TŁĮCHǪ GOVERNMENT RISK ASSESSMENT OF PROPOSED FORTUNE MINERALS NICO MINE

June 19, 2012

Technical Report submitted to the Mackenzie Valley Environmental Impact Review Board

CONTENTS

LIST OF TABLES

OVERVIEW

The Tłı̨chǫ Government prepared information, with expert assistance, on six categories related to the proposed NICO mine. These topics include:

A. Co-disposal and mine rock, based in expert assistance from SENES Consultants and Dr. Gibson MacDonald,
B. Mine economics, based in expert assistance from Dr. Scott Dunbar, University of British Columbia;
C. Water quality and quantity; based in expert assistance from SENES Consultants;
D. Socio-economics; based in expert assistance from SENES Consultants;
E. Caribou, based in expert assistance from Tłı̨chǫ Lands and Environment staff, harvesters, Elders and John Nishi of ALCES, and
F. Closure, based in expert assistance from SENES Consultants, Tony Pearse and Dr. Gibson MacDonald.

This document reviews what the Tłı̨chǫ Government considers to be the key issues and concerns in each category. It then provides a review of the key issues in each category, a hazard assessment, and a likelihood assessment. The hazards, likelihood, consequence and risk management were all rated by the expert consultants, in consultation with the Kwe Beh Working Group of the Tłı̨chǫ Government. After a complete exploration of the key issues, the Tłı̨chǫ Government assigned a risk rating and made a subjective risk assessment.

The Tłı̨chǫ Government conducted this risk assessment exercise on May 30, 2012. We acknowledge that these judgements may shift as new information is made available to the public record. The results of this risk assessment have provided the Tłı̨chǫ Government with an informed perspective on this proposed mine. Attendees to the meeting included the Chiefs of all four communities, the Grand Chief and the Kwe Beh Working Group.

Tables (2-7) used as a basis for forming the Tłı̨chǫ Government risk assessment judgements include a description of the:

- **Issue:** characterization of the issue and the information we have available.
- **Risk management**: how easy it is to control risks.
- **Risk**: hazard multiplied by likelihood of occurrence multiplied by consequence of hazard.
- **Risk assessment**: the Tłı̨chǫ Government judgement that has been made, which includes both the quantification of risk and in some cases relates to the acceptability of the level of information currently available or associated concerns.

The hazard, likelihood of occurrence and the consequence of the hazard were all quantified, using expert judgement. Table 1 shows our rating scheme. The risk management (or how easy it is to control the risk) was also quantified, and then these numbers were all combined to create an overall risk figure. There are three risk characterizations possible:

- **Green**, meaning this is an acceptable risk;
- **Yellow**, meaning there is conditional risk acceptance (and that there is likely information missing);
- **Red**, meaning this is an unacceptable risk because of the risk posed to key valued components and that major information gaps remain.

We close each section with recommendations for mitigations or further work required by the developer.

CO-DISPOSAL TECHNOLOGY AND MINE ROCK

CO-DISPOSAL RISK RATING: Overall, the Tłı̨chǫ Government gives co-disposal a *conditional or yellow risk rating*, given that is a strong likelihood of neutral metal leaching and acid rock generation, as well as the generation of thiosalts. Four issues were considered in the risk assessment. Other technical issues are discussed in the review below. See Table 2.

The developer has chosen to use a relatively new technology – co-disposal - to manage the tailings and waste rock. The Tłı̨chǫ Government notes that co-disposal reduced the size of the footprint for the mine rock and tailings. This technology has not been used in the north, and while the company has provided comparisons, there are no cases similar to the conditions and environment in the NWT (See Appendix A: Discussion of examples provided by Golder Associates at the Technical Sessions).

As the table in Appendix A illustrates, none of the co-disposal case studies used has useful relevance to the proposed NICO project. Some of these cases are still concepts, others are just barely into construction and operation, and none present any relevant environmental performance data to inform the current proposal. The Golder study did not present any examples of a functioning co-disposal operation involving thickened tailings and waste rock, let alone one with demonstrated results for environmental performance.

The proponent made the decision to pursue co-disposal as a technology in their 2010 *Trade-off Report*, which refers to a detailed trade off study in which three alternatives to the tailings and mine rock disposal were examined using environmental, engineering and economic criteria. These three cases were identified as:

> Alternative 1: Base case – disposal of conventional slurry tailings northeast of the Open Pit (Site 1) and mine rock in the valley immediately south of the Open Pit (Site 2).
>
> Alternative 2: Disposal of non-segregating, thickened tailings in a tailings facility and mine rock in a mine rock pile, located in Site 1.
>
> Alternative 3: Co-disposal of non-segregating, thickened tailings and mine rock in Site 1.

Co-disposal was the option chosen, but there is no evidence on the public record of what ranking system, quantitative criteria and weighting was used to evaluate the options. This is critical, because parties (including decision makers like the Review Board) may weight factors differently. The Review Board, Tłı̨chǫ Government and other parties to the environmental assessment currently have very little basis to consider whether, in fact, the co-disposal is the only option that meets criteria that are environmentally, culturally, socially and economically sound as well as technically feasible and optimal.

In examining the developer's chosen approach, there are remaining concerns, some of which could be resolved with more information. However, many of these concerns will not be resolved until the company actually proofs this concept in the north. This lack of proof of concept in the north increases the risk rating of this management strategy.

The Tłı̨chǫ Government notes the following performance gaps that have emerged in the consideration of the co-disposal concept.

Lack of management guidelines

There are no management guidelines for northern environments. This presents a particular concern for the region. There are a number of examples that have been raised by the Tłı̨chǫ Government in interventions, many of which will not be answered until performance is being tested. These include issues noted below.

Trafficking of tailings

There was concern raised that traffic into and out of the co-disposal facility (CDF) could transport contaminated material around the site. Fortune responded that trucks will never contact tailings and that if contamination was spread around it would be intercepted in runoff. Careful monitoring during operations is required to confirm Fortune's statements.

Ice lens formation

The Tłı̨chǫ Government suggested that ice lens formation could be an issue in the performance of the co-disposal technology. Fortune responded that ice formation will be minimized because of the use of thickened tailings and they reference two sites where ice formation is not an issue. Although not directly applicable, the original Key Lake tailings facility in northern Saskatchewan had to be abandoned due to ice lensing which are still present more than 20 years after placement.

Additionally, Fortune responded that if settlement occurred, the areas would be backfilled. The problem here is twofold. Ice lens melting adds to seepage flows and settlement resulting from ice thaw may occur over hundreds of years.

Thickener performance

If problems with thickener performance emerge, the problems could be endemic and long term. The complete concept would be in jeopardy.

Seepage model predictions

Fortune has expressed that seepage will be controlled by the vertical low permeability of the tailings. SENES indicated this was not likely to be the case and that the flow would be mostly horizontal along the permeable rock dykes and rock layers to the perimeter dam and drains. Fortune's second round response appears to agree that primary flow paths will be horizontal. This acknowledgement by Fortune is important as horizontally flowing waters may still result in metal leaching and poor quality seepage from the CDF.

Fortune was asked to support the seepage model predictions as the source terms for the model (quality of the wastewaters and seepages) were based upon the direct use of humidity cell data. The developer chose not to respond to this request for further information. The direct use of humidity cell data is simply not good practice; it is not a standard approach for assessing loadings from waste rock and tailings as outlined by Price and Errington (1998), as reported in the Draft BC Acid Rock Manual. However, the use of the upper range of data values to assign predicted conditions in the modelling may reduce the potential error associated with using the humidity cell data directly.

The implication of this finding is that planning and design work related to water treatment, operational procedures and closure cannot be effective without technically sound and defensible seepage quality predictions. Tłı̨chǫ Government's position on this issue remains unchanged. Fortune should be required to demonstrate the soundness of the seepage quality predictions.

Uncertainty of performance of wetlands in cold climates

Given the uncertainty in the performance of wetlands in cold climates, Fortune was asked to address the logistics and costs associated with long term treatment using reverse osmosis (RO). Fortune responded that they do not propose to use RO. Instead, they propose to use passive wetlands or passive subsurface bioreactors and provided an estimate for the costs for these systems. No design basis for the cost estimate was given but the costs do appear reasonable for the passive options.

However, the objective of the question was to identify the practicality of physical-chemical treatment over the long term and to assess the costs that would be incurred in the event that the proposed passive systems were not successful. In this regard, the response did not address the question posed.

Fortune also indicated that if the passive wetlands or passive subsurface bioreactors are not fully effective they would use alternative physical/chemical processes such as precipitation and ion exchange. However, Fortune did not provide the cost information necessary to assess the potential future costs if passive treatment was not successful.

The Tłı̨chǫ Government notes the following:

- Passive sub-surface reactors represent a potential long term treatment option for use at the site. The real secret to success will be flow control and equalization. Biological systems are typically not amenable to major variations in flow.
- Seasonal flow variation from the site will be significant. No information is presented on how flows to the reactors would be equalized or if reactors were designed for peak flows. Our experience suggests these systems are best applied to seepage streams and continuous discharges where flow variability is modest. Systems SENES has been exposed to typically include bypasses to divert untreated flows above design capacity such that the treatment system is not compromised.
- The developer's response information indicates that the quality of the seepage from the co-disposal facility will improve over time. This may or may not be the case. Given oxidation of the CDF will be ongoing, seepage quality and metals release may well increase over time.

Site expansion and CDF capacity

Fortune was asked to provide information related to the volume of ore that could be produced before the CDF height is increased such that it becomes visible above the ridge. Fortune responded that the CDF would have to be raised by 50 metres before it becomes visible but for operational reasons, the CDF height could only be increased by 25 metres and will remain hidden behind the ridge. The response was appropriate and no further information is required by the Tłı̨chǫ Government.

Oxygen penetration

Fortune was asked to provide some evidence that oxygen limitation will occur (IR TG-15g). The developer's response was trivial and inadequate. The basic issue is that this pile is filled with porous layers and drains. As such, oxygen entry is not likely to be curtailed. Soil covering will help but the cover will be unsaturated and oxygen penetration will readily occur. As such, ongoing oxidation of sulphide in the pile will not be curtailed. This is another benefit of a geo-membrane as it would impede oxygen entry into the pile.

Thiosalts

The issue of thiosalts was raised. Fortune state they are not expected. In SENES's estimation this would be the first base metal mine that did not produce thiosalts by alkaline oxidation in the process plant. The company suggests they will deal with the problem if and when it arises. However, this simple statement is disconcerting given that no real reasonable management strategy for thiosalts has been developed after 40 years of study.

Mine waste rock

Fortune was asked to explain how the waste rock classification criteria were developed (i.e. 0.3% sulphur, 1000 parts per million (ppm) arsenic, 50 ppm bismuth) (IR TG-18-1). Fortune responded that this information is in its existing report. We have repeatedly examined the reports and have not found an adequate rationale for how the waste rock classification criteria were developed. For example, we know that rock with 0.3% sulphur can be acid generating as was demonstrated

with the developer's own tests and thereafter ignored. As a minimum, this sulphur criterion level is not defensible and provides considerable uncertainty with regard to the seepage from "clean waste".

Waste rock management and monitoring

Additional details on the waste rock management plan were requested (IR TG 18-2), specifically related to monitoring waste rock during operations. Fortune responds that the plan will be as described in the DAR and will evolve over the life of the project. Future iterations of the waste rock management plan should describe waste rock monitoring protocols that will be followed during operations.

Waste rock production schedule

Fortune was requested to provide a schedule for waste rock production by waste type (IR TG 18). Fortune referred to a table in report; however, that table remains confusing and frankly unhelpful. Fortune should provide a simple table that identifies volume of waste rock produced each year by the main waste types with no further classification of rock.

Type 3 waste rock buffer

In IR TG 18-4, the Tłı̨chǫ Government asked for a basis for the 20 metre buffer used for Type 3 waste rock placement within the CDF. The response was effectively that the buffer width is arbitrary but that it should be adequate. This is clearly an inadequate response.

RECOMMENDATIONS ON CO-DISPOSAL AND MINE ROCK

1) There remain major substantive gaps in the developer's work, particularly on seepage. The Review Board should require new work from the developer on the soundness of the seepage quality predictions.
2) Large gaps remain on the costs associated with closure, and the practicality of the developer's proposals. The developer should be required to provide (as was asked for) the future costs associated with the full suite of closure options that are mentioned.
3) Strong management guidelines should be required of the developer for the co-disposal technology proposed with independent oversight by Inspectors trained to recognize likely issues. These management guidelines should clearly articulate how the developer will manage key performance challenges.
4) The developer should be required to develop a peer reviewed management strategy for thiosalts.
5) Future iterations of the waste rock management plan should describe waste rock monitoring protocols that will be followed during operations.
6) Fortune should provide a simple table that identifies volume of waste rock produced each year by the main waste types with no further classification of rock.
7) The Review Board should require new work on the classifications of rock, based on any emergent information by AANDC and/or Natural Resources Canada, to determine if the developer's sulphur criterion level is defensible—requiring the developer to prove that "clean waste" is just that.

MINE ECONOMICS (SEE DUNBAR 2012, TECHNICAL REPORT SUBMITTED BY TŁĮCHǪ GOVERNMENT)

The company proposes to mine four metals: gold, cobalt, bismuth, and copper. They are highly dependent for their profit equally on cobalt and gold commodities, at current commodity prices. The reserve estimates and project value are sensitive to the metal prices and to the $US/$CDN exchange rate. Reductions in the price of metals or a high exchange rate could have a negative effect on the profitability of this proposed mine.

MINE ECONOMICS RISK RATING: Overall, the Tłı̨chǫ Government gives mine economics a *conditional or yellow risk rating*, based in part on the possibility that there will be long delays if there are mineral processing complications, and possible short term or long term closures if the commodity prices (particularly cobalt or gold) fall. See Table 3.

The company undertook an exploration drilling program in summer 2010 and found "some interesting intersections". However, there has been no report on the evaluation of the drilling results and whether they can be translated into reserves or a spatially distributed body of ore.

Non-market risks can also affect project value. As an example, the Saskatchewan hydrometallurgical plant could take a long time to start up, and there are uncertainties about how successful the company will be in recovering the four metals.

These uncertainties are critical to understand, as they relate to the ability of the developer to weather market downturns, commodity price changes, or challenges in processing. There are areas of concern that have not had specific and detailed costing associated with them.

With the possible and project economic risks that have been specified, the Tłı̨chǫ Government believes it critical to have detailed and specific costing of closure options.

RECOMMENDATIONS ON MINE ECONOMICS

8) The developer should be asked once again to provide detailed costing for the changed closure plans, including for all treatment options that have been proposed and to clearly identify the difference in costs if the passive treatment option fails.
9) The developer should demonstrate the effect of failure of the passive treatment option on the net present value, i.e., to compute the present value of the costs incurred in the event of failure of the option, in order to illustrate that this mine is feasible if the water has to be treated forever.

WATER QUALITY AND QUANTITY

Fortune Minerals is planning to catch all of the water that comes into contact with any parts of the mine before it flows into the environment so that it can be treated. Treated water will be put in Peanut Lake while the mine is active and in Peanut and Nico Lakes when the mine is closed. The first big question related to water treatment is deciding how much of the metals and other chemicals needs to be removed from the dirty water to make it safe.

WATER QUALITY AND QUANTITY: Overall, the Tłı̨chǫ Government gives water quality a *conditional or yellow risk rating*, with the possibility there will be effluent that still could have an impact on the environment, and the remaining concerns for four metals (aluminum, arsenic, copper and selenium). See Table 4.

To figure out how much of the metals and other chemicals should be removed from the dirty water before it is released to the environment, Fortune studied the lakes at the mine site. Fortune looked at the properties of the lake water such as temperature and hardness, the types of metals found naturally in the water, and the types of fish, bugs and other animals that live in the water to understand site-specific information. Using this site-specific information, Fortune Minerals developed Site Specific Water Quality Objectives (SSWQO), which are limits for the amount of metals and other chemicals that can be found in the lake water where it is mixed with the treated mine water.

The second big question is whether the SSWQOs will keep the lakes safe by making sure that the lake water is clean enough. Early indications from the Tłı̨chǫ Traditional Knowledge work suggest that there is human use of the waters in the immediate area of the proposed development (for drinking water, for culturally based travel to visit, travel to meetings and gatherings, and to harvest fish, ducks and a variety of other animals). There is also evidence of significant public concern about:

- Increased cumulative effects on the area east of Hislop Lake and in the Marian River area from additional water and land contamination in the same general area already heavily impacted by the historic Rayrock mine.
- Project-specific and cumulative effects on the Marian River, the main source of water for Behchoko.

The Tłı̨chǫ Government's Technical Advisors reviewed the Site Specific Water Quality Objectives and they think that most of the limits will keep the lakes safe for fish and the other creatures living in the water. However, there are still a few concerns about four metals, including aluminum, arsenic, copper and selenium (see SENES Technical Report on SSWQOs).

- Aluminum: Uncertainty remains as to whether the aluminum limit will be protective of fish in the winter. The pH of lake water is reduced in winter which affects the levels at which aluminum become harmful to fish. As pH of the lake/river water decreases, acceptable aluminum levels also decrease.
- Arsenic: Uncertainty exists that the arsenic limit is sufficiently protective of the fish and other organisms in the lakes. A toxicity test using a type of algae was used to set the arsenic limit. However, the company did give evidence that the toxicity measure provides an appropriate level of protection for these lakes.
- Copper: Uncertainty exists as to whether the copper limit is sufficiently protective of the fish and other organisms in the lakes. A computer model, which is a good approach, was used to help figure out the copper limit but some of the information (pH) the developer put into the model is different from the natural conditions observed in their studies of the lakes.
- Selenium: The approach to setting the selenium limit seems to be good and includes consideration of site-specific information on fish uptake. However, the amount of selenium in the lake water is naturally quite low and it is hard to measure. To deal with the fact that selenium is hard to measure, Fortune Minerals estimated how much selenium was in the water (i.e. the detection limit was used). However, the estimation may not be right.

- Estimated exposure rations (ERs) exceed 1 for arsenic, selenium and vanadium. All ERs are less than 2 and are argued to be conservative as based on maximums of conservative modelling thus adverse effects negligible. Based on the information provided, the level of risk may be considered acceptable. However, the developer's assessment of risk classifies it as negligible. These values and predictions should be revisited. (From Golder 2011. Nico Cobalt-Gold-Bismuth-Copper Project. Fortune Minerals Limited Nico Developer's Assessment Report Information Request Responses. Attachment A: Wildlife Risk Assessment. December.)

RECOMMENDATIONS ON WATER QUALITY

10) Specific action should be taken, as noted in the SENES Technical Report on SSWQOs, on aluminum, arsenic, copper and selenium. Specifically, these are:
    a. Fortune should discuss whether the aluminum SSWQO is appropriate for the conditions expected throughout the year.
    b. Fortune should discuss whether an EC_{50} is an appropriate basis for setting the SSWQO.
    c. Either additional justification should be provided for the appropriateness of the derived copper SSWQO or the parameters used in the BLM should better reflect the conditions in the water bodies.
    d. The assumptions used in the derivation of the selenium SSWQO should be re-examined.
    e. The developer should revisit and revise predictions made about the level of risk based on revised exposure ratios for these arsenic, selenium and vanadium.
11) The developer should be required to establish SSWQOs that are as protective as feasible, given the nature of the water treatment that is being proposed. The Review Board should require the developer to revisit its currently stated SSWQO goals in this light, especially considering the high public concerns about water contamination.
12) The developer should clarify if the SSWQOs will apply in the receiving environment or at the end of the pipe, as the technical information to date has been confusing.

SOCIO-ECONOMICS

SOCIO-ECONOMICS: Overall, the Tłı̨chǫ Government gives socio-economic issues a *red or unacceptable risk rate*, especially with the number of remaining uncertainties associated with the current plan. There is a low threshold expectation for Aboriginal employment and likely even lower expectation for Tłı̨chǫ employment, and therefore little possibility for taxation revenues to accrue to the Government to cover likely increased social services and other costs. The impacts of in-migration to Whati have not been modelled. There has been no useful modelling of cumulative effects on the human environment, including of the required all-season road. See Table 5.

The company has proposed a two on and two off schedule for the 231 people for construction, after which there will be an estimated 127 jobs during operations, with an as yet to be determined mixture of shift rotations. Employment during closure and reclamation is estimated to require 100 workers. The company has developed no concrete targets for northern Aboriginal hires, and its estimate of the likely percentage of northern Aboriginal hires appears to be between 15-40%. **If the lower percentage is the actual amount, it would be one of the lowest in the Northwest Territories of all current mining companies.**

There is no estimate of actual likely local Aboriginal workforce engagement, which of course would be lower than the total northern Aboriginal workforce percentage. The developer has presented no information about the local, regional or territorial labour force currently available to work at the mines. The developer's argument on this point is that because of the timing challenges of this mine (i.e., no one knows when it is likely to open); it is difficult to predict the labour force that will be available at this unknown future time. The developer committed at the Technical Sessions to work with the Tłı̨chǫ Government and local economic development staff on a community-by-community workforce evaluation, but no evidence to this effect has been provided for the public record in the subsequent four months.

The Tłı̨chǫ Government and Tłı̨chǫ citizens have been provided no concrete estimations of the likely employment (let alone business) benefits likely to accrue from the mine should it proceed. Nor can the Tłı̨chǫ Government estimate how much income tax revenue it may generate from the mine, funds from which would be required to offset increased governance costs, especially strains on social and other services provided by the Tłı̨chǫ Government to its citizens.

Neither in- or out-migration pressures within and between Tłı̨chǫ communities have been appropriately assessed by the developer. Tłı̨chǫ people have already experienced major out-migrations from the Tłı̨chǫ communities, in part because there is a lack of housing in the communities and in part related to changes that have occurred as a result of increased wage economic employment, especially in the diamond mines. This out-migration has impacts on the government and communities. The government does not collect taxation from Tłı̨chǫ citizens who are Yellowknife residents, and as the communities are emptied of key harvesters and miners, the fabric of the community is changed.

On the in-migration side, the developer has not provided evidence to support its assertion that the community of Whati, in particular, may see increased through traffic, increased in-migration, and attendant beneficial and adverse impacts. The almost complete absence of effort to quantify and qualify potential in-migration effects means the developer's estimates of minimal impact must questioned.

In the absence of an employment modelling exercise and proper scenario analysis of whether the mine will a net contributor to in- or out-migration pressures, this portion of the SEIA, in the Tłı̨chǫ Government's opinion, remains incomplete at this late stage in the environmental assessment. The disappointing exclusion of socio-economic issues from the second round of IRs has effectively allowed the developer to skirt these issues, many gaps within which were identified during those technical sessions.

RECOMMENDATIONS ON SOCIO-ECONOMICS

13) The Review Board should require the developer to report on progress made toward all commitments and undertakings for further work made at the Technical Sessions on socio-economic matters, far enough in advance of the Public Hearing to facilitate meaningful review and preparation of response materials by the Parties.
14) The developer should be asked to clarify its current commitments/goals/targets and likely actual percentages for northern Aboriginal and Tłı̨chǫ citizen employment and business procurement. **The developer should be required to clearly present on these numbers at the public hearings, as there have been many inflated numbers spoken of in Tłı̨chǫ communities during recent developer engagement activities.**
15) The developer should provide the results of its previously committed to labour force/workforce evaluation study (how does the current excess labour supply, skill sets, and demographics "fit" with the type of jobs on offer should the mine proceed) in Tłı̨chǫ communities, given that useable data on this area has not yet surfaced in the environmental assessment.
16) As previously committed to at the Technical Sessions, the developer should actually show evidence it has reconsidered the shift schedule, and show evidence that it has engaged in dialogue with the Tłı̨chǫ Government and affected communities about this issue.
17) The developer should provide evidence of all work conducted to date with Community Development Officers to identify and manage recruitment, retention and advancement issues.
18) The developer should conduct a credible scenario analysis of likely in-migration and out-migration effects of the proposed development on Tłı̨chǫ communities.

CARIBOU

The cumulative effects on caribou of this proposed mine, along with the necessary all season road, is of great concern to the Tłı̨chǫ.

The proposed mine needs an all-season road in order to operate. The available information suggests that harvesting may have accelerated the recent decline of the Bathurst herd. There is no level of calf recruitment that can compensate for current estimated cow survival rates (TG IR response 11). The developer predicts good and high quality habitat for caribou could be decreased by 0.4% relative to 2010 baseline conditions.

An all-weather road would have a much larger potential impact on barren ground caribou than just the project footprint alone. The Tłı̨chǫ is concerned that this effect could persist.

CARIBOU: Overall, the Tłı̨chǫ Government gives caribou issues a *yellow or conditional rating*. New access to the region will be afforded through this proposed development, and increased access could delay the recovery of the Bathurst caribou herd, as well as have other impacts. See Table 6.

There is very little Tłı̨chǫ knowledge documented about predicted impacts on caribou on the public record, because the Tłı̨chǫ Traditional Knowledge study is not completed. Hence predictions on magnitude of impact are based on scientific evidence only. Fortune contends that there already exists good access. The Tłı̨chǫ Government respectfully and knowledgeably disagrees with this assessment, and considers that the new all-season access as a result of this proposed development will be significantly enhanced.

The Tłı̨chǫ people are entering a new phase in their long-relationship with caribou and the land. This modern phase represents an era where Tłı̨chǫ are the land managers, as set out and formally recognized in the Tłı̨chǫ Agreement. The Tłı̨chǫ Government wishes to contribute to decisions that favour the long-term viability of healthy caribou herds. This era requires Tłı̨chǫ citizens to become active, engaged, and responsible in managing and monitoring the caribou and the land.

The Tłı̨chǫ Government notes that mitigation measures and plans have shifted and looks forward to a new table of commitments to review in advance of the public hearings.

RECOMMENDATIONS ON CARIBOU

19) The developer should revisit caribou assessment endpoints and refine management plans using Tłı̨chǫ based values once the Tłı̨chǫ Traditional Knowledge study is complete. This exercise should be completed in a developer funded workshop that includes the scientists from Golder, the GNWT and Indigenous scientists (i.e., traditional knowledge holders) from the Tłı̨chǫ region.
20) The developer, responsible government authorities, and Aboriginal authorities should commit to discussions on an independent oversight body for environmental monitoring, which provide independent oversight and engages both scientific and Indigenous knowledge in tracking the changes due to development.
21) The developer should be required to review measures or data on noise and the impacts of noise on caribou, and identify through results of the Tłı̨chǫ Traditional knowledge study whether there has been a return of caribou to the Colomac or Rayrock mine areas after mining.
22) The developer should review the estimates of impact on boreal caribou, and seek measures to minimize the total disturbance on habitat in light of the ***Boreal Caribou Habitat and Habitat Use in Wek'èezhìi*** report issued by the WLWB. Given that total disturbance is already higher than the 37% limit suggested in the National Recovery Strategy for the Woodland Caribou, any new or further disturbance is of significant concern.

23) The developer should respect and commit to disturbance thresholds that are designed after the Tłı̨chǫ Land Use Plan is issued.

CLOSURE

The developer proposes to treat water that comes off of the co-disposal pile with passive treatment (which means a system that does not require constant work by people with technology), so that the wetlands or reactors built by the company will remove the metals that could impact on the environment and human health.

The developer suggests that a wetlands system would require maintenance for 25-100 years and the biochemical reactor would require maintenance every 10-20 years.

CLOSURE: Overall, the Tłı̨chǫ Government gives closure a *red or unacceptable risk rate*, with the number of uncertainties associated with the current plan. In many categories, there is simply not enough information, while in others, there is unproven technologies (e.g., wetlands performance in cold climates). See Table 7.

If both of these passive treatments fail, the company would use active water treatment, which means that water would have to be treated forever to reduce key metals, namely selenium and nitrogen. They would switch to chemical precipitation or ion exchange for water treatment. Reverse osmosis is much more expensive, and they do not believe it would be needed anymore as the metals that were high in mining years would not be high in post-mining years. It is not clear what will trigger them to start using the active treatment, rather than the passive treatment.

It is not clear, either, whether the predictions of low metal loadings will be borne out after mining activity is ceased.

Pit closure

The developer has presented two options for closure of the pit, including active re-filling and passive re-filling. The latter option could delay the proof of the wetlands concept for up to a century. This causes worry and concern for current Tłı̨chǫ Elders that they may leave a legacy of contamination for future generations, and may lead to significant concerns for future generations of Tłı̨chǫ citizens.

Wetlands

There has been no detailed evaluation of the design or likely performance of the wetlands in dealing with post-closure drainage. Existing wetlands will be destroyed during construction. In the Tłı̨chǫ Government Risk Assessment sessions, it was identified that there are two different types of wetlands (Tłı̨chǫ language terms and descriptions will be identified in the Traditional Knowledge Study), and that it may be important to seek new knowledge about what type of wetlands are in the study area.

The wetlands could, as the developer acknowledges, diminish during the winter months.

There has been no ecological risk assessment conducted about how the wetlands may act as a heavy metal repository that could be available to and accessed by wildlife after closure.

Water quality (RO treatment as a contingency)

Fortune was asked to commit to RO treatment until wetlands prove acceptable. They respond that RO is not required. This is a significant remaining difference of opinion.

Aerobic cells in the wetlands (Information Request TG 19-2)

Fortune was asked whether anaerobic wetlands would have aerobic cells. Fortune responded that aerobic cells are an integral requirement for the system and we agree. No further information is required, although aerobic cells should be incorporated into closure plans developed over the life of the project.

Pilot testing passive systems (IR TG 19-4)

Fortune was asked to address their methodology for pilot testing passive systems, especially testing for poor quality seepage. Fortune provide a long response but essentially stated that metals loads are not likely to be a key factor in performance but rather proper sizing for cold weather performance. Proper sizing should factor heavily in any research conducted to move from conceptual closure plans to final closure plans.

Geo-membranes

The primary concern SENES has identified is the predicted future characteristics of the seepage. Although the predicted quality of the seepage used for modelling is not unreasonable, future characteristics could be much worse. Fortune has gone to extensive means and costs to provide a stable long term co-disposal repository. An improved cover at closure would add to the up front closure costs but would minimize any concerns related to management of the seepage in the long term and would certainly reduce long term treatment costs.

Geo-membranes are typically only one component of the cover and given that performance over the long term (>200 years) cannot be assured, natural low permeability materials such as clays and/or glacial tills are typically used in combination with geo-membranes to provide long term cover performance.

Allowance can also be made to replace the membrane. For example for a 200 year geo-membrane life, the net present value (NPV) of cover replacement at a 3% discount factor would only be 0.27% of the initial cost for the cover.

Thickener performance – if problems with thickener performance emerge, the problems could be endemic and long term. The complete concept would be in jeopardy.

RECOMMENDATIONS ON CLOSURE

24) The developer should commit to actively refilling the pit within ten years of closure, in order to provide early proof of their passive treatment proposal.
25) The developer should commit to using reverse osmosis until the wetlands technology has been proven. The proof of concept should be subject to independent peer review on whether the system is operating to reduce metal loads from seepage to defined and acceptable levels.
26) The developer has not shown just how big the wetlands might need to be in order to manage maximum flows and cold weather performance. Given space constraints, the developer should model the maximum space required for the wetlands.
27) The developer should incorporate aerobic cells into closure plans as it evolves.
28) The developers should identify mitigation measure options for discussion and use in keeping animals (including birds) away from the wetlands.
29) The developer should commit to use a geo-membrane cover on the co-disposal pile, and to replace it at agreed upon intervals.
30) The developer should clearly state the thickness of the till layer that will be used as a cover, and then explain if there is a need for a deeper till layer.
31) The developer should discuss what management procedures will be followed if thickener performance issues emerge. The developer should also discuss what could cause thickener problems, the implications of these problems, and their risk management strategies.

HUMAN HEALTH

There was no specific risk assessment review completed for this review, however the Tłı̨chǫ Government notes that hazard quotients (HQs) in the Human Health Risk Assessment (HHRA) might need to be revised.

- In the DAR's HHRA conducted by Golder Associates, HQs were compared to a value of 1 however not all pathways accounted for (i.e. store-bought foods such as grains), therefore cannot compare to 1 and should use a lower HQ for comparison.
- The estimated HQ and risk values in the assessment indicate a level of concern with respect to human health. A discussion is provided on the conservative nature of the assessment and therefore concludes that the risk is low to negligible. We find it difficult to accept that the HQ and risks are acceptable based on the arguments of a conservative approach taken in the modelling of exposure. Particularly as this is an assessment of human health, if it is believed that the modelling assumptions are driving the risk to these unacceptable levels then the assumptions should be re-visited and more realistic, yet still conservative, approach taken in the assessment.

RECOMMENDATIONS ON HUMAN HEALTH

32) The Tłı̨chǫ Government requests written discussion of this human health issue, and whether a more conservative approach is warranted, and whether there is indeed concern for human health indicated. The Tłı̨chǫ Government takes this issue very seriously, given that country foods are fundamental to diet, culture, and way of life. However, concern should not be raised in conditions where it is not warranted, so the Tłı̨chǫ Government simply requests a plain language description and response to this issue.

TABLE 1: CATEGORIES AND CRITERIA USED IN THE TŁĮCHǪ GOVERNMENT RISK ASSESSMENT EXERCISE

Issue	*Hazard*	*Information*	*Likelihood*	*Consequence*	*Risk Management*	*Risk Rating*	*Risk Assessment*
identify topic	identify specific hazard being assessed (experts)	identify relevant info avail about the hazard (experts)	rank the hazard (experts) 1 = Unlikely 2 = Possibly (50:50) 3 = Likely 4 = High probability	rate the consequence (TG + experts) 1= Negligible 2 = Low (consequence short-lived, low impact to ecological and/or human resources, etc.) 3 = Moderate consequence (significant harm to ecological and/or human resources without mitigation) 4 = High consequence (serious long-term or permanent harm to ecological and/or human resources; substantial closure costs, etc.)	describe how easy risk is mitigate or manage (TG experts) 1 = Easy (inexpensive, demonstrated technology, TG can do if proponent fails, etc.) 3 = Challenging (expensive, requires substantial financial support, formidable technical challenges or unproven technology) 9 = Unmanageable or un-mitigable with known technology	multiply values in columns 4, 5 and 6 to get numerical rating	TG assignment of risk add subjective weighting by TG reps to numerical value to get TG final determination of Acceptable or Unacceptable Risk

[1] The ratings for 'risk management' are non-linear on purpose; the idea is to emphasize the separation between rankings to make serious problems really stand out.

[2] For the last column, Tłı̨chǫ Government (TG) final ratings: Acceptable = risk rating of 1 to 20; Conditional = risk rating 21-48; Unacceptable = risk rating >48.

TABLE 2. RISKS OF CO-DISPOSAL AND MINE ROCK FROM THE FORTUNE MINERALS MINE

Issue	*Hazard*	*Information*	*Likelihood*	*Consequence*	*Risk Management*	*Risk Rating*	*Risk Assessment*
1. Acid rock generation	Water and oxygen entering the pile interior will start sulphide oxidation and generate acid water and potentially heavy metal transport from dump during operations	10% of waste rock; 45% of sub-economic rock potentially acid producing and have high potential for mobilizing arsenic, molybdenum, antimony, selenium, uranium as shown by field and lab tests	3 (Neutral metal leaching greater concern than ARD)	4	3	36	Conditional risk because this seems likely to happen and it will have high consequence.
2. Neutral metal leaching	water entering the pile interior will leach heavy metals into pile drainage during operations	leaching of aluminum, iron, cadmium, cobalt, copper, arsenic, selenium, antimony, uranium, and zinc predicted at site under neutral conditions (i.e. non-acidic)	3	4	3	36	Conditional risk because heavy metals will be at high levels during operation.
3. Performance and stability of waste rock pile	Poor tailings thickening performance leads to increased water in pile, piping, and slumping of the pile	Co-disposal can create stable piles; the challenge is the practicality of implementing an untested management concept in the North	4	3	1 (fix in operation but goes to 9 after closure)	12-could be much higher if there is failure to adequately thicken tailings	This risk rating could change if the thickener fails, and it would be a permanent failure.
4. Process plant products	Thiosalts may form in the process plant and be disposed of in the CDF with the tailings, which may affect the acidity of water at the site	Thiosalts are a common product at base metal mines and after 40 years of study, no real management options have been developed	3	3	3	27	No information provided, and has impacts.

TABLE 3. MINE ECONOMICS AND THE FORTUNE MINERALS MINE

Issue	*Hazard*	*Information*	*Likelihood*	*Consequence*	*Risk Management*	*Risk Rating*	*Risk Assessment*
5. Cobalt and gold prices	Gold price drops below $1,000 and mine revenue becomes sensitive to cobalt (if price of gold goes below $1,000, it becomes a cobalt mine; and cobalt can vary).	Reductions in the price of metals could make the mine uneconomic	1	4 if cobalt is too low then the mine has to curtail or suspend operation	9	36	Conditional risk due to prices.
6. Mineral processing	Long start up times for the SMPP and poor recovery	Hydrometallurgical plants have a reputation for long start up times. There four metals to go after and it is complex mineralogy.	4	4	3	48	Unacceptable risk, because challenges change profitability and start up dates.
7. Diesel	High cost of diesel and the price is rising, and it is hard to handle it in the north. This could drive mining costs up vastly, and could require them to suspend or curtail operations.	The mine is primarily dependent on diesel as a fuel.	4	3	3	36	Acceptable risk, and hydro being explored.
8. Co-Disposal	Unknown costs of co-disposal lead to higher mining costs, leading the mine to suspend or curtail operations.	The mine is primarily dependent on co-disposal as a technology.	4	4	3	48	Unacceptable risk, because challenges change profitability and start up dates.

TABLE 4. WATER TREATMENT AND SITE SPECIFIC WATER QUALITY OBJECTIVES

Issue	*Hazard*	*Information*	*Likelihood*	*Consequence*	*Risk Management*	*Risk Rating*	*Risk Assessment*
9. Brine and effluent management	Effluent, even after treatment could still have an impact on the environment.	The company will do more tests to determine best design for the treatment plant but the tests will have to be done with synthetic effluent as no wastewater from the site is available. The synthetic solutions may or may not be fully representative of future conditions.	3	4	3	36	Conditional risk due to consequences, the importance of water in this region.
10. SSWQO	Proposed SSWQO are protective of the waterbodies downstream of the mine site	Overall the approach to setting the SSWQO was reasonable but questions remain about the limits for 4 specific metals: aluminum, arsenic, copper, and selenium.	3	3-4	3	27-36	Conditional risk due to consequences, the importance of water in this region.

TABLE 5. SOCIO-ECONOMIC ISSUES ASSOCIATED WITH THE FORTUNE MINERALS MINE

Issue	*Hazard*	*Information*	*Likelihood*	*Consequence*	*Risk Management*	*Risk Rating*	*Risk Assessment*
11. Hiring targets	Low employment because of low to no targets and potentially limited labour force "fit" for Tłı̨chǫ workers. Few Tłı̨chǫ workers = more non- Tłı̨chǫ people.	The company's conservative estimate is that it will fill positions with 15% to 40% aboriginal people.	3	3	3	27	Conditional risk due to need for jobs.
12. Taxation	The low employment expectation could mean very low taxation dollars for Tłı̨chǫ Government.	Low Tłı̨chǫ taxation because of likely low employment of Tłı̨chǫ citizens.	3	3	9	81	High risk because of low to no developer commitments.
13. In-migration to Whati	People move to Whati and its infrastructure and social services are not able to adapt.	Effects of this mine (along with the road) on Whati are central to decision-making on this file and there is clearly not enough evidence upon which to make a defensible decision.	3	3	3 or 9	27 or 81	High risk due to impacts and lack of planning for these changes.
14. Impacts of an all season road	Variety of socio-economic impacts, some adverse such as increased drug and alcohol, problems for youth, public safety, changing community character	The company did not provide in depth information from which to judge the impacts of an all season road on the community. Permitting this mine creates a pressure to engage in construction of an all season road.	4	4	3	48	High risk due to cultural, social and economic values that are at risk.

TABLE 6. RISKS TO CARIBOU FROM THE FORTUNE MINERALS MINE

Issue	*Hazard*	*Information*	*Likelihood*	*Consequence*	*Risk Management*	*Risk Rating*	*Risk Assessment*
Access	Unmanaged harvest access results in unsustainable harvest.	Access is the single biggest contributor to cumulative impact on caribou in the NWT.	2	4	3	24	Tłı̨chǫ Government are able to participate in co-management.
Delay the recovery of the Bathurst caribou	Unmanaged access contributes to a delayed recovery of the Bathurst herd, which means there will be a longer term of restricted harvest.	Delay of the recovery of the Bathurst caribou. The project "are assessed in the context of a population that undergoes natural cycles over decades."	2	4	3	24	Tłı̨chǫ Government are able to participate in co-management.
Boreal caribou or todzi	The footprint of the mine and the access road will contribute to the total disturbance of the range of the Boreal caribou.	The total disturbed habitat of the boreal caribou is already beyond thresholds that are manageable. Industry has argued that boreal caribou occur at such low densities on Tłı̨chǫ Lands.	4	2	3	24	Tłı̨chǫ Government are able to participate in co-management.

TABLE 7. CLOSURE RISK ASSOCIATED WITH THE FORTUNE MINERALS MINE

Issue	*Hazard*	*Information*	*Likelihood*	*Consequence*	*Risk Management*	*Risk Rating*	*Risk Assessment*
Wetlands footprint	There may be insufficient space to construct required area of wetlands	No reliable information presented on the area required for wetlands	4	4	9	144	Could require more space.
Wetlands flooding	freshest and/or flooding may impair wetlands performance	No reliable information on water requirements and hydrologic features onsite to demonstrate viability	3	4	3	36	Concern for freshet
Wetlands performance in subarctic temperatures	freezing conditions may impair/halt wetlands performance for significant periods of the year	No reliable information to demonstrate sub-arctic viability of wetlands	4	4	9	144	Lack of information and possibility for contamination
Wetlands general failure	wetlands technology fails for other reasons	This treatment process is unproven in this situation	4	4	3	48	
Long-term CDF cover integrity	CDF cover erodes or fails allowing significant ingress of water and oxygen into pile	No long-term performance data on covers provided by proponent	4	4 (note: reduces to 2 if rock geochemistry benign)	9	144	No commitment to geo-membranes by developer
Long-term physical stability of waste rock pile	Pile erodes and slumps in post-closure era	Long-term physical stability of CDFs not proven by proponent (slumping or ice lense formation)	4	4 (note: reduces to 2 if rock geochemistry benign)	9	144	Could represent long term management challenges
Post-closure site drainage quality	ARD and/or metal leaching begin after mine is closed	No reliable predictions for post-closure phase geochemistry	3	4	9	108	Could result in long term treatment

APPENDIX A: DISCUSSION OF CO-DISPOSAL EXAMPLES PROVIDED BY GOLDER ASSOCIATES (2012)

Mine	Description of tailings & waste rock disposal strategy	Relevance to NICO project assessment
Neves Corvo Mine, Portugal	operating conventional disposal methods since 1988; new co-disposal operation proposed to be added; partially constructed; no performance data	not relevant
Greens Creek, Alaska, USA	operating since 1989; uses filtered tailings disposal with segregated waste rock dump to 2009; now co-mingling waste rock and tailings with bulldozers; lab geochem testwork predicts improved drainage quality; no field tests; no actual environmental performance results	not relevant
Cerro de Maimon, Dominican Republic	co-disposal of ARD tailings and waste rock is proposed; facility not constructed yet; field tests of disposal methods revealed co-disposal of thickened tailings and waste rock would not be effective; selected inter-layering of rock and tailings instead; no environmental performance results	not relevant
Krumovgrad, Bulgaria	mine not operating yet; proposed concept uses paste tailings in waste rock cells similar to NICO; no performance data	not relevant
Nunavik Nickel Mine, Québec	mine not operating yet; codisposal of ARD tailings and wasterock is proposed for two constructed cells in wasterock; no performance data	not relevant
Unnamed Mine, South Africa	conventional segregated waste disposal mine; major expansion commenced in 2006 to incorporate co-disposal of 18% of tailings stream with overburden waste; no environmental performance data	not relevant
Brukunga Remediation Project, Australia	abandoned mine site with ARD legacy; plan is to remediate site by co-disposing tailings and waste rock and compacting them, with limestone addition for neutralizing capacity; will require a containment dam to prevent seepage; not operational; field tests showed that sulphide oxidation rates could be reduced to 'effectively zero' if wastes remain 'near-saturated'.	not relevant
Snap Lake, NWT	paste tailings deposited into specially constructed cells was the original plan; tailings slurries with high water content are the reality; not clear if small portions of waste rock are being co-disposed or simply dumped in the cells; situation not comparable to NICO concept; no performance data provided	not relevant

Reference cited

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