



Final Report:

Remedial Action Plan:

BLANCHET ISLAND MINE

Prepared For:

Public Works and Government Services Canada
Northern Contaminated Sites Group
and
Aboriginal Affairs & Northern Development Canada
Contaminants and Remediation Directorate

Prepared By:

SENES Consultants

August 2013

- FINAL -

REMEDIAL ACTION PLAN

FOR

BLANCHET ISLAND MINE

NORTHWEST TERRITORIES

Prepared for:

**Public Works and Government Services Canada
Western Region**

On Behalf of:

**Aboriginal Affairs and Northern Development Canada -
Contaminants and Remediation Directorate**

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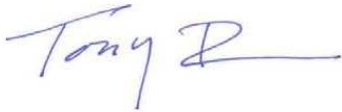
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August 2013

EXECUTIVE SUMMARY

Site and Project Introduction

The abandoned Blanchet Island Mine is located approximately 115 km southeast of Yellowknife on the southern shore of Blanchet Island, within the East Arm of Great Slave Lake, Northwest Territories. The former mine is the custodial responsibility of Aboriginal Affairs and Northern Development Canada (AANDC). The site was first staked as a high grade cobalt and nickel showing in 1968 and by the end of 1969 an open-cut and adit had been excised at the site of a granodiorite intrusion in limestone host rock. Small scale mining occurred at the site until 1970, at which point the property was abandoned (Silke 2009). The Blanchet Island Mine is comprised of the following three areas that correspond to former site activities: 1) the Mine Area which includes the adit, a waste rock deposit and a small scale ore transport system; 2) the Camp Area including former building structures for housing and administrative purposes; and 3) the Beach Area which was the point of access from Great Slave Lake for transport of materials to and from the mine.

Minimal infrastructure now remains at the site. Debris associated with the small scale mining operation is found in the vicinity of the adit and scattered throughout the Mine Area. The Camp Area is still distinguishable and contains 5 dilapidated structures and several small domestic waste dumps. Spilled drums of ore concentrate¹ were previously located in the Beach Area. The ore concentrate was re-containerized in the fall of 2010 and is currently awaiting transport from the island.

Community Interests

Prior to the development of the Blanchet Island Mine, Aboriginal people lived throughout the area for centuries. The site lies within the traditional Akaitcho lands and is part of the Interim Measures Agreement (IMA) area of the Akaitcho Dene First Nations (AKDFN) of the Northwest Territories. It is also situated in the Mowhi Gogha De Nitlee traditional lands as defined by the Tlicho Land Claims and Self Government Act, and within the asserted territories of the Northwest Territories Métis Nation (NWTMN). While the site is remote with no road access, residents from Aboriginal communities closest to the site (e.g., N'dilo, Dettah, and Lutsel K'e) continue to hunt, trap and gather traditional foods throughout the region. In addition to traditional land use, the East Arm of Great Slave Lake is visited by non-Aboriginal residents and tourists.

¹ Although referred to as “ore concentrate” in previous site documentation, there is no evidence to suggest that separation/concentration processes occurred on the site. The use of the term “ore concentrate” has been maintained for consistency only.

Throughout the Northwest Territories, Aboriginal residents have expressed significant concerns regarding abandoned mine sites on their traditional lands. Although the Blanchet Island Mine is very small relative to other historic mining developments in the region (e.g., Giant, Con and Pine Point mines), there remains a general concern associated with historic mining and exploration activities. The potential contamination of water and soils, as well as impacts to fish, wildlife and vegetation are commonly cited as the top priorities for attention. Physical hazards such as unsecured openings and debris have also been identified as concerns with respect to human and wildlife health.

Remediation Planning Process

This document presents a Remedial Action Plan (RAP) developed on behalf of AANDC's Contaminants and Remediation Directorate (CARD), which has a mandate to manage abandoned sites on Federal Crown Land in the Northwest Territories. The specific objective of the RAP is to manage potential human health and environmental risks associated with the former Blanchet Island Mine. The RAP is based on the findings of Phase I, II, III and IIIa Environmental Site Assessments (ESAs), a Human Health and Ecological Risk Assessment (HHERA), best practices in mine closure, current land uses in the project area, and community values and concerns.

Earlier drafts of the RAP included remedial options and technical recommendations which formed the basis of a community involvement and engagement process. The process was implemented to ensure that Aboriginal stakeholders and Northern residents were active participants in the selection of the preferred closure options for the final remediation of the site. Results of the community engagement process and Remedial Options Analysis Workout were used to select the preferred remedial options contained within this final version of the RAP. The RAP will be used to guide the development of detailed engineering and logistics plans for potential remedial actions and monitoring of the site.

Following implementation of the RAP, long-term monitoring and reporting will be carried out at the site to provide ongoing assurance that the remediation works perform as intended.

Proponents and Regulators

AANDC is the project proponent for the RAP and is responsible for securing appropriate approvals and resources. The implementation of the plan will be managed by Public Works and Government Services Canada (PWGSC). SENES Consultants (SENES) has been hired by PWGSC on behalf of AANDC to prepare the RAP. Remedial works are anticipated to require regulatory authorizations from the Mackenzie Valley Land and Water Board, as well as AANDC, the Government of the Northwest Territories and potentially the Department of Fisheries and Oceans Canada.

Findings of Previous Studies

The ESA process identified the physical aspects of the mine and any contamination of soil, vegetation, water and sediment. This information provided input to the HHERA which was used to identify potential impacts the site may be having on humans and the environment. The results of these studies, in combination with AANDC guiding principles, were used to determine what issues and concerns should be addressed in the RAP. The following aspects of the Blanchet Island Mine are discussed in the RAP:

- Mine Openings: The adit is the only mine opening and presents a physical concern due to the potential for human or animal receptors to enter the mine workings.
- Buildings: Dilapidated structures in the Mine and Camp Areas are a physical hazard to those who enter.
- Refuse and Debris: Empty drums, metal rail track, waste dumps and miscellaneous debris are present in isolated areas of the mine.
- Waste Rock: Elevated metal concentrations in waste rock are generally bound in stable minerals; however, waste rock is a potential natural source of arsenic release to the environment.
- Ore Concentrate: The ore concentrate in the Beach Area (now in drums) and in the Mine Area is enriched in metals (e.g., arsenic, cobalt, nickel), and represents a source of metals to the surrounding environment.
- Soils - Metals: Metals have leached from the ore concentrate to underlying and down gradient soils resulting in elevated metal concentrations in these areas.
- Soils – PHCs: A spill of petroleum hydrocarbons (PHC) from one drum in the Mine Area has been identified.
- Sediment/Water: Surface water and sediment concentrations of some metals are enriched within the creek, wetland, and the immediate shoreline of the lake at the Beach Area and discharge of the Mine Area creek.

Proposed Remediation Plan

Based on a comprehensive review of site conditions, evaluation of feasible remedial options, technical recommendations and Remedial Options Analysis with surrounding communities, the preferred remedial option for each component are as follows:

- Mine Openings (a single adit) – Seal using a foam plug;
- Former Buildings/Structures – Demolish and burn;
- Refuse – Consolidate and dispose in an off-site facility;
- Waste Rock – Re-slope and place under a low-permeability cover;
- Ore Concentrate – Consolidate and remove from site (drums and consolidated piles), and place under low permeability cover (when mixed with waste rock or soil);

- Metal-Impacted Soils – Excavate, consolidate and place under a low-permeability cover;
- Hydrocarbon-Impacted Soils - Consolidate and remove from site; and
- Surface Water and Sediments – Leave as is with long-term monitoring.

Monitoring activities will form an integral part of the comprehensive remedial plan for the site. Monitoring will occur during active remedial works to ensure the remedial measures do not result in unexpected impacts to the environment and to protect the health and safety of workers. At the completion of the remediation, ongoing monitoring will be conducted to confirm that the remedial measures perform as intended.

TABLE OF CONTENTS

	<u>Page No.</u>
GLOSSARY OF TERMS.....	G-1
UNITS AND ABBREVIATIONS	U-1
CHEMICAL SYMBOLS	CS-1
1.0 INTRODUCTION	1-1
1.1 Overview of the Project	1-1
1.1.1 Location and Access	1-1
1.1.2 History of the Mine	1-3
1.1.3 Community Concern.....	1-4
1.2 Designated Responsibilities	1-4
1.2.1 Approach to Preparation of the Remedial Action Plan	1-4
1.2.1.1 Overview	1-4
1.2.1.2 Regulatory Considerations	1-5
1.2.1.3 Federal Policies.....	1-6
1.2.1.4 Partnerships with First Nations.....	1-6
1.2.1.5 Principles Associated with Aboriginal Interests.....	1-7
1.2.1.6 Site Objectives	1-8
1.2.1.7 Remediation Planning Team	1-8
1.2.2 Community Involvement and Engagement	1-8
1.2.2.1 Guiding Principles to Community Involvement and Engagement ..	1-8
1.2.2.2 Blanchet Island Mine Community Involvement and Engagement ..	1-9
1.2.2.3 Evaluation of Remedial Options.....	1-9
1.2.2.4 Future Community Involvement and Engagement.....	1-10
1.3 Overview of Available Information.....	1-11
1.4 Report Structure.....	1-12
2.0 LAND USE AND CLAIMS.....	2-1
2.1 Historical Aboriginal Land Uses	2-1
2.2 Current Land Uses	2-1
2.3 Land Tenure.....	2-2
2.4 Mineral Leases and Claims	2-3
3.0 DESCRIPTION OF THE MINE SITE FEATURES.....	3-1
3.1 Beach Area	3-1
3.2 Camp Area.....	3-5
3.3 Mine Area.....	3-5
3.4 Road Network.....	3-10
4.0 NATURAL ENVIRONMENT	4-1
4.1 Topography and Physical Features	4-1
4.2 Geology	4-1
4.2.1 Regional Geology.....	4-1

4.2.2	Local Bedrock Geology	4-1
4.3	Soils.....	4-2
4.4	Climate	4-2
4.4.1	Temperature	4-2
4.4.2	Precipitation	4-3
4.4.3	Climate Change	4-3
4.5	Permafrost	4-3
4.6	Air Quality.....	4-4
4.7	Ecology	4-5
4.7.1	Classification.....	4-5
4.7.2	Vegetation Observations.....	4-5
4.7.3	Wildlife Observations.....	4-5
4.7.4	Species at Risk in Canada	4-5
4.8	Hydrology.....	4-6
4.8.1	Regional Hydrology	4-6
4.8.2	Site Hydrology	4-7
4.9	Hydrogeology	4-7
5.0	ENVIRONMENTAL SITE ASSESSMENT FINDINGS.....	5-1
5.1	Mineralization and Metal Enrichment in the Environment.....	5-1
5.2	Mine Openings	5-3
5.3	Buildings	5-3
5.4	Refuse.....	5-4
5.4.1	Non-Hazardous Refuse	5-4
5.4.2	Hazardous Refuse.....	5-6
5.5	Ore Concentrate.....	5-6
5.6	Waste Rock.....	5-11
5.7	Soil Findings.....	5-15
5.8	Vegetation Findings	5-20
5.9	Groundwater Findings.....	5-22
5.10	Surface Water Findings.....	5-24
5.11	Sediment Findings	5-29
5.12	Aquatic Biota Findings	5-33
5.12.1	Aquatic Vegetation.....	5-33
5.12.2	Sediment Toxicity and Benthic Community Analysis	5-35
5.13	Site Access Routes.....	5-36
5.14	Potential Borrow Sources.....	5-37
5.15	Potential Landfill Locations	5-38
5.16	Potential Soil Treatment Locations.....	5-39
6.0	ECOLOGICAL AND HUMAN HEALTH RISKS.....	6-1
6.1	Risk Assessment Approach and Methodology.....	6-1
6.1.1	Human Health Risk Assessment Methodology.....	6-2
6.1.2	Ecological Risk Assessment Methodology.....	6-4
6.2	Human Health Risk Assessment Findings	6-5
6.3	Ecological Risk Assessment Findings	6-6

6.4	Overall Conclusion	6-8
7.0	PROPOSED REMEDIAL ACTION PLAN	7-1
7.1	Process for Selection Of Remediation Activities	7-1
7.1.1	Process Approach and Considerations.....	7-1
7.1.2	Typical Remedial Objectives and Considerations.....	7-2
7.1.3	Listing of Remedial Components and Features	7-3
7.1.4	Review of Industry Standard Remedial Options.....	7-4
7.2	Remedial Assumptions.....	7-5
7.3	Remedial Options	7-6
7.3.1	Mine Openings	7-8
7.3.1.1	Key Issues.....	7-8
7.3.1.2	Potential Remedial Options.....	7-8
7.3.1.3	Preferred Remedial Option.....	7-10
7.3.1.4	Monitoring and Contingencies	7-10
7.3.2	Former Buildings / Structures	7-10
7.3.2.1	Key Issues.....	7-10
7.3.2.2	Potential Remedial Options.....	7-10
7.3.2.3	Preferred Remedial Option.....	7-12
7.3.2.4	Monitoring and Contingencies	7-12
7.3.3	Refuse	7-12
7.3.3.1	Key Issues.....	7-12
7.3.3.2	Potential Remedial Options.....	7-12
7.3.3.3	Preferred Remedial Option.....	7-14
7.3.3.4	Monitoring and Contingency.....	7-15
7.3.4	Waste Rock	7-15
7.3.4.1	Key Issues.....	7-15
7.3.4.2	Potential Remedial Options.....	7-15
7.3.4.3	Preferred Remedial Option.....	7-17
7.3.4.4	Monitoring and Contingencies	7-18
7.3.5	Ore Concentrate.....	7-18
7.3.5.1	Key Issues.....	7-18
7.3.5.2	Potential Remedial Options.....	7-19
7.3.5.3	Preferred Remedial Option.....	7-20
7.3.5.4	Monitoring and Contingencies	7-20
7.3.6	Soils - Metals.....	7-21
7.3.6.1	Key Issues.....	7-21
7.3.6.2	Potential Remedial Options.....	7-21
7.3.6.3	Preferred Remedial Option.....	7-23
7.3.6.4	Monitoring and Contingencies	7-24
7.3.7	Soils – Petroleum Hydrocarbons.....	7-24
7.3.7.1	Key Issues.....	7-24
7.3.7.2	Potential Remedial Options.....	7-25
7.3.7.3	Preferred Remedial Option.....	7-27
7.3.7.4	Monitoring and Contingencies	7-27
7.3.8	Surface Water and Sediments	7-27

7.3.8.1	Key Issues.....	7-27
7.3.8.2	Potential Remedial Options.....	7-28
7.3.8.3	Preferred Remedial Option.....	7-31
7.3.8.4	Monitoring and Contingencies	7-32
8.0	MONITORING AND LONG-TERM MEASURES	8-1
8.1	Health and Safety Monitoring	8-1
8.2	Remediation Monitoring	8-1
8.3	Performance Monitoring	8-4
8.4	Long-Term Monitoring (Environmental Monitoring)	8-4
8.5	Care and Maintenance.....	8-5
8.6	Contingency Planning	8-5
9.0	REMEDIATION SCHEDULE.....	9-1
10.0	REFERENCES	10-2
Appendix A	Remedial Action Plan Options Analysis Workout Transcript	
Appendix B	Remedial Action Plan Options Analysis Workout Minutes	
Appendix C	Remedial Action Plan Options Analysis Workout Tables	

LIST OF TABLES

	<u>Page No.</u>
Table 1	List of Species at Risk With a Range Extending into the Project Area..... 4-6
Table 2	Summary of Mine Buildings..... 5-4
Table 3	Summary of Non-Hazardous Debris 5-5
Table 4	Ore Concentrate - Volumes..... 5-6
Table 5	Ore Concentrate – Acid Base Accounting Analyses 5-8
Table 6	Ore Concentrate – Metals Analyses 5-9
Table 7	Ore Concentrate – Shake Flask Analyses 5-10
Table 8	Waste Rock – Acid Base Accounting Analyses..... 5-12
Table 9	Waste Rock – Metals Analyses 5-13
Table 10	Waste Rock – Shake Flask Extraction Analyses 5-14
Table 11	Soil – Summary of Metal Analyses 5-18
Table 12	Soil – Summary of Hydrocarbon Analyses..... 5-19
Table 13	Vegetation – Summary of Findings..... 5-21
Table 14	Groundwater – Summary of Findings 5-23
Table 15	Surface Water – Summary of Findings (Background) 5-26
Table 16	Surface Water – Summary of Findings (Beach/Camp Area)..... 5-27
Table 17	Surface Water – Summary of Findings (Mine Area) 5-28
Table 18	Sediment – Summary of Findings (Background)..... 5-30
Table 19	Sediment – Summary of Findings (Beach/Camp Area) 5-31
Table 20	Sediment – Summary of Findings (Mine Area) 5-32
Table 21	Aquatic Vegetation – Summary of Findings..... 5-34
Table 22	Review of Remedial Components and Options For Blanchet Mine 7-7
Table 23	Remedial Options – Mine Openings 7-9
Table 24	Remedial Options – Former Buildings / Structures 7-11
Table 25	Remedial Options- Refuse 7-14
Table 26	Remedial Options – Waste Rock..... 7-17
Table 27	Remedial Options – Ore Concentrate 7-20
Table 28	Remedial Options – Soil (Metals) 7-23
Table 29	Remedial Options – Soils (Petroleum Hydrocarbons)..... 7-26
Table 30	Remedial Options – Surface Water and Sediment 7-31

LIST OF FIGURES

	<u>Page No.</u>
Figure 1 Site Location Plan.....	1-2
Figure 2 Site Plan Overview	3-2
Figure 3 Beach and Camp Area Plan	3-3
Figure 4 Beach Area Before Clean-Up Program	3-4
Figure 5 Beach Area After Clean-Up Program.....	3-4
Figure 6 Camp Area Cabin	3-5
Figure 7 Mine Area Plan.....	3-6
Figure 8 Mine Area Adit Entrance	3-8
Figure 9 Mine Area Rail Track Terminus	3-8
Figure 10 Mine Area Waste Rock Slope	3-9
Figure 11 Mine Area Waste Rock Slope Profile.....	3-9
Figure 12 Potential Borrow Locations	5-40
Figure 13 Potential Landfill and Soil Treatment Locations	5-41
Figure 14 Human Health Risk Assessment – Conceptual Site Model.....	6-3
Figure 15 Ecological Risk Assessment – Conceptual Site Model	6-5
Figure 16 AANDC Approach To Remediation	7-1

GLOSSARY OF TERMS

Aboriginal land claim: A claim to a specific area of land based on legal concepts of land title and the traditional use and occupancy of that land by aboriginal peoples who did not sign treaties, nor were displaced due to war or other means.

Acid generating: Material capable of or actually producing acidic drainage.

Acid Producing Potential (APP): The potential of a material to produce acid, generally stated as kg CaCO₃ equivalent per tonne of rock.

Acid Rock Drainage (ARD): Drainage of low pH water from mineral areas as a result of the oxidation of sulphur-bearing materials that may release metals into the environment and result in significant environmental impacts.

Adit: A nearly horizontal passage from the surface by which a mine is entered and dewatered. A blind horizontal opening into a mountain with only one entrance.

Aerial photography: Photographs taken from an aircraft either obliquely or vertically.

Aggregate: Sand, gravel, or crushed rock.

Alkalinity: The aggregate measure of the concentration of hydroxyl, carbonate and bicarbonate ions, and dissolved CO₂. Therefore, it is a general indicator of the acid-buffering capacity of the water body.

Ambient: The natural surrounding (background) conditions in a given area.

Analyte: A compound or element being analyzed.

Analytic detection limit: The limit of measurement of a given parameter, below which variations in concentration are indistinguishable from one another.

Asbestos: A naturally occurring soft fibrous mineral commonly used in fireproofing materials and considered to be highly carcinogenic.

Assessment endpoint: A quantitative or quantifiable expression of the environmental value considered to be at risk in a risk assessment.

Baseline: See “Environmental baseline”.

Bedrock: The solid rock that underlies gravel, soil or other surficial material.

Benthic: Refers to the bottom of a lake or river and/or the organisms that inhabit it.

Benthos: The whole assemblage of plants or animals living on the lake or river bottom; distinguished from *plankton*.

Best Management Practice (BMP): Methods that have been determined to be the most effective, practical means of preventing or reducing pollution from non-point sources.

Bioaccumulation: The net accumulation of a chemical by an organism as a result of uptake from all routes of exposure.

Bioavailability: Degree of ability to be absorbed and ready to interact in organism metabolism.

Biological diversity (biodiversity): The variety of different species, the genetic variability of each species, and the variety of different ecosystems that they form.

Biomagnification: The tendency of some chemicals to accumulate to higher concentrations at higher levels in the food web through dietary accumulation.

Biota: The animal and plant life of a region.

Boreal Forest: The predominantly coniferous forest of northern Canada.

Buffering capacity: The degree to which a given volume of water or soil is able to neutralize acids.

Carbonate: Any mineral containing carbonate ions (CO_3^{2-}).

Carcinogen: An agent that has the potential to cause cancer.

Carnivore: An animal that eats the flesh of other animals.

Clay: Soil particles that are smaller than silt (less than 0.002 mm in diameter).

Conductivity: A measurement of the electrical conductivity of a water body or sample in order to determine the amount of dissolved material present.

Conservative: As used in the term *conservative estimates*. A cautious or moderate estimate to avoid underestimation of the level, effect or hazard.

Contaminant migration: The movement of contaminants from one location to another.

Contamination: Elements both radioactive and non-radioactive that are present at levels above those normally found (i.e., above background).

Contingency plan: A prearranged plan to be implemented in the event of some unforeseen happening of serious concern.

Crown or surface pillar: A body of rock of variable geometry, which may or may not contain minerals, located above the underground operations, it supports the surface above stopes.

Decommissioning: The act of removing a regulated facility from operation and operational regulation. This usually entails a certain amount of cleanup (decontamination).

Decontamination: The process of removing contaminants from equipment, personnel, buildings or water.

Delineate: To determine the outer limits and size of something (i.e., an ore body).

Dip: A vertical angle measured downward from the horizontal plane to the level of an inclined plane such as a tilted sedimentary rock unit (see strike).

Discharge: The volume of water passing a given point per unit time, usually expressed as m³/s.

Dose: A general term used to describe the amount of radiation or chemical absorbed by a person or in some cases a particular organ.

Drainage basin: The area of land and water bodies therein, draining to a given point, usually a lake or river.

Ecological Risk Assessment: The application of a formal framework, analytical process, or model to estimate the effects of human actions(s) on a natural resource and to interpret the significance of those effects in light of the uncertainties identified in each component of the assessment process. Such analysis includes initial hazard identification, exposure and dose response assessments, and risk characterization.

Ecosystem: Any natural system in which there is an interdependence upon and interaction between living organisms and their physical environment. This interdependence is characterized by the transfer of energy between the organisms themselves and their physical environment in a complex series of cycles.

Environment: The sum of all external conditions, influences and forces affecting the development and life of organisms.

Environmental baseline: The data collection characterizing the “natural” environment in its pre-development or pre-impact state. This data is used as a base for determining potential and actual impacts in the defined impact area.

Environmental Assessment: An environmental analysis to determine whether a site/facility would significantly affect the environment and thus require a more detailed environmental impact statement.

Environmental Impact: A change in environmental conditions resulting from an action or development, which may be negative, positive, or neutral.

Environmental Site Assessment (ESA): A systematic process to determine whether a site/facility has or has the potential to significantly impact the environment. The degree of impact is often based on comparisons to established environmental quality criteria. ESAs are performed in a phased approach, subject to the findings of prior assessments (Phase I: preliminary review; Phase II: intrusive testing to identify presence/absence of concerns; Phase III: delineation of known concerns).

Erosion: The wearing down (weathering) and removal of soil, rock fragments and bedrock through the action of rivers, glaciers, sea and wind.

Exposure: The amount of radiation or pollutant present in a given environment that represents a potential health threat to living organisms.

Exposure Assessment: Identifying the pathways by which toxicants may reach individuals, estimating how much of a chemical an individual is likely to be exposed to, and estimating the number likely to be exposed.

Exposure Concentration: The concentration of a chemical or other pollutant representing a health threat in a given environment.

Exposure Pathway: The path from sources of pollutants via, soil, water, or food to man and other species or settings.

Fault: A fracture in bedrock along which movement has taken place.

Foot wall: The underlying surface of an inclined fault plane.

Fracture (geological): A crack, joint, fault or other break in rocks.

Rock fracture: The general term given to any non-sedimentary discontinuity thought to represent a surface or zone of mechanical failure.

Geochemistry: Refers to the chemical analysis of surface and subsurface water, rock alluvium, soil and plants.

Grading: The process of making a surface level or evenly sloped.

Groundwater: Water beneath the earth's surface, accumulating as a result of infiltration and seepage, and serving as a source of springs and wells.

Habitat: The natural home of a plant or animal.

Hanging wall: The overlying surface of an inclined fault plane.

Hazard: Potential for radiation, a chemical or other pollutant to cause human illness or injury. Hazard identification of a given substance is an informed judgment based on verifiable toxicity data from animal models or human studies.

Hazard Assessment: Evaluating the effects of a contaminant or determining a margin of safety for an organism by comparing the concentration that causes toxic effects with an estimate of exposure to the organism.

Human Health Risk Assessment: The process of quantifying risks and determining the acceptability of those risks to humans.

Hydraulic head: A combined measure of the elevation and the water pressure at a point in an aquifer that represents the total energy of the water; since ground water moves in the direction of lower hydraulic head (i.e., toward lower energy), and hydraulic head is a measure of water pressure, groundwater can and often does flow 'uphill'.

Hydrogeology: The study of subsurface waters and related geologic aspects of surface water.

Hydrology: The study of the characteristics, occurrence, movement and utilization of water on or below the earth's surface and within its atmosphere.

Impervious liner: A layer of clay or manmade material such as High-Density Polyethylene (HDPE), used to seal the bottom of containment structures in order to prevent percolation and migration of potential contaminants.

Incremental: Small increase.

Leachate: The water that percolates through a porous medium such as soil and transports any salts or other dissolvable materials that may be found in the soil.

Leaching: Washing out of soluble substances by water passing down through rock or soil. In a milling sense, indicates the dissolving of ore minerals from the ground ore.

Limnological: Referring to the scientific study of lakes and their physical, chemical and biological components.

Loadings: Total mass of contaminants to a water body or to the land surface over a specified time.

Macrophytes: Rooted aquatic vascular plants.

Mean: The average value of the data.

Measurement endpoint: A quantitative summary of the results of a toxicity test, a biological monitoring study, or other activity intended to reveal the effects of a substance.

Mineral: A naturally occurring inorganic, crystalline solid that has a definite chemical composition and characteristic physical properties.

Mineralization: The process by which a valuable mineral or minerals are introduced into a rock, resulting in a potential or actual ore deposit.

Mitigation: An action or design intended to reduce the severity or extent of an environmental impact.

Modeling: Using mathematical principles, information is arranged in a computer program to model conditions in the environment and to predict the outcome of certain operations.

Monitoring: Sampling, measurement, and/or inspection of a setting or structure.

Neutralizing potential (NP): The potential of material to neutralize an acid or a base.

Ore: Naturally occurring rock material from which a mineral or minerals of economic value can be profitably mined.

Ore body: A continuous well-defined mass of material containing enough ore to make extraction economically feasible.

Outcrop: The part of a rock formation that appears at the surface of the earth, uncovered by water or overburden.

Overburden: Unconsolidated soil and rock material overlying bedrock.

Oxidation: The process of combining with oxygen, especially at the atomic level.

Particulate: Consisting of particles.

Pathway: The physical course a chemical or pollutant takes from its source to the exposed organism.

Pathways analysis: A method of estimating the transfer of contaminants (e.g., metals in water) and subsequently accumulating up the food chain to fish, vegetation, mammals and humans and the resulting dose to humans.

PCB's: A group of manufactured chemicals including 209 different, but closely related, compounds made up of carbon, hydrogen, and chlorine.

Permafrost: Thermal conditions remaining below 0 °C continuously for more than one year.

Permeability: Describes the ability of subsurface features to transport water.

pH: A number expressing the degree of alkalinity or acidity of a substance according to the hydrogen ion concentration. A substance is said to be “neutral” if its pH is 7, acidic if less than 7 and alkaline if greater than 7.

Phase I, II and III: See Environmental Site Assessment definition.

Phytoplankton: Any microscopic or near microscopic, free-floating autotrophic aquatic plant.

Population: A group within a single species, the individuals of which can, and do, freely interbreed.

Porosity: The relative volume of open spaces within a rock or soil. (usually expressed as a percentage of the total volume of the material occupied by the open spaces, or interstices)

Porewater: Water contaminated and trapped within void spaces in soils or rocks.

Precipitation: The deposition of atmospheric moisture as rain, sleet, snow, hail, frost or dew.

Pyrite: A common yellow mineral with a brilliant metallic lustre often crystallizing into cubes. It is an important sulphur ore and is often associated with gold and copper.

Receptor: A human or ecological entity exposed to a contaminant released to the environment.

Reclamation: Restoration of a site to a beneficial use that may be for purposes other than the original use.

Remediation: The improvement of a contaminated site to prevent, minimize or mitigate damage to human health or the environment. Remediation involves the development and application of a planned approach that removes, destroys, contains or otherwise reduces the availability of contaminants to receptors of concern.

Remediation Issue: Issues of concern for a specific aspect of the site.

Risk: A measure of the probability that damage to life, health, property, and/or the environment will occur as a result of a given hazard.

Risk Assessment: Qualitative and quantitative evaluation of the risk posed to human health and/or the environment by the actual or potential presence and/or use of specific pollutants.

Risk Characterization: The last phase of the risk assessment process that estimates the potential for adverse health or ecological effects to occur from exposure to a stressor and evaluates the uncertainty involved.

Screening: A preliminary stage of the assessment process for quick evaluation of relatively simple and routine activities or for determining the level of effort required for evaluating more complex projects.

Sediment: Loose, solid particles resulting from the breakdown of rocks, chemical precipitation or from organisms.

Seismic: Pertaining to, characteristic of, or produced by earthquakes.

Stopes: Underground mine working from which ore has been extracted for processing and metal recovery.

Strike: Refers to the direction taken by a structural surface as it intersects the horizontal plane e.g., bedding or fault plane. The strike is at right angles to the direction of dip.

Structure (geological): Features produced by deformation or displacement of the rocks, such as a fold or fault.

Sulphides: Any mineral compound characterized by the chemical linkage of sulphur with a metal e.g., galena (PbS), pyrite (FeS₂).

Taiga: The northern forest of coniferous trees that lies just south of the arctic tundra.

Tailings: Finely ground rock particle material rejected from a mill after most of the recoverable ore minerals have been extracted.

Tailings Containment Area or TCA: An area designated for the purpose of receiving and containing milling residues.

Tank farm: An area designed to contain various size tanks holding various types of liquids or gases, most commonly propane or petro-chemicals.

Till: An unsorted heterogeneous mixture of rock debris carried and deposited directly by a glacier, with very little subsequent reworking by melt water.

Traditional knowledge: Refers to the ancient understanding of philosophy, events and things passed on orally through generations by aboriginal people.

Traditional land use: Refers to land use by aboriginal people that reflect the historic activities of their people prior to European settlement (i.e., hunting, fishing, gathering).

Traditional lifestyle: Refers to the lifestyle of aboriginal people prior to European settlement.

Uncertainty: A quantitative expression of error.

Uptake: The process/act by which a contaminant (e.g., arsenic) enters a biological organism (e.g., inhalation, ingestion by humans).

Vent: A (vertical) opening used for input of fresh air or exhausting used air from underground.

Waste rock: That rock material that must be removed from a mine to access ore-grade minerals.

Watershed: A drainage area or basin into which all surface water from a particular area collects and is transported.

UNITS AND ABBREVIATIONS

g/m ³	grams per cubic metre
kg CaCO ₃ /t	kilogram calcium carbonate per tonne
m	metre
m ²	square metre
m ³	cubic metre
mg/kg	milligram per kilogram
mg/L	milligram per litre
t	tonne
ACM	Asbestos Containing Material
AEC	Area of Environmental Concern
APEC	Area of Potential Environmental Concern
AEC	Area of Environmental Concern
COPC	Constituents (or Contaminants) of Potential Concern
COC	Constituents (or Contaminants) of Concern
DQRA	Detailed Quantitative Risk Assessment
HHERA	Human Health and Ecological Risk Assessment
HQ	Hazard Quotient
masl	metres above sea level
mbsl	metres below sea level
PAH	Polycyclic Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyl Compound
PHC	Petroleum Hydrocarbon
ppm	parts per million
SI	Screening Index
TCLP	Toxicity Characteristic Leaching Procedure
TF	Transfer Factor
TRV	Toxicity Reference Value

CHEMICAL SYMBOLS

Aluminum	Al	Manganese	Mn
Antimony	Sb	Mercury	Hg
Arsenic	As	Molybdenum	Mo
Barium	Ba	Nickel	Ni
Beryllium	Be	Nitrogen	N
Bismuth	Bi	Oxygen	O
Boron	B	Phosphorus	P
Bromine	Br	Potassium	K
Cadmium	Cd	Radium	Ra
Calcium	Ca	Selenium	Se
Carbon	C	Silicon	Si
Chromium	Cr	Silver	Ag
Cobalt	Co	Sodium	Na
Copper	Cu	Sulphur	S
Gold	Au	Thallium	Tl
Hydrogen	H	Tin	Sn
Iodine	I	Titanium	Ti
Iridium	Ir	Tungsten	W
Iron	Fe	Uranium	U
Lead	Pb	Vanadium	V
Lithium	Li	Zinc	Zn
Magnesium	Mg	Zirconium	Zr

1.0 INTRODUCTION

1.1 OVERVIEW OF THE PROJECT

Aboriginal Affairs and Northern Development Canada (AANDC) has the responsibility to manage a number of contaminated sites that are no longer maintained by the original occupant. AANDC's portfolio of contaminated sites in the north originates from private sector mining, oil and gas activities, government/military operations and other uses of the land dating back over half a century, many years before the environmental impacts of such activities were adequately understood. The abandoned Blanchet Island Mine is one of these sites.

SENES Consultants (SENES) has been retained by Public Works and Government Services Canada (PWGSC) on behalf of AANDC's Contaminants and Remediation Directorate (CARD) to complete a Remedial Action Plan (RAP) for the abandoned Blanchet Island Mine in the Northwest Territories. The RAP was developed to address human health, ecological, and environmental concerns associated with the former nickel/cobalt mine.

The RAP is based on the findings of Phase I, II, III and IIIa Environmental Site Assessments (ESAs), a Human Health and Ecological Risk Assessment (HHERA), best practices in mine closure, current land use in the project area, and community values and concerns.

This document is intended to serve as a supporting document to assist with regulatory and funding decisions, and will provide the basis for development of tender documents and technical designs for the remediation project.

1.1.1 Location and Access

The now abandoned Blanchet Island Mine is located on Blanchet Island, within the East Arm of Great Slave Lake, Northwest Territories (Figure 1). The property, which is also known as HRL Claims, is located approximately 115 km southeast of Yellowknife on the southern shore of Blanchet Island. Center point coordinates for the former nickel and cobalt mine are 61° 59' 45" N 112° 23' 45" W, on NTS mapsheet 85H16 (SENES/Franz 2011).

The Blanchet Island Mine is a remote site, with access limited to boat, helicopter, float/ski equipped plane and snowmobiles. The nearest communities to the site are as follows:

- Yellowknife, N'dilo - 115 km to the northwest;
- Dettah – 107 km to the northwest;
- Lutsel K'e - 100 km to the northeast;
- Fort Resolution 135 km to the southwest; and
- Hay River 225 km to the southwest.

Figure 1 Site Location Plan



1.1.2 History of the Mine

The Blanchet Island Mine has been an area of interest for high-grade cobalt and nickel since the staking of the LUX claims in 1968. By 1969, an open-cut was blasted and 300 tons of high grade nickel arsenide ore had been bagged for off-site processing. The dimensions of the open-cut are approximately 9 m long, 6 m wide and 5.5 m deep. An adit was subsequently started in the face of the open-cut to accommodate the steep dip of the ore body. The terminal length of the adit was 23 m, with a height of 1.8 m and width of 1.5 m. A rail cart system was used to transport ore along the adit level, followed by an 18 m long steel chute system, where it was containerized in barrels at the base of the waste rock slope. A high line system (i.e., a cable line system) is also reported to have been used to transport ore sacks to the valley below the adit. Containerized ore concentrate² was shipped to France for processing. The property was explored and mined until 1970, when the end of the mineralized lens was reached and the grade of ore remaining was too low to warrant further operations. A number of claims were staked between 1970 and 2005, although no works were reported and all equipment was removed in 1971 (Silke 2009).

Camp facilities for the miners were located on the shore of Great Slave Lake, 1.3 km southwest of the Mine Area. Limited information exists of infrastructure present at the time of mine operation; however, the size and short duration of mine activity suggest that building structures would have been minimal and possibly limited to what is currently observed in the Camp Area.

Historical information indicates that the Beach Area was used to transfer ore concentrate from cloth sacks into drums, which were then transferred to a boat for eventual shipment to France (Silke 2009). This is consistent with recent (2010) observations of drums and the presence of spilled ore concentrate in the Beach Area.

In the 41 years since mining operations were terminated, the only remedial works conducted on site involved the consolidation and containerization of spilled drums of ore concentrate at the Beach Area. The work was conducted in the fall of 2010, immediately following the implementation of the Phase IIIa ESA. The prime contractor, Aboriginal Engineering Limited of Yellowknife completed the initial containerization of the ore concentrate (the containers of ore concentrate remain on site). Impacted soils underlying the ore concentrate spills were not consolidated as part of this remediation work.

² Although referred to as “ore concentrate” in previous site documentation, there is no evidence to suggest that separation/concentration processes occurred on the site. The use of the term “ore concentrate” has been maintained for consistency only.

1.1.3 Community Concern

Throughout the Northwest Territories, Aboriginal residents have expressed significant concerns regarding abandoned mine sites on their traditional lands. Although the Blanchet Island Mine is very small relative to other historic mining developments in the region (e.g., Giant, Con and Pine Point mines), there remains a general concern associated with historic mining and exploration activities. The potential contamination of water and soils, as well as impacts to fish, wildlife and vegetation are commonly cited as the top priorities for attention. Physical hazards such as unsecured openings and debris have also been identified as concerns with respect to human and wildlife health.

1.2 DESIGNATED RESPONSIBILITIES

AANDC is the project proponent for the remediation of the Blanchet Island Mine and, as such, it is the responsibility of AANDC to develop the RAP, obtain appropriate approvals, secure resources, and ensure the plan is implemented in a manner consistent with the remediation of other AANDC contaminated sites in the Northwest Territories. Furthermore, AANDC will retain custodial responsibility for the site post-remediation, which will include conducting any long-term monitoring if necessary to confirm the ongoing performance of remedial measures that are intended to address potential risks to human health and the environment.

PWGSC provides support to AANDC throughout the planning and implementation phases of the remediation project. Environment Canada (EC), the Department of Fisheries and Oceans Canada (DFO) and Health Canada (HC) also assist AANDC through the provision of environmental science expertise required for the selection of appropriate remedial measures.

1.2.1 Approach to Preparation of the Remedial Action Plan

1.2.1.1 Overview

Section 39 of the *Northwest Territories Waters Act* (1992) identifies AANDC's authority to manage environmental contamination and risk to human health and safety. Abandoned contaminated sites are properties where historic proponents cannot be identified or held responsible to address existing environmental contamination. AANDC works within a broader management system for all northern contaminated sites. This being the case, AANDC follows several guiding documents in developing RAPs for contaminated sites such as the Blanchet Island Mine. The following federal policies or guidance documents provide a broad context as to how AANDC approaches remediation of contaminated sites in Northern Canada:

- A Federal Approach to Contaminated Sites (CSMWG 2000);
- Northern Affairs Program Contaminated Sites Management Policy (INAC 2002a); and,

- Treasury Board Federal Contaminated Sites Management Policy (Treasury Board 2002).

Although the AANDC Mine Site Reclamation Policy for the Northwest Territories (INAC 2002b) and the Mine Site Reclamation Guidelines for the Northwest Territories (INAC 2006a) were not intended for abandoned properties such as the Blanchet Island Mine, some parts of the policy are generally applicable and have also been considered. The overall responsibility of AANDC is to minimize health and safety and environmental risks associated with the site by implementing a RAP that meets the needs and concerns of AANDC, its First Nation partners and all Northerners.

1.2.1.2 *Regulatory Considerations*

There are currently no active land use or water licenses associated with the former Blanchet Island Mine. The remedial measures implemented and the approach proposed by the selected contractor will determine the type of permits required by the Mackenzie Valley Land and Water Board. A “Type B Land Use Permit” will be required in accordance with Sections 4 and 5 of the *Mackenzie Valley Land Use Regulations* (1998) if the proposed remedial activities do not exceed the following triggers: the use of vehicles exceeding a net weight of 10 tonnes; the use of a campsite for a duration of more than 400 person days; or the use of a petroleum fuel storage container with a capacity equal to or exceeding 4,000 L. In the event that one of the triggers is met, a more comprehensive “Type A Land Use Permit” will be required.

A Water License as issued by the Mackenzie Valley Land and Water Board will also be necessary if certain triggers are met. Should the final RAP design require the alteration of a water course, diversion of a water course, erosion control, or the deposit of waste, either a “Class A” or “Class B Water License” will be required as dictated by the Northwest Territories Water Regulation (1993).

Due consideration of the *Fisheries Act* (1985) will be required in the assessment of remedial options within or near to a water body. Consultation with DFO is recommended to identify potential impacts to the aquatic environment and to determine if remedial measures may result in violation of the *Fisheries Act*. Examples of regulations within the *Fisheries Act* which may affect remedial planning and implementation include the prohibition to block the passage of fish, destruction of habitat, or release of “deleterious substances”. These activities are regulated and will require authorization.

Where the selected remedial approach requires the use of borrow material from the site, a Quarry Permit (issued by AANDC) will be required for associated earth works.

Certain remedial options require burning of wooden debris and structures. Burning of such materials will require a Permit to Burn which is issued by the Northwest Territories Department of Environment and Natural Resources.

Once the remediation of the site is complete, long-term monitoring suitable for the site conditions and remedial options will occur as identified through the Federal Approach to Contaminated Sites (CSMWG 2000).

1.2.1.3 *Federal Policies*

The following principles were adopted for the Blanchet Island Mine RAP from federal policy and guidance documents referenced above. Specifically:

- Meet the overall AANDC objective to contribute to a safer, healthier, sustainable environment for Aboriginal peoples and northern residents by striving to preserve and enhance the ecological integrity of the environment (INAC 2002a);
- Take immediate and reasonable action to protect the environment and the health and safety of persons (Treasury Board 2002);
- Meet federal and AANDC policy requirements and legal obligations regarding the management of contaminated sites (INAC 2002a);
- Ensure sound environmental stewardship of federal real property by avoiding contamination and by managing contaminated sites in a consistent and systematic manner that recognizes the principle of risk management and results in the best value for the Canadian taxpayer (Treasury Board 2002);
- Provide a scientifically valid, risk management based framework for setting priorities, planning, implementing and reporting on the management of contaminated sites (INAC 2002a);
- Develop a RAP to be sufficiently flexible to allow adjustments as the remediation progresses, including the flexibility to adapt to new and improved technologies and methodologies (INAC 2002b); and,
- Adopt solutions tailored to the northern environment and peoples wherever possible (INAC 2006b).

1.2.1.4 *Partnerships with First Nations*

The following principles regarding partnerships with First Nations were adopted from the policy and guidance documents referenced above for the Blanchet Island Mine RAP:

- Promote Aboriginal and northern participation and partnership (INAC 2002a; INAC 2006b);

- Promote respect and sharing of knowledge, experience and resources in partnerships/teamwork with clients and partners;
- Promote the social and economic benefits that may accrue to First Nations and northern communities (INAC 2002a);
- Plan, where appropriate, the scale and pace of remediation/risk management in keeping with northern and Aboriginal capacity to be involved (INAC 2002a);
- Incorporate economic opportunities, to the extent possible, for northern and Aboriginal communities in the management and remediation of the site (INAC 2002a); and
- In keeping with the above policies, community representatives will be requested to participate in engagement activities regarding this RAP. Records of community participation, the options reviewed, and preferred options selected by the community are presented in the appendix of the final version of the RAP.

1.2.1.5 Principles Associated with Aboriginal Interests

Prior to the development of the Blanchet Island Mine, Aboriginal people lived throughout the area for centuries. The site lies within the traditional Akaitcho lands and is part of the Interim Measures Agreement (IMA) area of the Akaitcho Dene First Nations (AKDFN) of the Northwest Territories. It is also situated in the Mowhi Gogha De Nitlee traditional lands as defined by the Tlicho Land Claims and Self Government Act.

The Akaitcho Dene IMA serves to guide stakeholders during the negotiations of a permanent Akaitcho Land Claim; however, the IMA does not provide guidance in regard to long-term land use and community objectives. In the absence of a specific Akaitcho guidance document, the following principles have been adopted from similar remedial projects within the Tlicho settled land claim (e.g., the North Inca Remediation Project):

- To protect and conserve the wildlife and environment of the settlement area for present and future generations;
- To directly involve communities and designated Aboriginal organizations in land use and planning; and
- To encourage self-sufficiency of Aboriginal peoples and to enhance their ability to participate fully in all aspects of the economy, specifically by protecting and promoting the existing and future social, cultural and economic well being of Aboriginal people.

1.2.1.6 *Site Objectives*

The site-specific objectives of the Blanchet Island Mine RAP were developed in accordance with regulatory considerations, Federal Policies and Aboriginal input on draft RAPs as presented during the community consultation process. The following objectives have been used for the development of the RAP:

- Minimize human health and safety risks associated with the site in its current condition;
- Minimize human health and safety risks associated with remedial activities;
- Protect fish, wildlife, and vegetation;
- Protect the water quality of the marsh environments, as well as Great Slave Lake;
- Minimize environmental impacts during remediation;
- Minimize long-term care and maintenance;
- Return the site to its original condition where possible; and
- Be cost effective.

1.2.1.7 *Remediation Planning Team*

The technical team responsible for the development of the RAP includes representatives from the following groups:

- Aboriginal Affairs and Northern Development Canada (AANDC), Contaminants and Remediation Directorate (CARD);
- Public Works and Government Services Canada (PWGSC);
- SENES Consultants (SENES).

1.2.2 *Community Involvement and Engagement*

In keeping with the design and implementation of other remedial projects at abandoned mining properties by AANDC, this final iteration of the RAP presents the remedial options discussed with the communities and preferred remedial options identified through the collaborative process. Aboriginal and non-Aboriginal community members were encouraged to provide feedback and to work collaboratively with AANDC to identify and mitigate concerns and risks.

1.2.2.1 *Guiding Principles to Community Involvement and Engagement*

As discussed above, the Contaminated Sites Management Policy specifies that AANDC “... *will promote First Nation, Inuit, and northerner participation and partnership in the identification, assessment, decision-making and remediation/risk management process relating to contaminated sites*” (INAC 2002a). The guidelines indicate that every effort should be made to incorporate

local knowledge on many different levels by, for example, creating working groups and interviewing elders and other age groups of the local people (INAC 2006b).

In addition to the federal policies and guidelines, a major objective of modern land claims in the NWT is to provide Aboriginal people with meaningful opportunities to participate in decision making concerning the use, management and conservation of land, water and resources. This objective is addressed in the NWT's environmental management framework, as described in the *Mackenzie Valley Resource Management Act* (MVRMA 1998). The overall engagement approach under the MVRMA includes:

- Providing the party to be consulted with:
 - notice of the matter in sufficient form and detail to allow the party to prepare its views on the matter;
 - a reasonable period for the party to prepare those views; and
 - an opportunity to present those views to the party having the power or duty to consult.
- The party with the duty to consult must:
 - consider, fully and impartially, any views so presented.

1.2.2.2 *Blanchet Island Mine Community Involvement and Engagement*

A community involvement and engagement process for the Blanchet Island Mine RAP was undertaken to ensure the priorities and insights of Aboriginal parties were considered during remediation decision-making. During this process, the site assessment findings, risk assessment findings and potential remedial options were reviewed. Records of the Remedial Options Analysis Workout Meeting are included in Appendix A through C.

1.2.2.3 *Evaluation of Remedial Options*

The overall approach to evaluating remedial options for Blanchet Island Mine was implemented as follows:

1. The site was divided into various aspects and issues as outlined in the Mine Site Reclamation Guidelines for the Northwest Territories (INAC 2006b).
2. For each aspect and issue, remedial options were developed by SENES with input from AANDC and PWGSC.
3. A review of the draft RAP was conducted by Federal Contaminated Sites Action Plan advisors and edits incorporated where appropriate.
4. A Traditional Knowledge study was conducted by AANDC to ascertain the uses of the land by local Aboriginal communities and relevant observations of the natural environment.

5. A Remedial Options Analysis Workout was lead by AANDC on June 13-14, 2013 in Fort Resolution, NT. Representatives of the Lutsel K'e Dene First Nation, Deninu Kue First Nation and the Fort Resolution Metis Council were present and worked with representatives from AANDC, PWGSC and SENES to determine the preferred remedial options. The Remedial Options Analysis Workout was conducted using the following framework:
- a) The project objectives and current status were presented;
 - b) The workout framework was discussed with participants to ensure the process was clear and transparent;
 - c) A site overview was presented identifying the features of the sites and primary environmental concerns;
 - d) The potential remedial options were then presented for each issue followed by a discussion of advantages/disadvantages of the option and response to any questions presented;
 - e) Each participant was given the opportunity to identify their recommendation for a preferred remedial option.
 - f) Incorporating the recommendation of each individual participant, the remedial options were classified as either:
 - i. P = preferred;
 - ii. A = acceptable; or,
 - iii. NA = not acceptable.

1.2.2.4 Future Community Involvement and Engagement

Local communities will be kept informed of key developments throughout the planning and implementation of remediation at the Blanchet Island Mine. This includes seeking additional input if there are any significant deviations from the preferred remedial options. To assist in communicating remedial progress, it is anticipated there will be opportunities for site tours during the remediation and/or post remediation phases of the project.

In addition to participating in the planning process, Aboriginal involvement during the remediation phase of the project will be encouraged through the use of “Aboriginal Opportunities Considerations” (AOC). All contractors bidding on the remediation project will be required to submit an AOC describing their commitment to Aboriginal employment and subcontracting. The commitments of the successful bidder will be enforced through contractual obligations.

1.3 OVERVIEW OF AVAILABLE INFORMATION

The development of a RAP for northern abandoned sites requires an integrated approach to incorporate site-specific characteristics, assessment findings, hazards/concerns, federal regulations, and input received through consultations with Aboriginal peoples and northern communities. The Blanchet Island Mine has been the subject of multiple site characterization studies since 2005, including Phase I, II, III, and IIIa ESAs. Findings of the ESAs are summarized in Section 5.0.

The Phase I ESA was conducted in 2005 by Jacques Whitford Environmental Limited (JWEL 2005). As part of the Phase I ESA, a records review was conducted to identify land uses and activities at the mine. The field program included site reconnaissance, a waste inventory, a small scale sampling program (four soil samples and two water samples), recommendations for continued assessment and remedial options/recommendations.

Columbia Environmental Consulting Limited (Columbia 2009) completed a Phase II ESA at the site in the summer of 2008. An environmental media sampling program was conducted to identify impacts to the receiving environment. Soil, sediment, surface water, and groundwater were sampled and submitted for laboratory analysis. An Acid Rock Drainage- Metal Leaching (ARD-ML) assessment was also conducted on waste rock at the mine.

A Phase III ESA was carried out in 2009 by Columbia Environmental Consulting Limited and Franz Environmental Incorporated (Columbia/Franz 2010). The objective of the Phase III ESA was to determine the current environmental and physical conditions at the site, reduce data gaps, and develop remediation strategies and costs. This included the identification and quantification of environmental impacts to soil, sediment, surface water, and groundwater. Hazardous and non-hazardous building materials at the site were also quantified.

A supplemental Phase IIIa ESA was carried out in 2010 by SENES Consultants Limited and Franz Environmental Inc. (SENES/Franz 2011). Confirmatory sampling was conducted during the site visit, targeting the Areas of Potential Environmental Concern (APECs) and known Areas of Environmental Concern (AECs); to confirm Constituents of Potential Concern (COPCs) identified in the Phase III ESA; and to address the environmental issues that required further investigation. Surface water, sediment, benthic invertebrates, soil, vegetation, waste rock, and ore samples were collected and analyzed, focussing on the delineation of impacts. In addition, a survey of background soil, vegetation, surface water and sediment was implemented.

At the request of AANDC/PWGSC, supplemental surface water and sediment sampling was conducted by SENES in summer 2013. The objective of the program was to determine metal concentrations in the aquatic environment immediately offshore of the Beach Area following the

ore consolidation activities in 2010. Results will be used as baseline measurements prior to the larger remediation program; however, the data report is currently under production. A preliminary assessment of the findings is provided in the relevant section of this RAP.

Results of the ESAs were used to complete a Human Health and Ecological Risk Assessment (HHERA) to evaluate potential impacts to ecological populations and human health. The HHERA has progressed through several iterations as additional data was collected at the site, the most recent version produced in 2013 (SENES 2013). The findings of the HHERA are provided in Section 6.0.

1.4 REPORT STRUCTURE

This report has been structured into several distinct sections, each of which describes the following specific aspects of the RAP:

Chapter 1 – Introduction: Introduction to the project, Blanchet Island Mine, designated responsibilities and the objectives of the RAP.

Chapter 2 – Land Use and Claims: Documents the relevant uses of the land by local Aboriginal peoples, as well as current land and mineral claims.

Chapter 3 – Description of the Mine Site Features: Provides the current mine infrastructure remaining at the site.

Chapter 4 – Natural Environment: Description of the natural environment in the regional and project areas.

Chapter 5 – Environmental Site Assessment Findings: Gives an overview of the findings of the site assessments and the identification of concerns specific to the Blanchet Island Mine.

Chapter 6 – Ecological and Human Health Risks: Presents the findings of the HHERA.

Chapter 7 – Proposed Remedial Action Plan: Identifies the key issues, potential remedial methods, and preferred remedial plan for each of the hazards and concerns at the mine.

Chapter 8 – Monitoring and Long-Term Measures: Proposes a performance monitoring plan, an environmental monitoring plan, and care/maintenance measures following the implementation of the RAP.

Chapter 9 – Remediation Schedule: Proposes a schedule of remediation activities in consideration of tasks and seasonal restrictions.

Chapter 10 – References: A list of references used in support of this document.

2.0 LAND USE AND CLAIMS

2.1 HISTORICAL ABORIGINAL LAND USES

The Blanchet Island Mine lies within the traditional land use areas of the Akaitcho peoples. Historically, land users would at times stay resident in a given area for several months, depending on the season and access to traditional food. Of particular importance, the area falls within the limit of the normal winter range of the Bathurst caribou herd. The caribou move into this area in the late fall, and remain until early spring when they migrate north for the calving season. During the early winter and late spring, Aboriginal groups travelled through the region to harvest caribou. The other important large animal harvested in the area was moose. In addition to hunting for large animals such as caribou and moose, the surrounding lands were used by Aboriginal people for trapping small game and fishing. A number of plant species that are part of the traditional diet are also present in the area, including blueberries, cranberries, and cloudberry.

Previous environmental site assessments of the Blanchet Island Mine have not identified evidence of traditional burial grounds at or in the vicinity of the site. While no traditional burial grounds have been documented, applicable regulatory authorizations (e.g., the Land Use Permit) will provide protection should any traditional burial grounds be found in the course of remedial activities.

A traditional knowledge (TK) study was conducted by AANDC in 2013 in the form of a questionnaire provided to six Elders from Lutsel K'e and six Elders from Fort Resolution. Results confirm that traditional pursuits (e.g. fishing, hunting, trapping and berry picking) were conducted in the project areas, although more commonly before (up to 60 years ago) and during mining operations. However, approximately half of responses indicated they had never visited the site. The questionnaire also focussed on the presence/absence of wildlife species, of which most species common to the East Arm region were documented to have been sighted within the project area, including caribou and moose although populations are suggested to have decreased. Responses also indicated that there is no indication of traditional burial grounds at the site (AANDC-CARD 2013).

2.2 CURRENT LAND USES

Visits to the site may occur on an occasional basis from local Aboriginal communities. Some Aboriginal residents from the nearest communities continue to use the land and water surrounding the site for traditional pursuits, such as hunting, fishing, trapping and the collection of plants. While moose, caribou and fish are harvested most frequently, smaller animals, various plants and berries are also important traditional foods. Ongoing contact with the land provides

the spiritual and cultural sustenance that comes from practicing the skills and lifestyle of their ancestors.

The East Arm of Great Slave Lake is also visited by non-Aboriginal residents and tourists. Camping, snowmobiling, boating, hunting, fishing and climbing all attract visitors to this remote area of the lake.

While the visible disturbance to the site would discourage visitors from establishing a camp within the footprint of the mine, it is assumed that Aboriginal and non-Aboriginal visitors to Blanchet Island will explore the mine site.

2.3 LAND TENURE

The land surrounding Blanchet Island Mine lies within the Interim Measures Agreement (IMA) area of the Akaitcho Dene First Nations (AKDFN). While surrounding lands are within the IMA, the footprint of the mine is not included in the potential land withdrawal, and instead remains the property of the Crown (AANDC 2011).

The AKDFN communities, all of which are situated on Great Slave Lake, include the following: Lutsel K'e, Deninu Kue (Fort Resolution), N'dilo and Dettah. The Akaitcho are descendants of the T'satsaot'ine tribe (trans. copper people) and are named after the historic T'satsaot'ine leader Akeh-Cho (1786-1838). The Akaitcho were signatories to Treaty 8, which was signed at Fort Resolution in 1900. In July 2000, the Akaitcho, as represented by the Treaty 8 Tribal Corporation, signed a framework agreement with the Governments of Canada and the Northwest Territories to work towards a land, resource and self-government agreement.

Blanchet Island Mine also lies within the asserted territories of the Northwest Territories Métis Nation (NWTMN). A separate IMA was established in 2002 and land claim negotiations are ongoing.

There are no federal land leases or special land reserves in effect in the project area (AANDC 2011), and no Land Use Permits or Water Licences issued for Blanchet Island Mine (MVLWB 2011). Any Land Use Permits or Water Licences that are required to implement the remedial action plan would be issued by the Mackenzie Valley Land and Water Board. AANDC-CARD does not currently hold any permits for the former mine site, as the limited extent of work previously conducted at the site has not necessitated a permit.

2.4 MINERAL LEASES AND CLAIMS

The most recent mineral claim at the Blanchet Island Mine was registered to Trevor Teed (Lux 1 mineral claim). The claim officially lapsed in February 2009 (AANDC 2011). There are no active mineral leases or claims of Blanchet Island Mine, or any other part of the island.

3.0 DESCRIPTION OF THE MINE SITE FEATURES

During the operational era of the mine, infrastructure was located primarily in the following three former operational areas (Figure 2): 1) the Beach Area (point of transport); 2) the Camp Area; and 3) the Mine Area.

3.1 BEACH AREA

The Beach Area is identified by a sparsely vegetated gravel and cobble beach on the shore of Great Slave Lake. The clearing is within a natural drainage area and ephemeral surface water flow is observed on its eastern margin. Saturated bogs and woodlands with peat rich soil and low lying vegetation surround the Beach Area. A scale drawing showing infrastructure and debris is provided on Figure 3.

Historical information and site observations suggest the Beach Area was used as a staging area to transfer ore from cloth ore sacks into drums, which were then transferred to boats or barges for eventual shipment to France where the ore concentrate was processed (SENES/Franz 2011).

Three drum caches were reported in the Beach Area. The first and main drum cache contains 47 drums, 20 of which were tipped over with ore concentrate contents spilling over the ground surface (Figure 4). The remaining 27 were empty fuel (diesel) drums. The area impacted with the spilled ore concentrate was devoid of vegetation and the surrounding surface soils (~236 m²) were stained white with spilled ore concentrate (SENES/Franz 2011). A small scale remedial project was commissioned by PWGSC in the fall of 2010, subsequent to the Phase IIIa ESA (PWGSC 2011). The spilled ore concentrate and associated drums were containerized in over-pack drums and are currently stored on site for disposal during the implementation of the RAP (Figure 5). The underlying soils were left in-situ.

The second drum cache is scattered along the shoreline east of the main cache, and contains 14 empty 205 L diesel fuel drums. The third drum cache is north of the main drum cache, and consists of 23 empty 205 L diesel fuel drums. A pile of degraded ore sacks (~35 m²) was also found northeast of the third drum cache. Two small spills of ore were noted just south of the ore sacks. An additional 18 empty 205 L fuel drums have been dumped within 20 m of the shoreline, to a maximum distance of 100 m west of the Beach Area (SENES/Franz 2011).

Figure 2 Site Plan Overview

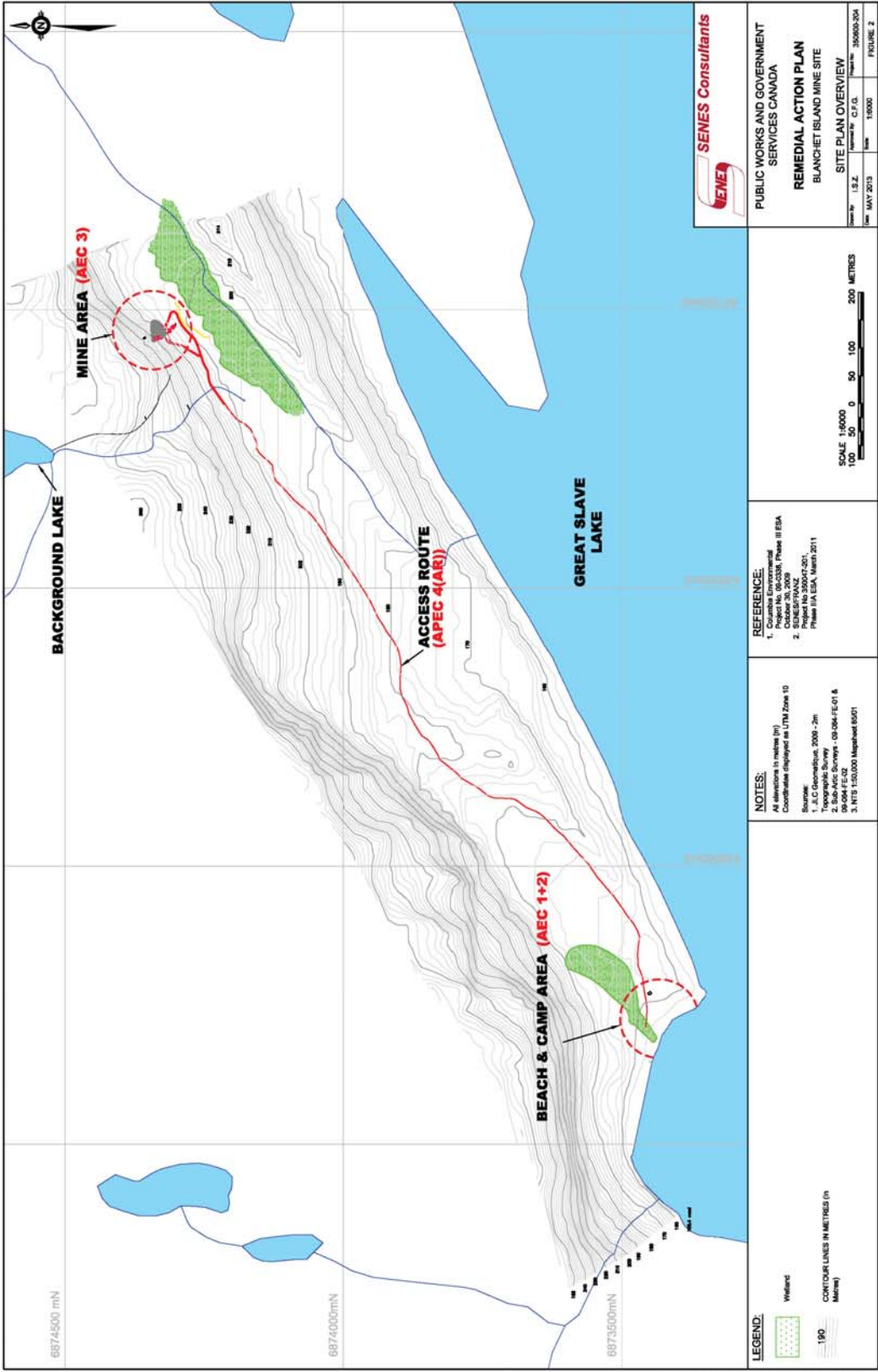


Figure 3 Beach and Camp Area Plan

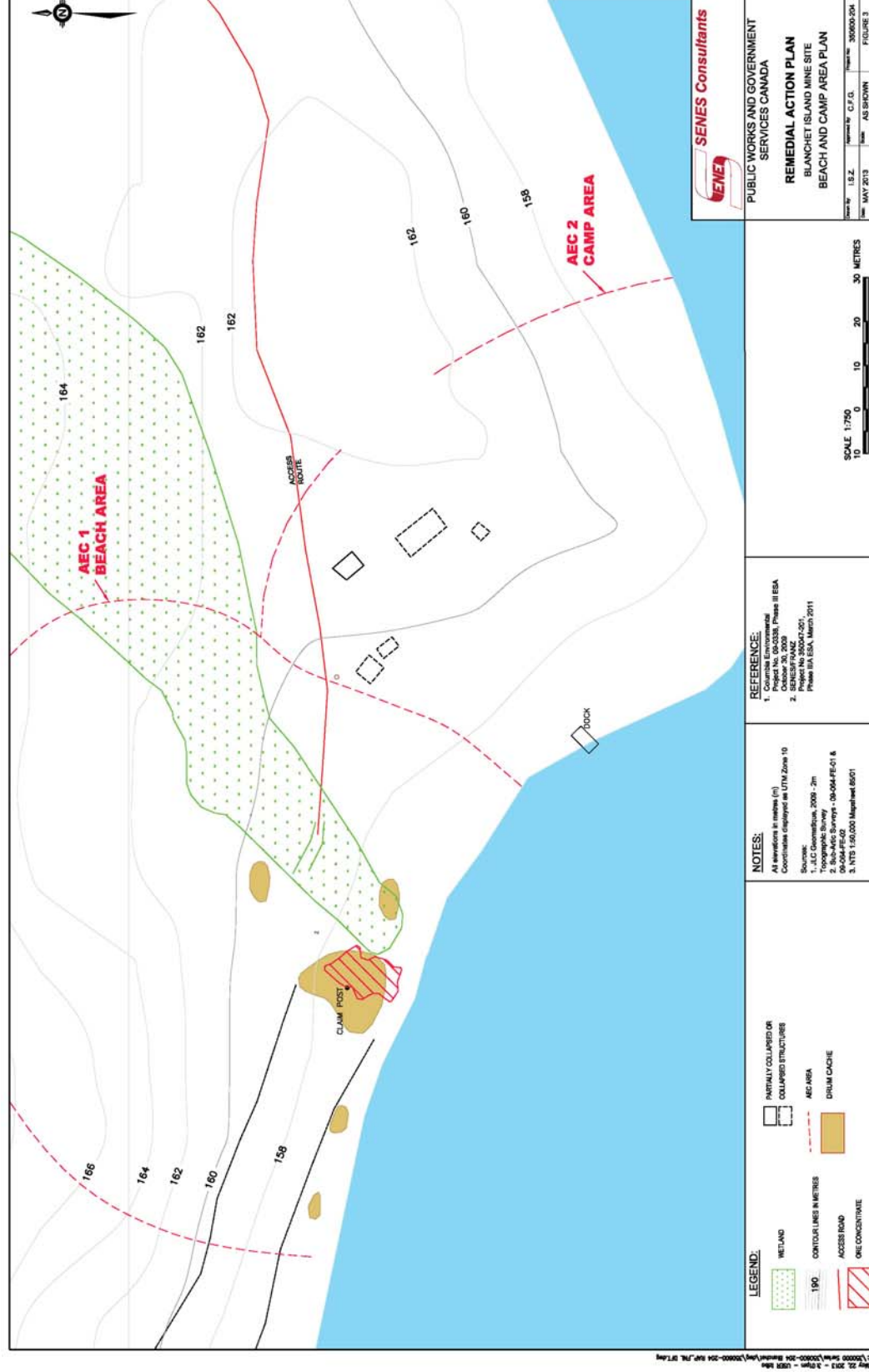


Figure 4 Beach Area Before Clean-Up Program

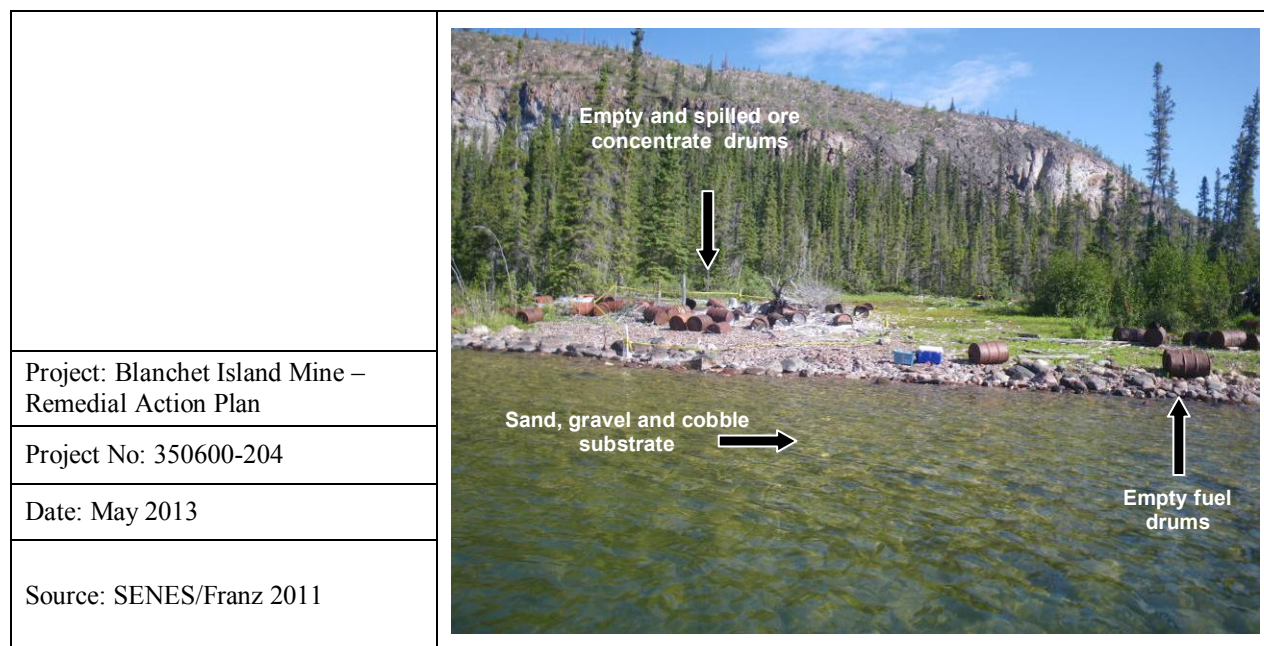
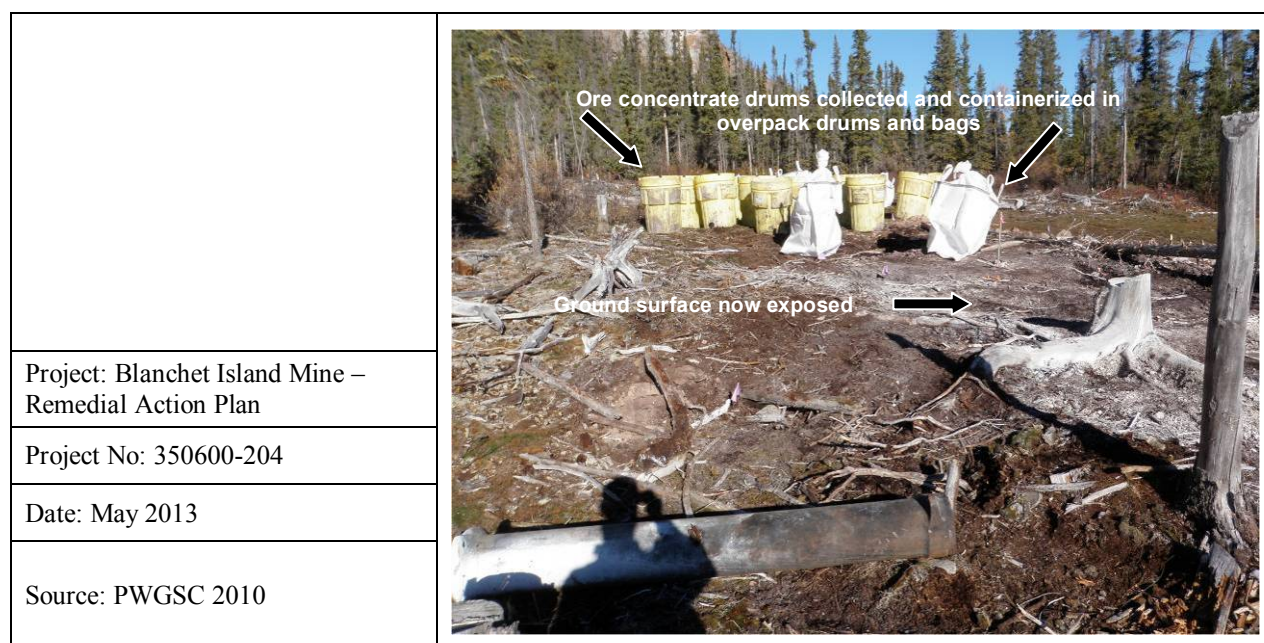


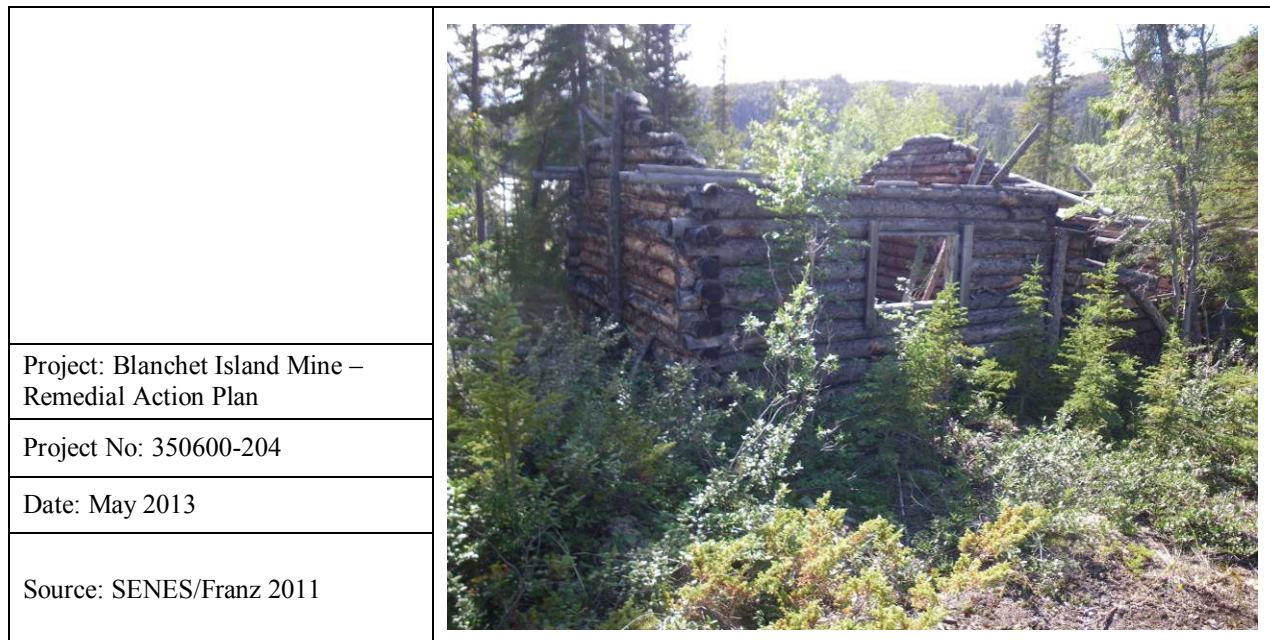
Figure 5 Beach Area After Clean-Up Program



3.2 CAMP AREA

The Camp Area is defined by five dilapidated and collapsed camp buildings which include: four tent frames and one cabin (Figure 6). Scattered metal debris is observed throughout the Camp Area and seven small discrete domestic garbage dumps are reported in the near vicinity (two of which are overgrown with sphagnum moss). Ten empty fuel drums are located in the Camp Area, as well as a small area of soil suspected to be impacted by spilled ore. A small heavily fractured concrete structure, assumed to be a former loading/landing dock, was observed along the shoreline (SENES/Franz 2011). The distribution of materials within the Camp Area is mapped on Figure 3.

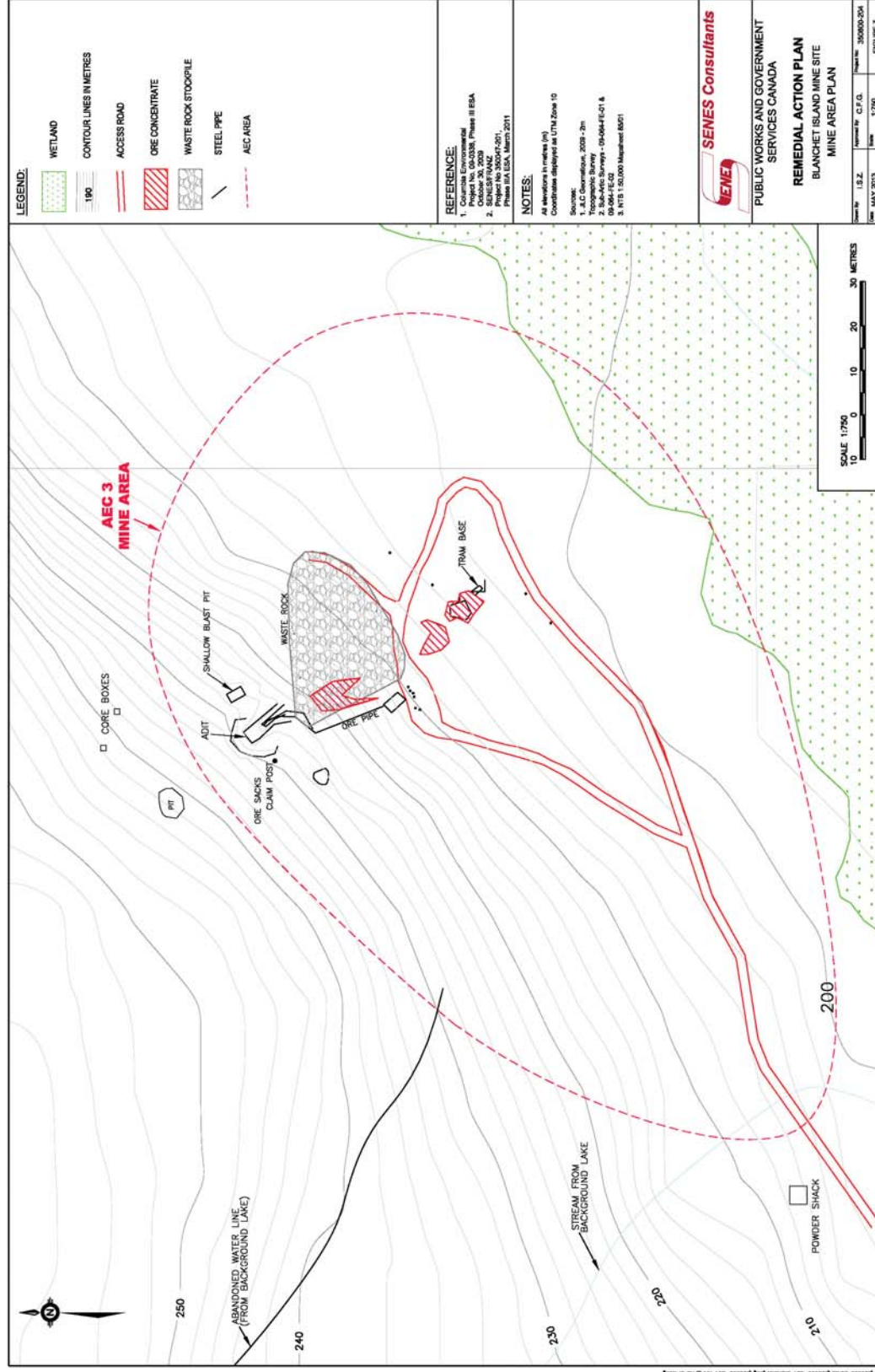
Figure 6 Camp Area Cabin



3.3 MINE AREA

The primary feature of the Mine Area is an unsealed adit located near the top of the escarpment, approximately 1.3 kilometres northeast of the Beach Area (Figure 2 and Figure 7). The orientation of the adit is roughly north-south and the entrance is approximately 1.4 m wide, 1.6 m in height and supported by wooden timbers (Figure 8). Historical reports indicate the adit is 22 to 25 m in length (Silke 2009). Beyond the entrance, the adit appears to be larger but this was not confirmed (due to health and safety concerns and regulations regarding accessing mine openings). There is no direct access route up the escarpment, and accessing the adit requires climbing the waste rock slope or descending down the escarpment face from above.

Figure 7 Mine Area Plan



A narrow gauge rail track and small rail car are located within the adit and along the connecting plateau (Figure 9). A number of abandoned cardboard and wood core racks, core, and ore sacks are also located on the plateau above the adit. A small pit excavation is located approximately 20 m northeast of the adit. Standing water was present within the adit at the time of the Phase IIIa site investigation, along with two empty fuel drums. No evidence of surface water flow into, or discharging from, the adit was observed (SENES/Franz 2011).

A waste rock pile (approximate volume of 1,000 m³) is situated on the slope immediately below the adit, descending steeply toward the access road (Figure 10). A steel pipe remains in the vicinity of the adit and is assumed to have been used as a chute to transfer ore down the slope (Figure 11). Spilled white/light green ore is abundant around the entrance to the adit, in discrete pockets on the waste rock slope, at the base of the ore chute, and on the landing area below. It is postulated that the wood and metal frame observed at the base of the waste rock pile was the terminus of a cable line used to transport sacks of ore to the roadway below, from where it was then transferred to the Beach Area for re-containerization in drums and for shipment off-site by boat or barge.

The 2008 Phase II ESA identified a partially full (~20%) 205 L steel drum of suspected diesel fuel at the base of the ore chute. The adjacent surface soils exhibited petroleum hydrocarbon staining and odour (Columbia 2009). The drum was observed to be empty during the Phase III ESA site visit (Columbia/Franz 2010), which was confirmed during the 2010 Phase IIIa field investigation (SENES/Franz 2011).

Minor metal is scattered throughout the Mine Area. Three empty and rusted 205 L drums are located near to the cable line base and a 19 mm diameter PVC water line runs south from a small lake approximately 350 m northwest of the adit.

The stratigraphy at the base of the mined escarpment is a mix of fine to coarse grained soils (sand and gravels mainly), with some areas covered with waste rock or colluvium (closer to the escarpment). A wetland situated down-gradient of the Mine Area trends approximately southwest with an open flowing channel up to 2 m wide on its southern margin (Figure 7).

A small powder magazine constructed from logs is located along the access route to the Beach Area, approximately 50 m southwest of the Mine Area.

A suspected exploration pit is documented approximately 1.3 km east of the Mine Area. Previous assessment reported white staining at the exploration pit, suggesting similar mineralization as the Blanchet Island Mine (Columbia/Franz 2010). However, in 2010 it was determined that this feature was in actuality fractured and displaced outcrop due to freeze/thaw action (SENES/Franz 2011).

Figure 8 Mine Area Adit Entrance

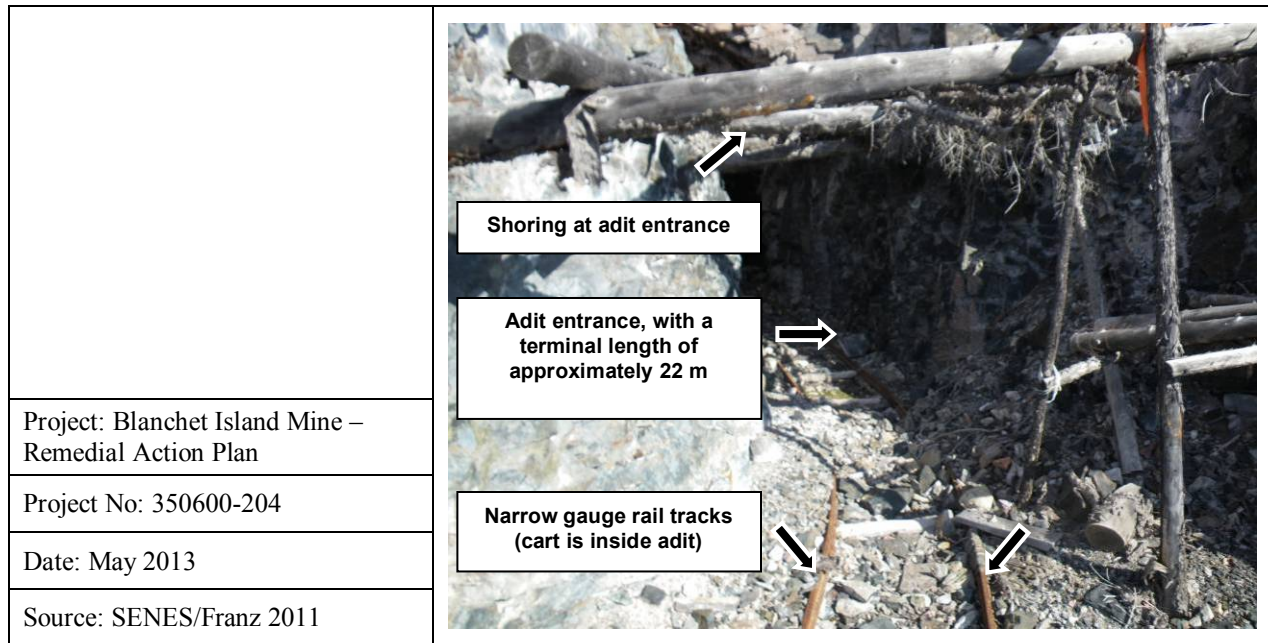


Figure 9 Mine Area Rail Track Terminus

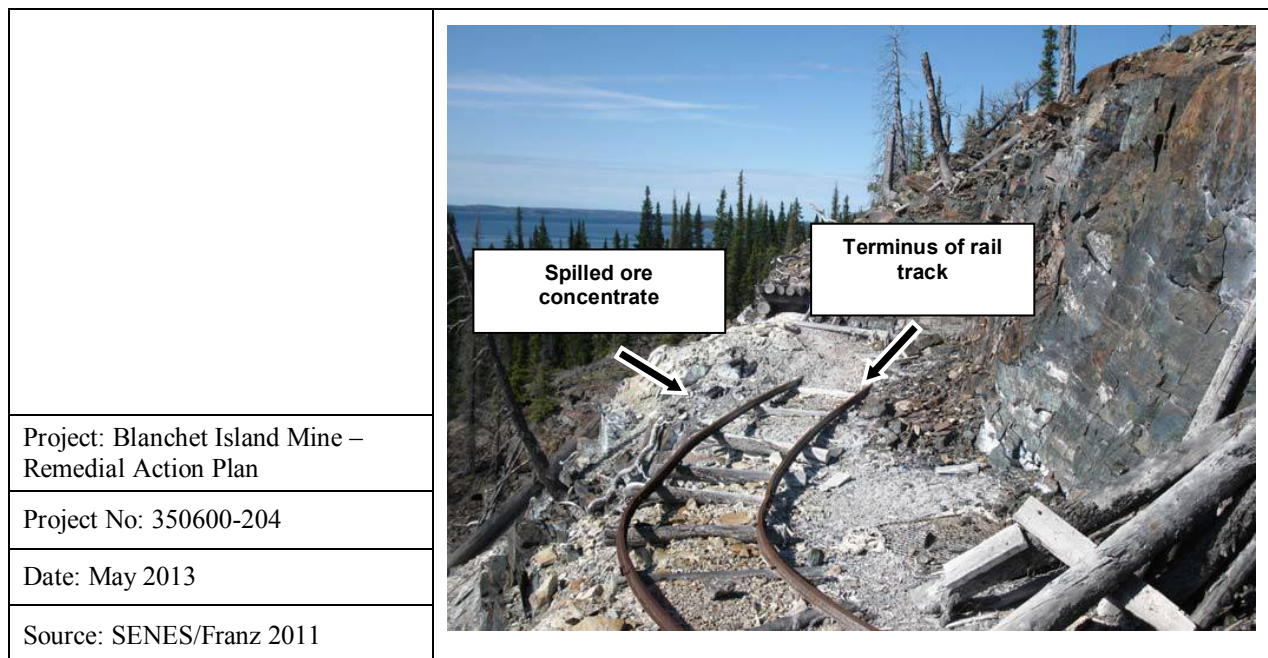


Figure 10 Mine Area Waste Rock Slope

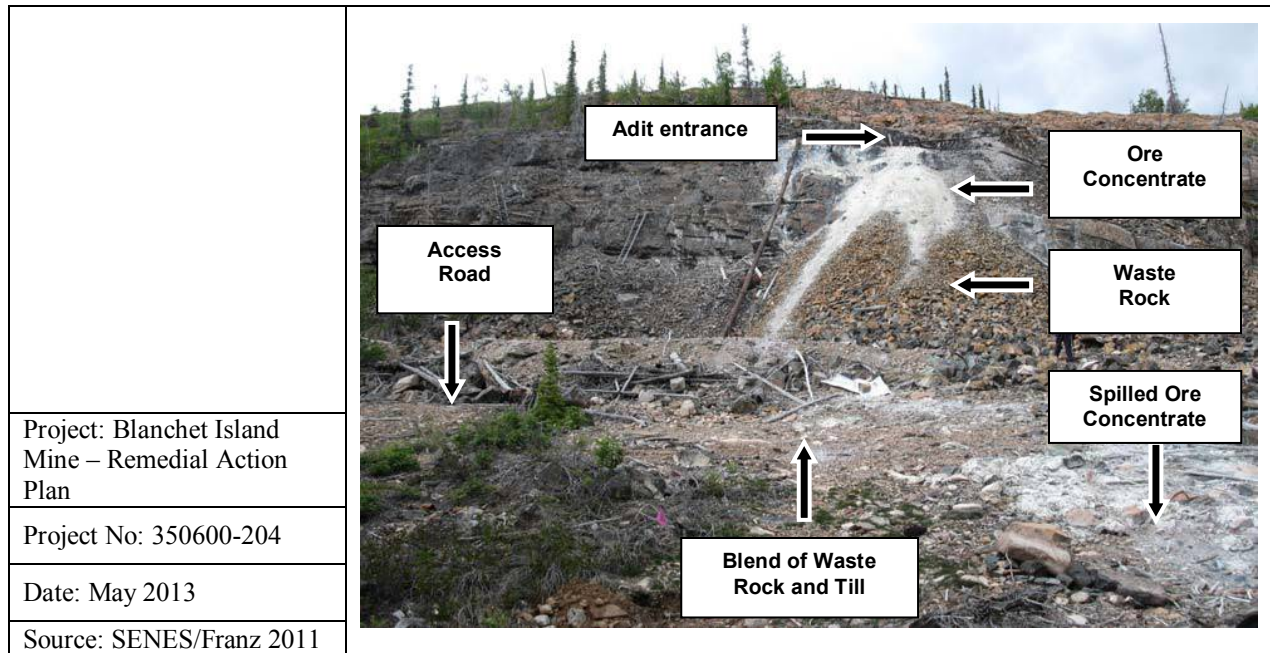
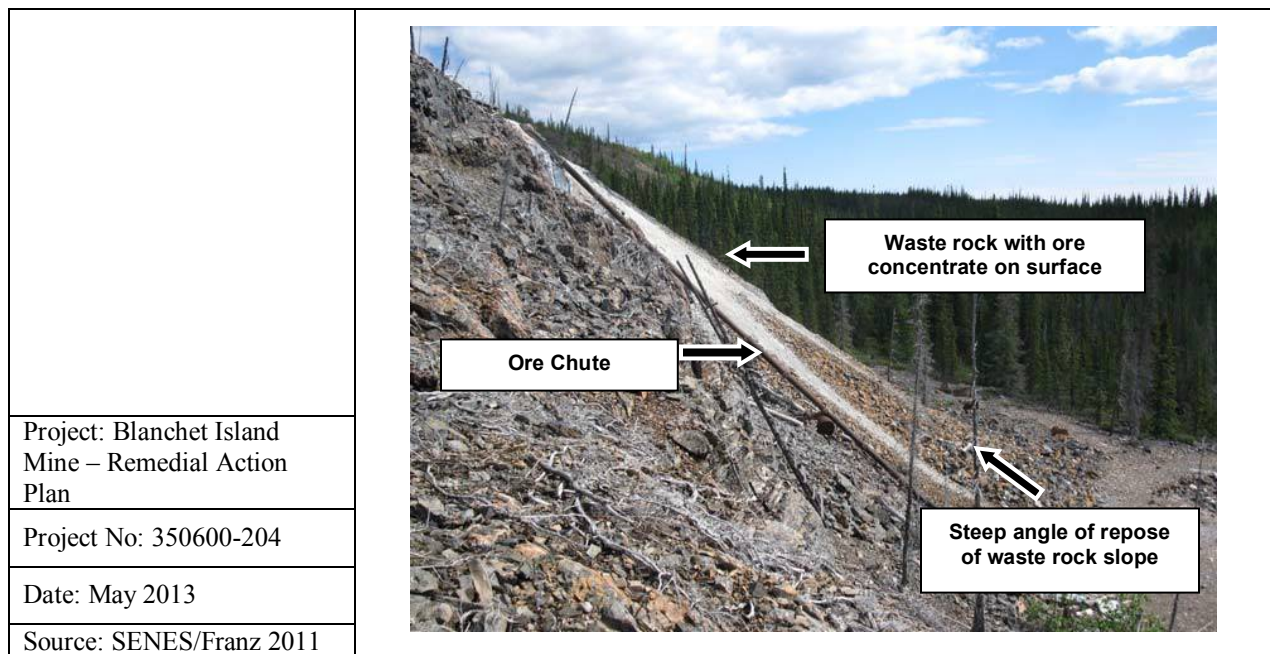


Figure 11 Mine Area Waste Rock Slope Profile



3.4 ROAD NETWORK

A 1.3 km long access road transects the Blanchet Island Mine, linking the Beach/Camp Areas with the Mine Area (Figure 2). The road gains approximately 65 m in elevation in its traverse northeast from the Beach Area to the Mine Area and no steep grades are reported. The access route has grown in and many sections of the road are densely covered with alders and black spruce. Although many areas are heavily overgrown, there is evidence that cobble rich granular material may have been used to surface the route in some locations. Minor spur roads and a perimeter road also exist within the footprint of the Mine Area.

4.0 NATURAL ENVIRONMENT

4.1 TOPOGRAPHY AND PHYSICAL FEATURES

Blanchet Island reaches a maximum elevation of 280 m above sea level (masl), with a relief of approximately 120 m. The Beach Area and Camp Area are situated at elevations of 156 masl (i.e., the surface of the lake) to 180 masl. The mine adit entrance is at an elevation of approximately 222 masl, the base of the waste rock pile at 206 masl, and the wetland to the southwest of the adit at 198 masl. The wetland is located in a relatively flat inter-ridge basin that trends southwest, with the west end of the wetland discharging to a creek which empties to Great Slave Lake. Bedrock outcroppings dominate the terrain, particularly at topographic highs (SENES/Franz 2011).

Three distinct terrain types are observed at the Blanchet Island Mine. The shoreline at the Beach Area is relatively flat, with abundant vegetation (excluding the ore concentrate spill area), and a ground surface consisting of cobbles, gravels, sands and organic peat rich soils. The Camp Area, as well as the roadway to the Mine Area, is glacially polished bedrock with southwest trending ridges. Terrain at the Mine Area is dominated by a limestone escarpment approximately 25 m in height, at the base of which is a thick talus deposit and shallow soils supporting minimal vegetation (Columbia/Franz 2010).

4.2 GEOLOGY

4.2.1 Regional Geology

Summarized from the NORMIN Database Blanchet Island Mine Showing Report (NORMIN 2010), Blanchet Island is part of the large Slave Geological Province. Within a smaller graben of partially deformed and metamorphosed sedimentary and volcanic rocks, lithologic units in the vicinity of the mine show evidence of thrusting and intrusion by diorites-monzonites. Results of earlier bedrock mapping indicate greywacke and carbonate sediments encircle Blanchet Island, and the center portion of the island is composed of hornblende-biotite diorite. The intrusives are clustered at the contact of the Pethei sedimentary unit and the Stark Formation breccias. Nickel, copper, and cobalt (and to a lesser extent silver and gold) arsenide hosted mineralization has been identified along the margins of the intrusions at multiple locations on Blanchet Island.

4.2.2 Local Bedrock Geology

A large escarpment (with associated talus and colluvial deposits) runs approximately northeast through the Blanchet Island Mine area. At an elevation of 90 m above the lake, the escarpment

represents the folded and undulating contact of sedimentary units with intrusive units. This contact is the site of mineralization at the Blanchet Island Mine.

Host rock lithologies are banded limestone/dolostone and metalimestone/metadolostone. Metamorphosis of the carbonaceous rocks increases with proximity to the diorite intrusion, with outcrops near to the adit the most severely altered. High temperature metamorphosis in combination with increased fluid flow within carbonaceous units resulted in silicification and chemical replacement.

At the brecciated contact of the host and intrusive units, massive calcite and dolomite were observed within veins, also the source of nickel, cobalt, and magnetite mineralization. Where nickel bearing ore minerals rammelsbergite and niccolite are exposed to surface elements (oxygen and water), alteration to the hydrated nickel arsenide annabergite occurs. Similarly, cobalt ore minerals cobaltite and safflorite alter to the hydrated cobalt arsenide erthyrite. These minerals, known as nickel bloom and cobalt bloom, are abundant at the site (SENES/Franz 2011).

4.3 SOILS

The soil profile at the Blanchet Island Mine is largely defined by the glacial events that took place in the area. Overburden is primarily sand and gravel, with minor quantities of silt, cobble, and boulders. A greater portion of fine materials (i.e., clay and silt) is observed surrounding water bodies, including the presence of a clay layer in test pits from the Beach Area. Mineral soils are overlain by a layer of organic materials (i.e., topsoil, peat, and vegetation), which increases in thickness in areas with high soil moisture such as the wetland in the Mine Area.

The depth of overburden was not confirmed during the course of the assessment work. However, based on the topography of the area there is the potential for more than 5 m of granular overburden to be present at the Beach and Mine Areas (SENES/Franz 2011).

4.4 CLIMATE

4.4.1 Temperature

As part of the Sub-Arctic Climatic Zone, Blanchet Island Mine experiences short cool summers and long cold winters. Environment Canada maintains climate statistics in Yellowknife (the nearest weather station), and climate averages are available from 1943 through to 2007. The lowest temperatures in the region are observed in January, recording an average daily temperature of -27.3°C and an extreme minimum of -51.1 °C (1947). The highest average temperatures are in July, during which the average is 16.5°C and the extreme maximum 32.5 °C

in 1989 (Environment Canada 2011). The implications of climate change on temperature trends in the project area are discussed in Section 4.4.3.

4.4.2 Precipitation

Average annual precipitation in Yellowknife is 269.1 mm. The average annual snowfall and rainfall are 139.1 cm and 155.3 mm respectively. The maximum snowfall is observed in November (average of 30.8 cm), while rainfall peaks in August (average of 39.8 mm). On average April is the driest month, reporting an average total precipitation of 10.5 mm (Environment Canada 2011).

4.4.3 Climate Change

The meaning of the term “climate change” within this report is consistent with its definition by the United Nations Framework Convention on Climate Change (1992):

“... a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods.”

The Blanchet Island Mine is within the Mackenzie climate region, from which an overall warming trend is recorded of approximately 1.5 °C/century. In the Mackenzie District the warming has occurred mainly in winter and spring, and warming temperatures accompanied by a decrease in winter precipitation. Alternatively, summer precipitation displays a minor increase in volume and variability (SENES 2005).

Climate trends at the Blanchet Island Mine have the potential to result in changes to freshwater ice thickness and duration, snow conditions, precipitation, permafrost, and habitat for plants and animals. Climate trends have been considered in the design of the RAP to ensure remedial measures function as intended over the long-term.

4.5 PERMAFROST

Permafrost is defined by the International Permafrost Association (IPA 2012) as:

“Ground (soil and rock and included ice and organic material) that remains at or below 0°C for at least two consecutive years”

The presence/absence of permafrost is dependent on many factors, such as air temperature, vegetation, snow cover, orientation of the terrain and ice content. Below 0° C, any soil moisture present will take the form of ice.

The Blanchet Island Mine lies within a zone of Extensive Discontinuous Permafrost of medium to low ground ice (NRC 1995). Discontinuous permafrost is defined as an area with 50-90% of the ground surface underlain by permafrost. Indications of permafrost were not observed during the Phase III or Phase IIIa ESAs; however, field investigations were conducted in the summer months when the active layer (the uppermost soil horizon which freezes and thaws annually) is at its deepest. The talik effects of Great Slave Lake, combined with thermal gain from bedrock outcrops (in the summer months), may contribute to the lack of permafrost evidence (SENES/Franz 2011).

Where permafrost is shallow, the clearing of vegetation and disturbance of the sub-surface may result in increased soil temperatures and thawing of permafrost. The loss of permafrost may cause a lack of soil cohesion, creating increased erosion and differential settlement of the ground surface. The degradation of permafrost may occur through impacts of increasing temperatures due to climate change, in addition to physical disturbances associated with remedial measures. However, as noted above, there is no evidence of shallow permafrost at the Blanchet Island Mine.

4.6 AIR QUALITY

Site-specific air quality measurements have not been collected during the ESA field investigations at the Blanchet Island Mine. Environment and Natural Resources (ENR) of the Northwest Territories monitors air quality at four stations, one of which is Yellowknife. Parameters measured vary by station, but include sulphur dioxide (SO₂), hydrogen sulphide (H₂S), fine particulate matter (PM_{2.5}), ground level ozone (O₃), carbon monoxide (CO) and nitrogen oxides (NO_x), as well as wind speed, wind direction and temperature (GNWT 2010).

Current air quality trends have been reported within the 2010 Status of the Environment Report (SENES 2011). Results show suspended particulate, SO₂ and NO_x on downward trends; ground level ozone consistent with background conditions; and a general decrease in the levels of Persistent Organic Pollutants (POPs).

4.7 ECOLOGY

4.7.1 Classification

Using the tiered classifications of the federal Ecological Framework for Canada (Ecological Stratification Working Group 1995), Blanchet Mine lies within the Taiga Shield Ecozone, Western Taiga Shield Ecoprovince, and finally the Tazin Lake Upland Ecoregion. The territorial Ecosystem Classification Group (2008) nomenclature classifies this region as part of the Great Slave Upland Low Subarctic Ecoregion. Dominant tree species in the ecoregion are black spruce and paper birch, with dwarf birch woodlands typical in low-lying areas or bedrock depressions. Peat plateaus are common and fens are often observed on lake shorelines (Ecosystem Classification Group 2008). Wildlife common to the ecoregion include black bear, wolf, caribou, moose, beaver, muskrat, snowshoe hare, and spruce grouse (Ecological Stratification Working Group 1995).

4.7.2 Vegetation Observations

Vegetation observed during the implementation of the Phase IIIa included: willow, alder, dwarf birch, tamarack, dogwood, black spruce, horsetail, Labrador tea, bog rosemary, sphagnum moss, wild rose, phragmites, wild strawberry, and lichen.

4.7.3 Wildlife Observations

Evidence (tracks, scat or sighting) of the following wildlife species was documented during the 2010 field investigation: wolf, moose, black bear, ptarmigan, beaver, raptors, arctic fox, scaup, common loon, wood frog, raven and red squirrel. A benthic community survey was also conducted which documented the following sensitive species within the shoreline: stonefly larva (at gravel beach west of spilled ore concentrate), caddis fly larvae (at beach near to ore concentrate spill) and leech (at beach, in deeper water).

4.7.4 Species at Risk in Canada

To determine the potential presence of any Species at Risk (SAR) at the site, information from the *Species at Risk in the Northwest Territories 2010 Edition* (Environment Canada 2010) was consulted. Table 1 summarizes the classified species that were found to have a range that may overlap with the project area. It is noted that an exact determination of the presence/absence of wildlife and vegetative SAR at the site would require a specific biological reconnaissance of the site.

Table 1 List of Species at Risk With a Range Extending into the Project Area

Common Name	Scientific Name	NWT General Status Ranking	COSEWIC	Species At Risk Act	General Habitat Discussion
Common nighthawk	<i>Chordeiles minor</i>	At risk	Threatened	Threatened	Nests in a variety of habitats
Horned grebe	<i>Podiceps auritus</i>	Secure	Special concern – western population	No Status	Small ponds, marshes and wetlands
Peregrine falcon	<i>Falcon peregrine, anatum</i>	Not-assessed	Threatened	Threatened	Sheltered ledges or crevices near water
Rusty blackbird	<i>Euphagus carolinus</i>	May be at risk	Special concern	Special Concern	Wetland areas in the boreal forest in spring, summer, fall
Short-eared owl	<i>Asio flammeus</i>	Sensitive	Special concern	No Status	Open (non-forested) areas
Short-jaw cisco	<i>Coregonus zenithicus</i>	At risk	Threatened	No Status	Great Slave Lake; deep water and spawning >9m depth
Wolverine	<i>Gulo gulo</i>	Sensitive	Special concern – western population	No Status	Wide variety
Yellow Rail	<i>Corturnicops</i>	May be at risk	Special Concern	Special Concern	Nests in marshes dominated by sedges and grasses, wet meadows, and shrubby wetlands
Olive-Sided Flycatcher	<i>Contopus cooperi</i>	At risk	Threatened	Threatened	Boreal forests near open areas

Source: Environment Canada 2010

4.8 HYDROLOGY

4.8.1 Regional Hydrology

With a surface area of 25,568 km² and an estimated volume of 2,088 km³, Great Slave Lake represents the principal hydrologic system in the region. The average depth of Great Slave Lake is 73 m, with a maximum depth of 614 m making it the deepest lake in North America. The Slave River is the largest freshwater source to Great Slave Lake contributing approximately 77% of total inflow. The Mackenzie River represents the principal outflow (MRBB 2003).

The Great Slave Lake Sub-Basin (part of the larger Mackenzie River Basin) has a catchment area of 379,000 km², stretching from Alberta and British Columbia and covering the majority of the central Northwest Territories. The sub-basin straddles the Precambrian Shield to the east and the Interior Plains to the west (MRBB 2003). The Blanchet Island Mine lies within the erosion resistant Precambrian Shield.

Great Slave Lake was formed through glacial scouring resulting in several distinct arms and islands. The East Arm has deep waters (up to 614 m) and lower dissolved minerals than observed elsewhere in the lake. The large Western Basin is shallower and contains high volumes of dissolved minerals and solids (i.e., silt) deposited in the lake via the Slave River. The oligotrophic lake is low in both planktonic crops and benthic invertebrate diversity (Biodiversity Institute of Ontario 2008).

4.8.2 Site Hydrology

Blanchet Island is typified by steep escarpments with talus slopes, rounded rock outcrops, and numerous lakes filling topographic depressions. Surface drainage on Blanchet Island is generally radial into Great Slave Lake, flowing along the topographic depressions. Elevated lakes, wetlands, and small creeks are present in the vicinity of the Blanchet Island Mine.

A small lake lies north and topographically above the Mine Area from which a small creek discharges toward the mine site (Figure 2). Immediately below the Mine Area, a wetland covers the low lying areas before discharging to a shallow creek that flows southwest to Great Slave Lake. This stream is characterized by multiple channels which merge and diverge along its course towards Great Slave Lake. Approximately 1,200 m east of the Beach Area, the creek cascades down a bedrock ridge before discharging into the lake. All reaches of the stream investigated in the Phase IIIa ESA were less than 1 m wide and a maximum of 0.3 m deep (SENES/Franz 2011).

A second and smaller creek was observed north of the Camp Area. The creek flows south and appeared to go underground before re-emerging between the Beach and Camp Areas and discharging into Great Slave Lake. The northern portion of the creek was observed to be approximately 1.5 m wide and a maximum depth of 0.5 m, reducing in size closer to the Beach Area (SENES/Franz 2011).

4.9 HYDROGEOLOGY

Groundwater investigations at the Blanchet Island Mine were limited to installation of seven shallow groundwater wells focusing on the collection of chemical data. Limited monitoring data has been obtained from the groundwater wells. Regionally, groundwater is anticipated to flow along bedrock surfaces radially from higher elevations towards Great Slave Lake. Due to the absence of shallow permafrost, groundwater rather than ground ice may be the dominant medium in the saturated zone, able to transmit groundwater from the upland areas down to Great Slave Lake during the spring and summer months. Where soils are absent, some groundwater

movement may occur along the joints and fractures of the low porosity bedrock. (SENES/Franz 2011).

At the Beach Area, the water table rises with topography at a shallow gradient upwards from Great Slave Lake. The overall groundwater flow direction is to the south-southwest and depth to the water table ranges from 0.7 metres below ground surface (mbgs) to 0.1 mbgs. Groundwater-surface water interactions are active during the summer months, as observed during the site investigations. It appears that the drainage course close to the lake shore exists predominantly as shallow groundwater as opposed to surface flow (Columbia/Franz 2010).

It is hypothesized that the majority of groundwater from the Mine Area drains to the adjacent wetland. The wetland serves as a groundwater sink from which water may then discharge to the creek system (SENES/Franz 2011).

5.0 ENVIRONMENTAL SITE ASSESSMENT FINDINGS

The following sections provide a summary of findings from ESAs conducted at the former Blanchet Island Mine. A small scale sampling program was implemented as part of the Phase II ESA (Columbia 2009); while a more detailed assessment of the site soil, water, sediment, vegetation and benthic invertebrates was conducted during a Phase III ESA (Columbia/Franz 2010) and Phase IIIa ESA (SENES/Franz 2011). During summer 2013 a small scale surface water and sediment sampling program was conducted in the Beach Area to identify metal concentrations following the 2010 ore consolidation activities.

The objective of the ESA process is to characterize the site and its features, and to identify and delineate impacted areas. To accomplish these objectives, Areas of Potential Environmental Concern (APECs) and Constituents of Potential Concern (COPC) were initially identified during the Phase I and II ESA investigations. Subsequently, in situations where impacts were confirmed, the APECs were reclassified as an Area of Environmental Concern (AEC) due to a known existence of a Constituent of Concern (COC).

5.1 MINERALIZATION AND METAL ENRICHMENT IN THE ENVIRONMENT

As is discussed in the subsequent sections, elevated metal concentrations (including arsenic) have been measured in soils, sediment and surface water at the Blanchet Island Mine. Excavation of ore at the advanced exploration property has exposed metal rich lithologies to atmospheric conditions resulting in increased rates of metal leaching and loadings to the surrounding environments. This is accelerated at Blanchet Island Mine, as carbonate lithologies are more susceptible to weathering and erosion than many other rock types.

While mining activities have undoubtedly enhanced metal loadings to soil, surface water and sediments, natural metal leaching from the ore deposit was occurring prior to mining activities. The fact that the mineral exploration industry uses metal concentrations in surface materials to help locate mineral deposits (Hamilton 2007) illustrates the extent to which metal concentrations can be affected by natural weathering. For example, naturally elevated metal concentrations in lake and stream sediments are a primary exploration tool, although soil and water sampling is also used (Moon et al. 2006).

In the case of the Blanchet Island Mine, there is unfortunately no pre-mining baseline environmental quality data that can be used to differentiate between naturally elevated and enhanced metal concentrations in environmental media. Throughout the ESA process, samples have been collected from areas unaffected by mine infrastructure (i.e. background samples); however, the areas are therefore not adjacent to mineralized bedrock and do not illustrate the natural metal enrichment typical in environmental media at such locations. In the absence of this

site-specific information, the following overviews of the Nechalacho and NICO Mines are provided to illustrate the extent to which highly mineralized zones can result in naturally elevated metal concentrations. While the details of these sites are not directly transferable to the Blanchet Island Mine (e.g., due to different mineralization, physical conditions and environmental factors), they serve as evidence that elevated concentrations at the Blanchet Island Mine are partially attributable to natural mechanisms. This includes the possibility that metal concentrations were above applicable EQG prior to the mining operation.

Nechalacho Project

The Nechalacho Project (formerly known as the Thor Lake Project), is a proposed rare earth mine approximately 15 km northwest of the Blanchet Island Mine. As part of the baseline assessment, metal concentrations were analyzed in sediment and surface water in both small and large water bodies. The deposit is rich in rare earth elements, and arsenic and nickel are not the primary elements of mineralization at the site (i.e. not the elements of concern at the Blanchet Island Mine). The study sampled 23 lakes and reported that 60% of sediment stations exceeded CCME guidelines for arsenic, and 28% for nickel (as well as 32% for silver and 16% for copper). The maximum reported arsenic and nickel concentrations in sediments were approximately 35 mg/kg and 40 mg/kg respectively. All reported water concentrations were below guidelines (Stantec 2010).

NICO Mine

The baseline assessment for the proposed NICO Mine (cobalt-gold-bismuth-copper) was also reviewed. The development is roughly 280 km northwest of Blanchet Island Mine and is not the same deposit type; however, the proponent has collected an extensive suite of baseline data within a mineralized zone. All sediment samples collected downstream of the ore body exceeded the applicable guidelines for arsenic (CCME-ISQG of 5.9 mg/kg). Concentrations of arsenic in small ponds near the mineralized zone showed the greatest arsenic concentration (Grid Ponds), which decreased with distance from the ore body. Sediment grab samples from the Grid Ponds ranged from 1240-2370 mg/kg arsenic, and 168-1090 mg/kg in the larger downstream Nico Lake. Surface water samples in these water bodies also exceed the CCME Freshwater Aquatic Guideline of 0.005 mg/L arsenic. Concentrations of arsenic in surface water from the Grid Ponds was 0.15-0.25 mg/L, decreasing to 0.01-0.015 mg/L in Nico Lake. Arsenic in both surface water and sediment decrease in water bodies further downstream from the Grid Ponds and Nico Lake (Golder 2010a). A total of 26 soil samples were also collected for arsenic analysis, of which 15 exceeded the CCME guideline of 12 mg/kg. Concentrations ranged from 1.92-3076 mg/kg and reported a mean of 206 mg/kg (Golder 2010b).

Summary

The results of metal analysis from the Nechalacho and NICO projects identifies the range and variability of baseline metal concentrations in environmental media. The mineralization has resulted in elevated metal loadings to the environment through natural processes. While it is impossible to determine the pre-mining conditions at the Blanchet Island Mine, it is predicted that soils, surface water and sediment would have displayed similar metal enrichment prior to mining activities. This factor should be considered during the interpretation of ESA findings and in designing remediation objectives.

5.2 MINE OPENINGS

The only mine opening at the Blanchet Island Mine is a small adit located part way up an escarpment in the Mine Area. Dimensions at the entrance of the opening are approximately 1.4 m wide by 1.6 m high. Historical records suggest a total length of 22 m to 25 m (Silke 2009). A narrow gauge rail and small rail car are currently located in the adit and along the connecting plateau. Timber support beams are used within and surrounding the adit (Figure 8), with the wood structure in visible disrepair. Access to the adit is limited as there is no clear access route from above or below and requires climbing the waste rock slope, or descending from above.

A geotechnical inspection of the adit was conducted as part of the Phase III and Phase IIIa ESAs. The Phase III concluded that the fractures in the escarpment face around the adit indicate stability concerns associated with the headwall above the adit opening. This issue was further investigated during the Phase IIIa ESA which concluded that the headwall and sidewalls are in stable condition with only minor scaling required to remove loose rock above the adit. Fractures identified in the Phase III were also further investigated in the Phase IIIa, and showed some evidence of frost action and cracking. The adit is not sealed, and the current condition of the adit does not meet current industry standards for a mine closure. For example, the timber support structures in and surrounding the adit opening are in disrepair and represent a physical hazard.

Small and shallow exploration pits were observed above the adit entrance and immediately to the east. Within the context of the local topography, the pits do not present significant incremental hazards.

5.3 BUILDINGS

Remnants from a total of six structures are within the footprint of the Blanchet Island Mine: a single cabin (assumed to be the former Powder Magazine) at the Mine Area; and four tent frames and a cabin at the Camp Area. In addition, a log foundation and suspected shower frame

(consisting of a stone pit with wooden frame) are located in the Camp Area. An inventory of the former structures and an inspection for hazardous building materials was conducted as part of the 2009 Phase III ESA (Columbia/Franz 2011) with the results summarized in Table 2 below.

The structures are constructed of rough timber, are unpainted, and show no evidence of hazardous building materials (e.g., friable asbestos containing materials, lead based paints). There is no indication the structures are of historical importance or serve as emergency shelter to persons accessing the Blanchet Island Mine. Structures are in various states of disrepair and are collapsed and/or partially collapsed, posing a potential hazard to those entering. The total volume of timber associated with the buildings is approximately 30 m³. Debris and refuse found in and around the Blanchet Island Mine Buildings are detailed within Section 5.4.

Table 2 Summary of Mine Buildings

Location	Building	Structure Details	Volume (m ³)
Camp Area	Tent Frame #1	Wood frame with bedrock foundation	4 wood
Camp Area	Tent Frame #2	Wood supports and platform with bedrock foundation	1.5 wood
Camp Area	Tent Frame #3	Wood Construction	2.5 wood
Camp Area	Tent Frame #4	Log and plywood foundation	2.5 wood
Camp Area	Log Cabin	Log construction	10 wood 0.4 tar paper 2 insulation
Camp Area	Log Foundation	Partial foundation and piled logs	3 wood
Camp Area	Suspected Shower	Collapsed rock pit and wooden frame	0.2 wood
Mine Area	Powder Magazine	Log construction	5 wood
TOTAL			28.7m³ wood 0.4 m³ tar paper 2 m³ insulation

Source: Phase III ESA (Columbia/Franz 2010)

5.4 REFUSE

5.4.1 Non-Hazardous Refuse

The Blanchet Island Mine contains minimal refuse as the historic operation was of a small scale, operated for approximately one year and did not have a mill or processing facility on-site. Non-hazardous refuse may be largely classified as metal, wood or concrete. An inventory of refuse at the mine was conducted during the 2009 Phase III ESA and confirmed during the 2010 Phase IIIa ESA field investigations. A summary of the findings is presented in Table 3 and comments are provided below.

A total of 102 drums remain in the Beach Area, 20 of which contain ore concentrate and have been placed in over-pack drums. The rest are rusted empty fuel drums located in three discrete parts of the Beach Area (27, 14 and 23 drums identified in the three areas). An additional drum

cache of 18 drums lies on the shoreline, approximately 100 m west of the main Beach Area. The standard 205 L drums may not have contained fuel, but may have been used for the transport of ore concentrate. A small cache of partially decomposed ore bags was also observed immediately north of the main drum cache (approximate volume of 1.5 m³).

The former Camp Area contains a variety of non-hazardous materials. A total of 11 empty and rusted drums were noted, as well as seven small dumps consisting of tin cans and miscellaneous domestic waste (total estimated volume of 27 m³). Unconsolidated debris (e.g., metal, pipe, wood) was limited, and estimated at a volume of 10 m³. A small and broken concrete dock (4 m x 1 m x 0.3 m) lies south of the site on the shore of Great Slave Lake.

Refuse at the former Mine Area was also minimal. Wood debris within the Mine Area includes timber used to support the adit, ladders against the waste rock slope, wooden core boxes, wooden rail ties in and surrounding adit, a cable line base, and a wooden (and metal) ore box. Cloth ore bags surround the adit entrance near to the ore concentrate spill. A small tin can dump, metal rail tracks and corrugated steel used for the ore box are the primary metal debris, although miscellaneous articles are scattered throughout the site. The Phase III located six empty and rusted drums. One 205 L drum was determined to be the source of soil contamination (underlying soils exhibited a petroleum hydrocarbon odour). The 2010 Phase IIIa site investigation confirmed PHCs in the soil profile; however, the drum had no residual contents.

Table 3 Summary of Non-Hazardous Debris

Location	Item	Volume (m ³)				
		Cloth	Wood	Metal*	Concrete	Total
Beach Area	Empty Drums (82)			5		5
Beach Area	Cloth Ore Bags	1.5				1.5
Camp Area	Empty Drums (11)			0.7		0.7
Camp Area	Tin Can and Domestic Waste Dumps (7)		3.5	23.5		27
Camp Area	Scattered Debris Centered Around Buildings, Foundation, and Shower			10		10
Camp Area	Concrete Dock with scattered debris		1.5	0.5	1.5	3.5
Mine Area	Empty Drums (6)			0.4		0.4
Mine Area	Rail and Cable Line Base and Track		13	1.5		14.5
Mine Area	Tin Can Dump (1)			1		1
Mine Area	Ore Box		3	8		11
Mine Area	Core Boxes		2			2
Mine Area	Cloth Ore Bags	2				2
TOTAL		3.5	23	50.6	1.5	78.6

Note: Does not include building structures, which are provided in Table 2.

* Assumes cans and drums to be crushed to 30% of current volume.

Source: Phase III ESA (Columbia/Franz 2010) and the Phase IIIa ESA (SENES/Franz 2011)

5.4.2 Hazardous Refuse

Hazardous materials have been interpreted as defined by the 2004 Guideline for Industrial Waste Discharges in the Northwest Territories (GNWT 2004):

“A contaminant which is a dangerous good that is no longer used for its original purpose and is intended for storage, recycling, treatment or disposal.”

By this definition, ore concentrate represents the only hazardous material present at the Blanchet Island Mine. Hazardous waste common to historic mine sites (e.g., friable asbestos, lead based paints, broken batteries) were not observed at Blanchet Island Mine. Further discussion of the physical and chemical nature of the ore concentrate is provided in Section 5.5.

5.5 ORE CONCENTRATE

Residual ore concentrate was documented and sampled throughout the ESA process. All ESA reports refer to the material as ore concentrate; however, there is no documentation to support the presence of a mill or plant to produce concentrated ore. It is consequently inferred that the material is simply high grade raw ore. To maintain consistency throughout the assessment and remedial process, the high grade ore will continue to be referred to as “ore concentrate”.

Analytical findings of the 2009 Phase III ESA (Columbia/Franz 2010) prompted the fall 2010 remediation of the drums and ore concentrate at the Beach Area by PWGSC. The previously observed spill of bulk ore concentrate within the Beach Area is now containerized in over-pack drums. The sealed over-pack drums remain in the Beach Area awaiting management as part of the comprehensive Blanchet Island Mine remediation.

In addition to the drummed ore, a small deposit (covering 18 m²) of ore concentrate was observed in the Camp Area, although the thickness of the spill is <1 cm (volume less than 1 m³). In the Mine Area, ore concentrate has spilled from the adit opening, approximately midway down the waste rock slope. The extent to which the ore concentrate has settled into the void spaces of the waste rock pile is unknown. Approximate volumes of ore concentrate at the Blanchet Island Mine are documented in Table 4 below.

Table 4 Ore Concentrate - Volumes

Location	Volume (m ³)
	Ore Concentrate
Beach Area (in over-pack containers)	5
Camp Area (impacted soil)	<1
Mine Area (impacted waste rock/soil)	19
TOTAL	25

Source: Phase IIIa ESA (SENES/Franz 2011)

The ore concentrate is fine-grained and composed primarily of erythrite and annabergite (weathered cobalt and nickel ore), with silicified limestone, high grade hornfels, metalimestone, and calcite. Massive ore (i.e., coarse grained ore) observed at the Mine Area contains a greater abundance of rammelsbergite (NiAs_2), the un-weathered host of nickel at the mine site.

Acid Base Accounting (ABA) was conducted as part of the Phase II and Phase III ESAs, from which it was determined that the ore concentrate at the Beach Area has low acid generating potential. A summary of ABA results is provided in Table 5.

Table 6 summarizes metal concentrations in the ore concentrate with the most current CCME guidelines for coarse grained soils in the residential/parkland setting (CCME 2007). Metal concentrations in the ore concentrate were elevated in arsenic, barium, cobalt, nickel and to a lesser extent uranium. The use of soil guidelines to evaluate the ore concentrate is highly conservative, as ore is inherently enriched in metals, lacks the organic components required to serve as a soil media, and is only surficial in depth (SENES/Franz 2011).

Shake flask extraction results (Table 7) indicate metal leaching is low for all elements excluding arsenic, and to a lesser extent nickel. Arsenic is predicted to leach from the weathered ore concentrate under neutral pH conditions and concentrations in shake flask effluent exceeded Metal Mining Effluent Regulations (MMER)³ by over two orders of magnitude (SENES/Franz 2011).

A single sample of ore concentrate from the Beach Area was also submitted for 10 weeks of humidity cell testing. Leachate concentrations of arsenic in the first week of testing were approximately 12,000 mg/L, decreasing to approximately 2,000 mg/L. Concentrations of nickel and cobalt demonstrated similar decreasing trends throughout testing, with concentrations in the first week of approximately 1 mg/L and 2 mg/L respectively. This suggests that arsenic, cobalt and nickel in the ore concentrate may be mobile in the presence of infiltrating rainwater and could potentially exhibit high concentrations in the resulting groundwater seepage.

³ The MMER are cited solely for comparative purposes and are not considered to represent appropriate regulatory controls for the abandoned Blanchet Island Mine.

Table 5 Ore Concentrate – Acid Base Accounting Analyses

Sample ID	Units	09-ARD-04	09-ARD-05	08-GS-2
Material Type		Ore (massive)	Ore (powdered)	Ore (powdered)
Location		Mine Area	Mine Area	Mine Area
Paste pH	---	7.6	5.4	5
Total Sulphur	%	0.92	0.5	0.23
Sulphate Sulphur	%	<0.01	0.33	0.12
Sulphide Sulphur	%	0.92	0.17	0.11
Acid Generating Potential (AP)	kg CaCO ₃ /t	29	5.3	3.4
Fizz Rating	---	3	2	2
Neutralization Potential (NP)	kg CaCO ₃ /t	72	19	46
Inorganic Carbon (as %C)	%	0.79	0.31	0.87
Inorganic Carbon (as %CO ₂)	%	2.9	1.2	3.2
Carbonate Neutralization Potential	kg CaCO ₃ /t	66	26	72
Neutralization Potential Ratio (NPR)	---	2.5	3.6	13
Carbonate NP Ratio (Carb-NPR)	---	2.3	4.9	21
ARD Classification	-	Low-PAG	Non-PAG	Non-PAG
Sample ID	Units	09-ARD-06	08-GS-1	09-ARD-07
Material Type		Ore (powdered)	Ore (powdered)	Ore (powdered)
Location		Beach Area	Beach Area	Beach Area
Paste pH	---	4.6	4.5	5.7
Total Sulphur	%	0.17	0.32	0.14
Sulphate Sulphur	%	0.15	0.23	0.07
Sulphide Sulphur	%	0.02	0.09	0.07
Acid Generating Potential (AP)	kg CaCO ₃ /t	0.6	2.8	2.2
Fizz Rating	---	1	1	2
Neutralization Potential (NP)	kg CaCO ₃ /t	7	1	46
Inorganic Carbon (as %C)	%	0.34	0.15	0.61
Inorganic Carbon (as %CO ₂)	%	1.3	0.6	2.2
Carbonate Neutralization Potential	kg CaCO ₃ /t	28	12	51
Neutralization Potential Ratio (NPR)	---	11	0.36	21
Carbonate NP Ratio (Carb-NPR)	---	45	4.4	23
ARD Classification	-	Non-PAG	Low-PAG	Non-PAG

Source: Phase III ESA (Columbia/Franz 2010)

Table 6 Ore Concentrate – Metals Analyses

Analysis	Unit	CCME Criteria*	A3-WR10-2	A1-WR10-1
			Mine Area	Beach Area
Ag	ppm	20	<0.1	0.1
Al	%	-	1.88	3.94
As	ppm	12	221,900	76,200
Au	ppm	-	0.2	0.1
Ba	ppm	500	7	1,306
Be	ppm	-	<1	<1
Bi	ppm	-	239.1	208.8
Ca	%	-	9.85	4.34
Cd	ppm	10	<0.1	<0.1
Ce	ppm	-	36	45
Co	ppm	50	18,730	18,880
Cr	ppm	64	23	53
Cu	ppm	63	10.2	23.3
Fe	%	-	2.54	2.77
Hf	ppm	-	0.9	2.6
K	%	-	0.1	1.97
La	ppm	-	17.6	21
Li	ppm	-	8.5	27.9
Mg	%	-	5.08	2.59
Mn	ppm	-	1,155	889
Mo	ppm	10	1.6	2.1
Na	%	-	1.306	0.94
Nb	ppm	-	2.9	5
Ni	ppm	50	78,570	32,390
P	%	-	0.015	0.033
Pb	ppm	140	9.4	20.2
Rb	ppm	-	2.6	75.7
Sb	ppm	20	11	4.8
Sc	ppm	-	2	6
Sn	ppm	-	0.9	1.7
Sr	ppm	-	38	62
Ta	ppm	-	0.2	0.4
Th	ppm	-	3.4	8.9
Ti	%	-	0.083	0.191
U	ppm	23	43.2	27.2
V	ppm	-	190	105
W	ppm	-	0.5	1.3
Y	ppm	-	13.8	14.3
Zn	ppm	200	16	42
Zr	ppm	-	31.7	87.4

* CCME (2007), Canadian Soil Quality Guidelines, Update 7.0, Table 1. Canadian Soil Quality Guidelines, Residential / Parkland for Coarse Grained Soils; Supplemented with the CCME (2007), Canadian Soil Quality Guidelines, Update 7.0, Table 2.

Highlight indicates exceedance of CCME criteria

Source: Phase IIIa ESA (SENEs/Franz 2011). Phase III ESA ore concentrate data not used, as nickel, cobalt and arsenic exceed the upper detection limits.

Table 7 Ore Concentrate – Shake Flask Analyses

Analysis	Units	MMER Criteria *	A3-WR10-2	A1-WR10-1
			Mine Area	Beach Area
Diss. CaCO ₃	mg/L		88	70
Diss. Al	mg/L		0.03	<0.01
Diss. Sb	mg/L		0.012	0.004
Diss. As	mg/L	0.5	68.7	43.8
Diss. Ba	mg/L		0.001	0.031
Diss. Be	mg/L		<0.0005	<0.0005
Diss. Bi	mg/L		<0.0003	0.0006
Dissolved Boron (B)	mg/L		<3	<3
Dissolved Cadmium (Cd)	mg/L		<0.0003	<0.0003
Dissolved Cesium (Cs)	mg/L		<0.003	<0.003
Dissolved Chromium (Cr)	mg/L		<0.005	<0.005
Dissolved Cobalt (Co)	mg/L		0.0084	1.09
Dissolved Copper (Cu)	mg/L	0.3	0.014	0.011
Dissolved Iron (Fe)	mg/L		<0.05	0.06
Dissolved Lanthanum (La)	mg/L			<0.003
Dissolved Lead (Pb)	mg/L	0.2	<0.0003	0.0005
Dissolved Lithium (Li)	mg/L		<0.03	<0.03
Dissolved Manganese (Mn)	mg/L		<0.003	0.012
Dissolved Molybdenum (Mo)	mg/L		<0.003	<0.003
Dissolved Nickel (Ni)	mg/L	0.5	0.256	3.35
Dissolved Phosphorus (P)	mg/L		<0.1	<0.1
Dissolved Rubidium (Rb)	mg/L		<0.003	<0.003
Dissolved Selenium (Se)	mg/L		0.011	0.012
Dissolved Silicon (Si)	mg/L		<5	<5
Dissolved Silver (Ag)	mg/L		<0.0003	<0.0003
Dissolved Strontium (Sr)	mg/L		0.016	0.02
Dissolved Tellurium (Te)	mg/L		<0.001	<0.001
Dissolved Thallium (Tl)	mg/L		<0.0001	<0.0001
Dissolved Thorium (Th)	mg/L		<0.0003	<0.0003
Dissolved Tin (Sn)	mg/L		<0.0005	<0.0005
Dissolved Titanium (Ti)	mg/L		<0.03	<0.03
Dissolved Tungsten (W)	mg/L		0.0008	<0.0005
Dissolved Uranium (U)	mg/L		0.0018	0.001
Dissolved Vanadium (V)	mg/L		<0.01	0.01
Dissolved Zinc (Zn)	mg/L	0.5	<0.005	<0.005
Dissolved Zirconium (Zr)	mg/L		<0.005	<0.005
Dissolved Calcium (Ca)	mg/L		35	22
Dissolved Magnesium (Mg)	mg/L		<3	4
Dissolved Potassium (K)	mg/L		<3	<3
Dissolved Sodium (Na)	mg/L		<3	<3
Dissolved Sulphur (S)	mg/L		<500	<500
Dissolved Mercury (Hg)	mg/L		<0.02	<0.02

^ Reportable Detection Limit

* Metal Mining Effluent Regulations (MMER 2011): Maximum Authorized Monthly Mean Concentration

Highlight indicates exceedance of MMER Guideline

Source: Phase IIIa ESA (SENES/Franz 2011), for consistency with metals in solids.

5.6 WASTE ROCK

Waste rock at the Blanchet Island Mine is found in a single location at the base of the adit within the Mine Area. The waste rock fan descends downwards from the adit level, reaching the access road and fanning outward from the escarpment face (Figure 10). The waste rock is at its natural angle of repose with no evidence of movement or instability over the forty years since the mining operations ceased. The total volume of waste rock at the Blanchet Island Mine is approximately 1,000 m³.

Surficial waste rock is approximately 0.1 to 0.5 m in diameter, with decreasing grain size observed with depth. Lithologies are primarily banded metalimestone/metadolostone and more minor quantities of unaltered limestone, carbonate vein material (calcite and siderite), quartz vein material, silicic intrusive (diorite) and hornfels. Erythrite and annabergite (cobalt bloom and nickel bloom respectively) were observed as small clasts throughout the waste rock stockpile.

Results of the Phase III ESA ABA analyses indicate the waste rock is low in sulphides and rich in inorganic carbon, and consequently classified as non-acid generating (Columbia/Franz 2010). Any sulphide mineralization present is predicted to be sufficiently buffered with host rock limestone (Table 8).

Metal concentrations in waste rock were assessed using ICP-MS and ICP-AES (Table 9). Concentrations of metals within the waste rock were evaluated with respect to six times the average elemental abundance in non-mineralized or unaltered limestone (as applied in the Phase III ESA). While numerous elements exceed the screening criteria (silver, aluminum, arsenic, barium, cadmium, cerium, copper, iron, niobium, sodium, nickel, scandium, selenium, tin, tantalum, thorium, uranium and vanadium), this indicates anomalous elemental concentrations from pure limestone and does not necessarily indicate toxic concentrations or potential impacts.

To identify potential waste rock impacts, CCME soil criteria were used to determine if an elemental abundance is known to have adverse human health or environmental effects. This is a very conservative assumption, as elements in the waste rock are typically locked within stable minerals (i.e., unable to weather and become available). Elements exceeding both the CCME soil criteria and the crustal abundance criteria are highlighted in yellow. While soil guidelines do not apply to waste rock, it is noted that of the enriched elements, only arsenic, cobalt, nickel and uranium exceed the most conservative CCME soil guidelines.

The metal leaching potential of the waste rock was determined using Shake Flask Analyses (Table 10). One sample exceeded the Metal Mining Effluent Regulation (MMER 2011) Maximum Allowable Monthly Mean Concentration for arsenic. Sample A3-WR10-1 displayed leachate concentrations of 8.16 mg/L arsenic, 16.3 times the MMER of 0.5 mg/L. The low acid

generating potential of the waste rock does not inhibit the leaching of arsenic as, unlike most heavy metals, arsenic does not require acidic conditions for mobility. The arsenic is hosted within the ore minerals and is consequently found in greater abundance at locations of where ore remains. The arsenic concentration observed in the single shake flask sample is assumed to be due to ore concentrate contamination of the finer waste rock material (fine waste rock fractions are used for geochemical analyses).

Humidity cell testing was conducted on one sample of waste rock for a total of ten weeks as part of the Phase III ESA. Concentrations of arsenic in humidity cell leachates ranged between 0.023 mg/L and 0.2 mg/L throughout the testing period. The sample showed a steady decline in arsenic concentrations after the first flush was complete. Of the other elements noted to be anomalous in the solid phase elemental analysis (i.e., Bi, Sb, Co, Ni, Se and U), the waste rock sample leachate was almost exclusively below detection levels (Columbia/Franz 2010). Massive ore from the mine area was also submitted for humidity cell testing; however, the volume of the ore is minimal, and the results are not considered representative of the waste rock pile.

Table 8 Waste Rock – Acid Base Accounting Analyses

Sample ID	Units	09-ARD-01	09-ARD-02	09-ARD-03
Location		Mine Area	Mine Area	Mine Area
Paste pH	---	8.3	8.7	8.9
Total Sulphur	%	0.1	<0.01	0.02
Sulphate Sulphur	%	<0.01	<0.01	<0.01
Sulphide Sulphur	%	0.1	<0.01	0.02
Acid Generating Potential (AP)	kg CaCO ₃ /t	3.0	<0.3	0.47
Fizz Rating	---	3	4	3
Neutralization Potential (NP)	kg CaCO ₃ /t	149	787	120
Inorganic Carbon (as %C)	%	1.68	9.79	1.37
Inorganic Carbon (as %CO ₂)	%	1.68	9.79	1.37
Carbonate Neutralization Potential	kg CaCO ₃ /t	140	816	114
Neutralization Potential Ratio (NPR)	---	50	5,247	256
Carbonate Ratio (Carb-NPR)	---	47	2,718	243
ARD Classification	-	Non-PAG	Non-PAG	Non-PAG

Source: Phase III ESA (Columbia/Franz 2010)

Table 9 Waste Rock – Metals Analyses

Analysis	Unit	Evaluation Criteria		A3-WR10-1	09-ARD-01	09-ARD-02	09-ARD-03	MEAN
		Crustal Abundance x6 *	CCME Criteria ^	Mine Area	Mine Area	Mine Area	Mine Area	
Ag	ppm	0	20	0.2	0.06	0.05	0.01	0.08
Al	%	2.52	-	3.19	3.28	2.33	7.35	4.04
As	ppm	6	12	7,936	43.3	26	470	2,118.8
Au	ppm	0	-	<0.1	NA	NA	NA	<0.1
Ba	ppm	60	500	114	NA	NA	NA	114
Be	ppm	0	-	<1	NA	NA	NA	<1
Bi	ppm	-	-	8.3	0.06	0.16	0.19	2.2
Ca	%	181.38	-	14.09	8.43	15.60	4.49	10.65
Cd	ppm	0.21	10	0.3	0.04	0.06	<0.02	0.1
Ce	ppm	0	-	51	NA	NA	NA	51
Co	ppm	0.6	50	2,598.1	51.1	6.0	40.2	673.9
Cr	ppm	66	64	41	35	19	19	29
Cu	ppm	24	63	3.3	30.3	8.4	5.8	12.0
Fe	%	2.28	-	4.51	24.40	2.99	0.85	8.19
Hf	ppm	1.8	-	1.6	NA	NA	NA	1.6
K	%	1.62	-	0.44	0.33	0.05	0.33	0.29
La	ppm	-	-	27.4	NA	NA	NA	27.4
Li	ppm	30	-	9.6	NA	NA	NA	9.6
Mg	%	28.2	-	6.48	1.79	8.61	0.69	4.39
Mn	ppm	6600	-	1,679	1,020	1,840	281	1,205
Mo	ppm	2.4	10	2.3	NA	NA	NA	2.3
Na	%	0.24	-	1.816	1.5	1.78	6.97	3.017
Nb	ppm	1.8	-	4.4	NA	NA	NA	4.4
Ni	ppm	120	50	5,292.1	40.2	12.6	191.0	1,384.0
P	%	0.24	-	0.033	0.043	0.017	0.071	0.041
Pb	ppm	54	140	18.8	26.8	54.0	12.5	28.0
Rb	ppm	18	-	12.3	NA	NA	NA	12.3
Sb	ppm	1.2	20	1.1	0.67	0.07	0.12	0.5
Sc	ppm	6	-	8	NA	NA	NA	8
Se	ppm	0	-	NA	3	2	2	2
Sn	ppm	0	-	3.0	9.0	0.7	0.9	3.4
Sr	ppm	3660	-	53	46.3	46.3	46	47.9
Ta	ppm	0	-	0.3	NA	NA	NA	0.3
Th	ppm	0	-	7.3	NA	NA	NA	7.3
Ti	%	0.24	-	0.137	NA	NA	NA	0.137
U	ppm	13.2	23	24.7	32.9	5.3	3	16.5
V	ppm	120	-	170	NA	NA	NA	170
W	ppm	3.6	-	1.4	NA	NA	NA	1.4
Y	ppm	180	-	17.3	NA	NA	NA	17.3
Zn	ppm	120	200	63	106	39	13	55.3
Zr	ppm	114	-	59.2	NA	NA	NA	59.2

* 6x Average Crustal Abundance in Carbonates (Price 1997)

^ Canadian Soil Quality Guidelines, Residential/Parkland Coarse Grained Soils (CCME 2007)

- No criteria available

NA Data Not Available

Bold indicates exceedance of 6x Crustal Abundance Criteria

Highlight indicates exceedance of 6x Crustal Abundance Criteria *and* CCME Soil Criteria

Source: Phase III ESA (Columbia/Franz 2010) and Phase IIIa ESA (SENES/Franz 2011)

Table 10 Waste Rock – Shake Flask Extraction Analyses

PARAMETERS			A3-WR10-1	09-ARD-01	09-ARD-02	09-ARD-03	AVERAGE
Analysis	Units	MMER Criteria*	Mine Area – 3	Mine Area - 3	Mine Area - 3	Mine Area - 3	
Diss. Ag	mg/L	-	<0.00005	<0.002	<0.002	<0.002	0.00075
Diss. Al	mg/L	-	0.128	0.31	0.14	0.54	0.28
Diss. As	mg/L	0.5	8.16	0.05	0.09	0.27	2.14
Diss. B	mg/L	-	<0.5	NA	NA	NA	0.5
Diss. Ba	mg/L	-	0.0041	NA	NA	NA	0.0041
Diss. Be	mg/L	-	<0.0001	NA	NA	NA	<0.0001
Diss. Bi	mg/L	-	<0.00005	NA	NA	NA	<0.00005
Diss. Ca	mg/L	-	13.8	6.5	6.9	6.9	8.5
Diss. Cd	mg/L	-	<0.00005	<0.002	<0.002	<0.002	0.00075
Diss. Co	mg/L	-	0.0481	<0.002	<0.002	<0.002	0.0128
Diss. Cr	mg/L	-	<0.001	<0.005	<0.005	<0.005	0.002
Diss. Cs	mg/L	-	<0.0005	NA	NA	NA	<0.0005
Diss. Cu	mg/L	0.3	0.0171	<0.002	<0.002	<0.002	0.005
Diss. Fe	mg/L	-	0.04	<0.01	<0.01	<0.01	0.01
Diss. Hg	mg/L	-	<0.02	NA	NA	NA	<0.02
Diss. K	mg/L	-	0.9	0.09	0.12	0.12	0.31
Diss. La	mg/L	-	<0.0005	NA	NA	NA	<0.0005
Diss. Li	mg/L	-	<0.005	NA	NA	v	<0.005
Diss. Mg	mg/L	-	1.5	0.46	2.9	0.39	1.3
Diss. Mn	mg/L	-	0.004	<0.001	<0.001	<0.001	0.001
Diss. Mo	mg/L	-	0.0016	NA	NA	NA	0.0016
Diss. Na	mg/L	-	1.6	0.53	1.0	1.0	1.0325
Diss. Ni	mg/L	0.5	0.123	<0.005	<0.005	<0.005	0.032
Diss. P	mg/L	-	0.08	<0.02	<0.02	0.02	0.03
Diss. Pb	mg/L	0.2	0.0004	<0.01	<0.01	<0.01	0.003
Diss. Rb	mg/L	-	0.0015	NA	NA	NA	0.0015
Diss. S	mg/L	-	<100	NA	NA	NA	<100
Diss. Sb	mg/L	-	0.0016	<0.02	<0.02	<0.02	0.008
Diss. Se	mg/L	-	0.0013	<0.02	<0.02	<0.02	0.008
Diss. Si	mg/L	-	<1	NA	NA	NA	<1
Diss. Sn	mg/L	-	<0.0001	<0.02	<0.02	<0.02	0.0007
Diss. Sr	mg/L	-	0.0098	0.007	0.008	0.004	0.0072
Diss. Te	mg/L	-	<0.0002	NA	NA	NA	<0.0002
Diss. Th	mg/L	-	<0.00005	NA	NA	NA	<0.00005
Diss. Ti	mg/L	-	<0.005	NA	NA	NA	<0.005
Diss. Tl	mg/L	-	0.00003	NA	NA	NA	0.00003
Diss. U	mg/L	-	0.0061	<0.1	<0.1	<0.1	0.039
Diss. V	mg/L	-	0.006	NA	NA	NA	0.006
Diss. W	mg/L	-	0.002	NA	NA	NA	0.002
Diss. Zn	mg/L	0.5	0.003	<0.002	<0.002	0.003	0.002
Diss. Zr	mg/L	-	<0.001	NA	NA	NA	<0.001

* Metal Mining Effluent Regulations (MMER 2011): Maximum Authorized Monthly Mean Concentration. Criteria are for Total Concentrations, however shake flask analyses report dissolved.

Highlight indicates exceedance of MMER Criteria

Source: Phase III ESA (Columbia/Franz 2010) and Phase IIIa ESA (SENES/Franz 2011)

5.7 SOIL FINDINGS

Soil samples were collected during the course of the Blanchet Island Mine ESA field sampling programs. While representative background and access road samples were also analysed, the sampling programs focused mainly on the areas with probable impacts from past operations (i.e., AECs); hence, the results do not provide a representation of the site as a whole but rather selected discrete locations with the highest potential impacts on the site. The soil sampling programs targeted the following locations within the abandoned mine site:

- Beach Area – AEC 1
 - Underlying and surrounding the ore concentrate spill (prior to the 2010 ore consolidation efforts);
 - Surrounding the decomposing ore bags; and
 - Amongst the drum caches;
- Camp Area – AEC 2
 - Underlying and surrounding the small ore concentrate spill;
 - Surrounding buildings, at suspected locations of fuel storage;
 - Amongst the drum caches; and
 - Within tin can dumps.
- Mine Area – AEC 3
 - Surrounding waste rock and ore concentrate descending from the adit;
 - Wetland area adjacent and down-gradient of the mine; and
 - Scattered drums.
- Access Road – AEC 4
 - Random locations along former roadway.

The soil samples were analyzed for a minimum of one of the following parameters: metals, polycyclic aromatic hydrocarbons (PAHs), benzene, toluene, ethylbenzene and xylene (BTEX), petroleum hydrocarbon fractions F1 through F4 (PHCs), and nitro aromatic compounds (Phase III only) as a function of the COC for the particular AEC. Soil sampling depths were typically between 0.0 m and 0.4 m.

Metals

Blanchet Island Mine soils are naturally enriched in ore elements (e.g., arsenic, cobalt and nickel), as is typical in mineralized areas. To account for natural enrichments, results of metals analyses in soil have been evaluated against the maximum of the appropriate CCME criteria (CCME 2007) and observed site-specific background concentrations.

Soil data from the Phase III and Phase IIIa ESAs are summarized in Table 11. Elevated concentrations of metals in soil were identified at locations exposed to ore concentrate. In the Beach Area, arsenic concentrations of greater than 40,000 mg/kg, cobalt concentrations of 8,230 mg/kg, and nickel concentrations of 33,000 mg/kg identify the primary COCs and have concentrations more than 100x the CCME soil guidelines (CCME 2007). Arsenic exceeds the maximum applicable background concentration of 46 mg/kg in site-specific lowland soils⁴ (SENES/Franz 2011) in a total of 41 samples. Chromium, copper, selenium, silver, and uranium concentrations are also elevated; however, maximum concentrations are less than 10x the CCME guideline and average concentrations are below the guidelines.

Elevated metal concentrations were also noted in a small number of soil samples collected from the Camp Area. Arsenic concentrations ranged from 4 mg/kg to a maximum of 670 mg/kg, with an average concentration of 74 mg/kg. However, only nine of the 27 soil samples collected from the Camp Area exceed the maximum observed arsenic concentration in background soils (46 mg/kg from lowland soils). Similarly, barium, chromium, cobalt, lead, molybdenum, nickel, uranium, and zinc exceed criteria at three or less locations, and selenium at a total of 8 locations (although less than 2x guideline). When evaluated against background concentrations, the Camp Area displays metal enrichment only in samples collected from below a small ore concentrate spill (arsenic, cobalt, nickel) and, to a much lesser extent, in the tin can dumps (selenium) and beneath batteries (lead). The total surface area of impacted soil at the ore concentrate spill in the Camp Area is estimated at 18m², with a volume of approximately 1 m³.

Within the Mine Area, elevated metals consistent with ore mineralogy were observed in soils surrounding and downgradient of the adit, waste rock, and spilled ore concentrate. CCME soil guidelines and/or applicable background concentrations were exceeded for arsenic (31 samples), cobalt (22 samples), nickel (31 samples), selenium (14 samples), uranium (13 samples), and zinc (10 samples). Arsenic is the primary COC at the Mine Area due to high concentrations (up to 820x the CCME soil criteria), wide distribution (31 samples), and mobility under the pH neutral conditions observed at the Mine Area. Arsenic, cobalt, nickel and selenium concentrations are predicted to be partially related to the transport and leaching of fine grained ore concentrate. Concentrations of barium, cadmium, chromium, copper, lead, uranium, and zinc may display localized exceedances of CCME and background concentrations; however, the average concentration of these metals within the Mine Area is below CCME criteria, and/or enrichments may be largely natural in soils from a mineralized bedrock location.

⁴ The maximum concentration of arsenic in lowland soils in the Camp Area and Beach Areas was 46 mg/kg; however, a background concentration of 200 mg/kg arsenic was reported in the Mine Area.

Five overburden samples were collected in random locations along the access road between the Beach/Camp Area and the Mine Area. While all samples exceed the CCME guidelines for arsenic, four of five samples were consistent with background from local lowland soils (i.e., less than 46 mg/kg). A single sample collected from within 100 m of the Mine Area displayed anomalously high concentrations of arsenic (750 mg/kg), cobalt (210 mg/kg), nickel (620 mg/kg) and uranium (30 mg/kg). The enrichments at this location are likely due to ore transferring activities. It has been concluded that the roadway soils do not exhibit measurable impacts from mining activities, excluding the 100 m of roadway nearest to the Mine Area.

PAHs, BTEX, PHCs

Results of hydrocarbon analysis in soils are provided in Table 12 below. A single soil sample collected from the northernmost drum cache in the Beach Area reported a PHC fraction F3 concentration of 610 mg/kg, approximately 2x the CCME soil guidelines. However, the soil at this location is primarily peat, which is known to result in naturally elevated F3 concentrations (O’Sullivan *et al.* 2010). There is no evidence of PHC, PAH, or other contaminant impacts to the soil environment of the Camp Area.

A single drum at the base of the waste rock slope was reported leaking in the Phase II (Columbia 2009) and Phase III ESAs (Columbia/Franz 2010). Several PAH compounds (acridine, 2-methylnaphthalene, naphthalene, phenanthrene, perylene, pyrene), all PHC fractions, and the BTEX compound ethylbenzene were identified in soils at this location. The total volume of impacted soil at this location is an estimated 50 m³.

Table 11 Soil – Summary of Metal Analyses

PARAMETER	Units	CCME Criteria*	Background			Beach Area - AEC 1			Camp Area - AEC 2			Mine Area - AEC 3					
			N	N<MDL	Max.	N	N<MDL	Max.	Avg.	N	N<MDL	Max.	Avg.	N	N<MDL	Max.	Avg.
Metals - total																	
Sb	mg/kg	20	7	6	0.5	74	55	5.0	0.9	27	20	4.0	0.7	51	40	1.1	0.6
As	mg/kg	12	7	0	200	74	0	40,000	1,679	27	0	670	74	51	0	9,840	733
Ba	mg/kg	500	7	0	365	74	2	370	139	27	0	650	298	51	0	530	181
Be	mg/kg	4	7	4	0.8	74	55	2.0	0.4	27	17	0.6	0.3	51	36	1.0	0.3
B	mg/kg	-	5	3	1.0	65	16	4.5	0.7	23	1	2.6	1.1	46	9	4.0	0.8
Cd	mg/kg	10	7	1	1.4	74	28	0.7	0.2	27	7	1.5	0.3	51	4	47.0	2.0
Cr (total)	mg/kg	64	7	0	32.0	74	9	128.5	17.6	27	4	99.2	15.1	51	3	110.0	15.1
Cr (hexavalent)	mg/kg	0.4	5	5	7.5	65	53	1.0	0.1	23	23	0.075	0.075	46	39	0.8	0.1
Co	mg/kg	50	7	0	90	74	6	8,230	371	27	2	150	15	51	2	4,010	255
Cu	mg/kg	63	7	0	90	74	5	120	18	27	1	50	20	51	3	310	34
Pb	mg/kg	140	7	1	60	74	14	30	4	27	4	860	38	51	5	1,200	46
Hg	mg/kg	6.6	7	4	0.18	74	50	0.38	0.05	27	13	0.22	0.06	51	25	0.20	0.06
Mo	mg/kg	10	7	3	2.0	74	27	5.0	1.0	27	11	13.0	1.3	51	11	3.2	1.0
Ni	mg/kg	50	7	0	71	74	2	33,000	894	27	0	590	52	51	0	4,030	399
Se	mg/kg	1	7	5	0.5	74	33	7.1	0.8	27	9	2.8	0.8	51	23	3.2	0.7
Ag	mg/kg	20	7	7	0.5	74	62	42.0	1.3	27	27	0.5	0.5	51	44	2	0.6
Tl	mg/kg	1	7	7	0.5	74	74	1.5	1.5	27	27	0.5	0.5	51	51	0.5	0.5
Sn	mg/kg	50	7	6	7	74	61	8	1	27	24	3	1	51	51	2.5	2.5
U	mg/kg	23	7	1	7	74	29	27	4	27	5	58	7	51	9	169	21
V	mg/kg	130	7	0	72	74	3	57	22	27	2	41	18	51	0	110	29
Zn	mg/kg	200	7	0	260	74	7	135	32	27	4	270	39	51	3	8,600	382
BTEX																	
Benzene	mg/kg	0.03	3	3	0.0025	2	2	0.003	0.0025	NA	NA	NA	NA	4	4	0.003	0.003
Toluene	mg/kg	0.37	3	3	0.01	2	2	0.01	0.01	NA	NA	NA	NA	4	4	0.01	0.01
Ethylbenzene	mg/kg	0.082	3	3	0.005	2	2	0.005	0.005	NA	NA	NA	NA	4	3	0.27	0.07
Xylenes (Total)	mg/kg	11	3	3	0.02	2	2	0.02	0.02	NA	NA	NA	NA	4	3	2.1	0.54
m & p-Xylene	mg/kg	11	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	4	3	0.5	0.14
o-Xylene	mg/kg	11	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	4	3	1.6	0.4

N Number of Samples

MDL Method Detection Limit

NA Values Not Available

Bold indicates all values < MDL. 1/2 MDL value used.

Highlight indicates exceedance of CCME Soil Criteria

* CCME Soil Quality Guidelines for the Protection of Environmental and Human Health – Residential/Parkland, Summary Tables (Table 1), update 7.0 (September 2007)

Max. Maximum Value

Avg. Average Value

Source: Phase II ESA (Columbia 2009), Phase III ESA (Columbia/Franz 2010) and Phase IIIa ESA (SENES/Franz 2011).

Note: Samples determined to be ore concentrate, and not mineral or organic soils, were removed from the soil dataset.

Table 12 Soil – Summary of Hydrocarbon Analyses

PARAMETER	Units	CCME Criteria*	Background			Beach Area - AEC 1			Camp Area - AEC 2			Mine Area - AEC 3					
			N	N<MDL	Max	N	N<MDL	Max.	Avg.	N	N<MDL	Max.	Avg.	N	N<MDL	Max.	Avg.
PHCs																	
F1 PHC	mg/kg	30	3	3	6	2	2	6	6	NA	NA	NA	4	2	980	353	
F2 PHC	mg/kg	150	3	1	65.5	5	2	11	6.9	NA	NA	NA	5	2	46,000	14,802	
F3 PHC	mg/kg	300	3	3	10	5	1	610	197.6	NA	NA	NA	5	0	16,500	6,716	
F4 PHC	mg/kg	2,800	3	3	5	5	1	620	194	NA	NA	NA	5	0	5,250	1413	
PAHs																	
Acenaphthene	mg/kg	7.9	3	3	0.0025	2	2	0.005	0.005	NA	NA	NA	4	3	0.33	0.09	
Acenaphthylene	mg/kg	0.15	3	3	0.0025	2	2	0.005	0.005	NA	NA	NA	4	4	0.025	0.025	
Acridine	mg/kg	-	3	2	0.011	2	2	0.01	0.01	NA	NA	NA	4	2	0.66	0.22	
Anthracene	mg/kg	2.5	3	3	0.002	2	2	0.004	0.0041	NA	NA	NA	4	3	0.02	0.01	
Benzo(a)anthracene	mg/kg	1	3	3	0.0025	5	5	0.01	0.01	3	3	0.005	5	5	0.253	0.253	
Benzo(b&j)fluoranthene	mg/kg	1	3	3	0.0025	5	5	0.01	0.01	3	3	0.005	5	5	0.253	0.253	
Benzo(k)fluoranthene	mg/kg	1	3	3	0.0025	5	5	0.01	0.01	3	3	0.005	5	5	0.253	0.253	
Benzo(g,h,i)perylene	mg/kg	6.6	3	3	0.0025	2	2	0.005	0.005	NA	NA	NA	4	4	0.025	0.025	
Benzo(c)phenanthrene	mg/kg	-	3	3	0.0025	2	2	0.005	0.005	NA	NA	NA	4	4	0.025	0.025	
Benzo(a)pyrene	mg/kg	20	3	3	0.0025	5	5	0.01	0.01	3	3	0.005	5	5	0.253	0.253	
Benzo(e)pyrene	mg/kg	-	3	3	0.0025	2	2	0.005	0.005	NA	NA	NA	4	4	0.025	0.025	
Chrysene	mg/kg	7	3	3	0.0025	2	2	0.005	0.005	NA	NA	NA	4	4	0.025	0.025	
Dibenzo(a,h)anthracene	mg/kg	1	3	3	0.0025	5	5	0.01	0.01	3	3	0.005	5	5	0.253	0.253	
Fluoranthene	mg/kg	7.8	3	3	0.0025	2	2	0.005	0.005	NA	NA	NA	4	4	0.025	0.025	
Fluorene	mg/kg	62	3	3	0.0025	2	2	0.005	0.005	NA	NA	NA	4	4	0.025	0.025	
Indeno(1,2,3-c,d)pyrene	mg/kg	1	3	3	0.0025	5	5	0.01	0.01	3	3	0.005	5	5	0.253	0.253	
2-Methylnaphthalene	mg/kg	0.99	3	2	0.0068	2	2	0.005	0.005	NA	NA	NA	4	3	6.70	1.68	
Naphthalene	mg/kg	0.13	3	2	0.0105	5	5	0.01	0.01	3	3	0.005	5	3	22.5	4.6	
Phenanthrene	mg/kg	0.046	3	3	0.0025	5	5	0.01	0.01	3	3	0.005	5	2	6.05	1.95	
Perylene	mg/kg	-	3	3	0.0025	2	1	0.005	0.0051	NA	NA	NA	4	4	0.025	0.025	
Pyrene	mg/kg	10	3	3	0.0025	5	5	0.01	0.01	3	2	0.02	5	2	0.13	0.06	
Quinoline	mg/kg	-	3	3	0.005	5	5	0.01	0.01	3	3	0.005	5	5	0.275	0.275	

N Number of Samples **Bold** indicates all values < MDL. 1/2 MDL value used.

MDL Method Detection Limit

NA Values Not Available

Highlight indicates exceedance of CCME Soil Criteria

* CCME Soil Quality Guidelines for the Protection of Environmental and Human Health – Residential/Parkland, Summary Tables (Table 1), update 7.0 (September 2007)

Max. Maximum Value

Avg. Average Value

Source: Phase II ESA (Columbia 2009), Phase III ESA (Columbia/Franz 2010) and Phase IIIa ESA (SENES/Franz 2011).

5.8 VEGETATION FINDINGS

Terrestrial vegetation samples were collected in the Phase III and Phase IIIa ESAs. A summary of the consolidated data is presented in Table 13. Metal concentrations were evaluated using the maximum of either the Ontario Ministry of the Environment (MOE) Upper Limits of Normal (ULN) Guidelines (MOE 1993), or the small scale background sampling program conducted at the site (six samples). These evaluation criteria serve to identify anomalous concentrations only, and do not represent maximum allowable levels within plant tissue. Results of metals analyses do not differentiate between metals within the plant tissue and metals that may be present on the plant (dirt/dust); an important distinction for the site given the powdered ore concentrate present at surface.

Terrestrial vegetation samples collected from the Beach Area display elevated concentrations of arsenic, cobalt, nickel, selenium, and uranium which are considered attributable to the ore concentrate spill. Arsenic concentrations reach a maximum of 300 mg/kg (60x background concentration), and an average of 27.7 mg/kg (5x background concentration). Elevated concentrations of other metals were observed in terrestrial vegetation samples from the Beach Area (e.g., mercury, molybdenum, strontium, thallium and titanium); however, the concentrations were considered unrelated to mining activities.

The two terrestrial vegetation samples collected from the Camp Area show elevated concentrations of magnesium and strontium with respect to background. However, these elements are not COC in soils and vegetation is consequently determined not to be impacted.

Similar to the Beach Area, elevated metal concentrations were observed in terrestrial vegetation samples from the Mine Area. Concentrations of arsenic (maximum of 129 mg/kg), cobalt (maximum of 84 mg/kg), nickel (maximum of 230 mg/kg), and uranium (maximum of 2.59 mg/kg) correspond with elevated concentrations in soil due to transport and leaching of spilled ore concentrate. The maximum concentration of arsenic and uranium are the most elevated relative to background conditions. All other metal concentrations are within a reasonable approximation of background (2x background or less).

Table 13 Vegetation – Summary of Findings

Parameter	MOE Criteria *	Units	Background			Beach Area - AEC 1			Camp Area - AEC 2			Mine Area - AEC 3		
			N	N<MDL	Max.	N	N<MDL	Max.	Avg.	N	N<MDL	Max.	Avg.	Avg.
Al	500	mg/kg	6	0	174.00	13	0	214.00	21.92	2	0	2.00	2.00	43.43
Sb	0.3	mg/kg	6	3	0.07	13	8	0.20	0.05	2	0	0.04	0.04	0.06
As	2	mg/kg	6	0	4.76	13	0	300.00	27.66	2	0	1.05	0.82	26.01
Ba	nc	mg/kg	6	0	76.70	13	0	76.70	29.18	2	0	37.80	25.75	48.61
Be	nc	mg/kg	6	6	0.05	13	13	0.05	0.05	2	2	0.05	0.05	0.05
Bi	nc	mg/kg	6	5	0.10	13	13	0.05	0.05	2	2	0.05	0.05	0.09
B	75	mg/kg	6	0	45.00	13	1	40.50	16.81	2	0	27.00	26.00	21.14
Cd	1	mg/kg	6	1	1.49	13	2	1.49	0.20	2	2	0.01	0.01	0.10
Ca	nc b	mg/kg	6	0	15,100.00	13	0	23,800.00	7,950.00	2	0	9,380.00	6,315.00	11,750.00
Cr	8	mg/kg	6	1	5.40	13	1	5.40	1.49	2	2	0.10	0.10	0.71
Co	2	mg/kg	6	2	5.79	13	2	37.40	4.74	2	0	0.07	0.05	12.72
Cu	20	mg/kg	6	0	7.50	13	0	7.50	4.28	2	0	1.89	1.68	5.39
Fe	500	mg/kg	6	0	282.00	13	0	351.00	66.54	2	1	27.00	16.00	95.00
Pb	30	mg/kg	6	0	1.97	13	0	3.05	0.51	2	0	0.02	0.02	0.86
Mg	nc b	mg/kg	6	0	2,290.00	13	0	4,480.00	2,102.23	2	0	2,530.00	1,555.50	2,289.57
Mn	nc c	mg/kg	6	0	170.00	13	0	68.30	37.25	2	0	55.90	40.25	97.54
Hg	0.3	mg/kg	6	4	0.06	13	6	0.86	0.08	2	2	0.01	0.01	0.01
Mo	1.5	mg/kg	6	0	2.25	13	0	2.90	1.04	2	1	1.64	0.83	2.61
Ni	30	mg/kg	6	0	10.50	13	0	75.80	11.94	2	0	0.61	0.50	35.36
P	nc	mg/kg	6	0	1,980.00	13	0	2,480.00	1,441.69	2	0	1,390.00	1,191.50	1,674.14
K	nc	mg/kg	6	0	16,100.00	13	0	35,000.00	12,326.15	2	0	9,160.00	6,825.00	10,044.14
Se	0.5	mg/kg	6	1	0.14	13	2	0.60	0.15	2	1	0.08	0.05	0.17
Si	nc	mg/kg	6	6	0.01	13	13	0.03	0.03	2	2	0.01	0.01	0.02
Na	50	mg/kg	6	4	95.00	13	6	40.00	14.00	2	2	5.00	5.00	10.14
Sr	nc	mg/kg	6	0	6.40	13	0	23.50	7.59	2	0	7.70	5.70	5.81
Tl	nc	mg/kg	6	4	0.01	13	10	0.03	0.02	2	2	0.00	0.00	0.02
Sn	nc	mg/kg	6	5	0.10	13	10	0.10	0.06	2	2	0.05	0.05	0.05
Ti	nc	mg/kg	6	5	4.00	13	8	7.00	1.38	2	2	0.50	0.50	1.43
U	nc	mg/kg	6	3	0.04	13	7	0.07	0.02	2	2	0.00	0.00	0.39
V	5	mg/kg	6	5	0.70	13	9	1.00	0.75	2	2	0.10	0.10	0.86
Zn	250	mg/kg	6	0	208.00	13	0	154.00	43.24	2	0	30.90	21.85	59.21

N Number of Samples

MDL Method Detection Limit

Bold indicates all values < MDL

Highlight indicates exceedance of maximum of MOE Criteria or Background (max)

* Ontario Ministry of Environment and Energy (MOE), Hazardous and Contaminants Branch, Phytotoxicology Field Investigation Manual, 1993

Source: Phase III ESA (Columbia/Franz 2010) and Phase IIIa ESA (SENES/Franz 2011)

5.9 GROUNDWATER FINDINGS

As part of the Phase II ESA, one stainless steel drive point piezometer (MW-1) was installed in the center of the ore concentrate spill at the Beach Area (Columbia 2009). Four groundwater wells were installed in step-outs to the north, south, east and west of MW-1 during the Phase III ESA site investigation (Columbia/Franz 2010). The down-gradient well was installed approximately 1 m offshore in Great Slave Lake and consisted of a shallow (MW-6S) and deep (MW-6D) nested well. One monitoring well (MW-5) was located approximately 75 m northeast and up-gradient of the Beach Area clearing, and is considered representative of background conditions. Samples from each monitoring well were analyzed for dissolved metals. Two groundwater monitoring wells were also installed at the Mine Area: MW-7 down gradient of the mine staging area; and MW-8 up-gradient of the Mine Area and considered representative of background conditions (Columbia/Franz 2010). Comprehensive groundwater results are provided in Table 14.

It should be noted that CCME (2012) Freshwater Aquatic Life (FAL) guidelines were used as screening criteria to evaluate the quality of samples collected from the wells. The rationale for the use of surface water criteria was that the shallow groundwater sampled is anticipated to be a source of discharge to local surface water environments. However, this is not intended to imply that the CCME FAL are applicable criteria for the protection of groundwater.

Groundwater analyses from the Beach Area report concentrations greater than the applicable screening criteria for arsenic, cobalt, copper, lead, nickel, selenium, and zinc. Lead and zinc exceedances identified in MW-1 in 2008 were not confirmed in the 2009 sampling event nor detected in any other monitoring well. Copper marginally exceeded the criteria in three locations but at concentrations less than the background. COCs retained in groundwater include arsenic, cobalt, nickel and selenium (metals associated with the ore concentrate). Step-out wells from the center point of the ore concentrate (MW-1) displayed a decrease in contaminant concentrations greater than two orders of magnitude (Columbia/Franz 2010).

Groundwater sampled at the base of the adit and waste rock slope (09-MW-7) displayed elevated concentrations of arsenic (0.028 mg/L; 20x background concentration), and cobalt (0.0041 mg/L; 10x background concentration). All other metals associated with the ore concentrate were below the CCME FAL guidelines, and/or background concentrations.

Table 14 Groundwater – Summary of Findings

ANALYT E	CCME Criteria*	Units	BEACH AREA - AEC 1								MINE AREA - AEC 3		
			08-MW-1	09-MW-1	08-AH-2 **	09-MW-2	09-MW-3	09-MW-4	09-MW-5 (BGND^)	09-MW-6S	09-MW-6D	09-MW-7	09-MW-8 (BGND^)
Hardness		mg/L	329	320	216	310	310	390	220	250	280	260	150
Diss. Cd	Calculated a	ug/L	0.0002	0.013	<0.001	0.006	0.024	0.027	0.006	0.012	<0.005	0.036	0.028
Diss. Al	0.005-0.1b	mg/L	0.01	0.006	<0.1	0.012	0.011	<0.001	0.034	0.008	<0.001	0.066	0.036
Diss. Sb	nc	mg/L	0.0019	0.0004	<0.004	<0.0002	0.0002	<0.0002	<0.0002	0.0003	0.0004	0.0007	0.0008
Diss. As	0.005	mg/L	1.55	9.2 (1)	11.6	0.018	0.037	0.16	0.0021	0.27	0.021	0.028	0.0014
Diss. Ba	nc	mg/L	0.223	0.26	0.09	0.46	0.24	0.41	0.07	0.35	0.32	0.20	0.11
Diss. Be	nc	mg/L	<0.001	<0.001	<0.01	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Diss. B	nc	mg/L	0.23	0.06	<0.5	0.04	0.03	0.02	<0.02	0.06	0.05	<0.02	<0.02
Diss. Ca	nc	mg/L	83.6	83	63.8	78	87	100	62	44	57	80	46
Diss. Cr	0.001 c	mg/L	<0.005	<0.001	<0.05	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Diss. Co	0.004 e	mg/L	0.042	0.0068	0.02	0.0004	0.017	0.0097	<0.0003	0.0011	<0.0003	0.0041	<0.0003
Diss. Cu	0.002-0.004 d	mg/L	0.025	0.018	<0.01	0.0007	0.0005	0.0061	0.0018	0.0011	0.0047	0.0030	0.0063
Diss. Fe	0.3	mg/L	0.007	<0.06	0.023	3.3	0.07	<0.06	0.11	<0.06	0.37	0.06	<0.06
Diss. Pb	0.001-0.007 d	mg/L	0.016	<0.0002	<0.001	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Diss. Li	nc	mg/L	0.041	<0.02	<0.03	0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Diss. Mg	nc	mg/L	29.3	28	13.7	28	22	33	16	35	35	15	8.1
Diss. Mn	nc	mg/L	0.054	0.013	0.009	0.20	0.37	0.038	0.018	0.006	0.026	0.26	0.012
Diss. Mo	0.073	mg/L	0.017	0.0077	<0.05	0.0081	0.022	0.0081	0.0013	0.0021	0.0033	0.016	0.034
Diss. Ni	0.025-0.15 d	mg/L	0.199	0.078	0.25	0.0018	0.052	0.070	0.0012	0.0055	0.0008	0.021	0.0013
Diss. P	nc	mg/L	-	<0.1	-	0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Diss. K	nc	mg/L	5.9	4.7	1.3	6.3	3.5	3.7	3.8	4.9	4.3	1.9	0.7
Diss. Se	0.001	mg/L	0.0005	0.0020	<0.004	<0.0002	<0.0002	0.0010	<0.0002	<0.0002	<0.0002	0.0003	<0.0002
Diss. Si	nc	mg/L	-	5.7	-	24	7.9	4.7	5.7	10	9.0	6.3	3.2
Diss. Ag	0.0001	mg/L	<0.0001	<0.0001	<0.001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Diss. Na	nc	mg/L	9.6	17	5.6	10	8.5	5.1	6.4	8.6	8.5	6.1	4.0
Diss. Sr	nc	mg/L	-	0.26	-	0.22	0.10	0.21	0.06	0.41	0.36	0.06	0.03
Diss. S	nc	mg/L	-	6.6	-	4.2	1.1	4.8	3.4	3.3	3.3	1.5	0.9
Diss. Tl	0.0008	mg/L	<0.0001	<0.0002	<0.001	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Diss. Sn	nc	mg/L	<0.05	<0.001	<0.5	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001
Diss. Ti	nc	mg/L	<0.001	0.001	<0.01	0.001	<0.001	<0.001	0.003	<0.001	<0.001	0.002	<0.001
Diss. U	nc	mg/L	0.0137	0.022	0.004	0.010	0.0030	0.012	0.0083	0.0064	0.0029	0.0065	0.0027
Diss. V	nc	mg/L	0.002	0.003	<0.01	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Diss. Zn	0.03	mg/L	0.062	0.025	<0.02	0.003	<0.003	0.008	<0.003	0.014	0.008	0.003	0.007

(1) MDL Raised to 0.004 due to sample matrix

* Canadian Council of Ministers of the Environment Canadian Environmental Quality Guidelines for Freshwater

Aquatic Life

Highlight indicates exceedance of CCME FAL Guidelines

Red Text indicates Method Detection Limit (MDL) > Criteria

** Sample was collected from standing water in a test pit

Source: Phase II ESA (Columbia 2009) and Phase III ESA (Columbia/Franz 2010)

a Criteria = 10^{^(0.86[log(hardness)]-3.2)}

b Criteria varies with pH

c Standard is for Chromium VI

d Criteria varies with hardness

e No CCME FAL, BC Approved Water Quality Guideline used.

^ Background groundwater sample

nc No criteria

5.10 SURFACE WATER FINDINGS

A total of 63 water samples were collected during the various ESA campaigns. Sampling focused on potentially impacted water bodies at the Beach and Mine Areas. All water courses within the footprint of the mine were examined, including: the small wetland in the Beach Area, the wetland immediately below the adit and waste rock pile, the creek transecting the Mine Area, and within Great Slave Lake (Beach Area and outflow of the Mine Area creek). Background water samples were collected from Great Slave Lake, a small unnamed lake north of the mine, and from upgradient ponded and stream water sources (Table 15).

The Beach Area was assessed in detail due to the proximity of the ore concentrate spill to the small wetland and Great Slave Lake (Table 16). Arsenic concentrations exceeded the CCME Freshwater Aquatic Life (FAL) guidelines (CCME 2012), and background concentrations, in four surface water samples collected from ponded water nearest to the concentrate spills. Arsenic concentrations in the north of the wetland area are comparable with background (< CCME guidelines), increasing in concentration with greater proximity to Great Slave Lake and the ore concentrate spill (maximum of 0.23 mg/L or 46x CCME criteria). Lake water collected from the near shore environment of Great Slave Lake and adjacent to the ore concentrate spill exceeded criteria for several inorganic elements. Concentrations of arsenic, cobalt, and nickel are above CCME guidelines in surface water samples collected nearest to the ore concentrate spill. Arsenic concentrations as high as 0.61 mg/L (122x CCME FAL guideline), cobalt concentrations of 0.0365mg/L (243x background), and nickel concentrations of 0.125 mg/L (1.4x CCME FAL guideline) were measured in the shoreline water. Samples collected from further afield (15 m and greater from shore) marginally exceeded the CCME FAL guidelines or background values for aluminum, barium, calcium, chromium, copper, iron, magnesium, manganese, potassium, silicon, sodium, strontium, titanium, vanadium, zinc and hexavalent chromium. These exceedances were not considered to represent a primary concern, as the elements in question were either relatively nontoxic (e.g. calcium), and/or the exceedance over background or CCME guidelines was minimal. On this basis, surface water samples collected from these “off-shore” locations are not considered to represent a concern.

Surface water sampling at the Mine Area focussed on the following pathways: adit water, wetland water, the stream that passes through the mine, and the outflow of this stream to Great Slave Lake (Table 17). As expected, surface water within the adit had elevated concentrations of arsenic (maximum of 70.3 mg/L), cobalt (max 0.064 mg/L), nickel (max 0.36mg/L), and selenium (max 0.0038 mg/L), all greater than the screening criteria. While adit water may enter the groundwater regime through percolation, it is not considered a drinking water source and does not represent an aquatic environment. Arsenic is the primary COC owing to high concentrations and enhanced mobility under the pH neutral conditions observed at Blanchet Island Mine. Upgradient conditions in the wetland exhibit metal concentrations roughly

consistent with CCME guidelines. COC concentrations reach a maximum in the wetland immediately below the waste rock pile/ore concentrate spill (i.e., arsenic concentration of 0.44 mg/L, or 88x EQG). However, COC concentrations in the small creek leaving the wetland are considerably lower, with arsenic concentrations dropping from 0.24 mg/L at the inlet of the creek to 0.077 mg/L at the outflow to Great Slave Lake. Great Slave Lake water displayed no impacts at the discharge point of the Mine Area creek. Water chemistry in the downstream reaches of the creek indicate a greater contribution from groundwater (harder water and higher concentrations of Fe, Mn, Sr). Arsenic concentrations may, therefore, be diluted by groundwater in downstream areas. Cadmium, aluminum, calcium, lithium, magnesium, manganese, nickel, phosphorous, potassium, selenium, silicon, silver, strontium, sulphur, thallium, tin, titanium, and uranium enrichments were also elevated in surface water from the Mine Area. However, these concentrations are not considered to represent primary concerns, as the elements in question were either relatively nontoxic (e.g. calcium), and/or the exceedance over background / CCME guidelines was minimal.

Surface and sediment sampling was conducted by SENES (on behalf of AANDC and PWGSC) in summer 2013 to determine metal concentrations following the 2010 consolidation of ore in the Beach Area. While the report is currently under production, a preliminary review of the data indicates a general decrease in metal COCs within the Beach Area surface water. Highest metal concentrations are reported in the immediate shoreline nearest to the previous ore spill; however, decreased from previous assessment programs. The maximum observed concentration of arsenic decreased from 0.61 mg/L to 0.2 mg/L and cobalt from 0.0365 mg/L to 0.027 mg/L, while nickel concentrations remained approximately consistent. Samples collected further offshore did not exhibit any exceedances for site COCs. Samples were also collected for dissolved metals analysis, which indicated significantly lower concentrations of most COCs in the dissolved phase when compared with total concentrations.

Table 15 Surface Water – Summary of Findings (Background)

Parameter	Units	CCME Criteria *	LAKE - Background			WETLAND - Background		
			N	N<MDL	Max	N	N<MDL	Max
Metals -Total								
Al	mg/L	0.1	2	0	0.031	1	0	0.014
Sb	mg/L	0.006	2	1	0.0001	1	0	0.0008
As	mg/L	0.005	2	1	0.00095	1	0	0.0006
Ba	mg/L	1	2	0	0.04	1	0	0.01
Be	mg/L	-	2	2	0.0005	1	1	0.0005
Bo	mg/L	5	2	2	0.01	1	1	0.01
Cd	ug/L	0.025	2	0	0.01	1	0	0.007
Ca	mg/L	-	2	0	25	1	0	28
Cr (total)	mg/L	0.0089	2	2	0.0005	1	1	0.0005
Cr (hexavalent)	mg/L	0.001	2	2	0.0005	1	1	0.0005
Co	mg/L	-	2	2	0.00015	1	1	0.00015
Cu	mg/L	0.002	2	0	0.0014	1	0	0.0012
Fe	mg/L	0.3	2	1	0.03	1	1	0.03
Pb	mg/L	0.002	2	0	0.0003	1	1	0.0001
Li	mg/L	-	2	2	0.01	1	1	0.01
Mg	mg/L	-	2	0	5.7	1	0	3.3
Mn	mg/L	0.05	2	2	0.002	1	1	0.002
Hg	mg/L	0.026	1	0	0.000004	0	0	-
Mo	mg/L	0.073	2	0	0.0007	1	0	0.0003
Ni	mg/L	0.065	2	0	0.00195	1	1	0.00025
P	mg/L	-	2	2	0.05	1	1	0.05
K	mg/L	-	2	0	1	1	1	0.15
Se	mg/L	0.001	2	2	0.0001	1	1	0.0001
Si	mg/L	-	2	0	1.3	1	0	1.9
Ag	mg/L	0.0001	2	2	0.00005	1	1	0.00005
Na	mg/L	200	2	0	6.9	1	0	1.4
Sr	mg/L	-	2	0	0.12	1	1	0.01
S	mg/L	-	2	0	6.1	1	1	0.1
Tl	mg/L	0.0008	2	2	0.0001	1	1	0.0001
Sn	mg/L	-	2	2	0.0005	1	1	0.0005
Ti	mg/L	-	2	0	0.001	1	1	0.0005
U	mg/L	0.015	2	0	0.0004	1	1	0.00005
V	mg/L	-	2	1	0.002	1	1	0.0005
Zn	mg/L	0.03	2	1	0.01	1	1	0.0015
Miscellaneous Inorganics								
Ca- Dissolved	mg/L	-	2	0	25	1	0	28
Mg - Dissolved	mg/L	-	2	0	5.75	1	0	3.3
Al - Dissolved	mg/L	-	2	1	0.0235	1	0	0.015
C - Dissolved	mg/L	-	1	0	4.05	0	0	-
Alkalinity	mg/L	-	1	0	68.5	0	0	-
HCO3	mg/L	-	1	0	84	0	0	-
CO3	mg/L	-	1	0	0.25	0	0	-
OH	mg/L	-	1	0	0.25	0	0	-
Dissolved SO4	mg/L	-	1	0	20	0	0	-
Hardness	mg/L	-	1	0	86	0	0	-

N Number of Samples

MDL Method Detection Limit

Max. Maximum recorded value

Avg. Average recorded value

Bold indicates all values < Method Detection Limit (MDL). 1/2 MDL reported.

Highlight indicates exceedance of CCME criteria

* CCME (2007) Summary Table, Canadian Water Quality Guidelines for the Protection of Freshwater Aquatic Life (FWAL) Update 7.0.

Source: Phase II ESA (Columbia 2009), Phase III ESA (Columbia/Franz 2010) and Phase IIIa (SENES/Franz 2011)

Table 16 Surface Water – Summary of Findings (Beach/Camp Area)

Parameter	Units	CCME Criteria *	LAKE SAMPLES				WETLAND SAMPLES			
			N	N<MDL	Max.	Avg.	N	N<MDL	Max	Avg.
Metals -Total										
Al	mg/L	0.1	16	0	0.16	0.03	10	0	0.083	0.0218
Sb	mg/L	0.006	16	9	0.0012	0.0003	10	6	0.0006	0.0003
As	mg/L	0.005	16	1	0.61	0.0540	10	0	0.23	0.0305
Ba	mg/L	1	16	0	0.05	0.04	10	0	0.068	0.05
Be	mg/L	-	16	16	0.0005	0.0005	10	10	0.0005	0.0005
Bo	mg/L	5	16	16	0.025	0.025	10	10	0.025	0.025
Cd	ug/L	0.025	16	7	0.019	0.007	10	4	0.028	0.009
Ca	mg/L	-	16	0	35	26	10	0	59.4	49
Cr (total)	mg/L	0.0089	16	16	0.0025	0.0025	10	10	0.0025	0.0025
Cr (hexavalent)	mg/L	0.001	15	11	0.002	0.001	8	5	0.002 **	0.001 **
Co	mg/L	-	16	13	0.0365	0.00297	10	6	0.03	0.00394
Cu	mg/L	0.002	16	0	0.004	0.001	10	0	0.018	0.004
Fe	mg/L	0.3	16	12	0.173	0.04	10	4	0.56	0.10
Pb	mg/L	0.002	16	12	0.0004	0.0001	10	7	0.001	0.0003
Li	mg/L	-	16	12	0.01	0.01	10	10	0.01	0.01
Mg	mg/L	-	16	0	7.75	5.9	10	0	12	9.7
Mn	mg/L	0.05	16	12	0.006	0.002	10	5	0.06	0.011
Hg	mg/L	0.026	12	9	0.00005	0.000005	6	3	0.00005	0.000027
Mo	mg/L	0.073	16	1	0.0025	0.0008	10	3	0.0025	0.0016
Ni	mg/L	0.065	16	0	0.125	0.0113	10	0	0.093	0.0135
P	mg/L	-	15	11	0.1	0.05	7	7	0.05	0.05
K	mg/L	-	16	0	1.1	0.9	10	6	0.8	0.3
Se	mg/L	0.001	16	12	0.0002	0.0001	10	10	0.0002	0.0002
Si	mg/L	-	15	0	1.85	1.3	7	0	2.7	2.2
Ag	mg/L	0.0001	16	16	0.0002	0.0002	10	10	0.0002	0.0002
Na	mg/L	200	16	0	7	6.6	10	0	7	4.6
Sr	mg/L	-	15	0	0.12	0.11	7	0	0.05	0.05
S	mg/L	-	15	0	6.2	5.9	7	0	2.9	1.0
Tl	mg/L	0.0008	16	16	0.0001	0.0001	10	10	0.0001	0.0001
Sn	mg/L	-	16	16	0.025	0.025	10	10	0.025	0.025
Ti	mg/L	-	16	9	0.006	0.0011	10	9	0.002	0.0007
U	mg/L	0.015	16	0	0.0008	0.0004	10	1	0.0022	0.0011
V	mg/L	-	16	4	0.003	0.002	10	8	0.002	0.001
Zn	mg/L	0.03	16	5	0.019	0.006	10	3	0.058	0.016
Miscellaneous Inorganics										
Ca- Dissolved	mg/L	-	15	0	34.5	26	7	0	54	50
Mg - Dissolved	mg/L	-	15	0	7.55	5.9	7	0	11	10.4
Al - Dissolved	mg/L	-	15	0	0.07	0.015	7	3	0.004	0.002
C - Dissolved	mg/L	-	11	0	5.9	4.5	3	0	17	12.7
Alkalinity	mg/L	-	11	0	100	72	3	0	180	123
HCO3	mg/L	-	11	0	130	88	3	0	220	150
CO3	mg/L	-	11	11	0.25	0.25	3	3	0.25	0.25
OH	mg/L	-	11	11	0.25	0.25	3	3	0.25	0.25
Dissolved SO4	mg/L	-	11	0	0.25	20	3	2	7	3
Hardness	mg/L	-	12	0	0.25	87.8	6	0	197	152.0

N Number of Samples

MDL Method Detection Limit

Max. Maximum recorded value

Avg. Average recorded value

Bold indicates all values < Method Detection Limit (MDL). 1/2 MDL reported.

Highlight indicates exceedance of CCME criteria

* CCME (2007) Summary Table, Canadian Water Quality Guidelines for the Protection of Freshwater Aquatic Life (FWAL) Update 7.0.

** MDL raised due to matrix interference, and all values are below detection limit

Source: Phase II ESA (Columbia 2009), Phase III ESA (Columbia/Franz 2010) Phase IIIa (SENES/Franz 2011)

Table 17 Surface Water – Summary of Findings (Mine Area)

Parameter	Units	CCME Criteria *	LAKE SAMPLES			STREAM AND WETLAND SAMPLES			
			N	N<MDL	Max	N	N<MDL	Max	Avg.
Metals -Total									
Al	mg/L	0.1	1	0	0.026	17	0	0.39	0.06
Sb	mg/L	0.006	1	1	0.0001	17	14	0.0021	0.0002
As	mg/L	0.005	1	0	0.0009	16	0	0.44	0.1056
Ba	mg/L	1	1	0	0.04	17	0	0.175	0.07
Be	mg/L	-	1	1	0.0005	17	17	0.0005	0.0005
Bo	mg/L	5	1	1	0.01	17	16	0.08	0.02
Cd	ug/L	0.025	1	0	0.008	17	11	0.066	0.009
Ca	mg/L	-	1	0	25	17	0	61	39
Cr (total)	mg/L	0.0089	1	1	0.0005	17	17	0.0025	0.0025
Cr (hexavalent)	mg/L	0.001	1	0	0.001	15	10	0.002	0.001
Co	mg/L	-	1	1	0.00015	17	9	0.005	0.00097
Cu	mg/L	0.002	1	0	0.001	17	0	0.01	0.002
Fe	mg/L	0.3	1	1	0.03	17	6	5.1	0.63
Pb	mg/L	0.002	1	1	0.0001	17	14	0.0007	0.0002
Li	mg/L	-	1	1	0.01	17	14	0.02	0.01
Mg	mg/L	-	1	0	5.7	17	0	21	7.9
Mn	mg/L	0.05	1	1	0.002a	17	3	0.28	0.052
Hg	mg/L	0.026	1	1	0.000001	10	8	0.00005	0.000012
Mo	mg/L	0.073	1	0	0.0007	17	3	0.004	0.0011
Ni	mg/L	0.065	1	0	0.0009	17	1	0.036	0.0055
P	mg/L	-	1	1	0.05	15	11	0.1	0.06
K	mg/L	-	1	0	0.9	17	11	2.85	0.5
Se	mg/L	0.001	1	1	0.0001	17	14	0.0013	0.0002
Si	mg/L	-	1	0	1.3	15	0	4.95	1.9
Ag	mg/L	0.0001	1	1	0.00005	17	17	0.0002	0.0002
Na	mg/L	200	1	0	6.6	17	0	10	3.1
Sr	mg/L	-	1	0	0.11	15	1	0.095	0.03
S	mg/L	-	1	0	6.1	15	3	1.65	0.4
Tl	mg/L	0.0008	1	1	0.0001	17	17	0.0001	0.0001
Sn	mg/L	-	1	1	0.0005	17	17	0.025	0.025
Ti	mg/L	-	1	1	0.0005	17	12	0.009	0.0015
U	mg/L	0.015	1	0	0.0004	17	0	0.0087	0.0016
V	mg/L	-	1	0	0.002	17	7	0.003	0.001
Zn	mg/L	0.03	1	0	0.008	17	4	0.032	0.009
Miscellaneous Inorganics									
Ca- Dissolved	mg/L	-	1	0	25	15	0	60	37
Mg - Dissolved	mg/L	-	1	0	5.7	15	0	21	7.0
Al - Dissolved	mg/L	-	1	0	0.019	15	1	0.014	0.005
C - Dissolved	mg/L	-	1	0	4.1	8	0	11	8.9
Alkalinity	mg/L	-	1	0	83	8	0	240	126
HCO3	mg/L	-	1	0	100	8	0	290	154
CO3	mg/L	-	1	1	0.25	8	8	0.25	0.25
OH	mg/L	-	1	1	0.25	8	8	0.25	0.25
Dissolved SO4	mg/L	-	1	0	20	8	8	0.5	0.5
Hardness	mg/L	-	1	0	86.1	10	0	236	136.4

N Number of Samples

MDL Method Detection Limit

Max. Maximum recorded value

Avg. Average recorded value

Bold indicates all values < Method Detection Limit (MDL). 1/2 MDL reported.

Highlight indicates exceedance of CCME criteria

* CCME (2007) Summary Table, Canadian Water Quality Guidelines for the Protection of Freshwater Aquatic Life (FWAL) Update 7.0.

Source: Phase II ESA (Columbia 2009), Phase III ESA (Columbia/Franz 2010) and Phase IIIa (SENES/Franz 2011)

5.11 SEDIMENT FINDINGS

Sediment sampling was initiated with a small scale collection program in the 2008 Phase II ESA (Columbia 2009), followed by an extensive survey in the 2009 Phase III ESA (Columbia/Franz 2010) and gap filling in the 2010 Phase IIIa ESA (SENES/Franz 2011). Sediments were analyzed for metal concentrations, which were determined to be the only COC in local sediments. Approximately 45 sediment samples were collected from the Beach and Mine Areas. Five stations were also sampled at background locations, the results of which were used to assess metal concentrations where sediment criteria were unavailable (Table 18). Notably, sediment samples collected from background locations were above CCME Interim Sediment Quality Guidelines (ISQG) for both arsenic and copper (CCME 2012). The naturally occurring elevated concentrations are assumed to be associated with mineralization in the vicinity of the mine.

Sediment sampling in the Beach Area focussed on the identification of impacts from the spill of ore concentrate. Samples were collected from the wetland area (1) and radially distributed in Great Slave Lake (23). A summary of sediment findings within the Beach/Camp Area are provided in Table 19 below. Metal concentrations in the single sediment sample collected from the wetland were consistent with background concentrations of metals; however, the sample was collected upgradient of the ore spill.

Sediment samples collected from Great Slave Lake offshore of the ore concentrate spill and adjacent wetland displayed elevated concentrations of multiple metals. Concentrations of arsenic (maximum of 4,730 mg/kg), cobalt (maximum of 708 mg/kg), and nickel (maximum of 2,780 mg/kg) were measured in the near shore samples immediately adjacent to the spill of ore concentrate. These values are well above the CCME ISQG, with arsenic being the most elevated (800x the criteria). Other metal concentrations (barium, beryllium, boron, cadmium, copper, molybdenum, thallium, tin and vanadium), exceed the background and/or guideline value by factors of less than two, and may be representative of natural variation in sediments. Concentrations of arsenic, cobalt and nickel decrease rapidly with distance from the ore concentrate spill. At approximately 20 m from shore, concentrations of arsenic in sediments have decreased to approximately 20 mg/kg, while nickel and cobalt concentrations are consistent with background levels. In general, the elevated arsenic levels in Beach Area sediments appear to be associated with outwash from the ore barrels.

In the Mine Area, elevated metal concentrations were observed in sediments collected from the wetland and the small creek (Table 20). The most elevated concentrations were observed in the western portion of the wetland, which is the discharge point of surface water and groundwater draining from the waste rock and ore concentrate areas. Arsenic, cobalt and nickel (with maximum concentrations of 8,600 mg/kg, 62 mg/kg and 340 mg/kg respectively) represent the primary COCs attributable to mining activities. At the discharge of the Mine Area creek to Great

Slave Lake, concentrations of arsenic and, to a lesser extent cobalt and nickel, increased with distance from the creek discharge (110 mg/kg arsenic at discharge of creek, 250 mg/kg near to shore, and 520 mg/kg further afield). However, it should be noted that samples with elevated arsenic concentrations were re-analyzed multiple times, with inconsistent results. On this basis, there is insufficient information to determine if there are spatial trends in arsenic concentrations in sediments collected from this area.

Table 18 Sediment – Summary of Findings (Background)

Parameter	Units ^	Criteria *	LAKE SAMPLES			WETLAND SAMPLES		
			N	N<MDL	Max.	N	N<MDL	Max.
Metals (Total)								
Sb	mg/kg	0.5 D	3	3	0.5	2	2	0.5
As	mg/kg	5.9 B	3	0	7	2	0	14
Ba	mg/kg	240.0 D	3	0	240	2	0	230
Be	mg/kg	0.6 D	3	2	0.6	2	2	0.2
B	mg/kg	1.1 D	3	1	0.8	2	0	1.1
Cd	mg/kg	0.6 B	3	2	0.6	2	0	0.4
Cr (total)	mg/kg	37.3 D	3	0	35	2	0	16
Cr (hexavalent)	mg/kg	0.8 D	3	3	0.075	2	0	0.79
Co	mg/kg	50 A	3	0	10	2	0	8
Cu	mg/kg	35.7 B	3	0	23	2	0	56
Pb	mg/kg	35 B	3	0	8	2	0	9
Hg	mg/kg	0.17 B	3	2	0.06	2	0	0.07
Mo	mg/kg	1.1 D	3	3	0.2	2	0	1.1
Ni	mg/kg	27.0 D	3	0	27	2	0	10
Se	mg/kg	1.4 D	3	3	0.25	2	0	1.4
Ag	mg/kg	0.5 A	3	3	0.5	2	2	0.5
Tl	mg/kg	0.2 D	3	3	0.15	2	2	0.15
Sn	mg/kg	0.5 D	3	3	0.5	2	2	0.5
U	mg/kg	104 E	3	2	2	2	0	17
V	mg/kg	40.0 D	3	0	40	2	0	39
Zn	mg/kg	123 B	3	0	56	2	0	77

N Number of Samples

MDL Method Detection Limit

Max. Maximum recorded value

Avg. Average recorded value

Bold indicates all values < Method Detection Limit (MDL). 1/2 MDL reported.

Highlight indicates exceedance of criteria

^ Units mg/kg dry weight

** Detection limit raised. All values below detection.

A = MOE (2004) Ontario Ministry of the Environment, Soil, Ground Water and Sediment Standards, Table 3. Full Depth Generic Site Condition Standards in a Non-Potable Ground Water Conditions, coarse-grained soils.

B = Canadian Sediment Quality Guidelines (CCME 2012).

C = Canadian Soil Quality Guidelines (CCME 2012).

D = Maximum of site-specific background

E = Thompson et al (2005), Lowest Effects Level by Weighted Method, Freshwater Sediments (Table 1)

Table 19 Sediment – Summary of Findings (Beach/Camp Area)

Parameter	Units ^	Criteria	LAKE SAMPLES				WETLAND SAMPLES				
			N	N<MDL	Max.	Avg.	N	N<MDL	Max.	Avg.	
Metals (Total)											
Sb	mg/kg	0.5 D	23	19	0.5	0.5	1	1	0.5	0.5	
As	mg/kg	5.9 B	23	0	4,730	271	1	0	10	10	
Ba	mg/kg	240.0 D	23	0	290	138	1	0	190	190	
Be	mg/kg	0.6 D	23	14	0.85	0.36	1	1	0.2	0.2	
B	mg/kg	1.1 D	22	6	78	3.8	1	0	1.8	1.8	
Cd	mg/kg	0.6 B	23	10	1.1	0.3	1	0	0.6	0.6	
Cr (total)	mg/kg	37.3 D	23	0	56	25	1	0	1	1	
Cr (hexavalent)	mg/kg	0.8 D	21	17	0.075	0.08	1	1	0.075	0.075	
Co	mg/kg	50 A	23	0	708	53	1	0	8	8	
Cu	mg/kg	35.7 B	23	1	72	21	1	0	24	24	
Pb	mg/kg	35 B	23	1	14	5	1	0	2	2	
Hg	mg/kg	0.17 B	23	19	0.09	0.03	1	0	0.09	0.09	
Mo	mg/kg	1.1 D	23	10	1.35	0.47	1	0	1.9	1.9	
Ni	mg/kg	27.0 D	23	0	2,780	161	1	0	10	10	
Se	mg/kg	1.4 D	23	17	0.8	0.3	1	0	1.2	1.2	
Ag	mg/kg	0.5 A	23	19	0.5	0.5	1	1	0.5	0.5	
Tl	mg/kg	0.2 D	23	19	0.5	0.2	1	1	0.15	0.15	
Sn	mg/kg	0.5 D	23	18	2.5	0.7	1	1	0.5	0.5	
U	mg/kg	104 E	23	13	2	1	1	0	12	12	
V	mg/kg	40.0 D	23	0	95	43	1	0	4	4	
Zn	mg/kg	123 B	23	0	90.5	40.0	1	0	55	55	

N Number of Samples

MDL Method Detection Limit

Max. Maximum recorded value

Avg. Average recorded value

Bold indicates all values < Method Detection Limit (MDL). 1/2 MDL reported.

Highlight indicates exceedance of criteria

^ Units mg/kg dry weight

** Detection limit raised. All values below detection.

A = MOE (2004) Ontario Ministry of the Environment, Soil, Ground Water and Sediment Standards, Table 3. Full Depth Generic Site Condition Standards in a Non-Potable Ground Water Conditions, coarse-grained soils.

B = Canadian Sediment Quality Guidelines (CCME 2012).

C = Canadian Soil Quality Guidelines (CCME 2012).

D = Maximum of site-specific background

E = Thompson et al (2005), Lowest Effects Level by Weighted Method, Freshwater Sediments (Table 1)

Table 20 Sediment – Summary of Findings (Mine Area)

Parameter	Units ^	Criteria	LAKE SAMPLES				WETLAND SAMPLES			
			N	N<MDL	Max.	Avg.	N	N<MDL	Max.	Avg.
Metals (Total)										
Sb	mg/kg	0.5 D	5	3	5	1.4	11	9	5	1
As	mg/kg	5.9 B	5	0	520	156.4	11	0	8,600	1,661
Ba	mg/kg	240.0 D	5	0	230	73.1	11	0	390	223
Be	mg/kg	0.6 D	5	3	2	0.56	11	8	2	0.5
B	mg/kg	1.1 D	5	1	1.1	0.56	11	1	6.2	1.3
Cd	mg/kg	0.6 B	5	3	0.5	0.17	11	1	1.2	0.4
Cr (total)	mg/kg	37.3 D	5	0	19	9.3	11	1	52	14
Cr (hexavalent)	mg/kg	0.8 D	5	3	0.18	0.096	11	5	0.69	0.18
Co	mg/kg	50 A	5	0	590	121.7	11	0	62	14
Cu	mg/kg	35.7 B	5	2	25	8.7	11	2	58	26
Pb	mg/kg	35 B	5	1	5	2.5	11	2	7	4.7
Hg	mg/kg	0.17 B	5	2	0.25	0.075	11	5	0.25	0.07
Mo	mg/kg	1.1 D	5	3	2	0.56	11	3	2.9	1.2
Ni	mg/kg	27.0 D	5	0	1,700	349.4	11	0	340	51
Se	mg/kg	1.4 D	5	3	2.5	0.7	11	4	3.4	1.1
Ag	mg/kg	0.5 A	5	3	5	1.4	11	11	5**	1.0**
Tl	mg/kg	0.2 D	5	3	1.5	0.42	11	8	1.5	0.3
Sn	mg/kg	0.5 D	5	3	5	1.4	11	7	5	1.2
U	mg/kg	104 E	5	2	17	4.7	11	1	46	16
V	mg/kg	40.0 D	5	0	32	17.4	11	2	41.5	26.3
Zn	mg/kg	123 B	5	0	50	21.5	11	1	93	56

N Number of Samples

MDL Method Detection Limit

Max. Maximum recorded value

Avg. Average recorded value

Bold indicates all values < Method Detection Limit (MDL). 1/2 MDL reported.

Highlight indicates exceedance of criteria

^ Units mg/kg dry weight

** Detection limit raised. All values below detection.

A = MOE (2004) Ontario Ministry of the Environment, Soil, Ground Water and Sediment Standards, Table 3. Full Depth Generic Site Condition Standards in a Non-Potable Ground Water Conditions, coarse-grained soils.

B = Canadian Sediment Quality Guidelines (CCME 2012).

C = Canadian Soil Quality Guidelines (CCME 2012).

D = Maximum of site-specific background

E = Thompson et al (2005), Lowest Effects Level by Weighted Method, Freshwater Sediments (Table 1)

A supplementary surface water and sediment program was implemented in 2013 to determine if the 2010 ore consolidation activities had resulted in a decrease in metal loadings to the aquatic environment. While the report is currently under production (SENES), a review of the data indicates decreased metal concentrations in surface water within the Beach Area. Sediment findings are less conclusive; however far shore measurements confirm that the impacts are not widespread.

5.12 AQUATIC BIOTA FINDINGS

5.12.1 Aquatic Vegetation

Samples of aquatic vegetation were collected during the Phase IIIa ESA site investigation (SENES/Franz 2011) from the marsh and lake environments in the Beach Area (three samples) and the Mine Area (three samples). Samples were analyzed for total metals and were assessed relative to the maximum of either site-specific background concentrations or the Ontario Ministry of the Environment Upper Limits of Normal (MOE 1993). The Ontario MOE Upper Limit of Normal values (MOE-ULN) are not based on toxicological studies, nor are they necessarily applicable to northern species or aquatic species. However, these values do provide a point of comparison for use in identifying vegetation that may be at risk due to mining-related contaminants. Findings of aquatic vegetation sampling are provided in Table 21.

Aquatic vegetation samples collected from the Beach Area demonstrate highly variable metal concentrations across species. Phragmites collected from the shoreline of Great Slave Lake exhibit relatively minor enrichment of arsenic (maximum of 7.48 mg/kg, or 5.3x screening criteria) and nickel (9.71 mg/kg, or 1.9x screening criteria). In contrast, horsetail (equisetum) collected from the marsh adjacent to the Beach Area had higher concentrations of arsenic (1,013x screening criteria), cobalt (78x screening criteria), and nickel (123x screening criteria). Results for metals in horsetail are consistent with elevated metal concentrations observed in soil and water collected from the area (Columbia/Franz, 2010). Vegetative cover within the Beach Area is sparse, and the total volume of aquatic vegetation available to ecological receptors is minimal.

Within the Mine Area, two aquatic vegetation samples were collected from the upland marsh, and one from the shore of Great Slave Lake at the discharge point of the creek that passes through the mine. Horsetail collected from the marsh area exhibited enrichment of arsenic (16.8x screening criteria); however, concentrations of other metals of concern (i.e., nickel and cobalt) were similar to background. Although elevated, measured concentrations of sodium and strontium are considered inconsequential in impact and size respectively. Downstream aquatic vegetation from the lower reaches of the marsh and from Great Slave Lake demonstrate minimal impacts (only one elevated concentration of arsenic was observed).

Table 21 Aquatic Vegetation – Summary of Findings

Location		Evaluation Criteria *	BACKGROUND			BEACH AREA			MINE AREA				
Sample ID	BG-VA10-1 Phragmites Lake		BG-VA10-3 Phragmites Marsh	BG-VA10-DUP1 Phragmites	AI-VA10-1 Phragmites Great Slave Lake	AI-VA10-1 Dup Phragmites Great Slave Lake	AI-VT10-3a Horsetail Marsh	A3-VA10-3 Phragmites Marsh	A3-VA10-8 Horsetail Marsh	A3-VA10-10 Phragmites Great Slave Lake			
Vegetation Type													
Environment													
Total Metals (mg/kg)													
Al		500	B	10	160	385	41	43	10	4	8	49	
Sb		0.3	B	0.025	0.032	0.035	0.018	0.024	0.071	0.037	0.034	0.041	
As		1.45	A	0.07	0.69	1.45	7.48	7.75	1,470	0.74	24.4	2.02	
Ba		29.7	A	26.3	13.5	29.7	34.1	33.1	28.2	27.6	19.4	26.4	
Be		0.0	A	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	
Bi		0.0	A	<0.1	<0.1	<0.1	<0.1	<0.1	2.3	<0.1	<0.1	<0.1	
B		75	B	23	19	23	28	27	24	16	35	16	
Cd		1	B	<0.01	0.02	0.04	<0.01	0.01	0.03	0.01	0.02	0.02	
Ca		NC		2,030	2,860	5720	3,500	3,370	18,600	2,560	11,600	3,330	
Cr		8	B	<0.2	0.7	2.4	0.6	0.6	0.9	0.3	<0.2	0.3	
Co		2	B	0.03	0.28	0.6	1.74	1.7	156	0.1	0.79	0.07	
Cu		20	B	4.13	4.1	4.85	4.65	4.85	4.29	5.49	2.9	6.87	
Fe		854	A	57	434	854	100	106	65	27	90	116	
Pb		30	B	0.03	0.26	0.42	0.05	0.06	0.11	0.1	0.05	0.25	
Mg		NC		1,210	968	1390	1,320	1,300	4,050	789	3,100	1,150	
Mn		NC		153	91.5	183	60.3	58.7	20.7	171	131	241	
Hg		0.3	B	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	
Mo		1.5	B	0.85	1.05	1.01	0.8	0.78	1.71	2.15	1.48	0.53	
Ni		5	B	0.31	0.76	2.15	9.7	9.71	615	0.4	1.69	0.52	
P		NC		1,800	1,220	989	1,430	1400	1670	1,110	4,220	1,970	
K		NC		13,800	9,240	10900	12,200	11,900	28,200	14,700	34,700	14,800	
Se		0.5	B	0.06	<0.05	0.05	0.08	0.09	2.71	<0.05	<0.05	<0.05	
Ag		0.02	A	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	
Na		70	A	<10	70	51	15	15	23	13	167	36	
Sr		8.4	A	8.4	2.4	4.4	10.8	10.5	19.5	3.0	10.0	3.7	
Tl		0.0	A	<0.002	<0.002	0.004	<0.002	<0.002	0.003	<0.002	<0.002	<0.002	
Sn		0.0	A	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	
Ti		19.0	A	<1	8	19	1	2	3	<1	<1	2	
U		1.0	A	0.004	0.401	0.984	0.031	0.028	0.820	0.006	0.025	0.031	
V		5	B	<0.2	0.7	1.5	<0.2	<0.2	0.4	<0.2	<0.2	<0.2	
Zn		250	B	21.1	24.1	28.1	11.5	11.4	21.4	17.3	37.4	33.4	

* Evaluation Criteria chosen as the maximum of A or B (see below)

A=The Ontario Ministry of the Environment and Energy (MOEE) HCB Phytotoxicology Field Investigation Manual (014-3511-93). "Upper Limit of Normal" contaminant guidelines (ULN) for concentrations of contaminants in foliage, grass, and moss bags in Ontario.

B= Maximum reported background concentration in site-specific aquatic vegetation

NC = No Criteria

Highlight indicates exceedance of evaluation criteria.

Source: Phase IIIa ESA (SENES/Franz 2011)

5.12.2 Sediment Toxicity and Benthic Community Analysis

Sediment toxicity and benthic community analyses were conducted at the Blanchet Island Mine during the Phase III (Columbia/Franz 2010) and Phase IIIa ESAs (SENES/Franz 2011). Analyses focussed on the identification of impacts to benthic populations in the Beach Area. Sediments collected from two background stations, six Beach Area stations and one Mine Area station (at the discharge of the stream into Great Slave Lake) were submitted for survival and growth bioassays using *Chironomus dilutus* (10-day tests) and *Hyalella azteca* (14-day tests) as test organisms. In addition, a survey of the benthic invertebrate community was conducted to evaluate the effects of mining wastes on the invertebrate populations. For each benthic sample, the total organism density (individuals/m²) was calculated based on the known area sampled. Benthic community descriptors for measuring potential impairment included total invertebrate density, taxon richness, Simpson's diversity index and evenness.

Toxicity analysis of background sediments indicate a 86-100% survival of *H. azteca*, and 100% survival of *C. dilutus*. The benthic survey identified representatives of 6 taxa in 2010, and 34 taxa in 2011 at the background sampling locations. Chironomidae (non-biting midges) and *Diporeia* "brevicornis type" (small crustaceans), were the most diverse and abundant of taxa recorded. The mean density of benthic organisms at the background site was 144 ind/m² in 2010 (Columbia/Franz 2010) and 21,853 ind/m² in 2011 (SENES/Franz 2011).

Analyses of sediment and benthos from the Beach Area identified impacts exclusively in the near-shore environment adjacent to the spill of ore concentrate. Sample 09-SED-16 (directly offshore of the Beach Area) showed evidence of toxicity in all four tests, with up to 100% mortality of test organisms (*H. azteca*), and 97% growth inhibition in *C. dilutus* when compared with background. Benthic community analyses at this location indicate the benthic community is significantly different from the background station in terms of density and diversity. The benthic survey detected representatives of only 1 taxon, *Chironomidae Cirotopus* (non-biting midge). The mean density of benthic organisms was 32 ind/m². These results are likely due in part to elevated metal concentrations in sediments, and partially to differences in environmental conditions that are unique to each station (Columbia/Franz 2010).

The sediment sample collected approximately 15 m offshore from the ore concentrate spill (sample A1-TX10-5 collected in the Phase IIIa ESA) showed evidence of decreased survival of *Hyalella Azteca*. The benthic survey identified representatives of 21 taxa at this location. *Diptera* constituted the most diverse group with 13 taxa recorded, and was also the most numerically abundant group, with 41 individuals found in one grab. The mean density of benthic organisms was 3,075 ind/m². While results of benthic community analysis at this station showed evidence of impairment relative to the background site, differences may be partially attributable

to natural factors (e.g., substrate type and potential chemical loadings both have the potential to influence benthic communities).

Four other sediment samples were collected at increasing distances from the ore concentrate spill (15 m to 140 m). Although results of the two sediment toxicity tests (09-SED-17 and A1-TX10-2) indicated some growth inhibition of test species, all other toxicity results were comparable with background and/or controls. Benthic community analysis at the offshore locations indicated a reduction in benthic diversity and density from background benthos (although less significant than observed in the near shore environment). However, taking into consideration the toxicity tests and benthic community analysis, the majority of results suggest that sediment in this area is not deleterious to benthos. Observed differences in the benthic communities are believed to be at least partially attributable to physical differences between the sampling locations (sediment clast size, wave action, etc.) as opposed to site contamination.

A single sediment/benthos sampling station was established at the discharge of the Mine Area creek into Great Slave Lake. Sediments collected from this station (A3-TX10-4, collected during the Phase IIIa ESA) indicated no evidence of toxicity to either test organism. The benthic survey detected representatives of 12 taxa at this location. *Diptera* constituted the most diverse group with 14 taxa recorded, and was also the most numerically abundant group, with 36 individuals found in one grab. The mean density of benthic organisms at A3-BEN10-4 was 2,471 ind/m². The high volume of woody organic matter in the substrate may result in reduced oxygen levels and inhibit plant growth, which is considered to be a potential cause of reduced benthic population numbers. Sediment toxicity testing did not indicate potential impacts to benthos at this location; however, arsenic concentrations in sediment collected from this area are as high as 520 mg/kg, well above the applicable sediment quality criterion. This indicates arsenic and other toxic metals in sediment may not be readily bioavailable.

In summary, impacts to benthic populations are limited to the near shore environment in the Beach Area, with samples greater than 15 m from shore approximately consistent with background. At the outflow of the Mine Area creek to Great Slave Lake, sediment toxicity testing suggests the site is not having an impact to the benthic population.

5.13 SITE ACCESS ROUTES

A 1.3 km road links the Beach and Camp Areas with the Mine Area to the northeast (Figure 2). Several sections of the access are overgrown with vegetation (primarily low growing alders and black spruce). Some evidence remains that cobble sized granular material may have been used to surface the route, likely in areas with standing water or increased soil compression.

The access route was used throughout the ESA site investigations and the route is easily discerned. The transport of equipment has not been attempted, and would be challenging due to standing water at the lower reaches of the roadway (at the Camp Area) and at a stream crossing near the Powder Magazine (at the Mine Area). In addition, the current width of the roadway is not sufficient for heavy earthmoving equipment. A considerable portion of the road would require clearing and grubbing of encroaching vegetation should earthmoving equipment be required at the Mine Area.

A winter mobilization would not require any resurfacing of the former access route once it was cleared and grubbed. If a summer mobilization of heavy equipment is required, some additional preparation work would be necessary at the water crossings and softer sections of the route. On the basis of the 2010 site reconnaissance, approximately 100 m of the route would require some up-grading work (75 m at the Camp Area and 25 m at the Mine Area).

5.14 POTENTIAL BORROW SOURCES

A survey of potential borrow sources was conducted as part of the Phase IIIa ESA site investigation, and two large scale borrow sources were identified in the near vicinity of the site: northwest of the Beach Area, and south of the adit within the Mine Area. The proposed borrow source locations are identified on Figure 12.

Northwest of the Beach Area is a small bay currently serving as a landing area for float planes and boats. The area spanning from this bay to the escarpment face immediately north is a mix of granular soils with cobbles and boulders. The borrow material at this location is defined as medium to coarse sand with trace silt and some fine sand, cobble and gravel. While this borrow source would require significant clearing, grubbing and possibly field screening (to remove roots and other organic material), the site is easily accessible from the lake or with a minor extension to the site access road. Although the depth of the deposit could not be confirmed, the borrow area is approximately 8,000 m². If it is assumed that the borrow source could not be extended below the Great Slave Lake high-water mark, the volume of available borrow is estimated to be approximately 40,000 m³. The use of the high-water mark as the southern boundary is in direct reference to regulations within the *Fisheries Act* (1985). All quarrying activities in the vicinity of the Beach Area, regardless of proximity to the lake, would require appropriate permits (Section 1.2.1.2) and use of sediment and erosion control plans. Mitigative controls would be used to limit impacts to both the terrestrial and aquatic environments.

A second borrow source was identified in the Mine Area. The area of available borrow is approximately 3,850 m² lying between the toe of the waste rock slope, and the downgradient wetland. Based on an estimated thickness ranging from 1 to 1.5 m, the volume of borrow at this location is approximately 4,800 m³. Visual observations indicate the material to be medium to

coarse sand, with some silt, cobble and gravel. The potential borrow would require some initial earthworks to remove the overlying colluvium, waste rock, and ore concentrate, as well as some surficial organic material. Minimum screening or sorting would be required prior to this material being available for use. Additional chemical analysis may also be necessary to fully characterize the chemical properties of this borrow source (e.g., to confirm the material has not been impacted by the historic mining operation).

In summer 2013 AANDC initiated a supplemental borrow source characterization study which is currently ongoing. These measures have been conducted to determine if the Blanchet Island borrow source may be used at other remedial projects in the East Arm region (i.e. Outpost Island Mine, Copper Pass Mine).

5.15 POTENTIAL LANDFILL LOCATIONS

Potential landfill locations were identified in the Phase IIIa ESA, should the use of an on-site landfill be recommended in the RAP. The areas identified as potential borrow sources (as described above) were determined to serve as the most appropriate locations for a non-hazardous and/or hazardous waste landfill. The potential landfill locations are northwest of the Beach Area and south of the adit (Figure 13). The amount of site preparation work for the respective landfill locations would be minor and coincident with the work related to the preparation of the borrow sources and site access roads. One potential drawback of the Beach Area location is the limited set-back from Great Slave Lake. Discussions with regulatory authorities would therefore be required to determine if the location is a viable alternative. Design of a landfill at this location would require due consideration of geotechnical stability to ensure there are no effects to the downstream aquatic environment in the long-term. Such considerations would include permafrost effects, groundwater flow, surface water erosion and potential failure mechanisms.

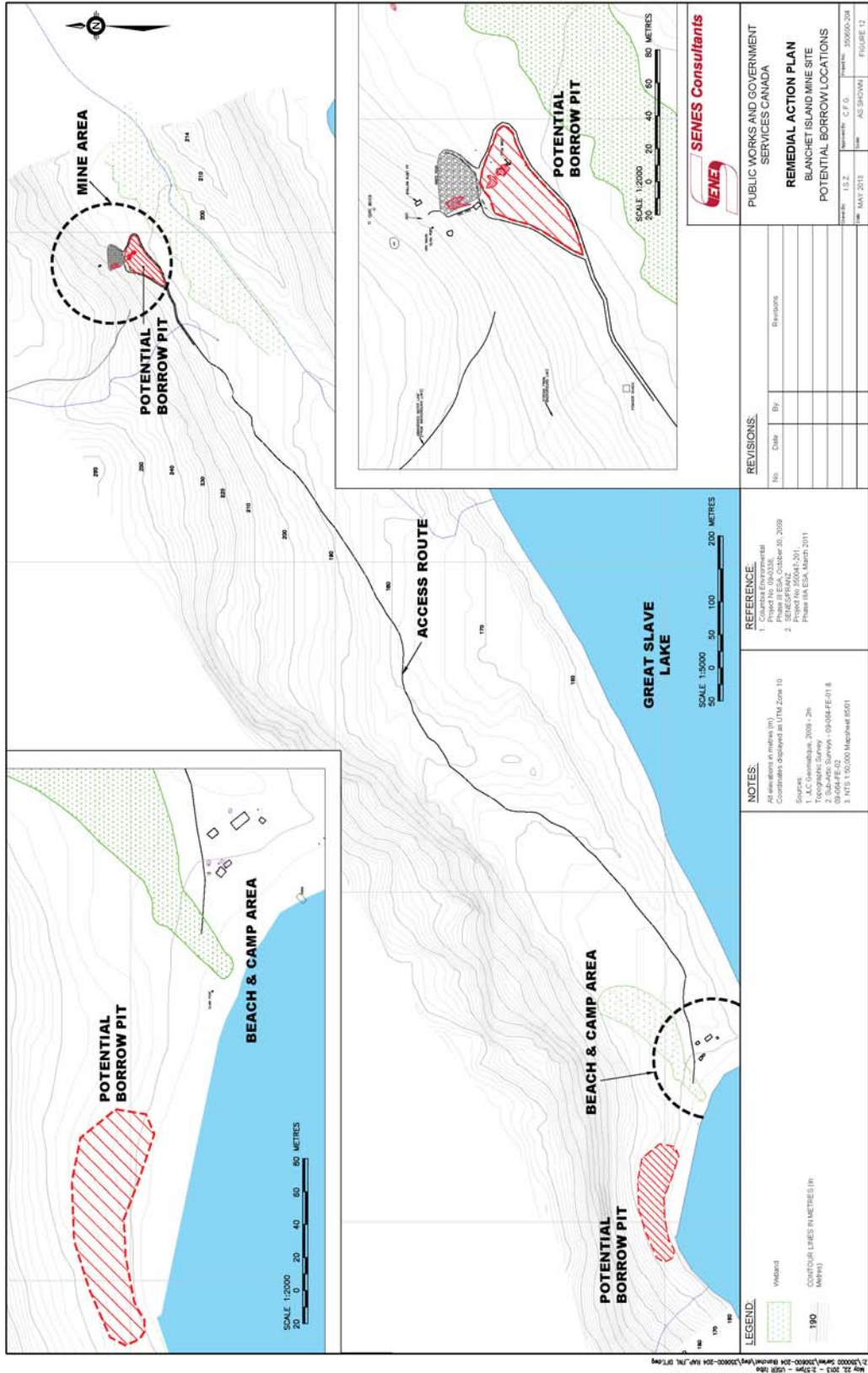
It should be noted that, based on the minimal volume of debris remaining at the Blanchet Island Mine, an on-site landfill is likely not required to manage debris. The majority of non-hazardous material is related to wooden structures (which are amenable to on-site burning) and approximately 100 empty drums to be crushed prior to disposal. The total volume of material that would require disposal in a non-hazardous landfill is approximately 5 to 10 m³ (assuming the drums would be crushed and the wood burnt). This volume of material does not warrant the construction of an on-site landfill.

If a decision is made to store the ore concentrate on-site indefinitely, an engineered landfill with a geo-composite cap may need to be constructed. This would assist in minimizing the potential for leaching of the ore concentrate into the surrounding environment. Such a facility would be best suited to the Mine Area landfill location (south of the adit).

5.16 POTENTIAL SOIL TREATMENT LOCATIONS

Soil treatment could be used address PHC impacted soils. However, based on the small volume of PHC impacted soils identified during the site characterization programs, the use of soil treatment at Blanchet Island Mine may not be justified. Nonetheless, the Phase IIIa ESA identified the land between the waste rock slope and the Mine Area wetland as the most suitable location for a soil treatment area, due to the close proximity to petroleum hydrocarbon impacts in the Mine Area. It is noted that soils with elevated PHC concentrations are part of the larger area of metal impacted soils. Management measures will require that both contaminant streams are appropriately addressed.

Figure 12 Potential Borrow Locations





6.0 ECOLOGICAL AND HUMAN HEALTH RISKS

At the conclusion of the ESA process, SENES was commissioned to conduct a Human Health and Ecological Risk Assessment (HHERA) of the site. A Detailed Quantitative Risk Assessment (DQRA) was submitted in January 2011. Based on feedback received on the DQRA, supplemental sensitivity analyses on the risk assessment were completed in November, 2011, and additional updates implemented in February 2013. The following sections present the risk assessment methodology and findings as taken directly from the Final HHERA (SENES 2013).

6.1 RISK ASSESSMENT APPROACH AND METHODOLOGY

The Blanchet Island Mine human health risk assessment was conducted according to Health Canada guidance on DQRA (Health Canada 2010a) to evaluate the probability of adverse health consequences to humans caused by the presence of contaminants in the environment. The ecological risk assessment was carried out using the framework as provided by the Canadian Council of the Ministers of the Environment (CCME 1996). Assumptions made throughout all stages of the risk assessment were selected to err on the side of caution in over-estimating intakes and exposures. This level of conservatism is consistent with the approach typically adopted in the risk assessment process.

A detailed review of the multi-year ESA findings was conducted to obtain the data for use in the risk assessment. It should be noted that the ESA data were biased towards areas of contamination and therefore are not representative of the entire site. Contaminants of Potential Concern (COPCs) were identified by comparing maximum measured concentrations in soil, surface water and sediment to the CCME guidelines (where available) and/or appropriate background measurements. The COPC that were evaluated in the risk assessment included the following:

Antimony	Iron (aquatic)	Uranium	2-Methylnaphthalene
Arsenic	Lead	Vanadium	Naphthalene
Barium	Manganese	Zinc	Phenanthrene
Boron	Molybdenum		Ethylbenzene
Cadmium	Nickel		F1 PHC
Chromium (total)	Selenium		F2 PHC
Chromium VI (humans)	Silver		F3 PHC
Cobalt	Strontium		F4 PHC
Copper	Titanium (aquatic)		

To determine the risk to receptors, both human and ecological, exposure point concentrations were calculated for soil, terrestrial vegetation, water, sediment, and aquatic vegetation. The exposure point concentrations were calculated for each of the main areas of the site (i.e., Beach/Camp Area, and Mine Area), as well as background conditions. It should be noted that the concentrations used in all aspects of the risk assessment represent the reasonable maximum exposure concentration, presenting a highly conservative assessment of risks.

6.1.1 Human Health Risk Assessment Methodology

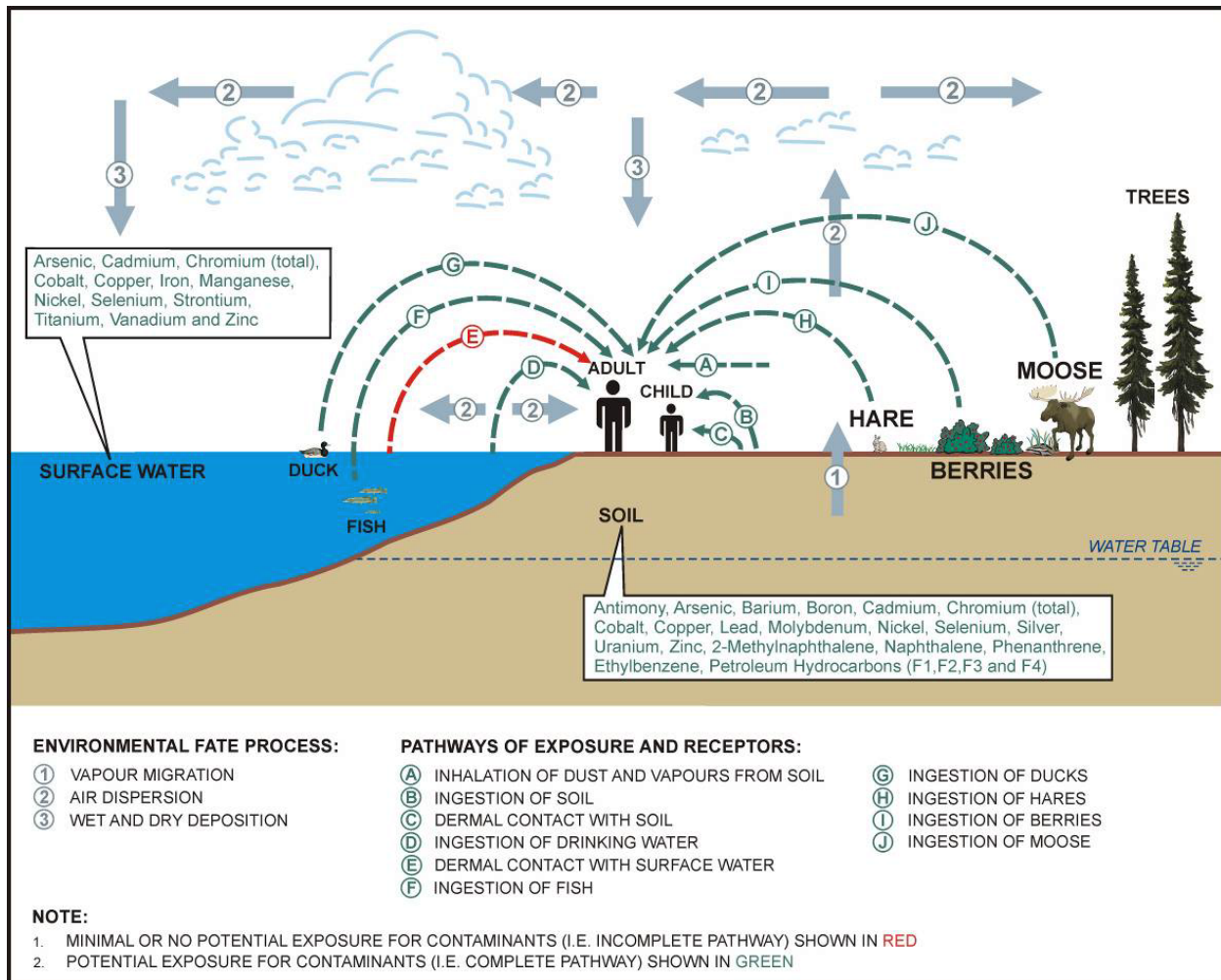
The Human Health Risk Assessment (HHRA) was undertaken to determine the potential for adverse human health effects from COPC present at the site. Although the site is currently unoccupied, it was assumed for the assessment that the site is used under the recreational land use scenario as described by Health Canada (2010b) with various age ranges present (toddlers, children, teens, adults) for a total of 200 hours per year. During the time the receptors are on site, it was assumed they would obtain all fish, game and berries from the site and would take meat back to their community, with a highly conservative estimate of 6 months food supply obtained. The pathways considered in the assessment included ingestion (soil, water, fish, ducks, hare, moose, and berries), dermal contact with soil, and inhalation of dust and vapours. Conservative assumptions were made in the characterization of human receptors for all aspects of the assessment. A graphical representation of exposure and contaminant pathways is provided in Figure 14.

The dose response assessment involved the identification of potentially toxic effects and the determination of the appropriate toxicity reference values (TRVs) for the various COPC. The TRV is defined as the amount of constituent exposure that can occur without resulting in the production of any adverse health effects (for threshold or non-cancer causing constituents). Toxicity reference values from Health Canada (2010c) were selected where available. The estimated exposures (or intakes) by the human receptors were divided by the TRVs to determine a hazard quotient (HQ) value. A HQ benchmark of 0.5 was selected to account for the various exposure pathways (inhalation, and ingestion of soil, water and food) that were evaluated in the assessment. For PHCs, the CCME (2008) considered exposure from additional pathways to derive a soil allocation factor for each of the fractions. This information is considered in the assessment and thus the comparison HQs for the fractions are 0.5 (F1 and F2 PHCs), 0.6 (F3 PHC) and 0.8 (F4 PHC).

Carcinogenesis is generally considered to be a "non-threshold" type phenomenon whereby it is assumed that any level of exposure to a carcinogen poses a finite probability of generating a carcinogenic response. For carcinogens, no threshold is assumed to exist (i.e., every dose presents some risk). An incremental risk is calculated by multiplying the estimated dose by the appropriate slope factor for dermal and oral exposures, and the amortized air concentration by

the appropriate unit risk for inhalation. The calculated risk is then compared to acceptable benchmarks. In this assessment, an incremental risk level of 1×10^{-5} was used to assess carcinogenic effects. Health Canada considers this value to represent an “essentially negligible” risk.

Figure 14 Human Health Risk Assessment – Conceptual Site Model



Source: SENES 2013

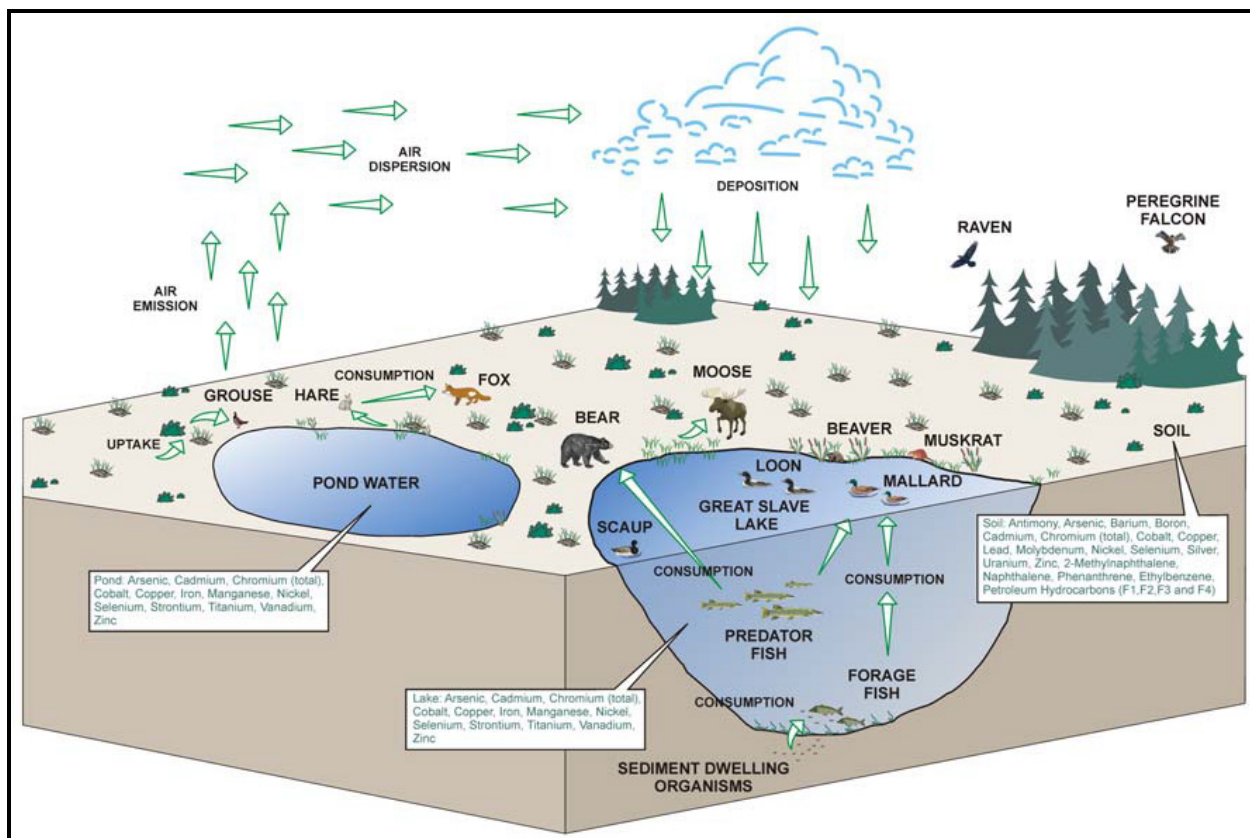
There are a number of conservative assumptions that are made in the risk assessment with respect to fish consumption, fraction of time obtaining food from the site and arsenic concentrations in fish and water at the site. Thus, a sensitivity analysis was also carried out to examine the effect of these various assumptions on the results relating to arsenic exposures.

6.1.2 Ecological Risk Assessment Methodology

The Ecological Risk Assessment (ERA) was undertaken to evaluate potential exposures of ecological receptors to contaminants present at the site. Aquatic receptors chosen for the ERA cover all trophic levels and include aquatic plants, phytoplankton (e.g., *Chlorophyta*), zooplankton (e.g., *Cladocerans*), benthic invertebrates (e.g., midge), forage fish (e.g., whitefish), and predator fish (e.g., trout). Terrestrial receptors were chosen to assess the exposure to COPCs of herbivores, omnivores and carnivores potentially present at the site. Species selected for assessment were black bear, wolf, fox, moose, Peregrine falcon, raven, beaver, muskrat, hare, grouse and waterfowl (i.e., loon, scaup). Ecological receptor characteristics were assumed to represent a maximum exposure scenario, in that cautious assumptions were made regarding receptor behaviour and home range. For example, it was assumed that the Peregrine falcon obtained all its food from the maximum concentration location while on site. The food sources and the animals that ingest them include: aquatic vegetation (moose, muskrat, mallard, scaup and beaver), benthic organisms (muskrat, mallard and scaup), fish (bear, merganser and loon), terrestrial vegetation (moose, hare, grouse, bear, fox, beaver and raven), earthworms (raven), hare (wolf, raven, fox and Peregrine falcon), ducks (fox and Peregrine falcon), grouse (Peregrine falcon) and birds (Peregrine falcon). A Conceptual Site Model of ecological pathways used in the ERA is provided in Figure 15.

Transfer factors were applied to determine COPC concentrations in different dietary components in the food chain (e.g., concentrations in fish were calculated using transfer factors from water). These calculated intakes were divided by intake levels considered to be protective of the species (i.e., toxicity reference values or TRVs) to obtain a screening index (SI) value for comparison to appropriate benchmarks. SI values greater than the applicable benchmark were highlighted for further interpretation.

Figure 15 Ecological Risk Assessment – Conceptual Site Model



Source: SENES 2013

6.2 HUMAN HEALTH RISK ASSESSMENT FINDINGS

For this site, both non-carcinogens and carcinogens (arsenic) were present in the soil and surface water. For many non-carcinogenic effects, protective biological mechanisms must be overcome before an adverse effect is manifested from exposure to the COPC. This is known as a "threshold" concept.

The findings of the risk assessment indicated that, for most non-carcinogens with the exception of cobalt, the HQ values were below the acceptable value of 0.5 and therefore were not of concern. The HQ values for cobalt are above 0.5 for the toddler in the Beach/Camp and Mine areas and for the child in the Mine Area. The major exposure pathways are ingestion of soil and berries. For cobalt, the berry concentrations used in the assessment were the reasonable maximum exposure concentrations for terrestrial vegetation in general, which includes measured concentrations in parts of the plant that will not be consumed in large quantities (i.e., leaves, roots). There were also only some very small "hot-spots" of cobalt that were used to derive the berry concentrations resulting in an over-estimate of risk. Human receptors were assumed to consume berries from the site for a six month period. It is unlikely that there are enough berries

at the site to take back to the community (in fact site reconnaissance indicated that no berries were observed on site) and consume over a six-month period and thus this represents a very conservative assumption. A sensitivity analysis was carried, assuming that berries were only consumed while visiting the site. The HQ values of cobalt for toddler and child in both the Beach/Camp and Mine areas do not exceed the benchmark of 0.5. The results of the sensitivity analysis indicate that exposure to non-carcinogens at the Blanchet site are unlikely to be a cause for concern for casual visitors to the site.

For carcinogenic COPC, lifetime incremental risk levels were estimated by multiplying the estimated incremental exposure by a slope factor. The calculated incremental risk levels show that arsenic exposure leads to risk levels above the Health Canada negligible risk limit (1×10^{-5}) for individuals present at both the Beach/Camp Area and the Mine Area for 200 hrs/year and who would take back food from the site and consume over a six month period. The exposure is dominated by the fish and berry ingestion. The concentrations of arsenic in both these media were developed using transfer factors which are very uncertain.

A sensitivity analysis was carried out to examine the influence of these assumptions on the risk assessment. The scenarios considered in the sensitivity analysis include varying arsenic concentrations in fish based on measured data from around the Giant Mine (an area with elevated arsenic concentrations), varying fish consumption rates based on advisories from Health Canada, varying the fraction of the time human consumed food from site, removal of the berry ingestion pathway since berries have not been observed on site and varying the drinking water concentration at the Beach/Camp area.

The results of the sensitivity analysis found that the incremental risk from arsenic exposure still exceed the negligible risk level in all scenarios even after using more realistic assumptions in fish consumption rates and removing the berry ingestion pathway and reducing the arsenic concentration in lake water. This is because the soil exposure pathway due to high arsenic levels in soil at the site (e.g. soil ingestion and consuming hare that ingests terrestrial vegetation) also results in fairly elevated intakes of arsenic. The area at the beach where the ore spill was removed still has elevated concentrations of arsenic as well as a large portion of the area around the mine site. Therefore, remediation of the soil at the site is required to reduce the exposure to arsenic.

6.3 ECOLOGICAL RISK ASSESSMENT FINDINGS

The SI values reported are not estimates of the probability of ecological effect. Rather, the values are positively correlated with the potential of an effect (i.e., higher index values imply greater potential of an effect). An SI benchmark value of one (1) was used to examine potential effects when all routes of exposure are included as well as background exposure. An SI value

above one does not necessarily indicate an effect but highlights combinations of receptors and COPC that require further consideration.

There are some inland water sources, separate from Great Slave Lake, such as creeks, wetlands and streams. During site visits, there was no evidence that these water bodies supported fish and, as such, they were evaluated for aquatic plants and benthic invertebrates only as well as a source of drinking water for terrestrial receptors. These inland water bodies were evaluated for the Beach/Camp Areas, as well as the Mine Area. Lake water from Great Slave Lake was evaluated as a whole entity surrounding Blanchet Island.

Assessments of surface water and sediment quality in these two sources ('lake' and 'ponded/stream') were undertaken to determine potential for effects on aquatic receptors (i.e., aquatic plants, benthic invertebrates, phytoplankton, zooplankton, forage and predator fish (lake only)). Arsenic water concentrations in a shallow localized area of Great Slave Lake, nearshore to the Beach Area, were reported to exceed the applicable TRVs. The elevated concentrations are likely as a result of leaching from contaminated soil near the former location of the spilled nickel arsenide ore, and from the historic ore spill itself. There are also several exceedances of sediment toxicity benchmarks for sediment in Great Slave Lake. Arsenic and nickel exceedances are the major concern, suggesting that leaching was occurring from the nickel arsenide ore. It should be noted that sediment toxicity results did not indicate potential effects on benthic communities based on tests using sediment samples with the highest concentration of arsenic. Although the spill has been containerized at the Beach Area, further remediation of this area may be prudent. Ponded/stream water (streams and wetlands) concentrations were found to exceed applicable TRVs for arsenic, chromium, cobalt, copper, iron and nickel which may indicate an increased risk for adverse effects on aquatic biota (if present) in these areas.

SI values from arsenic exposure are above 1 for all avian species except for the loon and Peregrine falcon. The SI values for cobalt are at or slightly above the applicable SI benchmark for grouse, raven and scaup. The dominant pathways of exposure to cobalt for the scaup is sediment ingestion; for the grouse and raven is soil, and also hare for the raven. For the grouse, the intake of arsenic is predominately from ingesting soil and terrestrial vegetation, and the SI values arising from arsenic intake are a larger concern for the Beach Area than for Mine Area (as a result of the nickel arsenide ore spill at the Beach Area). Since this ore has been containerized since the last round of sampling, it is likely that the current concentrations of arsenic in the area are lower than those used in the assessment. For the raven, the major contributors to the intake of arsenic are earthworms (59%) and ingestion of soil (32%). There are no measured data for earthworms at the site and thus literature derived soil-to-earthworm transfer factors were used to calculate earthworm concentrations which may lead to an over-estimate of exposure. The results suggest that remediation of arsenic and cobalt in soil should be considered.

The mallard and scaup consume benthic invertebrates. As previously discussed, some of the water concentrations, which were used to estimate benthic invertebrate concentrations using transfer factors, were measured in samples obtained near shore to the Beach Area and are likely impacted by runoff from the contaminated soil in the area. As such, these predicted SI values are likely overestimated. If these water samples are removed from the assessment (i.e., the assumption that remediation will result in reduced concentrations), then the estimated benthic invertebrate concentrations and resulting SI values for the mallard and scaup are below the benchmark SI value.

All mammalian receptors, with the exception of bear and moose, are exposed to arsenic at concentrations exceeding the acceptable SI values. Exposures to all other COPCs are not of concern. For the beaver and muskrat, the exceedance is in the Mine Area and is as a result of sediment ingestion. Intakes of sediment for these receptors were estimated using the ponded sediment data in at the mine (wetland, creek, etc.), which includes the creek and wetland that drain the Mine Area. It is likely that arsenic is leaching from the ore and ore stains around the Mine Area into the inland water bodies and, as such, remedial action in at the Mine Area should focus on the staining and ore spill. The SI values for the other mammalian ecological receptors are being driven by soil ingestion (wolf, hare, fox), and duck ingestion (fox). The results indicate that remediation of the arsenic in soils should be considered.

6.4 OVERALL CONCLUSION

The results of the risk assessment indicate that arsenic concentrations at the site may present potential health risks to human and ecological receptors, using maximum reasonable estimates of exposure and concentration. These concentrations are predominantly attributable to the ore concentrate in the Beach and Mine Areas. There are also some “hot-spots” of cobalt that may result in potential risks. The results of the HHRA reflect the conservative assumptions used in all phases of the process.

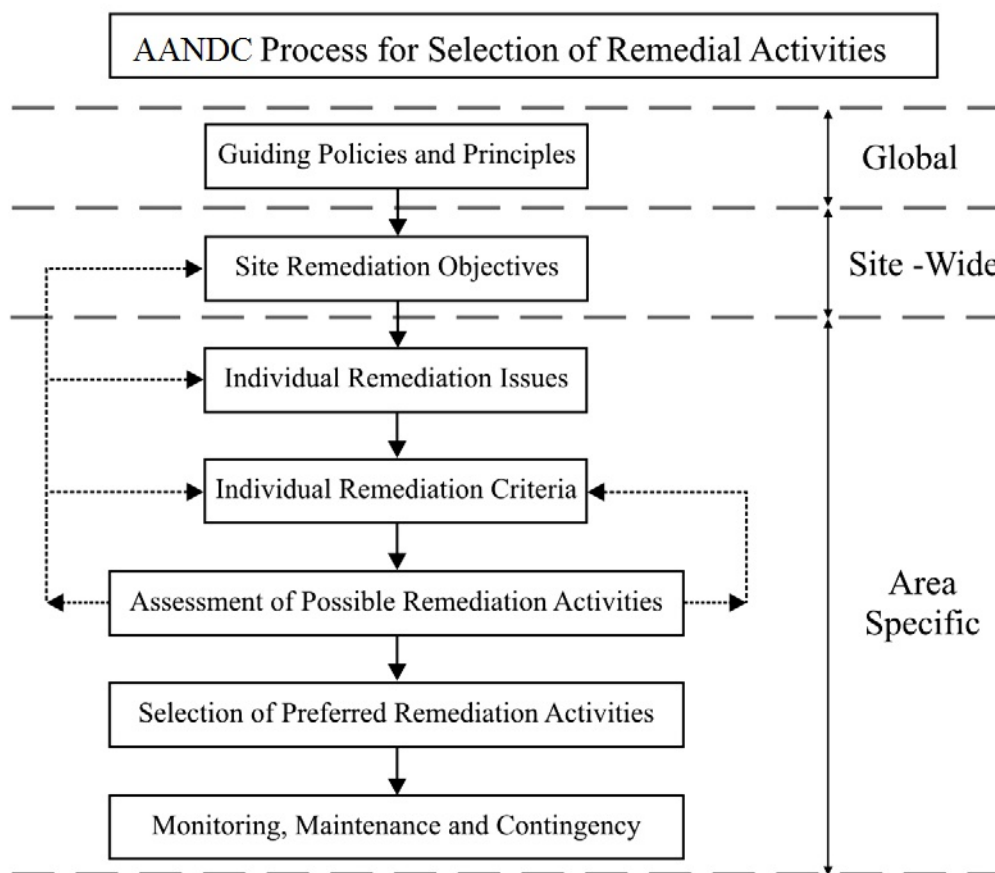
Overall, the assessment of both human health and ecological risks indicates that risk management measures may be justified to reduce the exposure at the site, particularly to arsenic as a result of nickel arsenide ore spills. Although the ore has been containerized at the Beach Area, the ore is still exposed in the Mine Area. The assessment was conducted using data obtained from environmental media before the ore was containerized. It should be noted that although the ore was containerized, the soil was not remediated and thus it was appropriate to use these data. However, it is likely that the concentrations of some of the COPC, in particular arsenic and nickel, are now lower than those used in the assessment. Remediation of the soil at the Beach Area and Mine Area will likely result in corresponding decreases in surface water and sediment concentrations, although subsequent sampling of environmental media would need to be undertaken for confirmation.

7.0 PROPOSED REMEDIAL ACTION PLAN

7.1 PROCESS FOR SELECTION OF REMEDIATION ACTIVITIES

The general AANDC approach to remediation is illustrated in Figure 16. The specific process components carried out for the Blanchet Island Mine and its development of remediation activities is provided in the following discussion.

Figure 16 AANDC Approach To Remediation



7.1.1 Process Approach and Considerations

The site consists of a number of features that have similar remediation issues. To enable the development of a coherent RAP, these features were grouped into like components that share similar characteristics and remedial issues. For each of these components, remedial issues and concerns were identified based on input from field studies and risk assessments. Remedial options were identified that can be used to address the concerns and hazards. The remedial options were assessed with respect to the ability to fulfill the overall framework and site-specific

remedial objectives. Rankings of “high”, “medium” and “low” were assigned for the performance of each of the options relative to the selected criteria. The rankings are qualitative in nature and are informed by the expertise/experience of the individuals performing the evaluation.

A Technical Recommendation was subsequently developed by evaluating the scientific merit, best practices, technical feasibility and the documented performance of similar measures at abandoned mines throughout the Northwest Territories. This version of the RAP presents the Preferred Remedial Option which has been identified through technical recommendations and community engagement meetings. AANDC conducted traditional knowledge studies and a Remedial Options Analysis Workout meeting to determine community values and traditional knowledge as it pertains to the Blanchet Island Mine. Upon conclusion of the community meetings, Preferred Remedial Options were chosen to address each of the components. The Preferred Remedial Option will then be finalized in the specifications or as required during the remediation.

Monitoring, maintenance and contingency plans are necessary to: 1) monitor for possible impacts and quality control while the remediation work is underway (*monitoring activities*); 2) to ensure health and safety of workers during remediation (*health and safety monitoring*); 3) monitor the effectiveness of the work that was done after its completion (*performance monitoring*); 4) ensure that any required maintenance work is done to keep the remediation work up to specifications (*maintenance activities*); and 5) make sure that backup plans are ready in case something unexpected takes place (*contingency plan*).

7.1.2 Typical Remedial Objectives and Considerations

In general, the objective for any mine closure strategy is to assure:

- The protection of human health;
- Minimization of environmental impacts; and,
- To the extent possible, restoration of the land to pre-mine conditions or a suitable alternative land use.

The Blanchet Island Mine is situated in a relatively inaccessible location, where the key long-term issues for the site include assurances that the site is not causing material environmental damage; and the site is free of significant physical hazards. To address these issues, the following technical reclamation guidance was considered appropriate for the remediation of the site.

Physical Stability and Health and Safety

- Ensure all surface openings are sealed to industry/engineering standards; and,
- Minimize physical risks associated with other physical hazards (slopes, buildings, etc.).
- Environmental Effects
 - Remove or mitigate direct exposure of human and ecological populations to the ore concentrate; and
 - Reduce environmental effects as low as reasonably achievable.
- Land Use
 - Limit the volume of waste material present on site (good housekeeping); and
 - Allow natural use of the land.

7.1.3 Listing of Remedial Components and Features

The ESA process identified the physical aspects of the mine and chemical concentrations in soil, vegetation, water and sediment. The HHERA determined the risk to humans and ecological populations from the environmental conditions. The results of these studies, in combination with AANDC guiding principles, were used to determine what issues and concerns should be addressed in the RAP. The following aspects of the Blanchet Island Mine are discussed in the RAP:

- Mine Openings: The adit is the only mine opening, and is a physical concern to human or animal receptors that could enter it.
- Former Buildings/Structures: Dilapidated structures may represent a physical hazard to those who enter.
- Refuse and Debris: Empty drums, metal rail track, tin can and waste dumps, and miscellaneous debris are present in small volumes in isolated areas of the mine.
- Waste Rock: Elevated metal concentrations in waste rock are generally bound within stable minerals; however, waste rock is a potential source of arsenic loadings to the environment.
- Ore Concentrate: The ore concentrate in the Beach Area (now in drums) and in the Mine Area is enriched in metals (e.g., arsenic, cobalt, nickel), and represents a source of metal leaching to the surrounding environment.
- Soils - Metals: Metals have leached from the ore concentrate to underlying and down gradient soils.
- Soils – PHCs: A spill of drum contents (from one drum) in the Mine Area was identified in the ESA process.
- Sediment/Water: Surface water and sediment concentrations of ore metals are enriched within the creek, wetland, and the immediate shoreline of the lake at the Beach Area and discharge of the Mine Area creek.

7.1.4 Review of Industry Standard Remedial Options

Closure options are determined on a site-specific basis. However, for sites with issues similar to those at the Blanchet Island Mine, the options that are typically considered include:

Do Nothing – This option is considered where the site component poses negligible risk to human or ecological health, and where there is limited potential for worsening conditions with time. This option is typically included for all facilities and may be adopted where:

- Facilities are stable and do not represent a physical or ecological hazard;
- An area has been, or is being, naturally reclaimed by native vegetation; and,
- The facility has historic or archaeological value.

Leave As Is With Monitoring - This option involves the application of a monitoring/inspection program to ensure physical or chemical conditions do not degrade with time; however, no remedial actions are implemented as part of the RAP.

Consolidation and On-Site Management – This option would involve the consolidation of potential contaminant sources in an engineered facility to be constructed within the boundaries of the site.

Consolidation, Transport, and Off-Site Disposal – This option would require consolidation, shipment off-site, and disposal in an appropriately licensed facility.

Burning – Burning of wood waste is often suggested to reduce the quantity of waste requiring disposal or transport. Ash residual may require management in an on-site landfill or an off-site licensed waste disposal facility.

Fencing – Fencing can be used to reduce hazards to people and animals. Fencing requires long-term care and maintenance, and is typically only considered as an interim measure or in cases where no credible remedial alternative is available.

Backfilling and/or Grading – Backfilling of shafts, adits, trenches, and pits is a common practice to reduce physical hazards at mine sites. Waste rock is often a candidate backfill material, which is used to reduce the footprint of the surface waste disposal area. Grading of waste rock piles may also be desirable to reduce physical risks and improve site aesthetics. Re-vegetation of graded surfaces is considered when appropriate.

Landfills – On-site disposal areas are a common and economically viable consideration when large quantities of waste require management and/or when transportation to off-site facilities is

prohibitively expensive. Issues to be considered include proper siting, long-term stability, leaching potential, cover options, and potential re-vegetation.

Dry Cover – Dry covers are applied to many facilities for a variety of reasons. These covers may be simple barriers to intrusion, low permeability covers to reduce infiltration, or covers to support vegetation. Cover materials may include local borrow, imported clays and synthetic materials and waste rock. The selection of the cover material depends on the requirements for the cover and the availability of local borrow sources.

Concrete Capping – Various designs of cast-in-place, or pre-cast concrete plugs and caps are used to prevent access to mine workings. The selection of the preferred method is a function of the characteristics of the opening (depth to bedrock, accessibility, size, availability of materials, etc.).

Alternate Seals – Foam seals have been used throughout Canada and the United States to seal mine openings, providing a viable option where access is limited. After hardening, seals are typically covered with granular material to protect against ultraviolet light and fire. Alternate sealing techniques could include metal cages frames for elevated remote locations, etc. as may be acceptable to the mines inspector based on site conditions.

7.2 REMEDIAL ASSUMPTIONS

For the purpose of conceptual planning, the following assumptions were used in the evaluation of the various remedial options:

- Materials and equipment required for the remedial work would be transported to/from the site using a barge system on Great Slave Lake during the open water season, and placed within a laydown area. The barge system would operate out of Hay River or Yellowknife.
- During barge access, due consideration should be given to the potential for the disruption of contaminated sediments and soils. This could occur during the docking process and in the unloading of equipment and supplies. For these reasons, such remedial activities should be avoided in the vicinity of the ore concentrate spill within the Beach Area. It is assumed that all barge landing activities would be conducted at the gravel beach west of the main Beach/Camp areas, near to the location of the proposed borrow area.
- The site access route will require grubbing and clearing, and an extension constructed west of the Beach Area to access the aforementioned proposed barge landing area. A winter mobilization would not require any resurfacing of the former access route once it was cleared and grubbed. If a summer mobilization of heavy equipment is required, some additional preparation work would be necessary at the water crossings and softer sections of the route. On the basis of the 2010 site reconnaissance, approximately 100 m of the

route would require some up-grading work (75 m at the Camp Area and 25 m at the Mine Area).

- Some options require heavy equipment. It is assumed that if heavy equipment is brought to the site, then it will be used strategically to remediate other portions of the site that would otherwise be managed by a risk management approach. As such, there will be common costs (e.g., excavator, bulldozer, mobilization) associated with a remedial approach.
- The camp size is estimated to consist of approximately 4-8 workers, the appropriate number of tents, a cooking area and a waste disposal area. The camp would be seasonal.

7.3 REMEDIAL OPTIONS

The following sections present the proposed and preferred remedial options for the Blanchet Island Mine. The general operating principles, characteristics, benefits and costs are discussed for each option and formed the basis of discussions during community engagement meetings. The remedial options are summarized in Table 22, with further discussion in the subsequent sections.

It is noted that Site Specific Target Levels (SSTLs) for use during remediation are currently under production. The development of SSTLs employs the findings of the ESAs and HHERAs to identify contaminant thresholds which may result in potentially unacceptable risks to human health or the environment. Upon completion of the SSTLs, the volume of impacted environmental media to be remediated will be refined and reflected in the technical specifications. The SSTLs will result in a decrease in the volume of materials to be remediated (which is currently based on CCME guideline); however, are not anticipated to result in a substantive change or require refinement of remedial options.

Table 22 Review of Remedial Components and Options for Blanchet Mine

COMPONENT	SUB-COMPONENT/ISSUE	REMEDIATION OPTIONS
Mine Openings		
Mine Area Adit	1.4 m x 1.6 m adit on the cliff poses a hazard to those who enter	1) Leave as is; 2) Backfill using borrow material; 3) Backfill using waste rock; and 4) Plug using foam.
Former Buildings/Structures		
Camp Area – Tent Frame #1	Wood frame with bedrock foundation	
Camp Area – Tent Frame #2	Wood supports and platform with bedrock foundation	
Camp Area – Tent Frame #3	Wood Construction	
Camp Area – Tent Frame #4	Log and plywood foundation	
Camp Area – Log Cabin	Log construction	1) Do nothing 2) Leave as is; and 3) Demolish and burn.
Camp Area – Log Foundation	Partial foundation and piled logs	
Camp Area – Suspected Shower	Collapsed rock pit and wooden frame	
Mine Area – Powder Magazine	Log construction	
Refuse		
Beach Area - Refuse (non-organic)	Empty drums (82)	1) Do nothing; 2) Consolidate and transport to off-site facility; and 3) Consolidate and dispose in an on-site landfill.
Camp Area - Refuse (non-organic)	Empty drums (11), small tin can/domestic waste dumps (7), concrete dock (1), and scattered debris	
Mine Area - Refuse (non-organic)	Empty drums (6), rail track (1), cable line(1), ore chute(1), tin can dump (1), ore box (1), and core boxes (many)	
Mined Materials		
Mine Area - Waste rock pile at the base of the adit entrance, approximate volume of 3000 m ³	Existing slope appears stable, with no visible erosion. Non-acid generating. Arsenic may be leaching and mobile.	1) Leave as is; 2) Re-slope; and 3) Option 2 and placement of a low-permeability cover.
Ore Concentrate in drums at Beach Area (5 m ³), in isolated spills in the Camp Area (<1 m ³) and overlying the waste rock pile in the Mine Area (19 m ³)	Non acid generating. Metal leaching is occurring of arsenic, cobalt and nickel, providing loadings to surrounding environment.	1) Consolidate and off-site disposal; and (for drums and piles) 2) Consolidate and on-site disposal. (when mixed with soil/waste rock)
Impacted Environmental Media		
Beach Area – Metal impacted soils	Associated with former ore concentrate spill.	1) Do nothing; 2) Leave as is;
Camp Area – Metal impacted soils	Associated with small ore concentrate spill and metal refuse	3) Capping (with granular material); and 4) Excavation and placement under a low-permeability cover.
Mine Area – Metal impacted soils	Associated with ore concentrate and, to a lesser extent, waste rock.	1) Do nothing; 2) Leave as is; 3) Off-site disposal; 4) On-site disposal; and 5) On-site treatment.
Mine Area – Petroleum hydrocarbon impacted soils	Soils underlying a single leaking drum in the mine area.	
Site Wide – Surface water and sediments	Small scale streams and wetlands in the footprint of the mine show evidence of metal enrichments, as well as the immediate shoreline of lake in Beach Area (next to former ore concentrate spill). The Beach Area represents the primary aquatic concern.	1) Do Nothing; 2) Leave as is and Monitor; 3) Sediment Removal; and 4) Cap sediments.

The selected Preferred Remedial Option has been identified in **bold/underline**

7.3.1 Mine Openings

7.3.1.1 Key Issues

The adit in the Mine Area is the only opening to underground. The host rock is competent and large scale failure is not presented as a concern in the diorite unit forming the crown pillar. While access to the adit is limited and requires climbing of the steep waste rock slope or descent from above, there are several hazards associated with the adit. Entering the adit presents a risk of rock fall from the roof and walls, failure of the internal wooden support structure, and a potentially dangerous atmospheric environment. Measures are required to mitigate the risks associated with the adit opening.

7.3.1.2 Potential Remedial Options

Several options have been considered for management of the risks associated with the adit (Table 23). For context, the current AANDC policy is that mine openings must be closed in accordance with the *Mine Health and Safety Act* (1994) of the Northwest Territories. However, given the limited amount of design details in this legislation, precedent practice at other abandoned mine sites in the NWT (e.g., Port Radium, Roberts Bay, Hidden Lake) has been to close mine openings in accordance with the Ontario Mine Regulations. As current legislation indicates that mine openings must be closed, the “Do Nothing” approach (i.e. no closure or monitoring), has not been considered.

Option 1 – Leave As Is with Monitoring

This option assumes no remedial work would be completed. A long-term monitoring and inspection program would be adopted to ensure that adequate barriers (e.g., potentially fencing) and/or signage were maintained at the openings. Fencing is typically not recommended (due to ongoing care and maintenance requirements) when other viable solutions are available. This option does not meet the requirements of the NWT Mine Health and Safety Act nor does it represent a “Walk Away” solution.

Option 2 – Backfill Adit (Borrow Material)

Borrow material (glacial till and/or talus) could be used to backfill and seal the adit entrance. Approximately 100 m³ of material would be required to construct an adequate seal and heavy equipment would likely be required to excavate the borrow material. Mobilizing heavy equipment and borrow material to the mouth of the adit may prove challenging due to the steep waste rock slope. As a result, there may be a need to use small tools and manpower to transport and place the borrow material that will form the adit seal. This would result in increased health and safety risks of workers performing the backfilling.

Option 3 – Backfill Adit (Waste Rock)

The waste rock deposit located immediately below the adit entrance is a potential source of backfill material to seal the opening. Similar to Option 2, accessing the adit with heavy equipment may be challenging and could result in a heavy dependence on manpower to construct the seal. An added consideration related to using waste rock is the presence of ore concentrate, assumed to have infiltrated the underlying waste rock pile resulting in metal enrichment of the waste rock. Although ABA and shake flask extraction analyses suggest these materials are not acid generating, there is potential that the waste rock would be a source of arsenic.

Option 4 – Plug Adit (Foam Plug)

Foam plugs have been used widely in the United States and various Canadian jurisdictions as a means of sealing mine openings. They have also been used by AANDC-CARD at locations in the NWT where the costs of mobilizing equipment and materials are prohibitive (e.g., Port Radium / Echo Bay).

Table 23 Remedial Options – Mine Openings

CRITERIA	Option 1 Leave As Is w Monitoring	Option 2 Backfill Using Borrow Material	Option 3 Backfill Using Waste Rock	Option 4 Plug Using Foam
Goals	Reduce the physical hazard with a permanent solution.			
Operating Principle	Monitoring of barriers, signage and conditions.	Nearby borrow materials are used to backfill and seal adit.	Adjacent waste rock is used to backfill and seal adit.	A foam plug seals the adit, with an aggregate cover.
Protection of Human Health and Environment	Moderate	High (access prevented)	High (access prevented)	High (access prevented)
Long Term Effectiveness	Low	High	High	High
Level of Confidence	Moderate	High	High	High
Potential Remedial Impacts	None	Excavation of in-situ materials (new borrow areas). Health and safety impacts to workers.	Leaching of waste rock metals to adit water potentially impacting seepage. Health and safety impacts to workers.	Excavation of in-situ materials (new borrow areas). Health and safety impacts to workers.
Implementation time for Remediation	1 Day / Year (inspection)	1 Week	1 Week	1 Week
Site Disruption	Low	Moderate	Low	Low
Ease of Implementation	High	Moderate	Moderate	High
Historical Community and Regulatory Acceptance	Low	High	High	High
Cost	Low (excluding long-term costs)	High	Moderate	Moderate

7.3.1.3 Preferred Remedial Option

Taking into consideration best practices and site-specific factors (e.g., difficulty of access), and the opinions presented within the Remedial Options Analysis Workout, Option 4 (foam plug) has been selected as the preferred remedial option for managing risks associated with the adit. Foam plugs have demonstrated success at other similar remote northern mine closures, both in installation and long-term performance. The foam plug would ensure that the physical hazard associated with the adit is addressed and that no additional metal enrichment is introduced into the adit water/groundwater environment. Community consultations also identified a preference that the ore cart within the adit should be removed and preserved for historical significance should this measure not pose a health and safety risk.

7.3.1.4 Monitoring and Contingencies

The condition of the foam plug will require routine visual inspections in both the short and long term by a suitably qualified engineer (i.e. performance monitoring). Any concerns identified during the inspections may require maintenance and/or replacement.

7.3.2 Former Buildings / Structures

7.3.2.1 Key Issues

A total of six former buildings/structures are present at the Blanchet Island Mine including log cabins and tent frames. The total volume of timber associated with the former buildings/structures is approximately 31 m³.

7.3.2.2 Potential Remedial Options

All of the structures are beyond the limit of repair (see Section 5-3) and pose no material asset to surrounding communities, historical societies, or for use during the remediation program. Consequently, remedial options focus on the destruction or monitored deterioration of the buildings/structures (Table 24).

Option 1 – Do Nothing

This option assumes no remedial work would be conducted and that structures would be allowed to deteriorate naturally, without the application of an inspection program or the use of signage indicating hazards. This is a no cost measure to address the negligible risk associated with the buildings; however, the wooden materials are slow to decompose in the northern environment and the structures may remain for decades.

Option 2 – Leave As Is With Monitoring

This option assumes no remedial work would be conducted and that structures would be allowed to deteriorate naturally. However, due to the presence of residual risk, a periodic monitoring and inspection program would be implemented to confirm that adequate barriers and/or signage are maintained to reduce the physical hazard to visitors. Based on the deterioration rate observed since buildings/structures were abandoned 40 years ago, it is anticipated that a minimum of 20 additional years is required before the structures have decomposed to a state of posing no physical hazard. Leaving structures to decay naturally is typically foregone when other remedial options are available to effectively address physical hazards immediately.

Option 3 – Demolish and Burn

This option would involve removing the contents of the buildings/structures, demolishing the wooden structures and consolidating the waste materials. The wood could be burned on site and the residual ash collected for off-site disposal or placed into an on-site non-hazardous landfill. This approach has been implemented for other wooden structures at remote northern mines, such as the former Discovery Mine. This remedial option is cost effective and manages all materials within the footprint of the site.

Table 24 Remedial Options – Former Buildings / Structures

CRITERIA	Option 1 Do Nothing	Option 2 Leave As Is with Monitoring	Option 3 Demolish and Burn
Goals	Reduce the physical hazard with a permanent solution.		
Operating Principle	No remedial actions would be implemented.	Signage would be posted indicating hazards, and a long-term inspection program implemented to monitor the deterioration.	Wooden structures would be demolished, materials consolidated and burned on-site. Residual ash would be collected and managed either on or off-site.
Protection of Human Health and Environment	Low	Moderate	High
Long Term Effectiveness	Moderate	High	High
Level of Confidence	Moderate	Moderate	High
Potential Remedial Impacts	None	None	Air emissions from burning, although minimal.
Implementation time for Remediation	None	1 Day/Year (inspection)	3 Days
Site Disruption	None	Low	Moderate
Ease of Implementation	High	High	High
Historical Community and Regulatory Acceptance	Low	Moderate	High
Cost	None	Low (excluding long-term costs)	Moderate

7.3.2.3 Preferred Remedial Option

The preferred remedial option is for the structures to be demolished and burned (Option 3). The wood could be burned on site and the residual ash collected for off-site disposal or placed into an on-site non-hazardous landfill. This approach has proven effective at remote sites to immediately remove the physical hazard from deteriorating structures, with minimal disruption to the natural environment at the site and was met with community acceptance.

7.3.2.4 Monitoring and Contingencies

Demolishing and burning the building structures will effectively remove all associated hazards and risks; although will require management during burning and work activities to minimize hazards and risks from burning in a remote environment. At the completion of remediation, long-term monitoring and contingency planning is not required for this component.

7.3.3 Refuse

7.3.3.1 Key Issues

The Blanchet Island Mine contains minimal non-combustible refuse, as the historic operation was of a small scale, required limited infrastructure and operated for only a brief period. No hazardous refuse has been identified on the site (e.g., asbestos containing materials, lead based paints). Relatively small quantities of non-hazardous material includes: cloth (3.5 m³), metal (50.5 m³), wood (23 m³) and concrete (1.5 m³). As described in the previous section, it has been recommended that wooden structures be demolished and burned along with other combustible refuse (e.g., scattered wooden debris and cloth ore bags). If this is not the case the demolition material could be incorporated into the management plan for other refuse. Wooden materials impacted with metals will not be burned, should it be assessed that the concentrations of metals have the potential to result in significant impacts to air quality.

7.3.3.2 Potential Remedial Options

Three remedial options have been considered to address the presence of non-hazardous debris at the Blanchet Island Mine. These options are discussed below and evaluated in Table 25.

Option 1 – Do Nothing

With the exception of minor physical hazards, there are no human health or environmental risks associated with the non-hazardous refuse currently on site. In this regard, the primary concern related to the material is aesthetics. Option 1 would involve leaving the non-hazardous refuse distributed on surface, without any effort to consolidate, manage or dispose the material. A long-

term monitoring program is not required as the conditions of such materials will not worsen with time.

Based on the assumption that other remedial works will be occurring on site, the “Do Nothing” option is not considered acceptable for refuse. With a minimal amount of additional effort the waste can be effectively managed, thereby improving the aesthetic quality of the area.

Option 2 – Consolidate and Transport to an Off-Site Facility

In this option, all waste debris and materials would be consolidated and placed into transportation bins for shipment (by barge or winter road) to an off-site licensed disposal facility. In the past, the Yellowknife Municipal Landfill indicated it would not accept significant quantities of industrial scrap metal sourced from beyond the city limits (threshold volumes are not known); however the Hay River landfill (of comparable barging distance) has received industrial wastes in the past. Although recycling of metal refuse is a preferred off-site disposal method, there are currently no recycling facilities in the Yellowknife or surrounding area that would accept industrial metal debris. The total volume of material requiring management is very small relative to other remedial projects in the area (approximately 52 m³ of metal and concrete, assuming wood and cloth are burned).

This option provides a long-term and permanent solution to remediating non-hazardous refuse and would be consistent with other aesthetic clean-up operations in the region.

Option 3 – Consolidate and Dispose in an On-Site Landfill

In this option, all refuse would be consolidated and placed in an engineered on-site landfill. As described in Section 5.15, two potential landfill locations have been identified on the site: one in the Beach/Camp Area and another in the Mine Area. Large metal pieces would require cutting into smaller, more manageable pieces, and the concrete from the dock would similarly need to be broken for transport and disposal. The refuse would be covered with local waste rock or with a geotextile (or equivalent), a surface layer of soil (from a local borrow source) and potentially re-vegetated. This option will cause some site disruption; however, the engineered design would limit the leaching of metals from the refuse and there are no suspected impacts associated with the burial of said material.

Table 25 Remedial Options- Refuse

CRITERIA	Option 1 Do Nothing	Option 2 Consolidate and Transport to an Off-Site Facility	Option 3 Consolidate and Dispose in an On-Site Landfill
Goals	Reduce the physical hazard and aesthetic concerns with a permanent solution.		
Operating Principle	Material left in place, without consolidation or management.	Wood and cloth would be consolidated and burned; metal and concrete would shipped to an approved waste disposal facility.	Wood and cloth would be consolidated and burned; metal and concrete disposed of in an on-site landfill.
Protection of Human Health and Environment	Moderate - High (only minor physical risks exist)	High	High
Long Term Effectiveness	Low	High	High
Level of Confidence	High (will perform as intended)	High	Moderate
Potential Remedial Impacts	None	None	Low (Small possibility of metal leaching should engineered cover fail)
Implementation time for Remediation	None	1 week for consolidation into containers and shipment.	1 week to prepare disposal area, consolidate, and move to landfill, and 1 Day/Year inspection
Site Disruption	None	Low	Moderate (construction of landfill)
Ease of Implementation	High	Moderate	Moderate
Historical Community and Regulatory Acceptance	Low	High	Moderate
Cost	None	Moderate	High

7.3.3.3 Preferred Remedial Option

Based on the small volumes of refuse involved, lower long-term liabilities, community acceptance and the assumption that other remediation activities will require barging/ice roads to move heavy equipment; the preferred remedial option for refuse is transportation and management in an off-site facility (Option 2). The potential site disruption caused through the construction of a dedicated on-site landfill, and the immediate and long-term costs (i.e., monitoring costs), provide further evidence that the small volume of materials would be best managed off-site. It is noted that during the Remedial Options Analysis Workout, community representatives voiced the opinion that if the materials are non-hazardous, they may be used in remedial measures where appropriate (e.g. fill materials).

7.3.3.4 *Monitoring and Contingency*

Consolidation and removal of the refuse materials will leave no residual hazard or risk. Long-term monitoring and contingency measures are therefore not required for this component.

7.3.4 *Waste Rock*

7.3.4.1 *Key Issues*

The total volume of waste rock is approximately 1,000 m³, all of which is located in a consolidated deposit in the Mine Area. Although the waste rock has elevated concentrations of metals, the potential for acid drainage and metal leaching is generally low. The most notable exception is arsenic due to its capacity for mobility under neutral pH conditions.

An additional concern is spilled ore concentrate that has infiltrated the waste rock pile. The fine grained ore contains higher metal concentrations and greater leaching potential than the waste rock itself. Elevated concentrations of ore elements (i.e., arsenic, cobalt, and nickel) measured in environmental media down gradient of the waste rock pile are assumed to be largely attributable to the ore concentrate.

7.3.4.2 *Potential Remedial Options*

Table 26 and the following sections discuss the remedial options that have been evaluated for management of the waste rock pile. Due to the metal leaching potential of the waste rock (with residual ore concentrate), and the potential for slope stability changes, the “Do Nothing” option has not been considered.

Option 1 – Leave As Is with Monitoring

This option assumes no remedial work would be conducted and that a monitoring/inspection program would be implemented to confirm that chemical impacts to the downstream environment (e.g., water, soil, and sediment) are not increasing. The inspection would also be used to confirm the physical stability of the waste rock pile.

In general, the metal leaching potential of waste rock is low and the associated environmental risks are quite minor. However, the co-mingling of waste rock with a much smaller quantity of ore concentrate has resulted in the waste rock pile being an ongoing source of potential environmental impacts. Furthermore, although the waste rock pile appears to be physically stable, there is a potential that slope failures will occur in the future due to the high angle of repose. Based on the combination of environmental and physical risks, leaving the waste rock pile in its current condition is not considered an acceptable option.

Option 2 – Re-Slope

The upper portions of the waste rock pile could be pulled down with heavy equipment⁵, re-sloped and landscaped to grades that would be more physically stable in the long-term. During this process, areas of the waste rock that are co-mingled with ore concentrate could be covered by “clean” waste rock. This would assist in limiting direct exposures of terrestrial receptors to contaminants of concern (particularly arsenic). Under this option, the waste rock would be graded to avoid standing water, enhance runoff from the piles and minimize overland flow contact with the waste rock. Grading could also enhance the stability of the rock piles against surface erosion.

Option 3 – Re-Slope and Placement of a Low Permeability Cover

Placement of a low permeability cover over the re-sloped waste rock pile (see Option 2) would limit the quantity of water passing through the waste rock. This would assist in limiting contaminant loadings that might otherwise occur through the solubilisation of ore concentrate in the pile.

Natural granular materials (primarily clay) are used extensively for the construction of low permeability covers. While such covers can significantly reduce water infiltration, they are most appropriate in situations where sufficient quantities of fine grained materials are located within close proximity. Based on field studies conducted to date, there are no sites on or near the Blanchet Island Mine that could serve as borrow source of natural low permeability cover materials. Taking into consideration the high costs and complex logistics associated with transporting borrow material to the site, construction of a low permeability cover with natural materials is not a reasonable alternative in the current case.

Synthetic cover systems can be highly effective in reducing water infiltration and have been used extensively in similar applications. Typically, woven and/or non-woven textile geosynthetics are used, however polyethylene or geomembrane layers or geogrid geotextile materials have also been incorporated into the design or in place of a textile layer to increase strength. Under most situations, synthetic cover systems are more effective than natural materials in controlling infiltration. The installation of such systems requires skilled trades and capital costs can be significantly higher than natural covers. However, in the case of the Blanchet Island Mine, cost premiums (if any) may be minimal due the small amount of waste to be managed

⁵ Note – It may be possible to remove some of the ore concentrate that is currently on the waste rock slope. However, there is also a potential that such removal will present occupational risks that cannot be justified. On this basis, it is assumed that the ore concentrate would not be removed prior to re-sloping the pile.

Construction of a cover system will utilize design considerations provided within the Cold Regions Cover System Design Technical Guidance Document (MEND 2012). Such considerations include impacts due to frost action, permafrost features, surface water management to reduce infiltration, techniques to minimize erosion. Where appropriate, the cover may be revegetated with native plant species. Revegetation is a preferred option to restore the site to pre-mining conditions; however, unlike contemporary mining projects, there is no cache of suitable overburden to serve as a growing medium. Any excess organic material generated during remedial measures may be used to encourage growth on the cover.

Table 26 Remedial Options – Waste Rock

CRITERIA	Option 1 Leave As Is with Monitoring	Option 2 Re-Slope	Option 3 Re-Slope and Low Permeability Cover
Goals	Mitigate chemical and physical hazards.		
Operating Principle	A monitoring program would be implemented to ensure drainage is stable and appropriate signage posted.	Waste rock would be graded to minimize standing water and promote drainage.	Building off of Option 2, waste rock would be capped to minimize water infiltration.
Protection of Human Health and Environment	Low-Moderate	Moderate	High
Long Term Effectiveness	Moderate	Moderate	High
Level of Confidence	Moderate	High	High
Potential Remedial Impacts	None	Site disturbance would occur in mining area, potentially creating a short term increase in metal influx to the environment.	No additional impacts (with the exception of those associated with Option 2)
Implementation time for Remediation	1 Day / Year	1 Week	4 Weeks
Site Disruption	Low	Moderate	Moderate
Ease of Implementation	High	Moderate	Moderate
Historical Community and Regulatory Acceptance	Low	Low to Moderate	High
Cost	Low (excluding long-term costs)	Moderate	High

7.3.4.3 Preferred Remedial Option

Consistent with technical recommendations and results of the Remedial Options Workout, Option 3 has been selected as the preferred remedial option. The waste rock and any incorporated ore concentrate will be re-sloped at a more natural angle of repose and covered with a synthetic low-permeability cover. Natural site derived aggregate will be used as a protective

barrier for the synthetic cover system, and to naturalize the ground surface. If site activities generate a sufficient volume of organic soils, this may be used to promote revegetation of the cover system. Construction of the cover system will utilize design considerations provided within the Cold Regions Cover System Design Technical Guidance Document (MEND 2012), with further details to be provided within the Technical Specifications for the site.

Due to the influence of other contaminant sources and naturally elevated metal concentrations, the placement of a low permeability cover over the re-sloped waste rock may not result in marked improvements in the quality of the downstream receiving environment. Nonetheless, it is anticipated that a low permeability cover could be constructed without a significant cost premium relative to the total project costs. The cover would also serve to isolate any ore concentrate that becomes/remains mixed within the waste rock deposit. Option 3 is considered to be the most protective of human health and the environment and provide a long-term solution.

7.3.4.4 *Monitoring and Contingencies*

A routine inspection program conducted by a suitably qualified engineer will be required to ensure the cover system is operating as intended. This will require inspection for such impacts as freeze/thaw damage, settlement cracking, erosion and surface water damage. Where deficiencies are observed, care and maintenance may be required to the cover system. In addition to the inspection of physical works, a monitoring program will be required to ensure the cover system is resulting in reducing metal loadings to surrounding environmental media. Sampling parameters may include surface water and sediment within the Mine Area marsh, as well as downstream water and sediment sampling Great Slave Lake. Vegetation sampling and surveys may also assist to determine if the cover system has been an effective measure to reduce metal leaching from the Blanchet Mine waste rock.

7.3.5 Ore Concentrate

7.3.5.1 *Key Issues*

In addition to the ore concentrate that was recently consolidated in drums located at the Beach Area (5 m³), a further 1 m³ has been identified in the Camp Area and approximately 19 m³ mixed with waste rock in the Mine Area. It is currently proposed that the Mine Area ore concentrate inventory be managed through the options intended to address waste rock (see Section 7.3.4), as the separation of the two materials is not considered to be practical. The rationale for this recommendation is that the ore concentrate covers waste rock clasts and fills void spaces; separating the ore concentrate from waste rock would be very challenging and require work activities on the steep waste rock slope.

However, where consolidated piles of ore are observed in the Mine Area, Beach Area or Camp Area, distinct management options may be assessed. The total volume of ore concentrate in drums and consolidated piles (i.e. not mixed with soil or waste rock) is approximately 9 m³.

Geochemical analyses of the ore concentrate indicate that, while there is no acid generating potential, metal concentrations and leaching potentials are high for arsenic, cobalt, and nickel, causing impacts to surrounding soil, vegetation, sediment and water. As described in Section 6.0, the HHERA determined that actions may be required to manage the ore concentrate to minimize exposure to receptors.

7.3.5.2 *Potential Remedial Options*

The remedial options proposed for the management of any additional ore concentrate focus on the removal of the material from exposure to surface water, wind and direct contact with receptors. Two potential options are proposed to accomplish these tasks (Table 27). Unlike most of the other site components, the “leave as is with monitoring” and “do nothing” options were not evaluated for ore concentrate due to the potentially unacceptable risks identified in the HHERA and the relative ease of implementing other options.

Option 1 – Consolidate and Off-site Disposal

Under this scenario all the consolidated ore concentrate (i.e., from the Camp, Mine and Beach Areas) would be placed into containers and the entire mass of ore concentrate would be transported to an off-site waste management facility. This strategy would result in all direct risks associated with the ore concentrate being removed from site, a manageable task for the 9 m³ of material.

Option 2 – Consolidate and On-Site Disposal

This option would involve placing the balance of the ore concentrate at the Mine and Camp Areas in an engineered landfill cell on site. The ore concentrate would be placed into a lined and capped cell to prohibit water infiltration and subsequent metal leaching. In the event a low permeability cover is placed over the re-sloped waste rock pile (see Option 3 in Section 7.3.4), the ore concentrate cell could be integrated with the waste rock management solution. Alternatively, a small stand alone ore concentrate cell could be constructed in the Mine Area.

Table 27 Remedial Options – Ore Concentrate

CRITERIA	Option 1 Consolidate and Off-Site Transport	Option 2 Consolidate and On-Site Disposal
Goals	Control exposure of ore concentrate to receptors, and leaching of metals to surrounding environment.	
Operating Principle	Consolidate all ore concentrate and ship to appropriately licensed storage facility.	Consolidate all ore concentrate and store in an on-site engineered lined and capped landfill.
Protection of Human Health and Environment	High	High
Long Term Effectiveness	High	High
Level of Confidence	High	Moderate
Potential Remedial Impacts	Low	Moderate
Implementation time for Remediation	1 week	2 weeks
Site Disruption	Low	Low
Ease of Implementation	High	Moderate
Historical Community and Regulatory Acceptance	High	Moderate
Cost	Moderate	High

7.3.5.3 Preferred Remedial Option

Consolidation and off-site disposal (Option 1) is selected as the preferred remedial option for ore concentrate. The 5m³ in the Beach Area has already been containerized in overpack drums, and < 1 m³ remains in the Camp Area. The majority of ore concentrate at the Mine Area may not be separated from underlying waste rock and must be incorporated into the on-site containment system for waste rock (see Section 7.3.4), and is therefore managed as per Option 2. However, where the ore concentrate in the Mine Area is observed in discrete deposits on surface, this will be containerized for off-site transport (approximately 3 m³). The incremental cost and level of effort to containerize this material is minimal, and off-site transport may be coordinated with other site activities and demobilization.

7.3.5.4 Monitoring and Contingencies

Remediation monitoring will be required during ore consolidation activities to ensure best practices are employed, health and safety measures are adhered to and there are no releases to the environment. Consolidation and removal of the ore concentrate will provide a walk away solution to prevent the release of metals from the material. However, it is recommended that a monitoring program be implemented to ensure the surrounding terrestrial and aquatic media are demonstrating an improvement of environmental quality. Long-term surface water and sediment sampling is recommended in the Beach Area (i.e. within Great Slave Lake) and downstream of the Mine Area.

7.3.6 Soils - Metals

7.3.6.1 Key Issues

Metal concentrations in soil are elevated around the Beach and Mine Areas (minor in the Camp Area). Although elevated concentrations have been measured for multiple metals, arsenic is the primary contaminant of concern and areas of impact are generally associated with locations where ore concentrate has been spilled on the ground surface. Findings of the HHERA indicate that elevated arsenic concentrations in soils pose an increased risk to both human and ecological receptors. These findings highlight the need to evaluate remedial options for the metal enriched Blanchet Island Mine soils. The Phase III ESA estimates a total volume of 1,200 m³ of metal impacted soil in the Beach Area, <1 m³ in the Camp Area, and 1,000 m³ in the Mine Area (SENES/Franz 2011).

7.3.6.2 Potential Remedial Options

Remedial options to address metal impacted soils at the Blanchet Mine would focus on soils within the Mine Area and Beach Area (Table 28). Remedial measures would address soils which have been in direct contact with, or are immediately downstream of consolidated ore concentrate piles. It is predicted that remedial measures to address the ore concentrate will result in lower metal loadings to the surrounding environmental media, including soils and associated vegetation. Invasive measures proposed to address soil contamination are intended to focus on unvegetated or poorly vegetated areas. The destruction of natural or regenerated plant communities and animal habitat is not considered to be an acceptable consequence to removal of subsurface contaminants.

Option 1 – Do Nothing

This approach assumes that no remedial activities, monitoring or inspections are implemented to address the metal impacted soils. The HHERA recommends that remedial measures are conducted at discrete areas to address arsenic concentrations in soil. The “Do Nothing” approach is therefore not considered to meet the site objectives and is not recommended.

Option 2 – Leave As Is with Monitoring

This option assumes that metal-impacted soils would be left in place and that a monitoring/inspection program would be implemented to confirm that chemical impacts to the downstream environment (e.g., water and sediment) are not increasing.

Based on the potential risks associated with metal-impacted soils (as identified in the HHERA), as well as the availability of other effective forms of mitigation, the “leave as is” option is not recommended.

Option 3 – Capping

In this option, the dermal contact, inhalation, and incidental ingestion pathways for metals in soil would be eliminated by placing a cap of granular material above the impacted soils. However, this option would not prevent the percolation of water through the granular cap and, as a result, mobilization of metals in the soils may continue. The construction of the cap would require the excavation of borrow material from a previously undisturbed area. Some degree of natural revegetation in the borrow area and above the granular cap may occur but this would likely require an extended period (i.e., multiple decades).

Construction of a cover system will utilize design considerations provided within the Cold Regions Cover System Design Technical Guidance Document (MEND 2012). Such considerations include impacts due to frost action, permafrost features, surface water management to reduce infiltration and techniques to minimize erosion. Where appropriate, the cover could be revegetated with native plant species. Revegetation is a preferred option to restore the site to pre-mining conditions; however, unlike contemporary mining projects, there is no cache of suitable overburden to serve as a growing medium and remedial activities may not generate sufficient material.

Option 4 – Excavation and Placement Under a Low Permeability Cover

This would involve excavating impacted soils from areas which have been physically disturbed by the historic mining operation (excluding roads). Based on the disturbed footprint of the site and an assumed excavation depth of approximately 0.5 m, the total volume of soil that would be excavated under this option is estimated to be 1,500 m³ (500 m³ from the Beach Area and 1,000 m³ from the Mine Area). Although elevated metal concentrations have also been measured in some areas that were not disturbed by the mining operation, excavating these natural areas (which are vegetated and/or treed) would result in significant impacts. Furthermore, it is also assumed that the elevated metal concentrations in these undisturbed areas are influenced by naturally high metal concentrations due to their proximity to a mineralized ore zone. On this basis, excavation of soils from these natural areas is not considered justified.

If this option is selected, the excavated soils would be placed under a low permeability synthetic cover similar to that which was proposed for waste rock (see Option 3 of Section 7.3.4). In addition to limiting the dermal contact, inhalation, and incidental ingestion pathways, metal leaching/mobilization would also be controlled by limiting infiltration. As listed in Option 3 (Capping), construction of a cover system will utilize design considerations provided within the Cold Regions Cover System Design Technical Guidance Document (MEND 2012).

Table 28 Remedial Options – Soil (Metals)

CRITERIA	Option 1 Do Nothing	Option 2 Leave As Is With Monitoring	Option 3 Capping	Option 4 Excavation and Placement Under a Low Permeability Cover
Goals	Remove exposure pathway to impacted soil and control mobilization of metals with a permanent solution.			
Operating Principle	No remedial actions, monitoring or inspections.	A monitoring program would be implemented to ensure drainage is stable and appropriate signage posted.	Discrete areas of metal impacted soils would be capped to limit exposure to receptors and reduce infiltration by water.	Previously disturbed areas (demonstrated to have elevated metals concentrations) would be excavated. Soils would be consolidated and placed under a low-permeability cover.
Protection of Human Health and Environment	Low	Low-Moderate	Moderate	High
Long Term Effectiveness	Low	Low	Moderate	High
Level of Confidence	Low	Moderate	Moderate	High
Potential Remedial Impacts	None	Low	Site disruption due to borrow and capping activities.	Site disruption due to excavation, borrow and capping activities.
Implementation time for Remediation	None	1 Day / Year	One week	Three weeks
Site Disruption	None	Low	High	High
Ease of Implementation	High	High	Moderate	Moderate
Historical Community and Regulatory Acceptance	Low	Low	Moderate	High
Cost	None	Low (excluding long-term costs)	Moderate	High

7.3.6.3 Preferred Remedial Option

As indicated above, leaving the metal-impacted soils in their current condition (Options 1 and 2) is not recommended. This is due to the potential risks identified by the HHERA, as well as the availability of other effective forms of mitigation. Capping the contaminated soils in place with a granular cover (Option 2) would assist in reducing direct exposure pathways to contaminants. However, this option would not prevent infiltration of precipitation through the cover and leaching of metals to downstream receiving environments.

The most effective option to manage risks associated with contaminated soils is to excavate soils from previously disturbed areas for placement under a low-permeability synthetic cover and Option 4 has been selected as the preferred remedial option. This solution is consistent with opinions presented during community engagement meetings and could be implemented without resulting in substantive increases to the overall project budget. Design details will be contained within the technical specifications and the management of metal impacted soil will be incorporated with waste rock management under a single containment/cover system in the Mine Area at the base of the escarpment (Section 5.15). This will reduce remedial impact, optimize future monitoring requirements and minimize project costs.

It is not recommended that natural and/or revegetated areas are excavated to chase sub-surface contamination.

7.3.6.4 *Monitoring and Contingencies*

Metal impacted soil will be combined with waste rock to permit the construction of a single landfill with one cover system. A routine inspection program conducted by a suitably qualified engineer will be required to ensure the cover system is operating as intended. This will require inspection for such evidence as freeze/thaw damage, settlement cracking, erosion and surface water damage. In addition to the inspection of physical works, a monitoring program will be required to ensure the cover system is resulting in reduced metal loadings to surrounding environmental media. Sampling parameters may include surface water and sediment within Vegetation surveys may also assist to determine if the cover system has been an effective measure to reduce metal leaching from the Blanchet Mine waste rock.

Should the inspection or monitoring programs identify deficiencies in the cover system, additional measures may be required. This may include improvements to surface drainage, grading of aggregate cover and patches to the synthetic cover. Such improvements will ensure the system operates as intended in the future.

7.3.7 Soils – Petroleum Hydrocarbons

7.3.7.1 *Key Issues*

Petroleum hydrocarbons were identified in the soil profile at a localized drum spill in the Mine Area. A highly conservative estimate of PHC, PAH, and ethylbenzene impacted soil is approximately 50 m³, the source of which appears to be a single drum which began leaking contents during the assessment process. There is no evidence of hydrocarbon mobility to downstream receiving environments, including the nearby wetland. The hydrocarbon impacted soil lies within the main Mine Area landing, and is also impacted with metals. Any remedial

measures for hydrocarbon impacts should not be assessed in isolation, but rather be examined with respect to the larger metal remedial program.

7.3.7.2 *Potential Remedial Options*

Due to the small area of impact, five remedial options have been assessed to address the hydrocarbon impacted soils (Table 29).

Option 1 – Do Nothing

This option assumes that no remedial activities, monitoring or inspection programs are implemented to address the hydrocarbon impacted soils. The area of impact is conservatively estimated to be $<50 \text{ m}^3$, although is in all likelihood $<8 \text{ m}^3$. The size of this contaminant source does not represent a substantive threat to the degradation of environmental quality at the site should the soils remain in the current state without ongoing monitoring.

Option 2– Leave As Is with Monitoring

Relative to other contaminants at the Blanchet Island Mine, the quantity of material and environmental risks associated with hydrocarbon impacted soils is considered to be minor. It is also assumed that natural degradation has occurred and that the hydrocarbon source is relatively immobile. This option would involve leaving the hydrocarbon impacted soils in their current location. The spill site and surrounding environment would be subjected to periodic inspections as part of a long-term monitoring program in an effort to identify any signs of environmental degradation.

Option 3 - Off-Site Disposal

This option would involve consolidating the petroleum hydrocarbon impacted soils into transportation bins and moving them off site for disposal. The City of Yellowknife will accept soils contaminated with hydrocarbons; however, if the metal concentrations are above CCME guidelines, the soils may not be accepted by the City (which is the case at the Blanchet Island Mine). Hydrocarbon-impacted soils with elevated metal concentrations could be shipped to appropriate facilities in other jurisdictions (e.g., Alberta).

Option 4 – On-Site Disposal

Under this option, the hydrocarbon impacted soils would be excavated and placed in an engineered landfill cell on site. The cell would be lined and capped to assist in preventing the release of hydrocarbons to groundwater. In the event a low permeability cover is placed over the re-sloped waste rock pile (see Option 3 in Section 7.3.4), the hydrocarbon cell could be integrated with the waste rock management solution.

Option 5 – On-Site Treatment

A number of in-situ and ex-situ methods are used to treat hydrocarbon impacted soils. These methods include bio-venting, vapour extraction, bioremediation, chemical oxidation and soil washing. The performance of most treatment technologies is sub-optimal in northern environments. Furthermore, on-site treatment is often cost-prohibitive when small volumes of soil require management. Given the small volume of hydrocarbon impacted soils present at the Blanchet Island Mine, this option is not recommended as it would not be cost-effective.

Table 29 Remedial Options – Soils (Petroleum Hydrocarbons)

CRITERIA	Option 1 Do Nothing	Option 2 Leave As Is With Monitoring	Option 3 Off-Site Disposal	Option 4 On-Site Disposal	Option 5 On-Site Treatment
Goals	Mitigate chemical hazards and concerns.				
Operating Principle	No remedial activities or monitoring conducted.	Impacted soils remain in place and are subjected to long-term monitoring.	Impacted soils are consolidated into transportation bins and transported off-site for management.	Impacted soils are consolidated and placed in an on-site engineered facility that limits mobility and exposure.	Hydrocarbon concentrations in soils are reduced to acceptable levels through <i>in-situ</i> or <i>ex-situ</i> treatment on-site.
Protection of Human Health and Environment	Moderate (no significant risks identified)	Moderate (no significant risks identified)	High	High	Moderate
Long Term Effectiveness	Low	Low	High	Moderate-High	Moderate
Level of Confidence	Low	Low-Moderate	High	Moderate-High	Low-Moderate
Potential Remedial Impacts	None	None	Minor due to site disturbance and hauling.	Minor due to site disturbance.	Minor due to site disturbance and ongoing presence during treatment.
Implementation time for Remediation	None	Long-term monitoring only	1/4 week	1 week	Potentially multiple field seasons.
Site Disruption	None	Low	Moderate	Moderate	Moderate
Ease of Implementation	High	High	High	Moderate	Low
Historical Community and Regulatory Acceptance	Low	Low	High	Moderate	Moderate
Cost	None	Low (excluding long-term costs)	Moderate	Moderate	Potentially high

7.3.7.3 Preferred Remedial Option

Results of the Remedial Options Analysis Workout identified off-site disposal (Option 3) as the preferred remedial option. Due to the minimal volume of material, other alternatives may not be cost effective and/or will not address elevated metal concentrations also documented in the soil. Soil will be containerized and shipped to an appropriately licensed soil treatment facility. It is predicted that the City of Yellowknife will not accept the hydrocarbon impacted soils due to elevated metal concentrations also found within the material. Shipment to other jurisdictions remains a possibility (e.g. Alberta). However, as the construction of an on-site landfill with low permeability cover has been accepted as the preferred remedial option to address metal impacted soil and waste rock, incorporation of hydrocarbon impacted soil may present negligible costs and is identified as a suitable alternative.

7.3.7.4 Monitoring and Contingencies

Verification sampling of soils will be conducted during the remediation process to ensure that samples exceeding applicable criteria have been excavated where possible. Through the removal of the hydrocarbon impacted material, there is no requirement for ongoing monitoring for this parameter.

7.3.8 Surface Water and Sediments

7.3.8.1 Key Issues

Historic operations have resulted in metal concentrations (particularly arsenic) that are elevated relative to background concentrations in surface water and sediments within localized areas. The elevated concentrations of metals in water and sediment collected from the Beach Area marsh, and from the near shore environment of Great Slave Lake (<15 m from shore) are causing localized impacts to benthos (observed in sediment toxicity analyses), and elevated metals in aquatic vegetation. Results of the HHERA indicate increased risk to human and ecological receptors due to metal concentrations in water and sediment, and subsequently in fish and other aquatic receptors. These results are conservative, as fish concentrations were determined using water to fish transfer factors (i.e., no fish tissue analyses were conducted in the ESA process), and all receptors were assumed to spend a maximum amount of time in areas with maximum metal concentrations.

A preliminary review of 2013 sampling data indicates a potential decrease of metal concentrations in surface water within the Beach Area, which may be attributable to the Fall 2010 cleanup of ore concentrate in the Beach Area. A definitive trend in sediment

concentrations was not identified during the preliminary review, and it is expected that additional time may be required before a measurable decrease in metal COCs is documented.

Elevated concentrations of COCs have also been measured in the water and sediment within the Mine Area wetland, creek, and in the sediment at the discharge to Great Slave Lake. Although some metal concentrations are naturally elevated due to local mineralization, concentrations measured in the receiving environment are assumed to be partially attributable to localized metal leaching of ore concentrate in the Mine Area. Aquatic impacts were not observed at the outflow of the creek to Great Slave Lake.

7.3.8.2 *Potential Remedial Options*

The aquatic environment at the Blanchet Mine may be roughly classified into two distinct categories. The first category is small streams and wetlands which originate in the bedrock uplands (e.g. Mine Area) which discharge to Great Slave Lake. During the ESA process, no evidence of fish was observed in the small streams and wetlands at the Mine and Beach/Camp Areas. Stream water could be a drinking water source for terrestrial receptors (e.g. moose). Drainage pathways at the mine are short and flow over bare bedrock surfaces, providing little to no attenuation. Where the streams terminate in wetlands, natural metal attenuation through soil/sediment deposition and vegetation uptake may occur. Streams would be subject to high volume flows from the Mine Area uplands during seasonal freshet. Given these conditions, little in the way of practical options exist with respect to the management of these small scale drainage pathways. The wetlands are currently acting as a natural sink and filter to inflowing source water. Furthermore, recommended remedial measures to manage source terms (e.g. ore concentrate) are anticipated to reduce COC loadings to the drainage pathways.

The second category of aquatic environment at the Blanchet Island Mine is Great Slave Lake. It is noted that there is no documented release of ore concentrate, waste rock, or any other mine material directly into Great Slave Lake during the operational period of the mine. Metal concentrations in surface water and sediments are believed to be due to erosion and leaching of the ore concentrate spill at the Beach Area. The ore concentrate was containerized in 2010, and it is assumed that metal contaminated soils will also be removed as part of the future remediation. The removal of these source terms is the key mechanism to reduce long-term metal concentrations in the aquatic environment. Four remedial options have been assessed for near shore water/sediment in the Beach Area, with additional evaluation provided in Table 30.

Option 1 – Do Nothing

The “Do Nothing” approach would require no remedial works, and no monitoring or inspection activities. While remedial activities in the terrestrial environment (i.e. the removal of ore and contaminated soil) will result in reduced metal loadings, the “Do Nothing” approach for surface

water and sediment is not a “Walk Away” solution. The remediation of the Blanchet Island Mine is a comprehensive project which will involve a range of remedial actions. Despite the use of sediment and erosion control measures, it is possible that remedial activities could result in short-term discharges to the aquatic environment or long-term dynamic responses.

Option 2 – Leave As Is with Monitoring

The goal of the long-term monitoring program is to confirm that remedial measures perform as intended and to verify that environmental quality is not degrading. Specifically, the program will involve periodic monitoring of:

- Water and sediment quality;
- The physical condition of remedial infrastructure that has the potential to affect the surface water environment (e.g., drainage ditches, areas for the management of ore-concentrate/contaminated soils, etc.); and
- Depending on the findings of the above monitoring, the scope and frequency may be adjusted to respond to changes that are observed.

Option 3 – Removal of Sediments

Sediment removal is a technique which may be employed to physically remove the sediments, thereby providing a “Walk Away” solution. Sediments may be removed while wet (dredging), or by diverting/draining water and removing sediments (excavating). Excavation is considered more successful in removing contaminated sediments (US-EPA 2005); however, it presents challenges due to the construction of dams and diversions in a remote location. Many of the same advantages and disadvantages apply to both techniques.

Sediment dredging and excavation does remove the contaminated sediment, which may also result in a reduction of metal concentrations in surface water. The success of sediment excavation is often limited by shallow water conditions and predominance of cobbles (US-EPA 2005), the conditions found at the Blanchet Mine. To dredge or excavate the sediments will inevitably result in habitat impacts. Best practices would be employed to limit the spread of contaminated sediments (e.g. silt curtains), though it will not prevent all contaminant releases and resuspension of contaminated sediments may result in increased metal concentrations in the surface water. Dewatering will be required of the area of excavation and/or the saturated sediments. This water will require treatment prior to discharge, which will present significant challenges in a remote site. A management plan will also need to be in place to address disposal of the sediments. The sediments could be contained in an on-site landfill or transferred off-site for disposal. A landfill would require a design that limits groundwater and surface water interactions, and an engineered lined containment cell may be required.

Option 4 – Cap Sediments

The contaminated sediments in the Beach Area may be capped to reduce the exposure of aquatic organisms to elevated metal concentrations. The technique typically employs the use of clean borrow material of engineered thickness. The granular material is ideally a clean natural sand (i.e. with fine fractions and organics), which may be armored with coarser fractions in high energy erosive environments. Geotextiles may be used to supplement the granular material and minimize mixing between the cap and the contaminated sediments below. The geotextile may have a core of engineered clay or other reactive/absorptive materials, though is not designed as an impermeable membrane. Placement of a sediment cap requires the use of sediment and erosion control measures (e.g. silt curtains); an engineered design to ensure the shear strength of the contaminated sediments is not exceeded; and detailed placement methodology to limit the release of contaminated pore water during cap placement (US-EPA 2005).

Granular material present in the Beach Area was previously identified as a potential borrow source. It is noted that these borrow materials have been allocated for use as a terrestrial cover at the Mine Area and the volume of material may not be sufficient for both purposes. The use of a granular material cap, with or without a geotextile, could isolate the sediments and reduce further contaminant transport. Heavy wave and ice action on the Great Slave Lake shore would require a thicker cap and more extensive armour. The cobble rich near shore sediments may physically support the mass of the cap, although the water depth is insufficient to allow for a thick cap (i.e. will be above the water line). Sediments further off shore are fine grained and may not physically support a thick granular cap. Measures may also be required to reduce the effects of groundwater upwelling at the Beach Area which may transport contaminants from the impacted sediments into the clean granular cap.

Table 30 Remedial Options – Surface Water and Sediment

CRITERIA	Option 1 Do Nothing	Option 2 Leave As Is with Monitoring	Option 3 Remove Sediments (Excavate or Dredge)	Option 4 Cap Sediments
Goals	Avoid significant impact to the aquatic environment (and its receptors) from chemicals of concern.			
Operating Principle	No remedial or monitoring activities conducted.	Monitoring of surface water and sediment during and after remediation to ensure no degradation in environmental quality.	Remove and dispose of sediments by excavation (i.e. dam and dewater) or by dredging (i.e. remove and dewater).	Place a granular cap material on the contaminated sediments. Synthetic materials may be used in addition.
Protection of Human Health and Environment	Moderate-High *	Moderate-High *	High	High
Long Term Effectiveness	High	High	Moderate	Low (cap integrity questioned)
Level of Confidence	Low	Moderate	Moderate	Low
Potential Remedial Impacts	None	None	High	High
Implementation time for Remediation	None	Once every three years for a minimum of 12 years	1+ weeks	1+ weeks
Site Disruption	None	Low	High	High
Ease of Implementation	High	High	Low	Low
Historical Community and Regulatory Acceptance	Moderate	Moderate	Moderate	Moderate
Cost	None	Moderate	High	High
* Note: As per the ESAs (SENEs/Franz 2011 and Columbia/Franz 2010) and HHERA (SENEs 2013), current conditions in the aquatic environment are such that significant impacts to human health and the environment are not occurring.				

7.3.8.3 Preferred Remedial Option

The primary mechanism to address concerns in the aquatic environment is the reduction of source terms. The containerization of the ore spill was conducted in 2010 and a preliminary review of 2013 sampling data indicates a reduction in metal concentrations in surface water, though not yet in sediment. It has been recommended that the soils immediately underlying the former ore spill are also containerized, thereby further reducing potential metal loading rates (Section 7.3.6). Removal of the soil and ore is anticipated to assist in the natural attenuation of the impacted sediments.

The “Do Nothing” approach (Option 1) is not recommended due to the remedial activities which are anticipated in the Beach Area. Monitoring of the aquatic environment is an important measure to ensure that the terrestrial remedial activities do not result in impacts to the aquatic environment and that environmental conditions are not degrading over time.

The removal of sediments and the use of a sediment cap can be effective, yet carry greater risks of remedial impact and project uncertainty. Sediment removal will require dewatering, water treatment and sediment management. These will present significant challenges, and may result in a net increase in impacts. The disruption of sediments could result in the spread of contamination or impacts to water quality. The management of excavated sediments may require an engineered lined containment cell to prevent leaching into the downstream environment. For these reasons, sediment removal (Option 3) is not a preferred technical option as the associated risks are considered greater than the current scale of impacts.

A sediment cap will require blanketing the existing aquatic environment, as well as additional impacts to the terrestrial environment to obtain the clean granular borrow material. The cap would need to be of significant thickness and have a coarse armour material to limit effects of wave and ice action. The near shore environment of Great Slave Lake is typically a high energy environment and the long-term stability and success of such a cap is questionable. Upwelling groundwater observed in the Beach Area may also result in metal transfer from the impacted sediments to the overlying clean cap. Considering all factors, the use of a sediment cap (Option 4) is not technically recommended.

A monitoring program may successfully determine if the removal of the ore and contaminated soil is resulting in reduced metal concentrations in the aquatic environment and was accepted as the preferred remedial option. Monitoring is recommended to start during the remediation process (i.e. Remediation Monitoring), and to continue in the following years (i.e. Long-Term Monitoring). It is predicted that the processes of natural attenuation within the limited area of impact will be observed and the use of invasive measures is not a necessity. Leaving the sediments in-situ, with a monitoring program in place (Option 2), is the technical recommendation best suited to the aquatic environment, and was also identified as the preferred remedial measure by community representatives during the Remedial Options Analysis Workout.

7.3.8.4 *Monitoring and Contingencies*

The remediation of metal enriched ore and soil at the Beach Area shoreline is predicted to result in additional improvements to surface water quality and sediment. Regulatory authorizations required for the remediation (e.g. Water License, Land Use Permit, Quarry Permit) will identify the controls necessary to minimize impacts to the aquatic environment, such as Sediment and

Erosion Control Plans. This may require the use of silt curtains, water discharge limits and sample collection. Remediation monitoring will be required to ensure near shore works do not result in impacts to the aquatic environment, including measurements of metals and suspended solids in near shore waters.

At the completion of remediation, a long-term monitoring program will be required to determine if remedial measures have resulted in a decrease of metal loadings to the aquatic environment. Surface water sampling at surface and depth is recommended adjacent to the shoreline and within the far shore environment. Sediment sampling is also recommended, although it is predicted that longer timelines will be required before definitive improvements are observed in sediments.

Contingency measures will be required during remediation and will identify suitable measures should remedial works result in an unacceptable increase in metal loadings to the aquatic environment. Action triggers will be identified as part of regulatory controls and/or sediment and erosion control plans. Further information regarding monitoring and long-term measures are provided in Section 8.0.

8.0 MONITORING AND LONG-TERM MEASURES

Monitoring, maintenance, and contingency plans are essential in the successful implementation of a RAP, serving the following key functions:

1. To ensure health and safety of workers during remediation (*health and safety monitoring*);
2. Monitor for possible impacts and quality control while the remedial work is underway (*remediation monitoring*);
3. Monitor the effectiveness and condition of the remedial work that was done after its completion (*performance monitoring*);
4. Monitor the environmental media to document physical and chemical conditions following the remediation (*long-term monitoring*);
5. Ensure that any required maintenance work is done to keep the remedial work up to specifications (*care and maintenance*); and,
6. Make sure that backup plans are ready in case something unexpected takes place (*contingency plan*).

The remedial actions outlined in Section 7.0 will require a commitment to monitoring, both during the implementation phase of the project, and after the remediation is complete. As a first step and in keeping with AANDC's "Mine Site Reclamation Guidelines for the Northwest Territories" (INAC 2006a) a 'Reclamation Completion Report' will be completed following the remediation of the site, which will compare the actual remedial works completed at the Blanchet Island Mine to the remedial specifications to ensure consistency.

8.1 HEALTH AND SAFETY MONITORING

Health and Safety monitoring is required during the remediation of the Blanchet Island Mine. A designated health and safety officer will be on-site at all times during the implementation, with the primary role of monitoring the health and safety of the workers. The monitoring could include activities such as confirmation dust monitoring, safety audits/inspections, ensuring the use of proper personal protective equipment, reviewing the use of standard operating procedures, etc. All measures will be detailed in the Site-Specific Health and Safety Plan to be drafted by the selected contractor and subject to review and approval.

8.2 REMEDIATION MONITORING

While the remedial options have been selected to provide projected net benefits in environmental quality, some of these measures have the potential to result in impacts to the terrestrial and aquatic environment. Some of these impacts may be predicted and are an unavoidable

consequence of the larger remedial plan, such as vegetation damage during development of borrow areas/roadways. Other impacts may be avoided through the use of best practices and will require the implementation of regulatory controls, a monitoring program and detailed project planning.

A Remediation Monitoring Program will be required to assist proponents in identifying remediation activities that may have an adverse impact on the natural environment. The program will focus on potential discharges to receiving waters in the near vicinity of remedial works. This should include the Beach Area and Mine Area Discharge (Great Slave Lake), and possibly at select locations in the Mine Area. During the construction of remedial works, it is recommended that no less than two small scale monitoring campaigns be conducted. These campaigns are not intended to serve as a comprehensive assessment of environmental conditions, but should be used to confirm that remedial activities are not causing new impacts. Observational monitoring of potential impacts to local wildlife would be conducted by on-site personnel employed as wildlife monitors for the duration of the site remediation.

It is recommended that a detailed Remediation Monitoring Plan be drafted in conjunction with the Long-Term Monitoring Plan and State of Environment Plan. The use of this phased approach to monitoring identifies potential remedial impacts and benefits during and following the remediation of the site. This approach will also permit the opportunistic combination of site monitoring activities at adjacent mining properties, ensuring consistency in approach and overall cost savings.

For context, a number of mechanisms already exist to control and monitor construction-related releases to the environment. These include:

1. Regulatory Authorizations - At least one Land Use Permit, Water Licence or Quarry Permit will be issued for the project. These authorizations will identify controls necessary to mitigate potentially adverse environmental impacts (e.g., use of silt curtains to control suspended sediments). These regulatory authorizations may also specify criteria for the release of potential contaminants to the receiving environment (e.g., for wastewater discharge) and reporting requirements for inadvertent releases (e.g., spill reporting).
2. Contractual Measures - As "proponent" and licensee, AANDC will be responsible for ensuring compliance with all regulatory authorizations. At a functional level, this responsibility will be transferred to the remediation contractor through contractual obligations. An example of a general measure to be imposed on the contractor is:

"Comply with all applicable environmental laws, regulations and requirements of Federal, Territorial and other regional authorities, and

acquire and comply with such permits, approvals and authorizations as may be required. "

A more specific example is:

"Provide an erosion and sediment control plan that identifies the type and location of erosion and sediment controls to be provided. Plan to include monitoring and reporting requirements to assure that control measures are in compliance with erosion and sediment control plan, Federal, Territorial, and Municipal laws and regulations"

The Crown Representative (i.e. Resident Engineer) will oversee the implementation of these obligations. This will include the authority to approve any monitoring requirements specific to individual construction activities. Throughout this process, AANDC will be given opportunities to comment on the monitoring requirements. Compliance with the authorizations will also be monitored and enforced by Land Use Inspectors.

3. Environment, Health and Safety Procedures - The remediation contractor will be required to submit a comprehensive Environment, Health and Safety Plan that will identify procedures to control and address potential impacts to the environment. Where appropriate, these procedures will include provisions for environmental monitoring. For example, in the event of a fuel spill, the procedures will define emergency response and remedial approaches that are to be followed. The Crown's Resident Engineer will have the responsibility and discretion to define requirements for confirmatory sampling which could include sampling within the receiving environment.
4. Standing Regulation - In addition to project-specific authorizations, environmental legislation of general application will also be enforced during the remediation project. Examples of such legislation include the Fisheries Act, Species at Risk Act, the Canadian Environmental Protection Act and the Northwest Territories Environmental Protection Act. Appropriate regulatory agencies including the Department of Fisheries and Oceans, Environment Canada and the Government of the Northwest Territories will have the authority to inspect and enforce against these pieces of legislation.

As evidenced above, a number of measures are in place to ensure that individual remediation activities are not having a deleterious effect on the receiving environment. Notwithstanding the conclusion above, there remains a possibility that limited additional monitoring will be required during the implementation of remediation. While it is difficult to predict the nature and scope of these requirements (e.g., sampling locations and required analyses), responsibilities for identifying such requirements should be clearly assigned. Prior to deciding how to implement

any construction activity monitoring, the realities of operating at a remote field location need to be considered. Specifically, the schedules of individual construction activities are typically very fluid, as are the nature and timing of potential environmental concerns. It is therefore very difficult to anticipate when and what monitoring requirements will arise. In this context, the Resident Engineer should be given authority to request that the remediation contractor conduct additional monitoring on an "as and when needed" basis to address potential environmental concerns if they arise. Collectively, these requirements are expected to be minimal.

8.3 PERFORMANCE MONITORING

Performance monitoring is recommended for all remedial measures constructed, including any drainage controls, slopes and the seals/barriers for mine openings. The performance of the remedial works should be measured in terms of physical stability, erosion and sedimentation. Performance monitoring is recommended on an annual basis for a period of a minimum of five years following completion of the remedial works. Based on the results of initial monitoring, the frequency and scope of the long-term monitoring program could be adjusted accordingly. The performance monitoring will include annual inspections by an appropriately qualified engineer, which are typically implemented as part of the annual Long-Term Monitoring Program. Detailed inspection requirements should be clarified within the Long-Term Monitoring Plan.

8.4 LONG-TERM MONITORING (ENVIRONMENTAL MONITORING)

Upon completion of remedial measures, a scheduled Long-Term Monitoring Plan is recommended. This should be drafted and approved prior to the completion of remedial measures.

An adaptive management approach would be taken in determining the long-term requirements of the environmental monitoring program. As initial monitoring results become available, the monitoring program would be evaluated to confirm it is capable of detecting and evaluating any substantive changes in site conditions that have the potential to result in adverse environmental impacts.

In similar remedial projects, AANDC has implemented this approach through an initial five year monitoring plan. The timing of annual campaigns should be fixed to reduce the influence of seasonal variation on the monitoring data set. The analytical parameters proposed for the Long-Term Monitoring Program may be selected based on: a) historic land-use; b) contaminants of concern identified prior to remediation; and, c) anticipated post-remediation site conditions. To the extent possible, analytes should be selected to be consistent with previous monitoring

activities at the sites. Details on sampling analytes, assessment criteria, sampling location and frequency will be required within the site specific long-term monitoring plan.

8.5 CARE AND MAINTENANCE

Long-term care and maintenance could include any activities that are required to ensure the ongoing integrity and performance of the remedial works. Additional works may be required to ensure that the impacts of past site activities are mitigated within the context of best practice and the specific commitments of this RAP. Examples of care and maintenance activities include: re-grading of aggregate covers, repairs to adit seals, and re-posting of signage.

8.6 CONTINGENCY PLANNING

Contingency planning provides a prescribed course of action for unforeseen events during remediation. Such plans are used to mitigate effects to human health and environment and to allow personnel to adhere to regulatory guidelines and best practices in an effective and efficient manner.

During remediation, contingency planning must address the potential that despite planning and the use of controls, remedial measures present risk. The contingency plan must identify regulatory authorities, reporting protocols and identify a clear course of action (INAC 2007). The contingency planning must at minimum provide specific protocols to address petroleum hydrocarbons or chemical spills, releases to the aquatic environment, wildlife encounters and fires. Additional planning may be required upon determination of the remedial approach and consultation with regulatory authorities. Production of contingency plans is most commonly tasked to the remedial contractor prior to the initiation of the remedial program.

9.0 REMEDIATION SCHEDULE

Remediation of the Blanchet Island Mine is a relatively small-scale project when compared to other AANDC-CARD remedial projects. The implementation of the RAP, under any combination of remedial options, is projected to require a maximum of one summer season (assuming on-site treatment of hydrocarbon impacted soils is not selected). At the time of this report production, the remedial program is projected to begin in spring/summer 2014.

It is assumed that barge transport between the mine and either Yellowknife (~150 km travel each direction) or Hay River (~250 km travel each direction), is the preferred option for equipment and material transport. Barge travel has been used extensively throughout Great Slave Lake, including during the operation of the Blanchet Island Mine. The primary limitations with respect to barge travel are seasonal, with the eastern half of Great Slave Lake ice free from late May to October, and inclement weather more likely in the early spring and late fall. A projected general schedule is provided below using barge transport:

- June: One week required to mobilize all equipment and materials to the site. One week required to establish camp facilities for the remediation workforce.
- July: Approximately one month is required to complete the remediation. This estimate is subject to change based on the preferred remedial options selected, with a maximum time allotment of two months (assuming the most time consumptive remedial options are selected).
- August: Approximately two weeks is required to de-mobilize all equipment and materials and transport mine materials to landfill (as selected in the technical recommendations). Deconstruction of camp facilities will require approximately one week, which may be conducted concurrently with material transport.

If a winter road is selected as the method of equipment and material transport, mobilization and demobilization would occur during the winter months (typically between January and March), thereby resulting in project duration of one year. The construction of a winter road is expensive, time consuming, and accompanied by uncertainties due to weather and ice conditions. For these reasons, it is unlikely an ice road will be constructed or utilized by the remedial contractors.

The schedule is subject to revision and refinement based on the selection of preferred remedial options, procurement approach, contract award and regulatory approval.

10.0 REFERENCES

- Aboriginal Affairs and Northern Development Canada (AANDC) 2011. *SID Viewer*. [Online] <http://ismsid.inac.gc.ca/website/sidvh1/viewer.htm>
- Aboriginal Affairs and Northern Development Canada – Contaminants and Remediation Directorate (AANDC-CARD) 2013. *Traditional Knowledge Questionnaire Summary*.
- Biodiversity Institute of Ontario 2008. *Great Slave Lake – Northwest Territories*. Encyclopedia of Earth.
- Canadian Council of Ministers of the Environment (CCME) 2012. *Canadian Environmental Quality Guidelines*. On-line version accessed May 2012 from <http://st-ts.ccme.ca/>.
- Canadian Council of Ministers of the Environment (CCME) 2008. *Canada-Wide Standards for Petroleum Hydrocarbons (PHCs) in Soil: Scientific Rationale*. Supporting Technical Document. January.
- Canadian Council of Ministers of Environment (CCME) 2007. *Canadian Soil Quality Guidelines, Update 7.0, Table 1 and 2*. Canadian Soil Quality Guidelines, Residential / Parkland Coarse Grained Soils.
- Canadian Council of Ministers of the Environment (CCME) 1996. *A Protocol for the Derivation of Environmental and Human Health Soil Quality Guidelines*. Report CCME EPC-101E, CCME. March
- Canadian Sites Management Working Group (CSMWG) 2000. *A Federal Approach to Contaminated Sites*.
- Columbia Environmental Consulting Ltd. 2009. *Phase II Environmental Site Assessment (ESA) of the Blanchet Island Mine Site, Great Slave Lake, NWT (SM463), Project No. 0301*
- Columbia Environmental Consulting Ltd./Franz Environmental Inc. (Columbia/Franz) 2010. *Enhanced Phase III Environmental Site Blanchet Island Mine Site, Great Slave Lake, Northwest Territories*.
- Ecological Stratification Working Group 1995. *A National Ecological Framework for Canada*. Agriculture and Agri-Food Canada. Research Branch, Centre for Land and Biological Resource Research and Environment Canada, State of the Environment Directorate, Ecozone Analysis Branch, Ottawa/Hull. 125 pp.

- Ecosystem Classification Group 2008. *Ecological Regions of the Northwest Territories –Taiga Shield*. Department of Environment and Natural Resources, Government of the Northwest Territories, Yellowknife, NT, Canada. viii + 146 pp. + insert map.
- Environment Canada 2011. *National Climate Data and Information Archive - Canadian Climate Normals* [Online] <http://www.climate.weatheroffice.gc.ca>
- Environment Canada 2010. *Species at Risk in the Northwest Territories 2010 Edition*. Canadian Wildlife Service.
- Environment Canada 2009. *National Inventory Report 1990-2008. Part 3 – Greenhouse Gas Sources and Sinks in Canada*. The Canadian Government's Submission to the UN
- Fisheries Act*. 1985. R.S.C., 1985, c. F-14. Last Amended 2012-06-29.
- Golder Associates 2010a. *Aquatic Baseline Report for the Proposed NICO Project*. Submitted to Fortune Minerals Limited. Retrieved from the Mackenzie Valley Review Board Public Registry.
- Golder Associates 2010b. *Baseline Soil and Vegetation Chemistry for the Proposed NICO Project*. Submitted to Fortune Minerals Limited. Retrieved from the Mackenzie Valley Review Board Public Registry.
- Government of the Northwest Territories (GNWT) 2010. *Northwest Territories Air Quality Report 2009*. Department of Environment and Natural Resources.
- Government of the Northwest Territories (GNWT) 2004. *Guideline for Industrial Waste Discharges in the NWT*. Developed by the Environmental Protection Service (EPS) of the Department of Resources, Wildlife and Economic Development (RWED)
- Hamilton, S.M. 2007. *Major Advances in Soil Geochemical Exploration Methods for Areas of Thick Glacial Drift*. Proceedings of Exploration 07: Fifth Decennial International Conference on Mineral Exploration. 2007. p.263-280
- Health Canada 2010a. *Federal Contaminated Site Risk Assessment in Canada. Part V: Guidance on Human Health Detailed Quantitative Risk Assessment (DQRA) for Chemicals*. September.
- Health Canada. 2010b. *Federal Contaminated Site Risk Assessment in Canada. Part I: Guidance on Human Health Preliminary Quantitative Risk Assessment (PQRA)*. September.

- Health Canada. 2009. *Federal Contaminated Site Risk Assessment in Canada. Part II: Health Canada Toxicological Reference Values (TRVs) and Chemical Specific Factors*. September.
- Health Canada 2007. *Federal Contaminated Site Risk Assessment in Canada. Part I: Guidance on Human Health Preliminary Quantitative Risk Assessment (PQRA)*. Draft. June.
- Indian and Northern Affairs Canada (INAC) 2007. *Guidelines for Spill Contingency Planning*.
- Indian and Northern Affairs Canada (INAC) 2006a. *Mine Site Reclamation Guidelines for the Northwest Territories*.
- Indian and Northern Affairs Canada (INAC) 2006b. *New Corporate Procedures Manual (Management Framework)*. Northern Affairs Contaminated Sites Program.
- Indian and Northern Affairs Canada (INAC) 2002a. *Northern Affairs Program Contaminated Sites Management Policy*.
- Indian and Northern Affairs Canada (INAC) 2002b. *Mine Site Reclamation Policy for the Northwest Territories*.
- International Permafrost Association (IPA) 2012. *What is Permafrost?* [online] <http://ipa.arcticportal.org/resources/what-is-permafrost>
- Jacques Whitford Environmental Limited (JWEL) 2005. *Preliminary Site Assessment Blanchet Island Mine*.
- Mackenzie River Basin Board (MRBB) 2003. *State of the Aquatic Ecosystem Report: Great Slave Lake Sub-Basin*.
- Mackenzie Valley Land and Water Board (MVLWB) 2011. *Interactive Map of Land and Water Permit Applications*. [Online] <http://www.mvlwb.ca/mv/pages/maps.aspx>
- Mackenzie Valley Resource Management Act* (MVRMA) S.C. 1998. 1998
- Mackenzie Valley Land Use Regulations*. SOR/98-429. 1998.
- Mine Environment Neutral Drainage Program (MEND) 2012. *Cold Region Cover System Design Technical Guidance Document*. MEND Report 1.61.5c
- Mine Health and Safety Act*. SNWT 1994. c 25. Northwest Territories.
- Metal Mining Effluent Regulations (MMER)*. SOR/2002-222. 2011.

- Moon, C.J., Whately, M.E.G. and Evans, A.M. 2006. *Introduction to Mineral Exploration*. Blackwell Publishing, MA.
- Natural Resources Canada (NRC) 1995. *The National Atlas of Canada 5th Edition – Canada Permafrost Map*. MCR 4177. Produced by the National Atlas Information Service, Canada Centre for Mapping, Geomatics Canada, and the Terrain Services Division, Geological Survey of Canada.
- Natural Resources Canada (NRCan) 2011. *The Atlas of Canada – Toporama Topographic Map Database* [Online] <http://atlas.nrcan.gc.ca/site/english/maps/topo/map>
- NORMIN. 2010. *Northwest Territories Geoscience Office NORMIN Database* [Online], Showing ID 085HNE0046, Blanchet Island Mine [Online] <http://ntgomap.nwtgeoscience.ca/>
- Northwest Territories Water Act. S.C.*, 1992. 1992
- Northwest Territories Water Regulation*. SOR/93-303. 1993
- Ontario Ministry of Environment (MOE) 2004. *Soil, Ground Water and Sediment Standards*.
- Ontario Ministry of Environment (MOE) 1993. *Ontario Typical Range Of Chemical Parameters In Soil, Vegetation, Moss Bags And Snow*.
- O’Sullivan, G., Bilyk, and Sandau, C.D. 2010. *Differentiating Aged Petroleum Hydrocarbons from Modern Phytogenic Hydrocarbons in High Organic Content Soils Using Biomarkers*. Environmental Forensics – Proceedings of the 2009 INEF Annual Conference. The Royal Society of Chemistry, United Kingdom.
- Price, W. 1997. *Draft Guidelines and Recommended Methods for the Prediction of Metal Leaching and Acid Rock Drainage at Minesites in British Columbia*. BC Ministry of Energy and Mines.
- Public Works and Government Services Canada (PWGSC) 2010. *PowerPoint presentation of Blanchet Island Mine Beach Area Drum Clean-up*.
- SENES Consultants Limited (SENES) 2013. *Human Health and Ecological Risk Assessment for Blanchet Island Mine Site, Northwest Territories – 2013 Update*. February, 2013.
- SENES Consultants Limited (SENES) 2011. *2010 Northwest Territories Environmental Audit – Status of the Environment Report*.

- SENES Consultants Limited (SENES) 2005. *Northwest Territories Environmental Audit 2005–Supplementary Report on the Status of the Environment*.
- SENES Consultants Limited and Franz Environmental Incorporated (SENES/Franz) 2011. *Phase IIIa Environmental Site Assessment of Blanchet Mine, Northwest Territories*.
- Silke, R. 2009. *The Operational History of Mines in the Northwest Territories Canada*, Northwest Territories Geoscience Office.
- Stantec. 2010. *Thor Lake Rare Earth Metals Baseline Project. Environmental Baseline Report: Volume 3 – Aquatics and Fisheries. Final Interim Report*. Prepared for Avalon Rare Metals Inc. Retrieved from the Mackenzie Valley Review Board Public Registry.
- Thompson, P.A., J.A. Kurias and S.S. Mihok 2005. *Derivation and Use of Sediment Quality Guidelines for Ecological Risk Assessment of Metals and Radionuclides Released to the Environment from Uranium Mining and Mining and Milling Activities in Canada*. Environmental Monitoring and Assessment 110 (1-3): 71-85. November.
- Treasury Board 2002. *Treasury Board Federal Contaminated Sites Management Policy*. June.
- United Nations 1992. *United Nations Framework Convention on Climate Change*.
- United States Environmental Protection Agency (US-EPA) 2005. *Contaminated Sediment Remediation Guidance for Hazardous Waste Sites*. Produced by the Office of Solid Waste and Emergency Response.

APPENDIX A

REMEDIAL ACTION PLAN OPTIONS ANALYSIS WORKOUT TRANSCRIPT



AKAITCHO REGION COMMUNITY ENGAGEMENT

GREAT SLAVE LAKE PROJECT REMEDIAL OPTIONS ANALYSIS WORKSHOP MEETING TRANSCRIPT

DATE: JUNE 13-14, 2013
PLACE: FORT RESOLUTION, NT.

PARTICIPANTS; Ron Breadmore (RBr), Project Manager, CARD
Joel Gowman (JB), Project Officer, CARD
George Lafferty (GL), Consultation Officer, CARD
Kaitlyn Vician (KV), Student, CARD
Jessie Hoyt (JH), PWGSC
Charles Gravelle (CG), SENES
Claire Brown (CB), SENES

August Enzoe (AE), LKDFN
Mike Tollis (MT), LKDFN, Tech Adv June 14 only
Ernest Boucher (EB), LKDFN, June 14 only
Arthur Beck (AB), FRMC
Tom Unka (TU), FRMC, Tech Adv
Pete King (PK), FRMC
Kara King (KK), FRMC, President, June 14 only
Ann Biscaye (ABi), DKFN, Translator
Robert Beaulieu (RBe), DKFN
Paul Smith (PSm), DKFN
Stanley Beck (SB), DKFN
Patrick Simon (Psi), DKFN, Lands Mgr June 14 only
Rosy Bjornsen (RBj), DKFN, Manager

DAY ONE – JUNE 13, 2013

Opening Prayer August Enzoe,

Introduction George, Ron & Everyone (introduced themselves)

Presentation Project Objective and Status Ron Breadmore

AB This is your first time in our community?

RBr We were here last week, for a meeting (*AB was not part of the meeting*)

AB Was not aware of the TK study and would like to opportunity to provide some information.

RBr We did the mapping exercise and maps were brought to Ft. Res last week; this gave an opportunity for other Elders to provide addition information such as, yourself.





- AB** How are people going to visit the site; are they going to fly or by boat some people don't fly.
- RBr** We are getting two twin otters on floats so it will be by flight.
- AB** I have one question. You say you are going to have two twin otters there but you are going to three different islands I would suggest that you have a boat out there so ... not audible.
- RBr** Thanks Arthur, we will consider that.
- Marc E'ntremont phones in from BC**
- RBr** ***AANDC presents the Workout Framework for the meeting.***
- TU** I have a question, here. You're referring to your water license to the MVLWB I know sometimes these process are may take a long time, have you considered that? It seems that you are timing whole bunch of stuff here looking at options and so forth yet you will require a license to work on some of the stuff you're working on. Did you look at that option also? Please describe the options a little for the rest of the people, here. Has the length of time required to get a water license been considered during planning? This may impact the schedule.
- RBr** Yes, the permitting process they can be quite lengthy and that's why we build the timing into our schedule to allow for that so what we are doing the technical specifications to tie the lose ends together we will have the application in. We'll have the site tour with the Board. I think we will be in good shape. This is a model we have used on other sites. I'll get to that slide in minute and talk about that hybrid. Just for discuss with our observation on meetings to date with the TK workout, public update and executive update in Lutsel K'e and here in Fort Resolution. We got a really good sense of cooperation between the communities and between the groups and we would like that to continue on through the meeting and we think that is going to happen. What we also like to see is this collaboration or combination of technical approach and TK; the two come together. We have a lot projects with great success where that has worked; Colomac comes to mind.
- TU** Do you think the whole clean up effort will go through an Environmental Process?
- RBr** The size of these clean up project I do not that as a risk. The biggest risk we have so far was on the Colomac Project and we had done a sufficient consultation and we had input from the communities and we build a very strong Remedial Action Plan so there was no trigger for EA. I am pretty that will be the case, here.
- PK** I want to say something before we start. We're talking about old mines but we don't say anything about O'Connor Lake Mine, east of Rocher River. I thought we would talk about that mine; it is still there. East of Rocher River called O'Conner Lake Mine.
- RBr** Thank you, Pete. That's right, O'Connor Mine is on our inventory that was assessed and we are working through that assessment process. So, it is on our list and we'll be looking at that within the next couple of years. We won't be talking about O'Conner today, but we do have it on our list. Thank you.
- CG** ***SENES technical presentation - Outpost Island Mine***
- ?** Can you show on the blueprint where the tailings was?
- CG** Ok, so what the question was where was the tailings. So, what they did in the original mining operations that went on in the 40s, correct me if I am wrong on this one. They were basically working in this are and just discharging the tailing right onto the land and that is not to say that some of it did not go into the north bay. When they went back in 51, 52 they actually went and re-processed some of those tailings and waste rock. So the tailings in most part are in this area; there is bit of spillage over here and a bit of spillage over here.
- AB** Who was there during the 1994?



- CG** We can find out who it was. I can't remember the name of the outfit right now but basically a couple of construction manager types working with the youth I believe and I think it was the Métis group. Their names are all welded onto a plate at the outpost island so if you want to I could, we have a photograph somewhere.
- AB** You talked about a lot stuff there but talking about small animals and whatnot. All of that waste rock and the rain, snow and melt all that goes into the GSL and that's one of the main fishing habitats. We use the lake for fishing which is important to the community. Have fish been assessed?
- CG** That's right that is being considered in the study right now. We'll take that one and have dialogue because it's one of the better issues. Ok, do you want to go right into Blanchet or take two
- RBr** Are there any questions on Outpost before we go into Blanchet?
- TU** Yes, there probably is because we do have other metals like the old equipment sitting there that sort of belongs to the NWT Mining Heritage. What are you going to do with it? Are you going to just let it sit there; it does have some historical value to it. It's not going anywhere and some of the Elders are saying why you don't just leave it there.
- RBr** Tom, good question. We've discussed that and we will discuss further during the options on debris on site. What we are going to try and do if we can do it safely and cost effectively is to bring those units back out as a whole, probably in pieces for the mine heritage society they are collecting all these artefacts from our mine sites in Yellowknife because they present a hazard on site and the concrete that's left from the foundation we try to break down. The impacted concrete, the hydrocarbons, oil, lube that would be consolidated under a cap at one of the sites with other hydrocarbon soils and the clean concrete we may have an option to use as break wall, in North Bay for example. The plan is get the equipment off-site.
- CG** Ok, if there aren't anymore question on Outpost, we will move onto Blanchet Mine so we moved a little further in the Hearne Channel now
- AB** If you don't mind, after we do one mine site we take a break so we can chat with our Elders. I think we should do one mine site at a time.

BREAK

CG *SENES technical presentation continued – Blanchet Mine*

- RBr** I'll start. That is a concern for traditional user for sure. What's difficult in Great Slave Lake is that it's such a huge water body and the fish move around so much it is really hard to make any connection with any impacts with these fish with these three sites. It may be a little easier at Copper Pass we got a small lake that would be easy to do. Great Slave Lake is a little trickier. Jessie, could you explain the process we used.
- JH** That is the consideration we are trying to find out how we can tackle that so we talked to experts we spoke with DFO, EC. We talked about how to best handle the fish issue and collectively what is decided was it will be very difficult to find out because of small impact on GSL. It's hard to actually pinpoint how this affects your fish. We have ongoing fish sampling in GSL region and we will continue with the fish study. What we have to do is address on site contaminants and the sources that is actually going into the GSL. When it comes to fish it is very hard to associate our sites with those fish because the fish have a large roaming area but we will continue monitoring the GSL. .
- AB** I understand all that. Let's do another one, let's sample the soil. There's current there, let's sample the soil right at the drop off at least. We should actually sample the soil at the bottom even at the drop off. It's not going to be that deep. We should check the soil, thank you.
- JH** We have checked the soil and when we mention sediment we are talking about soil at the bottom of the lake. We have done our test as far as the sediment is and have calculated our risk and we spoke with DFO and EC about our results there as while so. That was taken into consideration and sampling done.



- AB** You should bring some of those samples. ... non audible
- JH** You want to see the actual physical substance ...
- AB** Not the substance itself, but the results. It would make it a lot easier the people would trust you a lot more when you have something to show. Back in a day, we trust each other and everything was with a hand shake, now everything is now on paper.
- JH** On all our site assessment reports in the appendixes at the back of the report is where we have all the supporting documents from the lab and we also have summaries in the report.
- AB** What I am saying is for each one of these for example when we did outpost you test the site and you know what is going into the water and all that stuff but we do not know that here. We just hear what you say. It would be easier if you have this information at the end of each mine site presentation.
- RBr** Its one of those things when we have so much information out there and the communities do have the reports the environmental site assessments they do have those findings. What we want to say today is instead of parts per millions but what we say is we have exceedances above our standard. That's the kind information and concerns that are out there we want to show. If there are elevations above standards, that is what we need to talk about.
- AB** Exactly. The main ones like arsenic what levels are they at the lake bottom and the beach stuff like that.
- RBr** Just as an example you might want flash up those intensity maps on Copper Pass. There is some color coding that Charles showed we can have a closer look at that. What those levels actually mean. We do have some of that information here today.
- CG** The information we have from the lab is bunch of papers what might be more beneficial is showing the concentration if that is easier for you. I have this information on my computer we can link up my computer and we can view some of those tables.
- AB** I was not speaking for myself. We just want the information summary, you can break up the data and give us the information.
- CG** Yes,
- TU** While you are supplying us with all data can you give us exceedance levels and thresholds or some of metals you are talking about?
- CG** Just as a general rule Tom, in our assessment report we typically compare our information to the standards for that site.
--- Explanation of Graphs Used ---
- RBe** What are talking about PHC?
- CG** PHC is a technical term used for oil, gas, diesel fuel, that is what we are talking about.
- RBj** Did you do any sampling for phytoplankton?
- CG** That's part of the program we did back in 2010. The sediment samples were submitted for metal testing. We didn't do Hydrocarbon; we were not concern with hydrocarbon then.
- RBj** I have another question. This is regards to all the work that you guys are doing; you're talking to the Elders around but did you talk to anybody that worked at the mine? Are you guessing what happened, so.
- CG** Unfortunately, in a lot of these operations the people that worked the claims and whatnot aren't really around so we don't often have the luxury of speaking with them. Generally, these are old abandoned explorations or mine operations that went bankrupt and the people just disappeared so we get more information talking with you people. Who often worked on site so when we want to know where the winter road is done we often rely on you guys.
- RBj** I just wanted to know who you talked with.
- CG** Sometimes what we do is have access to data base where records are kept on how much mineral was produced and how much mining they actually did but really that is



what you are left with whatever the mining operator wanted to provide. The rest is what you observe.

RBr Just to add to that, Charles. That is a good question, Rosy. I guess when we do have that luxury of speaking with people that are still around like the Rayrock Mine, we do have those discussions. We do rely on historical information like Ryan Silk out of Yellowknife and he does put these reports together. It's based on some of those records, Workers Compensation Board (WCB), those historic are good source of information. You're never going to have the information but we have a pretty good handle on the information just from historic from what Ryan Silk has done alone.

TU What Rosy is talking about some of the old people and some of the mine owners and some people that worked at the mines sites are gone. For me, this program does not put enough enfances on traditional knowledge. If you spoke with some of the people that are alive today you may find some answers there. Our traditional knowledge is pretty vast it's came from centuries their observation and spiritual practices, living in harmony with the land and water, so we are part of whole. It is the intellectual properties of first nation's members through stories, experiences, practices, even spiritual feelings and teachings. It was passed on by our parents and ancestors. This knowledge will continue to exist it will be passed on to our children we will teach our children to live off the land. We have some of the rights it is not something you can take off the shelf and use it. That knowledge is for people all of us here have wealth of information. I feel it is not coming out here. We went through this traditional knowledge process I don't think you really thought out what is you are getting. Some of the historical stuff is not there because you didn't really talk to all the people. All of us here have some traditional knowledge so let use it let's not say we are done with it. As long as the people get involve it will involve traditional knowledge. It is our passed it is fact so let's use if properly.

AB We are here to help with this process you said something about contract. People talking about the area in regard before they build the mine and made a mess of course we are always stuck with the mess. We had very few people working at the mines. We want to be a part of labour force, could come out of the small community here.

CG When it comes to contracting that is something sometimes confusing because it is another department that takes of that. Everything that we do has to fare and transparent so anyone can apply for the job. We have caveat in there that contractors can commit to local employment. So what we do is we have contractors hire 60 % and over in aboriginal hire. Your community can pull together and put in a bid for the contract. The contractor would come into the community to look for skilled labourers like equipment operators and whatever and look for resumes. We do encourage local hire.

AB We already have affirmative action up here. When it was first introduced it was not followed and put on back shelf. Look at the mines, how many people from Ft Res work at the mines. More people are working from the south like Newfoundland. It is up to us to go to our Members of Legislative Assembly, MLAs to be included in economic benefits. In the small community like this, there is no work.

RBr I just had comment passed on to me I guess one of the Elders made observation that we'd like to move on to other mines site. I think we will have time to answer some other questions later on. I did mention we will talk about economic benefits later. Let's focus on the mine options and we will leave enough time at the end to answer questions.

CG ***SENES technical presentation continued – Copper Pass Mine***

TU Just a comment on your agenda here, I want to speak to that. Dealing with all the Elders we need to give them the opportunity to question some of your efforts while it is still fresh in their minds some will leave here in the hour or so. We should look at the agenda so the Elders will have some of their questions answered.

RBr I appreciate that Tom and we are trying to keep pace and we are also trying to keep focus on mine sites and remedial options and we can keep questions on contracts to another day or at the end of the meeting. But we really want to keep focus on the options so with that Charles can we move onto Copper Pass.



CG Copper Pass Presentation Con't.

? What is that stain?

CG What is in the rock at that location is when water is, it is reacting with the water it starts to stain and turns to powder.

TU How high is that waste rock?

CG I would say on the order of 25 feet.

CB I took that picture it is a little in the middle see where it says exposed bedrock its hard to see but it is bedrock so the waste rock is not that thick.

DISCUSSION REGARDING CORES

EB TALKS ABOUT STARK LAKE AND REGINA BAY

- details recording not included here

RBr Thank you, Ernest. A quick note on that, we are doing sampling with DFO around that area and sample in GSL and Copper Pass site. I think we just need to get more information back to the community. We will continue to work with Mike and your group and get that information back and just looking at the time, it may be a good time for a break

BREAK

RBr Ok, we'll start again. 4 or 5 slides on Copper Pass then we'll go to questions.

CG Copper Pass Presentation Con't.

AB You should take water samples too

CG As a general rule, they go hand in hand, with sediment sampling.

CG Copper Pass Presentation Con't.

AB Just a quick question. How many litres of water is in the trenches, approximately?

CG I think we are on the order of I want to say 5000 litres

AB Those 5000 litres, we can put that in drum and get it out of there, thank you.

CG One of two things we can bring in a treatment plant which will be expensive ... non audible

RBr Ok, that was a good discussion on Copper Pass. Are there any other questions, before we move onto Outpost? We'll have a good chance tomorrow before the end of the day when we summarize all the discussions and pick up any questions at the end of the day. If there is nothing else on Copper Pass let's get started with Outpost. This is Options Analysis we want to go through now. We'll do this a couple of different ways Joel's got some colour stickers he will put on posters as we go through our choices. We are going through each component with a review of what the issue is between Charles and Jessie and we will work through each option. On each option we want to meet the objectives of each project as while as the program. If it is technically feasible, cost effective, won't create any health and safety concern or environmental issue so those are all the considerations as we talk about the options. On that, look at slides and work off the posters starting with Mine Opening at the Outpost Mine.

OPTIONS ANALYSIS PROCESS

OUTPOST MINE SITE

Mine Openings –	Option 1	Not Acceptable
	Option 2	Acceptable
	Option 3	Acceptable
	Option 4	Preferred



Discussion (point form) – do nothing is not preferred, CG explains the retrofit with foam cover, AB asks how long the foam would last, CG wanted to get back to them but AB decides the cement would last 200 years (suggesting longer than foam cover) and he prefers the use of cement, CG says foam if left undisturbed would last like the cement but sunlight and forest fires would cause damages, mine inspectors would accept the use of cement for cover, AB suggests the cement would be a good choice, and does not want the waste rock to be moved around. PK says he talked about the mine caps before, 1946 Japanese were at Gro cap, Outpost open 1936 and closed 1946, GBL uranium mine. I want to seal it with cement. EB, arsenic is serious, people in Deline are concern, people die of cancer like Regina Bay, drain the water out or it will drain, we don't know how much water will drain, maybe arsenic there I don't know, someone may fall in, use concrete it don't matter, wants concrete, SB wants concrete, RBj wanted concrete and wanted it back to natural state, told no sign of vegetation growth, the opening cover will be smooth, so safe. SB asks about the foam and after CG explanation it was decides concrete would be better, RBr suggests maybe a combination of the two foam and concrete, we'll bring to WCB, we are good either way, AB agrees, Mine Inspector will be consulted,

Building –	Option 1	Not Acceptable
	Option 2	Preferred

Discussion (point form) – JG explains the options, AB burn no painted wood, treat and burn, JH says there are equipment and generators, CG says we can burn no hazard wood, PS, take away or burn, EB says to burn the wood, PK says mine shut down in 46 and was there last is 51, there use to be all kinds of equipment, mine is on rock, worked in con mine in 46 then later giant mine, now diamond mines, AE says burns the materials, TU says my feeling is burn, AB agrees

BREAK

Non-hazardous Waste –	Option 1	Not Acceptable
	Option 2	Preferred
	Option 3	Not Acceptable

Discussion (point form) – RBr explains the options, RB non-audible, AB wants option 2, TU wants it consolidated option 2, PK there in 51, lots of metal, today everything is covered, take to Yellowknife, EB (Chipewyan language), Paul, option 2, SB, CG explains the concrete, to take the concrete and break up and could be used for fill, AB says good idea, want to see safest way used, RBj, wants to remove, safe for walking, RBr some salvage can be done and museum, concrete for break wall on north pond, RBj option 2,

Hazardous Waste Materials –	Option 1	Not Acceptable
	Option 2	Preferred

Discussion (point form) – RBr explains the options, legal requirement to remove off site. Everyone agrees for remove off site. Some discussion on where the hazardous would go for disposal.

Mix tailings/Waste rock –	Option 1	Acceptable
	Option 2	Acceptable
	Option 3	Not Acceptable

Discussion (point form) – RBr explains the options, CB waste rock is acid drainage, not clean rock, AB it might make sense to level, JG explains the options, CG explains the options further, no borrow source available, contours will need to reviewed, TU ask about 3rd option, no material so why consider it, RBr little borrow material so real challenge, not enough for sloping, CG explains the challenges, TU sitting 60 years dormant, may be



better left alone, we should look at, CG good point, what benefit of moving it around, exposure may be a problem, so good point, RBr we could stabilize, AB slope away from the water, CG set back, RBr is that tailing in waste pile, CB it's compact and very hard, CG rework and bring material back, put larger material along the toe, we need to be clear to contractors, CG option 3, no liner was consider, AE no use in moving it leave as is, do not disturb, AB option 1 and 2 ok, option 2 preferred, TU like to leave it like that, disturb might cause problem, sat there long time, we should look at this, it's kind of out of the way, don't want to really say, if lined than I would say go with it and better drainage, CG explains the north bay is a concern, not stable, over the years the pile has changed or eroded, I would re-grade the north bay, I understand leave as is, but rework some, JH if there is wave action may cause exposure, slowly may cause some problems later, tailing may come out that is one problem, TU I don't see concern, it's been happening for years, JH we did some digging and found some tailings, your right there is wave action, we should try and improve it a bit, TU is it covered in sand, CB it is exposed, we want to re-slope to stop erosion, CG we understand what you are saying, PK been there long time, nothing wrong til today, leave as is for now maybe 50 years, EB been there for so long, like PK leave as is, Paul, like TU says leave as is, CG we are seeing some erosion, not immediate threat, we want to preventive measures in, right now it is not a threat, RBr how can minimize the erosion, question is how do we stabilize, CG we want prevent stuff from happening in the future, both point are valid but there is a potential for erosion both are valid point, AB maybe we could stabilize it for now, we should take a look at the site, CG is that option 2 – yes, this is the main raise we need back fill that, we can see what that looks like, AB we get the north wind the water get higher may cause more erosion, EB we should see the site to provide better solution, RBr we are going to site, maybe we can wait for decision til after the site visit, CG we sometimes leave some design with the contractors to decide what is the best for cleaning the site, there are different types of equipment they use, RBr it's a tough one, we have all options as acceptable, we can take 3 off the table, RBj just want to know, what is the best practices what would you recommend, CG we look at are we going to make the environment better, we look at contractors, we try to find the best solution, we hate to see some failure, we try to look at what is the risk of not doing anything, RBj it's hard to make a choice when everyone suggesting like the Elders wanting to leave as is, I will go with the majority with that one, RBr we can wait til later on this one, we don't have a preferred option right now, Time: 4:50 PM.

Waste Rock –	Option 1	Acceptable
	Option 2	Acceptable
	Option 3	No option written
	Option 4	Preferred

Discussion (point form) – CG we have some waste rock so we have to come with an option, leave as is right now or fill it in, look at this bedrock smooth, not a large deposit could be used for mine cap, ventilation is need on the cap you will see a steel pipe, AB waste rock use it if you need to if not leave as is, Robert, AB leave as is, PK want to say it was there for long time all I worry about is arsenic, we should leave as is, CB we tested the waste and there is some arsenic, but it is not as bad as we first thought, PK that is all I am worried about is the arsenic, CB arsenic is not the main concern there, EB leave as is, Paul if no concern use it or leave as is, SB leave as is, RBr we will finish for today.

Closing Prayer deferred till last day

DAY ONE MEETING ENDS



DAY TWO – JUNE 14, 2013

Metal Impacted Soils –	Option 1	Not Acceptable
	Option 2	Preferred
	Option 3	Not Acceptable

Ron Breadmore - welcome to day two, I want to welcome Mike Tollis and Patrick Simon, and Kara King who is joining us as while so welcome, quick recap, lots accomplished, good presentation from SENES, so let's pick up from where we left off,

Discussion (point form) – CG explains the options, AB any contaminants that is not hard to take off site that is what we should do, CG provides additional options explanations, JG reads through the options, AB option 2, Robert 2, PK option 2, TU option 2, MT option 2, EB does look good, sometimes moose go around there so it is better to take everything out, it's our main route we go through there depending on weather, better to remove, option 2, Paul option 2, SB bring off site, option 2, PS take it off site, option 2, KK option 2, RBj what will you do with the soil CG explains - option 2,

PHC Impact Soil –	Option 1	Not Acceptable
	Option 2	Preferred
	Option 3	Not Acceptable
	Option 4	Not Acceptable

Discussion (point form) – JG explains the options and explains the HC treatment land farm process, AB new thing you are talking about it was tried here at the airport, we don't know what came of it, RBr it's pretty effective for light fuel and gas, here we have small volumes to deal with, it would not be cost effective to build a big facility, AB looking at that you have no soil to work with, it would be better off site disposal, so option 2, Robert option 2, AE option 2, TU option 2, there is not much soil to work with, PK it has to clean, been there long, take it out of there, option 2, MT do we know it is going, RBr maybe Hay River or Zama, CG it will go to license facility, ... option discussed ... EB been there for so long, should take out, we don't know what will happen in the future, option 2, PS option 2, SB option, PS option 2, KK option 2, RBj it's unanimous,

Surface Water and Sediments –	Option 1	Not Acceptable
	Option 2	Preferred
	Option 3	Not Acceptable
	Option 4	Not Acceptable

Discussion (point form) – it was consensus for everyone option 2 was preferred. RBr we still need to go through the options, JG explains the options, RBr we will monitor the water quality and sediments, there for a number of years, less materials to work with, Robert option 2, TU are we talking about GSL or the site area, CG monitoring will be done around the site, TU why do that, it's not sitting in pond, it will not be the same but the sediment should be monitored, take the surface water out, what data are you getting, option 2, RBr we want to monitor for long term change, it may not be that long we do need monitoring, TU some need for monitoring, more on sediment, CG minor to monitor water and can be done together it is quick, we can see the water quality trend and find if we are making a difference, it is for the fish and lake health and the data can be passed to others, TU we should do the whole profile, we need it representative, CB we do not want disturb the surface, especially in the windy place, PK (non-audible) water is influence by the lake, option 2, MT option 2, EB same as Pete, option 2, PS option 2, SB option 2, PS option 2, KK option 2, RBj same as Tom and Pete, option 2, I have a question, how this will tie in RAP Review? RAP Review not all complete, more work may be needed, there are different options, Tech may come back with different answer, AB I don't why they would have different option, RBr we had a meeting with the Elders and it



is unfortunate Marc could not be here to meet face to face, we did receive comments already on Outpost, do you know if he will call in today it would be nice if he were part of the discussion, RBj no, he is not going to be calling in because it is too hard to hear, I am heading to the office and he will email me, RBr it would be an idea at some point that you would sit down with Marc and Elders and have that discussion, RBj yes, it's very important that happens, RBr Ok, we are finished Outpost, maybe time now for a break, then we can go onto Blanchet,

BREAK

BLANCHET MINE SITE

Adit –	Option 1	Not Acceptable
	Option 2	Not Acceptable
	Option 3	Not Acceptable
	Option 4	Preferred

Discussion (point form) – JG explains the options, CG explains the difficulty to get to the entrance, we can't burn the wood will be take away, tracks will be taken out as while, RB how high is the entrance, CG about as high as me, not very high, JH entrance is horizontal, foam plug would work here, RBr mine safety will in support of this, SEVERAL seem to want option 4, TU what about wiring around the opening, CG discussion with others on what to do with the cart it went in on track, AB with technology, we should be able to take it out, PK fill up foam and cement, MT option 4, but will you using rock to cover after foam, CG shot treat, MT how far into the adit, CG about 4 feet, JH when you walk in 4 meters you would hit wall, foam will get into the underground working, EB (Chipewyan language) option 4, PS option 4, SB option 4, PS option 4,

Building Structures –	Option 1	Not Acceptable
	Option 2	Preferred

Discussion (point form) – JG explains the options, RBr we have 3 option 2, TU option 2, PK been there long just burn, option 2, MT option 2 ... it was unanimous everyone wanted option 2,

Refuse –	Option 1	Not Acceptable
	Option 2	Preferred
	Option 3	Not Acceptable

Discussion (point form) – JG explains the options, AB Outpost is finished lets not go back there, maybe some of that could be used for fill, option 2, but material could be used, CG when it comes to refuse, we do have drums on site, dead spruce tree with white color need to be managed, option can to place and place a liner, can be manage with waste rock on site, one option is not relocating the waste rock, pull down and build landfill to minimize materials needed for landfill, lots of issue, not a lot of garbage, about 82 drums, JH maybe this is one, we can look at this later, how we look at waste rock, this will give us an idea on what to do, TU you are going to leave the waste rock, we want it off site, it's small amount, RBr are suggesting option 2 Tom, it is a small amount, let's focus on refuse then, so off site disposal, PK option 2, RB is talking option 3, but option, MT better to take off site, option 2, EB option 2, PSm option 2, PSi option 2,

Waste Rock –	Option 1	Not Acceptable
	Option 2	Not Acceptable
	Option 3	Preferred

Discussion (point form) – JG explains the options, CG option 2 is re-slope consolidate and cover with waste rock, option 3 cover with liner and waste rock, as long as no water is in contact then it would be safe and this is minimize with a liner, PS we kind of see



what you saying to cover with liner, CG option 3 is with liner, option 2 is soil cover, we are good at this site for cover, JH we want to far enough away from Great Slave Lake, CG we don't contact with humans or animals, CB there is about 20 meters cube, CG long reach boom will be needed to do the work, JH our preference is take down and cover, because of the slope it will be a challenge, RBr it will be a challenge but we think it can be done safely, TU airborne emission, water can be used to keep the dust down, RB option 3, AE option 3, TU option 3 and vegetation on top so it do not wash down maybe grass, CG we were thinking more coarse rock material because we did not have much vegetation material, we are in favour of grass material but little of it here, if we identify more material then we can use that, RBr that is a good idea and it can create some growth, PK maybe use cover and some dirt, option 3, MT option 3, Everyone agree on option 3. CG about the borrow sources, we will try and any soil we find.

BREAK

Ore Concentrate –	Option 1	Not Acceptable
	Option 2	Preferred
	Option 3	Not Acceptable

Discussion (point form) – Not Recorded

Metal Impacted Soil –	Option 1	Not Acceptable
	Option 2	Not Acceptable
	Option 3	Preferred

Discussion (point form) – JG explains the options ...late recording... AB option 3, TU option 3 also, PK option 3, MT how much soil are we talking, CG impact soil in the woods will be consolidated, were looking at working within that area, CB about 2000 meters cube, TU cubic meters?, MT why were not talking off site disposal, CG from result of risk assessment with measure in place and the volume it was considered on site, AB easier to put on barge, were talking two different things can be confusing, it should be hauled away, not brought back on the hill, RBr remove drainage risk by putting in liner, 7000 cubic meters is large amount for off site removal, AB are you talking beach, CG stuff on overpass will be taken off site, we want to combine with waste rock and cover, below waste rock is soil and we don't want people to touch, on the beach no liner but we'll have clean material, TU there will be back haul empty we should back haul the material, let's clean it up, we can save money by using back haul, Elders says he said that already, MT is all going under the same cover, JH yes, in the same area, consolidate, in one spot, done right, MT option 3 with cover, needs more discussion, RBr away from drainage location, dry area, CG location is important, let's talk location, building on JH point, Location on Map, up from marsh, - showing location on map – open to discussion, RBr good location for cover, CG – talking and viewing map – TU boys wondering, will another mine open? Trevor has land permit, what are the chances of another mine open again, RBr always that possibility, but we want to secure the site, any mine application has to go through the permit process and consultations, EB option 3, PS option 3, PS option 3, KK option 3, RBj yesterday, best practice, permeability if reliable then I would go with option 3, CG liner will be used at this site, RBj option 3,

LUNCH

PHC Impacted Soil –	Option 1	Not Acceptable
	Option 2	Preferred
	Option 3	Not Acceptable
	Option 4	Not Acceptable

Discussion (point form) – JG explains the options, included some HC treatment process, CG explain the context of oil, talking about small amount, about 50 cubic meters, RBr we



have small amount to deal with, off site disposal, on site treatment but big effort for small, SEVERAL want option 2 right away, everyone wants option 2 and unanimous,

Surface Water and Sediments –	Option 1	Not Acceptable
	Option 2	Preferred
	Option 3	Not Acceptable
	Option 4	Not Acceptable

Discussion (point form) – CG – Slide show explanation - JG explains the options, RB option 2 and monitor, AB option 2, TU option 2 but about option 4, RBr water can't be capped, were talking about the beach, we could cap but it is shoreline disturbance, we are talking low risk sediment impact, TU cap should be looked at, AB been there since 70s, JG you wouldn't want winter road on this shoreline, AB winter road would be further down, west would be the deepest part, we know this from traditional knowledge, PK – TU & PK discuss – leave the way it is, monitor, MT looking at page 27, wetland, will this be monitored, is it a creek, will you be going there, CG it is a monitoring point, MT that was what I was thinking, so option 2, CG interesting point yesterday name of Blanchet crumbling rock and that is what we are seeing, naturally high in arsenic, once cleaned it will get back to natural background, RBj it is actually is named after Blanchet, person who my grandfather worked with, CB I think they mean traditional knowledge name, EB rock in the valley, rain and drains to the lake, same as Regina Bay, any valley like that there is a creek, it runs year round, there is a creek there, there is road there, CG we do agree there is a creek there, west of the adit, CG – slide explanation – EB option, PS, Everyone agree on option 2, unanimous,

BREAK

COPPER PASS SITE

Surface Trenches –	Option 1	Not Acceptable
	Option 2	Not Acceptable
	Option 3	Preferred

Discussion (point form) – JG explains the options, CG two large trenches, partly filled with water, two other trenches not physical hazard, east showing not much trench, - slide explanation – water in trench impact is management, RBr mine safety not crazy for fencing not a walk away option, RB backfill, - some discussion – RBr so hybrid, CG trench 1 limited capacity will fill up not much free board, CG if backfill, water is contaminated, clean water first then backfill, to the surface and no water for animals, we will treat the water before release, RBr we need to get the information to the Elders, CG – slide explanation – trench 2 if fill will drain to the lake, AB how deep CG about 25 feet wide, AB how contaminated is the water, CB it is contaminated, AB freeze then take out, CG we agree we take the water out first, AB I can't see how you can't take it out, on winter road, CG we will treat and discharge, we want the same thing, we can come with a cost estimate, RBr we do want to treat the water, AB we don't want to depend on the contractors, RBr sometimes the contractors have some good ideas, CG we have 3rd party regulators we have to deal with, TU we got to deal with water first, no short cut, swamp can be used, we don't need process plant when we can use swamp and monitor, use the TK here, JG we do recognize the wetlands ability, we need to treat first it does not to be a fancy plant, use polishing system safe for fish and people, untreated may harm, TU it is small quantity, use the wetlands it can do wonders, CG we still need to look downstream receiver, more testing needs to be done, nature concentration is decreasing, we prefer to treat water before discharge, we could use the combination of things, then we can nature take it's course, at the source we should treat, AB take samples, CG we plan to sample this summer, AB I go with backfill, CG we need to deal with the water in the trench, RBr we don't want to do any harm, we can treat then discharge to the environment, good discussion, AB add to option 3 treat water and backfill, AB option 3, TU option backfill



and treatment of water, PK option 3, MT treat on site, option 3, no threat to wildlife, EB option 3, everyone else wanted option 3,

Ore –	Option 1	Not Acceptable
	Option 2	Not Acceptable
	Option 3	Preferred

Discussion (point form) – JG explains the options, AB good idea, option 3, CG for benefit of those not here yesterday, - slide explanation – we want to the ore consolidated and put trench 1 and 2, TU acid generating? CB, no, quantity is not a concern, RB quantity of ore? CB 150 cubic mix with other material, about 100 cubic meters, RBr Elders understand cubic meters, EB option 3, AE option 3, TU option 3, PK option – TU & PK discussion – water treatment, option 3, MT option 3, everyone else want option 3, RBr we have a request for 5 minutes break, translator needs a break,

BREAK

Waste Rock –	Option 1	Not Acceptable
	Option 2	Not Acceptable
	Option 3	Preferred

Discussion (point form) – JG explains the options, CG a bit of recap slide 36, waste rock with trench 2, this material for backfill the trenched, no acid drainage issue, AB page 35, water will be treated, backfill with waste rock option 3, AB option 3, TU option 3, PK option 3, MT option 3, EB option 3, PSi option, RBj option, everyone for option 3,

Metal Impact Soil –	Option 1	Not Acceptable
	Option 2	Preferred

Discussion (point form) – JG explains the options, CG similar to waste rock issue, pull back into the trenched, AB option 2, TU option 2, PK option 2, MT option 2, EB option, PSi, option 2, KK option 2, everyone wants option 2,

PHC Impacted Soils –	Option 1	Not Acceptable
	Option 2	Preferred
	Option 3	Not Acceptable
	Option 4	Not Acceptable

Discussion (point form) – JG explains the options, AB option 2, CG – slide 32 explanation, challenges to moving materials on site, on site treatment will not be easy given the space available, option 3 and 4 difficult to implement, RBr volume, CB 70 meters cube, EB option 2, TU option 2, CG you will end up with expose bedrock, will look different, PK option 2, MT option 2, CG do nothing to trenches 3,4 and 5, MT adit opening? CG less than 3 meters in, not considered as an opening, EB option 2, so many numbers, how many trenches dig CG main showing 2 large and 2 small ones, west trench not deep, over upland pond exploration trenches just knee deep so we are not looking at that, so everyone else want option 2,

Structures –	Option 1	Not Acceptable
	Option 2	Preferred

Discussion (point form) – JG explains the options, AB option 2, August option 2, TU option 2, PK option 2, MT option 2, RBj I have a question, CG generally we collect the ash, option 2, JG we use containers so we collect the nails and everything,

Non-Hazardous Materials –	Option 1	Not Acceptable
	Option 2	Not Acceptable
	Option 3	Not Acceptable



Option 4 Preferred

Discussion (point form) – JG explains the options, CG we have miscellaneous drums, couple location have timbers we can burn, off site or in trenches, AB haul the drum away and burn option 4, CG we will bring scraps off site, get rid of the ashes, RB option 4 and anything with metals, TU option 4, PK option 4, MT option 4, EB option 4, everyone agree with option 4, RBr on that note we will take a five minute break, then we will rap up, can we bring the dinner up to 4:30 pm, CG you're hard on the caterers, Laughter, Applause,

BREAK

CLOSING COMMENTS & DINNER

Ron Breadmore - start by saying my feelings for the two days, thank you to the Elders, not an easy work, Anne and Tom for translation, very productive day, Applause, Joel did a great job and he will complete the review,

Joel Gowman - reviews of the options, Outpost

Discussion (point form) - CG metal structure on site at Outpost, want to know comfort of taking off site, there is heritage value could be left on site, take other scrap off site, think about that and let us know what you want, RBr PK mention this, plaque may be a good idea, we will check with mine heritage and or look at other option, MT it would be a good idea to leave on site, PSi I like the idea, RBr we can look into this, everything is on risk, leave equipment on site may not be a risk, RBr not a bad idea, never been but the young people may go there,

Discussion (point form) - JG review of the options, there is a waste rock, tailings, RBr we had two options, we could leave it the community and the Tech Advisor, with site in two week, we can decide then,

Joel Gowman - review of the options, Blanchet

Joel Gowman - review of the options, Copper Pass

Ron Breadmore – RAP will be finalised, will include any input from the Tech Advisors,

George Lafferty – TK Questionnaire, 6 Elders from Lutsel K'e and 6 Elders from Fort Resolution, this is small part of TK for the RAP, this options analysis included TK knowledge you have, READ out the questionnaire items, included burial sites, overnight visit, trapping, hunting and fishing, berry picking, drinking water was taken from anywhere on site, burial sites is identify in Blanchet and Copper Pass and we can try locate them when we visit the site, no muskoxen or grizzly sighting, furbearing animal trapping was identified mostly marten, we asked for other stories but none was received, that is some of the information I have captured on the questionnaire, lastly confidential information used working papers will not be used in the RAP without the consent of the community. That is it. I want to thank the Elders and interpreters, that is not all the TK information we will be using, thank you, Applause

Ron Breadmore - right now we are building TK into the RAP like Tom says it is an on-going information, it will continue into monitoring phase, so thank you, Applause,

Joel Gowman - I also want to thank the Elders for their help during the mine site visit, thank you for your participation, Applause

Ron Breadmore - I want thank Joel for stepping in even when he was sick, thank you, Applause,

Rosy Bjornson - I also want to say thank to the Elders land user Dad, Anne Biscaye for interpreter, we hear the Elders how hard it was in the past, after we lose a few of them, we recall some stories and the knowledge behind and we think of those stories, it is



overwhelming, I think of those stories and they get me through the day and the long meeting, Masicho, Applause

Arthur Beck - land use and represent the FRMC, this is one meeting where we did not argue. Laughter, sitting on the same side for a change, we seen the changes, now 56, no aboriginal leaders at meeting before mostly done by Federal Government, Science learn their stuff in school but we learn from our Elders, I did some commercial fishing when younger, we are on the same page for a change, thank you,

Tom Unka - thank you for the effort and the Elders, the younger people will take over and we will leave something positive for them, thank you from the bottom of my heart, masi, Applause,

Pete King - I went to school in 33 only spoke French and Chipewyan, thank you everyone of you and my friends here, 87 today, today all my friends are gone that is all I have to say, thank you, Applause,

Ernest Boucher - most know me, been around well know to Beaufort Sea, think about the mine site, I want to Regina Bay, so in the future, closed 54, went to school here in the mission, now young Elder laughter, Applause,

Patrick Simon - I hope we treated you well thank you for teaching me some good stuff,

Kara King - thank you for being here, thank to Anne, glad for this meeting, we talk about so many site, we see you doing lots of work compared to giant, this is good for us, we see many mine being cleaned, Applause,

Ron Breadmore - we enjoy our stay and we will be back. I enjoy these meeting in the community and we will have a site tour and we will visit Lutsel K'e. Ft Res will then be able to visit some friends in Lutsel K'e,

Ernest Boucher - before prayer, everyone is happy here, I called PK my friend even when he is older, I know all the Elders. Thank you for the couple days here. Applause,

Ernest Boucher Closing Prayer

Masicho – APPLAUSE.

OPTIONS ANALYSIS MEETING COMPLETED.

Transcript Summary by:

George Lafferty, Consultations Officer, AANDC-CARD

July 15, 2013

APPENDIX B

REMEDIAL ACTION PLAN OPTIONS ANALYSIS WORKOUT MINUTES

Remedial Action Plan Options Analysis Workout

Date: 13-14 June 2013
Location: Fort Resolution (Deninu Kue), Northwest Territories
Participants: Mr. Ron Breadmore (AANDC)
Mr. Joel Gowman (AANDC)
Mr. George Lafferty (AANDC)
Mr. Jessie Hoyt (PWGSC)
Mr. Charles Gravelle (SENEC Consultants)
Ms. Claire Brown (SENEC Consultants)
Ms. Ann Biscaye (Translator)
Mr. Robert Beaulieu (Fort Resolution)
Mr. August Enzoe (Lutselk'e)
Mr. Arthur Beck (Fort Resolution)
Mr. Tom Unka (Fort Resolution)
Mr. Pete King (Fort Resolution)
Mr. Mike Tollis (Lutselk'e, June 14 only)
Mr. Ernest Boucher (Lutselk'e, June 14 only)
Mr. Paul Smith (Fort Resolution)
Mr. Stanley Beck (Fort Resolution)
Mr. Patrick Simon (Fort Resolution, June 14 only)
Ms. Kara King (Fort Resolution, June 14 only)
Ms. Rosy Bjornsen (Fort Resolution)

+ 4-6 Elders and adult observers

Context: Community consultations to discuss the remediation of three small abandoned mines within the East Arm of Great Slave Lake, including: Outpost Island Mine, Blanchet Mine and Copper Pass Mine. The meeting was chaired by AANDC and PWGSC; with technical presentations and responses provided by SENEC Consultants. Community representatives from Lutselk'e and Fort Resolution were presented with an overview of the sites, focusing on the components identified for remedial consideration. For the three sites, each remedial component was discussed and community members indicated their preferred remedial option.

Meeting Minutes - June 13, 2013

Approx. Time	Speaker	Topic/Comment/Discussions Actions
10:30	R. Breadmore	Meeting brought to order and attendees welcomed.
10:35		Opening Prayer
10:40	R. Breadmore	AANDC presentation outlining project objectives and status
	A. Beck	Was not aware of the TK study and would like to opportunity to provide some information.
	R. Breadmore	Anyone that was not able to attend can provide their information on the marked up map that has come back to the communities.
	A. Beck	How are people going to visit the site when the Elder's tour happens?
	R. Breadmore	Most likely using Twin Otters.
	A. Beck	Recommend that a boat is used to access the three sites.
	R. Breadmore	This option will be considered during planning.
10:50	R. Breadmore	AANDC presents the Workout Framework for the meeting.
	T. Unka	Has the length of time required to get a water license been

Remedial Action Plan Options Analysis Workout

Approx. Time	Speaker	Topic/Comment/Discussions Actions
		considered during planning? This may impact the schedule.
	R. Breadmore	The process can be lengthy and we have allowed for extra time to receive our approvals.
	T. Unka	Do you think this project will go to Environmental Assessment (EA)?
	R. Breadmore	Based on what is on site, AANDC does not anticipate that an EA will be required. The same process was used for Colomac (much larger project) and an EA was not required.
	P. King	O'Connor Lake Mine is also in the area, so why aren't we talking about it?
	R. Breadmore	O'Connor Mine is part of the list of AANDC sites to be assessed, but isn't part of today's discussion.
11:00 am	C. Gravelle	SENES technical presentation - Outpost Island Mine
	A. Beck	Who was there during the 1994 remediation?
	C. Gravelle	Do not have the names right now but can get that information after the meeting.
	R. Breadmore	The NWT Metis were involved as part of that work.
	A. Beck	All of that rain from the spring and summer goes into the waste rock and then into the GSL. We use the lake for fishing which is important to the community. Have fish been assessed?
	C. Gravelle	This will be considered as part of our options analysis when considering the tailings and waste rock. Fish have been assessed in the regional context and we'll talk to the community more about it later in the meeting.
	A. Beck	What will happen to the existing equipment on site?
	R. Breadmore	It would go to Yellowknife and the concrete blocks may be broken down.
11:30	BREAK	
11:35	C. Gravelle	SENES technical presentation continued – Blanchet Mine
	A. Beck	Knows the area well; the draw and drainage.
	R. Beaulieu	When was this mined?
	C. Brown	I believe it was the late 1960s, but we can confirm.
	T. Unka	What is meant by population and individual effects?
	C. Gravelle	Population is related to how many animals of a particular species are within its effective range relative to a site. The individual effects are what could impact on an individual animal.
	T. Unka	Have you looked at cumulative effects?
	C. Gravelle	The risk group has reviewed the cumulative effects in the HHERA (ore at beach, As and Co hot spots; As, Cr, Co, Ni in surface water at beach and As in soil). Findings indicate action required for As and Co.
	T. Unka	Do we propose to clean up the soil? Have you considered metals uptake in the vegetation?
	C. Gravelle.	The issue of soil impacts is limited to those related to the presence of ore concentrate at discrete locations on site.
	T. Unka	Will you be taking the ore off-site? Will you be taking soils out of the drainage pathway?
	C. Gravelle	The ore will be consolidated and removed from site while soil impacts will be remediated by eliminating the exposure pathway for both humans and ecological receptors.

Remedial Action Plan Options Analysis Workout

Approx. Time	Speaker	Topic/Comment/Discussions Actions
12:20	LUNCH	
1:30	C. Gravelle	SENES technical presentation continued – Blanchet Mine
	A. Beck	Fish is important to the communities, can they be checked?
	R. Breadmore	Fish is difficult to sample because the fish move around to many different sites in Great Slave Lake. This may be possible in Sachowia Lake.
	J. Hoyt	It would be difficult to determine if the concentrations in the fish are due to mine activities at the site. Our Expert Advisors (DFO) confirmed this and recommended we should instead look at cleaning up the source.
	A. Beck	Then sediment should be sampled at depth and we need to see the documentation.
	J. Hoyt	Sediments have been sampled at depth. This is provided in the assessment reports, but we appreciate this is a very large document.
	A. Beck	We would also like one page summaries of chemical concerns.
	J. Hoyt	We can do this in the future.
	T. Unka	Exceedance levels need to be made more clear.
	J. Hoyt	The figures show this, but we can also provide this in a summary table format.
	R. Bjornsen	Have benthics been tested?
	C. Gravelle	Yes.
	R. Bjornsen	It seems like there's some guesswork. Have you spoken with the former mine workers?
	C. Gravelle	They are often unavailable, but if available we do speak with them.
	R. Breadmore	The Ryan Silke report summarizes much of the available information in his historic mine report, but not everything.
	T. Unka	You are not relying enough on Traditional Knowledge (TK). There's a lot of benefit within TK, but it isn't coming out.
	A. Beck	The communities did not benefit from mining, but should benefit from the clean up (perhaps 25% of labor). This would provide on-site TK and work for the community.
	J. Hoyt	The process for the procurement of a remediation contractor needs to be transparent, fair, and must benefit local communities. This is often as high as 60-70% of the workforce. In PWGSC contracting procedures the percentage of local Aboriginals to be retained for a particular remediation contractor cannot be prescribed. The contractor will also be held accountable for meeting any employment targets they have set out for the project.
	R. Beaulieu	How do you ensure this happens?
	J. Hoyt	We can withhold funds if the contractor doesn't meet the requirements.
	R. Breadmore	We need to focus our discussions on the remedial options today
	C. Gravelle	SENES technical presentation continued – Copper Pass Mine
	S. Beck	Is the stain on the wall of the trench the mineral?
	C. Gravelle	Yes, it's the ore in the rock reacting with the environment.
	T. Unka	How tall is the waste rock pile?
	C. Gravelle	Approximately 20 to 25 feet.

Remedial Action Plan Options Analysis Workout

Approx. Time	Speaker	Topic/Comment/Discussions Actions
	C. Brown	It is important to note that it isn't just waste rock. It's a bedrock knoll with waste rock pushed over the side.
	A Beck	There's no equipment left behind at this site.
	S. Beck	They would've had diamond drill program and drill core – where is it?
	C. Gravelle	This is a difficult site to access. There is no mining equipment, but there is some exploration equipment and approximately 600 ft of core in the racks at the Camp Area.
	A Beck	The light green vegetation shows re-growth – this is the old roadway used to access the mine showings.
	A. Beck	Soil samples should be collected at the trench and further down the Main Showing draw. To get good background samples you need to get to high ground and out of the draw.
	C. Gravelle	This is agreed and is planned in the 2013 summer program.
	E. Boucher	They should test the water at Stark Lake. There has been testing in Regina Bay (it flows past Lutsel K'e and into Great Slave Lake) but no report of results and nobody will eat the fish because they feel it's contaminated.
	R. Breadmore	DFO is testing at this location as part of another project. AANDC will look into getting information to the communities.
2:15	BREAK	
2:30	C. Gravelle.	<i>SENES technical presentation continued – Copper Pass Mine</i>
	A. Beck	You should collect water samples when you sediment sample.
	C. Gravelle	This is typically the approach employed during the assessment of surface water and sediments.
	A. Beck	How much water in the trenches?
	C. Gravelle	Over 1,000,000 Litres.
	A. Beck	That should be pumped out and shipped south.
2:35	R. Breadmore	<i>Introduces remedial option discussions for Outpost Island Mine</i>
	J. Gowman	<i>Introduces the remedial options for mine openings at Outpost.</i>
	R. Breadmore	It is not appropriate to leave the openings as is
	R. Beaulieu	The site should be cleaned up.
	A. Enzoe	Leave it as is.
	A. Beck	Option 1 is NOT an option – there needs to be some action. Caps should be repaired due to underlying waste rock. Chemicals are a greater concern and it would be best to leave the mill equipment as is.
	J. Hoyt	These are good thoughts and we'll get to these topics too.
	P. King	Spoke in Yellowknife already on this issue - No opinion on this topic.
	E. Boucher	We don't know what will happen in the future. We should open it up.
	P. Smith	Recap so it does not cave in.
	S. Beck	All of this should be cleaned up. Anything that can be done to cleanup runoff from the tailings. Would like to see the shafts resealed (concrete lasts longer) and back to the original condition.
	R. Bjornsen	Clean it up.

Remedial Action Plan Options Analysis Workout

Approx. Time	Speaker	Topic/Comment/Discussions Actions
	J. Gowman	<i>Introduces option 2 and 3.</i>
	C. Gravelle	<i>Describes option 2 and option 3.</i>
	A. Beck	What is the lifespan of foam? Concrete is 200 years and we would prefer concrete.
	C Gravelle.	Manufacturer says it should last as long as concrete, however it is important to reduce the exposure of the foam to UV and forest fire. We look at using foam plugs because of the challenges of placing concrete at such a remote site.
	A. Beck	If you use a winter road, you're going to need TK and we would prefer to use concrete.
	A. Enzoe	Prefer concrete.
	P. King	Discussed this in Yellowknife 3 years ago and prefer concrete caps.
	E. Boucher	Arsenic is a problem and many people are dying of cancer. We should drain the workings and ship it out. Or fill it with cement. Concrete or foam – either is OK.
	P. Smith	Concrete cap preferred.
	S. Beck	Concrete cap preferred.
	R. Bjornsen	How can it be revegetated? How can you return the site to a natural state?
	J. Gowman.	It is surrounded by waste rock and isn't a natural environment.
	R. Bjornsen	Is vegetation growing around it now?
	J. Hoyt	It is not vegetated and the concrete (already in place) isn't even lasting 20 years because it hasn't been installed properly. There are ways to tie it into the bedrock to make it more natural, but foam can also last a very long time and withstand heavy equipment.
	S. Beck	Do you tie the cap all the way out to bedrock?
	C. Gravelle	Yes, using steel and a concrete structure.
	S. Beck	What are the specifications of foam, such as design life and strength?
	C. Gravelle	The main advantage of foam is the ease in which it can be used in remote locations while providing the same level of protection as a concrete cap.
	S. Beck	Is concrete best in this case?
	C. Gravelle	We would recommend the use of foam for everything except Shaft #1 where we would recommend a concrete cap.
	R. Breadmore	We should add this as a hybrid option.
	A. Beck	This is a good idea and we can see what techniques work well for the future.
	J. Gowman	<i>Adds Option 4 to Options Table (Hybrid – Concrete cap for Shaft #1, Foam for other shafts/raises). Option 4 Identified as Preferred Remedial Option.</i>
	J. Gowman	<i>Introduces Remedial Options for Buildings at Outpost</i>
	P. Smith	There's no poison in the outhouse. Take it away if painted, burn if clean.
	E. Boucher	It's been there so long, burn it.
	P. King	You could use blasted out areas.
	A. Enzoe	Burn it.
	R. Beaulieu	Burn it and consolidate equipment in Yellowknife to maintain

Remedial Action Plan Options Analysis Workout

Approx. Time	Speaker	Topic/Comment/Discussions Actions
		heritage value.
	P. King	This was the first mine in the Northwest Territories.
	T. Unka	You should dismantle and burn the buildings.
	A. Beck	Burn the buildings.
	J. Gowman	<i>Demolish and Burn is the preferred remedial option.</i>
3:35	BREAK	
3:45	J. Gowman	<i>Introduces Remedial Options for Non-Hazardous Waste at Outpost</i>
	J. Gowman	Is it acceptable to leave it as is?
	R. Beaulieu	Leave as is ok.
	A. Enzoe	Leave as is ok.
	A. Beck	Not an environmental concern, but it does look bad. It is preferred that this is taken off site.
	T. Unka	Prefer it is shipped off site.
	P. King	Everything is covered, but if you find metal when digging then it should go to Yellowknife.
	E. Boucher	The metal has been there a long time as the site has a long history. They don't make that equipment anymore so they should take it to a museum. It was hard work and it was Europeans, Black people and Chinese people all working there.
	P. Smith	Prefer off-site disposal.
	S. Beck	Would like to see it removed so it's not an eyesore.
	C. Gravelle.	Recommend filling the main raise with the broken concrete from the foundations existing on site.
	A. Beck	That's ok, but the water inside will need to be treated.
	G. Gravelle	It will be tested, if not already, before disposal.
	S. Beck	Concrete would be ok for a landfill, but not steel.
	C. Gravelle	Steel would come off site.
	R. Bjornsen	Remove equipment if it's still a hazard. If museum is not interested, could the steel be given to a charity?
	R. Breadmore	Salvaging is encouraged and incorporated into the RAP.
	R. Breadmore	<i>Option 2 (off-site disposal) is the preferred option, with concrete used for backfilling.</i>
	R. Breadmore	<i>Introduces Remedial Options for Hazardous Material at Outpost</i>
	R. Breadmore	There is a legal obligation to remove any hazardous materials. We can't leave it on site. Does everyone agree?
	All	Yes
	R. Bjornsen	Does it go to Swan Hills?
	J. Gowman	The contractor has to provide proof they are using a licensed facility, but it won't necessarily be Swan Hills.
	G. Lafferty	So a landfill is not the best option?
	R. Breadmore	The long-term costs would be very high – more cost effective to take off-site.
	J. Gowman	<i>Introduces remedial options for tailings/waste rock at Outpost.</i>
	A. Beck	Is the material at the top clean?
	C. Brown	It is still rich in metals and is leaching, but may have less metal impacts than the materials below (which has more tailings than

Remedial Action Plan Options Analysis Workout

Approx. Time	Speaker	Topic/Comment/Discussions Actions
		waste rock).
	C. Gravelle	Reshaping and grading has been proposed to minimize erosion. There is limited borrow material to work with.
	T. Unka	There isn't enough borrow, why are you including capping?
	R. Breadmore	Part of the management plan is to look at options.
	T. Unka	Leaving this alone is sometimes the best option. Did you really look at the reshaping option, and the disturbance it would cause before recommending it?
	J. Hoyt	This is an important comment and the net effects of remedial activities should be considered.
	R. Breadmore	What do we do with the tailings that are eroding in the shoreline area?
	A. Beck	Pull back and create setback.
	R. Breadmore	What are we seeing when we look at the sides of the pile where it's eroding?
	C. Brown	That is the tailings.
	R. Beaulieu	Option 2 (consolidate and reslope) is best, don't disturb what's been there for 60 years.
	A. Enzoe	Option 2.
	A. Beck	Option 1 (do nothing) or Option 2 (consolidate and reslope)
	T. Unka	Disturbing sometimes creates more problems. Option 1 or 2.
	C. Gravelle	Concerned with the 20% of the face that's exposed – the slope is changing. We do recommend sloping to stop the potential release of tailings (stabilize slope) to the North Bay.
	T. Unka	Tailings are getting pushed up by storm surges and onto land. Doesn't believe anything else will come out.
	J. Hoyt	There are tailings at depth (3 foot test holes were dug).
	C Brown	And there are exposed tailings.
	P. King	Should be left as is.
	E. Boucher	Leave it as is.
	P. Smith	If you disturb it you will have more effects. Leave it as is.
	S. Beck	Concerned with what's in there, which is north facing and exposed to waves. Erosion continues and it is moving. What is that material made of and does this cause a threat?
	J. Hoyt	We did sample and the risk assessment says it isn't a hazard to the regional environment; however, we should do what we can to stabilize it.
	S. Beck	Then we should do what we can now to stabilize it. Option 2.
	C. Gravelle	We think it's important to stabilize the side of the deposit that is eroding and unstable.
	S. Beck	The eroding is worse due to the north winds creating storm surges into the North Bay area.
	R. Beaulieu	You would get better recommendations if we went out on site.
	R. Bjornsen	What do you recommend based on your experience and best practices?
	J. Hoyt	We look at net benefits and that's why we recommend re-sloping the area that is eroding. You need to assess each situation individually to see that the remedial effects don't outweigh the costs.
	R. Bjornsen	Stabilizing seems like the right idea.
	R. Breadmore	<i>We don't have resolution in this case. "Leave as is" and</i>

Remedial Action Plan Options Analysis Workout

Approx. Time	Speaker	Topic/Comment/Discussions Actions
		<i>"consolidate and reslope" are both acceptable options and we will return to this issue later.</i>
	J. Gowman	<i>Introduces waste rock at Outpost Island</i>
	A. Beck	Use it if you need it, or leave it as is.
	R. Beaulieu	Use it if you need it, or leave it where it is.
	A. Enzoe	Leave it where it is.
	P. King	It's been there for 72 years, but is arsenic a concern?
	C. Brown	There is some arsenic, but copper is more of a concern.
	E. Boucher	Leave as is.
	P. Smith	Leave as is.
	S. Beck	Can you use the waste rock?
	J. Hoyt	We could use it to naturalize as much as possible.
	R. Bjornsen	If you're not concerned with it.
	R. Breadmore	<i>Reached consensus. Leave it as is, and use it as needed (Option 4 - Hybrid)</i>
17:00		<i>Meeting adjourned</i>

Meeting Minutes - June 14, 2013

Approx. Time	Speaker	Topic/Comment/Discussions Actions
9:35	R. Breadmore	<i>Opens meeting and requests Jessie/Charles discuss metal impacted soil at Outpost.</i>
	J. Hoyt	We are talking about metal impacted soil in discrete locations only, such as at dumps and batteries. We are not proposing to excavate all site soil.
	A. Beck	Remove where possible (Option 2 – Consolidate and transfer off-site)
	C. Gravelle	Just to clarify, that Option 2 relates to the impacted soils associated with can dumps and batteries.
	R. Beaulieu	Option 2
	A. Enzoe	Option 2
	T. Unka	Option 2
	M. Tollis	Option 2
	E. Boucher	Option 2
	P. King	Option 2
	P. Smith	Option 2
	S. Beck	Option 2
	P. Simon	Option 2
	K. King	Option 2
	R. Bjornsen	If you do remove soil, will you add borrow from elsewhere?
	C. Gravelle	No, these are very small areas on bedrock.
	R. Breadmore	<i>We have a preferred option to consolidate and transfer off site.</i>
	C. Gravelle	<i>Introduces concerns and remedial options for PHC impacted soil at north end of island.</i>
	R. Breadmore, J. Hoyt, J. Gowman	Soil treatment is when soils are put in liner and aerated before being tested again. There is minimal PHC impacted material at this site and the level of effort may not make sense.

Remedial Action Plan Options Analysis Workout

Approx. Time	Speaker	Topic/Comment/Discussions Actions
	A. Beck	Option 2 (off-site disposal)
	R. Beaulieu	Option 2
	A. Enzoe	Option 2
	T. Unka	Option 2
	P. King	Option 2, but add clean dirt.
	M. Tollis	Do we know where it will go?
	R. Breadmore	To a treatment facility.
	M. Tollis	If it's going to be land farmed, then Option 2.
	J. Hoyt	It has to go to a licensed facility.
	E. Boucher	Option 2
	P. Smith	Option 2
	S. Beck	Option 2
	P. Simon	Option 2
	K. King	Option 2
	R. Bjornsen	Option 2
	R. Breadmore	<i>Only acceptable (and preferred) option is off-site disposal (Option 2).</i>
	R. Breadmore	<i>Introduces surface water and sediment at Outpost.</i>
	A. Beck	I think we all agree with Option 2 (long term monitoring).
	J. Hoyt R. Breadmore	Let's review issue for those that were not present yesterday.
	J. Gowman	<i>Reviews surface water and sediment topic and options.</i>
	J. Hoyt R. Breadmore	Net effects need to be considered when you look at each of the options.
	R. Beaulieu	Option 2 (long term monitoring)
	A. Enzoe	Option 2
	A. Beck	Option 2
	T. Unka	Are we referring to tailings ponds or the lake?
	C. Gravelle	We are referring to the area around the lake.
	T. Unka	Why do you bother when it's constantly in motion? I would focus on sediment, as you won't get much from water. Option 2.
	R. Breadmore	We often do a 3 year plan and a 5 year monitoring plan after remediation to make sure there are no impacts and that the environment is stabilizing.
	T. Unka	Sediments will be of more use.
	J. Hoyt	It takes minimal extra time to water sample, so water samples are collected prior to sediment sampling.
	T. Unka	Water samples should also be at depth to avoid surface interactions.
	C. Brown	Correct and we typically collect at depth for that reason.
	P. King	Option 2
	M. Tollis	Option 2
	E. Boucher	Option 2
	P. Smith	Option 2
	S. Beck	Option 2
	P. Simon	Option 2
	K. King	Option 2
	R. Bjornsen	Option 2
	R. Breadmore	<i>Option 2 (long term monitoring) is preferred, all other not acceptable.</i>

Remedial Action Plan Options Analysis Workout

Approx. Time	Speaker	Topic/Comment/Discussions Actions
	R. Bjornsen	How may we incorporate this with the results of the technical reviewers which haven't had time to review yet?
	A. Beck	Could we give this information (i.e. preferred vs. not acceptable options) to the consultants to see what they say?
	R. Breadmore	Since your consultant can't be here, we recommend that he meet with members of your community to provide guidance.
10:20	BREAK	
10:35	R. Breadmore	Before going over the Blanchet remedial options, would Patrick and Kara like a review of yesterday's discussions?
	P. Simon	Not necessary
	K. King	Not necessary
	J. Gowman	<i>Introduces remedial options for the adit at Blanchet.</i>
	C. Gravelle	This is a difficult to access area. Wood in adit would be removed and probably can't be burned because of metal concentrations. The wood and steel rail track would be hauled out.
	R. Beaulieu	Option 4 (Foam plug), depending on the size of the adit.
	C. Gravelle	It's about person height and about as wide as your arm span.
	J. Hoyt	A foam plug would be strong enough here, partially because this is a horizontal opening.
	A. Enzoe	Option 4
	A. Beck	Option 4
	T. Unka	Option 4. Is the ore cart of historical value? Typically, chicken wire can be added to reinforce the shotcrete.
	C. Gravelle	Re-iterated that the use of a foam plug would require waste rock or shotcrete as a cover to mitigate potential issues with exposure to fire.
	A. Beck	We should be able to get the cart out.
	J. Gowman	We just need to do it safely which is difficult as the track isn't working.
	P. King	Option 4 (foam plug)
	M. Tollis	Option 4, but would it be covered with waste rock?
	C. Gravelle	Waste rock or shotcrete would be used as a cover.
	M. Tollis	How far would the foam go into the adit?
	C. Gravelle J. Hoyt	The foam plug would extend to the section of the adit where the headwall starts and extends to a depth equal to the width of the mine opening (approximately 1.5 m).
	E. Boucher	Agree with Option 4, but you're never going to completely repair it.
	P. Smith	Option 4
	S. Beck	Option 4
	K. King	Option 4
	R. Breadmore	<i>Preferred option is Option 4, and all other are not acceptable due to health and safety concerns.</i>
	J. Gowman	<i>Introduces remedial options for buildings at Blanchet Mine.</i>
	R. Beaulieu	Option 2 (Demolish and Burn)
	A. Enzoe	Option 2
	A. Beck	Option 2
	T. Unka	Option 2
	P. King	Option 2
	M. Tollis	Option 2

Remedial Action Plan Options Analysis Workout

Approx. Time	Speaker	Topic/Comment/Discussions Actions
	E. Boucher	Option 2
	P. Smith	Option 2
	P. Simon	Option 2
	S. Beck	Option 2
	K. King	Option 2
	R. Breadmore	<i>Option 2 (demolish and burn) has been selected as the preferred option.</i>
	J. Gowman	<i>Introduces remedial options for refuse at Blanchet.</i>
	A. Beck	We should use what we can, and take off site what we can't use. A hybrid option.
	C. Gravelle	At Blanchet, the refuse is empty drums, timbers, etc. Since we may need to construct a landfill, managing the small volume of refuse on site could be integrated. Pull the impacted material down off slope (including timber and refuse) and put under the cap.
	R. Beaulieu	If there's going to be a landfill then add it to the landfill (Option 3), but if not, then take it off-site (Option 2).
	A. Enzoe	Option 2 (Transport off-site)
	A. Beck	Option 2
	T. Unka	Option 2
	P. King	Option 2
	M. Tollis	Option 2
	E. Boucher	Option 2
	P. Smith	Option 2
	S. Beck	Option 2
	P. Simon	Option 2
	K. King	Option 2
	R. Breadmore	<i>Consolidate and transfer off-site (Option 2) is the preferred option.</i>
	J. Gowman	<i>Introduces waste rock remedial options at Blanchet.</i>
	C. Gravelle	The risk assessment says we should reduce exposure to ore and waste rock and could use a soil cover to provide the necessary protection.
	P. Simon	Would the cover be soil or plastic?
	C. Gravelle	Option 2 is soil only and Option 3 is a liner and then soil. There is enough borrow material at this site to use as capping material.
	R. Beaulieu	Why do you need to reslope?
	J. Hoyt	The slope is steep and could be unstable, and to reduce the amount of metals that would leach out.
	R. Beaulieu	How much ore is mixed in?
	C. Brown	We estimate about 20m ³ .
	R. Beaulieu	How would you reslope?
	C. Gravelle	Using an excavator with a longer or extension boom.
	J. Hoyt	We think it's important to stop exposure to this material and will take measures to reduce dust such as wetting it down.
	A. Beck	You may lose the slope if you disturb it.
	T. Unka	You need to re-vegetate and control the dust.
	J. Gowman	We think this can be done safely and dust management will be part of the health and safety plan.
	R. Beaulieu	Option 3 (Reslope and Cover)
	A. Enzoe	Option 3

Remedial Action Plan Options Analysis Workout

Approx. Time	Speaker	Topic/Comment/Discussions Actions
	A. Beck	Option 3
	T. Unka	Option 3, but with revegetation to minimize wash out.
	C. Gravelle	A coarse cover is proposed because there isn't enough organic material to cover it. If during work activities sufficient organics are generated, then it could be added as a cover.
	J. Gowman	This is bioengineering and it worked well at Colomac.
	P. King	It would be good to cover with soil. Option 3.
	M. Tollis	Option 3.
	E. Boucher	Option 3
	P. Smith	Option 3
	S. Beck	Option 3
	K. King	Option 3
	R. Bjornsen	Option 3
	J. Gowman	Option 3, reslope and cover, selected as the preferred option.
	C. Gravelle	There are requirements to re-grade and cover a borrow area with organic material after the extraction of borrow material have been completed. If there is enough material left over after this, then it can be used at the Mine Area.
	R. Breadmore	<i>Option 3 (re-slope and cover) is preferred option</i>
11:20	BREAK	
11:35	R. Breadmore	<i>Introduces remedial options for ore at Blanchet.</i>
	J. Hoyt	We are referring to the ore in small piles and in the Beach Area that is now in the overpacks and used to be in spilled drums.
	R. Beaulieu	Option 2 (Consolidate and offsite disposal)
	A. Enzoe	Option 2
	A. Beck	Option 2
	T. Unka	Option 2
	P. King	Option 2
	M. Tollis	Option 2
	P. Smith	Option 2
	S. Beck	Option 2
	P. Simon	Option 2
	K. King	Option 2
	R. Bjornsen	Which ore are we proposing to move?
	J. Hoyt	Drummed ore and small isolated pockets (spilled ore at the camp).
	C. Gravelle	Not the ore at the Mine Area which is mixed in with waste rock (can't be removed off-site).
	J. Gowman	<i>So Option 2 (off-site disposal) is the preferred option and all others classified as unacceptable.</i>
	J. Gowman	<i>Introduces metal impacted soil remedial options at Blanchet.</i>
	C. Gravelle	These are the same options as waste rock.
	J. Gowman	Option 3 (excavate and place under low permeability cover) would be the same as the management for waste rock.
	R. Beaulieu	Option 3
	A. Enzoe	Option 3
	A. Beck	Option 3
	T. Unka	Option 3
	P. King	Option 3
	M. Tollis	Option 3, but about how much soil is this? Should keep it together.

Remedial Action Plan Options Analysis Workout

Approx. Time	Speaker	Topic/Comment/Discussions Actions
	J. Hoyt	Approximately 7,000 m ³ .
	C. Gravelle	This is primarily the soil under the Beach Area ore spill and at the Mine Area.
	C. Brown	Approximately 1000m ³ in the Beach Area and 1000m ³ in the Mine Area.
	M. Tollis	What about offsite disposal if arsenic is the issue?
	C. Gravelle	The risk assessment said we need to reduce exposure, and placing it under a cover would do this.
	R. Breadmore	The soils would be managed outside of the drainage course with the potential for migration reduced by the cap.
	A. Beck	Could you please clarify how you would construct this?
	J. Hoyt	We would mix the soil with waste rock and incorporate under the same cover.
	T. Unka	We should take it offsite like the ore, and could use the backhauls.
	J. Hoyt	To clarify, the ore at the mine that is mixed with the waste rock would be under the cover.
	M. Tollis	At the Mine Area?
	J. Hoyt	Yes, there would only be one landfill and it would be in the Mine Area.
	M. Tollis	Option 3 (excavate and place under low permeability cover), but we should discuss where.
	J. Hoyt	Yes we should get some TK and some opinions regarding where this could be situated.
	C. Gravelle	We are proposing that the impacted materials be placed at the base of the escarpment at the Mine Area.
	J. Gowman	This is a good location because it's out of the drainage path.
	T. Unka	What is the probability of a mine reopening here and what if the claim is sold?
	R. Breadmore J. Gowman	The potential is always there depending on economics. We need to protect human health and the environment, but there is always the possibility of another mine. However, there is now a regulatory process (Land Use Permit or Water Licence) if anything were proposed.
	E. Boucher	Option 3 (excavate and place under low permeability cover)
	P. Smith	Option 3
	S. Beck	Option 3
	P. Simon	Option 3
	K. King	Option 3
	R. Bjornsen	Has a low permeability cover ever been used in the north? If it's reliable then I agree.
	C. Gravelle	We would recommend the use of a liner to minimize the exposure of capped materials to precipitation and snow melt.
	J. Gowman	We have used a liner system before. Is Option 3 suitable?
	R. Bjornsen	Yes, Option 3.
	R. Breadmore	<i>We have identified Option 3 (excavate and place under a low permeability cover) as the preferred option for metal impacted soil.</i>
12:05	BREAK	
1:10	J. Gowman	<i>Introduces remedial options for PHC impacted soil at Blanchet.</i>
	C. Gravelle	It's a small area that is estimated to be 50m ³ and is probably less. A test pit program will be implemented as part of the remediation

Remedial Action Plan Options Analysis Workout

Approx. Time	Speaker	Topic/Comment/Discussions Actions
		program once there is an excavator on site.
	R. Beaulieu	Option 2 (off-site disposal)
	A. Beck	Option 2
	T. Unka	Option 2
	P. King	Option 2
	A. Enzoe	Option 2
	M. Tollis	Option 2
	E. Boucher	Option 2
	P. Smith	Option 2
	S. Beck	Option 2
	K. King	Option 2
	R. Bjornsen	Option 2
	R. Breadmore	<i>Unanimous decision, Option 2 (off-site disposal) is the preferred option.</i>
	J. Gowman	<i>Introduces surface water and sediment remedial options at Blanchet.</i>
	C. Gravelle	We believe that once the cleanup work at the Beach Area and Mine Area is completed that the water quality will be improved over time. The risk assessment states that the source of the metal contamination needs to be remediated.
	R. Beaulieu	Fifty years ago when the mine was operating we would have more options, but now long-term monitoring (Option 2) is the only good option.
	A. Enzoe	Option 2
	A. Beck	Option 2
	T. Unka	Option 2, but what do you mean by capping the water?
	R. Breadmore	That refers to sediment capping and it could be used but there are challenges (Colomac and Giant examples).
	J. Gowman	We did a cover at Discovery using rock.
	R. Breadmore	These examples were for mine tailings and here we are dealing with only impacted sediments.
	T. Unka	Could it be pulled back?
	A. Beck	There are lots of contaminants in the sediments, but these are probably covered with a layer of cleaner sediments that form with time. It's also very deep offshore here.
	R. Breadmore	The natural silt layer and depth are important points to consider.
	J. Gowman	During the remediation we would have plans to prevent the sediments from being disturbed by barges at the old landing (i.e. Beach Area).
	A. Beck	This is an important use for TK during the remediation. There's deeper water to the west and we can interpret these things.
	P. King	Option 2 (leave it as is and monitor)
	M. Tollis	You also show there's a creek with impacts. Are you monitoring that?
	J. Hoyt	Yes we would do this in the long term monitoring program.
	M. Tollis	This is a good study case to see how mines recover. So Option 2.
	J. Hoyt	This is a mineralized area and we have heard the traditional name is Eroding Rock Island. So we will still see elevated arsenic, but we will look at this with background measurements as well.
	E. Boucher	Water flows down from the mine and to the lake year round from

Remedial Action Plan Options Analysis Workout

Approx. Time	Speaker	Topic/Comment/Discussions Actions
		snow melt and rain.
	J. Hoyt	We agree there is such a creek, and we have also taken measurements from the creek above the mine.
	E. Boucher	Option 2.
	P. Smith	Option 2
	S. Beck	Option 2
	P. Simon	Option 2
	K. King	Option 2
	R. Bjornsen	Option 2
	R. Breadmore	<i>We have reached a consensus and Option 2 (long term monitoring) is the preferred remedial option.</i>
1:35	BREAK	
1:45	J. Gowman	<i>Introduces remedial options for Copper Pass Trenches.</i>
	C. Gravelle	There are two main trenches at the Main Showing and the water within them would need to be treated. The other trenches there are not a major hazard. The West showing trench is a small hazard and is difficult to access. The other trenches are hard to access and much smaller.
	R. Breadmore	The mine inspector would need to sign off on remedial measures.
	J. Gowman	There is still a fall hazard with these trenches.
	A. Beck	What volume of water is in the trenches?
	C. Gravelle	We will confirm the volume of water within the trenches however we would estimate that there is more than 1,000,000 L in the two main trenches. Even if volume was less (500,000 L) it would still spill as the trench is filled.
	A. Beck	How contaminated is this water?
	C. Brown	This water is reported to contain very elevated concentrations of metals and we need to manage it.
	A. Beck	We could let it freeze and then take it out in the winter. It needs to come out.
	J. Hoyt	We want the same thing, but to a certain extent how to manage it is up to the contractor.
	A. Beck	We don't want the contractor to make the decision. How do you monitor them?
	R. Breadmore	Some flexibility is necessary but there is Crown site presence during all phases of the remediation works.
	J. Hoyt	We will monitor them, with third parties and the Crown representatives.
	T. Unka	Can't you use the wetland to treat it? It could be a better use of resources.
	J. Gowman	Wetland treatment does work, but we don't want to harm the wetland. We could do primary treatment and then polish using the wetland.
	T. Unka	Wetlands are effective and better value.
	J. Hoyt	We see that the wetlands are working to remove metals at the Main Showing. But we don't want to contribute additional impacted water. So we could use a hybrid solution.
	A. Beck	Did you test downstream of the Main Showing drainage?
	J. Hoyt	Not right at the drainage but we are planning to do this in the future.

Remedial Action Plan Options Analysis Workout

Approx. Time	Speaker	Topic/Comment/Discussions Actions
	R. Breadmore	Trench water metal parameter concentrations are too high to discharge – could be more than the wetlands could handle.
	A. Beck	The option should really be to backfill and treat.
	J. Gowman	<i>Edits Option 3 to Read "Backfill and water treatment"</i>
	A. Enzoe	Option 3
	R. Beaulieu	Option 3
	A. Beck	Option 3
	P. King	Option 3
	T. Unka	Option 3
	M. Tollis	Would the water treatment be onsite?
	J. Gowman	Yes
	M. Tollis	Option 3
	E. Boucher	Option 3
	P. Smith	Option 3
	S. Beck	Option 3
	K. King	Option 3
	R. Bjornsen	Option 3
	R. Breadmore	<i>Backfill and Treat Water (Option 3) is the preferred option.</i>
	J. Gowman	<i>Introduces remedial options for ore at Copper Pass.</i>
	A. Beck	Option 3 (consolidate in trenches and capping), it came out of the trench.
	C. Gravelle	We have ore in consolidated piles and smaller deposits.
	R. Beaulieu	How much ore is there at the site?
	C. Brown	About 150m ³ , of which 120m ³ is in consolidated piles.
	T. Unka -	Is there any ARD?
		ARD is not the primary concern at the site, but there are select locations where the ore/waste rock is classified as acid generating. However, metal leaching is occurring under neutral conditions, most notably of arsenic.
	R. Beaulieu	Option 3 (consolidate in trenches and capping).
	A. Enzoe	Option 3
	A. Beck	Option 3
	T. Unka	Option 3
	P. King	Option 3
	M. Tollis	Option 3
	E. Boucher	Option 3
	P. Smith	Option 3
	S. Beck	Option 3
	P. Simon	Option 3
	K. King	Option 3
	R. Bjornsen	Option 3
	R. Breadmore	<i>Consolidation in trenches and capping (Option 3) is the preferred option.</i>
2:15	BREAK	
2:25	J. Gowman	<i>Introduces remedial options for waste rock at Copper Pass.</i>
	C. Gravelle	The majority of waste rock is at Trench #2. This could be used as a backfill to reduce the physical hazard, but putting it in the trench would also reduce exposure to the material.
	A. Beck	So the water would be treated?

Remedial Action Plan Options Analysis Workout

Approx. Time	Speaker	Topic/Comment/Discussions Actions
	C. Gravelle	Yes.
	R. Beaulieu	Option 3 (consolidate in trenches and capping)
	A. Enzoe	Option 3
	A. Beck	Option 3
	T. Unka	Option 3
	P. King	Option 3
	M. Tollis	Option 3
	E. Boucher	Option 3
	P. Smith	Option 3
	S. Beck	Option 3
	P. Simon	Option 3
	K. King	Option 3
	R. Bjornsen	Option 3
	R. Breadmore	<i>Consolidate in trenches and capping (Option 3) is the preferred remedial option.</i>
	J. Gowman	<i>Introduces remedial options for metal impacted soil at Copper Pass.</i>
	C Gravelle	Issues are similar to waste rock
	R. Beaulieu	Option 2 (consolidate in trenches and capping)
	A. Enzoe	Option 2
	A. Beck	Option 2
	T. Unka	Option 2
	P. King	Option 2
	M. Tollis	Option 2
	P. Smith	Option 2
	E. Boucher	Option 2
	S. Beck	Option 2
	P. Simon	Option 2
	K. King	Option 2
	R. Bjornsen	Option 2
	R. Breadmore	<i>Option 2 (consolidate in trenches and capping) is the preferred option.</i>
	J. Gowman	<i>Introduces remedial options for PHC impacted soils.</i>
	C Gravelle	As some context, Options 3 and 4 would be difficult. Most of the PHC impacted soil is the Camp Area and it would be hard to get it to the mine showing trenches. It would also be difficult to do a landfarm in this area as there is little stable ground in the area of the camp.
	R. Beaulieu	Option 2 (off-site disposal)
	A. Enzoe	Option 2
	A. Beck	Option 2
	J. Gowman	How much soil is impacted?
	C. Brown	About 70m ³ .
	T. Unka	Option 2 (off-site disposal)
	C. Gravelle	It is important to note that when this soil is excavated it will change the topography of the Camp Area, and there will be exposed bedrock.
	T. Unka	It is a mined area and this is expected.
	P. King	Option 2 (off-site disposal)

Remedial Action Plan Options Analysis Workout

Approx. Time	Speaker	Topic/Comment/Discussions Actions
	M. Tollis	Option 2. But what are we proposing to do with Trenches 3, 4, 5 and 6?
	C. Gravelle	We wouldn't do anything as the risk is equivalent to the hazards presented by the local topography.
	M. Tollis	What about the adit?
	C. Gravelle	It's not really an adit, but the start of one. It's only 3m deep and we wouldn't propose to do anything at this location.
	R. Breadmore J. Gowman	The mine inspector would likely not classify this as an opening (it's not connected to any underground mine works).
	E. Boucher	How many trenches are there?
	C. Gravelle	Two big ones and two small ones at the Main Showing. One at the West Showing, two at the East Showing and five very small ones at the Upland Pond.
	E. Boucher	Option 2 (off-site disposal).
	P. Smith	Option 2
	S. Beck	Option 2
	P. Simon	Option 2
	K. King	Option 2
	R. Bjornsen	Option 2
	R. Breadmore	<i>Option 2 (off-site disposal) is the preferred option.</i>
	J. Gowman	<i>Introduces remedial options for buildings at Copper Pass.</i>
	A. Enzoe	Option 2 (demolish and burn)
	A. Beck	Option 2
	T. Unka	Option 2
	P. King	Option 2
	M. Tollis	Option 2
	E. Boucher	Option 2
	P. Smith	Option 2
	S. Beck	Option 2
	P. Simon	Option 2
	K. King	Option 2
	R. Bjornsen	Option 2. What do you do with the footprint?
	C. Gravelle	We would remove the ash.
	J. Gowman	The specs usually call for a container to burn in.
	J. Gowman	<i>Option 2 (demolish and burn) is the preferred option for the buildings.</i>
	C. Gravelle	<i>Introduces non-hazardous material remedial options at Copper Pass.</i>
	A. Beck	Haul the drums away but burn the wood.
	R. Breadmore	Let's add a hybrid option. Option 4 is burn all clean wood, remove the drums and steel, and remove ash.
	R. Beaulieu	Option 4
	A. Beck	Option 4
	T. Unka	Option 4
	P. King	Option 4
	M. Tollis	Option 4
	E. Boucher	Option 4
	S. Beck	Option 4
	P. Simon	Option 4

Remedial Action Plan Options Analysis Workout

Approx. Time	Speaker	Topic/Comment/Discussions Actions
	K. King	Option 4
	R. Bjornsen	Option 4
	R. Breadmore	<i>Option 4 is the preferred option for non-hazardous waste at Copper Pass.</i>
2:50	BREAK	
3:05	R. Breadmore	We presented a lot of material and thank you to everyone. A special thank you to Tom and Anne for their hard work interpreting.
	J. Gowman	<i>Reviews the preferred remedial option selected for each component at the three sites.</i>
	J. Hoyt	Is everyone comfortable with the mill equipment coming off site? Or do you want to leave this for heritage reasons?
	R. Breadmore	Such equipment has been left at other sites. Pete King did mention that this is one of the oldest mines in the territories.
	M. Tollis	If it isn't a hazard or environmental concern, then leave it.
	P. Simon	Mining hasn't always been good to us, but we should still look at the history of it.
	R. Bjornsen	I'm not sure how many young people would be visiting the site.
	J. Gowman	Outpost Preferred Remedial Options: Mine Openings: Option 4 – Hybrid (Foam for small openings, concrete for large) Buildings: Option 2 – Demolish and Burn Non-Hazardous Debris : Option 2-Offsite disposal (equipment TBD) Hazardous Waste: Option 2 – Offsite disposal Tailings/Waste Rock: We have two acceptable options (to do nothing, or to consolidate and reslope) Waste Rock: Option 4 – Hybrid (Leave as is, but use it if needed) Metal Impacted Soil: Option 2 - Off-site disposal PHC Impacted Soil: Option 2 – Off-site disposal Water/Sediments : Option 2 – Long Term Monitoring
	R. Bjornsen	DKFN needs to consult with its Technical Advisor.
	R. Breadmore	Speaking to your consultant on the tailings/waste rock issue is a good idea.
	J. Hoyt	We think stabilizing is a good solution.
	R. Breadmore	Take some time and the site visit may help to determine your preferred option.
	A. Beck	Are you going to stabilize the tailings in North Bay?
	G. Gravelle	We recommend stabilizing the waste rock/tailing stockpile slope on the east side of the North Bay and may install large boulders at the mouth of North Bay to act as energy dissipating structures.
	J. Gowman	Blanchet Preferred Remedial Options: Adit: Option 4 – Foam Plug Buildings : Option 2 – Demolish and Burn Refuse: Option 2 – Off-site Disposal Waste Rock: Option 3 – Reslope and Cover Ore: Option 2 – Off-site disposal Metal Impacted Soil: Option 3-Reslope and Cover (low permeability) PHC Impacted Soil: Option 2 – Off-site disposal Water/Sediments: Option 2 – Long-term monitoring
	J. Gowman	Copper Pass Preferred Remedial Options: Trenches: Option 3 – Backfill and treat water

Remedial Action Plan Options Analysis Workout

Approx. Time	Speaker	Topic/Comment/Discussions Actions
		Ore: Option 3 – Consolidate in trenches and cap Waste Rock: Option 3 – Consolidate in trenches and cap Metal Impacted Soil: Option 2 – Consolidate in trenches and cap PHC Impacted Soil: Option 2 – Off-site disposal Structures: Option 2 – Demolish and Burn Non-Hazardous Waste: Option 4 – Drums and metal off site, burn clean wood.
	R. Breadmore J. Gowman	The binder we have given you contains draft RAP summaries and preferred remedial options will be incorporated into the Final RAP.
	G. Lafferty	<i>Provides summary of TK questionnaire and indicated this information will be confidential. More TK, including what has been mentioned during current meetings, will be used to formulate RAP. Thank you to participants.</i>
	R. Breadmore	We will continue to use TK for such things as we move through the remedial planning stage, execution and into closure and monitoring (interpreting seasonal conditions, wildlife monitoring etc).
	J. Gowman	Thanks to the elders who participated in the flight tour.
	R. Bjornsen	Thanks to the land users and especially the Elders. Their stories have importance in these meetings and also in life. Thank you also to Anne, INAC and SENES.
	A. Beck	Thank you to everyone. This is one of the few times we were on the same side and didn't need to fight. Scientists need to understand the TK passed on from thousands of years and the benefits of this.
	T. Unka	Thank you for everyone's efforts. The next generation is going to appreciate this.
	P. King	Appreciative of the work activities.
	E. Boucher	Spent time at these sites in the 1950s and has been thinking about this a lot.
	S. Beck	Thank you and safe trip home.
	P. Simon	Thank you.
	K. King	Thank you, especially to the elders. This was a good start, especially with devolution and the number of sites to come.
	R. Breadmore	Thanks from all of us. We really do enjoy these community meetings. This workshop has been a true collaborative effort and we thank Ft Resolution leadership and community for its hospitality.
	A. Enzoe	Everyone has had a happy two days in a row and thank you.
16:00		<i>Closing Prayer</i>

APPENDIX C

REMEDIAL ACTION PLAN OPTIONS ANALYSIS WORKOUT TABLES



Outpost Mine – Remedial Options Evaluation

Fort Resolution
June 13-14, 2013

Mine Component	Option 1	Option 2	Option 3	Option 4	Option 5
Mine Openings	Leave as is	Retrofit Caps and Raise Fill in	Upgrade Existing Concrete Caps and Seal Main Raise	"HYBRID" -> Concrete Cap Shaft #1 -> foam for raise and Shaft #2	
Buildings	Leave as is	Demolish and Burn			
Non-Hazardous Refuse	Leave as is	Consolidate and Transport Off-Site	Consolidate and Place in On-Site Landfill		
Hazardous Waste Materials	Leave as is	Consolidate and Transport Off-Site			
Mixed Tailings/Waste Rock	Leave as is	Consolidate and Re-Slope	Consolidate, Re-Slope and Cover		
Waste Rock	Leave as is	Deposit in Surface Excavations		"HYBRID" -> leave as is -> use if needed	
Metal Impacted Soil	Leave as is	Consolidate and Transport Off-Site	Capping		
PHC Impacted Soil	Leave as is	Off-Site Disposal	On-Site Disposal	On-Site Treatment	
Surface Water and Sediments	Leave as is	Long-Term Monitoring			



Blanchet Mine – Remedial Options Evaluation

Fort Resolution
June 13-14, 2013

Mine Component	Option 1	Option 2	Option 3	Option 4	Option 5
Adit	Leave as is	Backfill w borrow	Backfill w waste rock	Foam Plug	
Building Structures	Leave as is	Demolish and Burn			
Refuse	Leave as is	Consolidate and transfer off-site	Consolidate and place in on-site landfill		
Waste Rock	Leave as is	Re-slope	Re-slope and cover		
Ore Concentrate	Leave as is	Consolidate and off-site disposal	Consolidate and on-site disposal		
Metal Impacted Soil	Leave as is	Cap w granular material	Excavate and place under low permeability cover		
PHC Impacted Soil	Leave as is	Off-site disposal	On-site disposal	On-site treatment	
Surface Water and Sediments	Leave as is	Long term monitoring			





Copper Pass Mine – Remedial Options Evaluation

Fort Resolution

June 13-14, 2013

Mine Component	Option 1	Option 2	Option 3	Option 4	Option 5
Surface Trenches	Leave as is	Fencing and/or Berms	Backfilling (and treat water)		
Ore	Leave as is	Grading and Covering	Consolidation in Trenches and Capping		
Waste Rock	Leave as is	Grading	Consolidation in Trenches and Capping		
Metal Impacted Soils	Leave as is	Consolidation in Trenches and Capping			
PHC Impacted Soils	Leave as is	Off-Site Disposal	On-Site Disposal	On-Site Treatment	
Structures	Leave as is	Demolish and Burn			
Non-Hazardous Materials	Leave as is	Consolidate and Manage Off-Site -> drums/steel off-site -> clean wood burned	Consolidate and Dispose in an On-Site Landfill	"HYBRID" -> drums/steel off-site -> burn clean wood	

