders shall be opened as soon as practicable after the Closing Time.

2.5 Tenders received by facsimile, except with respect to amendments as permitted elsewhere in these Instructions to Tenderers, or by other electronic transmission, will not be accepted and if received shall be disqualified.

IT.3 Amendments to Tenders

3.1 Amendments to a Tender by letter other written means delivered to the Closing Location or delivered by facsimile are acceptable provided that the amendment:

(i) is received in total on or before the Closing Time;

(ii) contains the Project name and number, name and address of the Tenderer and is signed by the same party or parties who signed the Tender; and

(iii) the amendment indicates only the applicable changes to the Tender in such a manner that the total Tender prices are not revealed.

3.2 Amendments to tenders delivered by facsimile shall be transmitted to the following facsimile number:

City: (867) 975-8505

3.3 All amendments submitted by facsimile should be confirmed by delivery of the original within seven days after the Closing Time, subject to adverse weather or transportation problems.

3.4 Amendments shall not be transmitted by electronic means, other than by facsimile as indicated above.

3.5 Tenderers assume all risk of delivery of amendments by facsimile. Without limiting the foregoing, the City shall not be held liable for any claim, demand or other action should a facsimile transmission be interrupted, not received in its entirety, received after the Closing Time, received by another facsimile unit other than stated herein, or for any other reason over which the City does not have control.

IT.4 Security Deposit

4.1 Every Tender shall be accompanied by a security deposit as follows:

4.1.1 Bid bond in an amount not less than 10% of the total Tender amount; or

4.1.2 Certified cheque payable to City of Iqaluit in an amount not less than 10% of the total Tender amount.

4.2 Bid bonds shall be in the name of the City of Iqaluit as obligee and signed and sealed by the Tenderer and by a surety licensed to conduct business as a surety in Nunavut.

Tenderer will have any claim against the City as a consequence. Unless required otherwise by the NNI Policy, the City shall not, at any time, be required to disclose any information to the Tenderers regarding the City's consideration and evaluation of Tenders.

9.5 Following acceptance by the City, a written Notice of Award will be issued to the successful Tenderer. If the Tenderer fails for any reason to execute and return the Articles of Agreement within seven (7) working days of receipt for signature of the Articles of Agreement from the City, or fails to provide the performance bond and labour and material bond or other security deposit stipulated in GC 11 or to satisfy such other terms and conditions specified hereunder within any period specified, or such extension of time as may be granted by the City, then the City reserves the right to terminate the Tenderer's right to complete the Contract and to award the Contract to whomever the City considers appropriate. The bid bond shall forthwith become payable.

9.6 The City shall not be obligated in any manner to the successful Tenderer whatsoever until the Contract has been awarded and the Contract has been duly executed by the parties.

9.7 If the City receives no Tenders satisfactory to the City in its sole discretion, the City reserves the right in its sole discretion to negotiate a contract for the whole or any part of the Work with any one or more persons whatsoever, including any one or more of the Tenderers, or to postpone or cancel this Tender and then issue a new tender, or to cancel or postpone some or all of the Work.

9.8 The City shall not, under any circumstances, be responsible for any costs, expenses, loss, damage or liabilities, whether direct, indirect, consequential or economic in nature, incurred by a Tenderer as a result of, in connection with or incidental to:

9.8.1 a Tenderer tendering for the Work, or

9.8.2 the acceptance or rejection of any Tender, or

9.8.3 the exercise by the City of its rights under IT.9.5.

9.9 By participation in the tendering process, the Tenderer on its own behalf and on behalf of all firms, corporations and individuals comprising the Tenderer, agrees that none of the City or its directors, officers, employees, agents and other representatives shall by liable to any Tenderer, or any firm, corporation or individual comprising the Tenderer, including in contract, tort, statutory duty, duty of fairness, duty of care, law, equity or otherwise, for any claims, direct or indirect, whether for costs, expenses, losses or damages, or loss of anticipated profits, or for any matter whatsoever, incurred in preparing and submitting a Tender, or negotiations of a Contract, or in any way arising in connection with the Tender Documents. The Tenderer further agrees on its own behalf and on behalf of all firms, corporations and individuals comprising the Tenderer, that the award of the Contract is in the sole discretion of the City and in no event shall the Tenderer or any firms, corporations or individuals comprising the Tenderer seek injunctive or other relief to prevent or delay the award of the Contract or the performance of any Work or services in relation thereto.

IT.10 Commencement and Completion of Work

10.1 The Tenderer, in submitting the Tender, agrees that the Tenderer can complete the Work by the date for completion stated in the Tender Form.

IT.11 Omissions/Discrepancies/Interpretations

11.1 Tenderers finding discrepancies or omissions in the drawings or specifications, or having doubt as to the meaning or intent thereof, shall at once notify the Engineer who will, if necessary, send written instructions or explanations to all Tenderers.

11.2 Oral interpretations made to any Tenderer shall not effect a modification of any provision of the Tender Documents.

IT.15 Site Examination

15.1 The Tenderer, either personally or through a representative, shall examine the Site before submitting a Tender, and shall satisfy itself as to the nature and location of the Work, local conditions, soil structure and topography at the Site, the equipment and facilities needed prior to and during the prosecution of the Work, the means of access to the Site, on-Site accommodation, all necessary information as to risks, contingencies and circumstances which may affect its Tender, and all other matters which can in any way affect the Work. The Tenderer is fully responsible for obtaining all information required for the preparation of the Tender.

15.2 The Tenderer is directed to contact the Engineer at the following address and telephone number in order to arrange a date and time to visit the Site:

Chileab Yue; Phone # 867-979-3300; Email: chileab@concentriceng.com

15.3 Claims for additional costs will not be entertained with respect to conditions which would reasonably have been ascertained by an inspection of the Site prior to the Closing Time.

IT.16 Tender Signing

16.1 The Tender must be executed under seal by the Tenderer.

16.2 If the Tenderer is an individual or a partnership, the Tender shall be executed by the individual or a partner in the presence of a witness and the signatory must show the capacity in which he or she signs (e.g. "Partner" or "Proprietor").

16.3 If the Tenderer is a corporation, the Tender shall be executed under the seal of the company, affixed in the presence of the authorized officers or two directors.

16.4 If the Tenderer is a joint venture, each party to the joint venture shall execute the Tender under seal in the manner appropriate to such party.

IT.17 Appendices to Tender Form

17.1 Tenderers shall complete all Appendices attached to the Tender Form and, subject to IT.24, submit these with the Tender.

IT.18 Working Hours

18.1 Work on the structure shall be carried out between the hours of: **7:00 A.M. and 7:00 P.M.** on weekdays and between **7:00 A.M. and 7:00 P.M.** on weekends unless other arrangements are made between the City and the Contractor.

IT.19 Special Inclusions

19.1 Prepurchased equipment.

19.2 Pretendered subcontracts (transferable contracts).

19.3 Nominated subcontracts.

19.4 Cash allowances.

19.5 Other contracts.

24.3 For purposes of this Tender, "Local" shall be considered to be the community in which the Work is undertaken unless noted otherwise in these Tender Documents.

24.4 In order to comply with the requirements of this Tender and specifically those included in the "Instructions to Tenderers" IT.24, the Tenderer is required to complete the attached forms entitled Appendix "J-1" "General Contractors & Subcontractors Dollar Amount" and Appendix "J-2" "Substantiation of Bid Adjustment".

24.5 For the Inuit Labour bonus or penalty, as set out in the NNI Policy, the benchmark shall be the minimum prescribed level for Inuit Labour identified on page 4 of Appendix K "Contractor's Obligations to Provide Inuit Content" of the Tender.

24.6 Joint Ventures: If the Tenderer is comprised of more than one party as in the case of a joint venture, (but not a partnership) for the purposes of the application of the NNI adjustments, each party to the joint venture will be treated as a separate Tenderer, and the value of their respective Nunavut, Inuit, and local content will be treated in the same manner as separate Tenderers.

24.7 This Tender will close in two phases as follows:

Phase I Tender Close: The Tenderer shall complete the Tender Form and all required appendices and, with the exception of Appendix J-2 shall submit them no later than the time identified for the Phase I closing of Tenders.

The Tenderer shall indicate on the Appendix "J-1" "General Contractors & Subcontractors Dollar Amount" the bid value and names of all major businesses which will be providing goods and services to the Tenderer in order to complete the Work. No further detail is required at the time of Phase I Tender closing.

At the time established for the Phase I Tender closing, the City shall receive Tenders and shall record the names of the Tenderers who have submitted Tenders. Those Tenders shall remain unopened and held in a secure place by the City for a period of 24 hours.

Phase II Tender Close: Within 24 hours following the Phase I Tender close, excluding holidays and weekends, the Tenderer shall submit to the City a detailed Appendix "J-2" "Substantiation of Bid Adjustments" showing the actual amounts of Local, Nunavut, Inuit and other content in respect to payroll, material, equipment, transportation, accommodation and other costs.

This detailed Appendix "J-2" "Substantiation of Bid Adjustments" shall be submitted in a sealed envelope or by facsimile with clear identification as to the name of the Tender and the Tenderer, and shall be received prior to the Phase II Tender close which shall be 24 hours, excluding holidays and weekends, after the Phase I Tender closing. Detailed Appendix "J-2" "Substantiation of Bid Adjustments" received late may be disqualified.

Tenders shall be opened after the Phase II closing.

NOTE 1: The Tenderer shall only receive a bid adjustment when a completed Appendix "J-1" "General Contractors & Subcontractors Dollar Amount" and Appendix "J-2" "Substantiation of Bid Adjustments" have been submitted in accordance with the above. Tenders submitted without such a submission shall receive no bid adjustment at all.

IT.25 Requirement for Using Hotels or Bed and Breakfast

25.1 If performance of the Work is undertaken where a Commercial Room and Board Facility exists within the Community, the Contractor shall be required to comply with the provisions of GC 13.5 of the General Conditions.

Date:

Submitted by: Name:
Address:

Telephone:

To: City of Iqaluit
City Hall
Iqaluit, Nunavut

Project: Project Title: Lake Geraldine Dam & Water Treatment Plant Grouting Program

The undersigned Tenderer, having carefully examined the Tender Documents and the Site, and having full knowledge of the Work and of the materials and products to be furnished and used, hereby agrees to provide all necessary materials, products, supervision, labour and equipment and perform and complete all Work and fulfill everything for the stipulated lump sum price of:

_____

(Total in Words)

_____ Dollars $_____

in Canadian funds, which price includes all specified cash and contingency allowances and the applicable taxes in force at this date including GST.

We have included herewith the security deposit and Consent of Surety as required by the Instructions to Tenderers.

The undersigned also agrees:

1. That the provisions of the Instruction to Tenderers apply, including without limitation provisions that provide that City is in no way obligated to accept this Tender, the City may at its sole discretion to accept any Tender or part thereof or waive any defect, irregularity, mistake or insufficiency and accept any Tender or alternative proposal, in whole or in part, which is deemed by the City to be most favourable to its interest, and that limit the City's liability.

2. That GST is included in the Tender price.

3. That the estimate of quantities shown in Tender Documents serves only to provide a basis for comparing Tenders and that no representations have been made by either the City or the Engineer that the actual quantities correspond therewith, and further, that the City has the right to increase or decrease the quantities in any or all items and to eliminate items entirely from the Work.

4. That this Tender is made without knowledge of the Tender prices to be submitted for the Work by any other company, firm or person.

5. That this Tender is made without connection or arrangement with any company, firm or person submitting a tender for the Work.

6. That this Tender is made without any undisclosed connection or arrangement with any other company, firm, or person having an interest in this Tender or in the proposed contract.

We understand that the words "As Required", or similar wording will not be sufficient to describe the equipment.

16.4 A list of Product Suppliers is appended hereto and identified as Appendix "D".

We agree that Product Suppliers shall not be changed unless permission of the Engineeer is obtained.

16.5 A schedule of "Labour and Equipment Rates" is appended hereto and identified as Appendix "E".

16.6 A list of "Unit Prices" is appended hereto and identified as Appendix "F".

In submitting these Unit Prices it is agreed that the City and Engineer maintain the right to select the method of valuation for changes in the Work in accordance with GC8-Change Orders. Unit Prices submitted are for additions and reductions to quantities shown in the Tender Documents.

16.7 "Alternatives and Options", "City Requested Alternatives" and "Tenderer Proposed Options" are appended hereto and identified as Appendix "G", Appendix "G-1" and Appendix "G-2", respectively.

16.8 A list of Separate Prices is appended hereto and identified as Appendix "H".

16.9 A Schedule of Prices is appended hereto and identified as Appendix "I".

16.10 Nunavummi Nangminiqaqtunik Ikajuuti (NNI) Policy Forms are appended hereto and identified as Appendix "J", "J-1" and "J-2". Appendix "J-1" "General Contractor & Sub-Contractors Dollar Amount" has been completed. Appendix J-2 "Substantiation of Bid Adjustment [*has been completed and is included in a separate sealed envelope] or [*will be completed and submitted with in 24 hours of the Closing Time in a separate sealed envelope.]
[*Tenderer to strike out inapplicable provision].

16.11 "Contractor's Obligations to Provide Inuit Content" is appended hereto and is identitifed as Appendix "K".

17. **Changes**

17.1 When the Engineer establishes that the method of valuation for extras in the Work will be net cost plus a percentage fee in accordance with GC 8.2

17.2 On work deleted from the Contract, our credit to the City shall be an estimated net cost approved by the Engineer plus one half the overhead and profit percentage noted in GC 8.2.

18. **Addenda**

18.1 The following Addenda have been received. The modifications to the Tender Documents noted therein have been considered and the effects are included in the Tender prices.

Addendum # _____, dated _____.

Addendum # _____, dated _____.

Addendum # _____, dated _____.

APPENDIX A
CONSENT OF SURETY

Herewith is the Consent of Surety of the Tender submitted.

By: _____

To: The City of Iqaluit

Dated: _____, 20____ and which is an integral part of the Tender.

CONSENT OF SURETY COMPANY

Should it be required, the undersigned Surety Company hereby consents and agrees with the City to become bound as Surety in all performance bonds and labour and material payment bonds required by the Tender Documents, all for the fulfillment of the Contract for the Work covered by the annexed Tender, which may be awarded to:

_____

(Name of Tenderer)

_____

(Address)

_____

at prices set forth in the attached Tender. The said Surety is legally entitled to do business in Nunavut.

The Corporate Seal of:

_____

(Surety - please print)

was hereunto affixed in the presence of:

_____

(Authorized Signing Officer) Title

_____

(Authorized Signing Officer) Title

APPENDIX C
EQUIPMENT

Herewith is the list of equipment that will be used on the project during the course of the Work.

Equipment	Size	Model	Make

APPENDIX E
LABOUR AND EQUIPMENT RATES

Herewith is the list of Labour and Equipment Rates (add to the list if required):

General Labourer:

Site Supervisor/ Foreman:

Skilled Injection Labourer

APPENDIX K
CONTRACTOR'S OBLIGATION TO PROVIDE INUIT CONTENT

1.0 General

This Contract pertains to work in Nunavut and contains provisions regarding minimum prescribed levels of Inuit Labour that must be met or exceeded in the performance of the Work. The requirements set out in this Appendix K to meet minimum prescribed levels of Inuit Labour is a fundamental term of the Contract. The minimum prescribed level of Inuit Labour shall be complied with.

If the amount of Inuit Labour identified by the Tenderer on Appendix "J-2" of the Tender is less than the Tender requirements, this would result in an obvious qualification to the Tender submission by the Tenderer that would ordinarily cause the Tender to be considered non-responsive.

For an Inuit Labour level achieved which differs from the level prescribed, a bonus or penalty will be assessed in accordance with the NNI Policy, specifically Articles 12.3 and 12.4 of the Policy. A bonus would be for exceeding the minimum prescribed Inuit Labour level, and a penalty would be for not meeting the minimum prescribed Inuit Labour level.

"Inuit Labour" and "Inuit Goods and Services" identified on the Tender Documents shall receive a bid adjustment in accordance with the NNI Policy and the adjustment percentages indicated on Appendix J-2 forms. "Inuit Goods and Services" means "Inuit Content" as defined in the Nunavummi Nangminiqaqtunik Ikajuuti (NNI) Policy definition appendix; the NNI Policy is attached to the Tender Documents.

Damages as described in GC 13.4 may apply if the Inuit Labour and/or Inuit Goods and Services proposed by the Contractor on the Tender Appendix J-2 forms are not met. In addition, if the minimum prescribed levels of Inuit Labour identified on page 4 of this Appendix (page 25 of the Tender Form) are not met, then for future tenders where there are similar prescribed minimum levels for Inuit Labour , the Contractor may be deemed "not responsible" (as defined in the Government Contract Regulations.)

2.0 Definitions

.1 "Inuit (singular Inuk)" means a person described in Article 1.1.1 of the Nunavut Land Claims Agreement (NLCA) and who has enrolled himself or herself on the Inuit Enrolment List under Article 35 of the NLCA.

.2 "Inuit firm" means an entity which complies with the legal requirements to carry on business in the Nunavut Settlement Area, and which is,

.1 a limited company with at least 51% of the company's voting shares beneficially owned by Inuit, or
.2 a cooperative controlled by Inuit, or
.3 an Inuk sole proprietorship or partnership; and
.4 is included on Nunavut Tunngavik Inc. (NTI)'s Inuit Firms Registry.

.3 "Labour"

For the purpose of this Contract and specifically Appendix K, "Labour" means the Labour (including Inuit labour) used on the job in any capacity and including, for example, tradespeople, administrative staff and professional staff whether in a head office or in a site office and attributable to this project. "Inuit Labour" refers to the status of employees and may be directly provided by the general contractor or indirectly through a sub contractor, and is not necessarily through an Inuit Firm.

.4 "Goods and Services"

For the purpose of this contract and specifically Appendix K, "Goods and Services" means the entire dollar value of the Work including Labour. For further clarification "Inuit Goods and Services" includes all labour of Inuit firms

It is a fundamental term of this contract that the contractor shall maximize the value of Inuit labour used to perform the Work. Therefore the City has set a minimum percent by dollar value for the use of Inuit labour. The Inuit labour content may be provided by the general contractor or any subcontractor and may include professional or administrative staff or skilled or unskilled trades people, and not necessarily through an Inuit Firm. The minimum may only be reduced where sufficient Inuit labour is not available and the approval of the City has been obtained in writing.

For the purposes of this Contract the City has prescribed that the following minimum percent of the total labour for this job by dollar value shall be provided by Inuit workers.	0 % **Prescribed** minimum level of Inuit labour as a percent of total labour by dollar value.

Substantiation

In order to substantiate the amount of Inuit Labour the Contractor shall be responsible for providing an amalgamated employment report that shall reflect the Inuit labour used by the Contractor and any other subcontractor or supplier. The Contractor shall submit this employment report with every Progress Claim. Receipt of an employment report shall be a condition precedent to the release of a progress payment, an interim payment and/or a final payment.

If requested, the Contractor shall also provide a completed "Employee Verification and Consent Form" for an Inuit worker.

END OF TENDER FORM

(b) "Unit Price Arrangement" means that part of the Contract that prescribes the product of a price multiplied by a number of units of measurement of a class as payment for performance of the Work to which it relates.

1.4 Any of the provisions of the Contract that are expressly stipulated to be applicable only to a Unit Price Arrangement are not applicable to any part of the Work to which a Fixed Price Arrangement is applicable.

1.5 Any of the provisions of the Contract that are expressly stipulated to be applicable only to a Fixed Price Arrangement are not applicable to any part of the Work to which a Unit Price Arrangement is applicable.

A2. DATE OF COMPLETION OF WORK AND DESCRIPTION OF WORK

2.1 The Contractor shall between the date of these Articles of Agreements and the _____ day of _____, in a careful and workmanlike manner, diligently perform and complete the following Work:

Work of this Contract comprises general construction of localized repairs and wood deck replacement of the existing Apex Bridge, located along the Road to Apex, in Iqaluit Nunavut.

A3. CONTRACT PRICE

3.1 Subject to any increase, decrease, deduction or set-off that may be made under the Contract, the City shall pay the Contractor at the times and in the manner set out or referred to in the General Conditions.

3.1.1 the sum of $_____ in consideration for the performance of the Work or the part thereof that is subject to a Fixed Price Arrangement, including goods and services tax (GST); and

3.1.2 a sum that is equal to the aggregate of the products of the number of units of measurement of each class of labour, plant and material, as certified by the Engineer, multiplied in each case by the appropriate unit price that is set out in the Unit Price Table in consideration for the performance of the Work or the part thereof that is subject to a Unit Price Arrangement, including goods and services tax (GST).

3.2 For the information and guidance of the Contractor and the persons administering the Contract on behalf of the City, but not so as to constitute a warranty, representation or undertaking of any nature by either party, it is estimated that the total amount payable by the City to the Contractor for the part of the Work to which a Unit Price Arrangement is applicable will not exceed _____, GST included.

3.3 A3.1.1 is applicable only to a Fixed Price Arrangement.

3.4 A3.1.2 and A3.2 are applicable only to a Unit Price Arrangement.

3.5 The Contract Price shall include Goods and Services Tax.

THE CITY OF IQALUIT

CONSTRUCTION CONTRACT

GENERAL CONDITIONS

1. GENERAL PROVISIONS

1.1 Definitions

The following terms, whenever used in the Contract Documents, shall mean:

(a) "**Adjustment**": a change in either the Contract Price or the Contract Time, or both, in accordance with the applicable provisions of the Contract Documents;

(b) "**Applicable Laws**": any and all applicable laws, rules, regulations, by-laws, codes and orders of any and all government bodies, agencies, authorities and courts;

(c) "**Arbitrator**": the person appointed under GC 9.3(a);

(d) "**Articles of Agreement**": the executed Articles of Agreement;

(e) "**Change Order**": a written instrument prepared by the Engineer and signed by the City and the Contractor stating their agreement upon:

(i) a change in the Work, and

(ii) the method and/or the amount of Adjustment, if any;

(f) "**City**": the party defined as such in the Articles of Agreement;

(g) "**Claim**": any or all of:

(i) a demand or assertion by the City or the Contractor seeking an interpretation of Contract terms, an Adjustment, or other relief with respect to the terms of this Contract;

(ii) other disputes and matters in question between the City and the Contractor arising out of or relating to this Contract; and

(iii) allegations by the City or the Contractor of errors or omissions on the part of the Engineer;

(h) "**Completion Date**": the date of Substantial Completion of the Work, as certified by the Engineer;

(i) **"Construction Schedule"**: the Construction Schedule referred to in GC 3.6, including revisions thereto as provided in GC 3.6, GC 10.2(d) or otherwise required by the Engineer;

(z) "**Supplier**": a party having a direct contract with the contractor to supply products not worked to a special design for the Work;

(aa) "**Work**": all or any part of the construction and services required by the Contract Documents, including all labour, materials, equipment and services provided or to be provided by the Contractor to fulfill his obligations under this Contract.

1.2 Documents and Interpretation

(a) It is the intent of the Contract Documents to include all labour, materials, equipment and services necessary to perform the Work in accordance with the Contract Documents. Any labour, materials, equipment and services that may be reasonably inferred from the Contract Documents or from prevailing custom or trade usage as being required to produce the intended result, will be furnished and performed by the Contractor, whether or not specifically called for.

(b) The Contract Documents are complementary, and what is required by one document shall be as binding as if required by all.

(c) This Contract represents the entire agreement between the City and the Contractor and supersedes all prior negotiations, representations and agreements, either written or oral.

(d) When words or phrases which have a well-known technical or construction industry or trade meaning are used in the Contract Documents and are not otherwise defined, they shall be interpreted in accordance with that meaning.

(e) The Contract Documents shall not be construed to create a contractual relationship of any kind between:

(i) the Engineer and the Contractor, a Subcontractor, a Supplier, a subsubcontractor or its or their agent or employee, or other person performing any of the Work;

(ii) the City and a Subcontractor, a Supplier, a subsubcontractor or their agent, employee, or other person performing any of the Work, or

(iii) between any persons or entities other than the City and the Contractor.

The Engineer shall however, be entitled to demand performance and enforce the obligations of the parties under this Contract, to facilitate performance of the Engineer's duties.

(f) Clarifications and interpretations of the Contract Documents shall be issued by the Engineer as provided in GC 4.1.

(g) In the event of any inconsistency or conflict between provisions of the Contract Documents, the following shall apply:

(o) The schedules, appendices and attachments to this Contract are an internal part of this Contract and a reference to this Contract includes a reference to the schedules, appendices and attachments.

(p) The language of the specifications and other documents comprising this Contract is in many cases written in the imperative for brevity. Clauses containing instruction, directions or obligations are directed to the Contractor and shall be construed and interpreted as if the words "the Contractor shall" immediately preceded the instructions, directions or obligations.

(q) Unless the context otherwise requires, wherever used herein the plural includes the singular, the singular includes the plural, and each of the masculine, feminine and neuter genders include all other genders.

(r) Unless otherwise provided in this Contract, all accounting and financial terms used in this Contract shall be interpreted and applied in accordance with Canadian generally accepted accounting principles, consistently applied from one period to the next.

(s) References containing terms such as:

(i) "hereof," "herein," "hereto," "hereinafter," and other terms of like import are not limited in applicability to the specific provision within which such references are set forth but instead refer to this Contract taken as a whole; and

(ii) "includes" and "including", whether or not used with the words "without limitation" or "but not limited to", shall not be deemed limited by the specific enumeration of items but shall in all cases be deemed to be without limitation and construed and interpreted to mean "includes without limitation" and "including without limitation";

(t) Whenever the terms "will" or "shall" are used in this Contract in relation to the Contractor they shall be construed and interpreted as synonymous and to read "the Contractor shall".

1.3 Notices

(a) Where a notice is required by the Contract Documents to be given in writing to the Contractor, it may be delivered personally to the Contractor or his site superintendent, or delivered or sent by mail or facsimile transmission to the Contractor's address set out in the Articles of Agreement or to his office at or near the Site.

(b) Where a notice is required by the Contract Documents to be given in writing to the Engineer, it may be delivered personally, or delivered or sent by mail or facsimile transmission to the Engineer's address set out in the Articles of Agreement, or to the office of the Engineer at or near the Site.

1.7 Successors and Assigns

This Contract shall ensure to the benefit of and be binding upon the parties hereto and their lawful heirs, executors, administrators, successors and assigns.

2. CITY'S OBLIGATIONS

2.1 Payment

Subject to any other provision in the Contract Documents, the City shall make payments to the Contractor at the times and in the manner set out in GC 5.

2.2 Site Availability

(a) The City shall furnish, as indicated in the Contract Documents, the lands upon which the Work is to be performed, rights-of-way and easements for access to the Site and any other lands designated for the use of the Contractor. The Contractor shall provide and pay for any additional lands and access the Contractor may require, in accordance with GC 3.10(a).

(b) Except for permits and fees which are the responsibility of the Contractor under GC 3.13, the City shall obtain and pay for necessary approvals, easements and charges required for the development of the Site and for the use or occupancy of permanent structures or for permanent changes in existing facilities.

2.3 Engineer as Representative

(a) Unless otherwise provided in the Contract Documents, the City shall communicate with the Contractor through the Engineer, and the Contractor shall communicate with the City through the Engineer.

(b) If the contract with the Engineer is terminated, the City shall promptly appoint a replacement.

2.4 Reference Points

The City shall establish physical reference points for construction on the Site which are, in the opinion of the Engineer, necessary to enable the Contractor to proceed with the Work. The Contractor shall safeguard such reference points in accordance with GC 3.11(b).

2.5 Materials Supplied by the City

Any materials, instructions, information or services required to be supplied by the City under this Contract shall be furnished with reasonable promptness to avoid delay in the orderly progress of the Work.

reasonably experienced in the Work would have discovered, without additional instructions from the Engineer, then the Contractor shall at the Contractor's cost remove or replace any incorrectly constructed Work.

3.4 Site Conditions

(a) By executing this Contract, the Contractor represents that the Contractor is familiar with the conditions under which the Work is to be performed. The Contractor further represents that the Contractor understands the requirements of the Contract Documents and what effects the Site conditions will have on the Work. The Contractor's failure to visit the Site will not excuse the Contractor from the responsibility which otherwise would have been assumed, had the Contractor visited the Site.

(b) Following the start of the Work, if the subsurface conditions are substantially different from what could reasonably have been expected, based on a reasonable and proper examination of the Site by the Contractor and the information provided in the tender documents, if any, the Contractor must promptly notify the Engineer in writing prior to performing the Work. The Contractor may make a claim for changed site conditions in only accordance with GC 9.1.

3.5 Temporary Structures

The Contractor shall have the sole responsibility for the design, erection, operation, maintenance and removal of temporary structures and other temporary facilities and the design and execution of construction methods required in their use. The Contractor shall engage and pay for professional engineering personnel, registered to practice in Nunavut, skilled in the appropriate discipline, to perform these functions where required by law or by the Contract Documents and in all cases where such temporary facilities and their method of construction are of such a nature that professional engineering skill is required to produce safe and satisfactory results.

3.6 Schedule

(a) Within fourteen days of executing the Articles of Agreement and as a condition of the first progress payment, the Contractor shall submit to the Engineer for review, a proposed Construction Schedule showing the anticipated time of commencement and completion of each of the major activities of the Work to be performed. This Construction Schedule shall include the sequence and coordination of the various operations and the estimated time required for the Work and shall provide sufficient detail to permit the Engineer to monitor the progress of the Work. The Contractor shall revise the proposed Construction Schedule as requested by the Engineer, and the Contractor shall perform the Work in strict adherence to the Construction Schedule, including revisions thereto required by the Engineer, unless it is changed in accordance with the terms of this Contract.

(c) The Contractor shall be fully responsible to the City for the acts and omissions of Subcontractors, their agents, employees, and all parties engaged by the Contractor or its Subcontractors for the provision of work or the supply of materials.

(d) The Contractor agrees to incorporate the terms of the Contract Documents into all the Contractor's subcontract agreements.

(e) The Contractor shall maintain good order and discipline among the Contractor's employees and the Subcontractors engaged in the Work. The Contractor shall not employ, or permit Subcontractors to employ, workers who are not skilled in the assigned task. The Contractor shall employ sufficient workers to perform the Work in compliance with the Construction Schedule.

3.9 Other Contractors

(a) The City reserves the right to let separate contracts with other contractors or workers, or to undertake work using the City's own forces to do other work. If other contractors, workers or the City's own forces are sent onto the Site, with or without plant and material, the Contractor shall, to the satisfaction of the City, grant access to and cooperate with such persons and, in accordance with usual construction practice, coordinate the Work with the other work and connect to other work as specified or shown in the Contract Documents.

(b) If the sending of other contractors, workers or the City's own forces onto the Site results in a delay in the performance of the Work, which could not have been reasonably foreseen or anticipated by the Contractor when executing the Articles of Agreement, the Contractor may make a claim therefor in accordance with GC 6.2 and 9.1.

(c) If the Contractor discovers any deficiencies in any other work which might affect the Work, the Contractor shall immediately report such deficiencies to the Engineer and then confirm such report in writing.

3.10 Use of the Site

(a) The Contractor shall make every effort to confine the Contractor's equipment and plant, storage of materials and operations to limits indicated by the Contract Documents, by a specific direction of the Engineer or by Applicable Laws, and shall not unreasonably occupy the Site. Where the Contractor requires additional land for the erection of temporary facilities and storage of materials, including access to them, the Contractor shall arrange for such and assume all costs and liabilities arising therefrom.

(b) The Contractor shall not load or permit to be loaded on any part of the Work, a weight or load or force that will endanger its safety or exceed the design loads.

(c) The Contractor shall not interfere in any way with the work or scheduling of any other contractor, worker or employee of the City. Subject to GC 3.9(b), in order

3.13 Permits

The Contractor shall procure and post at the Site all permits, certificates and licences required for the construction of the Work and shall be responsible for all fees in respect thereof.

3.14 Applicable Laws

(a) The Contractor shall perform the Work and give any required notices in full compliance with all Applicable Laws, ordinances, rules, regulations, codes and orders of the municipal and other authorities having jurisdiction which are in or come into force during the performance of the Work.

(b) The Contractor shall have due regard for the protection of the environment in the performance of the Work and shall not place any materials, including without limitation, hazardous materials, or dispose of any such materials, or perform any Work in a manner contrary to applicable federal or territorial or municipal environmental laws and regulations, either at the Place of the Work, or at any other place or property.

3.15 Material and Plant Supplied by City

(a) The Contractor is liable for any loss or damage to material, plant or real property that is supplied or placed by the City in the care, custody and control of the Contractor for use in connection with the Work, whether or not that loss or damage is attributable to causes beyond the Contractor's control.

(b) The Contractor shall not use any material, plant or real property placed in the Contractor's care, custody and control by the City, except for the purpose of performing the Work.

(c) The Contractor is not liable to the City for any loss or damage to material, plant or real property if that loss or damage results from and is directly attributable to reasonable wear and tear.

3.16 Equipment, Plant and Material Supplied by Contractor

(a) Unless otherwise specified in the Contract Documents, the Contractor shall furnish and assume full responsibility for all materials, equipment, labour, transportation, construction equipment and machinery, tools, appliances, fuel, power, light, heat, telephone, water, sanitary facilities, temporary facilities and all other facilities and incidentals necessary for the performance, testing, finishing, start-up and completion of the Work. All materials, equipment, facilities, etc., furnished by the Contractor shall be maintained in a clean and sanitary manner.

(b) Materials provided shall be new unless otherwise specified in the Contract Documents. Products that are not specified shall be of a quality best suited to their purpose and use, as approved by the Engineer.

(b) In any case where, pursuant to the provisions of the *Safety Act,* R.S.N.W.T. 1988, c. S-1, as duplicated for Nunavut by s. 29 of the *Nunavut Act*, the Director of Inspections or a Safety Officer orders the Contractor or any Subcontractor performing the Work, to cease work because of failure to install or adopt safety devices directed by the regulations made under the said Act, or required by it, or because the Director of Inspections or a Safety Officer is of the opinion that conditions of immediate danger exist that would likely result in injury to any person, the City may exercise its right to terminate this Contract or suspend the Work immediately, in accordance with GC 10, until the default or failure is corrected.

3.19 Cutting and Patching

(a) The Contractor shall do all cutting, fitting or patching of the Work that may be required to tie in properly with the work of other contractors shown in, or reasonably inferable from the Contract Documents.

(b) The Contractor shall not endanger any existing Work by cutting, patching or otherwise, and shall not cut or alter the work of any other contractor save with the consent of the Engineer and then only to the extent permitted by the Engineer.

(c) The Contractor shall not unreasonably withhold from the City or a separate contractor the Contractor's consent to cutting or otherwise altering the Work in accordance with any direction given by the Engineer.

3.20 Defective Work

(a) Defective work, whether the result of poor workmanship, use of defective products or damage through carelessness or other act or omission of the Contractor or any Subcontractor, and whether incorporated in the Work or not, which has been rejected by the Engineer as failing to conform to the Contract Documents, shall be removed promptly from the Work and replaced or re-executed by the Contractor in accordance with the Contract Documents, at the Contractor's expense.

(b) Where any part of the Work is damaged by such removals, replacements or re-execution, it shall be made good, promptly, at the Contractor's expense.

(c) Where the Contractor fails to correct defective or rejected work within the time limits specified by the Engineer, the City may correct defective or rejected Work and deduct the cost of same from the Contract Price, or may terminate this Contract in accordance with GC 10.3.

(d) In cases of emergency, the City may take whatever action it deems necessary to correct defective or rejected Work and deduct the cost of same from the Contract Price.

shall not relieve the Contractor from the responsibility for any failure to supply materials and complete the Work strictly in accordance with the Contract Documents.

3.22 Site Cleanliness

(a) The Contractor shall maintain the Site in a tidy condition and free from the accumulation of waste material and debris, to the satisfaction of the Engineer.

(b) Before the issuance of a certificate of Substantial Completion, the Contractor shall remove all the Contractor's plant and material not required for the remaining Work, and all waste material and other debris, and shall ensure that the Work and the Site are clean and suitable for occupancy or use by the City, unless otherwise directed by the Engineer.

(c) Before the issuance of a certificate of Final Completion, the Contractor shall remove from the Site all the Contractor's plant and material and any waste material and other debris, to the satisfaction of the Engineer.

(d) If the Contractor fails or refuses to remove all such plant, materials, equipment and waste within a reasonable time after achieving Final Completion then, on written notice from the Engineer to the Contractor specifying a reasonable time to remedy such failure or refusal, the City may do or cause to be done the removal and all reasonable resulting costs incurred by the City may be deducted from any amounts owing by the City to the Contractor.

(e) The Contractor's obligations described above do not extend to waste material and other debris caused by the City's agents or other contractors.

3.23 Claims Against and Obligations of the Contractor

(a) The Contractor shall pay out and discharge all its lawful obligations and shall satisfy all lawful claims against it arising out of the performance of the Work at least as often as this Contract requires the City to pay the Contractor.

(b) The Contractor shall, in accordance with the Contract Documents and whenever requested to do so by the Engineer, make a statutory declaration regarding the existence and condition of any obligations of and claims against the Contractor, any Subcontractors, or Suppliers. Upon request by the City, the Contractor shall provide letters from its Subcontractors and Suppliers regarding the status of any accounts with the Contractor and the details of any claims, if any.

(c) The City may, in its absolute discretion, and at any time prior to the final release of holdbacks, in order to discharge lawful obligations of and satisfy lawful claims against the Contractor, any Subcontractors, Suppliers or any subsubcontractors, arising out of the performance of the Work, pay any amount that is due and payable to the Contractor pursuant to this Contract, directly to the obligees of and the claimants against, the Contractor, Subcontractor, Supplier or

(b) The Contractor shall not erect or permit the erection of any sign or advertising on the Site without the prior written consent of the City.

3.28 Non-Compliance by Contractor

(a) If the Contractor fails to comply, within a reasonable time, with any decision or direction given by the Engineer, the City may employ such methods as the City deems advisable to do that which the Contractor failed to do.

(b) The Contractor shall pay the City the total of all costs, expenses and damages incurred or sustained by the City by reason of the Contractor's failure to comply with any decision or direction referred to above, including the cost of any method employed by the City. Where the amounts owing to the Contractor under this Contract are insufficient to cover such costs, the Contractor shall pay the balance to the City immediately.

4. ADMINISTRATION BY ENGINEER

4.1 Engineer's Duties and Authority

(a) The Engineer will administer this Contract on behalf of the City as provided in the Contract Documents.

(b) The Engineer will be the City's representative until the Work has been completed in accordance with the Contract Documents.

(c) Except as expressly stated in the Contract Documents, the Engineer shall have no authority to relieve the Contractor of any of the Contractor's obligations under this Contract.

(d) The Engineer will be the initial interpreter of the requirements of the Contract Documents and judge of the acceptability of the Work performed and shall deal with Claims as they arise, in accordance with GC 9.1.

(e) If any error, inconsistency, or omission in the Contract Documents is discovered, the Engineer shall provide directions or clarifications to the Contractor.

(f) During the progress of the Work, the Engineer shall have authority to reject Work that, in the Engineer's opinion, does not conform with the requirements of the Contract Documents, or to issue written additional instructions regarding the Work which may, in the opinion of the Engineer, be necessary to supplement or clarify the Contract Documents. Such additional instructions shall be consistent with the intent of the Contract Documents, shall not entitle the Contractor to an Adjustment and shall be binding upon and be carried out promptly by the Contractor.

(g) Wherever, under this Contract, the Engineer is required to exercise discretion by:

progress claim, he will promptly notify the Contractor in writing, giving reasons for the amendment.

(c) Where the Contractor does not submit a progress claim or where the Engineer does not endorse the Contractor's progress claim, the Engineer may calculate the progress payment and prepare a certificate for payment by the City. Where unit prices apply, payment will be calculated on the basis of the unit prices specified in the Contract Documents and the units of Work completed as determined by the Engineer. Where a lump sum price applies, payment will be calculated on the basis of the Engineer's estimate of the percentage of the Work completed.

(d) The progress certificate will show, to the end of the period covered by the progress claim, the estimated value of all labour and materials incorporated into the Work, GST monies paid, all materials stored at the Site and all Change Orders certified by the Engineer. The certificate shall also show the aggregate of previous payments and the amounts withheld. The gross amount shown on such certificate, less the aggregate of all payments to date and sums withheld, shall become due and be payable by the City to the Contractor within thirty days following receipt by the City of the progress certificate.

(e) The estimates referred to above shall not bind the City or the Engineer in any manner in the preparation of the final estimate of the Work done, but shall be held to be approximate only and shall in no case be taken as an acceptance of the Work or as a release of the Contractor from the Contractor's responsibilities under this Contract.

(f) If for any reason the City disputes the net amount shown for payment on a progress certificate the City shall, within the time specified in this GC, pay to the Contractor any amount not disputed and also deliver to the Contractor and the Engineer written reasons for any deductions.

5.2 Contract Holdbacks

(a) The City will retain Contract holdbacks in accordance with the following:

(i) ten percent from each progress payment made prior to the issuance of the first Holdback Payment Certificate by the Engineer (the "Lien Holdback"), and

(ii) five percent from any payments made to the Contractor following the issuance of the first Holdback Payment Certificate, other than from holdback payments.

5.3 Substantial Completion

(a) When the Contractor considers the Work ready to be utilized for its intended purpose, the Contractor may apply in writing to the Engineer to issue a certificate of Substantial Completion. The Contractor shall prepare and submit with its

(i) a statutory declaration as referred to in GC 3.23(b) that:

(A) the Work has been completed in accordance with the Contract Documents; and

(B) no claims exist or alternatively setting out the particulars of any claims relating to personal injury or death or property loss or damage arising out of the Work, and any alleged infringement by the Contractor of a patent or other property right in performing this Contract; and

(ii) particulars of, or a waiver of, all outstanding claims against the City, arising out of the Work.

(b) Following receipt of the documents referred to in GC 5.4(a), the Engineer shall, with reasonable promptness, conduct an inspection and assessment of the Work to verify that the Work has been completed in accordance with the Contract Documents. Within fourteen days of receipt of the above documents, the Engineer shall either issue a certificate of Final Completion to the City and the Contractor or a list of items to be completed or rectified, of which the Engineer is aware. The City may deduct from monies owed to the Contractor the costs associated with the Engineer being called upon to perform more than one inspection.

(c) Receipt by the Contractor of the certificate of Final Completion shall entitle the Contractor to payment in accordance with GC 5.5.

5.5 Final Progress Payment

(a) The final progress payment certificate will be prepared following the issuance of the certificate of Final Completion. The final progress payment certificate will show the total amount payable to the Contractor, less any amounts retained.

(b) The final progress payment amount shall be paid by the City to the Contractor within thirty days following receipt by the City of the final progress payment certificate.

5.6 Holdback Release

(a) Forty-five days following the date of the issuance of the certificate of Substantial Completion by the Engineer, the Contractor may apply to the City for release of fifty percent of the Lien Holdback. The Contractor shall with such application provide the Engineer with a statutory declaration as referred to in GC 3.23(b), with the content referred to in GC 5.4(a)(i), and the particulars of a waiver of, all outstanding claims against the City, arising out of the Work. The Engineer shall, within fourteen days' receipt of the Contractor's application, issue a Holdback Payment Certificate or a list of items to be rectified prior to payment.

6. TIME AND DELAYS

6.1 Time of the Essence

Time is of the essence of this Contract, including without limitation the dates and time limits stated in the Contract Documents. By executing this Contract, the Contractor confirms that this Contract Time is a reasonable period for performing the Work.

6.2 Delays

(a) Where a delay occurs in the progress of the Work and:

(i) the delay is attributable to or within the control of the Contractor or its Subcontractors, or was reasonably foreseeable by them at the time this Contract was entered into, the Completion Date will not be adjusted. The Contractor will be liable to the City for all costs and expenses incurred by the City, as well as for any losses resulting from the City's inability to utilize the Work for its intended purpose resulting from the delay, and the City may deduct such costs from payments owing to the Contractor under this Contract;

(ii) the delay is due to an act or neglect by the City, the Engineer, or other contractor, or of an employee of any of them, then the Contractor may make a Claim therefor, in accordance with GC 9.1, or

(iii) the cause for the delay does not fall within the circumstances described in (i) or (ii) above, the Contractor may make a Claim for an Adjustment in the Contract Time (but not for an Adjustments of the Contract Price), in accordance with GC 9.1. This shall be the Contractor's sole and exclusive remedy for such delays.

(b) In no event will adverse weather be considered to be a cause of delay beyond the Contractor's or its Subcontractors' control or not reasonably foreseeable by them at the time this Contract was entered into.

7. ASSESSMENTS AND DAMAGES FOR LATE COMPLETION

7.1 Late Completion

(a) For the purposes of this General Condition, "period of delay" means the number of days commencing on the Completion Date fixed by the Articles of Agreement and ending on the day immediately preceding the day on which the certificate of Substantial Completion is issued but does not include any day within a period of extension granted pursuant to GC 9.1 and 6.2, or any other day on which, in the opinion of the Engineer, completion of the Work was delayed for reasons beyond the control of the Contractor.

8.2 Valuation of Changes

(a) When a change results in a decrease in the Work, the Contract Price shall be decreased by an amount to be determined by the Engineer, with such decrease valued in the same manner as if it were an increase.

(b) When a change causes an increase in the Work, the Contract Price shall be increased in accordance with this provision.

(c) If this Contract specifies unit prices for changes to the Work, and the Engineer concurs in their use on a particular change or portion thereof, then the Contractor shall be paid for such change or portion, a sum determined by applying the unit prices to the actual quantum, as measured by the Engineer, determined after completion of the Change.

(d) Where this Contract specifies force account rates for labour, equipment and materials, and the Engineer concurs in their use on a particular change or portion thereof, then the Contractor shall be paid for such change or portion, a sum determined by applying the force account rates to the number of hours of labour and equipment expended and quantities of materials utilized. The Contractor shall present records of the work done to the Engineer for approval, at the times and in the manner specified by the Engineer.

(e) If there are changes, or portions of changes, for which unit prices or force account rates are not applicable or specified, then the Contractor shall propose to the Engineer a fixed price for such changes or portions. Upon agreement by the City on the amount thereof, the proposed fixed price shall become the sum the Contractor shall be paid for such change or portion.

(f) If the Contractor and the City are unable to agree on a fixed price, then the Contractor shall be reimbursed its costs for performing the changes as directed by the Engineer, consistent with the following:

(i) wages, salaries and travelling expenses of the Contractor's employees while actually engaged on the Work, excluding any and all expenses of head office personnel;

(ii) workers' compensation assessments, unemployment insurance premiums, pension plan payments and paid holidays;

(iii) rental cost of machinery and equipment that is used in the performance of the Work, or an allowance for depreciation if owned by the Contractor;

(iv) operation and maintenance costs for machinery and equipment used in the performance of the Work, other than costs of repairs arising out of defects existing before it was brought on to the Site;

shall, in the first place, be referred in writing to the Engineer in accordance with this provision.

(b) A written notice stating the general nature of the Claim shall be delivered by the party making the Claim to the other party and to the Engineer promptly, and in no event later than seven days after the occurrence of the event giving rise to the Claim. Any Work for which a Claim has been made, shall be kept readily accessible and shall not be covered up without the express permission of the Engineer.

(c) Notice of the extent of the Claim with supporting data shall be delivered within fourteen days after such occurrence. The Contractor shall keep contemporaneous records as may reasonably be necessary to support the Contractor's Claim, which may be inspected by the Engineer, as he deems necessary.

(d) The Engineer shall review the information submitted, consult with the parties and make reasonable efforts to obtain agreement between the City and the Contractor regarding the Claim. The parties agree that, both during and after the performance of the Work, each of them shall use their best efforts to resolve any disputes arising between them by amicable negotiations, and shall provide frank, candid and timely disclosure of all relevant facts, information and documents to facilitate those negotiations. The Engineer may request the parties to refer the matter to more senior levels of management within their organizations, in an effort to resolve the Claim.

(e) Where the City and the Contractor reach an agreement on the Claim, the Engineer will, where appropriate, prepare a Change Order for the City's approval, which shall be sufficient to effect a change in this Contract, in accordance with the terms of the Change Order and the Contract Documents.

(f) If the City and the Contractor cannot reach an agreement regarding the Claim, the Engineer shall decide the matter and notify the parties in writing of his decision, within fourteen days of the last submission, and in no event later than thirty days following the date of the occurrence giving rise to the Claim. Valuation of Adjustments in the Contract Price shall be determined by the Engineer in accordance with GC 8.2.

(g) Unless this Contract has already been terminated, the Contractor shall, in every case, proceed with the Work with all due diligence and the City and the Contractor shall give effect forthwith to every such decision of the Engineer unless and until the same shall be revised, as hereinafter provided.

(h) Where either party disputes the decision of the Engineer or where the Engineer fails to notify the parties of his decision in accordance with GC 9.1(f) then either party may, within fourteen days, notify the other party of its intention to refer the matter to the Referee in accordance with GC 9.2 or Arbitrator in accordance with GC 9.3, as application. No referral may be made unless such notice is given. Notices shall be copied to the Engineer for information.

(i) the Arbitrator shall have the authority to call upon the Referee to give evidence during the arbitration proceedings, including all documentation prepared by the Referee or reviewed by him;

(ii) the decision of the Arbitrator shall be final and binding upon the parties who covenant that their disputes shall be so decided by arbitration alone and not by recourse to any court by way of action at law;

(iii) arbitration proceedings may be commenced prior to or after completion of the Work, provided that the obligations of the City, the Engineer and the Contractor shall not be altered by reason of the arbitration being conducted during the progress of the Work;

(iv) before the arbitration proceeds on the substantive issues, a budget for the proceedings shall be established by the Arbitrator and each party shall deposit, as security for costs, a sum equal to half of such budget with the Arbitrator, who shall thereupon deposit such funds in an interest bearing trust account with a chartered bank. Subject to the award and payment of costs as hereinafter provided, the balance of the security deposits and interests shall be properly returned to the respective parties; and

(v) the cost of arbitration may be awarded against the parties hereto or against any one of them as the Arbitrator may decide.

(b) If a Claim involves the Work of a Subcontractor, either the City or the Contractor may join such Subcontractor as a party to the arbitration between the City and the Contractor. The Contractor shall include in all its subcontracts specific provision whereby its Subcontractors consent to being joined in an arbitration between the City and the Contractor involving the Work of such Subcontractors. Nothing in this provision nor in the provision of such subcontracts consenting to joinder shall create any claim, right or cause of action in favour of the Subcontractors as against the City or the Engineer, that does not otherwise exist.

(c) If no notice is received within the time limits set out or referred to in GC 9.3(a), the decision of the Referee shall be final and binding on the parties.

(d) The Contractor agrees that it shall join other arbitration proceedings with respect to the Project, as requested in writing by the City.

9.4 Adherence to Provisions

(a) The provisions, including without limitation, procedure and sequences, outlined in GC 9.1 to 9.3 for the resolution of disputes shall be strictly adhered to by both parties.

thirty days from the date of suspension, the Contractor may request permission from the City to proceed with the Work. If the City does not grant permission within fourteen days' receipt of the Contractor's written request, the Contractor may elect to treat the suspension, where it affects only part of the Work, as an omission of such Work by giving a further notice to the City to that effect or, where it affects the whole of the Work, treat this Contract as having been cancelled by the City, in accordance with GC 10.4.

10.3 Termination by City

(a) Without limitation, any or all of the following actions by or circumstances relating to the Contractor shall constitute default on the part of the Contractor:

(i) committing or threatening to commit any act of insolvency or bankruptcy, voluntary or otherwise;

(ii) having a receiver appointed on account of insolvency or in respect of any property;

(iii) making a general assignment for the benefit of creditors;

(iv) failing to comply with or persistently disregarding statutes, regulations, bylaws or directives of competent authorities relating to the Work;

(v) failing to comply with any requests, instruction or direction of the Engineer;

(vi) failing to pay accounts relating to the Work as they come due;

(vii) failing to prosecute the Work with skill and diligence;

(viii) assigning or subletting this Contract or any portion thereof without the required consent from the City;

(ix) failing or refusing to correct defective or deficient Work; and

(x) being otherwise in default in carrying out any of its obligations under this Contract, whether such default is similar or dissimilar in nature to the causes listed previously.

(b) The Contractor shall immediately advise the City in writing of any default listed in GC 10.3(a)

(c) If the Contractor is in default under this Contract, the City shall be entitled to any or all of the following:

(i) take possession of all Work in progress, materials and construction equipment at the Site, at no additional charge for the retention or use of the construction equipment;

(d) This section shall not apply to situations in which the City is entitled to terminate this Contract by reason of default by the Contractor.

10.5 Termination by Contractor

(a) If the City should be adjudged bankrupt, or makes a general assignment for the benefit of creditors because of the City's insolvency, or if a receiver is appointed because of the City's insolvency, the Contractor may, without prejudice to any other right or remedy the Contractor may have, by giving the City or receiver or trustee in bankruptcy notice in writing, terminate this Contract.

(b) If the Work should be stopped or otherwise delayed for a period of thirty days or more under an order of a court or other public authority and providing that such order was not issued as the result of an act or fault of the Contractor or of anyone directly or indirectly employed or engaged by the Contractor, the Contractor may, without prejudice to any other right or remedy the Contractor may have, by giving the City notice in writing, terminate this Contract.

(c) If the Contractor terminates this Contract under the conditions set out above, the Contractor shall be entitled to be paid for all work performed including reasonable profit, for loss sustained upon products and construction machinery and equipment, and such other damages as the Contractor may have sustained as a result of the termination of this Contract.

11. BONDS AND WARRANTY

11.1 Obligations to Provide Contract Security

(a) The Contractor shall promptly provide to the City the surety bonds called for in the Contract Documents, not later than ten days following receipt by the Contractor of the letter of acceptance.

(b) Such bonds shall be issued by a duly licensed surety company authorized to transact the business of suretyship in Nunavut and shall be maintained in good standing until the fulfillment of this Contract.

(c) Prior to or at the time of making a Claim under such bonds, the City shall send written notification to the Contractor, stating the nature of the default for which a Claim is being made.

11.2 Prescription of Acceptable Contract Security

(a) The Contractor shall deliver to the City:

(i) a performance bond and a labour and material payment bond each in an amount that is equal to and not less than fifty percent of the Contract Price referred to in the Articles of Agreement; or

(d) The City or the Engineer shall promptly give the Contractor written notice of observed defects and deficiencies.

(e) If any defects or deficiencies in the Work appear at any time prior to the end of the warranty period, the Engineer may instruct the Contractor to search for the cause thereof. If such defect or deficiency is one for which the Contractor is liable, the cost of the Work carried out in searching shall be at the Contractor's expense, and it shall in such case remedy such defect or deficiency at its own cost; otherwise it shall be at the City's expense.

(f) In an emergency or to prevent an emergency or if the Contractor neglects for any reason to correct defects or deficiencies within a reasonable time, the City may perform the Work or direct another party, on the City's behalf, to do the Work. All costs associated with the correction of such defects or deficiencies shall be paid for by the Contractor and the City may deduct such costs from amounts owing to the Contractor.

12. INDEMNIFICATION AND INSURANCE

12.1 Indemnification by Contractor

(a) The Contractor shall defend, indemnify and save harmless the City and the Engineer, their agents and employees from and against all claims, demands, losses, costs, damages, actions, suits, or proceedings arising out of or attributable to the Contractor's performance of the Work, or by reason of any matter or thing done, permitted or omitted to be done, by the Contractor, its Subcontractors, or their agents or employees, whether occasioned by negligence or otherwise. Such indemnity shall survive completion or termination of this Contract.

(b) Nothing contained in the Contract Documents or any approval, express or implied, of the Engineer or City shall relieve the Contractor of any liability for latent defects or any liability which may be imposed by law.

12.2 Indemnification by City

The City shall, subject to any law that affects the City's rights, powers, privileges or obligations, indemnify and save the Contractor harmless from and against all claims, demands, losses, costs, damages, actions, suits or proceedings arising out of his activities under this Contract that are directly attributable to:

(a) lack of or a defect in the City's title to the Site whether real of alleged; or

(b) an infringement or an alleged infringement by the Contractor of any patent of invention or any other kind of intellectual property occurring while the Contractor was performing any act for the purposes of this Contract employing a model, plan or design or any thing related to the Work that was supplied by the City to the Contractor.

continuously until the date the certificate of Final Completion is issued or an earlier date specified by the City;

(ii) the policy will allow for partial or total use or occupancy of the Work. If because of such use or occupancy the Contractor is unable to provide coverage, the Contractor shall notify the City in writing prior to such use pay for property and, if necessary, boiler insurance insuring the full value of the Work as in (i) above, including coverage for such use or occupancy and shall provide the Contractor with proof of such insurance. The Contractor shall refund to the City the unearned premium applicable to the Contractor's policy upon termination of coverage;

(iii) where, due to the nature of the Work, the full insurable value of the Work is substantially less than the Contract Price, the City may, at its sole discretion, reduce the amount of insurance required or waive the course of construction insurance requirement;

(iv) where such risks exist, the Contractor shall provide boiler and machinery insurance insuring not less than the replacement value of boilers, pressure vessels and other objects insurable under a boiler & machinery policy and forming part of the Work;

(v) the policies shall provide that, in the event of a loss or damage, payment shall be made to the City and the Contractor as their respective interests may appear. The Contractor shall act on behalf of the City for the purpose of claiming the amount of loss or damage from the Insurers. When the extent of the loss or damage is determined, the Contractor shall proceed to restore the Work. Loss or damage shall not affect the rights and obligations of either party under this Contract except that the Contractor shall be entitled to such reasonable extension of Contract Time relative to the extent of the loss or damage in accordance with the terms of this Contract; and

(vi) the Contractor shall be responsible for deductible amounts under the policies except where such amounts may be excluded from the Contractor's responsibility in accordance with the Contract documents.

(d) **Aircraft and Watercraft Liability Insurance**

Where such risks exist, the Contractor shall obtain aircraft and watercraft liability insurance with respect to owned or non-owned aircraft and watercraft if used directly or indirectly in the performance of the Work, including use of additional premises, and shall have limits of not less than two million dollars inclusive per occurrence for bodily injury, death and damage to property including loss of use thereof, and limits of not less than two million dollars for aircraft passenger hazard. Such insurance shall be in a form acceptable to the City. The policies shall be endorsed to provide the City with not less than fifteen days' written notice in advance of any cancellation, change or amendment restricting coverage.

meet all levels of proficiency, qualification and expertise as dictated by Applicable Laws and/or as defined in the Contract Documents.

(b) The Contractor shall provide to the Engineer a schedule indicating the anticipated total monthly value of all Inuit, Local and Nunavut content and labour to be expended in the execution of the Work. This schedule shall provide the benchmark for ensuring compliance by the Contractor with the requirements for the use of Inuit, Local and Nunavut content during the performance of the Work.

(c) For the Inuit Labour bonus or penalty, as set out in the Nunavummi Nangminiqaqtunik Ikajuuti (NNI) Policy, the benchmark shall be the minimum prescribed level for Inuit Labour identified on page 4 of Appendix K "Contractor's Obligations to Provide Inuit Content" of the tender.

13.2 Requirement for Community Meetings

(a) The Contractor shall arrange meetings on a monthly basis, or other basis as may be mutually agreed by the parties to this contract, to monitor the use of Inuit, Local and Nunavut labour and Inuit, Local and Nunavut content. The Contractor shall give the City 5 days notice of all meetings called under GC 13.2. The Contractor shall take reasonable steps to ensure that these meetings include the following representatives:

(i) a community representative who has been designated to speak on behalf of the community (if available);

(ii) a community manpower representative (if available);

(iii) the Contractor; and

(iv) the Engineer.

(b) In addition to the community meetings contemplated in GC 13.2(a), the Contractor shall arrange a community meeting prior to the start of the Work which shall be arranged on the same terms as indicated in GC 13.2(a) and at that meeting shall:

(i) provide a schedule referred to in GC 13.1(b) above to the community representative;

(ii) request from the community manpower representative or from the City if no community manpower representative has been delegated, a list of workers available in the community; and

(iii) identify specific types of workers required during the project such as plumbers, painters or electricians and how many of those workers are required and when they are required and based on information received in accordance with GC 13.2(b)(ii) maintain a list of community manpower.

(c) The Contractor is responsible to ensure that every worker identified as Inuit is on the NTI Inuit enrolment list, or would qualify to be on the list.

(d) If requested by the City to do so, the Contractor shall obtain a signed consent form from workers which verifies their residency and permits the City to obtain any and all information required to support the worker's claim of residency and/or Inuit status. A worker does not need to comply with the requirements of this clause if the worker is on the NTI Inuit enrolment list.

13.4 Failure to Comply with Proposed Inuit, Local and Nunavut Content

(a) The City and the Contractor recognize the high cost of living in Nunavut, and the need to build capacity of Inuit firms and labour in Nunavut, which is compensated for by the City through the provision of bid adjustments for the use of Inuit, Local and Nunavut labour and other Inuit, Local and Nunavut content, and the provision of bonuses under the Nunavummi Nangminiqaqtunik Ikajuuti (NNI) Policy. It is a priority of the City to maximize the opportunities for Inuit, Local and Nunavut workers and businesses to benefit from government contracts and the City may pay a premium in awarding its contracts to support this important objective.

(b) Therefore, it is a fundamental requirement of this Contract that the Contractor shall achieve, by the completion of this contract, at least the amounts tendered on Appendix J-2 "Substantiation of Bid Adjustment" of the tender, with the exception of decreasing Nunavut content with a corresponding equal or larger increase in Local content, specifically:

(i) the amount of Inuit labour;

AND

(ii) (A) the amount of Local labour and the amount of Nunavut labour; or

(B) the amount of Local labour and the total amount of Local and Nunavut labour

which the Contractor has identified in Appendix J-2 "Substantiation of Bid Adjustment" of the Tender,

AND at least:

(iii) the amount of Inuit content excluding the labour of Inuit firms; and

(iv) (A) the amount of Local content (excluding Local labour) and the amount of Nunavut content (excluding Nunavut labour); or

(B) the amount of Local content (excluding Local labour) and the total amount of Local and Nunavut content (excluding Local and Nunavut labour)

(i) "Commercial Room and Board Facility" means a Hotel or a Bed and Breakfast (Tourist Home) that holds a Tourist Establishment Licence issued by the Government of Nunavut under the *Travel and Tourism Act*.

(ii) "Community" means a community in which the Work (as defined in the Contract) is being performed and includes the entire area within a 20-kilometre radius of that community.

(c) The Commercial Room and Board Facility must:

(i) meet the applicable requirements under the *Public Health Act*, and of the *Eating or Drinking Place Regulations*; and

(ii) meet all applicable requirements of the *Public Health Act* the *Fire Prevention Act* and applicable regulations thereunder, and any other applicable Government of Nunavut or federal legislation.

14. TRANSPORATION OF MATERIALS

14.1 Marine Transport

(a) Whenever marine (water) transport is to be utilized, the Contractor shall use, and space should be booked directly with the following carrier:

(i) Nunavut Sealink and Supply (NSSI),
By ships loading at the Montreal area Port of Ste-Catherine
Contact: Daniel Desgagnés
Phone: (450) 635-0833
Fax: (450) 635-5126

(b) The annual shipping rates offered by marine carriers are dependent upon anticipated cargo quantities including the materials for construction projects; therefore, Contractors are to tender using the published sailing schedules and rates available from the above marine carriers, and also available from the Department of Public Works and Services, Finance Division, Contact: John Fast, Traffic Coordinator at (867) 975-5437.

(c) In exceptional or extraordinary circumstances, where the specified marine carrier's sailing schedule is in substantial conflict with the Construction Schedule, the City will review the circumstances, taking into account the adverse impact on the project and the specified marine carrier's interests, and the City may provide authorization to allow the relevant cargo to be shipped with a marine carrier other than the specified marine carrier, depending upon the circumstances; and such authorization must be writing.

(d) If a Contractor uses a marine carrier other than the City contracted marine carrier without the City's written authorization to do so, the Contractor shall be responsible for extra freight cost, administrative costs or any other costs, incurred by the City

APPENDIX "A" TO GENERAL CONDITIONS

CONTRACTOR'S CERTIFICATE OF INSURANCE

INSURED: _____
PROJECT NAME: Renovation to Apex Bridge

SCHEDULE OF MANDATORY INSURANCE

Type of Insurance	Insurer, Policy Number	Policy Period	Limit of Liability/Amount
Comprehensive General Liability including Non-Owned Automobile Liability		From _____ To: _____	Bodily Injury $_____ Each Person $_____ Each Accident $_____ Aggregate Products Property Damage $_____ Each Accident $_____ Aggregate Products OR Bodily Injury & Property Damage $_____ Inclusive $_____ Aggregate Products
Automobile Liability (Owned/Leased Vehicles)		From: _____ To: _____	Bodily Injury $_____ Each Person $_____ Each Accident Property Damage $_____ Each Accident OR Bodily Injury & Property Damage $_____ Inclusive
Property and Boiler and Machinery Insurance		From _____ To: _____	$_____
Contractor's Equipment		From _____ To: _____	$_____
OTHER			

This is to certify that policies of insurance as described above, and in the General Conditions of this Contract for Construction, have been issued through the undersigned to the Insured named above and are in force at this time. If cancelled or changed in any manner for any reason, during the period of coverage as stated herein so as to affect this certificate, immediate written notice will be given by the undersigned to the Manager, Public Works & Engineering, City of Iqaluit, Nunavut, PO Box 460, Iqaluit, Nunavut, X0A 0H0.
Name and Address of Insurance Agent, Broker or Insurance Company:

_____

Date: _____ By: _____
(Authorized Representative)

.4 Change Orders.
.5 Other Modifications to Contract.
.6 Copy of Approved Work Schedule.
.7 Health and Safety Plan and Other Safety Related Documents.
.8 Other documents as specified.

Part 2 Products

2.1 NOT USED

.1 Not used.

Part 3 Execution

3.1 NOT USED

.1 Not used.

END OF SECTION

1.4 PROGRESS MEETINGS

.1 During course of Work, the Consultant will schedule regular progress review meetings.

.2 Contractor involved in Work and Consultant and City are to be in attendance.

.3 Contractor will record minutes of meetings and circulate to attending parties and affected parties not in attendance.

.4 Project progress review meeting agenda to include the following:

- .1 Review, approval of minutes of previous meeting.
- .2 Review of Work progress since previous meeting.
- .3 Field observations, problems, conflicts.
- .4 Problems which impede construction schedule.
- .5 Corrective measures and procedures to regain projected schedule.
- .6 Revisions to construction schedule.
- .7 Progress schedule during succeeding work period.
- .8 Review submittal schedules expedite as required.
- .9 Maintenance of quality standards.
- .10 Pending changes and substitutions.
- .11 Review proposed changes for effect on construction schedule and on completion date.
- .12 Other pertinent businesses.

1.5 SAFETY MEETINGS

.1 Contractor is responsible for on-site safety; including but not limited to safety meetings. Contractor shall conform to all applicable laws and regulations.

.2 Regular safety meetings will be held on-site; minutes will be prepared and distributed by the Contractor to all concerned.

.3 Each contractor will be expected to become fully involved in the formation of the safety committee and be fully supportive of any workers under his control who may be appointed to the various safety committees.

Part 2 Products

2.1 NOT USED

.1 Not used.

Part 3 Execution

3.1 NOT USED

.1 Not used.

END OF SECTION

Part 2 Products

2.1 NOT USED

.1 Not used.

Part 3 Execution

3.1 NOT USED

.1 Not used.

END OF SECTION

1.7 WORK STOPPAGE

.1 Give precedence to safety and health of public and site personnel and protection of environment over cost and schedule considerations for Work.

Part 2 Products

2.1 NOT USED

.1 Not used.

Part 3 Execution

3.1 NOT USED

.1 Not used.

END OF SECTION

.3 Prevent sandblasting and other extraneous materials area from contaminating air beyond application area, by providing temporary enclosures.

.4 Cover or wet down dry materials and rubbish to prevent blowing dust and debris.

1.7 SPECIAL CONSIDERATIONS

.1 Work of this contract shall occur adjacent to the municipal water supply of the Community. All materials used in the construction shall be suitable for continuous contact with potable water.

.2 No hazardous materials may be stored in a location where spillage may endanger the water supply.

.3 Any spills of hazardous materials shall be immediately reported to the Engineer and to the Project Manger, and clean-up shall take precedence over all other work on site.

Part 2 Products

2.1 NOT USED

Part 3 Execution

NOT USED

END OF SECTION

Part 3 Execution

3.1 NOT USED

.1 Not used.

END OF SECTION

.9 Remove dirt and other disfiguration from exterior surfaces.

.10 Sweep and wash clean paved areas. Clean equipment and fixtures to sanitary condition; clean or replace filters of mechanical equipment.

.11 Remove debris and surplus materials from crawl areas and other accessible concealed spaces.

Part 2 Products

2.1 NOT USED

.1 Not used.

Part 3 Execution

3.1 NOT USED

.1 Not used.

END OF SECTION

.3 Canadian Construction Safety Code (latest edition).

.4 Canadian Environmental Assessment Act (CEAA), 1995.

.5 Rules and regulations of authorities having jurisdiction.

1.6 Measurement for Payment

.1 Payment shall be a combination of stipulated price and unit rate for work indicated on the contract drawings.

.2 Unit rate payment shall be based on a linear measurement of cracks injected. Crack injection shall be measured by the Consultants in the presence of the Contractor to the nearest 0.1 metre. The Contractor shall not exceed beyond the limits of the repair areas which have been agreed upon without prior authorization by the Consultant.

.3 The stipulated price and unit prices for crack injection shall be full compensation for the surface preparation, port installation, port removal and any other items required to accommodate the work, and for the supply and installation of the crack injection material of the type as specified.

1.7 Warranty

.1 The Contractor shall provide a written warranty for a period of 1 years from the date of final completion of the project as certified by the Consultants. The Contractor shall warrant that the crack injection repairs will be free of defects (ie: leakage) related to workmanship or material deficiency. Any repair required under the warranty will be carried out in accordance with the recommendations of the Consultant.

Part 2 Materials

2.1 Polyurethane Injection

.1 Flexible Water Reactive Polyurethane Resin as manufactured by MME Multiurethanes Ltd.

.2 The contractor shall provide suitable MME Multiurethanes Ltd. polyurethane injection materials for leaking cracks based on site conditions during the time of repair.

2.2 Injection Port

.1 The injection ports shall be approved plastic inserts. Surface mounted ports are not acceptable.

Part 3 Execution

3.1 Areas of Repair

.1 The general areas requiring repair are identified on the drawings. Contractor to confirm with Consultant the exact areas requiring repair prior to commencing work.

.2 Contractor will delineate and mark areas

Part 1 General

1.1 DESCRIPTION

.1 This section describes requirements that apply to construction involving work in waterbodies and waterbody banks.

1.2 REQUIREMENTS

.1 Two copies of a written strategy shall be submitted to the Engineer for review and for permission to proceed with the work.

.2 This strategy shall be submitted a minimum of 10 Working Days prior to the commencement of work.

.3 The strategy shall provide descriptions, working drawings, and schedules that fully describe the sequence of the work, the associated waterbody and fish habitat protection, and the related contingency measures associated with each stage of the work. The schedule shall include approximate date of installation, removal, and site restoration. Such information shall be provided at a level of detail, which addresses materials, equipment, methods employed, and procedures to be followed to provide effective waterbody and fish habitat protection and to comply with statutory authorizations, approvals and permits. The submission shall also include a schedule of checking and monitoring the work to ensure compliance with the strategy.

.4 The strategy shall apply to:

- .1 All phases of the work, and transitions between phases of the work;
- .2 The installation, operation, and removal of waterbody and fish habitat protection measures, and transitions between any adjacent environmental protection including temporary erosion and sediment control measures;
- .3 The interfaces between waterbodies and temporary water passage systems;
- .4 The containment or stabilization of disturbed earth material, including during the winter period and other shutdown periods, to prevent entry of such materials into waterbodies.

.5 The Engineer shall respond within 10 Working Days to each submission or resubmission by either giving permission to proceed, or returning the submission marked "Revise and Resubmit", and giving reasons.

.6 Permission to proceed shall not constitute acceptance of the technical adequacy of the strategy.

.7 Written notification shall be submitted to the Engineer two days prior to the actual date of installing or removing protection measures.

.3 The limit of the area to be disturbed shall be clearly marked prior to commencement of the work. The markings shall be maintained for the duration of the Contract.

.4 The work shall not commence while flows are in flood stage

.5 Construction shall be halted during periods of heavy precipitation and/or runoff.

.6 Vegetation shall be preserved where possible.

.7 The operation of equipment within such areas, shall be kept to the minimum necessary to perform the specified work.

.8 The number of entry and exit points, and the distance from the entry point to the work area, shall be kept to the minimum necessary to perform the specified work. Access to the site should wherever possible, be restricted to existing roads and trails.

.9 The work and all subsequent site completion and restoration activities shall proceed in a continuous fashion so as to minimize its duration.

.10 A shroud shall be installed beneath the bridge to trap and prevent construction materials from entering the water course.

.11 Effective bank erosion control measures such as filter cloth, rock, matting or polyethylene etc. must be installed prior to start of work.

.12 Eroded sediment shall be contained on-site using devices such as silt fences or sediment traps.

.13 The work shall be conducted so as to prevent harm to fish and aquatic wildlife and to allow fish passage.

1.5 SITE RESTORATION

.1 The waterbody and waterbody banks shall be restored to their original conditions if disturbance occurs.

1.6 CONTINGENCY MEASURES

.1 A standby supply of pre-fabricated silt fence barrier, or an equivalent ready-to-install sediment control device, sufficient to extend a linear distance of 200 m, shall be maintained at the contract site at all times, including shut down periods, for immediate deployment.

END OF SECTION

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Emergency Preparedness Plan

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Emergency Preparedness Plan

Currently an Emergency Preparedness Plan (EPP) does not exist. It is expected that the EPP would be completed in the future.

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Reserved

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