MEMO

To	Josée Peron		
From	Brian Geddes, Renata Wood		
Tel	403-387-1639	**AMEC File No.**	VM00605.TAR3
Fax	403-248-2188	**cc**	Patricia Randall
Date	25 July 2013		Serge Chevrier
Subject	**Mount Nansen Conceptual Pit Material Balance**		

1.0 INTRODUCTION

This memo presents preliminary Brown-McDade pit volume capacity and waste material storage requirements for the Mount Nansen closure project. The volumes are based on reported values in previous Mount Nansen Remediation Project (MNRP) documentation, and particularly on Lorax 2011[1]. The purpose of this exercise is to:

- confirm that there is a general balance between the available storage capacity and the required storage volume; and
- provide context for the 2013 site investigation program as additional/confirmed quantities are required for design.

2.0 DESCRIPTION OF CONCEPTUAL PIT BACKFILL PLAN

The selected closure plan (Option 4 in Lorax 2011[1]) for the site is to place the tailings and waste rock in the Open Pit in a dry configuration. Per the Option 4 conceptual layout (Lorax 2011[1]), a waste rock platform is to be constructed in the bottom of the pit allowing the tailings to be placed above the water table. Additional waste rock is to be placed above the tailings and graded to promote runoff away from the Open Pit. A low infiltration cover is then to be placed above the waste rock. This configuration may change as the design is developed but is being adopted for the purpose of the current exercise.

From subsequent discussion with the Yukon Government Department of Energy, Mines and Resources - Assessment and Abandoned Mines (AAM), it is understood that the intent is that all disturbed material that has been identified as impacting water quality is to be placed in the Open Pit. Such material includes:

- tailings (from the main tailings facility and the Mill area);
- potentially acid generating (PAG) waste rock;
- any native soils that have been impacted by the tailings or waste rock; and
- any dam material that has been impacted by the tailings.

[1] Lorax. 2011. "Mount Nansen Options for Closure", Report dated July 2011.

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Existing digital elevation data for the pit and reported material quantities were used to preliminarily determine:

1. the empty volume (storage capacity) of the Brown-McDade Open Pit;
2. the volume of contaminated material to be placed in the Brown-McDade Open Pit for closure (required storage); and
3. the net amount of waste material (surplus/deficit) that may be placed in the Open Pit.

3.0 CONCEPTUAL VOLUMES

3.1 Brown-McDade Open Pit Volume

AMEC performed a preliminary volume calculation of the Open Pit using AutoCAD CIVIL3D modelling software, based on the following information:

1. 2012 LiDAR survey provided by AAM in March 2013 was used for contours above the pit water level. This survey of the Open Pit walls and benches extends down to an elevation of approximately 1,184 m. Water is ponded in the bottom of the Open Pit, which precludes the use of LiDAR to gather elevation data at the pit bottom. EBA's 2012[2] pit assessment report indicates that water depths vary from 3 to 4 m in the smaller ponded area and from 6 to 8 m in the larger ponded area.
2. Pit survey completed by Underhill Geomatics Ltd. in 2004, supplied to AMEC by AAM on 30 April 2013 was used to define pit elevations below the pit water level. This survey includes the pit walls and includes elevation data below the current water elevation. The elevations appear consistent with the water depths reported above.

AMEC merged the two surveys together to develop a model of the Open Pit. The storage capacity of the pit depends on the configuration of the backfill above the footprint of the pit. Since the backfill configuration will change as the design is advanced, a model of the conceptual design presented in Lorax has not been created. The volumes up to a given elevation within the pit were compared to those extrapolated from the conceptual Option 4 cross section (Figure 5.7-1, Lorax 2011) summarized in Table 1. The values from AMEC's model and the Option 4 cross section appear to generally agree and, therefore, the total volume of 686,800 m^3 as reported in Lorax 2011 is accepted as the capacity for the option conceptual configuration.

The Option 4 pit backfill configuration (shown in the attached Figure 5.7.1) indicates that the waste materials will be distributed in the pit as summarized in Table 1. In addition, 156,000 m^3 of waste rock will be left in place outside of the Open Pit.

[2] EBA. 2012. Brown-McDade Pit Assessment at the Mount Nansen Site, Report to the Government of Yukon – Energy Mines and Resources, November 2012.

Table 1: Waste Material Distribution in Brown-McDade Pit for Lorax 2011 Option 4

Quantity (m^3)	Component of pit backfill	Description of Material
44,000	Waste rock submerged below EL. 1190 m	NAG waste rock (assumed)
300,000	Tailings	Tailings
300,000	Waste rock	PAG waste rock (assumed)
42,800	Cover (1 m thick)	NAG waste rock (assumed)
686,800	**Total Pit Backfill**	

3.2 Required Storage Volume Estimate

Table 2 summarizes the volumes of material that require remediation as reported in Lorax 2011 (mainly from the supporting Appendix C9 by AECOM) for the Option 4 restoration of Dome Creek and the "common elements". Total waste rock volumes were reported; however, there was no indication as to how much of the waste rock required storage in the Open Pit. Altura 2009[3] characterized waste rock material as Potentially Acid Generating (PAG, with a neutralizing potential ratio (NPR) <2) and Not Potentially Acid Generating (NAG). This information, shown in Figure 1, was used to generate a preliminary estimate of PAG and NAG volumes. A detailed estimate of PAG volumes is a significant component of the planned 2013 investigation program. These estimated volumes in Table require confirmation and updating.

Table 2: Volume of Waste to be Remediated

Area	Item	Volume (m^3)	Citation
Mill	Reactive Rock	6,500	AECOM 2011 Summary of Estimated Closure Costs (Appendix C9 in R88)
	Pond 1 Tailings	1,000	
	Pond 3[a]	100	
	Watercourse Restoration[a]	500	
	Contaminated Soil[a]	1,000	
Roads	Haul Road Berm Material (Waste Rock)	1,000	
Tailings Facility (Dome Creek)	Dome Creek (Under Tailings And Dam)[B]	43,280	Data from Altura 2010, Located in Lorax R88 Appendix C2
	Tailings	300,000	AECOM 2011 Summary of Estimated Closure Costs (Appendix C9 in R88)
	Tailings Dam[c]	80,000	
Waste Rock Area	PAG Waste Rock[d]	301,750	Altura 2009 Brown McDade Waste Rock Pile (R73), see Figure 1
	NAG Waste Rock[d]	207,250	
Total:		**942,380**	

Notes:
a. Approximated quantities listed.
b. Assumes 0.6 m depth of soils below the tailings facility is considered contaminated and will be placed in the pit.
c. Half of the tailings dam is considered contaminated and is scheduled to be placed in the pit.
d. Approximately one third of the waste rock around the Open Pit is considered PAG.

[3] Altura. 2009. Brown McDade Waste Rock Pile – Mount Nansen Mine Site, Yukon – Geochemical Characterization, Report to the Government of Yukon – Energy Mines and Resources, February 2012.

3.3 Material Balance

Table 3 summarizes the volume of waste material as follows: (1) the pit capacity as per the Option 4 concept, based on Table 1; (2) the amount of material that is required or available to be placed in the pit based on AMEC's understanding of the project objectives and the reported volumes of material as summarized in Table 2; and (3) the difference between (1) and (2).

Table 3: Summary of Material to be Stored

Component	Capacity (m^3)	Amount to be Placed / Available (m^3)	Net Amount (m^3) (+ means excess)	Net amount Requiring Storage Under Cover (m^3)
Waste Rock – Submerged (NAG assumed)	44,000	44,000	0	0
Tailings	300,000	301,000	+1,000	+1,000
Contaminated Material[1]	0	124,880	+124,880	+124,880
Waste Rock – Above Tailings (could be PAG or NAG)[2]	300,000	309,250 (PAG only)	+9,250	+9,250
Waste Rock –Cover (NAG)[2]	42,800	163,250 (remaining NAG)	+120,450	0
Total	**686,800**	**942,380**	**+255,580**	**+135,130**

Notes:

[1] Contaminated material includes contaminated soil, native materials from Dome Creek underlying the tailings area, dam materials, material from watercourse restoration, and material from Pond 3 at the mill site. The 124,880 m^3 is based on 43,280 m^3 of native material (from Altura report based on a 0.6 m thickness) plus 80,000 m^3 of tailings dam sand. This volume is not accounted for in the Option 4 backfill configuration presented in the Lorax report. No comment is being made on the validity of the 0.6 m thickness of native soils to be removed. It is noted that if the actual thickness of material that requires removal is greater than 0.6 m, this required storage volume will increase and there will be a greater difference in the material balance than reported in the memo.

[2] It is assumed that all PAG waste rock needs to be stored under a low infiltration cover in the pit. NAG waste rock, however, can be left in place outside of the pit. Note that this quantity was only intended to include the waste rock volume (1 m over 42,800 m^2 surface area) because that is the significant component for the mass balance. The graded soil and topsoil are indicated to be borrowed material and will be in the airspace above the pit.

The total excess waste rock volume of about 130,000 m^3 is close to the 156,000 m^3 of waste rock that is to be left in place per the Option 4 concept. However, about 9,000 m^3 of that volume appears to be PAG material and should be placed in the pit, although given the accuracy of the estimate, this is not a significant volume. It does appear that there are about 125,000 m^3 (based on an assumed material depth that cannot be validated prior to the proposed Site Investigation program) of contaminated material including native soils and dam material that should be placed in the Open Pit that was not included in the conceptual backfill configuration.

Based on this preliminary evaluation, it appears that the capacity of the backfilled pit needs to be increased by approximately 135,000 m^3. All of these quantities require confirmation during the 2013 investigation however.

As currently understood by AMEC, the primary constraints on the configuration of the final pit backfill are that the public access road on the north side of the pit should not be impacted and that the need for a dam/plug is to be avoided. The storage capacity can, therefore, be increased

by increasing the height and/or area of the backfill (note that measures required to avoid the need for a dam/plug will not be influenced by the backfill height). If a similar configuration to that conceptually proposed by Lorax is used, the additional 135,000 m^3 could be provided by increasing the elevation of cover by approximately 3. At this stage, there does not appear to be an issue with regards to available storage capacity.

4.0 PATH FORWARD

The 2013 investigation is intended to characterize and quantify the materials that require storage in the Open Pit. This is largely a geochemical exercise and details can be found in AMEC 2013[4]. The most significant volumes of material that require confirmation are:

- PAG vs. NAG waste rock - additional geochemistry samples will be taken from the waste rock dumps to provide information on their neutralizing potential ratio;
- tailings volume – depth of tailings will be confirmed by drilling;
- dam fill materials – sampling for geochemical analyses may provide a better volume estimate of the tailings and dam fill; and
- native materials in Dome Creek - sampling for geochemical analyses may provide a better volume estimate of the volume of impacted native materials.

Although the pit volumes below the ponded water level volume are not significant, accurate elevations of the base of the pit may be important for the pit backfill design, particularly if an underdrain system is considered. The need for this information will continue to be assessed as the work progresses.

5.0 CLOSURE

This memorandum is an interim document in the design process. It is based on the information available at the time of writing. The concepts may be modified through the design process and all values reported herein require confirmation.

Submitted by:

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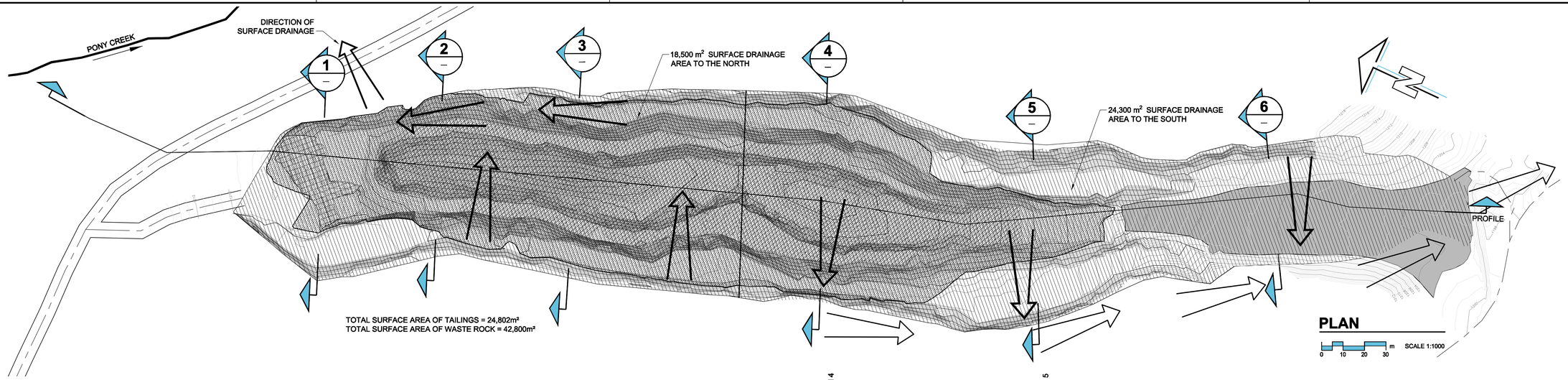
AMEC Environment & Infrastructure

BG/jm
Attachments:
Lorax Figure 5.7-1 – Option 4 Conceptual Pit Backfill Configuration
Figure 1 – Mine Rock and Tailings Geochemistry Sampling

[4] AMEC. 2013, Mount Nansen Remediation Project Preliminary 2013 Site Investigation Plan Final Draft, memo submitted to AAM, 24 April 2013.

Figures



PLAN

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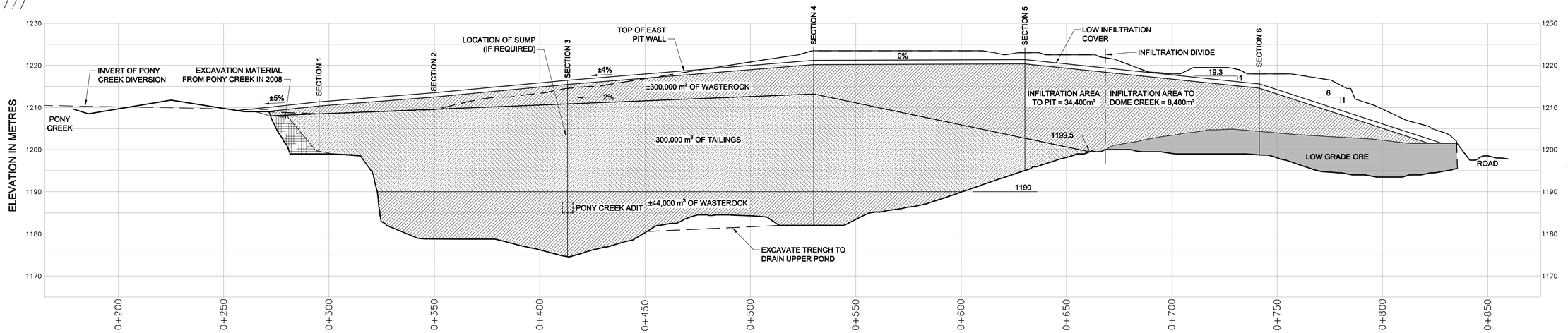

DISTANCE IN METRES
PROFILE THROUGH OPEN PIT

PROFILE

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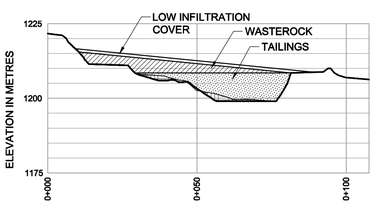
0 5 10 15 V=1:500



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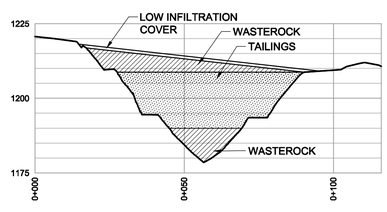

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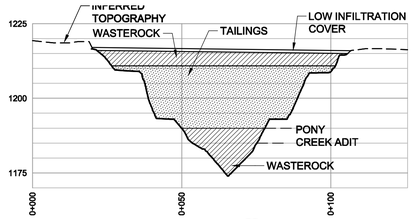

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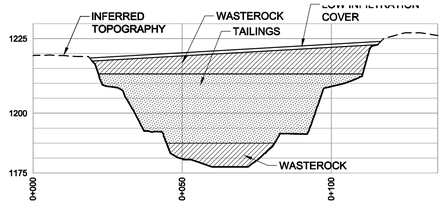

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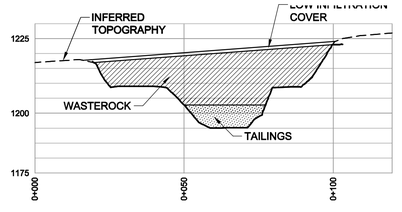

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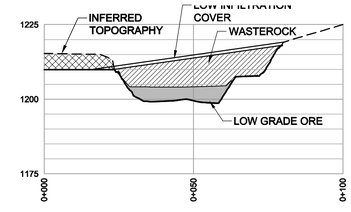

SECTION 6

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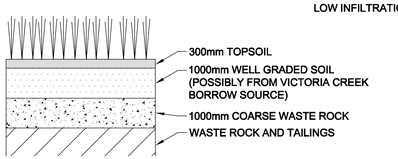
LOW INFILTRATION

LOW INFILTRATION



COVER

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Government of Yukon
Mt. Nansen Closure Alternatives Characterization

Option 4
Plan, Profile & Sections - Brown-McDade Open Pit

Figure 5.7-1 **Drawing - 04**

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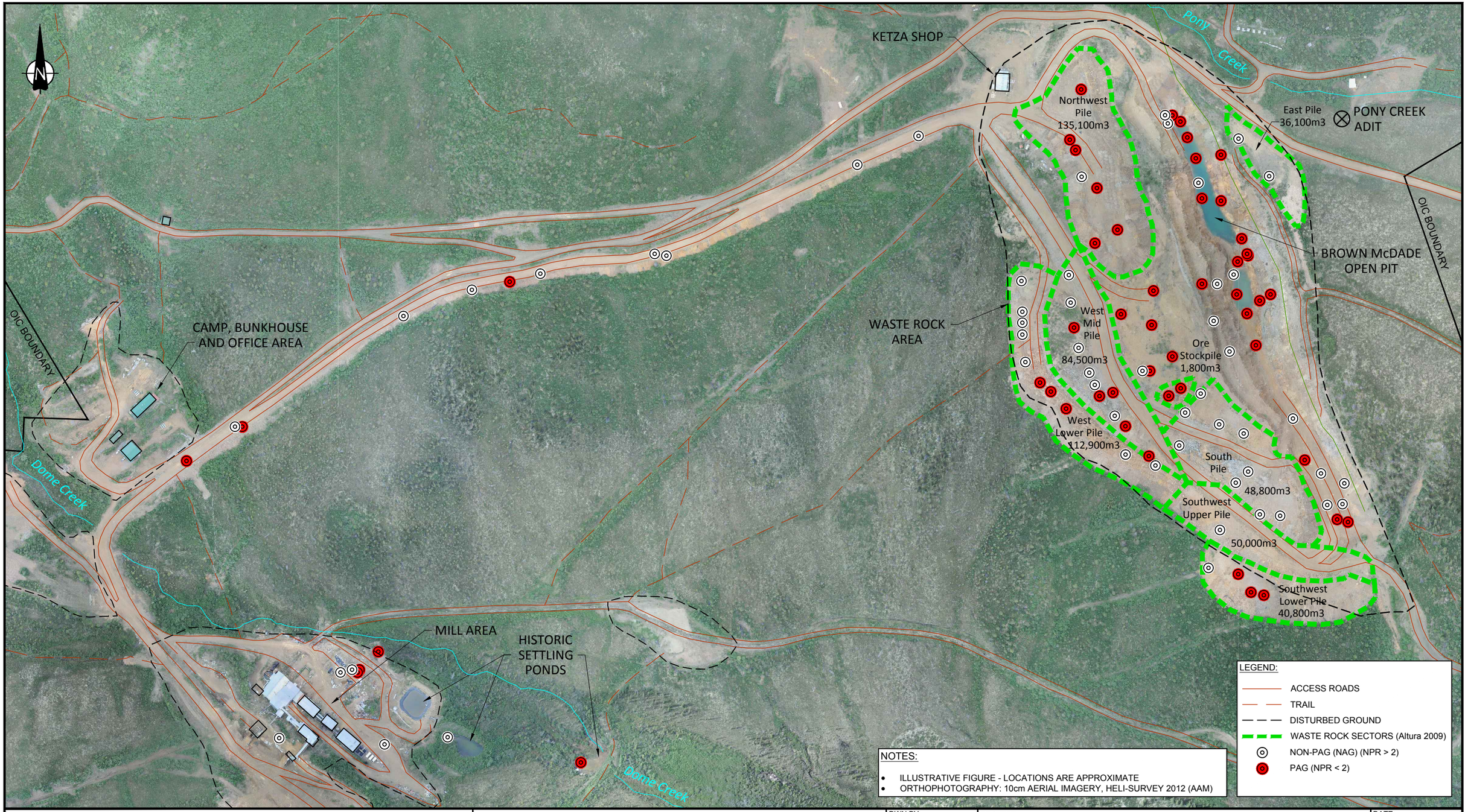
AECOM



NOTE:
THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH THE AMEC ENVIRONMENT & INFRASTRUCTURE DATA GAP ANALYSIS MEMO DATED JULY 2013.

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DWN BY:	TH
CHK'D BY:	RW / JA
DATUM:	NAD 83
PROJECTION:	UTM Zone 8
SCALE:	AS SHOWN

PROJECT:
MOUNT NANSEN REMEDIATION PROJECT
CONCEPTUAL PIT MATERIAL BALANCE

TITLE:
HISTORIC GEOCHEMICAL TESTING
AT WASTE ROCK DUMP, PIT AND MILL SITES

DATE:	JULY 2013
PROJECT NO:	VM00605
REV. NO:	A
FIGURE NO:	1

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