**ROUND TWO INFORMATION REQUEST (IR) RESPONSE**

**EA No: 0809-001** **Information Request No: Review Board IR #01**

**Date Received**

December 1, 2011

**Linkage to Other IRs (Round II)**

Review Board IR #05

**Linkage to October 2011 Technical Session**

Technical Session Undertaking #2 and #4

**Linkage to Other IRs (from Round I)**

Review Board IR #03

**Date of this Response**

February 17, 2012

**Request**

***Preamble***

The frozen block design and the assessments of the possible risks associated with failure of active and passive freezing are based on a climate change scenario. In the response to Undertaking No. 2 the developer state:

> *"The climate change scenarios assumed in the various Giant Mine reports were all intended to represent conditions in the year 2100. … For example, the graphs presented* in the *response to the MVEIRB's Information Request 3 cover a mean annual temperature range from today's values to an increase of 7.9 °C, which exceeds the 3.8 – 6.0 °C range of "worst case" temperature increases predicted by CCCSN's ensemble*-mean scenarios*"*

The ToR requires an illustration of at least 100 years after converting the active freezing system into a passive system, which will likely be around 2150. Further, the developer has specified that the solution is required to work in perpetuity.

As for projected changes in precipitation and the effect on hydrology, the developer's response to Undertaking No. 2 from the Technical sessions states:

> *"Potential climate change effects were not explicitly incorporated into the design basis for the Baker Creek remediation at the Giant Mine […]. However, the 1:500-year event specified as the current design discharge was increased by approximately 10% (from 22.8 $m^3/s$ to 25.0 $m^3/s$) from that indicated by the results of a frequency analysis of Baker Creek flood flows. The design also accommodates […] bedfast ice […] as well as […] freeboard, the combination of which provides a conservative design to accommodate flows greatly in excess of the design discharge. The capacity of the channel before reaching the lowest spill point is approximately 58 $m^3/s$ when only the ice accumulation is considered, and Approximately 183 $m^3/s$ with an ice-free channel that uses the entire freeboard allocation." (p2)*
>
> *"The two Canadian climate models discussed here both fail to accurately* represent baseline conditions and yield very different results for future projections, in particular when monthly *and seasonal precipitation values are considered."* (p6)

***Question***

1. Please describe potential long-term climate trends (i.e. more than 100 years from completion of the freeze implementation). Include a discussion of how the identified contingency measures, such as active freezing of the thermosyphons or increasing Baker Creek channel and floodplain capacity, have been incorporated in the risk assessment.

2. Considering the response to the previous point, please describe how the likelihoods for climate change related measures have been selected.

**Reference to DAR (relevant DAR Sections)**

s. 6.2.7 Long-term Freeze Maintenance, p. 6-30/31
s. 6.2.8.2 Thawing and Climate Change, p. 6-37

**Reference to the EA Terms of Reference**

s.3.1.2
"Consideration should be given to the impact of the environment, such as the impact of extreme weather events or climate change, on the development in each of the sections of 3.2, where applicable."

s.3.3.1
1b. "With the best available information, (provide) a prediction of the amount of active freezing, the amount of passive freezing, power requirements, numbers and general locations of thermosyphons that will be necessary to achieve stability"

1c. "An illustration of the stability of the proposed system for a duration of at least 100 years after converting the active freezing system into a passive system."
10. "An account of how climate change predictions and observations affect the risk level in the long term based on "best estimate" and "high estimate" scenarios, including discussion of risks in light of the current climate predictions as set out in the Fourth Assessment Report of the Intergovernmental Panel on Climate Change"

**Summary**

Climate change has been a significant consideration throughout the assessment and design of the frozen block option. Climate warming predictions for the period after 2100 are not as well-defined as the shorter term predictions. However, the very long term scenarios provided by the Intergovernmental Panel on Climate Change (IPCC) fall within the range of temperature increases examined by the Giant Mine Remediation Project Team (Project Team). More importantly, the proposed project does not rely on these predictions but instead includes a series of contingency measures that are capable of dealing with any of the future scenarios.

**Response 1**

Climate change has been a significant consideration throughout the assessment and design of the frozen block option.

The request is specific to the very long term, i.e. beyond the 100 years that are normally considered in climate change predictions. The climate system is complex and highly dependent on natural forcing mechanisms, such as ocean circulation and solar intensity, as well as anthropogenic factors such as population, economic growth, and fuel consumption. These complexities and uncertainties result in a high level of uncertainty in predictions of long term future climate change. As a result, the Intergovernmental Panel on Climate Change (IPCC) provides a wide range of climate change predictions only for the period up to 2099. Those predictions have been used in most of the climate change analyses reported in the Developers Assessment Report (DAR) and in responses to previous information requests.

For periods beyond 2099, the IPCC provides only "multi-century" projections covering a range of "stabilization scenarios". The presumption is that global climate will stabilize into one of those scenarios over a period of up to several centuries. In addition to all of the assumptions behind the 21$^{st}$ century predictions, the stabilization scenarios require assumptions about the long-term concentrations of carbon dioxide and other greenhouse gases and aerosols, as well the timing and level of peak emissions. Over 175 such scenarios have been analyzed and grouped into six categories. Table 5.1 of the IPCC Climate Change 2007 Synthesis report provides a summary and is reproduced below. The sixth column of the table indicates global average temperature increases of 2.0-6.1 $^{o}$C.

It is noteworthy that the highest values in the table, indicating a global average temperature increase of 4.9-6.1 $^{o}$C, is similar to range of local (Yellowknife) temperature increases assessed in the DAR and in earlier responses. SRK (2006) considered mean annual temperature increases of up to 5.2 $^{o}$C and the response to the Review Board's Round 1 Information Request #03 considered mean annual temperature increases of 7.9$^{o}$ C.

Most importantly, however, the Project Team has developed a series of contingency measures and shown that these are well able to deal with any of the projected climate warming scenarios. The contingency measures and the possible sequence of their application are described in several places. The most thorough and concise presentations are:

- DAR, s. 6.2.8.2 Thawing and Climate Change, pp. 6-33 ff. discusses the sequence of events, monitoring, and contingencies available for dealing with under-performance of the long-term freezing system.
- The response to Review Board Round 1 Information Request #03 from the examines the relationship between predicted temperature changes and the effectiveness of the contingency measures.

The Project Team believes that reliance on contingencies rather than predictions is consistent with current best practices. For example, NRCAN (2004) states:

- "*Given the complexity of these systems, uncertainty is unavoidable, and is especially pronounced at the local and regional levels where many adaptation decisions tend to be made. Nonetheless, there are ways to deal with uncertainty in a risk management context, and most experts agree that present uncertainties do not preclude our ability to initiate adaptation*" and
- "*In all sectors, adaptation has the potential to reduce the magnitude of negative impacts and take advantage of possible benefits. Researchers recommend focusing on actions that enhance our capacity to adapt and improve our understanding of key vulnerabilities. These strategies work best when climate change is integrated into larger decision-making frameworks*"

***Table 5.1. Characteristics of post-TAR stabilisation scenarios and resulting long-term equilibrium global average temperature and the sea level rise component from thermal expansion only.***[a]
*{WGI 10.7; WGIII Table TS.2, Table 3.10, Table SPM.5}*

| Category | $CO_2$ concentration at stabilisation (2005 = 379 ppm) [b] | $CO_2$-equivalent concentration at stabilisation including GHGs and aerosols (2005 = 375 ppm)[b] | Peaking year for CO2 emissions[a,c] | Change in global $CO_2$ emissions in 2050 (percent of 2000 emissions) [a,c] | Global average temperature increase above pre-industrial at equilibrium, using 'best estimate' climate sensitivity[d, e] | Global average sea level rise above pre-industrial at equilibrium from thermal expansion only[f] | Number of assessed scenarios |
|---|---|---|---|---|---|---|---|
| | ppm | ppm | year | percent | °C | metres | |
| I | 350 – 400 | 445 – 490 | 2000 – 2015 | -85 to -50 | 2.0 – 2.4 | 0.4 – 1.4 | 6 |
| II | 400 – 440 | 490 – 535 | 2000 – 2020 | -60 to -30 | 2.4 – 2.8 | 0.5 – 1.7 | 18 |
| III | 440 – 485 | 535 – 590 | 2010 – 2030 | -30 to +5 | 2.8 – 3.2 | 0.6 – 1.9 | 21 |
| IV | 485 – 570 | 590 – 710 | 2020 – 2060 | +10 to +60 | 3.2 – 4.0 | 0.6 – 2.4 | 118 |
| V | 570 – 660 | 710 – 855 | 2050 – 2080 | +25 to +85 | 4.0 – 4.9 | 0.8 – 2.9 | 9 |
| VI | 660 – 790 | 855 – 1130 | 2060 – 2090 | +90 to +140 | 4.9 – 6.1 | 1.0 – 3.7 | 5 |

Notes:

a) The emission reductions to meet a particular stabilisation level reported in the mitigation studies assessed here might be underestimated due to missing carbon cycle feedbacks (see also Topic 2.3).

b) Atmospheric $CO_2$ concentrations were 379ppm in 2005. The best estimate of total $CO_2$-eq concentration in 2005 for all long-lived GHGs is about 455ppm, while the corresponding value including the net effect of all anthropogenic forcing agents is 375ppm $CO_2$-eq.

c) Ranges correspond to the $15^{th}$ to $85^{th}$ percentile of the post-TAR scenario distribution. $CO_2$ emissions are shown so multi-gas scenarios can be compared with $CO_2$-only scenarios (see Figure 2.1).

d) The best estimate of climate sensitivity is 3°C.

e) Note that global average temperature at equilibrium is different from expected global average temperature at the time of stabilisation of GHG concentrations due to the inertia of the climate system. For the majority of scenarios assessed, stabilisation of GHG concentrations occurs between 2100 and 2150 (see also Footnote 30).

f) Equilibrium sea level rise is for the contribution from ocean thermal expansion only and does not reach equilibrium for at least many centuries. These values have been estimated using relatively simple climate models (one low-resolution AOGCM and several EMICs based on the best estimate of 3°C climate sensitivity) and do not include contributions from melting ice sheets, glaciers and ice caps. Long-term thermal expansion is projected to result in 0.2 to 0.6m per degree Celsius of global average warming above pre-industrial. (AOGCM refers to Atmosphere-Ocean General Circulation Model and EMICs to Earth System Models of Intermediate Complexity.)

### *References*

IPCC,2004. *Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Core Writing Team, Pachauri, R.K. and Reisinger, A. (Eds.) IPCC, Geneva, Switzerland. pp 104

Natural Resource Canada, Climate Change Impacts and Adaptation Directorate, 2004. *Climate Change, Impact and Adaptation: A Canadian Perspective.* http://www.nrcan.gc.ca/sites/www.nrcan.gc.ca.earth-sciences/files/pdf/perspective/pdf/report_e.pdf

**Response 2**

There is no likelihood assigned to any particular scenarios. According to the Intergovernmental Panel on Climate Change,

> *"There is no single central or "best guess" scenario, and probabilities or likelihood are not assigned to individual scenarios. Probabilities or likelihood are not assigned to individual SRES scenarios. None of the SRES scenarios represents an estimate of a central tendency for all driving forces or emissions, such as the mean or median, and none should be interpreted as such. The distribution of the scenarios provides a useful context for understanding the relative position of a scenario but does not represent the likelihood of its occurrence" (2000).*

***References***

IPCC. 2000. *IPCC Special Report Emissions Scenarios. Summary for Policymakers*. http://www.ipcc.ch/pdf/special-reports/spm/sres-en.pdf

**ROUND TWO INFORMATION REQUEST (IR) RESPONSE**

**EA No: 0809-001** **Information Request No: Review Board IR #02**

**Date Received**

December 1, 2011

**Linkage to Other IRs (Round II)**

Review Board IR #03
Alternatives North IR #14
Fisheries and Oceans Canada IR #02

**Date of this Response**

February 17, 2012

**Request**

***Preamble***

In the Developer's Assessment Report the proponent dismissed the possibility of diverting Baker Creek around the project site because surface water at the site would still need to be collected and discharged to Great Slave Lake. Section 6.9.2 (Page 6-86) states:

> *"The option of rerouting Baker Creek around the mine site entirely was examined as part of the method selection analysis. However, this option was discounted due to the fact that the mine site catchments would continue to drain to the current channel and a creek would continue to exist, albeit with significantly reduced flow."*

The Review Board notes the following:

- During the Technical sessions, the developer stated that "one of the greatest site risks at Giant Mine is Baker Creek" (Day 2, p207), and confirmed that the developer would "be willing to pursue relocating it if the creek were to pose an unacceptable long-term risk to arsenic containment" (Day2, p208)

- In the technical session, the Board's technical advisor on risk assessment noted 1) that the projects' design tolerances mean there was a five percent probability of failure to contain Baker Creek during the first 25 years; and 2) this was characterized a s a "staggering" risk considering the implications of failure during that period. (Day 4, p262).
- In response, the developer stated that it acknowledges the risk, that is not comfortable with the risk, and that is why the Giant Team has started looking at the north diversion of Baker Creek as a contingency (Day 4, p262).

Because of the risks associated with Baker Creek it is important that the Review Board understand the options and trade-offs as they relate to project design and implementation.

***Question***

1. Please describe the channel design criteria that are required to reduce the risks associated with Baker Creek to acceptable levels.

2. Please describe the effects that the above design criteria would have on the proposed mine remediation plans such as channel location, surface water drainage, schedule, accommodation of fish habitat, and any other relevant considerations.

3. What does the Giant Team consider to be the most significant constraints, limiting the diversion of Baker Creek around Giant mine site (e.g. costs, engineering, permitting process, etc)?

**Reference to DAR (relevant DAR Sections)**

s.6.9.2 Method Selection, Alternatives and Preferred Alternative

**Reference to the EA Terms of Reference**

s.3.2.5 Accidents and Malfunctions

**Summary**

Channel design criteria include those that control conveyance (cross-section, slope and roughness), erosion resistance (floodplain geometry, and bed, bank and floodplain materials), and additional flood risk mitigation measures (route selection, and freeboard and anchor ice allocations). An updated risk mitigation review for Baker Creek is currently in progress, considering updated information to determine whether the risks at Baker Creek have changed, or would be changed after mitigation is complete. If unacceptable risks remain within the current plan, additional reasonable short-term alternatives for risk mitigation will be identified and evaluated and recommendations will be made for further investigation.

Channel location is related to route selection, and concerns are related primarily to providing adequate floodplain width, providing separation from unstable areas and mine openings, and managing cut

volumes. The route was also selected to avoid most of the mine site but it is noted that the majority of site will drain to Baker Creek at closure, however the surface drainage design is largely unaffected by the channel design. New bridge crossings are designed to span the bankfull channel and provide adequate conveyance of the design flow. The preliminary design for the channel does not include fine scale fish habitat features, but it is designed to accommodate these at the detailed design stage. The construction schedule will be coordinated with other remediation tasks and could span as little as four years.

The Giant Mine Remediation Project Team (Project Team) is not currently pursuing the North Diversion as a contingency for flooding risks of Baker Creek. The North Diversion was evaluated to determine if it was a feasible measure to mitigate flood risks at Baker Creek. Mitigation measures constructed in the fall of 2011 reduce these risks, though the Project Team still considers Baker Creek a high risk. To address these risks, Project Team is currently undertaking a review of short-term risks and mitigation strategies that may be required until the Remediation Plan for Baker Creek is implemented. No additional work to advance the design of the North Diversion has been completed since the October 2011 Technical Sessions.

**Response 1**

Channel design criteria can be classified into several broad categories, including conveyance, erosion resistance and other flood risk mitigation features. More detailed descriptions of factors included in these categories these include:

**Conveyance:** The channel design must provide adequate capacity to convey the design flood. Factors to consider are essentially the components of the Manning equation (hydraulic radius, flow area, channel slope and channel roughness), and define flow velocity which affects erosion potential:

> Cross-section: The channel cross-sectional area and the distribution of that area (i.e., bed width, bankfull width and bankfull depth, floodplain width) must be designed to provide flow conveyance while being stable and managing the water surface elevation at acceptable levels.
>
> Slope: Steeper slopes will convey flow at lower depths, but greater velocity. Flatter slopes will convey flow at greater depths, but lower velocity.
>
> Roughness: Channels with greater roughness (due to larger bed and overbank materials, or form roughness from bedforms, channel instream structures, etc.) will convey flow at greater depth and lower mean velocity, while those with lower roughness will convey flow at lower depths and greater mean velocity.

The cross-section specified for the Project is based on natural analogues from undisturbed reaches of Baker Creek. A prismatic cross-section is proposed for all diverted reaches, to prevent constrictions that could cause backwater effects, with the exception of an encroachment at the Highway 4 bridge crossing.

**Erosion Resistance:** The channel design must provide adequate erosion resistance to prevent bed degradation and/or lateral channel migration that would increase the risk of a spill to the Giant Mine underground. Erosion potential is governed by channel geometry and the effects on flow depths and velocities already discussed, but also by the nature of the bed, bank and floodplain materials. Factors to consider include:

Bed materials: Heavier bed materials (boulders and cobbles) are more resistant to mobilization – erosion and scour - than lighter materials (gravels, sands and silts).

Bank and floodplain materials: As with bed materials, the size of bank and floodplain materials influences erosion resistance.

Floodplain geometry: Provision of an adequate floodplain plays a key role in reducing erosion potential, by reducing flow concentrations (depth and velocity) in the main channel, which reduces scour potential. It also reduces flow depth and velocity at the water's edge, which reduces the potential for lateral migration of the floodplain.

Again, materials specified for the project are based on natural analogues from undisturbed reaches of Baker Creek and the creek should not be prone to significantly greater than natural rates of erosion or deposition. The design floodplain geometry is also based on these natural analogues. The presence of bedrock in some locations should also partially mitigate erosion potential.

**Flood Risk Mitigation:** Additional flood risk mitigation features considered in the channel design include:

Freeboard: the channel and floodplain design has incorporated a 1 metre freeboard allocation before spill to adjacent land areas.

Anchor Ice: the channel and floodplain design has incorporated an additional 2 metre allocation for accumulation of *aufeis* or anchor ice.

Route Selection: the design has specified channel alignments to reduce proximity to adjacent mine pits (in particular A2 and C1 Pits) to reduce the potential for geotechnical instability to result in catastrophic failure of the channel and to increase the capacity for local dyking if and where required. Risks related to the underground mine (openings to surface and shallow underground features) were also considered.

**Baker Creek Risk Assessment:** An updated risk mitigation review for Baker Creek is currently in progress, considering investigation and mitigation work conducted in 2010 and 2011. This review will consider the project risk review and Independent Experts Panel report to determine whether the risks at Baker Creek have changed, or would be changed after mitigation is complete. If unacceptable risks remain within the current plan, additional reasonable short-term alternatives for risk mitigation will be identified and evaluated and recommendations will be made for further investigation.

**Response 2**

Descriptions of the influence of these design criteria on mine remediation plans are provided below:

**Channel Location** is related to the Route Selection factor discussed above. Primary concerns include providing an adequate corridor width to accommodate the required floodplain, and avoiding areas of potential geotechnical instability (in particular areas adjacent to the C1 Pit) or where there a limited distance between the floodplain/channel and mine pit (including the west side of C1 Pit and east side of A2 Pit).

Channel location also influences the cut volumes required to create a new creek valley at diverted reaches. These cut volumes can be large, in particular at the deep cut design variant for the western Reach 3 alignment. However, it is anticipated that material removed from these areas will be used by the Project (e.g., for pit and tailings covers) and this synergy is being incorporated in the preliminary design.

**Surface Water Drainage:** Most land areas within the Project area currently drain to Baker Creek and this will remain the case under the closure plan. These watercourses, with the exception of Trapper Creek, which drains to Baker Pond, are non-fish bearing and specific drainage designs will be developed during detailed design.

**Schedule:** The schedule for channel and floodplain construction will be coordinated with other tasks during mine closure. It is currently anticipated that the Baker Creek remediation can be accomplished within four construction years, subject to constraints (primarily related to borrow materials) due to other closure activities.

**Fish Habitat:** The preliminary design for the channel does not include fine scale fish habitat features. However, it is designed to accommodate these features at the detailed design stage, because channel geometry and materials are based on natural analogues from an undisturbed area on the same stream with consideration of a prior stream restoration within the project area. It is anticipated that the final design will incorporate such features as spawning riffles, bank and overbank vegetation, boulder clusters, etc., as appropriate.

**Bridges:** New bridge crossings in the lower reach of Baker Creek are currently designed to span the bankfull channel and to provide adequate conveyance of the design discharge to prevent backwatering and spill to the adjacent A2 Pit.

**Openings to Surface and Underground:** The channel and floodplain alignment was selected to avoid mine shaft openings which could convey water directly to the underground mine. The alignment was selected to avoid shallow underground features and any overlap with these will be checked to ensure stability of the underground. An impermeable channel liner will be incorporated into the design to prevent leakage to the shallow underground in these areas.

**Response 3**

The Project Team is no longer pursuing the North Diversion as a contingency for flooding risks of Baker Creek.

The North Diversion of Baker Creek was evaluated to determine if it was technically possible to divert water away from the Giant Mine site should an event occur that allowed water from Baker Creek to flood the mine. The risk of Baker Creek flooding the underground is one of the highest risks on the property until the Giant Mine Remediation Plan (Remediation Plan) is implemented on site. The technical feasibility of the North Diversion was assessed in September 2011 to address these high risks and heightened concerns arising from the subsidence at B1 adjacent to Baker Creek and the Creek changing course over the JoJo Lake tailings during the spring melt.

Some mitigation measures have been put in place during the fall of 2011 to reduce these risks, such as capping the JoJo Lake tailings, constructing a dyke between Baker Creek and subsidence at B1 and raising the road along reach 3 (C1 pit) of Baker Creek. With these measures in place, the Project Team still considers Baker Creek a high risk and to address these risks are doing a review of the risks associated with Baker Creek in the short term up until the final Remediation Plan is in place. This review may show that additional short term mitigation measures are required until implementation of the mitigation strategies found in the Remediation Plan.

This review is currently underway and an assessment of requirements for additional mitigation measures will occur in 2012 with support of Technical Experts. The Project Team is in the process of reviewing site risks and therefore do not have a firm date for the assessment of mitigation measures with Experts.

The Project Team has not done any additional work to advance the design of the North Diversion and is currently focusing on the risk review and assessment of all possible short term mitigation measures for Baker Creek. The Project Team will be pleased to share this information with the Mackenzie Valley Environmental Impact Review Board and the Parties to the Environmental Assessment prior to the Public Hearing.

**ROUND TWO INFORMATION REQUEST (IR) RESPONSE**

**EA No: 0809-001** **Information Request No: Review Board IR #03**

**Date Received**

December 1, 2011

**Linkage to Other IRs (Round II)**

Review Board IR #02
Alternatives North IR #14
Fisheries and Oceans Canada IR #01, #02

**Date of this Response**

February 17, 2012

**Request**

***Preamble***

During Day 2 of the Technical Session, the developer identified the possibility of re-routing Baker Creek to avoid the mine site. Historical observations indicate that fish continued to use Baker Creek during mine operation and that fish use of the creek increased as water quality improved following the cessation of ore processing in 1998. Physical habitat was also heavily affected during the operation of the Giant Mine and little of the original channel remains. The DAR describes that impacts are expected to persist until the remediation and rehabilitation activities in Baker Creek are completed in project year seven.

With one exception (the Reach 4 re-alignment in 2006), there has been to description of consideration given to providing fish habitat in the re-aligned sections. The Reach 4 re-alignment was constructed before the remediation plans had been developed and before a risk analysis of the creek to the project. The Review Board notes that the majority of Baker Creek at the project site is a human-constructed diversion channel, and that it is likely that any remediation and rehabilitation works will result in a human-constructed diversion channel with engineered habitat features.

***Question***

1. Can habitat similar to that which exists in Baker Creek be constructed in a diversion channel?

2. Taking into consideration the possibility of connecting and therefore augmenting habitat productivity in natural water bodies in the diversion plan, please provide a comparison of the habitat accounting for a) maintaining Baker Creek at site constructed to the design criteria that reduce to acceptable levels the risks that the creek poses to the project; and b) a preferred diversion channel design. Please include the effect of schedule lag between completion of the remediation and rehabilitation activities and the construction of a diversion channel.

**Reference to DAR (relevant DAR Sections)**

s.5.8 Baker Creek
s.7.1.2.1 Study Site Area
s.7.4.3 Aquatic Environment, Site Study Area

**Reference to the EA Terms of Reference**

s.3.5.2 Fish and Aquatic Habitat

**Summary**

The North Diversion of Baker Creek is not currently being pursued as a contingency measure.

**Response**

The Giant Mine Remediation Project Team (Project Team) is no longer pursuing the North Diversion as a contingency for flooding risks of Baker Creek.

The North Diversion of Baker Creek was evaluated to determine if it was technically possible to divert water away from the Giant Mine site should an event occur that allowed water from Baker Creek to flood the mine. The risk of Baker Creek flooding the underground is one of the highest risks on the property until the Giant Mine Remediation Plan (Remediation Plan) is implemented on site. The technical feasibility of the North Diversion was assessed in September 2011 to address these high risks and heightened concerns arising from the subsidence at B1 adjacent to Baker Creek and the Creek changing course over the JoJo Lake tailings during the spring melt.

Some mitigation measures have been put in place during the fall of 2011 to reduce these risks, such as capping the JoJo Lake tailings, constructing a dyke between Baker Creek and subsidence at B1 and raising the road along reach 3 (C1 pit) of Baker Creek. With these measures in place, the Project Team still considers Baker Creek a high risk and to address these risks are doing a review of the risks associated with Baker Creek in the short term up until the final Remediation Plan is in place. This review may show that additional short term mitigation measures are required until implementation of the mitigation strategies found in the Remediation Plan.

This review is currently underway and an assessment of requirements for additional mitigation measures will occur in 2012 with support of Technical Experts. The Project Team is in the process of reviewing site risks and therefore do not have a firm date for the assessment of mitigation measures with Experts.

The Project Team has not done any additional work to advance the design of the North Diversion and is currently focusing on the risk review and assessment of all possible short term mitigation measures for Baker Creek. The Project Team will be pleased to share this information with the Mackenzie Valley Environmental Impact Review Board and the Parties to the Environmental Assessment prior to the Public Hearing.

**ROUND TWO INFORMATION REQUEST (IR) RESPONSE**

**EA No: 0809-001** **Information Request No: Review Board IR #04**

**Date Received**

December 1, 2011

**Linkage to Other IRs (from Round I)**

Review Board IR #12

**Date of this Response**

February 17, 2012

**Request**

***Preamble***

In the developer's presentation on water management during the Technical Sessions and in its response to undertaking No 2 indicated the hydrologic design criteria for Baker Creek are conservative". However, there is no clear indication of how the term conservative is defined in the context of the design basis. This lack of clarity of definition makes it difficult to understand which criteria are considered conservative in an absolute sense and which are conservative only in a relative sense.

For example, the 1:500 year flow estimate was initially derived from a shorter period of flow records. When the estimate was recalculated using a longer period of flow records, the value decreased by approximately 10%. Nevertheless the higher flow value has been carried forward in the design basis and this is referred to as being conservative. However, this approach does not take into consideration the overall uncertainty associated with either estimate, and consequently it is not possible to assess the overall conservatism of the design basis for Baker Creek.

The 1:500 year design flow is an estimate by extrapolation. As is the case with all estimates there is associated uncertainty that is typically referred to as the confidence limits of the estimate. The estimate can have a high probability of occurring within the confidence limits (e.g., 95% is a commonly used probability) but the probability of the stated design flow value actually occurring is lower, and often considerably lower. Freeboard allowances need to take this uncertainty into consideration but there is no indication in the documentation provided to date what the uncertainty of the design flow is (i.e., the width of the confidence limits) and consequently how the design basis is conservative in consideration of this uncertainty.

***Question***

1. What are the confidence limits surrounding the 1:500 year design flow for Baker Creek? Does the channel design as presented in the DAR accommodate the upper 95% confidence limit for this design flow? If not, how would the design change in order to accommodate the upper confidence limit, at what additional cost, and what implications would this design change have for potential fish habitat compensation works?

2. The development of anchor ice in the Baker Creek channel is a relatively recent occurrence but in recent years appears to occur with some consistency. Given the recently common occurrence of anchor ice, how is the inclusion of an allowance for anchor ice in the design basis in any way conservative and not just representative of current conditions?

**Reference to DAR (relevant DAR Sections)**

s. 6.9 Baker Creek

**Reference to the EA Terms of Reference**

s.3.2.5 Accidents and Malfunctions

**Summary**

An updated frequency analysis of Baker Creek peak discharges, including confidence intervals, shows that the 1:500 year value selected for channel design is conservative relative to that presented in the Developers Assessment Report (DAR), and that the associated upper 95% confidence interval flow can be accommodated by the current channel design.

Several reasons are provided to justify calling the design anchor ice allocation conservative, including neglecting thermal erosion of the ice, including adequate floodplain width in the design, and assuming extreme ice and extreme discharge in the same year. Perpetual maintenance is also a mitigating factor.

**Response 1**

The available annual maximum instantaneous discharges for Baker Creek were compiled by combining the periods of record for Environment Canada Station 07SB009 (Baker Creek near Yellowknife, 1968 to 1970 and 1972 to 1982) and Station 07SB013 (Baker Creek at Outlet of Lower

Martin Lake, 1983 to 2010). Missing values of maximum instantaneous discharges were estimated by multiplying the available maximum mean daily discharges by the mean ratio of the two (1.01). Frequency analysis software was used to determine the discharge value with the 500-year return period, as well as the associated 95% upper and lower bound confidence intervals. The analysis was performed for the period of record 1968 to 2002 (representing the analysis in the DAR) and the updated period of record 1968 to 2010 (used for design purposes). The analysis was performed using the 3 Parameter Log Normal, Generalized Extreme Value and Log Pearson Type III frequency distributions. The results of the analysis are shown in Table 1.

***Table 1 Frequency Analysis of Baker Creek 1:500 Year Maximum Instantaneous Discharges***

| Frequency Distribution | Confidence Interval | Data Period of Record | |
|---|---|---|---|
| | | 1968 to 2002 | 1968 to 2010 |
| 3-Parameter Log Normal | Upper 95% | 63.9 | 38.7 |
| | Value | 23.5 | 18.3 |
| | Lower 95% | 8.4 | 8.6 |
| Generalized Extreme Value | Upper 95% | 30.2 | 25.6 |
| | Value | 23.2 | 18.7 |
| | Lower 95% | 10.3 | 9.7 |
| Log Pearson Type III | Upper 95% | 53.8 | 32.5 |
| | Value | 27.3 | 17.7 |
| | Lower 95% | 9.7 | 8.2 |

The analysis results show that the addition of 8 additional years of data, to expand the data set to 42 years of record, reduced the estimated 1:500 year maximum instantaneous discharges and also narrowed the confidence intervals. The upper 95% confidence interval values presently range from 25.6 m3/s to 38.7 m3/s.

Yes, the channel design will accommodate the upper 95% confidence limit for the design flow. The channel design as presented in the recent Technical Session was based on the 1:500 year discharge value noted in the DAR (25.0 m3/s), rather than the updated frequency analysis, and was therefore considered conservative. The channel design also considers 2.0 m of bedfast ice accumulation and 1.0 m of freeboard in the channel. The largest upper 95% confidence interval value of 38.7 m3/s (see Table 1) can be accommodated by this channel design, within the freeboard allocation, on top of the 2.0 m bedfast ice accumulation. The lowest upper 95% confidence interval value of 25.6 m3/s (see Table 1) is approximately equal to the design value.

**Response 2**

The anchor ice allocation is conservative for many reasons, including:

- The allocation does not consider thermal erosion that would be expected (and has been observed) during spring runoff. During the spring 2010 event at Reach 7, flowing water was observed to be very effective at rapidly expanding a short pilot channel that was cut through a portion of the aufeis[1] accumulation.

- Provision of an adequate floodplain is key to managing aufeis accumulations. This is not accommodated in the existing Baker Creek Reach 3, but is provided in the closure design.

- Large ice accumulations are not expected to occur every year, so combining a large accumulation with the design flood is conservative.

- 1.0 m additional freeboard is included above the aufeis allocation and the design flood.

- Given that the site will be under perpetual maintenance, it is assumed that monitoring of spring ice conditions will be performed and appropriate mitigation responses implemented if necessary.

[1] *Aufeis* is defined as "massive surface ice formed by successive freezing of sheets of water seeping onto the ice cover from the banks, from under the ice cover, or from surface runoff." (Ashton, G.D. 1986. River and Lake Ice Engineering. Water Resources Publications, Littleton, CO, 485 p.)

ROUND TWO INFORMATION REQUEST (IR) RESPONSE

**EA No: 0809-001** **Information Request No: Review Board IR #05**

**Date Received**

December 1, 2011

**Linkage to Other IRs (from Round I)**

**Date of this Response**

February 17, 2012

**Request**

***Preamble***

The developer's response to Undertaking #2 from the October technical sessions indicated there was no explicit incorporation of climate change into the design basis for the Baker Creek remediation. The justification for this decision was detailed in Attachment 1 of the response to Undertaking #2 filed by the developer. This response makes reference to the continuing uncertainty regarding the location-specific effects on climate parameters, such as precipitation, that may accompany the more-generally agreed-upon location-specific increases in temperature that are expected to result from climate change. Predictions of future (2071-2100) precipitation in the project area are presented for two different climate models and these indicate that 13 to 27% higher annual precipitation in comparison to the 1971-2000 period.

The predicted increases in precipitation have not been incorporated into the project design because of concerns regarding the applicability of these models to adequately predict the 1971-2000 baseline conditions, with one model under-estimating annual precipitation by 4% and the other model over-estimating annual precipitation by 18%. Variances were greater when considered on a monthly basis. These results are considered to be a limitation of the large spatial scale of the models which provides poor spatial resolution. Other concerns are indicated as well leading to the decision to not explicitly incorporate predicted increases in precipitation into the project design at this time despite the generally accepted wetter conditions that will occur with the warmer temperatures as a result of the greater moisture holding capacity of warmer air.

Evapotranspiration is expected to increase as well, with both precipitation and evapotranspiration affecting watershed runoff and stream flows. Notably, the evapotranspiration predictions were not examined as critically as the precipitation predictions yet, in the absence of critical review, these losses were considered to likely cancel out any increase in precipitation that may occur.

One factor that was not examined in the analysis of climate change effects at all is the potential effect of the expected warmer conditions on the Probable Maximum Precipitation (PMP) event. The water holding capacity of air increases with temperature, as does the PMP with the result of larger storm-based rainfall events, the consequences of which are not significantly attenuated by increased evapotranspiration.

***Question***

1. Given the stated incorporation of conservatism into the design basis for the Baker Creek remediation, and notwithstanding the questionable level of conservatism associated with the stated design considerations, please clarify how the decision to not incorporate any explicit consideration of climate change into the design basis is consistent with a conservative project design that effectively manages the project risks associated with flooding from an overtopping of the Baker Creek channel.

2. Please describe how climate change is expected to affect the probable maximum precipitation for the project site.

3. Please describe how the Baker Creek channel, as designed, will handle the current and potential future probable maximum precipitation flow.

**Reference to DAR (relevant DAR Sections)**

s.9.2.2.2 Potential Climate Change Effects

**Reference to the EA Terms of Reference**

s.3.1.2 "Consideration should be given to the impact of the environment, such as the impact of extreme weather events or climate change, on the development in each of the sections of 3.2, where applicable"

s.3.3.10 "An account of how climate change predictions and observations affect the risk level in the long term based on "best estimate" and "high estimate" scenarios, including discussion of risks in light of the current climate predictions as set out in the Fourth Assessment Report of the Intergovernmental Panel on Climate Change".

**Summary**

The Giant Mine Remediation Project Team (Project Team) has not found anything to definitively indicate that 20th century climate change has resulted in increased flood discharges in northern streams, and modeling indicates that 21st century climate change may result in decreased flood discharges, as changes in other components of the hydrological cycle more than compensate for projected increases in precipitation.

The Project Team has not found any conclusive evidence that 21st century warming will necessarily increase either the Probable Maximum Precipitation (PMP) or the Probable Maximum Flood (PMF) at Baker Creek. In addition to this, the PMF is not currently used as a design criterion for Baker Creek. The critical period between completion of diversion works and the stabilization of the freeze works is expected to be on the order of 20 to 30 years, while after the completion of the freeze works, any substantial spill of surface water to the underground mine will be managed. The proponent currently plans to re-evaluate Baker Creek flood design criteria and risk of spill to the underground mine in the first quarter of 2012.

For the reasons previously stated, no future PMF case with a different flow value was modeled.

**Response 1**

Though it is acknowledged that the Canada's north has warmed through the 20th century, the Project Team is unaware of any indication that there have been significant increases in annual water yields or extreme flood events in the Mackenzie River Basin. This suggests that the hydrological cycle may be less sensitive to warming than projected by climate models. An analysis of long-term flow data by Burn and Hesch (2008) noted some increasing trends during low flow periods but no trend or decreasing trends for annual and high flow periods, including decreases during spring freshet in some watersheds. Papers by Déry and Wood (2005) and Déry et al. (2009) came to opposite conclusions from each other, first noting a decline in streamflows in northern Canada, and then noting an increase in streamflows, after adding four years to their 40-year data set.

All of these papers acknowledged the influence of low frequency climatic cycles, such as the Pacific Decadal Oscillation (PDO), Arctic Oscillation (AO) and Atlantic Multidecadal Oscillation (AMO), on the hydrological cycle. The conflicting conclusions of the two Déry papers should be viewed in light of the work of Chen and Grasby (2009), which specifically referenced Déry and Wood (2005) while cautioning against the use of data sets less than 60 years in length. The key message here is that there are papers in the literature that point to trends of wetter or drier conditions, but the Project Team is unaware of any that have sufficiently long data sets to come to firm conclusions on the hydrological trends that accompanied 20th century warming.

Qualitatively, a warming climate may result in a wetter climate. However, this does not necessarily mean that floods would be expected to increase. Baker Creek is a typical northern watershed where annual maximum flows are almost invariably the result of spring snowmelt. In only 5 of 42 years has the annual maximum flood on Baker Creek occurred after June 15, and the largest annual flood peak attributable to rainfall was only 40% of the (snowmelt) flood of record. A warmer climate would also result in a shorter period of snowmelt accumulation, a greater evaporation potential, and rainfall spread over a longer summer season. Woo et al. (2007) examined changes that could accompany the projected climate changes, and concluded:

> "The effect of scenario climate change on streamflow is explored through hydrological simulation. Example of a Canadian basin under warming scenario suggests that winter flow will increase, spring freshet dates will advance but peak flow will decline, as will summer flow due to enhanced evaporation. While this simulation was site specific, the results are qualitatively applicable to other boreal areas."

In summary, the Project Team have not found anything to definitively indicate that 20th century climate change has resulted in increased flood discharges in northern streams, and modeling indicates that 21st century climate change may result in decreased flood discharges, as changes in other components of the hydrological cycle more than compensate for projected increases in precipitation.

**Response 2**

Very little definitive guidance exists in the literature with regards to climate change effects on probable maximum precipitation (PMP).

Alberta Transportation (2004) stated:

> "It is often speculated that higher mean temperatures will be accompanied by a greater range of extremes in climatic parameters, and it is sometimes claimed that a wider range has in fact been observed. Such claims are difficult to prove on the basis of climatic and hydrologic records usually lasting only a few decades. With respect to storm precipitation in Canada, Zhang et al. (2001) state: '*For the country as a whole, there appear to be no discernible trends in extreme precipitation (either frequency or intensity) during the last century*'. Referring to the Prairie Provinces as a whole, Hopkinson (1999) states: '*For the period 1953 to 1998, there is no evidence of a significant trend in maximum persisting dew point or in precipitable water derived from upper air soundings of the atmosphere*'.
>
> With respect to PMP and PMF studies for Alberta, as of 2004 there is no solid basis for increasing estimates based on historical data in order to account for climate change. Notwithstanding an absence of local evidence, however, hydrologists should be aware of emerging scientific conclusions and be prepared to consider the possibility of climate change affecting future extremes."

For a study of extreme rainfall in Great Britain, Collier (2009) stated:

> "an interim conclusion that as the climate warms current estimates of PMP (such as those reported by for example Collier and Hardaker, 1996 and Clarke and Pike, 2007) remain valid. However, further detailed analysis is urgently needed to confirm this conclusion."

For a study of extreme rainfall in Australia, Jakob et al. (2009) stated:

> "Our assessments show that individual GCMs [General Circulation Model] do not replicate rainfall totals and spatial and temporal variability well and that there is strong disagreement between

projections from different models. These differences are mainly due the limited ability in simulating rainfall producing mechanisms such as El-Nino Southern Oscillation (ENSO) and the Australian monsoon. As a result, it is difficult to have confidence in projections of rainfall extremes."

and

"So far we can not confirm that PMP estimates will definitely increase under a changing climate."

With particular focus on the Canadian mining sector, Stratos and Brodie (2011) reiterated the latter statement of Jakob et al. (2009), while noting that climate model projections for most regions of Canada "include increases in mean precipitation and more severe and frequent intense precipitation events (ICLR 2011)." However, the projections of ICLR (2011) do not address events on the scale of the PMP.

More importantly, any effects of climate change on Baker Creek floods will manifest through the Probable Maximum Flood (PMF) rather than PMP. Projected effects of increased air temperatures on the Baker Creek watershed would be expected to at least partially mitigate any increases in rainfall. Extreme rainfall events on the scale of the PMP would be expected to happen during warmer atmospheric conditions, when lake evaporation has increased storage in the upper watershed and soil moisture has dropped from a post-snowmelt maximum. Indeed, Spence and Hosler (2007) noted that "prolonged dry periods result in Baker Creek's intermittent discharge at the outlet of Lower Martin Lake" and "by mid-summer in a dry year only the three lowest lakes in the system can be hydrologically connected to the outlet of Lower Martin Lake. This equates to only 4% of the basin area."

In summary, the Project Team has not found any conclusive evidence that 21st century warming will necessarily increase either the PMP or the PMF at Baker Creek.

In addition to this, the PMF is not currently used as a design criterion for Baker Creek. The critical period between completion of diversion works and the stabilization of the freeze works is expected to be on the order of 20 to 30 years, while after the completion of the freeze works, any substantial spill of surface water to the underground mine will be managed. The proponent currently plans to re-evaluate Baker Creek flood design criteria and risk of spill to the underground mine in the first quarter of 2012.

**Response 3**

Extreme rainfall events on the scale of the PMP would be expected to occur under summer or early autumn conditions, after anchor ice has receded. The current design for the Baker Creek diversion was modeled with the estimated PMF discharge of 200 $m^3/s$ and no allocation for anchor ice. The modeling shows that in the absence of anchor ice, the channel as designed can pass the PMF without spill to the underground mine. The only exception to this at the Highway 4 crossing in Reach 1, where the bridge fill constriction of the floodplain would cause a backwater effect and corresponding spill into the A2 Pit. Washout of the bridge fill could alleviate the constriction and backwater effect.

For the reasons previously stated, no future PMF case with a different flow value was modeled.

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**ROUND TWO INFORMATION REQUEST (IR) RESPONSE**

**EA No: 0809-001** **Information Request No: Review Board IR #06**

**Date Received**

December 1, 2011

**Linkage to Other IRs (Round II)**

Review Board IR #07
Alternatives North #04

**Linkage to Other IRs (from Round I)**

Review Board IR #19
Review Board IR #27
Alternatives North IR #07

**Date of this Response**

February 17, 2012

**Request**

***Preamble***

At the Technical Session, parties expressed concern over the idea of transferring impacts and responsibilities to an unlimited number of future generations. The Developer has committed to an independent examination of relevant emerging technology every ten years, and has committed to reviewing the project after one hundred years to determine whether it is doing what it is supposed to, and whether it is the correct approach to continue. The developer indicated that this may involve other stakeholders.

The Review Board does not require a high level of detail about these future processes, but would like a better general understanding of what these entail.

***Question***

1. Please clarify how the independent reviews of emerging technology every ten years will be conducted over the long term.

2. Please clarify if and how the hundred-year review will include other stakeholders, and, in general terms, the mechanisms that will ensure an objective review.

**Reference to DAR (relevant DAR Sections)**

s.6.2.2.4 Future Re-Consideration of Alternatives

**Reference to the EA Terms of Reference**

s.3.3 Arsenic Containment

**Summary**

A review of emergent technologies will occur every ten years following the full implementation of the Frozen Block Method and the results will be reported in the State of the Environment Report for that year. The exact details on how this will be conducted will be determined as part of the development of the Environmental Management System (EMS), however it will include an organization or similar body that will oversee this review. The review will take place using public and private organizations and all emergent technologies identified in the review will be submitted to an Independent Peer Review Panel for applicability to the Giant Mine.

Communication to future generations on the principles, objectives and values associated with the management of this Project and the selection of the remediation option will be critical to ensuring that the 100 year review is objective. The answer to Review Board Round 2 Information Request #07 helps illustrate how we plan to communicate with future generations. This review will again be addressed in the EMS, but will be further explored in future iterations of the EMS.

**Response 1**

The Giant Mine Remediation Project Team (Project Team) will review emergent technologies on a regular basis in the future. The team will look at technologies that are being used throughout the world and will remain current through national and international technical networks. Emergent technologies that are identified in such a review will be submitted to the Independent Peer Review Panel, or a similar group on a 10 year cycle for a more detailed technical examination of applicability to the specific situation at the Giant Mine.

Once the site is stabilized and remediated, there will continue to be a need for certain aspects to be managed. These include managing the site (fences, tailings ponds etc), managing and treating water, monitoring the engineered structures and site, and providing oversight of these and other ongoing site management activities (e.g. information management, sharing and preservation). An organization will most likely be established to manage these functions. The use of scientific developments and emerging technology will play a key role in enabling this organization to perform its long-term function to ensure the latest tools are applied to maintain these aspects of the site safe. It is premature to specify exactly how science and technology will be used in the future, but possibilities include support for university research, engagement of experts to prepare a state of the science and technology report, and convening workshops of experts.

In addition, some of the elements of the remediation have a definite lifespan, for example the water treatment plant will not last 100 years, it will require upgrades. Each time an upgrade is needed emergent technologies will be examined as part of the regular life cycle and maintenance of these elements. This might not occur on the 10 year cycle but will be addressed on an as required basis.

Stakeholder participation in this future organization and processes will be worked out prior to transitioning the site from remediation to long-term management. Stakeholder engagement will be key to arriving at the participation mechanisms that best suits the specific needs of the Giant Mine site.

The ten year review process will also be outlined in the EMS, which is currently being developed.

**Response 2**

As acknowledged during the October 2011Technical Sessions, the expectation that a final decision on how the Project Team is going to communicate with generations in the extremely distant future cannot be made at this point. However, how the Project Team will communicate with future generations will be addressed within the EMS, and will be re-examined with each iteration of the EMS. In addition, Review Board Round 2 Information Request #07, Question #2, illustrates the Project Team's broad plan for communication with future generations, and the Project Team will ensure that the objectives of a 100 – year review are outlined and documented. The communication of the general principles, objectives and values of the project will be integral to ensuring that future generations conduct the review in a manner that is consistent with the original selection and implementation of the remediation technology. The need for a comprehensive, objective and inclusive review will also be integrated into the instructions for this review. The future generations conducting these reviews will have their own perspectives, knowledge, and experience that will add to the independence of this review.

**ROUND TWO INFORMATION REQUEST (IR) RESPONSE**

**EA No: 0809-001** **Information Request No: Review Board IR #07**

**Date Received**

December 1, 2011

**Date of this Response**

February 17, 2012

**Request**

***Preamble***

The site will require active management, including water treatment and regular replacement of various important components, for perpetuity. The developer has indicated it would study other perpetual care sites for lessons that are applicable to the Giant Mine Remediation Project. The report of the Perpetual Care workshop identifies several other perpetual care case studies with lessons for the Giant project. At the Technical Session, parties discussed ways to communicate risks about the site and responsibilities to people in the distant future about the site, and challenges of communicating with people 5,000 or more years from present considering changes in languages and culture over such timescales. The Perpetual Care workshop examined how this communication issue is being dealt with at other perpetual care sites elsewhere.

***Question***

1. Please describe how the Giant Team has examined other perpetual care projects, what lessons have been learned, and how they will be applied to the project.

2. Please describe any approaches being considered for communication with future generations over the very long term.

**Reference to DAR (relevant DAR Sections)**

s.14.2 Long-term Environmental Monitoring

**Reference to the EA Terms of Reference**

s.3.6 Monitoring, Evaluation and Management

**Summary**

A detailed table outlining the project, communities/parties involved, the lessons learned and the relevance to the Giant Mine Remediation Project (Remediation Project) is included. In short, seven case studies with lessons learned that are relevant to Giant Mine were considered: Britannia Mine (British Columbia); Sydney Tar Ponds (Nova Scotia); Bunker Hill (Idaho); Trail Lead Task Force (British Columbia); Flambeau Mine (Wisconsin); Sullivan Mine (British Columbia); and Nuclear Waste Management Organization (Canada).

Communicating with future generations is of particular importance for projects that span across generations. The Giant Mine Remediation Project Team (Project Team) will be considering at least three ways for addressing communication with future generations: through the Government of Canada collections; through lessons learned from Aboriginal groups; and by examining other projects that also span several generations.

**Response 1**

Project Team and its Technical Advisor are constantly examining similar projects throughout North America and beyond for lessons learned. They remain current on these projects in order to be leaders in this field. The attached Table 1, *Lessons Learned from Perpetual Care Case Studies and the Relevance to the Giant Mine Project*, below, has a listing of projects reviewed which are applicable to the subject of this request, along with the lessons learned and their relevance to the Remediation Project. It was compiled by the Technical Advisor and the Project Team after reviewing the case studies discussed in the Alternatives North/Yellowknives Dene First Nation perpetual care workshop and related reports. The examples selected provide an indication of how other projects are successfully using perpetual care remediation projects to achieve both environmental protection and economic goals of proponents and communities.

**Response 2**

The Project Team understands that how it communicates with future generations will dictate the long-term success of this project. The Project Team continues to examine relevant information on how others have or intend to communicate with future generations and will continue to do so for the length of this project. Our current approach for communicating with future generations is three-fold:

- Firstly, the Project Team will ensure that all Government of Canada (GOC) key documents are added to the GOC collections/archives in electronic form and managed as such. Library and Archives Canada will ensure that they are held in appropriate electronic form and cared for accordingly to ensure that they are legible for future generations.

- Secondly, the GOC will draw upon traditional knowledge and lessons learned from aboriginal groups on the sharing and transmittal of information from generation to generation.

- Lastly, the GOC is committed to looking at examples from similar projects and nuclear waste sites to learn what they have done or are planning to do to communicate with future generations.

**Attachment**

***Table 1: Lessons Learned from Perpetual Care Case Studies and the Relevance to the Giant Mine Project***

| *Project & Location* | *Communities/Parties Involved* | *Project Information and/or Lessons Learned* | *Points Possibly Relevant to Giant Mine* |
| --- | --- | --- | --- |
| Britannia Mine, British Columbia | First Nations (esp. the Squamish Nation), local residents, landowners, external technical advisory committee,<br>Local Government (The Squamish Lillooet Regional District), regulatory agencies | • Community consultation program allowed sharing of knowledge, vision and core values. Community was made fully aware of and was involved in all aspects of the consultation and decision making processes.<br>• Involvement of the public in water treatment site selection process maintained and affirmed intention for continued community engagement.<br>• Government collaboration with a motivated landowner with a commitment to site revitalization led to development and progressive execution of a shared vision.<br>• Provide multiple means for people to access information about the project and a means for providing updates.<br>• Creating clear ways for engaging local first nations as active partners in site remediation and long-term care. | Vision:<br>• Demonstrates what is possible when government and community engage to identify a shared vision, make clear commitments, and develop a sound strategy to revitalize and remediate a site requiring perpetual water treatment.<br>Ongoing Engagement:<br>• Ongoing input and consultation from technical advisory committee.<br>• The government worked closely with the landowner to redevelop the existing residential areas providing new economic stimulus for locality.<br>Monitoring:<br>• Transparency is possible in reporting monitoring data.<br>• Water monitoring data is updated every 5 minutes and is available on the website.<br>• Quarterly Monitoring Report and Monthly Progress Report available to the public<br>*References:*<br>http://www.al.gov.bc.ca/clad/britannia/ |
| Sydney Tar Ponds, Nova Scotia | Unama'ki<br>Residents of Cape Breton, NS,<br>Government of Canada,<br>Government of Nova Scotia<br>Cape Breton Development Corporation | • A clear and consistent framework enables decisions to be made with engagement of key parties at all stages of the process. A flow chart of interaction and engagement aided the process.<br>• Sensitive ecological systems can be protected with implementation of a sound technical plan and requisite monitoring and reporting.<br>• Demonstrated public accountability supports continuing collaboration for perpetual projects.<br>• A remedial objectives guidance document identifies targets to be achieved and sets forth metrics by which various parties can be held accountable.<br>• A legacy optimization approach helped various parties identify shared values and goals for the site.<br>• An Aboriginal Set Aside program specifying the nature of First Nations participation and engagement in overall remediation activities and project administration promoted greater collaboration among various parties. This translated into increased opportunities for aboriginal owned businesses required to meet established performance criteria and led to increased training and employment opportunities for employees of these businesses. | Vision:<br>• A clear plan, with appropriate funding and a means of effective implementation can be successful.<br>• The team responsible for execution/implementation of various aspects of the plan must be qualified to do so and held accountable for updates and delivery of results.<br>Ongoing Engagement:<br>• First Nations communities and local residents form a Remedial Objectives Advisory Committee to oversee the development of remediation plan.<br>• Clear identification of responsible parties, and metrics by which achievements of objectives will be measured.<br>Monitoring:<br>• Use of a risk-based methodology provides guidance on development of site-specific target levels.<br>• Reliability, consistency, frequency of reporting and access to data are provided.<br>• Screening criteria for water, sediment, and soil made clear.<br>*References:*<br>http://www.imwa.info/docs/imwa_2010/IMWA2010_Campbell_545.pdf; http://www.tarpondscleanup.ca/; http://en.wikipedia.org/wiki/Sydney_Tar_Ponds; http://www.unamaki.ca/ |
| Bunker Hill, Kellogg, Idaho | Local residents, the Tribe, the State and Kootenai, Benewah and the Shoshone counties | • Creation of the Basin Environmental Improvement Project Commission to serve as a "coordinating body" for site remediation provided opportunities for collaboration and local involvement in site remediation. The Commission meets quarterly and meetings are open to the public and include opportunities for public comment.<br>• Frameworks providing clear lines of communication among interested parties are essential for project success. Transparent frameworks indicating how various parties will work together, make decisions, implement action, and receive appropriate funding are essential.<br>• Recognition that sites requiring perpetual monitoring and care require strong relationships between partners who share a common goal. | Vision:<br>• The EPA (U.S. federal regulatory agency for Environmental Protection) was identified as the accountable party for remediation and encouraged active involvement by all interested parties.<br>• Clear community involvement plan was created.<br>Ongoing Engagement:<br>• Progress of mine closure cleanup is available for the public to review online.<br>• Every 5 years a comprehensive site-wide review is completed with representatives from all parties having a vested interest in the success of the project participating. A 2-month |

| Project & Location | Communities/Parties Involved | Project Information and/or Lessons Learned | Points Possibly Relevant to Giant Mine |
|---|---|---|---|
| | | | period for public comment is also provided once report findings have been issued.<br>Monitoring:<br>• Quarterly bulletins were issued providing a review of cleanup activities on identified compliance targets.<br>*References:*<br>*http://yosemite.epa.gov/R10/CLEANUP.NSF/46453efc0be3985c88256d140050c1ac/0aa63d9677f0a58388256d1a007fac6f/$FILE/Bunker%20Hill%20fs%2011-21-05%20.pdf* |
| Trail Lead Task Force, Trail, BC | Residents of Trail and Rivervale, Local School District, United Steel Workers of America, Provincial and Municipal Governments, Environmental groups, Teck (Cominco, Ltd.) | • A comprehensive, integrated and funded plan developed by interested parties and executed by clearly identifiable and responsible parties has the ability to achieve identified goals and set continuing goals.<br>• The TLTF identified a framework for reporting information out and through which decisions could be made.<br>• The Task Force was structured to be representative of all interested parties and provided a mechanism for its own periodic renewal to facilitate continued community engagement and response.<br>• The framework provided metrics to evaluate the success of measures that had been taken and to propose new.<br>• The Task Force that developed the plans was able to transform itself into a long-term oversight body, the Trail Area Health & Environment Program. | Vision:<br>• Created in 1990, the Trail Lead Task Force (TLTF) was founded to respond to a 1989 report identifying continuing elevated blood lead levels in a significant number of the children in Trail, BC.<br>• The Lead Program (hereafter the Program) was the operational arm of the TLTF. The BC Ministry of Environment, the Ministry of Health, Teck, and the City of Trail shared funding for the program.<br>• The Program is designed to safeguard health and the environment related to smelter metals under five main categories – Family Health, Air Quality, Home & Garden, Park & Wildlands and Property Development.<br>Ongoing Engagement:<br>• The TLTF targeted community education, case management, investigations into exposure pathways, intervention programs, and setting goals for continued improvement and providing a mechanism for options evaluation by residents and members of the general public. The TLTF has become the Trail Health and Environment Committee, which consists of representatives of all interested parties including 5 citizen members-at-large. Meetings are open to the public and the media and are held 4 or 5 times a year.<br>• Monitoring and reporting continues under the Trail Area Health & Environment Program which communicates progress via a website and a bi-annual newsletter that is distributed to each household in Trail and Rivervale.<br>Monitoring:<br>• BC Ministry of Environment oversees Teck's emissions reduction and air quality monitoring program.<br>• Interior Health Services provides blood lead testing and family health services.<br>• Teck pays for a contractor to provide home renovation support and a garden soils program.<br>*References:*<br>*www.thec.ca; www.thep.ca; http://www.thec.ca/reports/tffinalreport.pdf; http://thec.ca/thep/assets/docs/thep-factsheet-howtheprogramworks.pdf* |
| Flambeau Mine, Ladysmith, Wisconsin | Local communities, State and Federal Regulatory agencies, Kennecott Minerals | • Creation of a formal three-party Local Agreement (Mine, Local & Regulatory) to address economic, environmental, and social considerations created the basis for the working relationship, accountability, and transparency.<br>• Agreement specified protection of identified important resources (e.g. the Flambeau River), the percentage of locals to be included on workforce, creation and operation of a visitor center, regular means of information distribution, protection of potable water sources, and compensation for loss in property value associated with mining activity. | Vision:<br>• Adoption of and focusing of all activities on the motto "Promises Made, Promises Kept."<br>• At closure, 32 acres of the site were set aside for commercial development, 130 acres of diverse prairie ecosystem were created as well as 10 acres of wetlands, and 4 miles of public conservation and equestrian trails.<br>• The local community gained a $1.3 million library, $30,000 playground and an annual scholarship program.<br>• Demonstrated commitments to community longevity and sustainability were included in closure planning, implementation and ongoing reporting. |

| *Project & Location* | *Communities/Parties Involved* | *Project Information and/or Lessons Learned* | *Points Possibly Relevant to Giant Mine* |
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| | | | Ongoing Engagement:<br>• Flambeau High School students planted native tress, grasses, forbs and wetland plants to create diverse wildlife habitats.<br>• Regularly updated website with ongoing news about the site including information about reclamation, site video, discussion about how the Flambeau River is being protected, updates on the local economy, and information on groundwater quality.<br>Monitoring:<br>• Ongoing monitoring and reporting on surface and groundwater monitoring. All data and reports are available at the project website.<br>*References:*<br>*http://www.flambeaumine.com/;*<br>*http://www.anthonyhodge.ca/publications/Post_Mining_Regeneration.pdf; Department of Natural Resources. Local Decisions in Metallic Mining Projects.*<br>*http://dnr.wi.gov/org/aw/wm/mining/metallic/infosheets/loc-dec.pdf*. |
| Sullivan Mine, Kimberley, BC | Secwepemc, Government of BC, Teck | • Implementation of reclamation plans is aided by creation and maintenance of strong relationships between those responsible for implementing closure plans and neighboring communities.<br>• Transparency, commitment, and accountability must be demonstrated in tangible ways and are either reinforced or eroded with performance over time.<br>• Government policies (like decisions to close major medical service centers) can have a large impact on the long-term economic viability of neighboring localities. This lies outside of the realm of provisions made by private entities and suggests that attention be paid to other factor impacting overall post-closure viability of localities. | Vision:<br>• In 1990, ten years prior to closure, the Sullivan Mine Public Liaison Committee (SMPLC) was "established to ensure that community concerns were heard and that environmental issues were managed in consultation with the local government, the community, and NGOs in a transparent process."[1]<br>• At closure, the mine operator sought to build on the social capital created during mine operations that included significant infrastructure development in the City of Kimberley.<br>Ongoing Engagement:<br>• The SMPLC is chaired by a government official, and provides a forum where people can receive information about Teck Cominco's plans, make comments, and reach decisions by consensus on the best way forward.<br>Monitoring:<br>• Site water quality monitoring continues and is reported to the mine operator who reports on a scheduled basis to the BC Ministry of Environment.<br>*References:*<br>[1]Hodge, R.A. and Killam R. G. 2003. Post-Mining Regeneration Best Practice Review: North American Perspective.<br>http://www.anthonyhodge.ca/publications/Post_Mining_Regeneration.pdf;<br>http://www.teckcominco.com;<br>*http://siteresources.worldbank.org/INTOGMC/Resources/notoverwhenover.pdf* |
| Nuclear Waste Management Organization, Toronto, Ontario | Ontario Power Generation, NB Power, Quebec Hydro, AECL, and a growing number (8 at the moment) of communities exploring the possibility of hosting the deep storage facility | • NWMO's mission is enshrined in the *Nuclear Waste Fund Act* (NRCan) which requires that NWMO recommend to the GoC options for managing used nuclear fuel and that member companies establish segregated funds to finance long-term costs.<br>• An approved governance structure: President reports to a Board of Directors (current or former senior representatives from the member companies or academic members) with an Advisory Council of senior representatives from academia, NGOs, Aboriginal and community organizations, is important.<br>• Clearly articulated Values: Integrity, Excellence, Engagement, Accountability and Transparency, and a Transparency Policy which specifies what will be made available publicly: Work Program Documents, Governing Documents and Corporate Reports, Minutes of Board of Directors' meetings, and Records of Discussion of Advisory Council meetings, are important governance documents.<br>• Aboriginal and Municipal engagement are very important. An Aboriginal Policy, which focuses on the importance of participation, knowledge, mutual trust and safety of the land today and in | Vision:<br>• NWMO has adopted a long-term vision of its mandate; for example, plans show the actual deep disposal facility being built 100 years or more in the future. As well, the approach being pursued, Adaptive Phased Management, recognizes that science and technology, as well as social values, will continue to evolve and offer new possibilities in the future. However, at any one time, appropriate action is planned to ensure the ongoing safe management of used nuclear fuel.<br>• The establishment of segregated funds to finance future requirements shows a commitment to intergenerational equity.<br>Ongoing Engagement:<br>• Engagement with Aboriginal, municipal and other communities across Canada is very prominent in NWMO's activities and will continue into the future. As communities learn more about what can be a highly technical, safe approach to manage Canada's used nuclear fuel, including the significant economic opportunities that come with being a |

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| | | the long term, has been adopted.<br>• Aboriginal engagement via an Elders Forum and Nigani, an Aboriginal Working Group is grounded on a mission statement of: "To protect and preserve all creation: air, land, fire, water, plants, medicines, animals and humankind – guided by the seven universal teachings of love, trust, sharing, honesty, humility, respect and wisdom."<br>• An Adaptive Phased Management approach is appropriate for the perpetual care of used nuclear fuel in Canada. The following quote summarizes the basis for the approach: "What we can do is plan for the foreseeable future, act responsibly and confidently with the best science and technology in hand. What we must not do is pretend that we have all the answers for all time. A measure of humility will be essential as we move cautiously but surely toward the goal one step at a time." | host community for the deep geological repository, many communities are coming forward as potential hosts.<br>Monitoring:<br>• The deep geological repository will be designed so that the used fuel can be retrieved if necessary at a future date (e.g. for reprocessing). Monitoring of conditions of the stored used fuel as well as of the repository and surrounding environment have been identified as priority areas and will figure prominently in future design and implementation phases.<br>*References:*<br>http://www.nwmo.ca/home?language=en_CA |