






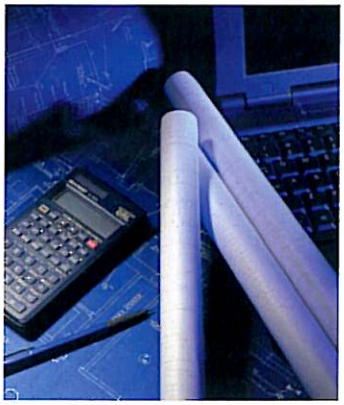

Cape Breton Development Corporation
Victoria Junction Tailings Basin
Review of Dam Safety Findings

ADI Limited
Report: L1573-048.1
Date: January 2010

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EXECUTIVE SUMMARY

Three Dam Safety Review reports have been completed for the Victoria Junction Tailings Basin between the years 1998 and 2009 by qualified engineering firms. The Cape Breton Development Corporation requested that ADI Limited/BGC Engineering Inc. perform a review of the reports, summarize the report findings and provide a consolidated list of recommendations.

ADI Limited/BGC Engineering Inc. has conducted the review with respect to the Canadian Dam Association's Dam Safety Guidelines (2007). Variations in the failure consequence classification are discussed with reference to the changes in the downstream flood plain and aquatic environment.

Stability, seepage, erosion and settlement issues identified in the previous reports are summarized with key recommendations made regarding the drainage blanket of the retention dam. The capability of the Victoria Junction Tailings Basin facilities to route the probable maximum flood safely, has been summarized.

Additional recommendations regarding the operations, maintenance and surveillance of the Victoria Junction Tailings Basin facilities, have also been provided by ADI Limited/BGC Engineering Inc.

The summary of the previous recommendations provided by the three consultants are provided in Table 1 at the end of this Executive Summary. The majority of these recommendations were extracted from the 2009 Dam Safety Review by AMEC Earth & Environmental.

The main issue of concern raised by AMEC Earth & Environmental was the performance of the blanket drainage along the downstream toe of the retention blanket. ADI/BGC reviewed the monitoring information available.

After the ADI Limited/BGC Engineering Inc. site inspection with Cape Breton Development Corporation in October 2009, it was decided that Cape Breton Development Corporation proceed with the plan to remove a portion of the discharge piping that appeared to be blocked by iron precipitate.

When the discharge piping was removed, the “phreatic level” in the dam (measured by monitoring wells) dropped by approximately 2 metres. This level is consistent with the original design intent.

Assessment of the groundwater chemistry immediately downstream of the dam indicated the presence of a Phase 1-2 acid rock drainage plume characterized by elevated iron and manganese. This is expected to be the source of the iron precipitate. There are two dam safety issues related to this finding that need to be addressed:

- An inspection of the perforated drain pipe in the dam should be completed to ensure the pipe is not being "clogged" by iron precipitate.
- Replace the discharge pipe linking the dam and the settling basin with an open channel. This action item will include a passive wetland treatment system within the existing settling pond to deal with the acid rock drainage plume.

Table A-1: Summary of DSR Recommendations from Previous Submissions

ITEM	ISSUE	LOCATION	ADI/BGC RECOMMENDATION	STATUS
AMEC Dam Safety Review (2009)				
1	Prepare Operations, Maintenance and Surveillance Manual	Retention Dam Settling Pond Dam	Minor adjustments to SGE Acres OMS Manual	ACT
2	Conduct Annual Dam Safety Inspection	Retention Dam	Follow normal procedures (maintenance inspection every year)	NIA
3	Conduct Dam Safety Review every 7 years	Retention Dam	Follow normal procedures (CDA Guidelines recommend every 5 years)	NIA
4	Review precipitation data and determine necessity of updating hydraulic and hydrologic analyses	Retention Dam	Agreed, given climate change and availability of new stream flow data. Also, assess the impact of droughts on water cover and hydrogeological modelling to assess impact of water levels on seepage blanket.	PA
5	Review monitoring well conditions and recorded water levels	Retention Dam	Install vibrating wire piezometers within fill layer only. Install monitoring wells within bedrock foundation downstream.	ACT
6	Confirm actual geotechnical properties of fill and foundation soils (compared to as-built and design)	Retention Dam	Native glacial soil properties are well documented and additional boreholes for new monitoring installation will confirm in-situ conditions. Information provided in the GeoCom Report is accurate.	NIA
7	Test water chemistry/quality (aid in identifying seepage mechanism)	Tailings Pond Monitoring Wells Downstream Drain	Agreed and should be expanded to assess impact of acid rock drainage plume on functioning of seepage blanket, as well as need for and, if so, the design and passive wetland treatment.	ACT
8	Conduct pumping test at main manhole to determine flow through dam	Retention Dam Main Manhole	Install a weir at point of downstream seepage discharge to monitor amounts of seepage through the dam	NIA
9	Conduct test pit investigation (check drain-clogging potential and corrugated steel pipe performance)	Retention Dam: toe drain and drainage pipe	No immediate action, see Item 11 below	NIA
10	Investigate connection/pipeline between manholes 1, 2 and 7	Pipeline system	Decommission/abandon manhole system. Install new open channel or pipeline for discharge. The work is in progress. The pipe between Manholes #5 and #6 was removed by CBDC.	ACT

11	Conduct video inspection of drain pipe in toe drain	Retention Dam: toe drain	Need video camera inspection of drainage pipe. Access through manhole #1.	ACT
ITEM	**ISSUE**	**LOCATION**	**ADI/BGC RECOMMENDATION**	**STATUS**
AMEC Dam Safety Review (2009)				
12	Assess potential risks caused by failure of toe drain pipe	Retention Dam	See Item #11. Determine phreatic level in the embankment and adjust discharge of the dam drainage blanket	ACT
13	Update dam stability analysis using actual phreatic surface data	Retention Dam	Phreatic levels have been reduced by CBDC.	NIA
14	Perform maintenance of dam crests	Retention Dam	To be conducted as routine maintenance as indicated in the OMS manual.	ACT/NIA
15	Remove vegetation	Emergency Spillway Bottom Retention Dam Slopes	To be conducted as routine maintenance as indicated in the OMS manual.	ACT/NIA
17	Investigate the riprap size, shape, quality and layer thickness	Retention Dam Slopes	To be conducted as routine maintenance and added to the OMS manual.	ACT/NIA
18	Develop plan for removal of vertical decant tower	Retention Dam	Decant tower to be removed at owner's discretion. There is evidence of minor seepage.	NIA
19	Inspect Settlement Pond Dam in detail	Setting Pond	Based on 2009 inspection, the setting pond dam is stable. The DSR of 2013-2014 should be expanded to include this structure. Conduct yearly inspection as per Item #2.	ACT/NIA
20	Survey Settlement Pond Dam	Setting Pond	Include in next Dam Safety Report.	ACT/NIA
21	Assess option of removing Settling Pond Dam	Setting Pond	See Item #19; use as passive treatment pond.	ACT/NIA
22	Printed / Digital Topographic Information	All Areas	Convert all mapping and drawings to SI units and include in PWGSC GIS database.	ACT

Status Definitions:
NIA - No immediate action
PA – Possible Action
ACT – Action
NAR – No Action Required

1.0 INTRODUCTION

ADI Limited (ADI) and its subconsultant, BGC Engineering Inc. (BGC), have been retained by the Cape Breton Development Corporation (CBDC) to provide a geotechnical engineering assessment of the Dam Safety Reviews previously completed for the Victoria Junction Tailings Basin (VJTB) facilities. Included in this assessment is an evaluation of the current state of the facilities with regard to the recommendations that have been made in the Dam Safety Reviews in 1998, 2003 and 2009.

The Victoria Junction Tailings Basin (VJTB) is located northeast of Sydney, Nova Scotia, between the Kehoe Lake and Kilkenny Lake. Facilities at the VJTB include: an earth embankment retention dam, a primary spillway, an emergency spillway, a previously abandoned system of manholes and pipelines to a demolished treatment plant, a decommissioned decanting structure, three monitoring wells in the dam (as well as numerous others to the north and east of the facility), an earth embankment Polishing Pond Dam and a discharge spillway.

This report provides a summary of the findings of the site investigation undertaken by ADI/BGC and the outstanding recommendations from the Dam Safety Reviews completed to date. Also provided in this report are the priority issues that ADI/BGC recommends be addressed first by CBDC.

2.0 BACKGROUND

2.1 Historical Reports on Dam Safety and Operations

Dam Safety Reviews were conducted by ADI in 1998, Jacques Whitford & Associates Ltd. (JWA) in 2003 and AMEC Earth & Environmental (AMEC) in 2008. Additionally, SGE Acres Ltd. completed an Inundation Study and preparation of an Operation, Surveillance and Monitoring Manual in 2004 and an Emergency Preparedness Plan in 2005. Some recommendations made in these reports continue to be outstanding. Additionally, some information included in these reports have been superseded by modifications made to the VJTB facilities and/or the surrounding areas.

Collated lists of the outstanding recommendations and issues of concern are provided in Tables A1 to A4, included in Appendix A.

2.2 Site Inspection

In October/November 2009, ADI and BGC conducted site inspections of the VJTB facilities. The purpose of these inspections was to confirm the current conditions of the various facilities, and to observe the issues of concern as identified in the Dam Safety Review reports. The components tailings storage facility observed during the site inspection were as follows:

1. Tailings retention dam
2. Polishing pond dam
3. Polishing pond spillway
4. Primary spillway (between tailings basin and polishing pond)
5. Discharge system manholes (access points to pipeline system)
6. Emergency spillway
7. Groundwater monitoring wells

3.0 CONSEQUENCE OF DAM FAILURE

The 2008 Dam Safety Review completed by AMEC indicated that the VJTB retention dam should be classified as having a "Very High" or "Extreme" consequence of dam failure, as defined by the 2007 Canadian Dam Association (CDA) Dam Safety Guidelines. The reasoning provided for assigning the VJTB retention dam to this classification level was that the potential for loss of life was estimated to be greater than 10, with the possibility of exceeding 100 lives lost.

AMEC identified the increasing housing density in the floodplain below the tailings basin, as contributing to the increased probability of loss of life, resulting in the higher consequence classification. In addition to the criteria for potential loss of life, AMEC identified that the potentially long lasting impact to aquatic life in the Kehoe Brook-Kilkenny Brook system would be cause to classify the consequence as "Very Extreme".

The 1998 Dam Safety Review completed by ADI classified the dam within the "Low to High" consequence of failure categories as defined by the CDA 1995 Dam Safety Guidelines. This classification was based on the probability of failure where a "High" category has a probability of failure of less than 1/100,000. JWA confirmed this assessment in the 2003 Dam Safety Review, stating that there was no basis for changing the classification. However, it should be noted that the inundation study information completed in 2005 was not available to the Dam Safety Review teams in 1998 and 2003.

Based on the results of the SGE Acres inundation study of 2006, the current review by ADI/BGC concludes that the dam classification of failure consequence should remain as "Very High" as provided in Table 2-1 of the CDA Dam Safety Guidelines.

This is based on:

1. SGE Acres conclusion that there was a very low risk of sudden failure of the retention dam.
2. SGE Acres conclusion that warning signs of an impending problem with the retention dam should be available to the owners.
3. Recent modifications to the drainage discharge system have reduced the elevated phreatic level in the dam, which had been observed in 2008.
4. As per Table 5-1 of the Guidelines, a Dam Safety Review should be completed every 5 years.

4.0 GEOTECHNICAL CONSIDERATIONS

The CDA Dam Safety Guidelines (2007) list the required geotechnical items to be analyzed in a Dam Safety Review as: hydraulic fracturing, piping, internal erosion, surface erosion, slope instability, static and dynamic liquefaction, seepage and deformation. Summaries of the Dam Safety Review inspections, analyses and conclusions are presented below.

4.1 Slope Stability

The stability of the retention dam was evaluated during each of the three Dam Safety Reviews (1998, 2003 and 2008), based on the design cross sections as provided by GeoCon in the original design reports. Changes to the cross sections between each stability analysis were limited to the recent installation of a buttress berm and updated groundwater levels.

For the static conditions, all three dam safety reviews have indicated that the upstream stability of the retention dam has a satisfactory factor of safety, due to the 3:1 upstream slope and stabilizing effect of the tailings material. The reported factor of safety for static stability of the downstream slope from the ADI (1998) and JWA (2003) dam safety review was approximately 1.5, with AMEC reporting a Factor of Safety of 1.57, all of which are sufficient by the CDA Dam Safety Guidelines (2007).

Pseudostatic analysis was completed by JWA (2003) and AMEC (2008). The ground acceleration applied in the analysis was 0.13 Gravity Acceleration (g) to 0.14 g. Both JWA and AMEC arrived at Factors of Safety of 1.1 to 1.2, which is considered sufficient by the CDA Dam Safety Guidelines.

Appendix F of the AMEC Dam Safety Review of September 2009 provides a summary of the slope stability assessment. The review indicates a Factor of Safety of >1.5 assuming "steady-state" (drained) conditions. It is assumed that the foundation soils are saturated below the dam.

The stability analysis was also performed for the condition of blocked drainage and increase in the phreatic level above the drain. In this case, the Factor of Safety is less than 1.5 and a berm is required at the toe of the dam. As discussed below in Section 4.1, the drainage blanket has been found to be performing satisfactory after the removal of the blocked drainage discharge pipe. The annual inspections should confirm that the drainage blanket continues to freely pass seepage. There are some recommendations with regard to the drainage conditions provided in this report as well; see Sections 4.2 and 7.0.

All records of site inspections completed to date, including the most recent by ADI/BGC (October 2009) have shown that there are no visible signs of concern, such as tension cracks or bulging that would constitute evidence of any slope failure.

4.2 Seepage

4.2.1 Summary of Observations 2009 DSR

Observations of seepage have been recorded in the previous Dam Safety Reviews from 1998 to 2008. Suggestions for monitoring seepage and water levels in the embankment have also been made by ADI (1998), JWA (2003) and AMEC (2008). In 1998, a buttress berm, approximately 25 metres south of the decant structure, was constructed at the downstream toe of the retention dam. This reinforcement buttress was recommended by ADI (1998) to address the concerns of seepage through the downstream slope at this particular location.

Seepage on the downstream slope of the retention dam was noted at several points extending along the toe of the dam approximately from 20 metres south of the buttress berm and extending 10 metres north of the buttress berm was observed during the BGC/ADI site inspection. ADI had also recommended monitoring the performance of the buttress and the general seepage conditions. It is recommended that a video camera

should be sent through the toe drain to evaluate the current condition of the toe pipe and to evaluate the continued performance of the toe drain.

Three monitoring wells were installed in 2004 to allow monitoring of the groundwater level measurements to be taken, as recommended by ADI (1998) and JWA (2003). Two of these monitoring wells contain screened sections extending beyond the contact between the glacial till and bedrock, the third monitoring well extends into the glacial till layer. The 2008 AMEC Dam Safety Review reports high water levels in the monitoring wells, approximately 0.4 metres to 1.2 metres above the contact between the native till and the embankment fill. The locations of the monitoring wells (MW1, MW2 and MW3) are shown on Figure T-1 (Inset).

The phreatic level, as estimated by the water levels measured in the monitoring wells, is higher than should be expected. The measured levels may or may not be reflective of the actual groundwater conditions in the embankment. It is possible that because the wells have been installed into the bedrock, flow or pressure in the bedrock have caused the water level readings to be higher than the actual groundwater level throughout the embankment. BGC/ADI recommends that three new monitoring wells be installed, limiting the depth of the screened section to within the embankment fill.

Site inspections conducted by AMEC (2008) and ADI/BGC (October 2009) have revealed surcharged or artesian pressures in each of the manhole components of the pipe system connected to the toe drain. The water levels are shown in Table 4-1. In June 2009, AMEC conducted a pump test at Manhole 1 (MH1), the first access point downstream of the toe of the dam (Figure T-1). The pump test results showed flow rates of 200 gpm to 400 gpm. Without having the benefit of water level measurements taken in the manholes before and after the pump test, it is inferred that the high flow rates are not necessarily indicative of seepage rate through the dam because it is probable that a high percentage of the pumped volume may have been withdrawn from the piping system and manholes downstream of the pump test location.

4.2.2 Recent Modification to Drainage System

The ‘backup’ of water within the manhole and pipe system, as indicated by the previous elevated groundwater surcharge conditions may be contributing to the apparently high ground water table measured in the monitoring wells. During the site inspection by BGC/ADI (2009) it was observed that most of the manhole installations were covered with an iron oxide coating. An overland channel that had formed from the overflow of MH5 was stained along the bottom and sides by oxidation build up. A recent (November 2009) site investigation conducted by CBDC has confirmed that the manhole/piping

Dec 15,2009 9:14am

TAILINGS BASIN
(Normal Operating Level 40.84m)

40.9m

41.75m

TREATMENT PLANT

DECANT TOWER

RETENTION DAM

EMERGENCY SPILLWAY

SETTLING POND
(Max. Elev. 32.0m)

POWER TRANSMISSION LINES/CORRIDOR

KEHOE BRK

KL-3

KL-1

PUDDLE #3

PUDDLE #5

PUDDLE #6

PUDDLE #7

MW

MW-1

MW-2

MW-3

MW-4

MH1

MH2

MH3

MH4

MH5

MH6

MH7

No.	Issue	Date
1	ISSUED FOR REVIEW	15-DEC-09

LEGEND:

- APPROX. PROPERTY BOUNDARIES
- APPROX. CONTOUR ELEVATIONS(ft)
- GRAVELLED ROADS/TRAILS
- APPROX. SWAMPY AREA
- MANHOLES
- MONITORING WELL(OLDER) FROM PREVIOUS INVESTIGATIONS

No.	Revision	Ckd. By	Date

Client:

Project No.

FOR INFORMATION ONLY

Const. North

Drawn By: NB

Dwg. Standards Ckd. By:

Designed By: BL

Date Printed: 09.Dec.15

Dwg. Design Ckd. By:

ADI Limited
Sydney, NS, Canada
Engineering, Consulting, Procurement and Project Management

Project Title

VJ TAILINGS BASIN CLOSE OUT PROJECT

Dwg. Title

OVERVIEW OF TAILINGS BASIN & ASSOCIATED INFRASTRUCTURE

Project No. 1573-048.1

Dwg. No. **FIGURE T-1**

Rev. No. 0

Scale **1:4000**
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Charlottetown, Moncton, Saint John, Truro, Halifax, Sydney
Port Hawkesbury, St.John's, Fredericton and Salem, NH

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system was blocked near MH5 due to a heavy accumulation of iron oxides in the pipes. Removal of the blocked pipes on 09 November 2009 has allowed a steady flow of water to exit the piping system.

Monitoring of the water levels in the manholes and monitoring wells is ongoing. The water levels in the monitoring wells prior to the removal of the piping system and water levels in both the monitoring wells and manholes since the abandonment are summarized in Table 4-1. Figure T-2 includes a cross section of the reported water levels between 10 June 2009 and 03 December 2009.

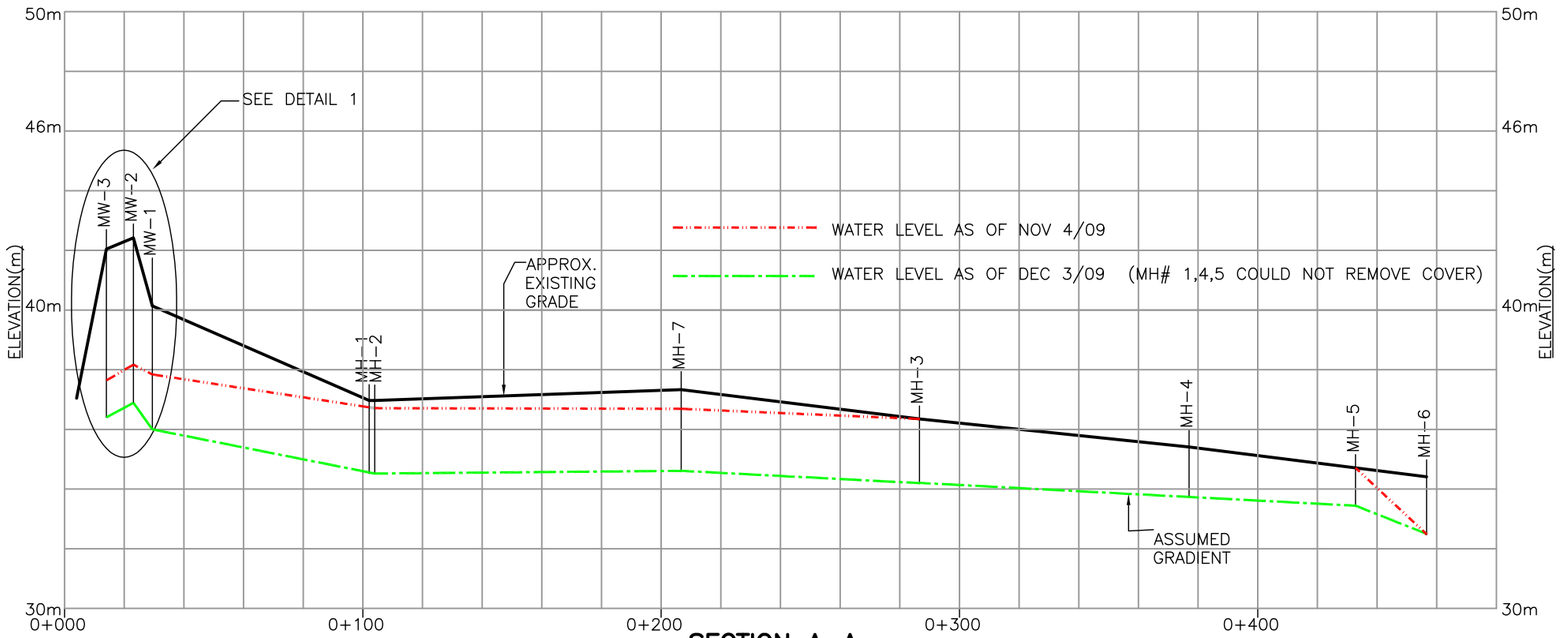
As noted in Table 4-1, the water levels in the monitoring wells have dropped between 1.2 to 1.8 metres since the blockage in the manhole piping system was removed in November 2009. As well, the manhole water levels have typically decreased by more than 2 metres.

Prior to the removal of the blocked pipe discharge, the water levels measured at the drainage blanket in monitoring well (MW1) was 37.9 metres. The water level in MH2, immediately downstream of the drainage blanket, was 36.7 metres.

Following removal of the pipe, the water level in MW1 decreased 1.9 metres to reach elevation 36.0 metres. The level in MH2 decreased 2.2 metres to reach elevation 34.5 metres. These elevations are consistent with the design intent provided by GeoCon in their report of 1983. Also the levels are consistent with the phreatic surfaces assumed for the stability analysis completed in 1998, 2003 and 2008.

As noted in other sections of the report, the satisfactory performance of the drainage blanket must be confirmed in the future. This can be accomplished by:

- Video inspection of the perforated drainage pipe (300 mm) in the collection trench.
- Installation of additional vibrating wire pneumatic piezometers in the dam structure.
- Installation of standpipe piezometers downstream of the dam.
- Annual inspections of the drainage system.



SECTION A–A
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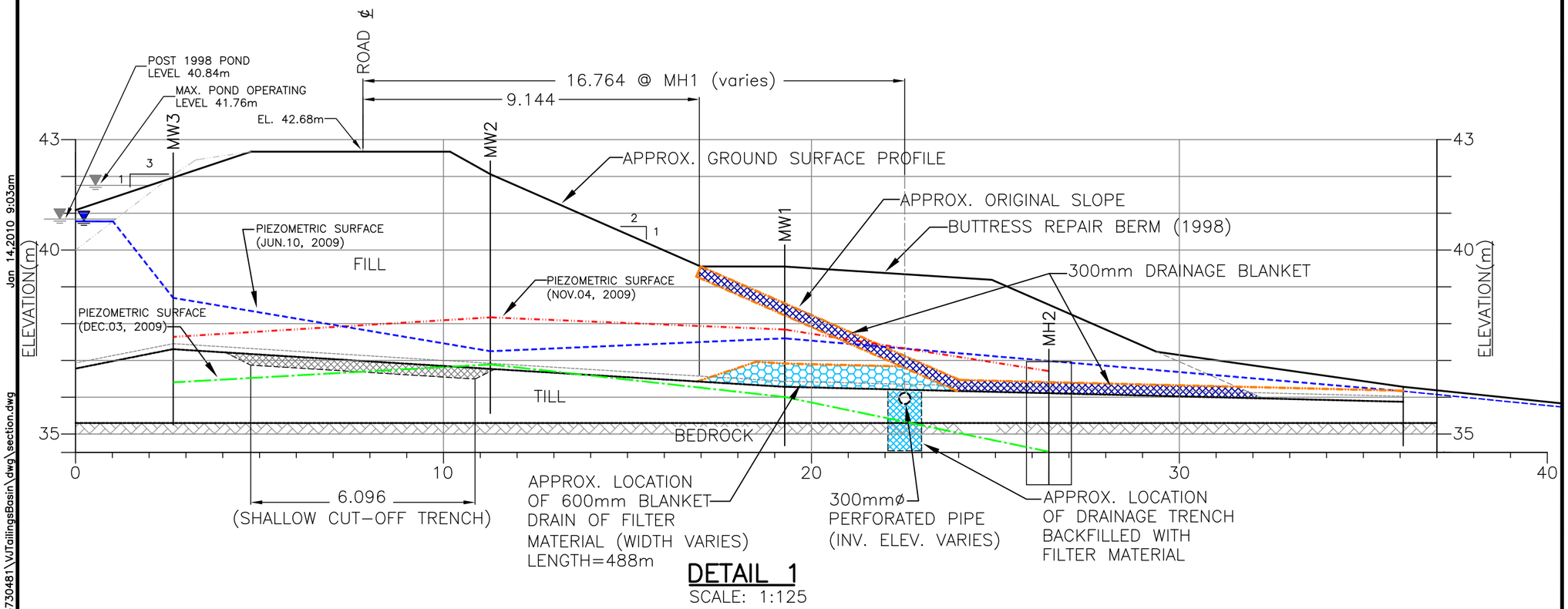

DETAIL 1
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No.	Issue	Date

No.	Revision	Ckd. By	Date

Subconsultant

Project No.

PRELIMINARY

Const. North

Drawn By: BDP

Dwg. Standards Ckd. By:

Designed By: BPL

Date Printed 10.Jan.14

Dwg. Design Ckd. By:

ADI Limited
Sydney, NS, Canada
Engineering, Consulting, Procurement and Project Management

Project Title

VJ TAILINGS BASIN CLOSE–OUT PROJECT

Dwg. Title

PROFILE THROUGH MONITORING WELLS & MAN HOLES

Project No.	L1573–048.1	
Dwg. No.	T–2	Rev. No. 0

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Table 4-1: Summary of Water Levels in Monitoring Wells and Manholes

Manhole/ Monitoring Well	Manhole/Monitoring Well Elevation (Top) (m)	Water Elevation Nov. 6/08 (m)	Water Elevation May 4/09 (m)	Water Level Nov.4/09 (m)	Water Elevation Nov. 4/09 (m)	Water Level Dec.3/09 (m)	Water Elevation Dec.3/09 (m)
MH1	36.967	nm	nm	0.23	36.737	nm	nm
MH2	36.967	nm	nm	0.26	36.707	2.45	34.517
MH3	36.347	nm	nm	flush	36.347	2.15	34.197
MH4	35.407	nm	nm	flowing	nm	nm - not flowing	nm
MH5	35.107	nm	nm	flowing	nm	nm- not flowing	nm
MH6	34.407	nm	nm	1.92	32.487	1.97	32.437
MH7	37.5 (assumed)	nm	nm	0.43	37.07	2.72	34.78
MW1	40.14	37.887	37.687	2.29	37.85	4.13	36.01
MW2	42.42	37.37	37.5	4.25	38.17	5.53	36.89
MW3	42.64	37.933	38.29	4.4	38.24	5.64	37.0
MW4	36.0 (assumed)	nm	nm	0.83	35.17	2.05	33.95

Notes:
1. nm - no measurement
2. Water level measured from top of pipe or top of manhole collar.
3. MW – Monitoring Well
4. MH – Manhole

4.3 Erosion

The 1998 ADI Dam Safety Review noted the usage of sandstone as rip rap along the upstream face of the retention dam. Sandstone does not generally meet the requirements for durability, soundness or abrasion resistance for rip rap material. The AMEC (2008) Dam Safety Review reports some sliding and benching of the rip rap and the presence of small particle sizes. Also noted in the AMEC (2008) report was rutting on the downstream slope and potholes along the crest of the dam, these concerns were confirmed during a BGC/ADI site visit.

During the October 2009 site inspection, ADI/BGC were in agreement that slight benching of the rip rap had occurred, and that there was a small percentage of small particle size rip rap along the upstream face. However, it was concluded by ADI/BGC that the performance of the rip rap appears to be sufficient for its intended function and there is no immediate need to investigate further or make alterations to the rip rap lining. Regular monitoring of the rip rap performance should continue. To prevent continued rutting of the downstream face and dam crest, efforts could be made to limit unessential and ATV traffic across the embankment.

4.4 Settlement

All reports, ADI (1998), JWA (2003) and AMEC (2008) are in agreement that there are no apparent cracks or other evidence of differential settlement occurring at the retention dam. Any small, localized areas of lower elevation have been attributed to rutting from vehicle traffic and weathering, as opposed to any settlement concerns.

4.5 Settling Pond and Containment Dyke

The containment pond and settling pond located downstream of the former Water Treatment Facility is considered a water retention structure as per CDA's Dam Safety Guidelines (2007).

As per the definition of a dam as provided in the Glossary of the Guidelines:

"A barrier constructed for the retention of water, water containing any substance, fluid waste, or tailings, provided the barrier is capable of impounding at least 30,000 m^3 of liquid and is at least 2.5 m high."

Therefore, future Dam Safety Reviews of the Kilkenny Tailings facility should include an inspection of the settling pond and dyke.

In October 2009, ADI/BGC toured the structure and observed that the downstream slope of the dyke appears stable. There is no evidence of seepage through the dam. Drainage along the toe appears to be emanating from surface water runoff and this needs to be addressed in the future.

The spillway discharge appears to be operating satisfactorily; however, design flow calculations should be completed in the next Dam Safety Review event.

5.0 HYDROTECHNICAL CONSIDERATIONS

The three Dam Safety Review reports address the statistical flood analysis, probable maximum flood, freeboard and flow control structures as required by the CDA dam safety guidelines. Summarized below, are some of the issues and concerns as indicated in the reports.

5.1 Level of Effort

The hydrogeological/hydrological review included the following level-of-effort:

5.1.1 Documents Reviewed

A total of nine documents were reviewed, including:

AMEC	March 2009 2007 Dam Safety Review
	September 2009 Dam Safety Review
SGE Acres	February 2005 Emergency Preparedness Plan
	March 2004 Operation Maintenance and Surveillance Manual
	Inundation Study and Risk Analysis
JWA 2003	Dam Safety Review
ADI	1998 Dam Safety Report
	1990 Assessment of the Groundwater Flow System between the Victoria Junction Tailings Basin and Kilkenny Lake
	1987 Victoria Junction Tailings Basin Ambient Trend Groundwater Monitoring Program October 1984 to September 1986

5.1.2 Aerial Photography

The site was flown over with a fixed wing aircraft on 30 October 2009; pertinent photographs of present conditions are attached in Appendix B.

Historical Photography: Internal files were reviewed to obtain photos during construction of the site. Pertinent photographs are attached in Appendix C.

Site Inspection: A field inspection of the site was undertaken on 27 October 2009. Pertinent details were provided in an internal memo dated 28 October 2009 and provided in Appendix D.

Monitoring Data and Mapping: Data collected and collated by ADI as part of the on-going monthly monitoring program was reviewed. A new base map was developed of the site based upon hand-held GPS locations (note the previous location of the Buttress Berm on AMEC's report Figure 2.1 appears to be in error).

Field Sampling for this Assignment: As part of this assignment more detailed field investigations were undertaken above the normal Monitoring Program. This included monitoring of three selected wells within the dam and one in the bedrock downstream of the dam, as well as seven manholes discharging water from the seepage blanket to the retention pond. Monitoring included both head levels and water chemistry; as reported on by ADI to CBDC under separate cover by memo of 24 November 2009.

5.2 Review of AMEC's Recommendations Related to Hydrology and Hydrogeology

The following sections contain the hydrotechnical related narrative on the 2008/2009 Dam Safety Review report prepared by AMEC.

5.2.1 Retention Dam

5.2.1.1 Update the Hydrologic and Hydraulic Analyses for the Retention Dam (Points 4 and 16)

ADI generally agrees with this recommendation with the following comments and refinements.

The updated analyses should consider:

1. Additional flow data on the gauged indicator watershed (MacAskill Brook) has become available and should be included.
2. The local climate has been changing over approximately the last 15 years, resulting in reduced streamflow.
3. Further alterations are expected in the water budget due to climate change out to 2100.
4. Reassess how the value for the probable maximum flood of 26.5 inches over 24 hours was derived? Is it overly conservative?
5. The forest cover is a major factor in hydrological modelling, which when updated should give consideration to:
    a. Not all of the watershed contributing to the basin appears owned by CBDC - forestry practices and land clearing may occur in the future; and
    b. Climate change scenarios also include potential for major changes in forest cover due to forest fires and/or bug infestation.

It is of note that two pertinent types of modeling have not been carried out to date, which should be incorporated within the updated analyses. These include consideration of :

1. Hydrological modeling to date has focused solely on the impact of high flow events on the dam and spillways. However it has not modeled the impact of droughts on being able to maintain the 1.3 metre water cover over the tailings to restrict development of acidic drainage. If modeling shows the dam/spillway configuration is not capable of supporting the water cover and the basin starts to go acid then this would lend support for developing a passive wetland treatment system in the settling pond. At this point there appears to be no regulatory stipulation requiring a specific depth of water cover (CBDC personnel comm.). Drought modeling should be included in the updated analyses.

2. While hydrological modeling (surface water) was undertaken for peak flow events no similar groundwater modeling has been undertaken. Therefore, this recommendation should also be augmented to include a hydrogeological modeling study of the dam during the peak flow events when the spillways are required. The resultant impact of the elevated water levels behind the dam must be translated into what the resultant elevated groundwater levels will do to groundwater flow through and under the dam. This should be designed to answer the question "Will the seepage blanket be capable of handling these flows and keep internal hydraulic gradients within the dam at acceptable levels?". In addition, the hydrogeological model should assess the duration of the high head levels behind the dam on the resultant change in groundwater flow patterns north toward Kilkenny Lake.

5.2.1.2 Review Condition of Monitoring Wells in the Retention Dam and Install Others (Point 5)

ADI agrees with this recommendation.

During this assessment consideration should be given to determining the source of water in the channel below the dam where overflow from the decant tower was directed. It presently exhibits standing water with iron floc precipitation.

5.2.1.3 Determine Water Quality In The Tailings Pond Wells and Downstream Dam To Aid In Understanding Seepage Mechanism Through Dam (Point 7)

ADI agrees with this recommendation and preliminary sampling has been undertaken.

This work was carried out on 04 November 2009, with chemical analyses and head levels noted in the 24 November 2009 memo.

A total of 17 water samples were collected including 2 surface waters behind the impoundments, four puddles, seven manholes and four wells. All samples were analyzed at Maxxam's Sydney laboratories (a CAEAL accredited lab) for 58 measured and calculated inorganic and physical parameters on field filtered and unfiltered samples. In addition, eight field measurements were measured with a YSI 650 Multi meter.

A total of 12 indicator parameters were selected for preliminary analysis of the data. These included Na, K, Ca, Mg, HCO_3, SO_4, Cl, pH, TDS, Fe, Mn and Typing. Pertinent points derived from the interpretation include:

1) Tailings Dam Water: The source water ponded behind the Tailings Dam is primarily a fresh dilute (TDS 44 mg/L) Ca-SO_4 type water, with alkalinity of 5 mg/L and a near neutral pH (6.8). Sulfate (19 mg/L) and chloride (7 mg/L) are at background levels. Iron (0.88 mg/L) and manganese (0.18 mg/L) are at relatively low concentrations. There is no evidence of basin waters going acid.

2) Standing Water (Puddles): The four puddles located immediately downstream of the dam exhibit a water similar to the Tailings Dam water with a fresh, dilute (TDS 40 to 49 mg/L), mixed (Ca/Na-SO_4 to Ca/Na-SO_4/Cl) type water, with alkalinity of 4 to 8 mg/L and slightly acidic pH (5.4 to 6.5). Sulfate (15 to 24 mg/L) and chloride (5 to10 mg/L) are at background levels. Iron (<0.1 to 1.6

mg/L) and manganese (0.04 to 3.6 mg/L) are sporadically slightly elevated. It suggests a mixture of rain water and Tailings dam water.

3) Groundwater Wells: To date the actual well logs for the four wells sampled have not been obtained. From AMEC's cross section Figure 2.5 it would appear that of the three wells positioned within the dam itself, MW1 is positioned within the bedrock, MW3 in close proximity to the bedrock surface and MW2 screened within the till. MW4 is positioned some 20 metres downstream from the toe of dam. With a depth below top of casing of 4.3 metres MW4 is assumed to be screened within the shallow bedrock. These configurations would agree with the indicator chemistry:
    a. MW2 exhibits a chemistry similar to the tailings dam water with a dilute, fresh (TDS 64 mg/L) Ca/Na-SO_4 type water, with an alkalinity of <1 and pH 6.0. Sulfate (24 mg/L) and chloride (6 mg/L) are within background concentrations. Iron (0.69 mg/L) and manganese (0.85 mg/L) are at relatively low concentrations.
    b. MW's 1 and 3 indicate probable influence of bedrock groundwaters as evidenced by an increase in TDS (276 to 173 mg/L, respectively), Ca/Na-SO_4 typing with alkalinity of 5 to 2 mg/L and pH of 6.8 to 6.0 (lower than expected). Sulfate (26 to 33 mg/L) and chloride (7 to 6 mg/L) are still within background levels. Iron (15 to 4.8 mg/L) and manganese (4.8 to 2 mg/L) and notably elevated. The lower than expected pH and elevated iron and manganese suggest either deep bedrock groundwaters within a groundwater discharge zone and/or influenced by a possible Phase 1-2 acid rock drainage plume discharging out from under the dam.
    c. MW4 notes a significant alteration in chemistry as evidenced by a brackish (TDS 1180 mg/L), calcium-sulfate type water with alkalinity of 200 mg/L and a near neutral pH (7.1). Sulfate (440 mg/L) and chloride (110 mg/L) are notably elevated. Iron (19 mg/L) and manganese (16 mg/L) are also notable elevated. These indicators support the Phase 1-2 acid drainage groundwater plume discharging out from under the dam within the bedrock.
    d. The presence of the acid rock drainage plume is in agreement with ADI's assessment of groundwater monitoring data in June 1990, specifically of PN106 positioned further down groundwater gradient between MW4 and the settling pond. By December 1989 it was noted that both shallow and deep bedrock wells at this site exhibited significant trends outside the stability boundaries in chloride, sulfate and manganese; pH was unaffected. Phase 1-2 acid drainage commenced around June 1986, characterized by a commencement of above background concentrations in sulfate and manganese. Assuming PN106S is in a similar location within the

groundwater flow system to MW4, it would appear the trends in Dec 1989 have continued to increase as noted by continued rise in:

i. Sulfate (~75 mg/L in 1989 compared to 440 mg/L in 2009); and
ii. Manganese (6 mg/L compared to 16 mg/L)

4) Manholes: Results of water samples from all seven manholes were relatively similar in chemistry, but positioned part way between the tailings dam water and that of the bedrock monitoring wells. They were characterized with a fresh (TDS 189 to 311 mg/L) calcium-sulfate type water, with an alkalinity of 47 to 64 mg/L and a near neutral pH (6.7 to 7.6). Sulfate (92 to 120 mg/L) and chloride (23 to 30 mg/L) are elevated. Iron (3.6 to 12 mg/L) and manganese (1.8 to 4.9 mg/L) are elevated. There is also a trend of increasing TDS downstream from 189 mg/L at MH1 to 311 mg/L at MH6. The chemistry and trends would suggest the seepage blanket is picking up the shallow portion of a Phase 1-2 acid plume and the trench in which the piping and manholes are located is picking up some additional seepage downstream.

This assignment was not directed at addressing the environmental issues of the Phase 1-2 acid plume extending eastward from the tailings dam. Its presence, however, does have two implications for this assignment, specifically:

1) The upward movement of the Phase 1-2 plume into the seepage blanket at the toe of dam has the potential for clogging the blanket and drain with iron/manganese precipitates, thereby rendering the drainage blanket inadequate to prevent seepage build ups within the dam; and

2) The possible need for treatment of the acid plume may necessitate consideration of developing a passive wetland treatment system within the settling basin.

Therefore; it is recommended that additional groundwater monitoring wells are required to confirm and, if so, delineate the extent and chemistry of the Phase 1-2 acid plume development under and downgradient of the dam. This would include collection and interpretation of all available chemistry on monitoring wells PN106S and D and PN105S and D. The level-of-effort should focus specifically on obtaining sufficient information to effectively address the two issues outlined above.

5.2.1.4 Conduct a Pump Test at the Main Manhole (Points 9, 10, 11)

ADI recommends an alternative method should be used to estimate the flow rate seeping through the dam.

Based upon the reduction in groundwater head in the dam and seepage blanket after cleaning of the manholes and associated piping this recommendation should be refined to a simple measuring of the flow rate out of the pipe.

Given the extent of iron precipitate developed within the piping, the reduced water levels may expose the seepage blanket and underdrain to oxygenated conditions allowing precipitate formation up within the seepage blanket. A camera inspection should be undertaken of the drainage pipe within the seepage blanket to determine the presence of any deterioration in the piping and/or iron precipitate build up with or without bio-fouling.

5.2.2 Remove Vegetation from Emergency Spillway and Slopes of the Dam (Point 15)

ADI agrees with this recommendation.

The removal of trees along the slopes of the Dam and emergency spillway channel has already been completed. Consideration should be given to additional cutting below the outfall of the emergency spillway channel.

5.2.3 Settling Pond Dam

5.2.3.1 Conduct a Detailed Inspection of the Settling Pond Dam (Points 19 and 20)

ADI agrees with this recommendation.

The absence of as-built information on the construction of the dam, its presence in a groundwater discharge zone and the absence of rip rap along the outer edge where large storm flows would move if discharged through the emergency spillway, necessitate a better understanding of the dam and its long-term viability. This is further reinforced by the possible need to maintain and convert it to a passive treatment system.

5.2.3.2 Assess Viability of Removing the Settling Pond Dam (Point 21)

ADI recommends that the settling pond remain in service at this time.

Given the iron precipitate and possible presence of an acid rock drainage groundwater plume this site may need to be retained and designed as a passive acid drainage treatment system.

5.3 Prepare an Operations, Maintenance and Surveillance Manual for Tailings Dam and Settling Pond Dam System (Point 1)

ADI agrees with this recommendation.

The Operations Maintenance and Surveillance Manual must give consideration to the new findings and recommended refinements of this report.

5.4 Additional Recommendations

An inundation study has been undertaken. It appears acceptable, although the calculations were not revisited and there were a lot of unknowns. Whether the assessment should be upgraded will depend upon regulatory requirements.

One item that was not covered was a cost analysis of the clean-up required after a dam breach. This would have to include excavating the tailings deposited over the wetland and stream downgradient of the dam, impact on fisheries, homes and infrastructure etc. Once this value is known the resultant cost/benefit analysis could be utilized to support the outlay of additional costs for maintenance.

5.5 Design Flood Capacity

The ADI (1998), JWA (2003) and AMEC (2008) Dam Safety Reviews all report that the capacity of the tailings basin is sufficient to handle the probable maximum flood (PMF). However, JWA (2003) mentions that in the occurrence of the PMF, applying a rainfall intensity of 673 mm in 24 hours, the available freeboard of the basin will be reduced to zero. In the 2008 Dam Safety Review, AMEC reveals an apparent discrepancy between the precipitation data used by JWA, and data provided by Environment Canada for the PMF.

Even with the substantial discrepancy in precipitation intensity, JWA's initial assessment indicated that the basin capacity was sufficient. However, some additional work is recommended as noted in Section 5.2.1.1.

5.6 Discharge Facilities

In 1998, ADI proposed the installation of a primary spillway and modifications to the emergency spillway, in order to provide discharge capacity for the PMF. With the construction of these facilities, it was reported by ADI (1998) that the PMF would be sufficiently routed to prevent overtopping of the retention dam. JWA (2003) did not

confirm the hydrologic model of the flood routing, however JWA did state that the primary spillway appeared to be sound in design, providing a suitable alignment and mostly capable erosion protection lining the primary spillway. AMEC (2008) assessed that the primary spillway appeared to be sufficiently designed to prevent any blockages and that acceptable erosion protection provided along the slopes and bottom of the spillway.

The secondary (emergency) spillway was noted by JWA (2003) to be lined only with the natural vegetation and erosion of the channel should be expected in the case of the PMF. AMEC (2008) reported thick growth of trees and other vegetation in the secondary spillway that would impede on the capacity for routing the PMF, which was also confirmed during the BGC/ADI site visit. It is recommended that trees and brush be cleared from the secondary spillway as a regular maintenance item.

6.0 OPERATIONS, MAINTENANCE AND SURVEILLANCE

An Operations, Maintenance and Surveillance Manual for the VJTB was completed by SGE Acres in 2004. There are some items that need to be appended to the Operations, Maintenance and Surveillance Manual, regarding any of the more recent changes to the VJTB facilities, such as: the monitoring of all the standpipe piezometers and a complete decommissioning of the existing manhole/pipeline system and replacement drainage system.

7.0 CONCLUSIONS AND RECOMMENDATIONS

A summary of recommendations from the previous DSR has been summarized in Table 1 in the Executive Summary. Recommendations from other Dam Safety Reports are included in Tables A1 to A4 in Appendix A.

Based on the review of the ADI (1998), JWA (2003) and AMEC (2008) Dam Safety Review Reports and the site inspection performed on 27 October 2009, ADI/BGC has identified a priority list of items to be addressed:

1) The existing manhole and pipeline system currently providing drainage for the toe drain has been modified by removing a blockage in the pipe. The drainage system should be replaced with a new open drainage channel or new pipe system for discharge to the polishing pond.

2) Perform chemical analysis on water collected from the toe drain, drainage system and shallow bedrock to identify seepage origin and mechanisms. Results may indicate the need for additional work on the seepage blanket and that a Passive Treatment System will be required to treat this seepage water.
3) Install three new vibrating wire or pneumatic piezometers within the embankment fill of the retention dam.
4) Video camera inspection of existing 0.3 metre diameter perforated corrugated steel pipe which is intended to intercept seepage through the dam. This is recommended to investigate the existing condition of this pipe and long-term reliability of this toe drain system. The concern is related to iron precipitate clogging of the drainage blanket.
5) Cut and clear trees and brush from secondary spillway. Include this action as part of the regular maintenance schedule prescribed in the Operations, Maintenance and Surveillance Manual.
6) Update the Operations, Maintenance and Surveillance Manual with the following:
    a. Include herbicide application to exposed vegetative roots after cutting and clearing the downstream slope face.
    b. Perform regular maintenance of the dam crest including but not limited to: cutting and clearing vegetation, filling depressions with suitable granular material, resurfacing with a lift of suitable granular fill.
    c. Inspect rip rap on upstream face of the retention dam on a regular basis, noting any changes potentially affecting performance of the riprap lining.
    d. Any changes to the facilities that have occurred since 2004 or any changes to Operations, Maintenance and Surveillance Manual procedures as prescribed by the CDA Dam Safety Regulations (2007).
7) The recommended dam classification should remain as very high and a Dam Safety Review conducted every 5 years. A complete summary of the recommendations printed in the ADI (1998), JWA (2003) and AMEC (2008) Dam Safety Review reports along with the corresponding ADI/BGC recommendations/comments are provided in Table 1 of the Executive Summary.
8) Update existing hydrological modelling incorporating new information, including a drought analysis and hydrogeological modelling of peak storm events to investigate impacts on the seepage blanket.

APPENDIX A:

Table A1 – ADI Dam Safety Report (1998)

Table A2 – JWA Dam Safety Review (2003)

Table A3 – AMEC Dam Safety Review (2009)

Table A4 – Summary of Recommendations

Table A1 – ADI Dam Safety Report (1998)

ITEM	ISSUE	LOCATION	STATUS	ADI/BGC RECOMMENDATION
ADI Dam Safety Report (1998)				
1	Construct north abutment spillway to provide runoff discharge for the 1/100 year precipitation	Retention Dam to Polishing Pond	NAR	Completed
2	Seal existing decant structure to prevent diversion of water to associated pipelines	Retention Dam	NAR	Completed
3	Cut tree growth on dam slope and apply herbicide to exposed surface	Retention Dam	NIA	Include as a regular maintenance item in OMS manual.
4	Control excess seepage localized at the centre of the dam by installing a buttress berm	Retention Dam	NAR	Completed
5	Install standpipe piezometers in dam core along crest and slope	Retention Dam	ACT	Existing monitoring wells have been installed to depths exceeding the dam fill, with screens at the bedrock contact. New standpipe piezometers should be installed with screen depths limited to within the dam fill.
6	Abandon current seepage drainage through manholes and buried pipe system	Retention Dam to Polishing Pond	ACT	Construct and implement new open drainage channel or new pipe system for seepage discharge to polishing pond.
7	Prepare written operations manual	Retention Dam and Polishing Pond Dam	ACT	SGE Acres 2004 OMS manual should be reviewed and updated to reflect new facilities, installations and regulations (Canadian Dam Association, 2007).
8	Confirm continuing satisfactory performance of sand stone rip rap lining on upstream slope	Retention Dam	NIA	Include as a regular maintenance item in OMS manual.

Status Definitions:
NIA - No immediate action
PA – Possible Action
ACT – Action
NAR – No Action Required

Table A2 – JWA Dam Safety Review (2003)

ITEM	ISSUE	LOCATION	STATUS	ADI/BGC RECOMMENDATION
JWA Dam Safety Review (2003)				
1	Treat remaining vegetation/roots (after cutting and clearing) on dam face with herbicide	Retention Dam downstream slope	NIA	Include in regular maintenance schedule to be defined in OMS Manual
2	Install Standpipe piezometers	Retention Dam	ACT	Recommended in 2003 in the absence of any monitoring wells. However, new standpipe piezometers should be installed with screen depth limited to within the dam fill layer
3	Change downstream drainage blanket discharge	Retention Dam	ACT	Decommission manhole and buried pipe system. Install new open channel or pipeline for discharge
4	Prepare policy manual for Operation, Maintenance and Surveillance.	Retention Dam and Settling Pond Dam	ACT	(SGE Acres 2004 manual) - should be updated for any facility design or installation changes and regulation changes (CDA 2007).
5	Cut and clear all tree growth at 5 year intervals on crest and slopes	Retention Dam crest/downstream slope	NIA	Continue with cutting and clearing as part of the regular maintenance schedule (include in OMS manual).
6	Place lift of well-graded gravel to restore or exceed the design crest elevation and provide protection from rutting/washout	Retention Dam crest	PA	Maintaining the crest elevation and surface condition should be included in the regular maintenance schedule (OMS manual).
7	Cut and clear all tree growth on the secondary spillway	Secondary Spillway slopes and bottom	ACT	Cutting and clearing of growth inhibiting the capacity of the secondary spillway should be included in the regular maintenance schedule (OMS manual).
8	Provide wave barrier to prevent overtopping due to PMF	Retention Dam upstream side of crest	PA	Hydrologic design parameters (PMF) need to be reviewed due to discrepancy between JWA 2003 and Environment Canada 2007. Re-evaluation of pond elevation due to PMF will determine necessity of wave barrier installation
9	Conduct inundation study and risk analysis	Retention Dam	PA	Inundation study and risk analysis may need to be revisited (SGE Acres 2004) due to possible change in hydrologic input parameters for PMF.

Status Definitions:
NIA - No immediate action
PA – Possible Action
ACT – Action
NAR – No Action Required

Table A3 – AMEC Dam Safety Review (2009)

ITEM	ISSUE	LOCATION	STATUS	ADI/BGC RECOMMENDATION
AMEC Dam Safety Review (2009)				
1	Prepare Operations, Maintenance and Surveillance Manual	Retention Dam Settling Pond Dam	ACT	Minor adjustments to SGE Acres OMS Manual
2	Conduct Annual Dam Safety Inspection	Retention Dam	NIA	Follow normal procedures
3	Conduct Dam Safety Review every 7 years	Retention Dam	NIA	Follow normal procedures
4	Review precipitation data and determine necessity of updating hydraulic and hydrologic analyses	Retention Dam	PA	Agreed given climate change and availability of new stream flow data. Also assess impact of droughts on water cover and incorporate hydrogeological modeling to assess impact of high water levels on viability of seepage blanket.
5	Review monitoring well conditions and recorded water levels	Retention Dam	ACT	Install monitoring wells within fill layer only and monitoring wells within in bedrock only
6	Confirm actual geotechnical properties of fill and foundation soils (compared to as-built and design)	Retention Dam	NIA	Native glacial soil properties are well documented and additional boreholes for new monitoring well installation will confirm in-situ conditions
7	Test water chemistry/quality (aid in identifying seepage mechanism)	Tailings Pond Monitoring Wells Downstream Drain	ACT	Agreed and should be expanded to assess impact of acid rock drainage plume on functioning of seepage blanket., as well as the need for and, if so, the design of a passive wetland treatment.
8	Conduct pumping test at main manhole to determine flow through dam	Retention Dam Main Manhole	NIA	Install a weir at point of downstream seepage discharge to monitor amounts of seepage through the dam
9	Conduct test pit investigation (check drain-clogging potential and corrugated steel pipe performance)	Retention Dam: toe drain and drainage pipe	NIA	No immediate action, see Item 11 below
10	Investigate connection/pipeline between MH 1, 2 and 7	Pipeline system	ACT	Decommission/abandon manhole system. Install new open channel or pipeline for discharge
11	Conduct video inspection of drain pipe in toe drain	Retention Dam: toe drain	NIA	Recommend video camera inspection of drainage pipe, access through MH1

Table A3 – AMEC Dam Safety Review (2009) (cont'd)

ITEM	ISSUE	LOCATION	STATUS	ADI/BGC RECOMMENDATION
AMEC Dam Safety Review (2009)				
12	Assess potential risks caused by failure of toe drain pipe	Retention Dam	ACT	See Item 11, determine phreatic level in the embankment and adjust discharge of the dam drainage blanket
13	Update dam stability analysis using actual phreatic surface data	Retention Dam	ACT	Requires installation of additional monitoring wells as noted in Item 5
14	Perform maintenance of dam crests	Retention Dam	ACT	To be conducted as routine maintenance as indicated in the OMS manual
15	Remove vegetation	Emergency Spillway Bottom Retention Dam Slopes	ACT	To be conducted as routine maintenance as indicated in the OMS manual
17	Investigate the riprap size, shape, quality and layer thickness	Retention Dam Slopes	ACT	To be conducted as routine maintenance and added to the OMS manual
18	Develop plan for removal of vertical decant tower	Retention Dam	NIA	Decant tower to be removed at owner's discretion
19	Inspect Settlement Pond Dam in detail	Setting Pond	ACT	Based on 2009 inspection, the settling pond dam is stable. The Dam Safety Report of 2013-2014 should be expanded to include this structure. Conduct yearly inspection as per Item #2.
20	Survey Settlement Pond Dam	Setting Pond	NAR	Include in next Dam Safety Review
21	Assess option of removing Settling Pond Dam	Setting Pond	ACT	See Item 19, use as a passive treatment pond
22	Printed / Digital Topographic Information	All Areas	ACT	Convert all mapping and drawings to SI units and include in PWGSC GIS database.

Status Definitions:
NIA - No immediate action
PA – Possible Action
ACT – Action
NAR – No Action Required

Table A4 – Summary of Common Recommendations of 1998, 2003 and 2008 Dam Safety Reviews

ITEM	ISSUE	LOCATION	STATUS	ADI/BGC RECOMMENDATION
Summary of Recommendations Common Items (ADI, JWA & AMEC)				
1	Cut tree growth on dam slope and apply herbicide to exposed surface	Retention Dam	NIA	Include as a regular maintenance item in OMS manual.
2	Install standpipe piezometers in dam core along crest and slope	Retention Dam	ACT	Existing monitoring wells have been installed to depths exceeding the dam fill, with screens at the bedrock contact. New standpipe piezometers should be installed with screen depths limited to within the dam fill.
3	Abandon current seepage drainage through manholes and buried pipe system	Tailings Pond to Polishing Pond	NAR	Completed
4	Prepare policy manual for Operation, Maintenance and Surveillance.	Retention Dam and Settling Pond Dam	ACT	(SGE Acres 2004 manual) - should be updated for any facility design or installation changes and regulation changes (CDA 2007).
5	Cut and clear all tree growth on the secondary spillway	Secondary Spillway slopes and bottom	ACT	Cutting and clearing of growth inhibiting the capacity of the secondary spillway should be included in the regular maintenance schedule (OMS manual).

Status Definitions:
NIA - No immediate action
PA – Possible Action
ACT – Action
NAR – No Action Required

APPENDIX B: Oblique Aerial Photographs Taken 30 October 2009, Courtesy of ADI Limited

APPENDIX C: Construction Photographs Courtesy of F. Baechler

Oblique Aerial Photos Prior to Construction - October 1979

Site Construction Photos -July 1982

APPENDIX D: Memo Re: Site Inspection 27 October 2009

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CANADA'S 50 BEST MANAGED COMPANIES

MEMORANDUM

PROJECT NO: L 1573 048.1

TO: Brain Latimer

FROM: Fred Baechler,

DATE: 28 October '09

RE: **VJ TAILINGS DAM - SITE INSPECTION 27 OCTOBER 09**

A summary of pertinent hydrogeological field measurements and observations collected during the site inspection of 27 Oct.'09 are provided below. Conditions monitored represent a mid Fall non-rainfall event, with no heavy rain this date or the previous day.

1) All photos have been saved digitally within the Project Number - Graphics - 27 Oct FB

2) Locations of all pertinent points were obtained with a Garmin hand held GPS unit in the field, as noted below:

- √ Secondary Lagoon
  - O Sampling Point near outflow: 20T0721098; UTM5119834
  - O Sampling Point at inflow: 20T0721058; UTM5120104
- √ Surcharging Manhole 20T0721019; UTM5120083
- √ Monitoring Wells
  - O farthest from dam: 20T0720831; UTM5119934
  - O top of Butress Berm: 20T0720784; UTM5119976
  - O east edge of dam: 20T0720778; UTM5119978
  - O west edge of dam: 20T0720769; UTM5119977
- √ Sampling Point Lagoon water(adjacent to):20T0720769; UTM5119977
- √ Puddles:
  - O #1 (adjacent to): 20T0720831; UTM5119934
  - O #2 (adjacent to): 20T0720784; UTM5119976
  - O #3 20T0720793; UTM5119995
  - O #4 (adjacent to #3)
  - O #5 (rock lined swale) 20T0720805; UTM5119971
  - O #6 20T0720782; UTM5119831
  - O #7 (directly west of #6)

2) Conductivities (C) and temperatures (T) were measured in the field with a YSI meter at selected water sources (identified as "Puddles" with GPS points and Photos) in an attempt to characterize sources. Five different types were recognized using these two indicators. Additional characterization, if so required, would necessitate collection and laboratory analysis for major ion chemistry. In that regard the following information is pertinent:

√Rain Waters:
found in Puddles on the top of Butresss Berm (Puddle #2)and dam (Puddle #7) exhibited low C (32 - 38 us/cm) and T (7-8 ^{0}C) as expected.

√Tailings Lagoon:
C rose to 81 us/cm but still with a low T of 6.5 ^{0}C

√Seepages at Toe of Dam:
Puddles #3 and 4 in the area which apparently always remains wet had a C of 67 to 68 us/cm with a temperature of 7.6 ^{0}C
Puddle #6 south of low point in valley floor had a C of 40 us/cm with a temp of 8.7 ^{0}C - this more closely approximates rain water than lagoon water and may not be a seepage
Puddle #1 on roadway some distance from toe-of-slop had an elevated C of 184 us/cm with a T of 9 ^{0}C - more closely approximates although lower than bedrock groundwaters - perhaps a mixture of a number of sources
Puddle #5 in rock lined swale below dam extension (was overflow from decant tower if required - but now that overflow pipe is apparently sealed) exhibited an elevated C of 222 us/cm with an 8.3 ^{0}C temperature - more closely approximating bedrock groundwaters.

√Underdrain Surcharging Overflow Pipe:
Exhibited elevated C (238 us/cm) and T of 11 ^{0}C- resembling bedrock groundwater

√Secondary Lagoon:
Inflow and outflow waters were similar and slightly lower than tailings lagoon water with a C of 60 to 63 us/cm and T of 7.0 to 7.1 ^{0}C

3) Of all the sampling points the only ones exhibiting some visual signs of iron, whether as a staining, precipitate or floc, were the ones with C resembling bedrock groundwaters i.e. the Underdrain surcharging overflow pipe and Puddle #5 in the rock lined swale.

This maybe: A)a natural phenomenon associated with natural bedrock groundwaters in a groundwater discharge zone, or B) impacted by tailings contacted water. At the present time the first scenario is thought to offer the more reasonable explanation. Confirmation would require lab analysis of the waters.

4) A suggested sampling program for laboratory analysis to further characterize water chemistry would include collecting water samples and pertinent field information during a non-rainfall event. Samples would be analyzed for RCAp and metal scans (both field filtered - metals acidified) at the following locations:

√1) outflow from tailings lagoon at spillway
√2) outflow from secondary lagoon just above concrete spillway
√3) overflow at surcharging manhole (identified above)
√4) Puddles #3,5 and 6
√5) all 4 monitoring wells

Field observations would include:

√ head levels in monitoring wells, head level in tailings lagoon (all tied to geodetic),
√ discharge at Puddles #3 and 5, surcharging manhole just before it enters spillway and outflow from secondary lagoon
√ field chemistry (conductivity, TDS, DO, temperature, pH, eH and colour)
√ photos