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INDEPENDENT REVIEW OF 2014 DAM SAFETY INSPECTION REPORT

Nickel Plate Tailings Dams

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REPORT



Reference Number: 1412161-005-Rev0-3000

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Executive Summary

Golder Associates Ltd. (Golder) was engaged by Barrick Gold Inc. (Barrick) to perform an independent review of the 2014 Dam Safety Inspection report for Nickel Plate Mine, BC, produced by Knight Piesold Consulting (KP). The work was commissioned on September 23, 2014, in response to Golder's proposal P1412161-001-P-Rev0.

The independent review was required based on the *Notification of Chief Inspector's Orders – Tailings Dams – Independent Review of Dam Safety and Consequence Classification* from the British Columbia Ministry of Energy and Mines (BC MEM) dated August 18, 2014 (BC MEM 2014).

The scope of the review included the following:

- site visit by Mr. John Hull, P.Eng. on October 9, 2014, to observe the condition and status of the tailings dams; and
- review of the draft 2014 Dam Safety Inspection (DSI) report for the Nickel Plate Tailings Facility produced by KP, reference VA101-3/19-1 Rev A, dated September 29, 2014 (KP 2014).

The findings of Golder's review are as follows:

- The DSI report prepared by KP general addresses the elements required by the BC MEM (2012); however there is no formal review of the 2014 climate data in the area of the tailings facility. An overview summary of climate data is noted, which states 2014 was a wet year at the mine site. There was no water balance developed based on the 2014 climate information.
- The dam consequence classification appears appropriate.
- The report provides a clear documentation of the status of the tailings dams.

The following are recommended:

- The DSI notes that the water level in the Tailings Facility and the phreatic surface under the tailings embankment are increasing and if this condition or trend continues in 2015, a dam stability assessment would be recommended in 2015.
- A Dam Safety Review should be completed in 2015.



Study Limitations

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1.0 INTRODUCTION

Golder Associates Ltd. (Golder) was engaged by Barrick Gold Inc. (Barrick) to perform an independent review of the 2014 Dam Safety Inspection (DSI) report for Nickel Plate Mine, BC, produced by Knight Piesold Ltd. (KP). The work was commissioned on September 23, 2014, in response to Golder's proposal P1412161-001-P-Rev0.

The independent review was required based on the *Notification of Chief Inspector's Orders – Tailings Dams – Independent Review of Dam Safety and Consequence Classification* from the British Columbia Ministry of Energy and Mines (BC MEM) dated August 18, 2014 (BC MEM 2014). This order states:

The mine manager must have the DSI reviewed by an independent qualified third party professional engineer from a firm that has not been associated with the tailings dam. The Independent Third Party Review of the DSI must also include a review of the dam consequence classification.

The scope of the review included the following:

- site visit by Mr. John Hull, P.Eng. on October 9, 2014, to visually observe the condition and status of the tailings dams; and
- review of the draft 2014 Dam Safety Inspection (DSI) report for the Nickel Plate Tailings Facility prepared by KP, reference VA101-3/19-1 Rev A and dated September 29, 2014 (KP 2014).

The independent review is not a Dam Safety Review as defined in the *Dam Safety Review Guidelines* produced by the BC Dam Safety Section (BC MEM 2012), Section 5 of the *Canadian Dam Safety Guidelines* (CDA 2013) and in the *Professional Practice Guidelines – Legislated Dam Safety Reviews in BC* produced by the Association of Professional Engineers BC (APEGBC 2014).



2.0 BACKGROUND

2.1 Site Description

The Nickel Plate mine was an open pit and underground operation located 3 km northeast of Hedley in southern British Columbia. The mine was located at the south end of the Thompson Plateau. The main tailings pond and dam and the contingency ponds are shown in Photographs 1 and 2 in Appendix A.

The mine tailings facilities and dams are summarized in Table 1.

Table 1: Summary of Nickel Plate Dams

Impoundment	Dam	Status/Comments
Tailings Facility	Tailings Embankment	The main tailings facility pond is closed, with a water pond adjacent to north corner of the tailings facility.
Tailings Facility	Contingency Pond	Water pond away from dam in north corner of TMF. Inside tailings embankment footprint.
Tailings Facility	Sediment Pond Dam	Downstream containment from the tailings facility.
Freshwater Pond	Freshwater Dam (Mascot Pond Dam)	The pond adjacent to the tailings facility stores water for contingency for water treatment operation.

2.2 Design Consultant

The original design consultant for the Nickel Plate Mine Tailings Facility was Robinson Dames and Moore and SRK-Robinson. The initial dam was built in 1986 with two centerline raises and one upstream raise to 1992. The dam is a zoned construction with a chimney drain and foundation drain. The final raises after 1992 were designed by KP. The mine continued to operate until 1996. The mine is now owned by Barrick and the current design consultant is understood to be KP.

The preparation of this report by Golder does not impact the design consultant role held by KP.



3.0 INDEPENDENT REVIEW OF DAM SAFETY INSPECTION REPORT

3.1 Compliance with Ministry of Energy and Mines Requirements

The requirements for DSIs are presented in *Guidelines For Annual Dam Safety Inspection Reports* (BC MEM 2012). Table 2 summarizes the compliance or otherwise of the BGC DSI report with the BC MEM requirements.

Table 2: Compliance of Dam Safety Inspection Report with British Columbia Ministry of Energy and Mines Dam Safety Inspection Requirements

Requirement	Included	Comment
Executive Summary	✓	Very High
Classification of the dam(s) in terms of Consequence of Failure in accordance with Table 2-1 of the CDA Dam Safety Guidelines (2013).	✓	
a. Significant changes in instrumentation and/or visual monitoring records.	✓	
b. Significant changes to dam stability and/or surface water control.	✓	
c. For major impoundments, as defined in Part 10 of the Code, a current Operation, Maintenance and Surveillance (OMS) Manual is required. The annual report shall indicate the latest revision date of the OMS manual.	✓	December 2013
d. For tailings dams classified as High, Very High, or Extreme Consequence, an Emergency Preparedness Plan (EPP) is required. The annual report shall indicate the latest revision date of the EPP document.	✓	December 2013
e. Scheduled date for the next formal Dam Safety Review in accordance with Table 5-1 of the CDA Dam Safety Guidelines (2013). Formal Dam Safety Reviews are required every 5 to 10 years (depending on consequence classification) and differ from annual dam safety inspections. The requirements for Dam Safety Reviews are included in Section 5 of the CDA Dam Safety Guidelines. Dam Safety Reviews may be conducted by the Engineer of Record with third party review, or by an independent third party with involvement of the Engineer of Record.	✓	Proposed 2015
Summary of past years' construction (if any) with a description of any problems and stabilization	✓	
Plan and representative cross-sections	✓	
Site photographs	✓	
Review of climate data	X	Reviewed 2014 climate data, but no summary of data
Water balance review	X	Water balance checked based on current configuration of the pond (Contingency Pond) in TMF
Freeboard and storage availability (in excess of the design flood)	✓	
Water discharge system, volumes, and quality	✓	Water quality reported by Barrick
Seepage occurrence and water quality	✓	
Surface water control and surface erosion	✓	
Instrumentation review including: (a) Phreatic surfaces and piezometric data (b) Settlement (c) Lateral movement	✓	Instrumentation is in the dams to monitor phreatic surfaces, settlement or lateral movement and reviewed.



3.2 Dam Consequence Classification

Tailings dams in British Columbia are regulated under the *Health, Safety and Reclamation Code for Mines in British Columbia* (BC MEMPR 2008), which references Canadian Dam Association (CDA) *Dam Safety Guidelines* (CDA 2007). The CDA (2007) dam consequence classification system is consistent with the revised CDA guidelines (CDA 2013).

Consequence categories are based on the incremental losses that a failure of the dam might inflict on downstream or upstream areas, or at the dam location itself. Incremental losses are those over and above losses that might have occurred in the same natural event or condition had the dam not failed. The classification assigned to a dam is the highest rank determined among the four loss categories.

Table 3 presents the dam classification criteria by CDA (2013).

Table 3: Dam Classification in Terms of Consequences of Failure

Dam Class	Population at Risk ^(a)	Incremental Losses		
		Loss of Life ^(b)	Environmental and Cultural Values	Infrastructure and Economics
Low	None	0	Minimal short term loss. No long term loss.	Low economic losses; area contains limited infrastructure or service.
Significant	Temporary Only	Unspecified	No significant loss or deterioration of fish or wildlife habitat. Loss of marginal habitat only. Restoration or compensation in kind highly possible.	Losses to recreational facilities, seasonal workplaces, and infrequently used transport routes.
High	Permanent	10 or fewer	Significant loss or deterioration of important fish or wildlife habitat. Restoration or compensation in kind highly possible.	High economic losses affecting infrastructure, public transport, and commercial facilities.
Very High	Permanent	100 or fewer	Significant loss or deterioration of critical fish or wildlife habitat. Restoration or compensation in kind possible but impractical.	Very high economic losses affecting important infrastructure or services (e.g., highway, industrial facility, storage facilities for dangerous substances).
Extreme	Permanent	More than 100	Major loss of critical fish or wildlife habitat. Restoration or compensation in kind impossible.	Extreme losses affecting critical infrastructure or services (e.g., hospital, major industrial complex, major storage facilities for dangerous substances).

Source: CDA (2013).

- a) Definition for population at risk:
None – There is no identifiable population at risk, so there is no possibility of loss of life other than through unforeseeable misadventure.
Temporary – People are only temporarily in the dam-breach inundation zone (e.g., seasonal cottage use, passing through on transportation routes, participating in recreational activities).
Permanent – The population at risk is ordinarily located in the dam-breach inundation zone (e.g., as permanent residents); three consequence classes (high, very high, extreme) are proposed to allow for more detailed estimates of potential loss of life (to assist in decision-making if the appropriate analysis is carried out).
- b) Implications for loss of life:
Unspecified – The appropriate level of safety required a dam where people are temporarily at risk depends on the number of people, the exposure time, the nature of their activity, and other conditions. A higher class could be appropriate, depending on the requirements. However, the design flood requirement, for example, might not be higher if the temporary population is not likely to be present during the flood season.

CDA = Canadian Dam Association



INDEPENDENT REVIEW OF 2014 DAM SAFETY INSPECTION - NICKEL PLATE MINE TAILINGS DAMS

The tailings facility is located at the top of the Cahill Creek valley above the Similkameen valley and river. A dam failure would have a significant impact on the environment in the Similkameen valley and to the Similkameen River below the mine site and dam. There are no permanent dwellings immediately below the Cahill Valley, but Highway 3 is located at the bottom of the valley on the north side of the river. The impact to the highway would be significant. The Tailings Embankment Dam has been classified as Very High consequence structure based on the impact which would occur to the environment and the economic loss anticipated in the restoration of the Cahill Valley after a failure.

The 2014 DSI (KP 2014) reassessed the dam classifications and reviewed a dam break analysis (EBA 2013) to confirm the dam classifications. On this basis, the Nickel Plate tailings dam classifications are assessed as shown in Table 4.

Table 4: Dam Consequence Classifications

Dam	Population at Risk	Incremental Losses		Dam Consequence Classification
		Environmental and Cultural Values	Infrastructure and Economics	
Tailings Embankment	Permanent 10 or fewer	Significant loss or deterioration of critical fish or wildlife habitat. Restoration or compensation in kind possible but impractical.	Very high economic losses affecting important infrastructure or services (e.g., highway, industrial facility, storage facilities for dangerous substances).	Very High
Freshwater Dam (Mascot Pond Dam)	Permanent 10 or fewer	Significant loss or deterioration of critical fish or wildlife habitat. Restoration or compensation in kind possible but impractical.	Very high economic losses affecting important infrastructure or services (e.g., highway, industrial facility, storage facilities for dangerous substances).	Very High

A possible dam break for the Freshwater Dam was also reviewed by EBA, as a failure of the Freshwater Dam would result in a failure of the west portion of the Tailings Embankment (Photograph 3 in Appendix A). The review indicated that the Freshwater Dam should be classified as a Very High consequence dam. The 2014 DSI references the dam break evaluation (EBA 2013) and the dam classification proposed by KP agrees with the dam break report (KP 2014).

The consequence of failure of the two dams is considered to be consistent with the classification assigned by KP (2014). The dam classifications assigned by KP (2014) are considered appropriate.

The dam consequence classification typically influences the selection of the design earthquake, design flood event and the frequency for Dam Safety Reviews. The 2014 DSI reassessed the dam classification and reviewed the proposed design earthquakes and flood events for the current dam classifications. The review indicates the dams satisfy the CDA (2014) criteria for closure – active care facilities.



3.3 Observations from Site Visit

Photographs from the October 1, 2014, site visit are presented in Appendix A.

Observations did not indicate potential dam safety concerns:

- The downstream slope of the Tailings Embankment appears to be dry and there was no indication of any 'wet' areas noted from the previous DSI.
- The lined ponds on the north end of the tailings facility appear to be in good condition, and functioning as designed.
- The spillway channel to the Sediment Pond is clear and there are no concerns with managing flows from the tailings pond area (Photograph 4 in Appendix A).
- The downstream slope of Tailings Embankment is in good shape and no cracking, settlement or movement of the downstream dam slope was noted (Photograph 5 in Appendix A). A half-round culvert on the downstream slope appears to be moving or has moved and should be re-anchored (Photograph 6 in Appendix A).
- The seepage collection ditches are in good shape and no maintenance is suggested or required. On-going maintenance will likely be required.
- The Freshwater Dam is in good shape. The water level in the pond was some 3 to 4 m below the dam crest.



4.0 FINDINGS AND RECOMMENDATIONS

4.1 General Findings

The general findings of Golder's review are as follows:

- The DSI report prepared by KP generally addresses the elements required by the BC MEM (2012) with the exception that there was no review of the 2014 climate data and no current or updated water balance for the Nickel Plate Tailings Facility.
- The dam consequence classifications appear appropriate and reflect a recent dam break evaluation (EBA 2013).
- The report provides an interpretation of the impact of recent updates to the CDA guidelines (CDA 2014) with respect to the Nickel Plate Tailings Facility. The report describes the current status and performance of the tailings dams.
- The DSI notes that the water level in the Tailings Facility and the phreatic surface under the Tailings Embankment are increasing and if this condition or trend continues in 2015, a dam stability assessment would be recommended in 2015.
- A Dam Safety Review is due in 2015.

4.2 Instrumentation

The instrumentation (piezometers) in the tailings pond and under the Tailings Embankment was reviewed in detail and a clear summary of monitoring results was provided (KP 2014). The water levels in the tailings pond and phreatic surface through the dam were evaluated. The review of the data indicate, as a result of a wet spring and summer, that some of the piezometers recorded higher than average water levels. Most of these piezometers indicated a falling water table in the late summer and fall. There were, however, several piezometers which did not show a decrease in water level in late 2014. It was recommended that all piezometers be carefully monitored and checked during the 2015 freshet and early summer period; and if the water levels stay at or above the 2014 levels the dam stability should be checked for the higher water levels.

4.3 Prioritization of Recommended Action Items

Several actions are recommended by KP and the recommendations are reasonable and will enhance the safety of the tailings facility and dams. Golder notes that none of recommendations relate to immediate dam safety concerns and the recommendations should be managed in 2015.



INDEPENDENT REVIEW OF 2014 DAM SAFETY INSPECTION - NICKEL PLATE MINE TAILINGS DAMS

5.0 REPORT CLOSURE

We trust that this Independent Review of the 2014 Dam Safety Inspection Report of the Nickel Plate mine tailings dams (KP 2014) meets your requirements. Please contact the undersigned if you require additional information regarding this review.

GOLDER ASSOCIATES LTD.

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APPENDIX A

Photographs



APPENDIX A PHOTOGRAPHS



Photograph 1: Overview of Tailings Facility, October 9, 2014



Photograph 2: Lined Pond and Contingency Pond at North End of Tailings Facility, October 9, 2014



APPENDIX A PHOTOGRAPHS



Photograph 3: Toe of Freshwater Dam Adjacent to Tailings Facility, October 9, 2014



Photograph 4: Contingency Pond Spillway, October 9, 2014



APPENDIX A PHOTOGRAPHS



Photograph 5: Downstream Slope of Tailings Embankment, October 9, 2014



Photograph 6: Culvert On Tailings Embankment Slope, October 9, 2014

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