Appendix C.3

Summary of the Geotechnical Conditions for the Thor Lake Project – Tailings Area T4. Report NB09-00733

Knight Piésold
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MEMORANDUM

To:	Mr. David Swisher	Date:	December 9, 2009
Copy To:	Bill Mercer, Jason Cox	File No.:	NB101-390/1-A.01
From:	Érika Voyer	Cont. No.:	NB09-00733
Re:	Summary of the Geotechnical Conditions for the Thor Lake Project – Tailings Area T4		

This memorandum summarizes the review of the expected geotechnical conditions of the Area T4 in the area of Buck Lake and Ring Lake for the Avalon Rare Metals Inc. (Avalon) Thor Lake Project (The Project), as part of the Pre-feasibility Study (PFS) support. The proposed general locations of the facilities are presented on Figure 1. Further to options previously presented for The Project, Tailings Area T4 was selected as the preferred arrangement for the PFS. No site investigations have been completed at this stage of the project. This memo should be considered part of the previous Summary of the Geotechnical Conditions for the Thor Lake Project summarized in KPL Memo Cont. No. NB09-00660, dated November 16, 2009. The overview of the site conditions and of the permafrost conditions for The Project can also be found in this previous memo.

EXPECTED GEOTECHNICAL CONDITIONS FOR TAILINGS MANAGEMENT AREA

This section outlines the expected geotechnical conditions in the proposed Tailings area T4 in the area of Ring and Buck Lakes. The information is based on site visit observations and satellite imagery analysis. This information will need to be confirmed by site reconnaissance, test pits and/or drilling at later stages of study.

Site T4 consists of a natural basin northeast of Thor Lake bounded on the north by the Rim Syenite ridge and on the south by some hummocky bedrock knolls. The T4 basin includes Ring Lake and Buck Lake, as shown on Figure 2. The T4 basin drains south into Drizzle Lake then Murky Lake before entering Thor Lake. Based on the topography, site T4 offers good natural containment, which will minimize the amount of required construction for the tailings facilities. The large Syenite bedrock ridge with minimal overburden coverage extends from the northwest side of Ring Lake to the north side of Buck Lake, as shown on the satellite imagery on Figure 2 and on the photograph in Figure 3. The southeast side of Ring and Buck Lakes include smaller bedrock ridges of various elevations. Several areas of exposed bedrock are located around the containment basin of T4, providing a good containment capacity and potentially reducing the amount of required dam construction. Exposed bedrock also provides generally good foundation for the embankment construction.

Within and around the containment basin area of T4, there are some potential till deposits that could be used as construction material sources, as determined using the satellite imagery. These sources of material are recommended since the excavation in these areas would provide additional tailings storage. The potential material sources are generally located in low level areas between bedrock outcrops, as displayed on Figure 2. These areas probably include thin till deposit, according to the general topography and the presence of numerous bedrock outcrops. These potential material sources are probably well drained. However, from the satellite imagery analysis, there are some potential areas poorly drained including fine and organic material within the containment basin, especially between Ring and Buck Lake. It is likely that these areas include some permafrost.

Development of the tailings facility site will consist mainly of clearing, stripping and grubbing to remove trees, small vegetation and organic material. Excavation of material for foundations for the dams is generally expected to be relatively shallow, as the material deposits in the area appears to be generally thin. Some deeper excavation may be required in some areas of the containment basin to remove permafrost soils if present.

Two test pits have been conducted northeast of Ring Lake, as part of the site investigations completed in 2008 by Jacques Whitford [1]. As recommended previously in memo No. NB09-00660, additional test pitting and drilling programs should be conducted in the dam locations, to assess overburden and bedrock conditions for future stages of the study. Hydrogeological drilling should also be considered within the containment basin, to assess the bedrock permeability and the groundwater patterns to analyse seepage possibilities. The hydrogeological conditions may be highly influenced by the presence of permafrost.

As previously noted in memo No. NB09-00660: *"Permafrost is expected within the area of the tailings facilities and will greatly influence the stability of the structures. As a result of the formation of a storage body, the permafrost in the bed of the reservoir can start to thaw rapidly and sometimes to a considerable depth [2]. As the result of thawing of the frozen soils, their physical-mechanical properties change and their bearing capacity can fall considerably, especially for ice rich permafrost [2]. There is inevitable settlement of the soil and the seepage properties can increase sharply [2, 3]. The thawing of frozen soils in the foundations of dams, particularly when containing inclusions or lenses of ice, can lead to settlement of the dam [2]. Permafrost distribution and characteristics are then essential to assess for the feasibility design of the tailings facilities."*

GENERAL RECOMMENDATIONS

Based on the review of the available information and expected ground conditions of The Project site, the recommendations made regarding future site investigation works to confirm geotechnical conditions in the previous memo No. NB09-00660 also apply to Tailings area T4 in order to gain information for the feasibility design of the required facilities.

Site reconnaissance, test pitting, drilling and sample collection and testing should be conducted in order to characterize the subsurface, types of material deposits, terrain and foundation conditions of Tailings area T4. Permafrost characteristics and distribution should also be assessed at the proposed location T4. The locations for potential sources of construction material, the local drainage conditions, the nature and parameters of the material should also be determined.

Signed: Érika Voyer, EIT
Geological Engineering

Approved: Matthew Parfitt, P.Eng.
Project Manager

M. R. PARFITT
DEC 09 2009

Attachments:

Figure 1 Rev 0	Preliminary Mine Site Layout
Figure 2 Rev 0	Tailings Management Area T4
Figure 3 Rev 0	Site Selected Photo from Site Visit – Tailings Management Area T4

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References:

1. Jacques Whitford Stantec AXYS Ltd., Thor Lake Rare Earths Project, Environmental Baseline Program Overview Summary, October 23, 2009
2. Trupak, N. G., Construction of earth dams on permafrost soils, Journal Power Technology and Engineering (formerly Hydrotechnical Construction), Springer New York, Volume 4, Number 9, September, 1970
3. Biyanov G. F., Experience in construction and operation of low-head dams on permafrost soils, Journal Power Technology and Engineering (formerly Hydrotechnical Construction), Springer New York, Volume 4, Number 9, September, 1970

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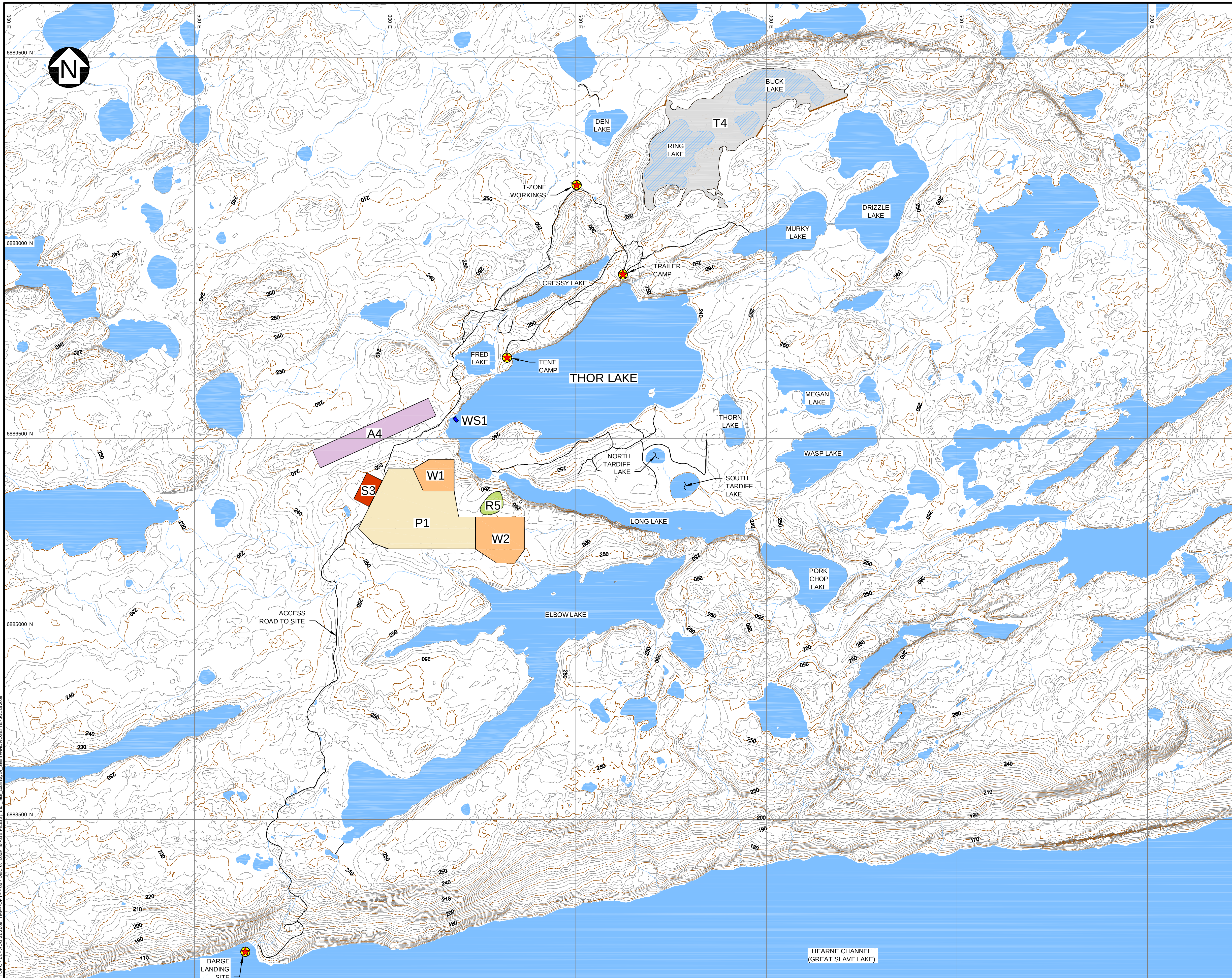

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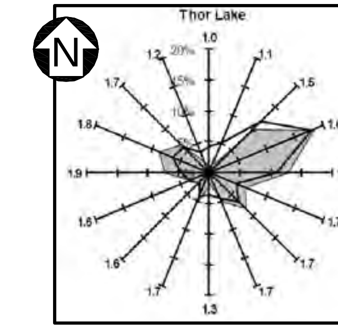

WIND ROSETTE
NTS

NOTE:
WIND ROSETTE PROVIDED BY AVALON RARE METALS INC.

LEGEND:

- R — RAMP PORTAL LOCATION
- P — PROCESS PLANT AREA
- T — TAILINGS MANAGEMENT AREA
- S — STAFF ACCOMMODATIONS AREA
- A — AIR STRIP LOCATION
- W — WASTE ROCK STORAGE SITE
- WS — WATER SUPPLY LOCATION
- WATER
- ROAD
- DAM LOCATION

NOTES:

1. COORDINATE GRID IS UTM (NAD83) ZONE 12N AND IS IN METRES.
2. PLAN BASED ON INFORMATION PROVIDED BY AVALON RARE METALS INC.
3. CONTOURS ARE IN METRES. CONTOUR INTERVAL IS 2 METRES.

FOR INFORMATION ONLY

SCALE 250 0 500 1000 1500 m

AVALON RARE METALS INC.

THOR LAKE PROJECT

PRELIMINARY MINE SITE LAYOUT

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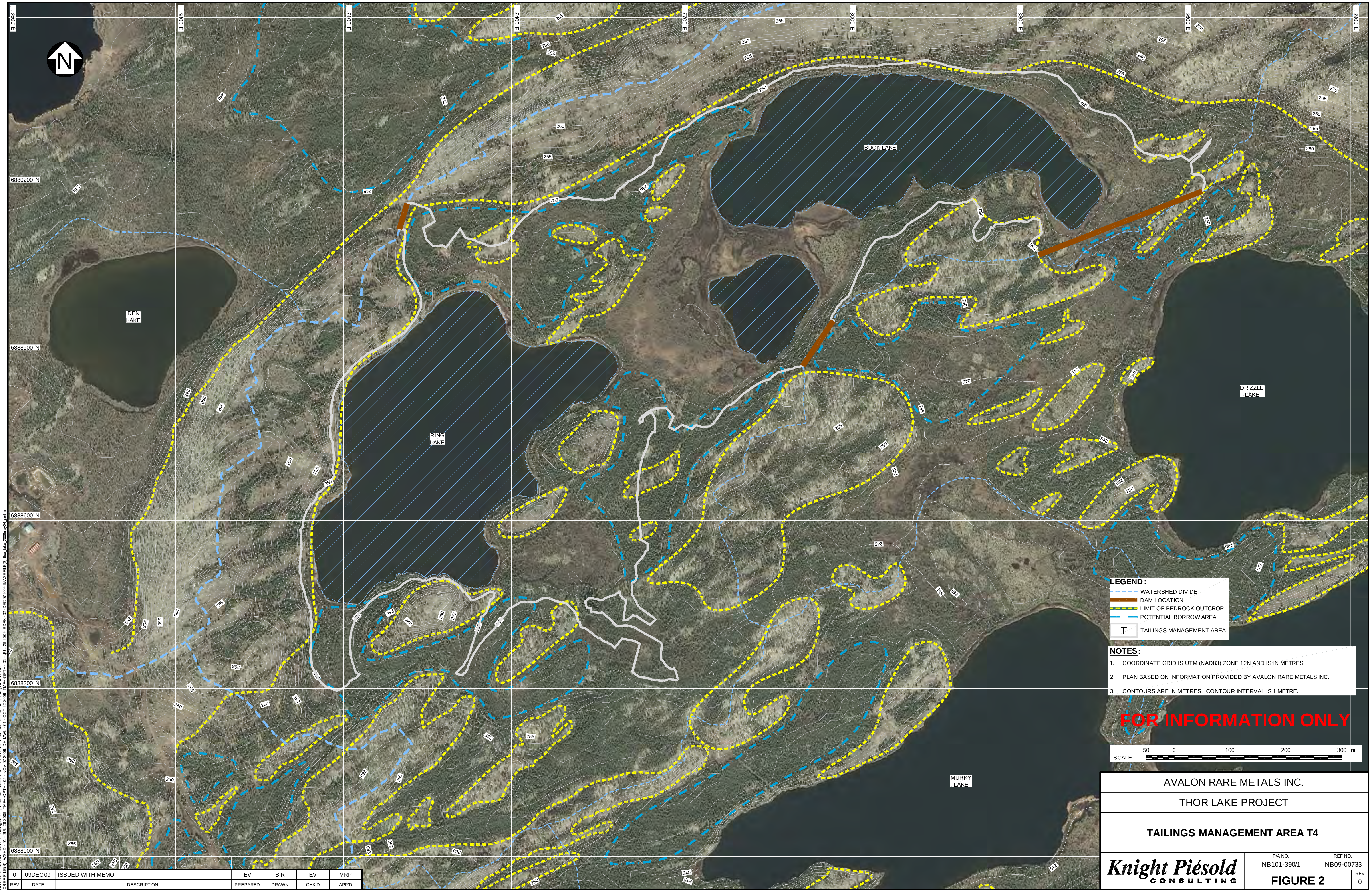
P/A NO.	REF NO.
NB101-390/1	NB09-00733

FIGURE 1 REV 0



AVALON RARE METALS INC.

THOR LAKE PROJECT

TAILINGS MANAGEMENT AREA T4

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P/A NO.	REF NO.
NB101-390/1	NB09-00733

FIGURE 2 REV 0

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Photo 1 - View looking east into potential tailings area T4 showing Ring Lake in foreground and Buck Lake in background.

NOTE:
1. PHOTO TAKEN DURING JULY 2009 SITE VISIT.

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AVALON RARE METALS INC

THOR LAKE PROJECT

SITE SELECTED PHOTOS FROM SITE VISIT - TAILINGS MANAGEMENT AREA T4

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P/A NO. NB101/390-1

REF. NO. NB09-00733

FIGURE 3

REV 0

Appendix C.4

Thor Lake Project Tailings & Water Management Design Basis for Feasibility Study.
Report NB10-00591

Knight Piésold
CONSULTING

MEMORANDUM

To:	Mr. David Swisher	Date:	November 29, 2010
Copy To:	John Goode, Bill Mercer, Matthew Parfitt	File No.:	NB101-390/2-A.01
From:	Cara Stapley	Cont. No.:	NB10-00591
Re:	Thor Lake Project Tailings & Water Management Design Basis for Feasibility Study		

The design basis for the tailings and water management for the Thor Lake Site (TLS) has been updated for the Feasibility Study. This memo supersedes previously issued Knight Piésold Memos NB09-00703 and NB10-00012, which summarized the design basis for the Pre-Feasibility Study. This memo details process flow information, estimated tailings properties and water management design values that will be used for the Feasibility Study design of the Tailings Management Facility (TMF).

Mining & Process Criteria

The mining rate for the Nechalacho Deposit will be as follows:

1. Ramp-up period (Months 1 to 3) - 438,000 tpa (average 1200 dtpd).
2. Mine Life (Month 4 to End of Mine Life) - 730,000 tpa (average 2000 dtpd).

There is a possibility that starting in Year 5, the mining rate will increase to 1,095,000 tpa (3000 dtpd).

It is estimated that 18% of the ore will become concentrate; therefore 82% of the mined ore will become tailings at the end of the process. Until the end of Year 4, all tailings will be sent to the TMF. From Year 5 onward, it is estimated that a portion of tailings equivalent to 50% of the total mined material (50% of the mining rate) will be diverted to become paste tailings backfill for placement underground.

The tailings stream from the concentrator will be in slurry form at a solids content or pulp density of 50%. This is much higher than the solids content assumed for the Pre-Feasibility Study because a thickener will now operate within the concentrator plant and will remove and recycle water to the process so that the solids content leaving the plant is 50%. The pulp density of slurry sent to the TMF will be reduced to 25% for Years 5 and onwards due to removal of tailings solids for paste backfill. The maximum recycle rate for water from the TMF will be 50% of the process water flow. The TMF will include the Tailings Basin for primary settlement of solids and supernatant water storage and a secondary pond (Polishing Pond) to allow for water treatment, if required. Recycled water will be pumped from the Tailings Basin to the flotation plant. For a 2000 dtpd mining rate the following process flows are calculated:

1. Concentrate will be 18% or 360 dtpd.
2. Tailings will be 2000 - 360 = 1640 dtpd.
3. Tailings slurry at 50% solids will be 1640 / 0.5 = 3280 tpd (Years 1 to 4).
4. Process Water flow will be (1 - 0.5) x 3280 = 1640 tpd = m^3/day.
5. Recycle Rate from Tailings Basin will be 50% of process flow or 0.50 x 1640 m^3/day = 820 m^3/day.

Although final reserves are not yet defined, it is currently assumed that 15 million tonnes of ore will form the basis for the Feasibility Study. This translates to approximately 20 years of mining given the aforementioned mining rate.

A mining and process flow summary, by production Year including the 3 month ramp-up period, is provided on Table 1. The fresh water supply requirement is proposed to be met with water from Thor Lake, in addition to water inputs from the ore and other sources.

Tailings Properties

Tailings properties to be used for the Feasibility Study design will be as follows:

1. The estimated specific gravity for tailings solids is 2.85 based on two tests performed by SGS (Combination Samples F29 and F30) and testing performed by the Knight Piésold Laboratory in Denver (as summarized in Memo NB10-00183, issued on April 30, 2010).
2. Based on a hydrometer test by SGS (Combination Sample F30) and particle size distribution tests conducted by the Knight Piésold Laboratory in Denver, the tailings range from 94 to 98% minus the No. 200 sieve (0.075 mm), with approximately 80 to 93% silt content and 5 to 14% clay fraction (0.002 mm). Sand content ranges from 2 to 6%, therefore, the tailings are quite uniform, consisting of predominately silt sized particles.
3. A final average settled dry density for the tailings in the TSF is estimated as 1.3 t/m^3 based on the two tests performed by SGS (Combination Samples F29 and F30) and testing performed by the Knight Piésold Laboratory in Denver. This corresponds to a final solids content or pulp density of approximately 70% by weight.
4. Tailings discharge will generally be from end of pipe rather than by spigots due to the cold operating temperatures.
5. Tailings beach slopes are estimated to be 1 % above water and 2 % below water.

TMF Capacity and Freeboard Requirements

The TMF capacity required will be a function of solids storage and water management design assumptions. The following summarizes values to be used for the Feasibility Study design:

1. Tailings solids storage requirement will be based on the aforementioned tailings properties and subsequent estimated annual volume, as indicated on Table 1.
2. The Minimum Supernatant Pond Volume will be based on 30 days of retention time or 30 x 1640 m^3/day = 49,200 m^3 (~50,000 m^3).
3. The Maximum Operating Supernatant Pond Volume will be in excess of the Minimum Required Pond Volume by the equivalent of 6 months of recycle water volume (to collect runoff from spring and summer to maintain recycle through winter) = 49,200 m^3 + (820 m^3/day x 6 x 30) = 196,800 m^3 (~200,000 m^3). This volume will be used to determine the Normal Maximum Operating Water Level in the Tailings Basin.
4. Design Storm storage in the TMF will be equivalent to a 1 in 25 year 24 hour storm. This will ensure that no untreated TMF effluent is released to the Polishing Pond unless a storm with greater magnitude than the 1 in 25 year event occurs.
5. The maximum storage capacity of the Polishing Pond will be approximately equivalent to 30 days retention time or 30 x 1640 m^3/day = 49,200 m^3 (~50,000 m^3).
6. Freeboard requirements will be 1 m for inflow design flood and an additional 1 m for wave run-up. This means that 2 m total freeboard above spillway invert will be required for both the TMF and Polishing Pond.

We trust this provides you with the information you require at this time. If you have any questions or comments, please do not hesitate to contact us.

Signed: Cara Stapley, E.I.T.
Geological Engineering

Approved: Matthew Parfitt, P.Eng.
Project Manager

Attachments:
Table 1 Rev 0 Nechalacho Deposit Mining and Process Flow Summary

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TABLE 1

AVALON RARE METALS INC.
THOR LAKE PROJECT

NECHALACHO DEPOSIT MINING AND PROCESS FLOW SUMMARY

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ASSUMPTIONS									
Concentrate Ratio:	**18%**	**Slurry Solids from Plant:**	**50.0%**	**Recycle Rate:**	**50%**	**Paste Backfill Ratio:**	**50%**	**Density (t/m^3):**	**1.3**

Year	Mining Rate tpa [1]	Concentrate tpa [1]	Tailings tpa [1]	Process Water m^3/yr	Water from Recycle m^3/yr	Fresh Water m^3/yr	Tailings tpa [1]	Solids to Backfill tpa [1]	Slurry Solids to TMF %	Solids to TMF[2] tpa [1]	Process Water to TMF[3] m^3/yr	Cumulative Tailings (t)	Cumulative Volume (m^3)
1 [4]	657,000	118,260	538,740	538,740	269,370	269,370	538,740	-	50	538,740	538,740	538,740	414,415
2	730,000	131,400	598,600	598,600	299,300	299,300	598,600	-	50	598,600	598,600	1,137,340	874,877
3	730,000	131,400	598,600	598,600	299,300	299,300	598,600	-	50	598,600	598,600	1,735,940	1,335,338
4	730,000	131,400	598,600	598,600	299,300	299,300	598,600	-	50	598,600	598,600	2,334,540	1,795,800
5	730,000	131,400	598,600	598,600	299,300	299,300	598,600	365,000	25	233,600	598,600	2,568,140	1,975,492
6	730,000	131,400	598,600	598,600	299,300	299,300	598,600	365,000	25	233,600	598,600	2,801,740	2,155,185
7	730,000	131,400	598,600	598,600	299,300	299,300	598,600	365,000	25	233,600	598,600	3,035,340	2,334,877
8	730,000	131,400	598,600	598,600	299,300	299,300	598,600	365,000	25	233,600	598,600	3,268,940	2,514,569
9	730,000	131,400	598,600	598,600	299,300	299,300	598,600	365,000	25	233,600	598,600	3,502,540	2,694,262
10	730,000	131,400	598,600	598,600	299,300	299,300	598,600	365,000	25	233,600	598,600	3,736,140	2,873,954
11	730,000	131,400	598,600	598,600	299,300	299,300	598,600	365,000	25	233,600	598,600	3,969,740	3,053,646
12	730,000	131,400	598,600	598,600	299,300	299,300	598,600	365,000	25	233,600	598,600	4,203,340	3,233,338
13	730,000	131,400	598,600	598,600	299,300	299,300	598,600	365,000	25	233,600	598,600	4,436,940	3,413,031
14	730,000	131,400	598,600	598,600	299,300	299,300	598,600	365,000	25	233,600	598,600	4,670,540	3,592,723
15	730,000	131,400	598,600	598,600	299,300	299,300	598,600	365,000	25	233,600	598,600	4,904,140	3,772,415
16	730,000	131,400	598,600	598,600	299,300	299,300	598,600	365,000	25	233,600	598,600	5,137,740	3,952,108
17	730,000	131,400	598,600	598,600	299,300	299,300	598,600	365,000	25	233,600	598,600	5,371,340	4,131,800
18	730,000	131,400	598,600	598,600	299,300	299,300	598,600	365,000	25	233,600	598,600	5,604,940	4,311,492
19	730,000	131,400	598,600	598,600	299,300	299,300	598,600	365,000	25	233,600	598,600	5,838,540	4,491,185
20	730,000	131,400	598,600	598,600	299,300	299,300	598,600	365,000	25	233,600	598,600	6,072,140	4,670,877
							11,912,140	5,840,000		6,072,140			

I:\1\01\00390\02\A\Correspondence\NB10-00591 - TLS Design Basis\Table 1.xls

NOTES:

1. tpa = TONNES PER ANNUM OR YEAR (DRY).
2. TMF = TAILINGS MANAGEMENT FACILITY.
3. AMOUNT OF WATER TO TMF DOES NOT INCLUDE INPUTS FROM USED POTABLE WATER OR OUTPUTS INTO PASTE.
4. YEAR 1 INCLUDES 3 MONTH RAMP-UP PERIOD AT 1200 dtpd MINING RATE FOLLOWED BY TYPICAL 2000 dtpd MINING RATE = AVERAGE 1800 dtpd MINING RATE.

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REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

Appendix C.5

Thor Lake Project - Pine Point Hydrometallurgical Plant Site Tailings Review. Report NB10-00488

Knight Piésold
CONSULTING

MEMORANDUM

To:	Mr. David Swisher	Date:	November 3, 2010
Copy To:	Rick Hoos	File No.:	NB101-390/2-A.01
From:	Matthew Parfitt	Cont. No.:	NB10-00488
Re:	Thor Lake Project - Pine Point Hydrometallurgical Plant Site Tailings Review		

David:

This memo presents our review and recommendations for tailings disposal for the Pine Point Hydrometallurgical Plant Site being proposed as part of the Thor Lake Project. The information provided below is based on two site visits to Pine Point and review of available historic information. A series of select photos from the site visits is presented in Appendix A and a list of reference documents in Appendix B.

Introduction

As part of the Thor Lake Rare Earth Metals Project Nechalacho, Avalon Rare Metals Inc. (Avalon) is proposing to build a Hydrometallurgical Plant at the site of the former Pine Point Mine (previously operated by Teck Cominco Metals Ltd. (formerly Cominco Ltd.) to process the flotation concentrate from the mine located north of Great Slave Lake. The Hydrometallurgical Plant Site is located on the south shore of Great Slave Lake approximately 75 km east of the town of Hay River NWT and approximately 70 km southwest of the town of Fort Resolution on Highway 5. The project site location is shown on Figure 1.

The former Pine Point Mine areas used for mining and processing, including the former town site area, were reclaimed by industry and government after closure of the mine in 1988 with the majority of the surface leases surrendered back to the Crown in the mid to late 1990's. Currently only one surface land lease (#85/16-9-9) continues to be held by Teck Cominco Metals Ltd. This lease encompasses the historic tailings impoundment area which is still managed by Teck Cominco. There are also mining claims held by Tamerlane Ventures located to the south of the historic tailings impoundment area as shown on Figure 2.

The existing site continues to be serviced by a Northwest Territories Power Corporation substation and line power from the Talston Dam. In addition, the site is directly accessible via Territorial Highway 5, which is classified as an all-weather highway with no load restrictions by the GNWT Department of Transportation. The highway also connects directly to the Canadian National Railways railhead located at Hay River.

The main components of the proposed Thor Lake Project Hydrometallurgical Site are summarized as follows:

- Barge Docking Facilities - Concentrate generated from mining and flotation processing at the Nechalacho Mine will be delivered by barge and offloaded at a temporary docking facility to be constructed on the south shore of Great Slave Lake (see Photo 1) approximately 8.5 km north of the proposed Hydrometallurgical Process Plant location.
- Hydrometallurgical Process Plant - The Hydrometallurgical Process Plant will be located on a previously disturbed area as shown on Figure 3. The proposed area consists of a historic gravel

borrow area stripped of vegetation and organics as shown on Photo 2. The plant will process the flotation concentrate from the mine located north of Great Slave Lake.

- Hydrometallurgical Tailings Management Facility (HTMF) - The HTMF will be located in close proximity to the Hydrometallurgical Process Plant. Potential alternative locations for the HTMF are shown on Figure 3 and include:
  - Alternative 1 - Within footprint of historic Tek Cominco Tailings impoundment (Photo 3)
  - Alternative 2 - New facility adjacent to plant site in area not previously impacted
  - Alternative 3 - Within historic open pit(s) (Photos 4, 5 and 6)

A brief summary of the site conditions and preliminary tailings design criteria are provided below along with a discussion of the tailings disposal alternatives and recommended approach.

Site Conditions

The Hydrometallurgical Process Plant site is located within the Great Slave Lowlands Mid-Boreal Ecoregion. It is a nearly flat wetland-dominated area which is part of the Taiga Shield (Ecosystem Classification Group, 2007). The area is characterized by short, cool summers and long, cold winters. The mean annual temperature is -17.5 ºC, and annual precipitation ranges from 300 to 400 mm. This ecoregion is classified as having a subhumid mid-boreal eco-climate.

Scattered patches of mixed-wood and jack pine forests rise only a few meters above a sea of patterned and horizontal fens and peat plateaus. Huge northern ribbed fens, net fens and horizontal fens occupy much of the area; linear beach ridges and other upland areas occur as islands within them and usually support mixed forests of pine, black and white spruce, trembling aspen, and balsam poplar.

The topography of the site can be described as flat to gently sloping, generally to the north. Topography around the proposed Hydrometallurgical Process Plant area typically ranges between 190 and 220 metres above sea level (mASL) and decreases to approximately 160 mASL along the south shore of Great Slave Lake.

Overburden

Overburden within the Pine Point area includes the following:

- Within the upland areas in the vicinity of the proposed Hydrometallurgical Process Plant, the depth of organics is minimal, typically less than 50 cm.

- Beach ridges (coarse-textured alluvial or wave-washed till) form prominent linear features running parallel to contour or in an east–west trend within the area of the proposed Hydrometallurgical Process Plant. The ridges mark the former extent of glacial Lake McConnell and provide a local abundant source of sand and gravel. Exposures of the sand and gravel on open pit slopes and within historic borrow pits suggest that the stratum is up to 3 to 4 metres thick (Photo 7).

- Flat lacustrine plains overlain by peatlands (poorly drained muskeg up to 3 m deep) cover much of the area north of the proposed Hydrometallurgical Process Plant area and south of Great Slave Lake. Wetlands occur throughout this area.

- A basal glacial till deposit typically underlies the beach and organic deposits. The till stratum is exposed in historic open pit walls around the site and ranges from a few meters in depth to upwards of 30 to 40 m (Photos 8, 9 and 10). Based on site visit observations, the till stratum appears to be relatively homogeneous consisting of a compact to dense clayey sand and silt with some gravel and small boulders. Historic testing (Knight and Piésold Ltd, 1984) indicates that the till in the Pine Point area is well graded and consists of approximately 13 percent gravel, 27 percent sand, 40 percent silt and 20 percent clay.

Bedrock

The bedrock geology of the Pine Point area has been studied extensively due to past mining activities. Generally the stratigraphy includes sedimentary rocks overlying a west dipping surface or Precambrian igneous and metamorphic rocks. On a regional scale, the Pine Point area lies within the interior platform between the Precambrian shield to the east and foothills of the western Cordillera to the west. A generalized regional geology plan is shown on Figure 4. The Pine Point Zn-Pb ore deposits are located within the Presqu'ile barrier reef complex consisting of Devonian carbonates which separates the Mackenzie basin made up of shales and limestones to the north and the Elk Point basin made up of evaporites and carbonates to the south. A summary of stratigraphic nomenclature used for the Presqu'ile barrier reef complex produced by Rhodes et al, 1984 is shown on Figure 5.

The barrier reef complex is about 10 km wide and 200 m in thickness in the Pine Point area and outcrops under overburden to the eastern portion of the Pine Point area dipping at a shallow angle of about 1.9 m per km to the west. A geological plan for the Pine Point area is shown on Figure 6. Simplified geological sections for the area are shown on Figure 7. The barrier reef complex includes the Sulphur Point formation (limestone/dolostone) and Pine Point (or Upper Keg) formation (dolostone) which are the principle hosts of the Zn-Pb mineralization. Some interpretations include a Presqu'ile formation at the top of the Pine Point formation which is a described as a coarse crystalline dolomite (Photos 11 and 12). The mineralization within the barrier reef complex is cited to be due to karstification of the host rocks as the ore bodies are pervasive within interconnected paleokarst networks. Tabular karst is the most common solution network which occurs along a crude stratabound horizon that coincides with the base of the Presqu'ile dolomite.

Permafrost

The Hydrometallurgical Plant site is located near the north boundary of the sporadic discontinuous permafrost zone as shown on Figure 8. It has been reported that there is no permafrost in the vicinity of the site. Observations during the site visit suggest that there is no evidence of permafrost within the upland areas around the Tek Cominco tailings impoundment, N-38 pit or proposed process plant site. However there are large differential settlements on historic haul roads (Photo 13) located to the northwest within lower elevations. These settlements indicate that there is likely discontinuous permafrost within low lying, poorly drained areas.

Hydrogeology

The hydrogeology for the Pine Point region has been previously studied by Geologic Testing Consultants (GTC, 1983) and Stevenson International Groundwater Consultants (Stevenson, 1984). The following hydrogeology description is largely based on this work.

Regional Hydrogeology

On a regional scale, groundwater flow is believed to originate in topographic highs (recharge area) such as the Caribou Mountains located 200 km south of the Pine Point area as shown on Figure 9. The Caribou Mountains rise approximately 600 m above the surrounding land surface and groundwater flow is more or less radially distributed. Stevenson (1984) has postulated that a perched groundwater flow system exists within the Caribou Mountain uplands which recharges the lower Slave Point formation. Due to geologic conditions, most of the groundwater is thought to discharge to the Hay River valley to the northwest and the Little Buffalo River and Slave River valleys to the northeast. A smaller portion is thought to flow north to Great Slave Lake.

The area surrounding Great Slave Lake represents a lowland and is considered a major groundwater discharge area. Other areas of regional discharge are the Hay River, Buffalo River, Little Buffalo River and Slave River. Groundwater discharge is evident as sulphurous springs and as areas of high specific conductance in rivers. Springs discharging mineralized groundwater have been observed along the south shore of Great Slave Lake at High Point, Sulphur Point and Windy Point. Springs have also been observed at the mouth of Salt River and at the base of the Little Buffalo River Formation escarpment. High specific conductance readings have also been observed along Slave River, Salt River, Little Buffalo River, Buffalo River and along Great Slave Lake between Fish Point and Presqu'ile Pont. Groundwater discharge is also evident through the presence of swampy areas and sulphurous springs throughout the northern sections of the Pine Point area. Sulphurous springs documented along tributaries of the Buffalo River within the Pine Point Area by EBA in 2005 are shown Photos 14, 15 and 16.

Site Hydrogeology

Local groundwater recharge to the bedrock aquifer at the Pine Point site is likely to be variable and largely controlled by the overburden geology. High rates of recharge are expected in areas where sinkholes are present, but in general recharge will be limited by the presence of till overburden. Several small ponds were observed in boggy areas that were several meters above the regional water table, indicating that recharge is relatively slow through the till. Local surface water / groundwater flows through the till, then downwards through fractured bedrock towards the water table. Several seepage points observed in pit walls indicate that there is some lateral flow within the unsaturated bedrock. Photos 17 and 18 show stains along the north wall of the N-33 Pit due to groundwater seepage occurring along bedding planes within the dolomite. This seepage is thought to be due to local infiltration being directed horizontally along bedding planes. The staining indicates that the local seepage is highly mineralised and sulphurous.

The bedrock units that represent the most productive aquifers are the Presqu'ile formation and the Pine Point formation. A simplified stratigraphy relating geology to hydrogeology (for the A-70 Pit area to the northwest portion Pine Point area) developed by Vogwill (1976) is shown on Figure 10. As shown, the Presqu'ile and Pine Point formations form the main aquifer consisting of highly porous, well fractured dolomite, and groundwater within the saturated bedrock is expected to flow along solution channels, bedding planes and fractured zones. According to Stevenson (1984), the aquifer is laterally confined by the Buffalo River shales to the north and the Muskeg evaporites to the south as shown Section 2 of Figure 7. Overlying clay till overburden and Watt Mountain limestones of generally low permeability act to confine the aquifer on top while the Chinchaca formation evaporites underlying the Pine Point and Keg River formations form an effective vertical barrier below the aquifer. The hydraulic continuity is thought to be more predominant along the northeast-southwest trend of the barrier reef complex due to karstification, solution channelling and jointing characteristics (GTC, 1983).

The permeability of the Presqu'ile aquifer formation is very high with transmissivities in the order of $1x10^{-2}$ m^2/s (GTC, 1983). Based on work completed by Stevenson (1984), the groundwater gradient in the Pine Point area is generally northwards towards Great Slave Lake while to the south of the Pine Point area, the groundwater gradient trends from west to east as shown on Figure 11. Local gradients range from about 0.4 percent northwards along the north part of the area and about 0.25 percent westward along the south portion. Interpretation of the groundwater gradient contours in relation to the topography indicates that the groundwater level is up to 30 m below the surface along the northeastward trending ridge in the east-central part of the site. In the northwest portion of the site (Figure 11), the piezometric surface is higher than the ground surface. High piezomteric levels have resulted in groundwater discharge as springs (Photo 14) along the incised Buffalo River channel and other small tributary channels in the area.

Although the Presqu'ile aquifer has a high permeability, the flow through it is thought to be slow due to the low gradient in the Pine Point area. Based on a preliminary calculation taking into account the documented transmissivity values, gradients and geological sections, the flow velocity is estimated to be less than 1 m per day. Due to the high porosity, the storativity of the aquifer is quite high. It is estimated that about 1 billion m^3 of water was removed during mining activities from 1968 to 1984. According to Stevenson (1984), this water came from water stored within the aquifer (16%), recharge from local precipitation (76%), with the remainder from the regional groundwater flow.

Tailings Characteristics

Although testing is underway, to date there are no physical or chemical testing results available for the Hydrometallurgical tailings stream. Based on testing results for the concentrate and the proposed process, the preliminary characteristics assumed for the Hydrometallurgical tailings are outlined below:

- The tailings solids from the proposed process will be predominantly gypsum (approx. 84%) which are expected to be similar to phosphogypsum tailings in terms of void ratio, dry density and consolidation properties. The following physical characteristics are anticipated;
  - A specific gravity for the tailings solids high in gypsum content has been assumed at 2.40 (Vick, 1990)
  - Based on an assumed final solids content of approximately 65% by weight and a void ratio of 1.3 (Vick, 1990) the assumed final average settled dry density for the tailings is 0.9 t/m^3
  - In general terms the settled tailings is anticipated to be a soft paste like material with relatively low shear strength / bearing capacity and a relatively low permeability
  - Due to the deposition environment (northern climate), air drying will be limited and consolidation of the tailings mass will be dependent on drainage conditions and material permeability

- From a geochemical point of view the tailings will be a fully neutralized material (by the addition of limestone) and it is expected that there will not be any regulatory exceedances of significant amounts of leachable metals based on testing of the concentrate completed to date.

Both physical and geochemical tailings test work will be completed as soon as Hydrometallurgical tailings samples are available to confirm the tailings parameters.

Tailings Disposal Alternatives

As noted previously there are three alternative locations for tailings disposal at Pine Point. The potential alternatives are discussed below and shown on Figure 3.

Alternative 1 - Teck Cominco Tailings Impoundment

For the pre-feasibility study it was proposed to place the HTMF on or within the historic Cominco Tailings Impoundment. The proposed layout included a lined facility constructed over part of the existing tailings beach. Other possibilities considered for use of the Cominco Tailings Impoundment involve raising the perimeter dams and utilizing the entire area for the HTMF. This approach was based on trying to make use of an existing brownfields site so as to minimize additional impacts to the area. Subsequent to visiting the site in June, 2010 and conducting a brief inspection of the Cominco Tailings it is not recommended that the HTMF be placed at this location for the following reasons:

- The entire Cominco Tailings Impoundment has been reclaimed by placing a sand and gravel layer over the tailings and allowing it to self vegetate (Photo 3). Establishing a new facility on it will disturb the existing reclamation.
- The existing dykes around the Cominco Tailings Impoundment are quite high and steep (Photo 3) and any additional loading or raising would need to be confirmed through significant geotechnical investigations
- It would be difficult to establish individual responsibilities for environmental liabilities between the historic Cominco tailings and a newly constructed HTMF

Alternative 2 - New Facility Adjacent to Process Plant Site

A second alternative for the HTMF is to establish a new facility adjacent to the Process Plant Site as shown on Figure 3. This would require clearing of a large area and construction of significant embankments and associated water management facilities. This would create a new impact to the Pine Point Area and leave long-term dams or embankments in place. The cost of constructing the dams will also be significant due to the relatively flat terrain. Although such a facility would be designed and constructed taking into account up to date best practice engineering and environmental techniques, it will add an impact to the site and represent a long-term (minimal) risk.

Alternative 3 - Place Tailings in Historic Open Pit(s)

The alternative to place the Hydrometallurgical tailings within historic open pit(s) was identified as a result of the site visit conducted in June, 2010. Cursory review of the site conditions and subsequent review of background information for the site, and other projects implementing pit disposal of tailings, indicates that this alternative has merit from a technical and environmental point of view. Use of one or more of the historic open pits in the area for tailings disposal offers the following advantages:

- Construction of dams and associated impacts related to site disturbance for fill placement, borrow excavations and tailings placement in undisturbed areas can be minimized
- Filing of one or more historic pits with tailings and use of previously stripped materials for capping and reclamation will help to restore these areas back to pre-development conditions
- Risks associated with building dams to contain low strength tailings and process waters can be avoided
- Earthworks costs related to dam construction can be minimized

The concept of placing tailings within one or more of the historic open pit(s) will require consideration of potential groundwater impacts. Due to the location of the open pits within the high permeability Presqu'ile aquifer, it is likely that all or most of the released tailings pore water will infiltrate into the aquifer unless a barrier layer is placed around the tailings. At this stage of the project, it is proposed that a barrier layer will not be required for the following reasons:

- Testing of concentrate from the Nechalacho Flotation process indicates that there will be no significant leachable contaminates or metals
- The hydrometallurgical tailings stream will be fully neutralized and pore water that is released from the slurry will be neutral and is expected to be of generally good quality

- The water quality from the Presqu'ile aquifer is typically sulphurous and saline and as such is not recognized as a valuable groundwater resource for human or wildlife consumption
- The volume of tailings pore water that will be added to the Presqu'ile aquifer will likely be a small fraction of the volume within the aquifer and is expected to have very minimal impact to existing groundwater flow, volume or quality

Tailings Disposal Concept

Following consideration of the above alternatives, it was decided that placing the HTMF tailings within historic open pit(s) (Alternative 3) is the most attractive option, taking into account environmental, economic and operational factors.

Based on a review of available open pits in close proximity to the Process Plant Site, the N-38 Pit was selected as the best option. The N-38 pit is located approximately 2.5 km south of the proposed Hydrometallurgical Process Plant site at Pine Point as shown on Figure 12. The N-38 Pit is located within the Presqu'ile Dolostone of the Sulphur Point formation. The N-38 pit was developed to mine a normal prismatic ore body approximately 250 m long and 150 m wide. The total ore extracted from the N-38 pit was approximately 1.2 million tonnes grading 4.9% lead and 7.4% zinc resulting in approximately 58,000 tonnes of lead and 87,500 tonnes of zinc being produced. Based on an estimated area of 25 Ha and anticipated depth of 20 to 25 m the available volume of the N-38 pit is roughly 5 million cubic metres which is similar to the solids storage capacity estimated for the Pre-feasibility Study.

An inspection of the N-38 Pit completed on September 10 and 11, 2010 indicates that the pit bottom is generally above the water table (Photo 4). There are 4 relatively small low areas where water is present within the pit. There is also quite a large amount of waste rock piled in the bottom of the pit (Photo 4), likely placed during later operations. The pit is also surrounded with waste piles of till, waste rock and some organics as well (Photo 5). The development concept of using the N-38 pit for Hydrometallurgical tailings disposal is described in the following points:

- Preparation of the pit for tailings disposal will involve the following items:
  - Existing waste rock within the bottom of the pit will be used to re-grade the bottom of the pit so that all areas are above the aquifer water table. This will ensure that the deposited tailings are not in direct contact with aquifer water and that tailings are deposited within a dry basin to promote drainage and consolidation of the solids.
  - A perimeter road will be constructed around the edge of the pit to allow tailings to be strategically discharged to form an initial layer as quickly as possible over the bottom of the pit. Once the initial layer is formed, the discharge can be managed to maintain a central pond, if appropriate, for water management.
- During ongoing operations, it is proposed that excess water accumulation within the pit be pumped to an adjacent pit (N-33 Pit in Photo 6) for discharge and infiltration within the Presqu'ile aquifer. A preliminary water balance flow sheet is shown on Figure 13. The water balance assumes there will be insignificant seepage through the tailings into the surrounding N-38 pit once enough tailings is placed to contain the water.
- Monitoring of water quality will be conducted in the following manner:
  - Samples of slurry will be taken at the plant discharge and both the solids and pore water will be tested for parameters of interest
  - Groundwater monitoring wells will be established around the pit and used for determination of baseline water quality as well as ongoing monitoring
  - Once a water pond starts to form within the pit, additional water samples can be taken to be tested for parameters of interest

- Once the pit has been filled to capacity with tailings solids, the following closure concept is proposed:
  - The tailings discharge will be managed to create a final tailings surface that will allow all excess water and runoff to be removed
  - Following an initial period of time to allow drying of the tailings surface and consolidation, a layer of local waste rock will be placed (likely in the winter) to provide a structural support layer
  - A capping or shedding layer of local till will be placed over the waste rock layer to minimize infiltration
  - Locally available organic material will be placed over the till layer and the surface will be vegetated with species that will establish quickly to minimize erosion. In the long-term other endemic species will be applied based on proposed final land use.

Summary

A summary of site conditions at Pine Point and alternatives for tailings disposal for the Hydrometallurgical process plant has been presented. Based on review of the site conditions and alternatives for tailings disposal, the recommended concept involves placing tailings within the N-38 pit south of the plant site. This approach for tailings disposal is deemed advantageous for both economic and environmental reasons as it minimizes construction costs, additional impacts and allows for reclamation of previously impacted areas from previous mining operations. Additional work including topographical site mapping, hydrogeological site investigations and testing of the Hydrometallurgical tailings will allow the concept to be refined to a feasibility level design.

We trust that this provides you with the information you require at this time. Should you have any questions or comments, feel free to contact us.

Signed: ______________ Approved: ______________

Jordin Barclay
Project Hydrogeologist

Matthew R. Parfitt, P.Eng.
Senior Engineer/Project Manager

NOV 0 3 2010

Attachments:

Figure 1 Rev 0	Pine Point Area - Site Location
Figure 2 Rev 0	Pine Point Area - Existing Site Plan
Figure 3 Rev 0	Pine Point Area - Hydrometallurgical Tailings Management Facility Alternatives
Figure 4 Rev 0	Pine Point Area - Simplified Devonian Geology of Northwestern Canada
Figure 5 Rev 0	Pine Point Area - Summary of Stereographic Nomenclature
Figure 6 Rev 0	Pine Point Area - Geological Plan
Figure 7 Rev 0	Pine Point Area - Simplified Geological Cross-Sections
Figure 8 Rev 0	Pine Point Area - Permafrost Distribution in Canada
Figure 9 Rev 0	Pine Point Area - Regional Plan Hydrogeology
Figure 10 Rev 0	Pine Point Area - Geologic and Hydrogeological Stratigraphy of the Presqu'ile Barrier Reef Complex at the A-70 Pit Area
Figure 11 Rev 0	Pine Point Area - Groundwater Gradient Plan
Figure 12 Rev 0	Pine Point Area - Hydrometallurgical Site - General Arrangement
Figure 13 Rev 0	Pine Point Area - Preliminary Water Balance Flow Sheet
Appendix A	Photos
Appendix B	List of References

/mrp

NOTES:

1. IMAGERY FROM NASA WORLD WIND.

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REV	DATE	DESCRIPTION	DESIGNED	DRAWN	CHK'D	APP'D

AVALON RARE METALS INC.

THOR LAKE PROJECT

PINE POINT AREA SITE LOCATION

Knight Piésold CONSULTING

P/A NO.	REF NO.
NB101-390/2	NB10-00488

FIGURE 1 REV 0