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MOUNT NANSEN REMEDIATION PROJECT
DESIGN BASIS MEMORANDUM (DBM) -
30% DESIGN PHASE

Submitted to:

Assessment and Abandoned Mines
Energy Mines and Resources
Whitehorse, YT

Submitted by:

AMEC Environment & Infrastructure,
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Burnaby, BC

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1 PROJECT BACKGROUND AND SCOPE

1.1 Introduction

Mount Nansen has been the site of mining exploration activity and/or active mining since the 1940s. The site location is shown on Figure 1 and a current plan of the site is provided on Figure 2. The most extensive stage of mining occurred between November 1996 and February 1999 in the Brown-McDade Open Pit. It involved construction of the existing tailings dam and deposition of approximately 240,000 m^3 of tailings within the tailings impoundment. A waste rock storage area containing approximately 360,000 m^3 of waste rock was also created adjacent to the Brown-McDade Open Pit. Earlier periods of mining contributed to smaller amounts of tailings, some of which are still present near the mill site, and localized zones of waste rock at the mill site and elsewhere on the site. Other site infrastructure includes the mill and camp facilities as well as various ancillary structures, power lines and pipelines.

In 1999, mining was halted because it was no longer economical, and sulphide ore was being mined in contravention of the water licence. The company operating the Mount Nansen property was put into receivership in March 1999. The site is now managed by the Yukon Government through Assessment and Abandoned Mines (AAM).

In support of site remediation, many studies and investigations have been carried out over the past decade to define the closure objectives and to explore various closure options. Detailed discussion of the closure objectives can be found in Yukon Government (2008) and are presented below.

1.2 Project Objectives and Scope

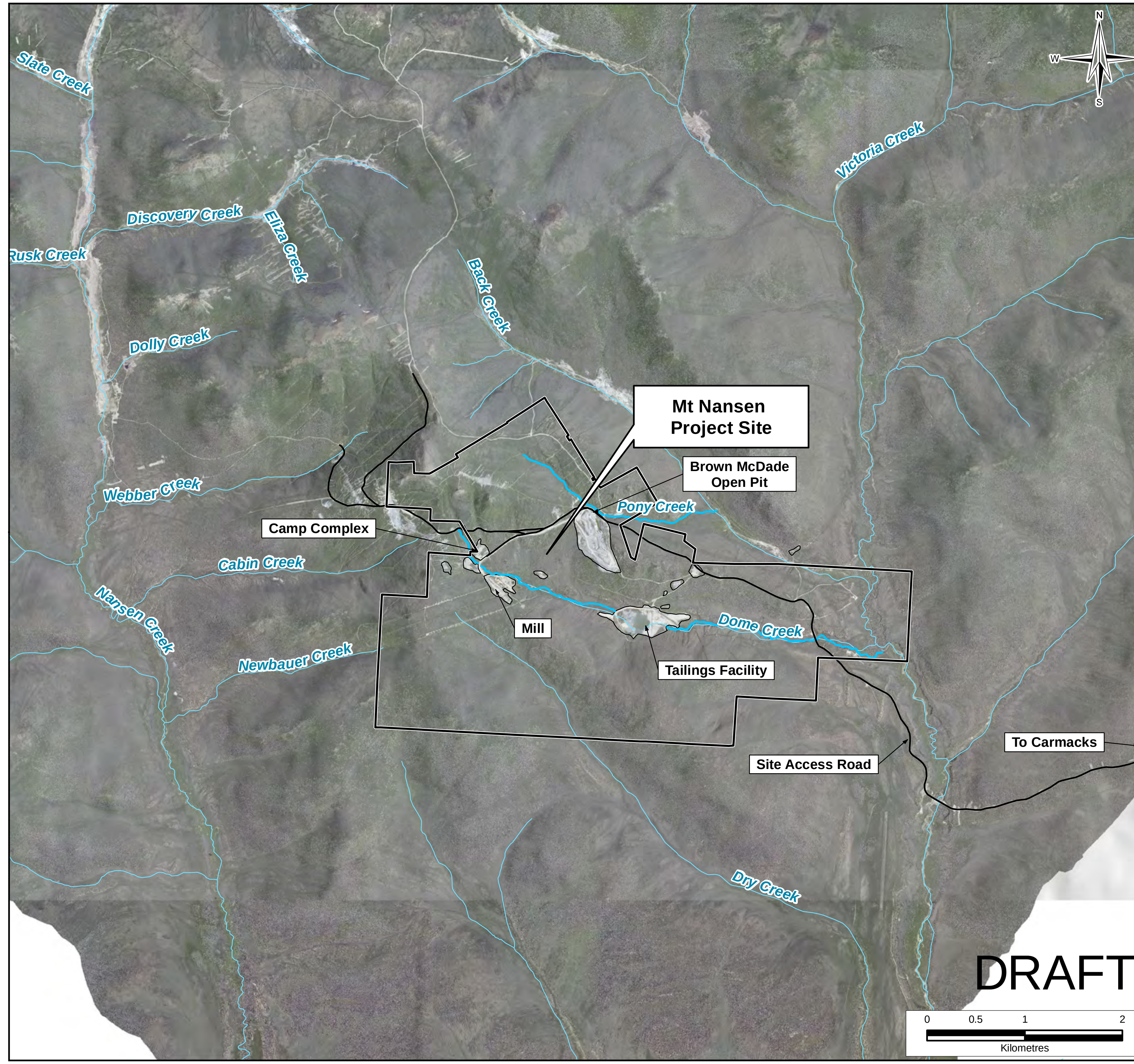
1.2.1 Objectives

The closure objectives for the Mount Nansen Remediation Project (MNRP) are as follows:

- protect human health and safety;
- protect and restore the environment including land, air, water, as well as fish and wildlife and their habitats;
- return the mine site to an acceptable state that reflects original, traditional, and pre-mining land use;
- maximize local, Yukon and First Nations benefits; and
- manage risk in a cost effective manner.

The principal design objectives for the Mount Nansen site are as follows:

1. Mitigate/minimize physical health and safety hazards.
    a. Mitigate onsite fall hazards (e.g. Brown McDade Pit, exploration trenches) by backfilling and/or grading.



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AMEC Environment & Infrastructure Suite 600 - 4445 Lougheed Highway, Burnaby, B.C., V5C OE4 Tel. 604-294-3811 Fax 604-294-4664	Associated Engineering amec	DATUM NAD83	TITLE	REV. NO A
		PROJECTION UTM ZONE 8	KEY MAP AND LOCATION PLAN	FIGURE NO 1
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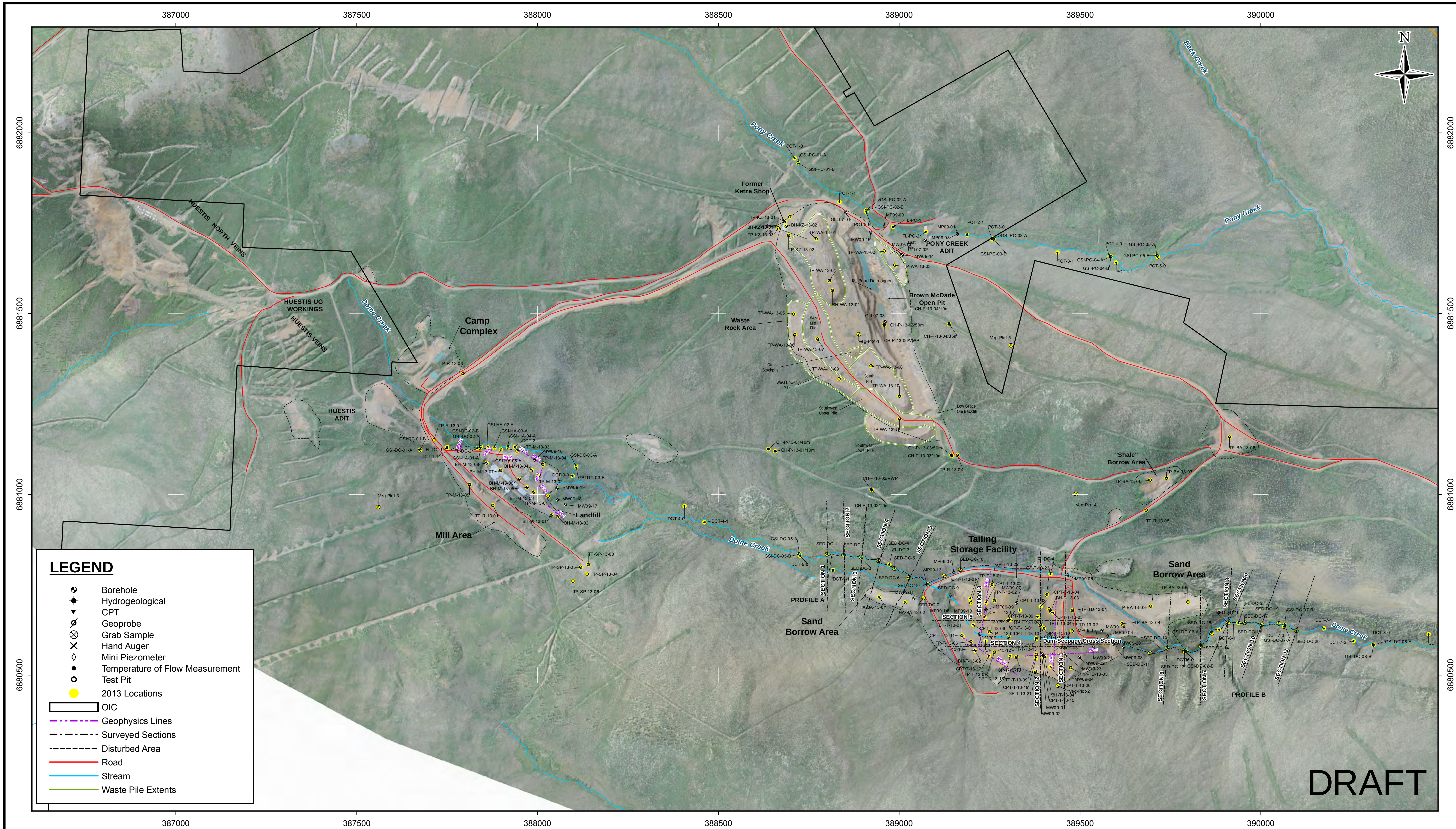

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PROJECT
MOUNT NANSEN REMEDIATION PROJECT
DESIGN BASIS MEMORANDUM

TITLE
OVERVIEW SITE PLAN

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   b. Mitigate tailings dam stability/permeability issues by moving tailings from existing storage areas and decommissioning the dam.
   c. Remove site infrastructure.
   d. Seal Open Pit adit(s), if needed for Closure Option 4. Mitigate drainage from other adits outside Open Pit (Huestis, Webber), if needed for surface water remediation.
2. Mitigate risk of exposure to contaminated materials.
   a. Placement of the tailings and waste rock within the Brown McDade Pit and encapsulate with an engineered cover.
   b. Design mitigation and/or remedial programs to address or prevent impacts to groundwater and surface water from historical site uses or during remedial construction.
   c. Assessment, removal and disposal of hazardous materials and petroleum hydrocarbons (liquids or contaminated soil and/or groundwater).
3. Undertake closure measures that will not adversely affect local environmental quality.
   a. Manage surface water and groundwater such that water quality is maintained to regulatory standards at the entry points to the environment.
   b. Manage acid rock drainage (ARD) and metal leaching (ML) potential that could have adverse affects on the environment.
   c. Rehabilitate surface and watercourse conditions of the tailings facility area to conditions equivalent to the pre-development environment.
   d. Improve landforms and general site conditions (i.e. consistent with the general objective of returning the site to conditions that reflect original, traditional and pre-mining land use).

1.2.2 Scope

The final remediation alternatives study (LORAX, 2011) presented technical information regarding four remediation options. The options were evaluated by representatives of Government of Yukon, Aboriginal Affairs and Northern Development Canada (AANDC) and the Little Salmon/Carmacks First Nation (LSCFN). Option 4, as described in LORAX (2011), has since been selected as the remediation option for the site. This remediation plan is comprised of the following:

- relocating the tailings and underlying affected soils from the existing tailings impoundment to the Open Pit;
- removing the main tailings dam and downstream seepage dam;
- relocating mineralized waste rock to the Open Pit;
- backfilling the Open Pit so that the tailings are located above the groundwater table and a stable final surface and topography is provided;
- developing a management method for the water currently in the tailings facility and Open Pit and for the short term seepage from the backfilled pit;

- covering the Open Pit area with an engineered low infiltration cover to substantially limit water contact within the tailings deposit;
- understanding the backfilled pit's hydrogeology so that seepage can be appropriately managed;
- remediating the mill area including building demolition, removing the rail tanker, restoring the water course, removing mineralized rock, removing hazardous waste, removing historic tailings, decommissioning historic settling ponds, providing compliant water quality and, if shown to be necessary, remediating the old landfill;
- remediating the camp area including demolishing existing buildings except those required for maintenance following closure, and removing hazardous waste;
- decommissioning all non-public roads, where not required for future monitoring;
- removing existing infrastructure (power lines, pipelines, sediment ponds, ancillary buildings, etc.);
- remediating hydrocarbon contaminated soils;
- remediating exploration trenches and disturbed areas as appropriate;
- decommissioning the Victoria Creek pump house and existing artesian well;
- reconstructing and reclaiming the Dome Creek channel and valley following removal of the tailings storage facility; and
- creating a remediated landscape that complements the natural topography and vegetation.

1.3 Project Development Status

1.3.1 30% Design Phase Objectives

The current phase of design development is referenced in AAM's process as the 30% Design Development phase. This phase is intended to:

- characterize the technical feasibility of Option 4;
- identify a base case design which can be further optimized and refined;
- provide bracketed predictions of the likely performance of the base case design (e.g. predicted ranges of downstream water quality relative to CCME criteria);
- provide a bracketed understanding of the risks associated with key project features and outcomes;
- characterize the nature and scale of uncertainties related to predictions of performance and risk;
- outline the basic elements of any adaptive management plans that may be needed to manage risks and uncertainties; and
- develop a project execution cost estimate with enough utility and reliability to support the next level of Partner decision making (generally equivalent to an AACE (Association for Advancement of Cost Engineering) Class 3 Estimate).

1.3.2 Current Design Status

The current design Base Case that has been developed to meet the 30% design phase objectives is described in Section 2.0. For the most part, this Base Case represents a single, integrated approach to executing Option 4 (i.e. it does not carry forward multiple options for completing the work). The departures from this general statement are as follows:

- Tailings Relocation: the Base Case brings forward two methods for placing tailings into the Open Pit: dumping from the pit walls and controlled placement from the bottom of the pit up. Both of these methods will be described in the Design Report (Section 4.0) to comparable levels of definition, consistent with the objectives for the 30% design phase. If these two methods or procedures are found to have equal merit, they may be carried forward into final design to allow contractors to most competitively bid the work.
- Design Contingencies: design contingencies refer to measures or features that may be incorporated into the Base Case in subsequent phases of design (i.e. post the 30% design phase) to mitigate risks and/or uncertainties. The major design contingency identified in the current Base Case (Table 1) relates to the potential need for pit water containment and collection measures to facilitate future adaptive management efforts, should they be required, to address deteriorations in downstream water quality. These measures will be described and costed in the 30% Design Report, but not to the same level of definition as the balance of the design (i.e. contingent measures have not been developed to the same level as Base Case components).
- Adaptive Management: the Design Report will reference some specific techniques that may be considered post remediation to support any Adaptive Management efforts and responses. These techniques will be outlined conceptually (i.e. not to a level of definition comparable to the Base Case, or to the Design Contingencies) because their development and design will be contingent on the specific circumstances and requirements that ultimately give rise to the need for some kind of future Adaptive Management response.

1.4 DBM Scope and Content

The Design Basis Memorandum (DBM) outlines the design philosophies and criteria that have been used as input to, and support for, the 30% Design Phase deliverables, particularly the Design Report. This DBM is an update to a preliminary version prepared early in the 30% Design Phase (AMEC, 2013). The DBM update reflects the design development work that has occurred since, and the findings of the Site Investigation completed in the fall of 2013 (AMEC, 2013a, 2014).

The DBM includes the following:

- Design Base Case: a description of the Design Base Case that has been developed to respond to the project objectives and scope;
- Design Criteria: a listing of the specific criteria that have been established to date in support of the 30% design phase; and
- Design Outline: an outline of the content of the Design Report that will be developed from the Design Base Case and Design Criteria.

2 DESIGN BASE CASE

Following completion of the 2013 Site Investigation, and at the onset of 30% design phase development work, the AMEC team outlined a Design Base Case for the MNRP. This Base Case is a design development tool, not a final statement of the execution scope, and reflects the design team's consensus on the most likely methods for executing Option 4. The Base Case serves to focus design activity, improves the efficiency of the development process and becomes progressively more defined as the design proceeds. Alternatives to the Base Case are considered as key design assumptions are validated (e.g. winter relocation of tailings, controlled placement vs. end dumping).

The evolution of the MNRP Design Base Case through the 30% design phase was reviewed with the Project Partners during meetings on November 28, 2013 and January 27, 2014. The current Base Case (as outlined in the January 27 meeting) is described in Table 1. The table also outlines the key design issues that were addressed during the 30% design phase in support of the Base Case and identifies issues that will require additional consideration in subsequent phases of design. The Base Case, as presented in Table 1, will be the starting point for refinements during the 60% and 100% design phases.

Table 1: MNRP Design Base Case

Element	Description of Current Base Case	Design Issues Addressed in Phase One (30% Design)	Design Issues Requiring Resolution Post Phase One
Tailings Relocation	▪ Tailings will be dewatered to the extent possible prior to excavation with a vacuum wellpoint dewatering facility. ▪ Tailings pond water and wellpoint production will be directed to a water treatment capability. ▪ Dewatered tailings will be relocated using a conventional truck and shovel operation. ▪ Adjustments to conventional equipment and methods will be incorporated to address the relatively small proportion of tailings that cannot be dewatered. ▪ Relocation will be completed via an integrated process of dewatering, tailings removal and dam removal undertaken over at least two summer construction seasons. ▪ The dam (or a portion of it) will likely remain following tailings removal as a sediment control measure until all work is complete and then be removed as a final layer for reclamation or cover.	▪ The option of excavating wet tailings was discounted for the following reasons: - excavating tailings in the wet will have very slow production so the costs of a dewatering operation are not likely to be significantly greater than inefficient truck/shovel operations; - wet excavation is subject to safety concerns as saturated loose tailings are subject to static liquefaction which can occur with little to no warning (i.e. creating a potential to engulf people and equipment); - dewatering tailings is aligned with “dry” Option 4 objectives. Tailings are placed “dry” so seepage is reduced and there is less time required to meet the general remediation objectives of Option 4; - “dry” tailings can be placed in a denser state and/or compacted if this is determined to be the most cost effective placement option (as opposed to end dumping from the pit walls). This will reduce post placement settlement in the open pit so cover performance may be improved; and - the storage volume available in the pit requires that tailings be stored above ground. Placing wet tailings above ground would introduce more significant stability concerns and would be particularly challenging in the areas constrained by the public road. ▪ Materials will be excavated with a conventional truck and shovel operation because alternatives (i.e. conveying, dredging) are impractical (i.e. insufficiently flexible to accommodate the particulars of the site and/or work scope), because truck/shovel operations align better with a local procurement strategy/ preference and because	▪ More detailed assessments of the uncertainties associated with the proposed tailings relocation methods with a view towards defining the need for tailings excavation trials as an early component of project execution (e.g. excavation methods validation, adjustment and potentially, repricing, as an early task in the field execution contract).

Element	Description of Current Base Case	Design Issues Addressed in Phase One (30% Design)	Design Issues Requiring Resolution Post Phase One
		mobilizing large equipment to site would be constrained by the road access. A dredging operation would be counter-productive relative to the "dry" tailings objective. ▪ Assessments of the tailings and of the capabilities of vacuum wellpoint dewatering technology have confirmed that dewatering followed by truck/ shovel excavation and relocation will likely be feasible for most, but not all of the tailings inventory. ▪ About 30% of the tailings inventory will probably not be dewaterable and will be transported wet. Excavation, haulage and pit placement for wet materials will use equipment and methods largely common to the drier materials with some adjustments in handling and sequencing. ▪ Current and predicted air temperatures indicate that it is unlikely backfill placed into the pit will freeze/remain frozen (i.e. the design will need to assume thawed conditions in pit backfills post remediation). ▪ The pit backfilling approaches described above (i.e. either controlled placement or end dumping) for the current Design Base Case will not invoke the requirements of the Canadian Dam Association's (CDA's) Dam Safety Guidelines in the pit.	
Dam Material Excavation and Relocation	▪ Dam materials will be excavated with a conventional truck and shovel operation. ▪ Dam material excavation will be integrated with tailings relocation and removed in stages consistent with geotechnical stability and sediment control (construction water quality) requirements. ▪ Uncontaminated dam materials will be utilized for:	▪ Assessments of the dam materials suggest that a large proportion of the materials will be classified as uncontaminated (i.e. not exhibiting significant, anthropogenically derived parameter excursions) and will, therefore, be available for other project purposes (e.g. reclamation requirements, cushions/ filters for cover or liner geosynthetics, general fill for site grading).	▪ More definitive assessments of background soil, sand and rock metal levels for the Mount Nansen area. Current determinations that these levels are likely elevated naturally will require confirmation via technically robust and statistically valid methods. ▪ Additional assessments of dam removal sequencing

Element	Description of Current Base Case	Design Issues Addressed in Phase One (30% Design)	Design Issues Requiring Resolution Post Phase One
	- reclamation requirements (to improve revegetation performance in granular surface soil profiles); - backfill required for the restoration of Dome Creek (in this case, sands will be utilized with other materials as needed to provide non-erodible surfaces); - source of material for the cover over the backfilled pit; and - general fill to restore ground surfaces to proposed profiles and topographies. ▪ Contaminated dam materials will be directed to the open pit and may be used to facilitate the handling, transport and placement of that portion of the tailings inventory that is not amenable to wellpoint dewatering.		
Open Pit Cover	▪ An interim pit cover will be required over the period following tailings relocation because the limits on differential settlements needed to permanently maintain cover integrity cannot be provided initially (even with placement of “dry” tailings). ▪ Pit covers will be constructed with geosynthetic materials and/or granular materials that are available, or can be processed, within or near the Order In Council (OIC) boundary (i.e. there are insufficient fine grained material volumes within economically practical distances of the site to warrant consideration of earth based barrier systems). ▪ A permanent cover constructed after differential settlements have declined to	▪ Differential settlements will result from the consolidation of tailings and settling of waste rock (the latter cannot be reduced as they might typically be accomplished by sluicing, because of the increase in the contaminated pit water inventory that would result from sluicing). ▪ The maximum differential settlements during the interim cover period (due largely to consolidation of the tailings) are anticipated to be large and well beyond the capabilities of any cover system to accommodate without damage. Similarly, maximum differential settlements over the long term (i.e. after the permanent cover has been installed, and largely the consequence of water induced collapses of tailings, or earthquake induced settlements) will, in all likelihood, exceed the accommodative capabilities of any cover system. In both cases (i.e. for both the interim and permanent covers), the most practical mitigation	▪ Assessments of the benefits of more robust predictions of settlement timelines (i.e. are there any material benefits provided via settlement predictions over observational monitoring of cover settlements and performance). ▪ Assess relative cost of providing a long term geosynthetic liner (i.e. Coletanche) versus Bentonite Admixture

Element	Description of Current Base Case	Design Issues Addressed in Phase One (30% Design)	Design Issues Requiring Resolution Post Phase One
	tolerable levels will be included in the initial project execution scope (i.e. this component will be a defined scope item, not an adaptive management element that may, or may not be necessary). ▪ The impacts of large differential settlements in both interim and permanent covers will be mitigated by an ongoing program of cover monitoring and maintenance/repair. ▪ Interim and permanent cover designs will minimize infiltration by utilizing contours and configurations that redirect precipitation to Pony and/or Dome Creeks. ▪ The cover will be configured to avoid encroaching on the public road at the north end of the Open Pit that will remain post closure.	for large differential settlements will be monitoring, maintenance and/or repair (i.e. design mitigations for the range of differential settlements are not available). ▪ The length of time over which an interim cover is required will depend on the settlement of the backfilled pit. There will be uncertainty associated with these settlement timelines (although it is known they will be measured in years) and that uncertainty will be influenced by the details of the tailings/dam relocation method selected (i.e. end-dumping tailings from the pit wall will produce a more uncertain settlement behaviour than controlled placement and compaction of tailings within the pit itself). ▪ Modelling indicates that surface water quality outcomes at likely receiving environments are not highly sensitive to short term degradations in interim cover performance, in part because the tailings will be largely unoxidized/acidified during this period. That said, monitoring interim cover condition and performance and responding to evident settlement damage will be required.	
Open Pit Containment Structure	▪ Open pit pond water removed prior to tailings and waste rock will be relocated and treated prior to discharge. ▪ The Pony Creek Adit will be decommissioned. ▪ A non-PAG waste rock bench will be constructed at the base of the open pit to maintain the base of the tailings above the likely maximum groundwater level. ▪ Tailings will be placed in the pit with two options advanced – end dumping and direct bottom up placement. ▪ The low grade ore at the south end of the pit will be relocated within the drainage catchment of the pit footprint.	▪ The existing quality of the open pit pond water is not compatible with direct discharge requirements and will require treatment prior to release. ▪ Characterizations of the pit water balance suggest that post remediation groundwater levels are unlikely to rise above the Pony Creek Adit. If levels do, on an infrequent basis, rise temporarily above the base of the tailings, there would be a short term increase in contaminant mass transport from the pit. However, this increase is unlikely to cause an unacceptable degradation of surface water quality at receiving environments (i.e. groundwater level increases are likely to be low probability, low consequence events). ▪ Current pit outflows are strongly influenced by precipitation and are likely to be reduced post	▪ Additional assessments of the uncertainties related to post remediation water quality predictions leading to a decision on the need for providing active containment, collection and treatment of pit flows and contaminants in the Design Base Case. ▪ Additional development of the regional model of groundwater flow to confirm the assumptions inherent in the water quality model. ▪ Confirmation that the Pony Creek adit does not need to be hydrogeologically sealed (i.e. groundwater flows restricted) to maintain downstream water quality.

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	▪ Other contaminated materials will be placed above the tailings within the footprint of the pit. ▪ NPAG (Non-Potentially Acid Generating) waste rock will be placed above the tailings and the existing low grade ore for physical stabilization and to provide suitable topography for surface drainage and end land use. ▪ NPAG will be used to fill in the ramp and re-contour the south end of the pit and may be used to flatten the slopes of the final pit cover once the final cover system is in place. ▪ Diversion ditches will redirect runoff originating upstream of the pit structure and protect portions of the cover from erosion and collect and control runoff from the cover. Long term surface water management will be provided by the contouring of the pit which will be designed to shed water. ▪ Contaminant fluxes from the pit will be passively reduced during transport in the local/regional hydrogeological flow regime to meet water quality criteria at an agreed upon compliance point.	remediation to levels that are small in relation to the local/regional surface water flow regime. ▪ These assessments of pit hydrogeology and surface water quality have concluded that groundwater level control via the Pony Creek Adit (or some alternate level control structure) will not be necessary. ▪ The current "most likely" modelling estimate suggests that the mass transport of contaminants from the pit post remediation will not likely create an unacceptable incremental impact at surface water receiving environments in Victoria Creek. There are uncertainties with this finding and scenarios where unacceptable water quality for specific parameters could occur. These uncertainties could be mitigated by cover maintenance or replacement and/or pit design contingencies that would provide for the containment, collection and management of pit outflows (e.g. via pit liners and sidewall drainage that would be produced via wells completed in the waste rock bench, discharging to a water treatment facility), if at any time, post remediation monitoring identifies unacceptable degradations in surface water quality. At the 30% design stage, these contingencies will be indentified and conceptually developed. ▪ The following qualifiers apply to the modelling estimates described above: - discussions with Project Partners and regulators will be required to establish site specific water quality criteria that reflect the influence of elevated parameter levels upstream of the site (i.e. will require relief on some typical aquatic life criteria (e.g. CCME criteria) to reflect background water quality conditions applicable to the Mount Nansen site);	▪ If Pony Creek adit must be sealed additional adit investigations will be required to fully understand the current state and performance of the existing adit bulkhead.

Element	Description of Current Base Case	Design Issues Addressed in Phase One (30% Design)	Design Issues Requiring Resolution Post Phase One
		- the water quality modelling conclusions are influenced by the location of the compliance point. Compliance at Victoria Creek is more feasible than at various points upstream; - the predicted risks to water quality are sensitive to the assumed characteristics and conditions of the tailings source terms. This is particularly true for the period following tailings acidification, the critical period with respect to water quality impacts and a condition that is not anticipated to occur until many years (potentially measured in decades) after tailings placement in the pit; and - the nature of the modelling platform used (GoldSim), while appropriate for this level of design, has inherent limitations in its predictive capabilities that require consideration in the characterization of, and response to, modelling uncertainties.	
Water Treatment	▪ All contaminated waters produced before and during remediation (i.e. pond waters at the Open Pit and Tailings Storage Facility, pore waters produced by the wellpoint dewatering system, surface runoff incompatible with agreed upon discharge criteria) will be directed to a single, fixed (i.e. non-mobile) water treatment plant constructed for, and dedicated to, the project.	▪ The water treatment capacity required to treat pond and pore water volumes over timelines that would support the desired base case schedule (one month to drain the tailings pond) is beyond that which can practically be provided by mobile, skid mounted facilities. ▪ Project flows will be managed and directed to a single, fixed water treatment location.	▪ Additional assessments to optimize the balance between water treatment capacity and onsite water storage (i.e. determining if schedule objectives can be realized more economically via the provision of storage with a lower water treatment flow capacity). ▪ Additional assessments of the potential range in raw water qualities to refine estimates of reagent requirements.

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Mill Area Remediation	▪ Non-hazardous contaminated soils, tailings and PAG waste rock will be removed and directed to dedicated areas of the pit containment structures with methods of placement and/or containment engineered appropriately for the nature of the materials involved. ▪ Hazardous contaminated soils will be removed and directed to appropriate offsite treatment and/or disposal facilities.	▪ Utilizing the air space that can be developed within the open pit containment structure for non-hazardous mill area soils will be more cost effective than developing dedicated facilities elsewhere onsite, or directing the materials to offsite facilities. ▪ The non-PAG waste rock inventory in the mill area will be left in place, or recontoured to suit the area regrading plan, consistent with the general site philosophy that non-PAG waste rocks do not require remediation and/or management. ▪ The Heustis adit does not appear to be producing any significant deterioration of downstream water quality. ▪ The upstream reaches of Dome Creek have high background metals concentrations.	▪ More definitive assessments of background soil, sand and rock metal levels for the Mount Nansen area will be needed to finalize the mill area volumes requiring removal. Current determinations that these levels are likely elevated naturally will require confirmation via technically robust methods vetted by the Project Partners. ▪ Assessments of the potential utility of human health and/or ecological risk assessments as a cost efficient method for limiting excavation requirements, particularly for materials at depth.
Structures	▪ Site structures will be brought to grade in accordance with structure specific dismantling and/or demolition plans. ▪ Non-hazardous materials generated by dismantling/demolition activity will be directed to offsite reuse or recycling options, or to dedicated areas of the pit containment structure with methods of placement and/or containment engineered appropriately for the nature of the materials involved. ▪ Structural elements containing or incorporating hazardous materials will be cleaned of these materials prior to onsite disposition, or directed to appropriate offsite treatment and/or disposal facilities. ▪ Hazardous materials stored in containers within, or ancillary to, site structures will be directed to appropriate offsite treatment and/or disposal facilities.	▪ Utilizing the available disposal capacity that can be developed within the open pit containment structure for non-hazardous dismantling/ demolition wastes will be more cost effective than developing dedicated facilities elsewhere onsite, or directing the materials to offsite facilities. ▪ The quantities of hazardous materials generated by the project are expected to be small and below thresholds that would warrant assessments of options with lower unit costs than commercial, offsite treatment and/or disposal facilities.	

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	▪ Victoria Creek well will be used as a water source during remediation activities and subsequently decommissioned and the Wellhouse dismantled/demolished.		
General Site Reclamation	▪ Final surfaces will be restored largely with materials available locally. ▪ The capabilities of surfaces restored with non-erodible granular materials will be enhanced by rebuilding local environments compatible with the surrounding landscape. ▪ Vegetated zones will be re-established within the disturbed area footprint using local sand sources (borrow and clean dam materials) supplemented (in relatively low volumes) with appropriate amendments to satisfy fines requirements and to support revegetation objectives.	▪ The project will not have silt and finer materials available in quantity for reclamation (sources are generally too distant to be economically viable). ▪ The proportion of the site disturbed area that can potentially be revegetated is limited by the local sand volumes (from dam removal and/or site borrow) that can be made available for reclamation purposes. ▪ There is uncertainty about the potential success of revegetation efforts relying on materials no finer than sands. ▪ Lands within the disturbed area that are not revegetated will be surfaced, contoured and/or configured in ways that, while different from the surrounding lands, meet the broad objective of providing compatible, complementary and/or equivalent land uses.	▪ More definitive assessments of background soil metal levels for the Mount Nansen area will be needed to accurately define the volumes of sand (both from the dam and site borrow areas) that can be devoted to reclamation. Current determinations that these levels are likely elevated naturally will require confirmation via technically robust methods vetted by the Project Partners. ▪ Additional assessments of the nature and long term viability of vegetated lands that can be supported with soil profiles incorporating materials no finer than sands including an examination of the potential utility of field trials. ▪ Additional assessment of the specific reclamation configuration proposed for lands outside revegetated zones in consultation with the Project Partners (to ensure that the more subjective elements of providing land use compatibility and/or equivalency are considered and incorporated into final plans).
Dome Creek Valley Reclamation	▪ Contaminated organic debris underlying the tailings and/or dam materials will be removed and directed to a dedicated location within the pit containment structure. ▪ Uncontaminated organic debris or silt beneath the tailings will be removed,	▪ Sediment quality downstream of the tailings facility suggests that tailings may be present in localized areas. These areas will require sediment removal and creek bed restoration. ▪ The lack of local organic reclamation materials requires a creek valley restoration Base Case relying largely on granular, non-erodible materials.	▪ Additional assessment of Dome Creek downstream of the tailings pond with regards to sediment quality and possibility of tailings migration / deposition in the lower portions of Dome Creek.

Element	Description of Current Base Case	Design Issues Addressed in Phase One (30% Design)	Design Issues Requiring Resolution Post Phase One
	stockpiled and dewatered for potential use as a reclamation material or amendment (although the volumes involved will not be large enough to materially impact the need for a reclamation plan based largely on no/low minus sands materials gradations). ▪ The original ground will be secured soon after exposure through placement of free draining and erosion resistant materials. ▪ The creek channel and disturbed valley slopes will be restored with layers of sand overlain by stable and non-erodible rock materials (e.g. NAG rock). ▪ The aesthetics of the creek valley restoration concept may be enhanced by incorporating stream restoration techniques that create natural features without compromising the fundamental hydrologic properties and/or capabilities of the restored channel, or the geotechnical stability of valley walls.	▪ The impact of warming air temperatures that is evident from the meteorological record over the last few decades will be considered in the stability assessments and design of restored valley slopes. ▪ The stability of the slopes considers the impact of thaw induced pore pressures.	▪ Assessments of the potential utility of constructed wetlands in the restored Dome Creek Valley, both to improve the aesthetics of the reclaimed area and potentially as a means of improving creek water quality. ▪ Development of details for the tie-ins between the reclaimed and undisturbed areas to minimize degradation of permafrost. ▪ Shallow probing/hand core auguring of near surface active layers in undisturbed terrain in the tailings area slopes that must be “connected” to reclaimed surfaces.
Exploration Trench Reclamation	▪ Reclamation will be completed for trenches that: - are likely to create major erosion, water quality or land use constraints if left unreclaimed; and - can be reclaimed without creating a reclamation liability greater than that being mitigated (e.g. where machine access will not cause inordinate damage). ▪ Those trenches that are reclaimed will use a common reclamation specification. That method will be comprised of:	▪ Trench reclamation requirements will need to be established on an individual basis giving due consideration to the intrusive impacts that reclamation activity will inevitably create, revegetation that has occurred naturally and the resulting fact that in some areas, reclamation efforts will cause damage disproportionate to the available benefits. ▪ Trench reclamation will proceed without the large scale import or placement of materials.	▪ Additional assessments of the need for more detailed characterization of individual trench reclamation requirements, likely in consultation with the project Partners or alternatively, an execution specification that equips the field execution team with the flexibility to adjust reclamation specifics to the particular characteristics and circumstances of each trench.

Element	Description of Current Base Case	Design Issues Addressed in Phase One (30% Design)	Design Issues Requiring Resolution Post Phase One
	- replacing available side cast materials back into the trench; no new fill will be imported or incorporated; and - vegetation that has become established on side cast materials will be stripped prior to moving the side cast material; produced mulch will be placed over side cast materials replaced in trench.		
Climate Change	▪ Has been accounted for by considering two scenarios (1) today's temperatures continuing on, and (2) making an allowance for warming as per IPCC/ Canadian guidelines. In both scenarios the long term expectation is that most permafrost will thaw out. If colder conditions eventuate permafrost that has been lost will reform and pit infill tailings will freeze.	▪ Current seepage patterns from the Pit to receiving waters are understood at a conceptual level based on limited hydrogeological and permafrost data. As future permafrost patterns evolve, seepage patterns may change in unpredictable ways. Maintaining a "dry" pit will help mitigate this risk. ▪ Adaptive Manage will of necessity be required to address long term uncertainties.	

3 DESIGN CRITERIA

Table 2 lists criteria that have been applied to the current phase of design. This list is not intended to capture all those criteria that will eventually apply to the final design. The implications of selecting particular criteria (i.e. from an available range or from alternative sources), has been, and will continue to be, assessed in parallel with design development activity. Similarly, the suitability of the criteria listed in Table 2 will be validated in subsequent phases of design, and there may be some adjustments to specific criteria during that process.

Note that many of the criteria applied during the 30% Design Phase have been identified, described and rationalized in the Project Design Report (AMEC, 2014a). These criteria are identified in Table 2 via references to the applicable table numbers from the Design Report.

Table 2: MNRP Design Criteria Applied During the 30% Design Phase

Criteria	Value[c]	Source
General		
▪ Project Material Volumes	Design Report Table 4.1 - Materials to be Placed in the Open Pit	AMEC (2014a)
Geotechnical		
▪ Slope Stability Factors of Safety		
- Short term / end of construction		
o Limit equilibrium	1.3	Standard engineering practice (e.g. CDA, 2007, CGS, 2006)
- Long term		
o Limit equilibrium	1.5	
- Earthquake		
o Liquefaction triggering per EERI/ NCEER methods	1.1	
o Pseudo static	1.1, if <0, requires deformation analyses	
o Deformation (closed form, e.g. Bray and Travasarou)	n/a - limit deformations to tolerable amount based on structure and consequence	
- Post earthquake		
o Static liquefaction	1.2	
▪ Design Earthquake		
- Earthquake return period		
o Dome Creek	1:1,000	Based on return event for significant consequence structures in CDA (2007)
o Ridgetop	1:2,500	Based on return event for high consequence structures in CDA (2007)
- PGA		
o Dome Creek	0.08	NRC (2010)
o Ridgetop	0.11	NRC (2010)
- Site class correction factor		
o Dome Creek	C = 1.0	NRC (2010)
o Ridgetop	B = 0.8	NRC (2010)

Criteria	Value[c]	Source
- Magnitude		
o Dome Creek	6.5	Engineering judgement based on previous seismicity characterization work and published literature
o Ridgetop	6.5	
▪ Material Properties	Design Report Table 4.9 - Material Properties Used in Stability Analyses	AMEC (2014a)
▪ Settlement Parameters	Design Report Table 4.11 - Settlement Parameters	AMEC (2014a)
▪ Dome Creek Stability Analyses Material Properties	Design Report Table 7.4 - Material Properties for Dome Creek Stability Analyses	AMEC (2014a)
Pit Cover		
▪ Design Basis	Design Report Table 4.4 - Description and Rationale for Principal Design Components for Interim and Final Cover	AMEC (2014a)
▪ Meteorological Data	Design Report Table 4.5 - Average Meteorological Data for Mount Nansen Site	AMEC (2014a)
▪ Cover Material Properties	Design Report Table 4.6 - Hydraulic Properties of the Cover Materials	AMEC (2014a)
Hydrology		
▪ Flood Events		
- Regular creek channel flow	1 in 2 years	
- Peak creek channel flows	1 in 1,000 years	Standard engineering practice development/design term judgement; see Design Report
- Diversion channels	1 in 1,000 years	Standard engineering practice
- Channel Design		
o Pit Cover Diversion Channel	Design Report Table 4.3 - Design of Diversion Channel Around the Pit Cover	AMEC (2014a)
o Dome Creek Channel Restoration	Design Report Table 7.6 - Design of the Dome Creek Restoration Channel	AMEC (2014a)
- Construction Water Management Plan and Erosion Control Plan	1 in 10 year (temporary sedimentation ponds), 1 in 25 year (temporary diversion channels)	Standard engineering practice
Water Quality		
▪ Assessment Standards[a] (Ground and Surface Waters)	▪ CCME Aquatic Life Guidelines ▪ Schedule 3 of the Yukon CSR	YG (1996) CCME (1999) YG (2002)

Criteria	Value[c]	Source
▪ Modelling Inputs		
- Parameter List	Design Report Table 5.1 - Summary of Input Parameters for GoldSim Model	AMEC (2014a)
- Precipitation	Design Report Table 5.2 - Mount Nansen Average Monthly Distribution of Precipitation	AMEC (2014a)
- Snow	Design Report Tables 5.3 and 5.4 - April 1 Snowpack for 100 Year Wet and Dry Return Periods; Snowmelt Release Rate	AMEC (2014a)
- Evaporation	Design Report Table 5.5 - Monthly Annual Lake Evaporation	AMEC (2014a)
- Runoff Coefficients	Design Report Table 5.6 - Runoff Coefficients	AMEC (2014a)
- Source Term Loading Rates	Design Report Table 5.11 - Selected Loading Rates for Waste Rock and Ore	AMEC (2014a)
Site Characterization		
▪ Soil and Tailings Dam Material Assessment Standards[a]	▪ Schedules 1 and 2 of the Yukon CSR	YG (2002)
▪ Special Waste Soil Thresholds	▪ Yukon Special Waste Regulation	YG (1995)
▪ Hazardous Materials Characterization	▪ Hazardous Waste and Hazardous Recyclable Materials Regulations (SOR/2005-149)	GC (1999)
Geochemistry		
▪ Neutralization Potential Ratio (NPR) Threshold Value	▪ 2 (i.e. NPR > 2 is non-PAG rock; NPR <2 is PAG rock)	MEND (2009)
▪ Assessment Standards[a]		
- Elemental content of mine rock	▪ Guidelines and Recommended Methods of ML/ARD	Price (1997)
- Metals in soil	▪ Schedules 1 and 2 of the Yukon CSR	YG (2000)
- Leachable metals[b]	▪ Schedule 4 of the Metal Mining Effluent Regulations ▪ CCME Aquatic Life Guidelines	GC (2012) CCME (1999)
Water Treatment		
▪ Plant Throughput Capacity	▪ 25 m^3/hr (to process tailings pond (10,000 m^3), seepage pond (2,000 m^3) and half of Open Pit lake (4,500 m^3) in 30 days)	Design team development/judgement; see Design Report
▪ Raw Effluent Quality	▪ 90^{th} percentile concentrations for critical parameters	Design team development/judgement; see Design Report
▪ Processed Effluent Quality	▪ Schedule 4 of Metal Mining Effluent Regulations	GC (2012)
▪ Engineering Design Basis	Design Report Table 5.16 - Design Criteria for Mount Nansen WTP	AMEC (2014a)

Criteria	Value[c]	Source
Reclamation; Revegetation Coverage		
▪ High Priority Areas		
- Riparian Zone	100%	AMEC (2014a)
- Creek Valleys	10%	AMEC (2014a)
▪ Moderate Priority Areas	10%	AMEC (2014a)
▪ Low Priority Areas	0%	AMEC (2014a)

(a) These standards were applied in the characterization of media to support preliminary design activity; final selection of criteria will be based on post Phase One design development activity and consultations with the Project Partners.

(b) Standards/guidelines applied for reference only; these criteria do not apply to leachates.

(c) Note that detailed descriptions of the nature of these criteria and their application to the design are provided in the applicable sections of the Project Design Report (AMEC, 2014a).

4 DESIGN OUTLINE

The Design Base Case and the Design Criteria will support the development of the MNRP Design Report. An outline of this key design deliverable follows. The cost estimate for the works described in the Design Report will be prepared as a separate design deliverable.

PROJECT BACKGROUND AND SCOPE

- Introduction
- Project Objectives and Scope
  - Objectives
  - Scope

PROJECT DEVELOPMENT STATUS

- 30% Design Phase Objectives
- Design Base Case
  - Description
  - Current Design Status

REPORT ORGANIZATION

MATERIALS MANAGEMENT AND CONTAINMENT PLAN

- Backfilled Open Pit Configuration
- Relocation of Material from Tailings Storage Facility Area
  - Insitu Tailings Condition
  - Tailings Removal
  - Insitu Soils Removal
  - Tailings Dam Removal and Relocation
  - Seepage Collection Dyke Removal
  - Considerations for Multi Season Operations
- Other Materials Requiring Removal
- Material Placement in Open Pit
  - Stabilization of Open Pit Walls
  - Placement of Platform Base
  - Pony Creek Adit Remediation
  - Placement of Tailings, Insitu Soils and PAG Waste Rock
  - Relocation of the Low Grade Ore

- Contaminated Soils Placement
- Dismantling and Demolition Waste Management/Placement
- Surface Water Management

- Pit Cover Design
  - Introduction
  - Design Objectives
  - Design Elements
  - Cover Performance
  - Cover Integrity
  - Cover Modelling Methodology
  - Meteorological Data
  - Hydraulic Properties of the Cover Materials
  - Cover Geometry
  - Cover Modelling Results
  - Final Cover
- Performance of Backfilled Pit
  - Stability Analyses
  - Consolidation / Settlement
  - Seepage
- Summary of Material Requirements for Remediation Efforts
- Design Contingencies and Adaptive Management Plans

WATER QUALITY MANAGEMENT PLAN

- Water Quality Modelling
  - Conceptual Model
  - GoldSim Model
  - Detailed Layout of the Model
  - Model Inputs
  - Existing Water Quality
  - Model Calibration
  - Model Outputs
  - Post Remediation Water Quality
  - Water Quality Model Sensitivity Analyses

- Water Treatment Requirements and Designs
  - Introduction
  - Design Basis
  - Water Treatment Plant Design
  - Uncertainties and Cost Implications
  - Water Treatment Summary
- Water Quality Monitoring
  - Construction Water Management and Erosion and Sediment Control Plan
  - Post Remediation Water Quality Monitoring Plan
- Huestis Adit Water Quality
- Design Contingencies and Adaptive Management
  - Design Contingencies
  - Adaptive Management

SITE INFRASTRUCTURE DECOMMISSIONING, DEMOLITION AND DISPOSITION PLAN

- Infrastructure Inventory
  - Mill Area
  - Camp Area and Miscellaneous Small Buildings
  - Miscellaneous Infrastructure
  - Underground Piping
  - Culverts
  - Road Bridge over Diversion Channel
  - Roads
- Contaminated Soil and Hazardous Materials Inventory
  - Contaminated Soils Volume Estimate
  - Hazardous Materials Volume Estimate
- Contaminated Soil and Hazardous Materials Disposition
  - Contaminated Soil Remediation Plan
  - Hazardous Materials Remediation Plan
- Deconstruction Plans
- Deconstruction and Demolition Materials Disposition
  - Buildings
  - Electrical Infrastructure

SITE RECLAMATION PLAN

- Reclamation Objectives and Policy
- Biophysical Setting
  - Terrain and Soils
  - Vegetation
  - Wildlife
  - Disturbance
- Reclamation Concepts
  - Northern Reclamation-Case Studies
- Preliminary Reclamation Plan
  - Assumptions
  - End Land Use Objectives
  - Landscape Stratification – High, Moderate and Low Priority Areas
  - Reclamation of High Priority Areas (Dome Creek Valley and Dome Creek)
  - Reclamation of Moderate Priority Areas (Mill, Camp and Pit Areas)
  - Reclamation of Low Priority Areas (Roads and Landings)
  - Exploration Trench Reclamation
  - Invasive Plant Management
  - Recommended Field Trials
  - Monitoring
- Reclamation Plan Summary
- Dome Creek Reclamation near Tailings Facility
  - General Configuration of Remediated Tailings Storage Area
  - Stability Analyses
  - Channel Design

5 LIMITATIONS AND CLOSURE

This report was prepared exclusively for Assessment and Abandoned Mines, Energy Mines and Resources by AMEC Environment & Infrastructure, a wholly owned subsidiary of AMEC Americas Limited. The quality of information, conclusions and estimates contained herein is consistent with the level of effort involved in AMEC services and based on: i) information available at the time of preparation, ii) data supplied by outside sources, and iii) the assumptions, conditions and qualifications set forth in this report. This report is intended to be used by Assessment and Abandoned Mines, Energy Mines and Resources only, subject to the terms and conditions of its contract with AMEC. Any other use of, or reliance on, this report by any third party is at that party's sole risk.

Yours truly,
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